POLAR 2018

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Abstract Proceedings

Open Science Conference

19 – 23 June 2018

Davos, Switzerland

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Table of contents

AA-1a - Astrophysics and Astronomy in the Polar Regions
19.06.2018 09:00-10:30, A Studio

1272
A 76 Day Period G-M Eclipsing Binary Discovered from Dome C, Antarctica

Nicolas Crouzet[1] (ncrouzet@iac.es), Djamel Mékarnia[2], Daniel Bayliss[3], Tristan Guillot[2], Lyu Abe[2], Abdelkrim Agabi[2], Yan Fanteï-Caujolle[2], Michaël Gillon[4], Laetitia Delrez[5], George Zhou[6], Jean-Pierre Rivet[2], Eric Chapellier[2], François-Xavier Schmider[2], Ivan Gonçalves[2], Jean-Baptiste Daban[7], Carole Gouvret[2], Eric Aristidi[2], Thomas Fruth[8], Anders Erikson[8], Heike Rauer[8], Erick Bondoux[2], Zalpha Challita[9], Cyprien Pouzenc[10], Emmanuel Jehin[4], François Fressin[6], Franck Valbousquet[11], Alain Blazit[2], Serge Bonhomme[2], Jérôme Gerakis[2], Guillaume Bouchez[12]
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M dwarfs account for 75% of stars in the Milky Way. However, their properties are not well understood and significant discrepancies exist between model predictions and observations. Low mass stars in detached eclipsing binaries are the most valuable objects to study because their radius, mass, and temperature can be measured. The vast majority of systems that have been characterized to date have short orbital periods (< 10 days), yielding a strong coupling between both stars. Sampling a larger parameter space is mandatory to explore the observed discrepancies. The four month continuous night during the Antarctic winter combined with excellent weather conditions is favourable to the detection of variable objects including with long periods. We observed a field centred on the celestial South Pole during four winters with the ASTEP South instrument, a 10 cm refractor in a thermalised box installed at Dome C, Antarctica, and we detected a 76 day period G-M eclipsing binary, among other objects. In this talk, we present this discovery, the follow-up observations of this object, and we investigate the properties of the M dwarf. At such a long orbital period, both stars are largely decoupled making this system a unique benchmark for the study of low mass stars. We also present some results about the characterization of Dome C for photometry in the visible.

1376
Pulsations and Planetary Transit Events of Beta Pictoris as Observed by ASTEP

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We present results of high-precision photometric observations of Beta Pictoris achieved during the 2017 and 2018 Antarctic polar campaigns, using the ASTEP-400 telescope installed at Dome C, in Antarctica. These observations, only focused on Beta Pictoris, enabled us to characterize the delta scuti pulsations of the star, by detecting 31 pulsation frequencies among which 28 are new, and to investigate the transit of the Hill sphere of its planet Beta Pictoris b.
Furthermore, because of its location in Antarctica, ASTEP is ideally suited to monitor stars with declination below -30°. In this talk, we will also present ASTEP+, the proposed ASTEP successor, designed to make the instrument fully robotic and able to get higher accuracy photometry, by minimising any turbulence along the optical path. ASTEP+, will be operational in 2019. It will observe stars with exoplanets detected in radial velocimetry to check for possible planetary transits, confirmed transiting planetary systems to characterize them, and generally any target of opportunity that is of high scientific interest. ASTEP+ will also follow up the southern hemisphere planet candidates to be discovered by NASA/TESS space mission.

761
Exoplanets in the Antarctic Sky

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While the space based exoplanet survey projects (e.g. Kepler) have achieved great success, there is still valuable exoplanetary science that can be done from the ground. This is especially important at some unique sites. Dome A, the highest point of the Antarctic plateau, is one of these sites. In 2008, China established a scientific site at Dome A. Now, in a significant collaboration with Australian astronomers, a large survey project has been ongoing there for several years. This is the Antarctic Survey Telescope (AST3) project, consisting of three 0.5m telescopes located at Dome A. The exoplanet searching program is one of the two major scientific aims of AST3. I will briefly outline this project and introduce the progress of the exoplanet survey in details. It will cover the exoplanet scientific goals, instruments, designs of survey strategy, data reduction pipeline and exoplanet candidates we found within TESS's Southern Continuous Viewing Zone.

503
Optical Observations of LIGO Source GW 170817 by the ASTs at Dome A, Antarctica

Lei Hu[1,2,3], Xuefeng Wu[1,2,3], Igor Andreoni[4,5], Michael C. B. Ashley[6], Jeff Cooke[4], Xiangqun Cui[2,7], Fujia Du[7], Zigao Dai[8], Bozhong Gu[7], Yi Hu[2,9], Haiping Lu[7], Xiaoyan Li[7], Zhengyang Li[7], Ensi Liang[8], Liangduan Liu[8], Bin Ma[9], Zhaohui Shang[2,9,10], Tianrui Sun[1,2,11], Nicholas B. Suntzeff[12], Charling Tao[13,14], Syed A. Uddin[1,2], Lifan Wang[1,2,12], Xiaofeng Wang[14], Haikun Wen[7], Di Xiao[8], Jin Xu[7], Shihai Yang[7], Xiangyan Yuan[7], Peng Jiang[15] (jiangpeng@pric.org.cn), Hongyan Zhou[15], Huigen Yang[15], Hui Zhang[8], Jilin Zhou[8], Zonghong Zhu[16,17]
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The LIGO detection of gravitational waves (GW) from merging black holes in 2015 marked the beginning of a new era in observational astronomy. The detection of an electromagnetic signal from a GW source is the critical next step to explore in detail the physics involved. The Antarctic Survey Telescopes (AST3), deployed at the Chinese Antarctic Kunlun Station, is uniquely situated for rapid response time-domain astronomy with its continuous night-time coverage during the winter. We report optical observations of the GW source (GW 170817) in the nearby galaxy NGC 4993 using AST3. The data show a rapidly fading transient at around 1 day after the GW trigger, with the i-band magnitude declining from 17.23±0.13 magnitude to 17.72±0.09 magnitude in ∼1.8 hour. The brightness and time evolution of the optical transient associated with GW 170817 are broadly consistent with the predictions of models involving merging binary neutron stars. We infer from our data that the merging process ejected about $\sim 10^{-2}$ solar mass of radioactive material at a speed of up to 30% the speed of light.

849
Measuring Atmospheric Turbulence at Dome A, Antarctica with AST3

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Dome A, Antarctica is expected to have excellent seeing, however, there has not been direct night seeing measurement yet, because DIMM is hard to be operated at Dome A automatically. Alternatively, we have attempted to measure seeing with the second Antarctic Survey Telescope (AST3-2). During CCD frame transfer, a bright star generates a visible trail along the readout direction, whose random motions can be utilized to derive seeing. When AST3-2 was tested in China, we compared this method with DIMM and found they agreed moderately. However, this method is biased by telescope vibration. Our new method utilizes the differential motion between a pair of stars. Benefiting from its wide field-of-view and adequately large aperture, AST3-2 is able to capture multi stars even in a 10 ms exposure. Since the two light beams (i.e. air beams)from the two stars to telescope have increasing distances with height, unlike DIMM, these image motions do not correspond to seeing directly, but instead reflect C_n^2 profile. In 2017, we have selected optimized fields with many bright stars, and taken continuous short exposures from 5 ms to 100 ms. There are a dozen of stars with separations from 0.1 deg to 2 deg. The rms of the differential motions has a typical values of ~ 0".1 at the separation of 0.1 deg and it increases with separation linearly in most cases. We infer the turbulence properties from this and show that Dome A is a superb site.

1939
Meteorological Data from KLAWS-2G for Site Testing at Dome A, Antarctica

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We built the second generation Kunlun Automated Weather Station for monitoring astronomical site at Dome A as well as for operation support of AST3 telescope. KLAWS-2G has 11 temperature sensors and 7 anemometers in different elevations, 1 humidity sensor and 1 barometer, which are mounted on a 15-meter-tall mast. It was installed by the traverse team to Dome A in early 2015 during the 31st CHINARE. From then on, it survived the extremely cold polar winter and continuously worked for more than one and half years. KLAWS-2G has been maintained by the traverse team of the 33rd CHINARE, and now the sensors below 4m are still working properly. By analyzing the data from KLAWS-2G, we find that a strong and lasting long time temperature inversion and stable atmosphere existed at all heights for most of the time in 2015 and 2016, confirming our finding for 2011 data from KL-AWS (Hu et al. 2014). The monthly wind speeds are 3-5 m/s. Strong temperature inversion and moderate wind speed suggest that Dome A should have a very shallow boundary layer above which we could obtain supreme free atmosphere seeing. All the data from KLAWS-2G can be viewed in real-time on http://aag.bao.ac.cn/klaws/.

OS-6a - Polar Ocean Dynamics
19.06.2018 09:00-10:30, A Forum

986
Southern Ocean Air-sea Fluxes: An Overview and Contrasts with the Arctic

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The Southern Ocean is a key component of the global climate system: insulating the Antarctic polar region, transferring climate signals and forming the southern component of the global overturning circulation. However, the air-sea fluxes that drive these processes are severely under-observed due to the harsh and remote location. This paucity of reference observations has resulted in large uncertainties in ship-based, numerical weather prediction, satellite and derived flux products. Here, recent and ongoing analyses of Southern Ocean observations from air-sea flux moorings, research ships, atmospheric reanalyses and high resolution coupled climate models will be reviewed. The moorings provide the first accurate near-annual quantifications of the cycle of net air-sea heat exchange and wind stress from Southern Ocean locations. They reveal a strong degree of variability in the net heat flux and are key reference points for addressing the high level of uncertainty that currently exists in Southern Ocean air-sea flux datasets. The reanalysis and coupled model output enables these results to be put in a wider context and the dependence of the air-sea exchanges on atmospheric modes of variability to be explored. Finally, Southern Ocean air-sea interaction will be contrasted with the regime that prevails in the Arctic Ocean with a focus on differences between the dominant terms in the surface heat budget and potential common causes for extreme heat loss events.

2524
PIPERS: Ocean Observations during an Anomalous Autumn-winter in the Ross Sea

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There are very few ocean observations during autumn-winter south of the Antarctic ice edge, particularly as far south as the coastal polynyas. In the Ross Sea alone, we know of only three prior autumn-winter U.S. oceanographic expeditions. In 2017 the PIPERS (Polynyas, Ice Production and seasonal Evolution in the Ross Sea) project conducted an oceanographic expedition to the southwestern Ross Sea aboard the RVIB Palmer during April-June. Its main objective was to assess the local/large-scale controls on sea ice production, water mass transformation, and carbon/trace metal inventories during an autumn-winter transition. In contrast to the strong positive sea ice trends observed over 1979-2015, the PIPERS ocean observations were acquired prior to, and during, very anomalous air-sea-ice conditions in the Ross Sea. These hydrographic observations extended from north of the ice edge, to the advancing ice edge, and along south/north transects to/from the coastal polynyas under an anomalously thin ice cover. Extensive observations were collected in Terra Nova Bay before/after several strong katabatic wind events, as well as in front of the Ross Ice Shelf under milder katabatic conditions. These ocean observations (water mass types, mixed layer evolution, heat/salt inventories) will be discussed within the context of the anomalous air-sea-ice conditions that occurred prior to and during PIPERS, as well as to the few autumn-winter ocean observations available for the Ross Sea.

1433
Ocean Forcing of Pine Island Glacier Melt Rate on Weekly to Monthly Time Scales

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Ocean-driven basal melting of Amundsen Sea ice shelves has forced significant acceleration, thinning, and grounding line retreat on many of West Antarctica's largest outlet glaciers. Here, we present a year-long (2014) time series of basal melt rate at daily resolution from a single location on Pine Island Ice Shelf, and determine the drivers behind the observed variability. Dynamical adjustment of the thermocline to local wind forcing is proposed as the dominant control on basal melting at weekly to monthly time scales, and the temporal variability in the basal melt rate appears to be representative of variability in the basal melt rate over a much wider geographical area. In other years the impact of local wind forcing on thermocline height variability is more limited, highlighting the various time scales of, and the intricate interplay between, the different processes that ultimately set the basal melt rate beneath Pine Island Ice Shelf.

2246
Using Noble Gases to Show Upper Ocean Glacial Meltwater in the Amundsen Sea

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Pine Island Ice Shelf, in the Amundsen Sea, is a region of high ocean-driven basal melting. Tracing the glacial meltwater it produces can help identify the regions most affected by the increased input of this freshwater. Here, optimum multi-parameter analysis is used to deduce glacial meltwater content from independent water mass tracers (hydrographic observations, noble gases and oxygen isotopes), collected during a ship-based campaign in the eastern Amundsen Sea in February-March 2014. Noble gases (neon, argon, krypton and xenon) are used to trace the glacial meltwater, and the results are compared to the standard hydrographic meltwater signature. Differences between the water mass analyses of up to 4 per mil glacial meltwater content are observed, and associated with the erosion of the hydrographic Winter Water properties by the meltwater. The noble gases are used to improve the hydrographic method, by simulating a 'pure' Winter Water endpoint. Remaining differences between analyses can be used to show upper ocean processes such as mixing and biological activity. The corrected glacial meltwater content values show a persistent signature in the upper 400 m of the water column across all of the sample locations (up to 500 km from Pine Island Ice Shelf), with increased concentration towards the west along the coastline.

1080
Convection in the Southern Ocean - What Controls it?

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Open ocean convection ("convection") in the Southern Ocean is rare phenomena. Despite its re-occurrence in the last years it was not present for roughly 40 years. However, coupled and forced simulations show an occurrence of these events in the Southern Ocean on various time and spatial scales with drastic implications for sea ice and heat content. We present results of an extensive sensitivity study of non-eddy resolving and eddy permitting global forced simulations. The sensitivity studies consider changes in the surface freshwater forcing, heat content management of Circumpolar Deep Water, vertical mixing and surface heat flux variations, as well as the parameterisation of mesoscale eddies. Results show that freshwater forcing affects directly surface stratification and thus the occurrence and intensity of convection. It will be demonstrated that brine rejection as a consequence of sea ice growth and thus stratification during winter season is a potential critical trigger for convection. Furthermore, we will show that increased vertical mixing leads to postponed onset of deep convection but not to a reduction as other studies have suggested. Mesoscale eddies reduce convection, since they tend increase the surface stratification.

386

Preconditioning of the Weddell Sea Polynya by the Ocean Mesoscale and Overflows

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The Weddell Sea polynya is a large opening in the open-ocean sea ice cover associated with intense deep convection in the ocean. A necessary condition to form and maintain a polynya is the presence of a strong subsurface heat reservoir. This study investigates the processes that control the stratification and hence the buildup of the subsurface heat reservoir in the Weddell Sea. To do so, a climate model run for 200 years under preindustrial forcing with two eddying resolutions in the ocean (0.25° CM2.5 and 0.10° CM2.6) is investigated. Over the course of the simulation, CM2.6 develops two polynyas in the Weddell Sea, while CM2.5 exhibits quasi-continuous deep convection but no polynyas, exemplifying that deep convection is not a sufficient condition for a polynya to occur. CM2.5 features a weaker subsurface heat reservoir than CM2.6 owing to weak stratification associated with episodes of gravitational instability and enhanced vertical mixing of heat, resulting in an erosion of the reservoir. In contrast, in CM2.6, the water column is more stably stratified, allowing the subsurface heat reservoir to build up. The enhanced stratification in CM2.6 arises from its refined horizontal grid spacing and resolution of topography, which allows, in particular, a better representation of the restratifying effect by transient mesoscale eddies and of the overflows of dense waters along the continental slope.

BE-1a - From boots to bytes: 'omics' tools for microbial diversity and biogeography
19.06.2018 09:00-10:30, A Dischma

2140
Some Like it Hot: Metagenomics of an Isolated Antarctic Geothermal Refugium

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Geothermal systems in Antarctica support a diverse microbiota and may have served as essential refugia for terrestrial organisms during periodic glacial maxima. As the most remote geothermal environments on the planet, they provide a rare opportunity to address questions around microbial biogeography and the interactions between globally distributed and endemic microbes. Despite their biological importance, these extremely remote geothermal locations remain vastly understudied. Tramway Ridge, an Antarctic specially protected geothermal area (ASPA 175 - elevation 3340 m), located near the summit of Mount Erebus, is home to a unique and poorly understood community of micro-organisms. Here we provide the first metagenomic characterization of high-temperature fumarolic sediments, and the first from terrestrial Antarctica. We recovered 17 nearly complete genomes, representing 11 prokaryotic phyla/divisions to infer their role in the environment. Our results demonstrate that the subsurface of Tramway Ridge on Mount Erebus is dominated by novel, possibly endemic deep-branching members of several bacterial phyla, and a single deep branching relative of the Thaumarchaeota. Based on its phylogenetic position and novel functional attributes we propose Candidatus *Austellarchaeum erebusii* to help infer the defining characteristics of the earliest Thaumarchaeota.

2256
Dynamics of Microbial Community Succession in Polar Deglaciated Forefields

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Melting glaciers in polar regions are indicators of global warming. A key consequence of the gradual ice retreat is that new terrestrial habitats are created as recently exposed soils and rocks are susceptible to biological colonization. Microorganisms are the first colonizers and subsequently vascular plants and cryptogams establish. Thus, glacier forefields offer a type of natural experiment in which temporal colonization dynamics can be explored.
In this study, chronosequences at Breiðamerkurjökull (Iceland) and Hurd (Livingston Island, Antarctica) glaciers were used as a comparative framework to examine microbial forefield colonization dynamics in both polar regions. By high-throughput amplicon sequencing of fungal and bacterial communities combined with scanning electron microscopy, we identifed microbial colonizers at different successional stages and assessed the specific colonization features of polar deglaciated areas.
Microbial community structure in recently uncovered soils and rocks (close to the glacier front) differed considerably from the components found in later successional stages with cryptogam covers. Similar succession patterns were detected for soil microbial communities along both glacier forefields. However, different colonization strategies were shown by lithobiontic communities in each polar region, as the extent of colonization was determined both by exposure time and by the textural features of the rocks.

2419
Cyanobacterial Diversity from Pole to Pole: Metagenome of Arctic and Antarctic

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Cyanobacteria are the most ancient and widespread group of photosynthetic prokaryotes, which had a major role in the evolution of the plant kingdom and Earth's atmosphere. They are primary producers in a wide variety of habitats, and are able to thrive in harsh environments. In this study, metagenomic approach was used to determine the diversity of cyanobacteria in soil samples collected from selected areas of Antarctica (Browning Peninsula, Dee Island, Greenwich Island and Reeve Hills) and Arctic (Spitsbergen, Kvartsitsletta and Baranowski Polar Station). DNA was extracted using Mo-Bio Powersoil DNA kit and the genomic DNA was sequenced using illumina, Miseq with targeted V3 and V4 regions. The reads were then processed using Qiime with at least 97% similarity. East Antarctica (Browning Peninsular and Reeve Hills) recorded nine species of cyanobacteria and west Antarctica (Dee Island and Greenwich Island) recorded seven species. The Arctic recorded the least numbers of species; five in the east sampling localities (Kvartsittsletta and Polar Station Baranowski). *Nostoc* sp., *Leptolyngbya* sp. and *Pseudanabaena* sp. were dominant in all Arctic and Antarctic samples. The cyanobacterial diversity in Antarctica was higher than the Arctic. Thus, metagenomic is important as a reliable tool to study the cyanobacteria diversity in soils.
Keywords: Cyanobacteria, Antarctic, Arctic, poles, sequencing, metagenomics.

1567
Biogeography of Cyanobacteria in Antarctic Mats and Implication for Conservation

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On the Antarctic continent, cyanobacterial mats are widespread in the lacustrine biotopes and they often dominate the phototrophic biomass. Their diversity and biogeography are poorly understood because most studies cover a limited geographic area or are based only on morphotypes. Therefore, cyanobacteria are not fully taken into account in the biological datasets used to delineate conservation biogeographic regions (ACBRs). Recently, we have shown by 454 pyrosequencing of cyanobacteria-specific 16S rRNA amplicons that their distribution across the lacustrine ecosystems could be explained by ecological parameters (e.g. salinity and dissolved organic carbon). In order to further test this hypothesis, we significantly increased the spatial coverage of our samples. Here, we describe the results of 16S rRNA amplicons Illumina sequencing of 98 cyanobacterial mat samples from 10 ACBRs. From the 16012393 raw reads, 713 OTUs were obtained by bioinformatics analysis. Preliminary results show that both ecological parameters and latitude could explain the patterns of cyanobacterial communities. Indeed, nonmetric multidimensional scaling shows that sub-Antarctic samples (Macquarie and Marion Islands) group with North-East Antarctic Peninsula samples, whereas more continental samples (e.g. East Antarctica, South Victoria Land) group together. These findings can form the basis for a better understanding and a more adequate conservation of lacustrine ecosystems in Antarctica.

90
Did Antarctic Lichens Originate in, or Arrive to, Antarctica?

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Lichens represent a paradigm of mutualism between two or more phylogenetically unrelated organisms involving an heterotrophic fungus, also called the mycobiont, and a population of at least one photosynthetic partner, either a green alga or cyanobacterium. About 500 lichens (ca. 2.5% of all known species worldwide) occur in Antarctica and reach as far as 84º S. They constitute the most conspicuous component of terrestrial macrobiota. Biogeographic evidence shows that about 38% of the current lichen diversity is shared with the Arctic and Sub-Arctic regions (bipolar distribution). Long-distance dispersion has been commonly invoked to explain this disjunct distribution pattern, but it is still unknown whether those species originated in or arrived to Antarctica. Similarly, the proportion of endemic Antarctic lichens is considerable (ca. 33%); several authors have suggested that these lichens have an ancient origin which pre-dates the last glaciations, implicating that these species may have taken refuge in ice-free areas. So far however, no studies have formally tested hypotheses modelling allele evolution in space and time in bipolar and endemic Antarctic species. Herein, through phylogeography analyses (including genetic clustering, divergence time estimation and gene flow inference), we provide evidence for the colonization of Antarctica in the Pleistocene by some bipolar species, and point to endemics as long-term inhabitants of this continent.

1148
Microbial Biogeography in Arctic Soils

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With a relatively low number of studies investigating microbial diversity in pristine Arctic soils and different analytical approaches used in each, the identification of microbial biogeographical patterns across the region remains difficult. Currently, differences in microbial communities are generally described on small scales, however, whether these are true ecological difference or merely methodological variations remains to be properly investigated. Furthermore, few studies have shown an absence of large-scale variation while other studies suggest regional differences. Using a small scale, mid-scale and pan-Arctic soil sampling design, we aimed to investigate the level of sampling required to understand terrestrial spatial patterns of microbial diversity across the Arctic.
We analysed core physico-chemical properties of sampled soils, used amplicon-sequencing and geostatistics to investigate biodiversity, diversity hotspots and to understand the potential drivers of microbial diversity in Arctic terrestrial ecosystems.
We identified microbial biogeographical patterns on different scales, with distinct Arctic regions harbouring different microbial communities. Alaska and Canada appear to support different communities than the European Arctic and Siberia. Identifying biogeographical patterns is a step towards a better understanding of microbial diversity and its drivers in the Arctic region.

OS-1 - The acoustic environment of the polar oceans: exploring polar soundscapes 19.06.2018 09:00-10:30, A Sertig

1311
The Soundscape of Western Fram Strait - A Key Habitat for Endemic Arctic Cetaceans

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Global warming and concomitant reductions in sea ice will affect the underwater soundscape of the Arctic, with the greatest changes expected to be linked to anthropogenic activities. Ocean noise is a growing conservation concern, but management of underwater noise pollution is constrained by a lack of baseline data. To address this concern, and to document area use by marine mammals, an acoustic recorder has been deployed on an oceanographic mooring in western Fram Strait (78°49N, 4°59W) 2008-present. Analyses show that the mean overall sound level of this area was low to moderate (< 60 dB). The level of anthropogenic activity in the region was low, with few ships traversing the area. However, airgun signals were prevalent throughout most of the year, in all years. During summer/autumn, signals from airgun surveys were detected > 12 h/day. Vocalisations by fin and bowhead whales were the main biotic sounds during autumn-spring. Nearly constant singing by bowhead whales dominated the winter soundscape at frequencies between 100-1000 Hz. Narwhal signals occurred year round, suggesting that this area is also important for this endemic Arctic cetacean. Bearded seal vocalisations were detected March-July, whereas blue whale calls were recorded mainly during summer/autumn. This study outlines the main contributors to the soundscape of western Fram Strait, describes seasonal patterns of both noise and biota and thus provides baseline data from which changing trends can be monitored.

2630
Sea Noise from Southern Australia to Eastern Antarctica

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In conjunction with the Australian Antarctic Division sea noise data was collected from moorings at 44°S (2006-2007), 54°S (2006-2009) and 65°S (2006-2007) using Curtin's underwater sound recorders. In January 2014, during a cruise of *RV Whale Song* south from Hobart, to and along the ice edge (138°6'E to 115°42'E) and returning to Fremantle, Western Australia, 140 sonobuoys were deployed at a ~4 hour interval. Mooring data showed seasonal trends in calls from whales: Antarctic blue; Antarctic minke; fin; Australian pygmy blue (to 54°S only); and the unidentified species producing the so-called 'spot' call. Seal calling showed pronounced seasonal patterns with a large variety of signal types. South of the Antarctic convergence sperm whale clicking and seal calling rates increased towards Antarctica. Feeding humpbacks near the ice edge were largely silent except on one occasion an animal approached a wide-band sonobuoy and produced a signal at ~20 kHz. General, nondescript increases in high-frequency sea noise were detected in the presence of large krill aggregations. Vessel noise was comparatively rare along the Antarctic coast. Seismic survey signals from a vessel operating over the western edge of Bass Strait (~ 40°S) in 2006 were detected on the line of stationary recorders to 65°S, although only when the vessel was operating over the shelf slope and at low levels. This presentation will discuss major trends in sea noise south of Australia and down to the Antarctic coast.

946
Estimating the Distribution of Vocalizing Whales from Ambient Sound Spectra

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Marine mammal vocalizations are transient sounds, but the combined sound energy of a population continuously repeating a vocalization, adds up to a quasi-continuous chorus. These choruses are frequently observed as peaks in ambient sound spectra throughout the worlds oceans. Here I present an approach to estimate the distribution of vocalizing marine mammals from averaged ambient sound spectra.
This is an extremely under-determined inverse problem. The method is based on inverse theory and uses simulated annealing to find the most likely distribution of sound sources (vocalizing animals) on a geodesic grid. This includes calculating a transmission loss matrix connecting all grid nodes and recorders, using an arbitrary sound propagation model. Two models were successfully implemented: geometrical spreading and the ray trace model BELLHOP.
The inversion method was tested under different simulated scenarios for vocalizing fin whales in the North Atlantic (ambient sound peak at 20 Hz). The accuracy of the inversion mainly depends on the number and distribution of recorders. For the Norwegian Sea, simulations indicate that fin whale chorus inversion is possible using as few as 12 recorders between Iceland and Svalbard.
Further development and application of the proposed method could admit automatic year-round monitoring of marine mammal distribution on a basin-wide scale, using existing mooring and float platforms.

2516
Spatio-temporal Variation in Arctic Ambient Noise in the Canada Basin

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The Canada Basin Acoustic Propagation Experiment (CANAPE) involved measuring underwater acoustic propagation and ambient noise in the Arctic over the course of a year. As a part of this experiment, from October 2016 to October 2017, four vertical hydrophone arrays were deployed north of Barrow, Alaska. The arrays were moored in water depths between 100 and 300 m. Each array recorded at approximately 15% duty cycle at sample rates between 4000 Hz and 64000 Hz, with a 24-bit dynamic range. The data from each recorder were processed to produce 1-minute metrics over the entire duration. The 1-minute metrics were then processed to look for correlations over time, frequency, space, and with environmental factors such as weather and ice cover, including ice keel depth inferred from high-resolution Radarsat images. The recorders were all equipped with Chip-Scale Atomic Clocks (CSAC), enabling each acoustic time series to be precisely time-aligned with the others as well as with supporting oceanographic and remote sensing data. Therefore the changes in soundscape can be compared at a wide range of temporal and spatial scales. We will compare the soundscape temporal and spatial variability over spatial scales of 20-50 km and time scales of seconds up to one year, in the area of the continental shelf break between the Chukchi Sea and the Canada Basin.

2547
Modelling the Effect of Air Gun Array Noise on Marine Mammal Communication

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Seismic airguns used in scientific surveys in the Southern Ocean produce high-intensity impulsive sounds with most energy concentrated in the low frequency band. This frequency range overlaps with many marine mammal vocalizations, especially the songs and calls of baleen whales. Even at large distances from the source, airgun noise may therefore interfere with marine mammal communication.
In order to assess the masking effect of airgun noise we first studied the propagation of airgun signals in the Southern Ocean. A parabolic equation approximation was used to model sound propagation. The propagation models were verified based on recordings and metadata for two seismic surveys in the Southern Ocean. Numerical predictions are consistent with the measurement results within a few dBs for the sound exposure and energy spectral levels.
Subsequently we studied the ability of a listening animal to detect vocalisations of a conspecific in the absence and presence of propagated airgun noise. The auditory detection process was modelled using a spectrogram correlation.

2604
Marine Soundscape Planning: Seeking Acoustic Niches for Anthropogenic Sound

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Both marine mammals and hydroacoustic instruments use underwater sound to communicate, navigate or infer information about the marine environment. Concurrent timing of acoustic activity or the use of similar frequency regimes may result in (potentially mutual) masking of acoustic signals when both sources are within reception range. In analogy to landscape planning, the concept of marine soundscape planning aims to reconcile potentially competing uses of acoustic space by managing the anthropogenic sound sources. We here present a conceptual framework exploring the potential of soundscape planning in reducing (mutual) acoustic interference between hydroacoustic instrumentation and marine mammals. The basis of this framework is formed by the various mechanisms by which acoustic niche formation occurs in species-rich communities that acoustically coexist while maintaining high fidelity (hi-fi) soundscapes, i.e., by acoustically partitioning the environment on the basis of time, space, frequency and signal structure. Hydroacoustic measurements often exhibit certain flexibility in their timing, signal characteristics and even instrument positioning, offering the opportunity to minimize the underwater acoustic imprint. We evaluate how the principle of acoustic niches could contribute to reduce potential (mutual) acoustic interference based on actual acoustic data from three recording locations in polar oceans.

GG-2a - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
19.06.2018 09:00-10:30, A Schwarzhorn

812
West Antarctic Ice Sheet History: IODP Exp. 374 (Ross Sea) Initial Results

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International Ocean Discovery Program (IODP) Expedition 374 was scheduled to collect a latitudinal and depth transect of six drill sites in the eastern Ross Sea in January to March 2018. The expedition will resolve the relationship between climatic/oceanic change and West Antarctic Ice Sheet (WAIS) evolution over the past 20 million years. This location was selected because numerical ice sheet models indicate that it is highly sensitive to changes in ocean heat flux and sea level. The drilling was designed for optimal data-model integration, which will enable an improved understanding of the sensitivity of WAIS mass balance during warmer-than-present climates (e.g., Pliocene and middle Miocene). The objectives were to 1) Evaluate the contribution of WAIS to far-field ice volume and sea level estimates; 2) Reconstruct ice-proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcings/feedbacks; 3) Assess the role of oceanic forcing on WAIS stability/instability; 4) Identify the sensitivity of the WAIS to Earth's orbital configuration under a variety of climate boundary conditions; 5) Reconstruct eastern Ross Sea bathymetry to examine relationships between seafloor geometry, and ice sheet stability/instability. We will present the initial scientific results that resulted from this expedition, with a focus on the paleoenvironmental reconstructions that were obtained from the sedimentolgical, geochemical and paleontological datasets.

1950
Initial Seismic Stratigraphic Results from IODP Exp. 374 in the Ross Sea

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International Ocean Discovery Program Expedition 374 will core several sites in the Ross Sea in January-March 2018. The geological records will recover the distal component of a Neogene latitudinal and depth transect across the continental shelf and rise, with previous ANDRILL and DSDP Leg 28 sites comprising the ice-proximal component. This transect approach will allow for assessment of oceanic drivers of marine ice sheet instabilities. The existing reflection seismic data suggests that intervals with limited ice cover occurred among episodes of grounded ice that extended to the shelf margin during the Neogene. Following initial shipboard characterization of the cores during the Exp. 374, the correlation between synthetic logs at the new drill sites and the crossing seismic sections will provide crucial information about the age and the environmental conditions during the deposition of glacial and marine strata. Changes in the bathymetry of the continental shelf are important for understanding the dominant West Antarctic Ice Sheet mass balance controls. The stratigraphic information from the Exp. 374 will allow us to date the paleobathymetric maps of the main seismic unconformities and therefore provide a measure of the geomorphological changes under the action of the ice sheet and ocean circulation. The results will be fundamental for numerical ice sheet models aimed to infer the past Antarctic volume fluctuation contribution to Neogene sea-level changes.

303
Modeling Antarctic Climate and Ice-sheet Variability in the Mid-Miocene

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The mid-Miocene Climatic Optimum (~17-15 Ma) serves as a possible analog for future Antarctic conditions, because atmospheric CO_2 concentrations were similar to those projected for the next few decades. During the mid-Miocene Climatic Transition, the Antarctic Ice Sheet evolved into a continental ice sheet roughly resembling its modern geometry.
Near-shore marine records from the Ross Sea (ANDRILL-2A; Levy et al., 2016) imply highly dynamic AIS behavior in the mid-Miocene. Reconstructed environmental conditions during this time period range from a fully glaciated Ross Sea region to a smaller 'interglacial' ice sheet during warmer conditions with higher CO_2 and orbital forcing sensitivity. These records are seemingly inconsistent with sedimentary and geomorphic studies in the McMurdo Dry Valleys (MDVs) that suggest the East Antarctic Ice Sheet was mostly invariable since the mid-Miocene (Sugden & Denton, 2004).
Here, we use a Regional Climate Model with a range of greenhouse gas concentrations, orbital configurations, ice sheet and shelf geometries, and sea surface conditions to reconcile the apparent dichotomy between marine and terrestrial records during the mid-Miocene. Model results are compared with emerging terrestrial data from the Friis Hills in the MDVs to test the hypothesis that climate in the marginal, continental setting of the MDVs remained relatively cold and insensitive to a highly variable West Antarctic Ice Sheet and marine conditions in the proximal Ross Sea.

175
Ice Sheet, Ocean Basal Melting and Bathymetry Interactions: A Sensitivity Study

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Marine sediment records from circum Antarctica show that the ice sheet volume and extent fluctuated substantially through time. The understanding of past Antarctic ice sheet (AIS) dynamics highly depends on the reconstruction of the bedrock and seabed morphologies evolution in time. Paleo-bathymetries based on reflection seismic interpretation combined with sediment cores analysis show that the marine basins of Antarctic continental shelf over-deepened through time. A first step of inner continental deepening below sea level, resulted from the fluctuations of a dynamical and temperate AIS, increasing in volume in response to global cooling prior to mid-Miocene (~15 Ma). A second step occurred between ~15 and 3 Ma, when the AIS, gradually more stable and cold-based (as recorded by decreasing sedimentation rates), fluctuated over the continental margins, thus causing an over-deepening with a pronounced landward slope due to the erosion and sediment transport from the inner shelf to the outer shelf and slope. We investigate the impact of over-deepening on the AIS by means of an ice-sheet model forced by Mid-Miocene and Last glacial cycle warm and cold climates. Idealised bathymetries based on BEDMAP2 are used to test the importance of ice fluxes, ocean water masses and bathymetry in the advances and retreats of the AIS. Results show the increasing influence of ocean on the AIS while the circum Antarctic continental margins gradually over-deepened through time.

281
Pre-glacial to Glacial Amundsen Sea Shelf from Seismic and Seabed Drill Records

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The sedimentary sequences of the Amundsen Sea Embayment (ASE) shelf contain records that have the potential to reveal the environmental and ice sheet evolution from pre-glacial to glacial times for a very dynamic sector of the West Antarctic Ice Sheet (WAIS). The currently observed massive loss of continental ice in this region may be a precursor to a partial or full collapse of the WAIS. Deciphering paleoclimate and paleo-ice sheet records from the shelf sediments is therefore a major scientific objective for studying processes of past warm times that can be considered as analogues to the present and future WAIS behavior. In previous work, the seismic stratigraphic model of the shelf was based solely on long-distance jump correlation with seismic records from the Ross Sea shelf. New MeBo70 seabed drill cores collected in early 2017 from the ASE shelf contain unconsolidated to highly consolidated sediments spanning time periods from the Holocene to Cretaceous. We are now able to correlate the mapped seismic horizons and units with the physical property and age information from the drill cores to obtain new insight into the sedimentary and paleoenvironmental development of the entire shelf. The drill records and seismo-stratigraphic units of the ASE provide new constraints on the timing of the transition from the pre-glacial terrestrial environment of the Cretaceous-Paleocene to marine transgression thereafter, and the first advances of grounded ice across the shelf.

1740
Surface Paleoceanography of the Oligocene and Miocene Southern Ocean

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Of notable interest, but poorly understood, is the magnitude and sensitivity of Oligocene and Miocene (35-5 Ma) Antarctic ice sheet change, and the role of warm ice-proximal oceans in past ice sheet behaviour. Oligocene and Miocene sediments were recovered from the Wilkes Land continental Margin. These allowed us to investigate Oligo-Miocene Southern Ocean oceanographic regime and variability therein also in older sedimentary archives. We will present quantitative paleoceanographic reconstructions based on dinoflagellate cyst and biomarker studies on Site U1356 and Site 269. These sites are conveniently situated below the present-day Antarctic divergence, and are today dominated by sea-ice affiliated dinoflagellates. The obliquity-paced glacial-interglacial variability detected in the lithologies allows us to separate our results between glacial and interglacial extremes. In the Oligo-Miocene we document the dominance of dinocysts which now thrive at the subtropical front. Moreover, we note considerable variation in oceanographic regime at the overlying site over glacial/interglacial extremes, arguing for profound oceanographic and SST changes over g-i cycles. Our results argue for a fundamental different and variable oceanographic regime during the Oligo-Miocene compared to today. We argue that much of the Oligo-Miocene benthic foraminiferal $d^{18}O$ variability may be explained by Southern Ocean surface ocean change, rather than ice volume change.

BE-3a - Polar perspectives on microbial evolution, adaptation, and ecological function
19.06.2018 09:00-10:30, A Seehorn

442
Stunning Stress Adaptation of a Black Fungus and Implications for Astrobiology

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The McMurdo Dry Valleys in Antarctica are the coldest hyper-arid desert on Earth characterized by several environmental stressors including low temperatures, freeze-thaw cycles, low water availability, high solar and UV irradiation; they are the best terrestrial analogue for Mars. Suitable niches for microbial colonization exist inside the rocks where some microorganisms can find a refuge. The cryptoendolithic endemic black fungus *Cryomyces antarcticus* demonstrated huge ability to withstand stresses beyond the conditions, already prohibitive, of its natural environment.
Here, we review the ability of *C. antarcticus*, to resist temperature cycles (-20°C/+20°C), high temperature (+90°C), high saline concentration (up to 25% NaCl), high UV exposure (up to $5x10^5$ kJ/m^2), ionizing radiation (Co^{60}, up to 55.81 kGy) and α particles (He^{2+}, up to 1000 Gy). The fungus survived and recovered the metabolic activity even after 1.5 years of real space exposure (10^{-4}Pa vacuum, -20°C/+47°C, 439 MJ/m^2 UV irradiation) and simulated Martian conditions (-25°C,Mars-like CO_2 atmosphere, 980Pa).For this remarkable resistance, this fungus is nowadays considered the best eukaryotic model for astrobiological researches.
The outcomes of these studies outstretched the concept of limits for microbial life and are giving clues for defining the boundaries for habitable environments on Earth, discovering life in environments previously considered sterile, and assessing the habitability of Mars or other planets.

1589
New Finding of *Marinilactobacillus sp* in the Subglacial Antarctic Lake Vostok

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The objective was to search for microbial life in the subglacial Antarctic Lake Vostok by analyzing the uppermost water layer entered the borehole and got frozen within following three lake unsealing (05.02.2012; 25.01.2015; 03.02.2015). The borehole-frozen water samples proved to be generally contaminated with the drill fluid. The cell concentrations varied from 167 (drillbit frozen water) until 5.5-38 cells per ml (clearer borehole-frozen samples). The sequencing of 16S rRNA genes came up with total 62 bacterial phylotypes. Of them only 3 phylotypes successfully passed all contamination criteria. Two phylotypes both detected after the 1st lake unsealing were reported before (Bulat, 2016) - hitherto-unknown and phylogenetically unclassified phylotype w123-10 showing less than 86% similarity with known taxa and likely belonging to *Parcubacteria* Candidatus *Adlerbacteria* featured by unusual biology and 3429v3-4 showing 93.5% similarity with *Herminiimonas glaciei* of *Oxalobacteraceae* (*Beta-Proteobacteria*) - water-inhabited ultramicrobacterium isolated from deep Greenland ice core. The new finding just came from the samples after the 3rd lake unsealing. The phylotype discovered (3698v46-27) showed the conspecificity with several species of *Marinilactobacillus* of *Carnobacteriaceae* (*Firmicutes*) featured by very similar 16S rRNA genes (e.g. *M. piezotolerans* from Nankai Trough). Thus, 3 discovered bacterial phylotypes may represent ingenious life forms from the subglacial Lake Vostok.

1745
Arctic Phytoplankton Can Compensate for the Effects of Multiple Stressors

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Arctic phytoplankton are exposed to particularly fast rates of environmental change caused by anthropogenic CO_2 emissions. In experiments with natural phytoplankton assemblages from different regions of the Arctic, we found primary production and species composition to be largely insensitive to ocean acidification, warming and changes in irradiances. These results are in contrast to those of similar studies from the Southern Ocean. Our Arctic results imply a high capacity to compensate for environmental change, which can be understood in light of the environmental history of organisms thriving in highly variable environmental conditions. Based on subsequent laboratory experiments and field observations, we could identify the underlying compensatory mechanisms such as physiological plasticity of organisms, intraspecific diversity of populations and functional redundancy of species.

2098
Arctic Bacterioplankton One-carbon and Methylated Compounds Metabolisms

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More widespread phytoplankton blooms predicted as the Arctic warms will impact the amount of algal metabolites released in the system which may in turn be a good source of energy, C, N and S to marine bacteria. Here, we assessed the metabolic potential of surface bacterial communities to use one-carbon and methylated algae metabolites in the Baffin Bay during the GreenEdge cruise in summer 2016. The bacterial response to a pulse of metabolites was also determined during 9-d enrichment experiments at sea-ice and open water stations. Bacterial community composition and activity show that despite the capacity to use these compounds *in situ,* bacteria did not appear to respond to the specific enrichments, suggesting that the summer Arctic bacterioplankton is dominated by generalist taxa adapted to an already rich environment. These results, complemented by quantification of functional genes of interest and single cell activity, will help understand whether the Arctic bacterioplankton is well adapted to use and cleave some of the algae metabolites (such as methanol, methylamines and DMSP) which may influence the fluxes of trace gases to the atmosphere. This is of particular importance as the sea-ice coverage declines increasing the area of potential sea to air exchange and the effect of biological emissions on atmospheric chemistry and radiative budget.

2214
Antarctic Subglacial Environments and the Extremophiles That They Host

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We now know that groundwater, saturated sediments and hundreds of subglacial lakes exist below the Antarctic Ice Sheet. While few have been sampled, subglacial environments are proving to be diverse microbial habitats. Because the overlying glacial ice can be 100s-1000s of meters thick, direct access is logistically challenging and sample acquisition is rare. Two recent drilling expeditions have enabled detailed study of the subglacial biomes below the Whillans Ice Stream (WIS) along the Siple Coast and the Taylor Glacier in the McMurdo Dry Valleys. Below the WIS, Subglacial Lake Whillans, a shallow fresh water lake, drains along the ice sheet base and into the Ross Sea at its grounding zone. Below Taylor Glacier an iron-rich brine episodically emerges at Blood Falls. These ecosystems exhibit measureable microbial metabolic activity and appear to persist independent of photosynthetically derived carbon inputs. Molecular data and biogeochemical measurements indicate these systems are chemically and phylogenetically distinct, however both are chemosynthetic with energy derived in part by cycling inorganic iron and sulfur compounds. Physiological and genomic characterization of microbial isolates obtained show adaptation to their local environment includes genes for growth at low temperatures and high salt concentrations. Collectively these data suggest that despite extended isolation in icy darkness, microbial life persists and possibly thrives below the Antarctic Ice Sheet.

1548
C. psychrerythraea 34H: Glycoconjugates Structures and Cold Adaptation

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Cold adapted microorganisms have evolved a large repertoire of adaptation strategies: the biosynthesis of lipids and enzymes with a sufficient physical flexibility to contrast cellular membrane rigidity, and the production of anti-freeze proteins and carbohydrate-based extracellular polymeric substances (EPS), which serve as cryo- and osmo-protectants.[1] *Colwellia psychrerythraea* 34H is an obligate psychrophilic γ-proteobacterium, isolated both from subzero Arctic sediments and Antarctic sea ice. It is considered a model to study adaptive strategies to subzero lifestyle.[2] In the last years, our team has been involved in an in-depth study of the structure of carbohydrate molecules from this model organism and of its role in sea-ice lifestyle. *C.psychrerythraea* 34H grown at 4°C produces a rough-LPS.[3] In addition, three different exopolysaccharides, a capsule[4] and two totally released polysaccharides,[5] displaying IRI activity, have been found. In this communication, the structural characterization of glycoconjugates molecules produced by *Colwellia* grown at -2°C, 8°C, and 15°C, is described. This study allowed us to establish how the carbohydrates polymers are involved in *Colwellia* cold-adaptation.

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TE-3a - Remote sensing of polar regions
19.06.2018 09:00-10:30, A Wisshorn

17
Improved subarctic and Arctic SWE Retrieval using Passive Microwave over Canada

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Over northern snow-dominated basins, the snow water equivalent (SWE) is of primary interest for monitoring the global warming impacts. SWE retrievals from satellite microwave (MW) observations, the only type of data sensible to snow volume, are still not well resolved. On the other hand, the use of snowpack models is challenging due to the large uncertainties in meteorological input forcings and the snow model parameterization. This presentation shows improvements for SWE prediction by assimilating satellite brightness temperatures (T_B) in a detailed multilayer snowpack model (SURFEX/Crocus) without any ground-based observations and driven by forcing data generated by the 10 km - Canadian GEM model. While the results appear in agreement with continuous in-situ SWE observations for subarctic snow covers over North-Eastern Canada, with 16 to 30% bias accuracy, the simulations are poor for arctic snow (in-situ database at the Cambridge Bay, Nu). We discuss the sources of the main uncertainties, including a bad stratification of the arctic snowpack density and microstructure simulated by the snow model. The presence of ice crusts within the snowpack also generates significant variations in T_B that have to be corrected. The snow radiative transfer model SMRT, used in this study, need to be scaled in order to reduce the RMSE between simulated and observed T_B. Preliminary results of these improvements, specific for this type of arctic snow, are presented.

222
A New Dual-frequency Ku-band Radar Mission Concept for Cryosphere Applications

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Moderate resolution (~1 km) terrestrial snow water equivalent (SWE) measured across the Northern Hemisphere at a revisit of 1 to 5 days is a priority observational gap which limits operational environmental monitoring, services, and prediction. To address this need, Environment and Climate Change Canada, the Canadian Space Agency, industrial partners at Airbus, and international scientific collaborators are developing a new dual frequency (Ku-band: 13.5 and 17.2 GHz) radar mission concept. Following technical trade-off studies, a concept capable of providing 250m spatial resolution measurements across a 500 km swath was identified. Orbital analysis defined a dawn/dusk orbit flying at a fixed offset of 3.5 hours ahead of Met-Op Second Generation (Sat. B). This orbit will provide synergistic active and passive measurements through complete swath overlap with the multi-frequency Microwave Imager (MWI). This presentation will provide an overview of the technical mission concept, and how it addresses measurement requirements for the primary mission objective of terrestrial snow, and secondary objectives related to sea ice, land ice, and ocean vector winds.
Modeling activities to
(1) identify the current state of backscatter modeling capabilities for layered snowpacks at Ku-band,
(2) develop and validate SWE retrieval algorithms, and
(3) determine the potential impact of radar backscatter measurements on radiance-based land surface data assimilation will also be presented.

2324
Automated Monitoring of the Sea Ice in the Kara Sea for Practical Applications

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Monitoring of sea ice processes, i.e. ice edge variations and motion, is important for practical tasks such as ice navigation and for scientific studies. High-resolution data from C-band SAR have been used as the main data source for analysis of the sea ice regime in the Kara Sea to *study* details of *ice distribution* as well as *changing* of the ice conditions and sea ice types. The aims of our study is to develop recommendations for the planning of ship routes around the habitats, migration of the endangered species of fauna objects, taking into account long-term trends, seasonal and interannual variations of the ice conditions in the Kara Sea. To accomplish this goal, an automated classification algorithm based on the support vector machine (SVM) approach for Sentinel-1 Extra Wide (EW) swath dual-polarization mode data (HH + HV), was applied. Several technical issues for Sentinel-1 Extra Wide (EW) data were solved in the pre-processing stage including thermal noise reduction in HV-polarization and correction of angular backscatter dependency in HH-polarization. Texture features were explored and used in addition to supervised image classification. Algorithm was trained to classify types of underlying surface in the Kara Sea region: first-year ice thin, first-year ice medium, young ice, water and nilas. The automated classification is included in the ice conditions monitoring system developed at NIERSC for solving practical problems.

2428
Spatial and Temporal Variability at the Toolik Lake Vegetation Grid (Alaska)

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Ground data for the validation of satellite-derived terrestrial Essential Climate Variables (ECVs) at high latitudes are sparse. Also for regional model evaluation of terrestrial variables we lack accurate ranges of terrestrial ground data and face the problem of a large mismatch in scale. Within the German research programs Regional Climate Change (REKLIM) and the Environmental Mapping and Analysis Program (EnMAP), we conducted a study on ground data representativeness for vegetation-related variables within a monitoring grid at the Toolik Lake LTE Research station in Alaska. The grid covers an area of ~ 1 km2 containing Eight five grid points spaced 100 meters apart. Moist acidic tussock tundra is the most dominant vegetation type. Permanent 1 m2 plots were also established to be representative of the individual gridpoints. During summer 2016, we conducted field spectrometry at selected plots during early, peak and late summer. We experimentally investigate more spatially extensive Elementary Sampling Units (ESUs) for the spatial representativeness of the permanent 1 m2 plots and to map ESUs for various tundra types. We will present the first data analyses and maps of biophysically-focused ESUs for evaluation of the use of remote sensing data to estimate these ecosystem properties.

2552
Hybrid Sentinel-1 / Radarsat Backscatter Time Series of Arctic Canada

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The Sentinel-1 satellites (S-1A/S-1B) currently provide approximately 1-2 day close-to-seamless revisit over Ellesmere Island in the Canadian Arctic. The impressive temporal resolution achieved using these two satellites can be further improved by integrating observations from other C-band satellites such as Radarsat-2 and, in the near future, data from the Radarsat Constellation Mission.
We employ radiometric terrain flattening and local resolution weighting to generate normalised gamma nought backscatter over wide regions, not restricted to a single sensor or track's swath width limitations. Ascending and descending passes are integrated into composite backscatter maps. These can be used to generate terrestrial snow/ice-melt and sea-ice-melt products with sufficient temporal resolution to delimit short-lived melting periods.
We illustrate the temporal resolution of wide-area composites time-series achieved by using the Sentinel-1 or Radarsat-2 in isolation. We then compare those results with what can be achieved with hybrid backscatter maps that accept observations from both missions. These tests have been undertaken within the framework of the World Meteorological Organisation's Polar Space Task Group (PSTG) and SAR Coordination Working Group (SARCWG). We describe coordinating actions that can and have been taken by the space agencies to help ensure generation of properly calibrated “hybrid” backscatter composite values that derive from multiple sensors.

2638
Retrieval of Ice Thickness on Large Northern Lakes from Jason-2 Data

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Lake ice grows steadily between the end of the freeze-up and onset of the break-up periods as a result of the thermodynamics of freezing water as well as dynamic ice motion on the surface. The value of passive microwave and radar altimeter data from satellite altimetry missions has been shown for the determination of ice dates (freeze-up and break-up) and only very recently been evaluated for the estimation of ice thickness. Data acquired from current satellite missions (e.g. Jason-2/3, Sentinel-3) provide an opportunity for investigation of the development of lake ice thickness retrieval algorithms.
The objective of this study is to investigate the potential of radar altimeter and passive microwave radiometer data from the Jason-2 satellite mission for the estimation of ice thickness on large northern lakes. Backscatter and brightness temperature (Tb) measurements from its nadir-pointing radar altimeter (13.575/5.3 GHz) and passive microwave radiometer (18.7 and 34 GHz) are compared against ice thickness estimates obtained with a thermodynamic lake ice model and in situ measurements collected on three lakes in northern Canada over the course of eight ice seasons (2008-2009 to 2015-2016). The temporal evolution of backscatter and Tb is then explored to estimate ice thickness. Results show that both passive microwave and radar altimeter data acquired in the 5-19 GHz frequency range allow for the retrieval of ice thickness on the lakes investigated with a 10-20 cm accuracy.

OC-1_OC-2a - Innovation, partnership and impact in polar science communication & Polar Research and Citizen Science: Exploring New Platforms and Opportunities
19.06.2018 09:00-10:30, B Pischa

141
A Framework to Increase the Value and Impact of Polar Education and Outreach

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Since the International Polar Year 2007-2008, polar education, outreach and communication (EOC) has matured significantly. This is illustrated by a shift from 'pop outreach' aimed at the general public, to 'informing decision-making' targeted at key stakeholders. However, a significant number of scientist communicators still lack the support, training and professional recognition required for effective and thoughtfully designed EOC activities.
Using a mixed-methods approach, including data from interviews and four different surveys, we explore the field of polar EOC over the past ten years. We draw on four polar outreach case studies — an expedition, a documentary, a festival, and an education event — that the authors have been associated with. We supplement this with data from a survey of 170 scientist communicators from 22 countries, which shows that while 90% of respondents engage in EOC activities, only 38% have training in science communication and only 10% incorporate formal or external evaluation.
Building on these data, we highlight the current barriers and opportunities associated with the evaluation and reporting of EOC activities. We also present a new framework for engagement design that encourages reflexive practice and mechanisms for development, delivery and evaluation of EOC activities based on explicit and articulated objectives. Through more thoughtful approach to science communication, we hope to increase the value, impact and reach of such activities.

2019
Engaging Students in Stem Education through Arctic Research

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The Arctic is changing rapidly with new business opportunities and environmental threats, calling for enhanced knowledge, efficient education and innovative educational support programmes not least in the fields of STEM. EU H2020 EDU-ARCTIC is a multilingual Pan-European science communication and educational support initiative available for all secondary schools, using Arctic research as a vehicle to encourage pupils aged 13 to 20 to pursue education in science, technology, engineering and mathematics.

Objectives:

- Encourage interest in science, technology, engineering and mathematics (STEM) education to secondary school students
- Provide an innovative and supportive educational program, accessible to schools, educators and students across Europe and beyond
- Establish strong links between the research and education communities by connecting schools to scientists at Arctic research stations and research institutes throughout Europe.

The project uses a mix of different innovative tools and methodologies for science communication supporting STEM education, including virtual lessons with scientists dealing with polar research, environmental monitoring program, teacher trainings and workshops, online Polarpedia, interactive portal explaining scientific terminology through text, images, maps, videos and multimedia tools.

Edu-Arctic has a strong webportal at edu-arctic.eu and uses actively and innovatively Social media outreach and communication tools to reach the widest audience.

2136
Major Lessons from Teaching Young Children Complex, Abstract Polar Concepts

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If researchers want to shift public perceptions about complex, abstract concepts—such as impacts of climate change on polar ecosystems—we need to educate young children. Many kids form negative opinions about Science, Technology, Engineering, & Mathematics (STEM) fields by the time they are seven-years-old; after this age, educators must combat previously ingrained attitudes towards STEM to teach new ideas. However, young children are not developmentally mature enough to understand complex, abstract concepts until reaching adolescence after 10-years-old. This mismatch in educational development may seem unfortunate, but is not insurmountable using the right engagement techniques to facilitate a child's exploration of the polar world. Promoting development of cognitive and emotional intelligence at an early age combats poor polar literacy and mistrust of scientists, opening the door for informed, public conversation on highly-politicized issues like climate change. This presentation highlights experiences teaching complex, abstract polar concepts to elementary school children in Fairbanks, Alaska, USA. We reflect upon methodology and major lessons learned to provide suggestions for scientists interested in communicating broader impacts of their research with children. We will also introduce plans to develop a working group for educators and researchers to collaborate on a resource bank for polar curriculum meeting educational standards in multiple countries.

2448
Teenager and School Teacher Program for the Polar Education and Outreach

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A teenager program of Korea Polar Research Institute (KOPRI) has been running for over 10 years, allowing selected individuals sent to visit the polar research infrastructure, usually our Arctic summer research station, and to join the efforts of field scientists. A nation-wide call is made before essay writings and interviews that help us to admit the best prepared and most willing students. Alumni are later invited to remain connected in order to make the most use of collective experiences gained. In some years, this program opted to take some variations to engage school teachers and artists. KOPRI also delivers customized education program, particularly to high school science teachers as a community service, namely the Polar Academy. This also led to our efforts to develop learning materials for students. Utmost challenge is to continue to engage these participants and have them connected and networked. Furthermore, KOPRI makes efforts to actively communicate via new social media; KOPRI vividly portrays activities like this program and others, for example, conducted by field researchers through its coverage of the scientific achievements from the research stations. For example, it creates and distributes contents such as interesting and informative news posts and events to many followers. KOPRI also organizes various events such as 'feel the polar world yourself' exhibitions or photo exhibitions in subway stations, to provide the urban audience with polar experiences.

2156
A Decade of USA-Mexico Virtual K-12 Participation in Antarctic Expeditions

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This session presents an innovative outreach initiative for the education and motivation of young learners on themes related to polar regions and science. Two binational groups of elementary students worked alongside polar scientists in an ongoing collaboration as virtual researchers. A decade of polar research in three Antarctic expeditions, and a teacher-scientist partnership, served as a basis for an interdisciplinary primary and secondary academic model. The project began with a 2nd/3rd grade bilingual class in Texas, transforming the classroom into a virtual icebreaker during the 2007 SIMBA expedition, and afterwards in an Antarctic thematic-unit to develop science knowledge and literacy skills. Many of the same children followed the 2010 Oden and 2017 PIPERS expeditions through digital technology, in classrooms in Texas and Mexico. With guidance by their teachers and support from the scientists, the students have served as ambassadors of polar knowledge and research creating research exhibits, presentations, science fairs, and conferences in their schools and communities, including presenting at the 2012 TABE (Texas Association for Bilingual Education) Conference where students demonstrated their acquired scientific polar knowledge in two languages. Through this session we hope to inform and illuminate an amazing 10 year outreach effort in polar science and education across two languages and cultures, and to promote this model in other schools and programs.

CR-1a - Permafrost: connecting measurements, monitoring, and modelling
19.06.2018 09:00-10:30, B Parsenn

2678
A Global Snapshot on the Thermal State of Permafrost and Active Layer Thickness

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The Global Terrestrial Network for Permafrost (GTN-P) is part of GTOS of the Global Climate Observing System, a joint undertaking of the WMO, IOC, UNESCO, UNEP and ICSU. GTN-P was established in 1999 by the International Permafrost Association with the goal of systematic and long-term documentation of the distribution, variability and trends of permafrost based on a global network of field measurements.
GTN-P developed a Data Management System (gtnpdatabase.org) for the collection, processing (incl. standardization) and dissemination of permafrost data and metadata. Recent data of ground temperature and active layer thickness are being compiled for a new global snapshot of the current permafrost state. Results indicate that permafrost temperature is generally following the trends in air temperature and increasing, especially in the Arctic areas where permafrost is relatively cold. In the Sub-Arctic, where permafrost temperatures are relatively high, the warming trend is less pronounced and at many locations current permafrost temperature is similar to that of the IPY snapshot. In alpine permafrost areas, most measurement sites significant warming. Active layer thickness exhibits large interannual variability, mainly due to variations in snow-cover, but has generally increased since the IPY, especially in the European Arctic sector. In several sites at northwest Antarctic Peninsula, active layer thickness has been stable or even decreased.

1880
Strategies and Data of Long-term Permafrost Monitoring in the Swiss Alps

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The Swiss permafrost monitoring network PERMOS documents the state and changes of permafrost in the Swiss Alps based on ground temperatures measured in boreholes and near the surface, changes in ice content, and rock glacier creep velocities. The core task of long-term monitoring, and at the same time the biggest challenge, is to deliver reliable, robust and comparable measurements from key sites over decades. This requires coherent strategies that are repeatedly evaluated and adapted to new findings from research.
The PERMOS Scientific Committee re-evaluated the PERMOS observation strategy in 2017 and we present the main outcomes. They mainly concern further improvement and definition of standard procedures for site maintenance as well as data processing and documentation because PERMOS evolved from individual research activities. The site maintenance in rough conditions is demanding and problems such as shearing of the boreholes and blocked chains can threaten the continuation of the time series. Renovation or re-drilling, for example, require careful planning to achieve overlap of the different systems and to consider experiences and standards. A second major task is a robust data management system with standardized processing and quality control of new and existing data as well as easy access. Finally, the results and assessments should be reported timely and in an understandable and useful way to researchers, authorities and the public.

1486
Circumpolar Active Layer Monitoring Program: Results and Future Directions

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The Circumpolar Active Layer Monitoring (CALM) program, established in the early 1990s, is designed to observe temporal and spatial variability of the active layer, near-surface permafrost parameters, and their response to changes and variations in climatic conditions. CALM is an integral part of the Global Terrestrial Network for Permafrost (GTN-P). The CALM network incorporates sites distributed throughout the Arctic. The majority of the sites are in Arctic and Subarctic lowlands. At approximately 90 sites, direct active-layer measurements are conducted on standard rectangular grids ranging from 10 x 10 m to 1 x 1 km. The locations of grids were selected to represent generalized surface and subsurface conditions characteristic of broad regions. Vast majority of CALM sites have continuous active-layer records longer than five years and more than 40 have twenty-year records or longer. Auxiliary information includes air temperature, soil moisture, soil temperature at different depth, snow cover, soil composition, and landscape characterization. Several sites have records of frost heave and thaw subsidence. CALM is the world's primary source of information about the active layer. The data is assimilated and distributed though CALM (www.gwu.edu/~calm) and GTN-P (gtnpdatabase.org) online databases. This presentation summarizes results and accomplishments of the CALM program and project future directions.

752
The Thermal State and Distribution of Rock Wall Permafrost in Norway

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Climatically driven permafrost degradation may be a serious threat to human activities and lives in Norway in areas where steep rock slopes are located above houses, infrastructures and large water bodies. The CryoWALL project (2015-2019) aims at studying rock wall permafrost in some of the most hazardous rockslide areas in Norway. In 2015 and 2016, 20 Rock Surface Temperature (RST) loggers were installed at 10 cm depth in 7 selected sites along a latitudinal transect from 60°50'N to 69°46'N. Twelve of these loggers are located north of the polar circle. In 2016 and 2017, 20 more loggers were installed at the surface of the coastal cliffs, canyons and alpine rock walls in the Ny-Ålesund area (78°55´N) in Svalbard.
The RST time series are used for *(a)* characterizing the thermal state and distribution of rock wall permafrost (RWP) across Norway and in Svalbard, *(b)* running steady-state and transient numerical models of RWP at selected sites, and to *(c)* calibrate a general linear regression model that will be used to *(d)* predict the spatial distribution of RWP at the national scale. The preliminary analysis shows that the mean RST differs by 3°C between N and S faces in Southern Norway. In Northern Norway the midnight sun and polar night effects, induce similar RST in both aspects during December, January, May and June and with a difference in RST of 1.5°C on annual scale. This first data set is shown to be of high relevance for predictive modelling.

2257
Decadal Landscape Change in the McMurdo Dry Valleys, Antarctica

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Recent observations of soil surfaces, streams, and glaciers in the McMurdo Dry Valleys of Antarctica (MDV) show extensive evidence of subsidence, channel migration, and surface roughing. To evaluate the spatial distribution and magnitude of change we compared elevations from two airborne LiDAR campaigns, one collected in the summer of 2001-02 and 2014-15. During this period the intensity of solar radiation increased significantly, indicated by long-term meteorological measurements and supported by long-term ecological responses. Results show subsidence is strongly associated with the presence of massive ground ice and with proximity to surface or shallow subsurface (active layer) water. Subsidence occurs across soil types and landforms in both low-lying, low-slope terrain with impeded drainage and high on steep valley walls. These observations, supported by modeling of heat transfer in the soils, highlights the importance of insolation-driven thermokarst warming and thawing in the MDV. The regional melt pattern shows a transfer of water storage from the local cryosphere (glaciers, permafrost) to the hydrosphere (closed basin lakes and ponds). We interpret this pattern as reflective of a transition process to Arctic and alpine-style, hydrologically mediated ground- and surface-ice loss. Although this may be only an episode within current climate variability, it is suggestive of the processes to be expected when the region warms as predicted by climate models.

2627
Estimating Shrub Height as Indicator for Snow Height and Permafrost Modelling

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Land cover has strong implications for the small-scale distribution of snow cover. Specifically shrub height is required in order to identify areas with trapping of snow and subsequent impact on ground thermal conditions. Current global and circumpolar maps lack thematic detail and/or spatial resolution to appropriately represent shrubs, their types and height.
The recently launched Sentinel-2 satellite optical data suitable for land cover monitoring with 10 m spatial resolution. We have selected a transect spanning from the northern tip of the Yamal peninsula (continuous permafrost) to the south into the tundra-taiga transition zone (with discontinuous permafrost) in order to test these data for shrub height retrieval. The region represents not only a gradient in vegetation zones but also sites with high heterogeneity of shrubs. Especially central Yamal is characterized by shrubs of up to 1.5 m height within continuous permafrost. Several studies over a CALM site and additional transects have exemplified the role of the shrubs for active layer thickness in relation to snow using in situ measurements as well as Synthetic Aperture Radar data from satellites in this region.
Shrub height measurements have been collected between 2014 and 2017. All available cloud-free images of summer 2016 and 2017 have been combined and seven indices derived. An R^2 of 0.72 could be obtained. The index can be potentially applied over the entire Arctic to derive maps of shrub height.

AC-5a - Tropical-Polar Teleconnections and their Climate impacts
19.06.2018 09:00-10:30, B Jakobshorn

2068
Links between Strong ENSO Events and Late Fall Barents-Kara Climate

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A late fall ENSO teleconnection with the midlatitudes involving the so-called tropical Northern Hemisphere pattern has previously been reported. Recently this teleconnection pathway has been hypothesized to extend eastward to the European sector with impacts on late fall continental temperature and precipitation. Given the likely mechanisms of such a teleconnection it is reasonable to propose that there are effects that extend into higher latitudes and the Barents-Kara region, in particular. This study investigates potential links between strong ENSO events and conditions in the Barents-Kara region. Lagged composites show that robust late fall ENSO - European teleconnections extend northward to include tropospheric atmospheric circulation, moisture transport and surface turbulent fluxes over this important and rapidly changing region. Responses linked to El-Niño and La-Niña are generally of opposite sense but are asymmetric suggesting nonlinear relationships. Analyses examining Rossby wave source, eddy heat fluxes, sea ice, and the role of internal variability are also presented, providing further support for a strong link between tropical variability and Arctic climate from early - late fall. Given that fall conditions in the Barents-Kara region are often assigned a driving role in proposed Arctic-midlatitude teleconnection pathways it is important to investigate the degree to which tropical, and other sources of, variability can modulate said pathways.

1790
Sensitivity of High Latitude ENSO Teleconnection to Global Warming

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The El Niño Southern Oscillation teleconnection (ENSO) to the northern extratropics includes a robust response in the Pacific-North America sector, and less robust responses in the Arctic and Euro-Atlantic sector. Recently, Deser et al. (2017) showed that uncertainty in the response arises mainly from atmospheric internal variability rather than from the diversity of El Niño/La Niña events. This presents a challenge in assessing how teleconnections to high latitudes will change under global warming.
We investigate the high latitude atmospheric response to two El Niño and two La Niña events in multi-model large ensembles (at least 100 members per model) for the present climate and in a 2ºC warmer world (relative to pre-industrial climate). The sea surface temperatures (SSTs) are prescribed such that the events themselves are identical in the two periods, but they occur within different background flows.
The multi-model ensemble mean response is stronger in the 2ºC world than for the present climate. This response can be linked to changes in the mean wave-guide for the high latitude teleconnection patterns. We also examine the spread in the responses and the changes in surface impacts associated with end members of the ensemble. The model uncertainty is assessed by looking at model biases in the wave-guide and in poleward propagating Rossby waves excited by tropical sources.

961
Spring Dust Weather in North China Linked to Sea Ice in the Barents Sea

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The link between winter sea ice cover in the Barents Sea (SICBS) and the frequency of spring dust weather over North China (DWFNC) is investigated. It is found that year-to-year variability of SICBS and DWFNC are strongly correlated for the period 1996-2014, whereas the correlation between SICBS and DWFNC is not statistically significant for the periods 1980-1995. During 1996-2014, low winter SICBS is associated with decreased snow cover over western Siberia (SCWS) in both winter and spring, which is also supported by a strengthening relationship between winter SICBS and spring SCWS since the mid-1990s. This leads to changes in atmospheric circulation and climate conditions that are favorable for increased frequency of dust weather events over North China. Our further analysis suggests that the interannual variability of the standard deviation of SICBS has intensified and the center of actions has moved eastward to the north Barents Sea and Kara Sea since the mid-1990s. Such change may easily induce stronger and southward stationary Rossby wave, influencing the dust-related atmospheric circulation (strengthened East Asian subtropical jet, increased cyclogenesis, and larger atmospheric thermal instability). Thus interannual variation of winter SICBS plays an increasingly important role in dust-related climate conditions over North China, which might serve as a new precursor for the prediction of spring dust activity in North China.

614
A Physical Mechanism for Indian Summer Monsoon Influence on Arctic Sea Ice

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Polar sea ice is a dominant component of the climate system and its the variability can cause great impact on global climate. In the recent past, Arctic witnessed many years of rapid sea ice loss. The reason for such a decrease has been attributed to both natural and anthropogenic drivers, though uncertainty remains. The aim of the present study is to understand whether there exists any relation between Indian Summer (June-September(JJAS)) Monsoon (ISM) and September Arctic sea ice retreat. The motivation behind the study is the findings from the analysis of 48 years of Hadley Centre sea ice and APHRODITE precipitation data, which indicated that during most of the strong (weak) ISM years, the Arctic sea ice increased (decreased) particularly over the Chukchi and Beaufort Sea during September. Further analysis with atmospheric parameters (height anomalies and wind divergence) from NCEP/NCAR reanalysis data showed that strong (weak) ISM is accompanied by positive (negative) phase of Summer North Atlantic Oscillation (SNAO) due to the contribution from strong/weak ISM, causing strong convergence/divergence over the upper/lower levels of the Mediterranean-Sahara region through monsoon-desert mechanism. This has great impact on the summer Azores high and SNAO which affects the Arctic circulation and sea ice. The link is supported by correlation with ISM index and sea level pressure. Thus, a tropical-polar teleconnection mechanism between ISM and Arctic sea ice is proposed.

661
Elucidating the Effects of Arctic Sea Ice Loss on Northern Hemisphere Climate

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The decline of Arctic sea ice is an integral part of anthropogenic climate change. Sea ice loss is already having a significant impact on Arctic communities and ecosystems. Meanwhile, there is also intensive scientific interest in considering its role as a cause of climate changes outside the Arctic. Evidence is mounting that Arctic sea ice loss can affect weather and climate throughout the Northern Hemisphere.
To fully capture the remote impacts of Arctic sea ice loss, models that simulate interactions among the ocean, sea ice, land and atmosphere are required. A synthesis of six such experiments with different models shows consistent hemispheric-wide atmospheric warming, strongest in the mid-to-high latitude lower troposphere and tropical upper troposphere; an intensification of the wintertime Aleutian Low and Siberian High; and a weakening and southward shift of the midlatitude westerly winds in winter. Fuller diagnosis of the tropical upper tropospheric warming response to Arctic sea ice loss suggests a critical role for ocean heat transport changes. Freshening of the subpolar Arctic due to sea ice melt reduces the strength of the Atlantic Meridional Overturning Circulation (AMOC) and associated northward ocean heat transport, causing a build-up of heat in the tropical oceans. The resulting increase in tropical sea surface temperature enhances atmospheric deep convection and associated latent heat release, leading to tropical upper tropospheric warming.

942
Changes in Climate Trends in the Antarctic Peninsula Region

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The largest climate warming in the Southern Hemisphere since the middle of the last century is observed in the Antarctic Peninsula in the winter months. Decadal variability of the winter temperature on the regional scale has been analyzed by SCAR READER datasets from the four stations in the Antarctic Peninsula region. Wavelet transform and Fourier analysis reveal both interannual (3-8 years) and decadal (10-20 years) temperature oscillations. Running correlation shows decadal variability in the Antarctic Peninsula winter temperature coupling with the central tropical Pacific. This variability is associated with intensity and persistency of the meridional wavetrain of stationary planetary waves, along which tropical disturbances propagate poleward reaching the Antarctic Peninsula. The period of the most significant tropical effects is 1980s-1990s, when the most rapid winter warming at Faraday/Vernadsky station was observed. One of the components of the winter temperature change on the Antarctic Peninsula is a 16-year periodicity with the amplitude of about 1°C, which also contributes to regional climate change. Absence of 21st century warming on Antarctic Peninsula discussed in the recent works can be partly caused by minimum in this periodicity.

AC-1a - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions
19.06.2018 09:00-10:30, C Sanada I

360
Effect of Arctic Sea Ice on Aerosols in Eastern Lapland, Finland

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Changes in sea ice are likely to affect the aerosols in the continental Arctic. We calculated linear regressions to median aerosol concentrations and mode peak diameters at SMEAR I in eastern Lapland, Finland, as a function of time over sea ice (TOSI), time over open sea (TOOS) and time over land (TOL). We divided the data into summer (Jun-Sep) and winter (Oct-May) as well as NAO and AO positive and negative phases.
During summer, the total aerosol number, Aitken mode and accumulation mode concentrations were decreasing with increasing time the air mass spent over the sea ice by -8.9, -5.3 and -1.6 $cm^{-3}h^{-1}$, respectively. The Aitken mode diameter was decreasing -0.3 nm/h and the accumulation mode diameter -0.5 nm/h. Accumulation mode concentration and diameter increased by +0.8 $cm^{-3}h^{-1}$ and +0.3 nm/h, respectively, as a function of TOOS. During winter there was a decrease in total, nucleation mode and Aitken mode concentrations (-1.3, -0.3, -0.6 cm^3/h, respectively) as a function of TOSI. Accumulation mode concentration and diameter were decreasing by -0.4 $cm^{-3}h^{-1}$ and -0.2 nm/h as a function of TOOS.
We conclude, that Arctic sea ice has strong impact on the aerosol concentrations in eastern Lapland, and the changes in the sea ice extent and time that the air parcel spends over sea ice can have an influence on the aerosol-cloud interactions in the continental Arctic. The concentrations of potential CCN have contrasting trends with decreasing sea ice during summer and winter.

822
Enabling Atmospheric Process Research at MOSAiC

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The Arctic is undergoing substantial change, embodied by diminished sea-ice cover, which is opening the region to enhanced human activities requiring an improved ability to model the system on many temporal and spatial scales. Atmospheric processes pose some of the greatest challenges to modelling the Arctic due to a dearth of detailed observations and the overall complexity of atmospheric processes and their interactions. Specific challenges involve clouds, aerosols, precipitation processes, the boundary layer, and the roles these play in the surface energy budget. The Multi-disciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) will provide a unique opportunity to examine atmospheric processes and their role in the coupled Arctic system in great detail over a full year. Atmospheric measurements will target science themes including: (1) Sea-ice surface energy budget; (2) cloud and precipitation properties; (3) aerosol concentration and composition; and (4) the stable and unstable atmospheric boundary layer. These measurements will enable a process-level understanding of the Arctic system and specifically coupled processes involving the atmosphere. They will also provide the basis for evaluating and improving process models and process representations in larger-scale models. This presentation will introduce the MOSAiC atmosphere measurements and explore specific scientific process-based analyses that they will enable.

On behalf of the MOSAiC Atmosphere Team International Consortium

1009
Aerosol Variability Linked to Clouds and Precipitation in the Sor Rondane Area

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Since 2010, continuous measurements of the aerosol number size distribution and total number, and of the aerosol absorption and total scattering coefficient within the boundary-layer have been realised at the Belgian research station Princess Elisabeth, in the Sør Rondane Mountains, East Antarctica (72° S, 23° E, 1390 m asl). In addition, an automatic weather station, a ceilometer (cloud base height and type) and a micro-rain radar (precipitation observation) have been installed for continuous operation. In December 2015, a MAX-DOAS instrument has been installed for the retrieval of the vertical profile of the aerosol extinction coefficient. Backtrajectory calculations for air mass origin complemented the dataset.
The aerosol total number concentration N_{total} showed a clear seasonal cycle with some hundreds of particles/cm^3 during summer and some tens of particles/cm^3 during winter. Frequently, N_{total} increased distinctly during short periods (hours to one/two days; up to some thousands of particles/cm^3), with particles smaller than 90 nm responsible for the increase. Three types of such events could statistically be distinguished and each of it with distinct meteorological, cloud and precipitation conditions. Clear changes of the spectral dependency of the absorption coefficient could also be linked to distinct meteorological conditions. The atmospheric stability parameter, MAX-DOAS and radio sounding observations help to link boundary-layer observations and higher levels.

1475
The Effect of Cloud Microphysics on the Surface Energy Balance of Larsen C

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Clouds are a poorly constrained component of the Antarctic climate system, yet their importance is huge. Antarctic clouds have a significant impact on the surface energy balance (SEB) of ice shelves, with consequent effects on melt rates. Cloud microphysics greatly influence cloud radiative properties and therefore the SEB, but there is a paucity of data due to the difficulty of making microphysical measurements in Antarctica. However, ice shelves around the peninsula are undergoing considerable change: the most recent example of this is the Larsen C ice shelf. Larsen C's stability may be diminishing following prolonged melting and surface lowering, as well as the loss of ~12% of its volume in a single calving event in July 2017. Understanding the drivers of change hinges on the development of atmospheric models that skilfully represent key (micro)physical processes, and which more accurately predict surface melting and ice shelf collapse for future climate change scenarios. In this work, we examine aircraft-based microphysical observations from campaigns over the Antarctic Peninsula. Specific case studies are identified and compared with model simulations using the Met Office Unified Model at 1.5 km grid spacing. We present preliminary findings and initial analysis, as well as directions for future work. Our process-based approach could contribute to an improved understanding of Antarctic clouds and reduced uncertainty in estimates of polar change.

1561
Impact of Meteorology on Aerosols and Clouds in the Antarctic Peninsula

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Atmospheric aerosol particles are an integral part of the climate, having effects on water-, carbon-, and nutrient cycles, the amount of solar radiation entering the surface and changing the amount of cloudiness and rain, as well as the properties of clouds. To understand the inter-annual characteristics of the aerosols in Antarctic Peninsula and their interaction with the Antarctic clouds and climate, we have studied aerosol particle physical and chemical properties in the Peninsula continuously since year 2013. Furthermore, we have studied the low-level clouds and fog, along with the aerosol profiles using a Vaisala ceilometer, operating since year 2016. These measurements are run in Argentinean station Marambio.
Our long-term analysis of aerosol optical properties and chemistry have shown clear patterns with 1) more chemically rich aerosol in summer with the origin in the Southern Ocean, 2) higher average aerosol scattering during winter as a result of stronger storms, resulting in dispersion of marine and soil particles in wind-driven processes, and 3) importance of primary aerosol sources, especially in winter. Currently, we are analyzing the presence of fog and low-level clouds using the ceilometer data. Our observations indicate several fog episodes during the Antarctic summer season. During these episodes, the scattering parameters present variability, suggesting an impact of aerosol cloud processing. How systematic these changes are, and is yet to be confirmed.

2598
Aerosol and CCN Properties and Sources in East Antarctica during Austral Summer

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Aerosol measurements were carried out in the framework of the BACCHUS-project (project number: 603445) at the Princess Elisabeth Antarctica Research Station during three Antarctic summers (Dec. 2013 - Feb. 2016). The total particle number concentration (N_{CN}) and the Cloud Condensation Nuclei number concentration (N_{CCN}, @ supersaturations (SS) between 0.1 and 0.7%) were determined using a Condensation Particle Counter and a CCN counter, respectively. Particle number size distributions were measured between 90nm and 7µm using an Optical Particle Counter. By applying the κ-Köhler-Theory (Petters and Kreidenweis, 2007) we determined a median hygroscopicity parameter κ of 1 (@ SS=0.1%). To investigate the influence of the air mass origin on N_{CN} and N_{CCN} we applied the dispersion model NAME and the Potential Source Contribution Function. In both methods we looked at the air mass history of the past 10 days. The NAME dispersion footprints were analysed for the proportional temporal stay in the surface layer (0-100m) over different categorized areas (continental, ocean and a reactive zone, including chlorophyll, penguin and sea ice zones). We found an Antarctic background of 200 to 400 #/cm³ for N_{CN}. Only the occurrence of none continental air masses lead to an enhanced N_{CN}. In terms of N_{CCN} this correlation in less clear, which might be attributable to sinks due to cloud processes. N_{CCN} covers a range between less than 10 at SS=0.1% and several hundreds #/cm³ for larger SS.

BE-4a - Climate change and ecosystems: physiology, biodiversity and ecological functions 19.06.2018 09:00-10:30, C Sanada II

2699
Impacts of Climate Change on Antarctic and Southern Ocean Species and Ecosystems

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Climate change resulting from greenhouse gases and/ or ozone depletion is presenting in a myriad of ways in Antarctica, the subantarctic and the Southern Ocean. Effects including localised warming, cooling, altered precipitation patterns, increased wind speeds, shifts in location of low pressure systems and extreme events are being documented. Associated changes in species and ecosystems are now emerging including localised species and ecosystem collapse, colonisation of new ground, shift in ranges, and species responses with various lag phases. In this talk we will examine the variety of species and ecosystem changes recorded, and demonstrate our development of species and ecosystem impact qualitative models.

965
Recent Species and Functional Diversity Dynamics across the Tundra Biome

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Widespread changes in temperature and precipitation have the potential to drive substantial shifts in tundra biodiversity, with important implications for the functioning of these ecosystems. We combine three decades of tundra plant community surveys at nearly 200 Arctic and alpine locations with 75,000 tundra plant trait observations to explore changes in both species and functional diversity in response to recent climate change. We find little evidence of consistent changes in species richness, but substantial community turnover over time in both species and functional composition. Our results suggest that the strongest impacts of near-term climate warming on tundra biodiversity-ecosystem function relationships will occur through changes in composition rather than diversity *per se*.

793
Tara Oceans: A Pan-arctic View on Plankton Diversity and Community Structure

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The *Tara* Oceans expedition, a global-scale study on the diversity and structure of planktonic ecosystems, conducted its circumpolar field campaign in the Arctic Ocean during the summer of 2013 (May-October). Sampling was conducted on board the research schooner '*Tara*', covering diverse environmental conditions on Arctic shelves. The result is a rich data set that includes DNA and RNA sequences of viruses, prokaryotes and eukaryotes for metabarcode, metagenome and metatranscriptome analyses, particle composition from imaging (phytoplankton, zooplankton and detritus) and 25,000 km of high-resolution inline measurements of physical, chemical and optical properties of surface waters (temperature, salinity, pCO_2, pH, Mercury, absorption and scattering), as well as other water column parameters (nutrients, light, DOM, HPLC pigments). We will provide an overview of the sampling program and data sets that are available, and highlight on-going research foci and major results. Particularly, we will show the pan-Arctic distributions and diversity of plankton (unstructured (generalist) vs. localized geographic distributions) as well as cross-comparison of Arctic plankton diversity with results already reported for the global ocean in the special issue of Science dedicated to the *Tara* Oceans project (22 May 2015). Such direct comparisons are possible thanks to the use of common sampling protocols and analytical pipelines at global scale.

333
The Way to the Top: The Drivers of Cold-climate Range Shifts in Plants

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Until now, non-native plant species were rarely found at high elevations and latitudes. However, partly due to climate warming and increased human presence in these cold environments, both non-native species and upward moving natives are now on the rise. These rapid shifts in distributions in what is often seen as a slow-reacting ecosystem make it timely to undertake a thorough assessment of what drives them, in order to accurately predict their future in a changing world. Here, we show the results from a series of observations and experiments in the subantarctic Andes and subarctic Scandinavian mountains. We assessed the role of human interventions (i.e., disturbance, nutrient increase and propagule input) and climatic factors on shifts in plant species distributions, with our integrative approach allowing us to tease apart the mechanisms. By acknowledging the interactions of the plants with small-scale abiotic
(e.g. microclimate, soil properties) and biotic (e.g. mutualism, competition) factors, we found that disturbance plays a defining role along all elevation gradients, a.o. through its effects on soils, biotic interactions, microclimate and seed influx. Undisturbed vegetation, on the other hand, was surprisingly hard to colonise by new-comers. These results -consistent within both our observational and experimental studies - suggest that sub(ant)arctic ecosystems are still relatively resistant to change, unless disrupted by anthropogenic disturbances.

AA-1b - Astrophysics and Astronomy in the Polar Regions
19.06.2018 11:00-12:30, A Studio

2637
Status and Future of Cosmic Microwave Background Measurements from Antarctica

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Measurements of the CMB have driven our understanding of the universe and the physics that govern its evolution from quantum fluctuations to its present state. They provide the foundation for the remarkable 6-parameter cosmological model, ΛCDM. Far from being the last word in cosmology, the model raises deep questions: Is Inflation correct? What is its energy scale? What is the dark matter? What is the nature of dark energy? Are there light sterile neutrinos, or other light relics? There remains a great deal more to learn from the CMB, especially from its polarization. South Pole experiments have have helped pioneer polarization studies, starting with the DASI detection of E-mode polarization, to the SPT detection of lensing B-mode, to BICEP/KECK's best limits on the level of B-mode polarization generated by inflationary gravitational waves. This talk will briefly review the current state of the art and then outline the plan for the next generation ground based CMB experiment, CMB-S4, stressing the critical role planned for measurements from the Antarctic.

2476
Spectral Distortions of the Cosmic Microwave Background from Dome-C

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COSMO (COSmological Monopole Observer) is a spectrometer aimed at detecting spectral distortions in the Cosmic Microwave Background (CMB). The spectrum of the CMB is a precise blackbody (within 100 ppm of the maximum brightness, as measured by the FIRAS experiment on the COBE satellite). According to theory, however, small spectral distortions must be present. Their measurement represents one of the very few ways to investigate the early or very early universe. The main challenge in this measurement is the presence of instrumental, atmospheric and astrophysical foregrounds, which must be minimized or carefully evaluated to estimate the spectral brightness of the CMB with the required accuracy. COSMO is a differential Fourier-transform spectrometer (DFTS) comparing the brightness of the sky above Dome-C to the brightness of a grey-body which, in the spectral range of interest mimics the brightness of the atmosphere. The DFTS is cooled at 4K to reduce its emission, and feeds two arrays of Kinetic Inductance Detectors covering the 1.3mm and 2.0mm atmospheric windows with a spectral resolution of 2 GHz. Accurate atmospheric modelling and template fitting allow to separate CMB spectral distortions from the other brightnesses. In a few months of integration, during the Antarctic winter, we expect to be able to detect a comptonization-like distortion with y at the level of a few ppm. See http://planck.roma1.infn.it/cosmo for info and a full list of collaborators.

2450
SWIPE-LSPE: Cosmic Microwave Background Polarimetry in the Polar Night

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The Large-Scale Polarization Explorer is a coordinated ground-based and balloon-borne effort to measure Cosmic Microwave Background (CMB) polarization at the largest angular scales, where cosmic inflation left its imprint in the form of a curly pattern (B-modes) of linear polarization. In this scenario the measurement of B-modes represents a way to study physical phenomena happening a split-second within the big bang, at energies which are not reacheable on Earth. The Short Wavelength Instrument on the Polarization Explorer (SWIPE) is in an advanced phase of preparation, to be launched from Svalbard in a long-duration stratospheric flight in the polar-night. The instrument features an array of 330 multi-mode TES bolometers, cooled at 0.3K, and collecting a total of 8800 modes of the CMB. The frequency bands of the detectors have been selected to optimize the sensitivity to CMB signals (with a 33% wide band at 140 GHz) while removing efficiently the polarized dust foregorund (with two 5% bands at 220 GHz and 240 GHz). The detectors are fed by a 50 cm refractive telescope; polarization modulation is achieved through a magnetically levitating spinning HWP, the first element in the optical chain. In a two-weeks-long flight flown from Longyearbyen in the polar winter SWIPE aims at a sensitivity to the tensor to scalar ratio r=0.01, roughly 10 times better than current upper limits. See http://planck.roma1.infn.it/lspe for info and for the full list of LSPE collaborators.

1476
Latest Results from IceCube

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The clear ice below the South Pole has proven to be an excellent medium for neutrino detection. In December 2010 the IceCube collaboration completed the deployment of over 5000 optical sensors at depths between 1450m and 2450m below the South Pole surface. The sensors detect the light which is produced when neutrinos interact in the ice or surrounding bedrock. Soon after completion, the IceCube telescope provided a breakthrough for the astroparticle community, with the first detection of astrophysical neutrinos reported in 2013. In the ensuing years IceCube has provided many more results over its wide physics portfolio. The success of IceCube has motivated plans for the extension of the current instrumentation. In this talk I will provide an overview of the latest results from the IceCube collaboration and the plans for a near-term upgrade to IceCube, and for a next-generation IceCube-Gen2 detector.

2481
The Askaryan Radio Array - Neutrino Astronomy at the South Pole

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The glacial ice at the South Pole offers ideal conditions for the detection of high energy neutrinos. The Askaryan Radio Array seeks to discover extremely high energetic cosmic neutrinos. The goal is to understand the origin of highest energy cosmic rays and there cosmic accelerators. I will report about new developments, new instruments deployed in the 2017/18 field season, current results and the vision for a very large array.

481
Measurements of Radio Emission of Cosmogenic Neutrinos in the Antarctic Ice

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The most-energetic atomic particles known today, ultra-high energy cosmic rays, are created in yet unknown astrophysical objects. A key ingredient to finding their origin will be the measurement of neutrinos of energies higher than reachable with current detectors. The only feasible way forward is to detect the faint radio emission that is associated with a neutrino interaction. To obtain the necessary sensitivity several tens of cubic kilometers of material will have to act as detector. A detector of this size is also likely to be extremely sensitive to neutrinos from explosive events such as recently observed in gravitational waves. An optimal place for such a detector is the polar ice, which is transparent for the radio emission in the MHz regime. Several pilot-stage experiments run in Antarctica to test the necessary hardware and different detector concepts. Following a number of unexpected observations, also detailed measurements are being performed that aim to study the propagation of radio waves in the ice, including the possibility of horizontal propagation of signals. We will report on the current efforts, focusing on the ARIANNA HRA that has been deployed in Moore´s Bay on the Ross Ice-shelf and the perspectives of radio detection of neutrinos.

OS-6b - Polar Ocean Dynamics
19.06.2018 11:00-12:30, A Forum

2241
Why Is Antarctic Bottom Water Disappearing?

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Antarctic Bottom Water (AABW) has warmed, freshened and reduced in volume in recent decades. Changes are largest near Antarctica but have spread through much of the abyssal ocean. The magnitude of the changes are sufficient to make a substantial contribution to sea level rise and global energy budgets. However, the causes of the widespread warming and freshening of AABW remain poorly understood because observations are sparse near sources of AABW. The natural experiment resulting from calving of the Mertz Glacier Tongue in 2010 provides insight into polynya dynamics and bottom water change. Changes in the regional icescape after calving reduced the size and activity of the polynya, leading to a sharp reduction in the salinity of dense shelf water formed in winter. This signal propagated to the deep ocean, where a twenty year time series of abyssal water properties confirmed a sharp reduction in the density of AABW. Freshening of the dense shelf water caused warming of the AABW, a result explained by mixing of less dense overflows with ambient waters offshore. Oxygen levels in the AABW remained high, suggesting that the new lighter variety of AABW was still sufficiently dense to reach the sea floor and continued to ventilate the abyssal ocean. The results highlight the sensitivity of AABW formation and ventilation to changes in surface forcing. Early results from a pilot array of deep Argo floats deployed to track change in AABW properties will be presented.

1167
Sources of Southern Ocean Freshening Inferred from Oxygen Isotope Data

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Long-term hydrographic observations of Southern Ocean waters reveal a substantial freshening signal in Antarctic surface, intermediate, mode and bottom waters over recent decades. These changes have been associated with a redistribution of freshwater by sea ice, an increased glacial meltwater flux from Antarctica, and a potential increase in precipitation or ocean circulation changes. However, large uncertainties in the magnitude and spatial pattern of the surface fluxes confound a quantification of their relative contribution to the observed salinity changes. The stable isotopic composition of the seawater provides an alternative measure of the contribution from these different freshwater sources, since it carries the characteristic imprint of the surfaces processes in the source region. We analyze a newly-compiled dataset of salinity and oxygen isotope samples from the Southern Ocean from the 1970s to the present. In particular, we investigate the hypothesis that sea-ice freshwater fluxes strongly imprint on water masses formed in the seasonal sea-ice zone, and that larger signals of meteoric freshwater can be found in water masses formed over the continental shelf and north of the Subantarctic Front. We discuss decadal changes in these respective contributions, which provide new insights into the driving processes of recent changes in the Southern Ocean properties and structure. These changes critically influence its ability to take up anthropogenic heat and carbon.

148
Sea Ice Variability and Predictability in the Nansen Basin

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Rapid loss of Arctic sea ice is a clear indicator of climate change. Predicting future change based on mechanistic understanding of air-ice-sea processes would be desirable in many regards, and this study investigates how warm Atlantic water directly influences the Arctic sea ice cover. We particularly assesses observed winter sea ice area variability and predictability in the Nansen Basin where the Atlantic water encounters the Arctic sea ice. Observations from the Norwegian Young Sea Ice Cruise in winter and spring 2015 show a well-mixed low salinity surface layer, with its freshwater predominately from sea ice melt moving in tandem with the Atlantic water below. Rooted in observations, we present a conceptual model to assess the sea ice variability and water mass transformation in the Nansen Basin. We find that Atlantic water melts approaching sea ice and thereby transforms into a low salinity surface layer locally. An imbalance between Atlantic heat, heat loss to the atmosphere, and heat needed for sea ice melt causes variations in the sea ice cover. Based on the proposed framework, we show that the variability of winter sea-ice area in the Nansen Basin may be skillfully predicted 1-3 years in advance from observed Atlantic water hydrography upstream. The framework generally captures the observed sea ice variability since the1970s, and we predict that the winter sea-ice cover in the Nansen Basin will be close to its climatological mean in 2018 and 2019.

1526
Connection of the Sea Ice Drift in the Arctic Ocean with the Synoptic Processes

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The condition of ice formation and the temporal structure of ice cover variability are not homogeneous in the Arctic ocean and depends on the dynamic processes. Transpolar drift and Beaufort gyre have time cycles with a predominance of different frequencies in the Eurasian and Amerasian parts of the Arctic Basin. The intensity and the position of the Transpolar drift and the center of the Beaufort gyre is changing from year to year, creating the conditions for various ice distribution and ice removal.
Different types of sea ice circulation is formed under the influence of atmospheric pressure and wind fields over the Arctic Ocean. The survey of predominant synoptic types in each year led us to allocation of the types, that can create the conditions for ice accumulation (at an agreeable temperature range), for ice removal and for the sea ice opposition formation.
The authors dissected the long-term changes in the atmospheric circulation and ice drift fields, basing of the satellite data, the ice drift fields calculation (1979-2016) and synoptic types catalogue, and launched the estimation of the relationships between ice drift fields changing and variability of the ice cover fluctuations in the last decades.

576
Large Eddy Simulations of the Ice Shelf-ocean Boundary Layer

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The rate of melting at the base of an ice shelf is primarily controlled by oceanic processes that occur on very small scales, namely the diffusive and turbulent fluxes of heat and salt through the viscous and turbulent regions of the ice-ocean boundary layer. These processes are too small in scale to be resolved in the present regional ocean models. Instead, heat and mass transport to the ice-ocean interface is parameterised using bulk transfer coefficients, which determine the interface conditions based on the properties of the ocean interior. Here we investigate the complex, dynamic processes inside the ice-ocean planetary boundary layer beneath an Antarctic ice shelf and estimate basal melt rates using resolved Large Eddy Simulations. Fluxes through the boundary layer are adequately captured, negating the need for parameterisations in the treatment of melting. We force the simulation with oceanic conditions observed in mooring data from beneath the Amery Ice Shelf. The resultant melt rate is consistent with the melt rate measured *in situ* at the same site. These results can be used to improve the ice-ocean parameterisations in regional ocean models.

823
Ice Shelf Meltwater Pump Contribution to Vertical Exchange around Antarctica

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Satellite estimates of chlorophyll in Antarctic coastal polynyas are strongly correlated with the basal melt rate of adjacent ice shelves. This has led to speculation that the high productivity of coastal polynyas may be related to the release of the limiting micronutrient iron from melting ice shelves.
Strong basal melting of ice shelves can drive a vigorous overturning circulation within an ice shelf cavity ("meltwater pump"). We use a high resolution (1.5 km) ocean/sea-ice/ice shelf model of the Amundsen Sea to examine the effects of this mechanism over the broader Antarctic continental shelf. Four plausible sources of dissolved iron are simulated with independent tracers, assumptions about the end member concentrations, and an idealized summer biological uptake. While direct injection of iron from melting ice shelves is an important contributor to the total dissolved iron supply in the adjacent polynya surface waters, there is an even larger contribution from "deep" sources of iron on the shelf (sediments and Circumpolar Deep Water). The Amundsen Sea is not a strong dense water formation region and sensitivity experiments show that the meltwater pump is far more effective than winter vertical mixing in bringing dissolved iron into the upper water column. The effect of the meltwater pump on vertical mixing is expected to be heterogeneous around Antarctica and experiments examining this were performed with a coarser resolution (5 km), circum-Antarctic model.

BE-1b - From boots to bytes: 'omics' tools for microbial diversity and biogeography
19.06.2018 11:00-12:30, A Dischma

470
A Computational Pipeline for Taxon, Gene and Allelic Analysis of Microbial Omics

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For environmental studies using high-throughput sequencing technologies, data analysis is now the limiting step in furthering our understanding of structure and function of microbial communities. There are several tools that facilitate the visualisation and analysis of such complex data, such as MEGAN and MG-RAST, but these focus on the taxonomic and high-level (gene ontology) functional annotation of individual shotgun sequences.
We have developed a pipeline to efficiently annotate assembled metagenome contigs using DIAMOND blast, to map raw reads back to their identified gene models and to identify significant differential gene abundance using a flexible General Linear Model. The approach relies on assembling all samples to create a common reference (metagenome or metatranscriptome) on which all DNA/RNA sequences can be mapped and quantified. Users can perform taxon and gene-wise statistical analyses of microbial communities and examine taxon * gene interactions. Differential abundance of functional Single Nucleotide Polymorphisms (SNPs) between sample factor levels is also included: a hitherto unexplored source of variation.
To demonstrate the utility of this approach and how it can be used to analyse complex data, such as microbial communities with geochemical data from different biogeographic regions, we present an analysis of microbial diversity and gene variation in samples from glacial forefield chronosequences collected from Greenland, Svalbard and Sweden.

2065
Keystone Arctic Microbial Genomes Linked to the Dynamics of Phytoplankton Blooms

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Microbial community composition in the north polar waters varies greatly throughout the year. Spring melting of the ice and increase in light disposal spur the bloom of phytoplankton, taking over the functional and phylogenetically diverse bacterioplankton communities of dark and cold winter waters. Mainly heterotrophic and photoheterotrophic bacterial populations feed on the nutrients derived from the phytoplankton bloom during summer. With fall´s shorter light hours and colder seawater temperatures, the bacterial community shifts to those chemolithoautotrophic that will prevail during winter. TaraOceans navigated around the north polar waters extensively sampling the microbial plankton communities during spring, summer and the beginning of fall (May to October 2013). We have generated around 900 microbial metagenomic assembled genomes (or MAGs) from the combination of the 41 sequenced metagenomes, which cover the whole polar circle from spring to the beginning of fall. Together with the physical and chemical information of all stations we are capable of detecting the distribution of the different keystone prokaryotic taxa around the pole and through the seasons at maximum resolution possible, at genome level, with a particular focus on the genomics and metabolic potential of those following the phenology of phytoplankton blooms.

694
Biodiversity of Endolithic Communities in Battleship Promontory, Antarctica

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The McMurdo Dry Valleys (Southern Victoria Land) constitute the most extensive ice-free area in Antarctica, represent the coldest, driest and windiest desert on Earth; they are considered the closest Martian analogous habitat on Earth, exhibiting extraordinary aridity, low temperatures, wide thermal fluctuations, low nutrient availability, seasonal increased UV radiation, and geographical isolation. In this study, we investigated both bacterial and fungal components of lichen-dominated communities in Battleship Promontory, McMurdo Dry Valleys. Nine rock samples were analyzed with a meta-barcoding approach on Illumina platform coupled, targeting the V4 of 16S and Internal Transcribed Sequence 1 (ITS1) regions for bacteria and fungi respectively. Taxonomic results, alpha-diversity and statistical analysis were performed to investigate microbial diversity and community structure to optimize sampling amplitude for a proper and exhaustive biodiversity description. Preliminary results show a large predominance of phylotypes belonging to the phylum Actinobacteria in bacterial compartment, while Ascomycota, with the classes Lecanoromycetes and Dothideomycetes prevail among fungi. Bacterial was higher than fungal richness (517 OTUs and 189 OTUs, respectively); both these microbial components showed a 'core' of recurrent species (OTUs present in at least 75% of samples) among all samples.

1132
Ice Microbiome: From Antarctic Glaciers to Alpine Ice Caves

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Environmental changes due to recent glacier retreat phenomenon are expected to challenge the structural and functional variability of ice microbiomes, with different impact on specific glacial habitats.
Our comparative study of Antarctic glaciers and Alpine ice cave investigated the bacterial and fungal diversity from glacier transects and subglacial water flows of Barton and Weaver peninsulas from King George Island, and a 13,000-years old ice chronosequence of Scarisoara ice cave. Illumina sequencing of 16S rRNA and ITS2 genes indicated major differences in microbial composition correlated with the habitat type, spatial distribution, geochemistry and age of ice.
Glacier ice showed lower diversity relative to subglacial water and cave ice. *Proteobacteria* clearly dominated all Antarctic samples, while the major phylum of cave ice block alternated between *Proteobacteria, Bacteroidetes, Actinobacteria*, *Firmicutes* and *Cyanobacteria* based on the age, organic content and light exposure of ice layers. Different Beta/ Gamma-*Proteobacteria* ratios were specific for Antarctic ice/water and cave ice of different age. *Acinetobacter* and *Polaromonas* prevailed in all Antarctic samples with a relative abundance depending on sample type and location. Fungal community analyses based on ITS2 sequencing, currently under way, will complete the comparative microbiomes overview of these icy habitats, and their response to environmental variables.
Funding: H2020 ELAC2014/ DCC0178 and PN16190105

1128
Metabolic and Community Changes Underpinning life Phase Transition of Snow Algae

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Snow algae communities consist mainly of green algal species of the genera *Chlamydomonas* and *Chloromonas*. They have a bi-phasic life cycle consisting of an active reproductive motile stage, seen as green patches in the snow, and a dormant encystment phase during which the cells accumulate the red keto-carotenoid astaxanthin, giving rise to red snow patches. We measured the metabolic composition of snow algae in both green and red phases, from samples taken in the field at various locations in Antarctica during the 2014/15 and 2017/18 austral summer seasons. We also determined the community composition of the blooms using 16S and 18S metagenomic sequencing. Our data showed that the metabolic composition of the cells was the same from four geologically distinct but spatially close locations in the vicinity of Ryder Bay (Adelaide Island, 68°S). However, our data also show a high degree of patchiness in the snow melt between the locations where snow algae communities occurred, from mean values of 0.5 g dry algae per L of snow melt at Lagoon Island to 3.25 g dry algae per L of snow melt at Léonie Island. Our metabolite data showed that the snow algae were rich in unsaturated fatty acids and that metabolomic assays could detect detailed changes in lipid, carbohydrate and protein chemistry in the cells during encystment. These Antarctic data are compared to similar community studies carried out in Arctic ecosystems.

SH-1 - Environmental Protection, Resource Rights and Evolving Geopolitics in Antarctica
19.06.2018 11:00-12:30, A Sertig

59
The Legal Grounds of Territorial Claims in Antarctica: A Sober Assessment

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By virtue of the Antarctic Treaty, the territorial claims made by seven countries over the continent in the previous decades were “frozen”. Putting the question of sovereignty on hold, the Treaty and its related legal instruments came to be considered over the years as a diplomatic success, allowing peaceful cooperation in the continent, built around science and with the protection of the environment at its core. Notwithstanding, the original claimant countries have never surrendered their territorial aspirations, and they have been actively engaged in antarctic matters, signaling their ongoing interest through the establishment of bases, the organization of scientific expeditions, active participation in the ATMs, and so on and so forth. In this presentation, I examine the legal instruments and doctrines upon which these countries grounded their claims, and assess them from a normative perspective. I inquire, that is, into their reasonableness and legitimacy both then and today. Old international treaties, unilateral declarations and later transfers based on them, as well as international law doctrines tailor-made for imperialist powers—like contiguity and continuity—played a key role founding these countries' aspirations. But do they withhold scrutiny? I suggest that they do not, and that a sober evaluation of them would dramatically reduce their scope. I conclude with some thoughts on how this should lead us to rethink the territorial status of most of the White Continent.

366
Property Rights: A Solution to the Tragedy of the Commons in Antarctica?

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Antarctica brings to many minds an image of a peaceful no man's land: pristine environment and scientific cooperation. However, the reality is that Antarctica is one of the least environmentally protected regions on the planet: only 1.5% of the ice-free habitats on the continent are designated as specially protected areas. Unresolved territorial claims in Antarctica create a jurisdictional vacuum that leads to one of the worst cases of the tragedy of the commons. Climate change and improvements in technology foreshadow future exploration and exploitation of Antarctic resources. To avoid potential conflict there is a need for a normative guidance for management of natural resources on the seventh continent. This paper builds upon Dr. Margaret Moore's work on the theory of territory in unoccupied areas. Dr. Moore suggests that the question of “unclaimed” territory in Antarctica should not be seen as a territorial dispute, but rather a property one. She argues that resources in unoccupied territories have instrumental value and should be regarded as property. This paper discusses some practical implications of applying this property conception to the management of natural resources in Antarctica and whether doing so would strengthen environmental protections. The paper investigates potential roles that stakeholders other than nations, such as the private sector and international organizations, would play in the governance of natural resources in the property-rights scenario.

651
Protection of Antarctic Historic Sites and Monuments by Domestic Law

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In February of 2014 a 'historic first' in Antarctic Environmental Protection occurred: two visitors to Antarctica were tried and condemned to pay a fine of ten thousand Euros each, due to the damage caused to an object of protection by the Madrid Protocol: A Historic Site or Monument. This outcome, however, is not product of a direct enforcement of a provision of the Protocol -a non-self-executing agreement-, but rather the implementation of an Antarctic Treaty-Party's domestic law. Article 13 of the Protocol requires Parties to take appropriate measures within their competence to comply with it, including laws and regulations. On the other hand, Annex V regulates Antarctic Specially Protected and Managed Areas, which include Historic Sites and Monuments.
Would the outcome have been similar if the case had been tried by another Party? Is the protection of Historic Sites and Monuments effectively implemented by domestic law? Is there room for improvement? Could ATCM measures or recommendations broaden the protection of these sites?

2429
Environment Protocol Challenges and Achievements: 20 Years in force

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The Protocol on Environmental Protection to the Antarctic Treaty was signed in 1991 and entered into force in 1998. Its adoption was a reaction to the environmental damage risks of the mineral activities regulated by the Convention on the Regulation of Antarctic Mineral Resource Activities (signed in 1988, not yet in force). But it is also a result of the Antarctic Treaty System long-time evolution. The Protocol is a milestone in this international regime putting the environmental protection as a central aim of it.
Since 1991 and more clearly since 1998, important advances in this task have been achieved: the establishment of a group of environmental principles (article 3), the prohibition of mineral resource activities (article 7), the prior assessment of the environmental impacts of major activities (article 8), the establishment of the Committee for Environmental Protection (articles 11 y 12), or the environmental inspections (article 14).
However, there are still several challenges. Some of them are results of the Protocol structure like the activities that are not covered by it or its geographical scope or the number of States for whom it is compulsory. Others come from the new and changing environmental problems that it is necessary to confront. Finally, some come from the implementation of the Protocol itself and how the national domestic law applies its regulations and control its fulfillment.
All this challenges and achievements will be discussed.

2606
How Should We Justify Ecologically Sustainable Resource Rights in Antarctica?

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How should we justify resource rights within a cryosphere that is being transformed as a result of anthropogenic climate change? In light of the increasing environmental pressure on Antarctica in terms of ice-melt, illegal, illegal, unreported and unregulated fishing, as well as tourism, we need to rethink our way of theorising both territory and the legal regimes that govern it. This paper argues that territorial claims in Antarctica have to fulfil certain conditions of environmental responsibility and distributive justice. More specifically we need to
1) question the connection between political self-determination and the claims to huge territories in the Polar regions, and
2) rethink the justification of resource rights under conditions of extreme environmental vulnerability.
The Earth's natural resources and ecosystems are an environmental commons, and hence access to this commons and its services should be shared. However, several of the claimants in Antarctica are taking more than their fair share of these commons, especially in terms of carbon emissions. Consequently, any principle of ecological justice in Antarctica has to include some sort of benefit-sharing mechanism to ensure that any given claimant state realises its desired capabilities with the lowest impact on ecosystems. I end by scrutinising to what extent the justifications in the Antarctic Treaty could ground ecologically sustainable resource rights.

GG-2b - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
19.06.2018 11:00-12:30, A Schwarzhorn

2588
Multiple Evidence for Early Deglacial Ice Mass Loss in East and West Antarctica

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Based on recent studies conducted on well-dated deep-ocean, near-shelf- and ice-core records from both West and East Antarctica, we show clear evidence for a very dynamic deglacial behavior o the Antarctic Ice Sheet (AIS) with multiple retreat events in sync with global meltwater and climate events, contrary to scenarios developed earlier (e.g., Bentley et al., 2014).
Highly resolved deep-ocean records from Iceberg Alley indicate major AIS discharge events (AID) bracketing Meltwater Pulse 1A (AID6) and 1B (AID2), between ~14.7 - 11.3 ka (Weber et al., 2014). Also, a blue-ice field in the Patriot Hills area indicates marked AIS draw down (in excess of 650 m) and ice mass loss across the Weddell Sea Embayment during the Antarctic Cold Reversal (ACR, 14.7 - 12.7 ka) (Fogwill et al., 2017). Foraminiferal radiocarbon ages from shallow-marine sediment archives in the eastern Ross Sea (DeCesare et al., submitted) directly constrain discrete intervals of WAIS grounding line retreat of 30 km at 14.7 ka (AID6) and 200 km at 11.5 ka (AID2).
The data evidence combined with thermodynamic ice-sheet modeling (Golledge et al., 2014, 2017), confirm that the AIS was highly-dynamic and sensitive to ocean warming and/or sea level forcing that allowed rapid retreat of ice margins into the interior of the ice sheet. Our findings are important in light of current discussions on potential AIS collapse in the near future and its impact on sea-level rise for the coming decades to centuries.

2664
Northern Hemisphere Influence on Antarctic Ice Dynamics during Last Deglaciation

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Recent work suggests that the Antarctic Ice Sheet was highly dynamic during the Last Deglaciation. Weber et al. (2014)'s analysis of iceberg-rafted debris in ocean sediment cores from Iceberg Alley shows that Antarctic deglaciation was punctuated by a series of rapid ice discharge events (AIDs). An ocean thermal forcing has been proposed, but triggers for these events and their connection to global ice and climate changes are still being explored. There was up to ~130 m global mean sea level equivalent of additional grounded ice cover globally at the Last Glacial Maximum. The majority of this ice was in the Northern Hemisphere (NH), but there remains significant uncertainty in the timing and distribution of global ice cover during the Deglaciation. Rapid pulses of ice loss occurring in the NH that are not fully resolved in the geological record could have raised sea level in Antarctica significantly. We adopt the coupled dynamic ice sheet - global sea level model described in Gomez et al. (2013) to investigate the possibility that the AID events observed in Antarctica could have been triggered or enhanced by pulses of sea-level rise associated with NH ice loss. We present results of simulations of Antarctic ice sheet evolution through the Deglaciation driving by climate changes and a suite of punctuated NH ice histories, and highlight the possibility of inter-hemispheric teleconnection through a sea level feedback on marine ice dynamics.

1889
Weddell Sea Embayment Deglaciations Traced by Provenance of Ice-rafted Debris

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Here we present iceberg-rafted debris (IRD) provenance records from sediment core PS1571-1 in the NW Weddell Sea, and interpret these records in terms of the geographic sequence of ice sheet retreat in the Weddell Sea embayment during the last three deglaciations. We first characterize the geochemical and geochronological fingerprint of eroded debris from the source areas using: 1. Till in modern moraines at the edges of the Foundation Ice Stream, the Academy Glacier, and the Recovery Glacier; and 2. Subglacial till from cores along the front of the Filchner and Ronne Ice Shelves. Provenance tracers include $^{40}Ar/^{39}Ar$ hornblende and biotite thermochronology, U-Pb zircon geochronology, Nd isotopes, and clay mineralogy. Results so far indicate that samples along the front of the ice shelves record the fingerprint that would be expected from tracing ice flow lines back to the upstream bedrock terranes, and that the Ronne (west), Hughes (central), and Filchner (east) sectors have distinguishable provenance source fingerprints. In core PS1571-1, changes in IRD provenance reflect output of debris-laden icebergs during ice sheet retreats from the different sectors of the embayment through each deglaciation. Preliminary indications are that different sectors of the embayment tend to export glacially-eroded debris sequentially, rather than all at the same time, and that MIS-5 has more of a West Antarctic fingerprint than the other deglaciations.

826
Ross Sea Deglaciation - Environmental Reconstruction from the RICE Ice Core

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The Roosevelt Island Climate Evolution (RICE) project recovered a 763.6 m deep ice core to bedrock during 2011-2013 from Roosevelt Island (RI), at the northern edge of the Ross Ice Shelf. The ice at RI is grounded 210 m below sea level and accumulates in situ, with the Ross Ice Shelf flowing around the rise. High resolution radar surveys show well-developed Raymond Arches of isochrones suggesting a stable ice divide.
Here, we show isotope and geochemical data spanning the past 30 ka and discuss reconstructions of sea surface and air temperature, sea ice extent, atmospheric circulation patterns, and ice shelf grounding line retreat. An ensemble of sensitivity modelling experiments is used to determine thresholds for the removal of RI ice and correlated grounding line and ice volume changes of the Ross Ice Shelf and the West Antarctic Ice Sheet.
Our data suggest that the onset of the Ross Ice Shelf grounding line retreat during the deglaciation was driven at least in part by the early deglaciation in West Antarctica as recorded in the WAIS Divide ice core, perhaps through a freshwater feedback. The Ross Ice Shelf grounding line started to retreat rapidly with the initiation of an ice shelf cavity. Atmospheric circulation changes precede the onset of the Antarctic Cold Reversal (ACR) by about 200 years. Maximum ACR sea ice extent is reached at the termination of the ACR and is maintained into the early Holocene, a time period of rapid atmospheric warming and circulation changes.

626
Totten Glacier History in Continental Slope Sediments, East Antarctica

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Developing an understanding of how the Antarctic Ice Sheet responds to climate change will require data from the continent's major drainage basins, records that cover multiple glacial cycles and data on how the ocean and ice sheet interact. To achieve this coverage, sediment cores from the Antarctic continental slope will be needed. The Totten Glacier is a large outlet glacier in East Antarctica which is potentially vulnerable to accelerated melting. The glacier occupies a trough that extends deep into the East Antarctic interior and has displayed rapid thinning, which could draw down of some of the thickest ice in Antarctica. The 2017 Sabrina Seafloor Survey aimed to collect palaeoclimate records from the continental slope seaward of the Totten Glacier to study the interactions of this part of the ice sheet and the Southern Ocean over multiple glacial cycles. Multibeam bathymetry surveying identified large sediment ridges separating submarine canyons. Ridge morphology and seismic stratigraphy suggest that they are composed of canyon overbank deposits. Six long piston cores and 11 Kasten cores were collected. Five of the six piston cores contain cyclic sedimentary facies indicating records going back to Marine Isotope Stage 10 (~350ka.). A single core was aimed at a condensed section and may have sampled Pliocene to Early Pleistocene sediments. Preliminary analysis of the cores suggests that each glacial-cycle sampled has unique features.

On behalf of the Sabrina Seafloor Shipboard Party, Australian National University, Acton, Australia

Tue_280_GG-2_1479
Holocene Climate Evolution off Northern Victoria Land, East Antarctica

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Regionally representative records of how the Antarctic climate system evolved through the Holocene are an essential component of understanding the processes that drive the Antarctic climate. We present a high-resolution multi-proxy record of Antarctic paleoclimate evolution during the last 7,200 yr from a sediment core retrieved by the RV/IB *Araon* from Robertson Bay, a previously unstudied sector of the Victoria Land Margin. Using diatom assemblages, bulk sediment geochemistry, and the magnetic properties of RS15-GC57, we reconstruct Holocene climate variability at the interface between the East Antarctic Ice Sheet and the Southern Ocean.
A rapid transition at ~3,500 cal yr BP, constrained using novel ramped pyrolysis ^{14}C dating, is evident in all environmental proxies and is coincident with the Hypsithermal-Neoglacial transition recorded in sediment cores from Adélie Land, the Ross Sea, and the Antarctic Peninsula. A sea ice-associated diatom assemblage characterizes a discrete interval from 700 cal yr BP to modern, suggesting an environmental response to the Little Ice Age at the northern margin of the EAIS. High frequency (80-350yr) environmental variations, attributed to solar variability in previous marine Antarctic studies, are superimposed onto these millennial scale regional trends. Preliminary analysis suggests that changes in westerly wind stress and the upwelling of Circumpolar Deep Water were a primary driver of late Holocene climate dynamics in the Antarctic.

BE-3b - Polar perspectives on microbial evolution, adaptation, and ecological function
19.06.2018 11:00-12:30, A Seehorn

633
Temperature-driven Structure and Activity of the Global Ocean Microbiome

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Marine microbes cope with a variety of environmental gradients that may impact their global distribution and their metabolic state. Previous studies have shown that the distribution and structure of microbial communities in low and mid latitudes are largely governed by temperature. Temperature is thus one of the major environmental factors that marine microbes will need to respond to. Given that the rate of seawater temperature change is particularly high in polar regions, a better understanding of microbial responses to temperature change is crucial. Here we analyze a dataset composed of 367 epipelagic and mesopelagic metagenomes and metatranscriptomes from the *Tara* Oceans Expedition (2009-2013). Sample collection sites are distributed across all main oceanic regions, covering a 143° latitudinal range, and includes a focused sampling effort from a circumnavigation of the Arctic Ocean. We describe a universal relationship between seawater temperature and the structure of microbial communities, which is consistent across the entire temperature gradient (-1.6 to 30.6º C). We define cold-adapted taxa and explore metabolic capacities that are enriched in cold waters using metagenomic data. We combine these data with metatranscriptomic information to analyze how metabolic potential and activities vary across the global ocean. The results are expected to help us predict how microbial communities will respond to the impact of climate change.

2151
Functional Responses of Microbial Mat Communities in Glacial Meltwater Streams

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The McMurdo Dry Valleys are considered a Martian analog environment due to extremes in aridity, high-speed winds and low temperatures. Life in this environment survives an absence of water for around 9 out of 12 months and is primarily comprised of cyanobacteria mats that harbor bacteria, eukaryotic algae, and micro-invertebrates. During the austral summer, rising temperatures cause glacial melting and streams of freshwater begin to flow downward through the valleys carrying alluvium and rehydrating cyanobacteria mats. Temperature fluctuations of the meltwater streams reach anywhere from 0.1 °C to a maximum of 15 °C with daily shifts between 6°C-9°C. Von Guerard is one of the longest streams (4.9km) in the Taylor Valley, Antarctica and has a record of high interannual stream flow variability. Microbial mat samples from Von Guerard were collected early summer before flow started and continued on a weekly basis until the stop of flow in late summer. This study shows the transcriptional responses of the Von Guerard microbial mat communities compared through the start and end of the season with the inclusion of stream discharge, water/air temperature and conductivity data. Transcriptional profiles under low temperatures and frozen conditions display an upregulation of known stress response genes. This investigation is the first to determine in situ function of Dry Valley transient stream microbial communities through a whole melt season.

2188
Sulphur Cycling and Microbial Dynamics along a Glacial-oceanic Transect

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Antarctica has been identified as a hot spot of organic sulphur cycling and ocean-atmospheric sulphur fluxes. Organic sulphur compounds, such as dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) produced by Antarctic phytoplankton affect marine food-web interactions, which are key to marine sulphur cycling and flux dynamics. This study examined Antarctic phytoplankton-bacteria associations and their influence on marine sulphur cycling along a coastal transect from an inner fjord of the Sørsdal glacier to the open ocean. Phytoplankton abundance increased with distance from the glacier, while community composition remained fairly constant. There was a corresponding increase in DMSP concentrations toward the open ocean, likely attributed to the increased biomass. Through combining nutrient dynamics, 16S next generation sequencing and qPCR, we aim to understand the way in which these observed patterns link to bacterial community composition and specific sulphur-metabolising genes and how environmental gradients produced from glacial runoff influences marine microbial communities and sulphur cycling.

2283
The Colonisation and Selection Processes Shaping Frost Flower Communities

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The temporal and spatial coverage of frost flowers on sea ice is expected to increase in the Arctic in line with the predicted impact of climate change, and yet, their ecological, biogeochemical and climatic roles are poorly understood. Frost flowers have been shown to host distinct microbial communities relative to the underlying sea ice, sea water and brine as a result of selective colonisation processes. To explore the mechanisms influencing frost flower community structure and the potential of atmospheric deposition as a colonisation route, sea ice and frost flowers were cultivated from sea water in the Roland von Glasow sea ice chamber at the UEA, UK. Samples were subsequently subjected to 16S rRNA gene and metagenomic sequencing. The community structure and the extent of the mobile gene pool were analysed. The formation of multiple niches within the ocean-sea ice-atmosphere profile is probably responsible for shaping the community structure. Metagenomic sequencing revealed an enrichment in mobile genetic elements that are suspected to contribute to the rapid adaptation of microorganisms to alien microhabitats. These results provide novel insights into poorly characterised ecosystems with increasing global significance in terms of their role in biogeochemical cycling. In addition, the mechanisms involved in the colonisation of microorganisms throughout sea ice formation can be deciphered with the metagenomic data.

2376
Antarctic Cyanobacteria and Toxins in Captain Scott's Discovery Microbial Mats

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Climate models predict that Antarctica will warm more rapidly than many other parts of the globe, and more widespread warming of continental Antarctica is expected to accelerate. Much of the productivity and biodiversity is linked to benthic cyanobacteria-based microbial mat communities. However, to identify and forecast biological responses to environmental change, baseline data is essential to understand the level, and time scales over which environmental change affects community assemblages and functioning such as cyanotoxin production. We carried out cyanobacteria-specific 16S rRNA gene high throughput sequencing and cyanotoxin analysis of freshwater cyanobacterial mats collected in 1902-03 during Captain Scott's Discovery expedition in Antarctica. We found that historic cyanobacteria assemblages showed some variation in community structure to modern cyanobacterial mats, but were dominated by the same genotypes. It suggests slow cyanobacterial genotype turnover and considerable community stability. Ultra-performance liquid chromatography-photodiode array detection and tandem mass spectrometry identified microcystins at concentrations from 0.5 to 16.1 $\mu g\ g^{-1}$ dry weight. BMAA (β-N-methylamino-L-alanine) and its isomers were found for the first time in Antarctic cyanobacteria. The results demonstrate the value and potential of historic cyanobacteria collections in temporal investigations of cyanobacteria, freshwater ecosystems and clima in Antarctica.

2488
Metagenomics and Viromics of the Mackay Glacier Ecotone

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Climatic variations will have profound effects across the cryosphere. Ecotones are susceptible regions, and are defined as boundaries between adjacent ecosystems. Macro-organisms within ecotones are sensitive to variations in climate - which have potentially long-lasting impacts. Here we show, for the first time, that microbial and viral communities within ecotones can be analysed to monitor biological changes resulting from warming. Collectively, we show that the Mackay Glacier ecotone, Eastern Antarctica represents a distinct ecosystem compared to the McMurdo Dry Valleys. We found soil respiration to be an order of magnitude lower in the ecotone than surrounding bioregions, likely the result of extremely low soil nutrient contents and soil stoichiometric imbalance. Isotope data indicate that soil carbon is transformed via the Calvin cycle, while soil nitrogen is recurrently assimilated *in situ*. These trends were supported by *in silico* gene analyses of 18 assembled metagenomes, which showed a prevalence of these carbon and nitrogen cycling pathways. These mechanisms are driven by dominant chemosynthetic heterotrophic bacteria of the *Bacteroidetes* and *Acidobacteria*. Site altitude was the strongest predictor of microbial community structure, which was also shown to drive viral populations within the ecotone. Finally, we show that viral population constitute the lowest trophic tier of Antarctic soil communities, and interact with their hosts to maintain diversity and function.

TE-3b - Remote sensing of polar regions
19.06.2018 11:00-12:30, A Wisshorn

134
Comparing L- and C-band Synthetic Aperture Radar Estimates of Sea Ice Motion

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Estimating sea ice motion from synthetic aperture radar (SAR) imagery at C-band is the most reliable approach because of its high spatial resolution and ever increasing temporal resolution given the multiple current and upcoming SAR platforms. However, there is still uncertainty in SAR derived sea ice motion depending on the ice type and its thermodynamic state. There have been suggestions (mostly theoretical) that use of L-band SAR and its inherent longer wavelength (15-30 cm) and subsequent increased penetration capability could be beneficial for estimating sea ice motion, especially during the melt season. Here, we estimate and analyze sea ice motion for 9 pairs of C- and L-band SAR imagery from RADARSAT-2, PALSAR-1 and PALSAR-2 located in the Canadian Arctic over a variety of sea ice types at different thermodynamic states. Results show that the increased signal penetration of L-band SAR into multi-year ice (MYI) during the melt season facilitates the detection of more motion vectors with stronger cross-correlation coefficients compared to C-band SAR. Over newly formed ice and dry first-year ice, the reduced sensitivity to surface scattering and richer texture from L-band SAR imagery facilitates the detection of more motion vectors with stronger cross-correlation coefficients compared to C-band SAR. Over dry MYI, L-band provided stronger cross-correlation coefficients but C-band detected more motion vectors with a more representative spatial distribution.

1196
ZY-3 Multi-view Satellite and Its Applications in Antarctica Remote Sensing

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ZY-3 is the first civilian high-resolution stereo mapping satellite of China, launched in January, 2012. It is equipped with a three-line-scanning camera system to build along track and quasi-real-time (~30 seconds) stereo pairs by a combination of forward, nadir and backward looking images. The along track stereo mapping technique has the advantages of quasi-real-time capturing of the 3D ground movement . The satellite was first time programmed in February 2014 to adjust its sensor parameters to fit the Antarctic setting and collected a collection of Antarctic stereo images for a number of selected sites. Two typical applications in Antarctica remote sensing by using ZY-3 images are investigated. First one is the detection and speed estimation of large scale blowing snow, for which we proposed a stereo photogrammetric technique. Blowing snow is referred as the phenomenon of uplift and horizontal transport of snow by wind. It occurs frequently in Antarctica and is important in many aspects including surface mass balance and surface morphology. The second application is 3D modelling of ice shelf rifts, which are a precursor to iceberg calving. The 3D models of a newly detected large rift in Filchner Ice Shelf from ZY-3 stereo images revealed important topographic information (rift length, width, depth, wall and mélange) that can be used to improve the reliability of ice shelf modeling and support enhanced analyses of ice shelf stability.

1465
Snow Deposition Characteristics at Union Glacier by SAR and Geospatial Analysis

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Surface mass balance is a key component to assess the net contribution of the ice sheet to the ocean. A precise quantification of the accumulation processes as snow precipitation and wind transport and deposition of snow is required. Union Glacier (UG) is an outlet glacier at the Ellsworth Mountain Range and drains into the Ronne-Filchner Ice Shelf. Previous studies agree that mean surface mass balance for this glacier range from 0.18 to 0.33m a-1. Although it seems a good estimation, they do not represent spatial variability in snow deposition due to: (i)topographic relief; (ii)wind driven accumulation; and (iii)sublimation rate. Our aim is to identify and delimitate different deposition zones on the glacial drainage basin of UG. Thus, we generate qualitative maps of snow density and grain-size, as derived from backscattering values of five Cosmo-SkyMed X-band images. We interpret these maps together with 7 snow pits dug in different sites through the glacier basin. Results confirmed a distinct pattern of snow deposition and densification along the glacier, strongly driven by wind. Wind exposed areas have larger snow crystals (i.e., 1-4mm against 0.5-1mm in wind protected areas), faceted forms due to higher temperature gradient, more deposition layers and layers with higher hardness. In order to delimitate different depositional zones, we run a cluster analysis with the snow density and grain-size maps, together with slope, aspect and wind effect data derived from TanDEM-X.

1833
Mitigating Effects of Penetration in the CS2-Swath Rates of Elevation Change

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One of the aim of the ESA Altimetry mission CryoSat-2 (CS2) is to identify changes in ice thickness to quantify the contribution of the cryosphere to sea level change. CS2 revolutionary design features SAR and interferometric capacities, that allow to increase spatial resolution while resolving the angular origin of off-nadir echoes occurring over sloping terrain, making it particularly adapted to monitor ice-sheet margins. On top of measuring more precisely the elevation of Point Of Closest Approach (POCA), the standard level-2 product, CS2 SARIn mode allows also the so-called CS2 Swath SARIn (CSSARIn) approach: elevations beyond the POCA are produced, leading to between 1 and 2 orders of magnitude more measurements than level-2 product. Among other products, the ESA project CryoTop Evolution aims to deliver to the community maps of rates of surface elevation change over the Greenland and Antarctic Ice Sheets. To produce accurate rate of elevation changes from the CS2 elevations, changes in the penetration properties of the snow or ice has to be taken into account. If retrackers have been developed to limit the effect of penetration in the POCA retrieval, CSSARIn samples far from the POCA can be heavily subject to penetration changes. Here we will present first attempts to separate changes in penetration from the rate of elevation change by including proxies for penetration in the model linking elevations to elevation changes.

2103
An Integrated Approach to Map Ice-free Areas of the Antarctic Peninsula Region

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Ice-free areas within the studied Antarctic region are considered highly dynamic and show a complex mosaic of surface covers due to periglacial, glacial and fluvial processes. The objective of this work is to develop an integrated remote sensing approach to map periglacial, glacial and geological structures in ice-free areas of King George, Livingston and Deception islands. This includes using remotely sensed satellite-borne Synthetic-Aperture Radar (SAR) RADARSAT-2 and Sentinel-1 data, and optical Landsat-8 and Sentinel-2 data. A georeferenced data base is compiled containing site specific data that include field measurements, observations and laboratory soil analysis, geomorphological and geological maps that are used as reference and validation data to obtain a distribution of the different landforms. The supervised classification results show the identification of complex and relatively small scale geomorphological features such as periglacial landforms. In this case, characterizing and monitoring the distribution of some of these landforms is often an indicator of the presence of permafrost and related to hydrological changing processes. The integrated approach shows that the synergetic use of SAR backscattering characteristics and optical reflectance properties improves extracting and identifying different surface covers. Furthermore, it has been possible to extrapolate the results to ice-free areas over a larger region where access is limited.

2227
Optical Fractional Snow Cover Retrievals under Development at Three Continents

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A large scale international snow products intercomparison and validation project initiated by the European Space Agency was recently completed in the Environmental Earth Observation company at Innsbruck, Austria. The project provides an independent comparison of various approaches to map snow, including subpixel snow fraction, using detailed stratified comparison with almost 500 Landsat reference data sets. The validation of snow fraction demonstrates that the algorithm initially developed by the author of the presentation jointly with Dr. Salomonson, NASA has advantages in comparison with other products both on open land and in forested areas.
The algorithm takes into account that the reflectances of snow and non-snow are characterized by a significant local variability and also by changes from one scene to another. The local snow and non-snow endmembers are approximated by the Normalized Difference Snow Index. The magnitudes of snow and non-snow Normalized Difference Snow Indexes are scene-specific and calculated on the fly to retrieve snow fraction. The development of scene-specific algorithms is an optimal way to fractional snow retrieval from moderate resolution satellite observations.
European Space Agency and Japan Aerospace Exploration Agency recently decided to derive snow fraction using visible observations from Sentinel-3 and GCOM-C respectively. It is assumed that the collaboration between several parties tackling the same problem can be very promising.

OC-1_OC-2b - Innovation, partnership and impact in polar science communication & Polar Research and Citizen Science: Exploring New Platforms and Opportunities
19.06.2018 11:00-12:30, B Pischa

584
School of Ice: Professional Development Program for College Geoscience Faculty

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The *School of Ice* (SOI) from the US Ice Drilling Program Office (IDPO) is designed for college faculty to increase background knowledge about ice core science and climate change and provide experiences with activities and labs for transferring information to students.
This presentation will identify valuable key ideas from our model: pairing researchers and educators as presenters; building a science community willing to participate in education/outreach; increasing participants' background knowledge and confidence; and encouraging teacher buy-in to ensure replication and dissemination. IDPO's drilling technologies also make it an ideal platform for intertwining engineering practices with science research to meet new science standards.
Results of the institute evaluations will be shared including the impact on the educators and a longitudinal analysis of data from interviews with past participants concerning continued impacts on their teaching, their courses and their students. Faculty who have attended this institute in the last three years have reported increases in their understanding of the content and how to teach it, as well as increased confidence in their ability to teach ice core science and climate change concepts.
Elements of SOI can inform the development of college professional development and student courses, as well as the creation of successful education and outreach programs for science research teams wanting greater impact of their research results.

625
A new South African National Antarctic Programme Portal Designed by ALSA

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The Antarctic Legacy of South Africa (ALSA) fulfil various aims within the South African National Antarctic Programme (SANAP), one aim being to promote the human involvement in the South African sector of the Antarctic region. This aim is achieved mainly through attracting post graduate students to the different research disciplines that form part of SANAP through the World Wide Web, social media and awareness activities e.g. museum exhibitions.
The success that the ALSA website has within the reach of South Africa did not go unnoticed by partners in the SANAP environment. This resulted into a collaboration effort with South Africa's Department of Environmental Affairs (DEA), Branch: Oceans and Coasts. DEA is responsible for the logistics and environmental management of our involvement in the Antarctic region. The collaboration effort entail the design of a new and improved SANAP- portal, in the form of a new website. This portal will present information on the logistics and research efforts of South Africa in the Antarctic region. The research efforts will cover the four themes as stipulated by SANAP, namely Earth Systems, Living Systems, Human Enterprise and Innovation: technology and engineering. Therefore, the portal will serve as a contact point within the broader SANAP community, including funding agencies and the public.
This presentation will thus focus on ALSA's role in promoting South Africa's involvement in the Antarctic community through the new SANAP portal.

1793
Science Outreach & STEM Education in Antarctica: Virtual Reality and Robotics

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The Antarctic Research & Education Program (AREP) is going to be implemented on the “St. Kliment Ohridski" Antarctic Bulgarian Base during the 2017-18 campaign, as a collaboration between the Physics and Instrumentation Laboratory of the Polytechnic Institute of Beja, Portugal, the Bulgarian Antarctic Institute, and the Sofia University St. Kliment Ohridski. Two schools in each country, with students with ages from 6 to 15 years old, are involved as case studies and proof of concept of the program. This edition of AREP contemplates two projects: ViRAL - Virtual Reality Antarctic Laboratory, and Antarctuino - Physical Computing with Arduino in Antarctica. The first initiative is a Virtual Reality based science outreach project, with the objective of bringing Antarctica closer to the public. Antarctuino aims the development of coding skills with an open source hardware platform, the Arduino, and robot programming with a scratch based language, engaging educators and students in project based learning in the framework of STEM education. The output of these projects will be used in several initiatives to increase public awareness on Antarctica related issues, such as global warming, and the importance of research, and monitoring in this region of the Planet. This communication will report the results of the first edition of AREP in terms of science outreach sessions, STEM education activities, lessons learned, and the future steps for the next campaign.

2180
Using Podcasts to Extend your Audience and Expand Content Communication Options

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The Antarctic Report is an online portal dedicated to all things on Antarctica and the Southern Ocean, published by Camino, a digital content and publishing company based in Auckland, New Zealand. The site showcases the hard science which underlines the importance of Antarctica as a bellwether of global climate change. It also highlights the continent´s unique political status, as well as the exceptional demands its environment places on people and equipment, and the romantic allure for travelers and explorers as the least discovered continent on the planet.
The weekly podcasts were introduced on the portal in June 2017 as a way to extend content options. The format of the podcasts is an interview with one expert, usually 30 minutes in duration. This long-form interview allows for greater focus on subject matters. It also creates transcript opportunities to extend the channels. The podcast are cost-effective with editing done in-house.
This presentation will outline why The Antarctic Report chose the podcast format, as well as present the practical step-by-step process in getting the podcast launched, and the lessons that were learnt on the way.

2389
A Special Role for Feature Films in Science Communication

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Through the 19th and 20th centuries scientists communicated within and beyond the community itself through peer-reviewed journal articles and books, advancing knowledge through a self-correcting process for the betterment of many. In the 21st century the pace of technology-driven change and media-driven competition for attention is making it increasing difficult to inform community thinking with evidence-based knowledge on solutions to the pressing problems of our time.
Though technology has made huge advances over its hundred year history, I'll suggest that film continues to appeal as an essentially communal viewing experience for such issues. With a viewing time of typically 1-2 hours a film has time to appeal both intellectually and emotionally on any one of a range of big issues. Arnold Schwarzenegger said recently the challenge is to be “simple and clear and make it a human story.” These days the film maker also needs to ensure self-evident authenticity.
Arguably the most effective in the “pressing problems of our time” genre is Al Gore's “An Inconvenient Truth” (2006), driven by good timing, sound science and a personal story. Since then there have been half a dozen science-based stories with a similar mission and a TV series “Years of Living Dangerously” (2014, 2016 - a total of 17 1-hour stories) that address both problem and solution. I'll discuss their different qualities and varying degrees of success. We can learn from these stories and need more of them.

1244
Taking Antarctica to the World. ICE101x, an Antarctic Massive Open Online Course

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In 2017 Victoria University of Wellington, supported by Antarctica New Zealand, launched ICE101x Antarctica: From Geology to Human History, a Massive Open Online Course (MOOC) via the edX platform. The fully online, interactive, interdisciplinary course attracted over 5700 students from 128 countries. Students had a wide range of backgrounds: from school and university students to retired people, science lecturers to Antarctic base staff.
ICE101x featured innovative, field-based video lectures filmed in Antarctica and at the 2014 and 2016 SCAR Conferences, supported by open access online resources and a discussion board. It was led by Antarctic experts from VUW and featured guest lectures or interviews with artists and scientists, offering a truly interdisciplinary teaching programme. Given the severely limited opportunities to take students to Antarctica, this MOOC gave students an authentic, yet remote, experience and insight into this unique environment.
Analysis of students' interactions with the course, and response to an end of course survey, revealed that students were highly engaged and satisfied with the course and emerged from the course with new understandings of issues such as climate change and the process of scientific research. A new version of the course ICE102X (2019) will include a new module on Antarctic biology.
We will present an overview of the course, including our insights, findings, and opportunities for future collaboration.

CR-1b - Permafrost: connecting measurements, monitoring, and modelling
19.06.2018 11:00-12:30, B Parsenn

302
Impacts of Forest Fires on Discontinuous Permafrost in the Northwest Territories

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Forest fire is rarely taken into account in predictive modelling of permafrost change even though severe fires have been shown to accelerate degradation. Moreover, the frequency and magnitude of fires is increasing as the climate warms. We are examining permafrost change following the 2014 fires in the Northwest Territories, Canada in order to improve predictive modelling of the fate of permafrost in the region. A total of 18 burned and unburned sites representing a range of conditions were established in 2015 and 2016. At each site, air and near-surface ground temperature are being monitored continuously. Direct current electrical resistivity tomography (ERT) surveys and frost table measurements are being been conducted annually. Burned sites were warmer than unburned ones: surface offsets averaged 0.5°C greater and the thermal offsets 0.1°C smaller. Average frost table depths at burned sites were 17 cm greater than at unburned sites, and were generally greater in 2017 compared to 2015. This reflects impacts of the burn as mean summer air temperatures differed by only 0.3°C. Results from ERT surveys show the possible loss of permafrost within some sites. The most-affected sites are underlain by coarser-grained substrates with thin organic layers, whereas peatland sites are less impacted. These results indicate the heterogeneity of permafrost reaction to fire at the landscape scale and suggest that permafrost may persist in peatlands while degrading elsewhere in the region.

274
Modelling Convective Heat Transfer in Permafrost Using Long-term Monitoring Data

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Thermal modelling is important for a better understanding of the ground thermal regime in Alpine permafrost. We present a modelling approach that makes use of common concepts in engineering sciences (FE-modelling) to represent and quantify convective heat transfer in air in coarse permafrost substrate. The effect of convective heat transfer in air has been addressed in many observation-based studies. Modelling approaches are still rare and often limited to one dimension which neglects lateral heat transfer. Previous results from a 2-D model showed that convective heat transfer may have a significant influence on the ground thermal regime in a talus slope. This modelling approach is now extended to explore the effects of convective heat transfer in other landforms (e.g. rock glaciers) and to more site-specific calibration allowing the validation of the used model approach. Studying different sites and landforms in the Swiss Alps is possible thanks to the availability of long-term monitoring data of different field sites which are systematically processed and stored within the PERMOS (PERmafrost MOnitoring Switzerland) network. Modelling results show that convective heat transfer in air cannot be neglected in Alpine permafrost and it has, at least for some landforms, important effects on ground temperatures. The study also shows that easily available long-term and high-quality monitoring data is of great benefit for model forcing and validation.

1129
Thermal Evolution of a Holocene Arctic Environment in Western Greenland

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We present a Holocene temperature reconstruction at the arctic Greenland Analogue Project (GAP) study area near Kangerlussuaq in western Greenland. The air temperature history is obtained by combining meteorological data from (i) the GAP tundra site, (ii) Kangerlussuaq and coastal sites in South-West Greenland, and (iii) selected Greenland Ice Sheet sites, together with temperature proxy ice-core records. For the glacial stage in the early Holocene, a one-dimensional steady-state ice-sheet model is developed to reproduce the ice thickness and basal thermal conditions of the ice-sheet, and the associated isostatic adjustment. The model uses the geologically-determined ice-margin position and modelled Holocene elevation change of the ice divide. Using the temperature reconstruction and information on present-day vegetation and water bodies, a numerical model, calculating e.g. heat transfer, groundwater flow and salt transport, is used to simulate the thermal evolution of the subsurface including soil and bedrock temperatures, geothermal heat flow and the depth and distribution of permafrost and perennially frozen ground. Seasonal variations in surface processes such as the freezing and thawing of the active layer are taken into account. Comparison with measured soil temperatures and bedrock temperatures measurements down to 570 metres reveals several important factors and processes for the development of permafrost and perennially frozen ground in Greenland.

2036
A High-resolution Coupled Permafrost - Ice Sheet Model

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We present the development of a high-resolution coupled permafrost - ice sheet model based on continuum thermodynamics. The model includes heat-transfer within ice, water and soil, including phase change, saturated groundwater flow, salinity transport as well as deformation and stress-distributions of ice, soil and bedrock. It further takes into account important couplings, such as effects of permafrost on glacier sliding and hydraulic conductivity of soil and bedrock, effects of solutes on the development of permafrost, and effects of ice flow and groundwater flow on heat transfer. Implemented in the Finite Element code Elmer, this package provides the possibility to couple a permafrost to a high-resolution glacier or ice-sheet model (Elmer/Ice) that accounts for all stress components (full-Stokes) and thereby - in contrast to usually deployed lower order approximations - has no limitations in spatial resolution. This makes it possible to study detailed processes at places that need high resolutions, such as ice-sheet margins where permafrost may play an important role in controlling the basal ice temperature, or geologically strongly varying bedrocks where permeability changes as a result of permafrost formation or degradation can significantly alter groundwater flow paths. The model is tested on problems of approaching and retreating ice margins using synthetic settings, and real geometries, where measurements for comparison and model constraints are available.

1522
Snow Observation and Modeling for Polygonal Tundra Permafrost Thermal Assessment

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Lacking knowledge on snow properties in high latitude regions poses a major limit to the modelling of the ground thermal regime for permafrost and climate science. To this end a dedicated snow campaign took place in 2013 at the Samoylov permafrost observatory in Siberia. We present estimations of snow thermal conductivity Keff-z based on X-ray microtomography from Samoylov samples, and investigate the links between snow properties and the polygonal tundra micro-topography. We analyse the consistency of estimated Keff-z with respect to measured soil temperatures. For that purpose, the snow model SNOWPACK is phenomenologically adapted to Arctic conditions to ensure a bare agreement with snow observations.
Our observations describe a relatively conductive snowpack at Samoylov (0.21 ± 0.01 W m-1 K-1 across grass-covered polygons) where the thermal resistance of the snowpack is mostly controlled by variations in snow height induced by the polygonal micro-topography. The modified SNOWPACK simulates reasonable density and Keff-z profiles, which strongly improves the simulation of the ground thermal regime. Finally, we use chained SNOWPACK and permafrost modelling to assess the thermal impact of snow spatial variability in both depth and structure: the sensitivity of soil temperatures to snow cover variability is high and most pronounced during the early and dark winter. This highlights the demand for improved snow characterization and snow parameterization in these periods.

2485
Efficient Data Assimilation in a Quasi-distributed Permafrost Modeling Framework

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The mountain cryosphere is undergoing significant changes globally, yet these changes are in many cases poorly constrained, particularly in remote regions where data is sparse. Previously developed methods for downscaling driving meteorology (Fiddes and Gruber 2014) and a subgrid scheme (Fiddes and Gruber 2012) have proven to be promising approaches to large area transient simulations of permafrost in remote areas due to order of magnitude efficiency gains. However, major sources of uncertainty still remain in the meteorological forcing, particularly precipitation which features high spatiotemporal variability and is heavily modulated by local topographic effects. Additional complexity arises due to the inherent uncertainty in precipitation observations, especially in the solid phase. Solid precipitation is an important target variable to accurately quantify as it is a key control on the ground thermal regime. To address these issues we employ an ensemble data assimilation scheme, based on the particle batch smoother, that assimilates MODIS fractional snow cover observations into the modelling framework. Efficiency gains in the underlying framework, due to the downscaling and subgrid scheme, make this approach particularly suited for the treatment of uncertainty through ensemble simulations and data assimilation.
We present results from validation in the European Alps and test applications in the Himalaya together with new results from the latest ECWMF reanalysis ERA5.

AC-5b - Tropical-Polar Teleconnections and their Climate impacts
19.06.2018 11:00-12:30, B Jakobshorn

465
A 20th Century Perspective on Summer Antarctic Pressure Change and Variability

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During the late 20th Century, the Antarctic atmospheric circulation has changed and significantly influenced the overall Antarctic climate, through processes including a poleward shift of the circumpolar westerlies. However, little is known about the full spatial pattern of atmospheric pressure over the Antarctic continent prior to 1979. Here we investigate surface pressure changes across the entire Antarctic continent back to 1905 by developing a new summer pressure reconstruction poleward of 60°S. We find that only across East Antarctica are the recent pressures significantly lower than pressures in the early 20th century; we also discern periods of significant positive pressure trends in the early 20th century across the coastal South Atlantic sector of Antarctica. Climate model simulations reveal that both tropical sea surface temperature variability and other radiative forcing mechanisms, in addition to ozone depletion, have played an important role in forcing the recent observed negative trends.

2194
Amazon and Antarctic Stable Isotope Ratios in the Southern Brazilian Rainfall

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This study examines interactions between the Antarctic air masses and those from tropical South America (SA) responsible for severe and regular precipitations events in Southern Brazil (SB) during 2016. This year also stands out as the warmest in the world since 1921, and the second in SA, but with regional monthly contrast (including negative anomalies in the La Plata Basin and the SB). A Palmex Rain Sampler RS1 collected rain in the city of Porto Alegre; the oxygen isotope ratios were determined by the Cavity Ring-Down Spectroscopy method (Picarro system). To analyze the geopotential height fields, wind vectors, zonal wind, precipitable water and temperature at 925, 750, 500 and 200 hPA, monthly and seasonally, using ERA-Interim Reanalysis data. The presence of polar fronts, coupled with the low and high atmospheric circulations, strengthened convection by developing severe storms in the SB. In addition, we have three moisture sources of intense rainfall in southern Brazil: the Amazon Forest, South Atlantic Ocean and Antarctica. So, it is suggested that temperature contrast observed between advection and circulation of tropical and polar air masses enhance convection and could be one of the reasons for stronger storms in the SB and other parts of the southern SA in 2016. The $\delta^{18}O$ values found in the precipitation present high variability, from -2.93 ‰ to -9.80 ‰ and show the different sources of air masses responsible for precipitation in Porto Alegre.

1436
Simulating the Southern Hemisphere Storm Track Shift

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In accordance with the Clausius Clapeyron equation, a warmer atmosphere will lead to an increase in atmospheric moisture content which theoretically will provide a positive trend in the Antarctic surface mass balance. An increasing surface mass balance over Antarctica would have negative implications on future sea level rise. This is why it is essential to accurately simulate changes to the Antarctic upper-level circulation to determine how circulation changes will impact these potential increases in Antarctic snow accumulation. During the past century, the Southern Annular Mode (SAM) has been increasingly positive which has shifted the storm track southward. This has resulted in significant warming along the Antarctic Peninsula and increased snow accumulation in West Antarctica and along the western side of the Peninsula. This shift in SAM is poorly represented in climate models along with its potential impact on future surface mass balance changes on the Antarctic continent. To properly simulate the potential Antarctic storm track changes requires a better simulation of the tropical and mid-latitude teleconnections that influence the Antarctic climate. Here we propose to improve the modeling of the storm track location using the stretched grid global model LMDZ6 and analyze the impact on the surface mass balance of Antarctica using the regional circulation model MAR.

2091
The Antartic Atmospheric Circulation and Cyclogenesis Anomalies in Spring 2016

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This work examines teleconnections between the cyclogenesis in Southern Hemisphere (SH) and its relationship to the Southern Annular Mode (SAM) and to the zonal wave three (ZW3) pattern at the end of October 2016. From 26th to 28th of that month, a strong extratropical cyclone developed on the southern coast of Brazil (SB). Then, from the 29th to the 31st, the southern coast of Australia (AU), including Tasmania (TA), was hit by an extratropical cyclone coming from the Indian Ocean. Both events caused numerous social and environmental damages. That year also stands out as the warmest in the instrumental record, both globally and in the SH, and recorded the smallest Antarctic sea ice extent (SIE) since 1979. This sea ice cover reduction has been attributed to positive sea surface temperature anomalies, the ZW3 and a SAM negative phase. Considering these observations, we reconstructed the geopotential height fields, wind vectors, zonal wind and temperature at 925, 750, 500 and 200 hPA, monthly, seasonally and annually, using ERA-Interim Reanalysis data. The analyzed SAM index and the wave, tidal and wind records show that the two observed anomalous events resulted from a combination of a negative SAM phase and of the ZW3. This association favored intense cyclogenesis, with a baroclinic intensification, as a response to the tropic-pole temperature contrast, and an exceptional atmospheric circulation observed between subtropical and polar latitudes in 2016.

207
Sensitivity of SH Westerly Winds to Boundary Conditions for the LGM

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The southern hemisphere (SH) westerly wind change in the LGM is critical in understanding the glacial-interglacial carbon cycle since its strength and position influence the upwelling of the carbon rich deep water to the surface. To examine the change in SH westerly wind in the LGM, we adopted CAM5 atmosphere general circulation model (GCM) and performed LGM simulation with sensitivity experiments by specifying the LGM sea ice in the Southern Ocean (SO), ice sheet over Antarctica, and tropical pacific sea surface temperature. The SH westerly response to LGM boundary conditions in the CAM5 was compared with those from CMIP5 LGM simulations. In the CAM5 LGM simulation, the SH westerly wind substantially increases between 40S and 65S, while the zonal-mean zonal wind decreases at latitudes higher than 65°S. The position of the SH maximum westerly wind moves poleward by about 8 degree in the LGM simulation. Sensitivity experiments suggest that the increase in SH westerly winds is mainly due to the increase in sea ice in the SO that accounts for 60% of total wind change. In the CMIP5-PMIP3 LGM experiments, most of the models show the slight increase and poleward shift of the SH westerly wind as in the CAM5 experiment. The increased and poleward shifted westerly wind in the LGM obtained in the current model result is consistent with previous model results and some lines of proxy evidence, though opposite model responses and proxy evidence exist for the SH westerly wind change.

2288
Evolution of Pacific to Southern Hemisphere Teleconnection in the Last Ice Age

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Jones et al (Nature, 2017) recently showed that the amplitude of the interannual variability in West Antarctica was substantially larger during the last ice age than it is today. They showed that the reduction in the amplitude of the variability can be linked to the height of the Laurentide Ice Sheet. In this presentation we shall show in detail how changes in the tropical Pacific climate altered the interannual variability seen in West Antarctica. Analysing the Rossby Wave source terms in a series of climate model simulations we can show that a shift in the mean convection in the West Pacific makes a more efficient teleconnection from the tropical Pacific to the high southern latitudes, particularly the Amundsen Sea region. By analysing the effect of the different glacial boundary conditions (the presence of ice sheets, lowered greenhouse gases, altered orbital forcing), we can show that the largest single cause of the change is the size of the Laurentide Ice Sheet. The ice sheet alters the position of the mean convection in the West Pacific, which makes a stronger Rossby Wave source. The shifted convection is supported by other paleoclimate proxy evidence. We shall show that although glacial boundary conditions cause changes in the zonal mean westerly winds, which might alter the teleconnection from the tropical Pacific to higher southern latitudes, these changes can not explain the climate variability seen in the water-isotope record of the WAIS divide ice core.

AC-1b - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions 19.06.2018 11:00-12:30, C Sanada I

66
Warming by Moist Air Intrusion and Cloud Radiation in the Arctic and Antarctic

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At Ny-Ålesund, Arctic, two distinct states are seen in downward longwave radiation (LD) during winter 2015/16. After the cold state with the temperature around -10 to -20 C, a warm state with plus temperature appears and LD increases from about 170 to 320-330 W/m^2. This abrupt and large increase of LD might be due to the change of cloud condition, from clear to overcast, which was examined from the cloud radar data taken during GRENE Arctic Research Project. However, only the cloud change could not explain this large change of LD. During the warm state, the atmospheric circulation patterns changes, distortion of tropospheric polar vortex appears with a high pressure ridge (blocking high), and strong low and intrusion of warm and moist air from the Atlantic Ocean together with longwave radiation from clouds influences the warming at Svalbard. This intrusion of warm-moist air from the lower latitude is one of the major processes contributing to the Arctic amplification, just as proposed using GCM by Yoshimori et al. (2017).
In the Antarctic, similar intrusion of warm-moist air brings abrupt temperature increases and high precipitations. These intrusions are called “Atmospheric River”, and attributed to the strong low and/or blocking high. Although the suppression of warming in East Antarctica has been explained by the strengthening of polar vortex in the strat. and trop. due to ozone hole, the role of intrusion and clouds is still an issue of discussion compared to the Arctic.

298
Climate Modeling of Ice Supersaturation and Haze at Dome C, Antarctica

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Ice supersaturation is usually found at high altitudes where cirrus clouds form. At such altitudes, continuous and detailed measurement of the different steps leading to cloud formation and their comparison to climate models is difficult. The Concordia station on the Antarctic plateau offers an opportunity to document supersaturation and cloud formation in similar thermodynamical conditions and over the long term. The 40-m meteorological mast at Dome C was therefore instrumented with two special hygrometers, one at the top and one at the bottom, and haze formation was detected via visibility measurements. Ice supersaturation is found in all seasons and a RH_i of up to 200% is measured. During summer, in the evening, the RH_i often reaches 120% and sometimes precedes the formation of haze and a drop in visibility (for more detail, see Genthon et al., this conference). This timing of events is examined in four atmospheric models: the ECMWF IFS, the MAR limited area model, PolarWRF and the IPSL Climate Model, for which the parameterization of supersaturation is being developed. The models predict realistic supersaturations but the detailed diurnal cycle and statistical distributions differ from the observations. Haze is predicted and compared in detail with the observations. The use of the mast also gives access to the vertical gradients of humidity. The strengths and weaknesses of the models are compared, and pave the way to improvements in the different parameterizations.

460
Clouds, Aerosols and Radiation Measurements during the Polarstern Cruise PS106

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As a central experiment of the German Collaborative Centre "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC)^3" the Arctic expedition **PASCAL** (Physical feedbacks of Arctic PBL, Seaice, Cloud And Aerosol, PS106.1) of the German research ice breaker Polarstern has been performed with a focus on clouds, aerosol and radiation measurements from May 24 to June 21 2017, followed by Arctic underway atmospheric measurements at the expedition PS106.2 until July 20, 2017. A 36 GHz cloud radar, a microwave radiometer, a Raman aerosol lidar, a network of pyranometer as well as a tethered balloon with in-situ aerosol, turbulence and radiation observations up to a height of 1500m were deployed on an ice floe at 82°N, 10°E for two weeks. Furthermore, detailed surface near-in-situ aerosol physical and chemical characterizations have been carried out. The presentation provides an overview of vertical aerosol and cloud profiling and discusses the relation to the observed surface fluxes.

493
Measured Radiation Budget Profiles of Arctic Clouds using a Tethered Balloon

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Arctic low-level clouds modify the surface energy budget as well as the vertical energy fluxes from the surface to the free troposphere. Thus, understanding the cloud radiative effects and their dynamics is a key factor to identify and quantify the processes leading to Arctic Amplification. However, observations of boundary layer energy flux profiles that determine the interaction of clouds and surface are challenging and limited in the central Arctic.
The Arctic Balloon profiling EXperiment (ABEX) took place north of Svalbard in June 2017 as part of an intense observational campaign coordinated by the Transregional Collaborative Research Centre TR 172 “Arctic Amplification” (AC)³, which combined the research vessel Polarstern and the Polar 5 and Polar 6 aircraft. During a two-week ice floe camp, radiative and turbulent energy flux profiles were investigated under different cloud conditions using a tethered balloon. Broadband solar and terrestrial irradiance profiles were measured. Furthermore, the cloud top cooling rates driving the cloud dynamics were derived while high-resolution probes measured the turbulent energy fluxes. The radiative energy flux profiles were affected by the cloud water content, the cloud base altitude and the temperature profile of the boundary layer, resulting in changes of cloud surface radiative forcing.
First results of radiative energy flux profiles determined during ABEX will be presented.
This work was supported by DFG Grant TR 172/1 A02.

502
Cloud Response to Moisture Intrusions into the Arctic

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Moisture transport into the Arctic influences surface energy budget in the time scales ranging from few days to few months. Moisture intrusions, i.e. the episodic extreme moisture transport events, are especially said to have a large impact on air-sea interaction processes, by inducing rapid changes in the thermodynamical structure of the lower troposphere. Persistent intrusions can have lasting impact on the seasonal sea-ice evolution, both during the recovery and melt phases. Apart from their direct radiative impact on the lower troposphere, moisture intrusions potentially modulate cloud frequency and physical properties, which in turn have feedback on the longwave surface forcing. Here we assess this cloud response to moisture intrusions and its seasonal character in detail. We use 10-years of A-Train data (CloudSat, CALIPSO and MODIS) as well as multidecadal climate data record of cloud properties, CLARA-A2, from EUMETSAT's Satellite Application Facility for Climate Monitoring (CM-SAF) for the period from 1982-2016. We investigate cloud response using two approaches, namely the “large-scale approach” and the “local approach”. In the former, the moisture intrusion events are defined based on the large-scale moisture variability, while in the latter, the local moisture variability is taken into account. We discuss relative merits and significance of these approaches.

1796
Stratocumulus Breakup in Cold Air Outbreaks over the North Atlantic

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In this paper we show from in-situ field observations that this break-up in cold air outbreaks over the eastern Atlantic is controlled by the development of precipitation in the cloud system while the boundary layer becomes decoupled, with both supercooled liquid and solid precipitation playing a role. Flights were conducted using the UK FAAM aircraft in the North Atlantic region around the U.K. featuring 4 case studies, making detailed microphysical, dynamical and thermodynamic measurements in the cloudy boundary layer during the cold air outbreaks. It is found that as the cloud moves over progressively warmer waters it initially deepens, with increasing drop size and the formation of liquid precipitation. Small numbers of ice particles are observed. In 3 of the cases the aerosol number in the boundary layer and the cloud droplet number, decreased with distance south as the aerosol was scavenged by precipitation, leading to increased precipitation and a reduction in the liquid water path and the eventual break-up of the cloud. It is concluded that it is the precipitation process that dominates the timing of the cloud break-up although both weakening of the capping inversion and boundary layer decoupling also occurred which may play a critical role in determining the timing of precipitation onset.

BE-4b - Climate change and ecosystems: physiology, biodiversity and ecological functions
19.06.2018 11:00-12:30, C Sanada II

56
The Greater than Expected Affect of Temperature on Antarctic Marine Species

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Antarctic marine species have evolved over millions of years in cold, thermally stable, but also seasonally intense conditions. In response to this many unique adaptations have been produced including antifreeze in fish, an absence of haemoglobin in Channichthyd fish and the absence of a heat shock response in some species. Recently (Peck 2016) it has been shown that the vast majority of biological processes are slowed in Antarctic marine species compared to those from warmer water sites. For respiration, aerobic capacity and activity the slowing in Antarctic species compared to temperate and tropical species is in line with the expected effect of temperature on biological functions as first described by Arrhenius over 100 years ago. For other processes, such as growth, embryonic development and the duration of elevated metabolic rates after feeding, the slowing is much greater than the expected effect of temperature. This contribution presents these data and then shows why the impact of low temperature on protein synthesis is the likely reason for these differing results.
Peck L.S. (2016). A cold limit to Adaptation in the Sea. **TREE**. 31 (1), 13-26.

2612
Polygenic Adaptation Drives Genomic Divergence between Spawning Modes in Capelin

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Capelin (*Mallotus villosus*) is a small salmonid fish that display two alternative life histories within its circumpolar distributional area: a long distance migrating ecotype that spawns offshore and are strictly semelparous or a more resident ecotype that spawns intertidally and can be considered as facultative iteroparous. Intraspecific divergence in life history may be regarded as a process of incipient speciation and when this process occurs in sympatry, the theory of speciation predicts that adaptive genomic differences will accumulate as a result of divergent natural selection acting against unbeneficial traits. In other words, adaptive genomic differences are expected to be the main driver of divergence between the two ecotypes and spawning modes. Here we addressed this prediction on two replicated systems of capelin spawning offshore vs intertidally from Norwegian waters. We compared divergence from a genome-wide panel of single nucleotide polymorphisms obtained by massively parallel sequencing of Restriction Site Associated DNA libraries (RADseq). Via machine learning approaches we firstly revealed that the ecotypes and spawning modes diverge at the genomic level, and secondly, we revealed that polygenic adaptive genomic differences have accumulated within the two alternative life histories. We discuss these results in light of how a changing Arctic environment may influence the apparent ongoing process of incipient speciation.

75
Quantifying the Role of Allochrony in Sympatric Seabird Niche Partitioning

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Competition within and between species shapes community structure and species distribution. Levels of competition are particularly high when closely related species share limited resources, meaning they must differentiate along multidimensional niche axes in order to co-exist. The degree of competitive dominance may also be affected by climate change. Sympatric central-place foraging seabirds with similar resource requirements experience high levels of competition during the breeding season and often display allochrony (differences in timing of breeding) to reduce this. We used sympatrically breeding Adélie (*Pygoscelis adeliae*) and Chinstrap penguins (*P. antarctica*) on Signy Island, South Orkneys, as a model system to quantify the role of allochrony in niche partitioning for the first time.
Foraging location (GPS tag) and dive depth (TDR tag) data were collected during 4 breeding seasons. We determined that the two species display 3D niche partitioning, utilising different core foraging areas during different breeding phases and diving to significantly different maximum dive depths within areas of high spatial overlap. Allochrony reduced horizontal overlap between species by 70%.
Both species breed later in colder years and recent cooler springs have seen both delay breeding by 10 days over the last 20 years. Penology changes have occurred in parallel over this time, maintaining allochrony, but if allochrony offset is reduced by a single day competition will increase by 2.6%.

2102
Climate Change and the Threat of Novel Marine Predators in Antarctica

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Historically low temperatures have limited skeleton-breaking predation on the Antarctic shelf, facilitating the evolution of a fauna poorly defended against durophagy. Now, rapid warming is restructuring Antarctic marine ecosystems as conditions become favorable for range expansions. The lithodid crab Paralomis birsteini currently inhabits some areas of the continental slope off Antarctica. They could potentially expand along the slope and upward to the shelf, where temperatures are no longer prohibitively low. We identified two sites inhabited by different densities of lithodids in the slope environment of the Antarctic Peninsula. Gut contents of crabs on the slope revealed them to be opportunistic invertivores. The abundances of three eurybathic prey—ophiuroids, echinoids, and gastropods—were negatively associated with P. birsteini off Marguerite Bay, where lithodid densities averaged 4280 ind·km^{-2} at depths of 1100-1499 m (range 3440-5010 ind·km^{-2}), but not off Anvers Island, where lithodid densities were lower, averaging 2060 ind·km^{-2} at these depths (range 660-3270 ind·km^{-2}.) Higher abundances of lithodids appear to exert a negative effect on invertebrate distribution on the slope. Lateral or vertical range expansions of P. birsteini at sufficient densities could substantially reduce populations of their benthic prey off Antarctica, potentially exacerbating the direct impacts of rising temperatures on the distribution and diversity of the contemporary shelf benthos.

290
Biodiversity, Distribution and Ecology of Cephalopods in Polar Marine Ecosystems

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Cephalopods are known to play an important role, both as prey and predators, in polar marine ecosystems. In this review, we compared the biodiversity, distribution and ecological role of cephalopods in the Arctic and in the Antarctic. Sixty-one species have been reported from the Arctic (including the Pacific Subarctic) while 54 species are known from the Antarctic. The only confirmed species known to occur in both poles is the giant squid *Architeuthis dux*. No cuttlefish species occur in either polar region. The cephalopod fauna of the Arctic and Antarctic are different and have different origins: the Arctic fauna colonized the Arctic relatively recently (< 12 000 years ago), whereas some of the Antarctic fauna has evolved *in situ* over the past 33 Ma (e.g., most octopods). Polar cephalopods prey on crustaceans, fish, and other cephalopods (including cannibalism), whereas predators include fish, other cephalopods, seabirds, seals and whales. Cephalopods from these regions are likely to be influenced by climate change: Arctic fauna is more subjected to increasing temperatures *per se*, with these changes increasing species ranges and probably their abundance. Antarctic species are likely to be influenced by changes in mesoscale oceanography, changes of position of oceanic fronts, changes of sea ice and increase of ocean acidification. Polar cephalopods may have the capacity to adapt to environmental change but more studies are needed on taxonomy, distribution and ecology.

AA-1c - Astrophysics and Astronomy in the Polar Regions
19.06.2018 14:00-15:30, A Studio

2204
Results from the High Elevation Antarctic Terahertz (HEAT) Telescope on Ridge A

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Deployed to Ridge A in 2012, the HEAT telescope forges entirely new capabilities for ground based infrared and submillimeter astronomy which otherwise would be unachievable except via expensive airborne or space-based platforms. HEAT and PLATO-R represent a new generation of polar instrumentation that permits the excellent conditions available from remote sites like Ridge A to be harnessed without the costs and hazards associated with manned operations. The unparalleled stability, exceptional dryness, low wind and extreme cold make Ridge A a site without equal for astronomy at infrared and submillimeter wavelengths. HEAT operates in the far-IR atmospheric windows in which the most crucial astrophysical spectral diagnostics of the formation of galaxies, stars, planets, and life are found. Through large-scale Galactic surveys, the measurement and impact of the Galactic environment on the life cycles of interstellar clouds and their relation to star formation are gradually being realized. HEAT´s key project is to map, with great sensitivity and precision, portions of the Southern Galactic Plane in the spectral light of the dominant coolants of the interstellar medium from 200-600 microns wavelength. HEAT´s mixer, local oscillator, low-noise amplifier, cryogenic, and DSP technologies will play essential roles in future Terahertz observatories. This pioneering mission paves the way for future astronomical investigations from the high plateau and beyond.

2619
Galaxy Cluster Science from the North Pole: The OLIMPO Experiment

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Polar regions represent the best sites on Earth to observe the distant Universe. High atmospheric transparency, low temperature, seasonal presence/absence of the Sun, and circumpolar currents make the polar stratosphere optimal for balloon-borne IR and mm-wave astronomy measurements.
The OLIMPO experiment will be launched from Svalbard islands during the arctic summer, and will float at 40 km of altitude in the arctic circumpolar current. OLIMPO is a mm-wave observatory, to be pointed in the direction of many galaxy clusters, to detect the Sunyaev-Zel'dovich (SZ) effect of the Cosmic Microwave Background (CMB) photons crossing clusters. Measurements of the SZ effect provide important morphological and dynamical information on galaxy clusters.
OLIMPO is equipped with a large-aperture telescope (2.6 m), feeding multi-band cryogenic focal planes populated with arrays of kinetic inductance detectors sensitive at 150, 200, 350 and 480 GHz. In addition to photometric measurements, OLIMPO provides spectroscopic measurements taking advantage of a plug-in differential Fourier transform spectrometer (DFTS), enabling the characterization of all the components of the SZ effect and its foregrounds with unprecedented precision and accuracy.
In addition to the scientific target, OLIMPO has a technological target: it will demonstrate that the KIDs and the DFTS can reach the expected performance in a space-like environment, representing the pathfinder of future space missions like Millimetron.

1403
The Kunlun Infrared Sky Survey

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The high Antarctic plateau provides exceptional conditions for infrared observations on account of the cold, dry and stable atmosphere above the ice surface. We describe the scientific goals behind the first program to examine the time-varying universe in the infrared from Antarctica - the Kunlun Infrared Sky Survey (KISS). This will employ a 50cm telescope to monitor the southern skies in the 2.4µmK dark window from China´s Kunlun station at Dome A, on the summit of the Antarctic plateau, through the uninterrupted 4-month period of winter darkness. An earlier paper discussed optimisation of the K dark filter for sensitivity (Li et al. 2016). Here we examine the scientific program for KISS. We calculate the sensitivity of the camera for the extrema of observing conditions that will be encountered. We present the parameters for sample surveys that could then be carried out for a range of cadences and sensitivities. We then discuss several science programs that could be conducted with these capabilities, involving star formation, brown dwarfs and hot Jupiters, exoplanets around M dwarfs, the terminal phases of stellar evolution, fast transients, embedded supernova searches, reverberation mapping of AGN, gamma ray bursts and the detection of the cosmic infrared background.

528
The BLAST-TNG Experiment

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BLAST-TNG is a long-duration, high altitude, balloon-borne telescope scheduled to fly in the 2018-2019 season from Antarctica. The data from the 28 day flight will provide new insight into the properties of dust and the role of magnetic fields in the interstellar medium through a wide range of densities, producing several degree-scale polarimetric maps at sub-arcminute resolution. It will perform simultaneous measurements in its 3 broad bands centered at 250, 350, and 500 µm. BLAST-TNG is the rebuilt and upgraded Balloon-borne Large Aperture Sub-millimeter Telescope for Polarimetry (BLASTPol), and with a 16-fold increase in mapping speed it will make larger and deeper maps. Major improvements include a 2.5 m carbon fiber mirror (40% larger diameter than the BLASTPol mirror), and ~3000 polarization sensitive detectors. The telescope will also serve as a pathfinder project for microwave kinetic inductance detector (MKID) technology, applied to feed-horn coupled sub-millimeter detector arrays. The arrays are cooled to 270 mK by a closed-cycle 3He refrigerator, all enclosed in a liquid helium cooled cryostat with long hold time (28 days expected). This will enable us to map more targets at a much higher level of detail than any sub-millimeter polarimeter to date. BLAST-TNG will also be the first balloon-borne telescope to offer shared risk observing time to the community.

2414
Cosmic Ray and Air Shower Studies with IceCube

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The IceCube Neutrino Observatory at the South Pole has been in stable operation since it was completed in 2010. The observatory consists of an array of more than 5000 optical modules deployed between 1450m and 2450m deep in the Antarctic ice, and IceTop, an array of detectors on the surface of the ice. These two arrays provide a complementary view of cosmic ray induced air showers, giving us a unique vantage point to study cosmic rays and the air showers they produce. We will review the insights we have gained on the composition of the cosmic ray flux and on high-energy interactions by using this hybrid approach. We will also discuss how the combination of a surface detector with a deep detector can be used to further the search for the sources of astrophysical neutrinos.

511
Advances in the LAGO Antarctic Node Implementation Design

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The LAGO (Latin American Giant Observatory) project is a collaborative network of Cherenkov detectors in water (WCDs) over ten Latin American countries (Argentina, Bolivia, Colombia, Chile, Ecuador, Guatemala, Mexico, Peru, Venezuela, and Brazil). The Scientific Objectives include the study of the energy spectrum and the integrated flux of the secondary particles generated by the primaries at the atmosphere. The collaboration network has nodes at sites with different rigidity cut-offs and different altitudes and asseses the monitoring of the Space Weather conditions through the modulation of the cosmic ray flux . This node will also permit to analyze energetic particles from solar origin, the so-called Ground Level Enhancements (GLEs), We present the update of the testing results for the implementation of the LAGO node in Antarctica. These were obtained at the precampaign of 2017, where the in situ data telemetry testing was performed for the meteorological station designed for the Marambio node, including the testing of the thermic control for the system. The improvements in the new design of the Cherenkov detector in water and first results are also presented.

On behalf of the The Latin American Giant Observatory (LAGO) Collaboration, Ciudad Autónoma de Buenos Aires, Argentina. See List of Members at www.lagoproject.org, lago-pi@lagoproject.org

OS-6c - Polar Ocean Dynamics
19.06.2018 14:00-15:30, A Forum

1002
Dynamic Barriers Preventing Flow of Warm Ocean Currents into Ice Shelf Cavities

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The observed thinning of many of the ice-shelves surrounding the Antarctic Ice Sheet is linked to oceanic heat fluxes, but the dynamics governing the flow of ocean currents towards and into the ice shelf cavities are poorly known. Dynamical constraints cause large scale, geostrophically balanced flows to follow depth contours. The warm salty ocean currents hence move towards the ice shelf cavities mainly in the deep troughs connecting the shelf break to the inner shelf. The water must then pass the ice shelf front - a vertical ice wall with a draft of several hundreds of meter, representing a major discontinuity in the water column thickness. Conservation of potential vorticity is expected to restrict barotropic flow across the front and into the ice-shelf cavity. It is not clear to what extent currents are blocked by the ice shelf front, and whether there is a difference between baroclinic and barotropic flows in entering the cavity.
We present the results of a set of experiments conducted on the Coriolis rotating platform. By inserting an idealized ice shelf on top of a deep trough representing an Antarctic continental shelf and ice shelf cavity, dynamical constraints of this system were explored. Barotropic and baroclinic currents were created by pumping water of different density in the trough and the flow was documented using in situ probes and various image techniques.

1183
Atlantic Water Supply toward the 79N Glacier in Northeast Greenland

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The ocean plays an important role in modulating the mass of the Greenland Ice Sheet by delivering heat to the marine outlet glaciers. The largest of the glaciers draining the Northeast Greenland Ice Stream is the 79 North Glacier. It is in contact with subsurface, warm Atlantic Water (AW). In order to understand how the AW supplies heat towards the glacier, we analyse mooring-based, shipboard and AUV-based observations obtained between 2014 and 2017 on the shelf of Northeast Greenland, complemented by an eddy-resolving ocean-sea ice model, which realistically represents the AW circulation in Fram Strait.
A sizeable amount of the AW carried northward from the Subtropics toward the Nordic Seas recirculates in Fram Strait, contributing to both the subduction below cold and fresh Polar Water and the formation of the East Greenland Current. A trough system on the shelf allows for the penetration of the subsurface AW across the 300 km wide shelf toward the inner shelf as a narrow boundary current.
Our moored measurements reveal a year-round, subsurface flow of AW towards the glacier, feeding into a hydraulically controlled density plume in the vicinity of the calving front, causing a rapid inflow of AW warmer than 1°C into the subglacial cavity. Historical observations further suggest a coherent decadal increase in AW temperatures both in Fram Strait and on the shelf. A warming-induced increase of basal melt may explain the observed thinning of the glacier over the past 15 years.

1604
Heat Loss in the Atlantic Water Boundary Current North of Svalbard

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A mooring array has been deployed since 2012 north of Svalbard, tracking the Atlantic Water (AW) inflow into the Arctic Ocean as it follows the upper continental slope. This topographically steered boundary current is the largest oceanic heat source for the Arctic Ocean. Heat content in the upper ocean varies significantly throughout the year with largest heat transport and highest heat loss in autumn and winter. Between 22 and 31 deg E, the longitudes of the moorings, the annual mean heat loss along the slope north of Svalbard is 16 W m^-2 in the upper 200 m. A large part of the AW heat is thus lost to the atmosphere. In autumn and early winter, sea ice is advected into the region on several occastions. This coincides with episodic events of heat fluxes > 100 W m^-2 which last over several days. These high ocean-to-ice heat fluxes contribute to ice melt and help to keep the slope area ice free well into winter. A persistent ice cover is then established in March 2013, modulating air-sea fluxes and leading to the formation of a cold and fresh mixed layer above the AW core. Local vertical processes such as wind- and tide-driven mixing and shedding of mesoscale eddies contribute to the spatial and temporal variability in the heat content. This study underlines the complexity of the oceanic heat budget in the Arctic Ocean inflow region north of Svalbard and highlights the ocean's role in modulating the sea ice cover.

2676
Hotspots of Internal Solitary Waves and Mixing in the Ice-free Arctic Ocean

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In this work we present the results of Arctic-wide observations of internal solitary waves (ISWs) derived from high-resolution spaceborne synthetic aperture radar (SAR) measurements acquired over the seasonally ice-free Arctic Ocean. Analysis of the data reveals key regions of ISW distribution that are primarily found over the shelf/slope regions poleward the M_2 critical latitude. Most of the ISWs are observed in regions where enhanced tide-induced vertical mixing and heat fluxes have been previously reported. We further show that satellite-derived probability of ISWs attributes well to model-predicted sites of high barotropic-to-baroclinic tidal energy conversion. Positive correlation is also obtained between ISW probability and the rate of TKE dissipation derived from microstructure observations over the continental slope, suggesting that internal solitary waves may promote enhanced vertical mixing in these regions. This work is supported by RFBR grant 16-29-02106 mol_a_dk, RSF grant No. 17-77-30019, and FASO Russia project No. 0827-2014-0011. ENVISAT ASAR data used in this study were provided by the European Space Agency (ESA) through Cat-1 Project C1F-29721.

499
Opening the Window to the Southern Ocean: Abrupt Change in Ventilation

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The surface waters of the Southern Ocean act as a control valve through which climatically important tracers such as heat, freshwater, and CO_2 are transferred between the atmosphere and the ocean. The process that transports these tracers through the surface mixed layer into the ocean interior is known as ocean ventilation. Changes in ocean ventilation are thought to be important for both rapid transitions of the ocean´s global overturning circulation during the last deglaciation, and the uptake and storage of excess heat and CO_2 as a consequence of anthropogenic climate change. Here I show how the interaction between Southern Ocean jets, topographic features, and ocean stratification can lead to an abrupt change in Southern Ocean ventilation. For increasing winds, this interaction leads from a state in which tracers are confined to the surface mixed layer, to a state in which tracers fill the ocean interior. This abrupt onset of Southern Ocean ventilation with increasing winds directly impacts the uptake of heat and CO_2 into the global ocean. For the Kerguelen Plateau, in the Indian sector of the Southern Ocean, this abrupt change in ventilation occurs for wind forcing predicted by climate models for the 21st century. These results imply a prominent role for jet dynamics in understanding rapid transitions of the global climate system.

1157
Subsurface Response of the Southern Ocean to Changing Westerly Winds

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Anthropogenic influences have produced a strengthening and poleward shift of the westerly winds over the Southern Ocean. We use observations and a hierarchy of models to explore the subsurface response of the Southern Ocean to a step-change in the westerly wind. The initial response is robust across models and observations, and consists of Ekman driven cooling at the surface and warming below the seasonal ice zone, as well as warming in the seasonal thermocline due to increased vertical diffusion. However, the long-term response is largely inaccessible from the observations and varies across models. The spread between the models can be explained by variations in the response of the residual overturning circulation. Our results highlight the importance of accurately representing the eddy contribution to the residual overturning circulation, and may provide a mechanism to explain the discrepancy between model predicted warming of Southern Ocean sea surface temperatures and the observed cooling.

OS-8 - Unifying perspectives: conceptualizing pan-Arctic and pan-Antarctic ecosystems 19.06.2018 14:00-15:30, A Dischma

203
New Concepts for the Role of Sea Ice in Structuring Southern Ocean Ecosystems

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Studies in different sectors of the Southern Ocean have shown that sea ice structures Antarctic marine ecosystems in multiple and complex ways. Sea ice acts as a biogeochemically active barrier for atmosphere—ocean gas exchange, controls light availability for phytoplankton, serves as habitat for microalgae and provides a refuge for pelagic herbivores. Antarctic sea ice is also changing with different sectors exhibiting opposite trends in both sea ice extent and ice cover duration. Models predict a significant decline in Antarctic ice extent and ice volume by the end of the century, and these changes are expected to have significant ramifications for Southern Ocean ecosystems. In this presentation I will provide an overview of new and emerging concepts for the role of sea ice in different sectors of the Southern Ocean, discuss the applicability of recently developed Arctic concepts of ice algal and phytoplankton phenology on Antarctic marine ecosystems, and highlight new research questioning the paradigm of the Antarctic sea ice - ice algae - krill relationship. Using recent findings on the physical drivers of Antarctic ice algal temporal and spatial variability, I will highlight the need to better understand sea ice quality rather than quantity to understand its role in structuring marine ecosystems. Furthermore I will discuss problems associated with extrapolating cause - effect relationships, identified in one Antarctic sector, to the entire Southern Ocean.

1119
An Integrative Conceptual Model of the Arctic Ocean's Freshwater System

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Two facts stand out from recent research: first, many key processes within and external to the Arctic Ocean are linked to its freshwater system, and second, the state and structure of the Arctic Ocean is undergoing rapid and uncertain change. To address these two facts we here propose a revised and integrative conceptual model of the Arctic Ocean freshwater system - its internal dynamics and external drivers - that links physics to geochemistry and biology, and land and atmosphere to the ocean. In so doing we follow a scaled hierarchical approach that recognizes regionality, seasonality, pattern and scale. The proposed model extends the Arctic Ocean's freshwater budget far beyond its classical 'gateway' boundaries fully to the Tropics and mid-latitudes, and draws attention to smaller scale sources and distributions within the Arctic Ocean.

1345
Arctic Marine Ecosystem Conceptual Model: Interactions Matrix Revealed (Part A)

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In November 2016, the US Bureau of Ocean Energy Management, Office of Naval Research, and National Science Foundation supported a workshop to create a unifying pan-Arctic conceptual model of the current state and future changes of the Arctic Marine Ecosystem (AME). One component of this conceptual model is a matrix of interactions that determine the functioning of the AME. This matrix was developed using a parsimonious list of Key Elements, distributed between five categories: ***Atmosphere, Land-Ocean/Shelf-Interior Connections, Physical Environment, Biology,*** and ***Human Impacts***. To determine the strength and direction of connections between Key Elements, direct interactions were characterized in a matrix array by evaluating directionality, relative magnitude, and scientific (un)certainty. Indirect interactions were removed, because these should be captured by chains of direct interactions. We found a relative paucity of two-way interactions between Key Elements as well as few very strong connections. Further work is needed to explore indirect causal pathways and the existence of multi-element feedback loops. We present the results of this work in two parts. In Part A we describe the iterative process followed creating the interactions matrix, including the challenges of choosing and characterizing direct interactions. Discussion generated during this presentation will be used to refine the matrix.

1352
Models and Methods to Support Marine Ecosystem Assessments for Polar Oceans

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A fundamental challenge for marine ecosystem ecology and management is that the properties that determine how ecosystems function are extremely hard to observe and measure - a challenge that is made even more difficult by the remote and challenging environment of the Southern Ocean. Furthermore, because of the scale and complexity of Southern Ocean ecosystems, it is hard to know how to robustly measure and summarize their overall status, and track how status is changing (i.e. to measure trends). In response to these challenges, there is growing international coordination to develop complementary suites of observation and models to enable quantification of ecosystem status and trends at circumpolar scales. At the recent Marine Ecosystem Assessment for the Southern Ocean (MEASO) conference in Hobart in April 2018, we sought to identify and synthesise current capabilities and to identify key future priorities for models and methods to support ecosystem assessment in the Southern Ocean. In this presentation, we summarise the outcomes of these discussions. We also consider similarities and differences between Antarctic and Arctic ecosystems that may help develop synergies in approaches to undertaking polar marine ecosystem assessments generally.

2100
Arctic Continental Slopes

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Arctic continental slopes form a contiguous domain encircling the Arctic Basins and are currently experiencing dramatic climate change. Here we present an integrative conceptual model that connects physical processes to ecological conditions in both the water column and at the seafloor. Vertical gradients in water mass properties above Arctic slopes are relatively large, while horizontal gradients along specific isobaths are weak, thus resulting in lateral belts - intersected by numerous canyons - of similar physico-chemical conditions and biological communities. The upper slope (approx. 200-800 m) is characterized by its contact with boundary currents, while the lower slope (approx. 800-2500 m) is a more quiescent environment. Owing to its contact with inflows from the sub-Arctic Atlantic and Pacific the upper slope domain is more productive, biomass rich and distinct in community structure across trophic levels (from phytoplankton to seabirds). The upper slope also shows evidence of a response to climate change including warming, sea ice loss, increased wind mixing, and shelf-basin exchange. The lower slope, in contrast, is cooler, less dynamic, lower in pelagic and benthic biomass and carbon input, and has not displayed evidence of climate change.

413
State of the Arctic Marine Biodiversity Report: Plankton across Sectors

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Microbial plankton and zooplankton are the base of the pelagic Arctic marine food web, feeding large-sized zooplankton, fishes, seabirds and marine mammals. Changes in these species can have cascading effects throughout the ecosystem and can represent the first sign of overall ecosystem perturbation. Despite their importance, their biogeography and taxonomic diversity are underappreciated and inadequately known. The Circumpolar Biodiversity Monitoring Program (CBMP) which is the cornerstone program of the Arctic Council´s Conservation of Arctic Flora and Fauna (CAFF) Working Group has recently, published a review of status and trends of Focal Ecosystem Components (FECs) across the Arctic. The CBMP Plankton Expert Network aggregated and reviewed data on Bacteria, Archaea, phytoplankton, heterotrophic protists and zooplankton as FECs across eight Arctic Marine Areas as well as documenting the state of current monitoring efforts for these species. Plankton are strongly affected by climate and differ between open water and ice-cover conditions, oceanic current patterns and salinity. Increased open water and less saline surface water could lead to range shifts and establishment of non-Arctic species, with unknown consequences for the Arctic marine food web. The approach and lessons learned from this exercise by scientists from all of the marine Circum-Arctic nations could be applied to a pan-national initiative to monitor plankton across international claims in the Antarctic.

SH-2 - Indigenous Governance and Knowledge: Intersection of people, policy & priorities 19.06.2018 14:00-15:30, A Sertig

484
Towards Data Sovereignty for Indigenous Arctic Communities

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The Exchange for Local Observations and Knowledge of the Arctic (ELOKA, eloka-arctic.org) fosters collaboration between resident Arctic experts and visiting researchers to facilitate the collection, preservation, exchange, and use of local observations and Indigenous knowledge of the Arctic. ELOKA provides data management and user support to Indigenous communities to ensure their data and knowledge are managed, visualized, and shared in an ethical manner in order to work toward information and data sovereignty for Arctic residents. In existence for over a decade, ELOKA's mission has evolved primarily from a data management project, creating archival and preservation tools for Indigenous Knowledge and information, towards enabling data and information sovereignty for our Indigenous partners. By data sovereignty, we mean that any data collected by, for, and about Indigenous peoples should be held under the control of those Indigenous groups, challenging many of the assertions made under the 'open data' movement. This paper will outline new efforts and future directions of the ELOKA project to ensure sovereignty of Indigenous peoples over their data and information, including full ownership and control over that information, with the development of a new research coordination network to further ensure data sovereignty for Arctic Indigenous peoples.

2174
Community-based Monitoring and Resource Governance in the Arctic

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Over the past decades, different actors have approached the Arctic with diverse agendas and visions, from laboratory to resource frontier to wilderness in need of conservation action. For Arctic Indigenous residents, these non-local visions impede a broad recognition of the Arctic as a homeland and adoption of governance models rooted in recognition of Indigenous rights.
Alongside these developments, community-based monitoring (CBM) has been proposed as a mechanism for supporting local involvement in resource governance, including oversight of extractive industry and participation in wildlife management. The scientific community has also embraced CBM based on its potential to contribute observations to broader scientific observing networks.
This paper examines possibilities and limitations of CBM as a mechanism to advance Indigenous peoples' rights and research priorities. We consider examples of the role that CBM has played in co-management approaches to resource governance as well as in community-initiated efforts for knowledge and information sovereignty. We also examine the role of data infrastructure, including current barriers to access for Arctic communities, in facilitating the use of CBM in different governance. We base our discussion on observations from participation in several CBM network building initiatives as well as interviews with CBM practitioners and members of the broader Arctic observing community.

1981
Mobilizing Inuit Research Methodologies: A Pond Inlet Case Study

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Inuit are heavily reliant on sea- ice travel for harvesting activities to maintain their nutritional and cultural needs (ICC-Canada, 2008; 2014). In response to unprecedented changes in sea-ice due to climate warming, and to augment Inuit decision-making in sustaining safe sea-ice travel, a community-driven sea-ice information service called SmartICE was established in Pond Inlet, Nunavut, Canada (www.smartice.org). A community-based participatory research (CBPR) approach (Castleden et al., 2015) is being followed to ensure SmartICE meets community needs, builds capacity, reclaims leadership and decision-making roles for Inuit, and utilizes Inuit Qaujimajatuqangit (IQ, Inuit Knowledge) on its own scientific merit. While Indigenous scholars find CBPR a decolonizing ally (Kovach, 2009; Smith, 2012), it does not capture the relational accountability inherent in IQ, (Price, 2007; McGrath, 2011; Healey, 2014). Thus, SmartICE has partnered with Ikaarvik, a community-based organization in Pond Inlet that engages and empowers Inuit youth in community research (www.vanaqua.org/act/direct-action/ikaarvik). Guided by IQ Societal Values (Government of Nunavut, 2013), Ikaarvik youth are developing an Inuit specific relational accountability model called “scIQ” that bridges the strengths of two ways of knowing between scientific enquiry and IQ. This presentation will highlight key aspects of the developing scIQ-CBPR methodology to guide Inuit and non-Inuit in co-producing Arctic research.

773

Indigenous Rights and the Sámi in Sweden - An Analysis of the *Girjas* Trial

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In 2009 a Sámi village went to court against the Swedish state to figure out who holds the right to permit fishing and hunting in the village's reindeer herding land, owned by the State. The *Girjas* trial was the major trial in recent years and gained international interest, especially since the district court granted the village an exclusive right to permit fishing and hunting in the specific area. Hence, the trial is used to reflect the current legislative and juridical situation of the Sámi in Sweden. Amongst others, inappropriate utterances by the state attorney and the handling of the Sámi's status as an Indigenous People need to be taken into account, too. On these grounds, the *Girjas* trial can also serve as a mirror for the social and sociological development and situation of, inter alia, the relationship Sámi- Swedish state.
Sweden has been criticized repeatedly for not including the Sámi in decision making processes and for not living up to the aims set by the *UNDRIP*. Therefore, this interdisciplinary study on one hand analyses the *Girjas* trial by various factors - the legislative and juridical one and the social one- and on the other hand develops a solution-oriented outlook. Since the Sámi are Europe's only Indigenous People, Sweden should work forward to protect and promote their rights and their cultural heritage.

1893
Opportunities & Limitations in Co-managing Water Resources in Yukon, Canada

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Yukon Energy Corporation (YEC) opened the Aishihik Hydroelectric Facility within Champagne and Aishihik First Nations' (CAFN) Traditional Territory in the Yukon, in 1975. Since then, CAFN has repeatedly expressed social and environmental concerns associated with the facility´s operation. As a solution to this persistent issue, YEC and CAFN are currently undertaking to co-manage the water resources for the Aishihik Water License renewal in 2019. One of their objectives is to fully integrate traditional knowledge into understanding the context and issues, as well as making management decisions. However, water resource co-management is a new field of governance, so opportunities and limitations are only just beginning to be identified. Our study assesses opportunities and limitations of the ongoing co-management approach through a conceptual adaptive co-management framework based on collaborative governance models. Data are collected using multiple methods such as semi-structured interviews, and participants observation. We identify some of the complexities and opportunities for improving water resources co-management in the Yukon, across Canada, and elsewhere.

2368
Changing Requirements for Indigenous Lands Documents: What Affect Do These Have?

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This paper analyzes the extent to which the adoption of various laws on indigenous peoples has affected the dynamics of the number of Clan Communes (*korennye rodovye obshchiny* or KROs), as well as the preparation of concomitant documents (such as certificates and licenses), and cadastral maps. In the 1990s, to establish a KRO required relatively informal documentation. More recently (year here) legally formalized documents are required for the establishment and continued functioning of such indigenous organizations. We look at the experiences of the Union of Clan Communes of South Yakutia, and its experiences with the increased requirement for formalized paperwork. To what extent are those KROs without formalized documents protected in today's legal environment? To what extent are they seeking the greater protection offered by more extensive documentation? The Law on the Far East Hectare has accelerated the requirement for documentation, a process that had already been initiated by the Government of Yakutia.

GG-2c - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
19.06.2018 14:00-15:30, A Schwarzhorn

885
Greenland Ice Cores Tell Tales on past Sea Level Changes

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All the deep ice cores drilled to the base of the Greenland ice sheet contain ice from the previous warm climate period, the Eemian 130-115 thousand years before present. This demonstrates the resilience of the Greenland ice sheet to a warming of 5 ^{o}C. Studies of basal material further reveal the presence of boreal forest over Greenland before ice covered Greenland. Conditions for Boreal forest implies temperatures at this time has been more than 10 ^{o}C warmer than the present.
To compare the paleo-behavior of the Greenland ice sheet to the present in relation to sea level rise knowledge gabs include the reaction of ice streams to climate changes. To address this the international EGRIP-project is drilling an ice core in the center of the North East Greenland Ice Stream (NEGIS). The first results will be presented.

1973
Variability of Terrigenous Supply in the Northern Bering Sea over the Past 23 ka

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We use gravity core B11 recovered in the northern Bering Slope to reconstruct millennial-scale changes of paleoproductivity and terrigenous matter supply since 23 ka BP. Based on the geochemical and high-resolution XRF core logging data, our results demonstrate closely interactions between the paleoproductivity and the terrigenous matter supply. Overall, the paleoproductivity is low during the LGM, Heinrich Stadial 1 (HS 1) and Younger Dryas cold phases (YD), and high during Bølling/Allerød (B/A) and Holocene. There are calcium carbonate peaks during B/A which suggest the high calcareous productivity whereas the siliceous productivity increasing rapidly since B/A. The paleoproductivity turns sustained high after YD. Ice rafting debris(IRD) are one of the major terrigenous matter of the Bering Slope, it plays significance role during the cold phases like LGM, especially early HS 1 period. Sea ice extended southward to the Bering Slope carrying masses of shelf sediment by glacier over deepening, the excavation transported vast of clay and terrigenous organic matter into the Bering Slope which responses for the high clay and Total Organic Carbon (TOC) contents during HS 1. The high Fe/S value reveals that the Bering Sea shallower than 1500m was well ventilated under the sea ice cover condition during HS 1. Since B/A, the terrigenous matter source turns to be the submerged shelf which is eroded by the current, tide and the river as the sea level raised.

1200
Late Cenozoic Sedimentary Processes Shaping the Lomonosov Ridge, Arctic Ocean

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With local water depths (wd) shallower than 1000 m, the Lomonosov Ridge is the most prominent feature of the Arctic Ocean. Several tectonic events have shaped the ridge during its Cenozoic history. Moreover, other sedimentary processes have also contributed to the ridge shaping during the recent past. These processes are poorly known, mainly due to the sparse coverage of data in the Arctic Ocean. However, substantial quantities of geophysical data have been collected during the past years in the framework of international research projects or the national UNCLOS programs of the circum-Arctic countries. Detailed analysis of the sub-bottom profiles across the entire Lomonosov Ridge has revealed the regional distribution of sedimentary features in the most recent sedimentary record, suggesting a variety of cryospheric and oceanographic processes involved in their formation. Truncated reflectors are identified in the highs of the Siberian side of the Lomonosov Ridge, above 1000 m wd. They have been linked to grounding ice sheet and iceberg ploughing. Sediment waves are identified between 1000 and 1500 m wd particularly along the ridge flank towards Amundsen Basin, slightly deepening in the surroundings of the North Pole. These sediment waves are linked to the Siberia-Greenland flow of intermediate water masses in the Arctic Ocean constrained by the morphology of the Lomonosov Ridge and following the Arctic cyclonic circulation.

2167
Last Interglacial Meltwater Signal from Far-field Sea-level and Proxy-climate

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Most of the geological record of Antarctic Ice Sheet extent during warmer interglacials has been lost due to glacial expansion and retreat cycles, and the ice-core record is geographically sparse. We take the novel approach of using the Southern Hemisphere (SH) coastal and specifically the Australian region imprint of sea-level history to identify ice sheet instability during the last interglacial (MIS5). The unique sea level signal archived in the coastal sediments and morphology contains evidence for a pulse of meltwater input during the mid-late MIS5e of ~2-3 m of sea-level equivalent. The spatial pattern of the differential sea-level rise during MIS5e, after correction for Glacio-Isostasy is matched to the gravitational meltwater fingerprint for each of the three polar ice sheets to determine the origin of the excess meltwater and hence, the source of ice sheet instability.
We also report our progress in reconstructing the MIS5e SH atmospheric pressure and wind field evolution. We apply a coastal and climate proxy-data -model assimilation by using a Last Interglacial simulation together with a regionally distributed multivariate proxy dataset, to produce atmospheric reanalysis for 129 ka BP, 125 ka BP and 120 ka BP (after Goodwin et al., Clim. Dyn., 2013). Ultimately, we compare the atmospheric circulation patterns together with the meltwater fingerprint pattern to the MIS5e ice core record and the Antarctic shelf-sedimentary record of meltwater discharge.

2014
Environmental Conditions in East Antarctica - Evidence from Mumiyo Deposits

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Antarctic snow petrels (*Pagodroma nivea*) produce stomach oil, which is ejected against predators to defend their nests. In some locations stomach oil accumulates and fossilizes and forms centimetre to decimetre thick deposits of so-called Antarctic mumiyo.
We studied mumiyo deposits from different sites in central Dronning Maud Land to explore their potential as a paleoclimate archive. Comprehensive ^{14}C-analysis shows that the finely-laminated deposits provide consistent age depth profiles. Besides from organic compounds, which are derived from stomach oil (mainly wax-ethers), the deposits contain inorganic minerogenic particles sourced from bedrock and from guano. High-resolution XRF elemental scans indicate that changes in inorganic composition are consistent within one deposit and likely reflect local environmental conditions. Mumyio profiles from one region can be correlated based on their age and chemical composition, which suggests that the deposits provide a regional signal.
Our data confirm the existence of un-glaciated areas during the Last Glacial Maximum (LGM) and extend the archive far into Marine Isotope Stage (MIS) 3, which is poorly understood in coastal Antarctica

1656
New Constraints on post-LGM Ice Sheet Dynamics in the Southern Weddell Sea

Jan Erik Arndt[1] (jan.erik.arndt@awi.de), Claus-Dieter Hillenbrand[2], Hannes Grobe[1], Gerhard Kuhn[1], Lukas Wacker[3], Robert D. Larter[2], Boris Dorschel[1], Simon Sørli[4], Matthias Forwick[4]
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Past ice sheet conditions in the southern Weddell Sea remain poorly known. Previous studies have led to contradicting scenarios of maximum ice extent during the Last Glacial Maximum (LGM). Scenario A is mainly based on terrestrial data indicating limited ice sheet thickening in the hinterland and suggests a LGM grounding-line position on the inner shelf. Scenario B is based on marine geological/-physical data and concludes that the grounding line was located on the outer shelf (~650 km further offshore than in scenario A). In addition, studies suggest a complex history of ice retreat and drainage pattern since the LGM that needs further constraint. We investigated hydroacoustic data acquired during 17 expeditions. A key finding is a previously unknown stacked grounding zone wedge (GZW) located in Filchner Trough on the outer shelf showing that a palaeo-ice stream stabilized at this position at least twice. Radiocarbon dates from sediment cores indicate that (i) the GZW was formed in the early Holocene and (ii) grounded ice did not extend seaward at the LGM. Hence, the grounding line in Filchner Trough experienced dynamic changes in the Holocene and ice sheet retreat after the LGM was not linear. Ice-flow switches in the hinterland possibly explain this behaviour. Further interesting findings are made in Brunt Basin suggesting the existence of cold-based ice or impacts of large icebergs. In addition, new data will be acquired in the area with *RV Polarstern* in Jan-Mar 2018.

OC-4 - Art meets Science: That Which Cannot Be Transmitted
19.06.2018 14:00-15:30, A Seehorn

2330
That Which Cannot Be Transmitted

Sandra Kuehne[1] (info@sandrakuehne.ch), Tamsin Relly[2], Daniel Kukla[3]
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In 2014 a group of visual artists sailed in a tall ship up the west coast of Svalbard. They all witnessed the same landscape, yet, as they filtered the experience through their individual thematic and aesthetic concerns, a series of translations occurred, across a range of media including photography, video and drawing. In response, seven of the artists developed *That Which Cannot Be Transmitted*, a project which considers how the process of translation can shape contemporary discourse about the Arctic. Exploring overlapping themes of temporality and the Anthropocene, three of these artists will each present their work.
Tamsin Relly works with the fluid and unpredictable qualities of printmaking and photography to disrupt the translation of landscape into image, and offer impressions of environments in states of uncertainty or impermanence.
Paper, lines and cutting are central to Sandra Kuehne´s practice. Printed materials such as polar maps are frequently used as media. Kuehne employs the variations of the line, its formal lyricism, but also challenges the absolute assertion of any printed map by making references to topography that is in continual flux.
Daniel Kukla´s work is informed by the intersection of his art practice and formal training in the biological and anthropological sciences. He is interested in the shifting tensions towards the natural world as our society expands with an insatiable appetite for resources.

1726
Invisible Dust: Making the Invisible Visible

Victoria Burns[1] (victoria@invisibledust.com)
[1]*Invisible Dust, London, United Kingdom*

Invisible Dust's mission is to encourage awareness of, and meaningful responses to, climate change and environmental issues. We facilitate dialogue between leading visual artists, creative technologists and scientists.
We aim to connect with people on a personal level through *making the invisible visible*.
Visibility plays a key role in creating understanding around the need to live sustainably and dramatically reduce climate change. Artists have many ways of making things visible and, particularly since the Land Art movement in the 60s and 70s (such as the ephemeral works of Richard Long and Robert Smithson) have responded to changes in the natural environment in a variety of forms.
How can people understand their own effect on the environment when the resulting gases disappear into the sky? Since the industrial revolution there have been huge gains to society but the creation of many of the gases are now poisoning the earth. Invisible Dust creates partnerships to illuminate these consequences and bring a sense of something human and fantastical to often very invisible problems.
Our lecture will case study Kasia Molga's *Human Sensor* which premiered in the streets of Manchester in 2016 - Molga created striking wearables which change colour in response to air pollution; and our 2017 exhibition *Offshore - Artist Explore the Sea* which included 23 artists works and 10 new commissions which were created in consultation with Ocean Scientists.

2220
There Is Always Something More Important

Mariele Neudecker[1] (mail@marieleneudecker.co.uk)
[1]*Bath School or Art and Design - Bath Spa University, Fine Art, Bath, United Kingdom*

Both scientific scrutiny and intuitive artistic exploration can give insights to the blurred zones between subjectivity and objectivity and alter our perception of the world.
I am a visual artist and often use technology's virtual capabilities in order to reproduce a heightened experience, often of Northern or Arctic landscapes. I am interested in notions of a contemporary sublime and have worked with scientists and engineers and their methods and research with the on-going quest to make the immeasurable measurable, the invisible visible.
I find it inspiring to look at places and situations that are overtly international, with a communal goal of seeking new knowledge, often situated on the fringes of civilization. In these "borderless" places, we find academic research centres that prioritize humanity to a social and political unit, where egos, politics and nationalities have become secondary.
I have travelled in Arctic Scandinavia and Greenland. With works that followed these journeys, I have been exploring the interphases and overlaps of imaginary and factual realities, the two and three-dimensional, as well as the analogue and digital.
In this talk I will present my projects that connect to the Poles or the Arctic in some way. I work with a variety of media, including sound, sculptural installations and scale.
I am interested in how knowledge: past, present and future, can come to life and what it means to be human in age of the Anthropcene.

2591
Resonant Evidence: Music and Soundscapes from the Ice

Douglas Quin[1] (dhquin@syr.edu), Jay Needham[2]
[1]Syracuse University, Television, Radio & Film, Syracuse, United States, [2]Southern Illinois University Carbondale, Carbondale, United States

This 15-minute panel focuses on the work of Jay Needham and Douglas Quin, two sound artists with extensive polar experience.
Needham utilizes multiple creative platforms and his works often have a focus on recorded sound, archives and the interpretation of artifacts. His field recordings from Antarctica have become the basis for his composition Chronography: Animal, that premiered at the Internationale Ferienkurse für Neue Musik Darmstadt in 2012.
An interest in soundscape and where art and science intersect are threaded throughout Quin's practice: from direct collaboration with scientists in field-based bioacoustics research into Weddell seal vocalization to drawing inspiration from and using ice-core data to inform compositional strategies and outcomes. Quin was the first composer and sound artist to be selected by the US National Science Foundation's Antarctic Artists and Writers Program in 1996. Over the past 20 years, his varied polar projects include site-specific and interactive sound installations, soundscape recording, composition, performance, live satellite broadcasts, and film.
The panel will include discussion and listening to samples of their compositions.

1690
Modern Hyperboreans

Evgenia Arbugaeva[1] (arbugaeva@gmail.com)
[1]*Freelance Visual Artist, Yakutsk, Russian Federation*

I am a documentary photographer, most of my life has been spent traveling in the North and pursuing personal stories and editorial assignments: I have been visiting hard-to-reach scientific stations; migrated with Nenets reindeer herders; explored the rush for natural resources across the Arctic; and lived on New Siberian islands with “pirates” who excavate mammoth tusks from melting permafrost.
In my journeys, I'm attracted to the visual simplicity of the Arctic landscape, and to the emotional complexity of the humans who inhabit it. I am curious about the motives that bring people to remote Arctic locations — a land that, quite honestly, is not made for living. But its remoteness offers refuge to those souls that seek isolation.
In this presentation, I would like to share the story of Slava - chief of the meteorological station Khodovarikha located on the narrow peninsula in the Barents Sea in Russia. Slava has been living at the station for 13 years. He is the kind of rare character that you meet only in the Arctic - *Polyarnik,* a specialist in the polar north*,* a hermit who chooses to live away from the rest of the world. Looking at him, I had a strange feeling that he is not only measuring the weather, but that he also lights up the sky with the Aurora Borealis, exchanges news with the wind, and converses with the sea. I tried to capture this impression in my photographs of a weather magician living in extreme solitude.

TE-3c - Remote sensing of polar regions
19.06.2018 14:00-15:30, A Wisshorn

32
Geospatial Tracking of Antarctic Iceberg Calving via Indian Space-borne Missions

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[1]*National Centre for Antarctic and Ocean Research (ESSO-NCAOR), Ministry of Earth Sciences, Vasco da Gama, India*

This study focuses on the tracking of iceberg calving events in the vicinity of Larsemann hills and environ, Ingrid Christensen coast, east Antarctica using multispectral images from Linear Imaging Self Scanning Sensor (LISS-IV) aboard IRS-P6 satellite. The two images captured specifically 384 days apart from LISS-IV, enabled a detailed understanding of the changes that have occurred during this short epoch. A careful and expert-guided onscreen manual digitization was used for tracing icebergs present in both the images. A total of 369 common icebergs present in both images were identified on the basis of their shape, size and texture for analyzing the changes in their dimensions because of melting or disintegration. Also, several among these were found to have deformed and diminished during the period from December 31, 2013 and January 19, 2015. Our analysis estimates that the number of icebergs is decreased by 70 from 2013 to 2015, suggesting the complete disintegration of these icebergs over the ≈1 year period. In case of 369 common icebergs, the total surface area has been decreased by 12.51%, suggesting the melting of icebergs in the given time period. The average deviation of the newly disintegrated icebergs from the coastline is found to be 51.59 m for 384 days. This study demonstrates the quantitative analysis of iceberg calving, changes in iceberg numbers, rate of iceberg disintegration, and rate of iceberg drift in the Prydz bay of the Larsemann hills area.

316
Snowmelt in Antarctica as Derived from SMOS Observations

Marion Leduc-Leballeur[1] (m.leduc@ifac.cnr.it), Ghislain Picard[2], Giovanni Macelloni[1], Arnaud Mialon[3], Marco Brogioni[1], Yann H Kerr[3]
[1]IFAC-CNR, Sesto Fiorentino, Italy, [2]IGE, UGA-CNRS, Grenoble, France, [3]CESBIO, CNES, CNRS, IRD, UPS, Toulouse, France

In the polar regions, the state of the surface is essential to understanding and predicting the surface energy and mass budgets, which are two key nivo-meteorological variables for the study of the climate and the contribution to the sea level rise of ice-sheets. The inter-annual variations of melt duration and extent are valuable indicators of the summer climate in coastal regions of the ice-sheets, especially on ice-shelves where melt water contributes to their fate.
Liquid water have a significant impact on the microwave emissivity of the surface and several studies exploited the 19 and 37 GHz long time series to detect snowmelt events. The European Space Agency (ESA)'s SMOS satellite carried on board a microwave radiometer operating at 1.4 GHz. At this low frequency, the signal is sensitive to a large thickness of snow when it is dry contrary to higher microwave frequencies, which are sensitive up to the first meters of the snowpack. Thanks this large penetration depth, SMOS observations could detect if melt water persists at depth and impacts on snowpack stability. In this study, we developed algorithms based on previous studies in order to detect melt from the SMOS brightness temperature at horizontal polarization. Snowmelt product is obtained from July 2010 and June 2015 with SMOS observations. Here, we explore the potential of combined low and high frequencies to provide a synergetic description of surface melting events in Antarctica and investigate their variations.

1761
Long-term Antarctic Elevation Change from Multi-mission Satellite Altimetry

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The contribution of the Antarctic Ice Sheet to present-day sea level change still contains large uncertainties. In several regions of West Antarctica, changing ice flow leads to rapid dynamic thinning while in East Antarctica the rates are relatively small. The time period of a single satellite altimetry mission is not long enough to distinguish between long-term elevation changes and interannual variations. Therefore, we apply a multi-mission approach to combine the observations of different missions and thus are able to create a joint long-term elevation time series. We show that a consistent reprocessing of ice sheet altimetry from different missions is not only a prerequisite for the combination, but also improves the accuracy and precision of conventional pulse limited radar altimetry by about 30%. We will discuss which special aspects have to be considered when combining conventional radar altimetry with the high resolution SARIn-mode data of CryoSat-2 and the high precision ICESat laser altimeter measurements. Therefore we will present a novel approach to create a joint time series. Our results provide an unprecedented insight into the variations of the interior of East Antarctica and help to separate the long-term trends from interannual variations.

1861
Surface Water Ocean Topography Mission Retrievals in the Ice-covered Ocean

Thomas Armitage[1] (tom.w.armitage@jpl.nasa.gov), Ron Kwok[1]
[1]*Jet Propulsion Laboratory, California Institute of Technology, Pasadena, United States*

Satellite radar altimetry has proven to be a valuable tool for remote sensing of the polar oceans, with techniques for estimating sea ice thickness and sea surface height in the ice-covered ocean advancing to the point of becoming routine, if not operational, products. Scheduled for launch in 2021, the Surface Water Ocean Topography mission (SWOT) payload, the Ka-band Radar Interferometer (KaRIn), will employ radar interferometry to estimate an ~120km across-track swath of surface elevation. In the polar oceans, SWOT will provide high resolution two-dimensional maps of sea level and sea ice elevation, offering the potential to derive instantaneous 2-D ocean currents and a detailed picture of the sea ice thickness distribution. Here, we present results from preliminary investigations into the KaRIn retrieval performance in the ice-covered oceans. First, we utilise the available near-incidence Ka-band airborne and satellite data to study the range of possible radar backscatter profiles. Second, the range of possible radar backscatter profiles will be applied in the SWOT mission simulator to produce synthetic data and evaluate the expected measurement capability.

2051
Recent Achievements in Deriving Sea Ice Thickness from Radar Altimetry

Robert Ricker[1] (robert.ricker@awi.de), Stefan Hendricks[1], Stephan Paul[1], Lars Kaleschke[2], Xiangshan Tian-Kunze[2]
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The retrieval of Arctic sea ice thickness is one of the major objectives of the European CryoSat-2 radar altimeter mission and the 7-year long period of operation has produced an unprecedented record of monthly sea ice thickness information. We present CryoSat-2 results that show changes and variability of Arctic sea ice for the period 2010 to 2018. CryoSat-2, however, was designed to observe thick perennial sea ice, while retrieving thin seasonal sea ice accurately is more challenging. We have therefore developed a method of completing and improving Arctic sea ice thickness information by merging complementary satellite retrievals. The European SMOS satellite can detect thin sea ice, whereas its companion CryoSat-2 lacks sensitivity. Using these satellite missions together overcomes several issues of single-mission retrievals and provides a more accurate and comprehensive view on the state of Arctic sea-ice thickness at higher temporal resolution. Nevertheless, stand-alone CryoSat-2 observations can be used as reference data for the exploitation of older radar altimetry data sets over sea ice. In order to observe trends in sea ice thickness, it is required to minimize biases between subsequent satellite missions. We show a climate data record of sea ice thickness derived from satellite radar altimetry that has been developed for both hemispheres, based on the 15-year (2002-2017) monthly retrievals from Envisat and CryoSat-2 and calibrated in the 2010-2012 overlap period.

2360
The Last Antarctic Frontier: Airborne Survey of the Satellite South Pole Datagap

Rene Forsberg[1] (rf@space.dtu.dk), Arne V Olesen[1], Tom Jordan[2], Fausto Ferracioli[2], Hugh F J Corr[2], Kenichi Matsuoka[3]
[1]Technical University of Denmark, DTU Space - National Space Institute, Kongens Lyngby, Denmark, [2]British Antarctic Survey/NERC, Cambridge, United Kingdom, [3]Norwegian Polar Institute, Tromsø, Norway

Satellite remote sensing cover Antarctica to varying degrees, leaving polar data acquisition gaps, depending on satellite orbit inclination. While GRACE provided mass change data for all of Antarctica, radar and laser satellite altimetry missions such as CryoSat, IceSat and EnviSat covered only regions in the range from 88-83°S from the South Pole; recent geophysical missions such as GOCE (gravity field) and SWARM (magnetic field) covered only regions north of 83°S and 87°S, respectively. To improve the coverage of the polar gap region, especially for the GOCE mission, the European Space Agency funded a major airborne remote sensing campaign - PolarGap 2015/16 - to provide a first systematic fill-in of the southern polar gap data. The PolarGap campaign were carried out by a British Antarctic Survey Twin-Otter operating from two deep interior field camps and Amundsen-Scott South Pole station, collecting a variety of lidar, radar, gravity and magnetic data. In the presentation the results of the PolarGap campaign are presented, along with comparisons to satellite data in the overlap zones, and some of the major discoveries summarized. The comparisons confirm large errors in existing data compilations such as BEDMAP2, ADMAP and ANTGRAV, and also provide new understanding of CryoSat Ku-band radar firm penetration on the Antarctic Plateau, confirming the sub-meter accuracy in ice sheet radar elevation mapping.

OC-1_OC-2c - Innovation, partnership and impact in polar science communication & Polar Research and Citizen Science: Exploring New Platforms and Opportunities
19.06.2018 14:00-15:30, B Pischa

1848
Using Digital Resources to Stimulate International Public Engagement

Jean Holloway[1] (jean.holloway77@gmail.com), Alexander Thornton[2], Jilda Caccavo[3], Gabriela Roldan[4], Hanne Nielsen[5], Gerlis Fugmann[6]

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The Association of Polar Early Career Scientists (APECS) is a multidisciplinary, international organization dedicated to maintaining a network of early career researchers to share ideas, develop collaborative research directions, provide career development opportunities, and promote education and outreach related to polar research. APECS has stimulated polar literacy through innovative science communication, well-integrated public outreach and engagement, and partnerships with Arctic and Antarctic organizations. Examples of one- and two-way engagement between APECS' members and the general public are illustrated in our involvement with digital events and social media initiatives. Successful events include Antarctica Day, webinars, and APECS' annual online conference. One of our popular social media initiatives is the biannual Polar Week celebration. This includes Twitter campaigns, Reddit “Ask Me Anything” discussions, and photo and video contests. Benefits to using modern technologies and techniques for stimulating public engagement about polar research include easier dissemination of ideas across geographical distances as well as to remote areas with minimal cost and a low carbon footprint. While this presentation focuses on APECS' experiences, we will highlight how innovative communication promotes international discussion and cooperation across disciplines, then offer suggestions on how to incorporate similar elements into other outreach programs.

380
The Power of the Tourism Fleet to Contribute to Science and Create Ambassadors

Annette Bombosch[1,2] (annette.polarcollective@gmail.com), Robert W. Gilmore[1], Lauren Farmer[2], Alex Cowan[2], Ted Cheeseman[3], Susan Adie[2], Brandon Harvey[1]
[1]Polar Latitudes, White River Junction, United States, [2]G Adventures, Toronto, Canada, [3]Southern Cross University, Lismore, Australia

Polar Regions are the focus of scientific research due to accelerated effects of climate change. Yet data collection in these areas is often limited by its remoteness and financial constraints. At the same time these areas experience increased traffic due to a heightened interest amongst travellers and a growing tourism fleet. Often visitors are well-educated and eager to gain a deeper understanding of the places they visit. Citizen science has developed into a recognised and indispensable means for robust data collection and guest education.
Expedition ships operate entire seasons in Polar Regions, providing cost-effective platforms for data collection over longer time periods than research cruises. Benefits of citizen science projects aboard encompass valuable data for the scientific community as well as turning guests into active polar ambassadors by increasing awareness and concern for the conservation of the Polar Regions.
Here we present how to successfully undertake citizen science programs aboard, using examples from tour operators Polar Latitudes and G Adventures, as well as how to coordinate data collection amongst the tourism fleet. Possibilities for guest engagement cover activities aboard, during Zodiac and land excursions. Challenges addressed include selecting suitable projects ensuring both data quality and feedback from scientists. Also an ambitious platform for coordinating and faciliating industry-wide citizen science efforts is introduced.

866
Antarctic Ambassadors Explore Meltwater Influence on Phytoplankton within Fjords

Allison Lee[1] (allisonlee9@gmail.com), Maria Vernet[1]
[1]*Scripps Institution of Oceanography, UC San Diego, Biological Oceanography, La Jolla, United States*

The Antarctic Peninsula has experienced rapid warming for decades, leading to an increase in glacial meltwater input within the coastal fjords. This freshwater released at the glacier front creates changes that may drastically impact various levels of the food web, particularly with phytoplankton. Small environmental variations may favor different compositions of phytoplankton and shift the timing of blooms during the season. These seasonal and interannual variations regarding phytoplankton phenology and community composition are not available within the fjords and detailed monitoring can provide insights into changes that may occur. A great opportunity exists for scientists to collect this vital data by engaging the Antarctic tourism community. The International Association of Antarctic Tour Operators (IAATO) brings visitors throughout the year, occupying coastal fjords during the austral growth period. This established community can collect scientific data thereby improving the knowledge gap of phytoplankton composition and phenology. This citizen science partnership with the IAATO operators, in which tourists can participate, will supplement our current scientific datasets gaining a more comprehensive view of phytoplankton community structure and bloom dynamics in the Antarctic fjords. This new knowledge will not only provide a better understanding of glacial meltwater impacts on biodiversity and ecology, but also increase public engagement and understanding of science.

396
How Citizen Science Evolved a Whole New Platform for Coastal Polar Research

Ben Wallis[1] (ben@ocean-expeditions.com)
[1]*Ocean Expeditions, Sydney, Australia*

Harnessed correctly, citizen science can be a huge asset to Antarctic science. During the 2017/18 season, the IAATO fleet alone is expecting more than 46,000 tourists to visit Antarctica. In recent years, such visitors have begun observing and cataloguing animals including humpback whales, orcas and leopard seals. There is a huge potential to further utilise this resource to create crowd-sourced observation data.
In 2011, when I created a fellowship program to host Antarctic scientists, I Initially hoped to add value to my passengers' Antarctic experience through their engagement with (and assistance to) guest scientists. In doing so, I picked up valuable lessons in the planning, permitting, organising and onboard management of small vessels support of both 'citizen' and government science.
During the 2017/18 season alone, I will be supporting seven different science projects, ranging from visual observations by tourists, to dedicated research voyages for national Antarctic programs. To date, these voyages have resulted in 28 published papers, 175 citations, the support of nine national Antarctic programs and 40 institutions, the transport of 90 scientists and 915 tourists. On voyages with both passengers and scientists, the interaction between the two has not only assisted scientists in their data gathering, but resulted in passengers returning north as true Antarctic ambassadors.

2494
Operational Ice Service Perspectives on Collaborations with Polar Tourism

Penelope Wagner[1] (penelopew@met.no), Nick Hughes[1], Keld Qvistgaard[2]
[1]Norwegian Meteorological Institute, Norwegian Ice Service, Tromsø, Norway, [2]Danish Meteorological Institute, Copenhagen, Denmark

With the increase of polar tourism, the Norwegian and Danish Ice Services have been collaborating with polar tourism to better understand data needs of ship operators when making tactical decisions travelling through or along icy waters. A main challenge that has been identified from an operational perspective is providing ship operators with sufficient and reliable daily ice information, including high quality sea ice and iceberg detection in the marginal ice zone, along the ice edge, and in harbours, and inshore. The operational ice services are developing better methods to provide better outlooks and forecasts which may require customized products, particularly for large ships that have less flexibility to change their planned trajectory. Near-real time data transmission continues to be unreliable in specific areas. It is essential that ice services supporting maritime safety in navigation consolidate efforts to work with the polar tourism industry and develop strategies to improve the coordination between data providers and users. Additionally, increasing citizen science endeavours on ships is ideal for ice services to exchange routine ship observations and satellite information. It also allows passengers to fully engage with operational and science activities. Using case studies of ice services providing support to Arctic and Antarctic cruise ships and participating in citizen science activities, we demonstrate how we can improve collaboration between the two groups.

1917
Encouraging Citizen Science with Community-based *Science Month* Events

Regina Brinker[1,2] (brinker.science@gmail.com)
[1]*Livermore Valley School District, Science, Livermore, United States,* [2]*Polar Educators International, Livermore, United States*

Science and Engineering Month (SEM) is celebrated during February in Livermore, California. Over 40 programs encourage the community to learn about science and engineering, get outdoors and observe the natural world around them, and contribute to citizen science projects. Many events, including lectures, bio-blitz surveys, water quality testing, and nature walks, relate to environmental and climate awareness.
A range of public agencies, including government, K - 12 and college education, libraries, park and recreation centers, and businesses participate in *SEM*. Programs are publicized through the internet, local newspapers, and social media.
Goals of *SEM* are to engage the community in science, make citizens more knowledgeable of and connected to local ecosystems, and increase awareness of local impacts of climate change.
This presentation will discuss *SEM*'s concepts, planning, and implementation. As the program coordinator, I will share best practices and lessons learned for creating a successful community-wide program. *SEM* may be modeled in other communities to fit the needs and interests of that area, including engaging citizens in community science project related to polar science.

CR-3a - Cryosphere-Hydrosphere interactions: The water cycle at the three Poles
19.06.2018 14:00-15:30, B Parsenn

157
Variable Connectivity between Glacial Melt and Streamflow, McMurdo Dry Valleys

Anna Bergstrom[1] (anna.bergstrom@colorado.edu), Michael Gooseff[1]
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The Dry Valleys of Antarctica are a system closely tied to the energy balance. In the summer months with air temperatures around 0 degrees C, slight shifts in incoming radiation, temperature, or albedo can have drastic effects on both the magnitude and partitioning of glacial ablation for sublimation and melt water generated for streamflow. Snowmelt is a very minor contributor to streamflow. The McMurdo Long Term Ecological Research site has been collecting records of glacial ablation, streamflow, and meteorological data for over 23 years. In the 2001-2002 season, unusually high persistent temperatures and solar flux caused unprecedented glacial melt and stream flow orders of magnitude higher than average. After this season, relationships between glacial melt and stream flow have shifted. There is better correlation between streamflow and ablation for all studied streams after the warm season. It is hypothesized that the melt event reorganized and concentrated sediment at or near the surface of the glaciers, lowering the albedo. This research utilizes the long-term records of streamflow, glacier ablation, and meteorological data to assess how the melt event may have resulted in lasting changes in the energy balance dynamics and degree of melt water generation from the Dry Valley glaciers. This work will help us better understand the controls on glacial melt as well as the connection between glaciers and the downstream ecosystems.

1347
Investigating Large Active Subglacial Lake Drainages in East Antarctica

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Spatially coherent surface-height anomalies have been mapped in regions of fast ice-flow across Antarctica. These features have been interpreted as the surface manifestation of a dynamic subglacial water system, with up to cubic kilometers of water moving into and out of active subglacial lakes on timescales of months to decades. By impounding and episodically releasing water, these subglacial lakes have been hypothesized to drive regional hydrological variability and modify the flow of the overlying ice. However, no datasets have been available with high enough time resolution to simultaneously observe surface-height motion, map velocity changes, and image the ice-bed interface through a hypothesized subglacial lake drainage event, leaving the relationship between surface-height anomalies, the basal environment, and ice dynamics unclear. Using satellite and airborne altimetry from the CryoSat-2 mission and Operation IceBridge, Landsat 8 feature tracking, MODIS image differencing, and repeat airborne radar sounding, we investigate two large (> 10 m) surface-height anomalies on Slessor and Recovery glaciers, East Antarctica. By mapping regional basal reflectivity and velocity changes before, during, and after surface-height changes, we explore the cause of these enigmatic, widespread features and their ultimate impact on ice flow in Antarctica.

2152
A Regional System of Briny Aquifers in the McMurdo Dry Valleys, Antarctica

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Liquid water is relatively scarce in high-latitude polar environments but plays an outsized role by influencing, and integrating, biological, biogeochemical, glaciological, and geological processes. Whereas surface hydrology and its role in ecosystem processes has been thoroughly studied over the last several decades, it has been difficult to map out and characterize subsurface water reservoirs and to understand their interactions with regional lakes, glaciers, and coastal waters. As part of the NSF-funded AntAEM project, we are using ground-based and airborne Time-domain ElectroMagnetics sensors to provide the first integrative system-scale overview of subsurface water distribution and hydrological connectivity in a partly ice-free coastal region of Antarctica, the McMurdo Dry Valleys. Our previous survey documented existence of a briny aquifer in Taylor Valley (Mikucki et al., 2015) and new data indicate similar subsurface features in neighboring valleys. In particular, we see that Don Juan Pond, the second saltiest waterbody on Earth, is likely connected to a subsurface aquifer, as is the largest lake in the Wright Valley, Lake Vanda. Airborne data collection in 2018 will further elucidate these relationships between surface and subsurface water systems. It will also focus on clarifying the connectivity between these inland groundwaters and the coastal zone. The briny groundwater systems found by us in the Dry Valley region may be common in coastal Antarctica.

1111
Using GPR to Investigate the Subglacial Hydrology of an Alpine Glacier

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Hydrological inference suggests that subglacial drainage networks under temperate valley glaciers are dendritic, meaning that their subglacial conduits have both streams and stream junctions. These networks, at their most developed, comprise subglacial conduits. They are typically associated with the combined effect of opening by hydraulic-pressure-driven ice melt and closure by ice overburden pressure. Inference from dye breakthrough curves has supported theoretical arguments that:
(1) these channels open up progressively during the summer; and
(2) close during the winter to leave a more inefficient drainage network at the start of spring.
This model has dominated modern glaciology for over 50 years, but geomorphological reasoning questions this domination. Temperate valley glaciers, when they retreat, commonly reveal beds of soft sediments. Borehole imagery as well as speological investigations have confirmed that the channels have potentially erodible beds. As such, they might better be viewed as rivers under ice rather than channels eroded into ice.
Here, we present the results of ground-penetrating radar (GPR) surveying on the Glacier d'Otemma in the south-western Swiss Alps. By looking at spatially dense grids of GPR measurements with a line spacing of 2 m, we aim to determine the locations and geometry of sub-glacial conduits below the glacier tongue, for ice thicknesses between 30 m and 80 m.

2041
Conceptual Model of Englacial Water Fluctuations of Hansbreen, Svalbard

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Drainage of meltwater and rainwater plays an important role in glacier dynamics. Behavior of drained water within the drainage system is poorly known and understood. During the years 2016 and 2017, our study focuses on the well-explored perennial conduit, known as Crystal Cave, present inside the tidewater glacier Hansbreen located in the southern part of the Svalbard archipelago. The polythermal regime of this glacier allows the development of a well-channelized internal drainage system.
Innovative ice cave monitoring techniques have been created in order to instrument the central part of an englacial conduit, preventing it to move because of water circulation and to freeze into the walls. Results are the first temperature and water pressure fluctuations recorded at 30 min frequency during the whole hydrological year inside an englacial system.
During the winter period, when the internal drainage system is inefficient, water levels rise up in the englacial conduits in response to positive air temperature and precipitation events with a few days of delay. On the contrary, during the summer period, when the internal drainage system is efficient, water level rises up in the englacial conduits synchronously with higher air temperature and precipitation events. In addition, during the winter period we observed reverse flow-water coming from the lower part of the internal system toward the upper part. Finally, presence of liquid water storage during the winter season was monitored.

371
Measuring Glacier Dry Calving with SAR Interferometry

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The glaciers of the Canadian Arctic Archipelago are currently undergoing rapid retreat. There is considerable interest in the mechanisms leading to ice loss in this region, as these glaciers have been identified as being a significant contributor to rising sea levels. Unlike surface melting or direct calving into the ocean, little is known about the contribution of meltwater from dry calving. This is where ice breaks off steep glacier edges and melts in place at a greatly increased rate. This results in accelerated water contributions to the ocean for which there are no reliable estimates available. A measure of the location and discharge rate of dry calving is required to better model glacial contributions to sea level rise.
For this project we developed a methodology for estimating calving potential, using estimates of glacier velocity at the main calving faces, derived from SAR interferometry. This study uses Fountain Glacier on Bylot Island as a case study because of the extensive baseline data in the region. Specifically, the SAR data enabled the identification of calving faces and their activity level, the speed and direction of glacier motion and along with ancillary data discharge estimates of the glacier from the calving front. It is believed that this is a practical approach, which will allow for the estimation of mass loss through dry calving for specific glaciers and the identification of calving potential at a regional level.

BE-10 - Polar fish: physiological adaptations and their responses to climate change
19.06.2018 14:00-15:30, B Jakobshorn

384
Acclimation Potential of Polar Cod from the Rapidly Warming Arctic Ocean

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The physics and biogeochemistry of the Arctic Ocean have changed significantly in the past century and are predicted to continue changing as rapidly. Missing, however, is a general knowledge on the thermal tolerance ranges for Arctic ectotherms and their acclimation potential, which are minimum knowledge requirements to accurately forecast the distributional patterns of marine species and their chances of survival in a changing environment. Thus, it is imperative to understand thermal optima, tolerance and acclimation potential of Arctic fishes to predict food web consequences with continued warming of the Arctic Ocean.
Polar cod (*Boreogadus saida*) are able to acclimate to different temperatures over time. We quantified acclimation potential using 3 methods including: the critical thermal maximum of 3 acclimation groups (0.5, 3.5, 6.5°C); the aerobic scope (AS) of similarly acclimated *B. saida*; and the heart rate of long term acclimated fish. A variety of compensatory responses to thermal acclimation were observed that would benefit *B. saida* in a warmer environment. These compensations include an increase in T_{cmax}, a > 2°C increase in the T_{opt} window for AS, and a significant down regulation of heart rate.
Climate models that predict species distribution and survival rarely include plasticity of thermal tolerance. We are developing a comprehensive physiological limits and acclimation potential database of key Arctic marine species to help improve model predictions.

2613
Parallel Adaptive Divergence in Fjord vs. Shelf Populations of Arctic Gadids?

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The cryopelagic Arctic gadids, *Boreogadus saida* and *Arctogadus glacialis*, occurs in North Eastern Greenland fjords and shelf areas, where they occupy the same habitats and have partly overlapping feeding niches. We have previously shown that populations of *B. saida* occupying fjords vs. shelf areas can be genetically discriminated at microsatellite loci suggesting that ecological, environmental, and/or spatial factors fuels the divergence. However, nothing is known about the population genetic structure of *A. glacialis* from this area. Here we tested whether replicated fjord vs. shelf population-pairs of *B. saida* and *A. glacialis*, respectively, show genome-wide differentiation. We compared divergence at a genome-wide panel of single nucleotide polymorphisms obtained by massively parallel sequencing of Restriction Site Associated DNA libraries (RADseq). Via machine learning approaches we firstly explored the genomic divergence within and between species, and secondly, we explored whether the footprint of the environment, ecology and life history, and spatial separation have resulted in parallel divergence in polygenic adaptive genomic traits. We discuss the results in light of how climate change may influence intra and interspecific divergence in these Arctic key-species.

1746
Historical DNA Metabarcoding of Trematomid Fishes using Museum Samples

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The Southern Ocean hosts delicate and unique ecosystems. Despite its distance to densely populated areas, human influence includes direct impacts such as commercial fishing, tourism and research, as well as indirect impacts such as global warming and pollution. With the exception of fishing, the largest increase of these impacts occurred within the past 100 years. Unfortunately, the knowledge on biodiversity in support of management remains small. This study focuses on prey item and microbiome composition of members of the circumantarctic genus *Trematomus*, which are amongst the most abundant members of the Antarctic icefish community. We collected tissue, stomachs and guts from 400 specimens curated at the Natural History Museum London. Specimens were had been collected between 20 and 120 years ago, were fixed in formalin and later transferred to ethanol. A 450 bp fragment of the cytochrome c oxidase subunit I (COI) was amplified and sequenced for prey item identification in the stomach and a 313 bp region of the 16S gene to investigate microbiome composition in the gut system. We evaluated various protocols for the suitability to infer DNA information from historically formalin-fixed samples. Based on the best protocol, we identified interspecific prey and microbiome variation. Unlocking information from museum stored samples holds great potential for microevolutionary insights that will benefit efforts to prioritize conservation units in the Southern Ocean.

390
Characterization of Protein Turnover and Proteome Stability in Antarctic Fish

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How susceptible are endemic fauna to the rapid changes in environmental parameters? Are stenothermal animals more at risk of global climate change impacts as a consequence of their evolutionary history? These are critical questions limited by a lack of basic understanding with regards to the drivers of divergence in the cellular stress response that has occurred in many endemic species of the Southern Ocean. The focus of this study is to understand how changes in seawater temperature impact protein homeostasis in Antarctic fishes. Previous studies have reported a permanent activation of the heat shock response and have suggested this change in regulation is related to an imbalance in protein folding efficiency at sub-zero temperatures in these fishes. Thus, these endemic fish may, at some level, benefit by the increase in sea surface temperatures expected to accompany global climate change. However, if protein folding efficiency does not increase with warming seawater then that would suggest the disruption is genetically hardwired. In this study we utilize fluorescent non-canonical amino acid tagging to assess the impact of increased seawater temperature on protein turnover in the proteome of Antarctic notothenioid fish acclimated to +4 °C for up to a month. We further link the changes in rates of protein synthesis and degradation to tissue specific changes in energy budgets in order to gain insight into the energetic cost of maintaining a stable proteome in a warming ocean.

2601
Metabolic Capacity to Acclimate to Multiple Stressors in an Antarctic Fish

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Although the Southern Ocean is experiencing some of the fastest rates of ocean change, few studies have explored how Antarctic fishes may be affected by co-occurring warming and acidification, and even fewer have examined early life stages. To date, no studies have characterized potential trade-offs in physiology and behavior in response to projected multiple climate change stressors on Antarctic fishes. Juvenile *Trematomus bernacchii* were exposed to three PCO_2 treatments at two temperatures After 2, 7, 14, and 28 days, metrics of physiological performance including cardiorespiratory function, metabolic rate, and cellular enzyme activity were measured. Behavioural responses, including scototaxis, activity, and escape response were assessed after 7 and 14 days. Elevated PCO_2 independently had little impact on either physiology or behaviour in rockcod, whereas warming resulted in significant changes across acclimation time. Increased physiological costs were accompanied by behavioural alterations including increased dark zone preference, reduced activity and reduced escape time. After 28 days, fish demonstrated a degree of temperature compensation; however, temperature compensation was only evident in the absence of elevated PCO_2. Our results provide evidence of stressor-induced energetic trade-offs in physiology and behaviour that may be an important mechanism leading to vulnerability of Antarctic fishes to future ocean change.

1451
Reproduction in *Parachaenichthys charcoti* (Bathydraconidae) in West Antarctica

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The reproductive biology of dragon fishes is poorly understood and particularly in *P. charcoti* (PCH). A histological analysis of PCH ovaries together with reproductive effort data using fish caught at Potter Cove, South Shetland Islands (SSI), are compared with data reported for the South Georgia's congener *P. georgianus* (PGE). In gravid females of PCH, GSI of 16-31%, mature oocytes of 1.8-3.9 mm and total fecundity (TF) of 9790-18937 oocytes/individual (mean 13216) were recorded. The histology of the ovaries confirmed the common characteristics of the suborder Notothenioidei observed macroscopically, i.e., two distinct batches of oocytes, one in previtellogenic stage, and the other in vitellogenesis and likely to be released in the current season. A longer incubation period of PCH compared to PGE is associated to colder waters at the SSI. Our sampling and reproductive effort data and the known nesting behavior of PCH, everything recorded at Potter Cove, suggest that this species spawns nearshore in summer, from late Dec to Feb. Spawning periods of both congeners differ from those reported for other notothenioids in the Seasonal Pack-ice Zone, suggesting divergence in some aspects of the life strategies in the genus *Parachaenichthys*. Likewise, although there are no substantial differences between PCH and other notothenioids regarding gonadal development, this genus shows distinct features in its reproductive strategies (e.g. higher TF) in comparison with other bathydraconids.

AC-1c - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions
19.06.2018 14:00-15:30, C Sanada I

7
Sources of Ice Crystals and Cloud Droplet in Orographic Mixed-Phase Clouds

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Knowledge about the phase and longevity of mixed-phase clouds (MPCs) is important for the radiative balance and the hydrological cycle. The co-existence of cloud droplets and ice crystals in MPCs is thermodynamically unstable due to the lower saturation vapor pressure over ice than over liquid water. Thus, MPCs are expected to quickly glaciate, as ice crystals grow at the expense of cloud droplets. In-situ measurements have, however, shown that MPCs can be persistent. As will be shown in the talk, this was confirmed by km-scale model simulations pointing to the dominant role of updraft velocities as a source of cloud droplets.
In addition, the ice crystal number concentration (ICNC) in MPCs regularly exceeds the ice nucleating particles (INP) concentration by several orders of magnitude. Therefore, additional sources of ice crystals, e.g. secondary ice production and ice outside the cloud, have to contribute significantly to ICNCs in MPCs. Here, we will present results estimating the various ice crystal sources. Measurements of cloud droplets and ice crystals, obtained with our digital holographic imager HOLIMO, and INP measurements taken with our continuous flow diffusion chamber, were performed at 3580 m asl at the Jungfraujoch (JFJ) in the Swiss Alps. To estimate the importance of blowing snow, in-situ observations of cloud particles were taken at different heights above ground taken at the Sonnblick observatory in Austria.

425

Recent Observations of Arctic INP and their Variation over the past 500 Years

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Measurements of ice nucleating particle (INP) concentrations in the Arctic are scarce, and historical records did not exist until now. Here, present-day observations onboard the RV Polarstern (PASCAL cruise from May to July 2017 in the area around Svalbard up to 83.7°N) and ice core-derived concentrations for the past 500 years are presented.

During PASCAL, the INP concentrations were measured online with the Spectrometer for Ice Nuclei (SPIN; DMT), and determined from filter samples by application of freezing array techniques. By combining these methods, the whole temperature regime relevant for mixed phase clouds is covered. The ice cores originate from Summit (Greenland) and Lomonosovfonna (Svalbard), and cover a time range from 1457 to 1989 AD and 1480 to 2001 AD, respectively. The ice core samples were analyzed by the freezing array techniques only.

The contribution of local sources to present-day INP is assessed by comparing the INP populations,

(a) from different sources such as the sea surface micro layer, deeper sea water, snow and fog,

(b) the correlation to meteorological parameters, and

(c) the use of back trajectory modelling. The sensitivity of the historical INP concentrations to other ice core-derived parameters is investigated to identify potential INP sources..

These datasets can be used in climate models to study the role of INP in the observed Arctic Amplification.

The works were carried out in the framework of the DFG-funded TR 172 (Arctic Amplification).

433
Variations in Ice Nucleating Particle Concentrations at Four Arctic Locations

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Filter samples collected at four Arctic measurement stations, Alert, Barrow, Ny-Ålesund and Villum were analyzed with respect to number concentrations of ice nucleating particles (N_{INP}). Measurements were done following the method proposed by Conen et al. (2012), examining immersion freezing. The obtained temperature dependent freezing curves were used to derive N_{INP}.
For Ny Alesund, samples from spring and summer months were examined, while a yearly coverage existed for the other stations. Differing values of N_{INP} were observed during the year, and in general during summer and fall, particles were more ice active than during winter and early spring, indicating that different sources of ice nucleating particles contributed to the pan-arctic area, their influence varying with season and site. The highest values determined for the Arctic samples were comparable to N_{INP} determined from precipitation samples collected in North America and Europe (Petters & Wright 2015), but the lowest values were more than two orders of magnitude lower. Ice nucleating particles have an influence on Arctic cloud glaciation and hence influence Arctic warming. This study reveals open questions and suggests future pathways concerning the examination of Arctic ice nucleating particles.
Literature:
Conen et al., 2012, Atmos. Meas. Tech., doi: 10: .5194/amt-5-321-2012.
Peters & Wright, 2015, Geophys. Res. Lett., doi: 10.1002/2015gl065733.

1222
Arctic Mixed-phase Cloud Sensitivity to Surface Forcing and Aerosol Perturbation

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Arctic clouds play a key role in the radiative balance of the Arctic region. In summer, the reflection of the incoming radiation dominates, while during the rest of the year the absorption and emission of longwave radiation prevails, causing a warming effect at the surface. The radiative properties of these clouds are strongly linked to the relative abundance of both phases (liquid and ice), which in turn is governed by a multitude of processes operating in conjunction across a wide range of spatial scales. The large-scale dynamical forcing, surface processes as well as the ambient aerosol concentration all impact mixed-phase cloud (MPC) amount and phase partitioning. Up to now, the persistence as well as the formation of Arctic MPCs remain largely unclear and their representation in models of all complexities poses a considerable challenge.
In this study we focus on the relative importance of different aerosol conditions on MPC formation and persistence in the Arctic. To address this issue, we perform COSMO-LES simulations (Possner et al., 2017) and designed a case study for the ACCACIA campaign in March 2013 in the European Arctic (Young et al., 2016). In our setup we successfully simulate a MPC with properties close to observations. In several sensitivity studies we explore the mechanisms in MPCs across different temperature ranges and aerosol loadings. Moreover, we contrast these effects in MPCs over ocean and sea ice.

1288
How Important Are Local Marine Sources for Arctic Mixed-phase Clouds?

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Arctic low-level clouds are highly sensitive to microphysical processes, which can either sustain or break down the unstable mixed-phase state and thereby determine the longevity of the clouds and their radiative impact. They are influenced by the availability of aerosol particles, which can act as ice nuclei (IN) or cloud condensation nuclei (CCN). Potential sources of aerosols in the pristine Arctic include local marine aerosol emissions and long-range transport, but it is not very well known what governs the Arctic background aerosol concentration and its variability. Therefore, it is important to quantify Arctic aerosol concentrations and the associated impact on cloud microphysics.
We derive characteristic vertical profiles of CCN and IN for two different situations in the Arctic and investigate the influence on the cloud microphysics and the evolution of a mixed-phase Arctic cloud. We compare a situation where the aerosol concentrations are predominantly governed by local sources (emitted at the surface) with one dominated by long-range transport (introduced above the boundary layer inversion). To compile the vertical profiles for different aerosol scenarios we use field measurements in combination with regional modeling using the regional model COSMO-ART (Vogel et al., 2009). The influence of the different vertical aerosol profiles on the cloud microphysics is investigated using the LES model MIMICA (Savre et al., 2014).

1473
Understanding the Sources of Arctic Biological Ice Nucleating Particles

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The Arctic is warming at an alarming rate, yet the wide range of processes that contribute to the surface energy balance are not well constrained. The effects of clouds and aerosols on the extent of sea ice is particularly not well represented in models. Specifically, relatively little knowledge exists regarding aerosols that serve as ice nucleating particles (INPs) and their subsequent impact on Arctic cloud ice formation. In general, biological aerosols such as bacteria, algae, and phytoplankton have been hypothesized to serve as some of the most efficient INPs in the Arctic region. The Arctic Ocean is a large vessel for biological productivity, but such productivity is highly variable depending on time of year and location. Here, we present results from ice nucleation studies in a relatively polluted coastal location in Prudhoe Bay during the spring and from a shipborne expedition through the Bering Strait and Chukchi Sea during the following summer of 2017. Prudhoe Bay is largely influenced by local oil extraction activities, while the marine measurements were conducted in a cleaner oceanic environment. INP concentrations and onset freezing temperatures were found to widely vary, but were highest in both locations when air masses originated from exposed ocean water from fresh sea ice melt and near phytoplankton blooms and coastal upwelling. Overall, these results demonstrate the crucial role the ocean plays as a source of cloud nuclei in disparate Arctic locations.

BE-4c - Climate change and ecosystems: physiology, biodiversity and ecological functions
19.06.2018 14:00-15:30, C Sanada II

1490
The Changing form of Antarctic Biodiversity

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Antarctic biodiversity was once thought to be poor, recent and isolated. Over the last two decades, this perception has been wholly altered. Both in marine and terrestrial systems, diversity is greater, with more structure and regular connections, both among sites and to areas beyond the polar front or Southern Ocean, than previously thought. Molecular approaches have been instrumental in revealing the substantial structure and dynamics of Antarctic biodiversity. But so has interdisciplinary work, combining new surveys, modern and palaeoclimatic information, data from marine and terrestrial sediment cores, and novel forms of analyses. In this talk, an overview is provided of these developments, how they are changing fundamental understanding of the biodiversity of the region and its evolution, and what they imply for conservation. Particular emphasis is given to work demonstrating links across the entire Antarctic and Southern Ocean regions, including the Southern Ocean islands.

60
Global Change Effects on Arctic and Antarctic Ecosystems

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Both Arctic and Antarctic ecosystems are affected by global change drivers, such as elevated temperatures and changing precipitation regimes. These effects can be investigated by experiments and research along gradients. In this presentation the results of our long-term warming experiments in sub-arctic Sweden (since 2000) and the Antarctic Peninsula (since 2004) will be presented and a bi-polar comparison will be made of the warming effects on the diversity and functioning of the various components of the food web, including soil micro-organisms, soil arthropods, cryptogams and vascular plants. Moreover, we will also compare the results of our geographical gradient studies with those of the experiments in order to investigate if geographical temperature gradient studies can be used as an analogue for experimental studies.

924
Can Antarctic Lichens Acclimatise to Changes in Temperature?

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The Antarctic Peninsula, a tundra biome dominated by lichens and bryophytes, is an ecozone undergoing temperature shifts. Such changes may demand a high physiological plasticity of the local species in order for them to maintain their role as key drivers in this habitat. We investigated how increasing temperatures vary the physiological responses of lichen species with different ecological response amplitudes. The main goal was to find out whether thermal acclimation occurs as biological feedback which would ameliorate the effects of temperature changes. All species tested at 5, 15 and 22°C were negatively affected, with 15°C representing the upper thermal limit for two endemic species. A widespread lichen species was able to recover its homoeostasis by a consistent increase in net photosynthesis. As a result, we postulate that any acclimation processes in lichen are species specific. This, together with the high degree of response variability and sensitivity to temperature in different species that co-occur spatially close, complicates predictions regarding future species composition. Our results suggest that species with a broad ecological amplitude may be favoured with ongoing changes. Such community shifts could lead to regional-scale biotic homogenization, which could alter ecosystem functioning and productivity in Antarctic ice-free habitats. The consequences for the conceptual view of physiological acclimation are highlighted and future research perspectives discussed

2189
Drivers of Soil Bacterial Community Structure in Antarctic Water Tracks

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Water availability is a key limitation of ecosystem function in the McMurdo Dry Valleys, Antarctica. Climate change in this region is projected to alter precipitation and promote melting of ground ice, resulting in the creation and expansion of water tracks that transport water, solutes, and heat downslope. We utilized surveys and perturbation experiments to understand the microbial communities associated with two water tracks. In the first track, diversity (Chao1; means of 4438/2593, $P < 0.005$) and abundance (16S copy number; means of 20055/10266, $P = 0.076$) were higher inside the track, corresponding to decreased salinity (EC; means of 59/307 µS, $P < 0.001$). Salinity did not vary significantly across the second track, although in the middle reach, diversity and abundance decreased inside where salinities were elevated (Chao1; means of 1638/4223, $P < 0.001$; 16S copy number; means of 1462/8522, $P = 0.017$). Overall, salinity was negatively correlated to diversity ($r = -0.43$, $P < 0.001$) and abundance ($r = -0.32$, $P = 0.003$). Experiments designed to simulate changes in water and solutes associated with the expansion of water track systems into dry soils suggested that lowering moisture and raising salt content increase the abundance of Acidobacteria and decrease Proteobacteria. These results highlight the sensitivity of endemic dry soil communities to future climate change and potentially provide insights into the limits of life with applications to astrobiology.

1432
Physiological and Genomic Responses of Chlorella to UVR across a Global Gradient

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Changes in the global environment, which resulted in increased UVR fluxes can have far-reaching impacts on microalgae, affecting their physiological processes and productivity. The present study investigated the physiological response of Chlorella strains isolated from the Antarctic, Arctic, temperate and tropical regions to UVR stress. Transcriptomic approach was used to investigate genetic responses of Chlorella to UVR stress. Chlorella originating from different latitudes exhibited different growth trends and photosynthetic performance. UVB inhibited the growth of the both polar Chlorella, but enhanced the growth of temperate and tropical Chlorella, compared to those exposed to PAR alone. Chlorella from polar regions appeared to be more responsive towards the damaging effects of UVB while tropical Chlorella tended to have higher tolerance towards UVB stress. However, the cellular contents of carotenoids and chl-a increased under UVB stress in both polar Chlorella while the pigment contents decreased in the tropical and temperate strains. Differentially expressed genes, relating to the fatty acid degradation, amino acid metabolism, starch metabolism and peroxisome pathways, suggest that conservation and remobilisation of energy resources, maintenance of newly synthesised protein and inhibition of protein degradation, ensuring membrane lipid homeostasis and regulating antioxidative mechanisms, are important in the acclimation strategies expressed in response to UVR stress.

Poster
19.06.2018 16:00-17:30, Foyer

Tue_1_AA-1_74
PAIX: Opening a New Window into the Universe

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PAIX, the first robotic multi-color photometer Antarctica project, has been successfully launched during the polar night 2007. This ongoing program gives a new insight to cope with unresolved stellar enigmas and stellar oscillation challenges with a great opportunity to benefit from an access to the best astronomical site on Earth, Dome C. PAIX achieves astrophysical measurement time-series of stellar fields, challenging photometry from Space. A continuous and an uninterrupted series of multi-color photometric observations has been collected each polar night - 150 days - without regular interruption, Earth's rotation effect.
PAIX shows the first multiband photometric light curves from Antarctica and the first steep for the Astronomy in Antarctica giving new insides in remote polar observing runs and robotic instruments towards a new technology.

Tue_2_AA-1_398
Developing a Spectrograph for Observing the Atmospheric Emission in K-dark Band

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We are developing a spectrograph for observing the spectrum of the atmospheric emission in the K-dark band (~2.4 µm) from the Antarctica.
Low atmospheric foreground environment can be obtained at the K-dark band at the Antarctica because there is a “window” of the dense forest of OH emission lines and the low temperature of the atmosphere (~200 K). Although the absolute brightness of the atmospheric emission at the K-dark band from the Antarctica is several tens of times brighter than the zodiacal light (Phillips et al. 1999), it is still beneficial for observations of diffuse radiations such as the zodiacal light and the extragalactic background light (EBL). Spatial structures with arcminute to degree scale of the atmospheric emission and its time variations are critical for subtracting the atmospheric foreground for the study of EBL.
To validate the atmospheric foreground environment for the EBL study, we are planning to observe the spectrum, spatial structure, and time variance of the atmospheric emission in the K-dark band from the Antarctica. We have developed an Antarctica-proof near-infrared camera in Tohoku University, and it will be a 5-cm aperture telescope with 2-degree FoV by putting a small lens on the camera. To obtain a simple spectrograph, we are developing a linear-variable filter (LVF) covering 2.2-2.55 µm with $\Delta\lambda$~0.02 µm, which will be installed in a filter wheel in the camera. We want to bring the camera with the LVF to the Antarctica by 2020.

Tue_3_AA-1_403
Opening the Dynamic Infrared Sky from Antarctica

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While optical and radio transient surveys have enjoyed a renaissance over the past decade, the dynamic infrared sky remains virtually unexplored. The infrared is a powerful tool for probing transient events in dusty regions that have high optical extinction, and for detecting the coolest of stars that are bright only at these wavelengths. The fundamental roadblocks in studying the infrared time-domain have been the overwhelmingly bright sky background (250 times brighter than optical) and the narrow field-of-view of infrared cameras (largest is VISTA at 0.6 sq deg). To address this challenge, we propose a low risk, economical and agile instrument located in the high polar regions to take advantage of the low thermal sky emission in the 2.5 micron region in particular. Such an instrument has the ability to observe the entire hemisphere sky to a depth of the VISTA VHS survey every 4 hours.

Tue_4_AA-1_679
Study of Cloud Cover and Aurora Contamination by KLCAM at Dome A in 2017

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An all-sky camera KunLun Cloud and Aurora Monitor (KLCAM) was installed at Dome A, Antarctica in January 2017 and has been working automatically through the austral winter. The unattended KLCAM aims for long-term monitoring for site testing and has collected tens of thousands of images used to evaluate usable observing time and optical sky background at Dome A. We have analyzed the data and developed methods to automatically classify the cloud cover and aurora contamination to the night sky. We present the results on the site characteristics in 2017.

Tue_5_AA-1_981
Introduction of Chinese Antarctic Optical Telescopes

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The Antarctica plateau is widely considered to be an excellent astronomical site for the superb seeing conditions. The preliminary site testing performed since the beginning of 2008 shows that Antarctic Dome A is an excellent astronomical site for observing wavelengths ranging from visible to infrared and sub-millimetre. In polar nights, the in-situ Antarctic telescopes manage to continuous observe for three months, which is quite suitable for the transits detection and time domain astronomy. Several Chinese wide field Antarctic telescopes have been built. The first generation is Chinese Small Telescope Array known as CSTAR, which is composed of four identical telescopes with 145mm entrance pupil, 20 square degrees FOV. CSTAR was fixed to point at the South Pole, and mainly used for variable stars detection and atmosphere extinction measurement, and deployed on Antarctica in 2008 and its automatic operation continued for four consecutive winters. The second generation is three Antarctic Survey Telescopes (AST3), with 500mm entrance pupil, 8.5 square degrees FOV can precisely pointing and tracing. AST3-1 and AST3-2 were respectively mounted on Antarctic plateau in 2012 and 2015, fully remotely controlled for supernovae survey, exoplanets search and GW counterpart photometry.

Tue_6_AA-1_1059
Modeling Ice Birefringence from SPICEcore for ARA Stations

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The Askaryan Radio Array (ARA) is an in-progress ultra-high energy (>1017 eV) cosmic neutrino detector composed of 37 radio receiver stations located ~200 meters below the surface in the ice at the South Pole. Interactions of neutrinos with the ice generate radio pulses that can be detected and observed in the 150 - 850 MHz range through the Askaryan Effect. The structure of the ice plays an important role in signal propagation between production and measurement point. The nearby South Pole Ice Core (SPICEcore) has been used to study changes in the Earth's climate from an ice core drilled to a depth of 1751 meters. This core has ice grain orientation data, which can be related to the birefringence properties of ice in the vicinity of ARA. Here we model an incoming signal propagating through a 3-axis ice crystal bulk orientation from SPICEcore data for a range of depths relevant to ARA stations, and compare with ARA data.

Tue_7_AA-1_1084
Cosmic Microwave Background Observations in Antarctica

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The exceptionally dry and cold Antarctic climate is ideal for CMB observation. I will discuss lessons learned over the past 20 years and prospects for future searches for primordial gravitational waves in CMB polarization.

Tue_8_AA-1_1088
The Antarctic Advantage for Optical Transient Follow-up Observations

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The rapid follow-up of transient sources will become an increasingly important aspect of astronomy over the next decade. This is primarily driven by new facilities coming on-line, such as LSST, more sensitive gravitational wave detectors, and precursors to SKA. Positioning a telescope in Antarctica has the obvious advantage that, during mid-winter at least, the sun has no effect on whether a source can be observed. Cloud permitting, observations can commence rapidly and continue uninterrupted for weeks, producing a higher quality and more uniform dataset than a network of telescopes from a lower latitude. There are a host of other advantages such as low-scintillation noise, low-airmass variations, low aerosols, and low & stable water vapor. There are also some more subtle advantages such as lower variations in CO_2 content. On the negative side, aurora need to be taken into account. On the whole, Antarctica offers significant improvements for precision photometry and spectroscopy, making it an excellent location for following up transient sources.

Tue_9_AA-1_1295

Photometric Monitoring of Proxima Centauri at the Chinese Zhongshan Station

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Proxima Centauri is known as the closest star from the Sun. Recently, radial velocity observations revealed the existence of an Earth-mass planet around it, with an orbital period of 11 days. If the planet transits, it would be interesting to probe its radius, internal compositions and atmospheric properties. We took a photometric monitoring campaign of Proxima Centauri using the Bright Star Survey Telescope at the Zhongshan Station in Antarctica. A candidate transit event occurring on September 8th, 2016, is identi

ed tentatively. Its transit epoch, 2,457,640.1990±0.0017 HJD, is consistent with the predicted ephemeris based on RV orbit in a 1σ con fidence interval. Time-correlated noise is pronounced in the light curve of Proxima Centauri, affecting detection of transits. The candidate transit event reported in this work, has a con fidence level of 2.5σ. Kipping et al. (2017) reported two candidate transit events of Proxima Centauri b, observed by the Microvariability and Oscillation of Stars space Telescope in 2014 and 2015, respectively. The midtransit time of our detection is 138 minutes later than that predicted by their transit ephemeris. If all the transit events are real, the misalignment of the epochs plausibly suggests transit timing variations of Proxima Centauri b induced by an outer planet in this system. We plan to perform follow-up observation of Proxima Centauri in next Polar night at the Chinese Kunlun Station in Antarctica.

Tue_10_AA-1_1322
Key Areas on Polar Astronomy and Related Sciences in Thailand

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Thailand has established a Polar Sciences Committee, under the Information Technology Foundation under the Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn and has become an associate member of SCAR since August 2016. Due to the long and continuous 6 months dark clear winter sky and the stable atmospheric condition with excellent sky seeing, Polar region (Arctic/Antarctic Plateau) is a perfect place for astronomical observations. Some Astronomy and related sciences research proposals initiated by NARIT have been planned to be performed in Polar region with some collaborative institutes.
NARIT signed the MoU with the Yunnan Observatories (YNO) since February 2007 and the Polar Research Institute of China (PRIC) since April 2016. The study on the evolution of close binary systems was closely collaborated with YNO. Several deep contact binary systems were observed and analyzed using observational data from optical telescopes at Dome A in Antarctica. Result from the collaborative meeting, NARIT and PRIC agree to cooperate on several fields of astronomical research, for example, on the search for exoplanets, astroseimology of oEA and other pulsating stars, the study of the growth of supermassive black holes and co-evolution of host galaxies etc. Other related sciences such as Jupiter's and Earth's aurora activities, latitude survey project etc. will also be discussed.

Tue_11_AA-1_1377
Solar Energetic Particle Spectra using Neutron Detectors at South Pole

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Neutron monitors are ground-level detectors of cosmic ray induced atmospheric secondary particles (mostly neutrons) that are employed worldwide to study variations in the flux of galactic cosmic rays and solar energetic particles (SEPs) in the GeV regime. The neutron monitor standard design (NM64) minimizes detector response to neutrons below ∼10 MeV produced by cosmic ray interactions in the ambient medium. Bare detectors or simply “bares”, which lack the lead and polyethylene of NM64 detect such neutrons and therefore respond on average to cosmic rays of lower energy. The array of NM64 and bares at the South Pole has been used for many years to measure SEP spectra relying primarily on relative response functions derived from a single latitude survey in 1976. We have recently completed analysis of a second survey from Nov, 1995 to Feb, 1996 from three bares operated together with a 3NM64. The solar modulation conditions in 1995 and 1976 were remarkably similar but the results from the 1995-6 survey differ significantly from the interpretation of the 1976 survey most commonly used for the determination of SEP spectra. We present results from a third survey from Nov, 2009 to Apr, 2010 with two bares that are now installed at the South Pole. A significant correction to the 2009-10 data due to highly different modulation conditions, and implications for interpretation of SEP spectra will be discussed.
Supported in part by Thailand Research Fund grants MRG6080086 and RTA5980003.

Tue_12_AA-1_1564
ITM (International Telescope Maffei) Improvements: A New Robotic Interface

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IRAIT-ITM is a s a f/21.16 Cassegrain-like reflector with two Nasmyth foci and a 0.8m parabolic primary mirror and a wobbling secondary mirror suitable for the specific techniques for mid and near IR but is also suitable for observations in the visible spectrum. During these first ten years of activity several modification has been done in order to provide a more robust control system in terms of hardware and software, using new technologies and materials. We present the status of the project ITM (International Telescope Maffei) formerly Irait (International Robotic Antarctic Infrared Telescope), that is located at Dome C in the Italo-French Concordia station and hosted by PNRA (Programma Nazionale di Ricerche in Antartide) and CNR (Consiglio Nazionale delle Ricerche). Managing a robotized telescope in Antarctica is not a trivial job. A thermal excursion about more than 70°C during the year with minimal peak around -84°C and a mean pressure of 630 hPa are not the best conditions to deal with for a telescope which goal is to perform continuous observations. In this presentation we want to present all the hardware/software features provided during this period of activity in order to achieve a remote continuous complete monitoring and control. The management system, basing on rts2 open software, has been fully customized for our altazimuthal mount. The first rt2 webapp has been released for a remote VPN management of all devices connected to the telescope.

Tue_13_AA-1_1782
Bipolar Disorder: The Uncertain Future of Spaceship Earth

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Neutron monitors are ground-level detectors of cosmic ray-induced atmospheric secondary particles (mostly neutrons employed world-wide to study variations in the flux of galactic cosmic rays and solar energetic particles in the GeV regime. Proper geographic distribution of the monitors is critical due to two characteristics of a particular location resulting from the geomagnetic field. One is the geomagnetic cutoff, or minimum primary particle energy that can reach the location, and the other is asymptotic direction - a rather specific direction outside the magnetosphere from which the primary particles must come to reach the location. Locations near the auroral zones are particularly important for observation of low energy but highly anisotropic solar energetic particles. In the late 1990's an informal collaboration of station operators known as Spaceship Earth was formed to coordinate observations from this critical region. Primarily due to retirement of several key people it is necessary to restructure this collaboration; some preliminary steps have been taken. The South Pole NM64 and Bares are now being operated by the University of Wisconsin, River Falls. Move of the McMurdo monitor to the South Korean station at Jang Bogo should be complete in 2018. A partial move and common data taking in 2016 provide for continuity of data. We are continuing to search for opportunities to keep the other Spaceship Earth monitors running, but a complete path forward has not yet emerged.

Tue_14_AA-1_2086
Optical Modules for the Next-generation Neutrino Telescope at the South Pole

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Following the first observation of an astrophysical high-energy neutrino flux with the IceCube observatory in 2013, planning for a next-generation neutrino telescope at the South Pole - IceCube-Gen2 - is under way. Instrumenting 5 - 10 km^3 of the deep clear ice with up to 15,000 sensors, the envisioned detector will significantly expand the sensitivity both towards high and low neutrino energies.
The sensors, so-called digital optical modules (DOMs), record the Cherenkov light emitted by charged secondaries created in the interaction of neutrinos in the ice, allowing the reconstruction of the energy and direction of the original particle. Apart from the larger volume, a significant increase in sensitivity and reconstruction precision is anticipated to be achieved by advanced optical module technology. The devices currently under development, include the modernization of the conventional IceCube DOM as well as new concepts featuring increased sensitive areas, homogeneous angular acceptance, UV sensitivity, directional information as well as reduced sensor self-noise.
This contribution, presented on behalf of the IceCube-Gen2 collaboration, will introduce the new module concepts and introduce the planned detector infrastructure and readout scheme.

Tue_15_AA-1_2209
Bringing Access to Space Down to Earth: The GUSTO Balloon-borne Observatory

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Recently funded by NASA´s Explorer Program, the Galactic ULDB Spectroscopic THz Observatory (GUSTO) will dramatically improve our understanding of the Universe by probing the topology and ecology of interstellar gas throughout the Milky Way and Large Magellanic Cloud (LMC). GUSTO is a cryogenic balloon-borne, 0.9m Cassegrain telescope designed to stay aloft on a long duration balloon for 100 days or more. During this time GUSTO will survey 124 square degrees of the Milky Way and all of the LMC in three important interstellar lines: [CII], [OI], and [NII] at 158, 63, and 205 um, respectively. From these data the global structure, dynamics, energy balance, pressure, and evolution of the interstellar medium within these objects will be discerned for the first time. The mission will be one of the first to utilize the 100+ day flight potential of the Super Pressure Balloon, also known as the Ultra Long Duration Balloon (ULDB), provided by NASA's Balloon Program Office. GUSTO features a proven measurement approach, a high-heritage payload, and a simple, repeatable observing strategy that, combined with the ultra-long duration capability of the SPB, enables these important new galactic and extragalactic observations at a fraction of the cost of a comparable orbital mission. GUSTO is slated to fly in 2021 from the LDB payload integration facility near McMurdo Station, Antarctica.

Tue_16_AA-1_2218
ALMA Band 11 Science without ALMA: A Terahertz Interferometer for Ridge A

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The exceptional atmospheric transparency and stability above the high Antarctic plateau at Terahertz frequencies (50-500 microns wavelength) lends itself to two important applications for astronomy: wide-field (spectroscopic) imaging, and interferometry. With the advent of the ALMA interferometer in Chile, the power of submm-wave interferometry is having a dramatic impact on astronomy. However, at the highest frequency ALMA bands near and beyond 1 THz, the number of days with suitable observing conditions is scant. Coupled with the high costs of outfitting dozens of stations with advanced receivers, it is unlikely that the Band 11 capability will ever become a reality. To this end, the Ridge A site that hosted the pathfinding HEAT telescope and PLATO-R observatory can play an enabling role. Recent, cross-cutting advances in low-cost telescope construction, sensitive receivers at temperatures above 4K, low-power cryocoolers, and low-cost hybrid correlators make the case compelling: a capable THz interferometer can tackle the critical Band 11 science questions at a small fraction (5%) of the cost of outfitting ALMA. Here, we explore the science questions, capabilities and requirements that can be advanced by a Twin-Otter-deployable THz interferometer at the most remote, space-like site on Earth. We also highlight the technological prototyping efforts that demonstrate its feasibility. Terahertz phase closure at Ridge A could happen as early as 2021.

Tue_17_AA-1_2221
GCR and Radioactivity in the Colombian Expeditions to the Antarctic

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We have calculated the absorbed effective radiation doses on a human phantom flying on route SKBO-SKCL-SCEL-SCCI-SCRM-SAWB with software CARI-7A from the Federal Aviation Agency FAA using the model ISO TS15390:2004-MSU-NYMMIK of Galactic Cosmic Rays GCR. Additionally we have calculated the same on a human phantom modelled as a sphere with radius equals to 30 cm, composed of water, flying in the same routes by using a simulation chain involving CORSIKA and GATE/GEANT4. Equivalent radiation doses are going to be measured with four particle detectors SAFECAST bGeigie Nano inside the aircrafts that will be used in the fourth Colombian scientific expedition to the Antarctic flying on the route mentioned above. We also are going to measure the equivalent dose around the scientific base of Marambio in the Antarctic. With the characterization of major, minor elements and trace done on the geological material collected in the fourth and second Colombian scientific expeditions to the Antarctic, we build new simulated materials according to their element mass fraction on each geological material compound sample and incorporate them into the GATE materials database and calculate the absorbed effective radiation dose by the spherical phantom due to the presence of radioactive elements in the samples. With the information obtained in the simulations and measured data, we establish a criterion for cellular repair and estimate the risks caused by exposure to radiation.

Tue_18_AA-1_2263
Current Status of Optical/Infrared Telescopes at Chinese Kunlun Station

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The first Chinese Small Telescope ARray (CSTAR, with entrance pupil of 145mm) was successfully mounted on Dome A at 2008. The first inland station of Chinese, called Kunlun, has been erected in 2009, and then two Antarctic Survey Telescopes (AST3) with entrance pupil of 500mm has been installed. Now Chinese astronomers have proposed a plan to build a 2.5-meter optical/infrared telescope at Dome A. Kunlun Dark Universe Survey Telescope, one of two major facility of Antarctic Observatory at Chinese Kunlun Station, is a 2.5-meter optic/infrared telescope. It is intended to take advantage of the exceptional seeing conditions, as well as the low temperature reducing background for infrared observations. KDUST will adopt an innovative optical system, which can deliver very good image quality over a 2 square degree flat field of view. KDUST will be perched on a 14.5-meter-high tower to lift it above the turbulence layer.

Tue_19_AA-1_2319
Neutrino Point Source Searches in IceCube Using a Multi-messenger Approach

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The IceCube high energy neutrino detector is deployed in Antarctica, with highly sensitive photodetectors buried deep within the ice sheet at the South Pole. Its construction started in 2005 and was completed in 2010. It is the first experiment to report the detection of high energy neutrinos of astrophysical origin. Given the low astrophysical neutrino fluxes expected, and the high atmospheric background, multi-wavelength observations are used to further enhance the sensitivity to potential neutrino sources. By requiring space and/or time correlation between neutrinos and gamma-rays, or high-energy cosmic rays, the background associated to a neutrino detection is reduced as uncorrelated backgrounds from different observatories are considered. This contribution will present the various aspects of multi-messenger searches for cosmic sources in IceCube. The latest results of targeted source searches and all-sky source searches will be presented.

Tue_20_AA-1_2511
Radio Frequency and Optical Measurements of the Glacial Ice at the South Pole

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A unique opportunity to investigate the radio glaciological properties of the glacial ice has become available through the SPICE core hole. A program and is in preparation to perform measurements of RF transmitters deployed in the SPICE core hole to a depth of more than 1500 m. Optical measurements are also planned. The signals will then be recorded with multiple radio detector stations of the Askaryan Radio Array and possibly other instruments for the RF signals. First results will be presented from a field campaign in 2017/18. The measurements are especially interesting the radio neutrino detector community that uses the almost 3 km thick glacial ice with experiments such as IceCube and ARA and future extensions of these programs.

Tue_21_AA-1_2655
A Brief Review of the Science Potential of Antarctic Astronomy

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In 2007, I chaired a conference on "The Astrophysical Science Cases at Dome C" in Antarctica, the results of which are published in Vol. 33 of EAS/EDP Sciences (Zinnecker, Epchtein, and Rauer 2008, eds.) Being cold, high, dry, stable, and completely dark for 3 long winter months, Antarctic astronomy offers exceptional ground-based atmospheric conditions to achieve unique astronomical observations and wide-field surveys (from the near- and mid-IR part of the spectrum to the far-IR/submm domain). Antarctic astronomical sites may also provide an outstanding platform for far-IR interferometry (perhaps at Ridge A) and for follow-up of future space missions of the 21st century.
In my presentation, I will briefly recall and review some of these science cases, including the potential for day-time and twilight astronomy as well as long time-seriesmonitoring (particularly in the Magellanic Clouds). In the far-IR (30-300 micron or 1-10 THz), future Antarctic THz astronomy (high-resolution spectroscopy, particularly of the interstellar medium) from the Chinese Kunlun station at Dome A with a 5m or larger aperture dish might compete with the airborne infrared observatory SOFIA (a 2.5m telescope in B747SP flying in the stratosphere, funded by NASA/DLR). Finally, I discuss the potential of balloon-borne far-IR astronomy from the Antarctic continent (e.g. GUSTO), compared to SOFIA and the ground-based facilities ALMA/APEX or TAO/CCAT´.

Tue_22_AA-1_2669
Inflationary Cosmology and South Pole´s Leading Measurements of CMB Polarization

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The BICEP Array and 10m South Pole Telescope are a suite of small and large microwave telescopes at the South Pole working together to detect polarization patterns in the cosmic microwave background (CMB) arising from primordial gravitational waves. Cosmologists believe that the entire observable Universe may have been spawned in a fraction of a second by the rapid “inflation” of a sub-atomic volume. Inflation provides a testable prediction: the same quantum process that plants the seeds of structure also produces a gravitational-wave background that may be detectable now via faint "B-mode" patterns imprinted in the polarization of the CMB. Detecting this faint pattern requires making maps of unprecedented sensitivity, while separating the faint polarization signals intrinsic to the CMB from other signals including polarized emission from dust and electrons in our own galaxy and patterns caused by weak gravitational lensing of large scale structure. The small-aperture BICEP/Keck Array telescopes have produced the deepest-ever maps of CMB polarization in four frequency bands. They are exploiting the unique Polar atmosphere to push these maps to high (up to 270 GHz) and low frequencies (down to 30 GHz) to separate galactic emission from CMB signals. The 10m SPT has deployed a new receiver with 17000 detectors and resolution sufficient to reconstruct the weak lensing patterns. Together they are producing the most sensitive constraints yet on primordial gravitational waves.

Tue_23_AC-1_71
Arctic Mixed Phase Clouds Observed from Tethered Balloon Platform

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Mixed phase clouds, consisting of ice particles and super cooled liquid droplets, are frequently found in the Arctic. The impact of these clouds on sea ice, cloud radiation feedbacks, and the Earth's surface radiative energy balance, critical to climate is poorly represented in various climate models. This research addresses the need for improved modeling capabilities in describing the role of Arctic clouds in climate models. This study hypothesizes that mixed phase Arctic clouds affect the surface energy budget due to unique cloud optical properties and positive cloud surface feedback in the near infrared wavelength channels. Therefore, it is important to estimate inherent cloud optical properties in wavelength channels including near infrared channels to provide an understanding about the cloud radiative forcing that affects the radiative transfer (RT) and energy budgets. A unique tethered balloon campaign carrying 4π radiometer, a cloud particle imager, and a meteorological package on board was conducted in 2008 in Ny-Alesund, Spitzbergen. Sikand et al. (2010, 2013) concluded that it would be valuable to build a next-generation radiometer that would include near-infrared channels. This research performs a feasibility study based on RT simulations using measurements from a test flight carrying an improved 4π radiometer including near-infrared wavelength channels that will be useful in the planned May 2018 Tethered Balloon Campaign to be conducted in Ny-Alesund, Spitzbergen.

Tue_24_AC-1_72
Black Carbon in the Russian Arctic Atmosphere:Anthropogenic and Wildfire Sources

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Black carbon (BC) emissions from Russian territory (2000-2014) were analyzed basing on official RF datasets and satellite data GFED. Some corrections for BC emissions from Russian intensive flaring zones of gas/oil mining industry are discussed. Total anthropogenic emission from Northern Eurasia (to the North of 52ºN) is estimated as 315 kt BC annually (with about 2/3 from Russia). The best estimate of air BC concentration from RF wildfires (with 25% deviation for every point of the Russian Arctic) is the mean value calculated from Russian and GFED emission data.
Spatial divergences of air BC concentrations along the Arctic coast are up to 100 times and more.
Anthropogenic air BC concentrations prevail annually, but in summer wildfire's BC concentrations may in some years at some points be higher than anthropogenic ones. Also, there are high variations in BC pollution from year to year due to variations in atmospheric circulation processes. Great inter-annual and seasonal variations in BC air concentration through Russian Arctic territory do not allow to use the measured BC air concentrations (obtained at one point during one season or even one year) for long term conclusions/forecasts concerning the Arctic region and climate in general.
The work is supported by RFBR (grant No. 17-05-00245).
Vinogradova A.A., Vasileva A.V.. Black Carbon in Air Over Northern Regions of Russia: Sources and Spatiotemporal Variations // Atmos. Ocean. Opt. 2017. V. 30. No. 6. P. 533-541.

Tue_25_AC-1_241
Long Term Aerosol Optical Measurements in Polar Regions from the GAW-PFR Network

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Long term ground-based sun-photometer measurements conducted at 2 Arctic (Ny-Ålesund 50 m asl, 8.91 N, 11.88 E, Summit 3238 m asl 72.58 N, 38.46 W) and 2 Antarctic sites (Marambio 205 m asl, 64.24 S, 56.62 W, Troll 1309 m asl, 72.01 S, 2.54 E) were examined to investigate aerosol optical depth (AOD) seasonal and year to year changes. Together with the AOD's at 368, 412, 500 and 865 nm, Ångström´s exponents have been calculated for spring to autumn in the Arctic and for austral summer in Antarctica. Sun-photometers used are part of the GAW-PFR network, where instrument calibration and data processing is performed by PMOD/WRC. Higher AODs have been measured in Ny-Ålesund (0.5 for 500nm) with a pronounced decreasing trend from spring to autumn and Summit (0.4 for 500nm) showing also a less pronounced change. This has been commonly attributed to the position of the Arctic polar front. During the winter, the front is situated at ~50°N, hence allowing long-range transport from major industrial regions in Europe, Russia and N. America into the Arctic. The circulation pattern is different in summer when the front is situated further to the north (about 70°N), hence preventing polluted air masses from effectively reaching the Arctic. Lower AODs (from 0.2 to 0.4 for 500 nm) have been found for the Antarctic sites.

Tue_26_AC-1_242
Development and AOD Measurements with a Lunar Photometer at Ny-Ålesund

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Atmospheric aerosols are known to impact the climate, but they still represent one of the largest uncertainties in climate change studies. Night-time AOD measurements could provide valuable information on the climatology of aerosols at high latitude stations, where direct sun measurements are not possible throughout the year. For example, in the northern hemisphere they can be used to monitor the arctic haze during polar winter. In passive remote sensing techniques, the moon or the stars are used as the light source.
The growing interest in night-time observations of aerosol optical depth (AOD) has led to the development of a lunar Precision Filter Radiometer (PFR) at PMOD/WRC. In addition to the retrieval of nocturnal AOD, the radiometric calibration of the lunar PFR aims to provide absolute lunar irradiance measurements with an expanded uncertainty of less than 5% (k = 2).
A lunar PFR was installed at Ny-Ålesund, Norway in October 2014 and it provides measurements from October to February.

Tue_27_AC-1_244
Cloud Condensation Nuclei and Ice Nucleating Particles in the Southern Ocean

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The Southern Ocean (SO) region is the most pristine aerosol environment on Earth, however almost the entire region is considered as heavily under-sampled. As partner of the "Study of Preindustrial-like-Aerosol Climate Effects" (SPACE) project, we participated in the unprecedented Antarctic Circumnavigation Expedition (ACE, December 2016 - March 2017), which gave us the unique opportunity to conduct high quality aerosol measurements in this remote region. ACE-SPACE in general aims at a detailed characterization of the pristine aerosol which is unaffected by anthropogenic pollution and therefore represents an aerosol comparable to that in a pre-industrial atmosphere. Our, i.e., TROPOS' special focus in context of ACE-SPACE is on aerosol particles involved in aerosol cloud interactions, specifically on particles able to act as cloud condensation (CCN), as well as particles able to nucleate ice (INP). We will present results concerning the spatial distribution of CCN and INP concentrations around the Antarctic continent, CCN hygroscopicity and INPs' freezing characteristics, and possible CCN and INP sources based on the analysis of back trajectories. Please notice two further contributions on ACE-SPACE at this conference giving (a) an ACE-SPACE overview and (b) results on new particle formation events.

Tue_28_AC-1_249
Tethered Balloon-borne Turbulent Energy Fluxes in the Cloudy Central Arctic

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Climate change is most pronounced in the Arctic, which is generally known as Arctic Amplification.
The Transregional Collaborative Research Centre TR 172 "Arctic Amplification" $(AC)^3$ aims to improve the understanding of climate relevant atmospheric and surface processes and feedback mechanisms by different modeling and observational projects.
Quantifying vertical energy fluxes in the Arctic Atmospheric Boundary Layer (ABL) is most important for understanding the exchange of energy between the surface and higher altitudes, and therefore is a key factor to understand the changing atmosphere in a warming Arctic. However, observations of vertical profiles of energy fluxes in the central Arctic are still rare due to the challenging conditions in that region.
One major field campaign of $(AC)^3$ is PASCAL: a cruise of R/V Polarstern into the Arctic sea ice north of Svalbard in June 2017. From an ice floe camp, we measured vertical profiles of turbulent energy fluxes with a tethered balloon under different stratification and cloud conditions. Turbulence parameters were measured with a hot-wire anemometer and an ultrasonic anemometer, which enables us to determine turbulent fluxes of heat and momentum. Additional radiation packages, developed by the University of Leipzig, complete the observations. Within the conference, we will present first results of balloon-borne turbulence and radiation measurements performed during PASCAL.
This work was supported by DFG Grant TR 172/1 A02.

Tue_29_AC-1_348
Assessing Aerosol-cloud-rainfall Associations at a High Altitude Himalayan Site

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The lack of an accurate understanding of the interplay between aerosol, cloud, and rainfall is one of the major scientific questions for global climate studies. Aerosols can affect cloud formation processes via activation of cloud condensation nuclei (CCN) and thereby modifying the cloud as well as rainfall patterns. The aerosol-mediated changes in cloud is termed as aerosol-indirect effect (AIE), and is a major source of uncertainty in assessing climate change, largely due to the regional variability in aerosol, clouds, and the complexity in aerosol-induced microphysical and/or dynamical feedbacks at different spatio-temporal scales. In an anthropogenically warming Earth, the accurate understanding of aerosol-cloud-rainfall interactions is essentially required to better project the future changes in the rainfall patterns and climate. In this context, we are in the process to setup a High Altitude Aerosol-Cloud Physics Laboratory (HAACPL) at *Swami* Rama *Tirtha* (SRT) campus of Hemvati Nandan Bahuguna Garhwal University (30.08^{o}N, 78.61^{o}E, 1706 amsl) to conduct continuous and long-term measurements of various aerosol and cloud properties together with weather observations in Himalayan ecosystem. The HAACPL research station is designed to address current shortcomings in aerosol-cloud-rainfall interactions. In this presentation, we will present a conceptual framework for studying aerosol-related impacts on climate from a high altitude site in Himalaya and preliminary data.

Tue_30_AC-1_377
Evaluation of Satellite Derived Cloud Top Properties on the Antarctic Peninsula

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Clouds play a key role in the energy balance of the atmosphere due to their radiative effects, and have a critical influence on the ice sheet's radiation budget. Changes in the glacier system on the Antarctic Peninsula (AP) have been observed: disintegration of ice shelves, acceleration and thinning of glaciers, variations in the limits between glacier faces and retreat of glacier fronts. However, rising surface air and ocean temperatures, as well as substantially increased snow fall in some regions, are also known, with tendencies linked to changes in atmospheric circulation. Hence, a better understanding of the processes and mechanisms leading to such changes is required, and the role of clouds over AP has not been yet studied well in this context. The measurement of cloud properties through satellite sensors is still a challenge, since discrepancies between data from passive and active sensors exist. Here, retrievals of satellite-derived cloud top properties from MODIS and CALIPSO are compared with cloud top properties derived from radiosonde measurements in Rothera and will be presented. This has the goal to identify undetected clouds in these sensors over the AP. The data is being analyzed in the special light of improving parameterizations in the Polar Weather Research and Forecasting model. This aims to ultimately enhance our understanding of how variations in the cloud cover and properties impact the energy balance on the Antarctic Peninsula at regional scales.

Tue_31_AC-1_405
Mineral Dust Radiative Forcing in the Arctic

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The polar regions experience relatively large temperature changes due to feedback processes leading to Arctic amplification of global climate change. It has been suggested that mineral dust contributes to Arctic amplification. We use recent dust load estimates from Groot Zwaaftink et al. (2016), to quantify the direct mineral dust radiative forcing (RF) in the Arctic. The annual direct mineral dust RF in the Arctic is estimated to be 0.43 W/m^2 and 0.21 W/m^2 at the top (TOA) and bottom (BOA) of the atmosphere, respectively. The largest individual source contributions to the TOA mineral dust RF come from dust transported from Asia south of 60^{o}N (~35 %) and Africa (~24 %), while all high-latitude dust sources contribute ~37 % to the TOA RF. The albedo reduction due to deposited mineral dust accounts for half of the TOA RF when there is snow on the ground. In terms of Arctic RF efficiency, i.e. TOA RF in the Arctic per emitted kilogram of mineral dust, high-latitude (>60^{o}N) dust sources are about one to two orders of magnitude more efficient than lower latitude dust sources. Mineral dust deposited on snow accounts for nearly all of the BOA RF of 0.21 W/m^2. More than half of the BOA RF is caused by dust from high-latitude sources, indicating substantial regional climate impacts not accounted for in current climate models.

Tue_32_AC-1_561
Shipborne Measurement of Particle Hygroscopicity and Volatility in Arctic Summer

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Continuous measurements of aerosol particle hygroscopicity and volatility have been performed on board the German research ice-breaker *Polarstern* in the high Arctic during June and July 2017, using a volatility hygroscopicity tandem differential mobility analyzer (VH-TDMA).
Here we present first results obtained by the VH-TDMA, combined with particle number size distributions (PNSDs) measured by a mobility particle size spectrometer (MPSS).
While being run in H-TDMA mode, the instrument measures the hygroscopicity of particles of a certain mobility diameter, which was chosen according to the maxima of the measured PNSD. When run in VH-TDMA mode, the measured signal is a result of the volatility of particles of the selected size and the hygroscopicity of their cores, i.e. the part of the particle that is left after volatilization at 300°C. In combination, these measurements give an indirect information about the chemical composition and mixing state of the atmospheric aerosol in a higher temporal resolution than e.g. filter or impactor samples.
We will present preliminary results of particle hygroscopicity and the refractory fraction encountered for discrete mobility diameters of the atmospheric aerosol in the high Arctic. These findings will be used to discuss the contribution of different compounds to the composition of the Arctic aerosol and thus its origins.

Tue_33_AC-1_579
A Significant Methane Source over the Chukchi Sea Shelf and its Sources

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Dissolved methane (CH_4) was measured at various depths in the western Arctic Ocean. The CH_4 concentrations at the surface show an increasing trend northward toward stations at the shelf break and a decreasing trend toward stations in the Canada Basin. The mean sea-to-air flux is estimated to be 10.08 μmol/m^2/d, indicates that the Chukchi Sea shelf (CSS) is an active site of CH_4. Methane concentrations at the shelf stations increase from the surface to the bottom, and the maximum nutrient concentrations occur in the bottom layer. Strong correlations exist between CH_4 and PO_4^{3-}, SiO_4^{2-}, or NO_2^-, suggesting that the production of CH_4 is likely related to the degradation of organic matter in the sediment, supporting a biogenic source. At the slope and basin stations, the maximum values were observed in the subsurface of the upper halocline layer (UHL), and the concentrations decrease with increasing depth. The CH_4 concentrations are elevated by ~7.9 nmol/L in the UHL compared with the homogeneous CH_4 concentrations observed in the deep water. The elevated values in the UHL result primarily from northward spreading of CH_4-rich water from the shelf. The mass balance model shows that effluxes of CH_4 from the sediment-water interface and the in situ production of CH_4 represent the major sources of CH_4 over the CSS (95%). The main outputs for CH_4 in the CSS are the sea-to-air flux and oxidation of CH_4 in the water column, which account for 95% of the CH_4 exports.

Tue_34_AC-1_621
Comparing Three Kinds of Satellite Retrieval Cloud Data in Tibet Plateau

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The Tibet Plateau is called the third polar in the earth. It plays a key role in weather and climate in the Asia, even the North Hemisphere. Cloud is an important parameter in either climate monitoring or weather analysis in Tibetan. Tibet Plateau has complex surface types, but there are less ground observation stations that are mainly located in the eastern part of Plateau. Satellite observation is a good supplement for ground based observations because of its advantage in wide observation rage and higher temporal resolution. Since the first meteorological satellite was launched in 1960, the operational meteorological satellite data have been accumulated more than 40 years. There are several long term cloud data sets that can be used to research cloud properties. CLARA-A2, Patmos-x and MODIS-ST cloud data records are used in this research. Firstly three kinds of cloud fraction are evaluated by comparing with synoptic observation data from 2003 to 2015. The compared results show that except different retrieval algorithm and observation ability, temporal and spatial properties may be a reason to cause different results. Based on different time scale, MODIS and Patmos-x cloud fraction data were analyzed. The data record of Patmos-x and CLARA-A2 are used to do cloud fraction tendency analysis. Associated with precipitation, cloud properties such as the different phase cloud fraction, cloud top temperature, cloud optical thickness, water path are discussed in Tibet Plateau.

Tue_35_AC-1_719
Single Particle Mass Spectrometry of Arctic Ambient Aerosol and Cloud Residuals

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The composition and origin of cloud forming particles in the Arctic is currently not fully understood. We show first results of aircraft-based particle measurements that were conducted during the ACLOUD campaign in May/June 2017 in the Svalbard region. An aerosol inlet was used for air sampling outside clouds, while a Counterflow Virtual Impactor (CVI) inlet allowed sampling of clouds residuals and ambient aerosol. Using the single particle aerosol mass spectrometer "ALABAMA", particle size in the range of 0.2 - 0.9 µm and chemical composition of single particles were investigated. Simultaneous measurements of gaseous air mass tracer such as CO, CO_2 and O_3 were used to identify different air masses.
The results show a significant difference between boundary layer and free troposphere particle chemical composition. The boundary layer composition was largely characterised by particles from marine origin like sea spray aerosol and organic particulate matter, such as trimethylamine (TMA). In contrast, pollution plumes with high fractions of elemental carbon (EC) and levoglucosan were measured above the boundary layer up to 4 km. More than 50 % of the analysed spectra from cloud residuals show signatures of amines. The molecular structure of these amines differ significantly from particulate TMA sampled in ambient air. Furthermore, the large abundance of amines in cloud residuals shows the importance of amines in cloud processes in the Arctic.

Tue_36_AC-1_738
Characterizing Tropospheric Clouds and Precipitation Using LIDAR in Antarctica

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Studying Antarctic atmospheric composition and processes with in-situ observations is challenging due to operational difficulties, implying a limited understanding of their interactions with climate and weather. Despite this complex scenario, significant efforts have been carried out using LIDAR techniques to monitor clouds, mainly to analyze cloud effects on the radiation budget, aerosols and ozone distribution both in troposphere and stratosphere. Recently a single-wavelength depolarization LIDAR has been deployed at Dumont d'Urville station on the coast of East Antarctica in February 2017 to characterize tropospheric clouds and precipitation in the framework of the Antarctic Precipitation Remote Sensing from Surface and Space project (APRES3). The observations are complemented with measurements from an automatic weather station, a Micro Rain Radar, a precipitation weighing gauge and daily radiosoundings. Profiles of backscattering coefficient and particle linear depolarization ratio (D_p) are used to analyze the vertical distribution of supercooled liquid water (*SLW*) and mixed-phase (*MP*) clouds, as well as the extent and occurrence of blowing snow (*BS*). D_p is retrieved using elastic assumptions of the backscattering and attenuation coefficients. Preliminary results show the predominance of low-level clouds, with high frequency of low depolarization ratio between 1-3 km height, suggesting the presence of SLW and MP clouds. BS has been mainly observed during the winter.

Tue_37_AC-1_767
Free Troposphere Wintertime Gas-phase Composition using CI-APi-TOF

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Atmospheric aerosols influence radiative forcing through direct interaction with radiation and by acting as cloud condensation nuclei (CCN).
Up to 45% of CCN are formed via new particle formation (NPF), with a large fraction formed in the free troposphere (FT).
While in the planetary boundary layer (PBL) new particle formation events have been frequently observed, measurements at high altitude because of intrinsic technical difficulties are scarce.
The high-altitude research station Jungfraujoch (JFJ), Switzerland (3580 m above sea level) is a research site in the Swiss Alps and is in the FT for a substantial fraction of the time (especially in winter).
NPF events often occur at JFJ (Tröstl et al., 2016) and it has been shown that they involve either sulphuric acid-ammonia or highly oxygenated molecules (HOMs) (Bianchi et al., 2016).
Nitrate chemical ionization atmospheric pressure interface time of flight mass spectrometry (CI-APi-TOF) has been shown to be selective in detecting gas phase sulfuric acid and HOMs at extremely low concentration (ppq) (Ehn et al., 2014).
Here we present the results of two winter periods during intensive campaigns involving CI-APi-TOF measurements. We describe the chemistry linked to NPF. A special focus is given to HOMs and their temporal variability, which provides various scenarios, in which HOMs from biogenic and anthropogenic precursors were identified to participate in NPF.

Tue_38_AC-1_784
Changes in OLR over Arctic as Depicted by AIRS, CERES, and MERRA-2

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In this presentation, we compare the temporal and spatial characteristics of monthly mean level-3 anomaly time series of OLR contained in the AIRS Version-6 with those in the CERES Edition 4 and MERRA-2 data sets over the 14 year period September 2002 through August 2016. Fourteen year global mean OLR average rates of change (ARCs) of AIRS and CERES data sets show slightly positive trends. The increase of OLR and clear sky OLR over Barents and Kara Sea region is noteworthy. The clear sky OLR changes more rapidly with surface warming, since it is more sensitive to surface skin temperature than the OLR. AIRS and CERES OLR time series agree extremely well in this aspect. This agreement validates the results of both data sets. Agreement of AIRS OLR with CERES also validates to some degree the AIRS retrieved geophysical parameters, which are used to calculate the AIRS OLR.
Analogous results are shown with regard to the MERRA-2 OLR data set. Some aspects of the MERRA-2 OLR data set perform reasonably well. MERRA-2 OLR has a serious short-coming however: The MERRA-2 OLR data set has a discontinuity, which results in a large spurious global mean OLR trend over the last 14 years.

Tue_39_AC-1_887
Poleward Transport of Saharan Dust Initiated by a Saharan Cyclone

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To enhance the understanding of the role of Saharan mineral dust in the Arctic climate system, this study focuses on the mechanisms by which Saharan dust emitted over North Africa reaches the Arctic. The poleward transport of dust was associated with an intense Saharan cyclone that occurred over North Africa in early April 2011. Satellites observations are used in this study in order to characterize qualitatively and quantitatively the dust activity over North Africa associated with the Saharan cyclone as well as the transport of dust toward the Arctic and its deposition over Greenland. Beside the observations, a simulation at high resolution is performed using the MesoNH model in order to estimation the dust load transported northward and to evaluate the dust deposition north to 60◦N. In this study, we identify a new mechanism for the transport of dust over long distances toward the northern pole: the poleward migration of the Saharan cyclone, in which the dust is transported toward the Arctic, was favorite by a negative-Arctic-Oscillation like situation associated with a slowed polar vortex and polar jet stream, which caused the intrusion of a lobe of low pressure further south with which the Saharan cyclone has merged and moved northward. A total dust load of about 38.35 Tg was carried by this cyclone to north of 40 N and dust deposition was estimated to be 1.3 Tg to the north of 60N.

Tue_40_AC-1_971
Possible Feedbacks of Arctic Cirrus Clouds on the Composition of the UTLS

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Cirrus clouds in the UTLS can affect the vertical distributions of the important greenhouse gas H2O via the direct processes of condensation and sedimentation of ice particles. They are further capable of trapping and redistributing nitric acid. The modification of the chemical budget of these gases may affect the distributions of ozone and methane. The role of high latitude and particularly arctic cirrus clouds is hardly understood. The aim of the project ICECREAM is to use measurements by the airborne infrared limb sounder GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere) during the POLSTRACC (Polar Stratosphere in a Changing Climate) campaign for the detection of cirrus clouds and to analyze the vertical distribution of the critical trace gases H2O, HNO3, O3 and CH4 during an entire arctic winter. The data will be compared with model simulations by the high-resolution forecast model ICON-ART (ICOsahedral Nonhydrostatic - Aerosols and Reactive Trace gases) and the climate-chemistry model EMAC (ECHAM/MESSy Atmospheric Chemistry) including and omitting cirrus cloud particle sedimentation and HNO3 trapping. The aims are to gain insight, how well cirrus cloud feedbacks on the vertical distributions of H2O, HNO3, O3 and CH4 at high latitudes can be simulated in the models, and to estimate the significance of the vertical redistribution of H2O and HNO3 in the UTLS at high latitudes for the distributions of the greenhouse gases H2O, O3 and CH4 in the UTLS.

Tue_42_AC-1_1039
Human Impacts on the Local Sources of Aerosols at King George Island

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Black carbon (BC) is important for the Earth´s climate because it absorbs sunlight efficiently, heats the atmosphere. BC particles originates from the incomplete combustion of fossil fuel or biomass burning. In pristine regions, local emission and their influence on the regional climate are typically neglected.The Antarctica exploration mode can be questionable, as the sustainability of occupation and daily activities have not been considered.The sampling site of this study was the King George Island, close to the flight´s arrival point. The aerosols were assessed using a multi-wavelength Aethalometer-AE33 and Scanning Transmission X-ray Microscopy with near edge X-ray absorption fine structure spectroscopy (STMX/NEXAFS). BC data indicate that fossil fuel combustion is the mainly source of carbonaceous aerosols, with the total average of 41.8 $ng.m^{-3}$,much higher than the average of related studies. STXM/NEXAFS was used for the carbon-specific characterization, demonstrating that almost all particles on site have a considerable portion of carbon content. Considering growing Antarctica tourism and scientific activities during austral summer among the last years, the main sources of BC particles can be related to the presence of ships and flights.The above conclusions reaffirm the urgency of a new discussion on sustainability issues in the exploration of Antarctica, highlighting the duty of all government authorities to take into account the impact of these actions in Antarctica.

Tue_43_AC-1_1052
Aerosol Integrated Analysis in Central West Antarctica:Brazilian Standalone Unit

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Changes in Antarctica ice sheets and ice shelves are of primary concern to the regional and global climate. We hypothesize that the West Antarctic warming can be related to the aerosols transported and/or formed in this region. Rather than being inert, snow is highly active, with snowpack impurities being photolysed to release reactive trace gasses such as OH, NO/NO_2 and O_3 into the troposphere. The impact of solar radiation, enhanced by O_3 depletion, creates the optimal conditions for heterogeneous gas-to-particle reaction, modifying the chemical and physical properties of aerosols substantially. This study shows evidence of atmospheric processing, via microscopic and molecular speciation of individual aerosol by Scanning Transmission X-ray microscopy with near edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS). Specifically, STXM reveals an accurate fraction of internally mixed particles with NaCl cores and nitrate coatings. The scattering efficiency of sea salt particles may decrease as a consequence of the external nitrate covering since the hygroscopicity of a mixed nitrate-salt particle is weak. The unique signal of ClO-type-molecules could be possibly associated with OH radical oxidation products of NaCl particles. Considering the perchlorate has a supercooling property, it is possible to assume that perchlorate could produce a small melting effect especially at ablation zones of Antarctic glacier experiencing severe mass loss due to warming.

Tue_44_AC-1_1122
Sea-air Transfer Measurements of Marine Carbohydrates in the Arctic

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Marine polysaccharides in sea spray aerosol are being discussed as an important source of ice nucleating particles in the Arctic. They may enter the planetary boundary layer by sea-air phase transfer processes such as bubble bursting and breaking waves. In this connection, the sea surface microlayer (SML) may play a key role as the direct interface between the ocean and the atmosphere. To date, there are only very few concerted measurements for carbohydrates in all these compartments in the Arctic available.
During the field campaign PS 106 aboard the German research vessel *Polarstern* during summer 2017 concerted sampling of aerosol particles, SML and underlying water was performed. The monosaccharide composition of these samples was determined via HPAEC-PAD, a very sensitive method for sugar analysis, before and after acidic hydrolysis. For avoiding analytical problems due to the high sea salt content in sea water samples a newly developed desalination step via electrodialysis has been applied.
The concentrations of neutral sugars, aminosugars and uronic acids in arctic sea water were determined in the low to middle $\mu g L^{-1}$ range. Depending on the kind of monosaccharide enrichment in SML samples could be determined up to a factor of 2.0. Via enrichment factors in aerosol samples, sea spray aerosol will be discussed as an important local source of organic matter in arctic aerosol particles.
This work was supported by the DFG-funded TR 172 (Arctic Amplification).

Tue_45_AC-1_1139
Particle Chemical Composition in the Arctic Summer - Local vs. Remote Sources

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We present size-resolved and vertical profile (up to 3 km) measurements of single particle chemical composition conducted during the aircraft-based measurement campaign NETCARE 2014 in July 2014 in the Canadian high Arctic (Resolute Bay, Nunavut). The single particle laser ablation aerosol mass spectrometer ALABAMA (0.2 - 1 µm vacuum aerodynamic diameter (Brands et al., 2011)) was deployed to identify different particle types and their mixing states.
We found that a significant fraction (approximately 60 %) of particles within the Arctic boundary layer contained trimethylamine (TMA). Several pieces of evidence suggest that this particulate TMA results from secondary conversion of precursor gases released by the ocean (Köllner et al., 2017). In contrast, a large fraction of particles above the local boundary layer contained levoglucosan (approximately 20 %). Mass spectra of levoglucosan-containing particles indicate the internal mixing with organic acids (e.g., dicarboxylic acids) (Sullivan and Prather, 2007; Zauscher et al., 2013), sulfate, potassium etc. Air mass history predicted by FLEXPART shows that those particles partly originated from remote biomass burning sources.

Brands et al., *Aerosol Science and Technology*, **45** (2011): 46-64.
Köllner et al., *Atmos. Chem. Phys., accepted* (2017).
Sullivan and Prather, *Environ. Sci. Technol.,* **41** (2007): 8062-8069.
Zauscher et al. *Environ. Sci. Technol.*, **47** (2013): 7633−7643.

Tue_46_AC-1_1156
High-latitude Cloud-aerosol-Climate Interactions in GFDL Climate Model CM4

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GFDL´s CMIP6 model CM4 contains a prognostic treatment of cloud-aerosol interactions. The analysis of a suite of simulations (e.g., with variable or fixed droplet number concentrations) yields a number of interesting findings related to the strength of negative cloud feedback and climate sensitivity. Besides this comprehensive model, an effort is made to use an idealized model for understanding those findings at the process level. The potential utility of satellite observations for constraining (or falsifying) model physics is also explored.

Tue_47_AC-1_1169
Polynya-driven Heat and Moisture Fluxes and the Associated Cloud Response

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The opening of a polynya in the North Water (NOW) region of the Arctic introduces positive fluxes of heat and moisture to the overlying atmosphere. This perturbation in surface radiative energy fluxes can impact cloud formation over the open water and cloud evolution over the nearby icepack as the rising plume of moisture and heat is advected downstream. With polar regions experiencing warming at a rate much greater than the global average, the effects of polynyas on the surface energy budget will become increasingly important. As such, it is imperative that models accurately capture resultant changes in the overlying atmospheric column to reduce intermodel spread, better quantify surface-atmosphere feedbacks, and improve precision in climate projections. This research uses the CALIPSO-Cloudsat-CERES-MODIS merged product (C3M) to study surface cover and associated cloud fraction, liquid water path, and ice water path profiles over and adjacent to wintertime polynyas in the NOW region between 2006 and 2010. Moisture and sensible heat fluxes, derived from NASA's EOS are combined with C3M-derived cloud and radiative heating rate profiles to quantify relationships between polynya-induced surface turbulent fluxes and lower tropospheric (0-3 km) clouds, testing the hypothesized link. It is expected that the opening and extent of a polynya strongly correlates with increases in heat and moisture to the atmosphere forcing a cloud response that supports longer polynya events.

Tue_48_AC-1_1182
Processes Governing Arctic Cloud Formation in CMIP5 Models

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CMIP5 models simulate rapid Arctic climate change by 2100 and large intermodel spread in cloud amount (*CA*). Many processes govern Arctic cloud formation, namely 1) surface-atmosphere interactions (clouds affect surface temperature and sea ice, and indirectly surface turbulent fluxes and BL stability), 2) microphysical processes (e.g. cloud ice formation), 3) temperature/humidity advection that provides a moisture source for cloud formation, and 4) the vertical structure of temperature/humidity. We use a multilinear regression methodology to determine *CA* using these variables as predictors: upper and lower tropospheric stability (*UTS*; *LTS*), 500-hPa vertical velocity (ω_{500}), temperature (T_{surf}; T_{air}), sensible and latent heat fluxes, and sea ice concentration (*SIC*). These variables were chosen because their effects on *CA* can be attributed to unique climate processes: *UTS* and *LTS* are thermodynamic indicators of the relationship between *CA* and stability, *SIC* and T_{surf} determine surface-cloud interaction, T_{air} governs cloud microphysical processes, and ω_{500} is a metric for dynamical change. Vertical profile data are obtained from the CMIP5 historical simulation, and statistical significance tests are used to confirm the regression equation and test the models for their ability to capture observed *CA* and behavior. Lastly, the intermodel spread in Arctic *CA* will be attributed to individual processes to shed light on emergent constraints in the Arctic climate change.

Tue_49_AC-1_272
Modelling Sulfate Aerosols over the Southern Ocean

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Dimethyl sulfide (DMS) is estimated to be the largest source of natural atmospheric sulfur over the Southern Ocean. It is released into the atmosphere via biogenic activity of marine phytoplankton, and subsequently undergoes several oxidation reactions ultimately leading to sulfate aerosol formation. Atmospheric aerosols affect Earth's radiative balance, and can act as cloud condensation nuclei, thereby altering cloud properties. Uncertainties in simulating aerosols in global climate models cascade to uncertainties in cloud formation, absorption of shortwave radiation by the ocean, and atmospheric circulation, thus reducing confidence in climate change projections for the Southern Ocean and surrounding countries. This presentation outlines an investigation into the representation of DMS in the HadGEM3(GA7)+chem coupled chemistry-climate model. We show the effects of different sea-air transfer velocities on atmospheric DMS concentrations, the role that modelled sea ice plays in blocking oceanic emissions of DMS, and results from a sensitivity study on increasing the complexity of simulated DMS oxidation chemistry. Finally, we present the sensitivity of Southern Ocean clouds to atmospheric DMS concentrations.

Tue_50_AC-1_1218
Attributing Convection in Arctic Mixed-phase Clouds to Large-scale Subsidence

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Models on various scales are notoriously poor at reproducing the persistent mixed-phase stratocumulus (MPS) clouds commonly observed in the Arctic. The role of microphysics-dynamics interactions in sustaining these unstable clouds is poorly understood; therefore, it is imperative to assess such feedbacks to gain a holistic view of their role in the Arctic system. Large-scale subsidence, associated with high pressure systems, is often imposed in cloud-resolving models to maintain the height of these boundary layer (BL) clouds; however, the interaction between subsidence and mixed-phase cloud microphysics has not been previously studied.
Using the UK Met Office Large Eddy Model (LEM), we find strong cloud microphysical sensitivities to large-scale subsidence: by enforcing BL inversion strength and reducing entrainment from above, widespread subsidence dynamically stimulates Arctic marine MPS, promoting a greater cloud liquid-water path and efficient precipitation formation. Convection development is driven by longwave radiative cooling at cloud top, and rain evaporative cooling and latent heating from snow growth below cloud base. Our results indicate that high pressure systems in the ocean-exposed Arctic regions have the potential to affect resident BL MPS by enhancing their liquid fraction, thus helping to sustain them for longer against cloud glaciation.

Tue_51_AC-1_1220
Systematic Investigation of Shortterm Variability in Antarctic Aethalometer Data

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Combustion processes at lower latitudes are primary sources of black carbon (BC) to the polar regions. Deposited BC can alter albedo of snow/ice surfaces, so reliably recording variability and trends in atmospheric BC is critical. Within ice cores, soot records changes in combustion activities over historic time periods, but data interpretation requires understanding of present-day mechanisms delivering BC to the poles.
Various instruments, including Aethalometers, measure BC via filter-based absorption methods. Being robust and easy to operate, Aethalometers have been widely used in the polar regions to determine, e.g. BC seasonality and long-term trends. Concerns exist, however, over possible artefacts in data from filter-based instruments. While these have been partially addressed through laboratory studies, they have not been adequately tested under field conditions.
Here we present a systematic investigation of short-term variability in Aethalometer data, measured over 1 year in coastal Antarctica. We find no direct correlation with wind speed (a concern raised in the literature) but episodes of high sea salt aerosol loading clearly influence observed BC values. Equally, 10-day air mass footprints link episodes of high BC in coastal Antarctica to biomass burning activities, primarily in South America, but occasionally in Africa. We thus demonstrate that filtering of Aethalometer data can render useful datasets to study BC variability over long- and short-timescales.

Tue_52_AC-1_1221
Modelling Aerosol-cloud Interactions over the Weddell Sea, Antarctica

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Clouds play a key role in the Antarctic radiative budget, yet numerical models cannot accurately reproduce them due to our poor understanding of aerosol-cloud interactions in the region. Current models typically underestimate cloud fractions leading to strong radiative biases, particularly at the coastal regions.
Coastal Antarctic clouds in the summertime are often mixed-phase; however, the ice phase is sporadically distributed throughout the clouds, hindering modelling efforts of primary ice nucleation based solely on cloud temperature. The patchy nature of the ice phase suggests that local aerosol sources - from the sea ice, ocean, or snow-covered continent - may be influencing these clouds, and such sources are not commonly represented in regional models which only consider meteorology.
To better comprehend the importance of spatially-dependent aerosol-cloud interactions in Antarctica, we need to increase the complexity of the models we use in the region. Using the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem), we investigate the effect of local aerosol sources on cloud microphysics through comparisons with in-situ observations made during the Microphysics of Antarctic Clouds (MAC) campaign. During MAC, measurements of aerosol particle and cloud properties were taken in the vicinity of the Weddell Sea, Antarctica in the austral summer of 2015, providing an invaluable dataset for model validation, investigation, and development.

Tue_53_AC-1_1313
Observation of Polar Stratospheric Clouds at McMurdo and Dome C (Antarctica)

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From 1991 up to 2010 a lidar observatory has been active at the Antarctic station McMurdo. Since 2014 the same lidar has been operated succesfully at Dome C on the Antarctic plateau. The lidar performs optical measurements of the stratospheric and tropospheric aerosols from about 6 km asl up to 40 km at wavelengths of 532 and 1064 nm. The scattered signal at 532 nm is detected at two different polarizations. The observations have been analyzed in terms of occurrences of different classes of aerosols present in the polar stratospheric clouds. A statistical comparison of polar stratospheric clouds (PSCs) occurrence from 2006 to 2010 at McMurdo and from 2014-2017 at Dome C, both included as a primary station in the NDACC (Network for Detection of Atmospheric Composition Change) with the satellite borne CALIOP lidar measuring over the stations, in order to assess possible biases arising from different classification methods deriving from the specific geometry and sampling. Point-to-point comparison between ground based and satellite based lidar measurements is practically impossible due to the intrinsic differences in the observation geometries and the imperfect overlap of the observed areas. Therefore a statistical approach has been used to compare ground based and satellite based observations. Recent results will be presented.

Tue_54_AC-1_1448
Free Tropospheric New Particle Formation Observed above the Andes

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A significant fraction of atmospheric cloud condensation nuclei arises from new particle formation (NPF) where 35% are directly formed in the free troposphere. While NPF has been observed in many places around the world, the mechanisms governing this process are still poorly understood, especially at high altitude. So far, only few studies have shown that NPF can frequently take place at high altitudes. However, none of these have identified the chemical composition of the growing clusters.
In the last few years, we have focused our studies on further characterizing NPF processes at high altitudes taking advanced instrumentation at specific locations, in order to have a better understanding of the chemical cluster composition and therefore the nucleation precursors. The equipment includes Atmospheric Pressure interface Time-Of-Flight mass spectrometers, Particle Size Magnifier and Neutral clusters and Air Ion Spectrometer. Measurements were performed at the Chacaltaya station (Andes, Bolivia), the highest in the world (5240m a.s.l.) for in situ aerosol observations.
In this study, we will present observations of NPF events that have been measured at this particular station, for the time period December 2017 - May 2018.

Tue_55_AC-1_1461
Relative Roles of Different Types of PSCs to Polar Ozone Depletion

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Heterogeneous reactions on the surfaces of PSC particles and denitrification of the stratosphere are the cause for Antarctic and Arctic ozone depletion in polar spring. We investigate the impact of the different types of PSCs on this polar ozone depletion with the help of the chemistry-climate model ECHAM5/MESSy Atmospheric chemistry (EMAC).
One standard and four sensitivity EMAC simulations (nudged with ERA-Interim) have been performed from 2005 to 2016 to evaluate the contribution of liquid, NAT and ice particles to ozone depletion in different polar winters due to chlorine activation by heterogeneous chemistry on their surfaces and due to denitrification of the stratosphere.
In the first three sensitivity simulations, we changed the heterogeneous chemistry on PSC particles by switching on and off the chemistry on liquid, NAT and ice particles. One further sensitivity simulation without NAT formation (only liquid and ice particles) was performed to evaluate the contribution of NAT due to denitrification of the stratosphere.
With the help of these different EMAC simulations, we will show the significance of liquid, NAT and ice particles to polar ozone depletion caused by chlorine activation and denitrification.

Tue_56_AC-1_1467
Is New Particle Formation an Aerosol Source over the Southern Ocean?

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Models estimate that about 43% of the cloud condensation nuclei (CCN) in the atmosphere are formed from condensable vapors [1] but field and laboratory experiments are required to confirm the validity of these predictions and improve their accuracy. With this contribution we will present the first comprehensive investigation of new particle formation (NPF) in the Southern Ocean.
Concentration of gaseous precursors (in particular sulfuric acid and iodic acid), chemical composition of small nucleating clusters and size distribution of ions and neutral particles at the nanometer scale were measured during the Antarctic Circumnavigation Expedition (ACE) as part of the 'Study of Preindustrial-like-Aerosol Climate Effects' (SPACE) project (a general overview of the campaign will be presented in another contribution).
Here we will show that, despite of the generally low temperatures and small condensational sink, NPF in the Southern Ocean rarely happen due to the small amount of condensable vapors. Our observations suggest that the few NPF events observed are sulfuric acid driven and the recently discovered iodic acid nucleation mechanism [2] is not relevant over the Southern Ocean. Finally, we will discuss the relevance of NPF in the Southern Ocean as a source of CCN (specific CCN and ice nucleating particles observations during ACE will be presented in another contribution).

[1] Dunne M. et al., 2016, Science
[2] Sipilä M. et al., 2016, Nature

Tue_57_AC-1_1492
Inter-annual Cycle of Bacteria in Atmosphere/Snow of King George Is. / Antarctica

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In this work we analyse bacteria reaching Antarctic Peninsula/king George Is. by atmospheric transport and their deposition on surface. Air was collected using a BioSampler® flask attached to a pumping system during the summer season and fresh snow was analysed from the winter season between February 2010 and February 2011. The samples were inoculated by amid R2A and were incubated at different temperatures (2° C, 12° C and 28° C). Aliquots of the samples were analyzed by flow cytometry for visualization and size quantification of living and dead organisms using the fluorochromes propidium iodide (PI) and SYTO 13, respectively. Replicas of samples were filtered on Isopore membranes and the retained material was analyzed by X-ray fluorescence (XRF) and SEM + EDS to determine the elemental composition of metals of terrigenous and marine origin of inorganic aerosols attached to the bacterias. For each monthly bacteria number concentration we conducted the HYSPLIT/NOAA atmospheric dispersion model to set the trajectories of air parcels reaching Antarctica. Results indicated mostly positive cocci gram and catalase. The quantitative variability of bacteria showed strong influence of precipitation and the inter-annual melting process being the bacteria content associated with the terrigenous elements and soil temperatures. Analysis of cell viability in fresh snow seems to correlate with UV, in Antarctica, when apoptotic cells in flow cytometry were analysed.

Tue_58_AC-1_1493
Shipborne and Ground-based Observations of Clouds in the Southern Ocean

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The Southern Ocean is characterised by sparse ground-based and in-situ atmospheric measurements. While satellite measurements provide continuous spatial and temporal coverage, they are generally not capable of observing low-level clouds and the cloud base, which are critical for accurately modelling radiative transfer. Results from general circulation models show significant biases in outgoing shortwave radiation in this region, believed to be related to deficiencies in representation of clouds, aerosols or their interaction. As part of the Cloud and Aerosol project of the New Zealand Deep South Challenge (DSC) we collected and analysed cloud measurements from multiple shipborne and ground-based deployments of several meteorological instruments: ceilometer, lidar, micro rain radar, radio soundings, aerosol sensors, sky cameras and UAV-borne sensors. With this combination of instruments we hope to advance understanding of cloud processes in this region, quantify model error compared to observations and contribute to the modelling effort of the DSC. Currently we have collected observations from a ground-based deployment on Macquarie Island and multiple voyages: Aurora Australis, R/V Tangaroa, HMNZS Wellington and R/V Nathaniel B. Palmer. By incorporating data from these and planned future deployments we intend to produce a Southern Ocean dataset of atmospheric measurements available for general use. This presentation will provide an overview of our progress and results.

Tue_59_AC-1_1546
Arctic Mixed-phase Clouds Properties from in Situ Measurements

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This study aims to characterize the microphysical and optical properties of low-level Arctic mixed-phase clouds (MPCs) in order to improve the knowledge of these particular polar clouds. Cloud in situ measurements from four airborne campaigns (18 flights, 71 vertical profiles in MPCs) in the vicinity of the Svalbard region are combined and analyzed.
Cloud phase discrimination and representative vertical profiles of the number, size, mass and shape of ice crystals and liquid droplets are established. The results highlight that the liquid phase dominates the upper part of the MPCs. The ice phase dominates the cloud properties in the lower part and below the cloud in the precipitation region. The analysis of the ice crystal morphology highlights that riming and diffusional growth processes, including the Wegener-Bergeron-Findeisen (WBF) mechanism, are the main growth mechanisms involved in the observed MPCs.
The impact of larger-scale meteorological conditions (temperature regimes, air mass origin) on the MPC properties is also investigated. The results highlight that clean situations with low temperatures exhibit larger values of ice crystal size and IWC, whereas the situations more polluted with air mass origins from the south exhibit larger values of LWC and number of smaller droplets associated with very low values of ice crystal size and IWC.
Finally, these data lead to the determination of several parameterizations relevant for remote sensing or modeling studies.

Tue_60_AC-1_1635
Intraseasonal Variability of Near Surface Weather Parameters Observed Antarctica

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High temporal resolution (1 Hz) records of temperature, wind speed and air pressure recorded at Antarctic research station Maitri (70° S, 11° E) during 2012-2016 are analysed to identify oscillations from daily to intraseasonal/extralong period timescales. The diurnal cycle dominates the hourly time series of temperature during the Antarctic summer and is almost non-existent during winter. In comparison, the hourly time series of wind speed and air pressure show a weak diurnal cycle. The dominant pattern of the intraseasonal variability of these quantities, which captures the out-of-phase of temperature and wind speed with air pressure, shows enhanced variability at timescales of, ~16 days respectively. The second pattern of intraseasonal variability, which captures in-phase variations of temperature, wind and air pressure, shows enhanced variability at timescales of ~8 days, ~16 days, ~32 days and ~40 days.

Tue_61_AC-1_1639
Surface Radiation Budget at Thule, Greenland: Role of Clouds and Surface Albedo

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The surface radiation budget (SRB) has peculiar characteristics in the polar regions, due to the predominance of the infrared radiation and to the absence of solar radiation during part of the year, as well as to the meteorological conditions related to low temperature and humidity values, and to the presence of highly reflecting surfaces.
Measurements of downward shortwave (SW) and longwave (LW) irradiance were available at Thule High Arctic Atmospheric Observatory (THAAO, 76.5° N, 68.8° W, http://www.thuleatmos-it.it/) since 2009. In July 2016, additional instruments were installed during the summer campaign of the Study of the water VApour in the polar AtmosPhere (SVAAP) project: among them, downward-looking SW and LW radiometers, a RPG HATPRO microwave radiometer, an infrared pyrometer, a meteorological station, a sky imager.
Measurements of SRB and of the derived cloud radiative forcing are presented and discussed as a function of simultaneous data of integrated water vapour, cloud parameters like liquid water path, cloud optical thickness and particles' effective radius (only during summertime), and under different regimes of surface albedo, typical of snow-free (from June to September) and of snow covered terrain. In summer the SRB is positive and its variability is dominated by the SW irradiance. The LW component offsets about 20% of the SW at noon in clear sky, and contributes up to 50% of the total SRB in thick cloud conditions.

Tue_62_AC-1_1679
Role of Katabatic Wind in Altering the Fair-weather Electric Field at Antarctica

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Automatic Weather Station (AWS) and Electric Field Mill (EFM) measurements at Maitri (70° S, 11° E), Antarctica from 2013-2016 are presented in this analysis. Time series of fair weather electric field shows the signature of katabatic wind is highly dominant in the summer than winter. There are ~ 80 such events categorized, which results from the criterion like the constancy of fair weather field range/gradient pre-and post event periods. It also applies to the wind speed & direction pattern where the event is taken only when they stable for more than one hour. From the statistics analysis, the average wind speed varied nearly 10 m/s during the event periods and the average response time of electric field is 50-65 min for the wind speed change of 30-45 min with the wind direction changes less than 30 mini. The effect of katabatic wind on electric field has seasonal and Local Time (LT) dependency. We suggest that the electric field response varied at season may be due to 1. Summer has relatively more number of fair weather days than winter, hence the only dominant factor is aerosol carrying wind, Katabatic, that modulates the conductivity of near surface region, 2. The added effect of winter, snowfall and blizzard and enhanced pattern of Katabatic wind together influence the fair weather field. Local time dependence is validated with other AWS observations (IMD, Dozer point).

Tue_63_AC-1_1703
Study of Ice Core and Present Day Mineral Dust in Antarctica by PIXE Analysis

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Atmospheric mineral dust deflated from continental surfaces is an important player in Earth climate. As it reaches inner Antarctica after long-range transport from other continents, the study of both current-days and ice-core-archived Antarctic mineral dust is very useful in recognizing its main source areas and therefore the present day and past atmospheric dust pathways. While glacial conditions, when dust concentrations are higher, have been well investigated assessing a dominant dust origin from Southern South America, a poorer knowledge is available for the Holocene and interglacials.
At the LABEC-INFN accelerator, a PIXE-PIGE setup has been optimized for high efficiency particulate matter analysis. These techniques, which are high sensitive to mineral dust elements, have been used for the analysis of dust in EPICA ice core samples (Marino et al., GRL 2009) and for preliminary measurements on present day mineral dust collected at Dome C.
This research activity will be carried forward and enlarged by the recently started PNRA SIDDARTA project, whose aim is studying present-day sources and transport processes supplying mineral dust to the Antarctic plateau (by the analysis of atmospheric aerosol, surface snow and snow-pit samples collected at Dome C, as well as soil samples collected in Southern South America and Australia).
Motivation, design and first results of SIDDARTA will be described together with results obtained by previous PIXE analysis of Antarctic mineral dust.

Tue_64_AC-1_1704
Source Apportionment of Arctic Aerosol: Results of the Ny Ålesund 2015 Campaign

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Ny Ålesund is located on a western fjord of Svalbard Islands, in the northernmost point influenced by the warm West Spitsbergen Current, and thus it is an ideal site for the study of the interaction between the climate change and the atmosphere, ocean and land variations. At the Gruvebadet laboratory, samplings are ongoing since 2010 in the period March to September; in particular, in this work we will focus on the results gained by the analysis of daily PM10 samples collected during the 2015 campaign.
Daily PM10 samples were analyzed for the ionic composition by Ion Chromatography (IC) and for metals and rare earth elements (REEs) by Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES). Further, for the first time, daily samples were analysed for the elemental composition by Particle Induced X-ray Emission (PIXE) analysis. PIXE is an almost unrivalled technique for the characterization of mineral dust, as it is sensitive to all the crustal elements (except O), included Si, which is usually not accurately quantifiable with other common chemical techniques.
Data on PM10 concentrations and speciation will be shown. Further, the Positive Matrix Factorization (PMF) model was applied for source apportionment and allowed the identification and the quantification of the contributions to the aerosol burden of several sources such as mineral dust, nitrate, ammonium sulfate, sea salt, biogenic emissions, anthropic emissions.

Tue_65_AC-1_1731
Black Carbon Snow Surface Processes Connected to Atmospheric Variables

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This work is the results of two experiments performed in Ny-Alesund (Svalbard) during the 2014 and 2016 spring. Two different experiments were performed to evaluate the relation between the atmospheric load of *black carbon* (BC) and its concentration in surface snow. One experiment focused on the *daily* BC concentration changes in the first 10 cm of the snow layer for a total of 80 days, the second with *hourly* temporal frequency for 3 consecutive days and 3 cm of snow for study the possible fluctuation of BC in surface snow due to the day and night cycle.
The atmospheric *equivalent* BC mass was measured by an Aethalometer, a PSAP and a mini- Aethalometer. Refractory BC concentrations in snow samples were measured with a SP2 (DMT) and the insoluble particles numbers with an Abakus system (Klotz).
Statistical modelling was considered to evaluate the relationships between the parameters and the variability of rBC variability in the snow. In both experiments a statistically significant relation was found between the dust content and rBC concentration in snow, indicating common atmospheric and depositional patterns. In the “80 days” experiment a *negative relation* was found between the atmospheric and the snow BC, whereas a *positive relation* between snow rBC content and snow *conductivity*. The high resolution sampling of the “3 days” experiment allowed detecting a diurnal cycle of the rBC in snow, inversely proportional to *solar radiation* and *snow temperature*.

Tue_66_AC-1_1752
Climatological Analysis of Aerosol Properties Including Moon Photometric Results

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Over the past decades, the Arctic has warmed more than any other region on Earth. However, the causes of this so-called Arctic amplification are not yet fully understood. Although model estimation of Black Carbon (BC) has been improved in the past years there is still an under or overestimation of BC in the prediction of a factor of two, which could be due to the mismatch of long-range transport due to the limited horizontal resolution. To provide better information to models, Finnish Meteorological Institute (FMI) has extended the Arctic observations to improve the capability to monitor the vertical atmospheric column in the dark period. In this work we present a new method to retrieve aerosols properties using a novel instrument that measures in dark conditions, using the moon as a source of radiation. The Lunar Photometer is an extension to the traditional Cimel sun-photometer with some significant technical modifications to optimize its performance to allow the retrieval of reduced incoming energy. Fifteen years of AOD and AE measured by collocated PFR and Cimel photometer measurements have been analyzed together with the first year of the lunar photometer measurements installed at Sodankylä station. The physical aerosol properties such as aerosol size distribution, refractive index, and the single scattering albedo analyses are also included, starting in 2013.

Tue_67_AC-1_1781
Aerosol as a Player in Arctic Climate Change - An Aerosol-climate Model Study

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The Arctic is warming twice as fast as any other part of the world. The rapid climate change is associated with various feedback mechanisms which relative importance is still debated. The German project “Arctic Amplification $(AC)^3$” aims to better quantify relevant processes and enhance the understanding of mechanisms involved with a range of field measurements and modeling.
Aerosol particles affect the Arctic energy balance by direct and indirect radiative effects. This study contributes to $(AC)^3$ by investigating sources and transport pathways of natural and anthropogenic aerosol and its radiative impact by global and Arctic-focused transport modeling. Particular focus is on black carbon (BC) which is highly absorbing at solar wavelengths and tends to warm the atmosphere. When deposited on snow/ice it lowers the surface albedo and accelerates sea ice melting.
Here, we present an evaluation study with the aerosol-climate model ECHAM6.3-HAM2.3. Using different state-of-the-art emission inventories, simulations have been performed in nudged mode with 1.8° grid spacing for the years 2006-15. The evaluation's emphasis is on the vertical layering and seasonality of Arctic aerosol using ground and airborne field data. The evaluation will reveal emission and transport-related uncertainties in aerosol radiative properties and forcing. Finally, the model results will provide an up-to-date estimate of the budget and direct radiative forcing of aerosol in the Arctic region.

Tue_68_AC-1_1789
Black Carbon Deposition to the Greenland Ice Sheet from Forest Fires in Canada

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Black carbon (BC) concentrations has been observed in 22 snowpits sampled in the northwest sector of the Greenland ice sheet in April 2014. The pits contain a strong and widespread BC aerosol deposition event, which accumulated in the pits during two snow storms between 27 July and 2 August 2013. This event comprises a significant portion (57% on average across all pits) of total BC deposition measured in the snowpits (~10 month record). We link this deposition event to forest fires burning in Canada during summer 2013 using modeling and remote sensing tools. Specifically, we use high-resolution regional chemical transport modeling (WRF-Chem) combined with high-resolution fire emissions (FINNv1.5) to study aerosol emissions, transport, and deposition to Greenland snow during this event. The model captures the timing of the BC deposition event and shows that fires in Canada were the main source of deposited BC. The potential implications for understanding the influence of BC originating from fires on the optical properties of snow is discussed.

Tue_69_AC-1_1820
10 Years of Polar Lows Using AMSU-B, MHS, ASR and Radiative Transfer Simulations

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Polar lows (PLs) are intense, high-latitude maritime cyclones that bring heavy precipitation and winds above gale force. Their small horizontal scale and short life time makes them hard to predict. Therefore, improved understanding and prediction is of high importance. Satellite observations in the microwave range that have a good coverage of the Arctic region offer high potential due to theirs sensitivity to snow. Two such satellite instruments, namely Advanced Microwave Sounding Unit -B (AMSU-B) and Microwave Humidity Sounder (MHS) have been used. The investigation of PLs is done for January, 2003 to December, 2012 over which 134 cases were reported. Arctic System Reanalysis version 1 (ASRv1) is used for the analysis of atmospheric genesis conditions of PLs and compared with satellite observations. For the latter, radiative transfer simulator called PAMTRA (Passive and Active Microwave Radiative Transfer Model) has been employed. We found that AMSU-B and MHS are performing well in representing the PLs, where channels around strong water vapour line, namely 183.31 GHz, are showing strong depression in PL convective cores that At times depression can be over 40 K. Generally, simulations show good agreement with satellite observations, though not all cores of multi-low PL are resolved. Furthermore, we investigate PL cases originating in different geographical area and the amount of snowfall they bring.

Tue_70_AC-1_1895
Tropical Palynomorphs Detected at Central-Western Antarctic

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The regime of transport and deposition of pollen grains and spores to Antarctica may help understanding the atmospheric capability of transporting biological material intercontinentally. Snow samples were collected in Central-Western Antarctica (84ºS-079ºW), Criosfera 1 laboratory, in the years of 2013 and 2015 to investigate occurrences of palinomorphs. The collected snow was filtered in polyester blanket with 6 µm lumen and later, the palinological slides were assembled. Simultaneously, atmospheric modeling (HYSPLIT/NOAA), surface wind diagrams and data obtained in situ (wind direction, snow accumulation, air temperature and relative humidity) were used to corroborate the sources of the palynomorphs. Eleven pollen / spore grains represented the taxa: *Thelypteris* sp., *Waltheria* sp., *Pinus* sp., *Smilax* sp., *Morus alba* L, *Anadenanthera colubrina* Brenan and Campanulaceae were observed in the year of 2015 and only one grain of Poaceae in 2013. We have attributed the difference in pollen concentration to an extratropical cyclone in the coastal South Atlantic characterized as explosive that occurred near Uruguay and North / Northeast of Argentina in November 2015. Polen source region was corroborated by radiogenic Sr/Na in concomitant dust. This event, due to its high energy, was responsible for the suspension of palynomorphs, followed by transportation to the high latitudes. In the Weddell Sea, a polar cyclone assisted the entry of palynomorphs into the Antarctic continent.

Tue_71_AC-1_1913
An Experiment at Lat 84S to Study the Link between Cosmic Ray and Cloud Cover

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Since Charles Wilson invented the cloud chamber in 19´s it is known that ionizing particles are capable to trigger cloud droplets. Only in 1997 the first evidence of a response of the cloud formation with respect to cosmic rays in real atmosphere has been reported, motivating many other studies, given to it potential implications to the global climate changes.
Recently the CLOUD Collaboration designed a special chamber dedicated to study the ion-aerosol mechanisms, the microphysical process to form clouds. They found that ions from galactic cosmic rays could strongly enhance the production rate of pure biogenic particles as well as oxidised biogenic vapours dominate particle growth in unpolluted environments.
In order to study the role of the cosmic ray in climate, the Criosfera 1, a remote Brazilian self-energy sustained laboratory, installed at 84^0 S, setup an experiment, named CREAT (Cosmic Ray Experiment at AnTartic), dedicated to monitor low energy muon flux efficiently, by means of plastic scintillators, multianode photo-multiplier and FPGA technologies. The location is benefited by the high cosmic flux, absence of background radiation, human pollution and rainfall. We will present the preliminary results obtained from 2014 to 2017, analyzed using advanced statistical method to quantify their correlation with cloud of different altitudes using NASA and ERA datasets. We will also discuss the long term perspective for the CREAT project and its upgrade.

Tue_72_AC-1_1920
US Dept. of Energy Atmospheric Radiation Measurement Facilities in the Arctic

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The U.S. Department of Energy (DOE) operates scientific user facilities at locations around the world, including polar regions. The Atmospheric Radiation Measurement (ARM) facility is a scientific user facility that provides researchers with strategically located atmospheric observatories. The resulting data are used to improve the understanding of how the Earth's atmosphere works and the way those processes are represented in regional and global models. Data from these facilities are provided to the international research community through an archive that is easily accessed via the web.
The ARM program currently operates two fixed ground-based facilities in Alaska and has a third inland location that can be used for field campaigns. These facilities include:
> Barrow: to measure ocean-land-atmosphere interface conditions,
> Atqasuk: to measure land-atmosphere interface for comparison of Barrow measurements for differences between land and shore conditions,
>Oliktok (AMF-3): to measure ocean-land-atmosphere interface; use of R-2204 and W-220 for aerial atmospheric measurements.
In addition to providing full time ground-based observations, the ARM facility at Oliktok is used for operations of instrument unmanned aerial systems and tethered balloon systems. Several activities related to the Year of Polar Predication (YPP) at North Slope ARM facilities have been proposed and are under review.

Tue_73_AC-1_2020
Study on the Cloud Condensation Nuclei Concentration and Aerosol Optical Depth

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The aerosol optical measurement to estimate CCN concentrations is challenging because of various aerosol characteristics. Thus, it is important to investigate the CCN-AOD relation using remote AOD data according to the regional and seasonal aerosol characteristics.
In this study, CCN-AOD relation at 500 nm is given in the Arctic region based on CCN measurement data collected during the period 2007-2013 at the Zeppelin observatory (78.91° N, 11.89° E, 474 masl). For remote sensing data, the AERONET network and MODIS AOD as well as MERRA-2 reanalysis data are analyzed. The seasonal characteristics as well as long term trends are also considered.
As a results, CCN concentration remains high during spring because of aerosol transportation from the mid-latitudes, known as Arctic Haze. Lowest CCN number densities were observed during autumn and early winter when aerosol long-range transport into the Arctic is not effective and new particle formation ceases. The results also show that the relation between AOD and CCN has a seasonally different tendency. This seasonal different CCN-AOD relation can be interpreted as many physico-chemical aerosol properties including aerosol size distribution and composition. Subsequently, CCN-AOD relation can be interpreted as many physico-chemical aerosol properties including aerosol size distribution and composition.

Tue_74_AC-1_2048
POLARUBI Field Campaign: Individual Particle Analysis of Atmospheric Aerosols

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This work presents in situ data from aerosol measurements that took place at the Arctic Lidar Observatory for Middle Atmosphere Research, located in the Andøya island, ~300 km north of the Arctic Circle. The main goal of the measurements is the characterization of individual aerosol particles to know their morphology, size distribution, mass and chemical composition. The technique used is the collection of aerosol particles on filters for posterior analysis in the laboratory. The system is composed by an inlet, an in-line filter holder, a vacuum pump and a flow meter. The filters are weighed before and after collection for determination of the amount of particulate matter. After weighed, the filters are prepared for observation on a scanning electron microscope (SEM) or on a transmission electron microscope (TEM). Both electron microscopes allow to see the size and morphology of the individual particles. A RONTEC energy dispersive x-ray system allows to obtain the information about elemental composition of the particles.This work is supported by Fundação para a Ciência e Tecnologia (FCT) through the Portuguese Polar Program (ProPolar), Project POLARUBI.

Tue_75_AC-1_2054
Columnar Aerosol Observations by Sun-sky-Lunar Photometry in Ny-Ålesund (79ºN)

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The Atmospheric Optics Group of the University of Valladolid and the Alfred Wegener Institute (AWI) have started a joint research project which included the installation of a new generation Cimel sun-sky-lunar radiometer (CE318-T) in the Ny-Ålesund Arctic base (Svalbard, 78.9ºN). This kind of instrument, in the framework of the worldwide AERosol ROBotic NETwork (AERONET), can provide aerosol properties during summer (sun) and winter (moon) time. This instrument follows all the standardized AERONET daylight observations and gives a large set of aerosol properties that can be combined with lidar and other collocated instruments using novel algorithms such as GRASP (Generalized Retrieval of Atmosphere and Surface Properties) open source code.
We present here the preliminary results of aerosol optical and microphysical observations in the French and German joint facility AWIPEV in Ny-Ålesund after several months of operation. The aerosol optical depth time series (since 1991) from a Schulz sun photometer at the AWIPEV site is compared with the first months of CIMEL database and the results highlight the necessity of re-calibration of the 1020 nm channel.
This work was supported by: project POLARMOON (CTM2015-66742-R) and IJCI-2014-19477 and PTA2014-09522-I grants of Spanish Government (MINECO), EU-H2020 under Grant Agreement Nr. 654109 [ACTRIS 2]; and RIS-ID 10745 project. Thanks to AWIPEV station crew.

Tue_76_AC-1_2119
Single Particle Characteristics of Biomass Burning Aerosol Transported in Arctic

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This paper reports an exceptional biomass burning (BB) advection event from Alaska registered at Ny-Ålesund from 10 to 17 July 2015 with special interest on the evolution of the particle characteristics and mixing state over time in relation to the optical properties of the aerosol. To this purpose we considered two DEKATI 12-stage aerosol samples spanning over the entire advection and analyzed them by scanning electron microscopy (SEM) techniques. Daily chemical data and hourly optical measurements were also evaluated in order to correlate individual particle characteristics with bulk aerosol properties at ground level. Results depict a complex advection event characterized by a first phase (P1) of massive input of BB organic particles (OPs), and by a second phase (P2) dominated by inorganic salts (ISs). The mixing state conditions also varied greatly, ranging from prevailing internal mixing of IS on OPs in P1 to prevailing external mixing of IS and MD particles with pre-existent OPs in P2. Optical measurements at ground level of Jul 10 are in good accordance with the particle features, but rapidly evolved likely due to a strong increase of the grain size by hygroscopic growth upon humidification. The observations reveal the influence of aging effects due to the long-range transport and to the stationing of the BB particles in the boundary layer.

References:

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Tue_77_AC-1_2134
Pico Mountain Observatory, a Free Tropospheric Remote Site in the North Atlantic

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Pico Mountain Observatory (PIC) is a mountaintop research station located in the summit caldera of the Pico Volcano (2225 m.a.s.l.) in the Azores. During summer, this site typically, lays in the free troposphere, sampling air decoupled from the boundary layer, which is different from other mountaintop observatories. PIC and the Izaña station are the only places in the North Atlantic where free tropospheric air masses can be studied over extended periods of time. Therefore, PIC, due also to its central location in the Atlantic, is an ideal place to investigate atmospheric background conditions and long-range transport effects.
We will present results of the aerosol measurements conducted at PIC since 2012. This dataset includes aerosol scattering and backscattering (by a 3-wavelength integrating nephelometer), aerosol absorption, black carbon and iron containing particles mass concentration (by a 7- wavelength aethalometer) and particle concentrations for particles bigger than 300 nm (with a 2-channel optical particle counter). In addition, several filters were collected for chemical characterization (using ion chromatography and ultrahigh resolution mass spectrometry), for microscopy and elemental analysis, and for ice nuclei analysis. During two summer seasons, we used an instrumented backpack to measure the vertical distribution (from 1225 to 2351 m.a.s.l.) of particle concentrations, in-situ optical properties, aerosol optical depth, and meteorological parameters.

Tue_78_AC-1_2250
Long-term Variability of Cloudiness over the Russian and Norwegian Arctic

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The study presents a long-term climatology of cloudiness over the Norwegian and Russian parts of the Arctic Ocean. The analysis is based on routine visual surface observations that conducted at island and coastal Russian and Norwegian stations from 1930s. Total and low cloud cover and fraction of different morphological cloud types are assessed. The climatology and inter-annual variability is evaluated separately for different seas (from the Norwegian to Chukchi seas) and for open-water and solid-ice regions. In general, total cloud cover (TCC) has higher intra- and inter-annual variability over SI than over OW. A decrease of TCC in the middle of the 20th century and an increase in the last few decades is revealed at individual stations and for the Atlantic sector. Long-term positive trend of convective and negative trend of stratiform cloud forms are found. Statistically significant relationship between cloudiness and sea-ice concentration is shown.

Tue_79_AC-1_2292
A Study of the Interaction between Precipitation and Blowing Snow in Adélie Land

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A recent study (Grazioli et al., 2017) has shown that a significant part of precipitation in Adélie Land sublimates in the upper part of the katabatic flow. On the other hand airborne snow particles eroded from the surface also sublimate in the lower part of the katabatic layer. The question raised here is to which extent both processes influence each other, as they may influence the surface mass balance of the antarctic ice sheet margin.
A new version of MAR (Modèle Atmosphérique Régional - Gallée, 2017, in preparation) has been developed, including a new blowing snow module. The code has been rewritten and parallelized using domain decomposition and the MPI (Message Passing Interface) software.
Validation show a good agreement between the model and observations made in Adélie Land. Sensitivity tests have been performed by switching on and off the blowing snow module, in order to better understand the interaction between snow precipitation and erosion by the wind. Here we show how the interaction develops along the slopes of Adélie Land.

Tue_81_AC-1_2374
Aerosol Optical Properties over the Arctic in the Light of Absorbing Particles

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The aim of this research is to investigate aerosol optical and microphysical properties during spring and summer conditions in the European Arctic. In the first part of the study, we performed a model-based investigation on spring and summer AOD trends in the last 15 years with the emphasis put on the changes in the occurrence of Arctic Haze and biomass burning transport events. We confirmed the negative trend of Arctic Haze AOD and a positive one of the latter. Secondly, we estimated mean spring conditions of the aerosol optical and microphysical properties (such as scattering and absorption coefficients, single scattering albedo, Angstrom exponent, AOD, etc.) during background conditions and high concentration events of respective aerosol species. These results utilised in-situ measurements from spring campaigns conducted in 2014-2017 at Ny-Alesund, Spitsbergen under iAREA (Impact of Absorbing Aerosols in the European Arctic) project. Finally, an investigation of HYSPLIT back-trajectories during high load events was performed indicating possible source regions of particular aerosol species.

Tue_82_AC-1_2527
Sensitivity Study of Energy Budget to Optically Thin Ice Clouds in the Arctic

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In situ and satellite-based observations reveal the existence of two types of optically thin ice cloud (TICs) in the Arctic during the polar night. The first type, TIC-1, consists of small none precipitating ice crystals and invisible to the CloudSat radar. The second type, TIC-2, is detected by CloudSat radar and CALIPSO lidar and is characterized by a low concentration of large ice crystals of sufficient size to precipitate. Energy budget diagnostics appears to be one of the most efficient ways to improve functioning physical mechanisms in atmosphere. In this study, the energy cycle equations as formulated by Nikiéma and Laprise (2013) will be used to analyse the energy budget of the atmospheric circulation in the Arctic during the polar night. To address this question, satellite-based observations (CloudSat and CALIPSO) are used to characterize the ice clouds and analyze the atmospheric conditions conducive to their formation. A reanalysis driven application of the Canadian Regional Climate Model version 5 (CRCM5) is used to perform two simulations, one with the TIC-1 conditions and the other with TIC-2 conditions. A comparative analysis will be carried out to determine the role of the thin ice cloud according to their type in the response of the energy balance. Overall, this study contributes to evaluate the relative importance of polar clouds on the atmospheric energy balance.

Tue_83_AC-1_2541
Arctic Urban Air Pollution: Knowledge Gaps, Challenges & Future Directions

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Urban areas in many high latitude regions have been shown to suffer from regular air quality standard violations, particularly during winter. Locally produced air pollution, in combination with cold, stagnant weather conditions and strong inversion layers, can lead to significant localized pollutant concentrations. Despite these effects, there are important knowledge gaps in our understanding of chemical and physical processes occurring under polluted conditions with limited sunlight and very low temperatures. Studies suggest wintertime aerosol in high latitude urban areas often comprises large mass concentrations of fine particulate organic carbon resulting from domestic wood burning, as well as substantial sulfate mass fractions. However, our knowledge about formation mechanisms, based on lower latitude studies, cannot explain these aerosol abundances under conditions of limited photochemistry.
We will present an overview of current knowledge regarding sources, processing and fate of wintertime air pollution in high latitude urban environments, and discuss challenges related to reconciling understanding of pollution formation and loss processes with limited observations available. A roadmap for recommended action to address knowledge gaps, being developed under the IGAC/IASC PACES (air Pollution in the Arctic: Climate, Environment and Societies) initiative will be presented, including plans for an international field experiment and new model evaluation activities.

Tue_84_AC-1_2650
Cloud, Aerosol, and Radiation Observations at Multiple Polar Sites

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The Atmospheric Radiation Measurement (ARM) facility is operated by the United States Department of Energy and provides extensive suites of atmospheric instrumentation for studying the interactions among clouds, aerosols, precipitation, and the surface energy budget at multiple ground-based observatories around the world (www.arm.gov). Two of these observatories are deployed for about a year at a time through a competitive proposal process. One of these deployable observatories has recently undertaken two separate missions to Antarctica and the surrounding Southern Ocean (which will have just recently been completed at the time of the Polar 2018 conference) and will soon be deployed on a third polar mission to the central Arctic Ocean as part of the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAIC) initiative. ARM also operates two observatories along the North Slope of Alaska, in Barrow and Oliktok, which will be the subject of a separate presentation. The goal of this presentation is to provide an overview of the capabilities of these ARM Mobile Facilities, highlight some observations obtained from these unique deployments, and describe how scientists interested in polar measurements can engage with the ARM facility, either through analysis of previously archived data (which are available to anyone) or by proposing future field campaigns.

Tue_85_AC-1_2671
Radiative Impact, Long-term Trends and Source Attributions of Arctic Aerosols

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Aerosols affect the Arctic radiative budget directly by interfering radiation and indirectly by modifying clouds. Black carbon (BC) in snow/ice can reduce the surface albedo. The direct radiative impact of aerosols on the Arctic climate can be either warming or cooling, depending on their composition and location. Anthropogenic emissions, especially, BC and SO_2, have changed drastically in low/mid-latitude source regions in the past few decades. Arctic observations show that BC and sulfate aerosols had a decreasing trend in the recent decades. We use the Community Earth System Model (CESM) equipped with a BC and sulfur source-tagging technique to quantify the source-receptor relationships and decadal trends of Arctic sulfate and BC during 1979-2014 and to identify variations in their transport pathways from lower latitudes. Emissions came from the CMIP6 datasets, which show strong regional trends in BC and SO_2 emissions during the simulation time period. Results show that emissions from East Asia and South Asia together have the largest contributions to Arctic sulfate/BC and their increasing trend in the upper troposphere, while the strong decrease in emissions from Europe, Russia and North America contributed significantly to the overall decreasing trend, especially, in the lower troposphere. The long-term changes in the spatial distributions of aerosols, their radiative impacts and source attributions, along with implications for the Arctic warming trend, will be discussed.

Tue_87_AC-5_176
Antarctic Surface Mass Balance Evolution through the Plio-Pleistocene Transition

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Changes in global Sea Surface Temperature (SST) gradients modulate the strength of the Southern atmospheric teleconnections, but the implications for Antarctic ice sheet (AIS) surface mass balance (SMB) are seldom investigated. Considering the Plio/Pleistocene transition as a good past analogue to future SST changes over the 21st century, idealized numerical Pliocene atmospheric and SMB simulations show that strong SST gradients induce dynamical changes that enhance or dampen the sensitivity of the AIS to teleconnections. A strong meridional SST gradient increases the influence of the Southern Annular Mode over the AIS Pacific sector. A strong zonal equatorial SST gradient strengthens the stationary Rossby wave pattern between East Australia and the Amundsen Sea, modifying the moisture fluxes pathway, which brings more precipitation over the main drainage basins of the East AIS. Similar dynamical mechanisms are simulated for projected RCP2.6 and RCP4.5 Antarctic SMB changes but compensations occur between the effect of teleconnections and the mean climate states of the simulations. Under warm climates, the SMB sensitivity to teleconnections increases, even though the atmosphere dynamics weakens and vice-versa under cold climate conditions. Although the mean climate state is a good indicator for future AIS changes, local SMB, modulated by teleconnections, might influence the retreat of key marine-based sectors.

Tue_88_AC-5_797
SSW Signatures of Semidiurnal Tides and 2 Day Waves in Low Latitude MLT Region

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Sudden Stratospheric Warming (SSW) events are found to be capable of significantly affecting the low latitude middle atmosphere. In the present study, we examine the signatures of SSW events in semidiurnal tides and quasi 2-day waves in the Mesosphere- Lower Thermosphere (MLT) region over low and equatorial latitudes using meteor wind radar observations from two stations Thumba (8.5°N, 76.5°E) and Kototabang (0.2°S. 100°E). After developing the climatology of the above parameters, behavior of equatorial and low latitude MLT region during typical polar stratospheric conditions, namely Quiet winter, Major SSW winter and Minor SSW winter, is investigated. The analysis clearly shows the amplification of semidiurnal tides during major SSW events, albeit the magnitude of enhancement varies from event to event. Interestingly, the semidiurnal tidal amplitudes are found to enhance selectively in zonal and meridional components, respectively over the low latitude and equatorial stations. Quasi 2-day wave amplitudes over both the observational sites increased in association with SSW events, with anomalously large amplitudes as high as 95 m/s during the minor SSW of January 2012. Unlike many case studies, the present study distinctively demarcates the characteristic response of semidiurnal tides and quasi 2-day waves simultaneously over low latitude and equatorial MLT region to typical polar stratospheric conditions.

Tue_92_AC-5_256
Influence of ENSO, PDO and Climate Change on Tropical Andean Glaciers

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Since the late 1970s, tropical Andes witnessed rapid glacier shrinkage in parallel with a warming trend observed in this region. Variation in the maximum snowline during the dry season (austral winter), which can be taken as nearly equivalent to the equilibrium line in the tropical Andes, was estimated using satellite data for selected glaciers along the tropical Andes since the early 1980s. Meteorological datasets were also analysed to observe changes in precipitation, temperature, and humidity. Inner tropical glaciers, particularly those situated near the January Intertropical Convergence Zone (ITCZ), are more vulnerable to increases in temperature and these glaciers are less sensitive to variations in precipitation. In contrast, outer tropical glaciers respond to variations in precipitation very rapidly that to temperature changes, particularly when moving towards the subtropics. Glaciers in the northern tropics and dry outer tropics showed relatively slower retreat, possibly due to the occurrence of cold phases of El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) together in some years. The observed anomalies in the meteorological variables slightly follow PDO patterns and annual snowline variations follow El Niño events, particularly when in phase with warm PDO.

Tue_93_AC-5_532
Influence of SST in the Tropical Oceans on the Arctic Climate

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The first objective is to assess the role of meridional atmospheric heat and moisture transport (MAHT) in the temperature variations in the Arctic. MAHT across 70N into 70-90N area was calculated using ERA/Interim reanalysis data for 1979-2016. It is found that main inflow in winter comes across 0-80E within layer between the surface and 750 hPa and explains more than 50 % of variability of surface air temperature in the 70-90N area. The second objective was to assess the influence of SST anomalies in the low latitudes of Atlantic, Indian and Pacific oceans on change in the winter MAHT to the Arctic. The area and month with maximal correlation between SST and winter MAHT (up to 0.75) as well as respective lags (27-30 months) in each ocean were found. The third objective is an assessment of the influence of SST anomalies on sea ice cover in the Arctic. Series of water temperature at the section in the Barents Sea, sea ice extent and surface air temperature in the Arctic were used additionally. It is found intimate link between change of Atlantic SST in low latitudes and sea ice extent in the Arctic with correlation coefficients up to 0.90 and delays up to 3 years. A mechanism of the influence of SST anomalies in low latitudes on winter MAHT, sea ice and air temperature is proposed. It includes the interactions of atmospheric (Hadley and Ferrel circulations, NAO) and oceanic (Gulf Stream, the North Atlantic and the Norwegian currents) circulation patterns..

Tue_94_AC-5_672
Interdecadal Pacific Oscillation Influences Timing of an Ice-free Arctic Ocean

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One of the most visible and iconic aspects of recent climate change is the dramatic loss of Arctic sea-ice. Without efforts to slow manmade global warming, an ice-free Arctic would likely occur in summer by the middle of this century. The precise timing of an ice-free Arctic will depend however, on both the magnitude of future human-induced global warming and upon the magnitude and phasing of internal climate variability. This talk will present results from a large initial condition ensemble of global climate model simulations. Each ensemble member has a different realization of internal variability superimposed on the underlying externally forced response. Ensemble members that transition more quickly from present-day to ice-free conditions tend to be those that over the same time period are transitioning from negative to neutral/positive conditions of the Inter-decadal Pacific Oscillation (IPO). The phase of the IPO can shift the projected timing of first ice-free conditions by 5-10 years. Ensemble members that depict the IPO- phase in the 10-year period ending 2016 tend to transition toward IPO+ in the following decades, which accelerates the loss of ice and leads to an earlier projection of ice-free conditions. If the real world IPO continues to transition towards it's positive phase, away from IPO- in the recent past, this may hasten the emergence of ice-free summers in the Arctic.

Tue_95_AC-5_841
Understanding the Interactions between Polar, Midlatitude and Tropical Regions

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Many studies document Southern Hemisphere tropical and midlatitude influences on the Antarctic sea ice, and, vice versa, Antarctic sea ice influence on the midlatitudes and tropics. Analogous types of associations have been documented for NH polar and midlatitude/tropical regions. In this study potential teleconnection patterns are identified using a range of techniques, including ray tracing (e.g. Karoly 1983, Shaman et al. 2012) and wave activity flux (WAF, Takaya and Nakamura 2001). These approaches allow one to diagnose a path of wave packets that propagate from a specific region, that can be interpreted in terms of 'waveguides'. A suit of low-frequency and stationary ray tracing experiments will be conducted with an ensemble of rays starting within Arctic/Antarctic sea ice regions and, then, midlatitude/tropics to identify 'hot spots' within them. Particular attention will focus on the refraction of rays and to what extent the stationary and low-frequency waves can 'escape' the sea ice zone regions, hence, be able to influence climate in lower latitudes.

Tue_96_AC-5_1149
Black Carbon Deposition to Antarctica: Low Latitude Hydroclimate Teleconnections

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Black carbon (BC) and other biomass-burning emissions increasingly are recognized as major components of climate forcing. BC aerosols impact climate directly by changing Earth's radiation budget and indirectly by reducing albedo when deposited on bright surfaces such as snow and ice. Yet quantification and predictive climate modeling have been hampered by limited understanding of the drivers of regional-scale biomass burning and few long-term burning records.
In this work, we will compare the Antarctic BC results from an array of eastern Antarctic ice cores to low-latitude paleoclimate proxies to investigate a potential link between low latitude climate, biomass burning, and BC emissions. We will present high-resolution records of BC concentration and BC particle mass distributions (a proxy for BC particle sizes) from these ice cores focusing on the last 2,000 years of BC deposition. For BC concentration and particle mass determinations, ice cores were analyzed using the Desert Research Institute continuous flow analysis method, allowing for seasonal resolution of BC measurements. Results will be compared between ice cores, to previously published BC modeling results, and to low latitude hydroclimate records from the BC source areas to determine potential teleconnections between the low and high latitudes.

Tue_97_AC-5_2495
Forty-year Negative Accumulation Trend in the Ellsworth Mountains

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The Ellsworth Mountains are located at the intersection between the western border of the West Antarctic Ice Sheet and the Ronne Ice Shelf (RFIS), at the base of the Antarctic Peninsula (AP).
Several firn cores retrieved from this region in 2014 and 2015, were analyzed for stable water isotopes and glacio-chemical content. The dating of the cores shows that the accumulation in this region is relatively high for Inland regions but low for coastal areas, with annual accumulation ranging between 200 and 400 kg m^2 y^{-1}.
A clear decrease of the accumulation is observed from the ice shelf border inland, with a clear orographic effect of the mountains. This indicates that moisture masses approached the region from the Weddell Sea (and not from the Bellingshausen-Amundsen Sea). Annual accumulation values show a strong decrease from the 1970´s to present, with the annual mean falling by a.50%. This is the opposite of observations made on the west coast of the AP, where accumulation has doubled during the last century.
In this work we will integrate circulation model and re-analysis datasets to explain the strong decrease of accumulation during recent decades and its link to changing oceanic conditions, with special focus on sea ice variability and the environmental forcing of the accumulation variability. Finally, we will compare our results to CMIP5 to better calibrate our observations and to generate future predictions, which are important to determine the stability of the RFIS.

Tue_98_AC-5_2611
Transient Atmospheric Response to Reduced Sea Ice Cover in the Barents-Kara Seas

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Sea ice is an important player in the global climate system owing to its properties:
1) It acts as an insulator between ocean and atmosphere,
2) it is an efficient reflector of incoming shortwave radiation and
3) phase changes related to freezing and melting processes alter the vertical stability characteristics of the water column and therefore ocean circulation.
Of the Arctic Ocean, the Barents-Kara Seas have experienced the largest loss in sea ice cover since the start of the observational period in 1979. For the atmospheric flow, areas of sea ice loss/reduction mean a change in the lower boundary condition. Areas of sea ice loss are characterized by increased latent and sensible heat fluxes from the ocean to the atmosphere, elevated near-surface air temperature and reduced vertical stability. Re-analysis data have revealed November sea ice anomalies to have a significant impact on later winter sea level pressure, surface air temperature, and precipitation anomalies over the Euro-Atlantic sector (Garcìa-Serano et al. 2015). The proposed coupled response with the stratospheric polar vortex could explain the delayed late-winter tropospheric response in the North Atlantic Oscillation seen in observational and modeling data. This study aims at investigating this aspect further by initializing a seasonal prediction system with reduced sea ice cover in the B/K Seas in autumn to study the timing and character of the atmospheric response in the following winter season.

Tue_99_AC-5_306
Arctic Warming and the Amazon Rainforest Precipitation

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The current atmospheric warming of the Arctic may weaken the Azores high pressure centre and, consequently, weaken the northeast trade winds, may reduce precipitation in part of the Amazon region. From this hypothesis, we explore possible teleconnections between the variability in the extent of Arctic sea ice and the volume of precipitation in low latitudes. Using NCEP reanalysis data for precipitation in the Amazon and NSIDC data for the extent of sea ice over the period 1979-2015, a linear regression analysis shows a positive correlation around $r = 0.4$. When we selected a point in the Amazon region called P1 ($r = 0.45$), where we extracted a time series for the volume of precipitation to compare with the Arctic sea ice variability, a linear scatter plot shows r-square = 0.2. The work also shows the behaviour of the pressure fields that highlight the teleconnections described here.

Tue_100_AC-5_474
South Pacific Climate Recorded in an Ice Core from the Pine Island Glacier

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This work examines the South Pacific Ocean climate variability as recorded by two proxies (MSA and $\delta^{18}O$) from an ice core collected in the Pine Island Glacier at the Mount Johns site (79°55´S, 94°23´W; 2100 m a.s.l.). The two proxies show a positive trend in the period 1979-2008 [MSA (+0.210 µg L^{-1} a^{-1}), and $\delta^{18}O$ (+0.054‰ a^{-1})]. At the same time, the Southern Hemisphere annular mode index (SAM) showed a positive trend in summer (+0.078 a^{-1}) and in autumn (+0.050 a^{-1}), indicating a more intense cyclogenesis in the Southern Ocean, displacement of the storm tracks towards the south, the deepening of the Amundsen Sea Low and the decrease in the sea ice extent, contributing to a greater advection of oceanic air masses into the interior of the Western Antarctica ice sheet, these are the probable causes for the positive trends of the two proxies. In winter and spring, the SAM does not show the same tendency (-0.004 a^{-1}) and (+0.004 a^{-1}), favouring the displacement of the polar jet stream and the storm tracks to the north, increasing the south flow from the Antarctic Plateau to the Mount Johns region. We also discuss the influence of the ENSO phenomenon on the environmental variability of the Mount Johns region.

Tue_101_AC-5_534
Influence of Tropical SST on Antarctic Sea Ice in the Global Warming

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The sea ice cover in the Antarctic did not show a downward trend for the observed global warming while global climate models show a decrease. The aim of our study is to explain this climatic phenomenon on base of the idea of joint dynamics of ocean structures in the Southern Ocean - the Antarctic circumpolar current (ACC), the Antarctic polar front (APF) and the edge of the maximumal extent of sea ice while the locations of these structures are changed under the influence of SST anomalies in low latitudes. We used ERA/Interim, HadISST data and sea ice data base for 1979-2016. The dependence between SST anomalies in the low latitudes of the Northern Hemisphere and the position of the Antarctic polar front, maximum sea ice extent is found. The obtained results reflect the opposite trends in the change of sea ice extent in the Arctic and in the Antarctic under the influence of SST anomalies in common region of the North Atlantic. This influence is spread by means of the shift of atmospheric circulation modes (intertropical convection zone (ITCZ), the Hadley circulation (HC)) to the north with a positive SST anomaly and vice versa for negative anomaly with the corresponding displacements of the zonal modes in the atmospheric circulation in the Southern hemisphere (AAO, SAM) and zonal ocean modes (ACC, APF) in the Southern Ocean, followed by the boundary of sea ice extent.

Tue_102_AC-5_1712
An Exceptional “Warm Arctic/cold Eurasia” Event in Autumn 2016

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During the last two decades, when surface air temperature (SAT) in the Arctic increased faster than globally, several abnormally severe winters occurred in northern continents. The "warm Arctic/cold continents" pattern of SAT anomalies in these winters has often been attributed to the Arctic sea ice loss. Here, using monthly mean fields from the ERA-Interim reanalysis, we investigate a spectacular event of this type observed in autumn 2016. Anomaly fields for each month in 2016 were constructed by removing local, 1979-2016 means from the raw data. In October 2016, negative SAT anomalies reached about 6°C over Eurasia (mainly in the Asian sector). They were accompanied by a weaker “cold spot” in North America and positive SAT anomalies exceeding 8°C in the Arctic. This SAT anomaly pattern was driven dynamically by an abnormal atmospheric circulation, as indicated by a wavenumber-2 pattern of sea level pressure anomalies with major centres of action over Scandinavia and North Pacific. In October 2016, temperature advection by northerly wind anomalies over Asia exceeded by far (4 times) the corresponding standard deviation in the 1979-2016 period. The distribution, magnitude and timing of the anomalies of sea ice concentration, sea surface temperature and surface heat flux from September to December indicate that the atmospheric circulation anomaly in autumn 2016 was rather triggered by anomalous air-sea interactions in the North Pacific than by Arctic sea ice anomalies.

Tue_103_AC-5_2129
Antarctic Surface Temperature Variability and its Relation to ENSO

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The variability of Antarctic tropospheric circulation is dominated by the Antarctic Oscillation (AO) and influenced by El Niño-Southern Oscillation (ENSO), due to the low-high latitude atmospheric teleconnections. Previous works have evidenced the impact of the warming/cooling phases of ENSO (El Niño/La Niña) on the distribution of precipitations, sea ice and near-surface temperature mainly in west Antarctica. Under a climate change scenario, the frequency of extreme El Niño episodes is expected to increase in response to a projected eastern equatorial Pacific warming. Therefore, the aim of this work is to assess the role of ENSO on the Antarctica Land Surface Temperature (LST) during the last century until the present in the framework of a project of the Chilean Antarctic Institute (INACH). LST is retrieved using data from MODerate resolution Imaging Spectroradiometer (MODIS), ERA-Interim and ERA 20th Century reanalysis and in-situ weather stations. Non-parametric test were used to estimate the trend of LST and the correlation in different spatiotemporal scales to the Oceanic Niño Index (ONI). Preliminary results showed a cooling trend (-0.324 K/decade; $p>0.05$) over the Peninsula and the eastern part of the Antarctic zone in the period of years 2001-2016. We also explore the seasonal variation of these trends and the relationship to ONI. The cooling and warming evidence contributes to better understand the surface temperature of antarctic climate system.

Tue_104_AC-5_2179
ENSO and SAM Influence in Southern Brazil Precipitation Anomalies

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We used precipitation data from the University of Delaware reanalyzes, zonal and meridional wind, geopotential height (925, 500 and 200 hPa), OLR anomalies (ERA-Interim), Niño (CPC/NOAA) and SAM (Marshall) index to examine the influence of the El Niño-Southern Oscillation (ENSO), the Southern Annular Module (SAM) and atmospheric circulation in the Southern Brazil (SB) spring and summer precipitation anomalies (1970-2000 period). Previous studies indicated positive (negative) precipitation anomalies during El Niños (La Niñas), but these anomalies vary with the ENSO intensity and its interaction with the SAM, by altering the atmospheric circulation pattern between Tropics and Antarctica. In summer, positive precipitation anomalies in El Niño exceed 150 mm, with weak (strong) SAM (Niño), negative anomalies below 50 mm with neutral (moderate) SAM (Niño). To La Niña, positive anomalies above 90 mm with negative SAM and Niño. Negative anomalies below 100 mm occur with neutral (strong) SAM (Niño). In spring, in El Niño years, positive (negative) anomalies of geopotential height are observed in the SB and negative (positive) anomalies in the subtropical jet. In La Niña years, the subtropical jet is strengthened (weakening of the subpolar jet) and there is a negative (positive) geopotential anomaly in the SB region and in Bellingshausen Sea (Weddell). We identified that the positive precipitation anomalies are more frequent during La Niñas, despite the highest occurrence in El Niños.

Tue_105_AC-5_2432
The High Frequency Variability of Antarctic Sea Ice and Transient Systems

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There is a great potential for Antarctic sea ice to affect atmospheric circulation, because its extent located in a very sensitive region, to the south of the Southern Hemisphere baroclinic zone of the. Thus, the objective of this study is to evaluate the propagation of transient systems over South America (SA) associated with the high frequency of Antarctic sea ice variability. We employed the NSIDC Antarctic sea ice dataset for the Bellingshausen-Amundsen Seas (BAS) and Weddell Sea (WS) sectors and the ECMWF ERA-Interim global atmospheric reanalysis. The anomalies without linear tendency were filtered for the 2-10 day period, generating a daily high frequency anomaly dataset. The quartile analysis defined the extreme high frequency sea ice anomalies. In the austral winter (JJA), extreme sea ice retraction (expansion) events for the BAS sector were associated with the extratropical (tropical-extratropical) high frequency wave train. Consequently, there are air temperature anomalies at 2 meters over the SA extratropical (tropical-extratropical) latitudes, with the warming/cooling associated with low / high anomalous surface air pressure. On the other hand, the high frequency wave train associated with extreme sea ice retraction (expansion) events in the WS sector does not affect SA, but suggest heating/cooling event modulation over Australia.

Tue_106_BE-1_93
Influence of Glacial Melt Water on Bacterioplankton Community of Kongsfjorden

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The Kongsfjorden, an Arctic fjord is experiencing warming due to increased input of Atlantic water masses. High-throughput sequencing was performed to examine bacterial diversity from the outer and inner zone of the fjord in summer and fall. A total of 11,999 operational taxonomic units (OTUs) were assigned into 19 known phyla and 5 genera *incertae sedis*. Significant variation (p = 0.001, n = 4) was observed between the bacterial community structure of outer and inner fjord while variation between summer and fall was minimum. *Proteobacteria* was the most abundant phylum (55.9-61.0%) in summer and fall. The most dominant alphaproteobacterial member of this phylum (OTU 263 *Pelagibacteriaceae*) contributed maximum to the observed dissimilarity between the outer and inner fjord community. Characterised by relatively fresher and warmer water, glacial meltwater input could be a major source of predominance of *Flavobacteriaceae*, *Psychrobacter*, *Sphingomonadales* and *Loktanella* in the inner fjord in summer. Thus, the significant variation in the bacterioplankton community composition of outer and inner fjord indicates strong and localized influence of glacial melt water in shaping the community structure.

Tue_107_BE-1_122
The Diversity of Ice Algal Communities on the Greenland Ice Sheet

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The Greenland Ice Sheet (GrIS) is an important component of Earth's cryosphere. Due to the extensive area over which surface melting occurs, which can be up to 100% during extreme melt events, it can be regarded as the largest supraglacial ecosystem on Earth. Ice algae are the dominant primary producers on bare ice surfaces throughout the course of a melt season. Ice-algal-derived pigments cause a darkening of the ice surface, which in turn decreases albedo and increases melt rates. Their role and importance in changing melt rates has only recently been recognized, yet we know little about their community compositions and functions.
Here we present the first high-throughput sequencing analysis of ice algal communities along a 100 km transect across the 'dark zone' of the GrIS combined with subsequent oligotyping of the most abundant taxa. Our data reveal an extremely low algal diversity with Ancylonema nordenskiöldii and a Mesotaenium species being by far the dominant taxa in all sites. We show that an OTU-based approach is not sufficient for the evaluation of the low ice algal diversity on the GrIS. Oligotyping revealed hidden diversity that could not be detected by conventional clustering of OTUs. Oligotypes of the dominant taxa exhibit a site-specific distribution, which may be linked to different stages in the melt season. Our results document for the first time the unknown distribution patterns of ice algal communities that play a crucial role in the GrIS ecosystem.

Tue_110_BE-1_664
Particle-associated and Free-living Bacterial Communities in Kongsfjorden

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Particle-associated bacteria are likely to play an increasing role in coastal biogeochemistry and carbon fluxes as a result of increased particle transport to coastal Arctic waters. However, few studies have characterized particle associated (PA) and free-living (FL) bacterial communities in coastal Arctic ecosystem. In the present study V3-16S rRNA amplicon sequencing was used for analyzing difference between free-living (FL, < 1.2 to 0.2 mm) and particle-associated (PA, >1.2 mm) bacterial community, and their spatial variation between inner fjord (IF) and outer fjord (OF) of Kongsfjorden. A total of 4,454,142 high quality V3-16S rRNA sequences obtained clustered into 32,058 OTUs which are distributed among 24 known bacterial phyla. There was a clear spatial variation among FL bacterial community, while PA community remained similar at both sampling locations. In addition, FL bacterial community differs from that of PA community and had relatively higher abundance (>4 fold) of *Alteromonas* and *Pseudoalteromonas*, while PA community was relatively more enriched with *Balneatrix*, *Ulvibacter*, *Formosa*, *Candidatus Planktomarina*, *Sulfitobacter*, *Loktanella*, members of SAR116 and *Acidimicrobiales.* However, certain bacterial taxa *Polaribacter* and SAR11 co-occurred in both FL and PA fractions with varied proportions in IF and OF. Our results suggest co-occurrence of both PA and FL specialist as well as generalist bacterial groups in Kongsfjorden.

Tue_111_BE-1_695
Bacterial Diversity in Rocks over 14 Localities of Victoria Land, Antarctica

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The endolithic microbial communities represent a borderline adaptation to extreme environmental stressors and are the predominant life form in the ice-free regions of Victoria Land, Antarctica. In the last decades, many studies focused on prokaryotic component in soils, while our understanding and knowledge on distribution and structure of bacteria in endolithic communities are still limited. In this study, we investigated the diversity of bacteria in cryptoendolithic communities growing within sandstone in Victoria Land, Antarctica. Rock samples were collected from 14 different sites, ranging from 1000 to 3300 m a.s.l of altitude and over a latitude of about 3°. V4 region of 16S rDNA was sequenced through meta-barcoding approach on Illumina platform. Our results showed that Actinobacteria and Alphaproteobacteria are predominant among all samples as 'core' group component of the bacterial *taxa* characterizing these communities. The general belief that such extreme environments harbor a relatively low species diversity was confirmed by the diversity indices values. In addition, the detection of a higher number of unclassified bacterial phylotypes respect to many other environments (about 20% of relative abundance) suggests that Antarctic rocks host a pool of novel *taxa*.

Tue_112_BE-1_949
Chronosequence of Active Bacterial Community from an Alpine Ice Cave

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Investigation of glacial habitats became a priority due to the impact of climate changes on the dynamics of Polar and alpine glaciers. Our study focused on cave ice microbiome unraveled the diversity of total and active bacterial communities from the 13,000 years old ice chronosequence of Scarisoara Ice Cave, Romania.
Vertical ice coring of the perennial ice block was carried out, reaching a record depth of 25.3 m. Radiocarbon dating of the ice core indicated a linear chronosequence up to 13,000 years B.P.
16 melted ice samples from every 1,000 years interval were filtered and used for total DNA and RNA extraction and geochemical analyses. Chemical parameters revealed large variations for the last 5 centuries followed by a stable period, and significant changes in the 5000 years B.P. ice layer. Bacterial diversity based on 16S rRNA gene MiSeq Illumina sequencing of both gDNA and cDNA is currently underway. Correlation with the chemistry of the ice substrate will unravel the microbial resilience, highlighting the active community composition in this habitat for the last 13,000 years. Total and viable microbial content of each sample was quantified by qPCR and LIVE/DEAD staining, indicating a correlation with age and organic content of the ice.
This report of the oldest cave ice chronosequence could contribute to identifying biomarkers of climate and environmental changes.
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Tue_113_BE-1_1038
Paprica: A Pipeline for Estimating Microbial Metabolisms in Antarctic and Beyond

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Microbial communities are often described by the diversity of 16S and 18S rRNA gene amplicons. The cost of amplicon sequencing has dropped considerably in recent years, making analyses of hundreds or thousands of samples a reality for even single investigator projects. Although this approach continues to provide enormous insight into microbial ecology, it can be difficult to interpret the metabolic processes underlying diversity without *a priori* knowledge of the observed taxa. To more easily connect 16S and 18S rRNA gene data with likely microbial metabolisms we developed paprica, an open source pipeline for metabolic inference. Rather than cluster reads into operational taxonomic units (OTUs), paprica assigns reads to their best location on a phylogenetic reference tree constructed from all completed genomes in Genbank. This allows for an easy analysis of samples through phylogenetic structure, and by associating environmental reads to the metabolism found at that location on the tree, metabolic structure. Paprica was initially developed for the analysis of marine samples from the western Antarctic Peninsula, but we have applied it to Antarctic marine and lake samples. Here we will provide an update on the paprica methodology, and highlight both the strengths and limitations of our approach.

Tue_114_BE-1_1366
Prokaryotic Communities in Sediments along the Pasvik River (Arctic Norway)

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The Pasvik river is one of the largest river in the Northern Fennoscandia. Its water conditions are representative of Eastern European rivers. The river collects snowmelt, and it is typically a freshwater environment at its inner zone and brackish at its outer zone. Sediment samples were collected from 9 stations during two seasonal surveys (May and July 2014). Physical-chemical parameters were monitored at sampling time. Samples were analyzed for viable heterotrophic bacteria, total prokaryotic abundance, microbial enzymatic activity rates, and phylogenetic composition of bacterial community. Microbial enzymatic activities generally increased in July, but showed spatial and temporal variability. In May, leucin aminopeptidase showed the highest values at outer stations (9.37 mmol/g/h). The bacterial community resulted highly variable among the sampling stations with the predominance of the Proteobacteria, followed by the Actinobacteria and CF group of Bacteroidetes. In July, an increased abundance of the Acidobacteria was observed at St.1 (from 4.7 to 22.1%). This study highlights both seasonal (May and July) and spatial differences within the microbial community that inhabit sediments along the Pasvik river. This finding is probably strictly dependent on freeze-thaw cycles of the water body, with consequent organic inputs to sediments in July. The microbial community appears to be adapted to fluctuating conditions modulated by seasonality.

Tue_115_BE-1_1368
Are they Really Poles Apart? Aerial Connection between High Latitude Ecosystems

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Extreme cold is a defining feature of High Arctic, Antarctic and Alpine sites which are separated by large distances and climatic barriers. Microbial environments are major features across those cryoenvironments. However, little is known about the biogeography and communalities of cold-dwelling microbes along the Cryosphere.
Recently attention has been focused on the rapid changes observed in polar regions. Summer warming in the Arctic has been observed to accelerate, peaking in the snow-free season and soil evapotranspiration. This alteration would potentially strength airborne microbial transportation at a planetary scale. In this context, Antarctica would become an ideal site for examining global scale microbial dispersal given that it is isolated from neighbour lands over 20 million years and it hosts habitats that are selective for the settlement and thriving of certain communities.
Generation times of bacteria in cloud-water mirror those in Arctic freshwater ecosystems and point out to atmosphere as a tributary site that may potentially act as bridge among the whole Cryosphere. Here, we test geographical isolation as an effective barrier to microbial transport by computing long distance trajectories from both Polar Regions and across different atmospheric layers. We study the 16S rRNA gene of different freshwater communities to evaluate the global affinities of low-temperature ecotypes throughout the Cryosphere.

Tue_116_BE-1_1633
Phylogenetic Relationships and Evolution of the Antarctic Bangiales (Rhodophyta)

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Members of the Bangiales (Rhodophyta) are distributed worldwide from tropic to Antarctic and Arctic waters. Three species of the Bangiales; *Bangia* sp. (as *B*. atropurpurea), *Pyropia endiviifolia* (as *Porphyra endiviifolium*) and *Wildemania plocamiestris* (as *Porphyra plocamiestris*), have been reported in the Antarctic. Morphological and molecular data were investigated for the Bangiales from the Antarctic and its adjacent waters. Molecular data from over 150 taxa of the Bangiales worldwide including previously published sequences, indicated that the genera *Bangia*, *Dione*, *Porphyra*, *Pyropia*, *Wildemania* and other related genera be recognized in the Bangiales as in the previous molecular study. The *Bangia* sp. from the Antarctic was strongly allied to *B*. sp. from Atlantic Canada, interestingly. *Pyropia endiviifolia* is olive green in color and it allied to a clade with at least three *Pyropia* species from Falkland Islands, Navarino Island, Rio Seco and Punta Arenas, Chile. *Wildemania plocamiestris* growing on other macroalgae in sub-tidal zone grouped into the genus *Wildemania* with the species having one or two cell layers in molecular data. The diversity, taxonomic issues, phylogenetic relationships, distribution and the divergence times of the Antarctic members of the Bangiales will be discussed.

Tue_117_BE-1_1948
Biogeography of Arctic Microbial Communities across the Svalbard Shelf

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Global warming and climate change have been manifested in the decrease of Arctic sea ice extent and thickness. The thinner sea-ice regime has significant implications for Arctic primary productivity and biogeochemistry. It is therefore necessary to improve our understanding of microbial dynamics that ultimately drive productivity and the strength of the biological carbon pump in order to better predict future trends in Arctic biogeochemistry. In this study we present a comprehensive analysis of the biogeographic patterns of Arctic prokaryote and eukaryotic protist diversity and distribution along two oceanographic transects in late July 2016 crossing fjord, shelf and oceanic domains along the western (Kongsfjorden) and northern (Rijpfjorden) coast of Svalbard. A total of 11 stations were sampled at three depths (surface, chlorophyll maximum and above the seafloor) and amplification of 16S rRNA and 18S rRNA genes was performed and sequenced in Illumina MiSeq with a sequence depth of about 100 thousand read-pairs. The prokaryotic and eukaryotic protist data set comprises highly complex and diverse microbial communities with a marked biogeographic pattern. Strong links were identified between bacterioplankton and phytoplankton/picophytoplankton distribution driven by environmental and biogeochemical factors that will help to unravel the role of microbial pathways in supporting Arctic Ocean primary productivity and system integrity.

Tue_118_BE-1_1999
Highest Cyanobacteria Diversity on Granite Substrates in Sør Rondane Mountains

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In the Sør Rondane Mountains (Dronning Maud Land, East Antarctica), cyanobacteria are mainly present in sheltered spots in rocky areas, supporting the importance of micro-topographic and -climatic conditions. Biofilms, crusts and gravels on granite and gneiss substrates were sampled in 2009-2010 near the Belgian Princess Elisabeth Station and their morphological (126 samples) and molecular diversity (26 samples) was assessed. Furthermore, strains were isolated. A DNA extraction protocol was designed for the taxa with large polysaccharidic sheaths. Based on microscopy, crusts were the richest samples followed by gravels. The most diverse communities were found on the granites. Based on DGGE of 16S rRNA gene, 28 OTUs shared at least 97.5% of 16S rRNA similarity. OTUs' richness varied between 1 and 5 per sample. A comparison of morphological and DGGE analyses showed that for most samples, the number of morphotypes was higher than the number of OTUs. However, both methods were congruent in defining the richest sites. The most frequently observed OTU was affiliated to *Phormidium/Microcoleus* sp. No OTU was common to all the 10 sites. The higher diversity on granite substrates (mainly big boulders) could be explained by higher stability of the underlaying rock and its ability to keep water on the surface, thus creating favorable conditions for development of organisms. Further insights will be given by the analysis of more samples with High-Throughput amplicon sequencing.

Tue_120_BE-1_2362
Seasonal Ecology and Biogeochemistry of Snow during Summer in Svalbard

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Snow covers >90% of glacial surfaces at the start of the summer and is a biologically active and dynamic habitat for microorganisms (Hodson et al., 2008) rather than merely a repository of deposited material. With a warming cryosphere, snow packs are getting wetter and less persistent globally but we are yet to understand the distribution of microbes and nutrients within different layers of a snowpack and how this supports the concept of the snowpack as an ecosystem. We therefore hypothesized that with the thermal evolution of a snow pack, greater heterogeneity will be expected in terms of microbial cell numbers, viability, species richness and nutrients within different layers. To test our hypothesis, we sampled seven different sites over four months from spring to summer on the Svalbard ice cap, Foxfonna. Snowpack communities were studied for microbial abundance, pigment inventories and nutrient chemistry. Our results demonstrate snow ecology is driven not only by meltwater evolution but by geochemical and physical changes within the snowpack as the melt season progresses. We also present microbial community analyses showing how the structure of microbial populations within snow and ice change during the transition from spring to summer. Our results highlight the importance of integrating snowpack physical and geochemical conditions to appreciate the dynamic response of resident microbes to seasonal melting in the High Arctic.

Tue_121_BE-3_573
Compare and Contrast the Arctic and Antarctic Atmospheric CH_4-oxidizing Bacteria

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Annually thawed near-surface cryosols that occur in the Arctic and Antarctic exhibit atmospheric CH_4 (atmCH_4) consumption. AtmCH_4 is believed to be utilized by aerobic CH_4-oxidizing bacteria (MOB) that have high affinity for atmCH_4 (atmMOB). By deep sequencing of soil metagenomes and binning, we constructed 90%-complete genomes of Upland Soil Cluster (USC) alpha from Axel Heiberg Island, Nunavut, Canadian high Arctic, and USCgamma from Taylor Dry Valley, Victoria Land, Antarctica. This study aims to compare and contrast the genomes and metabolic potential of these two genotypes that occur in the acidic Arctic and alkaline Antarctic cryosols. USCalpha and USCgamma both possess the high-affinity form of methane monooxygenase, and enzymes for complete CH_4 oxidation. The atmMOB genomes do not code for soluble methane monooxygenase. No genes for nitrogen fixation were detected but nitrate reductase. The ribulose monophosphate (RUMP) pathway for assimilation of formaldehyde typically found in gamma-proteobacterial methanotrophs is not detected in the USCgamma genome. Notably, both atmMOB genomes indicate the potential to use acetate, and store and consume glycogen, suggesting that they may be facultative methanotrophs. This genetic information provides insight into their adaption to the changing climate and their respective roles in the carbon cycle of the polar terrestrial ecosystems.

Tue_122_BE-3_616
Distribution of Picoeukaryotes in Summer and Autumn of the Southern Chukchi Sea

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Picoeukaryotes dominate the photosynthetic biomass and will thrive with increasing temperature in the polar marine ecosystems. The study of picoeukaryotes in the Chukchi Sea are rare. This work relates the community distribution and composition of the picoeukaryotes to different water masses and physicochemical parameters in the southern Chukchi Sea in both the middle summer (July) and early autumn (September) of 2012. Chrysophyceae, Mamiellophyceae and Dinophyceae were the main microbial classes in July, with relative abundance > 0.5%. Mamiellophyceae, Chrysophyceae, Trebouxiophyceae, Mediophyceae and Dinophyceae were the main microbial classes in September. *Nannochloris* and *Bathycoccus* were indicators to the Alaskan Coastal Water. *Cryptococcus*, *Prasinoderma* and *Bolidomonas* were indicators to the Bering Sea Water. The prevalence of *Poterioochromonas malhamensis*, a nano-Chrysophyceae and a bloom disordered the distribution of the picoeukaryotes in July. The abundance, biodiversity and structure of the picoeukaryotes community low related to the physicochemical parameters. *Micromonas* predominated in September, when all the community parameters of the picoeukaryotes high correlated to the physicochemical parameters. An upwelling were detected (67.7ºN, 168.9 ºW) and greatly influenced the distribution of picoeukaryotes and supplied nutrients to the regrowth or the *P*. *malhamensis* and diatoms.

Tue_123_BE-3_620
Bacterial Community Structure across East Antarctica Glacial Foreland

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Glacial forefields are extremely sensitive to temperature changes and considered ideal places to explore how microbial communities will response to climate-driven environmental changes. Our knowledge of how the bacterial community activities and structure was influenced by changing environment due to glacier retreat is still very limited. Here A series of soil samples with ice and without ice coverage along the glacial retreat path were sampled in the forehead of Larsemann Hill of East Antarctica ice sheet. By employing the Miseq sequencing methods, and combining geochemical data analysis, the bacterial diversity including the abundant and rare group were studied and compared among samples. Our results show that abundant bacterial communities were more sensitive to changing conditions in the early stages of deglaciat ion than rare community members. Moreover, among the environmental parameters tested, which included total organic carbon, pH, and moisture of the soils, ice thickness was the most influential factor affecting the community structure of abundant bacteria. These results show the different effects of abundant and rare bacteria on community shifts and highlight ice thickness as the primary factor affecting the bacterial community in the early stages of deglaciation. The response of microbial community to climate change can be predicted with more certainty in this polar region.

Tue_124_BE-3_956
Cold Adaptation Strategy of the Antarctic Cyanobacterium *P. priestleyi* ULC007

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In Antarctica, Cyanobacteria are key primary producers and play a major role in the colonization of deglaciated habitats. Cyanobacterial mats are widespread in aquatic biotopes and often dominate the total phototrophic biomass. In order to gain further insights on the mechanisms underlying the ecological success of Antarctic cyanobacteria, we studied the gene repertoire of *Phormidesmis priestleyi* ULC007, a filamentous cyanobacterium isolated from shallow freshwater lake microbial mats in the Larsemann Hills. Here, we investigate the occurrence of genes involved in the cold stress response as a proxy to the adaptation to environmental conditions in Antarctica. We compare a selection of 42 PEGs (protein encoding genes) linked to cold adaptation in 72 cyanobacterial genomes. Polar strains have the highest number of copies of genes coding for fructose aldolase, chaperone Hsp, and universal stress protein and a high number of fatty acid desaturase and genes involved in exopolysaccharide (EPS) biosynthesis. To provide a better overview of the genetic mechanisms of adaptation to cold, we investigated the gene functional categories based on the RAST subsystems technology. Polar strains have the most occurrences for subsystems "Choline and Betain Biosynthesis", "DNA repair", "EPS biosynthesis" and "Heat shock DnaK gene cluster". Our results underline the importance of these functions in the adaptation mechanisms of cyanobacteria to the polar environment.

Tue_125_BE-3_1019
Dispersant Impacts on Arctic Microbial Community Dynamics and Oil Biodegradation

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As a response strategy to oil spills in the marine environment, chemical dispersants are frequently applied to reduce oil slicks and oil delivery to shorelines. However, the impact of chemical dispersants on native microbial communities and, more specifically, oil degrading bacteria remains unclear. Particularly pristine, more extreme environments like the Arctic Ocean are largely unexplored in this regard, even though pollution risks are increasing with rising interests in Arctic oil exploration and transportation routes. Here, we assessed the impact of the chemical dispersant Corexit 9500A on Arctic microbial seawater communities and their oil biodegradation potential. For this, oil spill conditions were simulated in laboratory microcosms at 1.5 °C and 15 °C with Arctic seawater from 150 m depth, amended with oil only (± nutrients), oil-dispersant mixtures, or only dispersant. Dissolved organic carbon (DOC) concentrations, bacterial productivity data, and cell counts suggested active oil and dispersant degraders. Marine oil snow formation and DOC degradation was enhanced in oil microcosms compared to oil-dispersant setups. Additionally, ^{14}C-naphthalene oxidation rates suggested that the native microbial community might not be equipped for rapid biodegradation of aromatic hydrocarbons. Analyses of microbial community composition and hydrocarbon quantifications will help to further elucidate the impacts of oil and dispersants in Arctic pelagic ecosystems.

Tue_126_BE-3_1092
Nitrifiers Still Alive in Antarctic Soils under Moss Vegetation

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Nitrogen (N) as a macronutrient is cycled also in Antarctic terrestrial ecosystems, in which microbes are a main driver. In the N cycle, nitrification is the only source of nitrate other than atmospheric deposition of perhaps very small contribution in Antarctica. Nitrification is a two-step process, ammonia oxidation and subsequent nitrite oxidation. We measured ammonia oxidation potentials (AOP) of soils collected at two sites (69°14.5'S, 39°44.7'E, 52 m ASL and 69°14.4'S, 39°45.1'E, 114 m ASL) in Yukidori-zawa, Langhovde, East Dronning Maud Land, and at one site (66°46.3'S, 50°35.3'E, 121 m ASL) near Mt. Riiser-Larsen, West Enderby Land, East Antarctica. Soils were collected for each layer, i.e., moss layer, mineral surface soil with accumulated organic matter (A layer), and subsoil (B layer(s)). Fresh soils were used to determine their AOP values at around 10 °C by means of aerobic static incubation adding a substrate solution. Responses of AOP to a combination of incubation temperatures (10 and 20 °C) and substrate concentrations (8 steps from 0.1 to 4 mM ammonium) were also measured for the soil with the highest AOP (A layer of the site 2 in Yukidori-zawa). In all the sites, the A layers had relatively high AOP values. A unique response to the substrate concentrations was also found, it will be shown at the conference in combination with the relationships of AOP to key soil properties and characteristics of nitrifiers, i.e., ammonia oxidizing bacteria and archaea.

Tue_127_BE-3_1101
Horizontal Gene Transfer of dmdA Gene among Distantly Related Marine Bacteria

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Dimethylsulfoniopropionate (DMSP) is mainly produced by marine phytoplankton serving as an osmolyte, antioxidant, predator deterrent, and cryoprotectant. It is also a carbon and sulfur source for marine bacteria. Bacteria may metabolize DMSP via the demethylation pathway involving DMSP demethylase (dmdA) gene and the cleavage pathway involving several different DMSP lyase genes. Most of DMSP released into seawater is degraded by bacteria via demethylation. A total of thirty bacterial strains were isolated from Arctic Kongsfjorden seawater using low-nutrient medium containing 1mM DMSP. Analysis of 16S rRNA gene sequences showed that, except for strains BSw22131 and BSw22132 respectively belonging to the genera Pseudomonas and Glaciecola, all bacteria fell into the genus Pseudoalteromonas. dmdA genes were detected in three Arctic strains Pseudoalteromonas sp. BSw22112, Pseudomonas sp. BSw22131 and Glaciecola sp. BSw22132 within the Gammaproteobacteria, as well as one Antarctic marine alphaproteobacterial Roseicitreum antarcticum ZS2-28. Their dmdA genes showed significant similarities (97.7-98.3%) to that of Ruegeria pomeroyi DSS-3, a well-known roseobacterium possessing both pathways for metabolism of DMSP. Among the four tested strains, only Pseudomonas sp. BSw22131 was able to grow in M9 medium supplemented with DMSP as sole carbon source. Results in this study support a hypothesis of lateral gene transfer for dmdA among taxonomically heterogenous bacterioplankton.

Tue_128_BE-3_1138
Mycobryosphere: Fungi Associated with Bipolar Mosses Present in Antarctica

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Mosses are a major component of the vegetation in ice-free regions of Antarctica. The aim of the study was to examine the diversity of epiphytic and endophytic fungi, as well as those present in the ***rhizoids*** of *Polytrichastrum alpinum* and *Polytrichum juniperinum* collected in Antarctica. Five gametophytes were collected at King George Island, which were subjected to surface sterilization and inoculated onto Sabouraud agar (SBA) for isolation of fungi. After the different isolation process, 217 fungi isolates were recovered and 19 taxa were identified by molecular biology methods. *Thelebolus* sp., *Pseudogymnoascus* sp., and *Tumularia* sp. were the most abundant taxa recovered. *Pseudogymnoascus* sp., *Glarea* sp., *Chalara pseudoaffinis*, *Gyoerffyella entomobryoides*, *Helotiales* sp., *Leotiomycetidae* sp., *Microdochium phragmitis, Phaeosphaeria* sp., and *Pochonia* sp. were isolated only from *P. alpinum*. *Cladosporium* sp., *Exophiala* sp., *Fusicladium* sp., *Leptosphaeria* sp. and *Oleoguttula* sp. were isolated only from *P. juniperinum*. Our results suggest that bipolar mosses shelter rich and diverse fungal communities, including taxa phylogenetically near to symbionts, decomposer, and phytopathogenic fungi.

Tue_129_BE-3_1107
Surface Water Masses Constrain Microbial Communities across the Southern Ocean

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The Southern Ocean (SO) is a major site for sequestration of anthropogenic carbon dioxide (CO_2). The epipelagic regions are where key processes of photosynthetic CO_2 fixation are performed by both pro- and micro-eukaryotes. The effects of climate change on physical oceanography of the SO may have a globally significant impact on the efficiency of the biogeochemical cycling, but the extent of this is unclear, because the basic biogeography of these organisms are still quite limited to select locations of the SO. We sampled epipelagic seawater at multiple transects along the Indian, Australian and Pacific regions of the SO (71°E-170°W) and mapped both pro- and eukaryotic community composition using high resolution 16S and 18S rRNA tag sequencing. This is aligned with corresponding physical/biogeochemical observations to investigate potential triggers of observed community shifts. Across all transects, samples are dominated by the *Pelagibacteraceae* (SAR11) family with shifts in different *Pelagibacteraceae* oligotypes observed from low to high latitude samples. Spatial/longitudinal distance were not observed to drive community differences between samples at similar latitudes or surface water zones. Statistical analysis show temperature to be the major driving force for community selection. These findings contribute to filling critical knowledge gaps on how changes in SO physical oceanography under forcasted global change scenarios might alter CO_2 uptake and the biological pump.

Tue_130_BE-3_1130
Polar Ecology - A Guide for Planetary Research

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We highlight the findings of several years of research in Astrobiology and Planetary Sciences using concepts and methods of polar eco-physiological research, combining field research with planetary simulations in the lab and in space. The studies were carried out to gain insights into the interactions between extremophilic microorganisms (archaea, bacteria and eukarya) and changing environment which are achieving conditions as they were observed on another terrestrial planet such as Mars. Furthermore, the experiments which will be presented were performed to check the responses of the organisms to new simulated planetary and space conditions. They are the basis for classifying a planet from an experimentally point of view as to be habitable or not to be able to support any kind of life forms. The second eco-physiologically relevant investigation enterprise in the presented work focuses on key-molecules which play a specific active or protective role in physiological processes such as e.g. chlorophyll, carotene and methane besides others. These molecules are characterized by Raman spectroscopy and wavelength modulation spectroscopy and checked if they can be detected as specific bio-traces or biosignatures in a polar and Mars-like environment, what might support future exploration missions to other planets with the final goal to search for life.

Tue_131_BE-3_1141
Diversity and Antifreeze Activity of Fungi in Snow of Antarctic Peninsula

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The present study focused the characterization of the fungal community present in the seasonal snow of Antarctic Peninsula. Approximately 10 kg of snow from the uppermost 1.5 m layer was collected in the Deception, King George, Snow and Robert islands as well as in two sites of Peninsular region (Hope Bay and Arctowiski Peninsula) and melted at 20 °C over a period of about 12 h. This process resulted in 10 L of water and a total of 1.5 L of melted snow was filtered through of 0.45 µm membrane with 47 mm diameter in duplicate. The membranes were placed on the media Sabouraud agar, minimum medium and incubated at 10 °C for 60 d. Two hundred thirty-four fungi isolates were obtained and identified by molecular biology methods in taxa belonging to 24 genera of the *Ascomycota*, *Zygomycota* and *Basidiomycota* phyla. The genus *Penicillium*, *Phenoliferia* and *Leucosporodium* were the most abundant. A new, blue and endemic species, *Antarctomyces pellizariae*, was described. Fungal diversity of snow was high represented by cosmopolitan cold-adapted and endemic species. In addition, all fungi were submitted to deep freeze conditions and 82 isolates were able to survive at -74 °C after 30 days. The detection of the antifreeze capabilities of these fungi suggests that they have adaptive strategies to survive in the snow and can represent sources of compounds to biotechnological applications.

Tue_132_BE-3_1145
Mycosphere of Antarctic Plants *Deschampsia antarctica* and *Colobanthus quitensis*

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The aims of our study were to characterize the endophytic and epiphytic fungi, as well as those present in the rhizome of the two Antarctic angiosperms *Colobanthus quitensis* and *Deschampsia antarctica.* Plants were collected in the King George, Penguin, Elephant, Halfmoon Islands, as well as the Continental Peninsula. After the different isolation processes, 309 fungal isolates were recovery from *D. antarctica* and 89 from *C. quitensis* as endophytic and epiphytic of their leaves and roots. All fungi obtained were identified by molecular biology methods in 23 taxa from the 12 different orders. *Penicillium* was the most abundant genera associated with *D. antarctica* and *Vishniacozyma* with *C. quitensis*. *Antarctomyces*, *Pseudogymnoascus*, *Vishniacozyma*, *Microdochium*, and *Penicillium* occurred in both plants. Our results indicate that the Antarctic angiosperms shelter rich fungal communities in/on their tissues and represent a hotspot microhabitat of fungal diversity in different regions of Antarctic Peninsula.

Tue_133_BE-3_1197
Winter Survival of Freshwater Diatoms in the High Arctic

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Natural conditions in Polar Regions are characterized by many extremes and could seem unfavourable for life. Despite this fact, diatoms (Bacillariophyceae) apparently adapted well and belong to very important primary producers in a wide range of habitats in both Arctic and Antarctic environments. However, it remains unknown, which strategy enables them to survive long polar winters. For microorganisms, dormancy is a strategy to overcome unfriendly conditions, but morphologically distinct resting stages are rarely observed in diatoms. The aim of this project is the study of annual cycle of polar freshwater diatoms to reveal their overwintering strategy. We hypothesize that only a small amount of cells survive winter season and that diatoms do not form any morphologically different stages for survival. Morphology and viability of diatom cells is studied in natural samples collected during one year. For the multiple sampling four study sites (streams, shallow wetland, and seepage with high abundance of diatoms) were established during summer season 2017 in the Arctic (Central Spitsbergen, close to Longyearbyen). The viability of cells is evaluated five times following key events for survival (summer vegetative season, autumn freezing, winter, spring melting, summer season) using a multiparameter fluorescent staining (SYTOX Green, CTC and DAPI combination) combined with light microscopy.

Tue_134_BE-3_1284
Phenotypic Traits of Prokaryotic Cells Variability in the Southern Ocean

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The Terra Nova Bay (Ross Sea, Antarctica) is a microbiological laboratory owing to its high environmental variability that affects plankton dynamics. Previous studies on plankton communities mainly focused on phytoplankton biomass and production processes. Studies of the succession the heterotrophic populations have relatively been neglected also if a sudden variability of the micro- nano- and picoplankton size fractions biomass with the ice melting has been highlighed. In this context the prokaryotic cell morphometry and morphology assume a key role to quantify the carbon budget.
In the frame of CEFA "Coastal Ecosystem Functioning in a changing Antarctic ocean" project (31st PNRA expedition), in a fixed station of Terra Nova Bay (Michaud Pier - MP, repeatedly sampled) and along the roundtrips from New Zealand to the bay (NZ-TNB) seawater samples were collected.
The prokaryotic cell abundances, phenotypic variability (cell morphometry and morphology) and biomass were determined by image analysis. Moreover, the nutrient concentrations (NO_3+NO_2, NH_4 and PO_4) were detected. The aim of the study is to assess the relationships among the phenotypic variability and the nutrient pools. ANOVA showed a significant variability of cell morphometry among MP and NZ-TNB ($P< 0,05$). Different significative correlations between the prokaryotic abundance, cell volumes, biomass and cell morphotypes vs. nutrient concentrations were computed in MP and NZ-TNB.

Tue_136_BE-3_1442
Bacteria in the Atlantic Southern Ocean

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Bacteria play a key role in the Southern Ocean ecosystem functioning, including in the carbon, nitrate and iron cycles. We present a study aimed at identifying and cultivate bacteria from the subtropical, subantarctic and antarctic zones of the Atlantic Southern Ocean. We further interrogated the roles the observed bacteria play in the marine polar ecosystem. Metagenomic samples were collected from surface waters across the three zones in summer 2015, and summer and winter 2017. Microbial plates for cultivation and experiments were added in 2017. Results are discussed with regards to the functional characteristics of the observed and/or cultivated bacteria. For example, five genera were identified and cultivated in austral summer 2017: Halomonas, Pseudoalteromonas and Salinibacterium from the sub-tropics, Citricoccus and Pseudoalteromonas from the subantarctic, and Pseudoalteromonas, Salinibacterium and Vibrio from the Antarctic zone. Their functional roles in the ecosystem differ; for example, Citricoccus is a potential producer of siderophores, essential in the iron availability for phytoplankton, whereas Halomonas might play a role in the nitrogen cycle, but might also be involved in the degradation of hydrocarbons. In addition to the in-situ, transect biodiversity data we will present the impact of iron enrichment on shifts in the prokaryotic communities in the three zones.

Tue_137_BE-3_1551
LPS Structure from the Cold-adapted *Shewanella* sp. HM13 Grown at 4°C and 18°C

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Lipopolysaccharides (LPS) are the main component of the outer membrane of Gram-negative bacteria. Due to their external location, it is reasonable to think that LPS are involved into the life adaptation at low temperature. The LPS is composed of three different domains: an O-specific polysaccharide and a core oligosaccharide, which in turn is covalently linked to the third domain, the lipid A.[1] It has been reported that unsaturated fatty acids belonging to both phospholipids and lipid A moiety are responsible of the membrane fluidity enhancement when bacteria thrive at low temperature.[2] Up to now, only few LPS structures from cold-adapted bacteria have been characterized, and an interesting common feature is the production of rough-LPS.[3-5] The characterization of other LPS structures from cold-adapted bacteria can shed light about the interaction between the cell and the environment.
In this communication, the molecular characterization of LPSs from the fish intestinal bacterium *Shewanella* sp. HM13 is reported. In particular, the LPS structures obtained from *Shewanella* sp. HM13 grown at 4°C and 18°C are analyzed and compared.

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Tue_138_BE-3_1694
Microbial Respiration in the Ross Sea, Antarctica (ROSSMIZE and P-ROSE Projects)

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The Ross Sea continental shelf is a unique region of the Antarctic, both with regard to its physics and its ecology and it is considered a “natural laboratory” for investigating the potential effects of climate change. It is noteworthy that sea ice distributions has significantly changed with years in the Ross Sea, inducing unpredicted cascade effects on trophic dynamics and carbon and nutrient drawdown.
With the aims to identify signs and patterns of microbial responses to current climate change, the variability of the microbial respiration rates in the Ross Sea was assessed by comparing the data of two cruises carried out in late-spring and early summer (ROSSMIZE 1994-95 and P-ROSE 2016-17) twenty-two years later.
In particular, estimates of microbial community respiration and carbon dioxide production rates by ETS assay were performed.
A high variability of respiratory rates was detected on both time and space scales in the Ross Sea. The distribution of plankton respiration and organic matter degradation was put in relation with the different ice cover of the investigated areas. Comparing the two expeditions could help to better understand the carbon flux transfer efficiency and carbon export variability on a large time scale.

Tue_139_BE-3_1708
Total and Free Enzymes in the Ross Sea during the Austral Summer 2017

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The Ross Sea, one of the most productive seas of the South Ocean, includes polynyas, marginal ice zones, coastal areas and open sea that contribute differently to biological processes. To identifying responses of plankton compartment to climate change, an oceanographic PNRA campaign (P-ROSE Project) was here carried out in January-February 2017. Two polynyas occurred, a small near the Terra Nova Bay (TNB) and a larger one between the Ross Ice Shelf and Cape Adare. The variability of extracellular enzymatic activity (a proxy of organic matter degradation) in relation to environmental conditions (temperature, salinity and total phytoplankton biomass) was studied along longitudinal and latitudinal transects. Hydrolysis rates of aminopeptidase (LAP), beta-glucosidase (GLU) and alkaline phosphatase (AP) and -for the first time in this area- the corrispective free enzymes (dissolved in waters) were determined. Results showed decreasing trends in the TNB from coastal to off-shore stations and from surface to depth for LAP, that were related positively to temperature (T) and negatively to salinity (S) and depth ($p< 0.01\%$). High values in the N-S transect of offshore stations were observed, probably due to fresh organic matter. LAP were positively correlated with T and negatively with S and depth ($p< 0.01\%$). GLU was positively correlated with AP and LAP ($p< 0.05\%$). Free enzymes ranging from 17 to 99% on total showed variability among stations and high percentages for free-GLU at DCM.

Tue_140_BE-3_2003
Genomic Comparative Analysis of Bacteria Associated to Antarctic Sponges

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Sponge microbiome is composed of a wide range of microbial communities which display a key role in different aspects of the sponge biology and in biogeochemical cycling of key elements for ecosystem functioning. Here, we studied the metabolic potential of seven bacterial strains isolated from two Antarctic sponges, with emphasis on nutrient cycling and symbiotic lifestyle, using whole-genome Illumina sequencing and genomic comparative analysis using the RAST server. Bacteria isolated were assigned to the genera Pseudoalteromonas (E16.1, E19.1, 19.4), Nesterenkonia (E16.7, E16.10), Sporosarcina (E16.8), and Cellullophaga (E16.2). Genomic completeness was estimated as higher as 98% for all genomes. Bacterial strains isolated display metabolic potential to perform: nitrite reduction (Nitrite reductase, *nir*; Pseudoalteromonas and Nesterenkonia genera) and phosphorous cycle (i.e. Polyphosphate kinase, *ppk* gene; all genera). Interestingly, *Cellulophaga* has genomic elements associated with CRISPR systems. Genomic comparative of sponge-associated *Nesterenkonia* and *Cellulophaga* against free-lifestyle strains showed that associated bacterias have higher genome size and uniques functions related to virulence, phages. Overall, genomic features in bacterial isolated from Antarctic sponges shown a metabolic potential related to nutrient cycling and display signatures related to symbiotic lifestyle, extending previous results from tropic and temperate environments to polar systems.

Tue_142_BE-3_2165
Limits to the Three Domains of Life: Lessons from an Antarctic Salinity Gradient

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Extremophiles are found in all three domains of life, however, extremophiles from different domains utilize varying mechanisms for dealing with harsh environmental conditions. We used next-generation sequencing to investigate differences in inter-domain responses to extreme conditions along a high elevation salinity gradient in the McMurdo Dry Valleys, Antarctica. The soil salinity for the 25 samples collected along the gradient ranged from 50 to 8355 µS cm^{-1}. Richness varied widely between domains along the transect with a total of 354 bacterial, 2 archaeal, 56 fungal, and 69 non-fungal eukaryotic OTUs. Richness for all domains declined significantly ($P \leq 0.01$) with increasing conductivity, however, the strength of the relationship varied (R^2 of 0.83 for bacterial to 0.25 for fungal OTUs). Ordination (PCoA) revealed significant (ANOSIM $R = 0.97$) groupings of low/high conductivity bacterial OTUs, while OTUs from other domains were not significantly clustered. Beta-diversity analyses found significant patterns for bacteria only, including evidence of a nested structure indicating species loss as opposed to replacement. A PICRUSt analysis, which predicts metagenome functional content, indicated the high conductivity bacterial OTU cluster had an over representation of genes responsible for coping with osmotic stress. These results suggest that while increased salinity acts as a stressor for organisms across all three domains, within-domain responses also vary considerably.

Tue_143_BE-3_2271
ACBC - Antarctic Circumnavigation Bacterial Collection: Highway to Knowledge

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A freely accessible culture collection of polar bacteria will be available shortly (2019). We collected natural bacterial communities during the Antarctic Circumnavigation Expedition (ACE) from Dec. 2016 to Mar. 2017 for isolation and identification purposes. The expedition has travelled for 33,565 km all around Antarctica, allowing us to bring back unprecedented live samples from the Southern Ocean. Water samples were collected at 15 different sites at the surface, 15, 100 and 1000m depth. Two additional samples were collected: one in the Ross Sea at 3800m to get the signature of the Antarctic Bottom Water, and another one at 700m at on seabed underneath the Mertz glacier. Bacteria colonies were first grown in nutrient rich (Marine Agar) and poor (R2A) media at 4°C directly on board the R/V Akademik Treshnikov. Each colonies were subsequently isolated a first time at sea, followed by additional isolation steps in our home lab (Geneva, Switzerland) until we get pure cultures. A total of 314 isolates were recovered, documented and archived at -80°C. Using 16S rRNA Sanger sequencing, we have so far characterized the bacterial diversity of 186 of these isolates. One of the project's overarching goals was to identify the key microbial players across the Southern Ocean and to stimulate research on bacteria inhabiting this extremely harsh region of our world. The outcome of this project resonates with a better understanding of the functioning and diversity of the Southern Ocean.

Tue_144_BE-3_2272
Metabolic Response of Sea-ice Diatoms to Shifting Temperature and Salinity

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In polar oceans, sea-ice algae are important primary producers during the spring and winter months. However, we have a limited understanding of how they are physiologically adapted to the large variations in temperature and salinity associated with seasonal cycling of sea ice. Here, we use a mass spectrometry-based targeted metabolomics approach to evaluate the response of sea-ice algae to changing temperature and salinity. Axenic cultures of the Antarctic sea-ice diatom, *Nitzschia lecointei* were grown at salinities of 32 and 41 and at -1 and +4˚C. Under the culture conditions tested, growth, cell size and photosynthetic efficiency were unaffected despite large differences in intracellular metabolites among treatments. Temperature had a greater affect than salinity on metabolite composition, influencing cryo- and osmoprotectants, antioxidants as well as other metabolites. Compatibles solutes, including N-rich glycine betaine and proline, along with S-rich dimethylsulfoniopropionate (DMSP) were among the most abundant metabolites detected. Surprisingly, these compounds displayed different responses to temperature and salinity. We will compare laboratory results to environmental samples of first-year sea ice with a dominant *Nitzschia* community that we collected from Utqiaġvik, AK. Changes in metabolite composition in response to environmental change could have implications for biogeochemical cycling and ecosystem dynamics in sea ice over the season.

Tue_145_BE-3_2289
Growth Performance of Psychrotolerant Cyanobacteria from Svalbard Archipelago

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A filamentous benthic cyanobacteria, strain USMAC16, was isolated from High Arctic Svalbard archipelago, Norway, and was identified to species level using polyphasic approach that combine morphological and molecular characterization (16S rRNA gene sequence). Cell dimensions, and apical cell shape are consistent with the *Pseudanabaena* genus description. The molecular characterization of USMAC16 gave 100% similarity with *Pseudanabaena catenata* SAG 1464-1, originally reported from Germany. Strain USMAC16 was cultured under a range of temperature (4±2˚C, 15±2˚C and 25±2˚C), and photoperiod (24 hours light, 16 hours light, 12 hours light and 24 hours dark) conditions in liquid media, and harvested at exponential phase to examine growth and biochemical composition. The highest growth rate (0.538day^{-1}) and chlorophyll *a* (306.7 mg/L) concentration was recorded at 15±2˚C under 24L:0D and 16L:08D light durations, respectively. Highest carbohydrate (216.6 µg/L) and protein (2.67 µg/L) was observed at 25˚C in the absence of light. This analysis provides baseline data documenting the variations in biochemical compositions of *P*. *catenata* in response to changing temperature regimes and this indicates that the strain was psychrotolerant as it is an organism from a cold environment that can adapt to culture temperatures of > 15˚C.

Tue_146_BE-3_2310
The Resistance of Antarctic *Stichococcus bacillaris* to Cycloheximide

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The microalga *Stichococcus bacillaris* isolated from Signy Island soil was found to be resistant to cycloheximide (CHX), a eukaryotic protein synthesis inhibitor produced by *Streptomyces griseus*. The strain was first obtained from a mixed assemblage of several green algae species. When introduced to media containing 100µg/ml CHX, only *S. bacillaris* survived and continued to grow after three weeks of incubation. An initial lag of growth in the first two weeks of incubation indicates that *S. bacillaris* attained the tolerance by adaptation. Morphological comparison between cell cultures grown with and without CHX indicated no measurable change in their phenotypic characteristics. Species identification was confirmed by sequencing 18S rDNA. Subsequently, a series of experiments conducted using different CHX concentrations confirmed the ability of *S. bacillaris* to tolerate up to 400µg/ml CHX concentration. Ongoing research is addressing the mechanism by which *S.bacillaris* achieves resistance, and whether this phenomenon is widespread in the species or specific to this Antarctic strain.

Tue_147_BE-3_2461
The Secret Life of Bacteria: Ecological Function in Cryoconite Hole Environments

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Polar regions serve as a natural laboratory to study simplified microbial and biogeochemical processes in habitable niches. An example of such niches are cryoconite holes, regarded as hotspots of microbial processes on glacier surfaces. Data on how microorganisms, especially anaerobic ones, function in cryoconite holes are, however, scarce.
We applied a range of microbiological tests to understand the physiological capabilities of the most abundant cultivable microorganisms from cryoconite holes worldwide (Greenland, Svalbard, Antarctica). Oxic and anoxic conditions were applied to mimic microniches within the habitat. The growth of bacteria was assessed under a range of treatments: freeze-thaw cycles, temperature gradients, and varying organic carbon substrates.
Our study demonstrates that heterotrophs of cryoconite holes are adapted to fast - changing environmental conditions by ability to survive multiple freeze-thaw cycles and changing oxygen conditions, and scavenging a wide range of organic substrates. The elevated growth of anaerobic part of the community in the lowest temperatures indicates they might be key players in winter conditions or in early melt season, when the oxygen is potentially depleted and accumulated dead cells provide a source of organic matter for scavenging. Consequently, anaerobic heterotrophs are likely crucial for the reactivation of the community after the polar night.

Tue_148_BE-3_2513
The Nutrient Limitation of Soil Microbial Community in High Arctic Forefield

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Although the soil succession has been studied intensively in the forefields of retreating glaciers, little is known about the physicochemical constraints of microbial functioning which determines the rate of initial soil development. Knowing these constraints may improve our understanding of factors limiting microbial growth during the soil succession. Commonly meaured soil characteristics such as moisture and pH have been shown to change along the soil age and to shape microbial community structure and activity during the succession. However, the extent of microbial nutrient limitation, which is more difficult to estimate, remains unclear. It has been suggested that nutrient limitation has even stronger effect on the rate of microbial succession than climate, especially at very harsh conditions.
We assume that nutrient limitation of soil microbial community is especially pronounced on the bare forefields of the High Arctic regions, where the plant cover establish much longer. In order to estimate nutrient limitation of the microbial activity on the bare forefields in Svalbard, we set up an incubation experiment where we added organic carbon (C), inorganic nitrogen (N) and phosphorus (P) separately or in different combinations and measured the changes in microbial respiration rate and microbial biomass. The effect of nutrient addition on the microbial activity and growth is discussed in respect to microbial community structure and available nutrients at *in-situ* conditions.

Tue_149_BE-3_2647
Psychrophilic Adaptation of Cyanobacteria in Polar Regions

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Life on Earth appeared with UV resistant anaerobic organisms. Then, cyanobacterial prokaryotes have flourished oxygenic life on earth. In spite of global change biology, they are still the most successful organisms. Adaptive evolution create contemporary cyanobacteria, very tolerant to extreme circumstances. Foremost, UV radiation as the most lethal factor increase mutation rate. Also, prime necessities of life such as liquid water supply would play a key role on habitability on survivability of resistant life forms. A molecular dynamics approach can be used in order to obtain insights water/ice interface over continued cycles of freezing and thawing. Adventures in protein world revealed many positive biosignatures of antifreeze, ice-binding and ice structure proteins at Polar Regions. Although, working mechanisms has a long way to go, this study review these themes and psychrophilic adaptation process. It will make possible to understand the thermal hysteresis structures and function to potential biologic niches in more detail.

Tue_150_BE-3_2653
Global Metagenomic Analysis of Cold Desert Bacteria

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Bacterial taxa when stimulated by water additions will break dormancy, grow, and become dominant members of the community, contributing significant pulses of CO_2. Pulses are associated with high levels of bacterial productivity in soils. (Aanderud et al. 2011) I have examined the bacteria taxa that resuscitate and become metabolically active following two forms of water stress (soil drying-rewetting and freeze-thaw cycles) and I have captured and measured the CO_2 emanating from those soils. Specifically, I used target metagenomics, which uses a specific gene pool within bacteria that is associated with a function of an ecological process, in this case active (16S mRNA communities) bacteria and all bacteria (16S rRNA communities) during drying-rewetting and freeze-thaw cycles. I have measured an array of community dynamics as dry soils were rewetted and as frozen soils thaw multiple times in three cold desert soils. I am searching for continuity or predictability in the bacteria rapidly responding in ecosystems to understand if there are coherent or universal patterns of the bacteria within these stresses in cold desert ecosystems. I have examined three cold deserts which include the Great Basin Desert, UT, The Junggar Desert, China, and the McMurdo Dry Valleys, Antarctica. Overall I am looking to; Identify whether bacterial response to water stress is universal or only localized and if bacterial adaptations are the same within similar but geographically isolated systems.

Tue_151_BE-3_1888
Detection of Lipase Gene from *Sphingobacterium sp*. Isolated from Polar Region

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In past few decades, microbial enzymes have been favorable demands among industrial fields due to their high specificity and stability of being active under mild conditions. Known as a versatile enzyme beneficial to many biotechnological approaches, lipases have received massive interest worldwide. A psychrophilic microorganism isolated from polar soil sample tested positive as a lipase producer was studied. DNA extraction was conducted by modified CTAB method and 16S rRNA sequencing result revealed its identity to be in close resemblance with *Sphingobacterium* sp. (97% identity). The bacterium was found to be psychrotolerant with the growth temperature ranging from 4^{o}C to 25^{o}C ±2^{o}C. Halo zone formation in qualitative (primary) screening using sensitive and specific plate assay detected the presence of lipase produced by the bacterium. To date, not many studies on lipases from *Sphingobacterium sp* was done, and lipase structure from this bacterium has not been solved yet for better understand of its enzymatic activity. In the study on detection of lipase gene by PCR method using specific designed primers, two different lipase sequences from *Sphingobacterium sp*. which are SGNH subfamily hydrolase (lisophospholipase) (553bp) and alpha/beta hydrolase (esterase/lipase) (845bp) were detected. The lipase genes will be cloned, expressed and purified for further structure-function study of the enzyme.

Tue_152_BE-4_46
Isotopic-related Warming Effects on the Northern Antarctic Peninsula Ecosystem

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An isotopic approach was used to investigate whether the temporal and spatial patterns of energy transfer along the food web is similar in areas under different effects of warming around the Northern Antarctic Peninsula (NAP). Samples were obtained from 2013 to 2016 in Bransfield and Gerlache Straits and in Powell Basin. Mean values of $\delta^{13}C$ and $\delta^{15}N$ were, respectively, -26.3‰ (± 2.9) and 0.9‰ (± 1.7) for POM - particulate organic matter (n=65), -25.6‰ (± 0.9) and 5.3‰ (± 1.1) for krill (n=29), -24.1‰ (± 2) and 8.9‰ (± 1.5) for humpback whales - *Megaptera novaenglieae* (n=67), -24.6‰ (± 1.2) and 8.2‰ (± 0.7) for fin whales - *Balaenoptera physalus* (n=23) and -24.4‰ (± 1.6) and 8.7‰ (± 1) for Antarctic minke whales - *Balaenoptera bonaerensis* (n=16). The isoscapes generated for baseline at the NAP ecosystem provided knowledge on how the $\delta^{13}C$ and $\delta^{15}N$ values of POM varied spatially and temporally in the region. POM samples in which diatoms and cryptophytes were predominant significantly differed in the $\delta^{13}C$ values and the contribution of these groups to the total phytoplankton biomass was positively and negatively correlated with the POM $\delta^{13}C$ values, respectively. The differences observed are considered representative of contrasting environmental conditions. The present study provides new insights for the stable isotope values in the Antarctic ecosystem and may help to foresee the consequences of physico-chemical changes in water properties to the biota due to global warming.

Tue_153_BE-4_145
In Situ Antarctic Seabed Warming Drives Species and Assemblage Level Responses

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Forecasting assemblage-level responses to climate change is a great challenges for global ecology. Marine data limited because they largely come from experiments using small numbers of species, mesocosms whose interior conditions are unnatural, and long-term correlation studies based on historical collections. We describe the first experiment to warm benthic assemblages to ecologically relevant levels *in situ*. Heated settlement panels were deployed near Rothera Station on Adelaide Island, Antarctica,with three test conditions: ambient and 1°C and 2°C above ambient (predicted sea temperature increases in the next 50 and 100 years, respectively).There were massive impacts on the marine assemblage, with near doubling of growth rates. Growth increases far exceeded those expected from biological temperature relationships established more than 100 years ago by Arrhenius, and demonstrated to accurately describe temperatue effects on biological systems since then. The growth increases resulted in a single "*r*-strategist" pioneer species (the bryozoan *Fenestrulina rugula*) dominating seabed spatial cover and drove a reduction in overall diversity and evenness. In contrast, a 2°C rise produced divergent responses across species, resulting in higher assemblage variability. This divergence in response at 2°C warming probably indicates some, but not all, species were warmed to temperatures near their long-term physiological limits and their capacities to resist warming were compromised.

Tue_154_BE-4_149
Ecological Consequences of a Species Introduced to the Antarctic

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Rising human activity in Antarctica, combined with the recent changes to the polar climate mean that establishing the risk of non-native terrestrial species to vulnerable, biodiversity and nutrient-poor ecosystems is urgent. Yet the impact on Antarctic ecosystem function from existing introduced species remains unclear. Of the five known non-native invertebrate species in terrestrial Antarctica, the flightless midge *Eretmoptera murphyi* may currently present the highest risk to local indigenous communities and is an excellent case study to establish these impacts, as the only higher invertebrate in the terrestrial ecosystem of Signy Island. Introduced to Signy in the 1960s from sub-Antarctic South Georgia, *E. murphyi* has established successfully, with an estimated mean biomass 2-5 times greater than the entire native arthropod communities in the areas it has colonised. As a detritivore and with no competitors or predators, *E. murphyi* may have a major impact on nutrient cycling which will, in turn, affect peat decomposition and soil structure, thereby having wider impacts on all levels of biodiversity. This study seeks to identify whether and how much the midge is impacting the local ecosystem through *in situ* measurements of key nutrient levels, invertebrate community assemblage, substrate microbial loads and vegetation diversity, and will be combined with a revision of the species' current distribution range and abundance on Signy to establish the scope of its impact.

Tue_155_BE-4_180
Vertical Profiles and Feeding Strategies of Copepods in Prydz Bay, Antarctica

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The vertical profiles of zooplankton community structures and feeding strategies and trophic niches of dominant copepod species were investigated using fatty acids and stable isotopic biomarkers based on samples collected from various water strata of Prydz Bay, Antarctica during austral summer of 2013. Four zooplankton communities belonging to distinct water strata were identified. The four groups differed more in animal abundance than in species composition. A few species (*Metridia gerlachei*, *Rhincalanus gigas*, *Alacia* spp.) showed significant diel vertical migration based on quadratic regression analysis. Sampling depth was the strongest differentiating factor between samples. These results suggest that depth-related differences in the environmental characteristics of water masses, such as temperature and salinity, may have the greatest effect upon community structure. Copepods showed species-specific and depth-related differences in fatty acid biomarkers and stable isotopic values. Intra-population variability and higher $\delta^{15}N$ values in *M. gerlachei* and *Paraeuchaeta antarctica* dwelled in the mesopelagic and bathypelagic zone indicated the flexible feeding strategies of these copepods responding to the changing food availability. The species-specific and depth-related feeding strategies of copepods based on biomarkers in this study could enable them to utilize different ecological niches and minimize inter- and intra-specific completion in the Prydz Bay ecosystem.

Tue_156_BE-4_269
Exploring an Undocumented Diversification of Parasitic Gastropods in Antarctica

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Benthic marine invertebrates are diverse in Antarctica, but little is known about their parasitic counterparts. *Asterophila*, a genus of eulimid gastropod, is endoparasitic in asteroid sea stars. There are four known members in this genus, one of which has been described from the Antarctica Peninsula and forms part of a putative radiation of species in this region. In order to further explore this radiation, 61 *Asterophila* specimens were collected from 38 hosts in Antarctica. Five genes were used for phylogenetic reconstruction and species delimitation and a test of host-parasite co-evolution was conducted by employing global congruence and event-based reconciliation analyses. The resulting *Asterophila* phylogeny shows high support for nine species-level entities in Antarctica, suggesting undocumented diversity in this group. These nine putative species show varying degrees of host specificity and species with more extensive sampling show higher host diversity. Significant global congruence between host and parasite phylogenies was detected, suggesting these groups are co-evolving, but the majority of links were explained by host switching rather than strict co-speciation. Investigating co-phylogenetic patterns provides insight into whether host and parasite lineages are evolving in synchrony, which may have important implications for biodiversity conservation. In all, these results advance our understanding of diversity and the processes driving this diversity in Antarctica.

Tue_157_BE-4_334
The Effect of Low Temperature on Photosynthetic Processes in an Antarctic Lichen

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Physiological responses of autotrophic constituents of Antarctic vegetation oasis have met a great importance in respect to recent climate variability in the region of Antarctic Peninsula. In our study, we investigated the effects of low temperature and short-term photoinhibition at high and low thallus temperature, respectively, on the fast chlorophyll fluorescence transient (OJIP) and OJIP-derived photosynthetic parameters in foliose lichen *Dermatocarpon polyphyllizum.* The lichen thalli were collected at James Ross Island, Antarctica. In a laboratory, the samples were expossed to a gradually decreasing temperature (22, 18, 14, 12, 10, 7, 4, 0 and -5°C). The initial phase of the transient (O-J) caused by the reduction of the primary quinone acceptor (Q_A) was found temperature-dependent. The K-step was apparent for the samples measured at the temperature above 12°C, but not below 10°C in light-adapted lichen thalli. In photoinhibited samples, we used OJIPs, OJIP-derived parameters, and evaluated the effect of photoinhibition on samples with scraped and intact upper cortex of a lichen at 18°C (measured temperature optimum of *D. polyphyllizum*) and 4°C. In conclusion, OJIP is an useful tool to investigate temperature-dependent changes in photosystem II as well as the effect of photoinhibition and consequent recovery of photosynthesis in chlorolichen photobionts. The method thus might be used in thermal resistence studies. We thank to CzechPolar2 and ECOPOLARIS for funding.

Tue_158_BE-4_389
Winter Physiological Suppression in Antarctic Krill is Not Observed Everywhere

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With a combined biomass greater than almost any other animal on Earth, Antarctic krill (*Euphausia superba*) supports vast numbers of top predators, contributes to biogeochemical cycling, and is the subject of a growing fishery. Overwinter survival is one of the key factors contributing to the success of the Antarctic krill population but it is one of the least understood aspects of the species' life cycle. Physiological suppression is an important strategy used by krill to survive in regions where winter food resources are low, such as the Lazarev Sea. However, it has been shown that in other regions, such as the Bransfield Strait in the northern Antarctic Peninsula (AP), krill continue to feed during the winter, suggesting minimal physiological suppression. We measured winter respiration rates of krill in the northern AP, an important, but rapidly warming, overwintering region for these organisms. Our measured respiration rates were higher than those reported for other regions. Our results highlight the importance of the northern AP for overwintering krill. Elevated respiration rates, however, correspond to greater minimum energy demands and we will discuss potential food resources available to krill overwintering in this region. Finally, we suggest that the elevated winter respiration rates in the northern AP are indicative of life history plasticity with important implications for the timing of reproductive development.

Tue_159_BE-4_430
The Belgica120 Expedition: A Proof of Concept for Antarctic Ecology

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There is a dearth of knowledge about biodiversity levels found in shallow environment in the Southern Ocean, a situation opposite to that found in other oceans. These habitats are however exposed to fast-paced changes in key environmental parameters. Shallow marine fauna has been facing past climatic events, but at time frames of different orders of magnitudes. Its response to current change is (re-)shaping the function and structure of ecosystems. On top of understanding these aspects, the ongoing RECTO/vERSO projects have identified plasticities (trophic, dispersive) and connectivities as key research areas to characterize the response of Southern Ocean ecosystems to Global Change.
The Belgica120 expedition is an attempt to delineate the impact of contrasted glacial regimes on the structure of shallow benthic communities by

- mapping marine habitats and quantifying the physiological sensitivity of selected taxa
- assessing the levels of biodiversity in an underexplored area of the West Antarctic Peninsula (WAP)
- using genomics to unravel past and present connectivity of key species
- modelling trophic networks in fast-changing environmental conditions
- testing the concept of using an agile platform for Antarctic marine biology work

In this presentation, we will give an overview of the Belgica120 experience, present initial results as well as discuss new perspectives for future research on Southern Ocean biodiversity.

Tue_160_BE-4_443
Microbial Diversity by NGS along a Vegetation Transect in West Greenland

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Greenland is one of the Arctic regions that might be severely affected by climate change. The trend towards a rise in temperature could cause changes in soil microbial diversity. Despite the high ecological interest in Polar Regions, little is known about the structure and diversity of the terrestrial microbial communities in ice-free areas in West Greenland, compared to other Arctic regions. In the frame of the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT), the Effects of Climate change On Microbial Community of Soil in Greenland (COMICS-G) project aimed
i) to characterize and compare the soil prokaryotic and eukaryotic diversity along a vegetation transect (NERO line transect, established in July 2007 for monitoring future changes of boundaries between vegetation zones and in the species composition of the plant communities, including heat, bedrock, snow patch and nude soil) in the Kobbefjord field Station, West Greenland and
ii) to clarify how the biodiversity of these communities would respond to climate change. To this scope, meta-barcoding approach, targeting the ITS region and V4 region of 16S for fungi and bacteria respectively, is being performed on Illumina Miseq. The results will give important clues to figure out the potential effects of environmental changes predicted for the Arctic regions.

Tue_161_BE-4_446
Call to Complete the Circumarctic Juniper Network - An Environmental Proxy

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Due to spatial scarcity and lack of long instrumental climatic records as well as missing written sources from the Arctic, studies focusing on proxy archives and environmental reconstructions are important evidence of eco-climatic variations in (sub)-polar regions. We introduce here one such highly valuable proxy archive, the long-lived, circumpolar, and relatively abundant tundra shrub *Juniperus communis*. Although it has shown good potential for environmental reconstructions (e.g. summer temperature, or ice-sheet melt) it is still a chronically understudied species, not only in terms of its ecology but also with respect to its wide geographical distribution. As environmental reconstructions are becoming integral parts of climate and environmental change research the demand for reliable and complex proxy data rises. Therefore, we are currently building the circumpolar wood anatomy juniper network to satisfy this need. So far, seven locations - mainly along the Northern Atlantic coast - have been sampled. Nonetheless, field campaigns covering Asia and N. America are still missing. Here, we invite the polar scientific community to contribute to our juniper network with the benefits of co-authorship and network access for each data contributor. We have developed a sampling procedure to guarantee the comparability of the obtained collections. Sampling per site takes approx. two person days, only basic equipment is needed and samples are easy to transport.

Tue_162_BE-4_453
Primary Photosynthesis in Antarctic Lichen at Subzero Temperature: A Lab Study

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Antarctic lichens in wet state may witness freezing and thawing cycles during austral summer. It is well established that the lichens are capable to perform photosynthesis at subzero temperature. In our study, we focused on the decline of photosynthesis due to gradual freezing. To evaluate the temperature dependence of primary photochemical processes of photosynthesis, we exposed hydrated thalli of *Usnea antarctica* (collected at James Ross Island) to linear cooling from +20 to -50°C at a constant rate of 2°C/min. Simultaneously, two chlorophyll fluorescence parameters (F_V/F_M: potential yield of photosynthetic processes in photosystem II, φ_{PSII}: effective quantum yield of PSII) were measured by a modulated fluorometer. The two parameters showed a S-curve decline with temperature decrease. The decline started at -5 (F_V/F_M) and +5°C (φ_{PSII}), respectively. *U. antarctica* exhibited the first sign of F_V/F_M decline at -12°C. The critical temperature (CT) related to full inhibition of the photosynthetic processes in PSII (F_V/F_M), was found at -20°C. For individual samples, CT for F_V/F_M was typically lower than for φ_{PSII}. Analysis of S-curves was done in order to find a parameter evaluating lichen resistance to subzero temperature. The method of linear cooling combined with simultaneous measurements of chlorophyll fluorescence parameters proved to be an efficient tool in the estimation of lichen sensitivity/resistance to freezing. **Acknowledgements:** CzechPolar infrastructure, ECOPOLARIS.

Tue_163_BE-4_457
Genetic Patterns at Fine Spatial Scales: Complex Findings in a Complex Landscape

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Landscape genetics describes spatial genetic patterns, and overlays these onto a habitat matrix. Observed patterns can then be interpreted from the viewpoint of the individual organism, and how different organisms move and interact within their habitat. Using *Cryptopygus antarcticus travei* from sub-Antarctic Marion Island as a model organism, we explored spatial genetic structure across a 350 m transect, and interpreted our results in light of the factors driving small-scale evolution within the group. Our results for 390 individuals from 22 sampling sites revealed the presence of two genetic lineages whose, contact zone broadly coincides with a ridge in the landscape. The contact zone does not manifest as a clean break, but rather a complex pattern of clustering, with sampling sites on either side of the ridge showing alternating lineage membership. Individuals within each site were not admixed but, uniformly belonged to the same lineage, and the level of inbreeding was consistent with what is expected for sexually reproducing organisms. High genetic diversity reflects a large effective population size, consistent with the high census population size reported for the species. Taken together, our results argue against asexual reproduction as an explanation for the complex spatial pattern. A more plausible explanation might involve the occurrence of divergent micro-habitat preferences and/or a fitness vacuum driven by local adaptations.

Tue_164_BE-4_466
Lipid Carbon Turnover Reveals Stage-specific Differences in Antarctic Copepods

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Lipid turnover dynamics of two herbivorous Antarctic copepod species with different types of lipid depots (wax esters, triacylglycerols) were investigated by compound-specific isotope analysis to elucidate biochemical pathways and energetic adaptations. The dominant *Calanoides acutus* and *Calanus propinquus* were collected in the Antarctic Weddell Sea in late December and fed with ^{13}C labeled diatoms for 9 days. ^{13}C incorporation was monitored by isotope ratio mass spectrometry. Total lipid (TL) mass and fatty acid/alcohol compositions did not change significantly during the experiment. However, lipid carbon turnover was intense especially in the copepodid V (CV) specimens of *C. acutus*, which exchanged 80% TL, whereas lipid turnover rates of female *C. propinquus* and *C. acutus* were lower. Structural fatty acids (FA) were exchanged with similar rates in all copepod groups and twice as high for 16:0 and 20:5(n-3) as for 18:0 and 22:6(n-3). Long-chain monounsaturated FAs (MUFA) are largely stored as energy reserves. 20:1(n-9) and 22:1(n-11) showed highest turnover rates in *C. acutus* CVs, only 20:1(n-9) was exchanged in *C. acutus* females and there was no MUFA turnover in *C. propinquus* females. Fatty alcohols also exhibited much higher exchange rates in *C. acutus* CVs than in the females. These differences emphasize the more intense biochemical activities in growing CV stages, whereas in females metabolic processes are less pronounced and probably more related to egg production.

Tue_165_BE-4_513
Ecosystem Research at the Canadian High Arctic Research Station (CHARS)

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Polar Knowledge Canada (POLAR) was established to provide a world-class research station in the Canadian Arctic anchoring a strong research presence that serves Canada and the world. A strong component of this is to advance knowledge of the Arctic and to improve the quality of life for people living in the north. The Canadian High Arctic Research Station (CHARS) at Cambridge Bay in the central Canadian Arctic is now nearing completion and will provide a range of laboratory and office facilities in the 7,500 m^2 Main Research Building. From a regional biodiversity perspective, the station is located near four major bioclimatic zones and provides access to a range of freshwater, terrestrial and marine habitats. Available data suggest an abundance of previously unknown and/or cryptic species in the Arctic. This, combined with the area around CHARS being relatively little studied, make the CHARS location a highly interesting region for ecological and cryosphere studies. A nearby "Experimental and Reference Area" (ERA), will be the focus of intensive research efforts over the next two years in an effort to provide an accurate assessment of ecosystems within the ERA. This would benefit strongly from international collaborators. POLAR is strongly committed to developing productive research partnerships with national and international scientists and opportunities exist for international researchers to visit and use the facilities.

Tue_166_BE-4_581
Impact of Sea Ice on Phytoplankton Dynamics in the Northern Antarctic Peninsula

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The seasonal advance and retreat of sea ice around the northern Antarctic Peninsula can have a significant impact on phytoplankton, mainly due to alterations in the availability of ice-free areas, micro-nutrient inputs by meltwater and variations in water column structure. The aim of this work was to evaluate the effect of sea ice conditions on phytoplankton biomass and community composition in an area off the northern Antarctic Peninsula. Two contrasting conditions were studied: a strong environmental gradient around the sea ice edge, with a marked meltwater signal (summer 2013) and the same area with little indication of meltwater and no detectable sea ice conditions (summer 2014). There was a clear distinction between the phytoplankton communities under sea ice influence, where mainly cryptophytes were associated with shallow mixed layers and high water column stability in 2013 and an important presence of diatoms in 2014, associated with deeper mixed layers, lower silicic acid concentrations and higher magnitudes of both salinity and temperature, under very little sea ice influence. Gymnodinioid dinoflagellates were an important component in both years, apparently occupying sites/conditions less favourable to cryptophytes. These results support previous suggestions that climate factors leading to shortening of the sea ice season in the region do have an important impact particularly in shaping the dominance of the main phytoplankton functional groups in the region.

Tue_167_BE-4_662
Combining SDM and DEB Theory - An Integrative Approach to Ecological Niche Models

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Ecological niche models are now commonly used to characterize the relationship between species occurrences and environmental conditions. Amongst these models, the correlative approach (species distribution models, SDMs) has been widely applied to modeling the distribution of various organisms at different spatial scales. However, this approach has received some criticisms because it assumes that species distribution is at the equilibrium with the environment. This constitutes a serious limitation to modeling dynamic predictions such as future range shifts due to climate change. SDM are unable to integrate the full range of processes involved in physiological responses of species to environmental changes. In order to consider these biological processes in modeling procedures, we generated mechanistic models based on the Dynamic Energy Budget (DEB) theory, capturing metabolic processes of an organism during its entire life cycle using temperature and food availability. This approach allows getting an enhanced assessment of fitness components such as survival, development, growth and reproduction.
We modeled the distribution of the echinoid *Sterechinus neumayeri*, a common species in benthic communities from Antarctic shallow areas. We used an integrative approach based on both correlative and mechanistic models to predict species range shift with predicted environmental changes, a crucial issue for biodiversity conservation and management.

Tue_168_BE-4_675
Estimating Adaptive Capacities of *Salpa thompsoni* Facing Southern Ocean Warming

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The polar regions and the western Atlantic sector of the Southern Ocean in particular are among the fastest warming areas on the planet. Long-term data sets indicating a decline in krill abundance in the northern part of the Western Antarctic Peninsula (WAP) and an increase of salp populations as well as a shift in food quality and quantity, highlight the unique characteristic of the WAP region to observe the ecosystem response to climate change. Krill and salps are among the most important grazers, playing a crucial role in the WAP ecosystem. Thermal limits on physiological processes in krill and salp life cycles on different levels of the organism are yet unknown, limiting the accuracy of predictions on how these two species might respond to climate change. To assess the natural plasticity of Antarctic salp, *Salpa thompsoni*, between seasons, winter and summer samples were subjected to high throughput sequencing as well as additional cellular analyses. The *de novo* generated transcriptomes of *S. thompsoni* and its Mediterranean relative, *S. fusiformis*, were compared to detect regional adaptive strategies. First results on metabolic and reproductive activity in *S. thompsoni* in response to seasonal differences will be presented. The unique life cycle, changing between solitary and aggregate stage and therefore facilitating fast reproduction under favourable conditions, might be the baseline for potential adaptive capacity of *S. thompsoni*.

Tue_169_BE-4_712
A First Approach to the Leaf Hydraulic Properties of *Deschampsia antarctica*

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Increase temperature produces changes in photosynthetic limitations of *Deschampsia antarctica,* promoting higher rates of net photosynthesis. This photosynthetic response is related to change in leaf traits, specifically associated to the CO_2 mesophyll conductance (g_m). Considering that the CO_2 and water vapor share, partially, diffusion pathways in the leaf mesophyll, we ask if change in g_m under warmer condition are accompanied by changes in the leaf hydraulic properties of *D. antarctica.* Given that currently there are no studies about the hydraulic characteristics of Antarctic vascular species, both under field or laboratory conditions, our first goal was tune-up methodologies to measure the leaf hydraulic conductance (K_{leaf}) and the whole hydraulic conductance (g_{plants}). The increase in net photosynthesis triggered at higher growth temperatures were accompanied by increases in both K_{leaf} and g_{plant}. These changes were also associated to adjustment in the leaf traits as leaf density and leaf mass area production, and also with changes at vascular leaf level. Despite these adjustments could be positive for the growth of *D. antarctica* under warmer growth conditions, plants could be more susceptible to damage during sudden freezing events, which could increase, as a result of regional climate change.
Acknowledgments: INACH RT 13_16.

Tue_170_BE-4_723
Under Ice Flagellates Bloom in Coastal Area of the Ross Sea (Antarctica)

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In early spring 2016 water samples, under annual fast ice from 0-100 m, were collected in a coastal area in Terra Nova Bay (Ross Sea) from December to January (2015-2016). We investigated temporal distribution of temperature, chlorophyll *a*, particulate organic carbon and phytoplankton composition. Several new and unusual events were observed in the under-ice phytoplankton community of the Ross Sea. A massive under ice bloom dominated by flagellates, < 10 µm of length, was recorded. This group was numerically similar and/or dominant compared to diatoms in this study. Flagellates blooms showed a high temporal variability in species composition: i) the chrysophyte *Ochromonas* spp., generally found in Antarctic lakes, was observed for the first time in the sea; ii) the parmales *Pentalamina corona*, known for the Antarctic pelagic environments, was found for the first time under the ice with unusually high concentrations and iii) the haptophyte *Phaeocystis antarctica*, was reported for the first time in the under ice system in high concentrations.These events could be related to a peculiar seasonal progression in the ice melting process in the 2015-2016 period or may indicate an environmental change. The ecological role of this flagellates under the pack ice should be studied in detailed.

Tue_171_BE-4_836
Morphological Differentiation Reflect Ecological and Genetic Background in *Usnea*

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King George Island is the second largest ice-free area of the South Shetland Islands, and the fruticose lichen *Usnea aurantiaco-atra* is the most dominant and widespread flora around King George Island. It had been observed that the individuals of *U. aurantiaco-atra* with different phenotypes could grow on various substance. A comprehensive analysis combining morphological and phylogenetic traits reveals that the phenotypic differentiation of *U. aurantiaco-atra* (erect growth on stones or with prostrate growth with mosses) provides an effective approach to adapt to different micro-environments, and those individuals with complicated morphological traits grow on different substances (eg. Stone, wood, even other lichen such as *Umbilicaria antarctica*) could share the same genotypes (they have the same ITS rDNA sequences of both mycobiont and photobiont). Moreover, haploid disequilibrium testing indicates that there is no significant genetic difference for the two growth forms (erect and prostrate) when fungal and algal ITS rDNA were treated as two alleles of one lichen individual. The two growth forms of *U. aurantiaco-atra* appear to reflect different stages of lichen-moss community succession, and a mode is proposed for demonstrating the occurrence of this succession. Also, the current study implies that lichen is a mini-ecosystem more than a dual symbiotic association of fungus and alga.

Tue_172_BE-4_905

Introduction of the Journal *Advances in Polar Science* and Call for Papers

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Advances in Polar Science (APS) has been published since 1990 as a peer-reviewed English-language journal dedicated to the presentation of multi-disciplinary achievements in Arctic and Antarctic expeditions and research (until 2011 it was known as the Chinese Journal of Polar Science [English Edition]). In 2015, we made APS more truly international, with two new Co-Editors-in Chief, Dr. Huigen Yang and Prof. Ian Allison, and a new expert team of disciplinary Editors from China and many other nations involved in polar research (http://www.aps-polar.org/home/editorialboard). Our broad goals for the journal in the near future are to improve the quality of contributions and to attract more involvement and contributions from outside China. Specific objectives will include using APS as a platform to raise international awareness of Chinese polar research and to facilitate collaboration between China and other nations in polar science, and to build both inter-disciplinary and bi-polar links within our research community. APS is a true open-access, quarterly scientific journal. Articles published in APS are free of charge with generous funding from PRIC. For more details, please see the attached introduction file or visit the APS's websites: www.aps-polar.org

Tue_174_BE-4_950
The Results of Camera and Satellite Transmitter Deployment in Vernadsky Area

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We report the results of the work on establishing of camera network and penguin tags deployment in penguin colonies in the area around Vernadsky Sation as a part of the CCAMLR/CEMP Projects. The projects have been initiated by scientists from USA, Argentina and Poland, and supported by the CEMP Fund. The data of the project will allow analysing the climate changes and krill fishery influence on the Antarctic Peninsula ecosystem. Ukraine is responsible for support and providing the cameras and satellite transmitter deployment in gentoo and Adelie penguin colonies at the Galindez, Petermann, and Yalour Islands. The pictures of gentoo colonies at the Galindez and Petermann Islands, and Adelie colonies at Yalour Island have been processed according protocol and methods provided and coordinated by US scientists. Information on copulation, egg lay, maximum number of eggs, hatch, maximum number of chicks, date of cheche, and the maximum number of adults have been obtained and analysed during breeding season 2016/2017 from the photos of the all nine cameras. The results of visual observations coinsided with camera photos are discussed. ARGOS satellite tags have been installed successfully at fifteen adult gentoo penguins in Galindez Island colony and some of tags are still transmitting in the end of October 2017.
The work is supported by CEMP Fund of the CCAMLR, by National Antarctic Scientific Center of Ukraine and Taras Shevchenko National University of Kyiv, project 16BF051-02.

Tue_175_BE-4_999
Faraway, So Close: Midtrophic Feeding at the Poles, an Ecomorphological Study

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The polar cod (*Boreogadus saida*) and the Antarctic silverfish (*Pleuragramma antarctica*) are pelagic fish endemic of the Arctic and Antarctica, respectively. Shaped for life in icy waters, both the polar cod and the Antarctic silverfish are nowadays abundant in the pertaining polar marine ecosystem, playing a central role as link between top predators and lower trophic levels. Although phylogenetically distant, during their independent evolutionary histories in polar regions, these two polar fish has been subjected to similar ecological drivers, eventually leading to a comparable suite of, biological and ecological adaptations.
Both species are zooplanktivorous, known to primarily feed on copepods, euphausiids and amphipods. Intraspecific regional differences in diet, reflecting prey availability, have been recorded for both the cod and the silverfish, supporting the hypothesis of them being opportunistic feeders. In the light of the ongoing climate change how each of the species might cope with changes in the prey availability is of particular relevance with strong implications for the polar food web.
Here we apply an ecomorphological approach to characterize the feeding modes of the polar fishes, aiming at better understand their feeding adaptation, and their potential trophic flexibility. The morphofunctional bases of the feeding mechanisms are assessed through morphometric analysis of mouth structures, jaws, buccal cavity, muscles of the head and gill rakers.

Tue_176_BE-4_1121
Five Millennia of Environmental Dynamics from an Ice Core in the Mongolian Altai

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The Central Asian forest-steppe ecotones are highly vulnerable to environmental shifts such as drought and overgrazing. Knowledge about past vegetation and fire responses to environmental change may contribute to a better understanding of future ecosystem dynamics. However, paleo records are scarce in the region.
Our novel high-alpine ice record from Tsambagarav glacier (4130m asl) in the Mongolian Altai provides unique paleoenvironmental information at the landscape scale with an exceptional temporal resolution and a sound chronology covering the past 5500 years. We use pollen as proxies for vegetation composition and structure, microscopic charcoal as a proxy for fire activity, and spheroidal carbonaceous particles (SCPs) to infer fossil fuel combustion.
We present the first microcharcoal-inferred fire history record from Mongolia which can be directly linked to past vegetation dynamics. Reconstructed mid to late Holocene forests collapsed and fire increased, likely in response to climate change. Our results underscore the vulnerability of relict forest ecosystems in the Mongolian Altai and imply that in these steppic areas, moisture is more important than temperature for tree growth. We conclude that Central Asian forest ecosystems including the Russian Altai are highly vulnerable and may collapse rapidly in the future, if global warming will be associated to moisture declines as anticipated by regional climate models.

Tue_177_BE-4_1146
Diversity Structure of Rotifer Communities in Deglaciation Areas of Svalbard

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Glacial retreat occurs worldwide due to global climate change. Svalbard glaciers are ones of the most retreating in the world (Norwak & Hondson 2014). Their exposed forelands create new niches for terrestrial microbial organisms, in particular for microscopic invertebrates that influence further changes of the rock substrates. This study aims at understanding the diversity patterns, in particular, gradients of diversity and abundance in deglaciation areas, of a key group of soil microfauna, rotifers (Rotifera).
Soil and moss were collected in Adolfsbukta (Nordenskiöldbreen, NB), and the vicinity of Ny-Ålesund (Austre Brøggerbreen, ABB), both at a single point and along the transects, 0 to circa 500 m from the glaciers. Rotifers were extracted using the method of Freckman & Virginia (1993), counted and identified to species.
Eighteen rotifer species were found in NB and 12 in ABB, respectively, with *Adineta gracilis*, *Ceratotrocha cornigera*, *C. velata*, *Habrotrocha cf aspera*, *Macrotrachela* cf *concinna*, *M. insolita* being the most common and abundant species. Abundance varied from 0 ind/g (near the glacier) to 50-75 ind/g of soil (more than 200 m from the glacier), however no strict diversity and abundance gradients were observed, with a higher number of species and individuals occurring under moss patches.
Therefore, deglaciation areas in Svalbard provide new niches for microinvertebrate communities that might cause further changes in structure and composition of the exposed soils.

Tue_178_BE-4_1158
Relationships between Soils and Plant Communities in Maritime Antarctica

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Soil characteristics allow the understanding of the factors that drive vegetation development and dynamics in Maritime Antarctica, being extremely sensitive to between environmental changes. We investigated the relation between soil attributes with landscape features and plant community. We analyzed soil attributes in ten different plant communities following a toposequence, near Henryk Arctowski Polish Station, Admiralty Bay, Antarctica Maritime. Results indicate that coastal phanerogamic communities presented greater phosphorus and organic matter contents due to ornithogenic influence. In these areas, soil shows low levels of sodium and low pH at the bottom of the toposequence. Fruticose lichen communities were observed at high altitudes, characterized by higher exchangeable sodium and calcium contents, as well as lower amounts of phosphorus and organic matter. Mosses carpets are mainly found on wet soils, with low diversity of species, coupled with little soil organic matter accumulation. Bare soil as reference, presented very low organic matter content, high pH and sodium saturation. We observed that organic matter only accumulates at the bottom of the topossequence, under phanerogamic community. Lichens communities are found at higher positions of the landscape under very of higher diversity shallow and skeletic soils, indicating a strong dependence of vegetation establishment to physical conditions, especially moisture.

Tue_180_BE-4_1207
Similarity of Trends of Scrubs Expansion in Arctic and High Mountains in Russia

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In the beginning of the XXI century in tundra and high mountains growth of plant productivity and vegetative index (NDVI) was revealed (Walker et. al. 2012; Bhatt et. al. 2013; Belonovskaya et al., 2016; Tishkov et al., 2016; Shiyatov 2009; Vinogradova et al., 2015). The main cause of this process is synergism of climatic and anthropogenic impact changes. Growing season's increasing, active temperature sum's raising and soil melting depth's deepening result scrub vegetation of *Betula, Salix, Duschekia, Pinus, Juniperus, Rhododendron,* etc. genera's spreading in Russian tundra (Kola Peninsula, lower Pechora-river, Yakutia) and in the high mountains (Khibini, Urals, Eastern Sibiria, Caucasus). Similar process is noticed for Alaska and Canadian Arctic (*Duschekia, Salix* and *Betula*) (Tape et al., 2006). The trend of scrub vegetation invasion was recognized in global scale for various treeless biomes. In high mountain regions scrub area's enlargement is caused by climatic changes as well by abandoning of alpine pastures. In Arctic and high mountains widening of scrub vegetation initiates development of landscape diversity, increasing of snow accumulation and therefore development of continuous scrub cover, organic matter accumulation and changes of soil thermal regime. Thus this process may have the cyclic character because according the “cascading effect” it induces “inverse relationships”: reaction of all landscape components and as a result scrub degradation in the future.

Tue_181_BE-4_1234
Ecophysiology of the Sub-Antarctic Intertidal Midge *Halirytus magellanicus*

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First described around 100 years ago, *Halirytus magellanicus* is a non-biting midge native and probably endemic to southern South America. The species has received no specific research attention since its discovery, and little is known about its habitat, life cycle and other biological characteristics. Recently, it has been relocated in Navarino Island, southern Chile, providing the opportunity to document the species' biology, and compare with other, better studied, Antarctic and sub-Antarctic relatives. We completed a spatial point-pattern analysis to characterise its habitat at several bays on Navarino Island, and ecophysiological experiments addressing its adaptive features in terms of tolerance to desiccation, salinity, temperature variation and salinity+temperature interaction. The species is active for most of the year and has a multivoltine life cycle, in contrast with its assumed closest relatives, the Antarctic/sub-Antarctic endemics *Belgica antarctica* and *Eretmoptera murphyi*. Primary habitat requirements for the larvae include filamentous algae and thin sand, which appear to be necessary to secure larvae and pupae from being washed away during the tidal cycle. While the larvae can withstand wide variation in salinity and temperature, as may be expected during intertidal exposure, they are vulnerable to desiccation stress, especially at higher temperatures. These features permit the species to inhabit a wide range of intertidal microhabitats.

Tue_182_BE-4_1265
Biodiversity of Canadian Arctic Plants and Lichens: Field Work and Floristics

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Exploration of the flora of the Canadian Arctic has been ongoing for almost two hundred years, yet substantial gaps remain in our floristic understanding of this large, rapidly changing and difficult-to-access region. Detailed information on the diversity and distribution of Arctic plants and lichens at local, regional and global levels is urgently needed to understand the potential impacts of climate change on Arctic flora. Since 2008 we have been conducting floristic surveys in botanically-understudied regions of the Canadian Arctic; lichen exploration began in 2016. The comprehensive baseline data of our >8000 new collections, all housed permanently in the National Herbarium of Canada at the Canadian Museum of Nature, and other herbaria in Canada and internationally, adds important baseline knowledge to our understanding of Arctic plant and lichen biodiversity. Our collections include first records for specific areas (e.g., territories, parks, islands), major and minor range extensions, second or third collections of poorly-known species at the northern or southern edges of their ranges, new discoveries of rare species, and they fill in gaps in the known distributions of Arctic species. We are working on a new Arctic Flora of Canada and Alaska, which aims to bring together all available information on the diversity and distribution of vascular plants in this region, including keys, descriptions, nomenclature, distribution maps, images and more.

Tue_183_BE-4_1364
A Spatially Explicit Food Web Model to Evaluate Change on the Kerguelen Plateau

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The Kerguelen Plateau is a highly productive area. Seabirds and seals breed on the islands, parts of the plateau support nurseries and larval development for fish species, and iron enrichment from the shelf produces phytoplankton blooms that attract a wide range of species to forage in the area. The plateau also supports valuable fisheries for Patagonian toothfish and icefish. The area is changing, with increasing temperatures, and movement of oceanographic frontal systems that interact with the plateau. Climate model projections suggest that these changes are likely to lead to increases in primary productivity. We have developed the first balanced *Ecopath with Ecosim* model for the Kerguelen Plateau using published information on species biomass and diet. We present this model with an added spatial component (*Ecospace*) that allows us to examine spatial variation of the food web across the plateau. We present results from a set of spatially explicit scenarios to examine the combined effects of changes in primary productivity and fisheries for the Kerguelen Plateau and evaluate the impacts of these changes throughout the food web.

Tue_184_BE-4_1367
Abundances and Activities of Prokaryotic Community in Water of an Arctic River

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The spatial and temporal distribution of microbial biomass and metabolic rates were investigated in water samples collected along the Pasvik River (Arctic Norway) from 9 stations during two sampling campaigns (May and July 2014). Water samples were analyzed for physico-chemical parameters, viable bacterial abundance (VCs), prokaryotic abundance (PA), microbial enzymatic and respiratory activity. All data were statistically analyzed. VCs were generally homogeneous in May and July. PA showing enhanced abundance in July and higher values in the outer than in inner stations. Microbial respiration was higher in July than in May. Pearson's correlation coefficients showed that physical and chemical parameters affected both the PA and functionality. Respiration was significantly related to Temperature, suggesting its stimulation on the oxidation process. ANOSIM analysis showed seasonal significant differences ($R=0.231$, $p=0.002$), with temperature accounting for 11.4% of total variability. Psychrophilic microorganisms of the Pasvik river appear to be quite plastic to acclimate to seasonal changes of the cold habitat in which they live, modifying their abundance and metabolism, although further research is needed for a deepen knowledge of this Arctic ecosystem.

Tue_185_BE-4_1369
Dwarf Brooder *versus* Giant Broadcaster: Unrecognized Species in a Brittle Star

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Characterizing a species reproductive mode (brooder, broadcaster) is key to understand the evolution and resilience of SO organisms as reproductive mode affects connectivity and demographic patterns. Distinct reproductive modes might sometimes suggest unrecognized speciation that can be confirmed through genetic or morphological investigations. This is the case for the brittle star *Astrotoma agassizii* where divergent genetic clades were associated with a brooding (Patagonia) and a broadcasting reproductive mode (Ross Sea). Here we investigated the genetic diversity and reproductive mode of *A. agassizii* from individuals collected in South Georgia (SG) and around Antarctica (208 samples). Two CO1 clades were found, one restricted to SG (clade 1) and another shared between SG and Antarctica (clade 2). Size investigations revealed a dimorphism at SG: only small individuals (disc diameter < 2.5cm) were found in clade 1 while all the largest specimens (up to 6cm) were found in clade 2. Moreover, five specimens of clade 1 were brooding, whereas clade 2 included seven Antarctic specimens exhibiting broadcasting. These results suggest that there are different species in SG: a large broadcaster (shared with Antarctica) and a smaller brooder (specific to SG). This SG clade is also separate from the two Patagonian clades described in other studies. Species integrity and distribution will be tested by exome capture analysis (hundreds of nuclear loci) and by the addition of more locations.

Tue_186_BE-4_1419
Corals as a Model to Measure Change in Polar Oceans

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Initial research by the Antarctic Seabed Carbon Capture Change (ASCCC: www.asccc.co.uk) project indicates that Arctic and Antarctic seabeds are absorbing and storing more carbon as the climate warms. Understanding the oceanic carbonate system across space and time is a key objective of the ASCCC multidisciplinary team. This study uses stylasterid corals, which are key global habitat constructors, as a model taxa to conduct a systematic study of how, where and why the changing chemistry of the ocean has the potential to affect calcification (the ability to grow skeletons). Stylasterid corals may have the capacity to calcify and survive the predicated acidification of the Polar regions (where pH change linked to anthropogenic CO2 is strongest). Unlike other coral groups, stylasterids can either be composed of aragonite (more soluble), calcite (less soluble), and in some species both. If stylasterids are able to manipulate their skeletal composition in response to oceanic change, then they may acclimate to anthropogenic activities, such as predicted ocean warming and acidification, which would be a significant advance in our understanding of ocean life adaptation to current and predicted environmental change.

Tue_187_BE-4_1457
A New Centric Diatom Species from the Maritime Antarctic Region

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The freshwater genus *Aulacoseira*(Thwaites 1848: 167) was established in 1848 (Round *et al.*1990).In the Antarctic Region, only one specie was recorded so far (*A. principissa* Van de Vijver (2012: 35)), widespread on all sub-Antarctic islands such as Iles Crozet, South Georgia or Heard Island (Van de Vijver 2012). Doing a qualitativy analysis in a corer with 50cm sampled at the Glubokoe Deepe Lake, Fildes Peninsula, King George Island,west coast of the Antarctic Peninsula, 34 taxa were found and identified, of which only 19 were considered as frequent. Among these 19 taxa the most abundant species along all layers was the centric diatom *Aulacoseira glubokoyensis*, a new species discovered throughout this study. This data was relationed with environmental variables, and showed a decrease in relative abundance and cell size in the period of higher ozone variation. According with VICENT & SOY, 1993,
UV-B radiation can lead to harmful effects in all organisms living in aquatic environments, and some physiological adaptation to this new condition may take generations to occur, which could explain the decline in the relative abundance of *Aulacoseira glubokoyensis* during some phases and consecutive increase, showing a possible adaptation. As it is a new species further studies about the ecology and correlation with environmental factors are still underway.

Tue_188_BE-4_1501
Trophic Ecology of Antarctic Deep-sea Echinoderms of the Weddell Sea

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In the Southern Ocean, the trophic ecology of deep-sea communities is probably one of the most neglected. In the present study, the food sources and energy mobilization of three different deep-sea echinoderms living in the Weddell Sea (around 1500 m depth) were investigated with indirect tools (i.e. stable isotopes, biochemical balance and free fatty acids contents). The stalked crinoid *Dumetocrinus antarcticus*, the holothurian *Rhipidothuria racovitzai*, and the ophiuroid *Ophiura carinifera* were sampled in spring during a Polarstern cruise. We found that stable isotopes were in line of previous results of other species (δ13C ranging from -24.3‰ to -26.5‰; δ15N ranging from 6.8‰ to 7.9‰), showing similarities in the food sources used by the three echinoderms. The capability to store energy by these three organisms is conspicuous and different [e.g. from 18 to 45% of the organic matter (OM) are lipids]. The capability to mobilize energy in the form of carbohydrates and free fatty acids among species was also very different (e.g. biomolecules ranging from 9 to 22 µg Carbohydrates mgOM-1 and from 4 to 39 µg free fatty acids mgOM-1). The fatty acid markers and the Saturated, Mono Unsaturated and Poly Unsaturated Fatty Acid proportion were also very different depending on the species. It is suggested that even if the food sources are similar for the three echinoderms, the strategies to manage the energy inputs in these deep-sea organisms in polar environments may be quite different.

Tue_189_BE-4_1558
Sea Ice Duration and Ice Scour Influence Macroalgae at Potter Cove, Antarctica

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Isla 25 de Mayo/King George Island is one of the best studied areas, particularly Potter Cove. At Carlini station we recorded the (1) duration of sea ice cover, (2) iceberg scouring (using experimental markers on the seabed at 5 and 10m) and (3) biological responses, in terms of macroalgal % cover, since 2014. Although links between sea ice duration, ice scour and benthos structure have been established, only one other locality (Rothera, Adelaide Island) makes similar measures. We found much variability in sea ice duration, just 46, 64 and 20 days respectively in 2014, 2016 and 2017 compared with 118 days in 2015. Correspondingly more markers were hit (i.e. higher ice scour frequency) in 2014 and 2016 (53%±14 and 75%±10, respectively) than in 2015 (41±9). The macroalgal % cover was significantly lower (34%±8) in 2016 compared to 2014 and 2015 (78% ±4 and 57% ±14, respectively). These preliminary results suggest that a lower macroalgal % cover could be related with higher ice scouring due to reduced sea ice duration among abiotic and biotic factors controlling macroalgal cover. Maintaining these studies long term should tease out natural short term variability in time and space from benthic ecosystem responses to regional climate-forced physical changes. Collaboration between UK, Argentina and Germany has established matched protocols, enabling us to quantify how life on Antarctica's seabed is responding to profound sea ice losses.

Tue_190_BE-4_1559
Wind & Tide Affect Antarctic Krill Aggregations in a Biological Hotspot

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Antarctic krill, *Euphausia superba*, is an abundant and ecologically important zooplankton species in the Southern Ocean. Biological hotspots, with elevated krill biomass, exist around Antarctica, often as a result of the concentrating effect of bathymetry and ocean currents. Such areas are key foraging grounds for numerous top predators. A hotspot of krill biomass exists off southern Anvers Island, Western Antarctic Peninsula, and supports a population of Adélie penguins that feed almost exclusively on it. We investigated the variability in krill aggregations in the nearshore waters of this hotspot over four consecutive summers, identifying environmental factors that were responsible. We identified three distinct krill aggregation types (Large-Dense, Small-Close & Small-Sparse aggregations) and found that the relative proportion of each type varied significantly between survey days. Large-Dense aggregations were more frequent when westerly winds dominated and when the local mixed tide was in the diurnal regime. Small-Close aggregations were also more frequent during diurnal tides. Conversely, Small-Sparse aggregations were more prevalent when the mixed tide was in the semi-diurnal phase. We suggest that, under certain conditions, the biological hotspot in the nearshore waters off southern Anvers Island, functions as a zone of accumulation, concentrating krill biomass. Our findings provide important information on the dynamics of Antarctic krill at the local scale.

Tue_191_BE-4_1581
Permafrost Peatlands and Climate Change: Response on Hydrological Variations

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Nowdays permafrost peatlands (PP) of the forest-tundra transition zone are subjected to annual temperature increase which leads to permafrost thawing and evolution of PP landscapes. In present study two predictable scenarios of PP landscapes evolution were tested: i) flooding of PP and ii) drying with following forest invasion in case of good drainage. The aim of the study was to estimate how organic carbon (OC) of PP will respond to these scenarios. Peat samples were collected in northwest Siberia in the zone of discontinuous permafrost (N65°19', E72°53'). To simulate flooding peat samples were incubated under laboratory conditions (25°C) during 1 week at a range of WHC - from 15 to 100% and then basal respiration was measured. To simulate drying peat samples were dried completely (25°C) and later rewetted to 60% of WHC, CO_2 effluxe was measured after the rewetting and during 30 days, to reveal fast response of OC to changed moisture conditions.
PP show resilience to flooding and the water content changes as a whole. CO_2 efflux from peat ranged from 6.0 to 6.8 mkg C-CO_2 g^{-1} h^{-1} with max for 35 and min for 55% of WHC. For the dried samples CO_2 effluxes increased up to 2.5 times in the first four days after rewetting and reached values of 16.3 C-CO_2 g^{-1} h^{-1}, whereas declined afterwards and reached the 5.5 C-CO_2 g^{-1} h^{-1} at the end of experiment.
Thus, drying promotes rapid decomposition of OC, whereas flooding wouldn´t have the determinative effect on peat mineralization.

Tue_192_BE-4_1611
Squid Prey of Antarctic fur Seals as an Environmental Change Indicator

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Understanding how changes in environmental conditions affect prey and their predators is fundamental for interpreting variability in natural marine ecosystems. We used the Antarctic fur seals (*Arctocephalus gazella*), a top predator of cephalopods, to evaluate their potential as an indicator of change in prey availability and local/regional environmental conditions. We used Antarctic fur seal scats (i.e. faeces) to assess the cephalopod component of their diet from 2009 to 2013 and relate the stable isotopic signature of lower beaks ($\delta^{13}C$ and $\delta^{15}N$) to oceanographic conditions around South Georgia. Our results showed that Antarctic fur seals are capable of feeding on a wide variety of ecologically different squid species, with *S. circumantarctica* being the most frequent and with the highest number of lower beaks in the scats collected. Isotopic data revealed that *S. circumantartica* is an Antarctic water species, predominantly inhabiting an offshore/oceanic habitat, with low trophic level in relation to other species of Antarctic squids. From an ecological view, we demonstrated that in years of abnormal environmental conditions associated with low Antarctic krill *Euphausia superba* density, *S. circumantarctica* exhibited a higher trophic level as well a clear predominance for more offshore areas and, occurred more frequently in the diet of Antarctic fur seals.

Tue_193_BE-4_1613
Unrevealing the Life of the Giant Antarctic Octopus *Megaleledone setebos*

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Gigantism among Southern Ocean organisms is a very common feature, due to the cold and oxygen-rich water. The Giant Antarctic Octopus (*Megaleledone Setebos*), is known to inhabit the Southern Ocean, reaching sizes up to 90cm and 14500g. In our study, we report the largest specimen ever found with 115cm and 18300g, caught in January of 2017 at Dumont D'Urville Sea. This species have an important role in the food web being present in the diet of the valuable Antarctic toothfish (*Dissostichus mawsoni*) and other charismatic top predators. Yet, nothing is known about its ecology. To answer some questions, we used beaks found in the diet of *D. mawsoni* and measured the content of $\delta^{13}C$ and $\delta^{15}N$ along the beak to reveal habitat and trophic shifts along the life. Our results show that the values of $\delta^{13}C$ are relative stable along the life, suggesting that this species doesn't migrate, however the small increase of ^{13}C content may suggest a little movement towards offshore. In terms of $\delta^{15}N$ values, an increase of values along the beak suggest an increase of the trophic position along the life. Also, a correlation between $\delta^{13}C$ and $\delta^{15}N$ values suggest that the movement towards offshore and the increase in the trophic chain are related. Being a benthic species, the results might suggest that the octopus tend to descend the slope along the life, going to deeper waters and changing the type of diet along the life, being also available in bigger sizes to the deep-sea predators.

Tue_194_BE-4_1652
Diversity of Photoautotrophic Mats in Lakes on James Ross Island

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In connection to the threats connected with current climate changes, there is a growing interest in unravelling species diversity patterns across a range of Antarctic terrestrial and freshwater habitats. There is growing evidence that polar lakes represent valuable centres of biodiversity as well as sensitive indicators of environmental changes. A recent limnological survey described six lake types on the Ulu Peninsula (James Ross Island) that were classified according to their geomorphological position, stability, physico-chemical characteristics and biota. The lakes form a valuable set of ecosystems in the transitional zone between the maritime and continental Antarctica and therefore play an important role in the comparison with other freshwater sites. The aim of our study was to characterize the taxonomic composition of benthic autotrophic assemblages in the lakes and to assess the key factors that influence their composition. The sampling revealed high diversity of microbial assemblages that was primarily determined by lake type and associated differences in water chemistry. Massive autotrophic mats were observed mainly in the littoral zone of relatively old stable shallow lakes, whereas the mats were absent from the young lakes. However, a large variability was also observed within lakes belonging to one type suggesting the possible importance of priority effect in determination of community structure in environments with minor differences in environmental conditions.

Tue_195_BE-4_1688
Shrubs in a Changing Arctic: Benefit or Vulnerability?

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Air temperature is increasing and will keep rising, more rapidly in the Arctic than in other regions. As a consequence, soil warming is expected, which will accelerate permafrost thawing and soil organic matter mineralization. This acceleration will enhance in turn the nutrient availability for plants. The projected changes might affect plant diversity, traits and strategies, altering ecosystem functioning and vegetation-climate interactions.
Here, we explore experimentally the effects of increased permafrost thawing depth and shallow nutrient availability on plant traits, resource acquisition and growth strategy of tundra shrubs. We measured seventeen plant traits related to resource acquisition, light interception and growth in four shrub species in a thawing and fertilization experiment in a Siberian tundra ecosystem.
Shallow nutrient addition caused shrubs to shift from resource conservation to more rapid resource acquisition and faster growth. These strategy responses might enhance shrub vulnerability to pests and climate extremes, which are projected to become more frequent.
Our findings suggest that plant traits of tundra shrubs respond in a coordinated way to environmental changes. Taking this coordinated response into account will contribute to more realistic dynamic global vegetation models and robust predictions of shifts in vegetation, ecosystem functioning and vegetation-climate feedbacks.

Tue_196_BE-4_1737
Effect of Detached Algae and Predation on Soft-bottom Communities in Both Poles

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The polar areas are being affected hard by the climate change. By altering the characteristics of the marine ecosystem in both poles. In case of the sedimentary communities, which have been very little studied mostly in relation to the importance of the biological factors (i.e. consumption, competition and bioturbation) on the dynamic, structure and diversity of the communities.
The increase in climate change has led to an get increased in the storms, and therefore a greater action of waves on sessile organisms such as seaweeds. Which are detached, and afterwards stranding in the intertidal or staying at the bottom. These deposits of algae could attract predators, provide protection, perhaps to be a nursery, or this maybe physically disturbed the organisms that live in the soft sediment. This could trigger a change in the structure and dynamics of the community.
During 2017 work was done in the Arctic. There, samples were taken from soft bottom communities (intermareal and subtidal) characterizing the community through species richness, individual number, Shannon index and Evenness, as well as biomass. At the same time, field experiments are carried out to determine the effect of detached algae and the exclusion of predators on population dynamics. These activities will be repeated in Antarctica during the 2018 campaign.
Experiments and sampling will determine the degree of incidence of detached algae and the presence of predators in these communities.

Tue_197_BE-4_1932
Thermal Stress Response in Arctic and Antarctic *Pseudogymnoascus* spp. Soil fungi

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Pseudogymnoascus fungi, commonly isolated from polar soils, have been shown to secrete high levels of extracellular hydrolase enzymes (EHE), suggesting a role as important decomposers. *Pseudogymnoascus* has been shown to yield varying levels of enzymatic activity across different temperatures, but not much is known about their initial response to heat stress and how this modulates EHE production. We sought to measure the expression of known molecular markers of stress response following heat challenge. Three possible orthologs of *Saccharomyces cerevisiae* HSP70 genes (SSA1, SSA2, SSA3 and SSA4) and one possible ortholog of HSP90 (HSP82 and HSC82) were identified among available *Pseudogymnoascus* spp. protein predictions. Primers for quantitative real-time PCR were designed to amplify these identified orthologs (named HSP70A, HSP70B, HSP70C, HSP90) as well as nine putative reference genes. Two Arctic and two Antarctic strains were cultured at 15°C (ideal temperature) for 5 days then transferred to 25°C (heat challenge temperature) for 2 hours. Similar degrees of gene expression changes were observed in all four polar isolates. Expression of HSP70A, HSP70B and HSP90 was induced following heat challenge, suggesting thermal stress response was elicited. HSP70B and HSP90 showed greater upregulation and thus may be good candidates to serve as molecular markers for heat stress in *Pseudogymnoascus*. This study will be expanded to include temperate strains and time-course experiments.

Tue_198_BE-4_1996
Photosynthetic Activity of Marine Phytoplankton in the Antarctic Peninsula

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The photosynthetic activities of coastal marine microalgal community in the Antarctic Peninsula were investigated during the Malaysia Antarctic Scientific Expedition 2016 conducted from 13th January to 14th February 2016. A total of 7 stations were investigated along a southbound transect from King George Island (62°S 58°W) to Darboux Island, Graham Coast (65°S 64°W). Sea water temperature varied from 10.5°C to -1.2°C during the sampling. Microalgae communities were dominated by diatoms within the genus of *Odentella, Proboscia, Eucampia, Chaetoceros, Coscinodiscus* and *Thalassiosira* during the study. The ratio of variable to maximum fluorescence, a measure of maximum quantum yield of photosystem II (Fv/Fm) was recorded at Darboux Island with a value of 0.291, whereas the minimum Fv/Fm of 0.053 was measured at Trinity Island. Statistical analysis shows that although temperature, pH and light intensity, and nutrients (ammonia, orthophosphate, nitrite and nitrate) were significantly different ($p < 0.05$) among the sampling stations, photosynthetic activities of coastal marine microalgae in the Antarctic Peninsula were mainly driven by nutrients (mainly phosphate and nitrogen).

Tue_199_BE-4_2008
Predicting Diatom Diversity in the McMurdo Dry Valleys with Metacommunity Models

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Diatoms represent a diverse group of primary producers that reside in microbial mats in aquatic habitats in the McMurdo Dry Valleys. Recent work has shown that different factors control diatom biodiversity in stream and pond ecosystems. Glacier-fed streams provide intermittent habitats where flow permanence can vary widely depending on the geomorphology of the catchment and factors controlling glacier melt. Alternatively, ponds provide insulated and persistent habitats for microbial mats and their resident diatoms. As such, diatom community composition is predicted by flow permanence in streams, whereas variation in diatom biodiversity among ponds appears to be better explained by dispersal dynamics and colonization history. Numerical models provide a tool to test alternative hypotheses about the underlying processes that shape observed biodiversity patterns, and make informed predictions about biodiversity in future climate scenarios. Here we present advances in a metacommunity simulation package for R (MCSim) and demonstrate how it can be used to test alternative community assembly hypotheses to explain freshwater diatom biodiversity data that was collected by the McMurdo Dry Valleys Long Term Ecological Research (MCM-LTER) program. Further, we demonstrate how parameterized simulations can be used to predict biodiversity metrics, such as beta-diversity (among-pond or among-stream variation in community composition), in altered climate scenarios.

Tue_200_BE-4_2075
Down-fjord Changes in Macrobenthos in Glacially Influenced Andvord Bay, WAP

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Glaciomarine fjords exhibit substantially different ecosystem forcing than adjacent continental shelves and can be highly sensitive to climate warming. Extensive research indicates that subpolar Arctic fjords are heavily influenced by glacial meltwater/sediment inputs, resulting in high turbidity and seafloor burial rates, yielding macrofaunal communities with low abundance and diversity. In contrast, poorly-studied sub-polar fjords along the Western Antarctic Peninsula (WAP) sustain weak meltwater influences, resulting in low turbidity and seafloor burial rates. Thus, benthic communities in WAP fjords may not currently be limited by turbidity and burial disturbance, and have the potential to harbor abundant and diverse macrobenthic communities. Here we characterize the benthic macrofaunal community of Andvord Bay, a subpolar fjord along the warming WAP. We compare down-fjord changes in macrobenthic abundance, diversity and functional-group structure to a variety of potential ecological drivers including sediment burial rate, sediment Chl-a concentration (an indicator of labile detritus availability), and sediment-community respiration (an indicator of seafloor detrital carbon flux). Benthic abundance is high in mid-fjord, and is most strongly correlated with carbon flux and food availability, while burial disturbance may occur only within 1-kilometer of actively flowing tidewater glaciers. These patterns are likely to change as warming increases meltwater/sediment inputs.

Tue_201_BE-4_2097
Plant-endophyte Association: Tolerance Mechanism to Drought Stress in Antarctic

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One of plants mechanisms for stress tolerance is the functional symbiosis such as endophytism, which is defined as the mutual association of a plant with a microorganism, which lives inside the tissues of the plant without causing any symptom of disease. On the other hand, Antarctica is known as one of the most stressful environment, due to its extreme aridity and subzero temperature, however, despite the adverse conditions it is possible to find two vascular plant species: Deschampsia antarctica and Colobanthus quitensis. The presence of C. quitensis in Antarctica stands out above D. antartica, due to the fact that it has not been possible to establish a charasteristic to survive such extreme conditions. In this investigation, we compared the production of total soluble sugars, proline and oxidative stress in individuals of C. quitensis with endophytic fungi (E+) and without endophytic fungi (E-) under optimal irrigation (H+) and drought stress conditions (H-), concluding that the presence of endophytes plays an important role in the mechanism of tolerance to stress, since in individuals E+, there is a higher production of sugars and less damage by oxidative stress. Besides, this pattern was observed in three sampling sites along a latitudinal gradient from -53° to -67° latitude (South of SouthAmérica, Polish Base Arctowski and Lagotellerie in Antarctica), being individuals from more stressful sites more dependent on the presence of endophytes to tolerate drought stress.

Tue_204_BE-4_2348
Transcriptome of the *Branchinecta gaini*: Unraveling the Thermal Stress Response

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The Antarctic fairy shrimps crustacean *Branchinecta gaini* (Branchiopoda, Anostraca) inhabits freshwater lakes and pools in Antarctica, one of the most hostile environments on earth. In Maritime Antarctica occurs in several fresh water lakes in Fildes Peninsula (King George Island, South Shetland Islands). This crustacean showed a great physiological flexibility to support highly fluctuating environments. Despite their adaptations for cope a high environmental variability, transcriptome studies have not yet been performed on this crustacean. RNA samples were extracted from a pool of adults individuals and the sequencing was performed using the Illumina platform HiSeq2500. Over 48 million total reads were assembled into 43,847 contigs. 16,503 annotated genes were obtained and they represent 36,68 % of total transcriptome. A total of 57 GO terms in three ontologies was obtained. *B.gaini* expressed several heat shock proteins like as Hsp90, Grp94, Hsp70, Hsp40 and proteins related to ubiquitin mediated proteolysis. These data sets are the first transcriptome resource for this Antarctic Brachiopoda and constitute the first step toward further studies linked to stress response, phylogenetics or molecular mechanics to stress response.

Tue_205_BE-4_2404
GHG Emissions Potentials in Maritime Antarctica

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Soil development and nutrient cycling are the main drivers of greenhouse gas production in terrestrial ecosystems of Antarctica. Vegetation cover, biological influence, temperature and soil moisture strongly affect this dynamic. Thus, the objective of this work was to evaluate the potential of greenhouse gases production in lab of the main terrestrial ecosystems in a toposequence in King George Island, Maritime Antarctica, under different temperatures (-2, 4, 6 and 22ºC). Greater N_2O emissions were observed in *Deschampsia - Prasiola* communities, under ornithogenic influence, reaching 22.58 ngN/gsoil/day at 6ºC. Higher CH_4 emissions were observed in Moss Carpets and Fanerogamic Communities, showing greater variations at 6ºC (2.67 ngC/g_soil/day). Lichen community presented low potential of emission in elevated positions of the landscape, with similar behavior of bare soil. We observed elevated CO_2 emissions in Fruticosus Lichens community at 22ºC (22.08 ugC/g_soil/day), followed by Fanerogamic Communities. Biological activity and increasing temperatures enhances the potential of greenhouse gases emissions, especially in communities with ornithogenic influence and vegetation coverage.

Tue_206_BE-4_2463
Increase Temperature Favors the CO_2 Assimilation of Antarctic Vascular Species

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Under *in situ* warming experiment we have detected that the increase temperature favors the carbon gain of only one Antarctic vascular species, *Colobanthus quitensis*; whilst *Deschampsia antarctica* seems to be less responsive.Our *in situ* warming experiments increasing daytime temperature by about 3 ºC. However, climate change predictions indicate that event of supra-optimal temperatures become more prevalent. This raises the question of whether the differential response between Antarctic species depending on the magnitude of the increase temperature. In other words, would *D. antarctica* be able to show a similar response facing higher temperature increases? With this aim,Antarctic species were cultivated in room chambers at 5, 10 and 16 °C. Increase temperature favored the net photosynthesis (A_N) of both Antarctic species. However,*D. antarctica* requires higher increase temperature to respond. In both species, higher A_N were triggered by a reduction in mesophyll conductance, accompanied by changes in leaf anatomy. Therefore, in the long term, it is possible to assume that both species could be affected by regional climate change and their ability to respond will depend not only on functional but also structural adjustments that allow them to grow under the new conditions.
Acknowledgments: FONDECYT 11130332, PIA ART-1102, INACH RT 13_16 and H. Arctowski Polish Antarctic Station.

Tue_207_BE-4_2493
Transcriptome of Antarctic-endemic Sponge Reveals Heat Shock Proteins Expression

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At the molecular level, the production of heat shock proteins (HSPs) has been commonly used as an indicator of environmental stress. HSPs are highly conserved proteins that act as chaperones to stabilize and refold denatured proteins, preventing the formation of cytotoxic aggregates. The production of HSPs is a potential ecophysiological mechanism whereby Antarctic sponges can adapt to thermal stress; however, there is mixed evidence that HSPs are an important regulating mechanism in Antarctic organisms. In some Antarctic marine invertebrates the expression of HSP is absent. Although, previous studies on sponges from tropical waters have reported that thermal stress produces rapid molecular shutdown of sponge's molecular systems and increased expression of HSPs, the effect of heat stress on Antarctic sponges remains largely unexplored. In order to identify the heat stress protein in the Antarctic sponges, we obtained a reference transcriptome of Antarctic-endemic sponge *Isodictya* sp. resulted in 125,873 transcripts with an average size of 812 bp. In depth analysis of the data revealed an extensive catalogue of the cellular chaperone systems. Full length sequences were characterized for the chaperones HSP70 and several isoforms were identified during the thermal stress at 3°C and 5°C. Further studies of qPCR analysis will be used to validate changes in the transcript abundance of HSP70 during the heat shock.

Tue_208_BE-4_2515
Long-term Effects of Climate Change on High Arctic Plant Species

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Rapid climate change leads to changes in the structure and composition of Arctic tundra plant communities with unknown consequences for ecosystem functioning. Plant traits act as key mechanisms explaining feedbacks between climate change and vegetation. We investigated how elevated temperatures and altered snowmelt regimes affect common tundra plant species in a High Arctic evergreen shrub heath community at the International Tundra Experiment (ITEX) site at Alexandra Fiord on Ellesmere Island, Nunavut, Canada. A factorial experiment combining passive warming, snow removal, snow addition and control treatments was established in 1995. We examined phenological, growth and leaf functional trait responses of six common tundra species to two decades of experimental warming and altered snowmelt regimes. Snowmelt timing primarily controlled early season phenology, but had less influence on later phenological stages, on growth and leaf functional traits. Experimental warming generally advanced flowering and seed ripening. Warming effects persisted over the course of the growing season increasing plant growth, but had little effects on leaf functional traits. Our results underline the importance of understanding how interactions of temperature and snowmelt timing drive plant species responses to climate change in the Arctic.

Tue_209_BE-4_2528
The Distribution of Aerotechnogenic Pollutants on Islands of Arctic

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In this study, the results of a year research in the field of Arctic ecology will be considered. This research took place in different islandic territories of Arctic, such as Franz-Joseph Land, Novaya Zemlya, Svalbard, Iceland, Faroe islands. All of these islands are located in the western sector of Eurasian Arctic. In summer 2017 I took moss samples on several islands: Franz-Joseph Land (Heiss, Alger, Hooker islands), Novaya Zemlya (cape Zhelaniya on Northern island), Faroe islands (Sandoy, Mykines, Vágar, Streymoy). Also I have samples that were taken in Svalbard (with help of glaciology students in July, 2017) and Iceland's samples data (taken earlier by MSU research group).
The main goal of this investigation is deep analysis of spatial distribution of aerotechnogenic pollutants in Arctic and mapping it. Knowing the pollution values can help to investigate what affects the ecosphere of these islandic territories.
The main moss samples are mostly represented by following species: Tomentyphnum nitens, Sphagnum, Flavocetraria, Calliergon, etc. All of them have gone through the process of atomic absorption spectrometry analysis which is a procedure for the quantitative determination of chemical elements using the absorption of optical radiation by free atoms in the gaseous state. This type of analysis is considered as one of the most-used type of bioindication.
The results of this research will be represented in Moscow State University in may, 2018.

Tue_211_BE-4_2621
Meroplankton and Potential for Benthic Colonization in High-Arctic Ecosystems

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Barnacles (Crustacea: Cirripedia) are an important group of organisms in marine ecosystems, but they are also meaningful from the human perspective. They have big potential for biofouling, which is a significant vector for transferring invasive species. Furthermore, spreading over large distances and colonization of new territories is possible due to possessing planktonic larvae. Still, knowledge about larval development is scarce and because of their small sizes, differentiation of species by morphological methods is almost impossible.
We studied the timing, growth and duration of Cirripedia larvae year-round in a high Arctic fjord Adventfjorden (Spitsbergen). Zooplankton community analyses revealed that cirripedia occasionally was found in February-March, but first busted in abundance in late April at the onset of the spring bloom. DNA barcoding revealed the presence of two species: *Balanus balanus* and *Semibalanus balanoides,* of which the first one totally dominated the zooplankton community in April-May during the peak spring bloom. Image analyses based on photographs taken prior to molecular identification allowed to estimate the duration of each larval stage, including nauplii and cypris, and their growth over 300µm.
Long pelagic presence, large potential for biofouling on ships and larger plastic debris, combined with the disappearance of landfast sea ice and thus less ice scouring opens new opportunities for barnacles to colonize high-Arctic littoral zone.

Tue_212_BE-4_2632
Why the Arctic *Calanus glacialis* and Boreal *C. finmarchicus* Cannot Hybridize?

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Due to the recently observed climatic changes copepods are shifting their spatial distribution northwards, and increasing numbers of boreal species co-occur with the Arctic ones, what may potentially lead to interbreeding between sibling species. We determined the nearly complete mitochondrial genomes of the Arctic *Calanus glacialis* and its North Atlantic sibling *Calanus finmarchicus*, which are key zooplankton components in marine ecosystems. The sequenced part of *C*. g*lacialis* mitogenome is 27,342 bp long and consists of two contigs, while for *C. finmarchicus* it is 29,462 bp and six contigs, what makes them the longest reported copepod mitogenomes. The typical set of metazoan mitochondrial genes is present in these mitogenomes, although the non-coding regions (NCRs) are unusually long and complex. The mitogenomes of the closest species *C. glacialis* and *C. finmarchicus*, followed by the North Pacific *C. sinicus*, are structurally similar and differ from the much more typical of deep-water, Arctic *C. hyperboreus*. This evolutionary trend for the expansion of NCRs within the *Calanus* mitogenomes increases mitochondrial DNA density, what resulted in its similar density to the nuclear genome. Large differences in the length and structure of the sibling *C. glacialis* and C. *finmarchicus* mitochondrial genomes indicate that the species are genetically distinct and have evolved independently for quite a long time. Thus, it seems unlikely that *C. glacialis* and *C. finmarchicus* can hybridize.

Tue_213_BE-4_2672
Effects of Sea Ice on Arctic Biota

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The rapid decline in Arctic sea ice (*ASI*) area and volume during recent decades poses urgent questions regarding its effects on Arctic biota. These trends are occurring before we can understand many of the mechanisms through which *ASI* is coupled with biological processes both at sea and on land. This, in turn, hampers our ability to predict and manage the consequences of this enormous environmental change, making this a *crisis discipline*. Here, we propose a framework to study these effects, defining *direct effects* as those acting on life history events of Arctic biota, and *indirect effects*, where *ASI* acts upon biological systems through chains of events, normally involving weather/climate and/or biotic interactions. Examples of these processes, and of the array of methodologies used to study them, are presented. Given the breadth and complexity of *ASI*'s effects on Arctic biota, Arctic research requires a truly multidisciplinary mindset to address this issue. In the absence of effective global efforts to tackle anthropogenic global warming, *ASI* will likely continue to decrease, the conservation of many *ASI*-related taxonomic groups and ecosystems becoming severely compromised, with mitigation actions limited to other processes that interact with the biological effects of *ASI*, such as industrial human activities.

Tue_214_BE-4_2680
Phylogeography of *Halicarcinus planatus*: First Marine Alien Reaching Antarctica

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Climate change directly impacts and shapes the biodiversity. Biological invasions are a crucial component of global change, but also a threat to native biodiversity. Antarctica remains the most pristine and isolated continent surrounded by oceanographic, bathymetric, climatic and geographic barriers. Shallow marine benthic communities around Antarctica exhibit high levels of endemism, gigantism, slow growth, longevity and late maturity. The decapods are highly abundant and diverse in the Subantarctic but almost completely absent from the shallow Antarctic benthos. The West Antarctic Peninsula (WAP) is one of the areas most affected by global warming thus enhancing the probabilities of introduction of alien species. In 2010, a mature female *Halicarcinus planatus* was reported in Deception Island (WAP; Aronson et al., 2015). This species has a circum-subantarctic distribution, a low bathymetric range, an extended planktonic larval duration. In the Subantarctic, the genetic diversity of *H. planatus* is high and the phylogenetic relationships (mitochondrial and nuclear locus) between the Magellanic Region, Falklands/Malvinas Islands and Kerguelen Islands indicates a recent connectivity. However, some genetic differentiation is observed between close locations. An appraisal of the presence of *H. planatus* along the West Antarctic Peninsula at the end of our two first Antarctic expeditions is detailed.

Tue_215_BE-4_2685
DREB/CBF Analysis in *Colobanthus quitensis* (Kunth) Bartl., under Abiotic Stress

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Colobanthus quitensis is one of the two vascular plants native to Antarctica. Antarctic enviromental conditions are highly stressful for terrestrial vegetation, for example; low temperatures, low water availability and high winds are combined to make this continent a hostile habitat. Transcription factors DREB / CBF type, regulators of the response to abiotic stress, are activated by low water availability, low temperatures and salinity. The knowledge of this type of transcription factors in *C. quitensis* until now is limited. From the transcriptome sequenced antarctic *Colobanthus quitensis* fifteen putative sequences with a high percentage of similarity from DREB / CBF family were obtained. From these fifteen sequences, eight of them present a high percentage of identity for homologous genes and also present the APETALA2 (AP2) domain, characteristic for the family of this type of transcription factors. An analysis of the sequences, alignment and phylogenetic analysis were performer. Primers were design for eight sequences with greater identity. Results from quantitative real time PCR, showed significantly high levels of relative expression of putative DREB/CBF Colobanthus quitensis genes in response to abiotic-stress treatments.

Tue_216_BE-4_2690
Spiders in Warmer, Wetter Climates Experience Higher Rates of Egg Sac Parasitism

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Host-parasite relationships can be important drivers of population dynamics with community-level consequences. Although these relationships are often studied by monitoring populations through time, spatial variation also plays a role in shaping dynamics of host and parasite populations. In the Arctic, frequent turnover in arthropod community composition between habitats suggests that host-parasite dynamics also vary across the landscape. Moreover, differences in species-specific responses to rapid climatic changes are expected to result in altered host-parasite dynamics, although it is unclear what the primary drivers of these dynamics may be. Here I show that while rates of parasitism in wolf spider egg sacs by parasitoid wasps differ along a latitudinal gradient of tundra in Alaska (0-18%), they are not related to wolf spider population sizes, abundance of egg sac prey, or to abundances of potential parasitoid wasps. Rather, higher rates of parasitoid attacks on wolf spider egg sacs occur in areas that have warmer and wetter climates. Climate projections for N. Alaska include warmer temperatures and increased precipitation, suggesting that wolf spiders may experience higher rates of parasitism in the future with potential consequences for their population dynamics. As wolf spiders are one of the most abundant predators across much of the Arctic, increasing parasitism rates could also have cascading effects on lower trophic levels and on ecosystem functioning.

Tue_217_BE-4_2692
Integrative Biogeography in Southern Ocean Mollusks

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The biogeography of the Southern Ocean marine benthic biota and its current bioregionalization are the consequence of major tectonic, oceanographic and climate changes during the last 50 Ma. Here, we present new biogeographical analyses based on nuclear and mitochondrial markers in different groups of near-shore benthic mollusks with contrasting developmental modes that are currently distributed in different provinces of the Southern Ocean; direct developers (*Margarella*, *Laevilitorina*, and *Siphonaria*) and broadcast-spawners (*Nacella,* and *Yoldia*). In general, all groups exhibited major levels of genetic divergence between Antarctic and Subantarctic provinces suggesting that the Antarctic Polar Front is an effective biogeographic barrier. Phylogeographic analyses recorded low levels of genetic diversity in Southern Ocean mollusks as a consequence of Quaternary glacial processes that affected population sizes. Surprisingly, direct developers (*Margarella*, *Siphonaria)* exhibited high levels of genetic identity, thus supporting that rafting as an important biogeographic mechanism in the Southern Ocean. In contrast, broadcast-spawners (*Nacella, Yoldia)* showed marked genetic distinction among distant Subantarctic provinces. In this case, life-history traits constrains prevent long-dispersal through larvae in these groups. Finally, current biogeographical patterns in Southern Ocean mollusks are not related to particular groups but to historical and contemporary processes.

Tue_218_BE-10_67
Functionality of the Aryl Hydrocarbon Receptor 2 in Antarctic Notothenioid Fish

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The Aryl hydrocarbon receptor (Ahr) pathway is a common entry point for the biological activity of dioxin-like compounds. Currently, no information exists on the presence and functionality of the Ahr in Antarctic notothenioid fishes.
Several proteins have been lost in in Antarctic fish. We aimed to investigate if Antarctic notothenioids have conserved a functional Ahr. Specifically, we identified and cloned the Ahr2 sequence and tested its sensitivity to Ahr model-agonists *in vitro* using a luciferase reporter gene assay in which COS7-cells were transfected to express the Ahr2 ligand binding domain of the red-blooded *Trematomus loennbergii* and the white-blooded *Chionodraco hamatus*, originating from the Weddell Sea.
We firstly demonstrated that Antarctic fish express Ahr2 in liver and found that the Ahr2 of both species was activated by Ahr agonists (e.g. Benzo(*a*)pyrene & dioxine-like PCBs) in the ligand binding assay. The activation was similar or only 50% in the Antarctic fish compared to the response of the Atlantic cod (*G. morhua*) ligand-binding domain, which served as reference.
Our study revealed that Ahr2 in (the investigated) Antarctic fish have retained the ability of being ligand-activated, and could potentially induce the Ahr2-mediated toxicant metabolism. We thus conclude that Antarctic fish might have the capability to handle anthropogenic pollutants, yet differences in the induction capability and thus xenobiotics metabolism rate may exist to temperate zone fish.

Tue_219_BE-10_392
Regulation of a Lost Inducible Heat Shock Response in Antarctic Fishes

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The perciform suborder Notothenioidei is comprised of Antarctic and sub-Antarctic fishes, several of which have lost their ability to rapidly upregulate major heat shock proteins (HSPs) in response to stress. Rather, inducible HSPs such as the hsp70 and hsp90 families are constitutively expressed under normal environmental conditions and do not upregulate following oxidative damage to the cell. While it was initially suggested that the constitutive expression of HSPs resulted from constant cold-denaturation of the proteome, inducible HSPs are not downregulated by these species following reduced protein damage. It is plausible that this trait is attributed to functional alterations in regulatory elements of the inducible heat shock response (HSR). In order to identify genomic divergence within Notothenioidei that may confer the loss of an inducible HSR, we sequenced the full coding region of the transcription factor HSF1 as well as genome-wide, cis-acting heat shock element (HSE) motifs in two members of the Nototheniidae family: Trematomus bernacchii, which has lost induction of the HSR, and Notothenia angustata, a temperate notothen exhibiting a classical HSR. We have compared the degree of conservation between HSF1 orthologs in both species in addition to their homology and spacing of HSE repeats. These results provide insight into how the regulation of inducible proteins can be modified to confer constitutive expression or activation as a process of adaptation.

Tue_220_BE-10_1776
Evolutionary Adaptation Potential and Population Structure of *Notothenia* spp

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Global change is fundamentally altering marine ecosystems of Antarctica, albeit with at times opposite effects in different areas, e.g., decreasing or increasing sea ice cover. Marine organisms are expected to cope variably with these changes; some may benefit, while others face extinction. Adaptation to changing environmental conditions is one option to avert demise. Standing genetic variation is key for this as it can facilitate adaptation at much faster rates than adaptation from new mutations. In this context, knowledge of genetic diversity in time and space is important to investigate evolutionary adaptation potential of Antarctic species. We use reduced representation sequencing to genotype thousands of genetic markers in the Antarctic fish *Notothenia coriiceps* and *Notothenia rossii*. We assess genetic variation and differentiation, particularly in the Western Antarctic Peninsula region. Furthermore, we employ a series of genome scan methods to detect loci that are putatively under selection, i.e., showing signs of recent evolutionary action. Combining patterns of neutral and adaptive genetic variation can give clues as to how species have evolved in the past and how they may react to rapid changes in the future.

Tue_221_BE-10_2087
Identifying Thresholds for Cellular Stress Responses to Heat in Antarctic Fishes

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The fishes of the Southern Ocean display profoundly cold-adapted physiologies due to their long evolutionary history in the extreme cold. As oceans warm, these fishes are poised to act as bellwethers for the likely impacts of small incremental rises in water temperature. While the fact that these fish possess some of the lowest upper thermal tolerance limits of any vertebrate species has been established, the impact of sub-lethal heat stress is not as well characterized. Here, we measured the effects of increases in temperature on thermal tolerance and cellular stress responses in the common Antarctic rockcod genus, *Trematomus*. Interspecific differences in thermal tolerance and heat shock protein expression were characterized among co-occurring *Trematomus* spp. from McMurdo Sound. Flow cytometry revealed perhaps the lowest upper thermal threshold for the onset of programmed cell death in any vertebrate species, with significant increases in the number of hepatocytes entering apoptosis occurring at only 2°C. A key cell cycle arrest regulator was also induced by heat in these fish. Together these findings provide evidence at the cellular level that even seemingly minor elevations in temperature produce deleterious impacts on species from extremely cold environments.

Tue_222_BE-10_2128
Correlation between Degree of Herbivory and Gut Morphology in 8 Notothenioids

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Although many notothenioid fishes are primarily carnivorous, some species consistently feed on macroalgae and are therefore omnivorous. The degree of herbivory is reflected in the morphology of the digestive tract especially intestine length. We examined a large number of juvenile and adult specimens of eight sympatric notothenioid species collected at Potter Cove during eight consecutive seasons. We compare, in most cases for first time for an ontogenetic series, the distinct proportions of algae and animal prey in their diets (W %), and provide their relative intestine lengths [RIL= (IL/SL)*100]. Based on this correlation a “ranking” or degree of herbivory is established for the fish species analysed, and this was found to be related to their distinct feeding types and strategies. The benthos feeders *Gobionotothen gibberifrons*, *Notothenia coriiceps*, *N. rossii* and *Trematomus bernacchii* were the most herbivorous with higher RILs (> 70%). Conversely, *Lepidonotothen nudifrons*, *T. newnesi* and *Harpagifer antarcticus* were predominantly carnivorous, with lower and intermediate RILs values (< 43-52%). Our results are discussed in context of gut morphology, trophic ecology and buoyancy as aspects of their divergence into to the trophic web of the Antarctic ecosystem.

Tue_223_BE-10_2331
Notothenioids in the Ichthyoplankton at Potter Cove, South Shetland Islands

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At Potter Cove, King George Island/Isla 25 de Mayo, significant ichthyological research has been conducted in the last three decades, mainly on general ecology of notothenioid species in demersal stages from young juveniles to adults. Nevertheless, the knowledge of the ichthyoplankton composition in the cove, necessary for the overall comprehension of the species life-cycles, remained unexplored. Herein we report the first record of early stages of Antarctic notothenioids collected in pelagic hauls at Potter Cove in summers of 2014 and 2016 at depths of 6-9 m from the surface, where total bottom depth ranged 30-190 m. The ichthyoplankton consisted of a), 37 larval stages (preflexion and postflexion) of the species *Harpagifer antarcticus* (the most abundant), *Psilodraco breviceps*, *Lepidonotothen squamifrons*, *Pleuragramma antarcticum* and *Trematomus scotti*; b), 15 eggs of *Notothenia coriiceps*, of which two larvae hatched in aquarium. Part of this material is illustrated with photographs. The presence of early life stages of fish in the cove is linked to the major influx from the Bransfield Strait and also depends on local environmental conditions (i.e. hydrologic, water circulation). In addition to the spawning behavior of *Parachaenichthys charcoti* already reported in the literature, nearshore localities of the South Shetland Islands such as Potter Cove appear to be spawning sites also for *N. coriiceps* and *H. antarcticus.*

Tue_224_BE-10_2373
Lipid Dynamics and Trophic Patterns of Antarctic Silverfish in the Weddell Sea

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Antarctic silverfish (*Pleuragramma antarctica*) are a keystone species in the Southern Ocean, providing an essential link between trophic levels. Pelagic throughout all of their life history, with an energy-efficient foraging strategy, *P. antarctica* population structure is heavily impacted by hydrography and bathymetry. Considering the role of water mass dynamics in the distribution and availability of *P. antarctica* prey species, prey consumption might vary depending on the local hydrographic environment. High abundances of silverfish have been found associated with trough systems in the Weddell Sea. While much is known about the trophic plasticity and habits of adult *P. antarctica*, these data largely come from outside of the Weddell Sea, or from stomach content analysis which tends to represent only a snapshot of an organism's diet in time and space. In this context, we sought to provide a more comprehensive outlook on silverfish diet in the Weddell Sea by employing a lipids-based analysis illustrative of feeding over periods of weeks to months by analyzing fatty acid composition in adult *P. antarctica* and potential prey species. The question of diet variation within the Weddell Sea was framed in a hydrographic context by comparing diet in fish located along a trough inflow in the Filchner Trough, with those collected along the continental shelf near Halley Bay. Our results are a first step towards uncovering how physical-biological interactions impact silverfish diet.

Tue_225_BE-10_2416
Climate Change and Mitochondrial Metabolism in High-Antarctic Notothenioids

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Climate change affects the ocean systems world-wide by unprecedented rates of warming, acidification and deoxygenation. Marine fish possess physiological mechanisms of coping with these drivers, yet to a different extent in different species. While species from habitats with large diurnal or seasonal fluctuations in temperature, PO_2 and PCO_2 are naturally better adapted to cope with changing habitat conditions, especially Antarctic fish have been proposed to display very little metabolic plasticity to cope with a warming and acidifying ocean.
To shed more light on the fate of cold-adapted fish in a changing ocean, we investigated the metabolic capacities to cope with ocean warming and acidification in several high-Antarctic notothenioids, including red- and white-blooded species, during the RV Polarstern cruise ANT XXXI-2 to the southern Weddell Sea.
Much of the recent climate change research on fish has looked into effects at the whole animal level, while knowledge of the acclimation and adaptation potential of lower levels of organisation, e.g. metabolic pathways, is scarce. We thus focussed on the basis of sustainable aerobic energy metabolism, mitochondrial ATP formation, and investigated the acute effects of warming, rising intracellular PCO_2 and $[HCO_3^-]$ on the performance and efficiency of the involved biochemical pathways in isolated mitochondria and permeabilised muscle fibers.

Tue_226_BE-10_2469
Antarctic Silverfish *Pleuragramma antarctica* - Condition and the Role of Lipids

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The Antarctic silverfish, *Pleuragramma antarctica*, is a key species in the high Antarctic food web and threatened by direct as well as indirect effects of climate change. The lack of a swimbladder is compensated in this pelagic fish by high amounts of lipids which make up to 60% of dry weight, and the functional role of these lipids is discussed since decades. The lipids are not stored in common adipose cells but in intermuscular and subcutaneous lipid sacs, indicating that the lipids might be decoupled from metabolism, i.e. the lipids' role is limited to buoyancy. If the stored lipids are not available as energy reserve, *Pleuragramma*'s capability to cope with indirect effects of climate change such as (temporal) changes in prey availability and food shortage would be extremely low.
To gain deeper insight, data from several regions with different primary production were compared using a combination of classical ecological methods and Magnetic Resonance Imaging (MRI). Fish condition was found to vary strongly between different regions and these variations were reflected in total amount of lipids and in the size of the lipid sacs.
The data clearly show that the functional role of lipids in *Pleuragramma* is not exclusively limited to buoyancy but lipids may be used as energy reserve for periods with limited food supply.

Tue_228_BE-10_2695
Evaluation of the Dispersal Capacity of Sub-Antarctic Crab *Halicarcinus planatus*

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Atmospheric temperature in the West Antarctic Peninsula has increased between 5 and 6°C in the last 50 years. In the mean time, human activity (scientific and tourism) has dramatically increased in Antarctic, and so did the number of exotic species that reached the Antarctic. Until recently, there were no report of marine exotic species established in the shallow Antarctic ecosystem. However, in 2010, an ovigerous female of *Halicarcinus planatus* was reported in the shallow waters of Deception Island (Aronson et al; 2015). *Halicarcinus planatus*, is a small brachyuran crab distributed in southern South-America and Subantarctic islands, with a planktonic larval phase of 45 to 60 days. Moreover, *H. planatus* has the ability to down-regulate hemolymph's Magnesium ion concentration below sea water concentration, that would help to survive in Antarctic cold waters. Through population genetics analysis using SNPs, the population structure and connectivity of *H. planatus* will be evaluated at three different geographical scales: across the Southern Ocean (between Patagonia and Kerguelen), between Patagonia and Falkland Islands, and at regional scale among three locations in Patagonia (Punta Arenas, Beagle Channel and Tortel Cove). The potential of dispersal and capacity to broadcast to the West Antarctic Peninsula will then be discussed. Financial support: Fondecyt 1161358 and INACH DG_14_17.

Tue_229_CR-1_138
A Comparison of the Frost Environment of Three Disparate Climatic Locations

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Frost processes occur across climatic zones and warming temperatures affect regions where climatic thresholds are narrow. This paper explores the annual, seasonal and diurnal frost environments of three locations: western Dronning Maud Land (WDML) of Antarctica, sub-Antarctic Marion Island, and the High Drakensberg of the Eastern Cape of South Africa. WDML is characterised by annual frost with a paucity of diurnal thaw where permafrost is common and active layers shallow. Permafrost is absent for both sub-Antarctic Marion Island and mainland South Africa. Marion Island is characterised by a dynamic diurnal frost environment, with shallow and high-frequency cycles in evidence. The High Drakensberg of the Eastern Cape of South Africa exhibit seasonal freezing at higher altitudes with frozen ground occurring for up two months at a time at ~ 3 000 m.a.s.l. Global warming scenarios (1°C, 2°C and 5°C increases) and how these affect freezing cycles are explored, as are environmental and locational forcings on freezing cycles observed. Furthermore, results of WDML contribute towards ANTPAS scientific output and research. Higher altitudes show an increase in frost cycles; vegetation cover dampens such cycles. Furthermore, snow cover reduces diurnal frost in WDML, whereas it increases freezing depth on Marion Island. Finally, diurnal frost cycles are highly sensitive to temperature changes and associated thresholds and that such cycles can be used as indicators for warming conditions.

Tue_230_CR-1_139
The Active Layer and Permafrost Environment of Flårjuven (Antarctica): 2008 - 2017

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This paper provides a 10-year synopsis of the ground thermal and moisture regime of Flårjuven (western Dronning Maud Land, Antarctica) and contributes to ANTPAS scientific research and output. Flårjuven is associated with sediment of low organic content (TOC < 0.3%) and a coarse texture (fine gravel; fine earth fraction < 40%). The site is characterised by annual frost with a ground freezing index approaching 6 000. This is associated with a negligible thawing index approaching zero for summer, compared to a high freezing index of ~500 for winter. Annual degree days reflect the insulating effect of snow cover on ground thermal regimes and permafrost is present (average temperature of -19°C), with a shallow active layer (~15 cm). Temperature variability is highest for the active layer and lowest for permafrost. Diurnal thaw is rare, although approximately 15% of all diurnal cycles oscillate above and below 0°C. These potential thaw events occur exclusively during spring and summer months and thaw generally occurs from mid-morning to late afternoon (10:00-17:00), with most thaw events representing single diurnal cycles. An analysis of potential thaw events coupled with ground moisture data recorded show that less than half (~ 45%) of all potential thaw events translate into freeze-thaw events. The greatest active layer depth is reached in December and January, as are the longest ground thaw duration and most freeze-thaw cycles observed.

Tue_231_CR-1_202
Geomorphology and Antarctic Ecosystems in Dronning Maud Land

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Active-layer and ground thermal dynamics, together with periglacial landforms have been researched in the Ahlmannryggen and Jutulsessen areas of Droning Maud Land since 2007. Nine shallow boreholes were used to measure ground temperatures and moisture. All boreholes show distinctive ground thermal regimes from a combination of diurnal and synoptic-scale controls. Additionally, thermal conditions in autumn and spring suggest continent-wide controls.
The Nunataks in the Ahlmannryggen originate from ice-heaved pre-jointed and weathered bedrock that have formed blockfields. A spatial inventory has been developed with records of such landforms together with rock glaciers, unsorted and sorted patterned ground, weathering forms, solifluction terraces, lake ice blisters, and pro-nival ramparts. Many of these landforms are the first examples documented in region. Their presence is controlled by lithology, moisture supply and the substrate. Several of the landforms identified, such as the rock glaciers and pro-nival ramparts are unique and their formation and morphology challenge accepted characterisations.
The Geomorphology of Western Dronning Maud Land has resulted in a landscape that is crucial for the provision of a habitat for the region's biodiversity at a variety of scales. Changes in the landscape, and the associated links between the active layer and biodiversity in a changing climate, provide ideal positions to answer questions created by the SCAR Horizon Scan.

Tue_232_CR-1_284
Current State of Active Layer Research on James Ross Island

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Ulu Peninsula, the northern part of James Ross Island, is the largest ice free area in Antarctic Peninsula region. More than 300 km^2 of ice-free land offer unique opportunity to study active layer, permafrost and related periglacial processes from different perspectives and in variable environmental conditions within the area. Currently, three main topics are under study by the Czech research team:
1) Analysis of driving factors affecting active layer thermal regime and thickness,
2) Modelling of active layer thickness, permafrost temperature and ground thermal parameters,
3) Spatial monitoring of active layer thickness using geophysical methods.
To reach the goals, the network of about 15 sites for ground temperature monitoring (using Pt100 resistance thermometers) in profiles of depth from 2 to 30-200 cm has been gradually established since 2006 and significantly extended after 2014. Every site also provides data on air temperature. Furthermore, at the key sites of the network incoming radiation, albedo, snow thickness and wind speed and direction are measured as well. Additionally, we installed TDR CS616 sensors (Campbell) for soil moisture measurement and HFP01 plates (Hukseflux) for near-surface ground heat flux measurement at the key sites. The geophysical surveying of active layer thickness has been carried out using GPR Ramac CU-II with 500 MHz antenna (Mala Geoscience) and multidepth electromagnetic conductivity meter CMD-MiniExplorer (GF Instruments).

Tue_233_CR-1_452
Sulphur Dynamics in Permafrost Thaw Lakes

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Little attention has been given to sulphur (S) in thaw lakes, but its chemistry is of special environmental importance, since it plays a key role in natural organic matter (NOM) degradation. To understand sulphur dynamics in thaw lakes, we undertook studies in the Canadian subarctic in summer and winter. Water samples and sediment cores were collected from three thaw lakes. Results show that the amount of S is dependent on lake origin: in lakes derived from organic-rich palsa soils, S content is much higher than in mineral lithalsa lakes. NOM is the main source of S in the thaw lakes and its degradation in the water column and/or in the topmost sediment layers dominates S-mineralization. This process was more efficient in winter when the lake surface was frozen, decreasing oxygen availability, thus increasing the activity of sulphate reducing bacteria. Upon removal of lake ice, a rapid increase of sulphate occurred in the near-surface waters (5 cm) followed by its reduction within minutes, indicating the rapid system kinetics for both S reduction and oxidation. In deeper waters, dissolved sulphides promote the precipitation of metal sulphides, resulting in a sediment surficial layer that is enriched in amorphous trace element sulphides. These results show the importance of sulphur biogeochemistry and its strong linkage to lake origin, thus signalling the need for a regional assessment of sulphur related processes, based on broad, in-depth surveys of thaw lake origin.

Tue_234_CR-1_600
A High Resolution Permafrost Thermal Stability Map in the Third Pole

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The Qinghai-Tibet plateau (QTP), which is also called Earth's third pole, is the highest and most extensive plateau in the world. The degradation of “warm” and sensitive permafrost on the QTP has resulted in an increase in environmental fragility and the related hazards. Existing permafrost maps that cover the QTP typically rely on sparse air temperature data and employ continuity-based classification systems. In general, the continuity criteria are scale-dependent, inconsistent, not comparable, and are difficult to use in engineering applications. This study presents a new permafrost map based on the thermal stability classification system. The map was developed using a geographically weighted regression (GWR) model to integrate MODIS (Moderate Resolution Imaging Spectroradiometer) land surface temperatures (LSTs) with leaf area index (LAI) values from the Global Land Surface Satellite (GLASS), soil properties from SoilGrids250, highly accurate soil moisture and precipitation data, and in situ mean annual ground temperature (MAGT) measurements made at 142 boreholes distributed throughout the QTP and acquired in about 2010. Cross validation of the permafrost extent shows that the consistency with the latest permafrost distribution map covering the QTP and borehole measurements at 142 sites exceeds 94%. The new map is of fundamental importance for engineering planning and design to reduce permafrost-related hazards on the QTP in the future.

Tue_235_CR-1_715
OTC-induced Effects on Ground Thermal Regime and Moss Cover in James Ross Island

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Since 2007, a long-term research focused on the effects of climate variability along the eastern coast of the Antarctic Peninsula on the ground temperature (GT) has been carried out. On James Ross Island, GT was measured in the profile at depths of 5, 10, and 15 cm at control plots as well as those with open top chambers (OTCs). The OTCs were installed in a seashore ecosystem dominated by moss carpet (*Bryum pseudotriquetrum*) supplemented with a patchy distribution of more than 20 lichen species. GT regime in the particular depths was continuously monitored and related to presence/absence of OTCs and annual reference meteorological data from a nearby weather station (close to Mendel Base, Czech Rep.). For majority of OTC installations, the GT increase caused by OTC was apparent in the period of September-March. Detailed analysis of chamber effect on the increases in air and surface temperature, GT, and vegetation cover changes was done for austral summer seasons (Dec-2014 to Feb-2015, and Dec-2015 to Feb-2016). OTCs induced an increase in surface temperature, GT, and moss cover area. The increase in temperature was highest in warm radiation days with low wind speed (WS). On stormy overcast days with high WS, the temperature increase was smaller. Consequences of a long-term manipulation of Antarctic terrestrial ecosystems by OTCs for seasonal dynamics of GT are also discussed. **Acknowledgements:** The study was supported by CzechPolar infrastructure and Ecopolaris project.

Tue_236_CR-1_858
The Spatial Distribution of Critical Soil Properties in the McMurdo Dry Valleys

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Despite extreme conditions, a wide range of life forms occurs throughout Antarctic soils, and represent a major part of the Antarctic biodiversity. The spatial distribution of these microbiological communities has been shown to be strongly influenced by soil attributes such as water content, salinity, organic carbon, and pH. But while pedological maps have been published for various ice-free regions across the continent, the spatial distribution of the soil properties (as opposed to genetic classification) is largely unknown.
In this study, we collated different soil surveys in the McMurdo Dry Valleys in order to investigate the spatial distribution of soil properties that are critical for understanding the distribution of life in Antarctic soils: pH, electrical conductivity (EC), organic carbon, and nitrogen. To do so, we used geostatistical analysis to study the spatial structures of these soil properties. Two different sampling depths were considered: the desert pavement (0-2 cm), and the next layer down (2-10 cm), where most of the life forms has been observed. Semi-variograms of the soil properties selected were computed and analysed, and the results can be interpreted in relation to the sampling density that is necessary to capture a given amount of variability in each soil property. Finally, once the spatial structure of these variables has been modelled, maps estimating those soil properties across the region can be produced at the two sampling depths considered.

Tue_237_CR-1_1256
Effect of Mosses on Ground Thermal Regime in Three Different Areas of Antarctica

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The role of vegetation as an insulating factor on ground thermal regime is well-known from Arctic region. However, the knowledge on the interactions between vegetation and ground thermal regime in Antarctica are limited to few studies only from Maritime Antarctica and Continental Antarctica. In this study we evaluate the role of moss carpets on ground thermal regime across latitudinal and climate transect which consists of the sites on Signy Island (60°S, maritime climate), James Ross Island (64°S, maritime to continental climate), Victoria Land (75°S, continental climate) during thawing season 2015/16. The study sites have similar characteristics in terms of altitude, distance from sea and topography. On all sites, ground temperature was measured in profiles under moss carpets and under bare surfaces in depths 2 and 30 cm. The most pronounced effect of moss carpet was observed as smoothing the daily maximums under moss compared to bare ground, which could be lowered by more than 15 °C at 2 cm depth, while about 10 °C difference in maximum was found at 30 cm. This first comparative study of these areas suggest important role of mosses as a very effective insulator of ground temperature in these study areas.

Tue_238_CR-1_1562
Retrogressive Thaw Slumps: Indicators of Holocene Climate Changes

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The ongoing climate warming is expected to increase thermokarst activity and their impacts by inducing permafrost degradation and active layer deepening. A retrogressive thaw slump, which represents the most dynamic thermokarst landform, was investigated in the Peel Plateau region of the Northwest Territories, Canada. The exposed material at the thaw slump represents an opportunity to characterize the cryostratigraphy of the uppermost 5 m of permafrost and to make detailed observations of a thaw layer, a relict thaw layer, and four massive ground ice units. Analyses of the stratigraphy, sedimentology, isotope geochemistry and radiocarbon dating are presented. The main conclusions are that
1) the physical and chemical parameters of the massive ground ice exposed at the thaw slump are characteristic of buried glacier ice that experienced water infiltration and partial refreezing,
2) the relict thaw layer represents the period of maximum active layer deepening which occurred during the Holocene thermal maximum,
3) association of the region's thaw slump activity with paleoclimatic parameters indicate that stream-incised, ice-rich permafrost in formerly glaciated areas, coupled with major rainfall events, represent a set of conditions that is favourable to thaw slump activity.
The conclusions contribute to the understanding of the genesis of thaw slumps and how they fit in the climate history and terrain conditions of the region.

Tue_239_CR-1_1732
Stability of Relic Hydrates in Permafrost of Northern Eurasia and North America

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Global warming contributes to the permafrost degradation with destabilization of methane hydrates and the corresponding methane emissions to the atmosphere. Model estimates of the methane hydrates instability in regions of Northern Eurasia and North America with the risk of gas emission into the atmosphere during the Holocene Climate Optimum (HCO), under current climate changes and for future projections are obtained. The risk of craters and gas emissions into the atmosphere can be characterized by the probability that the strength of the soil upper layer with permafrost would be less than the pressure in the methane hydrate deposits. According to model simulations the regional excess of the annual mean temperature in 2008-2017 relative to the HCO could reach 1.5-2°C at a depth of 10 m in high latitudes of Northern Eurasia and North America. This trend contributes to a higher methane pressure during the dissociation of methane hydrates and a lower strength of the overlying layer of soil. In a number of regions of Northern Eurasia and North America the probability of craters and gas emissions into the atmosphere due to the relic hydrates dissociation is estimated from model simulations to be higher than during the HCO.
The results of model simulations indicate that the formation of craters of the type identified on the Yamal Peninsula in 2014 is associated with a high surface temperature in the regions of Northern Eurasia during last years.

Tue_240_CR-1_1840
Permafrost Thaw Related Surface Displacement in Qaanaaq Village, NW Greenland

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The infrastructure of the village Qaanaaq in NW Greenland suffers from surface displacement due to permafrost thawing. The typical gabble-roofed single-family wooden houses in Qaanaaq are constructed on shallow wooden foundations, which suffer from active layer slope movement and differential settlements from seasonal freeze-thaw cycles.
The aim of this investigation is to assess surface displacements in the Qaanaaq area of NW Greenland from a combination of remote sensing data and in situ measurements.
We have used a number of different techniques and data sources to assess ground movement around the settlement and neighbouring region. This allows a range of temporal and spatial scales to be addressed in the study as well as providing some means of cross-validation of results.
The study uses Sentinel-1 differential radar interferometry, DEM-differencing, long term GNSS survey, ground observations and base maps of the town to determine and validate surface displacements.
Assessment is challenging due to the lack of stable benchmarks in a region where it is likely that surface displacement is occurring non-linearly over a wider area. However, first results indicate that surface displacements occur in order of 3 - 15 cm/yr in the region.

Tue_241_CR-1_1904
The Permafrost Physics Performance of the Coupled CLASS-CTEM Model

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The Canadian Land Surface Scheme (CLASS) and the Canadian Terrestrial Ecosystem Model (CTEM) form the land surface component of the Canadian Earth System Model (CanESM). I present results derived from offline simulations of CLASS-CTEM forced with historical observed meteorology at the same model spatial resolution as CanESM. Model results are evaluated against observations from the Global Terrestrial Network for Permafrost for borehole temperatures (18 sites) and active layer depth measurements (51 sites). Several alternative parameterizations of snow and soil physics are investigated to determine their impact on simulated permafrost on a pan-Arctic scale. CLASS-CTEM, particularly after deepening and increasing the number of soil layers, does a good job of simulating the areal extents of permafrost zones and active layer depths of most sites. Borehole temperatures are more challenging to simulate with some sites well captured but other sites showing large differences between the model and observations. Overall, the model physics appear well suited to simulate the soil environment adequately for permafrost regions.

Tue_242_CR-1_1969
2-D Subsurface Permafrost Structure in the Canadian Beaufort Sea

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Subsurface permafrost formed in the continental shelf of the Canadian Beaufort Sea has been degraded since the last glaciation. Many studies to reveal distribution of permafrost were done using reflection, refraction and well logging method. However, cross section of permafrost distribution was not provided yet. In 2014, Korea Polar Research Institute conducted multichannel seismic survey with the cooperation of GSC of Canada. We applied the full waveform inversion(FWI) to the multichannel seismic data to get inverted 2-D velocity profile. FWI is a data fitting procedure based on wave field modeling and numerical analysis to extract quantitative geophysical parameters such as P-, S-wave velocities and density from seismic data. Because P-wave velocity in the permafrost varies depend on the concentration of ice, we deduced permafrost distribution from the inverted velocity model. Relatively high P-wave velocity cell is regarded as ice bearing sediment, and higher than 3.2 km/sec is regarded as fully ice saturated sediment. Inverted velocity models show permafrost bodies distributed irregularly and their size range from hundreds to thousands meters. The content of ice is higher in the core of permafrost body and lower in the outer body. Permafrost exists down to 600~700 meters and highest ice concentration exists at the depth of about 400 meters which coincide with previous well logging results.

Tue_243_CR-1_1995

Periglacial Landforms from Semi-arid Seymour Island, Weddell Sea, Antarctica

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Periglacial processes and landforms together with the presence of permafrost are among the most relevant geomorphological elements in the northern Antarctic Peninsula region. This study aimed to identify, analyze and map the landform and processes at Seymour Island, Weddell Sea, Antarctic Peninsula. For this, different thematic maps such as lithology, slope and shaded relief were manually overlain. The slope map was an effective tool to determine the occurrence of landforms and their limits, which together with the interpretation of the satellite image and lithology, allowed to identify and quantify the periglacial features of Seymour Island. Twelve landform units were identified, as follows: summit structural surface, little dissected structural surface, highly dissected structural surface, steep slopes, gentle slopes associated with solifluction processes, fluvio-marine plain, tidal flat, fluvioglacial plain, beaches, marine terraces and cliffs, talus deposit, patterned grounds, and lakes. The periglacial environment from Seymour Island is less intense than that of South Shetland and primarily conditioned by the regional semi-arid climatic conditions and strong geological and geotectonic control; most landforms and geomorphological processes are related to wind action, hydrogeology, lithological influence and presence of permafrost, in which altitude plays an important role. We acknowledge Fapemig for granting financial support.

Tue_244_CR-1_2539
Air & Soil Temperatures, Vegetation, & ALT (1995-2017), Toolik Lake, Alaska, USA

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The Circumpolar Active Layer Monitoring (CALM) Project has been monitoring 1 ha and 1 km^2 plots at Toolik Lake on the Alaskan North Slope. These sites are located in the Arctic foothills physiographic province. The 1 ha plot is composed of moist acidic tundra and a water-track complex. Air temperature and soil-surface temperature are measured in-situ daily at the 1 ha plot, and active layer thickness (ALT) is measured annually during maximum thaw (August) at both. This study describes changes over time (1995-2017), reporting an overall slight increase in mean summer (July-August) air temperatures and a slight decrease in mean soil-surface temperatures, resulting in an increase in the difference between these two measurements. Trends in ALT are less clear. Such an increase in the difference between air and soil-surface temperatures may be related to changing vegetation properties. Color-infrared aerial photograph pairs from peak greenness in 1995 and 2017 were analyzed using modern photogrammetric techniques to quantify vegetation change. This research complements coarser remote sensing efforts as well as plot-level biomass measurements showing Arctic greening in this region.

Tue_245_GG-2_124
Variations in Ice Sheet Dynamics along the West Antarctic Ice Sheet Margin

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Modern global warming and their possible contribution to sea level rise and flooding of low lying coastal areas has moved both Antarctic and Greenland ice sheets into the focus of public and scientific interest. Research has concentrated on reconstructing the dynamics of the ice sheets in order to understand their vulnerability to a changing climate by combining data collection and numerical simulations. Synchronous changes in ice sheet extent along its margin are often assumed. Here, the regional and chronological appearance, distribution, and modification of sedimentary features and structures identified at the slope and rise off the West Antarctic Ice Sheet margin are analysed to test this assumption.
A synchronous West Antarctic Ice Sheet dynamic is not supported but rather a West-East trend with an early Miocene ice advance in the Amundsen Sea, while a glacial advance in the Bellingshausen Sea occurs only post-15 Ma. For the Bellingshausen Sea a stronger variability in depositional energy is observed indicating stronger variability in ice extent. The dominance of down-/along-slope sediment transport is on opposing trends between the two seas, which also reflects the advance/retreat of the local ice sheet and thus an increase/decrease in sediment input from the continent and a modification in intensity and relocation of the bottom currents' pathways. A possible reason for this may be the local geology, basal geomorphology, and the geometry of the local ice sheets.

Tue_246_GG-2_187
Large Impact of the Agulhas Return Current on Late Glacial Indian Southern Ocean

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The Agulhas Current is a major actor of the Atlantic Meridional Overturning Circulation and thereof of global climate. Models and paleoceanographic data suggest that the volume of warm and saline Agulhas water leaking into the South Atlantic stimulates regional buoyancy anomalies that ultimately impact convective activity in the northern North Atlantic. Spillage of Agulhas Current into the South Atlantic was shown to strongly vary on glacial-interglacial timescales, possibly in relation to meridional shifts of the mobile Subtropical and Subantarctic fronts and the monsoon system. Conversely, the impact of the Agulhas Current on the Southern Ocean (SO), via its return branch, is much less documented.
Through the analysis of ice-rafted debris, diatom census counts and planktic foraminifera $\delta^{18}O$ and Mg/Ca we here reconstruct cool and icy conditions during the early Marine Isotope Stage 2 (MIS2, 30-23 ka) but warm, ice-free conditions during the full glacial late MIS2 (23-15 ka) in core DCR-1PC from Del Caño Rise (46°S, 44°E, 2632m), Indian sector of the SO. We propose that these unexpected warm conditions result from increased transport of warm waters from low latitudes to the SO via the Agulhas Return Current in time of reduced Agulhas Current leakage due to a northward shift of the Westerlies and SO hydrographic fronts. As such, a general cooling in the SO may conduct, via negative feedbacks, to warm surface conditions in regions of strong western boundary current.

Tue_247_GG-2_200
The Newly Discovered Odyssea Drift (Ross Sea): Preliminary Results

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The Hillary Canyon is one of the main conduits for dense shelf water forming in the Ross Sea, over-flowing the shelf edge and transforming into the Antarctic Bottom Water (AABW). The main changes in past ocean circulation are recorded in the adjacent sediment drift. A wealth of data were acquired on the drift west of the Hillary Canyon during the 2017 OGS Explora expedition, which included the PNRA ODYSSEA and EUROFLEETS ANTSSS projects. Data were obtained by various technics: single channel seismics, sub-bottom profiling, multibeam bathymetry surveying, gravity and box coring, XBT launching, water sampling, CTD, L-ADCP, ADCP-VM, turbidity and florescence profiling. This drift (that we name Odyssea Drift) is elongated in the NNE direction with dimensions of several tens of km. Prominent landslide scars and a giant landslide deposit, over 70 ms thick and spanning 200 km^2, are visible on the drift. The cores evidence a well-developed cross bedding suggesting vigorous past bottom currents. The oceanographic data show a well defined bottom layer with temperature < 0°C, presumably a newly-formed AABW, with downward increased turbidity and current velocity.
The overall aim of this work is to develop, together with the results of the forthcoming IODP drilling expedition 374, a conceptual model of sediment deposition relating to marine-based ice sheet and oceanic processes along the Ross Sea continental margin occurring through the Neogene and Quaternary.

Tue_248_GG-2_206
Paleo-Current Activity in the Eastern Arctic Ocean - Evidence from Seismic

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Four stages of deposition regime have been detected on high-resolution seismic reflection profiles. First, in strata of Paleocene-Eocene age small vertical faults indicate differential compaction of probably anoxic sediments deposited in the still isolated Eurasian Basin.
Than, a high-amplitude-reflector sequence indicates a time of widespread changes in deposition realm associated with the gradual opening of the Fram Strait and ongoing subsidence of the Lomonosov Ridge (LR) in Eocene and Oligocene. Episodical incursions of water masses from the North Atlantic were the consequences and led to the deposition of sediments of strongly different lithology.
The third stage marks widespread and pelagic sedimentation since earliest Miocene. Sediment waves are evidence for paleo-bottom current activity and the onset of an ocean circulation system. The slope of the LR is structured into terraces, indicating fault-controlled sediment drifts arisen due to the onset and intensification of current circulation. Advanced deepening of the Fram Strait likely enabled an effective exchange of water masses between the North Atlantic and Arctic Ocean. Continuous sagging of the LR, reactivation of former faults and bottom currents passing along the ridge may shape the steep sediment free flanks of the terraces in addition.
At least, a continuous regional drape of reflectors marks the transition to glaciation of the northern hemisphere in early Pliocene.

Tue_249_GG-2_328
Late Holocene Sedimentary Record from Two Infilled Lakes, Southwestern Greenland

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The Greenland Ice Sheet has sensitively responded to past and current climatic fluctuations. In order to reconstruct the past regional environmental and climatic variability, sedimentary cores from two infilled lake basins in the Kobbefjord area, SW Greenland, were retrieved and subjected to multi-proxy investigation. The absolute chronostratigraphic framework was established by ^{14}C and short-lived radioisotopes (^{210}Pb, ^{137}Cs) dating. We further performed analyses of magnetic susceptibility, grain size distribution, element composition by means of XRF and ICP-AES (for C, N, S and BSi content), and diatom biostratigraphy. The presented palaeoenvironmental reconstruction records ~800 years of lake ontogeny that was modulated by catchment processes and regional climate, manifested as alternating periods of enhanced biological productivity and increased influx of clastic material. Our reconstruction agrees with other proxy-based lacustrine, marine and glacier records as well as instrumental measurements. Main cooling events occurred at ~850-650 and ~100-30 years BP. The former coincides with the demise of the nearby Norse Western Settlement. The latter event corresponds to culmination of the Little Ice Age and maximum glacier advances. Warmer periods predominated ~550-150 years BP and in the 20th century, and coincided with mostly negative phases of North Atlantic Oscillation. Current warming is, however, obliterated by transition of the lakes into oligotrophic peat bogs.

Tue_250_GG-2_363
Holocene Oceanographic Change: Sabrina Coast, East Antarctica Diatom Assemblages

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The Sabrina Coast, East Antarctica, is an area of interest because
(1) satellite and airborne geophysical studies indicate substantial loss of glacial ice over the past decade, and
(2) the region is underlain by a deep subglacial basin, a configuration that is susceptible to “runaway” ice loss. Quantitative diatom abundance and assemblage data preserved in marine sediments in four kasten cores retrieved from the continental slope during the RV *Investigator* mission IN2017_V01, record Holocene oceanographic conditions as well as the transition from a glacial to interglacial period. During the last glacial period, diatom abundance was low, possibly due to increased sea-ice cover, resulting in light limitation of primary production. In addition, a greater proportion of reworked, extinct species are present, due to the input of older, glacially-scoured sediments sourced from the continental shelf. The environment transitioned steadily from a glacial to interglacial setting, marked by an increase in diatom abundance by up to three orders of magnitude. The mid-Holocene is characterized by the highest productivity, but no significant change in diatom assemblage accompanies the productivity peak. The assemblage is dominated by a single diatom species, *Fragilariopsis kerguelensis*, the signature species of the Antarctic Circumpolar Current, however, greater overall sea-ice cover in the western half of the field area is reflected by increased relative abundance of *Fragilariopsis curta*.

On behalf of the Sabrina Seafloor Shipboard Party, Australian National University, Acton, Australia

Tue_251_GG-2_364
Diatom Proxy Record of Quaternary Glacial Cycles, Sabrina Coast, East Antarctica

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Observed melting rates of the Totten Glacier, Sabrina Coast are among the fastest of the East Antarctic ice sheet yet this area remains notably understudied. Piston core C012_PC05, collected from the Sabrina Coast continental slope during the RV *Investigator* mission IN2017_V01, contains a 16m sediment record of the past nine marine isotopic stages, as estimated using magnetic susceptibility data, sediment lithology, and absolute diatom abundance, and constrained using the diatom biostratigraphic markers *Rouxia leventerae*, *Rouxia constricta* and *Hemidiscus karstenii*. Interglacial periods are characterized by biosiliceous clay-rich silts with low magnetic susceptibility. Glacial sediments are diatom-poor silts and fine sands with relatively high magnetic susceptibility. Quantitative diatom counts document diatom abundances more than one order of magnitude lower during glacials as compared to interglacials, a consequence of greater sea-ice cover and dilution. Glacial periods also show much higher proportions of extinct species, indicating reworking of sediments. Notable variation in abundance is observed among interglacials; early MIS 5 and mid-MIS 1 contain distinct peaks in productivity while MIS 3 has comparatively low overall primary productivity. *Fragilariopsis kerguelensis* is the dominant species (60-90%) throughout, with *Thalassiosira lentiginosa* subdominant; both open ocean zone indicators. Common sea ice associated species are present, but in low relative abundances.

On behalf of the Sabrina Seafloor Shipboard Party, Australian National University, Acton, Australia

Tue_252_GG-2_370
Crevasse Casts Preserved in the Whales Deep Basin Middle Continental Shelf

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The Whales Deep Basin (WDB) is a paleo-glacial trough that was occupied by the Bindschadler Ice Stream when grounded ice advanced to the outer continental shelf during the last glacial maximum (LGM). A bathymetric saddle that separates the WDB outer and middle continental shelf corresponds to a compound grounding zone wedge (CGZW) formed during post-LGM retreat. The north face of the bathymetric saddle corresponds to the marine foreset of the CGZW. The low slope on the southern side of the WDB saddle corresponds to the subglacial topography that existed prior to a major retreat of the grounded ice towards Roosevelt Island. This GZW topset is mantled by a series of relatively small-scale sinuous ridges. The ridges have amplitudes ranging from 2 to 11 m above grade and have an overall northeast-southwest orientation over an area of at least 500 km^2 in water depths ranging from ~500 to ~550 m. The ridges have spacing that mostly range between 1 and 2 km. The longest ridges are observed to be 40 km. In our ongoing investigation of these interesting features, we hypothesize that the ridges formed below a rapidly flowing ice stream as it thinned. The rapid ice-stream flow caused the development of large crevasses that reached the seafloor. Subglacial till was injected upward as the crevasses formed. Chronologic data indicates that these crevasse casts formed during rapid sea-level rise at 11.5 kyr BP, i.e., during MWP1B, which partly explains their amazing preservation.

Tue_254_GG-2_669
The Impact of the Totten Glacier on the Depositional Processes off Sabrina Coast

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The National Institute of Oceanography and Applied Geophysics (OGS) acquired about 320 km of multichannel seismic profiles offshore the Sabrina Coast (East Antarctica), in the frame of the PNRA Tytan Project, during the CSIRO survey IN2017-V01 on board the RV Investigator (Jan-March 2017).
The project aims at reconstructing the depositional environment of the continental margin off the Totten Glacier, starting from the Miocene, when temperatures and CO2 levels were more similar to those predicted for the next century. The PNRA Tytan project consists in two main research units: Unit 1 is focused on the integrated analysis of the new geophysical dataset and data available through the Seismic Data Library System (SLDS), aimed at identify key acoustic features indicative of advances and retreats of the ice sheet and of variations in the glacial regime. The comprehensive analysis of the seismic dataset will also be crucial to prioritize areas of interest for IODP deep drilling by identifying expanded and well-preserved sedimentary successions. Within Unit 2, sediment core analysis collected during the IN2017-V01 cruise are performed and are focused on Diatom biomarkers and assemblages.
The IN2017-V01 geophysical dataset has been undergoing several processing steps, which greatly improved the data quality. A preliminary analysis allowed recognizing key seismic reflectors indicative of major evolution steps of the continental margin.

Tue_255_GG-2_705
Late Cretaceous Model Paleogeography for Antarctica

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We present the newest interim versions of ANTScape's Late Cretaceous model paleogeography. Recent plate kinematic reconstruction parameters have been used to reconstruct a late Cretaceous austral landmass with Antarctica at its core, and continental connections to Australia and South America at its margins. The depths of the oceans and continent-ocean transitions surrounding this landmass have been modelled from an understanding of the variety of processes that can be expected to have led them to attain their current depth. In contrast, we model continental paleotopography by applying process-based adjustments to present-day measurements. In view of ongoing controversy regarding the history and development of the Transantarctic Mountains, we present two candidates. In one, the mountains do not figure because they developed as a marginal uplift to the Cenozoic West Antarctic Rift System. In the other, the mountains form just part of a much larger West Antarctic altiplano, supported by thickened crust that formed by long-lasting plate convergence at Gondwana's active margin. The candidate paleogeographies will be of interest as boundary conditions for paleo-ice sheet modelling and regional circulation and climate modelling.

Tue_256_GG-2_743
Simple Model of Melange and Its Influence in an Antarctic Ice Sheet Model

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Rapid grounding-line retreat and marine ice loss from West Antarctica, and possibly from major East Antarctic basins, may be triggered by climate warming. These rapid retreats are associated with geologic evidence of past high sea-level stands, and pose a threat of drastic sea-level rise in the future.
Rapid calving of ice from deep grounding lines generates substantial downstream melange (floating ice debris). It is unknown whether this melange has a significant effect on ice dynamics during major Antarctic retreats, through clogging of seaways and back pressure at the grounding line. Observations in Greenland fjords suggest that melange can have a significant buttressing effect, but the lateral scales of Antarctic basins are an order of magnitude larger (100´s km compared to 10´s km), with presumably much less influence of confining margins.
Here we attempt to include melange as a prognostic variable in a 3-D ice sheet-shelf model. Continuum mechanics is used as a heuristic representation of discrete particle physics. Melange is created by ice calving and cliff failure. The melange model is first tested with idealized geometries, and calibrated very basically to observed melange properties in Jakobshavn fjord, West Greenland. The influence of the new melange component is then examined in simulations of rapid Antarctic retreat in response to warm mid-Pliocene climate.

Tue_257_GG-2_747
Long-term Landscape Evolution of the Pensacola-Pole Basin, East Antarctica

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The evolution of Antarctic bedrock topography is a key control on ice sheet behaviour. Evolution of the subglacial landscape over geological timescales is controlled by tectonics, erosion, and deposition, as well as the solid Earth response to these processes. Here we aim to quantify these processes to better constrain the palaeotopographic evolution of the Pensacola-Pole Basin in East Antarctica, a previously unexplored sector of the ice sheet with bedrock situated over 1 km below sea level. The effective elastic thickness of the lithosphere in this region is determined by modelling recently acquired bedrock topography and airborne gravity data. We then use flexural isostatic modelling to quantify the response of the solid Earth to changes in surface loading associated with glacial and fluvial erosion and tectonic activity. Geological constraints on the amount of erosion and uplift include peneplanation surfaces exposed in the Pensacola Mountains and offshore sediment records. We also use 2D forward gravity modelling to determine the upper crustal structure of the basin and examine the role of the inherited tectonic structure in the topographic evolution of the region. By quantifying the landscape evolution of the Pensacola-Pole Basin since ice sheet inception at ca. 34 Ma, we can provide an improved boundary condition for modelling ice sheet behaviour close to the boundary between East and West Antarctica since the Early Oligocene.

Tue_258_GG-2_751
A Pliocene $\delta^{18}O_{diatom}$ Record of East Antarctic Glacial Discharge

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The East Antarctic Ice Sheet (EAIS) is traditionally thought to have remained largely stable since the middle Miocene. However, some evidence suggests the EAIS retreated substantially during intervening warm periods, e.g. the Pliocene. Given the major societal implications of a more dynamic EAIS, resolving the issue and determining what forces retreat, e.g. a warmer ocean, is essential. However, direct evidence for substantial retreat, and a thorough understanding of ice/ocean interactions during past warm periods, remain elusive. Here we take advantage of the particularly negative $\delta^{18}O$ signature of glacial ice ($\delta^{18}O< -20‰$) to generate the first Pliocene diatom oxygen isotope ($\delta^{18}O_{diatom}$) record of East Antarctic glacial discharge. The Pliocene can be considered an analogue for future climate, as the last time pCO_2 was >400 ppm and sea levels were ~20 m higher than today. Using material from the well-characterised continental rise IODP Site 1165B, our target interval (3.75-3.45 Ma) includes a period of proposed substantial retreat of both the local Amery ice shelf and more distal Aurora subglacial basin, as well as an episode of dramatic circum-Antarctic warming when sea surface temperatures (SSTs) increased to ~6ºC above present. Considered alongside existing diatom assemblage, SST, sea ice and ice-rafted debris records from the same cores, we investigate the role of ocean forcing on ice dynamics and constrain suborbital-scale glacial discharge/retreat during the Pliocene.

Tue_259_GG-2_765
Deep-water Evolution in the Southwest Atlantic from New Seismic Profiles

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Antarctic Bottom Water (AABW) flowing northwards into the South Atlantic Ocean has to pass around Maurice Ewing Bank (MEB), which lies at the eastern end of the Falkland Plateau. Above the AABW, the Antarctic Circumpolar Current (ACC), the largest ocean current on Earth with a mean transport of >100 Sverdrups, flows eastwards across MEB and the Georgia Basin. The two main fronts of the ACC, the Polar Front and the Southern ACC Front, traverse the region and interact with major topographic features. AABW is a key component of the global thermohaline overturning circulation, whereas the ACC is the main agent of water exchange between the world's large ocean basins and is important in blocking ocean heat transport towards Antarctica. Both currents initiated and strengthened during the Cenozoic era as bottom water production increased and the Southern Hemisphere westerly winds strengthened due to the intensification of Antarctic glaciation. Over the same period plate tectonic movements resulted in opening of deep gateways in the Southern Ocean, allowing circum-Antarctic circulation. These major currents control patterns of sediment deposition, and thus changes in sediment accumulation patterns through time record the history of the currents. However, seismic profile coverage of the region remains sparse. We plan to collect new multichannel seismic data over the MEB and Georgia Basin on RRS Discovery cruise DY087 in January-February 2018, and will present initial results.

Tue_260_GG-2_769
Unravelling a High-altitude Antarctic Blue Ice Field Meteorite Trap

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Antarctic blue ice zones are the most successful locations for meteorite retrieval missions on Earth. These zones are furthermore of large interest, as they can potentially contain old ice, which is easily accessible and available in large quantities. Despite this, meteorite traps remain generally not very well understood. Here, we use an interdisciplinary approach to improve our understanding of an ice trap in Dronning Maud Land (East Antarctica) on the Nansen blue ice field (2600-3100 m a.s.l.).
From the collected surface blue ice samples, one of the largest observed spatial patterns in the $\delta^{18}O$ to date is found. Relying on ^{14}C and ^{36}Cl terrestrial age dated meteorites, this surface ice is interpreted to be from the previous interglacial up to the present-day. Based on satellite derived surface velocities, we estimate less than 0.4 new meteorites per year are supplied to the ice field through ice flow. This suggests that the hundreds of new meteorites found after revisiting the ice field after 25 years are mostly meteorites that were previously not found, rather than newly supplied meteorites. By comparing the isotopic signal of the surface blue ice to the one from deep drilling projects, we derive information about the past glaciological and climatic conditions that occurred over this region.

Tue_261_GG-2_783
Enhanced Coal Fragment Input in the Chukchi Borderland during Last Deglaciation

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Frequent ice discharge events were identified as Ice Rafted Debris (IRD) peaks in the Chukchi Borderland, western Arctic Ocean sediments between the Brown Layers 1 (B1, Holocene) and 2 (B2, mid MIS3), but the timing and sources of these events are still poorly constrained. In this study, IRD (>250 um) grains from this interval in 10 sediment cores recovered from the Chukchi Borderland were examined under the microscope. Coal fragments and detrital carbonates were identified and the peak layers were dated at ~14 ka, making it a proper stratigraphic marker at the Chukchi Borderland during the last deglaciation. The abundances of coal fragments show clear northward and westward decreasing trend in the study area, suggesting a eastern source most probably the northern Alaska. During the deglaciation, the melting water from ice cap on the Brooks Range allowed the entrainment of coal fragments from the coal bearing the North Alaskan Slope terrain to the Chukchi Margin and spread by the Beaufort Gyre north- and westwards.

Tue_262_GG-2_833
Characterizing Holocene Climate Variability from Adélie Basin Sediment Core

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In 2010, a 180 m laminated sediment core was collected offshore East Antarctica in the Adélie Basin during International Ocean Discovery Program Exp. 318. Radiocarbon ages date the core to ~12,000 years B.P., and high sedimentation rates at the site suggest a high-resolution record capable of capturing both large and small scale climate variabilities. Initial findings of greyscale analysis on line scan photographs indicate cyclical frequencies of high productivity phytoplanktic bloom events, but these data were noisy due to gas expansion during core extraction and color issues associated with differential oxidation after core extraction. X-Ray Computed Tomography (CT) scans were undertaken to circumvent these issues and improve the frequency and facies characterizations of the phytoplanktic bloom events. Here we present the conclusions of our frequency and greyscale analyses, and how these analyses relate to the core X-Ray Fluorescence (XRF) data. We will also discuss these results in relation to a larger project aimed at linking the Roosevelt Island Climate Evolution (RICE) ice core and the U1357 sediment core. The U1357 site lies downstream from RICE and is influenced by Ross and Amundsen Sea waters, in addition to local variations. The relationship between these highly resolved records will better constrain the seasonal and long-term variations and (dis)connections between polynya activity and ice-ocean interactions in these regions during the Holocene.

Tue_263_GG-2_848
Ice Dynamics during the past 37 ka on Ross Sea Continental Shelf, Antarctica

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The Ross Sea Dense Shelf Water (DSW) comprises about 25% of the Antarctica Bottom Water today. The formation of this DSW is closely linked to the interactions with the Ross Ice Shelf (RIS). Thus the retreating processes of the RIS since the Last Glacial are of great importance understanding past changes of global ocean circulation and climate. Core ANT31-JB06 retrieved from the Joides Trough on the northwest Ross Sea continental shelf during the 31th Chinese Antarctic Expedition was investigated to reconstruct the RIS deglaciation history since the late Marine Isotope Stage (MIS) 3. The analysis includes AMS ^{14}C dating, ice rafted debris (IRD) abundances and grain size. The dating results suggest an fossil carbon contamination of ~3045 years in the organic carbon. The continuous ^{14}C sequence also indicates a lack of sediment disturbance, and the grounding line persistently south of the core site. 27-21 ka marks the coldest period during the Last Glacial, possibly with maximum extension of the RIS at ca. 24 ka. The initial RIS retreat from the Joides Trough started at about 21 ka. Major retreats and disintegration of the RIS occurred at the Antarctic Isotope Maximum (AIM) 1 warm interval (~17 ka - 14 ka) and the early Holocene, while the retreat was slowed down or ceased during the Antarctica Cold Reversal (ACR, ~14 ka - 12 ka). The RIS may have stabilized after about 5 ka, reaching its current location.

Tue_264_GG-2_889
Late Quaternary Lambert Glacier System Dynamics on Prydz Bay East Antarctica

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The Antarctica Ice Sheet (AIS) plays an important role in modulating global system. Our understanding on its dynamics, however, is still largely insufficient. In this study, the clay mineral composition and ice-rafted debris (IRD) data from two sediment cores retrieved off Prydz Bay extending back to 523 ka are reported to explore the late Quaternary forcing mechanisms of the Lambert Glacier Amery Ice Shelf system (LGAISS) on orbital time scales. The clay mineral assemblage is composed of illite, smectite, kaolinite and minor chlorite. Illite was likely produced by physical erosion of rocks rich in biotite. Kaolinite and smectite were mostly reworked from the older successions beneath the LGAISS and/or the Kerguelen Plateau. The kaolinite/illite ratio reveals the oscillation history of the LGAISS. It presents a power spectral structure similar with that of the global ice volume record, reflecting the dominant role of the northern hemispheric climate cycles in affecting the austral ice dynamics during late Quaternary. A more pronounced obliquity periodicity on the kaolinite/illite ratio may reflect the austral summer energy to exert a significant role in modulating the LGAISS dynamics. The IRD MAR record, however, only responded to the eccentricity forcing, likely indicating the EAIS became increasingly stable in response to the long-term climate cooling and development of the sea-ice field which prevents it from contacting with low-latitude warmer sea water.

Tue_265_GG-2_909
Thinning History and Modelling of a Paleo Ice Stream: David Glacier, Antarctica

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Ice-shelf collapse and grounding-line migration may result in rapid ice sheet retreat, representing a significant uncertainty in predicting future sea level rise. Marine ice-sheet processes, strongly influenced by ocean heat, have been monitored for less than 50 years. Geological evidence can extend this record over centuries to millennia, providing insights into the processes and rates of change that drive marine-ice retreat. Associated modelling, evaluated against geological data can aid understanding of these processes and lead to more realistic prediction of sea level changes. In this study, we aim to understand the pattern of thinning and retreat of David Glacier, the largest outlet glacier in northern Victoria Land, Antarctica.
We present the initial results from the 2017 field season, where we sampled ice-transported erratic clasts and bedrock from nunataks adjacent to David Glacier. *In situ* cosmogenic nuclide exposure dating of glacial erratics, sampled along vertical transects from the modern ice surface to several hundred metres above, constrains the ice-elevation history of David Glacier. We link ice surface lowering rates onshore to the offshore retreat chronology in the Drygalski Trough where at the LGM the David Glacier formed an ice stream, extending hundreds of kilometers into the western Ross Sea. We test the sensitivity of the glacier to ocean warming and ice shelf debuttressing using a flowline model with robust marine grounding line parameterisation.

Tue_266_GG-2_988
XRD-XRF Analysis Insight on Post-LGM Sediments from the NW Barents Sea (Arctic)

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This study focuses on the sedimentation history along the North-western Barents Sea continental margin after the Last Glacial Maximum (LGM). The sedimentary record contained in the Trough Mouth Fans (TMFs) of the Kveithola and Storfjorden glacial troughs and in the contouritic drift facing the Bellsund Fjord provides several proxies that can be useful for reconstructing the ice-streams dynamics during glacial periods, the onset of deglaciation and the climatic variability during interglacials. This area of the North-western Barents Sea continental margin has been investigated during several international oceanographic cruises: SVAIS onboard R/V BIO Hespérides; EGLACOM, onboard R/V OGS Explora; PNRA Project CORIBAR, onboard R/V Maria S. Marien; Eurofleets-2 PREPARED, onboard RV-G.O. Sars.
For this study five cores collected during these international cruises have been investigated through XRD analyses on clay minerals and XRF analyses through Avaatech core scan on the whole length of the cores. In polar areas clay mineral analysis can be used for reconstructing sedimentary processes, associated with glacial and interglacial conditions. XRF data provide useful proxies for environmental changes, provenance studies and core correlation.
Here we aim to describe the clay mineral distribution in response to the climatic variations that followed the LGM, the changes in ice-stream dynamics and related oceanographic/environmental changes along the margin.

Tue_267_GG-2_1005
Past Climate Records from the Ross Sea: Initial XRF Results from IODP Exp. 374

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International Ocean Discovery Program (IODP) Expedition 374 will core several sites on the Ross Sea outer continental shelf and slope/rise in January-March 2018 with the primary objective to examine the evolution of the West Antarctic Ice Sheet (WAIS) during the Neogene. Numerical models indicate that the Ross Sea sector of the WAIS is sensitive to changes in ocean heat content, making this an ideal location to examine past changes to improve predictions for future warming. Following initial shipboard characterization of the cores during the expedition, the cores will be shipped to the IODP Gulf Coast Repository in College Station, TX, USA. X-ray fluorescence (XRF) scanning of Ross Sea sediment cores will commence in May 2018 using an Avaatech XRF core scanner at the IODP Gulf Coast Repository. Final scanning details will be determined after the cores are collected, but we initially plan to scan at 9 kV, 30 kV, and 50 kV energies (2 cm resolution) to collect counts of Al, Si, K, Ti, Mn, Fe, Br, Rb, Sr, Zr, and Ba. This non-destructive technique will be used to distinguish lithologies and to make environmental interpretations based on elemental ratios at high resolution. These data will also be used to confirm stratigraphic splices for the continental slope/rise sites (where double or triple coring is planned). Coupled with other postcruise research results, these data sets should provide significant insights into changing conditions in the Ross Sea during the Neogene.

Tue_268_GG-2_1022
Geothermal Heat Flux Measured in the Amundsen Sea Embayment

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Due to a complex tectonic and magmatic history of West Antarctica, the region is suspected to exhibit strong heterogeneous geothermal heat flux variations. Although the maximum ice extent has retreated from the shelf since the last glacial maximum, the trends of offshore GHF patterns and the overall order of magnitude are hypothetically related to those areas onshore where the West Antarctic Ice Sheet (WAIS) rests on geologically related structures. High-resolution GHF will aid the understanding of the paleo-retreat of the ice sheet in the Amundsen Sea Sector. This presentation builds on our previous studies in which we discussed geothermal heat flux based on 26 in-situ temperature measurements that were conducted in 2010 in the Amundsen Sea Embayment (ASE) in West Antarctica. We found, that the shallow (3 m) in-situ temperature measurements were likely influenced by inter-annual bottom-water temperature variability, leading to GHF estimates biased towards lower values (mean = 33 mWm^{-2}). During RV *Polarstern* expedition PS104 in early 2017 we collected additional 28 in-situ temperature measurements in marine sediments (11 m) for deriving geothermal heat flux in the ASE, which will overall improve the spatial coverage of this region. Furthermore, we monitored the vertical temperature profile of the water column at these stations, which allows to map Circumpolar Deep Water (CDW) distributions across the inner Pine Island Shelf with greater detail.

Tue_269_GG-2_1086
The Eocene Evolution of Bathymetry in the Australian-Antarctic Basin

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Sediments on the conjugate Australian-Antarctic margins have been deposited through the interplay between continental sediment supply, tectonic motions, and ocean currents. During the transition from Greenhouse to Icehouse conditions, most of these components underwent drastic regional and global changes. Here, constraints from both conjugate margins are correlated using a comprehensive network of seismic reflection profiles and drill sites. The formation of two major hiatuses (33.6 - 47.9 Ma, 51.06 - 51.9 Ma) recently recovered by the IODP site U1356A offshore Wilkes Land, are the centre of this study. We propose a drastic sediment starvation along both margins during the pre-glacial Eocene period causing those gaps in sedimentation. During the warm and humid Late Cretaceous period (~83 - 65 Ma), fluvial sediments were deposited along both margins. Prominent sediment drift deposits of younger Early Paleogene age (~65 - 48 Ma), can be observed along both continental rises, indicating onset of clockwise bottom currents. With the following progressive global cooling (< 48 Ma) and increasing current strength, a large-scale sediment starvation occurred, which is geologically constrained along Southern Australia and most likely also affected the Antarctic margin till the onset of glaciation (~33.6 Ma). Using this interpretation, we create paleobathymetric reconstructions at ∼83, ∼65 and ∼48 Ma which provide essential information for paleoceanographic and -climatic investigations.

Tue_270_GG-2_1097
Eruptions and Lava-ice Interactions Elucidate past Ice Sheet Characteristics

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Some of the most important and unknown aspects of past ice sheet conditions, such as ice thickness and thermal regime (ice sheet stability), are best enlightened by looking at lava—ice interactions (glaciovolcanology). Lava—ice interactions were recently mapped at Mason Spur, a Miocene to recent eruptive centre approximately 100 km southwest of Ross Island, McMurdo Sound, Antarctica. A newly identified Miocene eruption was interpreted from the voluminous mapped caldera in-fill at this location. The eruption records environmental conditions at the time and may have been significant enough to have affected all of Antarctica's atmosphere. It occurred immediately after the mid Miocene Climatic Optimum during the descent into a deeper icehouse world, a time that is crucial to understanding how modern global warming and sea-level changes will affect the planet. Lava—ice interactions were also mapped in younger volcanic rocks (< 6 Ma) from which the thickness of the past Antarctic ice sheet can be calculated and wet- versus dry-based glaciation determined. Glaciovolcanology remains critical for understanding ice sheet behaviour; predicting variations in Antarctic ice sheets is a fundamental step in quantifying future global climate and sea level change.

Tue_271_GG-2_1124
OSL Dates of Moraines from Ny-Alesund Indicating Late Quarternary Climate Change

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Luminescence dating is micro-dosimeteric technique used on quartz / feldspar to estimate the time elapsed since the last day light exposure of the sediments, specially on Late Quaternary sediments. Sediment samples from the terminal moraines of Vestre and Austre Broggerbreen glaciers of NY-Alesund area, Svalbard, Arctic region were dated by OSL techniques. In order to remove the unstable luminescence signals an optimum heating temperature was found out which yielded best dose recovery. Many Arctic samples were not found suitable for OSL dating because their dose recovery was not optimal. In most of the Arctic samples recuperation is observed because of their dull nature. The correction was of recuperation was made by adding an additional step of Illumination at 2800 C at the end of every run of SAR protocol. The OSL data suggests the advancement of widespread glaciations in this area during Last Glacial Maxima (LGM). The dates of 32±3 ka and 19±2 ka obtained from the terminal moraines highlights deglaciations before and after LGM period. The date 32±3 ka marks the major recession of glacier system of Ny-Alesund region just before Last Glacial Maxima. After this, during LGM time, the glacier system has advanced to a much greater extent. After LGM time, the area has again witnessed the major recession at around 19± 2 Ka coinciding with the Late Weichselian ice sheet retreat as the climate became warmer. The results represent time span of Last deglaciations in Ny-Ålesund area.

Tue_272_GG-2_1160
The Climatic Significance of Laminated Sediments on the NW Barents Sea (Arctic)

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The recent depositional architecture of the north-western Barents Sea continental margin derives from past climate changes with alternating deposition of highly consolidated glacigenic diamicton (continental shelf) and debris flows (continental slope) associated to shelf-edge glaciations, and low-density, normally consolidated biogenic-rich sediments deposited during interglacial conditions. In addition, sub-bottom records outline the presence of acoustically laminated deposits locally having thickness of more than 10 m, which lithofacies characteristics indicate deposition from turbid meltwaters (*plumites*) during short-living, phases of glacial retreat (meltwater pulses, MWP). One of the youngest stratigraphic intervals recognized along the NW Barents Sea margin was related to the MWP-1a that was responsible for the deposition of about 1.1 x 10^{11} tonnes of sediments on the upper slope of the Storfjorden-Kveithola TMFs (south of Svalbard) (Lucchi et al., 2015). New compositional analyses of such *plumites* revealed a distinct signature that allow us to distinguish deposition from glacial melting form that related to the ice-sheet sub-glacial erosion and transport to the edge of margins. Sediment facies and compositional analyses lead to a new climate-related interpretation of the laminated deposits recognized during Marine Isotopic Stages 3 and 2 on the NW margin of the Barents Sea, including Heinrich Event H2.
References: Lucchi et al., αrktos DOI 10.1007/s41063-015-0008-6

Tue_274_GG-2_1202
Major Climatic Transitions Linked to the Tasman-Drake Tectonic Evolution

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The tectonic evolution of the Drake and Tasman passages during the Eocene-Oligocene and Oligocene-Miocene transitions have led to the modern-like Antarctic Circumpolar Current (ACC) accompanied by drastic changes in both terrestrial and oceanic conditions. However, the timing, the oceanic and climatic responses of these tectonic changes on the isolation of Antarctica and their role in the onset of major Antarctic glaciations remain largely debated. This is particularly true for the Drake passage history, for which several ages of opening have been proposed between 40 and 17 Ma. In this study, we aim at focusing on specific period of times by investigating sedimentary archives from the Ocean Drilling, Deep Sea Drilling and Integrated Ocean Drilling programs (ODP, IODP and DSDP, respectively) Sites 696 (~33.35 Ma), U1356 (~30.5-24.5Ma) and 269 (~25-14 Ma). Here we combined a suite of molecular proxies ($d^{13}C/dD$ of the *n*-alkanes, CPI and ACL indexes) with bulk organic matter parameters ($d^{13}C/d^{15}N$, TOC) in order to i) characterize the organic matter origin, ii) the related changes in vegetation type (C3 vs C4 plants) and iii) the hydrological variations (eg. precipitation) associated with the two gateways. Preliminary data reveal sufficient amounts of biomaterial for further isotopic analyses and refinement of interpretation. These new results will be presented during the POLAR2018 conference.

Tue_275_GG-2_1300
Clues to Glacial Regime and Bottom-current Changes in the Northwestern Ross Sea

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The sedimentary record in polar continental margins provides useful insights into the glacial regime and bottom-current changes during the past glacial and interglacial periods. Many of the previous seismic stratigraphic studies have been conducted over the Ross Sea embayment to reveal the Cenozoic Antarctic glacial history. Due to lack of data, however, there have been much less studies that could provide a more continuous record of ice-sheet dynamics and bottom-current activity on the Ross Sea slope and rise. Here, we present a seismic stratigraphic analysis of sediments in the Joides Basin mouth and Central Basin, northwestern Ross Sea using the new and existing seismic and adjacent drill site data. The seismic profiles and sequence maps indicate that gravity sedimentation processes dominated the Central Basin infill, and then downslope sediment supply to the lower slope and rise was gradually reduced through the late Neogene and Quaternary. The bottom-current-controlled sedimentary features that may initiated on the surrounding banks and slopes since the mid-Miocene were overlain by glacigenic debris flows near the Joides Basin mouth after the late Pliocene. These results would indicate that the Antarctic glacial regime was evolved toward a cooler, less erosive through the late Neogene and Quaternary and bottom-current activity was diminished near the paleo-shelf edge after the late Pliocene in the northwestern Ross Sea margin.

Tue_276_GG-2_1354
Diatom Reworking in the Ross Sea: Evidence for Quaternary Bottom Currents?

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Temporally accurate paleo-reconstructions of past ocean circulation can help us to understand climate change's influence on the Southern Ocean and the Antarctic in the past and into the future. Here, we present new chronostratigraphic constraints on an 11.75 m marine sediment core, RS15-LC42, recovered by the RV/IB *Araon* during the Korea Polar Research Institute cruise ANA05B. Collected from the continental slope in the Ross Sea at 2084 m water depth, this core is composed of alternating laminated muds and IRD bearing sand lithologies.

Our age model is based around a single paleomagnetic reversal at 8.26 meters below sea floor (mbsf), which we interpret to be the Bruhnes/Matuyama boundary (0.781 Ma). This interpretation is supported by the first occurrence (FO) of the diatom *Thalassiosira antarctica* (0.50 Ma) at 5.40 mbsf. While the presence of *Fragilariopsis kerguelensis* (FO 2.49 Ma) at 11.65 mbsf provides a maximum possible age for the base of the core, our preferred interpretation assigns the entire reverse polarity interval below 8.26 mbsf to chron C1r.1r (upper Matuyama), which provides a maximum basal age of 0.98 Ma. Diatom reworking is prevalent below 3.25 mbsf, so last occurrence biostratigraphic datums cannot be used to further constrain the age of the core. The transition from extensive reworking to primary accumulation at ~0.25 Ma suggests a change in circulation, which we now aim to evaluate using magnetic fabric as a paleocurrent indicator.

Tue_277_GG-2_1373
Unlocking Atmospheric Temperatures from Antarctica's past

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Computer model reconstructions of Antarctic ice sheet configurations during Earth's past warm intervals underestimate the contribution from East Antarctica - i.e. measured sea levels are higher than calculated melt amounts. These climate models employ ocean driven melt as the primary control of ice mass loss rather than atmospheric warming. To date, atmospheric temperatures have not been considered as a mechanism to melt Antarctic ice sheets. Instead, past Antarctic ice sheet configurations have been derived from geomorphic deposits in the Dry Valleys, and sea floor moraines. Such deposits do not reveal temperatures for inclusion in climate models. Deriving a paleothermometer for Antarctica that predates ice core records is required to test the role of atmospheric temperature in ice sheet melt. Recent discoveries of bacteria in Antarctic permafrost samples provide a potential solution. New molecular genetic tools allow microbial diversity and concentrations to be calculated for ancient permafrost horizons. We are developing a terrestrial paleoecological transfer function for paleotemperature from the microbial diversity and concentrations preserved in these permafrost horizons.

Tue_278_GG-2_1455
Buried Landscapes in Antarctica are Records of Ancient Local-scale Ice

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The degree to which The Antarctic Ice Sheet retreated during the Pliocene, mid-Miocene, or between the Eocene-Oligocene Transition (EOT) and the mid-Miocene is not well constrained. This limits our understanding of the potential response of the modern ice sheet to changing climate. A barrier to quantifying past ice distribution in Antarctica is the lack of direct record inland of the coast. However, the geomorphology of buried landscapes may reflect former ice configurations, but is relatively unexploited. We map the distribution of ancient small-scale ice caps and valley glaciers in the highlands of the Weddell Sea region of Antarctica. We exploit patterns visible at the ice surface in MODIS MOA and Radarsat AMM-1 data and map small-scale glacial landscape features including subglacial valleys, ridges and buried cirques. The geomorphology is consistent with glacial erosion under alpine glaciation such that localised ice caps or icefields existed separately from a smaller than present ice sheet. There are no direct dates for these landscapes, but there are 4 possibilities: 1) they document past retreat during the Pliocene; 2) they record ice configuration prior to the establishment of polar conditions during the mid-Miocene; 3) they date from the onset of glacial conditions in Antarctica at the EOT; or 4) they have survived since small-scale Neogene glaciation, for which there is some evidence in the Antarctic Peninsula.

Tue_279_GG-2_1478
Eastern Ross Sea Shelf and Slope Marine and Glacial Processes

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The advance and retreat of the West Antarctic Ice Sheet (WAIS) from the outer shelf and oceanic circulation are the main causes of depositional processes on the Eastern Ross Sea (ERS) continental slope. During the Last Glacial Maximum, the WAIS advanced to outer shelf and then retreated ~1000 km to the inner shelf. Currently Antarctic Bottom Water formation is linked to mixing of the relatively warm Circumpolar Deep Water (that encroaches the continental shelf) with the colder Ross Sea Bottom Water (RSBW).
The objective of our ongoing investigation is to understand interactions between glacial and oceanographic processes that occurred in the past and are currently active on the shelf and the slope of the ERS. Here we use geophysical, bathymetric and oceanographic datasets acquired during two recent campaigns (NBP1502B and PNRA16).
The data reveals several seabed structures:

- incised gullies, canyons and an elongated SSW-NNE ridge on the SE side of Hayes Bank;
- wedges and two large canyons in the Whales Deep Basin;
- ridges and incisions on the western side of Houtz Bank.

Here we discuss if 1) the origin of the structures found on the slope and shelf depends on processes related to bottom currents or sea level changes or 2) shelf structures are most related to grounding-zone repositioning whereas slope structures are caused by erosional processes that are linked to either meltwater discharge and/or RSBW overflow and down-slope flow.

Tue_281_GG-2_1533

Collapse of the British-Irish Ice Sheet: The Role of Climate and Sea Level Rise

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The pattern and timing of retreat of the last British Irish Ice Sheet has been constrained in more detail than any other palaeo ice sheet. The Minch Palaeo Ice Stream flowed NW from the Scottish Highlands to the continental shelf edge, and retreated from 30-16ka BP. The ice stream is thought to have been laterally topographically constrained, and on a reverse slope. Using the palaeo record it is possible to study timescales far greater than observations of the contemporary record allow. We test if topographic influence and Marine Ice Sheet Instability were influential during the retreat of the Minch Palaeo Ice Stream. We use BISICLES, an ice sheet model capable of accurately simulating marine ice sheets, to simulate the retreat of the Minch Palaeo Ice Stream. We ran a series of model simulations to isolate the influence of topography on the retreat of the ice stream. Experiments with a step-change climate perturbation reveal a non-linear volume and area response, caused by instabilities from basal topography and surface mass balance change. We found that the retreat pattern of the Minch was influenced by instabilities once retreat was established, and mapped a retreat margin beyond which the simulated ice stream did not recover to LGM extent given LGM forcing. A similar model set up has also been used for other domains of the British-Irish Ice Sheet, working to reveal the mechanisms of LGM Irish Glaciation, and North Sea common ice configurations.

Tue_282_GG-2_1557
The Glaciogenic Records in the Grove Mountains, East Antarctica

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The glacial sediments in Grove Mountains include:
(1) different kinds of moraine dikes distributes along or perpendicular to the ice moving directions above blue ice or surrounding the nunatakss.
(2) glaciogenic deposits occurred as ice debris of solitude tillite or loosen tills in different sizes. They are formed in the ice-sheet frontal area by the activities of local glaciers or the East Antarctic Ice-sheet.
(3) large glacial erratic boulders perched in the outcrops of the basement rocks.
Glacial erosion landforms is ubiquitous in the outcrops of the basement rocks this area, such as horns, cirques, U-shaped valleys, hanging valleys, roches moutonnées and so on. Furthermore, striations on rocks in the Gale Escarpment, and other 3 nunataks are observed and their directions are measured, which show an ice flow direction of 325-345 degree.
All the glaciogenic deposits and erosion marks found in Grove Mountains are closely related to the climatic changes in Antarctica that resulted in the major glacial movements. They involve at least three ice-sheet evolutionary events in east Antarctica. (1) The activities of the East Antarctic Ice-sheet at the period of the Last Glacial Maximum. (2) A warm event, and most probably the Pliocene warmth. (3) The products of the local Mountain glaciers developed before the formation of the Antarctic Ice-sheet. All these records are of great significances in understanding the ice-sheet evolutionary history in east Antarctica.

Tue_283_GG-2_1640
Analysis of the Climate during MIS3 Using the Climate Model EC-Earth

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As observations of the past climate are spatially sparse, climate models can be used to "fill in the gaps" and provide a qualitative estimate of the climatic state of the past, consistent with the proxy data. In this study we aim at investigating the state of the climate during the Marine Isotope Stage 3 (MIS3) as simulated by the climate model EC-Earth. Comparisons of the atmospheric and oceanic circulation patterns as simulated by EC-Earth and another Earth System Model, NorESM, are also carried out to understand the possible climate responses to the MIS3 conditions. Additionally, the sensitivity of the simulated circulation to changes in sea ice will also be addressed by nudging EC-Earth towards different sea ice extents as suggested by proxy data.

Tue_284_GG-2_1643
Plio-Pleistocene Nunatak Exposure Histories from Western Dronning Maud Land

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Confidence in the ability of numerical ice sheet models to retrodict and predict ice sheet geometries requires model outputs to broadly agree with empirical data. For significant parts of the East Antarctic Ice Sheet empirical data on paleo ice sheet thickness and extent is patchy. MAGIC-DML, a Swedish-US-Norwegian-German-UK collaboration, is working in western Dronning Maud Land to determine the timing and pattern of ice surface changes. A combination of geomorphological mapping using remote sensing data, field investigations, cosmogenic nuclide analyses, and numerical ice sheet modelling are being used iteratively to reconstruct the glacial history. Glacially modified bedrock and erratic boulders were sampled from nunataks at different elevations above the modern ice surface. Measured concentrations of ^{10}Be, ^{26}Al, and ^{21}Ne in these samples reveal a complex exposure history of the nunataks implying fluctuations in ice sheet thickness since at least the last 3.7 million years.

Tue_285_GG-2_1669
Pliocene Diatom Biomarkers in Sabrina Coast. EAIS Continental Marginal Dynamics

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PNRA Tytan project, supported by the National Institute of Oceanography and Applied Geophysics (OGS), focused on the advances and retreats dynamics of the ice sheet and on variations in the glacial regime. Unit 2 focused on Diatom biomarkers and assemblages analysis on sediments of core PC03, collected during the IN2017-V01 cruise on the eastern flank of the Minang-a (or Whale) submarine Canyon. The project aims at reconstructing the depositional environment of the continental margin off the Totten Glacier and diatom data remained a key tools to constrain past ice-sheet dynamics and to forecasting future behaviour in a warming world. Preliminary dataset from diatom biostratigraphic tools allows to refer the base of the core to Pliocene while the upper part of the core records more modern EAIS dynamics, indicative of minor sedimentary evolution steps of the continental margin.
Diatom assemblage analyses highlight Eocene-Oligocene reworked material and freshwater diatom inputs in Pliocene sequence, strengthening the debate about ice-sheet and paleoceanographic models, WAIS cyclic collapse and suspected Pliocene EAIS retreat into major subglacial Antarctic basins.

Tue_286_GG-2_1730
Ice Sheet Retreat in the Northern Baffin Bay Reconstructed from Bathymetric Data

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The retreat histories of the Greenland, Laurentide and Innuitian Ice Sheets that bordered the northern Baffin Bay during the last glacial are only poorly understood. Glacial landforms visible in high-resolution multibeam data can help to reconstruct the post-glacial retreat of these ice sheets. During two expeditions in 2015 and 2017, extensive surveys with multibeam and sediment echosounders were conducted in the Melville Bay, the Lancaster Sound trough mouth and on the north Baffin Island area to collect bathymetric data and data on shallow sediment architectures. In the recorded data, a variety of ice-sheet marginal and sub-glacial landforms including moraines, crag-and-tails, glacial lineations and grounding-zone wedges can be identified.
The distribution of these landforms in the northern Baffin Bay shows that in cross-shelf troughs, grounded ice sheets reached to the shelf edge during past glacials. Grounding-zone wedges in the cross-shelf troughs indicate that the retreat of the ice-sheet margins from their Last Glacial Maximum extents to their recent positions was not continuous but interrupted by repeated phases of stabilisations in mid-shelf positions. Furthermore, the distribution of glacial landforms on the continental shelves indicates an asynchronous retreat of the ice sheets in the northern Baffin Bay. Glacial landforms on the inter-trough banks furthermore point towards localised ice caps on the continental shelf.

Tue_287_GG-2_1734
Invigorated Southern Ocean Circulation Preceding Oligocene Antarctic Glaciation

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During the Eocene - Oligocene Transition (EOT, 34-33.5 Ma), Antarctic ice-sheets rapidly expanded leading to the first Cenozoic continent-scale glaciation. Quasi-coeval opening of Southern Ocean gateways and resulting changes in ocean circulation are probably not the primary driver of Antarctic glaciation, but the exact role of tectonic changes across the EOT remain unknown. Here we use organic dinoflagellate cysts (dinocysts) to stratigraphically date and correlate critical EOT Southern Ocean sedimentary successions. The results imply that typical, winnowed glauconite-rich lithological units were deposited ubiquitously all around Antarctica starting at ~35.7 Myrs ago, and continued across the EOT. In addition, quantitative biomarker- and dinocyst-based temperature reconstructions show progressive cooling during the Late Eocene. In contrast, the southwest Pacific experienced late Eocene warming, related to troughflow of low-latitude surface currents. Organic microfossil assemblages document a shift towards more productive, vertically mixed surface waters in areas influenced by polar wind-driven currents. The results imply (I) accelerated deepening of the Tasman Gateway, (II) invigorated surface and bottom water circulation at sites affected by polar westward currents (III) progressive southward migration of ocean frontal systems (IV) cooling of the circum-Antarctic surface waters. These positive feedbacks have preconditioned the Antarctic continent for glaciation.

Tue_288_GG-2_1894
Modelling Long Term Climate and Ice Sheet Changes to Understand Future Warming

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This study explores Greenland Ice Sheet reconstructions during the last interglacial period (~125,000 years ago) using the U.S. National Center for Atmospheric Research (NCAR) global climate model. Stable water isotopes ($\delta^{18}O$) of precipitation on the Greenland Ice Sheet are traced through the ice sheet and climate system, using precipitation isotopes that are simulated in the NCAR hydrological cycle. Isotope-tracing capabilities in the ice sheet model allow a prediction of 3D $\delta^{18}O$ fields, which can be compared with modern observed fields (e.g., in ice cores) to better understand and constrain the past. Of particular interest is how the Greenland Ice Sheet changed in response to a warmer climate at this time, and whether some portion of the isotopic signals from the last interglacial period are associated with melt effects on the ice sheet. I will be examining the question of what threshold temperature, if any, causes the decline of the Greenland Ice Sheet, and how isotopes can be used to constrain ice sheet volume and associated sea level rise during this last major warm interval.

Tue_289_GG-2_1937
The Response of the Totten Glacier to Past Climate Warming Using Marine Sediment

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The Totten Glacier is responsible for an average ice-loss of 7 ± 2 Gt/yr from East Antarctica (Li *et al*. 2016) and upon absolute melting, would contribute to a considerable 3.5m rise in global sea-level (Greenbaum *et al.* 2015). Marine sediment can be used to expand our understanding of ice dynamics and ocean circulation, which will ultimately facilitate the development of current ice sheet climate models. This study focuses on three marine sediment cores recovered aboard the *RV Investigator* from the continental slope of the Sabrina Coast. Multiple laboratory techniques have been employed to unravel the response of the ocean and the ice sheet to climate variability over the past glacial cycle. A transition from glacial to warmer conditions of the Holocene is characterised by a prominent peak in biological productivity - implying an ice-free, nutrient-rich photic zone. This transition is supported by trends in the XRF data which illustrate a change from clay-rich glaciogenic sediment (higher K/Ti values) to diatom-rich sandy surface sediments (lower K/Ti values) - and by an increase in the abundance of biogenic barium (Ba/Al) - a proxy of productivity export. Ongoing work will quantify the iceberg-rafted debris flux and measure temporal variations in primary productivity and ocean circulation. The provenance and age of heavy minerals will also be determined to help define the subglacial geology of the Aurora Subglacial Basin.

Tue_290_GG-2_1959
Late Eocene Marine Transgression Indicated by Glaucony Facies (Drake Passage)

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The rapid onset of continent-wide Antarctic glaciation during the Eocene-Oligocene transition was the most dramatic climatic perturbation of the Cenozoic. The Late Palaeocene separation of the Tasman Rise and South America from Antarctica led to the establishment of the Tasmanian and Drake Passages and to the development of the Antarctic Circumpolar Current. The Powell Basin formed as the South Orkney Microcontinent (SOM) was rifted from Antarctica in the Late Eocene. Sediments bearing Late Eocene green clay (glaucony) facies are a significant feature in the sediment cores recovered by the Ocean Drilling Program at Site 696 in the southeastern margin of the SOM. The mode of occurrence, mineralogy and chemistry of glaucony facies are important sedimentological proxies for paleoenvironmental reconstructions, as syn- to post-depositional controls determine the texture and composition of authigenic minerals that evolve from iron-rich smectite precursors to glauconite. The morphological, mineralogical and geochemical features of Late Eocene glauconitized fecal pellets/mica flakes denote an autochthonous origin of the evolved (mature) glaucony grains, indicating a period of low sedimentation rate probably associated with rising sea levels related to plate reorganization and opening of Drake Passage. In this scenario, the Powell Basin may have provided pathways for a proto-circumpolar current, favouring upwelling, stratigraphic condensation and glauconitization in the SOM margin.

Tue_291_GG-2_1963
The *'Ona Paleovalley'* (Drake Passage): A Submarine Slope Failure System

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The southern Scotia Sea hosts small oceanic basins developed through continental break-up and oceanic spreading during the Cenozoic. Ona Basin is the southwestern most basin of the Scotia Sea. It is bounded by several structural highs: the Shackleton Fracture Zone to the west, Terror Bank to the east, and the South Scotia Ridge to the south. The southern part of the basin is further divided in two sub-basins (the western and eastern Ona basins) separated by the submarine relief called Ona High. The Ona Basin is mainly affected by two major water masses the deeper branch of the Antarctic Circumpolar Current flowing eastwards and a westward flowing branch of the Weddell Sea Deep Water (WSDW). Interaction between mass movement and contouritic processes are likely to occur as a consequence of the complex geologic, physiographic and oceanographic setting. A combined approach including geomorphological, stratigraphic and seismic analyses allows us to document, for the first time, the record of repeated large-scale submarine landslides in the western Ona Basin. A major morphological feature named as *'Ona Paleovalley'* is genetically related to large-scale recent gravity/mass transport processes. The valley infill records channelized depositional periods alternated with erosive events when sediments were evacuated basinwards. This morpho-sedimentary pattern is attributed to the interplay between tectonic events leading to gravitational processes and the channelized flow of the WSDW.

Tue_292_GG-2_1968
Eocene-miocene Paleoceanographic Changes in Drake Passage (Antarctica)

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The timing and impact of the opening of the Drake Passage during the Eocene-Oligocene and Oligocene-Miocene transitions on global climate remain controversial. In this study, we aim to better understand the regional reorganization of the ocean circulation in the southeastern margin of the South Orkney Microcontinent (SOM) that remained isolated from Antarctica during these transitions. We combined a multi-proxy study: sediment facies analysis, diagenesis, ichnology, X-ray diffraction and fluorescence, and geochemical analyses using marine sediment samples from the Ocean Drilling Program (ODP) Site 696. The late Eocene, during which the SOM was still attached to the Antarctic Peninsula, was characterized by a thick, terrigenous sequence deposited at shallow-water (neritic) depths under reduced-oxygen conditions. However, the latest Eocene is marked by syn-depositional glauconitization under slow sedimentation and a relative sea-level rise/subsidence. The continuous sea-level rise led to the establishment of bathyal depths during the early Oligocene. At that time, the water column was stratified and local/temporal anoxic bottom water conditions developed, likely associated with a restricted ocean circulation in the Powell Basin due to the clockwise drift of the SOM from Antarctic Peninsula. The end of the transgressive pulse is detected at the end of the mid Miocene, recorded by a siliceous-biogenic ooze associated with oxic conditions as a result of the modern SOM geography.

Tue_293_GG-2_2130
Reconstruction of Antarctic Ice Sheet Variability during the Last Interglacial

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Recent observation revealed that the fastest melting rate of polar ice sheets ever observed is ongoing due to the global warming and there is growing concern of greatly rise of sea level in the future. Knowledge of sea level fluctuations in the past warm period provides useful information to better understand future sea level changes. Geological records have suggested that sudden and abrupt rises in sea level (~6 m) were happened during the last interglacial when global mean sea surface temperature was slightly higher than the preindustrial level. If this were really happening, there is a critical ice sheet stability threshold resulting in the catastrophic collapse of polar ice sheets and substantial rapid sea-level rise in the interglacial climate condition. Since the Greenland ice core record showed a 2 m eustatic component from the Greenland ice sheet during the last interglacial, the Antarctic ice sheet greatly contributed to eustatic rise of sea level at that time. However, variability of the Antarctic ice sheets during the period has not been investigated. In this study, we measured paleoclimate proxies in sediment cores collected from different parts of the Antarctic margins in order to reconstruct variability of Antarctic ice sheets during the last interglacial. In this presentation, we will show you preliminary results of our sediment core data.

Tue_294_GG-2_2035
Ocean Circulation across the Tasman Gateway during Mid-Oligocene to Mid-Miocene

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Establishment of deep ocean circulation between Australia and Antarctica through the Tasman Gateway has been suggested to start 30 million years ago (Ma), mostly attributed to the onset and strengthening of the Antarctic Circumpolar Current (ACC). However, uncertainty remains regarding the timing and intensity of such paleoceanographic reorganization because of the lack of data. Here, we present sedimentological records spanning the mid-Oligocene to mid-Miocene at two strategic Deep Sea Drilling Project (DSDP) Sites (a) 278 and (b) 269A from the Pacific and Indian sectors of the Southern Ocean, respectively. Paleomagnetic and biostratigraphic analyses have been conducted to obtain a new age model. In addition, visual core descriptions, conventional sedimentological analyses and geochemical X-ray Fluorescence (XRF) data were performed in order to define the main lithofacies and facies associations. Neodymium isotope ratios (εNd) were obtained from fossil fish teeth to reconstruct regional water masses and ocean circulation. At Site 269A, we find Oligocene/Miocene εNd values of -8.2 to -8.8, indistinguishable from modern deep circumpolar εNd values. More radiogenic εNd values (-6.2 to -6.9) are recorded at Site 278, similar to other records from the region. We conclude that from around 30 Ma, the signature of the ACC records mixing processes between Indian-Atlantic waters with Pacific and possibly Ross Sea deep waters after crossing the gateway.

Tue_295_GG-2_2040
Sedimentary Evidence for a Pre-Pleistocene Marine Environment in West Antarctica

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Elephant Head (79°49.298´S / 83°20.426´15 W), Ellsworth Mountains, is a deglaciated valley in which sediment samples were collected in the moraines. Particle size, morphometric, and chemical and mineralogical composition analyses were performed on the sediments. The predominance of calcium carbonate was observed in most samples; ripple marks suggested the existence of a shallow marine environment. A marine sedimentation possibly filled a shallow inland sea, associated with local tectonic uplift, posterior glacial covering and erosion. Calcareous and clastic sedimentation dominates the valley, reflecting the nature and composition of the main source of the sediments. Conglomerates also reflect the nearby source area. Further glacial conditions have not modified the sediment conditions substantially due to the dry climatic conditions. It is suggested that Elephant Head Valley preserves geomorphologic and sedimentological evidence for a marine sedimentary environment, potentially of pre-Pleistocene glacial cycles, supporting recent inferences from terrestrial deposits, which suggest the continuous presence of the WAIS in the southern sector of Ellsworth Mountains and the preservation of landforms and sediments at the scale of 3.5 Ma. The main unknowns now concern the timing of the events.

Tue_296_GG-2_2044
Eocene-Oligocene Tectonic-driven Paleoceanographic Changes, off the Cape Adare

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The opening of the Tasman Gateway drastically affected Antarctic ice sheet and global climate through its impact on atmospheric and ocean circulations. The relationships between the tectonics, circulation changes and Antarctic glaciation are still debated. We studied late Eocene to early Oligocene age sediments from DSDP Site 274 to provide insights into the relationship between the opening of the Tasman Gateway, the beginning of Antarctic glaciation and the onset of the "proto"- Antarctic Circumpolar Current (ACC). For this, we conducted paleomagnetic and biostratigraphic analyses to obtain a new age model. Sedimentary facies were defined based on visual core descriptions, scanning electron microscope (SEM) images, conventional sedimentological analyses, geochemical (XRF) and mineralogical (XRD) data. During the late Eocene, Site 274 sedimentation was dominated by high terrigenous inputs (silty clays). Towards the latest Eocene, silty clays are interbedded with cherts. From the early Oligocene onwards, sedimentation is dominated by siliceous oozes with sporadic ice rafted debris. We infer that the shift from terrigenous sedimentation to cherts reflects the onset of a prolonged period of high primary productivity. Fossil fish teeth will be analysed for Nd isotopes to identify intermediate/deep water masses across the observed shift in sedimentation and its relation with the establishment of the proto-ACC.

Tue_297_GG-2_2197
Late Pliocene Contraction of the Pacific Polar Front: A Warming Climate Analog?

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The Late Pliocene is the most recent interval in Earth's history to sustain global temperatures within the range of warming predicted for the 21st century. Global reconstructions and climate models find an average +2° C summer SST anomaly relative to modern during the ~3.3-3.0 Ma PRISM interval, when atmospheric CO_2 concentrations last reached 400 ppm. Here, we present a new diatom-based reconstruction of Pliocene (3.8-2.8 Ma) interglacial sea surface conditions from IODP Site U1361, on the East Antarctic continental rise. A prominent feature of this record is the transient southward shift of the Antarctic polar frontal zone during a single interglacial, marine isotope stage KM3 (3.17-3.15 Ma), bathing U1361 in warmer subantarctic waters. Building on this result, we revisited earlier reconstructions to explore the response of the Southern Ocean to peak late Pliocene warmth. By applying a modern chronostratigraphic framework to those lower-resolution records, we identify the same frontal migration in 4 other cores in the Pacific sector of the Southern Ocean, documenting a major migration of the polar front during a key interval of warm climate. These new results suggest that increased summer insolation during KM3, combined with atmospheric CO_2 similar to modern concentrations, provided sufficient forcing to overcome bathymetric constraints on polar frontal position, pushing warm subantarctic waters into proximity with vulnerable portions of Antarctica's marine ice sheets.

Tue_298_GG-2_2261
Paleoceanographic Changes during the Past One Million Years in the Ross Sea

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A 11.75 m-long core RS15-LC42 was collected from the Central basin in the Ross Sea (71°49´ S, 178°35.´E, 2084m deep) in 2015, by the Korean RVIB *Araon*. The chronology is inferred by paleomatnetism and diatom biostratigraphy, and the core covers about one million years. Magnetic susceptibility, grain size, oxygen and nitrogen isotopes, and concentrations of total organic carbon (TOC), opal, and $CaCO_3$ were measured. Foram oxygen isotopic compositions were analyzed, and elemental compositions were scanned by ITRAX system. The core is composed of two alternating facies:
1) well-laminated greenish gray diatomaceous mud, and
2) massive light gray sandy mud.
Well-laminated facies tend to include higher TOC, opal and carbonate compared to the other, so it is likely that they were deposited during interglacial period, but the possibility of remobilizing of sediments from the outer shelf to continental slope during glacial period cannot be excluded. Around 280 cm (about 0.25 Ma) from the core top, the massive facies is dominant in the upper part, whereas the laminated facies is dominant in the lower part. This indicates that there iwas a major shift in the depositional condition in the Central Basin at this time and which could be related with the extensive glaciation during Marine Isotope Stage (MIS) 8 in the McMurdo Sound (Christ and Marchant, 2017). Further work like clay mineral assemblage is necessary in order to ascertain whether the laminated sediments are primary or reworked.

Tue_299_GG-2_2327
Widespread Fine-grained Sedimentation in Melville Bay: A Huge Meltwater Event?

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Reconstructing the past dynamics of the Greenland Ice Sheet (GrIS) offers invaluable insight into its dynamics under a modern day changing climate. Two sediment cores (GeoB19946-4 and GeoB19948-3) from Melville Bay (NE Baffin Bay), into which 27% of the GrIS drain, were used to investigate the melting history and sedimentary dynamics in the area. The near-by cores were retrieved from two different major shelf troughs that are separated by a shallow sill. These are fed by individual glacier sources which allows for a clear differentiation of two major modes of glacier-derived sediment transport: in a surface plume potentially affecting both core sites vs. near-bed transport affecting only one site. Regarding grain size distribution, sediment elemental composition and microfossil content, both records reveal a very similar alteration of characteristic core sections, where large portions of the cores can be classified as glaciomarine-hemipelagic sediments. However, in both cores these layers are intersected by several meter thick, homogenous and very fine-grained sediment packages, barren of microfossils and showing little to no variation in their elemental composition. Combined, this synchronous, strong and sudden change in sediment characteristics indicates the occurrence of at least one huge, surge-like meltwater event that was not confined to a single trough. This interpretation is supported by initial radiocarbon dates that place the more recent surge at around 7.5 ka BP.

Tue_300_GG-2_2339
Deglaciation of the Eastern Antarctic Ice Sheet in Queen Maud Land

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The assessment of the stability of Antarctic ice sheets and of their contribution to the global sea level change as a response to climate change requires the reconstruction of their past volume variations. For instance, dramatic surface lowering of East Antarctic Ice Sheet (EAIS) during the last million years have been recently reported in several publications. However, the spatial distribution of this unloading and subsequent isostatic rebound remain unexplored. In this study, we will decipher the pace of deglaciation and quantify subglacial erosion of the EAIS in the Sør Rondane Mountains in the Queen Maud Land. To do this, we will focus on the Nunatacks around Mount Wideroe, Mount Nils Larsen and Perlabandet in the western Sør Rondane Mountains. We will use in-situ produced cosmogenic 10Be, 14C, 26Al and 36Cl to reveal the deglaciation history and amount of subglacial erosion. In the field, we will locate and map the paleo-positions of the ice margin during the retreat in the Nunataks. Measured cosmogenic nuclide concentrations will be then converted to both exposure ages and amount of glacially eroded bedrock. This study will produce scientific knowledge on
(1) deglaciation of the Queen Maud Land,
(2) amplitude, timing and frequency of the deglaciation, and
(3) subglacial erosional processes. The first results will be presented.

Tue_301_GG-2_2440
Landscape Evolution of the Ellsworth Mountains: Implications for Subglacial Lakes

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Antarctic subglacial lakes contain sediment records of past environmental change and ice sheet history. To interpret sediment records in context it is important to understand the nature, origin and history of such lakes. Here, we determine the long-term landscape evolution of the Ellsworth Mountains region, where at least two subglacial lakes have been suggested as targets for exploration, Subglacial Lake Ellsworth, and Subglacial Lake CECS. New geomorphological observations of exposed areas show that the Ellsworths contain preserved remnants of a pre-glacial landscape, incised by alpine glaciation and subsequent ice sheet glaciation, and with multiple trimlines recording former ice levels. Based on geochronologic techniques we suggest the likely timing of each of these stages of development. Beneath the ice we present a new bedrock topography based on a combination of new and existing radar survey data. Using this coupled to mapping of supraglacial ice topography we identify key features in the landscape including prominent glacial troughs cutting through the Ellsworth-Whitmore Block. Using this new subglacial topography we explore the contemporary subglacial hydrology of the region, and the hydrologic connectivity of the lakes through time. We will explore the implications for subglacial exploration, especially the likely nature of the sediment record preserved in the lakes, and which can provide insight into long-term ice sheet behaviour.

Tue_302_GG-2_2480
Modelling a Kilometre-thick Arctic Ice Shelf during MIS6

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<ol style="list-style-type: none;">
Sets of parallel erosional features have recently been identified on the Lomonosov Ridge in the central Arctic Ocean, indicative of ice grounding in modern water depths of up to 1,280 m. These features have been interpreted as being formed by an ice shelf, either restricted to the Amerasian basin (the 'minimum model'), or from an ice shelf covering the entire Arctic basin. We use a numerical ice sheet-shelf model of the Arctic and surrounding grounded ice sheets to explore how such a thick Arctic ice shelf could form and determine which ice sheet/shelf configurations are most consistent with the ice-flow features observed in the Arctic Basin. We suggest that such an Arctic ice shelf could only form with complete ice cover in the Arctic Basin, which places a minimum estimate on its volume. We explore how buttressing provided by an Arctic ice shelf would have affected the dynamics of the surrounding terrestrial ice sheets and examine how grounding on the Lomonosov Ridge affects the stability of the ice shelf. Our results also have significance for a hypothesized East Siberian ice sheet. <ol style="list-style-type: none;">

Tue_303_GG-2_2505
Exploring the Range of Parameters Favouring Antarctic Glaciation

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It is generally believed that a large ice sheet started to grow on the Antarctic continent around 34 million years ago. The development of the Antarctic ice sheet occurred at a time when ocean gateways surrounding Antarctica opened and atmospheric CO_2 concentrations declined from values likely above 1000 ppm to below 600 ppm. Recent work suggests that the elevation and configuration of the Antarctic continent was rather different from today when accounting for the effects of erosion and tectonic uplift, which impacts have not yet been studied in much detail.
Previous work considering off-line ice sheet simulations or asynchronous coupling with climate models show that CO_2 might have been the decisive factor in cooling the Antarctic climate and initiating ice sheet growth. Here we present transient simulations around the Eocene-Oligocene transition using HadSM3, a climate model that performs particularly well above the Antarctic continent, coupled with the Antarctic ice sheet model VUB-AISM. The latest insights in paleogeography and bedrock topography are used for the reconstruction of the boundary conditions. We make use of an emulator to predict temperature and precipitation above the Antarctic continent for a large range in CO_2, orbital parameters and ice sheet volumes to determine where ice sheet initiation is favoured.

Tue_304_GG-2_2572
Neogene Seismic Stratigraphy, McMurdo Sound: Tectonic and Climate Controls

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The interplay of tectonics and climate is recorded in the sedimentary strata within the Victoria Land Basin, McMurdo Sound, Antarctica, where patterns of sedimentation documented from interpretation of seismic reflection profiles are calibrated by drillhole data. Mapping of reflectors marking unconformities identified from the AND-2A core indicates that grounded ice did not extend from the south throughout McMurdo Sound until ~14.4 Ma. Prior to that point, erosion was limited to the western shelf as ice extended eastward from TAM outlet glaciers. Seismic facies patterns suggest that the shelf-slope-basin geometry within McMurdo Sound did not shift laterally through the Miocene, and was very similar to the present morphology. Mass accumulation rates calculated in this study are variable, but the broad trends are dictated by a combination of available accommodation space in the depocenter and ice sheet thermal regime. Sediment volumes and mass accumulation rates calculated for critical climatic intervals show that from ~22 Ma to ~13 Ma the overall trend of mass accumulation rates declined, with a particularly noticeable decline following the onset of cold-based glaciation following the Mid Miocene Climate Optimum ~15 Ma.

Tue_305_GG-2_2602
Sedimentary Processes at the Northern Svalbard Continental Margin

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Hydroacoustic and high-resolution seismic data reveal that glacial processes and slope instability extensively shape the sedimentary drape on the shelf north of Svalbard and the southern Yermak Plateau (YP). A complex association of overlapping submarine landforms is linked to the Middle to Upper Pleistocene glaciation history in the Arctic Ocean:
(i) Mega-scale glacial lineations (MSGL) formed either by an ice shelf advance from Svalbard or a coherent mass of large-scale icebergs exiting the Arctic Ocean across the YP,
(ii) Quasi-linear, huge ploughmarks, younger than the MSGL, formed by keels of a mega-iceberg or several icebergs trapped together in multi-year sea ice.
(iii) Freshly-looking large iceberg ploughmarks, and
(iv) irregular smaller-scale ploughmarks formed by keels of small icebergs.
A grounding-zone wedge located close to NW Spitsbergen potentially represents the maximum extent of the youngest advance of the Svalbard-Barents ice sheet. The shelf and slope off Nordaustlandet was subject to the giant Hinlopen/Yermak Megaslide (HYM) some 30 ka ago. Internal deformation of the sedimentary structures reveals secondary, partly incomplete sliding processes of different age. Gas seeping, paleo pockmarks and a former gas-pipe structure are likely linked to the mass failure. Large parts of the Nordaustlandet shelf and slope are currently preconditioned to fail completely in future.

Tue_307_OC-1_294
Challenges in Polar Education: Lessons Learnt Since International Polar Year?

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Education is a major legacy of the International Polar Year (IPY) carried out in 2007-08. This presentation aims to discuss how certain aspects of polar education have grown. For example, Regular international science education workshops and meetings, POLAR WEEKS (mainly coordinated by the Association of Polar Early Career Scientists (APECS) (with Polar Educators international (PEI) in some countries) are still a huge success while education and outreach is a growing theme within the Antarctic Treaty Consultative Meetings. However, challenges on polar education still stands, such as: a thorough evaluation of long-term educational activity success, and an activity implementation plan for other countries (and in other languages). To meet these challenges, there is increasing need of using the most recent technologies, placing polar subject into national curricula. In POLAR 2018, we will also aim to compare both Arctic and Antarctic education goals and discuss how further international and collaborative initiatives can be developed and implemented, under a polar framework for education.

Tue_308_OC-1_346
A Worldwide Glacier Information System to Go

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In the forefront of the Paris Climate Conference in December 2015, the WGMS and UNESCO jointly launched a glacier application for mobile devices. The wgms Glacier App aims at bringing scientifically sound facts & figures on worldwide glacier changes to the interested public and teachers. With the launch of the app at high-level events, we target the awareness of decision makers at governmental and intergovernmental levels for climate change. The app provides a map interface based on satellite images that display all the observed glaciers in the user's proximity. Graphs with observation data illustrate the glacier's development, along with information on latest principal investigators and their sponsoring agencies as well as detailed explanations of the measurement types. A text search allows the user to filter the glaciers by name, country, region, measurement type, special events (e.g. floods or avalanches) and the current "health" status, i.e. if the glacier has gained or lost ice over the past decade. A compass shows the closest observed glaciers in all directions from the user's current position. The app further allows the user to submit own glacier photographs and to send feedback. Finally, the card game allows the user to compete against the computer on the best-monitored glaciers in the world. In this presentation, we provide a visual entrance point to the app and discuss our experiences with this new way of sharing scientific observations with a wider audience.

Tue_310_OC-1_494
Preparing and Conducting a Live Online Class to Popularize Antarctic Science

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This paper reports the process of preparation and delivery of an inaugural class of the distance course for teachers *Antarctic or Antarctica?*

In order to contribute to the formation of a scientific culture, the preparation started from a dialogical learning approach, in which the teacher must abandon the role of information issuer and assume the place of learning mediator and, together with the student, to produce meanings. It was also considered to insert the polar sciences in contexts of popularization, reducing the abyss and the distance between specialists and laymen. The class was conducted by a multidisciplinary team with the objective of promoting the connection between participants in Portugal and 14 Brazilian states.

The broadcast of the class was performed live on YouTube by free and open source Open Broadcaster Studio (OBS). In total, 257 participants had access to the class and interacted with six tutors through multiple platforms: YouTube, Facebook and Whatsapp chat.

The use of collective teacher conception together with accessible tools was fundamental for the development of the class by promoting the interaction of people from different locations and the breaking of the barriers imposed for access to scientific knowledge. Synchronous mediation contributed to the consolidation of knowledge about Antarctica and promoted a greater involvement of the participants in the proposed course, enhancing such knowledge.

Tue_311_OC-1_577
Significant Learning on Antarctica in a Distance Learning Course for Teachers

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This article aims to present partial results of a research conducted in the learning process of the participants of a distance teacher training course: Antarctic or Antarctica: How to introduce the polar sciences in the primary school curriculum?
Our theoretical foundation is based on the socio-interactionist approaches, dialogic learning, and collaborative learning.
Antarctic or Antarctica? Is a fourty-hour distance learning course, structured in four modules (Ice, Convergence, Environment, and Life). There is a face to face class, and all others classes happen online and should be finished in ten weeks.
The course is composed of texts, video lessons, puzzles, etc. All the teaching material was prepared in an accessible language to different audiences and can be used by teachers to teach their classes.
Course participants had to answer a quiz before and after the course. Before the beginning of the course, there were a lot of misconceptions about Antarctica.
After attending the course, a few misconceptions persisted. However, most of the participants were able to learn crucial information about the continent.
The course helped participants to understand the importance of teaching about the continent in primary schools. There was significant learning about basic knowledge of Antarctica. Participants were able to contextualize that knowledge in their classes. Producing Portuguese teaching material is crucial to introduce Antarctica into the curriculum.

Tue_312_OC-1_925
Exposing Students to Polar Scientific Field Work: Partnership, Rocks & ECW

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Over the past 10+ years, through a partnership with elementary school teachers, the United States Polar Rock Repository (PRR) and Antarctic researchers, we have engaged with elementary classrooms highlighting the nature of Antarctic scientific field work. A typical classroom visit involves the use of google earth to orient the students, sharing field videos & photos, an opportunity to dress up in extreme cold weather (ECW) gear and a chance to inspect geologic samples from the PRR collection. In 2017, we expanded on our typical classroom visit to include a school-year-long project whereby a field team engages with the class over the entire life cycle of a field season, including blog updates from the field. After the initial class visit, we introduce the project and challenge the class to submit specific questions to the field team and teachers that may form the basis for a student designed project aimed at planning a field season to Antarctica. Near the end of the school year, the students present to a team of scientists to highlight their plans. For this session, we will present the results of this experiment, share lessons learned and seek input for further refinement.

Tue_313_OC-1_1282
Climate Change: A Semester Course Elective at the High School Level

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In its 4th year, Climate Change is a semester elective open from 10th to 12thgrade students at a private boarding school in Connecticut, USA. This course focuses on Earth systems, key environmental issues, political actions, social and cultural impacts as well as developing science literacy skills. Ideas are presented from both sides of the spectrum and students are able to arrive at their own opinions as they evaluate science sources. There are great discussions but also hands on labs, field trips and group projects. Students read through the Intergovernmental Panel on Climate Change report learning how to read various graphs and charts. Students observe the long term studies which enforces the difference between weather and climate. The variation in potential outcomes shows the difficulties of modeling and the meaning of uncertainty. Beyond reading technical papers, students also follow scientists, expeditions and latest news through various social media platforms. A final project is to have students craft a local project on campus that will last longer than their enrollment in the class. This is necessary to leave the students empowered as often when they become savvy to these dire issues there is an overwhelming sense of urgency and powerlessness. For the youth, having a real but hopeful take away message is imperative. This course has been highly successful, encouraging students to take further environmental courses or pursue higher studies in this field during college.

Tue_314_OC-1_1337
The Tiny Silverfish. A Journey of Discovery through the Southern Ocean

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Ross and Sesi are two tiny fish, waiting to come to life in the midst of the Antarctic sea ice. After hatching from small eggs they travel across the Southern Ocean, growing up in a fantastic environment inhabited by wonderful creatures and dangerous predators. Children are involved in this adventure, following Ross and Sesi as their life journeys unravel, and participating in the experience of discovering Antarctic marine life. This children's book, published in Italian in 2013, is now translated and available in English, ready to reach a wide audience of young readers and primary school teachers. In the book, the life cycle of a key fish species of the Antarctic Ocean, the Antarctic silverfish, and its unique relationship with sea ice, are translated into appealing graphics to illustrate the basic structure of the Antarctic ecosystem and the implications of ongoing climate change. The book is a result of the project "Communicate polar science: Antarctic fish", supported by the Italian Programme for Antarctic Research (PNRA). Both the graphics and the text are set with rigorous attention to the educational message in polar scientific issues, and to gender equality. The book is dedicated to John Macdonald, a much appreciated Antarctic researcher from the University of Auckland who, together with the authors, participated in the discovery of the Antarctic silverfish nursery in the northern Ross Sea region.

Tue_315_OC-1_1571
Training Scientists in Effective Science Communication via Lightning Talks

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Scientists are regularly expected to communicate their research and results with non-scientists although they often don't receive training in how to do so effectively. Further, with a growing emphasis on interdisciplinary research, scientists must also become adept at communicating with scientists outside of their discipline who may not be familiar with the discipline's base-level knowledge and jargon. The Interagency Arctic Research Policy Committee (IARPC) in the United States provides a unique platform to expedite communication between the research community and US agencies which fund Arctic research. The IARPC has created a virtual opportunity via the IARPC Collaborations website (iarpccollaborations.org) for early career scientists to receive training on communicating science to communities outside their discipline, non-scientists and policy makers. IARPC Collaborations hosted a workshop to train early career researchers in conducting a "lightning talk," or a short format presentation that emphasizes streamlined communication. The training focused on developing communication skills such as considering audience, avoiding jargon, and utilizing narrative structure. Following the workshop, participants presented their lightning talks to an audience of interdisciplinary Arctic scientists and Federal program managers. IARPC plans to repeat this workshop to promote interdisciplinary networking through IARPC Collaborations and continue to provide communication training.

Tue_316_OC-1_1574
Permafrost Young Researchers Network: The Next Generation of Permafrost ECRs

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The Permafrost Young Researchers Network (PYRN) is a platform created to engage future generations of permafrost early career researchers (ECRs) to promote multidisciplinary research collaboration, establish exchange on scientific news and activities around the world and make career development opportunities available by supporting activities, improving communication among permafrost ECRs and engineers, accumulating and sharing technical and non-technical information on permafrost such as upcoming events, travel grant and scholarship opportunities, and job postings. PYRN has been actively using the social media such as Facebook (https://www.facebook.com/PYRNofficial), Twitter (https://twitter.com/PYRN_official) and Instagram (https://www.instagram.com/pyrn_official) in order to reach as many ECRs as possible.
PYRN also works in close collaboration with the International Permafrost Association (IPA) and other partners in order to assist with the organization of the ECRs' activities during the regional and international permafrost events such as the coordination of travel grant programs and student presentation awards as well as organization of international PYRN workshops (e.g. EUCOP, ICOP), which represent a key contribution of the PYRN to the permafrost research community. In addition, PYRN has been continuously developing and the PYRN North America was established in order to increase the collaboration among ECRs based in Canada and in the USA in December 2017.

Tue_317_OC-1_1681
Use of Facebook for the Polar Sciences Popularization

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Social media are spaces for collaboration, information sharing and collective construction of knowledge. Facebook (FB) has in Brazil a penetration in 45% of the population, therefore approximately, 90 million of the users connected to the internet. This is the main reason the social platform was chosen to host an activity on the distance learning course to teachers *Antártica or Antártida?*
Sharing information, news and curiosities about Antarctica, on the Portuguese language, was the main objective along eight weeks when the students had to post on their FB profiles at least one weekly article about Antarctica, followed by the hashtag #CursoAntartica.
114 students published at about 912 posts on different subjects covering Antartica. Beyond sharing news and curiosities, it was realized that the students were engaged in the dissemination of what they have learned and researched, reaching the largest number of people among their connections on Facebook
Those posts had a potential reach of 1317 users, with 10 potential influential subjects that amplified the discussions about Antarctica. The sum of those users' Share of Voice reached a score of 99.491, therefore proving the potential of Facebook to popularize science.
The creation of a connected people network was fundamental to popularize science. Social networks are part of the students' lives and allow the educators new pedagogic possibilities, enabling flexible contexts, individual and collective approaches etc.

Tue_318_OC-1_1718
Digging for Gold: How New Metrics & Big Data Inform the Future of Polar Research

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The Arctic and Polar North have seen a dramatic increase in global attention from policy-makers and industry due to several important topics, including climate change and resource competition. International Arctic research collaboration has existed since the 19th century and, irrespective of political conditions, has grown visibly over the last decades through initiatives such as "International Polar Year" and annual activities and meetings of the Arctic Council.
As a result of these developments and the growing scale of research data there is an increasing need to regularly analyze research cooperation, activities and outcomes, identify centers of excellence, and to foster further international collaboration between disciplines and across geographies.
It is apparent that there are a lot of new insights that the Polar research community and decision makers can gain through the lenses of various research metrics. Questions that this session will address include:

- How big-data analytics tools and methods can be used to identify and evidence challenges and gaps in knowledge, and what solutions they might offer.

- A review of how policy makers and global audiences have engaged with the research - and what that might mean for its future.

- A discussion of we can identify centers of excellence and surface new opportunities for collaboration.

The session is open to anyone with an interest in the development of research programs, collaborations, evaluation and connected data.

Tue_320_OC-1_1898
Homeward Bound: Leadership, Science, Strategy and Gender in Antarctica

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The world's first leadership, strategy and science program for women in science, set sail for Antarctic in December 2016. It was the first voyage of a 10 year outreach initiative to build a 1,000 strong global collaboration of women in science, who have had shared experience and learning in Antarctica, with a curriculum focusing on leadership, strategy and science. Antarctica was the backdrop for this initiative and we report on how why Antarctica was pivotal to Homeward Bound's success.
The 2016 program selected 76 female scientists from around the world. They worked on a range of projects focusing on global change and sustainability throughout the year. They met for the first time as they embarked on a 20-day trip to Antarctica. Together and individually, they learnt to elevate their leadership capabilities, refining their ability to design and execute strategy, and devise plans for future collaborations as science leaders working towards a sustainable future. While undertaken this transformational journey, an immersive science program on Antarctic conservation, marine and terrestrial ecosystems, was delivered by experts. A participant led science symposium was held at sea, off the Antarctic Peninsula. There were 76 science presentations, the scientists then explored opportunities for collaborations, with new initiatives emerging from the voyage. The program is rolling out again in Feb 2018 with a new cohort of scientists, and a third voyage is fully subscribed for 2019.

Tue_321_OC-1_1915
Games and Art as Tools to Teach Astrobiology and Polar Science

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Earth's polar regions contain extreme environments that are the best analogs to those on other planetary bodies, like Mars and Europa. Furthermore, they can serve as analogs to early Earth, allowing us to explore questions about how life starts and thrives. Polar environments also serve as testing grounds for prototypes bound for other solar system locales.
A compelling combination of science, art, and gaming can inspire curiosity in young people about extreme environments of our polar regions, astrobiology, and frontiers in science and engineering. Teens love gaming, making them the perfect audience for this lesson series. Art and games can make abstract science concepts more accessible and help youth envision themselves as polar scientists.
The series begins as youth play a game about extremophiles, matching their environments with extraterrestrial environments within our solar system. Next, students compare and contrast environments of Antarctica and Europa, which are then highlighted in student-created, annotated artwork. After that, they play Microbe Madness, a game of evolution in which the microbe with the best genes survives changes over time. As a culmination of the lesson series, youth create their own game about being an polar astrobiologist, modeled after a “choose your own adventure” style of board game.Templates of the activities are offered for easy modification for other outreach purposes and goals across science disciplines.

Tue_322_OC-1_2025
The UK Polar Network: An Interactive Journey through UKPN Outreach and Workshops

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The UK Polar Network is the UK branch of APECS, one of our main aims is running education and outreach activities to excite and inspire young people about the Polar Regions. Another main aim is to run workshops and provide networking opportunities for early career researcher's interested in Polar Science. In 2017 the UKPN ran two ECR workshops, which included a session where participants thought up innovative outreach ideas and were awarded funding to the best idea from each workshop. One idea was a soundscape called 'Sounds of Change: Greenland Ice Sheet Melt' to be used in classrooms and outreach activities. A clip of the soundscape will be debuted and discussed during our talk. The UKPN also works with collaborators, such as the International Polar Foundation, using Arctic and Antarctic map continental jigsaw puzzles at science festivals to engage children and the general public. The UKPN also leads the APECS Antarctic flag project in which schoolchildren design a flag for Antarctica, which is then taken to Antarctica by scientists and photographed for the students to see. During this interactive presentation showcase the innovative outreach tools used by the UKPN at a variety of recent events. We will share our experiences on what we believe are effective outreach tools for polar science. We hope to provide others with ideas, as well as begin discussions on the best way to deliver polar science outreach now, and into the future.

Tue_323_OC-1_2117
Going vVrtual: 3D Opportunities for Antarctic Museums in the Internet Era

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In recent years, several worldwide museums, especially those focusing on archaeology, have launched virtual galleries of artefacts in order to enable a detailed observation of these items through 3D technology. Precious objects can now be observed at home, at the computer, virtually turned around and zoomed without any risk or damage for the museum item. In the biological field, such 'virtual galleries' of museum vouchers are not that common and, usually, are limited to type materials and new species. In the last year the Italian National Antarctic Museum (MNA) has launched the first 'virtual gallery' of 3D models of Antarctic organisms with the aim of providing the widest accessibility to the MNA collections and of producing materials useful for educational purposes. In this way, researchers from all around the world can have a 'direct' access to these museum materials and find hints and information for outreach activities. This initial set of biological 3D models will soon be increased by the addition of 3D models of historical artefacts related to the history of exploration of Antarctica, equipment, rocks, meteorites, etc. The 3D biological models of the MNA virtual gallery produced so far are based on micro-computed tomography for smaller specimens and on photogrammetry for larger ones. Either way, these 3D models are suitable to be printed. The MNA 3D virtual gallery is now visible on Sketchfab at: https://sketchfab.com/MNA.

Tue_324_OC-1_2247
Methods for Training Early Career Researchers in Polar Prediction

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Rapidly changing weather and climate is profoundly affecting the Arctic region, opening up new opportunities but also exposing new challenges such as environmental hazards. A growing user community thus requires enhanced predictive capacity at multiple spatial and temporal scales. The Horizon 2020 APPLICATE (Advance predictions in the Polar regions and beyond) project is bringing together a wide range of stakeholders to improve our predictive capacity for the Arctic and beyond. Knowledge transfer is a key aspect of APPLICATE and as part of it a training school is being organised in collaboration with the Association of Early Polar Career Scientists (APECS) and the Year of Polar Prediction (YOPP).
The second Polar Prediction School will take place in Abisko, northern Sweden, from 17-27 April 2018. The school will provide in-depth training on all aspects of making polar weather and climate predictions. This includes hands-on field measurements, exercises using computer models, and lectures covering topics ranging from chaotic systems to high latitude ocean processes. Each component of the course forms a crucial pillar of the prediction problem; combining these will provide participants with a complete overview of what is required to predict polar weather and climate. This presentation will describe the curriculum and learning tools developed to train early career researchers in polar prediction, focusing on active and skills-based learning through small projects and exercises.

Tue_325_OC-1_2393
Education and Capacity Building about Polar Regions through Science

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Today's students are eager to understand climate change, global warming and greenhouse gases. Therefore the evaluation of the following question plays an important role “Are teaching programs adequately planned for students to understand what is happening in Polar Regions?”. Providing students with the perspective and skills to address these challenges often requires instructional approaches from a variety of disciplines.
Today's early career scientists have more opportunities to develop their science communication skills with the range of tools and resources. For instance, visual tools such series of photographic, cinematographic images, clips and methodology currently being utilized to educate and inspire people around the world, in regard to Polar Regions issues. In this study, we share experiences, resources and lessons learned while teaching about climate change, also describe how students in all contexts arrive at understandings or problem-solve in response to the challenges. We aim to share new ideas and technologies that enhance Polar Regions education, advance learning and literacy.

Tue_326_OC-1_2402
Educational Role of Polar Researches

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Climate is studied with parameters as temperature, sea, wind and humidity. Temperature differs from season to season depending on the location. Likewise; Seas warm up slowly than the land and keep the temperature longer to balance the warm and cold water currents. Wind, plays an important role for the climate, allows to flow from one place to another depending on the variant in the temperature in the world. Another catalyst in the system is the moisture which is created by the water evaporating from sea and lakes. Moisture, is proportional to the temperature of the air, is able to carry the evaporated water and air currents in the seas to the interior of the land due to its continuous motion. We can refer those components as mechanism that works harmoniously with each other.
Sustainability of Earth´s current mechanism including Polar Regions have faced with extended difficulties because of the over-growth in population and accompanying role of industrialization. As of APECS Turkey, we teach climate mechanism including Global Climate Change by visiting primary-secondary-high school students with specifially established curriculum for twenty weeks. The general aim here is to spread social awareness starting from individuals. This has been an ongoing effort since APECS Turkey was established and we have created awareness by sharing dedicated disciplines of climate and polar regions to students. Therefore, this study will share APECS Turkey experiences and activities.

Tue_327_OC-1_2445
Experience about Scientific Committee on Antarctic Research (SCAR) Photo Exhibit

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This study provides the information about the exhibition; "Our Antarctica - Images from the Great White South" which exhibited several places in Turkey which aimed to raise awareness and inform people about scientific activities in Polar Regions. Ministry of Foreign Affairs hosted the photo exhibition, jointly with the Council of Managers of National Antarctic Programs (COMNAP), the Scientific Committee on Antarctic Research (SCAR) and Istanbul Technical University (ITU) Polar Research Center (PolReC). The exhibition included boards by PolReC illustrating Turkey's scientific activities in Antarctica. The opening reception was held on 14 October 2016 at the Ministry's art gallery in Ankara. National and foreign diplomats, including ambassadors, officials from Turkish government departments and academics attended the opening ceremony. Furthermore, ITU PolReC hosted the images in Istanbul. Significant number of people, from national maritime community, government departments, non-governmental maritime organizations, academicians, ITU maritime students and graduates, visited the exhibition. ITU PolReC and APECS Turkey arranged the photo exhibition to travel to several middle and high level schools in Istanbul. Exhibition took a lot of attention of young generation. This study will visualize the SCAR photo exhibition experience in Turkey. We do believe that SCAR photo exhibition reached more than a thousand citizens about of the importance of scientific activities in Antarctica.

Tue_328_OC-1_2498
Outreach Activities During and after Antarctic Expedition

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Turkish Antarctic Expedition - I (TAE - I) was carried out by participation of nine scientists between February-April 2017 onboard the Research Vessel Australis. Authors, APECS Turkey members, were participant in the expedition used the iridium satellite system to communicate with middle school and high school students via writing on blogs for interactive education from Antarctica. After the expedition, more interactive arrangements were made about polar science to raise awaraness and knowledge about Southern Ocean. Additionally, many seminars had been given to students from primary schools to universities about conducting science in Polar Regions.
Those nine scientists took nearly twenty five thousand photographs during the Antarctic expedition. After some detailed evaluation, best thirty of them were choosen. These photographs were displayed to raise knowledge about Antarctica in the public areas and museums as TAE - I Photo Exhibition. The first exhibit for the TAE - I Photo Exhibition was held during Polar Science Workshop, conducted at Istanbul Technical University in April 2017. Finally the exhibit moved with great effort to the many public and private schools, aimed as outreach activities about polar science by Turkish Student's Polar Research Team (PolSTeam) and APECS Turkey.

Tue_329_OC-1_2599
Elementary Polar Educational Material: Please Don't Forget the Younger Students

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If a six-year old knows all about a *Tyrannosaurus Rex* they can certainly make sense of *Cryospheric Processes*. Although, just as with the misconceptions regarding the T-Rex, science content needs to be presented appropriately with collaboration from science research experts and experienced primary educators. The issues are not localized; this need is recognized internationally. A greater quality educational opportunities are available for middle and secondary education, leaving primary educators with the task of adapting material for use with younger students, as best they can. This can result in an oversimplification, or misconception of the science. This presentation is both a call for assistance from scientists and a sharing of some effective strategies and activities that are both engaging and appropriate. Collaborations help to get it right.

Tue_330_OC-2_461
A Symbiotic Relationship: Sailboat and Scientist - Citizen Science Partnerships

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There is a need for more research in the polar regions and an increased public understanding of science. Scientific funding is stretched and the public rarely has opportunities to engage with scientists. Quixote Expeditions' Guest Scientist Program supports scientific efforts and provides passengers (non-scientists) with the opportunity to engage and participate in research.
The program provides free room and board to one scientist per trip for research. The scientist is encouraged to involve the guests and give presentations. For most of the Guest Scientists this is their only way to access Antarctica, as projects not associated with national research programs are often left without necessary logistical support. Highlights for scientists are the flexibility of a small vessel, and the enthusiasm of passengers. The guests interact daily with the scientists, asking questions throughout the day and helping with small tasks: from holding an instrument to making an observation. Most guests return home as ambassadors for Antarctic and its science, often giving talks to friends and family.
The presentation will discuss the Guest Scientist Program and its impact, as well as its life cycle from the application process to onboard experiences of scientists.
The data collected as a part of this program has been presented in a wide range of outlets, including PhD theses and academic manuscripts, as well as aiding public policy decisions.

Tue_332_OC-2_2162
Ghost Particle Catchers: The First IceCube Citizen Science Project

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The IceCube Neutrino Observatory launched the citizen science project Ghost Particle Catchers in winter 2018 to engage learners of all ages in the analysis of neutrino data taken at the South Pole. This project is built on Zooniverse, the largest platform for online citizen science projects in the world, and has been developed with four high school internship cohorts with a total of 15 students (7 girls and 8 boys) from four Madison (WI) area schools.
Volunteers examine data to help improve existing IceCube analyses, such as searches for astrophysical neutrinos or for new physics in the neutrino sector. Volunteers are trained to categorize data, e.g., determine the direction and whether more than one particle path is seen. Interns studied small samples of data with both the 2D displays implemented on Zooniverse and the more complex interactive 4D displays that IceCube scientists use. The results show that their classifications have an accuracy similar to computer algorithms when they use 2D displays but can be improved after practice with interactive 4D displays.
A main goal of this project is to inform enhancements to current algorithms and search for unexpected neutrino signatures. We will present the analysis of the first data from volunteers for Ghost Particle Catchers, which will inform a future IceCube in 4D citizen science project.

Tue_335_OC-4_1351
The Tale of Anna Schwartz

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This performance lecture is based on speculative eco-feminist autobiographical/ historiographical fiction and draws on my multimedia artwork including, photo-collage, sculpture, and projections. It builds on my collaboration with scientists and my experience in Antarctica as a recipient of the NSF Antarctic Artists and Writers Grant.
It examines Polar exploration and science from the perspective of a fictitious, unknown, female explorer, Anna Schwartz, who travels to Antarctica with the 1939 Byrd Antarctic expedition. Schwartz is a photographer and a naturalist obsessed with the microscopic and transparent planktonic snail the *Limacina helicina* and its predator the *Clione antarctica*. While the character of Schwarz is fictitious, I insert her into real events, and thus, her "archives" contain factual materials from the past and present. They also include objects and images created by me in the name of my protagonist. Hence my art making process is intricately linked to the narrative that explores bi-Polar research on climate change as well as the contrasting histories of exploration at the two Poles (with the presence of native populations in the north and their absence in the south). The archives also incorporate materials pertaining to Schwartz's daughter, who follows in her mother's foot-steps and finds that her mother's beloved planktonic snail, the *Limacina helicina*, functions as the canary in the coalmine when it comes to ocean acidification.

Tue_336_OC-4_1768
Artistic Snow Crystal Casting during the Antarctic Circumnavigation Expedition

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This project is a collaboration between an artist and scientists exploring commonalities such as applied methods and instruments, and visualizing the process of modeling in natural science. The goal is showing in an intuitive, tangible way how contemporary science is made to a wider public. Scientists are not only creating the most powerful actual pictures of our contemporary world, they are also shaping our awareness of the world. The starting point for this collaboration is the first Swiss Antarctic Circumnavigation Expedition ACE. By investigating snowflakes, the science project "quantifying precipitation and its contribution to surface freshening in the Southern Ocean" seeks to understand the fundamental question of how much snow falls over the Southern Ocean. Better information on precipitation is critical to the improvement of atmospheric models for the Antarctic. The ACE scientists collected Formvar replicates of falling snow on microscopic slides for quantification of precipitation characteristics and amounts. They collected similar samples for the artist on plates 24 time the size of the microscopic slides, applying the Formvar solution with an artistic tool, a paint brush. In the context of an art exhibition, the artwork questioned the non-scientific audience regarding whether the scientists were involved in the act of creating in the same way an artist would be? When collecting the flakes on larger sheets of glass, did the scientists actually compose a picture?

Tue_337_OC-4_1919
The soniDOME Project

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The soniDOME project **(**Sonification of Deep Ocean Microbial Ecology) innovates a sensorial path of inquiry for artist-scientist collaborations related to polar and deep ocean microbial ecologies. This unique collaboration spans data development and analysis through display, interaction, open-source software toolkit distribution and public engagement. We are expanding the sensoria of existing methods of complex data interpretations from visual forms to interactive soundscapes to explore and interpret structures, interactions and dynamics of remote microbial communities. Investigative outcomes include: creation and documentation of artist-scientist collaboration from data development through translation to sonic and listening-space outcomes; development of a 'lexicon' for enlightened data modeling/simulation, display, interactions and ecoinformational narratives in a shared spatiotemporal context; fostering of collaboration among scientists, artists and students in microbiology, marine ecology, digital media and sound arts; 'reduction-to-practice' of methods and vehicles for expressing sonic representations of “master ecological narratives”, specifically datasets of polar origin; and 'case studies' for workshop production, software toolkit distributions, exhibitions, concert performances and journal articles to further consciousness to polar oceans and the deep ocean biosphere. The soniDOME project is sponsored by the National Academies Keck Futures Initiative (NAKFI).

Tue_338_OC-4_2135
Art for the [Ant]Arctic's Sake: A Call for Greater Artist Involvement in APECS

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The Association of Polar Early Career Scientists (APECS) prides itself on being at the forefront of developing innovative science communication techniques, and to continue doing so means we need to advocate for greater involvement of artists in our work. By including professionals from these creative fields, STEM education becomes STEAM (Science, Technology, Engineering, Art, & Mathematics), an acronym more reflective of the interdisciplinary nature of modern polar research. APECS recognizes that including art in educational outreach increases public engagement and makes academic research more accessible to those without extensive STEM backgrounds. With nearly 3,000 members in over 67 countries, APECS' network represents a diverse group of professionals interested in Earth's polar regions and wider cryosphere. We aim to utilize uniting features of art to bridge barriers to, for example, language or geographic proximity to increase engagement from traditionally underrepresented places and cooperation amongst future polar experts. As well, we hope to improve understanding and inclusion of Indigenous peoples through artist partnerships. We will discuss how APECS has included art in past outreach efforts—such as biannual Polar Week celebrations—and call for greater artist involvement in the future. We believe that both our members and artists can benefit from collaborations, and that we can more effectively influence positive attitudes towards polar research by working together.

Tue_339_OC-4_2139
Art-science in the Development of IceCube Volumetric LED Displays

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Artist Mark-David Hosale (York University, Toronto, Canada), and physicist James Madsen (University of Wisconsin, River-Falls, USA) have been working regularly with each other since 2012. This presentation will describe several projects they have jointly developed that explore the visualization and sonification of data sets collected at the cubic kilometer South Pole IceCube Neutrino Observatory, The primary approach is in the construction of scale models of the observatory. The 3-D models have a one-to-one mapping to the actual ICECUBE array, where each light sensor in the array is represented by a full-color LED in the model. We have developed two versions of the display, one two meters in each dimension and the other one meter. The addition of spatial sonification (sound mapping) of the data enhances the representation of events on the models, allowing observers to audio-locate events as well as see them. Through these projects we create a high quality experience of the information being presented, with the goal of knowledge dissemination and the development of an intuitive understanding of the operation of the detector.The creation of novel interfaces of this kind represent an epistemological nexus between art and science. It has the potential to facilitate an empirical approach to sub-atomic astrophysics by using art methodologies to find optimal means for the expression of data in the domain of the human sensorium.

Tue_340_OC-4_2523
The Language of Ice

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What do you think of when you hear the word ice? Frozen - not only cold, but unchanging and brittle. Silent, white, lifeless. But ice is far richer than this. If we listen to the language of ice, we hear whispers of its secrets. And imagining polar landscapes can give voice to inner worlds and unheard stories.
Drawing on work using images and metaphors with art therapists, themes of polar exploration with 8-11 year old artists, and other collaborations, I will use images and myths to show beauty, contradictions and surprises of ice in the natural world, and how we - as scientists, artists, and storytellers - respond to them.

Tue_341_OC-4_2574
Emotional Response to CryoZenGarden: Installation on Ice Melt and Sea Level Rise

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For some, an abstraction of scientific objectivity resonates more clearly. *CryoZen Garden* installation operates as visual metaphor, modeling cryospheric processes and exploring the resulting effects of a warmer global climate on sea levels. For this installation, the tranquility of a traditional Zen garden is disturbed. In this altered garden, blocks of ice melt continually over the course of the exhibition. The melt water drips and pours into the neatly raked lines in the sand, creating jarring interruptions. The sound of dripping water is discordant with the expected static tranquility. As ice continues to melt, ocean levels rise. Flooding is a result.

Over the course of several months, viewers of this work responded with varying comments, but few expressed indifference. Rather, questions were raised and dialogue ensued. It is through this dialogue that engagement with science concepts occurs. A favored response was, "your CryoZen Garden is freaking me out!" And that was the point.

http://www.streetroad.org/julia-dooley-images-from-the-bottom-of-the-world-and-cryozen-garden.html

Tue_342_OC-4_2620
Flights of Fact and Fancy: Birds as Messengers in Antarctic Writing

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In *The Ancient Mariner*, a poem partly inspired by narratives of polar travel, the shooting of an albatross triggers a series of events which leads to the mariner's eventual transformation. He pays a heavy penance for his crime against Nature, freed from his suffering only when he learns to appreciate the beauty of the creatures in the world around him.
Birds are a consistent presence in writing about the Antarctic: they are trapped, shot, admired, preserved, dissected, and eaten. Cook's published journals record careful observations, of their appearance, their habits and their numbers, as well as a sense of their watching consciousness. Birds are a focus of scientific interest and of personal affection. The base record for Port Lockroy in 1954 describes the behaviour of cold and hungry sheathbills becoming “cocky” and bossing one another about after being given food; a later entry notes that a seagull with a broken leg “failed to appear for scraps”.
Physical creatures of the air, birds are a natural symbol, intermediaries between the spiritual and human worlds. A study of the ways in which they are represented in Antarctic writing reveals birds, real and imagined, as messengers; more than repositories of information, they are embodiments of a particular quality of the continent as a place where the actual collides with the metaphorical, the scientific with high art, and the material with the spiritual; in fiction and in fact, birds have something to tell us.

Tue_343_OS-1_896
Delimitation of the Arctic Shelf: Harmonizing UNCLOS, Customary International Law

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Among the Arctic Coastal States Canada, Denmark, Norway and Russia are parties to UNCLOS, while the USA is not. According to prevailing teachings, most rules of UNCLOS reflect customary International Law, but neither Part XI (about the Area - a "common heritage of mankind") nor article 76 of UNCLOS (about delineation of the continental shelf from the Area; in contrast to article 83 of UNCLOS - which definitely reflects customary rules of International Law on delimitation of the continental shelf. The paper provides what is an indisputable title of all five Arctic Coastal States relating to their respective parts of the Arctic continental shelf - independently of the fact whether a specific State is a Party to UNCLOS or not. In such a complicated legal environment, the paper provides critical analysis of the contemporary "Shelf rivalry" created by submissions of Russia, Norway and Denmark according to art. 76 of UNCLOS - in contrast to more conservative Arctic legal policy of Canada and US aimed at securing their established rights on the Arctic Shelf as existing *ipso facto* and *ab initio*. Taking into account specific factual and legal peculiarities of the Arctic Ocean it is argued that only international customary law is applicable for delimitation of the Arctic Shelf in the High North.

Tue_344_OS-1_1219
The Soundscape of a Calving Glacier: Blomstrandbreen, Western Svalbard

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In the rapidly changing Arctic, investigation of its marine sectors, and especially the underwater domain, has become increasingly important and is of interest to benefit areas ranging from environmental monitoring to safeguarding society. A robust characterization of the soundscape of the polar marine domains is essential if autonomous underwater vehicles shall be used in these regions. A first step is to characterize the ambient sound near to a glacier and to relate sound levels to specific
dynamical events. Ambient sound will not only contain information on the glacial activity but will also pose challenges for communication between autonomous underwater vehicles and underwater sensor nodes. Here, we report on first results describing the soundscape in front of the calving glacier Blomstrandbreen, Kongsfjorden, western Svalbard, based on acoustic data collected during September 8-10, 2017. This project is carried out within SMaRC, the Swedish Maritime Robotics Centre.

Tue_345_OS-1_1429
Acoustic Observations of Melting of Glaciers in the Arctic

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Underwater acoustic observations in the ocean provide the ambient noise prevailing in the location and they are useful for variety of applications. An ocean Ambient Noise Measurement System(ANMS) consisting of a hydrophone, a data acquisition system and power pack, has been developed to withstand the environmental conditions in the polar region and incorporated with the IndArc mooring in the Kongsfjorden region, Arctic sea. which was jointly deployed by NIOT and NCAOR, India. The ANMS has been placed at 30 m depth in the mooring where the ocean depth is 192m. ANMS was first deployed with IndArc in July 2015 and continuous data for a period of 280 days were obtained. The sampling rate was 50kHz, for a duration of 60 seconds, in every 3 hours. Later, in July 2016, hourly samplings were made, at the rate 25 kHz for a duration 180 seconds and 240 days of time series data obtained. It is observed from the analysis that the noise in Kongsfjorden ice bay in summer is strongly associated with different types of ice melting mechanisms such as calving, bobbing and blooping. Comparison of noise spectra in the summer 2015 and 2016 reveals that the melting events are more in 2016. Detailed analysis reveals that the maximum noise is produced below 2 kHz. In winter, the peak noise is due to marine animals. The main aim is to understand the arctic acoustic environment from the continuous measurements of noise and its usefulness in climate change studies.

Tue_346_OS-1_1621
The Chukchi Plateau: A True “Arctic” Soundscape?

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Climate change is altering the underwater acoustic environment of the Pacific Arctic as loss of sea ice results higher levels of environmental, biological, and anthropogenic noise. Since 2008, a long-term recorder has been moored at the Arctic Ice Monitoring site (75.1 N, 168 W) on the Chukchi Plateau. The recorder was deployed in October annually (except for 2012-13 when ice conditions impeded mooring servicing); recording duration varied by year due to battery life. This is a location that, although within the region of rapid sea ice loss and ocean warming, is still sea ice-covered for most of the year. Indeed, other instruments at the AIM site provide detailed information on sea ice, including surface cover, movement, thickness and topographic features (floes, leads and ridges). Overall, sound sources include wind and waves during the open water and shoulder season (August through early November), Arctic marine mammals from May into September or October, some ships and airguns August through October, primarily from seabed mapping efforts, and ice failure, and ridge building, and blowing snow during the months with heavy ice cover (usually late October through early August) . Overall, sound levels at this high Arctic location are low relative to sites further south in the Pacific Arctic and compared to data from further north in the Atlantic Arctic.

Tue_347_OS-1_1717
Fin Whale Vocal Activity on the SWIR: Temporal Patterns and Potential Drivers

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The main objective of this study was to reveal the presence and to explore the temporal patterns of fin whale vocal activity in an offshore area on South-West Indian Ridge (SWIR). Data were obtained from a 10-element ocean bottom seismometer network deployed near 13°E and 52°S, at an average depth of 3500m. Recorders digitized seismic and acoustic signals at a rate of 100Hz, continuously for about 1 year, from December 2012 to November 2013. Data were analyzed by using a custom MATLAB code for the automatic detection of 20-Hz calls. About 60.300 hours of acoustic data from 8 recorders were analyzed and calls were detected in about the 75% of the recording time. The spectral features of detected 20-Hz calls were consistent with other observations reported for southern fin whale populations (1-50 Hz frequency band). Results show that the animals were present and acoustically active in the study area from February 2013 to November 2013, when they stopped singing or left the area. Moreover, a periodicity was observed in call detection rates, with greatest peaks between August and October 2013. A positive correlation was also found between peaks in call detection and Sea Surface Height values obtained from satellite data. This possibly indicates that the meandering ACC (Antarctic Circumpolar Current) fronts may influence the location and possibly formation of prey aggregations and hence act as a driver for presence and acoustic activity of fin whales in the area.

Tue_348_OS-1_1918
Sonification of Deep Ocean Microbial Ecology (soniDOME)

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The soniDOME Project is a National Academies Keck Futures Initiative (NAKFI)
sponsored art-science investigation into novel means to model and experience deep ocean microbial ecosystems, and expand the perceptive foundations of research, all through sound. Parallel to the critical understanding, perception and interpretation of the natural ocean soundscape, we are investigating the sonic display of ecoinformatic data forms to expand current versions of deep ocean information beyond visualizations to explore ecological paradigms and representations of deep ocean microbiology, beginning with deepwater formation in polar regions. Our work investigates exemplary datasets as sources and structures for sonic transcoding. As an experimental 'reduction to practice' for our methods, a ´master ecological narrative' library of software processes and sound representations is being developed for polar and deep ocean, deep biosphere and pelagic microbial ecosystem data sets. This presentation will review our application of transcoding and sonification processes to the hima meta-database of Low Temperature Genomes and Metagenomes as an exemplary dataset for sonic interpretation, one that links sequences and phenotypic data of cold-active microorganisms from all three domains of life. Specifically, we will review our investigation into the use of sonic sensoria for the interpretation of *Colwellia* spp. from sea ice microbial communities, the Arctic cryosphere and the deep ocean.

Tue_349_OS-1_1940
Measurements of Under-ice Noise North of Svalbard Using Deep-sea Recorders

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This paper describes long-term passive acoustic recordings in the seasonally ice-covered ocean north of the Svalbard archipelago (eastern Arctic Ocean) from July 2016 to September 2017. Data from two mooring deployments has been analyzed for ambient noise spectra and noise statistics at frequencies from 10 Hz to 8 kHz. We present seasonal spectra and compare these with historic data from the Arctic Ocean. We discuss characteristics of the spectra and noise levels in relation to environmental forcing factors including ice cover, wind and sea state, and oceanographic conditions. Identification of components of the soundscape including transients due to marine mammals and anthropogenic noise will also be presented. The measurements were performed with AMAR Ultra Deep acoustic recorder instruments fitted to bottom-moored rigs. Technical details of the mooring design, deployment and retrieval will be discussed.

Tue_350_OS-1_1978
The Marine Soundscape off Elephant Island: A Southern Ocean Coastal Habitat

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Here we present a comprehensive description of the acoustic environment approximately 31 km west-northwest of Minstrel Point, Elephant Island, Antarctica at 210 m water depth based on three years (Jan 2013 - Feb 2016) of subsampled (5 min per hour) passive acoustic recordings. Long-term spectrograms reveal a notable recurrence of acoustic environments between years. Fin and Antarctic blue whale calls dominate the low (< 100 Hz) part of the biophonic spectrum energetically from end of January to late July/early August. November through early January are dominated by leopard seal vocalizations at around 300 Hz. Concurrently, the geophonic spectrum exhibits strong fluctuations between days, both due to storm and tidal influences, causing flow and shackle noise from the instrumentation itself. Manual analysis of every second day of the subsampled data by visual and aural screening (employing short term spectrograms) was used to examine the data in greater detail for additional acoustic contributions and to assign the various acoustic signatures to their sources. Six cetacean and two pinniped species were identified based on their acoustic signatures and analysed for seasonal and diel patterns in occurrence. Anthrophonic signatures were attributed to air guns on 3 % of the analysed days. Vessel noise was noted between 10 and 12% of days on annual averages, occurring mainly in austral summer and fall with sporadic events throughout the remainder of the year.

Tue_351_OS-1_2032
Arctic and Antarctic Soundscapes: Contributors and Acoustic Levels

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Polar ecosystems are undergoing major changes driven by sea ice decrease, air temperature warming and increasing anthropogenic activities. The ocean acoustic environment, called the "marine soundscape," consists of biological, abiotic and anthropogenic sounds. In polar seas, biological sound sources include marine mammals, fishes, and benthic organisms. Abiotic sound sources correspond to physical processes such as ice dynamics and meteorological events. Contributors to anthropogenic noise are classically commercial shipping and military activities.
In order to monitor how anthropogenic changes is impacting polar ecosystems, the first step is to identify, describe and quantify the features of soundscape contributors. Since 2013, underwater acoustic recorders have been deployed up to several months in several locations of the Arctic (Spitzbergen, Greenland) and the Antarctic.
In the Arctic, results show a strong variation of ambient noise levels between sites and seasons. Noise levels measured in Spitzbergen in October 2013 are up to 15 dB re1µPa higher than those measured in Mai 2013, due to an increase in wave and water flow noises. The Daneborg acoustic recordings display extreme differences in noise levels between August 2015 and August 2016 with a very quiet environment in 2015 and many ice sounds in 2016.
Antarctica soundscape is dominated by biological sound sources: benthic sounds and marine mammals vocalizations (including weddel seals, orcas and blue whales).

Tue_352_OS-1_2249
Overview of the Deep Water Soundscape off East Antarctica

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Since 2004 the Australian Antarctic Division has collected over 100,000 hours of underwater sound recordings in Southern Ocean off East Antarctica. The bulk of these recordings were made by mooring autonomous acoustic recorders in deep water. Continuous year-long recordings were made at sites along shipping routes during the annual resupply of Australia's three stations in East Antarctica, and many sites have now yielded several years of data. Initial work focused on blue and fin whales, but the number of species recorded has increased over the years in step with improvements in instrumentation. Since 2013, recordings have been able to provide information on the presence and behaviour of many top predators including some toothed whales, most pinnipeds, and all Antarctic baleen whales. Here we present an overview of this rich acoustic dataset to highlight advantages and challenges of remote acoustic monitoring in the Southern Ocean. We begin with investigation of wind and ice driven ambient noise. Then we present the highly seasonal contributions of blue, fin, and minke whales and leopard seals to the soundscape. Lastly we present systematic observations of sperm whales and preliminary observations of crabeater seals and humpback whales. Continued acoustic data collection and analysis are planned by the Southern Ocean Hydrophone Network (SOHN), a joint long-term project of the IWC's Southern Ocean Research Partnership (IWC-SORP) and the Southern Ocean Observing System (SOOS).

Tue_353_OS-1_2600
Spatio-temporal Patterns in Antarctic Marine Mammal Community Composition

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Passive acoustic monitoring tools have the potential to provide insights into community structure as devices can autonomously collect data on the acoustic presence of species. Data can provide information on local species diversity, residency times and patterns in species co-occurrence. Here, we apply multiple biodiversity measures to explore how marine mammal community composition develops over time using information derived from multi-year passive acoustic data from 6 sites throughout the Atlantic sector of the Southern Ocean, the Weddell Sea. Overall species richness showed relatively little variation over time, showing that a substantial number of species remains in Antarctic waters throughout austral winter, but community composition showed almost complete seasonal overturn, recognizing that species replace each other throughout the year. For all 6 sites, community dissimilarity increased with increasing temporal distance reflecting temporal trends in community composition beyond seasonality. Species co-occurrence analyses showed that a number of species exhibited either consistently positive or negative relations, while at the recording site off the Western Antarctic Peninsula, some relations were inversed compared to the oceanic sites. Patterns in co-occurrence are suggestive of predator-prey relationships between species, inter-specific interference with respect to prey species as well as acoustic interference between co-occurring marine mammal species.

Tue_354_OS-8_638
Sea Ice-ocean Modeling Study Collaborated with the Western Arctic Sediment Trap

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Seasonal and interannual variability in biogenic particle sinking was captured by the multi-year bottom-tethered sediment trap moorings in the Northwind Abyssal Plain (Station NAP: 75°N, 162°W, 1975 m water depth) of the Arctic Chukchi Borderland. The analysis of trap samples revealed summer and early-winter flux peaks of the biogenic particle including fresh organic materials and lithogenic minerals [Watanabe et al., 2014; Onodera et al., 2015; Watanabe et al., 2015]. In this study, background mechanisms of the observed variability on a couple of timescales were investigated using a numerical modeling approach. A pan-Arctic sea ice-ocean general circulation model COCO is coupled with a lower-trophic marine ecosystem model Arctic NEMURO, which represents both sea ice algae and pelagic plankton species (e.g., diatom, flagellate, and copepod). The horizontal resolution is about 5 km so that mesoscale eddies and narrow boundary currents are resolved [Watanabe et al., 2017]. An interannual experiment from 2001 to 2014 demonstrated that the higher sinking flux of Particulate Organic Nitrogen (PON) was located along the pathways of mesoscale shelf break eddies originating in the Barrow Canyon. Ongoing works with additional trap data newly obtained north of the Barrow Canyon (Station NBC), north of the Hanna Canyon (Station NHC), and in the Chukchi Abyssal Plain (Station CAP) will also be reported.

Tue_355_OS-8_795
Pan-Arctic Phylogeography and Connectivity of *Pseudocalanus* (Copepoda)

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Phylogeographic analysis of marine zooplankton species can reveal patterns of population connectivity. Three species of the copepod genus *Pseudocalanus* exhibit widespread distributions over polar and sub-polar latitudes of the northern hemisphere. These species are frequently highly abundant, and are ecologically important as trophic links in pelagic food webs. We report findings based on phylogeographic analysis of the mitochondrial cytochrome oxidase I (COI) gene for *Pseudocalanus acuspes*, *P. minutus* and *P. newmani* from Atlantic and Pacific sectors of the Arctic Ocean. Population connectivity was evaluated using Migrate-N to estimate the magnitude of directional, asymmetrical, non-equilibrium migration rates and evaluate hypothesized migration models based on Bayesian statistics. Pan-Arctic dispersal patterns and pathways were shown to differ among the three species of *Pseudocalanus*: the N. Atlantic Current and Pacific currents are most important for *P. acuspes*; *P. minutus* shows Pan-Arctic connectivity; and *P. newmani* shows panmixia among the sampled locations. Pan-Arctic phylogeographic analysis of widely-distributed and ecologically-important species can provide new insights into how a warming Arctic with diminishing sea-ice cover may reduce barriers to gene flow and alter patterns of population connectivity for Arctic and sub-Arctic copepods and other marine zooplankton species.

Tue_356_OS-8_810
Uncertainties in Light Supply to Phytoplankton in Arctic Waters

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Light exerts a primary control on photosynthesis. In the Arctic Ocean, this control differs from the classical open water situations because of the complex match between the very specific solar input and the seasonal variations in the the icescape, including contributions of open water, bare ice, snow and melt ponds, all exhibiting large spatial and temporal variations.
Here, we question how well satellite or modelling products could be used to derive under-ice light, in a relevant manner for ecosystem studies at pan-Arctic scales. To address this problem, we combine various satellite and modelling products to describe the seasonal evolution of the icescape characteristics. Using a simple radiative transfer formulation, we retrieve daily maps of under-ice light fields, from which various estimates of the photoperiod can be retrieved. We perform a sensitivity analysis to see which sea-ice phenology transitions are the most critical in terms of photo-period.

Tue_357_OS-8_840
Making and Breaking Stratification in the Kitikmeot Sea

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The Kitikmeot Sea Science Study was initiated in 2014 to provide the Canadian High Arctic Research Station a scientific basis for long-term ecological monitoring and research in the southern central Canadian Arctic Archipelago. The region is unique in the Arctic due to massive freshwater input relative to its area and its shallow bounding sills. Thus, 3 foci guide the study: the Pacific-origin estuarine inflow, which sets the oceanographic structure; the origin and pathways of freshwater, which influence the nutrient balances and stratification; and tidally influenced biological communities in narrow passages. To investigate these, we apply a suite of tools deployed from the R/V Martin Bergmann.
Our results show that the Kitikmeot Sea is characterised by two-layer estuarine flow, with surface outflows and sub-surface inflows across the bounding sills. River inputs along the southern boundary deliver freshwater, terrestrial nutrients, and carbon to the riverine-coastal domain, which then spreads throughout the system . Strong tidal currents in narrow passages enhance vertical heat and nutrient flux to maintain ice free conditions in winter and tight benthic pelagic coupling in summer. These sites have hard bottom substrate inhabited by suspension feeders, while elsewhere are soft sediments with deposit feeders. Our analysis reveals a dynamic ecosystem characterised by pelagic benthic coupling forced by the physical flow field and external inputs of nutrients and freshwater.

Tue_358_OS-8_940
Arctic Marine Ecosystem Conceptual Model: Interactions Matrix Revealed (Part B)

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In November 2016, the US Bureau of Ocean Energy Management, Office of Naval Research, and National Science Foundation supported a workshop to create a unifying pan-Arctic conceptual model of the current state and future changes of the Arctic Marine Ecosystem (AME). One component of this conceptual model is a matrix of interactions that determine the functioning of the AME. This matrix was developed using a parsimonious list of Key Elements, distributed between five categories: ***Atmosphere, Land-Ocean/Shelf-Interior Connections, Physical Environment, Biology,*** and ***Human Impacts***. To determine the strength and direction of connections between Key Elements, direct interactions were characterized in a matrix array by evaluating directionality, relative magnitude, and scientific (un)certainty. Indirect interactions were removed, because these should be captured by chains of direct interactions. As described in Part A, further work is needed to explore indirect causal pathways and the existence of multi-element feedback loops. In Part B participants can explore connections between Key Elements through an interactive platform. With this participatory presentation we hope to elicit feedback, comments, and criticisms of the interactions presented, including their magnitude and the direction of their effects now and into the future. Discussion generated during this presentation will be used to refine the matrix.

Tue_360_OS-8_1960
Arctic in Rapid Transition: Pan-Arctic Interdisciplinary & International Network

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The Arctic is changing at an unprecedented pace. Sea ice plays a central role in the Arctic system, and its decline and thinning has a multitude of implications ranging from physics and biology to geopolitics and economics. To enable robust future projections, a holistic pan-Arctic approach spanning across multiple disciplines is required. Arctic in Rapid Transition (ART; www.arcticinrapidtransition.com) is an international and interdisciplinary pan-Arctic scientific network, developed and steered by early-career scientists, aimed at implementing such an approach to address present and future changes of Arctic systems. The main goals of ART are bridging time-scales by incorporating paleo-studies with modern observations and modelling, and applying various science disciplines to better understand the past and present response of the Arctic marine ecosystems to changes in sea-ice cover, thus improving our capability of predicting their future state. Initiated in 2008, ART became an official IASC network in 2013. Past ART activities included the organization of science workshops, the coordination of a special issue in Polar Research, and the publication of topical priority fact sheets for the future of Arctic research, which contributed to the ICARP III process. Focusing on active data collection, ART led the TRANSSIZ expedition onboard RV Polarstern in 2015. Along with these activities, the new 5-year Strategic Plan of ART will be presented.

Tue_361_OS-8_2287
Ocean, Sea Ice, and Ecosystem Concepts for the Siberian Shelves and Slopes

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The Kara, Laptev and East Siberian Seas are wide and shallow interior Arctic shelves, with ecosystems dominated by the interplay between large rivers, seasonal ice cover, complex bathymetry and strong oceanic fronts. The seasonal sea ice system features mobile pack ice and a landfast ice cover that extends hundreds of kilometers across the shelf. Polynyas frequently open along the fast ice edge in winter and spring and contribute to the region's strong sea ice formation and export to the Transpolar Drift. Hydrography and ecosystem processes are dominated by freshwater runoff from the Lena, Ob and Yenisey, some of the largest rivers on earth. The distribution of the river plumes is variable and depends on the atmospheric circulation in summer. The river water controls water column stratification and therefore vertical mixing processes as well as biogeochemical conditions on the shelf. Summer expeditions in 2013 and 2014 provided comprehensive information from two years with contrasting winds and are now used to highlight the physical and biogeochemical linkages based on shipboard sampling and year-round oceanographic moorings. These recent observations combined with earlier campaigns to this under-explored part of the Arctic Ocean provide the base for the conceptual understanding of the Laptev Sea, representative of the interior Siberian shelves. In this presentation we link the important components of the ocean, sea ice and ecosystem, and discuss them in a pan-Arctic context.

Tue_362_OS-8_2543
Epibenthic Feeding of *Chrysaora melanster* Jellyfish in the Arctic

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Ecological and economic impacts of gelatinous zooplankton are increasingly apparent in the pelagic realm, but few studies have explored the idea that jellyfish can be of similar importance for benthic communities. Jellyfish exert a strong predatory pressure on invertebrates in the water column, controlling the population size of zooplankton, including pelagic larvae of zoobenthos. Unfortunately, no research so far has directly examined the idea that jellyfish may prey upon benthic fauna.
Video recordings made from 2011 to 2014 beneath land-fast sea ice in the Chukchi Sea near Utqiaġvik (Barrow, Alaska) demonstrate that large overwintering *Chrysaora melanaster* medusae often drag tentacles along the seabed, apparently feeding on zoobenthos as implied by the observation of an isopod entangled in the tentacles. We also review the existing, circumstantial evidence on benthic feeding by jellyfish and, with our own observations we propose that epibenthic feeding may be a common, but periodic trait of gelatinous predators, even in areas as remote as the Arctic.

Tue_363_OS-8_2616
Marine Planktonic Larvae -Vectors of Dispersal of Benthic Species in the Arctic

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Pelagic larval stages of benthic animals (meroplankton) can play a seasonally significant role in planktonic communities, as well as influence the abundance and distribution of benthic species, yet are frequently overlooked by both plankton and benthic studies. Within the Arctic, the role of meroplanktonic larvae may be particularly important in regions of inflow from the Atlantic and Pacific Oceans, where they can serve as vectors of advection of sub-Arctic species into the Arctic. In this study, we describe the links between the distribution of meroplankton on two important inflow shelves: the Bering/Chukchi Seas and the Barents Sea, using molecular tools to resolve larval taxonomic diversity, and the benthic macrofaunal and epifaunal communities in the region, based on original and published data from the past decade. We observed limited correlation between observed larval and adult benthos at similar locations, particularly for infaunal organisms, suggesting that most larvae are advected from other areas rather than produced locally. Seasonality and distribution of water masses were the most important parameters shaping meroplankton communities. We discuss differences between the two sectors and the implications of changing oceanographic and climatic conditions on the potential of range extensions by temperate species into the Arctic Ocean.

Tue_364_OS-8_535
New Views on the Conceptual Model of Advective Contiguous Domains

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A conceptual model is a representation of a system, made of the composition of concepts which are used to help people know, understand or simulate a subject the model represents. Here and before switching to Antarctica, I focus upon the central Arctic Ocean which is not isolated, but advection of water, nutrients and biomass: it is tightly connect to the hitherto ice-covered, lest known World Ocean and a gateway to/from the northern Pacific and Atlantic Oceans. The Arctic Ocean is thus an integral part of the oceans of the Northern Hemisphere and cannot be understood in isolation. The concept of the advective contiguous domain illustrates to which degree and how the integration of the Arctic Ocean is effectuated. Four advective contiguous domain are distinguished: The Atlantic, the Pacific, the Barents Sea and the Transpolar Drift domain. These lengthy contiguous domains connect subarctic with the arctic biota, supporting both primary production and higher trophic level consumers. In turn, the Arctic influences the physical, chemical and biological oceanography of adjacent subarctic waters through southward fluxes. In contrast to the central Arctic Ocean characterized by mainly perpendicular advective contiguous domains, strongly circular and isolating contiguous domains characterize Antarctica and the high latitude Southern Ocean.

Tue_365_SH-1_132
How to Establish a Legitimate Claim to Territory in the Antarctic

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Despite the fact that the Antarctic Treaty has 'frozen' claims to territory, countries continue to perform actions intended to establish future claims in Antarctica. They hope to build the basis for a claim to territory, when such claims become politically feasible.
This paper aims to outline the moral basis for a claim to territory. That is, this is a moral strategy for legitimacy, not a legal or political strategy. The moral strategy is commonsensical and rooted in the values at the foundation of contemporary international law. As such, it should carry significant weight in the thinking of international actors.
This paper draws on recent work done in political philosophy that characterizes morally legitimate claims to territory. Legitimate claims:
- are established by a verified political authority (i.e., not rogue governments or military dictators);
- contribute measurable value to the region and resources;
- do not take more than their fair share (defined broadly) of the Earth's natural resources; and
- make a claim to an area to which the group has a thick historical 'attachment'.
The paper argues that the final, attachment, condition is the least applicable in the context of Antarctica, especially given that the continent has never been home to a permanent population. It may be possible, though, to build the basis for future territorial claims through political, juridical, scientific and economic institutional investment that adds measurable value to the region.

Tue_367_SH-1_251
Critical View of Annex VI of the Antarctic Environment Protocol, on liability

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The Annex VI to the Protocol on Environmental Protection to the Antarctic Treaty "on Liability Arising from Environmental Emergencies" was adopted by the Antarctic Treaty Consultative Meeting (ATCM) in 2005 after 14 years of negotiations. It will enter into force once has been approved by the 28 Consultative Parties that had rights to participate in that meeting. Up to now (October 2017), only 15 Consultative Parties have approved it. The reasons why the approval process has been so slow are of course multiples, including the diverse domestic rules to approve an international agreement. But there are also some legal and political factors that were discussed in the negotiation and that are present in the text approved which can explain why States haven't shown a more enthusiastic attitude. The adopted text was unsatisfactory to several Parties. As well it has some elements that will do very complex its implementation if the Annex finally entry into force. It isn't clear that can be possible to reach an effective and better environmental protection with the Annex VI as we know it today. The presentation will review negotiation process of Annex VI, the finally adopted text, its approbation process and its domestic implementation by some States that have approved it. Some conclusions are presented and different alternatives to advance to a more effective regime of liability for Antarctic environment damage are discussed.

Tue_368_SH-1_722
A Regional International Society? The Exception of Antarctica

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The expansion of international society brought to Antarctica its primary institutions, although they have not been incorporated in similar terms. Sovereignty primary institution was suspended by the Antarctic Treaty in 1959, establishing a particular governance framework to the region. As a regional international society is formed when a region's institutions are absent at the global level, or when this region presents different interpretations for global level institutions, this work aims to understand Antarctica as a regional international society. Antarctic practices have been normalised despite the lack of a definition of its sovereignty and challenges have always emerged when the remaining international primary institutions (territoriality, diplomacy, balance of power, equality of peoples, nationalism and trade) demand addressment, producing different normative arrangements. Therefore, this work examines how resource management and environmental protection issues created particular norm localisation for primary institutions in the region. Resource management resulted in side agreements such as the 1964 Agreed Measures for the Conservation of Antarctic Fauna and Flora, the CCAS, the CCAMLR and the attempted CRAMRA. Likewise, the establishment of the Environment Protocol resulted from the environmental stewardship primary institution's growth, consolidating environmental preservation (along with peace maintenance and scientific cooperation) as Antarctica's own institutions.

Tue_369_SH-1_867
The Politics of Antarctic Marine Conservation: The Role of Argentina and Chile

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The establishment of Marine Protected Areas is one of the key issues discussed at the annual meetings of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). CCAMLR members decided by consensus to establish a Marine Protected Area (MPA) on the South Orkney Islands (2009) and the other in the Ross Sea (2016). Other MPA proposals still remain under discussions, such as a MPA around the Western Antarctic Peninsula proposed by Argentina and Chile. In this context, this conference paper examines the politics of MPAs at CCAMLR and the role of Argentina and Chile within this context.
This conference paper analyzes the transformations in the politics of Antarctica and discussions around MPAs at CCAMLR. It also addresses Argentina and Chile as original signatories of the Antarctic Treaty by analyzing the main guidelines of their Antarctic diplomacy and domestic policy on MPAs as well.
The research results suggest that the politics of MPAs in antarctic waters at CCAMLR happens in a context of antarctic environmental changes, a rising demand for natural resources and asymmetrical relations between states members of the ATS. In order to understand the role of Argentina and Chile within this framework, it is necessary to consider the importance of historical territorial claims in Antarctica, the role of science as a tool for diplomacy and also MPAs policies in the domestic domain.

Tue_370_SH-1_1409
Antarctica and the Environmental Account of Territory

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The Protocol on Environmental Protection to the Antarctic Treaty (PEPAT) sets forth the environmental principles governing activities in Antarctic. It expresses the conviction of the signatories regarding the protection of the Antarctic, designating the white continent as a natural reserve, devoted to peace and science (Art.2). More strikingly, PEPAT expresses the commitment to protect "the intrinsic value of Antarctica, including its wilderness and aesthetic values" (Art.3). These resolutions are to work as key elements in the planning and conduct of all activities in the Antarctic Treaty area (Art.3). Interestingly, there is no mention in PEPAT of one of the most remarkable elements of the Antarctic Treaty, namely, the freezing of State sovereignty on the Antarctic territory (AT Art.4). In a post-Westphalian world, this omission is problematic: comprehensive protection of the environment and its value requires reflecting on the question of state sovereignty claims over a territory. Although issues about the environment and its value are not central elements in most theories of territory, in this presentation I sketch an account of territory that both takes seriously PEPAT's idea on the intrinsic value of the Antarctic and incorporates environmental sustainability considerations as key aspects of legitimate territorial claims. The proposal, I argue, is a normative account of territory that is more adequate to face the environmental challenges in Antarctica motivating PEPAT.

Tue_371_SH-1_2131
Collaborative Governance in the Southern Oceans: The Ross Sea MPA

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As global extinction rates have accelerated, international regimes, such as the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), have proposed a variety of responses, including establishing networks of marine protected areas (MPAs). To address threats posed to Antarctic marine ecosystems by fisheries and climate change, CCAMLR endorsed efforts to establish a representative network of MPAs. In 2012, the United States and New Zealand proposed the Ross Sea Region MPA (RSRMPA) and following several years of negotiations it was agreed to by CCAMLR signatories in 2016. This research effort applied the collaborative governance framework, which stresses engaging state and non-state actors in building consensus to manage public resources, to identify the influential factors that contributed to this agreement and understand how it might be replicated in the future. More than forty interviews, ranging from twenty-five to ninety minutes, were conducted during and following CCAMLR's 36th meeting with delegation heads, chief scientists, committee chairs, Secretariat leadership, and observer delegates to provide a representative sample of key actors. Thematic coding of interviews using QSR Nvivo revealed the key drivers of consensus, which will be presented along with recommendations on how to incorporate the lessons learned from the RSRMPA negotiations into ongoing efforts to develop a network of Southern Ocean MPAs.

Tue_372_SH-1_2532
Enlightening Antarctica Deep Seabed's Unsettled Issues

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Even though the current and increasing natural resources dwindling might put pressure on the ATS, it seems that the core principles enshrined in it, such as Article IV of the Antarctic Treaty establishing the agreement to disagree on sovereignty, as well as Article II of the Madrid Protocol, designating Antarctica "as a natural reserve, devoted to peace and science", are strongly rooted enough to prevent any future litigation's arousal on land.
At sea though, and especially under the sea, the legal regime remains highly uncertain, and the expected fore coming pressure calls for its acute determination.
Indeed, with the recent evolution of the law of the sea and the fast development of new maritime areas, stagnant legal issues call for further certainties on austral seabed's legal regime.
Are Southern Ocean seabed's resources to be exploited in the future? Shall it be protected? Which State(s) or international entity should be in charge of doing so?
This communication proposes to focus on the issue of Antarctica seabed's legal regime, especially emphasizing on the articulation between two distinct regimes: seafloor's global legal regime, set up in the UNCLOS, as well as the specific one supposed to govern the seabed in the southern area according to the ATS.
A particular attention will first be brought on the general adequacy of those regimes, before moving to its apparent contradictions.
Finally, different proposals to avoid those contradictions will be evoked.

Tue_373_SH-1_2605
Multi-level Protection of Antarctic Region Against to Non-native Species

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The Region of Antarctica is biologically distinct from other regions. And, the increasing introduction of non-native species to the Antarctic Region is presenting a serious risk to biodiversity and environment of the Antarctica. Introduction of non-native species may arise from two different ways; native Antarctic species are moved by human activities between biogeographic regions, or non-native species established in one Antarctic biogeographic region and then are distributed to other regions by human or natural mechanisms.
At the 39th Antarctic Treaty Consultative Meeting (ATCM) Resolution 4 (2016) was introduced. The Annex of the Resolution introduces the “Non-native Species Manual”. The Manual aims to establish key guiding principles for minimising the risks associated with the introduction of non-native species. International Maritime Organization's (IMO) newly entered into force “International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004” deals with non-native species as well. Taking into other international law instruments, it is to say that, there is a multi-level protection of Antarctica against to non-native species. This paper aims to analyse the multi-level protection of Antarctic Region from a critical viewpoint, tries to extract gaps and overlaps among different international legal documents. Accordingly, the paper aims to provide recommendations for better coordinated and synchronized legal regime for the Antarctic.

Tue_374_SH-2_204
Establishing Indigenous TTP in Evenkia, Russia

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According to the Federal Law No. 49, Government of the Krasnoyarsk region had recently adopted the order on establishment of the traditional land use areas (TTP) of the indigenous peoples of the North. The Agency for Northern Development and Support of the Indigenous Minorities is designated an authorized executive for this action. The formation of such territories is to be carried out by decision of the regional government on the recommendation of the relevant Commission which is to consider the appeals of indigenous persons, communities or their authorized representatives. For the TTP decision process, it is necessary to take into account the prospects for socio-economic and investment development of the region, including possible negative effects from the imposed environmental protection and other restrictions on the use of aboriginal lands. The TTP establishment should not compromise or violate the rights and freedoms of other ethnic communities inhabiting these lands. This is a very important step in protecting the ancestral habitat of the indigenous minorities of the North in Evenkia district. Regional government took into account the proposals of neighboring provinces where TTP have already been formed: Irkutsk, Khakassia, Sakha (Yakutia), Khanty-Mansi (Yugra). But at the same time many legal obstacles on the way for protecting traditional land use areas are still existent and the perspectives for their operational management are to be revealed and analyzed.

Tue_375_SH-2_322
State Intervention in Whaling: A Case of Whaling in the Faroe Islands and Taiji

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Disputes about whaling have been polarized into for or against, and ignored to form a platform for diversified agenda such as politics, international relationships, environment, and animal welfare. In particular, subjects concerning indigenous knowledge of whaling and ethics based on rules shared among local people were less focused. I wish to discuss coastal whaling not from for or against point of view. My research fields are the Faroe Islands and Taiji town of Japan. In the past decades, traditional whaling in the two regions have been affected by anti-whaling movements and the controversies have changed them. In Taiji, they inevitably have made changes such as their method and regulations of killing, and reinforce security control. The Japanese government have taken some measures for protecting whaling in Taiji, however, its aim is in another issue, to protect the vested rights of government sponsored whaling. Another changes could be observed is local people's awareness of whaling. As the town exposed worldwide criticism some people have started questioning by themselves reasons of continuing whaling. In contrast, people in the Faroe Islands have not been tossed about by the changes compared to Taiji. From examining these findings, I have concluded that the state intervention greatly changes whaling and it may also affect people's way of thinking. I wish to show the difference of the changes in the regions and hope I could make a few contributions toward this subject.

Tue_376_SH-2_926
Sharing Knowledge as a Tool to overcome Socio-economical Issues

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Since october 2013, Greenlandic politicians have their own legislation regulating the exploitation of their soil´s natural ressources. Following this parlementarian vote, several companies and private industrials have shown their interest for the mineral ressources of Greenland, leading to the construction of the first greenlandic uranium and rare earths mine in Kvanefjeld (South Greenland).
In response, an anti-uranium movement began to actively criticize the Environmental and Social Impact Assessement procedure, thus being at odds with Greenlandic politics and private companies. Hence, the mine of Kvanefjeld has become a social debate articulated at different levels between farmers, anti-uranium activists, the governement of Greenland, and with the international private sector.
Through a multi-located ethnography - political spheres, anti-uranium movement, farming communities adjoining the mine - and understanding the criticisms towards the Assessement procedure, this contribution aims to articulate the farmers´ knowledge of the land and their will to be part of the implementation plan with the socio-economic necessities that motivate each stakeholder.
The study of this case is a tool to deepen the discussion about the place and role of Indigenous Knowledge and include them meaningfully by taking the socio-economical perspectives into account; In order to produce Indigenous Governance Model locally constructed connecting Indigenous People and Foreigners.

Tue_377_SH-2_2570
Future Challenges for Arctic Indigenous Peoples

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Multiple drivers of environmental and social change can be identified across the Arctic and more change is expected. Infrastructure development is currently the most significant driver of change in land use. Climate change is an increasing threat to traditional livelihoods. Impacts on indigenous peoples are exacerbated by their lack of voice in the development of adaptation tools and strategies for future planning and development.
Arctic Indigenous Peoples cooperate in the Arctic Council in Unique way through the Indigenous Peoples Secretariat in Arctic Council for more than 20 years. Building competence locally is important to be able to adapt to these changes.

Tue_379_SH-2_2652
The Current State of Mapping Indigenous Land Rights in the Sakha Republic Russia

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Clan communes (KROs) offer a mechanism by which families and groups of indigenous persons can request an allocation land on which to pursue their traditional activities (e.g. reindeer herding, hunting). KROs have been formed since the early 1990s. A federal law governing their creation passed in 2000. Local laws in various regions of the Russian North often preceded this: for instance, in the Sakha Republic (Yakutia), a law on KROs passed in 1992. Over the past 25 years, a variety of legislative revisions have affected KROs. KROs are best protected when situated inside a "Territories of Traditional Nature Management" (*territoriya traditsionnogo prirodopol'zovaniya* or TTP). TTPs, governed by a 2001 law, provide protection of lands for traditional use, including some capacity to exclude industrial activities that might negatively affect traditional activities.
Our paper will present the application of a cartographic-geoinformation method for studying the TTPs in the Republic of Sakha (Yakutia) under the situation of intensive industrial development. This method allows the identification of changes in the organization of TTPs as they are related to changes in the boundaries of the KRO, and thus the withdrawal of land from economic circulation, in areas of potentail conflict between industrial and 'traditional' users Completed maps can be used as an documents to protect and defend the TTPs, and thus the KROs situated within them, in case where legislation is changed.

Tue_COMNAP_2718
Nautical Assets' Fostering Scientific Research in the Antarctic Treaty Area

Andrea Colombo[1] (sec@comnap.aq), Michelle Rogan-Finnemore[1]
[1]COMNAP Secretariat, Christchurch, New Zealand

Vessels play a pivotal role in science and science support for the national Antarctic programs operating in the Antarctic Treaty Area. In fact, vessels not only deliver people and supplies to coastal infrastructures but also, while sailing, conduct an array of multi-disciplinary scientific projects thanks to their on-board facilities and personnel. The Council of Manager of National Antarctic Programs (COMNAP) developed two tools to display and share vessels position data for national Antarctic program vessels operating in waters below 60°S (as per ATCM XXXVI Resolution 4 (2013)). These tools help to foster international scientific projects through, and with, the support of national Antarctic programs and are also useful in times of emergency. The poster showcases examples of successful international collaborations on board of vessels operated by COMNAP Members, and hopes to create new opportunities for future multi-disciplinary and “big science” international projects. The sharing of capabilities on vessels amongst the international scientific community is another good example of international co-operation in Antarctica.

Tue_COMNAP_2719
Information Exchange: How COMNAP Productises Data for Members & the Community

Andrea Colombo[1] (sec@comnap.aq), Brad Herried[2], Michelle Rogan-Finnemore[1]
[1]COMNAP Secretariat, Christchurch, New Zealand, [2]Polar Geospatial Center, Minnesota, United States

The Council of Managers of National Antarctic Programs (COMNAP) often requests information from its Member national Antarctic programs. Once collected, the information is housed in the COMNAP database and is used and exchanged in a range of COMNAP products. Those products support the work of COMNAP Member national Antarctic programs in regards to international co-operation in science, science support, operations, logistics, and in Search and Rescue (SAR) situations to name only a few examples. COMNAP has produced procedures for such information exchange and there are also information exchange requirements which are an obligation on Antarctic Treaty Parties in Articles III and VII (5) of the Antarctic Treaty, in several articles of the Protocol on Environmental Protection to the Antarctic Treaty and in a number of Recommendations, Measures, and Resolutions as adopted by the Parties. This poster gives an overview of the projects and products served by the COMNAP database and how these can inform and advance exchange of information with Members, the wider Polar community and the general public. The COMNAP database was developed as a source of information primarily for use by Member national Antarctic programs and the COMNAP Secretariat. However, advances in technology coupled with good planning in development mean that information exchange into duplicate fields in separate databases is now possible.

Tue_COMNAP_2720
Antarctic Facilities: Hubs for Science and Environmental Protection

Andrea Colombo[1] (sec@comnap.aq), Michelle Rogan-Finnemore[1]
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This poster showcases a portion of the facilities-related data in the Council of Managers of National Antarctic Programs (COMNAP) database. Ninety-seven facilities (stations, camps, laboratories, refuges, depots, and airfield camps) are run and personned by the COMNAP Members in the Antarctic Treaty Area (2017-18 season data). A great array of facilities-related data, from main scientific disciplines supported, to hydroponics facilities, through medical capabilities and climate-related data, are available for the Members through the COMNAP database. The non-sensitive data, are also available to the Antarctic Treaty System organisations and to the general public.

In light of the COMNAP Antarctic Roadmap Challenges (ARC) project outcomes, sharing information on facilities and capabilities are seen as a tool which can directly support the key goal of improving international co-operation in Antarctica. The poster introduces some of the facilities-related data in the COMNAP database showcasing scientific activities, measures in place to reduce direct impact on the environment and waste management practices. The final aim is to stimulate the exchange of knowledge, scientific personnel and best practices furthering international co-operation.

Morning Plenary I
20.06.2018 07:50-09:00, A Davos

Keynote Lecture I

China's potential contributions to SOOS and MOSAiC

Dake Chen (dchen@ldeo.columbia.edu)
Second Institute of Oceanography, State Oceanic Administration, China

The Southern Ocean Observing System (SOOS), and the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC), are two of the major ongoing international initiatives for polar research. SOOS was officially launched at the end of 2011, and since then it has built a network of stakeholders and contributors, all working together to achieve its well-defined mission and objectives. Currently SOOS is implemented based on its regional working groups and there is a clear need for a broad-scale circumpolar design. On the other hand, MOSAiC is a more focused, short-term experiment presently at its final planning stage. It will have a three-tiered observational strategy, including a central observatory, a distributed network and a large-scale connection, as well as a comprehensive modeling hierarchy. This calls for a strong international collaboration to provide scientific, technic and logistic supports.

Here we first briefly review the scientific goals of SOOS and MOSAiC from a global perspective, and then discuss the potential roles of China in these two international initiatives, in accordance with our national polar research programs supported by various agencies. In particular, starting with a description of our existing capabilities in both Antarctic and Arctic research; we outline our plans for future enhancement in technology and infrastructure, as well as our suggestions on the implementation of SOOS and MOSAiC. The take-home messages include:

(1) China is now in the process of largely enhancing its polar research activities, which certainly will lead to significant contributions to SOOS and MOSAiC;

(2) For SOOS, we propose a multi-platform, multi-disciplinary circumpolar “Big Ring” design to serve as its sustained “backbone”;

(3) For MOSAiC, we will participate in all three tiers of its field observations as well as modeling efforts, aside from providing logistic support.

Morning Plenary I
20.06.2018 07:50-09:00, A Davos

Keynote Lecture II
Frozen in time - Unlocking the Earth's climate history using ice cores

Elizabeth Thomas (lith@bas.ac.uk)
British Antarctic Survey, UK

Ice cores have proved to be a powerful tool for reconstructing past climate. These "two-mile time machines" have driven our understanding of global climate variability, tracing the transitions from glacial to interglacial over the past 800,000 years. And yet the secrets in the ice are still being unlocked. In this presentation I will outline recent advances in ice core research, touching on the development of exciting new climate proxies and demonstrating the power of international collaboration in producing continental reconstructions with unprecedented spatial coverage. I will focus on climate variability over human timescales, decades to centuries, in Antarctica; a continent experiencing dramatic climate change in recent decades but one with the shortest historical observations and arguably the largest potential to drive future climate through its contribution to global sea levels. I will summarise findings from two recent community based reconstructions, of past surface temperature and snow accumulation, capturing the drivers of Antarctic climate variability and its influence on global sea levels during the 20th century.

OS-6d - Polar Ocean Dynamics
20.06.2018 09:00-10:30, C Aspen

1112
AW Boundary Current Characteristics and Eddy Formation North of Svalbard

Laura Crews[1] (laura.crews@npolar.no), Arild Sundfjord[1], Tore Hattermann[2], Jon Albretsen[3]
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Despite the importance of Atlantic Water (AW) to Arctic halocline formation and sea ice distribution, the dynamics and seasonality of the AW inflow and redistribution north of Svalbard are not well documented. Here we use a high resolution (800 x 800 meter) eddy-resolving sea ice and ocean model to characterize the boundary current, with particular focus on eddy formation. The flow regime in the Yermak Plateau (YP) region is variable, with flow over the YP alternating between a faster, narrower northern current and a slower, more diffuse current. Downstream of the Yermak Plateau, the current follows the shelf break. Directly north of Svalbard the current is most unstable between October-March, similar to previous findings from Fram Strait. Further East, the current is most unstable several months later. The boundary current sheds AW eddies along most of the length of continental slope considered, from the western YP to 40°E, though eddies forming east of 20°E are likely more important for slope-to-basin transport. Eddy formation seasonality reflects current instability in the eastern portion of the study domain, but on and immediately east of the YP eddy formation is out of phase with current instability, with formation rates highest during summer. Most of the AW eddies are anticyclonic, with radii close to the local deformation radius, and are centered in the halocline. They transport roughly 0.1 Sv of AW and, due to their warm cores, nearly 1.0 TW away from the AW current.

1341
Circumpolar Deep Water Variability in High Resolution Coupled Climate Models

Hannah Zanowski[1] (zanowski@uw.edu), Frazer Christie[2], Kyle Armour[1], Cecilia Bitz[1], Eric Steig[1]
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Observations have shown that West Antarctic ice shelf basal melt is strongly related to warm Circumpolar Deep Water (CDW) impinging on the continental shelf in this region. This critical discovery has led to multiple, high-resolution regional modelling studies aimed at identifying the underlying mechanisms that lead to CDW intrusions on the West Antarctic continental shelf and their subsequent circulation in ice shelf cavities. However, many of these models do not include a coupled atmosphere, potentially missing relevant ice-ocean-atmosphere interactions that impact CDW variability in the West Antarctic.
Here we characterize West Antarctic CDW variability in two coupled climate models with 0.1˚ oceans and identify the mechanisms that control this variability on interannual to decadal timescales. Consistent with observations, we find that temperature variability on the West Antarctic continental shelf is related to wind stress curl along the shelf break in the models. In addition to wind stress curl, we explore a range of local and large-scale atmospheric and oceanic processes, such as ENSO, that could contribute to CDW variability, and quantify the relative importance of each in controlling shelf water temperature variability.

2125
Circum-Antarctic Eddy/Tidal Overturning and Shoreward Heat Transport

Andrew Stewart[1] (astewart@atmos.ucla.edu), Andreas Klocker[2,3,4], Dimitris Menemenlis[5]
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The passage of warm Circumpolar Deep Water onto the Antarctic continental shelf is dynamically obstructed by the continental slope to varying degrees around the Antarctic margins. Previous studies indicate that high-frequency processes, such as tides and mesoscale eddies, are required to overcome this dynamical barrier and supply heat to the Antarctic coast. In this study we use a very high-resolution (1/48 degree) ocean/sea ice simulation to quantify the relative roles of mean flows, eddies and tides in transporting heat across the entire Antarctic continental slope and shelf. We find that eddies transfer heat across the continental slope, but tides make the largest contribution to the shoreward heat flux across the shelf break. However, the tidal heat flux is almost entirely compensated by an opposing offshore heat transport by mean flows. Consequently, the shoreward eddy heat fluxes coincides closely with the net shoreward heat transport across the shelf break. Approximate overturning circulations for the mean, eddy and tidal components of the cross-slope transport also show strong compensation between mean flows and tides at the shelf break, with negligible eddy-driven overturning. Taken together, these results suggest that eddy stirring of heat anomalies along isopycnals or along the ocean bed is the primary mechanism of heat transfer across most of the Antarctic continental shelf/slope.

2199
Eddies, Sub-mesoscale Structures, and Water Mass Variability In the Beaufort Sea

Luc Rainville[1] (rainville@apl.uw.edu), Craig Lee[1], Jim Thomson[1]
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Observations in the Arctic are often sparse in space and time. Mesoscale and sub-mesoscale processes are poorly captured by typical hydrographic sampling from large icebreakers, which is often the only way to provide access to the challenging ice-covered regions. In 2014 and 2015, the US Office of Naval Research funded a pair of programs designed to capture important processes in the changing Arctic Ocean and promote the use of autonomous technology and intense ship sampling. In particular, Seagliders surveys conducted as part of the Marginal Ice Zone Program in 2014, and ship-based underway CTD sampling in the SeaState Program in 2015 provide repeated sampling of important regions in the Beaufort Sea high spatial and temporal resolutions, capturing several eddies and upper ocean fronts. Eddies appear particularly important near the ice edge and near the shelf breaks. In this presentation, we synthesize observations from these intensive programs and describe the dynamics of mesoscale and sub-mesoscale processes in the Arctic, as well as the characteristics of dominant water masses (Pacific and Atlantic Waters) over the basin.

1568
Frontal Processes and Extreme High Chlorophyll *a* Values Investigated with an AUV

Sandra Tippenhauer[1] (stippenh@awi.de), Thorben Wulff[2], Wilken-Jon von Appen[1]
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Small-scale processes and their effects get more and more attention when it comes to understanding processes and changes in the (Arctic) ocean. Here we present a study on physical processes and ecological responses at a submesoscale front in Fram Strait at the interface between the Arctic Ocean and waters of lower latitude origin investigated using an autonomous underwater vehicle (AUV). The AUV is equipped with several physical and biogeochemical sensors.
High-resolution observations from the upper 50m of the water column, show extremely large physical and biogeochemical gradients associated with the frontal system. Extraordinarily high chlorophyll *a* values between 20m and 40m water depth were observed to be associated with polar surface water, which may recently have been raised above the compensation depth resulting in the subsurface bloom. A mooring in the vicinity showed that the chlorophyll *a* patch was present for a few days. Additional observations conducted from a Zodiac in parallel to the AUV survey show that the observed patch had an along-front extent of more than 400m. This indicates, that the observed feature was a dynamically active front, possibly experiencing wind-driven frontogenesis or the growth of mixed layer eddies.
The study was conducted in Fram Strait but the results are most likely transferable to other, dynamically comparable frontal systems in the marginal ice zone that experience large horizontal density gradients, e.g. in the Southern Ocean.

1292
Dynamical Controls on the Export of Antarctic Bottom Water from the Weddell Gyre

Alberto Naveira Garabato[1] (acng@soton.ac.uk), Carl Spingys[2], Eleanor Frajka-Williams[2], Kurt Polzin[3], Christian Buckingham[4], Povl Abrahamsen[4], Sonya Legg[5], Stephen Griffies[5], Keith Nicholls[4], Michael Meredith[4]
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During the last three decades, AABW has exhibited a striking warming and contraction in volume over much of the global ocean abyss, particularly in the South Atlantic. The causes of these changes are unknown. In the Atlantic sector, observations suggest that climatic variations in the basin-scale properties of AABW downstream of its sources in the Weddell Sea are primarily controlled by wind-forced changes in export, via a mechanism involving the modulation of small-scale turbulent mixing in the Orkney Passage. To test this hypothesis, the U.K. DynOPO (Dynamics of the Orkney Passage Outflow) programme set out to measure the circulation of AABW in the Passage, and to assess the dynamical controls underpinning the water mass´ transformation in the region. With this goal in mind, a finescale-resolving mooring array was recently deployed in the Passage for 2 years (2015 - 2017), and a research cruise was conducted to measure the turbulent properties of the AABW outflow with fine- and microstructure instrumentation and the autonomous underwater vehicle Autosub Long Range. Here, we will present results from the project. These indicate that: (1) the AABW outflow experiences concurrent broadening, deceleration, and intense mixing as it navigates the Passage; (2) these changes are underpinned by a distinct mechanism involving downslope Ekman flows and submesoscale dynamical instabilities. The implications of these findings for our starting hypothesis will be discussed.

OC-1_OC-2d - Innovation, partnership and impact in polar science communication & Polar Research and Citizen Science: Exploring New Platforms and Opportunities
20.06.2018 09:00-10:30, A Studio

1474
Not Just Penguins: Increasing Public Understanding of Antarctic Ecosystems

Claire Christian[1] (claire.christian@asoc.org), Amanda Lynnes[2], Lisa Kelley[2]
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People love pictures of cute penguins and seals, but often know little else about Antarctic marine ecosystems. Most Antarctic organizations and programs recognize these gaps but have limited resources to do large public education campaigns. Partnerships between organizations are therefore a logical choice to enhance capacity and reach a wider audience. In this presentation, we will analyse the outcomes of a successful joint social media campaign between the Antarctic and Southern Ocean Coalition (ASOC), an environmental organization, and the International Association of Antarctica Tour Operators (IAATO) to promote knowledge of lesser-known species. We developed a series of tweets and Facebook posts containing facts about Antarctic invertebrates, with accompanying videos, photos and graphics.
We will share our analysis of the campaign's success as measured by audience engagement with posts and tweets, as well as lessons learned. A key conclusion is that a multi-day, fact-based series of posts and images seems to be more popular on Twitter than on Facebook. The overall increased engagement demonstrates that social media campaigns are therefore an effective way to reach out to followers who are already interested in Antarctica (as well as gain new ones) and can be used to increase public understanding about Antarctic issues. Partnership was also effective as it expanded the content available to both organizations, and helped distribute the workload.

355
Building a Scientific Culture on Antarctica through a Discussion Forum

Silvia Dotta[1,2,3] (silviadotta@gmail.com), Eduardo Rodrigues da Silva[1]
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This paper aims to analyze the contribution of a discussion forum for the process of building a scientific culture on Antarctica.
The concept of scientific culture is broader than that of scientific literacy since it incorporates a social component of analysis and interpretation into the appropriation of the knowledge process. Communication and pedagogical strategies that seek scientific literacy, more focused on appreciation, lead to the incorporation of scientific knowledge as much to the social imaginary of the individual as to the surrounding society. Recognizing science as "interesting, stimulating and entertaining" is more realistic than equating the knowledge of non-specialists with that of scientists.
A discussion forum was conducted at a distance-learning training course for primary school teachers to whom were asked to discuss conceptual errors about Antarctica. It proposed the debate on where the lung of the world is: The Amazon or Antarctica. Participants were encouraged to defend predetermined ideas, based on scientifically consolidated arguments. 114 students and 6 tutors attended. Over three weeks, 577 messages were exchanged. Most of participants (76%) returned to interact with colleagues and tutors.
A forum is a tool that can contribute to incite interest in the research and dialectical construction of knowledge. Dialogue around the ways of problem solution has helped to encourage the popularization of socio-constructed scientific knowledge about Antarctica.

791
Using Media to Drive Conservation in the Ross Sea: Protecting the Last Ocean

John Weller[1] (johnwellerphotography@gmail.com), Cassandra Brooks[2]
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During this session, John B. Weller, an internationally acclaimed photographer, filmmaker and author, invites you to journey above and below the ice in Antarctica. In 2004, Weller and Antarctic ecologist David Ainley founded *The Last Ocean Project* - the first dedicated campaign for a marine protected area of the Ross Sea, Antarctica. They later co-founded *The Last Ocean Charitable Trust* with New Zealand filmmaker Peter Young and also brought on Antarctic scientist Cassandra Brooks. Weller's photographs of the Ross Sea became the face of Antarctic conservation efforts worldwide. He will explain how his efforts to protect the Ross Sea, Antarctica inspired a global coalition of organizations, scientists, diplomats and more than a million people, and helped entrain world leaders from the White House to the Kremlin. Twelve years of work came to fruition in October 2016 in a stone fortress in the center of Hobart, Tasmania, where diplomats from 24 countries and the EU adopted the Ross Sea Marine Protected Area - one of the most profound international environmental agreements of our times. It is the first large-scale international marine protected area and the largest MPA in the world. Focusing on lessons learned and the creative applications of media to emerging conservation opportunities, this session will examine ways in which media can help drive marine conservation.

1668
Social Media Outreach Coordinated across a Multinational Polar Research Project

Jennifer Newall[1,2,3] (jennifer.newall@natgeo.su.se), Jan-Ola Olofsson[4], Ida Kinner[4], Julia Spinolo[1], Maddie McGrath[5], Gryphen Goss[1], Logan Judy[1], Sarah Sams[1], Cody Wilson[5], Malin Stenberg de Serves[2,3], Jorge Bernales[6], Derek Fabel[7], Ola Fredin[8,9], Neil Glasser[10], Jon Harbor[1,2,3], Nathaniel Lifton[1], Irina Rogozhina[6,11], Arjen Stroeven[2,3]

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MAGIC-DML is an ongoing Swedish-US-Norwegian-German-UK collaboration focused on improving ice sheet models by filling critical data gaps in our knowledge of the timing and pattern of ice surface changes in Dronning Maud Land (DML), Antarctica. Outreach and science communication through social media is a priority in this international collaboration, and involves students, scientists, and communication staff at the partner universities and the Swedish Polar Research Secretariat (SPRS). One main focus of our outreach has been an online presence with an SPRS component focused in particular on research expeditions, and coordinated with the project website, blog, and social media elements (Facebook, Twitter, Instagram). Scientists and staff at the partner universities and SPRS coordinate with the overall social media, and repost/tweet to enhance impact. We will share both the challenges and achievements of coordinating social media across multiple organizations and countries with different levels of communications expertise and resources, and with target audiences that include the general public, teachers/students, and colleagues/peers. Quantitative and qualitative analyses of the social media component of our outreach program will also be presented, including special events (competitions), types of material posted, timing of posts, coordinated 'shares', and interactive elements.

2158
An IceCube Interactive and Immersive Exhibit for Learners of All Ages

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Research shows that virtual and interactive environments can boost learning outcomes for learners of all ages. These technologies can also increase engagement of underrepresented communities, since these environments are not usually associated with performance stereotypes and academic language proficiency.
The IceCube Neutrino Observatory in Antarctica has partnered with technology and education researchers to develop a virtual reality exhibit that connects users to the polar observatory, which is leading a new field in astronomy. IceCube detects small particles called neutrinos that can help us explore the universe in ways that cannot be done with light.
This novel exhibit combines a multitouch table and commercially available virtual reality (VR) head-mounted displays to facilitate learning of polar research. The exhibit, launched in November 2017, is studying how immersive VR can enhance informal STEM learning.
We will discuss the challenges and opportunities of working with an interdisciplinary team as well as assessment results. They seek to evaluate how technology can improve engagement of all learners, and to determine which technologies are better suited to enhance STEM learning. Contributing to the understanding of these questions is the goal of this NSF-funded project, which in the future plans to port this exhibit to more affordable platforms-such as tablets and google cardboards-, as well as integrate Antarctic research from other disciplines.

1506
The @OceanseaiceNPI Initiative: Polar Science Communication using Social Media

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Successful science communication is essential but also challenging with time constrains, limited financial resources and a lack of incentives in the academic environment. Many social media platforms have recently emerged, providing free and simple science communication tools to reach the general public, journalists, fellow scientists, and younger generations in particular. While individual researchers and large institutions are present on social media, smaller research groups are under-represented.
@oceanseaicenpi is a science communication initiative led by a small group of polar oceanographers, sea ice, and atmospheric scientists at the Norwegian Polar Institute in Norway. Here we present our experience establishing, developing, and maintaining this successful Arctic science communication initiative on Instagram, Twitter, and Facebook. The initiative is run entirely by the team of 25 researchers with limited time and financial resources. Over 4 years, it has built a broad audience of more than 7000 followers.
The initiative has boosted the alternative metric scores of our publications and helped researchers in the group to become better writers and communicators. We hope to inspire other research groups by sharing our experience on how to develop and conduct effective science communication using social media!

TE-1a - Observing with autonomous vehicles in polar regions
20.06.2018 09:00-10:30, A Forum

2559
Marginal Ice Zone Processes Observed from Unmanned Aircraft Systems

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Unmanned Aircraft Systems (UAS) are ideal to study sub-pixel satellite variability as well as providing “eyeballs over the horizon” information for both ship- and land-based field studies. For the past 5 years, we have developed and flown a number of payloads to study under-observed sea ice regions aboard long-range (5- to 20-hour endurance) UAS including most recently fixed-wing UAS with vertical take-off and landing capability. We have demonstrated the capability from both land and ships during a number of experiments in Alaska (Beaufort and Chukchi Seas) and Svalbard, Norway. We have developed and deployed payloads that include:
1) Down-looking hyperspectral visible imaging spectrometer to determine ocean color and biogeochemical mapping;
2) Upward- and downward-looking pyranometers (solar) and pyrgeometers (longwave) to measure full hemispheric irradiance to quantify the surface energy budget and map sea ice, ice floe, and ocean solar albedo;
3) High-resolution visible and infrared imaging is used to discern sea ice extent and coverage, whitecapping and other upper ocean processes as well as SST skin and ice temperature;
4) air-sea-ice turbulent fluxes as well as wave height, ice freeboard, and surface roughness with a LIDAR; and
5) drone-deployed micro-drifters (DDµD) deployed from the UAS that telemeter both atmosphere and upper ocean data. Measurements from UAS offer a unique opportunity to observe physical processes at sea-ice margins and will be explored here.

255
GLOBAL ARCHER The GLOBAL ARCtic High-altitude Environmental Research Initiative

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Additional activity in Arctic waters requires reliable environmental & domain awareness information critical for ecosystem, resource, community & emergency management & economic sectors including transportation, fisheries, tourism, & energy & mineral industries. Ice hazards that originate in the Arctic threaten maritime shipping in mid-latitudes further expanding the domain of Arctic impact on safe maritime operations. To address these issues, an international study team identified observational needs & developed mission objectives using UAS. The range, altitude (~20 km), & endurance (~26 hr) of High Altitude Long Endurance (HALE) UASs like the Global Hawk. This capability can fill critical gaps for Arctic Domain Awareness observations required for sea ice forecasting, transportation safety, oil spill detection & response, & extreme weather watches & warnings. Demonstrating HALE technology & communication innovations in the Arctic are needed for the growing number of requirements & stakeholders operating at high latitudes. The study team prioritized & developed flights that demonstrate Global Hawk's observational capability for providing: a) enhanced environmental knowledge; b) maritime awareness & responsiveness; &, c) insight into weather extremes in the Arctic. We present the concept of a month-long campaign, GLOBAL ARCHER (ARCtic High altitude Environmental Research), to demonstrate how Global Hawk can advance our capabilities & responses in a rapidly evolving Arctic.

1113
Internal Polar Boundary Layer Affected by Open Water in Antarctic Sea Ice

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As part of the *Polarstern* cruise ANT-XXIX, the Meteorological Mini Aerial Vehicle (M^2AV) was operated in the Antarctic Weddell-Sea during winter 2013. It was the first time that unmanned aerial system (UAS) were used on board *Polarstern* and the authors have gained high expertise in performance of UAS influenced by harsh polar environment (cold temperature, high wind speeds, potential of icing) since then. The aircraft's nose is equipped with fast meteorological sensors in order to investigate turbulence in the lowermost 1000 m. The main aim of the study was to analyse the effect of open water in sea ice that causes an internal boundary layer due to the high temperature difference of around 30 K between see ice surface and open water in the small horizontal extent of several metres. Taken from studies in modelling, the small-scale effect influences the Earth's climate. However, the knowledge of the extent is poor and leads to a high uncertainty in weather and climate predictions. Therefore, horizontal flights were operated with M^2AV perpendicular to open sea ice with a flight distance of at least 4 km in low heights of 15-150 m. Fluctuations of 3D-wind vector and potential temperature were significantly affected by one crack of around 500 m wide and showed updraft up to the height of 100 m, however downdraft above and near the inversion layer. The crack led to pronounced fluxes of sensible heat and turbulent kinetic energy, in contrast to measurements above closed sea ice.

670
RPAS Based Observations on the Arctic ABL over Sea Ice in the Baltic Sea

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The purpose of the research project ISOBAR (Innovative Strategies for Observations in the Arctic Atmospheric Boundary Layer) is to increase our understanding of the Atmospheric Boundary Layer (ABL) in the Arctic. In February 2017 we carried out a measurement campaign on the Finnish island Hailuoto in the northern Baltic Sea. During the three-week long field period, we studied processes within the ABL over the sea-ice of the Bothnian Bay, based on observations from several different Remotely-Piloted Aircraft Systems (RPAS) as well as ground based flux and automatic weather stations and remote sensing systems (Doppler Lidar and Sodar). Turbulence measurements from different altitudes were obtained by two different fixed-wing aircraft systems (MASC and miniTalon). A small fixed-wing system (SUMO) was used for atmospheric profiles from about 30 to 1800 m. In addition, different multicopter systems were applied to take profiles from the ground to an altitude of up to 400 m. In total more than 150 scientific flights were conducted during the three weeks with five intensive observational periods. Together with the ground based and remote sensing data this results in an extensive high-resolution data set of observations on the stable ABL which will be used for detailed investigations of the processes within the stable ABL. We further aim to take these processes into account in new ABL parametrization schemes for numerical models.

1586
U.S. DOE ARM Tethered Balloon System at AMF3 in Oliktok Point, Alaska

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Sandia National Laboratories (SNL) has operated a tethered balloon system (TBS) at the Advanced Mobile Facility 3 (AMF3) in Oliktok Point, Alaska, since 2015 on behalf of the U.S. Department of Energy's (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility. The TBS was flown as part of ICARUS (Inaugural Campaigns for ARM Research using Unmanned Systems) and AALCO (Aerial Assessment of Liquid in Clouds at Oliktok).
The TBS offers advantages for Arctic observations. Our TBS has operated for over nine continuous hours, within clouds, and at altitudes up to 1.45 km above ground (AGL). Varied instruments have been deployed simultaneously on the TBS, including Distributed Temperature Sensing (DTS) systems, printed optical particle spectrometers, a condensation particle counter, and supercooled liquid water content sensors (SLWCs). Measurements from these sensors, and their comparison with sUAS, radiosonde, and ground-based measurements are discussed. Additionally, technical aspects of DTS measurements, including the use of a fiber optic rotary joint, and comparisons of results from two DTS systems, are shown. Varied deployments of the TBS and DTS are touched on, including recent efforts to measure ocean temperature profiles as conducted on a research vessel deployed offshore of Oliktok Point, and DTS measurements collected by an sUAS.

2491
Manned Aircraft vs. UAS Surveys for Arctic Cetacean Density and Distribution

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Manned aerial surveys are routinely used to assess cetacean distribution and density, often over large geographic areas. Unmanned aircraft systems (UAS) have been identified as a technology that could augment or replace manned aerial surveys for cetaceans. To understand what research questions involving cetacean distribution and density can be addressed using manned and UAS technology in the Arctic, we conducted a three-way comparison near Utqiaġvik, Alaska, among visual observations made by marine mammal observers aboard an aircraft; imagery autonomously collected by a Nikon D810 camera system mounted to a belly port on the manned aircraft; and imagery collected by a similar camera system on a remotely-controlled ScanEagle UAS. Each survey platform conducted five flights within a 16,800 km^2 study area. The manned aircraft collected 23,580 images in 17.9 flight hours, during which marine mammal observers simultaneously collected sighting data. The UAS collected 20,568 images in 21.8 flight hours. Various technologies and operational procedures contributed to the ability to conduct routine, successful and safe beyond line-of-sight UAS flights. Comparisons of density estimates, associated estimates of uncertainty, data processing time, and cost can be the basis for design of future large-scale UAS projects.

CR-7a - Snow and firn: an open measurement and modelling challenge
20.06.2018 09:00-10:30, A Dischma

198
Assessing past Snow Cover Changes in the Kola Peninsula, Arctic Russia

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The very high albedo of snow means that changes in its coverage have a significant impact on the Earth´s global energy budget. Thus, Northern Hemisphere snow cover, which comprises approximately 98% of the global total area of seasonal snow, is responsible for the largest annual and interannual differences in land surface albedo. Here we examine recent changes in snow cover in the Khibiny Mountains on the Kola Peninsula in Arctic Russia, a region that has undergone significant climate change in recent decades. Future changes in snow cover have the potential to have a major socio-economic impact in this region, which is primarily dependent on mining and skiing for its economy. We used a combination of remote sensing data, meteorological observations and field data in our analysis. Field measurements of snow parameters were employed to validate the MODIS (Moderate Resolution Imaging Spectroradiometer) fractional snow cover and albedo products. First and last days of snow cover were derived for each year and compared to snow depth observations from three field stations in the Khibiny Mountains and three additional meteorological stations in the region to look for systematic biases in the satellite data. These 'locally calibrated' MODIS data were then used to determine the trends and variability in the duration of the snow season across the Khibiny Mountains from 2000 to 2016.

771
Are Accumulation Regimes of Central Asian Glaciers Changing?

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Various studies have shown that glacier mass loss in certain areas of Central Asia is low compared to the global average. The reasons for glaciers in these regions being relatively close to equilibrium, however, remain unresolved. A possible explanation is increased accumulation due to changes in atmospheric circulation. For the regions concerned, however, precipitation data are sparse. This lack of data could be mitigated by using in-situ measurements of glacier accumulation rates.
Here, we focus on the firn cover of Abramov glacier located in the Pamir Alay, southern Kyrgyzstan. Abramov glacier is the only glacier with a very rich set of historical scientific data located close to the areas of near-equilibrium mass balance. We use snow pits, firn cores and GPR measurements to derive present-day accumulation characteristics including annual accumulation rates and snow distribution. Furthermore, we compile past accumulation rates from the exceptionally detailed glacier mass balance measurements from the 1960s to the 1990s as well as from ice cores reaching down to the early 1920s. The accumulation rates and snow distribution patterns from the different periods are used to quantify temporal changes of the firn cover of Abramov glacier. First results suggest that annual accumulation rates may have increased during the last years.

901
Using Weather Radar Data to Estimate the Winter Mass Balance on Swiss Glaciers

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Precipitation estimates in high-mountain regions are essential for environmental studies in many research fields (glaciology, meteorology, hydrology, etc.). Although precipitation data exist for the Swiss Alps, accuracy is limited by data sparsity and measurement challenges in high-mountain regions. In glaciology, we propose a novel approach to estimate the snow water equivalent (SWE) on glaciers and to spatially integrate these measurements by combining continuous observations of SWE, conventional glaciological surveys and operational measurements of solid precipitation.
We investigate the application of weather radar data compiled by MeteoSwiss to estimate the amount and the spatial distribution of solid precipitation on glaciers in winter. To validate the time evolution of snowfall, we use a cosmic ray sensor (CRS) which directly measures the SWE of the snowpack. The CRS has shown a satisfying agreement with manual measurements (snow pits) taken over two winter seasons on the Glacier de la Plaine Morte in Switzerland. To expand the validation over several Swiss glaciers, we use end-of-winter glaciological surveys (snow pits, snow probings) provided by the Swiss monitoring network (GLAMOS). The advantage of the weather radar data is its spatial footprint with which we gain further insights on the snow distribution on glaciers, especially at high altitudes. Hence, we can show the usefulness of readily available weather radar data for the application in cryospheric studies.

1449
Quantifying Sublimation and Melt from Snow in the Semi-arid Andes

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Water is a critical resource in semiarid Chile, as the area supports more than 55% of the country's population, and the regional economy depends on agricultural production and mining, which are two industries that rely heavily on a consistent water supply. Despite the importance of snow cover for water resources in this region, there is currently a limited understanding of snow depth distribution and mass balance. Analysing relative ablation rates are critical for understanding snow depth sensitivity to variations in climate and simulating the evolution of the snow pack over a larger area and over time. This study aims to quantify melt and sublimation rates over a catchment during two contrasting years to determine the impact of El Niño and La Niña climatic modes on snow distribution and ablation. In this study, we model the snow cover evolution using a distributed snowpack model (SnowModel) in the instrumented watershed of La Laguna (3150-5630 m above sea level, 30°S), during 2014 and 2015. The model is calibrated and forced with meteorological data from seven Automatic Weather Stations (AWS) located in the watershed, and modeled WRF results. Temporal evolution of the simulated snow depth is validated using the snow depth measured at each AWS. The snow duration and snow cover extent are compared to MODIS and selected Sentinel-2 images. Results highlight the importance of accurately accounting for the precipitation forcing and the sensitivity to the chosen roughness length.

1318
Monitoring the Evolution of the Surface Snow on the East Antarctic Plateau

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The Antarctic Ice Sheet has a highly dynamical surface playing an active role in the exchanges of energy and mass between the atmosphere and the firn. The evolution of the surface geometry and snow properties are mainly driven by the local atmospheric conditions which in turn impacts the radiative and turbulent exchanges. This coupling results in feedback loops that can amplify or weaken the Antarctic response to global changes. Understanding the surface evolution is a major issue to address the prominent questions of the fate of Antarctic climate and ice sheet, the continental warming and the contribution to sea-level rise.
For nearly 10 years, we have been studying the surface and the upper snowpack at Dome C and on the East Antarctic Plateau. To this end, we have deployed automatic instruments, conducted intensive measurements during summer campaigns, organized long-term data collection in winter and participated to scientific traverses. The accumulated information concerns snow properties (SSA, density, temperature), surface properties (pictures, roughness) and snow accumulation. We found that the evolution of some variables (SSA or snow temperature) conforms to state-of-the-art model simulations while others (surface roughness or density) remain hard to explain using existing tools. This presentation will give an overview of the available observations, show the successful modeling simulations and discuss future developments needed to model Antarctic specificities.

1988
Modelling the Impact of Drifting Snow on the Surface Mass Balance of Adelie Land

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The transport of snow by the wind is an important component of the Antarctic surface mass balance (SMB) as drifting snow counts up for a large amount of snow ablation over the ice sheet. However, this process is frequently neglected in atmospheric models. Two simulations (one with drifting snow and one without) were performed at a resolution of 8 km with the regional climate model MAR forced by ERA-Interim, in order to assess the impact of drifting snow on the SMB of Adelie Land (East Antarctica) during the period 2002 - 2016. We evaluated results against field observations (including meteorological and snow skate measurements). Besides to better represent climate surface as airborne snow particles can sublimate and interact with the lowest atmospheric levels, the drifting snow simulation improves the modelled spatial distribution of the SMB and reduces the overestimation of the accumulation in comparison with MAR results without drifting snow.

SH-5a - Current and future change, sustainability and resilience in the Polar Regions
20.06.2018 09:00-10:30, A Sertig

5
Navigating the New Arctic: Trajectories of Change

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Because of Arctic amplification, the Arctic has been labeled the 'canary in the coal mine' or 'the frontline' of climate change. Rapid changes in temperature, ice and snow cover, and ecosystem distributions are leading to serious impacts on Arctic peoples. At the same time, these changes are inciting a "race for the North", with a range of industries showing increased interest the region. Low global oil prices, along with technological, geopolitical and security challenges, may render Arctic fossil fuel and mineral reserves economically nonviable for the foreseeable future, but industries such as freight, tourism and commercial fishing may benefit. Because of the high variability and concomitant low predictability of many components of the Arctic system in the near term, economic benefits have not accrued at the expected rate. Development trajectories remain highly contested. Safety and reliability concerns are ongoing. This confluence of opportunity and risk raises critical questions as to how well we understand the changing Arctic system on policy-relevant time scales. These questions will be explored through the lens of Arctic navigability.

199
Politics of Postcoloniality and Sustainability in the Arctic

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In the Arctic as elsewhere, there is no overall agreement on what exactly ´sustainability´ or ´sustainable development´ refer to. However, received discourses of the Arctic as a special place, characterized by a nature at once hostile and fragile, has empowered a distinct constellation of actors in the Arctic. For NGOs, indigenous peoples´ organizations, states, and companies ´sustainability´ implies different sets of opportunities and precautions. The paper reports the findings of a collaborative research project mapping sustainability narratives in the Arctic and analyzing the political consequences of sustainability becoming pivotal for politics in the region. Analysing sustainability as a concept that re-orders the relationship between society (identity), development (time), and nature (space) we find that: First, presenting one´s venture as contributing to sustainability has indeed become a precondition for participation in the negotiation of Arctic development and governance. Second, when sustainability meets the Arctic it changes meaning from a universal concern with a global ecosphere to a particular concern with a series of more limited environments (natural, cultural, societal, economic). Third, in practical governance and pragmatic discourse, cultural and societal sustainabilities often crowd out environmental sustainabilities. Fourth, sustainability is undergoing a transformation of meaning from being a concept that *limits* development to one that *allows* development to take place in the Arctic. Fifth, the variety of postcolonial configurations is central for understanding both the overall dynamics of the politics of sustainability and the variation across the Arctic.
Keywords: Sustainability, Postcoloniality, Political Theory, Arctic

545
Ground-scale Socioecological Interactions and Arctic Environmental Governance

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The changing landscape and economic relevance of the Arctic present a unique opportunity to monitor the change in interactions between people and the arctic nature as well as to shed light onto the funnelling of the existing at different scales environmental governance regimes to the local level and vice versa.
The work done within this framework attempted to understand and map ground-scale interactions between human and non-human actants (individual and community-based behaviour that can impact the environment especially if multiplied) in a case study conducted in Mys Kamenny, Yamal district, Russia, in 2017. Yamal is a region of rapid socioeconomic development undergoing noticeable climatic and geomorphological shifts. Individual and community level relationship with the environment especially of non-indigenous descent is often overlooked in assessments of environmental integrity, yet, it holds clues to the feedback loops between climate change, development and society.
The study found that using multiple tools to measure landscape change (e.g. GIS, interviews, fieldwork) relative to social and economic dynamics, individual behaviour and environmental regulation and enforcement can help better understand not only local but also generic ecological issues of the present day Arctic and draw insights from a close-up view to the environmental governance on a larger scale.

538
Resilience of the Antarctic Treaty System Beyond 2048

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In my presentation, I argue that it is the resilience of the Antarctic Treaty legal system nurtured and strengthened by the very members of its system over the past six decades that would effectively control within its manageable confines any future “manifestation of territorial pressures”, “international power plays”, and the potential reviews after 2048 of the operation of the Madrid Protocol, which prohibits mineral resource activities in the Antarctica.
After recapitulating the systemic resilience of the Antarctic Treaty System, which consists of an intricate balance between a few fundamental principles of unchanging nature and its flexibilities in adapting to the changing political and environmental landscape surrounding the Antarctic (Shibata 2015), I will re-examine the legal, political and environmental contexts within which the 1988 Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) was negotiated, agreed, and, because of the two claimant states' sudden change of policies, buried in oblivion. The external and internal accommodation the consultative parties at the time (1980s) endeavoured to achieve (and failed?) can serve as an interesting reference case when we consider the potential challenges the Antarctic Treaty System may face into the mid-21st century arising out of Antarctic resources.
Shibata, A. (2015): Japan and 100 Years of Antarctic Legal Order. 7 Yearbook of Polar Law, 1-51.

2275
Human Activity in the Ross Sea Region: A Temporal and Spatial Analysis

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With increasing human activity in Antarctica and the associated environmental pressures (such as non-native species incursions or protected area planning), there is a need to understand the scale of historic and current human activity on the continent.
Collating and harmonising data from various sources, we have developed a database of human activity within the Ross Sea region for the last 15 years. Data sources used to create the database account for tourism, science, and national operator activities within the region. This paper will utilise spatial analysis to explore how scientists, tourists, and base staff in Antarctica interact with the landscape. The paper will also highlight the various sources and methods used to access human activity data in the region.
We expect the database to enable the visualisation of the current and historic scale of human activity across the ice-free areas of the Ross Sea region and to assist in the management of the associated environmental pressures.

636
In the Footsteps of Visitors to the Ross Sea: Tracing Antarctic Tourism Patterns

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The last two decades have seen a rapid increase in Antarctic tourism numbers and a proliferation of Antarctic tourism research. Most of the growth in visitor numbers has occurred in the Antarctic Peninsula, which receives over 95% of all Antarctic tourists, and consequently much of the scholarly literature on Antarctic tourism focuses its attention to the particularities of tourism in this region. It is less well known that the Ross Sea region has been visited semi-regularly by commercial tour operators since the mid-1960s and annually since 1990. Tourism in the Ross Sea is concentrated on a dozen sites, out of just over 50 different visitor sites, and generally involves expedition cruising. While anecdotal accounts of tourism operations in the Ross Sea have shed some light on tourist experiences in this part of the world, no systematic analysis has been undertaken of tourism patterns in the Ross Sea over time.
In this paper, we present the results of a comprehensive study of tourism activities in the Ross Sea region and, using GIS-based analysis, discuss the changing footprint of Antarctic tourism in the Ross Sea over the last 50 years. This study forms one component of two larger integrated research programmes that aim at understanding the interconnected natural processes and human impacts that (re-)shape ecosystems in the Ross Sea in order to inform environmental management.

GG-2d - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
20.06.2018 09:00-10:30, A Schwarzhorn

1958
East Antarctic Ice Sheet Dynamics Inland of Shackleton and West Ice Shelves

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Geological constraints of former ice extent are very limited in the interior of East Antarctica, particularly in areas near deep subglacial basins. Not surprisingly, the absence of empirical constraints mean these areas also contain some of the most divergent models of both modern Glacio-Isostatic Adjustment (GIA), and projections of future ice loss from the continent. To improve this situation, we have collected records of past ice sheet geometries along flowlines from inland to coast in the poorly explored regions inland of the Shackleton and West Ice Shelves. Here, isolated nunataks in the middle of subglacial basins, and mountain ranges flanking outlet glaciers draining deep basins provide a rare opportunity to improve our understanding of the influence of subglacial basins on past ice dynamics.
In this presentation we will detail results from field observations collected since 2015/16 and an initial tranche of ^{10}Be exposure ages from inland outcrops in this area. Preliminary results suggest limited change in elevation during the LGM along the upper Denman Glacier, along with a substantive recent (potentially late Holocene) retreat close to the modern grounding line. We will discuss the significance of former ice sheet surface elevations in the context of existing models of GIA, present day ice loss, and the role of sub-glacial topography ice dynamics from a significant outlet of the Aurora Subglacial basin.

881
New Records of Holocene Glacial Fluctuations from Victoria Land, Antarctica

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Antarctic ice sheets represent the largest reservoir of melt water in a warming climate. Yet the most important and dynamic portions of these large systems have only been observed for ~50 years, since the beginning of the satellite era. Using geological dating techniques and focusing on outlet glaciers, the observational record can be extended 100-fold, from decades to millennia. By extending the observational range we can illuminate past changes in coupled ice-climate systems and infer their future response and related sea level change in a warming climate.
To more fully understand the nature of these important coupled ice-climate systems, surface-exposure dating of rocks adjacent to outlet glaciers can provide insight to the style and rate of change for outlet glacier surface-elevation through time. Sampling campaigns in Victoria Land have produced robust, high-resolution age-elevation transects for two glaciers draining East Antarctica along the Transantarctic Mountains.
We present 33 new ^{10}Be ages from Mawson and Tucker Glaciers. These new ice surface elevation chronologies directly constrain the style, rate, and magnitude of change for two outlet glaciers; and provide critical insight to Holocene ice-load history in Victoria Land. Both age-elevation profiles show rapid significant thinning of outlet glaciers during the Holocene. These data are critical analogues for modelling the response of present and future ice-climate systems in a warming world.

1374
Deglacial History of the Western Ross Sea since the Last Glacial Maximum

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Retreat of grounded ice in the Ross Sea since the LGM provides valuable insight into marine ice sheet stability and response to environmental change. Here, we present 10Be exposure ages from glacially transported erratics from South Victoria Land to gauge past extent and timing of retreat. Ages from Skelton Névé indicate the ice surface was between 50 and 106 m higher than present during the LGM. The ice surface elevation remained close to its maximum extent prior to 19.1 ka and lowered by at least 50 m since ~15.0 ka. These results suggest that ice sheet thinning in the Skelton Névé coincided with meltwater pulse 1A (MWP-1A). However, the thinning did not make a significant contribution at this time. Thinning continued after 9.7 ka at Skelton Glacier and data from southern McMurdo Sound reveals a late-glacial and Holocene deglaciation chronology. This is consistent with studies suggesting that EAIS outlet glaciers that drained into the western Ross Sea experienced most mass loss during the early to middle Holocene. This chronology coupled with sediment provenance define a two-stage ice flow scenario for McMurdo Sound. The thinning and pattern of retreat is likely to be in response to retreat of the grounded ice in the Ross Embayment causing a reduction in buffering of the Skelton Glacier and gravitational draw down into the Ross Sea.

1710
Variability in Sediments Deposited at a Retreating ice Stream Grounding Line

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Understanding the future response of ice streams and glaciers to climate change is of high importance but remains uncertain, due to the limited timescales over which we have recorded observational and satellite data. Sedimentary sequences, deposited on polar continental shelves during past episodes of ice sheet advance and retreat, can be used to improve our understanding of long term changes. Past studies on marine sediment cores have typically identified three sediment facies assemblages; sub-glacial, transitional and open marine. Transitional sediment facies, deposited proximal to the ice stream grounding line, have the potential to capture the ice-proximal environment and processes taking place during deglaciation; thus providing an insight into the cause and style of ice stream retreat. Despite the development of depositional models to help explain the processes occurring at grounding lines, there is still uncertainty about the variability in sediments deposited in this environment. Here we use a multi-proxy approach on marine sediment cores recovered from the Anvers-Hugo Palaeo-Ice Stream Trough, western Antarctic Peninsula shelf, to identify the variability in transitional sediment facies deposited along and across the trough. Our data reveal systematic variability in the types and volume of transitional sediments, resulting from changes in retreat rate, bathymetry, thermal regime, grounding line oscillations and the evolving nature of the ice margin over deglaciation.

973
Retreats of Ice Sheet/Ice Shelf Driven by Warm Water Incursions in the Ross Sea

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The stratigraphic data provide direct evidences and opportunities to address questions concerning retreat history of the Ross Ice Sheet and Ice Shelf, but there are significant uncertainties in the chronologies and interpretation. Here, we present and compare stratigraphic records of several sediment cores dredged from the continental shelf and slope of the Ross Sea. The sedimentological and geochemical records reveal the Circumpolar Deep Water (CDW) upwelled, mixed with more surface waters and contained higher oxygen since the Last Glacial Maximum (LGM), while sedimentary facies and paleoenironmental proxies indicate synchronous and rapid retreats of (ice sheet) grounding-line and (ice shelf front) calving line occurred on the continental shelf especially during Holocene. The stability of marine-based margins of the Antarctic Ice Sheet was evidently controlled by postglacial warm deep-water incursions onto the shelf in the past. Thus, it can be inferred that the ice sheet and ice shelf in the Ross Embayment will melt and retreat faster, or even disastrously collapse and disappear in the future with more incursions of much warmer water in a continuously warming world.
Keywords: Ross Sea, continental shelf and slope, paleo-records, retreats of ice sheet and ice shelf, warm water incursions, since the Last Glacial Maximum

1056
Ice Sheet Instability in the Western Ross Sea during the Last Glacial Maximum

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Last Glacial Maximum (LGM) deposit in the western Ross Sea is represented by glacial diamicton facies, and with an absence of sediment facies other than diamicton, it has been assumed that thick ice sheet was extended to the outer shelf and was grounded to the sea floor during the LGM. However, we cannot preclude the possibility that the ice sheet did not remain stable in the western Ross Sea, considering the unstable nature of a marine-based ice sheet, presence of deep Drygalski Trough that makes warm water-intrusion easier, and sporadic warm climate events such as AIM2 during the LGM.
Here we show that diatomaceous mud layers underlie diamicton in cores collected from the Southern Drygalski Trough (SDT), indicating there was an open marine environment prior to the latest glacial event in the western Ross Sea. Ramped PyrOx (RP) 14C dating on the diatomaceous mud revealed that ice sheet on the western Ross Sea retreated at ~26.6 ky BP (all ages here are uncorrected ^{14}C), and the SDT remained ungrounded until the latest ice sheet advanced at ~20.8 ky BP. The latest ice sheet retreated from the SDT at ~8.7 ky BP. This chronology is remarkably consistent with previous RP ^{14}C ages on glacial and deglacial successions from condensed sections on the open Ross Sea. Combined with a result from the eastern Ross Sea implying an earlier retreat of ice sheet prior to the LGM, it is possible that large areas of the Ross Embayment remained ungrounded during the global LGM period.

TE-3d - Remote sensing of polar regions
20.06.2018 09:00-10:30, A Seehorn

13
Regional Geology Mapping Using Satellite-Based Remote Sensing Data in Antarctica

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Satellite remote sensing imagery is especially useful for geological investigations in Antarctica because of its remoteness and extreme environmental conditions that constrain direct geological survey. The highest percentage of exposed rocks and soils in Antarctica occurs in Northern Victoria Land (NVL). Exposed Rocks in NVL were part of the paleo-Pacific margin of East Gondwana during the Paleozoic time. This investigation provides a satellite-based remote sensing approach for regional geological mapping in the NVL, Antarctica, focusing on the Bowers terrane with high potential for hosting orogenic gold mineralization. The Landsat-8 and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) datasets were used to extract lithological-structural and mineralogical information. Several new spectral-band ratio indices were developed using Landsat-8 and ASTER bands and proposed for Antarctic environments to map spectral signatures of snow/ice, iron oxide/hydroxide minerals, Al-OH-bearing and Fe, Mg-O-H and CO3 mineral zones, and quartz-rich felsic and mafic-to-ultramafic lithological units. The new spectral-band ratio indices were tested and implemented to Level 1 terrain-corrected (L1T) products of Landsat-8 and ASTER datasets covering the NVL. The new spectral-band ratio indices are especially useful for geological investigations in inaccessible locations and poorly exposed lithological units in Antarctica environments.

1153
Application of Navigation System for the Vessels Sailing in the Sea Ice Area

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Sea ice is an important factor affecting vessels navigation in the polar ocean. The University of Bremen, NSIDC and other agencies released the sea ice concentration and thickness of products etc.. In addition, such as visible light, SAR remote sensing data can provide data support for vessel navigation. So, how to apply these data in the best way to provide navigation guidance for vessels in the sea ice area? We use the combination of GIS, remote sensing and big data technology to realize the application of sea ice data in the vessel terminal. At the same time, the path planning of vessel sailing is realized by using visible light, SAR and other data. China Snow Dragon vessel equipped with a satellite receiver system, it can receive real-time data, such as MODIS and HY-2A remote sensing data. These data can be used to provide remote sensing monitoring products and wind products for the vessel, so as to ensure the navigation safety of vessel in the sea ice area.

1271
Late Winter Snow Thickness Estimation from Early Summer Melt Pond Fraction

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It is of great interest to understand the snow thickness variability in the Arctic to understand the geophysical properties at the ocean-seaice-atmosphere interface. The radiative and thermal properties of snow significantly affect the sea ice growth and decay. Moreover, presence of snow cover on sea ice plays a crucial role in satellite-based sea ice thickness retrievals. Prior research reported that, during summer melt, thin snow cover leads to dominant surface flooding (larger pond fraction), whereas thick snow cover leads to a greater fraction of snow patches (smaller pond fraction). Thus, summer measurements of melt pond fraction can be utilized as a proxy to estimate relative winter snow thickness. In order to quantify regional-scale melt pond fraction, aerial photography surveys were conducted in 2012, near Cornwallis Island, Nunavut. Polarimetric parameters and polarimetric texture parameters of winter RADARSAT-2 SAR fine quad-pol images were analyzed at different incidence angles, to estimate the relationship between the winter backscatter from snow cover on first year sea ice and early summer melt pond fraction, to predict late winter snow thickness. Our results indicate that the regression models derived from the most significant polarimetric and texture parameters provide better prediction to estimate the winter snow thickness variability and snow topography.

1741
Comprehensive Monitoring of Polar Land Ice by Sentinel-1

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The Sentinel-1 acquisition planning for polar regions provides nearly uninterrupted observations of the Greenland Ice Sheet margin, key regions in Antarctica and other polar ice masses. The dual satellite constellation has thereby changed the landscape for satellite earth observation entirely, providing excellent opportunities for operational monitoring of key climate variables like ice velocity (IV) and glacier discharge. Continuous coverage is now extended to include most of the Antarctic margin, allowing retrieval of dense time series of ice flow for major outlet glaciers hitherto only sparsely observed.
We developed a system for IV retrieval and discharge monitoring, applying advanced iterative offset tracking, utilizing repeat pass Sentinel-1 SAR. Generated IV maps compare well with those derived from other high-resolution sensors and provide detailed coverage even in regions with high accumulation and fast flow. Combined with ice thickness from RES, the maps form the basis for studying glacier dynamics, ice discharge and mass balance.
Including the latest observational data, we present IV maps of Greenland, Antarctica and smaller ice caps highlighting time series of IV fluctuations of major outlet glaciers. We demonstrate how IV and discharge varies over time scales ranging from days to years and between adjacent basins. Continuous monitoring of the polar regions, exploiting both satellites, is ongoing to detect changes of ice flow as indicators of climate change.

1774
PIPERS: Preliminary Analysis of Satellite Radar Imagery from Terra Nova Bay

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Satellite images provide the opportunity to differentiate different ice units in and around the Terra Nova Bay Polynya (TNBP) in the Ross Sea (Antarctica) on different spatial scales. However, at a first stage, the separation of units is usually be carried out in terms of radar signature variations, i. e. the result are “radar units” with statistically significant signature differences. In a second step, the radar units have to be linked to observations in the field in order to enable a geophysical interpretation of the stage of polynya development and the sea ice conditions around the polynya. In this specific analysis we focus on the first step. The radar imagery acquired over the TNBP comprises data from TerraSAR-X strip-map dual-polarization (HH, VV) mode, TerraSAR-X ScanSAR mode (HH-polarization), Sentinel-1 extra wide-swath mode (HH and HV polarization), and Sentinel-1 interferometric wide-swath mode (HH-polarization). Dependent on the temporal gap between image acquisitions it is possible in some cases to produce layer stacks including different imaging modes. We use different segmentation methods (such as e. g. Support Vector Machine) to arrive at a map of different radar units with only small overlaps of their radar signatures (i. e. significant discernibility). The goal is to generate a temporal sequence of radar unit maps, which in the second step in collaboration with the PIPERS team can be related to ground data gathered in the field.

1926
High-resolution Mapping of Streams and Moulins on the Greenland Ice Sheet

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Increasing surface melting on the Greenland ice sheet and rising sea level have heightened the need for understanding the complex pathways transporting meltwater from the ice sheet surface to the ice edge and the ocean. Supraglacial streams abundantly cover the western ablation zone throughout the melt season, transporting large volumes of meltwater into moulins and to englacial and subglacial networks before entering the ocean. However, current regional and global model projections of meltwater runoff from the GrIS do not incorporate this hydrological process. This knowledge gap is due to the lack of observations of meltwater transport off the surface of the ice sheet and into the ocean. Furthermore, current ice sheet watershed models lack the ability to determine actual flow paths on the ice because terrain-modeled networks cannot account for the presence of moulins without observations from satellite imagery. In this study, we map supraglacial stream networks and moulin termination points using high-resolution WorldView-1/2/3 satellite imagery from 2012 and 2015. These image-extracted features are also combined with a high-resolution digital elevation model (ArcticDEM) to model ice sheet watersheds.

OS-2a - Interdisciplinary research on sea-ice biogeochemistry and associated ecosystems 20.06.2018 09:00-10:30, A Wisshorn

497
Carbon Flux in Ice Algae-fuelled Food Webs of the Arctic and the Antarctic Ocean

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Climate-driven changes of sea ice habitats are impacting large parts of the Southern Ocean and virtually the entire Arctic Ocean. At the same time, we have only just begun understanding the importance of sea ice for the functioning of Polar ecosystems. Within the *Iceflux* project, we analysed the structure of ice-associated and planktonic communities in Arctic and Antarctic ecosystems in relation to habitat properties. Using isotopic and biochemical trophic marker analysis, the dependency of sea-ice fauna and zooplankton on ice algae-produced carbon was estimated. Our results show that sea ice properties were a key driver of community structure in both Polar Oceans. Certain abundant metazoan species were highly dependent on ice algae-produced carbon. Based on the consumption rates of these species, differences in the proportional trophic carbon flux from see ice into the pelagic food web were investigated between the Arctic Ocean and the Southern Ocean. Effects of declining sea-ice habitats on the food web structure in both Polar Oceans will vary seasonally and regionally, with winners who can adapt to new carbon sources and losers facing increasing difficulties to obtain resources and complete their life cycles. Due to the close linkage of central carbon transmitters with sea ice (polar cod in the Arctic and Antarctic krill in the Southern Ocean), sea ice decline may lead to disruptions of ecosystems until a new equilibrium is found.

1722
The Role of Mixotrophic Algae in Sea Ice Ecosystems

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The finding of heterotrophic carbon uptake in diatoms has challenged the representation of algae as pure autotrophs in current ecosystem models. Mixotrophy as adaptation to nutrient or light limitations, both typical conditions in sea ice ecosystems, have been described. Thus, it is not surprising to find living algae in the polar night, but the survival strategies remain speculative. For describing the importance of mixotrophy in sea ice algae, a variety of methods are applied. Multiple omics approaches are used for a molecular understanding of the metabolic processes involved. Metagenomics and Metatranscriptomics data are integrated and the potential for organic matter degradation in diatoms explored. Stable isotope probing experiments are used to estimate fluxes of dissolved organic matter uptake in algae under varying light conditions. The potential for phagotrophy is explored via fluorescent in situ hybridisations and feeding experiments with fluorescently labelled sea ice bacteria. All data will be integrated into a dynamic phytoplankton growth and photoacclimation model and the implications for bacteria-algae interactions and higher trophic levels discussed.

1309
Windows in Arctic Pack Ice: The Role of Leads for Algal Blooms

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Changes in the Arctic icescape include higher light availability for primary producers due to declining and thinning ice pack. In addition, the increasing dynamics of the thinner ice pack may result in higher ice deformation rates and more open water areas (leads) covered by new thin ice with higher light transmittance. Both the detailed light climate and the algal response to it require further studies. During the Norwegian young sea ICE expedition (N-ICE2015) in spring 2015 we studied the implications of thinner ice in leads, which enabled development of a phytoplankton bloom beneath the otherwise opaque ice cover - transmittance through the snow-covered thick ice was < 0.3 %, whereas up to 40 % of incoming light penetrated through the studied refrozen lead. Yet, ice algal biomass in the lead ice did not exceed that of the surrounding thicker and older ice over the lifetime (1 month) of the lead, suggesting that ice algal growth was not only a function of increased light availability. We discuss potential controlling factors, including high-light acclimation indicated by high concentrations of ultraviolet-protecting mycosporine-like amino acids (MAAs), and time needed for recruitment. The ice algal community shifted from dominance of flagellates towards dominance of pennate, ice-adapted diatom species. In summary, our results suggest that high-light environments like young ice benefit under-ice phytoplankton blooms but might not boost ice algal production per unit area.

2060
Phaeocystis versus Diatoms Blooms in the Ice Covered European Arctic

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The Arctic Ocean is one of the key regions where the effects of climate change are most pronounced. Massive reductions in sea ice thickness and extent are anticipated to cause large changes in the Arctic ecosystem. Two comprehensive expeditions in 2015, the Norwegian young sea ICE expedition (N-ICE2015) from January-June and the Transitions in the Arctic Seasonal Sea Ice Zone (TRANSSIZ) cruise from May-June carried out ecological and biogeochemical process studies during ice floe drift experiments and shelf-to-basin sampling across the European Arctic margin and on the Yermak Plateau. As previously reported, a *Phaeocystis* under-ice bloom was observed over the south-eastern Yermak Plateau, while the north-western Yermark Plateau was characterized by deep mixed layers associated with low standing phytoplankton stocks and weak productivity. In contrast, a large diatom bloom dominated by various *Thalassiosira* and *Chaetoceros* species, was observed over the continental slope further east. The diatom bloom was found above the core of the Atlantic water boundary current, concurrent with enhanced dissipation and large diapycnal heat fluxes into the mixed layer. Highlights from these contrasting bloom scenarios will help to improve our understanding of ecosystem functioning and predictions of the potential annual primary production in a rapidly changing Arctic Ocean.

1164
Impact of Ice Algae and under-ice Phytoplankton on the Marine Carbonate System

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Past research has suggested that ice algae play a role in reducing surface water dissolved inorganic carbon (DIC) during spring, pre-conditioning surface waters to low dissolved CO_2 (pCO_{2sw}) and uptake of atmospheric CO_2 during the ice free season. The potential role of under-ice phytoplankton blooms in this seasonal cycle has generally not been considered. The objective of this study was to look at trends in the inorganic carbon system in the upper water column under sea ice from early spring to ice melt onset near Qikiqtarjuaq, NU. Sample collection started midway through an ice algae bloom, and continued until the early stages of an under-ice phytoplankton bloom. During most of the ice algae bloom period we observed a slight increase in DIC and pCO_{2sw} in the top 5m of the water column, as opposed to the expected reduction in those parameters. Although it is possible that substantial pCO_{2sw}/DIC drawdown was missed at the initiation of the ice algae bloom, biomass calculations show that previous studies may have overestimated the role of ice algae, and that this null result may be widely applicable. Following the formation of melt ponds, we observed a rapid phytoplankton bloom in the upper 25 m of the water column that did dramatically reduce DIC and pCO_{2sw}. We conclude that under-ice phytoplankton blooms may be the most important biological mechanism predisposing the Arctic surface mixed layer to act as a CO_2 sink in the open water season.

2066
The Dependence of Sea Ice Algal Production on Conditions of Sample Melt

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The influence of algae on sea ice biogeochemical conditions is a significant aspect of sea ice flux and ecosystem modeling. Accurate estimates of sea ice algal productivity and responses to environmental change are particularly important in light of shifting Arctic sea ice conditions. The foundation of production estimates in such studies historically, and at present, often relies on the melt of ice samples prior to incubation. The specific procedure varies between studies, particularly the duration of melt and whether samples are buffered for changes in salinity. In this study we combine field and laboratory measurements to comprehensively investigate the impact of melt procedure on the gross production and photophysiology of sea ice algae, and demonstrate the potential for scientific protocols to contribute to variability of estimates reported across the Arctic. We found that estimates of productivity are likely artificially enhanced or reduced in individual studies depending on melt conditions, including: duration of melt, volume of filtered seawater added, and temperature. Recommendations for best practices in melting ice samples for biogeochemical studies is provided.

CR-3b - Cryosphere-Hydrosphere interactions: The water cycle at the three Poles
20.06.2018 09:00-10:30, B Parsenn

223
Variability and Trends in Arctic Snow Cover

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Determining robust trends in Arctic snow cover with quantitative uncertainty estimates is required to better constrain impacts on the climate system, the freshwater budget of the Arctic, and impacts of changing snow cover on vegetation, biogeochemical activity, exchanges of carbon dioxide and trace gases, and ecosystem services. In this study, we determine the spread in Arctic seasonal snow cover extent (SCE) and snow water equivalent (SWE) trends from multiple sources. The NOAA snow chart Climate Data Record (NOAA-CDR), dating back to 1967, shows dramatic reductions in Arctic spring SCE, particularly since 2005, and a positive trend in fall SCE. Trends derived from five other sources of snow information, including surface observations, passive microwave satellite data and land surface models (with snow schemes of varying complexity) driven by modern era reanalyses (from various reanalysis centres) identify weaker reductions in spring SCE compared to NOAA-CDR, along with a loss of fall snow cover. SCE trend sensitivity to surface temperature forcing is anomalous for the NOAA-CDR compared to other data sets for the months of October, November, May, and June, and so should be interpreted with caution in these months. Trends in maximum pre-melt SWE over the 1981 - 2016 period are negative when the Arctic is considered as a whole, but considerable regional and inter-dataset variability in the spatial patterns of change limit the confidence in these trends.

952
Arctic Snowfall from CloudSat Observations and Reanalyses

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While snowfall likely has a major contribution to the Arctic amplification, available state-of-the-art climatologies still significantly disagree. We will present a satellite-based characterization of snowfall in the Arctic using CloudSat data, and compare with and between various other climatologies. First, we examine the frequency, phase and rate of snowfall from CloudSat over 2007-2010. Then we compare with ECMWF (European Center for Medium Range Weather Forecast) Interim reanalysis (ERA-I), Arctic System Reanalysis (ASR) and Global Precipitation Climatology Center Monitoring Product (GPCC MP). Similar general patterns are observed in all datasets. Yet, significant mean snowfall rates differences are found over continents between 58° and 82°N between ERA-I (155 mm/an), ASR (197), GPCC MP (156) and CloudSat (210). These differences are larger between CloudSat (317 mm/an) and GPCC MP (181 mm/an), and larger overall over Greenland. In spite of its limitations, CloudSat clearly contributes to a better characterization of snowfall in the Arctic.

959
From the Clouds to the Ground - Snow Precipitation Patterns in Complex Terrain

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Snow accumulation patterns are determined by many different processes from ice crystal nucleation in clouds to snow redistribution by wind and avalanches. In between, snow precipitation undergoes different dynamical and microphysical processes, such as ice crystal growth, aggregation and riming, which determine the growth of particles and thereby influence the intensity and structure of the snowfall event. In alpine terrain the interaction of different processes and the topography may lead to orographic enhancement and preferential deposition of precipitation.
To better understand the relative importance of different pre-depositional processes on snow precipitation we analyze three snowfall events between January and March 2016 in Davos (CH). Snow precipitation patterns from MeteoSwiss operational weather radar measurements on Weissfluhgipfel and very high resolution Weather Research and Forecasting (WRF) model simulations show reasonable agreement with measurements from automatic weather stations. Overall, radar precipitation patterns show higher small scale variability compared to WRF simulations. Two-dimensional autocorrelation maps and variograms of precipitation patterns reveal a strong dependence of radar and WRF precipitation on topography and the prevailing wind direction, which emphasizes the importance of large-scale orographic enhancement on regional scales and small-scale topography-wind interactions on a mountain ridge scale.

1865
The Required Model Resolution for Resolving the SMB of the Greenland Ice Sheet

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For reliable estimates of past, current and projected mass changes of the Greenland Ice Sheet and its peripheral glaciers and ice caps, the surface mass balance (SMB) must be determined with sufficient spatial detail, which could be carried out with a global or regional climate model or statistical downscaling. This raises a number of questions: Which resolution is sufficient? Which method is appropriate for the SMB refinement at this resolution? Can we assess which method is most accurate?
In order to answer these questions, the regional climate model RACMO2.3 is run at 4 different resolutions ranging from 2.2 to 60 km for South Greenland. The results of these runs are statistically downscaled. Analysis of the downscaled products from various model resolutions shows that statistical downscaling improves the estimates of runoff and hence of SMB compared to interpolation, but has no beneficial effect on the other SMB components. From the comparison with observations it can be concluded that 20 km resolution is sufficient to represent the ice sheet accumulation zone. In the ablation zone, RCMs outperform statistical downscaling although the performance gain per grid refinement factor decreases for finer resolutions. Furthermore, we show that for RCMs run at resolutions finer than 20 km, snow pack initialization, snow model tuning and cloud physics are of equal importance for the quality of model results as resolution.

2506
Model-observed Runoff along the West Greenland Ice Sheet

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Despite the increasing importance of ice sheet surface ablation in Greenland's sea-level contribution, a quantitative inter-comparison between modeled and measured meltwater discharge across multiple drainage basins is conspicuously lacking. Here we investigate the accuracy of model discharge estimates from the Modèle Atmosphérique Régionale (MAR) regional climate model by comparison with in situ proglacial river discharge measurements at three West Greenland drainage basins - North River (Thule), Watson River (Kangerlussuaq), and Naujat Kuat River (Nuuk). At each basin, we:
1) determine optimal drainage basin delineations;
2) evaluate MAR at daily, 5-, 10- and 20-day time scales; and
3) identify potential sources for model-observation discrepancies by analyzing model bias relative to data from automatic weather stations.
Our results reveal that daily discharge is best captured by MAR across the Watson basin, whilst there is lower correspondence between modeled and observed discharge at the Thule and Nuuk basins. Model agreement with observed is reduced during periods of peak discharge, but is improved at the Thule and Nuuk basins over longer time scales. Our study highlights the importance of reducing MAR overestimation of surface albedo and warm bias in near surface air temperature, underestimation of cloud cover representation, and adding more realistic runoff delay functions to reduce model error and to improve prediction of Greenland's contribution to sea level rise.

2510
From Slope-scale Snow Processes to Hydrologic Response: A Validation of *Alpine3D*

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Snow modeling in mountainous areas remains a challenge because of the numerous processes affecting the mass and energy balance. In this study, we examine the influence of snowmelt on the hydrological response of the Dischma river basin, a high-alpine catchment of 43.2 km^2 in Switzerland. Based on recent developments in *Alpine3D*, we study the influence of snow distribution and liquid water transport within the snowpack on runoff dynamics. We show the added value of a more realistic snow distribution by comparing our results with multi-scale observations (snow lysimeter, distributed snow depths and streamflow). At the plot scale, snowpack runoff is well simulated when the initial (peak of snow season) mass balance errors are small, which is achieved with a precipitation scaling approach. At the sub-basin scale, a more realistic snowpack leads to a faster runoff pulse originated in the shallower areas while the melting period is extended by a month with snowmelt coming from deeper areas. The hydrological response at the basin scale is also enhanced by the more realistic snowpack, even though calibration processes smoothen the differences. The added value of a more complex liquid water transport scheme is obvious at the site scale but decreases at larger scales. Our results highlight not only the importance but also the difficulty of getting a realistic snowpack distribution even in a well-instrumented area and present a model validation from multi-scale observations.

BE-6a - Ongoing change in terrestrial and freshwater ecosystems of Polar Regions
20.06.2018 09:00-10:30, B Jakobshorn

1326
Arctic Freshwater Plankton Response to Environmental Stressors

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Arctic freshwaters are facing a number of environmental pressures, including rapid climate change that affects both the formation and loss surface waters, along with changing biogeochemistry of these waters. Freshwater plankton assemblages are expected to reflect the impacts of these stressors through shifts in productivity and species composition. This paper examines spatial and contemporary trends in phytoplankton and zooplankton biodiversity throughout the circumpolar Arctic. We have analyzed contemporary (1950-present) data of abiotic variables and plankton diversity collected from more than 400 Arctic and subarctic lakes in USA, Canada, Greenland, Iceland, Faroe Islands, Norway, Sweden, Finland and Russia using various univariate and multivariate analysis techniques. Based on our findings we will establish contemporary baselines for future comparisons of plankton communities in the Arctic region. We will evaluate patterns in biodiversity and environmental stressors to allow discussion of current and future responses to environmental pressures on Arctic plankton communities. We will also discuss the implications our findings have for the future monitoring.

352
Exploring Patterns of Diatom Assemblages from Circumpolar Arctic Lakes & Streams

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The assessment of spatial and temporal trends in Arctic freshwater biota and their physical and biogeochemical habitat in response to a warming climate requires a large-scale harmonized monitoring program. The presented work, performed by the freshwater group of the Circumpolar Biodiversity Monitoring Plan (Arctic Council: Conservation of Arctic Flora and Fauna), is one of the first steps towards such a harmonized monitoring program. Using circum-Arctic diatom assemblage data, specific goals of this study include:
1) establishing current and pre-industrial environmental conditions as reference points to guide future environmental monitoring programs, and
2) understanding the historical context of diatom distributions.
Large-scale assessments of diatom distributions in Arctic regions are currently scarce, and detailed taxonomic studies tracking species compositional changes in both lakes and streams have yet to be undertaken. We used contemporary stream and lake data from ongoing monitoring programs, spot data from research projects, as well as surface sediment (modern) diatoms from paleolimnological studies to provide a spatial assessment of species distributions of the circum-Arctic region. Additionally, we analysed a large set of dated and “top-bottom” paleolimnological records to better describe historical background conditions on a circum-Arctic scale.

1854
Landscape Filters as Drivers of Arctic Benthic Macroinvertebrate Biodiversity

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The concept of landscape filters allows us to test hypotheses about environmental driver-biological response relationships by examining the relative importance of drivers at different spatial scales. Across the Arctic, differences in warming rates, human development, and biogeography may be expected to contribute to differences in the relative importance of variables at different spatial scales. For example, in regions where large-scale variables, such as climate, have already had an effect on community structure: Are regional patterns of benthic assemblages more strongly associated with small-scale structuring variables such as water chemistry and substrate? This paper explores driver-response relationships across different spatial scales (i.e., both latitudinal and longitudinal) to determine whether similar patterns are evident among the sub-, low-, and high-Arctic across the circumpolar region. Specifically, the response of benthic macroinvertebrate assemblages to landscape filters across latitudinal gradients is used as a proxy for predicting shifts in biological pattern as a result of climate change. Moreover, longitudinal contrasts with respect to the importance of climate-related variables on biological pattern has implications for the importance of warming history across the circumpolar region, particularly when projecting risk for those areas that have experienced less warming.

1435
Trends in Biodiversity and Environmental Etressors in Fennoscandian Arctic Lakes

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Arctic lakes in Fennoscandia are experiencing rapid environmental changes resulting from human activities, large-scale oligotrophication, and climate change. These stressors are expected to alter both abiotic variables and biodiversity, i.e. communities of benthic invertebrates, algae, zooplankton, water plants, and fish. We compiled a data set for 74 selected Arctic/alpine lakes in Norway, Sweden and Finland and analyzed their spatiotemporal trends using both univariate and multivariate analyses. Multiple indicators will be used to assess biodiversity trends that are hypothesized to associate with spatial and temporal abiotic changes, and to identify regional biodiversity hotspots. Findings from this study will provide the basis for regional impact assessments for Fennoscandian Arctic lakes and establish contemporary abiotic and biotic baselines for future comparisons. The work is done in the framework of the Circumpolar Biodiversity Monitoring Group under the Convention of Arctic Flora and Fauna (CAFF).

2633
Aquatic Ecosystem Change in High Arctic Catchments due to Permafrost Change

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Understanding how climate-induced permafrost changes will alter riverine and lacustrine environments is critical to develop accurate predictions of how aquatic ecosystems will respond. We assess the impact of recent climate and permafrost perturbation on the hydrochemistry, nutrient transport and downstream aquatic ecosystem in paired catchments at the Cape Bounty Arctic Watershed Observatory ((75°N, 109°W; CBAWO) in the Canadian High Arctic between 2003-2017.
There has been a sharp increase in solutes in the lakes at CBAWO, and sulfate has notably increased 380-500%. River fluxes have similarly increased, exemplified by dissolved inorganic nitrogen fluxes. These hydrochemical and nutrient fluxes are interpreted to be associated with deep thaw and mobilization from the upper permafrost. Fish condition factor has improved steadily during the observation period and otolith analysis indicates that fish show abrupt geochemical changes associated with solute loading. Diatoms show a shift to small planktonic species in the past decade, suggesting primary productivity has responded to climate amelioration, ice cover, and river fluxes.
Our results from CBAWO indicate that climate-induced permafrost changes can impart rapid changes on High Arctic aquatic systems, and indicate that an integrated approach to predicting aquatic responses to environmental forcings will be necessary to predict future changes.

2294
Effects of Environmental Change on Signy Island Terrestrial Algae Diversity

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The terrestrial algal microflora of Signy Island (lat. 60° 43'S) has been sporadically studied since the 1960s. The first extensive report is that of Broady, investigating the microalgae diversity in the late 1970s from 122 samples including two Signy Island Reference Sites. The island has changed markedly since then under the influence of trends of rapid regional climate change. In 2016 we re-visited and re-examined in detail the diversity of the terrestrial microalgae at locations on Signy Island previously studied by Broady. Polyphasic assessments conducted to date indicate changes in the microflora community over the four decades between surveys. Morphological features observed in the new material suggest either the presence of species/strains not previously recorded at specific sites, or the expression of phenotypic plasticity in response to the environmental changes experienced. We also found morphospecies that were absent from previous records to be present in a number of sites, in some cases with high abundance. Increased understanding of past and present diversity and distribution of microalgae on Signy Island will support conservation of the indigenous biota and aid future research on ecological processes, including consequences of environmental change.

1199
A Critical Evaluation of NorESM1 to Understand Aerosol Effects on Arctic Climate

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Previous studies using the earth system model NorESM1 show that changing SO_2 emissions in various regions in the northern hemisphere mid-latitudes result in significant temperature responses in the Arctic. Evidence so far suggests that in NorESM1, amplified Arctic surface temperature response is obtained despite a weak sea-ice albedo feedback and without significant aerosol-induced changes in cloud properties in the Arctic.
This work aims at gaining a process understanding of the Arctic temperature response to mid-latitude emission changes both in the real world and in the model. To this end, we evaluate aerosol size distributions, cloud properties, and other entities in NorESM1 against remote and in-situ observations at high latitudes. Furthermore, results are compared to a newer version of NorESM1 including improvements of the sea ice model, convective transport and nucleation of aerosols to identify critical processes affecting Arctic climate.
A preliminary comparison between the NorESM1 output and in-situ measurements of aerosol size-distributions show that the model underestimates particle sizes, which is of direct importance to cloud droplet activation. Furthermore, a comparison with aerosol optical depths obtained from the CALIOP satellite suggests that the model overestimates aerosol transported to the Arctic through the free troposphere which implies that the modeled aerosol impacts on high-latitude low-level clouds are underestimated in NorESM1.

401
Characteristics of Biogenically-derived Aerosols in the Amundsen Sea, Antarctica

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Atmospheric concentrations of ionic species, water-soluble organic carbon (WSOC), total organic carbon (TOC), and total carbon (TC) were measured over the Southern Ocean and the Amundsen Sea, Antarctica between 43°S and 75°S during the ANA06B cruise conducted in the austral summer of 2016 on board the Korean icebreaker IBR/V *Araon*, in order to investigate abundance of biogenically-derived aerosol species and source of organic carbon. During the cruise, mean concentrations of non-sea-salt sulfate (nss-SO_4^{2-}) and methanesulfonic acid (MSA) in bulk aerosols were 0.61 ± 0.17 µg m^{-3} and 0.22 ± 0.13 µg m^{-3}, respectively. In the Amundsen Sea Polynya, MSA concentration increased from 0.35 µg m^{-3} up to 0.57 µg m^{-3}, and it showed a positive relationship with dimethyl sulfide (DMS) in sea surface water, showing significant influences of marine biological activities. Estimate using the MSA/nss-SO_4^{2-} ratio measured in Antarctica revealed that mean contribution of biogenic nss-SO_4^{2-} accounted for 69 ± 34% of total nss-SO_4^{2-}. Atmospheric TOC concentration varied from 0.16-0.65 µg m^{-3}, of which 16−47% was WSOC, showing that water-insoluble OC was dominant organic carbon species. Excitation emission matrix (EEM) analysis revealed that protein-like WSOC was dominant WSOC type (46−98%). This result suggests that most WSOC was derived from marine biological processes, and that biogenic WSOC as well as sulfur species could be a important source of cloud condensations nuclei in the Amundsen Sea.

1134
Sea-salt Aerosol from Blowing Snow on Sea Ice: A New CCN Source in Polar Regions

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Using winter cruise data collected within in the Weddell Sea during June-August 2013, for the first time, we are able to carry out a systematic examination to the parameterization of sea salt aerosol (SSA) production from blowing snow as proposed by Yang et al. [2008].
Aerosol elevation events have been frequently observed within the sea ice zone, which, however, could not be solely explained by the sea spray. When the SSA production scheme from blowing snow is implemented in to the model, further constrained by the campaign data, the model could reproduce well many of the elevation events. In addition, modelled SSA size spectrum generally matches the observations at size range of ~0.4-10 µm strongly indicating that the SSA production scheme implemented is working and the micro-physical process involved in the parameterization could be reasonable.
Moreover, the widely observed winter peaks of SSA in mass in polar regions can be reproduced by the model. Model also predicts that the total number density of SSA (down to size of 0.2 µm) over the sea ice zone can be larger than that in the marine boundary layer by about one order of magnitude, indicating blowing snow is favorable of producing sub-micron sized SSA compared to sea spray. These small SSA are not limited within the sea ice zone and can be long distance transported. Therefore they could potentially act as a source of CCN in high latitudes.

1846
Arctic Sea Ice Melt Leads to Atmospheric New Particle Formation

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Atmospheric new particle formation and growth significantly influences climate by supplying new seeds for cloud condensation and brightness. Currently, there is a lack of understanding of whether and how marine biota emissions affect aerosol-cloud-climate interactions in the Arctic. Here, the aerosol population was categorised via cluster analysis of aerosol size distributions taken at Mt Zeppelin (Svalbard) during a 11 year record (2000-2010) and at Station Nord (Greenland) during a 7 year period (2010-2016). Air mass trajectory analysis and atmospheric nitrogen and sulphur tracers link these frequent nucleation events to biogenic precursors released by open water and melting sea ice regions. The occurrence of such events across both temporal periods (2000-2010 and 2010-2016) are anti-correlated with sea ice extent.

2274
Details of Secondary Aerosol Formation in the Polar Atmosphere

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Secondary aerosol formation is globally contributing about 50% of cloud condensation nuclei. With increasing temperature, the emission of gases from the different spheres is changing, and therefore, the molecular composition of the atmosphere is changing as well.
For understanding to which extent the temperature rise and sea ice loss might contribute to future cloud formation and the radiation feedback, the mechanisms of secondary aerosol formation must be known. Therefore, we conducted a field campaign from March to August 2017 in Ny Ålesund, Svalbard. The key instrumentation included mass spectrometers for solving the molecular mechanism of particle formation. The known contributing gases to secondary aerosol formation in polar regions are sulphuric acid and iodic acid - detailed mechanisms are still only vaguely known. Changes in the phytoplankton dynamics, and sea ice extent will have an important effect on aerosol formation in those regions. To understand the effect of temperature change on secondary aerosol formation, all different spheres have to be taken into account. This study tries to combine all the components related to gas-to-particle conversion necessary for predicting the future behaviour of arctic clouds and climate.

2398
Vertical Dimethylsulfide Flux and its Relations to Sea Ice in Arctic Ocean

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Global warming of climate is connected to ecosystem change, especially in the Arctic ocean. Biogenic emissions of dimethylsulfide (DMS) are the main biogenic source of sulfate aerosols to the marine atmosphere and may make a rapid change in the Arctic due to the massive melting ice. Here we simulate DMS distributions and sea-to-air fluxes in the Barents Sea (30°W-40°E and 70°N-80°N) and Greenland Sea (20°W-10°E and 70°N-80°N) for the period 2003-2005. A genetic algorithm (GA) is used to calibrate the key parameters in the DMS model for both regions. Due to limitation of DMS observations in the Arctic Ocean, multiple data sources were used. Parameter sensitivity analysis were studied using a limit method. CMIP5 global model is used for obtaining the forcings for 4 CO_2 conditions. DMS flux under quadrupled CO_2 increases much more compared to late 20thC levels (1 CO_2). The reason for the increase in DMS flux under 4 CO_2 conditions is due to changes in sea surface temperature (SST), the sea ice melting and shoaling of the mixed layer depth (MLD). The double or tripling of DMS fluxes indicates that warming in the Arctic could be slowed through the controlling of greenhouse gases and changing of radiative budget associated with DMS derived aerosols.

BE-4d - Climate change and ecosystems: physiology, biodiversity and ecological functions
20.06.2018 09:00-10:30, C Sanada II

196
Hide, Survive and Hitch a Ride, a New View on the Krill-sea Ice Relationship

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A dominant Antarctic ecological paradigm suggests that winter sea ice is the feeding ground for larval Antarctic krill. Results from a late winter study in the northern Weddell Sea in combination with previous findings contradict this view and present the first evidence that although there's abundant food in winter sea ice, it is not accessible for larval krill compared to food supply in neighbouring open water regions. Despite high biomass in winter sea ice the growth rates of larval krill are constant low in winter pack ice regions. We found that complex under ice habitats are vital for larval krill, providing shelter from currents. During daytime the larvae feed on the sparse ice-associated food but after sunset, they migrate down into the water below the ice. This behaviour increases food uptake in a patchy food environment and ensures transport of larvae to spring feeding grounds in the Scotia Sea. Our study shows the first mechanistic linkage between larval krill and winter sea ice.

2562
Long Dark Winters Thwart the Borealization of High Arctic Plankton Communities

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Isfjorden Marine Observatory Svalbard (IMOS) is a long-term plankton time series from the largest fjord system in Svalbard, with data dating partly 20 years back. Hydrography, protist - and mesozooplankton are regularly sampled along a climate gradient from the ice-free outer fjord with Atlantic water influence to the seasonal ice covered inner fjord where local cold water of Arctic characteristics prevails. The high seasonal resolution of this time series makes it possible to disentangle natural variability in the plankton community from persistent changes caused by climate warming.
Microbial eukaryotes (0.45-10 µm size) display strong seasonality in community composition with rapid shifts during spring and summer, when also inter-annual differences are most apparent. In contrast, highly similar and stable communities are found during winter, suggesting a high degree of resilience in the system.The mesozooplankton community consists of a mix of boreal and Arctic species with a growing share of boreal ones towards the outer part of the fjord.The seasonal variability in community structure is higher than the inter-annual variability. While boreal species may be prominent during summer and autumn, the zooplankton community resets to a more Arctic community each winter. The long dark winter likely represent a bottleneck for survival of more temperate species. This may potentially thwart the Atlantification of the plankton community in the European Arctic.

682
Sensitivity and Adaptability of Antarctic Krill to a Warming Southern Ocean

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Antarctic krill *(Euphausia superba)* is a key species in the marine Antarctic ecosystem due to its central position in the food web. As the krill's life cycle is characterized by a strong interplay between endogenous physiological processes and seasonal environmental factors, it is crucial to understand how increasing water temperatures affect these processes. However, physiological studies providing insights on the performance of Antarctic krill under climate-induced environmental changes are scarce. By combining physiological performance indicators with transcriptomic approaches, we aimed to identify effective mechanisms determining sensitivity as well as adaptability of this species to a warming Southern Ocean. The seasonal transcriptome of *E. superba* was compared to a *de novo* seasonal transcriptome of the closely related Northern krill (*Meganyctiphanes norvegica).* Furthermore, long-term acclimation of *E. superba* at different temperature scenarios during austral summer provided insights into the effects of elevated ambient temperatures on Antarctic krill physiology, enabling a first estimate of putative effects on whole animal energy status when facing upcoming winter season. Therefore, our data do not only provide a more detailed insight into krill thermal physiology but also determine the capacity of *E. superba* to cope with Southern Ocean warming.

906
Energetic Value of Zooplankton and Nekton of the Southern Ocean: A Review

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The energy content of different prey items is an important factor in structuring food webs and relationships between species. Information on the energetic value of prey can be a key predictor of the behaviour and population dynamics of predators, trophic interactions between species and of energy flow through trophic levels. The Southern Ocean (SO) represents approximately 10% of the earth's surface and is home to a variety of top predators such as birds, seals and whales, which forage on zooplankton and nekton species. The strong seasonality occurring in the SO, in combination with regional differences in environmental properties caused by latitude, currents and/or fronts, cause variations in the energetic density within a single species or between ecologically equivalent species. Here we present the results of a review on available energetic data that contributed to the Southern Ocean Diet and Energetics Database. This database is a product of the Expert Group on Antarctic Biodiversity Informatics (EG-ABI). Data that contributed to the review include summary data as published in scientific literature as well as individual measurements kindly provided by the authors on request. The data on individual measurements can help to better assess possible ontogenetic, spatial and temporal patterns. Furthermore, we provide an overview of knowledge gaps, possible uses of the data in larger ecosystem studies and consider implications for models.

716
Genomic Basis of Adaptation of the Southern Ocean Salp, *Salpa thompsoni*

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The Antarctic salp, *Salpa thompsoni*, is an increasingly important player in the vulnerable Southern Ocean pelagic ecosystem. Field studies have documented rapid population growth resulting in dense blooms of salps that can displace other species, including the keystone Antarctic krill (*Euphausia superba*), and significantly perturb the pelagic ecosystem. We are developing new genomic resources, including a comprehensive reference genome, for the Antarctic salp to enable identification of genes and gene networks underlying physiological responses, including bloom formation. Our comparative genomic analysis is focused on novel aspects of genomic evolution found only in the invertebrate Class Tunicata and detailed characterization of genome evolution of *S. thompsoni*. We are examining evidence that rapid evolution of *S. thompsoni* orthologs (genes of the same function that share a common ancestor) is driven by positive selection, and that these genes and associated gene networks provide the basis for adaptation of the Antarctic salp to environmental conditions. Our results build upon our previously-published genomic resources and comparative transcriptomic data for this species, including *de novo* genome assembly, *de novo* transcriptome assembly, and small RNA analyses. Our results are yielding new understanding of the genomic basis of adaptation to environmental variation associated with climate change for the Antarctic salp.

OS-6e - Polar Ocean Dynamics
20.06.2018 11:00-12:30, C Aspen

486
Origin of CDW Intruding onto the Amundsen and Bellingshausen Sea Shelves

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The ice shelves and glaciers of the West Antarctic Ice Sheet are thinning rapidly, which is mainly caused by Circumpolar Deep Water (CDW) intruding onto the Amundsen and Bellingshausen Seas (ABS) continental shelves. Despite existing works on cross-shelf and on-shelf CDW transports, CDW pathways onto the ABS originating from further offshore have never been investigated. Here, we show that simulated CDW from the World Ocean Circulation Experiment (WOCE) S04P section (67ºS) circulates along the Antarctic Circumpolar Current (ACC) and Ross Gyre and travels into the ABS after 3-5 years. Simulated CDW warming off the ABS continental shelves in 2009-2014, consistent with limited observations available, is associated with different CDW pathways due to the strengthened Ross Gyre circulation and warmer temperature at the northern model boundary. Although wind over shelf and shelf-break areas has been commonly considered to control CDW intrusion, we conclude that the far field ocean properties and circulation control more than half of the off-shelf CDW warming in our model simulations, demonstrating a dominant link between large-scale atmospheric forcing and off-shelf CDW properties. Given the trend towards positive Southern Annular Mode causing a southern shift of the westerlies, the proposed mechanism may exert a dominant control on the on-shelf CDW intrusion and thus accelerate the retreat of West Antarctic glaciers and its impact on global sea level rise.

697
Impact of Glacial Meltwater on Ocean Warming and Antarctic Bottom Water

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Strong heat loss and brine release during sea-ice formation in coastal polynyas act to cool and salinify waters on the Antarctic continental shelf. Polynya activity thus both limits the ocean heat flux to the Antarctic Ice Sheet and promotes formation of Dense Shelf Water (DSW), the precursor to Antarctic Bottom Water. However, despite the presence of strong polynyas, DSW is not formed on the Sabrina Coast in East Antarctica and in the Amundsen Sea in West Antarctica. Using a simple ocean model driven by observed forcing, we show that freshwater input from basal melt of ice shelves partially offsets the salt flux by sea-ice formation in polynyas found in both regions, preventing full-depth convection and formation of DSW. In the absence of deep convection, warm waters from the Southern Ocean can spread across the continental shelf at depth and reach the ice-shelf cavities to drive the rapid basal melt observed at the Totten Ice Shelf on the Sabrina Coast and at the Dotson and Getz ice shelves in the Amundsen Sea. Our results suggest that increased glacial-meltwater input in a warming climate will both reduce Antarctic Bottom Water formation and trigger increased mass loss from the Antarctic Ice Sheet, with consequences for the global overturning circulation and sea-level rise.

1006
Observing Southern Subpolar Gyres: Thermodynamics and Dynamics Contraints

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Large gyre systems are prominent features of the polar Southern Ocean. They form elongated cyclonic features south of the eastward-flowing Antarctic Circumpolar Current, and provide pathways between the World ocean basins and the main global production sites of abyssal water. The subpolar gyre intensity therefore plays a key role in climate as a “dam” that ultimately controls the rate of Antarctic Bottom Water entering the world's ocean overturning circulation. Despite their potential key control on the Southern Ocean circulation, on water-mass pathway, and on the global overturning circulation, very little is known about Southern Ocean subpolar gyre. Here we use a novel observation database to investigate extent and seasonal variability of subpolar gyres in the Southern Ocean. We investigate the dynamics that sets their extent and variability using a combination of observation, as well as realistic and idealised models. Interestingly, the presence of sea-ice plays both a dynamical role in shaping the subpolar gyre structure, and thermodynamical role in driving seasonal variability of its strength. Variability and long-term change of sea-ice associated with a shift in wind regime might change strength, vertical structure, and extent of Southern Ocean subpolar gyres, with important consequences for the large-scale water-mass circulation.

1136
Circulation Beneath Filchner-Ronne Ice Shelf and Exchange with Open Ocean

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During the austral summer 2015/16 and 2016/17, seven oceanographic moorings were deployed through hot-water-drill holes located over the Filchner Trough east of Berkner Island. The aim was to investigate and monitor the processes determining the access of ocean heat to the ice base. The vertical structure beneath the southern part of the ice shelf is dominated by tidal mixing, and the water mass properties are related to the densest High Salinity Shelf Water (HSSW), which is known to be produced in front of the Ronne Ice Shelf. This water mass is observed to exit the cavity along the western flank of the Filchner Trough during parts of the year. In contrast, the northeastern part of the cavity is filled with HSSW and its Ice Shelf Water derivatives that have a local origin, in front of Filchner Ice Shelf. The preliminary time series shows that this less dense HSSW enters the cavity on the eastern side of the Filchner Trough during parts of the year, but seems to be trapped in the deep trough where it interacts laterally with derivatives of the Ronne-sourced HSSW; there is no evidence that it can penetrate to the deep southern grounding lines. The link of these two circulation regimes to different regions of dense water formation on the continental shelf needs to be taken into account, when investigating whether an inflow of warmer water in front of the Filchner Ice Shelf is important for basal melting today, and how that might change in a future climate.

1334
Flow Paths of the Arctic Halocline and Atlantic Layer Derived from Tracer Data

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We present $^3H/^3He$ age and hydrographic data from 21 expeditions spanning 25 years of Arctic Ocean section work (1987 and 2013) to independently estimate spreading velocities, flow paths, and stability of upper and lower halocline waters (UHW and LHW), as well as the Atlantic Water branches on a pan-Arctic scale. Our results corroborate and add a time dimension to previously established circulation schemes. Tracer data confirm the presence of a well-organized boundary current that cyclonically flows along the continental slope and add insights into the other, typically topographically steered, circulation branches for the LHW and Atlantic layers. The circulation scheme for the UHW still shows similarities to those of the Atlantic layer but differs significantly in certain regions of the Arctic Ocean. Tracer data show that within the limits of our method the current system has been stable over the 25 years of observation. The results are discussed in the context of the temporal stability of the circulation in the Arctic Ocean, as well as regional variability of spreading velocities along individual branches of the circulation pattern due to topographic and dynamic forcing.

1171
Polar Ocean State Estimation around the Greenland Ice Sheet

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Four-dimensional (space and time) ocean and ice data assimilation allows for the synthesis of diverse and temporally and spatially heterogeneous observational data with a numerical model to create a coherent representation of the coupled ocean, sea ice, and ice sheet system. This coherent representation of the time-evolving system, referred to a state estimate, is a dynamically-consistent reconstruction that is constrained to observations and their uncertainties in a least squares sense. In this talk I will describe recent progress, outstanding challenges, and future prospects of using four-dimensional data assimilation to reconstruct decadal changes in ocean circulation, temperature and salinity around the Greenland Ice Sheet with the goal of understanding the causes of increasing submarine melting of its tidewater glaciers. This effort supported by NASA's Estimating the Circulation and Climate of the Oceans (ECCO) project and its Oceans Melting Greenland (OMG) mission.

AC-4a - The Polar Atmosphere and Geospace
20.06.2018 11:00-12:30, A Studio

509
Perturbations on the Stratosphere Due to Intense Geomagnetic Storms: Study Cases

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We analyzed balloon sounding data gathered at the Argentinean Marambio Antarctic station from 1998 to 2016 (inclusive) by the National Meteorological Service of Argentina, in order to study the atmospheric profiles with height of temperature and pressure variables. During the study, and taking into account seasonality, we have found the associated climatology at Marambio station in order to compare the same profiles during 5 cases of intense geomagnetic storms (GS) where the balloon measurements where available. We compute the temperature anomalies for the day of the GS, and 14 days after the event at different height levels. The knowledge of the deviation of the seasonal profile during a geomagnetic storm will help to assess the possible deviation from the expected cosmic ray flux at the station during these GS events. The atmospheric profile with height is necessary to perform the Monte Carlo simulations of secondary cosmic rays showers, so this kind of study will help to improve them.

On behalf of the The Latin American Giant Observatory (LAGO) Collaboration, Ciudad Autónoma de Buenos Aires, Argentina. See List of Members at www.lagoproject.org, lago-pi@lagoproject.org

2228
Temperature Variations of Polar Ionosphere during Stratospheric Sudden Warming

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We analyzed ion temperature and velocity observed by the European Incoherent Scatter (EISCAT) UHF radar at Tromsoe (69.6°N, 19.2°E) during a stratospheric sudden warming (SSW) that occurred in January-February 2017. The zonal ion velocities at 85-100 km height reversed approximately 8 days earlier than the zonal wind reversal in the upper stratosphere and the ion temperature at 85-95 km decreased simultaneously with the zonal ion velocity reversal at the same altitude. We found that the time variations of ion temperature in the daytime are close to those of ambipolar diffusion coefficients derived from the the Nippon/Norway Tromsoe Meteor Radar (NTMR) data at the same altitude even when geomagnetic activity is moderate. This suggests that the D- and lower E-region ion temperature in the daytime is a good proxy for neutral temperature at the same altitude. We will explain the reliable ion temperature derivation in the D-region and its limitation, and also discuss relationship between ion temperature and vertical ion velocity variations at 85-95 km measured with the EISCAT UHF radar.

1676
Ionospheric Scintillation Climatology at Ny-Ålesund across Solar Cycle 23 and 24

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INGV operates a network of GNSS receivers acquiring data at 50 Hz incorporating a firmware especially modified to provide several parameters useful to monitor the perturbations of the high latitudes upper atmosphere. In particular, the first GPS receiver was installed in 2003 at Ny-Ålesund (Svalbard Island, 78°55'N 11°55'E). Currently, three receivers are operating at Ny-Ålesund, recording GPS, GLONASS, Galileo signals. The analysis exploits the scintillation parameters (S4 and sf), TEC and its rate of change (ROT) measured by INGV receivers to study the behaviour of the high latitudes ionosphere during the different phase of a solar cycle. The analysis is supported by the climatological reconstruction of the probability of the scintillation occurrence sorted also according different conditions of the geospace and of the geomagnetic field. This would enable to infer the relationship between the physical processes ruling the morphology of the high latitudes ionosphere and the amplitude and phase scintillations on GNSS signals. The knowledge of such relationship is necessary in view of a long term forecasting of the disruptive effects of the ionosphere on the L-band signals affecting the applications based on GNSS such as precise positioning and navigation. Moreover, a climatology of the scintillation over Galileo signals is here provided for the first time in the high latitude European sector.

1873
Chemical Impacts of Energetic Particle Precipitation in the Middle Atmosphere

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Energetic particle precipitation generates perturbations in the abundance of various neutral and ionic species in the polar mesosphere-lower thermosphere, partly through a complex ion cluster chemistry. In particular, mesospheric polar nitric acid enhancements have been attributed to energetic electron precipitation (EEP). We investigate such nitric acid enhancements following a series of EEP events during April and May 2010 with WACCM-D, a recently developed variant of the Whole Atmosphere Community Climate Model (WACCM) that includes a sophisticated ion chemistry of the D-layer of the ionosphere (50-90 km). Whereas the standard WACCM includes only 5 positive ions, WACCM-D comprises 21 negative ions and 20 positive ions. Using the specified-dynamics mode, we perform a one-year long simulation and contrast WACCM-D with the standard WACCM. Both simulations are performed with and without a forcing by medium-to-high energy electrons. We demonstrate the effects of the EEP events on nitric acid and on key ion cluster species, as well as other key species of the nitrogen family. The one-year long simulation allows placing the event-related changes in key neutral and ionic species in the context of their annual cycle. We especially highlight the important role played by medium-to-high energy electrons in triggering ion cluster chemistry in the mesosphere and lower thermosphere, leading to the production of nitric acid through the ion-ion recombinations.

1728
Surveys of 557.7/630.0-nm Dayside Auroral Emissions in Arctic and Antarctica

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The synoptic distributions of dayside aurora in the Northern and Southern Hemispheres, acquired from all-sky imagers at Yellow River Station in Arctic and South Pole Station in Antarctica, respectively, present the same two-peak structure, namely, the prenoon 09:00 MLT and postnoon 14:00-15:00 MLT peaks. The auroral intensity presents a hemispheric asymmetry, i.e., the postnoon intensity is less than the prenoon intensity in the Southern Hemisphere but more in the Northern Hemisphere. The hemispheric asymmetry is not changed with the change of IMF's polarity. We suggested that 1) the two-peak structure in the dayside oval are predominantly related with the prenoon/postnoon antiparallel reconnection in high-latitude magnetopause produced to the prenoon and postnoon peaks; 2) the IMF By should modulate the dayside aurora through the inter-hemispheric current, which is produced by a north-south oriented electric field, and changing the distribution of midday R0-R1 current; 3) the opposite prenoon-postnoon asymmetries of dayside auroral distributions in the two hemispheres are the combined effect of the prenoon-postnoon variations of the magnetosheath density and the variation of the local ionospheric conductivity in the two ground-based observatories.

1650
Unusual Amplitude Scintillation on GNSS Signals Recorded in Antarctica

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The storm onset on September 7, 2017 triggered several electron density fluctuations in the ionosphere causing severe phase scintillations at polar latitudes in both hemispheres. Concurrently, unusual amplitude scintillations were also recorded in Antarctica. At high latitudes, indeed, scintillations on the GNSS signal phase are expected to be more frequent than those on the amplitude. This is due to the higher reaction of the GNSS signal phase to the complex plasma dynamics caused by the coupling between the Interplanetary Magnetic Field (IMF) and the Earth's magnetic field, which directly exposes the high latitude ionosphere to the solar wind variability. This work investigates the physical mechanisms triggering the observed amplitude scintillations. In particular, leveraging on observations provided by receivers located at Concordia (75.10°S, 123.35°E), Mario Zucchelli (74.41°S, 164.10°E) and SANAE (71.68°S, 2.83°O) stations, supported by ancillary data, we reconstruct the scenario in which irregularities form, move and trigger both amplitude and phase scintillation. Our study includes scintillations derived from GPS, GLONASS and Galileo data.

TE-1b - Observing with autonomous vehicles in polar regions
20.06.2018 11:00-12:30, A Forum

116
Environmentally Adaptive Acoustic Navigation and Communication in the New Arctic

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The climate change induced enhancement of the “Beaufort Lens”, a warm water layer penetrating from the Bering Strait, has severe implications for under-ice acoustic sensing, communication and navigation. As part of the ICEX16 US Navy Exercise, an AUV with a towed hydrophone array was used for assessing the associated changes to the undersea ambient noise environment. The AUV operation depended on navigation updates from the submarine tracking range being communicated to the vehicle for fusion with the onboard inertial navigation. However, the tracking performance was severely deteriorated compared earlier deployments, to the presence of the warm layer, which creates a double duct environment with severe shadow zones for shallow sources and receivers. In addition, the dominant ice mechanical sources for the ambient noise has dramatically changed due to the reduced average thickness and the associated ice mechanics. As a combined effect of these environmental changes, the spatial and temporal signal/noise budget is fundamentally changed, characterized by robust environmental features that may be exploited by unmanned underwater vehicles. This paper describes the environmental effects observed and discusses how robust acoustic connectivity in requires manned or unmanned under-ice platforms to be capable of using their mobility to adapt to the environment for reliable sensing, communication and navigation [Work supported by ONR and DARPA].

2238
A Decade of Under-ice Operations by Long-endurance Seagliders

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Over the past decade, the long-endurance, buoyancy-driven autonomous underwater vehicle Seaglider has successfully completed a range of Arctic and Antarctic science missions that have included extended, multi-month operation beneath ice. Early developments began in 2004, targeting year-round operation in the seasonally ice-covered Davis Strait, a critical gateway connecting the Arctic with the Subpolar North Atlantic. Seaglider capabilities were augmented with enhanced autonomy, ice detection and avoidance, and real-time acoustic navigation. First-generation ice-capable Seagliders geolocated by multi-lateration from an array of 780-Hz RAFOS acoustic sources. Seaglider's first extended (hundreds of kilometers) under-ice transits occurred in 2008, followed by year-round occupation of Davis Strait and a multi-day transit, without acoustic navigation, under the ice bridge separating the Ross ice self from the Ross Sea Polynya in 2010. Continued development has included enhanced autonomy and navigation, and integration of a broadband acoustic source capable of encoding information onto the navigation signal. These advances opened new operational possibilities, including a 2014 experiment that employed four Seagliders to sample the marginal ice zone of the Beaufort Sea. This presentation will review the history of Seaglider missions under ice and the technological developments undertaken to enable them, and discuss ongoing missions and future plans for ice-capable Seagliders.

530
The Polar-ARV Unmanned Underwater Vehicle and Investigation of Sea Ice in Arctic

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Pole-ARV is a UUV used for observation under sea ice in Arctic, it has both the characteristics of AUV and ROV with onboard power and optical fiber technology, its scientific payloads include radiometer, CTD, altimeter, cameras and pressure sensor. Pole-ARV has been deployed in the Chinese Arctic expedition for three times since it was developed in 2008. The vehicle's maiden sub-ice voyage occurred during the summer of 2008 and the control system and sub-ice navigation system was tested. In 2010 the Polar-ARV was launched and recovered from an ice hole in the ice station, and collected a lot of scientific data, include ice thickness, spectral irradiance, video, photo, conductivity, temperature, pressure etc. Its volume and weight of the vehicle was reduced for field application after this deployment. In 2014, Polar-ARV was deployed in the 6th Chinese Arctic expedition. It surveyed under designated ice area for three times and got a detail ice draft based on the ice thickness and 3D spatial distribution of spectral irradiance. Recently we are just upgrading the Polar-ARV, and are now preparing for a 2018 deployment in Arctic to test the acoustic system and perform sub-ice investigation mission. The acoustic system includes a long range homing system, short range localization system and acoustic propagation system. In future, we plan to expand the operating range of Polar-ARV, and equip more sensors on it, such as multi-beam sonar.

2001
The West Spitsbergen Current in summer 2017

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The flow of Atlantic Water through Fram Strait is the main provider of heat to the Arctic Ocean. The poleward transport in the strait is achieved mostly by the West Spitsbergen Current, which flows as a slope current over the Svalbard shelf and slope. Repeat glider sections were carried out in July-September 2017 across the eastern Fram Strait as part of the EU-H2020 INTAROS project. These measurements aimed at monitoring the cross-slope structure of the West Spitsbergen Current and identifying possible mesoscale features and recirculation. Combining the glider data with results from a high-resolution sea ice-ocean model allows us to characterize the time-space structure of the eddies and to estimate their contribution to the flow of Atlantic Water which is diverted westward and possibly recirculates southward in the strait. The variability of the recirculated transport will be analyzed in relation to the interannual variability of the volume and heat transports, which eventually enters the Arctic Ocean through Fram Strait.

2212
Ocean Boundary Layer Variability in Drake Passage from Gliders: Hours to Seasons

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The Southern Ocean's surface boundary layer plays a key role in the exchange of heat and carbon between the atmosphere and the ocean interior. Submesoscale motions strongly impact mixed layer depths and vertical velocities, but observations that resolve these scales in the Antarctic Circumpolar Current (ACC) are extremely limited. We present observations from multiple glider deployments in Drake Passage for both summer (December 2014 - March 2015) and winter (May - August 2016) periods. The gliders provided persistent measurements of the ACC's frontal structure over the shelf and slope in southern Drake Passage, and completed multiple crossing of the Polar Front during the 2016 deployment. These observations provide a comprehensive view of surface and bottom boundary layer variability in this region. This presentation will summarize the major results of the project, which include:
(i) observations of strong eddy-induced subduction of shelf properties across the continental shelf break that sustains an off-shore subsurface chlorophyll maximum;
(ii) abrupt spatial transitions, modulated by topography, in how submesoscale motions influence mixed layer depths;
(iii) strong turbulent mixing and water mass modification arising from submesoscale symmetric instability in bottom boundary layers over the continental slope;
(iv) seasonal variations in submesoscale eddy mixing lengths and subduction properties at the Southern ACC Front (SACCF) and Polar Front.

1687
Revealing Physical and Ecological Dynamics at the Ice Edge - A Robotic Approach

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Marginal ice zones (MIZs) are characterized by the complex and dynamic interaction between the atmosphere, the ice, and the ocean. These high dynamics put MIZs among the - biologically - most productive regions of the world ocean and make them an ideal place to investigate the coupling between physics and ecology. Fostered by the last decades´ technological progress in robotics and sensor technology, marine sciences are increasingly able to investigate these processes, which occur on very small scales - both temporal and spatial.
The Alfred Wegener Institute (AWI) has regularly operated its Autonomous Underwater Vehicle (AUV) “PAUL” in the Arctic and especially in the MIZ of the Fram Strait since 2009. Starting in 2011 / 2012 AWI has also used Unmanned Aerial Vehicles (UAVs) to support AUV operations and gather a holistic picture of the investigated area. In our talk we will give an overview on the equipment and infrastructure used to support our AUV dives including an UAV for operations at high latitudes. We will present technical details of our vehicle´s scientific payload which is specifically designed to study the physical dynamics of the marginal ice zone and its ecological response.

CR-7b - Snow and firn: an open measurement and modelling challenge
20.06.2018 11:00-12:30, A Dischma

995
Effects of Snow Grain Shape on Climate Simulations with NorESM

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Snow consists of non-spherical grains of various shapes and sizes. Still, in climate model snow albedo calculations and many other radiative transfer applications, snow grains are often treated as spherical. We evaluate the effects of snow grain shape on climate simulated by the Norwegian Earth System Model (NorESM) in a slab ocean configuration of the model. An experiment with spherical snow grains (SPH) is compared with another (NONSPH) in which the snow shortwave single-scattering properties are based on a combination of three non-spherical snow grain shapes, optimized using measurements of angular scattering by blowing snow. The key difference between these treatments is that the asymmetry parameter is smaller in the non-spherical case (0.77-0.78 in the visible region) than in the spherical case (0.89). Therefore, for a given snow grain size, the use of non-spherical snow grains leads to a higher snow broadband albedo, typically by 0.02-0.03. Considering the spherical case as the baseline, this results in an instantaneous negative change in net shortwave radiation, with a global-mean top-of-the-model value of -0.22 Wm^{-2}. The effects on climate simulated by NorESM are, however, larger than what one would expect based on the global-mean radiative effect. The global annual-mean 2-m air temperature in NONSPH is 1.17 K lower than in SPH, with substantially larger differences at high latitudes. The climatic response is amplified by strong snow and sea ice feedbacks.

807
Dual Frequency Radar Altimetry - Measuring Greenland Firn Properties from Space

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For the last seven years the ESA CryoSat-2 Ku-band radar altimeter has been measuring the elevation of the Greenland Ice Sheet. Ku-band enables surface penetration at firn covered areas, which hampers the direct interpretation of surface elevation change from Cryosat-2 and other Ku-band altimeters. However, mapping the changes in penetration depth can provide information on firn stratigraphy. If the physical surface (snow/air interface) of the ice sheet can be determined from an independent source, the differences in the two surfaces may directly be linked to the penetration depth of Ku-band radar altimetry, and hence to the temperature and density of the upper firn.
Here, we use independent estimates of the surface elevation changes from the Ka-band radar altimeter (AltiKa) operated onboard the French/Indian satellite SARAL. The higher frequency of Ka-band reduces surface penetration to a minimum and combining the records from both Ku- and Ka-band satellites is the key to utilizing the full potential of CryoSat-2. Hence, providing both high spatial-resolution surface elevation change and insights into changes in firn properties. The interpretation of dual-frequency altimetry is supported by firn modeling. The model has previously been applied to gain mass balance from ICESat, and is now updated with a conceptual model for Ku-band radar penetration.
Ultimately, a dual-band radar altimeter operating from space may provide ice sheet wide measurements of firn densities.

1560
Snow-air Exchange and its Influence on Preservation of Climate Signals in Ice

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Water isotopes in ice cores have been used for decades as a temperature proxy in Greenland and Antarctica to provide information about past climate. However, there are still deficiencies in our knowledge about how post-depositional processes influence the recorded water isotope signal. It is unclear why water isotopes reflect continuous temperature changes when depositional snow events have a seasonal bias and can be separated by weeks or months. Recent studies have shown that surface snow isotopes exhibit intra-day to inter-day variations in parallel with near-surface atmospheric water vapor isotopes, suggesting that the snowpack is more closely tracking atmospheric conditions such as near-surface temperatures.
A study at the EGRIP field camp (North-East Greenland) in July 2017 showed that over a 40-hour period, surface snow experienced sublimation and interaction with near-surface atmospheric water vapor, changing the snow isotopic composition. A series of lab experiments conducted in a controlled environment in Fall 2017 will better quantify the acting processes, by filling a sealed chamber with homogeneous snow and an inflow of isotopically- and humidity-controlled vapor. Continuous laser-based measurements of water vapor are used to monitor changes in the air, and snow samples are measured over the duration of multiple-day periods. Effects such as wind and thermal gradients in the snow can be simulated to better understand natural processes taking place on the ice sheet.

1938
Measurement and Modelling of Tundra Snowpack Structure

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Shallow tundra snowpacks subject to strong winds and strong vertical temperature gradients have distinctive structures, with basal layers of large faceted grains overlain by hard fine-grained slabs. The physical properties of these layers differ greatly in how they control, amongst other processes, conduction of heat and scattering of microwave radiation; these are important for determining the amount of snow on the ground by remote sensing and the influence of that snow on ground - atmosphere heat exchanges for numerical weather prediction. Even the most sophisticated current snow physics models, which have largely been developed for alpine applications, are known to perform poorly in reproducing tundra snowpack structures. A Year of Polar Prediction / UK-Canada Arctic Partnership experiment will be conducted in the Canadian Northwest Territories during March 2018 to combine ground measurements of vertical microstructure and horizontal topographic variations in snow with airborne microwave measurements. Preliminary measurement and modelling results will be presented.

1235
Evolution in Geometry of Firn in Ice Sheets Detected by Dielectric Anisotropy

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Ice in polar ice sheets once experience a state of firn at near-surface depths. Therefore, it is important to understand physical processes of firn formation, metamorphism and deformation for ice core studies. We investigated firn through measurement of tensorial values of the dielectric permittivity at microwave and millimeter-wave frequencies. This method can detect presence and strength of anisotropic structure in the geometry of pore spaces and ice matrix. We applied the method to many firn cores drilled at both ice sheets. We find that firn that have shorter residence time at the near-surface depths does not form strong vertical anisotropy that is caused by vertical movement of moistures. In contrast, firn that have longer residence time at the near-surface depths tend to form vertical anisotropy. When density exceeds more than ~600 kg/m^3, a common feature of firn at many polar sites is that there are evolution of vertically elongated features of pore spaces in firn despite growth of vertical compression. We hypothesize an explanation as follows. As firn becomes denser, air within firn needs to "escape" to upward directions as compared to sinking firn. In firn, porous structure tend to have vertically elongated structure because of this vertical escape movement of air. The observed phenomena of the growth of the vertical dielectric anisotropy can be understood by this vertical movement of the air within firn.

1306
The ETracer+ a Wireless Sensor Suite for Monitoring Firn Processes

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Long-term monitoring of the subsurface processes taking place in snow and firn presents a significant technological challenge. Many *in situ* observational studies cover only short time intervals, or rely on sensors connected to surface dataloggers. Wired sensors connected to the surface may impact the physical processes within the firn, resulting in altered percolation pathways and the potential formation of artificial ice pipes or ice lenses. Here, we present results from a measurement campaign conducted with a suite of small (50 mm diameter) wireless sensors (ETracer+) that continuously transmit information on temperature, pressure and electrical conductivity (as a proxy for meltwater presence and solute content). The tested sensor platforms are small, robust and low cost, and communicate data via a very high frequency (VHF) radio link to surface receivers. The sensors can accurately log subsurface temperatures, and transmit the recorded data through up to 150 m firn.
The sensors were deployed in the upper 15 cm snow layer at the East Greenland Ice Core Project campsite in northeastern Greenland. Tests demonstrated that the sensors are capable of prolonged operation in low temperature environments, accurate measurement of subsurface temperatures, and of detecting meltwater pulses within otherwise dry firn. Our results show that wireless sensors have great potential for long term monitoring of sub-surface processes in firn.

SH-5b - Current and future change, sustainability and resilience in the Polar Regions
20.06.2018 11:00-12:30, A Sertig

1388
New Arctic Straits and Islands and their Potential Influence on Human Activity

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32 new islands (each above 0.5 km^2) appeared due to recession of Arctic glaciers under climate warming since the 1960s. Analysis of satellite images was a basic method of recognizing them. The islands' origin is a final stage of a process which began in the 20th century. They appear in the coasts where bedrock elevations above the sea are surrounded by depressions below its level, filled (at least from a land-side) with glaciers. Their recession leads to flooding the depressions by sea water and thus origin of new straits separating them from a mainland. Such new islands appear in Greenland and the European Arctic. Their ecosystems accommodate to new environmental conditions. In the nearest future, this process will be: - intensified in a case of further warming, - continued if climate will stabilize, - stopped after light cooling, - reversed after heavy cooling. All the new straits will become new sea-ways. Most of them will be of a local significance for an off-shore coastal traffic. However, a few new straits may become important for a state or international traffic, shortening important Arctic sea-ways. Such a new potential strait across the today's southern Spitsbergen - which may appear due to connection of the Hornsund and Hambergbukta fjords - would be of a great political-economic and ecological importance. It would become a useful way for ships going from west to the Barents Sea (to the eastern Spitsbergen coast, eastern Svalbard islands, Franz Josef Land, etc.).

1908
Engaging Youth to Envision and Advance Sustainability in Arctic Russia

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In order to ensure that the perspectives of youth are included in the investigation of sustainability issues, it is critical to involve youth directly in the research process. Involving youth as co-researchers ensures true participation and a 'voice' in both identifying relevant issues and determining appropriate solutions. The ability to manage and control social-ecological processes with active participation of young people is a key factor in achieving social-ecological resilience and sustainability. This paper presents the results of a youth engagement project to explore youth perspectives on these processes, using multiple methods including semi-structured interviews, quantitative data on key sustainability indicators and scenario planning. The project includes young people aged 15-29 from different regions of the Russian Arctic: Evenkia, Murmansk, Yakutia, and Chukotka. These regions and communities differ in terms of status (capital/regional center, village) natural-climatic conditions) and most importantly, access to transport and communication infrastructure, and thus provide good examples for comparing the relations between perceived quality of life and regional Arctic specific. The analysis helps to identify key indicators to monitor issues of the Arctic social-ecological sustainability facing Arctic youth and important steps for their solution.

1907
How Does Change Actually Affect Arctic Communities?

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We know that Arctic communities are experiencing rapid and far-reaching social, cultural, economic, environmental, and climatic changes. These changes in turn have had many effects on the communities and their residents, and are predicted to have many more. The closer we look at cause-and-effect relationships, however, the less clear the picture becomes. Using Arctic Alaska as one example, there is no evidence of demographic effects from climate change or other notable shocks to the social-ecological system. To the contrary, despite high reliance on traditional hunting and fishing, human outcomes appear de-coupled from environmental influences. Among the possible explanations are robust innovation that creates new opportunities, suffering that is not apparent in standard demographic metrics, and the use of reserves or subsidies as a buffer against negative effects. Each explanation has distinct implications for policies and practices aimed at achieving sustainability or resilience, a topic worthy of further study. We cannot rely on innovation, but neither can we expect communities to respond to change in mechanical and inevitable ways. Hidden suffering needs to be recognized to avoid undermining long-term sustainability. Buffers, too, need to be understood for what they are, so that they are used effectively rather than exhausted before long-term changes are made. This presentation will use examples from recent research to explore these ideas.

68
Socio-economic Changes in Mining Communities of Murmansk Region, Arctic Russia

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Murmansk region is the part of Arctic zone of Russian Federation; and is one of the most heavily industrialized. Among other Arctic territories of Russia, region holds the first place by number of single-industry cities. At present 1/3 of region's urban population live and work in single-industry cities and set up the greatest industrial potential for socioeconomic development of this area. The most part of regions' single-industry cities has a mining profile allocating several “industry big-player” companies. Along with its resource role Murmansk region is also perceived by the government as the model territory for the current socio-economic and more innovative way of development. Moreover it plays an international role as well by being the part of the Barents Euro-Arctic region. Even though there are a lot of positive changes in the state regulatory system and mechanisms such as development of regional and municipal territories with special financial regimes for investment projects, there are also some uncertainties and factors which deepen the disparity of socio-economic development within region. One of the ways to overcome this can be spatial development of territory. The most dramatic trend of the past 10 years in Murmansk region is depopulation which leads to the compression of socioeconomic and demographic space of the region. Nevertheless, such a compression can force the consolidation of social and economic resources which will be discussed during the conference.

1952
An Arctic Village Facing New Socio-economic Transformations: Teriberka, Russia

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This study documents and analyzes recent socio-economic and socio-ecological transformations of the coastal village of Teriberka in the Barents region of Russia. Teriberka is undergoing rapid and potentially radical change due to external pressures generated by various outside interests. Since the mid-20th century it experienced a number of boom and bust cycles: the rise and fall of shipyards and the fishing industry, construction and operation of hydropower facilities, and infrastructure development for the now-frozen Shtokman gas project. Since 2014, after the award-winning film "Leviathan" was produced there, the village has become an International tourist attraction, bringing thousands of visitors annually and building new hotels and restaurants. In 2016 it was designated as a priority development settlement meaning the regional government decides what investments are “appropriate” and how the settlement should look like. The local people are to be displaced and resettled while the region benefits from touristic, and bioresources processing development. Disappointed and clustered local commune quietly disavows the changes, but cannot make an offer of any alternative. Is “Leviathan” script being literally reproduced this time? Our socio-ecological study, employing interview, focus group, and environmental science methods, and community meeting allowed introduction of changes to the new area development plan.

2663
Mining Settlements in Transition: Analyzing Svalbard's Post-coal Future

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Svalbard is at a historical crossroads, with five former coalmining settlements in states of transition simultaneously. The Norwegian government's 2017-2018 budget proposition for Svalbard calls for the de facto end of coalmining, which has been Norway's primary means of effective occupation for over 100 years. Following a 2016 white paper, which signaled such a direction for Svalbard policy, the proposed budget entails the abandonment of Sveagruva, major changes in the socio-economic foundation of Longyearbyen and significant reorganization in Ny-Ålesund. Similarly, the Russian coalmining settlements at Svalbard are in different stages of transition to post-mining. In future visions for Barentsburg and Pyramiden, scientific research, tourism and cultural heritage are cornerstones. The process underway on Svalbard provides a point of departure for exploring how areas based on resource extraction in the Arctic can transition to post-extraction futures. To analyze this process, we draw upon research on the sustainable development of former Arctic mining communities within the Mistra Arctic Sustainable Development program and the Nordic Centre of Excellence REXSAC—Resource Extraction and Sustainable Arctic Communities. Research has included document analysis, interviews and contemporary archeological fieldwork on Svalbard and other Arctic locations. The paper provides an overarching analysis of Svalbard's post-coal future, built on five case studies of settlements in transition.

GG-2e - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
20.06.2018 11:00-12:30, A Schwarzhorn

2607
Plio/Pleistocene Preconditioning at Both Poles as Driver of Super Interglacials

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Paleoclimate records of climate change from northeast Arctic Russia (Lake El'gygytgyn) and Antarctica over the past 3-4 Million years provide a new opportunity for understanding the sensitivity of the polar regions to forcings involving natural green house gas variability, changing orbital configurations and associated feedbacks. While geography and transient atmospheric CO2 in excess of preindustrial levels can explain most of the Pliocene warming, the occurrence of Arctic super interglacials without clear pacing documented over the past 2.78 Myrs requires additional explanation. We hypothesize that super interglacials in the Arctic correspond with extremes in insolation leading to the demise of the WAIS. During MIS 11c, 31, 49, 55, 77, 87, 91, and 93 Milankovitch forcing coinciding with extreme lows in eccentricity and high obliquity likely preconditioned the Earth system to synchronize summer melt intensity and duration to produce bipolar warming. This warming likely led to the demise of the WAIS in the Southern Hemisphere and super interglacials in the Arctic Northern Hemisphere. Diatomite layers in the ANDRILL AND-1B record coincide reasonably well super interglacials (Melles et al, 2012) but unconformities in the AND-1B cores prevent direct correlation. The challenge has been to understand how these high latitude sites are linked with changes in ocean circulation and heat transport.

1826

A Transantarctic View of the Plio-Pleistocene East Antarctic Ice Sheet

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The East Antarctic Ice Sheet likely underwent some prominent changes as a result of global cooling from the mid- to late-Pliocene, yet direct evidence from the Antarctic ice margin is sparse. We here present new geochemical provenance analyses on Plio-Pleistocene marine sediment from the CIROS-2 drill site at the mouth of the Ferrar Glacier in the Transantarctic Mountains. Stratigraphic and sedimentological analysis revealed alternating sequences of diamictites and mudstones, interpreted as glacial and interglacial deposits respectively. New radiogenic isotope analyses show distinct provenance variations between these units, which can be directly compared to exposed bedrock samples from the vicinity of the Ferrar Glacier valley. Diamictites are characterised by locally-sourced material throughout the core, while mudstones from the early- to mid-Pliocene show an integrated provenance signature representative of additional lithologies located upstream within the Ferrar Glacier valley. We observe a fundamental shift in the provenance of the interglacial mudstones at ~3 Ma. A more local erosional source in younger sediments may indicate that the ice sheet margin became increasingly stable in the late Pliocene. Comparison of this new CIROS-2 record with other sites in the vicinity (e.g. ANDRILL, IODP Sites U1361 and 1165) will help to build a spatial understanding of the East Antarctic ice sheet at this crucial climate transition.

1877
Meltwater Contributions to Mid to Late Pliocene (3.3-2.6Ma) Global Sea-level

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The mid Pliocene (3.3 -3 Ma) has long been considered an analogue for future warming scenarios with climate conditions of 400 ppm pCO_2, temperatures 2-3 °C higher-than-present and a lack of large-scale ice sheets in the Northern Hemisphere. We present a direct and continuous sea-level record, from a shallow marine margin, Whanganui Basin, New Zealand, derived from a newly developed grainsize water-depth relationship. An integrated age model, independent of the global benthic $\delta^{18}O$ stack, was developed from paleomagnetostratigraphy, tephrochronology and biostratigraphy. Following back-stripping to remove effects of subsidence, our relative sea-level record characterises glacial-interglacial precession-paced fluctuations of 15±5m during the mid Pliocene, and obliquity-paced cycles of 23±5m for the Late Pliocene, not registered to present-day sea-level. Four paleomagnetic reversals allow correlation to orbital time-series, demonstrating sea-level in phase with 65°S summer insolation. We conclude an Antarctic dominated meltwater source eustatic sea-level for the mid Pliocene. An Antarctic ice-rafted debris record also suggest the marine based margins of the Antarctic ice sheets continue to be paced by local insolation (precession) through the Late Pliocene. The emergence of obliquity in the record is driven by developing northern hemisphere ice sheets. Glacio-isostatic adjustment modelling for the mid Pliocene suggests the Whanganui site approximates eustatic sea-level.

1430
A Framework for Understanding the Long-term Andscape Evolution of Antarctica

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The subglacial landscape of Antarctica is less well known than that of the moon or Mars. Much of our understanding of its evolution derives from land exposed at the coast, but the geomorphological record that lies beneath the ice holds significant potential for understanding changes in the Antarctic. As knowledge of modern bed topography increases yearly, we present a framework for using it to test hypotheses of interactions between plate movement, tectonics, surface processes and glacial erosion. We suggest that the landscape evolution of Greenhouse Antarctica before ca.34 Ma, has analogues with typical passive margin evolution (e.g. Australia), displaying feedbacks between base-level change, fluvial erosion, scarp retreat and marginal uplift. Intense weathering would occur under the warm conditions, and flat regions near the coast would form via surface wash. In Icehouse Antarctica, we propose that expansion and contraction of ice produced waves of warm-based erosion which were most effective where flow directions were maintained regardless of ice sheet scale, and where pre-glacial topography steers ice. There may be thresholds of glacial behaviour whereby topography controls significant jumps in ice volume between mountain icefields and ice sheet glaciation. Glacial erosion occurs over long timescales so marine-based beds continually deepen and become more reverse-sloped. We therefore suggest the modern ice sheet is more sensitive to climate changes than in the past.

745
Long-term Landscape Evolution of the Wilkes Subglacial Basin, East Antarctica

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Reconstructions of the bedrock topography of Antarctica since the Eocene-Oligocene Boundary (ca. 34 Ma) provide an important boundary condition for modelling past Antarctic ice sheets. This is particularly vital in regions where the bedrock presently lies below sea level, since these sectors are thought to be most vulnerable to future change. Here we use 3D flexural modelling to reconstruct the evolution of the topography of the Wilkes Subglacial Basin and Transantarctic Mountains, which are situated beneath the East Antarctic Ice Sheet. We estimate the spatial distribution of glacial erosion and restore this material to the topography, which is also adjusted for the associated flexural isostatic responses. We constrain our erosion estimates and the pace of landscape evolution since 34 Ma using offshore sediment stratigraphy. In our reconstructions, the 2 km-deep troughs within the Wilkes Subglacial Basin were much shallower at the Eocene-Oligocene Boundary due to the restoration of selectively eroded material. Our models provide a better-defined boundary condition for modelling early ice sheets, and show that the majority of glacial erosion and landscape evolution occurred prior to 14 Ma, which we interpret to reflect a more dynamic and erosive early East Antarctic Ice Sheet. Our flexural modelling shows that the inherited (pre-34 Ma) topography is consistent with long-wavelength elastic plate flexure and influenced by the inherited crustal structure.

1910
Glacial Geomorphic Features: West Antarctic Seafloor and Subsurface Barents Sea

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Analysis of subsurface geomorphic features, found beneath the modern-day seafloor, can illustrate past ice-sheet characteristics from before the last glacial maximum. Such analysis is not possible in the Antarctic but petroleum industry 3-D seismic data from Arctic Norway allow such subsurface mapping at a scale comparable to low-resolution multibeam swath bathymetry grids. This study uses detailed interpretation from 3-D seismic data from the Barents Sea to identify glacial features formed following the onset of glaciation across the region, around 1 Ma. A series of parallel, evenly spaced glacial lineations ranging from 0.5-10 km long, minimum length, and trending northwest-southeast, has been identified. The seafloor surface picked on 3-D seismic shows evidence of iceberg scours carved by drifting icebergs that formed following ice-sheet retreat after the LGM. In our data, iceberg scours have only been identified on the seafloor, and glacial lineations found only in the subsurface. Comparison of glacial features from multiple layers in the subsurface allows examination of the history of ice flow through multiple periods over the last several glacial cycles, with slight reorganization of flow direction between each glacial readvance. We compare the subsurface Barents Sea geomorphology to seafloor geomorphology from multibeam data collected in West Antarctica, where flow direction reorganization is mapped throughout the deglacial period.

1602
New Enhanced-resolution Passive Microwave Climate Record for Historical Analysis

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Since 1978, satellite sensors have observed Earth passive microwave emissions. Collected globally both day and night and able to see through most clouds, passive microwave measurements are used to derive significant and meaningful cryospheric climate records at high latitudes and high elevations, including sea ice concentrations, snow water equivalent and snow and ice melt onset. Until now, spatial resolution of historical products has been relatively coarse. Historical gridded passive microwave data sets did not meet many requirements of climate data records, most notably in intersensor calibration and consistent processing methods. Original gridding techniques for these data were relatively primitive, produced on 25 km grids using the original EASE-Grid definition that is not easily accommodated in modern software packages. Funded by NASA MEaSUREs, we have processed SMMR, SSM/I-SSMIS and AMSR-E (1978-2016) as gridded Earth System Data Records using state-of-the-art image reconstruction methods. The improved spatial resolution, enhanced to 3 km for the highest-frequency channels, is enabling new analysis of the sea ice concentration and SWE records, especially in mountainous regions that had not previously been possible. We will summarize the methods used to improve spatial resolution and include examples of melt onset detection and melt onset variability in the high-relief Upper Indus Hunza basin (13,000 sq. km, at 36N, 74E).

1605
Thermodynamic Technique for Estimating Ice Thickness from a Moving Icebreaker

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Ice thickness is a crucial parameter for coupled modeling on many time scales, for understanding ice evolution, and for the increasing polar operational maritime navigation. Correct ice thickness initialization has been recently identified as having the greatest impact on seasonal sea-ice forecasting, and even on seasonal terrestrial temperature anomalies. The proposed thermodynamic technique has previously been used with satellite measurements, but its use from an icebreaker allows elimination of some key assumptions and derived quantities to be directly measured. Measurements of the surface temperature over sea-ice in combination with measurements of surface energy budget terms allows the retrieval of ice thickness through inversion of a thermodynamic model. High temporal-resolution data, including the surface energy budget, from the Sea State research cruise in autumn 2015 are used for the ice thickness retrieval and validation. This cruise provides three other sources of independent measurements/estimates of ice thickness to be used as validation, including 1 Hz data from an electromagnetic device. The resultant 1 Hz ice thickness data set provides a resolution of approximately 3 m along the track of the ship. Ice statistics parameters, such as ice concentration, derived from the thicknesses have a nominal resolution of 2 km. This provides a unique data set with numerous scientific uses, a few of which will be illustrated.

1954
An New Algorithm to Detect Blowing Snow from Ceilometers in East Antarctica

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Surface mass balance (SMB) strongly controls spatial and temporal variations in the Antarctic Ice Sheet (AIS) and its contribution to sea level rise. The current scarcity of observational data and the challenges of climate modelling over the ice sheet limit our understanding of the processes controlling AIS SMB. Particularly, the impact of blowing snow (BS) on local SMB is not yet constrained and is subject to large uncertainties.
Tho assess the impact of BS on local SMB, we investigate the backscatter profiles from ceilometers at two East Antarctic locations in Dronning Maud Land. In addition to the traditional cloud base height and vertical structure retrievals, these instruments also provide information on the particles present in the boundary layer. We developed a new algorithm to detect BS from the ceilometer attenuated backscatter.
BS detection is also possible by satellite imagery: the near-surface BS layers are apparent in CALYPSO lidar backscatter profiles and enable BS events detection. However, the remote sensing detection of these events is limited to minimal BS layers thicknesses of 20-30 m. In addition, thick clouds, mostly occurring during winter storms, can impede BS detection from satellite products while the algorithm indicates that the majority of these events occur together or shortly after a storm. We will compare both ceilometer and satellite detections of BS, and present case studies focusing on the days when concurrent and divergent retrieval occur.

1957
Calibration and Validation of SARIn Radar Altimetry for Mass Balance Estimation

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Cryospheric applications of radar altimetry are hampered by spatiotemporal variability of signal penetration into snow, and uncertainties in the location of the Point of Closest Approach over sloping glaciers, ice caps, and ice sheet margins. The SARIn mode of the SIRAL instrument onboard ESA's CryoSat-2 allows Doppler and Interferometric processing, overcoming the latter limitation, and providing spatially extensive measurements of ice elevation. However, strong backscatter from within the snowpack, as well as underlying firn and glacial ice has the potential to lead to a 'radar elevation' which is below the physical surface. Airborne and field-based calibration and validation campaigns are necessary to assess this bias, allowing more precise calculation of elevation change and mass balance. Here, we present results from the 'Radar altimetry for ice mass balance - impact of melting and refreezing in the snowpack' project, which aims to derive optimum techniques for elevation change estimation over glaciers and ice caps in different climatic regimes, using Austfonna, Svalbard as an analogue for melt-affected snowpacks in the Arctic, and ice rises on Fimbulisen, Antarctica, as an analogue for dry snowpacks. In particular, we focus on bias estimation through the comparison of radar elevations with co-located GPS and Airborne Laser Scanner elevations from Svalbard and Antarctica. Additionally, we highlight glaciological results from Svalbard and Dronning Maud Land, Antarctica.

2409
A Decade of Changes of Glacier Facies Extents on Hansbreen (Svalbard)

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Extents of glaciers facies can facilitate estimations of glaciers mass balance and assessment of their drainage systems. In addition, changes in facies spatial distribution in time are indicative of glaciers response to the warming climate of the Arctic. Especially advantageous for distinguishing glaciers facies are Synthetic Aperture Radar (SAR) satellite sensors, which are sensitive on surface characteristic and independent on sunlight. However, due to complexity of SAR data, in situ measurements are recommended for their validation. For verification of glaciers facies determination both Ground Penetrating Radar (GPR) and shallow ice cores are very valuable source of information.
In our study, we analysed both SAR and in situ data in order to distinguish extends of facies of Hansbreen during last 10 years. Analysis included both simple classification of single- and dual-polarisation SAR data (thresholding, unsupervised classifications) and advanced analysis of fully-polarimetric images (H-α segmentation). For validation purposes we visually interpreted GPR data and applied Internal Reflection Energy (IRE) coefficient, sensitive on glacier's subsurface characteristic. Shallow ice cores provided additional information on the thickness and character of the facies and helped to assess the GPR visual interpretation. As a result, we present changes of Hansbreen's facies during last 10 years with a description of advantages and limitations of SAR sensors and methods of analysis.

2681
UAV Multispectral Remote Sensing of Sub-arctic Ponds (Nunavik, Canada)

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Thaw ponds are frequent features in Arctic and Sub-Arctic wetlands associated with degrading ice-rich permafrost. They show strong biogeochemical dynamics and are important players in the carbon cycle. Arctic warming is accelerating thaw, affecting whole landscapes and influencing hydrology and soils, generating new conditions for ecosystems and human activities. Significant changes have been affecting the tundra-forest boundary, with a marked increase in both tree and shrub formations.
Identifying small ponds using remote sensing is an important challenge for quantifying the processes affecting polar wetlands. The launch of Sentinel 2-A in 2015 and Sentinel 2-B in 2017 (S2 - 10 m resolution), that followed Landsat 8 (L8 - 30 m resolution) in 2013, offering revisiting times of a few days, opened a new breadth of possibilities for monitoring and advancing the understanding of remote Arctic and Sub-Arctic regions. Two field surveying missions were conducted in the summers of 2015 and 2017 in the sporadic and discontinuous permafrost zones (Kuujjuarapik and Umiujaq, Nunavik) using an Unmanned Aerial Vehicle (UAV) and a multispectral camera. The high spatial resolution (ci 15 cm) and spectral quality of the imagery provides ground truthing and allows assessing the quality of Landsat-8 and Sentinel-2 imagery and their accuracy for regional assessments of landcover, including lake colour.

OS-2b - Interdisciplinary research on sea-ice biogeochemistry and associated ecosystems
20.06.2018 11:00-12:30, A Wisshorn

231
Sea-ice Phenology in a Warmer Arctic

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Future projections of Arctic sea-ice changes are alarming, but the response of the ice-associated biological community is still uncertain. Here we investigate future changes in timing and intensity of primary production in Arctic first-year ice using a combination of climate and sea-ice biogeochemistry models. Overall, model results suggest a general increase in sea-ice primary production at all latitudes during this century. However, the projected phenological changes are not as quasi-monotonic as the changes in physical drivers. Three latitudinal clusters are identified and distinctly explained by snow cover thinning at the lowest latitudes, biological time windows narrowing in the mid latitudes, and ice seasons advancing towards more favourable photoperiods at the highest latitudes. When considering the changes in ice extent, the increase in sea-ice production at the highest latitudes is boosted due to significant first-year ice expansion at the expense of multiyear ice. The projected changes in sea-ice primary production suggest potential far-reaching consequences for the whole Arctic marine food web.

1777
Scales of Variability of Sea-ice Algae in Spring: Observations and Model Results

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Sea ice provides a stable environment for algae growth and survival. In the Arctic Ocean, ice associated algae guarantee a food source for sympagic and pelagic biota. The rapid decline of Arctic sea ice and the changes in its physical structure will lead to a new biological environment causing shifts in sea-ice algae dependent ecosystems. The impact of these changes on ice algae distribution and production can be quantified on large scales by sea ice numerical models. These models need data for calibration, comparison and parameterization of processes. Due to the high variability of sea-ice physical, chemical and biological properties, field sampling and representative model output of ice algae are challenging. In this work we present data from a 2-weeks ice station in the Arctic Ocean in spring 2017. Sea-ice algal chl *a* has been sampled at different spatial scales to asses its variability, and to determine any relationship of sea ice algae distribution with the variability of physical and chemical sea ice properties in spring. In addition, this work focuses on the study of ridged and deformed ice. We present a characterization of the biophysical environment of ridges in terms of temperature, salinity, nutrients, biomass. The results are used to assess the importance of ridges for the total biomass. We upscale the along-transect variability of sea-ice algae on a floe scale and on the average grid length of sea-ice-ocean numerical models to compare with recent model results.

2195
Progress in Modelling Coupled Sympagic-pelagic Ecosystems in the Canadian Arctic

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We will summarize recent progress in coupling sympagic (ice-associated) and pelagic ecosystems using 1-D and 3-D model approaches. The 1-D model studies highlight processes relevant to adequately represent ice algal growth, as well as carbon and sulfur fluxes. Important processes include ecosystem productivity, ice growth (via brine transport) and melt, and air sea exchange. 3-D model studies highlight gaps and issues when transferring parameterisations from 1-D to 3-D as well as preliminary results with respect to ice algal and pelagic primary production and air-ice-sea sulfur and carbon exchanges.

2090
Winter to Summer CO_2 Chemistry in Antarctic Sea Ice

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The west Antarctic Peninsula is a highly productive ecosystem where sea ice plays an important role in biological processes and the biogeochemical cycling of carbon and other elements. Carbon dioxide (CO_2) chemistry in sea ice and under-ice water was investigated to examine ice-ocean exchanges from austral winter to summer in the Antarctic coastal zone. Algal production and CO_2 uptake reduced winter concentrations of inorganic carbon (C_T) to less than 200 µmol/kg within the ice pack. Sea ice total alkalinity (A_T) reached lowest values (< 100 µmol/kg) during melting of the sea ice. Processes in the sea ice such as brine rejection and carbonate ($CaCO_3$) mineral precipitation also affected the carbon chemistry, increasing the A_T-C_T ratio in the ice to >1.5 from winter to summer. Nitrate concentrations at the ice-water boundary were enriched compared to bulk ice by late summer, likely resulting from re-supply from underlying ocean waters and sustaining ice-algal C_T uptake. Biological production and $CaCO_3$ dissolution during sea ice melt increased the A_T-C_T ratio in the under-ice water by late summer. Concomitant reduction in sea surface CO_2 enhanced CO_2 uptake upon retreat of the ice pack. Wintertime remineralisation of organic matter contributed to enhanced inorganic carbon and nitrogen in the snow-capped sea ice. This study reveals intense biogeochemical cycling in Antarctic sea ice to help to further elucidate the role of sea ice and ice-ocean interactions in a changing climate.

699
Seasonal Evolution of Light Transmission through Central Arctic Sea Ice

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Light transmission through sea ice has been identified as a critical process for energy partitioning at the polar atmosphere-ice-ocean boundary. Transmission of sunlight influences direct sea ice melting by absorption, heat deposition in the upper ocean, and in particular primary productivity. The recent years have seen an increase in spatially distributed light measurements underneath sea ice using remotely operated vehicles. These measurements allow us to reconstruct the seasonal evolution of the spatial variability in light transmission. Here we present measurements of sea ice light transmittance from 6 years of polar ROV operations. The dataset covers the entire melt cycle of Central Arctic sea ice. This data from multiple years is combined into a pseudo timeseries describing the seasonal evolution of the changing spatial variability of sea ice optical properties. Snow melt in spring increases light transmission continuously, until a secondary mode originating from translucent melt-ponds appears in the histograms of light transmittance. This secondary mode persists long into autumn, before snow fall reduces overall light levels again. Comparison to several autonomous time series measurements from single locations confirms the detected general patterns of the seasonal evolution of light transmittance variability. These results will allow further insights on the validity of radiation transfer parameterization used in ice-ocean models.

1778
Review on Status and Changes of the Barents Sea System

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As a part of the new Norwegian research project “Nansen Legacy”, involving eight Norwegian governmental and two private research institutions (https://site.uit.no/nansenlegacy/), a scientific review about the status and changes in the Barents Sea System is developed. We will present first results from this synthesis, focusing on the physical, biological and biogeochemical systems. The review is based on recent peer-review publications about the region, with additional use of publically available longterm monitoring data, such as satellite-based sea ice extent. The Barents Sea represents both geographically and temporarily a gateway to a changing Arctic: It is connected to the Arctic Basin in the central Arctic and ocean currents, sea ice drift and ship traffic illustrate this connection. One question scientists work with is to what extent the Barents Sea can be seen as a sentinel for current changes that in a similar way could happen in the future in other Arctic regions. The Barents Sea is highly relevant as a part of the climate system, as a habitat, and within socio-economics. It is exposed to natural forcing and direct or indirect human impacts, and it is is changing relatively fast, compared with other Arctic regions. We will present examples of such changes and relevant processes, including results from numerical modelling.

CR-3c - Cryosphere-Hydrosphere interactions: The water cycle at the three Poles
20.06.2018 11:00-12:30, B Parsenn

649
Global-scale Hydrological Response to Future Glacier Mass Loss

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Worldwide glacier retreat and associated future runoff changes raise major concerns over the sustainability of global water resources, but global-scale assessments of glacier decline and resulting hydrological consequences are scarce. Here, we compute global glacier runoff changes until 2100 for three greenhouse gas emission scenarios and analyze the glacial impact on streamflow for 56 large-scale glacierized drainage basins on Earth. In roughly half of the investigated basins modelled annual glacier runoff continues to rise until a maximum (´peak water´) is reached, beyond which runoff steadily declines, while in the remaining basins this tipping point has already been passed. Peak water occurs later in basins with larger glaciers, higher ice-cover fractions, and at higher latitudes. Most basins experience future glacier runoff increases in early summer but decreases in late summer. Although most of the 56 basins have below 2% ice coverage, by 2100 one third of them might experience runoff decreases greater than 10% in at least one melt season month due to glacier mass loss. The reductions are largest in central Asia and the Andes, hence exacerbating future water stress in these regions. We conclude that even in large-scale basins with minimal ice-cover fraction, the downstream hydrological effects of continued glacier wastage can be substantial, but magnitudes vary greatly among basins and throughout the melt season.

753
Pan-Third Pole Environment (Pan-TPE)

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Tibetan Plateau and its surrounding areas are known as the earth's Third Pole (TP). Major environmental changes are taking place on the TP characterized by complex interactions of atmospheric, cryospheric, hydrological, geological and environmental processes. We identified three modes of the modern westerlies-monsoon interaction system based on variation patterns of precipitation stable isotopes on the TP: Indian monsoon mode, westerlies mode and transition mode. The three modes directly affect environmental changes on the TP. We found the largest retreat of glaciers in the monsoon mode on southern TP, moderate retreat in the transition mode on central TP, and the least retreat, or even slight advance in the westerlies mode on northwestern TP. Further study shows that the enhancing westerlies against the weakening summer monsoon is the major driver of regional differences in environmental changes on the TP.
As TP research goes further, the Third Pole environment is not isolated, interacting with the changes in the Northern hemisphere and even the Arctic and Antarctic. The new program, called Pan-TPE, works to characterize the scenarios of monsoon-westerly interaction and its implications, the water-ecosystem interaction and oasis sustainability, as well as human and disaster impact on environment and consequent uncertainties, regarding earth system behavior in Pan-TP. It endeavors to map out a coordinated strategy for regional sustainable development with scientific vision.

1503
Impact of a Global Temperature Rise of 1.5 °C on Asia's Glaciers

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Glaciers in the high mountains of Asia (HMA) play a substantial role in regional water resources. In general, these glaciers have been losing mass over the last decades, a trend that is most likely to persist in the future. In 2015, 195 nations signed the “Paris Agreement” and agreed on efforts to limit the global temperature rise to 1.5 °C. It is unknown, however, how much of Asia's ice will be lost under a 1.5 °C temperature increase, or under more extreme temperature scenarios. To determine this, we modelled all individual glaciers in HMA larger than 0.4 km^2 transiently up to 2100 using the entire CMIP5 ensemble within a Monte Carlo framework to account for parameter uncertainty. Only a handful of the climate models project a global temperature rise of 1.5 °C. Under such a scenario HMA warms stronger than the global average (2.1±0.1 °C). By the end of the 21st century, the 1.5 °C scenario results in a 36±7% mass loss relative to the present-day ice mass. Mass losses projected by RCP4.5, RCP6.0 and RCP8.5 ensembles are considerably higher with 49±7%, 51±6% and 65±6%, respectively. Results also show large regional differences, which are primarily caused by differences in debris cover, ice mass, observed mass balance, and glacier sensitivity to climate perturbations. We conclude that even under the ambitious 1.5 °C scenario over one third of HMA's glacier mass will be lost by the end of century, and that the difference with more likely scenarios is considerable.

903
Fate of Glaciers on the Tibetan Plateau by 2100

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As the third polar on the Earth, the Tibetan plateau holds more than 40,000 glaciers which have experienced a rapid retreat in recent decades. Glacier loss has increased concern for water resources around the Tibetan plateau. The variability of equilibrium line altitude (ELA) indicates expansion and wastage of glacier directly. Here we simulated the ELA variability in the Tibetan Plateau based on a full surface energy and mass balance model. The simulation results are agreement with the observations. The ELAs have risen at a rate of 2-8m/a since 1970 throughout the Plateau, especially in the Qilian Mountain and the southeastern Plateau where the ELAs have risen to or over the top altitude of glacier, indicating the glaciers are accelerating to melting over there. Then the future ELA variability on the Tibetan plateau are forecasted in the scenarios of RCP2.6, RCP4.5 and RCP 8.5 given by IPCC. The results show the ELAs of most glaciers will arrive to its maximum in around 2040 in RCP2.6. While the ELAs will be over the top altitude of glaciers in the eastern Plateau in 2040-2050 in RCP4.5 and RCP8.5, suggesting most of the glaciers on the Tibetan Plateau will accelerate to melt until to disappear by the end of 2100.

1365
Possible Impacts of Black Carbon on Water Cycle Pattern over the Third Pole

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Water cycle pattern over the Third Pole has been changed apparently since the early-1990s. Stabilization even advance of glaciers and expansion of lakes accompanied with an increase of precipitation were found in the northwest Third Pole dominated by westerlies, in contrast to an accelerated decline of glaciers and lakes led by a decrease of precipitation in the south and east controlled by Indian monsoons. Despite its far-reaching influence on regional water supply, the reason is unknown. Here, we propose black carbon (BC) may have a dominating contribution to the different water cycle patterns in the Third Pole, demonstrated by 8 sequences of BC concentration for the last 150 years documented in ice cores. We found BC concentration has decreased by half since the early-1990s in westerly domain, while doubled in Indian monsoon region due to an increased emission in South Asia. It indicates BC effect on glacier melt has been greatly reduced in westerly domain, but increased in monsoon region, as well as its effect on rainfall suppression by interacting with clouds, especially an effect called “cloud-top gathering BC” in our new finding. The opposite trends of BC content in both glacier and atmosphere can explain the different water cycle patterns in the same background of global warming. We suggest reducing BC emission in South Asia can effectively mitigate glacier melting and increase precipitation in Indian monsoon region as happened in the westerly domain.

1970
The Role of Vegetation Dynamics in the Water Cycle over the Pan-Third Pole

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Changes in terrestrial vegetation could modulate the water cycle, with direct impacts on changes in soil moisture, evapotranspiration, streamflow and regional precipitation. The pan-Third pole vegetation has witnessed significant variations over the past several decades. However, analyses of the impacts of vegetation changes on the water cycle has so far been lacking over this region. Here we examined consequences of the two contrasting scenarios of vegetation changes (vegetation restoration and degradation) on the water cycle. The first case is to quantify the impact of large-scale ecological restoration program implemented in the headstream region of Yangtze River since 2000. Our analyses showed that grassland restoration in the headstream reduces the streamflow and increased evapotranspiration (ET), which improves local soil water conditions but undercuts any gain in downstream water resources associated with precipitation increases. The second case is to understand the role of deforestation in driving the long-lasting drying trend that is widely observed in the South Asian monsoon region of the pan-Third pole. We indicate that deforestation is the second primer driver of summer drying trend over the 20th century, while increasing aerosol emissions primarily contribute to this drying trend. Our results from these two case studies highlighted the importance of vegetation changes in understanding the past and future evolution of the water cycle over the pan-Third Pole.

BE-6b - Ongoing change in terrestrial and freshwater ecosystems of Polar Regions
20.06.2018 11:00-12:30, B Jakobshorn

2141
Causes of Multi-decadal Environmental Change near Toolik Lake, Arctic Alaska

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Long-term data near the Arctic LTER site in arctic Alaska show 40 years of environmental change on land and in surface waters. While some changes have been substantial (e.g., a doubling of alkalinity in Toolik Lake and an increase in permafrost temperatures and NDVI), other changes are small or undetectable. In addition, changes in the drivers of these trends, e.g., increases in air temperature or mean catchment thaw depth, have been muted. Clearly these terrestrial and aquatic ecosystems are vulnerable to change, and the stressors causing the changes are either undiscovered or hidden from our ability for detection. One hypothesis to explain the variability in ecosystem response is that certain changes are integrating the effects of a climate signal on multi-year to decadal time scales, acting as a medium-pass filter of climate that reduces the signal variability yet allows the effects of long-term warming to emerge, as seen in the alkalinity, NDVI, and permafrost temperature records. Other likely effects of climate change on the landscape are seen in dramatic land-surface disturbances such as thermokarst failures and tundra fires, which have the potential to rapidly alter land and water biogeochemistry and may result in larger transformations than will the steady trends of climate change. Similar environmental changes may be occurring in unmonitored regions of the Arctic, even when the obvious drivers of climate have changed little over time.

1543
Groundwater Exchanges on the Land Surface Control Stream Chemistry in Permafrost

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The mechanisms for export of dissolved carbon (C) and nitrogen (N) from land to rivers and lakes are poorly understood in arctic landscapes. In watersheds with continuous permafrost, overland flow at high discharge is thought to dominate export. We show here that surface microtopography drives overland flow into the ground, where surface water exchanges with soil waters having higher C and N concentrations. These surface-subsurface exchanges in the seasonal shallow aquifer control dissolved organic C and N export, regardless of whether the landscape is saturated or inundated by overland flow. Combined with rapid leaching of organic matter in shallow soils, these vertical exchanges explain the relatively constant dissolved C and N stream concentrations observed across a wide range of stream discharge. The dominance of groundwater influence on surface water C and N export, and the response of these transport and exchange mechanisms to ongoing permafrost thaw, is key to the fate of organic C and N stored in arctic soils.

645
How Do CO_2 and CH_4 Effluxes from Toolik Lake Change with Climate Change?

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Effluxes of CO_2 and CH_4 from Toolik lake, northern Alaska, during the ice-free season were measured from 2010 to 2015 using the eddy covariance technique. Measurements were made on a floating platform ca. 400 m from the lake shore. Our measurements are thus representative of the open water where the lake is deep enough to show a distinct thermal stratification throughout most of the ice-free season (typically end of June to mid-September). We analyzed the relationship between daily aggregated CO_2 and CH_4 fluxes and lake level height, hypothesizing that a low lake level would increase gas evasion from the lake and thus enhance the fluxes of these two greenhouse gases. Our measurements however showed that (a) ebullition of gases from bottom sediments was not detectable with a sonar device, thus indicating that diffusive fluxes are dominating total efflux; that there is a significant increase of (b) daily CO_2 effluxes with increasing lake level ($p=0.029$); and (c) of CH_4 fluxes with increasing lake level ($p=0.005$). Over the 28 years of continuous lake level measurements a significantly decreasing trend of 1.0 ± 0.2 cm per year was observed (except for the annual maximum lake level), which suggests that CO_2 and CH_4 effluxes should slightly decrease over time if this trend continues. This actual trend is in contrast to predicted increases in precipitation by 2100, which should increase rather than decrease the lake level, thereby increasing CO_2 and CH_4 effluxes.

307
Variability of Ecosystem Connectivity in the McMurdo Dry Valleys, Antarctica

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The McMurdo Dry Valleys are the largest ice-free area of Antarctica, made up of exposed soils, glaciers, streams, and ice-covered closed-basin lakes. The connections among these landscape units facilitate the movement of energy, mass, and biota - largely driven by physical processes of glacier melt water transport and aeolian transport. Glacial melt occurs during a 6-10 week period in the austral summer, with significant interannual variability. Aeolian transport, however, typically occurs during strong foehn events, which are most common during the austral winter. Despite these two primary modes of transport being out of phase, their impacts are most significant during the austral summer, when biological activity is the highest. Here we explore the ecosystem impacts of these differential connections.

1684
The Ecology of Small Glacier Animals: A Case Study from the Arctic

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Unique freshwater environments, called cryoconite holes, occur globally on the surface of glaciers. They are predominantly water filled and frozen throughout the winter and can cover up to 10% of the ablation zone of a glacier. These microhabitats host diverse viral, prokaryotic and eukaryotic life forms and are among the most productive ecosystems in the Polar Regions. The organisms living within the holes are able to cope with cold, dryness, strong winds and low levels of nutrients, and include small grazing animals such as rotifers and tardigrades. Whilst the autotrophic and bacterial communities have received considerable attention over the past decade, the grazing predators and their role on the cryoconite community composition and productivity remains an enigma.
These small animals occur in high numbers in cryoconite holes in Petuniabukta glaciers, Svalbard, and are likely to play a key role in recycling of nutrients, which is extremely important in sustaining the physiological functioning of the autotrophic and bacterial communities. The aim of this project is to understand the role of small grazing predators (rotifers and tardigrades) on the ecology of the cryoconite holes by assessing their effect on biogeochemical cycling and ecosystem production within the cryoconite communities.
Initial findings showed that nutrient levels related to recycling of limiting nutrients are the main factor driving variation in the community structure of microalgae and grazers.

2145
Roles of Hydrologic Variability in Understanding Arctic River lTemperature

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Understanding the dynamics of heat transfer in arctic rivers is critical for forecasting the effects of climate change on river temperatures. Building on the collection of five years of data throughout the Kuparuk River basin in Alaska, USA, spanning dry to wet summer seasons, we have adapted a dynamic river temperature model to quantify heat fluxes during varied hydrologic conditions in order to understand drivers of thermal change in arctic systems. We have identified hydrologic conditions where the dominant heat fluxes shift from lateral inflows, to solar radiation, to hyporheic exchange. We found that accounting for the mass contribution of lateral inflows throughout the basin was critical during high flow periods. However, the lower order portion of the basin is more sensitive to the temperatures assigned to these inflows. Under lower flow conditions, temperatures in the lower order portion of the basin also shift from a high dependence on lateral inflows to one relying primarily on air-water or surface heat exchanges. During the lowest flow conditions, the system is still dependent on these surface heat fluxes, but the heat transfer with the bed sediments, primarily via hyporheic exchange, rivals their influence and significantly buffers instream temperatures. Together the data and modeling results provide insight into the potential influences of the changing climate and the associated hydrologic shifts in areas of continuous permafrost.

AC-1e - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions
20.06.2018 11:00-12:30, C Sanada I

246
Arctic Cloud Residual and Ambient Aerosol Properties Measured during ACLOUD

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Supercooled or mixed-phase clouds are suspected to contribute considerably to the amplified warming of the Arctic. Thus, it is studied which arctic aerosol particles are involved in their formation during the aircraft-based field campaign ACLOUD, part of the German arctic research project (AC)[3]. In May/June 2017 cloud particles of low and mid-level clouds were sampled by means of a Counterflow Virtual Impactor inlet (CVI) aboard the Polar 6 aircraft in order to characterize their cloud particle residues (CPR), which are closely related to the original cloud condensation and ice nuclei. Number density, size distribution, chemical composition and mixing state of the CPR are determined to derive which aerosol particles form the arctic clouds. A case study reveals that all particles larger 150 nm are activated and that the 50% activation diameter is around 115 nm.
Beside these in-cloud investigations, it is of great importance to infer the origin of the cloud forming particles (natural vs anthropogenic, local vs long range transported) by measuring the vertical profiles of the same aerosol parameters from below cloud inside the boundary layer across the inversion up to the free troposphere operating the CVI as aerosol inlet. First results show particle number accumulation at the lower inversion, depletion above the cloud layer and a strong increase in long-range transported pollution layers. Absolute values of the BC mass concentration are found to be in the order of 50 ngm^{-3}.

1041
ACE-SPACE: Overview of Southern Ocean Aerosol and Trace Gases Measurements

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The main purpose of the 'Study of Preindustrial-like-Aerosol Climate Effects' (SPACE) was to conduct a comprehensive aerosol and trace gas characterization during the Antarctic Circumnavigation Expedition (ACE) from December 2016 to March 2017 in partly unexplored areas of the Southern Ocean. The data are not only of interest to understand atmospheric processes under pristine conditions, but also particularly to validate satellite retrievals of aerosol properties and model simulations, which are both essentially unconstrained in that region.
Here, we will present aerosol microphysical and chemical characteristics, discuss particle origin and trace gas correlations. Important factors influencing aerosol properties were different meteorological conditions, the thermodynamic structure of the boundary layer and ocean microbial regimes. For example, the leg between South Africa and Australia experienced a series of low-pressure systems characterized by a large fraction of Aitken mode particles, hinting at downward mixing of particles processed in the free troposphere. Near the west Antarctic coast larger particles were found and associated with Antarctic air masses and potentially cloud processing. They also contained methane-sulfonic acid. First results of a model-measurement intercomparison will be shown as well.
Note, there will be two more ACE-SPACE contributions on cloud condensation nuclei and new particle formation specifically.

1771
Aerosol and Surface Snow Chemical Composition at Dome C from 10-yr Long Records

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Chemical composition and the physical parameters of the atmospheric aerosol in the Antarctic plateau provide basic information on the main natural inputs, tropospheric transformation and long-range transport processes of the aerosol components. In addition, chemical and physical processes occurring at the atmosphere-snow interface are yet not fully understood and work is needed to assess the impact of atmospheric chemistry on snow composition and to better interpret ice core records there retrieved.
Thus, simultaneous aerosol and surface snow sampling was set up and run at Dome C station (75° 06' S; 123° 20' E, 3233 m a.s.l) all year-round over 2004-2013. Aerosol and snow samples were analyzed for main and trace ion markers, in order to study the extent and timing of main aerosol sources as sea salt (open ocean/frost flowers/blowing snow), biogenic production, crustal input, as well as transport
(e.g. free troposphere, stratosphere-troposphere exchange) and atmospheric reaction processes
(e.g. neutralization, chemical fractionation).
A comparison with ozone and solar irradiance measurements, carried out continuously over the same time period, is also attempted to better constrain the atmospheric processes involving the atmosphere-snow exchanges of N-cycle species.
Moreover, preliminary results achieved in the framework of a PNRA project (LTCPAA), started in 2016 and continuing the previous 10-yr long sampling and direct measurement activity, are presented.

1924
Full System Characterization of a Summer to Winter Transition

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Measurements of turbulent and radiation fluxes, CO2, equivalent black carbon, aerosol sizes/concentrations, meteorology and surface and near-surface temperatures are presented for a period during the fall freeze-up period in 2013 at Tiksi, Russia. The measurements are assessed in the context of cloud forcing, the first snow accumulations, and more winter-like, synoptic transport patterns and aerosol transports for expected and unexpected correlations and dependencies. Four episodes of precipitation occurred, one synoptically driven warming event, and 3 clear sky events which clearly impacted the timing of freeze up. The snow that accumulated on the ground during the precipitation periods was important as it acted as an insulator and essentially shut off communication between some atmosphere and surface for processes such as turbulent, radiative and CO2 fluxes. For some components of the system the primary control was advection from either local or remote source regions.One elevated equivalent black carbon (eBC) event was likely the result of long-range transport while two shorter eBC events on were due to contamination from the town of Tiksi (north of the observatory site). Ozone values were impacted by bromine sources from the open ocean - as the adjacent bay froze, ozone levels began to rise to higher winter values. The forcers, responders and feedbacks in the system are evaluated.

1967
Airborne Measurements in the Polar Boundary Layer over Sea Ice during ACLOUD

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In May/June 2017 the aircraft campaign ACLOUD (Arctic CLoud Observations Using airborne measurements during polar Day) has been carried out in the framework of the project $(AC)^3$ over the Fram Strait close to Svalbard. Two polar aircraft of the German Alfred Wegener Institute (AWI) were used during this joint project of the universities Leipzig, Köln, and Bremen, of the AWI, and of the Leibniz institute for tropospheric research (TROPOS). The aircraft were equipped with a large suite of instruments measuring mean and turbulent meteorological quantities as well as cloud particles and aerosol. We show first results of four flight missions that were mainly focusing on the boundary layer over sea ice. We discuss especially the turbulence measurements carried out with both aircraft which have been equipped with identical turbulence probes. It is shown that in general the turbulent fluxes were small as usual during Arctic summer conditions, but that both strongly stable conditions occurred with bulk Richardson numbers up to 0.26 and slightly unstable conditions with upward fluxes. We discuss especially the strong variability (intermittent and wave-like character) of the high resolution wind and temperature data during horizontal flight legs in strongly stable conditions. We further show that vertical flux profiles were nonlinear in the weakly convective boundary layer as a consequence of cloud cover.

2499
Surface Aerosols at Dome C and Comparison with Observations at the South Pole

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In situ aerosol measurements have been conducted at the Concordia station at Dome C (75˚S, 123˚E) on the upper plateau at about 3200 m amsl since December 2007. Part of these measurements have been continuous since then, part of them only for shorter periods. The size distributions in the size range 10 - 600 nm have been measured with a differential mobility particle sizer (DMPS) and with a Grimm Model 1.108 optical particle counter in the size range 0.3 - 15 µm. Air Ion Spectrometer (AIS), that measures charged particle size distributions in the size range of about 0.8 - 40 nm, was operated for almost a year. Light absorption by aerosols was measured with a 3-wavelength PSAP. There was no nephelometer so scattering was calculated from the size distributions using a Mie code. In addition to calculating scattering coefficients from the DMPS data it was calculated from PM1 and PM10 mass concentrations.
A comparison of the aerosol scattering at Dome C and at the South Pole Observatory (SPO) was conducted for 6 consecutive years. Despite being separated by approximately 1400 km some prominent features are visible at both stations at the same time, lasting from some days to a week. FLEXPART simulations show that the BC aerosols observed on the Antarctic upper plateau often have travelled more than 30 days from the sources in the surrounding continents South America, Africa and Australia.

BE-4e - Climate change and ecosystems: physiology, biodiversity and ecological functions
20.06.2018 11:00-12:30, C Sanada II

1114
How will Arctic Algal Bloom Phenology Change in the Future?

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The phenology of Arctic algal blooms in sea ice and water is determined largely by their environment. The Arctic has been changing rapidly during the past decades with a decreasing sea ice cover affecting light availability and ocean stratification. Further, ocean acidification poses physiological challenges that may lead to changes in species composition exacerbated by temperate species being transported towards the Arctic by ocean currents. The FAABulous project (**F**uture **A**rctic **A**lgae **B**looms - and their role in the context of climate change) aims to improve our understanding of how these multiple stressors may affect the timing, species composition and productivity of future algae blooms in the Arctic. It has utilized two model arctic fjord systems with contrasting oceanic and ice characteristics. In a multidisciplinary approach we combined seasonal field observations with high temporal resolution, with experiments and modelling.
First results show that the extent of Atlantic water advection determines the temperature regime and nutrient supply in the two different systems, resulting in large differences in bloom scenarios. Furthermore, experimental work shows a clear physiological response by dominating sea ice diatoms to future stress scenarios that differs fundamentally from their pelagic counterparts. We therefore anticipate profound changes in bloom phenology in the Arctic with cascading implications for higher trophic levels.

2260
Controls on Primary Productivity and Nitrogen Fixation in Arctic Waters

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In recent years, new studies demonstrate that biological nitrogen fixation (BNF) is an unresolved process in Arctic marine ecosystems. Low BNF rates have been measured in the shallow shelves of the Chukchi Sea and areas of the Canadian basin, and nifH genes have been recovered from widespread areas across the Arctic Ocean. However, there remains little to no evidence of BNF activity from offshore Arctic waters. Previous studies suggest that diazotrophic assemblages are potentially dominated by heterotrophic bacteria in Arctic marine waters, and not by photosynthetic cyanobacteria as is common in (sub)tropical oceans. This could imply decoupling between primary productivity and BNF in the photic zone. In the summer of 2017, experiments were conducted during an ice drift campaign in the Atlantic sector of the Arctic Ocean (~82N), north of Svalbard, to test controls on primary productivity and BNF activity. Natural, whole seawater microbial assemblages were amended with glucose and subjected to simple alterations in incoming irradiance to test how these variables may induce or suppress Arctic BNF activity and alter primary productivity. Experimental bottles were incubated in situ on an under-ice mooring line. Together, these experiments aim to elucidate plankton assemblage responses to variations in light and measure stimulations of BNF rates in the Arctic Ocean.

2302
Impacts of Light and Nutrients on Simulated Under-ice Phytoplankton Blooms

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The warming Arctic Ocean and increasing first-year ice cover (FYI) has helped fuel recent attention on under-ice phytoplankton blooms. Here we focus on the response of under-ice phytoplankton growth and taxonomic composition to varying light and nutrient conditions. This study will allow to better understand potential responses of a developing bloom. Experiments were carried out during the 2016 Green Edge ice camp, near Qikiqtarjuak (Baffin Island, Canada). The experiment included mimic of three light regimes (light availability underneath FYI, open water, and open water with an UV-blocking filter) and two nutrient conditions (ambient and doubled ambient concentrations). Experiments were ran from June 17 to July 06. For all ambient nutrient conditions the peak of chl *a* was obtained on day 12, whereas for all doubled nutrients treatments the peak occurred on day 14. However, chl *a* concentrations were significantly higher for conditions under lowlight whereas highlight and highlight minus UV treatments had similar results. All experimental conditions resulted in dominance of *Phaeocystis pouchetii*, but diatom species such as *Thalassiossira spp*., *Attheya spp.*, *Synedropsis hyperborea*, *Cylindrotheca closterium* as well as *Navicula spp*. were also observed to be dominant in different samples. These results highlight the sensitivity of under-ice phytoplankton to rapid light exposure, shedding light on the potential response of a surface under-ice phytoplankton bloom during ice break-up.

1427
Photophysiology of Nitrate Limited Phytoplankton Communities in Kongsfjorden

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In Arctic coastal regions, the phytoplankton bloom is initiated by meltwater induced stratification in spring, while the subsequent depletion of nutrients from surface waters is believed to be a driving factor in phytoplankton succession. A series of nutrient addition experiments showed that the phytoplankton community in Kongsfjorden, Spitsbergen, became N limited from mid-June onwards and co-limitation with P occurred later in summer. The onset of N limitation was followed by a pronounced change in taxonomic composition with a shift in dominance from chrysophytes to haptophytes and a decrease in phytoplankton cell size. Additional measurements of PSII photophysiology and electron transport rates by Fast Repetition Rate Fluorometry (FRRf) showed that the community dominated by chrysophytes was characterized by high PSII efficiency and electron transport rates that were efficiently used for growth. While the taxonomic composition of the phytoplankton community changed, alternative electron requirements became more important and energy was likely allocated to the uptake of nutrients rather than growth. It is suggested that the ongoing changes in sea ice cover and melting of marine terminating glaciers could change the duration and intensity of nutrient limitation in the Arctic with consequences for not only phytoplankton taxonomic composition, but also photophysiology and primary production.

2340
Combined Effects of Light, CO_2 and Iron on Antarctic Phytoplankton

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The Southern Ocean (SO) is an important sink for anthropogenic carbon dioxide (CO_2). Climate change will cause changes in various environmental parameters, which in turn can affect growth and productivity of SO phytoplankton. Due to global warming, sea surface temperatures will increase and lead to a more stratified and shallower mixed layer resulting potentially in higher light availability and enhanced primary production of iron-limited phytoplankton. On the other hand, ocean acidification may reduce the bioavailability of iron to phytoplankton. To examine the influence of iron availability in combination with current and future higher CO_2 concentrations under low and high irradiance on SO phytoplankton physiology, bottle manipulation experiments with a natural phytoplankton assemblage from the Drake Passage were conducted. Ocean acidification led to lowered abundances of *Pseudo-nitzschia* species at both irradiances. While higher irradiance stimulated daily particulate organic carbon production, this stimulating effect, however, was reduced under high pCO_2, but only under iron-limitation. Moreover, the ratio of biogenic silicate to particulate organic carbon remained unchanged by high pCO_2 for both iron treatments under high light, but declined under low light. Gaining more insight on the complex interplay of multiple environmental factors is valuable to predict future responses of SO phytoplankton to climate change.

2182
The Diatom Carbon Sink in a High CO_2 World

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Coastal Antarctic waters are amongst the most vulnerable to ocean acidification, as a result of their cold, well-mixed waters making a disproportionally large contribution to global anthropogenic CO_2 uptake. Changes in oceanic carbonate chemistry have been shown to differentially effect marine microbial communities, in some cases resulting in strong shifts in primary productivity and community composition, both of which have implications for carbon sequestration and biogeochemical cycling. Here we used 650 L tanks to incubate natural Antarctic marine microbial communities at six levels of $f CO_2$ (343 - 1641 uatm). Increasing $f CO_2$ resulted in a shift in the diatom community, with the larger diatoms (>20um) being negatively affected, while smaller diatoms increased in abundance or showed no change. Similarly, photosynthetic capacity of large diatoms declined, while smaller species were unaffected by the high $f CO_2$. There was a strong decline in silicate incorporation rates with increasing $f CO_2$, and total diatom silicification dropped by >60% from the ambient (343 uatm) to the highest (1641 uatm) $f CO_2$ incubation. The loss of larger diatoms and decline in silicification could have broad implications for trophic interactions, primary productivity and biogeochemical cycling, altering carbon sequestration capacity of Antarctic waters. Taken together, these data suggest that in a high CO_2 world, major changes to the future carbon sink can be expected for this region.

OS-6f - Polar Ocean Dynamics
20.06.2018 16:00-17:30, C Aspen

958
Circulation Patterns of the Atlantic Boundary Current along the Svalbard Shelf

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Warm Atlantic water enters the Arctic as boundary current through Fram Strait (West Spitzbergen Current, WSC) and is the major oceanic heat source to the Arctic Ocean. Along the North-Western Svalbard shelf, the WSC splits into the shallow Svalbard Branch, the Yermak Branch that follows the slope of the Yermak Plateau and possibly the Yermak Pass Branch that flows across the plateau.
The WSC has previously been studied using moorings, dedicated oceanographic transects and models. In this study, we mapped the WSC using Vessel Mounted Acoustic Doppler Current Profiler data from multiple surveys and vessels during 4 consecutive summers. Despite the “snapshot” nature of this compiled data set, persistent circulations patterns could be discerned.
We observed a stable northward jet between 79 and 80 °N and the 1000 - 500 m isobath, before the WSC divided into several branches, in all summers. Current profiles West of Svalbard and on the Yermak Plateau showed higher variability than North of Svalbard, which is linked to eddies, recirculation, tides and internal waves. Objective mapping showed a meandering boundary current West of Svalbard and a more homogeneous current centered around the 1000 m isobath North of Svalbard. In our data set, the shallow Svalbard Branch reunites with the Yermak Pass Branch between 10 and 15 °E. Transport estimates are given for several sections and compare well with previous observations and models.

1659
Atlantic Water Properties and Circulation North of Svalbard in a Changing Arctic

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The Atlantic Water (AW) inflow is crucial for the heat and salt budget of the Arctic. Its properties encountered in the Arctic Basin depend on the processes that largely alter the AW layer North of Svalbard.
IAOOS (Ice Atmosphere Ocean Observing System) platforms were deployed during the N-ICE2015 expedition gathering the first winter hydrographic data in the area. They document shallow warm water over the Svalbard continental slope that melts sea ice with ice-ocean heat fluxes reaching up to 400W.m^{-2}. Heat is brought from the AW layer up to the surface through near-inertial waves generated by winter storms, barotropic tides and geostrophic adjustments. Sea ice extent largely differs between winters 2015 and 2016 and can be explained by convection-induced upward heat fluxes suggested by the analysis of 1/12° operational model outputs from Mercator Ocean.
Model is used to examine AW inflow pathways north of Svalbard. It shows an AW winter pathway not much documented before : the Yermak Pass Branch (YPB) across the Yermak Plateau. YPB properties are examined using one-year (2007-2008) of moored ADCP data in the Yermak Pass. The flow is largely dominated by tides. In winter, baroclinic eddies and pulses of AW carrying AW eastward in the Pass are found.
Finally, the model suggests an important mesoscale activity along the AW flow, also suggested by high resolution glider observations performed in summer 2017 across the main AW branches and over the Yermak Plateau.

1857
Satellite-derived Sea Level in the Ice-covered Polar Oceans

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Sea surface height (SSH) is poorly observed in the polar oceans due to a lack of tide gauges, poor coverage by conventional altimeters, and the seasonal or perennial ice-cover. Using recently developed techniques to combine conventional altimetry with SSH retrievals from openings in the ice cover, time series of monthly SSH composites have been produced at both poles. In the Arctic, seasonal freshwater fluxes lead to a large SSH seasonal cycle, and SSH changes in the 2000's reflect Beaufort gyre (BG) freshwater accumulation. Meanwhile, surface circulation intensified and the center of the BG shifted some 300km to the northwest. In the Southern Ocean, the Antarctic Slope Current system is revealed to be a circumpolar feature which is strongest in autumn. Monthly circulation variability in the Ross and Weddell gyres is modulated by the local wind stress curl, which in turn is weakly correlated with the Southern Annular Mode (SAM). There are significant SSH responses to the SAM and the Southern Oscillation; in particular, the 2015-16 El Niño drove sustained negative coastal SSH anomalies, implying shoaling of isopycnals with the potential to deliver circumpolar deep water to the cavities of West Antarctic ice shelves. These data sets provide first looks at seasonal and sub-seasonal SSH variability in the polar oceans and their coupling to atmospheric forcing; extending this data set would provide invaluable observations of how the polar oceans are adjusting under climate change.

2171
Deep-water Upwelling in the Southern Ocean: Spirals, Hotspots, Carbon, and Ice

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Northern Deep Waters upwell in the Southern Ocean, carrying low oxygen, high nutrients/carbon from the Indian/Pacific to the sea surface, as well as warm and relatively saline waters from all oceans and especially the Atlantic. The 3-dimensional upwelling within the ACC is tracked using modelled particles and observations. The global-scale southward spiraling of the fronts is guided by underlying topography, shifting them far northeastwards in some regions, interleaving with regions of southward Sverdrup transport over abyssal plains. The nearly isopycnal upwelling is greatly enhanced at eddy hotspots where the ACC crosses topography. A circumpolar 'upwelling chimney' of carbon and nutrients results in large carbon outgassing to the atmosphere, as shown from a new array of biogeochemical Argo ('SOCCOM') floats and the Southern Ocean State Estimate. These fronts also guide the winter sea ice extent and its variability. Hydrographic observations show stronger penetration of full-depth ACC water into the Amundsen/ Bellingshausen Seas in 2011 compared with 1992, consistent with decreasing sea ice and increasing ice-shelf melt. In contrast, winter sea ice has increased where the southern ACC is topographically locked into northeastward pathways. The standing eddy pattern of ACC poleward heat flux, strengthening winds, and decadal winter sea ice changes are consistent with strengthening circulation along the southern side of the ACC, likely driven by increasing westerly winds.

2518
Distinct Dynamics of Arctic Heat Transport under Climate Change and Variability

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Climate model simulations suggest that ocean heat transport (OHT) into the Arctic is connected to a strong Atlantic Meridional Overturning Circulation (AMOC) under decadal variability (e.g., Zhang 2015). Meanwhile, when driven by greenhouse gas (GHG) forcing, models predict a robust increase in OHT into the Arctic and a high correlation with the degree of Arctic warming (Hwang et al. 2011; Nummelin et al. 2017). Yet, they also simulate a weakening of AMOC under GHG forcing, suggesting that the dynamics linking AMOC and OHT changes under GHG forcing are distinct from that seen under internal variability.
Here, we identify the dynamics governing OHT changes into the Arctic within GHG-forced and pre-industrial simulations of NCAR's CCSM4. We quantify OHT anomalies in terms of 'active' circulation changes versus 'passive' changes (warming advected by climatological currents). Unforced decadal variability in OHT is dominated by AMOC changes to the south of the subpolar gyre, while increased OHT into the Arctic is driven by active and passive gyre circulations in the Nordic Seas.
Under GHG forcing, OHT at 45N decreases as AMOC weakens, while OHT into the Arctic increases due to a combination of climatological overturning and changing gyre circulations in the Nordic Seas. These findings suggest that distinct dynamics control forced and unforced OHT changes, and that links between AMOC and OHT under decadal variability cannot be extrapolated to explain future forced changes.

2536
Metrics for the Evaluation of the Southern Ocean in Climate Models

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The Southern Ocean and its role in, and response to, the ongoing anthropogenic trend varies widely among global coupled climate models and earth system models. Observationally-based metrics are critical for discerning processes and mechanisms, and for validating and comparing climate and earth system models. New observations and understanding, especially those gained from semi-autonomous, biogeochemically-sensored floats (from SOCCOM), have allowed for progress in the creation of observationally-based data/model metrics for the Southern Ocean. These metrics provide a means to assess multiple simulations relative to the best available observations and observational products: climate models that perform better according to these metrics also better simulate the uptake of heat and carbon by the Southern Ocean. Observationally-based benchmarks are essential in order to reduce uncertainties in climate projections, and especially uncertainties related to oceanic heat and carbon uptake.

AC-4b - The Polar Atmosphere and Geospace
20.06.2018 16:00-17:30, A Studio

1499
Developing Synthetic Observation System for Polar Atmospheric Research at PRIC

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The polar regions are the entrances for the solar wind energy entering geospace. A conjugated system for space physics observation has been established at the Antarctic Zhongshan Station and Arctic Yellow River Station, which are both located in the unique polar cusp regions and approximately at the conjugated ends of one magnetic field line. To fill the current blank of atmospheric observation, we are developing a synthetic observation system for polar atmosphere, including a Na Doppler lidar currently and other lidars in the future. The Na Doppler lidar under developement is to measure the diurnal temperature and winds in the Mesosphere and lower Thermosphere, aiming to investigate the coupling between the activities of space weather and the neutral upper atmosphere. A coherent Doppler wind lidar for measuring tropospheric winds, a Raman temperature lidar and a Rayleigh temperature lidar for measuring tropospheric and mesospheric temperature are in the plan to form a synthetic observation system capable of profiling the vertical structure of atmospheric temperature and/or winds from surface up to lower thermosphere. This system will provide comprehensive data to study the interactions of solar activities with the Earth's atmosphere, and the dynamical coupling among the atmospheric layers in polar regions.

1003
Ground Based Water Vapor Retrieval over Antarctica

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Atmospheric water vapor is an important indicator of the Earth's climate state and evolution. Although representing a few percentages of the total content, Antarctic water vapor plays an important role in snowfall accumulation and surface mass balance. Thus, accurate long time series of water vapor content are crucial to understand the current climate and to assess the reliability of global climate models. Geodetic measurements are being made at permanent research stations maintained by different institutions. IGS, POLENET and regional networks now cover large sectors of Antarctica and provide long-term data sets that can be used for studying Precipitable Water (PW) and its variability. Long and consistent time series of data are required, possibly recorded by different and independent sensors to overcome systematic errors and obtain accurate results. Thus, Radiosounding (RS) data performed at 7 coastal stations using Vaisala radiosondes were analysed, to fully exploit the capability of GPS to provide reliable PW, even if RS observations are not available. A regional model of the mean Temperature was computed for this purpose. Up to 20-year time series of GPS observations acquired at all available geodetic stations were processed with the purpose of ensuring the utmost accuracy of the results adopting homogeneous, consistent, and up-to-date processing strategies. Results are shown for the available GPS sites, giving an up-to-date picture of the PW behavior over Antarctica.

1693
Latitudinal Ionospheric Scintillation Study in the American Sector

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Demonstrator for Global Navigation Satellite System (GNSS) Research and Application for Polar Environment (DemoGRAPE) is an international project leaded by the Istituto Nazionale di Geofisica e Vulcanologia (INGV), in partnership with Politecnico di Torino, Istituto Superiore Mario Boella, and with South African National Space Agency (SANSA) and the Brazilian National Institute of Space Physics (INPE), as collaborators. The aim of project is to improve satellite navigation particularly in Antarctica, where the accuracy is of paramount importance for the surface displacements, and it is strongly affected by atmospheric disturbances. The DemoGRAPE activities started on November 2015 with the system installed at Brazilian Antarctic Station Comandante Ferraz (EACF, 62º 05´07"S, 58º23´29" W) located in the King George Island. To investigate the ionospheric disturbances from high to low latitudes in the American sector we present the GNSS scintillations observed at EACF inside DemoGRAPE activities, which are combined with GNSS observations done at Universidade Mackenzie in São Paulo (23°32′56″S, 46°38′20″W, inside the South American Magnetic Anomaly - SAMA) and at Cauamê Campus of Universidade Federal de Roraima (02°49´12"N, 60°40´23" W) during 2016. The goal is to characterize the occurrence of scintillation at high latitudes in association with the fountain effect at low latitudes and inside the SAMA region.

2184
Small and Medium Scale Gravity Waves Climatology over Ferraz Station

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Gravity waves at distinct spectrum of wavelengths and periods play an important role in communicating, through energy and momentum transportation, between the different atmospheric layers. The main aspects associated to the gravity waves are the general circulations processes in the middle and upper atmosphere and the temperature gradients. Regarding the high gravity wave activity and observations at the Brazilian Ferraz Station (62.1°S, 58.4°W), we have been observed small and medium scale gravity waves from an all-sky airglow imager in the last three years, besides a full winter campaign in 2007 and two consecutive winters in 2010-2011. Even we suffered from a lack of observations in 2008-2009 and 2012-2014, during the observed years it was possible to identify many gravity waves of very distinct morphology, i.e., bands, ripples and mesospheric fronts, and a wide range of horizontal wavelength, period and propagation directions. In the present work we will summarize the gravity waves observations at Ferraz Station since 2007 up to 2016, focus firstly in the morphology of the small scale waves, its parameters and propagation directions. Latter on, it will be presented the methodology used to extract the medium-scale gravity wave parameters and the observed and intrinsic wave parameters. At last, will be presented the current status of the observations at Ferraz Station and future plans to maintaining these observations and restore or expand other type of observations.

1786
On the Impact of High-latitude Ionosphere on Synthetic Aperture RADAR

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The ionosphere can affect space-borne Synthetic Aperture Radar (SAR) measurements especially at lower frequencies producing some artefacts in the SAR images. They are mainly addicted to the Total Electron Content (TEC), i.e. the integral of the electron density along the path between the satellite and a given target. TEC fluctuations along the azimuth direction result in the degradation of the quality of the SAR imaging, visible as streaks in SAR images. Furthermore, TEC temporal variation between two SAR passes produces an error in the SAR Interferometry (InSAR) technique known as phase advance. These errors are expected to exacerbate at high latitudes, characterized by ionospheric irregularities and scintillation phenomena due to the direct interaction of the ionospheric plasma with the geospatial environment. In this work, the effects of high latitude ionosphere on selected SAR images are investigated in detail using TEC and scintillation measurements from GNSS receiver networks located at ground. The outcomes of this investigation are shown and critically discussed in relationship with the different roles of troposphere and ionosphere impacts on SAR data.

1944
Comparison between FPI and Meteor Radar Observations for MLT at KSS, Antarctica

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Neutral winds and temperature in the mesosphere and lower thermosphere (MLT) have been simultaneously observed by Fabry-Perot interferometer (FPI) and meteor radar (MR) at King Sejong Station (KSS), Antarctica for a full year of 2017. The simultaneous optical and radar observations for the neutral atmosphere in the MLT region provide us with an excellent opportunity of comparing the measurements from the two observation techniques. Furthermore, since Antarctic peninsula has been well known for strong wave activities such as orographic gravity waves, the observations from these two instruments can be used to reveal the characteristics of neutral atmospheric responses to the waves in the MLT region. Using these observations, the neutral winds are compared at two airglow layers of 87 km and 97 km. We found the well-defined semidiurnal tidal structures such as downward phase progression and 90-degree phase difference between zonal and meridional winds. Neutral temperatures estimated from two instruments are also compared to investigate the geomagnetic effects on MLT temperature.

TE-1c - Observing with autonomous vehicles in polar regions
20.06.2018 16:00-17:30, A Forum

1619
Saildrone Measurements in the Arctic

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Saildrones are sail- and solar-powered USVs developed by Saildrone Inc., NOAA and UW to make remote, season-long meteorological, oceanographic and fisheries measurements. They sail autonomously between user-controlled waypoints and transmit data ashore via satellite. Saildrones conducted three missions in the Bering Sea in summers 2015-2017 and into the Chukchi Sea and Arctic Ocean in 2017, each sailing over 6000 km per mission. They measure solar irradiance, wind, humidity, barometric pressure, air and water temperature, sea-surface salinity, dissolved oxygen, chlorophyll *a*, CDOM, and optical backscatter. In 2016-2017 the Bering vehicles made acoustic measurements of the abundance and distribution of walleye pollock, conducted focal follows of satellite-tagged fur seals and recorded the presence of marine mammals. A pCO2 system was added in 2017 to measure CO_2 exchange. Measurements were compared with ships and moorings. Wind speeds exceeded 40 knots at times. Low salinity and high CDOM and pCO_2 were found 200 km seaward of the Yukon River mouth. Near Bering Strait, the saildrones observed high chlorophyll *a* and oxygen saturation implying enhanced biological production. One saildrone reached 75˚N in the Arctic Ocean basin where it measured a cold surface temperature of -0.23˚C and a low salinity of 26.5 (PSS-78) on 13 August 2017. The Saildrone platform has proven to address key research questions and is continually being updated with new sensors and data-sharing capacity.

2237
Under-ice Argo Floats in the Southern Ocean

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The seasonal sea ice zone of the Southern Ocean is one of the largest remaining 'blind spots' in the global ocean observing system. Key science questions relevant to climate and sea level rise require sustained, broad-scale observations in the high latitudes. Historically, measurements from shipboard hydrography are sparse, particularly during the winter months. Ice-capable Argo floats have provided year-round sampling of the Southern Ocean since 1999, measuring approximately 50,000 profiles below 60°S. We review the status, achievements and future of the Argo array in the Southern Ocean with a focus on under-ice floats (longevity, reliability, dispersion and loss). Novel missions for under-ice Argo, including floats deployed on the Antarctic continental shelf and in polynyas have provided new insights into sea-ice production, air-sea-ice-ocean interactions, circulation, water mass formation and tides. Ice-capable floats parked on the sea-floor between profiles can provide data for several years on the Antarctic continental shelf. A major issue for under-ice profiles is the loss of position data when floats are unable to surface in winter. A new algorithm was developed to improve the estimates of profile location and uncertainty of under-ice data. Deployments of ice-capable floats have proven the feasibility of under-ice observing and provide guidance for the design of a sustained under-ice observing system.

147
A Challenge towards Cost-effective and Autonomous Observations under the Sea-Ice

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The cryosphere is a major indicator of global climate change and plays a fundamental role in the Earth System. Despite advances in numerical modelling, the reliability of weather forecasts and long-term climate predictions in the Arctic and Antarctic is severely limited by the lack of systematic in situ observations of and beneath the sea-ice. In situ ocean observations in polar regions are inherently expensive, risky and sparse, even more so under the sea-ice. Those shortfalls can be addressed by recent progress in **Autonomous Underwater Vehicle (AUV)** technology.
The **World Climate Research Programme (WCRP)** and the **Prince Albert II of Monaco Foundation (FPA2)** are jointly promoting a **Polar Challenge** that will reward with a **Prize of 500,000 Swiss Francs** the first team to complete a 2 000 km mission with an AUV under the Arctic or Antarctic sea-ice. Bonus awards will also be delivered for regular measurements of sea-ice thickness or draft, and for successful transmission of under-ice position and environmental data to operational networks in near real-time.
The overall vision of this challenge is to promote a cost-effective, sustainable and autonomous polar ocean monitoring system to drive a new era for research, application and services. The ultimate goal is to achieve with some analogy what ARGO (www.argo.ucsd.edu/) has accomplished for the open ocean with profiling floats.
More details at www.wcrp-climate.org/polarchallenge

1008
Autonomous Marine and Aerial Vehicles for Marine Glacier Surveys in Arctic

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Acquiring scientific data in Polar Regions is often problematic due to harsh weather and risky operating conditions. In the last decade the use of robots for substituting human beings in performing difficult, dangerous and burdensome tasks has become more and more frequent. According to this trend, in summer 2015 and 2017, a group of researchers of ISSIA-CNR carried out two scientific campaigns in the Kongsfjorden, an Arctic glacial fjord located in the Svalbard Archipelago. The campaigns involved both marine and aerial autonomous vehicles for collecting environmental parameters. In particular, the two USSVs (Unmanned Semi-Submersible Vehicles) Shark and PROTEUS, and the UAV (Unmanned Aerial Vehicle) OTTO were used to acquire both marine and atmospheric data in the proximity of the dangerous fronts of tidewater glaciers. Sampling in these areas is important to understand the peculiar local phenomena occurring during ice calving but data are missing due to the difficulties in accessing these extremely hazardous sites. The possibility of sudden falls of massive ice blocks and the steep and friable slopes of the sides make it impossible for operators to get close to the front of glaciers and the use of unmanned vehicle proved to be decisive. The success of the campaigns demonstrated that unmanned vehicles technology is mature for collecting data in these areas and can be of great help to scientists involved in the monitoring of processes occurring in the Arctic region.

289
Snow and Ice Thickness Retrieval from SIMBA Temperature Profiles in Antarctic

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Antarctic snow and sea ice thickness is an important indicator for global climate change and the main parameters for icebreaker sailing in the ice-covered region. A kind of SIMBA buoy with 240 sensors in every 2 cm interval was deployed in the fast ice near Antarctic Zhongshan Station during 2014 and 2015 to record snow and ice temperature profiles and heating responses and study the method to retrieve snow and ice thickness. The analysis showed that the adjacent temperature profiles changed largely in the air, about 2℃; Sea water beneath ice showed stable temperature, -1.7~-1.9℃; Snow and ice had a large temperature gradient vertically. The 60 s heating responses showed that, temperature increment was about 2.0~4.0℃ in the air, about 2.5~5.0℃ in the snow, about 0.8~1.0℃ in the ice and about 0.6~1.2℃ in the water. Depending on those results above, two independent methods "automatic algorithm" and "manual detection" were used to analyze snow and ice thickness. Compared to field observed ice thickness, RMSE of those two methods was 6.4 cm and 6.4 cm respectively in 2014, and 6.6 cm and 6.5 cm respectively in 2015. As to snow depth, RMSE was 10.8 cm and 8.5 cm respectively. The retrieved snow and ice thickness had acceptable bias of around 3 sensors for ice and 4~5 sensors for snow, considering the maximum ice thickness of around 150 cm. Therefore this kind of SIMBA buoy and the two methods were suitable and flexible for Antarctic snow and fast ice thickness retrieval.

730
Observing Stratigraphy and Crevasses with Robot-towed Ground Penetrating Radar

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We present results of using robot-towed ground penetrating radar for measurements of stratigraphy and crevasse features. We describe the development of lightweight (< 80 kg), electric and solar-electric rovers that navigate autonomously and tow scientific instruments secured to a sled. We report on use of the rovers for
1) imaging surface stratigraphy in a dry snow zone to estimate local variability in compaction;
2) imaging a 25 km^2 area of a marginal shear zone from surface to marine ice to observe complex shear zone dynamics from the characteristic surface and marine ice crevassing; and
3) autonomous detection and mapping of the length of individual crevasses within the shear zone.
From the first project, we demonstrate how local surveys relate to longer transects for establishing variation in snow and firn compaction. From the latter projects, we demonstrate construction of a local velocity map within the McMurdo Shear Zone (MSZ) derived from annual crevasse motion. The survey provides multiple crossings of long (> 1 km) crevasses that appear in echelon on the western and eastern boundary of the shear zone as well as two or more crossings of shorter crevasses in the chaotic zone. A local velocity field is estimated by mapping these crevasses and crevasse segments in annual datasets and projecting movement of crevasses annually. These projects demonstrate the use of autonomous robots to acquire data that would otherwise be inaccessible from human-operated vehicles.

CR-2 - Permafrost landforms in the two Poles as possible Mars analogue.
20.06.2018 16:00-17:30, A Dischma

215
Biogeochemistry of Lake Untersee Oasis, Queen Maud Land, Antarctica

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Regions of juxtaposed active and relict biogeochemical cycling are rare on Earth. Lake Untersee Oasis is one of these environments: it contains two perennially ice-covered lakes (Untersee and Obersee) with benthic, photosynthetic microbial mats, and an adjacent ice-free valley (Aurkjosen) that has evidence of a paleo-lake basin, with relic dried microbial mats buried in permafrost soils. We will present preliminary results of a broad research effort that aims at:
1) characterizing the present-day hydrological conditions of Lake Untersee;
2) characterizing the dynamics of microbial ecosystem in Lake Untersee;
3) reconstructing the past hydrological conditions in the Oasis; and
4) asessing the preservation state of molecular biomarkers in relic microbial mats of the Aurkjosen Valley paleo-basin.
Hydrogeochemical analysis indicates that the lake's primary source of water is derived from glacial meltwater with a small contribution of groundwater and that water loss is mainly through sublimation of its ice cover. Modeling suggest that the lake's geochemistry is controlled by sublimation, which affects the amount of freezing and associated D-^{18}O and solute fractionation. d^{18}O analysis of carbonates found in relict microbial mats suggests a water d^{18}O composition evolution to higher values over the Holocene. Upcoming biogeochemical analysis of active and relict organics mats should provide further insights on the preservation potential of organic compounds in this cold environment.

2094
Soils Influenced by Periglacial Processes in the South Shetland Islands

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Ice-free areas in the Northern Antarctic Peninsula region are influenced by periglacial, glacial, fluvial, and coastal processes and landforms. Permafrost is present in these areas and influences the fragile ecosystems containing cryosols. The objective of this work is to determine the interaction between periglacial processes and landforms on a variety of soil characteristics within different ice-free areas of the South Shetland Islands. Recent field work identified glacial deposits, patterned ground, pavements, and slope debris among the most prevalent surfaces. Laboratory analyses showed that soil properties are clearly related to lithological and geomorphological factors. In a number of cases, the soils have a sandy loam texture, which indicate a good drainage. Some soils have increased clay content which results in poorly-drained soils. In this case, drainage of the soil and surface processes defining the land cover are closely related to the permafrost environments. Active layer depth with freeze-thaw cycles that take place during the summer influence soil properties such as bulk density, texture and structure as well as the water holding capacity. Factors such as lithology, elevation, slope and distance from the coast further influence the soil properties. Therefore, the active surface processes during the limited Antarctic summer are dominant and soil material becomes displaced causing unstable soil development.

2371
Endolithic and Hypolithic Systems as Protosoils: Evidence from the Two Poles

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Endolithic and hypolithic bio-abiotic systems can be regarded as protosoils from the several aspects:
(1) as the closest modern analogues of soil progenitors that existed on Earth before vascular plants with root systems established,
(2) as precursors of more advanced soil formations in contemporary landscapes and
(3) as steady state soil-like bodies in regions with climatic extremes (e.g. East Antarctica). We will discuss in the presentation the structure, composition and weathering mechanisms in endolithic and hypolithic bio-abiotic systems providing the evidence for soil-like processes that occur in these formations at the both Poles: East Antarctica oases (Larsemann and Thala Hills, Schirmacher) and High Arctic archipelagos (Novaya Zemlya and Franz Josef Land). The areas with extreme climatic conditions at the both poles give an opportunity to study cyanobacteria and lichen driven endo- and hypolithic systems as protosoils with the minimum influence from more advanced organisms common to other environments. The newly formed products of biota-to-mineral interactions both in hypo- and endo- cryptic niches are redistributed by erosion processes and contribute significantly to raising complexity of the polar landscapes that are limited in energy and nutrients sources. Besides that endolithic colonization increases weathering rates, induces exfoliation and, thus, reshapes mineral surfaces contributing regularly to the biogeomorphological processes at the both Poles.

2077
Metal Enrichment in Desert Varnish from Ice-free Areas of Coastal Antarctica

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Desert varnish is a coating that forms on the exposed surface of stones located in both hot and cold arid areas. The semi-arid ice-free area of Ulu Peninsula, James Ross Island, represents the largest deglaciated land in Antarctic Peninsula (AP) region that contains numerous granite and basalt cobbles and boulders with well-developed desert varnish. It is generally accepted that desert varnish is composed of clay particles rich in iron and manganese oxides and that iron enrichment is typical for cold environments while desert varnish enriched in manganese is frequently associated with hot environments. Enrichment by 399 ± 239 % and 16 ± 8 % for manganese and iron, respectively, was found at basalt clasts by in situ X-ray fluorescence. The same values for AP granite clasts are 511 ± 644 % and 126 ± 170 % for manganese and iron, respectively. Both petrotypes show high enrichment in manganese. Fe-rich basalts tend to enrich by iron much less than Fe-poor granites. More variable enrichment found for granites corresponds to their larger grain-size and higher mineralogical diversity. At the microscopic level, metal oxides enrichment is connected with quartz and feldspar dissolution and formation of fluorapophyllite and zeolites. Our field and laboratory electron microprobe data from desert varnish on basalt and granite clasts from Ulu Peninsula show that the original rock petrology and mineralogy is more important for specific metal oxide enrichment than the environment.

2482
Wind-driven Rock Abrasion in Antarctica's Ice-free Valleys: Rates and Controls

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Wind is a principal geomorphic agent in dry regions of Earth and Mars, where it transports sediments and erodes rock surfaces, creating diverse geomorphic features, and helping generate dust and regolith. Despite its importance, few studies have defined rates of rock abrasion under natural conditions. We report rock abrasion rates well characterized through a comprehensive long-term (>30 year) field experiment in the hyper-arid ice-free McMurdo Valleys, Antarctica. More than 5000 rock targets of several lithologies (dolerite, basalt, and non-welded tuff) were installed at 5 heights above the ground (7 to 70 cm) facing the 4 cardinal directions at 10 sites. Periodic collecting of rock targets exposed to abrasion define the progressive mass loss, a simple measure of the amount of abrasion, after 1, 5, 10, 30 and 31 years of exposure. Abrasion rates generally show striking consistency for a given lithology at any site, but they vary considerably from site to site owing to differences in availability of transportable sediment, wind regime, and surface roughness. For example, for dolerite, basalt, and tuff targets facing the dominant winds, annual abrasion averaged 21, 49, and 3400 microns respectively in central Wright Valley (site 7); in contrast, it averaged 2, 4, and 200 microns at site 8, only 23 km directly up valley of site 7. At each site, rates primarily depend on target orientation relative to the dominant winds and, secondarily on height above the ground.

1524
The Origins of Antarctic Rock Glaciers: Periglacial or Glacial Features?

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In extensively glaciarized permafrost areas as Continental Antarctica, rock glaciers are quite common and considered postglacial cryotic landforms. This paper reveals that, two landforms previously mapped on geomorphological bases as rock glaciers, located in Northern Victoria Land should have the same glacial origin. In fact, by integrating different geophysical investigations and borehole stratigraphy, we show that both landforms have similar internal structures and cores of buried glacier ice. Therefore, this kind of rock glacier is possibly related to the long-term creep of buried ice rather than of permafrost creep alone. This interpretation can be extended to the larger part of the features mapped as rock glacier in Antarctica. In addition, a high-reflective horizon sub-parallel to the topographic surface was detected in Ground Probing Radar (GPR) data over a large part of the study area. Combining all the available information, we conclude that it cannot be straightforwardly interpreted as the base of the active layer but rather represents the top of a cryo-lithological unit characterized by ice lenses within sediments that could be interpreted as the transition zone between the active layer and the long-term permafrost table. More generally, the combined use of GPR and ERT is extremely helpful to understand the origin of landforms that can be found also on Mars and, possibly to contribute to understand the paleoclimatic evolution of the cryosphere.

SH-4 - Polar Heritage: Politics, policy, practice
20.06.2018 16:00-17:30, A Sertig

2645
Constructing the Pasts of Polar Futures: History and Heritage in Polar Conflicts

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This paper analyses the role of history and heritage in the international competition for resources and political influence in the Polar Regions. The paper builds on a book project contributing to a broad field of research exploring the production of future visions about the polar regions. A striking feature of these visions is the degree to which they are based on notions about the past. Actors involved in the competition for natural resources and political influence there have used and produced history and heritage as a part of their strategies to influence the future. They have done so on different arenas: through corporate and policy documents, popular history publications, museums, and through designation, narration and management of heritage sites. This paper discusses such practices in the Arctic and Antarctic over the course of the 20th century up until the present. The results show that such politics of memory have played significant roles in the polar regions. By enrolling actors from the past and the material remains of their actions into actor networks, competing actors have populated places with allied actors and actants. These networks have played different roles, defending national prestige, attracting tourists, creating a sense connectedness to distant polar places, as well as legitimizing claims for influence over territories and natural resources.

54
Landscape in White; Archaeology and Anthropology in Antarctica

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Antarctica was the last continent to be known. Human encounters with the region acquired different characteristics over time. Within the framework of dominant narratives, the early 'exploitation' of the territory was given less attention than late nineteenth-early twentieth-century 'exploration'. Dominant narratives on the period refer to the captains of sealing vessels, the discovery of geographical features, the volume of resources obtained. However, they do not consider the life of the ordinary sealers who lived and worked on the islands. In this chapter we will try to show the power of archaeology to shed light on these 'invisible people' and their forgotten stories. We hold that archaeology offers a possibility for reimagining the past of Antarctica, calling for a revision of traditional narratives.
In this presentation we will discuss some of the new lines of inquiry we are working with, and some of the results already obtained by the international project “Landscapes in White; Archaeology and Anthropology in Antarctica”. We will focus on the archaeology of experience, and the ways in which “being-in-the place” could be useful to discuss the life of the 19th-century sealers we are studying. Furthermore, we will present the results of the excavations we are conducting, the use of new technologies in the research, public archaeology and the creation of an interactive record for the archaeological sites.

2430
Competing Discourses and Practices at the Heritage-making Process in Antarctica

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Heritage making in Antarctica is a complex process that occurs at multiple contexts (e.g. policy making, archaeological research and tourism), and levels (e.g. international, national, individual). In this paper, heritage is considered a cultural process concerned with negotiating, creating and re-creating cultural memories and values. This process involves a range of discourses and actions used to construct meanings that have relevance and utility in the present. The aim of this paper is to present the characterization of three different competing discourses that underlie different contexts of the heritage making process:
a) policy making in the context of the Antarctic Treaty System,
b) archaeological research and,
c) tourism visitation.
I found that competing discourses understand Heritage as "a thing", as "a means to an end" and as "an experience". The actions and practices were analyzed through bibliographical review of the academic production published form 1960 to the present identifying the main objectives and actions taken place in Antarctica in the frame of research projects or conservation projects. I also analyzed the ATCM documents referring to historic sites form 1960 to 2016.

130
Antarctic Heritage: Cooperation and Conundrums

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In recent years, there has been increased public interest in Antarctic heritage, ranging from major centennial events to conservation projects. There has also been increasing cooperation between several Antarctic nations in sharing experience and expertise relevant to historic site and monument (HSM) management and conservation.
However, concerns have been raised regarding several aspects of Antarctic heritage. These include an appeal for increased involvement with the values associated (puesta en valor / mise en valeur) with Antarctic heritage, and broader recognition of less prominent people from Antarctica´s past. Standards of HSM management and conservation, and the question of whether or not to retain artefacts in Antarctica - a remote location with a hostile environment - have also arisen.
The decision, in 2015, by the Committee for Environmental protection (CEP) to have a temporary ´hold´ on future proposals for new HSMs, and the subsequent establishment of an Intersessional Contact Group to consider several heritage matters demonstrates that there are unresolved subjects related to Antarctic heritage.
Since 1961, heritage has been incorporated within Antarctic diplomacy. Whilst a system of HSM designation and protection was developed it was not entirely satisfactory. This presentation will review the history of Antarctic heritage, and identify and discuss the major diplomatic and cultural matters that inform the current conundrums.

2571
Employing Polar Heritage to Construct Antarctic Identity at the Gateway Cities

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Antarctica's absence of native human population poses challenges and opportunities for those communities living in the periphery of the Southern Ocean in creating connections with the South. Unlike the Arctic communities, people at the today-known Antarctic gateway cities had little association, if so, with Antarctica. Once the geopolitical and economic significance of their role in facilitating access to Antarctica, and its associated knowledge and services, is recognized by their respective nations, multiple strategies are set in place to establish a legitimate polar connection. Cultural imaginings of Polar heritage are employed daily in public spaces as reminders of polar explorers' past visits to the city, and of the participation of local heroes in Antarctic expeditions. This paper examines the use of Antarctic-related public art within each city, such as statues of polar explorers, the historical and political context in which these statues were erected, and the current significance to the local community in constructing polar belonging and the city's relationship with Antarctica throughout time.

GG-2f - Arctic and Antarctic past ice sheet dynamics and paleoclimate evolution
20.06.2018 16:00-17:30, A Schwarzhorn

1856
New Aerogeophysical Survey of Titan Dome and Ice-core Drilling Potentia

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Ice domes and divides, including East Antarctic Titan Dome and Dome C, are interior boundaries of major glacier drainages and are thought of as stable regions of ice sheets. As a result, these regions are targets for ice-core drilling including the search for high-resolution climatological proxies that date back 1 to 1.5 Myr. However, subglacial processes and ice flow-reorganization over glacial-cycle timescales can belie the stability of these regions. A new survey of Titan Dome conducted through a partnership between Polar Research Institute of China and University of Texas-Institute for Geophysics offer constraints on the subglacial environment and the distribution of water and heat. Though a combination of data analysis, radar and potential fields, and hydrological modeling the basal heat budget, geological character, and drilling site potential are evaluated. Analysis of Titan Dome observations reveal the presence and distribution of liquid water and complex internal ice structure including locations of local drawdown, suggesting past ice flow or enhanced basal melt. Subglacial water flow, including within the subsurface, influences the basal heat flux by up to multiple factors of assumed geothermal flux. This analysis is aided by the context of a similar but higher density survey of Dome C. Together they offer insights into ice sheet processes that occur at ice-sheet divides and future drilling site potential including in service to NSF's Rapid Access Ice Drill.

1638
Searching for Oldest ice in Antarctica, an Ice Sheet Modelling pre-site Survey

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Covering the Middle-Pleistocene Transition (MPT) transition with a well resolved ice core record is the main motive of the European Beyond EPICA - Oldest Ice (BE-OI) efforts. Pre-MPT glacial cyclicity was dominated by obliquity (ca. 40 ka) which then shifted to 100 ka excentricity-driven glacial-interglacial cycles typical for the last ca. 800 ka. The drivers of this transition are still obscure, hence a well resolved Antarctic ice core record spanning this transition would provide much needed proxy information. We present transient continental scale 3D ice sheet simulations of the Antarctic Ice Sheet (using the Parallel Ice Sheet Model PISM) which span the last 2 million years to capture, both, pre-MPT as well as excentricity driven ice dynamics. Employing passive tracers, we dynamically reconstruct the stratigraphy of existing deep ice cores and indicate potential sites of oldest ice around Dome Fuji and Dome C. Around the latter ice core sites, we incorporate new radar derived bedrock topographies to improve the lower boundary conditions. The ice sheet model is forced by a compilation of different geothermal heat fluxes, sea level and climate scenarios to account for a range of potential paleo-climate boundary conditions and their effects on ice dynamics. This study contributes to a variety of modelling and observational efforts to establish the most promising drill site for an ice core up to 1.5 million years old.

1397
In situ Cosmogenic ^{14}C and ^{36}Cl Inform Deglacial Ice Extents in Western DML

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MAGIC-DML is a Swedish-US-Norwegian-German-UK collaboration focused on improving ice sheet models by filling critical data gaps that exist in our knowledge of the timing and pattern of ice surface changes along the western Dronning Maud Land (DML) margin, combined with advances in numerical techniques. To provide empirical data on the timing of ice surface lowering, field studies in austral summer 2017 targeted slopes in the Heimefrontfjella and Vestfjella nunatak ranges for *in situ* cosmogenic nuclide (CN) sampling at a range of elevations above the modern ice surface. Comparing concentrations of nuclides with widely differing half-lives in bedrock and erratic samples from such sites can provide information on complex burial and exposure histories, and thus, past configurations of non-erosive ice. Quartz-bearing samples were analyzed for *in situ* ^{10}Be ($t_{1/2}$ 1.4 My), ^{14}C ($t_{1/2}$ 5.7 ky), ^{21}Ne (stable), and ^{26}Al ($t_{1/2}$ 705 ky), and mafic lithologies were analyzed for *in situ* ^{36}Cl ($t_{1/2}$ 301 ky). *In situ* ^{14}C is unique among these nuclides in that its short half-life makes it particularly sensitive to complex histories since the Last Glacial Maximum (Marine Oxygen Isotope Stage 2). We present preliminary *in situ* ^{14}C results from selected bedrock and erratic samples across the field area, compared with long-lived nuclide results (presented separately), as well as preliminary *in situ* ^{36}Cl results from associated glacially striated basaltic bedrock.

1618
Pleistocene Paleoceanographic Changes of the Southern Ocean off the Ross Sea

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A 8.4 m long gravity core RS15-GC107 was collected from a seamount in the Southern Ocean off the Ross Sea (68°04.0741´S, 178°37.9066´W, 3050 m deep). Geochemical proxies (biogenic opal, $CaCO_3$, TOC) and oxygen isotope of planktonic foraminifers (*Neogloboquadrina pachyderma* (sin.)) were measured in order to reconstruct paleoceanographic changes of the Ross Sea Sector of the Southern Ocean. Because $CaCO_3$ was relatively well preserved in upper 6 m of the core, the age of the upper part was constrained through planktonic foraminifer oxygen isotope correlation to LR-04 stack. $CaCO_3$ became to be preserved from 6.2 m of core RS15-GC107, whereas biogenic opal decreased from this interval. The changes at 6.2 m of core RS15-GC107 most likely corresponded to the beginning of the Mid-Pleistocene Transition (MPT) climate change. This means that the Ross Sea Sector of the Southern Ocean shifted from relatively more siliceous ocean to carbonate ocean during the MPT. Oxygen isotope values became lower during the interglacial periods with larger glacial-interglacial contrast at 1.5 m of the core, ~430 ka, which corresponds to the Mid-Brunhes Event (mWP). Interestingly, glacial planktonic Oxygen isotope values also became relatively lighter from ~430 ka than before. This may suggest that post-mWP glacial periods became more stratified along with increased ice volume.

831
Nonlinearities in Southern Ocean Response to CO_2 and Obliquity Forcing

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Paleoclimate records suggest an increased sensitivity of the Antarctic ice sheet to orbital forcings when atmospheric CO_2 concentrations reach above ~500 ppm. Here we present model experiments designed to explore the relative sensitivity of atmospheric CO_2 and obliquity forcing in Antarctica and the Southern Ocean using the University of Victoria Earth System Climate Model (UVic ESCM). We focus on the Pliocene, as this interval contains several orbital cycles and provides an example of Southern Ocean dynamics in a warmer-than-present, high CO_2 world in which the West Antarctic Ice Sheet (WAIS) is absent. We find a nonlinearity in the system response to obliquity when CO_2 is between 500-650 ppm, particularly in ocean temperature at intermediate depths. We analyse the possible drivers of this result and the implications for future warming.

1135
Paleobathymetry of the Cenozoic Southern Ocean and its Various Consequences

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Although the Southern Ocean plays a fundamental role in the global climate and ocean current system, paleo-ocean circulation models of the Southern Ocean suffer from missing boundary conditions. A more accurate representation of the geometry of the seafloor and its dynamics over long time-scales are key for enabling more precise reconstructions of the development of the paleo-currents, the paleo-environment and the paleo-ice sheets of Antarctica.
The reassessment of all available seismic reflection and borehole data from Antarctica as well as its conjugate margins of Australia, New Zealand, South Africa and South America allows us to create paleobathymetric grids for various time slices during the Cenozoic. We generated grids from the Eocene/Oligocene Boundary, the Mid-Miocene Climatic Optimum and the Pliocene/Pleistocene. These grids reveal changes in sediment distribution and volume as well a local sedimentation rates.
The observation of sediment distribution and local sediment volumes opens the door towards more sophisticated paleo-topograpy studies of the Antarctic continent and more detailed studies of the paleo-circulation. Local paleo-water depths at the oceanic gateways or the position of paleo-shelf edges highly influence the regional circulation patterns supporting more elaborated climate models.

TE-3f - Remote sensing of polar regions
20.06.2018 16:00-17:30, A Seehorn

1949
Variability in Glacier Dynamics of a Greenland Glacier Using Sentinel-1 SAR Data

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Following the general warming trend in Greenland, an increase in calving rates, retreat and ice flow can be observed at ocean-terminating outlet glaciers. These changes contribute substantially to the current mass loss of the Greenland Ice Sheet. In order to constrain models of ice dynamics, detailed knowledge of geometry, ice-flow, and environmental forcing factors are needed.
Using spaceborne synthetic aperture radar (SAR) systems in conjunction with in-situ measurements, we investigate the intra- and inter-annual variability of the flow dynamics of a medium-sized ocean-terminating outlet glacier located in Western Greenland. The satellite datasets consist of a time series comprising more than 150 acquisitions from ESA's Sentinel-1 SAR platform starting in 2014 as well as 20 Radarsat-2 images from 2015/2016. By applying feature tracking approaches, the data from these C-band SAR sensors allows derivation of quasi-continuous velocity estimates at high spatial and temporal resolutions. In addition, the C-band backscatter enables detection of *surface melt* and *ice mélange* extent as well as the position of the calving front with almost no additional knowledge required. The availability of such data time-series stemming from one single platform will allow investigation of the influence of environmental forcing (*melt* and *ice mélange*) on the variability in flow and terminus dynamics, and thereby provide constraints for models of calving dynamics.

1991
Remote Sensing of Coastal Sea Ice Using Passive Microwave and Visible Imagery

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Coastlines in the Arctic are made vulnerable by longer ice-free seasons, but studying the timing of freeze-up is limited by a lack of observations. Existing passive microwave sea ice concentration products are undefined near shore, and limited coverage of higher-resolution products can mean missing most of the freeze-up season. This presentation explores a new approach to remote sensing of coastal sea ice cover, loosely based on the NASA Team algorithm. Designed specifically for pixels with partial land and partial ocean area, it uses local land pixels as seasonally-varying tie points to control for changing land surface conditions over the course of the winter. The approach uses polarization and gradient ratios from brightness temperature retrievals to determine ice presence in the fraction of a pixel that is ocean. A reference dataset of visible, infrared, and SAR imagery complements local observations (compiled through SIZOnet) to validate the passive microwave approach.

2042
Monitoring of Ice Dynamics and Mass Balance in Central Dronning Maud Land

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Since 1991, various geodetic and glaciological research activities have been carried out in the region southeast of Schirmacheroase, Dronning Maud Land, East Antarctica. This region is characterized by the slowly floating Potsdam Glacier that crosses a wider area of bare blue-ice surface.
Repeated ground-based surveys (mainly GNSS) realizied during the last 25 years serve as a basis to studying the long-term behaviour of surface heights, ice velocity, accumulation and ablation in that region. In the last few years our ground-based measurements have been performed simultaneously with airborne radar and lidar observations. Additionally, we incorporated satellite laser and radar altimetry data from ERS-1/2, Envisat, ICESat and CryoSat-2. Satellite images (e.g. taken by Landsat satellites) provide optical snapshots over several decades.
We will discuss the long-term evolution of the ice regime based on surface-height variations and flow velocities. In terms of mass balance, the combination of ground-based, airborne and satellite-based data allows to give a comprehensive picture of the entire region. Furthermore, the comparison leads to accuracy estimates of the derived trends. Results based on temporarily and spatially limited GNSS observations serve as constraints for airborne and spaceborne measurements which cover larger areas. It will be shown that the permanent monitoring of relevant regions is essential for the derivation of reliable long-term trends.

2211
Estimating Melt Pond Fractions on First Year Ice with Compact Polarization SAR

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Melt ponds are common on Arctic sea ice. They are linked to surface albedo and energy transfer to the ocean from the atmosphere and are important in Arctic climate studies. This paper presents a first attempt to retrieve melt pond fractions from hybrid-polarized compact polarization (CP) SAR imagery, which will be available from RADARSAT Constellation Mission to be launched in 2018. CP SAR has wider swath and shorter revisit time than quad-polarization systems, like RADARSAT-2 (RS-2). The co-polarization (co-pol) ratio has been verified to provide estimates of melt pond fractions. But it is a challenge to link CP parameters and the co-pol ratio. The theoretical basis is presented for making this linkage with the CP parameter C_{22}/C_{11} (the ratio of the elements of the coherence matrix of CP SAR) for melt pond detection with the tilted-Bragg scattering model for the ocean surface. An empirical formulation, the 'compact polarization and quad-pol' ('CPQP') model, is proposed based on 2062 RS-2 quad-pol SAR images, collocated with in situ measurements. We compare the retrieved melt pond fraction with CP parameters simulated from quad-pol SAR data and results retrieved from the co-pol ratio from quad-pol SAR images from the Arctic-Ice (Arctic-Ice Covered Ecosystem in a Rapidly Changing Environment) project. Results are comparable for observed melt pond data in spatial and temporal distributions. Thus, the CP mode SAR is able to estimate melt pond fractions on first year ice.

2280
Variations in the Extent and Elevation of the Larsen Ice Shelf, Antarctica

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Ice shelf extent is extracted from declassified aerial photographs and modern satellite images, and a very long time series of the areal extent of the Larsen A Ice Shelf (LAIS) and the Larsen B Ice Shelf (LBIS) is compiled. In addition, we characterize the surface elevation changes of the LAIS and the LBIS over the last two decades by combining the Ocean Topography Experiment/Poseidon (T/P) and the Envisat Radar Altimeter-2 (RA-2) using the collinear analysis method. The northern Larsen Ice Shelf (LIS) displayed no significant changes until the late 1980s, whereas the LAIS has retreated rapidly since 1986, and the LBIS has followed a similar pattern since the early 1990s. The gradual retreat of the northern LIS is interrupted by several catastrophic calving events. The LAIS and the LBIS have already diminished by approximately 14,000 km^2 in total since 1968. At the same time, the surface elevations of the LAIS and the LBIS exhibit progressive lowering from 1992 to 2010, whereas the lowering rate of the LAIS is significantly higher than that of the LBIS. The northern LIS has warmed substantially in all seasons, but summer displays the least warming. The warmer air temperatures and increasing surface meltwater production and refreezing lead to continuous surface lowering by firn densification. However, considering the continuous retreat of the northern LIS, its surface elevation is more sensitive to the collapse and retreat of the ice shelf than atmospheric warming.

2381
Advance of Western Margin of the Vavilov Ice Cap Assessed by Remote Sensing Data

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The Vavilov ice cap (79.30° N, 95.47° E) is situated on October Revolution Island of the Severnaya Zemlya archipelago. In this project the images obtained from Landsat-1, 5, 7, 8, Terra (ASTER), Sentinel-1 and Corona were applied. We found out that from 1963 to 2017 the ice cap margin advanced seaward by 11.7 km (central line), and its area increased by 133 km^2. The accelerated advance started in 2010, in summer 2016 the marginal front terminated in sea began to disintegrate, in 2017 the advance continued but with lower velocity.
The data on ice cap velocities was taken from two sources. The first one is GoLIVE project, also we analysed the synthetic aperture radar data from Sentinel-1 satellite. Comparison of the velocities acquired from two sources for the same period shows that they are in a very good correlation. Maximum velocity of glacier was in 2016 and reached 25.4 m/day. From 2016 the velocity started to decrease.
To evaluate the volume changes of western part of the Vavilov ice cap we analysed ASTER DEMs of 2000 and 2015, radar data obtained during fieldwork in 2014 and topographic maps of scale 1:200 000. Above the contour line of 100 m (2015) the main trunk of the newly formed outlet glacier thinned by at least 1.918 km^3, and at the same time its snout increased by 4.101 km^3.
This study is supported by the Russian Foundation for Basic Research, grant 16-35-00333, and by the Russian Science Foundation, grant 14-37-00038.

OS-2c - Interdisciplinary research on sea-ice biogeochemistry and associated ecosystems 20.06.2018 16:00-17:30, A Wisshorn

744
Physical and Biogeochemical Properties of Winter Sea Ice during Pipers, Ross Sea

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The PIPERS (Polynyas, Ice Production and its seasonal Evolution in the Ross Sea) cruise on N. B. Palmer into the early winter Ross Sea took place between April 11 and June 14 2017. The main objective was to investigate the Atmosphere-Ice-Ocean interactions in the Terra Nova Bay and Ross Ice Shelf coastal polynyas. The cruise however extended these polynyas studies to a series of ice stations transects "in" and "out" of the Ross Sea. It involved a large set of multidisciplinary activities aiming at the detailed documentation of processes across the ocean-ice-atmosphere continuum. This paper presents the basic physical (Temperature, bulk salinity, brine volume, Rayleigh number) and biogeochemical properties (water stable isotopes, Chl-*a*) of the sea ice cover at 27 ice stations. The cruise encountered unusual sea-ice conditions in the 2016/2017 season, where exceptionally low sea-ice summer extent was recorded Antarctica-wide as early as November 2016, which stayed below previous records of the satellite era for the rest of the austral summer. It is also a year where active primary production was evidenced within the Ross Sea and Terra Nova Bay Polynya, a few weeks before the cruise took place. We will show how these conditions have potentially affected (or not) the physical and biogeochemical properties of the sea ice cover in the Central Ross Sea and discuss the contrasts with the sea ice properties of the Terra Nova Bay polynya and the MIZ.

2021
PIPERS: Role of Polynyas on the Atmospheric Budget of Methane and Carbon Dioxide

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Coastal polynyas are areas of anomalous open water and thin ice in regions that are otherwise covered by sea ice. They frequently occur around the Antarctic continent in response to strong offshore katabatic wind stresses. The loss of heat from the open ocean to the cold atmosphere can enormously enhance rates of ice production. In polynya areas, the coupling between the atmosphere, sea ice and ocean is complex, and the role of ice formation on the budget of the main climate forcing carbon gases remains unknown. During the PIPERS expedition on the N.B. Palmer from April to June 2017, we performed continuous measurements of methane and carbon dioxide concentrations in the atmosphere and in the surface water from New Zealand to the polynyas of the Ross Sea. Discrete sampling was carried out in parallel to calibrate the continuous systems and to later measure the stable isotope ratios of both gases in the water and in the air. The stable isotope data enable unravelling the pathways involved in gas formation and removal. While the concentrations of both gases were relatively low in the surface waters of polynyas, the preliminary atmospheric data show higher methane and carbon dioxide levels in the atmosphere at locations where sea ice formation was most intense. These data together with the isotopic ratios of both gases and with meteorological data will be discussed to better understand the role of sea ice formation on the exchange of climate forcing gases.

414
Antarctic Landfast Sea Ice: Autotrophy vs Heterotrophy, Sink vs Source of CO_2

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Sea ice is a biome actively participating in the regional cycling of CO_2 as both a source and a sink at different times of the year depending on its trophic status (autotrophic vs heterotrophic). In the frame of the YROSIAE project (Year-Round survey of Ocean-Sea-Ice-Atmosphere Exchanges), carried out at Cape Evans in McMurdo Sound (Antarctica) from Nov. 2011 to Dec. 2012, ice cores, seawater, and brines were collected at regular time intervals. We used dissolved inorganic carbon (DIC) and chlorophyll-a
(chl-a) as proxies of net community production and autotrophic biomass, respectively. From spring, very high chl-a concentrations (>2400µg.L^{-1}) were observed at the bottom of the ice. This suggests high primary production. Strikingly, at the same time, nutrients increased significantly indicating strong remineralization at the bottom. In the ice interior, evolution of DIC was marked by a succession of autotrophic and heterotrophic phases. The overall increase of DIC suggests that the ice interior was rather heterotroph. Such sea ice system should expel CO_2. Yet, strong under-saturation in CO_2 and DIC depletion appeared at the ice surface, suggesting that sea ice should take up CO_2 from the atmosphere. On the whole, land fast sea ice in McMurdo Sound appears as a puzzling ecosystem. High primary production and remineralization develop simultaneously at the bottom while the top of the ice is rather heterotrophic but still able to pump CO_2 from the atmosphere.

844
Modeling Iron Distribution in the Early Stages of Sea-ice Growth

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Primary productivity in the Southern Ocean (SO) is affected by the release of iron (Fe) from melting sea ice. Despite this, representation of sea ice as a source of Fe for the surface waters of the SO is poorly represented in models. Sea-ice extent and volume are predicted to reduce in the future. The extend to which these climate-induced changes will affect biological activity in the seasonal ice zone, and therefore primary productivity in the SO, both having a significant role on the climate system, is currently unknown.
We implemented a one-dimensional modelling framework (LIM-1D) to identify the main processes responsible for Fe distribution in a single ice floe during the very early stages of sea-ice growth. The model simulations are compared with field observations carried out during *in situ* ice-growth experiments during Austral winter in the Weddell Sea, Antarctica. The model successfully represented the vertical distribution of iron in newly formed sea ice, when the processes of entrapment and adsorption were included to represent the initial physical enrichment of particulate iron and dissolved iron. Our study is a first step towards the development of large scale modelling tools to simulate sea-ice associated primary production and further simulate its feedback impact on the climate, ultimately helping to forecast the response of Antarctic ecosystems to environmental changes.

1081
Using under-ice Radiance Spectra to Determine Antarctic Fast Ice Algal Biomass

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Fast ice is an important component of Antarctic coastal ecosystems, providing a habitat for thriving ice algal communities. This work examines the relationships between the normalized difference indices (NDI) calculated from under-ice radiance measurements and both sea ice algal biomass and snow depth for Antarctic fast ice. While this technique has been calibrated to assess biomass in Arctic fast ice and pack ice, and Antarctic pack ice, relationships are currently lacking for Antarctic fast ice. We analyze measurements along transect lines at two contrasting fast ice sites: near (affected by platelet ice) and distant from an ice shelf, i.e. in McMurdo Sound and off Davis Station, respectively. Snow and ice thickness, and ice salinity and temperature measurements underpin our paired in situ optical and biological measurements. NDI wavelength pairs near the first chlorophyll-*a* (chl *a*) absorption peak (≈440 nm) explain up to 70% of the total variability in algal biomass. Snow depth is estimated from an NDI with a wavelength pair of 648 nm and 567 nm explaining 88% of its total variability. Accounting for pigment packaging effects by including the ratio of chl *a* specific absorption coefficients improved the NDI-based algal biomass estimation only slightly. Our new observation-based algorithms can be applied to estimate Antarctic fast-ice algal biomass and snow depth non-invasively from moored sensors (time-series) or to map their spatial distributions using underwater vehicles.

1497
On the Fate of Primary Production in the Sea Ice Zone of the Southern Ocean

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Primary production (PP) in the Southern Ocean is of paramount importance for two main reasons. First, it contributes to the largest biological pump on the planet, mitigating climate change. Second, it is the basis food support for the Antarctic krill, the animal on the planet with the largest biomass, which feeds the largest number of top predators. In the Southern Ocean, the sea-ice zone and the sea ice itself only account for 10% of the basin-scale PP. However, sea ice is the critical habitat for overwintering krill and a reduction in its cover can have dramatic consequences on the food-web. Moreover, the release of algae by melting sea ice is often un-coupled from grazing activity and consequently sinks into the Ocean's interior. Hence, the sea ice zone plays additional ecological and biogeochemical roles above its contribution to the PP of the Southern Ocean. In this context, we present here a new algorithm to derive and demarcate the two main fates of PP - zooplankton grazing and the export of phytodetritus and faecal pellets - from a combination of biogeochemical sensors mounted on bio-Argo floats. We focus on floats which were profiling within the sea ice zone of the Southern Ocean over the last 5 years. We find that ~90% of the annual PP is grazed by zooplankton, while phytodetritus, the remaining 10%, accounts for up to 75% of the annual organic carbon export. This new proxy provides a new tool to study remotely the fate of PP in a geographically-remote environment.

CR-3d - Cryosphere-Hydrosphere interactions: The water cycle at the three Poles
20.06.2018 16:00-17:30, B Parsenn

2178
Runoff Generation Processes in Extratropical Andean Catchments

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Understanding the physical processes that dominate the volume and residence time of water stored in the extratropical Andes is of great importance to the success in the management of the resource for around 10 million people. A lack of direct, long term process observations motivates the use of hydrological modeling for hypothesis testing and process understanding, with the ultimate goal of achieving robust hydrological predictions under global change scenarios. Here, we employ a physically based suite of hydrological routines to estimate the energy and mass balance components of snow hydrology in extratropical mountain catchments, and their contribution to runoff. The model is forced with data from the Era-Interim re-analysis for the 2000-2016 period, which have been corrected through spacial and temporal downscaling and yield a very good agreement with observed snowpack dynamics. Our results suggest that in this complex topography, 22% of the snow is subject to reallocation either by wind or gravitational effects, such that meteorological elevation gradients are not in themselves enough for explaining snow water equivalent distribution. An estimated 80% of summer flow (DJF) comes from glacial melting, while it is shown that snow and ice melt contribute to runoff at all times of the year, dispelling the notion of distinct accumulation and melt seasons.

920
Glacier Meltwater Mitigates the Impact of Severe Droughts in the Semiarid Andes

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Glaciers in semiarid regions have been highlighted as key reservoirs of fresh water resources with the potential to sustain minimum flow levels in high-elevation catchments. However, few studies have quantified the glacier contribution to runoff during severe droughts. Here, we estimate the ice loss and associated runoff contribution of glaciers in the Maipo River catchment (semiarid Andes of Chile) in 2010-2015, the longest and most extensive drought on local records. The Maipo River is the largest source of freshwater for the capital city Santiago, and contains more than 800 glaciers, covering 377 km^2. We use the physically-oriented TOPKAPI-ETH hydrological model at a daily timestep and at a spatial resolution of 100 m to simulate snow processes, glacier mass balance and runoff generation. While the average summer streamflow at the catchment outlet decreased from 165.8m^{3}s-^{1}, in 2000-2009, to 97.8 m^{3}s-^{1} (-41%), during the drought, our preliminary results indicate that summer runoff from ice melt increased from 27.2 to 34.0 m^{3}s^{-1} (+24.9%), providing additional 65 Mm^3 y^{-1}, and more than doubling its summer relative contribution, from 15 to 34%. We build scenarios of extensive glacier retreat in which we estimate the impacts that similar droughts will have on the availability of water resources in a warming climate. Our study quantifies the impact of glacier retreat on water availability in a region where the frequency of droughts is expected to increase with climate change.

1452
Quantifying Rock Glacier Contribution to Streamflow in Semiarid Catchments

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In high altitude areas vulnerable to climatic change, rock glaciers act increasingly as important sources of water, especially during summer and dry periods. These cryoforms are considered to be long term water reservoirs that support efficient water storage and slow delivery. The role of rock glaciers in the wider hydrological system of the semiarid Andes is little known, and is the driving impetus for this study. As water resources become increasingly scarce, and their demand increases, there is a need for improved understanding of existing sources, and changes within the context of a warming climate. This study will take a multi-method approach utilising a combination of glaciological, geomorphological, geophysical, geochemical and modelling techniques to better elucidate the structure and function of the hydrological system of rock glaciers and to subsequently evaluate rock glacier contribution to streamflow in the Elqui catchment where there are over 300 rock glaciers. In this presentation, we will highlight the methodological considerations for undertaking such a study, will provide a first inventory of rock glaciers and their changes in the last six decades in semi-arid Andean catchments, and compare their distribution, characteristics and potential hydrological importance to that of glaciers in the same region.

1055
High Elevation Snow Depth and Importance to Streamflow in the Andes of Chile

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Accurate quantification of snow accumulation and the contributions of snow and ice melt to river streamflow is of critical importance for water management in the semi-arid Andes of central Chile (32-34°S). This is particularly noteworthy because of a heightened socio-economic demand following recent drought events, which have reached unprecedented duration. There is, however, much uncertainty regarding the spatial distribution of snow and snow depth (*dS*) as a source of meltwater in the upper basins of major rivers, which is often modelled assuming simple statistical relationships and with data extrapolated from low elevation meteorological stations. Here we explore the appropriateness of leveraging modern satellite techniques for derivation of *dS* in combination with high resolution ground-based LiDAR data in order to address some of these uncertainties. We evaluate the representation of *dS* in a glacierised basin of the upper Maipo River (Rio del Yeso, 112 km^2) using recently developed techniques with optical tri-stereo imagery from the French Pléiades satellites (resolution < 2 m). We discuss the sub-pixel variability of *dS* in relation to topographical features of the landscape and compare with alternative statistical models in the literature. Finally, we begin to present the importance of this information for seasonal hydrological forecasting when prescribed as initial conditions in a glacio-hydrological model for the winter-summer season of 2017/2018.

1956
Modelling Long-term Runoff from a Glacierised Catchment in High Andes

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Central Chile's economy relies on melt water from glaciers and seasonal snow to sustain a robust growth, as well as to provide drinking water to major cities, particularly during dry periods. These recurrent climatic events play an important role on glacier storage, runoff production and long-term changes in glacier mass balance and streamflow. Here we present a modelling study that aims at reconstructing the climatic forcing, glacier response and runoff generation from a high elevation catchment of central Chile over the past 4 decades. Recent modelling studies have considerably advanced our understanding of water storage and of the spatial distribution of energy, mass and water fluxes in glacierised Andean catchments. However, they all have focused on simulations of a few years or melt seasons for which extensive field datasets were available to constrain model parameters. Very little is known about long-term fluctuations in glacier mass balance and the resulting changes in runoff from glacierised catchments, and the partition of snow and ice contribution over the long term. Debris-covered glaciers are an important element of the Andean cryosphere that has been to date largely neglected in hydrological studies. These types of glaciers, common in the central Andes, are increasingly recognized as responding in a distinctive manner to climate compared to clean ice glaciers and have the potential to affect the hydrological regimes of catchments substantially.

2385
How Important Are Ice Cliffs for the Mass-balance of Debris-covered Glaciers?

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Supraglacial ice cliffs enhance locally melt and mass losses of the otherwise insulated ice on debris covered glaciers. However, their contribution to the total glacier mass balance has never been quantified, with inference obtained from upscaling models or observations at selected cliffs. Their overall importance remains little understood.
From six high-resolution satellite images we derive an inventory of ice cliffs in the Langtang catchment (Nepal) for 2006-2015 and we use it to:
i) assess the frequency and distribution of cliffs and ponds;
ii) characterize cliff geometries, pond areas and the life cycle of cliff-pond systems.
The volume losses associated with the backwasting of cliffs for the debris-covered glaciers of the Langtang catchment are calculated with a physically-based backwasting model considering the cliff-atmosphere energy-balance, reburial by debris and the effects of adjacent ponds. To estimate the contribution of ice cliff melt to total glacier mass balance we compare simulated cliff melt to the distributed glacier mass balance values from a glacio-hydrological model (TOPKAPI-ETH).
Ice cliffs vary greatly in space and time. The associated volume losses are a non-negligible term (with values >60% on the lower sections of the debris-covered tongues) in the total glacier mass balance of debris-covered glaciers, providing a partial explanation of the higher-than-expected mass losses of debris-covered glaciers of High Mountain Asia.

BE-7 - Up- and Down-scaling approaches in Polar Ecosystem Research
20.06.2018 16:00-17:30, B Jakobshorn

524
Role of Scale in the Analysis of Arctic and Southern Ocean Benthic Functions

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Comparative ecosystem studies are acknowledged to be crucial for soundly estimating the relative importance of physical-chemical (temperature, salinity) and biological (Chl a, faunal abundance) factors for ecosystem functions (e.g. remineralisation). However, such studies are still scarce in polar benthic habitats, as they are elaborate to conduct, and constraints imposed by differences in methodological approach, regional particularities, and spatio-temporal scales are known to bias the analyses and subsequent upscaling efforts. Here, we present the findings of comparative within-region versus across-region analyses of studies in Arctic and Antarctic shelf waters (Canadian Arctic and Laptev Sea, as well as Weddell Sea and off the Antarctic Peninsula). We demonstrate how the analysed scale can influence results and conclusions on the effects of environmental and biological drivers on benthic ecosystem functions (benthic remineralisation, oxygen consumption). The highly standardized field approach (ex situ incubations) applied in each region reduces methodological bias and allows for a sound comparison on different spatial scales. Our results point to the difficulties of comparative studies but also provide suggestions how to handle those issues when aiming for and interpreting upscaling approaches in polar marine benthic systems.

1037
A Seascape View of Decadal Change along the Western Antarctic Peninsula

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Located near the edge of the winter sea ice maxima, the marine ecosystem of the western Antarctic Peninsula (WAP) is a bellwether of global climate change. The Palmer Long Term Ecological Research (LTER) project has been documenting changes to the WAP marine ecosystem since 1993 with an annual summer cruise. To enable a comparison between multiple years in the Palmer LTER dataset we developed a seascape unit (SU) classification system based on temperature, salinity, nutrients, and chlorophyll *a*. By objectively mapping these parameters for each cruise we were able to classify the Palmer LTER grid into 8 recurrent SUs. We used clustering and PCA to evaluate the distribution of SUs between years, finding that years formed two statistically significant clusters. While mean chlorophyll *a* concentration did not differ between clusters, the location and SU association of chlorophyll *a* biomass differed. We used correlations and elastic-net regression to identify environmental factors and modes of climate variability that might account for cluster membership and SU abundance. We detected a strong association between early spring sea ice conditions and cluster membership, suggesting that early spring nutrient drawdown can impact the distribution of summer chlorophyll *a* biomass. Future improvements to the seascape concept for the WAP will enable further insights, and wider application to the coastal Antarctic may lead to a unified view of marine ecosystem distribution and change.

487
Arctic Benthic Diversity Research with PANABIO: Scale, Sharing and Modelling

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Arctic marine biota are affected profoundly and at large scales by accelerating environmental change, such as sea-ice decline. Moreover, increasing human activities, e.g. exploitation of natural resources, add further cumulative pressures. Substantial shifts in ecosystem functions and services, e.g. biodiversity, are expected. To understand, predict, and mitigate the profound ecological consequences of such shifts, it is critical to identify and analyse the relationships between environmental drivers and ecosystem functions at regional and pan-Arctic scales. We address this challenge by developing a pan-Arctic knowledge system on benthic biota (PANABIO). Underpinned by international efforts to combine data and expertise, PANABIO integrates quality-controlled and geo-referenced data on benthic communities in a public data-warehouse. This will support
(a) providing ecological baseline-data to gauge ecosystem changes,
(b) analysing coupling mechanisms between environmental drivers and ecosystem functions/services on regional and pan-Arctic scales,
(c) developing future ecosystem scenarios in response to external forcing, and
(d) creating online stakeholder-oriented visualization and analysis tools.
The talk will demonstrate the huge up-scaling of benthic data we realised, our achievements to support data-sharing, as well as first results of multi-variate species distribution models to discern distinct benthic sea-ice communities.

1864
Physiological Models in Antarctica: Dynamic Inferences in a Changing Environment

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The Western Antarctic Peninsula is facing rapid global changes which are currently the focus of an intense research effort to understand the potential of marine benthic populations response. Our knowledge about the impact of environmental changes on Antarctic species physiology has mostly been gathered from short term experimental designs and is limited by a broad range of practical constraints.
An alternative to these experimental designs is to use mechanistic models that relate species functional traits to environmental characteristics. Dynamic Energy Budget (DEB) theory describes organisms uptake and allocates energy throughout their entire life cycle. Their parametrisation requires observations of species life cycle and physiology, which are often available from the literature.
In this presentation, we showcase DEB models built for a series of representative benthic Antarctic species. Metabolic performances (growth rate, age at metamorphosis, reproductive performance, survival) will be assessed for these species on the extent of the Western Antarctic Peninsula. Potential shifts in physiological traits will be predicted and compared for a range of environmental scenarios (RCP scenarii, IPCC, 5th report) in order to characterise species sensitivity in the context of a fast-changing environment.

267
How Universal is the Keystoneness of Krill in Southern Ocean Food Webs?

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A principal goal of ecosystem ecology is to develop and test theories regarding the nature of species interactions and their contribution to the organisation of biological communities. In Southern Ocean ecosystems, Antarctic krill (*Euphausia superba*) are widely recognised to play a keystone role in transferring energy from primary producers, supporting large populations of marine mammals and seabirds. However, it is not clear whether the dominant role of krill in Southern Ocean food webs is universal. An alternative configuration is more diffuse trophic networks, where a variety of mid-trophic level organisms, other than krill, play major roles in energy transfer.
To evaluate how universal the keystone role of krill is in Southern Ocean food webs, we used the Southern Ocean Dietary Database to undertake the first large-scale circumpolar analysis of food web structure across the four major oceanic sectors of the Southern Ocean. Here, we describe how we quantified the contributions of various species and groups to energy flow within each sector, and provide a summary of our key findings. Previous analyses of Antarctic ecosystems have focused entirely on a single web topology or have provided qualitative descriptions of small sub-systems. We discuss how our generalised approach facilitates cross-system comparisons, emphasises critical processes for maintaining food web structure within each sector, and can inform the future management of Antarctic ecosystems.

1424
Towards Monitoring of Primary Production in Polar Regions

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Active chlorophyll *a* fluorescence techniques have the potential to provide estimates of phytoplankton primary production at unprecedented temporal and spatial scales. Fast Repetition Rate fluorometry (FRRf) is such a promising technique, however knowledge of the electron requirement of carbon fixation ($\Phi_{e,C}$) is required to accurately estimate primary production from FRRf measurements. While the $\Phi_{e,C}$ has been studied in fast areas of the open oceans, only a few studies have focused on polar regions. In the Arctic, the $\Phi_{e,C}$ seems to vary with *in situ* light conditions and is closely related to non-photochemical processes and other physiological processes such as cyclic electron flow. The present study assessed the $\Phi_{e,C}$ experimentally in freshly isolated Antarctic diatom species. In addition, the $\Phi_{e,C}$ was measured in natural phytoplankton communities from Ryder Bay, West Antarctic Peninsula, during two summer seasons. While $\Phi_{e,C}$ was influenced by species composition and environmental conditions, results showed a linear relationship between electron transport and carbon fixation. These results were used to estimate primary production from automated FRRf measurements in both the laboratory and the field. Further upscaling of the chlorophyll *a* fluorescence technique can strongly advance our understanding of factors that regulate primary production of marine phytoplankton in one of the most rapidly warming regions of the world.

EN-1 - Environmental and community challenges in rapidly changing polar coastal zones
20.06.2018 16:00-17:30, C Sanada I

109
Collapsing Coasts in the Arctic: Environmental and Socio-economic Impacts

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Arctic warming is exposing permafrost coastlines, which account for 34% of the Earth's coasts, to rapid thaw and erosion. Coastal erosion rates as high as 25 m yr^{-1} together with the large amount of organic matter frozen in permafrost are resulting in an annual release of 14.0 Tg (10^{12} gram) particulate organic carbon into the nearshore zone. We highlight the crucial role the nearshore zone plays in Arctic biogeochemical cycling, as here the fate of the released material is decided.
With Arctic warming, erosion fluxes have the potential to increase by an order of magnitude until 2100. Such increases would result in drastic impacts on global carbon fluxes and their climate feedbacks, on nearshore food webs and on local communities, whose survival still relies on marine biological resources. Quantifying the potential impacts of increasing erosion on coastal ecosystems is crucial for food security of northern residents living in Arctic coastal communities. We need to know how the traditional hunting and fishing grounds might be impacted by high loads of sediment and nutrients released from eroding coasts, and to what extent coastal retreat will lead to a loss of habitat. Quantifying fluxes of organic carbon and nutrients is required, both in nearshore deposits and in the water column by sediment coring and systematic oceanographic monitoring. Ultimately, this will allow us to assess the transport and degradation pathways of sediment and organic matter derived from erosion.

2168
Impacts of Sea-level Change on Antarctica

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Whilst much Antarctic research has been focused on determining how Antarctic ice sheets will contribute to global sea-level rise under warming, the potential effects on Antarctica of sea-level change have not been as comprehensively considered. Here we assess the potential effects of forecast sea-level rise and fall to Antarctic biodiversity and human infrastructure by 2100, using multiple sea-level scenarios (0.5 m, 1 m, 2 m). Under a 2 m rise scenario, up to 60% of Antarctic Specially Protected Areas, 58% of Important Bird Areas, 68% of penguin breeding colonies, 40% of research infrastructure, and 71% of tourist landing sites could be at risk of partial or complete inundation. A fall in sea-level would see infrastructure and biodiversity further from the coast, resulting in changed environmental conditions and new logistic challenges for National Programs. Simultaneous impacts on human activity and terrestrial biodiversity will compel several forms of adaptation across both groups, with potential for growing conservation problems. Better spatially explicit understanding of sea-level change is therefore also pressing from a conservation perspective.

1166
Dendrology and Newspaper Accounts: A Novel Approach to Coastal Storm Research in Alaska

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Frequent interactions with indigenous communities can lead to novel approaches in studying climate change. Such approaches generate new forms of knowledge, but also generate a fuller understanding of climate change as it occurs in infrequently studied regions. This presentation focuses on storm intensity in one such region in Alaska, the Bering Strait. While it is likely that storm intensity has increased and will continue to increase in this region with additional warming, there is little evidence to support these claims. This project aims to generate evidence of storm intensity in the region by combining natural science and traditional Siberian Yupik naming traditions. Driftwood deposits laid to rest at the extent of the storm surge are used as indicators of a given storm's intensity. The date of *when* the driftwood was deposited, however, cannot be determined precisely by dendrochronology techniques. Traditional ecological knowledge of storm events stored in the names of indigenous peoples in Savoonga, Alaska may reveal the dates of large storms that left the driftwood on their beaches. This Siberian Yupik village names babies after significant events, like large storms, to retain knowledge of those events; their birth dates are used to identify, with great precision, the date of past storms. Storm surge maps can be generated from these sources and the direction of storm intensity change may be identified.

1387
Coastal Landscape Transformation in Sørkapp Land (Spitsbergen), 1899 - 2016

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Sørkapp Land is the southern Spitsbergen peninsula - a wedge between the Barents and Greenland Seas. Its coasts transformed under climate warming since 1899. The eastern, most glaciated and coldest, mountainous coast (70 km long) underwent a huge change**:** - recession of tidewater glaciers (rapid since the 1980s) formed the new Hambergbukta fjord and Isbukta bay, and exposed the coastline to sea abrasion and accumulation, - hence, the plain with Davislaguna was abraded by the sea and several new plains appeared in areas abandoned by glaciers, - recession of glaciers located above the sea-level led to formation of a new landscape (new deposits, landforms and water-bodies), - animal colonization allowed plant succession what began soil formation. The western - least glaciated and warmest - lowland coast (55 km long) underwent a progressive change since 1899. It was generally ice-freed at the end of Pleistocene and covered with tundra, overgrazed by reindeer regenerated there since the 1990s. Recession of the only tidewater glacier led to origin of the Stormbukta bay. The coastline was modified due to shortening of a sea-ice season what intensified sea-action: filling bays with deposits and abrasion of headlands. The northern fjord coast (55 km long) lengthened a lot since 1899 due to recession of tidewater glaciers, which formed new lateral fjords and bays (Samarinvågen is the longest). The southern lowland coast is 27 km long and most stable due to a shallow sea offshore.

1289
Building a Collaborative Framework to Support Adaptation in Coastal Alaska

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In environments undergoing rapid change, increased adaptive capacity and resilience are only achieved with strong, ongoing collaboration. Recognizing this challenge, decision makers working in coastal communities across Alaska convened a series of workshops to share knowledge on current and future changes, their impacts, and potential responses. These workshops began in late 2012 with a focus on coastal hazards, and have continued through 2017 with a string of discussions centered on regional impacts. The 300+ participants included Alaska Natives, local governments, and State and Federal agencies, with input from all of these groups feeding into an assessment of the data and information needed to help communities better respond to coastal change. Based on these ongoing efforts, we will provide a summary of key data gaps related to the environment in these coastal zones (e.g., bathymetry, sea ice conditions, vessel traffic), and progress to date in addressing these gaps. Moreover, we hope to present an overview of how these workshops have been used to strengthen collaboration across stakeholder groups; consolidate and leverage research (both western and traditional); and ensure that results reach the stakeholders who need them. Overall, we seek to present a suite of “lessons learned” for those wishing to create a dynamic, collaborative process for identifying needs, conducting research, and communicating in support of those living and working in Polar coastal zones.

1976
Mechanisms Controlling the Evolution of Rocky Coastal Zone in Polar Climates

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Our work aims to address deficiency in understanding of mechanisms controlling the development of rocky coasts in polar regions. Over last few years we studied the processes controlling the evolution and behaviour of rock coasts in representative areas of South Shetland Islands (Antarctic) and Svalbard (Arctic).
Rock surface weathering and downwearing surveys along several morphologically different coast types demonstrated broad variety of interrelations between rock surface resistance and distance from present-day shoreline as well as thickness of snow covers. In general, cliff surfaces were the most resistant in their lower and middle zones which are thermally insulated by thick winter snowdrifts. Whereas the more exposed cliff tops were heavily fractured and weathered. The differences in rock resistance and downwearing rates observed along the shore platforms were highly dependent on thickness of sediment cover and shoreline configuration. These characteristics favoured stronger rock surfaces in areas exposed to the longest wave fetch, but also washing by meltwaters from decaying ice-foot. The results of ERT survey suggest that most of the rocky capes and platforms are free of continuous permafrost and frozen ground conditions develop further inland. The results presented in this paper emphasize the richness of microrelief features and processes operating in polar rock coastal environments.
This paper is a contribution to NCN project UMO2013/11/B/ST10/00283.

BE-4f - Climate change and ecosystems: physiology, biodiversity and ecological functions
20.06.2018 16:00-17:30, C Sanada II

273
Arctic Kelp Ecophysiology in a Warming Winter Scenario

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Kelps, large brown seaweeds of the order Laminariales, are important ecosystem engineers in Arctic coastal ecosystems. However, knowledge of seaweed ecosystem functioning under Arctic winter conditions is scarce, but essential to understand adaptive life strategies and adaptability in an era of climate change. In high latitude coastal systems, kelps, as perennial and primarily photoautotrophic marine plants, have to face several months of darkness, precluding photosynthetic activity. Still, winterly growth of kelp tissue has been observed, fuelled by the consumption of stored carbohydrates.
In the Arctic Kongsfjord (Svalbard), a pronounced increase in seawater temperature has been detected since 2006, and is expected to continue. Thus, it is essential to understand temperature related modulation of winterly ecophysiology in Arctic seaweeds. Two species of Arctic kelps (the cold-temperate *Saccharina latissima* and the endemic *Laminaria solidungula*) have been studied for the expression and regulation of house-keeping physiological processes in autumn and just at the end of the polar night. In *S. latissima* more than 80% of the storage carbohydrate laminaran is consumed during winter under current *in situ* fjord temperature, and our data suggest that carbohydrate turn-over will further increase with temperature. Experimentally increased temperature conditions during dark exposure point to a complex network of physiological adjustments of kelps in a changing Arctic environment.

287
Spatial Variation in the Structure of Benthic Communities in Siberian Shelf Seas

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Climate change and its consequences pressure the Arctic Siberian shelf region and impact marine benthic organisms severely. Since polar ecosystems are used to long-time stable conditions, even small changes could have wide-ranging consequences for benthic communities, food webs, and ecosystem functions. Yet, little is known about the response of Arctic benthic organisms to changing environmental conditions. We address this knowledge gap by combining data from different Arctic regions and employing recent ecological modelling techniques and study community structure, diversity and ecosystem functions in Arctic benthos across larger scales.
Expeditions in the Arctic seas from the years 1991, 1993, 2013 and 2014 provide the required ecological data for the modelling approaches. Sixty-nine stations across the Arctic Sea were sampled by trawling and grab methods within the TRANSDRIFT-framework. By employing multivariate spatial analysis tools, such as Moran's eigenvector mapping, an answer to the following question shall be provided: whether to include relationships between spatial structure and abiotic variables allow scientists to better detect patterns of species and communities in the Arctic Siberian Sea. The expected result will show which environmental variables are important at which scale, and which macrobenthic species are most associated with these distinct scales.

1751
Genetic Monitoring for Climate Change in Antarctic Marine Invertebrates

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Climate change is expected to disproportionately affect the diversity of polar regions. In comparison, in other areas with latitudinal scope, organisms may be able to respond by changing their distributions to suit their physiological capacities. However this is not possible for polar species that simply have nowhere colder they can migrate to, even if they were able to. Although some level of adaptation and response to changing conditions is predicted, undoubtedly the loss of species diversity is ultimately expected. We show here the importance of having baseline phylogeographic information to be able to detect when the species diversity of Antarctic communities begin being impacted. Our study system utilises cryptic species diversity in the Antarctic crinoid *Promachocrinus*, and differential species distributions to create a warning system of marine invertebrate community change.

1175
Structural Protein Constraints at Low Temperature

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The main question in the debate on climate change is whether some species will be able to adapt fast enough to keep up with the rapid pace of changing climate. Whatever the type of adaptive responses, underlying mechanisms are due either to evolution or plasticity. Empirical evidence suggests that physiological plasticity is often more important than genetic contribution in complex, long-living species. Of particular concern are "tipping points" where ecosystem thresholds can lead to irreversible shifts. The biological effects of increasing temperature on marine ecosystems are already evident. Temperature governs the rate of chemical reactions and pathways regulating the development and decline of life. Sensitivity to temperature influences the success of organisms in all habitats, and is caused by the susceptibility of biochemical processes, including protein function, to temperature change. Recent studies indicate that only minor structural modifications are needed to change the intrinsic stability of cold-adapted proteins, and that local rather than global flexibility may play an important role. In this contribution, we first summarise how cold temperature affects the physiology, then focus on the molecular mechanisms of cold adaptation revealed by recent biophysical, biochemical and genetic studies of a specific group: oxygen-binding proteins.

468
Functional Response Traits in a Changing Polar Ocean

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The northern high latitudes are experiencing some of the most rapid and severe climate change recorded globally. Changes apparent in the Arctic climate system are now well established and evidenced in observations of substantial warming and dramatic reductions in summer sea ice extent and thickness. However, the response of key components of Arctic ecosystems, such as benthic faunal assemblages, to environmental change is poorly understood. Here we investigate the ecological consequences of climate change in the Arctic by characterising and quantifying change in the functional response traits of representative benthic species along a gradient of variable sea ice conditions. To inform our interpretations, we focus on biogeochemically and population-relevant biological activities, including bioturbation and bioirrigation, and growth and reproduction, respectively. Our findings detail how and when the response of benthic invertebrate species and/or communities lead to functionally important changes in behavior that, in turn, alter important ecosystem processes and function.

2
Climate and the Magnitude of Blue Carbon Storage by Circumpolar Shelf Benthos

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High latitude continental shelves provide carbon capture and storage of millions of tonnes annually. The magnitude and variability in this biological accumulation, immobilization and ultimate sequestration of Carbon has been little quantified. Darwin Initiative, Antarctic Circumnavigation Expedition (ACE) and ICEBERGs projects have supported the Antarctic Seabed Carbon Capture Change project to sample shelf benthos in order to attempt estimation of this carbon budget by region and across years. This was undertaken by using Shelf Underwater camera System (SUCS) and video/photo-equipped trawls to estimate benthos densities and specimens were collected to evaluate carbon per age per species. SubAntarctic continental shelf benthos seem to play only a small role in carbon cycling, but are globally significant in terms of carbon storage and very likely sequestration. There is considerable temporal variation in benthic carbon storage, particularly around West Antarctica, correlated with climate forced sea-ice losses (and ice shelf disintegration). There is also evidence of warming increasing benthic carbon storage budgets, through faster growth. SubAntarctic continental shelves have considerable phytoplankton blooms, little sea ice and warmer sea temperatures than Antarctica; together with polar shelves they represent one of Earth's most significant and growing negative feedbacks on climate change.

Poster & Beer I
20.06.2018 17:30-18:30, Foyer

Wed_1_AC-2_62
Precipitation Measurements at Rothera Research Station in Antarctica

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Measuring precipitation in the Antarctic is very difficult and at present no reliable way of ground truthing the data exists. It is a very important parameter to accurately measure so that the measurements can be used for model verification. At the British Antarctic Survey's Rothera station on the Antarctic Peninsula at (67.5S, 68.1W) we are comparing a selection of precipitation sensors to assess which is the most accurate.
Three optical sensors are being compared, they are a Thies Laser Precipitation Monitor (LPM), a Biral VPF-730 combined precipitation and visibility sensor and a Campbell Scientific PWS100. They all use different measuring techniques to estimate precipitation type and intensity by analysing how the water droplets and snow particles interfere with the optical beams.
There is also a UPG1000 - Universal Precipitation Gauge that is manufactured by Environmental Measurements Ltd (EML). When snow falls into this gauge it is melted and then measured using a tipping bucket.
Initial results show a large difference between all of the sensors on a monthly scale but in low wind speed conditions there is close agreement between all. More analysis of the data are being carried out to try and ascertain which of them is most accurate for use in the Antarctic.
This presentation will look in more detail at the operation of the sensors and how the data compares in different wind regimes.

Wed_2_AC-2_292
Detailed Regional Reanalysis for Russian Arctic: Strategy and Methodology

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There are various estimates of the trends of certain meteorological parameters in different water areas and coastal zones of the Russian and rest Arctic regions. Taking into account the increasing number of dangerous phenomena and outlooks for the Arctic coast, the task of providing the region detailed hydrometeorological and climatic information with a horizontal resolution of at least several kilometers becomes particularly topical. To get there, we will use well-known regional climate model COSMO-CLM v5.0.
The regional reanalysis for Russian Arctic, an integrated archive of hydrometeorological parameters with a spatial resolution of less than 5 km, will be obtained for the first time after long-term simulation experiments. Detailed hydrometeorological fields in the Arctic over a long period (1980 - 2016) will be derived by the two-step downscaling technology with ~13 km and ~4 km domains and will cover most of Russian Artic (western Arctic seas more detailed).
The regional reanalysis output is possible to use as inputs to modelling the ocean´s characteristics (wind waves and dynamics), coastal ecosystems (turbulent heat fluxes, greenhouse gases), more detailed research of individual phenomena on nested domains (extreme situations, hazardous weather events), analysis of trends in the frequency of occurrence of extreme events and features of their spatial distribution, the hydrometeorological regime of coastal areas studies, climatology and tracking of polar mesocyclones, etc.

Wed_3_AC-2_337
The New Normal: The Synoptic Situation during the ACLOUD/PASCAL Campaigns 2017

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The Arctic is warming twice as fast as the global average. This feature, known as the Arctic amplification, results in and is a result of rapidly changing climate system components, where the effects of clouds remain one of our largest unknowns.
The joint field campaign Arctic CLoud Observations Using airborne measurements during polar Day (ACLOUD) May 22 - June 28, 2017 aimed at improving our understanding of physical processes above, below and in Arctic clouds. It offers crucial data for the representation of clouds and atmospheric processes in weather and climate models representing the new normal in the Arctic.
ACLOUD made use of two aircrafts based in Longyearbyen, Svalbard. Flying mostly together at different levels, the aircrafts Polar 5 and 6 applied in situ measurement techniques and remote sensing instruments. ACLOUD was coordinated with surface-based observations from the station in Ny-Ålesund and an ice camp north of Svalbard operated within the joint campaign PASCAL around RV Polarstern. This allowed us to measure properties of cloud and aerosol particles, trace gas concentration, and turbulent and radiative fluxes in the atmospheric column over and around Svalbard.
In this presentation, the first results of ACLOUD are given, with a focus on the synoptic situation during the campaign. We highlight the importance such field campaigns have also beyond the scientific community.

Wed_4_AC-2_475
ARPEGE Contribution for the Study of Antarctic Climate and SMB Change

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Assessing the evolution of Antarctic climate and SMB by the end 21st century is of first importance for evaluating the potential contribution to SLR. In this frame, we evaluate the contribution of atmosphere-only GCM, ARPEGE, with a stretched grid allowing a resolution of 45 kms on Antarctica. First, the ability to reproduce Antarctic climate of a free AMIP simulation (1981-2010) is assessed using observational data set, reanalysis and model inter-comparisons. Firsts results show that ARPEGE succeed in reconstructing surface climate. The use of an intermediate-complexity snow model allows taking into account processes such as snow sublimation and run-off. However, errors on atmospheric general circulation, particularly the underestimation of Amundsen Sea Low affects the spatial distribution of precipitations over West Antarctica. Nevertheless, mean 1981-2010 SMB of Antarctic Ice sheet of 2317.7 Gt.yr^{-1} concours with recent publications (e.g. Agosta *et al.,* 2013, Lenaerts *et al.,* 2015). Then, we use ARPEGE to evaluate changes of Antarctic climate and SMB in a RCP8.5 scenario. Thirty years simulations at the end of the 21st century (2071-2100) are realized using bias correction of oceanic forcings coming from CMIP5 AOGCM scenarios following recommendations from Beaumet *et al.,* (submitted). Remaining uncertainties coming from the climate change signal for oceanic surface conditions in different CMIP5 model are assessed independently from the bias on historical climate.

Wed_5_AC-2_492
The Vertical Structure of the Troposphere above the Southern Ocean during ACE

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Due to the poor observational constraint in the Southern Ocean, atmospheric analysis and reanalysis datasets are associated with larger uncertainties in this region than in the Northern Hemisphere. On this poster a series of 98 vertical soundings collected during the ship-based Antarctic Circumnavigation Expedition (ACE) in the austral summer 2016/2017 is compared to operational analysis data of the European Centre for Medium-Range Weather Forecasts. The ACE soundings were not assimilated and thus provide an independent validation data set. The vertical structure of temperature, humidity, and wind is analysed. In many soundings, a good match of the observations with the operational analysis is found for the upper troposphere (p< 500 hPa). In contrast, in the lower troposphere, 50-100 hPa thick humid layers generally associated with clouds are either not represented in the analysis data or shifted in space and time. Three cases of a marked isothermal mid tropospheric dry air layer above a precipitating cloud are discussed in more detail based on a Lagrangian analysis of the airmass history in this layer.

Wed_6_AC-2_666
One Year of Stratospheric Water Vapor Measurements at Thule, Greenland

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A new 22 GHz water vapor spectrometer, VESPA-22, was installed in July 2016 at the Thule High Arctic Atmospheric Observatory located at Thule Air Base (76.5° N, 68.8° W), Greenland (http://www.thuleatmos-it.it/). It was designed and built at the INGV and measures the 22.235 GHz water vapor emission line with a bandwidth of 500 MHz and a resolution of 31 kHz. The collected spectra are inverted using an optimal estimation algorithm in order to retrieve water vapor vertical profiles from about 25 to 75 km with an overall uncertainty between 5 and 12%. Depending on season and weather conditions, 2 to 4 vertical profiles a day are obtained. VESPA-22 has been operating in an autonomous mode since its installation, with very few short periods of data gaps. This study will present water vapor stratospheric profiles over Thule obtained during a complete yearly cycle, from July 2016 to July 2017, showing both the rapid variations measured in winter when the polar vortex moved away from Thule and the slow seasonal variations due to the air subsidence inside and at the edge of the polar vortex. VESPA-22 water vapor vertical profiles have been compared with version 4.2 of concurrent Aura/Microwave Limb Sounder (MLS) profiles. In the sensitivity range of VESPA-22 retrievals, the intercomparison between the two datasets reveals a correlation coefficient of about 0.8 or higher and an average difference reaching its maximum of -6% or -0.2 ppmv at the top of the sensitivity range.

Wed_7_AC-2_680
Column Water Vapor Impact on the Surface Infrared Radiation at Thule, Greenland

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The absorption of longwave radiation by water vapor and clouds influences temperature at the surface creating complex feedback cycles. Direct measurements of surface irradiance in the Arctic region are sparse and accurate parameterizations are therefore required in order to constrain climate models and study such cycles. This study presents an analysis of the impact of precipitable water vapor (PWV) and surface temperature on downwelling longwave clear-sky irradiance at the surface measured at the Thule High Arctic Atmospheric Observatory located at Thule Air Base (76.5° N, 68.8° W), Greenland (http://www.thuleatmos-it.it/). PWV measurements are obtained with the 22 GHz spectrometer VESPA-22 and the RPG HATPRO radiometer, whereas the longwave irradiance is measured by means of a CGR4 pyrgeometer. VESPA-22 and HATPRO PWV measurements are intercompared with those obtained by Aqua/AIRS, and by means of a Cimel sunphotometer (AERONET network) and a GPS receiver also installed at Thule. A new semi-empirical parameterization model is formulated using high-time resolution observations collected from July 2016 onwards. The relative weight of column water vapor and temperature on clear-sky longwave irradiance at the surface is investigated by means of the MODTRAN radiative transfer model during a full annual cycle. The semi-empirical model implemented in this study proves to be a valuable tool for parameterizing clear-sky longwave irradiance at high latitudes.

Wed_8_AC-2_746
Comparison Between Cloudsat and In-situ Radar Snowfall Rates in East Antarctica

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The Antarctic continent is a vast desert, the coldest and the most unknown area on Earth and contains its largest fresh water reservoir. Current global warming could threaten this ice sheet, leading to sea level rise. The main goal of the French-Swiss APRES3 project (Antarctic Precipitation, Remote Sensing from Surface and Space) is to document and understand current precipitation over the south polar cap, knowing that current climate models do not agree on snowfall amounts over the ice sheet [Palerme, Clim. Dynamics 2017]. Remote sensing observations of the coastal regions and the continent using CloudSat radar give a snowfall rate of 153 mm/year whereas the IPSL Climate Model gives a higher rate of 172 mm/year, knowing that CloudSat uncertainties are hard to constrain and range from about 50% up to 175% [Wood, Thesis 2011]. We did a comparison between CloudSat radar observations and a Micro-Rain Radar located at the French Dumont d´Urville station that brings a better understanding of CloudSat uncertainties and leads to a reassessment of these values. We compared these two different data sets over February 2017, when CloudSat overpassed the Dumont d´Urville radar four times, at one vertical level and the agreement is suitable. Using different CloudSat vertical levels and additional surface precipitation observation by a PLUVIO2 weighing gauge, we explore and analyze the vertical profile of precipitation over Dumont d´Urville and revisit the results over the whole continent.

Wed_9_AC-2_782
Comparison of Arctic Precipitation from Reanalyses for 1979 - 2016

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Precipitation and snowfall in particular are of great importance for the Arctic climate system due to their implications on physical mechanisms like sea ice growth and melt, permafrost, as well as on ecosystems and society.
Unfavorably, there are only few circum-Arctic stations and hardly any in the Central Arctic itself measuring precipitation. Therefore, many related studies use model simulations or reanalyses. However, it is somehow unclear how big the uncertainties from a specific product are.
Our study examines the spatiotemporal distribution and statistical characteristics of precipitation from various reanalyses (ERA-Interim, MERRA-2, JRA-55, ASR, CFSR) in the Arctic for 1979-2016. We show that the spatial distribution of precipitation and the timing at which the precipitation occurs are very similar across the reanalyses, as those are mainly influenced by the large-scale circulation. However, there does exist a large spread in the amount of precipitation caused by synoptic events as well as in the total amount.
Since the used parametrization schemes vary widely in the way they determine the precipitation phase, large differences in the snowfall to precipitation ratio can be observed.
We analyze how the trend in the amount of precipitation and the precipitation phase can be interpreted.
This work was supported by the SFB/TR 172 “ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms (AC)³” in sub-project E04 funded by the DFG.

Wed_10_AC-2_805
Characteristics of Gravity Waves over Antarctica Using Radiosonde Observations

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By now the momentous role of atmospheric gravity waves in shaping the thermal and dynamical structure of the middle atmosphere is irrefutable. More observations of gravity waves in the polar stratosphere, especially over the remote and hostile Antarctic, are required for the betterment of their representation in models. In this regard, a study was conducted to characterize gravity waves in the Antarctic lower stratosphere using campaign mode balloon borne radiosonde observations from the Indian research base at Antarctica, Bharati (69^{o}S, 76.8^{o}E) during the austral summers of 2014-15, 2015-16 and 2016-17. The average potential energy densities in the lower stratosphere were found to be less than 1J/kg. The gravity wave kinetic energy densities were found to be much higher than the corresponding potential energy densities (KE/PE>1), suggestive of the dominance of inertia-gravity waves in the wave field. Further, Stokes parameter analysis was used to extract the propagation characteristics.The intrinsic period of the gravity waves were found to be closer to the inertial period at the location. The deduced horizontal wavelengths were large, of the order of 1000km. The observed waves were predominantly upward propagating which is typical of summertime Antarctic stratosphere. The significance of the present study lies in bringing out the characteristics of gravity waves over Antarctica during three summer seasons with different prevailing atmospheric conditions.

Wed_11_AC-2_859
Influence of Ozone Hole on Precipitation in the Pacific Coast of South America

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Both simulations and observations consistently proved that the ozone hole left a clear signature of its effects on the surface climate of the Southern Hemisphere. Within this framework, results based on an ozone attribution study, performed by some of the models participant to the Coupled Model Intercomparison Project Phase 5 (CMIP5) initiative, suggest that the evolution of the ozone hole contributed to the previously identified reduction of precipitation occurred along the Pacific coast of southern South America during the last decades. Such ozoneinduced variations, which maximize in summer, are coupled to corresponding changes in cloud fraction and surface temperature. The individual response of each model is shown to be dependent on the magnitude of the ozone forcing. This influence is explained by the ozone hole impact on the general atmospheric circulation and confirms previous results pointing to a largescale control on this region. In particular, the response to ozone hole in the zonal winds is shown to determine the strength of uplift on the windward side of the Andes with consequent larger humidity there and, possibly, dry conditions in the eastern plains. Since the ozone hole is simulated to recover by the next decades, its forcing is shown to counteract the GHG forcing under the RCP4.5 scenario. As a consequence, no evident changes in cloudiness and precipitation affect the investigated region during this period.

Wed_12_AC-2_915
Overview of Stable Water Isotope Meteorology in the Southern Ocean during ACE

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The dynamics of the large-scale atmospheric flow strongly influences the Southern Ocean fresh water budget. For example, the passage of cyclones is responsible for a large part of strong precipitation events, whereas cold-air outbreaks are often associated with intense ocean evaporation. Stable water isotopes (SWI) are useful tracers to analyse atmospheric moisture sources and transport pathways. During the Antarctic Circumnavigation Expedition (ACE), a unique observational dataset was collected on board the vessel Akademik Tryoshnikov from 16 Dec 2016 to 17 March 2017. These observations include measurements of SWI in atmospheric water vapour, precipitation and surface waters, radar observations of precipitation, high-resolution humidity measurements, and atmospheric profiles from radiosondes.
Together with different meteorological diagnostics, these observations are used to investigate key aspects of the Southern Ocean water cycle. The meteorological conditions during austral summer 16/17 are presented using operational analysis data of the European Centre for Medium-Range Weather Forecasts. Various tools to identify weather systems are used to characterise the meteorology during the ACE expedition. The encountered weather systems are then linked to the SWI composition of atmospheric water vapour. This includes a detailed characterisation of the spatial and temporal SWI variability in atmospheric vapour along the ship track, and the involved meteorological phenomena.

Wed_13_AC-2_928
Antarctic Ozone Asymmetry and Regional Climate Changes

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The asymmetry in the Antarctic total ozone zonal distribution has changed during the last four decades, showing an eastward shift in the zonal ozone minimum of quasi-stationary planetary wave. The satellite data 1979-2016 analyzed by the authors related to changes in the zonal asymmetry of the Antarctic ozone and to their coupling with atmospheric parameters in the Southern Hemisphere (SH) are presented. Long-term changes of total ozone content in the SH in spring are accompanied by changes in its asymmetric distribution. Interannual variations of the longitudinal ozone minimum position demonstrate statistically significant relation to the structure of the quasi-stationary planetary waves in the distribution of atmospheric parameters. The long-term longitudinal shift of the ozone minimum is similar to shift in the zonal structure of planetary waves in the tropospheric parameter distribution and is also accompanied by meridional displacement of the climatic anomalies toward the equator. The obtained relationships characterize interdependence between the large-scale tropospheric and stratospheric disturbances in the SH during the ozone hole season. Eastward movement of the zonal ozone minimum over Antarctica has slowed and reversed to westward during the last decade that can relate to the first sign of recovery in Antarctic ozone. The zonal ozone asymmetry behavior accompanying ozone depletion/recovery could be associated with regional climate changes in the SH in spring.

Wed_14_AC-2_976
Arctic/Antarctic UV Measurements: Sodankylä 67ºN Marambio 64ºS

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The Finnish Meteorological Institute (FMI) has collaborated with the Servicio Meteorológico Nacional, Argentina, to establish new UV measurements in Antarctica. A GUV-2511 multifilter radiometer was installed at Marambio (64ºS) in January 2017. The radiometer measures spectral irradiance at five UV wavelengths and one wavelength in the visible (555 nm). An addition channel measures PAR. The new observations continue UV measurements performed between 2000 and 2012 with a NILU-UV radiometer of the Antarctic NILU-UV network, which is a collaboration between FMI, SMN, Spain, and DNA-IAA, Argentina. The gap between the two UV time series can be filled with measurements of a broadband UV radiometer, which is part of the albedo measurement setup in Marambio
The FMI measures UV radiation at seven stations in Finland. In Sodankylä (67ºN), measurements started in 1990, and the spectral UV time series is among the longest in the Arctic. Observations are made with a Brewer spectroradiometer, which also measures total ozone. As both Sodankylä and Marambio are located in areas of spring-time stratospheric ozone depletion at similar latitudes but in different hemispheres, it is interesting to compare the measured UV time series. The irradiance scale of the measurements was homogenized and is traceable to Aalto-MIKES, Finland. At Sodankylä, the maximum UV index was found to be 6 (summers 2011 and 2013). At Marambio, the maximum UV index measured between 2000 and 2010 was 12 (Nov 2007).

Wed_15_AC-2_992
Ozone Column Variability at Marambio Base, Eastern Antarctic Peninsula

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Ozone monitoring is still very important even more than 30 years after the Montreal Protocol agreement, because the first signs of ozone layer healing have only been observed very recently. Since February 2010, the Czech Hydrometeorological Institute monitors the total column ozone and vertical ozone profiles at the Marambio Base (64° S, 56° W), eastern Antarctic Peninsula , by the MK-III Brewer spectrophotometer B199. Using the eight years (2010-2017) of observed data, we have been focusing mostly on these topics:

1. Assessment of the total column ozone variability
2. Intercomparisons of the B199 total ozone column with various satellite data products
3. Validation of the B199 Umkehr vertical ozone profiles using the Finnish Meteorological Institute ozone soundings

Our results indicate that due to dynamical processes in the stratosphere, the ozone layer recovery is more variable in time than the ozone depletion onset. For example in 2013, a fast recovery was observed, while in 2011 the ozone hole lasted till mid-November. Moreover, we confirmed that B199 data fits very well satellite total column ozone. The most reliable dataset seems to be OMI (TOMS) with over 95 % variability in common with B199. On the other hand the Umkehr profiles are too smooth and overestimating the ozone amount in days characterized by the strong ozone depletion linked with strength of the polar vortex.

Wed_16_AC-2_1017
Total Ozone, UV and Radio Sounding Measurements in the Sør Rondane Mountains

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Since December 2010, a Brewer ozone spectrophotometer for measuring the total ozone column and UV spectra (283 to 363 nm) has been operated during austral summers at the Belgian research station Princess Elisabeth (PES), in the Sør Rondane Mountains in East Antarctica (72° S, 23° E, 1390 m asl). We will present an overview of the measurement results since 2010/11 up to 2017/18. In 2015, the Antarctic ozone hole was one of the largest and most stable one on record and total ozone amounts showed local record minima between 170 to 180 Dobson Units for the end of November 2015. These conditions persisted until 15 December 2015. Consequently, the UV index reached local record values up to 12.
In addition, weather balloons with radio sondes (vertical profile of temperature, relative humidity, pressure, wind speed and direction up to 30 km) have been launched during austral summers 2014/15, 2015/16 (planned for 2017/18). During season 2014/15 the mean tropopause height was 9607 ± 836 m asl with a corresponding temperature of -56.6 ± 4.9 °C (9178 ± 735 m and -56.9 ± 4.1 °C in 2015/16, respectively). During summer season 2014/15 a distinct temperature inversion at around 2500 m asl was observed during almost all launches in January and February. However, this pattern was not observed in season 2015/16. The mean relative humidity ranged between 30 and 50 % throughout the troposphere in 2014/15 and 2015/16. However, February 2016 showed distinctly higher relative humidity profiles

Wed_17_AC-2_1058
The Interplay between Cold Air Outbreaks, Convergence Zones and Polar Lows

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Geographically confined, equator-ward excursions of cold air masses into ice-free regions are frequently accompanied by the development of severe mesoscale weather phenomena, such as intense low-level jets and polar lows. Cold air outbreaks and polar lows have both been studied independently and are known to be closely related, though it remains unclear how often polar lows accompany cold air outbreaks. Furthermore, polar lows tend to develop at the leading edge and outer boundaries of cold air outbreaks, yet little is known about the temporal and structural evolution of this cold air outbreak periphery and the triggering mechanisms for mesoscale cyclone development along these frontal structures.
In this study we utilize ERA5-reanalysis data to examine the interplay between cold air outbreaks, convergence zone formation and mesoscale cyclone development focusing on the Nordic Seas region. We apply objective detection methods for each of these features, and identify regions and atmospheric conditions which are (non)-favorable for the development of polar lows during cold air outbreaks. We examine the spatial and structural evolution of contrasting cases, i.e. with/without mesoscale development, and explore the role of thermal and moisture gradients at the fringes of cold air outbreaks for mesoscale cyclone initiation.

Wed_19_AC-2_1348
On the Mean Age of Stratospheric Air and the Polar Vortex Preconditioning

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The mean age of stratospheric air (AoA) is a useful transport diagnostic. We study the hypothesis that AoA can be used as a proxy for the polar vortex preconditioning, because it reflects the cumulative effect of transport processes. Using a composite analysis of sudden stratospheric warming events from the CMAM specific dynamics simulation we formulate an AoA anomaly index and study its ability to predict polar vortex events up to one month prior to the event. The dynamical origin of these anomalies is then analysed with respect to the anomalous planetary and gravity wave activity.

Wed_20_AC-2_1383
A Lagrangian Analysis of Atmospheric Rivers at Livingston Island, Antarctica

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Atmospheric rivers (AR) are long and narrow regions in the atmosphere that accounts a major horizontal transport of moisture outside the tropics. AR are responsible for coastal heavy rainfalls in midlatitudes. Similarly, AR contributes significantly to heavy snowfall events in coastal Antarctica. In the Antarctic peninsula, AR events are important due to their impact on the surface mass balance of the ice sheets, that may be positive by snow accumulation or negative by snow melting caused by liquid rain events in summer. Other significant impacts involve their potential to transport microbial propagules from South America that may succeed into the deglaciated areas of the Shetland Islands.
To study AR reaching Livingston Island, a climatology of 368172 trajectories (12 year between 2005 and 2016, 4 times a day and 21 levels) has been computed using the Hybrid Single-Particle Lagrangian Trajectory model (HYSPLIT). Following the methodology described by Gorodetskaya et al (2014) to detect AR at high latitudes, we selected the cases where AR impinged on JCI station at Livingston Island between 2005 and 2016. In this communication we present the lagrangian analysis of these events focusing on their climatology, their moisture sources and the synoptic settings that produces them.

Wed_21_AC-2_1595
Contribution of Foehn Winds to the January 2016 West Antarctic Melt Event

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In January 2016, the Ross Ice Shelf (RIS) experienced one of its most prominent surface melt events since the advent of satellite observations in the late 1970s. This event followed a pattern already seen during previous events: the melting begins along the Siple Coast, on the eastern side of the RIS, expands to the rest of the ice shelf, before retreating to where it started. Previous work has highlighted the role of the strong 2015-16 El Niño event in promoting warm air advection toward western West Antarctica. While important in initiating the melt event, this phenomenon only partially explains the spatial and temporal distribution of the melting and ignores other important physical mechanisms. Here, we present the results of a detailed three-dimensional investigation of the meteorology of the January 2016 event based on model output from the Antarctic Mesoscale Prediction System (AMPS) and the ERA5 Reanalysis. Using backward trajectory analysis, we highlight in particular the foehn effect taking place downwind of the coastal mountain ranges of Marie Byrd Land, which acts to amplify the warm advection, especially during the early stage of the melt event. To our knowledge, the existence of this foehn effect has thus far never been demonstrated nor its effect quantified. Our analysis underscores the importance of high resolution for atmospheric simulations of West Antarctic surface climate, an important aspect to consider when projecting the future of the RIS.

Wed_22_AC-2_1654
Snowfall Rate Retrieval and its Relation with the Antarctic Surface Mass Balance

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The Antarctic Ice Sheet (AIS) is the largest ice body on earth. In order to understand its contribution to sea level rise, local surface mass balance (SMB) measurements are crucial. Precipitation is generally considered the dominant source term in the SMB budget of the AIS. Both SMB and snowfall are not well constrained in both models and observations, and the relation between both quantities remains unknown.
At the Princess Elisabeth station (East Antarctica), a ground-based vertically pointing 24 GHz Micro Rain Radar provides radar reflectivity measurements. When information about snow particle microphysics is available, one can get an idea of snowfall rates. This is provided by an optical disdrometer (Precipitation Imaging Package). As such, radar reflectivity snowfall rate relations ($Z=a*SR^b$) are derived for the East Antarctic escarpment region including an overview of their uncertainties.
The local SMB at the station is measured using an Automatic Weather Station and the link between snowfall rates and accumulation at the surface was investigated. It was found that snowfall events are much more common than accumulation events. During 38% of the snowfall cases observed, the freshly-fallen snow is ablated by the wind during the course of the event. In this study, the conditions for ablation and accumulation are investigated discovering a non-linear relation between snowfall and accumulation at the surface.

Wed_23_AC-2_1671
What Controls Deuterium Excess in Coastal Antarctica?

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The second-order water stable parameter deuterium excess (d-excess) can be used to understand the spatial and temporal changes in the isotopic-temperature relationship. However, so far no simple result is obtained from statistical analyses of continental surface measurements or from measurements in precipitation and ice cores.
In order to make progress in understanding d-excess measured in Antarctica, we compiled an updated database of water stable isotope data from vapour, snow surface and ice cores. We then completed this database with new data from Adélie Land, obtained from in situ water vapor monitoring at Dumont d'Urville during 40 days of the austral summer 2016/2017 and new high resolution measurements from one shallow ice core drilled at 25 km from the station during the austral summer 2014/2015. Our data are combined with the meteorological observations from Dumont d'Urville and the dry and wet back-trajectories simulated by Hysplit and Flexpart respectively.
Our limited dataset shows the complexity of d-excess signals, and call for new datasets obtained in water vapour, snowfall, surface snow and shallow ice. We show that coastal Antarctic d-excess variability is not controlled by local climate variables and appears related to atmospheric circulation and moisture transport at the local to regional scale. Further studies are needed to deconstruct the exact drivers of coastal Antarctic d-excess and exploit this signal.

Wed_24_AC-2_1727
Cyclone Activity in the Arctic from an Ensemble of Regional Climate Models

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The ability of state-of-the-art regional climate models to simulate cyclone activity in the Arctic region is assessed based on an ensemble of 13 simulations from 11 models from the Arctic-CORDEX initiative. Some models employ large-scale spectral nudging technique. Cyclone activity characteristics simulated by the ensemble are compared with four reanalyses in winter and summer during the 1981-2010 period. Biases in cyclone frequency, intensity and size over the Arctic are quantified.
Variations in cyclone frequency across the models are partly related to the differences in cyclone frequency over land. The variations across the models are largest for small and shallow cyclones for both seasons. A connection between biases in the zonal wind at 200 hPa and cyclone characteristics is found for both seasons. Most models underestimate zonal wind speed in both seasons, which likely leads to underestimation of cyclone mean depth and deep cyclone frequency in the Arctic.
In general, the RCMs are able to represent the spatial distribution of cyclone characteristics in the Arctic region but models that employ large-scale spectral nudging are in much better agreement with ERA-Interim reanalysis than the rest of the ensemble. Trends also exhibit the benefits of nudging. Most non-nudged models cannot reproduce cyclone trends while the opposite is true for models with spectral nudging. However, the choice of nudged variables also affects the cyclone characteristics and trends.

Wed_25_AC-2_1804
Polar Mesoscale Cyclone Climatology for the Nordic Seas

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Polar mesoscale cyclones (PMCs) are automatically detected and tracked over the Nordic seas using the Melbourne University algorithm applied to the ERA-Interim reanalysis. The novelty of this study is the length of the dataset (1979-2014) and the usage of PMC tracks to infer relationships to large-scale flow patterns.
The angle between the ambient mean and thermal wind is used to distinguish two different PMCs genesis environments. The forward shear environment (thermal and mean wind in same direction) features typical baroclinic conditions with a temperature gradient at the surface and a strong jet stream at the tropopause. The reverse shear environment (thermal and mean wind in opposite direction) features an occluded cyclone with a barotropic structure throughout the entire troposphere and a low-level jet.
In contrast to previous studies, PMC occurrence does neither feature a significant trend nor a significant link with the North Atlantic Oscillation and the Scandinavian Blocking (SB), though the SB negative pattern seems to promote reverse shear PMC genesis. The sea ice extent in the Nordic seas is not associated with overall changes in PMC occurrence but influences the genesis location. Selected cold air outbreak indices and the temperature difference between the sea surface and 500 hPa (SST-T500) show no robust link with PMC occurrence but the characteristics of forward shear PMCs and their synoptic environments are sensitive to the choice of the SST-T500 threshold.

Wed_26_AC-2_1927
Identification of a Physically Based Arctic Cold and Transition Seasons

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Arctic 'seasons' are physically unique compared to lower latitudes and have strong latitudinal dependence within the Arctic due sun-earth geometry. Therefore, physically-based seasons are here defined to be a long cold season (~6 months), two short transition seasons, and a warm season. Arctic extremes and trends must be defined using different criteria for each of these seasons. In the warm season the obvious extremes are in changing sea-ice extent/area. Trends and extremes for transition seasons are more defined by a trend towards earlier (latter) melt (freeze-up) dates. The Arctic cold season is therefore the most interesting for looking at temperature trends, variability and trends. For in-situ temperature records from Tiksi, Russia, cold season temperature trends are shown to decrease as the length of the record over which trend is calculated increases due to a significant warm period in the 1940s. The incidence of extreme temperature events (exceeding the 95th and 99th percentiles) also show a bimodal distribution with peaks in the 1940s and the present. Results from Tiksi are compared to
(1) various reanalysis products and
(2) other Arctic sites such as Barrow, Alaska.
It is proposed that it is the temperatures during the Arctic cold season are the most relevant for determining linkages with global climate and weather. In addition, the seasonal partitioning described here is expected to be useful for analysis of data from YOPP.

Wed_27_AC-2_1936
Characteristics and Synoptic Environment of Polar Lows over the Barents Sea

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Polar Lows are intense mesoscale maritime storms, which form over open sea during wintertime north of the main baroclinic zone. They occur during cold air outbreaks and are generally associated with heavy snowfalls, reduced visibility, and changing surface winds which can be in excess of 30 m/s. The degree of predictability varies from case to case but they have always represented a challenge in terms of forecasting: their rapid development, their small scale extent (200-600 km) and short lifetime (average 15-20 hrs), the absence or rarity of synoptic observations and real time satellite derived winds, the poor radar coverage and, in many cases, unreliable model fields, has led in the past to a rather low skill, with even some polar lows undetected until they affect coastal regions.
The Barents Sea has long been known to be a prime site for the development of such storms, but climatological aspects of Polar Lows affecting this region are poorly known. In addition, recent retreating sea ice may expose this area to increased occurrences of extreme weather systems. The characteristics of Barents Sea Polar Lows over more than 15 years and the synoptic environment in which they develop will be discussed.

Wed_28_AC-2_1974
Enhancement of Gravity Wave over Syowa Observed by Rayleigh/Raman Lidar

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Typical gravity wave activities and its seasonal variations have been studied at various places around the world. However, what causes a shorter temporal and local variations of the activities are poorly understood. To understand this cause, we estimated the potential energy of gravity wave over Syowa Station (69°S, 40°E) from a Rayleigh/Raman (RR) lidar observation between 2011 and 2015. We found a clear enhancement of the potential energy during 8th-21st August 2014. The energy in this period was about two and five times as large as the winter mean in the other years at 50 and 60 km. There are two possible causes. The first one is that some source would exist around 45 km, but there seemed no specific source within the MERRA. The second one is that the gravity waves would converge from the lower atmosphere at lower and higher latitudes due to the meridional gradient of the westerly wind [Dunkerton, 1984]. The polar night jet around 40°E during the enhancement period slanted to ~70°S from ~50°S. In such condition, the gravity waves with west-ward wavenumber incline to converge to Syowa. We estimated paths of gravity waves in order to examine whether the gravity waves could converge to Syowa. We found that the large-scale gravity waves could converge to 50-55 km altitudes over Syowa in that period. This result suggests that the enhancement could be caused by the convergence of the gravity waves. we will show these results and discuss the cause of the enhancement.

Wed_29_AC-2_1977
Stratospheric Ozone and Nitrogen Oxides in Antarctic Regions

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Since the discovery of the ozone hole phenomena in Antarctica during the spring season, the studies on the atmospheric tracers related to the ozone chemistry are of extreme interest for the scientific community. At the Mario Zucchelli station, since 1995, GASCOD (Gas Analyzer Spectrometer correlating Optical Differences) equipment performs measurements of zenith sky scattered radiation, for the assessment of stratospheric NO2 and O3. In 2013 the SAMOA (Automatic Station monitoring Antarctic Ozonesphere) system is placed side by side to the old spectrometer to assure the continuation of the time series for the above mentioned compounds and to enlarge the monitoring capabilities. SAMOA is composed of the UV-Vis GASCOD NG1 (New Generation), the VELOD (Vertical Looking Device) to measure the zenith sky scattered radiation and the MIGE (Multiple Input Geometry Equipment) to perform measurements in different directions.
Here, the SAMOA station is described and the improvements with respect to the old system are highligted. Moreover, the DOAS and MAX-DOAS algorithms are briefly introduced and the results obtained during the full period of measurements of the GASCOD instrument are presented and discussed together with a trend analysis for NO2 and O3 total columns. the first comparison of the observations obtained with the two systems, are analyzed.

Wed_30_AC-2_1998
Characteristics of Near-surface Wind Field over Terra Nova Bay, Antarctica

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Terra Nova Bay is often affected by storms moving along the coast and katabatic flow from the continental interior towards the coast. Data from Jang Bogo Station, other available automated weather station (AWS) from Terra Nova Bay and ERA interim reanalysis are used as the as the primary dataset to develop the climatology of near surface winds. In-situ surface meteorological parameters from the AWS used in the study are wind speed, direction, temperature and pressure. The surface wind field over the Jang Bogo Station is influenced by its complex topography. A bimodal direction in the wind regime is noted throughout the season with wind speed greater than 10 ms^{-1} coming from the direction 225° to 315°. Criteria were set to classify wind events based on the wind speed and duration. A strong wind event is defined as the event which has wind speed more than two standard deviations. Several thresholds in terms of duration are tested to capture a representative number of wind events for further analysis. The mesoscale and synoptic background of the events are also investigated using reanalysis data.
Boundary layer characteristics during the SWEs were also analyzed using SODAR and Radiosonde data. Case studies of SWEs over Terra Nova Bay was carried out to understand the interaction between and katabatic wind and storm of the coast.

Wed_31_AC-2_2064
Riming in Alpine and Antarctic Precipitation

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Precipitation is crucial in the Alps for water resources and hydro-power. In Antarctica, it is a key term in the surface mass balance but it remains poorly understood because of extreme conditions making observations very challenging. Precipitation in the Alps is better documented, thanks to past field campaigns, and operational measurements including weather radars. However, the interactions between cloud microphysics and orography need to be further investigated. In particular riming, the collection of supercooled water by ice crystals, can significantly contribute to snow accumulation. It is therefore necessary to investigate riming in Alpine and Antarctic precipitation to further its understanding in both environments.
We present results from two field campaigns in Antarctica and in the Swiss Alps. The occurrence and intensity of riming are investigated using hydrometeor classifications from polarimetric radar data and snowflake photographs. The results show that besides aggregates, graupel is the second most important hydrometeor type. The vertical structure of precipitation during riming events is different in the Alps and in Antarctica. In the Alps, the proportion of rimed particles is larger and intense riming is confined to a layer of about 1000 m. In Antarctica, the proportion of rimed particles is less variable in the vertical, without intense riming layers. This study contributes to document an important process for Alpine and Antarctic precipitation.

Wed_32_AC-2_2163
Urban Heat Island Arctic Research Campaign (UHIARC): Results and Perspectives

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Now, in 2017 more than one half of Earth population lives in urbanizes areas. So, the problem of land-use and microclimate changes in city area becomes more important in the context of inhabitants' long-term quality of life. And good knowledge about nature of urban climate and formation of urban heat islands (UHI) became one of important tasks.
Despite the number of big cities are located in high latitudes, especially in Russian Arctic (Murmansk with ≈300 000 inhabitants, Norilsk with ≈180 000 inh., Novy Urengoy with ≈110 000 inh. and a number of cities with more than 50 000 inh.), the climatology of their UHIs has not been practically studied. For Arctic region such investigation was performed only for towns in Alaska (Barrow and Fairbanks). Keeping in mind that during polar night and polar day sunlight conditions are quite different, the idea to explore UHI climatology in Arctic becomes more and more attractive.
After the first experience in 2013-2014, our team developed Urban Heat Island Arctic Research Campaign (UHIARC) in five cities of Russian Arctic. Four of them are located within flat and homogeneous terrains which makes them especially prospective places for Arctic UHI study.
Analysis of the collected data showed the existence of significant UHI with the difference between city center and surrounding landscape up to 10-12ºC that can have strong impact on house heating strategies and inhabitants' thermal comfort.

Wed_33_AC-2_2259
Representation of the Antarctic Stratospheric Vortex in a Global Climate Model

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The Antarctic circumpolar vortex (ACV) forms each winter and spring as a zone of strong stratospheric westerly winds surrounding Antarctica. The ACV presents a barrier to transport of air masses between middle and high-latitudes which contributes to stratospheric temperatures above the polar region dropping sufficiently low in spring to allow for the processes leading to ozone loss. The dynamics of the stratosphere and how they may be changing over time can also affect circulation in the troposphere and have an impact on weather and climate. The processes controlling the permeability of the ACV, and how they are likely to respond to a changing climate and a recovering ozone hole, have not been well studied, and as a result are not well simulated in Global Climate Models (GCMs). This research makes use of reanalysis data and GCM data - using the UK Met Office Unified Model (UM) - together with trajectories from Loon balloon flights over Southern Hemisphere middle and high latitudes to determine how well the permeability of the ACV is represented in a GCM. Results are expected to indicate how improved representation of ACV transport process can be captured in GCMs.

Wed_34_AC-2_2388
Comparison of Temperature Extremes between the East and Antarctica Peninsula

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On the base of daily minimum, maximum, and mean surface air temperatures (T_{min}, T_{max}, T_{mean}) at Great Wall Station (GW, 1985-2015) and Zhongshan Station (ZS, 1989-2015) in Antarctica, changes in temperature extremes are analyzed in the last three decades. Annual mean temperature reveals the strongly warming trend in T_{min}, slightly warming in T_{mean}, while cooling in T_{max}, and shows different seasonal variabilities with the least variability in summer. Annual mean of daily temperature range (DTR) has decreased by -0.39 and -0.29 °C/decade at Great Wall Station and Zhongshan Station, respectively.More importantly, we have found that the seasaw exists East Antarctica and Antarctica Peninsula in the interannual time scale. Eleven indices of extreme temperature are also examined. The occurrence of extreme warm days has decreased by -0.53 and -0.048 d/decade at GW Station and ZS Station, respectively, while the occurrence of extreme warm nights has shown nonsignificant trend with much variability. The number of melting days has increased by 4.3 d/decade at Great Wall Station. Although our analysis can explain part of the variability by changes in winds or to the coastal icescape, an additional but unknown factor is how atmosphere has responded to changes in ocean heat. Unraveling cause and effect, critical for predicting changes to the ocean-atmosphere-sea ice-ice sheet system, will require more in situ observations and improved atmosphere modeling.

Wed_35_AC-2_2434
Long-term Ozonesonde Observations at Marambio, Antarctic Peninsula

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The ozonesonde measurement program at Marambio was established in late 1980s, soon after the discovery of the Antarctic ozone hole. The Marambio Antarctic Station is located in an island at the North of the Antarctic Peninsula, surrounded by Weddell Sea (at 64º 14 ´S, 56º 38´W 198 m.a.s.l). The location is suitable for observing Antarctic stratospheric ozone depletion. In addition to the springtime measurements we have also performed regular soundings during other seasons. The soundings have been made by electrochemical concentration cell ozonesondes, using a potassium iodide solution. The sounding system in Marambio is DigiCORA III from Vaisala and the radiosondes are Vaisala RS92-SGP. The sondes measure ozone profiles from surface up to the altitude of 30-35 km. The effective altitude resolution is 100-150 meters, uncertainty of the stratospheric ozone measurements is about 5 %. Here we present results of the long term measurements. The time series have been recalculated using the knowledge from dual ozonesonde experiments. The ozonesonde observations are also compared to the available total ozone measurements by a ground based Dobson instrument at Marambio and by satellite borne instruments. Finally, the reprocessed data set is used to study trends and variability in measured ozone profiles. A statistical model is applied on the profile data, the model includes terms for effective equivalent stratospheric chlorine and meteorological variability.

Wed_36_AC-2_2551
A Numerical Simulation of Strong Wind Event at King Sejong Station, Antarctica

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In this study, a strong wind event that recorded a 10-min average wind speed of about 22 m/s at King Sejong(KSJ) station was simulated using the Polar WRF (Weather Research and Forecasting) model, which is an optimized version of WRF. Also, sensitivity experiments of the initialization time on a strong wind simulations is conducted. Through this, first we have evaluated the strong wind simulation performance of the Polar WRF by carrying out cross validation by comparing with local surface observations and reanalysis data. Second, we verified that the main cause of the strong wind event observed in KSJ Station by analyzing in detail observations and numerical simulation results. In addition, we investigate the climatological characteristics of the surface meteorological fields by analizing the in situ meteorolocial observations for 22 years in KSJ station. It is revealed by in situ observations, numerical weather prediction, and reanalysis fields that the synoptic and mesoscale environment of the strong wind event was due to the passage of a intense low pressure system with the center pressure of 950hPa. Verifying model results from 3 km grid resolution simulation against observation showed that high skill in simulating wind speed and surface pressure, respectively. The surface variables of 10m wind, 2m temperature and surface pressure observed in KSJ station shows clear annual cycles in the analysis of long-term observation from 1994 to 2015.

Wed_37_AC-2_2636
Urban Heat Islands in the Arctic: The First Quasi-climatological Results

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Urban heat island (UHI) effect is well studied for moderate and low latitudes and is considered in general as a negative phenomenon due to its influence on human thermal comfort and energy consumption rates. For the Arctic, on the contrary, its positive effects could be related with mitigation of severe frosts and fuel economy for house heating. However, until nowadays the knowledge about polar UHIs was extremely poor and limited by few studies for Alaskan towns, while the biggest Arctic cities located in Russian sector of Northern Eurasia were the terra incognita for urban climatology.

In this study we present **the first quasi-climatological estimates of UHI intensity** (urban-rural temperature difference) **for Arctic winter conditions**. They are based on UHIARC (Urban Heat Island Arctic Research Campaign) seasonal-scale experimental meteorological observations in five medium-sized Russian Arctic cities (Apatity, Vorkuta, Nadym, Novy Urengoy, Salekhard). Measurements in these cities have shown quite similar values of UHI intensity and patterns of its temporal variation. For all of them **the average winter UHI intensity** could be estimated as **1-1.5 °C**, while **extremes up to 6-7 °C** are observed in frosty anticyclonic weather. However, the Arctic UHIs could be strongly amplified by local orography. For Apatity this results in extremely high (up to 12 °C) values of temperature differences between the city, located at the top of the hill, and WMO weather station at the lowland.

Wed_39_AC-4_382
Gravity Wave Propagation through a Tidally Varying Wind above Davis, Antarctica

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Gravity waves in the night-time mesosphere/lower thermosphere can be observed using infrared imagers sensitive to emissions from the hydroxyl layer. Wave propagation directions from these imagers are often used to infer possible lower atmosphere source regions either approximately by direct projection or using ray tracing methods. However, it is generally assumed that the waves are propagating in an invariant wind environment. The height region around the hydroxyl layer (near 87 km) coincides with significant increases in tidal wind amplitudes and is thus subject to strong diurnal or semidiurnal wind fluctuations. These have the potential to change the propagation characteristics of gravity waves just prior to their observation.
In this study, gravity-wave horizontal wavelengths, frequencies, orientations and phase propagation speeds are extracted from images of the hydroxyl layer above Davis station, and used to seed ray tracing analyses of 3-D wave propagation. MLS satellite observations provide daily average temperature profiles and instantaneous wind fields were obtained using the Davis MF Radar. The influence of the wind and its variations can thus be assessed by back tracing the observed gravity waves through a mean or tidally varying field.
The results of this study will be presented. Their implications for these and other ANGWIN measurements will be discussed.

Wed_40_AC-4_385
ANGWIN: International Collaboration in Polar Atmospheric Research

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Atmospheric gravity waves play a fundamental role in transporting energy and momentum between atmospheric regions and drive circulations that affect key processes like the formation of the ozone hole and the cold summer polar mesosphere. Despite their importance, gravity-wave activity over Antarctica suffers from a lack of comprehensive observations. The ANtarctic Gravity Wave Instrument Network (ANGWIN) is a highly successful grassroots programme that was started in 2011. It seeks to use a network of observations to measure gravity waves continent wide and through all levels of the atmosphere, in order to fully understand their impact and to constrain modelling work. Although initially focused on the Antarctic, the group is now aiming to develop collaborations in both Polar Regions.
ANGWIN is an international network, supported by activities based in Australia, Brazil, Japan, Korea, the United Kingdom and the United States of America.
The objectives of the ANGWIN network include: Quantify the longitudinal variation in gravity-wave activity and determine causes; Characterise wave propagation and influence; Relate observed gravity waves to sources throughout the atmosphere; Study the interaction of gravity waves with global scale waves; Compare polar wave observations to model parameterizations; Determine the effects of gravity waves on polar stratospheric cloud formation.
This poster will describe the ANGWIN network, its objectives and some recent results.

Wed_41_AC-4_578
Simultaneous Observations for Neutral Winds and Ion Drifts at JBS, Antarctica

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It is well known that the thermospheric winds are mainly driven by the ionospheric plasma convection in the polar region. However, it was observed that there are significant differences between thermospheric winds and ion drifts in the polar cap region. The ionosphere and the thermosphere have been simultaneously observed by Vertical Incidence Pulsed Ionospheric Radar (VIPIR) and Fabry-Perot Interferometer (FPI), respectively, at Jang Bogo Station, Antarctica, which is located in the polar cap region. Using these unique observations, we investigate how much the thermospheric winds are affected by ion drifts in the southern polar cap region. In this study, we will present the response time, relative velocity and direction of thermospheric winds with respect to ion drifts as well as the physical characteristics in the polar cap region during the observation periods.

Wed_42_AC-4_640
Climatological Behaviours of the Total Electron Content over Antarctica

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The understanding of the impact of solar activity on polar regions upper atmosphere is not as strong as compare to low and mid-latitudes due to lack of experimental observations, especially over Antarctica.
To characterize the differences in the ionosphere-plasmasphere total electron content (TEC) climatological patterns over Antarctica, we reprocessed the GNSS (GPS + GLONASS) data available since 1999 up to now for stations situated at latitudes below S50°. For that, we used the data from POLENET/IGS networks and stations installed around the Princess Elisabeth polar Base (Utsteinen, North-East Antarctica).
The estimated TEC data set is then employed to constrain an empirical model to predict the TEC from F10.7P solar index in entrance using a least-square adjustment. To minimize the differences between the modelled and observed vTEC we considered: (1) an eight-order polynomial function with monthly coefficients between the TEC and F10.7P; (2) a discretization with respect to different zones over Antarctica region to highlight different climatological patterns; (3) different time definitions such as Solar Local Time, Magnetic Local Time, and UTC.
From the output of this model we discuss the different climatological behaviors identified in the ionosphere-plasmasphere TEC at these high latitudes. Finally, we show some examples of typical TEC disturbances observed during extreme solar events.

Wed_43_AC-4_755
ULF Geomagnetic Activity and Atmosphere Dynamics in the Southern Polar Cap

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We investigated the possible coupling between geomagnetic activity and the low atmosphere dynamics in the polar cap. To this purpose, we compared the ULF geomagnetic activity, computed from geomagnetic field measurements at Terra Nova Bay (Antarctica, corrected geomagnetic latitude λ ~ 80°S), with several atmospheric parameters (temperature, zonal wind, specific humidity and cloud cover) obtained from re-analysis dataset. We used data collected in the years 2003-2007. We found a statistically significant correspondence of temperature and zonal wind fluctuations in the stratosphere and troposphere (greatly reduced at the tropopause height) with geomagnetic ULF power fluctuations at the ~27 day periodicity, related to the Sun's rotation period. We observed a similar, clear relationship between the atmospheric parameters and the polar cap potential difference.
We also found that the atmospheric parameters significantly change following the increase of geomagnetic activity within 1-2 days. These changes are evident in particular when the interplanetary magnetic field is oriented southward with the azimuthal component duskward. We suggest that both the precipitation of electrons induced by ULF activity, and the intensification of the polar cap potential difference, modulating the microphysical processes in the clouds, can affect the atmosphere conditions.

Wed_44_AC-4_772
ICT Framework for Field Acquisition and Processing of GNSS Data in Polar Regions

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The scientific research community dealing with polar regions is increasing its interest in ICT solutions allowing to overcome the strong environmental limitations of these areas in terms of power, data exchange and computing infrastructures.
The “Upper atmosphere observations and Space Weather” project, developed under the SCAR GRAPE (GNSS Research and Application for Polar Environment) expert group, aims to extend the GNSS measurements to new sites for the assessment of the delay and corruption induced by the ionosphere on satellite signals in polar regions.
On-field data are acquired by means of an energetically autonomous prototype with pre-processing capabilities (called GreenLab), which has been successfully installed in Antarctica, close to the italian base “Mario Zucchelli”, which is able to send data to the base station by means of an innovative smart antenna.
Data can then be further processed exploiting the cloud computing federated infrastructure already deployed in DemoGRAPE project and leveraging the Linux Containers technology (i.e. Docker) to run applications where data are stored, thus avoiding to move large amounts of data.
These two main blocks, the GreenLab and the federated cloud infrastructure, constitute a complete ICT framework for data acquisition and management, which could be a reference architecture for several scientific topics dealing with polar regions.

Wed_45_AC-4_779
Scintillation Studies in the GPS Era - What Went Wrong in the Last 10 Years?

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Global Navigation Satellite Systems (GNSS), including the Global Positioning System (GPS) support a wide range of civilian and military applications, and have become indispensable in precise positioning and time keeping. As our society moves towards a state characterized by an increasing dependence on space technologies, and since our environment affects our daily life like never before, understanding the Solar-Terrestrial interaction, and its impact on the geo-space environment, has become critical to the well being of our modern technology-dependent society.
Scintillation, random rapid fluctuations of the trans-ionosphere radio signal, is caused by the refractive and diffractive properties of the medium, and the structures within it. Understanding the generation and dynamics of these irregularities will in turn help model/forecast this physical phenomenon, and mitigate it if possible. Over the last few years we have been focussing on the scintillation indices to develop a better understanding of the underlying physics of the scintillation producing irregularities, and attempt to develop predictive models. However, we believe that relying on such indices may very well be the wrong approach. We will show with evidence, using very high sampling rates (50 &100 Hz), that the conventional approach relying on the conventional indices led us down the wrong path. We will propose a new approach to study the micro-physics of scintillation producing ionospheric structures.

Wed_46_AC-4_1624
Impact of Solid Earth Tide Model Error on Tropospheric Zenith Delay Estimates

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The elastic response of the crust due to the external Tide Generating Potential (TGP) is called the solid Earth tide, which can result in periodic 3-dimension displacements of a point on Earth's surface. To demonstrate how 'error' in the modelling of the solid Earth tide affects the estimates of tropospheric zenith total delay (ZTD) and how it propagates into long-period signal in the daily GPS time series, we analyze GPS observations collected between 2009 and 2013 for 13 sites in the coastal regions around Antarctica using GAMIT/GLOBK 10.6 software. Satellite orbital parameters, 2-hour tropospheric zenith delays, atmospheric gradients and Earth orientation parameters are estimated along with site coordinates. Two solutions are generated with or without the inclusion of K_1 correction in the frequency domain of IERS2003 model, while all other processing strategies are held constant. We show the differenced time series of both the ZTD estimates and site coordinates, along with their corresponding admittances (ratio of amplitude of output signal to amplitude of input signal). In such a way, we conclude that ZTD differenced time series, with amplitude at the 2 mm level, have inverse correlation with the input K_1 error, and the corresponding admittances range from 6% to 14%; Propagated spurious annual signals are evident in the vertical component of coordinate differenced time series, with amplitudes at the mm level and admittances of around 2% to 11%.

Wed_47_AC-4_1772
Fast Dynamic of Polar Ionosphere from GNSS SDR High Sampling Rate Measurements

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Software Defined Radio (SDR) receivers are able to process Intermediate Frequency (IF) signals acquired by a front-end in order to generate Global Navigation Satellite Systems (GNSS) In-phase and Quadrature amplitude values at very high sampling rate (up to 1000 Hz). The analysis of GNSS signals at frequencies higher than the usual 50 Hz, provided by the traditional ionospheric scintillation receiver monitor, gives the possibility to describe the dynamics of the scintillation driven irregularities spanning a wider time scales range. In this work, a new spectral decomposition analysis technique named Adaptive Local Iterative Filter (ALIF) is applied to the data provided by a GNSS SDR developed by Politecnico di Torino in order to highlight the contributions to the scintillations characterized by frequencies higher than 50 Hz. The objective is to relate such contributions to the very fast dynamics processes typical of the ionosphere at polar regions that are not caught using the very well-known scintillation indices S_4 and s_f that is calculated on 50 Hz samples. Results on scintillation case events using data from both SDR and Septentrio PolaRxS receivers installed in the South African Antarctica station SANAE IV (71° 40' S, 2° 50' W) in the framework of the DemoGRAPE project are here presented.

Wed_48_AC-4_1887
A View from Geomagnetic Observation Points along the 80°S Parallel in Antarctica

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Contributions to the knowledge of the Earth's magnetism from polar regions is extremely important to understand the magnetospheric dynamics because local field lines reach extreme magnetospheric regions where the interactions with the solar wind occurs. The Earth's magnetic field shows temporal variations which go from seconds to hundreds of thousands of years. We study low frequency fluctuations (approximately in the Pc5 range, ~1-7 mHz).
INGV has a consolidated experience in Antarctic research activities and in management of permanent geomagnetic observatories as Mario Zucchelli (MZS, at Terra Nova Bay) and Concordia (DMC, at DomeC) stations, as well as temporary installations as Talos Dome (TLD), installed during 2007-2008 Antarctic campaign and working for a few months. The availability of simultaneous measurements from MZS, TLD and SBA (Scott Base), allows to make an interesting comparison in that the three stations are located approximately at the same geomagnetic latitude (~ 80°S), with approximately 2 hours total displacement in magnetic local time. This location is particularly useful to study the signal propagation in the azimuthal direction. We review the results obtained so far from the analysis of diurnal variation, coherence, power and propagation direction of Pc5 pulsations observed along the 80°S geomagnetic parallel, underlying the importance of such observational point, in anticipation of the future installation of a new geomagnetic station at TLD.

Wed_49_AC-4_2316
Studies of Antarctic Atmospheric Dynamics by a Large Aperture Atmospheric Radar

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A large-aperture atmospheric radar, PANSY (Program of the ANtarctic SYowa Mesosphere, Stratosphere, and Troposphere/Incoherent Scatter [MST/IS] Radar) radar, was constructed at Syowa station (69S, 39E) during the 2010-11 austral summer (Sato et al., 2014). Valuable atmospheric data in Antarctic troposphere, stratosphere and mesosphere has been being accumulated based on continuous operation using a quarter system since early 2012 and the full system since late September 2015. Such continuous observation data set using a full MST/IS radar system is the first of its kind in the world. It will enable us to capture various temporal- and spatial-scale phenomena in the Antarctic atmosphere with high temporal and vertical resolutions throughout the year and to contribute to improving global climate models for better understanding of future climate change.
The Japanese Antarctic Research Expedition (JARE) is currently in a six-year long research project, Phase IX (2016-2021). The main scientific theme, “Investigation of changes in the Earth system from Antarctica”, has been launched in Phase IX. The PANSY radar is the core facility of one of the three projects in the main theme, “The global atmosphere system explored by precise observations of the Antarctic atmosphere”, which combines various radio and optical instruments for comprehensive understanding of the whole atmosphere. In this paper, recent studies using the PANSY radar are reviewed.

Wed_50_AC-4_2561
Effects of Energetic Particles Transfer and Precipitation in High Latitude

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Quantitative evaluation of energy transfer in and around the auroral oval under the influence Solar plasma ejection and the electromagnetic status of the interplanetary medium were carried out on the ground based data collected at the stations in Dronning Maud Land, Enderby Land and Princess Elizabeth Land of Antarctica. Geomagnetic storms with negative and positive vertical component of interplanetary magnetic field were chosen for evaluation. This evaluation of the release and transfer of energy due to drifting or injection of energetic particles during various geomagnetic conditions may give us ability to identify critical inputs of the dynamics of the entry of energetic charged particles into the polar upper atmosphere. Moreover geomagnetic quiet time enhancement of total electron content shows the indirect energy transfer in polar ionosphere from magnetotail along the field lines. The drifted energetic particles and subsequent precipitation of energetic particles in the sub-auroral, auroral and polar region gives the estimated time delay, span and duration of ionospheric irregularities. Thus dynamics of energy transfer and drift of energetic charged particles in polar upper atmosphere that involved in linking the entire system, under the influence of interplanetary magnetic field were analysed which begins at the Sun and ends on the Earth.

Wed_51_AC-4_2624
Storm-time Ionospheric Convection in the Central Polar Cap

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Observations of the ionospheric convection during a storm main phase on 9th September 2011 were examined. Measurements were obtained by three SuperDARN radars (ZHO, SYE and MCM) located in the southern hemisphere, the conjunction of these 3 radars plays an important role in revealing the dynamic process in magnetosphere-ionosphere coupling system. During the storm period, MCM radar scanning polar cap ionosphere monitored sequential strong antisunward large-scale plasma irregularities, which clearly presents the polar cap patches moving across the pole to the nightside and eventually into the the nightside auroral oval in quasi-periodical variation. While the ZHO radar recorded intense ionospheric backscatter echo power and moderate Doppler negative velocity in the poleward boundary of the nightside auroral oval, and simultaneous observation by the optical auroral imager did not get aurora data. In the duskside sector, Doppler velocity monitored by the SYE showed irregular plasma structures towards or away from the radar site. Furthermore, ionospheric digisonde at Zhongshan station observed strong spread F during the storm main phase. For this kind of event, coordinated observations suggest that the ionospheric convection dominates the periodical plasma transportation during typical disturbed geomagnetic environment.

Wed_52_AC-4_2696
Collaboration at the NOAA Atmospheric Baseline Observatories

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The NOAA Global Monitoring Division (GMD), based in Boulder, CO, has operated four long-term atmospheric baseline observatories for over 40-years. These sites are located at Barrow, AK; Mauna Loa, Hawaii; Tula, American Samoa; and South Pole, Antarctica. In addition, GMD previously operated observatories at Trinidad Head, CA and at Summit, Greenland; however, both sites were downgraded from full baseline observatories in 2017 following a GMD reprioritization of global observing networks. These long-term sites with NOAA facilities, technical staff, baseline atmospheric measurements, and meteorology, are also available to support cooperative research proposals from the global community. The one exception being South Pole Station, as the site is operated by the National Science Foundation and they approve science projects at the station. This poster will detail measurements at the four sites, focusing on Barrow and South Pole, and encourage collaboration. In addition, it will discuss the vision for the sites to become more "green" with added renewable technologies and backup power and safety measures to ensure continuity of operations. Often emergency plans from remote sites can be challenging and NOAA has various plans in place for each location. Finally, other NOAA/GMD measurements from across the Artic and Antarctic will also be highlighted, including sampling sites in: Canada, Greenland, Norway, Russia, Finland, and the Antarctic Peninsula.

Wed_53_AC-7_301
Polar Lows and Climate Change

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Polar lows (PLs) are intense mesoscale cyclones (diameter of 200-600km) that form at high latitudes during winter. Their wind speeds (above 15m/s) can substantially impact on and offshore activities. PLs may have an impact on deep-water formation, and thus affect the Atlantic Meridional Overturning Circulation (AMOC), which suggests that PLs are important for the climate system. However, there are still large uncertainties in their frequency, spatial distribution and response to climate change. Previous studies showed that PLs may experience a decrease in the future over the North Atlantic Ocean, due to a future increase in static stability caused by a faster increase in sea surface temperatures compared to the increase in mid-tropospheric temperatures. This decrease would imply a reduction of PLs impact on deep ocean convection with the concomitant weakening of the AMOC. To investigate PLs possible future changes, the UPSCALE dataset is used: a series of ensemble simulations of the HadGEM3 global atmosphere-only model at resolutions of 130, 60 and 25km for present climate conditions and a potential future climate scenario, the IPCC RCP 8.5 scenario. The aim is to explore how PLs might respond to climate change and how this response may be affected by the model resolution. The 25km results will be compared to the PL climatology previously analyzed from the coupled climate model HadGEM3-CG2. Results will be presented on PLs representation for the current and future climates.

Wed_54_AC-7_1211
Advanced Prediction in the Arctic and Beyond: The APPLICATE Project

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The Arctic is changing rapidly carrying the potential to influence weather and climate in mid-latitudes. It is therefore crucial to predict these changes and their impacts. Recognizing this priority, a European consortium of scientists set out to advance our capability to predict the weather and climate in the Arctic and beyond in the framework of the EU-funded project APPLICATE. The project aims to improve the representation of key processes in coupled atmosphere-sea ice-ocean models, in order to deliver enhanced numerical weather forecast, seasonal to interannual climate predictions and centennial climate projections. The linkages between the Arctic and mid-latitudes is explored through a coordinated multi-model approach using coupled atmosphere-ocean models. APPLICATE will also provide guidance for the design of the future Arctic observing system to improve our capacity to reanalyse the climate system and enhance models' predicting skills.
The APPLICATE Consortium is also engaging in clustering activities to exploit synergies with other programs. On the European level we participate in the EU Arctic Cluster, but we also have strong links with North American partners (e.g., US CLIVAR), and several other international projects (e.g., the Polar Prediction Project, MOSAiC). In this presentation, we will give an overview of APPLICATE activities as part of our effort to understand changes in the Arctic and their far-reaching impacts for both environment and communities.

Wed_55_AC-7_1380
Lagrangian Meteorological Simulations to Study Polar Aerobiology

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Aerial dispersal in polar regions is a booming issue because it provides new insights on biogeography and may allow forecasting alterations in biodiversity in a global change scenario. Moreover, it is a major challenge due to the difficulties of gathering representative samples of airborne propagules and tracking their paths to estimate where they come from. As a result, this issue is nowadays poorly understood. To improve our knowledge on this topic a multidisciplinary project is being conducted to fill this gap at three different scales: local, regional and global, in both polar regions.
There are a variety of strategies to track the airborne propagules into the atmosphere, each one with specific advantages and disadvantages. In this communication we focus on the simulation of the trajectory of a single particle into the atmosphere on the assumption that propagules transit altogether. Thousands of simulations have been conducted using HYSPLIT model with different configurations and input data for each specific requirement.
We present some of these experiments: backward trajectories at sampling sites in Byers peninsula, trajectories of the air parcels reaching the ship during the Antarctic Circumpolar Expedition and the WindSled during the Ice River Greenland Expedition, and a lagrangian climatology of trajectories over the Southern Ocean. Trajectories simulated are widely dispersed with some preferential directions that will be analyzed using clustering techniques.

Wed_56_AC-7_1482
The Contribution of Natural Variability to Recent Sea-ice Loss across the Arctic

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The total extent of Arctic sea ice over the last half century has dramatically declined, at a rate of nearly 5% a decade, with yearly Arctic sea ice minimums in each of the last five years being at least two million square kilometres below the mid 20th century average. Focusing on the total sea extent over the Arctic polar cap, several recent studies have shown that only approximately half of the recent loss is anthropogenically forced, suggesting that internal (i.e. unforced) variability may be responsible for the remaining half. Analysing 40 historical runs of the CESM Large Ensemble over the period 1950-2015, we here ask whether the relative contributions of anthropogenic forcing and natural variability to September sea ice loss over that period have a robust regional structure. We find a large spread in regional patterns of September sea ice loss across the Large Ensemble: however, these patterns are well captured by the leading EOFs of internal variability, highlighting two key regions, which have experienced the largest September trends in recent decades: the East Siberian Sea and the Barents Sea. We will discuss our findings detailing for which regions the forced response is dominant and for which regions internal variability is more important. Implications for future trends and for potential impacts on the mid-latitudes will be discussed.

Wed_58_AC-7_1799
Estimating Changes in the Collins Glacier, King George Island, Antarctica

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This work proposes future scenarios for the extent of the Collins Glacier (King George Island, Antarctica) and for hydrogeomorphological changes in its periglacial environment. We used a method based on ellipsoidal height changes to estimate modifications in this ice mass up to 2067. We assume insignificant ice flow, refreezing and basal melting, and the same climatic conditions of the period 1998-2009. The ice mass will continue to retreat in all sectors, if the current regional warming trend is maintained, and the periglacial ice-free zone will increase by 4.5 km². The current area of the glacier is 15 km² and according to this scenario can reach 10.5 km². The local hydrological system will be strongly modify, mainly in the Maxwell Bay area, and a proglacial lake formed in the last 30 years may disappear by then, influencing the patterns of sedimentary deposition and local erosion. The new ice-free area may develop a new meltwater stream system at the ice margin, forming lakes and wetlands, increasing chemical weathering, creating soils favouring the fixation and expansion of vegetation. In short, the expected changes may cause a rapid change from proglacial to periglacial environment.

Wed_59_AC-7_2026
Probabilistic Projections of Annual Runoff and Hydropower Production in Finland

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Social, economic and environmental benefits of forecasts of weather and climate are obvious.Among others, risks in hydroenergy production are usually connected to extremes, which can be estimated from projected exceedance probability curves (EPCs) of annual runoff.The exceedance probability indicates the likelihood that a particular annual runoff value will be exceeded. In our study the EPCs of annual runoff were applied to evaluate the potential hydropower production in Finland. The climate related changes in hydroelectric production of the existent plants were estimated based on the the EPCs of annual runoff at catchment and regional scales.

Wed_60_AC-7_2438
Recording, Predicting and Responding to Rapid Environmental Change in Siberia

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The pace and depth of environmental change across the largest terrestrial region of the Arctic - Siberia - is dramatic. The impact of vegetation alteration across the taiga and tundra zones; changes in biological productivity and hydrology; and the resulting impact on fauna, especially those relied upon by Indigenous and local people, is combining to create environmental and human impacts with local, regional and global effect. . More than ever there is a need for researchers, authorities and Indigenous and local people to work together to record, predict and adapt to environmental change. Over the last two years the Siberian Environmental Change Network of Tomsk State University, The Government of the Yamal-Nenets Autonomous District, the UK Science and Innovation Network, and the EU INTERACT trans-national access programme together with other international partners and senior Indigenous peoples´ representatives have brought together interested stakeholders to put in place effective monitoring which addresses the needs and skills of local people and researchers, most recently in the context of winter weather and climate extremes.
The Abstract will present the findings from the last two practical workshops; suggest a range of promising approaches; identify emerging good practice; and set out the next steps. Attendees will see how international cooperation is combining with local knowledge to create meaningful practical action and important research.

Wed_62_AC-6_339
Glaciological Changes on the Northern Antarctic Peninsula

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During the last decades the climatic conditions along the Antarctic Peninsula have undergone significant changes. Consequently, the glacial systems along the Antarctic Peninsula reacted with widespread retreat, surface lowering as well as variations in flow speeds. Moreover, numerous ice shelves along the Antarctic Peninsula retreated, started to break-up or disintegrated completely. The aim of this work is to study the reaction of glaciers at the northern Antarctic Peninsula to the changing climatic conditions and the readjustments of tributary glaciers to ice shelf disintegration, as well as to better quantify the ice mass loss and its temporal changes.
We analysed time series of various satellite sensors (ERS-1/2, ENVISAT, RADARSAT-1, ALOS, TerraSAR-X/TanDEM-X, ASTER, Landsat) to detect changes in ice dynamics of glacier along the northern Antarctic Peninsula (< 65°). Intensity feature tracking techniques were applied on data stacks from different SAR satellites over the last 20 years to infer temporal trends in glacier surface velocities. In combination with ice thickness reconstructions and modeled climatic mass balance fields regional imbalance were calculated.
The detailed multi-mission time series analysis of glacier changes supports the interpretation of the ongoing processes in this region and allows multi temporal imbalance estimates.

Wed_63_AC-6_350
First Detailed Quantification of Glacier Elevation Changes on South Georgia

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Glaciers are frequently regarded as indicators of climate change, several studies indicate that most of the glaciers worldwide are retreating. In the Southern Hemisphere glacier mass balance information is scarce. Therefore, this gap of information generates an uncertainty about the current status of glaciers. South Georgia is the largest subantarctic islands, lying south of the Antarctic polar front. About of 56% of the surface is glacierized. Previous studies carried out on South Georgia have shown heterogeneous pattern of glacial advance and retreat over time. However, mass balance data is lacking for this region. Our focus in this study is to derive glacier surface elevation changes using SRTM-C band and TanDEM-X bistatic SAR-data for the period 2000-2012/13. This information is used to obtain the first detailed quantification and interpretation of glacier elevation and mass change on South Georgia.

Wed_65_AC-6_770
Glacier Velocity and Ice Thickness Measurements on James-Ross-Island, Antarctica

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In this poster we present glacier velocities (by remote sensing and field data) as well as ice thickness measurements (by an airborne 25 MHz ground penetrating radar) on Gourdon Glacier (James Ross Island, Antarctica).
James Ross Island is located east from the northern Antarctic Peninsula in a region which has undergone considerable changes in the last decades with the retreat or disintegration of several ice shelves. The glaciers of James Ross Island have shown predominantly retreat over the last decades while some glaciers showed also advance. In this context, we investigate the glacier dynamics and mass changes on James Ross Island using different approaches: geodetic glacier mass balances and the flux-gate approach (input-output method).
A comprehensive set of field observation (surface mass balance, time lapse camera, automatic weather stations, permanent GPS recorders) is run over several years. Additionally, a detailed remote sensing data analysis of the temporal evolution of velocities is carried out.
In order to improve the ice flux estimates we started a comprehensive airborne ground penetrating radar (GPR) campaign on Gourdon Glacier in February 2017. Ice thickness and elevation data were collected on more than 50 km of profiles with ice thicknesses of up to 350 m. Further measurements are planned for February 2018 and will include repetitions of profiles flown by previous ice thickness surveys in order to evaluate potential changes in the accumulation area.

Wed_66_AC-6_1596
The 1979 Barrier to Antarctic and Southern Ocean Climate Reanalysis

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Since the very first global atmospheric reanalysis projects in the early 1990s, handling the ever-changing observing system has proved an important and recurring challenge to producing temporally consistent reanalysis datasets. The problem has been exacerbated over Antarctica and the Southern Ocean by the data scarcity characteristic of these regions. Important changes in the type and/or availability of observations (most notably the massive input of satellite data in the late 1970s) have produced major artifacts in the reanalysis time series in high southern latitudes. Reanalysis projects going back to the early 1900s have sought to achieve greater temporal homogeneity in the observing system by assimilating only a limited set of conventional observations. In these instances, however, the prescription of unrealistic sea-ice conditions prior to 1979 and the rapidly decreasing density of surface observations poleward of 60S prior to the 1980s have again resulted in significant inhomogeneities and spurious trends in the time series. Overall, these issues have severely reduced the usefulness of reanalysis products for Antarctic and Southern Ocean studies prior to 1979 and limited our understanding of long-term climate changes in these remote regions. Here, we reassess the skills of global reanalyses in high southern latitudes, take stock of recent improvements, and offer some recommendations for addressing some recurring issues and ultimately helping bridge the 1979 barrier.

Wed_67_AC-6_1600
Surface Air Temperature Trends Across the Southern High and Middle Latitudes

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Recent studies have concluded that overall warming trends in Western Antarctica since the 1950s, as well as the cooling in more recent years, are within the bounds of natural variability. We want to provide a more comprehensive and widespread picture of how surface temperatures are changing throughout recent decades across much of the Southern Hemisphere mid- and high-latitudes. The study includes station observations from the entire Antarctic continent, mid-latitude island stations, South America, South Africa, southern Australia, and New Zealand. Using seasonal and yearly temperature anomalies, our goal is to determine the trends and their statistical significance and then investigate the drivers behind them, using time periods of various lengths to determine the longevity of said drivers. Teleconnections being considered include the Southern Annular Mode and the El Nino Southern Oscillation, due to their known influence on the Southern Hemisphere climate.

Wed_68_AC-6_1725
Isotopic Composition of Atmospheric Water Vapor around Antarctica

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It is well-known that the isotopic composition of the ice cores is a proxy for the temperature change at the drilling site. However, several studies showed that there are many other factors influencing the ice cores data. One of these factors is the isotopic composition of water and water vapour at the site of the airmass formation. In order to separate these factors we carried out continuous measurements of the isotopic composition of water vapor over the ocean surface during the Antarctic Circumnavigation Expedition (ACE) 2016/17.
For the measurements on board of the ship, two water vapor isotope analyzers (Picarro L2120-i and Picarro L2130-i) were used equipped with two types of calibration devices. This helped to obtain robust and accurate results. As a by-product result we present comparative characteristics of different types of equipment.
This data is also combined with the previously published results (see review in Galewsky et al., 2016). Here we present the results of these data analysis combined with the meteorological observations and air mass trajectories calculations.
The research was possible due to funding from EPFL, Swiss Polar Institute and Ferring Pharmaceuticals. We thank Picarro Inc. for providing us with the Picarro L2130-i and Standard Delivery Module.

Wed_69_BE-6_212
Lake Bonney High Resolution 3D Structure using an Autonomous Underwater Vehicle

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We used an Environmentally Non-Disturbing Under-ice Robotic ANtarctic Explorer (ENDURANCE) to make measurements of conductivity and temperature in Lake Bonney, in Taylor Valley. The lake is divided into two lobes - East Lobe Bonney (ELB) and West Lobe Bonney (WLB), each with unique temperature and salinity profiles. Most of our data were collected in November 2009 from WLB to examine the influence of the adjacent Taylor Glacier on the structure of the water column. Temperatures adjacent to the glacier face between 20-22 m were 3°C colder than in the rest of WLB, due to latent heat transfer associated with melting of the submerged glacier face and inflow of cold brines that originate beneath the glacier. Melting of the glacier face into the salinity gradient below the chemocline generates a series of nearly horizontal intrusions into WLB that were previously documented in profiles measured with 3 cm vertical resolution in 1990-91. WLB and ELB are connected by a narrow channel through which water can be exchanged over a shallow sill that controls the position of the chemocline in WLB. A complex exchange flow appears to exist through the narrows, driven by horizontal density gradients and melting at the glacier face. Superimposed on the exchange is a net west-to-east flow generated by the higher volume of meltwater inflows to WLB. Both of these processes can be expected to be enhanced in the future as more meltwater is produced.

Wed_70_BE-6_558
Seasonal Dynamics in the Extreme Arctic: Ward Hunt Lake, Canada

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Lake ecosystems occur along the far northern coast of the Canadian High Arctic, but almost nothing is known about their seasonal dynamics. Ward Hunt Lake is Canada's northernmost lake, located on Ward Hunt Island (lat. 83 °05'N, long. 74 °10'W), off Ellesmere Island, Nunavut. The lake is oligotrophic, and given its extreme northerly location, is a potentially sensitive indicator of global climate change. Our aims were to determine the structure and functioning of this remote aquatic ecosystem, and to better understand the nature and implications of ongoing change. A mooring installed at the deepest point of the lake (10m) recorded temperature, oxygen, chlorophyll fluorescence and underwater irradiance. This information was coupled with images from an automated camera system to track the seasonal variations in ice cover from July 2016 to July 2017. The annual chlorophyll *a* maximum coincided with open water conditions in September when there was increased light availability and water column mixing. Contrary to expectation, oxygen concentrations dropped rapidly after ice-up, and anoxia was recorded in the bottom waters in December. The oxygen and temperature records also revealed an internal wave pattern during the period of ice-cover. These high-resolution measurements indicated large-amplitude temporal variations in biogeochemical processes despite the low-nutrient status of this High Arctic ecosystem.

Wed_71_BE-6_612
Characterising Seasonal Water and Melting in the Ross Sea Region of Antarctica

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Increased meltwater is a feature of nearly all models of Antarctica's future, and underpins analysis of environmental and biological domains. We characterised surficial occurrences of water, or ice re-frozen from meltwater, throughout the Ross Sea Region (RSR) using two important new datasets:
(1) a GeoMAP GIS defining exposed bedrock and glacial cover sequences, including 869 seasonal meltwater accumulations;
(2) an Antarctic-wide datacube of daily land surface temperatures (LST) from 2003-2015, detected by MODIS instruments at 1 km resolution.
Local temperature statistics were assigned to water occurrences to derive empirical thresholds for melting. Water is only observed where average annual LST is > -35°C, but with significant regional differences in conditions of meltwater occurrence. Growing degree days (GDD) above a temperature threshold, albedo and % rock are key factors strongly correlated with meltwater. Probability that water is present or absent is modelled across the RSR using a variety of environmental covariates weighted by correlation strength in a training dataset. Environmental conditions were then adjusted and models re-run to forecast future conditions under a warmer climate (LST +2ºC, GDD +30%). As well as defining where surficial water can be expected in future, the study highlights the importance of regional-scale datasets to characterise cryosphere-lithosphere interactions, and role geology may play on the melting of Antarctica.

Wed_72_BE-6_977
Seasonal Change of Photosynthesis of Phytobenthic Communities in Antarctic Lakes

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The most luxuriant vegetation is found in freshwater lakebeds as thick phytobenthic mats in East Antarctica. Photosynthetic activities of phytobenthic mats are measured well in many lakes on Antarctica during summer, whereas little is known about it for a period from autumn to spring. We collected phytobenthic mat samples from Lake West Ongul (69°01′S, 39°33′E) in Sôya Coast, East Antactica once or twice per month throughout the year except June, and from nine freshwater lakes (69°14′S-69°30′S, 39°33′E-39°47′E) in Sôya Coast, East Antactica in both summer and early-spring, of which two lakes were a target of continuous monitoring of PAR (photosynthetically active radiation) and temperatures underwater by installing mooring systems. Then, we measured photosynthetic characteristics using a chlorophyll fluorescence instrument (Phyto-PAM, Walz) as soon as possible after arrival in the base, and rest of the samples were frozen in the dark at -20°C for analyzing the pigments composition as an index of light-utilization and photo-community composition. The photosynthetic activities changed seasonally and are quite different between spring and summer, in addition to this, the community compositions contributing to photosynthesis of the benthic mats changed depending on the season.

Wed_73_BE-6_1582
Sub-daily Biogeochemical Cycling in Sediment from an Ephemeral Meltwater Stream

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Glacial meltwater streams are often characterized by diel fluctuations or cessation of flow, especially in regions where the energy balance of the source glacier is alternately positive and negative throughout a day. These characteristics drive a highly dynamic physical environment, in which stream sediment undergoes periodic inundation and drying as channel flow varies. The role of long-term (i.e., seasonal to inter-annual) sediment drying-rewetting on biogeochemical cycles has been studied extensively in temperate systems characterized by wet and dry seasons. However, these relationship have remained understudied in systems characterized by short-term (i.e., sub-daily to weekly) flow intermittency, as often occurs in glaciated environments. To advance understanding of how short-term variations in physical conditions alter nutrient cycling (specifically, inorganic nitrogen availability), we present preliminary findings on the spatiotemporal variability of pore-water chemistry during diel pulsing in an ephemeral glacial meltwater stream (McMurdo Dry Valleys, Antarctica). We present these results in the context of a laboratory rewetting experiment, high- and low-frequency stream nitrate concentration data from the MDV Long-Term Ecological Research Project, and results from prior studies in Arctic and Antarctic streams. Our results will inform understanding of sediment-channel interactions that control nutrient transport and retention in polar and alpine ephemeral streams.

Wed_75_BE-6_1843

North American Arctic Freshwater Biodiversity Trends in a Changing Climate

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Within the North American Arctic, the effects of climate change have led to more pronounced temperature change in the west, with substantially more warming in Alaska and the Northwest Territories than along the eastern coast of Nunavut. Though records of increased temperatures and increased occurrence of permafrost degradation have been noted, widespread and long-term assessment of freshwater biotic responses to the changing climate have been lacking in North America. Assessment of trends across the North American Arctic presents the opportunity to investigate biotic responses to different rates of warming (west to east) with relatively little interaction from anthropogenic effects, compared to more developed regions of the circumpolar Arctic. The biodiversity of fish, benthic macroinvertebrates, and algae in lakes and rivers was evaluated along latitudinal transects from west to east, and biotic patterns were related to trends in abiotic descriptors to characterize environmental drivers of change in these communities. Through the analysis of spatially- and temporally-distributed data for the North American Arctic, this study aims to assess the current status and historical trends in freshwater biodiversity in response to physical and chemical habitat shifts related to climate change.

Wed_76_BE-6_1906
Modeling Vulnerability to Thermokarst Disturbance in Boreal Alaska

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Recent climate change is driving permafrost degradation, threatening to mobilize vast reservoirs of ancient carbon previously protected from decomposition. Although large scale, progressive, top-down permafrost thaw has been well studied and represented in high-latitude ecosystem models, the consequences of abrupt and local thermokarst disturbances (TK) are less well understood. To fill this gap, we conducted a detection analysis characterizing 60 years of land cover change in a major wetland complex subjected to TK disturbance in Interior Alaska, using aerial and satellite images. We observed a nonlinear loss of permafrost plateau forest associated with TK disturbance and driven by precipitation and forest fragmentation. The results of this analysis were integrated into a state-and-transition model that simulates land cover change associated with TK disturbance. By 2100, the model predicts a mean decrease of 7.4% (sd 1.8%) in permafrost plateau forests associated with an increase in TK fens and bogs. We evaluated the consequences of TK-related land cover change on the regional carbon balance using a process-based biogeochemical model. We used long-term field observations of vegetation and soil physical and biogeochemical attributes to develop new parameterizations for TK wetlands and permafrost plateau forest land cover types. Preliminary simulations suggest a 7.5% (sd 3.5%) decrease in Net Ecosystem Exchange associated with TK-related land cover change by 2100.

Wed_77_BE-6_1992
Validating Approaches to Determine Biodiversity Attributes of Arctic Freshwaters

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Improved understanding of how human-induced changes in Arctic freshwater ecosystems, e.g. climate change and resource development, may impact the health of northern freshwater resources and the provision of ecosystem services, e.g., sustainable fisheries, is essential. Here we discuss a research template consistent with the Circumpolar Biodiversity Monitoring Program to determine how aquatic ecosystem function and structure varies with spatial scale to support juvenile fish production, the diversity of other resident organisms, and the habitats upon which fisheries health and sustainability depend. The study also aims to measure cumulative impacts on aquatic ecosystem structure (e.g., biodiversity loss, reduced fish harvestability). Research focuses on the Lake Greiner Watershed, Victoria Island Nunavut, is multi-trophic and will expand beyond simple, single study of lake ecosystems to include landscape-level, watershed attributes such as tributary streams that provide important rearing and connectivity habitats for fish. The study is timely and necessary as it has been more than 40 years since such investigations were last conducted in the Canadian Arctic. The work will establish and validate monitoring protocols for aquatic ecosystems in the north, thereby providing tools to government agencies for the continued routine monitoring of Arctic freshwater systems and a means to assess the accumulation of future ecosystem impacts (e.g., climate change, development).

Wed_79_BE-6_2251
Characterizing Microhabitats at Relevant Scales for Polar Terrestrial Biota

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Ground temperatures in the top few centimetres of the soil profile are key in many processes yet remain very poorly documented, especially in the polar regions or over longer timescales. They vary greatly at various scales across the often heterogeneous polar landscapes. Meteorological air temperature records provide a poor proxy for soil temperature profiles, while at present no biological microclimate datasets exist that are of sufficient duration to allow comparison with large-scale climate trends. Responses of soil-associated biota both to existing climate and to projected change cannot be understood without improved description of these microclimates. We introduce and provide an overview of multi-annual temperature records at biologically-relevant scale from 20 High Arctic (Svalbard) and maritime Antarctic sites. General features that are likely to have important influences on polar terrestrial biology include
(a) summer ground and sub-surface temperatures vary much more than those of the air;
(b) winter ground temperatures are generally uncoupled from atmospheric temperatures;
(c) the ground thawing period may be considerably shorter than that of positive air temperatures;
(d) ground freeze-thaw event patterns differ between Arctic and Antarctic;
(e) rates of ground temperature change are generally low;
(f) accumulated thermal sum in the ground usually greatly exceeds air cumulative degree days.

Wed_80_BE-7_523
Comparative Benthic Experiments in Polar Seas - What Can we Learn from them?

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To predict changes in the future, we need to identify links between parameters in the ecosystems, such as food supply to the benthos, composition of benthic communities and effected functions. Comparative experiments can be used to distinguish different causes for effects, particularly in regions differing in environmental conditions such as sea-ice cover. Here we show results from benthic chamber incubation experiments, in which the same method was applied in
(i) Arctic shelf and deep seas and
(ii) Arctic and Antarctic shelf seas.
Our results show that the comparative approach can point to challenging global assumptions such as the largely diffusion-driven oxygen consumption rates in the deep sea and the biodiversity-driven rates of ecosystem functions (here: remineralisation rates). We argue that experiments manipulating the biological system (e.g. species) or environment in contrasting regions such the Arctic and Southern Ocean can elucidate physico- and biochemical mechanisms crucial for a better state description and prediction of processes in marine and polar ecosystems.

Wed_81_BE-7_529
Ecological Role of Arctic Squid *Gonatus fabricii* Inferred using Stable Isotopes

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Gonatus fabricii is the most abundant (and the only one species of) squid, living in the Arctic throughout its life cycle. Its detailed ecological role was assessed using stable isotope analysis of its beaks in the Arctic: Western Greenland, Eastern Greenland and the Barents Sea. The values of both $\delta^{13}C$ and $\delta^{15}N$ were not sex-related, despite ontogenetic differences in life cycle. $\delta^{13}C$ showed low ontogenetic increase while having significant geographical differences: more eastern areas had lower values, more western areas had higher ones. Such pattern in $\delta^{13}C$ values, despite of not reported previously, was spotted in many taxa in the Arctic. $\delta^{15}N$ showed no geographical variation, while having significant ontogenetic increase (9.99‰ $\delta^{15}N$; 2.8 trophic levels) from epipelagic forms (1.4-2.6 trophic levels) to bathypelagic ones (2.2-4.2 trophic levels), being comparable with the largest fishes, seals and whales. Consequently, *G. fabricii* is considered the top predator invertebrate in the Arctic, with the widest trophic niche. *G. fabricii* had the highest values of $\delta^{15}N$ ever recorded in cephalopod beaks, 14.85‰. Its trophic level was surpassed only by the Antarctic colossal squid, *Mesonychoteuthis hamiltoni*: seems like in polar ecosystems squids occupy higher positions, than in the rest of the World Ocean. As the maximum recorded mantle length of *G. fabricii* is 389 mm (257 mm in the studied ones), its trophic level and predatory role would increase as our research develops.

Wed_82_BE-7_580
Regional Variation of Antarctic Krill Lipids and their Fatty Acid Composition

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Antarctic krill are an important trophic link between phytoplankton and higher organisms. Knowledge of their lipid (oil) biochemistry can assist in understanding and predicting potential ecological changes and can also inform the fishery on sustainable practices, optimising krill harvest. This study examined how the lipid and fatty acid content and composition of Antarctic krill varied between the three major ocean basins surrounding Antarctica (Indian, Atlantic and Pacific). Lipids were analysed from krill collected by a commercial krill fishery, along with samples collected on the K-Axis and ACE voyages.
Krill were staged, sexed, weighed and measured before undergoing lipid and fatty acid analysis. The digestive glands and stomachs were dissected out of samples so that a clear dietary signal could be attained and compared to the signal detected from samples of whole krill. Fatty acid signatures from the digestive glands and stomachs serve to show the immediate differences in diet between these regions, whilst the fatty acids of the whole krill show which lipids are being retained by the krill between regions.
These analyses serve as a baseline of the differences at a regional scale for lipid levels, energy usage and budgeting of krill. Knowing how krill diet and energy budgets vary around Antarctica will ensure an accurate measurement of krill production and energy flow in ecosystem models as well as helping to ensure the krill fishery is sustainable into the future.

Wed_83_BE-7_1301
A Novel High-resolution Model of Moss-bed Microclimate in Maritime Antarctica

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Moss communities dominate the terrestrial vegetation in Antarctica, and thus are disproportionately important for the preservation of ecosystem services and biodiversity continent-wide. Understanding physical drivers of moss-community-level processes in Antarctica is a key challenge due to difficulties associated with sampling at temporal and spatial scales relevant for moss. Further, the ability to predict future impacts of climate change on Antarctic vegetation has been hampered by a scale mismatch between coarse scale climate models and scales biologically relevant for moss communities. Modelling at a scale appropriate for the study of mosses will lead to novel insights into how microhabitats are distributed across micro-topography, what impact microclimates have on community assemblages and productivity, and what changes may occur in the future. We surveyed microclimates in 10 quadrats (1m x 1m) in maritime Antarctica in January 2017 and 2018. Microclimatic variations were captured under different weather conditions, and moss-bed surfaces were digitised at a 1cm resolution using structure from motion. These data were used to parameterise a novel empirically calibrated mechanistic model that predicts moss-bed microclimates on a centimetre scale. This model allows us to scale-down from coarse climate data to determine how processes affecting moss composition, health and physiology vary in different microhabitats and how these might be altered under future climate scenarios.

Wed_84_BE-7_1505
Winter to Summer Trophic Shift of Gondogeneia Antarctica in an Antarctic Fjord

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The amphipod *Gondogeneia antarctica* is one of species predominating shallow Antarctic coastal macrobenthic communities. *G. antarctica* has been considered a key component of nearshore Antarctic food web, preyed by a high number of predators, and relying on various food sources over a year. In order to investigate its trophic preferences, *G. Antarctica* and its potential food (Suspended Particulate Matter and macroalgae) were collected, from intertidal water at King Sejong Station (Feb-Nov 2015). The C and N stable isotopes were analyzed in the potential food and the body of amphipods. We found similar $\delta^{13}C$ values of *G. antarctica* during the year (e.g. -19.4‰ ± 0.8: summer, -20.2‰ ± 0.5: winter), being close to those of red algae analyzed *(Iridaea cordata* -21.1‰ ± 3.2*, Gigartina skottsbergii* -22.6‰ ± 1.5*, Palmaria decipiens* -19.9‰ ± 0.7), indicating that the macroalgae were a primary food source, and SPM (-25.4‰ ± 1.2) the secondary one. The digestive tract contained organic matter (summer) and macroalgae (winter) confirming the isotopic results. The range of $\delta^{15}N$ values (5.6 to 7.7‰) of the amphipod indicated omnivory when food is relatively abundant in summer, though they generally appeared to be primary consumers in the other seasons. This seasonal trend was consistent among different sizes & reproductive status. We further discuss about the relevance of this seasonal shift with environmental parameters, such as seawater temperature, salinity, Chlorophyll a and sea ice cover.

Wed_85_BE-7_1637
Multiscale Analysis of Epibenthic Communities off the Antarctic Peninsula

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Patterns in epibenthic community distribution and composition are regulated by a variety of environmental and biotic drivers. The multiscale nature of these fundamental cause-effect relationships, albeit generally known to be very important for the understanding of ecological processes and development of conservation and environmental management practices, has very rarely been explicitly addressed in marine polar research. To tackle this issue, we performed an ecological survey of epibenthic communities in three regions off the northern Antarctic Peninsula (northwestern Weddell Sea, southern Bransfield Strait and southern Drake Passage) by means of high-resolution seabed images (n=2799 taken with the Ocean Floor Observation System (OFOS)). We used Moran's eigenvector mapping of the epibenthic composition data to extract spatial scales at which communities are structured (700 m to 30 km) by physical and biological environmental factors, such as sea-ice dynamics, primary production, and water depth. The analysis indicates that at different spatial scales the community structure is driven by different environmental variables. However, the small-scale variability in epibenthic composition was not sufficiently explained by the measured environmental factors, very likely because it is primarily driven by biological interactions. Our study underpins the necessity to assess the relationship between environmental drivers and biological assemblages across a range of scales.

Wed_86_BE-7_1866
Dynamic Growth Model of Antarctic Macroalgae in a Fast-changing Environment

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Understanding communities functions and trophic interactions between Antarctic species has been the focus of a lot of research over the past few years. Modeling approaches help integrate increasing information about these communities using ecological network frameworks. Within these networks, macroalgae, as primary producers, are strong drivers in benthic ecosystem functioning. Characterising relationships between macroalgae growth performance and environmental parameters is an interesting approach to assess potential ecosystem responses to fast-changing environments. In this context, we build a dynamic growth model for Antarctic macroalgae that describes biomass changes in time and predicts macroalgae growth according to forcing environmental variables like: light intensity, water turdidity, current speed, ice cover. Our objective is to define a mathematical model structure that can encompass the environments observed in the Western Antarctic Peninsula, we will obtain parameters from published studies mainly from Potter Cove, King Georges Island (South Shetlands). After defining it we study the existence of alternative stable states with respect to environmental variables that could produce regime shifts in these Antarctic ecosystems.

Wed_87_BE-7_2085
Antifouling Activity in Sessile Antarctic Invertebrates by in situ Experiments

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Competition for space is a remarkable ecological force, comparable to predation, which produces a strong selective pressure on sessile benthic invertebrates. The settlement of organisms on the surfaces of living organisms can be either advantageous or disadvantageous to the host. To obtain protection, many benthic marine invertebrates, including sponges and bryozoans, contain secondary metabolites with antibacterial properties. Here, extracts from five sponges and two bryozoans from Antarctic waters, have been shown to exhibit selective antibacterial activity. Three replicates of each fraction treatment were tested submerging the plates in the sea during one lunar cycle (28 days). Amplification from environmental DNA was performed searching for bacteria, eukaryota, and archea. Different levels of bacterial and eukaryotic activity were found in the tested extracts when compared to controls. An important activity against eukaryotic fouling were detected. The hydrophylic fractions of *Mycale tylotornota* and *Cornucopina pectogemma* completely inhibited the growth of eukaryotic organisms, one of the early succession stages involved in biofouling. Thus, although chemical defenses may be quite species-specific in their ecological roles, these results suggest that different chemical strategies exist to deal with space competition, reinforcing the importance of marine organisms in the production of bioactive substances.

Wed_88_BE-7_2673
Disentangling the Coupling between Sea Ice and Tundra Productivity in Svalbard

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The rapid decline in Arctic sea ice poses urgent questions concerning its ecological effects, such as on tundra terrestrial productivity. However, reported sea ice/terrestrial productivity linkages have seldom been constrained, and the mechanism governing them remains elusive, with a diversity of spatial scales and metrics proposed, at times in contradiction to each other. In this study, we use spatially explicit remotely sensed sea ice concentration and high-resolution terrestrial productivity estimates (Normalised Difference Vegetation Index, *NDVI*) across the Svalbard Archipelago to describe local/sub-regional and large-scale components of sea ice/terrestrial productivity coupling. Whereas the local/sub-regional component is attributed to *sea breeze* (cold air advection from ice-covered ocean onto adjacent land during the growing season), the large-scale component might reflect co-variability of sea ice and tundra productivity due to a common forcing, such as large-scale atmospheric circulation (North Atlantic Oscillation, *NAO*). Our study clarifies the range of mechanisms in sea ice/terrestrial productivity coupling, allowing the generation of testable hypotheses about its past, present, and future dynamics across the Arctic.

Wed_89_BE-7_2697
Elemental Stoichiometry Drives Nematode Life History and Genome Evolution

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The presence of bioavailable phosphorus (P) differs significantly across the Transantarctic Mountain (TAM) landscape where it is highly correlated with age of exposure and the composition of glacial tills. Terrestrial habitats with very old surface exposures have relatively little bioavailable phosphorus whereas as younger tills typically are much more phosphorus rich. Thus, provenance and weathering play an instrumental role in patterns of distribution and abundance of this important nutrient in the TAM.
Phosphorus is the most limiting element in DNA transcription and translation such that P availability is directly coupled to high demands for the protein synthesis that is required for organismal growth and development. Using field and laboratory approaches we show that conspecific TAM nematodes from high versus low bioavailable P environments contain greater somatic P concentrations and have evolved 1) faster growth rates, 2) earlier reproduction, 3) shorter reproductive cycles, 4) smaller body size, 5) increased rates of transcription, and 6) increased rRNA gene copy number. These findings have important implications on the evolution of organismal life history traits and ultimately the development of trophic complexity in terrestrial ecosystems.

Wed_90_BE-7_1579
Soil Visible and Near Infrared Spectroscopy as an up-scaling Tool

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The combination of partial least square regression (PLSR) and soil visible (VIS) and near infrared (NIR) spectroscopy measurements can be used to predict soil properties and assist estimating the spatial characteristics of soil properties from the pedon to regional scales. VIS-NIR spectroscopy was successfully used to describe, estimate and further map the spatial patterns of soil properties in unknown locations using PLSR in R program. The parameters such as oxalate and dithionite extracted iron, aluminum and manganese oxides and (hydr-)oxides, soil organic carbon and total N concentrations, and pH were investigated in this research. Moreover, the geostatistical methods (e.g. Moran´s I: spatial autocorrelation) can be used in order to better understand the pedogenic processes pertaining to permafrost thaw. This research illustrates how VIS-NIR spectroscopy can be implemented in order to improve the global soil spectral library as well as assist in up-scaling of soil properties and processes in cold climate regions.

Wed_91_CR-2_210
Ice Table Depth, Ground Ice and its dD-d^{18}O Composition in Cold-dry Soils

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In the ultraxerous region of the Dry Valleys of Antarctica, the very cold and dry climate ensure that dry soils overlie icy permafrost; a characteristic unique to this region, but is the norm on Mars. Here, we present of summary of our work in University Valley, upper Dry Valleys. In University Valley, mean annual air temperature approximates mean annual ground surface temperature (ie, surface offset ~ 0°C); however, mean annual relative humidity (45.5 ± 14%) is much lower than mean annual ground surface relative humidity (varying from 100 to ~ 85%$_{ice}$). The ice table depth increase with distance from the glacier: from < 1 cm to ~ 60 cm, indicating that despite being a cold and dry region, ground ice is pervasive. Excluding the two bodies of buried glacier ice, volumetric ice contents ranged from 0 to 93%. These high ice contents suggest the cold temperatures and low precipitation in the upper Dry Valleys are likely not limiting factors to the development of ice-rich permafrost. Based on D-^{18}O measurements, the ground ice has different origins: vapor-deposition, freezing of evaporated snow meltwater or burial of glacier ice. We modeled the net water vapour flux, ice table depths and D-^{18}O of ground ice using the conditions measured in the valley. When ground surface conditions are used (instead of those measured in the atmosphere), our modeling predicts that the measured ice table depths in the valley are likely in equilibrium with contemporary conditions.

Wed_92_CR-2_282
Quantification of Holocene Nivation Rates on James Ross Island, Antarctica

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Nivation encompasses a breadth of slowly operating landscape modelling processes, which have been studied only very little in the recent years. In the semi-arid polar continental climate of James Ross Island with annual precipitation of 300-500 mm and strong redistribution of snow by wind that causes the formation of snow-patches, meltwater from the late-lying snow-patches is not only capable of transporting fine particles downslope and slope profile shaping, but also controls the presence of vegetation in the landscape. The area for this study is located on Cape Lachman. The deglaciation of this area took place 12.9 ± 1.2 ka ago. The study site consists of ca 2 km long and 200 m wide semi-circular depression. Snow accumulations on the lee slopes last throughout the summer and the long-term downslope transport of fine particles by meltwater has caused significant remodelling of the slope profile. dGPS measurements on 20 transects have been used for comparison between transects which have been affected by nivation processes and those which have been not. Besides, a digital terrain model was constructed to quantify the scarp retreat and slope profile change along the depression margin due to nivation and to calculate the rate of these changes since the deglaciation, i.e. for the whole Holocene. Furthermore, grain-size changes of material in studied profiles support the removal of fine-grained particles by meltwater from the slope and their accumulation on the depression floor.

Wed_93_CR-2_332
Blowing in the Wind - Where Does the Antarctic Fluvial Suspended Load Come from?

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When studying fluvial transport in Antarctic streams, an obvious question arises: where does the material come from? The sources of bedload and suspended load generally differ in most catchments. Chemical composition of suspended material transported in Bohemian and Algal streams on Ulu Peninsula, James Ross Island (eastern Antarctic Peninsula) didn't bring any clear answer (Kavan et al., 2017). Here we test the hypothesis that an important source of material for fluvial transport is the material brought by strong barrier winds transporting material from relatively vast ice-free areas of Ulu Peninsula. Two sets of passive aeolian samplers were installed on upwind and downwind sides of Bohemian Stream braidplain with respect to prevailing southerly to westerly barrier winds. The material was sampled for 23 days (29/01/2017-20/02/2017) without an occurrence of significant wind storm during the period. Nevertheless, samplers ahead of the braidplain did collect 41.66 g/m^2 in average, whereas only 29.09 g/m^2 were sampled behind the braidplain. This suggests a significant part of wind-blown material (>30%) was lost from aeolian transport and was stored in braidplain being available for subsequent fluvial transport. The redistribution of aeolian material through fluvial systems causes spatially unequal input of fine-grained material to coastal marine environment and shapes significantly the Antarctic coastline.

Wed_94_CR-2_829
Inflated Soils on Earth and Mars: Cold Deserts, Old Features and Young Surfaces

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How do rocky boulder pavements and oriented boulder landforms form atop dust and ice? How do they persist through orbital/spin-axis-induced climate change? We describe silt-dominated inflated soil textures in the McMurdo Dry Valleys of Antarctica and evaluate a class of potentially similar martian landforms on Mars referred to as “boulder halos.” Boulder halos are circular arrangements of clasts present at martian middle to high latitudes. They are thought to result from impacts into a boulder-poor surficial unit that is rich in ground-ice and/or sediments and that is underlain by a competent substrate. To determine the distribution of boulder halos and to evaluate mechanisms for their formation, we mapped boulder halos over 4,188 HiRISE images located between 50-80° north and south latitude. Boulder halos are about three times more common in the northern hemisphere than in the southern, and have size-frequency distributions suggesting recent Amazonian formation (tens to hundreds of millions of years). In the north, boulder halo sites are characterized by abundant shallow subsurface ice and high thermal inertia. Spatial patterns of halo distribution indicate that surface processes such as inflation either promote boulder halo preservation in the north or destroy boulder halos in the south.

Wed_95_CR-2_1520
Investigations of Patterned Ground in Antarctic Permafrost as a Mars Analogue

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The results of a combined geophysical and geomorphological investigation of thermal-contraction-crack polygons in Northern Victoria Land (Antarctica) are reported. An area of ~30,000 m^2 characterized by random orthogonal polygons was investigated using 10 GPR and 2 ERT surveys. The terrain consists of Holocene-age raised beaches. The polygons are well developed only on beaches that are >14 m above current sea level. Uplift curves for the region suggest the beaches formed between 4.2 and 6.3 ka BP. Sections were excavated through two of the fissures that form the polygons. There was good correlation between field observations and GPR (250 Mhz) data. It is concluded that the polygons are composite in nature because the shallow linear depressions that outline the polygons are underlain by fissures that can contain both sandy gravel (i.e., sand wedges) and foliated gravelly ice (i.e., ice wedges) in the same polygon network. Generally, the ice infill is less common than the sandy gravel infill. While thermal-contraction-cracking is the principle mechanism for polygon formation, it is suggested that local micro-site conditions, mainly snow distribution, leads to the different type of fissure infill.

Wed_96_CR-2_1525
Microbial Communities in the Brines of Two Antarctic Frozen Lakes (Boulder Clay)

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During a GPR survey, two lenses of liquid brines were found at different depths in two adjacent frozen Boulder Clay lakes (Lake-1: 2.5 m; Lake-2: 2.0) with a different salinity (0.2 and 3.6 mS/cm, respectively) and pH (8.17 and 8.76, respectively). Brines were analyzed for bacterial diversity by Ion Torrent DNA and cDNA sequencing, microbial abundances (by image analysis and flow cytometry) and metabolic activities (by Biolog-Ecoplate™ and potential rates of ectoenzymatic activities determinations). The analysis of DNA sequences generally showed the predominance of Bacteroidetes, followed by Proteobacteria and Actinobacteria. The highest percentage (6.0 *vs* 1.7%) of active bacteria (by the analysis of RNA sequences; mainly Bacteroidetes) was observed in Lake-1. This latter harboured microbial populations characterized by higher prokaryotic cell abundances, volumes, biomass and virus abundance than Lake-2. Diverse cell morphotypes were observed in the two lakes. Different metabolic responses were also determined, with higher numbers of respiring cells and higher rates of ectoenzymatic activities, as well as the ability to better utilize carbon sources, in Lake-1 than in Lake-2. Results highlighted differences in the analyzed cryoenvironments in terms of diversity, abundance and metabolism, suggesting that Antarctic lakes might possess distinct microbial features in spite of their spatial proximity

Wed_97_CR-2_1527
Two Microbial Assemblages in Lake Brine Pockets Separated by a Thick Ice Layer

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Two distinct hypersaline brine pockets (TF4 and TF5) separated by a 12 cm-thick ice layer were sampled from Tarn Flat, an unexplored Antarctic perennially frozen lake. Samples were analyzed for prokaryotic (Bacteria and Archaea) diversity (Ion Torrent sequencing), microbial abundances (image analysis and flow cytometry) and metabolic activities (Biolog-Ecoplate™ and potential rates of ectoenzymatic activities). The two sites shared only 22 and 18% of OTUs for Bacteria and Archaea, respectively. Shannon diversity for archaeal and bacterial communities was higher in TF5 than TF4 (p value < 0.001). Both bacterial communities were dominated by Proteobacteria, followed by Bacteroidetes and Actinobacteria. The Archaeal community was mainly constituted by Euryarchaeota and Crenarchaeota. Prokaryotic and virus-like particle abundances were in the order of 10^9 cells/l and 10^{10} VLP/l, respectively, in both samples, with slightly higher counts in TF4 than TF5. However, the VLP/PA ratio was 2.7 times higher in TF4 than in TF5. Larger cells were detected in TF5 (0.105 μm^3) than TF4 (< 0.06 μm^3) as well as higher values of physiological diversity, substrate richness, substrate evenness and equitability were determined in TF5 than TF4. The prokaryotic community hydrolyzed proteins rather than organic phosphates, and polysaccharide degradation was negligible in TF5 and high in TF4. Overall data revealed the occurrence of highly different microbial assemblages in the studied brines.

Wed_98_CR-2_2018
Rock Glaciers in Antarctica Provide Evidence of Multiple Glacial Advances

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Rock glaciers in the Dry Valleys of Antarctica vary across the region in terms of origin and internal structure. Based on ground-penetrating-radar data and field excavations, rock glaciers in central Wright Valley are cored by ice-cemented sediments and recharged by meltwater, whereas those in Taylor and Pearse valleys often contain 3+ m of clean ice buried beneath sediments. Based on field observations, the latter type of rock glacier forms along the margins of cold-based glaciers as a mélange of glacial ice blocks, meltwater and sediments. These clean-ice rock glaciers often show evidence of complex formational histories and can therefore be used to map multiple glacial advances. Stable isotopic analyses of buried ice from a rock glacier in Pearse Valley support the presence of two distinct ice bodies:
1) one from a previous advance of East Antarctic outlet Taylor Glacier, possibly dating to Marine Isotope Stage 5 and
2) another from a modern alpine glacier which is still actively supplying ice and sediments.
This study outlines the environmental conditions that foster rock-glacier formation in cold deserts with implications for lobate flow features on Mars. The data also provide a baseline to study the geomorphic impacts of present and future climate change. Meltwater-fed rock glaciers, such as those in Wright Valley, may grow in response to warming, whereas clean-ice rock glaciers will likely experience degradation by thermokarst melting and stream erosion.

Wed_99_CR-2_2033
Weathering Rate Study in Maritime Antarctica Using Onsite Nondestructive Methods

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Periglacial processes are highly active under the maritime environmental conditions of the South Shetland Islands. Weathering associated with such conditions influences soil and landform development. Dating of deposits and erosive surfaces in the region poses difficulties due to the scarcity of sedimentary elements adequate for dating. This is the case of one of the prominent geomorphological features in the studied region: raised marine features located up to 260 m a.s.l. The aim of this work is to explore the possibilities of discriminating exposure ages using a combination of measuring methods to study weathering. There are studies on the use of Schmidt hammer for relative dating glacial weathered surfaces; however, there are other onsite nondestructive techniques that could further improve the dating results. In this study, a range of techniques including Schmidt hammer, ultrasound pulse velocity, spectroscopy and surface temperature were applied to relatively date exposed rock surfaces in the South Shetland Islands. Measurements have included Holocene and pre-Holocene raised beaches containing pebble sediments, and marine erosive platforms located at different altitudes in Livingston and King George islands. In addition to onsite and laboratory measurements, the spectral signature of these features was determined in order to characterize the spectral information from satellite observations, which in turn can be extrapolated to further areas over a larger region.

Wed_102_CR-3_182
The Hydrochemal Characteristics of Ground Ice on the Qinghai-Tibetan Plateau

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The vertical distribution and controlling factors of the hydrochemistry of ground ice are critical to explore the mechanism of salt-moisture migration during the soil freezing-thawing processes, which are of great importance to understanding the hydrological cycles in cold regions. This study examined the characteristics of ground ice hydrochemistry using data from nine soil profiles investigated in permafrost regions of the central Qinghai-Tibet Plateau (QTP), which is called as the third pole. The isotopes and anion values of subsurface water on the QTP were higher than those in Arctic polygonal ground regions. The spatial tendency of anions was not obvious, while well-developed hydrochemical depth gradients were found within the soil profile, presenting depleted isotopes and increased anions with depth. Cl^- and SO_4^{2-} concentrations in soil water increased with depth, while NO_3^- concentration did not change obviously with depth. Freeze-out fractionation, self-purification, and desalination greatly impact soil hydrochemistry. Correlation analyses showed that the major controlling factors for the variations of soil water chemistry were soil moisture, air temperature, and active layer thickness. The results could provide fundamental framework to understandthe ground ice origins and the saltmoisture migration pathways in the context of permafrost changes, and should be considered in establishing the process-based permafrost hydrologic models.

Wed_103_CR-3_659
Lake Volume and Groundwater Storage Variations in the Tibetan Plateau

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The Tibetan Plateau (TP), the highest and largest plateau in the world, with complex and competing cryospheric-hydrologic-geodynamic processes, is particularly sensitive to anthropogenic warming. The quantitative water mass budget in the TP is poorly known. Here we examine annual changes in lake area, level, and volume during 1970s −2015. We find that a complex pattern of lake volume change during 1970s−2015: a slight decrease of -2.78 Gt yr^{-1} during 1970s−1995, followed by a rapid increase of 12.53 Gt yr^{-1} during 1996−2010, and then a recent deceleration (1.46 Gt yr^{-1}) during 2011−2015. We then estimated the recent water mass budget for the Inner TP, 2003−2009, including changes in terrestrial water storage (TWS), lake volume, glacier mass, snow water equivalent (SWE), soil moisture, and permafrost. The dominant components of water mass budget, namely changes in lake volume (7.72 ± 0.63 Gt yr^{-1}) and groundwater storage (5.01 ± 1.59 Gt yr^{-1}), increased at similar rates. We find that increased net precipitation contributes the majority of water supply (74%) for the lake volume increase, followed by glacier mass loss (13%), and ground ice melt due to permafrost degradation (12%). Other term such as SWE (1%) make a relatively small contribution. These results suggest that the hydrologic cycle in the TP has intensified remarkably during recent decades.

Wed_104_CR-3_681
Vapor Stable Isotopes in the Tibetan Plateau Record Moisture Transport Processes

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The water cycle in the southern Tibetan Plateau as a crucial region in the "Asian Water Towers" impacts water supply in downstream countries. Moisture transport processes determine the variation of regional water cycle directly. Water vapor stable isotopes ($\delta^{18}O$ and δD), as an integrative tracer of water phase-transition and diffusivity process provide the potential of enhancing our knowledge of the moisture transport processes from the moisture origins to the southern Tibetan Plateau. Continuous, in situ high-resolution measurements of atmospheric water vapor stable isotopes have been conducted at Lhasa, Motuo and Everest, southern Tibetan Plateau (TP), since October 2014, using the laser analyzers. Combined with local meteorological data, reanalysis data and simulations from the iso-GCMs model, the relationships between water vapor stable isotopes and atmospheric processes are explored at daily and seasonal scales. The changing of vapor stable isotopes is resulted from the moisture transport processes, especially the transfer from the westerlies to the Indian summer monsoon. Our results will improve the implications of stable isotopes in ice cores and understanding of water cycle in this region.

Wed_105_CR-3_686
Characteristics of Wet Season Precipitation Gradients on the Tibetan Plateau

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The Tibetan Plateau (TP) with its vast land mass and high elevation affects regional climate and weather. More importantly, the TP is the headwater of 9 major Asian rivers that provide fresh water for 1.65 billion people and many ecosystems, with wet season (May - September) precipitation being the most critical component of the fresh water. Using station observations and ERA-Interim reanalysis for 1979 - 2015, we show that wet season precipitation on the TP displays distinctive regional variations in vertical gradients (i.e., changes with elevation). The variations can be largely explained by considering those of vertically integrated moisture, convective available potential energy and condensation level. The increase of precipitation with elevation for all groups is predominantly the result of combined increasing CAPE and decreasing LCL with elevation that cancel out the decreasing vertically integrated moisture with elevation. Below 4000 m and excluding desert, precipitation change with elevation is mainly determined by the effects of energy and condensation level. Above 4000 m and in the desert, condensation level dominates over energy.

Wed_106_CR-3_701
Hydrogeochemical Characteristics of the Gandaki River Basin in Central Himalayas

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Hydrogeochemical Characteristics of the Gandaki River Basin of Central Himalayas was analyzed based on 165 river water samples taken during pre-monsoon, monsoon and post monsoon seasons from 55 sampling sites. The pH, EC and TDS were measured on site while major ions (Ca^{2+}, Mg^{2+}, K^+, Na^+, Cl^-, SO_4^{2-}, NO_3^-) and Si were analyzed in the laboratory following the standard procedures. The results revealed mildly alkaline pH with the pattern of average ionic dominance: $Ca^{2+}>Mg^{2+}>Na^+>K^+$ for cations and $HCO_3^- > SO_4^{2-} > Cl^- > NO_3^-$ for anions. Gibbs plot and ionic relations displayed the predominance of carbonates weathering processes which is supported by geochemical facies of water in Piper plot as Ca-HCO_3 (83.03%), mixed with Ca-Na-HCO_3 (12.73%) and Ca-Cl (4.24%). Strong spatiotemporal heterogeneity was observed between upstream and downstream segments in terms of distinct precipitation, meltwater, local geogenic sources and anthropogenic interferences. Suitability analysis of river water for drinking as well as irrigation purposes revealed that the river has mostly retained its natural water quality. However, increasing anthropogenic interferences could be serious threats for water quality and ecological integrity of the river basin in the future.

Wed_107_CR-3_863
Coordinated Regional Climate Downscaling Experiment (CORDEX) Activity in Asia

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CORDEX is a sub-project under WCRP (World Climate Research Program). From 2013, APN (Asian-Pacific Network for Global Change Study) funded a regional project to support the CORDEX devlopment in Asia. The objective of this joint CORDEX activity for Asia is to set up a more enhanced, open, efficient, and shared collaborative platform for climate downscaling groups in Asia. In last 4 years, re-grouped and re-designed 3 sub-domains for CORDEX Asia have been conducted, which are South Asia, East Asia and Southeast Asia. This project has set up the mechanism of sharing the data, experiences and technics on climate downscaling with all the CORDEX groups in Asia. This APN project has also supported setting up the ESGF nodes (RCM data sharing) in Asia by collaboration with WCRP-ESGF core group. The CORDEX Asian Empirical-Statistical Downscaling (ESD) group was established to support the application of climate downscaling products to end-users. The science-policy dialogues platform focusing on climate adaptation during the workshops was build up. This project has trained more than 130 young scientists from developing countries in Asia.

Wed_108_CR-3_864
Third Pole Environment (TPE) Programme: History, Achivements and Future Plan

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After the North and South Poles, the Third Pole is the highland core of Asia, and includes the Hindu-Kush, Karakorum, Himalayas, Tibetan Plateau and all the mountain ranges that surround it. This region provides the water resource and ecosystem services to billions of people in Asia. It is well accepted that the regional environmental change will have huge implications for millions of people living in the Third Pole region and downstream areas.
Formally Launched in 2009, the Third Pole Environment (TPE) program is to understand the mechanisms of the earth system multi-sphere (atmosphere, cryosphere, hydrosphere, lithosphere, biosphere and anthroposphere) interactions in the Third Pole region. This Poster will give brief introduction of history, achivement, onging activities and future plan of TPE.

Wed_109_CR-3_884
Thermal Behaviour of Debris Covered Glaciers, Western Himalaya

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Debris is one of the unavoidable components of Himalaya glaciers and having a critical role in glacier dynamics. Contrasting to normal ablation pattern over glaciers, debris covered glaciers of this region has experienced inverse ablation rate due to significant control of debris cover. Considering complex nature of debris materials, surface temperature becomes crucial factor to estimate thermal resistance of debris to calculate ablation under debris covered glacierized area. In this investigation, an attempt has made to quantify the thermal resistivity of supraglacial debris of Chandra basin by using heat flux method. The ablation and temperature (surface and subsurface) data was obtained from stake networks and T-data logger installed over glaciers in different altitude ranging from of 4100 to 5100 m.a.s.l. during year 2016-17. The Chandra basin has 702 km^2 glacierized areas and almost ~22% of this area is covered by debris with various thicknesses (10-150 cm). The major components of the debris in this basin are Quartz, Phyllite, Mica, Slate, Gneiss and feldspar. Observation revealed lower temperature at the debris surface and debris-ice interface during November to May and vice - versa during June to August. There is significant diurnal variation in thermal resistance of debris, higher during day than night may be caused by variation in vapour pressure in the debris layer under the saturated water pressure condition.

Wed_110_CR-3_908
Multi-sphere Hydrological Modeling over the Third Pole Region

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For improved predictive ability of regional water resources and water-related disasters in the Third Pole region (Tibetan Plateau and its surrounding area), in recent years, we aim at developing a multi-sphere hydrological modeling system that is applicable to the high-elevation environment.
The major achievements of our work can be summarized as follows.
(1) A distributed land surface hydrological model (WEB-DHM) was developed in 2009, which can consistently describe the exchanges of water, energy, and CO_2 fluxes in the land-atmosphere interactions at the basin scale. The model has been widely applied into dozens of watersheds in Asia, Africa, North America, and South America, to serve their integrated water resources management.
(2) Key cryosphere processes (e.g., snow, frozen soil, glacier) have been significantly improved under the framework of the distributed land surface hydrological model WEB-DHM, and the physically-improved multi-sphere (atmosphere-hydrosphere-cryosphere-biosphere) hydrological model have been extensively applied into cold river basins for addressing critical water issues in the Third Pole Region (e.g., Floods, Droughts, Lake area changes, and so on).

Wed_111_CR-3_1010
Spatio-temporal Analysis of Snowmelt in Tibet Plateau, Greenland and Antarctica

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As an important sensitive factor of global climate change, the surface snowmelt in Tibet Plateau, Greenland and Antarctica is a key factor impacting the free water resources in world. Understanding the spatio-temporal variation of snowmelt in the three areas is very important to change of water resources. Many studies for surface snowmelt have been conducted already, but most of them only focused on one of three areas. The climate conditions of Tibet Plateau, Greenland and Antarctica differ, and local characteristics are diverse within their regions as well. However, linkages through atmosphere, ocean and another climate system make local climate change in the three areas correlated. Therefore, in order to understand precisely the impact of snowmelt on Tibet Plateau, Greenland and Antarctica to water resources, the variation of snowmelt on the three areas should be studied as a whole system. Spaceborne earth observation provides an efficient means of measuring snowmelt dynamics in a long term. Therefore, based on spaceborne microwave radiometer datasets from 1978 to 2014 by using improved freeze-thaw detection algorithms and new proposed snowmelt index, we investigate the snowmelt change on Tibet Plateau, Greenland and Antarctica in this paper by addressing the following three questions: What is difference between the snowmelt change on the three areas? How is the snowmelt change on whole three areas ? What is relationship between the snowmelt change in on the three areas?

Wed_112_CR-3_1026
Relationship between Passive Microwave Remote Sensing and SWE in Chilean Andes

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Spaceborne passive microwave remote sensing (e.g. SSM/I, AMSR-E) and its relationship with physical properties of the snowpack has been widely studied in the last decade. Furthermore, AMSR-E measurements from Level 2A (L2A) product, are three times more sensitive than EASE-Grid for mountainous regions. In spite of this, advantages of passive microwaves remote sensing technologies are still unexplored for the Andean Region, such as the Upper Maipo basin (about 7562 km^2) located in the Central Andes of Chile. The aim of this study is to examine passive microwave brightness temperature (Tb) at 36.5 GHz from L2A (14 x 8 km), and its relationship with the snow water equivalent (SWE) in the Upper Maipo. For this, Tb observations were processed at basin and point scales, and a recent SWE reanalysis, with a spatial resolution of 0.05°, were used in this study. There is a high negative correlation (R=-0.80) between the minimum Tb (nighttime) of each hydrological year (2002/03 - 2011/12) with the concurrent SWE for basin scale, and significant higher coefficients of determination (R^2>0.75) for cells above ~3500 m.a.s.l. Nevertheless, there is a high spatial scattering between Tb and SWE due to different spatial scales of each product and other variables involved in the radiative transfer of the snowpack. Finally, it was shown that Tb observations are sensitive to SWE in the Central Andes of Chile, with a high empirical correlation during the accumulation period.

Wed_113_CR-3_1035
Interannual Variability of Snowfall Interception in Deciduous Nothofagus Forest

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Native nothofagus forests in the mid-latitude regions of the Andes Cordillera are notorious biodiversity hotspots, uniquely situated in the Southern Hemisphere such that they develop in snow-dominated reaches of this mountain range. Spanning a comparatively smaller surface area that similar ecosystems in the northern hemisphere, the interaction between vegetation and snow processes in this ecotone has received relatively little attention in the scientific literature. Here, we present the first systematic study of snow-vegetation interactions in the nothofagus forests of the Mediterranean Andes, focusing on the interplay between interception, climate and energy exchange in determining patterns of snow water equivalent variability. The Valle Hermoso experimental basin, located in Nevados de Chillan, was fitted with eight continuously measuring snow depth sensors, located at varying elevations, aspect and forest cover. Also, manual measurements of snow properties and canopy parameters as distance to canopy, leaf area index and total gap area were obtained during end-of winter and spring seasons during three years, 2015 through 2017. We find that interception implied a 22% - 32% reduction in snow accumulation in forested sites compared with clearings. Differences in snow duration were not statistically significant between forested and clearing sites, indicating that long-wave energy exchange is unable to overcome the shading induced by the forest canopy, even in deciduous forest.

Wed_115_CR-3_1189
Closing the Water Budget of the Wolverine Glacier Basin, Kenai Mountains, AK

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Water budgets of glacialized basins are difficult to constrain, despite the significant potential to undergo change as ice coverage decreases and rain becomes the dominant form of precipitation. Wolverine Glacier (WG) is a coastal mountain glacier in southcentral Alaska that has experienced 27 m w.e. a-1 mass loss since monitoring began in 1966. A basic water budget was calculated for the WG basin using meteorological, glacier surface mass balance, and stream discharge data from water years 2011 through 2017. The water budget was partitioned into on-glacier and off-glacier components in order to quantify how different hydrologic components contribute to annual stream discharge. Our results indicate the dominance of on-glacier fluxes and a large and temporally-variable residual that likely accounts for unmeasured variables. As the glacier continues to retreat, off-glacier components will become more important as new vegetation expands into previously ice-covered regions, altering timing of water delivery, storage, chemistry, and evapotranspiration. Understanding the water budget of glacierized basins will become increasingly important, as they provide delivery of freshwater and nutrients to downstream habitats. Water source (on versus off glacier), timing, and magnitude of basin runoff will be critical to predict impact on these diverse and economically significant ecosystems.

Wed_116_CR-3_1192
A Framework of Remote Sensing Products for Three Pole Studies

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The Three Poles play an important role in the earth system and global change studies. Much of research efforts have been made in studying the individual poles and their immediate and intermediate surroundings, while research results of three poles as non-separate entities have been less published. We present a framework of remote sensing product generation which will establish a collection of maps and databases to support integrated three poles studies. These products will geographically cover all three poles and have a range of cryospheric and hydrospheric attributes, including permafrost, sea ice, snow, albedo, ice sheets and glaciers (mass balance, ice flow speed etc.) and others. Existing products will be evaluated and updated considering their consistencies, errors, and spatial and temporal changes. New products will be generated to fill gaps or to improve the quality as new data and technology become available. Models can be used to guide observations and data collections, as well as to demonstrate the capability of uncertainty reduction of predictions. The remote sensing products are expected to support a focused set of science applications including the anomaly change trend of some local and regional glaciers in Tibet Plateau, change and instability of polar ice sheets vs. sea level changes, and global sea ice change trend.

Wed_117_CR-3_1280
Effects of Glacial Meltwater on pCO_2 and Air-sea CO_2 Flux in Greenland Fjord

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In order to clarify effects of glacial meltwater discharge on surface water carbonate chemistry and air-sea CO_2 flux, observational studies were carried out in the Bowdoin Fjord in northwestern Greenland during the summer of 2016 and 2017. Due to the freshwater supply from the melting glacier, surface water salinity was low down to 6.5 near the calving front of the glacier as compared to that in the outer side of the fjord (Salinity=30.5). The dissolved inorganic carbon (DIC) and total alkalinity (TA) in surface water were also low near the calving front while they were high in the outer side of the fjord. A relationship between salinity and DIC/TA in surface water indicates high correlations, suggesting that variations of DIC and TA in surface water are explained mainly by the dilution effect due to the discharge of the pure glacial meltwater. The partial pressure of CO_2 (pCO_2) in surface water estimated from DIC and TA was low, especially near the calving front down to 100 µatm as compared to that in the atmosphere (about 400 µatm). Therefore, the surface water affected by the glacial meltwater acted as a sink for atmospheric CO_2. Present results indicate that the discharge of glacial meltwater draws down the pCO_2 in surface water and enhances the air-to-sea CO_2 flux.

Wed_118_CR-3_1762
The Subglacial Recovery Lake: New Insights from Airborne Radar Data

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The Recovery Region, with its largest glacier Recovery Glacier, was identified as the biggest contributor to sea level rise from East Antarctica in future. Active subglacial lakes along the glacier suggest an active hydraulic network controlling the enhanced ice flow of Recovery Glacier. Four giant lakes (Lake A--D) were identified at the onset of the enhanced ice flow from satellite data. Their stability and potential hydraulic link to the downstream lakes is unknown. We conducted an extensive radar survey over these lakes in 2015/16, complementing radar data from the region from 2013/2014. We analyze this new radar data together and compare it to previously collected data from 2008/2009. Hence, we show that the two southern lakes, Lakes C and D do currently not contain significant amounts of water. Within the originally-proposed area of Lake A and B we identify one Lake/Swamp area and estimate its current area to be about 4320 km^2. Water leakage from the western boundary of this lake triggers the fastest enhanced ice flow branch of Recovery Glacier. We suggest that this Lake is part of the system of active subglacial lakes further downstream within the Recovery trough, affecting their multi-year cycle of filling and draining.

Wed_119_CR-3_2030
Water Balance and Thermal Regime of Lakes in Antarctic Oases

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Connection between thermal regime and water balance for lakes in the Antarctic oases was studied. The study based on observation on 18 lakes located in the King George Island, the Larsmann Hills and the Schirmaher oasis in summers 2011-2018. The role of evaporation in the seasonal water balance of the Antarctic lakes are discussed. The latent heat flux or the evaporation rate was evaluated from the lake model FLake simulations forced by standard meteorological observations. Also, the evaporation was estimated from the empirical equations. The sensitivity of the different methods to calculate evaporation, by the Dalton-type empirical equation and by the atmospheric surface layer block of the FLake model, was studied. For endorheic lakes, the sensitivity appeared to be large, up to 47% of the total seasonal water volume change, which assumes that FLake has the potential to be used in hydrological applications to calculate evaporation.

Wed_120_CR-3_2038
Consequences of a Human-induced Lake Drain in Antarctic Permafrost Environment

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Böeckella Lake, located in Hope Bay, northern Antarctic Peninsula, is a thermo-karstic lake surrounded by morainic deposits. The area has continuous permafrost with 80-100 m mean depth. This is a relevant location from the ecological point of view, containing one of the main Adelie penguin's colonies. The natural lake recharge came from glacial melting water, direct precipitation and underground circulation from the surrounding moraines. The lake discharge from the lake was mainly by underground flow in the northern sector to the Böeckella stream. The lake has been the source of fresh water for the Argentinean Esperanza Base for more than 30 years. In order to increase the volume of stored water in the lake, its level was artificially increased by means of construction of a wall in the natural drain sector. During the 2009-2010 austral summer the closure of the lake broke, due to permafrost melting, and in a few hours the lake water discharged to the sea. The lake was replaced by a dry surface containing five ponds corresponding to the main natural lake depocenters. In this work, the causes and consequences of the mentioned event are analyzed, including the effects in the vegetation and animal colonies around the lake. Broader effects discussed are those connected with exposure to the atmosphere of stored organic matter, which started an oxidation process and CO_2 transference to the air.

Wed_121_CR-3_2073
Contributions to High Asian Runoff from Glacier Ice and Seasonal Snow

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Realistic, accurate estimates of future availability and vulnerability of water resources across the High Asia region are not possible without a better understanding of the current hydrologic regime. The amount, timing and spatial patterns of snow and ice melt play key roles in providing water for downstream irrigation, hydropower generation, and general consumption. Separating the specific contribution of seasonal snow (renewable) versus glacier ice (non-renewable) melt is the main goal of the Contribution to High Asia Runoff from Ice and Snow (CHARIS) project that focuses on the Ganges, Brahmaputra, Indus, Amu Darya and Syr Darya basins. Our methodology involves the application of MODIS-derived remote sensing products to calculate separately daily melt from snow and glacier ice. Using an automated partitioning method, we generate daily maps of:
1) snow over glacier ice,
2) exposed glacier ice, and
3) snow over land.
These are inputs to a temperature index (TI) model that yields melt water volumes contributing to river flow. Here we present a high-level summary of our overall methodology as well as preliminary results for the five full CHARIS basins. The western regions of High Asia are heavily reliant on snow and ice melt sources for summer dry season flow when demand is at a peak (15-20% specifically from glacier ice melt) whereas monsoon rainfall dominates runoff during the summer period in the east (< 5% from glacier ice melt).

Wed_122_CR-3_2093
Intensity of Internal and External Water Cycle for the Tibetan Plateau

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Tibetan Plateau (TP) is referred as "Asian Water Tower" for the large amount of water storage and the wide-range influence on the downstream countries through a large network of rivers. In the water cycle, energy released from the phase change of water during precipitation is part of the elevated thermal effect on the weather and climate over the Northern Hemisphere. The study presents the relative contribution of internal and external water vapor to the precipitation based on basin-scale analysis over the TP. The result shows that the water vapor transportation varies depending on the circulation and terrain complexity. Overall, the atmosphere conveys about 60% of the water vapor condensation into the precipitation over the TP, whereas the local evapotranspiration contributes the rest 40%.
Noted the reanalyses produced excessive precipitation over the TP, we also compare the water cycles in several reanalyses. The result could give some light on the errors of the reproducing the water cycle processes in reanalyses and be helpful to improve the performance of the model over TP.

Wed_123_CR-3_2148
Oxygen Stable Isotope Variability on the Pine Island Glacier Ice Divide

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This work reports the δ18O variability in the upper 45 m of a 92 m firn-ice core recovered from the West Antarctic Ice Sheet in the 2008/09 austral summer. The core site, called Mount Johns, is at 79°55'S; 94°23'W, 2122 m a.s.l., the 12 m temperature is -33 °C. The core was melted in a continuous melter system and the first 300 samples analyzed by IRMS at Climatic Change Institute, University of Maine. Further, 1500 samples were measured by laser spectroscopy at the Centro Polar e Climático Isotopes Laboratory. The medium value for these 1800 samples is 36.4 ± 1.9‰, ranging from -42.7 to -30,3‰, covering about 105 years of accumulation (i.e., about 0.21 m in water equivalent per year). The isotopic profile recorded at Mount Johns shows a warming trend similar to the ones observed in others West Antarctic Ice Sheet sector (WAIS) since the 1990s. These changes are directly linked to variations in the regional atmospheric circulation, we discuss these stable isotope ratios in term of changes in the moisture source areas.

Wed_124_CR-3_2232
Permafrost as a Key Factor of River Runoff Generation in Central Yakutia, Russia

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The study aims in estimation of role of permafrost-related processes in runoff generation in continuous permafrost in Eastern Siberia. Terrain is elevated plain (100-500 m a.s.l.) with occasional uplands. The climate is cold and dry. Mean air temperature varies from -9 to -11°C, precipitation ranges from 270 to 310 mm/year. Main land cover types are slopes, uplands and thermokarst areas. Studied 18 river basins with areas 80 - 65400 km2 were classified into three groups with distinct behavior:
1) with flow larger 100 mm/year and variation coefficient (Cv) lower 0.4;
2) transitional;
3) with flow lower 24 mm/year and Cv larger 1.1.
Rivers of the 1st group do not freeze up to the bottom and do not dry. Rivers of 2nd group freeze up to the bottom in winter but flow every year in warm season. Rivers of 3rd group could be frozen and/or dry for the whole year. Precipitation does not explain spatial and temporal variability of flow. Land cover analysis showed that rivers with high and stable flow have less than 4% of the watershed area subject to thermokarst. More than a half of basin areas of rivers with low and unstable flow are occupied by thermokarst. Study showed that permafrost conditions could play a larger role in runoff generation than hydroclimatic factors.
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Wed_125_CR-3_2298
Enthalpy-based Distributed Melting Modelling of Two Glaciers on Tibetan Plateau

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Glacier-climate interaction and its spatial variability over the Tibetan Plateau is still poorly understood. We present a new distributed glacier mass balance model applied on two glaciers of the Tibetan Plateau: Parlung No. 4 Glacier, 11.7 km^2, a temperate-maritime glacier, and Zhadang Glacier, 2.0 km^2, a sub-continental glacier. Enthalpy, rather than temperature, is used in the energy budget equations to simplify the computation of latent heat fluxes from water phase changes and the movement of liquid water in the snow. Two novel methods are used to distribute near-surface air temperature and wind speed from a set of Automatic Weather Stations (AWS). Further, we apply a new method to discriminate between solid and liquid precipitation based on daily mean air temperature, relative humidity, and elevation. Model results are evaluated by in-situ mass balance observations of the Parlung No. 4 Glacier and remote sensing products.
Our aims are to:
i) develop a novel enthalpy-based model and test its performance on the distributed simulations of glacier mass balance and energy budget;
ii) compare the physical processes typical of the summer season on two different types of glaciers on the Tibetan Plateau;
iii) identify the key model sensitivities at both study sites.
We present the interplay of precipitation thresholds, albedo and net radiation at these different glaciers and discuss their implications for future mass balance modelling on the Tibetan Plateau.

Wed_126_CR-3_2301
Oxygen 17 Fractionation during Water Freezing in the Subglacial Lake Vostok

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Stable water isotope content is widely used in paleo-climatology, glaciology and hydrology as a proxy of the precipitation formation conditions, water origin etc. In particular, the concentration of heavy isotopes is applied in hydrology for mass-balance studies, to assess contribution of different water sources and other issues. Understanding the isotopic transformations of water during the hydrological cycle requires precise knowledge of the fractionation coefficients. While for deuterium and oxygen 18 these coefficients are known within satisfactory uncertainty, this is not the case for the oxygen 17 fractionation coefficients.
In this study, we use a unique opportunity provided by the hydrological system of Antarctic subglacial Lake Vostok, where the lake water is slowly frozen in equilibrium conditions to form the accreted lake ice underneath the Antarctic ice sheet. We have precisely measured the isotopic composition (including oxygen 17 concentration) in the accreted lake ice and water, which for the first time allowed us to directly obtain robust values of oxygen 17 fractionation coefficients during water freezing. It has been demonstrated that the ratio between 17O and 18O fractionation coefficients during water freezing differs significantly from the value known for evaporation and sublimation processes. We use these new findings to re-assess the characteristics of Lake Vostok water mass balance.

Wed_127_CR-3_2305
Impact of Topography on Snowfall, Assessed by a Dual-pol Radar

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In this contribution we analyse the impact of topography on snowfall, in terms of variability and microphysics, by interpreting polarimetric radar data. The former is related to the dynamics i.e. growth and decay analysis of the snowfall precipitation field, while the latter is related to the 3D hydrometeor classification in precipitation. The analysis focuses on the region around the Weissfluhgipfel (WFG) radar, in the vicinity of Davos, Switzerland.
The growth and decay analysis is based on the advection (semi-Lagrangian scheme) of the snowfall field and the comparison with the following actual measurement. Basically, we shift the precipitation field as if it was not affected by the local topography and then compare it with the measurement which obviously accounts for the micro-scale influence.
The applied hydrometeor classification is a semi-supervised approach, adapted to the technical specificities of a radar, capable of distinguishing between 9 different hydrometeor classes, among which rimed ice particles, aggregates (AG), crystals (CR) and vertical ice.
Links of both variability (snowfall growth) and microphysics (intense riming + AG/CR co-occurrence) observation to the local topography are assessed through multi-scale wavelet analysis. The analysis shows an interesting correspondence between the zones of snowfall growth on one side and the zones of relatively more intense riming and AG/CR co-occurrence on other side.

Wed_128_CR-3_2436
Arctic Precipitation: Observed Trends and Changes at Ny-Alesund, Svalbard

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Liquid and solid precipitation are important climatic variables in the Arctic that are expected to have undergone significant changes in the past and will undergo further changes due to the changing climate. However, only a few in situ data sets of these variables are currently available in the Arctic. Due to the long history of monitoring activities Ny-Alesund, Svalbard offers the possibility to generate a quality-controlled data set that may serve as a reference of precipitation for the analysis of the impact of a changing climate on the hydrological cycle, on cryospheric processes, on atmospheric chemistry, or on the properties of the soil. However, it is well known that standard gauges to measure precipitation can strongly be biased especially in the case of solid precipitation. We will present our recent work on the correction of observed precipitation in Ny-Alesund for arctic conditions and how these corrections modify the recorded data. Moreover, the uncorrected and corrected precipitation time series will be analyzed regarding parameters like total accumulation, number of events, modification of precipitation phase, and strength and frequency of extreme events.

Wed_129_CR-3_2449
Rapid Expansion of Glacial Lakes in the Central Himalayas

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Glacial lake outburst floods are among the most serious natural hazards in the Himalayas. Such floods are of high scientific and political importance because they exert trans-boundary impacts on bordering countries. The preparation of an updated inventory of glacial lakes and the analysis of their evolution are an important first step in assessment of hazards from glacial lake outbursts. Here, we report the spatiotemporal developments of the glacial lakes in the Poiqu River basin, a trans-boundary basin in the Central Himalayas, from 1976 to 2010 based on multi-temporal Landsat images. Studied glacial lakes are classified as glacierfed lakes and non-glacier-fed lakes according to their hydrologic connection to glacial watersheds. We found that lakes connected to glacial watersheds (glacier-fed lakes) significantly expanded from 1976 to 2010, whereas lakes not connected to glacial watersheds (non-glacier-fed lakes) remained stable during the same period. This contrast can be attributed to the impact of glaciers. Retreating glaciers not only supply meltwater to lakes but also leave space for them to expand. Compared with other regions of the Hindu Kush Himalayas (HKH), the lake area per glacier area in the Poiqu River basin was the highest. This observation might be attributed to the different climate regimes and glacier status along the HKH. The results presented in this study confirm the significant role of glacier retreat on the evolution of glacial lakes.

Wed_130_CR-3_2500
Persistent Pollutants in Kongsfjorden (Svalbard) Sea Water and Coastal Sediments

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Persistent organic pollutants (POPs) are chemicals with long-lifetime in the environment, and therefore have the potential to be transported over long distances.
As the environmental behaviour of POPs depends on complex interaction of many factors, any significant environmental alteration is likely to affect their distribution and fate; temperature as well as many other mechanisms are known to influence their distribution in the environment.
Sea ice, as well snow melting, can be well considered an indicator of climate change and it is also a significant POPs reservoir, and influences the contaminant dispersion through the sea ice trajectories.
Kongsfjorden is situated in the northern part of Spitsbergen island (Norwegian Arctic). Surface and depth water, as well as sediments, were collected at four sites during three sampling campaigns between June and September 2012, which means before, during and after ice and snow melting. The sampling stations were characterized by different degrees of glacial "runoff" and different anthropogenic impact.
The present investigation reveals the results of the analysis of the samples for their PAH, OCP and PCB content. Twelve of 16 studied PAHs, seven of 29 PCBs and four of 14 OCPs were determined in the sea waters. Total PAH, PCB and OCPs concentrations in the sea waters were from 50 to 500 ng/L, 5 to 30 ng/L and 10 to 150 ng/L respectively.

Wed_131_CR-3_2658
An Assessment of the MAR Regional Climate Model over High Mountain Asia

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The lack of ground measurements has made the use of remote sensing, atmospheric reanalysis and modelling tools over the High Mountain Asia (HMA) pivotal for understanding the impact of climate change on the hydrological cycle and on the cryosphere . Here, we show the results of the analysis of the assessment of the outputs of Modèle Atmosphérique Régionale (MAR) model RCM over the HMA region as part of the NASA-project '*Understanding and forecasting changes in High Mountain Asia snow hydrology via a novel Bayesian reanalysis and modeling approach*'.
We compared the MAR outputs with reanalysis data from ERA-Interim over the region bounded by the following coordinates: 66°E to 89°E and 21°N to 39°N. In particular, we evaluated the following parameters: surface pressure, snow depth, total cloud cover, two-meter temperature, wind speed, surface new solar radiation, skin temperature, surface sensible heat flux, and surface latent heat flux. The level of agreement between the RCM outputs and the reanalysis highly depend on the specific parameters. For example, in case of surface pressure the maximum percentage error is 13.24% while the 2-m air temperature has a maximum percentage error of 340.62%.
Lastly, we report results concerning the assessment of MAR surface albedo and surface temperature over the region through MODIS products. Next steps are to determine whether RCMs and reanalysis datasets are effective at capturing snow and snowmelt runoff processes.

Wed_132_CR-7_94
Multiyear Observations on Stable Isotopes of Surface Snow along CHINARE Transect

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Water stable isotopes from Antarctic surface snow have long been used to understand physical processes occurring in hydrologic cycle. In this study, a dataset including new measurements and previous observations is presented here for the determination of water isotopic composition along the traverse from Zhongshan Station to Dome A, East Antarctica. All 661 samples were collected in 7 field seasons by Chinese National Antarctica Research Expedition. The spatial distribution of $\delta^{18}O$ and δD show significantly decrease tendency from coastal to inland regions, with a latitudinal gradient of -2.42 ‰/degree(r^2=0.85), an altitudinal gradient of -1.02 ‰/100m (r^2=0.85), a temperature gradient of 0.95 ‰/℃(r^2=0.85). In addition, the accumulation, moisture source, transportation paths and post-depositional effects are also possible to have an association with spatial variability of water stable isotopic ratios. To disentangle the complicated influences on water isotopic composition of surface snow samples, the Hysplit trajectory model combining with MCIM model are used to calculate δ values during snowfall process. The results indicate that the moisture source of each region is completely different. Simulated experiments under various temperatures were conducted to reveal sublimation and isotopic exchanges between snow and air. This comparison suggests the isotopic composition of surface snow on coastal region may get a more impact by post-depositional processes than other regions.

Wed_133_CR-7_168
Ionic and Isotopic Variability in a Firn Core in the Antarctic Ice Sheet

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This work investigates the concentrations the major ionic and the stable isotope variability in a 42.92 m firn core (called IC-2) collected at 88°01´21.3"S, 82°04´21.7"W (2,621 m a.s.l.) in the West Antarctic sheet, during a Chilean-Brazilian traverse in the 2004/05 Austral summer. We subsampled the core using a continuous melting system at the Climate Change Institute (CCI, University of Maine, USA) under a Class 100 room conditions. This process generated 1,755 samples (about 40 samples by meter) for ionic chromatography determination Na^+, K^+, Mg^{2+}, Ca^{2+}, MS^- ($CH_3SO_3^-$), Cl^-, NO_3^- e SO_4^{2-}. We used a Picarro system (Wavelength-Scanned Cavity Ring Down Spectrometer, WS-CRDS) for determining the $\delta^{18}O$ and δD in each sample. The mean $\delta^{18}O$ is -46.45‰ (ranging from -50.77‰ to -41.40‰); while the mean δD is -369.68‰ (ranging from -408.18‰ to -323.85‰). The deuterium excess (d) varies from -5.84‰ to 9.23‰ (mean = 3.74‰). The first 800 samples (the upper 23 m) show a mean snow accumulation rate of 0.40 m y^{-1} in eq. H_2O, corresponding to about 32 years of precipitation. The ionic analysis of the first 200 samples show a strong predominance of H^+ (2.52 µEq L^{-1}), indirectly calculated through the ionic balance, indicating an acid contribution, and low concentrations of NO_3^- (68.52 ± 31.39 µg L^{-1}) (Lindau *et* al., 2016), probably resulting from post-depositional effects (glaze ice is observed in the area).

Wed_134_CR-7_312
Spatio-temporal Variations of Firn Properties on the Western Greenland Ice Sheet

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On the Greenland ice sheet a significant portion of surface melt percolates, refreezes, or is stored in porous firn. However thick (>5 m) ice layers in the ice sheet, now present at lower elevations, can seal off underlying porous firn, forcing meltwater to generate runoff instead of refreezing. Using five 20-26 m firn cores collected 40 to 100 km apart (1963 to 2355 m a.s.l.) in spring 2017 in addition to GPR data, automatic weather stations and ice temperature profiles, we investigate stratigraphy and spatio-temporal variation of firn properties in the Kangerlussuaq sector of the western Greenland ice sheet. We find significant spatial variability in firn properties on both large and small scales. For firn cores extracted at the lowest elevations thick (>1 m) ice lenses are present in the upper portion. The fraction of ice lenses for the upper 20 m of the cores ranged from 10% to 55%. A short core (5 m) drilled 16 m away from one of the longer cores shows significant small-scale variability in the distribution of ice lenses. Comparing 2017 core data to legacy data from 1989 at one drilling site shows a substantial increase in mean firn density and the size and number of ice lenses.

Wed_135_CR-7_412
Analysis of IceCube and QualitySpec Trek Derived Snow SSA Measured in Sodankylä

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Snow microstructure is important for microwave and optical remote sensing of snow. One parameter describing it is specific surface area (SSA), which is defined as volume to surface area ratio of snow grains. Several measurement methods are developed to measure it, including reflectance derived methods, as reflectance at NIR and SWIR wavelengths is sensitive to grain size and therefore SSA.
IceCube (A2 Photononic Sensors, France) is developed to SSA measurements and it measures hemispherical reflectance of 1310 nm laser from the snow sample surface. Method is presented to be accurate (10 % error) but it needs removal of the snow from snowpack during the sampling. Recently developed hand-held QualitySpec Trek (QST, ASD Inc., US) measures spectral reflectance of 350-2500 nm with direct contact to the object.
The collected data set includes measurements of vertical snow profile with IceCube and QST during five days between February and April 2017 in Sodankylä in Finland at research station of Finnish Meteorological Institute. Some of the IceCube samples were measured also with QST.
Preliminary results shows usability of QST for SSA observations, thus error seems to be larger than for IceCube. QST observations confirms also that reflectance measured from IceCube samples differs little from reflectance measured directly from the snowpack at the same height.

Wed_136_CR-7_552
Wind-packing of Snow in Antarctica

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A snowfall and subsequent drifting snow event were observed in Antarctica. The event was similar to recent wind tunnel experiments on wind-packing of snow and could therefore be used to compare wind-packing in Antarctica with those experiments. The results from Antarctica were similar to those from the wind tunnel. Drifting snow is necessary for wind-packing and the hardening is more efficient at wind-exposed surfaces than in wind-sheltered areas. The results show that the insight gained from the wind tunnel experiments are applicable in nature. Furthermore, it is demonstrated for the first time how fresh snow gets organized in Barchan dunes during subsequent drifting with significant increase in surface hardness at all locations on the dune. This quantitative analysis of surface and associated hardness change improves our understanding of Antarctic snow deposition.

Wed_137_CR-7_728
The Challenge of Automatic SWE Measurements in High Altitudes

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Information about the available snow water equivalent (SWE) of a snow pack is valuable for many applications including the validation of remote sensing data, flood forecasting, designing buildings for snow loads and assessing changes in snow water resources in mountain catchments. The measurements of SWE are particularly important in mountain regions where measuring winter precipitation by conventional rain gauges is problematic due to wind under-catch. Manual measurements of SWE are time consuming and therefore often only performed on monthly time-intervals. The automatic measurement of SWE in Alpine terrain is not reliable despite the fact that some commercially available devices are on the market. These devices often need either regular calibration, complicated post-processing or are limited by a maximum SWE they are able to measure.
We use a multi-year data set from the high alpine experimental site Weissfluhjoch at 2540 m asl, where the mean maximum measured snow depth is 240 cm. On this site SWE has been measured manually in a snow pit and simultaneously by a snow pillow, a snow scale, a ground penetrating radar and GPS receivers.
We assess the different SWE measurement methods during the typical seasonal evolution of the snow pack and compare it with state-of-the-art parameterization and modelling approaches.

Wed_138_CR-7_806
Synchronizing Borehole Depths to a Temperature Time Series

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The Plateau Detroit divides the warmer and moist west side from the colder and drier east side of the Antarctic Peninsula and has a very high deposition rate. We use hydrogen peroxide concentration with a high resolution sampling, averaging 36 samples/year from a 98m borehole as a robust seasonal marker. We found the hydrogen peroxide concentration to be well preserved in that high accumulation site. We have also estimated a daily temperature time series at the site by using daily records from four Antarctic Stations forming a polygon having the borehole in its interior. Both records, hydrogen peroxide concentration and daily temperature, follow the same seasonal variation, the passing of years, but in a different fashion. The former has a frequency scaling in relation to the former. As the temperature has a constant spectral contents we compensate the peroxide frequency scaling by a non--linear pairing transformation based on mathematical optimization, without human intervention. That pairing allows for the estimation of a relation of depth to time; a chronology for the borehole data chronology spanning from 01-Jan-1980 to 29-Dec-2010. The estimated borehole chronology suggests that at least the first 109.29m were accumulated within a time frame spanning a mere 30 years period. This points to a deposition rate of 2.7m(weq)/year, or 2.5 times the accumulation rate found at Gomez, further South.

Wed_139_CR-7_1228
Snow Microstructure Evolution in Presence of Mineral Dust

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Light absorbing impurities in snow such as black carbon or mineral dust are known to decrease snow albedo. This engenders several positive feedbacks generally leading to an acceleration of snow metamorphism. Though many studies have been focused on measuring, modeling and quantifying the radiative impact of light absorbing impurities in snow, only a few have been focused on the non-radiative impact of such impurities and especially on the impact of the presence of impurities directly on snow metamorphism.
In this study we present 'in vivo' X-ray tomography monitoring of snow microstructure containing mineral dust (desert sand with size distribution centered at 1 micron) under several conditions and especially under temperature gradient metamorphism. Snow microstructure evolution along with the change in the spatial distribution and exact location of the dust particles observed during such an experiment are especially relevant to understand metamorphism/impurities interplays for arctic snowpacks that frequently undergo high temperature gradient metamorphism.

Wed_140_CR-7_1323
Rapid Measurements of the Snow Surface Specific Area using the ASSSAP Instrument

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The surface specific area is a snow properties defined as the surface area of the air-ice interface per unit of mass. It has become in a decade a variable of choice to predict snow optical and microwave behavior and to quantitatively simulate snow metamorphism allowing significant progresses. The development of instruments and protocols to rapidly take accurate measurements of SSA in the field has greatly contributed to this emergence.
ASSSAP, the Alpine/Arctic/Antarctic Snow Specific Surface Area Profiler, is an instrument designed to measure profiles of SSA at 1 cm resolution in 1-2 meter long boreholes. It estimates SSA from measured snow reflectance at two wavelengths (1310 nm and 850 nm). It uses laser diodes and photodiodes as the sole optical elements and basic embedded electronics which is very robust and is able to operate at -40°C. It allows 4 modes of operation:
i) in-situ measurements of profiles in boreholes directly
ii) measurements on samples, in the field or in the lab, with a sampler holder compatible with IceCube
iii) in-situ nondestructive 1-2 meter long transects of SSA of the snow surface,
iv) measurements of profiles along 1-m snow cores in the lab.
The profiles and transects are measured in a matter of minutes, and are equivalent to about 100 independent measurements. Measurements on sample takes about 30 s. The accuracy has been shown to be around 15% in a well controlled experiment but our experience suggests that this depends on conditions.

Wed_141_CR-7_1372
Results from COST ES1404 Action for Harmonization of Snow Measurements in Europe

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The COST Action ES1404 entitled "A European network for a harmonized monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction" aims to enhance and harmonize the observations of European operational services and the snow research community. This presentation illustrates the results of the Action activities related to the harmonization of in situ snow observations and instrumentation, to establish quality-assured and comparable regional and global observation-based data on the variability of depth, structure and other physical properties of snow cover. Members of the Action designed a survey carried out among European institutions on measured snow parameters and applied instrumentation. It was answered by 125 groups from 38 European countries, providing a compilation of the measurement practices applied by different communities and in various environments and regions. In addition, the Action organized two field measurement campaigns in Turkey in March 2016 and in Iceland in February 2017 dedicated to the measurements of two essential snow variables, snow water equivalent (SWE) and snow depth (HS). The results contains the comparison of SWE and HS measurement techniques including error analysis aiming to develop instrument recommendations for range of environmental conditions. The Action included several workshops and Short term Scientific Missions that strengthened networking and co-operation among the participating countries.

Wed_142_CR-7_1471

Linking Area Extent of Melt to Changes in Snow and Firn in Greenland

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In recent years, increasing melt on the Greenland ice sheet (GrIS) has caused significant changes in percolation regimes in GrIS's firn. Aquifers have grown in some regions and impermeable ice slabs are forming in others, which directly affect runoff. The effects of refrozen melt water have been observed in firn cores, but continuous high-resolution data has not yet been available to document the nature of these changes as they happen. Very little is known about percolation depths, liquid water content, refreezing and seasonal mass fluxes, and vertical versus horizontal flow of water in areas where refrozen melt water is becoming the dominant regime in near-surface firn. To overcome this deficit and provide continuous data for model evaluations, we installed impulse radar systems at 3 locations in various glacier regimes: at the transition zone from accumulation to ablation (Swiss Camp), within the deep percolation regime where meltwater inputs are steadily increasing (Dye-2), and in the dry snow zone (Summit). For summer 2016, we compare monitored changes within snow and firn at these locations with spatial extent and duration of melt over the GrIS from remote sensing data. Such comparisons provide valuable information on water retention and percolation at certain glacier regimes of the GrIS. Linking the detail of in situ data at select sites with the spatial melt extent supports a more comprehensive interpretation of changes occurring within meltwater regimes over the GrIS.

Wed_143_CR-7_1496
Inter-comparison of Direct Observations of Snow Grain Size

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This work focuses on snow grain size data measured during the MicroSnow workshop held in March 2014 in Davos, Switzerland. The workshop was motivated by the recent development of new techniques to measure the snow microstructure, and aimed to quantify the differences among the various existing methods. The main objective of this study is to describe direct grain size measurements techniques, which include visual grain size estimation and calculation of the grain size from macro-photos using image processing software, and inter-compare the obtained measurements. Each of the inter-compared method applies a specific grain size metric, which is linked to the original application of the method: traditional visual estimations were developed by snow scientists to characterize the snowpack, e.g. for hydrological and avalanche forecast purposes. The Aoki grain size and the short skeleton metric are used to represent the optical properties of the snowpack when studying its interaction with the visible and near-infrared solar radiation. Finally, grain metrics that represent the dimension of the aggregated crystals are applied to represent the upper edge of grain size distribution in the simulation of the radiative transfer in the snow. In this work we assess differences between the used grain metrics, also in relation to other microstructure quantities such as specific surface area and optically equivalent grain size, evidencing merits and shortcomings of the applied methods.

Wed_144_CR-7_1515
Triple Surface Snow Isotopic Composition Records Metamorphism

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Water isotopic composition from ice core is a key proxy for past climate reconstructions. In particular, the longest climatic records from ice core are obtained from the low accumulation areas of the East Antarctic Plateau. Still, the low accumulation which enables long term records implies a longer exposure of the surface snow to the atmosphere, and thus, a more significant role of post-deposition processes. This limits the interpretation of isotopic composition from ice core records, specifically at short time scales.
Here, we compare series of surface snow isotopic composition from East Antarctica to grain index satelitte observations, highlighting that during intense summer metamorphism events, the climatic signal in the surface snow isotopic composition is erased. Still, we observe a signature of these events left in surface snow ^{17}O-excess. We compare the evolution of surface snow isotopic composition in between precipitation events to the first measurements of ^{17}O-excess in the vapour in Antarctica to estimate the mass balance and the associated fractionation. These results provide new applications for ^{17}O-excess as a tracer of post-deposition processes.

Wed_145_CR-7_1921
Seismic Evidence of Anisotropy in the Firn of the Amery Ice Shelf, Antarctica

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In order to better understand the relationship between the firn layer and the underlying ice, a seismic refraction experiment was carried out on the Amery Ice Shelf in Eastern Antarctica. The experiments aimed to reveal a detailed view of the subsurface structures and physical properties both in the direction of flow and perpendicular to it. Several surveys were carried out along and across the shear margin of two ice units that originated from the Lambert Glacier and the Mawson Escarpment Ice Stream. The firn is an important component of ice sheet dynamics, as the firns anisotropy provides an indication of where the ice is undergoing deformation.
Seismic velocity is directly related to mechanical properties. An increase of anisotropy leads to differences in seismic velocity when measured in different directions. We use this to determine the degree of anisotropy for the surveyed area. The seismic velocities is calculated by applying the 1D inversion algorithm of Wiechert-Herglotz-Bateman to the data. We find that the seismic velocity of the firn exhibits anisotropic behaviour in both surveyed directions:
The degree of anisotropy decreases in flow-direction (along the shear margin). Across the margin (across-flow) the degree of anisotropy is higher on the ice unit closer to the ice shelf boundary, with the highest values being found above the shear margin. The ice unit further away from the ice shelf boundary exhibits only small anisotropic behaviour.

Wed_146_CR-7_1929
Surface Mass Balance Changes during the Last Deglaciation

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Modeling the surface mass balance (SMB) from long-term climate simulations with Earth System Models (ESMs) remains a major challenge, specifically due to the required downscaling from coarse resolution atmospheric data onto high-resolution topographies.
We present a sophisticated energy balance model (EBM) to calculate and downscale the SMB for multi-millennial simulations. The EBM accounts for changes in the snow albedo due to varying snow properties (age, depth, melting and refreezing of water) and cloud cover, as well as key physical processes like percolation and refreezing of melt water. The atmospheric forcing is obtained from simulations with the Max-Planck Institute Earth System Model (MPI-ESM).
To evaluate its performance, the EBM is used to calculate the SMB based on the MPI-ESM CMIP6 historical simulation and shows good agreement with reconstructions from regional climate modeling (RACMO and MAR). To estimate the SMB changes throughout the last deglaciation, the EBM is forced with a transient simulation with MPI-ESM in coarse resolution. For the latter, MPI-ESM is run with prescribed ice sheets and topography and accounts for changes in river directions, ocean bathymetry and land sea mask due to the retreating ice sheets and isostatic adjustments. In this presentation, we not only depict the challenges of modeling the SMB from coarse resolution climate data but also highlight the benefits of using a sophisticated EBM for long-term simulations.

Wed_147_CR-7_2144
SNOWAVE: A Novel Radar Architecture for Snow Cover Monitoring

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Snow avalanches are a persistent risk for Alpine infrastructures. Cost-effective strategies for risk mitigation invariably require avalanche forecasting tools, based upon the knowledge of the physical parameters of the snow cover (depth, density, liquid water content, etc.). Currently, the most common measuring method for these parameters is the manual analysis of snow cover, through in-situ excavation of snow pits. This method, although time-consuming, is usually very accurate, but for safety reasons it cannot be applied when and where most needed (along critical slopes, under bad weather conditions).
To get around these constraints, systems based on microwave radars have been proposed. Such systems can deliver a rapid, non-destructive, and possibly automatic analysis of the snow structure. While very promising, standard radar architectures cannot deliver, without external aids, measures of the snow depth and physical parameters at the same time, thus strongly limiting the accuracy and applicability of this approach.
This paper presents a novel radar architecture, called SNOWAVE, capable of simultaneously measuring the propagation distance and wave speed, and possibly also attenuation in the medium. This way, snow depth, density, and possibly liquid water can be estimated at the same time. Experimental results from field test at elevations above 2500 m in the Italian Alps (Valle d'Aosta) are also presented to show the feasibility and potential of this innovative approach.

Wed_148_CR-7_2335
Topography and Snow Accumulation in the Marginal Zone of the Greenland Ice Sheet

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The marginal zone is of importance for accumulation and melt of the Greenland Ice Sheet. We measured snow water equivalent (SWE), snow depth and snow stratigraphy along a transect of 100 km length between Crawford Point 1 and Swiss Camp. The transect extended from the edge of the dry zone to the ablation facies (Benson, 1962). We measured the snow stratigraphy every 5 km by a high-resolution penetrometer (SnowMicroPen), besides to conventional snow pit records every 10 km. In addition, a ground-penetrating radar (GPR) system (1.3 GHz) was towed by skis to resolve the spatial variability of seasonal SWE along the transect. We found that end-of-winter SWE slightly decreased from about 500 mm to 400 mm along the transect. More surprisingly, we found quite large fluctuations of SWE between 350 and 550 mm along the GPR-record which we analyzed by variograms. We propose that point SWE-measurements in this zone should be complemented with GPR-measurements to arrive at unbiased SWE estimates and its spatial variation. In addition, SnowMicroPen measurements are found to be essential to keep track of the rather complex stratigraphy.

Wed_149_CR-7_2423
Sensitivity Experiments for the Impact of Metamorphism on Signals in Polar Snow

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Under prevailing temperature gradient metamorphism in near-surface snow, the ice matrix may undergo full recrystallization via sublimation-deposition cycles, with potential consequences for the formation of climatic signals in polar snowpacks. Polar field studies naturally focus on the in-situ evolution of snowpacks, thereby facing unavoidable difficulties of discerning controls from stratigraphy, spatial variability or the atmosphere. In contrast, ex-situ laboratory studies on metamorphism are able to reasonably constrain the forcing, but were hitherto limited to small, homogeneous samples which hinders an understanding of stratigraphic variability. To bridge the gap between typical lab and field conditions we developed a portable rack of macroscopic metamorphism boxes in which large (0.4 x 0.4 x 0.3 m^3), stratigraphically heterogeneous snow blocks can be subjected to different temperature forcing under sealed conditions after excavation from the natural snowpack. The experimental setup enables to conduct ex-situ sensitivity experiments for the evolution of signals (microstructure, isotopes, etc) if combined with an *a posteriori* comparison to the concurrent in-situ dynamics. In this contribution we present the design of the experiment and report preliminary results from the first deployment at Dome C during the Antarctic Summer 2017/2018 to detail the role of metamorphism within the project “Snow properties evolution in a changing climate in Antarctica”.

Wed_150_CR-7_2459
Post-depositional Changes of Delta O-18 in Snow

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The delta O-18 records of ice cores are used as a proxy for temperature fluctuations. However, the processes leading to the final embedding of the measured ratio of O-18 to O-16 are not completely understood: Snow with a certain delta O-18 is deposited on the ground during snowfall. Snow close to the surface is exposed to high temperature gradients and therefore metamorphoses by high water vapor fluxes. These fluxes alter the ratio of stable water isotopes after deposition. It has also been shown that advective fluxes (wind) contribute to a change in isotope ratio. Therefore, it is of high importance to better understand these processes for the interpretation of ice core data. We investigated these effects the upper snowpack at a field site above Davos Switzerland. From January to May 2017 we sampled weekly the top 20 cm of the snow. Monthly, we sampled the complete profile of delta O-18 with a vertical resolution of 6 cm. In parallel, we continuously measured the delta O-18 signal in the air. In addition, the full energy balance is known, as well as microstructural properties of the snow (density, SSA). First results showed that delta O-18 in the surface snow is generally lower than in the simultaneously measured air. This can be explained by equilibrium fractionation of the snow. Some events also showed an enrichment in the snow surface in absence of precipitation. We assume this is due to predominant fractionating sublimation.

Wed_151_CR-7_2464
Continuous Sensing of Snow Water Equivalent Using Natural Gamma Radiation

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Since 2014 we have been using the Campbell CS725, an instrument based on the attenuation of the natural gamma radiation of the soil to record the water equivalent of snow (SWE) at the Metsähovi Geodetic Research Station, Kirkkonummi, near Helsinki, Finland. The snow in this area is seasonal, the snow cover lasting 4 months with peak SWE of 100 mm on the average (1981-2010). The purpose of the measurements is to provide a correction for the attraction of the snow mass to the continuous record of variation in gravity of the superconducting gravimeter (SG) at the site. The SG has sensitivity better than 0.1 ppb for step-type changes in gravity, corresponding to the attraction of a water layer of 2 mm. However, the presence of the laboratory building modifies considerably the response as there is no snow under the SG and instead the snow stays on the roof producing a component in the direction opposite to the attraction of the snow on ground. We compare the record of the gamma device with manual sampling using the Korhonen-Melander snow sampler and meteorological observations, and discuss whether the gravity record in turn could be used to infer changes in SWE.

Wed_152_CR-8_92
New Organic Compounds in Ice Cores for Use in Paleoclimate Reconstruction

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Despite contributing up to 50% of atmospheric aerosol concentration (Jimenez et al., 2006), detection and understanding of organic compounds in ice cores is not as well developed as their inorganic counterparts. Two groups of organic compounds emitted from the marine and terrestrial biosphere, fatty acids and terpene secondary oxidation aerosols (SOAs), display characteristics suitable for ice core paleoclimate reconstruction. Emission rates depend on ambient atmospheric conditions and/or plant species, compounds survive long-distance transport in the atmosphere to high latitudes (Fu et al., 2013, Pokhrel et al, 2016, among others), and some compounds are shown to survive in ice layers up to 450 yrs old (Kawamura et al., 1996).
Contamination potential for these organic compounds, from various media used in the core drilling and analysis process, is quantified. A single, robust method of quantification for trace levels of compounds is developed, including preconcentration of samples and analysis with high resolution liquid chromatography - mass spectrometry (HPLC-MS).
These methods are finally used to test shallow snow and ice core samples representing both dominant terrestrial and marine aerosol input locations (identified using back-trajectory analysis). We present a first inventory of chemicals found in detectable amounts in locations including the Altai Mountains (Russia), Antarctic Peninsula, and sub-Antarctic island cores collected on the recent ACE Expedition.

Wed_153_CR-8_183
Urban Contamination in Andean Mountains near Santiago, Chile

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Santiago, Chile is a South American mega-city with very high levels of air pollution despite the introduction of contamination reduction measures in the past 20 years. The city relies heavily on glacier and snow melt for its supply of fresh water during spring and summer. However, it is unclear how much of an impact the Santiago pollution plume has on nearby high-altitude glaciers.
We have identified the major sources of air contamination, their chemical profiles, and their temporal evolution since 1998 through analysis of urban air filters. Since 2016 we have collected tree samples from the mountain slopes and firn cores from the glaciers on top of the mountains. The comparison of anthropogenic contaminant profiles in tree and firn samples allows an estimation of the altitudinal reach of the Santiago pollution plume.
Here we show contaminant measurements from several firn cores drilled in glaciers downwind from Santiago between 4000 and 5200 m. We show that urban contaminants do reach the highest peaks near Santiago. However, the very high recent summer temperatures produce surface melt that mixes with underlying layers in all but the highest mountain glacier above 5000 m. We therefore compare only this high´altitude firn core record with contaminant time series from urban air filters and mountain slope dendrochemistry measurements.

Wed_154_CR-8_201
Air-snow Transfer of Nitrate in Dronning Maud Land, East Antarctica

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The “Isotopic Constraints on Past Ozone Layer in Polar Ice” (ISOL-ICE) project is investigating the variability of past ultraviolet radiation and the ozone layer over the past 1000 years using a combination of ice cores, atmospheric measurements and numerical models. The ultraviolet radiation proxy, based on stable isotopes of nitrate, is being applied to a new 120 m ice core that was recovered from Dronning Maud Land, Antarctica in the 2016-17 Antarctic field season. During the field season, continuous atmospheric measurements of nitrogen oxides, turbulent flux and down-welling irradiance were also made. The first step to apply the new ultraviolet radiation proxy to the ice core record is to evaluate the regional air-snow transfer and post-depositional changes in nitrate and its stable isotopic composition. Here we present the nitrate isotopic composition and concentration of daily aerosol and surface snow from Dronning Maud Land throughout January 2017. We compare these observations to existing data sets in Terre Adelie and Dome C, another low accumulation region on the high elevation East Antarctic Ice Sheet.

Wed_156_CR-8_554
Modelling the Influence of Layering and Barometric Pumping on Firn Air Transport

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Ancient air trapped in ice core bubbles is a key source of information about past climate and atmospheric composition. Before air bubbles become isolated in ice, the atmospheric signal is altered in the firn column by transport processes such as advection and diffusion. However, the influence of impermeable layers and barometric pumping (driven by surface pressure variability) on firn air transport is not well understood and cannot be captured in conventional 1-dimensional firn air models. Here we present a 2-dimensional (2D) trace gas advection-diffusion-dispersion model that accounts for discontinuous horizontal layers of reduced permeability. We find that layering and barometric pumping individually yield too small a reduction in gravitational settling of trace gases to match observations. In contrast, a combination of both processes strongly supresses gravitational fractionation. Layering focuses airflows in the 2D model and thus amplifies the dispersive mixing resulting from barometric pumping. Hence, the representation of both factors is needed to match the well-known observation of an interval of zero gravitational settling in the lock-in zone. Moreover, we find robust scaling relationships between kinetic isotope fractionation of different noble gas isotope and elemental ratios. These relationships may be used to correct for kinetic fractionation in future high precision ice core studies.

Wed_157_CR-8_602
20th Century Dramatic Dust Influx to Antarctica & Associated Aridity in SSA

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Atmospheric dust is known to be a significant influence to the global climatic variability. The present study uses a high-resolution dust flux record of an ice core retrieved from the central Dronning Maud Land of East Antarctica to identify the factors controlling the dust flux during the last century (1905-2005 AD). The results show that there was a nearly 2.5 fold increase in the dust influx (from an average of 2.5 to 37.0 $mgm^{-2}yr^{-1}$) to the East Antarctica between the early to late 20th century, which was similar to the elevated dust fall over the West Antarctica. Such dramatic changes within the spatially distinct sites of Antarctica support the spacial extent and temporal consistency attributed to regional climate variability. A common source for the concomitant deposition of dust across the Antarctica appears to be the desert storms originating from the southern parts of the South America (SSA). The dust influx showed significant correlations with relative humidity, soil moisture, wind speed since the 1980's compared with air temperature of Patagonia region supporting their the dominant role in production and transport of dust in Southern south America. The significant correlation of dust flux in Antarctica with the anthropogenic forcing (from CCSM4/CMIP5 model) indicates significant impact of the anthropogenic factors on the dust deposition and vice versa in Antarctica.

Wed_158_CR-8_684
Environmental Signals from the Dust in a High Altitude Tropical Ice Core

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High altitude ice cores from Central Andes are sources of information on the mechanisms leading the intense mid-tropospheric warming of the last decades, and also provide high-resolution data for a better understanding of the tropical-polar teleconnexions. In order to provide a proxy for atmospheric circulation variability over tropical South America during the last century we determined the dust size and concentration from the Illimani ice core (Bolivian Andes) recovered in 1999 at 6300 m. The content of particles with diameters from 0,7 to 20 µm was measured using a Coulter Multisizer at the LGGE, Grenoble. The seasonal resolution register comprises the 1919 - 1998 period and is characterized by a pronounced increase in dust concentration during the austral winter (JJA), reaching concentrations up to 22 $\mu g\ g^{-1}$, which responds to the increase of westerly winds over the Bolivian Altiplano during the dry season. The mode of the size distribution also increases during JJA, sometimes ranging from 6 to 10 µm which indicates an important local dust contribution. The dust concentration record suggests a slight increasing tendency as higher peaks are more frequent in the most recent years of the time series. These highest dust peaks, however, do not correspond to the same years of the main El Niño events. Additional methods are needed to separate the local dust from the regional/continental environmental signal in order to obtain significant correlations with atmospheric parameters.

Wed_159_CR-8_766
Ultralight Ice Coring System

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Major incentives for developing lightweight drilling systems are: 1) cost reduction of field operations, and 2) accessibility of high altitude glaciers. A new approach to field operations is use of the Ultralight ice coring systems (ULICS), commercial flights and regular transportation in complex logistic regions instead of charter carriers. It also allows deployment of the ULICS equipment and ice cores to and out of a drilling site by small group of researchers. The minimal deployment total weight of the ULICS drilling equipment including power source, fuel and shelter is about 60 kg. Operation of the ULICS requires 2 persons.
The ULICS logistics based around small ice core diameter. This implementation relies on low power drilling equipment and lightweight high-efficiency power sources. Small diameter ice cores can be stored in portable freezers on a drill site or/and base camp.
The ULICS prototype is built at the Cryosphere Research Solutions LLC. Current model of the ULICS equipped with thermal-electric drill capable of producing 42 mm ice core. Estimated total deployment weight of the ULCS capable of recovering ice cores down to 150 m depth at about 4 m h^{-1} production drilling rate is 25 kg. It includes custom high altitude power generator. A suit of electro-thermal and electro-mechanical drills suitable for the same lightweight rig to recover ice cores of 15-82 mm in diameter in temperate and polar glaciers is currently in development.

Wed_160_CR-8_818
Shape and Size Constraints on Ice Core Dust Optical Properties

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Mineral dust aerosol influences global climate. It changes the radiative properties of the atmosphere through scattering and absorption of solar (shortwave) and terrestrial (longwave) radiation. Paleoclimate modeling studies generally assume a spherical shape for dust particles, an assumption that implies a significant deviation of light scattering from scattering properties of real particles. Through the novel **Single Particle Extinction and Scattering (SPES)** method applied to East Antarctic ice core samples from the last glacial period and the Holocene we were able to derive information about dust particle shapes, which is critical to determine the intrinsic optical properties of dust.
We consider the first-order impact of different sets of optical properties derived from SPES analyses on atmospheric dust Aerosol Optical Depth (AOD), based on dust mixing ratios simulated by the Community Earth System Model (CESM), tuned to match size and deposition at Dome C. We derive that the net effect of considering the actual variability in particle shape can contribute to changes in AOD up to ~10%. Actually, spatial and temporal variations in dust load, particle size distribution and shape combine together to determine the net effects on atmospheric extinction.
Given the importance of modeling light scattering by non-spherical particles, we recommend the use of the novel SPES technique to ice core analyses for an improved understanding of the role of dust in past climate change.

Wed_161_CR-8_819
Internal Bubble Pressures and Bubble Trapping Function in Ice Cores

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Ice core data recorded significant and abrupt past climate changes that are associated with large and rapid changes in atmospheric greenhouse gases, such as methane. Due to the gradual close-off of gas bubbles, even a stepwise increase in air composition is spread out into a ramp in the data, because laboratory analysis of gases only considers the mean of all bubbles across one sample. The convolution of the distribution of trapping ages with the history of atmospheric composition smears the measured gas record in each sample. We propose to use the shape of the trapping function derived from bubble-pressure-distribution and site characteristics to deconvolve bubble close-off history from the atmospheric composition record. Here, we first present a non-destructive method that can simultaneously estimate pressure-distribution in all bubbles in a sample, not only for present conditions, but back through time under varying atmospheric conditions. The method uses temperature-driven air-bubble-migration as a proxy for the pressure of individual bubbles and thus the gradual close-off of gas bubbles. We then use the pressure-distribution to model the gas trapping functions and to constrain the age distribution of air bubbles for past conditions, which are preserved at different depths. The trapping functions will help us to obtain a more accurate gas signal in the future that is less attenuated through the age distribution of the gas during the close-off process.

Wed_162_CR-8_868
Reconstruction of Early Holocene Environmental Conditions from the RICE Ice Core

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As part of the Roosevelt Island Climate Evolution (RICE) project, a deep ice core was drilled at Roosevelt Island, an ice rise situated at the north-eastern edge of the Ross Ice Shelf, a major drainage pathway of the marine based West Antarctic Ice Sheet (WAIS). The RICE records provide new insights into our understanding of the stability of the Ross Ice Shelf in a warming world and associated sea-level rise contributions of WAIS.
Here we present high precision (low to sub ppb concentrations) Ion Chromatography data from discrete samples of the RICE core representing the Early Holocene from ~ 10.5 ka BP to ~ 7.5 ka BP in high resolution (sub-annual to 3-5 years). This record permits the reconstruction of sea ice extent and marine primary production in the Ross Sea Polynya using MSA^- and the ratio of Na^+/SO_4^{2-} to estimate the frost flower contribution. Additionally atmospheric circulation patterns are reconstructed based on K^+, Mg^{2+} and NO_3^- , which have a continental source and are therefore related to katabatic winds, and Na^+, Cl^- and Ca^{2+} which are marine aerosols and are associated with cyclonic activity.
This detailed picture of Early Holocene atmospheric conditions, sea ice and marine productivity in the Ross Sea is used to link changing environmental conditions to the retreat of the Ross Ice Sheet/ Shelf, which may have been largely complete by the mid-Holocene as suggested by recent results from marine studies, combined with ice sheet modelling experiments.

Wed_163_CR-8_876
Spatiotemporal Variations of Monocarboxylic Acids in Snow in Eastern Antarctica

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The spatiotemporal distributions of formate and acetate in snow layers along a transect from Zhongshan Station to Dome A are presented here. In the snow pit samples, the concentrations varied between 0.47 ± 0.14 ng g−1 and 3.12 ± 4.24 ng g−1 for formate and between 5.31 ± 1.55 ng g−1 and 13.29 ± 4.64 ng g−1 for acetate. Spatially, the concentrations of both acids featured negative trends with increasing elevation and distance inland for the initial 600 km of the transect, which implies that marine sources from the coastal oceans dominate the acid supply. Different distribution styles of the acids in the interior section (600-1248 km) suggest that different source region and transporting mechanism may be responsible for the acid deposition in the interior regions. Seasonal variations in the amounts of acid in a coastal snow pit (29-A) indicate highervalues in the summer and lower amounts in thewinter. An enlarged source region and intensifiedproduction and transport mechanisms were primarily responsible for the higher values insummer. Lnger records from the interior snow pits (29-L and 29-M) indicate elevated values inthe 1970s and lower values in the 1980s and early 1990s. The increases in the mono-carboxylic acids since 1999 in snow pit 29-L and since 2005 in snow pit 29-M were temporally coincident with Chinese expedition activities in the area, suggesting that human activities were responsible for the increases in the acid load during recent decades.

Wed_164_CR-8_979
Last Interglacial Climate Variability at TALDICE, East Antarctica

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The last interglacial period, also known as Eemian (ca. 132-116 ka BP), characterized by global temperatures and sea level higher than today, has been found in six East Antarctic ice cores: Vostok, Taylor Dome, Dome F, EPICA Dome C, EPICA Dronning Maud Land and TALDICE. Here we present a new deuterium excess record obtained from the TALDICE ice core analysing the high-resolution samples obtained from the 5 cm cuttings between 1384 and 1414 m, corresponding to the 115-130 ka BP period. Talos Dome is a peripheral dome of East Antarctica, located in the Ross Sea sector where the TALDICE deep ice core (1620 m) has been retrieved. A previous study has shown that the $\delta^{18}O$ records obtained from the East Antarctic deep ice cores depict a quite homogeneous pattern during the present and last interglacials. However, regional differences, particularly important in the case of the TALDICE ice core, may be related to both elevation and regional atmospheric circulation changes. The north-western drainage area of Talos Dome is mostly below sea level (Wilkes Subglacial Basin) and could be more sensitive to climatic and sea level fluctuations than other sectors of the East Antarctic Ice Sheet, possibly causing a distinct $\delta^{18}O$ signal in the TALDICE ice core. The $\delta^{18}O$ and deuterium excess records will be compared to high resolution ssNa and nssCa records as well as to the EPICA Dome C isotopic records to understand the regional differences highlighted by this site.

Wed_165_CR-8_1024
Atmospheric Contamination on the Top of the Himalaya over the Last 500 Years

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The Dasuopu ice core was drilled in 1997 at 7200 m altitude in the Himalaya and provides the highest elevation ice core climate record ever obtained. Due to its high altitude this site has the potential to have a large spatial significance including long distant pollution from Europe and climatic signals influenced by the North Atlantic. This area is heavily influenced by the monsoon regime providing seasonally and highly variable annual snow accumulation rates. The preservation of annual layers in this low latitude - high altitude ice core has allowed for the possibility to obtain a detailed snow accumulation record that can be used to calculate chemical fluxes to the central Himalaya. Here we present the results of a new trace element record from the Dasuopu ice core spanning the period between 1500 and 1993 AD. Crustal enrichment factors are used to discriminate between the terrigenous and non-crustal contributions (e.g. anthropogenic origin). In this study we focus on two research topics:
(1) determine the onset and origin of the earliest anthropogenic contamination from trace elements at high elevation (7200 m) in the Himalaya and
(2) determine annual, intra-annual, and decadal variations of atmospheric trace element fluxes.

Wed_166_CR-8_1030
New Results from the Mineral Dust Record of the TALDICE Ice Core

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Thanks to ice cores the history of the dust cycle and its tight connections with the climatic system were reconstructed. Here we present an update of the current research on the atmospheric dust content of the TALDICE ice core (Ross Sea sector, East Antarctica). Thanks to the application of different techniques it was possible to characterize the mineral particles deposited in the last 150 kyr. New constraints on provenance during the last climatic cycle will be given, showing that peripheral and inner sites, well coupled during glacial stages, present differences in relation to the different atmospheric evolution occurred during the last climatic transition. In addition the analysis of the elemental composition of dust allowed preparing a first and preliminary inventory of the elemental depositional fluxes in Antarctica. This is the first step to define a robust reference to assess the current impact of human activities on Antarctic glaciochemistry. But important results were also achieved looking at the deep disturbed part of TALDICE. For the first time significant weathering affecting particles entrapped in deep ice was appreciated and quantified. Chemical and physical processes alter the composition and aggregation state of dust below a critical depth. Future projects focused on the retrieval of very ancient ice, will need to take into account such phenomena.

Wed_167_CR-8_1043
X-Ray Computed Tomography System for Analysis of Full Length Ice Cores

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A wide range of methods are available in studying ice cores nowadays. Nevertheless, most of them have a lot of disadvantages related to destruction of samples and their melting during the analyses, which may prevent the future sample processing.
X-ray computed tomography (CT) is a well-known and common method to obtain cross sectional images using X-Rays. The primary use of CT doesn't affect further processing of samples. Another advantage of method is its promptitude: the analysis cost is low, while the amount of information obtained is very substantial.
The shallow ice cores from Elbrus region were analyzed with the help of X-Ray CT scanner. RCT-180 scanner is able to scan cores with a length of 1 m and with a diameter of 10 cm. Scanner has a 150-180 µm spatial resolution and 100x100x1000 mm active area. For supporting the natural conditions of ice, a special cryothermos was created, which allows to keep the sample frozen during the survey.
This method permitted us to define the inner structure of full length ice cores, to find the core disturbances; to obtain a 3D pattern of ice density which appears to provide much more information than the visual observation of the axial ice cutting; to obtain 3D stratigraphy for subsequent correlation; to reveal and calculate the typical layers with contrast density and to find total porosity and individual pores.
The research was supported by the Russian Science Foundation (project no. 17-17-01270).

Wed_168_CR-8_1053
Leads/Lags between Antarctic Temperature and CO2 during the Last Deglaciation

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Here we accurately determine the phasing between East Antarctic temperature and atmospheric CO_2 variations during the last deglacial warming based on Antarctic ice core records. We build a stack of East Antarctic temperature variations by averaging the records from 4 ice cores (EPICA Dome C, Dome Fuji, EPICA Dronning Maud Land and Talos Dome), all accurately synchronized by volcanic event matching. We place this stack onto the WAIS Divide WD2014 age scale by synchronizing EPICA Dome C and WAIS Divide using volcanic event matching, which allows comparison with the high resolution CO_2 record from WAIS Divide. Since WAIS Divide is a high accumulation site, its air age scale, which has previously been determined by firn modeling, is more robust. Finally, we assess the CO_2 / Antarctic temperature phasing by determining four periods when their trends change abruptly.
We find that at the onset of the last deglaciation and at the onset of the Antarctic Cold Reversal (ACR) period CO_2 and Antarctic temperature are synchronous within a range of 210 years. Then CO_2 slightly leads by 165 ± 116 years at the end of the Antarctic Cold Reversal (ACR) period. Finally, Antarctic temperature significantly leads by 406 ± 200 years at the onset of the Holocene period. Our results further support the hypothesis of no convective zone at EPICA Dome C during the last deglaciation and the use of nitrogen-15 to infer the height of the diffusive zone.

Wed_169_CR-8_1261
Frequency of Large Volcanic Eruptions over the past 200,000 Years

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Volcanic eruptions are an important component of climate forcing, and an essential component of the long-term budget of carbon dioxide in the atmosphere. However, establishing the past frequency of eruptions of various magnitudes is challenging. The record of episodic sulfate deposition in Antarctic ice offers the opportunity to establish such frequencies for larger eruptions. Here, we build on recent work that has synchronised records back to 200,000 years, between the East Antarctic sites of Dome C, Dome Fuji and Vostok. In each record, and for each volcano, we can estimate the amount of sulfate deposited above the background across the years following an eruption; in some cases we will use electrical conductivity data as a surrogate for sulfate. For some eruptions we will measure the profile of mass independent fractionation of sulfur isotopes to establish whether the eruption reached the stratosphere. By using the three records together we can for the first time place uncertainty estimates on the amount of sulfate deposited for each eruption. We will then use (and test) methods we have developed for making an assessment, unbiassed by diffusion and thinning, of the frequency of eruptions above a given magnitude (in terms of sulfate deposition). Initial work suggests that the frequency of large eruptions is rather constant through the glacial and interglacial stages of two glacial cycles, but we hope to have fully tested this by the time of the meeting.

Wed_171_CR-8_1591
Taylor Glacier Ice Core Shows Dynamic Taylor Dome Accumulation during MIS 5-4

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A new ice core retrieved from the Taylor Glacier blue ice area (McMurdo Dry Valleys, Antarctica) contains a well-preserved record of the marine isotope stage (MIS) 5/4 transition. Methane and $\delta^{18}O_{atm}$ measurements were used to build a gas age scale for the new core by tying to preexisting, well-dated ice core records. Measurements of particle concentration (dust) were used similarly to build an ice age scale for the new core. The ice age-gas age difference approaches 10,000 years during MIS 4, suggesting very low precipitation or high wind scouring at the Taylor Glacier accumulation zone near Taylor Dome. Revised gas age and ice age models spanning the MIS 5/4 transition in the Taylor Dome ice core indicate a delta age = ~ 3000 years during MIS4, which in conjunction with the Taylor Glacier data implies large spatial gradients in accumulation and/or wind scouring across Taylor Dome. Curiously, the delta age relationship between Taylor Glacier and Taylor Dome at the MIS 5/4 transition is reversed relative to the last glacial maximum (Baggenstos, 2015). This could be due to changes in the trajectory of paleo storm tracks that effectively reversed spatial gradients in accumulation across Taylor Dome at different times in the past (e.g., Morse et al., 1998).

Wed_172_CR-8_1610
Aerosols Preserved in a High-accumulation Dome Ice Core, Southeast Greenland

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On May 2015, we drilled a 90.45 m ice core in a high accumulation area of the southeastern Greenland Ice Sheet (SE-Dome; 67.18°N, 36.37°W, 3170 m a.s.l.). Then we measure physical and chemical properties of the SE-Dome ice core. First, we propose a dating method based on matching the $\delta^{18}O$ variations between ice-core records and records simulated by isotope-enabled climate models. The close similarity between the $\delta^{18}O$ records from the ice core and models enables correlation and the production of a precise age scale, with an accuracy of a few months. Second, we measured the major ion fluxes, and obtained records of annual ion fluxes from 1957 to 2014. From 1970 to 2010, the trend of non-sea-salt SO_4^{2-} flux decreases, whereas that for NH_4^+ increases, tracking well with the anthropogenic SO_x and NH_3 emissions mainly from North America. The result suggests that these fluxes reflect histories of the anthropogenic SO_x and NH_3 emissions. In contrast, the decadal trend of NO_3^- flux differs from the decreasing trend of anthropogenic NO_x emissions. We also find a high average NO_3^- flux (1.13 mmol m^{-2} yr^{-1}) in the ice core, which suggests a negligible effect from post-depositional NO_3^- loss. Thus, the SE-Dome region is an excellent location for reconstructing nitrate fluxes. Over a decadal timescale, our NO_3^- flux record is similar to those from other ice cores in Greenland high-elevation sites, suggesting that NO_3^- concentrations records from these ice cores are reliable.

Wed_173_CR-8_1622
High Resolution East Antarctic Climate History: Ice Core Isotopic Records

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In Antarctica, a reasonable coverage of ice core records exist for the last couple of hundred years, however there is poor spatial coverage of high-resolution climate data over the last 2,000 years, particularly in East Antarctica (EA). Here, we use a range of high-resolution ice cores from EA covering the last 2,000 years from the IPICS array and PAGES Antarctic2k projects, and adding the recently recovered Aurora Basin North (ABN) ice core. The isotopic composition of snow and ice from this site is compared with other ice core isotopic records from Wilkes Land Coast and the transition region into the East Antarctic Plateau. The isotopic variability at ABN shows annual cycles in the upper 50 m and longer-term variability on decadal to centennial timescales. The ABN record shows no long-term isotopic trend over the ~2,700 year record length, whereas the isotopic ice core records used in EA regional composite show there is a long-term cooling over the last 2,000 years. A comparison of the preliminary dated ABN isotope record with the Law Dome (LD) isotopic record shows they are correlated, despite differences in site-specific influences. This correlation indicates a common climate signal at both sites and a spatial coherence in regional climate from coastal LD to the inland plateau of the ABN site. The isotopic records from ABN in conjunction with other EA high-resolution ice core records are used to explore, quantify and determine natural variability of key climate processes.

Wed_174_CR-8_1641
Development of a Method for the Measurement of $\delta^{15}NH_4$ in Ice Core Samples

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Ammonium (NH_4^+) in Antarctic ice samples originates mainly from marine biogenic sources and is transported in aerosol form to the ice sheet, where deposition takes place. Due to the coupling of the biogeochemical cycles of nitrogen and carbon and isotopic fractionation, a dependence of the isotopic signature ($\delta^{15}NH_4$) of ammonium and the efficiency of nutrient turnover in the surface ocean is expected.
The low concentration of NH_4^+ in ice and only small changes in the isotopic ratio make this analysis challenging. The basis of our new $\delta^{15}NH_4$ system is the well-established CFA system, which provides a continuous and contamination-free flow of meltwater containing ammonium. We are currently developing an interface that comprises four main steps: In a first step, the dissolved NH_4^+ is incorporated into an organic molecule and retained from the water phase by solid phase extraction. Secondly, this organic-N is quantitatively oxidized to N_2 using Cu/CuO as redox agents. In a third step, combustion side products (i.e. CO, CO_2 and H_2O) are separated using cryotraps and gas chromatography. In the last step, the $\delta^{15}N$ of the purified N_2 is determined by isotopic ratio mass spectrometry. We already constructed and tested the lines for step 2-4 and the oxidative conversion works well for a NH_3-gas-standard and N-containing organic compounds. The coupling towards the ammonium-N in the water phase will be our next step and we present the current status of the analytical system.

Wed_176_CR-8_1721
Lead in the European Atmosphere from the Ortles Ice Cores, the Last 7000 Years

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Four ice cores were recovered in 2011 from the Alto dell'Ortles glacier (3859 m, South Tyrol, Italy). This study presents the results from the analyses of the ice cores #1 (73.5 m) and #3 (74.83 m) performed at the University of Venice (Department of Environmental Sciences, Informatics and Statistics, DAIS) and at The Ohio State University (Byrd Polar and Climate Research Center, BPCRC) that cover the last 3000 and 7000 years, respectively. Core#1 and #3 were analyzed by Continuous Flow Analyses (CFA). The samples from core#1 were also measured discreetly. Trace elements analyses performed at DAIS were performed by using an ICP-MS (Agilent 7500), whereas those performed at the BPCRC by means of a ICP-SF-MS (Element2, Thermo).
The Ortles cores provide a detailed Lead contamination reconstruction of the past European atmosphere. A first Lead enrichment was found during the time of the Roman Empire, due to intense Lead and Silver mining activities. Afterwards Lead levels remained low except during the periods 1380- 1500 AD and 1580-1680 AD, revealing an enhancement in European Silver mining activities. The highest Lead levels were determined during the last century, starting in the 1920s, mostly caused by leaded gasoline.
A comparison with other local archives corroborates the results of the Ortles ice cores. A comprehensive comparison with most of the available lead reconstructions allows obtaining a worldwide perspective of atmospheric contamination from this toxic metal.

Wed_177_CR-8_1744
Coupled Production of CH_4, C_2H_6, and C_3H_8 in Dust-rich Greenland Ice

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Air enclosures in ice samples are the only archive to reconstruct atmospheric trace gases and their isotopic composition beyond the time where firn air samples are accessible. Reconstructing the past atmospheric composition accurately requires that the respective trace gas is neither consumed nor produced in the ice. It is known for decades, that CO_2 production in Greenland ice compromises the atmospheric signal, and for trace gases like N_2O and methyl chloride production in dust-rich sections in Antarctic ice cores has been documented. Here, we show that for dust-rich Greenland ice samples production of short chain hydrocarbons (CH_4, C_2H_6, and C_3H_8) occurs in significant amounts to compromise accurate reconstructions of these gases. We found that the production of these hydrocarbons is tightly coupled to the dust concentration in these samples, which support results from independent experiments at Oregon State Univ. (presentation J. Lee). We further observed that these three hydrocarbon homologous occur in a stoichiometric ratio of about 20:2:1 for CH_4, C_2H_6, and C_3H_8, respectively, pointing to a shared production process, e.g. from an organic precursor molecule. With experiments we show that the production proceeds via a rather slow process in the water phase. With regard to the CH_4 produced in glacial Greenland ice, published results require a careful reevaluation of methane stable isotope records and reconstructions of the interhemispheric gradient during the glacial.

Wed_178_CR-8_1750
Towards Gas Measurements in Extremely Thinned Ice: The Mid-IR Laser Spectrometer

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The European Partnership in Ice Core Sciences (EuroPICS) plans to drill an ice core extending over 1.5 million years (Myr), nearly doubling the time span of the existing greenhouse record. The oldest section from 1-1.5 Myr is expected to be close to the bedrock and, due to glacial flow, extremely thinned. Thus, a 10,000 year glacial/interglacial transition can be compressed in 1 m of ice, reducing the sample vertical extent to cm-scales and its volume to 1-2 ml air STP, respectively, for a targeted century-scale temporal resolution.
Within the ERC Advanced Grant "deepSlice" we aim to unlock such atmospheric archives in extremely thinned ice by developing a novel coupled semi-continuous sublimation extraction/laser spectroscopy system. Here we present the custom-made laser spectrometer developed in this context whose goal is to measure simultaneously CO_2, CH_4 and N_2O concentrations and $d^{13}C(CO_2)$ isotope ratios in such small air samples without destructing it. The analytical approach is based on direct absorption using two Quantum Cascade Lasers emitting at 4.34 and 7.87 µm, respectively. The main challenge stems from the small sample volume which requires high precision and stability from the electronic and optical part of the system as well as low reactivity from the inner surfaces of the absorption cell. Preliminary results will be presented which show that the high-precision targets can be reached for all four parameters.

Wed_179_CR-8_1760
Alpine Ice Cores Indicate Persistently High Nitrate and Ammonium Concentrations

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Ice cores from glaciers in the Alps are well suited to document the effects of anthropogenic emissions on air pollution, since they are surrounded by highly populated and industrialized countries in Europe. Concentration records of sulfate, nitrate and ammonium covering the 20th century until 2015 from Col du Dôme (4250 m asl, French Alps) and Colle Gnifetti (4450 m asl, Swiss Alps) ice cores agree well in absolute concentrations and temporal trends. Sulfate originating from fossil fuel combustion peaked in the 1970-80's with a significant downward trend in recent decades, in agreement with results from atmospheric chemical transport modelling. In contrast to sulfate, in the case of nitrate related to traffic and energy production and ammonium to agricultural emissions, ice core data show persistently high concentrations, which do not correspond to the model simulations and/or data from Western Europe in the European Monitoring and Evaluation Programme network. The good agreement for sulfate indicates that transport and atmospheric chemistry is well simulated by the models. The discrepancy for nitrate and ammonium suggests uncertainties in the emissions estimates, which in the case of nitrogen oxides are possibly related to underestimated car emissions. Such uncertainties are also relevant for ammonia released from fertilizer use and animal husbandry, since it plays a significant role in secondary aerosol formation with a corresponding negative effect on human health.

Wed_180_CR-8_1764
Stable Methane Isotope Data from Antarctic Ice Cores over DO7/8 and HS4

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Ice cores are used to reconstruct past changes in atmospheric methane. The stable isotopes of CH_4 enable us to draw conclusions about processes behind source and sink budget changes. By measuring δD(CH_4) on trapped gas from the NGRIP ice core over the period of Dansgaard-Oeschger (DO) events 7 and 8, Bock et al. (2010) ruled out the clathrate gun hypothesis, which calls upon the destabilization of marine CH_4 hydrates to explain the rapid CH_4 increases. However, for dust-rich Greenland ice there is evidence of excess CH_4 production during the melt extraction that calls into question previous results (presentations of J. Schmitt and J. E. Lee). New δD measurements using Antarctic ice from TALDICE show that the NGRIP δD values are likely affected by this process. The TALDICE δD values show only small variability over the two DO events, indicating no dramatic change in the CH_4 source mix. The new data are therefore still clearly in disagreement with the clathrate gun theory. Furthermore, we present new δD and $\delta^{13}C$ data from the WAIS core covering a short-lived CH_4 excursion documented in the very high resolution CH_4 data by Rhodes et al. (2015) in Heinrich Stadial 4. Such rapid CH_4 excursions leave a characteristic imprint in both $\delta^{13}C$, from firn diffusion, and for δD, due to atmospheric imbalance effects, which are visible in our record. After accounting for these transient effects, the remaining isotope signal suggests a heavier source mix for $\delta^{13}C$, but little changes for δD.

Wed_181_CR-8_1775
Towards Gas Measurements in Extremely Thinned Ice: Sublimation Extraction

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The European Partnership in Ice Core Sciences (EuroPICS) plans to drill an ice core extending over 1.5 Ma, nearly doubling the time span of the existing greenhouse record and covering the time period of the Mid Pleistocene Transition. The oldest section from 1-1.5 Ma is expected to be close to the bedrock and, due to glacial flow, extremely thinned. A century-scale temporal resolution reduces the sample vertical extent to cm-scales containing only 1-2 ml air STP.
Within the ERC Advanced Grant deepSlice project we aim to unlock such atmospheric archives by developing a novel coupled semi-continuous sublimation extraction/laser spectroscopy system. Sublimation is the only dry method that extracts 100% of all gas species avoiding potential issues with gas fractionation which showed to cause offsets between ice cores/different extraction methods. With the target of reducing ice waste and increase sample throughput, the development of our new gas extraction method aims at vertically sublimating an ice-core section with subsequent collecting the released air via cryo trapping in a dip tube. However, there remain several challenges: the heat transport within the sample could induce subsurface melting or lateral sublimation, inhomogeneity in the ice or of the radiation field delivering the heat could create inhomogeneity in the sublimation front, and CO_2 adsorption, a problem to all CO_2 extraction methods, particularly affects isotope ratios.

Wed_182_CR-8_1874
Growth of Air-hydrate Crystals in the Bottom Section of the EPICA DC Ice Core

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The post-formation growth (Ostwald ripening) of air-hydrate crystals occurs in polar ice sheets due to the diffusion of air molecules through the ice matrix from smaller crystals towards larger ones. The earlier studies of this phenomenon in the Vostok (Tsyganova & Lipenkov, 2011) and Dome Fuji (Uchida et al., 2011) ice cores have shown that, in the lower sections of these cores, the mean radii of hydrates increase linearly with their age. The existence of a robust linear relationship between the size and age of air hydrates in very old polar ice would imply that the geometrical properties of hydrate crystals could be used for estimating the age of ice in the near bottom layers of the ice sheets.
Here we present the preliminary results of a study of geometrical properties of air hydrates in the bottom section of the EDC ice core. The size distribution and the number concentration of hydrate crystals were measured at 23 depth levels between 2802 and 3258 m using the ice samples from the low-temperature collection stored in the undersnow cave at Concordia station. Experimentally determined correlation between the size and age of hydrates in the well dated part of the 800-kyr old EDC ice core is used to constrain the parameters of a mathematical model which describes the growth of air hydrates below the bubble-to-hydrate transition (Salamatin et al., 2003). The implication of the new data for dating the disturbed section of the old meteoric ice at Vostok is discussed.

Wed_183_CR-8_2007
An Extended Climate Archive from the Eastern Alps: The Mt Ortles Ice Cores

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Oxygen and hydrogen stable isotopes have been widely used in ice cores as temperature proxies for the last 50 years. In autumn 2011 three ice cores were drilled down to bedrock on the Alto dell'Ortles glacier (3859 m a.s.l.), Eastern Alps. The ice core chronology, based on lead-210 in the upper part and on carbon-14 measurements for the lower part, proves that this record is the most extended of the Eastern Alps and the second most extended ice core record from the Alpine region, extending beyond 7000 years BP. The long temporal extension of this glacial archive represents a unique opportunity to study the climate of the past in this part of the Alps, normally characterized by low-elevation shallow glaciers, whose have been particularly affected by the recent warming. The oxygen and hydrogen isotopic composition was measured for all the three cores and an isotope stacked record was created combining the three isotope profiles. The composite record shows a long warm period during the mid holocene, followed by a decreasing trend extending until the roman period. A large negative anomaly is present during the last 500 years, suggesting the presence of a colder period which was interrupted only in the XX century.

Wed_184_CR-8_2290
Dating the Aurora Basin North Ice Core with Seasonal Cycles and Volcanic Ties

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The aim of the Aurora Basin North (ABN) ice core drilling project is to provide a 2000 year climate record from a data sparse area of East Antarctica to add to the IPICS 2k array and the PAGES Antarctica2k projects. ABN is a 303m ice core from East Antarctica, 550km inland and about half way between the coastal Law Dome and inland Dome C sites. A combination of annual layer counting and volcanic ties was used to date the record. Annual peaks were found in many trace chemical species (e.g. sodium, sulphate, hydrogen peroxide) and other species such as black carbon. The ABN chronology has been established to ~1900 years before present (or 120 CE) through a combination of volcanic synchronisation to DSS and WAIS divide ice cores and layer counting between volcanic events. Below this date, annual layer counting becomes less certain and volcanic ties alone indicate the record extends to around 2700 years before present. We will present an update of the ABN results on this timescale for reconstructed temperatures, snow accumulation rate and aerosol concentrations, including volcanic sulphate concentrations and fluxes. These will be compared to other Antarctic ice core records.

Wed_185_CR-8_2304
Trace Elements Variation between ~600kyr BP to 800 kyr BP in Dome C Ice Core

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Geochemical proxies were measured from the EPICA (European Project for Ice Coring in Antarctica) Dome C ice core, covering a period from ~600 kyr BP to ~800 kyr BP, by inductively coupled plasma sector field mass spectrometry (ICP-SFMS) and ion chromatography (IC) for trace elements and platinum group elements (PGEs) and major ions, respectively. The main trend of trace element and other proxy concentrations match well defined insoluble dust concentration profile. It shows that mineral dust was the dominant source of trace elements to East Antarctica whatever the period. PGE concentrations show a less difference between glacial and interglacial periods in comparison with crustal enriched elements and concentration ratios of Ir and Pt indicate that PGEs in Antarctica may be originated from non-crustal sources. These geochemical evidence suggest that changes in relative contribution of crustal dust, volcanic and extraterrestrial input to Antarctic ice during period from ~600 kyr BP to ~800 kyr BP.

Wed_186_CR-8_2479
Synchronizing Ice Core Chronologies: An Automated Method

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Ice cores can be synchronised to other ice cores, to paleoclimate records such as speleothems or marine sediment cores, or to orbital targets using time series measurements. Here, as part of the IceChrono dating model (Parrenin et al., 2015), we propose a generalized Bayesian synchronisation method, built on minimising residuals between series using a parallelized Metropolis-Hastings simulation. We test the method on the gas phase synchronisation of the Epica Dome C and Fletcher Ice cores to the WAIS Divide chronology, using measurements of CH 4.
Our method is able to precisely synchronise the two gas records, introducing a level of reproducibility and objectivity unavailable in manual time series synchronisation methods. To guarantee an accurate estimate of chronological uncertainty, we present the chronologies we produce as ensembles of all the scenarios accepted in the Metropolis-Hastings simulation.

Wed_187_CR-8_2490

Astronomical Dating: An Inverse Method Applied to Antarctic Ice Cores

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The chronologies of deep polar ice cores are vital to our understanding of how climate variables and atmospheric greenhouse gas concentrations interacted over the last 800,000 years. The most recent chronologies of the deepest Antarctc ice cores rely in part on proxies that follow the periodicities of Earth´s insolation, defined by its rotational and orbital parameters, which can be calculated well into the past. The processes that link astronomical forcings to their proxies, on the other hand, operate on multiple spatial and temporal scales and are not well-modeled; and the synchronization between a proxy and its target can be ambiguous. This translates into significant uncertainty in astronomical chronologies. Since the alignment of proxies with their astronomical targets is typically performed visually, this uncertainty is difficult to formally address.
Here, we pose the synchronization of ice cores to astronomical targets as an inverse problem, based on the calculation of a cost function that takes into account residuals between proxy and target series. We compare the chronologies and respective uncertainties calculated by this method, using Total Air Content and d18O and dO2/N2 isotopic ratios as tracers of Earth´s astronomical parameters, to visual astronomical chronologies, and compare the results of the chronologies we produce using each proxy-target pair. We discuss the implications of our work for ice core chronologies, focusing on robust uncertainty estimation.

Wed_188_CR-8_2517
Exploring a New Proxy for Reconstructing Past Wind Strength in Ellsworth Land

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In the last decade, several efforts have been carried to assess the causes of the current rapid recent warming measured on West Antarctica and Antarctic Peninsula. The increase in wind strength and shifts in atmospheric circulation patterns have shown to play a key role in driving the advection of warm air parcels from mid-latitudes to high-latitudes. Winds are also responsible for driving basal and surface melting in the ice shelves by enhancing the removal of surface snow and by promoting the upwelling of deep warm water, respectively. All these combined have shown to produce substantial effects on environmental parameters, such as: sea surface temperatures, sea ice extension, air surface temperatures and precipitation.
Even though winds are fundamental components of the climatic system, there is a lack of past records which can help to understand completely the role that winds have played through time and the significance of the recent warming observed in the region.
In this work, we present a record of marine diatoms preserved in an intermediate depth ice core retrieved from the Amundsen Sea region. We explore the diatom abundance, species assemblages and total particulate content to assess the capacity of this record to represent the local/regional variability in wind strength and circulation patterns that influence the onshore northerly winds.

Wed_189_CR-8_2538
New Insights into Disruptions in the Isotopic Record from the Ronne Ice Shelf

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In the last decades, the Filchner-Ronne Ice Shelf (FRIS) region has emerged as an important location to study the response of the West Antarctic Ice Sheets and Ice Shelves in a climate change context. Recent research has highlighted the sensitivity of this region to current changes in the climatic conditions.
Instrumental records from this remote region are short and scarce. However, several environmental parameters can be interpreted from proxy records preserved in ice cores. These records can be used to produce accurate chronologies of variations in meteorological parameters.
Even though these records are valuable tools to interpret climate trends, the lack of consistent annual cycles in a suite of chemical species, as well as the presence of peaks within the year cycle, can induce to errors in the production of age models. Identifying the presence of these peaks and understanding the processes behind their development is essential to improve chronologies.
In this work, we use meteorological observations, atmospheric reanalysis and stable water isotopes from firn cores to explore the relation between atmospheric processes and disruptions observed in the stable water isotope records from FRIS and inland. We assess the ability of synoptic scale events, atmospheric circulation modes and post-depositional processes to generate these sporadic patterns in the isotopic profiles.

Wed_190_CR-8_2575
The Fidelity of Ice Core Methane Records: Excess Methane in Greenland Ice Cores

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Ice core records of methane are important indicators of the response of terrestrial biogeochemical cycles. Recent work has greatly enhanced the detail and precision in these records (*Bock et al*, 2010; *Chappellaz et al*, 2013; *Baumgartner et al*, 2014*; Rhodes et al*, 2015), but their interpretation depends on the fidelity of ice cores in preserving the paleo-atmospheric record. We review published data sets and observe enrichments of methane in samples from Greenland that are correlated with the abundance of dust in the ice (*Steffenson*, 1997). This is the first evidence of a non-atmospheric source of methane, which we refer to as ``excess´´ methane, affecting ice core samples absent of melt layers or interaction with basal material. Enrichments of ~6 µmol CH_4 per mol Ca^{2+} in the sample were observed which corresponds to enrichments in concentration of several 10's of ppb and depletions in δD-CH_4 up to ~10‰. The release or production of excess methane was directly measured using a multiple melt-refreeze strategy on samples from the GISP2 Greenland Summit ice core and the North Greenland NEEM ice core. Enrichments of methane were absent in Antarctic ice core samples. Of several potential mechanisms, our results are best explained by the desorption of methane from dust particles during sample analysis. Ultimately, excess methane may be adsorbed onto the dust particles from emissions at the dust source or during methanogenesis within the ice sheet.

Wed_191_CR-8_2579
Water Isotope Characterization of the Styx Glacier Ice Core in East Antarctica

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The Antarctic Northern Victoria Land (NVL) is adjacent to the Ross Sea and comprises the Transantarctic Mountains, which has both coastal and plateau environmental conditions. The Styx Glacier (SG) is a well-known snow accumulation area with least influence of katabatic wind in NVL and forms a flat surface with an area of >100 km^2. The field campaign, a part of the Korean Antarctic research program, drilled a 210.5 m long ice core, two firn cores and a snow pit at SG during the 2014-2015 summer season. Stable water isotopes (d^{18}O, d^{17}O and dD) were determined for the uppermost 100 meters of the ice core, a firn core and the snow pit. The results were combined with a firn densification model, electrical conductivity measurement data and firn air composition to establish a reliable depth-age relationship and to reconstruct the snow accumulation rate. The results were compared with ice core data from neighboring sites, and the spatial variability at the regional scale was investigated. Statistical approaches were applied to the water isotope time series to derive climate implications and to capture potential teleconnection influence.

Wed_192_CR-8_2589
Assessment of Fractionation Processes and Corrections for Noble Gas Thermometry

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Noble gas thermometry allows reconstruction of mean ocean temperature (MOT) from the noble gas content (dKr/N_2, dXe/N_2, and dXe/Kr) of glacial ice. This technique promises to advance our understanding of past ocean heat uptake, potentially narrowing uncertainty in the climate sensitivity. Since the development of this proxy, improvements in the method have allowed for MOT reconstruction with unprecedented precision. These significant steps forward require us to reassess the validity and sensitivity of the assumptions that go into MOT reconstruction. Investigations into mechanisms that decouple the MOT proxies from ocean heat content have primarily focused on processes that affect atmospheric noble gas content. Here we address processes that decouple the noble gas content of air in glacial ice from the atmosphere and assess associated uncertainties in the interpretation of MOT records. We analyze modern firn air and surface ice samples from multiple polar sites, in which the air is young enough that the true atmospheric composition is known. We then correct them for gravitational, thermal and kinetic fractionation and gas loss using several approaches. From this we identify a 'best method' for correction of dKr/N_2, dXe/N_2, and dXe/Kr data, and quantify systematic error in MOT records. Using these findings we make suggestions for identifying and correcting potential bias in future MOT campaigns.

Wed_193_CR-8_1670
Radiocarbon Analyses of Dissolved Organic Carbon (DOC) in Glacier Ice

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Dating of ice cores from high alpine glaciers is challenging due to limited glacier thickness, the complex bedrock geometry and strong annual layer thinning. Water Insoluble Organic Carbon (WIOC) in glacier ice has been used for radiocarbon dating for years [1]. However, this method is limited by the WIOC concentrations. The majority of the carbon containing matter in snow and ice is present as Dissolved Organic Carbon (DOC) [2]. To investigate the suitability of $DO^{14}C$ dating, we develop a high efficient and low blank extraction system. Ice samples after cutting are further cleaned and melted under helium gas. WIOC is separated by filtration and Inorganic Carbon (IC) is removed via acidifying and degassing. The remaining DOC in the solution is oxidized by UV lamps. Produced CO_2 is quantified after cryogenic trapping and sampled to glass vials for ^{14}C analyses. This setup has been applied to the Fiescherhorn ice core to estimate anthropogenic contribution of DOC to Alpine glaciers and establish the time boundary of applying $DO^{14}C$ as a dating tool.

[1] Uglietti, C. et al (2016). Radiocarbon dating of glacier ice: overview, optimisation, validation and potential. *The Cryosphere*, *10*(6), 3091-3105.
[2] M. Legrand, et al., Major 20th century changes of the content and chemical speciation of organic carbon archived in Alpine ice cores: Implications for the long term change of organic aerosol over Europe, *Journal of Geophysical Research: Atmospheres* 118.9 (2013): 3879-3890.

Wed_194_EN-1_47
Ecological Architecture of Antarctica: The Usage of Natural Building Materials

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Today the building industry has a strong impetus and emphasis on sustainable building, a prevalent aspect of which is the use of endemic materials. What happens when the natural resources available aren't what is traditionally considered usable or practical? Throughout the history of building practices in Antarctica there has been minimal employment of materials that are available despite knowledge of the vernacular architectural practices in Arctic regions. Snow and ice are an ever present consideration in Antarctica, whether the structure interacts with drifting snow defensively, treating it as a negative quality, an impediment, or embraces it as a secondary building material and potential insulator. Recent research stations, in contrast to many of the older stations and huts, have been more cognizant of what impact they have on natural surroundings, which has resulted in more creative and innovative structures, including one proposal which incorporates snow as a primary building material. An interpretive-historical study of the building practices provides cultural and environmental insight into why this practice wasn't utilized more as well as the successes and failures.

Wed_195_EN-1_568
Vulnerability of Ice-free Landscapes to Human Impacts, East Antarctica

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Ice-free regions of Antarctica make up only a fraction of the continent but are often the site of intensive activity associated with national programs and tourism. Without the protection of permanent snow and ice, poorly consolidated sediments and fragile polar landforms can be easily damaged by human activities. Natural recovery processes in the cold, dry climate are slow and poorly understood. Over the next three years a collaborative project between Geoscience Australia, the Australian Antarctic Division, University of Waikato (NZ), and University of Canberra (AUS) will build on existing systematic methods for assessing impact and recovery. Through field experiments and geomorphology mapping, we will identify chemical and physical processes in ice-free landscapes that may influence recovery from disturbance. Preliminary remote landform mapping in the Vestfold Hills, East Antarctica, shows a variety of potentially vulnerable sedimentary landforms between bedrock outcrops, including muddy drainage depressions, ephemeral ponds, raised beaches, boulder fields, dunes, moraines, and gently undulating water-lain deposits. Salt efflorescence on the surface is common, particularly in areas with deeper sedimentary cover. We will link verified landform mapping to soil characteristics to reveal patterns of vulnerability, aid planning and environmental management practices and provide geoscience information to inform predictions of future environmental changes.

Wed_196_EN-1_1626
Penguin Guano Play an Important Role in Antarctic Coast Ecosystem

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Study shows that chlorophyll-a concentration in 80% area of the South Ocean is lower than 0.5 ug/l. Incubation experiment has proven that addition of guano with high content of nutrients may efficiently improve production of chlorophyll.
In south bay of the Doumer island CTD cast data show fluorescent of Chlorophyll-a in upper 100m water are about 0.14-3.64 ug/l with average of 1.09 ug/l, and has a observable peak in depth about 20-30m with temperature of 0.97 ℃. POC/PON in the bay is about 4.0-6.4 with average of 5.0, is remarkably lower than FOODBANCS C/N (5.9-7.8) in east of the Anvers Island and Palmer LTER C/N (7.1-9.2) in the west Antarctic Peninsula continent shelf, which may be explained that some guano debris are brought into the bay by melt water, redistributed by tidal current and deposit in coastal zone. These additional input of undissolved particulate guano reduce value of observed C/N, with a trend of being smaller in coast than inner bya. Moreover, low concentrations of coprostanol and cholesterol were detected in the surface sediments in center of the bay, which may be an another indicators for penguin guano effect in this area.
It can be inferred that in circumstance of global warming, the historical penguin excretion may release much more nutrients to coastal water. These will stimulate phytoplankton community production and benefit krill resource in the Antarctic. More attentions should be exerted to understand guano role in ecosystem nutrient cycling.

Wed_197_EN-1_1686
Diversity and Ecophysiology of *Vaucheria* sp. in Coastal Tidal Flats of Svalbard

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The Arctic coastal zone, especially tidal flats, is the one most dynamic polar landscapes due to frequent disturbance of the seabed and random recolonization of very unstable fine sediment in temporary system of channels and lagoons. One of such unique areas where these processes occur is the Adventfjorden tidal flat, located near Longyearbyen (Svalbard). The microphytobenthos carpet covers large area of several hectares there, contributing thus significantly to tidal flat stabilization. The xanthophycean microalga *Vaucheria* sp. (Vaucheriaceae, Xanthophyceae) is dominant there in various habitats ranging from freshwater to marine ones. In summer seasons 2016 and 2017, we focused on morphological and molecular diversity of *Vaucheria* sp. with respect to the area distribution, impact of tide and distance from sea on *Vaucheria* sp. distribution together with chemical and physical water and sediment ecological properties. These ecological studies were followed by measurements of photosynthetic activity of *Vaucheria* sp. in two types of microcosmos as well *in situ* using variable chlorophyll fluorescence and gasometry approaches.

Wed_198_EN-1_1844
Mapping the North East Greenland Coastal Zone with Satellite Imagery

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The North East Greenland National Park holds unique and sensitive ecosystems as well as archaeological heritage sites, but is also generally well protected. Nevertheless, the Greenland Sea hydrocarbon licensing round in 2011 opened up a new chapter in hydrocarbon exploration in Greenland, as previously all exploration licenses concerned the west coast of Greenland. Our current knowledge concerning the very remote North East Greenland coastal areas is generally poor, and thus decision support concerning emergency prevention, preparedness and response is challenged.
This project seeks to improve our understanding of the coastal response to oil spill, by assessing potential oil spill sensitivity and resilience. The project utilizes a remote sensing approach to map and characterize the coastal zone in NE Greenland. We develop a Digital Elevation Model covering more than 60.000km^2 at a resolution of 8 meters, based on ArcticDEM data. In areas of special interest we further derive intertidal zones, shallow water bathymetry and shoreline types based on both commercial VHR imagery and publically available satellite imagery. Validation will be carried out by in situ measurements.
The obtained knowledge will enable the provision of informed planning and decision making by a number of stakeholders, to support a sustainable management regarding exploration and potential exploitation of hydrocarbon resources.

Wed_199_EN-1_1971
Svalbard Paraglacial Coasts - Processes, Landforms and the Future

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Here we summarize the results of several coastal research projects carried out along paraglacial coasts of Svalbard during the last decade. We reconstruct the post-Little Ice Age evolution of coasts in western, central and southern Spitsbergen to illustrate the highly variable coastal zone responses to both paraglacial and periglacial landscape transformation associated with deglaciation and intensification of extreme geomorphological processes.
Our results show the key role of climate changes in controlling sediment fluxes from deglaciated valleys to the coastal zone. Under intervals characterized by a warming climate, retreating local ice masses, a shortened sea-ice seasons and melting permafrost most of studied coastal systems rapidly responded to excess of freshly released sediments and experienced significant geomorphological changes leading to development of new coastal landforms (e.g. spits) and progradation of existing forms (e.g beach-ridge plains, barriers). We discuss our new data in the context of previously published coastal evolution studies from Svalbard. The study highlights the need for a greater understanding of the controls on High Arctic coastal systems, especially given the potential for future accelerated climate warming, decay of sea-ice, storminess and sea-level rise and rapidly growing human impact on Arctic resources and strategic locations.
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Wed_200_EN-1_2137
Need for an Integrated Research & Development Center in the Alaskan High Arctic

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Arctic research stations provide critical monitoring and research on climate change for conditions and trends in the Arctic to address gaps in observations, infrastructure, resource management, and emergency response. This poster proposes development of a permanent integrated US High Arctic Research Center (USHARC) at Oliktok Point, Alaska; taking advantage of assets and infrastructure, controlled airspace, an active UAS program and local partnerships.
To address research and technology gaps, USHARC is envisioned to partner stakeholders from science, safety and security to develop comprehensive solutions. The Station will offer year-round use, logistic support, access to varied ecological settings, and support testing of technologies; such as autonomous platforms, energy microgrids, and sensors.
We propose that USHARC, combined with Toolik Field Station and Barrow Environmental Observatory, will form a US network of Arctic Stations. Unique assets from USHARC include: access via land, sea and air; coastal and terrestrial ecologies; controlled airspaces (land and ocean); logistic support; atmospheric observations; connections to Barrow and Toolik; fiber-optic communications; and a University of Alaska Fairbanks UAS Test Facility with an airstrip and hangar.
World-class Arctic research requires year-round access and facilities. A US High Arctic Station network enables monitoring to better study, predict and understand impacts that affect people, communities and planet.

Wed_201_EN-1_2253
The Coastal Community Ocean Observers (C2O2) Program

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The Coastal Community Ocean Observers (C2O2) is a coastal science program that seeks to build a framework for long-term community-driven monitoring of oceanic environmental variables. The C2O2 program combines cost-efficient means for communities to collect environmental data with local interest, promoting mutually beneficial partnerships and relationships for collecting and sharing information. The C2O2 program is currently active in six Alaskan communities which have uniquely different climates, cultures, and local concerns, and represents different oceans and environments. Using simple-to-operate conductivity-depth-salinity-fluorescence profilers, each of these communities have generated a large number of hydrographic data on weekly to months intervals which is reported in near-real time via a web interface and immediately available on the project website for community residents, scientists and stakeholders. Here we describe the C2O2 program, focusing on data collection, results and a build-out plan for the future, including implementation of a biological sampling component. C2O2 is interfacing with similar efforts in Canada, the Mosquito Fleet to the south and the CROW project to the north, to create a linked network of ocean observations in a south-to-north framework to detect and describe climate change propagation and its impact on local ecosystems and communities. We also discuss the possibility to build this to an pan-Arctic wide network of community observations.

Wed_202_EN-1_2345
Assessment of the vulnerability of Populated Sections of the Arctic Coast

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The area of the Arctic is inhabited by about 4 million people, and the vast majority of human activity in the Arctic is focused on the coast. Over the past three decades, the climate of the Arctic has changed significantly, the observed increase in temperature was twice as high as the global average. Modern arctic coastal landscapes are strongly modified by accelerated degradation of permafrost and its thawing threatens the existing infrastructure, increases inflow of deglaciation sediments resulting in shallowing of the port basins and extending the period of open water, causing the increase of wave activity and hence increase of the erosive activity. **The warming in the Arctic led to the acceleration and intensification of geomorphological processes that directly affect safety of human activities.** Most available Arctic literature focuses on coastal zone changes in the local context. However, there is no overall assessment of the vulnerability of the Arctic coast in a global context, which focuses on threats for settlements at the arctic coast. **The aim of our study** is to show the variability of the vulnerability of human settlements (over 500 inhabitants) along the Arctic coastline and to identify the most endangered areas. Evaluation will be made using indexing methods, e.g. the adapted CVI index and remote sensing tools based on the ArcGIS geographic information system.

Wed_203_OS-2_233
Long-term Mesoscale Variability of Sea-ice Primary Production in the Baltic Sea

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We describe a new ocean-sea ice-biogeochemical model, apply it to the Bothnian Bay in the northern Baltic Sea for the time period 1991-2007 and provide the first long-term mesoscale estimates of modelled sea-ice primary production in the northern Baltic Sea. After comparing the available physical and biogeochemical observations with the model results, we show the modelled spatial and temporal variability in sea-ice physical and biogeochemical properties and consider the main factors limiting ice algal primary production. Sea-ice permeability in the studied area was low compared with the polar oceans, which appeared to be a major reason for the generally low primary production rates. Although the sea ice was less saline in the northernmost parts of the basin, these parts were characterized by sea ice with a larger amount of habitable space, higher levels of photosynthetically active radiation and increased macronutrient availability near the coast, which favoured higher algal growth rates. Other parts of the southern central basin were mostly co-limited by less favourable light conditions and lower seawater macronutrient concentrations than in the coastal zones. Although a change towards milder winters was previously detected on a half-century timescale and could partly be seen here, analysis of the temporal evolution of sea-ice biogeochemical properties showed no significant trends over time, though these properties were characterized by large interannual variability.

Wed_204_OS-2_291
Biogeochemistry of Antarctic Landfast Sea Ice and the Potential Role of Biofilm

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Antarctic landfast sea ice exhibits a large accumulation of biomass in the bottom few centimetres of the ice, with particulate organic carbon (POC) concentrations reaching 2 mmol C l^{-1} during spring bloom. Surprisingly, fieldwork measurements (Adélie Land 2011, McMurdo Sound 2012, Prydz Bay 2015) of nitrate and phosphate concentrations show a simultaneous increase, with values exceeding those of underlying seawater, suggesting an intense remineralisation process within the ice. Such co-evolution of nutrients and biomass contradicts the classical view of nutrient consumption during the growth period followed by remineralisation after the bloom peak, and suggests an intense supply of N from the underlying water column. Results of a NPZD-model indicates that a second nutrient pool, in addition to the brine pool, is essential to successfully model and reproduce field observations. The presence of a biofilm attached to the ice walls could act as a water-retaining substrate forming microenvironments with chemical gradients within the brine channels. The effect of biofilm on nitrogen dynamics (concentration and isotopic composition) in sea ice will be discussed as well as potential implications for other parameters (phosphate, carbon, oxygen).

Wed_205_OS-2_358
Cycling of DMS,P in Early-winter Ross Sea Pack Ice during the PIPERS Project

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Ice-algal assemblages are known to produce large amounts of the sulfur metabolite dimethylsulfoniopropionate (DMSP), and of its volatile degradation product dimethylsulfide (DMS). Sea ice DMS is subsequently released to the polar ocean and atmosphere where it plays multiple roles in the sulfur and carbon cycle, and mediates the formation of climate cooling sulfate aerosols. Previous studies on the cycling of DMS and DMSP in sea ice are mostly limited to the spring/summer seasons, when large blooms develop in first-year ice due to favourable light and nutrient regimes. In contrast, there is much less information about the production of DMS,P during the first stages of sea ice formation in light-limited early-winter. In this context, we carried out measurements of sea ice DMS,P concentrations in the Ross Sea from April until June 2017 in the framework of the PIPERS project. Multiple ice types and thicknesses were sampled (frazil, unconsolidated and consolidated pancakes, first-year ice) together with sea water and brine, in contrasted areas (marginal ice zones, polynyas, and the central Ross sea pack ice). Sea ice DMS,P concentrations (maximum of 95 and 492 nM) were lower than values typically reported during ice-algal spring blooms, but still significantly higher than sea water concentrations at the time of sampling (maximum of 3 and 15 nM). We present and discuss working hypotheses to explain how these concentrations build up through the different steps of sea ice formation.

Wed_206_OS-2_378
Biogeochemistry at the Early Stages of Ice Tormation: Insights from PIPERS

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The PIPERS cruise on N. B. Palmer into the early winter Ross Sea took place between April and June 2017. PIPERS was a unique opportunity to investigate biogeochemistry of pack ice during early stages of ice formation. We will present insights of the dynamics of sympagic microalgae assemblages, nutrients, particulate organic carbon and 2 potent greenhouse gases (carbon dioxide and nitrous oxide) during early ice growth.
The comparison of CO_2 fluxes over consolidated and unconsolidated ice show that
1) sea ice acts as a source of CO_2 for the atmosphere
2) largest fluxes occur at the earliest sea ice growth stages (i.e. frazil ice, unconsolidated grey ice, pancake ice). Large fluxes are due to ongoing active rejection of impurities, high porosity of highly saline/high temperature young ice, and the absence of snow. Overall, snow appears to restrict CO_2 fluxes. In some cases, fluxes over snow appears to be nil or even opposite to fluxes over bare ice. Therefore, while snow is often view as a transient buffer for air-ice gases fluxes, the role of snow appears to be more complicated. The new measurements of CO_2 fluxes over young ice carried out during PIPERS potentially allow to complete a budget of CO_2 fluxes over Antarctic pack ice by filling a significant gap.

Wed_208_OS-2_464
What is the Impact of Environmental Stress in Sea Ice Brine on DMS Production?

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Sea ice plays a significant role in the production and exchanges of climate active gases between the ocean and the atmosphere. One of them, dimethylsulfide (DMS), is a key precursor of sulfate aerosols which affect the Earth radiation balance. DMS is produced by the degradation of two algal metabolites: dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO), typically found in very high concentrations in sea ice. Little is known about the factors driving the production of these metabolites in the stressing environmental conditions (in particular low temperatures and high salinities) of the brine inclusions in which sea ice algae thrive. In this context, we present results from axenic cultures experiments with two emblematic species of the sea ice ecosystem: the diatom *Fragilariopsis cylindrus*, and the prymnesiophyte *Phaeocystis antarctica*. We discuss changes in DMSP and DMSO concentrations in response to gradual shifts in salinity and temperature corresponding to the typical seasonal variability encountered by these algae in the brine inclusions (from 4°C and salinity of 34, up to -18°C and salinity of 250). Globally, we show how the outcomes of this research project should improve our understanding and modelling capabilities of the sea ice sulfur cycle.

Wed_209_OS-2_506
Differing Drivers of Taxonomic versus Trophic Structure in Arctic Communities

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In the Arctic Ocean, continuing sea ice decline will increase light availability, but enhanced stratification could decrease nutrient supply to the euphotic zone. To investigate the effects of these factors on the taxonomic and trophic structure of planktonic and sympagic communities, we sampled environmental parameters, protists from the under-ice layer and from the water column, zooplankton and under-ice fauna in the Central Arctic Ocean in summer 2012. We identified
1) a 'Shelf-influenced' regime with decaying sea ice, high silicate concentrations and low NO_xconcentrations;
2) a 'Polar' regime with low silicate concentrations and low NO_x concentrations; and
3) an 'Atlantic' regime with low silicate concentrations and high NO_x concentrations. Across all communities, the taxonomic composition primarily responded to the variability of sea ice properties.
The trophic structure of the communities, however, responded to NO_x concentrations. The most heterotrophic taxa significantly dominated in the two NO_x-depleted regimes compared to the NO_x-rich Atlantic regime. The different nutrient regimes were also associated with differences in ecosystem functions, such as primary production, secondary production and carbon export. While changing sea ice properties will affect taxonomic composition at multiple size classes, low nutrient concentrations in the upper Arctic Ocean may induce a more heterotrophic food web, affecting key ecosystem functions.

Wed_210_OS-2_708
Community Structure and Photoacclimation in Antarctic Ice-algal Communities

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Microalgal composition and production was studied in sea ice in Ryder Bay, West-Antarctic Peninsula. This area is the fastest warming oceanic region on earth; between 1979-2007 a 41% decline relative to the mean was recorded. The impact on biogeochemical cycles is poorly described. Development of microalgal sea-ice communities was studied from winter to summer during three years. Over the course of spring, modest surface communities developed with a Haptophyte pigment signature. Major biomass increases were recorded in the bottom layers and reached a maximum concentration of more than 700 µg Chl-a l^{-1} in December 2014. Early in the season, a mixed algal community inhabited the bottom layer. From November onwards, diatoms dominated the bottom community, with *Nitzschia, Fragillariopsis and Berkeley sp.* as the main species. The maximum electron transfer rate (ETR) as determined by PAM-fluorescence at the bottom gradually increased over spring from 3 to 30. At the same time, the slope of ETR versus irradiance (alfa) increased. The value for light saturation (I_k) hardly changed and measured ca. 150µmol photons m^{-2} s^{-1}. Data will also be presented on production rates determined by means of C13-incorporation and on 13C-POC as a tracer for sea-ice microalgae. These times series provide unique patterns of community structure and photoacclimation in Antarctic landfast ice-algal communities.

Wed_211_OS-2_811
DMSP Production and Conversion in Antarctic Landfast Ice

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The marginal sea-ice zone around Antarctica is one of largest sources of the climate-active gas dimethylsulphide (DMS). DMS is produced from the enzymatic cleavage of dimethylsulphoniopropionate (DMSP), which is an osmolyte and cryoprotectant in ice algae. The release of DMS occurs mainly during springtime when the ice melts, but may also happen during brine drainage and when gap-layer communities form and mix with melting snow.
Here we present the development of DMSP in sea ice of Ryder Bay, during two winter seasons: 2014 and 2016. Ice cores were taken as soon as ice was accessible and continued until spring. Over winter only total and GF/F-filtered DMS+DMSP was taken, together with HPLC pigments for algal biomass analyses and classification. Bottom-ice concentrations of total DMS+DMSP increased during September/October and reached maximum values in December: generally between 1 and 2µM, but a maximum of 15µM was observed in December 2014. Internal- and surface communities regularly developed earlier in the season and also reaching µM-levels of DMS(P). High DMS(P) concentrations coincided with the presence of Haptophyte algae. In spring, ice cores were fully analyzed for DMS, DMSP and DMSO. Stable-isotope additions were used to calculate conversion rates within the sulphur cycle. In layers with high biomass, DMSP was quickly consumed: approximately 20% ended up in DMS. Other important pathways were uptake by organisms and demethylation.

Wed_212_OS-2_814
The Arctic Microbiome During the Winter-spring Transition: Nitrogen-cycle Genes

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Pelagic microbial communities are a key component of the Arctic Ocean when evaluating the ecological impact of the thinner Arctic icescape, as they constitute the basis of the marine food web and biogeochemical cycles. During the Norwegian young sea ICE expedition (N-ICE2015), that took place in drifting pack ice north of Svalbard between January-June 2015, seawater was collected at 5, 20 or 50, and 250 m depth on 9 March, 27 April and 16 June, together with environmental data. Illumina MiSeq paired-end reads from SSU rRNA amplicon and metagenomes were sequenced to study the composition, diversity and key nitrogen-cycling functions of the Arctic's microbiome through the winter-spring transition. Results show that nitrifiers, aerobic ammonia oxidizers and nitrite oxidizers, mostly affiliated with *Thaumarchaeota* and *Nitrospinae*, are abundant in subsurface waters below the pack ice during winter-early spring (6.3-27.4%) but nearly absent in late spring (0.1-2.0%). Urease and ammonia monooxygenase encoding genes are positively correlated with total dissolved nitrogen (urea included) suggesting the coupling of ureolysis and ammonia oxidation. Urease encoding gene increases along depth meaning that distinct species of thaumarchaeotes, *i.e.*, '*Ca*. Nitrosopumilus' and Marine Group I, found at different depths in the water column have different potential to carry out ureolysis. These results provide new knowledge about the nitrogen-cycling communities and pathways in the Arctic Ocean.

Wed_213_OS-2_861
Biogeochemistry of Late Summer Sea-ice in East Antarctica

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The contribution of sea-ice primary productivity to the Southern Ocean biological carbon pump is not well constrained. In this study, we partly address this gap and present concentrations of particulate organic carbon (POC) and nitrogen (PON), chlorophyll *a* (Chl *a*), exopolysaccharides (EPS) and macro-nutrients in fast ice, pack ice and underlying seawater collected in the East Antarctic sector in late summer 2016-2017 (Dec-Jan). Very few sea-ice biological data exist for this time of the year where ocean-ice interactions are maximal due to ice melt and drift.
Chl *a* concentration in late summer sea ice was up to 130 µg/L in fast ice and 95 µg/L in pack ice. Particulate organic carbon concentrations in the ice were high (up to 7000 µg/L), and C:N ratios were always higher than the Redfield ratio, suggesting carbon overconsumption in the ice. A loss of biomass during sea-ice melting and the production of EPS, which would have retained POC in the ice, could explain the high POC:Chl *a* ratios (>7000 in fast ice and >1000 in pack ice) encountered in sea ice. Preliminary results also showed that ammonium was consistently enriched in the ice while nitrate+nitrite was predominantly depleted. Sea ice could have been acting as an organic carbon reservoir and recycling factory at this time of the year when the phytoplankton bloom is at its peak. These data also contribute to increase our understanding of the role of pack-ice biogeochemistry, which is less studied than fast ice.

Wed_214_OS-2_1278
Inter-comparison between Chambers for CO_2 Flux Measurements over Sea Ice

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In order to validate the difference of air-sea ice CO_2 flux measurements by different types of CO_2 chamber, inter-comparison experiments were carried out on winter Antarctic pack ice in the Weddell Sea (R.V. Polarstern AWECS cruise, July-August 2013). Our ultimate goal is to understand the methodological gaps for the CO_2 flux measurements betweem chamber and eddy covariance methods over sea ice as an activity for SCOR Working Group 152 (ECV-Ice). Two kinds of CO_2 chamber systems were used: semi-automated CO_2 chambers developed at Hokkaido University and automated long-term CO_2 chambers (Li-8100A, LI-COR Biosciences, USA). These chambers were installed at the same ice/snow surface conditions within a 2-m × 2-m area. Based on the quantitative comparisons using least squares linear regression analyses, slope was 1.08, suggesting that the air-sea ice CO_2 flux from two chambers were good agreement. Therefore, our inter-comparison experiments confirmed that there was no instrumental bias between two chambers, thereby the past data for air-sea ice CO_2 flux obtained by each chamber's group in the world polar oceans could be shared.

Wed_215_OS-2_1279
ECV-Ice: Measuring Essential Climate Variables in Sea Ice-SCOR Working Group 152

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Observations over recent decades suggest that sea ice plays a significant role in global biogeochemical cycles, providing an active biogeochemical interface at the ocean-atmosphere boundary. However, a pressing need exists to perform methodological intercalibration experiments in order to obtain reliable measurements of basic biogeochemical properties, including many of the Essential Climate Variables of the Global Climate Observing System. With newly emerging techniques, and pressed by the rapid changes in sea ice, the time has come to evaluate and improve our approach to study sea-ice systems. In 2016, the Scientific Committee on Oceanic Research (SCOR) launched Working Group 152 on Measuring Essential Climate Variables in Sea Ice (ECV-Ice). This working group will synthesize past intercalibration exercises and design and coordinate new experiments. Our ultimate goal is to provide the international community with standardized protocols for processing sea-ice samples and collecting data for key variables, including CO_2 partial pressure, nutrients, algal biomass and production, and gas exchange. We will also establish the effectiveness of new techniques to address sea-ice heterogeneity (often referred to as "patchiness"). These tasks will directly benefit the long-term community goal of understanding the response of polar marine environments to ongoing climate change.

Wed_216_OS-2_1531
Bacteria Control Virus and Nanoflagellates in Water and Sea Ice during Winter

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Water and ice samples were collected weekly in the Baltic Sea from October to May. Abundances of bacteria, virus-like-particles and nanoflagellates as well as chl a concentration were determined and environmental parameters were measured. The effects of environmental conditions and biological interactions on the organisms were examined with Pearson's correlation test and a first order vector autoregressive model. All studied organisms had clear seasonal succession patterns and the sea ice microbial community had a wintertime succession independent of that of the water column. Accumulation of nanoflagellates and chl a were observed in ice. Bacteria were observed to have a key role in the trophic interactions in both ice and the water column. The results suggest that bacteria have a higher dependence on external factors than biological pressures. Viruses and nanoflagellates, however, seemed more responsive to changes in bacterial abundance. Our findings confirm that ice has an important role for biomass accumulation which is enhanced when the ice melts and carbon is released from ice. While examining the possible future changes of polar ecosystems, is is important to consider the extent to which the microbial food web during winter supports the water column and the benthos and affects ecosystem functioning throughout the year.

Wed_217_OS-2_1580
The Effect of Light on $^2H/^1H$ of Highly Branched Isoprenoids (HBIs) in Diatoms

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Sea ice is a key component of the Earth's climate system. Even though changes in sea ice extent and thickness are well documented, understanding processes that control climate in the polar regions back in time and over longer time scales requires proxy-based paleo reconstructions.
Several highly branched isoprenoids (HBIs) have been used previously to investigate changes in sea ice extent in the past. However, the potential of these biomarkers - particularly their $^2H/^1H$ ratios - to provide information about other parameters of sea ice such as ice thickness and/or snow cover have not been explored.
This study focuses on investigation of $^2H/^1H$ of HBIs isolated from the diatom *Pleurosigma intermedium*. We cultured this organism to test the hypothesis that d^2H values would reflect different levels of irradiance. The diatom culture was grown at different levels of light intensity in laboratory condtions. We obseved ^2H-depletion in HBIs extracted from the cultures grown at higher light intensity.
Improved understanding of the underlying mechanisms responsible for the isotopic differences in the diatom *Pleurosigma intermedium* would provide key insights for interpreting d^2H values of environmental samples from the polar regions. The goal is develop a new methodological approach that could be used to estimate ice thickness or/and snow cover, which are among the key parameters with respect to sea ice albedo and heat exchange between the ocean and the atmosphere.

Wed_218_OS-2_1583
Lipid Photooxidation: A Biogeochemically Significant Process in Polar Plankton

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Ultraviolet radiation (UVR) is one of many sources of stress to surface-ocean microbial communities in high-latitude ecosystems. Polar phytoplankton divert a remarkably large fraction of their biomass into lipids that perform functions such as energy storage and cell structure, making these molecules particularly susceptible to UVR-induced degradation compared with lower-latitude species. While there is considerable evidence from the Arctic Ocean that lipids in sinking marine particles can be degraded photochemically, we present new evidence for lipid photooxidation in living plankton communities from the marginal ice zone (MIZ) in West Antarctica. We use a combination of environmental data, field experiments on natural microbial communities, and evidence from an abiotic liposome model designed to mimic the behavior of lipids in living cells to show that UVR exposure can increase the overall oxidation state of plankton living in the MIZ. We use high-resolution mass spectrometry and new lipidomics data analysis methods to identify a diverse suite of oxidized lipids and oxylipins that are produced under these conditions; many of these molecules have not been previously identified in the environment. Using contemporaneous data from the Palmer Long Term Ecological Research study, we show that the removal and modification of intact lipids by UVR exposure can represent a carbon flux equivalent to 22% of the strength of bacterial production in the same waters.

Wed_219_OS-2_1594
Arctic Sea Ice: Investigating the Origin of Nitrate using $\delta^{15}N$, $\delta^{18}O$ and $\Delta^{17}O$

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Atmospheric deposition (AD) is hypothesized to be the primary source of reactive N (N_r) to Arctic sea ice. While advection from the Pacific Ocean delivers a significant supply of N_r, it is unclear if AD (directly or from sea ice melt) supports primary production in the N-deplete western Arctic Ocean. Isotopes of NO_3^- from sea ice cores provide an opportunity to understand whether melting sea ice represents an external supply of N to the ocean; examination of snow provides an isotopic end-member for direct AD. Sea ice collected during the US Arctic GEOTRACES leg between 82 and 89°N exhibits NO_3^- concentrations from 0.2-1.0 µM, while snow ranges from 1.1-3.7 µM. The isotopic composition of NO_3^- ($\delta^{15}N$, $\delta^{18}O$, $\Delta^{17}O$) was measured on all snow and ice samples. The $\Delta^{17}O$ ($\Delta^{17}O=\delta^{17}O-0.52*\delta^{18}O\neq0$) is a diagnostic tool for atmospheric NO_3^- compared to other NO_3^- sources because only atmospheric NO_3^- contains a nonzero $\Delta^{17}O$. Snow samples were characteristic of atmospheric NO_3^- with generally negative $\delta^{15}N$ (-5.9-2‰) and highly enriched ^{17}O and ^{18}O ($\Delta^{17}O$=27.1-33.5‰; $\delta^{18}O$=70.8-87.8‰). In contrast, sea ice samples were more enriched in ^{15}N (-0.3-15‰) and depleted in ^{17}O and ^{18}O ($\Delta^{17}O$=0-12.4‰; $\delta^{18}O$=23.3-67.5‰). The presence of a $\Delta^{17}O$>0‰ occurs at various depths, indicating that atmospheric NO_3^- is important in sea ice. However, low $\Delta^{17}O$ and $\delta^{18}O$ values and numerical modeling of isotope dynamics suggest that a majority of the NO_3^- is derived from seawater/produced biologically in situ.

Wed_220_OS-2_1787
Biophysical Characterization of Arctic and Antarctic under Ice Environments

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Sea ice is a highly inhomogeneous habitat varying on scales of meters to kilometers. The spatial variability of physical factors is reflected in the variability of sea ice microbial community and of sympagic fauna. Characterizing the biophysical environment of sea ice at scales of meters to kilometers is still a challenge. In this work we present data collected with a Surface and Under Ice Trawl (SUIT) during three Arctic and two Antarctic expeditions between 2012 and 2017. The SUIT is a relatively new net, which can catch organisms residing in close proximity to the sea ice underside. The SUIT is equipped with a sensor array from which we can retrieve key environmental properties: water salinity, temperature, chl *a*, sea ice thickness, under-ice light, and ice-algal chl *a*. An average trawl is about 2km long, it thus covers scales that can be hardly sampled with classic methodologies. In the present work we show results for sea ice thickness, ridges density, under ice light, and sea-ice chl *a* concentration derived from the SUIT sensor array. We investigate how the presence of ridges affect the light transmission through sea ice in both the Arctic and Antarctic region. We derive in-ice chl *a* based on under ice hyperspectral measurements to characterize the food standing stocks in both regions. We present a first habitat characterization on the kilometer scale. Moreover, this work represents the first Arctic-Antarctic comparison of under ice environmental characteristics.

Wed_221_OS-2_2027
Understanding the Origin(s) of Methane in Sea Ice Using Stable Isotope Ratios

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In 2012, an unexpected CH_4 excess has been reported above open leads in the Arctic Ocean showing that sea ice plays a role in the ocean-atmosphere CH_4 dynamics. However, the processes involved there have not yet been identified.
We performed CH_4 stable isotope ($d^{13}C$ and dD) analyses on sea ice samples, as well as geochemical and physical measurements, to determine the possible pathways involved in CH_4 production/removal in or under sea ice. We present results from ice cores collected above the shallow shelf of Barrow (Alaska) from January to June 2009 as well as in the landfast ice of McMurdo Sound (Antarctica) from September to November 2012. We found a clear difference in isotopic signature between the two sites. The McMurdo ice was supersaturated in CH_4 and showed isotopic signatures surprisingly enriched in heavy isotopes ($d^{13}C$ between -47 and -12 ‰ and dD between -87 and -350‰). No natural pathways have yet been identified with such isotopic signatures, but we suggest that aerobic CH_4 formation in or under the ice might be a candidate. In contrast, the CH_4 concentrations were much larger in ice overlying the shallow shelf of Barrow and there the origin of CH_4 was clearly biogenic ($d^{13}C$ between -48 and -68 ‰ and dD between -180 and -250‰), thus likely originating from the sediment. In the McMurdo ice, the seasonal evolution shows that CH_4 was becoming more enriched in heavy isotopes with time, suggesting the occurrence of aerobic oxidation processes in the ice.

Wed_224_OS-2_2193
RISE UP: Robotic Exploration Beneath the Ross and McMurdo Ice Shelves

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The NASA-funded RISE UP program (Ross Ice Shelf and Europa Underwater probe) is a three-season project to observe ice-ocean interactions and conditions beneath McMurdo Sound, the McMurdo Ice Shelf (MIS), and the Ross Ice Shelf (RIS) in Antarctica. In addition to traditional water column sampling and profiling methods, these observations are being made via the AUV/ROV *Icefin*, designed to conduct basal ice and benthic surveys through 30 cm boreholes in remote locations. During the 2017-19 austral summers, and in cooperation with the Antarctica New Zealand Ross Ice Shelf Programme (PI Christina Hulbe), RISE UP will provide insight into these largely unmapped and uncharacterized sub-ice environments.
RISEUP aims to autonomously characterize habitability and sample under-ice environments on broad spatial scales via robotic platforms. By combining data from *Icefin*'s sensors with CTD profiling, nutrient sampling, cell counts, and DNA extractions, we are mapping observations from the vehicle to the biologically relevant environmental parameters that support life. Across the gradient of field locations from the front of the RIS to the grounding zone, we can trace circulation, ice mass balance, nutrient flux, and sub-shelf biodiversity while refining the sensors autonomous vehicles can use to link environmental processes and habitability. Here, we present the results of this complementary water column sampling from the first season of RISE UP beneath the McMurdo and Ross Ice Shelves.

Wed_225_OS-2_2458
Sea-ice Chemistry and Influence of Glacial Meltwater in a Spitsbergen Fjord

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Several fjords on Svalbard are affected by glacier meltwater. We investigated the sea-ice carbonate (or CO_2) chemistry in Tempelfjorden, a west-Spitsbergen fjord, and the influence of different processes such as ice-brine rejection, calcium carbonate precipitation and glacial meltwater during two winters in 2012 and 2013. The two contrasting years clearly showed that the influence of freshwater affected the chemical and physical characteristics of the sea ice. We found large variability of sea-ice total alkalinity (A_T), total dissolved inorganic carbon (C_T), pCO$_2$, dissolved inorganic nutrients, oxygen isotopic ratio (d^{18}O), and freshwater fractions, from the glacier front to the outer part of the fjord. Processes within the sea ice such as calcium carbonate formation (ikaite) and brine rejection also affected the sea-ice carbonate chemistry. The variability in the sea ice showed the lowest A_T in 2012 near the glacier front coinciding with the highest freshwater fractions (glacial water). Relatively high A_T in relation to salinity was observed mainly in 2012, which could either be a result of ikaite precipitation in the sea ice (dissolved during analysis) or calcite and dolomite minerals originating from the bedrock/glacial freshwater. We found crystals of ikaite, calcite and aragonite (forms of calcium carbonate) in the snow/frost flowers in 2013 as a result of to sea-ice processes.

Wed_226_OS-6_152
'Atlantification' of Arctic Ocean - Oceanic Control and Variability

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Arctic is warming at a much higher rate than the rest of the globe. Several studies have pointed out dramatical changes in the Arctic atmosphere over the past few decades due to local as well as large scale changes in the atmospheric circulations. However, though not as rapid as in the case of atmosphere, the Arctic ocean and its surrounded counterparts have also been undergoing significant modifications in their role in determining the Arctic climate. Atlantic Water transported from the Nordic Seas through the Fram Strait and Barents Sea Opening are the major sources of oceanic heat to the Arctic Ocean. There are several evidences of warmer atlantic water intrusion in the arctic and surrounding oceans, popularly termed as 'Atlantification'. In this study we show that under the changing North Atlantic climate system, the transport of Atlantic water can be significantly modified through a defining contribution from the oceanic circulations. This has significant implications on the net oceanic heat transport towards the Arctic and also on the regional climate patterns. The teleconnections between North Atlantic climate and monsoon, Indian Ocean also indicates to the fact that tropical atmosphere-ocean dynamics can also indirectly influence the oceanic heat transport towards Arctic Ocean through changes in North Atlantic atmospheric dynamics.

Wed_227_OS-6_247
Analysis of Storm Waves in the Antarctic Marginal Ice Zone

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Southern Ocean waves are the largest on Earth, but their interaction with sea ice is a particularly poorly understood feedback in the climate system. Limited observations of waves in the Antarctic marginal ice zone (MIZ) show that waves can travel hundreds of kilometers into the ice and that current representations of wave decay are inappropriate in a sea ice regime.
Waves induce floe break up, but the mechanisms of this process are poorly understood. Characterizing the wave field in the MIZ is fundamental to modelling wave motion through sea ice, and is crucial for estimating sea ice cover in this dynamic region. An observed southward shift in storm tracks over recent decades and a predicted increase in wave heights at the ice edge have implications for sea ice extent under changing climate.
Two Waves-In-Ice-Observing-Systems were deployed 1.5 km apart near 62.8 S, 29.8 E on 4th July, 2017 to measure waves in the MIZ. Deployment coincided with the arrival of a low front accompanied by winds averaging 25 m/s. Long period (16 s) waves of nearly 8 m waveheight were recorded at a distance of over 100 km from the ice edge. We show that a significant amount of energy can be transported well into the sea ice by ocean waves. These results provide rare measurements of waves-in-ice during winter storms in the Antarctic MIZ.

Wed_228_OS-6_387
Ocean Warming of the Antarctic Continental Shelf in an Eddying Climate Model

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Ocean warming near the Antarctic ice shelves has critical implications for ice sheet mass loss and global sea level rise. Here, we use a global climate model with an eddying ocean to quantify the mechanisms contributing to ocean warming on the Antarctic continental shelf in an idealized 2xCO_2 experiment. We find relatively large warm anomalies both in the upper 100 m and at depths above the shelf floor, which are controlled by different mechanisms. The near-surface ocean warming is primarily a response to enhanced onshore advective heat transport across the shelf break. The deep shelf warming is initiated by onshore intrusions of relatively warm Circumpolar Deep Water (CDW), in density classes that access the shelf, as well as the reduction of the vertical mixing of heat. CO_2-induced shelf freshening influences both warming mechanisms. The shelf freshening slows vertical mixing by limiting gravitational instabilities and the upward diffusion of heat associated with CDW, resulting in the build-up of heat at depth. Meanwhile, freshening near the shelf break enhances the lateral density gradient of the Antarctic Slope Front (ASF) and disconnect isopycnals between the shelf and CDW, making cross-ASF heat exchange more difficult. However, at several locations along the ASF, the cross-ASF heat transport is less inhibited and heat can move onshore. Once onshore, lateral and vertical heat advection work to disperse the heat anomalies across the shelf region.

Wed_229_OS-6_393
Circumpolar Deep Water Intrusion onto the Prydz Bay Continental Shelf

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Variability of Circumpolar Deep Water (CDW) intrusion onto the Prydz Bay continental shelf was studied based on CTDs, Moorings, and some other observations. CDW intrusion in Prydz Bay shows significantly temporal and spacial variability. Water exchange occurs all through the year, but the temperature recorder and current meters shows different characteristics in the Prydz Channel. The key reason which causes the different seasonal responses of temperature and current around CDW intrusion region is documented. CDW intrusion process and character reveal that eddy form is the dominant mode during the CDW intrusion events. Heat and salt budgets along the Prydz channel are also studied, which help to estimate the contribution of Prydz Bay to Southern Ocean in heat, salt and water exchange.

Wed_230_OS-6_562
Deep Bottom Mixed Layer Instability Drives Variability of Antarctic Slope Front

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Ocean-driven melting plays a fundamental role in the mass loss of the Antarctic ice sheet. The ocean temperature on the continental shelf is modulated by heat exchange across the Antarctic slope where the so-called Antarctic Slope Front separates the cooler continental shelf seas from the relatively warm Southern Ocean. Nevertheless, little is known about the dynamics of the Antarctic Slope Front in modulating this heat exchange. Here we use a process model to show how downslope bottom Ekman transport of shelf water leads to enhanced bottom mixing on the offshore side of the Antarctic Slope Front. Every few years, this enhanced bottom mixing triggers instabilities of the Antarctic Slope Front which allows Circumpolar Deep Water to propagate closer to the continental shelf and enhances near-bottom water mass transformation. The mechanism exists in the model for both constant and seasonal forcing. The identified mechanism needs to be confirmed in realistic models and in the real ocean. It could impact variability of the cross-shelf heat exchange and basal melt rates as well as of the overturning circulation on interannual time scales.

Wed_231_OS-6_570
Sea Ice Drift from High Resolution Satellite Images in the Ross Sea, Antarctica

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Sea ice remains one of the least explored climate components. Sea ice drift is forced by winds and ocean currents and is an essential element in the dynamics of the polar oceans. Sea ice extent, concentration, and thickness are heavily influenced by ice dynamics. For the accurate representation of sea ice in climate models, realistic parameterization of the sea ice motion and deformation rates are crucial. Here we present high resolution sea ice deformation fields of the Western Ross Sea as a basis to explore ice-atmosphere interactions. The Ross Sea region including three main polynyas; McMurdo Sound, Terra Nova Bay and the Ross Ice Shelf Polynya has experienced a significant increase in sea ice extent in recent decades. For this study, we used sequential high resolution Advanced Synthetic Aperture Radar (ASAR) images from the Envisat satellite. We downsampled the Wide Swath (WS) mode images from 75 m pixel resolution to 150m, which has a swath width of 400km. For this case study, we focused on the month of maximum sea ice extent, October 2011. The images are acquired roughly 24 hours apart and drift velocity is calculated in kilometres per day. We carried out the correlation using feature tracking and pattern matching techniques. The calculated displacement vector field has been compared with the low resolution available sea ice motion vector standard product. Uncertainty has also been calculated as the coarse resolution product is unable to show short term variation.

Wed_232_OS-6_574
Turbulent Resolution Simulation of Dissolving Ice-shelves into Polar Sea Water

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Precise knowledge of ocean dynamics and interactions with the grounded ice at high latitudes is very crucial for predicting the sea-level rise and further development of adaptation strategies in a global warming climate. The physics of these ocean-ice interactions particularly related to small scale processes, is poorly understood which, along with limited observation constraints, leads to uncertainties in the predictions of future melt rate. We perform direct numerical simulations to investigate dissolving of ice into cold and salty seawater in the presence of turbulent convection. The main focus will be on the dissolving of ice as characterizes many sites around Antarctica. Under these conditions, the diffusion of salt to the ice-water interface depresses the freezing point and further enhances heat diffusion to the ice. Our simulation also shows boundary layer next to the ice face turbulent motions dominant which further amplifies the basal melt rate. It is also important to quantify the difference between the melting of a vertical ice wall and the melting of a sloping ice shelf. The basal slope is observed to vary significantly, due to the formation of crevasses, channels, and terraces. Our high-resolution simulations are designed for direct comparison with laboratory measurements and theory. The temperature and density structures found under Pine Island Glacier show several layers having a vertical scale that can also be explained by this study.

Wed_233_OS-6_627
Atlantic Water and Sea Ice Variability in the 20th Century Arctic Ocean

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Both historical observations and outcome from a fully coupled earth system model show a warming trend in core temperature of Atlantic Water entering the Arctic Ocean over the last few decades (1977-2015). The Atlantic Water is also observed to rise systematically in the water column since the 1990's. This suggest an “Atlantification” of the Arctic Ocean, i.e. an ongoing expansion of the Atlantic domain. A portion of this “Atlantification” and recent warming has been attributed to the current global warming and possibly anthropogenic activity. However, past periods of warm Atlantic Water (1930-1940) have been documented. We believe that the Atlantic Water warming trend in the Arctic Ocean may be part of long-term multidecadal variability, which is influenced and reinforced by strong anthropogenic forcing.
We have therefore investigated the interannual, decadal and multidecadal variability of Atlantic Water and sea ice in the Arctic Ocean using a global ocean model. Here we present results from a simulation for the period 1871-2009 with the ocean-sea ice component of the Norwegian Earth System Model (NorESM-O) forced by a Twentieth Century Reanalysis data set, which are compared with available hydrographic measurements of Atlantic Water in the Fram Strait and north of Svalbard, and observations of sea ice.

Wed_234_OS-6_635
Variation of Summer Surface Water and Circumpolar Deep Water in the Prydz Bay

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Based on hydrographic data obtained during four CHINARE (Chinese National Antarctic Research Expedition) cruises (i.e., the 27th, 28th, 29th, and 31st) in the Prydz Bay (Antarctica), we analyzed the distribution of water masses, interannual variation of Summer Surface Water (SSW), reasons for the interannual change, and interannual variation of the characteristics of upwelling Circumpolar Deep Water (CDW). It was found that SSW had wide ranges of temperature and salinity, especially during the 27th and 29th cruises, with temperatures up to 1.22°C higher during the 27th cruise. There appeared to be less sea ice during the 29th cruise. The SSW was distributed within the upper 50 m of the ocean in the sections of 73°E, 75.5°E, and 67.25°S , whereas it was distributed within the upper 100m during the 31st cruise. The upwelling of CDW was particularly evident in the section of 73°E during the 28th and 29th cruises. It was observed during the 28th cruise that CDW upwelled to 90m and it was found to extend southward to 67.67°S during the 29th cruise. Cyclonic circulation has considerable effect on the transportation of the upwelling of CDW in the Prydz Bay.

Wed_235_OS-6_737
Decadal Predictability of Arctic Sea Ice from Oceanic Heat Transport

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The retreat of the Arctic sea ice provides an opportunity for increased economic and scientific exploration. Those require predictions of sea ice conditions up to a few years in advance, which so far has proven challenging. One potential cause is that the role of the ocean is still not fully understood. Using multi-ensemble simulations of the global coupled model EC-Earth, initiated at different states of decadal variability and totalling 2000 years, we here investigate the potential for predictability of the oceanic heat transport through Fram Strait and the Barents Sea Opening. We first determine the atmospheric and oceanic drivers of enhanced heat transport, notably focusing on the dynamic relationship between oceanic heat transport into the Arctic and deep water formation in the Nordic Seas, but also in the North Atlantic where it is easier to observe. We then quantify the impact of enhanced oceanic heat transport through either Fram Strait or the Barents Sea Opening onto the Arctic sea ice.

Wed_236_OS-6_768
Three Decades of Deep Water Mass Investigation in the Weddell Sea (1984 - 2014)

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The role of Antarctic Bottom Water (AABW) in changing the ocean circulation and controlling climate variability is widely known. However, a comprehensive understanding of the relative contribution and variability of Antarctic regional deep water mass varieties that form AABW is still lacking. Using a high-quality dataset comprising three decades of observational shipboard surveys in the Weddell Sea (1984-2014), we updated the structure, composition and hydrographic properties variability of the Weddell Sea deep-layer, and quantified the contribution of the source waters composing Weddell Sea Bottom Water (WSBW) in its main formation zone. Shifts in WSBW hydrographic properties towards less dense varieties likely equate to less WSBW being produced over time. WSBW is primarily composed of 71±4% of modified-Warm Deep Water (mWDW) and 29±4% of Dense Shelf Waters, with the latter composed by ~two-thirds (19±2%) of High Salinity Shelf Water and ~one-third (10±6%) of Ice Shelf Water. Further, we show evidence that WSBW variability in the eastern Weddell Sea is driven by changes in the inflow of Dense Shelf Waters and bottom water from the Indian Sector of the Southern Ocean. This was observed through the rise of the WSBW contribution to the total mixture after 2005, following a twenty-year period (1984-2004) of decreasing contribution.

Wed_237_OS-6_944
Observations of Ice Tongue-ocean Interaction at Shirase Glacier

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Shirase Glacier Tongue (SGT) is a thick floating slab of ice that forms where the glacier flows down onto the ocean surface at the southern closed-section of Lutzow-Holm Bay (LHB) off Enderby Land, East Antarctica. Compared with other major ice shelves/tongues around Antarctica, SGT is smaller in area but its basal melt rate was estimated to be relatively high at a rate of ~7 m per year (Rignot et al., 2013) based on presence of warm deep water. Detailed analysis of the winter hydrographic observations in 1990/92 suggests a 3-dimenstional circulation, associated with the SGT-ocean interaction, that comprises: (1) warm mCDW (modified Circumpolar Deep Water) flows southward at the deep layer of submarine canyon that leads into the region beneath SGT, (2) mCDW meets to melt the base of SGT, and (3) mixture of mCDW and basal melt water exports northward at subsurface layer.
To explore in detail the SGT-ocean interaction, summer comprehensive hydrographic observations in LHB were conducted in 2016/17 under the project called ROBOTICA. The latest observation data show clear evidences that support the suggested SGT-ocean interaction mentioned above. Basal melt signals with elevated melt water fractions are clearly found in the temperature, salinity, and dissolved oxygen profiles, especially at subsurface layer (Winter Water) near the northern edge of the SGT. In this talk, preliminary results from the next hydrographic observations in 2017/18 are also presented.

Wed_238_OS-6_955
Eastern Ross Sea Shelf-break Observations during 2017 OGS-Explora Expedition

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Cold and dense water masses formed over the Ross Sea continental shelf provide a not negligible contribution to the Antarctic Bottom Water and then, to the global thermohaline circulation. Volume and properties are constrained by cross - slope exchange and mixing along the whole Ross sea shelf break.
In the past, different international expeditions, focused on the Cape Adare trough and Glomar Challenger trough exchanges, have significantly advanced our understanding of the involved processes.
In this work we describe, mainly from the oceanographic point of view, some observations performed during the 2017 Antarctic expedition, carried out on the r/v OGS-Explora, along selected transects in the eastern part of the Ross Sea. This area, core of the PNRA WHISPERS Project, was poorly explored in the past because often covered by the sea ice.
Data reveals that the energetic variability at small scales and strong mixing induced by overflow/down-slope flow have a significant role on the ways the eastern shelf break of the Ross Sea impacts the deeper circulation and abyssal water renewal.

Wed_239_OS-6_957
Variability of the Thermocline Depth on the Amundsen Sea Continental Shelf

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The West Antarctic Ice Sheet has been losing mass at an increasing rate over recent decades. The presence of warm ocean water at the ice-ocean interface has been identified as an important contributor to this mass loss. Access of the warm water to the ice base and grounding lines in the ice shelf cavities surrounding the Amundsen Sea is strongly determined by the depth of the thermocline that separates the bottom layer of warm, salty Circumpolar Deep Water from the overlying layer of colder, fresher Winter Water. Ekman pumping has been invoked as a process controlling thermocline depth near the western shelf break and deep mixing as a result of local surface buoyancy forcing has been shown to affect thermocline depth near Pine Island Glacier. Hydrographic observations since 1994 indicate coherent large-scale inter-annual to decadal variability of the thermocline across the shelf. In addition to the ship-based hydrographic observation a series of hydrographic moorings have been deployed across the Amundsen Sea continental shelf since 2009. We make use of these to identify common patterns and differences in the seasonal to inter-annual variability of the thermocline and to discuss the forcing mechanisms responsible.

Wed_240_OS-6_960
Inter-annual variability of Hydrodynamics between Cape Town and Antarctica

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Density profiles in the upper 1000m were recorded using Expendable CTD probes operated from a cargo ship chartered for Indian Antarctic Expedition from Cape Town (38^{o}S, 16^{o}E) to Antarctica (70^{o}S, 9^{o}E) during austral summer of 2013-2017. The vertical density structure showed deep mixed layers (~100m) in the Agulhas Retroflection Region (ARF) due to the presence of downwelling warm-core eddies. The ARF dynamics was monitored using 1/3^{o} x 1/3^{o} Maps of *Absolute* Dynamic Topography derived from merged altimetry data, which showed that at least 10 warm core eddies get detached from the ARF and they enter the Atlantic during the austral summer period. The geostrophic transport computed relative to 1000 m indicated that large westward transport into the Atlantic ocean is associated with North Subtropical Front during 2013-2015. The hydrological fronts meander southward in 2016 and 2017 due to enhanced and positive nature of Southern Annular Mode. The Southern boundary of Antarctic Circumpolar Front shifted northward from 2013-2017 possibly due to expanding sea ice extent. We discuss the role of role of air sea interaction in genesis of water masses and evolution of mixed layer.

Wed_241_OS-6_974
Marine Observations in the Ross Sea on Board r/v OGS - Explora in 2017

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We review the oceanographic data collected during the 2017 Antarctic cruise (r/v OGS-Explora). The underway measurements provided flow velocity in the upper 700 m, and sub-surface temperature (T) and salinity (S). While crossing the Southern Ocean, 7 autonomous floats, 10 drifters and 29 XBTs (eXpendable BathyThermograph) were deployed. In the Ross Sea (RS), 146 XBTs were launched. The most complete oceanographic assessment was achieved over the slope of the Hillary Canyon (HC; ANTSSS and ODYSSEA projects) where eight closely spaced CTD (Conductivity-Temperature-Depth) casts were done. Two additional casts were performed west of the HC where a new sediment drift was explored by geological and geophysical surveys. The CTD system provided pressure, T, S, fluorescence and turbidity. Lowered Acoustic Doppler Current Profiler registered the flow velocity during the CTD casts. We aimed to explore some dynamical aspects of the down-slope flow near the shelf-break where RS bottom water descends and contributes to the Antarctic Bottom Water formation. East of the HC, where the slope area was explored by seismic surveys (WHISPERS project) another XBT transect was performed. Finally, XBTs provided temperature distribution along 550 km transect near the Ross Ice Shelf front. The acquired data provide a unique opportunity to describe the present water properties and concomitant flow patterns to be associated with the geological evidence of the past circulation.

Wed_242_OS-6_996
Fast-ice Control of Vertical Mixing and Nutrient Fluxes on the Antarctic Shelf

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Fast-ice isolates the ocean from kinetic energy input by the wind, a fundamental driver of the surface ocean. We report on new, coincident vertical mixing (microstructure), ocean energy and nutrient concentration observations made at the same Antarctic shelf site during both summer ice-free and winter fast-ice conditions. To our knowledge these are the first combined measurements of their kind. In late summer, the water column above Circumpolar Deep Water (the source of oceanic heat and nutrients) is temperature stratified in the upper 75 m and turbulent mixing is elevated, then falling by an order of magnitude between 80 m and 100 m, remaining at that lower level down to the maximum measurement depth (300 m). By way of contrast, in mid-winter, and in the presence of continuous fast-ice, turbulence is at near-detection limit down to the maximum measurement depth. Thus, isolating the shelf waters from wind during times of fast-ice cover fundamentally alters the turbulent state of the upper water column. Concurrent wind speed and current profile measurements are used to scale the dependence of mixing, in these contrasting regimes, on atmospheric and oceanic energy levels. Nutrient profiles are used in conjunction with mixing profiles to quantify changes in vertical nutrient supply to the euphotic zone during the spring break-up of fast-ice. Shelf-wide upscaling using remotely sensed data is investigated.

Wed_243_OS-6_1007
The Freshwater Cycle of the Southern Ocean: A Stable Water Isotopes Approach

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The freshwater cycle of the Southern Ocean is pivotal for Earth's climate, but it is still poorly observed and understood. Indeed, the large freshwater fluxes between the ocean and sea ice, as well as between the ocean and the polar ice caps, directly control ocean circulation, the geography of sea-ice, the melt of the ice-caps, with global and major consequences for global climate and sea-level rise. In particular, the relatively warm circumpolar deep water entering in contact with ice-shelves, and the dense water formed as a result through ocean-ice interactions is essential for establishing global ocean circulation, for the carbon cycle, and for the thermal regulation of the planet. In this study, we aim at shedding light in the freshwater cycle of the circulation in the Southeastern Weddell Sea, on the continental shelf, in front of the Filchner ice-shelf. As part of the WAPITI project cruise, we acquired in Jan-Mar 2017 a new set of oxygen and deuterium isotope from in-situ water-column sampling. Measurements have been acquired on the entire continental shelf, from the shelf break to the ice-shelf front, and over the entire Filchner Depression (from East-to-West). We will present preliminary results from this exciting set of observations and present longer-term plans for freshwater cycle, ocean-ice interaction, and ocean circulation analysis of the region.

Wed_244_OS-6_1012
Simulations of the Southwestern Weddell Gyre, its Shelves and Sub-iceshelf Seas

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Realistic high-resolution model simulations of the southwestern Weddell Gyre are prepared using a state-of-the art z-coordinate ocean plus sea ice model (NEMO, LIM version 3). One of the novelties of the proposed setup consists in the explicit resolution of the sub-iceshelf seas adjacent to the Weddell shelves, including the cavity between the Filchner-Ronne iceshelf (FRIS), modelling the melt at the iceshelf bases, the oceanic processes accounting for it, as well as its impact on the ocean circulation in the cavities and beyond. The configuration is designed to explore the mechanisms of communication between the open Weddell Gyre and the sub-iceshelf seas, and notably, the role played therein by the circulation, stratification and water mass (trans-)formations on the Weddell shelves. Simulations are spun up from a $1/4^\circ$ Nemo simulation, and carried out at an isotropic horizontal resolution of $1/12^\circ$ longitude, which ranges from about 4.5 km at the northern boundary of the gyres, varies between 4 to 2 km over the gyre's shelves, and reaches less than 2 km in the FRIS cavity.

Wed_245_OS-6_1040
Seasonal and Interannual Variability of the Mixed Layer in Baffin Bay

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A better description of the seasonal and interannual variability of the mixed layer and the underpinning mechanisms is necessary for a clearer understanding of the primary production evolution in Baffin Bay. Spring and summer in-situ measurements are used to estimate the winter maximum of the mixed layer depth and to establish its spatial variability. This observational study is complemented by the analysis of numerical simulations with a ¼° ice-ocean model, which extends over the Arctic and Atlantic Ocean. The timing of the mixed layer deepening, its maximum and its retreat is established and its variability over the period 1979-2016 is analyzed. Fresh water and heat budget are computed to evaluate the role of the surface forcing (brine rejection by ice growth, fresh water flux due to ice melt, heat fluxes) and the advection of polar water from the Arctic and Atlantic water from the Labrador Sea on the evolution of the mixed layer.

Wed_246_OS-6_1099
Antarctic Sea Ice Trend: Insights from a Suite of Climate Models

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Antarctic sea ice concentration has been observed to increase over the last 30 years, in contrast with the decrease that most climate models show. Here, we aim to understand this disagreement by investigating the respective roles of natural variability and anthropogenic forcing in shaping Antarctic sea ice trend. To do so, we use a suite of three climate models of varying resolutions in the ocean that displays a range of behaviours in natural variability with the representation of Weddell Sea polynyas, and different intensities in the decrease of sea ice trend. We find that the disagreement between models and observations is partly due to a desynchronized or too weak natural variability in models compared to observations. In particular, in one model, the sea ice trend between two polynyas is found to be of similar sign and magnitude to that observed over the satellite record. At high latitudes, all models show a surface cooling on a short time scale, followed by a warming on a longer time scale, consistent with the delayed warming mechanism of Ferreira et al. (2015). Of all models, the higher resolution model shows the strongest surface warming and decrease in sea ice, suggesting an important role for eddies in the response of Antarctic sea ice to climate change.

Wed_247_OS-6_1137
Seasonal Thermocline Evolution at the Weddell Sea Shelf Break-data and Dynamics

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Observations and models suggest that access of Warm Deep Water to the Weddell Sea ice shelf cavities links closely to variations of the Antarctic Slope Front thermocline along continental shelf break. A new monthly climatology of the slope front hydrography based on CTD profiles from ships and instrumented seals between 1977 and 2016 shows an elevated thermocline (by about 100 m) depth during the austral summer at Kapp Norvegia (17W). The correspondence of this signal with a seasonal warming at the Filchner Trough further downstream (40 W), indicates a coherent evolution of the slope front structure along a larger portion of the shelf break. The climatological cross sections also show a distinct seasonality of the slope current and upper ocean hydrography, where downwelling of fresh Antarctic Surface Water forms a secondary front above the Warm Deep Water interface in summer. Enhanced baroclinic growth rates at this front suggest that the momentum input from wind, which suppresses the thermocline along the shelf break, is partially dissipated by a shallower eddy-overturning cell when surface water is present. A simple overturning model of the southern limb of the Weddell Sea Gyre confirms the sensitivity of the thermocline depth to the upper ocean density changes and reproduces the observed seasonal evolution of the thermocline as a response to wind and buoyancy forcing.

Wed_248_OS-6_1176
Negative Feedback of the Beaufort Gyre Circulation on Ice-mediated Ekman Pumping

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Motivated by observations we explore a negative feedback loop between ice-mediated Ekman pumping and surface geostrophic currents in the Beaufort Gyre (BG). We show that anomalous anticyclonic surface stress due to sea-ice drift leads to increased Ekman downwelling which strengthens the surface geostrophic currents. Accelerating the geostrophic current reduces the ice-ocean relative velocity and hence the effective surface stress. This provides a strong damping of the downwelling processes in the BG and must be a central part of any theory of BG dynamics.

Wed_249_OS-6_1291
Seasonal Quasi-circumpolar Acceleration of the Antarctic Slope Current System

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The Antarctic slope current system plays a pivotal role in the circulation and climate of the Southern Ocean. By flowing westward around Antarctica, it mediates the flow of water masses and freshwater across the polar Southern Ocean, and regulates the cross-slope exchange of warm deep waters offshore and recently ventilated waters onshore - thereby influencing the melting of Antarctic ice shelves and the production of Antarctic Bottom Water.
Despite its significance, the dynamics of the Antarctic slope current have only begun to be probed. As sea ice often covers the Antarctic slope, in situ measurements are very sparse, and conventional remote sensing approaches are incapable of taking ocean observations. Here, we tackle this issue by developing and analysing a new satellite altimetric data set of the Southern Ocean, based on the SIRAL radar altimeter on board CryoSat-2. Sea level measurements from leads between ice floes are extracted to construct a 5-year time series of the circulation in the seasonally and perennially ice-covered ocean. Analysis of these data reveals that the Antarctic slope current exhibits a seasonal cycle of acceleration and deceleration around much of Antarctica, with maximum transport in April - June and minimum transport in November - February. These altimetric diagnostics are shown to be coherent with observations gathered by a small set of near-coast mooring arrays, and to be indicative of driving by variable winds around the Antarctic continent.

Wed_250_OS-6_1307
Seasonal Chlorophyll-*a* Variability in the Indian Sector of the Southern Ocean

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Despite being high-nutrient low-chlorophyll (HNLC) region, the Southern Ocean(SO) plays a key role in global carbon cycle by fixing carbon and exporting it from surface to deep Ocean. The unused nutrients also control primary productivity in the tropical ocean. Phytoplankton growth in SO is hypothesized to be limited by availability of iron and sunlight. Recent study shows that the SO is changing now: it's warming and freshening due to climate perturbations which may have implications to the seasonal evolution of biological properties. The Bio-Argo floats equipped with chlorophyll sensors together with traditional CTD sensors deployed in the frontal zone of the Indian sector of the SO provide critical imformations on phytoplankton and the deep chlorophyll maxima. The high productivity at fronts in the open ocean is commonly attributed to availability of sunlight during the austral summer and supply of large quantities of dissolved iron to the ocean surface through deep mixing/plateau effect. We found that the frontal zone results obtained from the floats show a bloom in the spring in the three frontal regions STF, SAF and PF. Our results also show that the shallowing of MLD over the critical depth and resultant light exposure in the MLD during the spring season play a major role in bloom initiation.

Wed_251_OS-6_1335
Austral Summer-time Variability in the Prydz Bay over the Last One Decade

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Prydz Bay is a large triangular-shaped embayment in the Indian sector of Southern Ocean (SO) and this region plays a key role in SO thermohaline circulation. Compared to other coastal regions, such as Antarctic Peninsula, Weddell Sea, and Ross Sea, relatively little attention has been paid to understand the complex physical processes occurring in the Prydz Bay. In this study, 3-day continuous *in-situ* high resolution hydrographic data collected from the Prydz Bay during Indian Southern Ocean Expeditions 2006 and 2017 has been used. During 2017, the sea surface temperature in the Prydz Bay was unusually warm (> 1°C) as compared to 2006 which was also well noticeable in the satellite SST. As compared to 2006, wind speed was less and air temperature was higher in 2017 resulting in a less heat loss (-8 W/m^2, minus sign indicates heat loss from ocean to atmosphere) from the Prydz Bay region in 2017 as compared (-20 W/m^2) to that in 2006. Large variability in the properties of water masses was also noticed in 2017 as compared to 2006. During 2016-17, the warming in the Prydz Bay was started well before the austral summer and continued upto fall. Such an elongated warming period in the upper layer may be enough to melt existing ice and/or prevent new ice forming, resulting in the formation of heat polynyas. Using satellite derived data, model outputs and ARGO data; an attempt has been made to illustrate possible mechanisms of this warming in the Prydz Bay over the last one decade.

Wed_252_OS-6_1395
Internal Variability in the Arctic Freshwater Budget

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Changes in freshwater fluxes can have implications for stratification and deep convection in the Arctic and North Atlantic. It is therefore important to understand the potential for future change in the Arctic freshwater budget. However, on short to intermediate timescales it is challenging to separate changes due to internal variability from those due to external forcing. To explore changes in Arctic freshwater fluxes between the 20th and 21st centuries and quantify the respective role of these two drivers of variability, we have analyzed the output from the CESM Large Ensemble (LE), which is forced by the strong (RCP8.5) CMIP5 forcing. We find that individual freshwater flux terms have varying degrees of internal variability, which influences when we see the forced signal emerge from the natural background variability. This provides information to put the observed changes into a longer-term context, as well as provides projections as to where we are most likely to first see a forced trend emerge. For example, based on the CESM LE, the Davis Strait liquid freshwater export to the North Atlantic is showing full emergence from the natural variability of the background state between 2009 and 2037, indicating that significant changes might be imminent in the near future, despite no clear trend in the short observational record to date.

Wed_253_OS-6_1439
Frontal System Changes at the High Latitudes of the Southeastern Atlantic Ocean

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The transition between the South Atlantic and the Southern Ocean is marked by a frontal system that includes both the South Atlantic Current and the Antarctic Circumpolar Current (ACC). In the eastern part of the basin the latitudinal position of these fronts is thought to control the input of warm waters into the Atlantic basin through the Agulhas Leakage. Changes in the Subtropical and Polar regimes associated with the frontal system that composes the boundary between the Subtropical Gyre and the ACC are investigated using the simulation results of the ocean component of the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM), POP2. Sea surface height gradients and specific contours are used to identify and track the ocean fronts position. We compare the Subtropical Front position at the eastern edge of the South Atlantic to changes in temperature and salinity as well as Agulhas Current trans- ports and the overlying wind field in order to determine what could be driving frontal variability at this region and its consequences to mass transport from the Indian into the Atlantic. Results suggest that the Subtropical Front is not the southern boundary of the subtropical gyre, but it responds to changes in the "Supergyre", especially the Indian Ocean Subtropical Gyre expansion.

Wed_254_OS-6_1445
Future Changes of the Antarctic Coastal Current: A Downscaling Experiment

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The Antarctic Coastal Current (ACoC) plays an important role in the hydrographic properties of Antarctic continental shelf. This current helps to maintain the Antarctic Slope Front, and therefore the exchange between the cold and, relatively fresh waters from continental shelf and warmer, saltier waters offshore. However, the impact of the strengthening and shifting poleward of the southern hemisphere westerly winds observed in the last decades in the interplay between coastal winds, coastal current and heat distribution remains poorly understood. In order to understand this relationship, we investigated the ACoC variability and its influence in coastal oceanography dynamics using a high-resolution regional simulation with Regional Ocean Model System (ROMS) for the period of 1975 to 1999. The preliminary results shows that the model is capable to reproduce the ACoC and its seasonal variability. The maximum ACoC mean transport is approximately 6 Sv in 10°W, where this current becomes part of Weddell Gyre. For the same region, the ACoC transport reaches its maximum during austral winter (~8 Sv) and it is weaker during summer, decreasing by up to 2 Sv compared to winter. Results for temperature-salinity diagrams show that the model reproduces satisfactory the water masses structure in Weddell Sea, identifying predominant water masses for this region.

Wed_255_OS-6_1463
The MOMA Project - In Situ Observations and Numerical Simulations of the ACC

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The aim of the MOMA project is to describe the Antarctic Circumpolar Current (ACC) and its variability, in space and time, south of Africa on the basis of an up-to-date high-resolution observational dataset complemented with model simulations performed for this project.
To do this,
(i) a high-resolution observational database describing the ACC and its variability in the Southern Ocean sector south of Africa will be obtained through dedicated activities during SANAP oceanographic cruises;
(ii) a modelling activity based on sigma-coordinate ocean general circulation model (MACC) and an analysis of a dataset produced by a NEMO ocean/sea-ice global model provided by the LGGE-CNRS partner will be carried out;
(iii) experimental and modelling data will be combined to achieve a deep knowledge and understanding of the hydrographic and dynamical features of the region of interest and of the physical mechanisms that govern locally the variability of the ACC fronts and their predictability.
The MOMA project is part of the international efforts solicited and sustained by the Southern Ocean Observing System (SOOS) and in the First Antarctic and Southern Ocean Science Horizon Scan concerning the study of the Meridional Overturning Circulation, the ACC variability and their impact on global climate.
MOMA is funded by the Italian “Programma Nazionale di Ricerch in Antartide” (PNRA) grant nr. PNRA_16_00196.

Wed_256_OS-6_1508
Storm Impact on Ocean Mixing and Internal Waves under Arctic Sea Ice

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The internal wavefield under the Arctic sea ice is considered mild compared to open-water areas elsewhere. Sea ice insulates the ocean from the atmosphere, lessening energy transfers between those systems. Yet, with the transition in the Arctic to a first year ice regime that has a thinner and more dynamic ice cover, it is important to understand how energy is transferred, in particular from the atmosphere to the ocean.
Here we present mixing and internal wavefield observations from the upper ocean north of Svalbard using a six months' time series of microstructure and ADCP current data. Collected between January and June 2015 from ice camps during the Norwegian Young sea Ice (N-ICE2015) expedition, these data cover the Nansen Basin in pack ice, over the Yermak Plateau, through the marginal ice zone, and to the ice edge.
Our observations show that atmospheric storms strongly impact the ocean even under packed sea ice. Storms enhance mixing in the upper ocean with dissipation rates at the ice-ocean interface 10 times larger during storms than average unforced background values. Near-inertial signals with downward energy propagation follow strong storms. These storms also increase the velocity power spectra in the upper water column. The potential increase of storm frequency in the Arctic currently under debate would affect mixing intensity and distribution, with large implications for nutrient fluxes in the water column and heat fluxes at the ocean-ice interface.

Wed_257_OS-6_1512
Water Masses Circulation and Transformation in the Southern Weddell Sea

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The Weddell Sea is largely fuelling the global thermohaline circulation by transforming large amount of water masses and producing the densest waters of the world´s oceans. Water-mass transformation occurs over the entire area covered by the subpolar gyre, but the most intense and probably the least understood fluxes are concentrated near its southernmost fringe : at the Antarctica continental slope, on the continental shelf, and under the floating ice shelves. In this study, we explore the impact of a continental shelf break in restraining the flow across it, and investigate how water masses circulate and are transformed on the continental shelf, when it is reached. We use a unique combination of in-situ observations (e.g. moorings, profiling floats, instrumented seals and CTD casts) to investigate circulation patterns and water-mass characteristics and transformation on the continental shelf in the Southeastern Weddell Sea, as well as novel experiments done in a 13m diameter rotating platform to examine the dynamical constraints of the flow.

Wed_258_OS-6_1555
The Southern Ocean in Global Climate: The ORCHESTRA Programme

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The Southern Ocean accounts for around half of all oceanic uptake of carbon, and more than three-quarters of the heat uptake. Despite its profound importance, the Southern Ocean is also the least measured and arguably the least understood of the world's oceans: its remoteness and inhospitable nature have led to a dearth of sustained, strategic measurement programmes, and the small-scale and complexity of many of the key processes have precluded the desired advances in simulation. To address these issues, a new £10M programme funded by the United Kingdom NERC has now commenced - 'Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA)'. ORCHESTRA will span five years and use a combination of data collection, analyses, and computer simulations to radically improve our ability to measure, understand and predict the circulation of the Southern Ocean and its role in the global climate. It will make unique and important new measurements in the Southern Ocean using a range of techniques, including basin-wide ocean/carbon/tracer sections, as well as deployments of autonomous vehicles, meteorological aircraft, seal tagging and other innovative techniques for collecting data. It will also involve the development and use of advanced ocean and climate simulations, to improve our ability to predict climatic change in coming decades. This poster will outline the rationale, plans and key results from the ORCHESTRA programme.

Wed_259_OS-6_1627
Finding Mooring Datasets for Southern Ocean Scientists

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Mooring data are critical for understanding dynamics in oceans because they provide long time-series of observations from a single location. They are particularly valuable in the Southern Ocean where observations of all kinds are spatially and temporally sparse. Many hundreds of moorings have been deployed in the Southern Ocean in recent decades, but to date it has been difficult to find the resulting data, which are scattered across numerous data repositories around the globe.
Now, however, the Southern Ocean Observing System and our colleagues have compiled a central list of historic and current mooring deployments with links to the data centres that host the data. This is a low-tech, community-driven solution to the lack of centralised data management and will improve data discovery for a neglected data type.
As part of this project, we have also worked to rescue unpublished datasets from scientists' hard drives and filing cabinets. This data rescue operation has involved working with individual scientists to convert their data to an international standard and to write comprehensive discovery metadata records before curating the data itself in international data repositories. In this presentation, we will share our progress in data rescue and invite input on future needs for managing and sharing these valuable datasets.

Wed_260_OS-6_1628
SOOSmap: Finding and Accessing Circumpolar Southern Ocean Data

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For many scientists, finding comparison data to complement their fieldwork is a persistent problem. SOOSmap is a new way to find data from many disciplines in one convenient place. Through SOOSmap, you can find data from many of the world's data centres and explore thematic, spatial, and temporal gaps in the existing set of observations.
The Southern Ocean Observing System (SOOS) is tasked with finding ways to better aggregate and share observing data from around the Southern Ocean. We are developing SOOSmap with our colleagues at the EMODnet Physics group, who have developed data sharing infrastructure for European marine observing data and are now expanding their horizons to support marine observation systems in other parts of the globe.
In this presentation, we will share our progress in developing SOOSmap as a tool for discovering biological, physical, cryospheric, and other environmental data and for exploring gaps in the existing networks of observations. Through SOOSmap, you can filter data layers and time periods to narrow your search to only the most relevant datasets for your purpose.

Wed_261_OS-6_1729
Under-ice Turbulence and Vertical Fluxes in the Arctic Ocean in 2015

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The Arctic Ocean is a quiescent ocean due to its sea ice cover and a strong halocline, which decouple the subsurface ocean from atmospheric processes. For a better understanding of the Arctic ocean, sea ice, and ecosystem it is important to understand processes that drive the vertical energy and matter fluxes in the water column. Nevertheless, direct flux measurements are difficult to obtain and therefore sparse. We present under-ice turbulent microstructure observations from the Eurasian and Makarov Basin of the Arctic Ocean from two expeditions in 2015. These cover periods of melt during late spring north of Svalbard and freeze-up during anomalously cold late summer conditions across the Eurasian and Makarov basins. Long-term (4-24 h) sampling generally showed elevated dissipation rates at the base of the mixed layer with strongest dissipation near the Eurasian continental slope. In the Makarov Basin, the presence of Bering Sea Summer Water led to stratification and enhanced dissipation within the upper halocline in the Makarov Basin. We discuss these findings in the light of the anomalous conditions in the upper ocean, sea ice and atmosphere during 2015 and present estimates of vertical fluxes of heat, salt and other dissolved substances across the Arctic Ocean.

Wed_262_OS-6_1738
Subtropical Frontal Mixing and Turbulence in the Indian Sector of Southern Ocean

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AbstractIn the subtropical frontal region the upper layer diapycnal mixing studies were carried out using the microstructure shear profiles measured during one of the expeditions to Indian sector of Southern Ocean. In the dynamic and extremely turbulent subtropical region nitrate flux was calculated with the nutrient and turbulence measurement. The low nitrate flux indicates weak turbulence and weak vertical gradient of nutrient. The eddy diffusivity ($K\rho = 10^{-5}$ m^2/s) has been computed and its application to nutrient gradient appears that the nutrient supply in the study period may not be due to vertical diffusion and a very low quantity of nutrients is supplied through this process. Hence it can be suggested that the vertical supply of nutrients perhaps may be due to advection.

Wed_263_OS-6_1754
Experimental Highlights of the Eddy Saturation Regime in the Southern Ocean

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Drifter, satellite, XBT and Argo float data are used to define the response of the Pacific Sector of the Southern Ocean (PSSO) to the large scale climatic patterns as depicted by the Southern Annular Mode Index -SAMI- and the Multivariate ENSO Index - MEI in the period 1995-2017.
During this period, the SAM index is predominately positive, strengthening the westerlies, but ENSO might have played an important role producing an increase/decrease of the EKE during La Niña/El Niño events. In fact, The interplay between SAM and ENSO generates peculiar scenarios with different ocean responses where positive values of SAMI are positive/negative correlated with the EKE when MEI is negative/positive.
In particular, the effects of the SAMI trend are consistent with an increase of the eddy kinetic energy (EKE) field and the ACC transport relatively constant up to the 2007.
Results confirmed that the ocean state were close to the eddy saturation regime up to 2007 underlining the important role of eddies in modulating the ocean circulation response to the main atmospheric forcing. After 2007, the ACC transport shows a different pattern with three well defined maximums. Two of them are in agreement with the SAMI and MEI phases whereas there is the maximum on 2012 that is still difficult to explain.

Wed_264_OS-6_1788
Horizontal Advection Critical for Maintaining an Antarctic Biological Hotspot

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Along the Western Antarctic Peninsula, ecological hotspots are spatially coherent with submarine canyons and have persisted for millennia. Palmer Deep Canyon, a representative hotspot, is known to have higher phytoplankton biomass than the surrounding non-canyon regions. The physical mechanisms that maintain and deliver phytoplankton and Antarctic krill biomass, potentially increasing prey availability to predators, are not well known. To better understand these important mechanisms, we deployed a purpose built integrated polar observatory consisting of high frequency radar, coordinated gliders, and moorings. The gliders identified a depth dependent influence of the underlying canyon bathymetry on physical and biological variability. A series of simulated particle release experiments in the HF radar current maps were used to estimate surface residence time and connectivity across the canyon. With an average residence time of 2 days, our analysis indicates that the elevated phytoplankton biomass over the central canyon is transported into and out of the hotspot on time scales much shorter than the observed phytoplankton growth rate, suggesting that the canyon may not act as an incubator of phytoplankton productivity as previously suggested. It may instead serve more as a conveyor belt of phytoplankton biomass produced elsewhere, continually replenishing the phytoplankton biomass for the local krill community, which in turn supports numerous top predators.

Wed_265_OS-6_1947
Italian Mooring Observations in the Western Ross Sea from 1995 to 2016

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Antarctic Bottom Water (AABW) plays an important role in the deep ocean stratification and in the transport of heat, carbon and nutrients throughout the global ocean. In the Pacific Sector of the Southern Ocean, the Ross Sea is responsible for shaping the properties of approximately 25% of the world´s AABW.
The Italian Marine Observatory in the Ross Sea (MORSea) project, funded by the Italian National Program of Research in Antarctica (PNRA), has a network of four active moorings in the western Ross Sea: two located in the Terra Nova Bay polynya, where the AABW precursor (High Salinity Shelf Water) is formed, and two close to the shelf break in the Drygalski and Joides troughs where the AABW is formed from the interaction of the shelf waters and the warm circumpolar deep water and subsequently exits from the continental shelf.
This network together with 3 moorings deployed from 1998 to 2007 in the central Ross Sea have an important role to assess the cross-shelf exchanges processes and changes in the AABW formation in the Ross Sea and how rapidly these changes occur.
Here, we present temperature and salinity time series and the flows variability measured at the four moorings from 1995 to 2016 to describe trends and variability of the water properties inside the Ross Sea. In particular, the flow and water properties variability associated with the tides and mesoscale instabilities are considered to establish their role in the cross-shelf exchange processes.

Wed_266_OS-6_1972
Changes of the Mixed Layer Depth in the Greenland, Labrador and Irminger Seas

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Deep convection (DC) in the Greenland, the Labrador and the Irminger Seas form the main source of waters of the Atlantic Meridional Thermohaline Circulation (AMOC), and presents an important component of the global climate system. The DC is formed in highly localized mesoscale regions and is accompanied by formation of submesoscale convective cells, instability vortices, narrow jet streams, which makes it difficult to observe in-situ and reproduce in ocean models. In this study we analyze the DC variability using 3 complementing data-sets: in-situ data from EN4 Hadley Centre dataset, SODA ocean reanalysis model and ARMOR3D dataset, combining satellite and in-situ observations, data covers period from 1993 to 2015. The Mixed Layer Depth (MLD) was calculated using Montegut (2004), Kara (2003) and Dukhovskoy (2017) methods. Interannual variability of DC, based on analysis of all available in-situ profiles, show significantly shallower DC, as compared to ARMOR3D and SODA data. The latter results also show the similar tendencies with various DC indices (integral potential energy, volume of the water mass formed, etc.)
The research was supported by RSF (project No. 17-17-01151)

Wed_267_OS-6_1990
On the Response of the LEC for the Southern Ocean to Intensified Westerlies

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The potential impact of intensified westerlies on the Lorenz Energy Cycle for the Southern Ocean is examined by employing a global eddy-permitting ocean-sea ice model. Two idealized sensitivity experiments are designed for this purpose: one is driven by 1992 forcing with weaker westerlies and the other driven by 1998 forcing with stronger westerlies. The intensified westerlies lead to the most significant increase of about 30% in the EKE, followed by the mean kinetic energy (MKE) increase (17.9%), eddy available potential energy (EAPE) increase (8.6%), and mean available potential energy (MAPE) increase (6.5%). In contrast, the increases in the generations of kinetic energy and available potential energy are quite similar, ranging from 21% for EAPE generation to 26% for MKE generation. There are considerablly increased energy transfers from MKE to MAPE (about 75%) and from MAPE to EAPE (about 78%), reflecting greatly enhanced baroclinic instability pathway. The conversion rates are strongly influenced by large topography; in particular, a relatively large energy conversion from EKE to MKE exists in the regions associated with large topography, in contrast to the energy flow from MKE to EKE over the broad Southern Ocean. Under stronger wind forcing, all energy conversions are enhanced, and the increases in the conversion rates from EAPE to EKE and from EKE to MKE are more prominent than the increases from MKE to MAPE and from MAPE to EAPE near large topography.

Wed_268_OS-6_2122
Benefits of High Resolution Modeling of the Ocean and Sea Ice in Adelie Land

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Benefits of high resolution modeling of the ocean and sea ice in Adelie Land
A set of regional simulations is performed in the d'Urville sea, Eastern Antarctica. This coastal area boarded by the Antarctic Slope Front, is one of the windiest place in the world and a major spot for dense water formation. Our goal is to assess the importance of spatial resolution and the explicit reprensation of small scale processes in the ability of the model to reproduce sea ice state and ocean circulation. For this purpose, two resolutions - respectively 1/4° (~10km) and 1/24° (~2km) - will be tested in the NEMO-LIM3 model during years 2010-2013. To also evaluate the effect of interactions with the atmosphere, both configurations will be forced by DFS (0.75° ~30km) and by outputs of the MAR atmospheric model at 8km resolution. The simulations will be analyzed with several foci : at a regional and seasonal scale (~500 km) to evaluate the effect of resolution on heat, momentum and freshwater fluxes. Then, at a smaller scale (~50km), we will give a closer look at the circulation on the continental shelf and the way it is linked to sea ice, ice shelf melting and katabatics. Finally, a focus will be given to the air-sea interface in the presence of sea ice, to investigate in which way small scale processes could influence fluxes between the component of the polar climate.

Wed_269_OS-6_2181
Under Ice Robotic Exploration of the McMurdo Sound and Ross Ice Shelf

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The NASA-funded RISE UP program (Ross Ice Shelf & Europa Underwater Probe) is a three-season project to monitor basal ice conditions, ice-ocean interactions, and environmental conditions from the ice to the sea floor beneath the McMurdo sound sea ice, the McMurdo Ice Shelf, and the Ross Ice Shelf. The main feature of the program is the novel and scientifically capable Icefin hybrid AUV/ROV vehicle that will conduct surveys from the ice to the seafloor to provide an integrated picture of the conditions below the ice. Nominally, the project will conduct its work in the 17/18, 18/19, and 19/20 austral summers. In cooperation with the Antarctica New Zealand Ross Ice Shelf Programme, PI Christina Hulbe, RISE UP will also deploy Icefin through a borehole at two positions on the Ross Ice Shelf to access previously unmapped regions of the sub-shelf water column.
I will highlight the first results of RISE UP's first field season from October 2017 to early January 2018. This season includes data collection at three sea ice locations, two that allow us to swim Icefin underneath the ice shelf, and one at the Erebus Glacier Tongue. Onboard Icefin, we collect data from two sonars, two cameras, a DVL/ADCP, and sensors for conductivity & temperature, depth, pH/ORP, DO, CDOM/FDOM and turbidity. I will describe Icefin, and provide preliminary observations of the basal ice conditions, oceanographic properties below the sea ice and ice shelves, and seafloor conditions we observed.

Wed_270_OS-6_2186
Variability of Ocean Properties along the West Antarctic Peninsula Shelf

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The west Antarctic Peninsula shelf has been one of the most rapidly-warming systems in the southern hemisphere, and glaciers terminating in this coast have undergone dramatic retreat, although with a distinct along-shore pattern: on average, those in contact with the colder waters in northern Bransfield Strait have retreated slower than those terminating in the warmer, southern central coast. The supply of warm Circumpolar Deep Water to this southern region is modulated by deep troughs cutting across the shelf which steer the circulation, and provide a pathway for relatively small, warm ocean eddies to carry heat shoreward. Here, we use the output of the highest-resolution, shelf-wide numerical model available for the wAP as well as available hydrographic data to characterize the spatial and temporal scales of variability of the ocean properties forcing glacier retreat along the coast. The model (ROMS) configuration is eddy-resolving at 1.5 km horizontal resolution, includes 24 vertical levels, and was forced with realistic meteorological fields and observed sea-ice (at the model boundaries) for two years. Results show that the deep northern shelf water variability is dominated by seasonal inflow from the Weddell Sea and bottom-intensified synoptic variability while in the southern wAP shelf seasonal variability in deep water properties is mostly absent. The dynamics of exchange between these two regions and the implications for glacier retreat along the wAP are discussed.

Wed_271_OS-6_2231

12-day Arctic Ice-tethered Mooring: Velocities, Particles and Plankton Migration

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Observational data of the under-ice circulation characteristics were collected in June 2017 during a twelve-day ice drift over the northern Yermak Plateau (approx. 82°N/10°E), as part of the R/V Polarstern expedition PS106. A top anchored mooring line equipped with three upward looking RDI Acoustic Doppler Current Profilers (ADCP) and three SBE microCATs (CTD) was deployed through the ice with the main purpose to measure under-ice water velocities and temperature/salinity characteristics in the upper 180 m of the water column. Additional measurements of under-ice particle size distribution and concentration were undertaken with a Laser In-Situ Scattering and Transmissometry (LISST) particle size analyser, both in profiling and constant-depth mode. Supplemental data of the water properties were collected with the standard shipboard instrumentation. Here, we present results in terms of the vertical and horizontal under-ice water motion and the consequences for the distribution of mass and heat within and below the mixed layer. The ADCP data are additionally interpreted as sound scattering layers used to identify vertical migration patterns of small mesozooplankton (a few mm in size). Our study provides yet some pieces of information about the under-ice dynamics and the vertical positioning of organisms in the spring-to-summer transition of the Arctic Ocean.

Wed_272_OS-6_2282
Interannual Variability of Modern Fram Strait Outflow Revisited

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Several studies have shown strong variability in the composition of shallow waters leaving the Arctic Ocean through the western Fram Strait. In particular, the fraction of Pacific-derived waters has been suggested to vary annually from dominating to absent. However, this fraction has been determined by calculations involving dissolved nutrient relationships, which can be altered by biogeochemical processes (occurring, for example, on the Greenland Shelf) and, hence, not always reflect water mass advection and mixing alone. An alternative approach uses dissolved radiogenic neodymium (Nd) isotopes (expressed as ε_{Nd}) to identify and quantify the different Arctic water mass components present in the outflowing Arctic waters. This method is applied here to review the interannual variability of the outflow composition. New dissolved ε_{Nd} data obtained for the years 2014, 2015 and 2016 for the western Fram Strait are complemented by Nd isotope data previously reported for 1999, 2002 and 2012. Constant ε_{Nd} signatures near -9 and Nd concentrations of ~30 pmol/kg in the core of the outflow are observed for all investigated years and reflect nearly steady contributions of Pacific- and Atlantic-derived waters at a ratio of ~2:3, and minor slightly varying riverine inputs. The remarkably constant Nd characteristics argue for a stable composition of the outflowing Arctic waters, which allows us to hypothesize that the annual outflow was more uniform in the past than previously assumed.

Wed_273_OS-6_2411
Southern Ocean Stratification Delayed by Submesoscale Wind-front Interactions

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Ocean stratification and the upper mixed layer influence the rate and magnitude the ocean absorbs and stores atmospheric heat and carbon. One way in which these air-sea fluxes are moderated is through the interaction between surface winds and ocean flow fields, such as fronts and eddies. The energetics of the ocean are particularly amplified at submesoscales (1-10 km) which manifest in regions of large horizontal density gradients. Both strong atmospheric forcing and submesoscale features are ubiquitous in the Southern Ocean. We use four high-resolution glider experiments to investigate the impacts of these wind-front interactions on upper ocean processes in the Subantarctic Zone. The mixed layer is found to have a strong seasonal signal superimposed with large submesoscale fluctuations. These periods consist primarily of MLD deepening phases which drive an offset in the onset of summer restratification by up to 35 days. Summer restratification is arrested when the winds orientated along the flow of fronts (down-front) induce a destabilising flux via a horizontal Ekman buoyancy flux (EBF) towards the less dense domain of the front. By incorporating an EBF equivalent heat flux into a 1D model, the upper ocean stratification improves significantly compared to when the model is run using 1D forcing. This study shows the need to incorporate submesoscale processes, such as EBF, into global climate models to correctly account for upper ocean processes that impact climate.

Wed_274_OS-6_2497
Modification of Atlantic Inflow along its Northern Passage into the Arctic Ocean

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Understanding variable oceanic fluxes of volume and heat, carried by Atlantic water (AW) into the Arctic Ocean, and their impact on ocean-atmosphere-ice interactions, ocean heat content, sea ice cover and propagation of anomalies are key challenges to understand the new, warmer regime of the Arctic Ocean. As the AW progress northwards, its properties are modified by ocean-atmosphere interactions, mixing and lateral exchange. AW temperature drops from 7-10°C at the entrance to the Nordic Seas to 3-3.5°C when it leaves Fram Strait. Warm anomalies reaching the Arctic Ocean can result from smaller heat loss during AW northern passage towards and through Fram Strait, and/or from an increased oceanic advection. During the last two decades the extraordinary warm Atlantic water inflow has been reported to progress into the Arctic Ocean, however with strong interannual variations. Here we present results from 20 years of annual hydrographic surveys, covering the Atlantic water inflow in the eastern Norwegian and Greenland seas, Fram Strait up to the southern Nansen Basin. Observations from year-round moorings west and north of Svalbard and regularly deployed Argo floats are also used to elucidate processes contributing to AW modifications during its passage into the Arctic Ocean. Long-term observations reveal new details on spatial structure and temporal evolution of warm anomalies carried into the Arctic Ocean, and their links to heat fluxes and sea ice variability north of Svalbard.

Wed_275_OS-6_2534
Contrasted Sea Ice Response to Increased Freshwater Flux from Antarctic Glaciers

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Antarctic outlet glaciers are undergoing rapid transitions. Induced changes in freshwater release to the Southern Ocean have been suggested to contribute to ongoing trends water mass properties and sea ice regimes. However, ocean/sea-ice models disagree as to the quantitative response of the Southern Ocean to changes in glacial freshwater forcing.
In this study, a series of ocean/sea-ice modeling experiments is undertaken with NEMO global 1/4° model configuration in order to study the physical processes involved in the changes of Southern Ocean sea ice over recent decades. Perturbation experiments are carried out with respect to atmospheric and freshwater forcing over recent decades. The freshwater forcing scenario explicitly takes into account the observed changes in the volume of Antarctic ice shelves, which is found to be a key component of changes in freshwater release.
Our results show that changing freshwater release overall increases Antarctic sea ice extent, but with distinctive regional patterns and with large changes in sea-ice thickness. The processes involved in the response differ substantially from region to region depending on the local conditions. Our results suggest that up to one half of the observed total changes in sea ice extent over recent decades might be due to changes in freshwater release, the other half being induced by atmospheric changes. This study emphasizes the need for improving the representation of freshwater sources in climate models.

Wed_276_OS-6_2577
Existence of the Mendeleev Gyre and its Role in Arctic Circulation

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On the basis of *conductivity, temperature, and depth (*CTD) *and* nutrient data obtained during the Korean R/V *Araon* 2012 summer Arctic cruise, a gyre-like local circulation in the Chukchi Abyssal Plain is identified as the Mendeleev Gyre (MG). Evidence supporting the existence of the MG includes uniform temperature, salinity, and density in the central plain; a cold core surrounding the plain; a bowl-like surface steric height embedded in the background field; and a lens structure appearing in the vertical section. The nitrate-phosphate (N-P) relationship in the Chukchi Abyssal Plain suggests gyre-like mixing. In an ice-ocean coupled model used to simulate the MG and its multiyear variation, a gyre-like flow pattern is shown to appear only during 2011-2014 corresponding to the sea ice retreat, particularly in 2011 and 2012. Therefore, the MG might be an accompaniment of sea ice retreat. Lateral entrainment is suggested as the driving factor of the MG. The eastward boundary current and the northwestward Pacific inflow provide momentum and relative vorticity by lateral turbulent friction, which facilitates the current leaving from the isobaths to generate a gyre. The inclined isopycnal interfaces from west to east are verified to facilitate an eastward slope flow along inclined isosteric height interfaces. The MG plays the role of a watershed in preventing the outflow of the shelf water and benefiting the colder and fresher shelf water transported directly to the Canada Basin.

Wed_277_OS-6_2626
Pacific Waters in Eastern Chukchi Sea Observed by Chinese Cruises in Last Decade

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Multi-disciplinary observations have been conducted by the Chinese Arctic Research Expeditions (CHINARE) at several sections in Chukchi Sea since 1999. With CTD data from 6 CHINARE cruises during 1999-2014 and outputs from a coupled sea ice - ocean numerical model, Pacific inflows in the Chukchi Sea and their inter-annual variations are analyzed. These sections are limited in the eastern Chukchi Sea, consist of one meridional section along 169°W and several nearly zonal sections between the meridional section and the Alaskan coast. The Alaskan coast water (ACW) occurred in the east end of the zonal section to the Point Hope, as a northward coastal current. The ACW observed in 2012 and 2014 were obviously warmer than that in 2010, approaching to 10°C. At section 169°W, relative warm and fresh waters concentrated at surface layer in the Central Channel to the south of the Herald Shoal, with two separate cores observed in some cruises (e.g. 1999, 2003 and 2010). These waters are identified as ACW with the additional supports from numerical model outputs. The simulated circulation shows that a branch (or two branches) of ACW flows to northwest from Point Hope, across 169°W and reaches Herald Canyon, while most ACW still flows toward northeast along Alaskan coast and enters Barrow Canyon. The thermohaline structure around Herald Shoal showed large inter-annual variability, which implies the complicated interactions between different water masses, including Pacific waters.

Wed_278_OS-6_2634
Circulation of the Weddell Gyre Inferred from Long-term Observations

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The Weddell Gyre plays a fundamental role in the climate system by advecting heat poleward to the Antarctic ice shelves and by regulating the density of water masses that feed the lowest limb of the global overturning circulation. Profile and trajectory data between 2002 and 2015 from a fleet of Argo floats between 50 and 2000 m are exploited in order to produce a full gyre scale view of the Weddell Gyre's circulation. The data exhibit a gradual cooling of the Warm Deep Water (WDW) as it circulates cyclonically around the gyre. A double-cell structure of the Weddell Gyre is revealed, with a stronger eastern core that intensifies with depth, and a weaker western core that remains invariant with depth. The deep outflow of Weddell Sea Deep and Bottom Water (WSDW, WSBW) at the western boundary of the gyre, formed from WDW by complex modification processes involving sea ice formation, and basal ice shelf melting, is not covered by the float observations. Using mooring array-based observations near the tip of the Antarctic Peninsula between 1989 and 1998, and between 2005 and 2014, a cooling of the WSBW plume is revealed over the observational period. This is in striking contrast to the WSDW in the interior Weddell Sea which has been undergoing a decadal warming. While the cause of the cooling of the WSBW plume is currently unclear, the mooring-based velocity observations indicate that the volume transport of the WSBW plume of 2.5 Sv has been stable over time.

Wed_279_OS-6_2644
Decadal Covariability of Arctic and Subarctic North Atlantic Freshwater Content

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Significant freshwater changes have recently been observed both in the Arctic Ocean and the subpolar North Atlantic. To investigate possible links, we compared the liquid freshwater content of the subarctic North Atlantic with the sum of liquid and solid freshwater content of the Arctic Ocean from observations. We found a distinct decadal anti-correlation of the freshwater anomalies in these two regions with anomalies of almost the same magnitude. An analysis of freshwater fluxes from the global Finite Element Sea ice Ocean Model (FESOM) and the CORE2 atmospheric forcing data set revealed that the observed freshwater variations resulted from changing freshwater transports. Furthermore these changes are correlated with the Arctic and North Atlantic Oscillation indices. We suggest that changing freshwater export from the Arctic Ocean to the subarctic North Atlantic responds to multidecadal alternations of the dominant large-scale atmospheric variability. According to the present phase of this large-scale atmospheric variability, the freshwater accumulated during the previous decades in the Arctic Ocean might be released into the sub-Arctic Seas in the coming years. This has the potential to impact the North Atlantic meridional overturning circulation. To further investigate the involved processes, find the driver of freshwater transport changes and proof our hypotheses we show further results from the FESOM simulation and an analysis of the atmospheric forcing.

Wed_280_OS-6_2648
Wind Flows and Ocean Surface Currents in Marginal Ice Zone with Satellite Data

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Marginal ice zone (MIZ) is an area of active interaction between atmosphere, ocean and sea ice. The change of roughness and temperature over the underlying surface (ice/open water) impacts the wind speed and direction. Accurate wind estimates are the core not only for more exact heat fluxes assessments in rapidly changing environment, but also can help to predict the wind drift on the short time-scales. The estimates of wind drift in MIZ can help to reconstruct the ocean surface currents speed finally.
With the lack of in situ measurements in MIZ, one of the best tools covering large areas in polar regions is satellite data. We studied the transformation of wind flows using high resolution Sentinel-1/SAR-C data. The wind fields were calculated from EW Sentinel-1 images with CMOD-5 geophysical model function at 500 m horizontal grid and then compared to ECMWF ERA-INTERIM reanalysis wind data. The possible role of the fetch when calculating wind speed with CMOD-5 is discussed. Several configuration of wind flows position according to the sea edge were studied: on-ice/off-ice, for weak and moderate wind speeds. The estimates of wind-driven ice drift and ocean surface currents are provided for the case studies in 2014-2017 in the Arctic.

Wed_281_OS-6_2649
Variability and Drivers of the Ice-covered Ross Gyre Circulation

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The Ross Gyre (RG) is one of the main current systems of the polar Southern Ocean, and conveys the warm waters from the Antarctic Circumpolar Current toward the cold continental shelves of the Antarctic Pacific sector - regulating the stability of the Ross Ice Shelf. Due to the seasonal sea ice cover, little is known on the variability of the RG circulation and its driving forces. Here, novel altimetry data from Cryosat-2 is used to document the variability and drivers of the RG circulation in the period 2011-2015. The variability of altimetric sea surface height (SSH) is highly coherent with that of ocean bottom pressure inferred from the GRACE mission, suggesting that RG variability on time scales up to interannual has a dominant barotropic component. The ocean surface stress curl was identified as the main driver of the observed variability in the surface circulation. Statistical analyses indicate that variations in the area and strength of the RG are regulated by ice-mediated wind forcing via two distinct dynamical modes of SSH variability:
(1) one involving barotropic modes that either follow the continental shelf break around the entire Antarctic continent or are trapped within the Southeastern Pacific basin;
(2) and another implicating coherent variability across all ice-covered regions of West Antarctica. This work illustrates the potential of this new altimetric technique in uncovering the nature and dynamics of the circulation in the ice-covered Southern Ocean.

Wed_282_OS-6_2679
Remote Sensing of Eddies in the Arctic Ocean

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Here we present the results of high-resolution satellite observations of oceanic eddies over the selected Arctic regions, including the Eurasian Arctic sector, and Chukchi and Beaufort Seas. The study is based on analysis of a large dataset of ENVISAT Advanced Synthetic Aperture Radar (SAR) images acquired in summer-autumn 2007-2011. Detailed maps of eddies' locations, their diameters and vorticity sign are presented and discussed. This work is supported by RFBR grant 16-29-02106 mol_a_dk, RSF grant No. 17-77-30019, and FASO Russia project No. 0827-2014-0011. ENVISAT ASAR data used in this study were provided by the European Space Agency (ESA) through Cat-1 Project C1F-29721.

Wed_283_SH-4_25
The Sealer-Whalers' Footwear in Livingston Island: Clothing in the 19th Century

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The research discusses the cultural identity of the sealer-whalers who were in the Livingston Island (South Shetland Islands, Antarctica) in the nineteenth century through the practices of footwear. The studies were developed from the shoes archaeological collection rescued by the LEACH/UFMG-Brazil. Three groups of related materiality were investigated: the footwear; the bodily practices; and the Antarctica as a place of experience. The study of the format indicates the permanence of models and traditional construction techniques of their shoes. However, they also incorporated the industrial production of the early nineteenth century and, often, articulated to the supply of ships and the whaling crew. All identified units or parts come from simple shoe models similar to "slippers". There are no adornments or use of other aesthetic features among the shoes of ordinary whalers. The shoes have heavy usage and repairing marks and evidence of material removal. These data tell us about the unavailability of resources and how footwear functioned as an interface between physical performance and the work space in Antarctica.

Wed_284_SH-4_26
The Conservation Practices of Sealer-Whalers' Remains in Livingston Island

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The proposal aims to present questions about the methods of the conservation after the archaeological excavation of the sealer-whalers sites in the Livingston Island (South Shetland Islands, Antarctica). These objects are characterized mainly by the presence of very fragile wet organic materials; only preserved by the specific conditions provided by the Antarctic context. The hunters were taken to the islands by whaler shipping companies during the first half of the eighteenth century. They performed their hunting activities in the summer months, living on the beaches in shelters built from rocks found in the region and other resources. Since the first excavation expedition made by the (Leach/UFMG-Brazil), in 2010, an axis of research that articulates the methodology of excavation to conservation has been developed.

Wed_285_SH-4_296
Remoteness, Environmental Protection, Mobility and Antarctic Material Remains

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This presentation explores the relationship between heritage and environmental protection in Antarctica through focusing on the potential mobility of Antarctic material remains. Using research infrastructures as an example, I ask to what extent heritage designation can be not only geopolitically motivated but also a more pragmatic strategy - for example, to avoid the cost of removal. This also leads to the question of whether or not particular historical remains' heritage status can be enhanced through removal to a more accessible site - and what value impact that has. Could the *de facto* exemption of pre-1958 structures from environmental regulations be seen as a testament to different environmental regimes in the past, and of the remains' importance to particular national narratives? Have the values of environmental protection that underlie removal and eradication programs influenced Antarctic cultural heritage and if so, how does this reflect on our understanding of the relationship between cultural heritage and the Antarctic environment?

Wed_286_SH-4_611
Trust in the System of the Formation of Social Capacity in the Arctic Region

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One of the foundations of social harmony, largely determining the dynamics of the development of the social situation is trust which is acting as confidence in the integrity and sincerity of others or the state and public institutions.
Sociological studies conducted by the authors in recent years in the Yamalo-Nenets Autonomous District recorded a decrease in the level of trust among representatives of different social groups of the population. Thus, mass surveys on representative samples in cities, shift camps and national villages showed that indigenous people representing one northern ethnos less trust the others, and, especially, alien visitors who live in the North constantly, are increasingly negative to shift workers from other regions.
It was found, that the greatest level of social dissatisfaction, pessimism and distrust to the authorities was expressed by the representatives of indigenous ethnic groups (Nenets, Khanty and Selkups), who believe that "they are all deceived". They are often afraid to answer frankly (about half of the respondents chose" difficult to answer" option).
Meanwhile, the social situation in the Arctic and subarctic regions, the resources of which have provided the economic stability for many years, remains largely outside the field of attention of the authorities and the expert community. At the same time, there are still latent processes of social frustration, which can lead to unpredictable forms of protest.

Wed_287_SH-4_824
Cultural Heritage and Commercial Fishing in the Southern Ocean

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The cultural heritage of Antarctica reflects over two hundred years of human presence in the region, primarily early exploration, site occupation and scientific research. The exploitation of Antarctic marine ecosystems began early on with sealing and then whaling. In the past several decades commercial fishing for finfish and krill has been one of the dominant forms of human presence in the Antarctic region. Although now regulated by different instruments and bodies, sealing, whaling and some of the earlier commercial fishing resulted in over-exploitation of target species and a lasting ecosystem legacy. Paradoxically, the material cultural record of commercial fishing is almost entirely absent or invisible in Antarctica, including a lack of associated Historic Sites and Monuments. Since the establishment of the Commission for the Conservation of Marine Living Resources (CCAMR) the legacy of fishing includes a body of databases and scientific knowledge, legal instruments, and “lines on the map” reflecting spatial management measures. Southern Ocean fishing is also associated with some places outside Antarctica. This presentation discusses some concepts of cultural heritage as they apply to Southern Ocean fishing. It suggests that the history and heritage of fishing requires more public visibility. This would contribute to maintain the memory of past over-exploitation and to increase the transparency of CCAMLR's management of Antarctic marine life.

Wed_288_SH-4_880

Managing Antarctic Heritage: The Sealer Sites in the South Shetland Islands

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The concern about the protection and conservation of historical patrimony in Antarctica has been developing during the last decades. These efforts are evidenced by the creation of guidelines and resolutions that aim to avoid the destruction and damage of the sites caused specially by human activities.
Sealer sites of the nineteenth century identified in the South Shetland Islands are in an ambiguous position considered part of this patrimony. Differently to other “relevant” historical sites, these places are not directly linked to one particular nation (for example the Heroic Era huts), resulting in a lack of interest in developing conservation strategies. As a consequence of this, several factors that impacted negatively on the conservation of these places have been identified, the main ones being: natural causes (presence of animals and rising sea levels), the increasing tourism activity in the area and the presence of other researcher's parties in the location. Taking this situation as a starting point, in this presentation we seek to discuss the initial actions that have been carried out by the Antarctic Historical Archaeology Project in order to secure the preservation of these sites. At the same time, we aim to encourage a broad and interdisciplinary discussion between researchers from different disciplines that can help to generate new ways of cooperation and dialogue concerning the conservation of the historic patrimony in Antarctica.

Wed_290_SH-4_2359
Shooting the Arise of the Antarctic Overwintering Social Institution

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In 1927 the Argentine José Manuel Moneta, head of the Meteorological Station at Laurie Island, shot there the documentary *Among Orkney Islands ice* (Entre los hielos de las islas Orcadas). Through a sociohistorical analysis of its representations, this paper considers this film as a cinematic document of a new Antarctic social institution, which includes a series of practices internalized by scientists overwintering on permanent stations. Since 1904 these practices were institutionalized through logistical and scientific crews that are yearly relief and today this is one of the most characteristic features of the Antarctic science. The film shows a new form of human activity in Antarctica in a way that differentiates from the heroic age and its most characteristic elements. There, a scientific station becomes the space where scientific activity develops over twelve months, repeating itself each year with a set of elements and social practices that defines it to the present. Moneta shot the documentary during his third winter in Antarctica. He overwintered four times, so he knew very well the details of regular overwintering scientific experience and filmed those practices in the Antarctic environment to show them to the society. Here we will also use his book *Four Years in the South Orkney Islands* (Cuatro años en las Orcadas del Sur) to complement the analyses with other media and understand how this Antarctic social institution was perceived at that time.

Wed_291_SH-4_2454
Antarctic Wintering Art of Living: AWAL

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The Antarctic Observatory CryoSalide project looks at the human presence organization in southern environments. In this intention, the AWAL project is dedicated to the collection and the highlighting of craft and art developed on Antarctic stations during wintering periods. In order to compensate some lack of equipment, craft has naturally being developed, using the limited local means. These creations are unique witnesses of the art of living in Antarctica, and it represents a precious culture heritage, which should be known, collected, archived and valued, Focusing on both Dumont d'Urville (Adélie Land) and Dome C Concordia (East-Antarctic plateau) stations, we offer to conduct a preliminary inventory of art and craft realisations locally performed. Thanks to the voluntary participation of people who have wintered, the AWAL team will provide a catalogue describing, explaining and referencing the different kind of arts (fine arts, culinary art, etc.) developed during wintering times. This data base will be available from the Antarctic Observatory CryoSalide under creative common license (or other to be defined). The purpose is to make this Antarctic art alive, and systematically included in our cultural heritage. So the art of living in Antarctica will become one day a history of the southern art.
First results of the Antarctic art and craft catalogue will be shown with the intention of demonstrating the interest and the potential of such an effort.

Wed_293_SH-5_3
Building an Arctic Urban Sustainability Index

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This presentation will discuss the progress of a multi-disciplinary, international project designed to build an Arctic Urban Sustainability Index. The project looks at 50 cities across the circumpolar area. The index focuses on five areas: economic, environmental, social, governance, and planning. The purpose of the Index is to help policy makers and ordinary citizens promote sustainability and resilience by providing tools to measure progress, identify areas of most urgent need, select verifiable best practices, examine opportunity costs, and determine where external actors can have the greatest impact.
The presentation will examine issues related to defining "urban" and "sustainability" in Arctic conditions. It will discuss the issues related to identifying appropriate indicators for the five areas that make up the index. It will also discuss the issues related to gathering data to measure sustainability and the indicators involved.
In the concluding section, the presentation will present preliminary finding of the project and examine what the next steps will be. Most important is work to define specific indicators that can be used to measure sustainable outcomes in Arctic urban settings. This discussion will focus on the use of indicators that measure such things as greenhouse gas emissions and the appropriateness of different types of education systems for promoting sustainability in Arctic cities.

Wed_294_SH-5_4
Antarctic's Values and Perception of Responsibility in its Protection and Care

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Social identity is the part of the self that is built from the recognition of our belonging to social groups (Tajfel, 1984). Its link to different social categories which comprise the belonging to a cultural or geographical region has been extensively studied.
The Regional Ecological Identity (IRE) tries to represent an aspect of who we are that depends on our connection with natural environments (the environment we interact with, either in a real or a symbolic way). We present the results of a study on this topic whose subject are inhabitants of the extreme south of Patagonia, who are linked to the Antarctic from a scientific and logistic perspective. A set of instruments measured IRE, the attribution of values to the Antarctic and the perception of personal responsibility in its protection and care; some other socials and ecological variables were also applied. The results show that the participants attribute a high general value to the Antarctic territory, particularly aesthetically and scientifically. Their identification with this territory is strong despite little knowledge and no direct contact. Finally, the social variables are more useful than the ecological ones in explaining the link with this territory. These results are discussed in the background of their significance for the evolution from an anthropocentric concept of the Antarctic to a biocentric / conservationist view.

Wed_295_SH-5_18
Arctic City Resilience to Energy Infrastructure Damage from Permafrost Thaw

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Thawing Arctic permafrost poses a threat to Arctic cities that are reliant on fossil fuel development by altering the landscape on which critical energy infrastructure is built. Permafrost thaw can not only destabilize oil and gas pipelines by shifting the underlying earth, but resulting exploding methane bubbles can create large craters that have the capacity to damage oil and gas infrastructure. Arctic cities face potential economic, security, and environmental risks from such damage. Many cities in the Arctic rely on oil and gas revenue to meet the needs of their people. Disruptions in oil and gas delivery from pipeline damage may have larger energy security implications that can impact regional and international supplies. Lastly, such damage can cause leaks which can have negative environmental consequences for the surrounding environment. As an extension of the National Science Foundation grant, Arctic PIRE: Promoting Urban Sustainability in the Arctic, this paper will examine the nature of the threat of permafrost thaw on oil and gas infrastructure for a sampling of Arctic cities and discuss if and how these cities are planning to build greater resilience into the energy infrastructure on which they depend.

Wed_296_SH-5_656
Participatory Processes in the Arctic: The Case of Urban Development

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The Arctic is subject to complex and in many regards interrelated environmental, social-cultural and economic changes and in this context, the proposed presentation discusses specifically the case of urban development in the Arctic, which is encouraged by climate change impacts and the growing development of mineral resources. The presentation first illustrates the various interests and different say that stakeholders have in policy-making processes that concern urban development in the Arctic. Second and under consideration of approaches from political science and legal studies, it discusses how more inclusive policy-making can be encouraged in the governance of Arctic regions. Thereby, the proposed presentation relates to a central criticism often formulated by "people from the North" on the one hand (their perception of being dominated by policies adopted in distant capital cities), and to the often stated need to include local knowledge in policy-making to address the complex challenges in a sustainable manner, on the other. Overall, the proposed presentation outlines different strategies how local stakeholders from remote regions in the Arctic can be better and more effectively included in policy-making processes that affect their livelihoods. By embedding the proposed options also in the wider debate on the governance of the Polar Regions, the proposed presentation concludes by relating these options to local, national, regional and global levels.

Wed_297_SH-5_1044
Importance of Sustainable Development: Impacts of Future Arctic Air Pollution

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The Arctic is warming at a rate twice as fast as the global average; sea ice-free summers are possible by 2050. Arctic exploration and exploitation is expected to increase due to the presence of significant oil and gas resources. Although this provides an opportunity for socio-economic development of the region, environmental risks would also be associated with such activities. Increase in air pollution and related health and ecosystem issues would likely result from growth in industrial, transport, tourism and domestic activities. Given this possible future scenario, it is important to close knowledge gaps of Arctic air pollution sources, their societal and ecosystem impacts, and conceivable future development. A transdisciplinary study design is being developed to define the mitigation options for local Arctic scenarios to advice on sustainable development. This design requires a focus on:
(a) physico-chemical analysis of air pollution, its atmospheric processing and transport,
(b) human exposure assessment,
(c) community-based monitoring,
(d) environmental system analysis,
(e) development of mitigation scenarios together with citizens, policy-makers and other stakeholders, and
(f) meta-analysis in order to transfer the obtained knowledge and mitigation strategies to other Arctic locations.
This is a cross-cutting effort by the international initiative 'Air **P**ollution in the **A**rctic: **C**limate **E**nvironment and **S**ocieties' (PACES) and the International Arctic Science Committee.

Wed_298_SH-5_1045
Promoting Arctic Urban Sustainability: Research and Education

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Urban sustainability is an important research topic on the global scale. Organizations including the World Bank and UN are leading efforts to measure sustainability in many global cities. Arctic cities, which are characterized by accelerated climate-change, boom-bust economic cycles, diverse societies, and complex governmental structures, have been overlooked within these initiatives. This presentation describes the results of an ongoing project focused on assessing Arctic urban sustainability.
The Arctic Partnership for International Research and Education (PIRE) project has two major components. The first is focused on the development of research tools to measure past, present and future levels of urban sustainability. These data-driven tools are intended to help policymakers define and implement strategies, compare cities, and describe the interactions between pillars of sustainability. The second component focuses on increasing student engagement with Arctic themes. Initiatives include classroom-based digital storytelling exchanges and university-level international field courses. Such pedagogic tools promote knowledge sharing between students of various age groups, within the circumpolar region and outside it.
These components work together to enhance the quality, accessibility, and reach of knowledge about Arctic cities, with applications for diverse Arctic stakeholders.

Wed_299_SH-5_1070
Planning for Climate Change using Vulnerability Analysis Frameworks

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The continental shelf of the Eastern Bering Sea is home to some of the most productive fisheries in the world. Over the last few decades, winter ice cover in the Bering Sea has retreated earlier and returned later each year, changing the landscape of this diverse region. Species that rely on sea ice for critical life stages such as marine mammals have already begun to experience the negative effects of habitat loss associated with a warming climate. As sea ice projections over the coming decades become even more dire, subsistence communities must face the possibility of the loss of the species they rely so heavily on for survival. As of yet, little is known about how the Bering Sea's marine mammal-dependent communities will be impacted by the loss of biodiversity that is expected in this region. This study uses two vulnerability analysis frameworks to
(1) identify the vulnerability of marine mammals in the Bering Sea to climate change,
(2) determine how these changes will affect indigenous populations dependent on subsistence harvesting in the region, and
(3) assess the management institutions in place in and their capacity to provide an adequate response in order to adapt to and mitigate the impacts of climate change.
We demonstrate how this interdisciplinary type of analysis can be used by Native Arctic communities and resource managers to plan ahead for the impacts of climate change and develop management solutions aimed at reducing ecological and social vulnerability.

Wed_300_SH-5_1089
Economic Valuation of Changes in Ecosystem Services of the Arctic

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According to the recent observation by NOAA(US National Oceanic and Atmospheric Administration), 2015 was the warmest year based on global average temperature since 1880. The air temperatures in the Arctic have been rising at almost twice the global average and the extent and thickness of sea ice in the Arctic have declined. The warming process in the Arctic is accelerating rapidly. These impacts of drastic change in sea ice caused by climate change in the Arctic threaten the eco-system service and biodiversity in the Arctic.
This study intends to estimate the economic value on changes in eco-system services and biodiversity of the Arctic caused by climate change. The result of the valuation indicates that the total benefit from improvement of ecosystem in the Arctic ranges from 318.6 billion won to 715.9 billion won per annum. Replication scenarios can be explored into two broad categories: scenarios in consideration of conflicts of different stakeholders and scenarios based on wider or narrower definition of biodiversity in the Arctic.
Finally, based on those analysis, this study puts forward some feasible policy suggestions for strengthening the extent of sustainability in the Arctic region.

Wed_301_SH-5_1212
Tthe Antarctic Bases as Communication Links between Society and Environment

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This research tries to assess if the antarctic bases studied respond or not to the needs of the users. Architecture can be read as the expression of a way of communicating between human collectives and the environment. Design of spaces, distribution in the land, esthetics, the functionality and the historical context can explain the set of relationships that were looking to develop those who carried out the buildings more than 50 years ago. Actually, those who inhabit and use these stations condense different needs from those who have built them, that´s why it is necessary to find the incompatibilities to take them into account in order to undertake reforms. The methodology is based on the complex systemic approach, which consists of the theoretical construction of systems, searching for their observable features as empirical anchorage and the analysis of the relationships that structure them. The processes are differentiated by levels, so as to integrate them through the concrete manifestations of their mutual determinations. Institutional histories, political contexts, regulations and ecological determinants are analyzed. Data were collected in two scientific stations by interviews and participant observation. The human relationship with nature makes antarctic bases emerge as technical sets of artifacts and organizations, which, when studied, reveal systemic contradictions that were developed over time, and are difficult to identify from daily management.

Wed_302_SH-5_1215
"More Swans Lately": Indigenous Perspectives of Biodiversity Change in Yakutia

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Global change drivers have altered biodiversity in the Arctic. As a result, many terrestrial, freshwater and marine species have shifted their distribution, abundance and seasonal activities. Biodiversity change has implications for local indigenous peoples since they depend on biodiversity for their traditional activities. There is a lack of scientific records of biodiversity change in remote Arctic areas and thereby it is vital to incorporate indigenous perspectives to scientific research. Therefore, this paper assesses indigenous perspectives of biodiversity change caused by global change drivers in the Arctic region of the Republic of Sakha (Yakutia) in North-Eastern Siberia, Russia.
The results of the study demonstrate that global change drivers have significantly affected Arctic Yakutian biodiversity. Climate change has altered species distribution. Land use change has impacted plant and animal species. New species are competing with the native ones, thereby some species have shifted their habitats. Global change in Arctic Yakutia has either natural or anthropogenic reasons. Interviewees attribute changes in biodiversity to technological development (abundance of vehicles as well as shipping), and natural processes (e.g.increasing precipitation). The narrative of the predatory but sacred swan symbolizes the quandary indigenous people of Arctic Yakutia find themselves in, when trying to deal with global change.

Wed_303_SH-5_1342
Aquamess: Portraits of Garbage at the Earth´s Poles, Clean It

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Aquamess is a science art exhibit and study of marine debris found in the Arctic and Antarctic. The project explores garbage samples from Svalbard (currently exhibited in the Canada Science and Technology Museum) and includes multimedia materials, and scientific information about how marine debris circulates in oceans. It also highlight polar and global initiatives to research, avoid, intercept and redesign the plastic economy for marine ecosystem and human health.
Polar oceans store anthropogenic heat and carbon dioxide and help regulate global atmospheric temperatures. Yet oceans are the trash bins of the planet with an estimated 8 million tonnes of plastics circulating today. What are humans doing, what can and must we do better? This presentation is a blend of visuals, scientific facts and questions to encourage dialogue.
I helped with a cleanup in Svalbard in 2015, collecting and exhibiting a survey of the marine debris and documented in an exhibit *Aquamess* with portraits of the trash and landscapes. In 2016 in Antarctica I collected a survey of garbage found there, which has not yet been exhibited.
We´re still learning about the volume, location and impact of marine debris in polar regions and in between. But we know it´s harmful to wildlife and to organisms and us too when it breaks down and enters the food chain.
Aquamess is presented in the context of international frameworks and initiatives to protect marine environments significant for planetary health.

Wed_305_SH-5_1434
The Dry Valley Ecosystem Resilience Programme: Overview and implementation

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Although a consensus exists internationally that Antarctica is vulnerable to invasive species, climate change, and increasing human presence and activity, there is a notable lack of objective measures that facilitate evidence-based environmental management and clearly articulated conservation goals. The aims of the DryVER programme are to deliver objective, evidence-based planning and management tools for the McMurdo Dry Valleys (MDV). This interdisciplinary project's primary output will be a comprehensive understanding of the resilience and sensitivity of MDV habitats to human impacts and invasive species. This understanding has been gained through fieldwork, laboratory analyses and experimentation, remote-sensing and instrument-based data collection, and climate and ecological modelling. The information is spatially explicit for direct integration into an interactive GIS framework that will map and predict biodiversity, productivity, and sensitivities to impact and invasion across the entire MDV region. Specific information has been obtained on the legacy of previous human impacts and the efficacy of remediation. Importantly, a predictive, physics-based climate model of the MDV will underpin our GIS framework, allowing us to project outcomes under climate change scenarios. The research direction has been informed and enhanced by direct engagement with our primary end users ensure clear pathways for implementation of the research outputs.

Wed_306_SH-5_1462
Findings from a National Survey on Gender Equity in Australian Antarctic Science

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Although 60% of polar early career researchers are women, there is little available data on gender equity in polar science (Strugnell et al 2016). Existing research primarily tracks publications to measure women's STEMM participation. This approach risks ignoring disproportionate rates of gender bias and sexual harassment experienced by women. For instance, women in polar research are 3.5 times more likely to experience harassment than men (Clancy et al 2014).
This paper reports findings from an online survey designed to1) identify socio-demographic characteristics of women working in Australian Antarctic science and 2) detail and contextualize their experiences of scientific research cultures/field-based research. Survey results indicate that 64% of respondents had been sexually harassed during their career, and that most women did not report sexual harassment at the time. Other experiences of reported gender bias included lack of appropriately fitted Antarctic clothing; fewer leadership opportunities; lack of career mobility; and penalties associated with caring responsibilities. Such findings indicate a pressing need to address significant structural barriers to women's career advancement and leadership opportunities in polar research. They also highlight the problematic contextual and relational conditions that put women at high risk of sexual harassment in the field. These findings can be used to inform long-term responses to gendered inequality in the field.

Wed_307_SH-5_1612
Leadership in Extreme and Isolated Environments: Perceptions from Antarctica

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The extreme, isolated and confined environment encountered at Antarctic stations provide unique challenges to management and leadership. The study investigated effective leadership at Antarctic stations, as well as the difference in perceptions based on gender, expedition experience, and the occurrence of emergencies or interpersonal conflict.
The findings were gathered from 180 returned expeditions who participated in the South African National Antarctic Programme from 1961 to 2015. The research collected primary data, using a standardised questionnaire as a survey instrument. The results were analysed using descriptive statistics.
The analysis showed that an effective station leader maintains a personal bond with individuals, maintains a balance between active and passive regulation of the emotional well-being of team members, makes an effort to create and sustain a positive team climate, and maintains a moderate involvement in professional duties of the team. Gender, experience and events at the station influenced perceptions of the station leader's role in maintaining a personal bond, individual well-being, the team climate and intervention in professional duties.
This research report is of value to National Antarctic Programs, space exploration missions, as well as to organisations in distress, who find themselves in environments that are harsh and unforgiving, similar to the isolated and extreme environments at an Antarctic station.

Wed_308_SH-5_2395
The Afterlives of Mines: A Comparative Study in the Arctic

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In this paper I will present my dissertation project within the framework of REXSAC - Resource Extraction and Sustainable Arctic Communities. The objective of my research is to explore how stakeholders in different parts of the Arctic have dealt with mining legacies - both material and immaterial - during different time periods and in different places. I will compare former mining areas in three regions; Northern Sweden, Svalbard and northern Canada. Stakeholders in all of these regions have had to deal with a multitude of legacies from mining, from both recently closed mines as well as legacies from older mines. The operations are gone, but their legacies still linger in the collective memories of the local communities and in the landscape. My approach will be multidisciplinary, combining theory and method from critical heritage studies, history of technology, economy, human geography and social/cultural anthropology. I will primarily work with methods such as archival research and interviews, as well as archaeological field work at industrial and post-industrial sites in the Arctic.

Wed_310_TE-1_107
Autonomous Thermal Sonde for Subglacial Lakes Exploration

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To date, more than 400 relatively small subglacial reservoirs and several large lakes were discovered in Antarctica. Certainly subglacial lakes exist in Greenland. In recent years, different approaches were taken to access and directly sample subglacial water environments. RECoverable Autonomous Sonde (RECAS) allows to access subglacial lake when water remains isolated from the modern ice sheet surface during sampling. The thermal drill can melt a hole to ice sheet bottom and is able to move upwards. It includes two electrically powered thermal drill bits located at the upper and lower ends of the sonde, heated body, control system, sampling chamber and coiling system. All down-hole RECAS components will be sterilized prior to deployment. The melted water is not recovered from the hole and it refreezes behind the sonde. The power and signal line is released from the coil inside the sonde. When sampling and monitoring are complete, the coil motor is activated and the top drill bit is powered. It is proposed that the research personnel leave the site after RECAS deployment and the sonde operates as a fully autonomous system. The power is provided by no-live-operator diesel engine generators. The first laboratory tests of sonde prototype are scheduled for early 2018, field tests are planned in season 2018-2019, in the area of Chinese Antarctic station Zhongshan.

Wed_311_TE-1_934
Comparing Data Derived from Animal-borne and Argo Observations

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The physical structure of the Southern Ocean (SO) plays a crucial role in the global ocean and climate system. Nevertheless, many areas of the SO have remained relatively poorly sampled. Oceanographers often rely on ship-based measurements to track water masses; however, these data are scarce in the SO and seasonally biased. A significant enhancement is Argo, which is a global array of temperature/salinity profiling floats. However, Argo does have limitations in Antarctica - for example, there are few Argo profilers south of 60S due to sea ice. An important addition to data collection methods is conductivity-temperature-depth satellite relay data loggers (CTD-SRDLs) deployed as animal-borne platforms to sample vertical temperature and salinity profiles. While studies have used Argo and CTD-SRDL data, little is known about how well the two data sources complement each other both spatially and temporally, and how comparable they are in data quality. Therefore, this study examines data from CTD-SRDLs and Argo to assess the comparative value of the data sources to increasing our understanding of the ocean dynamics in the South African sector of the SO. This will help to improve our confidence that seals can be used to comprehensively sample regions previously restricted to ship-based observations.

Wed_312_TE-1_376
UAS for Evaluating Retrievals and Model Performance at High Latitudes

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Over the past several years, scientists have deployed to Oliktok Point, Alaska to make atmospheric measurements as part of the Evaluation of Routine Atmospheric Sounding measurements using Unmanned Systems (ERASMUS) and Inaugural Campaigns for ARM Research using Unmanned Systems (ICARUS) campaigns. These deployments included operations using the University of Colorado DataHawk UAS. The DataHawk was configured to make measurements of atmospheric thermodynamics, wind and surface temperature.
Over these deployments, hundreds of profiles of lower atmospheric temperature have been derived between the surface and cloud base. These profiles are being used to help evaluate the performance of retrievals conducted using measurements from ground-based remote sensors. As a part of this presentation, we will show results from this evaluation and provide insight into the strength of using these sorts of platforms for this purpose.
Additionally, during a recent October deployment, the team witnessed the development of near shore sea ice. In this presentation, we will give an overview of measurements obtained during this time and how they were used to better understand freeze up processes in this coastal environment. Additionally, we will provide insight into how these platforms are being used for evaluation of a fully-coupled sea ice forecast model. Finally, we will provide details on planned 2017 Arctic unmanned aircraft operations by the US DOE, NOAA and others.

Wed_313_TE-1_472
New Set-up of ALADINA for Atmospheric Studies in Polar Region

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The unmanned aerial system ALADINA (**A**pplication of **L**ight-Weight **A**ircraft for **D**etecting **I**n-situ **A**erosol), based on a funded project of the German Research Foundation, is operated for atmospheric research at the Institute of Flight Guidance since 2013. The total amount of more than 200 measurement flights at different locations, prove the high usability of the aircraft. In order to obtain the high quality of atmospheric boundary layer research in harsh Arctic conditions, ALADINA was re-engineered and newly designed for the planned campaign in Ny-Ålesund for spring 2018. The system was insulated to avoid cooling of batteries and to guarantee a flight endurance of about 30-40 min. In addition, the modular payload is heated constantly to temperatures of approximately 30°C, so that all instrumentation can run properly. Further, the system was equipped with a new autopilot system as well as new telemetry to adapt the frequency limitation of less than 2 GHz, due to a sensitive radio telescope on site. Besides, a modular package for batteries was implemented in order to change the batteries by minimal outlay and in a short time period so that flight missions can be performed continuously. With the presentation of the new set-up, we fulfil the expertise to show a reliable system that is optimal prepared for studies in polar region.

Wed_314_TE-1_536
Remote Assesment of Albedo by Photographic Equipment Based on UAV

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A method for determining of albedo was developed and tested with the combined use of radiation and a photo device. The proposed original method is based on the use of available measuring techniques and is intended primarily to reduce the time required to obtain albedo values on large areas. The theoretical possibility of using the proposed technical solution and its testing in the field using UAV are considered. Based on the results obtained, conclusions are drawn about the possibility of using the proposed schematic diagram, the potential for its improvement and application for the data collection. Mean vile that simple method for determining the albedo of the underlying surface give the opportunity to collect data in situ non-stop, what led us to big data of underlying surface, what is a good basis for future researchers and projects. Method for determining the albedo of the underlying surface gives the chance to work with photos for getting results. The obtained results of the research allow to draw a conclusion about the high potential of the proposed technical solution, not only for carrying out data collection and observing albedo, but also for designing new devices based on the proposed principles. The change in dimensions and the possibility of installation on UAV made it possible to develop a new method of surveying. The developed method provides the ability to quickly and qualitatively collect data on large areas with the help of advanced aircraft technology.

Wed_315_TE-1_553
Unmanned Aerial Systems over Sea Ice during the SeaState and PIPERS Expeditions

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In recent years we have deployed multi-rotor and fixed wing Unmanned Aerial Systems (UAS) in support of Autonomous Underwater Vehicles (AUV) missions beneath sea ice in both the Arctic (ONR DRI SeaState - Beaufort Sea, Oct 2015) and Antarctic (NBP1704 PIPERS - Ross Sea, Apr-Jun 2017). Despite significant logistic and meteorological challenges in the polar environment, our UAS project has developed into a cost-effective and integral component of the modern sea ice research expedition. Using ´off-the-shelf´ multi-rotors and a delta-wing photogrammetry UAS developed by the TerraLuma facility at the University of Tasmania, we achieved icebreaker-based and ice station launch and recoveries with over ten hours of missions. These missions collected visual imagery for ice reconnaissance, floe-size distribution over marginal ice zones and 3D surface topography of larger floes in concert with AUV ice draft mapping below. New fieldwork is planned for the Antarctic marginal ice zone that will incorporate additional thermal IR and hyperspectral capabilities, together with an evolution towards longer missions beyond visual line of sight, once again in tandem with long-range AUV missions.

Wed_316_TE-1_569
Intricacies of Making Measurements in Supercooled Water

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For the past 15 years, New Zealand researchers have been investigating interactions between the ice and ocean, principally in McMurdo Sound, Ross Sea. During this time, the range and technical capability of oceanographic instruments has increased dramatically. However none of the standard oceanographic equipment has been designed to incorporate process near the phase-change limit.
Here we document our experience teasing data from ocean that is near, and often below, in-situ freezing temperature, as a set of principles of operation. We discuss the difficulties routinely experienced, and suggest mitigation strategies for these. We also highlight some of the curiosities of working in crystal-laden water, and the surprising results that flow from detailed examination of these data.
Finally we introduce the 'Supercool-ometer' - a modified SeaBird CTD that incorporates a heating chamber and second set of sensors designed to characterise the effects of ice formation (and/or melt) inside the instrument. We will outline the development to date of the supercool-o-meter and highlight results from three recent deployments in significantly supercooled water.

Wed_317_TE-1_763
Robotic Snow-firn Sequence Density Profiler

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Non-coring electro-thermal drills, often called as Hotpoint drills (HPD), allowed fast penetration rate (up to 25 m/h) at relatively low power. As lab and field experiments show penetration rate of the HPD is proportional to snow-firn-ice density. Continuous registration of the HPD penetration rate allows one to obtain continuous density profile up to a few dozen meters of depth. Density resolution of the HPD is close to 5 kg m^{-3} while depth resolution is about 10 mm. Snow-firn density profiling system includes: 1) HPD, 2) instrumented rig, 3) data acquisition and power source. The system is called Speedograph - penetration rate/speed recorder. Robotic version of the Speedograph can operate as addition to glacier surface moving autonomous platform. The robotic Speedograph can be programmed to perform density profiling as calibration option to snow-firn radar. Required power for the robotic version of the Speedograph is 300-800 W. Estimated weight of Speedograph is about 6 kg while total volume is about 0.02 m^{-3}.

Wed_318_TE-1_815
Wind and Turbulence Measurements with RPA during the ISOBAR Campaign

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The remotely-piloted fixed-wing aircraft MASC (Multi-purpouse Airborne Sensor Carrier) from the environmental physics working group of the University of Tübingen was used to investigate physical processes in the ABL during the ISOBAR (Innovative Strategies for Observations in the Arctic Atmospheric Boundary Layer) campaign over the frozen Baltic Sea in northern Finland in February 2017. MASC is equipped with a high resolution thermodynamic sensor package including a five-hole probe and IMU for wind vector measurements. During the three week long field period also ground based weather stations, remote sensing systems (Lidar and Sodar) and a small fixed-wing system (SUMO) for atmospheric profiles up to 1800 m were applied. Intensive observational periods including nocturnal flights with MASC were performed. This talk will focus on results for the wind, turbulence and flux measurements from some flights with MASC. The strategy of the measurements as well as the quality of the data and comparisons will be addressed. Furthermore future adaptions and developments of the measurement system and the remotely-piloted aircraft for polar use will be presented.

Wed_319_TE-1_846
Advances in Sub-ice Navigation: AUV Tests in Overhead Environments

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Beyond the obstacles to navigation presented by underwater operations (e.g. the lack of continuous, precise external aiding from GPS), sub-ice navigation presents unique challenges to an autonomous vehicle. The overhead environment prevents essentially all external navigation aiding, and severely limits ingress and egress locations for deployment, recovery, or data transfer. In such environments (e.g. under sea ice, ice shelves, or in sub-glacial lakes), existing methods of exploration autonomy eventually break down as highly-limited sensor range and unbounded navigation drift lead to the inability of the vehicle to return to the point of origin for recovery, or to return to a site of interest following an initial broad survey. Groundbreaking work on overcoming these limitations using the local environment as a navigation reference was conducted as part of the NASA DEPTHX project (2003-2007). A distant, miniaturized successor to DEPTHX, known as SUNFISH, has been tested by Stone Aerospace in the overhead environment of underwater caves in northern Florida, acting as a surrogate for complex sub-glacial lakes. We present field test results of SUNFISH on new autonomous behaviors and methods to navigate such overhead environments with sufficient precision to allow the AUV to approach or contact objects of interest; provide a 3D map updated in real time; and to plan paths for egress and exploration despite map inconsistency—all in the absence of any external navigational aiding.

Wed_320_TE-1_923
Marine Mammals Exploring the Oceans Pole to Pole: Review of the MEOP Consortium

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Polar oceans are poorly monitored despite the important role they play in regulating Earth's climate system. Marine mammals equipped with biologging devices are now being used to fill the data gaps in these logistically difficult to sample regions. Since 2002, instrumented animals have been generating exceptionally large data sets of oceanographic CTD casts (>500,000 profiles), which are now freely available to the scientific community through the MEOP data portal (http://meop.net). MEOP (Marine Mammals Exploring the Oceans Pole to Pole) is a consortium of international researchers dedicated to sharing animal-derived data and knowledge about the polar oceans. Collectively, MEOP demonstrates the power and cost-effectiveness of using marine mammals as data-collection platforms that can dramatically improve the ocean observing system for biological and physical oceanographers. Here, we review the MEOP program and database to bring it to the attention of the international community.

Wed_321_TE-1_997
Meander-driven Export of Shelf Waters in the West Antarctic

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The West Antarctic Peninsula (WAP) has undergone rapid atmospheric warming occurring between the 1950s and the late 1990s, with significant reductions in the duration and thickness of sea ice and rapid thinning of ice shelves and glaciers. Many of these changes are driven by a warming Circumpolar Deep Water (CDW) layer, the deep water mass that originates in the open Southern Ocean and supplies heat to the WAP shelf. Consequently, much attention has focused recently on the delivery of heat to the shelf through mechanisms including eddies, and flow inertia, particularly at deep glacially-carved troughs such as Marguerite Trough (MT). However, less attention has been focused on the export of colder shelf waters that compensates the inflow of CDW. Here, we use ocean glider data from 2015 to examine the hydrographic structure of a quasi-permanent meander found close to the mouth of MT, from which cold-core cyclonic eddies detach and export dense water into the Southern Ocean. Rossby numbers of these features (0.05-0.1) are consistent with geostrophic dynamics. The circulation structure observed is consistent with an onshore transport of CDW (by small 5-10 km eddies) towards the northeastern parts of the trough, and an offshore transport of colder, fresher waters towards the southwestern edge. Potential vorticity fields from the gliders and an ocean model are used to determine the instability mechanisms that drive the production and separation of eddies from the boundary current.

Wed_322_TE-1_1066
Measurements of Snow Properties on Ice Sheets with a Polar Robot

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Snow specific surface area and optical grain size of snow on the polar ice sheets are key parameters for measuring the atmospheric interactions of snow, monitoring metamorphosis in response to environmental change, and facilitating interpretation of remotely sensed data. Making the measurement by a ground-based robot can save time over human deployment, and eliminates the amount of fuel that would be needed if the instrument were towed by snowmobile. We describe robotic deployment of an instrument that uses a shortwave infrared camera with changeable optical band pass filters (centered at 1300 nm and 1550 nm) that can be used to quickly measure the average SSA. The device and method are compared with calculations made from measurements taken with a field spectral radiometer, and performance of the robot is documented.

Wed_323_TE-1_1071
Mapping Penguins and Blue-eyed Shags at Remote Islets by Fixed Wing UAV

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The rocky northwestern coast of Nelson Island and the southwestern coast of King George Island (South Shetland Islands) is known as a breeding area for chinstrap penguins. However, due to its difficult accessibility the last published population counts date back to the 1980s. To obtain current, accurate and complete data, several flights with a UAV have been carried out during December 2016 and January 2017. The 30 km long investigation area ranges from Smilets Point at Nelson Island to Sygit Point at King George Island. In that area all larger islets have been mapped by a micro fixed wing UAV equipped with an optical camera. The images have been processed to orthophotomosaics with a ground resolution of about 2 cm. In these mosaics more than 200 rocks, islets or rock outcrops have been surveyed for penguin colonies or other breeding birds. We found 26 sites with breeding chinstrap penguins (*Pygoscelis antarctica*) and four sites with breeding blue-eyed shags (*Phalacrocorax atriceps*), some of them recorded for the first time. For all sites breeding pair numbers of the penguin colonies were derived by counting the individuals manually from orthophotomosaics and using a correction factor. For blue-eyed shags the breeding pair numbers were derived by counting the nests directly. As a result the most complete and accurate dataset on the distribution and numbers of breeding chinstrap penguins and blue-eyed shags in the investigated area was created and will be presented.

Wed_324_TE-1_1115
Polar Boundary Layer Aerosol Observed with ALADINA in Ny-Ålesund

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The unmanned research aircraft ALADINA (**A**pplication of **L**ight-Weight **A**ircraft for **D**etecting **I**n-situ **A**erosol) was extensively used during field studies in Melpitz (Germany) and Savè (West Africa) since 2013. The performance of more than 200 measurement flights and several publications support the reliability of the system. The main focus of the project is on the variability of aerosol particles depending on different atmospheric boundary layer conditions. For future perspectives, a new aircraft campaign is planned for spring 2018 at the local airfield in Ny-Ålesund (Spitsbergen), in association with project partners of Leibniz Institute of Tropospheric Research and Eberhard Karls University Tübingen, as well further international collaborators. The goal of the campaign is to study the horizontal and vertical distribution of aerosol particles in the particle diameter from around 5 nm to 5 µm between ice surfaces up to the height of around 1000 m. In addition, one aethalometer is installed, in order to investigate black carbon mass concentrations in a generally clean environment that is, however, temporarily affected by ship emissions. Due to harsh Arctic conditions by low temperatures and possible icing, the sensitive aerosol instrumentation had to be adapted properly and the new paylaod will be presented. Further, the performed campaign will be introduced and first results of the pending application with the main focus on polar new particle formation will be shown.

Wed_325_TE-1_1170
Using an AUV and a Buoyant Rover for *in situ* under-ice Observations

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Melting tidewater glaciers and ice shelves from the Greenland and Antarctica Ice Sheets are now substantially contributing to global sea level rise. The most significant submarine melt acceleration has taken place deep within ice shelf cavities near the grounding zones where glaciers begin to float beneath more than 500 m of ice and 10-100 km or more from the open ocean. There is a need for long-range, long-duration, in situ under ice exploration and data collection in these environments to determine how warming ocean waters are affecting ice shelf stability. Scientists and engineers at JPL are developing new technologies to enable autonomous exploration and data collection in these unexplored ice shelf cavities with the objective of improving our fundamental understanding of their physical, chemical, and biological characteristics.

Wed_326_TE-1_1231
Mapping of Antarctic Wildlife by Drones

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Changes in size and distribution of Antarctic wildlife populations are difficult to monitor. Breeding sites of seabirds are often located at remote and difficult to access locations while seals can be found at almost all parts of the Antarctic coast. Therefore, by classical methods a high effort is necessary to conduct detailed surveys of larger areas with often incomplete results. Besides, mapping or counting these populations directly implies a significant disturbance of the animals. Thus, the use of drones provides an option to map colonies and aggregations of seabirds and seals.
We studied the feasibility of mapping Southern Giant Petrels (*Macronectes giganteus*), Cape Petrels (*Daption capense*) and Kelp Gulls (*Larus dominicanus*) as well as different Antarctic seal species by use of an electric powered quadrocopter micro drone. While Giant Petrels often breed at remote islets and are known to be very sensitive to disturbance, many breeding sites of Cape Petrels and Kelp Gulls are located at steep inaccessible rocks. Seal aggregations can be found at many sites almost everywhere along the Antarctic coast. The study was performed at different sites of Fildes Peninsula (King George Island, South Shetland Islands).
We present the results of this survey regarding quality, effort and disturbance. Advantages and disadvantages of different methodological settings will be discussed.

Wed_327_TE-1_1363
The Dry Valley Summertime Atmospheric Boundary Layer Evolution

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The Dry Valleys are snow-free polar deserts surrounded by patches of frozen lakes and glaciers. The arid environment limits life to microbial subsurface communities, and the complex terrain allows the development of localized meteorology modulated by surface-atmospheric energy fluxes that are largely controlled by the insolation diurnal profile and topographic shading.
Two custom built fixed-wing small UAVs were used to sample the atmospheric boundary layer near Lake Vanda of the Wright Valley. The objectives of the January 2017 field campaign was to understand the diurnal variability of the mean velocity, temperature, and turbulence from the surface up to 1000m, which influence the microclimate spatial variability of the Dry Valleys. The meteorological payloads consisted of air temperature, pressure, relative humidity sensors, GPS and a 5-hole probe for mean wind and turbulence measurements at 50Hz. We conducted a total of 19 vertical profiling flights over a period of 6 days covering a wide range of stable, unstable and transitioning boundary-layers. This data provides a unique opportunity to understand the time scales of the thermodynamic evolution of the near-surface atmosphere in a region where mountain meteorology directly influences available melt-water for biodiversity.

Wed_328_TE-1_1371
Preliminary Results of an Experimental Survey in Kongsfjorden Area (June 2017)

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During the last years polar oceans showed the effects of global climate change, with important variations of physical, chemical and biological characteristics. Global warming causes a significant reduction in sea-ice thickness and in tidewater glaciers extension during late summer and autumn intensifying the input of freshwater and sediments, causing a reduction of water transparency as a consequence of increasing water turbidity. These processes have an impact on phytoplankton biomass life cycle, especially in the Kongsfjorden area, Svalbard Archipelago, that is relatively warmer than other Arctic areas. An oceanographic experimental survey was performed during June 2017 to study the ice melting of the tidewater glaciers in the Kongsfjord making use of traditional and innovative instrumentations. Two 'state of the art' probes, Idronaut 305 plus and Cyclops-7F™ Turner Design, and a new low-cost probe were installed onboard an innovative unmanned marine vehicle, PROTEUS (Portable RObotic TEchnology for Unmanned Surveys). The survey was carried out along Kronebreen and Blomstrandbreen glaciers, where a series of transects extending from a support boat up to the direct front of the glaciers allowed the acquisition of surface water temperature, conductivity, dissolved oxygen, chlorophyll *a,* fluorescence and turbidity. This work shows the preliminary results of data acquired by the different probes, with a particular focus on the comparison between traditional and innovative ones.

Wed_329_TE-1_1391
ALICE - A Remotely Piloted air Sampling System for Methane Isotopic Analysis

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Methane is a very effective greenhouse gas, but the role of the Polar Regions in the methane budget and its sources there is subject to discussion. The sparse surface network data and satellite data indicate significant source regions above the polar oceans. The remotely piloted system (RPAS) of quadrocopter type ALICE was developed at the Technische Universität Braunschweig for taking air samples to study methane isotopic composition related to different polar atmospheric boundary layer conditions above sea ice and open water. The quadrocopter ALICE has a maximum take-off weight of 25 kg and a large payload capacity of 18 kg. The thrust to weight ratio is high compared to other RPAS to operate in wind speeds up to 70 km h^{-1}. The scientific subsystem consists of different meteorological sensors and twelve 100 ml glass bottles for air sampling. Profiles with high resolution meteorological data and air samples at operator selected altitudes up to 1000 m can be obtained. The initially tested prototype was field operated for the first time during *Polarstern* cruise PS109 (ARK-XXXI/4), so-called GRISO (Greenland ice sheet/ocean interaction) from 12 September until 14 October, 2017. During this proof of concept expedition the safe shipborne operation and system functionality in harsh polar environment was demonstrated successfully. In this presentation, the design of the RPAS and the scientific payload will be introduced and functionality discussed based on flight test results.

Wed_330_TE-1_1480
Micro-Tethers for Under Ice Robotics

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Robotic vehicles have proven valuable scientific assets in subsea polar environments; yet the ability of fully autonomous vehicles (AUVs) to physically interact with the seafloor or ice remains limited or non-existent. Remotely operated vehicles (ROVs) routinely execute these activities in ice-free waters. Real-time data access, via the ROV's tether, enables pilots to execute complex interaction tasks and to react immediately to the unknown or unanticipated, a capability that could prove especially important in the relatively unexplored polar environment. However, conventional tethering systems require the host vessel to hold station above the vehicle, a constraint that makes operating conventional ROVs in ice difficult. Micro-tethers, small diameter unarmored fiber-optic cables, alleviate this constraint. Micro-tethers transmit only communication signals and not electrical power, thus vehicles that use them must carry their own batteries and are referred to as AUV/ROV hybrids. We have adapted a 250 µm diameter micro-tether system, 20 km in length, to a purpose-built under-ice hybrid ROV called NUI. In 2016 we demonstrated the ability to operate NUI on the Arctic sea floor at 87 N, over a km away from the host vessel, on a dive that obtained high-definition (HD) video imagery of the seafloor and acquired targeted samples using NUI´s dexterous manipulator arm. We discuss the micro-tethering system, NUI, and potential future polar applications of each.

Wed_331_TE-1_1511
Water-air Column Characterisation in Arctic Region using Unmanned Vehicles

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Monitoring the Arctic regions allows understanding the impact of global warming on Earth's climate but some processes affecting the climate change cannot be fully discerned because data are sparse and even missing due to difficulties in collecting them in hazardous area. This is particularly true in the proximity of the arctic calving glaciers that induce changes in the physicochemical and biological properties of the seawater. Unmanned marine and aerial vehicles allow the in-situ observing of such processes. In June 2017 CNR-ISSIA, in collaboration with other institutes of the CNR (IAMC, ISMAR, ISAC, IBIMET) and UNITUS, has conducted a measurement campaign in the Kongsfjord, a small fiord in Svalbard. A customised octocopter (OTTO) capable of carrying various types of heavy payloads was used. A set of low cost and high-resolution sensors were used to analyse the column of air in order to monitor atmospheric parameters and gases (humidity, temperature, CO, CO2, O3, NO2). A thermal camera was also installed on the drone to reconstruct a thermal map of the sea/ice in the area surveyed by the Unmanned Marine Vehicle PROTEUS equipped with underwater sensor. The measurements performed allowed to fully characterise the state of air-sea interface near marine glacier fronts. A preliminary data analysis to correlate the different measured quantities shows interesting results but further experiment need to be done to achieve a complete understanding of the processes.

Wed_332_TE-1_1529
Unmanned Vehicles for Autonomous Sensing and Sampling 2017 Scientific Campaign

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The goal of the UVASS (Unmanned Vehicles for Autonomous Sensing and Sampling) project is the use of unmanned vehicles to perform air, water and ice data sensing and sampling in dangerous places (e.g. close to fronts of tidewater glaciers), difficult to access for human beings. The purpose of the Arctic expedition carried out in Summer 2017 by ISSIA-CNR, in cooperation with other institutions, was the use of a little swarm of unmanned vehicles performing simultaneous data acquisition in order to improve the understanding of phenomena related to the global climate changes, especially ice melting. The marine autonomous vehicle PROTEUS was equipped with sensors and samplers, i.e. multi-parametric probe and turbidimeter and towed a small trimaran vessel hosting heavy or voluminous sensors i.e. an automatic water multisampler, a plankton multisampler and a SeaBird CTD probe. Besides PROTEUS, two drones were also used: the OTTO drone recorded pictures and videos of the area and was equipped with additional payload (thermal camera, humidity, temperature and air quality sensors) to collect environmental parameters. The Splash drone was used to record videos and images of the coordinated operations performed by PROTEUS and OTTO for documentary and dissemination purposes. The atmospheric data coming from OTTO, together with the marine data acquired by PROTEUS, will allow scientists to obtain a good characterisation of the whole marine-air column in the proximity of tidewater glaciers.

Wed_333_TE-1_1909
Long-term Automatic Ice Buoy System for ArcticAtmosphere-ice-Ocean Observation

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The interaction process of atmosphere, sea ice and ocean is a major topic of CHINARE Arctic researches. Various types of ice buoys were utilized to observe Arctic , but few of them shall provide long-term, effective or highly integrated observation, which limits the development of the interaction process researches.This article offers one long-term automatic ice buoy system for Arctic atmosphere-ice-ocean observation.
System consists of main buoy, attached buoy and atmosphere tower. Main buoy is equipped with ice/snow thickness sonar, ice temperature chain sonar and ice radiation flux sensors. Atmospheric pressure, temperature and humidity sensors are installed on top of the main buoy body, which shall provides one-layer atmosphere observation. Fixed profile observation module is equipped beneath the bottom of the attached buoy, profile observation module consists CT, chlorophyll sensors and dissolved oxygen sensors, which shall provide six-layer multiple ocean physical data observation.Atmosphere tower consists anemometers, atmospheric pressure sensors and temperature and humidity sensors and shall provide 2-layer atmosphere physical data observation. The material of buoy body is high-strength aluminum alloy, covered with cathodic protection. Buoys are equipped with buoyant material, which shall keep the system alive after the ice melts and continue the observation work.Battery of the systems shall provide system with more than 1 year long-term observation duration.

Wed_334_TE-1_2203
Arctic Observing Using Integrated Systems of Autonomous Instruments

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Systems of autonomous platforms offer the ability to collect sustained, collocated measurements of the ocean-ice-atmosphere system, accessing spatial and temporal scales that have previously been difficult or impractical to sample. The recent Office of Naval Research Marginal Ice Zone and Arctic Sea State Programs provide examples of these systems applied to investigations of the processes that govern evolution of the rapidly-changing seasonal ice zone in the Beaufort Sea. Autonomous platforms operating from the ice and within the water column collected measurements across the atmosphere-ice-ocean system and provided the persistence to sample continuously through the springtime retreat and autumn advance of sea ice. Autonomous platforms also allowed operational modalities that reduced the field programs' logistical requirements. These programs demonstrate effective use of light-weight logistics and integrated systems of autonomous platforms for persistent, multi-scale Arctic observing. Networks of autonomous systems are well-suited to capturing the vast scales of variability inherent in the Arctic system.

Wed_335_TE-1_2354
Expanding Argo Float Measurements into the Arctic

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Ice-tethered profilers have already successfully been used as part of the integrated Arctic observing system and provide platforms for multidisciplinary ice-atmosphere-ocean observatories under stable ice conditions. But several observations and predictions suggest that an ice-free Arctic summer is likely to occur within the next decades and the ongoing decrease of sea ice coverage in the Arctic Ocean is already leading to extended periods of open water in parts of Arctic. This development facilitates measurements with profiling Argo floats in the Arctic.
The Euro-Argo ERIC, the European contribution to the international Argo program, has therefore started to investigate the use of profiling floats in the Arctic. First deployments are intended for summer 2018 in the Barents Sea and north of Svalbard within the national Argo programs of Finland, Norway and Poland.
In order to avoid damage to the floats by surfacing under ice-conditions it is necessary to hold them in ice-free areas and/or to equip them with ice-sensing algorithms. Within the context of the EU funded MOCCA project (Monitoring the Oceans and Climate Change with Argo) the Euro-Argo ERIC has started to develop such algorithms for the hydrographic conditions in the Arctic and is coordinating the European deployments in the area.
The talk is meant as a summary of the present state of activities within the project and a possibility to discuss ideas and collaborations for the future.

Wed_336_TE-1_2356
Vertical Profiling of Aerosol and Cloud Properties during PaCE2017

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Aerosols and clouds have a large impact on the radiative balance of the earth's surface. The aerosol-cloud interactions are still not well understood and have significant uncertainties. Especially in turbulent environment of the boundary layer with low aerosol burden such as the sub-Arctic region of Northern Europe. The 7th Pallas Cloud Experiment (PaCE2017) took place at the Pallas Atmosphere-Ecosystem Supersite - Sammaltunturi Global Atmospheric Watch (GAW) station (67°58' N, 24°07' E). Unmanned Aerial Vehicles (UAVs) of three teams - the Cyprus Institute, Airclip Service GmbH & Palas GmbH, and Finnish Meteorological Institute (FMI) - were employed to perform airborne in-situ measurements of aerosol and cloud physical properties together with meteorological parameters. The airborne measurements took place within the FMI's reserved airspace EFD431 - PALLAS that is centered around the Sammaltunturi GAW station with boundaries of 7 km and ceiling limit FL80 (1994 m MSL). The acquired vertical profiles cover five consecutive days from Sept 24th to Sept 28th 2017, and characterize situations under-, in- and above-clouds. The collected data were also combined with balloon soundings, concurrent continuous ground-based observations and remote-sensing instrumentation.

Wed_337_TE-3_14
Landsat-8 Satellite Data for Lithological Mapping in the Northern Greenland

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Geological investigations in the Arctic confront many difficulties due to its remoteness and extreme environmental conditions. Greenland has unique potential for discoveries of mineral ore deposits of world-class scale. Mineral exploration activities in Greenland have been only focused on certain targets or areas with variable intensity and density of data collection, leaving most of the parts of Greenland largely underexplored compared to other areas with similar geology elsewhere in the Arctic. The northern Greenlandic Archean terranes are often remote and not well-known. In north Greenland the Palaeozoic Franklinian Basin is recognized to host several Zn-mineralization, of which the Citronen Fjord Zn-Pb deposits is the best known. In this investigation, the application of Landsat-8 satellite remote sensing data was evaluated for lithological discrimination and mineral prospecting in the northern Greenland. Developed image processing approach such as specialized band rationing, image transformation techniques and directional filtering were implemented for mapping lithological units, gossans and structural features. Geological units, the facies-border and structures that most likely have a guiding on mineralizing systems within the Franklinian Basin in north Greenland were mapped using Landsat-8 spectral bands. This satellite-based remote sensing approach is comprehensively applicable for ore minerals prospecting in other inaccessible regions in Greenland.

Wed_338_TE-3_15
Changing Arctic Snow Cover: Rain-on-Snow and Ice Layer Detection

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The first and strongest signs of global climate variability and change have been observed in the Arctic over the past three decades. Patterns in the spatial extent and mass balance of snow show a statistically significant trend towards negative anomalies. More specifically, the currently observed warming in the Arctic leads to winter rain-on-snow (ROS) events, which are now more frequent. Those events often leads to the creation of ice layers that prevents ungulates from accessing their food.
We present here results from ROS detection algorithms, validated with 625 ROS observations across the Canadian Arctic Archipelago. Three periods were studied separately and results show that despite no significant trends in the cumulated yearly occurrence, an increase is seen in the occurrence of fall and winter ROS events. Furthermore, an anomaly analysis suggest positive anomalies in event occurrence starting in the late 80's. In addition to monitoring ROS, presence of ice layers is detected from satellite observations using variability in the polarization ratio at 11, 19 and 37 GHz. Observed trends in ice layer presence and ROS occurrences are similar. It is shown, however, that ice layers are less frequent, given that not all ice layers are of sufficient thickness to be detected by our algorithm. Finally, a spatio-temporal analysis identified specific areas such as Cornwallis Island, Sommerset Island and Northern Baffin Island to be more prone to ROS and ice occurrence.

Wed_339_TE-3_83
Retrieving Ice Parameters with a UAV-mounted RADAR

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To estimate the thickness of lake ice and detecting ice layers within the snowpack, a frequency-modulated continuous-wave (FMCW) RADAR has been mounted on a small UAV. The RADAR is working at 24 GHz (Ka band) and has an approximate retrieval accuracy of 2cm. The system will be flown in several locations in Canada, including Cambridge Bay (Nunavut) during a winter expedition in April 2018. Additionally, the system will be tested over sea ice to estimate the influence of brine on ice thickness retrieval accuracy.
Combined with other techniques (e.g. Snow Depth-retrieval), this platform offers the perspective to greatly improve measurements for estimating the amount of snow and ice presence in the ecosystem.
Initial results are promising, but the potential for (arctic) applications is unclear as an underestimation was measured in wet snow conditions and the required low flight level of less than 5m limits the area of operation. This presentation will highlight retrieval accuracy and ice layer detection potential for Arctic areas while discussing pros and cons of UAV operations at high latitudes.

Wed_340_TE-3_184
Relationship between Radiation and Vegetation in Fildes and Ardley Peninsula

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The aim of this work is to produce a simplified vegetation map of ice-free areas of the Fildes Peninsula (FP) and Ardley Island (AI) thought object-oriented classification using a Quickbird satellite image and to evaluate the influence of the global solar radiation (GSR) over the vegetation distribution. The vegetation data was generated from multiresolution segmentation, and for the classification we calculated the normalized vegetative difference index and the green normalized vegetative difference index. Two classes were created Lichen and Moss Cushion Sub-Formation and Moss Sub-formation with 48 vegetation samples collected in 2008 and 2009. The GSR was estimated in order to evaluate the effect of meteorological phenomena and cloud cover, and we measured the GSR using a net radiometer model CNR4 installed in FP between 2014 and 2016. The estimate of GSR was done for seasons of 2015, in order to estimate the light compensation point and the saturation point for the plant communities in FP and AI. The kappa index was 0.73 and the global accuracy was 0.78, showing consistency between the classification and ground truth. The area was covered by vegetation in FP was 16.7% and in AI is 59.1%. The vegetation cover is distributed differently at FP and AI and our results suggest GSR plays an important role in vegetation distribution and these tendencies could be related to greater GSR demand by mosses when compared to lichens.

Wed_341_TE-3_217
A Parametric Method for Snow Density Estimation Based on Ultrasonic Waves

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In this paper a method for snow density estimation based on non contact ultrasound examination is described. This ground based method involves a constant frecuency, air coupled ultrasound waves and incorporates a parametric method for reflected energy estimation. The paper issues theoretical considerations as well as the technolgical details of the addressed problem. Due to the fact that the amount of the reflected sound energy is related to the snow density the acoustic data processing scheme is presented. The theoretical model was applied to the data collected during field experiments in the vicinity of the Polish Antarctic Station Arctowski, South Shetlands, Antarctic. The results obtained permit to develop a new autonomous sensor for measurements of the snow ablation and density.

Wed_342_TE-3_268
KOMPSAT 5 SAR Sea Ice Concentration in the Chukchi Sea in Summer

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Sea Ice concentratiosn (SIC) has been used as a primary data source for climate change prediction and ship navigation. However, Passive Microwave (PM) SIC have an uncertainty in accuracy during summer. In this research, we evaluated the SIC derived from PM measurements using four representative sea ice algorithms: NASA Team (NT), Bootstrap (BT), Ocean and Sea Ice Satellite Application Facility (OSISAF) hybrid, and Arctic Radiation and Turbulence Interaction STudy (ARTIST) Sea Ice (ASI). KOrean Multi-Purpose SATellite-5 (KOMPSAT-5) Enhanced Wide-swath synthetic aperture radar (SAR) images was used for the evaluation in the Chukchi Sea in summer. SIC estimated from the NT and BT algorithms were largely underestimated and overestimated, respectively, compared to KOMPSAT-5 SIC, while the OSISAF and ASI algorithms slightly overestimated the SIC. Meanwhile, SIC estimated from the algorithms showed different error trends according to the KOMPSAT-5 SIC range. All algorithms overestimated SIC in open drift ice zones, in marginal ice zones and in consolidated pack ice zones SIC. The differences in SIC estimated from each algorithm were due to different sensitivities to surface effects, atmospheric effects, and the presence of melt ponds.

Wed_343_TE-3_270
High Resolution Sea Ice Motion and Deformation Measurements

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Sea ice motion and deformation have generally been measured using low-resolution passive microwave remote sensing technique to monitor wide polar regions, e.g., entire arctic ocean or polynya. This study presents an application of multi-sensor optical satellite images for high-resolution sea ice motion and deformation measurements. The sea ice motion was measured by using a maximum cross-correlation technique with hierarchical approach to decrease outliers and multi-temporal images acquired from multiple optical sensors of Korea Multi-Purpose Satellites (KOMPSATs). The sea ice motion extracted from image pairs of short acquisition time intervals were compared with time-interpolated in-situ buoy location records. The root mean square errors and biases of the image-derived ice motion indicate more accurate measurements than from the sea ice motion datasets from conventional low-resolution passive microwave satellite data. In the dense sea ice deformation grids, free drift patterns of ice floes that appear in summer were delineated. The results demonstrate that using high-resolution multi-sensor optical images from operational satellites enabled accurate sea ice motion and deformation measurements, thus this approach could be used for validation of wide-range sea ice motion studies as a supplementary dataset to buoy based reference datasets.

Wed_344_TE-3_271
Regional Chlorophyll Algorithms in Coastal Waters of Svalbard, Arctic

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AOP (Apparent Optical Properties) and IOP (Inherent Optical Properties) data from 2007 to 2013 were analyzed to evaluate the performance of the ocean color algorithms to retrieve chlorophyll concentration in polar coastal waters. Field data were collected from the Svalbard coast, Arctic, in late spring and early summer between May and June. For the measurement of chlorophyll concentration using satellite data, we statistically evaluated and analyzed current algorithms. Current algorithms tend to overestimate chlorophyll at low chlorophyll concentrations, while underestimating chlorophyll at high concentrations. Bio-optical analysis of the coastal waters in this region showed that high chlorophyll-specific absorption coefficients and suspended sediment concentration were the main causes of chlorophyll overestimation and large size phytoplankton such as diatoms caused chlorophyll underestimation. We proposed regionally tuned algorithms, which led to better results in the Svalbard coastal waters.

Wed_345_TE-3_276
Ice Thickness and Frontal Ablation of Nine Outlet Glaciers on Novaya Zemlya

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Knowledge of the volume and proportion of ice mass loss due to frontal ablation (the sum of ice loss through calving and submarine melt) from tidewater glaciers on Russian Arctic archipelagoes is very limited. Meanwhile the frontal ablation there is an important factor of current change of glaciers, as well as this knowledge is required for iceberg hazard assessments. We present our estimations of frontal ablation for nine Novaya Zemlya tidewater glaciers, calculated from satellite-derived ice velocities, airborne 20 MHz GPR RES measurements of glacier ice thickness in 2014-2016, and mass change due to changes in terminus position (MCTP). These glaciers are located in northern part on Novaya Zemlya
(5 on its western side, and 4 on eastern side).The average ice thickness at glacier fronts varies from 70 to 250 m, and average ice velocity at fluxgates varies from 40 to 840 m a^{-1}.
The total mean rate of frontal ablation for these nine glaciers in 2015-2016 is 2.47 $km^3\,a^{-1}$ of ice with dominance of western side glaciers (2.08 $km^3\,a^{-1}$). The average ratio of MCTP to frontal ablation is 2/5 on western side and 1/5 on eastern side. The most active frontal ablation is found on Inostrantsev Glacier, where it comprises 0.72 $km^3\,a^{-1}$ (with gate ice flux 0.58 $km^3\,a^{-1}$ and MCTP 0.14 $km^3\,a^{-1}$). On Kara Sea side, the especially active frontal ablation 0.24 $km^3\,a^{-1}$ is on Vershinsky Glacier. RES data allows also to identify those frontal parts of studied glaciers that are close to the flotation.

Wed_346_TE-3_280
High Resolution Sea Ice Observation using Space-borne Fully Polarimetric SAR

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Satellite images are an essential source of information for sea ice products such as the sea ice concentration maps issued by the national ice charting agencies. In this regard, Synthetic Aperture Radar (SAR) is especially valuable given its all-weather capabilities. Within this study we investigate the usefulness of fully polarimetric SAR by utilizing an automatic sea ice classification algorithm, developed for Near Real Time (NRT) services, on two sets of spatially and temporally near coincident fully polarimetric acquisitions from the ALOS-2, Radarsat-2 and TerraSAR-X satellites acquired during the N-ICE2015 sea ice drift study.
Overlapping coincident sea ice freeboard measurements from Airborne Laser Scanner (ALS) data are used to validate the classification results. We analyzed the usefulness of 18 different polarimetric parameters for sea ice characterization. In order to deliver sea ice products in NRT savings in computational time are very important and by reducing redundant parameters we can speed up the delivery time. Validation with the coincident ALS data shows that 100 % of the open water is separated from the surrounding sea ice and that the sea ice classes have at least 96.9 % accuracy. A notable difference between the C/X-band and the L-band images was the high importance of entropy for the L-band sea ice classifications.

Wed_347_TE-3_308
Thermodynamic Evolution of Arctic Sea Ice Using L-band SAR

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Selection of C-band SAR (synthetic aperture radar) as the preferred frequency for sea ice monitoring was made in the 1980s when the Arctic sea ice regime was different (i.e. Multi-year ice [MYI]) from what it is today (i.e. predominantly first-year ice [FYI]). Moreover, during the melt season, it has been demonstrated that C-band fails to exhibit necessary backscatter contrast among various ice-types that make classification difficult compared to L-band. Thus, L-band SAR is considered as an optimal choice for sea ice monitoring in the new Arctic sea ice regime. Considering limited L-band sea ice application, this study aims to investigate the thermodynamic evolution of snow-covered Arctic sea ice over the Canadian Arctic Archipelago using L-band ScanSAR imagery from ALOS PALSAR. Time-series microwave backscatter signatures for both FYI and MYI are explored using L-band SAR imagery in 2010. Seasonal evolution of L-band microwave backscatter over FYI shows similarity with C-band, with lower intensity. However, this study reveals that seasonal evolution of L-band MYI signature during winter to melt transition is opposite to C-band, which certainly exhibit different scattering mechanism. The unique characteristic of L-band SAR during thermodynamic evolution of Arctic sea ice that will be invaluable with imminent launch of future L-band missions (e.g. SAOCOM, NISAR). This study recommend further investigation of L-band SAR interactions with sea ice compared to higher frequencies.

Wed_348_TE-3_317
L-band Brightness Temperature and Snow Surface Properties at Dome C, Antarctica

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The physical properties of the surface are essential for understanding the surface energy and mass budgets of the Antarctic ice sheet and, in turn, for predicting climate change and a rise in the sea level. Several glaciological properties are relevant, such as snow grain size, density, roughness, etc.
A careful analyse of snow surface properties at Dome C showed that an unusual event happened during the 2014-2015 austral summer. At the same time, an exceptional variation (2 events in 6 years) is observed by L-band radiometers (DOMEX ground radiometer and the ESA's SMOS satellite). Here we present our investigation of this period combing multiple sources of information. From November to March, a slow increase in brightness temperature (Tb) occurred concomitantly with a decrease in surface snow density. During this period, low wind speed made the presence of hoar and the accumulation of light snow possible. Around 20 March 2015, an abrupt decrease in Tb was observed and corresponded with a clear increase in surface snow density. Strong wind was also observed, which could have compacted or removed the light snow presents on the surface. Simulations performed with the WALOMIS snow-emission model indicated that L-band Tb was affected by both the surface snow density and the thickness of the superficial layer. Future work will explore the widespread nature of this kind of event and the interest to use them as climate indicator of change at the continent scale.

Wed_349_TE-3_406
Cloud Optical Thickness over the Arctic: Retrieval & Validation Challenges

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Accurate characterization of the Surface Radiative Energy Budget (SRB) of the Arctic is critically important for understanding its key role in climate regulation. This is most cost-effectively done with satellite observations. In particular, we know that accurate estimates of the Cloud Optical Thickness (COT) of Arctic clouds are a prerequisite for successful SRB calculations. Yet we also know that COT retrievals over bright surfaces such as snow or sea ice are very challenging, particularly for legacy instruments such as the Advanced Very High Resolution Radiometer (AVHRR). Yet, utilization of the multi-instrument AVHRR timeseries offers us the single best chance for obtaining a long SRB timeseries if the challenges can be overcome.Thus our research question: How do AVHRR-based COT retrieval methodologies perform over the Arctic, and can we identify specific issues that set limitations for COT retrieval accuracy?
We have spatiotemporally collocated a large multi-year dataset (N=270K+) of individual AVHRR-based COT retrievals from the CM SAF CLARA-A2 and NOAA APP-x datasets with corresponding observations from both CALIPSO/CALIOP and Cloudsat, based on the SNO method. We show a comparative analysis of the different COT retrievals, taking into account the inherent limitations in each (e.g. CALIPSO's COT saturation over thick clouds, Cloudsat's insensitivity to very low clouds, etc.). We furthermore present the findings grouped by background surface type and cloud type.

Wed_350_TE-3_420
DLR's Near-real Time Radar Information for Antarctic Research Vessels

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Sea ice coverage is one of the major challenges for ship expeditions in the Antarctic Southern Ocean. Even icebreakers with a high ice class can get into trouble on their journeys through sea ice covered areas. Sea ice information in near-real time independent of weather conditions and daytime are therefore highly desirable. The German radar satellites TerraSAR-X (TSX) and TanDEM-X (TDX) are capable to provide such a near-real time application.
The Earth Observation Center (EOC) of the German Aerospace Center (DLR) covers the entire spectrum of remote sensing from data reception to processing, as well as developing new information products. In combination with the German Antarctic Receiving Station (GARS) O'Higgins, which is equipped with an operational near-real time processor for TSX/TDX data, it is possible to deliver sea ice information just about 60 minutes after the raw data has been acquired. These information products can be used by ship crews for navigation purposes as well as for planning biological, geological or oceanographic sampling sites by scientists aboard the supported research vessels.
Since 2015 this service has been successfully tested during several ship expeditions. Information on the processing chain and examples of delivered products will be presented.

Wed_352_TE-3_498

Add-on Value of Sentinel-2 Imagery to Map Supraglacial Rivers in the Arctic

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Supraglacial river networks set efficacy and time lags by which surface meltwater is routed to the englacial and proglacial portions of the ice masses and thereby have important implications for surface ice mass balance and ice dynamics. However, these crucial hydrologic features remain poorly studied mainly because they are too narrow to be reliably delineated from conventional moderate-resolution satellite images. This study uses 10 m Sentinel-2 MSI images to map supraglacial rivers on the Northwest Greenland Ice Sheet, Devon Ice Cap, and Barnes Ice Cap. Results show that Sentinel-2 images are preferable to Landsat-8 images for delineating narrow and continuous supraglacial meltwater channels, yielding sufficient detail and higher drainage density than Landsat-8. The Sentinel-derived rivers form different surface meltwater drainage patterns at each study area. In northwest Greenland, supraglacial rivers drain meltwater directly off the ice sheet into proglacial rivers, whereas on the Devon Ice Cap and the Barnes Ice Cap, numerous supraglacial rivers are interrupted by moulins and thereby drain considerable portions of surface meltwater to subglacial systems, potentially coupling surface melt with ice dynamics. Overall, the Sentinel-2 images raise prospects for investigating supraglacial meltwater drainage patterns and improving our understanding of surface hydrology and ice flow of global ice masses.

Wed_353_TE-3_507
Ice Cliff Contribution to Ablation of Debris-covered Changri Nup Glacier, Nepal

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Ice cliff backwasting on debris-covered glaciers is recognized as an important process, potentially responsible of the so-called "debris-cover anomaly", i.e. the fact that debris-covered and debris-free glaciers loose mass at a similar rate in Himalaya. In this study, we assess the total contribution of ice cliff backwasting to the ablation of Changri Nup Glacier tongue over one year. We use three very high resolution datasets (terrestrial photogrammetry, UAV photogrammetry, Pléiades tri-stereo) acquired simultaneously in November 2015 and 2016 to survey the glacier tongue topography. Using terrestrial photogrammetry data, we calculated the volume losses of 12 cliffs with various size applying a full 3D method. We used these reference volume loss estimates to assess the applicability of UAV and Pléiades data to calculate volume losses of individual ice cliffs. We found that the total difference between the volume loss measured with the terrestrial photogrammetry and the UAV and Pléiades was less than 3% and 7%, respectively, demonstrating the suitability of these datasets to measure volume loss from ice cliffs. We then applied the same method to the entire glacier tongue, and found that ice cliffs contribute to 23 ± 5 % of the total ablation of Changri Nup Glacier tongue.

Wed_354_TE-3_533
The Spatiotemporal Patterns of Sea Ice in the Bohai Sea during 2000 - 2016

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In this study, sea ice thickness (SIT) and sea ice extent (SIE) in the Bohai Sea from 2000 to 2016 were investigated. A surface heat balance equation was applied to calculate ice thickness using ice surface temperatures estimated from MODIS data with input from air temperature and wind speed from reanalysis weather data. No trend was found in ice thickness in this period. The mean SIT and SIE during this period were 5.58±0.86 cm and $23\times10^3\pm8\times10^3$ km^2, respectively. The retrieved ice thickness in the winter of 2009/2010 agreed reasonably well with *in situ* observations at two offshore oil platforms, with RMSE of 6.42 cm and 2.26 cm. Annual variation in mean ice thickness was rather limited within a range of 3-7 cm. The SIE varied significantly with a rather large standard deviation of approximately 8,000 km^2. The largest ice thickness and ice extent periods were observed during the second half of January and the first half of February, respectively. The Spearman correlation coefficient between mean ice thickness and average air temperature from 21 automatic weather stations around the Bohai Sea was -0.94 ($P < 0.005$), and the coefficient between median ice extent and negative accumulated temperature was -0.503 ($P < 0.001$). The rate of increase in air temperature around the Bohai Sea is 0.271°C decade^{-1} in winter for 1979-2016 ($P < 0.05$), which has not resulted in a decreasing trend in sea ice thickness and extent for the past 16 years in the Bohai Sea.

Wed_355_TE-3_655
Remote Sensing of Grounding Lines - Current Methods and Data

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The grounding line is the boundary between the floating and the grounded part of an ice sheet or tidewater glacier. Knowing its position is critical for assessing glacier/ice sheet stability, glacier/ice sheet mass balance calculations and numerical modeling. However, as it is a subglacial feature, mapping of the grounding line is challenging. Although ice sounding surveys may be capable to map grounding line positions directly, they often do not yield satisfying results. Other field measurements try to map grounding lines indirectly e.g. by measuring ice flexure with tiltmeters or kinematic GPS. Nevertheless, such surveys are not suitable for picking grounding lines over large and inaccessible areas. In contrast, the continuous development of new remote sensing sensors and techniques over the last decades enabled grounding line delineation over extensive areas at low costs. Modern remote sensing techniques mainly use space- and airborne SAR, optical, radio echo sounding and altimeter data to map features in the grounding zone which can be taken as grounding line proxies. We present a state-of-the-art review of existing remote sensing techniques and data for mapping grounding lines. We discuss the advantages and disadvantages of the methods and evaluate commonly used sensors and data. We also give an overview of freely available grounding line products. Finally we compare grounding lines inferred from different remote sensing methods and data in example regions.

Wed_356_TE-3_733
Sea Ice Leads Detection Based on Multisensory Remote Sensing Data

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Sea ice leads serve as prime window for heat transfer between the Arctic ocean and the atmosphere during winter seasons. They also provide pathways for human to enter the core Arctic area. The objective of this study is to extract sea ice leads utilizing multisensory remote sensing data and explore potential use of high-resolution Radarsat-2 images in lead detection. We found that ice surface temperature derived from MODIS thermal bands has capability of detecting leads prevailed by open water or thin ice, but cannot differentiate refrozen leads from the surrounding thick ice, i.e. multi-year ice (MYI) and first-year ice (FYI). Whereas Radarsat-2 images outperformed in discriminating several sea ice types including new ice (NI), young ice (YI) and refrozen leads (RL). Ice surface temperature and optical reflectance from MODIS were introduced using decision tree to reduce ambiguity in Radarsat-2 classification. We concluded that dual-polarization Radarsat-2 data could provide more details on sea ice condition in lead area compared with moderate resolution MODIS images, especially for refrozen leads. On the other hand, could-free optical images, if available, can add valuable information for discrimination between FYI and NI, thus improve the classification accuracy.

Wed_357_TE-3_792
Estimation of Wet Snow Fraction Images for the Antarctic Continent (1978-2017)

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A Spectral Linear Mixing Model (SLMM) is proposed to estimate wet snow fraction images for the Antarctic continent based on calibrated SMMR, SSMI and SSM/IS EASE-Grid data (25 km spatial resolution) with a daily temporal resolution. We compared calibrated brightness temperatures of DMSP SSM/I images (19GHz-H, 19GHz-V, 37GHz-H and 37GHz-V channels) with fraction images of Wet Snow Zone (WSZ), Dry Snow Zone (DSZ) and Rock Outcrops (RO), derived from classified ENVISAT ASAR wide swath images (150 m) acquired at 16 dates. Then, these data were used on a least squares solution to estimate the unknown spectral signatures in brightness temperatures (Kelvin) for these three endmembers, in channels 19H, 19V, 37H and 37V, respectively: WSZ (256.122; 269.679; 239.865; 251.192); DSZ (200.256; 227.464; 204.568; 224.161); RO (261.514; 287.697; 215.217; 227.824). The r^2 were higher than 0.98 and p-values lower than 0.00001 for all channels. These spectral signatures and SSM/I images were then used in this SLMM to estimate WSZ fraction images, which were compared with correspondent ASAR fraction ones at 11 dates. The average overall accuracy was 73% for class ranges of 0.2 (*i.e.*, each class represents 20% of one pixel). The RMSE was lower than 0.06 for all dates, excepting for one with 0.29. The analysis of the estimated WSZ fraction images indicated that the most persistent and intensive melt was observed on the Larsen and Wilkins ice shelves during the period 1978-2017.

Wed_358_TE-3_856
The Latest Image Mosaic of Greenland based on Landsat8

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In order to support studies on landscape changes of elements like snow, ice, water bodies and vegetation, a new and updated mosaic of Greenland is necessary. In this study, we created a 30m mosaic of Greenland from 229 individual Landsat8 scenes acquired during June to August in 2014 and 2015. There are four steps to finish the mosaic. Firstly, planetary reflectance for three single spectral bands (red, green and blue bands) was calculated. Since concentrations of atmospheric water vapor and aerosols are very low over Arctic regions, the planetary reflectance is a good approximation of surface reflectance. The planetary reflectance was used as the surface reflectance in this study. Secondly, to minimize differences of surface reflectance among scenes caused by acquisition date, solar elevation angles and other factors, a solar elevation correction and a non-Lambertian adjustment were applied to the surface reflectance data. Thirdly, non-linear piecewise functions were used to convert surface reflectance values to 8-bit values ranged from 0 to 255 for each visible wave band of Landsat8 scenes. Then three 8-bit values images were combining into a 24-bit multispectral scene in order of red band, green band and blue band. Finally, all multispectral scenes were mosaicked to finish the full image mosaic of Greenland.

Wed_360_TE-3_874
Mapping Ice Shelf Surface Melt using Object Based Image Classification

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Surface melt features, such as supraglacial ponds, influence ice shelf stability through hydrofracture induced iceberg calving, and change other ice shelf properties through the redistribution of mass. Accurately mapping the pattern of surface melt at a high temporal and spatial resolution is key to understanding the surface melt regime. Previous studies have used algorithms to successfully discriminate ice shelf surface facies using multi-temporal Synthetic Aperture Radar (SAR) data to map the spatial-temporal patterns of surface melt, identifying the onset of melt and refreezing. However, these studies were restricted by low resolution images and noisy data quality which reduced classification accuracy. The work presented here investigates the application of Object Based Image Analysis (OBIA) to classify Sentinel-1 SAR images covering the Sørsdal Glacier, a small ice shelf in East Antarctica that experiences significant surface melt. The classification was performed using Trimble's eCognition software, where user-defined rules are based on *a priori* knowledge of the relationship between ice surface properties and radar back scatter intensity and how this relationship changes with surface melt. The OBIA based classifications will be evaluated using classified Landsat 8 imagery. Mapping the dynamics of the surface melt regime is key to understanding how it influences other ice shelf processes, especially iceberg calving, and how this influence may change in the future.

Wed_361_TE-3_948
Temporally Resolved Ice Velocities of Greenland Glaciers using Sentinel SAR Data

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The mass loss due to ice discharge via marine-terminating glaciers in Greenland is largely well known. Previous studies have indicated interannual variabilities of ice velocities of different glacier systems in Greenland. However, in most cases these studies were limited by low temporal resolution of the available data. Here, we present ice velocities of 45 Greenland glaciers, including, 79N Gl., Helheim Gl. and Upernavik Isstrøm, with very high temporal sampling during 2015-2017, derived from SAR offset tracking applied over Sentinel SAR data. Moreover, we combine radar backscatter from Sentinel SAR data and air temperature recorded at various weather stations in Greenland, to mark the onset and extent of the melt season. We also derive the changes in the frontal positions of selected glaciers. Seasonal velocity fluctuation of most of the investigated glaciers (26) appear to be primarily controlled by subglacial hydrology. For instance, a group of glaciers (8) speed up with the onset of surface melt, attain maximum velocity in the middle of the melt season and slowdown afterwards. Other glaciers (18) show comparable velocities during late winters and early melt season with significant slowdown afterwards. Seasonal velocities of 6 glaciers appeared to be sensitive to their ice front positions. Our results with such temporal details are crucial for calibrating models projecting the future ice dynamics of marine-terminating glaciers and their mass loss due to ice discharge.

Wed_362_TE-3_966
Gap Filling of Antarctic Sea-ice Freeboard from ICESat: Comparison of Approaches

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Due to the sparse laser-point observations by ICESat, methods are needed to get a complete Total Freeboard (TF) of sea ice coverage over the Antarctic. Three methods, Gaussian Weight Regression (GWR), Ordinary Kriging Interpolation (OKI), and Random Forest Regression (RFR), have been used for gap filling of TF under 6.25 km grid scale with 17 ICESat observation periods during 2003 and 2009. The TF is derived from ICESat by the improved Lowest Level Elevation method and randomly divided into training set (80% grids) and test set (20% grids). Gap filling grid extents are defined with average AMSR-E sea ice concentration larger than 0 in corresponding time periods. Differing from GWR and OKI that only use TF values for gap filling, the RFR method integrates TF values with sea ice cover, sea surface temperature, air pressure, 10 m U wind component, and 10 m V wind component from atmospheric reanalysis data ERA-Interim. With estimated RMSEs on the test set, our primary results show that GWR and OKI have very similar prediction accuracy. By integrating several climate parameters, the RFR shows the best accuracy during the 17 periods.

Wed_363_TE-3_1063
Precipitable Water Retrieval over Antarctica from Satellite Microwave Sounders

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Atmospheric water vapor is an important constituent of the global hydrological cycle; it transports humidity and heat and it is the most important greenhouse gas. Large-scale observations in polar regions with low water vapor burden are difficult to obtain because of the low water vapor signal and, over sea ice and land ice, the high and highly varying surface emissivity. A procedure has been suggested exploiting the data of the satellite humidity sounders SSM/T2, AMSU-B and MHS aboard the DMSP, Aqua and Metop satellites or satellite series, respectively.
The algorithm uses three channels of neighbouring frequencies around the water vapor absorption line near 183 GHz plus the 150 GHz channel. The procedure excludes the surface contribution in the satellite signal by considering the ratio of brightness temperature differences. Moreover, the procedure has been adapted to the microwave humidity sounders AMSU-B and MHS with slightly different channels (Melsheimer and Heygster, 2008). Results for Antarctica will be presented for the years 2006-2007. In coastal Antarctic areas, PW time series are available from Global Positioning System (GPS) and radiosounding (RS) stations. Data from five Antarctic sites (Negusini et al. 2016) will be used to correct the satellite based retrievals and then to extend the PW retrieval over whole Antarctica.

Wed_364_TE-3_1069
Support of Logistics by Satellite Remote Sensing in East Antarctica

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For scientific and logistic expeditions in Antarctica, identifying safe traverse routes and safe landing areas on snow or ice is a significant challenge. The ability to perform meaningful assessments of ground conditions during the planning phase of an expedition is invaluable. Here we present satellite based approaches to support traverse planning as well as exploration of a new blue ice runway in Dronning Maud Land, East Antarctica. For traverse planning we used both optical (Landsat 8, 15 m ground sample distance (GSD)) and C-band radar images (Sentinel-1, 10 m GSD and Radarsat-2 1.5 m GSD). Data on ice flow speed helped us to detect shear zones with higher risk of crevasses. For the blue ice runway we used hi-res optical images (World View 2, 0.4 m GSD) and a stereographic derived Digital Surface Model (2m GSD). By combining and analyzing these data sets we could identify dangerous areas (e.g. crevasses, erratica, steep slopes). For the runway exploration additionally hi-res maps on micromorphological parameters (e.g. slope, roughness) and cross sections were created in scales up to 1:12,000. All results were delivered as interactive field maps with offline usability. To deal with highly dynamic glacial areas, near-time support to field teams, using of the most recent satellite images can be provided. Antarctica is a high stakes environment and our studies can identify potential hazards during the planning phase to reduce costs, time and increase the safety of field work.

Wed_365_TE-3_1131
Identifying Blooming Algae in Antarctic Remote Sensing Observations

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The quantity, distribution and contribution to primary productivity of snow algae in Antarctica are currently unknown. We present the first remote sensing analysis of snow algae distribution in Ryder Bay (Adelaide Island, Antarctic Peninsula, 68°S) using a detection algorithm for World View 3 satellite data. Impurity concentration is one of the primary inherent characteristics that determine the optical properties and albedo of snow and snow algae are a prolific impurity that darken the snow pack and increase snow melt through absorption of solar radiation. This analysis is supported by ground and atmospheric spectral field sampling of the same region obtained during the 2017/18 growing season. We compare the area coverage of snow algae to other photosynthetic organisms such as mosses, lichens and higher order vegetation.

Wed_366_TE-3_1310
Copernicus Glacier Service - Monitoring Glaciers using Sentinel

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Monitoring of glaciers and glacier changes is important for many purposes. The goal of the Copernicus Glacier Service Norway is to develop a national service for glaciers. The Norwegian Water Resources and Energy Directorate (NVE) and Norwegian Polar Institute (NPI) are responsible for monitoring the ice masses in mainland Norway and Svalbard, respectively. The project will mainly use optical imagery from Sentinel-2, but also other sensors such as Landsat-8 and Sentinel-1. Glacier products that will be produced are:
1) Glacier outline, area and calving front,
2) Glacier surface type and snow line,
3) Ice velocity,
4) Glacier crevasses and surge, and
5) Glacier lake outlines.
Here we report results on geometric performance of Sentinel-2, we present ice velocity maps for Svalbard and selected glaciers in mainland Norway, we demonstrate how combined sensors can be used for glacier snowline mapping and we use Sentinel-2 for mapping evolution of glacier lake outlines at selected sites with potential for glacier lake outburst floods.
The glacier products will be made available from NPI and NVE websites (as Web Map Service´s and download) and through the CryoClim portal. Data will also be submitted to GLIMS.

Wed_367_TE-3_1314
A New Approach to Ice Concentration Retrieval from MW-retrieved Refractive Index

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This study attempts to develop a new algorithm for retrieving sea ice concentration from AMSR (Advanced Microwave Scanning Radiometer)-retrieved refractive index. This algorithm is based on the property that the refractive indices of ice and snows are nearly constants regardless of frequency in microwave domain, on the other hands, refractive index of sea water highly varies with frequency. Therefore, the new algorithm gives possibility to reduce statistical uncertainty by using difference of the retrieved refractive index from dual-channel observations because it can reduce tie points for three different types (i.e., first-year, multiyear, and open water) to one for open water. The tie points for sea water are found from analyzing monthly distributions of the retrieved refractive index of water. In other words, dynamic tie points are selected in this algorithm for considering seasonal variation of refractive index of water due to temperature change itself. The sea ice concentration retrieved in this study is compared with those with three different algorithms (e.g., NASA Team, bootstrap, and ASI (ARTIST Sea Ice) algorithm) and the result shows that accuracy of ice concentration produced using refractive index is comparable to the others. In this presentation, systematic difference over the complete AMSR period between developed algorithm and others will be presented and discussed.

Wed_368_TE-3_1324
Mapping Surface Facies of Alpine Glaciers from Himalaya using WorldView-2 Image

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Glacier facies are distinct zones in the surface layer of an ice sheet or glacier, which are related to patterns of accumulation and ablation. This study has attempted to map the surface facies of selected glaciers from the Chandra Basin, in the Great Himalayan Range. The digital mapping of spatial extent of glacier facies was carried out using object-based and pixel-based approaches on very high resolution satellite imagery. Traditional glacier facies mapping methodologies have usually utilized data acquired during the melt season. This study however has attempted to map glacier facies using data acquired during early winter. WorldView-2 (WV-2) imagery was used to develop customized spectral indices using the new spectral bands in its multispectral (MS) range. Error matrices were utilized to assess the classification accuracies of final maps. The object-based approach provided an overall accuracy of 88.33%. Two pixel based classifiers, namely maximum likelihood (MXL) and spectral angle mapper (SAM) were utilized, which yielded overall accuracies of 81.67% and 78.33% respectively. The highest kappa statistics obtained for the object based strategy is 0.86 and the pixel based classifiers delivered Kappa statistics of 0.78 and 0.74 respectively. The results indicate that the object-based classification is superior to the pixel-based classification methods for glacier facies mapping in Himalayan environment.

Wed_369_TE-3_1356
Spectral Vegetation Indices Derived by UAV Images to Map Patchy Vegetation

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Environmental changes observed on the northern tip of the Antarctic Peninsula over the last decades have contributed to recession in local glaciers and expansion in ice-free areas of the region, creating more adequate conditions for vegetation grow and colonization of newly exposed ground. However, identifying vegetation cover in areas such as the Antarctic Peninsula can be a challenge to remote monitoring due to the nature of the typical Antarctic cryptogamic vegetation, which often appears in small patches and scattered across ice-free areas. In this study, we use remote sensing techniques and criteria to identify this cover in very high-resolution images, acquired by unmanned aerial vehicles (UAV). Spectral Vegetation Indices (SVI) - based on the high absorption in the visible range and the increased reflection in the NIR by plants - were applied in the ice-free area of Hope Bay, in the Trinity Peninsula. The results enabled an evaluation of the indices according to the targets of the area (especially vegetation and penguins nests), and to the types of cryptogamic vegetation (algae, lichens and mosses), in addition to a quantification of local vegetation. We found 5% of the area imaged with some type of vegetation cover, and the best method for the automatic identification of areas with presence of mosses and algae was the Green Normalized Difference Vegetation Index (GNDVI).

Wed_370_TE-3_1358
Climate Change and the Expansion of Ice-free Areas on the Trinity Peninsula

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Among one of the most rapidly warming regions on Southern Hemisphere, the northern tip of the Antarctica Peninsula has been reacting to rising air temperatures over the past decades, which have led to greater-than-average summer melting, causing changes in its ice-covered and ice-free areas. In the Trinity Peninsula, areas not covered by ice are sparse and restricted to a few headlands, although it is assumed these could significantly expand as a result of a warmer weather. Mapping these areas create conditions to identify and monitor the changes occurring in these environments, checking for eventual responses to climate change. Here, we performed a survey of variations occurred over the last three decades (1988-2017) in the ice-free areas of the Trinity Peninsula, using Remote Sensing techniques. The study used Landsat satellite imagery to identify ice-free area variations using the VIS, NIR and SWIR bands to differentiate ice and snow from rocks, which can be problematic in the Antarctic environment due to extensive cloud cover and areas with shadow.

Wed_371_TE-3_1370
On the Retrieval of Ice Sheet Temperature Profile by using SMOS Satellite Data

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The internal ice sheet temperature is a key parameter for the understanding of the ice sheet dynamics which, at present, is available only from glaciological models or in the few boreholes where temperature has been measured. However, the drilling of boreholes is a very expensive activity and the state-of-the-art climate or glaciological models are unable to determine the temperature profile at continental scale with a sufficient accuracy. From the spatial analysis of space-borne L-band data from the ESA's SMOS, collected over Antarctica, it was proved that they are sensitive to the ice sheet temperature profile. The latter depends on several factors as the ice thickness, the surface temperature, the geothermal heat flux, the mean annual accumulation. The satellite observations suggested that, by using a proper glaciological and microwave emission model it is possible to retrieve the ice sheet temperature profile starting from SMOS data. Starting from these considerations an inversion algorithm, which uses as inputs SMOS data and ancillary information, the ice sheet temperature profile was derived from a large portion of Antarctica. Areas where the retrieval is not applicable (i.e. near to the coast or where the ice sheet velocity is higher than 10m/yr) are masked out and a quality flag with the confidence of the estimation was also provided. Secondary products are the geothermal heat flux and snow accumulation maps at the same spatial resolution of SMOS.

Wed_372_TE-3_1469
Ice Dynamics of Union Glacier from SAR Offset Tracking

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The Antarctic ice sheet is predicted to be the major contributor to sea-level rise during the XXI century. Therefore, monitoring ice dynamics of outlet glaciers in Antarctica is of great importance to assess future sea-level rise predictions. Union Glacier is one of the major outlet glaciers of the Ellsworth Mountains and drains into the Ronne-Filchner Ice Shelf. We acquired high resolution Stripmap HIMAGE SAR images from the COSMO-SkyMed satellite constellation during austral summer of 2011-2012, and applied SAR offset tracking to compute ice velocities. Then, we compared our derived velocities with field data obtained between December 2011 and January 2012. Mean values of ice velocity estimated for the main trunk of the glacier are 15.7 ma-1, with maximum values of 109.9 ma-1 and 14.3 ma-1 SD, and are in agreement with previous studies and field measurements. Higher velocities are associated with changes in elevation between the plateau and the main valley. A model of ice thickness based on lamellar flow theory is proposed, using estimated surface ice velocity in combination with surface slope derived from TanDEM-X as input data. Comparison of our modeled ice thickness with radar data from published studies agree with high accuracy. Finally, we computed principal strain rates and compared with glacier surface features as seen in high resolution COSMO-SkyMed Spotlight-2 SAR images in order to show the relation between surface features and acting strain components.

Wed_373_TE-3_1570

Spatiotemporal Trend Analysis of Snowmelt on the Antarctic Continent (1978 - 2017)

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We performed a spatiotemporal trend analysis of snowmelt in the Antarctic continent for the 1978-2017 period based on wet snow fraction-images, calculated by the Spectral Linear Mixture Model - SLMM. This subpixel analysis was performed using passive microwave brightness temperature data (SMMR, SSM/I and SSMI/S) with daily resolution, and 25 km of spatial one. To measure the snowmelt surface area, we used the total fraction melt area calculated by the sum of the total wet snow fraction-images during 90 days of the Austral summer with the highest snow-melt (December, January and February) in seven regions of Antarctica. Using the Mann-Kendall test, we performed a analysis that shows negative trends in the Antarctic Peninsula, Marie Byrd Land, Amery Ice Shelf and Dronning Maud Land regions. On the other hand, positive trends are observed in the Ross Ice Shelf/Siple Coast and Wilkes Land. Taking in consideration these results, we are able to distinguish two different snow-melting trends according to two groups of regions in the Antarctic continent, which show a negative trend as a whole.

Wed_374_TE-3_1658
Automatic Sea Ice Drift Tracking from SAR Images

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The first systematic observation of the ice drift had been held more than a century ago. Spatial ice drift vector fields can be retrieved from remote sensing data. The sea ice motion is estimated by comparing the points of sea ice patterns in two subsequent snapshots.
We propose a feature tracking algorithm for sea ice drift retrieval from sequential satellite synthetic aperture radar (SAR) images. The method is based on feature tracking comprising of feature detection, description and matching steps. The Scale Invariant Feature Transform (SIFT), its alternative called ORB and A-KAZE features are selected for the intercomparing. The approach exploits the benefits of nonlinear multi-scale image representations using A-KAZE features, which is a method that detects and describes image features in an anisotropic scale space that preserves important object boundaries while adaptively removing noise and small image details.
These techniques were implemented as a part of ice drift retrieval algorithm and tested on dual polarized Sentinel-1A C-SAR extra wide swath mode data over Arctic Seas. To evaluate the developed of sea ice drift retrieval algorithm we performed a series of experiments over the Arctic seas. Data collection and processing is done in real time. Validation of the results performed in parallel and includes comparisons with other statistical and manual methods.

Wed_375_TE-3_1675
Remote Sensing Mapping of Western Dronning Maud Land (Antarctica) Geomorphology

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Given current climate trends, it is imperative that we improve our understanding of ice-sheet responses to climate change and consequent sea-level changes. Numerical ice sheet models are central to addressing this challenge, and are tested and refined by comparing model predictions of past ice geometries with field-based reconstructions from geological, geomorphological, and ice core data. However, on the East Antarctic Ice Sheet, Dronning Maud Land (DML) comprises a critical gap in the empirical data required to reconstruct changes in ice sheet geometry. MAGIC-DML is an international collaboration working to delineate the timing and pattern of past ice surface changes on the western DML margin and produce a comprehensive reconstruction of the region's glacial history. Part of this work involves remote-sensing-based mapping of western DML glacial geomorphology to recognise potential traces of a thicker ice sheet that may have covered some or all of the mapped nunatak ranges during previous glacial maxima. High-resolution WorldView (WV) optical satellite data was used in ArcGIS to map landforms manually across a range of scales. Observations from two field seasons are being used to validate the remote sensing mapping. Here we present the mapping to date, and evaluate the use of the WV datasets for geomorphological mapping and for cosmogenic nuclide site selection.

Wed_376_TE-3_1836
Wetlands Identification Methods Applied for Fildes Peninsula, Antarctica

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The wetlands are flat areas of low altitude that accumulate a thin layer of water and allow the vegetation growth. So, this study compares a supervised classification and a new multicriteria method developed for the delimitation of meltwater wetlands. The study area is an ice-free area in the south of King George Island, Antarctica. We classified seven images of the Landsat series (1986-2017), using the QGIS 2.19.8 software, for delimiting the wetland area. After classification tests, we concluded the vegetation location is the main factor to determine the wetlands limits, we use different weights to develop a new processing chain, with the following variables: vegetation (obtained with the Normalized Difference Vegetation Index - NDVI), slope, altitude and slopes oriented north and northwest (from a Digital Elevation Model). Supervised classification identified only lakes, but does not identify correctly wetlands areas. As most wetlands are located in vegetated areas under 50 m of altitude and slopes less than 16%, respectively, the new method showed good results with accuracy from 78 to 89%. The new method, however, does not work properly in shadowed areas (due to the relief) and images with thick snow cover. In short, relief parameters added to the location of the vegetation allow better results than a simple supervised classification.

Wed_377_TE-3_1897
Impact of Tundra Snow Layer Thickness on Measured and Modelled Radar Backscatter

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Microwave radar backscatter within an Arctic tundra snowpack is strongly influenced by spatial variability of the thickness of internal layering; often comprising two dominant snow layers (basal depth hoar overlain by wind slab). Determining the relative proportions of depth hoar and wind slab from a snowpack of a known depth may help our future capacity to invert forward models of electromagnetic backscatter to improve simulations of snow water equivalent.
Extensive snow measurements were made within Trail Valley Creek, NWT, Canada in April 2013 at 18 pit and 9 trench locations (trench extents ranged between 5m to 50m). Ground microstructure measurements included traditional stratigraphy, near infrared stratigraphy, Specific Surface Area (SSA), and density. Coincident airborne Lidar measurements were made of snow depth across the catchment, in addition to airborne radar snow backscatter (X- and Ku-band Synthetic Aperture Radar).
Ground measurements showed the mean proportion of depth hoar was just under 30% of total snow depth and the mean proportion of wind slab was consistently greater than 50%, which showed an increasing trend with increasing total snow depth. Consequently, we run forward simulations of the SMRT microwave scattering model using Lidar derived snow depths. The influence of microstructural variability on relationships between airborne radar and simulated backscatter, with spatial aggregation between scales of 10m to 250m, was then explored.

Wed_378_TE-3_1984
Application of Multi-source Remote Sensing Data in Antarctic/Arctic Expedition

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Remote sensing is increasingly being used in the Chinese National Antarctic/Arctic Research Expedition (CHINARE). In the 33th Chinese Antarctic Research Expedition and the 8th Chinese Arctic Research Expedition, multi-source remote sensing data were utilized for providing support to ship ice navigation, discharge and investigation on sea ice. The remote sensing data that used including AMSR2, Terra/Aqua MODIS, Landsat-8, SPOT-5, Radarsat-2, Sentinel-1A, COSMO-SkyMed, etc. With the aid of the analysis results from the multi-source and multi-temporal remote sensing data, the 33th Chinese Antarctic Expedition planned ship route reasonably, explored land-fast sea ice and laid down a plan of discharge; and the 8th Chinese Arctic Expedition crossed the Trans-Polar Passage successfully, chose appropriate sea ice stations. Applications of remote sensing data saved time for scientific investigation and logistics services, ensured the safety of people, ship and equipments.

Wed_379_TE-3_2052
Influence of Gap Filling on the Accuracy of Snow Mapping Using MODIS and VIIRS

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Global snow-cover maps have been produced from the MODerate-resolution Imaging Spectroradiometer (MODIS) since 2000 at 500-m resolution, and from the Suomi-National Polar Program (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) since 2011 at 375-m resolution. Development of an Earth system data record (ESDR) that utilizes both MODIS and VIIRS snow maps is underway. In November 2017 the second in a series of VIIRS sensors will be launched on the Joint Polar Satellite System-1 (JPSS-1), with the JPSS-2 satellite scheduled for launch in 2021, providing the potential to extend NASA's snow-cover ESDR for decades into the future. Studies are underway to investigate the continuity of time series of datasets between the MODIS/VIIRS NASA snow-cover data products. In the present study we focus on a time series of daily Terra and Aqua MODIS and NASA VIIRS cloud-gap filled (CGF) snow-cover maps. A MODIS CGF snow map is available every day irrespective of cloud cover. We explore the accuracy of cloud-gap filling at different sites in North America, and also compare the CGF maps with other available snow maps, such as for example, the cloud-free maps derived from the National Oceanic and Atmospheric Administration (NOAA)'s Interactive Multisensor Snow and Ice Mapping System (IMS). The advantages and uncertainties of cloud-gap filling are discussed in the context of various applications of the moderate-resolution ESDR.

Wed_380_TE-3_2108
SnowPEx-The International Snow Products Intercomparison and Evaluation Exercise

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Seasonal snow is a main element of the global water cycle and climate system. Accurate, long-term data sets on main snow cover parameters are crucial for climate monitoring and validation of climate models. In order to assess the accuracy and performance of different satellite-based snow cover products of continental to global extent, an international collaborative effort, SnowPEx, was initiated by ESA.
SnowPEx focuses on two parameters of the seasonal snow pack, snow extent (SE) from medium resolution optical satellite data and snow water equivalent (SWE) from passive microwave sensors. 14 continental to global snow extent products and three SWE products were evaluated. Statistical measures and spatial pattern analysis following standardized protocols defined in the project were applied to assess the agreement between the products in different environments and climate zones. For validation of the products reference data sets, derived from more than 450 Landsat scenes, and in-situ data from various organisations in Europe, North America and Asia, were used. SWE products were also compared with output from land surface models driven by atmospheric reanalysis data. In support of climate studies the trends in the hemispheric SE and SWE time series of the different satellite based snow products were compared. We provide an overview on the results of SnowPEx and report on agreement and differences of multi-decadal trends of the various snow products.

Wed_381_TE-3_2159
An Improved Method for Sea Ice Concentration Estimation from SSM/I and AMSR-E

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To improve the accuracy of the NASA Team (NT) sea ice concentration (SIC) algorithm, a new SIC estimation method was proposed by combining the NT algorithm and a numerical optimization technique with Special Sensor Microwave/Imager (SSM/I) data and Advanced Microwave Scanning Radiometer for EOS (AMSR-E) data respectively. In this method, the noise was taken into consideration to improve the SIC estimation equation, and then the fully constrained least squares was used to further optimize the estimation results from the improved equation. Validation was performed using comparisons between the proposed method, the NT, the Bootstrap, the NT2, the ASI and in situ data. The quantitative results from SSM/I showed that the proposed method accurately generated SIC with smaller bias (0.2) and RMSE (9.7) than the other methods. The results also indicated that the proposed method consistently performed better in not only summer but also winter (with bias 2.0 in summer and 2.0 in winter, RMSE 13.3 in summer and 7.3 in winter) than the other methods. The accuracies of all methods in summer were lower than winter, among which the accuracy of the Bootstrap was the lowest. The accuracies of the proposed method, NT2 and ASI using AMSR-E indicated that the performance of the proposed method was found to be better than the NT2 algorithm and ASI algorithm in quantitative comparisons. This research demonstrated the benefit of incorporating numerical optimization into SIC estimation.

Wed_382_TE-3_2224
AIM-North: The Atmospheric Imaging Mission for Northern Regions

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Low Earth orbit (LEO) satellites offer global sampling, but revisit times can be days to weeks. Geostationary (GEO) satellites can observe a selected region multiple times per day, but have difficulty poleward of ~50°N/S. A constellation of 2 satellites in a highly elliptical orbit (HEO) configuration can provide quasi-geostationary observations of the high latitudes. AIM-North is a Canadian mission concept that would provide observations of unprecedented frequency, density and quality for monitoring greenhouse gases (GHGs) and air quality (AQ) over landmasses from ~40-80°N, using a pair of HEO satellites. AIM-North would image the GHGs CO_2 and CH_4, as well as CO in the shortwave-infrared (SWIR) and AQ species: O_3, NO_2, SO_2, HCHO, BrO, aerosol and others, in the ultraviolet-visible (UV-vis), multiple times per day with a pixel size of 3x3 km^2. Additional IR bands could provide complementary observations for weather, climate and AQ research and operations. AIM-North would improve our ability to monitor the delicate carbon balance of Arctic permafrost and boreal forests, and help to quantify anthropogenic GHGs emissions at multiple scales. Its unprecedented observations could capture emissions from wildfires, the oil sands, or cities improving our understanding and prediction of air quality in the north. Since AIM-North would make valuable observations over many northern countries, scenarios for an international partnership in the AIM-North mission can be explored.

Wed_383_TE-3_2314
Multiyear Sea Ice Concentration Estimates Using ASCAT and AMSR2 Data

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Multiyear ice (MYI) concentration can be retrieved from passive or active microwave remote sensing observations. One of the algorithms that combine both observations is the Environmental Canada Ice Concentration Extractor (ECICE). In this study, data from the Advanced Scatterometer (ASCAT) and the Advanced Microwave Remote Sensing Radiomter 2 (AMSR2) are employed to retrieve concentrations of MYI. Combined active and passive microwave data can help to distinguish MYI from first-year ice, however, factors such as ice deformation, snow wetness and metamorphism can cause significant changes in brightness temperature and backscatter, leading to misidentification of MYI. Therefore, two corrections were applied to the MYI concentration retrievals from ECICE with inputs from ASCAT and AMSR2 observations. One correction utilizes air temperature to restore the underestimated MYI concentrations under warm conditions, whereas the other mainly uses sea ice drift to correct the overestimated MYI concentrations. The results are compared with the ice charts from Canadian Ice Service (CIS), sea ice age dataset from NSIDC, and sea ice type product from EUMETSAT OSISAF. The MYI concentration from ASCAT/AMSR2 agrees well with that in the ice charts. Compared to the ice classified as two years or older in the sea ice age dataset, the MYI concentration from ASCAT/AMSR2 is approximately 50% or greater. Besides, SAR images from Sentinel-1 are used to evaluate the MYI estimates in different regions.

Wed_384_TE-3_2326
Low Power Wide Area Network Deployment for Science

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Operations in polar regions have a high cost compromising the scope of scientific campaigns. Equipping sensors in a distributed network with satellite links is impractical and expensive. Furthermore satellite networks are not designed to support large scale multi-parametric studies. A new paradigm has emerged in regional scale telecommunications, the LPWAN (Low-Power Wide Area Networks). This technology is specifically tailored for distributed networks.

AntarctiQ´s mission is to support operations in extreme environments. AntarctiQ has a multiple-year experience in Antarctica ranging from infrastructure design, systems engineering, science support, prototyping, science equipment customisation, expedition planning, logistics and on-site activities.

In 2017/2018, AntarctiQ - in partnership with Sigfox (LPWAN) and Sensolus (sensors) - will demonstrate a case of distributed low-power science sensors and LPWAN deployment in Antarctica, this for future large scale network deployment. A vessel will be hosting an LPWAN base station, ensuring a local +50 km low-power radio network dedicated to remote sensing. Different wireless scientific and operational sensors will be placed in the field to demonstrate operational safety and scientific optimisation. Data will be sent to the project stakeholders over marine satellite communications with a minimal impact on the bandwidth due to the Sigfox communication protocol. Users will be able to collect their data and activities in real-time.

Wed_385_TE-3_2382
Gravimetric Mass Balance Products for the Antarctic and Greenland Ice Sheet

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The ESA Climate Change Initiative (CCI) projects on the Antarctic Ice Sheet (AIS_cci) and the Greenland Ice Sheet (GIS_cci) provide Gravimetric Mass Balance (GMB) products based on satellite gravimetry data acquired by the GRACE (Gravity Recovery and Climate Experiment) mission. Monthly solutions produced at TU Graz are utilized to derive two different types of products for the period 2002 - 2016:
(1) GMB basin products (i.e. time series of monthly mass changes for the entire ice sheets and selected drainage basins) and
(2) GMB gridded products (e.g. mass balance estimates with a formal resolution of about 50km). While a regional integration approach is used by the AIS_cci project, the GMB products of the GIS_cci project are derived using a point mass inversion.
Here we present the final version of the ESA CCI GMB products, which are freely available through data portals hosted by the projects (data1.geo.tu-dresden.de/ais_gmb, products.esa-icesheets-cci.org/products/downloadlist/GMB). Since the initial product release in mid 2016, the applied processing strategies have been improved in order to further reduce GRACE errors and to enhance the separation of signals super-imposed to the ice mass changes. The differences between both processing strategies are investigated through the example of the GIS. Finally, mass balance estimates for both ice sheets as well as their corresponding contributions to global sea level rise are derived from the final GMB products.

Wed_386_TE-3_2384
Vegetation Identification by Image Processing at Fildes Peninsula, Antarctica

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Wetlands are common in proglacial areas and are associated with the occurrence of vegetation. Mapping these areas is essential for environmental studies. The aim of this study is to identify vegetation fields in the Fildes Peninsula on King George Island, Antarctica using a combination of image processing techniques. The target vegetation was used to facilitate the identification of flooded areas by satellite images. For the image processing, we chose a Landsat 8 OLI image from 2016. Segmentation was performed for the identification of endmembers that are later used in the linear mixture model. Three fractions were defined: vegetation, snow, and shade. Our results show that those areas presenting the greatest vegetation fraction are coincident with areas of mosses and lichens in the Fildes Peninsula. We plan to compare the results with other images and field data to verify the accuracy of the vegetation fraction.

Wed_387_TE-3_2431
Digital Processing of Non-conventional Aerial Photos of Maritime Antarctica

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The development of new technologies applied to cartography and digital mapping allowed the reprocessing of old materials obtained by non-conventional techniques, such as non-metric cameras, generated at a time when the available tools were not so accurate. In this work we reprocessed aerial photos obtained in January 2003 from a flying over Keller Peninsula, located on King George Island, South Shetland, where the Brazilian Research Station in Antarctica is located. 56 photographs were obtained, revealed and digitized, producing a mosaic of the entire area. A total of 50 points were evenly distributed across Keller peninsula in the form of semi-regular grid. With these data it was possible to generate both the new MDS and the orthophotomosaic. The result was a much less time consuming effort in the post-processing of the images, besides determination of the level of accuracy of the data generated. This work demonstrates that past aerial photos obtained in Antarctica through conventional techniques over the last decades can be reprocessed using these new tools and the data of this collection assumes historical importance in monitoring the dynamics of the glaciers of that region. Allied to this technology, the use of light aerial vehicles (VANTS) has great potential in the studies of terrestrial ecosystems of Antarctic ice-free areas and in the monitoring of glaciers, greatly reducing the logistics and costs of this type of work.

Wed_388_TE-3_2437
Landsat Polar Remote Sensing: Data Acquisition, Access, and Quality Advancements

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Cryosphere measurement capabilities from instruments prior to Landsat 8 were plagued by radiance saturation and limited Polar Region data acquisition. The long term acquisition plan (LTAP) was revised to include imaging of all sunlit land areas with greater than 85^o solar zenith with the launch of Landsat 8. This has significantly increased polar region coverage. With Landsat 9's 2021 launch and commissioning target, the Landsat 8/9 multi-mission LTAP will substantially increase sub-weekly cloud-free measurements over the circumpolar Arctic and Antarctica. Access to Landsat's archive is evolving with the global Analysis-Ready Data (ARD) concept. Global ARD will deliver well-calibrated geophysical data products with known measurement traceability and quality assurance. Here, we summarize efforts to benchmark Landsat 8's surface measurement quality over northwestern Greenland by using NIST traceable visible-to-shortwave infrared (VSWIR) spectrometry as part of a NASA ICESat-2 airborne campaign to the Arctic in the summer of 2015. Our July 29, 2015 flight line analysis with near-coincident Landsat 8 acquisitions indicates that the Operational Land Imager (OLI) is measuring land ice surface reflectance and ocean leaving reflectance at 4-30% accuracy, which is wavelength dependent and largely attributable to atmospheric compensation uncertainty. Our goal is to define polar measurement requirements for Landsat's next generation instruments by learning from Landsat 8 capabilities.

Wed_389_TE-3_2656
Multi-decadal Arctic Sea Ice Roughness

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The transformation of Arctic sea ice from mainly perennial, multi-year ice to a seasonal, first-year ice is believed to have been accompanied by a reduction of the roughness of the ice cover surface.
This smoothening effect has been shown to
(i) modify the momentum and heat transfer between the atmosphere and ocean,
(ii) to alter the ice thickness distribution which in turn controls the snow and melt pond repartition over the ice cover, and
(iii) to bias airborne and satellite remote sensing measurements that depend on the scattering and reflective characteristics over the sea ice surface topography.
We will review existing and novel remote sensing methodologies proposed to estimate sea ice roughness, ranging from airborne LIDAR measurement (ie Operation IceBridge), to backscatter coefficients from scatterometers (ASCAT, QUICKSCAT), to multi angle maging spectroradiometer (MISR), and to laser (Icesat) and radar altimeters (Envisat, Cryosat, Altika, Sentinel-3).
We will show that by comparing and cross-calibrating these different products we can offer a consistent multi-mission, multi-decadal view of the declining sea ice roughness. Implications for sea ice physics, climate and remote sensing will also be discussed.

Morning Plenary II
21.06.2018 07:50-09:00, A Davos

Keynote Lecture III, IASC Medal Recipient
Governing the Polar Regions in an Era of Global Change

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Bren School of Environmental Science and Management, University of California (Santa Barbara)

I address three themes: the focus of my research program, lessons learned about governance that are relevant to the polar regions, and the consequences of the onset of the Anthropocene for polar governance. Focusing on governance as a social function centered on steering societies toward desirable outcomes (e.g. long-term sustainability) and away from undesirable outcomes (e.g. the tragedy of the commons), I analyze the creation and effectiveness of governance systems. Key lessons include: (i) regime design matters, (ii) international legally binding instruments often have drawbacks, (iii) regulation is not the be all and end all of governance, (iv) clustering regimes into complexes makes sense under some circumstances, and (v) regimes can produce islands of cooperation even in times of conflict. The onset of the Anthropocene, occurring at a more rapid pace in the Arctic than anywhere else on the planet, will have major consequences for the development and implementation of effective governance systems for the polar regions. Among other things, we will need to: emphasize early warning; beware of the dangers of institutional reductionism; avoid institutional lock in; and learn to live with high levels frequent surprises.

Morning Plenary II
21.06.2018 07:50-09:00, A Davos

Keynote Lecture IV, Tinker-Muse Prize Recipient
Changes in Southern Ocean circulation and properties: causes and consequences

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The Southern Ocean exerts significant influence over the rest of Planet Earth, and directly affects the lives and livelihoods of its inhabitants. It is a key regulator of global climate, absorbing large quantities of heat and carbon (including human-produced) from the atmosphere, and storing them deep in the ocean interior. It is also increasingly seen to be a key influence on the stability of the Antarctic Ice Sheet, and is the home for diverse marine ecosystems and species, some of which are of commercial significance. There is strengthening evidence that the Southern Ocean circulation is changing, from the surface to the abyss, and the increasing availability of data from innovative sources is unveiling new levels of complexity to this to change. This talk will discuss some specific examples of Southern Ocean circulation change, its importance, and the ongoing requirement for sustained observations from this most challenging of environments.

BE-4g - Climate change and ecosystems: physiology, biodiversity and ecological functions
21.06.2018 09:00-10:30, A Schwarzhorn

1443
Local Environmental Gradients Interact to Structure Arctic Arthropod Communities

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The organization of ecological communities along local environmental gradients provides important information about how such communities may respond to environmental change. By replicating observations along gradients in shrub and moisture at multiple elevations and using space-for-time substitution, it is possible to examine how arthropod communities may respond to future change. We collected and identified 4640 adult specimens of spiders and beetles near Narsarsuaq, South Greenland during the 2014 growing season from 112 pitfall traps. The traps were arranged in plots covering local gradients in either soil moisture or tall shrub dominance at low and high elevation. Multivariate generalized linear models revealed that community composition was significantly related to shrub height and soil moisture, and that this relationship varied between low and high elevation. Among the 46 species we found, more species were unique at high than at low elevation, a finding that was most pronounced for spiders in plots along soil moisture gradients. Indicator species analysis corroborated earlier findings of the indicator value of specific species and suggested that beetles are better indicators of specific habitats than spiders. Placing plots along local environmental gradients allowed us to detect fine-scale variation in arthropod communities. Together, our results suggest that Arctic arthropod community responses to environmental change may differ among low and high elevation sites.

2686
Tundra Fire Alters the Structure and Function of Microbial-invertebrate Food Web

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While historically rare, arctic wildfire is becoming more common due to warmer temperatures and drier conditions. The 2007 Anaktuvuk River fire burned over 1000 km^2 of the Alaskan Arctic, resulting in combustion of most of the organic soil horizon and fundamentally altering the above- and belowground systems. We investigated recovery of the microbial-invertebrate food web six years post-fire in order to understand how fire alters the structure and function of these communities and how recovery varies with fire severity. We constructed comprehensive food webs based on functional groups of microbes, protozoa, and invertebrates from the soil, soil surface and plant canopy at three sites (non-burned, moderately and severely burned) and used an energetic food web model to estimate C flow through the food web and group-specific rates of C and N cycling. We found that soil and canopy invertebrate biomass was disproportionately higher at the severely burned site compared to non-burned or moderately burned sites. Aboveground herbivory increased significantly with burn severity but food webs at all sites were still primarily based on C derived from detrital resources. Contributions to nutrient cycling were highest by soil-dwelling consumers and increased with fire severity. While responses were asynchronous across microhabitats, our results demonstrate rapid recovery of community function to wildfire and suggest that the microbial-invertebrate food web is more resilient than expected.

2325
Microbial Biodiversity in Siberian Ecosystems: Insights into Methane Cycling

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High-latitude ecosystems are strongly affected by climate change. Methane emissions resulting from the microbial activity in soils and lakes might constitute a positive feedback. Indeed, warming may disrupt the methane cycle, by altering the microbial community composition and the relative abundances of key players in methane cycling, by affecting the metabolic pathways, yields and productivities of methane producers and consumers. Surveying the microbial diversity and functionalities in these ecosystems is essential for a better understanding of their potential feedback to climate change. In this study, 90 samples were collected from various ecosystems in Siberian Arctic (discontinuous permafrost, including 7 peatlands, 5 lakes, and 4 taiga ecosystems representative of the region). In each site, various samples were collected to take into account the local heterogeneity. DNA was extracted, the bacterial and archaeal 16S rRNA genes were amplified by PCR using universal primers. High-throughput sequencing of these amplicons was carried out with Illumina MiSeq technology. This survey of microbial biodiversity evidenced a structuration of microbial communities as a function of ecosystem characteristics. The relative abundance and taxonomy of methane producers (acetoclastic / hydrogenotrophic) and methane consumers (aerobic / anaerobic) was extracted from sequences analysis. These data improved our understanding of the CH_4 cycling in such ecosystems affected by climate change.

1979
Will Rhizosphere ´Priming´ Limit Soil Carbon Sequestration in a Warmer Arctic?

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Northern high latitudes store significant amounts of carbon (C) in soil organic matter (SOM). There is major uncertainty over the vulnerability of these C stores to both climate and land-use change. Previous research has focused on the direct effects of warming on plant growth and/or SOM dynamics in isolation, but there is increasing evidence that plant-soil interactions complicate these relationships dramatically. Plants not only control litter inputs (both quality and quantity), but may also influence rates of decomposition if the amount of C allocated to the ´rhizosphere´ (defined as the area of soil in the vicinity of plant roots in which the chemistry and microbiology is influenced by their growth, respiration, and nutrient exchange) is positively related to microbial activity and the breakdown of older, more recalcitrant, organic matter. This process is referred to as rhizosphere ´priming´, and despite suggestions that it may be critical in determining ecosystem C storage, it remains extremely poorly understood, especially in natural and semi-natural ecosystems.
Here we outline the approach underpinning a new research project ('PRIME-TIME') on rhizosphere priming, based in Swedish Lapland, and we present our initial findings. The project deploys state-of-the-art natural abundance 14-C methodologies, and mycorrhizal fungal community analysis, to determine the impacts of shifts in plant (and associated mycorrhizal) functional composition on SOM dynamics and C fluxes.

1514
Decomposition Rates along Two Arctic Shrub Dominance Gradients in West Greenland

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Due to recent climate change, many Arctic tundra regions are currently undergoing a vegetation shift towards increasing growth and ground-cover of deciduous shrubs. Canopy-forming shrubs can alter key ecosystem functions with strong links to climatic feedbacks, such as carbon sequestration into plant biomass and energy balance. However, we know little about the potential biological and physical feedback mechanisms by which these shrubs may affect litter and soil organic matter decay, and thus whole-ecosystem carbon balance.
Here, we present summer and annual decomposition data, using the Tea Bag Index, from Disko Island, Greenland (69ºN), where we incubated 800 teabags along two deciduous shrub dominance gradients (*Betula nana* and *Salix glauca*, respectively). We incorporated landscape variation in soil temperature and moisture regimes within our shrub gradients by establishing 25 study sites across a 4 km^2 area. This allowed us to investigate the effect of increasing deciduous shrub dominance on teabag decay rates and nutrient content - and relate these dependent variables to multiple vegetation, and soil microclimate and biogeochemistry parameters.
Summer data show faster decay in the tallest shrub communities, and this vegetation-specific effect appeared unrelated to soil microclimate. Understanding the intricate feedback mechanisms between deciduous shrub growth and decomposition rates is vital to predict the impacts of vegetation-climate feedbacks in tundra environments.

1847
The Effects of Deep Nitrogen and Root Traits on Arctic Vegetation Dynamics

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The release of permafrost-derived nitrogen (N) has the potential to fertilize tundra vegetation, modulate plant competition, stimulate productivity, and offset carbon losses from thawing permafrost. To test if Arctic plants can access deep permafrost-derived N, we characterized rooting profiles and quantified acquisition of ^{15}N tracer applied at the top of the permafrost table in moist acidic tundra subjected to almost three decades of experimental warming at Toolik Lake, Alaska. We harvested roots by depth increment down to the top of the permafrost table in ambient and warmed plots. The average thaw depth in warmed plots was close to 18 cm deeper than in ambient plots (warmed 58.3 cm ± 6.4 S.E.; ambient 40.8 cm ± 1.8 S.E.). Across treatments the deepest rooting species was the forb *Rubus chamaemorus* (warmed 50.3 cm ± 9.8 S.E.; ambient 40.8 cm ± 1.8 S.E.) followed by the sedge *Eriophorum vaginatum*. These species showed the greatest uptake of tracer after 24 hours. Deciduous and evergreen shrubs had more shallow rooting depths and lower tracer enrichment. We will present a conceptual framework for integrating dynamic rooting in relation to thaw depth into a process-based ecosystem model coupled with a dynamic vegetation model to evaluate these effects on vegetation productivity. Future modeling experiments will contribute to more accurate predictions of vegetation change in the Arctic modulated by belowground plant traits and changing soil resources with warming.

BE-2a - Phytoplankton, productivity and carbon export dynamics
21.06.2018 09:00-10:30, A Seehorn

2265
Riding on the “Ferrous Wave”— Bacteria Are Outcompeted by Small Phytoplankton

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Iron (Fe) is a paradox in the Modern Ocean—its sits at the heart of many life-critical enzymes but is barely available across most of its surface. Despite inventive Fe uptake systems, recent works suggest that heterotrophic bacteria are outcompeted by small diatoms, therefore limiting their access to Fe. To test this hypothesis, incubation experiments were carried out in the Subantarctic Zone of the Southern Ocean (Mar.-Apr. 2016). Experiments were designed
(1) to determine whether carbon (C), Fe, or both elements limit the bacterial growth and
(2) to investigate microbial interactions to acquire Fe.
A pronounced response in bulk and cell-specific bacterial production to single (+C) and combined (+C+Fe) additions of C was observed, while no stimulation by Fe addition alone was detected. Moreover, for concomitant Fe and C additions, cell-specific bacterial Fe uptake rate increased by 8-folds compared to control and was up to 240-times larger when small phytoplankton was excluded from incubations. The results suggest that bacterial growth was limited by labile C rather than by Fe, and that C availability enhances the bacterial Fe demand. Consequently, the competition for Fe would arise among prokaryotes and eukaryotes when limitation in C is alleviated. We believe that such interactions among members of the microbial community could have a marked effect on the extent of bacterially mediated Fe and C cycling, especially towards the end of nutrient-limited phytoplankton blooms.

1281
Role of Particle-attached Bacteria in Rendering Iron and Carbon Bioavailable

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Iron and carbon are essential for microbial heterotrophic activity, but the bioavailability of these elements is low in surface waters of the Southern Ocean. In the present study we tested the hypothesis that the activity of particle-attached heterotrophic bacteria affects microbial dynamics in surrounding waters due to the release of bioavailable sources of iron and carbon. We performed incubation experiments with biogenic and lithogenic particles collected during the Heard Earth-Ocean-Biosphere Interactions (HEOBI) cruise aboard the Australian R/V *Investigator* (8 January -27 February 2016). Our results reveal pronounced differences in the bacterially-mediated processing of biogenic and lithogenic particles. This contribution will present data on the chemical composition of the particles, the taxonomic composition of the associated bacterial community and their gene expression patterns for a better understanding of the access to particle-bound iron and carbon in the Southern Ocean.

1614
Sea Ice is a Source of Iron-free Organic Ligands

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The incorporation and the release of iron in forming and melting sea ice are paramount mechanisms for primary productivity in polar environment. It is thought that iron-binding organic ligands (Lt) can help in stabilizing dissolved iron (DFe) at surface seawater. In order to test the hypothesis that Lt control the DFe distribution in Antarctic pack ice, we investigated iron organic speciation during the Sea Ice Physics and Ecosystem eXperiment-2 voyage, in 2012. Concentration of Lt ranged from 4.9 nM to 41 nM, always in a higher concentration than the corresponding DFe. Their similar profiles and strong correlation suggested that Lt control DFe distribution in Antarctic pack ice. Both strong and weak ligands were observed, with conditional stability constants ($\log K'_{Fe3+L}$ = 21.7-23.0) values similar to those previously observed in land-fast ice. Organic ligands were not saturated with iron (Lt/DFe > 1), unlike previous results for fast ice. Flux estimates show that pack ice would release 0.45 µmol/m^2/d of Lt during spring melt, 0.21 µmol/m^2/d of which are free of Fe, and therefore available for further complexation. This may suggest that the free ligands excess released from sea ice could help in stabilizing Fe at surface, in the marginal ice zone of the Southern Ocean. Given our findings and the fact that sea-ice extent is thought to decrease, the sea-ice capability to stock Fe during winter would also decrease, leading to less bio-available Fe in the marginal ice zone.

89
Recycling of Iron Binding Ligands in the Context of Ocean Circulation

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Iron-binding ligands are paramount to maintain iron in solution and sustain primary producers. In surface water of the open ocean, ligands are mostly derived from in situ biological activity. Microbial decomposition processes alter and transform organic matter as it is transported at depth, leaving behind refractory humic substances rich in carboxylated aliphatic molecules. Here we compared labile and freshly-produced dissolved organic matter (DOM) collected from a diatom bloom with refractory DOM collected at 1000 m. Both types of DOM contribute to the iron-binding ligand pool, with stability constants similar to those reported in the ocean. However, only the deep DOM has a strong iron-binding humic-like signature, consistent with previous structural characterizations. Ability to support phytoplankton iron assimilation was 4-fold greater for plankton-derived than deep DOM. This observation reinforces the importance of biologically-produced DOM for iron biogeochemistry in surface water. Exposure the deep DOM to full sun spectral light under controlled temperature, showed altered molecular size and structure of the refractory DOM as well as any iron-binding ligands within our analytical detection limit. Therefore, photodegradation of freshly upwelled iron-binding ligands can fuel iron remineralisation and its binding to labile and highly bioavailable DOM present in surface water. These two process thus act together to sustain primary producers.

594
Nutrient Recycling Influences Microbial Communities in the Southern Ocean

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Phytoplankton and bacteria are two key components of the biological carbon pump. Autotrophic phytoplankton acts as a sink of carbon dioxide. Comparatively, heterotrophic bacteria act as a source of CO_2 but also convert labile dissolved organic carbon to recalcitrant dissolved organic carbon. The widespread scarcity of the trace element iron has been demonstrated to limit phytoplankton and heterotrophic bacterial growth in large areas of the Southern Ocean resulting in potential competition between these groups to access the available iron fraction. We investigated the response of the autotrophic and heterotrophic microbial communities through incubation experiments with whale faecal additions over a 12-day period in the sub-Antarctic Southern Ocean region, close to Heard Island. The addition of 3 types of whale faecal material to surface seawater resulted in an increase in dissolved iron and organic carbon concentrations while major inorganic nutrients were not enhanced. Our results demonstrated that the addition of whale faecal material stimulated the growth of heterotrophic bacteria and heterotrophic nanoflagellates, but not autotrophic pico-nanoeukaryotes. Similar studies in the region have demonstrated that the growth of heterotrophic bacteria is co-limited by iron and organic carbon. Whale faecal material likely provided the heterotrophic community with organic carbon and iron to rapidly increase in biomass.

1657
Biogeochemical Cycling of Metal Micronutrient Isotopes in the Southern Ocean

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The metal micronutrients iron (Fe), zinc (Zn) and cadmium (Cd) play vital physiological roles in phytoplankton and, ultimately, their distributions control primary productivity and sequestration of carbon by the ocean's biosphere. Dissolved stable isotope ratios of these bioactive trace metals provide useful information, both for understanding their cycling through the oceans and tracing their influence on phytoplankton ecology.
Here, we present water column profiles of dissolved Fe (δ^{56}Fe), Zn (δ^{66}Zn) and Cd (δ^{114}Cd) isotopes from the Pacific and Atlantic sectors of the Southern Ocean, from the recent Antarctic Circumnavigation Expedition. We compare distributions of dissolved isotopes highlighting differences and similarities between the three metals. South of the Antarctic Polar Front δ^{66}Zn and δ^{114}Cd are dominated by upwelling of nutrient-rich deep waters. Zn isotopes show no fractionation despite intense uptake by diatoms in the surface ocean. Cd does show biological uptake of light isotopes. While Southern Ocean surface waters also carry heavy δ^{56}Fe, indicating uptake of light Fe by phytoplankton, the difference in fractionation between the three metals points to important differences in metal cycling in this region.
Overall, we aim to use this data to better understand how the interaction between ocean biogeochemistry and physical circulation affects regional cycling of these metal micronutrients in the Southern Ocean and how this influences their global distributions.

CR-6a - Glaciers and Ice Sheets: from the Mountains to the Poles
21.06.2018 09:00-10:30, A Wisshorn

2578
Thresholds for Antarctic Ice Sheet Retreat and the Paris Climate Agreement

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New ice-sheet modeling, calibrated to past and present changes in sea-level, is painting a stark picture of the future fate of the polar ice sheets if greenhouse gas emissions continue unabated. This is especially true for Antarctica, where a substantial fraction of the ice sheet bed rests far below sea level. Here, we explore the climatic thresholds capable of triggering major ice sheet retreat. We use an ice sheet-climate model that considers changes in mass balance and sub-ice melting, ice deformation, grounding line retreat on reverse-sloped bedrock, and previously omitted glaciological processes including hydrofracturing of ice shelves and structural collapse of thick, marine-terminating ice margins.
The results discussed here suggest that previous estimates of the maximum potential rate of future sea level rise might need to be reconsidered, due to ice loss through mechanical failure in addition to basal sliding and deformation. In high emissions scenarios, we find the potential for ~2m (or more) of sea level rise by 2100. We also find that aggressive mitigation strategies, like those discussed at the Paris Climate Conference, substantially reduce the the risk of extreme sea-level rise, but a 3ºC temperature rise is still enough to trigger major retreat of the West Antarctic Ice Sheet. Finally, we discuss key uncertainties in constraining climatic thresholds, timing, and rates of major ice-sheet retreat.

293
Continuous Mega-channels Across the Foundation Ice Stream Grounding Zone

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There is a scant knowledge on the subglacial geomorphology across the Foundation ice stream. MODIS satellite imagery reveals surface lineations from the ice sheet onto the ice shelf, which are thought to be associated with ice flow. While such channels are thought to be formed by organised flow of basal water from the upstream ice sheet, measurement of discrete channels upstream that would demonstrate the process remains elusive. Using data from various airborne geophysical, we discuss evidence from radio-echo sounding (RES) revealing continuously measured basal channels extending from the Foundation ice stream, across the grounding line and beneath the ice shelf. Within the zone of grounding line ambiguity, a massive channel is observed (~800 m in height). This channel can be seen in numerous RES transects and is manifested at the ice surface as a feature detected by MODIS. These data make it highly likely that basal water from the upstream grounded ice sheet is responsible for the channels. While the grounded channels are too large to be 'le Brocqian' bed channels (i.e. the flow of water necessary to maintain one of the channels is equal to the flow of the Amazon), their explanation as sediment-filled channels is challenging to rectify against the known glacial geomorphological record. We discuss that while the channels are undoubtedly associated with basal water, as required to form the ice shelf channels, the nature of the channels across the grounding line is obscure.

28
Multi-System, Multi-Decadal Radar Sounding of Thwaites and Pine Island Glaciers

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Recent observational and modeling studies have shown that the behavior and stability of both Thwaites Glacier and Pine Island Glacier in the Amundsen Sea Embayment of the West Antarctic Ice Sheet are modulated by a combination of ocean forcing, bed topography, and basal conditions. Despite this, little research has focused on characterizing the basal condition context for modeling current and potential interaction across their boundary. This is due, in part, to the fact that modern radar data in this region were collected by three different radar systems and much of the Thwaites / Pine Island boundary lies at the boundary of these data sets. These include the 2004 survey of Thwaites Glacier by the UTIG HiCARS system, the 2004 campaign over Pine Island Glacier by the BAS PASIN system, and the 2011 - 2016 surveys by the CReSIS MCoRDS system.
In addition to this modern data, two transects of airborne radio echo sounding data collected in the early seventies cross the Thwaites Glacier catchment. However, the storage of these data on film have made such comparison at the full radiometric and geometric resolution of the data difficult. To address this challenge, we utilized a state-of-the-art high-resolution film scanning system to digitize the entire SPRI/NSF/TUD archive. Here present results from processing, analyzing, and synthesizing four distinct data sets to characterize basal conditions for modeling and interpretation.

1303
Using Terrestrial Radar Interferometry to Understand Calving Processes

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Recently, many marine-terminating glaciers of the Greenland ice sheet revealed rapid retreat, thinning and flow acceleration. These glaciers lose mass by calving, a process which can change on short timescales. Despite their importance for global sea level rise, major limitations in understanding the dynamics of these glaciers remain. Terrestrial radar interferometry provides displacement and topographical data with a high spatial and temporal resolution. We observed two Greenland outlet glaciers in one minute intervals with a spatial resolution of 5 meters during four multi-day field campaigns in the summers 2014 to 2017. We use these data to establish detailed calving event statistics which are compared to environmental forcing like tides or weather conditions. By identifying source areas and ice volumes of individual calving events we quantitatively investigate the relationship between calving front geometry, calving rate and potential drivers. We find for example substantial differences in calving volume statistics between grounded and floating parts of the glacier front. We further compare the observed calving volumes with data of tsunami waves which were continuously recorded with pressure sensors between 2014 and 2017. The resulting relationship between calving volumes and tsunami waves allows us to establish continuous calving catalogs over four years and investigate calving periodicity.

1648
Sun2Ice: Monitoring Calving Glaciers from Solar-powered UAVs

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Here we present the first outcomes of ETHZ´s Sun2Ice project, which aims to use a state-of-the-art, highly-optimized, solar-powered Unmanned Aerial Vehicle (UAV), AtlantikSolar, for long-range, and multi-day monitoring of calving glaciers in the Arctic. The „midnight sun" in polar summer time offers unique conditions for solar-powered flights, including potentially energetically perpetual flight, consequently enabling frequent, high-resolution and large-scale glacier surveys. In Sun2Ice, this cutting-edge technology is dedicated to the monitoring of iceberg calving, a still poorly understood process which plays a major role in the observed retreat of many ocean-terminating glaciers. The main achievement of Sun2Ice´s 2017 fieldwork was the undertaking of the first-ever autonomous, solar-powered flights of a UAV in a polar region, including a flight of more than 12 hours duration, and the survey of the calving front of Bowdoin Glacier, Northwest Greenland. This monitoring revealed the opening of a major crack, which led to a major calving event one week later. This presentation will focus on the technical challenges, the glaciological outcomes, and the potential of using such a technology for monitoring the Cryosphere with a spatial and temporal resolution not achievable by satellite remote sensing.

1483
Modelling the Calving Contribution to Sea Level in Alaska and Greenland

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Iceberg calving is an important mass loss process for ocean-terminating glaciers and ice shelves. Where ocean-terminating glaciers drain ice sheets, as at the margins of Greenland, the rate of calving modulates a large potential contribution to global sea level. Parametrizing this process for numerical modelling has been challenging due to the widely varying spatial and temporal scales involved. We have developed a new, physically-consistent model that captures the effect of iceberg calving for the evolution of individual glaciers and their tributaries in both Alaska and Greenland. Here, we apply our model to Jakobshavn Isbrae, Kangerlussuaq Glacier, and Helheim Glacier, showing that we are able to reproduce observed patterns of terminus advance/retreat and upstream thickness change over the past decades. We then apply the model to the 30 ocean-terminating glaciers responsible for the majority of Greenland ice sheet discharge. Using a heuristic upstream forcing—a thinning rate that varies linearly, quadratically, or exponentially—we estimate the dynamic contribution to sea level rise that Greenland can make in the 21st century.

CR-4a - Ice sheets, ice shelves & proximal processes in past, present & future climates
21.06.2018 09:00-10:30, B Parsenn

250
Ice Shelf-ocean Interactions in High-resolution, Global Simulations: Part II

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Critical to reducing uncertainty in projections of future sea-level rise is an improved understanding of how the Antarctic ice sheet will evolve in response to current and future climate. We discuss efforts towards simulating Antarctic ice sheet evolution within the U.S. Department of Energy's global, coupled, Energy Exascale Earth System Model (E3SM), which includes variable-resolution, atmosphere, land, ocean, sea ice, and land ice components. Importantly, E3SM includes the ability to simulate ocean circulation within Antarctic ice shelf cavities. Part I of this talked focuses on the model configuration and tuning. In part II of this talk, we focus on analysis of global simulations aimed at understanding differences due to
(1) the presence or absence of Antarctic ice shelf cavities in global simulations,
(2) prescribed (CORE) versus fully-coupled atmospheric forcing and,
(3) low (non-eddying ocean) versus high (eddy-permitting ocean) spatial resolution.
Simulation differences and biases are discussed in the context of validation against observations of ocean water mass properties, sea ice extent and thickness, and submarine melt rates. We also discuss short- and longer-term strategies for applying validated, E3SM-derived submarine melt rates towards simulations of Antarctic ice sheet evolution and future sea-level rise.

2285
On Ice-ocean Interaction and Ocean Circulation under the Ross Ice Shelf

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The future fate of the Ross Ice Shelf will likely be determined by the ability of the Ross Sea to melt the ice shelf. The Ross Sea has not yet seen the rise in temperatures or the encroachment of Circumpolar Deep Water experienced in other sectors of Antarctica. However, ablation rates equivalent to several meters a year have been observed for short periods near the front of the Ross Ice Shelf, as part of the significant variability between winter and summer in the ice shelf ablation rates and ocean temperature. The observations highlight inconsistencies in existing parameterisations of ice shelf-ocean interaction, and demonstrate the role warm surface water subducted under the ice shelf has in enhancing ice shelf ablation. An ocean model of the Ross Sea region places the existing observations in an inflow region to the ice shelf cavity, and demonstrates the important role of the Ross Sea polynya in driving seasonal ocean variability both at the ice shelf front and within the cavity. This increased understanding of the cavity oceanography asks more questions than it answers. To better understand these questions a new mooring is planned for near the middle of the Ross Ice Shelf in December 2017. The initial timeseries from this mooring will be important for understanding the dominant time scales of ocean variability within the cavity, and if these can be linked to seasonal drivers outside the cavity or if other processes are at play.

1592
Modelling the Retreat of Pine Island Glacier with Bayesian Networks

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The stability of marine-based sectors of the West Antarctic Ice Sheet (WAIS) under future climate change has important implications for the potential WAIS contribution to sea level rise, yet large uncertainties still exist surrounding the magnitude, rate and timing of change. Here we investigate the potential to use Bayesian Networks (BNs) as an approach to model the retreat of WAIS and to explore the sensitivity of marine-based ice sheets in a changing climate.
BNs are probabilistic, graphical models that provide an elegant way of expressing and visualising the uncertain behaviour of a large number of interrelated variables of a system. They have been applied in hazard and risk assessment as decision support tools and to enhance understanding of complex systems. Current modelling of the Earth's cryosphere relies on deterministic, process-based models. BNs are a complementary approach that provide a rigorous statistical framework in which to explore the relative sensitivity of climatic and topographic features without the need to model detailed ice dynamics.
We focus initially on Pine Island Glacier (PIG) because it is a relatively well-studied, small outlet glacier over retrograde-sloping bedrock, and is currently undergoing accelerated retreat. We present a prototype BN of PIG, including as variables ocean and air temperature, precipitation, ice velocity and thickness, bed topography, and sea ice, which can be adapted and applied to larger and more complex areas of WAIS.

379
Future Research Directions in Antarctic Surface Hydrology & Ice-shelf Stability

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We will present recent progress and future research directions in the growing field of Antarctic surface hydrology, with a focus on how surface hydrology could affect the stability of Antarctic ice shelves. We will report the outcomes of a scientific workshop on these topics held in February 2018 and funded by the US National Science Foundation (NSF).
It is widely hypothesized that static meltwater ponds can expedite iceberg calving by flowing into and enlarging fractures and trigger ice-shelf disintegration via stresses generated by melt ponds. When ice shelves collapse, the adjacent grounded ice accelerates and thins, contributing to sea-level rise.
The flow of water across the surface of Antarctica is also increasingly recognized as important. This phenomenon is more widespread than previously assumed and melting is predicted to increase significantly this century. Without considering water flow explicitly, the latest ice-sheet models respond dramatically to increased ice-shelf melting, predicting up to 1 m of sea-level contribution from Antarctica this century.
Our current knowledge of the present state and controlling dynamics of the Antarctic surface hydrological system is poor. Drawing from the outcomes of the NSF workshop, we will summarize present knowledge and look ahead to the key questions, most important for predicting the role Antarctic surface hydrology will play in the ice sheet's future.

1931
Water on the Antarctic Ice Sheet: Mapping Supraglacial Lake Depth and Volume

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Though Antarctica is Earth's coldest continent, surface melting is widespread across its ice perimeter. Melt plays an integral role in modulating Antarctic sea level contributions via its influence on ice shelf stability and grounding line retreat. Despite their glaciological significance, there has been no systematic study of Antarctic lake occurrence either spatially or temporally. Here, we begin to answer the questions: When and where do supraglacial lakes form in Antarctica? And how much water is stored in these lakes?
Put simply, supraglacial lakes are identified by how blue they are and so multispectral data are needed. While many studies in Greenland have used MODIS sensors to track supraglacial lakes, Antarctic lakes have been shown in one comparative study to be smaller and shallower than their Greenlandic counterparts. Accordingly, the workhorses of this study will be the higher resolution Landsat series, complemented by Sentinel-2, and augmented by MODIS. After lake identification, a physically-based (and open source) lake depth retrieval will be used to calculate lake volume. The combination of these sensors will allow us to track supraglacial lake distribution and volume in Antarctica over 30+ years, yielding an unprecedented understanding of lake behavior in Antarctica. First, however, this presentation will show progress toward this goal by beginning with various case study areas around the perimeter of Antarctica.

696
In Search of Perennial firn Aquifers in Antarctica

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We predict the location of perennial firn aquifers (PFAs) in Antarctica using the updated regional atmospheric climate model RACMO2.3p2, that is specifically adapted for use over the polar regions. With RACMO2 output we force two firn models, IMAU-FDM and SNOWPACK, that explicitly calculate processes in the snowpack, such as densification, meltwater penetration, refreezing, retention and runoff.
In this presentation, we primarily focus on the Antarctic Peninsula (AP), where conditions are favorable for the formation of PFAs: there is both sufficient meltwater production and snowfall to store the meltwater in the firn during winter without refreezing, as the fresh snow insulates the meltwater from the winter cold wave. These conditions are similar to those locations where PFAs were discovered in Greenland and Svalbard. The firn models predict the formation of PFAs on Wilkins ice shelf and on the northwestern mountain slopes of the AP. Using observations obtained with, amongst others, satellite C-band scatterometry, we evaluate the robustness of these findings. In addition, we try to better understand processes controlling PFA formation, longevity and extent in Antarctica, which clearly differ from Greenland and Svalbard. In Antarctica, we distinguish multiple types of PFAs: long living (>20 years) PFAs, PFAs that frequently disappear and reform and PFAs that are only maintained during individual winters. Finally, we try to locate PFAs elsewhere in Antarctica.

OS-3a - Sea ice extent, properties, volume & ice shelves: modern and paleo records
21.06.2018 09:00-10:30, B Jakobshorn

29
Driftwood Insights into Holocene Pan-Arctic Sea Ice Dynamics

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The rapid decline in Arctic sea ice extent, age and thickness is well documented, with such changes due to cause far-reaching impacts. At present unknowns remain about the nature of the spatiotemporal Arctic sea ice fluctuations of the Holocene preceding satellite observation, limiting the extrapolation of modern trends to predictions of future change. Driftwood can be used as a novel and robust proxy for sea-ice reconstructions in the Arctic, with driftwood transport and deposition determined by sea ice and surface current dynamics. The collation of driftwood samples from across the western Arctic with spatiotemporal distribution and available provenance data has enabled the production of a high-resolution proxy-based reconstruction of Holocene Arctic Ocean surface current and sea ice dynamics. To further constrain this spatiotemporal reconstruction, isotopic analysis of driftwood using Strontium 87Sr/86Sr radiogenic isotope ratios combined with a framework of potential source Strontium signatures enables a spatial link between the deposited driftwood and its originating growth site, leading to a robust reconstruction of the wood-bearing sea ice dynamics. Combined with links between ice movement with the expansion and contraction of the Arctic Ocean circulations of the Beaufort Gyre and Transpolar Drift, the method enables a proxy-based reconstruction of Arctic sea ice and broader climatic states throughout the Holocene.

2063
Arctic Sea Ice Export during the Globally Warm Pliocene

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Sea ice is an important component in Arctic and global climate, but there is limited knowledge about Arctic sea ice extent and export throughout the geological past. Today, the East Greenland Current (EGC) is the main exporter of sea ice into the Atlantic, yet its behavior in the Pliocene globally warm climate is poorly documented. We reconstructed the EGC and sea ice variability in the Iceland and Labrador seas during the Pliocene (~5-2.4 million years ago) using the sea ice proxy IP_{25}, paleoproductivity biomarkers, alkenone-based sea surface temperatures and dinoflagellate cysts. Our results show that sea ice first appeared in the Iceland Sea around 4.5 million years ago when a proto-EGC developed. A more modern-like Nordic Seas circulation developed around 4.0 Ma, when our data indicate a seasonal sea ice cover in the Fram Strait and Iceland Sea. In the Late Pliocene, prior to 3.0 Ma, a relatively weak EGC likely caused the frequent occurrence of seasonal sea ice in the Iceland Sea, while sea ice rarely occurred in the Labrador Sea. After 3.0 Ma, when global climate cooled, a stronger EGC established a sea ice edge close to Greenland resulting in limited sea ice presence in the Iceland Sea, whereas the Labrador Sea more frequently received sea ice. The changes in sea ice regime are likely driven by oceanographic changes and may have played a role in the gradual expansion of the Greenland Ice Sheet from the Early to Late Pliocene.

646
Past Sea Ice Variability Derived from Ice Cores: The Bromine Approach

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Sea ice is a crucial parameter in the climate system, and it is declining at a faster rate than models predicted. Bromine plays a central role in sea ice chemistry, from where it is released as BrO during springtime, enriching its abundance in the polar atmosphere. Therefore, bromine enrichment in snow, with respect to the sodium ratio in seawater, can be been linked to first year sea ice variability at the Poles. Measurements of Bromine enrichment (Br_{enr}) have been carried out in Greenland (NEEM and Renland ice cores), Svalbard, Severnaya Zemlya and Antarctica (Talos Dome, Law Dome and Dome C). These climate ice archives investigated, cover both the satellite era and the older climate periods back to the last glaciation. The results obtained from deep drilling in the Arctic suggest that during the Holocene climate optimum (9- 10 ky BP) in summer time open water was present in the Canadian Arctic, whilst multi-year sea ice was present during the last glaciation, with rapid interstadial periods able to changes the sea ice structure. The Antarctic results (except Talos Dome) were mainly focussed on covering the last 200 years, the Talos Dome ice core covered back to the previous glaciation (150 ky BP). The results obtained from the Law Dome and Dome C ice core, support the idea that Br enrichment can also be used in Antarctica and suggests that the variability of sea ice, especially in the Indian sector, might be explained by the changes in the SAM (Southern annular mode).

1257
Biogeochemical Cycling and Sea Ice Dynamics in the Bering Sea across the MPT

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Today the Bering Sea is characterized by high primary productivity along the eastern shelf, maintained by CO_2 and nutrient rich upwelled deep waters and nutrient release during spring sea ice melting. As such, low oxygen concentrations are pervasive in mid-depth waters. On glacial/interglacial (G/IG) timescales sea ice formation plays a pivotal role on intermediate water ventilation with evidence pointing to the formation of North Pacific Intermediate Water (NPIW) in the Bering Sea during late Pleistocene glacial intervals. Additionally, sea ice plays a significant role in both long- and short-term climate change via associated feedback mechanisms.
Here we use a multi-proxy approach to study sea ice and bottom water dynamics, across three intervals prior to, across, and after the Mid-Pleistocene Transition (MPT, 1.2-0.7 Ma) from International Ocean Discovery Program Site U1343. The biomarker-based sea ice record shows substantial increase in sea ice extent across the MPT and the occurrence of a late-glacial/deglacial sea ice spike, with potential consequences for land glacier retreat via the temperature-precipitation feedback. U/Mn of foraminiferal authigenic coatings is used to reconstruct sedimentary redox conditions, a factor of export productivity and bottom water oxygenation. This aids to elucidate the interactions of sea ice with biogeochemical cycling and NPIW formation on G/IG timescales, with potential implications for the North Pacific carbon cycle.

1685
Arctic Ice Sheets and Sea Ice Extent during MIS 6/MIS 5: A Biomarker Perspective

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The Quaternary glacial history of the Arctic Ocean is characterized by the repeated build-up and decay of circum-Arctic ice sheets on the continental shelves and related changes in ocean-circulation patterns and sea ice cover. Here, we present new biomarker records that give insights into the interactions between the Eurasian-Siberian ice sheets, sea ice extent and Atlantic water inflow during the Penultimate Glacial Maximum (Marine Isotope Stage (MIS) 6) to Last Interglacial (MIS 5e) transition. Along the Svalbard and northern Barents Sea continental margin, the MIS 6 ice sheet and sea ice conditions might have been similar to those of the LGM. An extended Barents Sea Ice Sheet had reached the shelf edge causing polynya-like open-water conditions (triggered by strong katabatic winds) with phytoplankton and sea ice algae production, and the deposition of suspended (terrigenous) material along the slope, as reflected in the biomarkers from this area. Furthermore, the seasonally open-water conditions along the Barents Sea continental margin might have been fostered by the inflow of Atlantic Water. Biomarker records from the southern Lomonosov Ridge area close to the Siberian continental margin support an extended (MIS 6?) East Siberian Chukchi Ice Sheet, with strong katabatic winds and polynya-like open-water conditions in front of the ice sheet. Such a scenario would clearly contradict the hypothesis of a MIS 6 ice shelf covering the entire Arctic Ocean.

2264
Sea Ice Reconstructions Using Ancient DNA

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Environmental ancient DNA (aDNA) as a tool in paleoceanographic studies is still in its infancy and its potential for sea ice reconstructions is promising but not yet fully explored. To document the sea ice history of the Greenland Sea, we characterized a sediment core using metabarcoding of aDNA, dinoflagellate cyst assemblages and the sea ice biomarker IP_{25}, to determine how plankton dynamics preserved in aDNA corresponds to established proxies for sea ice reconstructions. We extracted total DNA and performed metabarcoding analysis of the V7 hypervariable region of the eukaryotic small subunit ribosomal RNA gene (SSU rRNA) on nine sediment samples ranging in age from modern to ~100,000 years ago. The aDNA sequences in one sample dated ~34 ka were unique in the study interval with nearly-absent diatoms and a dominance of dinoflagellates, cercozoans and unclassified sequences. Notably, we observed a high relative abundance of sequence reads resembling the sea ice-associated dinoflagellate *Polarella glacialis* in this sample. Together with a dinoflagellate cyst assemblage dominated by the sea-ice-associated genus *Islandinium* and a clear signal in IP_{25}, this indicates a likely seasonal sea ice cover. Our preliminary aDNA work thus demonstrates (1) the presence of amplifiable aDNA back to ~100,000 years ago in the Greenland Sea and (2) the potential for aDNA to complement traditional microfossil analyses in order to strengthen estimates of past seasonal sea ice cover.

AC-1f - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions
21.06.2018 09:00-10:30, C Sanada I

477
Aerosol Microphysical Effects on Cloud Fraction over the Nighttime Arctic Ocean

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Cloud fraction is a key component affecting the surface energy balance in the Arctic. Aerosol microphysical processes can affect cloud fraction, for example through cloud lifetime effects. However, the importance of aerosol impacts on cloud fraction is not well constrained on a regional scale at high latitudes. Here a new method is presented for identifying and comparing clean and aerosol-influenced cloud characteristics using a combination of multi-year remote sensing data (CALIPSO, CloudSat) and the FLEXPART aerosol model. This method is used to investigate a variety of aerosol microphysical impacts on nighttime Arctic Ocean clouds on regional and local scales. During the polar night study period, aerosols were associated with noticeable regional cloud fraction differences, suggesting possibly significant changes in longwave cloud radiative effects at the Arctic Ocean surface. We present evidence for combustion aerosols acting as ice nucleating particles at the cold temperatures of high altitude (>4 km) Arctic ice clouds. Potential mechanisms for aerosol-driven microphysical changes on cloud fraction within lower altitude clouds will also be discussed.

589
Far IR Measurements of Thin Polar Ice Clouds in View of TICFIRE Mission

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The water cycle in the dry and cold Arctic is not well understood, yet it is by far the dominant factor controlling polar climate with strong implications on the midlatitude weather. Optically thin ice clouds (TIC) processes are still poorly represented in atmospheric models. Furthermore, it is now recognized that anthropogenic aerosol can alter cloud microphysics and precipitation. These ubiquitous clouds, sensitive to aerosols via ice nucleation, can significantly modulate the amount of far infrared radiation escaping the Earth, and consequently the temperatures in the upper troposphere, and occasionally in the UTLS region. Since TIC signature in the far infrared is also very sensitive to their microphysical properties (crystals size and shape) and optical depth, these quantities can be retrieved from ground-based and satellite observations. Theoretical calculations demonstrate that the far infrared spectrum of the atmosphere could provide valuable information for weather forecast data assimilation and climate simulations, about its water vapour content, the microphysical characteristics of ice clouds and common light precipitation, especially in dry and cold regions. In the context of YOPP, with the Canadian Space Agency and in collaboration with NETCARE, PAHA and AVATAR, we have initiated new measurements in the mid and far IR range (8-50µm) to advance our knowledge of the water cycle in the High Arctic with the deployment of the Far IR Radiometer (FIRR).

703
Satellite Observations of Summer Arctic Sea Fog

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Under global warming, the rapid increase in open water surface area resulting from sea ice melting may lead to an increase in fog (here defined as any cloud with a base height below 1000 ft), which may imperil ship and air transportation in the region. There is a need for real-time monitoring of fog formation over the Arctic. Given that ground-based observations of fog over Arctic open water are sparse, satellite observations are currently the most effective way for real-time monitoring. We developed a fog detection algorithm using the temperature difference between the cloud top and the surface, called ∂T in this work. A fog event is said to be detected if ∂T is greater than a threshold, which is typically between −6°C and −10°C, depending on the time of the day (day or night) and the surface types (open water or sea ice). As a test, we apply this method to the coastal regions of Chukchi Sea and Beaufort Sea near Barrow, Alaska. We showed that the ∂T method can detect Arctic fog with an optimal probability of detection (POD) of 77−84% and false alarm rate (FAR) of 13−19%. The feasibility of the ∂T method, however, critically relies on the accuracy of the physical quantities (such as the cloud-top height) determined from the same infrared measurements.

809
Interactions Between Arctic Clouds, Sea Ice, and Lower Tropospheric Stability

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Arctic low clouds strongly affect the Arctic surface energy budget and through this impact influence the rest of the Arctic climate system: namely surface and atmospheric temperature, sea ice extent and thickness, and the atmospheric circulation. Arctic clouds are in turn influenced by the Arctic climate system creating the potential for cloud-climate feedbacks. We quantify the influence of atmospheric state on the surface cloud radiative effect (CRE) and the covariability between surface CRE and sea ice concentration (SIC) using instantaneous, active remote sensing satellite footprint data from the NASA A-Train. First, the results indicate significant differences in the surface CRE when stratified by atmospheric state. Second, a statistically ***insignificant*** covariability is found between CRE and SIC for most atmospheric states. Third, we find a statistically significant increase in the surface longwave CRE with decreased SIC in fall. Specifically, a +3-5 W m^{-2} larger longwave CRE is found over footprints with 0% versus 100% SIC. Because systematic changes of 1 W m^{-2} are sufficient to explain the observed reductions in Arctic sea ice, our results (1) indicate a potentially significant amplifying sea ice-cloud feedback that could delay fall freeze-up influencing sea ice variability under certain atmospheric conditions and (2) suggest that a small change in the frequency of atmosphere states may yield a larger Arctic cloud-climate feedback than any cloud response to sea ice.

987
Antarctic Cloud Microphysics using the DARDAR Synergetic Satellite Products

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In Antarctica, surface radiation biases of several tens of watt per square meters are calculated in mesoscale high-resolution models, which point to major problems in the simulation of the cloud phase. Antarctic clouds need to be correctly represented in both regional and global atmospheric models, to improve daily operational forecast as well as for future global climate predictions. Indeed Antarctic cloud microphysics affect lower latitudes too via their impact on the North-South temperature gradient. Because of the inaccessibility of most Antarctica to in-situ cloud science, observations are sparse, and satellite observations appear as a welcome if not crucial complement.
DARDAR satellite products were developed in order to take advantage of both radar (CloudSat/CPR) and lidar (CALIPSO/CALIOP) measurements which are used seamlessly to retrieve cloud properties at a horizontal resolution of 1.7x1.4 km and a vertical resolution of 60 m. We will present results of the analysis of Antarctic cloud thermodynamic phase using the DARDAR products over the period 2007-2010, at the continental and regional scales, paying close attention to the supercooled liquid phase. So far unreported links between Antarctic clouds and the Southern Annular Mode over different regions, and the atmosphere dynamics continent-wide, will be also highlighted.
Acknowledgement: CL acknowledges the post-doctoral funding from CNES.

2110
Vertical Distribution of Aerosol Properties in the Spitsbergen Region

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Primary objective of this long-term research activity is to build a climatology of aerosol vertical profiles in and above the Arctic Boundary Layer. To this aim since 2011 an international research team has performed yearly field campaigns at the Ny Alesund super-site thanks the support of the Italian CNR Arctic station Dirigibile Italia and German AWI Koldway station. Making use various aerosol payloads and tethered balloons systems (TBS) up to date about 500 aerosol profiles have been regularly recorded in the first 2 km, providing detailed information on black carbon concentration, aerosol size distribution, aerosol scattering coefficients and chemical composition. Seasonal trends have been obtained for spring, summer and autumn. Case studies will be highlighted describing the impact of ship emissions, Arctic haze and new particle formation events on the vertical aerosol structure. In situ TBS activities have been often accompanied by parallel lidar profiling and a closure study of aerosol microphysical property retrieval is in progress based on this data and also on a full chemical aerosol characterization both at bulk level on filter samples and on single particles by scanning electron microscopy.

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OS-7a - Atmosphere-Ice-Ocean interactions in the Polar Regions
21.06.2018 09:00-10:30, C Sanada II

2418
Importance of Processes and Feedbacks in Modeling & Prediction of Arctic Climate

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Some of the largest changes due to warming climate have occurred in the Arctic. Historical reconstructions from Earth System Models (ESMs) are in a broad agreement with these changes, except for the modeled rates of change, which generally remain outpaced by observations. Such limitations imply a limited skill in ESM projections of future Arctic System states and are likely due to a combination of coarse model resolution, inadequate parameterizations of sub-grid processes, and a limited knowledge of physical interactions. One of the least understood limitations are processes controlling ocean-ice-atmosphere surface momentum and energy transfer.
We demonstrate the capability of the Regional Arctic System Model (RASM) in addressing some of the ESM limitations in simulating observed variability and trends in arctic surface climate. RASM is an example of limited-area, process-resolving, fully coupled ESM. Due to the constraints from boundary conditions it facilitates detailed comparisons with observational statistics that are not possible with ESMs. This talk will emphasize the need for fully coupled climate model simulations, high model resolution and fine-tuning of scale-aware parameterizations of sub-grid physical processes. In support, selected RASM results will be presented on physical processes and resulting feedbacks controlling seasonal cycle and variability of the Arctic ocean-ice-atmosphere boundary layer.

329
Multidisciplinary Drifting Observatory for the Study of Arctic Climate

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MOSAiC is an international initiative under the umbrella of IASC, designed by an international consortium of leading polar research institutes.
Rapid changes in the Arctic lead to an urgent need for reliable information about the state and evolution of the Arctic climate system. This requires more observations and improved modeling over various spatial and temporal scales, and across a wide variety of disciplines. Observations of many critical parameters have, to date, not been carried out in the central Arctic for a full annual cycle.
MOSAiC will be the first year-around expedition into the central Arctic exploring the coupled climate system. During 2019 to 2020 the research vessel Polarstern will drift with the sea ice from the Siberian Sector of the Arctic across the polar cap towards the Fram Strait.
The focus of MOSAiC is based on a constellation of in-situ observations of the climate processes that couple atmosphere, ocean, sea ice, biogeochemistry and ecosystem. These measurements will be supported by weather and sea ice predictions, and remote sensing operations to aid implementation and extend the observational results in time and space. The project includes coordinated aircraft campaigns and expeditions by icebreakers from MOSAiC partners. All observations will support the main scientific goals of MOSAiC: Enhancing the understanding of the regional and global consequences of Arctic climate change and sea ice loss, and improving weather and climate prediction.

214
Improving Forecasts of Air-ice-Ocean Interactions in the MIZ during Autumn 2015

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The United States Office of Naval Research SeaState campaign took place on the ice breaker R/V Sikuliaq Sept 28-Nov 10 2015 in the Beaufort Sea. This field program was designed specifically to understand the effects of an increasingly dynamic sea state on autumn ice recovery. Comprehensive air-ice-ocean measurements were taken during the campaign to quantify the coupled mechanisms responsible for fluxes at the air-ice/ocean-ice interfaces.
During Oct 9-15 2015, it was observed that pancake ice in the marginal ice zone unexpectedly retreated. This was unexpected because surface measurements indicated water at the freezing point and a loss of heat to the atmosphere, demonstrating that processes other than atmospheric fluxes were responsible for the retreating ice edge.
This modeling study investigates the relative roles of ocean mixing and ice advection in reversing the observed seasonal ice advance during Oct 9-15 2015, and the ability of state-of-the-art forecast models to simulate the observed retreat, with a hierarchy of ocean models (i.e., with and without ocean dynamics) at this time period and location.
Of specific interest is the role of the Pacific intermediate water and the initial ocean conditions required to simulate the observed variability. Results from experiments varying initial ocean conditions will be presented to identify potential model biases and strategies to improve the coupled model forecasts.

660
Arctic Climate Spatio-temporal Modes of Variability as Sources of Predictability

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The Arctic region has suffered a transformation in the past decades that will very likely continue in the future. Since the late 1970s, declining trends in pan-Arctic sea ice extent and volume, and increasing trends in air and sea surface temperature have been observed. However, the region has a large natural climate variability that can usually be mistaken for a long-term forced response. Furthermore, this natural Arctic variability has been linked to mid-latitude weather extremes in the northern hemisphere, both as a cause and a as response. Disentangling natural variability and forced response is of critical importance from a climate change perspective.
Using observational evidence and advanced statistical methods (K-mean clustering), we studied natural modes of variability in key Arctic climate variables (i.e. sea ice concentration, sea surface and near surface air temperature). The main objective was to identify spatio-temporal coherence in the series and lag-lead correlations between variables after detrending them.
Sea ice concentrations show three main modes of variability, as previously found. Both atmospheric near surface temperature and sea surface temperatures can individually affect sea ice and partly explain some regional patterns of natural variability on seasonal timescales. Pan-arctic sea ice extent shows a delayed response of 1-3 months to near surface air temperature and about a year to sea surface temperature variations.

2055
Satellite-derived Sea Ice Export and its Impact on Arctic Ice Mass Balance

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Sea ice volume export is affecting the Arctic ice mass balance, and certainly the multiyear ice volume variability. Climate relevance is also given by the significant fresh water input into the North Atlantic, affecting the thermohaline circulation. The Fram Strait represents the main sea ice export gate in the Arctic. Here, we present the first estimates of winter sea ice volume export through the Fram Strait using CryoSat-2 sea ice thickness retrievals and three different ice drift products for the period 2010-2017. The export rates vary between 20 km^3 and 550 km^3 per month. We find that sea ice drift is the main driver of seasonal and interannual ice volume export variability. Moreover, 79 % of the interannual variability can be explained by the relation to the North Atlantic Oscillation index (NAO). The seasonal trend, however, is driven by the mean ice thickness, associated with the thermodynamic ice growth, which is typically peaking in March. Considering Arctic winter multiyear ice volume changes, 50 % of the seasonal variability can be explained by the ice volume export through the Fram Strait.

1046
Contrasting Antarctic and Arctic Atmospheric Responses to Projected Sea Ice Loss

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By the end of this century, annually-averaged Antarctic sea ice area is projected to decline by an amount comparable to the one in the Arctic. However, the impact of future Antarctic sea ice loss is largely an open question, having received very little attention to date. Here, the atmospheric response to future sea ice loss in the Antarctic is investigated, and contrasted to the Arctic case, using the Community Earth Systems Model Whole Atmosphere Coupled Climate Model (WACCM). Comparing time-slice model runs with historic sea ice concentrations to runs with sea ice in each hemisphere reduced to values representative of the late 21st-century (from a high CO_2 emission scenario) allows us to disentangle the effect of future sea ice loss on the atmosphere from other aspects of the coupled system. It is found that both Antarctic and Arctic sea ice loss act to shift the tropospheric jet equatorward, acting as an internal negative feedback to the net poleward shift associated with increased greenhouse gases. Furthermore, the atmospheric response to Antarctic sea ice loss is found to be of slightly smaller amplitude, more vertically confined, and less seasonally varying than in the case of Arctic sea ice loss. Finally, our model shows that the surface temperature response to Antarctic sea ice loss is unable to penetrate the Antarctic continent, suggesting that the sea ice increases of recent decades cannot explain the observed lack of warming over much of the Antarctic continent.

BE-4h - Climate change and ecosystems: physiology, biodiversity and ecological functions
21.06.2018 11:00-12:30, A Schwarzhorn

365
Dynamics of Peat Frontiers in the Arctic and Antarctic under a Warming Climate

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Amplified climate warming in the Arctic and Antarctic Peninsula in recent decades has caused a multitude of changes, including ice/snow reduction, permafrost soil thaw, and vegetation greening. Peat-forming ecosystems are "hotspots" of long-term carbon (C) sequestration in the high northern latitude region during the Holocene. However, we don't know if peat-forming ecosystems are expanding under a warming climate and whether they contribute significantly to regional C balance. Here we use some case studies from the North Slope of Alaska and from the Antarctic Peninsula to show potential peat expansion in both polar regions. In Arctic Alaska, we found that shallow "peat patches" (typically dominated by peat moss *Sphagnum*)—that may represent the initial stage of peatland formation—are distributed across some tundra landscapes. Our results from 6 soil cores indicate the onset of rapidly-accumulating *Sphagnum* peat at ~1930 AD, likely responding to regional climate warming directly or indirectly through permafrost dynamics. In the Antarctic Peninsula, we found rapid increase in C accumulation rates in recent decades from peat cores collected from aerobic moss-dominated peatbanks. Furthermore, we observed the re-appearance of waterlogged peatlands responding to rapid warming climate. The possible transformation of polar landscapes to more peat-forming ecosystems has implications for a sustained C sink, impacting the regional and global C balance over decadal or century timescales.

2610
Linking C Sequestration Service and High Arctic Ecosystem Multi-functionality

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The mechanistic response of Arctic terrestrial ecosystems to ongoing climate changes is the key of carbon (C) sink status of the soil. The assessment of the sustainability of Arctic soils C sequestration service requires deeper understanding of the ecological mechanisms leading to C accumulation in the soil. We explored the links among plants, soil invertebrate and microbial communities, and the C biogeochemical cycle along environmental gradients in different valleys of central Svalbard. This multifunctional approach integrates the holistic aspect of the ecosystem structure and aims at stressing the association of ecosystem service resilience with the functional links among the compartments. We sampled
(1) plant composition, abundance, above and belowground traits,
(2) soil invertebrate composition, abundance and feeding traits,
(3) soil microbial communities functional composition and activity; and
(4) soil C organic and inorganic contents.
Our preliminary analyses showed functional clustering across the compartments and also different levels of sensitivity to environmental gradient depending upon the compartments. Analyses need to be deepen and complete with manipulative experiments to disentangle the mechanisms but our results already illustrate a breakthrough in functional ecology with an explicit consideration of multitrophic functionality.

1882
Greening and Browning Trends in Circumpolar Arctic Tundra Vegetation

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Until recently the scientific literature has seen an abundance of papers describing the "greening" of the Arctic; from a remote sensing perspective this has meant an increase in the Normalized Difference Vegetation Index (NDVI), or a similar satellite-based index. More recently, there have been more widespread observations of tundra "browning." Here, we use a circumpolar remote sensing dataset to evaluate the spatio-temporal patterns of arctic tundra vegetation dynamics (greening and browning), and its control by summer warmth, at the circumpolar, continental (North America, Eurasia), and tundra subzonal (i.e. latitude) scales over the past 35 years. Significant warming trends, significant greening trends, and significant inter-annual relationships between NDVI and summer warmth were not spatio-temporally consistent. Significant warming trends tended to occur further north, whereas significant greening trends tended to occur more in the southern tundra. Some significant browning trends were observed in the northern tundra subzones. Significant relationships between NDVI and SWI were more likely found in the middle tundra latitudes. Over the satellite record, the number of years of greening was similar to the number of years of browning, with the exception of the most southern tundra subzone (Subzone E). The spatio-temporal dynamics of tundra vegetation and the controls on greening and browning appear to be highly complex and in need of continued study.

133
Spatial Redictions of Essential Biodiversity Variables: A Bird Perspective

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With increasing human pressure on biodiversity, populations of sensitive species become more isolated and decrease in size as their suitable habitats become fragmented and degraded. In this context, landscape composition, especially the arrangement of mountain is often key for population persistence and biodiversity conservation. Monitoring how landscape changes affect biodiversity should be a central component of landscape planning. Biodiversity includes too many dimensions, so defining which of them are essential is key to successful monitoring. For this reason, the concept of essential biodiversity variables (EBV) was defined, with the intent to identify key elements to monitor. One way to derive EBVs spatially may be through the use of species distribution models (SDM) based on quantification of species' habitat suitability, and use them to support planning and decision-making over large areas. One can further use stacked species distribution modelling (S-SDM) of constituent species to approximate the properties of assemblages. S-SDM outputs can then be used to predict various EBVs spatially. We aim to develop and test new approaches based on SDMs, to build spatial predictions of EBVs for birds in a mountain area of the Swiss Alps. We first study the power of different environmental and geographical factors for building S-SDM predictions,then we use these to derive bird EBVs as support to biodiversity management and help identifying priority bird conservation areas.

353
Climate Warming Accelerates Increase in Plant Species Richness on Alpine Summits

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Species climate envelope models predict that a large proportion of Europe's alpine flora is threatened by local extinction in a warmer climate, as stronger competitors move to higher altitudes and might out-compete cold climate specialists.
We study how the species composition in the Arctic and Alpine, particularly on mountain summits, has changed over the past decades, especially during the pronounced warming since approx. 1980. We compare historical and recent plant occurrences in a summit re-visitation study.
The comparison of historical and recent plant occurrence data from c. 250 mountain summits in European mountain ranges showed that species richness increased considerably due to upward migration of species, while there was little evidence for extinctions of high-alpine specialists. Fine-scale species distribution revealed that "successful" and less successful species differ in the type of microhabitats they occupy. This spatial and ecological segregation might explain why colonization with new, potentially highly competitive species has not (yet) been followed by a wave of local extinctions.
Our findings shed light on processes that drive the spatial distribution of plant species in alpine terrain and thus may, in the longer term, help to refine predictions of threats to particular plant species.

On behalf of the E Summit Flora consortium.

1125
European Alpine Glacier Reveals one Millennium of Fire and Vegetation Dynamics

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Wild fires are a disturbance agent across the continents, driving ecosystem dynamics and societal hazards. We analyze ice-core pollen and spores as proxies for vegetation composition and land use, microscopic charcoal for fire activity, and spheroidal carbonaceous particles for fossil fuel combustion. The results derive from the highest glacier of Europe (4452 m asl), from Colle Gnifetti. To our knowledge they provide the first long-term and high-resolution palynological record of Europe from an ice-core.
The central position and large microfossil catchment of the Colle Gnifetti allows us to address vegetation and societal responses to climatic change and wildfire disturbance on a subcontinental scale, presumably covering substantial parts of Western, Central and Southern Europe. The ice core record provides an excellent chronological control for the past millennium, particularly over the most recent 200 years, the period that experienced important climatic changes and an increasing globalization of economy.
We reconstruct large scale impacts such as extreme weather, societal innovations, agricultural crises and pollution in Europe. Surprisingly, pollution tracers occur in the record as early as 1750 AD. They anticipate industrialization but coincide with a shift to large-scale maize production in Northern Italy and strongly increased fire activity. Our multiproxy record may allow desentagling the role of climate and humans for vegetation composition and biomass burning.

BE-2b - Phytoplankton, productivity and carbon export dynamics
21.06.2018 11:00-12:30, A Seehorn

676
Southern-Atlantic Phytoplankton Community Composition Response to Light and Iron

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Understanding the response of phytoplankton communities to specific environmental drivers in different Southern Ocean water masses is critical to improve projections under current threats of global change. We show the importance of understanding of the role the biological pump play in the future global climate and more specifically the effect of different phytoplankton communities. Different phytoplankton play different roles in the ocean biogeochemical cycles, especially carbon export, and thus on climate feedback processes. This study presents changes in the community composition across a South-Africa to Antarctic transect along with an assessment of the effects of increased micronutrients using a series of on-board iron/light bulk incubation experiments. Phytoplankton composition was assessed using their photosynthetic pigments. Diatoms are dominant in the Sub-Antarctic, Polar Frontal, and - along with *Phaeocystis antarctica* - the Antarctic zone. This was re-enforced when cultivated under increased light/iron conditions and the new bulk community was diatom dominated. Incubations also revealed that *P. antarctica* acclimated its pigment ratios to function more efficiently within different light and iron conditions and that community compositions in the Antarctic zone depend more on iron availability than that of the Polar Frontal zone. We conclude that both light and iron are significant controls on the phytoplankton community and that their effects varies regionally.

693
Southern Ocean Phytoplankton Silica Uptake Relating to Leakage and Carbon Export

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The silicic acid cycle is closely linked to the carbon cycle in oceans as diatoms, a dominant, siliceous phytoplankton in the Southern Ocean (SO), are estimated to be responsible for the removal of approximately 55% of the total organic carbon in modern oceans.
The incorporation of silicic acid into the diatom cell wall structure, carbon export, productivity and biogenic silica distribution are reported in this paper through incubation experiments and transect data addressing pitfalls of the Silicic Acid Leakage Hypothesis. Upon iron (Fe) fertilization, the potential for the community to utilize less silicic acid from the water column is evaluated. The study spans a winter and three summer cruises, including the Atlantic and Indian Sectors of the SO. Biogenic silica is coupled with ancillary trace metal, macronutrient, particulate organic carbon (POC), Chlorophyll *a* and community composition data.
Incubation experiments within the community illustrate a noticeable increase in biogenic silica under high iron and light regimes, whilst transect data reiterate these limitations. Results suggest an increase in productivity across all oceanic zones. Scanning Electron Microscopy imaging indicates that upon Fe fertilization, changes in the thickness of the diatom cell wall are species-specific. To conclude, Fe addition drastically increases diatom production with certain species displaying a thinning of the cell wall marking potential for excess silicic acid in the water column.

1386
Impact of Light and Iron Availability on Antarctic Phytoplankton Ecophysiology

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Although iron (Fe) availability sets primarily the rate of phytoplankton growth and primary and export production in the Southern Ocean, other environmental factors, most significantly light, also affect productivity. Due to wind-induced vertical mixing, the total irradiance dose can be reduced, but exposing phytoplankton also to periods of excessive irradiance when residing near the surface. As these dynamic alterations between low and high irradiance in low Fe-waters are important drivers of species distribution, we investigated the effects of light (20, 200 and 500 µmol photons m^{-2} s^{-1}) in combination with low and high Fe availability (0.4 and 2 nM Fe) on the physiology of the two ecologically relevant species *Chaetoceros debilis* and *Phaeocystis antarctica*. Fe-limited cells of *P. antarctica* displayed similar high growth rates at all irradiances. In comparison, Fe-limited *C. debilis* cells grew much slower under low and medium irradiance and were unable to grow at the highest irradiance. Compared to *C. debilis* Fe-limited *P. antarctica* cells fixed more particulate organic carbon at all irradiances. When exposed to short-term excessive irradiances *C. debilis* could cope better than *P. antarctica* under low Fe conditions, but this was at the expense of lowered carbon production. Overall, our results show that *P. antarctica* was more tolerant to changes in the availability of Fe and light, providing it a competitive advantage under a dynamic light regime in Fe-deficient waters.

1172
Phytoplankton Group-specific Contributions to the Subantarctic Biological Pump

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Summer Subantarctic surface waters are characterized by high concentrations of unconsumed nitrate (NO_3^-), likely due to combined iron, light and silica limitation of phytoplankton growth. Phytoplankton diversity and community structure response to such nutrient limitation is not well understood. The degree to which phytoplankton consume NO_3^- (“new production”) is proportionate to net carbon (C) removal to the deep ocean, while growth fueled by recycled ammonium (NH_4^+) yields no net C flux. The N isotopic composition (d^{15}N) of upper ocean biomass can be used as an integrative tracer of NO_3^- vs. NH_4^+ uptake; however, surface particles include heterotrophs and detritus in addition to phytoplankton, complicating the use of bulk particle d^{15}N as a metric for new vs. recycled N uptake. This is overcome by coupling cytometric cell sorting (FACS) - isolating important populations (e.g., cyanobacteria, picoeukaryotes, diatoms) - with group-specific d^{15}N analysis. On the summer 2016/2017 Antarctic Circumnavigation Expedition cruise across the Indian sector of the Subantarctic Ocean, we collected particles for FACS-d^{15}N analysis and seawater samples for analysis of nutrients and nitrate d^{15}N. Four phytoplankton groups appear to be dominant across the basin. Their contribution to new production and C export will be discussed, as will that of Subantarctic island populations occupying waters where iron and possibly silica are no longer limiting due to mesoscale upwelling and island runoff.

678
Coccolithophore Controls on the Southern Ocean Carbon Cycle

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Southern Ocean (SO) phytoplankton biogeography impacts carbon cycling and the transport of macronutrients to lower latitudes. The relative importance of calcifying coccolithophores is especially important, since calcification and photosynthesis have opposing impacts on seawater pCO_2 and air-sea CO_2 fluxes. Further, calcite acts as ballast material for exported organic matter, enhancing the sequestration of organic carbon. Recent evidence suggests areas of high coccolithophore abundance in the SO, yet, the quantitative contribution of coccolithophores to SO biogeochemistry is not well understood. Here, we address this question using a regional high-resolution ocean circulation model for the entire SO (>24°S) with an embedded biogeochemistry module and an explicit representation of coccolithophores (ROMS-cBEC). Comparing our standard simulation to one without calcification by coccolithophores, we find the net air-sea flux of CO_2 to increase by 50% when neglecting calcification, making the SO a larger CO_2 sink. In contrast, we find little change in NPP and carbon transfer efficiency (< 5%), implying only a small ballasting effect. When coccolithophores are excluded from the model's phytoplankton community, preliminary results suggest a 15% increase in the northward transport of nitrate relative to silicate. Thus, future changes in the relative importance of coccolithophores could substantially impact carbon cycling not only in the SO, but potentially at lower latitudes as well.

2133
Main Drivers Regulating the Strength of Carbonate Counter Pump in the SO

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The Biological Carbon Pump (BCP) is counteracted by the Carbonate Counter Pump (CCP), which causes an increase in surface ocean CO_2 through the export of Particulate Inorganic Carbon (PIC). The ability to precipitate carbonate as well as the ballasting effect change according the different plankton calcifying structures. Thus understanding the variability in calcifying assemblage and/or their relative abundance it is crucial in order to forecast the fate of CO_2 uptake and sequestration in the deep ocean. Here, we describe a 2-year-long series of particles flux, as measured by deep moored sediment traps located at two sites close to South Georgia (Northern Scotia Sea). The aim of this study is to assess the specific contribution of the whole calcifying organism compartment (pteropods, foraminfera, coccolithophores and ostracods) to the Carbonate flux as well as their role in regulating the strength of the CCP. We found that when pteropods drive the magnitude of Carbonate flux, the total annual reduction of CO_2 transferred to the deep ocean double respect to the other year (when conversely foraminifera and coccolithiphores are dominants). This work provides an insight into the importance of the plankton calcifying assemblage to drive the magnitude of the CCP in a sensitive region such as the Southern Ocean which is responsible for 40% of the global anthropogenic carbon uptake.

CR-6b - Glaciers and Ice Sheets: from the Mountains to the Poles
21.06.2018 11:00-12:30, A Wisshorn

543
Major 20th Century Contribution to Sea-level Rise from Uncharted Glaciers

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Global mean sea-level rise (GMSLR) during the 20th century was primarily caused by glacier and ice sheet mass loss, thermal expansion of ocean water, and change of terrestrial water storage. Whether based on observations2 or results of climate models, the sum of estimates of each of these contributors tends to fall short of the observed GMSLR. All estimates of the glacier contribution to GMSLR rely on the application of glacier inventory data, which are known to under-sample the smallest glacier size classes. Here we show that missing glaciers (those small glaciers that we expect to exist today, but which are not represented in the inventories) may have contributed 42.7±6.5 mm to GMSLR during the period 1901 to 2015, even though their total 2015 ice mass is very small (2.4±0.4 mm GMSLR equivalent). Additionally, disappeared glaciers that existed in 1901, but had completely melted away by 2015, and which are therefore not included in modern global glacier inventories, may have contributed 5.3±2.4mmto GMSLR. Together, these uncharted glaciers (missing glaciers and disappeared glaciers combined) made an estimated contribution of 48.0±8.9 mm to GMSLR. Failure to consider these glaciers may be the cause of difficulties in closing the GMSLR budget during the 20th century. We suggest that accounting for uncharted glaciers in some fashion is essential for accurate historical glacier GMLSR contribution estimations.

1379
Data Assimilation & Uncertainty Analysis of a Stochastic Subglacial System Model

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The subglacial drainage system plays a crucial role not only in ice flow dynamics, but also in erosion of the bedrock, catchment hydrology, and potential hazards related to of glacier outburst floods. The study of subglacial drainage system is challenging due to the inaccessibility of such environments, resulting in a lack of direct observations. Even though physical deterministic models have been built, it difficult to constrain their outputs to observations and to perform sensitivity analysis and independent validation of these model.
In this context, we aim to infer the spatial structure and hydraulic parameters of the subglacial drainage system based on indirect data such as water pressure and tracer experiment. To this end, we develop an approach that uses a combination of stochastic and physical processes. An inversion procedure is used to determine a set of possible models that all agree with the data, and to determine parameters uncertainty. The proposed methodology incorporates three main components:
1) a stochastic channel generator to produce realistic geometries for the subglacial drainage system;
2) a physical model where distributed water pressure and mass transport are computed over the domain;
3) an inverse loop where the results (pressure, mass concentration) are compared with observed data in order to assess the channel network geometry and hydraulic properties of the system.

99
Time-lapse Thermal Imagery Used to Resolve sub-debris Glacier Melt in Alaska

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Rock debris at the surface of a glacier often insulates the underlying ice from incoming energy fluxes thereby reducing the local melt rate. The relation between debris thickness and melt suppression is nonlinear and consistent throughout many field studies. Debris that is about 10-15 cm thick can reduce the local melt rate by half and debris >50 cm thick can reduce melt to near zero. The distribution of debris cover on glaciers globally is not explicitly known at the time of writing, but is estimated at around 17%. The impact of debris cover on glacier melt is neglected in most large-scale glacier melt models and is likely one of the leading sources of error. The spatial distribution of debris on glaciers is fairly simple to derive from remote sensing, yet the governing term, the thickness of the debris, is much more difficult to resolve. We use time-lapse thermal imagery collected in the Alaska Range coupled with classical glacier field data and satellite based thermal imagery to
(1) test the hypothesis that thermal data can be used to derive debris thickness at wide spatial scales, and
(2) develop a simple model for estimating the impact of debris cover on glacier melt at a regional scale.
Modeling efforts that are successful at a regional scale are an essential step towards larger-scale efforts. This work is targeted towards the inclusion of a debris cover term in global glacier melt models.

2124
Recent Changes to Glaciers on Northern Ellesmere Island, Nunavut, Canada

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Using optical satellite scenes, this study quantifies change in the extent of 1755 glaciers across northern Ellesmere from 1999-2015. Our results show that ice coverage decreased by ~6% over the 16-year period. This indicates an acceleration over the 3.4% loss recorded by Sharp et al (2014) between 1960-2000. Our results show that ice shelves had the greatest losses relative to their size, a loss of ~25%. Tidewater glaciers reduced by 3% and included the transition of two tidewater glaciers to land-terminating. 18 glaciers that were identified as marine-terminating with an ice tongue in 1999 had their tongues disintegrate. Past studies have linked the loss of ice shelves to warmer summer air temperatures, and the loss of the protective barrier created by multi-year landfast sea ice (MLSI). These factors may have also played an important role in the loss of the floating ice tongues observed in this study, particularly in Yelverton Inlet where several ice tongues have disappeared since the recent loss of MLSI in this region. Land-terminating glaciers lost 5% of their area, including the complete loss of three small ice caps (< 1.5 km2). This is consistent with trends observed from other regions where ice loss has been dominated by small, remnant glaciers, due to their greater sensitivity to climate. Overall our work suggests that the rate of ice loss has increased and that the ice masses most susceptible to accelerated loss are glaciers with floating termini and small ice caps.

2677
The 50 Year Response and Future Stability of Canada´s Arctic Reference Glaciers

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The Canadian Arctic hosts the largest area of ice outside of Greenland and Antarctica and is currently the largest contributor to modern global sea level rise as a result of Arctic amplification. Since 1960, annual measurements of surface mass balance have been conducted on three ice caps and one mountain glacier on Meighen, Melville, Devon, and Axel Heiberg Island in the Canadian Arctic. Together, these records indicate a trend of increasing mass loss over the past two decades alongside rising equilibrium line altitudes and shrinking accumulation area ratios. The sensitivity and long-term stability of these glaciers is closely linked to ice dynamics, and specifically the rate of ice transfer from cold, high elevations to lower, warmer elevations where melt conditions prevail. We present a synthesis of the long-term mass balance records in the Canadian alongside a case study from White Glacier on Axel Heiberg Island, Nunavut, to demonstrate the role of thinning, retreat, and ice dynamics in the long-term stability of high-Arctic glacier response.

421
Elevation Changes of Greenland's Glaciers using AeroDEM, ArcticDEM and TanDEM-X

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Greenland peripheral glaciers and ice caps are sensitive key indicators of climate chance but recent evolution of ice volume along Greenland's periphery is still poorly understood. The restricted number of geodetic glacier thickness changes on Greenland is probably related to the absence of digital elevation models (DEM) of sufficient accurac
In this study we used the reanalyzed AeroDEM (late 1970s to mid-1980s) and the two recently released high resolution DEMs ArcticDEM (2012-2015) and TanDEM-X (2010-2014) to calculate geodetic glacier elevation changes. Thereby, the main challenge was to appropriately deal with the data voids and artefacts occurring in all three DEMs. In the framework of a pilot study, the ArcticDEM was subtracted from the AeroDEM over the Holm Land ice cap, northeast Greenland. The data voids were filled (A) by spatial interpolation and (B) by interpolating the mean of the respective elevation bin, resulting in a mean elevation changes of −9.3 m and −9.9 m, respectively. Based on the results of this pilot study, we are applying these approaches to calculate glacier elevation changes for larger regions on Greenland.
This work is carried out in the framework of the Copernicus Climate Change Service (https://climate.copernicus.eu/about-c3s) for which the World Glacier Monitoring Service (WGMS) aims at generating glacier specific elevations changes for regions around the world.

CR-4b - Ice sheets, ice shelves & proximal processes in past, present & future climates
21.06.2018 11:00-12:30, B Parsenn

1758
Ice Shelf Buttressing and Ice Sheet Flow

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Ice shelves buttress ice at the grounding lines of the Antarctic Ice Sheet and changes in the geometries of ice shelves can affect upstream flow. We review theoretical concepts related to ice-shelf buttressing and grounding-line stability, and use numerical ice flow models to quantify the impact of loss of ice shelves on ice flux across grounding lines. We give both a general overview over the sensitivity of grounding-line ice flux to changes in ice-shelf thickness, and more specifically estimate the impact that recent thinning may have had on ice flow in Antarctica. We find that the spatial pattern of observed current ice loss matches closely that predicted by numerical modelling. Hence, loss of ice shelf buttressing appears to be modulating grounding line ice flux in Antarctica today. While these findings are in good agreement with prevailing views on the importance of ocean-induced thinning over ice shelves, this is the first time that such a link is explicitly derived using numerical ice flow models.

44
An Observation Based Approach to Calculating Ice Shelf Calving Flux

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Traditionally it has been very difficult to determine the non-steady state behaviour of ice shelves from observations. In order to define the state of an ice shelf one of the key components, the calving flux, is required. Antarctic wide calculations of ice shelf calving fluxes have tended to ignore the smaller ice shelves and/or smaller calving events, often assuming that the calving flux of an ice shelf is temporally constant and so not accounting for non-steady state behaviour. An approach is needed that captures the sum total of all calving along with the variation in calving front position between calving events. We have developed an observation based approach that uses a combination of ice flow velocities, ice thicknesses and a time-series of calving front positions to calculate the calving flux of an ice shelf at a high temporal and spatial resolution. The Sørsdal Glacier of East Antarctica is used as an example. The sensitivity of the approach to the input datasets (e.g. ice velocities and ice thicknesses) is investigated. Quantifying the calving fluxes of smaller ice shelves at a high temporal and spatial resolution will allow a more accurate estimate of the mass loss from the Antarctic Ice Sheet due to ice shelf calving. Using such an observation based approach to quantify the calving flux will also give an insight into ice shelf dynamics and how these may change with changing environmental forcings.

606
Nature or Nurture? Rift Generation(s) at the NE front of the Ross Ice Shelf

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Understanding the conditions that drive ice shelf rift geometry and propagation is critical to understanding contemporary change in Antarctic systems. Rifts become the planes along which tabular icebergs calve and thus play an important role in ice shelf mass balance and response to climate change.
We use a linear elastic fracture mechanics (LEFM) modelling approach coupled with an ice shelf model to investigate a family of rifts at the front of the Ross Ice Shelf, between Roosevelt Island and the Shirase Coast. This is an ideal section of the ice shelf for our study because stress conditions are straightforward and spatial variation in ice properties appears to be relatively straightforward as well. The propagation of two generations of rifts is recorded in images collected between 1986 and 2017 by Landsat 4, 7, and 8. Rifts originating from very different spatial circumstances are observed to develop into similar near-front geometries. We consider both differing origins and similar fates of these features, simulating both using the same far-field stress conditions.

1191
Study on Fracturing of Ronne-Filchner Ice Shelf using Multisource Satellite Data

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Ice shelves play a very important role in buttressing the Antarctic ice sheet. Monitoring the stability of the ice shelves is an integral part of the study of AIS mass changes and the associated sea level rise. We propose a new framework of systematic fracture mapping and major calving event prediction for the large ice shelves in Antarctica using optical imagery, SAR imagery, altimetric data, and stereo mapping imagery. It is implemented and applied for a comprehensive study of the fracturing of Ronne-Filchner Ice Shelf using a long time dataset dating back to 1957. New remote sensing data that have been made available in the past decade, including Landsat 8, WV-2, ZY-3 and others, greatly enhance our abilities to detect new fractures and monitor large rifts in three dimensions. Two large rifts, Rifts 1 and 2, were newly detected and are comparable to the Grand Chasm that caused a major calving event in the region in 1986. Based on the results of the 2D and 3D fracture mapping, the spatial and temporal analyses of the overall fracture changes and large rift evolutions, the level of fracturing in RFIS was slightly increased, particularly at the front of the ice sheet. The overall fracture observations do not seem to suggest immediate significant impacts on the stability of the shelf. However, the most active regional fracturing activities occurred at the front of Filchner Ice Shelf. A potential upcoming major calving event of FIS is estimated to occur around 2051.

1127
MADICE - Exploring Ice Rises and Shelves of Dronning Maud Land, East Antarctica

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Ice shelves of Antarctica are rapidly changing and could largely affect the Antarctic ice sheet stability. Ice rises, grounded ice domes, affect ice-shelf stability and are useful sites to investigate the proxy records of Antarctic climate variability. Dronning Maud Land (DML) is characterized by small ice shelves that are punctuated by ice rises. To fill the knowledge gap and to undertake a detailed study of ice shelves and ice rises of coastal DML, an Indo-Norwegian project named MADICE (Mass balance, dynamics, and climate of the central Dronning Maud Land coast, East Antarctica) was initiated. During the 2016-17 season, the first joint MADICE campaign was under taken within the Nivlisen Ice Shelf and adjacent ice rises (Djupranen and Leningradkollen). This campaign successfully collected a range of glaciological data using GPS and radar, and recovered two ice cores at the summits of the ice rises (depth 122 and 51 m, respectively). The ice core from Djupranen ice rise includes negligible melt features, whereas the ice core from Leningradkollen shows many melt features. This is primarily caused by the difference in surface elevations (150 m). We are analyzing the stratigraphy, stable isotope other properties of these ice cores. The second MADICE campaign is currently underway. We will present scope, outline and initial results of this project. Details of geophysical/glaciological findings are proposed as another presentation in the same session (Lindbäck and others).

2424
Multi-disciplinary Observation Network to Monitor Rapid Changes in Antarctica

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The Polar Regions have been experiencing dramatic changes particularly including glacier retreating, ice thinning, declining in sea ice extent, and so on. Recent literatures illuminate that the melting rate of ice sheets and glaciers in the West Antarctic has accelerated, which may lead significant contributions to global sea level rise. In an attempt to understand the complex forms of interaction between the Lithosphere, the Hydrosphere, the Atmosphere, and the Cryosphere, Korea Polar Research Institute has been operating an integrated Cryosphere monitoring network (EGGNet; Extreme Geophysics Group observation Network) in the Terra Nova Bay (TNB) since December, 2010. The EGGNet consists of local broadband seismic stations, GPS stations, AMIGOS systems, Ocean Bottom Seismometers, oceanographic moorings, and Autonomous Underwater Hydrophones. In addition to operation of the year-round stations, we have performed magnetotelluric survey near Mt. Melbourne, CTD castings in TNB, airborne geophysical surveys on Nansen Ice Shelf, Drygalski Ice Tongue and David Glacier. In this presentation, we show some of interesting features observed through the EGGNet: identification of David Glacier subglacial lakes, basal melting occurring under Drygalski Ice Tongue, existence of super-cooled water in TNB, seismic velocity structure under Mt. Melbourne, etc. We anticipate that these *in situ* observations could help to improve our understanding of physical processes for ice sheet models.

OS-3b - Sea ice extent, properties, volume & ice shelves: modern and paleo records
21.06.2018 11:00-12:30, B Jakobshorn

391
Drivers of Southern Ocean Sea Ice Trends in CMIP5 Models

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Formal change detection studies indicate that the observed trend inSouthern Ocean sea ice cover is within the range of internal variability. However, this result depends on global coupled models that fail to capturestrong local trends, in especially during summer in the western Ross andBellingshausen sectors. Additionally the model response to individual forcings has not been considered except for total sea ice extent changes. In this work optimal fingerprinting has been applied to Southern Ocean sea ice, and to the local atmosphere and ocean, to individually explore the sea ice response to anthropogenic greenhouse gas and anthropogenic ozone depletion. The former is characterised by a thermodynamic reduction in sea ice at all seasons andsectors; the latter shows a seasonally and spatially-dependent response that is driven by the atmosphere and is similar to observed patterns. The all-forcings response, which has been used in previous detection studies,is dominated by the thermodynamic greenhouse gas forcing. This indicates that the models over-represent the thermal response in the high latitudeSouthern Hemisphere.

304
Atmospheric Influences on the Anomalous 2016 Antarctic Sea Ice Decay

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In contrast to the Arctic, where total sea ice extent (SIE) has been decreasing for the last three decades, Antarctic SIE has shown a small, but significant increase during the same time period. However, in 2016, an unusually early onset of the melt season was observed; the maximum Antarctic SIE was already reached as early as August rather than end of September, and was followed by a rapid decrease. The decline of the sea ice area (SIA) started even earlier, namely in July. The decay was particularly strong in November where Antarctic SIE exhibited a negative anomaly (compared to the 1979-2015 average) of approximately 2 Mio. km^2, which, combined with reduced Arctic SIE, led to a distinct minimum in global SIE. ECMWF- Interim reanalysis data were used to investigate possible atmospheric influences on the observed phenomena. The early onset of the melt and the rapid decrease in SIA and SIE were associated with atmospheric flow patterns related to a positive ZW3 index, i.e. synoptic situations leading to strong meridional flow. Particularly, in the first third of November northerly flow conditions in the Weddell Sea and the Western Pacific triggered accelerated sea ice decay, which was continued in the following weeks due to positive feed-back effects, leading to the extraordinary low November SIE. In 2016, the monthly mean SAM index reached its second lowest November value since the beginning of the satellite observations. SIE decrease was preconditioned by SIA decrease.

609
Exploring Kinematic Contributions on Antarctic Sea-ice Extent

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The recent collapse of annual maximum extent of Antarctic sea ice brings the long-term evolution of Antarctic sea ice into line with the polar response to global warming. For about the last two decades the Antarctic winter ice cover had expanded, exceeding 20Mio km^2 in 2014. The underlying processes for this expansion are thought to be due to either melt-induced cold freshwater lenses at the ocean surface in the Southern Ocean or a combination of wind-driven advective and thermodynamic changes. Here we investigate the contribution of advection on the ice extent using SAR and MODIS imagery. Since 2001 during most years in the region off East Antarctica, strengthened synoptic-scale surface winds increased the northern sea-ice extent. However, during some years, including the most recent once, winds acted to compact the near-coastal sea ice, and by virtue of deformation increased the ice thickness. In the Weddell Sea and to a lesser degree in the Ross Sea, ice advection was found to modulate the strength of the regional northward ice export. Off East Antarctica and in the Weddell Sea ice advection correlated with shear and has been linked to deformational thickening. A pathway of ice advection affecting the regional sea-ice extent and ice-thickness distribution can be identified for most Antarctic regions.

2519
Sea Ice Type Distribution in the Antarctic from Microwave Satellite Observations

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Sea ice can be classified into several types, such as young ice (YI, thin and smooth new ice), first-year ice (FYI, formed during one cold season), and multiyear ice (MYI, ice that has survived at least one melt season). As the physical properties of sea ice differ significantly for the different ice types, knowledge of the sea ice type is essential, e.g., for properly modelling the ice-ocean-atmosphere system.
Here we apply a new satellite-based retrieval of sea ice type in the Antarctic. This retrieval has originally been developed and tested for the Arctic, where it can distinguish YI, FYI and MYI. The motivation to apply the sea ice type retrieval in the Antarctic is that there is a considerable amount of MYI in the Antarctic (albeit less and younger than in the Arctic), and that, however, the ice type distribution in the Antarctic has not yet been investigated much.
The retrieval method uses input data from active and passive microwave instruments (radar scatterometer and radiometer, respectively) for the retrieval but in addition applies several correction schemes to account for the effect of melt-refreeze processes, snow metamorphosis and sea ice drift on the sea ice type retrieval. The needed satellite data have been available since 1999, there is daily full coverage (but no retrieval during summer melt), and the spatial resolution is about 25 km.
We will present first results of the new retrieval applied to Antarctic sea ice and compare with results from the Arctic.

802
Sea Ice Thickness Estimates from Icebridge over the Weddell Sea in 2009-2016

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NASA's Operation IceBridge (OIB) aircraft flights aim at extending the laser altimeter time series through the gap between the end of ICESat data collection in 2009 and the launch of the ICESat-2 lidar in 2018. OIB data is used to estimate sea ice total freeboards and thicknesses over the Weddell Sea during 2009-2016. Local sea level heights are extracted from the ATM (lidar) L1B over leads/thin ice mapped by the DMS images. Total freeboard of sea ice is then derived from the ATM L2 by subtracting the nearest local sea level height. For the 2011 flights, our results are also compared with a previously published result that used the ATM L1B of the lowest reflectance threshold (< 0.25) as local sea level. Ice thickness derived by using the empirical equations shows reasonable spatial and temporal distributions, with thickest ice in the coastal northwest Weddell Sea. The averaged ice thickness estimated at each track varies from 1.27m to 2.25m, with an overall increasing linear trend of 0.035 m/yr from 2009 to 2016, although statistically insignificant ($p = 0.13$). Our next step is to bring into the analysis the ICESat data (2003-2009) for the same tracks and thus generate a longer time series (2003-2016) and more complete picture of sea ice variability in the Weddell Sea.

945
Spatial Variabilities and Trend Analysis of the Antarctic Sea Ice with ICESat

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Obtaining accurate measures of the Antarctic sea-ice thickness (I) is becoming increasingly relevant given below-average sea-ice extents observed after 2014 and the reappearance of the Weddell Sea polynya during winter/spring 2017. Satellite laser altimeter observations of the total (sea ice plus snow) freeboard (F) have proven to be useful in this context. However, in addition to uncertainties in F the conversion from F into I is subject to several uncertainty sources, e.g., snow density and snow depth (S). Here we present a novel method which combines several approaches. We derive F with the well-known lowest-level elevation method. We avoid known uncertainties in the conversion from F into I (see above) by using a simplified buoyancy equation in concert with the idea to consider sea ice and snow as one layer. The density of this layer required for the F-to-I conversion can be computed as product between ice density and the ratio S/I. We derive the latter dynamically from first guess values of I and S computed using two empirical equations based on in-situ observations. Hereby we assume that contemporary application of these empirical equations to F results in a smaller uncertainty in sea-ice thickness than when utilizing a potentially biased snow depth from another data source. We show and discuss results of our enhanced sea-ice thickness retrieval method for ICESat / ICESat-2 in a circum-Antarctic as well as regional context.

AC-1g - Polar and high altitude atmosphere: clouds, aerosols, climate and interactions
21.06.2018 11:00-12:30, C Sanada I

114
Supersaturated Atmosphere on the Antarctic Plateau

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Relative humidity with respect to ice (RHwri) is often reported close to or at saturation in the surface atmosphere of the antarctic plateau. However, this does not exclude the possibility that the air is actually supersaturated because conventional hygrometers cannot measure supersaturation and rather stick to their 100% instrumental ceiling. While they are frequent at high altitude, ice supersaturations do not generally occur in the surface atmosphere where measurement is obviously much easier. Atmospheric conditions close to those occurring at the tropopause are, however, found at the surface of the Antarctic plateau, both in terms of temperature and humidity, and of low concentration of ice nuclei. Frequent reports of saturation probably actually reflect poorly sampled supersaturation. Adapted sensors that can measure beyond saturation show that at Dome C supersaturation is frequent and the norm rather than the exception (https://www.atmos-chem-phys.net/17/691/2017/), and RHwri can occasionally reach 150% or more in winter. In summer, RHwri rises to supersaturation as temperature decreases in the evening, then the vapor often coalesces to form surface haze. RHwri decreases as the haze develops then as temperature increases, to reach undersaturation during the day. This succession and chronology of events could offer a fair test for cold microphysics parameterizations increasingly implemented in meteorological and climate models to simulate high-altitude cirrus clouds.

495

Empirical Trace Gas Gradients in the Arctic and the Polar Dome Location

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The Polar Dome has long been recognized as a transport boundary for mid-latitude air travelling into the Arctic. Measurement based identification of the Polar Dome is difficult due to the temporal and spatial variability and a lack of consistent measurements in the lower few kilometers of the Arctic. Particularly the climatological role of the Dome as a transport boundary for pollution tracers has not yet been fully addressed on the basis of in-situ measurements.
We present aircraft based trace gas measurements in the Arctic during different seasons since 2014 (NETCARE 2014/2015, RACEPAC 2014, PAMARCMiP 2015/2017, ACLOUD 2017) covering an area from Spitsbergen to Alaska. We analyze the distribution of CO and CO2 in different coordinate systems and identify the Dome location from observed trace gas gradients. Significant differences regarding the Dome location and transport between winter/spring and summer appear. During winter/spring the Dome is characterized by an almost isentropic distribution of CO and CO2, whereas in summer diabatic processes introduce isentropic gradients. Consistent with the tracer measurements the analysis of kinematic 10-day back trajectories revealed different transport regimes with contributions of mid-latitude air ranging from 15%-55%. The North American continent is the dominant source region of air masses in the Canadian Arctic. However, erratic WCB transport originating in Eastern Asia affects the composition of the high Arctic troposphere.

1447
Chemical Composition and Growth of Newly formed Particles at Chacaltaya, Bolivia

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The ability of atmospheric aerosols to act as cloud condensation nuclei (CCN) is influenced by both the particles´ size and chemistry. For particles formed in the atmosphere via nucleation of vapors, this means that they must undergo significant growth before they can become active as CCN. Direct atmospheric observations at high altitudes of the life cycle and chemistry of aerosol particles from nucleation to cloud droplets are still scarce. We present first results from a comprehensive 6-month field campaign (December 2017 - May 2018) conducted at the GAW station Chacaltaya in the Bolivian Andes. The station is at an altitude of 5240 m a. s. l., in the Cordillera Real, which separates the Amazon basin from the Altiplano. Regular regional new particle formation events, the influence of the emissions from the nearby city of La Paz on an almost daily basis, and of air masses from the Amazon during the rainy season make this a highly interesting site to study atmospheric particle formation and growth processes. To this purpose we deploy several state-of the-art mass spectrometers. This abstract focuses on results from a chemical ionization mass spectrometer with filter inlet for gases (FIGAERO-CIMS), which is used to investigate the nature and relative importance of anthropogenic and biogenic organic components contributing to the growth of newly formed particles to sizes where they can become active as CCN.

1163
The Fate of Arctic Black Carbon Aerosol from Clouds to Snow

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Black carbon (BC) aerosol is considered to play a strong role in Arctic warming. However, the lack of measurements represents a large source of uncertainty in assessing the total radiative forcing of BC. In order to quantify the presence and properties of BC we performed simultaneous airborne and shipborne field experiments between Svalbard and the Fram Strait in May/June 2017. The BC particles were thereby measured in the cloud-free atmosphere, in particle residuals of mixed-phase clouds and in snow, by means of a single particle soot photometer. Within the ACLOUD (Arctic Cloud Observations Using airborne measurements during polar Day) experiment, vertical distribution of BC and its presence in cloud particles were investigated. Simultaneously, during the PASCAL (Physical feedbacks of Arctic PBL, Seaice, Cloud And Aerosol) campaign, BC atmospheric concentration was monitored at sea level from the RV Polarstern and more than 200 snow samples were collected over the sea ice for BC quantification. Shipborne and airborne observations showed extremely clean Arctic conditions above 65°N, with BC mass concentration below 10 ng m^{-3} at sea level and strong vertical variability (from 5 to 70 ng m^{-3}). BC cloud residuals, sampled with a counter-flow virtual impactor, were larger in diameter (300 nm) as compared to outside-cloud conditions (150 nm). The analysis of snow samples will allow understanding the time evolution of BC concentration and its metamorphism during the melting season.

1381
Insoluble Brown Carbon Emitted by Marine Engines: Relevance to a Warming Arctic

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The majority of ships travelling through the Arctic operate on heavy fuel oil (HFO). The exhaust associated with HFO combustion contains light-absorbing black carbon (BC) particles but also substantial amounts of brown carbon (brC). This brC absorbs more strongly at shorter (blue) wavelengths than at longer (red) ones, and can dominate the total light aerosol light absorption by HFO-combustion aerosols. Here, we show that it is fundamentally different to brC produced by sources such as biomass-burning. We show that this brC is insoluble, thermally refractory, and absorbs in the near infrared. These properties resemble those of the tar balls which have been previously observed from biomass combustion, rather than to the light-absorbing organic molecules that have been the focus of recent brC research. These properties also mean that common techniques for measuring BC may result in strongly biased estimates of aerosol light absorption. The insolubility of this brC means that it may accumulate on snow and ice, perhaps explaining recent observations that 32% of albedo reduction in Arctic snow is due to non-BC particles. Further field measurements are needed to quantify these light-absorbing brC particles in order to understand anthropogenic impacts on the Arctic environment.

1402
Black Carbon in the Atmosphere and Snow in the McMurdo Dry Valleys, Antarctica

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Measurements of light absorbing particles in the boundary layer of the high southern latitudes are scarce, particularly in the McMurdo Dry Valleys (MDV), Antarctica. During the 2013 - 2014 austral summer near-surface boundary layer refractory black carbon (rBC) aerosols were measured in air by a single particle soot photometer (SP2) at multiple locations in the MDV. Near-continuous rBC atmospheric measurements were collected at Lake Hoare Camp (LH) over two months and for shorter periods at more remote locations. Snow samples were also collected in a 1m pit on a glacier near the camp. The range of concentrations rBC in snow were 0.3 - 1.2 ± 0.3 ng-rBC/g-H_2O, and total organic carbon were 0.3 - 1.4 ± 0.3 mg/L. At LH, the average background rBC mass aerosol concentrations was 1.3 ng/m^3. rBC aerosol mass concentrations were slightly lower, 0.09 - 1.3 ng/m^3, at the most remote sites in the MDV. Concentration spikes as high as 200 ng/m^3 were observed at LH, associated with local activities. During a foehn wind event, the average rBC mass concentration increased to 30-50 ng m^{-3}. Here we show the rBC increase could be due to resuspension of locally produced BC, which may remain on the soil surface until redistributed during high wind events. Quantification of local production and long-range atmospheric transport of rBC to the MDV is necessary for understanding the impacts of this species on regional climate.

1181
Early Winter Sea Ice Dynamics and Ice Production in the Ross Sea during PIPERS

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The Ross Sea sea ice cover is one of the few regions of the cryosphere that have been expanding in recent decades. However, 2017 saw a significantly delayed autumn ice advance and record low early winter sea ice extent. To better understand the causes and impacts of this variability on sea ice production, we present a suite of in situ and satellite observations made during the PIPERS (Polynyas, Ice Production and its seasonal Evolution in the Ross Sea) cruise in April-June 2017. To assess the relative role of sea ice dynamics and thermodynamics in sea ice production, four arrays of GPS and ice mass balance buoys were deployed in the outflows of the Ross Ice Shelf and Terra Nova Bay Polynyas. High-resolution synthetic aperture radar imagery are used to provide regional context. Despite high rates of ice production in the polynyas, the ice remained thin due to rapid export and northward drift. Compared to the only prior winter observations made in 1995 and 1998, the ice was thinner, with less ridging and snow cover, reflecting a younger ice cover. Surprisingly, granular ice was less prevalent in 2017, particularly in the outer pack, due to less snow ice formation and less pancake ice formation at the advancing ice edge. We discuss the relative roles of ice dynamics and thermodynamics in both the polynyas and the main ice pack, and the dynamic interactions between these regions in governing total sea ice production.

2112
Air-sea-Ice Interaction Associated with the 2016 and 2017 Weddell Polynyas

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Maud Rise, a seamount in the Weddell Sea, is a location where polynyas occasionally form. The most dramatic of these events was the ~300,000km^2 polynya that occurred over the 3-year period from 1974-1976. Another smaller polynya developed in 1994 and there is evidence of a persistent halo of reduced ice cover in the region that may be a signature of a Taylor Cap. The presence of a polynya can lead to vigorous air-sea interaction resulting in a densification of the surface waters and a convective overturning of the water column. There is still much that is unknown regarding how they form as well as the characterization of the atmospheric forcing that occurs within them and the oceanic response. In 2016, a polynya developed in late July and persisted for approximately 3 weeks. In September 2017, the polynya returned and has remained open through November. Here we use new high resolution atmospheric, oceanic and cryospheric datasets to examine the air-sea interaction that occurred within the recent polynyas. Observations from SOCCOM under-ice profiling floats show prominent cold, fresh, high-oxygen anomalies to a depth of 1700m after the 2016 event. In addition, there was an intermittency to the area of open water within the polynya in both 2016 and 2017 that was associated with variability in the wind field suggesting that a coupling exists between the atmosphere and ocean in the region.

1468
Quantification of Sea-ice Production in Weddell Sea Polynyas (Antarctica)

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A multi-method approach is used to quantify sea ice production polynyas in the southern Weddell Sea for the period 2002-2015. We use
1) a regional climate model (CCLM) with 5km and 15 km resolution (C05/15),
2) retrievals from MODIS data at a high resolution of 1-2km and
3) simulations of a sea ice-ocean Model (FESOM) with a resolution down to 3 km.
Methods 2) and 3) need atmospheric forcing, which is taken from different reanalyses (ERA-I, CSFR, JRA55, NCEP2) as well as from CCLM data. Estimates of sea ice production and comparisons of the different methods are presented for polynya areas of the Weddell Sea. We study the following polynyas: Antarctic Peninsula (AP), Ronne Ice Shelf (RO), Iceberg A23a (IB), Filchner Ice Shelf (FI), Coats Land (CL) and Brunt Ice Shelf (BR). In all methods, the largest ice production (IP) is found for RO and for BR. However, significant differences between different methods and forcing data sets are found for polynya area (POLA) and IP. In particular, relatively too low temperatures in JRA and C05 lead to higher IP compared to ERA in the MODIS retrievals. Estimations based on CCLM simulations agree generally well with MODIS/ERA-I, but tend to be smaller due to the coarser resolution of the microwave sea ice data used in CCLM. In contrast, FESOM yields a generally larger ice production and shows also a pronounced sensitivity to the atmospheric forcing, but the effect on POLA and IP depends on the region.

264
Coastal polynyas on PIPERS: enhanced ice growth in strong katabatic wind events

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The PIPERS cruise to the Terra Nova Bay (TNB) polynya during April-June 2017 focused on joint measurements of air-ice-ocean wave interaction. Measurements were taken during intense katabatic wind events (over 35 ms^{-1}) and temperatures of -15C. Wave amplitudes of over 2m and 7-9 sec periods built and large amounts of frazil ice crystals grew. The frazil ice gathered initially into short plumes that were added together laterally to create longer and wider streaks, an apparently “self-herding” characteristic of ice in small pieces, found in other granular materials. The wave field within the wider streaks was dampened and enhanced the development of pancake ice. Eventually, the open water areas sealed off and developed a uniform pancake ice cover. As the waves died off, sustained katabatic wind velocities resulted in a wide area of concentrated, rafted, pancake ice of 30 to 40cm thickness that was rapidly advected downstream until the end of the katabatic event. High resolution TerraSar-X radar satellite imagery showed the length of the ice area produced in one single event extended over 300km or ten times the length of the open water/frazil ice area during the polynya event. The TNB polynya is therefore an “ice factory” where frazil ice is manufactured into pancake ice floes that are then pushed out of the assembly line, rafted into “dragon skin” ice and advected, until the katabatic wind dies off at the coastal source.

2185
Salinity Response to Atmospheric Forcing of the Terra Nova Bay Polynya

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The density and salinity of High Salinity Shelf Water (HSSW), a key component of Antarctic Bottom Water emanating from the Ross Sea, are intensified by brine rejection induced by ice formation within the Terra Nova Bay (TNB) polynya. Meteorological observations from Automatic Weather Stations in conjunction with ocean mooring data from 2007 and a satellite-derived opening of TNB polynya delineate higher-frequency water column salinity variability linked to atmospheric forcing. Lagged correlation analysis indicates that on average salinity response lags the polynya opening by two days and the wind forcing by four days. Closer examination reveals stronger lag correlations of salinity with the wind in the fall and with polynya extent in the winter/spring. A one-dimensional mixed layer model incorporating thermodynamic ice formation captures the order ten day oscillations in salinity linked to polynya expansion and contraction. The model illustrates two stages of the seasonal scale salinity response to forcing. The depth-integrated heat content governs the time required for the water column to reach the freezing point as wind mixing and heat loss redistribute the salinity and density profiles. Once the excess heat is removed from the water column, heat loss is primarily through the latent heat released during ice formation and the time to reach complete homogenization of the water column depends only on the integrated salinity deficit.

2096
Sea Ice Deformation and Heat Fluxes through Leads in Arctic

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Sea ice deformation is extremely localised in both space and time, and associated with intense fracturing, the opening of leads and the formation of ridges. In particular, the spatial and temporal properties of lead patterns control the surface heat fluxes between the ocean and the atmosphere, with a potentially strong impact on the dynamics of the ocean mixed layer and the stability of the atmosphere boundary layer. In this talk, we will present how a new generation sea ice model, called neXtSIM, is able to reproduce the statistics of Arctic sea ice deformation, as retrieved from buoys and satellite (SAR) observations. The simulated lead fraction is also compared to the estimates calculated from the AMSR-E satellite observations. The statistics of simulated heat fluxes through leads are finally presented and their scaling properties investigated.

BE-9a - Life distribution and responses to environmental changes in Polar ecosystems 21.06.2018 14:00-15:30, C Aspen

1842
Arctic Global Change Impacts Little Auk Foraging and Fitness in East Greenland

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Ongoing global changes apply drastic environmental forcing onto Arctic marine ecosystems: sea surface temperatures are increasing, sea-ice is declining and anthropogenic pollution is reaching this area despite its remoteness. To test the effects of these changes on marine ecological functioning in the Arctic, we used a 12-year integrative study of little auks (*Alle alle*), which are the most abundant seabirds in the North Atlantic and feed on zooplankton. In East Greenland, we monitored their foraging behavior, diet, fitness proxies (adult survival and body condition), hatching date and chick growth rate. We tested linkages between these biological variables and a set of environmental parameters from the breeding and wintering sites, as well as their mercury contamination. Little auks showed substantial foraging plasticity, notably via an increase in foraging effort in the absence of sea-ice. Yet, in contrast to former studies conducted over shorter time periods, their fitness proxies were also impacted by environmental changes: adult body condition decreased across years, and with increasing wind speed, and adult diet changed across the study period. Hatching date was gradually delayed, and chick growth rate tended to decrease with time. However, no trend was found for adult survival despite a high variability. Overall, our study shows how global changes affect a key Arctic species, and stresses the importance of monitoring arctic ecological processes in the longer term.

488
Divergent Trends and Unsynchronized Dynamics across a Seabird Community

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Global change is evident around the globe. Understanding how ecological communities are structured and how they might respond to these changes is of critical importance. However, in many cases, studies focus on a single species. Taking a community perspective, we looked at both long-term and year-to-year responses for a community of Antarctic seabirds and explored how environmental forcing might be driving demographic- and population-level processes. Data on breeding success and abundance for six sympatrically breeding seabird species located in East Antarctica were available from 1981-2013. Hierarchical Bayesian models were used to assess trends in these metrics, the degree of community-level synchrony in breeding productivity, as well as the contributions of environmental factors to this synchrony. We find a surprising discordance between trends in abundance and breeding success, with several species showing increasing abundance even as breeding success declines. In addition, we found little evidence for synchrony in breeding productivity, which was only weakly correlated with environmental factors thought to contribute to breeding success. In contrast to this overall pattern of asynchronous dynamics, exceptionally poor years were seen to drive similar negative responses among species and accordingly, measures of population dynamics aggregated over the community appear to provide more specific feedback on extreme environmental conditions than any individual species.

735
Predicting Population Response of Emperor Penguin to Future Climate Change

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The Emperor Penguin (EP) is an Antarctic seabird threatened by future sea ice change. I present novel approaches to predict population and species responses to future climate change using climate models developed in the assessment report of the IPCC. The MUP (Measuring, Understanding, and Predicting) approach, provides a general framework where an enhanced understanding of climate-population processes, along with improved long-term data, are merged into coherent projections of future population responses to climate change. Population forecasting studies have often been analyzed in terms of climate conditions at a particular location. We projected that the Terre Adélie EP population will decline dramatically by 2100. However, climate change will also produce changes in the spatial distribution of habitat quality (e.g.sea ice change in Antarctica). We developed a species-level threat assessment using a spatially explicit model. At least two-thirds of the EP colonies are projected to become endangered by future sea ice decline. We also recently included complex dispersal processes in a novel meta-population model because individuals may respond to climate change by moving permanently to other locations. For EP, relative to a scenario without dispersion, dispersal can either offset or accelerate climate driven population declines. Finally, new population modeling methods and remote-sensing products hold promise for reducing uncertainties to improve ecological predictability.

921
Influence of Antarctic Sea Ice Dynamic and Coastal Polynyas on Emperor Penguins

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Emperor penguins breed on fast ice during the Antarctic winter when the constraint to acquire resources is high, thus, seasonal and interannual variability in fast ice and coastal polynyas are likely to effect adult and juvenile foraging performance at-sea, and ultimately their survival and population dynamics. Breeding emperor penguins use polynyas as a predictable open water access for feeding by reducing the commuting time and energy expenditure between colony and food supply. Antarctic coastal polynyas are key bio-physical features, however, our understanding of their use by emperor penguins is largely theoretical. To tackle these issues, we use both (i) tracking data of juvenile emperor penguin movement and behaviour at-sea over 2 years and (ii) the longest time series available on demographic parameters of emperor penguins at the breeding colony of Dumont d'Urville from 1952-2016. We first describe if juvenile emperor penguins use polynyas as a foraging habitat and whether diving and foraging behaviour is affected by sea ice and its spatio-temporal variability. In a second time, we investigate the combined roles of surface wind, polynya properties and fast ice spatio-temporal variability on the demography of emperor penguins. The novelty of combining juvenile tracking data with demographic data allows suggesting mechanisms by which sea ice and polynyas effect emperor penguin demography through both their breeding success and the following juvenile performance at-sea.

2196
Mechanisms of *Pygoscelis* Penguin Population Response to Environmental Change

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Breeding colonies of Adélie (*Pygoscelis adeliae*), chinstrap (*P. antarcticus*), and gentoo (*P. papua*) penguins occurring west of the Antarctic Peninsula (wAP) are demonstrating pole-ward range shifts that correlate with long-term warming trends of the region. We examined mechanistic relationships that link marine ecosystem variability with demographic parameters that drive population change. At Anvers Island, where reductions in sea ice have been notable, *Pygoscelis* penguins became more similar isotopically throughout the breeding season, due to depletion in $d^{13}C$ and $d^{15}N$ of blood tissue. Crèched chicks of all species occupied similar trophic levels and the proportions of prey provisioned were similar across species within years. Crèched Adélie penguin chicks were isotopically enriched at Avian and Charcot Islands, southern breeding colonies where sea ice is more prominent. At the regional scale, a provisioning diet enriched in $d^{15}N$ resulted in heavier five-week-old Adélie penguin chicks. Corticosterone hormone did not mediate variation in breeding performance. We found no overall genetic structure among Adélie penguins. However, pairwise comparisons including Charcot Island were significant. Variability in sea ice-associated food webs of the wAP is an important determinant of *Pygoscelis* penguin reproductive performance, but not at the physiological level. A lack of genetic structure suggests dispersal may importantly structure population responses to future ecosystem change.

1577
Penguin Colony Responses to Climate Change and Volcanism

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Changes in penguin populations on the Antarctic Peninsula (AP) have been linked to several environmental factors, but the potentially devastating impact of volcanic activity has not been considered. Genetic, biogeochemical and modern count studies all show gentoo populations increasing during 'warmer' periods. Using detailed biogeochemical analysis, we tracked penguin colony change over c. 8,500 years on Ardley Island, currently home to one of the AP's largest populations of gentoo penguins. By comparing our data with sub-fossil evidence of penguin occupation and records of past climate, sea-ice extent and volcanic activity from across the AP, we found that the first sustained penguin colony was established on Ardley Island c. 6,700 years ago. The colony experienced five population peaks during the Holocene, reaching its maximum, c. 4,000-3,000 years ago during a phase of regional warming, but there are no consistent relationships with local-regional atmospheric and ocean temperatures or sea-ice conditions. Instead, three of the five phases of colony expansion were ended abruptly by the deposition of volcanic ash from large eruptions of the nearby Deception Island. Sustained post-eruption colony recovery took, on average, 400-800 years, and was slowest following the most disruptive event, c. 5,500 years ago. We are currently undertaking biomarker and DNA analysis of lake sediments and sub-fossils from the AP to better understand drivers of long-term penguin population change.

1802
A New Antarctic Blowing Snow Particle Characterization Data Set

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The rate of mass transport of blowing snow in numerical models depends quite strongly on the size distribution of the particles being transported. Field observations of blowing snow using instruments are equally susceptible to the anticipated particle parameters used to calibrate those instruments. The blowing snow size distributions presented by Budd et al (1966), measured at Byrd Station, West Antarctica, can be found as the basis of most such models.
We present a new data set, collected during blowing snow events over Antarctic sea ice. Like Budd et al, we used formvar-coated microscope slides to collect 3d replicates of snow particles inside aerodynamic traps during three discrete storms during the SIPEX-2 and AWECS expeditions. We then acquired high-resolution digital scans of these formvar replicates, to allow detailed computational analysis of the particle characteristics (size, sphericity, etc). Our method allows not only a significant advance over the 2-dimensional “equivalent rectangle” size evaluation of Budd et al., but through the acquisition of scans at multiple focal depths (microns separation) we can also determine the 3rd dimension for many of the measured particles. The minimum particle size category identified using the methods employed by Budd et al was >35 microns. We find a substantially greater number of small particles than are included in the 1966 blowing snow particle size distributions.

2113
New Insights into the Atmospheric Oxidising Capacity above the Antarctic Plateau

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Field studies in the high and mid latitudes have demonstrated that snowpack emissions of reactive trace gases driven by photolysis alter regional atmospheric composition, the fate of pollutants and the polar ice core archive of past environmental change. Of particular interest are reactive nitrogen and halogen species released by surface snow, which in turn influence atmospheric levels of ozone and hdyroxyl radicals. Previous field campaigns at South Pole and Dome C showed that surface-near air on the high East Antarctic Plateau in summer is highly oxidising due to the interplay of photolytic snow emissions, a shallow boundary laye and cold temperatures. However, open questions remain regarding the atmospheric oxidant budget. Here we present new observations carried out at Kohnen Station (75ºS 0ºW) in summer 2017, located at a similar latitude as Dome C. Measurements included nitrogen oxides (NO and NO2), atmospheric nitrate collected on filters, ozone, slant-column BrO, actinic flux and atmospheric turbulence. In contrast to Dome C a distinct and strong diurnal cycle of ozone with an amplitude of more than 10ppbv is observed. We discuss these new data with respect to potential sinks and sources, and compare to the other sites on the Antarctic Plateau.

1404
The Great Antarctic Climate Hack, Sponsored by the SCAR AntClim21 RSP

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In October 2017, the first, #GreatAntarcticClimateHack was held in La Jolla, CA at the Scripps Institution of Oceanography. The aim was to bring together climate modelers, climate data users, and observational field scientists to decide on metrics to evaluate current earth system model output. With the upcoming release of CMIP6 and subsequent preparation for IPCC reports it is imperative that the broad Antarctic and Southern Ocean science community is well prepared to make the next step in advancing both regional and global climate science. A key unique goal of the workshop was to involve both specialists and non-specialists in the development of climate model evaluation metrics that address cross-disciplinary scientific priorities. Discussion and participation across broad Antarctic science communities was therefore a key aspect of the #GACH[BTJ1] . Results of the workshop are metrics that will be incorporated into the Earth System Model Validation Tool (ESMValTool), as well as a forthcoming publication.

1951
A Long-term Hindcast Simulation with COSMO-CLM² over Antarctica

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The surface mass balance (SMB) of the Antarctic ice sheet (AIS) is crucial to understand Antarctica's contribution to 21st century sea level rise. Therefore, it is essential to understand the large scale atmospheric processes that affect accumulation as it is the only source term of the ice sheet.
Given the scarcity and low spatial coverage of observations over the AIS, the regional climate modeling approach, which is not very common over Antarctica, is the adequate tool to gain insights in AIS SMB. In this respect, COSMO-CLM 5.0 was coupled to the Community Land Model (CLM4.5) and adapted for Antarctic conditions. ERA-Interim is used as initial and lateral boundaries for a time period of 30 year (1986-2016; excluding 3 years of spin-up time) at a resolution of 0.22° by 0.22° over the whole Antarctic continent. Lackings in the model representation of basic climatic variables such as temperature and wind speed were tackled by adapting the turbulence scheme, implementing a two-moment cloud microphysics parametrization, as well as several modifications to the Community Land Model (e.g. snow metamorphosis, wind dependent compaction,...).
Here, we present the results of this long-term COSMO-CLM² simulation adapted for Antarctica. Results are compared to observations from automatic weather stations, field campaigns and radiosondes. In the next steps a blowing snow module and refined cloud-aerosol-precipitation interactions will be implemented into the model.

9
Modeling the Dynamics of the Stable Boundary-Layers over the Antarctic Plateau

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The 5th IPCC report states that the Antarctic Plateau is one of the regions where the near-surface temperature is the less well constrained in climate models and re-analyses. The misrepresentation of the stable boundary layer (SBL) may be suspected. Investigation of meteorological measurements at Dome C evidenced the extreme nature of the SBL at this location. The summertime diurnal cycle, the very strong stratifications in winter and the two-regime behavior of the SBL dynamics challenge our understanding of the SBL and its parametrization by climate models. After characterizing the Dome C SBL from measurements, we present an innovative conceptual model that provides insights into the SBL dynamics, explaining the reversed ´S-shaped´ dependency of the near-surface inversion with the wind speed. The LMDZ General Circulation Model, involved in the next CMIP/IPCC exercise, is then evaluated in 1D and 3D configurations. Extensive sensitivity tests to the turbulence parametrization, resolution and surface parameters are presented. They lead to a satisfactory configuration of the model´s physics, in which the turbulent mixing sharply decreases with increasing stability. The analysis of simulations further sheds light on the critical roles of radiation and subsidence in the heat budget of the SBL. Radiative and humidity issues associated to strong biases in the SBL representation are discussed, paving the way for both observational and modeling studies in the future.

1980
Wind Gust Climatology in the Antarctic ABL over the Dronning Maud Land

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Extreme wind gust conditions are frequently observed in the coastal regions of Antarctica. At some locations they can even reach hurricane force. The strong winds are typically of katabatic origin occasionally intensified by passing cyclones. Even though the extreme wind conditions have been recognized, the wind gusts have received only a little attention from the scientific community. To better understand the climatology and dynamic origins of the gusts, the data from eddy covariance stations installed near the Finnish Antarctic station ABOA during the austral summers of 2010/2011 and 2014/2015 was analyzed.
The region is located about 130 km from the coast and is primarily covered by a gently sloping glacier and has the Basen nunatak as a defining feature. Energetic gravity waves generated by the nunatak have been previously studied as well as the katabatic winds which are often present. The local, small scale dynamics is predominantly influenced by the position in relation to the Basen nunatak. A comparison of an upwind site and a site near the Basen nunatak demonstrates the spatial variability of the wind gust climatology in the Antarctic ABL. Further analysis of the high resolution time series isolates the dynamic structure of the wind gusts and results are supplemented by SODAR data.

AC-8a - Causes and Effects of Changing Polar Climate, Cryosphere and Hydrological Cycle 21.06.2018 14:00-15:30, A Forum

27
Causes of Accelerated Warming of the Arctic in Winter

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Over recent decades, the rate of winter warming increased dramatically over the Arctic while plummeting to near zero over northern midlatitudes. Climate models predicted neither. The reasons for the warming slowdown over northern midlatitudes are well understood; the reasons for the warming acceleration over the Arctic are not. Here we show, using a novel combination of atmospheric reanalyses and climate model simulations, that these phenomena are linked through a large amplitude signal of internal trend variability with opposing sign over the Arctic and northern midlatitudes. For the Arctic, we estimate that internal trend variability accounted for 50-90% of the increased rate of Arctic warming since the early 1980s. Uncertainties in trend estimates depend on atmospheric reanalysis, climate model, and trend period and length considered. These results challenge the perception of a dominant influence from human activities on recent warming rates over the Arctic, suggesting instead that multi-decadal internal variations had an impact nearly as large as, or larger than, the human influence.

907
Arctic Temperature Trends: A Role of Internal Variability and External Forcing

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Relative contributions of internal atmospheric variability, lower boundary conditions and external radiative forcing to the recent warming trends in high northern latitudes are investigated based on large (30 members) ensemble of numerical simulations with an atmospheric general circulation model (AGCM). The model is forced with the same historical boundary conditions (sea surface temperatures and sea ice concentrations) for 1979-2012 period and different initial conditions with and without time varying radiative forcing. It is found that simulated ensemble mean Arctic temperature changes considerably underestimate the observed temperature increase. The difference between model results and observations may not be explained by internal atmospheric variability that is reasonably well simulated by the model. Analytical model describing climate zonal trend uncertainty as a function of internal fluctuations of zonal temperature anomalies is suggested and found to successfully describe AGCM results. Introducing direct radiative forcing considerably improves the model's results in simulating Arctic temperature trends. The strongest contribution of direct radiative forcing is found in the European part of Russia and in the Western Arctic. Comparison of the simulated trends with observations suggests possible problems with sea ice concentration data used to force atmospheric models.

731
Non-linear Impacts of Future Anthropogenic Aerosol Emissions on Arctic Warming

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Past reductions of anthropogenic aerosol concentrations in Europe and North America could have amplified Arctic warming. In the future the impact of air pollution policies may differ, because the major anthropogenic sources of atmospheric aerosols are increasingly in Asia. In this study numerical experiments indicate that, while reduced carbon dioxide (CO_2) emissions weaken Arctic warming, future reductions of anthropogenic aerosol concentrations can either amplify or diminish it. Interactions between regional atmospheric aerosol concentrations in Asia and internal climate variability may differently initiate and sustain atmospheric planetary waves propagating into the Arctic. In a non-linear manner they may redistribute atmospheric and oceanic meridional heat fluxes at the high latitudes. In experiments until 2050 lower anthropogenic aerosol concentrations combined with current CO_2 emissions amplified Arctic warming by increasing atmospheric meridional heat fluxes, but when combined with lower CO_2 emissions they further diminished Arctic warming by decreasing oceanic meridional heat fluxes.

2569
Does the Atlantic Windstorms Have Significant Influences on the Arctic Warming?

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During the northern winter, strong Atlantic windstorms often intrude into the Arctic and play important roles as a moisture supplier into the Arctic. Recent unprecedented Arctic warming event happened in early January of 2016 is the best example: In this episode, the Atlantic sector of Arctic experienced tremendous warming more than 25 DegC than its daily climatology due to the entry of strong Atlantic windstorm of 950 hPa as its central pressure. However, quantitative assessments on the role of Atlantic windstorms on the Arctic warming episodes are rare in the current literatures. Here we provide robust statistical evidences that strong Atlantic windstorms tend to move northeastward to the Arctic and induce significant Arctic warming. Positive North Atlantic Oscillation (NAO) condition and, thus, intensified upper-level winds and tropospheric instability contribute favorable conditions for the intensification of the stronger storms. Enhanced poleward energy transport by moisture intrusion is observed during the lifecycle of the Atlantic windstorms of strongest 10-20% category. The increase of Arctic temperature critically depends on the strength of storm. This linkage between strong Atlantic windstorms and Arctic warming events are well simulated by the two independent climate model simulations.

2120
Collapse of the 2017 Winter Beaufort High: A Response to Thinning Sea Ice?

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The winter Arctic atmosphere is under the influence of two very different circulation systems. The eastern Arctic is impacted by extra-tropical cyclones that travel from Iceland towards the Barents Sea along the primary North Atlantic storm. In contrast, the circulation in the western Arctic is characterized by a quasi-stationary region of high pressure known as the Beaufort High. Both of these circulation systems play important roles in the Arctic climate system. Here we show that the winter of 2017 featured a reversal of the normally anticyclonic surface winds and sea ice motion in the western Arctic. We argue that this reversal can be traced to a collapse of the Beaufort High as the result of the intrusion of low-pressure systems from the North Atlantic, along the East Siberian Coast, far into the Arctic Basin. Thin sea ice as the result of an extremely warm autumn of 2016 contributed to the formation of an anomalous thermal low over the Barents Sea that, along with a northwards shift of the tropospheric polar vortex, permitted the intrusion of low-pressure systems deep into the Arctic Basin. This collapse was associated with 2-sigma sea-level pressure, surface wind and sea ice circulation anomalies in the western Arctic. As the Arctic sea ice continues to thin, such reversals may become more common and impact ocean circulation, sea ice, and biology.

1655
Towards a Rain-dominated Arctic

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Climate models project a strong increase in Arctic precipitation over the coming century, which has been attributed primarily to enhanced surface evaporation associated with sea-ice retreat. Increases in Arctic precipitation are thus firmly linked to Arctic warming and sea-ice decline. Since the Arctic is still quite cold, especially in winter, it is often (implicitly) assumed that the additional precipitation will fall mostly as snow. However, little is known about future changes in the distributions of rainfall and snowfall in the Arctic. In this study we use 37 state-of-the-art climate models in standardised twenty-first-century (2006-2100) simulations to show a decrease in average annual Arctic snowfall, despite the strong precipitation increase. Rain is projected to become the dominant form of precipitation in the Arctic region (2091-2100), as atmospheric warming causes a greater fraction of snowfall to melt before it reaches the surface, in particular over the North Atlantic and the Barents Sea. The reduction in Arctic snowfall is most pronounced during summer and autumn when temperatures are close to the melting point, but also winter rainfall is found to intensify considerably. Projected (seasonal) trends in rainfall and snowfall will heavily impact Arctic hydrology (e.g. river discharge, permafrost melt), climatology (e.g. snow, sea-ice albedo and melt) and ecology (e.g. water and food availability).

SH-6a - Connecting Polar Research Across Boundaries
21.06.2018 14:00-15:30, A Sertig

1962
Science-policy Interface in the Two Poles - Comparison and Lessons Learnt

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At first sight, the two poles differ in some fundamental ways. Whilst the Arctic consists of ocean surrounded by continents, the Antarctic is a continent surrounded by ocean; where the Antarctic has no permanent human habitation, the Arctic is inhabited by indigenous peoples and other local communities. Those differences find a clear expression in the distinct legal arrangements and governance mechanisms for the Arctic and the Antarctic. At the same time, two polar regions share certain important similarities that, we argue, render their comparison valuable. Among others, what they have in common is the paramount importance of scientific research and informing relevant decision-making with best available scientific knowledge on changes in socio-ecological systems and biophysical environments of the Arctic and Antarctic. How is the science-policy interface organized in the two regions? What are the differences and similarities between them? What are the pros and cons of present arrangements centered in case of the Antarctic around the Scientific Committee on Antarctic Research (SCAR) and around the Arctic Council (AC), albeit in a much looser manner, in case of the Arctic? Are there lessons that two poles could learn and benefit from each other? This paper examines the above issues. As such presented work spans not only boundary between science and policy-making, but also between the Arctic and the Antarctic, providing fertile ground for further research and collaboration.

2011
Engaging, Involving and Empowering Stakeholders for Arctic Climate Prediction

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The Arctic environment is changing rapidly with new opportunities and threats, calling for enhanced collaboration between academia and stakeholders.
The EU H2020 project APPLICATE aims to improve climate prediction, **applying** user engagement to share knowledge by a three-level approach:
Engaging, Using optimum communication tools, APPLICATE targets the broader stakeholder community: (i) scientific and intergovernmental organisations, as advanced data users that can highlight knowledge gaps; (ii) Public and private sector, who benefit from enhanced operational predictive capacity; (iii) Society at large, general public and local communities; (iv) relevant international projects.
Involving, Interacting with stakeholders in meetings and via the Polar Prediction Matters Blog, APPLICATE extends discussion and knowledge exchange. A User Group composed of representatives from various stakeholder groups, closely follows and collaborates with the project.
Empowering, Relationships with stakeholders are achieved through their participation in project meetings and activities. Co-development of user-relevant metrics improves our understanding of impacts and opportunities of potential changes in the Arctic and their effects. Active collaboration helps produce sound project results and relevant products and services, supporting stakeholders decision making, training and education.
User engagement supports informative decision making and capacity to adapt to new conditions in the Arctic

1642
Crossing Boundaries in Science - INTERACT Science Diplomacy

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At a time of increasing geopolitical tensions, it is important to adopt all diplomatic activities including those in science. INTERACT is a network of 83 research stations in 18 countries (including all Arctic nations). The Stations share activities, data and experiences independent of nationality. Funding through the EU, USA and Canada allowed INTERACT to offer Transnational Access (TA) funding at a pan-Arctic scale for the first time. TA has so far funded about 600 researchers to work in infrastructures outside their own national facilities. A community of grant holders has cemented a multinational and multidisciplinary team of researchers working throughout the North. In addition, the INTERACT experience has been used as a model within various Arctic nations and has contributed to the establishment of national networks linked internationally. The science diplomacy operated by INTERACT has received attention and support from various Embassies and has explicitly improved relationships between Russian and western researchers and infrastructures. INTERACT seeks to improve the wellness of Indigenous Peoples and other Arctic residents. For the first time, it provides a one-stop-shop (a Red Phone) for alerting infrastructures throughout the Arctic to identify, observe and respond to potentially hazardous environmental events. It has also worked with Russian and other local governments and universities to improve the relevance and awareness of science to local peoples.

1277
Antarctic Cities: Rethinking the Gateways

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The five recognized Antarctic gateways cities of Cape Town, Christchurch, Hobart, Punta Arenas and Ushuaia all stand on the Southern Ocean Rim. As all significant engagement with the South Polar Region is co-ordinated through these cities, they have a unique opportunity to act as custodian cities of this ecologically and geopolitically fragile region. Each city is formed by long and complex histories of engagement with the Antarctic going back to the nineteenth century. However, until now these cities have been thought of primarily as exit/entry points for tourists and base-personnel traveling to Antarctica. This presentation provides an overview of the international collaborative research project *Antarctic Cities and the Global Commons: Rethinking the Gateways* which is the first study to offer a systematic rethinking of both the engagement and outlook of these cities — not as five far-flung ports competing for the same commercial opportunities but as members of an interlinked network. This rethinking is crucial in offering ways of reorienting these cities not just as thoroughfares, but as urban centers that can embody the cosmopolitan values associated with Antarctic custodianship: international co-operation, scientific innovation, and ecological conservation. As the cities envision their urban futures this project explores a possible shift in urban practices and imaginaries from 'gateway cities' to 'custodian cities'.

BE-2c - Phytoplankton, productivity and carbon export dynamics
21.06.2018 14:00-15:30, A Seehorn

1075
Modelling Cross-latitude Variability in Carbon Export Efficiency

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We investigate generic algorithms to improve variability in modeled carbon export by emphasizing the influence of plankton community structure. We conducted tests on a 1D lower trophic level model set at various time-series stations in the North Atlantic, and each community was allowed to modify the settling and remineralization rates of detritus-based on their traits (i.e diatoms produce fast sinking particles with higher remineralization rates, while particles from prokaryotes are slower with lower remineralization rates). Additional tests were conducted on aggregation, mineral ballasting, and DVM. Results indicate that a community-based scheme is superior in representing temporal and spatial changes in export and transfer efficiencies without any region-specific parameterization. As communities adapt to different hydrography, so does the regional export efficiency. Cross-latitude comparisons show that high latitudes, which sustain larger plankton, receive higher export efficiencies compared to both low latitudes and experiments using constant global rates. Such an export mechanism has important implications for regional and global models since hydrography is thus tightly coupled to export through community structure, which may improve predictive skills for future ocean communities and carbon export. We present experiments in 1D from subtropics to Arctic, as well as initial tests in the Arctic in a 3D operational model.

108
Autonomous Multi-trophic Observations of Southern Ocean Production and Export

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Spring blooms provide insight into the importance of physical versus ecological controls of ocean productivity and export, and potential responses to climate change. We present high temporal resolution records from the Southern Ocean Time Series south of Australia, for physical drivers (temperature, salinity, surface mixed layer depth, currents, wind speeds, insolation, and air-sea heat fluxes) and biological responses for four (NPZD) trophic levels commonly used in biogeochemical models (Nutrient depletions and Phytoplankton community structure from automated sample collections; Zooplankton from four-frequency acoustics; POC and ballast mineral Detrital fluxes from sediment traps, as well as net community production (NCP) from O_2/N_2). Chlorophyll increased slightly ahead of the spring mixed layer shoaling, when zooplankton populations were lowest. The summer zooplankton increase was accompanied by shallower daytime migrations, especially for the high frequency (small) sound scatterers. Diatoms dominated biomass in spring, when NCP was highest, and continued to be important in summer even after silica was depleted. Nonetheless, seasonal N/Si drawdown shows non-diatoms were important to export and the major biogenic mineral reaching the ocean interior was carbonate, along with global median levels of POC export, despite low dissolved iron levels. These results suggest the current maximal state of the Si pump may not limit future Southern Ocean carbon export.

1093

Effects of Sea Ice on the Biogenic Carbon Export in High-Arctic Svalbard Fjords

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Variation in the strength, timing and composition of the biological carbon pump determines energy transfer to higher trophic levels and the capacity of the ocean to sequester atmospheric CO2. The lack of knowledge on sinking fluxes in Svalbard fjord ecosystems limits our understanding of the drivers of this critical process for carbon cycling. By comparing two Svalbard fjords with different environmental settings, our aim is to assess the nature of annual sinking fluxes in these systems and identify forcing factors and implications for food web processes. We analyzed samples from autonomous ocean observatories with sediment traps at 100 m depth in ice-free Kongsfjorden and in the seasonally ice-covered Rijpfjorden. The total mass and protist flux was an order of magnitude higher in Kongsfjorden than in Rijpfjorden. However, timing of the sharp protist peak flux was similar in the two fjords. Over three annual cycles in Rijpfjorden, the peak flux of the obligate ice-algal diatom *Nitzschia frigida* preceded the peak flux of the pelagic diatom spring bloom by only one to two weeks. Sinking flux linked to ice-algal and phytoplankton blooms appeared to be intense but brief events followed by low post-bloom export, except in 2014 in Rijpfjorden. Drivers of the observed flux patterns are interpreted based on oceanographic and sea-ice cover information, and surface fluorescence data as a proxy for pelagic primary production.

1699
The Gypsum Gravity Chute to the Arctic Abyss

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In the ice-covered central Arctic Ocean vertical carbon flux has been considered especially low with some notable exceptions that highlight the importance of fast-sinking aggregates for the biological carbon pump. Incorporation of ballast minerals into sinking aggregates can significantly increase the carbon export efficiency from the surface ocean to depths below the pycnocline. However, little is known about the importance of ballasting in the ice-covered Arctic Ocean, and in particular the composition of ballast minerals.
Lacking a mineral shell the haptophyte algae *Phaeocystis* is usually remineralised above the pycnocline. Here we show that, during the TRANSSIZ expedition in spring 2015, gypsum crystals released from melting sea ice were trapped by an under-ice *Phaeocystis* bloom. A geochemical model indicates that the gypsum crystals formed at temperatures below -6.5°C and were subsequently released during the melting of sea ice and coincident to the formation of the under-ice *Phaeocystis* bloom. This led to an accelerated and enhanced vertical export of gypsum-ballasted *Phaeocystis* aggregates to the sea floor at 2147 m water depth. Our findings suggest an important and previously unknown role of cryogenic gypsum in ballasting under-ice *Phaeocystis* blooms. Current environmental changes in the Arctic likely favour this gypsum gravity chute with consequences for carbon export and energy partitioning between pelagic and benthic Arctic ecosystems.

2079
Importance of Zooplankton Grazing for Arctic Pelagic-benthic Coupling

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Field observations are always point measurements and it can be demanding to elucidate driving processes for pelagic-benthic coupling based on only these data. We complemented therefore our field observations (hydrography, suspended biomass, particle export estimated with short-term sediment traps modified with a gel containing glass jar) at three contrasting Arctic sites around Svalbard with a novel microscopic simulation for particle dynamics to reproduce the particle production, sinking and degradation and estimate the vertical export.
Our observations showed that particle size and abundance changed with depth, suggesting that strong zooplankton grazing on settling aggregates at the base of the mixed layer (ML) caused a change in the attenuation mechanisms with depth. This conclusion is supported by the results of the simulations, because the observed vertical fluxes could be reproduced if a significant depth decrease in the particle degradation rate (e.g. three fold) below the ML was applied in the simulation.
In this work, we show the potential of the combination of field observations and process modelling, allowing to improve the information obtained from a few points of field observation in relation to processes in the water column and to identify potential drivers for organic carbon export from the surface ocean to the sea floor.

1237
20 Years of Particle Export in West Antarctic Peninsula Coastal Waters

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To understand how warming in the West Antarctic Peninsula (WAP) has affected the polar ecosystem and the global carbon cycle, a multi-decade sediment trap time-series is analyzed in relation to environmental (temperature, sea ice duration) and biological (primary and bacterial production, zooplankton abundance) factors. The continental shelf region of the WAP has experienced over 6°C increase in winter temperatures since 1950. The recent warming and declines in sea ice have been associated with changes at all levels of the WAP ecosystem, including reduction in phytoplankton biomass, shift in phytoplankton community composition, reduction in krill abundance, as well as decline in top predators such as Adelie penguins. These changes to the phytoplankton and krill have resulted in notable changes in particulate organic carbon (POC) flux, as these components represent two major drivers to the biological carbon pump. The Palmer Long Term Ecological Research program has been conducting extensive studies along the WAP for the past 25 years, including deployment of a moored sediment trap which intercepts sinking particles at 170 m in the water column. Data from this sediment trap time-series is unique in its longevity, allowing us to understand how POC flux has changed seasonally and annually over two decades. Evidence of environmental changes at the ocean surface are reflected at depth in the sediment trap data as a decrease and shift in timing of POC flux over the past two decades.

CR-6c - Glaciers and Ice Sheets: from the Mountains to the Poles
21.06.2018 14:00-15:30, A Wisshorn

165
Using Microseismicity to Study the Role of Subglacial Fluids in Basal Slip

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Icequakes are triggered by glacier or ice sheet movement. Here, we are particularly interested in basal icequakes, primarily induced by basal slip of ice over bedrock or sediment. The specific Icequakes investigated in this study are associated with Skeiðarárjökull, an outlet glacier of the Vatnajökull ice cap, Iceland. To detect and locate these icequakes, we use a network of 13 seismometers deployed on the glacier surface. The seismic energy that travels from the icequake source to the seismometers can be used to understand the processes that generate the icequake. We use moment tensor analysis combined with modelling to investigate whether subglacial fluids exert influence during a basal icequake event, and to what extent they govern slip occurring. Although these results are associated with a relatively small outlet glacier in Iceland, the glacier is sufficiently thick and fast moving that these results are likely also relevant for ice sheet behavior. The role of subglacial fluids in promoting basal slip observed here could therefore aid our understanding of ice sheet dynamics, both in Greenland and Antarctica.

1868
Long-term Changes of Cryosphere and Glaciers in Kaffiøyra Region, NW Spitsbergen

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Recent changes of cryosphere and glacier dynamics in north-western Spitsbergen were based on infrastructure of the Nicolaus Copernicus University Polar Station, located in Kaffiøyra. It was mainly related to mass balance, ablation and snow accumulation on three glaciers: Waldemarbreen, Irenebreen and Elisebreen. Changes in the surface area and recession of the land and sea-terminating glaciers were analysed. Changes in the outflow from Waldemarbreen were analysed in detail. The active layer of permafrost was also covered by measurements, especially its thermals and thickness changes.
Systematically field studies of glaciers mass balance components were carried out from 1996 to 2017, and remain some of the longest measurement series run on Svalbard. The measurements of the glaciers´ recession and the magnitude of thawing of the active layer of permafrost on Kaffiøyra are similarly unique in terms of their length. All the studies aimed at understanding the intensity and size of changes in the cryosphere of north-western Spitsbergen, the Kaffiøyra region, as well as processes ruling them nowadays, as a result of changes taking place in this part of the globe. Like other contemporarily glaciated areas, the Kaffiøyra region is a place of wide variety of cryosphere components, which in recent years have been rapidly responding to climate change.

1312
On Various Approaches to Map Glaciers and their Changes

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Accurate glacier surveys are essential in glacier monitoring. Surface elevations are needed for glaciological calculations, and repeated surveys are used to detect glacier changes of glaciers and to reanalyse glaciological mass-balance series. Whereas traditionally ground surveys and aerial photogrammetry were used for glacier surveys, today a wealth of approaches to map glaciers exists. Possibilities include laserscanning (LIDAR), aerial photos and high resolution satellite imagery. What is suitable depends on scale, for smaller glaciers and ice patches unmanned aerial vehicles (UAV) and ground surveys may be appropriate, for larger glaciers other approaches are needed.
Here we report on experiences of mapping glaciers and glacier changes in mainland Norway using various mapping techniques. Over recent years 1/3 of the glacier area has been mapped using airborne laser scanning. We compare this data with previous laserscannings and aerial photogrammetry where available. We also demonstrate how scanned historical aerial photos can be used to reconstruct glacier surface elevations. We show that new satellite sensors such as Pleiades can be used for glacier change detection and reanalysis. We also discuss the possibilities and shortcomings of using UAVs for glacier survey for our reference glaciers. Finally, we present a geodetic mass balance estimate of all glaciers in Norway from the 1960s to the 2010s. Results reveal an overall mass loss and area shrinkage in this period.

910
IACS Working Group on Ice Thickness Estimation - What Have we Achieved?

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The Working Group (WG) on Ice Thickness Estimation, hosted by the International Association for Cryospheric Sciences, was established in 2015 with the goal of (a) performing a model intercomparison experiment for models that estimate glacier ice thickness from surface characteristics, (b) associating a distributed ice thickness estimate to all glaciers included in the Randolph Glacier Inventory, and (c) supporting the World Glacier Monitoring Service in the effort of creating a database centralizing ice thickness measurements across the Globe.
In this contribution we report from the WG's activities during its three years of existence. We highlight our successes - particularly including the results obtained within the Ice Thickness Models Intercomparison eXperiment (ITMIX) and the release of new versions of the Glacier Thickness Database (GlaThiDa) -, report on the challenges faced during our work, and provide an outlook for the activities that will follow from our endeavours.
We hope our experiences to be insightful, inspiring, and motivating for WG's yet to come.

On behalf of http://www.cryosphericsciences.org/wg_glacierIceThickEst.html

1544
Estimating Changes in Glacier Sliding Velocity from Drone Images

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Glacier sliding velocity is difficult to measure because the subglacial environment is typically inaccessible. We propose an approach to infer sliding velocity based on glacier surface velocities measured by remote sensing, as well as the physics of ice rheology.
Until recently, measuring the spatial distribution of glacier surface velocity was challenging because it required expensive high-resolution satellite acquisitions. Moreover, these acquisitions are often subject to cloud obstructions, which make it challenging to acquire images at a sufficient frequency to estimate high ice velocities. In the last years, the development of UAVs has offered the possibility to acquire images at an unprecedented resolution and frequency, and at a fraction of the cost of satellite images. Here we use such acquisitions to derive a high resolution surface velocity field of the Gorner glacier (Swiss Alps) and its evolution through the 2017 summer season.
The same glacier was then modeled using a finite element ice flow model (Elmer/ice), using as inputs the drone-derived surface DEM, a glacier bed topography available from geophysical surveys, appropriate boundary conditions, and assuming a zero sliding velocity. The modeled surface velocities thus corresponds to the pure deformation velocity component. Assuming that the sliding velocity corresponds to the difference between the deformation velocity and the UAV-derived surface velocity one can finally derive the sliding velocity.

2392
Simulating the Evolution of Rhonegletscher Since 1600 with Úa and GERM

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At the end of the Little Ice Age (around 1850), glaciers in the Alps reached their last maximum extent. However, it is still uncertain what caused the preceding advance and the following retreat. Several studies have concluded that temperature alone cannot explain this behaviour. A precipitation increase of about 25% could explain the anomaly, but this is not supported by observations. Further processes have been proposed, including changes in solar radiation (due to either solar activity variations or aerosols in the atmosphere), surface impurities on ice and snow, and dynamical effects in both the atmosphere and the glaciers. We will test some of these processes in a model study and determine their relative importance by coupling the ice flow model Úa to the mass balance part of the Glacier Evolution Runoff Model (GERM).
We simulate the evolution of Rhonegletscher between 1600 and today using the coupled model based on different temperature and precipitation reconstructions, e.g. Casty et al. (2005), the PAGES2k database, and Pauling et al. (2006). We compare these simulations to a simpler approach prescribing the mass balance as a function of temperature and precipitation. Furthermore, we validate the simulations with observations of glacier length change, flow velocity, and geometry change.

EN-3_EN-4a - Geological heritage and geo-conservation in the Polar Regions & Conservation in the Polar Regions: Challenges, Strategies and Collaborations
21.06.2018 14:00-15:30, B Pischa

619
Protection Strategies in a More Accessible Maritime Arctic

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Profound Arctic sea ice retreat is creating greater marine access and potentially longer seasons of navigation throughout the region. Arctic natural resource developments onshore and offshore are linking the Arctic to global markets using advanced marine transportation systems. These key drivers of change require a holistic approach to enhancing marine safety and environmental protection in the Arctic marine environment. The Arctic Council´s Arctic Marine Shipping Assessment (AMSA) identified 17 recommendations that covered three critical themes: I. Enhancing Arctic Marine Safety (through International Maritime Organization measures and international instruments/binding agreements such as for search and rescue); II. Protecting Arctic People and the Environment (through identifying indigenous marine use, designating Arctic marine protected areas , and addressing measures for oil spills, air emissions, invasive species, and more); and, III. Building the Arctic Marine Infrastructure (such as establishing Arctic traffic systems, investing in hydrography and charting, and developing enhanced response capacity). This will be a review of current and future strategies , including ecosystems-based management, being used to address the impacts of greater marine operations and shipping throughout the Arctic Ocean. All of the multi-faceted approaches for protection must address the serious maritime infrastructure gap throughout the Arctic.

1903
Conserving Abundance, or How to Avoid What Has Happened Everywhere Else

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Many conservation approaches focus on scarcity and vulnerability. Fear of extinctions rightly drives endangered species laws. The recognition of biological hot spots understandably leads to the designation of protected areas. Concern about overharvesting produces fish quotas and hunting limits. These are necessary and appropriate measures. They fall short, however, of protecting the abundance that still characterizes many aspects of Arctic ecosystems. In a global context, Arctic fisheries are well managed, and the Arctic has vast expanses of relatively undisturbed, connected habitats. The risk is that we take such bounty for granted, encroaching bit by bit into more and more areas, willing to take a little more here and there, over and over. The end result is an Arctic that looks much like the rest of the world: relic populations of large animals living in small fragments of habitat. One alternative is to recognize and protect what remains abundant, rather than reacting only to scarcity. Cautionary approaches to fisheries management in Arctic Canada and Alaska provide one example, which may soon be extended to the international waters of the central Arctic Ocean. Widespread habitat protections offer another mechanism, allowing some types of human use but extending over far larger areas than just the most spectacular aggregations of wildlife. This presentation will suggest a new vision for Arctic conservation, recognizing what makes the Arctic distinct in today's world.

2520
A Step-wise Plan for Integrated Ecosystem Science in the Central Arctic Ocean

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The international waters of the central Arctic Ocean are experiencing rapid sea ice reduction and transition to a seasonally open system that can lead to increased human usage. With these changes there is a need for better understanding of the Central Arctic Ocean (CAO) ecosystem and its connectivity to the surrounding seas. Multiple efforts are underway to develop an integrated ecosystem assessment for the CAO. Coincidently, the five Arctic coastal states (Canada, Denmark/Greenland, Norway, Russian Federation, United States of America) and five distant-water fishing jurisdictions (the European Union, Iceland, Japan, People's Republic of China, Republic of Korea) are negotiating a closure to commercial fishing in these waters until sufficient scientific information is available to support management decisions related to commercial fisheries within an ecosystem approach. Recently, a series of three international "dialogue" meetings have occurred to encourage international arctic science community discussions for an ecosystem approach to minimize unregulated fisheries in the CAO. We propose a step-wise approach in which basic monitoring is undertaken to detect ecosystem component status and any significant changes. This approach will facilitate determining if and when more intensive efforts are needed to gather data on specific ecosystem components, fish population dynamics, and potential outcomes to track ecosystem response and fish populations in the changing Arctic region.

790
Towards a Representative System of Marine Protected Areas in the Southern Ocean

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Global threats to ocean biodiversity have generated a worldwide movement to take action towards better conservation and management. A number of international targets have recommended the adoption of marine protected areas (MPAs) in national and international waters. While establishing MPAs in international waters has proved to be incredibly challenging in most of the world, national governments and the Commission for the Conservation of Marine Living Resources (CCAMLR) have succeeded in adopting multiple MPAs in the Southern Ocean. But are these MPAs representative of Southern Ocean biodiversity and ecosystems? This talk will present on the current status of Antarctic MPAs and future trends using existing benthic and pelagic bioregionalizations as well as other ecological data sets as a proxy for biodiversity. Results show that currently about 8% of the Southern Ocean is protected in MPAs. While this is a relatively large proportion of protected areas when compared to other international waters, it falls short of existing international MPA targets. Further, current Antarctic MPAs are not fully representative of all bioregions. Yet CCAMLR is currently negotiating a variety of additional MPA proposals and if these are adopted in the coming years, CCAMLR may be the first international ocean management organization that meets global ocean biodiversity targets.

1198
Joining Forces in Implementing the CEP's Climate Change Response Work Program

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In 2015 the Antarctic Treaty's Committee for Environmental Protection (CEP) adopted a Climate Change Response Work Program (CCRWP: www.ats.aq/documents/ATCM39/att/atcm39_att072_e.doc), to be implemented as a matter of priority and kept under regular review. In 2017 the CEP established a subsidiary group with the responsibility to oversee the implementation of the CCRWP, through facilitating coordination and communication between stakeholders, by updating and by reporting on progress of implementation to the CEP.
In this presentation, the aim is to highlight and discuss opportunities and challenges regarding the science-management interaction in implementing the CCRWP. A large portion of the CCRWP points to knowledge gaps, as well as research and monitoring needs that would support future conservation efforts in a changing Antarctic environment. Knowledge about ongoing research programs/projects (from Parties, SCAR, WMO, etc.) that seek to or will provide insight into CCRWP issues will be important in this context, and even more so ensuring an appropriate flow of new knowledge from this work, thus facilitating the further implementation of CCRWP actions and tasks. SCAR and the science community will play an important and active role in this context. Furthermore, the science community will be important in supporting the SGCCR's work in developing management advice on basis of new knowledge within the framework of the CCRWP.

1321
Anthropogenic Transfer of Species between Antarctic Biogeographic Regions

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The distribution of terrestrial biodiversity within Antarctica is complex, with 16 distinct biogeographic regions currently recognised within the Antarctic Treaty area. Much of this diversity is endemic not only to Antarctica as a whole, but to specific regions within it. Further complexity is added by inclusion of the associated sub-Antarctic ecosystems found on islands in the Southern Ocean. Within Antarctica, scientific, logistic and tourism activities may inadvertently move organisms over potentially long distances. Species translocation can disrupt natural species distribution patterns and biogeography through:
(1) movement of spatially restricted indigenous species to other areas of Antarctica;
(2) movement of distinct populations of a more generally distributed species from one area of Antarctica to another, leading to genetic homogenisation and loss of assumed local patterns of adaptation; and
(3) further dispersal of introduced non-native species from one area of Antarctic to another.
Species can be moved between regions in association with people and their cargo by ship, aircraft and overland travel. Movement of cargo by ship between stations located in different biogeographic regions is likely to present one of the greatest risks, particularly as coastal stations may experience similar climatic conditions, making establishment more likely. We make practical recommendations aimed at reducing the risk of species transfer between Antarctic regions.

1060
The iSTAR Research Programme on Pine Island Glacier and the Amundsen Sea

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The future of Earth's large ice sheets in Antarctica and Greenland represents the greatest uncertainty in projections of future sea level, and the behaviour of the West Antarctic Ice Sheet, in particular, is difficult to predict. The UK-NERC iSTAR Programme (www.iSTAR.ac.uk) is a 7-year effort (2010-17) to improve understanding of West Antarctica's combined Pine Island Glacier-Amundsen Sea system. Of all glaciers worldwide, Pine Island Glacier is the one now making the biggest single contribution to sea level rise. This imbalance has been driven by changes in the Amundsen Sea, which have brought warm ocean waters into contact with floating ice.
iSTAR's objectives were: understanding the transport of ocean heat towards the ice sheet, understanding the sub-ice processes affecting ice melt; and understanding the response of the inland glacier to the ocean-induced changes. Data acquisition campaigns focussed on the ocean, the ice shelf, the inland glacier and the ice sheet. Data analysis, remote sensing and modelling are still on-going. We present an overall summary of the iSTAR Programme and some of the main results and conclusions so far.

854
On the Bathymetry of Getz Ice Shelf Cavity from Airborne Gravity Data Inversion

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The Getz Ice Shelf, stretches along ~500 km of coastline in the Amundsen Sea Sector of West Antarctica, is the largest meltwater source in Antarctica. Getz Ice Shelf itself has nearly constant melt rate of 4.3 ± 0.4 meters of water per year, which is possibly affected by intrusions of modified Circumpolar Deep Water (mCDW). The warm, salty mCDW crosses the continental shelf break through the Dotson-Getz Trough and melts the floating ice shelf from below. Bathymetry has significant implication for possible CDW pathways and is required as one crucial boundary condition for cavity circulation modeling. However, no direct observation of bathymetry under Getz Ice Shelf is available yet. Here, we perform airborne gravity data inversion with multiple geophysical data constraints to obtain an inferred bathymetry. Our results indicate a sill between Siple Island and Carney Island complicates flow of mCDW through the Getz Ice Shelf from east to west and may impact ice shelf basal melt rates. To explore this further, we put the bathymetry in the context of MITgcm (MIT General Circulation Model). A similar approach can be applied to small ice shelves from East Antarctica in the future.

1759
Ice Shelf Thickness Change from 2010 to 2017

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Floating ice shelves that fringe the majority (74%) of Antarctica´s coastline provide a direct link between the ice sheet and the surrounding oceans, and changes in their constitution have been shown to influence the flow of inland ice due to their buttressing effect. This process has become increasingly important over recent decades as Antarctic ice shelves have thinned, retreated, and collapsed - events that have been recorded largely by European satellites. At the Antarctic Peninsula, ice shelf retreat has been observed throughout the satellite era (18% over 50 years), and large sections of the Larsen-A, Larsen-B, and the Wilkins Ice Shelf collapsed, catastrophically in 1995, 2002, and 2008, respectively. In the Amundsen Sea, ice shelves at the terminus of the Pine Island and Thwaites glaciers have thinned at rates in excess of 5 meters per year for more than two decades. Both signals are indicative of long-term changes in the regional climate, and have impacted on the ice inland. We use CryoSat-2 to map ice thickness change on Antarctic ice shelves by exploiting the dense spatial sampling and repeat coverage provided by the SARIn mode data acquired by CryoSat-2 from 2010 to the present day. We find that ice shelf thinning rates exhibit large fluctuations over short time periods, and the improved spatial resolution of CryoSat-2 enables us to resolve the spatial pattern of thinning with ever greater detail in Antarctica.

2628
Channelized Melting Drives Thinning under a Rapidly Melting Antarctic Ice Shelf

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Ice shelves play a vital role in regulating loss of grounded ice and in supplying freshwater to coastal seas. However, melt variability within ice shelves is poorly constrained and may be instrumental in driving ice-shelf imbalance and collapse. High-resolution altimetry measurements from 2010 to 2016 show that Dotson Ice Shelf (DIS), West Antarctica, thins in response to basal melting focussed along a single 5 km-wide and 60 km-long channel extending from the ice shelf's grounding zone to its calving front. If focused thinning continues at present rates, the channel will melt through within 40-50 years, almost two centuries before melt through is projected from the average thinning rate. Our findings provide evidence of basal melt-driven sub-ice shelf channel formation and its potential for accelerating the weakening of ice shelves.

2175
Ice--ocean Wave Interaction on Ice Shelves

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Distant storms, tsunamis, and earthquakes generate waves in floating ice shelves. In several instances, seismic observations have clearly demonstrated a mechanistic link between periods of elevated wave activity and iceberg calving. The detailed mechanical interpretation of observed seismograms is complicated, however, by the existence of numerous types of waves that propagate in the coupled ice--ocean--earth system. Here, I describe wave propagation in an elastic, finite-thickness, buoyantly floating ice layer above a uniform and inviscid water layer. I place particular focus on waves with wavelength greater than the ice thickness, as have recently been observed on the Ross, Pine Island, and Amery Ice Shelves. I show that mode uncoupling occurs at long period such that waves occur as either symmetric or flexural modes. I calculate the stresses associated with the seismically observed wave field on the Ross Ice Shelf. In the context of linear elastic fracture mechanics, this stress field provides a mechanistic explanation for the occurrence of ice shelf rifting during periods of elevated ocean swell. This theory paves the way for more realistic depictions of iceberg calving in large scale ice sheet models.

1598
Early Weakening of the Larsen B Ice Shelf Prior to Break-up

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Precursor changes in the Larsen B Ice shelf beginning more than a decade before its disintegration have been identified, and coincide with a trend towards reduced sea ice cover and increased foehn winds. Ice flow speeds in the major tributary glaciers of the Larsen B increased, even in the period prior to the loss of critical areas of the ice shelf (which began in 1998 for the Larsen B), and elevation of the ice shelf surface decreased. Ice shelf surface lowering is interpreted as resulting from actual ice shelf thinning for this area, since field studies on both the Larsen A and B noted the upper firn of the shelf was almost completely converted to ice. Examination of satellite images spanning 1963 - 1997 shows that Larsen B shear margins and some suture zones evolved significantly prior to significant ice shelf retreat. Overall, these changes suggest either increased ocean-driven basal melt or effects of increased surface meltwater on grounded glacier outflow are a cause of early shelf weakening that leads eventually to disintegration. Available ocean temperature data show that modified Weddell Deep Water, having a temperature 0.1-0.4°C above the surface freezing point, is present near the former ice fronts in some 1995-2012 profiles, but to date has not been detected within the embayments near the glacier grounding lines or beneath the ice shelves.

941
Examining Antarctic Coastal Exposure - Sea Ice-free Coastal Regions

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While the change and variability of Antarctic sea ice extent, area and seasonality are well documented, very little information is available on broad-scale change and variability of sea ice-free coastal regions. This is an important topic since there is mounting evidence of potentially strong relationships between coastal sea ice distribution and the characteristics and stability of glacier tongues and ice shelves, such that a lack of the protective "buffer" of sea ice could potentially enhance flexure and fatigue of exposed outer ice-shelf margins by storm-generated ocean swells.
In this study we introduce and examine two methods that focus on sea-ice free regions: a simple, large-scale index called the "Antarctic Coastal Exposure Index"; and a second method which determines the Coastal Exposure Length. For this study we use satellite imagery from 1979 through to 2016 and examine temporal and spatial occurrence and trends. Results show that the West Antarctic coastal regions are dominated by an increase in coastal exposure, particularly in the West Antarctic Peninsular region, but also in the Amundsen Sea. In East Antarctica, trends, when viewed as a longitude-time plot, show that a decrease in coastal exposure around the eastern Antarctic has a distinct westward progression over the summer months. Not all increases in coastal exposure are found within West Antarctica, with some smaller pockets of East Antarctica also showing a positive trend.

526
Influence of Continental Ice on Sea Ice Thickness Distribution in SW Ross Sea

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Melting at the base of an ice shelf or a glacier tongue freshens and cools the fluid in the ice-ocean boundary layer, producing Ice Shelf Water (ISW), a water mass colder than the sea water surface freezing point. If ISW becomes *in situ* supercooled by pressure release, ice crystals can persist. These crystals add to the mass of the coastal sea ice cover, forming a porous, friable layer, called the sub-ice platelet layer, which can be several metres thick beneath the two-metres of sea ice. Consequently platelet ice formation not only causes sea ice to be thicker, but it also alters the hydrostatic relationship between sea ice elevation and thickness, influencing satellite altimeter determination of sea ice thickness. Here we report on the sea ice thickness distribution in the SW Ross Sea in spring, and describe how this distribution is influenced by interaction with the ice from the continent. The SW Ross Sea is fringed by a number of ice shelves (e.g. McMurdo, Hells Gate, Ross) and glacier tongues (e.g. Drygalski, Erebus), features that have the potential to form ISW. We have conducted airborne sea ice thickness surveys using electromagnetic (EM) induction sounding. These regional surveys have been supported over smaller geographic areas by detailed on-ice sea ice and snow thickness measurements, by on-ice EM induction transects of sea ice thickness, and by under-ice oceanographic observations that track the heat deficit and mixing in the upper ocean at selected sites.

424
Wave Propagation in Frazil/Pancake Ice: The Beaufort Sea MIZ during Fall 2015

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The wave frequency and the physical properties of the ice cover determine the way in which waves propagate in ice. Large floes interact with waves via a scattering process which results in an exponential decay of incoming wave energy with distance. Very small floes, like pancake ice where the individual cakes may be less than 3 m in diameter, interact in a different manner; they behave like a continuum and can be considered as a very viscous fluid which not only causes decay of the waves but also causes them to propagate with a different dispersion relation. A careful analysis of in situ measurements, collected in the Beaufort Sea during fall 2015 through the use of directional wave buoys, has allowed us to examine attenuation rates, spectral spread rates and anomalous dispersion for different ice conditions met in the MIZ during several in situ experiments.
The buoys deployments lasted 1-3 days temporally and spanned up to 100 km spatially. After inter-calibrating the buoys, the vertical displacement (heave) time series for the buoys was hence analyzed for calculation of the scalar wave energy spectra and bulk wave parameters (i.e., significant wave height, dominant wave period). As expected, our measurements show that waves play an important role in inhibiting the fall freeze-up of the Beaufort Sea, especially near the ice edge facing the prevailing easterly winds. Results on the attenuation of waves in different MIZ conditions are presented and discussed.

263
PIPERS: Overview of the 2017 Winter Cruise in the Ross Sea Pack Ice

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The PIPERS cruise on N. B. Palmer into the early winter Ross Sea took place between April 11 and June 14 2017. The keystone project was to investigate the Atmosphere-Ice-Ocean interaction in the Terra Nova Bay and Ross Ice Shelf coastal polynyas. The cruise however involved multidisciplinary and complementary activities that were conducted in several different phases of the cruise. These activities were: ARGO and SOCCOM Float deployments north of the sea ice; marginal ice zone(MIZ) wave buoy deployments and sampling activities; along track sampling for physical oceanography , trace metals, and trace and noble gasses; ice thickness, roughness and physical property sampling at ice stations; gas fluxes(CO2, DMS, Methane) and sea ice biogeochemistry sampling at ice stations and in polynyas; boundary layer profiling using drone aircraft and met towers at ice stations; and atmosphere, ice and ocean investigations in the coastal polynyas. An overview of some of the newer technologies used on the cruise and how measurements were coordinated will be described here for these multiple phases of the cruise. Other presentations will be identified for specific details and results.

2503
PIPERS: Air-sea-Ice Interactions during a Very Anomalous Season in the Ross Sea

Sharon Stammerjohn[1] (sharon.stammerjohn@colorado.edu), Stephen Ackley[2], Ted Maksym[3], Peter Guest[4], John Cassano[1], Peter Sedwick[5], Brice Loose[6], Jean-Louis Tison[7], Bruno Delille[8], Guy Williams[9]
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The PIPERS (Polynyas, Ice Production and seasonal Evolution in the Ross Sea) project conducted a research expedition to the southwestern Ross Sea aboard the RVIB Palmer during April-June 2017. Its main objective was to assess the local/large-scale controls on sea ice production, water mass transformation, and carbon/trace metal inventories during an autumn-winter transition. Between 1979 and 2015 the Ross Sea was notable for showing strong positive sea ice trends in all seasons (strongest in autumn and spring). The PIPERS expedition however took place prior to the lowest austral summer sea ice extent ever observed in the Ross Sea since 1979. This anomalous 2017 summer season followed record-breaking anomalies that first emerged the preceding winter-spring of 2016. Subsequently, during the autumn of 2017, the ice edge was slow to recover during March-April, but by late May, the ice edge east of ~165W finally reached its climatological location, while the ice edge between 165E to 165W remained anomalously south (by ~240km). This ice edge anomaly then shifted eastward during winter-spring 2017. To help explain these anomalous sea ice conditions, air-sea-ice and ice-climate interactions leading up to and during the PIPERS cruise will be described and discussed. These regional analyses will then be compared to the ship-based observations acquired during PIPERS to help validate and distinguish local/large-scale controls on sea ice production and thickness evolution.

725
Variability of Sea Ice Production in Ross Ice Shelf Polynya

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The Ross Ice Shelf Polynya (RISP) has the highest sea ice production in the Southern Ocean. We calculated sea ice production of RISP from 2003 to 2015 by a thermodynamical model based on sea ice concentration derived from AMSRE, SSMIS and AMSR2, and ERA-Interim meteorological data. The result of ice production model is sensitive to parameter variation. The value of the parameters such as the latent heat of sea ice fusion and the bulk transfer coefficients have a great impact on the results of the model. When different parameter value are chosen, the ice production results vary as much as 46%. The wintertime total ice productions of RISP for 2003-2015 range 164-313 km^3 with an average of 219 km^3, showing no obvious temporal trend. The ocean surface produces ice at a high rate within the distance of 20-30 km from the ice shelf front. In most high production areas, the ice production significantly increases. Some local regions show a contrarily significant decreasing trend as a result of ice shelf expansion and iceberg events. The monthly total RISP ice production ranges from 14 to 76 km^3, showing substantial fluctuations in each month during 2003-2015. The seasonal variation of each year also shows substantial fluctuations. Finally, the ice production by RISP is related to sea ice extent in Ross sea section and its contributions to the increasing trend are discussed.

AC-2a - Polar meteorology, climatology and stratospheric processes
21.06.2018 14:00-15:30, C Sanada I

2123
Observing the Stratosphere at South Pole with High-energy Muons in IceCube

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The IceCube Neutrino Observatory, located at the geographical South Pole, records high-energy muons at depths of 1450-2450m in the Antarctic ice. While the sensors look for rare astrophysical neutrinos as signal, downgoing muons with energies above 400 GeV are able to penetrate and trigger the detector at a rate of 2.15 kHz. The bulk of the downgoing muons are created by cosmic ray interactions in the lower stratosphere and their rate best correlates with the temperature variations around 50-150 hPa (12-20 km) layers. Here we report on the observation of both seasonal modulation of the rates and the short term correlations with the stratospheric temperatures.

For the IceCube Collaboration

1077
The SPARC Polar Stratospheric Cloud Initiative (PSCi)

Michael Pitts[1] (michael.c.pitts@nasa.gov), Lamont Poole[2], Ines Tritscher[3], Thomas Peter[4], Reinhold Spang[3], Jens-Uwe Grooß[3], Michael Höpfner[5], Alyn Lambert[6], Simon Alexander[7], Francesco Cairo[8], Terry Deshler[9], Sergej Molleker[10]
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After more than three decades of research, the role of polar stratospheric clouds (PSCs) in stratospheric ozone depletion is well established. However, important questions remain unanswered that have limited our understanding of PSC processes and how to accurately represent them in global models, calling into question our prognostic capabilities for future ozone loss in a changing climate. A more complete picture of PSC processes on vortex-wide scales is emerging from a suite of contemporary satellite missions: the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat (2002-2012), the Microwave Limb Sounder (MLS) on Aura (2004-present), and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) on CALIPSO (2006-present). These datasets have motivated numerous research activities that both extend and challenge our present knowledge of PSC processes and modeling capabilities. The SPARC PSC initiative was organized in January 2015 to address key questions related to PSCs and their representation in global models with the following main objectives: identify key PSC parameters required by global models; identify strengths and limitations of the PSC datasets; define a methodology to obtain the key PSC properties required by models from the observational datasets; develop a state of the art PSC climatology; and identify remaining open science questions. In this presentation, we describe the PSCi activities, key findings, and remaining open questions.

2412
New Satellite Climatologies of PSC: Assets for Model Improvement

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The MIPAS instrument onboard ESA's Envisat satellite operated from July 2002 until April 2012. The infrared limb emission measurements represent a unique dataset of day- and nighttime observations of polar stratospheric clouds (PSC) up to both poles. The cloud detection sensitivity is comparable to spaceborne lidars like the CALIOP instrument on the CALIPSO satellite (operating since June 2006). Both instruments allow the differentiation of PSC types, like solid particles of ice and nitric acid trihydrate (NAT), as well as liquid droplets of super-cooled ternary solution (STS). From the MIPAS and CALIOP measurments an unprecedented database PSC type observations is now available for validation and improvement of PSC schemes in chemistry transport and chemistry-climate models for a better predictability of future polar ozone loss in a changing climate.
The spatial, intra-seasonal, and inter-annual variation in the PSC type occurrence have been analysed for MIPAS and compared to CALIOP as well as model results. Key parameters such as Volume and Area PSC, frequently used as a proxy for ozone depletion, have been investigated in comparison with model results of the Chemical Lagrangian Model for the Stratosphere (CLaMS). Finally, an analysis of mountain wave (MW) induced formation of NAT and ice clouds based on measurements of the nadir looking AIRS instrument and the MIPAS climatology - focusing on both hemispheres - will be presented.

2682
Multi-decadal NDACC Measurements of Atmospheric Trace Species at Thule GR

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To understand better the effects of changing emissions, possibly changing transport pathways and chemistry in a rapidly changing Arctic atmospheric environment, consistent observations of key species for a duration preceding and spanning our current time period are invaluable. Since the late 1990's observations have been taken in the Arctic at several NDACC sites (Network for the Detection of Atmospheric Composition Change). These FTIR (Fourier Transform Infra-Red) instruments that pass through a process of intercomparison to maximize consistency of spectral data and retrievals, routinely acquire spectra for many species. The remotely sensed vertical distributions provide trends and a measure of variability of species in both the tropospheric and stratospheric and aid in evaluating transport and chemistry processes. In this presentation, we will discuss trends in trace species and focus on carbonyl sulphide a key precursor to the stratospheric sulphate aerosol layer with highly variable sources in a changing Arctic.

1209
Analysis of Middle Atmospheric H_2O and O_3 Measurements at Ny-Ålesund, Svalbard

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The ground based ozone and water vapour radiometers GROMOS-C and MIAWARA-C have been located at the Arctic research station AWIPEV at Ny-Ålesund, Svalbard (79°N/12°E) since September 2015. Both radiometers were built at the University of Bern, Switzerland and are specially designed for campaigns. The instruments measure the vertical distribution of ozone and water vapour in the middle atmosphere with a high time resolution and under most weather conditions. GROMOS-C provides hourly ozone profiles where for MIAWARA-C a resolution of 2-4 hours is realistic, depending on the atmospheric opacity. The unique datasets from these instruments are used to study dynamical events and the chemistry of ozone and water vapour in the middle atmosphere. We present an overview of the data from two years with characteristic events in summer and winter such as effects of sudden stratospheric warmings or the tertiary ozone layer. Special emphasis is given to the investigation of the link between ozone and water vapour concentrations in the upper stratosphere and lower mesosphere. The specified dynamics version of the Whole Atmosphere Community Climate Model (SD-WACCM) is used to support this investigation.

1217
The Canadian Arctic ACE/OSIRIS Validation Campaigns at PEARL

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Ground-based measurements provide critical data for the validation of satellite retrievals of atmospheric trace gases and for the assessment of long-term stability of these measurements. As of February 2018, the Canadian-led Atmospheric Chemistry Experiment (ACE) satellite mission has been making measurements of the Earth´s atmosphere for nearly fourteen years and Canada´s Optical Spectrograph and InfraRed Imager System (OSIRIS) instrument on the Odin satellite has been operating for sixteen years. As ACE and OSIRIS operations have extended beyond their planned two-year missions, there is an ongoing need to validate the trace gas profiles for the satellite instruments.
To this end, fifteen Canadian Arctic ACE/OSIRIS Validation Campaigns have been conducted during the spring period (February - April in 2004 - 2018) at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut (80N, 86W). The spring period coincides with the most chemically active time of year in the Arctic, as well as a significant number of satellite overpasses. A suite of as many as 12 ground-based instruments, as well as frequent balloon-borne ozonesonde and radiosonde launches, have been used in each campaign. This presentation will focus on an overview of the measurements made by the ground-based, balloon-borne and satellite-borne instruments during the recent ACE/OSIRIS Arctic Validation campaigns and highlight how these have been used for satellite validation.

OS-7c - Atmosphere-Ice-Ocean interactions in the Polar Regions
21.06.2018 14:00-15:30, C Sanada II

2471
Wave-ice-Ocean Interactions during Storm-induced Sea Ice Breakup

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The Marginal Ice Zone (MIZ), an area of transition between open ocean and sea ice is characterized by highly fragmented ice cover and strong temporal and spacial variability. Over the last three decades, it has been undergoing dramatic expansion in the Arctic due to sea ice retreat and increased wave activity. We present a model development which implements surface ocean wave effects into global ocean model NEMO and sea ice model CICE to account for a number of physical processes specific to the MIZ, in particular sea ice breakup due to waves and the effect of floe size distribution on lateral melting of sea ice. We perform high resolution model studies of recently documented large storm events in polar areas and investigate the impact of waves on both sea ice and upper ocean, identifying potential mechanisms for momentum and heat exchange between waves, ocean, sea ice and atmosphere following periods of enhanced wave activity.

1206
Bridging the Scales in Sea Ice Deformation for Sea Ice Damaged by Winter Storms

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In the changing Arctic where the sea ice is getting thinner and at the same time moving faster, also ice deformation processes are increasing. The magnitude of deformation rates are however hard to compare as they depend on spatial and temporal scales of the measurements. Here we present results from the N-ICE2015, an expedition to the ice covered region north of Svalbard in the first half of 2015. The deformation rates we measured on N-ICE2015 by buoy arrays were one of the highest ever recorded in the Arctic at similar scales (10-100 km at 1-3 hour interval). We also measured the deformation at shorter scales (100 m-5 km at 10 min interval) from the ship radar images. To bridge between the spatial scales we will supplement these two deformation estimates by deformation rates from satellite remote sensing (SAR) images based on sea ice drift (1-500 km at 1 day interval). These three datasets will allow us to quantify the scaling law relationships over a large range of spatial and temporal scales, and help us to estimate the extent and consequences of the major deformation events observed. During N-ICE2015 the sea ice in the Atlantic sector of the Arctic was impacted by several powerful storms. These storms penetrated deep into the pack ice and permanently damaged the ice. We will use the deformation rates obtained from SAR sea ice drift to estimate the importance of the ice age and distance to the ice edge for deformation and healing processes of sea ice.

239
Impact of Severe Storm Conditions on the Marginal Ice Zone in the Southern Ocean

Marcello Vichi[1] (marcello.vichi@uct.ac.za), Sebastian Skatulla[2], Keith Machutchon[2], Ehlke de Jong[3], Clare Eayrs[4], Jhon Mojica Moncada[4], David Holland[5], Alessandro Toffoli[6], Alberto Alberello[6], Miguel Onorato[7], Clinton Saunders[8], Anriette Bekker[8], Warren Joubert[9]
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The winter marginal ice zone (MIZ) in the Southern Ocean is one of the least explored regions of the world ocean, where synoptic weather, sea-ice and oceanic processes are more tightly interlinked. Remote sensing observations have revealed the large variability of the Southern Ocean sea ice over the past 20 years, and the increased spatial resolution of sensors now allow to capture synoptic patterns in the ice edge. The actual reliability of these data is however not known because of the very few in situ observations particularly during the winter period. This contribution reports on a process study conducted in July 2017 in the Indian Ocean sector, aimed at studying the winter MIZ, the relation with met-ocean conditions and how they impact navigation performances. The response of the MIZ to a large-scale storm was documented by means of sea-ice observations, ice-drift buoys, wave cameras and the ship-response to vibrations. The sea ice was composed of pancakes of varying dimensions that did not show compaction for more than 150 km into the MIZ. The preliminary results hint at a coherent large-scale response of the pancake ice field to wind and swell, with drifts of up to 0.8 m/s, more typical to brash ice conditions rather than the observed semi-consolidated surface. The results are analysed in conjunction with atmospheric reanalyses data and ocean forecasting models to provide insights on the process dynamics and improve future polar predictions in the southern hemisphere.

482
Wave-induced Floe-floe Collisions and Ocean-sea Ice Momentum Transfer

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In the marginal ice zone (MIZ), waves entering from the open ocean often induce collisions between neighboring ice floes. Due to limited observational data, it is not known to what degree wave-induced collisions contribute to the stress within the ice and to the dissipation of wave energy in MIZ. In this paper, wave-induced collisions between ice floes are analyzed with a numerical, discrete-element model. The model simulates surge motion of an ensemble of ice floes on a prescribed wave field. It is shown that the collision pattern depends on ice concentration, wave steepness, floe size relative to wavelength, floe-size distribution, as well as the restitution coefficient and drag between the ocean and the ice. For relatively large ice floes, the results are very sensitive to the formulation of wave forcing and ice-water drag. If the forcing correctly takes into account floe size relative to the wavelength, the model accurately reproduces surge RAOs of single floes, as well as accelerations and forces of floes impacting a structure. The modelling results are used to estimate the granular temperature, as well as covariance between ice floes' velocities and forces acting on them for a wide range of conditions. This is crucial for developing parameterizations of source terms related to wave-induced collisions in the granular-temperature evolution equation used in large-scale sea ice models.

77
Waves, Turbulence, and Thin Sea Ice at the Autumn Air-Ice-Ocean Interface

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Winds, waves, and turbulent mixing at the air-ice-ocean interface set the exchange of momentum, heat, and gases between the ocean and atmosphere. Surface waves and associated near-surface turbulence are particularly tightly coupled in thin, new ice. We present observations made from drifting buoys in autumn pancake sea ice in the Arctic and Antarctic during Sea State and PIPERS programs, respectively. Coincident measurements of sea ice, wind, waves, and turbulence from the buoys allow quantification of feedbacks between ice growth, attenuation of waves, and suppression of turbulence. Thin ice attenuates waves from open water conditions, preferentially attenuating high frequency waves. Thus, the net effect of ice is to increase the dominant wave period and length. We find that floe diameter throughout the growth process is proportional to the ratio of wavelength squared to wave height (known as the tensile failure mode), indicative of a feedback between ice growth and wave attenuation. Near-surface wave-breaking turbulence is simultaneously reduced, due to decreased wind input transfer velocity. Thin ice also has the potential to increase turbulence below the surface due to shear between the ice and ocean. As air-ocean production of turbulence weakens, the ice-ocean interface becomes the dominant source for shallow turbulence. Our results suggest parameters for estimating near-surface turbulence in thin pancake and frazil ice, which are ubiquitous in autumn marginal ice zones.

1298
Wave-ice Interactions during the Antarctic Circumnavigation Expedition

Alberto Alberello[1], Luke Bennetts[2], Susanne Lehner[3], Egbert Schwarz[3], Keith MacHutchon[4], Konny Reichert[1], Alessandro Toffoli[1] (alessandro.toffoli@unimelb.edu.au)
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Southern Ocean waves play a crucial role in global climate system. Besides regulating energy exchanges in the upper ocean via turbulent mixing, waves influence sea ice formation and its break up. However, the underlying physics involved in wave-ice interactions poorly understood. The rate of wave energy dissipation and the intensity of the wave induced drift are still uncertain. During the Antarctic Circumnavigation Expedition waves and their interaction with sea ice was investigated, with the wave climate monitored via an onboard wave radar WaMoS II that provided the full two-dimensional wave spectrum and the surface current. Concurrently, satellite images overlapped with some of the cruise track allowing a cross-comparison of onboard and remote wave measurements. Global altimeter and SAR wave mode data as well as Sentinel-1 and TerraSAR-X scenes were used. Compared to onboard measurements, remote sensing provides information on the metocean conditions at a much larger areal scale. Here, we examine data collected during the crossing of an ice band between Balleny Islands and the Mertz Glacier when a swell was coming from an easterly direction. The wave energy dissipation is found to be frequency dependent, i.e. the ice cover acts as band pass filter where the maximum dissipation occurs at frequency comparable with the ice floe length, corroborating previous laboratory experiments. Moreover, the wave-induced ice drift is found to exceed predictions based on the Stokes' drift.

BE-9b - Life distribution and responses to environmental changes in Polar ecosystems 21.06.2018 16:00-17:30, C Aspen

123
Deep Scattering Layers, the Feeding Ground of Antarctic Deep-diving Predators

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During the day, myctophids (lanternfish), krill, squid and jellyfish form layer-like aggregations in the mesopelagic zone (200-1000m deep) to reduce exposure to visual predators. These layers can be detected by echosounders and are known as deep scattering layers (DSLs). Myctophids are very abundant in DSLs and offer great potential as a protein source for human consumption, but play a key trophic role as food for predators. In the framework of the Commission for the Conservation of Antarctic Marine Living Resources, pressing management issues arise because myctophids make up to 90% of the diet of deep-diving air-breathing predators such as King Penguins (Aptenodytes patagonicus, dive depth >350m) and Southern Elephant Seals (Mirounga leonina, dive depth >1500m). More data on DSLs are needed to develop a biogeographic zonation and understand likely future responses to climate change before any large-scale exploitation begins. A unique data set of DSL geographic variability in depth and echo-intensity (proxy for biomass) throughout the Southern Ocean was collected during the Antarctic Circumnavigation Expedition (ACE), along with CTD data and satellite remote sensing. We also collected position, depth and accelerometry data from predators off the coasts of South Georgia and Kerguelen as the ACE vessel approached each island. The tracking data are co-located with the DSL landscape to better understand predator-prey interactions and inform fisheries and conservation management.

286
Climate Change and Polar Range Expansions: Could Cuttlefish Cross the Arctic?

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Climate change can have major effects on the distribution of species. In marine ecosystems, the cold waters of the Arctic have restricted warmer water species from crossing between Eurasia and North America. However, with Arctic waters becoming warmer, various marine species have expanded their distribution. Cuttlefish are fast-growing, voracious predators and are absent in American waters. The European cuttlefish *Sepia officinalis* is the most northerly distributed cuttlefish, with potential to expand its range and cross to the American continent. Our climate model predictions suggest that the S. officinalis could potentially reach American shores, by 2300 via the north Atlantic with medium mitigation of greenhouse gas concentrations; we predict that adult dispersal of cuttlefish across the Atlantic sector would require a migration distance of over 1400 km at depths below 200 m and temperatures above 7 °C (temperature below which cuttlefish cannot maintain routine metabolic processes physiologically). If they reach American shores they could have large impacts on coastal marine ecosystems, due to their wide diet (e.g. diet covers many shallow-water crustacean and fish species) and its potential as prey, and due to their short life-history strategy of “live fast, die young”. Discussions to how cuttlefish may also be present in the Antarctic in the future, and their possible impacts in Antarctic marine coastal ecosystems is discussed.

930
Feed like a Toothfish: Foraging Behavior from *In Situ* and *Ex Situ* Analysis

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In the Ross Sea, the world's largest Marine Protected Area has recently been created. In this area, the commercially harvested Antarctic toothfish *Dissostichus mawsoni*, plays a key ecological role as the piscine apex predator. Although trophic interactions have been well documented on the continental slope and northern seamounts in the region, observations from sea-ice covered coastal margin areas are much more limited.
Our aim is to better describe Antarctic toothfish natural history by studying the feeding ecology of this species in sea-ice covered areas.
During field activities, conducted in November from the fast ice at McMurdo Sound (2015) and Terra Nova Bay (2016), sampling methods, based on vertical longline fishing, were combined with low impact visual sampling techniques, relying on the use of Baited Underwater Video cameras (BUVs).
The diet and age structure of the Antarctic toothfish sampled in sea ice covered areas, as well as hypotheses on the feeding strategies emerging from the combination of sensory system information, feeding structure morphology data and behavioral records, are presented.

1632
Can Isoscapes of Mesopelagic Fish Predict Top Predator Hotspots?

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Assessment of marine predator habitat use can reveal geographic hotspots of foraging activity, and when linked with diet information can provide an improved understanding of biological processes and predator dependence on trophic resources. Mesopelagic myctophid fish, as a key trophic link between the meso-zooplankton and higher trophic levels (seabirds, penguins and marine mammals), are expected to be a good indicator of biological hotspots in oceanic waters. To explore this idea we developed spatially-resolved isoscapes using Southern Ocean mesopelagic fish populations. Fish were sampled along survey transects from the Antarctic shelf to BANZARE Bank and waters to the west and east during January to February 2016. The wide spatial range aimed to account for variability in the nutrient sources and oceanographic conditions in the southern Kerguelen Plateau region. The mesopelagic distributions were analysed in relation to the spatial distribution of flying seabirds and subsurface feeders (e.g. seals, penguins) based on telemetry data. We investigated multi-species spatial overlap areas and examined the extent to which isotope mapping of prey distributions can be used to identify important oceanic areas for marine predators in the southern Indian Ocean. This integrative approach can provide important insights into the structure and function of Southern Ocean ecosystems, and aid large-scale efforts to identify areas of ecological significance for marine seabirds and mammals.

2045
Range Shifts in Arctic and Antarctic Zooplankton: The Role of *Themisto* Amphipods

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Both the Arctic and Southern Ocean, in particular the southwest Atlantic sector, are experiencing rapid environmental changes. In the southwest Atlantic sector of the Southern Ocean, a long-term trend of density changes of key pelagic species has been noted over the last decades. A decline in Antarctic krill is hypothesized, whilst salps are on the rise and shifting their distribution poleward. A similar poleward expansion is anticipated for a third key player, the amphipod crustacean *Themisto gaudichaudii*, leading to an increasing overlap of the distributions of these three species. In Arctic waters, two congeneric amphipod species co-exist: *T. libellula*, a genuine Arctic species and *T. abyssorum*, considered sub-Arctic boreal. Despite their overlapping distributions, the two species seem to occupy distinct ecological niches and are preyed upon by different predators. Due to the ongoing Atlantification of the Arctic, a range expansion of *T. abyssorum* concomitant with a retraction of *T. libellula*'s range are very likely to occur. Due to major knowledge gaps in the ecology, biology and genetic connectivity of *Themisto* species, the consequences of these shifts for food web structures and biogeochemical cycles remain largely unexplored. In this context, we carried out a comparative study of *Themisto* populations at both poles. Their distribution, genetic and trophic connectivity were investigated with population genetics, molecular diet analyses and feeding experiments.

2554
Drivers of Jellyfish Diversity, Demography and Distribution in European Arctic

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Jellyfish, here as pelagic ctenophores and cnidarians, are increasingly important for the functioning of marine ecosystems worldwide. They feed on preys ranging from unicellular protists to large fish, simultaneously, in spite of their relatively low energy density, they also constitute a prey of choice for numerous predators even as large as cods or seabirds. Although jellyfish are undoubtedly relevant at the global scale, still little is known about them in polar areas, especially with regard to factors affecting their spatially and vertically structured biodiversity and population structure.
To elucidate the role of jellyfish in the European Arctic, we have characterized their diversity, size structure and demography in stratified vertical samples (1000 m to the surface) collected in 2012 from the two latitudinal sections in the Fram Strait, a crucial pathway for warm and biologically rich Atlantic waters to the Arctic. Overall, we have identified 13 taxa, with *Aglantha digitale* and *Dimophyes arctica* being the most numerous. We have then contrasted our data on jellyfish with both environmental (salinity, temperature, depth) and biotic (descriptors of whole plankton community, chlorophyll *a*) ecosystem characteristics using numerical ecology tools to elucidate how these factors shape jellyfish diversity and distribution in the European Arctic.

821
Atmosphere-surface Energy Budget Process Relationships over Central Greenland

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The Greenland Ice Sheet (GIS) plays important roles in global climate, impacting sea-level rise, circulation patterns, and potentially the ocean thermohaline circulation. Variability in the GIS mass budget results from numerous processes including surface melt, runoff and precipitation. In the context of a warming Arctic, surface melt is increasing dramatically, making it essential to understand key processes that control variability in surface temperature and melt. The surface energy budget, comprised of radiative, turbulent, and conductive heat fluxes, controls surface temperature variability. To represent surface temperature and melt in current and future climates, numerical models must accurately represent the surface energy budget, including the partitioning of energy into individual terms and the key atmospheric drivers. This presentation draws on a comprehensive set of surface and atmosphere measurements made at Summit, Greenland to examine the surface energy budget. Changes in surface radiation, largely driven by the solar cycle and clouds, elicit responses in the surface temperature, turbulent sensible and latent heat fluxes, and conductive heat flux. Relationships are developed that relate radiative forcing terms and responding terms as they manifest over a full annual cycle. These relationships are then used to evaluate how surface energy budget processes are represented in model and reanalysis products, including ERA-Interim, CFSv2, and CESM.

2504
On the Clear-sky Cooling during Polar Night over the Sea Ice in the Arctic

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We present a simple analytical model of the atmospheric boundary layer (ABL) over the sea ice during polar night in clear-sky conditions. The model represents coupling between the ABL and sea ice in the presence of leads. Both steady-state and time-dependent analytical solutions are obtained. The solutions describe air and surface temperatures as functions of many parameters among which are wind speed and sea ice concentration. In particular, analytical solutions describe the transition from coupled to decoupled ABL state when wind speed is decreasing. The model demonstrates the warming effect of leads and shows that leads might contribute to decoupling over the ice. Analytical solutions are compared to those of a more complex numerical single-column atmospheric model coupled to the thermodynamic model of the sea ice.
Also, observations from several recent Russian „North Pole“ drifting stations are used to demonstrate the sensitivity of the thermal regime over the sea ice to wind speed. The observations show that stronger wind speeds are associated with warmer temperatures, while for weak winds decoupling often occurs. Analytical solutions provide several possible explanations of the observed dependency of temperature on wind speed.

2496
Evaluation of the Polar Atmosphere-ice-Ocean Interface in CNRM-CM6

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We present a polar-oriented evaluation of CNRM-CM6-1, the updated version of the atmosphere-ocean coupled model developed at CNRM (Meteo France/CNRS) and CERFACS to contribute to CMIP6 and YOPP. The nominal horizontal resolution is 150km in the atmosphere and 1° in the ocean. Main evolutions since CMIP5 include a fully new physics in the ARPEGE Climat atmosphere model, the version 3.6 of NEMO ocean model, enhanced vertical resolutions in the atmosphere and the ocean, a revised atmosphere-ocean coupling strategy in the presence of sea ice and revised sea ice parameters in the GELATO sea ice model. The focus is on the representation of the air-ice-ocean interface, including the boundary layers, sea ice and the upper ocean. The evaluation is done in atmosphere-only mode (with a one-dimensional version of the GELATO sea ice model embedded into the SURFEX surface scheme), in coupled mode following the CMIP6 DECK protocol and in seasonal prediction mode using the coupled model initialized with ocean-sea ice reanalyses produced with Mercator Océan. Improvements include reduction of a bias in geopotential heights in both polar regions, a more realistic representation of temperature inversions over ice-covered seas, and overall better simulations of Arctic and Antarctic sea ice in all seasons. Seasonal predictions are used to assess predictive skill, as well as analysing how persisting biases at the air-ice-ocean interface develop from close-to-observed initial conditions.

35
The Atmospheric Boundary Layer Response to Sea Ice Fragmentation

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The response of oceanic and atmospheric boundary layer (ABL) to subgrid - scale variations of sea ice properties and fracturing has only recently attracted attention and mostly focused on the mixing occurring in the ocean. Additionally, processes taking place on the level of individual ice floes are not fully understood and therefore not taken into account in mesoscale Numerical Weather Prediction (NWP) models parameterizations. In response to growing need of improving the models performance, a series of high-resolution simulations with Weather Research and Forecasting (WRF) model is performed for different spatial sea ice distributions, ice concentrations and ambient wind speed profiles. The model parameters are set to represent Arctic winter conditions. The results indicate that the structure of ABL is highly sensitive to the spatial distribution of sea ice and open water. With identical ice concentration, considerable variability of several domain-averaged quantities like surface turbulent heat flux or ABL water vapor content for different arrangements of leads and ice floes is found. Furthermore the formation of convective cells is determined. The structure and size of the cells is significantly dependent on the sea ice distribution and wind speed applied to the model. We suggest that NWP models need improvement and new parameterizations of the ABL are necessary. Our study may provide a basis for such development and guidance for the planning of field measurements.

369
Observations of Strong Gap Flows in the Nares Strait Region (Greenland)

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The boundary layer structures of gap flows were studied in northwest Greenland during the aircraft-based experiment IKAPOS (**I**nvestigation of **Ka**tabatic winds and **Po**lynyas during **S**ummer) in June 2010. The measurements were performed using the research aircraft POLAR 5 of the Alfred Wegener Institute (AWI, Bremerhaven). The aircraft was equipped with a suite of meteorological sensors, including a turbulence measurement system on a nose boom with a sampling rate of 100 Hz.
In the area of the Nares Strait a stable, but fully turbulent boundary layer with strong winds of up to 22 m/s was found during conditions of relatively warm synoptically induced northerly winds through the Nares Strait. Strong surface inversions were present in the lowest 100 m to 200 m. As a consequence of channeling effects a well-pronounced low-level jet (LLJ) system was documented. The channeling process is consistent with gap flow theory and can be shown to occur at the topographic gap between Greenland and Canada represented by the Smith Sound. While the flow through the gap and over the surrounding mountains leads to the lowering of isotropic surfaces and the acceleration of the flow, the strong turbulence associated with the LLJ leads to the development of an internal thermal boundary layer past the gap.

963
The Iceland Greenland Seas Project: Meteorological Highlights

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A coordinated meteorological and oceanographic field campaign over the Iceland and southern Greenland Seas is scheduled for February and March 2018. The aim being to characterise the atmospheric forcing and the ocean response of coupled atmosphere-ocean processes; in particular cold-air outbreaks in the vicinity of the marginal-ice-zone and their triggering of oceanic heat loss and the generation of dense water masses. We will observe the spatial structure and variability of surface flux fields in the region and the weather systems that dictate these fluxes, through the first meteorological field campaign in the Iceland Sea. This will be done as part of a *coupled* atmosphere-ocean field campaign in winter 2018 involving a rare wintertime research cruise, airborne observations and a host of ocean and atmosphere observing systems. We will make in situ observations of air-sea interaction processes from several platforms. Here we will present some highlights from the meteorological component of the field campaign - illustrated by observations from some of the research aircraft cases.

AC-8b - Causes and Effects of Changing Polar Climate, Cryosphere and Hydrological Cycle
21.06.2018 16:00-17:30, A Forum

1375
Future Emergence of Deep Convection in the Arctic and Impact on the AMOC

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We investigate the potential for deep Mixed Layer Depths (MLDs) to appear close to the Arctic sea ice edge under a warming climate, using results from present day simulations of two climate models, and also from simulations with a 4 times increase in atmospheric CO2 levels, representing a future, warmer climate. Under a warming climate, we expect
(i) a reduction of the AMOC,
(ii) a MLD shoaling in the North Atlantic and
(iii) a northward retreat of the sea ice edge.
We document the changes affecting the MLD in the Arctic and the North Atlantic. There is a strong shoaling in the present-day areas of deep convection in the North Atlantic, but also a deepening in the Eurasian Basin, where MLD can episodically reach up to ~1000m. The temporal and spatial structures of the changes in ocean surface properties reveal a strong surface warming (linked with the sea ice edge retreat) and a strong salinization (due to Arctic gyre intensification driven by stronger surface stress as the sea ice pack is shrinking). Together, these changes decrease stratification, triggering convective events. A quantitative Lagrangian diagnostic of climate model output allows us to determine where the ML subduction contributes to the AMOC. For present-day conditions, AMOC main contributors are subduction in the Labrador, Irminger and Greenland Seas. In contrast, in the 4xCO2 simulations, the AMOC is greatly reduced and subduction in the Arctic and the subtropical gyre contribute significantly to the AMOC.

2341
Ocean Heat Transport Changes Connecting the Midlatitudes to the Arctic

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Arctic amplification of global warming has many drivers, including important feedbacks related to changes in sea ice and the vertical structure of the atmosphere. In the ocean, climate models simulate a weakening of the Atlantic Meridional Overturning Circulation and its associated ocean heat transport at midlatitudes, but an increase in the ocean heat transport to the Arctic Ocean. These opposing trends indicate what could appear to be a discrepancy in the reported ocean contribution to Arctic amplification. Here, we clarify how ocean heat transport affects Arctic climate under strong greenhouse warming using a set of the 21st century simulations performed within the Coupled Model Intercomparison Project. The results suggest that subpolar atmosphere-ocean interactions are key to linking midlatitude and Arctic ocean changes: future reductions in subpolar ocean heat loss enhance ocean heat transport to the Arctic Ocean, driving an increase in Arctic Ocean heat content and contributing to the intermodel spread in Arctic amplification. Implications for understanding the rapidly changing Barents Sea ice cover, which has been linked to midlatitude weather extremes, are discussed. Finally, the results caution against extrapolating the forced oceanic signal from the midlatitudes to the Arctic.

1935
Changes in Arctic Hydrological Cycle in a Rapidly Warming Arctic

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The decreasing areal extent and thickness of the Arctic sea ice have apparently increased heat and moisture fluxes from the ocean to the atmosphere in particular in autumn and early winter. These changes may locally affect air temperature, moisture, and cloud cover, and in turn remotely cause anomalous weather, such as cold and snowy winters, in the subarctic and mid-latitude regions. As a consequence, changes in the hydrological regime and its thermal conditions may occur. To investigate these changes, statistical analyses have been conducted on various observational records and modeling output. It has been identified that permafrost has warmed due to changes in snow cover in addition to global warming effects. The warmed permafrost was also implicated for the alternation of seasonality, variability, and magnitude of Arctic river discharge, such as an earlier occurrence of spring peak and an increase in the annual discharge. At the same time, the warming climate has also increased river water temperature, resulting in a larger heat flux into the Arctic Ocean when combined with the increased discharge. The increase in heat flux from the northern rivers may have contributed to the recently observed sea ice melt. This presentation will review sea ice-retreat-induced processes driving intensification of Arctic water cycle in a warming climate and evaluate robustness of the previous findings using the latest field observations and modeling experiments.

2646
Coupled Climate Simulations on the Influence of Reduced Arctic Sea Ice Cover

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The influence of Arctic sea ice cover decline on mid-latitude climate has been studied extensively in the light of the drastic sea ice decline of the last decades. However, most previous studies focused on the atmosphere. Here we present results of coupled climate model sensitivity simulations with the Alfred Wegener Institute Climate Model (AWI-CM). We artificially reduced Arctic sea ice in the coupled system with various different methods and investigated the response of the coupled system. Atmospheric responses include an AO minus type large-scale circulation response along with a southward shift of the mid-latitude storm track. In the ocean, the thinner and therefore weaker Arctic sea ice cover leads to an intensified Beaufort Gyre, and with a time lag of 50-80 years to increased outflow through the Fram Strait. Ultimately, the entire Arctic and North Atlantic ocean circulation is intensified leading to an Atlantification of the Barents Sea / Kara Sea. Surprisingly, at least in the investigated time scale of 150 years the influence on the Atlantic Meridional Overturning Circulation (AMOC) is limited.

435
Winter Atmospheric Response to Summer Sea Ice Loss in the CNRM-CM6 climate Model

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Continuous measurements of summer Arctic sea ice over the past four decades have revealed a large year-to-year variability superimposed on the negative trend (Stroeve et al. 2014). Excursions from the forced trend, if big enough, could impact mid-latitude weather and climate but the mechanisms behind such linkages remain uncertain. In this study we investigate the winter atmospheric response to summer sea ice anomalies using coupled model experiments based on the CNRM-CM6 high-top model recently developed for CMIP6. 40-member ensemble simulations in which sea ice albedo is reduced from realistic values to the ocean value are run for 15 months, yielding an ice-free state during the first summer after initialization. The atmospheric response to sea ice loss shows a classical polar warming as well as weakened westerlies that promote a negative NAO-like sea level pressure pattern during winter. We present how sea ice loss affects wintertime synoptic variability by looking at the position and strength of the jet stream, the frequency of blocking events and the sinuosity of the flow. The importance of stratospheric pathways in setting the winter atmospheric response is also discussed. Following Screen et al. (2017), we examine the respective contribution of the dynamical and thermodynamical part of the response to sea ice loss and link it with the occurrence of cold extremes over Northern Europe. We assess the robustness of the response by comparing our results to previous studies.

2303
Response from Arctic Sea-ice Loss - Internal Variability vs SIC Uncertainties

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Impacts of Arctic warming on mid-latitude climate and weather have recently been studied extensively. Simulated winter atmospheric circulation response to the Arctic sea ice loss varies among model studies. This makes difficult to understand an observed relationship of northern midlatitudes weather and climate with the Arctic sea ice loss. Recognizing the differences among sea ice concentration (SIC) data due to various sources and algorithm, it became an issue whether or not SIC uncertainties contribute to varying model results. Here we conducted a large ensemble simulation of climate impacts of the Arctic sea ice loss using 18 sea-ice configurations derived from 6 different datasets. Based on large resembles (n=3600) we found that a mean response to the Arctic sea ice loss, while SST being fixed across all runs, is a negative AO-like signal. However, sea ice anomalies in the GIN Seas appear to have a control on amplitude and details of the AO-minus response. We propose a mechanism in which sea ice anomalies in the GIN Seas modulate otherwise a mean negative AO-like response of the BK Seas ice loss by the formation of a blocking high with upscale energy flux from transient eddies. The results imply that
(1) both sea ice coverage in the GIN Seas and North Atlantic SST must be critically evaluated in AGCM and/or coupled experiments, and that
(2) possible structure embedded in variability of air-sea-ice interaction over the GIN Seas must be further quantified.

SH-6b - Connecting Polar Research Across Boundaries
21.06.2018 16:00-17:30, A Sertig

1159
Svalbard Science Forum: Added Value through Cooperation

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The Svalbard Science Forum (SSF) promotes coordination and collaborative efforts in research activities in Svalbard. Our objective is to contribute to the development of Svalbard as a platform for international research cooperation in the Arctic and enforce Svalbard´s position as a key location in high Arctic research.
SSFs tasks include managing the database "**Research in Svalbard**" (RiS) which contains information relating to more than 3300 Svalbard related projects. RiS is established in cooperation with the Norwegian Polar Institute and is a valuable source for information on previous, current and future research activities in the region. SSF is always working towards helping both researchers and management and strives to simplify registration of research projects, bookings of logistics and applications to the Governor of Svalbard by offering all services via one portal: the RiS database.
The SSF organises workshops and administers two funding schemes targeted towards the Svalbard research community: Svalbard Strategic Grant and Arctic Field Grant. **Svalbard Strategic Grant** supports seed money for workshops and collaborative activities where the goal is to enhance international and inter-disciplinary cooperation and/or initiate pilot studies for planning of larger projects with relevance to Svalbard. **Arctic Field Grant** support costs for fieldwork by students and/or researchers conducting field work in the area of Svalbard and Jan Mayen.

SH-6b - Connecting Polar Research Across Boundaries
21.06.2018 16:00-17:30, A Sertig

1831
The Forum of Arctic Research Operators (FARO): The First 20 Years

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The Forum of Arctic Research Operators, FARO, was initiated by 24 operators from 11 countries in August 1998. Now, in 2018, FARO has 20 member countries with Arctic research activities. It acts as an international forum for information exchange, establishment of cooperation and development of new ideas. It aims to encourage and optimize logistics and operational support for scientific research in the Arctic. It is closely associated with the International Arctic Science Committee (IASC) and holds its annual meeting during Arctic Science Summit Week (ASSW).
Over the last 20 years Arctic research has changed in many ways driven by changing needs and stunning changes in technology, but the underlying need for collaboration and information exchange across national boundaries remains critical to the success of research endeavours. This is particularly true when a large infrastructure commitment is needed or many observing sites are involved.
As FARO celebrates 20 years of dialogue and information exchange, we will review the past, consider the present and anticipate the future of international collaborative Arctic research.

SH-6b - Connecting Polar Research Across Boundaries
21.06.2018 16:00-17:30, A Sertig

1636
Project and Community Management in Polar Sciences: Challenges and Opportunities

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Geoscientific research often occurs via community-instigated bursts of activity. Successful attainment of research goals thus requires skilful scientific project management. In addition to usual matching scientific ambitions to limiting resources and on-going coordination, polar science confronts additional challenges. Planning and implementation of polar science projects often involve many uncertainties caused by, for example, unpredictable weather, ocean and sea ice conditions, or large-scale logistical juggling. Large amounts of funding are needed to procure the considerable infrastructure and technical equipment required for interdisciplinary and international polar expeditions; or permissions to enter certain regions must be requested. Assessment of risk is key to successful polar science project management as failure can be extremely costly. There is thus an increasing demand to employ professional project and community managers able to support their colleagues' operations in the field. Project managers in polar science need to have comprehensive expertise in polar sciences themselves in order to understand requirements, structures and funding schemes that drive interdisciplinary polar research. Polar science community managers must understand the science and the institutional landscapes that polar researchers work within. In this presentation, we provide an overview of specific challenges of project and community management in polar sciences.

331
Co-designing a European Research Programme and the Lessons Learned along the Way

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The EU-PolarNet consortium has been tasked by the European Commission to develop an integrated European polar research programme, which is co-designed with the European science community, international partners and relevant polar stakeholders. Well into its fourth year and with one and a half years left to deliver the programme, the consortium can look back on many boundaries it has bridged - to various level of success. This presentation aims at illustrating how the members of EU-PolarNet have navigated the challenges of "transdisciplinarily" identifying polar issues that are of high interest to the European society, and where the outcomes of future research could have social, economic and environmental benefits. It will give insight to how the consortium has successfully managed to get social and natural scientists to cooperate; to its efforts of meaningfully involve stakeholders from indigenous communities, industry and national administrations; and to its objective to provide European policy makers with relevant information on the changes affecting both the Arctic and the Antarctic. Within this framework, different engagement strategies will be presented, which have led to a steep learning curve within the project and which provide valuable lessons learned for researchers seeking to connect polar research across boundaries, including online consultations, European policy briefings and a transdisciplinary polar white paper workshop.

SH-6b - Connecting Polar Research Across Boundaries
21.06.2018 16:00-17:30, A Sertig

1108
Making the Connection: A Path to Connecting Researchers and Indigenous Peoples

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The US Interagency Arctic Research Policy Committee's (IARPC) Coastal Resilience Collaboration Team (CRCT) has made progress bridging boundaries between researchers and Indigenous Peoples. As an interagency body with a large Federal base but functionally open to all, IARPC is in a unique position to bring Arctic community and Indigenous voices into the discussion of Federal research initiatives. The CRCT is a case study for others interested in bridging boundaries between researchers and Indigenous Arctic communities in order to encourage involvement of Indigenous voices more fully in the discourse on Arctic research. This will take long-term consistent effort. The CRCT has made progress bridging boundaries by (1) devoting time and space for Indigenous Peoples to ask questions and become familiar with IARPC; (2) continuous outreach through Indigenous networks, setting aside specific time for engagement, and including Indigenous speakers regularly in meeting agendas; and (3) listening and taking action. These efforts have resulted in active Indigenous participation in several CRCT meetings and a focus placed on Indigenous concerns. Yet, uncertainty remains about the value to Indigenous Peoples of participation in IARPC. This presentation will demonstrate IARPC's efforts to bridge the boundary between Federal research efforts, academia, and Indigenous people and explore ways to make further advances. It will include the Federal, academic and Indigenous community perspective.

BE-11 - Using satellite imagery to study wildlife ecology in polar regions
21.06.2018 16:00-17:30, A Seehorn

1798
A Nine-year Emperor Penguin Population Assessment from VHR Satellite Imagery

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Emperor penguins are a key study species if we are to understand change in the Southern Ocean. Their dependencies upon sea-ice as a breeding platform and as a foraging environment makes them vital for providing insights into this key part of the marine ecosystem. However, the logistical challenges of working in the sea-ice zone means that there are few long term studies for the species. In 2012, the first census of emperor penguins by satellite was published, assessing the major part of the population in a single breeding season. Satellite technology provides an insight into population state irrespective of logistical difficulties with ground-based methods. Since 2009 we have therefore continued to task Very High Resolution (VHR) satellites to take imagery of every colony and now, using the same methodology as our 2009 study, we report on population change at the 16 colonies located between 0° and 90° West. This nine year study of emperor populations shows there is high inter-annual variability at most colonies, highlighting colony movements, colony dispersal and occasional complete breeding failures. Our goal is to relate the population data, at the scale of a colony, group of colonies, or geographic region, to sea-ice, and other environmental conditions to better understand the relationship of emperor penguins with their environment. This will facilitate future models of regional population trajectories for this iconic species.

1914
Range-wide Adélie Penguin Abundance from 30 Years of Landsat Satellite Imagery

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We developed a novel approach to incorporate the existing Landsat 4, 5, 7, and 8 imagery archive into models of Adélie penguins (*Pygoscelis adeliae*) distribution and abundance in Antarctica. Building on sensor-specific algorithms to automatically retrieve Landsat pixels classified as guano, we constructed an observation model that accounts for satellite detection failures when converting pixels into nest abundances and their associated observation errors. Using these satellite-derived nest abundances, we refit a recently published Bayesian population dynamics model that includes process and observation error to all known Adélie penguin abundance data (1982-2015) in the Antarctic, covering >95% of their population globally. By comparing models with and without satellite data, we assess how satellite derived nest abundances reduce our uncertainty of population trends at the CCCAMLR sub-area and regional scale. In addition, our analysis of the historical Landsat archive finds that several newly discovered Adélie penguin colonies have been in existence at least as far back as the late 1980s. Based on these results, we believe the Landsat-8 will allow for the automated mapping of Adélie penguin colonies over the life of the Landsat 8 program.

478
Geographic Structure of Adélie Penguin Populations

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We hypothesize that regional spatial organization of Adélie Penguin colonies is dependent on proximity and size of adjacent colonies, availability of coastal, snow-free terrain, and proximity of polynyas and submarine canyons. The hypothesis of Furness & Burkhead (1984) was tested previously before the availability of extensive biologging results to quantify colony foraging areas and when assessments of colony size was a compendium of historical counts. These critical data sets are now available following 20 years of biologging and real-time satellite assessment of colony locations and sizes continent-wide. We collated colony counts from Schwaller et al. (2013) and Lynch and LaRue (2014) and literature on foraging ranges to determine the relative importance of the three factors reviewed above. Indeed, colonies occur in clusters and in general large colonies do not exist adjacent to one another, with a zone of ~180 km being the critical distance, i.e. the outer edge of the foraging area of large colonies. Results are relevant to assessing effects of climate and other factors on penguin population trends, it being necessary to consider entire colony clusters rather than individual colonies.

1054
Intraseasonal Variability of Remotely Sensed Penguin Colony Counts

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In recent years significant progress was made in the field of satellite based detection of penguin colonies. As single penguin nests cannot be detected reliably, the coverage of the breeding area by guano is used as a proxy for the population size. Due to the frequent cloud coverage at Antarctic coasts, satellite images often cannot be acquired at the desired time related to the breeding phenology of a colony. Aim of this study was to understand how much the extent detected the guano cover changes during the breeding season. We studied the relation between guano coverage and breeding pair numbers in the course of the breeding seasons 2014/15, 2015/16, 2016/17 and 2017/18 in a colony of pygoscelid penguins at Ardley Island (South Shetland Islands). Data from multitemporal remote sensing images of different satellite sensors and from drones were collected as well as data on breeding phenology. Additionally, the colony was mapped on ground for its precise spatial extent and to obtain the exact breeding pair numbers. The analysis of this data shows that the extent of guano coverage in a Pygoscelid penguin colony undergoes significant intraseasonal changes. Hence, the timing of satellite image acquisition matters for the analysis of penguin populations and should be considered during the analysis.

447

Monitoring Pack-ice Seal Populations from Space with Deep Learning

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Antarctic pack-ice seals are a fundamental component of the Southern Ocean (SO) foodweb and, as key krill consumers (CCAMLR, 2008), reflect the spatial and temporal distribution of krill stocks. Despite their importance to Antarctic ecology, mapping Antarctic pack-ice seals at large scale has proven challenging. In this talk, we demonstrate how high-resolution (sub-meter) satellite imagery in concert with automated detection algorithms provides a feasible and cost-efficient alternative to aerial surveys. Our computational pipeline involves two Convolutional Neural Networks (CNNs) trained using TensorFlow (Abadi et al 2016) on a set of manually-labelled images. Our training set contained two seal target classes -
(1) seals on pack-ice, and
(2) seals on fast-ice - and three additional target classes -
(3) empty pack-ice,
(4) non-pack-ice empty substrate, and
(5) emperor penguin.
Our pipeline is > 95% accurate at classifying images when compared to manual classification of images. In addition to being immediately applicable to ongoing international efforts to monitor pack-ice seals, this approach can be easily adapted for other large-bodied species visible from satellite imagery. Automated “scanning” of the SO for pack-ice seals has the potential to radically expand the scale and frequency at which we can track their populations, and demonstrates the use of deep learning methods that have not been fully exploited for the interpretation of high-resolution satellite imagery.

1179
Environmental Factors Influencing Presence of Weddell Seal Populations

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Weddell seals are an important indicator of Southern Ocean health, yet are difficult to study at regional- to continental-scales due to their reliance on inaccessible areas of fast ice particularly in the springtime. Here, we combined citizen science with remote sensing to, for the first time, learn about the environmental factors that explain Weddell seal presence across Antarctic regions. We employed the crowd-sourcing platform Tomnod at Digitalglobe to select and host high-resolution satellite imagery (VHR) of the Antarctic coastline during November 2010 and 2011 --- images made available to volunteers, who were asked to categorize maps into seal presence and absence. We then created a 5km grid of seal presence within the extent of fast ice per year, and determined environmental variables that explained presence. We modeled habitat suitability of seals using a generalized linear model (GLM). Our best models included the positive influence of cracks in the fast ice, fast ice width, distance from the continental shelf break, and proximity to emperor penguin colonies, though covariate influence varied across regions. Our results represent an important step toward disentangling the factors that may influence Weddell seal populations around the Antarctic coast.

CR-6d - Glaciers and Ice Sheets: from the Mountains to the Poles
21.06.2018 16:00-17:30, A Wisshorn

2061
Evolution of Djankuat Glacier (Central Caucasus) under Climate Change

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In general, Caucasus glaciers lost approximately one-third of the area and half of the volume during the 20th century. Prediction of their further degradation in changing environment is a challenging task because rivers fed by glacier melt water provide up to 70% of the total river run-off in the adjacent piedmont territories. Therefore accurate assessment of future glacial run-off is a key problem of sustainable development in the regions where hydrological regime is dependent on glacial run-off. The problem is solved by dynamical modeling of mountain glaciers. It is feasible to focus on several reference glaciers in the region and to further extrapolate modeling results on the whole glaciated area.
We employ a 3D higher-order ice flow model coupled with a surface mass-balance model with treatment of debris-covered areas to perform prognostic numerical experiments aimed at simulation of future dynamics of the reference Djankuat Glacier. It is a typical valley glacier on the northern slope of the main Caucasus chain. It is one of the most well studied glaciers in Russia (and, perhaps, in the World) which has been monitored during the last fifty years.
To validate the model, we utilize observations from the nearest weather stations, as well as flow velocity, radio echo-sounding, accumulation and ablation measurements.
Predictions until the end of the 21st century are performed by downscaling of global climate modeling results according to various climate change scenarios.

1667
Impact of Climate Change on the Mountain Glaciers of Russia

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Glaciation exists on the territory of Russia for thousands of years. At present mountain glaciers are wide-spread on continental part of the country where it currently covers the area of about 3,480,000 km². There are 18 glacier regions. Five out of twelve Atlantic regions (Khibiny, Urals, Putorana, Byrranga and Orulgan) are situated within subarctic latitudes and seven (Caucasus, Altai, Kuznetsk Alatau, East Sayan, Kodar, Barguzin and Baikal Ridges) - within mid-latitudes. Six Pacific glacier regions (Chukotka, Koryak and Kolyma Plateaus, Chersky Mts., Suntar-Hayata Mts., Kamchatka) are located relatively close to the Pacific Ocean within 68° - 62° N.
All recent data available indicate that during the last few decades almost all glaciers in mountain areas were retreating that manifested in decrease of their size, volume and ice mass. The paper presents the review of results of evaluation common factors and regional features of changes in glaciation of continental Russia based on satellite imagery interpretations and field surveys, analysis of the USSR Glaciers Inventory, topographic maps and aerial photographs as well as published research papers.
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953
Heterogeneous Glacier Thinning Patterns in Karakoram-Himalaya during 2000 - 2012

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Regional heterogeneity of glacier elevation and mass changes in high-mountain Asia (HMA) is well known. However, the changes in individual glaciers located in the same region can also be different primarily due to supraglacial features (debris-cover, ponds, lakes and ice cliffs). These features coexist on glacier ablation zones and affect the energy available for ice melt. While few studies have reported similar thinning rates of debris-covered and debris-free glacier areas in HMA, other studies provided evidences of debris insulation and enhanced melt due to supraglacial water bodies and ice cliffs. In order to contribute to this ongoing scientific debate, we derive spatially detailed glacier elevation changes in the Karakoram-Himalaya regions for the period 2000-2012. For this, we employ SRTM and TanDEM-X digital elevation models. Our regional scale altitudinal distribution of elevation change indicates the insulating effects of debris cover, whereas the debris-covered glaciers show two different patterns. First pattern shows maximum thinning upstream indicating the insulating effects of thick debris-cover at lower altitudes. The second pattern shows maximum thinning at the glacier terminus, which is most likely because of enhanced ice melt due to supraglacial water bodies and ice cliffs. To validate our assumptions, we combine debris thickness and the extents of supraglacial ponds of Satopanth Glacier, central Himalaya. These variables were measured in the field.

951
Region-wide Mass Balance Series from Snowline Observations for Central Asia

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The Tien Shan and Pamir-Alay are among the largest mountain ranges on earth, hosting more than 15000 glaciers. These glaciers are important water sources for the downstream populations. Most studies focus on region-wide, decadal mass changes and only a few address seasonal/annual mass balance series for Central Asia. Here, we use a mass balance model coupled with repeat snowline observations throughout the melting seasons to infer daily mass balance series over a multi-decadal study period (2000 - 2017). By integrating snowline observations into the mass balance modelling, we produce an improved estimate at high temporal and spatial resolution. Snowline mapping is carried out automatically based on LandSat, ASTER and Sentinel images. We derive spatially distributed shortwave broadband albedo for the glacierized area of each scene to discriminate snow-covered and bare-ice surfaces using an automated, multi-step classification scheme. The mapped snowlines are used to calibrate an accumulation and temperature-index melt model.
We validate these results through comparison with geodetic mass balances calculated from ASTER images covering the entire region. To compute digital elevation models the MicMac ASTER (MMASTER) package, an enhanced method to process ASTER data, was used.
In this study, we present daily mass balance series supported by sub-seasonal snowline observations of glaciers located in the Tien Shan and Pamir-Alay, validated with region-wide geodetic mass changes.

1678
Ice Flow Modeling to Constrain SMB and Ice Discharge in Patagonia

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We simulate the ice dynamics of San Rafael Glacier located in the Northern Patagonia Icefield (46.7oS/73.5oW). The model is initialized using an inverse method to infer the basal friction coefficient from observed surface velocity. These observations are given by previous studies based on multiple synthetic aperture radar and optical satellite data collected between 1994 and 2014. Low values of basal shear stress (< 100 kPa) are obtained at the glacier front and are in agreement with values from other ice streams. These values are reasonable considering the high surface velocities in this zone (up to 7.5 km/a). The modeled ice flow results suggest that the horizontal velocities are quasi-independent of depth in the lowest zone of the glacier.
We force the 3D full-Stokes model Elmer/Ice based on San Rafael Glacier surface mass balance (SMB) given by previous studies. We use geodetic elevation changes during the study period (2000-2012). We analyze the influence of different SMB distributions on the glacier dynamics, ice discharge and mass balance. The analysis of different SMB scenarios suggests that the average SMB for the entire glacier is 0.08±0.05 Gt/a and that previous SMB estimations for San Rafael Glacier significantly overestimated the accumulation. The ice discharge is estimated as 0.77±0.29 Gt/a representing the main source of glacier wastage.

1691
Fast Recession of Patagonian Glaciers Dynamically Modulated by Calving Activity

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The Southern Patagonia Icefield (SPI) is the second ice mass in the Southern Hemisphere outside Antarctica. With only a couple of exceptions, all its glaciers have experienced substantial frontal retreats, high thinning rates of the ablation zones and ice flow acceleration, a pattern that is climatically triggered, but dynamically modulated by calving activity, since the great majority the SPI outlet glaciers are calving into tidewater fjords or freshwater lakes, where the bathymetry is playing a critical role in controlling ice dynamics. In spite of the importance of calving in explaining recent glacier changes, very little is known about the lake or fjord waters nearby the main glaciers fronts, especially the bathymetry, sedimentation rates, temperatures and the consequent sub aquatic melting. In recent years we have studied this problem by conducting several on the ground and airborne campaigns to Glaciares Jorge Montt, O'Higgins, Chico, Viedma and Upsala. In these surveys we have detected very deep fjords of up 600 m in areas recently occupied by glaciers, water temperatures with contrasting vertical structures and high subaquatic melting rates. Also, we have measured high ice velocities with satellite feature tracking techniques as well as time lapse videos. The most dramatic event recently captured with these techniques was the collapse experienced by Glaciar O'Higgins between May and June 2017 when it front lost 2 km^2 of ice in a sequence of huge calving events.

EN-3_EN-4b - Geological heritage and geo-conservation in the Polar Regions & Conservation in the Polar Regions: Challenges, Strategies and Collaborations
21.06.2018 16:00-17:30, B Pischa

2034
Challenges Associated with the Protection of Antarctic Geological Features

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Increased visitation, easier access, infrastructure construction and collection of samples for scientific purposes can all impact the conservation of Antarctic geological features. Therefore, there is a need to identify geological features that merit protected and possible ways to do it. The geographic location of Antarctica, its distinctive environmental conditions and the existing system for protection of values present a unique context for geoconservation in comparison with other regions of the world. Therefore, an adaptation of the criteria usually used to identify and protect geological heritage in other continents may be necessary. Given the existence of vulnerable geosites in Antarctica, the establishment of procedures to catalog and protect the Antarctic geological heritage may be recommended. This work analyses the components involved in the identification of Antarctic geological values and the associated risk of possible loss of values should some features not be identified. The advantages, difficulties and viability of identifying Antarctic geological heritage are discussed within the framework of existing experience and global protection mechanisms, including the management of geological heritage in existing protected areas. This work is a contribution to the ongoing work of the SCAR Action Group on Geological Heritage and Geoconservation, which aims to recommend possible measures to protect geological heritage in Antarctica.

827
Informing Conservation Planning for Terrestrial Antarctica

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Antarctic Specially Protected Areas (ASPAs) are an important conservation mechanism of the Protocol on Environmental Protection to the Antarctic Treaty. While most ASPAs protect values that are consistent with those outlined in the Protocol, several recent assessments have questioned the efficacy of the current set of ASPAs. Concomitant with the increasing scrutiny of ASPAs, and sometimes critical assessment, is a suite of research into the provision of an evidence-base for the designation of protected areas in terrestrial Antarctica. Much of this research is underpinned by a strong focus on more holistic approaches to protected area designation, typically incorporating continental or large-scale data and analyses
I will provide examples of empirical, continental scale analyses for terrestrial Antarctica with a focus on two key areas - species and ecosystems. For species I will report on i) a recent synthesis of continental scale species distribution modelling for over 30 taxa, and ii) a snapshot of Antarctic biodiversity protection. For ecosystems, my focus will be on i) a new assessment of Antarctic terrestrial habitats, and their potential as proxies for biodiversity and ii) the application of the IUCN Red List of Ecosystems process to terrestrial Antarctica. I will conclude with a summary of how these analyses, both individually and together, can contribute to the foundation of a more integrated and systematic protected area network for terrestrial Antarctica.

229
Conservation and Historical Research in the McMurdo Dry Valleys, Antarctica

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With particular attention to sites of past human activity, this paper explores how historical research can inform environmental conservation efforts in the McMurdo Dry Valleys, Antarctica. Since the late 1950s scientists have worked in the Dry Valleys every summer season making the region one of the most intensive sites of scientific activity anywhere on the Antarctic continent. Historical research can provide information about the location of field camps, the duration of occupation, and the nature of activities being conducted. This historical information has then been used to inform field observations and sampling conducted as part of the work of the McMurdo Dry Valleys Long Term Ecological Research site to provide insights into the long-term legacy of human activity in the McMurdo Dry Valleys. Alongside a presentation of results, this paper will also consider the challenges and opportunities of interdisciplinary conservation work in the polar regions.

564
A Multi-discipline Assessment of Foot Traffic Impacts in the McMurdo Dry Valleys

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The McMurdo Dry Valleys are recognised as a unique environment in which landscape and biodiversity are protected as an Antarctic specially managed area. The management plan associated with such areas allow tourist and scientific operations to occur with the minimum of environmental impact.
Yet the magnitude and longevity of impacts associated with human foot traffic are poorly quantified, particular in respect to the identification and mapping of soils sensitive to such impacts. Therefore, gaining a greater understanding of how Antarctic soils respond to trampling is key to ensuring such protected areas remain as undisturbed as possible.
We present preliminary results of a combined near-target remote sensing and soil study of geomorphological units in the McMurdo Dry Valleys and their resilience to trampling. Using structure from motion photogrammetry and tension infiltrometery, 140 sites in the MDV ASMA have been visited, and their response to a range of human impacts measured. Our results show that the style of foot traffic, whether it be single or multiple pass, plays an important role in the magnitude of physical and visual disturbance observed at these sites.
It is hoped that this technique will identify soils in polar desert regions sensitive to disturbance. By providing environmental managers a tool to plan science and tourist visitation into ice free areas, human impacts can be assessed and management plans to mitigate then implemented prior to visitation.

2118
Assessing Risks to Polar Ecosystems: The IUCN Red List of Ecosystems Criteria

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Polar ecosystems face an uncertain future, with threats posed by exploitation of minerals, fossil fuels, fish and wildlife, shipping, tourism, invasive species and climate change. Understanding the relative risks to different ecosystems is fundamental to well-informed ecosystem management. The IUCN Red List of Ecosystems (RLE) protocol is an international standard enabling systematic assessment of ecosystems at risk of large detrimental changes involving loss of biodiversity and functionality. Several qualities make it well suited for application to polar ecosystems. First, it provides an adaptable and consistent framework for risk assessment across terrestrial, subterranean, freshwater and marine ecosystems. Second, RLE assessments may be framed to accommodate data of varying quality and abundance. Third, the RLE assessment process mobilises experts to compile and critically review available data, identifying gaps to support strategic investment in data acquisition. Finally, it enables scenario analysis, given plausible alternative futures for polar environments. We will briefly explain the assessment process and review applications to selected polar ecosystems. We will explore the potential for developing systematic Red List assessments of polar ecosystems to support decisions about design and management of protected areas, indigenous peoples' interests, industry development, impact assessment, reporting against global targets and climate change mitigation and adaptation.

546
Conservation Issues in the High Arctic and Pole-to-Pole Comparisons

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With the increasing impacts of global change, conservation activities are more important than ever to protect and preserve high latitude environments and their biota. Efforts to date in the Arctic have focused on higher plants and animals; for example, the Red List of threatened Arctic plants is currently limited to vascular species, and no attention has been given to lower plant and microbial communities that are often dominant features of far northern ecosystems. One of the largest northern conservation zones in Canada is Quttinirpaaq National Park, a 37,775 km^2 region that extends to the northern coast of Ellesmere Island, Nunavut. Studies over the last two decades at the northern coastline of this park have shown that the land, lake and fjord environments contain diverse microbial assemblages and functions ('environmental microbiomes') and that these are responding strongly to the current trend of accelerated warming at these extreme high latitudes (82-83N), leading to the extinction of certain ecosystem types. In Antarctica, increased (albeit still limited) attention is being given to protection measures for microbial ecosystems (e.g., ASPAs and SCAR codes of conduct for activities and research in terrestrial, geothermal and subglacial aquatic environments) and a similar level of stewardship is needed for analogous High Arctic microbial ecosystems. A Red List of vulnerable microbiomes in High Arctic and Antarctic environments may help inform conservation efforts.

SH-3 - Historical perspectives on Arctic and Antarctic connections
21.06.2018 16:00-17:30, B Parsenn

12
C. Christensen and C. Larsen: A Comparative Analysis of Two Whaling Entrepreneurs

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Chr. Christensen and C.A. Larsen are usually considered among the most important pioneers in the transfer of whaling to Antarctic waters in the early 20th century. After a period of close cooperation during the 1890s, they took different courses and built up their Antarctic enterprises independently of each other. While Larsen initiated the foundation of shore station whaling at South Georgia, Christensen sent a floating factory ship to the South Shetland Islands.
The main aim of the paper is to make a systematic comparison of the two entrepreneurs and their companies, and focus explicitly on the considerations and decisions they made when whaling was transferred from North to South. They obviously chose different strategies, but we will ask how different they really were in their thinking about how Southern whaling was going to develop.
Both entrepreneurs brought along their experiences from how whaling had been undertaken in the Northern waters. It was not obvious what organizational patterns that would work in the South, and we shall study how familiar and new ways of organizing the industry were combined - as is often the case in entrepreneurial innovations.

20
The Transfer of Sledging Technology from the Arctic to the Antarctic

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Sledges have been used by northern cultures for millennia, and were adapted and modified for exploration expeditions through the nineteenth century. When exploration in the Antarctic began, the experience of northern explorers was drawn on in the selection of sledges best suited to Antarctic conditions. The Nansen sledge proved to be the most popular, and the influence of Fridtjof Nansen as a model and mentor was immense, but other designs were also used. The paper looks at the development and the sledge for northern exploration, and its transfer to the Antarctic in the late nineteenth and early twentieth centuries.

319
Why Go So Far? The Ainu with Lt Shirase's 1910 - 1912 Japanese Antarctic Expedition

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After the successful use of ponies on Shackleton's 1907-09 *Nimrod* expedition, Scott wasn't the only explorer who wanted to do likewise. In Japan Lt Shirase's original plan had also been to use horses, but when his Antarctic Expedition finally found a ship it was much smaller than he envisaged. Horses were abandoned in favour of sledge dogs from the Japanese sub-Arctic Prefecture of Karafuto on the island now known as Sakhalin in the Russian Far East.
Just days before the Expedition sailed the 36 dogs and their handlers arrived to join the Japanese expedition members in Tokyo. Yasunosuke Yamabe and Shinkichi Hanamori were from the indigenous Ainu community on Sakhalin. The Ainu were discriminated against and impoverished by Japanese settlers who flocked to develop the north of the country after the Meiji restoration in 1868. So why did these two men volunteer for such a dangerous mission so far from home? Why did they go so far as to risk their lives for the glory of their oppressors?
Little is known outside Japan about Lt Shirase's Heroic Age expedition, and even less about the Ainu who set Antarctic dog-sledging records, but never knew it.
However, when they got back to Tokyo in 1912 Yamabe took the time to write his autobiography before returning to his community in the far north. Starting with his earliest memories and finishing with his experiences in Antarctica, his book gives us insights into the thoughts of a leader of an indigenous sub-Arctic community.

97
Historical Exchanges and Precedence in the Production Ice Sheet Knowledge

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The cultural and scientific history of ice sheets cannot be considered from the point of view of just Greenland or Antarctica. Although they are located at opposite poles, both regions have played central roles in the interconnected, but not always synchronous production of ice sheet knowledge. Through examples of surface exploration, seismic sounding, radio echo sounding (RES) and ice coring, this paper examines the processes of exchange and precedence that have constructed our perception and understanding of ice sheets from their earliest physical exploration in the second half of the 19th century, up until the early 1980s. In mapping the history of where, when and how new methodologies and technologies were deployed in the study of the Greenland and Antarctic ice sheets, it demonstrates how ice sheet knowledge was shaped as much by scientific priorities, as by questions of accessibility, institutional and budgetary constraints, geopolitical interests, and individual or institutional leadership. This history also provides us with new insights into collaborative mechanisms, directions of exchange, and polar interdependence from both an exploratory and an Earth System perspective.

1779
SCAR, IASC and the Coordination of Polar Research during the Cold War

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Established in 1958, SCAR has a much longer history of coordinating polar research than its Arctic equivalent, IASC, which was established decades later in 1990. By using new material from the recently opened SCAR archive, this paper sets out to investigate the events that led to the creation of an Antarctic research committee far earlier than one for the Arctic.
I will argue that we can understand this disparity in light of the different systems of governance existing in the Arctic and the Antarctic in the Cold War years. So, whilst for many years polar research developed in similar ways at both poles and often through coordinated efforts (Baker, 1982), there was only one agency devoted to its coordination. The disparity also originates in SCAR's relationship with the Antarctic Treaty System, which was unparalleled in the Arctic. In particular, although there are specific cases in the Arctic (e.g. Svalbard) for which sovereignty was decided, upon on the basis of international treaties (Lüdecke, 2011), the Cold War prevented extending such legislation to the entirety of the Arctic Circle. This meant that whilst a body coordinating Antarctic research was needed to further strengthen the ATS, the same was not possible at the North Pole. It is thus no surprise that the potential of coordinating research in the Arctic, and also such research as a vehicle of international diplomacy, emerged only towards the end of the Cold War.

311
Polar Art and Climate Change: Perceptual Shifts in Polar History Mediated by Art

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This paper draws on writing done for my book project **Polar Art and the Climate Crisis: Witnessing the Anthropocene.** It brings together the Arctic and Antarctic by asking in the context of climate change how we can imagine the shift in perception from the last spaces of heroic exploration to the first places of global decline. And how does this shift from space to place and the heroic to the climatic specify a shift in perception and history of both these polar regions mediated by art?
Through a discussion of the work of Judit Hersko, Annie Pootoogook, and Subhankar Banerjee on both the Arctic and Antarctic, I examine the shift from polar fantasies of the old flag-planting heroism of explorations to "the ends of the earth" of an earlier epoch to the new critical realities of place in the present. I focus on how these very different polar histories as mediated by art intersect and play an enormous part in replacing the sublime aesthetic of the polar heroic regions with an alternative aesthetic that is ant-heroic, feminist and indigenous (Inuit) one. More especially, the paper argues that art and visual culture about the polar regions in their most capacious aspects play a very key role in our thinking on the Anthropocene.

OS-3d - Sea ice extent, properties, volume & ice shelves: modern and paleo records
21.06.2018 16:00-17:30, B Jakobshorn

2017
Arctic Sea Ice Volume Variability over the Past 40 Years

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We compared Arctic sea ice volume estimated from PIOMAS (Pan-Arctic Ice-Ocean Modelling and Assimilation System; Zhang and Rothrock 2003) and Arctic sea ice volume estimations based on observed freezing conditions expressed as Freezing Degree Days (FDD; Harpaintner et al 2001) deduced from ERA-Interim reanalysis (Dee et al 2011, Gao 2013) for the past 40 years. During the early 80s the amount of sea ice calculated from FDD was significantly lower than sea ice volume produced by PIOMAS in winter. This was due to the abundance of multiyear ice (MYI) during the early 80s that FDD could not account for. During more recent years, PIOMAS and FDD estimations are both producing a similar amount of sea ice. This is a remarkable result due to the disappearance of MYI during recent years. But the similarity between PIOMAS and FDD sea ice volume winter production including the long-term trend as well as the interannual and interdecadal variability is striking. This suggests that in the northern hemisphere as a whole, the surface air temperature driving freezing is a major factor for the sea ice volume production in winter. Since the 1980s the ice cover has shrunken by half in both extent and thickness, leading to a total sea ice volume reduction of 75 per cent in summer. It should only take one or two decades at most to melt away the remaining 25% of Arctic sea ice at the end of the summer season. Most of the Arctic Ocean would then refreeze during the following winter season.

1394

Assessing Internal Variability of Arctic Sea Ice Thickness and Volume

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Satellite-based remote-sensing measurements of Arctic sea ice thickness provide important new constraints on the sea ice changes in the Arctic for the last 1.5 decades. However, ICESat and CyroSat-2 campaigns did not overlap, they (so far) provide only a short timeseries in terms of climate records, and they have sampled an unprecedented period of rapid sea ice decline in the Arctic. Given all of these constraints, how do we best use these sea ice thickness products for model assessment? By analyzing the variability of sea ice thickness from the CESM large ensemble, CMIP5 (and if possible CMIP6) models, and the satellite data in novels ways, we will show how we can interpret these short but crucial records of Arctic sea ice change in the light of natural variability, and which insights they allow about sea ice thickness and volume biases and their sources in climate models.

644
Spatial and Temporal Patterns of Arctic and Antarctic Sea-ice Leads, 2003 - 2016

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The occurrence of leads represents a key feature of the polar sea ice cover. Leads promote the flux of sensible and latent heat from the ocean to the cold winter atmosphere and are thereby crucial for air-sea-ice-ocean interactions and feedbacks. We use the thermal signature of leads in the MODIS ice surface temperature product and a subsequent cloud artefact filter to infer daily and monthly composite lead maps for the sea ice area in both hemispheres during wintertime, 2003-2016. For the Arctic, our results highlight the marginal ice zone in the Fram Strait and Barents Sea as the primary region for lead activity. The spatial distribution of the average pan-Arctic lead frequencies reveals distinct patterns of predominant fracture zones along the Arctic Boundary Current, in the Siberian sector of the Arctic Ocean as well as in the well-known polynya and fast-ice locations. For the Antarctic, we present results for the most active sea-ice regions with respect to lead occurrences and their inter-annual variability. Hemispheric and regional peculiarities as well as methodological issues are discussed. Results are compared to passive-microwave lead products and the potential of this data set for an operational high-resolution sea-ice monitoring is investigated.

1853
Changes in Arctic Sea Ice Dynamics: Ice Speed, Wind, and Thickness Change

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Arctic sea ice has displayed significant thinning as well as an increase in drift speed in recent decades. Both buoy observations and satellite microwave radiometer based sea ice speed estimates show a strong increase in the Arctic-wide sea ice drift speed for the period 1979-2007 and 1992-2009, respectively. For the satellite data, the strongest ice speed increase was observed between 2004 and 2009. During these time periods changes in wind speed cannot explain the ice drift speed increase overall and sea ice thinning is the main driver for the ice speed changes. During the last ten years 2007-2016, however, the ice drift speed increase got reduced and became spatially more variable. Now the ice and wind speed trend patterns are in better agreement, and changes in the wind forcing can explain a larger fraction of ice drift changes. At the same time the ice thickness is at a very low level and therefore the ice drift got more susceptible to wind forcing, which is supported by a higher correlation between the two. The sea ice thickness, however, also did not change during recent years. The CryoSat-2 time series since 2010 shows thin ice and high inter-annual variability but no further overall thinning. The Arctic might have reached a new state with thin ice and higher ice drift speeds.
The MOSAiC experiment in 2019/2020 will allow to observe this new Arctic for a complete seasonal cycle and can provide new insights to the coupling between sea ice dynamics and ice thickness.

1573
A New Time Series of Sonar-based Sea-ice Draft Records from the Siberian Shelf

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The Laptev Sea is an important region for net ice production and a major contributor to the Transpolar Drift System. Seasonal and interannual ice thickness variability in this shallow shelf sea is primarily controlled by ice dynamics. Recent studies have shown increasing sea-ice area and volume export from the Laptev Sea, which is likely related to increasing drift speeds. This increased export accelerates summer sea-ice retreat and has far-reaching consequences for the entire Arctic sea-ice mass balance.
In order to increase the limited knowledge about seasonal and interannual variability of sea-ice thickness on the Laptev Sea Shelf, a set of moored Ice Profiling Sonars (IPS5, ASL Environmental Sciences Inc.) were deployed from September 2013 to September 2015. Here we present this comprehensive sea-ice draft data set for the first time. Observed seasonal changes in ice draft are linked to atmospheric and oceanic processes and used to validate different satellite-based sea-ice thickness products from altimeter and radiometer missions like CryoSat-2 and SMOS. Based on the comparison between ice thickness time series obtained from IPS and Acoustic Doppler Current Profiler (ADCP) bottom track data, we are able to extend the ice thickness time series even further back in time. This may provide us with the opportunity to compare our data sets to sea-ice thickness estimates obtained from ENVISAT radar altimeter data.

968
The ESA CCI Radar Altimeter Sea-ice Thickness Data Set: Some Evaluation Results

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Sea-ice thickness (SIT) is a key to quantify variability in the hemispheric sea-ice volume. Polar-orbiting satellite altimeters, in operation since the early 1990ties, permit to derive hemispheric-scale SIT from elevation measurements. Unlike for sea-ice concentration, changes in sensor characteristics and data coverage are substantial and complicate creation of a SIT climate data record (CDR) from altimeter data. We present evaluation results for the new ESA CCI SIT CDRs based on Envisat RA-2 (RA2) and CryoSat-2 SIRAL (CS2) satellite radar altimeter observations. The CDRs include monthly radar freeboard, ice freeboard (FB) and SIT at 25 km (Arctic, winter only) and 50 km (Antarctic, entire year) grid resolution. The CDR's parameters are mostly consistent across the RA2 - CS2 sensor change. Regionally, however, FB and SIT from RA2 often exceeds that from CS2, particularly in early winter; the Ross Sea, Antarctic, seems to be especially problematic. We find a linear regression of 0.88x+0.03 m between Arctic CS2 SIT and airborne total (sea ice + snow) thickness, RMSE=0.73m; regression is 0.26x+1.45 m for RA2 SIT, RMSE=0.90m. Agreement between Antarctic SIT and airborne total thickness is worse than in the Arctic. Arctic sea-ice drafts measured by BGEP ULS and estimated from RA2 and CS2 SIT agree within ~0.5 m depending on ice type, month and snow-depth. On average, Arctic RA2 SIT underestimates ICESat SIT by ~0.4 m, with wide-spread differences > 1.5 m on 25 km grid scale.

1964
Different Propagation Characteristics of Gravity Waves over Syowa and Davis

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Source, propagation and intermittency of gravity waves are only poorly understood because of the lack of observations. To understand their source and propagation, our group has observed gravity waves over Syowa (69°S, 40°E), Davis (69°S, 79°E) and other stations using various instruments [Kogure et al., 2017; Matsuda et al., 2017].
We will show the ground-based horizontal phase speed spectrum over the two stations derived from OH imagers. We analyzed the OH airglow imager data obtained from March to October in 2016 with the M-transform [Matsuda et al., 2014]. We analyzed the data without clouds and aurora contaminations continuously for at least one hour. The numbers of nights with such data sets are 40 at Syowa and 55 at Davis. The seasonal variations of the nightly mean variance were very similar with winter maximum, but the variance over Syowa was larger than that over Davis in September. In 2016, clear sky and aurora free data were available at both station on ten nights. Comparison of phase velocity spectrum obtained on the same night showed similarities on only one night out of ten nights. At five nights, the spectra were different. At the other four nights, the spectral peaks with slow westward phase velocity were commonly observed but additional spectral peaks were found over Davis and not over Syowa. We will also present comparisons of kinetic energy and propagation direction of gravity waves derived from MF radars, and compare with the results from OH imagers.

2105
Dynamics of Extreme Stratospheric Positive Heat Flux Events in a Simple Model

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Extreme stratospheric positive wave-1 heat flux events are coupled to significant variability in the polar troposphere. In particular, the events are associated with large amplitude wave-1 geopotential height anomalies, near surface cooling over Eurasia and warming over Northern Canada. Here a dry dynamical core is used to investigate the dynamical mechanisms driving the events. Ensemble spectral nudging experiments are used to isolate the roles of specific dynamical components:
i) the tropospheric wave-1,
ii) the stratospheric zonal-mean flow and
iii) the higher-order planetary wavenumbers.
Nudging tropospheric wave-1 partially reproduces the events whereas they are not reproduced when nudging stratospheric wave-1, supporting the role of upward wave coupling from the troposphere to the stratosphere during the events. Nudging tropospheric wave-1 and the zonal-mean flow largely reproduces the events whereas they are not reproduced when nudging the latter alone, showing that the zonal-mean flow is a necessary but not sufficient condition in driving the upward wave coupling. Nudging the higher-order wavenumbers and the zonal-mean flow also largely reproduces the events. Mechanism denial experiments, whereby one component is fixed to the climatology and others are nudged to the event evolution, show that higher-order wavenumbers play a key role in driving the tropospheric wave-1 source during the events.

760
Stratospheric Polar Jet Oscillation Events and their Surface Predictability

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The surface impacts of stratospheric sudden warming (SSW) events tend to extend up to several weeks. It is however unclear which mechanisms lead to the long lifetime of the surface impacts on seasonal timescales. About half of all SSW events are associated with so-called Polar Jet Oscillation (PJO) events, which are characterized by an extended recovery of the stratospheric flow and long-lasting temperature anomalies in the lower stratosphere. It is here investigated if this extended recovery may in part be responsible for the extended duration of the surface impact of SSW events (though PJO events may also occur independently of SSW events) - and therefore a possible improvement in winter predictability in the extratropical troposphere.
The hypothesis is tested using a 30-member ensemble of seasonal hindcasts initialized on November 1st of each year from 1979 to 2014 from the seasonal prediction system based on the Max Planck Institute Earth System Model (MPI-ESM). Evidence is found that the ensemble provides improved statistical predictability for both SSW and PJO events in the stratosphere. In addition, the surface impact of PJO events is well represented in the model as compared to reanalysis, and it is significantly stronger and longer-lived than for SSW events. Prediction skill over the North Atlantic and the Arctic is significantly enhanced during years with SSW or PJO events.

1599
Arctic System Reanalysis Provides High-resolution Accuracy for Arctic Studies

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To detect and diagnose rapid climate changes occurring in the Arctic, a state-of-the-art assessment and monitoring tool is imperative. The Arctic System Reanalysis is a university-led reanalysis of the Greater Arctic region using blends of the polar-optimized version of the Weather Research and Forecasting (Polar WRF) model and WRF three-dimensional variational data assimilation system. The latest is a comprehensive integration of the regional Arctic climate for 2000-2016 (ASRv2.1). ASRv2.1 features 15 km horizontal resolution, updated model physics including sub-grid scale cloud fraction interaction with radiation, and a dual outer loop routine for more accurate data assimilation. Analysis reveals superior reproduction of near-surface and tropospheric variables. Forecast precipitation and downward radiative fluxes demonstrate significant improvements over earlier versions. The high-resolution topography and land surface, including weekly-updated vegetation and realistic sea-ice fraction, sea-ice thickness, and snow cover depth on sea ice, resolve fine-scale processes. This allows in-depth investigations of topographically-forced wind events, marine cold air outbreaks, and polar lows, all important components of the Arctic climate. Thus, ASRv2.1 permits a reconstruction of the contemporary changes in the Arctic, complements global reanalyses, and may be used in environmental models, to verify regional processes, or aid in the siting of future observation networks.

870
How Well Do we Know the Polar Energy Budgets?

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While the underlying theory behind polar feedback mechanisms has been known for a long time, current climate models still struggle to capture observed rates of sea ice decline and ice sheet mass. This may be explained, at least partially, by a lack of observational constraints on polar energy budgets and, in particular, the roles clouds and precipitation play in modulating them. One solution to the challenges of making sustained, high quality atmospheric measurements in this inhospitable region, is to turn to satellites. This presentation will introduce a new multi-satellite, multi-model dataset for probing the state of the Arctic and Antarctic climates and documenting its representation in predictive models. Recent satellite-based reconstructions of the polar energy budgets and their annual cycle from this dataset will be used to demonstrate that atmospheric reanalyses and global climate models exhibit significant biases in several key energy flows at both poles. These biases, in turn, lead to discrepancies in both the magnitude and seasonality of the implied surface heat storage and heat transport into polar regions from lower latitudes. The significance of these biases is illustrated by examining their influence on ice sheet dynamics and the surface mass balance of the Greenland Ice Sheet.

1098
The Variations of Tropopause and TIL in the Arctic Region during SSW2009

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The mechanism to explain the variations of tropopause and tropopause inversion layer (TIL) in the Arctic region during a sudden stratospheric warming (SSW) in 2009 was studied with MERRA reanalysis data and GPS/COSMIC temperature data. During the prominent SSW in 2009, the cyclonic system changed to the anticyclonic system due to the planetary wave with wavenumber 2 (wave2). The GPS/COSMIC temperature data showed that, during the SSW in 2009, the tropopause height in the Arctic decreased accompanied with the tropopause temperature increase and the TIL enhancement. The variations of the tropopause and TIL were larger in higher latitudes. A static stability analysis showed that the variations of the tropopause and TIL were associated with the variations of the residual circulation and the static stability due to the SSW. Larger static stability appeared in the upper stratosphere and moved downward to the narrow region just above the tropopause. The descent of strong downward flow was faster in higher latitudes. The strong downwelling in the stratosphere was mainly induced by wave2, which led to the tropopause height and temperature changes due to the adiabatic heating. Around the tropopause, a pair of downwelling above the tropopause and upwelling below the tropopause due to wave2 contributed to the enhancement of static stability in the TIL immediately after the SSW.

OS-7d - Atmosphere-Ice-Ocean interactions in the Polar Regions
21.06.2018 16:00-17:30, C Sanada II

1254
Sea-ice Properties Derived from Ice Mass-balance Buoys using Machine Learning

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Sea ice in the polar regions determines the energy, mass and momentum exchange between the atmosphere and the ocean. However, remoteness of the polar oceans as well as the harsh weather conditions make observations challenging and expensive. Sea Ice Mass-balance Buoys (IMBs) are autonomous instruments, consisting of a thermistor chain, measuring vertical temperature profiles extending from the air through snow and sea ice into the upper ocean. So far, deriving the respective interfaces between the media to investigate the local sea ice energy and mass balance is a crucial challenge. Here we present a semi-automatic algorithm based on supervised machine learning techniques that is capable of reliably identifying the interfaces between atmosphere, snow, sea ice and ocean from IMB temperature and heating data. We use a random forest classifier, based on a number of subsets of the training set to fit an ensemble of decision trees. The classification is achieved by averaging over the ensemble and the algorithm is applied to IMBs deployed in the Arctic and Antarctic since 2012. Our results show time series of sea-ice growth/melt, snow accumulation/ablation, snow-ice formation and thermal conductivities. We discuss the time series and the spatial variability in order to improve our understanding of seasonal variations in the energy and mass budgets of sea ice and its impact on the climate system.

2207
Sonar Probing of Ice Thickness and Ice-related Climate Feedbacks

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Arctic sea ice retreat has been observable since 1950 and is reaching a stage where the summer ice cover will soon disappear. The rapidity of change was masked because the decline in area (easily mapped by satellite) was accompanied by a rapid decrease in mean thickness (less easily mapped by submarine sonar). We begin by surveying how sonic range probing of the ice underside has developed, from use in wave recording to single-beam then multi-beam mapping. We go on to survey the implications of the observed volume decrease, since the retreat has feedbacks on other aspects of the climate system. The feedbacks involve
(1) albedo - as sea ice and snow on land retreat, the average albedo of the Earth is reduced, now equivalent to adding 50% to the emissions of CO_2;
(2) sea level - the retreating sea ice warms the atmosphere around Greenland in summer, speeding its melt rate and increasing the rate of global sea level rise;
(3) methane - increasing quantities are being emitted from the Russian continental shelves, and this could accelerate into a methane pulse with major climate implications;
(4) weather - extreme weather changes relate to the ice retreat and these threaten global food supply;
(5) weakening of the Atlantic thermohaline circulation due to a loss of sea ice from the Greenland Sea, which reduces the warming rate of Europe while increasing that of the tropical Atlantic.
We estimate the magnitudes of the five feedbacks and their total impact on the global climate.

785
PIPERS: Sea Ice Thickness Redistribution from Early Winter Deformation

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The morphology of sea ice deformation is important for the representation of deformation in sea ice models and interpreting satellite observations of ice thickness. Deformation features in the Antarctic differ from those in the Arctic, yet we have limited understanding of how deformation drives ice morphology. In this study, sea ice deformation is characterized and quantified with relevant statistics using high-resolution three-dimensional observations of ridges collected during the 2017 PIPERS cruise in the Ross Sea in early winter. These observations primarily consist of ice draft from multibeam sonar on an autonomous underwater vehicle (AUV) and are supplemented with terrestrial lidar for surface elevation and manual MagnaProbe for snow depth. We quantify ridge statistics such as roughness, symmetry (skew) and linearity using computer vision techniques and model the thickness distribution using generalized extreme value distributions. To understand how deformation processes determine these morphologies, ridge spatial statistics are verified using a three-dimensional Discrete Element Model, which also allows for investigating the effects of different initial floe statistics on resultant ridge morphology. This yields improved estimates of sea ice thickness redistribution due to ridging that will ultimately improve sea ice dynamic models, algorithms for remote sensing of ice thickness distribution and parameterizations of ice-ocean drag.

1174
Observations of Sea-ice Mediated Upwelling and Downwelling in the Beaufort Sea

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We present observational estimates of Ekman pumping in the Beaufort Gyre region. Averaged over the Canada Basin, our results show a 2003-2012 average of 2.5m/y downward with strong seasonal and interannual variability superimposed: monthly and yearly means range from 30m/y downward to 10m/y upward. A clear seasonal cycle is evident with intense downwelling in autumn and upwelling during the winter months. Wintertime upwelling is associated with friction between the large scale Beaufort Gyre ocean circulation and the surface ice pack, and contrasts with previous estimates of year-long downwelling; as a consequence, the yearly cumulative Ekman pumping over the gyre is significantly reduced. The spatial distribution of Ekman pumping is modified as well, with the Beaufort Gyre region showing alternating, moderate upwelling and downwelling, while a more intense, year-long downwelling averaging 17.5m/y is identified in the northern Chukchi Sea region. Implications of our results for understanding Arctic Ocean dynamics and change are discussed.

1549
The Impacts of El Niño on the Observed Sea Ice Budget of West Antarctica

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We assess the impact of El Niño induced wind changes on seasonal West Antarctic sea ice concentrations using reanalysis data and sea ice observations. A novel ice budget analysis reveals that in autumn a previously identified east-west dipole of sea ice concentration anomalies is formed by dynamic and thermodynamic processes in response to El Niño generated circulation changes. The dipole features decreased (increased) concentration in the Ross Sea (Amundsen and Bellingshausen Seas). Thermodynamic processes and feedbacks make a substantial contribution to ice anomalies in all seasons. The eastward propagation of this anomaly is partly driven by mean sea ice drift rather than anomalous winds. Our results demonstrate that linkages between sea ice anomalies and atmospheric variability are highly nonlocal in space and time. Therefore, we assert that caution should be applied when interpreting the results of studies that attribute sea ice changes without accounting for such temporally- and spatially-remote linkages.

1290
Cooling and Freshening of the Southeast Pacific Driven by Sea Ice Export

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Strong cooling and freshening was observed in the southeast Pacific in 2008-2010 and 1998-2000, affecting both the Southeast Pacific Subantarctic Mode Water (SEPSAMW) and the Antarctic Intermediate Water (AAIW) density ranges. Both 1998 and 2008 experienced an exceptionally low Amundsen Sea Low, a strong positive Southern Annular Mode, and a negative El Niño Southern Oscillation. In both years two varieties of SEPSAMW were formed: a colder, fresher, denser variety in the immediate vicinity of the Subantarctic Front (SAF), and a warmer, saltier, lighter variety further north. Results of analyses of an ocean-sea ice data-assimilating Southern Ocean State Estimate (SOSE) and other products suggests that this bimodal structure of SEPSAMW is associated with strong zonal wind forcing in the vicinity of the SAF and sea ice influences further poleward. In both 1998 and 2008, anomalously strong meridional winds drove strong sea ice export from the Ross Sea. The sea ice melt propagated eastward in the subsequent two year time period, causing destruction of water in the AAIW and SEPSAMW density ranges. Particles released along the sea ice edge in 2008 and advected by SOSE velocities confirmed that on timescales up to three years, the strongest influence on the AAIW and SEPSAMW comes from water that originates in the Ross Sea. Thus strong sea ice export from the Ross Sea can play an important role in modifying the AAIW and the SEPSAMW properties during subsequent years.

Poster & Beer II
21.06.2018 17:30-18:30, Foyer

Thu_1_AC-3_283
The Effect of Wind Direction on air Temperature Variability on James Ross Island

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The western and eastern parts of the Antarctic Peninsula are quite different, especially due to frequent atmospheric blocking or foehn events induced by the mountains. In order to study the influence of topographic modification on atmospheric circulation and its impact on cryosphere, the air temperature measurements from the northern part of James Ross Island were evaluated with respect to surface wind direction. Meteorological parameters from 2013-2016 were observed in one-hour interval by multiple automatic weather stations, while 1000-hPa pressure level data from the ERA-Interim reanalysis were used to assess the surface wind effect. Furthermore, near-surface temperature lapse rates were calculated and linked to boundary layer processes. The results were analysed with respect to topographic conditions, separately for ice-free parts and glaciers of the Ulu Peninsula. The seasonal and inter-annual variation of the selected near-surface atmospheric variables was emphasized in the study.

Thu_2_AC-3_505
A Satellite Perspective of Summer Warm-air Advection over Melting Sea Ice

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Some very special conditions apply in summer warm-air intrusions as compared to in winter. As long as significant melting sea ice is present, surface temperature must remain at the melting point, in contrast to winter when the surface temperature can respond to changes in the heat surface fluxes. Strong surface inversion forms often accompanied by fog and the high temperature of the fog and its large longwave emissivity brings positive net longwave surface radiation, while the inversion conditions bring a downward turbulent heat flux. Studies based on data from the 2014 Arctic Clouds in Summer Experiment (ACSE), on the Swedish icebreaker Oden, indicate that while low clouds and fog reduce the net solar radiation at the surface, the combined effect on all terms in the surface energy budget leads to additional heat flux to the surface in these conditions; the net outgoing longwave radiation at the top of the atmosphere also increases. We hypothesize that cloud-top cooling and cloud-induced along with surface mixing eventually erodes the surface inversion downstream and the boundary layer transforms into the often-observed well-mixed cloud-capped boundary layer; the extra surface energy is concentrated to a zone inside the ice edge. To evaluate the hypothesis, and to determine the time/length scales involved in the transition, we use a combination of reanalysis, back trajectories and satellite products to extend the view from the local column observations from the icebreaker.

Thu_3_AC-3_508

Exploring Air Mass Origin in the Arctic for Clear and Cloudy Boundary Layers

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The observations from the Surface Heat Budget of the Arctic (SHEBA) campaign revealed the presence of two preferred states of wintertime Arctic boundary layer, a radiatively clear state and a cloudy state with low-level mixed-phase clouds (Persson et al. 2002). Both of these states have distinct impacts on radiative and turbulent heat fluxes of the Arctic boundary layer. The clear state is being characterized by strong longwave cooling under the clear sky or ice clouds and, the cloudy state by little to no surface longwave cooling (Stramler et al., 2011). However, most climate models lack a realistic representation of the cloudy state of the Arctic boundary layer (Pithan et al 2013).
We examine what leads to the formation of these boundary layers. In order to study that, we calculate the back trajectories from the radiosondes data obtained from the SHEBA Ice Camp. For the calculation of these trajectories, we use the Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) by NOAA Air Resource Laboratory.The various back trajectories provide us with an overall evaluation of the air mass formation in the Arctic boundary layer. Furthermore, the case studies can be used to design Single Column Experiments and Large-Eddy Simulation Models to improve the biases in climate models representing the Arctic boundary layer. It will also help us to inform the setup of the future observational campaigns in the context of YOPP and MOSAIC.

Thu_4_AC-3_698
Application of Controlled Meteorological Balloons in Polar Regions

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CMET balloons can fly for multiple days in the lower troposphere while changing altitude on demand. Around 20 CMET balloons have been launched from Svalbard and Antarctica during 2010-2017. In May 2011, one balloon launched from Ny-Ålesund, Svalbard achieved a suite of 18 continuous soundings that probed the Arctic marine boundary layer (ABL) over a period of more than 10h. Profiles were compared to model output from ECMWF Era-Interim reanalysis (ERA-I) and to a high-resolution (15 km) Arctic System Reanalysis (ASR) product. To the east of Svalbard over sea ice, the CMET observed a stable ABL profile with a temperature inversion that was reproduced by ASR but not captured by ERA-I.
In January 2013, two balloons were launched from the Aboa station in Dronning Maud Land, Antarctica. They were airborne for 60 and 106 hours with trajectory lengths of 885.8 km and 2367.4 km, respectively. The most interesting feature deteced was a mesoscale anticyclone over the Weddell Sea and the coastal zone, which was reproduced by the WRF model with reduced intensity. Another balloon launched from Aboa in January 2017 was airborne for 157 hours and made a trans-Antarctic flight before it landed in the Ross Sea. It made multiple deep soundings to the surface over the interior of the continent.
The results above demonstrate that CMET balloons are a valuable approach for profiling the free atmosphere and boundary layer in remote regions such as Polar Regions.

Thu_5_AC-3_775
Annual Variability of the Temperature Profile at the THAAO Observatory

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Surface Temperature Inversions (STIs) are typical features of the polar atmosphere. They are principally due to a) the imbalance between outgoing longwave radiation from the surface and downwelling shortwave and longwave radiation, leading to a surface cooling, and/or b) the advection of warm air over a cooler surface layer. Recently, it has been suggested that STIs play an important role in the Arctic winter warming damping the infrared cooling of the lower atmosphere, and thus constituting a positive warming feedback contributing to the Artic Amplification.
The present study shows and discusses the variability of the vertical temperature profile retrieved by a RPG Humidity And Temperature PROfiler (HATPRO-G2) installed at the Thule High Arctic Atmospheric Observatory (THAAO, 76.5° N, 68.8° W, http://www.thuleatmos-it.it/, Northern Greenland) in July 2016. A statistical retrieval is used to estimate the temperature profile from the brightness temperatures measured by HATPRO. The retrieval accuracy in the Arctic environment is studied by comparing the obtained profiles with radiosondes launched in summer and wintertime.
The temperature evolution and vertical structure of the atmosphere at THAOO in the period July 2016-March 2018 is discusses together with the occurrence and intensity of STIs. The relationship between and STIs and cloud occurrence is also investigated.

Thu_6_AC-3_1245
Observations and the Source Investigations of Boundary Layer BrO at Ny-Ålesund

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Bromine monoxide is a reactive halogen species which has profound impact on the chemistry of the tropospheric polar boundary layer. A considerable challenge for understanding enhanced BrO and the associated ODEs is the difficulty of real-time observations. In this study, we found a typical process of enhanced bromine and depleted ozone in Ny-Ålesund boundary layer using ground based differential optical absorption spectroscopy (DOAS) techniques in late April 2015. BrO was observed as high as 6×10^{14} molecular cm^{-2}, while the in-situ ozone and gaseous mercury reduced by 85% and 90% separately at the same period. The largest BrO column densities were found at elevation angle of 2° above the horizon. The vertical distribution of BrO was present at 0.5-1km layer using radiative transfer model simulation. Although the HYSPLIT model and satellite data showed air masses coming from the High Arctic area, which was enriched in bromine, the sea ice in the Kings Bay area, occurred only for a short period exactly during the enhancement, was considered as the main local source of this bromine enhancement event. The key role of bromine on the atmospheric oxidation and the ecosystem will be further discussed.

Thu_7_AC-3_1346
Multi-scale Modeling and Measurements of Arctic Clouds

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Arctic clouds are important to the radiative budget, but they are difficult to represent in atmospheric general circulation models (AGCMs). Three approaches to improving Arctic clouds in models are presented. First, a cloud system resolving model (CSRM) is embedded into each gridcell of a traditional AGCM to explicitly simulate more cloud processes. Second, a variable resolution AGCM is used to understand modeled cloud response to increasing horizontal resolution. Third, stand-alone large eddy simulations (LES) are used to explicitly resolve cloud processes. The AGCM simulations have a negative low cloud amount bias when compared with multi-year satellite retrievals. The Atmospheric Radiation Measurement program's (ARM) third ARM Mobile Facility (AMF3) and the restricted airspace associated with it at Oliktok Point, Alaska, are used to operate a tethered balloon system (TBS). Sensors deployed on the TBS are compared with the ground-based instrumentation also at the site, and with the AGCM and LES simulations previously described. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2017-12294 A.

Thu_8_AC-3_1393
The Canadian Arctic Weather Science Project: An Overview

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ECCC established two supersites at western and Eastern Arctic for understanding weather and climate, testing suitable observation technology and support validation of space-borne observations of wind, aerosols, cloud and precipitation from ADM-Aeolus, EarthCARE and Global Precipitation Mission. Winds can be localized and impact the distribution of snow and ice affecting human activity and navigation. Aerosols from mid-latitudes can impact the cloud/precipitation distribution affecting the radiation balance and resulting in intensification of cold air outbreaks that affect mid-latitudes. The weather in Whitehorse is at the confluence of the Pacific Ocean, the Western Cordillera, the North American continent and the Arctic Ocean and is challenge to predict. Iqaluit is at the center of different Arctic large scale weather systems and Eastern seaboard of North America. Observations at the Iqaluit (64°N, 69°W) revealed high frequency (40% daily occurrence) of multiple (4-10) wind layers (0.2 to 4.4 km in depth) from surface to 7.2 km. These stratified wind layers are visible as shifting wind directions with height in Doppler lidar and dual-polarization Ka-band radar range-height scans and in the Doppler lidar and radiosonde data. Analysis showed that NWP surface variables were inaccurately predicted during wind layer events. Surface-based inversions can exceed 10 K with depths as large as 1 km the model appears to underestimate their intensity or fail to predict any inversion.

Thu_9_AC-3_1709
The Surface wind Circulation over a Complex Terrain of Central Spitsbergen

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Better understanding of the Svalbard climate conditions requires a comprehensive knowledge of atmospheric boundary-layer processes including the effects of local topography and ground surface properties. The atmospheric boundary layer often includes large vertical gradients in air temperature, humidity as well as wind speed, which is mainly generated by a complex interaction of a large-scale circulation and small-scale processes. The aim of the study is to 1) compare surface wind measurements and reanalysed low-level geostrophic winds in the period of 2013-2016, and 2) evaluate a role of topography on spatiotemporal variability of winds within a fjord. For studying near-surface wind characteristics in central Spitsbergen (Billefjorden area), we chose three sites differing in terrain elevation and local surface properties: Petuniabukta terrace (15 m a.s.l.), Mimerbukta terrace (20 a.s.l.), and the top of Mumien Peak (773 m a.s.l.). Patterns of atmospheric circulation were identified using 1000-, 925- and 850-hPa geopotential heights and geostrophic winds based on the ERA5 reanalysis data provided by the ECMWF. Our results indicate that a large-scale flow was often modified by channelling and drainage effects accompanied by an increase in wind speed and wind direction frequency at the coastal sites. On the other hand, the near-surface wind at the top of the Mumien Peak was most similar to the geostrophic wind, irrespective of the circulation type.

Thu_10_AC-3_1742
Bulk Flux Parametrization for the Stable Atmospheric Surface Layer over Sea Ice

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In climate and weather prediction models the near-surface turbulent fluxes of heat and momentum and related transfer coefficients are parameterized on the basis of Monin Obukhov similarity theory (MOST). Its application requires an iterative solution of the MOST equations. To avoid iteration many models determine the transfer coefficients using the Louis method relating the stability parameter $\zeta=z/L$ (L is the Obukhov length and z is height) to the bulk Richardson (Rib) number. However, the presently used methods are valid only for larger surface roughness and weaker stability than observed over the polar oceans. In contrast to the popular methods of polynomial fitting we propose an approximate solution that results in ζ as a function of Rib and of the surface roughness. For the stability functions we use those based on SHEBA data (Grachev et al. 2007) and thus on the most modern data over sea ice. Using the new ζ approximation, bulk transfer coefficients for momentum and heat are obtained without iteration depending on stability and surface roughness. It is shown that these coefficients reproduce the coefficients obtained by the classical, iteration based solution of the MOST equations with a mean accuracy of 5 % for Rib between 0 and 0.3 for a large range of surface roughness. At large Rib the new bulk transfer coefficients are much smaller than those currently used. The new non-iterative parametrization can be easily implemented in climate and weather forecast models.

Thu_11_AC-3_2010
Boundary-layer Structure during Super-cooled Fog Events at Summit, Greenland

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Persistent stable stratification of the boundary layer at Summit, Greenland (72.58ºN, 38.48ºW, 3210 masl) drives the development of liquid fogs by surface radiative cooling. These fogs are most common from June through October and are super-cooled, typically ~ -20 ºC. We present case studies from June 16th and 23rd, 2013 that are associated with the diurnal development of surface-based temperature inversions during clear skies, each lasting ~10 hours. We analyze measurements collected by meteorological sensors, cloud particle probes, and isotopic vapor composition from a 46 m tower, as well as a nearby high resolution minisodar and other remote sensors. The common driving mechanism and the typical transition in the boundary-layer from stable stratification to a shallow convective layer led to similarities between the cases in the evolution of the fog microphysics. There were important differences too, such as in the liquid water path, which was larger on the 16th and suppressed the surface cooling. We explore how these differences may be related the boundary-layer structure, including Kelvin-Helmholtz instability identified on the 16th while the liquid water path was high, and transient disturbances of the boundary layer at 10 to 20 minute intervals during the 22nd and 23rd. Improved understanding of the physical processes that govern fogs will inform on the importance their representation in the models used for ice sheet surface energy and mass balance projections.

Thu_12_AC-3_2071
The Role of Atmospheric Rivers and Summer Surface Melting in Greenland

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Past work implicated atmospheric rivers (ARs) in the melting of the surface of the Greenland Ice Sheet (GIS) in 2012 and 1889 (Neff et al. 2014). In this work we examine the degree of melt along the western slopes of the GIS from 2000 to 2012. We compare three different reanalyses (ERA-I, NCEP, and 20CR) in their ability to detect the northward transport of moisture to the west of the GIS and then compare such events with the degree of melt for the period June-August (available through NSIDC). We assessed the three reanalyses at four locations to the west of the GIS, between 50N and 66N, comparing wind speed and direction at 850 hPa and total integrated water vapor (IWV). Events were detected using thresholding of wind speed and IWV at 60N and 66N. These events were compared with the fraction of melt observed in two geographical regions west of the highest topography: from -55W to -43W and south to north 63N to 68N and 68N to 73N. Two case studies will also be presented: One will be an AR on 18 August 2000 with extensive melt inland and temperatures just below freezing at Summit Station and one on 24 August 2011 that produced significant rain along the coastal glaciers (Doyle et al. 2015) with more limited melt inland. We will also explore the potential of identifying the impact of ARs on the GIS using the 20CR back to 1880.

Thu_13_AC-3_2074
The Meteorology and Chemistry of High NO Concentrations at the South Pole

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This presentation summarizes key results from a recent paper submitted to ACPD (doi.org/10.5194/acp-2017-812). Our study examined the effect of the seasonal cycle in meteorology from November through December and the effect of stratospheric ozone depletion on the photochemical production of nitrogen oxide (NO) from nitrate in the snow at the South Pole. We found a systematic evolution of the large-scale wind system at 300 hPa over the ice sheet from winter to summer that controls the surface boundary layer and its effect on NO: Initially in Early Spring (Days 280-310) the transport of warm air and clouds over West Antarctica dominates the environment over the South Pole; In Late Spring (Days 310-340), of significance to NO, the winds at 300-hPa exhibit a bimodal behavior alternating between NW and SE; In Early Summer (Days 340-375), the flow aloft is dominated by winds from the Weddell Sea. During Late Spring, winds aloft from the SE are strongly associated with clear skies, shallow stable boundary layers, and light surface winds from the east: it is under these conditions that the highest NO occurs. We also found that ozone depletion which now extends into late November- early December coincides with optimum conditions (clear skies, strong surface temperature inversions, and light winds) for high concentrations of NO to accumulate at the surface.

Thu_14_AC-3_2584
An Evaluation of the WRF Model for the Antarctic Peninsula

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The near-surface wind field of the Antarctica is determined by Katabatic winds which is originated by the occurrences of the strong temperature inversion zone, whose intensity is driven by the temperature gradient between surface and the atmospheric layer above it. Numerical weather prediction studies show that large and mesoscale circulation pattern can be captured with reasonable accuracy by having small biases (Turner et al, 1996; Van Den Broeke, 1997; Wilson et al., 2012). In this study, The Polar WRF model is used to simulate the atmospheric conditions of selected days of 2016 for each season. The model is configured with three nested domains to provide high-resolution model outputs which are compared to in situ observations of the Antarctic Peninsula. The finest domain resolution of the model is 1 km. The model offers multiple physics options for microphysics, radiation, cumulus parameterization, boundary layer, snow surface physics and sea-ice treatment. MODIS land use/cover data is adapted to the model to determine the snow surface characteristics of the model more accurate. The WRF configuration is designed to have 45 terrain-following vertical levels. Initial and boundary conditions are obtained from NCEP/NCAR Reanalysis data. The results of the WRF model are compared to the available temperature and wind data of automatic weather stations on the Antarctic peninsula to discuss katabatic wind patterns and their relations with temperature gradients.

Thu_15_AC-3_2662
Regional Analyses of the Antarctic Atmospheric Boundary Layer during Concordiasi

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This study investigates characteristics of the atmospheric boundary layer (ABL) observed over continental Antarctica during the Concordiasi campaign in spring 2010. The Concordiasi dropsondes are high-resolution atmospheric profile measurements, valuable for studying the ABL. The surface air temperature is in good agreement with collocated 2 m air temperature from the Antarctic Mesoscale Prediction System (AMPS). Regional analyses show that the ABL is often well-mixed in the west and southeast regions of the continent. Increased temperature and wind speed shear associated with synoptic disturbances is the likely cause for the high frequency of well-mixed ABLs in West Antarctica. Higher temperatures and wind speed shear are also associated with well-mixed ABLs in northern Antarctica. In other regions, thermal effects appear to dominate over mechanical mixing in the ABL. Solar heating plays an important role in eroding surface-based inversions and mixing the ABL in higher latitudes (south of 80°S). A similar effect is observed along the slopes of the east Antarctic plateau, where adiabatic warming associated with downsloping winds appears to increase surface air temperatures and reduce boundary layer stability. Although we do not measure cloud properties, the dewpoint depression profiles suggest that the most pronounced saturation differences (and associated longwave feedback) between stable and well-mixed ABLs may occur along the eastern coastal regions of Antarctica.

Thu_16_AC-8_6
Sea Ice and Planetary Wave Activity over the 20th Century

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The contrasting geographies of the Southern and Northern hemispheres play a significant role in the observed Rossby wave regimes. In addition to differences in the continental distribution and the location of major north-south mountain chains, the mean equator-to-pole temperature difference is significantly larger in the Southern Hemisphere (around 70 K) than in the Northern Hemisphere (around 40 K). The evolving nature of these wave regimes have been extensively studied in climate models and re-analyses. Planetary wave amplitude is a challenging measurement compared to parameters such as wave propagation speed, jet strength and location, and wavenumber. In this study, the evolution of planetary wave amplitudes over the 20th Century are analyzed using a novel implementation of the quasi-geostrophic wave activity parameter. The trajectories of change are distinctive between the hemispheres and can be linked to sea ice properties.

Thu_17_AC-8_8
Contrast between Antarctic and Arctic Sea Ice Change

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A key issue to be resolved in cryospheric science is to fully understand and explain the contrast between Antarctic and Arctic sea ice change: Why Antarctic sea ice has been stable or even slightly increased while Arctic sea ice has been reduced drastically in the past several decades? We discuss multiple interactions and processes controlling the polar sea ice covers. We present results from SeaWinds scatterometer aboard the QuikSCAT satellite and from aircraft acquired during the NASA's Operation IceBridge (OiB). Results indicate that Antarctic sea ice cover is encapsulated by a band of circumpolar frontal ice zone (FIZ) containing older, rougher, and thicker sea ice in the zone adjacent to the sea ice edge. This is in a stark contrast to Arctic sea ice where the marginal ice zone (MIZ) consists of young and thin sea ice along the ice edge, which is easily reduced by melt and by wind and wave effects. For Antarctic sea ice, topography and bathymetry, which are stable geological factors, can have a significant role in sea ice processes that must be considered in explaining the overall stability of Antarctic sea ice. Finally, we will describe the 2017 OiB/TanDEM-X Antarctic Science Campaign (OTASC) to obtain extensive observations in characterizing Antarctic sea ice, by coordinating NASA Operation IceBridge (OiB) aircraft with DLR TanDEM-X satellite SAR data acquisitions together with other multi-sourced remote sensing data and surface field measurements.

Thu_18_AC-8_16
The Warm Arctic-Cold Siberia Temperature Pattern: Has it Happened before?

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The Warm Arctic-Cold Siberia surface temperature pattern during recent boreal winter is suggested to be triggered by the ongoing decrease of Arctic autumn sea ice concentration and has been observed together with an increase in mid-latitude extreme events and a meridionalisation of tropospheric circulation. However, the exact mechanism behind this dipole temperature pattern is still under debate, since model experiments do not support this sea ice forcing. We use the early Twentieth Century Arctic warming as a case study to investigate the link between September sea ice in the Barents-Kara Sea and the Siberian temperature evolution. Analysing a variety of long-term climate reanalyses, we find that the overall winter temperature and heat flux trend can be largely attributed to a reduction of September BKS sea ice. Tropospheric conditions show a strengthened atmospheric blocking over the BKS, strengthening the advection of cold air from the Arctic to Central Siberia on its eastern flank, together with a reduction of warm air advection by the westerlies. This setup is valid for both, the early and the current Arctic warming period.

Thu_19_AC-8_171
Impact of Permafrost Melting on the Hg Cycling in Thermokarst Pond

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Mercury naturally occurs as elemental mercury (Hg°) and organic and inorganic species as well. Microorganism can transform inorganic Hg to methylmercury (MeHg), and thus easily bioaccumulated in biota and biomagnified in the food web. Melting permafrost has the potential to release a large proportion of previously stored Hg and organic carbon that could alter the Hg cycling in permafrost zone and subarctic region. The aim of this study is to characterize Hg levels and carbon contents in thermokarst ponds during the cold and the growing season, to assess the contribution of allochtonous input of Hg and to evaluate their potential transport towards the aquatic system. Thaw ponds are formed by the collapse of peat mounds in discontinuous permafrost, eastern Canadian subarctic region. Our results suggest a strong link between MeHg production, nutrient status and the importance of anaerobic methylation. Winter results will be compared to summer measurements in order to assess the biogeochemical cycle of Hg in warmer months and to evaluate the potential Hg transport towards the aquatic system. Quantifying the Hg source originating from melting permafrost and soil leaching in subarctic and Arctic region in a changing climate is crucial of interest to assess the Hg dynamic in the aquatic ecosystem and the food chain.

Thu_20_AC-8_195
Arctic Precursors of Changing Eurasian Storm Tracks and Surface Climate

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Since synoptic eddies forming midlatitude storm tracks shape the day-to-day weather and several aspects of surface climate, seasonal predictability of their seasonal mean activity is of paramount importance to society. While some seasonal predictability of the Pacific storm track and related climate variations in North America is provided by atmosphere-ocean coupling in the tropics, seasonal predictability of Eurasian storm track variations has not been demonstrated yet. Here statistical analyses of atmospheric reanalysis (NCEP/NCAR) data and observed Arctic sea ice concentration (SIC) in the era of satellite observations (1979-2017) are used to identify linkages of a dominant mode of interannual variability in wintertime upper-tropospheric storm tracks over Eurasia to the concurrent surface climate anomalies and pre-winter Arctic SIC variations. This mode explains an exceptionally large fraction (about 70% of the variance) of the North Atlantic Oscillation (NAO) and of a leading mode of Eurasian surface air temperature variations. As more than 50% of its variance is found to be accounted for by October SIC anomalies in the Barents/Kara Sea, we conclude that wintertime Eurasian climate variability is to a large extent predictable. It is further shown that the predictability of the storm track/NAO system from Arctic sea-ice anomalies might have increased after the acceleration of the Arctic sea-ice decline in the 2000's.

Thu_21_AC-8_278
Hydrometeorology of Three Arctic Catchments in Different Stages of Deglaciation

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The Arctic is regarded as one of the most vulnerable regions to climate change. Retreat and thinning of glaciers is a prominent response, which, in turn, alters the functioning and importance of processes in proglacial and periglacial zones. When deglaciated, fluvial (along with slope) processes substantially determine the evolution of landscape and thus represent an important topic in climate change studies. Despite the progress in an understanding of fluvial systems over the past decades, lack of empirical studies in various environmental conditions has limited to address handful of questions such is the difference in importance of controls on hydrological response of streams across catchments. In the study, we focus on a description of relationship between meteorological factors and hydrograph during two ablation seasons in three catchments (Elsa, Ferdinand, Bertil Streams) in Billefjorden, Svalbard. These have similar geology, geomorphology and climate; however, they differ in an extent of glaciers. Meteorological variables are represented by air and ground temperatures, global radiation, precipitation, wind speed and direction, all measured by automatic weather stations with one-hour interval. Discharges were obtained in stable gorges near the outlet into the sea by applying discharge - water stage rating curve using continuous hydrostatic pressure sensors and handheld Acoustic Doppler Velocimeter.

Thu_22_AC-8_445
Sea Ice Influence onto Eurasian Snow Revealed by Model Sensitivity Experiments

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Snow is a critical element of the Arctic system and is rapidly changing due to global warming with unexpected impacts on environment, society and economy. Snow variations affect the atmosphere via changes in ther reflectance of shortwave solar radiation (albedo), emissivity of longwave radiation, insulation of the atmosphere from the soil below and latent-heat and water- release in association with melting. Understanding snow processes is a crucial need. Here, we show an intercomparison of an ensemble of CMIP5 models with observations for snow-related variables over the Arctic climate system for historical runs and future projections in different RCP scenarios. Moreover, we perfom two different sensitivity experiment prescribing SIC and SST with two atmospheric model CAM4 (low-top) and WACCM (high-top) to investigate the influence of sea ice on Eurasia regarding variability and trends of snow cover and on the atmospheric circulation on the North Atlantic sector.

Thu_23_AC-8_489
A Climatology of Strong Large-scale Ocean Evaporation

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In this presentation an object-based, global climatology (1979-2014) of strong large-scale ocean evaporation (SLOE) is presented. This study is based on the reanalysis data set ERA-Interim from the European Centre for Medium-Range Weather Forecasts (ECMWF). The mechanisms underlying the frequent occurrence of SLOE are discussed as well as the typically associated climatic properties. In polar regions more than half of the total wintertime evaporation is associated with SLOE. An analysis of the past history and fate of air parcels involved in cold season SLOE in the North Atlantic and the Southern Indian Ocean shows that cold advection is the main mechanism that induces these events. Extratropical cyclones thereby play an important role in setting the necessary equatorward synoptic flow. An analysis of the interannual variability of SLOE associated with the North Atlantic Oscillation and the Southern Annular Mode shows that SLOE is very sensitive to the location of the storm tracks in both hemispheres. This study highlights the strong link between transient synoptic events and the spatio-temporal variability in ocean evaporation patterns. The possible implications of this study for our understanding of the water cycle at mid- to high latitudes and for the interpretation of deuterium excess as a proxy for changes in climatic conditions are highlighted.

Thu_24_AC-8_560
Interconnectivity and Drivers of Baffin Bay and Greenland Melt/freeze Onset

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Oceanic and atmospheric warming of Greenland and surrounding areas has led to increased ice sheet spatial melt extent and decreased sea ice coverage during the summer months. The last two decades have witnessed increased warm air and moisture advection into the region from Greenland blocks and transient synoptic patterns that have exasperated the background warming signal and led to several melt season anomalies and isolated extreme melt events. The scope of the melt season is also evolving rather rapidly, particularly throughout much of Baffin Bay and adjacent portions of the western Greenland Ice Sheet, where melt (freeze) is occurring earlier (later) within the annual melt cycle. Less is known, however, about processes driving ice sheet and sea ice changes at the temporal boundaries of the melt season and how these ice environments physically interact during times of melt and freeze onset. Utilizing observational data from passive microwave satellite sensors, in situ weather stations, and reanalysis products we look to better understand the local sea/land ice interactions by 1) assessing relationships between the timing of melt and freeze onset, and 2) evaluating preconditioning factors, such as heat and moisture intrusions, that influence subsequent melt responses. Emphasis is placed on the autumn freeze onset period and how processes leading to a fluctuating freeze date influence ice sheet and sea ice melt during the subsequent spring.

Thu_25_AC-8_634
Reason for Accelerated Decline in Arctic Sea Ice in Recent Decades

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In recent decades, the Arctic sea ice has been declining at a rapid pace along with a significant warming in the region at a rate of twice the global average. The underlying physical mechanisms for the Arctic warming and accelerated sea ice retreat are not fully understood. We present evidence that the anomalous autumn Arctic intrinsic atmospheric modes could explain as much as 50% of autumn sea ice decline for the 1979-2016 period. The Arctic atmospheric circulation anomalies associated with anomalous sea surface temperature patterns over the North Pacific and North Atlantic influence sea ice concentrations primarily through anomalous water vapor advection and associated radiative feedback.

Thu_26_AC-8_878
Mechanism of Sea-ice Variability in the Indian Ocean Sector of the Antarctica

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The influence of global warming on the Arctic sea-ice exhibits a profound declining trend as expected. In contrast, sea-ice around Antarctica exhibits an overall expansion with regional heterogeneity that comprises of increasing and decreasing pattern in different sectors. Regional sea-ice variability in the Indian Ocean sector of the Antarctica (IOSA) during 1979-2015 revealed significant expansion of sea-ice extent at an average annual rate of 2.4%±1.2 per decade. The sea-ice expansion trend in this sector has a substantial seasonal variability which peaks in summer (10.6%±4.1 decade^{-1}), followed by autumn (4.0%±1.6 decade^{-1}), winter (1.9%±0.9 decade^{-1}) and spring (1.7%±1.2 decade^{-1}). Result showed robust features of sea surface freshening and cooling trend (up to ~100m depth) in the IOSA region which is conducive for expansion in sea-ice. The spatial trend map of sea surface temperature (SST) shows wide spread cooling throughout all seasons. Analysis of Ocean Reanalysis System 4 (ORAS4) and Met office EN4 observations shows sub-surface warming trend below ~100m depth, possibly from advection of modified circumpolar deep water which advects warm water onto the ice-shelf. In the present work, the mechanism of observed sea-ice expansion is analysed with respect to SST, winds, current, heat flux, vertical thermohaline structures, and leading climate oscillator of ocean-atmospheric coupled phenomenon.

Thu_27_AC-8_933
Bi-Polar Sea-ice Trends - An Overview of Possible Teleconnections

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Currently, Arctic sea ice extent for Sep 2017 was 4.87 million sq km, 7^{th} lowest in the entire satellite record since 1979 and was 1.67 million sq km (1.24 million sq km) below (above) the 1981-2010 average (Sep record low-2012). Antarctic sea ice has reached its maximum extent on Sep 15, at 17.98 million sq km among the earliest maxima on record. If this extent holds, it will be second lowest daily maximum in the satellite record at 20000 sq km above 1986 record. Antarctic sea ice extent has been record low since Sep 2016 though it has recorded highest until 2014-15. What is causing these drastic inter-annual changes? These changes are definitely causing on longer temporal forcing of multiple teleconnections. Depending on which teleconnection is strong on a particular time-period, which is weakening the other whilst together influencing sea-ice. We explain how multi-decadal scale teleconnections are acting on inter-decadal, inter-decadal on decadal, thereby annular modes and local factors. Study addresses how Pacific Decadal Oscillation (20-30 years)-Inter decadal Pacific Oscillation(15-30)-Atlantic Multi-decadal Oscillation-North Atlantic Oscillation-El Nino Southern Oscillation(2-7), Indian Ocean Dipole (1-2)-Annular Modes (North & South) had affected the polar climate over a period; thereby enhancing local factors. Since both the poles are behaving anomalously in terms of sea-ice, we focus on outlining the changes driving these on a broader scale with possible evidences.

Thu_28_AC-8_980

Response to the Arctic Sea Ice Decline in a Regional Climate Model

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Record high global temperatures in the beginning of the 21st century were accompanied by more frequent anomalously cold spells during winter in the Northern Eurasia. A number of previous studies based on empirical data analysis and global atmosphere general circulation models revealed a link between negative surface air temperature anomalies and rapid Arctic sea ice reduction. A mechanism of such a link is under discussion. The major hypothesis is based on interaction between large-scale atmospheric circulation and anomalous wave activity induced by low troposphere heating in the areas of sea ice retreat. The response can also be explained by regional circulation response to the modified local temperature contrasts. In order to test a possibility of the regional response, we performed ensemble simulations with COSMO regional atmospheric model for the region covering a part of the Northern Eurasia and Eastern Arctic. Simulations were performed for high and low sea ice concentrations in the Barents Sea and strong and weak zonal circulations for the both low and high sea ice cases. The model reproduced anticyclonic circulation anomaly in the southern Ural region accompanied by negative temperature anomalies as a response to the sea ice reduction only under conditions of a weak zonal flow. The results support a possibility of the regional response independent on interaction with stratosphere and/or circumpolar circulation modes and highlight a role of background circulation.

Thu_29_AC-8_1083
The Impacts of Greenland Ice Sheet Collapse on the Tides in Hudson Bay

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In Hudson Bay, sea level changes associated with Greenland ice loss vary across the bay and differ significantly from the change in global mean sea level equivalent due to gravitational effects. Changing water depths give rise to changes in ocean tides, for which tidal energy dissipation and tidal amplitudes are directly linked to ocean bathymetry (Green, 2010). In the present study, we investigate the impact of sea level changes on tides in Hudson Bay, Canada - a region where tidal energy dissipation is strongly sensitive to bathymetry (e.g. Egbert and Ray, 2000), and the bathymetry is in turn highly uncertain in some parts of the bay. Recent work by Wilmes et al. (2017) indicates that regional variability in future sea level changes as a consequence of ice sheet collapse will impact tides globally, in particular in Hudson Bay. We present simulations of the sea level changes associated with a suite of Greenland ice loss scenarios using a gravitationally self-consistent sea level model (Gomez et al., 2010) and consider the impact of these sea level changes on tides in the Hudson Bay using the OTIS tidal model. We also investigate the sensitivity of our tidal calculations to uncertainty in regional bathymetry. Our results aid in constraining the response of Hudson Bay tidal dynamics to projected sea level changes, elucidating the feedbacks between energy dissipation and shoreline migration, and assessing the impact of climate change on coastal regions in the Hudson Bay.

Thu_30_AC-8_1273
Predicting Arctic Sea Ice Extent using Causal Effect Networks

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Chukchi and East Siberian seas play a vital role in the polar resource exploration and ship transportation. In this study a novel data-driven approach named causal effect networks (CEN) was applied to explore the potential factors triggering the sea-ice loss in this region. The CEN is an adjusted causal discovery method, which can reduce data dimension by initially selected regional mean time series and avoid false correlations by conditionally independence tests. We took September sea-ice extent (SIE) as an example to know how it correlates with potential predictors including downward short- and long-wave radiation, sea surface temperature, and winds. It is shown that the predictors from selected lower-latitude regions are more closely related to September SIE than that from the local areas. The results are sensitive to parameters in the algorithm, such as significance level, temporal resolution, and max leading time. On the monthly scale, R^2 values for all the models exceed 0.97 when the max leading time is less than nine months with other parameters fixed. If the max leading time is seven months, the best prediction model can explain 98.7% of September SIE variance by Leave-One-Out Cross-Validation. We found the earlier zonal winds at 10 m height near the tropical eastern Pacific and Inner Mongolia are both the most significant predictors, while the downward long-wave radiation to the south of Greenland is an important heat source associated with September sea-ice loss.

Thu_31_AC-8_1316
Large-scale Atmospheric Teleconnection Related to Pan-Arctic Wildfire Activity

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The pan-Arctic has the potential for positive carbon-climate feedbacks by releasing a substantial amount of carbon buried in the permafrost zone. Wildfires can rapidly transfer carbon to the atmosphere, thereby playing an important role in the pan-Arctic terrestrial carbon cycle. One expected response to recent pan-Arctic warming is an increase in wildfire activity, but satellite-based observations suggest that the interannual variability of wildfires is much higher than a linear increase. We found diverse large-scale atmospheric teleconnections with wildfire activity in East Siberian and North American permafrost regions. However, dipole structures in sea-level pressure between Arctic and pan-Arctic commonly drive temperature anomalies in the pan-Arctic region and directly modulate wildfire activity. This dipole pattern is consistent with previous studies that showed teleconnections related to Arctic temperature variation via Rossby wave propagation. Furthermore, some large-scale atmospheric teleconnections lead few months later to wildfire activity; therefore, these climate variabilities could be a possible predictor for the pan-Arctic wildfire activity.

Thu_32_AC-8_1700
Landscape and Climate Interaction on sub-Antarctic Marion Island

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Marion Island in the southern ocean has a hyper-maritime climate and an environment where diurnal processes dominate the landscape. In a diurnal soil frost environment like Marion Island, the impact of climate change on the landscape occur at a higher resolution than for seasonal and permafrost environments and needs investigation at the synoptic time scale. Results from automated and manual measurements of the abiotic characteristics of a variety of habitats show that the passage of synoptic scale weather systems dominated the landscape on Marion Island. These systems influences the thermal characteristics of soil, intensity of rainfall, snowfall, soil frost dynamics, needle ice development, aeolian erosion, the hydrochemistry of stream water and a host of other abiotic processes and its direct and indirect interactions with the ecosystem. This presentation reviews the current knowledge on the interaction between climate and the landscape, the current methodologies employed to investigate these interactions and specifically addresses the possible landscape responses under a future climate.

Thu_33_AC-8_1702
Atlantic Multidecadal Oscillation Modulates the Impact of Arctic Sea Ice Decline

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Arctic sea ice cover has been rapidly declining in the last two decades and the connection between the sea ice decline and the Arctic Oscillation (AO) remain unclear. Here we use both observations and model simulations to investigate how the Atlantic Multi-decadal Oscillation modulates the connection between the sea ice decline and the AO. We find that the sea ice decline during the AMO|− induces increased Ural blocking activity and southward-extended snowpack over Eurasia in December through enhanced cold air advection and moisture transport from the Arctic. The increased Ural blocking activity and extended Eurasian snowpack strengthen the upward wave propagation over the Siberia-North Pacific in the lower stratosphere and hence lead to weakened stratospheric polar vortex and to the negative AO at the surface in February. However, corresponding to the sea ice decline during the AMO|+, one finds extended Arctic warming, less Ural blocking activity, and reduced snowpack over northern Eurasia in December. The stratosphere-troposphere coupling is suppressed in early winter and no negative AO anomaly is found in February. We suggest that the AMO|− is important to regulate the atmospheric circulation response to the Arctic sea ice decline and our study provide insight to the ongoing debate on the connection between the Arctic sea ice decline and the AO.

Thu_34_AC-8_1811
Causal Effect Networks in Arctic-midlatitude Teleconnections

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Mid-latitude variability can affect and be affected by Arctic climate change. Evidence exists for mechanisms operating in both directions, for example, sea ice decline causing cold winters in Eurasia (Mori et al. 2014), and moisture transport from the mid-latitudes driving sea ice decline (Park et al. 2015). An essential difficulty in investigating Arctic-midlatitude teleconnections is demonstrating causal links in a system with large internal variability. Here, we use causal effect network analysis (Kretschmer et al. 2016) to identify robust causal links between the mid-latitudes and Arctic, and to elucidate the characteristics of their lead-lag behavior. This approach allows us to test a range of pathways within the same framework, using variables such as poleward moisture transport, downward longwave radiation, surface turbulent heat fluxes, Barents-Kara seas ice cover, vertical wave activity, and polar vortex strength. This network analysis builds a clearer picture of the physical mechanisms linking the Arctic and mid-latitudes, as well as their relative importance in today's climate.
Kretschmer, M. et al. *J.Clim*. **29**, 4069 (2016)
Mori, M. et al. *Nat.Geosci*. **7**, 869 (2014)
Park, H.S. et al. *J.Clim.* **28**, 5030 (2015)

Thu_35_AC-8_1816
Impacts of Arctic storms on Atlantic Water Transports into the Arctic Ocean

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The impacts of Arctic storms on the Atlantic water transports into the Arctic Ocean are investigated using a coupled atmosphere-ice-ocean model (NEMO). In the Nordic Sea, Arctic storms play an important role on the air-sea interactions. To understand the impacts of the Arctic storms on the water volume transports through Fram Strait and the Barents Sea Opening, NEMO is implemented in the Arctic Ocean, forced by PHC temperature (salinity), GLORYS currents and CORE II surface fields. Compared to PHC data, NEMO can reliably reproduce the upper layer water temperature and salinity, suggesting a warm layer at intermediate depths. In addition, the model simulations exhibit significant decadal variations of water volume transports through Fram Strait and the Barents Sea Opening. Moreover, the storm activity in the eastern Arctic Ocean plays an important role in the variability of Atlantic water inflows. In the early 1990s and 2000s, while increased storm activity in the Greenland Sea tended to enhance the Atlantic water transport through Fram Strait, the increased Atlantic water inflow through the Barents Sea Opening was mainly associated with the storm activity in the northern Barents Sea. Furthermore, our results also show that the decadal variability in the storm activity is related to decadal variations of atmospheric baroclinicity.

Thu_36_AC-8_1821
The Atmospheric Circulation Response to Sea Ice Change in an Aquaplanet AGCM

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Despite considerable modelling efforts, there remains uncertainty about the magnitude and nature of the sensitivity of the atmospheric circulation to sea ice change. Here, the impacts of sea ice loss on the global atmospheric circulation are investigated using equilibrium simulations in an aquaplanet AGCM with prescribed, zonally symmetric, sea ice.
Responses can be separated into two broad categories; for sea ice constrained to poleward of 60º, the difference relative to a simulation with no ice is a moderate acceleration on the poleward flank of the eddy-driven atmospheric jet stream which projects increasingly onto the annular mode. For larger extents, anomalies are much larger relative to the magnitude of the forcing and a shift in circulation regime is evident, with the jet and storm tracks shifting polewards and intensifying.
This is consistent with previous work in which sea ice reductions are connected to equatorward shifts in the jet. Moreover, the apparent nonlinearity in the magnitude of the response aids our understanding of the range of responses found in previous studies with models of varying complexity.
It is also demonstrated that jet latitude variability increases as ice extent increases, and that certain features of changes in the jet speed are masked by looking only at the time-mean picture. These results have implications for understanding the impact of different sea ice extents in paleoclimate, as well as the twentieth and twenty-first centuries.

Thu_37_AC-8_1829
The Role of the Aleutian Low in Seasonal Melt of the Pacific Arctic Cryosphere

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Recent springtime climate extremes have been observed along the northern coast of Alaska. The dates when snow melted at Barrow in 2015 and 2016 were the 4th and 1st earliest recorded, respectively, since 1901. These early years were followed in 2017 by the latest date of snow melt since 1988, nearly seven weeks later than in 2016. Previous work implicates the northward advection of warm air circulating around the Aleutian Low during years of early melt and blocking by the Beaufort High during years of later melt. The same circulation patterns have been linked to the timing of the onset of ice melt in the Chukchi Sea. Here, we further investigate how the transport of Pacific air to the Arctic is linked to the position of the Aleutian Low and its juxtaposition with the Beaufort High. Using reanalysis, satellite and surface-based data sets we analyze how the spatial distribution of air temperature is modified by variability in the atmospheric circulation. Anomalies are further investigated by analysis of the resulting spatial patterns in the timing of snow melt over land areas and melt onset over the sea ice. We introduce a new climate index that explains some of the variance in those variables. This index is suitable for monitoring changes in regional circulation and may be useful for developing seasonal-scale predictive tools.

Thu_38_AC-8_1928
Variability of Circulation Eddy Energy Components in High Latitudes of Siberia

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Acceleration of warming in the Arctic region over last decades causes reduction of sea ice cover and intensification of heat exchange between ocean and atmosphere. Observed changes in atmospheric circulation processes lead to climate change in the adjacent regions, for instance, winter cooling in the midlatitudes of Eurasia.
Main goal of this study is the investigation of seasonal variability in energetic characteristic of atmospheric circulation in West Siberia (50°-70°N, 60°-90°E), where special attention paid for its Arctic part. Statistical estimations of climatic variables and energy characteristics (zonal and eddy components of available potential and kinetic energy), were derived using reanalysis data (ERA-Interim, JRA-55) and climate system model INMCM 4.0. The calculation of baroclinic instability parameter fields allowed us to reveal baroclinity zones, to define the changes in its intensity and, as a result, to get an overview about the variability of advection over the region of under study. It was revealed that in the beginning of XXI century the variability of eddy kinetic energy has significant contribution to temperature variability over the territory of West Siberia. Moreover, constructed temporal variability of relative vorticity value (anticyclonic type) showed the increase of this parameter in winter months.
The work is supported by the grant of the RF President MK-2018.2017.5 and by RFBR, according to the research project No.16-35-60088 mol_a_dk.

Thu_39_AC-8_2002
Inter-seasonal Temperature Teleconnections in the Northern Hemisphere

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On the basis of ERA-Interim reanalysis we analysed relationships the between Earth surface temperature (Ts) in the Northern Hemisphere (on grid 1.5°-1.5°) and 2-m air temperature (T2m) in 13 selected study regions in Europe, Greenland, and parts of Asia and North Africa for the period 1979-2016. Applying detrended data we eliminated spurious correlations resulting from similar trends in the two variables.
We detected significant correlations between the surface temperature over the Labrador Sea, Canadian archipelago and North Atlantic and 2-m air temperature in different study regions for inter-seasonal spring - summer (MAM-JJA) and autumn - winter (SON-DJF) relationships.
Among the strongest correlations between the spring Ts and summer T2m were the positive correlations found between Ts in the North Atlantic and T2m in Scandinavia, Ts in the Labrador Sea and T2m in Northeast Europe, and Ts in Norther Sahara and T2m in Urals.
As well, among the strongest correlations between the autumn Ts and winter T2m were the positive correlations found between Ts in the North Atlantic and the Labrador Sea and T2m in Scandinavia and Northwest Africa; and the negative correlations found between Ts in the Labrador Sea and the North Atlantic and T2m in Scandinavia, Northeast Europe, Urals, Black Sea region and Northcentral Asia.
Authors acknowledge RSF project No. 17-17-01151.

Thu_40_AC-8_2012
Coupled Modes of Barents Sea Ice and Atmospheric Anomalies in Autumn and Winter

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Recent studies report linkages of late autumn Barents-Kara sea ice and winter atmospheric circulation anomalies but it is unclear what the zero-lag feedbacks and higher coupled modes do. Here, we revisit the problem using Maximum Covariance Analysis (MCA), examining not only the first modes but also higher modes that contribute significantly to the squared covariance fraction (SCF). Besides sea ice concentration, SLP, and geopotential height, we also analyse heat advection and surface temperature to elucidate the climate impact on Europe. In reanalysis/observational data, the first two atmospheric modes at zero lag advect cold/warm air southward/northward over the Arctic-Atlantic sector, and are associated with positive/negative sea ice anomalies. Additionally, the atmospheric modes at zero lag can cancel or reinforce, depending on the regions, the lagged atmospheric responses to sea ice reported previously. Applying the same analysis to coupled model simulations, we find that models can reproduce the first MCA modes, but they are far too dominant (SCF > 60%) compared to those in observational data (SCF ~ 40%). This suggests that coupled modes in models are not as diverse as in the real world, and that the lagged coupled modes are underestimated by models. By considering all the leading modes, we can have more complete understanding of the lagged and zero-lag feedbacks. Additionally, examining MCA beyond the first modes can be used to assess coupled modes simulated by models.

Thu_42_AC-8_2092
Enhanced Poleward Moisture Transport Contested

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The catchment of the Ob, Yenisei and Lena rivers covers stretch from 46°N to 71°N and cover 7.95 million square kilometers. The water cycle over these basins is sensitive to rising temperatures due to melting permafrost, reduction in snow cover, increased atmospheric moisture and possible circulation changes. Downstream, the river discharge is a major contributor to the Arctic Ocean freshwater budget. Changes in the regional water cycle are constrained upstream by the quantity of water vapour transported by winds into the domain, which can be monitored with atmospheric reanalyses.
Our study builds upon the work of Zhang et al. [Nature Climate Change 3.1 (2013): 47-51.] using NCEP NCAR R1. We evaluate the robustness of their conclusions using state of the art reanalyses (ERA-Interim, NCEP CFSR, JRA 55 and MERRA 2) and prolonging the reference period from 2008 to 2015. The increasing trend in NCEP NCAR R1 is found to be sensitive to the start and end points and is weaker or absent in the other datasets. We confirm that the variability of the moisture convergence is a consequence of changing winds rather than increasing moisture. Finally, we contrast this behaviour with moisture fluxes into the High Arctic (north of 70°N) where winds and humidity show opposite trends.

Thu_43_AC-8_2172
What If Paris Works: Ice Sheet Surface Melting in Low and High Warming Worlds

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Surface melting on the Greenland ice sheet has seen dramatic change with increasing global air temperatures, e.g., recent melt extent often exceeds the 1981-2010 median through much of the melt season. To evaluate potential future change, we investigate surface melting drivers under both low (~1.5 °C) and high (RCP 8.5) warming scenarios including differences in scenario outcomes.
Melt-relevant climatologies are developed from two publicly available ensembles of CESM1-CAM5-BGC runs: the 30-member Large Ensemble (CESM LE; Kay et al. 2015) for historical calibration and RCP 8.5 scenario and the 11-member Low Warming ensemble (CESM LW; Sanderson et al. 2017) for the 1.5 °C scenario. For higher spatial resolution (15 km) and improved polar-centric model physics, we also apply the regional forecast model Polar WRF to decadal subsets (1996-2005; 2071-80) with ERA-Interim Reanalysis (ERAI) & GCMs for boundary conditions.
Models are skill-tested against ERAI and AWS observations. For example, CESM LE tends to overpredict both maximum (above-freezing) and minimum daily average surface temperatures vs GC-Net Swiss Camp AWS observations.
Future (2081-2100) Greenland warms even in the LW scenario, but positive changes vs ERAI are mostly coastal (2-3 °C) with the interior showing only minor change. Under RCP 8.5, the entire ice sheet has warmed by 2-6 °C, or a median increase of ~5 °C vs LW. Adjusting for the CESM cold bias pushes these values closer to more frequent melting conditions.

Thu_44_AC-8_2277
Reconstruction of Autumn SIE during 1289-1993AD for Barents-Kara Seas, Arctic

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Using high resolution ice core and tree ring proxies for sea ice extent (SIE), we reconstructed robust time series of autumn SIE over the Barents-Kara (B-K) sector of Arctic during 1289-1993 AD. After inter-comparison of the results and statistical parameters of the Ordinary Least Squares Regression (OLSR), Principle Components Regression (PCR) and Partial Least Squares Regression (PLSR) methods, the SIE time series are synthesized into a more convincing one using weighted average method with the explained variance as the weight. The result shows that during 13th to 18th century, autumn B-K SIE is in a high level with high oscillations and has a slight trend of expanding. It reflects significant multidecadal oscillations during the little ice age (LIA) background. B-K SIE starts to decline since the end of 18th century and the shrinking trend becomes very significant during the second half of the 19th century lasting to 1930s-1940s. 1930s-1940s is a period of relative low SIE in B-K sea and the SIE has a short period of expandation during 1940s-1970s. However, the B-K SIE has continuously been shrinking significantly since 1970s,with industrial activities may be a dominant factor. B-K SIE retreats significantly since 1970s with the speed 6.18 times as the former mean retreating speed, the Arctic SIE in recent years may be the lowest one over the last millennium.
Keywords: Arctic; Sea ice; Ice core; Tree rings; Paleoclimatology; Global Warming

Thu_45_AC-8_2487
Analyses of Explosive Cyclones Reaching the Antarctic Coast in 2017

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Explosive cyclones or meteorological bombs are a kind of mesoscale cyclones known for their rapid intensification, but are not necessarily short-lived. They can produce strong winds, heavy rainfall and dangerous oceanic conditions as a result of rapid change of central pressure. It is likely that climate change is causing an increase in this type of event in the Antarctic coast and, if this increase is confirmed, the regime of winds and temperatures may be changing. In the northern portion of the Antarctic Peninsula a decrease in temperature has been recorded over the last 15 years, with a higher incidence of explosive cyclones over the region having been noted during this period. Explosive cyclones, which change the wind patterns when they reach certain areas, therefore may be contributing to this change in the Antarctic climate. This study is part of the "Explosive Cyclones on the Antarctic Coast" (EXCANC) Project conducted by the World Environmental Conservancy organization which analyzes data from 13 meteorological stations strategically scattered throughout the coast and operated by various international Antarctic programs, and also utilizes satellite images. Results show that through October of 2017, 96 cases of explosive cyclones in the Antarctic continent have occurred with around 100 cases being expected through the end of the year; the greatest number of events have been recorded at the Australian Casey station (16 cases). Intensity analyses also are shown.

Thu_46_AC-8_2581
Light-absorbing Impurities in Coastal Snowpacks in Western Antarctica

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Black carbon (BC), light-absorbing impurities plays an important role in Earth's cryosphere due to its strong absorption of visible light. Direct absorption of solar radiation by BC leads to atmospheric warming, while BC deposition on snow increases the fraction of solar energy absorbed accelerating in turn melting.
In this context, we focused our efforts on the measurement of the BC concentration and other light-absorbing impurities as well as algae in snow. In the last two years, we sampled in the snow across a north-south transect of almost 2000 km of the Chilean Andes: from at 8 locations from King George Island (62°S) to the southern Ellsworth Mountains on the broad expanse of Union Glacier (79°S; 3030 km from the southern tip of Chile and just about 1000 km from the South Pole). The sampling methodology was the meltwater filtration (MF) technique, whereby our 235 snow samples (of about 2.5 liters each) were melted shortly after collection and passed through a 0.4 mm nucleopore filter.
As expected, we found significant geographical differences in the content of light-absorbing impurities. For surface snow, the estimate of BC-equivalent mass loading was found to be 5 ng/g on King George Island to 0.5 ng/g at Union Glacier Camp. Our measurements also showed that light-absorbing impurities as well as the effect of algae in the snow decreased as we went south.

Thu_47_AC-8_2596
Interplay of Sea Ice and Oceanic Vertical Mixing in the Arctic Warming Hotspot

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The Arctic is warming twice as fast as the global mean, with the northern Barents Sea being the absolute warming hotspot. This region has seen the largest decline in winter sea ice and the strongest surface warming, with the warming signal extending deep into the water column and high into the lower troposphere. The mechanisms controlling the heat transfer from the sub-surface warm Atlantic layer, and thus the sea ice cover and the lower troposphere temperatures, are not well understood nor quantified. In this presentation, we explore some of the mechanisms that we believe are important in the Arctic warming hotspot.
Our analysis is based on an extensive observational hydrographic data set from late summer and early autumn 1970-2016 in the northern Barents Sea. Focus for the study is the relationships between the upper ocean stratification, vertical fluxes of heat and salt from the deep Atlantic layer, and influx of sea ice and fresh water to the region. Year-to-year changes in the distribution of heat and salt in the water column reveal substantial variations in vertical fluxes of heat and salt that is controlled by upper ocean salinity. Special focus is on the freshwater input to this region, its interplay with vertical mixing, and its role in the Arctic warming hotspot.

Thu_48_AC-8_2689
Properties and Predictability of Precipitation over the Mertz Glacier Region

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Intense precipitation events are important contributors both to the surface mass balance of the Antarctic ice sheet and Southern Ocean salinity. As they are typically associated with high wind speeds and whiteouts they also strongly disturb local operations. Here we analyse several precipitation events affecting the Mertz glacier region and Dumont D´Urville (DDU) station in February 2017 combining unique ship-based measurements performed during the Antarctic Circumnavigation Expedition (ACE) and DDU station measurements. Precipitation amounts and properties are obtained using a combination of techniques, including precipitation radars, photoelectric particle counters, and formvar imprints of snowflakes for microphysical characterization. Atmospheric profiles are analyzed using radiosonde measurements. The events were forecasted and closely monitored using operational analysis of the European Centre for Medium-range Weather Forecasts (ECMWF) model and the Antarctic Mesoscale Prediction System (AMPS)/Polar WRF model. A combination of ACE and DDU measurements provide a unique opportunity to evaluate model performance and assess predictability of the events at different forecast lead times.

Thu_49_BE-2_55
Nitrogen uptake by Phytoplankton in the Indian Sector of Southern Ocean

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This study reports nitrogen uptake rate (using ^{15}N tracer) of phytoplankton in surface waters of different frontal zones in the Indian sector of Southern Ocean (SO) during austral summer of 2013. The investigated area encompasses four major frontal systems, i.e., the Subtropical Front (STF), Subantarctic Front (SAF), Polar Front-1 (PF1) and Polar Front-2 (PF2). Analysis of nutrient ratios indicated potential N-limited conditions at the STF and SAF but no such scenario was observed for PF. In terms of phytoplankton biomass, PF1 was found to be the most productive followed by SAF, whereas PF2 was the least productive region. Nitrate uptake rate increased with increasing latitude, as no systematic spatial variation was discerned for NH_4^+ and urea. Linear relationship between nitrate and total N-uptake reveals that the studied area is capable of exporting up to 60% of the total production to the deep ocean if the environmental settings are favorable. Like N-uptake rates the *f*-ratio also increased towards PF region indicating comparatively higher new production in the PF than in the subtropics. The moderately high average *f*-ratio (0.53) indicates potentially near equal contributions by new production and regenerated production to the total productivity in the study area. Elevation in N-uptake rates with declining temperature suggests that the SO with its vast quantity of cool water could play an important role in drawing down the atmospheric CO_2 through the “solubility pump”.

Thu_50_BE-2_57
Plankton Production in Open Southern Ocean and Surrounding subantarctic Islands

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The Southern Ocean supports a complex foodweb which is shaped by the many interactions occurring between the planktonic system and the physico-chemical conditions of the marine environment, which affect both primary production and net ecosystem production. Southern Ocean ecosystems are thought to be changing rapidly due to climate change, yet much remains unknown of the “baseline” state of trophic carbon fluxes, which is key to understanding the potential ecosystem response to ongoing or future perturbations. We investigated ecosystem production and plankton trophic dynamics in the waters surrounding the Subantarctic Prince Edward Island archipelago during two expeditions to the Southern Ocean - the Antarctic Circumnavigation Expedition (ACE) in December 2016 and a SANAP cruise to Marion Island in April/May 2017. We collected biological (e.g., plankton abundance, biomass, diversity) and chemical (e.g. dissolved organic carbon, nutrients, chlorophyll, carbon and nitrogen) samples and measured biogeochemical rates (e.g. primary and secondary production, net ecosystem production) in the open Subantarctic and in the vicinity of the islands. Trophic structure, rates of production, nutrient biogeochemistry and their interactions will be discussed, with a view to better understanding Subantarctic ecosystem carbon cycling.

Thu_51_BE-2_226
Contribution of Small Cells to the Total Primary Production in the Amundsen Sea

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The warming ocean is anticipated to increase the importance of small phytoplankton. However, little information has been reported in the Amundsen Sea. To understand the seasonal variation of the small contribution to the carbon uptake rates, the ^{13}C-^{15}N dual stable isotope tracer techniques were carried out during January-February 2016 and the small contributions were compared with the previous results in different seasons. The total daily carbon uptake rate and the small contribution to the primary production averaged in all stations were respectively 0.59 g C m^{-2} d^{-1} and 24.8 %. In the polynya region alone, the average total daily carbon uptake rate was 0.72 g C m^{-2} d^{-1} and the average small contribution was 24.2 %. The mean proportion of small cells to the total carbon uptake rates in the polynya region in this study was significantly different from previous results: 50.8 % in February-March 2012 and 14.9 % in early January 2014 (one-way ANOVA; $F = 15.66$, $p < 0.01$). Different bloom timings of large and small phytoplankton are suggested for causing the large seasonal variation of small contribution. The total daily carbon uptake rates and the euphotic depths were also changed largely along the season. A strong negative correlation ($r = -0.52$, $p < 0.01$) between the small contributions and the total daily carbon uptake rates was found in this study, whereas a strong positive correlation was found between the small contributions and the euphotic depths ($r = 0.75$, $p < 0.01$).

Thu_52_BE-2_234
In-situ Carbon and Nitrogen Uptake Rates of Arctic Melt Pond Algae

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Relatively little studies on melt pond ecosystems have been conducted in the Arctic Ocean although melt ponds are a ubiquitous feature of summer Arctic sea ice. Twenty two melt pond samples at ice camp 1 (146.17 ºW, 77.38 ºN) and 11 melt pond samples at ice camp 2 (169.79 ºW, 76.52 ºN) were obtained to measure uptake rates of carbon and nitrogen from various melt ponds in the western Arctic Ocean. The major nutrient concentrations were largely variable among melt ponds at the ice camps 1 and 2. The chl-a concentrations averaged from the melt ponds at the camps 1 and 2 were 0.02-0.56 mg chl-a m^{-3} (0.12 ± 0.12 mg chl-a m^{-3}) and 0.08-0.30 mg chl-a m^{-3} (0.16 ± 0.08 mg chl-a m^{-3}), respectively. The hourly carbon uptake rates at the camps 1 and 2 were 0.001-0.080 mg C m^{-3} h^{-1} (0.025 ± 0.024 mg C m^{-3} h^{-1}) and 0.022-0.210 mg C m^{-3} h^{-1} (0.077 ± 0.006 mg C m^{-3} h^{-1}), respectively. In comparison, the nitrogen uptake rates at the camps 1 and 2 were 0.001-0.030 mg N m^{-3} h^{-1} (0.011 ± 0.010 mg N m^{-3} h^{-1}) and 0.002-0.022 mg N m^{-3} h^{-1} (0.010 ± 0.006 mg N m^{-3} h^{-1}), respectively. These values obtained in this study are significantly lower than those reported previously. A large portion of algal biomass caught into new forming surface ice in melt ponds appears to be a main potential reason for the lower chl-a concentration and subsequently lower carbon and nitrogen uptake rates in this study.

Thu_53_BE-2_314
Water Column Stability Drives Production/export Dynamics in Two WAP Bays

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Normally the Southern Ocean is characterized by its high nutrient availability and its low chlorophyll concentrations (High Nutrients Low Chlorophyll or HNLC). Discrepancy, which seems to be caused by the paucity of micronutrients (e.g. Fe). Nevertheless, this general pattern does not entirely apply in coastal areas (e.g. bays), where iron is more abundant due to meteoric water inputs (i.e. glacial melt). In the Western Antarctic Peninsula water column stability has been proposed as the main cause for massive phytoplankton blooms that attain very high primary production rates.
During the extremely warm summer of 2017 (January and February) we found huge phytoplankton blooms (chlorophyll > 15 mg m-3) inside Maxwell Bay (King George Island, South Shetland Islands) and South Bay (Doumer Island, Palmer Archipelago). Accordingly, primary production rates were very high (1.3 - 8.9 g C m-2 d-1) agreeing with concomitant measures of low pCO2 (< 200 µatm) near surface waters. Fast winds (>70 km h-1) mixed the water column, breaking the stability promoting phytoplankton blooms and diminishing chlorophyll concentrations, whereas its downward vertical flux increased.
These findings suggest that bays on the Western Antarctic Peninsula may act as biological “hot spots” (i.e. CO2 sinkholes) gathering phytoplankton, when they present a stable water column, that afterwards may be exported horizontally (nearby oceanic waters) or vertically (carbon sinking) due to fast winds forcing.

Thu_54_BE-2_320
Macromolecular Compositions of Phytoplankton at the Jang Bogo Station

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To obtain the monthly variation in macromolecular compositions (carbohydrates, proteins, and lipids) of phytoplankton, surface water samples were collected at the Jang Bogo Station (74° 37.4´ S, 164° 13.7´ E) located in Terra Nova Bay, Antarctica. Samplings were performed approximately once every second week from February to October, 2015. The total chlorophyll a (Chl-a) concentration was 0.32 μg L^{-1} (S.D. = ± 0.88 μg L^{-1}) averaged from our observation period. The phytoplankton community was dominated by large-sized phytoplankton (> 20 μm) accounting for 58.9 ± 18.5 % (mean ± S.D.) of the total Chl-a concentration, followed by middle-sized (2-20 μm; 26.8 ± 10.5 %), and small-sized phytoplankton (0.7-2 μm; 14.3 ± 9.4 %). Overall, carbohydrates were dominant components of total phytoplankton with a mean of 69.3 % (± 13.8 %) and had an increasing trend over our study period except February 9, 2015. On the other hand, protein contribution was lowest (9.4 ± 11.0 %) except February, 2015 and had a decreasing trend from February to October. Lipids, however, did not show any specific trend with a few fluctuations (21.4 ± 4.4 %). In comparison, the overall contributions of carbohydrates, proteins and lipids of small phytoplankton were 68.8% (± 12.0 %), 6.5 % (± 9.2 %) and 24.6 % (± 5.9 %), respectively.

Thu_55_BE-2_559
Carbonate Sensitive Phytotransferrin Controls High-affinity Fe Uptake in Diatoms

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In large regions of the Southern Ocean the scarcity of iron controls the growth and productivity of phytoplankton. While most dissolved iron in the marine environment is complexed to organic molecules, picomolar amounts of unchelated ferric iron (Fe’) are maintained within the euphotic zone and are an important source of iron for eukaryotic phytoplankton, particularly diatoms. In the model diatom *Phaeodactylum tricornutum,* we show high-affinity Fe’ acquisition is mediated by phytotransferrin, a endocytosis-dependent functional analog of transferrin. Like transferrin, phytotransferrin coordinates the binding of iron with carbonate (CO_3^{2-}), and manipulation of the carbonic acid system reveals that the synergistic binding of [Fe’] and [CO_3^{2-}] occurs at environmentally relevant concentrations of seawater carbonate, and [CO_3^{2-}] co-limits Fe’ uptake. We show phytotransferrin has broad phylogenetic distribution among marine eukaryotes and is abundant in Southern Ocean genomic and proteomic datasets, suggesting that ocean acidification and the decline in seawater [CO_3^{2-}] will negatively impact this iron acquisition mechanism, with possible implications for carbon export rates and marine biogeochemical cycles.

Thu_56_BE-2_642
Enhancing of Biological Pump in the Chukchi Sea Based on Chinese Arctic Cruises

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With decreasing of sea ice cover there would the potential for deepening of nutricline and an increasing of annual biological pump in the Arctic Ocean because of more nutrients in the euphotic zone will be consumed in an ice free sea or open ocean. Since 1999 (in summers, 1999, 2003, 2008, 2010, 2012, 2014, 2016), seven Chinese Arctic Expeditions has been carried out in Chukchi Sea and Canadian Basin where upper ocean nutrients are abundant compared with European sector of the Arctic Ocean. During those cruises, we analyzed nutrients, DO, pH, chl a, opal and HPLC pigments in the water column, which allow us to look the variation of nutricline and biological pump after sea ice retreat since 1999. The results showed that size fractionation of chl a and opal, chl a-maximum depth, phytoplankton communities changed dramatically in the West Arctic Ocean, especially along the longitudinal 170°W section since 1999. A highlight of those changes is deepening of nutricline in summer and increasing of the depth of chl a-maximum in the shelf waters such as Chukchi Sea and ice edge in the Canadian Basin since1999. Organic carbon, opal burial and biomarkers records in sedimentary cores in the Chukchi Sea also indicated that increasing of organic carbon burial and relative abundance of diatoms while the contributions of haptophytes decreased since last 250a. We will involve MOSAIC program and future Chinese cruises in the west Arctic Ocean focusing on biological pump observation.

Thu_57_BE-2_647
Sedimentary Pigments as Biomarkers of Benthic Communities in Kongs-Krossfjorden

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In the present study, the surface sediments from Kongsfjorden-Krossfjorden, Arctic were examined for spatial distribution and biomarkers of benthic communities. Photosynthetic pigments (chlorophyll a and b), accessory pigments (fucoxanthin, zeaxanthin, alloxanthin, lutein etc.), and chlorophyll a decomposition products (chlorophyllide a, pheophorbide a, pheophytin a) from surface sediments were analyzed using high performance liquid chromatography. The distribution of pigments was found to be spatially variable with overall greater concentrations in Krossfjorden than Kongsfjorden. In both the fjords, the most abundant pigment was chlorophyll-a (0.1-0.8 µg g-1) followed by pheopigments (0.06-0.6 µg g-1) with greater concentrations recorded in mid-fjord stations, indicating the productivity distribution within the fjord. Similarly, the concentration of β-carotene (total algal abundance) & carotenoids like alloxanthin (cryptophyta), fucoxanthin (diatoms), lutein (Chlorophyta, Euglenophyta, Plantae) and zeaxanthin (cyanobacteria) recorded to be elevated at middle of fjord, but peaked at outer fjord stations. The ratio Chl-a:pheo was >1 in most stations, indicating that chlorophyll-a was preserved despite grazing and degradation pathways that accumulate pheopigments. The overall study outlines the spatial distribution of benthic communities in the two fjords and baseline for further ecological studies to be undertaken for the region.

Thu_58_BE-2_741
The Effect of Climate Change on the Carbon Balance in Microalgae

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The Southern Ocean is an important sink for the atmospheric CO_2 due to the physical and the biological (photosynthetic) activity of phytoplankton. Some studies have investigated the photosynthetic activity of the benthic and pelagic producers, but there is only very scarce knowledge about the carbon losses due to respiration of phytoplankton. The reason for this lack of information is principally methodological limitations. In the light of expected changes of environmental conditions due to the climate change, the aim of the project is to investigate the range of variability of photosynthesis over respiration ratio (rP/R) in response to different growth conditions, namely: different temperatures, water salinity and in dependence on iron availability. In this respect, two key species of the Southern ocean are investigated: the diatom *Fragilariopsis cylindrus* and the prymnesiophyte *Phaeocystis antarctica.*

Thu_59_BE-2_756
Particle Flux and the Biological Pump in Prydz Bay, Antarctica

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The ''biological pump" (BP) plays a central role in the sequestration of carbon away from the atmosphere for long time. Sea ice change, slope transport, CDW upwelling and other climate change processes will change the Antarctic BP process and efficiency. Between 2009 to 2017, ten sets of mooring system with sediment trap were deployed in the Prydz Bay to study the seasonal variations of particle fluxes. 6 moorings with 7 sediment traps were successfully recovered. The annual average flux of organic carbon (OC) and biogenic silica (BSi) were comparable to other similar Antarctic seas. The summer flux is the main contribution of the whole year flux, ca. >80%. The major contributor to the total mass flux was BSi. Comparison of remote sensing data, there are significant inter-annual differences. The results of carbon and nitrogen stable isotopes show that, the lowest organic carbon flux during the summer of 2014/2015 may be caused by strong lateral transport from east, thereby in-situ production of high organic matter cannot settle down to the trap. In deep ocean, the upper fluxes were extremely low while the lower fluxes relatively high during winter, which may be explained by sediment suspension or lateral transport. High fecal flux during winter suggest that strong biological process would happened on the continental slope. This speculation requires further evidence, and it could improve a better understanding of the link between the BP and Antarctic ecological process.

Thu_60_BE-2_778
Effects of Iron Bioavailability on Plankton Communities from the Southern Ocean

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Organic ligands such as saccharides and exopolymeric substances (EPS) are known to complex with iron (Fe) and influence Fe bioavailability to phytoplankton. In this work, we addressed how Fe enrichment associated to organic binding ligands influences productivity and biodiversity of natural phytoplankton communities from two sites of the Drake Passage and one from the Western Antarctic Peninsula. At each station, short- (24h) and long- (6d) term incubations were performed with the *in-situ* phytoplankton community without (control treatment) and after addition of different Fe-binding ligands including: the siderophore desferrioxamine B, two saccharides, two different bacterial EPS and a virally degraded EPS. While siderophores consistently decreased Fe uptake rates, effects of saccharides and EPS were variable the different plankton size fractions. Additionally, Fe speciation measurements allowed us to characterize the pool of Fe-binding ligands naturally present in the samples, and determine the impact of the added organic ligands on Fe bioavailability and phytoplankton productivity. Our results illustrate that the different organic ligands used have great capability to differentially modulate Fe bioavailability for different plankton groups. The simultaneous characterization of chemical and biological parameters provides valuable insights in the rarely carried out relationship between Fe chemistry and Fe bioavailability.

Thu_62_BE-2_914
Seasonality of Carbon Cycling in the Kerguelen Bloom Reveals by Autonomous Tools

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The central Kerguelen plateau hosts a recurrent massive phytoplankton bloom essentially sustained by natural iron fertilization. During the past decade, this bloom has been extensively studied thanks to oceanographic cruises but a complete view of the seasonal dynamics was still missing. The SOCLIM project has filled this gap with the deployments of both instrumented moorings and biogeochemical Argo floats. The subsurface mooring (40 m) was equipped with biogeochemical sensors and a remote autonomous sampler. Two sediment traps were also deployed at 300 m at the same site. This 1D view was completed by 2 BGC argo floats that drifted close to the moorings and captured the export events. The data collected during SOCLIM will allow to understand the interplay between environmental factors (light, nutrients) and bloom dynamics, and how biological activity and ecological vectors contributes to the CO_2 sink and carbon storage in the deep waters.

Thu_63_BE-2_922
Satellite Study on Particulate Inorganic Carbon Content within *E. huxleyi* Blooms

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By implementing the developed methodologies of *E. huxleyi* blooms identification and special processing algorithms to the satellite data, multi-year time series of variations in occurrence, spatial extent, and content of particulate inorganic carbon (PIC) within *E. huxleyi* blooming areas in the North, Norwegian, Greenland, Barents, and Bering Seas were obtained for the time period 1998-2013. The analysis of obtained results permitted to reveal the specific features of *E. huxleyi* blooming events in the studied regions. During the intra-annual cycle, *E. huxleyi* blooms advance from temperate to higher latitudes along the pathways of the Gulf Stream propagation starting from North and Norwegian Seas (in early June), and ending in the Barents Sea (in late July-early September). The highest bloom areas in the North Atlantic-Arctic waters were registered in the Barents Sea (up to 250,000 km^2). The same pattern holds for the total PIC content within *E. huxleyi* blooms: values of this parameter reached the amount of ~0.35 Mt in the Barents Sea. In the Bering Sea, the temporal and spatial dynamics of E. huxleyi development proved to be highly irregular: before and after the 1997-2001 period of high intensity of this phenomenon, the blooms are sporadic, their extent and PIC production are either very low or insignificant, whereas during 1997-2001, it even exceeded the values for the Barents Sea: up to ~0.4 Mt and, on one occasion (in 2001), even about ~0.7 Mt.

Thu_64_BE-2_929
Dissolved CO_2 Increase within Coccolithophore Blooms in Subpolar and Polar Seas

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Coccolithophore *E*. *huxleyi* cause less uptake of atmospheric CO_2 by the ocean. A global assessment of this phenomenon has so far not been quantified. We used Ocean Colour Satellite time series data for a 19-year period (1998-2016) to quantify the CO_2 partial pressure increase (ΔpCO_2) within *E*. *huxleyi* blooms in the North, Norwegian, Greenland, Barents, and Bering Seas. *E*. *huxleyi* outbursts in the North Atlantic and Arctic Seas proved to occur annually, but their extent vary interannually. In the Bering Sea, during 1998-2001 there was a splash in blooming activity followed by a drastic drop. The bloom duration in the Bering Sea in 1997/98-2001 reached 10 months, in the North Atlantic seas it was ~ 1 month. The maximum inorganic carbon content in *E*. *huxleyi* blooms in all seas varied over the 19 years between ~ 15 and 70 Kt. When normalized to pCO_2 in the absence of bloom, the mean and maximum ΔpCO_2 values within the bloom areas varied in percent between 21.0 - 43.3 and 31.6 - 62.5, respectively. Utilizing OCO2 spaceborne data on columnar pCO_2, we also quantified changes in atmospheric columnar CO_2 over *E. huxleyi* blooms in the target seas and documented a reversion of CO_2 flux from ocean to atmosphere. As huge outbursts of *E*. *huxleyi* also occur in the southern hemisphere, such blooms unfold in the world oceans across the entire year. Our data can serve as a baseline for assessing the importance of the phenomenon for climatology, marine chemistry and ecology on a global scale.

Thu_66_BE-2_1319
Zooplankton Mediate Faecal Pellet Fluxes across Southern Ocean Environments

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The Southern Ocean (SO) is the world's greatest carbon sink and, via carbon uptake and sequestration, the SO Biological Carbon Pump exerts a strong control over global climate. Central to its efficiency is the production and fate of zooplankton faecal pellets (FPs), particularly the magnitude of, and processes governing, FP flux to depth. Primary productivity and seasonal ice cover vary considerably across the SO, impacting secondary consumption and FP production. Constraining this variability is crucial for improving SO representation in ocean biogeochemical models.
We address this by investigating the distribution and fate of FPs over 400m, the region where attenuation is potentially highest. We studied three sites within the Scotia Sea: i) ice-influenced; ii) comparatively oligotrophic; and iii) within a seasonally extended phytoplankton bloom. FPs obtained from CTD bottles and mesozooplankton from net samples were analysed to derive estimates of and investigate controls on FP flux from the epi- to mesopelagic. Within the top 200 m, FP fluxes varied by a factor of 6 but, at 400m, by < 3. We suggest that, whilst FP production in surface waters may vary between productivity regimes, zooplankton-mediated controls on remineralisation and FP lability can act to narrow differences in respective levels of export. This has implications for our understanding of carbon export at intermediate depths, and for resulting carbon sequestration to bathypelagic depths in differing regimes.

Thu_67_BE-2_1470
Low Mesoscale Kinetic Energy as a Precondition for Blooms in the Southern Ocean

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In the Southern Ocean, surface waters are typically macro-nutrient rich in the austral summer, yet they are characterized by patchy, intense phytoplankton blooms within a generally unproductive environment. Due to the remoteness and harsh conditions, there are a dearth of in-situ chlorophyll observations in the Southern Ocean. Furthermore, persistent clouds and low sun-angle make remote sensing observations of chlorophyll comparatively rare. However, we have detected a hyperbolic relationship between satellite estimates of chlorophyll and radar-based satellite estimates of surface current kinetic energy. This is important because satellite derived estimates of kinetic energy, which are not hampered by cloud cover, and can possibly be used to improve estimates of total Southern Ocean biomass. While iron is a major limiting factor for Southern Ocean phytoplankton blooms, our analysis suggests there is a low-kinetic energy pre-condition before large phytoplankton blooms can occur. This is observed by both satellite and Argo biofloats, suggesting that kinetic energy estimates from space serve as a proxy for ecologically relevant mixing of phytoplankton populations in the Southern Ocean.

Thu_68_BE-2_1494
Carbon Uptake in Bi-polar Regions and their Responses to Climate Change

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Carbon uptake data sea were integrated from the 1999 to 2017 not only in the Antarctic, but also in the Bering Sea and the Western Arctic Ocean. Both ere summer cruises of the Chinese National Arctic and Antarctic Research Expedition (CHINARE). Parameters including CO_2 system parameters etc., were well measured. Bering carbon sink, Arctic carbon sink, and the Southern carbon sink were all well calculated during the past two decades. Both Bi-polar carbon sink including Bering carbon sink were well compared with each other. Results showed distinguished differences between the bi-polar ocean carbon sink. The Bering Basin carbon uptake was almost remained stable compared with its adjoin spacious Pacific Ocean, however, those in Bering Slope Current region was coincide well with climate change. Due to rapid Arctic Change, Chukchi Sea's carbon sink was remained strong uptake during the past two decades, where nutrients was supplied well by the Pacific inflow, however, the other regions where there were not nutrients supply was different change. In Contrast, the Southern Ocean carbon sink was response to the climate change in December, however, there was negative feedback was observed during Astral Summer season due to the bio-production, especially in Prydz Bay, Antarctic.
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Thu_69_BE-2_1859
Effects of High CO_2 on Pteropod Contribution to Carbonate Flux in the Ross Sea

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The Southern Ocean (SO) plays a key role in global climate and biogeochemical cycles. Thecosomate pteropods (calcareous molluscs) are the main planktonic producers of aragonite in the world's oceans and in the SO they can contribute to > 50% of the total biogenic carbonate export. Pteropods are vulnerable to the forecasted increase in ocean acidification (OA), owing to their aragonite shell which is prone to dissolution. Understanding pteropod flux dynamics is crucial in order to predict how a drop in their population will impact the balance between Particulate Inorganic Carbon (PIC) and Particulate Organic Carbon (POC) export to the deep ocean. Here we present an investigation of pteropods collected from subsurface and deep moored sediment traps in Terra Nova Bay, Ross Sea for one year. In this region, the presence of CO_2-rich water masses promotes OA. Pteropod abundance and biomass were investigated to assess their contribution to deep carbonate export. Level of shell dissolution was estimated by scanning electron microscope (SEM) to evaluate the impact of OA on shell condition. Results highlight the significance of pteropods as a vector for carbon export, contributing up to 88% of the total carbonate flux. The observation of a mass mortality of larval stage pteropods along with extensive "in-life" shell dissolution amongst all individuals, highlights (with in situ evidence) the threat of OA to the key role of pteropods within the SO carbonate system.

Thu_70_BE-2_1975
Is There More to Diel Vertical Migration?

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The Southern Ocean plays an important role in moderating our climate through the biological carbon pump (BCP), in which atmospheric carbon is drawn down and sequestered into the deep ocean through a combination of biological and physical processes. The zooplankton community plays a key role in BCP both through their individual vertical migrations and also in the generation of waste matter that may rapidly sink, both of which contribute to a process termed active flux. Vertical migration in zooplankton is a well described phenomenon where animals migrate on mass from depth to the surface layers to feed under the cover of darkness and return to depth during the daylight hours. However, recent studies suggest that individual zooplankton may also make several shorter migrations into shallow waters, termed forays, over the course of 24 hours. These forays may lead to an increase in active flux and could augment the BCP. Here we aim to use novel technology and traditional methods to look at migration behaviour at both the individual and population level. In particular, we have developed a 2-way net trap that can be deployed in open-ocean environments which can intercept individuals during their forays. We identify the main migrators that participate in foray behaviour in the Scotia Sea, which is a key region of carbon drawdown in the Southern Ocean.

Thu_71_BE-2_2031
Influence of Coccolithophore Species-specific Growth Rates on Calcite Production

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Coccolithophores are single celled phytoplankton which produce an exoskeleton of calcium carbonate plates. The production and export of these coccoliths play a major role in ocean carbon cycling. The rates at which species produce coccoliths, as well as the calcite content of species can influence the flux of carbon from the euphotic zone.

In this study, we measured the abundance, biometry and species specific growth rates of coccolithophores on the extended Ellett line between Scotland and Iceland during June 2015. The coccolithophore community was dominated by *Emiliania huxleyi* and the larger species *Coccolithus pelagicus*. Abundances of *E. huxleyi* and *C. pelagicus* varied from 22-1,500 and 0.3-129 cells mL^{-1} respectively. However, *C. pelagicus* accounted for 20-95% of daily calcite production due to its larger calcite per cell content and similar growth rates to *E. huxleyi*. Across the entire cruise the average contributions to calcite production was 55 and 45% for *E. huxleyi* and *C. pelagicus* respectively.

This research highlights the importance of species specific rates when considering biogeochemical rates, as less abundant but larger species can dominate calcite production. How different species respond to environmental change will also impact on regional carbon dynamics.

Thu_72_BE-2_2367
Phytoplankton variability in the Indian Ocean sector of the Southern Ocean

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The phytoplankton communities, adaptations and variations in the frontal ecosystems of the Indian sector of the Southern Ocean (IOSO) have been investigated along with the sea surface temperature (SST), sea surface wind (SSW), photosynthetically active radiation (PAR), and nutrients. The *in situ*, model and satellite observations during austral summer 2013 indicates that the variability of chlorophyll a (*Chl-a*) and diatoms were primarily influenced by light and wind. The *Chl-a* was higher in the sub-Antarctic front (SAF) followed by the sub-tropical front (STF) and the polar front (PF). However, in throughout the period during 1998-2012, the diatoms concentration was higher at the SAF followed by the PF and STF. Dominance of diatoms at the PF may be attributed to their adaptability for low light conditions. During a time series (1998-2014) in austral summer the diatoms contribution to the *Chl-a* biomass was ≥80% at the PF. On the other hand, the chlorophytes to *Chl-a* biomass showed ≥70% at the STF and gradually decreased towards the PF mainly attributed to the temperate adaptation. The variability of flagellates and diatoms from the STF to PF is attributed to the variability of PAR, SST and SSW.The results from this study of the frontal ecosystems would help to understand the shifting of communities in the ecosystem, biogeochemical cycle of the IOSO.

Thu_74_BE-2_2483

Trends in Primary Production under the New Arctic Sea-ice Regime

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Here we analyze trends in sea-ice primary production (PP) under the new thinner and more dynamic Arctic sea-ice regime using empirical data and various biogeochemical models, ranging from analytical to numerical and from one-dimensional vertically-resolved to three-dimensional. We argue that the traditional conceptual view of a spring phytoplankton and ice algal bloom in the Marginal Ice Zone (MIZ) following its progression as a PP "front", should be replaced by a "network view". This view does not contradict the existence of a frontal PP zone, but it merely acknowledges the effect of the thinner and more dynamic ice cover in creating a fractal network of refrozen light conduits, deep into the ice pack, along which phytoplankton and ice algal growth rates may be enhanced. We further argue that this network will lead to an increase in spring phytoplankton areal PP under the ice pack, ultimately limited by nutrient availability. However, the outcome of these light conduits is not so obvious for ice algae. In spite of the increased growth rates, nutrient and recruitment limitation in the expectably more frequent and extensive young sea ice along the light conduits may prevent standing stocks from reaching the levels observed in older ice types. These bottlenecks may be partly compensated by horizontal spreading of transmitted light to thick ice and ridges bordering the refrozen areas, where ice algal standing stocks are higher and not recruitment limited.

Thu_75_BE-2_2484
Arctic Ocean Carbon Cycle Response to Atlantification and CO2 Invasion

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Arctic Ocean carbon cycle is a hotspot for strong perturbations driven by rising CO2 emissions and concomitant climate change in future projections. We investigate these perturbations with the Max Planck Institute´s Earth System Model, focusing on the high CO2 scenario RCP8.5 extended until 2300. Model results project an SST increase in the Arctic Ocean by 4°C in 2100 and by 10°C in 2300, respectively, accompanied by the loss of summer and eventually also the winter sea ice. Warming enhances thermal stratification, but ice free water favors formation of convection cells. Intensification of the Atlantic water inflow leads to erosion of the halocline in the central basin of the Arctic Ocean. The carbon cycle responds to these complex hydrodynamic changes, but is also directly affected by the uptake of anthropogenic CO2. We will show that while future changes in the Arctic Ocean carbon cycle proceed at rates determined by atmospheric CO2 levels, the regional patterns are driven by shifts in the hydrodynamic regime.

Thu_76_BE-2_2582
Timing of Meroplankton in Different Arctic Primary Production Regimes

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Larvae of benthic organisms that temporarily inhabit the pelagic environment (meroplankton), are important contributors to coastal Arctic marine zooplankton communities. Their seasonal dynamics is, however, poorly described due to their small size and limited presence in the pelagic. Here we present high resolution meroplankton data from three different fjords in the Svalbard archipelago, one ice-free fjord and two seasonally ice covered fjords. Among the eight main meroplankton groups that were present the most important were Cirripedia and Bivalvia.
Based on 5 seasonal data sets from these three fjords with different primary production regimes, we conclude that the timing of meroplankton is mainly steered by the timing of the phytoplankton bloom, and less by ice algae and hydrography. Reduction in sea ice cover and thickness may lead to changes in the onset, duration and magnitude of the phytoplankton bloom, and eventually the meroplankton seasonal dynamics in a future warmer Arctic.

Thu_77_BE-2_2592
Metagenomic Analysis of Antarctic Communities of Thalassiosirales Diatoms

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Antarctic coastal regions are highly productive ecosystems characterized by temperatures below the freezing point, complete darkness in winter and continuous day light and high UV radiation in summer. In these systems, photosynthetic microorganism, especially diatoms, are the base of the food web, contributing in great manner to carbon fixation and intake during spring and summer blooms. Thalassiosirales inhabiting this environment have adapted their physiology to maintain their basic functions in these extreme conditions. In this work, we aim to analyze the metagenomic features allowing Antarctic diatom communities to thrive in this environment.
Metagenomes corresponding to pico and nano- phytoplankton communities from a short diatom bloom were analyzed by standard bioinformatic analyses. Our results show that:
i) The major diatom group was Thalassiosirales order, representing 43 and 73 %, with members belonging to Detonula, Skeletonema and Thalassiosira genus.
ii) We observed a large number of genes related to photosynthesis and genetic information processing.
iii) Functional predictions of ORFs assigned to Thalassiosirales show a substantial number of heat shock proteins, DEAD- box, RNA helicases, fatty acid desaturases and other proteins involved in functions that are indicative of a low-temperature-adapted metabolism.
Our results remark the special characteristic of an important Antarctic community member as Thalassiosirales, who has a key role in this environment.

Thu_78_BE-2_2639
Long Time-series of POC Fluxes over Arctic and Antarctic Margins

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The export of particulate organic carbon (POC) from the sea surface is an essential part of the biological pump. POC from the upper layers is delivered to the deep ocean, which retains CO_2 for a relatively long period compared with the epipelagic CO_2 residence time.
This work summarizes POC fluxes measured in the past 25 years in the Ross Sea (Antarctica) and western Svalbard (Arctic) by using moored sediment traps.
In the Ross Sea, fluxes of POC and total mass are well correlated implying that particle fluxes are dominated by biogenic debris. Annual POC fluxes to below 200 m average 4.4±3.3 g C m^{-2} y^{-1}. Particle fluxes are relatively low when primary production is high (spring-summer) followed by enhanced sedimentation in late summer-fall. The high degree of decoupling between production and sedimentation is unusual compared to records of Antarctic Peninsula and may represent low grazing rates.
In the past decades, the decrease of sea-ice in Fram Strait (NW Svalbard) is significant. From 2002, water temperature increases in general, while POC fluxes tend to decrease. Starting from 2010, moored sediment traps have been deployed also in SW Svalbard slope. Here, marine POC fluxes show the typical temporal variability of high latitudes with higher content of biogenic compounds in spring-summer linked to phytoplankton blooms. However, most of the POC is laterally advected in late winter by occasional intrusions of warmer, saltier, less dense and more oxygenated water.

Thu_79_BE-5_144
Potential Primary Production of Microphytobenthos in the Changing Potter Cove

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The retreating Fourcade glacier in Antarctic Potter Cove uncovered new space for primary production. Thought, pelagic and macroalgae primary production does not provide enough organic carbon to feed the benthic community. Benthic microalgae, the microphytobenthos (MPB), are proposed to partly provide the required organic carbon. To estimate the potential primary production from MPB, we incubated 12 intact sediment cores from three stations (8 m depth) at increasing light intensities (up to 70 µmol photons/m² s) and measured the oxygen exchange. Further, we measured *in situ* photosynthetic active radiation (PAR, 400-700 nm), chlorophyll a (*Chl a*), and the MPB composition. The diatom *Gyrosigma fasciola* was the most occurring species at all stations, while *Chl a* showed large intra- and inter station-specific variability. *In situ* PAR intensities partially exceeded the calculated light compensation point of the MPB, which indicates MPB as a potentially important carbon source for the heterotrophic benthic community. However, primary production differed strongly between the stations, following the general *Chl a* pattern. Further, PAR availability depends on turbidity, caused by melting related processes and its distribution in Potter Cove by wind and currents. Therefore, our study is a first step to reveal the contribution of microphytobenthic primary production in Potter Cove and thereby expand our understanding of how melting glaciers may alter Antarctic coastal primary production.

Thu_80_BE-5_191
Identifying Vulnerable Ecosystems in an Antarctic Coastal Marine Environment

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Monitoring changes in shallow-water benthic ecosystems requires baseline information against which any future changes can be assessed. This includes information on the existing spatial extent and physical habitat requirements of the different benthic communities.
A detailed study in shallow coastal waters of the Vestfold Hills has shown that seafloor geomorphology information provides a physical framework for understanding benthic habitats and a broad indication of the distribution of benthic communities in the region. Macroalgae is common in the coastal waters, inhabiting very shallow areas with hard substrate. Areas with extended sea ice cover are dominated by invertebrates and are devoid of macroalgae. Studies have shown that these shallow invertebrate-dominated ecosystems are vulnerable to changes in sea ice extent which will increase light availability and drive regime shifts towards macroalgae-dominated communities (Clark et al. 2013. DOI:10.1111/gcb.12337).
New high-resolution multibeam data collected over the broader Vestfold Hills region is being used to expand our understanding of the spatial extent of benthic habitats across the shallow coastal environment and identify potential habitat for macroalgae communities. Bathymetry derived from multispectral satellite imagery is used to fill data gaps in very shallow areas and areas under sea ice. This seafloor information is useful to guide further biological studies to determine if and when regime shifts occur.

Thu_81_BE-5_400
Polynya Formation and its Associated Chlorophyll - A Variability in Antarctica

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Antarctic coastal polynya is the most productive area in the Southern Ocean, therefore they play a significant role in polar ecosystem. Change in polynya phenology can alter, or even disrupt, the polar food web. As such, it is important to understand the polynya phenology. However, despite polynya's significance in the polar ecosystem, there are still many unfamiliar aspects of polynya and its associated changes in ecosystem. Our aim is to organize relevant polynya data, reveal insightful polynya characteristics: determine whether physical polynya features have an effect on phytoplankton dynamics. We investigated to what extent the physical polynya parameters affect polynya phenology. By looking for correlations between such parameters and chlorophyll-a concentration of each season and their respective dates, we hope to develop a thorough understanding of the relationship between the physical input and biological output. We focused on Antarctic polynyas, and we are especially interested in the types of environment that contribute to distinct correlations. We are also interested in the causation and the implications of our findings. Understanding the driving force behind the physical parameters of polynya would allow us to predict what sort of effect a polynya can have on its ecology. We will talk about how physical forcing could affect chlorophyll variability in Antarctic coastal polynyas in recent decades, and whether the relation has any connection with climate change.

Thu_82_BE-5_455
Shelf Ice-associated Cryo-benthos and Environmental Features

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Incidences of cryo-benthic communities beneath ice shelves are rare and recent discoveries. Combined seal- and ROV-borne imagery and novel sampling technologies allowed for a re-assessment and augmentation of earlier findings on a cryo-benthic isopod community (*Antarcturus cf. spinacoronatus*), being attached head-down to the underside of floating shelf ice at depths of around 80-150m. The shelf ice-associated cryo-benthos was discovered at Drescher Inlet (-72.83667 -19.15300), Riiser-Larsen Ice Shelf (eastern Weddell Sea). The inlet constitutes a 25km long and between 2 and 4km wide crack in the surrounding shelf ice, which is associated with certain environmental features. Here we compile all available local physical, biological, and biogeochemical data and discuss their relevance in the wider regional context for this faunal hotspot. These include data on shelf, sea and platelet ice, seafloor topography, hydrography and water chemistry, as well as associated pelagic and benthic marine life, in particular affinities of the cryo-benthic isopod community to related fauna occurring in nearby seabed communities using molecular barcoding.

Thu_83_BE-5_583
Microbial Eukaryotes in Sea Water From Fildes Peninsula, Antarctica

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Data on Antarctic coastal sites remain scarce and are generally limited to microscopy; the diversity of coastal Antarctic ecosystems has been long underestimated. The diatom-dominant community in the coastal sea waters of the Fildes Peninsula has been described according to traditional protocols. Molecular diversity of microbial eukaryotes (≤ 20 µm) from Great Wall Cove and Ardley Cove, Fildes Peninsula, has been determined by Illumina MiSeq2000 sequencing. Inferred metabolisms of summer phytoplankton in the two coves are characterised by autotrophy and heterotrophy. The frequent occurrence of such nanoflagellates as Dinoflagellates, Cryptophyta, Stramenopiles, Pyramimonas, Telonema, and Cryothecomonas, is predicted to be important in these Antarctic coastal communities. Seawater exchange exists between the two coves when high tide occurs, indicating that there appears to be mixing between the microbial communities in the two coves. Cluster analysis of the microbial eukaryote composition at the phylum and genus levels reveals a conservation of the community composition between the two coves. The inner stations of Great Wall Cove are clustered closely together, surrounded by islands and formed into a semi-closed body of water. The samples from the outer stations of Great Wall Cove, are more similar to the Ardley Cove samples.Sea water exchange between the outer basins might be the effect of their community compositions.

Thu_84_BE-5_882
Lipid Composition of the Sea Ice and Water Column in Early Spring

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To understanding the role of sea ice in the Southern Ocean ecosystem, we need to also understand the availability of key and essential nutrients to consumers. Baseline biochemical data are therefore required in order to gauge any impact the reduction of sea ice will have on the sea ice community. Here we compare lipid class, fatty acid and sterol content and composition of sea ice and water column samples collected during early spring in East Antarctica. The availability of key essential omega-3 long-chain (≥C20) polyunsaturated fatty acids, including - 20:5w3, eicosapentaenoic acid, EPA and 22:6 w3, docosahexaenoic acid, DHA - the major constituents of cell membranes, were found to be severely limited during late winter and early spring, particularly in the under ice water samples. The ramifications for sea ice obligate organisms such as larval krill are discussed.

Thu_85_BE-5_893
Macrobenthic Communities along a Shelf-slope-Basin Transect in the Bering Sea

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The study analyzed the macrobenthic community and the spatial-temporal patterns of the Bering Sea based on a number of summer surveys. Polychaetes (*Scoloplos armiger*), crustaceans (*Ceradocus capensis*) and sea urchins (*Echinarachnius parma*) were the main dominant groups in the shallow shelves. The sea star (*Ctenodiscus crispatus*) and the brittle star (*Ophiura sarsii*) were the main dominant groups in the continental slope, whereas small polychaetes (*Prionospio malmgreni*) dominated the basin. Sediment type, water depth, and current were the major factors affecting the macrobenthic community and spatial distribution. The Bering shelves and slope showed an extremely high-standing biomass. In particular, the northern shelf, which is primarily controlled by Anand Water, is an undersea oasis. In contrast, a deficiency in the downward transport of particulate organic carbon has resulted in a desert-like seabed in the basin. Compared to previous studies, macrobenthic communities of this area have undergone significant structural changes in recent decades, resulting in a decrease in density and an increase in biomass. In addition, populations of amphipods and bivalves in the northern shelf have decreased significantly and have been gradually replaced by other species. These changes might be associated with advanced seasonal ice melting, changes in organic carbon input, and global warming, indicating that large-scale ecosystem changes have been occurring in the Bering Sea.

Thu_86_BE-5_918
Dispersal of Fjord Megabenthos in Andvord Bay: A Modeling Approach

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Dispersal is a key factor affecting the biogeography and connectivity of Antarctic benthic communities. The potential for planktotrophic larval dispersal is typically inferred from genetic data and current distributions of adult forms. However, these methods do not provide insights into the mechanisms behind observed patterns nor information on processes occurring on ecologically relevant time scales. In regions of complex topography and potentially limited circulation (e.g. in fjords), source-sink population dynamics may be very important in assembling communities. Fjords along the West Antarctic Peninsula are known to harbor rich and abundant benthic communities distinct from those on the open shelf and even adjacent fjords (Grange and Smith, 2013) and are therefore likely to exhibit limited connectivity and larval dispersal. We applied the Lagrangian TRANSport model (LTRANS) (North et al. 2005) to Andvord Bay, a fjord on the northern West Antarctic Peninsula, to address this key question: can the abundant megabenthic populations of Andvord Bay export larvae to adjacent fjords and the open continental shelf? The model tracked simulated larvae (i.e. particles) in a range of dispersal scenarios over time scales representative of PLDs for a range of organisms (14-120 days). Results indicate that Andvord Bay acts to retain larvae over 120-d time scales, and may not routinely export larva to adjacent fjords the open continental shelf along the West Antarctic Peninsula.

Thu_87_BE-5_1065
Decadal Population Trends of Two Pacific Arctic Clams as Related to Production

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Dynamic factor analysis of bivalve abundance and biomass, along with two covariates, sea ice extent and bottom water temperature, have identified time-series benthic macrofaunal changes in the Distributed Biological Observatory (DBO) in the Pacific Arctic. Station SLIP 5 in the northern Bering Sea (DBO region 1) was determined to be a transition point for abundance and biomass of the common deposit-feeding bivalve *Macoma calcarea* between three stations to the south and two to the north. In addition, an increase in the suspension-feeding bivalve *Serripies groenlandicus*, has been observed during field sampling (2014-2017) in the DBO 3 region. We determined the spatial and temporal resolution of abundance and biomass of *M. calcarea* and documented the increased abundance and biomass of *S. groenlandicus* north of Bering Strait. We also tracked changes in abundance and biomass of the two species at five additional sites in the DBO 3 region (north of Bering Strait) and over two additional years. We will present results relating the potential significance of sediment chlorophyll-a, integrated water column chlorophyll-a concentrations, and sediment parameters that include total organic carbon content and grain size as potential drivers for these changes. We will show that these additional covariates contribute to the assessment of abundance and biomass trends for these two Arctic bivalve species and reflect on the overall biological productivity of the system.

Thu_88_BE-5_1225
Linking Fine Scale Distribution of Zooplankton to Sea Ice Cover and Predators

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As sea ice retreats due to a warmer climate, habitats of seabirds, such as little auks (*Alle alle*), will change. To understand how this affects populations of little auks, it is essential to study the relations between them, their zooplankton prey and water mass characteristics. A study was carried out in NW Greenland in July-August, a period where little auks depend on lipid-rich zooplankton to feed their chicks. Results suggest that the abundance of prey integrated across the upper 50 m, which was what we were able to measure from net hauls, may only be important if the prey items are also concentrated in the vertical plane. The use of high-resolution acoustic echo sounders represents a method to study fine scale zooplankton distribution patterns in details and non-invasively. This approach was used in a similar study in NE Greenland where water mass characteristics, fine scale zooplankton distribution and little auk abundance were assessed across areas with different sea ice cover and stratification, from shelf to off-shelf areas. Here, we will present data on zooplankton fine-scale distribution in relation to sea ice cover, physical and biological oceanography, and furthermore discuss how this relates to the abundance of little auks.

Thu_89_BE-5_1268
Small-scale DVM of Zooplankton and Susceptibility to Light Pollution

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Light is a major cue for nearly all life on Earth. However, most of our knowledge concerning the importance of light is based on organisms' response to light during daytime, including the dusk and dawn phase. When it is dark, light is most often considered as pollution, with increasing appreciation of its negative ecological effects. Using an Autonomous Surface Vehicle fitted with a hyperspectral irradiance sensor and an acoustic profiler, we detected and quantified behavior of zooplankton in an unpolluted light environment in the high Arctic polar night, and compared the results with that from a light polluted environment close to our research vessels. First, in environments free of light pollution, the zooplankton community is intimately connected to the ambient light regime, and perform synchronized diel vertical migrations in the upper 30 m despite the sun never rising above the horizon. Second, the vast majority of the pelagic community exhibits a strong light-escape response in the presence of artificial light, observed down to 100 m. This study underscores the need to adjust sampling platforms, particularly in dim-light conditions, to capture relevant physical and biological data for ecological studies. It also highlights a previously unchartered susceptibility to light pollution in a region destined to see significant changes in light climate due to reduced ice cover and increased anthropogenic activity.

Thu_90_BE-5_1484
Phytoplankton Community Composition and Distribution in an Antarctic Fjord

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As the Western Antarctic Peninsula (WAP) region responds to a warmer climate, the impacts of glacial meltwater on the Southern Ocean are expected to intensify. Because fjords provide an extreme in the meltwater's spatial gradient from the glacio-marine boundary to the WAP continental shelf, Andvord Bay is an ideal study site to understand the impacts of environmental conditions, particularly glacial meltwater, on phytoplankton community composition and their spatial distribution. While meltwater processes are weaker in Antarctic fjords in comparison to the Arctic, they can still influence phytoplankton due to the direct entrainment into water column; meltwater is rich in macro-nutrients and iron, induces stratification, and impacts underwater light field, but the net effect of these factors is elusive. Fluorometric chlorophyll measurement indicates that the concentration range is ~1 order of magnitude higher in Dec. 2015, while significant deep chlorophyll and phaeo-pigment accumulations were found in Apr. 2016. Concurrent high-performance liquid chromatography samples were also collected; and in the context of environmental conditions, further analyses of these samples can illustrate the spatial distribution of phytoplankton community composition and their seasonal variability. The hypothesis being tested is the impact of meltwater presence can shift phytoplankton community to one that is dominated by cryptophytes due to reduction in salinity and mixed layer depth.

Thu_91_BE-5_1590
Organic Carbon Budget of the in Ice-covered Arctic Ocean during Late Spring

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The Arctic Ocean is undergoing substantial warming and sea ice loss, which are likely to cause changes in primary production, export fluxes and productivity of the Arctic marine ecosystems. Yet, we lack sufficient information about the ecosystem productivity, organic carbon cycling and cryo-pelago-benthic coupling processes in the Arctic Ocean. Such information is particularly scarce for deep Arctic basins and during the spring to summer transition under seasonally ice-covered waters. Our aim was to provide carbon budget estimations under different environmental regimes and bloom development stages in the region north of Svalbard. We conducted ecological and biogeochemical early spring process studies in sea ice covered areas, from the shelf to the basins of the European Arctic margin and on the Yermak Plateau during the TRANSSIZ cruise PS 92 on the ice breaker R/V Polarstern in May/June 2015. We identified the potential characteristics of carbon production of primary producers in the sea ice and water column, and secondary production of zooplankton and benthos. We looked into the organic carbon production fate and export, including respiration and burial, as well as identified similarities and differences in ecosystem functioning along topography- , sea ice- and water mass-related gradients. This scientific initiative was undertaken by Arctic in Rapid Transition (ART) International Arctic Science Committee (IASC) network .

Thu_92_BE-5_1905
High Resolution Hydrographic Surveys: Fjord Ecosystem Experiment Results

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Fjords with tidewater glaciers occur widely at temperate to polar latitudes, and extensively along the sub-polar Western Antarctic Peninsula (WAP). Fjord ecosystems can be heavily modulated by local conditions, causing ecosystem structure and function to differ from the open continental shelf and to be highly sensitive to climate warming. Fjord ecosystems remain very poorly studied along the WAP, and several lines of evidence suggest that WAP fjords are intense hotspots of biological productivity. In December 2015 and April 2016, a series of high resolution hydrographic surveys were conducted utilizing a towed undulating instrument platform and an autonomous underwater vehicle to investigate phytoplankton distributions, meltwater content, and sediment inputs to Andvord Bay, a sub-polar glacio-marine fjord on the WAP. The towed vehicle and glider completed several transects near glacier termini, over sills and along the length of Andvord Bay. Our observations reveal elevated chlorophyll values associated with a persistent upper water column frontal boundary near the mouth of the fjord and limited subsurface sediment plumes near glacier termini. We hypothesize that the high (benthic and pelagic) productivity in Andvord Bay may be facilitated by elevated turbulence associated with bathymetric features, fjord geometry and tidally driven flow and further aided by existing conditions of low meltwater content and the limited extent of glacial-derived sediment input.

Thu_93_BE-5_2029
Inter-annual and Seasonal Sediment Trap Zooplankton Variability - Arctic Fjords

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Sediment traps may provide a useful tool to study Arctic zooplankton during the whole year, irrespective of environmental conditions or sea ice. Year-round sediment traps were moored in 2014/2015 and 2015/2016, in high Arctic fjords on Svalbard - Kongsfjorden and Rijpfjorden respectively, to monitor seasonal and inter-annual variability in zooplankton community. These fjords require enhanced monitoring, because of the progressive alteration of extent and dynamics of the relatively warm West Spitsbergen Current. Thus, fjords differ strongly in the amount of flowing Atlantic Water, which influences the composition and distribution of zooplankton species. Our study demonstrated the relationship between distinct water masses and zooplankton structure in fjords. The zooplankton community was divided into several groups, strictly related to hydrological shifts and advection in the fjords: spring, summer/autumn, and winter. The dominant species in the winter group in fjords consisted mainly of Arctic taxa such as *Oikopleura* spp, *Pseudocalanus* spp., *Metridia longa*, *Themisto libellula*, *Limacina helicina*, but also typical boreal species like *Limacina retroversa* and cosmopolitan *Oithona similis*. The spring and summer seasons in fjords were characterized by high numbers of Copepoda eggs and nauplii, small copepods and genus *Calanus* which differed in proportions within the fjords. Especially three species were linked to the advection events in the fjords - two pteropods and *O. similis*.

Thu_94_BE-5_2078
ART Initiated TRANSSIZ -Transitions in the Arctic Seasonal Sea Ice Zone - Cruise

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The TRANSSIZ ('Transitions in the Arctic Seasonal Sea Ice Zone') cruise PS92 was carried through by the “Arctic in Rapid Transition” (ART) International Arctic Science Committee (IASC) network on the German research icebreaker R/V Polarstern in May/June 2015. The overall cruise goal was to use a multidisciplinary approach to identify the potential characteristics in carbon production as well as to investigate similarities and differences in ecosystem functioning related to gradients in topography, sea ice and water masses, and to link past and present sea-ice transitions in the Arctic Ocean. Thus, ecological, physical and biogeochemical early spring process studies were conducted across the shelf of the European Arctic margin and on the Yermak Plateau. At each station R/V Polarstern was anchored for 36 hours to an ice floe. Special emphasis was given to the quantification of the environmental preconditions for biological productivity (e.g. nutrients, stratification) under sea ice and in open waters. With this study we gained new insights for improving predictions of the potential annual primary production in the changing Arctic Ocean and the understanding of ecosystem functioning and biogeochemical cycles in the transition from spring to summer in the European Arctic margin. Investigations during TRANSSIZ will also enable reconstructions of productivity, food web carbon flux, and sea ice and ocean circulation across the few last glacial cycles.

Thu_95_BE-5_2270
Functional Patterns of Chukchi Sea Benthos

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Traits - i.e. the life history, morphological and behavioural characteristics of species - provide a link between species and multiple ecosystem-level processes, such as the fluxes of oxygen, energy and nutrients. In marine ecosystems, trait-based approaches are often applied to detect early responses of communities to environmental changes or stressors, to estimate ecosystem resilience or vulnerability, or to indicate overall ecosystem functioning. They are however still rarely applied in studies from polar marine regions, albeit these areas are facing dramatic and rapid environmental changes today. One reason is that biological trait information of polar species is often not ready at hand, and its collation requires a time and labor intensive survey of literature. The open access to trait databases is an important step in overcoming this obstacle. Here we demonstrate how trait information retrieved from the online accessible Arctic Traits database is used to analyze functional patterns of benthic communities in the Chukchi Sea, a shallow Arctic shelf sea characterized by tight pelagic-benthic coupling. The observed community patterns are further related to environmental parameters like water temperature and sea ice concentration in order to detect potential drivers of change in benthic ecosystem functions.

Thu_96_BE-5_2413
Sea Ice and Glacier Control of Antarctic Coastal Ecosystem Dynamics and its Fate

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Bays and coves in King George Island, Antarctica represent a sentinel embayment ecosystem in South Shetland Islands that is sea ice affected in a highly seasonal manner and subject to accelerating glacier retreats in the region. Oceanographic measurements mostly from fixed points and the station weather logs for nearly 20 years have been examined in order to determine the mechanisms of ecosystem responses and the critical governing factors. Sea ice formation and break-up in the Bay appear to be controlled by physical oceanography in offshore waters and sea ice trend in the wider region. In addition, yearly varying sea ice dynamics combined with local meteorology seem to determine the fate of the algal blooms and the major primary producer species. There is an inconspicuous yet consistent trend with the taxonomic group and size compositions. Moreover, glaciers receding at high paces (most recently, around 100 m per year) are opening up new waters and create new habitats both pelagic and benthic. This already provided for a new start of ecological successions but also would modify key environmental features that will shape the future ecosystems and determine the changing functions. Models that came out of this would greatly assist us in assessing the future changes in the ocean-cryosphere boundary along the Northern Antarctic Peninsula.

Thu_97_BE-5_2651
Arctic Benthic Community Structure and Functioning during Late Spring

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Changes in sea ice cover are affecting the bloom timing, quantity and quality of primary production, and thus quantity and quality of organic matter reaching the seafloor. Changes in organic matter export fluxes are predicted to influence structure and functioning of benthic communities, especially in the deep-sea. The aim of this study was to examine meio- and macro- benthic community structure and function in relation to sea ice cover, bloom stage and depth from the shelf to the basins of the European Arctic margin and on the Yermak Plateau, Svalbard fjords and in the Barents Sea. Material was collected during spring cruises PS92 - TRANSSIZ in May-June 2015, and ARCEx in May 2016, and included sediment and particulate Organic Matter (OM) samples. OM sources and trophic position of benthic animals were determined with use of stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes. Additionally bioturbation experiments were performed. The particulate OM concentrations in the water column decreased with depth, and increased with the bloom progress. Benthic density, biomass and intensity of bioturbation were the highest at the shelf stations where intensive bloom was observed and were related to higher concentrations of fresh OM input to the sea bottom. Low benthic infaunal diversity, abundance, and biomass were noted in fjords and deep stations where low concentrations of lower quality OM reaching seafloor were noted.

Thu_98_BE-8_38
Molt Phenology Mediates Colony Attendance and Pupping Success in Weddell Seals

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Mammalian species have been shown to shift life history event phenology in response to environmental change, but this response is highly variable across species. The replacement of hair (i.e. molt) is an intermediate life history event that may affect subsequent breeding attempts; however, the magnitude of its impact is poorly understood. Our aim was to understand the carry-over effects of molting and pupping phenology in Weddell seals. To do so, we conducted demographic surveys of 4,252 uniquely identified seals in Erebus Bay, Antarctica during the austral summers of 2013-2017. The start date of each animal's molt was back-calculated based on hair loss progression, and pupping success and dates were obtained for the breeding season prior to and following the molt. The molt in Weddell seals lasted 29 ± 8 days. Within adult females, molt phenology was markedly different across reproductive and non-reproductive individuals, with non-reproductive seals beginning molt 16 days earlier than reproductive seals (mean start date Jan06 and Jan22, respectively, t-test $p < 0.0001$). Animals that molted later were less likely to be seen in the breeding colonies during the following pupping period, suggesting they either did not pup that year or were deceased. By systematically manipulating estimated transition probabilities between pupping and molting categories using a simulation model, we demonstrate the importance of intermittent skipping of pupping to reset life history phenology.

Thu_101_BE-8_1593
How Do Hormones and the Skin Transcriptome Drive Molt in a Polar Pinniped?

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Pinnipeds replace their fur each year in an annual pelage molt, the timing of which is tightly regulated to conserve energy. Recent cases of disrupted molt in Arctic seals have highlighted how little is known about the underlying mechanisms of this key life history event. To characterize the drivers of healthy molt in a polar phocid, we examined hair cycling in 121 prime-age female Weddell seals (*Leptonychotes weddellii*) during the Antarctic summer (Nov-Feb). At each handling (n=1 or 2 per female), skin biopsies were collected to determine hair cycle phase (i.e., anagen, catagen, telogen) by histology, and serum hormone levels and body composition were measured to test for endocrine and nutritional effects on molt. Hair follicles became active in Nov/Dec, at least a month prior to the onset of shedding, and did not complete growth until late Jan at the earliest. Elevated prolactin appeared to delay molt, while body condition did not impact molt timing. To identify gene expression changes between three hair cycle phases, skin transcriptomes were profiled using Illumina RNA-Seq (n=9). Over 4000 genes were differentially expressed between phases. These included hormone receptors and genes involved in wound healing, suggesting skin's response to hormones and its healing capacity change across the molt. Our novel findings on endocrine and transcriptomic control of molt indicate how this process may be impaired, as well as how altered hair cycling may impact integumentary health.

Thu_102_BE-8_1839
Environmental Influences on the Thermal Flux of a Molting Polar Pinniped

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Antarctic pinnipeds face complex thermoregulatory challenges, as they must conserve heat in both air and water. Primary adaptations to reduce heat loss include a thick blubber layer and the ability to limit blood flow to the peripheries via vasoconstriction. These adaptations reduce heat flux by decreasing the temperature gradient between the animal and the environment. During the annual molt however, heat conservation may be compromised, as hair follicles may require more constant perfusion; this could result in higher rates of heat loss and higher metabolic costs. In warmer summer months, the thermal gradient between the animal and environment is reduced, providing optimal ambient conditions for molting.

Across a four-year study, surface temperature and heat flux were directly measured in-air, on adult female Weddell seals (n=77, *Leptonychotes weddellii*) across the progression of the molt. Surface temperatures increased significantly with increased ambient temperature and relative humidity and decreased wind speed and solar radiation. Heat flux was significantly higher during the molt than prior to its onset, resulting in greater overall heat loss in molting seals. This suggests that perfusion is increased during molt to support hair follicles at the expense of increased thermoregulatory costs. Correlations between time-activity budgets and ambient conditions will be measured to determine how environmental perturbations may influence summertime molting haul-out decisions.

Thu_103_BE-8_2084
Effects in Renal and Hepatic Cells by Cd, Pb, Cr and Se Found in Penguins

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Recent studies carried out by our research group revealed high levels of Cd, Pb, Cr and Se in the kidney and liver of three penguin species: Papua - *Pygoscelis papua*, Barbijo - *Pygoscelis antarctica* and Adelia - *Pygoscelis adeliae*. According to these results, the effects on the cell cycle have been studied, that the average concentrations found in chickens, juveniles and adults and the EC50 (effective concentration 50) provoke on the cell lines VERO (renal) and AML12 (hepatic). The cells were treated for 24 hours with each concentration. Subsequently using the IP fluorochrome (propidium iodide) by flow cytometry and with the ModFit computer program, the changes produced with respect to the control were detected, by the different concentrations, in each phase of the cell cycle. For both cell lines we observed that the concentrations of Cr, Se and the highest Cd (adults), produce an increase in the percentage of cells in S phase, causing their blockade in this phase and preventing cell division. In the case of lead, we find that the effect is similar for the highest concentration (EC50), that is, blockade in S phase; however, at lower concentrations, an increase in the percentage of cells in G2 / M phase is observed, and therefore, an increase in the percentage of cells in mitosis.

Thu_104_BE-8_2101
Metals Found in Penguins Produce Oxidative Stress in Renal and Hepatic Cells

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Antarctica is one of the last virgin regions, however studies carried out by our group have shown an increase in the levels of certain elements, in three species of penguin: Papua - *Pygoscelis papua*, Barbijo - *Pygoscelis antarctica* and Adelia- *Pygoscelis adelie*. The mean concentrations of Cd, Pb, Cr and Se and EC50 (effective concentration 50) found in chick, juvenile and adult individuals from three penguin species of the Antarctic Peninsula and Associated Islands, were evaluated in renal and hepatic cells (cell lines VERO and AML12). The cells were treated for 24 hours with each concentration. Later, using the colorimetric probe DCFH-DA (dichloro-dihydro-fluorescein diacetate) and by means of flow cytometry, the changes produced by the concentrations of each element on oxidative stress were detected. In the VERO cell line, the results show a decrease in fluorescence proportional to the concentration and therefore a decrease in the reactive oxygen species (EROs). This is due to the fact that these concentrations modify the integrity of the cellular DNA, not allowing the cell to produce EROs. Therefore, the determination of ROS is more an indicator of mortality than of toxicity for said cell line. In the AML12 cell line, the highest concentration corresponding to the average concentration of adults causes an increase in the EROs; for the rest of the elements no significant differences appear or, as in VERO, a decrease in fluorescence occurs in a concentration-dependent manner.

Thu_105_BE-8_2236
Adélie Penguin Diet: Comparison of Stomach Flushing with Faecal DNA Analysis

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Adélie penguin diet is studied at colonies around Antarctica as part of CCAMLR's Ecosystem Monitoring Program (CEMP). The standard methodology involves stomach flushing of breeding birds to identify prey species and record diet composition by mass. Due to the invasive nature of sampling, genetic approaches using faecal samples are being investigated.
High-throughput sequencing of DNA barcoding markers recovered from faecal samples has become a common method for assessing of diet in a wide range of animals. However, direct comparisons of DNA-based diet analysis with traditional methods are still limited.
We report on a study carried out at Signy Island (South Orkneys) comparing stomach lavage data (n= 60; collected in 2014/15 and 2015/16) with DNA data from concurrently collected faecal samples (n=450). For the DNA analysis a conserved marker (18S rRNA) was used to identify broad prey groups and mtDNA markers used to provide high resolution taxonomy of main prey groups.
Antarctic krill (*Euphausia superba*) and bony fish (Actinopterygii) made up >98% of the stomach content mass and also >99% of the prey DNA sequence reads. Both datasets also identified a switch from a krill dominated diet in 2014/15 to a nearly even split between krill and fish in 2015/16.. We discuss the strengths and weaknesses of each approach, comparability of the datasets and the prospects for incorporating DNA diet analysis into long-term monitoring programs.

Thu_106_BE-8_2366
Adélie Penguin Telomeres: Eco-indicators of Environmental Stress?

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Defining the impact of anthropogenic stressors on Antarctic wildlife continues to be an active aim for investigators. Physiological conservation has emerged as a new research topic that aims to identify key physiological variables that can help ecologists to assess the impact of human activities in the environment. Recently, telomeres have been suggested as a promising molecular tool to investigate the fitness of wild vertebrates. Telomeres are well-conserved repeated sequences of non-coding DNA located at the terminal ends of chromosomes. They shorten with advancing age and this telomere attrition is accelerated by the occurrence of environmental stressors. Furthermore, telomere length appears to be a reliable predictor of longevity and survival in captive and wild vertebrates. In this study, we examined the relationship between telomere length and various degrees of long-term human exposure in Adélie penguin chicks (*Pygoscelis adeliae*) from Terre Adélie, East Antarctica. Thus, telomere length was quantified and compared between chicks from two sites with sustained and continuous human activity (Petrels Island) and two sites on neighboring islands with little or no human presence (Lamarck and Bernard Islands). Our results will provide a powerful insight into the long-term impacts on wildlife living in close proximity to human activity, as well as contribute to the growing body of research on the efficacy of telomere length as an eco-indicator.

Thu_107_BE-8_2338
Modelling of Ballast Water Discharge in the Arctic Ocean

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Sea-ice concentration in the Arctic Ocean has decreased by 9 % per decade since 1978. As a consequence, more vessels are navigating the Arctic, increasing the risk of alien species introduction by ballast water (BW) discharge. The ships depend on BW for stability and structural integrity. Ballast water, however, also contain aquatic species, and in turn, these introduced species might survive and establish a reproductive population.
A tracer for BW was implemented into a high-resolution North Atlantic/Arctic Ocean-Sea Ice Model (NAOSIM). The flow of the BW-tracer discharged in the Arctic and possible areas of accumulation were investigated. In total, 17.407 vessels navigated the Arctic waters in 2013, with an estimated amount of discharged BW of about 13 million m^3. In the model, the BW-tracer is released along the shipping routes navigated in 2013. Results show that the seasonal cycle of the ocean mixing affects the BW-tracer distribution significantly. In winter, the BW-tracer reaches deeper waters, than in spring, when the sea-ice starts melting and stratifies the upper ocean. In spring and summer, the BW-tracer remains within the upper 20 m, where the availability of sun and nutrients lead to favorable living conditions for non-indigenous species. One area of BW-tracer accumulation is the vicinity of the Kara Gate in the Barents Sea. There, 10 % of the BW-tracer remains more than 20 days after its release. Lower percentages of the BW-tracer remain almost three months.

Thu_109_BE-9_42
Trophic and Non-trophic Connections of Potter Cove Marine Ecosystem

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Organisms eating each other are only one of many types of well documented and important interactions among species. However, ecological interactions of coexisting species involve much more than just feeding. Within an ecosystem, species interact with each other in many different ways including predation, competition and facilitation. These interactions can be modelled as trophic and non-trophic networks which constitute a group of links that mediates ecological communities' response to perturbations, such as exploitation and climate change. Here we expose the trophic and non-trophic interactions of the marine ecosystem of Potter Cove (62°14´S, 58°40´W, King George Island, Antarctica) expressed in four different networks depending on the type of interaction: trophic (+/-), commensalism (+/0) and amensalism (-/0), mutualism (+/+) and competition (-/-). Conducting a preliminary analysis, we argue the importance of incorporating both direct and indirect non-trophic and trophic interactions and their ecological context, suggesting that it is the key to predicting community dynamics, thus it stability.

Thu_110_BE-9_158
Snow Does Not Mirrow Air Microbial Communities as Shown on Transects in Iceland

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Snow and ice surfaces host viable and diverse bacterial and fungal communities. These originate partly from wet and dry aerial deposition. However, the impact of short or long distance air transport, meteorological features, selective deposition and colonization processes remain unclear in their role with air and snow microbial diversity. Rapidly changing climate patterns in polar regions evoke a pressing need to investigate such air-snow community dynamics.
Eighteen air samples, comprising 56m³ of air, were taken at 15 sites along three transects in northern Iceland, covering distances of 50 to 120km with MD8 Air Port (Sartorius) and Coriolis µ (Bertin) air samplers. In two transects 11 snow sites were sampled. Airborne and snow-associated bacterial and fungal diversity, abundance and ice nucleation potential were investigated for temporal and spatial variation and correlated with multiple environmental factors.
Bacteria and fungi feature some ubiquituous core phyla, but show significant differences between air and snow on taxa level. Local aerosolisation sources, geographical and meteorological features impact on small scale spatial variability. Temporal site variation amongst the respective habitat was low.
Results hint towards a high contribution to snow microbial diversity from other than single cell deposition, suggesting snow inoculators originate from wet deposition, particle-associated microbe input or airborne, rare but highly successful colonizers.

Thu_111_BE-9_159
Snow and Photosynthetically Active Radiation in Lakes of the McMurdo Dry Valleys

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The role of snow on underwater photosynthetically active radiation (UWPAR) in the McMurdo Dry Valleys (MDVs) has been understudied due to lack of a detailed snowfall record. Research has shown that a relationship between snow cover and UWPAR exists, but the extent has never been evaluated in great detail. Although annual snowfall values in the MDVs are low (3 to 50 mm water equivalent annually), trends of increasing snowfall on the continent under future warming conditions could lead to an increased role for snow in regulating UWPAR (and associated primary productivity). Here, we discuss evidence from the snowfall record, surface PAR, and UWPAR, of the influence of snowfall on UWPAR in the major lakes of Taylor Valley. A new, detailed record of snowfall over the last 10 years created from camera and satellite imagery, and ground-based instruments will be presented. Statistical analysis of snow events within the record reveals the nature of their role in governing UWPAR rebound at Lake Hoare. In one large snowfall event in November 2016, UWPAR took 41 days to recover to levels equivalent to before the snowfall at Lake Fryxell which is more proximal to the coast. At the more distal West Lobe Bonney the recovery time was only 9 days. We will also present progress on a spatial model of UWPAR which will aid in evaluating the annual light budget under the lake and provide insight on snow as an ecological disturbance and the implications for lacustrine primary productivity.

Thu_112_BE-9_186
Climate Variability Positively Affects East Antarctic Moss Communities

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Polar regions are characterised by microclimates that are highly variable in space and time. Such high climate variability is expected to negatively impact biodiversity as it increases the probability that conditions will exceed species' physiological limits or the thresholds to ecosystem resilience. Not all microhabitats are equally variable, but few studies have examined how spatial differences in variability can affect the distribution of biodiversity. We surveyed 60 quadrats of Antarctic mosses over 10 years to determine if the health or composition were affected by the mean or variability of available water. We found that higher climate variability was associated with more green, photosynthetically active moss and a greater proportion of the endemic species *Schistidium antarctici*, compared to the cosmopolitan species *Ceratodon purpureus*. The healthiest quadrats were those with the highest mean water availability, but variability in water availability also positively affected species composition, especially where the mean water availability was low. Antarctic mosses can dehydrate and become physiologically inactive during drier periods to prevent damage, so our results suggest that periodic flooding is more beneficial for moss health and endemic species than having moderate, stable conditions. These results are especially important as 21st century climates are expected to be more variable and this could therefore impact ecosystems regardless of changes in mean climate.

Thu_113_BE-9_205
Age, Density, Prey, and Climate Drive the Demographics of an Apex Predator

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Ecologists widely acknowledge that a complex interplay of endogenous (density-dependent) and exogenous (density-independent) factors impact demographic processes and that individuals respond differentially according to their age, ultimately shaping the population dynamics of wild species. Here we provide an insight of the mechanisms affecting four vital rates (survival probability, probability of breeding, probability of a successful breeding with one, and with two chicks) of an apex Antarctic marine predator by combining longitudinal time series of know-age individuals, abundance data, climatic and prey abundance covariates. We found evidence for age-related changes in the four vital rates. Traits at younger ages were smaller and had larger temporal variance than those of older age-classes for all parameters. Results clearly evidenced an impact of extrinsic factors, with a direct influence of local climate (sea ice concentration) and of available prey resources (penguins), and of intrinsic factors with an influence of the size of the breeding population. More covariate effects were found on reproductive traits than on survival traits, and age classes responded differentially to these effects, the younger age classes being more sensitive than the older ones. Using a half a century dataset, we provide a compelling evidence to support the importance of considering multiple causal effects when studying demographic process in seabirds and the impact of environmental variability.

Thu_114_BE-9_374
Multi-million Year Antarctic Presence within the Moss Genus *Schistidium*

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Schistidium is the most species-rich plant genus in the Antarctic, as well as containing most Antarctic endemic moss species. To assess the diversity, richness and relative age divergences within the genus in Antarctica we applied phylogenetic and molecular dating methods, using the nuclear Internal Transcribed Spacer, on all known Antarctic species with available samples. We additionally investigated the continent-wide genetic diversity within the common and widespread endemic species *Schistidium antarctici*. Most previously described Antarctic *Schistidium* species were genetically distinct, confirming their specific status. All species had separated from each other at least ~1 Mya. In particular, *S. antarctici* diverged from other Antarctic *Schistidium* species as early as the late Miocene, thereby being the oldest extant plant species currently known in Antarctica, and providing strong support for vegetation survival through multiple glacial periods. Genetic patterns within *S. antarctici* suggest the mountainous spine on the Antarctic Peninsula has formed a strong barrier to gene flow over time, while the increased genetic diversity in this species in the northern Maritime Antarctic indicates likely glacial refugia in this area. This study provides an important first step towards assessing the evolutionary history of the largest plant genus in the Antarctic, and provides an insight into their adaptive potential to climate change over both past and contemporary timescales.

Thu_115_BE-9_657
Sensitivity of Coccolithophores to Ocean Warming and Acidification

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Coccolithophores are an important component of the Earth system and represents an essential footing to the marine ecosystem. This study presents the results of 10 year observational investigations on coccolithophore ecology and morphology in the Southern Indian Ocean (SIO). Samples were collected during four SIO Expeditions and three Antarctic Expeditions (December-April). Our data evidently indicates a pronounced seasonality in coccolithophore biogeography and noticeable size variation in *E. huxleyi*. The *E. huxleyi* show highest production in the STF and SAF region during the early austral summer and is more prone to dissolution at South of the SAF regions despite of high pH saturation. Whereas, during mid-austral summer, *E. huxleyi* population expands southwards forming heavily calcified morphotypes despite of low pH saturation. The study indicates it is unlikely that the increase in PAR and probable shifts in carbonate chemistry could cause *E. huxleyi* shift in high latitudes. We documented over-calcification in *E. huxleyi* when conditions were most acidic contrary to the earlier predictions. However, the occurrence of large *E. huxleyi* cells with numerous coccoliths in mid austral summer period indicates slowed cell division to cope with low pH conditions. On the contrary rapid increase in heterotrophs and subsequent grazing on coccolithophores in the late austral summer period raises further questions about the fate of coccolithophores in the future high-CO2 world.

Thu_116_BE-9_658
Ecoregionalisation of the Southern Ocean in the Context of Climate Change

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Understanding species distribution in the Southern Ocean is challenging in many aspects. Sampling in this region is logistically difficult because of its remoteness and extreme environmental conditions. Today, species distribution models (SDM) can be used to provide spatial projection of species distribution and quantify the relationship between species occurrence and their environment, and can fill knowledge gaps in data deficient areas. Based on the SDM approach, ecoregionalisation aims at *defining ecoregions* for conservation purposes that is, biogeographic entities that differ in their biotic and abiotic characteristics. In the context of rapid climate change, ecoregionalisation can provide a direct prediction of species assemblages that are linked to environmental features in under-sampled areas. In addition, projection of ecoregions in future environmental conditions can help identify regions that might be particularly at risk. In this framework, we proposed an ecoregionalisation of the Southern Ocean for echinoid species, which are common benthic organisms in the Southern ocean benthic communities. We first developed individual SDM for each species and then combined them using a Gaussian mixture model and a clustering approach using R to define ecoregions.

Thu_117_BE-9_688
Southern Ocean Influence on Robertson Bay, Northern Victoria Land

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Robertson Bay lies to the west of Cape Adare at the North Western corner of the Ross Sea (71.5°S 170°E). It is 500 m deep at its deepest and open to the North. A temperature inversion in the summer months results from strong offshore winds, linked to cyclonic storms, drawing warmer deep water into the bay. In the winter and spring months, the winds are decoupled from the ocean by the formation of sea ice. At the surface, water circulates in a clockwise gyre, developing a South-North long-shore current along the Adare Peninsula of a few knots. Flora and fauna are strongly coupled to the marine environment. The shallow benthos is diverse with many ophiuroids, anenomes, and sponges, and common macroalgae (also observed at Cape Hallet but no further south). The water column is also rich with plankton. Within 5-km of Ridley Beach, at the tip of Cape Adare, diversity and density of benthos drops off due to the presence of the million strong Adelie penguin colony. The penguin colony also dominates the terrestrial flora and microbial signature. At Robertson Bay, rather than deep warm water incursion driving change in the environment, the strong South / South East cyclonic winds dominate and drive ocean circulation. This phenomenon has recently been reported further west in East Antarctica where the cyclonic winds also influence the extent of sea ice. But the extent of sea ice does not seem indicative of circulation at depth where warm water is being drawn onto the continental shelf.

Thu_118_BE-9_707
Social Structure of Leopard Seals at Livingston Island, Antarctica

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The rapid environmental change occurring in the Antarctic Peninsula region has led to changes in the biota and community structure. Changes in top predator populations include shifts in distribution, abundance and the relative importance of top predators within the ecosystem. As ice-habitat in the Peninsula region has decreased, Leopard seals (*Hydrurga leptonyx*) have been dramatically increasing on land at Cape Shirreff, Livingston Island. Animals hauling out are primarily large females and juveniles. Remarkably, there is no published information on the social structure of leopard seals. Therefore, we set out to investigate the social structure of Leopard seals, via the estimation of genetic relatedness and parentage analyses. A preliminary assessment (17 samples; 10 microsatellite markers) revealed two pairs of mother-offspring, suggesting some level of individual association in hauling out behavior. However, genetic diversity was relatively low (heterozygosity, H_E= 0.57), so more genetic markers are needed to increase statistical power in our analyses. Despite this caveat, our results suggest that kinship associations are common and likely an important aspect of hauling out patterns in Leopard seals. We are currently expanding the scope of our study to add more samples, including animals from other areas, so we can better understand this species' behavior and population dynamics.

Thu_119_BE-9_727
What´s in a Size? Phenotypic Variation across *Acutuncus antarcticus* Populations

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Tardigrades, are one of the most diverse and common groups of animals found throughout continental Antarctica and play an important role in biological processes in its challenging terrestrial ecosystems. *Acutuncus antarcticus* is currently thought of as a truly pan-Antarctic species which can survive in most terrestrial habitats in Antarctica, although it is most commonly found within algal mats. Previous studies into phenotypic variation between continental populations of this species showed little difference. Here we build on these studies by measuring phenotypic variation over a geographical area expanded to include the sub- and maritime Antarctic. Principal component analysis of morphological data obtained identified distinct regional variation and suggested two alternative explanations for the variation seen. Firstly, local adaptation to their environment in individual populations or second, the early stages of speciation across different geographical areas. These alternatives will be addressed with molecular phylogenetic analyses. Knowing the history and colonisation routes of these animals in Antarctica could contribute to predicting future changes to biodiversity associated with climate change.

Thu_120_BE-9_800
Three Decades of Plant Succession at Rip Point, Nelson Island, Antarctica

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Long-term studies of plant succession are still negligible in Antarctica. Such evaluations allow correlations between plant development, climatic change and ecological consequences in specific areas of Antarctica. We compared the phytosociological data collection carried out in 1990 with recent data from 2017 Austral Summer at Rip Point, Nelson Island - Maritime Antarctica. Ten areas dominated by mosses selected in 2017, which out of 17 areas studied in 1990. The Braun-Blanquet square methodology was adapted to the Antarctic conditions, in which we compared vegetation differences through frequency and coverage data and analyzed the plant community succession in the area. The results indicate that varying water availability influences local vegetation, reducing cushion forming mosses and *Warnstorfia* spp. community, more dependent on waterlogging. This was attributed to lower snow cover, remaining in the area compared with data 1990, the general species composition revealed the appearance of *Brachythecium* sp. not observed in the earlier study. *Sanionia* spp. carpets área now increasing growing and vigour, except in áreas under intense human impact, where the community is reducing. Even though the decreasing water availability with time, *Polytrichum piliferum* Hedw. is being completely overgrown by *S. uncinata*. Some areas showed the appearance or increasing growing of muscicolous lichens, indicating a process of plant succession at Rip Point.

Thu_121_BE-9_832
Efficiency of the Antarctic Protected Areas Conserving the Terrestrial Diversity

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The Antarctic Specially Protected Areas and Managed Areas (ASPA/ASMA) are Antarctic zones defined to protect scientific, historic and environmental values, including the conservation of the fauna and flora. The delimitation of these areas is reviewed regularly during the workshops of the Antarctic Treaty Meetings. However, information of the geographic distribution of the Antarctic biodiversity has not been considered strictly to delimit these areas. Thus, to produce a baseline to support this kind of decisions, this study was focused to estimate how the terrestrial biodiversity is distributed within the protected areas and how it changes as the distance from their current limit increase. To achieve this, first, we estimated the geographic distribution of the terrestrial Antarctic biodiversity using stacked distribution models of 68 species. Each species distribution was obtained from a consensus model, combining MaxEnt, GARP, GAM and SVM models. After, we estimated how the biodiversity changes as the distance to the current ASPA/ASMAs increased: evaluating dissimilarity due to species replacement and species loss in ring buffers located at different distances to the protected areas. Finally, we ranked all the ASPA/ASMAs from the most efficient to the less one based on the replacement and loss of species. The maps of change in biodiversity and the efficiency ranking obtained constitute a key baseline to redefine the limits of the Antarctic protected and managed areas.

Thu_122_BE-9_839
Closely Related Antarctic Octopus Show Different Spatial Genetic Structures

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Determining whether comparable processes drive genetic divergence among marine species is relevant to molecular ecologists and managers alike. Sympatric species with similar life histories might be expected to show comparable patterns of genetic differentiation and a consistent influence of environmental factors in shaping divergence. We used microsatellites to quantify genetic differentiation across the Scotia Arc in three octopod species; Pareledone turqueti, P. charcoti, and Adelieledone polymorpha. The relative importance of environmental factors in shaping genetic structure was investigated. Isolated populations of P. turqueti and A. polymorpha at these species' range margins were genetically different to samples close to mainland Antarctica; however, these species showed different genetic structures at a regional scale. Samples of P. turqueti from the Peninsula, Elephant and Signy Islands were genetically different, and this divergence was associated primarily with depth. By contrast, weak or nonsignificant spatial genetic structure was evident across the Peninsula, Elephant and Signy Island regions for A. polymorpha. P. charcoti exhibited no genetic differentiation between samples from a small region of the Scotia Arc. Thus, closely related species with similar life history strategies can display contrasting patterns of genetic differentiation depending on spatial scale; moreover, depth may drive genetic divergence in Southern Ocean benthos.

Thu_123_BE-9_964
What Drives the Distribution of Antarctic Krill at the South Orkney Islands?

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Antarctic krill is a key species in the marine ecosystem of the Southern Ocean and the target of a commercial fishery. Determining the physical and behavioural drivers for krill distribution, including the formation, maintenance and distribution of krill aggregations, is essential to understanding the ecosystem, its function, and sensitivity to climate change and human impacts. This is particularly important as the fishery for krill is increasingly geographically focussed on local krill hotspots.
Here we present modelling results from two related projects investigating the distribution of Antarctic krill at the South Orkney Islands (~60^{o}S, 45^{o}W). One of the main fishing grounds for krill, this region is also critical for determining the overall availability of krill across the wider Scotia Sea. Modelling studies using state-of-the-art ocean-sea ice models at differing spatial resolutions allow us to understand temporal and spatial variability in krill flux into and out of the South Orkney region, and the relationship to sea ice conditions. Individual-based models incorporating key behavioural characteristics permit further investigation into the role of krill behaviour on retention and dispersal of krill in the region. Such insights and predictive tools are essential for a sound implementation of a feedback management system for Antarctic krill, which is currently being developed under the auspices of the Commission for the Conservation of Antarctic Living Resources (CCAMLR).

Thu_124_BE-9_978
Physical Forcing of Marine Ecosystems in the Prince Edward Islands Region

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The Southern Ocean (SO) plays a crucial role in the global ocean and climate system. Its ecosystems affect global biogeochemical cycles, sustain globally important marine biodiversity and will be important in maintaining food security. Somewhat alarming therefore is the rapid rate of environmental change being experienced by the region with resultant impacts to ecosystems and food webs. Understanding the impacts of a changing physical environment on biological systems is a key question in marine ecology. However, linking ecosystem changes to physical ones remains difficult. Ecosystem models allow computational exploration of disruptions on ecosystems that would otherwise be impossible experimentally. However, much research to date has focused on species-specific research. Therefore a great emphasis has been placed on the need for the development of modelling strategies that span all levels of the biotic system, from end to end. While integrated whole ecosystem views of the SO from nutrients through primary producers and consumers to top predators are starting to emerge, models integrating physics and biology are lacking. Therefore we use physical oceanographic data to drive biological ecosystem models of the sub-Antarctic Prince Edward Islands. Physical oceanographic processes are of considerable importance to the marine ecosystem in the vicinity of these islands and therefore changes to these processes are predicted to have significant impacts on species and communities.

Thu_125_BE-9_1018
Integrating Niche Modelling to Assess Spatial Risks of an Invasive Midge

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Eretmoptera murphyi, a flightless midge endemic to the sub-Antarctic island of South Georgia, was inadvertently introduced to Signy Island (South Orkney Islands) in the 1960s, establishing an alien population that has since been expanding locally. In order to identify future expansion risks, different modelling techniques are explored here. Mahalanobis distances were calculated based on the species' current realized distribution, as an indication of environmental distances to the species niche centroid at different sites. In addition, ecophysiological experiments were performed on E. murphyi larvae to identify those temperatures most beneficial for survival to build into mechanistic models. Potential range distribution scenarios are generated for current and predicted future scenarios up to 2100. Increasing risk of invasion into Antarctic locations further south is predicted over time. Sites in synergy with high visitation at the South Shetland Islands and northern Antarctic Peninsula are likely to be at particularly high risk. How the endemic maritime Antarctic midge (*Belgica antarctica*) will be affected in the event of southwards range spreading and range overlap with *E. murphyi* remains to be assessed. Human activities in the this region should follow particularly strict biosecurity protocols if visiting Signy Island or South Georgia and then traveling to other maritime Antarctic locations, in order to minimize the risk of assisted dispersal to such highly vulnerable sites.

Thu_126_BE-9_1020
Antarctic Sponges as Prokaryotic Diversity and Biotechnology Hot-spots

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Polar Regions are experiencing multiple environmental stressors and the increasing contaminant influxes are likely becoming more severe. As filter-feeders, in Porifera ingestion becomes the primary route in the uptake and accumulation of particle-associated contaminants, which may accumulate in animal tissues. Porifera also provide an important habitat for aquatic prokaryotes that colonize outer surfaces and interstices of ostia and oscula, and may be particularly responsive against contaminants accumulated in the sponge tissues. Symbiotic microorganisms can adhere to the sponge surfaces by forming biofilm with complex 3D-structures, composed by microbial consortia encased in an extracellular polymeric substances. The exopolymeric substances possess high biotechnological potentialities with applications in biomedical, cosmetic, food and environmental fields. Despite Porifera are abundant invertebrates in Antarctica, the associated prokaryotic communities and their biotechnological potentialities were largely disregarded. Funded by the Italian PNRA, the **P^3** project "*Antarctic **P**orifera: Hot-spots for **P**rokaryotic diversity and biotechnological **P**otentialities*"" (PNRA16_00020) will aim at linking the ecological traits (e.g., phylogenetic diversity and metabolic activities) and biotechnological potential (e.g., biofilm production, pollutant degradation) of prokaryotes associated with Antarctic Porifera by applying a multidisciplinary approach.

Thu_127_BE-9_1025
Peracarids of the Larsen-C Shelf Area Compared with Non-ice Covered Regions

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The Larsen-C PEARL Project (The influence of Larsen-C ice-cover on macrobenthic peracarid crustacean assemblages on the Antarctic shelf) compares and analyses the benthic peracarid distribution in ice covered (Larsen-C, calved iceberg A 68) and ice-free Southern Ocean areas. The project's governing hypothesis is: H: "Until the calving of the Larsen-C iceberg, A68, the benthic fauna on the seabed beneath ice shelf has likely comprised oligotrophic assemblages resembling deep-sea Weddell Sea assemblages. The calving of A68, and the exposure of the seabed to open-marine and sea-ice conditions will initiate a rapid colonisation by new species that will transform the benthic ecosystem significantly within a short timeframe." Larsen-C Pearl will focus on peracarid crustaceans and analyse biodiversity and assemblage structure of the epi- and suprabenthic peracarid crustaceans and compare the occurrence of species from the Larsen-C area with that of the deep sea of the Weddell Sea as well as the Filchner Trough and South Orkney area.

Thu_128_BE-9_1091
An Investigation into Social-biology of Penguins in Antarctica

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Presentation will be made on Social Networks of animals to understand animal behaviour, animal cognition and the dynamics of animal societies in extreme environments like Antarctica. And its role in the designing the instinctive layer of social systems.
Social structure of *penguins*¾a group of primitive flightless birds living in the coastal regions of *Antarctica* continent will be explored.
These primitive birds living in the earth for more than 60 million years by withstanding extreme evolutionary challenges. Various adaptive strategies in their daily life are examples of highest level of cooperative behaviour, and reasons for their survival for such a long time; while majority of animals of that period are now extinct and no longer exist in earth. All this made possible with a very primitive brain structure.
Importance of multidisciplinary studies will be explored to understand the structure and dynamics of their social system; biological and mathematical characteristics responsible for developing into a well-structured organised society. Adaptive features of their anatomy, physiology and cognition will be presented.
The studies into the social network of penguins will make it possible to understand *instinctive nature* and *robustness* of their social systems functioning with a primitive and simple brain, body and social structure. The role of biotic and abiotic factors in shaping up animal societies will also be discussed.

Thu_130_BE-9_1155
Are there Barriers for Microbial Dispersal in Antarctica? Clues from Rotifers

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According to the recent biogeographical classification (Terauds et al. 2012, Terauds & Lee 2016), ice-free regions of Antarctica are divided into 16 Antarctic Conservation Biogeographic Regions (ACBRs), each of those with characteristic fauna including microscopic organisms (fungi, algae, microarthropods and other invertebrates). Various historical and contemporary drivers may underlay the observed biodiversity patterns, including population isolation during glacial maxima, physical and/or atmospheric connectivity barriers.
Our research aims at discovering the patterns of isolation/long-distance dispersal in the populations of 5 species of Antarctic rotifers: (1)*Adineta editae*, (2)*A. emsliei,* (3)*A. grandis*, (4)*Macrotrachela* cf *musculosa*, (5)*Philodina gregaria*. Species were collected in 7 ACBRs of maritime (1,4) and continental Antarctica (1,2,3,5). Sequences of mtCOX1 partial gene were used for AMOVA, Mantel test and building TCS haplotype networks. The analysis has shown significant patterns of local isolation in the populations of all species, and long-distance dispersal for (4).

Thu_131_BE-9_1204
Under Sea-ice and under Protection: Low Impact Sampling of Antarctic Toothfish

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The Antarctic toothfish (*Dissostichus mawsoni*) is the largest notothenioid fish inhabiting high Antarctic waters where it is a keystone species in the food web as apex predator, and commercially fished. The life cycle of the species is only partially known since large amount of data is available from open waters, where the toothfish resides as adult, whereas information from sea-ice covered areas is still poor. This leaves in the field of uncertainty a significant portion of the species life cycle, including the sub-adult phase. Where and how the sub-adults toothfish forage in the water column and to what extent they are able to perform vertical migration in sea-ice sheltered areas are among the issues that still remain uncovered.
In this frame, and taking into account the conservation goals of the recently established Ross Sea Region Marine Protected Area (RSRMPA), low environmental impact methodologies for the visual survey of Antarctic toothfish are being developed for collecting data from under sea-ice areas. The work, performed under the umbrella of the scientific scholarship 2017 of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), aims at contributing to refine the sustainable management of the Antarctic toothfish, and to develop a standardized protocol for non-invasive sampling to be used for monitoring in the RSRMPA.

Thu_132_BE-9_1255
Retarded Ice Growths in Antarctic Lichen Thalli

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Antarctic lichens are resistant to low temperatures and to deep dehydration. The understanding of that requires the knowledge on the formation of tightly and of loosely bound water fractions at different steps of hydration process.
The thalli of fruticose lichen *Cetraria aculeata* (Schreb.) Fr. were collected in maritime Antarctica.^{1}H-NMR spectra were collected on Bruker Avance III 300 spectrometer (Bruker Biospin),. DSC scans were performed on Perkin Elmer DSC 8000 calorimeter.
^{1}H-NMR experiments allow us to distinguish besides the signal from lichenized fungus tissue also the signal from tightly bound (immobilized) water and the signal from loosely bound (more mobile) water fraction.
^{1}H-NMR spectra temperature dependence reveals two processes of bound water immobilization, *i.e*. coherent ice freezing and gradual non-coherent immobilization of water molecules. Besides these two mechanisms observed by us in other biological systems/living organisms, e.g. in wheat photosynthetic membranes, a novel effect was discovered using DSC, namely ice crystallites growth inside the Antarctic *Cetraria aculeata* thallus was retarded by diffusion of supercooled liquid water molecules. The retardation is probably correlated/induced by morphological diversity of the thallus, consisting of fungus and of isolated algal cells. However, there is a question to what extent this phenomenon creates an evolutionary advantage of lichenized fungi.

Thu_133_BE-9_1266
Substrate Colonization in the Ross Sea, Antarctica: The ANT-BIOFILM Project

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Microbial biofilms play a key role in substrate colonization in aquatic environments, as hot spots of biodiversity and sources of secondary metabolites with biotechnological potential. In Terra Nova Bay (Ross Sea, Antarctica), microbial biofilm communities are under-explored in their structure and functions; particularly, their response to environmental and/or anthropogenic forcings remains to be elucidated yet. Funded by National Antarctic Research Program (XXXIII Italian expedition), the ANT-Biofilm project "Microbial colonization of benthic ANTarctic environments: response of microbial abundances, diversity, activities and larval settlement to natural or anthropogenic disturbances and search for secondary metabolites" (PNRA16_00105) includes short and long term (3-12 months) experiments in two bays (Road Bay and Tethys Bay) characterized by anthropogenic (i.e. sewage) and natural (i.e. low salinity) stressors, respectively. Total, viable and respiring prokaryotes, culturable bacteria, potential enzymatic activity rates, physiological community profiles, microalgae and macrobenthic community are studied. Selected biofilm samples will be sequenced and analyzed by hybridization (i.e. Card-FISH) and bacterial isolates screened for antibiotic resistance and metabolite production. Physical-chemical environmental characterization will be performed. This contribution reports the preliminary results obtained by the four Research Units during the short term experiments.

Thu_134_BE-9_1357
Environmental Drivers of Mesopelagic Community Structure on the Kerguelen Axis

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In January - March 2016, the Antarctic Climate and Ecosystems CRC led an integrated ecosystem survey voyage on the Southern Kerguelen Axis - a productive region spanning from Banzare Bank on the southern Kerguelen Plateau towards Prydz Bay in East Antarctica. The voyage track encompassed an 8850 km path including 9 transects, designed to encompass major environmental transitions that may drive ecosystem structure in the region. A primary goal was to characterize the pelagic foodweb structure and major energy pathways, with a strong focus on the mesopelagic community. The mesopelagic community was sampled at 36 stations, from the surface to 1000m in 200m depth strata, using an IYGPT net equipped with a multiple cod-end MIDOC device. Calibrated acoustic data were also collected throughout the voyage, using SIMRAD EK60 echosounders, operated at 38, 120 and 200 kHz. We present a summary of the mesopelagic community results from this voyage, including abundances key nekton groups, and analyses examining the relationship between catch composition, total acoustic backscatter, and key environmental drivers. This work provides new information on a poorly represented ecosystem component and pilots methodologies for future ecosystem observation and monitoring.

Thu_135_BE-9_1405
Assessment of Ground versus UAS Flight Surveys on Antarctic Predator Behavior

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Accurate population counts are fundamental to wildlife management. The recent proliferation of unmanned aerial systems (UAS) has provided new opportunities for collecting census and distribution data that are as, or more, accurate than traditional ground surveys. Reports on the effects of UAS on wildlife, however, vary widely. Wildlife response differs depending on many factors including species, type and size of UAS, method of operation, amplitude and frequency of noise, etc. We compared the effects of UAS flights to ground surveys by assessing the behavioral responses of chinstrap penguins (CP), Antarctic fur seals (AFS), and leopard seals (LS) to flights at specific altitudes. For CP & AFS we also controlled for differences in human exposure history and stage of reproduction. Flights were conducted Jan-Mar 2017. Observations for all three species were recorded by a UAS camera, a lateral camera with a sound meter and visual observers. We conducted 35 flights over CP (N=272), AFS (N=68) and LS (N=10). Lateral camera and visual observations were also made for ground surveys of CP (N=130) at the same location. During flights as low as 8 m < 1% of CP, 10% of LS, and < 15% of AFS responded to UAS. No animals moved their location. By comparison >85% of CP and 100% of LS left their location during ground surveys. Our studies indicate that a UAS, operated within guidelines appropriate to the situation, can have less impact on wildlife than traditional survey methods.

Thu_136_BE-9_1406
Modelling the Diet of Leopard Seals at Cape Shirreff, Antarctic Peninsula

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Leopard seals are a widespread and important predator in Antarctic coastal ecosystems. Previous studies have identified a broad range of prey items; however, due to anecdotal or otherwise limited information leopard seal diets remain largely unresolved by seal sex, inter-individual variability, age class, region, or season. As a result, leopard seals are commonly reported as generalist predators. Over three summer field seasons we collected visual, scat and stable isotope tissue (blood and plasma) data from nineteen adult female and two adult male leopard seals foraging near mesopredator breeding colonies at Cape Shirreff. We summarized a priori diet information and applied a three isotope ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$), four source (fish, fur seal, krill, penguin) Bayesian mixing model to examine temporal variability in both prey sources and leopard seal tissues, and define their trophic position within the local food web. The distribution of the four prey groups in isospace appears to explain the entire leopard seal diet. Rather than a generalist diet pattern, posterior probabilities of prey proportions identified two distinct groups among female diets. One diet was dominated by Antarctic fur seal pups and krill, while the other was predominately penguin and demersal fish. The diet of the two males was mostly krill. Additionally, $\delta^{15}N$ values were consistently enriched for plasma versus red blood cells implying a seasonal diet change for both female groups.

Thu_137_BE-9_1413
Parsing Environmental Stressors in the Southern Ocean Ecosystem

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Ecological systems are being impacted by a wide variety of environmental stressors. Changes in the abiotic environment and resource extraction are two areas of particular concern in the Southern Ocean. Parsing the impacts of these stressors, however, has proven difficult. Not only is resource extraction in the region difficult to quantify, impacts of both abiotic and biotic stressors may result in similar ecological responses in metrics commonly measured by researchers. Using data on penguin demographics, krill catch, and abiotic environmental conditions such as sea ice dynamics, we assess the impact of these drivers on penguin reproductive performance. We combined data on *Pygoscelis* penguin reproductive success from a network of remote time-lapse cameras positioned across the Antarctic Peninsula and previously unanalyzed high-spatial and temporal resolution krill catch data obtained from Aker BioMarine. A hierarchical Bayesian state-space model was used to estimate penguin chick survivorship as a function of both abiotic environmental conditions and krill catch across both space and time. Through the integration of multiple sources of data over large spatial scales, we identify key drivers of penguin breeding success, which has important implications for management efforts and our understanding of the Southern Ocean marine ecosystem.

Thu_138_BE-9_1414
Environmental Change and Ecosystem Monitoring of the Ross Sea Region

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The Ross Sea region of the Southern Ocean is a significant focus of global research. Important unanswered questions remain on the drivers and extent of oceanographic change and on the response of marine ecosystems to a changing environment. Managing and mitigating the effects of human activities (especially fishing and tourism) against this backdrop of environmental change is challenging and has led to the establishment of the world´s largest Marine Protected Area in the Ross Sea region. Ongoing stewardship requires an understanding of environmental-ecosystem interactions and the development of an effective approach to monitoring.
This presentation outlines the first results from a New Zealand research voyage to the Ross Sea region in 2018. New information will be presented on the main science questions:
1. How has the export of Antarctic Bottom Water from the Ross Sea changed over the past two decades?
2. What are the key interactions between aerosols and cloud formation?
3. How do marine microbial planktonic communities vary across the Ross Sea region?
4. What is the structure, and key environmental drivers, of benthic and demersal habitats and faunal communities of the Pacific-Antarctic Ridge in the Ross Sea sector?
5. Is the Ross Sea region ecologically critical for key species of Antarctic whales?
6. How is the distribution, abundance and trophic ecology of mesopelagic fishes and zooplankton in the Ross Sea region related to the oceanographic environment?

Thu_139_BE-9_1441
Complementary eDNA and Micropaleontological Foraminiferal Record from Ross Sea

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The seafloor morphology of the western Ross Sea has been shaped by glacial and post-glacial processes, including subglacial deposition, erosion of paleo-ice streams, and iceberg scouring. The similarities of repeatedly recycled sediments pose a problem with distinction between sedimentary facies. However, in most of these records, foraminiferal microfossils are present, carrying significant information.
During the NBP15-02A cruise, we collected samples from megascale glacial lineations (MSGLs), Grounding Zone Wedge (GZW) topsets, foresets and slope deposits for micropaleontology and next-generation sequencing of environmental DNA (eDNA). In sediments from different geomorphological features, we found various assemblages of fossil foraminifera, which are complemented by information from foraminiferal DNA. Species detected by molecular methods were dominated by monothalamids, which are absent in the fossil record. Information derived from eDNA increases our knowledge of true foraminiferal diversities as well as supports the interpretation of in-situ character of investigated assemblages. The distribution of biogenic remains fits well with environmental interpretations based on sedimentology and geomorphology. It shows an absence of eDNA in sediments from GZW topsets and MSGLs paired with low microfossil abundances. In contrast, in GZW foresets, eDNA is accompanied by numerous foraminiferal tests.

Thu_140_BE-9_1550
How *C. quitensis* Can Cope with Global Warming: A Focus on Photosynthesis

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The West Antarctic Peninsula is one of the areas on Earth mostly affected by global warming which is inducing a temperature rise at an alarming rate. This makes the Antarctic Peninsula an open-air laboratory where the study of the genetic and molecular traits of the adaptation of living organisms to rapidly changing environmental conditions may allow the disclosure of molecular biomarkers for efficient climate change monitoring. The two plants species native to Antarctica, *Deschampsia antarctica* Desv. and *Colobanthus quitensis* (Kunth) Bartl., are exposed to high light and low temperature during their natural growing season which alter their photosynthetic yield and make them more susceptible to photooxidative damage.
In this work, we investigated the influence of the temperature rise on the *C. quitensis* photosynthetic performance. To this, we compared the expression level of key genes of the photosynthetic pathway in plants grown in natural conditions versus plants grown for one year inside small greenhouses open on the top (Open Top Chambers) which determine an increase of about 4 °C during midday, mimicking the effect of global warming.
Interestingly, we found that higher temperatures induce a general over-expression of the genes involved in the photosynthetic process, but plants seem to be less protected from high irradiation since the genes involved in the non-photochemical quenching appear to be down-regulated.

Thu_141_BE-9_1552
Assessment of Housekeeping Genes for qPCR Data Normalization in *C. quitensis*

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The areas along the Antarctic Peninsula are warming faster than any other part of the world hard testing the native organisms which often live at their physiological limits. This makes particularly interesting to study the genetic and molecular traits of the local plants to assess the molecular basis of adaptation to low temperatures and their ability to respond to climatic changes. The use of molecular tools, such as qPCR, to perform differential gene expression studies requires the identification of the most stable houesekeeping genes (HKG) to normalize the data and obtain robust and consistent results.
In this work, we identify and validate new reference genes for qPCR data normalization in the Antarctic plant *Colobanthus quitensis* (Kunth) Bartl. under various abiotic stresses (temperature, nitrogen and salinity). In particular, we selected a set of eight candidate HKG whose stability was evaluated using the freely available *RefFinder* web tool that uses 4 different software (NormFinder, BestKeeper, ΔCt and geNorm) to calculate the geometric mean of weights for the comprehensive ranking order recommended and to determine the best reference gene or pair of genes.
In addition, to test the reliability of the selected reference genes, expression analysis of catalase was presented. Ultimately, our data provide a useful set of reference genes that can be used in qRT-PCR to analyze gene expression in *C. quitensis* under different experimental procedures.

Thu_142_BE-9_1615
Small-sexual Segregation Despite Large Scale Overlap in Wandering Albatross

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Sexual segregation in foraging habitat occurs in many marine predators and is usually attributed to intra-specific competition or habitat specialisation associated with sexual size dimorphism. We studied habitat use, diet and feeding ecology of female and male wandering albatrosses Diomedea exulans, fitted with GPS and stomach-temperature loggers during the chick-rearing period at South Georgia. During this period, when oceanographic conditions were unusual and prey availability was low in Antarctic waters, tracked wandering albatrosses showed high consistency in foraging areas at a large spatial scale. Despite consistency in overall habitat use, males and females showed different foraging behaviours in response to oceanographic conditions. Males appeared to be more opportunistic, exploiting oceanic and less productive waters mostly to scavenge for offal or non-target fish discarded by fishing vessels. In contrast, females commuted directly to natural productivity hotspots; most prey ingestions were on the outbound part of the trip, returning directly to the chick and fed on a wide variety of fish and cephalopods. The consistency in habitat use at a large scale, and sex differences in feeding ecology and behaviour at finer scale, indicate that males and females adopt different strategies in core foraging areas when prey availability is low. This leads to differences in diet composition between sexes in the absence of large-scale sexual segregation.

Thu_143_BE-9_1724
Selection of Food Concentrating Surface Convergent Zones by Penguins

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Discovering the environmental predictors of foraging locations can be challenging and is often the critical missing piece for interpreting the ecological significance of the observed movement patterns of marine predators. This is especially true in dynamic coastal marine systems, where food resources are diffuse and must be either physically or biologically concentrated to support top trophic levels. At Palmer Canyon, a known biological hotspot in the West Antarctic Peninsula, we deployed an integrated polar observatory consisting of high frequency radar, coordinated gliders, and moorings. Lagrangian coherent structures (LCS) derived from surface currents measured by high frequency radar were used to estimate the location of convergent ocean features relative to penguin foraging locations. Acoustic scattering measurements from an underwater glider suggest that krill may be more prevalent within convergent LCS, suggesting they are important for penguin foraging behavior. We found that shallower foraging (< 50 m) Adélie penguins selected for surface convergent features, while the deeper diving (< 100 m) gentoo penguins did not demonstrate the same preference, suggesting that these species are selecting for different dynamic habitats. Changes in the location of convergent LCS appear to explain historic patterns in Adélie penguin foraging behavior, suggesting that the frequency and location of surface convergent features are important ecological drivers in this region.

Thu_144_BE-9_1757
Facilitating Southern Ocean Population Genomics - A RADseq Pilot Experiment

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The Southern Ocean (SO) is subject to (local) rapid environmental changes and increasing anthropogenic perturbation. Consequently, major efforts are under way to protect, manage and/or sustainably use the living marine resources. Such aspirations depend on knowledge of spatio-temporal distribution and diversity patterns of Antarctic organisms. Reduced representation sequencing such as RADseq enables cost-efficient characterization of genome-wide SNP markers in non-model species. Large numbers of SNPs facilitate population genomic studies to investigate intra- and interspecific genetic differentiation, as well as evolutionary adaptation potential. Obtaining useful amounts of SNPs at appropriate sequencing depth, requires carefully optimized experimental designs, particularly in species lacking genomic resources. Here, we present a pilot experiment to determine if and how RADseq approaches can be applied to a variety of SO taxa (Bivalvia, Amphipoda, Asteroidea, Perciformes and Aves). We perform computational *in silico* digestion of simulated genomes and genomes of related taxa with a variety of restriction enzymes and size selection combinations to determine the expected number of markers. Results are compared to empirical data from actual DNA digestions and promising combinations are used to prepare pilot sequencing libraries. We present this approach as it will likely be useful and applicable to other target organisms, ultimately advancing SO conservation efforts.

Thu_145_BE-9_1801
Sea Stars Comparative Evolutionary Patterns in the Southern Ocean

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Ecological traits such as the dispersal ability will influence the biogeographical patterns of benthic organisms in a significant way over local to large scale in space and time. When biogeographical observations are based on morphological identification of specimens, conclusions assume morphology accurately reflects evolutionary processes. In order to test the fit of morphologically based biogeographic patterns recently identified in Antarctic sea stars with contrasting reproductive modes (here used as a proxy for dispersal ability), we re-examine the dataset with the addition of mitochondrial sequence data. We identified diversity and divergence patterns of 1500 specimens across five genera of Southern Ocean asteroids with contrasted dispersal abilities. Using a comparative phylogeographical approach we were able to test for shared historical processes as phylogeographic congruence among lineages. These outcomes were critically compared to the interpretation of the former study.

Thu_146_BE-9_1807
Accepted Taxonomy versus Real Specific Diversity in Southern Ocean Sea Stars

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Studying and estimating species diversity of given taxonomic groups has been an ongoing process for centuries. First based on a morphological characterisation of specimens, the study of diversity is nowadays more powerful than ever with the democratisation of molecular tools such as the DNA barcoding. Correlatively with the enhancement of genetic analysis is observed a decrease of experimented systematicians to fulfil the work of morphological characterisation of species.
We propose in this work via the analysis of asteroids barcode sequences a powerful tool to highlight the gap between the accepted taxonomy and the real specific diversity. COI sequences of over 2,500 specimens of sea stars collected in the Southern Ocean were analysed following a genus-by-genus approach. Procedures like the ABGD, GYMC or PTP could rapidly help taxonomists into pinpointing taxonomic groups to focus on. The Southern Ocean certainly is a particularly adapted laboratory for such a study as it is the theatre of various diversification processes leading to the presence of cryptic/unrecognized diversity.
This study is the perfect example of the interest of this kind of analyses as it demonstrates the large gap between what is described in books and what is observed at the molecular level.

Thu_147_BE-9_1809
Kerguelen Asteroid Fauna Diversity and Biogeography with the Southern Ocean

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Marine fauna of the isolated archipelago of Kerguelen has been studied for decades as it might represent a crucial link for benthic biogeography of the Southern Ocean. Its pivotal position in the sub Antarctic (between South America - the Scotia Arc and the Macquaries) and the possible links with high Antarctic might play an important role in the global biogeography of the region.
Compiling data from three research projects (POKER, Proteker and ACE - ASCCC) we conducted diversity, phylogeographic as well as multivariate analyses to better characterize the Kerguelen Plateau in term of asteroids assemblages (Echinodermata).
Mitochondrial gene COI sequences of hundreds of specimens were used to understand the relationships of the Kerguelen Islands with the surrounding Southern Ocean. Gene sequences from the Kerguelen's specimens were compared with thousands from the whole Southern Ocean allowing a better understanding of the role of the Kerguelen Islands in the frame of the Southern Ocean.
This work brings new insight in term of the possible origin of the asteroid fauna on the Kerguelen Plateau but also in term of the role of this sub Antarctic area as a source for post-LGM recolonization.

Thu_148_BE-9_1832
Remote Characterization of Microbial Mats in Taylor Valley, Antarctica

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Microbial mat communities, consisting primarily of cyanobacteria, are the most abundant and widely distributed terrestrial phototrophs in the McMurdo Dry Valleys of Antarctica. Prior work has shed light on the niche preferences and eco-physiology of these communities, but the combination of low photosynthetic rates and patchy distribution has limited assessment of microbial mat dynamics to habitat-scale investigations. We present data using high-resolution multispectral remote sensing techniques linked with field sampling campaigns in Taylor Valley to examine the sensitivity of these microbial mat communities to environmental variation. Our work demonstrates that:
1. microbial mat communities can be identified from orbit;
2. satellite images can be captured throughout a season and can be synchronized with in-situ measurements; and
3. the temporal resolution is sufficient to discern temporal variation in microbial mat activity.
Our results highlight the opportunity for using remote sensing in coordination with field-based campaigns to systematically study the base of terrestrial Antarctic food webs, i.e., microbial mat communities, at scales relevant to quantify spatial distribution and detect the influence of hydroclimate variability on temporal dynamics of microbial communities.

Thu_149_BE-9_1875
A Synergistic Approach to Understand the Ecological Impacts of Climate Change

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Understanding potential climate change impacts on Southern Ocean ecosystems requires the inclusion and interpretation of climate model projections. The use of global climate models in ecological studies is growing, but drawing meaningful conclusions is difficult. Issues of temporal and spatial scale are amongst the key challenges. For instance, these models do not sufficiently represent ecologically important features such as the marginal ice zone since it is relatively small in area and comprises a complex variety of sea ice types. Using Southern Ocean sea ice as an example, given its crucial role for the biology of the region, we initiated a joint study comprising ecologists, biogeochemists, climate modellers and fishery scientists, to explore the use of these models for ecological insights. With an emphasis on ecologically-relevant criteria (sea ice extent and seasonality) we selected a subset of available global climate models that reliably reproduce extant sea ice distributions. Whilst the mean of this subset is similar to the model ensemble, there is a marked reduction in the range. This improved the precision of projected future sea ice distributions by approximately one third, and means they are more amenable to ecological interpretation. Our study demonstrates how multidisciplinary evaluation of climate models can enhance their ecological application, and is a first step towards a set of community-agreed future scenarios for Southern Ocean ecosystems.

Thu_150_BE-9_2004
Local Rapid Expansion of the Antarctic Hair Grass in the Maritime Antarctic

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During the past decades, the western and northern parts of the Antarctic Peninsula (Maritime Antarctic) have experienced the largest warming trend of atmospheric temperatures. This climatic change strongly affects biotic and abiotic components of Antarctic ecosystems on different levels.
Fildes Peninsula and Ardley Island, King George Island, South Shetland Islands, represent one of the largest ice-free areas in the Maritime Antarctic and are characterized by a high biodiversity. The terrestrial ecosystem host a diverse range of breeding bird species, high numbers of seals and locally the best-developed and most extensive plant communities in the South Shetland Islands. The only vascular plant present in this area is the Antarctic hair-grass *Deschampsia antarctica*. Repeated assessments of its distribution have been carried out in 1984/85, 2000/01, 2007/08 2004-06, and recently in 2016-18. The data revealed a considerable expansion of the distribution of *D. antarctica* over the past three decades. The grass has spread at many known sites and has additionally colonised further suitable areas. The distribution is widely connected to associations with mosses and lichens, but also includes fresh moraine material in areas newly exposed by glacier retreat. Apparently, entry of nutrient by birds and seals have a strong impact on the growth of *D. antarctica*. Moreover, regional warming seems to be crucial for the considerable expansion for vascular plants in the Maritime Antarctic.

Thu_151_BE-9_2015
Latitudinal Consistency of Food Web Topology in Subtidal Rocky Bottoms

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The potential impact of latitude on the structure of the food web of shallow sublittoral rocky bottoms was assessed using stable isotopes of C and N. Samples were collected at five sites along a gradient from King George Island (South Shetland Islands; 62°11′04″S 58°54′14″W) to Adelaide Island (western Antarctic Peninsula; 67°34′06″S 68°07′33″W). Phytoplankton, encrusting red algae, brown macroalgae (*Himantothallus grandifolius*, *Desmarestia menziesii* and *Desmarestia anceps*), red algae (*Palmaria decipiens*), sponges (*Dendrilla antarctica*), snails (*Margarella antarctica*), limpets (*Nacella concinna*), holothurians, sea urchins (*Sterechinus neumayeri*), nemerteans (*Parborlasia corrugatus*) and starfishes (*Odontaster validus* and *Diplasterias brucei*) were collected at each site. Results revealed short food webs, supported by a diversity of carbon sources. Phytoplankton was the main source of C for holothurians, sea urchins relied primarily on macroalgae and encrusting red algae were the staple food of limpets. Sponges were more depleted in ^{13}C than any other animal group, thus revealing a unique niche. The starfish *Odontaster validus* was usually the top predator of the ecosystem. No latitudinal differences in food web topology were observed, but sites differed in the stable isotope baseline and the diversity of C sources, thus highlighting that local processes are more relevant for benthic communities than any potential latitudinal gradient.

Thu_152_BE-9_2114
Polar Cod Population Structure: Connectivity in a Changing Ecosystem

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Climate-induced changes put an increasing pressure on the Arctic ecosystem and its populations, including the most abundant circumpolar marine fish polar cod (*Boreogadus saida*). As a keystone species, changes in its abundance and distribution will impact the entire Arctic food web. Despite polar cod's significance, its population structure is largely undescribed. The genetic diversity and population connectivity of polar cod living in fjords of West-Spitsbergen and the Eurasian Basin were investigated using eight microsatellite loci. On a local scale, polar cod from Arctic (Billefjorden, Hornsund) and Atlantic (Kongsfjorden) influenced fjords were compared, and on a larger scale also specimens from the Amundsen and Nansen Basin were included. Results revealed significant population structuring on both local and large scale, suggesting reduced gene flow between these areas. Juvenile polar cod track sea ice drift and consequently, the under-ice distribution depends on coastal populations where sea ice originates (David et al., 2015). Hypothetically, polar cod hatched in the Kara and Laptev Sea drift into the Nansen and Amundsen Basin, respectively, and join populations in downstream areas by following the Transpolar Drift System. Understanding polar cod's population spatial and temporal dynamics, population diversity and adaptive divergence is critical for making predictions about its future distribution and for protecting this key species in the Arctic.

Thu_153_BE-9_2126
Hierarchical Bayesian Modeling of Continental-scale Pygoscelid Penguin Abundance

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We present a hierarchical Bayesian model of pygoscelid penguin abundance and distribution at all 509 known pygoscelid colonies. This model incorporates both presence-absence data and abundance estimates, collected from all known publically accessible data on pygoscelid penguin abundance and distribution, including nest and chick data derived from ground counts, aerial surveys, satellite imagery, and citizen science efforts. Our model provides abundance estimates for each population in each year since the 1979/80 season, including years for which no data are available, and allows us to both estimate species-specific trends at each penguin breeding site and understand how sites co-vary in their interannual dynamics. We investigate whether Allee effects, stemming from skua predation on penguin chicks and eggs, were mitigated for small Adélie or chinstrap populations embedded in larger gentoo colonies. Our model provides the best global-scale model for pygoscelid penguin population dynamics, and provides a means by which to assess the impact of climate change and other hypothesized drivers of population change.

Thu_154_BE-9_2143
Dive Behavior and Stable Isotopes: Index of Foraging Specialization in Seals

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Understanding the response of marine organisms to climate change requires a set of indices that can be obtained on a routine cost effective basis. While electronic tagging provides considerable insight into the foraging behavior ecology of marine vertebrates, it can be expensive and is applicable to those species where instruments can be deployed and recovered. Stable isotope analysis (SIA) can be carried out from tissues obtained by remote biopsy methods, from carcasses, from preserved or ancient material. However, alone at best SIA can provide an estimate of diet, but no information on the foraging behavior of the animal sampled. Here we determine the efficacy of using SIA data to infer the foraging behavior of the Weddell seals in the Ross Sea. Over a three year period (2010-2012) the foraging behavior and movement patterns of 63 Weddell seals was examined by instrumenting them with Satellite Relay Data loggers near Ross Island Antarctica. At capture tissues samples (hair, blood and whiskers) were collected and later analyzed for Carbon and Nitrogen isotope levels. The SIA data provided information on distinct differences between individuals and their diet that correlated with the individual specific diving behavior. This approach suggest that with sufficient validation SIA analysis can provide information not only on diet, but also on individual specific foraging patterns.

Thu_155_BE-9_2157
Myctophid (*Gymnoscopelus nicholsi*) Population Dynamics from Otoliths

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Myctophids are ecologically important in the Southern Ocean, where they constitute an important energy resource to higher predators and serve as an alternative to krill in trophic pathways. Given the changes predicted for Southern Ocean ecosystems owing to climate change and the recovery of top predators, understanding the population dynamics of key prey species like myctophids is critical for ecosystem-based management. Due to challenges associated with sampling mesopelagic fishes, there is a lack of information on their life histories and population dynamics. Using biological samplers, such as piscivorous mammals, may provide large amounts of information about myctophid demographics. Here we reconstruct age, growth and length of *Gymnoscopelus nicholsi* using sagittal otoliths recovered from scats of Antarctic fur seals (*Arctocephalus gazella*) at Cape Shirreff (Livingston Island). We derived a 16-year time series (2000-2015) and found that *G. nicholsi* in the diets of fur seals ranged from 2 to 6 years of age. Additionally, we found that *G. nicholsi* mean age declined significantly during this time frame. This study demonstrates the utility of biological samplers to assessing population dynamics of mesopelagic fishes. The results presented here show that myctophids in waters off the South Shetland Islands exhibit dynamics that have yet to be understood, especially given the environmental changes and ecosystem regime shifts occurring in this region.

Thu_156_BE-9_2169
Use of the Thermal Structure of the Water Column by Multiple Predator Species

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Animals that feed in a dynamic environment should adopt strategies that will optimise energy acquisition. The use of top predators as a bio-samplers is a complementary approach to understand how physical changes in the environment may influence their foraging success. The thermal structure of the water column is a key physical feature in pelagic waters that likely affect the vertical distribution of micronekton (fish, crustacean), and ultimately the foraging efficiency of their predators. Here, for the first time, we examine how this information links predator foraging behaviour with access to their pelagic prey. During the MYCTO-3D-Map campaign performed off the eastern side of Kerguelen (Southern Indian ocean), *in situ* conductivity-temperature-depth (CTD) profiles, acoustics, and net sampling of micronektonic organisms (prey) have been combined with bio-logging tracks of seabirds and marine mammals (predators). This information is then exploited for identifying potential foraging hotspots in outputs of ocean models (MERCATOR). Our aim is to determine the threshold of each species based on their access to prey along the horizontal and vertical axes. A better understanding of the links between ocean physics and the trophic food web has strong implications for predicted environmental shifts in the face of future climate change.

Thu_157_BE-9_2222
Bacterial Community Structure in Glacier Ice and Subglacial Streams, Antarctica

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Antarctic glacier retreat is expected to have an important impact on the microbial communities embedded in perennial ice. In this context, our study focused on investigating the bacterial diversity from glacier ice and subglacial streams of King George Island, NW Antarctica, in relation with the spatial distribution and substrate geochemistry.
Samples were collected from Barton, Weaver and Potter Cove areas. Physicochemical measurements indicated a low mineral content and slightly alkaline pH in glacier ice relative to subglacier water. All ice samples showed a reduced organic carbon content and a homogenous Na-HCO3 type chemistry, while stream water was more heterogeneous, belonging to Na-Ca-HCO3 and Na-Cl types, with a high Al, Fe and Sr content.
Illumina MiSeq sequencing of 16S rRNA gene highlighted variations of bacterial diversity with the type of habitat, locations and geochemical characteristics. Phyla distribution in the two types of habitats showed the dominance of *Proteobacteria* followed by *Bacteroidetes*, with spatial variations of other phyla representation between the peninsulas. High content of *Proteobacteria* characterized both the ice and stream microbial communities, with a major presence of *Acinetobacter* mainly in glaciers.
Analysis of the distribution pattern of bacterial communities in ice and subglacial streams, in relation with the habitat geochemistry, contributes to unravel the impact of melting glaciers on the resilience of the embedded microbiome.

Thu_158_BE-9_2234
Levels of Heavy Metals in Rocky Bottom Organisms along the Antarctic Peninsula

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Previous research has revealed the existence of a latitudinal gradient in the levels of several heavy metals in pelagic predators foraging along the Antarctic Peninsula. To assess the generality of that pattern, samples of benthic organisms were collected at five sites along a latitudinal gradient from King George Island (South Shetland Islands; 62°11’04”S 58°54’14”W) to Adelaide Island (western Antarctic Peninsula; 67°34’06”S 68°07’33”W). Phytoplankton, brown algae (*Desmarestia menziesii* and *Desmarestia anceps*), red algae (*Palmaria decipiens*), limpets (*Nacella concinna*) and starfishes (*Diplasterias brucei* and *Odontaster validus*) were collected at each site. Levels of Cr, Pb and Hg were assessed in each organism. Results revealed much higher levels of heavy metals in macroalgae than in phytoplankton or any animal organism considered, thus suggesting a minor role of *Desmarestia antarctica*, *Desmarestia anceps* and *Palmaria decipiens* as sources of organic matter for limpets and starfishes. On the other hand, levels of Hg increased from *Nacella concinna* to both starfish specie, thus suggesting biomagnification. Levels of Cr, Pb and Hg differed among sites, but no latitudinal gradient existed. This suggests that local processes are more important that regional patterns in determining the levels of heavy metals on benthic organisms and that the existence of permanent scientific research stations might be a relevant factor.

Thu_159_BE-9_2242
Genetic Identification and the Southern Ocean CPR Survey: A Useful Combination?

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Plankton surveys using the continuous plankton recorder (CPR) have characterised biodiversity along open ocean transects covering thousands of kilometres in Polar Regions. We investigated the potential to use DNA metabarcoding (species identification using high-throughput DNA sequencing) in the Southern Ocean CPR survey. Samples (n= 53) were collected in two transects and metazoans identified using standard microscopic methods and by sequencing a mitochondrial COI marker. DNA increased the number of metazoan species identified and provided high resolution taxonomy of groups problematic in conventional surveys (e.g. larval echinoderms and hydrozoans). Metabarcoding also generally produced more detections than microscopy, but this sensitivity may make cross-contamination during sampling a problem. In some samples, the prevalence of DNA from large plankton such as krill masked the presence of smaller species. Overall, the genetic data represents a substantial shift in perspective, making direct integration into current long-term time-series challenging. We discuss a number of hurdles that exist for progressing DNA metabarcoding from the current snapshot studies to the requirements of a long-term monitoring program. Given the power and continually increasing efficiency of DNA metabarcoding, it is almost certain this approach will play an important role in characterising polar marine ecosystems.

Thu_160_BE-9_2258
Spring Bloom of *Corethron* in Coastal Waters of the Western Antarctic Peninsula

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Corethron is a cosmopolitan taxon and one of the most abundant diatom genera in the world ocean (Malviya et al. 2016). *C. pennatum* is often a dominant species in polar plankton communities with historical bloom events preserved in sediments (Leventer et al. 2002). During austral late winter/early spring 2011, observations of phytoplankton species succession in coastal waters of the Antarctic Peninsula documented the inception and development of a *C. pennatum* bloom. Cell densities increased from 100 (Sept) to 11,000 (Nov) cells/L, representing 25-100% of the net phytoplankton. Eighty-three phytoplankton taxa (including several abundant picoplankton species) were recorded, and *C. pennatum* comprised the bulk of the phytoplankton biomass during the study period. Cell diameters of *C. pennatum* ranged from 6-74 µm. From early Sept to mid-Oct mean cell diameter decreased from 29±9 to 19±8 µm. Doublets ranged from 9-32% of cells, with the maximum proportion of cells dividing in mid-Oct coinciding with sexual reproduction and auxospore formation. Up to 4% of cells observed at this time were male gametangia or auxospores. Enlargement of cells after auxosporulation resulted in a mean cell diameter of 33±11 µm by mid-Nov. Sequencing of the transcriptome indicates correlation between the occurrence of doublets and proteins involved in DNA replication (e.g., helicases), providing additional insights on the physiological state of *C. pennatum* during bloom formation.

Thu_161_BE-9_2281
Ross Island Adélie Penguin Population Responses to Variability in Sea Ice Extent

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Adélie penguins *(Pygoscelis adeliae)* are an indicator species used to detect and monitor the effects of environmental change on Antarctic marine ecosystems. Since the early 1980s, New Zealand has conducted an annual census of Adélie penguins in the Ross Sea region, with data submitted to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Ecosystem Monitoring Programme (CEMP). Changes in the number of breeding pairs are considered in relation to environmental factors, allowing hypotheses about population responses due to natural versus anthropogenic changes to be tested.
Sea ice conditions in McMurdo Sound in November 2016 and 2017 were significantly different. Extensive and persistent sea ice cover in McMurdo Sound in 2016 led to many abandoned Adélie penguin nests at colonies on Ross Island. The number of breeding pairs at Cape Royds, Cape Bird and Cape Crozier decreased by 44%, 23% and 8%, respectively, compared to 2015 numbers. The early breakout of sea ice in the 2017 austral summer provides a complete contrast. This inter-annual variability is considered in terms of the short-term impact on Adélie penguin populations on Ross Island, with a view to predicting longer-term effects of changing environmental conditions on Adélie penguin populations in the Ross Sea.

Thu_162_BE-9_2309
Alpha Amylase from *Geomyces* sp. Isolated from Antarctic and Arctic

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Geomyces sp., a soil microfungi deserve a very special place in the polar ecosystem. This species is reported to be positive for various hydrolase enzymes which makes it a successful decomposer in the polar region. Objective of this study is to compare alpha-amylase from *Geomyces* sp. from Arctic and Antarctic. Soil samples were collected from King George Island, Antarctic during 2007 Austral summer and Svalbard, Arctic during boreal summer in 2006 and 2010. Soil microfungi were screened for amylase activity. One strain with highest relative enzyme activity from each region were chosen for further enzyme activity analysis. Alpha amylases were purified using forced affinity chromatography column. The purified enzymes were run on SDS PAGE to confirm the molecular weight. Twenty five of 33 Antarctic and 4 of 4 Arctic *Geomyces* sp. showed significant relative amylase activity in the preliminary screening. From this, one best amylase producer from each region were chosen for enzyme activity assessment. Purified alpha amylase of both isolates showed optimum temperature for enzyme activity at 10°C and the optimum pH was 6.6. SDS PAGE showed both alpha amylase had molecular weight around 70kDa. Alpha amylase from Antarctic *Geomyces* showed higher enzyme activity in comparison with Arctic *Geomyces*. This is probably because, relatively harsher environment of Antarctic prepared these fungi to perform maximally when the optimum temperature provided.

Thu_163_BE-9_2329
Polyphasic Characterization of Terrestrial *Leptolyngbya* on Signy Island

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Studies of members of the genus *Leptolyngbya* are mostly reported from tropical and temperate regions. Although the genus often dominate microbial communities in Antarctic soils, their diversity and ecological significance are not well understood. We have investigated four *Leptolyngbya* strains obtained from soil collected from Signy Island, South Orkney Islands, and maritime Antarctic. Morphologically, all four strains in culture showed diacritical characteristics consistent with the genus *Leptolyngbya*. However, 16S rDNA analysis showed that three of the strains were closely related to the genus *Wilmottia* while one was a close relative of the new cyanobacterial genus *Nodosilinea*. At present, only two *Wilmottia* species, *Wilmottia murrayi* and *Wilmottia* sp., have been characterized from Antarctica. Under the most recent classification system, *Wilmottia* is recognised as a special genus (*Wilmottia* gen. nov.) because of it similarities with *Leptolyngbya* and *Phormidium* while *Nodosilinea* includes members with unique ability to form nodules along the length of the filament and has mostly been recorded from environmentally extreme locations. Polyphasic characterization is now being used to evaluate the taxonomic positions of these four strains. Moist plate enrichment culture of the soil, transmission electron microscopy (TEM) and physiological studies such as pigment tests and salinity tolerance assessment are being used to aid in species identification.

Thu_164_BE-9_2363

Marine Ecosystem Assessment of the Southern Ocean: Outcomes of MEASO2018

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Status and trends of Southern Ocean ecosystems are being assessed to update the SCAR Antarctic Climate Change and Environment Report and to provide inputs to the Sixth Assessment Review of the IPCC. These assessments are also intended to provide scientific inputs on marine ecosystems important to the Committee on Environmental Protection under the Antarctic Treaty and to the Commission for the Conservation of Antarctic Marine Living Resources. Interpretable measures of change in habitats, species and food webs are being synthesised for four sectors of the Southern Ocean (East and West Pacific, Atlantic and Indian), and divided into assessments for coastal/sub-polar and subantarctic areas. Results from the recent Marine Ecosystem Assessment for the Southern Ocean (MEASO) conference in Hobart in April 2018 will be presented on behalf of many scientists from ICED, SCAR Life Sciences, AnT-ERA, AntEco and SOOS. We summarise the conclusions and gaps in the assessments for each sector and highlight directions for the next MEASO.

Thu_165_BE-9_2370
Seasonal Ecology of High Arctic Ice Cap

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Snow packs are important interfaces with global climate and biogeochemistry (Wadham et al., 2013) and form a biologically productive microbial habitat (Hodson et al., 2008). However, far less attention has been paid to supraglacial snow packs compared with snow covers on top of soil and aquatic ecosystems (Jones 1991). In addition, snow packs are getting wetter and less persistent globally in response to warming air temperatures. More importantly, supraglacial snow packs are well-connected to marine and terrestrial systems, therefore any changes will result in ecological implications downstream. Therefore, in order to understand the variation in space and time of microbial diversity and biogeochemistry of a supraglacial snow pack, samples were collected monthly for four months on seven areas of a High Arctic ice cap (Foxfonna, Svalbard). This work will therefore establish the changing ecology of snow with the evolution in the snowpack's physical condition during melt and hence present the systematic change expected in resident microbial communities and nutrient dynamics through the summer, both spatially and temporally. In summary, this work will present a seasonal 'album' for ecology of glacial snow packs.

Thu_166_BE-9_2380
Changing Light Regimes in Polar Deserts: A Metatranscriptome Analysis

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Microbial communities in Antarctic Dry Valleys are dominated by cyanobacteria that provide the heterotrophic community with photosynthetic carbon as well as nitrogen through diazatrophic activities. Diazatrophic heterotrophs also contribute to nitrogen input, but are a carbon sink rather than a source. Little is known about the seasonal effects of changing light intensity on the dynamics of these two groups of microbes. The objectives of this study were to investigate the transcriptional response of the microbial community to changes in light regime. Plots along a stream in Taylor Valley were shaded to reduce light by 10%, 50% and 100% and samples were collected at the initial time point and after 11 days. The transcriptomes were paired-end sequenced and assembled, producing approximately 55,000 transcripts with an N50 of 2,098. Reads from each treatment were mapped to the assembled transcripts for differential expression analysis. Analysis is ongoing, but shows that metatranscriptomes generated from samples collected on day 11 were significantly different from the initial time point, and also that samples collected from the 50% and 100% reduced light treatments on day 11 were significantly different from the 10% treatment. Here, we will present an analysis of transcriptional changes affecting carbon and nitrogen cycling. Results of this research will contribute to our understanding of microbial dynamics and community responses to changing light regimes in polar deserts.

Thu_167_BE-9_2417
Tardigrades from King George Island, Antarctica: Taxonomy of *Dactylobiotus* sp

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Phylum Tardigrada is a minute, hydrophilous animal group with a five segmented body which consists of a head and four trunk segments. This phylum is famous for the ability to survive the severe conditions such as cold, dry, or high radiation environments. The limno-terrestrial tardigrades are one of the dominant animal groups in the terrestrial ecosystem of Antarctica. However, due to their limited morphological characteristics and restricted access to the habitats, taxonomic study on Antarctic tardigrades is difficult to carry out. KOPRI ecology team collected several species of tardigrades from King George Island, Antarctica during 2014-2015 season expedition. Among the collected tardigrades, one species shows a bucco-pharyngeal apparatus with 10 peribuccal papillae reminiscent of *Macrobiotus*-type and the cuticular connection between claws, which are characteristics of the genus *Dactylobiotus*. This species is large in size (600-700 µm) with smooth cuticle and no conical papillae between 3rd and 4th limbs. Key morphological characters of bucco-pharyngeal apparatus and claws are being measured, and *pt* ratio (the ratio of the length of a given structure to the length of the buccal tube) are compared to that of other *Dactylobiotus* species to see whether the species is a previously reported *Dactylobiotus* species documented in other regions around the world, or a new species.

Thu_168_BE-9_2441
Insights into Tundra Fern Physiology from Remote Sensing and Leaf Gas Exchange

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We have deployed, for the first time, a close-distance remote sensing system to study leaf level physiological processes of Blechnum penna-marina at fine time scales (minute x minute) on Marion Island, over an annual cycle. Combined with this, standard leaf gas exchange approaches were also employed. We placed the remote sensing stations at a range of elevations, and these collected micrometeorological data, as well as an index which indicates levels of plant stress. Experiments using a LICOR 6400xt gas exchange system were performed on low altitude plants, which were acclimated for 3 days at different treatment temperatures. Field data suggested that plants experienced stress above 11°C, and leaf gas exchange information allowed us to explore this relationship in more detail. We used structural equation modelling, to identify the major meteorological factors that influence plant stress response. Machine learning was used to characterize the archetypical diurnal conditions, which in turn allowed us to further understand how plant physiology reacts to the abiotic environment. We argue that this mix of techniques allows the exploration of crucial aspects of how the abiotic environment affects plant function. In conclusion, a multi-tiered approach using both remote sensing and gas exchange will be valuable in future to understand the complex interaction climate has with organisms.

Thu_169_BE-9_2465
Phototrophic Picoeukaryotes and their Antarctic Winter Niche

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Reduced photoperiod, absence of picocyanobacteria, low surface temperatures and a highly variable sea ice ecosystem shape the polar winter, which has become increasingly warmer and shorter. A survey was conducted off the South Shetland Islands (SSI) during three consecutive late winter seasons. The expected low chlorophyll a concentrations in the system correlated with phototrophic picoeukaryote (PPE) abundances in the upper mixed layer (UML), characterized by Winter Water and varying sea ice types. To further address the ecological significance of Antarctic PPE, we also quantified contemporaneous bacterioplankton populations. The highest microbial abundances where detected north of the SSI and PPE counts correlated with chlorophyll a concentrations stronger than with prokaryotes in the UML. High throughput amplicons of the hypervariable V4 region of the 16S and 18S rRNA marker gene were used to better comprehend the diversity and potential functional networks of the microbial community, revealing a strong presence of Bathycoccus in open waters. Multivariate statistical analyses were used to test the significance of the influence of inherent physical properties of the ocean on the diversity and plasticity of Antarctic picoplanktonic assemblages. The interannual nature of this study contributes to revealing the ecosystem biological baseline and explores its resilience given the current changes in the ecosystem.

Thu_170_BE-9_2508
Elevated Salinity Alters Biotic Interactions in McMurdo Dry Valley Soils

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The McMurdo Dry Valleys (MDV), Antarctica are relatively simple soil ecosystems compared to temperate soils. Soil microbes and a few species of nematodes, rotifers, tardigrades, and micro-arthropods occur in the MDV; however, soil food web structure varies landscape-wide. Nearly 95% of the area is dry soil (< 3% gravimetric moisture) dominated by an endemic microbivore nematode, *Scottnema lindsayae*. Wet soil habitat is generally limited to lake and stream margins and contains greater invertebrate biodiversity. Climate change is predicted to alter hydrological connectivity across the MDV, shifting soil salts and solutes and changing dry and wet soil habitat distribution. It is unknown how this will affect the distribution, abundance, and interactions of soil biodiversity.
MDV Long Term Ecological Research data show nematode populations are negatively associated with soil salinity, but responses to soil moisture are species-dependent. We tested the effect of increased salinity and moisture on four different soil communities in a laboratory microcosm experiment (full factorial: 2 salinity x 2 moisture x 4 biota treatments). Elevated moisture significantly reduced adult *S. lindsayae* abundance, while elevated salinity significantly reduced the total *S. lindsayae* population. In the presence of *S. lindsayae*, total microbial abundance was significantly lower, but this effect was diminished under the high salinity treatment, possibly due to a release of predation pressure.

Thu_171_BE-9_2615
Fine-scale Population Genetic Diversity of *S. thompsoni* in the Southern Ocean

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The need for information about population structure is most acute for ecologically key species like salps because they play a key role in the marine ecosystem, and are likely to be heavily influenced by climate change. This impact is believed to be positive in the Antarctic waters, with pronounced expansion of pelagic tunicates under favorable environmental conditions. This study as one of the first shows a different approach to research on Antarctic salps population and possible could fulfil the gap in knowledge about their evolution and expansion in the Southern Ocean.
Oozoids caught off South Georgia, the Antarctic Peninsula and Polar Front area generated barcodes consisting of a few different DNA sequences and reveal some signals of inter and intra-population variation. Analysis of the prominent barcode sequence data yielded high haplotype (h: 0.7198-0.9346) and low nucleotide (p: 0.0099) diversities, and reveal statistically significant evidence for genetic structure between studied population (Fst= 0.37748 with P value= 0.0000) as assessed using analysis of molecular variance. Negative Tajima's D and Fu and Li's D statistics indicates excess of new mutation as a result of evolutionary forces, such as selective sweeps or population grow. It could be as well an evidence for heteroplasmy arising from a dynamic mitochondrial genome.

Thu_172_BE-9_335
Morphometric Analysis of Antarctic Foliose Lichens Using 3-D Digital Microscopy

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Recently, digital microscopy is an emerging technique that combines the tools of classic light microscopy with a computerized imaging system. Here we present application of the method in morphometric analysis of Antarctic lichen thalli. The main goal of the study was to evaluate changes in 3-D structute of thalli as dependent on hydration status, and interspecific differences as well. Another goal was to provide quantitative biometrical data on size and shape of morhological structures such as fruiting bodies. Lichen thalli collected from several sites on deglaciated northern part of James Ross Island were analysed using a digital VHX-900F microscope (Keyence, Japan) with a maximum resolution of 19.5 megapixels. The microscope with built-in LEDs allowed accurate measurements of lichen surface structures viewed in real time depth composition at the magnificion ranging from 20 to 200. Data forming a 3-D view of the upper cortex were used to analyze the size of lobes, outgrowths, and fruiting bodies, respectively. Using a VHX software, we applied processing tools: 1) height profile along a selected line placed across a thallus, 2) DFP method (Depth From Defocus) which compiles different focal planes. We studied Placopsis contortuplicata, Dermatocarpon polyphillizum, Rhizoplaca melaophthalma and other species. Gained resuts on a 3-D structure are discussed: interspecific, hydration-, and developmental stage-dependent differences. Thank to support from CzechPolar, ECOPOLARIS.

Thu_173_BE-11_582
Relating Antarctic Krill Lipids and Fatty Acids to Environmental Parameters

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Antarctic krill are at the centre of the Antarctic ecosystem, linking phytoplankton and higher organisms. Knowledge of their lipid (oil) biochemistry can assist in understanding and predicting potential ecological changes and can also inform the fishery on sustainable practices, optimising krill harvest. Knowing how krill will respond to environmental changes is difficult to predict or explore at large scales through typical experimentation. The use of satellite imagery can help look at krill production by using their lipids and fatty acids as a proxy for their health and ability to reproduce.
This study examined how the lipid and fatty acid content and composition of Antarctic krill was linked to large scale environmental parameters determined through satellite imagery. Lipids were analysed from krill collected by a commercial krill fishery over 3 years, allowing for long-term environmental and seasonal shifts to be seen, as well as from the K-Axis and ACE voyages, allowing for regional differences to be seen.
The fluorescence levels, chlorophyll a, irradiance, sea surface height and temperature from the same collection dates and locations was used to compare krill lipids and fatty acids to their environment. Whilst this link has been studied on small scales and with few samples, this study describes differences seen temporally (over 3 years in the Scotia Sea) and spatially (in 3 ocean basins) in krill lipids with their relationship to environmental conditions.

Thu_174_BE-11_838
Hyperspectral Mapping of Sentinel Organisms from Ground, UAS, and Satellite Data

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As the primary producers in Antarctic terrestrial and fluviol ecosystems in the McMurdo Dry Valleys (MDV), the distribution and areal extent of microbial mats is hypothesized to reflect changes to water and nutrient availability. Therefore, observations of “sentinel” microorganisms such as Nostoc, Phormidium, and other Cyanobacteria can be used a proxy for environmental change. In order to utilize such biological proxies, it is necessary to produce a baseline census of mat distributions and compositions to compare to future change. Here we report on observations collected in 2016-2017 of microbial mat occurrences in Wright Valley that link ground-based hyperspectral and molecular measurements with a UAS-enabled hyperspectral airborne survey (600-1000 nm with 4 nm band spacing). We compare these observations to near-concurrently collected, satellite-based Worldview-2 imagery in order to identify diagnostic microbial mat absorptions that can be mapped using multispectral data. Initial observations suggest that the targeted mats are low-reflectivity at visible wavelengths and bright in the near-IR portion of their reflectance spectra, consistent with reflectance from photosynthetic pigments. NIR-bright mats can be detected in ground-based and airborne (UAS) hyperspectral observations. Space-based mat detection is hampered by the need to generate scene-specific atmospheric corrections due to large polar phase angles and subpixel mixing of mat, sediment, and rock spectra.

Thu_176_BE-11_1087
Penguin Watch: Using Citizen Science to Aid Large-scale Penguin Conservation

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Historically, large-scale monitoring (both spatially and temporally) of Antarctic and sub-Antarctic penguin colonies has been impracticable, owing to technological restraints and the remote locations involved. A remote camera network, comprising ~100 time-lapse devices positioned across the Falkland Islands, South Georgia and the Antarctic continent, aims to fill this data gap. However, with each camera capturing ~8000 images per year, we are presented with another issue - how to efficiently process the photographs and automatically extract meaningful phenological data. Here we discuss Penguin Watch, an online citizen science project (part of the Zooniverse platform) which asks volunteers to 'tag' penguins in time-lapse images. To date, over six million images have been classified by nearly 48,000 registered volunteers. Annotations are clustered and filtered (to allow removal of erroneous classifications), and used to create time-series data, which in turn can be used to extract phenological information such as date of adult arrival and date of chick hatching.

Thu_177_BE-11_1094
King Penguin Population Monitoring through Remote Sensing

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Over the past century, king penguin colonies have been increasing in number and spatial area across the island of South Georgia. Monitoring these populations has proven difficult due to limited access and the large numbers of individuals within the major breeding colonies. Additionally, the unique multi-year breeding cycle of the king penguin complicates survey efforts, since there is no single point at which the number of individuals engaged in breeding can be directly assessed. Remote sensing methods have been used for other species of seabirds and marine mammals that colonize regions with limited access for on-the-ground censusing. To monitor populations of king penguins, we used high-resolution (sub-meter) satellite imagery to estimate the distribution and abundance of king penguins in South Georgia. To accommodate for the complex phenological challenges of translating counted individuals into an estimate of the breeding population, we developed an individual-based simulation model that allows us to correct for availability bias in direct or remotely-derived counts completed throughout the austral summer. These methods, which were used to estimate the total number of king penguins currently breeding in South Georgia, represent a first step in a more-regular monitoring scheme tracking the total abundance of king penguins in South Georgia and identifying changes in abundance that are relevant to their conservation.

Thu_178_BE-11_1110
Weddell Seal Count: Citizen Science for the Ross Sea Region MPA

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Weddell seals (*Leptonychotes weddellii*) are a focal species for research & monitoring in the new Ross Sea region Marine Protected Area. Weddell seals have a pronounced diel or quasi-diel haul-out cycle that affects their availability for counting. We investigated two potential drivers of haul-out behaviour, solar altitude and ocean tides, as a basis for effective monitoring of Weddell seals in the Ross Sea region by remote sensing. Using two autonomous survey cameras activated at 10-minute intervals, we collected ca. 10,000 static images of the Turtle Rock seal colony, McMurdo Sound (77°44´38.22"S, 166°46´33.42"E), from Nov 2014-Jan 2015. Turtle Rock is surrounded by sea ice and seals access the water through tidal cracks. Seals in images were counted by two methods: (a) citizen science ('Zooniverse'); (b) automated image processing using machine learning. We compared both methods for efficacy and for accuracy relative to images counted by the authors. Preliminary results indicate that during a 20-day period from 28 Nov 2014, the activity pattern of Weddell seals appeared to be correlated both with solar altitude and with the tides, with peak haul-out at low tide/solar noon. Given the unusual tide cycle in McMurdo Sound (low tides largely coincide with solar noon during summer), further research at different latitudes and/or times of the year may be required to disentangle the relative importance of solar altitude and tides as zeitgebers for Weddell seal haul-out behaviour.

Thu_179_BE-11_1151
Multi-modal Survey Reveals the Danger Islands as a Seabird Hotspot

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Despite concerted international effort to track and interpret shifts in the abundance and distribution of Adélie penguins, ecologically significant populations of Adélie penguins continue to be identified. Here we report on a major hotspot of Adélie penguin abundance discovered in the Danger Islands off the northern tip of the Antarctic Peninsula (AP). We present the first complete census of Pygoscelis spp. penguins in the Danger Islands, estimated from a multi-modal survey consisting of satellite imagery, direct ground counts, and computer-automated counts of unmanned aerial vehicle (UAV) imagery. Our survey reveals that the Danger Islands host 751,527 pairs of Adélie penguins, more than the rest of AP region combined, and include the third and fourth largest Adélie penguin colonies in the world. Our results validate the use of Landsat medium-resolution satellite imagery for the detection of new or unknown penguin colonies and highlight the utility of combining satellite imagery with ground and UAV surveys. The Danger Islands appear to have avoided recent declines documented on the Western AP and, because they are likely to remain an important hotspot for avian abundance under projected climate change, deserve special consideration in the negotiation and design of Marine Protected Areas in the region.

Thu_180_BE-11_1152
Is the Antarctic Petrel Breeding Colony on Mt. Biscoe the Largest in the World?

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We recently developed an algorithm to retrieve Antarctic petrel (*Thalassoica antarctica*) colonies from Landsat-8 Operational Line Imager data, and applied the algorithm in a continent-wide search for new and existing breeding locations. One of the results of this survey suggests that the breeding population at Mt. Biscoe (66˚13´S 51˚21´E), currently reported to be in the 1000s, may actually be on the order of 400,000 breeding pairs. If verified, this colony would be the largest known Antarctic petrel breeding community in the world, and a colony of this size would nearly double the known breeding population of this species. Our results also suggest other testable hypotheses: we provide geographic coordinates of a previously suspected but undetected breeding colony on Mt. Provender, and we make predictions on how the diet of the Antarctic petrel (and therefore the chemistry of its guano) may affect the detection of colonies in satellite remote sensing. We lay out a way forward for verifying the results of our survey, for algorithm improvement, and for employing such improvements in a successively more precise understanding of the distribution and abundance of the Antarctic petrel with remote sensing techniques.

Thu_181_BE-11_1180
Learning about Weddell Seals: Engaging Citizen Scientists with New Technologies

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To understand habitat use by Weddell seals, it is imperative to know where and when they are present around the continent. The necessary data to date have been impossible to gather across such a large geographic area. We established our project, Satellites Over Seals (SOS), in late 2016 as a crowd-sourced method of gaining information about presence and abundance of Weddell seals on fast ice around Antarctica - To engage citizen scientists, we used a novel technology: the online platform at Tomnod to select and host high-resolution satellite imagery (VHR) for “the crowd” to search, using VHR from November 2010 and 2011, covering the Ross, Amundsen, Bellingshausen and Weddell Sea regions. More than 318,000 citizen scientists searched 550 images covering 105,124 km^2 of fast ice to determine locations of seals. Seal presence ranged from 0.5% - 2% on all maps (n = 778,447) searched. When detecting presence/absence of seals on a map (i.e., not seal abundance) rate of false negative detections was 0%, though false positive rates were high (80%); this highlights the importance of training for image interpretation to ensure differentiation among seals and landscape features. We provide recommendations on image resolution, quality, training and outreach for future implementation of citizen science methods to learn about Southern Ocean ecology.

Thu_182_TE-3_1780
Combining Satellite Datasets to Track Changes in the Vegetation of Kerguelen

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The Kerguelen Islands (49°30´ S, 69°30´ E) are among the most isolated islands in the world, located in the sub-Antarctic region 2000 km from Antarctica and 3800 km from Africa. The vegetation of these uninhabited islands is very little diversified (only 22 native phanerogams) and undergoes changes that increase since the last two decades. The structure and the composition of the plant communities are strongly affected by the combined effects of climate change and the introduction of animal and plant species.
In order to track changes in plant communities over large spatial and temporal scales, we have developed a mapping method based on satellite images from different sources. High resolution SPOT images were used to characterize the evolution of vegetation cover from 1995 to 2016, i.e. since the observation of the first significant changes in plant communities . In addition to SPOT, Sentinel-2 imagery, thanks to its easy access, allowed to expand temporally and spatially this general monitoring. For the most recent years, very high resolution Pléiades images allowed a mapping of all the different plant communities. Moreover, fine data on the evolution of floristic composition of the communities were recorded from field surveys carried out since 1995.
This mapping approach, based on multi-source satellite data and combined with field data, provides a better understanding of the current dynamics and is a valuable tool for managing these fragile ecosystems.

Thu_183_BE-11_2631
Camera Derived Phenology of Pygoscelid Penguins in Relation to Fishing

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On the Antarctic Peninsula, chinstrap and Adélie penguins are in decline while gentoo populations are expanding in size and range. Potential drivers of these changes include climate change, winter sea ice extent, ocean productivity, tourism, fishing and prey competition with other predators. However these drivers are usually confounded in space and time, presenting a challenge that cannot be answered by conventional remote monitoring. Here we show that a combination of time-lapse cameras, citizen science and machine learning allows us to elucidate the timing of breeding and nest-based reproductive success. We show differences in the timing of breeding, reproductive success and crèching behaviour across the breeding range of these penguin species. We also report remotely monitored Automatic Identification System (AIS) derived spatio-temporal patterns of fishing, their overlap with foraging ranges during the penguin breeding season, and the potential impact on penguin reproductive success. A proposal for an Antarctic Peninsula Marine Protected Area (MPA) is already being discussed in CCAMLR and, once extant catch limits expire after the 2020/21 fishing season, it is expected that there will be pressure to increase krill fishing quotas in the region. We consider our paper a first step towards a more sophisticated analysis to investigate the influences of fishing pressure on krill predator reproductive success and to disentangle the confounding stressors in the region.

Thu_184_BE-12_40
Opportunistic Fungi in the Contaminated Soils of the Kola Peninsula

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The opportunistic fungi (OF) were studied in the soils contaminated by the industrial plants emissions, as well as their virulence was estimated on the basis of protease, phospholipase activity, and the growth capability at a temperature of 37C°.
51 species of the fungi belonging to the OF group, were isolated in the soils of the Kola Peninsula. The share of the OF increases to 15-20%, compared to the background soil, under the anthropogenic impact (oil products, the aluminum and copper-nickel plant emissions).
The most dangerous for a human being are considered to be 7 fungi strains from the checked 75 ones: Amorphotheca resinae st.1, *Aspergillus fumigatus st.1, A. niger, Paecilomyces variotii st.1, Penicillium commune, P. purpurogenum, Trichoderma viride*. 55% of the investigated fungi strains isolated from the soils contaminated by the aluminum plant emissions had the pathogenicity properties, compared to the strains of the same species isolated from the clean soil (25%). *A. fumigatus, Paec. variotii, P. aurantiogriseum* showed both protease and phospholipase activity. *A. resinae, Cephalotrichum stemonitis, Cladosporium herbarum* revealed protease activity and the growth capability at a temperature of 37C°. The fungi isolated from the soil can constitute a danger to the human being´s health, as most of them reveal the pathogenicity properties, to a greater or lesser extent. The regular monitoring research should be fulfilled to determine potentially-dangerous fungi species.

Thu_185_BE-12_169
Does Arctic Warming Affect Lichen- and Bryophyte Microbiota and their Functions?

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Lichens and bryophytes are an essential part of the vegetation in Arctic ecosystems. In addition to the mutualistic association of a fungus and an alga and/or a cyanobacterium, lichens are also known to harbour species-specific bacterial communities, typically dominated by Proteobacteria. Similarly, bryophytes possess their own microbiome. Among the potential functional roles of these bacteria are inorganic phosphate mobilization and nitrogen fixation. In the light of climate change and the effect on Arctic ecosystems, the question rises what the effect will be on lichen and bryophyte associated microbiomes and their functions.
The main aim of this study is to characterise and compare the composition of lichen- and bryophyte-associated bacterial communities differentially impacted by a long-term warming experiment. Active and resident bacterial communities are assessed by taxonomic analysis of MiSeq libraries of 16S-rDNA and -rRNA targeted amplicons. Also, expression of different genes involved in N-fixation are measured by RT-qPCR.
The lichen and bryophyte-associated microbiota are strongly dominated by Proteobacteria, with members of Rhizobiales, Sphingomonadales and Burkholderiales particularly prominent. Changes in abundance of individual taxa are expected to reflect the different living conditions expected in the warming Arctic. In addition, some microbial functions might emerge, others disappear, with consequences for the biogeochemical cycles in Arctic ecosystems.

Thu_186_BE-12_417
What is the Best Practice for Microbial C and N Assessment in Subarctic Soils?

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The aim of our work were to assess the comparability of the results of determiningmicrobial carbon (C) and nitrogen (N) in organogenic Subarctic soils by different methods under maximally standardized conditions. Four methods of microbial C and N pools assessment were considered to subarctic soils in the European part of Russia: fumigation-extraction (FE), fumigation-incubation (FI), rehydration-extraction (RE) and rehydration-incubation (RI). We studied organogenic horizons of soils under 4 types of vegetation in the mountain tundra, 2 vegetation types in the lowland tundra, soils of birch and spruce forests, and swamps. FI and RI methods require a substantial amount of time and little use for subarctic soils (including due to low pH and predominance of fresh litter). FE and RE methods are more rapid and gives good reproducible results, but FE method usually gives higher values of microbial biomass C and N in comparison with the RE method. The microbial C:N ratio, determined by these methods in almost all soil is the same. The greatest differences are characteristic of the horizon containing fresh litter. Obviously, fumigation with chloroform leads to greater mobilization of carbon and nitrogen of plant residues compared with the drying.Concentration of microbial C and N (determinate by FE and RE methods) more comparable for horizons with a lower content of fresh litter.
The study was supported by the Russian Science Foundation (grant No. 17-76-10020).

Thu_187_BE-12_471
Ecophysiological Characteristics of Cyanobacteria from Biological Soil Crusts

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Biological soil crusts (BSCs) are biological communities inhabiting the uppermost layer of soil. They are frequently formed in polar regions, where the severe environmental conditions limit the growth of higher plants. The intact BSCs represent complex communities of cyanobacteria, algae, fungi, lichens, bryophytes, bacteria and even small invertebrates. Generally, BSCs show high resistance to stress factors common in Antarctica, i.e. low and freezing temperatures, desiccation, high UV-B doses in austral spring, high global radiation in austral summer and no radiation in winter. In this study, the tolerance to these stress factors was tested in single-species cultures of cyanobacteria isolated from the BSCs collected during Czech Antarctic expeditions to James Ross Island, Antarctica (2016, 2017). We tested Leptolyngbya sp. and Nostoc sp. cultivated on agar plates to evaluate their physiological activity under a variety of temperature and irradiance treatments. The species showed temperature- and radiation-dependent changes in chlorophyll fluorescence parameters derived from slow Kautsky kinetics and quenching analysis (Fv/Fm, Quantum Yield, NPQ). We concluded that the isolated cyanobacterial species showed different sensitivity of their photosynthesis to temperature and irradiance. The results present activity limits of cyanobacterial component of the Antarctic BSCs.
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Thu_188_BE-12_599
Functional Potentials of Supraglacial Cryoconite Hole Microbial Communities

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Dust particles on the glacier surface melts into the ice and forms nutrient rich melt water holes called cryoconite holes that provide refuge for diverse and active microbes. We show here that cryoconite holes from Antarctica and a Himalayan glacier (Sutri Dhaka) harbour genes responsible for carbon fixation (Betaproteobacteria, Basidiomycota), nitrogen fixation (Actinobacteria, Betaproteobacteria), ammonia oxidation (Betaproteobacteria, Basidiomycota), nitrate reduction (Actinobacteria, Alphaproteobacteria, Betaproteobacteria), denitrification (Alphaproteobacteria, Actinobacteria, Betaproteobacteria, Basidiomycota), dissimilatory nitrate reduction (Actinobacteria, Betaproteobacteria) and anaerobic ammonium oxidation (Actinobacteria), indicating that they have good potential for cycling C and N in these ecosystems. Microcosm experiments show that resident microbes are able to degrade carboxylic acids, such as lactate, acetate, formate, propionate and oxalate found within the cryoconite hole environment. In addition, microbial communities are also capable of metabolizing a diverse array of compounds, such as, proteins, lipids, carbohydrates, cellulose and lignin that are documented to be present within cryoconite holes, thereby influencing the chemistry of these environments. It is proposed that, in the event of glacier melting, these microbes can act as important colonizers that can influence biogeochemical processes in downstream ecosystems.

Thu_189_BE-12_700
Are High-alpine Microbial Communities Able to Deal with Temperature Extremes?

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The response of microbial communities to the predicted rising temperatures in the alpine regions may be an important part of the ecosystem ability to deal with climate change. Soil microbial diversity, community structure and activity might be significantly affected by higher temperatures which influence the ecosystem functioning of high-alpine soils. To evaluate the potential of the permafrost microbiome to adapt to temperature extremes we set up an incubation experiment with permafrost soils (collected at a soil depth of 160 cm) and an active soil layer from a high-alpine mountain ridge of Schafberg, Switzerland. Soils were incubated to increasing temperatures (4 - 40 °C) for two weeks as a pre-treatment before exposing them to a heat shock of 40 °C for 5 days. All the samples were then evaluated for the changes of the bacterial and fungal communities and their functional abilities by measuring respiration, enzyme activities and carbon utilization patterns. Results revealed a different ability of the microbial communities to withstand and regenerate after the heat shock according to the origin of the soils and also partly due to the pre-treatment. The adaptability of the permafrost microbiome to the temperature rise and the heat shock will be discussed.

Thu_190_BE-12_830
Parasitic Marine Alveolate DNA Dominates Southern Ocean

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Polar ocean plankton communities are extremely important for global biogeochemical processes. However, recent efforts to survey marine eukaryote diversity focussed on tropical and temperate plankton communities, with limited sampling of the polar oceans. We sequenced 18S ribosomal DNA to characterise eukaryotic diversity in 284 size-fractionated plankton samples collected across 52 sites south of the Kerguelen plateau, one of the most productive regions in the Indian Sector of the Southern Ocean.
We show that a single parasitic Marine Alveolate group I (MALV I) operational taxonomic unit comprised more than half the reads in samples from several locations near the sea ice edge. Although an identical MALV 18S sequence was previously found to be associated with a Northern Hemisphere radiolarian, we find the sea-ice associated cercozoan, *Cryothecomonas* sp., is the likely host in the Southern Ocean samples.
Parasitic MALV are also known to be abundant in marine and sea ice ecosystems in the Arctic and Western Antarctic Peninsula. Parasites divert energy and nutrients from the phytoplankton - krill - marine predator food chain to the microbial loop but are rarely included in marine ecosystem models. Our findings indicate MALV parasites have the potential to influence the abundance of a key sea-ice organism, influencing biological and geochemical processes in polar marine and sea ice ecosystems.

Thu_191_BE-12_873
Key Parameters for Modeling of Dissolved Oxygen Concentration in Antarctic Lakes

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Freshwater terrestrial water ponds and small basins are important aquatic habitats for autotrophs in deglaciated Antarctic areas. Since 2011, we have been monitoring physical properties (temperature regimes continuous data, supplementary conductivity, pH, photosynthetic active radiation-PAR, dissolved oxygen concentration-DOC courses during summer period) in two selected water ponds in the northern part of James Ross Island. The two ponds differ in size, morphology, and origin. First one is located in a depression of sedimentary rock (10 m a.s.l.), the other one on stony glacier surface (220 m a.s.l.). In both of them, *Nostoc* and *Leptolyngbya* are dominant autotroph species in microbiological mats forming a bottom cover. The ponds freeze during winter, temperature decreases to -15 to -20°C. In austral summer, a long ice-free period (5-10 weeks) occurs. Daily courses of DOC recorded in summer showed frequent supersaturation. However, a strong variability in DOC was found. DOC changes within a day and season were dependent on PAR, pH, and lake area to depth ratio (positive correlations). Water temperature and electrical conductivity were negatively correlated. These parameters, supplemented with chlorophyll concentration, serve as inputs for a multiple regression model. An analysis of the dynamics of the ecosystem and prediction of autotrophs activity are done using the model.
Acknowledgements: The study was supported by the CzechPolar infrastructure and the ECOPOLARIS project.

Thu_192_BE-12_927
In a Search for Ancient Marine Virus and Bacteria in Lake Cadagno, Switzerland

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Lake Cadagno, an alpine meromictic lake originated around 10,000 years ago. It has a persistent oxic and anoxic layers separated by a bacterial biofilm and are known to inhabit ancestral microorganisms. Although photosynthetic and heterotrophic bacteria have been studied extensively, however, nothing is known about viruses in this Lake. To fulfill this gap, we have collected samples at different depths of the lake to isolate 'Bacteriophages' (viruses that infect bacteria) and to investigate their relations with host microbial communities. Virus/host abundance was investigated using Flow Cytometry and metagenomics analyses were employed to characterize the viral diversity in the lake, which may probe the presence of 'ancient' virus-host models. Also, results will be put in relationship with chemical gradients as well as bacterial and phytoplankton biodiversity and productivity. Our study is the first step towards an exploration of the role of viruses in the ecological functioning of Lake Cadagno.

Thu_193_BE-12_1011
Heat Shock Response of Glacier Microbiome

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Glacier ice occupies a significant area of the planet and is currently experiencing one of the most rapid and severe melting rate, associated with possible changes of microbiome composition due to exposure to temperature variations when passing to adjacent soil. Our study investigated the thermal response of total and active ice-contained microbiome from a Svalbard glacier ice core and using a psychrophilic model bacterium, in order to identify an enzymatic biomarker. Glacier melted ice samples were submitted to a 7-day heat/freeze cycling experiment, and the total DNA and RNA was extracted and analyzed. Changes in the total and active microbiome composition after heat shock treatment are currently investigated by Shotgun metagenomics and metatranscriptomics. Quantitation by qPCR of the aspartate transcarbamoylase (ATC) expression, a key enzyme of pyrimidine nucleotides biosynthesis, revealed associated changes in the microbiome DNA synthesis. Thermal response of pyrimidine gene expression was investigated in a parallel bacterial model experiment using psychrophilic *Glaciibacter superstes*. Analysis of the ATCase gene expression pattern in the psychrophilic bacterium and ice microbial community is currently carried out in order to propose an enzymatic biomarker for ice microbiome response to temperature variations when changing habitats due to glaciers melting.
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Thu_194_BE-12_1242
Induction of Cryptic Secondary Metabolites from Rare Antarctic *Marinobacter*

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Microbes from extreme environments represent untapped sources of novel, bioactive metabolites with unique molecular frameworks, as they have evolved genes, many of which are cryptic or silent under standard fermentation conditions, required for survival in unusual environments. Only recently have microbiological samples been obtained from cold, dark isolated ecosystems in Antarctica. Blood Falls, one of the better-characterized subglacial environments in Antarctica, is a cold (-7 °C), iron-rich (~3.4 mM) subglacial brine (8% NaCl) that leaks out from below the Taylor Glacier. A moderately halophilic, heterotrophic psychrophile was recently isolated from the Blood Falls brine that clusters within the *Marinobacter* genus. Bioinformatic analysis of this strain's genome indicated the presence of at least four gene clusters involved in secondary metabolism with low sequence identity (~30%) to other known genes in GenBank. These gene clusters are most similar to those that produce aryl polyenes and terpenes, which function as pigments/antioxidants, protecting bacteria from reactive oxygen species. To identify uncharacterized, cryptic secondary metabolites with potential bioactivity, we used culture-dependent and -independent methods to induce the expression of cryptic biosynthetic gene clusters. Our data provide insight into the *Marinobacter* metabolome and its role in cold environments, such as those found in Antarctica.

Thu_195_BE-12_2116
Functional Resilience of Antarctic Microbiomes to Climate-induced Changes

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The biological productivity of McMurdo Dry Valley ecosystems is composed primarily of microbial processes, which are limited by the availability of liquid water and extreme weather conditions. Climate models predict an increase in temperature for the next decade, which will likely impact the hydrology and consequently the biodiversity and functionality of the ecosystem. Facing a regime of change, it is critical to understand to what extent microbial communities are able to retain their functions, thereby maintaining ecosystem services and the status quo. Using a "space-for-time" approach to approximate resilience, four wetness transects were sampled from the edges of Lake Brownworth and Lake Vanda, Wright Valley. We hypothesize that systems without historical hydrological changes (Lake Brownworth) harbor microbiomes well adapted to the permanently wet/dry conditions and that these microbiomes are structurally and functionally different to systems subjected to annual hydrological changes (Lake Vanda) where the microbiomes are more functionally heterogeneous and potentially more resilient to hydrological changes. Using a combination of metagenomics and metatranscriptomics, the levels of functional redundancy present in communities from both stable and dynamic systems will be examined, and the capacity of current microbiomes to engage with future environmental change will be discussed. Work of this type will help us to understand the fragility and resilience of polar ecosystems.

Thu_196_BE-12_2191
Distribution and Diversity of Heterotrophic Diazatrophs in McMurdo Dry Valleys

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Melt-water streams in McMurdo Dry Valleys (MDV) harbor a diverse assemblage of mat-forming cyanobacteria that play a key role in nitrogen cycling due to their diazatrophic activity. Prior research showed that heterotrophic diazatrophs may also contribute over 50% of nitrogen fixation in some mats. Our goals were to survey heterotrophic diazatrophs across the MDV to identify factors that regulate distributions. We collected samples from wetted, adjacent hyporheic, and dry regions at 23 sites, with and without visible mat. 16S rRNA genes were sequenced from 69 samples and *nifH* was sequenced from samples with positive amplification. Results show that the heterotrophic and cyanobacteria community structures were significantly correlated. Assemblages from several mat-free sites were more closely correlated with those from dry sites, regardless of the presence of water, suggesting that mats play an important role in structuring bacterial communities. *NifH* sequence analysis also showed that diazatrophs were highly and significantly correlated to the bacterial community as a whole. In addition, *nifH* genes were not amplified from samples collected in mat-free areas, suggesting a metabolic coupling between phototrophic and heterotrophic diazatrophs. This work contributes to our understanding of key drivers of bacteria community structure in polar deserts and informs future efforts to investigate the contribution of nitrogen fixation to community diversity and resilience in the MDV.

Thu_197_BE-12_2223
Permafrost Thaw and Resource Additions Alter Arctic Stream Microbial Communities

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As permafrost thaws across the Arctic, more of the organic carbon stored in permafrost soils is becoming available for transport to aquatic ecosystems. The response of arctic stream microbial communities to the effects of permafrost thaw will help determine how much added carbon is taken up or released, but this is a poorly characterized part of the Arctic carbon cycle. Deeper water movement through the thawing soil profile and thermokarst formation will increase terrestrial resource subsidies to aquatic microbial communities, and it may also alter the inoculation of soil microbes to streams, impacting community composition and function.
To assess the effects of thaw depth on stream microbial communities, we sampled streams during the early and late growing season throughout three watersheds on Alaska's North Slope: the Kuparuk, a tundra stream; the Oksrukuyik, a lake-influenced tundra stream; and Trevor Creek, a mountain stream. To investigate how nutrient additions alter community composition and rates of dissolved organic matter decomposition, we also incubated a subset of streamwater samples with combinations of N, P, and C amendments. We characterized in-stream and incubation bacterial communities via a target metagenomic approach. We hypothesized that increased thaw depth will create greater soil-stream community connectivity, with diversity decreasing downstream, and that concurrent carbon and nutrient additions will most affect incubated stream communities.

Thu_198_BE-12_2267
Microbial Communities along Consecutively Connected Habitats in East Antarctica

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The ultraoligotrophic Lake Untersee is the largest and deepest surface lake of Central Queen Maud Land in East Antarctica. It is located in a cirque-like valley which is dammed by the Anuchin glacier at its northern tip which provides the only known water source for the lake. Water-loss only occurs through ablation and sublimation of the perennially lake ice cover. Lake Untersee pelagic and benthic microbial communities are relatively well studied. However, the Anuchin glacier is still unexplored even though its potential role as major contributor of nutrients and biota to the lake ecosystem.
Based on 16s rRNA gene targeted PCR and subsequent Illumina tagged sequencing, we show that aerial deposition of biota on the glacier leads to distinct microbial communities in glacier ice and cryoconite holes. These communities ultimately become part of the lake Untersee ecosystem. Significant differences in microbial diversity were also recorded between supraglacial habitats and the lake ice cover, suggesting a shift in glacier microbial communities once they melt into the lake. The highest relative abundant phyla in lake, glacier and aerosol samples belong to *Actinobacteria, Cyanobacteria, Bacteriodetes, Firmicutes*, and *Proteobacteria*.
The glacier can be considered as a vector for the colonization of Lake Untersee and hence shapes the lake Untersee ecosystem. The microbial input from deeper depths of the glacier to the lake is unknown and requires further investigation

Thu_199_BE-12_2444

Contrasted Methanogenic Activity of Sub-Polar Wetlands in Climate Change Context

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Due to organic matter accumulation and anaerobic microbial processes, wetland ecosystems are known to contribute greatly to global warming through methane emissions. Polar wetlands are more strongly affected by climate change, resulting in expected modifications of microbial community structure and methanogenesis activity rate, leading to a positive feedback on regional methane budget and global warming. Yet, the outcome of temperature increase on methanogenic communities and processes in Sub-Antarctic wetlands in comparison with their Sub-Arctic counterparts has not been investigated to date.
In this study, the screening of methane production rate in lake sediments and peatlands from 10 Sub-Antarctic ecosystems (Patagonia to Cape Horn, Chile) and 15 (sub)Arctic ecosystems (Denali to Toolik, AK, US) collected in austral summer, highlighted the heterogeneity of methanogenic activities between the considered ecosystems, with regional specificities and higher potential in lake sediments. In controlled microcosm incubations, methane production pathway was mainly acetoclastic and increased temperature (5-10-15-20°C) resulted in enhanced methane production rate. The most temperature-sensitive samples were identified by comparison of modeled energy activation. The quantification of functional genes involved in methanogenesis in *in-situ* and microcosm samples and microbial diversity evaluated by sequencing will be investigated.

Thu_200_BE-12_2492
What Determines the Microbial Succession on the Glacier Foreland?

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Glacier forelands are ideal places to study the ecological succession but microbial succession is relatively poorly understood. We conducted a meta-analysis of bacterial communities using six different successional soils datasets, scattered across different regions, with different pH conditions in early and late successional soils. We found that extreme acidic or alkaline pH conditions lead to the assembly of phylogenetically more clustered bacterial communities through deterministic processes, whereas pH conditions close to neutral lead to phylogenetically less clustered bacterial communities with more stochasticity. We suggest that the influence of pH, rather than successional age, is the main driving force in producing trends in the phylogenetic assembly of bacteria. We also investigated the microbial succession along the chronosequences in front of two different glaciers (Austre Lovénbreen & Blomstrandbreen) in Svalbard. Ordination analysis revealed that all microbial communities shifted from early to the later successional stage following deglaciation in both glacier forelands. The main factor of the bacterial succession was soil pH, whereas fungal communities differed more by vegetation type and coverage. The successional age since glacier retreat is not a single driver of community convergence at the later stage of succession, but alternate factors such as geochemistry and geomorphology could also lead to distinct convergence pattern of microbial communities.

Thu_201_BE-12_2553
Functional Metagenomic of Microbial Communities Associated to Antarctic Sponges

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Marine sponges harbor diverse and abundant microbial communities, that perform fundamental processes related to biogeochemical cycling and nutritional coupling with the host, forming what is called the sponge holobiont. Most studies about sponge holobionts have focused on the bacterial component and come from temperate and tropical environments, and functional roles of sponge symbionts from Polar Regions remain largely unknown. Here, we use a combination of metagenomic and culture-based approaches, with the aim to explore the functional potential from microbial communities associated to Antarctic sponges.
Our analyses indicate that Antarctic sponge holobionts display a particular taxonomic signature, with the absence of Cyanobacteria and Poribacteria, two common phyla in temperate and tropical sponges. Functional potential analysis shows genes involved in nitrogen, carbon, sulfur and phosphorus cycles. Protein-coding genes related to vitamin synthesis and host-microbe interactions are enriched inside the sponges compared to planktonic communities. Genomic features of bacterial strains isolated from Antarctic sponges showed several genomic signatures related to symbiotic lifestyle. To our best knowledge, this work is the first insight into the functional potential of sponge-associated microbial communities from the Antarctic environment and reveals that fundamental biogeochemical, defense and nutritional processes are transversal across sponge-holobionts.

Thu_202_BE-12_2698
Impact of Increased Snow Melt on the Development of Cryospheric Communities

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The vast snow covers of the cryosphere are covering up 35% of the Earth´s surface and exert substantial impact on the biosphere. Hence, it has been addressed merely as a physical component that, due to hostile conditions has long been regarded as devoid of life. However, snow and ice microbial communities have gained increasing interest due to their potential to contribute to the labile carbon which is available after snow melt. Nowadays, the general picture of snow merely being a repository for wind-transported and snow-trapped microorganisms has changed dramatically even to breeding chambers for microbial life once liquid water is available. Here we show a study from Svalbard, where the impact of the snow pack has been investigated over glacier ice, lake ice and soil, respectively, during the period of snow melt. All three habitats show distinct responses to the input of ions, biological particles and nutrients which causes an enhancing effect for microbial productivity during these few weeks. With ongoing increase in temperature which implies more liquid water, snow melt is a crucial process for the adjacent habitats in terms of increased productivity, activity and metabolism. Hence, with global warming the periods of dormancy are reduced leading to higher carbon turnover rates over large areas potentially altering the carbon budget of high altitude and high latitude regions.

Thu_203_CR-4_50
Glacier Monitoring in Bhagirathi River Basin using Remote Sensing

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The Bhagirathi river basin is an important basin of central Himalaya and is a source of the river Ganges, which feed water to most of the northern Indian states. Here, glaciers of this basin are monitored using remote sensing for more than a decade and status of the glaciers are presented. The area has been divided into six sub-basins i.e. Bhagirathi, Bhilangna, Pilang, Jahnvi, Jalandhri and Kaldi. The glaciers were selected from all the sub-basins with different area, altitude, orientation etc. to make representation of the basin. In the present study, Landsat satellite images from the year 2000 to 2015 were used to monitor 20 glaciers. The snout elevation varies approx. from 3800m m.s.l to 5200m m.s.l. ASTER GDEM V2 has been used for extraction of glacier terrain features e.g. elevation, slope, area, orientation etc. It is observed that Bhagirathi sub-basin has maximum glacierised area about 35% followed by Jalandhri, Jahnvi, Bhilangna, and Pilang with 13%, 9%, 4.5% and 3.2% respectively. Kaldi is the only sub-basin having no glacier. it is also observed that 4 glaciers has more than 70% area towards North, while 10 glaciers has area in the range of 50%-70% towards North, while 06 glaciers shows having area less than 50% North. 17 glaciers have shown retreat, while 3 glaciers have shown advancement during last 15 years. The recession has been observed from 62m to 913m, while three glaciers have shown advancement of 3m to 239m.

Thu_204_CR-4_164
An Overview of Deep Ice Core Drilling Project at Dome A in Recent Two Seasons

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Recently, the news that 2.7-million-year-old ice core drilled in Antarctic had been detected, which causes the human attention. Although the ice age exceeds 1.9 million years than the previous record-holder, the record is not continuous and difficult to explain climate change. Dome A is the place, where more than one million years of continuous ice most likely to be found. Therefore the process of deep ice core drilling at Dome A received a high degree of attention in many countries.
During the Antarctic field season of 2015/2016 and 2016/2017, 9 scientific research team members from 4 different organizations had been dispatched to Antarctic by Polar Research Institute of China (PRIC), to perform "Deep Ice Core Drilling Project at Dome A", near to which China's Antarctic Kunlun Station sits. After two expedition seasons, a total of 117+93 drilling roundtrip was implemented, 6400+3600 liters drilling fluid was injected, 18+12 drums ice chips was collected within 12 days. What's more, 353.3+145.86 meters ice core has been extracted, 351.5+146.21 meters borehole has been penetrated by these nine drill crews with the deep ice coring drill. So far the total depth of the bore hole has been drilled to 800.93 meters, which is the first time to drill through shallow ice layer and this depth is also the deepest glacier drilling depth in China.

Thu_205_CR-4_167
Subglacial Conditions of Antarctic Ice Sheet between Zhongshan Station to Dome A

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A radar dataset was collected by using a ground-based radar system, along a 1083 km traverse line from Zhongshan station to DT401, in 2004/2005. The internal layering structure and subglacial conditions were revealed along the radar profile. The continuous internal layers, disturbed layers and Echo Free Zones (EFZ) along the profile were identified and classified, and its spatial distribution was presented. Basing on the recent surface ice velocity, we found that the internal layers at depth 200-300 m in the upper ice sheet are continuous and smooth, and nearlly parallel to the ice surface topography. The thick band of the continuous layers changes little with increasing latitude. Below the depth of 300 m, the geometric structure of the internal layers and the vertical width of the EFZ band were influenced by the surface ice velocity and the bed topography. The relatively high disturbance, discontinuity of the layers and the larger width of the EFZ band correspond directly to higher surface ice velocity and sharper bed topography. In particular, two areas are identified as that,
Zone 1: at km 60-70, there exists a concave zone with a 200 m depth of surface depression;
Zone 2: at km 650-950, the Lambert Glacier Rift at the Gamburtsev Mountains with faster ice flow, where the radar system failed to obtain the echo signal from its bed, the revealed internal layers are disturbed or broken, and the maximal vertical width of the EFZ band is likely more than 2000 m.

Thu_206_CR-4_394
Ice Retreat History in Pine Island Bay, Revealed by Sedimentary Be-10 Records

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Reconstruction of the past dynamics of the Antarctic ice sheets by studying records from their margin is essential to evaluate their stability and their contribution to future sea level rise. Recently, the first direct evidence for a paleo-subglacial lake on the Antarctic continental shelf was reported from a sediment core from a small bedrock basin in Pine Island Bay (PIB), West Antarctica. Here we report further evidence for this paleo-subglacial lake based on down-core changes in Be-10 concentrations in the sediments. Very low Be-10 concentration in the lower part of the core indicate limited input of meteoric Be-10, suggesting deposition of the corresponding sediments in isolation from the open ocean. The Be-10 concentration shows a drop within a sand, silt and mud interval in the middle part of the core that was interpreted to result from deposition during the transition from the subglacial lake to a sub-ice shelf cavern caused by grounding line retreat in PIB around 11 kyrs B.P.. The Be-10 concentration increases significantly toward the top of the core, indicating the establishment of an open marine setting later during the Holocene. In addition, we report new Be-10 data from marine sediment cores in other parts of PIB. Our results demonstrate that Be-10 concentration changes in marine sediments from glaciated margins are a valuable recorder of ice sheet - ice shelf transitions.

Thu_207_CR-4_547
Ice Shelf-ocean Interactions in High-resolution Global Simulations: Part I

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The ability to include ocean cavities below ice shelves is a new feature of the U.S. Department of Energy's Energy Exascale Earth System Model (E3SM). This capability is critical for projecting Antarctica's potential future contributions to global sea level, which is one of E3SM's primary science drivers. In part I of this talk we describe the model configuration and tuning, while part II describes analysis and comparison to observations. E3SM is a coupled climate model with variable-resolution components, which allows global simulations to include enhanced-resolution regions below ice shelves. The ocean, sea ice, and land ice components use the Model for Prediction Across Scales (MPAS) framework for unstructured horizontal meshes based on Voronoi Tessellations.
In order to gain confidence in our implementation of ice shelf cavities, we have performed a series of standard, idealized test cases as well as comparisons of global simulations with and without ice shelf cavities. Validation uses observed sub-marine melt rates and other relevant oceanographic features, and the identification and minimization of coupled model biases. Here we present the results from a large number of global simulations at modest resolution (30 to 60 km grid cells), most of which include static ice-shelf cavities. Based on these simulations, we attain a tuned moderate resolution state that we use as a control configuration for a smaller number of sensitivity experiments at higher resolution.

Thu_208_CR-4_615
Structural Glaciology at Minna Bluff: Crevasses Gone Wild (or not)

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A complex crevasse field forms offshore of Minna Bluff, along the western coast of the Ross Ice Shelf. Tracking the crevasses downstream is equivalent to tracking propagation history in time and thus provides a unique opportunity to investigate the evolution of secondary features around a system that is analogous to strike-slip faults in Earth's crust. A primary population of mode II (shear) fractures propagate into the shelf and arrest at the edge of a relict flow boundary. A subset of these open into through-cutting rifts and continue to propagate as mode I (opening) fractures until they also arrest at a relict flow boundary. We characterise relationships between the primary rifts and associated secondary crevasses, and compare these to other strike-slip systems. Secondary crevasses form on both the extensional and compressional sides of the primary rifts but unlike elsewhere, the largest splays form in the compressional regime. Also unlike other settings, splay faulting appears to be initiated mainly by a change in fracture toughness of the ice rather than misalignment of the propagating tip with respect to far-field principal stresses. Correct understanding of these features will provide important insight into the role of ice properties in mediating crevasse and rift formation.

Thu_209_CR-4_632
Early Warnings of Further Disintegration of Pine Island Glacier's Ice Shelves

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Pine Island Glacier (PIG) is among the fastest changing outlet glaciers of West Antarctica, with strong changes in acceleration, retreat, and thinning in recent decades. If these changes continue, PIG is expected to have an even larger impact on accelerated future retreat and contribute to increasing mass losses from West Antarctica. Therefore, understanding evolving PIG behavior is crucial for improved future sea level rise estimations.
In this study we highlight some early warning signs of further weakening of PIG's floating ice tongue and adjacent ice shelves by combining multi-source satellite data (optical, altimeter and SAR radar) and analysing derived acceleration, retreat, and thinning time series.
The early warnings of further PIG disintegration include changes in calving patterns and rifting dynamics. For example, over the last decade calving frequency has increased and the calved icebergs have disintegrated more rapidly as a result of changes in the rifting patterns likely caused by warm waters in Pine Island Bay. The rifting patterns have shifted from rifting in the shear zone near the northern ice shelf to internal rifting once this zone retreated. Satellite imagery since 2016 shows that a new rift zone is developing in the southern shear zone which may be related to changes in glacier velocity. This rifting may be part of a positive feedback loop which could result in a further decoupling from the southern ice shelf and which may initiate further disintegration.

Thu_210_CR-4_702
A New Grounding-line Proximal Sedimentary Record from Inner Pine Island Bay

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Pine Island Glacier (PIG) is one of the fastest changing ice streams of the West Antarctic Ice Sheet. Its ice shelf underwent major calving events throughout recent years. The main factor for the considerable mass loss of PIG is sub-ice shelf melting caused by the advection of warm deep water into Pine Island Bay on the shelf of the southeastern Amundsen Sea Embayment (ASE). Unique ice conditions during expedition PS104 with RV "Polarstern" to the ASE in February-March 2017 allowed to recover a 7.59 m-gravity core in an area that had been covered by the PIG ice shelf until 2015. The sediment core PS104_008-2 was taken at a water depth of 698 m near the eastern margin of the ice shelf. The new sedimentological data from the core will provide insights into sub-ice shelf environmental conditions and the Holocene history of meltwater plume deposition and oceanic ice-shelf melting. We will present results of our new multi-proxy study, including down-core lithological changes, grain size distribution and excess ^{210}Pb data. Occasional occurrence of calcareous benthic foraminifera shells in the lower part of the core will allow the application of radiocarbon dating. Coupled with the excess ^{210}Pb data, the AMS ^{14}C ages will provide constraints on sub-ice shelf sediment accumulation rates and the discharge rates of subglacial meltwater plumes.

Thu_211_CR-4_749
History of Larsen C Ice Shelf Reconstructed from Sub-ice-Shelf Sediments

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The Larsen C Ice Shelf is the largest ice shelf on the Antarctic Peninsula. Radar and satellite data show that the ice shelf has been thinning from above and below which has been driven by a combination of decreased snowfall/warmer atmospheric temperatures together with basal melting/ice flow divergence, respectively. Continued thinning and retreat of the ice shelf front could push the ice shelf beyond a critical threshold, leading to rapid retreat and this subsequent discharge of continental ice. Ice shelves, however, can respond over a range of times-scales from decades to millennia so it is critical to disentangle short-term variability from long-term trends. Collapse of Larsen B Ice Shelf in 2002 for example, was at least partly related to ocean-driven thinning over many thousands of years (Domack et al., 2005). This highlighted the need to understand the long-term history of ice shelves. Here we present new insight into the Holocene (past 11,500 years) history of Larsen C Ice Shelf based on the analyses of sediment cores recovered from beneath the ice shelf. This is combined with new dating constraints on cores recovered from the continental shelf, seaward of the current calving front, to reconstruct the timing of grounding line retreat and subsequent development of an ocean cavity. We conclude by placing our findings in the context of modern ice shelf retreat.

Thu_212_CR-4_860
Tidal Grounding Line Migration at the Darwin Glacier

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The Darwin Glacier is a small outlet glacier draining the East Antarctic Ice Sheet through the Transantarctic Mountains. Its motion is affected by ocean tides yet largely shielded from climate-driven variability, allowing observations of short-term grounding line (GL) behaviour without the added complexity of contemporary mass-imbalance. We conducted a detailed study of the glacier grounding zone in the 16/17 field season, mapping surface and internal flexure, GL migration, sub-daily velocity fluctuation and ice thickness. This high-resolution data is used to re-interpret a sequence of twelve TerraSAR-X interferograms. Double-difference tidal flexure fringes are heavily modified by migration of the GL across a two-kilometre ´ice-plain´ at the glacier´s upstream margin, despite relatively steep basal topography.
The asymmetric vertical displacement is re-interpreted by separating the four-image interferograms using flexural modelling with a migrating GL and homogeneous rheology. In the flexure zone, a neutral bending layer is found in the upper third of the ice column suggesting stiffer or cooler ice near the surface. We show that GL migration is proportional to the bed slope in the migration zone, but that it does not equal the rate expected from a simple flotation criterion. This simultaneous analysis of multiple interferograms reveals new information on GL and ice properties that can help predict future GL retreat associated with glacier thinning or sea level rise.

Thu_213_CR-4_865
Hot Water Drill Project at the Amery Ice Shelf, East Antarctica

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Mass loss of ice shelf is of great significance to a better understanding of the ice sheet dynamics and a more precise prediction of global sea levels. However, the melting processes and ocean currents beneath the ice shelf remain poorly understood. The hot water drill, a highly efficient drill technique, provides an opportunity to investigate the physical and chemical processes beneath the ice shelf. With the financial support from the Ministry of Science and Technology of China, a hot water drill system has been successfully developed. Drilling test results show that the average drilling speed is >30 m h^{-1}, and the diameter of the obtained borehole is >35 cm. The length of the main hose is 2200 m. In the following five years (2018-2023), the hot water drill will be employed on Amery Ice Shelf to penetrate the ice at 9 sites with thickness varying from ~600m to 1800m (near the grounding line). Through the borehole, seawater and sediment beneath the ice shelf will be sampled. The ice core will be recovered from three layers of the ice shelf (i.e., the upper, middle and lower layers). In addition, CTD and ADCP will be installed beneath the ice shelf. Besides, the automatic weather station, surface mass balance observation system and the GPS will be set up near the drilling site. The data logging to a local disk will be performed, and the disk will be replaced annually.

Thu_214_CR-4_871
Sea Ice Loss and Ocean Swell as a Trigger for Antarctic Ice Shelf Disintegration

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Understanding the causes of catastrophic disintegration of ice shelves on the Antarctic Peninsula over the past few decades is crucial to: i) the improved representation of complex ice sheet-ocean-atmosphere interaction processes in Earth system models; ii) determining the impact on sea level rise; and iii) assessing the vulnerability of remaining shelves to environmental change. While progress has been made towards understanding melt-related and glaciological processes that precondition and weaken ice shelves, the mechanisms responsible for triggering their disintegration remain largely unknown. In this work, we combine satellite observations, wave hindcast data from WAVEWATCH III and ice shelf-sea ice-wave modeling to show possible linkages between regional decrease in sea ice coverage (both pack and fast ice), resultant enhanced impingement of ocean swells, and the disintegration events of the Larsen A and B and Wilkins ice shelves since 1995. In so doing, we highlight the potential role of regional sea ice loss in both i) contributing to preconditioning the shelves for collapse; and ii) determining the nature and timing of eventual disintegration of shelves weakened by multiple factors. The new results underline the need to consider sea ice (change) as a factor affecting ice-shelf stability, depending on the ice shelf.

Thu_215_CR-4_877
Chinese Dome A Deep Ice Core Project: The Main Progress and Perspectives

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Dome A deep ice core project was started in 2009-2010, when the main drill trench was constructed. In 2010-2011 season, the drilling slot construction was finished, then a 121 m deep pilot hole was drilled in 2011-2012. In 2012-2013 season, the deep ice core drill, i.e., the modified version of Japanese deep electromechanical drill, was installed. After surface and borehole testing the drilling fluid (n-butyl acetate) was dumped into the hole, and three runs were done from the depth of 112.3 m to 122.75 m with average core length of 3.66 m. During the season 2014-2015, the deep ice core drilling was continued, reached the depth of 304 m. In the season of 2015-2016, 354 m ice core was obtained, with the borehole depth extended to 654 m. Then, another 146 m ice core was recovered in 2016-2017, and the depth reached 801 m. The main scientific objectives of this project were to extend available climate records from ice cores, to investigate the main mechanisms of climate change, and to investigate the subglacial processes. In order to achieve the objectives, the deep ice core, with the diameter of 95 mm, will be divided into 6 parts, for the measurements of physical properties, gas concentrations and isotopes, major ions and nitrate isotopes, water isotopic compositions and biological signature. In general, an international cooperation on analysis of the deep ice core is essential, and the groups abroad are welcome to join and contribute to Dome A deep ice core project.

Thu_216_CR-4_894
A Glimpse Beneath the Ekstroem Shelf: First Results from Wide Angle Seismic Data

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Drilling into marine sediments and their subsequent basement provides sound constraints on the geological history of a region. Although marine sediments have been successfully cored globally, the most valuable information about the paleo ice sheet evolution of East Antarctica is hidden in the inaccessible sub ice shelf deposits in our research area. Drilling of the presumably Cretaceous-Cenozoic sediments and the underlying basaltic basement is planned at the Ekstroem Ice Shelf. Thus, in the austral summer season 2016/17 an over-ice seismic presite survey was conducted to gain information on the sediment and basement structures.
In this context, a precise depth estimate of the target horizons/basement is of critical importance for selecting the best drill sites. To achieve this, we installed seismic recording stations along several seismic reflection lines to record the refracted seismic energy at long offsets. In total, we setup 14 stations along 8 profiles. The number of stations per profile varied between 1 and 5 with a spacing of 7 to 13 km. Each station was equipped with a Reftek 130 recorder and 9 geophone chains consisting of six 4 Hz vertical components. The source was a 9-ton EnviroVibe vibrator with a maximum pressure of 57 kPa emitting a 10 s linear sweep within a frequency range of 10 to 220 Hz. The shotpoint distance was 120m. Here we present technical details and challenges of the experiment, the data processing and the first preliminary results.

Thu_217_CR-4_899
Totten Glacier - Southern Ocean Interactions during the Late Quaternary

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This research examines the interactions between the Totten Glacier and the Southern Ocean during the Late Quaternary using a 350kyr sediment archive on the Sabrina Coast continental margin. Stable isotope and trace metal analyses were conducted on planktonic foraminifera *Neogloboquadrina pachyderma* (s) to reconstruct hydrographic changes in this region. Lithological and assemblage observations, sediment physical properties and ice rafted debris mass accumulation rates were combined to develop a conceptual model of climate induced depositional changes.
The Sabrina Coast record exhibits a muted oxygen isotope ($d^{18}O$) signal across the MIS 5/6 transition where the observed isotopic shift is ~20% of the expected 1.0 per mil shift from global ice volume. Mg/Ca ratios suggest that Antarctic surface waters cooled by 2.4 ± 0.8°C between the Holocene and MIS 3, which indicates that changes in $d^{18}O_{cal}$ are primarily influenced by $d^{18}O_{sw}$. Other Late Quaternary $d^{18}O$ records from the Antarctic Margin appear to exhibit similar trends. We discuss possible mechanisms buffering the $d^{18}O_{sw}$ ice volume signal including changes in deep water upwelling and increased [CO_3^{2-}] concentrations under permanent sea ice. Peak ice rafted debris is associated with glacial stages and deglacial transitions. The last glacial period is punctuated by a series of IRD spikes which could indicate millennial scale variability in the Totten.

Thu_218_CR-4_1021
Ice Velocity Mapping in Antarctica, 1960s to 1980s, Based on Historical Images

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Ice flow velocity is an important parameter for estimating mass changes in glaciers. Long-time observations on the surface velocity are of great significance for assessing the relationship between Antarctic ice sheet and global climate change. Existing research on Antarctica ice velocity based on modern satellite remote sensing dated back to 1970s, the early film-based ARGON satellite photographs extended the timeline back to 1960s. This research presents a rigorous geometric processing method for estimating Antarctica ice flow velocity fields by using ARGON/Landsat satellite images. In view of various image configurations in Antarctica, two different methods are developed and implemented. The first method proposes a novel parallax decomposition technique that separates the effect of the terrain relief from the ice flow motion is proposed for the ARGON stereo image pairs. The second method deals with images with longer time baselines and ortho-rectifies the images and then calculate ice flow velocity based on the feature matching technique. The above methods for estimating ice flow velocity are applied in mapping the major glaciers of East Antarctica (Totten, Amery, Rayner, etc.) from 1960s-1980s for the first time. Comparison with recent Antarctic ice velocity products from 2000-2010 shows different change patterns in different glaciers. The initial results and a discussion of the speed change and the associated cryosphere environment are introduced.

Thu_219_CR-4_1031
Evaluation of Antarctic Ice Sheet Surface Mass Balance over the Last Millennium

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Improving our knowledge of the variability of the Antarctic surface mass balance (SMB; i.e. the difference between the incoming and outgoing mass at the surface of the ice sheet) is crucial to reduce the uncertainties of past, present and future Antarctic contribution to sea level rise. Here, we present an evaluation of the SMB simulated by those global climate models that have a last millennium simulation available. In the first phase, we focus on the last four decades, for which we present a detailed comparison with in-situ observations, atmospheric reanalysis, and regional atmospheric climate models. The goal is to estimate the ability of the models to reproduce the spatial distribution of the SMB, its temporal (seasonal and inter-annual) variations and the potential links with standard modes of large-scale climate variability such as Southern Annular Mode. In a second step, we analyse the SMB over the last millennium as simulated by the GCMs following the PMIP3 (Paleoclimate Modelling Intercomparison Project Phase 3) protocol and compare it to ice core records synthesised in the framework of the Antarctica2K working group. In this exercise, we focus particularity the spatial structure, the main drivers of the SMB variability and the analysis of the natural climate variability role in SMB changes.

Thu_220_CR-4_1036
Using Damage Mechanics to Model Calving from Tidewater Outlet Glaciers

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Many ocean terminating glaciers in the Arctic are undergoing rapid retreat, thinning and strong acceleration in flow. The calving process plays a crucial role for the dynamical mass losses and occurs when the stresses at the calving front exceed the fracture strength of ice, leading to the detachment of blocks from the glacier front. However, the understanding of the processes involved in calving as well as the capability of flow models to represent this mechanism remain limited.
We use a transient 2d finite-element flow model coupled to a damage model to model break-off at the front of tidewater glaciers. The flow model computes velocities and the resulting stresses, which are in turn used to calculate the evolution of the glacier geometry and damage. The damage variable is defined by a change of rheological properties with increasing material degradation. Elements are removed once damage reaches a critical threshold. We use observations from glaciers in the Arctic to constrain the material properties. We further assess the sensitivity of the glacier evolution to external forcings such as submarine frontal melting or surface mass balance changes.
The coupled ice flow/damage model allows for reproduction of calving front geometries typically observed for different tidewater glaciers in the Arctic. The proposed approach should be applicable to model calving on any glacier, and thus be used to analyse the evolution of tidewater glacier variations from the past to the future.

Thu_221_CR-4_1074
Glaciological Characteristics of Ice Rises at Nivlisen Ice Shelf East Antarctica

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The coastal region of the East Antarctic Ice Sheet has numerous ice shelves and ice rises, consisting of locally grounded ice that controls ice dynamics and mass balance of the region. An Indo-Norwegian joint project, called MADICE, is investigating dynamics and evolution of the Nivlisen Ice Shelf and adjacent promontory-type ice rises by means of geophysical field surveys, satellite remote sensing, ice-flow models and ice cores. We have conducted two field seasons in 2016-17 and 2017-18. Two ice rises, Djupranen and Leningradkollen, have dome shaped summits with elevations of 325 m and 170 m above sea level, respectively. Low-frequency radar data show relatively flat subglacial beds below the summits, with subglacial elevations of 100 and 150 m below sea level, respectively. Well-developed Raymond arches indicate that the summits have been stable the last hundred years, except for one ridge where the arches have migrated landward (south) in the shallower ice. Farther south from the ice domes towards the ice sheet, the subglacial topography drops 500 m at a 2 to 3 km narrow through aligned in the east-west direction, comprising a distinct margin between smooth beds in the north (seaward) and rougher subglacial terrains in the south (landward).

Thu_222_CR-4_1078
Going against the Flow: Small-scale Pinning Points within the Ross Ice Shelf

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The flow of the Ross Ice Shelf (RIS) is limited by regions of localised grounding termed pinning points. While pinning points are common features within the RIS and are generally assumed to have a stabilising effect, the mechanics of these features have not been studied in detail. This study focuses on a collection of small pinning points (and overlying ice rumples) located downstream from the outlets of the MacAyeal and Bindschadler Ice Streams within the eastern sector of the RIS.
Here we use high spatial resolution ice velocity derived from Landsat 8 imagery and thickness inferred from satellite laser altimetry to investigate the momentum balance and mass flux in the region. Drag forces exerted by the pinning points on the surrounding ice shelf are computed using a force budget approach and are compared to the forces expected for a similar ice shelf with no pinning points. The pinning points have contrasting effects on the surrounding flow field. Upstream, compressive stresses act to resist ice flow from the MacAyeal Ice Stream, supporting thicker ice than would otherwise exist. As the ice flows over and around the pinning points, its speed decreases and mass flux declines, creating a wake of thinner ice downstream. At the ice rumple boundaries, lateral shearing creates bands of heavily crevassed ice that advect downstream, further modifying the flow field. This analysis improves understanding of how small-scale pinning points regulate the flow of the RIS.

Thu_223_CR-4_1248
Current Status and past Evolution of Blåskimen Island, Dronning Maud Land

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The ice-shelf-fringed coast of Dronning Maud Land in East Antarctica contains numerous ice rises that influence the dynamics and mass balance of the region. However, only a few of these ice rises have been investigated in detail. We present glaciological settings and late Holocene evolution of Blåskimen Island, an isle-type ice rise adjacent to Fimbul Ice Shelf. This ice rise is largely dome-shaped, with a pronounced ridge extending to the southwest from its summit (410 m a.s.l.). Its bed is mostly flat and about 100 m below the current sea level. Shallow radar-detected isochrones dated with a firn core reveal that the surface mass balance is higher on the southeastern (upwind) slope than the northwestern (downwind) slope by ~37%, and this pattern has persisted for at least the past decade. The mass balance estimated using the Input-Output method show that this ice rise has thickened by 0.12-0.37 m ice equivalent per year over the past decade. To investigate longer-term evolution, we applied a thermo-mechanically-coupled Elmer/ICE model to a profile going across the summit and along flowlines on either side. Constraining the model results with present-day flow speeds and englacial stratigraphy, it is likely that the ice rise is thickening with a rate of 0.4 m i.e. per year for at least a century. Also, we found a larger-than-present north-south imbalance in the surface mass balance sustained over several centuries in the past.

Thu_224_CR-4_1275
Predicting the Oldest Ice Optical Signal using a Marine Dust Record

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The marine sediment record shows that glacial-interglacial cycles transitioned from regular ~41,000 year cycles to irregular ~100,000 year cycles approximately 1 million years ago, an event known as the Mid-Pleistocene Transition. However, the ice core record only extends 800,000 years into the past, severely limiting our understanding of this major change in the climate system and thus of fundamental climate forcings and feedbacks. A primary goal of the International Partnership in Ice Core Sciences is therefore to retrieve a 1.5 million year old continuous ice core, yet complex glacial processes, limited bedrock data, and surprisingly young basal ice in previous cores necessitate careful reconnaissance studies before extracting a full core.
Ice borehole optical logging reflects ice dust content and may be used to date ice quickly and inexpensively. Here I develop a transfer function between the 800,000 year optical dust log of the EPICA Dome C ice core and a 4 million year marine dust flux record from a sediment core in the subantarctic zone of the South Atlantic, which lies along the path of dust sources to Antarctic ice. I then use the transfer function to predict the optical signal in 0.8-1.5 million year old ice from the marine dust record. In future field seasons, I will extract the optical log at potential old ice sites using the newly developed Rapid Access Ice Drill (RAID) and apply the transfer function to evaluate these sites for 1.5 million year old ice.

Thu_225_CR-4_1400
A Minimal Model of Tidewater Glacier Evolution

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The iceberg calving process influences the geometry of a tidewater glacier, and is in turn controlled by the terminus geometry through the stress field which controls damage and fracture of the ice. We analyze the feedbacks in this intricately coupled process with an explicitly formulated model, consisting of evolution equations for three state variables representing glacier geometry. The simplicity of the model allows for formal investigation of stability of glacier states on different basal geometries during advance and retreat. This model, complemented with a simple parametrization of glacier calving rates, can also be used to understand tidewater glacier change rates. Model runs on realistic bathymetries yield evolution histories which compare favorably with recorded tidewater glacier histories.

Thu_226_CR-4_1458
Correlation of Recent Calving Front Retreat at Pine Island Glacier to Bathymetry

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Pine Island Glacier (PIG) currently experiences the largest negative mass balance in comparison to other outlet glaciers in Antarctica and hence is the largest contributor to modern sea-level rise. Due to the glacier's topographic setting, a bed that deepens beyond the grounding line to the deep interior basin of the West Antarctic Ice Sheet (WAIS), it has been suggested that this increased ice loss may be a precursor of WAIS collapse. Despite the increased mass loss, however, the calving front of PIG remained more or less stable since the earliest observations in the mid-20th century. Large icebergs where calved at intervals of a few years but subsequently the calving front re-advanced close to or even beyond its former position. This pattern changed in 2015 when a calving event resulted in a reoriented (45°-25° clockwise compared to previous calving lines) and most retreated calving line position ever observed. This new calving geometry was confirmed by a calving event in September 2017. In February 2017 we were able to access the formerly ice-shelf covered area during RV Polarstern expedition PS104. Bathymetric data from this area revealed a bathymetric ridge that has acted as a pinning point of PIG in the past. We use these bathymetric data in combination with satellite data from the last decades to investigate the correlation of bathymetric features to the calving dynamics of Pine Island Glacier.

Thu_228_CR-4_1597
Present ENSO Modulation of Summer Surface Melting of Amundsen Sea Ice Shelves

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Enhanced surface melting over Antarctic ice shelves is known as an important precursor of ice-shelf break-up. Although the marked ice-shelf thinning along the Amundsen Sea (AS) coast observed in recent years has been mainly attributed to ocean-related sub-ice shelf melting, future climate model projections point toward increased summer surface melting in this area in the coming decades. A better understanding of atmospheric conditions promoting ice-shelf surface melting in the present-day climate can provide insight into the future of West Antarctic ice shelves. Here, we present the results of a 15-km resolution simulation of West Antarctic summer climate spanning 1979-2015 carried out with the polar-optimized version of the Weather Research and Forecasting model (Polar WRF) and complemented with melt data derived from satellite passive microwave observations. Consistent with previous studies, we find that a westward shift of the Amundsen Sea Low (toward the Ross Sea) favors warmer conditions and enhanced melting along the AS coast. The impact of the El Niño-Southern Oscillation (ENSO) is significant only when focusing on strong ENSO events, with surface melting being significantly enhanced during strong El Niños compared to strong La Niñas. In this context, the increase in the frequency and intensity of El Niño events projected for the twenty-first century could expose the AS coast to enhanced surface melting and thus to an enhanced risk of ice-shelf disintegration.

Thu_229_CR-4_1649
Bathymetry and Bed Conditions of Subglacial Lake CECs, West Antarctica

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Under favourable conditions, the sediments within Antarctic subglacial lakes provide unique records of ice sheet history and microbial life. Subglacial Lake CECs, in West Antarctica, has the potential to host such an environment. However, key to record preservation are the lake volume and depositional environment. The lake lies beneath 2650 m of ice in a topographically-steep subglacial region to the west of the Ellsworth Mountains. The lateral extent of the lake has been delimited by surface radar measurements. However, no constraints have been placed on the bathymetry or bed conditions within the lake. In December 2016, a series of seismic reflection profiles was acquired across the lake to determine the water column thickness and bed properties. Profiles indicate a maximum water column thickness of 300 m at the widest part of the lake. The relative reflection strength from the ice-base and lake-bed have been used to investigate the bed material. The lake-bed is likely formed of fine-grained silts or clays, consistent with a low-energy sedimentary environment. The volume of water and low-energy depositional environment indicate that Lake CECs is a suitable candidate for deep exploration.

Thu_230_CR-4_1673
Recent Research Advances on Subglacial Lake CECs in West Antarctica

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Subglacial Lake CECs (79º15´S / 87º34´W) is a near 20 km^2 fresh water body located underneath 2650 m of ice in West Antarctica. Recently collected seismic, radar and GPS data have allowed a more detailed delineation of the lake and the surrounding subglacial topography, including the pathways of water flow potentially coming in and out the lake. The repeat survey of 30 metal poles deployed in 2014 indicates a mean ice surface velocity of 83 cm per year and a surface snow accumulation of 23 cm water equivalent per year. This surface snow accumulation value is very close to the mean accumulation between 1986 and 2014 obtained by glaciochemical and stable isotope analyses of 2 shallow firn cores retrieved from the area. An automatic weather station (AWS) installed on the ice sheet surface at 2057 meters above sea level, close to the centre of the lake, has discontinuously recorded data since 2014. Thanks to power improvements carried out in December 2016, the station was able to measure and transmit data in real time during the entire Antarctic winter when an absolute minimum air temperature of -59ºC was reached. Data collected at a permanent GPS station installed next to the AWS showed vertical movement commensurate with the surface mass balance, without any indication of elevation changes resulting from possible water volume changes within the lake. All these new insights confirm the advantages of this subglacial lake as a target for a deep exploration program.

Thu_231_CR-4_1680
Melt Characteristics of Antarctic Ice Shelves

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The piling up of surface meltwater on ice shelves can lead to hydrofracturing, a process that severely damages the structural integrity of an ice shelf and could possibly lead to its collapse. Thorough analysis of the Surface Energy Balance and its individual components can provide insight in their separate contributions to surface melt.
In this presentation, we will present the results from running an Energy Balance model forced by 25 years of meteorological observations from Neumayer Station, located on the Ekström ice shelf in Dronning Maud Land, Antarctica. The model calculates the turbulent fluxes for sensible and latent heat, as well as subsurface processes such as meltwater percolation and densification of snow and firn. The melt season at Neumayer is limited to December and January in most years, with melt occurring on approximately 20 days on average. We will also comment on limitations due to measurement and modelling uncertainties.
In addition, we have forced the model by meteorological data from two additional automatic weather stations on Antarctic ice shelves (one on the Riiser-Larsen ice shelf and one on the King Baudouin ice shelf) in order to assess the spatial variability of the melt season. Furthermore, these results could be used to evaluate the ability of regional climate models to calculate the Surface Energy Balance.

Thu_232_CR-4_1698
Challenge in Determining the Impact of Warming Limited to 1.5/2°C for Antarctica

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To assess the impact of various future climate scenarios (1.5°C, 2°C, RCP4.5, RCP8.5) on the Antarctic ice sheet and its contribution to the global sea level, we exploit a large ensemble of ice sheet simulations. It covers the period from 1850 to 5000 to determine short-term and long-term implications of different future climate paths. To sample the uncertainty range, we use atmospheric and oceanic output of 3 CMIP5 models, two initial ice sheet states, and different ways in applying the climate forcing. Two major challenges are detected: First, the oceanic and atmospheric conditions of global climate models are too warm for pre-industrial and present-day climates. Hence the forcing cannot be applied directly, while our simulations driven by the widely established method of anomaly forcing are generally more realistic. Second, we detect a very large uncertainty of near future projections up to 2100 and more so for the far future projections. This uncertainty makes conclusions on the impact of global climate warming limitation difficult to impossible. Some ensemble members lose the West Antarctic Ice Sheet or even parts in the east, while others do not. Ultimately, realizations with instabilities project sea level rises significantly larger than CMIP5 estimates. On the other hand, some of the realizations even show a negative sea level contribution due to mass accumulation in the interior of the Antarctic.

Thu_233_CR-4_1870
The Paraglacial Response in the Ice-free Terrains of the Antarctic Peninsula

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The Antarctic Peninsula (AP) is the warmest region of the Antarctic continent. This work studies the paraglacial response in this region. Past glacial retreat since the LGM has reshaped the configuration of the AP, favouring the emergence of new lands and the exposure of formerly glaciated environments. The shrinking and spatial retreat of the glaciers has favoured glacio-isostatic uplift, which has redefined the coastlines, with the development of new islands, peninsulas, etc. These changes occurred during the paraglacial stage promoting changes in the distribution of wildlife and flora, mainly distributed along the coastal fringes. Glacial retreat has also conditioned environmental dynamics, which has been more or less intense according to topography, geomorphological setting and permafrost existence/absence. The pronounced warming trend recorded during the second half of the 20th century has accelerated some of these processes. The abundance and variety of records (glacial, periglacial, permafrost, alluvial, coastal) as well as observations on ecological processes, has shown evidence of the rapid paraglacial readjustment of AP environments in the transition from glacial to ice-free conditions. High uplift rates have continued to reshape coastlines, permafrost degradation in newly exposed areas is accelerating mass wasting, sediment redistribution and changing hydrological processes, and wildlife and flora are rapidly fitting within the new environmental setting.

Thu_235_CR-4_2005
Pre-site Study for Deep Geological Drilling below Ekström Ice Shelf, Sub-EIS-Obs

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During the last seasons and ongoing, pre-site seismic surveys have taken place in the Ekströmisen region of Dronning Maud Land, with the primary of building a stratigraphic age framework of the under-ice-shelf sediments. These sediments are overlying the Explora Wedge, a syn- or post-rift volcanic deposit. Expected ages range from Late Mesozoic to Quaternary. From new vibroseismic profiles we will select sites for short core seafloor sampling through Hot Water Drill (HWD) holes of the oldest and of the youngest sediment sequences to confine their age time span. There is further potential for drilling deeper sediment cores with the support of international partner. Deep drilling should recover the sediments overlying the Explora Escarpment, in order to discover the nature of the Explora Wedge. We expect the overlying sediment sequences to reveal the history of polar amplification and climate changes in this part of Antarctica, the build-up of the East Antarctic Ice Sheet during past warmer climates, and its Cenozoic and future variability.
Having HWD holes through the shelf ice and sampling the sea floor will provide the unique opportunity for further piggy back experiments consisting of multi-disciplinary nature. Experiments and measuring setup for oceanography, sea and ice shelf physics, geophysics, geology, hydrography, biogeochemistry could be planned to characterize the ocean-ice-sediment interactions, processes and ecosystem observations.

Thu_236_CR-4_2150
Seasonal Control on Totten Ice Shelf Dynamics by Sea Ice Buttressing

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Previous studies of Totten Ice Shelf have relied upon surface velocity measurements to investigate its mass balance and sensitivities to interannual climate forcing. However, short-term displacement measurements cannot be used to characterize long-term flow rates where ice velocity fluctuates with the seasons. Quantifying annual mass budgets or analyzing interannual changes in ice velocity requires knowing when, whether, and where observations of glacier velocity may be aliased by short-term variability. Here, we analyze 16 years of velocity data for Totten Ice Shelf, which we generate at sub-annual resolution by applying feature tracking algorithms to several hundred MODIS satellite image pairs. We find the ice shelf is characterized by a seasonal cycle of spring to autumn speedup of more than 100 m/yr close to the ice front. The amplitude of the seasonal cycle diminishes with distance from the open ocean, suggesting the presence of a resistive backstress at the ice front that reaches a maximum in winter. Springtime acceleration precedes summer surface melt and is not attributable to thinning from basal melt. We find that the ice shelf accelerates each spring in response to lost buttressing from the breakup of seasonal landfast sea ice.

Thu_237_CR-4_2200
Antarctic Ice Sheet Volume Sensitivity to Boundary and Initial Conditions

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Ice sheet model outputs require inputs from uncertain initial and boundary conditions, and other parameters. We show how one particular ice sheet model, SICOPOLIS (SImulation COde for POLythermal Ice Sheets), depends on these inputs through comprehensive adjoint-based sensitivity analyses. SICOPOLIS discretizes the shallow-ice and shallow-shelf approximations for ice flow, and is well-suited for paleo studies of Antarctica. The adjoint model of SICOPOLIS was developed via algorithmic differentiation, facilitated by the source transformation tool OpenAD. While model sensitivity to various inputs can be computed by costly methods involving input perturbation simulations, the time-dependent adjoint model of SICOPOLIS delivers model sensitivities to initial and boundary conditions throughout time at lower cost.
Here, we explore the sensitivity of the Antarctic Ice Sheet's entire and regional volumes to: initial ice thickness, precipitation, basal sliding, and geothermal flux over the Holocene epoch. The West Antarctic Ice Sheet (WAIS), in particular, is well known to be sensitive to changes in basal melting, and we use the SICOPOLIS adjoint model to make quantifiable the WAIS' sensitivity to these controls. Sensitivity studies such as described here are now accessible to the modeling community, based on the latest version of SICOPOLIS that has been adapted for OpenAD to generate correct and efficient adjoint code.

Thu_238_CR-4_2213
Bedrock Roughness in Antarctica: Connections to Subglacial Water and Basal Slip

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Over the last twenty five years, extensive ice penetrating radar (IPR) coverage of Antarctica has been obtained, at lines spacings down to 1 km in some cases. However, many glacial processes occur at finer scales, so infering likely landscape parameters is required for a useful interpolation between lines.
Here we present a compilation of IPR-derived profile roughness data covering three great basins of Antarctica: the Byrd Subglacial Basin in West Antarctica, and the Wilkes Subglacial Basin and Aurora Subglacial Basins in East Antarctica; and treat these data using root mean squared deviation (RMSD). Coverage is provied by a range of IPR systems with varying vintages with differing instrument and processing parameters; we present approaches to account for the differences between these systems. We use RMSD to investigate the self-affine behaviour of the bed at kilometer scales and extract fractal parameters from the data to predict roughness and uncertainties in ice thickness measurement, and compare to simulations from subaerial topography.
We further compare these data to inferences of subglacial hydrology from specularity content, lithology from airborne gravity, and inferences from basal slip and find a good match between a distinct quantifiable roughness parameter and subglacial "canal" systems, low density anomalies, and regions of high basal slip. This map can be used a a tool in modeling ice sheets.

Thu_239_CR-4_2216
Modeling Ice Shelf Weakening with Damage Mechanics and the Material Point Method

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Thinning and fracture of Antarctic ice shelves reduces their ability to restrain discharge of grounded ice into the ocean. Implementing these weakening processes in models of ice sheet-ice shelf systems could improve projections of ice sheet evolution and sea level rise. However, current models at this scale cannot accurately represent fracture-induced weakening despite attempts with damage mechanics. These damage models fail because they often lack a strong physical basis and they encounter numerical diffusion when damage is advected with the ice flow. Here, we overcome these issues by developing a modeling framework that incorporates a thermodynamically consistent and anisotropic damage model and is based on an implicit material point method (MPM) to ensure error-free advection of damage. In MPM, a set of Lagrangian particles discretize the ice domain, carry all variables, and advect with the flow. Similar to the finite element method, model equations are solved on an Eulerian grid, but the particles serve as moving integration points. We test our methods with a shallow shelf model of the Larsen C ice sheet-ice shelf system. We initialize the model using high resolution Cryosat-2 data for ice geometry and by conducting a dual inversion for the basal friction and damage parameters that minimize mismatch between modeled and Landsat-derived velocities. We simulate potential triggers of ice shelf collapse and discuss the resultant implications for stability of the ice shelf.

Thu_240_CR-4_2378
Water on the Antarctic Ice Sheet: Quantifying Surface Melt via Radar Satellites

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Surface melting is an important precursor for Antarctic ice shelf collapse owing to its ability deplete firn air content and generate complex surface hydrological features including meltwater lakes. Recent ice sheet-climate modeling suggests intensified surface melting may initiate rapid change in the ice sheet system over this century. Accurate prediction of future melt evolution, and thus sea-level rise estimates, requires a robust observational baseline for melt owing to important nonlinearities in the melt response to a warming atmosphere. Here, we present new investigations of Antarctic ice sheet surface melt using satellite radar remote sensing and field observations. We focus on extending a legacy 10-year melt intensity record from the QuikSCAT satellite with more recent scatterometer missions. Next, we assess the capabilities of high spatial resolution satellite synthetic aperture radars in recording variability in ice shelf surface melt. Satellite data are evaluated against in-situ estimates of meltwater production derived from observations of the surface energy balance. We further evaluate satellite observations against field observations of refrozen melt stratigraphy resulting from a widespread 2016 West Antarctic melt event. Our resulting observations provide important insights into the coupling between the atmosphere, meltwater production, firn conditions, and ice sheet surface hydrology, all processes critical to quantify for improved sea-level projections.

Thu_241_CR-4_2410
Morphology and Mass Balance of Land-terminating Ice Cliffs in North Greenland

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Wide parts of the ice sheet in North Greenland terminate as cliffs on land. However, the characteristics of this feature and its response to a changing climate have so far received little attention. While land-terminating ice cliffs are studied in other regions, detailed investigations in Greenland were carried out only more than six decades ago in the Thule area (*Red Rock, Northwest Greenland*). These studies showed a continuous advance at one location over multiple years, despite the local mass balance was reported negative.
The purpose of our study is twofold. First, we extend the morphological analysis to the complete Northern ice margin employing high resolution digital terrain models (Arctic DEM). We focus on main characteristics of the land-terminating ice margin in Northern Greenland, its slope and aspect distribution and comparison to spatial datasets of flow velocity and mass balance. Results show that the advance at Red Rock is long-term, continuing unabated today at rates of up to several meters per year. Similar magnitudes were found for large other stretches along the ice margin. Second, we investigate processes and drivers of the ice cliff evolution. With data from our recent field experiment we show that under the same atmospheric forcing the mass balance response of the cliff front is different to the horizontal glacier surface above the cliff. Hence, the cliff morphology determines different energy balance regimes with specific sensitivities to climate.

Thu_242_CR-4_2530
The Imitation Game: Reconstructing the Greenland Ice Sheet (GrIS)

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Model parameters control the sensitivity of ice sheets to external forcings, and introduce uncertainty to model output due to poor understanding of their optimum, or true values. The complexity of model physics means few studies have explored parameter interactions. This study aims to
(1) Quantify the influence of model parameters, and their interactions on GrIS evolution, and
(2) Determine parameter ranges that reproduce a GrIS target state assumed to represent the its extent at the Medieval Warm Period (MWP) onset.
A parameter sensitivity analysis, using principal component data reduction and Bayesian approaches is performed using the Parallel Ice Sheet Model (PISM). For a suite of parameter settings, the GrIS is spun up from 125 to 1ka using grid sequencing to gradually increase spatial resolution from 40 to 5km. Modelled output at 1ka is compared with target model E-W ice thickness transects across the GrIS to
(1) quantify sensitivity of ice sheet profile to parameter set-up and
(2) to identify parameter values that best allow the GrIS to evolve into an assumed MWP extent.
(3) Produce a posterior probability distribution of each influential parameter
(4) Determine if posterior probability distributions of parameters are spatially variable
Identifying influential parameters and a probability distribution of their values allows for the development of a parameter scheme that closely reproduces target ice sheet extents and simultaneously quantifies their interactions.

Thu_244_CR-4_88
Morphodynamical Changes and Predictions of Amery Ice Shelf, Eastern Antarctica

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The Amery ice shelf (AIS) plays a critical role in Earth's climate system and its morphology is controlled by the physical forcing and global human interventions. The coastline changes of AIS are investigated for about 460 km into three different sectors and each-sector into a number of transects at uniform intervals between 2001 and 2016 using multi-dated MODIS satellite images. Further, past coastline positions were constructed and future positions are estimated for 5- and 10- years. The rate of change in AIS coastline positions were estimated using the statistical methods—end point rate, average of rates and linear regression—and cross-validated with correlation coefficient and root-mean-square error (RMSE) methods. About 51% of transects exhibit ±200 m RMSE values, indicating better agreement between the estimated and satellite-based ice-shelf positions, and the transects closer to the sectors boundaries exhibit 47% uncertainties in coastline change rate estimations. Based on correlation coefficient and RMSE, the influence of physical/natural processes and global anthropogenic activities on coastline changes has been calculated. The AIS ice sheet are gaining mass (5.4 ± 3.1 Gt/yr) due to increased accumulation of snow in this region. Significant morphological changes in AIS have been recorded at every 5-years and attempted to link with the ice mass change and climate indices, such as El-Niño Southern Oscillation (ENSO) and Southern Annular Mode (SAM) at different sectors.

Thu_245_CR-5_115
Absolute Gravimetric Studies of GIA in Antarctica and in Fennoscandia

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Finnish Geospatial Research Institute (FGI) has a long history in studying the Fennoscandian glacial isostatic adjustment (GIA) in Finland through modelling and different kinds of measurements. Absolute gravimetry (AG) has been done in Finland since 1980´s, first through international collaboration and then with our own gravimeters. FGI has also participated in seven Finnish Antarctic Research Program expeditions since 1989. The main research theme has been the study of the Antarctic glacial isostatic adjustment utilizing AG and constant GPS measurements. Absolute gravity measurements have been carried out at five research stations located in Dronning Maud Land, Antarctica. Repeated absolute gravity measurements can bring multiple benefits to geodynamical work, when used together with vertical rates or even in standalone mode. At individual stations, gravity rates can be used to control observed vertical rates and predictions from GIA models. In a regional approach, plotting gravity rates versus vertical rates at a number of stations provides a slope that gives information on the mechanism behind the vertical rates (e.g., GIA) and an intercept that can be used to control the reference frame of the vertical rates. Along with the above mentioned geodynamics studies, absolute-gravity stations are an important part of the global geodetic infrastructure. We review the FGI absolute gravity reseach in Fennoscandia and in Antarctica and present latest results.

Thu_246_CR-5_153
Seismic Signals from Ice and Ocean: Results from ICE-VOLC Project

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Thanks to the complete lack of anthropic noise, Antarctica can be considered a perfect natural laboratory to investigate seismic signals generated by atmosphere-cryosphere-hydrosphere interaction. In the framework of the ICE-VOLC project (www.icevolc-project.com) funded by the Italian PNRA, Antarctic ice-quakes and microseisms were studied.
In particular, by a temporary installation of two seismic stations in Tethys Bay close to Mario Zucchelli Station in 2016, three icequakes were detected, with dominant low frequencies (below 2 Hz), located in the David Glacier area with local magnitude of 2.4-2.6. These events were likely to be generated at the rock-ice interface under the glacier.
As for microseism study, we quantitatively investigated the relationship between microseisms recorded on the coasts of the Ross Sea, sea ice concentration in the Ross Sea and significant wave height in the southern hemisphere. We show how, according to the different seismic station and frequency band, the areas characterised by the strongest anti-correlation between microseism amplitude and sea ice concentration are distinct. Accordingly, we present an algorithm to infer the sea ice distribution on the basis of the microseismic amplitudes. Finally, we note how the oceanic areas, whose wave activity mostly affects the microseisms recorded in the Ross Sea, are the Antarctic coasts close to Ross Sea and the Drake passage.

Thu_247_CR-5_238
Antarctic GIA Estimated by Combining GRACE, ICESat and GPS

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Based on the significant difference between ice/snow density and lithospheric density, a new iterative method is proposed to simultaneously estimate the present-day glacial isostatic adjustment (GIA), ice/snow mass change and corresponding elastic vertical crustal deformation over the AIS by combining GRACE, ICESat and GPS datasets. The influence of active subglacial lakes on GIA estimates, which is up to 1.5 mm/yr with all datasets applying a 400 km Gaussian smoothing filter, are mitigated for the first time through additional processing of ICESat data. The inferred GIA shows that the strongest uplift is found in the Amundsen Sea sector and subsidence mostly occurs in Adelie Terre and the East Antarctica inland. The total GIA related mass change estimates for the entire AIS, West Antarctica Ice Sheet, East Antarctica Ice Sheet, and Antarctic Peninsula Ice Sheet are 43 ± 38, 53 ± 24, −23 ± 29 and 13 ± 6 Gt/a, respectively. The most significant ice mass loss and most significant elastic vertical crustal deformations are concentrated in the ASE and northern Antarctic Peninsula. Ice/snow mass loss rate in the northern Antarctic Peninsula and Amundsen Sea sector is more than 10 cm/a EWH. For the corresponding elastic vertical crustal deformation rates, in the Amundsen Sea sector is more than 4.5 mm/a and the Northern Antarctic Peninsula is about 2 mm/yr.

Thu_248_CR-5_297
How to Give Accurate Surface Mass Balance Projections for the 21st Century?

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Climate models still fail to accurately reproduce the temporal Surface Mass Balance (SMB) trends at a regional scale, mainly because complex processes are still insufficiently considered, such as:
1) atmospheric circulation changes related to complex ocean/ice/atmosphere interactions,
2) specific polar atmospheric features (cloud microphysics, wind scouring and impact on stable surface boundary layers),
3) surface firn physics involved in surface drag variations, or in firn air depletion and albedo feedbacks.
We propose an approach based on 1) bias corrections of future sea surface conditions coming from AOGCM scenarios. These corrections are then used as boundary conditions for a modeling with a stretched grid atmospheric GCM (LMDZ4), whose systematic errors in atmospheric circulation are corrected using tendency errors from nudged simulations. These outputs are then used to force the regional atmospheric model (MAR) to assess future regional scale SMB variations in Antarctica. The MAR is adapted to account for interactions between drifting snow and surface drag over sastrugi fields by introducing a specific formulation for the roughness length. This formulation accounts for the relationship existing between snow-surface temperature and microrelief erodibility caused by the sintering of surface crystals. This adaptation is necessary to reproduce the seasonal variations in drifting snow frequency and horizontal snow mass transport as evidenced from observations.

Thu_249_CR-5_404
GIA-induced Crustal Deformation around Syowa Station, East Antarctica

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Geodetic and geomorphological surveys in Soya Coast area, East Antarctica have been conducted by Japanese Antarctic Research Expedition (JARE) in order to evaluate the crustal deformation induced by Glacial Isostatic Adjustment (GIA) in various time scales. In particular, several geodetic observations (e.g., Global Navigation Satellite Systems: GNSS and continuous gravity observations) have been carried out on outcrop rocks in this area since the 1990s to monitor recent crustal movements. These observations include the components of the GIA induced by last deglaciation and elastic deformation due to recent surface mass balance. Therefore, it is important for the separation of the components of viscous and elastic signals to compare these observations with numerical predictions using GIA model. In this presentation, we will show the geodetic signals calculated by GIA model based on the previously published deglaciation histories, and the results of geodetic observations obtained by JARE for about 20 years. We intend to discuss the separation of the components between recent ice mass change and last deglaciation, and estimate influences of recent Antarctic ice sheet mass changes on the geodetic measurements in Soya Coast area.

Thu_250_CR-5_456
20th Century Vertical Land Motion due Changes of the Greenland Ice Sheet

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Quantifying the contribution from ice sheets and glaciers to past sea level change is of great value for understanding sea level projections into the 21st century. However, quantifying and understanding past changes are equally important, in particular understanding the impact in the near-field where the signal is largest.
We assess the impact of 20th century mass balance of the Greenland Ice Sheet on land motion using results from Kjeldsen et al, 2015. These results suggest that the ice sheet on average lost a minimum of 75 Gt/yr, but also show that the mass balance was highly spatial- and temporal variable, and moreover that on a centennial time scale changes were driven by a decreasing surface mass balance.
Here we present and discuss land motion during the 20th century due to mass balance-, surface mass balance-, and ice dynamics changes.
Kjeldsen, K. K. *et al.* (2015), Spatial and temporal distribution of mass loss from the Greenland Ice Sheet since AD 1900, *Nature*, 396, 528, doi:10.1038/nature16183

Thu_251_CR-5_590
Sea-level Fingerprinting as a Reconstruction of AIS History during MIS 2

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Sea-level fingerprinting by GIA model is useful to detect ice-sheet change scenarios. Regardless of lacking direct ice-sheet data in near-field, sea-level fingerprinting can reconstruct timing and amplitude of ice-sheet change. Marine Isotope Stage 2 (MIS 2) is the latest glacial period (29,000-15,000 years ago), including the Last Glacial Maximum (LGM) at the timing of global ice volume maximum. Further understanding of the glacial earth climate system requires a comparison of various paleoclimatic records with sea-level and ice-sheet change in this period. However, Antarctica Ice Sheet (AIS) history during MIS 2 is still less understood due to lack of field data. Here we demonstrate AIS history during MIS 2 using sea-level fingerprinting analysis on observations in far- and intermediate-field. Our results indicate that far- and intermediate-field relative sea-level records provide the new insight of AIS history during MIS 2 through sea-level fingerprinting analysis.

Thu_252_CR-5_820
Changes of Ice Surface Heights Between 1912 and 2017 in Southern Greenland

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In 1912 a Swiss expedition, leaded by the meteorologist Alfred de Quervain, crossed the inland ice of Greenland on a track from Disko Bay to Tasiilaq. It was the second successful crossing of the ice cap after Nansens expedition in 1888. De Quervain provided first good height data of the glacier surface. The accuracy of the heights is in the range of 2 m about 10 m. There are only a few such data sets available which are measured more than 100 years ago.
In 2002 a series of six geodetic expeditions started on the same traverse as 1912. The last measurements were made in August 2017. In result there are a lot of information available:
- very precise height changes for the last 15 years along a 700 km profile,
- height differences measured on more than 20 camp sites of the 1912 expedition
- very dense (spacing of some meters) profiles of heights of the rim of the inland ice.
The results can be used to answer different questions: Are there significant differences in the height changes and mass loss resp. between the 100 years after 1912 and the last decade? Is the speed of mass loss more or less stable or increasing? How the surface topography is changing (an analysis of remote sensing data is included)? An observed height change is mainly a mass change or a change of snow density?
And last but not least the data are usable for direct verification of altimetry data such as IceSat. Both the IceSat heights and the height changes can be compared.

Thu_253_CR-5_837
Processes of 21st Century Ice Sheet Melt and their Global Consequences

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Both external and internal processes drive ice sheet evolution over decadal to centennial timescales, yet the partitioning between these drivers is often hard to quantify. Here we present a new suite of high-resolution simulations of ice sheet evolution from present-day to 2100 based on CMIP5 climatologies. Our results predict the magnitude of possible sea level rise under different climate scenarios, but also highlight the spread of values that arises from differing parameterisations of key physical processes, such as grounding line behaviour or the calculation of surface melt. By quantifying mass changes in individual ice sheet drainage basins that arise from environmental processes such as surface and basal melt, we then derive an estimate of the dynamic component of the total discharge signal. In this manner we are able to attribute spatially-variable changes to regional differences in climate forcing and ice sheet dynamics.

Thu_254_CR-5_862
Solid Earth-Cryosphere Interaction with a Focus on East Antarctica

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This contribution focuses on the interplay between the solid Earth and the cryosphere with the aim of progressing knowledge of ice extent and retreat history, and Antarctica´s contribution to sea level change, via observation and modelling. Solid Earth-cryosphere interaction research requires an interdisciplinary approach which is facilitated through the Antarctic Gateway Partnership research program centred in Hobart, Tasmania, Australia. New observations are provided through onshore and marine basement rock and sediment sampling, and GPS, seismic and airborne geophysics data collection. These observations are carried out in the context of ice sheet modelling at both basin scale and continental scale.
We investigate the Earth deformation, including horizontal motion, associated with ice sheet evolution. We also improve constraints on geothermal heat as an ice sheet model input by combining information from geological, plate tectonic and geophysical inputs. The present day research findings are placed in the context of paleo ice sheet models which consider a coupled ice sheet / ocean / solid Earth framework. With a focus on East Antarctica, we find that the major ice sheets and their basement catchments behave with contrasting sets of controls. Through our combined approaches, we are better able to constrain model inputs, understand the impact of uncertainty in model inputs and investigate the impact of feedbacks between Earth systems.

Thu_255_CR-5_1000
Multi-year Analysis of Antarctica GNSS Data in the Frame of the VLNDEF Project

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Victoria Land (Antarctica) is located at the boundary between the Western Antarctic Rift System and East Antarctic Craton. This region is characterized by a complex tectonic architecture mainly dominated by NW-SE regional right-lateral strike-slip faults, block faulting, tilting along NE striking, and SE dipping extensional faults. In order to estimate the neo-tectonic geodynamics of the region, in 1999 Victoria Land Network for DEFormation control (VLNDEF) was established and repeatedly surveyed during the Australian summer seasons. The network nowadays is constituted by 27 sites in a region which extends over 500 km North-South and 300 km East-West, including the "Mario Zucchelli Station" Italian base. In this paper, GPS observations of VLNDEF, collected from DOY 349 of 1998 to DOY 365 of 2017, together with all free available geodetic observations for Antarctica (IGS and POLENET sites) were processed with Bernese 5.2 Software, using a classical double difference approach. Almost 100 IGS stations were used as a global frame and the IGS14 core network was adopted to align Antarctica´s stations into ITRF2014 reference frame. GPS time series for more than 80 Antarctic sites were analyzed to remove outliers and to estimate trends, annual/semiannual signals components and eventually offsets parameters. Finally, the principal component analysis (PCA) was applied to filter out the common mode component (CMC) of the calculated GPS time series.

Thu_256_CR-5_1057
Calibrated Projections of Jakobshavn Isbræ's Contribution to Sea Level Rise

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Jakobshavn Isbræ (JI), West Greenland, has become a major contributor to global sea level rise since the disintegration of its floating ice tongue in the early 2000's. Calving controls the evolution of the ice stream, but no robust calving rate parameterization for large-scale ice sheet models exists to date. Therefore, large uncertainties remain concerning the future evolution of this glacier.
Here, using the Ice Sheet System Model (ISSM), we perform a model sensitivity study on JI. We estimate its future evolution and mass loss by calibrating a calving rate parameterization based on a von-Mises yield stress criterion with available observations over the 1985-2017 period. First, we perform a large ensemble of model runs over the past 30 years, in which we vary several parameters that influence calving. Second, we introduce metrics to evaluate the agreement between model runs and observations of JI, and determine the parameter combinations that best reproduce the observed dynamic changes. Finally, we project JI's future evolution for each of the selected parameter combinations for the next 100 years.
We discuss the robustness of our results, the sensitivity of the glacier to the respective calving parameters, and future pathways for observations and model development. This ensemble study explores scenarios of JI's potential evolution and yields an informed estimate of JI's contribution to global sea level rise for the next century.

Thu_257_CR-5_1064
High-resolution, Global Ice Sheet/RSL Simulations using the Higher-order ISSM

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Relative sea-level rise is driven by processes that are intimately linked to the evolution of glacial areas and polar ice sheets. So far, most Earth System models capable of projecting the evolution of RSL on decadal to centennial time scales have relied on offline interactions between RSL and ice sheets. In particular, grounding line and calving front dynamics have not been modeled in a way that is tightly coupled with Elasto-Static Adjustment (ESA) and/or Glacial-Isostatic Adjustment (GIA). Here, we present a new simulation of the entire Earth System in which both Greenland and Antarctica ice sheets are tightly coupled to an RSL model that includes both ESA and GIA at resolutions and time scales compatible with processes such as grounding line dynamics for Antarctica ice shelves and calving front dynamics for Greenland marine-terminating glaciers. The simulations rely on the Ice Sheet System Model (ISSM) SESAW module, which models RSL using an anisotropic meshing apprach, as opposed to the more classic spherical harmonics appraoch. Using such an approach, one can show the impact of higher-order ice flow dynamics and coupling feedbacks between ice flow and RSL. We quantify the exact impact of ESA and GIA inclusion on grounding line evolution for large ice shelves such as the Ronne and Ross ice shelves, as well as the Agasea Embayment ice streams, and demonstrate how offline vs online RSL simulations diverge in the long run, and the consequences for predicting sea-level rise.

Thu_258_CR-5_1226
Calving-induced Tsunami Analyzed through Seismic Signals and Numerical Codes

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The dynamics of sizeable outlet glaciers in Greenland has been studied through the analysis of seismic data collected by the regional Greenland Ice Sheet Monitoring Network (GLISN), of satellite images and of local tide gauge data. With a particular focus on the Jakobshavn Glacier, West Greenland, major calving events have been identified by automatically detecting the ground flexure in response to sea waves generated by iceberg detachments.
In addition, numerical techniques simulating the propagation of a tsunami in the Ilullisat fjord have been applied. The tsunami source has been simply represented by means of a single, instantaneous sea-surface bump, localized approximately in the area where the calving event takes place. The main interest in this preliminary phase is focused on the assessment of the main tsunami features in the basin: propagation time, sea-surface maxima and minima distribution and frequency characterization of the waves reaching the fjord coasts.
The comparison of the seismograms spectra associated to calving events in the low-frequency window against the spectra of the simulated tsunami is encouraging and opens new perspectives in the study of the interaction between glaciers, fjords and oceans.

Thu_259_CR-5_1616
Glaciers and Sea Surface Change Around Kara Sea in Russian Arctic

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One of the recent climate changes is the temperature and precipitation increase in the Arctic. In an area of East Russia Arctic, loss of sea ice is large and glaciers shrink due to the temperature increase and sea ice decrease. We analyzed sea ice area, land weather and glacier mass balance of three areas in western Russian Arctic to evaluate the influence of sea ice distribution on glaciers.
The study area has three islands. Franz Josef (FJ), Severnaya Zemlya (SZ), Novaya Zemlya (NZ). FJ and SZ are surrounded by sea ice and has ice cap on the land. NZ is covered by a large ice cap. We used monthly mean temperature observed in July and NCEP reanalysis data for summer mean temperature as a climate indicator. The GRACE data was converted to water storage on land and regarded it as glacier mass change. Also, Sea ice distribution and sea surface temperature were analyzed with the satellite data.
The glacier mass balance has decreased during 2002-2004 in FJ and NZ, and 2011-2012 in all area. For 2004-2010, NZ showed the gradual mass balance decrease and FJ and SZ showed small change. NZ showed open seawater in early July, which is earlier than usual year. After 2011, sea ice was separated to coastline of NZ. Higher summer temperature was shown in FJ in 2011, SZ in 2004 and 2012, and NZ in 2004 and 2007-2008 and after 2011. Glacier mass loss and high air temperature was seen in the same period in all areas.

Thu_260_CR-5_1784
Geothermal Anomaly Onfluences Subglacial Meltwater Flow at South Pole

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New radar data from the PolarGAP project reveal a broad area upstream of South Pole where >400m has been lost from the ice sheet due to enhanced basal melting. We estimate by modelling dated englacial layers that the geothermal heat flux required is 120 ±20 mW/m^2, indicating a previously undetected geothermal anomaly. Hydrological models show that subtle changes in the ice sheet can switch melt water flow from this region between glacial catchments. We propose that this mechanism helps explain past variability in flow deep in the ice sheet interior.

Thu_261_CR-5_1812
Mass Change in Greenland and Antarctica Derived from LAGEOS and GRACE

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Large scale continental mass change in polar regions is sensed by Earth observation satellites dedicated to gravity field determination like the GRACE mission (2002 - 2017) and its successor GRACE-FO (scheduled for launch in spring 2018). But also other low Earth orbiters (LEOs) with high-latitude orbits may be used to assess the mass transport in polar regions. The spatial and temporal resolution of the derived mass estimates is much coarse then what we get from GRACE, but they may serve to extend the time-series before the start of GRACE and to bridge the gap to GRACE-FO. Satellite Laser Ranging (SLR) observations to the LAGEOS satellites allow polar mass change estimates back to the early 1990s. They indicate that major ice melting in Greenland started around 2002, so GRACE was launched just in time.
We present and compare time-series of Greenland and Antarctica mass changes derived by SLR and from GRACE and discuss limitations in temporal and spatial resolution. We also address the problem of spectral leakage due to the limited spatial resolution and of signal separation, because satellite gravimetry senses the integrated mass change including global isostatic adjustment (GIA), snow cover and ice dynamics.

Thu_262_CR-5_1863
Analysis of the Ice Dynamics of the Amundsen Sea Embayment from 2009 to 2017

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POLENET GPS sites located in the Amundsen Sea Embayment (ASE) of the West Antarctic Ice Sheet (WAIS) are recording some of the fastest uplift rates seen anywhere in the world. This data strongly indicates that the glaciers in the ASE are undergoing drastic dynamic changes, having a significant impact on the WAIS contribution to sea level change. We use high resolution optical stereo imagery from the DigitalGlobe satellite cluster, co-registered with laser altimetry and RADAR data collected during the NASA IceBridge and ICESat missions, to generate a time series of digital elevation models (DEMs) spanning the time period between 2009 and 2017. These optically derived DEMs are extracted using the SETSM algorithm and are used to identify glacier surface elevation (dh/dt) changes. Volume changes (dV/dt) are calculated by combining dh/dt values and bed elevations from Bedmap2. GoLIVE data is used to identify surface velocity speeds of glaciers in the ASE using a fixed fluxgate. We expect to see significant changes in the surface elevation, velocity and mass balance of glaciers in the ASE and will compare our results with data obtained from studies using Cryosat-2 and ICESat. Establishing the nature of load changes in the vicinity of the POLENET GPS sites will enable the identification of the extent to which uplift is dominated by instantaneous elastic response due to ice mass changes.

Thu_263_CR-5_2024
Investigating the Greenland Ice Sheet and its Interaction with Solid Earth

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Since 1995 our group has been working in Greenland. In Northeast Greenland, between 72 and 81 North, geodetic GNSS measurements on bedrock were started in 2008 and carried out lastly in 2016 and 2017 during campaigns based on the German research vessel “Polarstern” as well as on a field camp. Results of the GNSS data analysis will be presented together with the inferred correction for the immediate elastic response to recent ice-mass changes in order to link the vertical uplift rates to glacial-isostatic adjustment (GIA). A focus will be given to Nioghalvfjerdsbraen, the northern branch of the major outlet of the Northeast Greenland Ice Stream (NEGIS). This region is subject to a new joint research project “Greenland Ice Sheet - Ocean Interaction“ (GROCE) that a number of German universities and research centres are cooperating on. We will shortly introduce this project that aims at investigating in detail the processes which interlink atmosphere, ocean and ice sheet. Within the GROCE project our group deals with GIA, mass balance and dynamics of the Greenland Ice Sheet in that focus area. The GIA effect will be determined also by the combination of satellite altimetry and gravimetry, which then can be compared to the results of the in-situ GNSS measurements. We will discuss the benefit of utilizing additional methods and observations to support the separation of the effects of surface mass balance and ice dynamics.

Thu_264_CR-5_2142
Geothermal Heat Flux and Predictability of West Antarctic Ice Sheet Evolution

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Climate changes are overall the primary driver of West Antarctic Ice Sheet (WAIS) variability over time. However, climate sensitivity of a marine ice sheet should be strongly modulated by the magnitude and spatial pattern of subglacial geothermal heat flux (GHF). Low GHF values favor development of slow-moving ice rises and inter stream ridges which are frozen to their beds and offer buttressing for ice shelves and ice streams. High GHF values hinder or prevent development of such slow-moving features because they make it hard, or impossible, to reach freezing conditions at the bed. In general, high GHF values will favor marine ice sheet instability. A number of recent publications reported data and modeling results indicating zones of high GHF beneath the WAIS, purportedly related to subglacial volcanic or magmatic activity in the West Antarctic Rift System (WARS). Diffuse continental rift zones, such as the WARS, are characterized by elevated and spatially highly variable GHF. For instance, GHF within the Basin and Range Province has a modal value close to the average continental GHF (ca. 60 mW per meter squared) but also a long tail of high values that reach over 300 mW per meter squared. Regional differences in GHF of such large magnitude should play a significant role in evolution of fast/slow ice flow patterns during WAIS thinning, making it necessary to incorporate realistic GHF fields in predictive ice sheet models.

Thu_265_CR-5_2284
Measurements of GIA with Absolute Gravimeter and GNSS by JARE

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The Antarctic ice sheet plays a key role in control of the global climate and sea level. Then its ice mass changes have been estimated from in-situ geodetic observations, satellite observations such as satellite gravimetry and satellite altimetry as well. These estimations, however, include an uncertainty arising from the effects of GIA, where GIA is the rheological response of the solid Earth to the ice mass changes.
With objective of observing the GIA effects, JARE (Japanese Antarctic Research Expedition) have conducted the repeated absolute gravity (AG) and continuous GNSS measurements and other geodetic observations in Dronning Maud Land (DML), East Antarctica. Especially, the repeated AG and continuous GNSS measurements at Syowa Station have been carried out since 1995, and these data reveal the temporal variations in both gravity and crustal deformation due to the GIA. JARE also succeeded the AG measurement at Langhovde during 2011/2012 austral summer, which was the first outdoor measurement in the JARE activity. Subsequently, we performed the outdoor AG measurement at Selungen, the central parts of the Sør Rondane Mts., during 2013 austral summer. Furthermore, we plan to conduct the combination of repeated AG and GNSS measurements at several sites on the bare rock area around Lutzow-Holm Bay, DML in 2017/2018 austral summer. In this presentation, we will report the geodetic observations by JARE.

Thu_266_CR-5_2311

Temporal Variability of the Antarctic Ice Sheet Observed from Sattelite Geodesy

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Quantifying the Antarctic Ice Sheet (AIS) mass balance remains challenging as several processes compete to differing degrees at the basin scale with regional variations, leading to multiple mass redistribution patterns. For example, analysis of linear trends in surface-height variations from 1992-2003 and 2002-2006 shows that the AIS is subject to decimetric scale variability over periods of a few years. Every year, snowfalls in Antarctica represent the equivalent of 6 mm of the mean sea level. Therefore, any fluctuation in precipitation can lead to changes in sea level. Besides, over the last decade, several major glaciers have been thinning at an accelerating rate. Understanding the processes that interact on the ice sheet is therefore important to precisely determine the response of the ice sheet to a rapid changing climate and estimate its contribution to sea level changes. We estimate seasonal and interannual changes of the AIS between 01/2003 and 10/2010 and 09/2016 from a combined analysis of surface-elevation and surface-mass changes derived from Envisat data and GRACE solutions, respectively. While we obtain a good correlation for the interannual signal between the two techniques, differences in amplitude, phase, and spatial pattern are obtained for the seasonal signal. We investigate these discrepancies by comparing the crustal motion observed by GPS and those predicted using monthly surface mass balance derived from the regional atmospheric climate model RACMO.

Thu_267_CR-5_2349
Greenland and Antarctica Mass Changes by Multiple-satellite and Land Uplift Data

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Understanding the long-term changes in the ice sheets of Greenland and Antarctica has global climate significance, especially on long term global sea level rise predictions. We present results of satellite-derived ice sheet change time series of Greenland and Antarctica, covering up to a 25 year time span, and highlight the dynamic nature and of the ice sheet changes, including the large interannual variations and regional accelerations of major ice mass loss regions. We also highlight, using satellite data from a.o. the ESA Climate Change Initiative, how the combination of multiple satellite measurement types, such as mass change, ice velocities, elevation changes and solid earth land uplift from GNET and ANET, may improve the overall spatial and temporal monitoring the ice sheet changes.

Thu_268_CR-5_2446
Laboratory Observations of the High Temperature Creep of Polycrystalline Ice

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The largest source of uncertainty in predictions of future sea level is the contribution arising from the discharge of ice from the polar ice sheets. A key factor in reducing this uncertainty is to improve the numerical models used to predict ice sheet evolution. One important aspect of model development is to improve the constitutive relationship that describes the rheological properties of ice.
Factors influencing creep deformation rates include: the magnitudes of the stresses causing ice to deform; strain-induced anisotropy of polycrystalline ice, and temperature. Creep rates at high temperatures, within 2 degrees (K) of the melting point, are constrained by a relatively small number of laboratory observations due to the inherent difficulties in conducting experiments at such temperatures.
We present results from a series of laboratory ice deformation experiments conducted in simple shear at temperatures between -2°C and -0.3°C at 0.1 MPa (octahedral shear stress). Unlike previous experimental studies conducted at temperatures close to the melting point, these experiments were continued through to high shear strains (>10% strain) to ensure that anisotropic flow, compatible with the stress configuration, had developed.
These data contribute to the continued development of a constitutive relationship for polycrystalline ice that will improve the accuracy of ice sheet models and are relevant to model studies utilizing inverse methods to infer the spatial extent of basal sliding.

Thu_269_CR-5_2550
The Influence of Close-field Snow and Ice on Absolute-gravity Measurements

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Often it is assumed that the change in gravity observed with absolute gravimeters in the Antarctic primarily depends on solid earth motion caused by Glacial Isostatic Adjustment and/or by elastic deformation due to changes in contemporary regional ice mass balance. However, variation in the close-field snow and ice masses can be caused for instance by local wind ablation/accumulation and does not necessarily reflect the regional mass balance. As the gravity stations typically are on nunataks well above the surrounding glaciers, the variation in the gravity effect by local masses may be considerable and it can mask the large-scale solid-earth phenomena of interest. The Finnish Geospatial Research Institute maintains time series of absolute gravity at five stations in Dronning Maud Land, starting at the Finnish base Aboa in 1994 and continuing later at Sanae IV, Novolazarevskaya, Maitri and Troll. We describe the various measurements used to monitor the near-field masses, from tachymetry and snow stake lines to GNSS, altimetry and Lidar, the calculation of corrections to observed gravity, and the influence of these corrections on the time series.

Thu_270_CR-6_82
Geophysical Characterization of Boulder Clay Glacier (Victoria Land, Antarctica)

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The Boulder Clay Glacier is a partially debris-covered glacier belonging to the Northern Foothills (Victoria Land, Antarctica) placed close to the Italian base Mario Zucchelli Station. In the frame of XXIX, XXX and XXXI Italian Antarctic Expeditions (from 2013-14 to 2015-16 summer seasons), several investigations, such as Ground Penetrating Radar (GPR), Geodetic Global Positioning System (GPS) network, multi-temporal satellite SAR interferometry (by means of Differential Interferometric Synthetic Aperture Radar, D-InSAR, methodologies), were carried out with the main aim of determining the general assessment of this glacier. The scientific tasks assigned to each single technique were: i) GPR: to investigate the main glacier features (i.e. superficial frozen lakes, shear zones and ice thickness) ; ii) GPS: to determine the ice flow speed vectors over 12 points spread over the moraine covered area; iii) D-InSAR: to estimate deformation trends and surface displacements evolution.
The image provided by the integration of the results pointed out that glacier deformation behavior is dependent, other than the bedrock shape, by also the relationship between the glacier, the moraine (that exhibits different deformation patterns) and the interaction with the ablation due to the strong katabatic winds blowing in the area.

Thu_271_CR-6_100
Radio Echo Sounding and Seismic Observations at the David Glacier, Antarctica

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Integrated geophysical observations in polar regions make it possible to study the interaction between lithosphere and cryosphere and their evolution in the framework of a global climate system.
We have collected Radio Echo Sounding (RES) measurements combined with passive continue seismic observations in the area of the David Glacier (Victoria Land, Antarctica) in order to improve our knowledge about changes in basal conditions due to melting processes.
This work provides detailed maps of the bedrock morphologies, ice thickness and physical condition at ice/bedrock interface in the domain of the David Glacier.
The inferred 3D structural model of the ice and bedrock is integrated into the inversion algorithm in order to improve the accuracy of local seismicity location. In continuity with previous seismic monitoring experiments in the area, we analyze the seismicity induced by the glacier flow and we discuss the characteristic of seismic occurrences in terms of location, frequency and possible seasonal cycling.

Thu_272_CR-6_143
Consistency between Changes in Simulated Climate and European Glacier Length

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It is standard to compare climate model results covering the past millennium to reconstructions based on various archives to test the ability of models to reproduce the observed climate variability in conditions close to the present ones. Up to now, glacier length fluctuations have not been used in this framework while it offers information on multi-decadal to centennial variations complementary to other records. One reason is that glacier length depends on several factors and so cannot be simply linked to simulated climate. However, climate model skill can be evaluated by comparing the glacier length provided by a global glacier model driven by the simulated temperature and precipitation to observations. This is done here using the version 1.0 of Open Global Glacier Model (OGGM) forced by fields derived from a range of simulations with global climate models over the past millennium. The focus is first on European glaciers. Sensitivity experiments are performed to estimate the uncertainty that can be related to the glacier model itself compared to the one that is due to the forcing derived from the climate model. These experiments are dealing with the initialisation of the glaciers in 850 CE, the uncertain creep parameter needed to compute ice dynamics, key parameters in the surface mass balance model, the way climate model biases are taken into account and the downscaling of model results at the location and altitude of the glaciers.

Thu_273_CR-6_154
Ice Front Retreat of Two Adjacent Glaciers in the Antarctic Peninsula

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This study uses aerial photographs and LANDSAT and Sentinel 2 satellites images to determine the retreat dynamics of two tidewater glaciers from 1957 to 2016, Drummond (66°40´S, 65°43´W) and Widdowson (66°43´S, 65°46´W), in the Antarctic Peninsula western coast. A modified digital elevation model AsterDEM2 was used to characterize the morphology and the morphometry of their drainage basins. The two ice fronts have retreated during the period; however, the Widdowson Glacier had a more significant loss (36.37 km^2, 16.97% of the original area) and a higher snow line elevation (200 m a.s.l. in 2016) than the Drummond Glacier (19.11 km^2, 4.33% of the original area; snow line at 100 m a.s.l. in 2016). These differences, of two ice masses side by side and with the same flow orientation, are attributed to different surface slopes and proportion of accumulation areas. The smaller glacier has been more sensitive to environmental changes (e.g., increase in the regional mean annual temperature), and reached a stabilization point (supported to the lateral bedrock) only in 2001, while the Drummond front stabilized in 1974. The Widdowson Glacier has a steeper frontal sector, which may have influenced on the calving rate and generated a more efficient basal slip. The dynamics of these glaciers is also influenced by changes in ocean forcing, precipitation rates, surface melting and bedrock morphology.

Thu_274_CR-6_170
Glacier Flow Acceleration in Response to the Local Climate Change

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Based on in-situ collected GPS data, high-precision ice velocities of a Svalbard glacier, Austre Lovénbreen, were observed over a decade during 2005-2017, including both horizontal and vertical annual surface ice velocities. GPS results indicate that the mass balance of this glacier is negative, which is identical to other neighbor glaciers. GPS data analysis revealed that the surface ice flow was stable in the beginning surveyed years, however, the ice flow velocities increased in recent two years.
A 3D finite element simulation proves that the ice flow acceleration is a response of the glacier to the warming local climate, but the glacier ice flow will slow down soon in the next decade suppose the current climate keeping steady.
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Thu_275_CR-6_266
Chukotka: Climate and Glacier Change

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The paper presents the assessment the current state of the Chukotka highlands' glaciers by satellite images at the background of climatic change, projection of glacier evolution in the near future. It also gives the general description of the regional socio-economic drivers of the region of study as a part of AACA-BCB (AMAP) cluster. Trends of the mean annual and summer temperature for entire Chukotka Peninsula within 1966-2012 are positive. Precipitation trends of annual sum and for cold period are negative in coastal regions, and positive on the continent between the Cross Gulf of Anandyrskiy estuary. Thus, climate processes occurring over Chukotka, do not contribute into the development and extension of glaciation.
Estimation of the evolution of the Chukchi Highlands' glacier was an objective to assess possible variant of evolution of the Chukotka glaciers consisted in construction of balance schemes for each glacier system by climatic data, which is the only available for this poorly studied region and in involving climate scenario, in our case for the time period up to 2030 (Ensemble of 31 scenario from SMIP5, RCP4.5).
Up to this time the glaciation of the Iskaten ridge and Provedensky Massif will greatly reduce, and glaciers of the Pekulney Range will disappear; the glaciers of Chantalsky Ridge (Amguema River Basin) will save their area by maximum.

Thu_276_CR-6_275
Chinese Radioglaciological Studies on the Antarctic Ice Sheet in the past Decade

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Radioglaciological studies commenced relatively late in China.. During CHINARE 21 (Chinese National Antarctic Research Expedition, 2004/05), Chinese glaciologists traversed to Dome A from the coastal Zhongshan Station for the first time and were able to survey the region on a detailed surface RES gird. Since then, different kinds of radar systems have been deployed for both fine-scale surveying networks in the Dome A and along the traverse route for multiple scientific purposes, such as mapping subglacial conditions, distinguishing crystal orientation fabric types, measuring internal layers and freeze-on ice. Significant motivation has been to search for the oldest ice on Earth and to map the unknown bedrock topography of the Gamburtsev Subglacial Mountains and infer the early origin and evolution of the AIS and the GSM. In 2015, China deployed its first fixed-wing airplane named “Snow Eagle 601” for Antarctic expeditions, and an international campaign of International Collaborative Exploration of the Cryosphere through Airborne Profiling in Princess Elizabeth Land was initiated. It has great implications for investigation of ice sheet expansion, stability and the subglacial geology of East Antarctica. In future, we will engage in and make Chinese contributions to more science issues, such as subglacial water and lakes, subglacial canyons and channels and the subglacial hydrological system, basal processes across grounding zones, bathymetry under ice shelves etc.

Thu_277_CR-6_305
Recent Glacier and Proglacial Dynamics Changes in King George Island, Antarctica

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This paper investigates the current dynamics in proglacial geomorphology systems and glacier fluctuations in King George Island (KGI), South Shetland Islands, Antarctica, since 1956. The glaciological, sedimentary and remote sensing data analyses evidenced recent environmental changes. COSMO-SkyMed (Constellation of Small Satellites for Mediterranean Basin Observation), Wordview 2 and Sentinel 2 imagens were used for temporal analysis of glaciers outlines and recognition ice-marginal geomorphological features. From 1956 to 2017, the glaciers in Kraków and Warszawa Ice Fields presented a continuous retreat processes. Due to its small size and thermal conditions, these glaciers respond rapidly to climatic changes. The marine terminating outlet glaciers presented more lost area than land-terminating glaciers. A rapid ice-marginal evolution is evidenced in land-terminating glaciers as consequence of the glacial retreat processes. The geomorphological map of the recent ice-marginal areas showed several types of glacial deposits, such as frontal and lateral moraines, flutes, meltwater channels and erosional features like rock moutonnés, striations and U-shaped valleys. The results evidenced recent changes in proglacial and periglacial successional patterns for Wanda, Potter, Ecology, Znosco and Collins Glaciers. The Znosco Glacier changed the marine-land terminating for land-terminating conditions in last decade and reveal the rapid ice-marginal evolution.

Thu_278_CR-6_309
Monitoring Recent Glacier Changes in Melimoyu Mount - Chile

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This work analysed the application of Sentinel-2 MultiSpectral images and GLIMS data in retreat mappings for to detect and estimate glacier area changes, between 1970 and 2017, in Melimoyu Mount, located in northern Patagonia, Chile. The results presented a decreased glaciers area of approximately by 35.61% in analysis period and there is an overall trend of glacial retreat. Majority of area loss has been identified for glaciers with mean elevation around 1700-1725 m. The decreasing trend in mean annual precipitation presented a possible connection with the recent glaciers changes in the study area, which indicates a large sensibility for meteorologicals variabilitys on the region. This sensitivity also influenced by hypsometry, slope of the terrain and total area of glaciers. The glacier mapping using sentinel 2 data in 2017 provided conditions for new observations of rock glaciers in study area. Analysis of outline glaciers by manual delineation showed satisfactory results with application of Sentinel-2 MSI data to these environments, and use of these enables the continuity of retraction monitoring with greater accuracy of mapping.

Thu_279_CR-6_603
Topographical Influences on Glaciers in the Jankar Chhu Watershed, NW Himalaya

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This paper examines the influences of topographical factors on glaciers between 1971 and 2016 for 127 glaciers in Jankar Chhu watershed, north-west (NW) Himalaya using satellite remote sensing data and limited field observation. Change detection was done based on Corona KH-4B (1971), Landsat ETM+ (2000) and Sentinel 2A (2016) imageries restricted only to a set of 127 glaciers due to cloud masking. The relationship between the magnitude of glacier changes and a set of local factors was carried out using multivariate statistical techniques. Cumulative influence of this factors was evaluated for each glacier using Topographic Influence Index (TII) proposed by Garg et al., (2017). Our result show that:
(1) glacier area decreased by 7.48 ± 2.17% between 1971 to 2016; whereas glacier retreated at an average rate of ~4.82 ± 0.35 m a^{-1};
(2) The debris cover area increased by 56.77 ± 3.33%, and the average ELA changed to ~20 m;
(3) Δ Area (%) and Δ retreat (m) of glacier are strongly affected by local factors while Δ ELA does not show any significant relationship, indicating that it may be controlled by climatic factors and;
(4) More than 75% of glaciers show moderate to high influence of local factors on Δ area based on TII values. This study provides important insight into the local controls on recent de-glaciation which are of critical importance to assess the future glacier dynamics on a regional scale.

Thu_280_CR-6_610
Snow Accumulation, Melting and Ice Thickness Variability on a Himalayan Glacier

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Knowledge of different aspects of glacier dynamics is significant to understand the variety of glaciological processes and its characteristics. In this study, an attempt has been made to relate accumulation and ablation rate, and ice thickness pattern over Sutri Dhaka Glacier in Chandra basin, Western Himalaya. To investigate ice thickness, ground based radar survey has conducted using 16 MHz frequency in a distance mode. The radar derived ice thickness varies from 65 m to 310 m for the surveyed area on this glacier, respectively. Transverse profile of the survey formed the higher order of parabola due to friction forces at the margin against bedrock constraints. The study also revealed that the tributaries margin of the glacier had a greater thickness as compared to its main valley margin. The frequent avalanches on the side valley have a strong influence on the glacier behavior and ice thickness.
Sutri Dhaka is a debris free glacier and the observed snow accumulation rate during the last one decade at 5500 m asl varies from 16 cm to 34 cm w.e. and the standard deviation is 5.6 cm w.e. The Glacier has strong mass wasting during four consecutive negative balance years (2013-17) with the average melting of 0.74 m w.e. a^{-1}. Overall, the signature of accumulation, ice volume and mass balance reflect enhanced melting rate of Sutri Dhaka Glacier during last decade.

Thu_281_CR-6_617
Variability of Thermal Regime and Snow Water Equivalent of Glaciers in Svalbard

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Many Arctic glaciers have been experiencing enhanced melting in response to ongoing global warming and are predicted to shrink faster over the next few decades. Vestre Broggerbreen (VB) and Feiringbreen (FB), two valley glaciers in Ny-Ålesund, Svalbard, Arctic have been monitored for annual mass balance, ice flux, surface ice movement and terminal retreat since last six years . As part of this, both the glaciers have been mapped for snow and ice thickness, sub glacier channel and distribution of warm and cold ice across the glacier tongue by using radar. Apart from radar derived snow depth, variability in snow accumulation pattern over both the glaciers has also been measured by snow pits, snow cores and snow probe. Results reveal that both the glaciers having mostly cold ice (below 0^{o}C), except in the interior part of the glacier. There is small area (12% area) with warm ice (at 0^{o}C) in the deep interior where ice is thicker than 130m and is warmed to the pressure melt point. We have also observed that while the glacier terminal has retreated, the warm ice area has reduced significantly (30%) during last six years. The mean average Snow Water Equivalent (SWE) for VB and FB were 600 ± 172 kgm^{-2} during 2012-2017 and 382 ± 187 kgm^{-2} during 2015-16 respectively. The strong correlations between snow depth and SWE for both the glaciers reflect the significant control of snow depth and altitude on SWE across the Svalbard valley glaciers.

Thu_282_CR-6_774
Glaciological Investigations on the Mocho-Choshuenco Ice-cap, 40 °S, Chile

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In this contribution we summarize our glaciological investigations on the ice cap, which is covering the Mocho-Choshuenco Volcanic Complex located in the Northern Patagonian Andes. The climate on Mocho Ice Cap is relatively mild (+2.6°C annual mean temperature near the equilibrium line) and is marked by very high rates of accumulation. The Annual Surface Mass Balance of Mocho Glacier (one of the catchments of the ice cap) shows very high interanual variability. On average the balance is negative which coincides with the observed thinning and retreat of the glacier. Our research on the Mocho-Choshuenco Ice Cap includes surface mass balance and energy balance modelling, observation of the formation and drainage of glacial lakes and ice-flow modelling. Due to its easy access the ice cap is an ideal research laboratory for Patagonian Glaciers, which are usually hard to reach because of their remoteness and the extreme weather conditions.

Thu_283_CR-6_794
Simulating the Surface Mass Balance of Ice Sheets in the ModelE2 GCM

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Simulating the surface mass balance (SMB) of ice sheets in General Circulation Models (GCMs) is a challenge because of the coarse resolution and simple physics used to efficiently simulate global processes. However, algorithmic advances have allowed for a more sophisticated physical representation of ice sheets in GCMs. We have applied two improvements to the ice sheet surface in the NASA GISS ModelE2 GCM: an elevation class scheme, in which the surface model is run at multiple elevations within a single grid cell, and a sophisticated multi-layer snow model. We compare surface mass balance simulated for the Greenland ice sheet with state of the art regional climate model (RCM) simulations from the Modèle Atmosphérique Régionale (MAR), and satellite measurements. The simulated SMB is particularly sensitive to the representation of surface albedo and refreezing. Using a more realistic surface albedo consistent with satellite measurements more than doubles surface melt. Refreezing can prevent 50% of meltwater from leaving as runoff, but can also warm the snowpack, increasing the likelihood of melt. The addition of elevation classes has a more muted impact on SMB, resulting in changes of less than 10%. Over the Antarctic ice sheet, sublimation and precipitation play a more important role because runoff is a minor component of overall mass balance, highlighting the need for accurately capturing all components of SMB in a global model.

Thu_284_CR-6_883
Land Surface Temperature Analyses of Miyar and Gangotri Glacier (2000 - 2016)

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In the absence of weather stations in the remote areas of the Lahaul District of Himachal Pradesh, satellite derived Land Surface Temperature data can supplement for the lack of data. The MOD11B3V6 images were processed for 17 years (2000-2016). The aim of this paper is to bridge the aspects of Temperature and the Frontal changes noted in the Glaciers of the Miyar Basin. Iso-lines showing temperature pattern of each year have been interpolated according to LST values of 78 geographical points on the Miyar and Bhagirathi watershed map. Major Findings- 1. Extent of Miyar Glacier shows a decrease of 0.11sqKm, a retreat of 0.15% in 16 years; Gangotri Glacier decreased by 0.07sqKm. 2. The LST shows a decreasing trend in the yearly averages at the Miyar Accumulation Area; negatively sloped graph at the R2 value of 0.13. Similarly, the Miyar Snout region shows a land surface temperature of -6.54°C in the year 2009 and the trend is negative with the R2 value of 0.12. Similarly in all of the tributary glaciers this trend has been seen. The range of temperature however has increased in the recent years and the R2 value is calculated to be 0.10 at the accumulation area and at the Miyar Glacier Snout, it is 0.08 with a positively sloped trend over the years. In Gangotri Glacier a there is little or no change, near accumulation area slight negative trend of 0.008 and 0.002 at snout. The study will be very helpful in understanding the glacier dynamics in relation temperature variation.

Thu_286_CR-6_932
Modeling the Effect of Water-filled Crevasses on the Flow of Calving Glaciers

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Observations in Greenland show that large-scale occasional calving events often contribute more to the mass loss of tidewater glaciers than small frequent events (Medrzycka et al., 2016). Large-scale calving events primarily result from the propagation of fractures triggered by high stresses and sustained by the presence of water, which causes the crack to deepen (Benn et al., 2007).
Here, a 2D Shallow Shelf Approximation (SSA) model is implemented with an *ad-hoc* boundary condition that accounts for the effect of water-filled crevasses on the ice flow and is applied to the calving front of Bowdoin glacier, North-West Greenland. Using the SSA instead of the more computationally expensive 3D Full Stokes (FS) model is justified since the contribution of the ice deformation to the total motion is small compared to the basal motion for the calving front of Bowdoin glacier. The SSA model is validated against the FS velocity field computed with Elmer/Ice and ice flow fields inferred by Unmanned Aerial Vehicle photogrammetry and feature-tracking techniques (Jouvet et al., 2017).
D. I. Benn et al. Calving processes and the dynamics of calving glaciers. Earth-Science Reviews, 82:143-179, 2007.
G. Jouvet et al. Initiation of a major calving event on the Bowdoin glacier captured by UAV photogrammetry. The Cryosphere, 11(2):911, 2017.
D. Medrzycka et al. Calving behavior at Rink Isbræ, West Greenland, from time-lapse photos. Arctic, Antarctic, and Alpine Research, 48(2):263-277, 2016.

Thu_285_CR-6_652
Seasonally Predicting European Glacier Mass Balance using the Arctic Oscillation

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Estimates of the magnitude of glacier melt during the coming summer season are highly beneficial for water resource management but predicting meteorological conditions with a lead time of several months is challenging. Here, we explore the potential of large-scale atmospheric indices to explain and predict observed variations in long-term mass balance of Swiss glaciers. We rely on a comprehensive 70-year data set of seasonal mass balance observations from up to a dozen Swiss glaciers. Monthly indices of the major atmospheric/ocean modes (NAO, AO, AMO, ENSO) are available for the entire study period. By correlating aggregates of the indices over various combinations of months against observed winter, summer and annual glacier mass balance anomalies, we investigate the skill of the large-scale indices to explain mass balance variability. No significant correlations with Alpine winter mass balances were found. Also, indices averaged over the summer season or annual periods did not correlate with annual or summer balances. However, we found a significant correlation between the January-to-May Arctic Oscillation Index (air pressure differences in the North Atlantic) and glacier melt during the subsequent summer season. Fitting a regression model based on the AO index over 1948-2008 enables to correctly predict the sign of summer balance anomalies of the last decade in 90% of the cases and with a lead time of four months.

Thu_287_CR-6_1161
Response of Glaciers on James Ross Island to Regional Climate Variability

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Air temperature records from the Antarctic Peninsula (AP) region show prominent warming trend over the second half of the 20th century and a significant temperature decrease over last 10 years. Magnitude of interannual to decadal-scale climate variability, however, differs significantly between western and eastern side of the AP, reflecting the extreme internal variability of regional atmospheric circulation. In order to describe a response of glaciers to climate variability, we analyse surface mass-balance, equilibrium line altitude and air temperature data from Whisky Glacier and Davies Dome in the northern part of James Ross Island on the eastern side of the AP. The surface mass-balance changes were estimated using the glaciological method based on ablation stake measurements over the seven years period (2009/10-2016/17). Our results indicate a change from surface mass loss that prevailed on James Ross Island during the late 20st century to predominantly positive surface mass balance after 2009/10. We attribute the deceleration of the mass loss and the spatial pattern of surface mass-balance distribution to the snow redistribution by wind on both glaciers rather than to temperature changes.

Thu_288_CR-6_1185
Quantifying Greenland Water Budget from Top to Bottom using Radar Sounding

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On the Greenland ice sheet, drainage of surface meltwater produces complex velocity changes that vary temporarily and spatially. These differential responses likely relate to what happens to the water once it enters the ice and its interaction with both the englacial and subglacial drainage systems. However, most hydrologic studies using radar sounding focus on what happens at the bed, neglecting the role of the englacial system. Also, most radar observations only provide information at a single snapshot in time. The absence of continuous observations, along with separate treatment of different hydrologic components, makes comprehensive assessments of melt influence on velocity difficult. Here we demonstrate the application of a high-resolution ground-based radar system in Store Glacier in western Greenland to continuously measure hydrologic changes through the ice column to the bed. We capture the development of englacial water storage from spring to winter. We show how these seasonal changes in englacial storage coincide with basal drainage. We also present new techniques to quantify and constrain the amount of basal water storage from airborne radar sounder by merging reflectivity and specularity content of the bed echoes in their subglacial hydrologic context. By comparing bed echo properties with surface runoff models, we place observational constraints on the portion of surface water that is drained to the bed versus stored englacially along west coast of Greenland.

Thu_289_CR-6_1262
Assessing Patterns and Drivers of Surface Elevation Change on Devon Ice Cap

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Strongly negative mass balances have been observed for glaciers and ice caps in the Canadian Arctic over the past three decades, with a notable increase since 2005. Major uncertainties in current climate assessment reports include how glacier dynamics will change under these conditions, and the representativeness of in-situ surface mass balance point data extrapolated over broad spatial scales. In this study, we co-register a suite of digital elevation data of various resolutions (i.e. ArcticDEM, TanDEM-X, CryoSat-2, IceSAT and NASA airborne laser altimetry) available for Devon ice cap. From these datasets, we calculate volume change and estimate the geodetic mass balance of Devon ice cap for distinct time periods over the past 20+ years. Our focus is primarily over the northwest basin of the ice cap where in-situ surface mass balance has been measured since 1961. An integrated analysis of available ice surface velocities and derived surface elevation change is used to isolate thickness change solely due to surface mass balance (accumulation and melt), providing an independent validation to the long-term glaciological mass balance dataset. Results from this study will increase our knowledge of the reliability of this historical mass balance dataset, and associated estimates of the contribution of Devon ice cap to non-steric sea level rise since the 1960s.

Thu_290_CR-6_1276
Concurrence of Quaternary Glaciations of the Third Pole with S and N Poles

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Choosing the Puruogangri ice field in central Tibet where tectonic is stable, surface erosion is low and Quaternary glacial relicts are well preserved, and using calibrated ^{10}Be surface exposure dating techniques, we compare the dates of Quaternary glaciations of the Puruogangri with those of cold records from the ice core and Quaternary glaciations in the Arctic and Antarctic and find that the major events were coeval in three regions, suggesting that they are controlled by the same mechanisms in a same climatic system.

Thu_291_CR-6_1283
Reconstructing the Evolution of Glacier Surface using Mass Balance Data

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The availability of sufficiently accurate surface topography of glaciers is essential for a variety of glaciological studies, including glacier dynamics modelling and mass balance studies. In particular, for glacier dynamics modelling the surface topography data is necessary for inferring the bed topography from ice-thickness data collected using ground-penetrating radar. For surface mass balance estimates (SMB) using the glaciological method, surface topography is required for integrating to the entire glacier the observations performed at individual points (mass-balance stakes, snow-probing points, snow pits). However, quite often the dates of these observations do not coincide with that of the surface topography, which implies errors in the derived estimates. We present a method to estimate the elevation at any point on the glacier surface and at any date between those of two existing surface topographies, using the seasonal SMB data during the time period between the two available topographies. From the spatial interpolation of the surface elevation data at the initial and final dates, the proposed method reconstructs the surface elevation at any date within that period, in two steps: first, it estimates the elevation change due to the SMB, and second, it estimates the elevation change due to glacier dynamics.

Thu_293_CR-6_1466
Snow Accumulation Processes on a Retreating Antarctic Tidewater Glacier

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The glacier complex on King George Island in the South Shetland Islands has been exhibiting accelerated rates of retreat over the last decade. Several studies have investigated the response of the upper parts of the ice cap, but the outlet glaciers have received less attention. The Ecology Glacier is a polythermal outlet glacier of the Warzawa ice field, which is located in the southern quadrant of King George Island. Even though a positive surface mass balance has been recorded, this glacier has been retreating at a relatively high rate, and analysis of bathymetry data suggests that there is an overdeepening at the current front of the Ecology Glacier, which might lead to enhanced retreat rates. As the glacier is sensitive to changes in climate and oceanic conditions, it is necessary to understand mass balance sensitivities. This study aims to understand accumulation processes on the Ecology Glacier during a winter season using a multi-method approach. We combine accumulation stake, snow probing, snowpit, glaciochemical and meteorological datasets taken over the course of one year with results from related mass balance modelling to understand snow deposition patterns, accumulation processes and biogeochemical cycling.

Thu_294_CR-6_1510
Spatial and Temporal Changes of the Snow Cover in Greenland

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The Greenland ice sheet (GrIS) is known to have the potential to contribute to sea level rise in a warming climate. The snow cover on the ice sheet, which is the direct link between a potentially warmer atmosphere and the ice itself, is, however, poorly investigated and little is known about the microstructure and especially about the spatial and temporal variability of the snowcover, except from indirect evidence from remote sensing. The dataset gathered during two campaigns in spring 2015 and 2016 are analyzed in detail. It represents the first detailed spatially distributed observation of the GrIS snowpack since the 1950ies. The current dataset consists of high-resolution snow profiles located at stations of the Greenland Climate Network. We link snow physics with snow cover modeling through the evaluation of the snow cover models with high-resolution snow microstructure measurements. Further, the measured variables are essential for remote sensing applications (e.g. correlation length for microwave remote sensing, snow surface SSA) and therefore provide the unique opportunity to unambiguously investigate the microwave emission as well as the albedo of the snowpack on an ice sheet.

Thu_295_CR-6_1539
Tidewater Glacier Retreat Throughout the Canadian Arctic Archipelago since 1958

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Recent studies of post-2000 observational data have shown variability in the dynamic ice discharge of tidewater glaciers throughout the Canadian Arctic Archipelago (CAA). Expanding this to all tidewater glaciers in the region on a decadal time scale can help identify when glacier retreat began, and determine longer-term temporal trends in mass balance.
Our study shows that over 94% of 300 tidewater glaciers in the CAA (from southern Baffin Island to Ellesmere Island, excluding those on the northern coast) have retreated since the earliest observational records (1958-1960). Mean overall length change between the 1950s and 2015 is -9.3 ma^{-1} (± 1.38 SE) for the 211 glaciers in the Queen Elizabeth Islands, and -7.1 ma^{-1} (± 0.72 SE) for the 89 glaciers on Baffin and Bylot Islands. Length change rates have been calculated across 6 time intervals, and results indicate a similar trend throughout the CAA: glaciers show slow retreat in early years, followed by acceleration in retreat rates since the early 2000s. To understand the primary control behind regional changes, the results have been analysed alongside ocean temperature records and surface mass balance from the latest atmospheric climate model. Statistical analysis reveals that on a regional scale ocean temperatures have had little control on the frontal change rates. The clear correlation with ablation and runoff, however, shows the significant impact that atmospheric temperature has had on glacier fronts in this region.

Thu_296_CR-6_1647
Features of the Kolka Gllacier Recovery after the Karmadon Disaster

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There were events that attracted attention by the grand scale of the glacial catastrophe and itsconsequences in the North Ossetia (Caucasus Mountains) in 2002. The Kolka Glacier was completely thrown out of its bed. The recovery of a new glacier in the empty circus of the Kolka glacier began almost immediately. This report describes the next stage of the state of the new Kolka glacier - relative stabilization - and analyzes the features of the process of its recovery based on the field observations data, modern space images and the data of changes in summer air temperatures and winter precipitation on the glacier area at the beginning of the 21st century. In recent years, the rate of increase in the area of the glacier does not exceed 0.015 km^2 per year. By September 2016, its area reached 1.11 km^2, the volume - about 0.044 km^3. The conditions for the formation of a new glacier on the empty bottom of the circus differ significantly from the previous ones. In addition to increase in the summer air temperatures, the thermal balance in the circus has changed due to the increase of the open surface area of the bed and the lateral moraine. At the same time, the growth of the debris cover on the glacier restrains the melting process. Fumarolic activity in the crown area of the starboard side of the circus is preserved and this circumstance the restoration of the Kolka glacier.

Thu_297_CR-6_1674
Modeling the Artificially Triggered Flood of the Mauvoisin Ice Dammed Lake, 1818

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Almost exactly 200 years ago, on 16 June 1818, the ice-dammed Mauvoisin lake drained catastrophically causing 44 fatalities and considerable damage in the Rhone Valley, Switzerland. We take the opportunity of this anniversary to analyze this remarkable glacier lake drainage with numerical simulations.
The Mauvoisin lake formed due to the advance of the Gietro glacier, which is located in a hanging side-valley of the Val de Bagnes. This advance caused ice avalanches to built up a regenerated glacier behind which a lake started to form in spring 1818. The authorities of the Canton Valais, under the lead of the engineer and early glaciologist Ignaz Venetz, decided to artificially drain the lake with a tunnel dug through the ice dam. The early phase of this mitigation measure was successful: the lake started draining through the tunnel on 13 June 1818 and its level lowered by 10m until 16 June. However, a backward incision of the spillway led to the failure of the ice dam and subsequent catastrophic drainage of the remaining lake water. The flood wave propagated down the Val de Bagnes and then down the Rhone valley.
We first give an overview over the historical events. We then present a model of the hydraulics of the lake drainage based on the melt enlargement and the backward incision of the spillway. We compare model results for a lake drainage with and without artificial tunnel to assess the effectiveness of the mitigation measures.

Thu_298_CR-6_1795
Glacier Changes in Western Greenland Derived from New Satellite and DEM Data

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The region to the NW of Jacobshavn Isbrae (Disko Island to Svartenhuk Peninsula) in western Greenland is hosting >1000 glaciers and ice caps that receive comparably little attention. With the now available image as well as DEM data from the mid1980s (Landsat TM, Greenland Orthomap and AeroDEM) and ~2015 period (Landsat 8, Sentinel 2, TanDEM-X DEM and ArcticDEM), it is now possible to study past glacier fluctuations in detail. However, the region is well known for its surge-type glaciers of which the largest one had a massive surge in 1995/96 (advance >10 km). Their changes have to be excluded when interpreting length, area or volume changes in climatic terms as they easily dominate the overall change for the entire region.
In this study, we present a new glacier inventory derived from Landsat 8 and Sentinel 2 satellite scenes (2015-2017), as well as area and volume changes since the mid1980s using the above datasets. Glaciers were mapped with the band ratio method and subsequent manual correction (debris, water, shadow, seasonal snow, sea ice). Drainage divides and topographic data for all glaciers are derived from the TanDEM-X DEM. DEM artefacts required analysing elevation changes on selected glaciers only. We found generally retreating valley glacier tongues, a strong area decrease for ice caps at higher elevations, and volume loss (and/or gain) being strongest for glaciers that have surged. Their elevation changes (>150 m) can be well recognized despite DEM artefacts.

Thu_299_CR-6_2000
Behaviour, Pattern and Dynamics of Vestre Breggerbreen Glacier, Svalbard, Arctic

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Glaciers cover about 36600 sq km area of the Svalbard Archipelago. Amongst the various types of glaciers present in the region, the most dominant ones are the continuous ice masses/sheets which are divided into smaller ice-streams by ridges, nunataks etc. Vestre Broggerbreen (VB) (~4.69 sq km) glacier has been studied over the period 2009 to 2016. Traditional methods of monitoring/mass balance estimation applied to studying the glacial dynamics and nature of ice body. Over the last seven years, VB-I shows negative mass balance with a striking similarity in pattern to that of Austre Broggerbreen. The moraines depicts that a probable recession of 1.2 km of VB snout has taken place over a century. Recent data also show regular retreat of the order of 12 m/yr, giving credence to the fact that low altitude glaciers are shrinking faster. The data show the variable surface velocity vector with the highest of 5m/yr at the central part of the glacier. The ice thickness estimated over large areas on VB-I glacier shows a maximum ice thickness of 105m. Basal stress pattern shows differential stress distribution developed within the glacier. Snow pit data shows numerous refreeze layers which could be correlated with the local temperature variations. The glacial melt water analysis shows possibility of the presence of elements like Th, U, which can be aid to thermal heating of the sub-surface of glaciers thereby adding to the list of causes for their diminishing in this area.

Thu_300_CR-6_2059
A 3D-assessment of Basal Freeze-on for a Greenland Ice-sheet Ablation Region

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Recent ground penetrating radar observations have revealed plume-like englacial structures, rising from the ice-sheet base reaching up to half of the ice sheet thickness. Such structures are found in the interior as well as at the margin of the Antarctic and Greenland ice sheet and coincide with a rise in basal topography along ice flow. We undertake a detailed spatial analysis of basal water flow paths and the 3D-radar-structure of a plume-like feature in the ablation area of Eqip Sermia in West Greenland and suggest that this structure originates from basal freeze-on of ascending water flowing along the hydraulic gradient at the ice-sheet base. As the water at the base is abundant in the ablation region, the amount of water available for freeze-on may be quite substantial. By means of numerical modelling we investigate the effect of basal-freeze-on and the resulting 3D-structure. Further, this allows us to make some estimates about the total mass added due to basal freeze-on and to put it in the context of the catchment mass balance. Such refreezing of melt water at the base is currently not accounted for in traditional mass-balance assessments.

Thu_301_CR-6_2067
Marginal Lake Drainage and Implications at a Tidewater Glacier in Greenland

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In summer 2014 a lake at the margin of the Greenland ice sheet drained irreversibly into the relatively shallow fjord of tidewater outlet glacier Eqip Sermia. Using time series of high resolution digital elevation models from the ArcticDEM project and UAV surveys, we investigate the evolution of the lake level, the geometric adjustment of the bounding calving front and the thinning trend of the main outlet glacier trunk between 2011 and 2014. We combine these data with time series of meteorological data, ground surface temperatures, satellite imagery, time-lapse photographs and fjord surface temperatures in order to reconstruct the timing and discharge rates of the drainage event and investigate potential triggering mechanisms.
We find that the lake level dropped by 70m and drained subglacially a volume of 70 Mio m^3 within 1 to 3 days. The lake drainage is unprecedented in the satellite era and seems to be preconditioned by the recent rapid thinning of the outlet glacier Eqip Sermia and triggered by a strong precipitation event. The large pulse of freshwater and entrained sediment had a profound impact on the circulation and water properties of the fjord and likely enhanced oceanic melt at the calving front. Further, the drainage event provides an excellent natural experiment for studying the geometric adjustment of the calving front that bounds the lake to sudden changes in lake level.

Thu_302_CR-6_2115
East-Antarctic Ice Stream Dynamics Inferred from Monitoring Icequake Activity

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In Antarctica, investigations of the interactions of fast moving ice streams with the underlying bedrock and coastal ice shelves provide crucial information about the ice sheet dynamics. Monitoring cryo-seismic activity sheds new perspectives on cryosphere studies. Since 2010 a permanent seismic station is installed at the Princess Elisabeth base, in the eastern Dronning Maud Land, East-Antarctica. During the 2014 campaign, 5 other temporary stations were deployed in the nearby Sør Rondane Mountains. Most of the recorded seismicity is of small magnitude (ML< 1.5) and restricted to the few small outlet glaciers cutting through the mountain chain. It is associated with largest ice flow speed and significant ice surface topography suggesting a source origin related to surface crevassing. Two other spots of seismicity are found 80 km westwards along a 30 km wide and flat ice stream. They are distributed upstream and downstream of a 1000 m high bedrock topography associated with a 75% ice flow speed decrease over an along-flow 25 km distance. While the seismicity upstream of this bedrock topography may be caused by the ice flow resistance on hard bedrock, the one downstream may be linked to the rapid increase of ice load over a sediment-covered bed. Investigations of time occurrence of seismic events confirm two distinct patterns and highlight seasonal variations of the ice stream dynamics.

Thu_303_CR-6_2306
Regional Modeling of the Antarctic Surface Mass Balance from Multiple Reanalyses

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Given the scarcity of ground-based observations of the Antarctic surface mass balance (SMB) and the lack of remote sensing products covering the entire continent, outputs from regional climate models (RCM) have been extensively employed for mass balance studies of the Antarctic ice-sheet.
The most reliable and used products are currently from the RCM RACMO2 at 27km resolution forced by ERA-Interim. Here we set up the polar-oriented regional climate model MAR for the Antarctic region at 35 km resolution and used 6 reanalyses as lateral boundary conditions (ERA-Interim, MERRA2, JRA-55, NCEP1, NCEP2 and 20CRv2) for 1979-2015.
Spatial differences in SMB between reanalyses and RCMs are primarily driven by differences in precipitation. Whereas SMB patterns are significantly divergent between reanalyses, this is no longer the case after the downscaling step with RCMs, which all show similarly good performances against ground-based SMB observations. Regional climate modeling is consequently a valuable step to obtain realistic Antarctic SMB patterns. A major uncertainty remain in katabatic channels at the ice-sheet margins, where MAR is significantly dryer than RACMO2 but where there is hardly no observation.
Finally, we show that the interannual and seasonal variability of RCM-downscaled SMB is mostly driven by the forcing reanalyses, with agreeing results between ERA-Interim, MERRA2 and JRA-55, whereas NCEP1, NCEP2 and 20CRv2 show dissimilar (spurious) temporal variabilities.

Thu_304_CR-6_2425
Echo-free Zone and Internal Radar Reflections around Dome Fuji, Antarctica

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We present data from an array of airborne radar lines collected in the 2016/2017 Antarctic season in the region around Dome Fuji, Antarctica.
The radar campaign is part of the Beyond EPICA - Oldest Ice (BE-OI), and aims to determine a suitable drilling location to reach undisturbed ice older than 1.5 Ma to extend the record of climate proxies derived from ice cores.
The nearly 20,000 km of radar lines cover an area of about 170,000 km^2, with a spacing of 10 km for most lines and 15 km for the five southernmost lines. The data were measured with the AWI Electromagnetic Reflection (EMR) system on board the DC-3 aircraft Polar 6, with a 600 ns pulse at a frequency of 150 MHz. The processed and filtered radargrams were used to handpick prominent internal reflectors, and the upper boundary of the echo-free zone, a depth in which most internal radar reflections are lost, leaving a transparent layer between this depth and the bedrock.
The setup of the radar system results in a vertical resolution of about 50m, with excellent returns from the bedrock, and also good results for internal reflections. Several consistent reflectors could be picked throughout most of the lines, allowing for tying in the results to the ice core at Dome F.
Preliminary results show a varying thickness of the echo-free zone over the survey area, with an approximate thickness of 400 m in regions with thicker ice, and approximately half of this over the more rugged terrain with thinner ice.

Thu_305_CR-6_2467
A 30-year Mass Balance Data Set from the Hofsjökull Ice Cap, Central Iceland

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Temperate ice caps cover 10% of Iceland. They are located mainly in high-precipitation regions in the central highlands or near the southern coast and their total volume corresponds to a sea-level equivalent of 9 mm. A mass-balance program has been operated annually on Hofsjökull in the period 1989-2018. Standard measurements of winter and summer mass-balance have been conducted on three ice-flow basins comprising 40% of the ice cap, which currently has a total area of 825 km^2 and an estimated volume of 186 km^3. The annual mass balance has been negative in all but five of the thirty years of measurements and mass loss occurred every year in the 20-year period 1995-2014. In total, Hofsjökull has lost more than 10% of its total volume since 1989. In recent years, digital elevation models of the ice cap have allowed more precise estimates of volume changes of the ice cap during 2-13 year time windows in the period 1986-2015. Comparison with the mass balance data set indicates that the traditional winter snow thickness and summer ablation measurements at ground locations overestimate the annual mass balance by 0.4 m w.eq. on average. We describe main results from the mass balance program, including data from snow-radar studies which have increased our knowledge of the precipitation distribution over Hofsjökull and helped explain the origin of the bias in ground-based measurements.

Thu_306_CR-6_2542
Mass Balance Modelling of Austre Grønfjordbreen Glacier, Svalbard

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Recent efforts by the Institute of Geography RAS have been aimed at establishing mass balance observation at Austre Grønfjordbreen (7,6 km2) located 16 km south of Barentsburg. The Arctic archipelago Svalbard consists of a vast glacierized area which contributes significantly to the sea level rise outside of Greenland and Antarctica due to recent warming. The glaciers of Svalbard have already experienced an unprecedented increase in average summer temperatures, melt periods, and rainfall in late autumn and early summer. Noteworthy a full absence of Austre Grønfjordbreen accumulation zone was pointed out in recent years. Current goal is to determine the most suitable approach for mass balance simulations and its application for long time periods assessments.
The physical and mathematical modelling of the internal and external mass transfer of Austre Grønfjordbreen glacier were carried out using the field work data and remote observations. The dependence of the mass balance from the certain climatic factors is revealed. We apply spatially distributed model A-MELT (Rets et al., 2012) using all available glaciological and meteorological measurements carried out since 2012 and energy balance determination according to spatial grid. The snow line level has been reconstructed using all available satellite images from 1986 to 2016.
The obtained mass balance gradients are compared with the results of temperature-index simulations and traditional glaciological methods.

Thu_307_CR-6_2590
Reconstructing the Deglaciation of Ice-free Areas in the Antarctic Peninsula

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The chronology of the deglaciation of the ice-free environments in the Maritime Antarctica has significant geomorphological and ecological implications. In the Antarctic Peninsula, most research has focused on lake sediment records to reconstruct the onset of deglaciation. This is the case for Byers (Livingston Island) and Barton peninsulas (King George Island). The dating of basal sediments collected from different lakes from these peninsulas enables inferences of the age of formation of each lake. The integration of multiple ages based on radiocarbon dating and thermoluminescence permits the reconstruction of regional spatial and temporal deglaciation patterns. In both peninsulas the deglaciation started at 8 ka cal BP, with the central parts progressively deglaciated at 5-6 ka cal BP. Finally, during the Late Holocene, glacier fronts remained confined to their current positions defined by the present frontal moraines, with minor advances and retreats. We are also conducting research in different ice-free areas using a multiple-dating approach combining absolute (cosmogenic, lichenometry) and relative dating techniques to reconstruct the spatio-temporal patterns of glacial oscillations since the Last Glacial Maximum. We will discuss the potential of these techniques as well as of key areas (nunataks) that will allow comparisons between present and past glacial thinning rates in order to evaluate the significance of recent patterns within the paleoenvironmental record.

Thu_308_CR-6_2640
Modelling the Drifting Snow Climate of the Antarctic Ice-sheet

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Drifting snow is an important component of the Antarctic near-surface climate, particularly pronounced in windy coastal regions of the ice sheet. However, drifting snow measurements suffer from a high scarcity both in space and time, making it difficult to evaluate model results. This study evaluates the ability of the regional atmospheric model MAR to reproduce the drifting snow climate of Antarctica. MAR has been run at a fine spatial (15 km horizontal and 1 m vertical) resolution over the entire continent and forced by ERA-Interim (1979-2016) at its lateral and ocean boundaries. Model results are evaluated against a compilation of recent drifting snow data including visual observations, sensor-based measurements and continent-wide remote sensing products. Seasonal cycle, intra- and inter-annual variability of drifting snow frequency and, when available, horizontal snow mass transport are discussed.

Thu_309_CR-6_2687
Importance of Snow Cover for Changes in Glacier Geometry, Hansbreen, Svalbard

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Snow is the material forming glaciers and ice caps, hence its supply, spatial distribution, metamorphism and decay are factors influencing geometry changes of ice masses all over the world. Regular studies on interseasonal snow depth variability have been carried out using radar sounding on Hansbreen since 2011. The results show strongly irregular snow distribution, with the thickest snow cover in the western section of the glacier. The conditions of snow deposition on remaining parts of the glacier are less favourable, but, at the same time, interseasonal variability of the snow depth is smaller there.
Asymmetric pattern of snow cover distribution on Hansbreen is not reflected in observed in the years 2011-2014 changes of surface geometry. Despite the fact that the western section of Hansbreen gets maximum snow accumulation, the actual reduction of the elevation in this area is the greatest. This demonstrates that the winter mass balance is not a decisive factor determining changes in glacier surface geometry. Hence, the change in geometry is largely controlled by spatially variable summer ablation and glacier dynamics. Asymmetric snow distribution only modifies the influence of the above factors on the glacier shape.

Thu_310_CR-6_85
Dynamics of the Antarctic and Greenland Ice Sheets - Evolution of the Geosphere

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Based on measurements obtained from the deep ice wells, radar and space-based geodetic observations in Antarctica and Greenland, a number of phenomena of mass transfer in ice were registered which did not fit into the traditional, albeit hypothetical, ideas of monotonous uniform change in the dynamics of ice sheets. The availability of new experimental data calls for a review of the existing models of ice sheet dynamics, taking into account the following features:
1) The ice flow is characterized by sub-horizontal pullback according to the structure, properties and velocity of ice movement;
2) radar cross sections reflect “isochronous” as well as “isorheological” surfaces;
3) the upper layer of firn “runs down” the lower stratum;
4) the lower masses of ice in the ice sheets move faster, which leads to, among other things, formation of discharge structures;
5) the bottom third cross section contains structures of the infolded turbulent ice flow;
6) the general spreading of ice sheet represents an array of local glacial streams.

Thu_311_CR-6_1090
Understanding the Spatial Pattern of the Glacier Changes in the Tibetan Plateau

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In recent years, the Karakoram Anomaly has attracted much attention. In order to better understand the causes of this phenomenon, the spatial pattern of the variations of the glaciers in the whole Tibetan Plateau should be explored on a longer time scale. During the Little Ice Age (LIA), the glaciers over the Tibetan Plateau advanced and formed easily recognizable end and lateral moraines, which could be used to identify the extents of glaciers. We recognized the distributions of the LIA's moraines of about 2000 glaciers over the Tibetan Plateau. It was found that the glacier areas have reduced by larger than 25% in the southeast Tibetan Plateau and the northeast margin of the Tibetan Plateau while less than 10% in the northwest Tibetan Plateau (including the Karakoram) since the LIA. A similar spatial pattern of the shrinkages of the glaciers was also revealed over the past decades. It's noted that the summer freezing level is much higher than the glacier median elevation in the southeast Tibetan Plateau while much lower in the northwest Tibetan Plateau, and the summer freezing level showed a decreasing trend in the northwest Tibetan Plateau (including the Karakoram) while increasing in the southeast Tibetan Plateau over the past decades. These imply that the summer freezing level play an important role in the spatial variations of the glaciers over the Tibetan Plateau.

Thu_312_EN-3_566
High Resolution SfM Models of Foot Traffic Impacts in the McMurdo Dry Valleys

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One important but underestimated anthropogenic impact observed in polar deserts such as the McMurdo Dry Valleys is that of human movement. The unique glacial and lacustrine sediments found within the valley floors are typically associated with well-developed lag gravels and desert pavements. As footprints and walking tracks disrupt and break though these protective surfaces, the underlying fine-grained material is exposed and becomes susceptible to erosion and transport by wind. Therefore, the method in which field parties' travel across these surfaces is directly related to the long-term impact that may be observed.
To quantify such disturbances, we apply structure from motion photogrammetry (SfM) to map surficial impacts. A computation technique that analyses groups of overlapping input images, SfM creates a 3D point cloud of elevation values, similar to those produced from scanning laser systems. Combined with accurately measured ground control points, SfM-MVS allows high resolution, low error 3D models to be created at a 1:1 scale at a low cost.
Our initial results show that extremely high resolution digital terrain models (DTMs) of human impacts can be produced, from SfM-MVS derived clouds of up to 120 million points per square metre, using simple methodologies and equipment. The production of such DTMs at the sub-millimetre vertical scale can provide a wealth of information about the distribution of surface clasts and post disturbance morphology.

Thu_313_EN-3_1144
The Polar Rock Repository: Preservation of Geological Samples from Antarctica

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Geological field expeditions in polar regions are logistically difficult, financially expensive and can have a significant environmental impact on pristine regions. The scarcity of outcrop in Antarctica (98% ice-covered) makes previously collected rock samples very valuable to the science community. Samples from areas of unique geological heritage and sites of special scientific interest are available for research from the Polar Rock Repository (PRR), helping to lessen the impact of proposing additional field work in these distinctive and potentially fragile areas. The PRR was created by the US National Science Foundation, who recognized the need for preserving rock, dredge, and terrestrial core samples from polar areas. The PRR curates geological samples collected primarily from Antarctica and the southern oceans, providing full and open access to both samples and metadata via the PRR website. More than 44,000 samples are available from the PRR for scientific analysis to researchers around the globe. In addition to the samples and their basic metadata, the PRR archives supporting materials from the collector, images of the samples, field maps, air photos, thin sections and any associated bibliography/DOI's. An advanced search engine for the PRR website allows scientists to “drill down” into search results using categories and look-up object fields similar to websites like Amazon.

Thu_314_GG-1_2170
Cambrian Palaeontology in North Greenland and the Early Animal Evolution

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Peary Land of North Greenland is a land of the highest latitude in the northern hemisphere, but has received limited attention due to its extreme remoteness. Nevertheless, this area holds a celebrated Cambrian fossil locality, Sirius Passet (82° 47.603′ N, 42° 13.394′ W), which is a conservation Lagersttäte, producing soft-bodied marine animal fossils of ca. 520 Ma. Since the first discovery of Sirius Passet in 1984, there have been only seven times of palaeontological expeditions to the area. In 2016 and 2017 seasons, expeditions led by Korea Polar Research Institute collected ca. 1.5 tons of fossil slabs from the outcrop and the scree of the Lower Cambrian Buen Formation. The fossils include various metazoans, such as sponges, arthropods, stem-group arthropods, primitive mollusks, annelids, cycloneuralians including priapulids and loriciferans, primitive deuterostomes, and possible chordates, which would help reveal the aspect of the 'Cambrian explosion' of the animals. This area is part of the Northeast Greenland National Park which is the world's largest protected land area with almost no permanent human settment. North Greenland needs to be more understood in terms not only of geology, but also of ecology and other research fields. Korea Polar Research Institute is planning to visit the area for the next two years, which would bring more information on the paleontology, geology, and ecology of this remote part of the world.

Thu_315_EN-4_43
Geospatial Analysis of Protected Areas in Arctic Regions of Russia

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Geospatial analysis of the Russian Arctic protected areas (PA) has been carried out by specially developed information analysis system (IAS). Information support of PA system in the arctic region of Russia was fulfilled by the IAS. Performance of the IAS can be carried out under management of several operating systems. The IAS was characterized by the four structural organization levels connected with work flows and information exchange in the system. Geoinformation system (GIS) was applied as a background and intelligence core of the IAS. Spatial data base (DB) of the PA system was designed in terms of three freeware DB:
(i) WDPA World Database on Protected Areas of UNEP-WCMC,
(ii) CAFF DB of Conservation Arctic Flora and Fauna organization,
(iii) DB of organizations: Russian Social and Ecological Union, World Wildlife Fund, World Resources Institute, and the Transparent world. It was fulfilled through retrieving, processing, analysis and modeling on the spatial and attributive data of the PA. Protected areas were divided into the six arctic physical geography provinces. The PA system was described by means of the data analysis classical methods such as descriptive statistic parameters and several models of cluster-analysis with bootstrap replication approach. Artificial neural networks (ANN) were also used for the analysis, classification and modelling of the PA system.

Thu_317_EN-4_188
The Footprint on Antarctica

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Antarctica is the least developed and populated continent on Earth. But does the degree of human activity and impacts present challenge the imagination and preconceptions of a continent of wilderness? Continually increasing accessibility has seen research stations, historic sites, runways, field huts, weather stations, tourism landing areas, maintained traverse routes, and even lighthouses spread across the continent. Occupying these are a peak population of nearly 5 000 national program personnel and in excess of 35 000 tourists landing per year resulting in substantial human activity. The history of activity at these sites vary, with some exceeding 115 years. This human presence has resulted in localised modification to the environment with impacts to biological, scientific, aesthetic and wilderness values. This paper presents the first continent-wide measurement of these impacts, in the form of spatial datasets of the disturbance and building footprint. These pioneering data will help to present the actual scale of human impacts on protected Antarctic values, and will have implications and wide-reaching application for management of conservation and protected areas, policy, future development, and operations.

Thu_318_EN-4_592
An Analysis of Environmental Incidents for a National Antarctic Program

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Research stations in Antarctica are concentrated on scarce ice-free habitats. Operating these stations in the harsh Antarctic climate provides many challenges, including the need to handle bulk fuel and cargo increasing the risk of environmental incidents. We examined 195 reports of environmental incidents from the Australian Antarctic Program, spanning six years, to investigate the impacts and pathways of contemporary environmental incidents. Fuel and chemical spills were most common, followed by biosecurity incursions. The majority of reports were assessed as having insignificant actual impacts. Either the incidents were small or rapid response and mitigation procedures minimised impact. During the period only one spill report (4000 l) was assessed as a 'high' impact. This is despite over 13 million litres of diesel utilised. The majority of incidents occurred within the existing station footprints. The pathways leading to the incidents varied, with technical causes predominately leading to spills, and procedural failures leading to biosecurity incursions. The large number of reports with inconsequential impacts suggest an effective environmental management system with a good culture of reporting environmental incidents. Our findings suggest that the key to continual improvement in an ongoing environmental management system is to learn from incidences and take action to prevent them occurring again, with an end-goal of minimising the residual risk as much as possible.

Thu_319_EN-4_788
Leadership in Conserving the Global Commons: Protecting the Ross Sea, Antarctica

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In October of 2016, nations made history by coming together to adopt the world's largest marine protected area (MPA) in the Ross Sea, Antarctica. This feat required the consensus of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), comprised of 24 countries plus the European Union, and took five years of intense international negotiations, and more than 10 years of scientific planning. But what actually led to consensus in 2016? I will present on a five-year case study of the Ross Sea MPA process to reveal what conditions led to success in the ultimate adoption of the MPA. Some key factors included high-level diplomacy between Russia and the United States, a decade of scientific effort that involved hundreds of scientists from all over the world, and a wave of targeted international media and the resulting pressure from millions of global citizens. This talk will also reflect on CCAMLR's ability to find the political will to protect 1.55 million km^2 of the Ross Sea region, demonstrating international leadership and inspiring hope that despite political tensions in other parts of the world, the Antarctic continues to be a global commons dedicated to peace, science and conservation.

Thu_320_EN-4_1208
Development of a CCAMLR Marine Protected Area in the Antarctic Weddell Sea

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The Antarctic Ocean may contribute considerably to the global network of Marine Protected Areas (MPA), as proposed by the World Summit on Sustainable Development in 2002. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is responsible for establishing Antarctic MPAs. Within the CCAMLR framework, Germany leads the initiative to establish a MPA in the Weddell Sea region and our group develops the scientific foundation for this task.
Here, we describe the development of the Weddell Sea MPA proposal within the political context, albeit with emphasis on its scientific foundation. Our intention is twofold, (i) to explain the science involved and its specifics in the Antarctic region, and (ii) to visualize how our scientific work is embedded in the political framework constituted by the diverse interests present within CCAMLR. We will highlight those issues and steps in particular that represent the most sensitive obstacles on the road towards a CCAMLR Weddell Sea MPA.

Thu_321_EN-4_1328
Proposal for a MPA in the West Antarctic Peninsula and the Southern Scotia Arc

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Since 2011, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has been working on a development of a representative network of Marine Protected Areas (MPA) around the southern oceans, with the main objective of the protection of biodiversity. In order to achieve this, during CCAMLR´s annual meeting 2017, Argentina and Chile introduced a preliminary proposal for a MPA in the West Antarctic Peninsula and the southern Scotia Arc (D1MPA). The D1MPA proposal is the outcome of an inclusive, multinational process that started in 2012, based on 143 spatial data layers and associated conservation objectives and conservation targets. Priority Areas for Conservation have been identified taking into account potential threats posed by climate change and krill fishery. Preliminary boundaries for the D1MPA were introduced, in order to assist with the planning process and future management of the area. The aims of this presentation are to introduce the D1MPA to a wider scientific community, and to look for synergies amongst different actors/stakeholders involved in the Antarctic Treaty System.

Thu_322_EN-4_1421
RAS: Understanding the Taxonomic Diversity in Antarctica and the Southern Ocean

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The register of Antarctic Species (RAS) is an essential taxonomic compilation system, which serves the scientific community by providing all authorised taxonomic information for Antarctic and the Southern Ocean biota. RAS builds upon the Register of Antarctic Marine Species (RAMS) and forms an integral Antarctic component of World Register of Marine Species (WoRMS).
Here we highlight our recent achievements in harmonising and updating the taxonomy in RAS by cross-referencing information from databases of species. Information from the Oceanic Biogeographic Information System (OBIS), Global Biodiversity Information Facility (GBIF) and ANTarctic Algae DATAbase (ANTADATA) are currently being examined by the taxonomic editors of WoRMS, Interim Register of Marine and Nonmarine Genera (IRMNG) and RAS for this purpose.
RAS is the most complete and thorough authorised compilation of the taxonomic diversity of Antarctica and the Southern Ocean. With a cleaned-up authorised backbone, it aims to serve the scientific community by, for instance, providing knowledge on the taxonomic accumulation at a spatiotemporal scale, identifying taxonomic groups that are under-represented, and offering an open source analytical tool for scientists with similar interests in this and other regions.

Thu_323_EN-4_1477
Antarctic Marine Spatial Protection in Black and White

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Spatial protection is one of the tools used to protect polar marine environments. In the Southern Ocean, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and related technical bodies use several forms of area-based instruments to meet the objectives of the 1980 CAMLR Convention. These include Small Scale Research Units (SSRUs), Vulnerable Marine Ecosystem (VME) areas, and Marine Protected Areas (MPAs), the latter having been considered by CCAMLR since 2009. Two CCAMLR MPAs have been adopted, and three more have been proposed. Some of these instruments provide temporary closures, and some include zoning approaches that regulate activities like research and fishing. Overall, marine spatial protection schemes apply across a range of spatial and temporal scales, target species, and activities. Aside from inherent scientific complexities, the adoption and implementation of further protection measures (such as MPAs) has proven to be increasingly difficult due to political and economic considerations. In this presentation, we attempt to present this complex arrangement in black and white. We address basic questions concerning the application of these tools in the Southern Ocean. What activities are covered by these instruments, and when? What are the gaps in marine spatial protection? We provide an overview of the current status of Southern Ocean area protections, and make recommendations for improvements.

Thu_324_EN-4_1500
TARDSS: A Decision Support System for Antarctic Environmental Management

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Providing the Antarctic policy community the tools and knowledge to support environmental management is critical for both the health of the Antarctic environment but also the Antarctic Treaty itself. This paper will introduce a tool that has been designed to provide context to, and assist, the Antarctic Policy community in the planning, permitting, and implementation of Antarctic activities. The tool, which has been developed with input from the Antarctic Policy community, leverages new and existing insights into the environmental pressures facing the Antarctic continent through a range of climate, biological, human activity, geological and soil perspectives.
The resulting tool is based on the established principle of a 'spatial decision support system', an interactive approach that provides knowledge to support management using analysis of spatially explicit data. We expect that this tool would be utilised to enable the conservation of the Antarctic continent through activities such as: Investigating a NNS incursion and the likelihood of continued incursions in areas based on current and future climate as well as current and predicted future human activity; The comparison of multiple sites for future activities or to provide a set of baseline environmental data to support area protection; and supporting a CEP Member to undertake Environmental Impact Assessment of activities in context with regional scale environmental patterns.

Thu_325_EN-4_1566
Marine Conservation Incentives: Interdisciplinary Dimensions of Climate Change

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Arctic marine resources overlap is increasing (in space and time) as climate change narrows the availability of appropriate habitat ranges for existing species to survive, and new species enter and compete. This challenges the management of both commercial and ecosystem-valued species. Two invasive crab species (snow crab and red king crab) offer a platform to explore adaptive conservation challenges for Arctic countries facing dynamic and spatial changes in new (crab) and existing (benthic and commercial) resource productivity. Shifting supply (US, CAN, NOR, RUS) and increasing demand (esp. Asia) add economic uncertainty to the ecological changes. Ongoing sovereign and international policy interests matter, as they evolve in ongoing legal cases. The crabs differ in their uncertainty, biology, economic, climatic and political factors. We exploit these differences using quantitative and qualitative data in a bioeconomic framework that spans time and space dimensions. The crab invasions in the Barents Sea region serve as a building block for broader pan Arctic conservation issues in the Year of Polar Prediction and beyond. Optimal decision-making regarding commercial species such as crab in ecosystems must incorporate how strategic institutional shifts, occurring in response to the economic incentives, asymmetrically affect local and global stakeholders in addition to standard concerns over ecological and economic damages amidst climate change.

Thu_326_EN-4_1588
Ex-situ Conservation of Polar Cyanobacteria in the BCCM/ULC Collection

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The BCCM/ULC public collection is funded by the Belgian Science Policy Office (BELSPO) and aims to gather a representative portion of Polar cyanobacterial diversity from different ecological origins (limnetic microbial mats, soil crusts, cryoconites, endoliths, etc.) and ensure their ex-situ conservation in a context of global change. These strains are available for researchers to study the biodiversity, taxonomy, evolution, adaptations to harsh environmental conditions, and genomic make-up of Polar cyanobacteria. Currently, there are 120 cyanobacterial strains of Polar origin in the collection (catalogue: http://bccm.belspo.be/catalogues/ulc-catalogue-search). The strains are kept living and their cryopreservation is currently tested. The collection is ISO 9001 certified for depositing and distributing strains, as part of the multi-site certification of the Belgian Coordinated Collections of Microorganisms (BCCM) consortium.
Morphological and molecular identification (based on 16S rRNA sequences) indicate that the strains belong to the orders Chroococcales, Chroococcidiopsidales, Nostocales, Oscillatoriales, Pleurocapsales, and Synechococcales. This broad genotypic distribution makes the BCCM/ULC collection particularly interesting for phylogenomic studies. The genomes of several strains are currently being sequenced and the first genome of an Antarctic cyanobacterial strain, *Phormidesmis priestleyi* ULC007 was recently published.

Thu_327_EN-4_1814
Krill for All: What the Antarctic Krill Fishery Can Learn from Other Systems

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The notion that marine predators (seabirds and mammals) and fisheries compete for the same resources (i.e., small pelagic fish) has been of interest to the marine conservation community for decades. In the Southern Ocean, fishing grounds for Antarctic krill (*Euphausia superba*) overlap with foraging ranges of krill-dependent predators. Combined with the impacts of climate change, competition for resources in the Southern Ocean could compromise conditions for Southern Ocean species, particularly as the fishery grows. To address these challenges, the Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources has agreed to advance ecosystem-based management for the krill fishery in its 2017-2021 work plan. Here, we provide an overview of Antarctic krill fisheries management. Next, we review practices for detecting and managing for competition between marine predators and fisheries, focusing on two recent synthesis workshops. These workshops evaluated three approaches to understand fisheries impacts on seabirds and other predators:
1) models including food web models that parameterize biomass
2) Experimental manipulation of fisheries (e.g., time-area closures) in the vicinity of seabird colonies or marine mammal rookeries and
3) observational studies.
We share best practices including data requirements and method variations, and hope to initiate a dialogue where practitioners from Antarctica and other systems can share lessons learned.

Thu_328_EN-4_2009
Persistent Anthropogenic Pressure on Fildes Peninsula

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Fildes Peninsula, King George Island, South Shetland Islands, Antarctic, is characterized by a high biodiversity and hosts six permanent stations and an airport turning the region into a major logistic hub for the Antarctic Peninsula. It is the scene of a multitude of human activities including scientific research, station operations, transport logistics and tourism. Consequently, the human pressure on the local ecosystem affects natural and historical values. Numerous provisions and guidelines, in particular the Madrid Protocol, have been developed in order to reduce negative impacts of human activities on fauna and flora. Most of the legally binding and non-binding provisions have relevance on Fildes Peninsula due the unique concentration of different human activities.
Human activities and environmental impacts on Fildes Peninsula have been documented and quantified since 2003/04 and have repeatedly revealed substantial shortcomings in the implementation of some aspects of the Madrid Protocol by resident national Antarctic programmes. Various improvements are in opposition with current observations of persistent breaches of the legal requirements for environmental protection. Sadly, the lack of consensus of the local stakeholders hampers the immediate implementation of effective management measures along with an accompanying monitoring scheme, which is required to prevent a further degradation of the habitat and to safeguard scientific and environmental values in the area.

Thu_329_EN-4_2095
A Unified Approach to Distribution Modeling of Benthic Habitats at South Georgia

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The waters around South Georgia and the South Sandwich Islands are home to some of the highest levels of marine biodiversity in the Southern Ocean. In 2012 the regional government established a large IUCN category IV marine protected area for the conservation of this diversity. With the MPA currently in a period of review, a detailed assessment of the benthic biogeography of the region is paramount, if the importance of its benthic habitats are to be reflected in spatial planning policy for the region. There is however a mismatch between the size of this very large MPA and the biological data available to underpin its establishment and inform on its zonation.
Here we present the findings of a three-year project to map benthic habitats around South Georgia from coastal waters to deep-sea. Habitat mapping has increasingly been adopted as a means of addressing paucity in biological data, through use of environmental proxies and biological surrogates. We integrated biological, geophysical and oceanographic data to evaluate the application of landscape mapping and an ensemble approach to predictive distribution modelling, in assessing the benthic community structure of the region. This ambitious synthesis of multi-disciplinary information enabled, for the first time in the Southern Ocean, a biotopic characterisation of an entire archipelago's benthic habitats and provided a framework for policy makers to set priorities for its future management.

Thu_330_EN-4_2164
Conserving Terrestrial Antarctic Biodiversity in the Face of Multiple Threats

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Like many corners of the globe, Antarctica is subject to multiple threatening processes, including climate change, invasive species and an expanding human footprint. Prioritising management actions in the face of these multiple threats is a challenging, yet essential goal for progressing biodiversity conservation in the region. One method of prioritising management actions for taxonomic groups or regions is using a Priority Threat Management (PTM) approach, which relies on expert elicitation to derive a cost-efficient outcome. We applied the PTM approach to terrestrial Antarctic biodiversity in an international workshop that brought together over twenty-five biodiversity experts, logistics managers and policymakers in Belgium, in July 2017. Here I will present the results from this workshop, including the identification of management strategies and priority actions to be employed across the Antarctic region. This work represents a substantial leap for conservation planning in the region and will be of great use to future management decisions.

Thu_331_EN-4_2351
Analyzing Ballast Water Convention and Polar Code for Arctic Navigable Water

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The problem of invasive species in ships' ballast water is getting large over the last few decades due to the expanded trade and traffic volume. Quantitative data show an alarming rate of increasing bio-invasions in new areas. The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) is a new international convention to prevent the potentially devastating effects of the spread of harmful aquatic organisms carried by ship ballast water has been adopted by the International Maritime Organization (IMO). IMO has also adopted the International Code for Ships Operating in Polar Waters (Polar Code). The Polar Code is intended to cover the full range of shipping-related matters relevant to navigation in waters surrounding the two poles - ship design, construction, and equipment; operational and training concerns; search and rescue; and, equally important, the protection of the unique environment and Eco-systems of the polar regions.
Considering that the shipping traffic already increased in Arctic because of the new routes, operations in the Arctic and even Antarctic environments are exposed to a number of unique risks. In this work, authors analyze and compare Polar Code and BWM, also evaluates the new requirements for marine environmental protection and safety of ships for these remote and sensitive areas.

Thu_332_EN-4_2396
A Comparative Study: Polar Regions

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While Arctic and Antarctic have some similar geographic aspects, they exhibit differences such as administration and legal status conditional to their location. On the basis of scientific predictions, Arctic is warming faster than the global average. The annual minimum Arctic sea ice extent has declined by 50% since late 1970's. On the other hand the giant iceberg broke free from Antarctica's Larsen C ice shelf which was the largest ever recorded.
According to sea ice modeling scenarios; Arctic region, is under risk to have larger openings in the future, might provide a wider area for shipping operations. Unfortunately, several collisions occured in the Arctic already during such operations. Those incidents have been caused through the special conditions which underlines the special need for appropriate ship safety infrastructure in form of ports of distress, maritime salvage stations and bases for search and rescue operations. Arctic is surrounded by land however Antarctica surrounded by the Southern Ocean which means search and rescue operation standarts can not be same. IMO has adopted the Polar Code which includes existing regulations on ship safety and pollution prevention of Polar Regions. However, there is still a debate if it provides significant additional protection for Antarctic waters. In this study we will discuss the lack of any significant new provisions in Polar Code.

Thu_333_OS-3_53
Establishing the Sea Ice Proxy IPSO$_{25}$ at the Western Antarctic Peninsula

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Sea ice proxies are important and useful tools to reconstruct the climate and environmental history in polar regions. In the Southern Ocean, the biomarker IPSO$_{25}$, a highly branched isoprenoid (HBI) diene produced by sea ice diatoms (Belt et al., 2016), is not well established yet. To evaluate the advantages and limitations of IPSO$_{25}$, recent ocean surface sediments from the southern Drake Passage and the Western Antarctic Peninsula (WAP) were used for an analysis of several biomarkers (HBIs, sterols, alkenones, GDGTs) and diatom assemblages.
The concentrations of IPSO$_{25}$ are significantly high along the WAP and on the shelf, pointing to a spring sea ice cover. In contrast, IPSO$_{25}$ is absent in Drake Passage sediments. Similary, the distribution of open marine and sea ice diatoms suggests a seasonal sea ice coverage at the shelf, along the Bransfield Strait and a reduced sea ice extent towards the continental slope up to 61° S. These proxy-based sea ice estimates are in good agreement with satellite-derived sea ice data. The further consideration of e.g. higher unsaturated HBIs alongside IPSO$_{25}$ proves helpful and supports the application of IPSO$_{25}$ as a suitable tool for sea ice and environmental studies of the past in the Southern Ocean and Antarctica.
Belt et al., 2016. Nature Communications, v. 7, p. 12655.

Thu_334_OS-3_78
Sediment Trap Particles (2014 - 2016) in the Terra Nova Bay of the Ross Sea

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KOPRI mooring system has been operated at Site X1 (74º50.27'S, 166º15.89'E, 1,050 m) during March 2014 to Dec. 2016 and at Site X2 (74º33.13'S, 167º38.92'E, 850 m) during Feb. 2015 to Jan. 2017, respectively, in the trough of Drygalski Basin adjacent to Jangbogo Station of the Terra Nova Bay in the southwestern Ross Sea. The bottom-tethered mooring system was deployed at 550 m below sea level (mbsl) at Site X1 and 350 mbsl at Site X2, consisting of a Seaguard RCM current meter, a SBE Micro CAT conductivity/temperature recorder, and a 13-cup time-series sediment trap. However, sediment trap system was not operated at Site X1 during a year of 2015. All flux data (total mass, $CaCO_3$, organic carbon, and biogenic opal) of sediment trap particles show the distinct seasonal and inter-annual variations. Biogenic opal flux occupies more than half of total mass flux, indicating that the seasonal diatom bloom is a key process to contribute to the biogenic opal composition. Higher flux occurred seasonally during a short time of March to May at both sites, but a peculiar high total flux continued from Feb. to June 2015 at Site X2. During this period, the abnormally high $CaCO_3$ flux was observed. Inter-annual variation is also distinct, showing that the total flux in April 2016 was remarkably high particularly at Site X1. These preliminary analytical results will be discussed in terms of physical and sea ice data which have been organized.

Thu_335_OS-3_248
Analysis of Synoptic Variability of the Antarctic MIZ with in Situ Observations

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Our knowledge of sea ice variability, which contributes to the detection of climate change trends, stems primarily from remotely sensed information. However, sea ice in the Southern Ocean is characterised by large variability that remains unresolved and limits our confidence in the remotely sensed products. Although one of the biggest seasonal changes on Earth is the annual advance and retreat of the Antarctic sea-ice cover, relatively little attention has been given to the processes by which the marginal ice zone (MIZ) edge forms and responds to synoptic events. The objective of this study was to compare sea-ice observations from the *SA Agulhas II* to high resolution satellite imagery when transecting the MIZ. The location of the ship was tracked, allowing a more quantitative description of spatial sea-ice characteristics, specifically focusing on the MIZ and its edge. SAR as well as ASI-AMSR2 data were used to retrieve sea-ice properties. Extent and concentration were investigated to evaluate the quality of satellite retrievals with respect to on-board observational estimates, based on the ASPeCt protocol. To maximize the retrieval of information from previous cruises not specifically dedicated to sea-ice observations, an algorithm was developed to automatically retrieve sea ice concentration from still images and videos. This method can be used to obtain quantitative sea-ice data from vessels of opportunity without the need to have trained personnel on-board.

Thu_336_OS-3_410
Antarctic Sea-ice Lead Frequencies and Regional Distribution from Satellite Data

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Leads are elongated cracks within the pack ice more than 50 m in width and up to several hundreds of kilometers in length. Since sea-ice leads influence the lower atmosphere as well as the ocean it is crucial to specify their temporal and spatial patterns. They are caused by mechanical forcing such as ocean currents or wind stress and are therefore short-lived and fast moving objects. Sea-ice leads influence e.g. the fluxes of moisture and sensible heat from the ocean to the atmosphere as well as the ice production. The characteristics of leads require a temporally and spatially accurate monitoring. Satellite thermal imagery from the MODIS sensor is used to produce daily potential lead maps for the entire southern ocean at a spatial resolution of 1.5 km. Data are analyzed for the winter periods from 2002 to 2017. Digital image processing and advanced filtering techniques are used. In particular, fuzzy logic is applied to minimize errors induced by a misclassification of leads caused by clouds. A variety of lead characteristics e.g. the object eccentricity is taken into account to distinguish between leads and artifacts. Here we present improvements of the filtering algorithms and preliminary results of potential lead occurrences in the Southern Ocean.

Thu_337_OS-3_428
SAR Pancake Ice Thickness in the Southern Ocean during the PIPERS Project

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Pancake and frazil ice represent an important component of the Arctic and Antarctic cryosphere, especially in the Marginal Ice Zones. The retrieval of its thickness by remote sensing is, in general, a very difficult task. A processing system has been developed and refined by these authors in the framework of the EU SPICES project; it is meant for routinely deriving ice thickness in frazil-pancake regions using the spectral changes in wave spectra from imagery provided by space-borne SAR systems. This methodology has been successfully tested in the Beaufort Sea through comparison with ground truth collected during fall 2015.
In the present study, this technique has been adapted and applied to Antarctic frazil/pancake icefields. Several case studies have been identified using different SAR products (CosmoSkyMed, Sentinel-1, TerraSAR-X). Our retrievals have been analyzed and validated through the comparison with co-located in situ observations collected by international research cruises realized in different sectors of the Antarctic region (i.e., Ross Sea, Weddell Sea). Particular attention has been addressed to in situ information collected in the framework of 2017 PIPERS cruise in the Terra Nova Bay and its polynya.
A broad agreement was found between measured thicknesses and those retrieved from the SAR imagery. Results and statistics are presented and discussed in details.

Thu_338_OS-3_459
Increase of the Antarctic SIE is Highly Significant only in the Ross Sea

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In the context of global warming, the question of why Antarctic sea ice extent (SIE) has increased is one of the most fundamental unsolved mysteries. Although many mechanisms have been proposed, it is still unclear whether the increasing trend is anthropogenically originated or only caused by internal natural variability. In this study, we employ a new method where the underlying natural persistence in the Antarctic SIE can be correctly accounted for. We find that the Antarctic SIE is not simply short-term persistent as assumed in the standard significance analysis, but actually characterized by a combination of both short- and long-term persistence. By generating surrogate data with the same persistence properties, the SIE trends over Antarctica (as well as five sub-regions) are evaluated using Monte-Carlo simulations. It is found that the SIE trends over most sub-regions of Antarctica are not statistically significant. Only the SIE over Ross Sea has experienced a highly significant increasing trend ($p = 0.008$) which cannot be explained by natural variability. Influenced by the positive SIE trend over Ross Sea, the SIE over the entire Antarctica also increased over the past decades, but the trend is only at the edge of being significant ($p = 0.034$).

Thu_339_OS-3_479
PIPERS:Ross Sea Ice Freeboard and Thickness Retrieve from IceBridge ATM Data

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Ross Sea ice thickness is an important indicator of Antarctic climate change but needs to be evaluated over several seasons to define any trends. In November (20,21,27 and 28) 2013, NASA'S IceBridge mission flew over the Ross Sea, Antarctica and collected important surface sea ice data with airborne lidar(ATM) and digital camera imagery(DMS) for the first time. An automatic lead-classification method based on DMS images is developed in this paper. Using the leads only, we were able to derive the sea surface height anomaly by subtracting geoidal mean sea surface height product DTU15 from ATM L1B (~1m resolution) retrieved surface elevations. We then computed total freeboard (over the sea ice) by subtracting the derived sea surface anomaly from the difference between ATM L2 retrieved surface elevation (80 m sample width 40 m spacing along track) and mean sea surface height product DTU15. Preliminary results are, apparent reflectivity values of leads in Ross Sea are mostly less than 0.15; Track 1 and 4 (the two most near the coast) shows the thickest ice thickness, which can be as great as three meters. For all tracks (except one) mode thicknesses vary between 0.35-0.45 meter. Track 3 (east-west) shows the thinnest mode ice thickness (0.35 m) and mean ice thickness (0.48 m). An ATM and DMS mission using the NSF C-130 with the Icepod system was flown in 2016 and will be repeated in 2017. Using the 2013 mission shown here as a baseline will assist in defining any trends.

Thu_341_OS-3_724
East Siberian Sea Fast Ice: Linkage with Atmospheric Forcing

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By using operational sea ice charts (Arctic and Antarctic Research Institure, Russia)we analyzed seasonal and interannual variability of fast ice extent in the East Siberian Sea between 1999 and 2015. We identified key events in each annual fast ice cycle and linked the occurrence of these events to freezeup and melt onset and air temperature (FDDs and TDDs). The analysis reveals that fast ice in the region is sensitive to the thermodynamic processes throughout a season. On the interannual time scale we found a tendency towards shorter fast ice season. The duration of fast ice season reduces by 1.5 d/y which is in agreement with Arctic-wide trend. Analyzing fast ice annual cycle in the East Siberian Sea we describe two modes of fast regime charactered by small (S-mode) and large (L-mode) extent. By liking the occurrence of the modes to thermodynamic and dynamic factors we suggest the large fast ice extent forms during seasons with atmospheric circulating favoring sea ice import to the East Siberian Sea. This likely results in a higher rate of sea ice deformation and formation of grounded sea ice ridges which stabilize extensive fast ice cover. To confirm this hypotheses, the processes of ice ridging in the East Siberian Sea further investigated.

Thu_343_OS-3_851
Sea Ice Leads Detection using High-resolution SAR Imagery

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From sea ice monitoring, the line feature like sea ice leads due to winds and ocean currents not only influences the exchange of heat between ocean and atmosphere, and it is of great significance for ship navigation. SAR is sensitive to surface roughness of sea ice with different dielectric properties and polarization feature, and it can be utilized for detecting leads from SAR imagery. A line operator based edge detection method is proposed for leads detection in high-resolution SAR imagery. Co-polarization of different polarization channels and frequencies is investigate to measure the energy distribution of leads from different orientation and wavelength. Histogram of gradient is calculated, and the linear feature of leads can be extracted after a segmentation procedure, where the bounding line of leads has the largest gradient with lowest energy. Spatial smoothing procedure is carried out to connect the segmentation of leads into a curvilinear line. Algorithm is validated on Sentinle-1 SAR imagery with a pixel spacing of 40 meters and GF-3 SAR imagery in Beaufort Sea. Main work is listed: 1) A line segmentation based edge detection method is proposed for high-resolution SAR imagery. 2) The assessment of the proposed segmentation based method and classification based algorithm has been presented. 3) The preferable parameters sets including incident angle correction, the polarization ratio threshold and spatial smoothing window size have been discussed.

Thu_344_OS-3_919
The Northern Sea Route under New Ice Conditions

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Arctic sea ice area has been decreasing over the last decades and increased area of open waters releases new possibilities for navigation along the Northern Sea Route (NSR). Model simulations indicate an accelerated Arctic climate change in the next decades with a potential total loss of Arctic sea ice in summer season around the middle of this century. Increased area of open water will cause generation of larger waves in the marginal seas that can make an area dangerous to navigation. Here, we analyze changes in sea ice and wave conditions in the NSR over the period of satellite observations. The study is done for several standard navigation routes suggested by NSR Advisory. The decline in the Arctic sea ice extent at the end of melt season has been estimated at about 10% per decade over the period of satellite observations. In the seas of the Russian Arctic the similar trend was from -9% per decade in the East-Siberian Sea to -25% per decade in the Kara Sea over the same period. Satellite data demonstrate almost complete NSR opening in September for the period from 2008 and 2012 and from 2014 to 2017. In 2013 the passage was blocked by the ice in the Vilkitsky Strait, which is known to be a bottleneck of the whole NSR. Ice conditions in the Kara Gates, Long Strait and Vilkitsky Strait has been studies separately. In the Vilkitsky Strait, where ice conditions were the heaviest and most changeable, the average ice concentration has decreased at about 10% per decade.

Thu_345_OS-3_939
Evaluation of the EUMETSAT OSI SAF - ESA CCI Sea-ice Concentration Data Set

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Surface sea-ice area fraction (sea-ice concentration or SIC) data sets derived from satellite microwave radiometry have been among the backbones to quantify amplification of global climate change in the Arctic with its remarkable sea-ice cover reduction contrasted by a yet to be understood Antarctic sea-ice cover variability. For this purpose SIC data sets require the accuracy level of a climate data record (CDR). They should be insensitive to sensor drift or change. They should include retrieval uncertainties to ease usage for climate applications. Retrieval limitations should be understood well. We present the maturity of the joint EUMETSAT OSI SAF and ESA CCI CDRs of daily global SIC at 25 km grid resolution. We find the SIC, its retrieval uncertainty, and the filters applied to be consistent across sensors. Open water (SIC=0%) is retrieved with a bias < 0.1%. Pack ice (SIC=100%) is retrieved with a bias < 2% during winter. Associated precisions fall into the retrieval uncertainty range of 2 - 4%. Retrieval uncertainties reflect seasonal variations of atmospheric and surface properties. CDR SIC agrees within 3% with SIC derived from ~ 400 Landsat optical images. Over < 0.2 m thick ice SIC is biased low by up to 20%. Pan-Arctic (regional) SIC differences to 1 minus open-water fraction derived from nine summers of MODIS data are < 5% (< 20%) but CDR SIC exceeds MODIS net ice surface fraction by up to 30% during peak melt. Grid resolution 25 km vs. 50 km will be discussed.

Thu_346_OS-3_972
Evaluation of Passive Microwave Sea-ice Concentration Products with Landsat Data

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Evaluation of a sea-ice area fraction (sea-ice concentration or SIC) climate data record (CDR) obtained from satellite microwave (MW) radiometry - like the joint EUMETSAT OSISAF - ESA CCI SIC CDRs - against independent data is one of the key activities required to quantify its maturity. Optical imagery acquired by the Landsat satellites provides an independent, high-resolution SIC estimate under clear-sky conditions with daylight.
In this contribution, we use Landsat optical imagery in bands 2, 3 and 4 of Landsat 5 TM, Landsat 7 ETM, and Landsat 8 OLI. We compute the broadband surface albedo and classify the scenes into surface types (open water, thin sea ice, and thick >~ 0.3m sea ice). The resulting Landsat ice maps (with 30 m resolution) are co-located with the CDR SIC, having grid resolutions between 12.5 km and 50.0 km depending on the MW frequencies used for the SIC retrieval.
We compare CDR SIC and Landsat SIC of more than 400 clear-sky Landsat images, from both hemispheres, from years 2002 to 2015. We document a bias between Landsat SIC and the CDR SIC of about 2% to 4%. We discuss this bias in relation to the type of ice in the scene (thin vs thick), the MW frequencies used in the SIC CDR, and the Landsat SIC estimation accuracy.

Thu_347_OS-3_1109
Early Holocene Sea Ice Variability in Moubray Bay, Antarctica

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Laminated diatom oozes collected from Antarctic coastal basins provide an opportunity to create high-resolution paleoclimate records of ocean-atmosphere variability. The relationship between sediment geochemistry, diatom assemblages, and related environmental conditions can be utilised to reconstruct a range of climatic conditions at a particular site through time.
We present results from a unique marine sediment core, LC-62 (4.82m long), collected from Moubray Bay, Ross Sea, Antarctica. The upper portion of LC-62 comprises a laminated diatomaceous ooze with the horizontal layering differentiated by changes in colour, texture and density. The lower half of the core is composed of ooze of the same colours and textures but in undulating and interweaving layers. Overall, $\delta^{13}C$ values in LC-62 are more negative than typical Antarctic values (-24-25‰). At the base of the core $\delta^{13}C$ is very negative (-33‰) but becomes more positive up core (-27 to -30‰). Core top samples contain diverse and well-preserved diatom assemblages characterized by sea-ice associated species. Section break samples are dominated by assemblages associated with a shallow mixed layer and rapid export and burial, and by variable abundances of sea-ice associated species. This record will provide a new point of comparison to high-resolution ice and sediment cores from Antarctica and sediment cores from the mid-latitudes of the Southern Hemisphere.

Thu_348_OS-3_1247
New Insights into the Application of the PIP_{25} Index in the Arctic Ocean

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In this study we investigated suspended particulate matter (SPM) collected along a transect from the East Sea of Korea to the Bering Sea from 18 to 28 July in 2015, a multicore (ARA01B-3MUC) retrieved from the Chukchi shelf region, and a piston core (MD95-2009) taken from the Nordic Seas. We analyzed the samples for the Arctic sea ice proxy IP_{25} together with a tri-unsaturated highly branched isoprenoid (HBI triene) and two sterols (epi-brassicasterol and dinosterol) to assess the suitability of these compounds for the so-called PIP_{25} index in the Arctic region as a proxy for sea ice change in the past. Our results highlight that the use of HBI triene, epi-brassicasterol, and dinosterol, as strict phytoplankton markers for the PIP_{25} index (i.e. P_TIP_{25}, P_BIP_{25} and P_DIP_{25}, respectively), might result in misleading outcomes. Accordingly, our study highlights that more work is needed to better constrain the use of HBI triene, epi-brassicasterol, and dinosterol, as strict ice-free, open ocean phytoplankton biomarkers when applying the PIP_{25} index for reconstructing past sea ice changes.

Thu_349_OS-3_1251
Application of $IPSO_{25}$ for Reconstructing Sea Ice Conditions in the Amundsen Sea

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A continuous decline in sea ice extent has recently been observed in the Amundsen Sea, standing in stark contrast to observations of an increasing trend in other regions around Antarctica. Polar sea ice plays a key role in Earth´s global climate system as it has a strong influence on atmospheric and oceanic processes. Reconstructions of sea ice extent and the understanding of sea ice-induced mechanisms are therefore of crucial importance.
Here, we apply organic geochemical proxies in order to reconstruct the paleoenvironment in the Amundsen Sea. Several samples from the Amundsen Sea Shelf will be investigated with a main focus on the reconstruction of sea ice conditions via a specific organic biomarker, a highly branched isoprenoid (HBI), called $IPSO_{25}$, which is produced by sea ice diatoms and well preserved in marine sediments (Belt et al., 2016). For surveying $IPSO_{25}$ as a sea ice proxy, surface sediment samples will be investigated, while the analysis of two sediment cores (PS104/014-3 and PS69/274-1) give insight into the environmental and climatic conditions across the last deglaciation.
First measurements show highly variable concentrations of $IPSO_{25}$ at both core sites. Further biomarkers, such as HBI trienes, GDGTs (TEX_{86}) and sterols will be investigated for reconstructions of SSTs and primary productivity. Comparisons to diatom assemblages and diatom-derived sea ice concentrations are intended for an evaluation of both approaches to reconstruct sea ice conditions.

Thu_350_OS-3_1302
Record Low Antarctic Sea Ice Area in Springtime of 2016: Forcing and Responses

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Antarctic sea ice area reached record lows for the season in the springtime of 2016. The analysis of sea level pressure from two reanalysis datasets revealed that the atmospheric forcing at southern high latitudes appeared to be extremely strong during the first three months of 2016, and in June and September 2016, characterized by record low daily and monthly mean sea level pressure at southern high latitudes. Satellite sea ice concentration data, winds from ERA-Interim, and results from a global high resolution ocean-sea ice model, were analyzed to investigate the responses of sea ice and near-surface ocean to such atmospheric forcing. It was found that the patterns of sea ice anomalies in June and September 2016 were controlled by both the thermal and dynamical effects of atmospheric forcing. The anomalously strong cyclonic wind forcing at southern high latitudes associated with extreme atmospheric conditions generated warmer near-surface oceanic states from April 2016 onwards than in previous years.

Thu_351_OS-3_1327
Sea Ice Reconstruction Over the Last 3ka BP in the Ross Sea (Antarctica)

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Reconstruction of past changes to sea ice extent is central to understanding the factors that control its distribution and informs how changes in sea ice might occur in the future. Such reconstructions are often hindered, however, by poor age control (or resolution) in marine archives, or the absence of robust proxy signatures. Here, we show preliminary results from a 14.6 m long piston-core collected in the Edisto inlet (Cape Hallett, Ross Sea, Antarctica). The aim of the project was to obtain a continuous and highly resolved record of sea ice dynamics and other environmental parameters during the late Holocene. With this goal in mind, the coring site was chosen in the inner bay where the Holocene unit is particularly expanded (up to 60 m thick). Bottom core AMS ^{14}C dating of the acid insoluble organic fraction (2820 cal. aBP after reservoir correction) indicates an average annual sedimentation rate of ca. 0.5 cm/y. X-ray radiographs show well-preserved laminated sediments dominated by diatom oozes alternating with dark-like sediments likely supplied from the inner bay. In this abstract, we present high resolution bulk organic carbon geochemistry ($\delta^{13}C$ and carbon content), XRF core scanning data, diatom assemblages and lipid biomarker results. Specific focus will be placed on the di-unsaturated highly branched isoprenoid biomarker IPSO25, which has been recently proposed as a proxy of Antarctic landfast sea ice.

Thu_352_OS-3_1362
Southern Ocean SST & Sea Ice Changes: Southern Oceanand Indian Monsoon Linkages

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Here we present the Southern Ocean (SO) pastsea ice (SI) duration and summer SST estimates utilizing 2sediment cores.SSTs and SIreconstructionis based on diatom transfer function and is compared with other climatic records from SO and Arabian Sea. SIrecords reconstructed here reveal that the SI presence at the core siteswasdiscontinuous during the past. SIwas largely absent at the core site during the interglacial stages. Nonetheless, the winter SIpresence of 1 month/year at the core sites was evident during glacial periods. The advance phases of SI coverage which occurredduring the glacial periods (MIS 2, 3 and 4) apparently coincided with the drop in summer SSTs. On comparing our records of SSTs and SI with ISM reconstruction, it was seen that the weakening of ISMduring glacial period was in phase with the equatorward shift of Antarctic SI. In addition to the SI, the SO fronts werealso likely to have shiftedequatorward during the glacial period,this in turn is in compliance with the equatorward shift of the southern hemisphere westerly winds. Such latitudinal changes in the westerly wind belt during glacial-interglacial periodswas recorded to have been in phase with thenorth-south shift of Intertropical Convergence Zone, thereby hinting at a possible modefor SO and ISM linkages in the past. Hence there is a need to understand how such modesimpacted the variation of the thermal gradient developed between the Indian landmass and southern tropical ocean.

Thu_353_OS-3_1408
Modelling the Annual Cycle of Antarctic Sea Ice Extent

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Satellite-observed, total Antarctic sea ice extent (SIE) experiences a distinct annual cycle, peaking in September and troughing in March on average. The amplitude and phase of the annual cycle also varies regionally. What forces the observed annual cycle and its variations is not completely understood. The average annual cycle may be calculated by simply taking the average SIE for each day of the year. However, while simple and transparent, this method produces a value that is subject to substantial variation since it is based on fewer than 40 numbers, one for each year of observed data. It also disguises the fact that the annual cycle might be slowly changing phase and that the amplitude as well as shape of the daily extent might vary. Here, we present a model that allows the mathematical and stochastic representation of the proximate forces that lead to the observed annual cycle of sea ice extent. Our methods allow amplitude and phase dilation and contraction. Thus, the annual cycle is not constrained to be a fixed cyclical pattern rather, it is a pattern that allows both temporal dilation and contraction as well as amplitude modulation. We use this model in an ensemble interpolation to reconstruct missing daily data in the early part of the satellite- observed sea ice data set. Results are presented and discussed.

Thu_354_OS-3_1653
Comparing Pre-industrial and Late Pleistocene Antarctic Sea Ice Trends

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The Antarctic sea ice proxy $IPSO_{25}$, a highly branched isoprenoid (HBI) alkene (Belt et al., 2016; Massé et al., 2011), constitutes a promising palaeoceanographic tool for the community of Antarctic polar marine geologists. In particular, where (or when) the application of diatoms is limited due to silica dissolution, this biomarker approach seems highly valuable to gain insight into sea ice-ocean-atmosphere interactions. Here, we target at HBI-based sea ice reconstructions covering the pre-industrial time interval and the last interglacial. Pursuing a multi-proxy approach, sediment cores obtained during RV *Polarstern* cruises PS97, PS104 and PS111 in the southern Drake Passage, the Amundsen and Weddell Sea, respectively, will be investigated for, amongst others, their biomarker inventory and diatom assemblages to reconstruct sea ice and ocean temperature changes and associated fluctuations in primary productivity. These records will provide the base for an assessment of how sea ice variability may have been linked to shifts in atmospheric circulation (ENSO, SAM) and ocean warming - two of the main drivers of recent environmental changes in the Southern Ocean.
Belt et al., 2016. Nature Communications, v. 7, p. 12655.
Massé et al., 2011. Antarctic Science, v. 23, no. 5, p. 487-498.

Thu_355_OS-3_1824
Comparison of Ice/Water Classification from C- and L-band SAR Imagery

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In this article an algorithm for ice/water classification of C- and L-band dual polarization synthetic aperture radar data is presented. A comparison of the two different frequencies is made in order to investigate the potential to improve classification results with multi frequency data. The algorithm is based on backscatter intensities in co- and cross-polarization and autocorrelation as a texture feature. The mapping between image features and ice/water classification is made with a neural network.
Accurate ice/water maps for both frequencies are produced by the algorithm and the results of the different frequencies generally agree very well. Differences are found in the marginal ice zone, where the time difference between acquisitions causes motion of the ice pack.
C-band reliably reproduces the outline of the ice edge, while L-band has its strengths for thin ice/calm water areas within the icepack.
The classification shows good agreement with ice/water maps derived from met.no ice-charts and radiometer data from AMSR-2. Variations are found in the marginal ice zone where the generalization of the ice charts and underestimation of ice concentration from radiometer data limit accuracy. Usage of high resolution dual frequency data increases timeliness and resolution of sea ice cover information for navigation and modelling.

Thu_356_OS-3_2058
Environmental Sensitivity of Diatom Biomarker Lipids Linked to Ice Edge Dynamics

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In recent years, the source or environmental specificity of certain C_{25} Highly Branched Isoprenoid (HBI) alkenes has led to their use as organic geochemical proxies for seasonal sea ice reconstruction. Thus, a mono-unsaturated C_{25} HBI termed IP_{25} provides a useful proxy measure of the past occurrence of Arctic sea ice, a di-unsaturated HBI ($IPSO_{25}$) has been proposed as an equivalent proxy for Antarctic sea ice, while a tri-unsaturated C_{25} HBI counterpart (HBI III) has been suggested as a possible proxy indicator of the retreating ice edge during spring in both the Arctic and the Antarctic. Here, the environmental sensitivity of one of these diatom lipids, HBI III, to ice edge dynamics has been investigated further, through analysis of water column samples collected from two consecutive annual sampling events north of Svalbard, corresponding to a transect that tracks the retreating ice margin. Preliminary results show that, within this study area at least, biosynthesis of HBI III is indeed favoured in locations close to the retreating ice edge, consistent with the sedimentary distribution of this biomarker in the nearby region. To provide further context to the findings, we also measured the occurrence of HBI III from a temperate location in the English Channel (www.westernchannelobservatory.org) spanning three contrasting seasons (spring-autumn). Some new sedimentary HBI III data from the Antarctic will also be presented.

Thu_358_OS-3_2161
Extraction Method of Arctic Sea Ice and its Multiscale Change Characteristics

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The extent of polar sea ice is one of the key parameters of cryosphere and polar environmental change, which plays an important role in the study of global climate change. According to the recently research results from NASA, the extent of Arctic sea ice showed obvious decreasing trend with the average loss of 13.3% per decade, and decreased significantly since 2007. In this study, a new extraction method of Arctic sea ice is proposed based on multi-source remote sensing data. The accuracy of extraction results is validated using sea ice concentration products estimated by microwave data, such as SMMR. On the other hand, the temporal change analysis results of Arctic sea ice extent are also included. The change characteristics in various time scales, such as decade, annual, seasonal, are presented by using the extent products from 1979 to 2017, downloaded from the website of the National Snow and Ice Data Center (NSIDC). Moreover, this study would present the seasonal changes in the recent 20 years, and the correlation of sea ice changes in long-term and medium-term is revealed. In the further, we would like to improve the accuracy of extraction results and strive to the reasonable prediction of the future tendency of Arctic sea ice according to the sequential analysis. These results could provide important support for the research on global climate change.

Thu_359_OS-3_2226
Sea Ice Volume in the Greenlanad, Irminger and Labrador Seas, 1978 - 2016

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Deep convection in the Greenland, the Irminger and the Labrador Seas is an inherent part of the Atlantic Meridional Overturning Circulation (AMOC), which modulates its intensity. Interannual variations in the intensity of deep convection, among other factors, are thought to be controlled by variations in the intensity of freshwater fluxes to these regions and the overall sea-ice extent in winter. In this study we investigate the role of sea ice transport and melting in the freshwater balance of the Greenland, the Irminger and the Labrador Seas between 1978 and 2016. The study is based on time series of sea ice volume and velocity from Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS). The analysis revealed variation of the sea ice volume with periods of 3 and 6-8 years in the Greenland Sea and 8-10 years in the Irminger and Labrador Seas. The 6-8 years cycle in the Greenland Sea lags between a quarter and a half of the period the corresponding variations in the Irminger and Labrador Seas. The links to the corresponding cycles in oceanic and atmospheric regional indexes (NAO, AO, AOO, etc.) are analyzed.
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Thu_360_OS-3_2291
Antarctic Sea Ice Response to Climate Changes in a Model Study

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In a warming climate, observations indicate that sea ice surrounding Antarctica has been slowly expanding since 1979. Changes in the melt rates of Antarctic ice shelves and in atmospheric dynamics are both considered key drivers of sea ice variability. We present a sensitivity study with a global eddy-permitting ocean-sea ice model, which aims to investigate how modifications of regional/local climate conditions (freshwater discharge and wind fields) can affect sea ice properties around Antarctica. Numerical exercises with modified surface runoff shows that enhanced freshwater supply can increase the sea ice extent. However, a very strong increase of freshwater will eventually invert the trend. In our runs, the freshwater spatial distribution largely affects sea ice dynamics and regional sea ice concentration and thickness. Numerical runs with idealised changes of ERA-Interim wind velocities show that both zonal and meridional wind modifications do only slightly impact regional properties of sea ice.

Thu_361_OS-3_2353
Interannual Dynamics of the Ice Regime of the Sea of Azov in the XX-XXI Century

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Ice regime of the Sea of Azov over the period XX-XXI centuries on the basis of the author´s GIS "Ice regime of the Southern Seas of the Russia" was investigated. The long-term dynamics of the ice cover, the duration, the beginning and the end of the ice period was considered. The analysis of the data showed that the average long-term value of the ice cover of the Sea of Azov is 33% for the period 1950-2015. The average area of fast ice is 6.3% of the total sea area. The duration of ice cover in the coastal weather stationswas reduced by 5 to 9 days. Typification of winters in terms of severity was carried out for three coastal weather stations: the Taganrog, the Genichesk, the Kerch. Typification showed that the winters with moderate characteristics are prevail in the Azov region. A total allocated of 15 severe winters, 70 moderate and 40 soft winters. New classification of winter periods,which combined all the ice regime parameters and typification winters in terms of severity, was developed. It is shown that the moderate winter periods are prevalence. A total allocated of 9 severe winter period, 36 moderate and 21 soft winter periods for GMS «Taganrog» and 8 severe winter period, 41 moderate and 17 soft winter periods for GMS «Kerch».

Thu_362_OS-3_2555
The Role of Northern Sea Ice Variability during Abrupt Glacial Climate Changes

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Changes in sea ice cover in the Nordic Seas likely played a crucial role in amplifying ocean circulation and climate changes of the Dansgaard-Oeschger (D-O) cycles during the last glacial. We investigate the role of sea ice for abrupt Greenland climate changes, using high-resolution sea ice records from two Norwegian Sea cores covering four D-O cycles at 32-40 ka. These records are based on the sea ice diatom biomarker IP_{25}, open-water phytoplankton biomarkers (sterols and alkenones) and semi-quantitative phytoplankton-IP_{25} (PIP_{25}) sea ice estimates. Our biomarker records indicate that the Norwegian Sea was characterized by a near-perennial sea ice cover during cold stadials and enhanced open-ocean conditions during warmer interstadials. These changes in sea ice likely facilitated shifts in atmospheric circulation, potentially contributing to far reaching atmospheric teleconnections transmitting the D-O climate signals. Moreover, we find that initiation of sea ice retreat systematically preceded Greenland warming and major deep mixing in the Nordic Seas, acting as a precursor of oceanic reorganizations that likely generated much of the atmospheric warming of the Greenland D-O events. We thus conclude that the glacial sea ice variability acted as positive feedback mechanism for abrupt ocean circulation and Greenland climate change during D-O cycles.

Thu_363_OS-3_1576
Multivariate Biomarker Methods for Reconstructing Arctic Sea Ice Conditions

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The discovery of the C_{25} Highly-Branched Isoprenoid (HBI) termed IP_{25} provided a direct geochemical biomarker approach for reconstructing Arctic sea ice. Subsequent introduction of the PIP_{25} index, based on the ratio of the sympagic IP_{25} and certain pelagic biomarkers (e.g. sterols) facilitated semi-quantitative reconstructions of paleo spring sea ice concentration (SpSIC).
Despite these developments, the objective selection of appropriate marine open-water biomarkers as pelagic counterparts to IP_{25} is challenging, and the same biomarkers may not be applicable in different Arctic regions. Further, the PIP_{25} threshold values previously used to classify different sea ice conditions, ranging from open water (PIP_{25} < 0.1) to extensive sea ice cover (PIP_{25} > 0.75) were not based on a reproducible classification procedure, but arbitrarily estimated using linear regression.
To adress these limitations, we constructed a classification tree (CT) model based on a multivariate set of sympagic and pelagic HBI biomarkers, including IP_{25}, in ca. 200 surface sediments encompassing the Barents Sea. The CT model was used to classify sea ice conditions as marginal (< 10% SpSIC), intermediate (10-50% SpSIC), or extensive (>50% SpSIC) in sediment cores from the Barents Sea spanning the last ca. 13 cal. ka BP. Comparison of CT model results to PIP_{25}-based SpSIC estimates showed consistent results, supporting the application of multivariate statistical methods for reconstructing paleo sea ice.

Thu_364_SH-3_84
Ice, Snow, or Canvas? Best Protection against Harsh Weather Conditions

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Hans Gazert (1870-1961), physician of the German South-Polar Expedition (1901-1903), evaluated various types of clothes, headgear, gloves, shoes as well as sleeping bags, tents, ice and snow huts and their use during the exploration of Antarctica around 1900. To demonstrate the historical value of Gazert's manuscript that contains his findings I will present his thoughts about the best means of protection against harsh weather conditions in polar regions during sledging excursions.
Particularly interesting is his review of pros and cons of European tents made from canvas or silk of dark or light colors, ones differing both in size and shape from tents commonly constructed for summer use in the Arctic by Inuit people. Gazert describes contemporary types of tents developed by Fridjtof Nansen for the Arctic, or Frederick Cook and Roald Amundsen, as well as Robert Falcon Scott for Antarctic use. Arctic igloos, Gazert found are very warm, and therefore seem to be very useful for overwintering or to establish a secondary observing station. He recommended a simpler version to be built each day during sledging trips. Ice houses were more stable and lasted longer than igloos and were, he said, very good for observatories, but too cold as accommodation. Apart from Gazert's findings the present paper will also illustrate and discuss further developments of tents designed by Nansen and Alfred Wegener for use as stations around the year 1929.

Thu_366_SH-3_295
Antarctic Research and the Evolution of Arctic Institutions, c. 1940 -1960

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Institutions play a central role in the production of knowledge, and in the maintenance of cultures that facilitate that production. We argue that the study of research institutes can be used as a window into the changing nature of science and politics. We study the evolution of four distinct but comparable Arctic research institutes during the early Cold War: the bi-national Arctic Institute of North America (AINA, US-Canadian), the Scott Polar Research Institute (SPRI, UK), the Norwegian Polar Institute (NP) (Norway) and the Arctic Research Institute (ARI, USSR). Using these institutional histories, we show how research in Antarctica - particularly in connection to the International Geophysical Year (IGY) of 1957/58 - had repercussions for Arctic research. We demonstrate how this bipolarity can be seen as part of the interplay between logistical and geopolitical frameworks and choices in polar research agendas. Moreover, focusing on these institutes can reveal how the relationship between the state, the individual scientists and these institutions as nodes in an international network were negotiated during the early Cold War.

Thu_367_SH-3_1350
From the Archives of the Unknown Explorer

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This paper explores the research on polar history that shapes my "Unknown Explorer" series. Structured around objects from the archives of a fictitious, female explorer, Anna Schwartz, this project builds on my collaboration with scientists and my experience in Antarctica as a recipient of the NSF Antarctic Artists and Writers Grant. It intersects with the history of both Arctic and Antarctic exploration and science.
The archival structure allows for a layered narrative that explores the bipolar research on climate change as well as the contrasting histories of exploration at the two poles, with the presence of native populations in the north and their absence in the south. While the character of Schwarz is fictitious, the archives contain factual materials from the past and the present. For example, Schwartz who has family ties to the 19th century Austro-Hungarian North Pole expedition is a photographer and a naturalist who grows obsessed with the microscopic planktonic snail, the *Limacina helicina,* through a chance meeting with the son of Admiral Scott in 1935. Her quest to find this organism in its habitat connects her with Vilhjalmur Stefansson, the Arctic explorer who helps her join admiral Byrd's Antarctic Expedition in 1939. The archives also incorporate materials pertaining to Schwartz daughter who follows in her mother's foot-steps and finds that her mother's beloved planktonic snail functions as the canary in the coalmine when it comes to ocean acidification.

Thu_368_SH-3_1416
Whaling, Claims and a Doctoral Thesis from 1940

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Whaling has been a business in the Arctic and Antarctic. Over time, it has also become a political issue, especially amongst Britain, Norway and Germany. The Northern Sea was mainly controlled by the British (economy) and the Norwegians (whaling in the North and also in the South). The inter-war period brought great hardship for Germany because of failed industrial and agricultural developments, the political and financial pressure from the allied countries and the global financial crises. The so called "fat gap" (lack of providing enough food for the population) became a political issue for Germany. The attempts of the German "Schwabenland Expedition" 1938/39 to secure whaling grounds in the South failed. In 1940, a PhD candidate, Hans-Georg Baare-Schmidt researched the whaling business, science and claims in the Antarctic, mainly by the British. This thesis shows the political background, economic pressure and national ambitions in the Antarctic. This paper will explore the complexity of whaling, science and claiming sectors of the Antarctic, as outlined in the 1940 doctorial research and how the thesis unintentionally provided a vision for, then future, developments in economic, political and scientific terms, which followed the decades after the Second World War.

Thu_369_SH-3_1660
Probing Antarctic Ice in the Arctic: Connections in Radioglaciology´s History

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In the 1960s polar explorers started using airborne radar to measure the depth of the Antarctic ice. There are several studies (e.g. Turchetti, Dean, Naylor and Siegert, 2008) showing how the development of radio-echo sounding (RES) was pivotal to establishing morphological profiles of its ice-sheet. RES is still widely used today to further refine ice depth maps and charts.
Yet the set of crucial experiments catering for the adoption of RES in Antarctica took place at Camp Century, one of the heavily militarized U.S. bases north of the Arctic Circle. Promoted by the SCAR, two "international experiments" were completed in the spring of 1962 and 1963. Crews of engineers from several countries tested a variety of airborne (and land-based) instruments thus gaining a novel understanding of their merits in penetrating Greenland's ice-sheet and paving the way to their adoption in Antarctica.
In this presentation I re-appraise the history of these land-marking trials in light of a fresh analysis of unpublished diaries and reports of one of the protagonists: the US Army Signal Corps radio engineer Amory H. (Bud) White. These papers are revealing of the tests' utility in perfecting the instruments utilized. But also of their progeny in the context of surveillance-driven Cold War research...
Lit. cited: S. Turchetti, K. Dean, S. Naylor and M. Siegerts, “Accidents and Opportunities: A History of the Radio-Echo Sounding of Antarctica, 1958-1979,” *BJHS* 41/3 (2008), pp. 417-444.

Thu_371_SH-3_2420
Sealing in Antarctic during the Nineteenth Century. Three Decades of Archaeology

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The main goal of this paper is to show the analytical power that material culture studies have for understanding the sealers' presence in the history of Antarctica. This paper poses the following general question: What has the study of material remains meant to our knowledge of the historical sealing industry in Antarctica? The sealers presence in Antarctica represents the process of exploration and of the incorporation of an unknown and remote place. From this perspective, I am interested in learning about the particularities of this process by posing specific questions that help characterize the strategies used by sealers.
This paper presents a summary and meta-analysis of the data produced during three decades of archaeological research on the topic, addressing specific questions regarding the decisions involved in the uses of space, the selection of the economic activities developed, the organization of onshore activities and possible temporal changes in these choices. More specifically, this paper examines whether the sealer strategies were expansive or focalized in terms of their use of space, were opportunistic or specialized in terms of the resources exploited and were flexible or rigid in terms of their organization as well as to what degree they changed through time during the nineteenth century. The data to answer these questions were gathered through a deep review of all the currently published information.

Thu_372_SH-3_2545
Isla Observatorio and its Significance for Antarctic Expeditions in 1900s

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Following the conclusions of the International Geographical Congresses of 1885 and 1899, Argentina built in 1902 a magnetic observatory, a meteorological station and lighthouse at Isla Observatorio, Tierra del Fuego, to cooperate with international Antarctic expeditions. Although its use only spans a few decades, it was the required stop for calibrations, meteorological information and even sledge dogs training for polar expeditions heading South. Its past significance was marked by the visits from well-known polar explorers, such as Nordenskjold and Charcot, who spent time on the island before and after their Antarctic expeditions. This paper analyses the international significance of Isla Observatorio in the support for science expeditions at the beginning of the 20th century, and examines the reasons for the state of disrepair and abandonment of this National Historic Monument, and the newly discovered interest by the regional and national governments of Argentina.

Thu_373_SH-3_2556
History of French Polar Shuttles

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Focus on the French polar fleat from the "Pourquoi Pas? " of Charcot early 1900´s to the brand new Astrolabe, this paper will demonstrate how those vessels are tools to connect poles, oceans and people using corpus of memories. To illustrate that point the Astrolabe is used as a case study. The initial corpus is based on the one used in the book «L´Astrolabe , le passeur de l´Antarctique 1988-2018 » (Buiron and Degast Oct 2017, E/P/A) build from a collabortive gathering of memories in the framework of the retirement of the « old Astrolabe ». This corpus points out the evolution of this ship from a simple supply to a platform for research, heritage and creative solution to logistic issues that concern different polar countries and initiatives. More than a shuttle this boat is also a bridge between French Polar activities and Tasmanian one as discovered through a pilote study conducted in Hobart in July 2017 by collecting some memories about this ship which is a second corpus in the framework of this ongoing work.

Thu_374_SH-6_105
The Surface Ocean-Lower Atmosphere Study in the Polar Oceans

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The Surface Ocean-Lower Atmosphere Study (SOLAS) is an international science coordination and capacity-building body established “to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and the atmosphere, and of how this coupled system affects and is affected by climate and environmental change.” The new SOLAS science plan places particular emphasis on air-sea exchange in the polar oceans, including the roles of sea ice and fresh water. Specific high-latitude activities sponsored by SOLAS include the Biogeochemical Exchange Processes at Sea-Ice Interfaces (BEPSII) and Cryosphere and Atmospheric Chemistry (CATCH) research communities, and other workshops and working groups. These polar initiatives integrate research on all five core SOLAS themes: Greenhouse gases and the oceans; Air-sea interface and fluxes of mass and energy; Atmospheric deposition and ocean biogeochemistry; Interconnections between aerosols, clouds, and marine ecosystems; and Ocean biogeochemical control on atmospheric chemistry. The SOLAS Science & Society task team also explores topics such as impacts of increasing ship-plume emissions on Arctic Ocean biogeochemistry, blue carbon, open-ocean stewardship, and implications of proposed geoengineering strategies. As a grass-roots science organization, SOLAS encourages involvement of new people with new ideas for studying air-sea exchange processes and their implications for the global system.

Thu_375_SH-6_571
Antarctic Sun Lines: Connecting Antarctic Gateway Cities through Art

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The cities of Cape Town, Christchurch, Hobart, Punta Arenas and Ushuaia can be described as Antarctic Gateway Cities. Although supporting international Antarctic operations is something these cities have in common, each city has its own diverse history, culture and political concerns. The significance of the sun is one unifying factor: the austral summer season is the narrow window of time when Antarctic activity is at its peak.
In October 2017, I established *Antarctic Sun Lines* working with the Antarctic Gateway Cities research network, COMNAP, Gateway Antarctica researchers, and the UK and NZ Antarctic Heritage Trusts. Each gateway city and several Antarctic research and heritage sites hosted a 'Solar Collector' pinhole camera throughout the summer season. Up to 4 months of sunlight and the ebbing of the summer sun were captured in a single image at each site. Founded on international collaboration and requiring the active participation of key stakeholders, the work bridged cultural and political boundaries and created connections.
In this paper I examine the role art can have in supporting international Antarctic relationships. I argue that this project contributed to shaping a sense of shared identity and offers opportunities for further shared gains: inspiring new research and continuing creative collaborations; shared international cultural events such as exhibitions; and opportunities for public engagement.

Thu_376_SH-6_643
ARICE: Arctic Research Icebreaker Consortium

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The recent changes and the increased economic activity in the Arctic region have triggered a societal demand for accurate sea-ice and weather predictions, information on the status of the Arctic Ocean (AO) and its marine life, and complex predictions of future scenarios. To address these issues and to develop policy recommendations for a sustainable usage of the AO and its resources, the international Arctic science community must have access to world-class research icebreakers (RIs) to access the ice-covered AO. The new EU infrastructure project ARICE joins the efforts of 14 partners from 12 different countries to provide Europe with better capacities for marine-based research in the AO. ARICE will develop strategies to ensure the optimal use of the existing polar research vessels and will work towards an International Arctic Research Icebreaker Consortium which shares and jointly funds operational ship time on the available RIs.
ARICE will also provide transnational access to six key European and international RIs for European scientists, based on scientific excellence of submitted proposals. Amongst others, it will give access to the winter experiment MOSAiC on board the PRV Polarstern.
ARICE is partnering with the maritime industry on a "ships and platforms of opportunity" programme and will improve the research icebreakers' services by exploring into new key technologies which could lead to an improvement of ship-based and autonomous measurements in the AO.

Thu_377_SH-6_962
International Collaboration at Ny-Ålesund Research Station in Svalbard, Norway

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The Ny-Ålesund Arctic Research Station in Svalbard, Norway, is a location for true international research collaboration. Ny-Ålesund is located at the northernmost point of the warm Atlantic Ocean inflow, and hosts a sophisticated infrastructure enabling observations of relevant parameters in the ocean, on land, and in the atmosphere. The site is thus, among other, ideally positioned for research and monitoring of contemporary environmental changes related to climate change issues. With its long-term data series, the station represents one of the most important environmental monitoring site in the Arctic, and hosts numerous international multidisciplinary collaborative science projects from institutions from more than ten nations. With so many actors and initiatives, it is essential creating coordination tools for increased and enhanced collaboration.
The Ny-Ålesund Science Managers Committee (NySMAC) was established some twenty years ago to enhance cooperation and coordination between institutions, and includes representatives from all parties with major vested interests in Ny-Ålesund.
The research in Ny-Ålesund is coordinated through four flagship programs: Atmosphere, Marine System, Terrestrial Ecosystem and Glaciology. The flagship's chair and science committees are working on establishing meeting-places for scientific discussions and collaboration, coordinating field-activities, and generally increasing information flow between the individual research groups.

Thu_378_SH-6_1085
Knowledge Production in Polar Research: Science, Creativity and Infrastructure

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Remote polar research stations and field camps may embody a long-term combination of extreme weather, physical boundedness, and blurred boundaries among work, play, and sleep as personnel necessarily work, live, and socialize within the same, fairly-restricted space. Many of those personnel document and share their experiences through creative work including writing, visual and performing arts, and craft. This creative documentation appears to be a common practice in remote research settings and a significant, yet overlooked, form of knowledge production. In addition to these creative documentation practices, there seems also to be a more pragmatic type of creativity operating as scientists, engineers, and support staff manipulate station infrastructure and use limited materials to facilitate their work and domesticate an austere living environment. Thus, it appears that in these remote research settings, science, creativity, and infrastructure function together in unexpected and exciting ways; yet, despite the critical implications of polar science, the creative processes at work in polar research settings have received little scholarly attention. The proposed work uses archival research and semi-structured interviews to expand scholarly understanding of the roles of creativity in knowledge production and to advance infrastructure studies by exploring how science and creativity interact through material, technical, and social infrastructures in remote research settings.

Thu_379_SH-6_1123
Efficacy of Outreach Efforts: An Insight from Stakeholders

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The role of science in sound decision making is vital. Scientific awareness helps people to see the socio-scientific problems in different way and try to find their solution or how they can contribute in solving the problem.
Outreach efforts at NCAOR have been made to link the science with its stakeholders. The pervasiveness of science is well explained by organizing public lectures and events like Open Day, Antarctic Day, educational tours, etc for students and/or community. The main aim of such efforts is to make students/ community aware about the polar sciences with respect to Indian endeavors in Polar Regions and also global socio-scientific issues like climate change etc. Moreover, the engagement of community creates a sense of appreciation for the scientist which is a source of motivation and encouragement for scientists.
Although the increased response received from schools and colleges indicates its success. However, a survey has been conducted to understand and assess the efficacy of outreach activities. The survey included the opinions and suggestions of school and college teachers, school and college students etc. based on their experiences either in events or educational tours to NCAOR. The survey indicated increasing interest of audiences in Polar sciences, which is also a motivation for the team to further improve the outreach activities so that more and more number of audiences can be approached. This is an attempt to inculcate a scientific outlook in them.

Thu_380_SH-6_1214
The State of Environmental Science in Svalbard - The SIOS Optimisation Report

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The State of Environmental Science in Svalbard (SESS) is an annual report produced by the Svalbard Integrated Arctic Earth Observing System (SIOS). It summarises the state of current knowledge of key Earth System Science parameters in and around the Norwegian High Arctic archipelago of Svalbard. The SESS report outlines the work that has been done in the previous years within the SIOS cooperation to optimise the observing system and recommends research priorities for the following year(s).
The report contains information about the long-term monitoring data that form the core of the SIOS observing system. It will also cover new, innovative monitoring and research that has been carried out through SIOS. The focus is on integrating datasets, encouraging new thinking about connections between measured parameters and pursuing quantitative links. In addition to evaluating the state of current knowledge, the SESS report highlights the questions that remain unanswered and recommends solutions.
SIOS promotes scientific innovation and sees cooperation across nations and disciplines as an important means to this end. By improving access to new and existing monitoring data, prioritising investment in new research infrastructure and strengthening collaboration, SIOS will use the SESS report to promote innovative solutions to answering the big questions in Earth System Science.
The preliminary findings of the first SESS report are presented here. It will be published in autumn 2018.

Thu_381_SH-6_1238
Disaster Diplomacy in the Arctic: Advancing Research and Bridging Boundaries

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Disasters are destructive anywhere, but in the Arctic, the disruption is further intensified by the region's unique features. Lack of preparation for the weather, vast distances, limited physical and communication infrastructure, and seasonal lack of daylight pose significant obstacles to emergency response in the region. Collaboration between disaster scholars and practitioners across the Arctic countries could significantly reduce the adverse impacts of disasters. Examples of collaborative initiatives include search and rescue exercises, and exchange of best practices in disaster risk and crisis management among emergency managers and Arctic populations. Benefits of international and interdisciplinary research and practice collaborations include advancement in risk assessment and monitoring, and disaster risk reduction. Faced with shared risk, opposing parties are often eager to collaborate to find solutions. Fostering disaster diplomacy in the Arctic would help to bridge the boundaries between diverse communities with shared risk, and advance scientific understanding of disasters. The effectiveness of disaster diplomacy was evident in the 2015-2016 collaboration between US and Russian scientists, emergency managers, regional administration, and communities' leaders to reduce adverse impacts of spring floods in Alaska and the Sakha Republic (Siberia). This and other examples of effective disaster diplomacy in the Arctic will be discussed.

Thu_382_SH-6_1308
Young Researchers Develop Lists of Sustainable Practice in Arctic Communities

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Pairing scientific and traditional knowledge approaches is crucial to understanding the fate of environmental systems under ongoing climate change; however creating a bridge between non-local, non-indigenous research scientists and traditional knowledge holders in northern communities brings its own challenges. In an IASC cross-cutting initiative, Fellows of the Terrestrial, Cryosphere and Marine Working Groups organized a workshop on “Community-based Research: Do`s and Don`ts of Arctic Research” bringing together young researchers with resident Arctic representatives and experts to discuss best practices in the exchange of traditional and scientific knowledge and in conducting research in northern communities.
The format and organization of the workshop allowed an interactive and fruitful discussion, generating a diverse list of Arctic Research considerations and sustainable practices. An extensive list of positive (Do`s) and few negative recommendations (Don`ts) was generated together with the young researchers and Arctic representatives, including considerations of
(1) the research design and early planning,
(2) the contribution of science to northern communities,
(3) the relationship of researchers and indigenous people,
(4) the communication and overall impression of visiting scientists and
(5) ways to get involved with local people.
This study is a good example of bottom-up strategy development to enhance knowledge transfer between scientists and indigenous communities.

Thu_383_SH-6_1536
Research Vessel Aranda - Experienced, Refitted and Again Ready for Polar Work

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Finnish research vessel Aranda has undergone a major conversion and refit during 2017-2018. In this update the vessel´s ability and capacity for polar work has been significantly improved and enhanced.
Since commissioning in 1989, Aranda has completed two expeditions to the Antarctic, and several to Arctic Seas. Aranda was originally designed as a polar r/v, and these properties have been further enhanced in the conversion/refit. Aranda is oceanic class research vessel, and has very good capacity for 3 season ice edge work in the Arctic Seas. Aranda is one of very few mid-size polar capacity research vessels, with a very good capacity/cost ratio, especially in ICES/European Arctic area.
Presentation will give a full description of Aranda´s conversion/refit, and describe her capacity for polar work in different diciplines, most important of which is arctic biological oceanography, environmental research and food web studies. Aranda is also very environmentally friendly r/v, with very low noise emission to sea, high fuel efficiency, and capacity for using biofuels.

Thu_384_SH-6_1644
Year of Polar Prediction - Bridging Boundaries to Improve Environmental Safety

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The Year of Polar Prediction (YOPP) has been initiated by the World Meteorological Organization's World Weather Research Programme resulting from the ongoing changes in polar regions and increasing new opportunities such as raising economic, touristic, transportation, and scientific activities. Scheduled from mid-2017 to mid-2019, YOPP is a major international activity to significantly advance our environmental prediction capabilities for the polar regions and beyond on a wide range of time scales from hours to seasons. Supporting improved weather and climate services, various international stakeholders such as the interdisciplinary polar science community, the operational centres providing but also those using polar forecast products are involved when it comes to the various YOPP activities such as intensive observing, modelling, prediction, verification, user-engagement and education. The International Coordination Office for Polar Prediction hosted by the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, not only oversees everyday activities and fosters communication and outreach but also coordinates, plans and prepares details of the different work packages together with the YOPP steering group and several task teams. Engaging such a wide range of interdisciplinary and international stakeholder groups, YOPP will contribute to the knowledge base needed to managing the opportunities and risks that come with polar climate change.

Thu_385_SH-6_1666
Towards the Marine Arctic Component of the Pan-Eurasian Experiment (PEEX)

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The recent rapid climate change in the marine Arctic has strong environmental and socio-economic impacts, which calls for enhancement of cross-disciplinary research. We present a plan for a marine Arctic component of PEEX. The plan is based on
(a) evaluation of the state and change of the marine Arctic climate and environmental system,
(b) identification of the actual research needs and the state of existing observations in relation to the needs,
(c) evaluation of the information available on the basis of atmospheric and ocean reanalyses,
(d) and evaluation of the relevant socio-economic and cultural aspects that both affect and are affected by the climate and environmental changes.
Among the first practical steps is establishment of a coherent, coordinated, comprehensive observation system. It is a pronounced technological and logistical challenge, but advance is possible via international collaboration, new observation technology, community-based coastal observations respectful for knowledge holders, better data management, and better reanalyses supporting observations. The marine Arctic component of PEEX is aimed to be integrated with the well-established structure and activities of the terrestrial and atmospheric components of PEEX. This requires particular attention to the linkage and feedback processes between the marine Arctic and Eurasian continent. These include atmospheric transports in and out of the Arctic, river discharge, and various other coastal processes.

Thu_387_SH-6_1852
Rapid Response to Environmental Emergency Alerts. An INTERACT Initiative

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INTERACT - International Network for Terrestrial Research and Monitoring in the Arctic is an infrastructure project funded by the EU. Its main objective is to build capacity for identifying, understanding, predicting and responding to diverse environmental changes throughout the wide environmental and land-use envelopes of the Arctic. It encompases a circum Arctic network of 82 terrestrial field bases in Europe, Russia, US, Canada and stations in northern Alpine regions.
Rapid response to environmental emergency alerts, the “Red Phone”, is a work package within INTERACT with a main goal to help protect Arctic and global residents from the hazards of potential future environmental emergencies by identifying and responding to any upcoming environmental hazards and disasters. Relevant agencies and organisations (such as GEO, Arctic council, SAON, COOPEUS, CLINF, etc) are planned to be contacted to help with rapid response actions.
The Red Phone's main output will be the development of protocols for monitoring of any potential environmental risks and hazards and a subsequent implementation of an alert system for Arctic research stations and adjoining territories.
The whole project is dependent on efficient networking throughout the Arctic, for which INTERACT provides a great platform with its comprehensive net of research stations where sampling and observations can be carried out simultaneously and comparatively across a wide range of territories, often in remote regions.

Thu_388_SH-6_1876
Polar Research Center - Together Conducting Research in Svalbard

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Polar Research Center is an independent unit of the university´s Faculty of Earth Sciences of Nicolaus Copernicus University in Torun.
Main tasks of Polar Research Center are:
- Initiating and leading interdisciplinary research in polar regions and other glaciated areas,
- Encouraging interdisciplinary research projects,
- Supporting Polish Nicolaus University Polar Station. Kaffiøyra, Spitsbergen,
- Cooperation with Polish and foreign polar research institutions,
- Cooperation with non-academic partners interested in polar research and exploration,
- Promoting knowledge about polar regions and their important role in our life and global provesses.

Our research in Svalbard has essentially covered all components of the geographic environment, however with a particular focus on glaciology, glacial geomorphology, permafrost and periglacial processes, as well as climatological and biological studies. The glaciology studies cover: mass balance of glaciers, glaciers geometry change processes, glacier dynamics, glacier surge, glacier-climate interactions, polar hydrology, subaqual extent change records in the forefields of marine-type glaciers and others.
For us Svalbard is a unique natural research laboratory. It is a place where we can witness processes which once shaped the surface features of Poland. As such, it provides a perfect educational base for research fellows, academic staff, and doctoral, postgraduate and undergraduate students.

Thu_389_SH-6_2225
Connecting Polar Research across Boundaries at the Snow Remote Sensing Example

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The presentation considers opportunities of communication, coordination, and collaboration to help span disciplinary, institutional, international, and sector boundaries at the example of snow remote sensing.
The NASA snow algorithms are capable to provide daily global snow output including subpixel snow fraction at 500 m resolution. Snow fraction information improves downstream remote sensing products: vertical atmosphere profiles, soil moisture, heat fluxes, etc. The global snow observation is an important component of land surface and hydrologic models estimating water storage and runoff from melting snow for agricultural and other activities. Snow cover influences not only the terrestrial water cycle but
climate change too.
Recent developments show increasing interest to fractional snow cover, confirmed by the decisions made by European Space Agency and Japan Aerospace Exploration Agency to derive snow fraction using visible observations from Sentinel-3 and GCOM-C respectively. The collaboration between several parties tackling the same problem can be very promising and successful.
After the SCAR Working Group, SnowAnt, made its first successful action - organizing Snow Science Winter School, it is recommended that the group contributes efforts aimed at the key goal - improve the knowledge on processes in Antarctic snow and its feedbacks to the climate system; develop a snow classification for Antarctica - the tasks impossible without implementing snow remote sensing.

Thu_390_SH-6_2245
Studying the Poverty of Local Communities in the North: Ways of Cooperation

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The interdisciplinary project "Comparative analysis of the sources of incomes and the problem of poverty in traditional communities of northern regions of Russia, the USA and Canada" is running with funding of the Russian Foundation for Basic Research in 2017-2019. It aims at a comprehensive study of the phenomenon of poverty among native communities of the northern regions and the development of effective mechanisms to overcome it.
The first stage of 2017 consists in the analysis of the structure and size of incomes, poverty level as well, retrospective analysis of the spatial transformation, accessibility to lands and natural resources for the local people and the evolution of the social policies in designated northern countries. Regional factors that affect poverty and its long-term retention are studied in conjunction with other factors (institutional, demographic, and economic). Surveys in selected settlements were implemented on this basis.
Thereby, subjects of presentation and discussion are:
- common issues and national features of poverty including inefficient and redundant mechanisms of social protection;
- cases of industrial projects affecting the sustainability of the traditional economy and communities of the indigenous peoples of the Russian North;
- benefits and risks of the local communities under implementation of the model Guaranteed Annual Income or Basic Income;
- cross-country studies and surveys.

Thu_392_SH-6_2252
The INTERACT Fieldwork Guidebook - A Brief Introduction

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The Horizon-2020 INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic) aims for a geographically comprehensive and excellent state-of-the-art terrestrial research infrastructure throughout the Arctic and in adjoining forest and alpine regions. The project will help to identify environmental change, to facilitate understanding and prediction of future change, and to inform decision makers about societally-relevant impacts. INTERACT uniquely unites 83 research stations offering access to the Arctic and surrounding regions and stimulating new collaborations and information flow.
Effectively carrying out research in the field means being well-prepared in relation to planning and safe execution of the field activities. Together with the Association of Polar Early Career Scientists (APECS), INTERACT is developing a fieldwork planning handbook and a general practical field guide. The handbook will include recommendations for preparing for fieldwork, covering a wide range of topics such as health and safety, environmental issues, outreach, and country-specific sections on obtaining relevant permits. The field guide will be a practical guide to be carried into the field, providing recommendations on practical issues related to conducting field work at research stations. The handbook and field guide will be developed in cooperation with INTERACT station managers to make use of their wealth of expertise.

Thu_393_SH-6_2318
Early Career Engagement Bridges Polar Boundaries: A Case Study from Horizon 2020

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Early Career Researchers (ECRs) comprise a significant portion of the workforce in the Arctic and Antarctic communities, yet remain an underutilized resource in many large polar research projects. A key goal of the Association for Early Career Polar Scientists (APECS) is to develop opportunities for ECRs, and part of that is achieved by integrating ECRs into polar research and coordination activities from the outset. Benefits to projects who welcome ECRs include gaining unique perspectives from passionate, skilled minds as well as having an active role in training future leaders of these groups. APECS also serves as an institutional partner to support early career involvement to reduce a project's organizational risk of working with ECRs given, for example, inherent and relatively unpredictable career transitions. This poster will describe opportunities available to ECRs through APECS' engagement in large consortia like the EU Horizon 2020 funded projects APPLICATE, INTERACT, ARICE, and NUNATARYUK. APECS is uniquely qualified to plan digital and in-person training experiences, as evidenced through our long-term webinar series and the Polar Prediction School 2018 as part of APPLICATE. Successful collaborations have depended on early engagement with APECS as a partner in order to integrate education, outreach, and training activities within these projects. APECS looks forward to working with other polar research groups to include ECRs through every phase of development.

Thu_394_SH-6_2377
RoSES - Role of the Southern Ocean in the Earth System: A NERC Funded Programme

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The Role of the Southern Ocean in the Earth System - RoSES - is a programme funded by the UK's Natural Environment Research Counci (NERC) and aims to substantially reduce uncertainty in 21st century global climate change projections through improved assessment of the Southern Ocean carbon sink. It is a five-year programme, funded from 2017 to 2022. RoSES (@RoSES_ocean, www.roses.ac.uk) currently consists of three projects (with a fourth to be funded in due course):
- CUSTARD: Carbon Uptake and Seasonal Traits in Antarctic Remineralisation Depth. Principal Investigator: Dr Adrian Martin, National Oceanography Centre. #RoSES_CUSTARD
- PICCOLO: Processes Influencing Carbon Cycling: Observations of the Lower limb of the Antarctic Overturning. Principal Investigator: Prof Karen Heywood, University of East Anglia coPI Tom Bell, Plymouth Marine Laboratory. #RoSES_PICCOLO
- SONATA: Southern OceaN optimal Approach to Assess the carbon state, variability and climatic drivers. Principal Investigator: Prof. Corrine Le Quere, University of East Anglia. #RoSES_SONATA
Here we present the aims and objectives of these three projects, and their links to the ORCHESTRA programme - Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports. @ORCHESTRAproj, www.bas.ac.uk/projects/orchestra.

Thu_395_SH-6_2525
Arctic Pedagogic Landscape Inquiry Bridging the Polar to the Peak

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Synthesis of high latitude and high altitude, territories of high peaks expand from Arctic polar regions to the Third Pole Hindu Kush-Himalayan regions, storing snow and ice and facing climate change, industrial challenge, infrastructure development, resource management, traveler pressure and indigenous need. Landscape researchers situated in Tromso been inquiring into Arctic challenges, are expeditioners to Mount Gongga of the third pole region, observing and mapping similar social and ecological challenges, referencing Arctic cases, providing alternatives to the high altitude. Perceptional and motional mapping from ground into both the polar and the peak, high walking routes and high ecological lines, and representational images of both start to bridge the high polar to the high peak. The paper is a critical reflection on the bridging value of Arctic pedagogic landscape inquiry to Third Pole high peaks.

Thu_396_SH-6_2531
International Cooperation in Arctic: The Role of the UK Arctic Office

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The biggest questions in Arctic research need the best partnerships and the most joined-up research communities. The UK Arctic Office, funded by the Natural Environment Research Council, exists to:
- support UK-based researchers in the High North;
- provide advice to policy makers; and
- develop new international research initiatives across the Arctic

Since 2010 the UK Arctic Office has supported a wide range of initiatives and is ambitious to do even more. This Abstract provides attendees with the opportunity to hear about the role of the Office; to discover new international initiatives, such as the UK-Canada Bursaries Programme (2017 & 2018); and see how a small team can add value in building new collaboration.

Thu_397_SH-7_61
British Science and the Forge of Antarctic Politics: 1895 - 1961

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The United Kingdom has always been a key player in Antarctic politics. Almost all studies regarding the politics of the white continent on the period previous to the Antarctic Treaty have taken into consideration the British policy on those latitudes. Much of those studies have centered their attention into the geopolitical variables that influenced the British imperial ambitions, and when considering the role of 'science', they usually have ascribed it a merely 'instrumental' —when not absolutely accessory— role. Based on the idea that scientists and scientific institutions have played a significant role in shaping the Antarctic politics, we contend that 'science' could not be reduced to being instrumental to the imperialist policy, and that exerted important influences on the political agenda setting and further structuring of southern polar politics, particularly in determining the shape of the final arrangement of the 1959 Antarctic Treaty. In order to contrast those ideas and adopting a pluralistic approach informed on the Historical Sociology, we will apply a process tracing of the British Antarctic history through archival material, paying special attention to the involvement of scientist and scientific institutions, alongside other geopolitical, economic and ideational variables.

Thu_399_SH-7_539
The Policy Relevancy of Arctic Marine Scientific Research: A PRS Case Study

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Many of the challenges facing modern societies today like climate change cannot be adequately addressed without the input from science and scientific advice. At the same time, the science necessary to solve societal problems and the expensive scientific activities to support it, more often than not, need to be prioritized and selected because of, for example, budgetary reasons. The Policy-Relevant-Science (PRS) study, embarked upon by Kobe University PCRC and JAMSTEC under the Japanese ArCS project, tries to explore academically the ways in which to support such decision making by public entities regarding the prioritization and selection of scientific activities.
In our examination, we utilize the Value Tree Analysis (VTA) as a methodological tool for identifying the degree of policy relevancy of Arctic marine observation activities. In applying the VAT, we analyze the Arctic strategies of major Arctic marine research countries so as to clarify the key policy objectives in each of the major international Arctic policy areas. The policy relevancy is the subjective value to be achieved in our PRS Study. We then examine the key scientific outcomes that would support and realize the key policy objectives. The degree of policy relevancy of a particular Arctic marine observation activity would be evaluated by examining how much such activity supports the multiple key scientific outcomes that in turn support to achieve the key policy objectives of the international community.

Thu_400_SH-7_648
Importance and Interest on Arctic and Svalbard Treaty

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As the Arctic is increasingly becoming one of the focus points of international community, Svaldbard Islands, with its location, rich wildlife, arctic nature, and old mining towns also draw attention of the states which are interested in the region. The 1920 Svalbard Treaty confers full and absolute sovereignty on Norway. Nevertheless, under the Treaty, Norway is obliged to give the citizens and companies of the signatory nations equal rights in certain areas, such as; entrance to and residence in Svalbard; fishing, hunting and trapping; maritime, industrial, scientific research, mining and commercial activities; acquisition and utilization of property and mineral rights.
More than 40 states have signed the treaty since 1920. Turkey, a maritime country surrounded by sea on three sides, with its 80-million population as having seventeenth largest economy and being close interest to global affairs is not among signatory states. Besides, Turkey has signed the Antarctic Treaty in 1996. In a very short period, launching the initiatives to become a party of the Svalbard Treaty will be evaluated.
This study aims to reveal the position of Turkey in Arctic related issues within the concept of Svalbard Treaty.
Keywords: Arctic, Svalbard Treaty, Turkey

Thu_401_SH-7_1193
The Diplomacy of Science in Antarctica

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Antarctic diplomacy seen through the lens of States negotiating The Antarctic Treaty after World War II and the environmental protections of the 1990s has to date emphasised traditional diplomatic practices and approaches. Much of what is known outside Ministries for Foreign Affairs about the dynamics of Antarctic diplomacy behind the scenes comes to us via the recollections of diplomats in conference papers, and the personal insights of Antarctic decision-makers published after they left office. No matter their starting point, or whether these negotiations were about State interests exclusively or preserving the continent untouched in keeping with collective interests, many of these decision-makers took opportunities inside and outside diplomatic tracks to reiterate that Antarctica and its management constitute a special case in international engagement. 'Specialness' is prominent in the diplomatic lexicon of Antarctica. This presentation is responding to the challenge that this specialness poses by exploring what is unique, different, replicable or generalisable about Antarctic diplomacy. It focuses on whether Antarctic diplomacy has a signature that sets it apart from mainstream diplomacy, and what this means for managing Antarctica seen through the lens of science diplomacy as an evolving and necessary adjunct to international engagement on Antarctica and Antarctic issues.

Thu_403_SH-7_1983
How Can My Research Data Be Useful for Conservation and Policy-making?

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Biodiversity conservation is a main goal of the Protocol on Environmental Protection to the Antarctic Treaty. Policy should be based on the best scientific data available, and policy-makers are eager to have access to up-to-date and high quality information. Scientists are on the frontline to gather relevant data, though their primary aim is to publish in international refereed journals. However, once the data, and resulting information, have been scrutinized and quality-checked during the review process, their usefulness for policy-making should be also considered as they may have the potential to inform conservation measures or document processes affecting biodiversity.
However, it is not always simple to find out how to convey this information to policy-makers. In this poster, three main pathways are presented, through
(a) the Scientific Committee on Antarctic Research (SCAR) and its Standing Committee on the Antarctic Treaty System (SCATS: see www.scar.org/policy/scats/);
(b) your National Delegates to the Committee on Environmental Protection (see: www.ats.aq/devAS/cep_authorities.aspx); or
(c) writing a summary for the Antarctic Environments Portal (www.environments.aq). The latter publishes short articles presenting state-of-the-art research findings after a thorough review process.
Hopefully, this description will encourage scientists to consider the value of their research data for conservation of Antarctic biodiversity.

Thu_404_SH-7_2243
An Assessment of South Korean-New Zealand Cooperation in Antarctica

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While the Antarctic Treaty System intended to keep Antarctica an area of international cooperation and science free from politics and militarization, it is not protected from global and regional power transformations today. Among the emerging players from Asia, South Korea has already been identified as likely key challenger to the status-quo polar order. This raises questions about what South Korea wants from its presence in Antarctica and how challenging Seoul's demands are perceived to be for the existing Antarctic order. This paper is an role theoretical assessment of Antarctic cooperation between South Korea and its main partner, New Zealand. This cooperation is crucial for South Korea not only for the politics and logistics in relation to the newly established Jang Bogo research station in Terra Nova Bay, but also scientifically between the Antarctic agencies Antarctica New Zealand and the Korean Polar Research Institute (KOPRI). How was this cooperation experienced so far and how is it valued especially with regard to an increasingly less engaged US Antarctic program and an growing Chinese polar presence? How do especially the NZ government and Antarctica New Zealand perceive South Korea in the role of a ´challenger´? Does Wellington see any chance in socializing Seoul through engagement into something else than a challenger to the Antarctic order?

Morning Plenary III
22.06.2018 07:50-09:00, A Davos

Keynote Lecture V
The Emerging Importance of the Humanities and Social Sciences in Polar Research

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The humanities and social sciences are increasingly recognized as central components of Antarctic as well as Arctic research. This presentation provides an overview of emerging trends with a particular focus on critical heritage studies, human relationships to physical geographical environments, and the construction of governance structures. Specific examples discussed include 1) processes for identifying, managing, and in some cases re-using the material legacies of human presence; 2) how the construction and implementation of fauna management regimes reflect particular conceptions of how humans should interact with the natural world; and 3) how changing social expectations can be accommodated within polar governance structures. In each case, emphasis is placed upon exploring the assumptions that underpin human activity in the polar regions and how these can (and indeed) have changed through time. The presentation concludes with brief reflections on how the significant differences between the Arctic and Antarctic have shaped research agendas, while nevertheless including substantial opportunities for bi-polar comparisons.

Morning Plenary III
22.06.2018 07:50-09:00, A Davos

Keynote Lecture VI
Dating West Antarctic ice sheet collapse using genomic data

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West Antarctica has been identified as one of the fastest warming places on the planet. Large parts of the West Antarctic Ice Sheet (WAIS) are predicted to melt as a result of climate change. Reducing uncertainties over the rate of that melt has been identified as a key research priority in the 5th IPCC Assessment Report. It is well understood from geological reconstructions that there are times in the past when average temperatures were only ~2-3°C warmer than today, but global sea levels may have been up to 20 m higher. Determining which of these times may have been accompanied by a widespread collapse of the WAIS is needed to provide critical insights into the potential rate and magnitude of sea-level rise over the coming decades and centuries. It is unknown whether there was a collapse of the WAIS during the Last Interglacial, 125,000 years ago – the last time Earth was +1°C warmer than the pre-industrial period. A recent ice sheet model implies Antarctica may have contributed up to 5m of the 6-9m of global sea-level rise known from geological evidence. Confirming this is particularly important for constraining future sea level projections. The complete collapse of the WAIS would lead to the existence of trans-west Antarctic seaways linking the present day Ross, Weddell and Amundsen Seas. Such seaways would allow marine animal migration across newly opened straits, and a genetic signature of that historical connectivity will persist in the genomes of benthic animals present in Antarctica today. I will describe how we are using this information to distinguish between hypotheses to determine when the WAIS last collapsed.

BE-9c - Life distribution and responses to environmental changes in Polar ecosystems 22.06.2018 09:00-10:30, C Aspen

1
The Influence of Abiotic Factors on the Plant Growth in the High Arctic

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The aim of our studies was to comprehensively evaluate the abiotic factors that influence changes in the annual growth rates of selected species of tundra plant. The study was conducted on Wedel Jarlsberg Land, SW Spitsbergen.
It is argued that the spatial and seasonal variability of annual growth is determined by the rate at which snow cover disappears, and also by soil moisture, which determines the plants' access to water. Soil moisture depends on soil particle size distribution and weather; it is regulated by the supply of snowmelt water and rainfall and also the depth at which the top layer of permafrost is situated (thaw depth), which determines the level of groundwater during the growing season. The spatial characteristics of the process of seasonal snow cover disappearance are co-determined by the morphology of the substrate and the physical properties of the soil. An important but also destructive role is played by thawing episodes, which are increasingly frequent in the winter season. The observed trend towards warming in polar areas does not inevitably lead to an increase in biomass production. An increase in temperature during the growing season does not necessarily promote plant growth, but rather is an indicator of drought stress caused by the lowering of groundwater levels related to the increase in the depth to which the active permafrost layer thaws.

437
Remote Sensing of Spatial Structure of the Circumpolar Tundra-taiga Transition

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The tundra-taiga ecotone (TTE) or the arctic treeline is the world's longest vegetation transition zone, the configuration, composition and dynamics of which vary greatly across the circumarctic region. Overall, the TTE responds positively to global temperature changes with a net global treeline advance, although showing significant regional diversities in movement patterns, which are linked to different controlling factors of tree growth. Despite its high ecological significance, currently available derivation of the TTE suffers from low spatial resolution and high dependence on arbitrary vegetation coverage thresholds. This study uses texture analysis of Landsat Vegetation Continuous Field data to separate the TTE from other land cover types trained using a collection of ground truth sites with known types. We also further explore the detailed texture differences within the treeline class which greatly influences treeline response to climate change. Using the FOurier-based Textural Ordination (FOTO) technique, treeline areas are separated into abrupt, diffuse and islands forms which correspond to different levels of treeline vulnerability to climate change. Thus, this study identifies the TTE and further divides it into ecologically significant categories, which may serve as a global map of treeline vulnerability and provide the basis for future studies into the detailed correlation between treeline processes and spatial characteristics.

1051
Marginal Population Hotspots of Cold-adapted Species in a Warmer World

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We know little about factors shaping geographical location of margin ranges in plant species. However, understanding factors and processes allowing populations to survive at the range edge or migrate is crucial to trace the effect of past climate changes and to predict future species distribution and evolution. This is particularly important for cold-adapted species that are predicted to be affected by global warming more than other species, especially at the southern range edge.
Consequently, identification of areas where arctic-alpine, circumpolar and circumboreal species reach their southernmost ends of their distribution and group together (marginal hotspots) will present a unique opportunity to highlight uncover processes that shaped current biogeographical patterns, as well as prepare for future scenarios and set conservation management.
We identify areas where southernmost populations of 183 cold-adapted taxa, are clustered in north America and Europe, based on the number of species reaching their southern range edge in each cell of a 50×50 km grid. Marginality hotspot partially correspond to known refugia, in other cases high latitude areas are extremely important.
From an applied conservation perspective, we detected areas where studies and monitoring of cold-adapted species are best performed to maximize the knowledge gain and where conservation efforts should be directed to allow marginality hotspots to continue their function of refugia in a warmer world.

462
Micodiversity across Altitudinal Gradient and Solar Exposure in Antarctic Rocks

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Rocky outcrops support the highest standing biomass in the Antarctic ice-free areas; along the Victoria Land, the largest ice-free area of the McMurdo Dry Valleys, together with mountain tops and nunataks hanging from the ice sheet, represent significant examples. In some of these locations, conditions approach the limits of tolerability for most organisms and endolithic communities are the predominant life-forms. This study focused on sandstone, the best substratum for endolithic colonization, collected in 3 locations over an altitudinal gradient from 800 to 3100 m asl; both north/south sun expositions were considered. Rock samples were analyzed with a meta-barcoding approach on Illumina MiSeq platform, targeting the Internal Transcribed Sequence 1 (ITS1) region for fungi. Taxonomic results, alpha-diversity and statistical analysis were performed to investigate microbial diversity and community structure related to environmental changes. Preliminary results show a large predominance of Ascomycota in all the sites studied, the classes Lecanoromycetes and Dothideomycetes prevailed. Among the localities considered, species richness varied between 80 and 106. All the biodiversity indexes (Shannon, Pielou and Simpson) clearly showed that the number of predominating species decreases with the environmental pressure, indicating a higher specialization of the community, and that sun exposition is the parameter that influences fungal community composition most.

1922
Physiological Responses and DNA Repair in *Pseudogymnoascus* spp. Fungi toward UV

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Solar radiation drives almost all biological activities on Earth and regulates morphological, biochemical and developmental processes in many organisms. Soil microorganisms such as fungi within the polar regions can be continuously exposed to considerable solar UV radiation in the summer. This could negatively impact their key functions, for instance in regulating nitrogen and carbon cycles. We examined the responses of four polar strains of *Pseudogymnoascus* spp. (isolated from Hornsund, Svalbard, and King George Island, Antarctic), assessing growth, pigmentation, conidia production, post-UV DNA lesion changes and expression of DNA repair genes. Cultures were irradiated with 6.1 $kJm^{-2}d^{-1}$ UV-B dosage and 12 h of PAR at 15°C for 10 d in the laboratory. All strains showed growth rate reduction of between 21.74 and 35.52%. Coloured pigment production was not induced by exposure to UV-B, suggesting no dependence on pigments for protection. UV-B exposure also reduced conidia production. We are now targeting genes involved in photoreactivation and nucleotide excision repair, primary DNA repair pathways responsible for maintaining DNA integrity under UV. The expression levels of genes will be determined after UV exposure in dark and light conditions, and UV-induced DNA lesions, CPDs and 6-4PPs will be quantified. Preliminary ELISA results suggest that *Pseudogymnoascus* HND16 R4-1 sp.1 is able to reduce UV-B induced CPDs significantly after 2 h in both dark and light conditions.

1886
Environmental vs Ecological Drivers of Microbial Adaptation to Frozen Ecosystems

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Similar to abiotic particles, microorganisms from marine and terrestrial environments are transported via the atmosphere to glaciers all over the world through dry or wet (snowfall or rain events) deposition, sometimes carried over thousands of kilometers. Once deposited, these organisms can survive in the snow and interact with their environment even at sub-zero temperatures. However, in order to colonize some of these new niches, microorganisms must either already be equipped with, or rapidly acquire, the necessary functions. Since cryosphere environments are undergoing rapid change, they are ideally suited for understanding the dynamic and rapid adaptation of microbial communities. Based on our cold environment metagenomic research performed over the last ten years, different drivers of adaptation lead to dynamic shifts in microbial community structure and function in Arctic environments and strategies used to acquire genes critical for ecosystem functioning. This field and laboratory-based research in snow and ice ecosystems, including sea-ice and terrestrial snow packs, has examined multiple habitats that present steep environmental gradients. As climate change continues, we need to improve our knowledge about the biotic system in order to predict its response to environmental forcing. Microorganisms are both sentinels and bioindicators of change, but the information they encode is rapidly being lost as habitats disappear.

EN-7a - Biogeochemical cycling in the Polar Regions: Terrestrial and Ocean interactions
22.06.2018 09:00-10:30, A Studio

1103
High Fe Lability of Particles Sourced from Glacial Erosion, Heard Island

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Iron (Fe) is a critical micronutrient that controls phytoplankton growth in the Southern Ocean. As part of the Heard Earth-Ocean-Biosphere Interactions (HEOBI) voyage in January/February 2016, we surveyed suspended particles in the water column and underlying sediments at 11 stations over the southern Kerguelen plateau close to Heard and McDonald Islands (HIMI) to assess the sources of natural phytoplankton iron fertilisation in the region. Heard is glaciated, while McDonald is ice-free. These characteristics should, we hypothesise, ensure unique fertilisation in the downstream waters of these highly productive island hotspots. Glacial erosion and fluvial outflow into surrounding waters near Heard proved to be an important source of highly labile nanoparticulate Fe oxides. In contrast, proximal to diffuse gasohydrothermal sites near McDonald, only highly refractory titanium and iron bearing minerals (Ilmenite) were found. We conclude that glacial erosion of Heard Island is an important mechanism of Fe supply to downstream waters and therefore critical to the productivity of the area near-shore and downstream of the Kerguelen plateau. Conversely, shallow gasohydrothermal sources seem less efficient at delivering labile Fe. As our climate warms and our glaciers retreat, this source of labile Fe may temporarily increase and then dramatically decrease into the future.

2255
Sources and Transport of Iron and Organic Carbon in the Lena River

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The Lena River basin, which is one of the largest contributors of organic carbon (OC) and Fe to the Arctic Ocean, is mainly underlain by continuous permafrost. This area is vulnerable to climate driven permaforst thawing, with possible future changes in OC and element fluxes.
Filtered water (< 0.22 µm) with colloids and particle fraction (>0.22 µm) have been separated in samples from the Lena River main channel and major tributaries collected during 2012 to 2017. The particles in river water are dominated by authigenic Fe primarily in the form of chemically reactive ferrihydrite with a wide size range, between 20 to 1 µm. The ferrihydrate constitute about 70% of the particulate Fe transported in the Lena River and tributaries, and thus is an important carrier for trace elements and adsorbed carbon.
The annual export and fluxes of organic carbon, based on concentration data of DOC (dissolved organic C) and POC (particultae organic C) and long term discharge data, showed large geographical variations related to differences in precipitation and catchment topography. The $\delta^{13}C$ and C/N ratios showed that the primary sources of DOC were terrestrial plant debris and soil organic matter (SOM), while POC was a mixture between SOM and aquatic primary production. These results, from a large areal, show that the contribution to the river water concentrations and composition primarily depend on the water flow pathways in a permafrost dominated region.

362
Tracing Controls on Iron Export from High Latitude Peat Soils (Keynote Speaker)

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Incipient warming of peatlands at high latitudes is expected to modify soil drainage and hence the redox conditions, which has implications for Fe export from soils. To disentangle the complex biogeochemical interactions in soils controlling the sources and processes which govern this vital function, understanding the controls on stable isotope fractionation of Fe in peat soils is essential. This study uses Fe isotopes to assess the processes controlling Fe export in a range of Icelandic soils including peat soils derived from the same parent basalt, where Fe isotope variations principally reflect differences in weathering and drainage. An additional constraint on soil weathering is provided by Si stable isotopes. Si supersaturation in solution with respect to amorphous silica is reached upon freezing when Al availability to form aluminosilicates is limited by the affinity of Al for metal-organic complexes. Therefore, the precipitation of amorphous silica in peat soils indirectly supports the formation of metal-organic complexes in poorly drained soils. The influence of organic matter on metals is confirmed using Zn stable isotopes. These observations highlight that in a scenario of decreasing soil drainage with warming high latitude peatlands, Fe export from soils as Fe-organic complexes will increase, which in turn has implications for Fe transport in rivers, and ultimately the delivery of Fe to the oceans.

816
Iron and Nutrient Flux to the Southern Ocean from McMurdo Dry Valleys Antarctica

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Primary production in the Southern Ocean is thought to be limited by the micro-nutrient iron (Fe). Numerous investigations over the past decade have attempted to quantify the major sources and chemical speciation of Fe into the Southern Ocean. The potential sources include icebergs, atmospheric deposition, deep-water upwelling, melting glacier and sea ice, and groundwater/subglacial inflow. Our initial work demonstrated that as glaciers retreat and ice-free areas in Antarctica expand, streams could also be a major source of Fe into the coastal ocean. We have expanded our work, and have examined streams flowing directly into the ocean from the McMurdo Dry Valleys (MDV). In addition to the filterable Fe (passing 0.4 µm filter), we have analyzed a number of these samples for biologically important metals such as Mo and V. We have also compared the stoichiometry of the stream waters (N:P:Si:Fe) to that of phytoplankton, and conclude that these streams provide excess Fe and P, relative to fixed N and Si, needed by plants. Our results support the idea that increased cryospheric loss should increase the flux of Fe and other macro and micro-nutrients into the coastal Southern Ocean.

2540
Impact of Ice-ocean Interactions on Nutrient Fluxes in Barilari Bay, Antarctica

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The West Antarctic Peninsula (WAP) is home to a thriving marine ecosystem whose dynamics are closely linked to the physical environment. Recent studies along the WAP continental shelf have suggested that the seasonal input of iron-rich glacial melt from the continent may serve to regulate primary production. Export of glacial meltwater occurs primarily through coastal bays and fjords, which serve as the link between the large-scale ocean and the ice sheet. Limited observational datasets have identified these systems as hotspots of primary and secondary productivity, suggesting that input of meltwater may have important consequences for both local and regional carbon cycling. In this study, we provide insight into glacier-ocean interactions along the AP by examining physical, chemical and biological properties of Barilari Bay, a coastal embayment where glacier fronts have experienced net retreat since the 1960s. We show that warm, Upper Circumpolar Deep Water, thought as the primary source of heat for submarine melting of the ice sheet, reaches and interacts with the glacier front in this system. In turn, delivery of meltwater affects local ocean circulation, enriching the fjord with macro-nutrients by entraining deep nutrient-rich water through upwelling at the glacier front. Linking these observations to phytoplankton community composition, biomass and productivity provides insight into glacial contributions to local and regional carbon cycling.

601
Scales of Southern Ocean Productivity Responses to Iron Inputs

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Inputs of iron, the nutrient limiting Southern Ocean photosynthesis, are expected to increase in future. To assess possible productivity responses, we examined biomass dynamics (using satellite ocean colour, autonomous profiling floats, and shipboard bio-optics) near the Kerguelen plateau, which has elevated iron inputs from volcanism, glaciers, sediment resuspension, and deep water upwelling. Low iron loss rates (1-2% per day) during downstream transport in the Antarctic Circumpolar Current in winter can explain the overall length scale (1000 km) of the elevated biomass plume. Mesoscale (10-100 km) biomass variations close to the plateau are also reasonably described by Lagrangian transport, provided Fe loss rates are higher in spring (3-5% per day), and recycling or resupply processes modulate Fe influence offshore. Surprisingly, at small scale (1-10 km) close to the Heard and MacDonald islands, phytoplankton biomass is low despite elevated iron and high photosynthetic competency. Multiple processes may contribute, including short residence times and removal by grazing and/or settling induced by lithogenic particle inputs. These varying responses emphasize the difficulty of assessing future Southern Ocean productivity changes from local studies, the importance of considering iron removal processes (noting that first-order removal implies the scope of responses will scale with the logarithm of supply), and the usefulness of comparisons across scales.

1646
Sea Ice Retreat and Cold European Winter Revisited

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Arctic sea ice has been retreating during most of the satellite era. In recent years, Arctic sea ice experienced a dramatic reduction: the summer extent in 2012 and 2016 was only half of the 1979-2000 average. With such dramatic changes in the current sea ice coverage as a point of departure, several studies have linked reduction in wintertime sea ice in the Barents-Kara Seas to cold weather anomalies over Europe and through large scale tele-connections to regional warming elsewhere. Here we aim to investigate the interaction between sea ice changes in the Barents-Kara Seas and mid-latitude dynamics. Particular focus will be if, and how, Arctic sea ice impacts European winter weather, i.e. if the Arctic sea ice works as the ´cold heart´ of European weather. Additionally, the potential for the atmosphere to precondition the sea ice conditions in the Barents-Kara Seas is also investigated. To understand the effects of the sea ice reduction on the full climate system, a fully-coupled atmosphere-ocean-sea ice global climate model, EC-Earth, is used. A new method for assimilating sea ice using the sensible heat flux is implemented in the coupled climate model. Using this method, experiments are performed with reduced sea ice cover in the Barents-Kara seas. Results indicate an increase in extreme cold winters over Europe as a response to this reduction in sea ice cover. Here we present some preliminary analysis of the chain of processes responsible for this apparent teleconnection.

668
Cold Winters in Midlatitudes Coincident with, Not Caused by, Low Arctic Sea Ice

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Rapid Arctic warming has coincided with a spate of cold winters over midlatitude continents. Previous work has proposed two distinct influences of Arctic warming: warm conditions over the Barents-Kara Sea are associated with cold winters across East Asia, whereas severe winters over North America are related with anomalous warmth in the East Siberian-Chukchi Sea. However, this work is based upon correlation and causality has not been established. Here we use physical arguments based on the direction of the surface heat flux over the Arctic regions to elucidate whether low Arctic sea ice is a cause of cold midlatitude winters. We make use of large ensemble simulations with two coupled ocean-atmosphere models under present day conditions. The models are able to accurately capture the two observed modes of interannual variability between low sea ice and cold midlatitude winters, and the anomalous large-scale circulation patterns in which they are embedded. However, these associations are only present during winters when low sea ice coincides with a downward turbulent heat flux, implying the atmosphere is driving the ocean-ice. No midlatitude cooling is found during winters where low sea ice coincides with an upward turbulent heat flux anomaly. This strongly suggests that low sea ice loss is not a cause of severe midlatitude winters, but instead that anomalous large-scale atmospheric circulation simultaneously drives cold midlatitude winters and contributes to Arctic warmth.

721
The 'Warm Arctic Cold Continents' Pattern during 1901 - 2010

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The 'Warm-Arctic Cold-Continents' (WACC) winter weather pattern is investigated using the European Centre for Medium-Range Weather Forecasts 20th Century reanalysis data (ERA20C) spanning 1901-2010. Both the 1920-1940 and 1990-2010 periods are characterized by Arctic Amplification (AA) and mid-latitude cooling, although the Arctic warming signal for 1990-2010 is almost twice as strong as that for 1920-1940. Compared to the reference period of 1951-1980, significant weakening in mid-latitude poleward temperature gradient and zonal wind, wavier upper level flow character, and strong regional blocking frequency/intensity changes are detected during both AA periods. These results based on statistical analyses highlight the possible role of AA in affecting mid-latitude weather patterns, but further work is needed to quantify the influence of AA on particular mid-latitude dynamical features.

575
Significant Contribution of Stratospheric Pathway to “Warm Arctic Cold Siberia”

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Previous studies have extensively documented the impact of Arctic sea ice melting on the midlatitude circulation in winter. However, whether and how sea ice retreat affects the adjacent continent cooling is still unclear and controversial among the scientific community. Here we use a state-of-the-art atmospheric general circulation model, that has been extended into the stratosphere and above, to provide evidence of “Warm Arctic Cold Siberia” pattern. In particular, we explicitly show that an active stratosphere plays a key role in the cold conditions in northern Asia in the subsequent winter following sea ice loss over the BKS. The mechanism involves two-way stratosphere-troposphere coupling and the downward effect from the stratosphere significantly enhances the ridge over East Europe and trough over East Asia, which causes cold air advection and increased frequency of extreme cold air outbreaks over Siberia. The results suggest that it is necessary to use a well-resolved stratosphere model to understand the full impact of Arctic sea ice retreat.

1537
Mechanisms for the Influence of Arctic Sea-ice Loss on Mid-latitudes

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To explore the mechanisms linking Arctic sea-ice loss to changes in mid-latitude surface temperatures, we conduct idealised modelling experiments. In these, we use an intermediate general circulation model and confine sea-ice loss of two different magnitudes to the Atlantic or Pacific sectors of the Arctic (respectively the Barents-Kara or Chukchi-Bering Seas). Extending previous findings, in the Atlantic and Pacific experiments there are opposite effects on the winter stratospheric polar vortex, for both large-magnitude (end of twenty-first century) and moderate-magnitude sea-ice loss. Accordingly, there are opposite tropospheric Arctic Oscillation (AO) responses for moderate-magnitude sea-ice loss. However, there are similar strength negative tropospheric AO responses for large-magnitude sea-ice loss, suggesting that tropospheric mechanisms become relatively more important than stratospheric mechanisms as the sea-ice loss magnitude increases. The mid-latitude surface temperature response for each loss region and magnitude can be understood as the combination of an 'indirect' part induced by the large-scale circulation (AO) response, and a residual 'direct' part that is local to the loss region. Additional experiments designed to definitively quantify the relative role played by stratospheric and tropospheric mechanisms in the tropospheric AO responses will also be discussed.

2328
How Does Arctic Change Affect European Weather and Climate?

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During the period of Arctic amplification since the mid-1990s, air masses originating from the Arctic have become warmer, but the direct advective effects from the marine Arctic to Europe are limited. However, changes in the Arctic affect large-scale circulation regimes that further affect European weather. Important circulation regimes include the positive and negative NAO patterns, a circulation pattern resembling the East-Atlantic West-Russia pattern, and a high-pressure system over Scandinavia with a tongue towards northern Siberia (SCA). During the Arctic amplification period, based on daily data, the frequency of occurrence of SCA has increased in December and January, and the negative NAO pattern has become more common in February and March. Sea ice decline in the Barents and Kara seas has favoured intensification of SCA, which interferes with the Atlantic wave train in autumn. The wave train contributes to strengthening of the Siberian High, generating increased vertical wave flux up to the stratosphere, and further to weakening of the Polar vortex in December - February. Downward feedback to the troposphere perpetuates strong Siberian High, favouring cold-air advection to eastern Europe. In addition, Arctic amplification affects the jet-stream latitude and speed, the occurrence of split jets, and the persistency of weather. Greenland Blocking affects European weather both directly and indirectly via forcing on the jet stream.

TE-2a - Advancing Polar Engineering and Sustainable Infrastructure Development
22.06.2018 09:00-10:30, A Sertig

891
Chinese Deep Ice Core Drilling at Dome A, Antarctica: Progress and Problems

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During last six years, five seasons were realized at Dome A, East Antarctica within the Chinese Deep Ice Core Drilling Project DK-1. The tasks of the first two seasons were to construct pilot-hole and to install drilling system. From the very end of the second season (January 2013), the deep ice core drilling was commenced from ~120 m to 800.73 m recorded in January 2017. As the hole became deeper, more drilling data were obtained which allows to analyze the drilling process with depth and gives useful reference to improve the drilling technology. At the same time, drilling team gained more experience. Nevertheless, drilling problems often occurred due to technological reasons and human factor. In general, drilling parameters' variation exhibits some certain regular pattern, however, unusual service condition often came across because of the indeterminacy of ice structure and complicated situation at the bottom. Even the drilling system was always operated according with certain regulations, the rig, ice and operations form a complicated time varying system. Some key drilling parameters collected in the last three seasons, problems met in the field, experience of drilling system repairing and drilling accident treatment are analyzed and discussed.

764
Lightweight Ice Coring Systems

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In mid-1970th a few portable shallow ice core drills were designed and successfully used for study of polar ice sheets. Later, shallow ice core drills were employed for mountain glaciers research.
Depending on ice core diameter and depth capabilities of the drilling system its weight can be 200-300 kg, including power source. Considering personnel involved in an ice coring field operation, total depth of drilling and duration of stay of a drilling site, the total weight of drilling and camping equipment, including food and fuel, can reach 3 ton. This deployment weight is not a big burden for transportation by avionic or surface vehicles but is prolonged and expensive for high altitude coring operations.
Major goals of new ice coring and non-coring drills development are: reduction of its weight, increasing depth capabilities and production drilling rate. These modifications will reduce costs of field operations, as well as reduce environmental impact of thereof. All mentioned modifications are suitable and applicable to high altitude and Polar glacier research.

1072
New Drilling Technology for Agile Sub-ice Rock Coring

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Evidence of sea level under paleoclimate conditions that were warmer than the present is important for prediction of sea level rise anticipated under current climate change. Cosmogenic nuclides in rock beneath ice sheets can reveal former ice sheet extent and the timing and duration of past exposure periods. Under ice less than 700m thick, nimble methods for reconnaissance recovery of small rock cores would be useful for use near outcrops and near the ice margins. This was previously not possible because a drill capable of drilling the core did not exist. A development project in the Ice Drilling Program Office - Ice Drilling Design and Operations (IDPO-IDDO) group has succeeded in developing such a drill. The Agile Sub-Ice Geological (ASIG) drill is capable of drilling through 700 meters of ice and then retrieving 8 meters of 39-mm diameter rock core. The drill was successful in the first field season of its use, when IDDO retrieved 8 meters of rock core from under 150 meters of ice at Pirrit Hills, Antarctica during the 2016-17 field season. This is the first time that a rock core more than a meter long has been retrieved from beneath glacial ice. In this presentation characteristics of the drill are described, along with a description of the drill performance in the field at Pirrit Hills.

128
Movable Drilling Rig for Coring in Antarctic Traverses

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Drilling to bedrock of ice sheets and glaciers offers unique opportunities to research processes acting at the ice sheets bed for paleo-environmental reconstructions, subglacial geology, tectonics, geophysics, microbiology. To drill through the ice and bedrock a novel movable drilling rig and cable-suspended electromechanical core drill are designed. All drilling equipment is installed inside a movable, sledge-mounted, temperature-controlled, and wind-protected drilling shelter and workshop connected by steel pathway. The drilling shelter (without the sledges and mast) has overall dimensions of 7.8×4.8×3.0m. The shelter is set on two transverse frames with four 3.05×0.8 m skis. Four hand screw jacks with a travel of 300 mm are located on the corners of the shelter. The mast can be folded during transportation. The workshop has the same basic design and dimensions as the drilling shelter. It is divided into two rooms: one room for generators and one that serves as a logging/ glaciological laboratory and workshop. Drilling shelter and workshop are transported with crawler tractors and could be ready for drilling operations 2-3 days after arrival at the chosen site. Drilling is carried out with electromechanical drill that permits the accomplishment of three different tasks: a large-diameter auger for dry core drilling in the upper snow-firn layers; ice-core drilling with near-bottom fluid circulation; and bedrock core drilling.

1233
Intermediate Depth Drill Design Innovations

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In response to a call from the International Partnership in Ice Core Sciences group (IPICS) for ice core records to contribute toward the 2k array and 40k network, the U.S. science community identified the retrieval of cores to depths of 1000-1500 meters as a high priority. In response, the Ice Drilling Program Office - Ice Drilling Design and Operations (IDPO-IDDO) group developed a new Intermediate Depth Drill (IDD) system that was successfully utilized for the South Pole Ice Core (SPICEcore) project from 2014-2017 to drill a 1750 meter core. The drill, which is based on the Danish Hans Tausen (HT) drill design, was paired with new IDDO component designs for the winch and surface systems that focused on improved core quality and ease of use. This presentation focuses on the new and innovative features of the IDD system and ever-important lessons learned from the SPICEcore project.

514
Direct Laser Ice Penetrators: A Breakthrough in Subglacial Access Technology

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The exploration of sub-glacial lakes on Earth presently requires an extraordinary logistics footprint (up to 1,000 tonnes of equipment) to use either traditional drilling technology or hot water drilling approaches. Stone Aerospace has investigated alternative methods to make access to sub-glacial lakes both routine and, critically, allow for persistent science. An ideal access method should allow for any length of time for downhole instrumentation and vehicles to make temporal measurements, investigate areas far from the access hole, and be recoverable to the surface on demand at the conclusion of a mission. With NASA funding we have developed an entirely novel ice penetrating technology using focused laser light carried by an optical fiber and emitted from the nose of an ice penetrator. Photons are used to directly melt the ice in front of the descending vehicle at near 100% efficiency. Laboratory tests show that this approach could lead to unprecedented ice penetration rates and enable access to any Antarctic sub-glacial lake. The design is bi-directional and could melt its way to the surface at conclusion of a mission.

GG-1a - Magmatic, tectonic, and geodynamic investigations of the Polar Regions
22.06.2018 09:00-10:30, A Schwarzhorn

1229
A New Volcanic Province: An Inventory of Subglacial Volcanoes in West Antarctica

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The West Antarctic Ice Sheet overlies the West Antarctic Rift System about which, due to the comprehensive ice cover, we have only limited and sporadic knowledge of volcanic activity and its extent. Improving our understanding of subglacial volcanic activity across the province is important both for helping to constrain how volcanism and rifting may have influenced ice-sheet growth and decay over previous glacial cycles, and in light of concerns over whether enhanced geothermal heat fluxes and subglacial melting may contribute to instability of the West Antarctic Ice Sheet. Here, we use ice-sheet bed-elevation data to locate individual conical edifices protruding upwards into the ice across West Antarctica, and we propose that these edifices represent subglacial volcanoes.We used aeromagnetic, aerogravity, satellite imagery and databases of confirmed volcanoes to support this interpretation. The overall result presented here constitutes a first inventory of West Antarctica's subglacial volcanism. We identified 138 volcanoes, 91 of which have not previously been identified, and which are widely distributed throughout the deep basins of West Antarctica, but are especially concentrated and orientated along the >3000 km central axis of the West Antarctic Rift System.

1569
Melting of the West Antarctic Ice Sheet (WAIS), Accelerates Subglacial Volcanism

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Melting of the West Antarctic Ice Sheet (WAIS) would raise global sea level ~ 3 m. WAIS flows through the volcanically active West Antarctic rift system (WARS), possibly associated with a mantle plume. Heat flow is high beneath WAIS. Satellite altimetry shows rapid retreat of ice shelves bordering WAIS resulting from the warming ocean resulting from climate change. GRACE satellite data indicate accelerating mass loss from WAIS, reducing basal pressure. Aeromagnetic and radar ice sounding surveys (5 by 5 km line spacing) over the central WAIS revealed >1000 high-amplitude magnetic anomalies having mostly < 200 m bed relief, indicative of the late Cenozoic-recent age subglacial volcanic rocks at its base.17 anomalies have 600-2000 m edifices beneath the ice. Increased volcanic activity resulting from decompression mantle melting beneath a thinning WAIS may serve as a positive feedback mechanism that could further destabilize WAIS. In both Iceland, and on midocean ridges, dated volcanism suggests decompression mantle melting associated with reductions in either ice or water loads drives significant volcanism. Acceleration of volcanic activity as the WAIS thins, could enhance the rate of ice loss and accelerate global sea level rise.

197
Subglacial Water Flow Adjacent to Mt. Melbourne Volcano, Antarctica

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The volcano-ice interaction is very important to understand the glacial process adjacent to volcanoes. In order to investigate the influence of volcano on glacier, we deployed three GPS stations on the Campbell Glacier nearby the Mt. Melbourne, Antarctica. From year-round GPS records, we observed a sudden elevation change probably caused by the draining of subglacial water reservoir. The elevation change was propagated downstream in company with a phase change from draining to filling. Immediately after the draining, the velocity of ice flow was suddenly increased at downstream area, while it was significantly decreased at the reservoir. The sequential velocity change implies that the ice velocity of Campbell Glacier is partly controlled by the draining of subglacial water flow. Previous seismic records and InSAR velocity changes also indicate the presence of dynamic changes in this area, although they are not concurrent with the GPS events. Since there was no significant change in elevation and ice velocity at the GPS station upstream of Mt. Melbourne, the source of subglacial water seems to be the water melt by the geothermal heat from Mt. Melbourne. Further long-term monitoring of ice flow at the Campbell Glacier would give more valuable information on the activities of Mt. Melbourne volcano and subsequent volcano-ice interactions.

156
Melbourne and Rittmann Volcanoes: Results from ICE-VOLC Project

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Melbourne and Rittmann volcanoes are located in the Victoria Land. While Rittmann's last eruption dates back probably to Pleistocene, those of Melbourne occurred between 1862 and 1922, thus suggesting that it is still active. At present, Melbourne and Rittmann show fumarolic fields. Despite the limited knowledge on both volcanoes (particularly for Mt. Rittmann), the Antarctic uncontaminated framework (characterised by absence of anthropic noise) and the proximity to the Italian Mario Zucchelli Station make them ideal sites for studying volcano seismic sources, geothermal emissions and volcanic gas impact on the environment.
In the framework of the ICE-VOLC project (www.icevolc-project.com), multiparametric investigations have been performed during the XXXII and XXXIII Italian expeditions in Antarctica (2016-2017). During the campaigns, different kinds of research activities were carried out, in particular: i) acquisition of seismic signals by two temporary stations on different sites of both volcanoes; ii) collection of rock samples from Mt. Rittmann and Melbourne; iii) sampling of ash layers within glaciers nearby Melbourne; iv) sampling of fumaroles gases on both volcanoes; v) remote sensing measurements of volcanic gases in atmosphere; and vi) prospection, exploration and mapping of ice-caves on both volcanoes. Results gathered in the first phase of the project allowed us to shed new light into the state of activity of these poorly-known volcanoes.

598

Holocene Volcanic Activity of Mt. Melbourne Recorded in Talos Dome Ice Core

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Tephra layers in Antarctic ice cores are valuable time planes and are useful for reconstructing the eruptive history of young volcanic centers. An ice core drilled at Talos Dome in northern Victoria Land contains many tephra layers and some have been attributed to eruptions from Mt. Melbourne. Three young englacial tephra layers are exposed on the flanks of Melbourne volcano. The youngest tephra is inferred from snow accumulation rates to be between 100 and 300 years old. The other two tephra are over 1 m thick and closely spaced to each other and probably represent two significant eruptions from the same vent. We geochemically analyzed the two older tephra and young lavas from the summit area of Melbourne to try and identify the source vent for the tephra. The tephra have a strong geochemical correlation with the Talos Dome tephra layer TD85, which suggests they are the same. This is an important finding as it indicates that significant eruptions of Melbourne occurred at 1280 CE. The youngest tephra on Melbourne is not found in the Talos Dome ice core, suggesting the eruption was smaller than that for the 1280 CE tephra or the wind direction did not disperse the tephra towards Talos Dome.

1095
Petrogenesis of the Lithospheric Mantle Beneath the Erebus Volcanic Province

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Cenozoic alkalic igneous rocks of the Erebus volcanic province (EVP) are extensive in the southwest Ross Sea and provide insight into the nature of the underlying upper mantle. Younger basanites also host numerous xenoliths of spinel lherzolites, harzburgites, crustal granulites, and rare dunites, glimmerites and plagioclase-bearing spinel lherzolites. The latter are thought to have formed via metamorphic reaction and refertilisation. Pyroxenite and crustal xenoliths show an atypically hot EVP geotherm of 50-100 °C/km with heat potentially from advective transfer from melt refertilisation over the past 24 Ma. A deca-kilometre-scale mantle H_2O, trace element and Sr-Nd-Pb isotopic heterogeneity is demonstrated and it has been variously suggested that the lithosphere has been refertilised and metasomatised by carbonatite, N-MORB or alkalic melts. Isotopic data for primitive basanites define trajectories between DMM and HIMU, with enriched EMI and EMII components also evident at White Island and Mount Morning. Erebus volcano samples also record a HIMU component on U/Th and $^{230}Th/^{232}Th$ versus Pb isotope plots. Some pyroxenites at Mount Morning share trace element and isotopic characteristics with eclogite. Despite this complex regional history, oxygen fugacity averaging -1 FMQ at Mount Morning (from Mössbauer spectroscopy), overlap with the global median in rifted settings (-0.9 FMQ).

SH-6c - Connecting Polar Research Across Boundaries
22.06.2018 09:00-10:30, A Seehorn

375
Acting upon what we Know: Making Arctic Connections across Boundaries

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The Arctic Research Consortium of the United States (ARCUS) has been making connections across boundaries in support of Arctic research since 1988. There are many recent activities that have strengthened communication, coordination, and collaboration across disciplines, organizations, sectors, nations, and knowledge systems. This presentation will describe a process for planning and implementing collaborations and will highlight recent case studies.
Building cross-cutting connections requires a carefully planned and strategic approach. Examples of successes and failures will be drawn from ARCUS' portfolio of projects, including activities focused on co-production of knowledge with Arctic Indigenous communities and researchers, cross-disciplinary research collaborations, and education and outreach efforts.
As a real-time exercise in making connections and networking, attendees of this presentation will have the opportunity to use online polling technology to share their own efforts at brokering connections in support of Polar research.

245
NERC Changing Arctic Ocean: Implications for Marine biology and Biogeochemistry

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The Changing Arctic Ocean is a 5 year (2017-2022) research programme to investigate the effects of climate change on the marine biology and biogeochemistry of the Arctic Ocean. The programme has 4 large projects (Arctic PRIZE, ARISE, ChAOS, DIAPOD) that form the core of the programme, funded by the UK's Natural Environment Research Council (NERC), and a further 10 smaller projects co-funded by NERC and the German Federal Ministry of Education and Research. An important aspect of the CAO programme is the strength of its international collaboration, reflected by the links established with over 60 international partner institutions. The topics covered by this international collaboration span the full scope of the science in the programme, as well as addressing societal challenges specific to the Arctic and the provision of evidence to feed into decision and policy making. The forms of this collaboration range from the level of communication between individual researchers, data sharing, exchange of staff on respective cruises, to representation of CAO investigators by collaborators at Arctic committees and other international bodies. Ultimately, the aspiration of the CAO programme is to forge lasting engagement with the international Arctic community beyond the funded lifetime of the programme. In this talk, I outline the scope of the programme and describe our activities in encouraging science-to-policy translation.

2146
Early Career Involvement Prepares Workforce for the Future of Polar Research

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The Association of Polar Early Career Scientists (APECS) bridges disciplinary, institutional, national, and sector boundaries in the Arctic and Antarctic communities. APECS is an interdisciplinary organization for early career professionals (ECPs) interested in Earth's polar regions and the wider cryosphere, with a global membership of nearly 3,000 actively-engaged ECPs from 67 countries. Our network creates opportunities for international collaborations and information exchange amongst both ECPs and established mentors from a range of disciplines. We aim to recruit, retain, increase cooperation amongst, and promote future polar experts. APECS facilitates the involvement of skilled ECPs in the working groups and committees of our partners, including those of the International Arctic Science Committee (IASC) and Scientific Committee on Antarctic Research (SCAR). This provides ECPs with an opportunity to practice career skills and to work with senior scientists to synthesize information and identify emerging research questions. In this presentation, we discuss how APECS contributes to training diverse, future leaders in the Arctic and Antarctic research and policy communities. Support of ECPs through APECS develops a workforce more adept in interdisciplinary, international, and collaborative work and is, therefore, an investment in the future of the Arctic and Antarctic science and policy.

2276
Evaluation of Costs and Societal Benefits of Arctic Observing Systems

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Observing the Arctic system is difficult due to the extremely harsh environmental conditions and long distance from the major research facilities. A number of past and existing EU research projects and international stakeholder initiatives have evaluated the present observational system in the Arctic, but still an overall picture on present and future observational requirements regarding the needs of stakeholders and costs for maintenance and investments has not been fully established. In order to support investments in observing the rapidly changing Arctic environment, taking also into consideration the expansion of a number of human activities in the area foreseen for the next decades, this study estimates costs and societal benefits of existing and future observational systems in the Arctic. The first part of the presentation gives an overview of investment and running costs of observational systems in the Arctic, the second shows the methodology based on the value tree analysis connecting observational systems and societal benefit areas and the third evaluates benefits for selected activities and societal benefit areas.

2248
An Agent-based Mobilities Assessment for Enhanced Arctic Climate Services

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Recent developments in safe navigation, such as the passing of the Polar Code, have addressed important issues in marine transportation in Arctic waters. Yet contrary to a global downward trend, shipping losses have steadily increased in the past decade in this region due to expanded shipping operations and increasing spatial and temporal variability of Arctic weather patterns and sea ice hazards. The availability and quality of climate services in support of Arctic shipping operators therefore is an important factor in reducing hazards. SALIENSEAS (Enhancing the saliency of climate services for marine mobility sectors in European Arctic seas), an ERA4CS project has undertaken the development of user-focused demonstration services based on an assessment of sector-specific user needs for climate services. Following an initial round of stakeholder interviews, the project's first phase produced an integrated assessment model of mobilities, risks and vulnerabilities in the European maritime sectors. The model integrates spatial and temporal variables that impact stakeholder interests, and delineates the critical infrastructures and key resources that drive risk-informed decisions. We discuss the role of this model in an iterative, participatory research framework, and the model's scalability in the assessment of other types of spatial data infrastructures.

CR-8a - Latest highlights from high altitude and polar ice cores
22.06.2018 09:00-10:30, A Wisshorn

1513
Archival Processes of Water Stable Isotope Signal in East Antarctic Ice Cores

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The oldest ice core records are obtained from the East Antarctic plateau. Water isotopes records are key to reconstructing past climates. The accuracy of climate reconstructions depends on knowledge of all the processes affecting water vapour, precipitation and snow isotopic compositions. However, a quantitative understanding of processes potentially altering the snow isotopic composition after the deposition is still missing. In low accumulation sites, such as those found in Antarctica, these poorly constrained processes are likely to play a significant role and limit the interpretation of isotopic composition.
Here, we combine observations of isotopic composition in the vapour, the precipitation, the surface snow and the buried snow from Dome C, a deep ice core site in Antarctica. At the seasonal scale, we suggest a significant impact of metamorphism on surface snow isotopic signal compared to the initial precipitation signal. Particularly, in summer, exchanges of water molecules between vapour and snow are driven by the sublimation/condensation cycles at the diurnal scale. Using snowpits in five Antarctic sites, we identify common patterns, despite different accumulation rates, which cannot be attributed to the seasonal variability of precipitation. Altogether, the difference in the signals observed in the precipitation, surface snow and buried snow isotopic composition constitute evidences of post-deposition processes affecting ice core records in low accumulation areas.

427
Probing the Evolution of the past CH_4 Budget - The Power of Stable Isotopes

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Reconstructions of atmospheric methane mixing ratios using ice cores have been available since decades. The large dynamic range, 350 to 800 ppb, and the abruptness of these CH_4 changes at DO events and during the final deglacial phases suggest that CH_4 is a powerful parameter to constrain past climate conditions, e.g. inferring the extend of wetlands. However, based on CH4 concentrations alone, the methane source budget is notoriously underdetermined and allows numerous hypotheses to be accommodated with the CH_4 records. For example, catastrophic CH_4-clathrate releases have been suggested to cause CH_4 jumps, likewise, continuous geologic CH_4 emissions were thought to comprise a large fraction of the glacial CH_4 budget. Recent studies applying $\delta^{13}C$, δD and ^{14}C of CH_4 were able to reject many hypotheses and concluded that low-latitude wetlands dominate the past budget and no additional source type is needed to explain CH_4 jumps. We provide an overview on the past CH_4 budget using $\delta^{13}C$ and δD (Bock et al. 2017) and present a $\delta^{13}C$ record extended by additional 120,000 years covering MIS7 to MIS10. As already visible in previous data, the $\delta^{13}C$ evolution of our new interval shows a remarkable covariation with CO_2 for inceptions and glacials. By contrast, the $\delta^{13}C$ trend departs from this covariation for deglaciations and interglacials, with the anomaly from the general $\delta^{13}C$-CO_2-covariation being proportional to the size of the interglacial CH_4 peak.

834
Constraining the Sources of Abrupt CH_4 Rise in the past with CH_4 Triple Isotopes

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Methane (CH_4) is the third most important greenhouse gas in the atmosphere after water vapor and CO_2. Understanding how the natural CH_4 budget has changed in response to changing climate in the past can provide insights on the sensitivity of the natural CH_4 emissions to the current anthropogenic warming. CH_4 isotopes ($\Delta^{14}CH_4$, $\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_4$) from ice cores can be used to fingerprint the sources of CH_4 increases in the past. Here we present CH_4 triple isotopes data from Taylor Glacier horizontal ice cores, Antarctica spanning the Oldest Dryas-Bølling transition (~14.7ka) - the first abrupt warming and CH_4 rise since the LGM. Among the CH_4 isotopes, our $\Delta^{14}CH_4$ data during this transition are novel and unique in their ability to unambiguously distinguish between “old” CH_4 sources (e.g. marine clathrate, geologic sources) and “modern” CH_4 sources (e.g. tropical wetlands). The $\Delta^{14}CH_4$ data unambiguously rule out marine clathrate and old permafrost as the sources of the abrupt CH_4 rise. Our stable isotopes data ($\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_4$) agrees well with existing CH_4 stable isotopes dataset from other polar ice cores. Moreover, our CH_4 stable isotopes data provides the highest resolution paleoatmospheric CH_4 stable isotopes dataset that is currently available for this specific ~150 year timespan. Methane isotopes box modeling combined with interpolar CH_4 concentration gradient suggest that tropical wetlands were the dominant driver for the OD-BØ CH_4 rise.

1423
Atmospheric CO_2 Variations on Millennial-scale during MIS 6

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Understanding natural carbon cycle / climate feedbacks on various time scales is highly important for predicting future climate changes. Paleoclimate records of Antarctic temperatures, relative sea level and foraminiferal isotope and pollen records in sediment cores from the Portuguese margin have shown climate variations on the millennial time scale over the Marine Isotope Stage 6 (MIS 6; from approximately 135 to 185 kyr BP). These proxy data suggested that an intensified hydrological cycle and iceberg calving in the North Atlantic may impact the Atlantic Meridional Overturning Circulation. This leads to cooling of the Northern hemisphere and warming of Antarctica, which is explained by the bipolar seesaw mechanism in the ocean (Margari et al., 2010). Atmospheric CO_2 reconstruction from Antarctic ice cores can provide key information on how atmospheric CO_2 concentrations are linked to millennial-scale climate changes. However, existing CO_2 records lack of suitable temporal resolution and precision. In this work, we present improved CO_2 data, obtained from the Dome C ice core (75°06´S, 123°24´E) spanning the MIS 6 period, using dry extraction methods. This new CO_2 data show variabilities which are similar with those of temperature in Dome C. Further investigations on those millennial-scale features will be conducted, with the aim of linking them to other possible atmospheric proxies.

CR-8a - Latest highlights from high altitude and polar ice cores
22.06.2018 14:00-15:30, A Wisshorn

103
Sub-Antarctic Ice Core Drilling

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The sub-Antarctic islands (SAI) are uniquely located to capture changes in the globally significant circumpolar westerly winds and the Antarctic circumpolar current, key to the mixing and ventilation of the world´s deep oceans. The glaciers on a number of these SAI's potentially contain an inimitable record of past climate, atmospheric circulation, westerly winds and pollution from this data sparse region. Here we present the first results from seven new shallow (10-20 m) ice cores collected as part of the Antarctic Circumnavigation Expedition (ACE), including the first ever records from Bouvet Island, Peter 1st Island and the Balleny Islands.

SH-7a - Science, Policy, and Politics at the Poles
22.06.2018 09:00-10:30, B Pischa

64
China as a Polar Great Power

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In the last five years China has emerged as a member of the unique club of nations who are powerful at both poles. Polar states are global giants, strong in military, scientific, and economic terms. The concept of a polar great power is relatively unknown in international relations studies. Yet China, a rising power globally, is now widely using this term to sum up its aspirations and symbolise the significance of the polar regions to China's national interests. Chinese Communist Party General Secretary Xi Jinping first referred to China as a polar great power when he visited Australia in November 2014. China's focus on becoming a polar great power represents a fundamental re-orientation—a completely new way of imagining the world. In setting its sights on the polar regions now, China is looking to the mid to long term and planning for its future economic, political, and strategic needs. The Chinese government´s stated core national interests in the current era—to maintain China's social system and state security, to preserve state sovereignty and territorial integrity, and the continued stable development of the economy and society—all require access and engagement in the polar regions. China has global interests and is well on the way to becoming a global great power. To succeed in this evolution it must be powerful in the polar regions.

368
Renaissance of the Russian Arctic: Geopolitical, Economic, Environmental Factors

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The Arctic is the most important region that will ensure the future of Russia. Already, the largest Russian projects are being implemented there. For the last hundred years, Russia for the third time begins a large-scale industrial advancement to the Arctic. In addition, climate change is no longer scientific assumptions, but a reality. The ice is melting and new commercial opportunities are opening up in the Arctic, non-Arctic countries appear as investors and economic partners of Russia. Today the NSR is considered as the main Arctic shipping line in Russia and the government tries to make the NSR a competitive transport corridor of global importance as well as to strengthen geopolitical influence and Russia´s national security in the Arctic and a state program for the creation of stationary points for the development of the Arctic is proof of this. Industrial development in the Arctic is connected with preservation of the indigenous peoples, the traditional economy of nature. Also, the key priority remains the protection of the unique natural environment of the North, environmental security issues. Elimination of accumulated environmental damage throughout the Arctic zone, is a long-term process that requires considerable material and financial resources. In this regard, it can be argued that effective development of the Arctic can be achieved through an open, equitable and effective approach aimed at strengthening international political, economic, social dialogue.

1961

Korea's Arctic Policy and Implications through Comparison with That of Japan

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Korea has started to conducted basic survey and research on the Arctic in 1993 and the full-scale Arctic researches after the Korea's Arctic Dasan Research Station was opened in 2012.
Based on these Scientific activities and outputs, Korea joined the Arctic Council Observer with Japan, China, India, etc in 2013 and set the 5 years' Arctic Master plan(2013-2017) as an after-action on that year, which was a governmental platform for implementing the comprehensive Arctic Policy for the first time in history. The 2nd phase master plan(2018-2022) by the inter-ministerial work in 2017 is under way. Also, The Korean president offered Russia to cooperate on a range of projects, including NSR, shipbuilding, and others including the NSR at East Economic Forum in september of 2017: Arctic (Northern) policy of the new government is strengthened in various points.
This research will focus on change of Korea's Arctic policy through the comparison between the 1st and 2nd master plan and will do the policy-analysis on Arctic policy of Japan, a neighbor country on the Korean perspectives and draws implications for the improvement of Korea's Arctic policy.

SH-7a - Science, Policy, and Politics at the Poles
22.06.2018 11:00-12:30, B Pischa

2147
Polarnomics: A Geo-economic Framework for Systemic Analysis of Polar Affairs

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While humanities and social sciences are increasingly represented, supported and well considered in Polar research and policy circles, the sub-discipline known as “geoeconomics” remains largely underrepresented and overlooked. As an example, none of the EU H2020-funded projects do explicitly provide geoeconomics analyses as part of their research steps or their research objectives. Moreover, geoeconomists are often mistaken with economists, logistics or even geopolitics experts. This misunderstanding of geoeconomics studies applied to Arctic and Antarctic research has a direct impact on both the quality of the governance of the Polar regions and on the effective environmental stewardship of both Polar regions. The fact that policy-makers don't have access to a wide number of Polar geoeconomics research prevents them from approaching Polar affairs in the most comprehensive way possible. This lack of capacity may lead them to overlook some foreseeable negative policy externalities, and even allow for socio-economic, diplomatic and/or future environmental so-called black swan events to happen. It is therefore important to raise the profile of geoeconomics as a useful research discipline in Polar policy-making. This presentation aims at laying down the foundations of a widespread discussion on the use of geoeconomics in Arctic and Antarctic policy; and to that aim, proposes a geographically-bounded framework for systemic analysis of both Arctic and Antarctic affairs: Polarnomics.

SH-7a - Science, Policy, and Politics at the Poles
22.06.2018 09:00-10:30, B Pischa

2608
Geopolitical and Security Challenges in the Arctic

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The geopolitics in the Arctic has been influenced by the current international relations' developments and increasing tensions between Russia and the West. Additional drivers for geopolitical challenges are the availability and accessibility of energy resources (mainly oil and gas) and opening of new transportation routes for destination and transit shipping. The geopolitics of the Arctic is also influenced by the security developments. There are two major types of security issues facing the Arctic: issues related to military security of individual Arctic states and those relating to the common security of multiple regional states - including piracy, terrorism and environmental disasters. The aim of the presentation is to provide overview of geopolitical and security challenges which the Arctic faces in relation to climate change and current trends in international relations. The author will focus on how geopolitics transforms into policy and what are the key variables that influence the relations of cooperation/competition among states in the Arctic region.

CR-4d - Ice sheets, ice shelves & proximal processes in past, present & future climates
22.06.2018 09:00-10:30, B Parsenn

315
Simplified Kamb Ice Stream Flowline Models with Differing Subglacial Conditions

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The subglacial environment exerts an important control on ice sheet velocity and on the volume of ice discharged across the grounding zone. Many subglacial processes and conditions, such as sediment porosity and the subglacial deformation profile, are still poorly constrained. For example, basal friction from ice-sediment contact can slow and thicken ice, whereas an increase in basal meltwater may accelerate flow. These processes are particularly important beneath ice streams, where deforming basal till allows fast ice motion in the absence of high driving stresses, ultimately controlling whether ice streams are flowing or stagnant. The importance of these processes means that there is still a need to focus on characterising the subglacial environment from observations.
Here we present flowline model results from PISM (a thermodynamic, coupled ice-sheet/shelf model) simulations that investigate variability using seismic estimates of basal conditions from the Kamb Ice Stream (KIS) as boundary values and tuned parameters. Seismic constraints are provided by an active-source seismic profile collected across the grounding zone of the KIS. Reflection coefficients along the seismic line signals a change in acoustic impedances, which can be used as a proxy for porosity and effective pressure. In our model experiments we varied subglacial conditions (deformation behaviour, basal roughness) and quantified the impact of each on ice stream velocity, discharge and grounding line location.

828
Post-stagnation Retreat of Kamb Ice Stream´s Grounding Zone

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Grounding zone processes include the interaction of subglacial sediment and water with the overlying ice. These processes regulate accommodation space in the ice shelf cavity, supply and deform sediment, and determine the grounding zone´s location. Despite the importance of grounding zone sedimentation for ice sheet stability and ice sheet history, evidence for sedimentary deposits beneath West Antarctica´s modern grounding zone remains sparse. Recent seismic surveying shows that Kamb Ice Stream has no detectable grounding zone deposit. As grounding zone deposition relies strongly on ice flow, the absence of a deposit suggests that the transition from the ice stream to the ice shelf has moved after stagnation of Kamb Ice Stream. Further support for a recent grounding zone occupation comes from satellite imagery of sub-ice shelf channel features that likely originated at previous grounding-zone locations. These features begin 25 km seaward of the current grounding zone and cut across ice flow streak lines. We estimate that retreat to the modern grounding-zone position was abrupt at rates >0.2 km a^{-1}.

1756
Controls and Change of Enhanced Ice Flow in the Recovery Region, East Antarctica

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The Recovery Region in East Antarctica has remained poorly explored, despite representing the largest potential contributor to future global sea level rise on a centennial to millennial timescale. The region, consisting of Recovery, Bailey and Slessor Glaciers, currently discharges 5 % of the total fresh water outflow of Antarctica into the Filchner Ice Shelf, which is subject to extensive sub-shelf melting under ongoing climate change. No direct ice thickness data were available within 200 km in this region, which was identified as one of two 'poles of ignorance' by BEDMAP2. We use new airborne radar data to investigate the bed topography and controls of fast-ice flow in this region. We show that Recovery Glacier is underlain by an 800 km long trough. Its fast flow is strongly controlled by topography in its downstream region and the presence of subglacial water in its upstream region. Recovery Glacier is connected with the adjacent Slessor Glacier via the newly-discovered Recovery-Slessor Gate. Fast flow of Slessor Glacier occurs over a rougher bed and is controlled by an inferred channelized hydrological system. Englacial layer studies suggest changes in direction of past fast flow likely occurred within Slessor and Bailey glaciers. Similar changes could also reoccur here in future. Our findings refine the knowledge of the Recovery Region and provide a more precise understanding of past ice dynamics and potential of future change of this region.

1264
Active Seismics at the Grounding Line of Support Force Glacier, Antarctica

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We report on a high-resolution seismic reflection survey, conducted across the grounding line and ice shelf of Support Force Glacier, an ice stream feeding into the Filchner Ice Shelf, Antarctica. Two longitudinal profiles were acquired in the ice-flow direction: a 43 km profile crossing the grounding line, parallel to a nearby ice shelf channel and a 10 km profile in the ice shelf channel. These are connected by three cross-profiles at 2, 8 and 33 km from the grounding line. The data indicate the grounded ice flows over a flat bed from which the top 20 m most likely are consolidated sediments. The ice becomes uncoupled from the bed 3 km upstream of the grounding line. Downstream of the grounding line we observe disturbed sedimentation at the seabed, increasing to a 300 m thick sequence at 6 km distance from the grounding line. At 10 km distance, the sedimentation sequence is undisturbed and stratified. We interpret the disturbed sedimentation as deposits from a possible subglacial water conduit upstream of the ice shelf channel although past changes at the grounding line position cannot be ruled out at this stage. The three cross-profiles show the ice shelf channel at 2 km and 8 km downstream of the grounding line. While the shape of the channel does not change, it widens 22% between 2 and 8 km and increases its height by 12% further downstream between 8 km and 33 km.

2560
Using Radar to Evaluate the Thermal Stabilization of Ice Stream Shear Margins

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Ice-stream shear margins define highly localized transitions in ice-flow behavior. To reproduce these transitions, models typically impose lateral variability in either the substrate properties, the subglacial hydrologic system, or the thermally controlled rheology of the ice. Identifying the relative impact of these three mechanisms is critical to predicting shear-margin evolution, but attempts to identify the dominant process using ice penetrating radar suffer from unresolvable tradeoffs between ice temperature, bed roughness, and basal water availability. To improve our understanding of shear-margin dynamics and aid in radar-data interpretation collected over ice streams, we use Elmer/Ice to model the thermal state of ice-stream shear margins as a function of the shear-strain rate, the margin width, and the magnitude of cross-marginal ice flow. We show that lateral variability in ice temperature across shear margins is controlled by the balance of heat production and advection, making it possible to estimate temperature gradients across shear-margins using surface velocity observations alone. Finally, we compare temperature estimates derived from surface velocities with radar observations across the shear margin of the Northeast Greenland Ice Stream.

736
On-ice Vibroseis: Sediment Features below Ekström Ice Shelf, East Antarctica

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An extensive grid of seismic reflection data collected on Ekström Ice Shelf, East Antarctica, between 2010-2018, using an on-ice vibroseis source and snowstreamer, are used to reconstruct the glaciological and tectonic history of this region.
The data clearly image the outcrop and sub-ice extent of the volcanic Explora Wedge (generated through Jurassic rifting and seafloor spreading). The wedge is overlain by a sequence of truncated, dipping marine-sediment layers. The sediment were likely truncated by former ice advance and subsequent retreat; which has also left evidence in the form topographic over-deepening and glacial debris deposits at the sea floor. The debris deposits range from elongated bedforms in a topographic trough (indicating probable former ice-stream flow) to layered sediment wedges at the current ice-shelf front (indicating the likely former extent of grounded ice).
A series of sub-ice shelf geological drilling campaigns in the area will take place (2017-2019) to recover sediments from the sea floor. Combining the topography and material characteristics from vibroseis data with stratigraphic evidence from sediment cores allows a robust reconstruction in this area. Future integration of these results with numerical models will provide a better understanding of past and present interactions between the ice sheet and the solid Earth in Dronning Maud Land, which will in turn improve understanding of future contributions of this region to sea-level rise.

OS-4a - Sea ice modeling and prediction: Sea ice Projections
22.06.2018 09:00-10:30, B Jakobshorn

1426
Arctic Sea Ice in a 1.5 °C Warmer World

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We examine the seasonal cycle of Arctic sea ice for different levels of global warming and quantify the possible variations around this seasonal cycle caused by internal variability. To do so, we combine observations with simulated internal variability from a very large ensemble, the MPI-ESM Grand Ensemble. We use the observed sea ice sensitivity to global warming to recalibrate the sensitivity of the modelled sea-ice evolution.
We show that for a global warming of 1.5 °C above pre-industrial levels, it is unlikely that September Arctic sea ice vanishes. The internal variability causes a range of about ±0.2 °C to the global warming magnitude at which September Arctic sea ice is lost. For a 2.0 °C warming, the Arctic Ocean becomes virtually certainly ice free in August and September. In March, for a 1.5 °C global warming, sea-ice area is reduced to about 85% and for a warming of 2.0°C to about 80% of pre-satellite levels.

1392
For Arctic Summer Sea Ice, Staying Below 2.0°C Global Warming Matters

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What impact would the IPCC target of limiting global warming to 1.5° to 2°C have on Arctic summer sea ice? To answer that question, we analyze five initial-condition Community Earth System Model (CESM) ensembles with global warming ranging from 1.5°C to 4°C by 2100. We find that if warming can be limited to 1.5°C, 45% of the time September sea ice extents will still be higher than the minimum observed to date by 2100, and there is a 30% probability for an ice-free September. If warming reaches 2°C, September sea ice extents will only be above the minimum to date 2% of the time, and we find a 100% probability of at least one occurrence of ice-free conditions. If warming exceeds 2.5°C, the sea ice extents will always be far below the minimum to date and ice-free conditions will occur frequently in the summer. Hence, for preserving Arctic summer sea ice, staying below 2.0°C global warming matters.

1663
Polar Amplification and Sea Ice Changes in NorESM Low Warming Scenarios

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The differences in polar amplification and consequences for sea ice were studied with the Norwegian Earth System Model (NorESM) during the multi-model project HAPPI, whose main focus was to evaluate differences in impacts between scenarios of 1.5- and 2.0-degree warming above pre-industrial. Simulations from an updated version of the fully coupled model (NorESM1-Happi) have been evaluated. Compared to earlier versions of the NorESM, the simulated Arctic sea ice is greatly improved. In addition, slab ocean (SO) versions of the model, specially designed to be comparable to the AMIP-style experiments used in the HAPPI-protocol, have been analysed to look at differences in polar amplification and sea ice properties. We find large differences in the polar amplification in the Northern and Southern Hemisphere depending on fully coupled, or slab ocean set-ups of the model. Ocean heat transport seems to be the main contributor to this difference between the hemispheres. Also, in the SO experiments designed to have similar ocean heat transport changes as the CMIP5 multi-model ensemble, we find very large changes in the September sea ice extent in the Arctic between the 1.5- and 2.0-degree warming scenarios. These large changes are sensitive to the simulated present-day sea ice cover in the model, and the sensitivity of this is discussed in light of model assumptions and uncertainties.

799
Sea-ice Cover Timing in the Pacific Arctic: The Present and Projections

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With the sea-ice cover in the Arctic fast declining, changes to the timing of sea-ice break-up and freeze-up is an urgent economic, social, and scientific concern. Based on daily sea-ice concentration data we assess the dates of sea-ice break-up and freeze-up, and the annual sea-ice duration in the Pacific Arctic. The simulation results from the coupled climate models from the Coupled Model Intercomparison Project (CMIP5 and CMIP6) are the major source for this study. Based on CMIP5 results, the length of sea-ice duration is shrinking, with the strongest downward trend occurring for the period 1990-2014; this downward trend is projected to continue through mid-century. Comparisons made at eight Chukchi Sea mooring sites maintained by PMEL and eight Distributed Biological Observatory (DBO) regions show consistent results. The 30-year averaged trend for annual sea-ice duration in the southern Chukchi Sea is projected to be -0.68 (-0.74) days/year to -1.20 (-1.17) days/year for 2015-2044 under RCP8.5 (RCP4.5) emissions scenarios. This is equivalent to a reduction of 20 to 36 days in the annual sea-ice duration. Models project both earlier break-up dates and later freeze-up dates, and that a later freeze-up contributes more to the overall shortening of annual sea-ice duration. Up to a 60-day reduction of the annual sea-ice duration in the Chukchi, East Siberian, and Beaufort Seas, and less than 20 days in the Bering Strait area is projected near the middle of the 21st century.

1178
Arctic Sea Ice Melt Season Length in the CESM Large Ensemble and CMIP Models

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Melt season length—the difference between the sea ice melt onset date and the sea ice freeze onset date—plays an important role in the radiation balance of the Arctic and the predictability of sea ice cover. Using the CESM Large Ensemble and CMIP5 model simulations, we explore three sources of uncertainty in the assessment of melt season length in climate models: definition choices, internal variability and model differences.
There are multiple possible definitions for sea ice melt and freeze onset in climate models, and none of them exactly correspond to the remote sensing definition. We first show how the mismatch between model and remote sensing definitions of melt and freeze onset limits the utility of melt season remote sensing data for bias detection in models. Then, by using the CESM Large Ensemble, we account for the role of internal variability, allowing us to assess the comparability of different melt and freeze onset definitions. Finally, we expand our analysis to CMIP5 models to study how model differences affect projections of melt and freeze onset. If possible, we will also include CMIP6 simulations in that analysis. Our study of CMIP5 models (and CMIP6 models when available) will explore the hypothesis that an underestimation of the melt season length trend is one factor contributing to the generally underestimated sea ice loss in climate models.

801
Arctic Sea Ice-free Season Projected to Extend into Fall

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The recent Arctic sea-ice reduction is associated with an increase in the ice-free season, with comparable contributions of earlier retreat and later freeze-up. Here we show that within the next decades, the trends towards earlier freeze-up should progressively exceed and ultimately double the trends in ice retreat date. Such asymmetry is due to the response of ice and ocean thermodynamics to warming: the extra solar heat reaching the ocean due to earlier ice retreat is absorbed at a higher rate than it is released until freeze-up. Based on climate change simulations, we envision an increase and a shift of the ice-free season towards fall, which will affect Arctic ecosystems and navigation.

AC-2c - Polar meteorology, climatology and stratospheric processes
22.06.2018 09:00-10:30, C Sanada I

86
The Local water Cycle Associated with Marine Cold Air Outbreaks

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At high latitudes marine cold air outbreaks (CAOs) are the dominant weather systems injecting moisture into the atmosphere - yet their role in the water cycle is not well understood and their representation in coarse resolution models is subject to substantial biases. We present a numerical process study of one of the most intense CAOs that occurred in the Nordic Seas in recent years. To that end we perform a set of simulations with the limited area weather prediction model COSMO at resolutions from coarse to convection resolving. Using tagged water tracers transported within a secondary water cycle built into the model, we follow the moisture that evaporates into the CAO air mass from evaporation to precipitation.
Based on these simulations we characterize the water cycle associated with the CAO. Specifically, we quantify the amount of moisture injected into the atmosphere by the CAO and analyse the footprint of the CAO in surface evaporation and precipitation, as well as moisture pathways. Most importantly, we show that the CAO is associated with a local water cycle, where moisture origin and precipitation are close together and take place on a time scale of less than 3 days. This contrasts other weather systems that are associated with rather long-range moisture transport, such as frontal systems. This local nature of the water cycle associated with CAOs allows to study limitations of parameterised processes regarding evaporation and convection within a limited-area model.

135
Atmospheric Variability in the Subpolar North Atlantic: A Long-term Perspective

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Understanding the interannual atmospheric variability in the polar and subpolar regions is essential for detecting and understanding future changes in these regions. Unfortunately, observations at high latitudes are sparse and the records are short, making it difficult to assess changes.
The Arctic is dynamically linked to the mid-latitudes, for example via the poleward transport of heat and moisture in extratropical cyclones. Moreover, in the North Atlantic, the position of the eddy-driven jet stream is related to the occurrence of blocking, and accounts for a large portion of the internal (natural) variability in the region. The jet stream´s position also influences the occurrence of cold air outbreaks (CAOs), which contribute substantially to the oceanic heat loss in the Arctic due to air-sea heat exchanges.
The aim of the study is to investigate interannual variability and trends in the frequency of the jet configurations at mid-latitudes over the past century, and the implications for the conditions in the polar and subpolar regions. We use the long term (1900-2010) wintertime ECMWF ERA-20C reanalysis for the North Atlantic. First, we identify the North Atlantic jet configurations, which are closely related to the quasi-stationary states of the atmosphere, so called weather regimes. We then characterize each jet configuration with respect to cyclones, blocking and CAOs frequencies and study their long-term variability.

439
Temporal and Spatial air Temperature Changes in the Arctic, 1951 - 2015

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Detailed research into air temperature tendencies in the Arctic based on instrumental data for the periods 1951-2015, 1976-2015 and 1996-2015 revealed the predominance of positive trends, statistically significant at the level of 0.05. In the two later periods the rate of warming was on average 2-3 times faster than in the entire study period. This is particularly true for mean annual values for the entire Arctic, and also for seasonal means (DJF, MAM, etc.) for the period 1976-2015. In the most recent 20-year period very large increases in both seasonal and annual means were observed in the Atlantic and Siberian climatic regions (after Atlas Arktiki 1985), while in the rest of the Arctic the rate of warming was usually weaker than trends for the period 1976-2015. In particular, there was a large fall in the rate of warming in spring, with near-zero trends (Baffin Bay and Canadian regions) and even a negative trend (-0.34°C/10 years, Pacific region). The scale of warming for the recent 20-year period relative to the reference period 1951-1990 ranges from 1.3°C (Baffin Bay region) to 1.7°C (Atlantic region). The average anomaly for the entire Arctic reached 1.6°C. The greatest warmings were for autumn (1.9°C) and winter (1.7°C), while the smallest was in summer (0.9°C).
The research work was supported by a grant entitled 'Causes of the early 20th century Arctic warming', funded by the National Science Centre, Poland (Grant No. 2015/1.9/B/ST10/02933).

531
Increasing Frequency and Duration of Arctic Winter Warming Events

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Near-surface air temperatures close to 0°C were observed in situ over sea ice in the central Arctic during the last three winter seasons. Here we use in situ winter (December-March) temperature observations, such as those from Soviet North Pole drifting stations and ocean buoys, to determine how common Arctic winter warming events are. Observations of winter warming events exist over most of the Arctic Basin. Temperatures exceeding −5°C were observed during >30% of winters from 1954 to 2010 by North Pole drifting stations or ocean buoys. Using the ERA-Interim record (1979-2016), we show that the North Pole (NP) region typically experiences 10 warming events (T2m > −10°C) per winter, compared with only five in the Pacific Central Arctic (PCA). There is a positive trend in the overall duration of winter warming events for both the NP region (4.25 days/decade) and PCA (1.16 days/decade), due to an increased number of events of longer duration.

557
Modification of Polar Low Development by Sea Ice and Svalbard Orography

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The life cycles of intense high-latitude mesoscale cyclones, polar lows, are uniquely shaped by their local geographical features. Our research focuses on the influence of Svalbard mountains and sea ice cover in the Norwegian and Barents Seas on polar low formation.
We present a modelling study of two typical polar lows that were in the Norwegian Sea during a northerly cold air outbreak. Each case is simulated using the UK Met Office Unified Model with grid spacing of 2.2 km. Compared to satellite cloud imagery and wind estimates, the model captures key features of the mesoscale vortices with reasonable accuracy. A series of sensitivity runs is conducted with artificially changed land mask, orography, and sea ice cover.
Besides its role in blocking stably stratified air from the ice-covered Arctic Ocean, Svalbard acts as an additional source of low-level cyclonic vorticity that helps polar lows to intensify. The change in the sea ice cover, especially west of Svalbard, results in larger changes in polar low intensity, particularly in the convectively-driven case.
The cases analysed in our study exemplify that polar mesoscale cyclones, originating from small vorticity clusters advected by synoptic-scale weather systems, often have stochastic nature.
To make broader conclusions about statistically significant influence of sea ice cover in the region, in the second part of our study we compile a climatology of mesocyclones in the vicinity of Svalbard using the ERA5 reanalysis.

717
Arctic CO_2 Variability Induced by the Madden-Julian Oscillation

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Variability of atmospheric CO_2 must be well understood in order to better characterize the surface sources of anthropogenic CO_2 release. Previous studies have revealed the influence of the tropical Madden-Julian oscillation (MJO) to tropical mid-tropospheric CO_2 via convection. In this work, the observation by NASA's Atmospheric Infrared Spectrometer (AIRS) is used to further study the MJO impact on the CO_2 concentration over the Arctic. A composite analysis shows that CO_2 north of 60°N varies with an amplitude of ±0.6 ppm over the MJO cycle. An empirical correlation analysis is applied to explore some possible mechanisms through which the MJO perturbs the Arctic CO_2 concentration remotely. The spatial pattern of the MJO-related Arctic CO_2 anomalies is found to resemble that of the isentropic potential vorticity (PV) anomalies at 475 K. A potential role of the lower stratospheric tropics-extratropics exchange is discussed.

OS-7e - Atmosphere-Ice-Ocean interactions in the Polar Regions
22.06.2018 09:00-10:30, C Sanada II

2609
Local Surface Mass and Energy Balance Processes in East Antarctica

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In Antarctica, direct observations of key processes shaping the surface mass balance such as precipitation and snow deposition, wind transport of snow, and sublimation, are sparse due to the extreme environment and related difficulties in measuring the variables of interest. The ongoing project 'Local Surface Mass Balance in East Antarctica' (LOSUMEA) is designed to address these processes at the local scale with the objective of gaining insight on the dominant surface mass and energy balance components and their link to near-surface atmospheric dynamics and surface and sub-surface snow properties. To this end, two measurement stations have been installed near the Princess Elisabeth Station, Antarctica, in December 2016. Besides standard meteorological data the stations are equipped with snow particle counters and 3-D sonic anemometers relating wind, turbulence and mass flux. Pre- and post-storm Terrestrial Laser Scans (TLS) record the resulting surface morphological changes. While preliminary data is being analyzed, the full data set of the year 2017 is retrieved in early 2018. Addition of moisture sensors in 2018 is expected to provide valuable information on latent heat fluxes related to sublimation. This contribution presents an overview of the project experiments, the data obtained to date as well as their analysis and some first results.

2028
Energy Exchange between the Ground and Atmosphere at PEARL

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Energy exchange between the ground and the atmosphere in the Arctic is of great interest to understand the amplification of global warming that is being experienced in that region. At very high latitudes the absence of sunlight in the prolonged Arctic night leads to conditions very different from most of the rest of the planet. In particular convection is suppressed though the presence of a very persistent inversion and this means that a major mechanism for energy exchange is turned off and other mechanisms (conduction, radiation, etc) are responsible for the exchange.
At the Polar Environment Atmospheric Research Laboratory (PEARL), Eureka, Nunavut, Canada, a research station at 80N latitude we have been studying this situation through the Polar night. We have used many in situ measurements including a microbarometer to watch small pressure fluctuations and a drone to measure the temperature gradient over a significant spatial area and through the lowest levels of the atmosphere.
This talk will introduce some of the results from this work showing a strong spatial heterogeneity and significant variations in the conditions through the night. From these measurements we can begin to piece together a picture of the energy exchange in these unusual conditions.
PEARL is currently supported by the Natural Sciences and Engineering Research Council, Environment and Climate Change Canada and the Canadian Space Agency.

512
Cloud Role in Surface Radiation in Moisture and Sensible Heat Flux into Arctic

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Previous studies show the impact of moisture and sensible heat into the Arctic on the surface energy budget, the Arctic sea ice concentration, and other atmospheric parameters. This study investigates how the moisture and sensible heat advection into the Arctic in the winter time affects the Arctic cloud. Composite analysis of radiation, cloud properties, air temperature, column integrated water vapor, and atmosphere circulation are performed using data from ECMWF Interim Re-Analysis (ERA-Interim), the Moderate Resolution Imaging Spectroradiometer (MODIS), and cloud profiling radar (CPR) onboard CloudSat. Results from ERA-Interim show greater downward longwave radiaton (DLR), clear-sky downward longwave radiation (DLR_CLR), and cloud radiative forcing (CRF_LW), with CRF_LW accounting for approximately 40% of the total positive anomalies in the surface energy. Greater DLR_CLR can be attributed to higher air temperature, and higher column integrated water vapor; greater CRF_LW are results of greater cloud amount, and higher cloud ice and liquid water content. Changes in cloud properties are more obvious in the low-level clouds. Composite analysis from MODIS cloud shows similar spatial pattern as that from EAR-Interim. Composite analysis from CloudSat CPR shows moisture flux impact on the cloud vertical distribution stronger in the low-level, and stronger on the Atlantic side than that on the Pacific side of the Arctic Ocean.

1210
Micrometeorology Controlling Snow and Ice Ablation Processes

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Changing micrometeorology during an ablation season strongly affects melt dynamics of seasonal snow covers, perennial ice fields and small glaciers as complex boundary layer development over heterogeneous land-surfaces significantly alter the local air temperatures (and humidities). Micrometeorological processes such as advective heat transport, cold-air pooling or thermal wind systems are important meteorologic drivers for the mass balance of very small glaciers, by strongly affecting their sensitivity to an increase in the ambient air temperature.
In this study, we experimentally and numerically investigate the relative contribution of micrometeorological processes to the melt dynamics of seasonal snow-covers in alpine catchments and to the mass balance of the lowest perennial ice field of the Alps, the *Eiskapelle*. Measurements indicate that the well-developed katabatic wind system significantly modifies the local air temperature field over the ice-field by decoupling the near-surface air from the warmer ambient air. For seasonal snow-covers we could evidence a high frequency of developing shallow stable internal boundary layers over snow patches, coinciding with atmospheric decoupling causing a shut-down of turbulence close to the snow surface. As a counteracting process, the advective transport of warm air is revealed to significantly increase the mean air temperature over snow resulting in 20-40% larger catchments mean daily depletion rates.

2332
The Role of Particle Cohesion in the Wind-driven Erosion of Snow Surfaces

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Snow particles in a sintering snowpack develop cohesive bonds that significantly affect the predisposition of the snow surface to wind erosion. A better understanding of how cohesive bonds affect surface entrainment mechanisms is crucial to improve quantifications of the surface mass balance in polar regions. Given that particle cohesion is difficult to measure in experimental and field studies, this investigation relies on numerical models. Here, we use the discrete element method (DEM) to investigate the role of cohesive bonds in the granular splash process, which is the most efficient surface entrainment mechanism in wind-driven snow transport. Our granular splash simulations show a non-linear decrease of the number of ejected grains with increasing cohesion. The ejection speed, however, increases with increasing cohesion seemingly due to the smaller dissipation of elastic energy in frictional rearrangements. The interplay between number and velocity of ejected grains balances the cumulative kinetic energy of the splashed particles across a wide range of cohesion values. We further perform DEM simulations of wind-driven snow transport to show that the conservation of kinetic energy in the splash process can sustain the saltation mass flux over highly sintered snow beds. Our results may improve current surface parameterizations in larger scale models of snow transport and help us quantify, e.g., the amount of snow transported from the Antarctic ice sheet to the ocean.

2451
Revisiting the Thorpe-Mason model for calculating sublimation of saltating snow

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Sublimation of drifting and blowing snow has been recognized as an important component of the mass budget of polar and alpine regions. The Thorpe and Mason (TM) model is the basis of all existing small and large-scale estimates of drifting snow sublimation. We revisit this model to test its validity for calculating sublimation from saltating snow grains.
Through simple numerical experiments, it is highlighted that the TM model is a steady-state model that reconciles well with the solution of the unsteady mass and heat balance equations of an individual snow grain, albeit after a transient regime. Next, we simulate snow saltation using high-resolution large-eddy simulations of the atmospheric surface layer with lagrangian snow particles, coupled with statistical models of aerodynamic, splash and rebound entrainement of particles from an underlying snow surface. It is found that the residence time of a typical saltating particle is shorter than the period of the transient regime, implying that using the TM solution might be erroneous.
In simulations with similar air and surface temperatures, these errors range between 25% for low-wind and low-saturation conditions and 40% for high-wind and high-saturation conditions. With a small temperature difference of 1 K between the air and the snow surface, the errors due to the TM model are already as high as 100% with errors rapidly increasing for larger temperature differences.

BE-9d - Life distribution and responses to environmental changes in Polar ecosystems 22.06.2018 11:00-12:30, C Aspen

1896
Ecosystem Monitoring for Conservation: When to Monitor and Use Biodindicators

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Ecosystem monitoring is not high impact, novel research to undertake in Antarctica or the sub-Antarctic, as such it is often not supported. Yet in order to understand ecosystem change and detect climate change impacts or assess conservation targets, monitoring must occur. Due to economic and logistic constraints and a desire to minimise our footprint we have to rationalise when, where, what and how we monitor in the region.
On sub-Antarctic Macquarie Island we are developing an optimal monitoring strategy to determine the current ecosystem state and track change into the future following invasive species eradication and under climatic change. We will quantify if conservation targets are being achieved. In order to do this we must identify when, what and how we monitor the terrestrial ecosystem. Firstly, management objectives for the region were clearly define. Secondly, temporally and spatially explicit historic data were located and compiled from various sources. This provided us with a suite of taxa and ecosystem variables that could be monitored into the future. We then had to consider which were suitable as bio-indicators, with which to detect change. A gap analysis was undertaken to determine if management objectives could be determined with this suite of bio-indicators or if new monitoring had to be initiated to ensure greater coverage of taxa and features. Finally, we are determining how monitoring can be in repeatable, low impact and cost effective into the future.

185
Species on the Move in East Antarctic Terrestrial Communities

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Antarctica has experienced major changes in temperature, wind speed and stratospheric ozone levels over the last 50 years. Whilst West Antarctica and the peninsula showed rapid warming and associated ecosystem change, East Antarctica appeared to be little impacted by climate warming, thus biological changes were predicted to be relatively slow. Detecting the biological effects of Antarctic climate change has also been hindered by the paucity of long-term data sets, particularly for organisms that have been exposed to these changes throughout their lives. We monitored vegetation communities in the Windmill Islands, East Antarctica from 2000 to 2014 and found significant changes in species composition. In addition, we have shown that radiocarbon signals preserved along shoots of the dominant Antarctic moss flora can be used to determine accurate growth rates over a period of several decades, allowing us to explore the influence of environmental variables on growth. Stable isotopic measurements suggest that the observed effects of climate variation on growth are mediated through changes in water availability and most likely linked to the more positive phase of the Southern Annular Mode and changing westerly wind patterns. For cold remote locations like Antarctica, where climate records are limited and of relatively short duration, this illustrates that mosses can act as microclimate proxies and have the potential to increase our knowledge of coastal Antarctic climate change.

1985
Vascular Plants and Moss Responses to Passive Warming in Antarctica

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In contrast to vascular plants, bryophytes are major components of green landscapes of Antarctica's small ice-free areas. Mosses, with more than 100 species, extend from maritime Antarctica well into the continent. However, only two vascular plants colonized Antarctica, the native *Deschampsia antarctica* and *Colobanthus quitensis*. After long term passive warming, we found that vascular plants grew faster producing more seeds. In mosses, an increase of sporophyte production after passive warming both in monoecius (*Bartramia patens*) and dioecious (*Polytrichastrum alpinum*) was found. *Sanionia uncinata* is a dominant and pioneer moss on glacier moraine and covers most part of the ice-free areas on the South Shetland Archipelago. We found that *S. uncinata* facilitates the growth of the vascular plant *D. antarctica* in the field and we observed that experimental warming did not change this positive interaction. We study heat resistance, antioxidant capacity. We observed no change in photochemical efficiency between passive warming and control after seven years of treatments, however lipid peroxidation rises in warmed mosses during the experiment, indicating that *S. uncinata* has been affected by the long term treatment. We suggest that *S. uncinata* will be able to support the future scenario of warming, but desiccation will be important for the success of this moss and this will affect the interaction with other component of the tundra ecosystem.

1014
Traits Determining Invasiveness of Temperate Plant Species in Polar Regions

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There are several ecological traits that could explain the capabilities of invasive species for the colonization of new areas. Traits that promote invasiveness may largely vary due to the prevailing ecological limiting factors across climatic regions. Temperate and Tropical areas are subjected to a stronger biotic competition than in Polar Regions, while in contrast abiotic conditions of polar areas may result particularly stressful for plant invaders. The present study compiles and analyzes climatic, mechanistic and physiological traits from 70 reported non-native plants of 4 different plant families historically found at nine biogeographic areas within Arctic and Antarctic/Sub-Antarctic high latitudes. General invasiveness was related to wide macroclimatic tolerances observed from temperature and precipitation ranges. Furthermore, the number of sites colonized per species was related to other factors such as plant height, seed production and/or human facilitation. The observed patterns are discussed in light of global change scenarios, taxonomic relationships and cold areas regionalization.

713
Predicting Plant Invasion Risks to the Subantarctic Islands

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Worldwide, alien invasive species constitute one of the greatest threats to biodiversity. Therefore, to prevent and manage invasions, it is of utmost importance to understand invasion risks. The remote Sub-Antarctic Islands harbour a unique flora and fauna. Although they are mostly considered to be fairly pristine and little impacted by humans, a number of alien species have established and spread on the islands. Indeed, along with climate change, invaders are considered the greatest threat to the native biodiversity of the islands. In this study, we first assess the risk of invasion for all Sub-Antarctic Islands. We use a global pool of invasive plant species to assess which global invaders have a high probability of establishing on the islands. Second, using a trait-based approach, we assess what characteristics of plants make them successful invaders once they arrive in the Sub-Antarctic. Our assessment indicates which species pose the greatest invasion risk and which islands are most at risk to invasion. Furthermore, we find that weedy, generalist species with few specialised defences against extreme weather are particularly effective invaders. Worryingly, these species are predicted to become significantly more successful with climate change, at the expense of the native species. Our results allow us to make recommendations on which species pose the greatest risk to the islands and to prioritise the eradication of alien plant species on Sub-Antarctic Islands.

37
Mechanistic Models to Improve Antarctic Biosecurity

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Invasive species are one of the most important threats to Antarctic terrestrial biodiversity. While Species Distribution Models (SDMs) are a useful tool to assess the suitability of non-occupied areas for invasive species, the uniqueness of the Antarctic environment has proven a challenge. We apply a new mechanistic modelling approach that allows the inclusion of prior physiological data to predict the distribution of species, providing strong predictive power. Six non-native Collembola species have been recorded from the Antarctic Peninsula and many more from the Southern Ocean Islands, some identified as invasive. We therefore use this group as an exemplar for the model. In particular, *Ceratophysella denticulata* is an invasive species on several Southern Ocean Islands, and a high risk to others and to the continent. Therefore, we apply our approach to *C. denticulata* SDM using its native range and physiological characteristics, and validate our results with high resolution sample data from Marion Island (South Africa). The projection of our model shows a strong congruence with field-collected sample data. The projection of the model to seven other Southern Ocean Islands shows that *C. denticulata* would find suitable environments on four of them, resulting in a potential threat to the native soil fauna. Our results support the rigorous implementation of biosecurity protocols to prevent the arrival and establishment of alien species on the Southern Ocean Islands and Antarctica.

EN-7b - Biogeochemical cycling in the Polar Regions: Terrestrial and Ocean interactions
22.06.2018 11:00-12:30, A Studio

2056
Geochemical Constraints on Particle Flux Processes in the Western Arctic Ocean

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A growing body of evidence suggests that delivery of particulate matter, including associated biogeochemically-relevant materials to the interior Canada Basin in the central Arctic Ocean is dominated by lateral inputs. The magnitude and origin of lateral inputs has substantial implications for central Arctic Ocean biogeochemical processes and the ecosystem they support, as well as on records preserved in underlying sediments.
Coupled measurement of organic and inorganic tracers provides a promising approach to unravel the sources and cycling of particulate matter in the western Arctic Ocean. In this study we used carbon (^{13}C, ^{14}C) isotopes, as well as strontium and neodymium isotopes to constrain terrestrial and marine organic carbon sources and detrital sediment provenance, respectively. Potential implications of future changes in the flux and provenance of materials supplied laterally to the central Arctic Ocean in relation to ongoing ocean and climate change are assessed.
Our data show a predominance of marine organic carbon in the Bering and Chukchi Sea whereas the Beaufort Sea and the Canada Basin is more strongly influenced by terrestrial inputs, with Beaufort Sea Nd and Sr isotopic signatures suggesting the Mackenzie River as major contributor of detrital particles whereas the Chukchi Sea receives a mixture of Aleutian Arc and Mackenzie derived material.

19
Increase in Acidifying Water in the Western Arctic Ocean

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The uptake of anthropogenic CO_2 from the atmosphere by the ocean has decreased seawater pH and carbonate mineral saturation state, a process known as Ocean Acidification (OA). It has been reported that the Arctic Ocean is particularly sensitive to climate change and that the aragonite mineral saturation state (Ω_{arag}) will become undersaturated sooner than in other oceans. The extent and expansion rate of OA, however, are still unknown. Here we show that low Ω_{arag} waters were largely confined to 50-150 m depth and south of 80ºN in the 1990's, but data from multiple trans-western Arctic Ocean cruises show that the extent of low Ω_{arag} waters has since expanded to 50-250 m and to 85ºN. The vertical distribution of the $\Omega_{arag} < 1$ water has increased by about six-fold between the 1990's and 2010. Tracer data and model simulations suggest that the recent increase in Pacific Winter Water (PWW) transport, driven by anomalous circulation pattern and sea-ice retreat, is primarily responsible for the rapid expansion of the low Ω_{arag} water. Local carbon recycling and anthropogenic CO_2 uptake have also played roles in increasing the extent of the affected area. Our new results indicate that rapid acidification has happened in the Arctic Ocean and is far more serious than that in the Pacific and Atlantic Oceans where decadal OA trends have recently been reported.

416
Glaciers, Icebergs and Silicon: Preliminary Findings from the ICY-LAB Expedition (Invited Speaker)

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The supply and distribution of dissolved silicon (Si) in the oceans is a key factor in the growth of marine diatoms, which precipitate biogenic silica (or opal). Rivers and groundwater have long been considered the major inputs of dissolved Si, which is released during the weathering of silicate rocks. Glaciers are known sources of both dissolved and particulate Si phases, but the impact on oceanic systems needs further quantification to produce a more robust global budget. The aim of the ICY-LAB project is to investigate the role of high-latitude processes on the Si marine cycle. Expedition DY081 (RRS Discovery, summer 2017) focused on characterising the physical and chemical properties of the shelf and slope waters off Southwest Greenland, and investigating the impact of meltwater dynamics and circulation on biological production and ecosystems. Here, we present some of the initial results from the project, including the distribution of dissolved nutrient phases and tracers of meltwater components in the water column. We use observational and experimental approaches to explore the role of both continental runoff and shelf sediments in glaciated regions in supplying dissolved nutrients into the offshore waters. Our findings improve the understanding of the Si cycling between terrestrial sediments, shelf processes and seawater in glaciated regions, which represents an important but understudied component of internal cycling as well as a key input into the oceanic Si budget.

1120
Pulsed Iron input from Svalbard to the Arctic Ocean over the past 180 ka

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Climate warming in high latitude terrestrial regions has the potential to significantly influence ocean biogeochemical cycling through increased delivery of freshwater, nutrients, and organic material. Changes in iron (Fe) input from terrestrial regions is especially important because Fe is a bioessential micronutrient, can control the sedimentary cycling of macronutrients (phosphorus), and can increase sedimentary preservation of organic carbon. Sedimentary records of past biogeochemical cycling are, therefore, important to evaluate and predict the effects that changes in the input of Fe-rich terrigenous material to the Arctic Ocean will have on nutrient cycling and organic carbon burial.
During a 2015 Polarstern expedition, sediment cores were retrieved north of Svalbard, on the Yermak Plateau. Based on preliminary age constraints, the PS92/39-2 core includes sediments from the penultimate glaciation (MIS 6) to the Holocene. Here we present XRF analyses to quantify and evaluate changes in biogeochemical cycling in this region during the past two glacial cycles. Initial results indicate a series of high Fe delivery events during the record with Fe concentrations of up to 9.8 wt.%. Pulsed delivery of Fe is likely associated with increased delivery of material from northern Svalbard, which is dominated by Fe-rich Devonian red beds. Tight coupling between Fe and P concentrations throughout the record suggests dynamic nutrient delivery and burial in the region.

1606
Constraining Silicate Weathering Fluxes in a High-arctic River using Li-isotopes

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Silicate weathering is an important driver in both the inorganic and organic C-cycles. CO_2 is removed from the atmosphere by the weathering of silicate rocks at the Earth's surface, and is transported via rivers as bicarbonate (HCO_3^-) to the oceans, and locked up as marine carbonates. Silicate weathering also delivers nutrients to the oceans, promoting organic carbon burial.
Understanding how cryospheric weathering processes and the presence of glaciers and permafrost may affect physical and chemical weathering fluxes in high-Arctic rivers, and thus CO_2 removal in such high-latitude regions, remains poorly understood. In order to investigate this, we sampled rivers draining into the glacially fed, permafrost-dominated Zackenberg River Basin, NE Greenland.
Based on dissolved major element chemistry, we can identify a silicate-rich end-member draining easily erodible Cretaceous sandstones and Tertiary basalts, and a carbonate-rich end-member draining from the Lindemanselven. Tributaries fed by the A.P. Olsen glaciers, and melt water streams that drain the Caledonian granitic gneissic basement are also geochemically distinct.
Riverine lithium isotopes are a unique tracer of silicate weathering processes that are unaffected by biology, carbonate weathering or primary lithology. Dissolved and suspended particulate Li isotopes will be presented for rivers draining into the Zackenberg River to assess the role of silicate weathering, and ultimately CO_2 drawdown, in this region.

AC-8d - Causes and Effects of Changing Polar Climate, Cryosphere and Hydrological Cycle
22.06.2018 11:00-12:30, A Forum

2565
On the Relative Roles of Feedbacks and Heat Transport in Polar Amplification

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Here we present evidence that zonal-mean climate and its changes can be understood in terms of a moist energy balance model (MEBM) that represents atmospheric heat transport as a simple diffusion of latent and sensible heat - as a down-gradient transport of moist static energy with constant diffusivity, as supported by comprehensive models and atmospheric reanalyses. Given patterns of local radiative feedbacks, radiative forcing and ocean heat uptake, the MEBM accurately predicts the evolution of zonal-mean temperature and atmospheric heat transport (moist and dry) as simulated by the ensemble of CMIP5 GCMs. These results suggest that, despite all of its dynamical complexity, the atmosphere essentially responds to energy imbalances by simply diffusing latent and sensible heat down-gradient.
It further provides insights into
(i) the mechanisms of polar amplification and
(ii) how uncertainty in the spatial pattern of radiative feedbacks, forcing, and ocean heat uptake project onto uncertainty in polar warming.
In the absence of any spatial structure in feedbacks or forcing, polar amplification emerges due to enhanced poleward atmospheric heat transport associated with latent heat. When the full spatial structure of radiative feedbacks are accounted for, polar amplification emerges due to the feedbacks and is damped from a decrease in atmospheric heat transport into the Arctic. These results suggest that polar amplification is an inevitable feature of climate change.

1177
The Two Major Sources of Uncertainty in Antarctic Climate Change Projections

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Some of the largest uncertainties in projected anthropogenic climate change impacts occur in or are tied to Antarctica and the Southern Ocean. Projected changes in Antarctic surface mass balance, sea ice extent, and surface temperature differ widely among current-generation climate models, and this uncertainty largely stems from two major sources, internal variability and structural uncertainty. In this presentation, I will highlight recent work with the Community Earth System Model that aims to characterize the range of structural (model physics) uncertainty in Antarctic climate change projections and to determine its importance relative to Antarctica's large natural climate variability. In particular, I will present results from new experiments that address how the Southern Ocean sea ice and sea surface temperature responses to stronger westerly winds differ according to the model's ocean temperature and salinity structure.

787
The Signature of Ozone Depletion in Recent Antarctic Precipitation Change

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Precipitation as snow is a primary control on Antarctic Ice Sheet (AIS) mass balance and its contribution to sea-level rise, with regional trends in snowfall at the interannual scale linked to patterns of broader atmospheric circulation variability. Long-term historical AIS precipitation trends and their underlying external climate drivers, however, remain inconclusive. Here, using a pair of climate model simulation ensembles, we uncover a strong spatial signature of ozone depletion-forced Antarctic precipitation change characterised by an overall increase in snowfall. Distinct areas of little change or precipitation decrease, arising from interaction between ozone depletion-forced atmospheric circulation changes and ice sheet topography, are outweighed by large-scale precipitation increases. This signature bears notable similarities to a new ice core-based reconstruction of Antarctic surface mass balance change and drives a significant increase in annual integrated precipitation (38 +/- 10 Gt over the 1986-2005 period or 51 +/- 11 Gt over the 1991-2005 period) that has the same magnitude as observed Antarctic mass loss and thus strongly dampens recent Antarctic sea-level rise contributions.

1004
Dynamical Mechanisms of Anomalous Moisture Transport towards East Antarctica

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During the last decade Antarctic ice sheet accumulation patterns exhibited large regional differences. While the total ice-sheet mass of Antarctica declined, East-Antarctica experienced increases in ice mass. During 2009 and 2011, this increase was caused by only a handful of intense precipitation events. In this study, we investigate such an episodic accumulation event, thereby exploring linkages between oceanic evaporation in subtropical regions and Antarctic ice-sheet accumulation.
We use both Eulerian and Lagrangian analysis to demonstrate that moisture transport towards East-Antarctica was facilitated by several cyclones of different scales. Moisture transport occurred in coherent air-streams, manifested initially as intense low-level jets embedded in the warm sector of the cyclone(s), followed by a transition to slantwise (isentropic) ascent before reaching the continent. Water vapor loading of this air-stream was driven by low-level convergence in the warm sector along the advancing cold-front, whereas the slantwise ascent phase of the moisture transport was characterized by moisture removal (precipitation). Oceanic evaporation along the filamentary structured, anomalous moisture transport area was virtually absent, indicative for long-range moisture transport during the event. In addition to the moisture transport mechanisms we identified moisture source regions associated with the event.

2674
Impact of Sea Ice Anomaly on Antarctic Precipitation and its Source Attribution

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Modeling and experimental evidence suggests that Antarctic Ice Sheet (AIS) surface mass balance (SMB) increases in a warming climate due to increased precipitation. We use the Community Earth System Model (CESM) with an explicit water tagging capability to partition the causes of increased precipitation in high latitudes. Sensitivity experiments have been conducted to understand the impact of sea ice anomalies on regional evaporation, moisture transport, and source-receptor relationships for regional precipitation over the Antarctica. Three composites of sea ice concentrations (SIC), constructed from the 1800-year CESM Large Ensemble Project using mean, 10% lowest, and 10% highest southern hemispheric SIC years (and corresponding sea surface temperatures), respectively, have been employed to drive three atmosphere-only simulations. Moisture sources in twenty-five geographical regions are explicitly tracked using the water tagging capability to establish source-receptor relationships of vapor and regional precipitation over the Antarctica. Results show that vapor sources for Antarctic precipitation primarily originate from lower latitudes; however, the tagged vapor source regions in high latitudes have discernable changes in their contributions to regional precipitation over the Antarctic in response to the SIC changes. There is also a strong regional and seasonal variability in vapor source attributions.

TE-2b - Advancing Polar Engineering and Sustainable Infrastructure Development
22.06.2018 11:00-12:30, A Sertig

1067
Risk Assessment of Climate-change Impacts on Infrastructure in the Arctic

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The Arctic is home to a population of about four million and is experiencing significant economic and environmental transformations as a result of ongoing natural resource development and climate-change. Mitigation and/or adaption efforts will be necessary to maintain the proper functioning of infrastructure over intended lifespans. This study examines the spatial distribution of risks from projected climate-change to built infrastructure in the Arctic and examines the economic costs of climate-change impacts on human development.
Changes in environmental variables such as temperature, precipitation, permafrost, freeze-thawing cycles, and ground subsidence are estimated in order to evaluate the risks of various types of infrastructure including roads, railways, pipelines, and buildings. The areas of significant climate-change driven risks are determined across the circumpolar region. The costs of mitigation and adaption efforts are used to provide quantitative estimates of climate change impacts. The results of this assessment can be used as a tool for businesses, policymakers, and urban planners in order to guide sustainable development in the Arctic.

1716
SmartICE: A Sea-ice Monitoring System for Arctic Communities and Industries

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SmartICE (smartice.org) is a northern social enterprise that puts into the hands of communities the technology that helps them adapt to unpredictable sea-ice changes, resulting from climate change. Inuit knowledge of sea ice has been acquired from millennia of observation and use. But in the last decades this traditional knowledge has become less effective in the face of unprecedented environmental changes. SmartICE is an award-winning (Arctic Inspiration Prize 2016, UN Momentum for Change 2017) climate change adaptation tool that integrates on-ice technology, remote sensing and Inuit knowledge to generate near real-time information on sea-ice conditions. It maintains a network of *in situ* and mobile sensors that measures and transmits sea-ice thickness data from community trails. It also maps sea-ice surface conditions from satellite imagery to inform safe travel choices. It uses information technology to generate accessible products that match the needs of community users. The SmartICE information system directly benefits public safety, food security, health and wellbeing, while supporting economic activities for communities (e.g., ice-based fisheries and tourism), especially during highly dynamic freeze-up and break-up periods. Through technological innovation and science, SmartICE strives to integrate and augment Inuit knowledge about local sea-ice conditions, not replace it, through involvement of Inuit in all aspects of its operation and decision-making.

288
A Vision for Safe and Sustainable Arctic Maritime Transport

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In the face of an expected increase in Arctic ship operations, driven by climate change, improvements in ship technology, and a high demand for Arctic natural resources, the understanding and management of related risks is paramount. Our vision for safe and sustainable Arctic maritime transport is based on a holistic design approach incorporating the goal-based regulations (GBRs) of the recently enforced Polar Code. In contrary to traditional design rules, GBRs do not determine the required solution, but determine instead the required function(s) to meet the goal(s). This gives designers more freedom to apply new and innovative solutions, where a high (and known) level of safety and sustainability is achieved without compromising cost efficiency. However, to ensure that the goals of the Polar Code are met, it is first necessary to determine appropriate performance measures and acceptance criteria for all critical safety and sustainability functions of a ship, and to develop and validate related performance assessment methods. This requires comprehensive understanding of Arctic ship operations, the applied technologies, and their interactions. Thus, we are working towards our vision both by increasing the knowledge about specific technologies (e.g. cold-resistant steel), and by developing a holistic design framework for Arctic ships, considering both operational and regulatory demands. The overall aim is to enable better-informed design decisions, reducing the level of risk.

2317
Mechanical and Thermal Ice Borehole Reamers

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Various stages of deep-hole drilling in ice require local enlargement of boreholes in order to perform different technological operations, e.g. installation of a casing string or sidetracking. Such tasks are accomplished using dedicated mechanical and thermal borehole reamers.
The paper provides a brief analysis of existing designs of mechanical and thermal reamers, which was used as the basis to specify requirements for new reamer designs. Based on these requirements, innovative designs of mechanical and thermal reamers have been developed. The paper presents schematic diagrams of these reamers and describes their design features, principles of action and operation practice in details.

80
Building a Modern Heavy Icebreaker: Balancing Security and Science Capabilities

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The United States Coast Guard is designing and building new heavy polar icebreakers to replace aging and increasingly obsolescent ships. We have developed and evaluated icebreaker operational requirements, seeking the greatest capability within the bounds of affordability. These ships must conduct the missions of U.S. Coast Guard (which include safety, security, and stewardship of U.S. waters) while serving the survey and science needs of our partner agencies across the federal government. In this presentation, I will outline the icebreaker acquisitions process, highlighting our outreach with the U.S. Navy, industry and international partners. I will discuss the concept of icebreaker operations in both the Arctic and Antarctic. I will present the key performance capabilities required of the vessel in terms of icebreaking, endurance, and interoperability, and the resulting design implications. I will discuss the capabilities that support U.S. Coast Guard maritime missions such as boat and aviation operations. Finally, I will detail the survey and science capabilities required of these icebreakers to increase our knowledge of the remote Polar Regions.

2198
Antarctic Near-shore and Terrestrial Observation System: Technology Overview

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ANTOS (Antarctic Near-shore and Terrestrial Observation System), a SCAR Expert Group, is a biology-focused initiative to coordinate and harmonize efforts to assess environmental variability and change across the Antarctic continent and National Antarctic Programs. The primary aim for ANTOS is to foster and facilitate autonomous collection and sharing of long-term climate and associated environmental observations using standardized protocols and instrumentation in terrestrial and coastal habitats. The ANTOS draft technical guidelines include specifications for three tiers of ANTOS stations with increasing complexity and cost. The three-tiered approach aims to enable the widest possible deployment of ANTOS-compliant automatic weather stations across Antarctica and the broadest participation by National Antarctic Programs and Antarctic researchers.
Leveraging decades of development and experience from polar engineers and scientists, ANTOS platforms will be integrations of off-the-shelf products to maximize reliability and the ease of procurement and replacement. By presenting a technology overview of ANTOS to an audience of polar engineers and field scientists, we seek feedback on the current draft technical guidelines and wish to explore possible inclusion of emerging technologies. We particularly hope to collect information on the performance of various new battery and power technologies (e.g., $LiFePO_4$ and methanol fuel cells) in polar settings.

GG-1b - Magmatic, tectonic, and geodynamic investigations of the Polar Regions
22.06.2018 11:00-12:30, A Schwarzhorn

1819
The Laurentia-East Antarctica Connection Revisited

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Following the suggestion of Canadian geologists Bell and Jefferson, who compared the Proterozoic stratigraphy of southeastern Australia and western Canada, Moores and Dalziel published separate papers in 1991 proposing that the Pacific margins of East Antarctica-Australia and Laurentia had been juxtaposed prior to the opening of the Pacific Ocean basin in the Neoproterozoic. Following Moores, this became known as the **S**outh**w**est United States-**E**ast **A**n**t**arctica, 'SWEAT', hypothesis. Over the past quarter century several variations of the proposed juxtaposition have been suggested, and some authors have put forward reconstructions with Asian crustal blocks interposed between East Antarctica-Australia and Laurentia.
In a series of publications between 2004 and 2017, Goodge, Fanning and coilleagues have demonstrated that morainal material originating under the East Antarctic ice sheet bears compelling similarity to the Laurentian craton. Detrital zircons in the Beacon Supergroup also have a distinctly Laurentian signature. There is, however, a significant difference between the reconstructions stemming from these studies and one taking into account the apparently Laurentian nature of the Mesoproterozoic volcanic rocks in Coats Land reported by Loewy and colleagues. The latter indicates that the ca. 1.0 Ga type- Grenvillian orogeny of Laurentia continues into the Maud orogen along the eastern margin of the Weddell Sea. The purpose of the presentation is to explore this discrepancy.

704
Integrated 3D Lithosphere Model of Antarctica

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We present a new 3-dimensional model of the Antarctic lithosphere, integrating seismological and gravity gradient data in a self-consistent manner. Current studies on the lithospheric structure, in particular the Moho depth, of the Antarctic continent contradict each other in many cases, depending on the applied geophysical method. This has huge implications for considerations regarding the isostatic state of the continent despite ongoing glacial isostatic adjustment (GIA). We attempt to reduce inconsistencies and ambiguities from separate geophysical methods by combining multiple observational data in a thermodynamically self-consistent 3D model, considering temperature and petrology of the lithosphere, seismic body wave velocities, and isostasy. Gravity gradient data from ESA's GOCE satellite mission are used to constrain the density distribution within the lithosphere.
Our results indicate that Antarctica is largely in isostatic equilibrium, however, the topography of some regions seem to have components which cannot be explained by pure isostasy. The subsurface thermal field of our model can be used to derive the mantle's viscosity for the purpose of GIA modelling. Our forward-calculated surface heat flow estimations may serve as background values for modelling basal melt rates of Antarctica's ice sheets.

780
India-Antarctic Breakup: Constraints from New Geophysical Data

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The India-Antarctica separation is still an open problem due to the absence of critical geophysical data. So far no wide-angle data existed along the conjugate margins of East India and the Enderby Land off East Antarctica to define the position and composition of the continent-ocean boundary - a pre-requisite for any sound reconstruction. Furthermore, along both margins only old marine magnetic random track data are available for identifying seafloor spreading anomalies to describe the drift of both continents in the Cretaceous. The Kerguelen Plateau, located just north of the East Antarctica coast, however, has been drilled several times providing the only reliable age constraint on the formation of this huge magmatic plateau. In general, the poor information resulted a wide variety of kinematic models for the drift of the India.
In the last years several newly acquired geophysical data provide new constraints on its drift. Two deep seismic sounding lines off Prydz Bay and across the Princess Elisabeth Trough show that oceanic crust is already present much closer to the present-day shelf break than previously known. Magnetic data acquired parallel to these lines provide excellent timing constraints for the initial breakup of India. Finally, marine magnetic data gathered in 2017 south of Sri Lanka indicate that here the oceanic crust is definitely younger than magnetic chron M0, questioning several kinematic models for the Indian Ocean.
The latest results will be presented.

855
Defining Blocks and Boundaries within the Gondwanan Kuunga Orogen

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The East Antarctic region between Princess Elizabeth and Wilkes lands occupies a critical position in tectonic reconstructions, encapsulating part of the enigmatic Kuunga Orogen. Here, crust of broadly Indian affinity and Australian affinity is generally thought to have been juxtaposed during Ediacaran-Cambrian (~550-530 Ma) Gondwana amalgamation. However, a lack of identified ophiolite or consensus on the location and geometry of any sutures makes it difficult to incorporate the Kuunga Orogen into models of Gondwana evolution.
If Indo-Antarctica and Australo-Antarctica had distinct geological histories, then a suture zone should juxtapose crust of different protolith age. This approach can constrain suture location from geochronology of available outcrop even when the suture itself is not exposed. Although this boundary might not be the only suture or the final suture, it is a fundamental paleo-plate margin and an important first step in determining the overall orogenic architecture.
Here we explore the implications of approaching this problem via integration of geological and geophysical data in a plate reconstruction framework. We present new zircon and monazite U-Pb geochronology, together with zircon Hf-isotope data, to examine the crustal evolution and affinity of rare coastal exposures of the Kuunga Orogen. Based on these integrated datasets, we suggest a fundamental terrane boundary intersects the Queen Mary Land coast, east of Mirny and west of Alligator Island.

639
Crustal Structure off Enderby-Wilhelm II Lands: Implication for Gondwana Breakup

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The history of rifting and sea-floor spreading between India and Antarctica remained vague long time mainly because of data scarcity and insufficient depth resolution of seismic data off both continents. Revision of all available geophysical data (including recently derived) in the region off Enderby-Wilhelm II Lands (Antarctic sector between 35E and 100E) and published information on crustal structure of the eastern India margin based on commercial seismic data give much better understanding of break-up history of East Gondwana. The rifted continental margin off Enderby-Wilhelm II Lands shows variable crustal characteristics. Off eastern Enderby Land, it is 300-400 km wide and includes a 100-km-wide continent-ocean transition zone consisting mostly of exhumed mantle. The western Enderby Land, Princess Elizabeth Land and Wilhelm II Land margins are narrower and range in width from 50 to 200 km. The sea-floor spreading started in the eastern part of studied region (76E-100E) at about 130 Ma. Off western Enderby Land (55E-76E), early oceanic opening was compensated by mantle exhumation. The pole of rotation was located close to Gunnerus Ridge. The southern Kerguelen Plateau was the part of the India margin and was attached to the Antarctic plate due to a ridge jump at about 124 Ma. The sea-floor spreading between 36E and 66E occurred during CNS. It started at about 120 Ma off eastern Enderby Land and later off western Enderby Land.

1412
New Model Bathymetry and Tectonic Boundary Beneath Ross Ice Shelf, Antarctica

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A new tectonic boundary has been discovered beneath the Ross Ice Shelf (RIS), a 476,000 km^2 floating icesheet that obscures the seafloor topography and crustal structure of the West Antarctic rift system. Mapping of magnetic and gravity anomalies by the ROSETTA-Ice airborne survey (2015-2017) reveals a major break between cratonic East Antarctica and accreted crust of West Antarctica, midway across the Shelf ~300 km east of the Transantarctic Mountains. The Central High, a fault-riven block formerly identified and drilled in the Ross Sea, is found to span the tectonic boundary and continue south as a basement high separating two distinct crustal regions beneath the Ice Shelf. The modeled bathymetry shows a deep, smooth Ross-EAIS sector of dense crust that displays subdued, long wavelength magnetic anomalies. This contrasts with the shallow, more complex seabed in the ROSS-WAIS sector, comprising less dense crust with high amplitude, short wavelength magnetic anomalies. Modeling of geophysical data allows the identification of glacially-carved and sediment-filled troughs, faults, and tectonic transfer zones, together with magma conduits and centers. A revision of the existing tectonic framework for the Ross Embayment is needed to accommodate these new findings from the fuller characterization of sub-RIS extended crust. The presence of shallow and deep sectors have consequences for ocean circulation beneath Ross Ice Shelf and modes of past and future ice sheet retreat.

On behalf of the Rosetta-Ice Team, Columbia University, Lamont -Doherty Earth Observatory

BE-5a - Productivity, Biodiversity & Ecosystem Shifts at Cryosphere-Ocean Boundaries
22.06.2018 11:00-12:30, A Seehorn

551
Melting Glaciers and their Impact on Coastal Productivity in Greenland

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The Greenland Ice Sheet is melting at an unprecedented rate, and as a result, fjords and continental shelves around Greenland are exposed to an increasing freshwater runoff. Yet the impact of high meltwater input on the biogeochemistry and productivity remains largely unquantified. To resolve the effect on Greenland's fjord, sampling was conducted in several fjords impacted by melting glaciers in Greenland and physical, chemical and biological gradients were studied from close to the glaciers towards the open sea. Hydrographic and biogeochemical data from several fjord systems adjacent to the Greenland ice sheet, suggest that ecosystem productivity is very differently regulated in fjords influenced by either land-terminating or marine-terminating glaciers. Our data shows that rising subsurface meltwater plumes originating from marine-terminating glaciers entrain large volumes of ambient deep water to the surface and consequently supply upwelling of nutrient-rich deep water. This sustains sustains a high phytoplankton productivity throughout summer in the fjord with marine-terminating glaciers. In contrast, fjords with only land-terminating glaciers lack this upwelling mechanism, and are characterized by lower productivity. These results suggest that a switch from marine-terminating to land-terminating glaciers can substantially alter the productivity in the coastal zone around Greenland with potentially large ecological and socio-economic implications.

324
Fjord Marine Ecosystem Response to Ice Shrinking in KGI: A Case of Marian Cove

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King George Island (KGI) is located at the northern tip of the Antarctic Peninsula, one of the most rapidly warming regions on earth. About 90% of the island is covered by glaciers, and significant glacier retreat has been observed in many coastal areas including a small embayment, Marian Cove (~4.5 km long and ~1.5 km wide). Fast and consistent glacier retreat (ca. 1.9km during 1956-2017) has been reported in MC. Recent studies revealed a suite of environmental parameters with distinct gradients which were apparently developed by glacier retreat and consequent processes. These studies also demonstrated that spatial pattern of benthic communities was significantly associated with these environmental suites, suggesting MC as a model ecosystem for assessing and predicting climate impacts. As a follow-up, this year we started a new integrative and interdisciplinary project, **CHAMP2050** (**CHA**nges in Coastal **M**arine Systems of the Antarctic **P**eninsula: A 2050 Outlook). In this presentation, we introduce latest findings from a long-term dataset on hydrology and phytoplankton communities, which also revealed strong influence of glacier retreat and melt-water processes. We also present further findings on the benthic communities, and suggest that current distribution of megabenthos reflect somehow successional processes in the past, which in turn may provide insight into future scenario in the Antarctic fjords.

943
Impacts of Greenland Ice Sheet Melt on Marine Carbon Cycling in Adjacent Fjords

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The Greenland Ice Sheet (GIS) is melting at unprecedented rates increasing the freshwater content of the Arctic Ocean. Freshwater run-off influences circulation patterns and stratification in Greenland fjords and also introduces inorganic particles, which can limit light availability to photosynthetic organisms. Furthermore, recent glaciological studies have documented that GIS melt water contains significant amounts of bioavailable organic carbon, which are likely to impact microbial carbon cycling and thus potentially transform the coastal ecosystem around Greenland. In this presentation we will show the results of recent studies in a Greenland fjord influenced by land-terminating glaciers as a model for future glacier retreat, where primary production is limited by both light and vertical flux of nutrients due to strong stratification of the water column by freshwater run-off. Additionally, We will present the results of an experimental study, which follows the incorporation of allochthonous carbon from freshwater run-off into the microbial loop. As glaciers retreat, Greenland fjord ecosystems are likely to become less productive and dominated by heterotrophic processes. This may have consequences for the metabolic balance of the ecosystem that has a major role in contributing to the uptake of CO2 in the Arctic Ocean as well as affect the commercial and subsistence fisheries that take place in Greenland fjords.

2239
The Glacial Influence on Fjord Ecosystems of the Western Antarctic Peninsula

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Glacially influenced fjord ecosystems on the Western Antarctic Peninsula are unusually productive, compared to their counterparts in the northern hemisphere. We hypothesize that this is due to low levels of glacial freshwater runoff, which leads to reduced burial of benthic organisms from turbid glacial waters. The mass loss of most of these glaciers occurs as a flux of solid ice into the ocean. A two-year study of Andvord Bay used timelapse cameras and remote sensing to derive a time series of ice flux, calving and sea ice cover. The biggest ice flux contributor to the bay, Bagshawe Glacier, is characterized by maximum flow velocities of 7 m/d and an ice flux of ~1.5 km3/yr. Calving events are episodic: in 2015/16, the majority of summer calving occurred in three big calving events that released large tabular ice bergs. These calving events were separated by a few much smaller events. Submarine melting has not been quantified, but is expected to be low due to cold water and little subglacial freshwater discharge to drive ocean circulation. This is also corroborated by the absence of a plume near the glacier front. The northern location of this glacier makes it subject to fundamental changes, should regional warming continue. At present, these glaciers do not have ablation areas. Future warming could lead to significant amounts of glacial runoff, with invigorated water circulation in the fjord and more subglacial sediment, with profound consequences for the fjord ecosystem.

1343
A Model to Predict Fast ice Timing in Coastal Fjord Ecosystems

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In the coastal fjords of the West Antarctic Peninsula (WAP), especially in the northernmost area of Bransfield Strait, fast ice conditions have shown high variability within the past 25 years, resulting in year-to-year changes of coastal ecosystem productivity. In some recent years, late fast ice break-up resulted in exuberant blooms, potentially related to the variability of fast ice timing and duration. To resolve ice dynamics, we generated a model that uses local and regional sea ice cover, air temperature, wind direction and intensity as predictors for Potter Cove, King George Island (WAP). Daily sea ice cover data were obtained from digital photographs taken with a still camera at Carlini Station from 2009 to 2015. In-situ meteorological data were obtained from NCDC Surface Data Hourly Global dataset, and daily regional sea ice data from NSIDC Sea Ice Concentration dataset. An information-theoretic model selection scheme showed coastal ice duration was best predicted by models including all predictors, and that start and finish of the longest fast ice period responded differently to these variables. The fit of the models was consistently good, suggesting that coastal sea ice timing can be predicted using a combination of regional and local data. Since all analyses are automated and input data are freely available, this modeling tool can be used to analyze how coastal sea ice is linked to inshore bloom dynamics and coastal productivity in WAP fjordic systems.

1489
Ecosystem Physics of a WAP Fjord: A Modeling Study of Key Controlling Factors

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The FjordEco Project is evaluating the role of physical oceanographic processes and glacial input in fjord ecosystems along the Western Antarctic Peninsula (WAP). Between Dec 2015 and Mar 2017, three research cruises to Andvord Bay, a WAP fjord, were conducted to measure physical properties as well as the structure and function of pelagic and benthic biological communities. The sparse in situ oceanographic measurements allow estimates of processes such as nutrient upwelling and seasonal temperature variability. However, a lack of long-term measurements limits the identification of key controlling factors from observations alone. Therefore, we built a high-resolution numerical model (350 m) of Andvord Bay using the Regional Ocean Model System (ROMS) to explore physical processes influencing fjord ecosystem dynamics. The model includes tidal forcing as well as atmospheric forcing from the Regional Atmospheric Climate Model. Initial conditions and oceanic boundary conditions are based on observations. Key controlling factors of fjord dynamics and climatology were determined using adjoint sensitivity analysis. Results provide insights into the influence of sea ice and icebergs on the heat budget and light availability below the sea surface. Our sensitivity studies have improved understanding of the key controlling factors in the fjord and indicate potential ecosystem consequences of climate warming along the WAP.

CR-8b - Latest highlights from high altitude and polar ice cores
22.06.2018 11:00-12:30, A Wisshorn

1749
Mean Global Ocean Temperatures during the Last Glacial Transition

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Due to a lack of robust reconstructions and limited observations, little is known about the ocean temperature's response to climate perturbations. While it is observed that the ocean takes up most of the 'excess' heat from the current global warming, its changes before the first observations (ca. 1865 CE) and in the future are uncertain. Considering the slow overturning time of the global ocean (centuries to millennia) which determines the responsiveness of global ocean temperatures to changing climate, much interest exists in reconstructing ocean temperatures for pre-industrial periods. Here, using a novel ocean temperature proxy based atmospheric noble gases derived from trapped air in ice cores, we show that mean ocean temperature increased by 2.57 +/- 0.24°C over the last glacial transition (20,000 to 10,000 years ago) - a period of major global climate change. Our noble gas based reconstruction provides unprecedented precision and temporal resolution for the integrated global ocean and is not suffering any depth-, region-, organism- and/or season-specific effects intrinsic to such proxies/estimates available thus far. We find that mean ocean temperature is closely correlated with Antarctic temperature and has no lead or lag with atmospheric CO_2, thereby confirming the important role of southern hemisphere climate for global climate trends. We also reveal an enigmatic 700-year warming during the early Younger Dryas that surpasses estimates of modern ocean heat uptake.

1763
An Attempt to Reconstruct Planetary Radiative Imbalance over the Last 40,000 Yrs

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Global climate change arises from an energy imbalance at the top of the atmosphere (TOA). The direct measurement of TOA radiative fluxes is difficult even today, such that most assessments of it are based on changes in the total energy content of the Earth system. We apply the same approach to estimate the long term evolution of the planetary radiative imbalance in the past.
The energy budget of the climate system is dominated by the ocean's heat capacity. On Pleistocene timescales the latent heat changes associated with the waxing and waning of the large ice sheets are of similar magnitude as the ocean heat uptake. Ice core noble gas thermometry allows us to estimate changes in ocean heat content, while sea level reconstructions provide a measure for the contribution of the ice sheets from their latent heat release or consumption. The temporal derivation of the sum of these two dominant components should yield the planetary radiative imbalance.
We present measurements of noble gas derived mean ocean temperature from the EDC ice core covering the past 40,000 years. We infer TOA radiative imbalance as described above. As expected from the relatively stationary climates of the last glacial maximum and the Holocene, the radiative imbalance is close to 0.0 W/m2 in those periods. During the deglaciation a positive imbalance is maintained for ~10,000 years, with two distinct peaks that reach up to 0.4 W/m2, highlighting the importance of internal variability in the climate system.

518
Long-term Change in Ocean Heat Content using Ice Core Noble Gas Thermometry

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Oceanic heat uptake carries the lion's share of glacial/interglacial changes in the planetary heat content, and is thus the most integrative and representative parameter for quantifying long-term changes in the Earth's energy budget.
Here, we are focusing on peak glacial and interglacial conditions over the last 800,000 years, i.e. covering the last eight glacial and interglacial intervals. The only proxies for ocean temperatures during this time period so far were marine sediment cores which show strong variability of ocean temperatures both between and even within individual ocean basins as well as with depth.
The novel method of ice core noble gas thermometry allows us to reconstruct a global mean ocean temperature (GMOT) on the basis of physical principles. The xenon/krypton ratio in the atmosphere is a direct proxy for GMOT because of the temperature dependence of their solubility coefficients. The GMOT in past times can therefore be estimated using high-precision measurements of noble gas elemental ratios from gases trapped in glacial ice after appropriate correction for archive-specific effects.
We performed Xe/Kr analyses on around 100 ice core samples from the EPICA EDC and EDML ice cores from East Antarctica over up to the last 800,000 years. The measurements imply warmer ocean temperature during interglacials and significantly colder temperatures during glacial times quantitatively in line with deep ocean temperature reconstructions from sediment cores.

279
The Spatial Structure of the 128 ka Antarctic Sea Ice Minimum

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Sea ice is an important amplifier in the climate system, affecting the surface energy budget by reflecting incoming solar radiation and regulating the atmosphere-ocean exchange of heat and CO2. Our understanding of the long term (i.e. beyond the satellite era) interplay between sea ice and the climate system can be improved by examining how sea ice responded during a range of past climates. In particular, the last interglacial (LIG; 130,000 to 115,000 years ago) allows investigation of the sea ice response to warmer than present conditions. We compare multi-ice core data with δ18O model output for the early last interglacial Antarctic sea-ice minimum. The spatial pattern of δ18O across Antarctica is sensitive to the spatial pattern of sea-ice retreat. Local sea ice retreat increases the proportion of winter precipitation, depleting δ18O at ice core sites. However, retreat also enriches δ18O because of the reduced source-to-site distance for atmospheric vapour. The joint overall effect is for δ18O to increase as sea ice is reduced. Our data-model comparison indicates a winter sea-ice retreat of 67, 59 and 43 % relative to pre-industrial in the Atlantic, Indian and Pacific sectors of the Southern Ocean. A compilation of Southern Ocean sea-ice proxy data provides weak support for this reconstruction. However, most published marine core sites are located too far north of the 128,000 years BP sea ice edge, preventing independent corroboration for this sea ice reconstruction.

209
Using Ice Cores and Emulation to Reconstruct Last Interglacial Ice Sheets

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Far-field sea level records have provided evidence that parts of the Antarctic Ice Sheet and Greenland ice sheet were likely lost during the Last Interglacial (LIG) period, 116-129 thousand years ago. Reconstructing ice sheet changes within the LIG however remains a difficult problem. Sediment cores from beneath the West Antarctic Ice Sheet (WAIS) support the view that parts were lost within the last 1.3 million years but the timing of the loss is unknown. This lack of knowledge about the ice sheet changes during the LIG hampers our ability to calibrate models of potential ice sheet loss in the future.
Ice cores provide amongst the best dated proximal evidence of LIG change across the Antarctica and Greenland, it is therefore very helpful to use ice core measurements to provide constraints on the rate and timing of ice sheet changes. Holloway *et al.* (2016) explored the ice core signal of WAIS change; we found that ice sheet meltwater and/or ice sheet morphology changes would be recorded in the polar ice cores. Here we present our recent progress on reconstructing ice sheet changes. We simulate how LIG ice sheet and sea ice changes would be imprinted on Antarctic and Greenland ice cores using isotopically enabled climate model simulations of the LIG, and present initial results from applying an emulator (statistical) based approach to this problem, exploring the impact of ice sheet, meltwater, and sea ice changes on the ice core record.

490
The Effect of Northern Hemisphere Ice Sheet Topography on West Antarctic Climate

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The behavior of the Pacific climate system across the last deglaciation is widely debated. Resolving these debates requires long-term and continuous climate proxy records. Here, we investigate multi-year climate variability for the last ~31 ka using an ultra-high resolution and continuous water isotope record (dD, $d^{18}O$, dxs) from the WAIS Divide ice core (WDC) in the Pacific sector of West Antarctica. We document an abrupt decline in the amplitude of dD and $d^{18}O$ multi-year climate variability at ~16 ka. Using the HadCM3, we demonstrate that the climates of both West Antarctica and the Indo-Pacific were substantially altered at ~16 ka by the same forcing mechanism: the lowering topography of the Laurentide and Cordilleran Ice Sheets (LCIS). In the tropics, the LCIS topography affects the rainfall patterns, which explains the Indonesian deglacial shift from expanded-grasslands to rainforest-dominated ecosystems. Similarly, the LCIS affects the tropical Pacific-to-West Antarctic teleconnection strength, which changes WDC multi-year climate variability. The dxs shows a different amplitude pattern than dD and $d^{18}O$, for example, 3-7 yr dxs variability declines slowly from ~16 to 6 ka, whereas 3-7 yr dD and $d^{18}O$ variability declines abruptly at ~16 ka and reaches a minimum at ~10 ka. Initial results suggest that dxs could provide information about pan-Pacific changes in rainfall location, as well as the extent and movement of sea ice during deglaciation in West Antarctica.

SH-7b - Science, Policy, and Politics at the Poles
22.06.2018 11:00-12:30, B Pischa

852
Regional Cooperation in Antarctica: the Cases of Asia, Europe and South America

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International cooperation, with the aim to facilitate research in the Antarctic harsh and extreme environment, plays a pivotal role for the logistic support and for the deployment of scientific projects run by multiple nations. These cooperation can either be intra- continental or external; while inter-Antarctic cooperation are based on Antarctic regional area, external ones find their fundaments in the geographical and political boundaries of every country.
This paper analyses the current situation of three different regional groups that find their roots, in an oversimplified way, in Asia, Europe and South America.
The Asian Forum for Polar Sciences (AFoPS), the European Polar Board (EPB) and the Reunión de Administradores de Programas Antárticos Latinoamericanos (RAPAL) are operating in Antarctica, and with the exclusion of the latter in both Poles, are an excellent example of logistic and scientific cooperation in Antarctica based on a regional scale.
My presentation attempts to further analyse the concept of regional cooperation in Antarctica and underline the importance of joint projects to fulfil scientific research that a single country might not be able to achieve on its own.

2426
Turning Observer Science into Policy in the Arctic; Lessons from the Antarctic

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Accelerating changes and enhanced accessibility of the Arctic call for policymaking based on more and better science. Many of the observer states to the Arctic Council focus on science as the most significant element in their plans. We have mapped scientific capacities of national research programs over the Arctic spatial domain and examined the movement and usage of mobile and fixed research platforms. The scientific endeavors of observer states already form a critical link in the overall observation network and represent significant sources of the data required for sustainable development of the Arctic. There are mounting challenges in need of sound Arctic science, such as the Northern Sea Route, fisheries, or ocean acidification among many others. It is a legitimate question to ask how the Arctic as a whole is institutionally prepared to incorporate all available science, particularly that from observers. There are notable cases of scientific findings turned into policy in the Antarctic, for example the ozone-hole depletion, alien species, and others. In the Antarctic, institutional tools are present and in operation that allow for deliberations and decision-making processes engaging a whole range of stakeholders. Existing and even new arrangements in the Arctic may be inviting but are not inclusive enough, as we will illustrate in the presentation. More solid and embracive mechanisms are warranted to make the most use of observer contributions for the benefit of all.

2279
The Impact of Arctic Scientific Cooperation Agreement on Non-Arctic States

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At the 10th Arctic Council Ministerial Meeting in May 2017, the third binding agreement *Agreement on Enhancing International Arctic Scientific Cooperation* was adopted, which would lower the barriers in international Arctic scientific cooperation, such as the difficulties in accessing research facilities and data .However, it seems that only the eight Arctic States benefit from such improved environment while non-Arctic States may be relegated to an inferior category in Arctic science . With the ratification of the Agreement in Oct. 2017 and the upcoming 2nd Arctic Science Ministeral Meeting in Oct. 2018, the degree of benefits to non-Arctic States under the Agreement needs to be carefully considered. Therefore, the main goal of this report is to discuss the influence of the Agreement on non-Arctic states´ approaches to Arctic scientific cooperation.In the first place ,this report tries to critically analyze the main articles of the Agreement according to the international law as well as provides a description of its purposes and rule-making process. It then seeks to the influence of the Agreement on non-Arctic states´ participation in international Arctic scientific cooperation. The Sino-Russian Arctic scientific cooperation will be evaluated as a case study to explore the possibility of scientific cooperation between Arctic and non-Arctic states. In concluding, this report looks into the future and discusses challenges and opportunities for non-Arctic states.

2278
IASC and its Role in Bridging Arctic Science with Decision-making

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The need to better connect Arctic science with decision-making is well recognized. Initiatives like ICARP-III and the Arctic Science Ministerial stress that Arctic science must be communicated beyond Arctic research community and underline the utmost importance of scientific information to advance constructive decision-making. To respond to those calls, in 2017 the International Arctic Science Committee (IASC) established Action Group on Communicating Arctic Science to Policy-Makers (CASP) - to enhance IASC capacity to provide advice on issues of science in the Arctic and the communication of scientific knowledge to policymakers. Arguably, IASC is very well positioned to serve as the primary source of information about Arctic science. It is the leading international Arctic scientific organization, which brings together all countries active in Arctic research and representatives of disciplines across humanities, social and natural sciences spectrum. The challenge to communicate Arctic science is, yet, paramount. Not only because of the unprecedented scale and pace of changes in the region, but also because of extremely dispersed nature of Arctic research. What is the role IASC can and should play in communicating Arctic science to decision-makers? What are its assets and limitations? CASP Action Group will deliver results of its work to IASC Council at the meeting in Davos. This paper builds upon its efforts, reflects on the CASP process and considers the next steps to take.

73
How Does Science Get into Policy in the Antarctic Treaty System?

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Governments declare that they want evidence based policy and scientists are asked to show how their science can be used for policy. Whilst there is now an apparently well defined route through SCAR Working and Information papers for the community into the CEP, ATCM and CCAMLR and another through national delegations it was not always so. What then are the key drivers that make some science more effective in Antarctic policymaking and how should you define outcomes when describing the effectiveness of the transfer? Using examples I will describe how topicality, risk, political expediency, practicability and affordability will always interact to determine if your efforts will result in a recognisable policy outcome and how and why this process can take some time.

2563
Canada´s Diplomatic and Juridical Foreign Policy: Continental Shelf in the Arctic

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Canada submitted in 2013 a complete process for the expansion of its continental shelf in the Atlantic Ocean, and a partial process to expand its continental shelf in the Arctic. Canada now has an extension to further their research and present a complete process to Commission on limits of the Continental Shelf (CLCS).
In this sense Canada will present the United Nations Convention on the Law of the Sea with a focus as the most relevant issues to the expansion of the Canadian continental shelf in the Arctic.
Around the world, Governments have taken steps to include the most extensive adjacent sea areas in their jurisdictions, acting to exercise their rights onto overseas neighbours, assess the capabilities of its waters and the floor of the continental shelf. The praxis of States, in almost every aspect, has been implemented in line with the Convention, especially after entry into force and rapid acceptance by the international community as a parameter to all actions dealing with oceans and the Law of the Sea.The definition of the territorial sea contributed to the slowing of conflicting requirements. Navigation by the territorial sea and maritime Straits now is backed by legal principles. Coastal States already benefit from provisions that give them extensive economic rights over an area of 200 miles wide along their shoreline.

CR-4e - Ice sheets, ice shelves & proximal processes in past, present & future climates
22.06.2018 11:00-12:30, B Parsenn

813
Antarctic Ice Sheet Evolution Explained by CO_2 Changes and Obliquity Sensitivity

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Since at least 34 million years ago, polar ice sheets have served as an important component of the Cenozoic climate system, yet many details of that history remain enigmatic, and a coherent model for cryosphere evolution remains elusive. Here, we establish a novel measure of Earth system sensitivity to obliquity forcing, quantified through the analysis of $\delta^{18}O$ data, which highlights distinct intervals in Earth system evolution and ice sheet history. We integrate this measure with direct records of Antarctic ice sheet (AIS) variability including sediment cores and seismic data. The results identify an increase in obliquity sensitivity associated with favourable astronomical configurations and key planetary thresholds in CO_2 concentrations and tectonics. The emergence of marine-based ice around Antarctica is coeval with enhanced obliquity sensitivity, and based on this, we establish a three phase AIS model (terrestrial-based ice sheet, marine-based ice sheet, and marine-based ice sheet with extensive sea ice). Long-term climate variability, and continental scale AIS expansion and retreat, is broadly commensurate with the 2.4-My-long eccentricity cycle. Maximum ice extent typically occurs during episodes of low obliquity variance and medium-to-high eccentricity. This integration of ice proximal and distal records provides a new coherent model for AIS evolution, with implications for future behaviour.

875
Evolution of the Ross Ice Shelf since the Last Glacial Maximum

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Given the position of the Ross Ice Shelf, which buttresses both the West and East Antarctic ice sheets, the potential future sea level contribution of its grounded ice drainage basins could be substantial. Here, we perform regional ice sheet model simulations to investigate past grounding line migration of the Ross Ice Shelf using the Parallel Ice Sheet Model (PISM) to better understand how the ice shelf system responds to environmental drivers. The regional simulations, performed at 10 km resolution, include both the Ross Ice Shelf and its grounded ice drainage basins, allowing for the grounding line to evolve through time. Climate forcing experiments are performed using different combinations of the temperature and accumulation reconstructions of the West Antarctic Ice Sheet (WAIS) Divide and EPICA Dome C ice cores, the output of two transient climate model simulations, and multiple SST and sea level proxy reconstructions. Differences in the pattern and timing of retreat between the model experiments highlight the relative impacts of atmospheric and oceanic changes and bathymetry on Ross Ice Shelf grounding line retreat. Our simulations are analysed in the context of the Roosevelt Island Climate Evolution (RICE) ice core and sediment cores from the Ross Sea and wider region. Together, these results provide insight into the environmental conditions that most strongly control grounding line changes, allowing inferences to be made for future controls on sea level rise.

1076
Extensive Holocene WAIS Grounding Line Retreat and Uplift-driven Readvance

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Numerical models used to project future ice-sheet contributions to sea-level rise exploit reconstructions of post-LGM ice loss to tune model parameterizations. In the Weddell and Ross Sea sectors, reconstructions of West Antarctic Ice Sheet (WAIS) grounding line (GL) retreat history have been limited by lack of data south of the ice shelf calving fronts. We present new evidence from
(1) ice-penetrating radar showing Holocene ice rise evolution,
(2) the prevalence of subglacial radiocarbon and
(3) glacio-isostatic adjustment (GIA) modeling that collectively challenge prevailing views of Holocene WAIS behavior.
We show that the GL retreated more than 200 kilometers inland of its present position in these sectors, driven by climatic warming and sea-level rise, followed by GL re-advance to its current position, driven by GIA and ice rise formation. We explain these observations using an ensemble of ice-sheet simulations, using the PISM model suite. These simulations reproduce widespread post-LGM GL retreat well inland of its current location and later re-advance. These findings overturn the assumption of progressive Holocene GL retreat in the Weddell and Ross Seas and suggest that climate-initiated ice loss was reversed by GIA-driven stabilizing processes. Whether these processes could reverse present-day loss elsewhere in Antarctica on millennial timescales depends on poorly-known bedrock topography, mantle viscosity, climatic forcing and future ice-shelf stability.

2580
Weddell Sea Embayment Ice Stream Till Can Be Used to Trace Past Ice Flow Paths

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Till from the margin of the major ice streams of the Weddell Sea Embayment contains detrital minerals with distinct age populations. These differences mean that they can be used as provenance tools to reconstruct past ice stream dynamics and determine the origin of iceberg-rafted debris (IRD) in the marine sediment record. Distinctive zircon age populations for each ice stream include - Institute Ice Stream: 560 Ma and 1070 Ma (dominant), Foundation/Academy Ice Streams: 505 Ma (dominant) and 1030 Ma, Recovery Glacier: 530 Ma (southern margin) and 1610Ma (northern margin), and Slessor Glacier: 2260 Ma, 2345 Ma, and 2415 Ma. Many, but not all of these peaks are consistent with local bedrock sources suggesting measurable input from unexposed subglacial sources. Ar-Ar ages from detrital hornblende and biotite from the Foundation/Academy Ice Stream are typically younger than zircons, whereas till from the northern margin of Recovery Glacier has similar Ar-Ar age peaks as the zircon data. Comparison of these data with offshore U-Pb zircon and Ar-Ar signatures in tills from the Ronne (west), Hughes (central), and Filchner (east) sectors allow us to constrain LGM ice flow paths. The data suggest the Foundation Ice Stream flowed east of Berkner Island at some time during the LGM and that input from the Slessor/Bailey Glaciers was very limited in extent. If the Recovery Glacier bed is underlain by rocks of the Beacon Supergroup, the Recovery extended into the eastern Filchner trough.

729
Diverse Landscapes Beneath Pine Island Glacier Influence Ice FLow

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The retreating Pine Island Glacier (PIG), West Antarctica, presently contributes ~5-10% of global sea-level rise. PIG's retreat rate has increased in recent decades with associated thinning migrating upstream into tributaries feeding the main glacier trunk. To project future change requires modelling that includes robust parameterisation of basal traction, the resistance to ice flow at the bed. However, most ice-sheet models estimate basal traction from satellite-derived surface velocity, without *a priori* knowledge of the key processes from which it is derived, namely friction at the ice-bed interface and form drag, the resistance to ice flow that arises as ice deforms to negotiate bed topography. Here, we present high-resolution maps, acquired using ice-penetrating radar, of the bed topography across parts of PIG. Contrary to lower-resolution data currently used for ice-sheet models, these data show contrasting topography across the ice-bed interface. We show that these diverse subglacial landscapes impact on ice flow, and present a challenge for modelling ice-sheet evolution and projecting global sea-level rise from ice-sheet loss.

2566
A Varied Subglacial Landscape under Thwaites Glacier, West Antarctica

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Deglaciated landscapes, whether subaerial or submarine, are often host to a rich panoply of subglacial landforms. These landforms are formed and shaped by interactions between the ice and underlying substrate, and thus have implications for the flow of the overlying ice. Robust interpretations of the relationship between the ice and its substrate based on subglacial landforms that remain after deglaciation have been inhibited by a dearth of high-resolution observations of currently glaciated subglacial landscapes. Here we present two detailed gridded subglacial topographies, obtained using 3-dimensional radar tomography, from Thwaites Glacier, West Antarctica, where ice flows over a highly variable bed. One grid is located ∼170 km downstream from the ice divide where ice is moving ∼100 m/yr. Here the ice advects over a broad basin and then flows into a subglacial ridge. A deep canyon (~400 m) cuts through this ridge. Relatively soft sediments on the downstream side of the basin suggest that a large subglacial lake may have formed in this location. Multiscale glacial lineations are also observed in the subglacial basin. The second grid is located ∼300 km downstream of the ice divide where the ice is moving ∼350 m/yr. A large crag and even more extensive multiscale subglacial lineations are observed here. Our results suggest that multiple subglacial landforms form in close geographic proximity due to heterogeneous basal conditions.

OS-4b - Sea ice modeling and prediction: Sea ice process understanding
22.06.2018 11:00-12:30, B Jakobshorn

1459
Quantifying Drivers of Internal Variability of Sea Ice

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The rapid decline of Arctic sea ice in the last decades is superimposed by strong interannual variability. The mechanisms that cause internal variability of sea ice are debated. Many studies suggest that sea-ice variability is driven considerably by radiative feedbacks (e.g. Hall 2004, Letterly et al 2016, Kashiwase et al, 2017), ocean or wind forcing (e.g. Arthun and Eldevik 2012, Ogi et al 2010, Park et al 2015), while others suggest atmospheric temperature variability as the key driver (e.g. Deser et al 2000, Ding et al 2017).
To resolve this contradiction, we here quantify how much the suggested drivers contribute to the total sea-ice variability in the fully coupled global climate model MPI-ESM-LR. We perform and analyse experiments in which the radiative effects of clouds, water vapour and surface albedo, and the forcing by surface winds and meridional oceanic heat transport are decoupled from the overall climate.
Our experiments show that radiative feedbacks, ocean and wind forcing are not the key drivers of Arctic sea-ice variability. In total, they cause about 1/4 of the total variability. We show that sea-ice variability instead is primarily driven by direct thermal coupling to tropospheric temperature, which is consistent with other global climate models, reanalysis and observations.

1822

Production of Stable Land-fast Ice Bridges in the VP and MEB Models

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Land-fast ice is an important component of the Arctic system, yet its representation in large-scale sea ice models remains a challenge, partly due to the difficult parameterization of ice fracture that governs the stability of ice bridges. This study aims at improving our understanding of how the ice bridges are maintained by the formation of ice arches at the land-fast ice edge. In particular, the process at which arching fractures are developed is investigated and their sensitivity to the yield curve parameters is discussed. We also stress that the model configuration and the coast morphology are also largely influential in determining the timing and shape of the arching fractures.
Using an ideal channel configuration, we perform a range of experiments in which the model material parameters are varied to determine their relation to the strength of the ice cover. These experiments are made using both the Maxwell Elasto-Brittle and the Viscous-Plastic rheology, which are implemented using the same numerical framework. This allows us to isolate the differences in the modelled ice bridges (and ice fractures) that are due to the different choice of rheology from those that are introduced by the different model parameters, such as the time resolution and discretization.

500
Interplay between Arctic Sea Ice Dynamics and State in HighResMIP

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Sea ice area, thickness and volume have substantially decreased in the Arctic Ocean since the beginning of the satellite era. As a result, sea ice strength has been reduced, allowing more deformation and leading to increased sea ice drift speed. We investigate the links between sea ice dynamics and what we call 'sea ice state' (concentration and thickness) using a process-oriented approach. Our methodology is applied to various global climate models coupling the atmosphere, ocean and sea ice, and participating to the High Resolution Model Intercomparison Project (HighResMIP), within the framework of the EU Horizon 2020 PRIMAVERA project. Model results are compared to different observation datasets. We show that some models can capture the observed relationships between sea ice drift speed, concentration and thickness with more or less accuracy. The domain choice for computing diagnostics and metrics is crucial for our analysis. The impact of model resolution is also assessed and reveals lower Arctic sea ice area and volume with finer grid size, but the effect on the volume depends on the model used. This is correlated to higher northward ocean heat transport with finer grid size. In terms of sea ice dynamics, the impact of resolution on drift speed is less straightforward and really depends on the month of the year. Further analysis is needed to understand the root causes of the model differences.

1817
Evaluating Sea Ice Processes in CMIP5 Models Using Concentration Budgets

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The ability of coupled climate models to recreate observed sea ice behaviour is a natural subject of scrutiny, given their use in projecting future sea ice change. The contrasting trends of Arctic and Antarctic sea ice during the satellite era, and difference in ability of CMIP5 climate models to represent them, means it is crucial to work towards a process-based understanding of sea ice biases.
We seek to understand the thermodynamic and dynamic origins of biases in the seasonal cycle of sea ice area, in both hemispheres, in the CMIP5 multi-model ensemble. This question will be addressed through the use of sea ice concentration budgets calculated from daily sea ice and drift diagnostics, evaluated against a recent eight-year budget derived from observations.
I will present a novel evaluation of the budget terms in the available ensemble. These will be discussed in the context of biases in the underlying drift fields, possible sources in oceanic or atmospheric processes, and the implications for seasonal biases in sea ice area. Previous work based on a single model family has suggested a compensating error whereby too-strong model ice dynamics may be balanced by excess melt. I will discuss the impact of sampling uncertainty- in time, physical space, and 'model space'- on the robustness of this conclusion.

898
Impacts on Antarctic Sea Ice in CESM1(CAM5) from Time-dependent Freshwater Input

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Earth System Models do not reproduce the observed increase in Antarctic sea ice extent which may be due to the unrealistic representation of ice shelves. We investigated the response of sea ice to increasing freshwater input from ice shelves using the Community Earth System Model with the Community Atmosphere Model version 5 [CESM1(CAM5)]. We conducted model experiments adding fresh water as if from ice shelf melt with a linear increase in the rate of input over the period 1980-2013.We found that an increase in the rate of change of freshwater input of ∼45 Gt yr^{-2} was sufficient to offset the negative trend in sea ice area in CESM1(CAM5), although the freshwater input by the end of the experiment was larger than observed at that time.

1769
Variability & Trends of Antarctic Sea-ice in HighResMIP Simulations with AWI-CM

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Climate models struggle to capture observed Antarctic sea-ice extent trends, which has critical consequences for sea-ice projections. To tackle this, it is often suggested to develop models at high spatial resolution. In this study we focus on the September sea-ice extent in prototype simulations for the "High Resolution Model Intercomparison Project" (HighResMIP). Scenario simulations (RCP8.5) are performed with the AWI Climate Model (AWI-CM) at "high-resolution" in both ocean and atmosphere (HR) and "low-resolution" (LR) under the same protocol.
Compared to LR, HR predicts a much weaker warming signal around Antarctica in austral winter for the end of this century (2070-2099) relative to 1976-2005. This may partly be explained by the different sea-ice mean states in LR and HR. However, we also observe increased extent variability and strongly reduced rates of sea-ice decrease. Specifically, HR shows excessive polynya-like features in the Weddell Sea in the pre-satellite era, followed by a stable September sea-ice extent until ~2050. "Mixed-resolution" runs (HR ocean with LR atmosphere, and vice versa) attribute this difference in trends and variability to the HR ocean, independent of the atmospheric resolution.
In light of the observed stable Antarctic September sea-ice extent and the recent return of the Weddell polynya, we will discuss possible common mechanisms and implications for other modelling centres participating in HighResMIP.

AC-2d - Polar meteorology, climatology and stratospheric processes
22.06.2018 11:00-12:30, C Sanada I

136
Late Autumn Boundary Layer Observations in the Ross Sea from the PIPERS Project

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The Polynyas, Ice Production and seasonal Evolution in the Ross Sea (PIPERS) project spent mid-April to mid-June 2017 in the western Ross Sea observing the atmosphere, ocean, and sea ice states to estimate sea ice production and water mass transformation in the Ross Sea. The meteorological observations during PIPERS included a ship-based weather station, radiometers, and ceilometer, a flux tower deployed during ice stations, and radiosonde and unmanned aerial system (UAS) measurements. Ship-based and radiosonde observations were made during transects through Terra Nova Bay during a strong katabatic wind event with winds in excess of 30 m s^{-1}. Bulk estimates of the turbulent fluxes during this event ranged from several hundred to over 1000 W m^{-2}. A sequence of radiosonde measurements during the transects provide detailed observations of the downstream evolution of the katabatic air mass as it passed over the Terra Nova Bay polynya, documenting a downstream decrease in wind speed and an increase in boundary layer temperature and depth. UAS profiles through the lowest 1000 m of the atmosphere, repeated at hourly to several hour frequencies, documented the temporal evolution of the boundary layer during multiple ice stations. Both well mixed and inversion conditions were observed and the time evolution from these UAS profiles will be used in conjunction with the flux tower measurements to describe boundary layer processes occurring over the sea ice covered Ross Sea.

449
Low-level Sublimation of Antarctic Snowfall Due to Katabatic Winds

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Over the Antarctic continent, precipitation (snowfall) is the most important input of the ice sheet mass budget. The margins of Antarctica are characterized by persistent katabatic winds, supplying the low level of the atmosphere with air masses of low relative humidity, originating from the elevated Antarctic plateau. Despite the importance of these winds for the climate of coastal regions, their interaction with snowfall has not been quantified so far. In this contribution, we show, using unprecedented remotely-sensed data (X-band and long series of K-band radar data) collected in Dumont d'Urville on the coast of Adélie Land, that katabatic winds lead to a significant low-level sublimation of snowfall. At the scale of individual precipitation events, sublimation is inversely proportional to the intensity of precipitation, because more developed systems can extend further into the continent and eventually saturate the low levels of the atmosphere. This phenomenon is reproduced as well with the simulations of three different atmospheric models, that are used to extend our findings to the entire continent. In quantitative terms, sublimation in the lowest kilometer of the atmosphere, before deposition, accounts for about 17% of total snowfall over the entire continent and up to 35% on the margins of East Antarctica.

739
Parameterizing Antarctic Snowfall in the IPSL Climate Model Using Radar Data

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Precipitation over Antarctica is poorly known but was recently re-examined thanks to new radar instruments deployed by the APRES3 team (Antarctic Precipitation, Remote Sensing from Surface and Space), which gave access to precipitation profiles over the French coastal station of Dumont d´Urville. These precipitation events are characterized by sublimation of snow in lower atmospheric layers [Grazioli et al., Cryosphere 2016, PNAS 2017]. The understanding of these events is essential to improve our knowledge of the Antarctic climate and to obtain reliable estimates of snowfall over coastal areas. We modelled these events using the IPSL climate model and nudged simulations zoomed over the Dumont d´Urville area reaching a 25 km resolution. We observed in our simulations that the altitude where sublimation starts to dominate is too high compared to the field observations. Furthermore, the modeled snowfall sublimation process is not as strong as observed. Concerning our analysis over the whole Antarctic continent, we find that the IPSL climate model tends to underestimate the snowfall rates but to overestimate the occurrence of precipitation events. The model thus predicts a realistic annual accumulation rate by a compensation of the two biases. In this study, we will explore the sensitivity of the model to new parametrizations of cloud to snow conversion, sublimation, sedimentation and riming of snowflakes.

1472
High Precipitation Events across the Antarctic Continent

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A knowledge of the processes responsible for precipitation over the Antarctic is essential for the correct interpretation of the signals in ice core. While the many depressions that ring the Antarctic are responsible for most of the precipitation in the coastal region, in the interior of the continent there is an almost daily fallout of clear-sky precipitation or diamond dust. It has been known for some time that there can be significant falls of precipitation on the Antarctic plateau from short-lived intrusions of maritime air, however, the broadscale distribution and frequency of such events has not been documented. I will present fields of occurrence of high precipitation events based on high resolution model output and show that they can make a significant contribution to the annual total precipitation even on the high interior plateau and that their variability dictates the inter-annual variability of total precipitation.

1661
A High-resolution Climatological Snowfall Map for Antarctica

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Precipitation is the dominant source term in the surface mass balance of the Antarctic Ice Sheet (AIS). However, direct observations of this quantity are scarce and often limited to proxies. In 2006, the Cloudsat satellite was launched carrying a 94-GHz nadir-looking radar on board, able to detect precipitation profiles. This instrument allowed to get a first coherent observational dataset of radar reflectivity, snowfall rates and ice water content for the whole AIS. However, these data products have not yet been evaluated over the AIS and only a very coarse-resolution snowfall map for the AIS is currently available (Palerme et al., 2014).
In this study, the individual tracks for the whole Cloudsat record are geostatistically interpolated (kriging). Microwave scattering information obtained from satellites in the A-train is used as an external parameter in the interpolation, in order to capture the spatial structure of the precipitation systems. As such, a high-resolution (0.1° x 0.2°) climatological snowfall map for the whole AIS is obtained. The product is evaluated against three ground-based vertically pointing 24 GHz Micro Rain Radars and shows adequate matches for both individual event evaluation as for long-term records including significant improvements compared to previous studies. It therefore has the potential to be used by the modeling community for the evaluation of their climate models and small-scale process evaluation as e.g. snowfall shadow zone detection.

2587
Spectral Measurements of Radiation on King George Island (Antarctic Peninsula)

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Double monochromator-based instruments developed according to the specifications defined by the World Meteorological Organization (WMO) and the Network for the Detection of Atmospheric Composition Change (NDACC), can produce high quality spectral measurements with relatively low uncertainties.
These instruments are able carry out absolute measurements of the solar spectrum, and therefore they are useful as a reference for calibration or validation of other instruments, satellite products, and radiative transfer models.
Since the solar spectrum is modulated by the ozone, clouds, albedo and aerosols, our measurements can be exploited in order to track the temporal evolution of these parameters.
We present a summary of spectral measurements carried out since 2011 at our station on King George Island (62oS; Antarctic Peninsula/Southern Ocean) by using a Double monochromator-based instrument that complies with specifications of NDACC.
The measurements have been exploited in order to retrieve the ozone Column, the aerosol column, and the cloud modification factor. The latter is particularly important since this area is known to have one of the high cloud fraction in the planet. Spectral measurements carried out at the Izaña Observatory (Tenerife, Spain), in Hannover (Germany) and in Chajnantor (Atacama Desert), were used for further comparisons.

OS-7f - Atmosphere-Ice-Ocean interactions in the Polar Regions
22.06.2018 11:00-12:30, C Sanada II

1396
A Physical Wave Mixing Parameterisation for the Polar Regions

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Breaking waves cause mixing of the upper water column and present mixing schemes in ocean models take this into account through surface roughness. Sea surface roughness in the polar regions depends on significant wave height and sea ice bottom roughness. Surface roughness is commonly parameterised using significant wave height from local wind speed, ignoring the effect of sea ice. We present results from simulations using modelled surface roughness instead, which accounts for the presence of sea ice and the effect of swell. The simulations use the NEMO ocean model coupled to the CICE sea ice model in a one-degree configuration, with wave information from the ECWAM model of the European Centre for Medium-Range Weather Forecasts (ECMWF). The new mixing formulation affects vertical heat fluxes to and from the sea ice, which in turn affects sea ice concentration and ice thickness. The mixed layer depth under sea ice is improved, without affecting mixed layer depth in ice-free regions.
Wave heights in a large part of the Arctic are increasing and expected to increase further due to sea ice retreat and a larger wave fetch. Therefore wave mixing and other aspects of wave and sea ice coupling will become more important in the future.

2208
Heavy Footprints of Upper Ocean Turbulence on Sea Ice

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Signatures of mesoscale and submesoscale ocean eddies, fronts and filaments are ubiquitously manifested in sea ice patterns, particularly in marginal ice zones. However, localized and intermittent sea ice heating and advection by ocean eddies are currently not accounted for in climate models and may contribute to their biases and errors in sea ice forecasts. Here we use a submesoscale-resolving global ocean-sea ice model to demonstrate that a substantial sea ice area in both Arctic and Southern Oceans is strongly affected by ocean eddies that induce large sea ice vorticity, redistribute its mass via Ekman dynamics, and impact its melt rates via lateral and vertical advection of warm waters. When the sea ice weakens as its concentration falls below about 60%, the sea ice vorticity starts to correlate with the underlying ocean vorticity at spatial scales of about 5-50 km. The increasing similarity between the sea ice and the ocean currents dramatically diminishes the ice-ocean drag. This implies that the sea ice can no longer dissipate ocean eddies, and the combined sea ice--eddy system nearly conserves its energy and angular momentum. Our results suggest that a continuing sea ice melt should lead to an intensification of the upper ocean turbulence, which could affect the underlying large-scale circulations as well as vertical heat and tracer fluxes.

1446
Mixed Layer Regimes and Submesoscale Fluxes under Sea Ice from Seal Data

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The Marginal Ice Zone in Antarctica can have an area of up to 18 x10^6 km^2 in winter, influencing the upper layers through brine rejection and increased drag from sea ice movement. The freshwater flux associated with sea ice processes is a strong buoyancy forcing on upper ocean mixing, and can cause submesoscale instabilities. However, despite its large extent, this region remains poorly undersampled, and is the biggest missing link in climate models. Here, we present tagged elephant seal data from the Bouvet Island - Dronning Maud land region, over the austral winter of 2008. We show tagged seal data is an underused, and viable, dataset to estimate wintertime submesoscale fluxes in the Marginal Ice Zone. We assess the resolution of the seal data, and find that the peak sampling rates are 10 m vertical, 8 km horizontal and 6 hours spacing. Using this data, we estimate submesoscale fluxes between March and September, revealing four distinct regimes: summer stratification, sea ice formation/brine rejection, open lead events and wintertime stable mixed layer. Short time-scaled events, such as the opening of leads, are compared to regional wind forcing and local sea ice concentrations to identify air-sea ice-ocean momentum fluxes. This improved understanding of upper ocean processes under sea ice will help to identify the drivers of sea ice variability in the region.

2235
Upper Ocean Evolution Across the Beaufort Sea Marginal Ice Zone

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The observed reduction of Arctic summertime sea ice extent and expansion of the marginal ice zone (MIZ) have profound impacts on the balance of processes controlling sea ice evolution.
Four long-endurance autonomous Seagliders followed the retreating Beaufort Sea ice edge to repeatedly occupy sections that extended from open water, through the marginal ice zone, deep into the pack during summer 2014. Gliders penetrated up to 200 km into the ice pack, under complete ice cover for up to 10 consecutive days. Sections reveal strong fronts where cold, ice-covered waters meet waters that have been exposed to solar warming, and O(10 km) scale eddies near the ice edge. In the pack, Pacific Summer Water and a deep chlorophyll maximum form distinct layers at roughly 60 m and 80 m, respectively, which become increasingly diffuse as they progress through the MIZ and into open water. The isopynal layer between 1023 and 1024 kgm^{-3}, just above the Pacific Summer Water, consistently thickens near the ice edge, likely due to mixing or energetic vertical exchange associated with strong lateral gradients in this region. This presentation will discuss the upper ocean variability, its relationship to sea ice extent, and evolution over the summer to the start of freeze up.

718
Linking Ocean Convection to the Recent ice Edge Retreat along East Greenland

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Warm subtropical-origin Atlantic water flows, as an extension of the Gulf Stream, northward across the Greenland-Scotland Ridge into the Nordic Seas where it relinquishes heat to the atmosphere and gradually transforms into dense Atlantic-origin water while circulating around the basin. Before returning southward as part of the East Greenland Current, a major contributor of dense water to the Denmark Strait overflow, the Atlantic-origin water subducts beneath a layer of cold, fresh surface water and sea ice. Here we show, using measurements from autonomous ocean gliders deployed from fall 2015 to spring 2016, that the Atlantic-origin water was re-ventilated while transiting the western Iceland Sea in winter. This re-ventilation is a recent phenomenon made possible by the retreat of the ice edge toward Greenland, which had previously insulated the waters of the East Greenland Current from the atmosphere. The fresh surface layer that characterizes this region in summer is diverted toward the Greenland shelf by enhanced onshore Ekman transport induced by stronger northerly winds in fall and winter. Severe heat loss from the ocean to the atmosphere offshore of the ice edge subsequently triggers convection which further transforms the Atlantic-origin water. This re-ventilation is a counterintuitive occurrence in a warming climate, and highlights the difficulties inherent in predicting the behaviour of the complex coupled climate system.

808
The Iceland Greenland Seas Project: Oceanographic Highlights

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A coordinated meteorological and oceanographic field campaign over the Iceland and southern Greenland Seas is scheduled for February and March 2018. The main goal is to document the ventilation of the densest water feeding the lower limb of the Atlantic meridional overturning circulation (AMOC) and to quantify the associated atmospheric forcing. Particular focus will be on cold-air outbreaks and their forcing of oceanic convective overturning in the vicinity of the marginal ice zone. We will characterize the spatial variation and temporal evolution of the oceanic mixed layer in relation to the hydrography and the circulation of the region, including the presence of boundary currents and interior gyres. We will also investigate the exchange of water between the Greenland and Iceland Seas across the West Jan Mayen Ridge. Finally, the connection between the newly ventilated water and the pathways providing dense water to Denmark Strait will be addressed.

EN-7c - Biogeochemical cycling in the Polar Regions: Terrestrial and Ocean interactions
22.06.2018 14:00-15:30, A Studio

1317
Sr and $^{87}Sr/^{86}Sr$ in Antarctic Lakes: Chemical Weathering in Extreme Environment

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Chemical weathering is an important process for regulating biogeochemistry of Antarctic lakes and coastal oceans surrounding the Antarctica and atmospheric CO_2 consumption. There are about ten thousand surface and subglacial lakes where these processes could play an important role in supplying nutrients to the organism and CO_2 consumption in silicate weathering reactions. However, this process in extreme environments, particularly in the Antarctic lakes, is less studied compared to tropical river basins.
Sr isotopes are generally less affected by physical and biological processes, hence, used as a robust proxy for chemical weathering. To study chemical weathering processes and assess its role, water samples were collected from 10 lakes in the Larsemann Hill oasis, East Antarctica. These samples were analyzed for major ions, dissolved [Sr] and its isotopes ($^{87}Sr/^{86}Sr$). Dissolved [Sr] and $^{87}Sr/^{86}Sr$ ranges from 0.09 to 0.69 µM and 0.71104 to 0.7121 respectively. All the data in the mixing plot between $^{87}Sr/^{86}Sr$ and 1/Sr shows three clusters which indicate three possible sources such as weathering of silicate, sea spray, and atmospheric dust. We have made an attempt to fingerprint the sources and their apportionments using dissolved Sr, $^{87}Sr/^{86}Sr$ together with the inverse model. This study would improve our understanding of chemical weathering processes in extreme environments and its role in CO_2 sequestration and regulating biogeochemistry in Antarctic lakes.

2391
Weathering in Siberia and Li Isotopes in the Lena and Yenisey Rivers

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The Lena River drains a vast area (2.5Mkm^2) in eastern Siberia that is largely underlain by permafrost, and is a major contributor of nutrients, trace elements, and water to the Arctic Ocean basin. The Yenisey River drains a similar area in western Siberia, though the extent of permafrost coverage varies widely and includes permafrost-free areas. These watersheds have been sampled as part of programmes to understand weathering and the hydrological transport of nutrients and trace elements to the Arctic Ocean.
Lithium isotopes are widely used as a measure of the extent of clay formation and so incongruent weathering processes of silicate weathering in a watershed, and so provide valuable information on how weathering in cold regions occurs. Data has been collected for waters from tributaries across both the Lena and Yenisey basins and draining smaller watersheds representing a range of different conditions, including underlying lithology, topography, extent of permafrost, and mean annual temperature. A wide range of Li concentrations and isotope compositions were found, which likely reflect a range of weathering and lithological controls and variations in water-rock interaction time, parameter that are likely to be sensitive to active layer processes. However, the overall range of values was similar to that found in other major global rivers, so that the effects of climate on Li isotope compositions and concentrations are complex.

1719
Seasonal Change of Geochemical Sources and Processes in the Yenisei River

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The Yenisei River has the highest annual discharge of all the rivers draining into the Arctic Ocean and therefore changes in the chemical flux composition would have a profound effect on the nutrient input to the ocean. The hydrological cycle of this region is predicted to change due to changing precipitation patterns and thawing permafrost. By studying the seasonal changes in the geochemistry of the river, information on which end-member sources are important under different hydrological conditions can be gained and therefore provide a basis to model future change.
In this study 50 water samples were collected throughout 2012 from Igarka, 670 km from the river mouth, and analysed for their major ion composition. To further investigate the sources and processes affecting the geochemical composition of the stream water, a subset of 10 samples, covering the full range in discharge, were analysed for Sr, Mg and Li isotopes. The radiogenic Sr isotopic composition is higher in summer compared to winter, indicating a change in the relative contribution of sources. There is negligible seasonal variation in Mg isotopes and a 4 permil variation in Li isotopes with lower values at high discharge. In this contribution we will discuss the potential sources and processes contributing to the observed variation (or lack of) in the three isotope systems and how this knowledge can be used to inform models of future changes in the major element fluxes from the Yenisei to the Arctic Ocean.

2050
Biogeochemical Importance of High-latitude Dust in the Arctic and Antarctica

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Estimates from field studies, remote sensing and modelling all suggest around 5% of global dust emissions originate in the high latitudes (≥50°N and ≥40°S), a similar proportion to that from the USA (excluding Alaska) or Australia. This paper identifies contemporary sources of dust within the high latitudes and their role within local, regional and hemispherical environmental systems. Field data and remote sensing analyses are used to identify the environmental and climatic conditions that characterize high latitude dust sources in both hemispheres. Examples from the Arctic and Southern Ocean-Antarctica regions are used to demonstrate and explain the different regional relationships among dust emissions, glacio-fluvial dynamics, sea-ice and snow cover. The relative timing of dust input to high latitude terrestrial, cryospheric and marine systems determines its short to medium term environmental impact. This is highlighted through quantifying the importance of locally-redistributed dust as a nutrient and sediment input to high latitude soils in the Arctic and marine systems around Antarctica.

1665
Modeling the Local Effect of Subsea Permafrost Thawing on Arctic Biogeochemistry

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Methane is as a strong greenhouse gas and its emission from thawing permafrost could cause an accelerating effect on global warming and acidification in the ocean. To better understand the consequences for Arctic marine environments, we used a complex biogeochemical model to explore the local effects of methane seeps caused by permafrost thawing. Permafrost found in the outer part of Eastern Siberian Arctic Shelf (ESAS) has mostly degraded, and represents an area where methane fluxes are very high. For that reason, we focused on simulating the biogeochemical changes in the water column resulting from methane seeps for the ESAS region. Bubbles from a single seep area tend to dissolve at about the same depth above the seafloor, resulting in the formation of methane-rich layers within the water column. At the same time, parts of ESAS are seasonally covered by ice, serving as an almost impermeable lid for methane fluxes and promoting the formation of methane-rich layers in the surface waters. To explore the state of the water column we used a 1D Ice-Pelagic-Benthic transport model coupled to the biogeochemical models Bottom RedOx Model and the European Regional Seas Ecosystem Model.
The results show significant local impacts of the subsea methane source on marine biogeochemistry on seasonal timescales. As subsea permafrost thawing is expected to continue, our modelling approach may also be useful for parameterizing long-term impacts on Arctic marine biogeochemistry.

2477
Controls on Fluxes of Labile DOC from the Kuparuk River to the Arctic Ocean

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Thawing permafrost soils may increase export of dissolved organic carbon (DOC) to rivers, where this DOC may be converted to CO_2 or partially degraded by sunlight as it is transported to the Arctic Ocean. The concentration, composition, and lability of DOC to complete and partial photo-degradation were quantified in the Kuparuk River (arctic Alaska) during ice-free summer seasons of 2011-2017. DOC characterization, supporting water chemistry and hydrological measurements were conducted along a 350 km transect from the Kuparuk River headwaters in the Brooks Range to its mouth at the Arctic Ocean, and from major tributaries entering the river. River surveys were done each year during the freshet, the height of summer, and later in summer when thaw depth was maximum. Seasonal variability in downstream trends in DOC composition and lability indicated influences of water residence time, prior light exposure, and different sources of DOC. DOC composition suggested a greater proportion of DOC in the Kuparuk River from deeper mineral soils towards the end of the summer coincident with maximum thaw depth. Overall, there was little change in DOC lability to complete and partial degradation from the headwaters to the Arctic Ocean. This finding suggests that in-stream degradation of DOC to CO_2 may be offset by inputs of fresh, labile DOC with distance downstream, indicating that coastal waters of the Arctic Ocean may receive DOC labile to conversion to CO_2.

GG-1c - Magmatic, tectonic, and geodynamic investigations of the Polar Regions
22.06.2018 14:00-15:30, A Schwarzhorn

641
Imprints of Neoproterozoic Orogeny in Princess Elizabeth Land, Antarctica

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East Antarctic shield preserves a history of ~ 4 billion years that includes remnants of every major orogenic event. One way of characterizing these events is by studying the metamorphic evolution of the limited coastal outcrops and nunataks.
Larsemann Hills and Brattstand bluff are present along the coast of Princess Elizabeth Land (PEL) and form a fragment of the extensive granulitic East Antarctic shield. It was considered to be a Grenvillian tectonic belt until recent geochronological data which proves it to be a significant Pan African belt. The time frame between 1000 and 500 Ma is obscure and possesses no firm age data except for few published detrital zircon ages of 750-900Ma.
Our investigations of metapelites from Larsemann hills indicate metamorphic assemblage developed at ~500 Ma as estimated from chemical geochronology of texturally constrained monazite. No Grenvillian age has been recorded, which supports the idea of Pan African dominance in the area. Monazite ages obtained from the pelitic granulites of Brattstrand bluff and adjacent Svenner Island are 820±56 Ma and 734±31 Ma; partially reset at 486±21 Ma and 494±56 Ma respectively. The 700-800 Ma orogeny represents a hitherto less recognized mountain building event in this sector. The resetting can be ascribed to the Pan-African event which formed the Larsemann hills. This work substantiates evidence of ~800 Ma event in Brattstrand bluff and adjacent islands.

1315
United Plates of Dronning Maud Land Revealed by Connecting Geology & Geophysics

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Integrating geophysics with geology, and specifically geochronology, reveals the complex tectonic history of Dronning Maud Land, East Antarctica, which is a crucial element for Rodinia and Gondwana reconstructions. We recognise three major tectonic provinces: a westernmost part with Kalahari, Africa, affinities and an easternmost part from about 35°E with Indo-Antarctic affinities; sandwiched in between these two blocks, is an extensive region with juvenile Neoproterozoic crust (ca. 990-900 Ma), the Tonian Oceanic Arc Super Terrane (TOAST) that shows very limited signs of a pre-Neoproterozoic history. We have tested the spatial extent of the TOAST by a regional moraine study that confirm the lack of older material inland, though latest Mesoproterozoic juvenile rocks frequently do occur in the glacial drift and probably record a slightly earlier precursor of the TOAST inland. The TOAST records 150 Ma of almost continuous tectono-metamorphic reworking at medium- to high-grade metamorphic conditions between ca. 650 to 500 Ma. This long-lasting overprinting history is thought to record protracted accretion of ocean island arc terranes and the final amalgamation of East Antarctica along the major East African-Antarctic Orogen. There is no sign of significant metamorphic overprint immediately after the formation of TOAST. Therefore, these island arcs may have formed independent of or peripheral to Rodinia and may reveal major accretionary tectonics outboard of Rodinia.

1168
Plate Tectonics and Basin Formation at South Pole

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The tectonic boundary between East and West Antarctica is one of the most fundamental features of the continent but is particularly poorly understood between the Weddell Sea Rift and South Pole.
During the 2015-2016 Antarctic campaign we flew an extensive aerogeophysical survey, collecting 30,000 line km of radio echo sounding, airborne gravity and aeromagnetic data over the region. Linear gravity lows within the Pensacola-Pole Basin reveal a system of interconnected and glacially overdeepened grabens flanked by horst blocks. The grabens likely originated within the Jurassic Transantarctic rift system, and may have been reactivated in response to Cretaceous-Cenozoic far-field stresses, which also affected the East and West Antarctic rift systems respectively.
The magnetic data reveal a composite Precambrian crustal block northeast of the Pensacola Pole Basin. We call it the Recovery Block, and suggest that it may form the "missing link" between the subduction-related Ross Orogen and a Pan-African age collisional and transpressional suture zone identified in the Shackleton Range.
Overall, we interpret our new gravity and magnetic data compilations to reveal a wider and more distributed Mesozoic plate boundary zone between East and West Antarctica, which included several smaller microplates.
We propose that this was a strike-slip dominated distributed plate boundary, which kinematically linked the eastern margin of the Weddell Sea Rift System with the Pensacola-Pole Basin.

2233
Crustal Terranes in the Gondawanan Lützow-Holm Complex of East Antarctica

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The Lützow-Holm Complex (LHC) of east Antarctica was assembled during and metamorphosed at high-T during the formation of Gondwana. The intense nature of orogenesis obscures geological relationships, especially in Lützow-Holm Bay, where recumbent folding was extensively reworked by ductile shearing. Ion microprobe dating and Hf isotopic analysis of zircon in gneisses across the LHC provides a window into pre-orogenic geological history, revealing a juvenile late Archean igneous basement in the south of the bay that was marginally affected by ca. 2.1-1.8Ga magmatism. The remainder of the LHC is composed of juvenile late-Mesoproterozoic igneous crust with minor volcanism at ca. 630Ma. The boundary between these domains is completely transposed by Gondawanan orogensis; however, geological independence is suggested from detrital zircon in metasediments deposited on either domain, which have no common provenance. We suggest that these domains represent different geological terranes, herein named the Skallen and Ongul Terranes for the older and younger basements, respectively. A high-T metamorphic history is shared by the terranes, from ca. 610Ma to ca. 510Ma, an extended period of orogensis typical of long-lived high-T orogens that assemble large continental blocks. Evidence of earlier orogenesis is lacking except in a couple of localities on the Prince Olav Coast, where ca. 1020Ma arc magmatic rocks and metasediments were metamorphosed at high T around 960Ma.

2521
A New Thermochronometric Evaluation of Central Transantarctic Mountain Formation

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The Transantarctic Mountains (TAM) form one the longest mountain belts on Earth, but are unusual as they have been dominated by extension tectonics related to development of the West Antarctic Rift System since ~100 Ma. A lack of a post-Jurassic onshore stratigraphic record means that TAM uplift and erosion history has been informed largely indirectly by thermal histories recorded by apatite fission track (AFT) thermochronometry. Traditionally these results are interpreted as recording erosion related to episodic rift flank faulting and uplift in the Early and Late Cretaceous, and Paleogene. However, more recent studies have proposed alternative explanations for TAM formation, including a vast Mesozoic sedimentary basin that buried the TAM until Paleogene rift-related inversion; Cretaceous extensional collapse of a high elevation "Altiplano-like" plateau; and that central TAM peak elevations increased by ~50% owing to isostatic rebound in response to post-Eocene glacial incision. To help resolve this debate, we present new results from multiple thermochronometers (apatite and zircon FT and (U-Th)/He dating) in the central TAM. Thermal histories that best predict our initial results favor slow cooling through the Mesozoic, a period of elevated heat flow coeval with onset of rifting at ~100 Ma, and onset of glacial incision-related accelerated cooling at ~34 Ma. Our initial data also rule out episodic cooling episodes, and long-term burial beneath a Mesozoic sedimentary basin.

1955
Zircons from the Granite Harbour Intrusives, Northern Victoria Land, Antarctica

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The Wilson Terrane in northern Victoria Land appears to be the leading edge of the East Antarctic craton and was intruded by the calcalkaline magmatic arc of the Early Paleozoic Ross Orogen, i.e. the Cambro-Ordovician Granite Harbour Intrusives (GHI). Previous data suggested that subduction processes started at least at ca. 550-530 Ma, but may have started much earlier at 580-560 Ma based on arc-derived detrital zircon ages (1). In this study, zircons and their host rocks from the GHI have been investigated with respect to regional evolution of continental crust as well as the reliability of zircon as a recorder of crustal formation.
We present a combination of U-Pb, $\delta^{18}O$, trace element and inclusion data of zircons from these granitoids, as well as geochemical analyses of accessory apatite. With careful evaluation of zircon-U-Pb-age data and related isotopic, chemical, and mineralogical features, our study shows that even I-type granitoids do not have a simple formation history. Instead our results present a history of early (from about 580 Ma onwards) magmatic- and fluid alteration events, in contrast to simple inheritance. Our data thus supports that magmatic arc evolution in the Wilson Terrane was related to Andean-style, long-lived, migrating accretionary processes at the East Gondwana active continental margin.
1 Goodge, J.W., 2007, Geological Society of America, Special Paper 419, 2007 p. 185-203

BE-5b - Productivity, Biodiversity & Ecosystem Shifts at Cryosphere-Ocean Boundaries
22.06.2018 14:00-15:30, A Seehorn

1682
Drivers of Phytoplankton Biomass and Composition in a Changing Arctic Fjord

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Kongsfjorden on the west coast of Spitsbergen has undergone significant changes over the last decades. Warmer Atlantic advection has decreased wintertime sea ice formation and increased melting of marine terminating glaciers. This raises the question how this affects phytoplankton productivity and composition. Drivers of phytoplankton productivity and composition in central and inner Kongsfjorden were assessed using four years of pigment monitoring (2014-2017) and detailed observations during spring (2014) and summer (2015). Increasing irradiance correlated to chl-a of all taxonomic groups from February to mid-April that increased from the low values observed during the polar night. Stratification was initiated during April and May, coinciding with a diatom dominated surface bloom in inner Kongsfjorden. This suggested that spring blooms are initiated further into the fjord due to reduced sea ice cover. Surface depletion of winter nutrients characterized the post bloom period from June to October, where flagellates of diverse taxonomic groups dominated. Nutrient addition experiments showed that nitrate rapidly simulated biomass growth, but did not change phytoplankton composition. Furthermore, variability in biomass correlated to episodic wind mediated nutrient upwelling near the glaciers. Overall, our research suggest that the recent changes in Kongsfjorden cause spatial changes in phytoplankton biomass and composition, whereas temporal changes are less clear.

683
Arctic Sensitivity? Shifting Distributions due to Changing Environmental Drivers

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Arctic marine ecosystems are commonly assumed to be highly sensitive, and their structure and function are predicted to suffer significantly from ongoing climate change. Community shifts are likely to result from changes in key physico-chemical drivers, such as increased temperature and CO_2, but there is little autecological data on most Arctic species to support any specific predictions as to how sensitive they are, or how future communities may be structured. Lacking such empirical data, we extracted collection records for 90 Arctic and boreal taxa from the Barents Sea region from the OBIS database. A coupled climate-ocean model (SINMOD) was used to both hindcast and project temperature and carbonate saturation states (omega) for sample locations. These data provided ´realized niche´ distributions in three dimensions (depth, temperature, omega) for each benthic taxon, and this niche space was compared with projected values for these variables in the region for 2090-2099. Preliminary results indicate that, contrary to many predictions, calcifying taxa are no more sensitive to changing environmental conditions than non-calcifiers. In addition, Arctic taxa were similarly no more susceptible to predicted changes than boreal taxa. These results highlight the weakness of general statements regarding sensitivity of taxa on biogeographic or physiological grounds, and suggest that more basic biological data on Arctic taxa are needed for improved projections of climate impacts.

748
Zooplankton in Changing Arctic Seas: Examples from West Greenland Ecosystems

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With reduced sea ice cover, increased melt water discharge and pelagic primary production the transfer to higher trophic levels through zooplankton will change; e.g. species composition, phenology and productivity of the zooplankton community may be altered. In this presentation, we use dataset from coastal waters of west Greenland to discuss the impact of melting ice (glacial and sea ice) and primary productivity on the zooplankton community. Data from Disko Bay (69.23°N, 52.52°W) sampled with high temporal resolution during spring blooms in the period 1996 to 2012 are used to evaluate phenology and species changes within the dominant zooplankton genus *Calanus* on a decadal scale. Further north along the Greenland west coast the arctic species *Calanus hyperboreus* dominate, and we use distribution data (from 71- 76°N) to discuss how difference in ice cover/glacial impact influence their productivity and phenology, and how this may impact higher trophic levels exemplified by the dominant avian predator Little Auk (*Alle alle*).

1079
Zooplankton Productivity in Arctic Estuarine Habitats under a Changing Climate

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The low-lying North American Arctic coast is characterized by numerous lagoons that are utilized by marine mammals, waterfowl, and seabirds, and many of which have been providing important subsistence resources for local peoples for centuries. Arctic lagoons are poorly described because of their remoteness and difficultly to access by survey vessels. Food webs in the Arctic lagoons are thought to be dominated by benthic detritivores dependent on microbial processing of terrestrial carbon. Recent findings of dense aggregations of lipid-rich, fast-growing omnivory copepods in the brackish water estuarine habitats suggest high levels of pelagic primary and secondary production in summer and, therefore, an efficient pelagic food web. We synthesized data on composition and distribution of zooplankton, fish diets and physical processes that may influence estuarine communities in the coastal Chukchi and Beaufort seas to address the following fundamental question: how may changing climate conditions structure and influence trophic diversity in Arctic lagoons during ice-free summer time.

1082
Is the Shallow Kitikmeot a Marine Zoogeographic Barrier in the Canadian Arctic?

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Lack of information on large-scale spatial patterns of zooplankton, fish and benthos distribution limits our knowledge of ecological connectivity within the Canadian Arctic marine ecosystem and, thus, the ability to develop predictions about the ecosystem response to the multiple effects of Arctic warming and increased human activity. We used data collected from 2005-2017 as part of the ArcticNet annual expeditions across the Canadian Arctic Archipelago and the Kitikmeot Marine Ecosystems Study to map the distribution of Arctic cod (*Boreogadus saida*), zooplankton and benthos from the Beaufort Sea in the west to the mouth of Lancaster Sound in the east. Arctic cod larvae and adults were rare, and the large copepods *Calanus hyperboreus*, *C. glacialis* and *Metridia longa* much less abundant in all years in the shallow (< 100 m) south Kitikmeot, compared to deeper areas to the west and east where these organisms usually dominate in terms of biomass. By contrast, benthos biomass and diversity were relatively high compared with surrounding areas. Low biomass of *Calanus* species can partly explain the limited populations of vertebrate predators such as the Arctic cod, seabirds and the bowhead whale in the south Kitikmeot. The combination of shallow depths, slow water circulation and late sea-ice breakup suggests that this region acts as a significant barrier reducing West-East exchange among populations of pelagic fish like the Arctic cod and of key oceanic zooplankton.

1912
Phytoplankton Production in Arctic and Sub-Arctic Oceans: The Role of Diatoms

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This presentation will address spatial and temporal patterns in phytoplankton production and nutrient concentrations in the Arctic and sub-Arctic marine waters surrounding North America. Results from the International Polar Year Canada-3-Oceans project and other programs (e.g. GEOTRACES, Distributed Biological Observatory) conducted during the last decade show that phytoplankton production in marine Arctic and sub-Arctic waters is highly variable from region to region, with hotspots of activity in the Chukchi Sea, the Canadian Arctic Archipelago and Baffin Bay. These high production sectors markedly contrast with the oligotrophic waters of the Canada Basin. We will zoom into those Arctic hotspots and describe the role of diatoms in total phytoplankton production, nutrient cycling and particle dynamics in the pan-Canadian Arctic from the NE Pacific to the NW Atlantic Oceans. We will present results from experimental manipulations in the eastern and western Arctic using the radioisotope ^{32}Si and a novel fluorescent probe (PDMPO) as tracers of whole-assemblage and genus-specific diatom production. Despite the dominance of diatoms in several Arctic regions, the rates of silicon, nitrogen and carbon production were several times higher in the western Arctic (Chukchi Sea) than in the eastern production hotspots. These studies provided benchmark data against which future estimates can be compared to better predict the effects of climate change on high-latitude marine ecosystems.

CR-8c - Latest highlights from high altitude and polar ice cores
22.06.2018 14:00-15:30, A Wisshorn

886
Ice Cores Deformation Tests and Borehole Data Inform on Flow Properties

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Deformation tests on ice from the Greenland ice cores GRIP, GISP, NGRIP and NEEM reveal that ice from the glacial and interglacial have very different flow properties. By combining with repeated measurements of the deformation of the deep boreholes in Greenland the different flow properties of ice is discussed.
The discussion is broadened out to discuss the basal processes of the deep ice and conditions for oldest ice in Greenland and Antarctica to be stratigraphic and not folded and disturbed.

709
An Andean Ice-core Based Holocene Biomass Burning Record of the Amazon Basin

Dimitri Osmont[1,2,3] (dimitri.osmont@psi.ch), Michael Sigl[1,3], Margit Schwikowski[1,2,3]
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The Amazon Basin is known to be one of the most important worldwide contributors to biomass burning emissions. However, past fire activity is still poorly known due to the complex linkages between fires, climate and humans. Biomass burning proxies such as black carbon (BC) measured in ice cores can improve our understanding and bring new constraints on models. BC consists of aggregates of carbonaceous spherules produced by the incomplete combustion of fossil fuels and biomass from both anthropogenic and natural origin. Here, we present the first Andean BC ice-core record, derived from Illimani glacier, Bolivia, which spans the entire Holocene back to the last deglaciation 13 000 years ago. A strong seasonality, with BC peaking in the dry season, can be observed due to the combined effects of biomass burning emissions from the Amazon Basin, transport and deposition. Slightly increasing BC concentrations are visible in the 20th century, potentially reflecting an anthropogenic contribution. Long-term BC variations follow regional climatic trends along the Holocene, with higher concentrations during dry/warm periods such as the mid-Holocene (8500-5500 BP) or the Medieval Warm Period and lower values during cold/wet periods like the last deglaciation or the Little Ice Age. Except for the 20th century, a similar temporal variability was observed in a BC record from two Antarctic ice cores, for which South America is assumed to be the dominant source area.

402
Ice-core Evidence of Earliest Copper Metallurgy in the Andes 2700 Years Ago

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The importance of metallurgy for social and economic development is indisputable. Advances in agriculture, warfare, transport, cookery, and the entire Industrial Revolution are impossible without metal. Historically, Andean copper (Cu) in particular was an essential resource of wealth for pre- and post-colonial societies and still plays a central economic role in many South American countries today. Despite of this importance the onset of extensive Cu metallurgy in South America is still debated.
Here we present a 6500-years Cu emission history for the Andean Altiplano, based on ice-core records from Illimani glacier in Bolivia, providing the first complete history of large-scale Cu smelting activities in South America. We find earliest anthropogenic Cu pollution exceeding the natural background range during the Early Horizon period ~700-50 BC. This work highlights the importance of considering changes in the natural background of heavy metal deposition to deduce earliest stages of prehistoric extractive metallurgy from natural archives. Our results imply that the onset of intensified Cu smelting in South America occurred during the central Andean Chiripa and Chavin cultures ~2700 years ago. This study provides for the first time substantial evidence for extensive Cu metallurgy already during these early cultures. In our work we further provide archeological artefacts to document changing Cu metallurgy in South America during the past 2700 years.

1297
Heterogeneous Reduction of Glaciers in the High Mountains of Asia during HCO

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Glaciers in the high mountains of Asia (HMA)—encompassing the Himalayas, Karakoram, Kunlun Shan, Tian Shan and Qilian Shan mountains — form the headwaters of major river systems that provide fresh water for over 1.4 billion people in Asia. Their future changes and consequent impact on water resources are hindered mainly due to a paucity of past glacier variation data. Here we provide ^{14}C age of bottom ice of eight glaciers in the HMA, and estimate that, during the Holocene climate optimum (HCO), glaciers in the Qilian Shan Mountains almost disappeared completely, while lost over 80% of its present glacier area in the Himalayas, and over 40% in the central Tibetan Plateau and in the Tian Shan Mountains. Remarkably, glaciers in the west Kunlun Mountains showed a negligible reduction during the HO, implying that the recent "Karakoram anomaly" identified by remote sensing data may persist on millennial time scale. Thus we suggest that most part of the present glaciers in the HMA excluding the west Kunlun and Karakoram regions might develop since the Neoglaciation. Our results suggest that the modern spatial variations of glacier in the HMA are an enduring feature on millennial time scale, thus providing a wide application for the water resource management and adaption in the HMA.

237
Investigating the Microscopic Location of Trace Elements in Glacier Ice

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Past atmospheric pollution can be reconstructed from high-alpine ice core trace element records. Due to the current global temperature increase glaciers at high altitudes are in danger to melt, strongly altering the information originally stored in these archives. The preservation of impurities with respect to meltwater percolation depends on their microscopic location in firn and ice, i.e. segregation to grain surfaces versus incorporation into the lattice. Here, we present for the first time a comprehensive study on the microscopic location of trace elements in glacier ice using two different approaches.
Firstly, we indirectly assessed the location of trace elements by analyzing their concentration records in an ice core from the Swiss Alps affected by an inflow of meltwater using ICP-MS. Our results suggest that atmospheric concentration levels of the investigated trace elements are a major driving force explaining their microscopic location in ice. Abundant pollutants such as Ca, Mg, Mn, Na and Zn are mostly segregated to grain boundaries, prone to meltwater relocation. Rare elements including Ag, Bi, Cs, Sb and W are rather incorporated into the ice lattice, indicated by a strong preservation of these species. Secondly, we directly analyzed the microscopic location of trace elements in ice using cryocell laser ablation ICP-MS. This study aims to evaluate the potential of trace elements as environmental proxies in glaciers partially affected by melting.

516
A Revised Chronology of the Dome Fuji Ice Core from O_2/N_2 of Trapped Air

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Accurate ice core chronology is essential to examine the sequences, durations and phasing of climatic records. A chronology for the Dome Fuji (DF) ice core (DFO-2006, for 340 kyr BP) was constructed by synchronizing variations in O_2/N_2 of occluded air with local summer insolation, with stated 2σ error of about 2 kyr (Kawamura et al., 2007). However, it was found that DFO-2006 at ~100 kyr BP and ~129 kyr BP (end of Termination II) are older by ~3 kyr and ~2 kyr, respectively, than U-Th radiometric dating of Chinese speleothems with stated 2σ error of < 1 kyr (Cheng et al., 2009; Fujita et al., 2015). Poor quality of the O_2/N_2 data due to diffusive gas loss during core storage in "warm" freezer (-25 °C) may be responsible for the discrepancies. Here, we re-analyzed O_2/N_2 to improve the DF chronology for 80 - 165 kyr BP, using the samples stored at -50 °C. After careful tests, we found that ~1-cm-thick surface layer must be removed to eliminate the effect of gas loss for ~20 years. With our new O_2/N_2 data, the DF chronology was revised with the matching technique of Kawamura et al. (2007). The new DF chronology agrees with the speleothem chronology within 1.2 kyr. In particular, the DF age at the end of Termination II agrees with the speleothem chronology and the AICC2012 ice core chronology within ~1 kyr. The results suggest that O_2/N_2 in the DF core faithfully records local summer insolation, and that the revised chronology greatly improved from DFO-2006.

OS-4c - Sea ice modeling and prediction: Sea ice prediction
22.06.2018 14:00-15:30, B Jakobshorn

173
700 Predictions: Update on the SEARCH Sea Ice Outlook from 2008 to 2017

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Each Arctic summer since 2008, the Sea Ice Outlook (SIO) has invited researchers and the engaged public to contribute predictions regarding the September extent of Arctic sea ice. The public character of SIO, focused on a number whose true value soon becomes known, brings elements of constructive gamification and transparency to the science process. Updating earlier analyses, we look back on the performance of almost 700 predictions made over a full decade of SIO activity. In 2017, statistically-based methods outperformed coupled ice-ocean-atmosphere modeling, but in past years that was not always the case. Past retrospectives noted a pattern of easy and difficult years, corresponding roughly to dominance by climate or weather. Difficult years, in which most predictions are far from the observed extent, tend to be those exhibiting large positive or negative excursions from the overall downward trends. 2017 was a difficult year, with September ice extent more than half a million square kilometers above its quadratic trend. The observed extent fell outside the interquartile range of SIO predictions as a whole, although well within the IQR of statistical predictions made in July and August. Close prediction remains elusive, but the median of SIO predictions demonstrably outperforms naive methods including linear and quadratic trends, or persistence. Prediction has been difficult because summer weather strongly affects September ice extent, in this transitional Arctic era.

1554
Regional Arctic Sea-ice Prediction: Potential versus Operational Forecast Skill

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Seasonal predictions of Arctic sea ice on regional spatial scales are a pressing need for a broad group of stakeholders, however, most forecast skill assessments to date have focused on pan-Arctic sea-ice extent (SIE). In this work, we present a direct comparison of potential and operational seasonal prediction skill for regional Arctic SIE. This assessment is based on two complementary suites of seasonal prediction ensemble experiments performed with a global coupled climate model. First, we assess the operational prediction skill for detrended regional SIE using a suite of retrospective initialized seasonal forecasts spanning 1981-2017. These retrospective forecasts are found to skillfully predict regional winter SIE at lead times of 3-11 months and regional summer SIE at lead times of 1-4 months, owing partially to subsurface ocean temperature and sea-ice thickness initial conditions, respectively. Second, we present a suite of perfect model predictability experiments with start dates spanning the calendar year, which are used to quantity the potential regional prediction skill of this system. These perfect model experiments reveal that regional Arctic SIE is potentially predictable at lead times beyond 12 months in many regions, substantially longer than the current operational skill of this system. The skill gap identified in this work indicates a promising potential for future improvements in regional SIE predictions.

1607
Subseasonal Forecast of Arctic Sea Ice Concentration via Statistical Approaches

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Subseasonal forecast of Arctic sea ice has received less attention than the seasonal counterpart, as prediction skill of dynamical models generally exhibits a significant drop in the extended range (>two weeks). The predictability of pan-Arctic sea ice concentration is evaluated by statistical models using weekly time series for the first time. Two statistical models, the Vector Autoregressive model and Linear Markov model, are evaluated for predicting the 1979-2014 weekly Arctic sea ice concentration (SIC) anomalies at the subseasonal time scale, using combined information from the sea ice, atmosphere and ocean. The Vector Autoregressive model is slightly inferior to the Markov model for the subseasonal forecast of Arctic SIC. The cross-validated forecast skill of the Markov model is found to be superior to both the anomaly persistence and damped anomaly persistence at the lead time > 3 weeks. Surface air and ocean temperatures can be included to further improve the forecast skill for lead time > 4 weeks. The long-term trends in SIC due to global warming and its polar amplification contribute significantly to the subseasonal sea ice predictability in summer and fall. Both statistical models also exhibit much better skill than the NOAA operational dynamical model in most cases except for the 1-week lead in summer.

2350
Predictive Skills Evaluation of Subseasonal to Seasonal Arctic Sea Ice Forecasts

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Seasonal sea ice forecasts are becoming a demanding need since human activities in the Arctic are increasing. This study evaluates the predictive skills of the forecast systems contributing to the Subseasonal to Seasonal Prediction Project, focusing on the sea ice edge position. As verification metric, we employ the Spatial Probability Score and its decompositions. This is designed to quantify the correctness of the forecasted sea ice spatial distribution when compared to the observations. Moreover, the SPS allows a probabilistic description of both forecasted and observed sea ice.
Our findings reveal that some of the forecast systems are promising, exhibiting better predictive skills than the observation-based climatology and persistence of the initial condition. The results also point to critical biases concerning the data assimilation procedure and the tuning for some of the models. Comparing different versions of the ECMWF forecast system, we show the improvements brougth by the employment of a fully coupled sea ice model instead of an approach based on the sea ice prescription. Given the increasing availability of new and better sea ice observations and the potential future development of the forecast systems, the formulation of reliable Arctic sea ice predictions at the considered time scales appears to be a realistic target for the scientific community.

1706
Evaluating Roughness as a New Source of Arctic Summer Sea Ice Predictability

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Although melt ponds on Arctic sea ice evolve in stages, ice with smoother surface topography typically allows the pond water to spread over a wider area, reducing the ice-albedo and accelerating further melt. We have quantified this relationship between premelt surface roughness and summer sea ice albedo using simulations of meltwater distributed on statistical topographies. Our method, applied to ICESat observations of the winter sea ice roughness, could account for 85% of the variance in summer ice albedo observed by AVHRR during the 2000s [Landy et al., *Albedo feedback enhanced by smoother Arctic sea ice*, GRL 2015]. Thus, winter sea ice roughness offers an exciting route for potentially bridging the reported May-June barrier in summer sea ice predictability.
Here we present ongoing efforts through the ScIMiTaR project (forecasting summer Sea Ice MelT from winter ice Roughness) to develop a new multi-decade sea ice surface roughness product from various data sources, including ICESat, Cryosat-2 and MISR. To improve the resolution of roughness measurements to ~1 km, we are developing a facet-based radar scattering model to simulate Cryosat-2 return echoes from LiDAR scans of sea ice topography. Finally, we will discuss plans to initialise the Los Alamos sea ice model: CICE with winter surface roughness data, benefiting from the added predictability offered to forecast summer sea ice conditions (ice melt rate, breakup timing) from the roughness data at a lead time >6 months.

2155
Monthly Antarctic Sea Ice Forecast

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Since 2001, we have been forecasting the climatic fields of the Antarctic sea ice (SI) at the Argentine Naval Hydrographic Service with different techniques that have evolved with the years. Forecast is based on the results of Principal Components Analysis applied to SI series (S-Mode) that gives patterns of temporal series with validity areas and, to SI fields (T-Mode) that give us the form of the SI fields anomalies based on a classification of 16 patterns. Each T-Mode pattern has unique atmospheric fields associated to it. Therefore, it is possible to forecast whichever atmosphere variable we decide for the Southern Hemisphere. The forecast gives the probability of occurrence of the different patterns. Only those with higher value are used to compose the fields to obtain the final result. S-Mode and T-Mode are monthly updated with new data. We used Monthly Polar Gridded Sea Ice Concentrations database derived from satellite information generated by NASA Team algorithm provided monthly by the National Snow and Ice Data Center. Data begins in November 1978. During 2016 we introduced multilayer Perceptron (neuronal network) with supervised learning and a back-propagation algorithm to improve the forecast. It was implemented through the use of surface air temperature and pressure anomalies fields that were associated with the different sea ice anomaly patterns to simplify the density of input data and avoid a non-converging solution.

AC-2e - Polar meteorology, climatology and stratospheric processes
22.06.2018 14:00-15:30, C Sanada I

1140
The Antarctic Record Maximum Temperature: 19.8°C, Signy Island, 30 January 1982

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Signy Island (60.7S, 45.6W) is one of the smaller islands in the South Orkney Islands group. The island is low-lying, but is situated just a few km south of the much larger Coronation Island, which rises to over 1200 m elevation. A UK research station was established on Signy Island in 1947 and operated a basic climatological observing programme from 1947 to 1996. On 30 January 1982, a daily maximum temperature of +19.8°C, recently recognised by the World Meteorological Organisation as a record for the Antarctic region, was reported by the station.
Examination of global atmospheric reanalysis fields shows that the record temperature was associated with southward advection of an exceptionally warm air mass from the subtropical South Atlantic. However, during the southward passage of this air mass over the cold Southern Ocean, there was rapid cooling of the lowest kilometre of the atmosphere, leading to near-surface temperatures that were not exceptional for this region. At the time of the observed record temperature, the wind at 1 km had a strong northerly component and was thus blowing across the high topography of Coronation Island towards Signy Island. Using a high-resolution (1 km horizontal grid spacing) simulation made with the WRF model, we demonstrate that the flow across Coronation Island generated a föhn wind that brought relatively unmodified warm air down towards the surface over Signy Island, giving rise to the observed record high temperature.

1361
Ross Sea Climate Variability from MODIS Air Temperature and Climate Simulations

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Regional and local atmospheric circulation patterns influence the near-surface air temperature variability of the Ross Sea Region (RSR). Providing meteorological context to spatio-temporal patterns of air temperature allows for a better interpretation of climate variability that impact biodiversity, ecology and hydrology. We utilize multi-scale datasets, which are capable of resolving synoptic and mesoscale meteorological processes controlling the near-surface air temperature variability of the RSR.
This work uses a MODIS and machine learning based daily air temperature dataset (1 and 10km resolution from 2002 to 2016) and mean sea level pressure data from regional climate simulations. Self-organizing maps are used to reveal intra-annual patterns of the synthesized datasets that are supported by atmospheric circulation forcing. This includes cases from the localized McMurdo Dry Valley warming episodes caused by foehn winds, and regional scale West Antarctic and Transantarctic Mountain coastline warming episodes resulting from cyclonic-induced northerly air streams. This research presents a unique approach of synthesizing satellite, ground based, and numerical climate datasets to study surface climate variability at a high spatial resolution across the entire Ross Sea region. This work is the basis to investigate inter-annual variability and sensitivity of near-surface air temperature associated with changes of circulation patterns.

1464
Evaluation of Models using Radio Sounding Observations on the Antarctic Plateau

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Three global reanalysis products, the regional climate model RACMO and the weather forecast system AMPS were evaluated against profiles obtained from radio soundings on the Antarctic plateau. Measurements at Kohnen Station, which represent independent in situ data, were performed in Jan 2006, Dec 2013 and Jan 2014 four times a day. JRA-55 had the most accurate temperature profiles, MERRA-2 the best relative humidity profiles and ERA-interim the smallest errors in wind speed profiles. Biases and root mean-square errors vary considerably with altitude in the troposphere and in the tropopause region. Surface or elevated inversions in the lowermost 1000 m are captured quite differently. ERA-interim always shows a surface inversion with thickness and temperature increase that hardly vary in the course of a day. The frequency of surface and elevated inversions is better captured at 00 and 06 UTC compared to 12 and 18 UTC in JRA-55 and MERRA-2 as well as in the two regional models, which indicates that processes in the boundary layer, which lead to an erosion of a surface inversion are still poorly represented in the models. All reanalyses and regional models are able to simulate a low-level jet. However, ERA-interim, RACMO and AMPS underestimate the frequency at all four times. Similar evaluations were performed using routine radio soundings at South Pole and Dome C in 2016. Results indicate that processes in the boundary layer are also not captured well during Austral winter.

1521
Impact of Anthropogenic Forcing on High Latitude Southern Hemisphere Circulation

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We examine the impact of the individual and combined effects of three anthropogenic forcings on high-latitude Southern Hemisphere circulation through a novel suite of climate model simulations. Using the UK Met Office Unified Model (UM) coupled to the UK Chemistry and Aerosols (UKCA) interactive climate-chemistry model, we investigate the climatic response due to ozone depletion, and increases in both greenhouse gases and anthropogenically-produced aerosols. A suite of experiments, comprising a 'control' and seven further 'perturbed' runs, covering all possible individual and combinations of the three different forcings. The control-run is forced by pre-industrial concentrations of greenhouse gases, ozone depleting substances, and aerosols, while the perturbed experiments comprise the control simulation plus fixed present-day values of one or more of the forcings. We focus our results on the effect of the forcing(s) on the Southern Hemisphere Annular Mode (SAM), which is the principal mode of atmospheric variability at southern high latitudes, although we also look at changes in meridional circulation around Antarctica, which play a major role in climate variability across the continent. Individual forcing responses in our model are consistent with previous studies. However, in contrast to some other studies, we find that the effect of the individual forcings are not linear when compared to the simulation combining all three forcings.

2643
Ship-based Radiosonde Observations of Atmospheric Rivers over the Southern Ocean

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Atmospheric rivers (AR) transport large amounts of moisture from subtropics to mid- and polar latitudes. Their important role in intense precipitation and anomalous snow accumulation has been already demonstrated for East Antarctica (Gorodetskaya et al, 2014). Such extreme events are particularly challenging for both weather prediction and climate models, especially in the Polar regions where measurements are very sparse. The Antarctic Circumnavigation Expedition (ACE) provided a unique opportunity to perform continuous radio soundings of the atmosphere onboard a ship as it circumnavigated Antarctica during December 2016 - March 2017. In this study we target several AR events observed during ACE that brought intense precipitation over the Southern Ocean and the ice sheet coastal areas. Using vertical profiles of temperature, humidity and wind from radiosondes we calculate moisture fluxes and locate levels of warm and moist advection, study low level jets, identify cloud boundaries, and follow the profiles evolution along with cyclone development. The data allow the first-ever direct observation of the vertically integrated water vapor amount and transport in an AR over the Southern Ocean. These measurements give a unique opportunity to evaluate models, reanalysis and satellite products. Possible mechanisms that feed the ARs with moisture as well as the large-scale forcings favoring convergence and the strong coherent moisture advection are explored.

BE-9e - Life distribution and responses to environmental changes in Polar ecosystems 22.06.2018 14:00-15:30, C Sanada II

140
Upper Slope Processes and the Distribution of Life on the Antarctic Seafloor

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The seafloor of the Antarctic upper continental slope is a dynamic and varied environment. The upper slope is influenced by oceanographic processes, including export of dense shelf waters, upwelling of Circumpolar Deep Waters and strong along slope flow and mixing associated with the Antarctic Shelf Front. These features can enhance the productivity of the surface waters and influence the food supply to the seafloor. The interplay between oceanographic and glacial processes over long time periods has created a complex morphology of dense gully networks, rugged submarine canyons and broad sediment ridges.
The upper slope is of biological significance as an area often proposed as a refugia for shelf biota during glacial cycles and as the interface between shelf and deep sea species. This study draws on case studies from the East Antarctic margin to understand the processes that drive the modern distribution of benthic biota on the upper slope. These studies illustrate how the seafloor biota are shaped by oceanographic, glacial and sedimentary processes. Flow of dense shelf waters through shelf incising canyons off the George V margin influences the occurrence of Vulnerable Marine Ecosystems, while variations in gully types on the Sabrina upper slope creates heterogeneity in the occurrence and diversity of sessile suspension feeders and mobile fauna. The upper slope provides a unique setting for understanding how the benthic biota respond in a dynamic environment.

259
El Niño and La Niña Signals in the Reproduction of Antarctic Echinoderms

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Ongoing impacts of climate change are well established and predicted to continue at an unprecedented rate. Superimposed on this backdrop of environmental change is an increase in the frequency and severity of extreme weather events. Fluctuations in extreme events have been implicated as major mechanistic drivers of ecological responses to climatic trends, often being more relevant than variances in mean climate. They are, however, infrequent and underestimated. In addition, ecologists have historically focused on quantifying the effects of locally measured components of weather as opposed to regional modes of climate variability that integrate over multiple local variables, and facilitate a more holistic approach when researching climate change effects. Here we investigate the impact of local and large-scale climate cycles on reproduction in two Antarctic echinoderms over 17 years of monthly samples. We report long-term trends in reproductive performance, measured as gonad index and egg size, and observe extreme El Niño and La Niña signals in the reproduction of both polar taxa. We identify the complex interplay between food supply, seawater temperature, and faunal energy allocation strategies as key drivers of reproductive responses, where climate extremes underpin long-term trends in biological flexibility. The infrequency of extreme weather events thus underscores the need for long-term biological time series to better predict faunal responses to future climate change.

349
More Losers than Winners in a Century of future Southern Ocean Seafloor Warming

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The waters of the Southern Ocean are projected to warm over the coming century, with potential adverse consequences for native cold-adapted organisms. Warming waters have caused temperate marine species to shift their ranges poleward. The seafloor animals of the Southern Ocean shelf have long been isolated by the deep ocean surrounding Antarctica and the Antarctic Circumpolar Current, with little scope for southward migration. How these largely endemic species will react to future projected warming is unknown. By considering 963 invertebrate species, we show that within the current century, warming temperatures alone are unlikely to result in wholesale extinction or invasion affecting Antarctic seafloor life. However, 79% of Antarctica's endemic species do face a significant reduction in suitable temperature habitat (an average 12% reduction). Our findings highlight the species and regions most likely to respond significantly (negatively and positively) to warming and have important implications for future management of the region.

711
Benthic Biodiversity of the Larsen-C Shelf Previously Covered by Iceberg A68

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On 12 July 2017, the Larsen-C Ice Shelf calved one of the largest icebergs originating from the Antarctic Peninsula ever recorded, leaving an area of 5,800 km2 of seabed newly exposed to open marine conditions. The calving of A68 offers a unique scientific opportunity for fundamental research to address questions focussed on the mobility and colonisation capacity of benthic fauna. In early 2018 an international, multidisciplinary science group on-board the RRS James Clark Ross investigating the benthic biodiversity beneath the Larsen-C, will address the hypothesis that: “Prior to the calving of iceberg A68, the benthic fauna beneath the ice shelf probably comprised oligotrophic assemblages resembling deep-sea Weddell Sea systems. The calving of A68 will now lead to rapid colonisation by new species that will significantly transform the benthic ecosystem within 3 to 5 years.” Our survey, including stations both outside and inside the pre-calving ice front, coupled with stations in the region of Larsen-A&B will comprise trawls, corers, towed camera systems, CTD, and echo-sounders. We will sample from the surface to the seafloor. Our holistic approach will enable us to collect information on the assemblage structure, biodiversity and abundance of the in-, epi-, and supra-benthic meio-, macro- and mega-fauna, setting a baseline for future research. In this presentation we will report our preliminary results from the expedition.

On bealf of the ship-Board Party of Royal Research Ship James Clarke Ross, JR17003a, Cambridge, United Kingdom

1106
High Beta Diversity of Microbes in Southern Ocean Abyssal Water Masses

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The Southern Ocean (SO) is known to be an important site for carbon dioxide sequestration and dominates many key biogeochemical nutrient cycles through microbially driven processes. The pelagic dark ocean hosts up to 60% of heterotrophic activity, but knowledge on the community structure of these heterotrophic microbes and their interaction with the surface community is still scarce. This study greatly expands our understanding of SO microbes within the deeper water masses with interest on the roles of ocean circulation in structuring microbial biogeography. At two multi-latitudinal transects from the Indian (71-99°E) and Pacific sector (170°W) of the SO, we sampled seawater from the full water column at 8 depth points and examined bacterial, archaeal and eukaryotic community compositions through high resolution 16S and 18S rRNA tag sequencing. We found the biogeographical distribution of microbes were explained in part by distinct water masses hydrographies, but bacteria and archaea from deeper (Antarctic bottom-lower circumpolar) water masses, which spread across a wide range of latitudes, displayed niche communities with varying abundances of specific phylotypes that were not explained by hydrography or geographical distance. The abrupt changes in phylotype abundances corresponded with crossing frontal zones in surface waters, suggesting that the varying communities of surface water masses influences community compositions in deeper water masses.

1047
Distributional Shifts of Two Antarctic Metazoans under Climate Change Scenarios

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Distributional range shift is a well-known species response to climate fluctuation and has been documented for various taxonomical groups in different parts of the global ocean. Circum-Antarctic habitats of the Antarctic krill, *Euphausia superba*, and pelagic tunicate, *Salpa thompsoni*, were modelled using presence only environmental niche models. KRILLBASE and the Southern Ocean CPR data were used. An ensemble suit of models, including species range envelope, non-parametric probabilistic ecological niche, boosted regression trees and maximum entropy models, were used to predict the past, present and future distributions of both species. Habitat shifts of both species and their potential contemporary and projected overlap were investigated under two IPCC: RCP2.6 and 8.5. The overlap in krill and salp niches/habitats appear to be significant in the Scotia Sea and Indian Sector of the Southern Ocean as well as in coastal regions, except perhaps the Ross Sea. Both species showed a southward shift in distribution under climate change scenarios, which was most profound under the RCP8.5 scenario. Predictions demonstrated that since 1950s the habitat overlap increased and stabilized. This suggested the persistence of the habitat overlap under climate change projections with a potential increase in inter-species interactions and in competition for limited space between both species. Potential “winners” and “losers” with implications for the high Antarctic ecosystem are discussed.

EN-7d - Biogeochemical cycling in the Polar Regions: Terrestrial and Ocean interactions 22.06.2018 16:00-17:30, A Studio

604
Microbial Loop and Organic Carbon Dynamics in Kongsfjorden during June 2011

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Depthwise vertical distribution of microbial components including samples of bacterioplankton, phytoplankton assemblages, heterotrophic nanoflagellates and picoplankton and water samples for chlorophyll *a* (chl *a*) and organic carbon were analysed at nine stations in Kongsfjorden during Arctic summer in 2011. Phytoplankton abundance (excluding picoplankton) decreased with depth and their surface abundance ranged from 2.56 x 10^3cells L^{-1} at K1 (mouth) to a maximum of 16.76 x 10^3cells L^{-1} at K7 (outside Ny-Ålesund). On the other hand, picoplankton abundance ranged from 0.3 x 10^3 cells L^{-1} (K4 & K7) to 8 x 10^3 cells L^{-1} (K7). Heterotrophic bacterial and nanoflagellate abundance ranged from 7.4 x 10^6 (K1 and K2) to 665 x 10^6 cells L^{-1} (K4) and 2.6 x 10^3 cells L^{-1} (K7) to 21.6 x 10^3 cells L^{-1} (K3), respectively. Prymnesiophyceae (44.5%), Dinophyceae (30.4%) Chlorophyceae (10.9%) and Bacillariophyceae (9.1%) were the major phytoplankton groups. Dominance of dinoflagellates indicated post-spring bloom scenario. Column integrated biomass of picoplankton, nanoflagellate and heterotrophic bacteria ranged from 3.3 x 10^{-5} to 8.3 x 10^{-3} µM-C, 5 x 10^{-3} to 0.01 µM-C and 3.3 to 27 µM-C, respectively. Multivariate analyses of the data indicate that abiotic factors like light availability played important role in controlling the phytoplankton community distribution. The dynamics of carbon and its partitioning within microbial loop is also discussed.

463
Organic Carbon Sources in Arctic and Subarctic Atlantic Fjord Sediments

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During the past decade fjords attract notice as important shelf areas for carbon burial due to relatively high sedimentation rates as well as high organic matter (OM) input. As terrigenous derived OM is more resistant to remineralization than marine OM, a comprehensive knowledge of the carbon source is crucial to better constrain OM burial rates in fjords sediments. Recent findings indicate that the majority of the OM in fjord sediments globally to be terrigenous derived. However, these findings are based only on a very few studies from the North Atlantic region. To improve the understanding of the controlling factors on OM sedimentation in mid- and high-latitude fjord systems we investigate the OM sources of highly productive arctic fjords off the Lofoten Islands, northern Norway and compare our results with available and new C_{org}/N_{org} and $\delta^{13}C_{org}$ data from various arctic and subarctic fjord systems in Mid-Norway, western Svalbard and East Greenland. Our results show that in Northern Norwegian fjords the sedimentary OM is primarily controlled by marine productivity variations and marine C_{org} values of up to 4.4 wt.% indicate that this region is a hotspot for marine C_{org} burial. Moreover, the amount of terrigenous OM is generally higher in Arctic fjords compared to Norwegian (Boreal) fjords and marine water inflow versus freshwater runoff seems to be an important controlling factors of the OM composition in fjord sediments.

87
Errors in Marine vs. Terrestrial Carbon Sequestration Budget for Arctic Region

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The Arctic region holds a disproportionate importance in the global carbon cycle. The changing sea cover due to the global warming may likely change the relative marine vs. terrestrial organic carbon deposition in the region. It is therefore important to have an accurate estimate of relative carbon burial flux for which the carbon isotope ratio ($\delta^{13}C$) and carbon to nitrogen ratio (C/N) of the sedimentary organic matter (SOM) are the most widely used tracers. These proxies that are so reliable in other parts of the world have significant limitations in the Arctic region due to various proxy-specific uncertainties resulting in gross differences in relative burial flux calculations. This allowed us to better constrain the marine and terrestrial end-member carbon isotopic composition, which we found to be anomalously more depleted (marine $\delta^{13}C$ ~−24‰) and enriched (terrestrial $\delta^{13}C$ ~−22.5‰), respectively, than usually assumed. This particular result also provides the explanation for the high $\delta^{13}C$ of SOM from central Arctic despite a high terrestrial input that remained a puzzle since reported. We find that the bound inorganic nitrogen (ammonium attached to the clay minerals) forms a significant proportion of total nitrogen concentration and should be removed to avoid an underestimation of terrestrial contribution. Using these new values, we find that the terrestrial contribution to the organic carbon deposition in the Arctic has been severely underestimated.

2268
Transport of Inorganic Carbon and Nutrients across the Eurasian Shelf

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One of the main features of Eurasian Arctic Seas is the huge amount of fresh water coming from great Siberian rivers: Ob, Yenisei, Lena whose input is about 2000 km^3/year into the Arctic Ocean basin. Depending on annual discharge and wind stress riverine water can either accumulate on the shelf or according to Carmack et al (2015) transformed riverine water moves eastward along the Eurasian shore as a narrow and shallow flow. This flow contains huge amount of organic and inorganic matter coming to the Arctic Ocean with continental runoff (Gordeev et al, 1996). Thus, the existing mechanism moves the nutrient and carbon in the Arctic and our goal is to determine the volume of the transported substance and the possible degree of impact on the Eurasian coastal ecosystem.
In August-September 2017 Shirshov Institute of Oceanology (SIO) organized cruise of RV “Academician Mstyslav Keldysh” to East-Siberian Sea. Along the vessel course (through the Kara and Laptev Seas) direct measurements of temperature and salinity were conducted as well as sampling from the surface layer. Chemical analysis of the samples included nutrients (P, Si and N in dissolved forms) and carbonate system parameters (alkalinity and pH). We also calculated concentration of DIC, Ω_{ca} and Ω_{ar} and pCO_2 in surface water. The primary analysis of the data confirmed the existence of the eastern fresh water transfer and determined the possibility of estimating the content of nutrients and carbon in these waters.

2361
Small Scale Distribution and Composition of Organic Carbon in Arctic Soils

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Tremendous amounts of organic carbon (OC) are stored in permafrost-affected soils in the Arctic. The ongoing warming will change the accessibility and bioavailability of the previously frozen soil organic matter (SOM). Although OC stocks and C fluxes in the Arctic are extensively studied, there is only scarce information on the small scale (pedon scale) distribution and composition of organic matter in differently stabilized fractions. However, this information is crucial to understand and model the fate of differently bioavailable SOC. By combining bulk analytical methods (e.g. C and N analyses, ^{14}C, NMR spectroscopy) with state of the art spectromicroscopic techniques (e.g. NanoSIMS) it is possible to unravel processes stabilizing organic carbon reaching from the formation of organo-mineral associations to soil aggregation. We will present results from Alaska and Siberia demonstrating the distribution of distinct SOM fractions with soil depth. Using NMR spectroscopy, we were able to demonstrate that free SOM particles showed larger amounts of rather labile C (O/N alkyl-C) in comparison with SOM particles occluded in mineral soil structures. Soil OM directly associated with minerals showed rather similar chemical compositions due to comparable effects on SOM sorption by minerals. These results clearly indicate that mechanisms like soil aggregation and the formation of organo-mineral associations play also a role for SOM bioavailability in permafrost-affected soils.

2473

Source and Age of Soil Carbon in the Sør Rondane Mountains of East Antarctica

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On Antarctica, cold temperatures and months of darkness create a near inhospitable environment. Yet, microbial life has been shown to thrive in some regions of this polar desert leading to the production of organic carbon. The highest abundances of organic carbon are found in lakes and where microbes inhabit rocks (endoliths), with less known about the organic carbon within soil. Presently, it is not well constrained if soil organic carbon is produced locally within the soil or produced elsewhere and subsequently transported to the soils. In an effort to further our understanding of the processes contributing to Antarctic soil organic carbon, we studied the microbial community and organic carbon abundance and composition in soils collected in the Sør Rondane mountains, 200 km inland, in East Antarctica. Using a suite of samples that range from lake-side soils with deposits of macroalgae to dry high elevation soils devoid of visible life, we will report on the organic carbon abundance, isotopic (^{13}C, ^{14}C) composition, and microbial composition of soil organic carbon in order to determine variations in the carbon composition. Additionally, the microbial community composition of the soils will provide insight into the relative contribution of autotrophic and heterotrophic organisms. This work will provide the first estimates of carbon abundance and age as linked to the microbial community in soils from a previously understudied region of East Antarctica.

GG-1d - Magmatic, tectonic, and geodynamic investigations of the Polar Regions
22.06.2018 16:00-17:30, A Schwarzhorn

1715
Polyphase Brittle Tectonics in North Victoria Land and Gondwana Fragmentation

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Antarctica was at a centre position within Gondwana and holds a key position for any plate tectonic reconstruction related to its break-up history. North Victoria Land (NVL) is located at the Pacific end of the Transantarctic Mountains (TAM), which represent the uplifted western shoulder of the West Antarctic Rift System. The basement of the TAM formed during subduction of the Palaeopacific Ocean under E Gondwana during the Ross Orogeny. Major uplift of the TAM commenced around the Eocene-Oligocene boundary following sediment accumulation within the wide "Mesozoic Victoria Basin". This long-lasting geological history led to highly anisotropic crust that is susceptible to repeated reactivation. We present evidence for a polyphase structural evolution of NVL after initial break-up of Gondwana at ca. 180 Ma coeval with the Ferrar volcanic event. Mainly Neogene NW-SE striking dextral strike-slip tectonics with local transtension and transpression controls the present structural architecture of NVL. It may be interpreted as dynamic response to intra-oceanic fracture zones between Australia and Antarctica extending into NVL and the Ross Sea. Dextral strike-slip overprints two older increments:
(i) WNW-ESE striking sinistral tectonics of possibly late Mesozoic-early Paleogene age within a transform margin setting between Australia and Antarctica,
(ii) ENE-WSW directed extension of NVL continental crust possibly coeval to Adare Trough spreading in Eocene-Oligocene times.

2403
The Distribution of Crustal Heating in West Antarctica from Aeromagnetics

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West Antarctica hosts the large West Antarctic Rift System (WARS), a region of continental extension which has formed during several stages of rift reactivation from the Cretaceous through the Cenozoic.
Anomalously high geothermal flux has been reported within WARS at the WAIS Divide ice core drilling site and Subglacial Lake Whillans, which is consistent with estimates in the Thwaites Glacier (THW) catchment from airborne radar based techniques. Together, these observations suggest that elevated geothermal flux characterizes large sectors of WARS. Moreover, subglacial volcanic activity has been recently documented along the ECR, where a swarm of deep long-period earthquakes was registered in 2010 and 2011 by the POLENET seismic network.
Here we analyze magnetic anomalies in the context of other aerogeophysical data in central WARS, along THW, Pine Island (PI), and eastern Marie Byrd Land (MBL), in order to evaluate the distribution of potential hotspots in the region. We identify three different regions with distinct magnetic character and correlate each one of them to specific stages of tectonic and magmatic activity in WARS. Our interpretation supports both the hypothesis that MBL was tectonically and magmaticaly reactivated multiple times during the Cretaceous and that a hotspot was emplaced there later in the Cenozoic, therefore pointing to a hotter MBL compared to THW and PI.

690
A Multi-domain Lithospheric Model of East Antarctica

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The geology of East Antarctica is poorly constrained and covered by ice which can be several kilometers thick, however, these hidden and inaccessible rocks are of major interest in interdisciplinary studies linking the solid Earth and cryosphere. Subglacial geothermal heat flux is an important parameter for ice sheet models and depends on heat production within the crust, but also the deep geothermal gradient that is defined by the lithospheric structure.
Seismic tomography studies derive lithosphere thickness and structure, but the resolution is relatively low, and the smoothed models don't reflect the amalgamation of lithospheric terranes that formed the continent. We combine geophysical constraints from seismic properties and potential field data, with geological knowledge from the sparse Antarctic outcrops and from Gondwanan neighbours in a plate reconstruction framework. We use Bayesian inference to suggest the most probable boundaries by using a multivariate prior. The boundaries form a segmentation of the Antarctic lithosphere and can be weighted with probabilistic significance and location.
The result is presented as a first draft of a multi-domain tessellated terrane map of the East Antarctic lithosphere. We believe that this approach will be useful in estimating both basal lithosphere and crustal contributions to heat flux, and is a robust stepping stone towards more refined models.

436
Crustal and Lithospheric Structure Beneath the Antarctica Based on Gravity Data

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Investigation of deep crustal and lithosphereric structures is essential to understand the nature of geodynamical processes beneath the Antarctica Plate. We present a hybrid approach comprising isostasy and spectral analysis to decompose the observed gravity field into its deep crustal and lithospheric components and derived density cross sections beneath the Antarctica plate using integrated 2D modelling of gravity, topography and geoid data incorporating constraints from seismic information. We also present new crustal and lithospheric thickness maps based on integrated modeling of elevation and geoid and thermal analysis. This approach assumes local isostasy, thermal study state, and linear density increase with depth in the crust and temperature-dependent density in the lithospheric mantle and our result compares well with the depth of Moho and LAB derived from seismic and tomographic models**.** It is observed that most of the east Antarctica high topographic region is isostatically compensated by thick crust based on Airy model. For example, depth of the Moho discontinuity beneath the Gamburtsev Sub glacial Mountain is inversely correlated with surface topography. Our new lithospheric thickness map derived from 3D inversion of lithospheric field component brings out distinct features like thin lithosphere in the west (100-150Km) and thickening of the lithosphere in the east Antarctica (160-220Km) and therefore east Antarctica appears to similar to other stable cratons.

1274
Mantle Seismic and Viscosity Structure Beneath Antarctica and Adjacent Oceans

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We develop a new seismic structure model for Antarctica and surrounding oceans to depths of 700 km using more than 300 far-southern hemisphere seismic stations. We calculate full-waveform synthetics for 3D earth models using a spectral element method, and fit the entire 3-component waveforms. The new model overcomes the limitations of previous spatially- and depth-limited regional models and low-resolution global models. In East Antarctica, the results reveal fast seismic velocities extending to 250 km depth beneath Wilkes Land and the Gamburtsev Mtns. In contrast, fast velocities extend to only 100-150 km depth beneath the Lambert Graben, Enderby Land, and portions of Dronning Maud Land, consistent with younger or tectonically disrupted lithosphere. The West Antarctic coast from Marie Byrd Land to the Antarctic Peninsula is underlain by low velocity mantle. The slow anomalies along the Amundsen Sea coast connect to an offshore velocity anomaly beneath elevated bathymetry, suggesting a thermal anomaly that is associated with a larger geodynamic process. We estimate the mantle viscosity structure from the seismic structure assuming laboratory-derived relationships between seismic velocity, temperature, and rheology. The results indicate several orders of magnitude variation in viscosity, with extremely low viscosity (< 10^{19} Pa s) beneath the Amundsen Sea coast, consistent with low viscosity inferred by glacial isostatic uplift models constrained by GPS data.

1042
Deep Structure and Geodynamics of the Antarctic Plate with the Tomography Data

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This article contains the tomographic modeling results of the Antarctic Plate up to the depth of 5,300 km. Density anomalies were calculated relative to PREM with the EGM2008 geoid model using the gravity tomography method (www.uac.gov.ua/SitePages/Home/atlas.aspx).
The hot and ascending Ross Plume, the cooled and subducted Kerguelen-Conrad Plate masses and the Antarctic Continent are the main structures of the Antarctic Plate bounded by the mid-ocean ridges. The Ross Plume extends from the depth of 2,800 km up to the surface within some sectors of the marginal ridges. Surface-continental density anomalies have a radial orientation from the South Pole. Distribution of density anomalies within the oceanic lithosphere is determined by the movement of divergent and transform spreading centers. The density anomalies of the Antarctic Peninsula and the Continental East Antarctic are shown up to the depths of 2,800 km.
The cross-section along the ridge of the Plate boundary for a distance of 40,000km is shown. Intraplate and interplate geodynamics is shown along cross-sections and lateral slices up to the depths of 2,800 km. Coupling of Arctic and Antarctic can be seen only at the layers of the mantle-core. The slice at the 5,300 km-deep consists of four symmetrically located density anomalies of different signs. They come together both in Arctic and Antarctic. That is shown on the global maps with the Lambert Projection.

BE-5c - Productivity, Biodiversity & Ecosystem Shifts at Cryosphere-Ocean Boundaries
22.06.2018 16:00-17:30, A Seehorn

1587
Infaunal Benthic Diversity, Trophic Sensitivity and On-going Changes in Sea Ice

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Reductions in seasonal ice and changes in organic carbon fluxes are influencing benthic communities in Arctic shallow shelves, which can have critical consequences for ecosystem productivity. We describe multi-year changes of macrobenthic communities in the “hot-spot” areas of benthic biodiversity and biomass in the northern Bering and Chukchi Seas identified in the Distributed Biological Observatory. Our goal was to assess benthic vulnerability to increasing temperature and ice decline, and its effect on the food webs and ecosystem productivity. We examined potential implications of changes in ice cover for trophic positions of selected species and potential food sources along a latitudinal gradient and in relation to environmental data. Benthic organisms were collected from southwest of St. Lawrence Island, in the Chirikov Basin, the southeast Chukchi Sea, and Barrow Canyon, at the same stations from 2007 to 2015. Samples for compound-specific stable isotope analysis of amino acids were collected in each 'hot-spot' in 2015. Changes observed include a decline of biomass, a switch in some dominant species, and an increase in species diversity in recent years. Variation in $\delta^{13}C_{AA}$ and $\delta^{15}N_{AA}$ values reflect differences in food source and trophic level shifts. The compound specific isotope analysis is consistent with the capacity of some benthic species to shift from deposit to active suspension feeding as environmental conditions change.

1187
High Export Flux and Benthic Biomass Indicate Warming Sensitivity in a WAP Fjord

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Rapidly-warming West Antarctic Peninsula (WAP) fjords are hotspots of pelagic and benthic biomass/biodiversity. The drivers of fjord productivity, and benthic sensitivity to climate warming, remain poorly known. Our FjordEco Project integrates field/modeling studies in Andvord Bay to explore how (1) glacial and oceanographic processes enhance fjord productivity and biodiversity, and (2) increased meltwater/sediment inputs from climate warming may alter these ecosystems. Field studies in Andvord Bay in Dec 2015 and Apr 2016 indicated intermittently high primary production throughout the fjord but did not resolve the location of highest seasonal export flux. We use benthic ecosystem parameters to integrate summer seafloor POC flux and identify fjord areas of high benthic food availability. Sediment *Chl-a* was low throughout the fjord in Dec, but 10-fold greater in Apr, with highest levels in the inner fjord 1-km from fast-flowing glaciers. Seafloor carbon respiration also was enhanced in Apr, with highest rates near glaciers. Megabenthic abundance matched the patterns of food availability with an inner fjord peak, while macrofaunal abundance/biomass peaked in mid fjord, 10 km from glaciers. We hypothesize that macrofauna are more sensitive than megafauna to the burial stress in the inner fjord due to lower mobility/body size. Our results suggest that warming enhanced meltwater/sediment input near tidewater glaciers will alter inner-fjord hotspots of productivity/biodiversity.

1534
Seasonality and Spatial Variability of Epifaunal Recruitment in the Arctic

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Recruitment process is one of the first steps of community development and has a substantial consequence for population dynamics and structure.
The main aim of the project was to investigate seasonal variability of larvae recruitment in the Arctic fjord - Isfjorden (West Spitsbergen) in relation to location (two sites under the influence of Atlantic versus transformed fjordic waters), depth and predation impact. Samples were collected every third month (July 2016, October 2017, January 2017, April 2017, July 2017), at two sites and two depths with the use of SCUBA. At each site two experimental constructions with panels were deployed: first one covered with a cage and second one - uncovered, to assess the predatory impact on recruiting epifauna. Meroplankton was collected with three different types of gear in order to examine the larvae occurrence in different layers of water column: on the bottom using vacuum pump manipulated around and under rocks, 2 m above the bottom - net towed horizontally by divers and WP2 net. In addition the influence of environmental factors (temperature, salinity, suspension concentration, sedimentation flux, light penetration) on colonization was studied. The study shows that larvae are present in the water column all year round with a peak of occurrence in summer season. The recruitment pattern follows the trend of meroplankton abundance and recruitment was the highest in summer months.

911
Intense Seafloor Pulses and Rapid Processing of Phytodetritus in Andvord Bay

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Fjords along the West Antarctic Peninsula (WAP) are productive ecosystems where seasonal phytodetritus pulses sustain rich benthic communities. However, the timing and intensity of phytodetritus pulses, and benthic community response, remain unevaluated. We used a calibrated seafloor camera to study the arrival and utilization of phytodetritus over a 9-month period (Dec 2015 - Sept 2016) in Andvord Bay, a typical northern WAP fjord. We developed automated color-recognition methods to quantify phytodetritus on the seafloor and measured fecal cast production by the dominant deposit feeder, an ampharetid polychaete. An intense phytodetritus pulse led to a rapid, 5-fold increase in deposit-feeding rate, indicating tight coupling between plankton blooms and benthic detritivores in the fjord. Nonetheless, ampharetids fed throughout the time-series, suggesting that phytodetritus can sustain fjord benthos into winter, consistent with the "foodbank" hypothesis (Mincks et al. 2005). Despite high ampharetid feeding rates, the bulk of phytodetritus was not consumed by deposit feeders but appeared to degrade by microbial processes or macrofaunal not visible in images. This contrasts with similar depths (~500 m) on the open shelf where phytodetritus was consumed rapidly by mobile megafauna (Sumida et al. 2014), highlighting substantial differences in pelagic-benthic coupling and carbon cycling in WAP fjords versus the less productive open shelf.

1835
Exploring Life-cycle Adaptations in a Sympagic Amphipod: Is it Truly Sympagic?

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Sea ice supports a diverse range of sympagic species found within brine channels and at the sea ice-water interface. *Apherusa glacialis* (an Arctic gammarid amphipod) is typically found under sea ice and considered an important trophic link between primary producers and upper trophic-level predators. While much is known about its distribution and behavior when associated with sea ice, its potential ability to occur away from sea ice is less clear, and adaptive roles of a pelagic stage have been hypothesized (Berge et al. 2012). Pan-Arctic pelagic catch data was analyzed in order to determine the occurrence of *A. glacialis* away from sea ice to better understand how ocean currents can be used for transport to better ice conditions. We found *A. glacialis* present in depth-stratified net hauls (range: 13-3400 meters) throughout the Arctic Ocean, and at different times of year. In Svalbard waters during the polar night, a small number of deep-water net hauls (n=8, range: 200-2000 meters) found gravid females in good body condition. Assuming *A. glacialis* indeed conduct vertical migrations, particle trajectories from a coupled ocean-sea ice model were incorporated to evaluate the possible distribution and migration patterns of this species. We assess how *A. glacialis* might use the Arctic Ocean spatially (both in horizontal and vertical dimensions) and throughout the year, and discuss potential responses and consequences during a period of diminishing sea ice coverage.

2603
Tracing Sources of Carbon: Trophic Web Overlap between Antarctic Seals

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We investigated the trophic ecology of two species of Antarctic phocids along the western Antarctica Peninsula: the southern elephant (Mirounga leonina) and crabeater seal (Lobodon carcinophaga) using stable isotope analyses (SIA). Our objectives were
(1) to evaluate what trophic webs of the western Antarctica Peninsula are impacted by these species, and
(2) to accurately define the trophic position (TP) of both species.
Crabeater seals consistently having significant lower values for both $\delta^{13}C$ and $\delta^{15}N$ than elephant seals. Despite their more restricted spatial ranges, crabeater seals showed larger variability in their isotopic values, likely a result of seasonal shifts in the composition of the coastal phytoplankton community. Using SIA of amino acids we were able to discriminate between three food webs that are impacted by crabeater and elephant seals: a coastal, intermediate and oceanic food web. As predicted, most crabeater seals occupy a coastal trophic web, whereas elephant seals are fueled by both oceanic and coastal trophic webs. Most individuals occupy similar TPs when comparing values within species (TP crabeater seal coastal = 2.12, TP elephant seal oceanic = 3.21), however, the TPs of both species of seals is similar for those individuals in the intermediate trophic web (TP crabeater seal intermediate = 2.96, TP elephant seal intermediate = 3.29), which could indicate krill consumption by elephant seals.

CR-8d - Latest highlights from high altitude and polar ice cores
22.06.2018 16:00-17:30, A Wisshorn

1216
The IceCube Neutrino Observatory as an Instrument for Glaciology

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The IceCube Neutrino Observatory instruments about 1 km^3 of deep, glacial ice below the geographic South Pole with 5160 optical modules to register the Cherenkov light of passing relativistic, charged particles.
After discovering a diffuse flux of high-energy cosmic neutrinos in 2013, there is now an on-going search to identify the astrophysical sources.
This effort relies heavily on an ever more precise understanding of the optical scattering and absorption properties of the instrumented ice. In turn IceCube can now provide a unique insight into the glacier which, due to the large distances observed, is in many ways complimentary to ice cores.
Most notably we observe a dependence of the scattering length on the propagation direction of the photons, with the direction of least scattering being aligned with the local flow direction of the ice. In this talk a depth dependent measurement of the strength of this anisotropy will be presented and possible explanations of the effect in the context of the distribution of scattering impurities in the crystal fabric are going to be discussed.
This contribution is presented on behalf of the IceCube collaboration.

126
Glacial Dust Sources: Constraints from Radiogenic Isotopes and Raman Mineralogy

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We investigate dust provenance during the last glacial period in central East Antarctica (Dome B) by coupling the radiogenic isotope composition of dust ($^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$) with single-grain Raman mineralogical analyses of a statistically-significant number of dust particles. This latter technique allows identifying mineral species and polymorphs within the samples. Through these two powerful complementary approaches, complemented by microscopic observations, we confirm the southern South American provenance of glacial dust in Antarctica. In addition, for the first time we highlight the important role of the exposed Patagonian continental shelf and glacial outwash plains of southern Patagonia at the time when sea level reached its minimum, as evidenced by the presence of abundant aragonite particles in some samples along with diatom valves of marine benthic/epiphytic species as well as freshwater species living today in the northern Antarctic Peninsula and southern South America (Delmonte et al., 2017). Our study also demonstrates that the variable dust particle sorting recorded in central East Antarctic ice cores reflects transport variability from a unique source area. Thus, through this proxy the evolution of the past atmospheric circulation in central East Antarctica during Holocene is going to be investigated in tandem with local temperature, humidity sources, volcanic forcing and solar activity in the framework of the Franco-Italian SOLARICE ice core project.

1634

Lead Isotopes from the Oldest Two Climate Cycles in the EPICA Dome C Ice Core

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Pb isotopic compositions are recovered from the oldest two glacial-interglacial cycles recorded in the EPICA Dome C ice core on the East Antarctic plateau providing 800,000-year climatic records. This is to trace the origin of the dust that into the Antarctica during the period before the Mid-Brunhes Event (~43 kyr BP). All sample handling and analytical operations were performed inside a Class 10 clean room provided with High-Efficiency Particulate Air (HEPA) multi-staged filtration (Curtin University) and under class 10 laminar airflow bench or booth in class 1000 clean laboratories (KOPRI). Pb isotopic compositions have been determined using thermal ionization mass spectrometry (TRITON, Thermo Scientific). Pb isotopic compositions show variations in changing climate due to relative proportions of mineral dust and volcanic Pb. Similar to previous studies, it was confirmed that the main source of Antarctic dust was Patagonia during glacial period. The results also demonstrate that Pb in EDC ice was influenced by less radiogenic non-crustal Pb when the contribution from volcanic emissions appears to be important. This suggests that radiogenic volcanoes of the Antarctic interior were not active during the period before MBE. Our data also indicate that the source of less radiogenic non-crustal Pb is oceanic island including New Zealand.

796
A Global Perspective of Ice Core Fluorescent Organic Matter

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Reconstructing atmospheric composition during distinct climate periods is a central focus of ice core research, and incorporation of fluorescent organic matter (OM) characterization is improving our understanding of Earth's paleoecological history. Polar and alpine ice contain significant records of preserved carbon as OM, thus identifying OM origin and reactive nature become essential targets, not only for atmospheric reconstructions, but also to project potential impacts upon release in a warming climate. We present the OM fluorescent characterizations from Antarctic (West Antarctic Ice Sheet), Arctic (Greenland and Canada), and high alpine (Wyoming, USA) ice cores, encompassing OM fluctuations over long- and short-term time and spatial scales. Variability of ice core OM fluorescence signatures among datasets reflected ecosystem changes as a function of climate. Complex, terrestrially derived fluorescent OM was a signature of the youngest Antarctic and Greenland ice cores only. More-labile fluorescent OM was reported over spatial and temporal scales for all ice cores, indicating simple, low molecular weight, and less aromatic chemical species preserved ubiquitously. Outspreading ice core research to routinely incorporate fluorescent OM characterization in polar and alpine studies is still in its infancy, but has value to the cryosphere community and other aquatic and terrestrial fields as disintegrating icy reservoirs of OM release their contents in a warming climate.

537
High-resolution Analyses of Black Carbon and Dust in a Greenland Ice Core

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An ice core to the depth of 225 m was drilled at the SIGMA-D site, Northwest Greenland, in 2014 under the SIGMA (Snow Impurity and Glacial Microbe Effects on Abrupt Warming in the Arctic) project (Matoba et al., 2015). We analyzed the ice core to the depth of 113 m using a Continuous Flow Analysis (CFA) system, which was recently built at the National Institute of Polar Research (NIPR), Japan. The NIPR CFA system allows high resolution analyses of black carbon (BC), stable isotopes of water, microparticles, electric conductivity, and trace elements (Na, K, Mg, Ca, Fe, and Al). We used a recently developed Wide-range SP2 (Single Particle Soot Photometer, Droplet Measurement Technologies) for BC analysis. While a normal SP2 detects BC particles in the size range between 70 and 800 nm, the Wide Range SP2 enabled us to detect BC particles in the size range between 70 and 4000 nm (Mori et al., 2016).
Here we report the variability of BC and dust species over the past 350 years. BC concentrations started to increase in the 1890s, reached its maximum in the 1930's - 1940's, and decreased again since then. The increase is likely due to anthropogenic input. We also find anthropogenic changes in size distribution of BC as well as seasonality. Dust-originated species Ca, Fe and Al show higher concentrations during the first half of the 19th Century, which might be related to cooler climate during that period.

2415
A Comprehensive Study of the Drivers of Surface Snow Isotopes in Greenland

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Ice cores from polar ice sheets can be used to reconstruct past climate. However, an increasing number of studies highlight the influence of post-depositional processes altering the isotopic composition of surface snow on top of polar ice sheets. These processes are not accounted for by interstitial molecular diffusion and re-distribution of snow and will influence the mean annual isotopic composition of the ice core record and hence the paleo-climate interpretation.
To quantify these drivers we carried out a comprehensive study of surface snow and water vapor isotopes at the new deep drilling site in North-East Greenland, EastGRIP. To balance the water stable isotope budget of the surface snow we combine precipitation and daily snow surface and sub-surface isotope observations with water vapor isotope flux measurements obtained from eddy-covariance and near-surface atmospheric vapor isotope-gradient measurements.
These combined observations document snow fractionation during sublimation resulting in an enrichment of the snow surface isotopes. Further, we observe that the change in the snow surface isotopes during clear-sky days is comparable to the estimated cumulative water vapor isotope flux. This gives us confidence that we can balance the water isotope budget for the snow surface and conclude that post-depositional processes are influencing the deposited mean snow isotopic composition, specifically the second order isotope parameter, the d-excess.

OS-4d - Sea ice modeling and prediction: Sea ice Model Development
22.06.2018 16:00-17:30, B Jakobshorn

1270
Exploring the Feasibility of a Sea-ice Satellite Simulator

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Sea-ice concentration is usually retrieved from satellite by analysing surface passive microwave brightness temperatures. However, different algorithms, based on slightly different assumptions, result in different values for the retrieved sea-ice area. Not knowing which of these retrievals is closest to reality has consequences for both model evaluation and model initialization for seasonal hindcasts.
In our study, we investigate the drivers of sea-ice microwave surface brightness temperatures. This is a first step to assess the possibility to obtain synthetic brightness temperatures from the output of a General Circulation Model (GCM). Ultimately, comparing simulated to observed brightness temperatures could remove the uncertainty introduced by a satellite retrieval algorithm and might hence allow for a more reliable evaluation of both GCMs and retrieval algorithms.
As brightness temperatures are a combination of emissions by different media (sea ice, ocean, snow, atmosphere), we explore the importance of various parameters for simulating realistic brightness temperatures. Using a thermodynamical ice model combined with an emission model, we conduct sensitivity experiments to understand which simplifications of the vertical temperature and salinity profiles in the ice most strongly affect the simulated brightness temperature. First results suggest that simplifying the salinity profiles introduces the largest error into the simulated brightness temperature.

142
Process-informed Modelling of the Sea Ice Floe Size Distribution

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The lateral size of sea ice floes is receiving increasing attention as an important variable for the polar climate system. Sea ice floe size distributions, which can include floe sizes orders of magnitude smaller than the grid resolution, can now be simulated in global sea ice models. This allows inclusion of additional model physics, including alternative sea ice growth pathways and fracture of ice by ocean surface waves.
Floe size distributions are difficult to observe at sufficiently high resolution and sufficiently large spatial and temporal scales for global model validation. However, individual model processes can be observationally constrained. Here, we present results from a model-motivated observational study from images captured by wave buoys in the autumn Arctic Ocean.
These results inform our implementation of a joint sea ice floe size and thickness distribution in the Los Alamos sea ice model, CICE, coupled to a dynamic ocean. Our process-based approach to model development allows us to investigate the impacts of each process individually. We find a strong contribution of sea ice growth processes to power-law behaviour in the floe size distribution.
A key remaining question is whether such alterations to model physics affect larger-scale sea ice properties. We will present coupled model results that investigate this question, and discuss future possible work that may cause significant impacts on the polar climate system.

2053
Physics of Refreezing Melt Ponds in CICE

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Realistic representation of melt ponds in sea ice models has been demonstrated to have a significant impact on summer melts by enhancing the albedo feedback mechanism. In addition to this effect, it has been shown that melt ponds play a role in delaying the winter basal growth of sea ice during the period of melt pond refreezing. In order to assess the impact of these processes on Arctic variability and predictability in sea ice models, one needs to be able to correctly represent the temperature profile throughout the ice layer during and after the formation and refreezing of trapped ponds. We present a modification of the vertical thermodynamics and melt pond scheme in CICE that allows us to model multiple concurrent phases relevant to melt pond physics (i.e. the refreezing pond, ice beneath the pond, the ice lid) with a goal to realistically account for the heat transfer and heat storage of refreezing melt ponds, and test its ability to provide more skillful sea ice predictions of the summer sea ice extent.

2641
New Insight from CryoSat-2 Sea Ice Thickness for Sea Ice Modelling

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Estimates of Arctic sea ice thickness are available from the CryoSat-2 radar altimetry mission during the ice growth seasons since 2010. We derive the sub-grid scale ice thickness distribution (ITD) with respect to 5 ice thickness categories used e.g. in the sea ice component CICE of HadGEM3 climate simulations. This allows us both to verify the simulated cycle of ice thickness and to initialize the ITD in stand-alone simulations with the sea ice model CICE . We find that a default CICE simulation strongly underestimates the ice thickness, in spite of doing a reasonable job regarding the inter-annual variability of summer sea ice extent. We can identity the underestimation of winter ice growth being responsible and show that using ice and snow conductivity values on the upper end of the observed range makes sea ice growth more realistic and generally improves the model simulation. Sensitivity studies provide insight on the role of ice strength, momentum and heat turbulent fluxes on the annual cycle of sea ice thickness. We show that the width of ITD plays an important role for the summer lead fraction and basal ice melt. Furthermore, a major discrepancy is revealed regarding the annual cycle of sub-grid scale thick sea ice. According to Cryosat-2 there is a strong formation of thick ice during winter, but hardly any thick ice survives the summer. CICE simulations only show a weak seasonal cycle, indicating that both the formation and the melting of thick is underestimated.

869
Antarctic Sea Ice and Southern Ocean Simulations using the ACCESS-CM2 Model

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The ice component of the ACCESS-CM2 climate model has been updated in preparation for the CMIP6 experiments with multi-layer ice thermodynamics and pond dynamics that were provided by the UK Meteorological Office Hadley Centre with the Unified Model (UM) upgrade that has been adopted in the atmospheric component of the coupled model.
The sea ice model used is the CICE5.1 model from Los Alamos with adaptions to couple to the UK Met office atmospheric model and it is coupled to the MOM5 GFDL Ocean GCM.
The Southern ocean has a warm bias which has been reduced over the latest upgrades of UM atmospheric model, however, the ACCESS-CM2 model still does not have extensive enough ice cover in the Antarctic winter, and the ice does not survive the summer season.
This is due to the summer ocean mixed layer being too shallow in the MOM ocean model compared to the NEMO ocean model used by the MOHC and we have tested a number of ocean mixing schemes in an attempt to improve our summer ice results.
Another sensitivity test we have done is to include the effect of the fresh water land ice flux from the UM in the form of a pseudo iceberg flux which has been implemented as a freshwater and latent heat loss from the ocean in a region of the coast off Antarctica and Greenland though avoiding the key bottom water formation areas. Early results from these tests have allowed the ice to survive through the summer season and gives more realistic autumn ice extents in the model.

2269
A Robust Solver for Viscous Plastic Sea Ice Models in a Finite Element Framework

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Subject of this talk are the mathematical challenges and the numerical treatment of large scale sea ice problems. The model under consideration goes back to Hibler (Hibler 1979) and is based on a viscous-plastic description of the ice as a two-dimensional thin layer on the ocean surface.
We present a new efficient Newton solver. The idea of the solver is to combine a fixed-point iteration (Picard solver) with a Newton method. We analytically derive the Jacobian and show its positive definiteness. The positive definiteness guarantees global convergence of a properly damped (e.g. line search) Newton iteration. The Jacobian is split into a positive definite part, which is assumed to give stable convergence and a negative semidefinite part, which might be troublesome. The negative semidefinite part is adaptively damped if convergence worsens and the Newton solver turns towards a Picard iteration. We show the improved robustness of the modified Netwon solver and compare it to a full Newton scheme. In every Newton step a linear system of equations must be solved. We introduce a geometric multigrid solver as preconditioner to accelerate the solution of the linear problems.
C. Mehlmann, T. Richter, *A Finite Element Multigrid-Framework for Discretizing Sea Ice Dynamics,* Journal of Computational Physics 348, p. 847-861, 2017.
C. Mehlmann, T. Richter, *A modified Newton solver for viscous-plastic sea ice models,* Ocean Modeling 116, p. 96-107, 2017.

OC-3 - The role of museums in promoting polar heritage and advancing polar science
22.06.2018 16:00-17:30, C Sanada I

1417
How Nations Research, Collect and Communicate their Antarctic History

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This paper will illustrate results from research on how to communicate the past in order to keep the balance among national efforts, the international importance of Antarctic history, and today's Antarctic activity on the southern continent. The research was made possible due to the New Zealand Winston Churchill Memorial Fellowship 2018, which I was awarded in order to investigate how nations research, collect and communicate their Antarctic history. The Fellowship award allowed me to work in the USA, the UK and Germany, in order to examine archives and museums, to understand outreach programs to bring awareness of the Antarctic history, so to understand the importance of the Antarctic to each of those nations. Many of the current National Antarctic Programs have their foundations on this history. New countries are now participants in the Antarctic research community, and there is a need for them to be aware of their own history in that regard. The wider public too plays a role, as, often, the general public are not conscious of their own history. Museums play a great part in education and in communicating the past so that people can understand developments in the present. Personal stories, sometimes collected in oral history programs, diaries, photos and artifacts are a great resource that can be used to connect with the wider public.

63
Argentine Museums Cooperation in Antarctic Study - Inspiring and Educating

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Doing research in Antarctica turned out to be a difficult task. We started using a sailing boat (the 47-feet ketch *Callas*) in 1994. It was quite an adventure. Still, the size of the sailing boat did not allow us to take the necessary equipment on board. Our aim was finding the sunken and abandoned ships of whalers that sailed around the Antarctic Peninsula (Le Maire and Gerlache straits) between 1906 and 1930. We conducted a mapping. Then, we organized other voyages aboard the *Irizar*, an icebreaker of the Argentine Navy. This was equipped with all we needed, but it is so big that we could not approach sites. Then came voyages on tourist icebreakers - the *Academik IOFFE* and the *MIKIEV*. This only served to visit new places. Thanks to a group of businessmen that bought a small icebreaker at Moss (148 feet long), a joint venture was made with the National Naval Museum, the Maritime Museum of Ushuaia, the Antarctic Museum José María Sobral, and the Itinerant Museum *Ice Lady Patagonia*. Expeditions were conducted until 2007. The Museum heritage was increased. And now we got the final results involving six partners: a new museum, and cooperation among museums and research institutes resulted in books, TV cartoons, and magazines for students. These engaging materials inspire and educate citizens on polar regions and their issues.

622
Antarctic Legacy of SA Collaborates to Celebrate South Africa's Polar Heritage

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In 2017 the Antarctic community celebrated International Polar Week from the 18th to the 24th of September, together with all involved in polar research over the world. South Africans also celebrate our rich heritage in September, whereby we celebrate the various cultures that constitute our heritage. ALSA (Antarctic Legacy of South Africa) saw this as an opportunity and coincided heritage and Polar Week celebrations by creating the slogan 'Celebrating SA's Polar Heritage'.
South Africa has a rich Polar Heritage, due to our involvement in Antarctica (SANAE Base) since 1959 and in the sub-Antarctic since 1947 when the Prince Edward Islands became South African territory. ALSA plays a crucial role in archiving this history and was invited to exhibit SA's Polar Heritage at the Iziko Museum of South Africa in Cape Town in September when we celebrated our Polar Heritage. Celebration efforts was focussed on the Marion Island Exhibition in the Iziko Museum, enabling ALSA to fulfil the role of preserving and promoting South Africa's involvement in the Polar region.
This presentation will focus on the role of ALSA to collaborate with the Iziko Museums of South Africa in promoting polar heritage and advancing polar science in South Africa.

1838
Polar Lab: Connecting Across Borders

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The Anchorage Museum's Polar Lab program connects across disciplines and across the Circumpolar North. Focusing on people and the environment, the Museum works with artists, designers, scientists, historians, social scientists, Indigenous communities and others to examine a complex and changing landscape. The Arctic region is changing rapidly, in ways that dramatically affect people's lives and ecosystems. Polar Lab places the museum in the role of a convener, to operate across sectors and disciplines. The Museum brings designers and scholars from Alaska and around the world to the Arctic landscape for long-term, multi-year research projects that connect to scientific research and Indigenous knowledge related to the environment. By supporting non-traditional research, we create new investigations, new collaborations, and new knowledge, that is informed by centuries of adaptation. Current artists, designers and scholars-in-residence through Polar Lab are investigating everything from the global migration of Arctic terns, pingos, place names and language, polar bear dens, food security, changes to Arctic animal species, walruses, timekeeping in remote places, and other areas that enrich our understanding of place and environment. This presentation will explore the role of museums in polar heritage and advancing polar science through non-traditional collaborations and residencies and bold programs that redefine standard museum practice.

1259
The Centre for Arctic Knowledge & Exploration at the Canadian Museum of Nature

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For over 100 years, the Canadian Museum of Nature (CMN) has been a leader in exploring and documenting the natural history and natural science of Canada's Arctic. Today, the museum's Centre for Arctic Knowledge & Exploration (CAKE) aims to transform people's understanding of Canada's Arctic and to position the CMN as a global museum leader in Arctic knowledge and exploration. The CAKE is an interdisciplinary hub dedicated to research, collections development and care, data sharing, public programs, exhibits, galleries, and mentoring of students. Current Arctic research programs focus on Arctic biodiversity in botany, phycology, palaeontology, and invertebrate and vertebrate zoology. A core function of the museum is the collection, preservation, stewardship and curation of natural history specimens, facilitating access to these specimens, and using the collection to engage and educate the public. Among the 14.6 million specimens housed by CMN are about 260,000 Arctic specimens, the largest natural history collection from the Canadian Arctic. These collections represent a substantial component of the global Arctic natural history record. The CMN recently opened the signature Canada Goose Arctic Gallery, comprising sections about Arctic geography, ecosystems, sustainability and climate change, and including the Northern Voices Gallery, which provides an opportunity for Northern communities to share their own perspectives about the Arctic and their relationship with the land.

2107
Putting Natural History Collections of Antarctic Museums to Work

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Museums and other natural history collections (NHCs) worldwide house millions of specimens, contributing to science in a variety of ways. Given the expected environmental changes that will likely affect Antarctica, NHCs of Antarctic organisms will become increasingly important in the future. In order to provide a good service to the scientific community, all the materials stored and curated by Antarctic NHCs should be made accessible and available, virtually leaving 'no jar behind'.
With this idea in mind, at the Italian National Antarctic Museum (MNA, Section of Genoa), the institution hosting all the biological materials collected by the Italian PNRA, we have pinpointed five operational targets to accomplish this mission: i) give a name to all the species/specimens present in our collections (~20,000 units); ii) validate and publish distributional records in form of datapapers (e.g. in Zookeys); iii) publish all the available images in the Antarctic Field Guide (http://afg.biodiversity.aq), iv) provide a freely accessible database of DNA sequences from museum materials and v) publish a synthesis on the “Marine, Terrestrial and Limnetic fauna and flora of Terra Nova Bay” (3 volumes). By following these steps (some of which already accomplished), all the materials stored at the MNA and related information will be made permanently available to the scientific community. The synthesis volumes will summarize more than 30 years of Italian research in the Terra Nova Bay area.

BE-9f - Life distribution and responses to environmental changes in Polar ecosystems
22.06.2018 16:00-17:30, C Sanada II

597
Breaking Down the Barrier: Biological Dispersal to the Antarctic

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Antarctica has long been considered to be biologically isolated. Indeed, many Antarctic organisms are endemic, found nowhere else on the planet, and many have probably remained and evolved in the Antarctic for millions of years. Yet molecular studies are starting to show some post-Gondwanan biological connections between Antarctica and other parts of the world, suggesting that - at least occasionally - movement into and out of Antarctica has occurred. Recent observations of floating marine organisms drifting on either side of the Antarctic Polar Front also challenge the assumption that the Southern Ocean is an impassable barrier to dispersal.
In this talk, I will present evidence that Antarctica is not biologically isolated - that organisms can, and frequently do, cross the Southern Ocean and reach Antarctica. The unique ecosystems of Antarctica are thererfore probably more a consequence of environmental extremes in the region than of isolation. With global warming, we should expect to see successful establishment of numerous non-Antarctic species, even without human-mediated transport of organisms to the region.

2346
Benchmarking Southern Ocean Ecosystems in 2022-2023: A Proposal from MEASO2018

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Circumpolar assessments of change in the Southern Ocean ecosystem have been advancing over the last two decades. The Census of Antarctic Marine Life during the International Polar Year (leading to the SCAR Biogeographic Atlas of the Southern Ocean) and Southern Ocean GLOBEC made substantial progress in unifying approaches to characterising these ecosystems. The Fifth Assessment Review by Working Group II of the IPCC highlighted that long term observations to measure ecosystem change are a priority. To date, long-term whole-of-system biological observations in the Southern Ocean have been mostly concentrated in the Antarctic Peninsula and Scotia Arc. The scientific communities of IMBER's ICED program, the Southern Ocean Observing System and SCAR Life Sciences have been designing a program of work to advance these earlier programs to have sustained circumpolar measurements of the Southern Ocean ecosystem for assessing change. A program of co-ordinated circumpolar measurements of the ecological state of the ecosystem in 2022-2023 is to be considered at the MEASO2018 conference in April 2018. The plans arising from these discussions will be summarised in this presentation on behalf of contributors so far, with invitations to participate in further co-ordination and implementation of the program along with synthesis of results.

596
Comparing Methods for Ecoregionalisation using Sub-Antarctic Demersal Fish

Nicole Hill[1] (nicole.hill@utas.edu.au), John McKinlay[2], Scott Foster[3], Piers Dunstan[3], Skipton Woolley[3], Dirk Welsford[2], Craig Johnson[1]
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Understanding the distribution of species and their relationship with the environment is a central goal in ecology. Mapping these patterns also facilitates ecoregionalisation, the delineation of ecologically meaningful spatial units to assist the planning and evaluation of management and conservation options. Statistical models that link sparse biological data with more prevalent environmental data are fundamental in modelling and mapping species' distributions and have successfully been used for key species in the Southern Ocean. However, a suite of recently developed statistical methods identify and model patterns in the distribution of *multi-species* assemblages; thus facilitating ecoregionalisation. We briefly review these methods, which encompass algorithmic distance-based, machine learning, and GLMs with latent variables. Methods also differ in how they define assemblages and predict into geographic space. We apply a selection of these methods to a sub-Antarctic demersal fish dataset, comparing the resulting ecoregions and their interpretation in light of our knowledge of this region. We discuss the relative dis/advantages of the approaches from a statistical, ecological and pragmatic viewpoint. Taking into account the role of ecoregionalisation in conservation management, we recommend the methods most appropriate to particular circumstances in describing and capturing the relationships between environment and species distributions in the Southern Ocean.

1165
Response of Antarctic Krill to Rapid Regional Warming over the Last 90 Years

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Productive, high latitude ecosystems comprise some of the fastest warming marine habitats on the planet. Stenothermal polar species might be sensitive to rising temperatures and loss of sea ice, but solid evidence is still scarce and conflicting. Long-term, temporal-spatial coverage is a key to understanding climate change responses, and *Euphausia superba* is one of the very few species with the necessary intensity of sampling, due to its role in commercially exploited food chains. Within the KRILLBASE project we have rescued and compiled all available net sampling data on krill spanning the period 1926-2016. KRILLBASE now comprises three databases, on abundance of the larval stages, on postlarval abundance and on postlarval length, sex and maturity stage. This has allowed a comprehensive analysis of long-term trends in abundance, distributional range and body size. We have identified a strong bottom-up control on krill population dynamics, with the Southern Annular Mode (SAM) influential in modulating recruitment across the SW Atlantic sector. This presentation will discuss the implications of the ongoing trends that we are observing, in the context of future access to spawning grounds, linkages to the rest of the food web, biogeochemical cycling and fisheries management.

1239
Climate Model Projections of under Ice Habitats for Antarctic Krill Larvae

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Overwintering of larvae underneath Antarctic pack ice is an important stage in the life cycle of Antarctic krill. Previous work based on simplified climate change scenarios has demonstrated that simple assumptions for the important characteristics of under ice habitats for larval krill can reveal surprising predictions for available habitat under climate change: reductions in overall ice extent may not necessarily lead to less larval krill habitat. Here we extend that approach using the ensemble of CMIP5 models. Despite variability in future projections (and varying model skill in representing ice), all models project a significant decrease in sea ice cover over the coming century across a range of scenarios. However, even at the resolution of GCMs, reductions in total area do not necessarily lead to reductions in projected habitat. In this presentation, we consider some of the regional differences in projected habitat change, including considering whether strength of dependence of larval krill on winter sea ice may vary between regions of Antarctica. We also discuss limitations to using GCM output for such analyses; specifically, that required variables are not retained from runs of most models. We suggest that better dialogue between climate modellers and ecologists will help maximise the utility of future GCMs for understanding the ecological implications of physical changes.

1841
Sea Ice Dynamics on West Antarctic Peninsula Underlying Ecosystem Alterations

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The sea ice of the West Antarctic Peninsula (WAP) has experienced significant change over the last fifty years. Using 25-year spatial time series collected by the Palmer Long Term Ecological Research program, we assess long-term patterns in sea ice, upper mixed layer depth and food web dynamics (phytoplankton, zooplankton, higher trophic levels). Over decadal time scales, the heating on the WAP has been driven by subsurface intrusions of the warm Antarctic circumpolar current onto the shelf that is topographically steered to the coast terminating in regions of abundant penguin colonies presumably fueled by high productivity phytoplankton blooms. Sea ice has steadily declined from the 1980's until a recent reversal that began in 2008. In the southern WAP, upper ocean mixed layer depth has shallowed significantly and associated with the shallower mixed layer is enhanced phytoplankton carbon fixation. Associated with the recent increases in sea ice has been a large increase in the photosynthetic efficiency in both the northern and southern. Using a decade of glider data, shallower mixed layers appear to promote phytoplankton blooms. There was significant inter-annual variability in phytoplankton blooms, but high chlorophyll years, associated with diatoms, were associated with high krill recruitment suggesting a tightly coupled ecosystem and strong bottom-up control of the food-web. Results demonstrate the close fidelity between the biology and physics on the WAP.

Poster & Beer III
22.06.2018 17:30-18:30, Foyer

Fri_1_EN-2_48
Diisopropylnaphthalene in Sediments of Arctic Fjord: Environmental Significance

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This study addresses the tracking of the presence of a synthetic aromatic compound, diisopropylnaphthalene (DIPN) in the surface sediments of Kongsfjorden, an Arctic fjord fringing the International Arctic Research Facilities of Ny-Ålesund, Svalbard. Increasing anthropogenic impacts in the form of Persistent Organic Pollutants (POPs), related to human activities and increased use of fossil fuels have been observed at many places along the Arctic regions. Our studies suggest that the source of DIPN to the fjord could be a result of human activities at Ny-Ålesund and its environs While its present-day concentrations may not be alarming, considering the increasing activities at Ny-Ålesund, it might be prudent to exercise caution to ensure that the levels do not increase over time. This is the first such report of DIPN in the sediments of Kongsfjorden

Fri_3_EN-2_174
Citizen Scientists: Marine Litter Pollutes Arctic Beaches and Affects Wild Life

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Recent data indicate accumulation areas of marine litter in Arctic waters and significant increases on the seafloor over time. Beaches on remote Arctic islands may be sinks for marine litter and reflect pollution levels of the surrounding waters particularly well.
We provide the first quantitative data from surveys carried out by citizen scientists, which participated in sailing cruises around Svalbard in 2016. Litter quantities on six beaches varied from 9 - 524 g m-2 and were similar to those from densely populated areas. Plastics accounted for > 80% of the overall litter, most of which originated from fisheries. Photographs provided by citizens show deleterious effects of beach litter on Arctic wildlife including polar bears (Ursus maritimus), which is already under strong pressure from global climate change. Our study highlights the potential of citizen scientists to provide scientifically valuable data on the pollution of sensitive remote ecosystems. Similar programmes could be adopted in other poorly sampled areas of the world to increase our knowledge base and to stimulate a sense of connectedness with the environment visited.

Fri_4_EN-2_235
Perchlorate in Surface Snow along a Traverse Route in East Antarctica

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Perchlorate in the environment is of significant interest because of potential threat to human health. Recent research suggests that perchlorate is naturally formed in the atmosphere and atmospheric formation constitutes a significantly large portion of perchlorate in the current environment. By virtue of its geographical position and meteorological conditions, Antarctic ice sheet provides chronological records for atmospheric deposition of different substances. Surface snow samples collected along a traverse route from Zhongshan Station to Dome A in East Antarctica were used to assess the spatial variability of perchlorate along the traverse route, to explore possible sources of perchlorate in Antarctic snow and to determine what atmospheric and glaciological factors influence spatial variability of perchlorate in snow. Results show that the perchlorate concentrations vary between 32 and 200 ng kg^{-1}, with an average of 104.3 ng kg^{-1}. Perchlorate concentration profile presents an apparent decreasing relationship with increasing distance inland in the coastal region and a generally increasing trend approaching the dome in the inland region. Perchlorate in Antarctic snow is probably formed in the atmosphere and deposited in snow. Different rates of atmospheric production, dilution by snow accumulation and re-deposition of snow-emitted perchlorate (post-depositional change) are the three possible factors influencing the spatial variability of perchlorate over Antarctica.

Fri_5_EN-2_253
High Altitude Lake Environments: Sinks for Chemical Pollutants?

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The melting of alpine glaciers mobilizes compounds from anthropogenic origin such as persistent organic pollutants that had been stored in the perennial ice for the last decades. Similarly, hydrophobic polyaromatic hydrocarbons (PAHs), which are potentially carcinogenic and are released by combustion processes, are compounds with the potential for long range transport to remote regions. These compounds that were released decades ago may now be found in glacier ice and glacial streams. Since glacier-fed meltwater often passes through several smaller and larger lakes in alpine glacier forefields, the hydrophobic PAHs can be retained in the sediments of these lakes. We hypothesize that these sites serve as sinks for PAHs. During two field seasons and at three different glaciers we quantified the concentrations of PAHs in sediments of lakes along spatial gradients from the glaciers. We found PAHs in all samples, albeit in the lower concentration range and three orders of magnitude less than in polluted streams in Germany. PAH concentrations decreased with increasing distance from the glacier. Contrary to our hypothesis, we found higher concentrations of PAHs in lakes, which were not directly fed by glacial meltwater but by snowmelt, rain and permafrost. This may be caused by the temporal dynamics of input rates, the age of the lakes, but also due to other biotic and abiotic factors that influence PAH distribution, such as the sediment composition and bacterial degradation.

Fri_6_EN-2_323
Air Dispersion Modeling Application for Impact Assessment in the Antarctic

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In the paper modelling results of air impacts of Mount Vechernyaya Belarusian Antarctic station using AERMOD as well as available from Comprehensive Environmental Evaluations (CEE) of construction and operation of the Antarctic research stations are considered. It is shown that emission dispersion models application for impact assessment in Antarctica is limited: from 12 known cases of air impact assessment for CEE no dispersion modeling was done in 6 cases; ICS3 model was applied in 2 cases; SYMOS97, OND-86 and AERMOD were applied in other 4 cases. Among these results both short-term and long-term predicted concentrations were obtained only for two stations: Jang Bogo Station, Korea and Mount Vechernyaya, Belarus. There is a number of reasons of such limited application, first of all high time- and resource-consuming and lack of input data. But more wide application of dispersion modeling in impact assessment in Antarctica is important as it allows to get qualitative estimates of impacts and make projections.
Study have shown that taking into account restrictions it is possible to provide acceptable accuracy of pollution dispersion model results, applying non-standard methods of interpolation of meteorological data. Air dispersion can be combined with geochemical models for analysis of pollutants migration in soils and waters and estimation of critical loads and thresholds. Possibilities of retrospective modelling for estimation of cumulative impacts is also discussed.

Fri_7_EN-2_372
Trace Elements in an Ultraclean Snow Pit on the King George Island

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This work reports the analysis of 4.5 m pit sampled under ultra-clean conditions on the King George Island ice cap (62°07'42.2”S and 58°36'39.9” W, 700 m a.s.l.), collected in 1997 and representing one year of snow accumulation. We analysed 25 samples for trace elements, ionic content and stable isotopes in a site that suffers intense post-depositional phenomena, with superficial melting, followed by percolation and refreezing. Here we evaluate the anthropogenic and natural contributions for the concentrations in 47 trace elements, determined by ICP-MS at the Laboratoire des Mecanismes et Transferts en Geologie in Toulouse (France). The crustal enrichment factors are low for Al, Si, Ti, V, Cr, Mn, Fe, Co, Ga, Ge, Zr, Nb, Cs, Ba, Ce, Nd, Sm, Tl, Pb, and Bi and the ocean enrichment factors are low for Na, Mg, Cl, K, Br, Sr, and I. The elements Li, C, P, S, Sc, Rb, Ta, and U show mixed source (crustal and oceanic) and contributions of volcanic and/or biogenic source. Ni (129.29 ± 163.48 pg g^{-1}), Cu (93.51 ± 106.26 pg g^{-1}), Zn (214.76 ± 124.14 pg g^{-1}), As (8.93 ± 7.54 pg g^{-1}), Se (63.10 ± 42.37 pg g^{-1}), Mo (10.18 ± 3.63 pg g^{-1}), Ag (6.38 ± 6.79 pg g^{-1}), Cd (399.36 ± 880.65 pg g^{-1}), Sn (17.65 ± 10.99 pg g^{-1}), Sb (4.17 ± 3.51 pg g^{-1}), W (15.74 ± 11.05 pg g^{-1}) and Hg (1.19 ± 0.71 pg g^{-1}) show high enrichment factors, suggesting anthropogenic inputs and/or local contamination.

Fri_8_EN-2_411
PBDEs vs Biological Traits in *Boreogadus saida* from NE Greenland

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Polybrominated diphenylethers (PBDEs) are flame retardants used worldwide. Their physical-chemical properties allow them to reach the Polar Regions and enter into the food webs. *Boreogadus saida* is a key species in high Arctic marine ecosystems, connecting lower and higher trophic levels in the food web. In NE Greenland *B. saida* forms populations with differentiated life histories in fjords and offshore waters, respectively. The main aim of this study was to elucidate whether PBDEs accumulate differentially in these populations. We collected *B. saida* specimens inside a fjord (Scorebysund Fjord, n=50) and at the NE Greenland continental shelf (n=40) during the TUNU II expedition. We measured biological parameters and 24 PBDE congeners and we correlated PBDEs and biological traits; we calculated Fulton´s condition factor, hepatosomatic index, gonadosomatic index.
The ∑PBDE concentrations were 0.33±0.16 and 0.31±0.08 ng/g wet weight in fish muscle from the shelf and the fjord, respectively. BDE183>BDE47>BDE28 were the most abundant in all specimens, with BDE99 in individuals from the fjord representing the lowest concentration. Positive and significant correlations between PBDEs vs length and PBDEs vs weight were observed in fish from fjord ($p< 0.05$), while these correlations were negative, but still significant ($p< 0.05$), for *B. saida* inhabiting the shelf.
To our knowledge, this is the first study on the correlation between contaminants and biological parameters in *B. saida.*

Fri_9_EN-2_522
Geographic Variability in Gentoo Penguin Mercury Burdens

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Numerous studies have shown increases of mercury throughout the environment as a result of increased anthropogenic pollution. As contaminant loads continue to rise, investigations have turned toward monitoring mercury throughout the isolated southern polar region, often using penguins as biomonitors in both the Antarctic and sub-Antarctic region. The utility of penguins as biomonitors of contaminants throughout the Southern Hemisphere has been demonstrated due to their confinement within relatively localized geographic ranges, their widespread distribution, their status as high trophic predators, and their unique simultaneous molt that produces homogeneous feathers. Gentoo penguins (*Pygoscelis papua*) in particular occupy the widest latitudinal breeding range of any penguin species and may be characterized as highly pragmatic biomonitors across both the sub-Antarctic and the Antarctic, however numerous studies have shown Gentoo penguins have high inter-population variability in their mercury burdens. For this study, we investigate mechanisms that generate differences in Gentoo penguin mercury burdens between South America and Antarctica through the use of multi-tissue mercury and stable isotope analyses in contemporary samples. We also reconsider the feasibility of estimating Gentoo mercury exposure trends in relation to the high inter-population mercury variability of this widely distributed species.

Fri_10_EN-2_555
Accumulation of Crude oil in Arctic Marine Zooplankton

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A future increase in oil and gas activities in the Arctic will increase the risk for accidental oil spills. Due to high lipid content in polar organisms, bioaccumulation of lipophilic contaminants, which are present in crude oil, is more prone to take place. In Disko Bay, West Greenland, we conducted crude oil exposure experiments with three co-existing ecologically important zooplankton species; the lipid rich Arctic copepod *Calanus hyperboreus*, the smaller and less lipid rich Atlantic copepod *C. finmarchicus* and larvae of the shrimp species *Pandalus borealis*, which has the lowest lipid content of the three species. Our results show that lipid rich zooplankton species accumulate heavy hydrocarbon groups, despite that the crude oil they were exposed to mainly consisted of light hydrocarbon groups. Results also indicate that grazing activity in lipid rich zooplankton may be less directly affected by short-term crude oil exposure compared to less lipid rich species. Furthermore, data reveal that elimination rates of crude oil model compounds are minimal and that even short-term exposure may result in long-term bioaccumulation and internal exposure of oil compounds in lipid rich zooplankton. Slow elimination and depuration of oil components indicate a risk for transfer of oil component up the Arctic food web to pelagic fish, seabirds and baleen whales.

Fri_11_EN-2_726
Plastic Pollution in the Southern Ocean and its Impact on Antarctic Wildlife

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The microplastic pollution of the marine ecosystem is a growing issue that is repetitively reported. Antarctica, once believed to be pristine, is also threatened by microplastic pollution, however not enough data exists to estimate the size of the damage and the impact of microplastic on the Antarctic environment, especially Antarctic wildlife.
The aim of the project is to collect and analyze water samples south and north of the polar front in the Southern Ocean in order to establish the extent of microplastic pollution. The samples will be collected at Drake Passage, in the Southern Ocean off the east coast of South America and along the Antarctic Peninsula, north and south of the polar circle, within 100 meter water column, what corresponds to the depths at which gentoo penguins forage. Further, sampling of juvenile gentoo penguin's digestive systems (carcasses found in colonies) is planned in order to find out, whether at the earliest stage of life parents are feeding the chicks with a) food contaminated by microplastic b) big plastic particles, in order to assess the impact of the plastic pollution on the Antarctic biota. Sampling and analyzes will be conducted according to standardised method scheme provided by the NOAA Marine Debris Program. The surveying will take place on board of mv Ocean Diamond in cooperation with Quark Expeditions Inc. between January and March 2018. The preliminary results and conclusions will be presented in June at the POLAR 2018 conference.

Fri_12_EN-2_742
Polybrominated Diphenyl Ethers (Pbdes) in Indoor Environments from Antarctica

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Polybrominated diphenyls ethers (PBDEs) are nowadays widely used as flame retardants in electronic components, plastics, textiles and buildings materials. Their commercial mixtures Penta-BDE and Octa-BDE were banned in the European Union because of their toxic effects. Due to their physical-chemical properties, PBDEs can be found in the indoor dust. In this study dust samples were collected from two Antarctic research bases, the Gabriel de Castilla and Prof. Julio Escudero Stations, and a research vessel, the R/V James Clark Ross of the British Antarctic Survey. The PBDE concentrations ranged from 0.1 to 69 ng/g dust. Sample from the Gabriel de Castilla Base showed the highest levels of the ∑PBDEs, 302 ng/g, followed by those from the James Clark Ross Base, 166 ng/g, and the Julio Escudero Base, 80 ng/g. BDE99 was the most abundant congener in the Gabriel de Castilla Base sample (48 ng/g, contributing ~50% of the total BDE burden) followed by BDE47 (41 ng/g, ~40% of ∑PBDEs), and BDE100 (10 ng/g, ~10% of ∑PBDEs).

Fri_13_EN-2_936
Melting Glaciers Stimulate Hg Cycling in High Altitudes in the Tibetan Plateau

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Glaciers at high-altitude mountains have been receding globally at an accelerated rate in recent decades. The glacial melt-induced release of pollutants (e.g., mercury) and its potential impact on receiving environments has drawn increasing concerns. During 2011-2015, we performed intensive sampling on diverse waters in a typical glacierized basin - Qugaqie Basin (QB), in the inland Tibetan Plateau, to investigate the export and transport of mercury from glacier to downstream environment. The total mercury (THg) concentrations in waters showed a decreasing order of glacier snow, glacier, meltwater, glacial runoff, and wetland. Particulate Hg was the predominant form in all sampled waters except for that of wetland. THg in runoff showed a clear diurnal variation and is closely linked to glacier melt intensity. We estimated that annual Hg exports by the glacier, the upper river basin and the entire QB were 8.76, 7.3 and 157.85 g, respectively, with respective yields of 4.61, 0.99 and 2.74 μg m^{-2} yr^{-1}. Unique landforms and significant gradients in mountain regions can promote weathering and erosion, thereby controlling the transport of Hg. In comparison with other glacier-fed river basins globally, QB has a small Hg export yet remarkably high Hg yield, underlining the significant impact of melting alpine glaciers on regional Hg cycles. Such impacts are expected to be enhanced in high altitude regions under the changing climate.

Fri_14_EN-2_984
The Impact of Nanoplastics on Antarctic Krill *Euphausia superba*

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Under current climate change scenarios, Antarctic krill (*Euphausia superba*) is facing multiple stressors which could affect its abundance and distribution. Microplastics have been recently reported in Antarctic waters, representing an additional potential impact on krill population. In this study we investigated the effects of model nanoplastics (< 1 µm) on krill juveniles through short-term exposure (48h) of polystyrene nanoparticles (PS NPs) with different surface charge. The behaviour of anionic (60 nm PS-COOH) and cationic (50nm PS-NH_2) NPs in Antarctic natural seawater (NSW, 34‰, 2°C) was also investigated by Dynamic Light Scattering. PS-COOH formed nanoscale aggregates (average size of 862nm) in Antarctic NSW, while PS-NH_2 maintained their nominal size. No mortality was observed upon exposure to 2.5µg/ml PS NPs after 48h. However, krill exposed to PS-NH_2 showed lower motility than individuals exposed to PS-COOH and were characterised by significant up-regulation of *cb6* gene involved in new cuticle formation. Similar findings reported for other microcrustaceans have been associated with mortality over long-term exposure. Both PS NPs also accumulated in faecal pellets (FPs), which were characterised by lower density and sinking rate compared to control. Our findings demonstrate that PS NPs are able to affect swimming behaviour, cuticle formation and FPs properties of Antarctic krill, with potential serious consequences on Southern Ocean food web and biogeochemical cycle.

Fri_15_EN-2_1073
Antibiotic Resistance in *Escherichia coli* Strains from Antarctic Seawater

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Antimicrobial resistant bacteria are widespread in aquatic environments. The aim of the present study was to obtain information on the occurrence of bacteria with antimicrobial resistance in seawater surrounding Antarctic stations.
Escherichia coli strains were isolated from seawater. The samples were collected from sites distributed around the sewage outfalls of six Antarctic stations. Antibiotic susceptibility patterns were determined with the disk diffusion method, using different groups of antibiotics: penicillins, carbapenems, aminoglycosides, quinolones, tetracycline, phenicols, and trimethoprim. *Escherichia coli* ATCC 25922 was used as the control for the tests.
A total of 213 samples were analysed. *E. coli* were detected in 58 % of the samples. The highest bacterial counts were found in seawater surrounding the sewage outfalls. However, the bacterial counts decreased rapidly with increasing distance from the outfall. Seventy strains isolated were studied to determine antibiotic susceptibility. The strains studied showed resistant to 16 out of the 18 antibiotics tested. Thirty-seven strains were susceptible to all the antibiotics tested, and 21 showed susceptibility or intermediate susceptibility to Ampicillin. Thirty-three were resistant to at least one antibiotic, and 11 were multidrug resistant.
The presence of bacteria with antimicrobial resistance in the Antarctic environment is indicative of how widespread the global antibiotic resistance situation has become.

Fri_16_EN-2_1258
Total Petroleum Hydrocarbons in Sediment Around Four Antarctic Stations

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Total petroleum hydrocarbons (TPH), pH and nutrients were analyzed in intertidal sediment samples for three years (2014 to 2016). The samples were taken at increasing distances from the discharges of 4 Antarctic stations, located in Bahía Fildes and Bahía Potter.
The maximum average values, considering the three years analyzed, were 1576 and 1180 (mg TPH / kg) for Bahía Fildes and Bahía Potter respectively. The results show that the differences between the years analyzed are not significant, suggesting that the impact of the TPH on the environment remains approximately constant over time. Statistically significant differences are observed between both bays. The points of greatest impact correspond mainly to the places where maneuvers are carried out with boats. In Fildes Bay, these points coincide with the wastewater treated discharges from two stations.
The cluster statistical analysis shows that the samples are grouped according to the activities carried out on the coast, separating the points without human activities in a distinct cluster.
The results of nutrients (nitrogen and phosphorus) in the sediments do not show relationship with the discharges or with the maneuvering sites of boats. These results seem to be more influenced by local situations, such as the presence of backwaters and algae.
This study shows that the maximum pollution detected, with high local values TPH, are confined to places where boat maneuvering and wastewater discharges occur.

Fri_17_EN-2_1399
Occurrence of PBDEs in the Greenland Shark *Somniosus microcephalus*

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Polybrominated-diphenyl ethers (PBDEs) include a class of brominated flame retardants (BFRs) that are added to many products (e.g. plastics, household textiles, etc.) to reduce their flammability. The top predator Greenland shark *Somniosus microcephalus* is an important cold-water species with slow growth and it is also the longest-lived vertebrate known, for these reasons it is vulnerable to bioaccumulation of POPs.
PBDE concentrations in the muscle and liver of fifteen Greenland sharks were evaluated and then correlated to the tissue lipid content and age/sex of sharks. ∑PBDEs ranged from 0.143 to 82 ng/g (mean 20 ± 25) lipid wt in the liver and from 2.49 to 57 ng/g (mean 14.1 ± 15.2) lipid wt in the muscle. The percentage contribution of the PBDE congeners showed the following patterns: BDE-47 > BDE-28 > BDE-154 >BDE-209 > BDE-99 > BDE-100 > BDE-85 > BDE-66 > BDE-153 > BDE-66 > BDE-183 in the liver, and BDE-47 > BDE-99 > BDE-100 >BDE-28 > BDE-209 > BDE-154 > BDE-153 > BDE-66 > BDE-85 > BDE-183 in the muscle. Our results showed that sex and age/size may not be the main factors affecting the BDEs bioaccumulation in liver and muscle, since no significant differences were observed between males and females or age groups.

Fri_18_EN-2_1401
POPs in Cod Fish and Greenland Halibut from NW Greenland

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The Atlantic cod *Gadus morhua*, the Greenland cod *Gadus ogac* and the Greenland halibut *Reinhardtius hippoglossoides* are particularly sensitive to persistent organic pollutants (POP) exposure, playing an important role in monitoring the potential effects of these chemicals in Arctic marine ecosystems.
DDTs, PCBs, PBDEs and HBCDs were determined in the muscle of five cod and five Greenland halibut specimens collected in the Uummannaq Fjord (NW Greenland). The lipid content ranged 14.5-50% in cod fish and 46-82 in the Greenland halibut. No significant relationship was observed correlating lipid content and POP concentration in these species. The POP contribution to the total residue was PBDEs > PCBs > DDTs > HBCDs in both the cod fish and PCBs > DDTs > PBDEs > HBCDs in the Greenland halibut. The ratio ΣDDTs/ΣPCBs was significantly lower than 1 in cods (0.384-0.989 ng/g lw) respect to the Greenland halibut (0.793-1.47 ng/g lw), suggesting a higher POP contribution of industrial and agricultural origin in the two species, respectively, and/or a different inter-specific DDT and PCB bioaccumulation processes. Further investigations are needed since these fish species are commonly eaten by humans and are thus considered an important economic resource.

Fri_19_EN-2_1422
Source Assessment of Trace Elements in the Polar Regions by Isotopic Analysis

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A thorough assessment of the exposure of the Polar environments to contaminants from local and distant areas requires the identification of their sources and transport patterns and the capability to distinguish between natural and anthropogenic inputs. In this context, lead and strontium isotope ratios proved to be very powerful, providing information not easily achievable otherwise. In particular, the $^{208}Pb/^{207}Pb$ and $^{206}Pb/^{207}Pb$ values differ significantly between crustal and ore Pb deriving from various locations and mining areas, whereas natural variations of $^{87}Sr/^{86}Sr$ can be used for tracing the geographical sources of mineral dust.
In the framework of PNRA (National Program for Antarctic Research) and RIS (Research in Svalbard) projects we have developed and have successfully applied novel analytical procedures based on both single- and multi-collector inductively coupled plasma-mass spectrometry, thus obtaining interesting information on the sources and transport pathways of trace elements in various environmental compartments.
Representative results concerning the marine environment of Kongsfjorden (The Arctic), the atmospheric particulate reaching Ny-Ålesund (The Arctic) and Terra Nova Bay (Antarctica), and the surface snow accumulating at Dome C (Antarctica) will be presented and discussed, together with preliminary results of the ongoing SIDDARTA project, the aim of which is studying present-day sources and transport processes of mineral dust to the Antarctic plateau.

Fri_20_EN-2_1437
Orographic and Anthropogenic impact at Antarctica and POPs Contamination

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Over the past decades, research in Antarctica has built a new understanding of Antarctica, its past, present and future. Human activities and long range pollutants are increasing on the Antarctic continent. Research on Persistent Organic Pollutants (POPs) have been carried out internationally by several countries having their permanent research stations to explain the impact of an ever increasing range of POPs in Antarctic ecosystem. POPs have been detected in Antarctica despite its geographical isolation and almost complete absence of human settlements. Presence of POPs in different abiotic (atmosphere, water bodies, sediments, soil, sea ice) and biotic components (mosses, lichens, krill, penguins, skua etc.) in Antarctica have been studied and documented around for decades and have either been banned or strictly regulated but are still found in the environment. This review focuses on recent research pertaining to sources and occurrence of POPs in Antarctic lake water, soil, sediment, lichen, mosses and other Antarctic marine community. The talk proposes to summarize the current state of research on POPs in Antarctica environment and draw the earliest conclusions on possible significance and impact of POPs in Antarctica based on presently available information from related Antarctic environment.
Keywords: Persistent Organic Pollutants (POPs), Biotic and Abiotic Compounds, Ecotoxicology and Antarctic Pristine Environment.

Fri_21_EN-2_1609
Organic Compounds Emitted by Ships as Potential Contaminants in Polar Regions

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Maritime transport is a globally important source of submicron particulate matter and gaseous pollutants. Ship engines typically combust low-grade fuels without application of exhaust gas after-treatment systems. Hence, they may constitute an important source of air pollution in Polar Regions. The composition of gas phase organic species and the identification of important precursors for secondary organic aerosol (SOA) formed from ship emissions itself remain largely uncharacterized. We investigate the semi-, intermediate- and volatile primary organic carbon (S-/I-/VOC) emitted from a ship engine operated with heavy fuel and marine gas oil. VOC analysis is performed using proton-transfer-reaction mass spectrometry. This is complemented by analysis of sorbent and filter samples using gas chromatography-mass spectrometry. We find a large fraction of aromatic and polycyclic aromatic hydrocarbons in the emissions, present emission factors of those species and an estimated SOA potential providing relevant information also for assessments in Polar Regions.

Fri_23_EN-2_1834
Characterization of HMW TPH Patterns from Soil at McMurdo Station, Antarctica

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McMurdo Station is located in an approximately 4 km^2 ice free area at the southern tip of the Hut Point Peninsula on Ross Island, Antarctica. The summer population of over 1000 people makes it by far the largest population center on the continent. Human occupation at the site dates back to 1902. Spatial patterns of Total Petroleum Hydrocarbons (TPH) measured in the terrestrial environment surrounding McMurdo Station during the period from 1999 through 2015 as part of a long-term environmental study indicated many areas with little to no impact. There are areas with elevated TPH which are found associated with helicopter operations, refueling operations, vehicular usage and near parking/vehicular maintenance operations. Petroleum hydrocarbons in impacted McMurdo Station soils are characterized by a low molecular weight (LMW) gasoline/JP5/AN8, residual weathered petroleum TPH signature and a HMW signature that has not been characterized. The LMW TPH pattern suggests relatively freshly released petroleum in surficial soils with n-alkanes resolved on an unresolved complex mixture hump. The high molecular weight compounds are spatially-linked and generally restricted to vehicular operations such as historical roadways and parking areas. However, the actual composition of this HMW component has not yet been explored. This research explores the composition of this HMW pattern using GCxGC TOF/MS and Ion Mobility Q-TOF LC/MS which should provide better insight into its origins.

Fri_24_EN-2_1930
Inputs of Halobenzenes to Ice Cores at Svalbard and Antarctica

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Inputs of industrial organic contaminants were measured at Holtedahlfonna, Svalbard, and Site M, Antarctica. The Holtedaholfaonna core was drilled in 2005 and covered 52 years from 1953 - 2005, and at Site M in 2004 and covered a 47-year period from 1957. Both cores were analyzed by the same lab for 15 halobenzene compounds, including 10 chlorobenzenes, 2 bromobenzenes, 2 chloromethoxybenzenes, and pentachloroanisole (PCA). These compounds are all highly volatile and, in general, would not be expected to condense except under extreme cold conditions, or under situations where the atmospheric concentrations are very high. The Antarctica results show flux and core burden dominated (70%) by 1,3-dichlorobenzene (1,3-DCB), hexachlorobenzene (HCB), 1,2,4-trichlorobenzene, 1,2,3,4-tetrachlorobenzene, and 3,4,5-trichloromethoxybenzene. PCA was not detected. Holtedahlfonna is dominated (90+%) by 3 DCBs (1,4-, 1,3-, 1,2-), PCA and HCB. Quantitatively, all 15 contaminants in Antarctica contribute 30.8 ng, or 0.66 ng yr^{-1}, while at Holtedahlfonna, 1894 ng, or 36.4 ng yr^{-1}. The difference appears extreme because Holtedahlfonna is dominated 80% by 1,4-DCB, and without that contribution, the total is 363 ng or 7.0 ng yr^{-1}. The halobenzene input at Holtedaholfonna is at least 10 times greater than Site M during this period. This result is consistent with investigations of organic contaminants in Svalbard glaciers suggesting Eurasian sources that do not exist at Antarctica.

Fri_26_EN-2_2022
Anthropogenic Impact on Soil Prokaryotic Communities of Fildes Peninsula

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The Antarctica continent is characterized by its extreme environmental conditions and low anthropogenic pressures. However, throughout the year´s many research stations have been implemented in the few ice-free regions of the continent. One of these areas is on the Fildes Peninsula (King George Island). The human footprint in the region has led to the increase of pollution issues around the area such as elevated levels of heavy metals and persistent organic pollutants. In this study, we aim to understand how these human activities are shaping the soil prokaryotic communities of these regions. We collect a total of 20 soil samples along a transect with decreasing human impact at Fildes Peninsula. At a preliminary stage, the structure of bacterial communities was achieved through automated approach for ribosomal intergenic spacer analysis (ARISA), and based on the community fingerprinting profile of ARISA, nine samples were chosen to sequence massively the V4-5 region of 16S rRNA gene to capture all the prokaryotic diversity. The structure of the prokaryotic communities was correlated with the heavy metal contents and persistent organic pollutants measured for each site. Strong relations were identified between the prokaryotic communities and the pattern of distribution of the contaminants analyzed in the present study, alerting us to the risks that anthropogenic activities pose on this pristine environment.

Fri_27_EN-2_2043
Soil Contamination at Impacted Sites in the McMurdo Dry Valleys

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From 1999-2015, an environmental monitoring program has characterized spatial patterns and temporal trends in anthropogenic contamination of the local terrestrial near McMurdo Station. Soil samples were also collected annually at control sites in areas experiencing minimal human impacts and were analyzed for Total Petroleum Hydrocarbons (TPH) and selected metals. TPH concentrations at the control sites were generally at near background levels and show no evidence of changing significantly over the study period. Trace metals concentrations are similarly low though the impacts of varying parent material among sites are evident. In 2013 and 2015, the monitoring program was expanded to encompass established field camps at Lakes Bonney, Fryxell and Hoare and a temporary campsite in the Meirs Valley within the McMurdo Dry Valleys. Samples were also collected at sites of suspected contamination in the Barwick and Balham Valleys Antarctic Specially Protected Area. This research synthesizes this sampling along with historical sampling conducted as part of operational environmental operations by the United States Antarctic Program to characterize typical levels of contamination at impacted sites in the McMurdo Dry Valleys in comparison to levels found at the well-characterized control sites. It also proposes effective sampling design strategies for characterize soil contamination to inform management decisions in the McMurdo Dry Valleys Specially Managed Area (ASMA).

Fri_28_EN-2_2190
Effect of Copper Contamination on SOD Activity of Polar & Tropical *Chlorella sp*

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Environmental conditions affect many aspects of cellular metabolism. Superoxide dismutase (SOD) is the most important enzymes in the front line of defense against oxidative stress; where SOD catalyzes dismutation of two superoxide anion into hydrogen peroxide & molecular oxygen. Algae are notable bioindicator species in environmental pollution studies. In view of this, efforts are made to investigate the use of SOD activity, DNA damage level, growth responses and biochemical composition as biomarker for evaluation on how microalgae responses and adapt to copper contamination occurred at Arctic, Antarctic & Tropical region. Results showed that the carbohydrate, protein, lipid and AP-site content decreased with increasing concentration of copper. The SOD activity in the exposed algae increased with increasing copper concentration until the threshold, beyond which the cells lost their resistance and died. Levels of these SOD enzymes; DNA damage, growth, biochemical composition in microalgae & correlation with physical-chemical characteristics of water quality at Polar and Tropical region measured; will allow the establishment of baseline data that will be used for developing a monitoring programed. The findings of the present study may contribute to the understanding of how the Arctic, Antarctic and Tropical algae respond to environmental stress, and to use SOD enzymes levels to monitor the impact of climate change and increased contamination of the polar and tropical habitats.

Fri_29_EN-2_2337
Comparative Analysis of Pollutants in Polar, High- and Low-altitude Cryoconites

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Rapid industrialization in the Asian countries is one of the greatest contributors of anthropogenic pollutants such as Black Carbon (BC). These pollutants accumulate on the surface of glaciers and in lake ice. Microbes glue these pollutants together with dust in the form of *cryoconites* in a process called *biological darkening*, accelerating the melting of glaciers, snow and ice-caps. The Himalayan Mountain range is the second largest ice mass after the Polar region. Anthropogenic fossil fuel combustion and production of non-ferrous metals, leading to bulk release of trace metals such as, As, Cr, Cu, Ni and Zn into the atmosphere, have an adverse impact on the Himalayan ecosystem. There have been very few studies on the Himalayan cryoconites with the first one in 2017 showing high As levels; an element of concern for downstream human populations. Cryoconites in other regions, such as the Hans glacier, reveal high concentrations of anthropogenic Pu, Cs, Sr while those in Alpine glaciers are heavily enriched in artificial radionuclides. Simultaneous monitoring and comparison of various pollutants in polar, high- and low-latitudes will be important in understanding pollutant cycling. With this intent, we are undertaking a multidisciplinary assessment of the mineral, organic and biological components of cryoconites from the Arctic expedition, the Pyrénées and the Himalayas with a special focus on inorganic micropollutants such as artificial radionuclides, Hg and other trace metals.

Fri_31_EN-2_2343
Environmental Relationships of the Heavy Metals in a Periglacial Landscape

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Although only 8.8% of King George Island are ice-free areas, they represent key hot spots where biodiversity is maximum, and greater anthropogenic impacts occur. In the Admiralty Bay of King George Island, four research stations are located, and generate local environmental impacts to different degrees. The objective of this work was to identify the relationship between heavy metal contents and environmental and anthropogenic covariates in Keller peninsula, where the Brazilian station is located. Soil sites located far away from the station were used as control for serving as reference for comparison between anthropogenic and non-affected soils. Categorical covariates such as landforms, lithology, soils and morphometric covariates (from a digital elevation model with spatial resolution of 1 m) were used. Soil samples were collected in 57 points distributed in grid form, in two depths (0-10cm and 10-20cm). The samples were analyzed by X-ray fluorescence spectrometry and the contents of zinc, copper, nickel, cadmium, mercury cobalt, arsenic and chromium were determined. We used the functions “findCorrelation” and “recursive feature elimination”, both using the R software. The model with the lowest number of variables was chosen, which obtained 97%, the highest value of Kappa. This interpretation was very useful to illustrate the general behavior of heavy metals in Antarctic landscapes.

Fri_32_EN-2_434
Plastic Debris in Antarctic Marine Organisms: First Results of PLANET Project

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For decades plastic debris accumulated in the world's oceans and recently their presence and impact has been documented in one of the most remote and pristine region on Earth as Southern Ocean around Antarctica. Increasing local human impacts (fishing, tourism and scientific bases) and transportation from transboundary sources will differentially affect occurrence, spatial patterns and biological impact of plastic debris in Antarctic waters. The PLANET project (PLastics in ANtarctic EnvironmenT) launched in 2015 by the Italian Antarctic Research Programme is an international network of researchers sharing the common aim to address the impact of plastic pollution on Antarctic marine organisms with particular regard to the smallest debris as micro (< 5mm) and nanoplastics (< 100 nm). An initial monitoring study in 2016 revealed the presence of microplastic in several marine species from the Ross Sea. They resulted more abundant in scallops and fish than in phytoplankton, krill and blood and faeces of seabirds (penguins and skua). Rayon fibers of a size below 100 µm (µ-FTIR) were the most present thus raising concern in terms of toxicity since approaching the nano-scale but also chlorinated polyethylene, poly(butylene terephthalate) and melamine/alkyd resin were identified. Cross-contamination underline the need to standardize protocols for sample handling, digestion and polymer identification in order to properly assess micro and nanoplastic occurrence in Antarctic biota.

Fri_33_EN-2_2509
Long-range Transport of Pollutants to Antarctica

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Antarctica is considered a pristine ecosystem; nevertheless it is influenced by Persistent Organic Pollutants (POPs), mainly driven by long-range atmospheric transport. Antarctic ice-free areas, where rare lakes are located, are influenced by such sources. In this work, we determine polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbon (PAHs) and pesticides (banned and still in use) in water and sediment samples of 7 shallow lakes in Northern Victoria Land during the austral summer season.
POPs concentrations in lakes resulted low and rather similar across the sites despite their distance.
There is always a higher presence of low molecular weight PAHs both in comparison between the various expeditions, and comparing water and sediment of the same campaign. Phenanthrene is the predominant compound in all the sampled sites (single PAHs concentration is in the range 0,1-0,4 ng/L).
The 6 PCBs marker (28, 52, 101, 138, 153, 180) are quantifiable and comparable (single PCBs concentrations are in the range 0,01-0,3 ng/L).
Among the pesticides, simazine is most represented for the azine class, especially in aqueous matrices.
Endosulfan sulfate is present in all samples often at high concentrations.
p, p´-DDT isomer is the most concentrated isomer, but we have found also o,p-DDT and their metabolites.
Hexachlororobenzene and BHC-g (Lindane) are present in most samples.
Iprodione is present in most of the aqueous analyzed samples, while in sediments it is less represented.

Fri_34_EN-2_2691
Using DGT to Assess the Risk of Metal Contaminants in Polar Environments

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Metal contaminants, such as those that leach from historical Antarctic waste, are known to cause toxicity to a wide-range of organisms. The development of environmental quality guidelines will help environmental managers to understand the risk of contaminants. However, a lack of environmental toxicological data and environmental monitoring tools is limiting the development of guidelines. Diffusive Gradients in Thin-films (DGT) have been established as a robust method for analysing the biologically-available contaminants *in situ* and is well-positioned to assess the toxicity of metal contaminants.
This study uses DGT to assess the toxicity of Cd, Cu, Ni, Pb, and Zn singly and in mixtures, to two common Antarctic marine microalgae, *Phaeocystis antarctica* and *Cryothecomonas armigera*. DGT devices were optimised for use in Antarctic conditions by determining metal diffusion coefficients and quantifying the DGT's metal-binding capacity. Preferential binding of metals was observed prior to reaching the metal-binding capacity with Cd, followed by Pb, and Zn, outcompeted by Cu and Ni. DGT measurements were then used to predict toxicity to two algal species exposed to a mixture of the metal contaminants. This research demonstrates the applicability of DGT to identify contaminated sites which may pose a risk to Antarctic organisms.

Fri_35_EN-5_361
PANGAEA® - Data Publisher for Earth and Environmental Science

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PANGAEA - Data Publisher for Earth & Environmental Science (www.pangaea.de) is an Open Access data-library aimed at archiving, publishing and distributing georeferenced data from earth and environmental science. The development of the system started with the beginning of the Internet and since then offers data curation services to national and international projects, institutes and individual scientists. The World Data Center PANGAEA is member of the World Data System (WDS) of the International Council for Science (ICSU). Observational and analytical data files are stored together with their metadata in a relational database. Each data set includes a bibliographic citation and is persistently identified using a Digital Object Identifier (DOI). Data are archived as a supplement related to an article or as an independent citable data-publication. PANGAEA is a recommended repository for supplements in several hundred journals related to earth system research.
PANGAEA currently provides more than 368 000 data set, consisting of >12 billion data points. This includes important collections from international Antarctic and Arctic research programs, e.g. the Cape Roberts Project, ANDRILL, EPICA project, and data of the first and last International Polar Year (IPY 1882-1883 and 2007-2008). Additionally, the full data amount of combined high and low latitude research projects, e.g. JGOFS, WOCE, DSDP/ODP/IODP and German expeditions are archived and published.

Fri_36_EN-5_665
How, what, where, when: Expedition Metadata and Data Collection

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Three months of data and sample collection on the Antarctic Circumnavigation Expedition during the southern summer of 2016/17 required a system to collect metadata and data during the research cruise.
A network was established on board the R/V Akademik Tryoshnikov, to automatically store data streams from ship-based instruments, access the local intranet and allow for communications on board. An intranet with event-logging and data-entry system was prepared to allow scientists and data managers on board to record the cruise metadata, database ship-based data streams and perform in-situ checks on the generic data streams being collected during the expedition. This allowed extensive checking of metadata and completion of metadata records of raw data sets whilst on board.
This presentation will describe the system used as well as the particular advantages and disadvantages of the systems used on a multi-disciplinary research cruise.

Fri_37_EN-5_673
Making the Most of ACE Data

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Over 30,000 samples and 30 TB of data were collected during the Antarctic Circumnavigation Expedition. ACE was a unique expedition to the Southern Ocean, sub-Antarctic and Antarctic islands during the austral summer of 2016/17. The scientific potential of resulting data sets depends on good data management and investment in methods to ensure the integrity of these data sets, as well as careful data processing and checking.
In addition, once initial analyses have been done on the quality assured data sets, there is huge potential to combine them in new ways and apply data science and machine learning techniques to explore the vast linkages between disciplines.
This presentation will explore the potential of the ACE data sets, from the basis of their archiving, the extent of the data sets and how they will be made available to all. Finally, we will discuss how data science methods will be used as part of the project, "Delivering Added-value To Antarctica", ACE-DATA, to explore air-sea interactions.

Fri_38_EN-5_853
The United States Antarctic Program Data Center (USAP-DC): Recent Developments

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Polar data are valuable, unique research assets that are acquired under substantial and expensive logistical effort. Historically, data management for the US Antarctic Program (USAP) has made use of existing disciplinary data centers. However, disciplinary repositories do not exist for all USAP generated data types and often it is unclear what repositories are appropriate, leading to datasets being served locally from scientist's websites or not available at all. The USAP Data Center (www.usap-dc.org) contributes to the broader preservation of data acquired with funding from NSF's Office of Polar Programs by providing a repository for diverse Antarctic data. In Spring 2016, USAP-DC and the NSIDC began a new collaboration to consolidate data services for Antarctic investigators and to integrate the NSF-funded glaciology data at NSIDC with the collection hosted by USAP-DC. Investigator submissions for NSF's Glaciology program now make use of USAP-DC's web submission tools, providing a uniform interface for Antarctic investigators. The tools have been redesigned to collect a broader range of discovery and preservation metadata. Each data submission is reviewed and verified by a specialist from the USAP-DC/NSIDC team depending on disciplinary focus of the submission. A recently updated web search interface is available to search data by title, NSF program, award, dataset contributor, large scale project (e.g. WAIS Divide Ice Core) or by specifying an area in map view.

Fri_39_EN-5_879

Providing High-quality Long-term Data Management at the McMurdo Dry Valleys LTER

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Established in 1993, the McMurdo Dry Valleys Long Term Ecological Research Program (MCM LTER) is an interdisciplinary effort focused on the long-term study of aquatic and terrestrial ecosystems in a cold desert region of Antarctica. The McMurdo Dry Valleys are located on the western coast of the McMurdo Sound, forming the largest relatively ice-free region on the Antarctic continent. MCM represents one of twenty-eight sites in the United States (U.S.) LTER Network funded by the U.S. National Science Foundation (NSF).
Like all LTER sites, MCM is a data-intensive endeavor with a diverse set of monitoring and experimental studies that span temporal and spatial scales. Data generation largely occurs through the intensive laboratory analyses of biogeochemical parameters and biotic composition of field-collected samples. Additional high-frequency datasets are obtained using automated technologies that include environmental sensor networks and satellite imaging. MCM data standards and access policies are set by the U.S. LTER Network in accordance with NSF guidelines, and were recently revised in the spirit of open science to promote enhanced data quality, visibility, and accessibility.
Here, we describe the complete data life cycle at MCM, focusing on both the technological and human aspects of collecting, curating, and preserving high-quality, publicly available long-term datasets for use by researchers, educators, and policy-makers alike.

Fri_40_EN-5_1263
Liberating Arctic Botanical Biodiversity Data at the Canadian Museum of Nature

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Core to the polar research information spectrum are the millions of biological and geological specimens in natural history collections. These specimens represent biodiversity data documenting the distribution of species in time and space; they serve as vouchers for the datasets that underpin scientific conclusions, allowing future workers to confirm or revise identifications; and they are sources of new data, such as genetic information. Most natural history museums face the massive "big data" challenge of databasing and imaging their collections, allowing them to be widely discovered, shared, used and reused in research and outreach. Many also possess backlog material: specimens collected and stored, sometimes many decades ago, that have never been accessioned or prepared for long-term use, and that are consequently not discoverable or available for study. The Canadian Museum of Nature houses over 300K Arctic specimens - the largest Arctic natural history collection in Canada - but data for only a subset are currently accessible online. To correct this, the National Herbarium of Canada is engaged in a project to digitize, georeference and image its Arctic plant, moss and lichen specimens, according to global standards that facilitate collection data sharing and integration. We are also processing important Arctic backlog material, including 3025 Canadian Arctic specimens collected in the 1970s to the 1990s at great expense that were never mounted or formally acquired.

Fri_41_EN-5_1545
Developing a Metadata Portal for Researchers

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One of the challenges when developing a portal is how to get the researchers to work with it. Scientists complain about the number of systems, being from their home institution, funding agency or international, they are required to provide with information and the amount of time this costs. Time they can´t use to perform research.
For the Netherlands Polar Program (NPP) we developed a portal to provide access to all data and information from the NPP. We worked with the researchers to make it as easy as possible for them to provide information about their projects, data sets and publications. In this talk we will show the tools we created and how easy it is for researchers to add information. The portal was built using open standards and only requires free software to run, this way it can easily be incorporated into other national polar programs. The source code for the portal is freely available to the community via Github.

Fri_44_EN-5_2321
Enhancing Polar Decision Making: Data Sharing through Active Collaboration

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Recent conferences, workshops and meetings have confirmed that there are many projects and programs that are active in polar data management and stewardship at multiple scale. These initiatives have a mandate or desire to contribute to regional or international coordination of effort and activities. These programs have resources available and are making progress towards an envisioned connected, interoperable polar data system. The international polar data community is eager to improve cooperation and coordination of their efforts.
In the spring of 2018, more than ten active programs and initiatives came together to focus on work planning and coordination of effort. This meeting complemented past workshops and fora (e.g. IPY, Polar Data Forums etc.) that have been effective in defining important community challenges and technical issues. The focus of the meeting was to generate detailed plans on how best to mobilise existing and pending funded activities to develop a particular international data sharing case study.
The meeting was co-led and co-organized by key polar data projects and programs associated with polar science and observing coordinating bodies, international initiatives, regional, national and disciplinary programs, and Indigenous organizations. Here we report details of the planning process, the established case study, established interoperability mechanisms and a discussion of the collaborative process involved in bringing together a diverse group of data.

Fri_45_EN-5_2357
Using Concept Analysis and Visualization to Mediate Data for Different Audiences

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The volume and variety of data available for research, decision making and local, community-driven projects and programs is rapidly increasing. These data may be produced using different methods, epistemologies and overall world views. At a more technical level, the data are often stored in different formats using a range of different vocabularies that are specific to a natural language or particular domain.
Drawing on examples from the Exchange for Local Observations and Knowledge of the Arctic, the activities of the Arctic Data Committee, and other related projects, data and information generated from different perspectives and managed using different techniques are analyzed and linked through the analysis of concepts and related categories. The results of the analysis are visualized to provided insights into how disparate data and information might be mediated for use between and among actors from different communities, domains and communities of practice. The challenges of representation using visualization to represent non-spatial concepts are discussed as are possible opportunities.

Fri_46_EN-5_2435
Biogeographically-linked Resource to Share Polar Microbial & Environmental Data

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The microbial Antarctic Resource system (mARS; mars.biodiversity.aq) is an information system dedicated to facilitating the discovery, access and analysis of molecular microbial diversity and 'omics (meta)data generated by researchers. Here we report on the expansion of the geographic coverage of mARS to include all polar and subpolar regions. This enhancement is envisioned to facilitate comparative studies between the poles and serve as a collaborative, networking resource for polar scientists. mARS incorporates standardized environmental context data into a custom MySQL database in which users can search by latitude/longitude coordinates, environmental temperature, salinity, depth, or elevation etc., so that studies submitted by other researchers can be discovered which may be relevant for comparative diversity and metagenome or transcriptome studies. Visualization tools have also been created to capture the sequence coverage of different studies, geographic coverage, and in the future, phylogenetic coverage of data sets that are reflected in mARS. The mARS team partnered with the ERANET/LAC-supported METHANOBASE project which has characterized archaea and bacteria in permafrost, wetland and lake ecosystems in subarctic and Antarctic, and sub-Antarctic sites over the past two years. This large project, which collected over 480 samples from diverse ecosystems, served to help improve the mARS infrastructure and its usability by the user community of microbial scientists.

Fri_47_EN-5_2661
The CCADI Initiative: Advancing Arctic Research with Connected Data

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The Canadian Consortium for Arctic Data Interoperability (CCADI, http://ccadi.ca) is an emerging initiative to advance collaboration, nationally and internationally, through the development of an integrated Canadian Arctic data management system that will facilitate information discovery, establish metadata and data sharing standards, enable interoperability among existing data infrastructures, and provide accessible data to a broad audience of users, from researchers to the general public.
Importantly, the Consortium aims to connect a broad variety of information types ranging from bibliographic records and research licenses, to metadata and raw data sets. Connecting these various kinds of data grants users the ability to build a holistic view of research, from inception and throughout the data lifecycle, and provides enhanced opportunities to recreate scientific studies and review them from different angles. It also provides countless opportunities to compare and link data, both qualitative and quantitative, across disciplines.
The CCADI also aims to include Inuit Knowledge and is working with regional Inuit organizations and Inuit Tapiriit Kanatami to ensure that indigenous data is included ethically, with full Inuit involvement in the design of systems, and in the management and use of their data.
The CCADI is composed of six Canadian universities, two Canadian federal agencies, two Inuit organizations, and three non-profit partners.

Fri_48_EN-6_34
Source, Processes & Productivity-investigation through Lake Sediment, Antarctica

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Two sediment cores retrieved, one each from lake GL-1 of Schirmacher Oasis and lake L-12 of Larsemann Hills, East Antarctica were investigated at 2 cm interval for sedimentological and geochemical parameters viz. grain size, total organic carbon, total nitrogen, total phosphorus, biogenic silica and bulk metal concentration. High sand content (>72%) in the major portion of the cores revealed predominant mechanical weathering process, which resulted in coarse-grained material from the rocks in the catchment area of the lakes. Relatively, higher biogenic silica along with high total organic carbon associated with high clay in the upper portion of both the lakes indicated deposition of finer particles from suspension in recent years which facilitated high primary productivity due to exposure of the lakes to the ice-melt water influx. C/N ratio for both the lakes was found to be < 10 which indicated that the major source of organic matter was autochthonous. However, N/P and N/Si ratios were lower than Redfield ratio indicating N and Si were limiting elements in the lakes. In these lakes, TOC and TN exhibited a poor correlation indicating their different source. Cd in both the lakes was found to be of mainly biogenic origin, whereas Pb in these lakes was found to be of lithogenic origin. Silt and organic matter in core GL-1 and organic matter along with the Mn-oxide in core L-12 regulated the distribution of metals.

Fri_49_EN-6_429
Long-term Growing Season Dynamics Inferred from Birch Leaf Cuticle

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A significant lengthening trend of the Northern Hemisphere growing season increasingly affects vegetation dynamics. Growing season length data, however, are currently restricted back to 1982, when satellite based vegetation monitoring began. All forward modelling of potential consequences to date are restricted to this short reference period. Sound evaluation of positive or negative effects for ecosystem performance requires longer time-series data to place ongoing changes into ba broader temporal context. Palaeobotanical investigations provide a tool to generate long-term growing season records beyond the short-term satellite records. Our novel growing season length proxy is capable of accurately reconstructing past growing degree days and spring onset data. In this study, micro-phenological data from modern and fossil leaf cuticles are tested against historical meteorological data, and validated by field climate manipulation experiments. Growing season signals from historical and fossil leaves are subsequently used to estimate spring thermal properties over the past century. We here focus on Disko Island, Greenland and Kevo, Finland, both extremely sensitive to seasonal temperature changes. The generated time-series records of spring dynamics will support the understanding of ongoing climate change on time scales beyond the instrumental record.

Fri_51_EN-6_548
Holocene Environmental Change Around the Lutzow-Holm Bay using Penguin Rookery

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Adelie penguin carries pebbles to rookery during summer breeding season, so pebbles deposit thickly year by year with relics such as feces, egg shells, feathers and bones.
Prior to the start of summer nesting of Adelie penguin, I excavated sediments of rookery of Adelie penguin that existed around the Lutzow-Holm Bay in Antarctica, and described the sections of feces, bones, feathers and eggs from the basement to the surface layer, and took the radiocarbon dating and nitrogen isotope measurements.
In this research, based on this result, I examine the following four contents: 1) Geographical distribution of Adelie penguin rookery and their formation history, 2) History of change of the sea level change and Antarctic ice sheet , 3) Penguin´s food content, and discuss Holocene environmental change around the Lutzow-Holm Bay region.

Fri_52_EN-6_618
Diatom Variation Reconstructed from Two Lake Sediment Cores from East Antarctica

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Biogenic proxies such as diatoms retrieved from sedimentary deposits are a good tool to decipher and understand climate changes in the cold environments of Antarctica. The use of diatoms as a paleoclimate indicator in lacustrine systems of Antarctic ice free areas is well documented. In this study, we report diatom abundance and species variation for two sediment cores collected from two freshwater lakes viz., Mochou Lake (ML) and LH-73 of Broknes Peninsula in Larsemann Hills, East Antarctica. The cores were collected at different elevation (ML: 2 m & LH-73: 22 m asl) and distance (ML: 350 m & LH-73: 250 m) from the coast. The ML core spans the last 28.6 kyr while the LH-73 covers the last 25.8 kyr. In the time-series, the appearance of diatoms was recorded at 15.63 ky BP in ML record while it appears at 19 ky BP in LH-73 records wherein the deglaciation in Antarctic ice-core records is at 19 ky BP. This suggests that the lakes became ice-free after the deglaciation in Antarctica aiding growth of diatom community though at different times. This difference is most likely due to the geographical setting of both the lakes. The late-Holocene records higher diatom abundance as compared to the down-core indicating a favorable condition for the diatom community to flourish. The most abundant species in both the records is Stauroforma inermis followed by *Planothidium quadirpunctatum*, *Amphora veneta*, *Diadesmis australis* and *Psammothidium abundance*.

Fri_53_EN-6_786
A Land Mammal Tibia from the Eocene of Marambio/Seymour Island, West Antarctica

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Despite Antarctica is the only continent without terrestrial mammals, in the past it played a key role in the evolutionary history of Southern Hemisphere mammalian communities. Sometime between the Late Cretaceous and the latest Paleocene, before the complete break-up of Gondwana, West Antarctica functioned as a land bridge for the dispersal of metatherians and monotremes, from Southern South America to Australia in the first case, and in the other way round in the last. Fossil land mammals in Antarctica are mostly constrained to the dental remains from the Eocene of La Meseta and Submeseta Formations in Marambio Island. Here we described and discuss the implications of the first mammalian long bone, represented by an almost complete right tibia (MLP 94-III-15-6). The remain came from the lower conglomeratic shell bed from Cucullaea I Allomember at La Meseta Formation (Telm 4) in the locality DPV 2/84. The minimum length of the tibia is approximately of 230 mm; the prominent cnemial crest and most of the proximal epiphysis are cracked and with most of its surface were reconstructed. Proximally, the medial condyle is broken as well as most of the tibial malleolus. The distal third of the bone is the best preserved, particularly the astragalar articular surface. The distal moiety of the shaft resembles some Proterotheriidae litopterns for being more trihedral and less oval in section suggesting Sparnotheriodontid affinities.

Fri_54_EN-6_798
First Cranium of the Giant Penguin Anthropornis from Marambio/Seymour Island

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Anthropornis, described more than a century ago, is one of a fascinating species of fossil penguins. The robustness and massiveness of its bones caught the attention of Carl Wiman in 1905, and made him worthy of the name *Anthropornis*, which means "man-bird". Both species of this genus were only known through isolated bones (tarsometatarsi), until a few years ago, when the reinterpretation of some articulated bones Only isolated bones were described for both species of this genus until that new articulated skeletons from the Antarctic Eocene allowed the reinterpretation and assignment of associated limb remains to *Anthropornis* sp. A new skeleton found in Priabonian levels of the Submeseta Formation, Marambio (Seymour) Island, Antarctic Peninsula, constitutes the first specimen with a complete tarsometatarsus (that allowed the assignment to *Anthropornis grandis*), and the cranium, besides many fragments of other bones. The importance of this finding is that it is the first fossil cranium of Antarctica that can be assigned to any of the known species of penguins since all findings of cranial elements constitute isolated remains. *Anthropornis grandis* has an extremely elongated and slender bill and a small neurocranium, compared to modern penguins. Dimensions of the occipital condyle and the foramen magnum, however, are congruent with a large cranium and neck. These proportions seem to be the rule among large and giant penguins during the Paleogene.

Fri_55_EN-6_917
Reconstructing Temp in Antarctica over the past Based on Water Stable Isotopes

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Full title: Reconstructing air surface temperature in Antarctica over the past millennium based on water stable isotopes. Last millennium temperature changes over Antarctica are still relatively uncertain. This has several origins:
1) The number of high resolution ice cores is small, in particular on the Antarctic Plateau;
2) The instrumental records are short which limits the calibration period for reconstructions and the assessment of the methodologies;
3) The link between isotope records from ice cores and local climate are usually complex and dependent on the spatial and time scales investigated.
Here, we assess the potential of statistical reconstructions methods and data assimilation-based methods to obtain better understanding of last millennium temperature changes over Antarctica. This is first achieved in a pseudo-proxy framework. A long simulation performed with an isotope-enabled model is sampled at the same spatial and temporal resolution as existing data to provide the pseudo-data of surface temperature over the recent past and of stable oxygen isotopes over the past millennium. The performance of the statistical and data assimilation reconstructions based on those pseudo-data is then assessed by comparing the reconstructed temperature with the simulated one. In a second step, the data assimilation method tested and improved in this idealized framework is applied to real data and the results compared to available reconstructions based on statistical methods.

Fri_56_EN-6_938
Hunting for Dansgaard-Oeschger-type Variability in the Earliest Pleistocene

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Geological studies indicate the Earth's climate system is capable of undergoing abrupt and profound change when surface temperature is cooler than present (Dansgaard et al., 1993). It is now known that these co-called Dansgaard-Oeschger (DO) events likely occurred during a range of intermediate ice-volume states for the past 1.3 million years (Birner et al., 2016). Yet, it remains unknown when DO-events were first a feature of North Atlantic climate during the Quaternary. To shed new light on this issue, we present new suborbital palaeoceanographic records that track variability in surface and intermediate water properties of the northeast North Atlantic Ocean during the onset of major Northern Hemisphere glaciation, 2.5 million years ago.
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Dansgaard, W., Johnsen, S.J., Clausen, H.B., Dahl-Jensen, D, Gundestrup, N.S et al. (1993). Evidence for general instability of past climate from a 250-kyr ice-core record. *Nature* 364, 218-220

Fri_57_EN-6_1032
Subdecadal Holocene Climate Reconstruction of Byers Peninsula (Antarctica)

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Byers Peninsula (Livingston Island, South Shetland Islands) is one of the few glacier-free areas in Antarctica that allow the high-resolution characterization of Holocene history based on paleolimnological studies. Several lakes on the peninsula with sedimentary infills up to 5 m of thickness provide excellent opportunities to conduct multidisciplinary environmental reconstructions. The complete sedimentary infill of five lakes was retrieved in 2003 and 2008 (Limnopolar) and November 2012 (Chester, Escondido, Cerro Negro and Domo). Sediments ranged from nearly completely mineral to an alternation of mosses and mineralogical layers. The age model of these five sedimentary records was built using 53 AMS 14C and 4 TL dates covering the last ca. 8,000 cal years BP. Past climate and environmental changes are here inferred using the results obtained with an X-ray core scanner and x-ray diffraction analysis. Our results are related to the main Holocene climate fluctuations in this area. However, the comparison of the obtained reconstructions for each lake allowed for dintinctions between local ontogenic processes controlled by the catchment and lake internal dynamics and those caused by regional climate fluctuations.

Fri_58_EN-6_1224

New Wet Extraction Technique to Measure CH_4 and N_2O Mole Fractions in Ice Cores

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Reconstructions of past greenhouse gases (GHG) concentrations from polar ice cores are highly valuable to study the coupling between GHG and the climate system. A detailed understanding of their past natural variability and feedback mechanisms with temperature is crucial to constrain the future evolution of the climate.

We present a new gas extraction technique coupled to a gas chromatograph. It is characterized by a continuous vacuum extraction of the gases during the ice melting and subsequent collection on an active charcoal adsorber. Our efforts are currently devoted to the reduction of possible sources of contamination connected with desorption and/or outgassing phenomena connected to the ice extraction line.

The goal is to provide precise measurements to increase the temporal resolution of the EPICA Dome C Antarctic CH_4 and N_2O records. Our new data will allow for a better quantification of the phasing between CH_4, N_2O and CO_2 during rapid climate changes along with better estimates of the magnitudes and rates of change of these GHG fluctuations.

Fri_59_EN-6_1428
Records of the Southern Hemisphere Westerlies from the Cape Horn Archipelago

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Recent changes to the strength and latitudinal range of the Southern Hemisphere Westerly winds (SHW) have highlighted their importance in regulating atmospheric CO_2, sea ice extent, and the stability of Antarctic ice shelves. Despite their critical role in global climate and mitigation of anthropogenic climate impacts, little is known about their long term natural variability. Here we present efforts to reconstruct past SHW intensity and associated late Glacial and Holocene climate variability from two islands in the Cape Horn Archipelago, Isla Hermite (55º50'S, 67º40'W), the westernmost in the archipelago, and Isla Hornos (55º56'S, 67º16'W), the southernmost. Combining peat and lake records from a suite of low-lying, westerly-facing sites on Isla Hermite, and a lake sediment record from a headwater cirque lake on Isla Hornos, we aim to reconstruct past aerosol deposition and westerly wind intensity using a novel diatom- and geochemistry-based multiproxy approach. Here we present our latest radiocarbon age-depth models, diatom reconstructions, and micro-XRF scanning results from the cores. These records form part of a larger project to reconstruct late glacial-Holocene SHW intensity from sedimentary records from the sub-Antarctic islands, in an effort to understand past migration and changes in intensity to the SHW, and ultimately how these variations affect CO_2 sequestration on multi-millennial timescales.

Fri_60_EN-6_1453
Diatoms as Indicator of Regional Climatic Variability in Antarctica

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The use of diatoms as micropaleontological indicators has been used in the last decades, once these organisms that are sensitive to environmental changes, having their frustules preserved in the sediments which enables paleoclimatic reconstructions. In this context, the present study reconstruct regional climatic variations in the west coast of the Antarctic Peninsula, using fossil records of diatoms in a sedimentary corer with 50 cm sampled at the Glubokoe Deepe Lake, King George Island. 25 layers (period 2013 to 1737) was submitted to qualitatively analysis where 19 taxa was considered as frequent and there relative abundance was correlated with environmental variables to established three reconstruction models. The first reconstruct the temperature in Antarctica Peninsula based on the relative abundance of *Brachysira minor* and *Pinnularia* sp. and presented an associated error of 13%. The second reconstruct the energy of cyclones occurring between 50 ° and 70 ° S based on the relative abundance of *Nitzschia cf. Kleinteichiana*, *Pinnularia borealis*, *Gomphonema* sp. and has an average error of 2%. And the last one reconstruct the ozone content in the atmosphere using *Planothidium australe, Pinnularia borealis, Gomphonema* sp. and *Humidophila tabellariaeformis* relative abundance with a mean associated error of 11%. The results corroborate with other models proposed thereby allowing to concluded that diatom assemblages can be used as paleoclimatic reconstructors for this region.

Fri_61_EN-6_1603
Pliocene-Pleistocene Paleoproductivity on the Wilkes Land Margin, Antarctica

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Although the East Antarctic Ice Sheet (EAIS) is considered relatively stable, the Wilkes Land Margin (WLM) is susceptible to global warming because its marine-based glaciers are at risk of contact with warm mid-depth waters. Unstable ice sheets cause sea-level rise and threaten coastal communities, but our understanding of ice variability and response to climate change is poorly constrained due to a lack of data. We present a Plio-Pleistocene biogenic silica (wt% BSi) stratigraphy, diatom assemblages, and bulk sedimentary stable isotope data from a marine sediment core collected from IODP site U1361A, located on the WLM continental rise. Characterizing Southern Ocean conditions from 1.8 - 3.8 Ma allows us to examine the shift from the warm Pliocene, which is an analog for future warming conditions, to the cooler Pleistocene, and may improve the parameterization of EAIS response to climate forcings. High wt% BSi intervals are interpreted to reflect interglacial episodes of elevated diatom productivity, while lower wt% BSi intervals are interpreted to reflect glacial episodes of decreased productivity and/or increased terrigenous input. Diatom assemblages from mid- and late-Pliocene interglacial intervals indicate the onset of cooler interglacial surface ocean temperatures around 3.3 Ma, punctuated by short-lived warm water incursions. Work is underway to extend this reconstruction into the early Pleistocene.

Fri_62_EN-6_1620
Preliminary Study on the Geochemistry and Diatom of Core Sediments in Ross Sea

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The paleoenvironments, XRF, biostratigraphy, and age dating of the piston cores (RS14-GC04) collected from Ross sea Strait, Antarctica are studied by the micropaleontological studies based on diatoms.
As a result of dating, the age of the core represents about 6,000 years. The variation of sediment core including diatoms were analyzed from the drilled core which was obtained from the Ross sea for the purpose of reconstruction of the environmental variations during the Holocene.
A total of 25 species and varieties belonging to 58 genera are identified from the Core RS14-GC04. The range of diatom valves per gram of dry sediment was approximately0 to 26.3* 10^7/g in quantitative diatom assemblage analysis.
The diatom assemblages from RS14-GC04 are dominated by *Fragilariopsis curta*, *Thalassiosira antarctica* cold type, *Eucampia Antarctica* var, *recta*. A minor species appeared as *F. obiquecostata*, *F. turgiduloide*, proboscia alata, *Rhizosoleni styliformis* and *Stellarima microtrias*.
Ba is a good correlation with TOC, suggesting their relation to biogenic debris, precipitation from seawater, or hydrothermal input.

Fri_63_EN-6_1645
Implications of Biogenic Sulfur Species from GV7 Firn Core, East Antarctica

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The concentrations of ionic species in conjunction with stable isotopes were measured from firn core drilled in the austral summer of 2014 at the GV7 site (70° 41´S, 158° 52´E, 1950m a.s.l.) conducted as a scientific cooperation between ENEA from Italy and KOPRI from Korea. This study presents the snow chemistry of a short firn core covering a time period of at least 35 years (1979-2013). The concentration variations of biogenic sulfur species were studied in detail to investigate their implications as proxies to indicate the long-term perspective on the change of oceanic environmental in the past. The seasonal concentrations of methanesulfonic acid (MSA) were determined according to the age-depth relationship based on the annual layer counting using the variations of oxygen isotope ratio, $nssSO_4^{2-}$, Cl^-/Na^+, and Pinatubo volcanic record. The correlation analyses with satellite-derived sea ice area and firn core MSA were systematically conducted. Variations of MSA during austral summer season were found to be positively correlated with sea-ice area (~60-65°S) between the 150°E and 150°W sector during spring season and the correlation between them at each 10° sector was strongest at 180° ($p < 0.05$).

Fri_64_EN-6_1867
Morphology and Sediments of the Confined Outwash Fan in the High Arctic Region

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Controls affecting the morphology and surficial lithology of a confined outwash fan of the Waldemar River (NW Spitsbergen, Svalbard) were analysed on the basis of geomorphological and sedimentological researches which indicate multiple correlations between the shape of distributary channels and textural features of fluvial deposits. The statistical techniques were used to find relations between the morphological and sedimentary features of a confined outwash fan developed in High Arctic conditions. The ability of these techniques to detect relationships was analysed and threshold values for changes in relations between fan slope, channel morphology, sediment distribution and confined outwash fan width were detected. The results of our research indicate that the morphology and surficial lithology of the confined outwash fan developed under High Arctic conditions are closely related to the existence of permafrost. Changes in the confined fan slope, width and rate of sediment supply (as a result of lateral, mechanical and thermal erosion and degradation of the uppermost part of permafrost) control the distributive channels bed lithology. Thus, the evolution and determination of the rate and dynamics of transformations of confined outwash fans in High Arctic regions, affected by climate warming, can be considered as an indicator of polar environment changes resulting from climate fluctuations. This also will help us to understand the outwashes evolution during the Pleistocene.

Fri_65_EN-6_1986
Last Decades Warming Evidences in the NW Barent Sea (Arctic)

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The Arctic area is responding more rapidly to global warming than most other areas on our planet. The Kveithola Trough located in the NW Barents Sea has an interesting sedimentary record due to its geographical conditions and its dynamic glacial history formation. Its location allows the input and interaction of two of the main water masses, the cold, fresh Arctic Water coming from the north and the warm, salty Atlantic Water flowing from the south.
Four sediment cores collected in the Kveithola Trough area during the oceanographic cruise EUROFLEETS2-BURSTER were analysed with regard to benthic foraminiferal assemblages and sedimentological parameters in order to elucidate past variability of the water masses, the organic matter flux and oxygen concentration to the sea floor during the last decades. The foraminiferal assemblages composition and and taxonomic abundance allow inferring significant environmental differences between the evolution of the inner and outer shelf areas. The dominant foraminiferal species recurrent in the study area may indicate that during the last 45 years a higher influence of warm water and an increase in the anoxic conditions has been established along of the Kveithola Trough area. These evidences need to be confirm by further multidisciplinary analysis including biological, sedimentological and chemical data.

Fri_66_EN-6_2057
Early Holocene Shallow Marine Mollusc Palaeodiversity, Billefjorden, Svalbard

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Species communities of marine molluscs from two geochronologically identical early Holocene sites with different positions in the northern part of Billefjorden were compared. Kapp Ekholm (KE) site is situated in the main fjord and the terrace surface lies at ~25 m a.s.l. Mimerdalen 1 (MD1) site has a terrace surface at 28 m a.s.l. and is situated in a valley, which represented a shallow cove. Although both sites are identical in morphostratigraphy and geochronology, they bear species compositions, which correspond to different biostratigraphical levels according to classical concept. The species community on KE is correlated to the morphologically highest, i.e. the oldest Holocene terraces. On the contrary, species composition on MD1 is correlated with morphologically lower and younger terraces. This diversity is caused by different palaeodepths on both sites. According to the sediment architecture, the depth of the sea floor inhabited by studied organisms was ~20 m on KE and ~5 m on MD1. The results indicate that past species communities do not have to correlate necessarily with the morphostratigraphy of terraces. They depends more on the palaeogeographic position within the fjord than on chronostratigraphic position within the early Holocene. Species-poor community does not indicate only temperate conditions shortly after the LGM, but can also occur later in connection with ecological conditions at specific locations.

Fri_67_EN-6_2166
Reconstruction of Sedimentary Environment in Western Ross Sea Since Early LGM

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The Western Ross Sea is an important drainage channel for the Ross Ice Shelf（RIS）and paleo-ice sheet, and its sedimentary records reflect the retreat history of the RIS and the changing processes of the local ocean circulation. The lithologic feature, internal structure, physical characteristics and organic molecular geochemistry of the gravity sediment core ANT31-JB03 in the Central Basin, western Ross Sea revealed that two stage sedimentary environmental change: (Phase I) and (Phase II) in the early Last Glacial Maximum (LGM) and since the Holocene with the boundary of 78cm depth below sea floor. The missing sediment matter during the two stages maybe eroded by the glacial drift flow during the Last Deglaciation followed the LGM. The sedimentary environment of Phase I was glacial-marine sediment still under RIS extension, with two age reversal events which means that the sediment on the Ross Sea shelf were prone to slide migration and mixing effected by ice shelf drainage flow because of sea water temperature rise or the ice-sea interacts strengthening with each other weak reducing-reducing environment. Since the Holocene, with the rising of the sea level, and the retreating of RIS, the sediments grainsize became thinner, the biological activity increased, the productivity increased, the source of organic matter increased, and the influence of ocean circulation increased gradually. In the meanwhile, three events with increased density and reduced porosity.

Fri_68_EN-6_2240
Greenland NEEM Ice Core Records of Trace Metals during the 1710~1970

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In this research, we present high resolution record of Al, As, Ba, Cd, Co, Cr, Mn, Mo, Pb, Rb, Sr and V from Greenland NEEM ice core samples covering the period from 1710 to 1970. To our knowledge, long-term trends of these elements except Cd and Pb have never been reconstructed from Greenland ice cores at such a high resolution. The ice core records of the trace metals concentrations are characterized by large fluctuations. The ratios between maximum and minimum concentrations range from 69 for Sr to 1596 for As indicating a stark variation in concentration with depth. To help understanding long-term changes in atmospheric trace metals, individual data points were averaged for a decadal period. The main features of long-term changes are all categorized into three groups. Al, Ba, Mn, Rb, Sr and V show no distinct peaks in their concentrations over the whole period. Meanwhile, Co, Cr and Mo concentrations are largely peaked from the mid-1830s to the mid-1850s and steadily increase for the 20th century. For As, Cd and Pb, two concentration peaks are appeared around 1800 AD and 1900 AD. The different patterns in the periods reaching peaks in concentrations are likely due to the primary anthropogenic sources for the different element. Our first comprehensive and reliable time series for various trace metals from Greenland NEEM ice core provide valuable insights into significant enrichments of these elements due to human activities from the early-19th to the mid-20th century.

Fri_69_EN-6_2364
Reconstructed Plutonium Fallout in the GV7 Firn Core from East Antarctica

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Atmospheric nuclear explosions during the period from the 1940s to the 1980s are the major anthropogenic source of plutonium (Pu) in the environment. In this work, we analyzed fg g^{-1} levels of artificial Pu, released predominantly by atmospheric nuclear weapons tests. We measured 351 samples which collected a 78 m-depth fire core at the site of GV7 (S 70°41´17.1", E 158°51´48.9", 1950 m a.s.l.), Northern Victoria Land, East Antarctica. To determine the Pu concentration in the samples, we used an inductively coupled plasma sector field mass spectrometry coupled with an Apex high-efficiency sample introduction system, which has the advantages of small sample consumption and simple sample preparation. We reconstructed the firn core Pu fallout record for the period after 1954 CE shows a significant fluctuation in agreement with past atmospheric nuclear testing. These data will contribute to ice core research by providing depth-age information.

Fri_70_EN-6_2486
Anthropogenic Contaminants in the Last Hundred Years of Antarctic Ice

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The deposition of contaminants, transported by the aerosol, occurs mainly through snowfalls and therefore the ice-cores represent an archive of notions of the variation of trace chemicals. From the stratigraphy of the ice cores, the ice-layers can be temporally related. Antarctica is the ideal site to perform basic studies on contamination: it provides an atmospheric environment free of local sources or anthropogenic contamination, giving a low background of native-pollution which is essential for transportation studies. As the ice compartment represents a reservoir of historically deposited POPs, quantification of concentrations in Antarctic continental ice is particularly relevant in order to predict the possible future POP re-emission into the atmosphere and oceans through ice melt.
In this work we investigated the presence of Organo Chloride Pesticides (OCPs) in a 50-m deep snow/firn core, collected at the peripheral site GV7 in East Antarctica during the 2013-2014 XXIX Italian expedition, to elucidate historical deposition rates of OCPs.
The concentration depth profile was obtained on the basis of the total concentration of twenty-two OCPs individually detected by GC-MS QqQ.
SOCPs showed linear and constant trend from 1890 till 1960 (with an average value of 0,01 ng/l), then an increase, in the period 1960-2010, from about 0.01 to 0.20 ng/l (200% increase).

Fri_71_EN-7_33
Soil Organic Carbon Variability Along a Latitudinal Transect in Arctic Siberia

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The aim of our study was to assess variability in the soil organic carbon pool from the peatlands and bog soils in taiga and tundra zones along the latitudinal transect in Arctic West Siberia (Russia).
The taiga research site is located in discontinuous permafrost zone (N65º18´, E72º52´). The average active layer thickness was 163±8 (August 2015). The CO_2 efflux from the peatlands was low (202 ± 37 mgCO_2/m^{2}hr). The upper horizons of the peatland soils statistically differed from those of the bog in the contents of the total, labile and microbial carbon.
The tundra research site is located in continuous permafrost zone (N 67°48; E 76°69'). Soils of this research site are characterized by low active layer thickness, CO_2 efflux and content of microbial carbon (August 2016). The spatial distribution of CO_2 efflux and content of water-extractable organic carbon are strongly correlated with hypsometric levels (r = -0,33, and r=-0,42 respectively, p-level < 0,05) in tundra ecosystems.
Despite the wide array of changes in both physical (soil temperature, soil moisture) and biological conditions (vegetation composition, content of labile and microbial soil carbon), our results showed that soil CO_2 flux did not vary significantly throughout transect (taiga- tundra). But depth of permafrost table differed significantly. It explains the necessity of adequate assessment of the spatial variability on the active layer thickness as a significant factor influencing regional CO_2 emission.

Fri_72_EN-7_41
Fire Effects on Greenhouse Gas Emissions on Wetlands in the YK Delta, Alaska

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Climate change is increasing both fire frequency and fire intensity, especially in Arctic regions. Fire leads to increased soil temperature, which increases the likelihood of permafrost thaw. Permafrost soils in northern latitudes store large amounts of carbon, and thawing of this permafrost will alter carbon cycling processes, which may substantially impact ecosystem processes in aquatic ecosystems. One potential consequence of altered aquatic ecosystem processes is changes in carbon emissions resulting from altered carbon inputs from thawing permafrost. Aquatic ecosystems are known to be hotspots of greenhouse gas emissions, so changes in greenhouse gas fluxes from them may have important impacts on global climate. In this work, we focused on CO_2 and CH_4 fluxes from plateau and lowland ponds, fens and bogs in the Yukon-Kuskokwim (YK) Delta in southwest Alaska. The YK Delta experienced unprecedented fires in summer 2015, presenting an opportunity to assess the impacts of permafrost thaw on greenhouse gas fluxes from aquatic ecosystems. We sampled in sites that had burned in 2015 as well as from similar sites where there have been no recorded fires in the past 75 years. We found little difference in gas flux between aquatic sites in burned and unburned sites, with the exception of channel fens, which showed substantially higher CH_4 and CO_2 flux in burned sites. Results may indicate the response of aquatic ecosystems to fire may lead to positive feedbacks on climate change.

Fri_73_EN-7_261
Estimating pCO2 in Cambridge Bay Nunavut Using an Autonomous Sensor Platform

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Continuous monitoring platforms contribute to our understanding of long term ocean change, offering increased temporal resolution and ability to resolve variability compared to occasional measurements. We will present pCO2 time series data from on-board an Ocean Networks Canada cabled seafloor platform at sub-tidal depth in Cambridge Bay, Nunavut. The platform, which supports a Pro-Oceanus sensor for measuring pCO2 and instruments for measuring temperature, salinity, ice thickness, oxygen, chlorophyll, current velocity, and pH was deployed from August 2015 to August 2017. We will quantitatively distinguish influencing oceanographic processes on pCO2 daily, seasonally, and annually for this unique marine biogeochemical time series. This work contributes to quantifying pCO2 cycling in the Arctic Ocean, influencing climate modelling and future projections of the Arctic Ocean carbon cycle. We will also review the performance of the pCO2 sensor operating in near continuous subzero seawater.

Fri_74_EN-7_277
Terrestrial - Atmosphere Mercury Exchange in the Arctic Tundra

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Mercury (Hg) is a global pollutant of great concern for human and ecosystem health. The Arctic is particularly vulnerable because of the high dietary exposure of indigenous populations to Hg in fish and mammals. Atmospheric Hg deposition to Polar Regions has been extensively studied in coastal zones with the goal to better understand the nature and relevance of halogen-driven atmospheric mercury depletion events (AMDE´s). Little attention has been given so far to the interior, continental Arctic. We will present a comprehensive Hg stable isotope mass balance of the arctic tundra made at Toolik Field station, AK and compare our findings with extensive terrestrial - atmosphere Hg^0 flux measurements conducted at the same site. The Hg stable isotope results agree well with micro-metrological flux measurements. Both independent approaches suggest that vegetation uptake of gaseous elemental Hg represents the dominant Hg flux between the atmosphere and Arctic tundra soils. The Arctic tundra thus represents a globally important sink for anthropogenic Hg emissions. Changes in environmental conditions, such as warming and thawing of permafrost due to climate change or could however lead to a remobilization of a large Hg pool stored in Arctic tundra soils to the Arctic Ocean.

Fri_75_EN-7_313
Tracing the Iron Cycle in the Southern Ocean during the ACE Voyage

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Incubation and mesoscale enrichment experiments demonstrate that iron is a key micronutrient limiting the growth of phytoplankton in Southern Ocean waters. It is the size of the bioavailable iron pool that shapes the phytoplankton community and hence their draw-down atmospheric carbon dioxide.
During project 15 of the Antarctic Circumnavigation Expedition (ACE) we collected trace metals samples from Indian, Pacific and Atlantic sectors of the Southern Ocean. Preliminary results reveal that the dissolved iron concentration in open ocean waters is sub-nanomolar in concentration. Near continental features such as the Kerguelen Plateau, iron concentrations are elevated which is consistent with continental supply. In contrast, there was latitudinal surface gradient in the concentration for dissolved zinc, copper, nickel and cadmium. Concentrations for these elements were high in surface waters south of the Antarctic Polar Front consistent with a deep-water supply whereas concentrations declined as surface waters are advected northward in the Subantarctic zone. Using this data, our goal is to develop a mechanistic understanding of the role iron, zinc, copper, nickel and cadmium play in regulating plankton communities in the Southern Ocean.

Fri_76_EN-7_591
Export of Particulate Organic Carbon in the Dalton, Mertz and Ninnis Polynyas

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Photosynthetic production of particulate organic carbon (POC) by marine phytoplankton is a key mechanism for the uptake of carbon dioxide that enters the surface ocean, which is then cycled through the complex marine food web. Sinking of POC from surface waters to the deep ocean represents a major pathway in the long-term storage of carbon. However, only a small fraction of the surface POC is sequestered in the deep ocean. We examined the fate of POC throughout the water column in the Dalton, Mertz and Ninnis polynyas in the Southern Ocean towards the end of the summer bloom. POC concentration in surface waters (2-10m) of coastal polynyas are higher (162 to 274 mg m^{-3}) than the Antarctic open water reference station (114 mg m^{-3}). Compared to the Dalton where POC concentration decreased with depth, POC concentration in the Mertz and Ninnis polynyas increased (>300 mg m^{-3}) between 10-50m before decreasing. Background POC in the twilight zone was also higher within the polynyas. Large fraction of the organic carbon in the sinking particles is subjected to a range of processes such as bacterial remineralisation, abiotic disaggregation and fragmentation into smaller, slower sinking particles by the zooplankton community during its transit through the water column. Seawater ammonia concentrations suggest active bacterial remineralisation in surface seawater. Biologically productive polynyas are hotspots for elevated surface POC, and could play an important role in carbon export.

Fri_77_EN-7_613
Nutrient Cycling in Supraglacial Ecosystems at Larsemann Hills, East Antarctica

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Microbial communities in supraglacial ecosystems like cryoconite holes and surface snow strongly influence nutrient cycling in these environments. In order to understand carbon flow within these systems, we carried out in-situ measurements of primary (PP) and bacteria production (BP) in cryoconite holes and surface snow at Larsemann Hills, East Antarctica during 2016-17 season. The rates of PP and BP in six cryoconite hole water samples were 0.09±0.03 $\mu gCL^{-1}d^{-1}$ and 10.26±7.18 $ngCL^{-1}d^{-1}$, respectively, with higher rates observed in the sediment (PP=5.88±3.77 $\mu gCL^{-1}d^{-1}$; BP=138.40±86.25 $ngCL^{-1}d^{-1}$), suggesting that sediments play a crucial role in the carbon cycling of the cryoconite holes ecosystem. In snow, mean rate of PP was 0.08±0.02 $\mu gCL^{-1}d^{-1}$ whereas BP was below detection limit. To understand the photochemical and microbial transformations of dissolved organic matter and ionic constituents associated with snow and cryoconite holes, *in-situ* field experiments were carried out in the presence of: microbes under dark, microbes+light and only light (no microbial activity) conditions. Significant changes in DOC and major ions (Na^+, Cl^-, Mg^{2+}, Ca^{2+}, SO_4^{2-}, K^+, NO_3^-, Ac^-, Fo^-, Oxy^{2-} and HCO_3^-) concentrations were observed after 30 days incubation. Observations made in this study are crucial for an improved understanding of the nutrient cycling in supraglacial ecosystems of polar regions.

Fri_78_EN-7_740
Microelements in Soils of Oases of Thala Hills, Enderby Land, East Antarctica

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The paper is devoted to the studies of spatial and temporal patterns of microelements content in soils of Vecherny oasis (Thala Hills, Enderby Land) and their connections to human impact. The paper is based on the results of soils investigation during Belarusian Antarctic Expeditions in 2011-2017.
General description of soils features of the oasis in comparison with others oases of Enderby Land is provided. It is shown, that the most developed soils with profile up to 50-60 cm can be found at bottoms of hollows; such sites are usually partially covered by lakes or snowfields. Their area varies from less than 1 m^2 to several hundred meters. Soils are acidic or slightly acidic, characterized by low humus content and low sorption capacity; soils properties and intensity of radial and horizontal microelements migration are highly impacted by the hypsometric level of a site location.
Certain connections of microelements content in soils with human impacts in this area is found. Among microelements sources are: erosion of old mechanisms, constructions, waste fuel oil barrels as well as fuel leaks. Generally, detected levels of microelements content can be considered as not very high. No common area of soils contamination was found due to high level of soils fragmentation.
The results of soils study will be used for model of heavy metals migration in soils parametrization to provide the forecast of soil pollution taking into account climate change and human activities.

Fri_79_EN-7_754
Dynamics of Inorganic Components in Terra Nova Bay Lake Ecosystems (Antarctica)

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A large suit of inorganic analytes was determined in water collected from six shallow Antarctic lakes of Terra Nova Bay (Northern Victoria Land, Antarctica), as well as in algae, mosses and suspended particulate material (SPM). The sampling campaigns took place between 2007 and 2012 (and one in 2002) within the framework of the Italian National Program of Research in Antarctica (PNRA). The purpose of this work was to gain insight into the natural processes regulating species distribution, define natural background values and detect possible present or future local and/or global anthropogenic contamination.
The results were processed with multivariate chemometric techniques. Lake water composition was found to be mainly influenced by marine spray and meltwater input, i.e. natural phenomena. The obtained results were compared with older literature data from the same lakes. A considerable variability was observed in metal concentrations, but no clear trend was identified; no evidence of an increase of metal concentrations over time was found for water or vegetation samples. Seasonal variability was also evaluated for each analyte, and explained considering the natural transport processes involving each species. Higher element concentrations were found in SPM than in water, suggesting that weathering plays an important role on the chemistry of these lakes. The exam of the SPM samples with a SEM showed the presence of many diatoms belonging to different species.

Fri_81_EN-7_1015
Microbial Metabolism in Front of Kongsfjorden Glaciers

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Understanding how the climate change affects the microbial community in the Arctic Sea and the ongoing heating results in cascading effects on the earth delicate climatic equilibrium is an important challenge of recent research performed in vulnerable ecosystems such as the Svalbard Islands. Within the UVASS (Unmanned Vehicles for Autonomous Sensing and Sampling) project, an unmanned marine vehicle (PROTEUS, Portable RObotic TEchnology for Unmanned Surveys), equipped with an automatic water multisampler, designed and built by ISSIA-CNR and IAMC-CNR respectively, were exploited to study the response of planktonic communities, particularly prokaryotes, in the extreme environment of Kongsfjorden. In June 2017 seawater samples were collected by those automatic systems along three transects extending from glaciers fronts to the open sea. The samples were analyzed for nutrients, organic matter and its utilization by microbial activity using Biolog-Ecoplates™ and extracellular enzymatic activity rates (leucine aminopeptidase, beta-glucosidase and phosphatase activities). Richness and Shannon-Weaver index and Principal Component Analysis were used to depict differences in the microbial catabolic potential. Variations in organic matter distribution and in functional diversity of microbial assemblages were observed. Freshwater runoff from ice melting was found to increase the amount of terrestrial organic matter to the fjord and microbial processes allowed organic matter decomposition.

Fri_82_EN-7_1201
Sediment Transport in the Northwestern Laptev Sea

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Arctic summer sea ice extent is continuously declining, affecting the hydrography and biogeochemical cycles on the seasonally ice-free shallow Siberian shelves. The prolongation of the open-water season during summer causes higher sediment resuspension and coastal erosion due to larger wind fetch and wave heights. This impacts the optical properties of the water column and hence biological productivity in this region. In order to link changes in sediment distribution with ecosystem consequences under a warming climate, detailed studies of sediment transport and pathways are required.
On the central and eastern Laptev Sea shelf, suspended particulate matter (SPM) transport is mainly characterized by two nepheloid layers, originating from bottom resuspension, erosion of thawing permafrost coasts and the input of turbid river water from the Lena River. In the northwestern Laptev Sea, SPM dynamics and transport mechanisms from the Kara Sea through Vilkitsky Strait and into the Eurasian Basin remain largely unknown due to the inaccessibility of the region. Nevertheless, several ship expeditions and deployments of long-term oceanographic observations were carried out in the western Laptev Sea from 2013 until 2015 to investigate year-round SPM distribution and dynamics. This study presents first results of year-round SPM distribution, obtained by combining optical backscatter data, ADCP echo intensity data and filtration measurements from summer expeditions.

Fri_83_EN-7_1246
Antarctic Derived Dust in the South West Ross Sea

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Dust in the SW Ross Sea Region is transported by katabatic winds from ice-free areas, offshore onto ice shelves and sea ice where it is released into the ocean. The dust contributes sediment to the Antarctic shelf and is one source of iron (Fe) involved in triggering vast phytoplankton blooms which regulate the oceanic biological pump, drawing down atmospheric CO_2. However, the source, distribution and impact of the dust is still poorly constrained. Although some modelling studies suggest that the McMurdo Dry Valleys is an important source of dust, our field data indicate that most of the dust flux comes from relatively small areas around the coast, in particular an area of unconsolidated debris on the McMurdo Ice Shelf.
We present new major element X-ray florescence analysis from a comprehensive suite of samples from potential source areas in Victoria Land as well as samples from extensive areas of sea ice and ice shelves fringing the coast and also from sea floor grab samples from across the SW Ross Sea. The results shows clear compositional patterns suggesting that dust can be geochemically traced from various onshore sources to offshore Ross Sea sink. This provides constraints on the modern dust flux, transport processes and impact on sedimentation and biogeochemical cycling in the Ross Sea. The data will contribute to the new international High Latitude and Cold Climate Dust Network database, www.hlccd.org.

Fri_84_EN-7_1293
Illuminating Dissolved Organic Matter Diversity in Antarctic Lakes and Streams

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Dissolved organic matter (DOM) exists ubiquitously in water and is involved in various biogeochemical processes. In Antarctica, most of DOM is considered to be originated from lower plants. This unique feature of Antarctica is ideal to unveil structural properties and functionality of DOM, which depend on the source materials and environmental processing. In this study, we present the diversity in the properties of DOM obtained from various lakes and streams at Soya Coast, East Dronning Maud Land, East Antarctica (n = 81). Water samples were collected from streams, and the center or shore of lakes. They were filtered with a pre-combusted glass fiber filter (< 0.3 µm), and the absorbance and excitation emission spectroscopy (3D-EEM) were measured immediately. Some portion of water samples were stored in a glass bottles and transferred to Japan, where DOM in the samples were fractionated into humic substances (HS) and non-HS. Optical indices such as $SUVA_{254}$, $S_{275-295}$, FI, BIX, and HIX were calculated from the absorbance and 3D-EEM data to elucidate the structural properties and origin of DOM. We further analyzed 3D-EEMs by parallel factor analysis (PARAFAC) to deconvolute them into distinct fluorescent components. It was suggested that Antarctic DOM increases its molecular weight, aromaticity, and degree of humification along glacier melt-lake water-pore water spectrum, and these changes are attributed to be driven by the activity of primary producers.

Fri_85_EN-7_1385
Meltwater as a Source of Iron to Terra Nova Bay Polynya (Ross Sea, Antarctica)

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Iron (Fe) availability and its influence on phytoplankton community structure and nutrient cycling has been recognized in the Ross Sea. This region is one of the most productive of the Southern Ocean, thus significantlycontributing to the CO_2 sink.The most investigated source of Fe is sea ice melting, but recent studies in the Central and Southern Ross Sea also identified the importance of the CDW intrusion and the glacial melt water. The Fe input evaluation due to glacial melt water in the western Ross Sea is one of the goals of CELEBeR (CDW Effects on glaciaL mElting and on Bulk of Fe in the Western Ross sea) project. To this purpose, CELEBeR carried out ship measurements during a cruise in the austral summer 2016-17, as part of the Italian National Program of Research in Antarctica (PNRA). Dissolved and particulate Fe data were collected in 18 stations sampled in Terra Nova Bay polynya together with physical, chemical (O_2, $H_2{}^{18}O/H_2{}^{16}O$ ratio, nutrients, CO_2 system variables) and biological (phytoplankton and prokaryotic biomass, characterization of bacteria at DCM) parameters. Water mass characterized by temperature below the surface freezing point and associated with Fe contribution was detected in the intermediate layers of the water column. Particulate Fe concentrations were on average an order of magnitude higher than those of dissolved Fe. The Fe distribution will be discussed taking into account the chemical, physical and biological characteristics of the area.

Fri_86_EN-7_1389
Dissolved Organic Matter (DOM) and Microbial Enzymes in the Ross Sea

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In the Ross Sea the dissolved organic matter and the role of culturable heterotrophic microbes in its degradation are almost unknown. In the carbon cycle, dissolved organic carbon (DOC) concentration and its optically significant fraction, the chromophoric component (CDOM) are important for DOM budget estimates. Within the CELEBeR project [Circumpolar Deep Water (CDW) Effects on glaciaL mElting and on Bulk of Fe in the Western Ross sea - PNRA], DOC and CDOM, culturable heterotrophic bacteria and the enzymatic activities, expressed by bacterial isolates, were examined in the Ross Sea during the austral summer 2017, in relation to CDW contribution. The covered areas were the Drygalski Ice Tongue and the nearby Terra Nova Bay polynya (A) and the continental Shelf Break area near Cape Adare (B). Within the area A, the lowest DOC (38.33 µM), CDOM (a_{280} of 0.27 m^{-1}) and SUVA$_{254}$ (0.54 L mg^{-1} m^{-1}) were measured at 225 m (CDW); the highest DOC (63.29 µM), CDOM (a_{280} of 1.39 m^{-1}) and SUVA$_{254}$ (1.6 L mg^{-1} m^{-1}) were recorded at the northernmost area B (DCM), also characterized by the lowest spectral slopes (SR= 1.37). Heterotrophic bacteria ranged from 5.0x10^{1} (CDW) to 7.0x10^{3} CFU/ml (DCM); aminopeptidase and alkaline phosphatase were the most expressed enzymes. Based on microbial cells counting, the distribution of heterothrophic bacteria seems to be not affected by DOC concentration and its composition, as highlighted by the lack of correlations between the two variable sets.

Fri_87_EN-7_1460
Extracellular Enzymatic Activities in the Ross Sea (CELEBeR Project)

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The microbial community uses extracellular enzymatic activities (EEA) to initialize degradation of high molecular weight organic matter in all the ocean.
The intrusion of the warm Circumpolar Deep Water (CDW) into the Antarctic shelf area is one of the recognized drivers of ice shelf melting, playing an important role on the shelf physical and biological processes. The investigated areas covered: a) the Drygalski Ice Tongue and the nearby Terra Nova Bay polynya; b) the coastal area between the Mariner and Aviator glaciers; c) the Antarctic continental Shelf Break area near Cape Adare (North Victoria Land).
During an oceanographic cruise performed in the framework of the CELEBeR (CDW effects on glacial melting and on bulk of Fe in the Western Ross Sea) project (funded by Italian PNRA), the EEA distribution was studied in order to investigate the spatial and depth patterns in the Ross Sea. In particular rates of leucine-aminopeptidase -LAP, β-glucosidase -GLU and alkaline phosphatase -AP were measured. The contribution of free enzymes fraction in some stations was also determined and the relationships with the main environmental parameters were analyzed.
Results suggested the potential capability of the microbial community to decompose proteins, carbohydrates and organic phosphates. In the Shelf Break area LAP values showed higher values than Terra Nova Bay at surface. The decreasing trend with increasing depth was confirmed. Hydrology had also effect on EEA distribution.

Fri_88_EN-7_1498
Drivers of Phytoplankton Biomass in Three East Antarctica Polynyas

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In the Southern Ocean, polynyas have the highest primary productivity rates and represent one of the largest CO_2 sinks. As a consequence, top predators favour these biomass rich areas. Three contrasting polynyas were visited in East Antarctica in January 2017: the Dalton, the Mertz and the Ninnis polynyas. The average phytoplankton biomass was ~ twice as high in the Mertz and Ninnis (411 and 466 mg Chl-a m^{-2}) than in the Dalton (266 mg Chl-a m^{-2}) Polynya. Sea surface $\Delta O_2/Ar$ was also significantly higher in the Mertz and Ninnis (5 to 12%) than in the Dalton (-8 to 8%) Polynya. These strong regional differences were further explored using physiological and physical parameters. First, the maximum yield of photosystem II was not significantly different and > 0.4 in all the polynyas. The higher productivity in the Mertz and Ninnis could be due to higher stratification and iron-rich sea-ice meltwaters. This scenario is supported by the significantly lower surface salinity in the Mertz and Ninnis (33.18 ± 0.33) than in the Dalton polynya (34.01 ± 0.33). In contrast, the major driver of primary productivity in the Dalton Polynya seemed to be the outflow of Ice Shelf Water from the neighbouring Moscow University Ice Shelf. Alternative hypotheses included a trophic cascade due to less top predators in the Dalton and differences in the phytoplankton composition of the three polynyas. Our study highlights the role of cryosphere-ocean interactions on carbon cycling in Antarctic polynyas.

Fri_89_EN-7_1502
Dissolved Cr Redox Speciation and Isotope Composition in the Southern Ocean

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Variations in stable chromium isotopes (δ^{53}Cr) may serve as a useful tool for understanding biological and physical processes in the modern and past oceans. For example, the redox activity of Cr and the isotope fractionation and solubility changes associated with Cr redox transformations have led to the use of Cr for inferring the paleoredox state of seawater. Additionally, recent data showing the scavenging of dissolved Cr onto growing phytoplankton suggests that δ^{53}Cr in marine sediments may yield constraints on changes in marine biological productivity in the past.
To help assess δ^{53}Cr as a productivity proxy and better understand the as yet poorly constrained marine Cr cycle, samples for dissolved Cr concentration, redox speciation and δ^{53}Cr were collected during the Antarctic Circumnavigation Expedition (ACE) as a component of project 15. These samples, collected across strong gradients in macro- and micronutrient concentrations and in primary productivity, will provide insights into the relationship between Cr speciation, δ^{53}Cr and primary production in varying oceanographic regimes and will help determine the potential of the proxy in modern and paleoceanographic settings. Additionally, the samples will add significantly to the global body of δ^{53}Cr data and help to further a mechanistic understanding of Cr cycling in the global ocean.

Fri_90_EN-7_1532
Automatic Sampling Near an Arctic Glacier: First Microbial Results

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In the frame of the ARCA project (ARctic: present Climatic change and pAst extreme events) aimed at studying the hydrological cycle in the boreal hemisphere, a first prototype of automatic equipment was specifically designed to perform discrete sampling of waters in the area close to a glacier. The Shark USSV (Unmanned Semi-Submersible Vehicle), designed and built by CNR-ISSIA, was the first to reach and autonomously collect samples of water near the front of a glacier, the Kronebreen in the Kongsfjorden. Shark towed, through an adequate rope, a small catamaran carrying an Automatic Water Multisampler built by CNR-IAMC. In June 2015, surface water samples were collected by the automatic Multisampler along a transect subdivided into 9 sampling stations and extending from the glacier front to the open sea. This research reports the results of the first in situ application of this device related to the study of the distributions of prokaryotes, virus-like particles and nutrients. Viral and prokaryotic abundances were significantly correlated with each other and their spatial distributions resulted not to be affected by the presence of the glacier. A low viruses abundance was found compared to the other marine ecosystems and it might be explained by adsorption on particles. The low virus/prokaryotes ratio suggested a lysogenic phase of virus. High nutrient concentrations were detected but they appeared to be not linked to microbial patterns.

Fri_92_EN-7_1825
Biogenic Matter in Surface Sediments of the Weddell Sea Continental Shelf

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The organic carbon (OC) and biogenic silica (bSi) contents in the upper 5 cm of the seabed were investigated in more than 60 sediment cores from several regions along the continental shelf of the Weddell Sea and the northern Antarctic Peninsula. The results showed that the shelf on the western flank of the Filchner Trough has the lowest contents in OC, 1.2 mg g-1, in contrast to the northwestern Weddell Sea where values of up to 16 mg g-1 were found. In the case of bSi the lowest values were also observed in sediment from the western flank of the Filchner Trough, 5 mg g-1, whereas the highest concentrations were measured in samples from the Bransfield Strait, 114 mg g-1. The lowest values corresponded to regions where sea ice distribution drastically reduces primary production at the sea surface and consequently there is a relatively small export flux of biogenic matter such as in the cases of the western flank of the Filchner Trough and the Larsen A, B and C continental shelves. In contrast, in regions where the typical ice-free seasonal summer conditions take place, such as Bransfield Strait and the northwestern Weddell Sea at the vicinities of the Antarctic Peninsula and the eastern Weddell Sea off Kapp Norvegia, the biogenic matter contents in the sediment are higher. Ongoing climate change directly affects sea ice distribution and most likely will transfer this signal to the chemical characteristics of the seabed sediment.

Fri_93_EN-7_1845
Reactivity of Glacially Derived Particles in West Greenland Coastal Environments

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The Greenland Ice Sheet (GRIS) creates large amounts of fine-grained mineral particles by bedrock erosion. This glacial rock flour (GRF) is transported to the ocean via a series of intermediate environments: pro-glacial river valleys, lakes, estuaries and fjords. GRF in estuaries of meltwater rivers is very fine-grained as exemplified by Ilulialik in West Greenland: D90=24, D50=4, D10=0.7 (microns).
The migration of GRF from land to open ocean is accompanied by export of dissolved carbon and alkalinity, nutrients, trace elements and isotopes, and by change in turbidity and ocean albedo. GRF behaviour is highly dependent on its fine grain size, which allows high-residence time in the water column before settling, and high reactivity in aqueous solutions. We report experimental results on GRF reaction rates in freshwater and saltwater in order to develop a predictive model quantifying these effects and to determine the ultimate fate of glacially derived rock particles during transit through the photic layer in Arctic marine environments.
We propose that the export rate, settling velocity and reactivity of GRF affects the primary productivity and CO_2 drawdown capacity of Greenland near-shore environments, and potentially the whole North Atlantic region. Increased melting of GRIS has caused increased sediment export (Bendixen *et. al.*, 2017: Nature 550, 101-104: doi:10.1038/nature23873). We address some of the potential effects of this increase on the Arctic marine environment.

Fri_94_EN-7_1869
Source and Sunlight Influence Dissolved Black Carbon Signature in the Cryosphere

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Black carbon (BC) is derived from the incomplete combustion of biomass and fossil fuels and can enhance glacial recession when deposited on snow and ice surfaces. Here we explore the influence of environmental conditions and the proximity to anthropogenic sources on the concentration and composition of dissolved black carbon (DBC), as measured by benzenepolycaroxylic acid (BPCA) markers, across snow, lakes, and streams from the global cryosphere. Data are presented from Antarctica, the Arctic, and high alpine regions of the Himalayas, Rockies, Andes, and Alps. DBC concentrations spanned from 0.62 µg/L to 170 µg/L. The median and (2.5, 97.5) quantiles in the pristine samples were 1.8 µg/L (0.62, 12), and non-pristine samples were 21 µg/L (1.6, 170). DBC is susceptible to photodegradation when exposed to solar radiation. This process leads to a less condensed BPCA signature. DBC across the dataset was comprised of less-polycondensed DBC. However, DBC from the Greenland Ice Sheet (GRIS) had a highly-condensed BPCA molecular signature. This could be due to recent deposition of BC from Canadian wildfires. The high concentration measured in supra-glacial melt on the GRIS also suggests DBC can be mobilized across ice surfaces. Overall, variation in DBC appears to be driven by a combination of photochemical processing and the source combustion conditions under which the DBC was formed, and was found to persist across the global cryosphere in pristine and non-pristine areas.

Fri_95_EN-7_2013
Composition and Transformation of Dissolved Organic Matter in Antarctic Snow

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The processing of dissolved organic matter (DOM) in glacier systems is an important part of the global carbon cycle. We applied ultrahigh-resolution mass spectrometry and other chemical and biological approaches to understand the molecular composition of DOM along two coast to inland (up to 300 km from the sea) transects in East Antarctica. We also carried out *in situ* field incubations to understand photochemical and biological (photo-biochemical) transformation of DOM on the ice surface. DOM composition in Antarctic snow was mainly related to autochthonous production by resident microbial communities, with significant inputs from marine and long range atmospheric transport. We present strong evidence of extensive photo-biochemical alteration of both autochthonous and allochthonous DOM on the coastal Antarctic ice sheet surface, resulting in major shifts in the composition and bioavailability of nitrogen, sulfur, and phosphorous bio-molecules. In some cases, photo-biochemical processing appears to result in altered compounds that are photo- and bio-labile. The opposite is also observed, converting some components of the DOM to photo- and bio-resistant forms. Thus, the biogeochemistry of DOM is highly complex and closely connected with microbial and photochemical processes. The new insights on the interactions between microbes, light and specific DOM molecules highlight the need for focused studies on supraglacial carbon biogeochemistry and its response to a changing climate.

Fri_96_EN-7_2069
Carbon Export by the Mackenzie River during Spring Freshet

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Rapid ongoing warming and accompanying hydrological changes in the Arctic influence the mobilization and fate of terrestrial organic carbon transported along the land-to-ocean continuum, with implications for regional and global carbon cycles. The Mackenzie River is the largest supplier of sediment and particulate organic carbon to the Arctic Ocean, with a majority of the annual sediment load being exported during the spring freshet. However, thus far, relatively few studies have attempted a comprehensive quantification and characterization of organic carbon exported by the Mackenzie during the spring freshet.
We collected water column samples for analysis of dissolved inorganic and organic carbon, and depth profiles of suspended particulate matter, as well as bank and channel sediments from the main channel of the Mackenzie River, the Peel River and the Arctic Red during the spring freshet in 2017. We present a comprehensive data set comprising sedimentological characteristics (grain size, mineralogy mineral-specific surface area), bulk geochemical properties (e.g., %OC, d^{13}C-OC, D^{14}C-OC) and molecular signatures (i.e. long-chain *n*-alkanes and fatty acids) to constrain sources and derive fluxes of terrestrial organic carbon during the freshet. We compare these data from the 2017 freshet with complementary information available from previous studies in order to assess potential temporal changes in the nature of materials exported by the river system.

Fri_97_EN-7_2076
Modern Sediment Distribution and Composition in Kongsfjorden, Svalbard

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The Kongsfjorden is a small fjord located in western Svalbard. 12 short sediment cores were sampled in 2011 to describe modern sediment distribution and geochemical composition. Core locations were chosen based on a high resolution seismic survey in order to delineate surficial seismostratigraphic features.
Based on the different acoustic response, seismic reflectors are continuously or irregularly laminated, transparent-chaotic, or continuous and highly reflective. Maximum sediment thicknesses (~10 m) were recorded close to the calving line of ice tongues.
Sedimentation rates, based on seismic and radionuclide profiles, resulted in high values (up to 10 cm/y) in the laminated fine mud near the glaciers, and lower sedimentation rates (0.2-0.6 cm/y) in the bioturbated muddy sediment of the outer fjord.
Organic carbon content of surface sediments showed values decreasing toward the inner fjord, reflecting the higher accumulation rates and the lower biological production in the turbid water near glacial fronts. High Br/Cl in outer fjord sediments reveals the presence of organic matter of marine origin consistent with the bulk organic carbon data.
High Ca/Ti ratios measured in inner fjord sediments prove the deposition of Ca-rich sediments supplied by the catchment of Kronebreen-Kongsvegen glaciers. In contrast, Ca/Ti is lower in the outer fjord. However, the down core distribution suggests the occurrence of past events during which the glacier influence extended further seaward.

Fri_98_EN-7_2081
Changes in Ocean Chemistry from 6 Year Time Series in Arctic Outflow Waters

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The Fram Strait is the main gateway for the exchange of warm and saline Atlantic water and the cold and fresh outflow waters from the Arctic Ocean. For six years, we collected data on the chemical (carbonate chemistry, nutrients) and physical (salinity and temperature) data along a section at ~79 °N across Fram Strait from 2011 to 2016. In this study, we focus on the change of the outflow waters in the top 400 m on the NE Greenland shelf between 12°W and 4°W. The largest variability and change in physical-chemical characteristics were observed in the top 100 meters, where temperature and salinity generally increased in the study period. Except for in 2012, total alkalinity (AT), total dissolved inorganic carbon (DIC) and CO_2 (fCO_2) showed a clear increase in the whole water column throughout the period. Simultaneously, pH and calcium carbonate ($CaCO_3$) saturation decreased, and we found indications of a deepening and spread of the lower aragonite saturated waters. This confirms recent findings in the Arctic Ocean that the low $CaCO_3$ saturated waters are spreading horizontally at depth. The study shows that even a relatively short time-series such as six years gives important information on the present changes in the chemical and physical environment in the Arctic Ocean. We discuss and compare results from previous studies and discuss possible causes for the observed changes in the carbonate chemistry and ocean acidification state.

Fri_99_EN-7_2082

Effects of Arctic Sea-ice and Biogeochemical Drivers on Under-ice Water *f*CO_2

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The ice cover in the Arctic Ocean has decreased during the last decades, manifested in particular as an extensive transition from thicker multiyear ice to thinner first-year ice. As the summer sea-ice cover is decreasing, larger areas with open water will be exposed to the atmosphere. This will have implications for the carbonate chemistry and sea-air carbon dioxide (CO_2) exchange. We present measurements of CO_2 fugacity (*f*CO_2) and estimates of the effects biogeochemical processes in the under-ice water, driving the sea-air CO_2 fluxes. The data was obtained from January to June 2015 during the Norwegian young sea ICE (N-ICE2015) expedition, where the ship drifted with four different ice floes and covered the deep Nansen Basin, the slopes north of Svalbard, and the Yermak Plateau. This unique winter-to-spring data set includes the first winter-time under-ice water *f*CO_2 observations in this region. The observed under-ice *f*CO_2 was undersaturated relative to the atmospheric *f*CO_2. Although the sea ice partly prevented direct CO_2 exchange between ocean and atmosphere, frequently occurring leads and breakup of the ice sheet promoted sea-air CO_2 fluxes. In winter, the main drivers of the change in under-ice water *f*CO_2 were dissolution of $CaCO_3$ (ikaite) and vertical mixing. In June, in addition to these processes, primary production and sea-air CO_2 fluxes were important.

Fri_100_EN-7_2138
Methane Cycling in Peatlands Ponds of the Cape Horn Region, Southern Chile

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Navarino Island (55º S) is the southernmost territory of the sub-Antarctic Magellanic ecoregion, which is a part of the world where ecosystems have been understudied and from which methane cycling and emissions in lakes have never been reported before. The Island is populated by less than one inhabitant per square kilometer. This pristine environment is dominated by evergreen Magellanic forest, peat bogs with various species of sphagnum moss, and peatland ponds which are the prevailing aquatic ecosystem of the region. In the present work we characterized, for the first time, the methane cycle of two characteristic peatland ponds located close to the northern coast of the Island. Both studied ponds, of 17,900 and 7,600 m^2 , were bordered by forest on the north and south shores while large sphagnum bogs were present at the east and west sides of the ponds. Our study included winter and summer quantification of methane and carbon dioxide concentrations. In addition, several physicochemical parameters were measured together with methane oxidation (methanotrophy) activity. The results indicate that peatland ponds were net sources of methane to the atmosphere with a relatively low seasonal variation. these results will be discussed in a global context.

Fri_101_EN-7_2286
Soils and Landforms of Elephant Island, South Shetland Islands

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Elephant Island geology is basically metamorphic rocks (gneiss, schists) from Meso-Cenozoic subduction complex, great contrast with the volcanic nature of Shetland´s Archipelago. Soil formation in different geomorphic settings following the Holocene glacial retreat at Stinker point was analyzed. Twenty-three pedons were selected dug, sampled and analyzed. Soil pH, exchangeable nutrients and soil texture were determined. Soils from till and glacial deposits can be separated by age of exposure: older soils are skeletic, shallow depth, acid reaction and moderate contents of P, SOC and base saturation; recently exposed till have soils with moderate depth, alkaline reaction and very high base saturation. Soils at the mid platforms are shallow, coarse, skeletic textured, with elevated P contents, low pH Ca and Mg. Soil weathering is controlled by the foliation of parent material. The ornithogenic influence is variable, but there are either recent or abandoned areas of birds influence. Soils from the present day beaches are alkaline, very coarse with no horizon differentiation, whereas soils on Holocene beaches are acid and nutrient rich due to the or past influence of the fauna (seals, penguins). Soils from Stinker point are generally shallow, skeletic and strongly related to the geomorphological position on the landscape. Compared with South Shetlands soils, soil development is less pronounced, due metamorphic nature parent material with greater resistance to weathering.

Fri_102_EN-7_2336
The Importance of Aeolian Dust Inputs into Oligotrophic Lakes in West Greenland

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Biogeochemical cycling in aquatic environments is strongly tied to elemental inputs from terrestrial sources. However, while most previous work has focused on nutrient delivery via hydrological inputs, the effects of atmospheric dry deposition are comparatively understudied. This paper examines the influence of aeolian derived elements on water and sediment nutrient chemistry of oligotrophic lakes in West Greenland. Estimates of dust elemental composition and seasonal deposition rates are combined with seasonal lake nutrient concentration measurements to establish connections between glaciofluvial dust and lake biogeochemistry of downwind lakes. Further, elemental profiles of lake sediment cores are used to explore historical changes in elemental deposition in this region. Together, these analyses demonstrate the importance of atmospheric dust deposition on lake biogeochemistry in arid high-latitude environments and demonstrate the need to better understand the role of aeolian deposition in cross-system nutrient transport in polar regions.

Fri_103_EN-7_2352
Vegetation Determines the Fate of Soil Organic Matter on Antarctic Islands

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With a low degree of ecosystem interactions and thus unique conditions for soil development, Antarctica offers the opportunity to disclose basic soil biogeochemical processes. We studied soils from vegetation-free and vegetated sites on King George Island (KGI) with a maritime cold climate, and on James Ross Island (JRI) with an arid continental cold climate. The autochthonous vegetation mirrors the climatic differences; while it solely consists of cryptogams on JRI, on KGI vascular plants are also endemic. This permits the study of the complex interplay between soil organic matter (SOM) sequestration and soil structure development with respect to the varying presence of vegetation. Main aim of the study is to decode the mechanisms determining the fate of SOM in maritime Antarctica and to understand how the scarce vegetation drives SOM distribution within specific physical soil fractions and its chemical composition. The distance to vegetation patches was reflected in variations in the distribution of carbon and nitrogen and in a decrease in labile SOM constituents as revealed by 13C-CPMAS NMR spectroscopy, while mineral associated SOM of the clay sized mineral fractions dominated the carbon storage throughout all sites. The ongoing climate change is assumed to significantly alter the vegetation distribution and thus drive the storage and composition of SOM. This will also affect soil microbial activity and land-ocean transitions on the studied islands.

Fri_104_EN-7_2355
Characteristics of Soils Derived from Olivine-basalts in Antarctica

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It was collected 26 soil profiles distributed through Barrientos Island, Robert Island (Maritime Antarctica) and James Ross Island (Antarctic Peninsula) formed by olivine-basalts. The samples were submitted to chemical and physical analyses such as: texture, pH in water, H+Al, exchangeable bases, phosphorus and total organic carbon (TOC). Clay fraction mineralogy was assessed by X-ray diffraction. Due to the warmer and wetter climate of Maritime Antarctica, permafrost is generally absent in the soils collected and were classified as Entisols. The islands are fully vegetated by mosses and lichens and the presence of bird populations result in physical and chemical changes in soils. The soils have some degree of chemical weathering and leaching bases, with acid pH values and high values of P, TOC and H+Al. On the other hand, the drier and cooler climate of James Ross Island favor the presence of permafrost and soils were classified as Gelisols. The vegetation and bird populations are virtually absent. The soil weathering is predominantly by physical processes. The soils have neutral to alkaline pH values, low values of P and H+Al, and devoid TOC. Meanwhile, the 26 soils pedons have characteristics in common attributed to olivine-basalts and show little transformation in relation to the parent material as the amounts of exchangeable Ca and Mg high, coarse texture (sandy loam) and the clay fraction is mainly composed of feldspar, illite, quartz, kaolinite and vermiculite.

Fri_105_EN-7_2397
Benthic Nutrient Fluxes at Greenland Coast under the Setting of Melting Glaciers

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Greenland glaciers play an important role in providing nutrients, dissolved silicon (DSi) in particular, to its coastal area. Given predictions of accelerated melting of the Greenland glaciers, an increase in coastal DSi supply is expected to facilitate production of biogenic opal by Si-precipitating phytoplankton, and the subsequent remineralisation of nutrients at depth will have an impact on the benthic ecosystem. As yet there is little understanding of benthic nutrient fluxes at coastal Greenland, which hinders quantitative examination of the evolving nutrient cycles in the light of enhanced glacial melting. Here, we address this issue through the analysis of sediment pore water and core incubation experiments carried out on a set of mega-cores recently acquired from coastal Greenland. Down-core profiles of pore water DSi concentrations and isotope composition mainly reflect biogenic opal dissolution for the upper ~15cm. Beneath that, precipitation of authigenic Si increases with increasing depth. There is also some evidence of glacier influence which provide greater amount of Si to sites proximal to the coastal fjord. Results from core incubation experiments enable us to quantify the flux of DSi at the sediment-water interface. Together, the new results contribute to the evaluation of benthic Si fluxes at coastal Greenland, which have significant implications in the biogeochemical cycling of Si and other nutrients in the polar regions.

Fri_106_EN-7_2447
High-arctic Weathering, Sulfide Mineral Oxidation and the Zackenberg River

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The impact of weathering on atmospheric CO_2 depends upon the balance between
(1) alkalinity generation by carbonate and silicate mineral dissolution, and
(2) sulfuric acid generation by the oxidation of sulfide minerals.
In regions of high physical erosion, (e.g., mountainous and glaciated terrains), increased exposure and oxidation of sulfide minerals, such as pyrite, may change the balance of (1) to (2), leading such regions to become short term sources of CO_2[1].
To test the influence of glacial erosion and permafrost freeze-thaw cycles in high-Arctic environments, we sampled from the Zackenberg River (NE Greenland), and surrounding tributaries, which individually integrate different lithologies, and are fed by either glacial rivers, seasonal snowmelt or seasonal permafrost thaw. Major cation and anion data revealed a major tributary, Aucellaelven, has an extremely high concentration of sulfate (SO_4^{2-}), the highest in the region (>2mmol L^{-1}). Here we present coupled sulfur and oxygen isotope data ($\delta^{34}S_{SO4}$ and $\delta^{18}O_{SO4}$) measured in SO_4^{2-} to constrain the source of sulfur to the river system. Determining if the source of SO_4^{2-} is from either evaporate mineral (sulfate containing) dissolution, or oxidative sulfide weathering, is vital to determining the importance of sulfuric acid in silicate weathering reactions in terrestrial Arctic environments, and the impact on inorganic carbon cycling in the region.

[1]Torres et al. (2016) EPSL 450 381-391

Fri_107_EN-7_2544
Sea Water and Sediments Biogeochemistry Studies in the Templefjord, Spitsbergen

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The aim of this work was to assess the current chemical regime of sea water and bottom sediments exposed to coastal runoff and glacial melting and an analysis of the possible consequences associated with climate warming (melting of glaciers, permafrost thawing). The work is based on chemical studies of sea water, fresh water, sea ice, fresh ice, glacier, bottom sediments, soil and permafrost, carried out at different intervals within the framework of the Norwegian Research Council POLRES program Norwegian-Russian grants CARSIC (http://www.niva.no/carsic) and POMPA (https://pompaproject.wordpress.com). Totally there were performed 5 expeditions: in February 2011, in September 2011, in March 2014, in June 2015 and in June 2017. We studies distributions of nutrients, carbonate system parameters, metals, including mercury and methyl mercury, and POPs. Chemical analyses were made in parallel in Norwegian and, when possible, in Russian laboratories. The data received allowed to estimate the characteristic ranges or concentrations of the studied parameters, estimate their seasonal changes, that can be used for the model validations.

Fri_108_EN-7_2583
Changing Nutrients and Primary Production in the Baffin Bay/Labrador Sea Complex

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The western subarctic Atlantic collects large amounts of water from the North though the Baffin Bay/Labrador Sea complex and is directly affected by changes occurring in the Arctic Ocean (AO) and its remote source waters. Because it carries the cumulated impact of biogeochemical changes in source regions, the nutrient properties of this water can be used to diagnose shifting contributions by different water masses or alterations in micro-algal productivity and microbial processes. These changes potentially impact biological productivity and the contribution of different phytoplankton functional groups, both regionally, through the influence of the Labrador Current along the eastern North American seaboard, and globally though lateral exchange with the subpolar gyre and the central Labrador Sea, where deep convection occurs. Using historical data and time-series of observations collected during ArcticNet, the Atlantic Zone off-shelf Monitoring Program and other program, we present trends in productivity and nutrient concentrations for waters entering Baffin Bay and propagating to the western Labrador Sea, with a focus on probable causes and consequences.

Fri_109_EN-7_2635

Temporal Variability of Particle Fluxes in Kongsfjorden (Svalbard) in 2010-2017

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Over the last decades, the Arctic has experienced faster environmental changes than any other regions on Earth in response to global warming. The Arctic amplification may be due to feedback mechanisms from loss of sea ice and changes in atmospheric and oceanic circulation.
Kongsfjorden is a small Svalbard fjord whose glaciers are rapidly retreating. However, how the land-to-ocean fluxes of particulate matter are changing in the fjord remains elusive.
Here, we show results from a mooring deployed in the inner fjord since 2010 that collected multiannual time-series to monitor the interaction between the entering Atlantic water (AW), melting glacier water and local winter water.
Thermohaline properties reveal a large seasonal and interannual variability (θ = -1.91/6.87°C, S = 34.10/35.28) with greater AW intrusion in November. Middle and bottom water temperatures generally follow the same pattern, although periods of water stratification occur. Bottom temperatures show a consistent increasing trend of 0.16 °C y^{-1}. Currents are generally < 10 cm/s.
The average total mass flux (TMF) is 20 g m^{-2} d^{-1}, with higher peaks in summer (~100 g m^{-2} d^{-1}) and reduced fluxes in autumn-winters (~7 g m^{-2} d^{-1}). Notably, in summer 2013, TMF reached ~330 g m^{-2} d^{-1}. Lithics and clastic carbonates by glacier and iceberg melting are the most abundant components. During May-June, higher contents of $bSiO_2$ and OC with heavier $\delta^{13}C$ show a higher fraction of marine organic matter by diatom production.

Fri_110_EN-7_2657
Terrestrial-marine Connections in the Coastal Ross Sea during the Mid-Pliocene

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Orbital frequencies are well documented in a number of terrestrial and marine climate records throughout the Cenozoic; however, assessing the feedbacks and timing of terrestrial-marine systems on glacial-interglacial timescales is often challenging. This is particularly the case in high-latitude, near-shore environments where traditional proxy records like benthic foraminifera are absent. Here we present a combined oxygen ($\delta^{18}O$ and $\delta^{17}O$) and silicon ($\delta^{30}Si$) isotope record from marine diatom silica in the mid-Pliocene (3.5 - 4.7Ma) section of the AND-1B core from McMurdo Sound, Antarctica. Diatom silica $\delta^{18}O$ values range between +28.1 and +36.4‰ VSMOW, and have an inverse relationship with the stacked benthic foraminifera $\delta^{18}O$ record. We interpret the diatom $\delta^{18}O$ values as a record of terrestrially-sourced cryogenic brine flux to McMurdo Sound; density-driven transport of these brines from the McMurdo Dry Valleys to the marine costal environments during the warm mid-Pliocene is a potentially overlooked terrestrial source of hypersaline waters. The $\delta^{30}Si$ values range from +0.5 to +2.2‰ and appear to correlate with the benthic stack. The considerable variability in $\delta^{30}Si$ values may record large-scale changes in silicon and other nutrient cycling. Combined, these proxies indicate strong terrestrial-marine connections during the mid-Pliocene when sea ice in the Ross Sea was significantly reduced, and serve as a potential analog for future warming and sea ice/ice-sheet retreat.

Fri_111_EN-7_2666
Mass Budgets of Methylmercury in Kongfjorden, Svalbard

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Methylmercury (MeHg) is a neurotoxin that bioaccumulates in marine food webs and human can be exposed to MeHg through seafood consumption. While MeHg concentrations in Arctic food webs are relatively higher than lower latitudes, major sources of MeHg in Arctic organisms and seawater remain uncertain. In the current study, we observed the concentrations of total Hg and MeHg using a CVAFS, and the methylation/demethylation rate constants using enriched stable isotope methods combined with MeHg measurement by GC-ICP-MS. Furthermore, the compositions of dissolved organic matter (DOM) in seawater were determined by excitation-emission matrix fluorescence spectroscopy. The average MeHg concentration in seawater was 0.11±0.03 pM (0.053-0.17 pM), and the highest concentration was found to be 0.17 pM at the surface of the inner fjord. The largest source of MeHg was in-situ methylation in the water column and input from stream and glacier discharge was the second largest source, based on the MeHg mass budget estimated using the field observation and incubation data. The result of mass budget agreed well to the spatial distribution pattern of MeHg and DOM components in this region, showing higher concentrations of MeHg and soil humic-like DOM in the surface layer. Overall, an increase of terrestrial organic input, in relation to future climate change, is likely to amplify methylation rates of Hg(II) in Arctic fjord.

Fri_112_GG-1_96
Geological Structure of the Lambert Glacier Area (East Antarctica)

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The Lambert Glacier area (Mac.Robertson Land−Princess Elizabeth Land) is underlain by a wide range of geological bodies in terms of their age, lithology and tectonic setting. Various models to explain the complex geological composition and protracted tectonic evolution have been proposed but nevertheless it remains the subject of continuing discussion and investigation.
The study region consists of three major crustal provinces, defined by their geological histories and Sm-Nd T_{DM} model ages: the Ruker Province (2.8-3.6 Ga), the Vestfold Province (2.7-3.0 Ga), and the Rayner Province (1.6-2.4 Ga). The Ruker Province comprises the Mawson−Stinear Zone composed of an early Precambrian basement and overlying Proterozoic supracrustal sequences, and accreted the PP Lambert Zone. The Rayner Province comprises: (1) Fisher Inlier composed of mid-MP juvenile arc-related mafic and felsic rocks, (2) Beaver−Prydz (BEAP) Zone comprising late-MP arc(?) felsic rocks with rare mid-MP inheritance, and (3) South Princess Elizabeth (SPEL) Zone comprising late-MP − early NP felsic rocks of either juvenile or within crust origin. The Fisher Inlier and BEAP Zone include recently discovered PP rocks (India edge? Mawson Continent?) subsequently reworked. Tectonothermal events in the Rayner Province are concentrated in three age intervals: ca 1200−1100 Ma (Fisher Phase), ca 1000−950 Ma (Beaver Phase), and ca 800 Ma (Bolingen Phase). Cambrian reworking affected much of the SPEL and eastern BEAP zone.

Fri_113_GG-1_118
Upper Mantle P-wave Velocity Structure Beneath the Terra Nova Bay, Antarctica

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The Extreme Geophysics Group (EGG) at Korea Polar Research Intititue (KOPRI) have installed four broadband seismic stations around Mt. Melbourne during the Antarctic summer in 2010-2011 to monitor the activities of Mt. Melbourne. Next summer season, seven broadband seismic stations were installed around the end of David Glacier which is the biggest glacier outlet in the Terra Nova Bay area. The number of seismic station is increasing year by year, and the Korea Polar Seismic Network (KPSN) consists of seventeen broadband stations and one infrasound array. The division of Polar Earth-system Science is focused on the research titled “Characterizing mantle domain beneath West Antarctic Rift System and Antarctic mid-ocean ridges”, and trying to install OBSs (Ocean Bottom Seismometers) in Terra Nova Bay in order to optimize the data usage combining with the data set from the landbased seismic network.
The P-wave upper mantle velocity structure was modeled with the teleseismic events observed on the KPSN and the Transantarcic Moutains Northern Network (TAMNNET) to extend the spatial coverage of the rays. The preliminary results show two separate low velocity anomalies located beneath Terra Rift and the inland area from Mt. Melbourne to the north, respectively in 100 km depth.

Fri_114_GG-1_146
1:1000 000 Geological Map of the Lambert Glacier Area (East Antarctica)

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The Lambert Glacier area (Mac.Robertson Land−Princess Elizabeth Land) including the Prydz Bay shelf has been subject of long-term multinational and multidisciplinary geological and geophysical research.
A huge amount of geological mapping work in the study area has been done and numerous papers published elsewhere, while U−Pb zircon ages were obtained for >350 samples. We present a specific zonal legend which describes the geology of map region. The tectonic grid is dominated by three pre-Cambrian provinces variously overprinted within the Cambrian orogen. Prydz Bay shelf is generally covered by Late Paleozoic to Mesozoic deposits and different stratigraphic units crop out in the sea bottom due to differentiated crustal uplift/subsidence tectonic history and recent ice-sheet erosion.
The basic map units are assigned to two categories: stratigraphic (sedimentary and volcanic including their metamorphosed counterparts) and non-stratigraphic (intrusive bodies, metamorphic or plutonic-metamorphic complexes). High-grade metamorphic and plutonic-metamorphic complexes predominate. They are shown with stripe color patterns, with separate colors indicating protolith age and metamorphic/structural age. We invent a complex format of indices which includes two age components. The first symbol stands for protolith age and the second indicates the age of the main-stage metamorphism and pervasive deformation. Thus at the same time both geological and tectonic features are indicated.

Fri_115_GG-1_150
Study of Ice-caves on Melbourne and Rittmann: Results from ICE-VOLC Project

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Thanks to the interaction between permanent thick ice layers and fumarolic hot gases, Antarctic volcanoes host very peculiar features called ice-caves. These are networks of passages melted into the base of the snowpack where geothermal heat and warm gases are supplied to the ice-rock interface. Recently, Antarctica ice caves have attracted the attention of scientists working on both geology and biology fields, since they can provide precious insights into degassing and heat release from volcanoes, as well as into organisms that thrive in physically extreme conditions inside the caves.
In the framework of the ICEVOLC project (www.icevolc-project.com) funded by the Italian PNRA, several activities focused on the investigation of ice-caves in both Melbourne and Rittmann volcanoes (Victoria Land) were carried out such as:
i) identification of pinnacles and ice-towers, chimney-like ice formations indicating the entrance of the ice-caves;
ii) identification and mapping of unexplored ice-caves on both volcanoes;
iii) sampling of gases released by fumaroles within the ice-caves to get insights into volcano dynamics and its state of health;
iv) thermal survey to investigate ice-cave microclimate and evaluate energy exchanges.

Fri_116_GG-1_162
Cenozoic Tectonic Characteristics of the Adare Basin, West Ross Sea

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Based on the geophysical data from the Adare Basin, we employed the F-K filtering method to recover the newly processed dataset with high signal noise ratio and complete seismic event which highly contributes to reveal more detailed geological structures. Combined with glaciation, the associated sedimentary facies were summarized. Our analysis revealed that, at 16 Ma, due to the thermal effect caused by residual magmatism and asymmetric spreading of Adare Basin, surrounding areas of two flanks of the Adare trough were characterized by uplift folds and tilted uplift zone, respectively. The small-scale uplift fold zone was characterized by nearly upright faults and folds and was located in the southern part of the eastern flank, whereas the tilted uplift zone dominated in the corresponding district of western flank that reached the continental margin. By utilizing the contact relationship between igneous rocks and surrounding rocks, igneous rocks can be divided into two periods: early-stage and late Cenozoic igneous rocks. The early-stage rocks are generally located dispersedly in the tilted uplift zone and the age is poorly known. It is suggested that they were related to the residual magmatism. On the other hand, the spatial distribution of Late Cenozoic igneous rocks, formed not earlier 5.5 Ma, almost covered the whole study area, which indicates that they might be affected by decompression melting of the mantle because of the large-scale deglaciation since Pliocene.

Fri_117_GG-1_193
Geochemical Analyses of Marine Sediments to Infer sub-ice Geology of Antarctica

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Drilling of the Wilkes Land margin of East Antarctica during expedition 318 was designed to provide a long-term record of the sed¬imentary archives along an inshore to offshore transect of Cenozoic Antarctic glacia¬tion. To develop an understanding of sourcing of these sedimentary archives, geochemical characterization was carried out on the sediments of site U1359 of Miocene age. The prime objectives of this study are to delineate source rock characteristics, degree of chemical weathering, sorting processes and the geochemical behaviour of sediments during transportation and deposition.

The Chemical Index of Alteration shows a variability from ~55% to 65% indicating a moderate alteration index. The chondrtite normalized, UCC and shale normalize graphs conclusively show that the sediments depict variable behaviour hence cannot be supplied from single source. The significance of grain size and its role in this particular site was also supported by the La/Th plot and ternary plot of La-Sc-Th.

The sediments source from basic, felsic and metasedimentary provenance interpreted from the heavy mineral population and mineral chemistry is also supported by various ratio plots and ternary diagram (La-Sc-Th). A continental island arc tectonic setting along with few samples from active/passive continental margin is interpreted from the geochemical behaviour of the sediments.

Fri_118_GG-1_230
Geological Mapping in the Convoy Range, Victoria Land, Antarctica

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In the austral summer 2017/18, a three person team performed geological and geological-glacial field mapping in the Convoy Range, at the scale 1/250000. Activity was heli-supported, starting from the Italian Mario Zucchelli Station, with two principal targets: 1) to complete geological mapping for the area between 76° and 76°30´ S, filling a gap existing between the GIGAMAP maps (Pertusati et al., 2016) to the north and the geological maps by GNS Science - New Zealand to the south (Gunn & Warren, 1962; Pocknall et al., 1994); 2) to collect new data (stratigraphic, structural, sedimentological, petrographic and geochronological data) to better characterize the lithotectonic units cropping out in the investigated area.
In more detail, in Antarctica the activity included:
- geological and geological-glacial field mapping.
- photogeological analyses, to support the field work;
- rock sampling.

On return from Antarctica the activity comprised:
- digitisation of the new cartographic data and their integration in the Geomap dataset;
- elaboration of structural data;
- microstructural analyses;
- minero-petrographic analyses of rocks and glacial deposits.

Gunn B.M., Warren G. - 1962 - New Zealand Geological Survey bulletin 71, 156 p.
Pertusati P.C., Ricci C.A., Tessensohn F. - 2016 - Terra Antartica Reports, 15, 1 - 15.
Pocknall D.T., Chinn T.J., Skyes R., Skinner D.N.B. - 1994 - GNS Science Geological Map 11, 36 p. + 1 map.

Fri_119_GG-1_325
High-resolution Aeromagnetic Imaging of the Lanterman Range, North Victoria Land

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The Lanterman Range covers the boundary between the Wilson Terrane and Bowers Terrane, i.e. the two western tectonometamorphic units of the Ross-orogenic basement of North Victoria Land, Antarctica. This boundary is formed by a distinct belt of highly deformed mafic and ultramafic rocks with UHP relicts. It is interpreted as the trace of a former suture zone that formed during continuous accretion at the Palaeo-Pacific active continental margin of East Gondwana in the Early Paleozoic.
We report on high-resolution magnetic anomaly data over the Lanterman Range. Preliminary results show two distinct and nearly parallel magnetic lineaments. These magnetic lineaments follow the main strike of the Wilson-Bowers terrane boundary. The western of these lineaments correlates with the boundary zone itself. The eastern lineament cannot be attributed to any exposed rocks so far, which show only rather low magnetic susceptibility values. Similar paralleling magnetic structures occur further to the southeast, where they are apparently offset by a possibly post-Jurassic WNW-ESE oriented left-lateral strike-slip zone.
We tentatively propose that the origin of the eastern lineament is due to remnants of the Palaeo-Pacific subducted slab hidden under the boundary zone of the Bowers Terrane and the easterly dominantly turbiditic Robertson Bay Terrane. The western may represent remnants of a closed back-arc basin intermittent between the Wilson and Bowers terranes.

Fri_120_GG-1_327
Geodynamic Modelling of the West Antarctic Mantle - Rift or Plume Dominated?

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The observed gravity change and GPS uplift rates beneath the Amundsen Sea Embayment in western Antarctica can only be explained by glacial isostatic adjustment (GIA) in the presence of a thin elastic lithosphere and low upper mantle viscosity. Different geological concepts exist to explain the upper mantle structure. The low viscosity might relate to a warm upper mantle, which might in turn relate to the West Antarctic Rift Zone or the previously proposed West Antarctic mantle plume.
To address which of the suggested processes is responsible for the low upper mantle viscosity, we combine a 3D lithospheric scale model with geodynamic modelling of the large-scale mantle structures underneath Antarctica. The 3D lithospheric model is established for the Antarctic continent by combing satellite gravity gradients and seismological data. The geodynamic models are calculated with the mantle convection code ASPECT, an open-source code based on finite elements. It features an adaptive mesh refinement that considerably improves the resolution at regions of interest. Our models focus on West Antarctica and explore how to reconcile a possible plume with the lithospheric structure. Another aspect that is investigated is the importance of the sublithospheric composition and temperature on the upper mantle viscosity structure.

Fri_121_GG-1_338
Axial Transport and Sources of Fluvial Gravel in Munindalen, Svalbard

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In order to study the effect of axial transport and lateral inputs on sediment characteristics in High Arctic proglacial streams we focused on the sediments of Munindalen in central Svalbard. Muninelva River is ~6 km long; its channel belt is 50-250 m wide and has a valley-train character, which changes into a braided outwash fan at the mouth. The river is dominantly pebble-cobble gravely along the entire stream with predominant sandstone and limestone clasts from two main sources according to their position in respect to the main stream: I) axial head source - Muninbreen Glacier and its terminal moraine-mound complexes; II) lateral sources - colluvial and alluvial fans, terminoglacial outwash fan from a lateral glacier and bedrock in the channel belt banks. Our results show that the axial head source is crucial for the origin of cobble fraction, whereas lateral sources contribute by large amount of pebble material and overwhelms thus the downstream trend in pebble clasts' roundness. On the contrary, the amount of cobbles transported from the lateral sources is smaller; therefore the downstream trend of cobble clasts roundness is not masked by lateral inputs. Pebbles are highly mobile both in river transport and on lateral fans; therefore lateral inputs hides the downstream roundness trend in Muninelva River sediments, which was not found for cobbles. This study emphasized the importance of material sources on sedimentary characteristics in proglacial streams.

Fri_122_GG-1_340
Structure and Extent of the Tonian Oceanic Arc Super Terrane, Dronning Maud Land

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Sør Rondane and adjacent regions in eastern Dronning Maud Land are of major interest regarding our understanding of the architecture of crustal fragments that were involved in the amalgamation and breakup history of Rodinia and Gondwana.
Approximately 40.000 line kilometre of new magnetic anomaly data were collected to the east and south of Sør Rondane with 10 km line spacing. These data are integrated with exposure information from Sør Rondane, the Belgica Mountains, and the Yamato Mountains. Main emphasis was placed on estimating the spatial extent of the recently discovered Tonian Oceanic Arc Super Terrane (TOAST), which is interpreted as early Neoproterozoic juvenile crustal additions within the East African-Antarctic Orogen (EAAO).
The FMA is interpreted as western extent of the TOAST, whereas evidence for its prolongation is provided by SE-striking parallel positive magnetic anomalies that can be correlated with ca. 1000-900 Ma juvenile rocks in Sør Rondane. New data constrain the southern and eastern minimum extent of the TOAST, which corresponds in size with ca. 500000 square kilometres to at least 5% of East Antarctica. The juvenile Tonian rocks developed outside Rodinia and represent major remnants of the Mozambique Ocean. They resemble rocks of the Arabian-Nubian shield, but are slightly older. Thus, the EAAO is characterised by major Neoproterozoic crustal additions on either ends.

Fri_123_GG-1_341
Seismicity of the Eurasian Basin Based on the Data of Polar Seismic Stations

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On the basis of the N. Laverov Federal Center for Integrated Arctic Research there is an Arkhangelsk seismic network (ASN). Some of seismic stations of the ASN were installed at the Arctic region. There are on the Franz Josef Land and Severnaya Zemlya archipelago and on the coast of the Kara Sea. Main goal is seismic monitoring of the Eurasian Basin.
Seismic information of the Arctic region is not quite complete. For the Eurasian Basin by combining seismic data bases of the NORSAR (Norway), Kola Department Geophysical Survey of RAS (Russian Federation) and ASN a General Seismic Catalog above 70°N was created for 1998-2015 for magnitude above 2.0. We compiled the map of main tectonic elements of the Eurasian Basin and applied on it the seismic information.
Results about the latest seismicity shows tectonic activation in the Arctic Basin caused by rifting, stretching lithosphere blocks and volcanic activity. Areas of the Mid-Arctic Ridge, transition continent-ocean zone and graben sides are the most seismic active regions. The weak seismicity of the Barents-Kara shelf can be explained by ultra-slow speeds of the processes occurring in the lithosphere.
Polar stations record many icequakers associated with formation of icebergs, cracking of glaciers and their movements. First results correlations of icequakers number with meteorological data were obtained, a database was created.

Fri_124_GG-1_347
ADMAP-2: The Second Generation Antarctic Crustal Magnetic Anomaly Map

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ADMAP-2 is the second generation crustal magnetic anomaly compilation for the Antarctic region south of 60°S. It was produced from more than 3.5 million line-km of airborne and marine magnetic observations collected since the International Geophysical Year 1957/58 through 2013. The data were edited, IGRF corrected, profile levelled and gridded on a polar stereographic projection at an interval of 1.5 km. Microlevelling was also performed on some of the grids from more recent detailed surveys. Data quality was maintained by statistical analysis of the crossover errors.

Given the ubiquitous polar cover of snow, ice and sea water, the magnetic anomaly compilation offers important constraints on the global tectonic processes and crustal properties of the Antarctic. It also links widely separated areas of outcrop to help unify disparate geologic studies, and provides insights on the lithospheric transition between Antarctica and adjacent oceans, as well as the geodynamic evolution of the Antarctic lithosphere in the assembly and break-up of the Gondwana, Rodinia, and Columbia supercontinents and key piercing points for reconstructing linkages between the protocontinents. The magnetic data together with ice-probing radar and gravity information greatly facilitate understanding the evolution of fundamental large-scale geological processes such as continental rifting, intraplate mountain building, subduction and terrane accretion processes, and intraplate basin formation.

Fri_125_GG-1_351
Extent of Princess Elizabeth Land Stenian Accretional Belt Based on Magnetics

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Aeromagnetic surveys over Princess Elizabeth Land have revealed extent of continuous accretional orogen characterized by low amplitude, linear NE-trending magnetic anomalies that is extremely unique relative to other regions of the East Antarctic. It can be traced from Clemence Massif to the southern margin of the Vestfold Hills crustal block and further east to 88° E. Positive anomalies associated with the predominantly orthogneiss Pickering Series (Laiba, Kudriavtsev, 2006; Mikhalsky et al., 2013) and negative anomalies with the paragneiss Manning Series. Mafic granulites from the Manning Nunataks show typical characteristics of island arc basalts; whereas felsic orthogneisses have the characteristics of volcanic arc granites (Liu et al., 2014). Geochronological data give protolith ages ranging from 1347 to 1020 Ma for these arc-related rocks, indicating a long-lived magmatic accretion in the Rayner continental arc. The most prominent Robertson anomaly is reflected by amphibolite-facies rocks only occur in Robertson Nunatak where mafic schists and subordinate orthogneiss crop out. Isotopically juvenile rocks from the Fisher Terrane and Robertson Nunatak may represent a small-scale oceanic arc extending eastward across the Lambert Rift. Two fragments of this oceanic arc, displaced for a distance of about 50-60 km along dextral strike-slip system of faults, are most likely related to Cretaceous transtensional tectonics associated with break-up of India and Antarctica.

Fri_126_GG-1_354
Vanderford-Totten Rift Structure, East Antarctica

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The new aerogeophysical data collected within the international ICECAP and IceBridge projects (Aitken et al., 2013) allowed us to distinguish spatial characteristics of the Vanderford-Totten (VT) rift over Wilkes Land in East Antarctica. Its length exceeds 400 km and width varies from 50 to 100 km. The VT Glaciers are underlain by distinctive continuous depression with depth up to 2525 m below sea level, their shoulders are extremely steep, suggesting the tectonic origin of the riftogenic structure. In accordance with the results of the local Airy isostatic Moho depth estimations, the axial part of the rift is characterized by an essential thinning of the Earth crust thickness (up to 24-27 km) and it is elevated along entire length of this structure. The potential field modeling indicates more than 3 km of sedimentary infill within the suggested rift. Additional argument for the riftogenic crust beneath the VT Glaciers is significant level of seismicity registered here, more than 30 intraplate earthquakes have occurred to date. Earthquakes magnitude varied from 3.9 to 5.8 and their sources concentrated in upper part of earth crust in a depth range of 8-10 km, although some of them were registered at 33 km depth. By analogy with intracratonic basins of southern Australia, it is suggested Permian age of the rift formation. The VT rift may inherit pre-existing tectonically weak zone between the Albany Fraser orogen's counterpart in Antarctica and the West Mawson craton.

Fri_127_GG-1_550
Toward a Seismic-based 3D Thermo-mechanical Model of the Greenland Lithosphere

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During the past 120 million years, the Greenland craton drifted over the Iceland hotspot; however, uncertainties in geodynamic modeling and a lack of geophysical evidence prevent an accurate reconstruction of the hotspot track. I image the Greenland lithosphere down to 200 km depth with seismic noise tomography. The 3D shear-wave velocity model obtained using 4-5 years of continuous records from the GLISN seismic network is well resolved for most of the Greenland main island. The crustal part of the model clearly shows different tectonic units. The hotspot track is observed as a linear high-velocity anomaly in the middle and lower crust, most probably associated with magmatic intrusions. In the upper mantle, a pronounced low-velocity anomaly below the East coast might be due to the remnant effect of the Iceland hotspot when it was at its maximum intensity. Thermo-mechanical modeling suggests that this area has higher temperature and lower viscosity than the surrounding cratonic areas and experiences a higher than average surface heat flow. This new detailed picture of the Greenland lithosphere will drive more accurate geodynamic reconstructions of tectonic plate motions and help to better understand the North Atlantic tectonic history. Models of Greenland glacial isostatic adjustment will benefit from the 3D upper mantle viscosity model, which in turn will enable more precise estimations of the Greenland ice-sheet mass balance.

Fri_128_GG-1_629
Inferring a Rift-thinned Lithosphere in Princess Elizabeth Land, Antarctica

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Geophysical surveys including radar sounding, laser altimetry, gravity, and magnetics under ICECAP-2 (International Collaborative Exploration of Central East Antarctica through Airborne geophysical Profiling) program reveal that PEL hosts an assortment of previously unidentified subglacial lakes and complex geomorphology. Presence of a 1,100 km-long system of canyons and two large lakes connecting south of the Lambert Rift to the West Ice Shelf has been confirmed.
Ice free exposures of East Antarctic Shield are available along the ~250 km long coastal fringe of East Prydz Bay. The major outcrop in the east is Archean granulite terrain of the Vestfold hills. The adjacent Rauer Group contains both Archean and Proterozoic components. Further ~70 km west, Brattstand bluff, Larsemann Hills and Bollingen Islands constitute the mid-Proterozoic block with a strong Pan African overprint. ~140 km westwards, Landing Bluff exposes the undeformed granites of Pan African age. A westward younging sequence is evident and the large time gap of >2000 Ma suggests presence of complex geological history and interleaved distinct terrains.
We propose presence of a thinned lithosphere (probably a failed rift) in sub-ice East Antarctic terrain along the detected canyon. Analog modelling related to the Lambert rift is used to demonstrate influence of pervasive mechanical anisotropy of the basement in defining orientation of this rift system and its connection to the Lambert Graben.

Fri_129_GG-1_653
Magma-poor Margin off Wilkes Land, Antarctica: Comparison with other Analogs

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The parts of eastern Indian Ocean off Wilkes Land (Antarctica) and Australia include good examples of conjugated hyperextended magma-poor margins. In this research we compare crustal characteristics of Wilkes Land continental margin with those in northern Atlantic (well-studied Newfoundland-Iberia margins) and Indian Ocean (still poorly-studied Enderby Land - Eastern India margins). According to data from the studied pairs of passive margins there are few notable differences which include 1) character and duration of crustal stretching;
1) width of rifted regions and zone of exhumed mantle (ZEM)
2) pattern of potential fields above ZEM;
3) morphology of and deformations of ZEM;
4) resolution of Moho boundary beneath ZEM by seismic data;
5) the style/regime/geometry of sea-floor spreading followed rifting and mantle exhumation;
6) crustal (tectonic) prehistory of rifting.
Revealed differences can be explained by rheological conditions of lithosphere, global plate motion, mantle convection, serpentinization process etc.

Fri_130_GG-1_689
Ammonites from the Byers Peninsula, Livingston Island, Antarctica

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During the field season in 2016, Bulgarian geological team collected ammonite fauna in the southwestern part of the Byers Peninsula, Livingston Island. The cephalopod fauna was obtained at the vicinity of the Devils Point and southern part of the President Beaches areas. The ammonites from this area have already been subject of studies, mainly by Chilean paleontologists (Tavera, 1970; Covachevich, 1976).
From the Devils Point the ammonites come from dark-grey mudstones, intercalated between coarse-grained sandstone beds. From this locality we recognize *Haplophylloceras strigile* and *Protancyloceras* sp. indet. The first one is characteristic species for the Uppermost Tithonian and/or for the base of the Berriasian (Thomson, 1979; Yin and Enay, 2004).
The sedimentary rocks cropping out in the southern part of the President Beaches are mudstone-dominated with small sand-bodies. The ammonites from this area were obtained from the coarse-grained sandstones. From this locality we identify *Spiticeras (S.) spitiensis*, *S. bilobatum*, *?Spiticeras tripartitum lovaldesensis* and *Argentiniceras lonchochense*. Based on this ammonite assemblage we assume Late Berriasian age for the sandstone beds exposed in southern part of the President Beaches area.
The biostratigraphic interpretation allowed us to consider late Tithonian-early Berriasian age for the sedimentary sequence of the Devils Point area and late Berriasian age for the sand-bodies of the President Beaches area.

Fri_131_GG-1_692
Hydrothermal Breccias from Hurd Peninsula, Livingston Island, Antarctica

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Based on field data we proposed classification of hydrothermal breccias from Hurd Peninsula. They are intruded among sedimentary rocks (medium- to coarse grained sandstones, alternating with mudstones and fine-grained sandstones).
Hydrothermal breccias are classified as magmatic hydrothermal injection breccias (Corbett and Leach, 1998). These kinds of breccias are related to hydraulic breccias and form by injection of mineralized magmatic fluids. Magmatic hydrothermal injection beccias in studied area comprise host rock fragment, set in a hydrothermal matrix, composed of quartz, carbonates and ore minerals (pyrite, chalcopyrite, galena and malachite).
These breccias are classified as rotational, mosaic (jigsaw) and fluidized breccias. Rotational breccias are characterized by substantial fragment rotation or transport in association with fluid injection. Mosaic or jigsaw breccias are distinguished by fragments which are separated, but have not undergone substantial transport. Rock fragments in these breccias may be joined back together by removal of the matrix. Fluidized breccias contain milled fragments in a transported matrix, to form dike-like bodies.
The formation of the magmatic hydrothermal breccias is an integrated element of the formation and the evolution of the magmatic hydrothermal system. They are formed by the explosive release of overpressured magmatic fluids from the fluid saturated magma.

Fri_132_GG-1_714
TRACERS Project: Tephrochronology Study of the Ross Sea, Antarctica

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Marine sediment sequences from the polar regions are crucial archives for paleoclimatic and paleoenvironmental studies. Often, they contain tephra layers produced during large explosive volcanic eruptions. The study of tephra provides significant data and constraints for volcanological reconstructions e.g. the age of eruptions, their recurrence, dynamics, as well as the spatial and temporal evolution of volcanic activity. If geochemically fingerprinted and tied to a known, dated eruption tephra layers became isochronous marker horizons that provide high-resolution time-stratigraphic information. ROSSTEPHRA project, carried out within the Italian PNRA (2010/A2.12), demonstrated that marine sediment of the Ross Sea, Antarctica, contain a number of primary tephra layers (Del Carlo et al. 2015). This project laid down the groundwork for the new multidisciplinary research project TRACERS aimed at the tephrochronology-tephrostratigraphy study of selected sediment cores sampled in Ross Sea, downwind the principal volcanic edifices. Here we present the preliminary results of TRACERS project. The projects have proven the validity of the multidisciplinary approach in polar region to contribute substantially to the improvement of the chronological framework of the area. In addition, their results contribute to gain new knowledge about eruptive history of the Antarctic volcanoes (age, frequency, intensity of eruptions, volume of the material erupted).

Fri_133_GG-1_750
Petrology of Charnockite-enderbite Algae Lake Pluton, East Antarctica

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Algae Lake Pluton is located in SW part of Banger Hills and its area is around 15 km^2. This intrusion is formed by different rock types and can be applied to anorthosite-mangerite-charnockite association. However, opx-bearing granites here are enderbites (Pl 70-50%, Afsp 10-15%, Qz 20-15%). Accordingly, rock composition varies from gabbro-diorite to monzonite and monzodiorite on QAPF diagram. Gabbroic and anorthosite-like rocks are concentrated at the edge of Pluton. Central part of Pluton is composed by enderbites. Thanks to their specific geochemistry enderbites and charnockites are essential for reconstruction of geodynamic circumstances of their formation time. Intrusion of enderbite-charnockite magma is supposed to be syn-orogenic event. Geochronology data (U-Pb, zircon) provides that intrusion event happened after the maximum of granulite metamorphism. Obtained geochemical and isotopic data (Sheraton et al., 1991; Tucker et al., 2016, 2017 and our preliminary data) reveal that studied rocks have sufficient crust influence. On tectonic diagrams (Pearce et al., 1984; Whalen et al., 1987) they are within syn-orogenic fields and A-type granites. The source of enderbite-charnockite magma is still under discussion. Data on zircon geochemistry, Sm-Nd system, geochemistry of inclusions in minerals are coming up.

Fri_134_GG-1_762
Seismic/Thermal Structures of the Crust and Uppermost Mantle Beneath Antarctica

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Since the 1990s, over 200 broadband seismic stations have been deployed across Antarctica. In this presentation, we discuss our recent efforts to build reference crustal and uppermost mantle shear velocity (Vs) and thermal models for continental Antarctica with those seismic stations. First, by combining the Rayleigh wave dispersion maps with P receiver functions, we develop a 3-D Vs model for the crust and uppermost mantle beneath central and West Antarctica to a depth of ~200 km. Second, using this 3-D seismic model to constrain the crustal structure, we re-invert for the upper mantle thermal structure using the surface wave data within a thermodynamic framework. The final product, a high-resolution thermal model together with associated uncertainty estimates from the Monte Carlo inversion, allows us to derive lithospheric thickness and surface heat flux maps for the continent. A variety of tectonic features, including a slower/hotter but highly heterogeneous West Antarctica and a much faster/colder East Antarctic craton, are present in the 3-D seismic/thermal models. Notably, a seismic signature of lithospheric foundering is observed beneath the southern TAMs, and an uppermost mantle compositional anomaly is found beneath the Gamburtsev Mountains. These features from the 3-D models help further investigate the dynamics of Antarctica's lithosphere and asthenosphere, and provide key constraints on the interaction between the solid Earth and the West Antarctic Ice Sheet.

Fri_136_GG-1_913
Middle Cambrian Slope Deposits in Northern Victoria Land, Antarctica

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Carbonate-bearing slope deposits are reported from the upper Cambrian Series 3 Spurs Formation in northern Victoria Land, Antarctica, deposited during the Ross Orogeny. The formation consists of shales interbedded with conglomerates and thin- to thick-bedded sandstone, which overlies the middle Cambrian Series 3 Glasgow Volcanics and coeval volcaniclastic Molar Formation and is overlain by the Furongian sandstone-dominated Eureka Formation. The Spurs conglomerates are composed of granule- to boulder-sized polymictic clasts of shales, sandstones and limestones. Various limestone clasts include thrombolites, dendrolites, oolitic-peloidal packstone to grainstone, and minor lime mudstone. These are collectively interpreted as downslope deposits, in which limestone clasts may have been derived from missing platform margin carbonates, analogous to Cambrian to Lower Ordovician slope successions elsewhere. On the other hand, devoid of thinly bedded lime mudstone in the Spurs slope successions is markedly different, possibly due to subdued lime muds behind the platform edge. It is suggested that the Spurs carbonate platform may have developed within narrow shelf margin area in the volcanic quiescent time until regression with clastic influx. Such small-scale carbonate platform dominated by microbial reefs and coarse-grained carbonates would hint how syn-orogenic carbonates developed in arc-related sedimentary basins along the pacific margin of Gondwana.

Fri_137_GG-1_967
Historic Hydrovolcanism at Deception Island (Antarctica): Hazards Implication

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Deception Island (DI), the southernmost island of the South Shetlands Archipelago (Antarctica), is characterised by a Quaternary caldera system and a post-caldera succession due to a dispersed (monogenetic), volcanic field. Volcanic activity since the 18th century involved monogenetic small volume eruptions such as scoria cones and hydrovolcanic edifices with estimated VEI magnitude of 2-3. The latest volcanic unrest episodes in the 20th and 21st centuries, demonstrates that the volcanic system is still active and that future eruptions are likely.
Magma-water interaction represents a major issue on DI as shown by the 1967, 1969 and 1970 explosive episodes, where the scientific stations on the island were destroyed, or severely damaged. Nowadays, DI is an important touristic destination during the austral summer hosting two temporary military bases as well.
A detailed revision of the historical hydrovolcanic post-caldera eruptions of DI was carried out, to understand the dynamics of magma-water interaction, and to characterise the most likely eruptive scenarios from future eruptions. Crimson Hill (estimated age 1825-1829), Kroner Lake (estimated age 1829-1912) eruptions and 1967, 1969 and 1970 events were characterised by describing the eruption mechanisms related to the island's hydrovolcanic activity.
The project was partially funded by the POSVOLDEC project (CTM2016-79617-P)(AEI/FEDER-UE). D.P. is grateful for his Beatriu de Pinós contract (2016 BP 00086).

Fri_138_GG-1_969
Peculiarities of Ultramafic Alkaline Magmatism in the Lambert Rift Area

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This research is focused on the study of Mesozoic ultramafic alkaline rocks developed in the north-western flank of Lambert Rift in East Antarctica. The rocks are represented by high- and low-magnesian associations which are akin by lithophils and Nd-Pb ratio. High-magnesian association was resulted from melting of metasomatized continental mantle at T~1270^o and at depths ~130-140 km. Increased Ni/Co ratios in magmatic rocks are close to mantle values and demonstrate the mantle source of magma. Analysis of olivine grains in rock samples shows that liquidus high-magnesian olivines (Fo_{90-91}) from lavas are similar to those of mantle inclusion. The mantle is distinguished by presence of carbonate, minerals of biotite-phlogopite group and volatiles. The ultramafic alkaline magmatism is associated with the melting of the ancient metamorphosed mantle, which is similar with the mantle of the southern Kerguelen Plateau. The plume thermal effect on the continental blocks margins of India and East Antarctica 117-110 Ma led to the melting of the deep parts of mantle enriched with volatile components.

Fri_139_GG-1_975
Lateral Variations of Seismic Anisotropy in Grove Mountains

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We estimate the azimuthal anisotropy in the upper mantle of the Grove Mountains, East Antarctica. The shear-wave splitting technique has been applied to the teleseismic data recorded from the 3-component seismic stations in that region, which were deployed by the Institute of Tibetan Plateau Research (ITPCAS). The patterns of the azimuthal anisotropy, for the stations a little far from the Lambert rift, show that the fast S-wave orientation is nearly parallel to the Lambert rift and their amplitudes are relatively small. However, the orientations and amplitudes of the shear-wave splitting are much more complicated in and around the Lambert rift. The formation of anisotropy beneath the stations away from the rift is possibly related to the breakup of Gondwana, and we attribute the complex results near the Lambert rift to the existence of ancient lithospheric mantle.

Fri_140_GG-1_1013
Crustal Structures and Heat Flux from Curie Depth Estimates in West Antarctica

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The West Antarctic Rift System is one of the least understood rift systems on earth, but displays a unique coupled relationship between tectonic processes and ice sheet dynamics. Geothermal heat flux (GHF) is a poorly constrained parameter in Antarctica and suspected to affect basal conditions of ice sheets, i.e., basal melting and subglacial hydrology. Thermomechanical models demonstrate the influential boundary condition of geothermal heat flux for (paleo) ice sheet stability. Young, continental rift systems are regions with significantly elevated geothermal heat flux (GHF), because the transient thermal perturbation to the lithosphere caused by rifting requires ~100 Ma to reach long-term thermal equilibrium. We discuss airborne, high-resolution magnetic anomaly data from the Amundsen Sea Sector, to provide additional insight into deeper crustal structures related to the West Antarctic Rift System in the Amundsen/Bellingshausen sector. With the depth-to-the-bottom of the magnetic source (DBMS) estimates we reveal spatial changes at the bottom of the igneous crust and the thickness of the magnetic layer, which can be further incorporated into tectonic interpretations.

Fri_141_GG-1_1133
Precambrian Crustal Architecture in the Gamburtsev Province of East Antarctica

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The Gamburtsev Subglacial Mountains are underlain by 50-60 km thick crust and over 200 km thick lithosphere formed during the assembly of a mosaic of distinct geophysical provinces that make up interior East Antarctica. Enhanced magnetic and gravity images, depth to magnetic and gravity sources and 2D models help unveil the crustal architecture of the Gamburtsev Province (GP). Potential field imaging enables us to trace major fault systems that segment the GP into the Northern, Central and Southern domains. Apparent offsets within the Central Domain are interpreted as revealing a transpressional fault system parallel to the previously proposed Gamburtsev Suture. Magnetic and gravity modelling, combined with independent sediment provenance constraints, are interpreted here as revealing arc and back arc terranes of inferred Grenvillian age (1.3-1.0 Ga) in the Northern and Central domains of the GP. Anomalously dense lower crust beneath these domains may reflect widespread magmatic underplating. Distinct magnetic anomalies correspond to older Paleoproterozoic crust of the Lambert Terrane, north of the Gamburtsev Suture. The Southern Domain may represent an extension of the South Pole Province, an inferred Mesoproterozoic (1.6-1.4 Ga?) igneous province.
The Precambrian crustal architecture of the GP is remarkably well-preserved, in spite of proposed reactivation of interior East Antarctica during Pan-African age collision responsible for final Gondwana assembly.

Fri_142_GG-1_1415
Stratigraphy of the Basal Beacon Supergroup, Northern Victoria Land, Antarctica

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Regional reconnaissance field works and reviewing previous works on the sedimentary strata of the Beacon Supergroup (BS) in northern Victoria Land (NVL) have showed a new perspective of the initial post-Ross sedimentation in NVL. BS in NVL formed on top of an unconformity developed on the basement of the early Paleozoic in age and the upper boundary of the supergroup is mostly demarcated by Ferrar Dolerite intrusion or Kirkpatrick Basalt, Jurassic in age. The late Paleozoic glacial deposits herald initiation of post-Ross sedimentation; Permian Takrouna (TF), Triassic-Jurassic Section Peak, and Jurassic Shafer Peak formations follow. An outcrop section showing transitional change from the basal glacial deposit into the TF occurs in the Lanterman Range, northern part of NVL. Morozumi Range and Helliwell Hills, west of the Lanterman Range, expose the TF which needs to be tested for the geological age based on new plant fossils. BS at the southern part of the Freyberg Mountains in the north of the Evans Névé, is characterized by basal glacial tillite and overlying TF. Low-relief hills in the west of the Mesa Range expose thin BS on the basement. The Section Peak and Shafer Peak formations near Priestly Glacier occur on topographic highs, directly overlying the unconformity with thin discontinuous diamictite of unknown origin. Difference in the lithology and probable age of the basal part of the BS in NVL might be resulted from tectonically controlled geometry of the basin.

Fri_143_GG-1_1630
Someting about "CROSS" Program

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CROSS Program, a detection and research project, will complete the "CROSS" formed transects which cross the South Pole through the Antarctic continent to take comprehensive detection research, which will be lasted by 10 to 15 years. Along the perpendicular two transects such scientific surveys as geology, geophysics, geochemistry, ecology, environment and the atmosphere will be carried out, and the structure and geodynamic processes of the crust, mantle and the core of Antarctic will be revealed systematically and comprehensively. Such problems of the global level as splitting of the Gondwana land, the evolution of Tethys tectonic domain, the hyperplasia of Eurasia continent, the drive mechanism of plates and the asymmetric structure between northern and southern hemispheres will be discussed. This program will study the resources, environment, ecological and atmospheric processes of the Antarctic and its impact on global climate change; this program will also study the genetic relationship between the South Pole and the third pole (Tibetan Plateau), and establish the northern boundary of Gondwana continent, and develop the theoretical system of earth science in the Antarctic continent. At the beginning of the Program, we have installed 30 seismic stations in the eastern part of the Antarctic and the first-term (two years) seismic data have been obtained. By data processing and interpretation, some results have been obtained.

Fri_144_GG-1_1689
Synsedimentary Deformation in the Permian Takrouna Fm (North Victoria Land)

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We report on synsedimentary deformation structures in upper Permian deposits of the Takrouna Formation (Beacon Supergroup) exposed at an unnamed spur east of Mt Remington north of Boggs Valley, central Rennick Glacier area, North Victoria Land. In the lower part of this section, the formation consists of fluvio-lacustrine successions of pebbly sandstone, climbing-ripple-laminated sand- and siltstone, and carbonaceous silt- and mudstone rich in plant debris (*Glossopteris* leaves and *Vertebraria* roots). Sand- and siltstone beds in particular are characterized by prominent synsedimentary brittle-ductile deformation structures at the outcrop scale, e.g., sedimentary dikes, thrust, growth microfaults, shear folds, normal faults, laminated convolute beds, and intense slumping. This succession is overlain by about 10 m of barren sand- and siltstone deposits that lack such evidence for synsedimentary deformation, and are instead folded and tilted by post-sedimentary deformations. Our synsedimentary tectonic structures may testify to an active tectonism during the late Permian in northern Victoria Land and give constraints for the changes in paleoclimatic and tectonic conditions of Gondwana during late Paleozoic-Mesozoic transition.

Fri_145_GG-1_1697
Fault-controlled Ancient Hydrothermal Systems in North Victoria Land, Antarctica

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Northern Victoria Land (NVL) at the Pacific end of the Transantarctic Mountains is a key region for understanding the geodynamics of East Antarctica and provides a window to its crustal architecture. The structural frame of NVL derives from polyphase tectonics and is mainly characterised by NW-SE striking lineaments, which transect the NVL crust and the Cenozoic rift basins of the Ross Sea and which are responsible for the reactivation of inherited Paleozoic - Mesozoic discontinuities.
We present preliminary data on regional scale metasomatic and hydrothermal alterations linked to different exhumed fault systems in NVL. Main hydrothermal alterations are: (i) Mg-Ca- carbonation and silicification of mafic and ultramafic rocks along faults and brittle-ductile shear zones at the boundary between the Wilson and Bowers terranes; (ii) Mg-Ca-Fe carbonation of metavolcanic rocks accompanied by syntectonic carbonate coatings on fault planes, hydraulic brecciation, and quartz-carbonate veining in the Bowers Terrane and at the Bowers-Robertson Bay terranes boundary; (iii) epidote and chlorite indurated gouge and cataclasite in fault cores in granitoid rocks and epidotization of metabasalt in the Lanterman Range and in the Bowers Terrane and in Ferrar Dolerite.
We discuss the fluid-rock interaction during faulting and the relevance of these hydrothermal systems in reconstructing the tectonic history of this sector of the Transantartic Mountains.

Fri_146_GG-1_1701
Study of a Syntectonic Au-transporting Fluid in North Victoria Land (Antarctica)

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We constrain the physical-chemical properties of a hydrothermal fluid linked to the Dorn Glacier shear zone (Crispini et al., 2011) that crosscuts the metabasalts and metasandstone of Sledger Group (Bowers Terrane, North Victoria Land, Antarctica). Fluid constraints derive from the analysis of syntectonic quartz vein and provided by a combination of LA-ICP-TOFMS of fluid inclusions, microthermometric determinations, spindle stage measurements of fluid inclusions, and panchromatic cathodoluminescence imaging of quartz.
The geological framework for these veins is: close occurrence to regional tectonic lineaments; location within a greenschist to low-greenschist metamorphic sequence; mineralogic assemblage made mostly by quartz and carbonates, and low modal abundance of sulphides; carbonate-sericite-albite-sulphide hydrothermal alteration well developed adjacent to the vein and postdating the regional metamorphism. Moreover there is a poorly developed mineral and metal zoning within the veins and is gold mineralized. Our dataset provides informations on the composition and origin of the vein fluid, which formed massive and euhedral quartz crystals. Assuming P correction of 100-200 MPa, entrapment of massive vein fluid is estimated at 330-400 °C and at 260-320 °C for druse fluid. The very high Sb concentrations in vein fluid could be explained by fractionation of Sb into vapour phase of an orogenic fluid.
Crispini L. et al. 2011. Gondwana Res., 19, 128-140.

Fri_148_GG-1_1791
New Permian-Jurassic Deposits in the Far North of Victoria Land, East Antarctica

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The geology of the Transantarctic Basin in the far north of Victoria Land is still poorly known. Joint Korean-Italian-German field work in the central Rennick Glacier area during the 2015-2016 season has yielded exciting new results. Based on lithology and fossil content, we recognize four distinct terrestrial sedimentary units in the area; in ascending order,
(1) the Permian Takrouna Formation (thickness ~300 m) with common glossopterid remains;
(2) a previously unknown unit (thickness 75+ m) mainly of reddish-weathering, commonly tabular-cross-bedded pebbly sandstone with intercalated siltstone and palaeosols, barren of body fossils but rich in trace fossils;
(3) another previously unknown unit (thickness 250+ m) of olive-weathering fine-grained sandstone and thick overbank mudstone with palaeosols and thin coal seams, containing abundant silicified wood (*Kykloxylon*, *Agathoxylon*), silicified peat, and plant compressions (e.g., *Heidiphyllum*, *Lepacyclotes*) indicating a Triassic age; and
(4) about 15 m of mainly conglomeratic trough-cross-bedded, medium- to coarse-grained quartzose sandstone similar to the Section Peak Formation (Rhaetian to Early Jurassic) further south. Our results reveal a much more complete Permian to Jurassic basin fill in that area than was previously thought; on-going palynological analyses should help clarify the precise stratigraphic relationships to better-known sections elsewhere in the Transantarctic Mountains and in Tasmania.

Fri_149_GG-1_1830
Satellite Gravity Gradient Imaging of the Antarctic Lithosphere

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Satellite gravity gradient data from GOCE provide a new tool to investigate the structure and geodynamic evolution of the Antarctic lithosphere. Here we analyse satellite gravity gradient images and superimpose them on a new estimate of crustal thickness derived from inversion of satellite gravity data, combined with independent seismic estimates. The gradient data clearly image the thinner crust and lithosphere beneath the Cretaceous to Cenozoic West Antarctic Rift System and the Jurassic Weddell Sea Rift System with respect to the thicker Precambrian lithosphere of East Antarctica. Within East Antarctica, the satellite gravity data provide significantly more detail than seen in current passive seismic imaging, including new views into the extent of the Archean to Mesoproterozoic Terre Adelie Craton and the adjacent crust and lithosphere beneath the Wilkes and Aurora subglacial basins.
Thick crust underlies the Transantarctic Mountains, the Terre Adelie Craton, the Gamburtsev Subglacial Mountains and also Eastern Dronning Maud Land, in particular beneath the recently proposed Tonian Oceanic Arc Superterrane sector.
One of the most prominent lithospheric-scale features recognised from satellite gravity gradient data is the Trans East Antarctic Shear Zone, which separates the Gamburtsev Province from the Tonian Oceanic Arc Superterrane. We propose that it represents a major previously unknown Pan-African age suture and/or shear zone related to Gondwana assembly.

Fri_151_GG-1_1933
Crustal Deformation Derived from GPS Measurement Data around Lützow-Holmbukta

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With objective to monitor crustal deformation due to Glacial Isostatic Adjustment (GIA), Japanese Antarctic Research Expedition (JARE) have conducted campaign GPS measurements at nine sites on the outcrop rocks around the Lützow-Holmbukta and in the Riiser-Larsen Mountains areas, Dronning Maud Land (DML), East Antarctica for a maximum of eighteen years.
In this study, we analyzed the data observed at seven sites, Tottsuki Misaki, Langhovde, Skarvsnes, Skallen, Rundvågshetta, Padda and Syowa Station during 2004-2017, with precise point positioning (PPP) procedure. Consequently, subsidence in the range of 2 to 4 mm/year are found at six sites.
We consider that the subsidence is caused by recent increase of surface ice mass loading on DML.

Fri_152_GG-1_1993
U-Pb Zircon Age Constraints from Prydz Bay Evidence of Late Neoproterozoic Basin

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Prydz Bay area rock broadly classified into basement Sostrene Orthogneiss and overlying metasediments Brattstrand Paragneiss. These rocks bear evidence of two granulite facies, Late Mesoproterozoic-Early Neoproterozoic and Late Neoproterozoic-Early Cambrian. These two granulite events have been likened to collisional tectonics related to Rodinia and Gondwana. The rocks of Prydz bay holds the key towards Rodinia vs Gondwana. New U-Pb Zircon ages (LAICPMS Multicollector) supports presence of a Late Neoproterozoic basin. Samples were from Storness, Wilcock and from Mcleaod Island. Analysis shows large concordant cluster around 810Ma. Considering the array of ages it is opined that the maximum depositional age of this rock is around 550Ma or younger. The bedded sillimanite schist rock from Wilcock is also a part of Brattstrand Paragneiss. A large concordant cluster of zircon from the samples is around 1.1Ga and some prominent smaller clusters are around **550**-2550Ma. It is opined that the maximum depositional age of this rock is around 550Ma. Zircons from the meta-arkosic rock rock show a large concordant cluster around **550Ma**. This rock is interpreted to be a tuffite and signifies the age of deposition of the basin. The work indicates at least parts Brattstrand Paragneiss in the Stornes Island and in the northern part of McLeod Island formed during 550 Ma. Thus, Pan-African suturing in the Prydz Bay area is thus supported even though its orientation and extent remains conjectural.

Fri_153_GG-1_2023
Magmatism and Paleomagnetism of the Quaternary Volcanism in Bransfield Strait

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The Quaternary volcanism in the Bransfield Basin, northern Antarctic Peninsula region is related to the extension of the back-arc basin and the former Phoenix Plate subduction and roll-back under the South Shetlands Block, combined with the eastward motion of the Scotia Plate along the South Scotia Ridge. The main and more active volcanic edifices are located parallel to the NE-SW basin axe in blocks differentiated by NW-SE strike-slip faults. This work shows new results of recent petrologic, mineralogic, geochemical and paleomagnetic studies in the three most relevant Quaternary volcanic edifices in the region: Deception, Penguin and Bridgeman islands. The evolution of the magma and the paleomagnetic and magnetic fabric signals of these volcanoes are interpreted in the framework of the tectonic and geodynamic evolution of the Bransfield Strait region. Different episodes in the evolution of the mentioned volcanoes are pointed out, including the caldera formation in Deception Island. Signatures related to the magma source, depth of crystallization and crustal influence have been identified, showing differences between the main units in the case of Deception Island.

Fri_154_GG-1_2121
Rittmann Volcano, Northern Victoria Land, a Source of Englacial Tephra

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Northern Victoria Land (NVL) is the home to the “active” volcanoes: The Pleiades, Mt Melbourne and Rittmann volcano. All 3 volcanoes have evidence of recent activity which have deposited tephra in ice cores, blue ice/snow areas and as surficial tephra layers. Although there is a significant area of geothermal activity at Rittmann until now there has been no evidence of any recent eruptive activity. We propose that a tephra layer erupted in 1254 CE and found in ice cores from East and West Antarctica was erupted from Rittmann. We report a new occurrence of the tephra in an ice core from the Styx Glacier in NVL. Ignimbrite samples formed by explosive pyroclastic eruptions from Rittmann have glassy fiamme and electron microprobe analyses of the fiamme have trachytic and phonolitic compositions. Some of the fiamme are identical in composition to glass tephra shards from the 1254 tephra and suggest Rittmann was the source of the eruption. The 1254 tephra is found over 2000 km from Rittmann and is the most significant tephrochronological marker in Antarctic ice cores. The eruption of the 1254 tephra is the largest known of any Quaternary volcano in Antarctica and probably resulted in the formation of the current 2 km wide caldera which defines Rittmann volcano. This new discovery and the occurrence of numerous Holocene eruptions from Melbourne volcano show that there is a significant volcanic hazard from these volcanoes especially to aircraft operations.

Fri_155_GG-1_2149
The Canyon and Isostatic State in PEL

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Princess Elizabeth Land in East Antarctic has only several ice radar profiles currently. The aerogeophysical exploration project team of CHINARE 32 carries out the aerogeophysical survey by Chinese snow eagle 601 fixed-wing aircraft in PEL. To maximize the accurate ice/rock interface conditions, the result of two-dimensional gravity interface inversion under radar constraints reveals the formation of the canyon in the study area. It proved a big canyon under the ice sheet of PEL, quantitative characterization of the canyon features and analysis the detailed structure. The isostatic gravity anomaly is closely related to the vertical gravity balance compensation movement of the crustal, and the stability of the regional crust can be understood through the isostatic state. PEL is widely distributed in subglacial mountains, which is up to 3000km above sea level. With the area's huge overlying ice sheet, the isostatic state of the crust has a great impact. We calculated the isostatic gravity anomaly of PEL by the Erie isostatic model and analyzed the crustal isostatic state of this area, the result shows that the region is negative isostatic anomalies, the southern inland negative anomalies are very large, which is most likely due to the ablation of ice sheet produced a strong imbalance force, to promote the crust rising and thicken to supplement the ice loss.

Fri_156_GG-1_2153
The Snow Eagle 601 Scientific Briefing and Preliminary Subglacial Lake Result

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The aero-geophysical survey over Princess Elizabeth Land (PEL) was carried out during the Chinese 32th and 33th National Antarctic Research Expedition based on Chinese first fixed-wing aircraft "Snow Eagle 601", one purpose of the studies is to reveal the ice sheet processes and glacial history. The platform of "Snow Eagle 601"was equipped with advanced deep ice penetrating radar system (HiCARs radar), it has the advantages of strong ice-penetrating ability, high resolution and rich data information, based on electromagnetic theory and radio-echo sounding technique, will allow studies of internal structure of ice sheet, subglacial environments, as well as ice-sheet dynamics and evolution; The intent of GT -2A airborne gravimeter is also to study the characteristics of the ice sheet, and the geological structure of the earth under the ice sheet. Preliminary findings was on the basis of the data of 29 aerogeophysical lines proved the geophysical characteristics of the ice sheet and bedrock under the PEL. Through the three-dimensional gravity interface inversion method under radar constraints, we invert the subglacial lake and obtain its structural characteristics. The results show that this lake is only part of the narrow subglacial lake, and it is likely to become the second large subglacial lake in Antarctica, which is just after the largest one - Lake Vostok.

Fri_157_GG-1_2210
Constraints on the Evolution of the Marie Byrd Land Dome Topography

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The elevated subglacial topography underlying the Marie Byrd Land dome likely has played a crucial role in the inception and evolution of the West Antarctic ice sheet through time. The Marie Byrd Land ice dome hosts a number of subaerial Miocene to recent propagating volcanic chains, but the crust underlying these volcanoes was poorly understood. The volcanic centers, a nearby abundance of high amplitude magnetic centers, and occasional exposures of a ~23 Ma elevated erosion surface have been used to argue for a distinct Cenozoic hotspot underlying this region and lifting topography over time. Other interpretations include that this region represents the collapsed remnant of an ancestral West Antarctic orogeny, or represents a broad region uplifted by subduction driven mantle flow.
In this presentation we review
1) constraints on the **the** evolution of the Marie Byrd Land Dome from subglacial geomorphology;
2) present the results of airborne gravity for the compensation and rigidity of the MBL crust; and
3) integrate these results with observations of basal melt and additional potential fields data.

Fri_158_GG-1_2219
Eoarchean Crust and 2.7/2.5Ga Orogens in Labrador and East Antarctica - A Link?

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The record of continent formation in the first half of the Earth's history is obscured by the advent of plate tectonic processes that repeatedly ruptured and reassembled Archean crust into new continents. By the end of the Archean Eon, 2.5 billion years ago (Ga), such processes were already in operation, and continents worldwide contain late Archean orogens produced by the collision of older crustal remnants. The Nain Province of coastal Labrador, on the western margin of the North Atlantic Craton (NAC), was assembled from early Archean and mid-Archean components around 2.7Ga, as indicated by widespread high-T metamorphism and ductile deformation (Kusiak et al., 2018, Chem. Geol.). New evidence from dating of zircon and monazite in high-T metamorphic assemblages and in ductile-deformed granitoids indicate widespread orogenic re-working of the margin of the NAC at ca. 2.5Ga. Similar orogenic ages, recently identified in the conjugate part of the NAC on the western Greenland coast, also indicate dual timing in the late Archean assembly of the craton. Dual metamorphism associated with orogenesis in the late Archean is also known from the Napier Complex of East Antarctica, which also contains early Archean crust (Kelly & Harley, 2005, Contrib. Min. Pet.). These similarities increase the likelihood that both polar terranes were components of a lost supercontinent, which also may have included the North China Craton and the Yilgarn Craton of Western Australia.

Fri_159_GG-1_2299
One Period Magma Intrusion or More of Landing Bluff Adamellite

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Landing Bluff Adamellite was common considered as one magma intrusion happened at ca. 500Ma based on the results of granites from Landing Bluff (Tingey, 1981; Sheraton & Black,1988). Sansom Island located in Sandefjord Bay, one of marginal gulf of Prydz Bay, east Antarctica and are composed of two kinds of undeformed biotite granites, which is part of Landing Bluff Adamellite. these granites were firstly conducted the Ion-microprobe U-Pb zircon dating. The zircons of two samples yield two SHRIMP zircon U-Pb concordant ages of 516±5 Ma and 496.5±4.7 Ma, respectively. The results indicate that these granites emplaced at two pulses in Cambrian, and further demonstrated the Pan-African event overprinted this area. These ages reveals that Landing Bluff Granite has the complex magmatism.
The research was funded by the National Natural Science Foundation of China (No. 41530209) and the Chinese Polar Environment Comprehensive investigation & Assessment Programmes (CHINARE2015-02-5; CHINARE2017-04-3).

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Fri_160_GG-1_2387
Precambrian Evolution of the Ruker Granite-greenstone Terrane of East Antarctica

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The area under study belongs to the Ruker granite-greenstone Terrane of the Archaean stabilization. The studied mountain massifs of Rymill and Bloomfield are located in the southern part of the Prince Charles Mountains, in the northern part of the archean Ruker Terrane in the area of its connection with the Reiner province. In the course of isotope-geochronological studies, new data were obtained on the age of protoliths of the ortho- and para-rocks. The zircons of samples of orthogneisses of the Mawson series and of the primary sedimentary rocks of the Menzies series were studied. The southern part of the Mt Rymill is composed of Mesoarchean orthogneisses of the Mawson series whose age of crystallization of magmatic protolith is 3164.2 ± 9.2 Ma and 3163.2 ± 7.8 Ma. The maximum time of deposition of the sedimentary protolith of the Menzies series is estimated at 3.1-3.0 Ga. The rocks of the series form a folded, granite-gneissic, domed structure. A significant degree of recrystallization most ancient rocks of the Mawson series is associated with high-grade metamorphism, whose time is compared with the formation of Meso-Neoarchean granite gneisses with an age of about 2800 Ma. The distribution of the values of the age of detrital zircon in metasedimentary rocks makes it possible to consider the Mawson series as the foundation for the primary sedimentary rocks of the Menzies series, the formation of which is associated with the rifting of the Paleoarchean continental crust.

Fri_161_GG-1_2421
Brief Introduction of Natural Earthquake Observation in the East Antarctica

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During the 30th Chinese Antarctic scientific expedition, the Grove Mountains earthquake investigation project completed 10 seismic stations set-up, 5 stations in the Grove Mountains and 5 stations around the Zhongshan Station. The installation of the station has been carefully researched, and the station is powered by 200w solar panels and 6 100ah Gel batteries. The seismometer and recorder were installed in a special Heat insulation box and heated by 4 pieces 3w silica gel heating plate, heated for 30 minutes every 4 hours. After two years of field observation, a total of 48GB of seismic data has been obtained, which achieves the desired observation effect. Especially in the Grove Mountains during the polar night and under low temperature conditions, we obtained 19GB data for the first time. The temperature in the Grove Mountains is as low as 60 degree Celsius below Zero, and under such conditions our seismic instruments record data continuously for up to 572 days, which provided valuable experience for future improvement earthquake observation.
The distribution of seismic stations are located in Pu Liz orogenic belt and extending southward in the Grove Mountains. We can get preliminary crustal structure characteristics for the tectonic evolution of this region, by analyzing the recorded seismic data from stations using anisotropy and receiver function method.
Keywords: East Antarctica; Earthquake observation; Seismic data; Crustal structure

Fri_162_GG-1_2478
The Franklin Ocean - Evidence for Oceanic Crust in Northern Ellesmere Island?

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The origin and emplacement of the Precambrian/early Palaeozoic Pearya terrane, northern Ellesmere Island, Canada, is still a matter of debate. A suture zone between Pearya and the passive margin of the Franklinian basin is assumed within the Petersen Bay Fault Zone [1]. Within this fault zone, amphibolitic rocks of the Kulutingwak Formation crop out, for which some authors [2, 3] assume an island-arc affinity. During the CASE19 expedition in 2017, amphibolite and metasedimentary rocks of the Kulutingwak Formation were collected within the Petersen Bay Fault Zone west of Kulutingwak Fiord. Preliminary data of selected samples show that the volcanic rocks can be classified as subalkaline andesitic basalt to andesite with tholeiitic to calc-alkaline geochemical signature. Both, amphibolite and metasedimentary rocks indicate an island-arc setting. These first geochemical results in combination with a 450-Ma zircon U-Pb age for the amphibolitic rocks [2] might be an indicator for the existence of an oceanic island arc during Ordovician times and, therefore, an oceanic basin between Pearya and the passive margin of Laurentia, which might be represented by the Kulutingwak Formation. However, further investigation is necessary to constrain these preliminary results and to consider a new assignment of the Kulutingwak Formation.

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[3] Beranek et al. (2015) J Geol Soc London 172:201-212.

Fri_163_GG-1_2537
Neotectonic Deformation in the Southwestern Ross Sea

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Seismic mapping combined with revised age constraints document the structural evolution of the Terror Rift and superposed Erebus flexural basin in the southwestern Ross Sea. Terror Rift fault-related subsidence was underway in the early Miocene (by at least 18 Ma) and syntectonic stratal growth signatures show that most extension occurred between ~15-5 Ma, but faulting continued through the Pliocene. Ubiquitous normal-sense fault displacement, the strong case for rollover origin of regional folds within the rift, and the absence of flower structures, all support an orthogonal rift model with regional extension in the ENE-WSW direction. Total extensional strain is on the order of < 10%. The eastern margin of Terror Rift is defined by a zone of west-dipping faults projecting to depth with a listric ramp-flat geometry. This border fault zone projects beneath Ross Island and the Erebus Basin formed by flexural loading by Plio-Pleistocene volcanoes. Seismic mapping within western Erebus Basin shows evidence of two discrete sub-basins formed by Mt. Bird loading since 3.8-4.6 Ma and Mt. Erebus loading since ~1.31 Ma. A 3D thin elastic plate model, using the dip angle of seismically mapped reflector surfaces as constraints, simulates flexural basin evolution with a best fit lithospheric effective elastic thickness of 4-5 km.

Fri_164_GG-1_2548
Terminal Deformation and Granitoid Ages of the Kuunga Orogeny, WDML. Antarctica

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Two widely distributed granitic vein types are seen in Sverdrupfjella, W. Dronning Maud Land (WDML), Antarctica. The younger generation (P2) comprise 2-mica granites and pink 2 feldspar pegmatites. The older (P1) generation comprises white biotite plagioclase rich pegmatites.
The P2 veins dip mostly shallowly (~45-50^{o}) to N and NW and displace the older veins along planes with extensional and compressional top to the south geometries. In contrast, the older P1´s dip mostly ~60^{o} toward the S and SW with no displacements. Similarly oriented local shears show normal displacements to the S and SW. The structures are consistent with late extension toward the S and SW followed by top to the S and SE compression.
SHRIMP zircon ages on the P1´s yield ages of ~520Ma whereas data from the P2´s yield ages of ~490Ma. Radiogenic Sr and Nd data from the two types indicate relatively juvenile sources for the P1´s, in contrast to the P1 granites which were sourced in older crust, similar to Mesoproterozoic TTG gneisses in W Sverdrupfjella. Radiogenic Sr/Nd data from basement gneisses hosting the veins in E and W Sverdrupfjella show differences with W Sverdrupfjella characterised by older evolved crust in contrast to the juvenile basement rocks in E. Sverdrupfjella. The two areas are separated by major thrust faulting coincidant with strong magnetic anomalies.
The data are inferred to reflect the emplacement of a Kuunga Orogeny mega nappe complex with top to the S geometry.

Fri_165_ME-2_30
Arctic Explorers in Their Own Words: Interviews, Mental Health and Cognition

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Palinkas (1990) notes that research into humans in isolated and confined conditions has more frequently taken place in Antarctica, which Suedfeld (1991) explains by the fact that Arctic teams are somewhat more accessible and thus easier to evacuate. This is true but neglects an essential characteristic of Arctic team safety: polar bears. Bears pose a significant threat to human survival in Arctic regions; this means that Arctic teams have to handle large-calibre fire arms on a regular basis (Norwegian Polar Institute, 2005). Levesque (1991, p. 16) describes that an Antarctic team spent some of their wintering time plotting an unpopular crew member's death. In the Arctic, such behaviour would be even more worrying than in this Antarctic team because the means to murder are ever-present. My research investigates the eleven members of the 38th expedition to the isolated Polish Polar Station, Hornsund, Svalbard (77° N). This study illuminates their lives via mental health questionnaires, cognitive testing as well as interviews. Each participant was interviewed before, during and after polar night. The interviews are a unique approach to understanding how isolated teams feel and why they feel this way. My results show what makes individuals feel poorly or well, and also what makes a good polar explorer in the eyes of other polar explorers. Conclusions about preparation and selection techniques are possible.

Fri_166_ME-2_31
Psychiatric Survival in Arctic Isolation: A Case Study using EFT

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Historical reports of different psychiatric afflictions during polar night have always been common, for example Sidney Buddington from the Arctic Polaris expedition (1871) or Sidney Jeffryes from Mawson's Australasian Antarctic Expedition (1911-1914). Through the past six decades, research has indicated that there are individuals who have required medical evacuations on psychiatric grounds from Antarctica (e.g. Pattarini et al., 2016). During my research with the 38th expedition to the Polish Polar Station, Hornsund, Svalbard (77° N), a participant - Albert - developed severe psychiatric complications in the polar night which eventually resulted in his evacuation. Albert has allowed me to present his case study. The quantitative results will show how his mental health differs from the rest of his team at the station but also from an age-/gender-matched control group in a normal environment (Symptom Checklist-90-Revised and the Profile of Mood States). Albert's interviews from before and during the polar night illuminate his personal experience. Most important however, is the successful application of Emotional Freedom Techniques (EFT) in order to alleviate Albert's depression, anxiety and suicidal ideation. EFT helped Albert feel better and should be considered as a preventative technique that can be taught to isolated teams pre-deployment to avoid psychiatric afflictions and possibly, evacuation.

Fri_167_ME-2_112
Disease and Injury Statistics of Japanese Antarctic Research Expedition

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In observation activities in the Antarctic region, evaluation of the injury and disease trends in party members during wintering is indispensable to advance the medical system and research.
A total of 4,233 injury or disease cases in the 1st -39th Japanese Antarctic Research Expeditions were analyzed and reported in Nankyoku Shiryo (Antarctic Record) (2000).
We obtained disease and injury statistics based on the wintering reports by the 40th-56th wintering party members who performed activities from February 1999 to January 2016.
Among a total of 578 members (27 females), 2,604 disease or injury cases (4.5 per member) were observed. The 2,604 cases included cases in the Surgical and Orthopedic (45.1%), Internal Medicine (19.9%), Dermatological (10.2%), Dental (9.8%), Otological (7.8%), and Ophthalmological (5.6%). The period from February, when wintering was initiated, to January of the following year was divided into quarters, and changes in the incidence of diseases and injuries were analyzed. Although results differed among parties, the incidence was low irrespective of the department in the 3rd quarter (August-October) in each party.
Neither severe cases requiring transportation nor deaths were observed. There was no surgery performed under general anesthesia. In the 44th party, peritoneal lavage and appendectomy were performed under lumbar spine anesthesia due to localized peritonitis associated with diverticulitis in 1 case.

Fri_168_ME-2_225
The Adaptation of Chinese Expeditioners under the Antarctic Dome A

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Dome A (80°22'S, 77°22'E) has the highest ice peak in Antarctica, with an elevation of 4093m. The average temperature of -54℃ with a barometric pressure of 560-590 hpa (January-April). It is among the most challenging environments on Earth, due to poor oxygen availability, harsh weather conditions, dangers related to glaciers and difficult accessibility for transportation. Chinese Kunlun Station was established at Dome A in 2009. We focuses on the adaptation patterns of expeditioners under the hypoxic and cold environment. We firstly identified the association between psychophysical phenotypes and genome-wide gene expression changes in human adaptation at Dome A. A group of genes were found to be strongly related to significant phenotypes. We found 28 genes were potentially involved in the psychological disturbance. A reliable method was developed to search novel genes and mechanisms related to phenotypes. At Kunlun Station, more than half of expeditioners experienced AMS symptoms, among which sleep disturbances were prevalent. Our polysomnography (PSG) study at Dome A suggested that sleep architecture changed and slow wave sleep reduced. Apneas were prevalent, with almost exclusively of periodic breathing. The nocturnal oxygen saturation decreased. The strict physical screening examination and pre-acclimatization training before departure heading Antarctica is necessary.

Fri_169_ME-2_467
The Psychological Safety of Workers in Oil and Diamond Productions in the Arctic

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The Arctic is very rich in oil, gas and other minerals. An important role in the development of the Arctic is played by attracting and retaining a relatively small number of able-bodied people in these remote regions. For the possibility of prospecting and mining in these hard-to-reach regions with extreme climatic conditions, the shift method of labor organization is used. Despite the development of the problem in this direction, there remain a number of poorly understood questions. What are the psychological features of the employee making mistakes in the workplace, the employees, what position in the oil producing and diamond mining industries has the greatest risk of accidents, what are the components of the psychological safety of these workers in the Far East North and the Arctic. The goal is to identify differences in the psychological safety of workers in oil producing and diamond mining industries under shift work organization in the Far North and the Arctic.
As the research result, the models of psychological safety of oil producers and diamond mining companies under the shift work organization in the Far North and the Arctic (including psychological properties, functional states, behavioral characteristics and attitudes to dangerous and extreme factors and conditions of the professional environment) are refined. The role of production factors in the formation of psychological safety and safe behavior of the personnel of extractive companies was determined.

Fri_170_ME-2_521
Physiological Stress in Brazilian Antarctic Program (PROANTAR) Participants

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From a physiological perspective Antarctica has a very challenging environment since the cold; the wind and the sensory monotony are considered stressful stimuli for the human body. However, acclimatization can attenuate stress responses consequent to sympathetic activation caused by this extreme environment. In addition, the voyage to Antarctica is commonly carried out by ship, which lasts for a long period and represents a confinement stress. The aim of this study is to investigate biological variables (autonomic activity, endocrine and metabolic markers) and humor parameters of progressive adaptation during an Antarctic expedition, including a period of ship confinement and a period in a camp. Ten volunteers from Brazilian Antarctic Program were evaluated during 3 weeks in a ship and 3 weeks in an extreme camp, during Brazilian Antarctic Operation in 2017 summer. Initially, the volunteers performed a maximal progressive exercise and basal data were collected at 3 moments in the ship. After 1 month of ship confinement, the group camped in Antarctic. There were evaluated autonomic balance, by measuring the heart rate variability, mood, by Brunel Mood Scale (BRUMS), and hormonal parameters - samples of blood, saliva and urine were collected to measure TSH and T4, catabolic state (cortisol/testosterone) and catecholamine's concentration. We will also test the hypothesis that biological parameters of adaptation and humor relates with VO_{2MAX} along Antarctic field stay.

Fri_171_ME-2_527
Pre-Antarctic Training Mood State in Brazilian Researchers and Military

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Every year Brazilian researchers and military personnel are sent to the inhospitable Antarctic environment. Expeditions to Antarctica include hiking and staying in camps or research stations, with durations ranging from one season to a year (for a group of wintering military). Considering that participants perform functions in which they need to maintain attention and focus, changes in their mood and cognitive ability may result in errors that compromise their functions and even security in an extreme environment such as Antarctica. In order to prepare the participants of the Antarctic Operations for the conditions faced in the expeditions, the Brazilian Antarctic Program (PROANTAR) promotes Pre-Antarctic Training (TPA) in which researchers and the military participate in activities that simulate the stress experienced in the expeditions, such as the pressure of time for the accomplishment of tasks, the coexistence in restricted groups and strenuous daily physical activities. Thus, it is possible that the mood responses of the participants to a week of TPA predict the expected mood changes in the Antarctic field. We used one validate questionnaire - the Brunel Humor Scale (BRUMS) to compare the mood of researchers and military of PROANTAR at the beginning and at the end of a Week of TPA. We believe that by understanding these responses we can seek strategies to minimize the risks of the Antarctic environment on the physical and mental health of the PROANTAR participants.

Fri_172_ME-2_998
Medical and Physiological Studies at the Ukrainian Antarctic Station

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Since the very beginning of the scientific presence of Ukraine in the Antarctic biomedical research direction has been developed for the monitoring of individual biomarkers of Antarctic winterers and medical accompaniment Antarctic expeditions. Constant medical supervision (including the possibility of telemedicine) the state of health of Antarctic experts and new technology for monitoring the individual parameters of the functional state of the organism, despite the extreme conditions, allowed to maintain the health and performance of all the participants of 20 Ukrainian Antarctic expedition (over 200). The main success of the Antarctic medicine is to preserve the health of all members of 20 expeditions, the creation of an effective system of medical and psychological selection of candidates, the development of health monitoring methods for winterers at the Antarctic station, using telemedicine, the introduction of innovative technologies for prevention, treatment and rehabilitation. The main achievements of scientific developments in the field of medicine and physiology are to receive new information about human adaptation features to the extreme conditions of Antarctica, clarifying mechanisms of disadaptative, desynchronosis, "Antarctic syndrome" symptoms determine the causes of stress, problems of interpersonal relations in a small team, as well as a significant expansion of knowledge in the field of environmental physiology, extreme and preventive medicine.

Fri_173_ME-2_1117
The Relationship between the Third-quarter Phenomenon and Medical Statistics

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Psychological states and health conditions are known to change as a result of long periods of stay in Antarctica. The “third-quarter phenomenon” hypothesis suggests that these changes in condition occur in the latter half of long stays. The aim of this research is to analyze the relationship between the third-quarter phenomenon and statistics of disease and injury during ten wintering periods of ten years in Japanese Antarctic Research Expeditions (JARE). An analysis of mood scales (the Positive and Negative Affect Schedule [PANAS] and the Profile of Mood States [POMS]) indicated that seven of ten wintering parties experienced the third-quarter phenomenon (we name these parties the third-quarter (TQ) parties), and the other three parties did not (two parties of three had flat mood scores, and one party had unclear results). We name the three parties the non-third-quarter (NTQ) parties. Subjective complaints of disease and injury were measured by the Subjective Health Complains Inventory [SHC]. The following findings became clear as a result of the investigation. First, the number of consultations with a doctor decreased in the third-quarter for all NTQ parties. Second, the number of consultations regarding surgery and orthopedics decreased by half in the fourth-quarter for only one of the NTQ parties. Third, the members of both the TQ and NTQ parties had almost the same complaints, but the members of the NTQ parties did not consult a doctor very much in the third-quarter.

Fri_174_ME-2_1188
Stress Assessment of Performance by Japanese Antarctic Research Expeditions

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Japanese wintering members were kept enclosed and isolated in Antarctica. In our post-mission interview, although they underwent considerable stress, they maintained themselves. In Antarctica, it was not easy for them to narrate their psychological problems. We could not determine their maladjustment using standard methods like asking their self-assessment. The main purpose of this research was to investigate their stress by their performance. We used the Uchida-Kraepelin psychodiagnostic (U-K) test as a performance measure. Data have been collected for 30 members of one wintering party at 6 periods during mission. Furthermore, using the Profile of Mood States (POMS), we investigated the relationship between performance by physiological responses and subjective assessment.
The following became clear as a result of the investigation.
1) In U-K test, the score of PF (which shifted from standard value) changed continuously . Especially, many members' score on PF was worse at polar daybreak.
2) In POMS, the score on Tension-Anxiety (T-A) was higher at midnight sun. The result did not correlate much with U-K.
3) Some members rejected this survey.
Most of their scores on PF before rejecting were the worst. Their rejection was also interpreted as performance suggestive of their coping.
These results indicated that their performance was the clue that helped to assess members under stress. Therefore, we need various stress assessment methods for providing mental support in Antarctica.

Fri_175_ME-2_1411
Mental Health Management by Leaders of Wintering Parties in Antarctica

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Successive Japanese wintering parties were placed in an isolated environment in Antarctica for durations of about one year. They received few visitors because there were no other permanent research stations nearby. The environment was very stressful. However, all members completed their tasks with very few injuries and few big accidents.
We interviewed the wintering members after they returned to Japan from their expeditions. In our interviews, we hypothesized that the leaders' management of the party played an important part in their party members' mental health. The main purpose of our research was thus to investigate what the leaders of wintering parties did to prevent their party members from suffering mental distress and what the leaders considered most important for managing their parties.
We did semi-structured interviews of ten former leaders of Japanese wintering parties. We focused on their regard for their parties and their party members in the period of preparation in Japan and of wintering in Antarctica.
We found that the leaders put careful consideration into selecting a suitable head of each section of the party, respected the specialties of each member, and maintained a sense of distance between themselves and their party members so as to remain unbiased.

Fri_176_ME-2_1553
The History of Human Fight against Infectious Disease in Antarctica

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In the history of each station in Antarctica, many report were published about infectious disease. You may think there is no pathogen ,like bacteria and virus but it´s not true. This is a review of the pathogens we human being fight against. We hope this article will help you to protect from them in Antarctica in the future.

Fri_178_ME-2_2347
An Introduction to the Korean Society of Polar Medicine (KSPM)

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The Korean Society of Polar Medicine (KSPM) is an academic and social organization for Antarctic health care, emergency response, and medical research. Founded on 21st June 2014, it gathered three existing groups about polar medicine: the Korean Society of Antarctic Practitioners, the Korea University Research Group for Polar Medicine, and Korea Polar Research Institute. The day of founding KSPM was a day of Antarctic winter solstice so it has an alias "Antarctic Dong-ji Association". ('Dong-ji' is pronounced same as that of Korean character 'winter solstice' and 'the companion')
The purpose of the KSPM is not only to provide health care for diseases control, but also to investigate and characterize the features of medical specificity occurring in the polar region. So the main contents dealt with by KSPM are
(1) Antarctic Stations,
(2) icebreaker Araon,
(3) medical evacuation,
(4) telemedicine,
(5) psychological and physiological research,
(6) extreme medicine and its medical resource,
(7) medical microbiology,
(8) international cooperation in medicine,
(9) humanities and science: combined research on convergence and integration.
As an well-organized platform, KSPM is an attempt in Korea which is going to be a good 'Agora' for collecting the experiences and opinions of people who were in Antarctica. The outcomes will be valuable for not only the Antarctic field but also the development of various research, and ultimately give benefit to humanity and future generation.

Fri_179_ME-2_2529

Cosmic Ray Measurements in Antarctica and their Impacts on Human Activities

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The primary and the secondary radiation produced in the atmosphere can be a serious issue for the reliability of microelectronics devices embedded in aircraft and this is of a major concern for aircrew member´s dose assessment. Moreover, Polar Region development induces an important issue related to space weather.
In the framework of the CHINSTRAP project supported by the French Polar Institute (IPEV), a new cosmic ray induced neutron spectrometer has been installed in December 2015 in the inner Antarctic Plateau, at Concordia station. Atmospheric shower modelling associated to a primary cosmic ray model allows for deducing the proton, muon and electron fields from cascade neutron measurements.
Using the fluence to human dose conversions coefficients, the complementarity of measurement and modelling makes it possible to calculate the human dose, but also to extrapolate it for other localization. In the same way, Single Event Effect risk can be determined from electronic devices, which is particularly critical for nanoscale technologies whose sensitivities are increasing with the technological integration. This paper proposes to analyze two-year measurements from December 2015 to 2017, and to investigate the Cosmic Ray impacts on Antarctica activities, in the point of view of human dose and electronic systems. Discussions of this work will be extended to contributions of the cosmic ray knowledge improvement to the space weather and the cosmogenic nuclide dating activities.

Fri_180_ME-1_178
Extreme Environment Effects on Human Health in High Altitude in Antarctica

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Introduction: The Antarctic inland, with average altitude of 2450 m above sea level (a.s.l.), is an extremely cold and dry place with rarefied air. Many inland parties, from various countries, conduct research activities in Antarctica: however, obtaining clinical data is challenging. To improving the safety of members during Antarctic expeditions, we evaluated the impact of extreme environmental conditions of the Antarctic inland on health.
Methods: In total, 33 members of 4 inland parties from the Japanese Antarctic Research Expeditions (JARE) 40, 43, 44, and 46 were included in the study. Dome Fuji Station (Dome F), located 3810 m a.s.l., was the destination of all the parties. We evaluated the impact of the extreme environmental conditions on subjective symptoms, percutaneous arterial blood oxygen saturation (PaO_2), and hematological findings.
Results: The correlation coefficients of SpO_2 levels and headache/sleep disturbance scores were −0.181 ($p < 0.001$) and −0.101 ($p = 0.007$), respectively; both headache and sleep disturbance scores exhibited significant negative correlations with SpO_2 levels. Serum erythropoietin concentration increased promptly, and the number of erythrocytes peaked within 6 weeks.
Conclusion: Thus, as is widely alleged, hematological adaptation occurs over several weeks. SpO_2 monitoring might be useful for the early detection of acute mountain sickness, prior to adaptation.

Fri_183_ME-1_1692
Effects of Environmental Conditions from Antarctica on the Human RBCs Viability

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Our research analysed human erythrocytes viability in relation to environmental conditions from Antarctica and was conducted two years on three Romanian researchers that participated in two expeditions in West Antarctica, King George Island. We chose to study the RBCs adaptation because under these conditions it is expected that the adaptation of an organism to extreme conditions will be determined by cellular adaptations, especially at the level of RBCs involved in oxygen transport. The methods to investigate cellular changes at erythrocyte level was flow cytometry for morphological changes (FSC/SSC analysis) correlated with scanning microscopy, erythrocytes viability determined with Calcein-AM and the analysis of RBCs apoptosis with Annexin-V- FITC. We also investigated the number of reticulocytes in the circulation. The results were obtained by comparing the data gathered from the explorers before and after three weeks spent in Antarctica. Our investigations have shown a clear decrease of erythrocytes viability in the absence of significant morphological changes and an increasing of reticulocytes number as a result of a greater elimination of RBCs by apoptosis, as a compensatory mechanism. It is difficult to say at the moment what climatic factors have led to the change in the viability of RBCs. Further more we will correlate the results with the climate parameters variations.

Fri_184_ME-1_1982
Health Problems in a Long Term Stay in Antarctic High Land

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Purpose: There is need to study both acute mountain sickness and chronic response during a long term stay in Antarctic high land. We examined medical cases of wintering-over teams at Dome Fuji (S77, E39, 3810 m a.s.l.) and compared them with Syowa station(S69, E39, 29 m a.s.l.).

Methods: Dome Fuji summer operations started in 1995. Wintering-over operations were carried during the 1995-1998 period. The number of wintering-over participants was 9 per year and 27 in total with 243 medical consultations.

Result: Medical consultations occurred frequently at the beginning of wintering-over and polar night. The proportion of medical consultations showed that the largest group were surgery and Orthopedic (82 cases) followed by internal medicine (80 cases), teeth problems (23 cases). The forth is psychiatric problems that totaled 23 cases. Comparing with Syowa station, internal medical and mental problems were dominant with less injury cases. Dome Fuji had more cases of headache, gout, alcohol related disorder, frost bite and insomnia.

We had no fatal case nor major operation in high land. There was one severe case of bradycardia with AV block that occurred in summer. The patient could be airlifted to Japan.

Discussion: During the long term stay at Dome Fuji, we detected some difference of health problems compared with Syowa station. To solve these problems, we need to further study hypoxia, coldness, daylight change, smaller group isolation and work patterns.

Fri_186_OC-3_216
Building the International Guide for Online Arctic Ethnographic Collections

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The museum practices of collecting objects from indigenous peoples has created a vast and diverse landscape of museum holdings across the world. Through acquisition, trade, scientific expeditions, and government policies, the ethnographic collections held in many museums worldwide have achieved a distinct character in terms of their history, scope, depth of catalog record, and accessibility. Scholarly researchers, indigenous communities, educators, and the public face many challenges in navigating this uneven and uncharted territory of world's ethnographic museum collections for northern regions. The paper introduces an effort launched at the Smithsonian National Museum of Natural History to produce an international "guide" for Arctic ethnographic collections using individual museum websites and other mostly web-based resources. As of late 2017, the guide covers 15 states, including all polar nations, and over 100 individual museums, with more than 250,000 ethnographic objects total. The paper discusses the rationale and purpose underlying the project, and explains why accessibility is a critical issue for northern ethnographic collections to address the main question: To what degree are museum materials available online to outside researchers, students, and indigenous users?

Fri_187_OC-3_623
Promoting the Antarctic Heritage of South Africa with a Digital Museum

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A museum is devoted to the procurement, care, study, and display of objects of lasting interest or value for a specific subject. The internet and virtual environment create a possibility of digital museums that is a digital footprint of the physical. Physical museums are essential; humans want to relive the experiences of others. This is however not always a possibility for everyone. Therefore, the digitised era of objects is more accessible to a wider audience. A digital museum need to communicate research and exploration to the public, and provide access to their specimens. It involves a location for the collection and a set of digital objects, on a permanent base. Therefore, it is necessary to investigate new ways where museums can work together in a global context to advance research and collections, and engage, inspire and educate the future generations of all countries and especially South Africa. Antartic Legacy of South Africa's (ALSA) main aim is to preserve our legacy in the Antarctic region by maintaining a digital archive. It is to be a resource for research in history and humanities, and secondary to promote this legacy. ALSA investigate the possibilities of utilizing the digitised material in the archive. This poster will outline the process of creating a digital museum with the digitsed material in the archive and highlight the open accessibility of such a museum. A copy in CD Format of the ALSA digital museum will be available during the poster session.

Fri_188_OC-3_1260
Arctic Evidence Eight: An Alliance of Global Arctic Natural History Museums

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Natural history museums hold the record of nature over time, including millions of specimens from the Arctic, yet museums have been largely on the periphery of Arctic science and Arctic data discussions. The "Arctic Evidence Eight" is an alliance of eight national Natural History Museums in the eight Arctic Council countries: Canadian Museum of Nature; Finnish Museum of Natural History; Icelandic Institute of Natural History; National Museum of Natural History, Smithsonian Institution; Natural History Museum of Denmark; Natural History Museum, University of Oslo; Swedish Museum of Natural History; and Zoological Institute of the Russian Academy of Sciences. The Arctic Evidence Eight aspire to play a vital role in saving the world with evidence, knowledge and inspiration. Each institution holds substantive collections of Arctic flora and fauna, as well as cultural artefacts and genetic resources, which provide a foundation for creating new knowledge. The Arctic Evidence Eight are engaged in Arctic exploration and discovery, and have research expertise in diverse Arctic disciplines, such as taxonomy and systematics, Arctic ecology, environmental monitoring, climate change monitoring, and Arctic culture, human history and exploration. The Arctic Evidence Eight are engaged in finding ways to better work together and with the broader scientific community to advance Arctic research and collections, and engage, inspire and educate citizens about the global Arctic.

Fri_189_OC-3_1485
Canada C3: A Natural History Museum´s Role on a Ship-based Mission Around Canada

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All credible museums conduct research. Natural history museums assemble collections as part of the research done by their staff of experts and in association with a broad network of collaborators. Work in the Arctic occurs as part of regular programs of work to explore the vast polar reaches of our planet. It can also happen opportunistically as part of events that mark significant milestones, for example the International Polar Years, or in this case the 150th anniversary of the Confederation of Canada, a year of celebrations known as Canada 150. One of the feature projects of Canada 150 was entitled Canada C3, a 150-day icebreaker exploration of the entire coastal region of Canada, from Toronto, Ontario to Victoria, British Columbia via the northwest passage. The complex program of activities during the voyage addressed the four themes of Canada 150, the environment, youth engagement, diversity and inclusion, and reconciliation. Canada C3 developed a scientific research program as part of the environment theme that explored marine and terrestrial habitats as the ship moved along its 25,000 kilometer transect around the country. This poster describes how the Canadian Museum of Nature, Canada's national museum of natural history, participated and lead the program of research.

Fri_190_OC-3_1523
20th Century Italian Antarctic Exploration: The Ajmone-Cat Collection

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The Antarctic National Museum - Trieste Section (University of Trieste) collects and preserves marine geological findings, and preserves archives regarding the history of exploration to present them to the public on a permanent basis. The Museum is divided into two sectors: the Permanent Exhibition and the Sorting Center. Since the end of the 1800s many Italian explorers have organized or taken part in various expeditions to the Southern Seas and by the early 1970s some private expeditions were also being carried out, which are also included in the Permanent Exhibition.
Here we present the collection of Naval officer Giovanni Ajmone-Cat who made two Antarctic expeditions (1969-1971 and 1973-1974) on board the steam motorsailer San Giuseppe Due which had been specially built for the expeditions. He explored Deception Island (South Shetlands), Wiencke and Anvers Islands, and visited Argentine and American Stations in the Antarctic Peninsula. Recently the Italian Navy, in accordance with the wishes of the Ajmone-Cat family, has lent the Captain's entire collection to the MNA - Trieste Section. The collection consists of photographs, slides, movies, maps, papers and information about these two autonomous trips. These materials are catalogued and we are currently digitizing part of the collection using a laser scanner with photographic overlay to create a 3D model appropriate for long distance access in order to communicate these two Antarctic explorations to the public.

Fri_191_OC-3_1651
The Italian Museo Nazionale dell'Antartide

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The Italian Museo Nazionale dell'Antartide (www.mna.it) was established as a consortium of three universities (Genova, Siena, Trieste) in 1996 with the aim to preserve, study, and increase the value of all material collected during the Italian Antarctic expeditions, as well as to promote public understanding of Antarctic science.
The specimen repositories host rocks, meteorites, sediment and ice cores and marine and terrestrial flora and fauna, collected by the Italian Antarctic expeditions since 1985. All the material stored in the repositories is described in specific data bases. The museum operates as an infrastructure of the Italian Antarctic programme (PNRA) in support of the national and international scientific community. The storing, classification and distribution of Antarctic scientific material is a peculiar aspect of the Italian Antarctic museum that marks a clear difference to other polar museums.
The museum contribues to education, outreach and training by promoting polar knowledge to schools through lectures, guided visits and didactic experiments to all-level students, from kindergarten to PhD level and to the general public through permanent exhibitions in Genova, Siena and Trieste.
The museum publishes scientific journals, volumes, and multimedia and is also partner of international initiatives devoted to the dissemination of information of the specimen collections and results obtained by PNRA.

Fri_192_OC-3_1785
The History of German Polar Research goes Theatre - The Project “Staging Files”

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How can a Polar Research Institute convey its history and the historical heritage of its discipline to the public? What kind of role can archives of these institutions play in this matter? How can these archives use records and other materials kept by them for the best effect on the public sphere? How can they combine historical research with the focus on polar research with public relation activities of Polar Research institutes? These questions will be answered during this talk by having a close look on a staged reading on the history of German Polar Research, a result of a collaboration between the Alfred-Wegener-Institute´s own Archive for German Polar Research (AGPR) and the project “Aus den Akten auf die Bühne” (AdA) (“Staging Files”), a cooperation between the institute of history at Bremen University and the “bremer shakespeare company”.
To fulfill this task, the talk will initially present both AGPR and AdA with the regard to their history, their task or aims and their work approaches and ways of working. Next, the cooperation between the AGPR and AdA on the history of German Polar Research will be described with respect to its emergence and its work modus. Afterwards an overview of the project product, the stage reading, will be given with regard to its contents, structure and theatrical means. Finally, since the staged reading started in May 2018, a first evaluation of the project will be presented.

Fri_193_OC-3_1818
Ardently Glacial - Social Issue

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Climate change is no longer a theory to be debated but rather an indisputable reality that requires immediate global engagement. Given this reality, what role does a museum play in encouraging public awareness and activism? The Museum of Natural History of Neuchâtel, in presenting an exhibition (2 june 18 - 30 june 2019) on the polar regions and climate change, is hoping to stimulate a discussion about one of the most pressing issues of our time. By presenting our natural history collections in the context of the Poles and global warming, and by presenting pertinent research carried out in polar and alpine regions, the Museum encourages the visitor to enter an exhibition characterized by paradox. This polarized world is one both up and down, both water and ice, hostile yet teeming with life, plunged in crisis but with solutions in sight. In the context of the exhibition, participants have been invited to send us their personal reactions to a brief text written by Claude Lorius, the French glaciologist who first discovered that gases trapped in polar ice held the key to unraveling the history of earth´s climate. These reactions, whether in the form of text, video..., will be incorporated into our exhibition, allowing the public to manifest their opinions in the museum. We thus hope to create a synergic space where scientific, cultural and personal information is transmitted in two directions, both from the museum to its visitors and from the visitors to the museum.

Fri_195_OC-3_2300
Archive of Polar Fish Chromosomes, a New Biological Resource for Polar Science

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Climate change is expected to impact on marine polar fish leading to local extinctions, invasions and modifications in the structure of the ecosystems. In the last decade, polar bodies and polar scientists have spent great effort in establishing monitoring activities in order to gather baseline data on both Arctic and Antarctic fish, and to interpret future reassessments in the communities. Over time, the potential for accessing and exchanging scientific information has greatly improved, but the need of specimen and tissue repositories (not only focusing on DNA) remains of high priority for polar research, representing an invaluable basis for monitoring plans and a legacy for the future.
Aiming at contributing to this issue, a polar fish chromosomes archive has been established in the framework of the PNRA Project “Polar Fish Cytogenetic Diversity” (POLICY) carried out at Institute of Marine Sciences, Genoa. The archive is hosted and curated by the Italian National Antarctic Museum (MNA), Section of Genoa which will guarantee the link with other biological databases. The archive is organized as a repository of cytogenetic samples (frozen mitotic cells and slide chromosome preparations) with an associated database including karyotypic and cytogenomic data and DNA barcodes. Such an overall organization aims at providing the polar community with a useful biological resource for a wide range of applications, from species characterization and identification to genome adaptation.

Fri_196_OS-4_117

SIPN South: Coordinating Seasonal Predictions of Sea Ice in the Southern Ocean

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Like many regions of our planet, the Antarctic is currently undergoing profound environmental changes. Sea ice is a prominent element of this environment: it controls the heat, gas, mass and momentum exchanges between the atmosphere and the ocean. Sea ice has been steadily expanding in the Southern Ocean since the late 1970s but has displayed significant negative anomalies in recent years. Understanding and predicting how the sea-ice cover develops over time scales as short as a season is important not only for scientists but also for stakeholders or teams organizing field campaigns. Despite all potential applications, there has been to date no overall assessment of the capabilities of current prediction systems to forecast sea ice conditions at time scales of a season. This is the goal of SIPN South. SIPN South is a 2-yr project endorsed by the Year of Polar Prediction (YOPP) project. SIPN South aims at evaluating the skill of various forecast systems (statistical, dynamical) in predicting the regional summer conditions around the Antarctic continent. In this poster, we are presenting the very first coordinated austral sea ice prediction that will take place in February 2018 (summer sea ice minimum).

Fri_197_OS-4_345
Operational Polar Sea Ice Forecast and Service in China

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The polar sea ice forecast and service is needed urgently with the development of polar research expeditions and Chinese cargo ship navigations through polar regions in recent years. The operational polar sea ice forecast and service system is developing at National Marine Environmental Forecasting Center of China (NMEFC). The synoptic scale sea ice forecasting system is based on a coupled ice-ocean model with multiple parameter data assimilation and is operational running. The subseasonal and seasonal sea ice prediction are based on the NCEP Climate Forecast System version 2 (CFSv2) and statistic forecasting method. Moreover, due to the importance of in-situ sea ice observation data for the sea ice forecast, the sea ice and snow thickness, albedo observations have been sustained for more than 5 years based on the Zhongshan station in the Antarctic, and ice buoys were placed on the floe ice in the Arctic ocean to monitor ice drift and ice thickness in recent several years. Synthesizing the forecast, satellite and site observation data, sea ice service are provided to users such as Xuelong icebreaker and Chinese merchant ship.

Fri_198_OS-4_408
Sea Ice and Ocean Model Development for CMIP6 at Tsinghua University

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We summarize the model development for sea ice and ocean component and the initial evaluation for the CMIP6. A nominal resolution of 0.5 degree is adopted for grid of the ocean and sea ice components, with much improvement of spatial resolution in the Arctic region. A diagnostic floe-size parameterization and lateral melt scheme is integrated in the sea ice model, with observational data specific to both Arctic and Antarctic. Through initial evaluation based on OMIP, pre-industrial and historical runs in CMIP6, we show that the ocean-ice coupled model and the fully coupled model reproduces reasonable Arctic climatology and changes, and the positive bias in the Antarctic sea ice extent is greatly reduced. The improvements in the sea ice model and ocean model serve as an integral part of the coupled model development for CMIP6 at Tsinghua University.

Fri_199_OS-4_451
Arctic Ice Ocean Prediction System (ArcIOPS): An Evaluation of Sea Ice Forecasts

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The Arctic sea ice decline in summer opens new shipping routes and increases the marine operations in the Arctic Ocean. To well manage the opportunities and possible risks, accurate sea ice predictions are strongly required. In an effort towards reliable Arctic sea ice numerical prediction, the Arctic Ice Ocean Prediction System (ArcIOPS) was developed at National Marine Environmental Forecasting Center of China (NMEFC). This system is based on a regional Arctic configuration of the Massachusetts Institute of Technology general circulation model (MITgcm) and a localized error subspace transform ensemble Kalman filter (LESTKF) to assimilate weekly CryoSat-2 sea ice thickness data together with daily SMOS sea ice thickness and daily AMSR2 sea ice concentration data. The NCEP GFS numerical weather prediction is used as the atmospheric forcing. The real-time ensemble based sea ice forecasting experiments were carried out to facilitate the Chinese National Arctic Research Expedition in summer 2018 (CHINARE2018). The forecasts were evaluated against SSMIS sea ice concentration data and the *in situ* sea ice concentration and thickness data. Both sea-ice concentration and thickness forecasts show reasonable agreement with the independent observations, which proves the forecasting system has a good potential for the Arctic sea ice predictions.

Fri_200_OS-4_608
Assimilating Copernicus SST into a Arctic Ice-ocean Model with a LSEIK Filter

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Sea surface temperature (SST) data from the Copernicus Marine Service are assimilated into a pan-Arctic ice-ocean coupled model using the ensemble-based Local Singular Evolutive Interpolated Kalman (LSEIK) filter. It is found that the SST deviation between model hindcasts and independent SST observations is reduced by the assimilation. Compared with model results without data assimilation, the deviation between the model hindcasts and independent SST observations has decreased by up to 0.2 ºC at the end of summer. The strongest SST improvements are located in the Greenland Sea, the Beaufort Sea and the Canadian Arctic Archipelago. The SST assimilation also changes the sea ice concentration (SIC). Improvements of the ice concentrations are found in the Canadian Arctic Archipelago, the Beaufort Sea and the central Arctic basin, while negative effects occur in the west area of the Eastern Siberian Sea and the Laptev Sea. Also sea ice thickness (SIT) benefits from ensemble SST assimilation. A comparison with upward-looking sonar observations reveals that hindcasts of SIT are improved in the Beaufort Sea by assimilating reliable SST observations into light ice areas. The study illustrates the advantages of assimilating SST observations into an ice-ocean coupled model system and suggests that SST assimilation can improve SIT hindcasts regionally during the melting season.

Fri_201_OS-4_630
Daily Arctic Sea Ice Thickness Estimates in Cold Seasons

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The Arctic multi-year sea ice thickness has undertaken substantial thinning in recent decades. However, direct observations are inadequate because of the limited in situ expeditions and immature satellite retrievals. The complementary of CryoSat-2 launched in 2010 and SMOS sea ice thickness allows it possible to combine these two datasets to get a purely statistical dataset CS2SMOS in cold seasons.
A new daily sea ice thickness dataset in cold seasons from 2010 to 2016 is generated by the Massachusetts Institute of Technology general circulation model (MITgcm) with the assimilation performed by a localized error subspace transform ensemble Kalman filter (LESTKF) filter coded in the Parallel Data Assimilation Framework (PDAF). The atmospheric ensemble forecasts of the UK Met Office Unified Model (UKMO) available in the TIGGE archive are used to force the model. The available weekly CryoSat-2 sea ice thickness data together with daily SMOS sea ice thickness and daily SSMIS sea ice concentration data are then assimilated into the model during analysis process. In situ sea ice thickness observations from Beaufort Gyre Exploration Project and Ice Mass Balances data are used to evaluate the sea ice thickness estimates. Statistic results show that the sea ice thickness data have comparable performance to CS2SMOS data in cold seasons, and further provide daily evolution for future studies.

Fri_202_OS-4_671
Seasonal Prediction of the Antarctic Sea Ice using NEMO3.6-LIM3

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The Southern Hemisphere sea ice extent has followed an overall positive trend over the last 30 years. In this context, the last two years appear unusual with a lower than normal sea ice extent for almost all the months. This drop in sea ice extent after a record high in 2014 highlights the importance of the Antarctic sea ice variability at the seasonal and interannual timescales. Multiple mechanisms have been proposed to explain this variability. Although there is evidence that recent changes in the Antarctic sea ice are triggered by atmospheric conditions, the persistence or re-emergence of the sea ice anomalies has been partly attributed to sea ice-ocean interactions. In this study, we explore the critical influence of the state of the Southern Ocean on the seasonal predictability of the sea ice. A simulation covering the period 1979-2016 using the ocean-sea ice model NEMO3.6-LIM3 driven by atmospheric fields derived from atmospheric reanalyses is first performed and compared to observations. In a second step, the state of the ocean is perturbed to evaluate the implications of a warmer or colder than usual ocean on the evolution of the sea ice. In practice, this is achieved by replacing the ocean conditions at specific times by those simulated at the same season but for a different year, while keeping the same atmospheric forcing. The impact of such changes on sea ice conditions over the following months is then assessed.

Fri_203_OS-4_677
Seasonal Sea Ice Forecast Skills and Predictability of the KMA's GloSea5 System

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Ensemble sea ice forecasts of the Arctic Ocean is conducted with the KMA's GloSea5 seasonal prediction system. We assess the temporal and spatial characteristics of the monthly projection of Arctic sea ice extent and thickness in terms of forecasts accuracy and variability. The forecast skills are significant for all lead months, but anomalous around Siberian shelf, Chukchi Sea and Beaufort Sea during summer months. This study shows the summer sea ice prediction depends strongly on the previous winter sea ice thickness interacting with the accuracy of the snow depth. In spite of the uncertainties in atmospheric conditions, this system provides skillful Arctic seasonal sea ice cover predictions up to six months.

Fri_204_OS-4_691
Assimilation of Sea Ice Concentration in a Fully Coupled Earth System Model

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A data assimilation method capable of constraining the sea ice of an Earth system model in a dynamically consistent manner has the potential to enhance the accuracy of climate reconstructions and predictions. The difficulty in finding such a method lies in the strong nonlinearity of sea ice as well as in the sea ice variables, that are strongly non-Gaussian distributed and tightly coupled to the rest of the Earth system - particularly thermodynamically with the ocean.
We assess key practical implementations for assimilating sea ice concentration - the predominant source of observations in polar regions - with the Norwegian Climate Prediction Model that combines the Norwegian Earth system Model with the Ensemble Kalman Filter. For our study we conducted ten-year reanalyses in a perfect model framework. We discuss the benefits of weakly coupled (sea ice only) assimilation, as well as the impact of strongly coupled ocean-sea ice assimilation. Focusing on the ice variables, we investigate the performance of solving the analysis for the aggregated and for the multicategory ice states. The case of updating the ice volumes during the assimilation, thus necessitating the post-processing of unphysical thicknesses, will also be discussed. The robustness and reliability of the optimal setting is demonstrated for a 20-year reanalysis.
Finally, leaving the perfect model framework, we demonstrate the added value of sea ice assimilation in a realistic framework.

Fri_205_OS-4_734
Re-interpreting Thermodynamic Arctic Sea Ice Feedbacks

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One of the clearest manifestations of ongoing global climate change is the dramatic retreat and thinning of the Arctic sea-ice cover. All state-of-the-art climate models reproduce consistently the sign of these changes but largely disagree on their magnitude. The very deep causes remain contentious and consensual methods to reduce uncertainty in projections are lacking. Here we propose a process-oriented approach to revisit this question. We show that inter-model differences in sea-ice loss and, more generally in simulated sea-ice variability at all time scales, can be traced back to differences in the simulation of two competing thermodynamic sea-ice feedbacks. In turn, we show that both feedbacks are closely tied to the average ice thickness simulated by each model, regardless of the complexity of its sea-ice component. The results prompt modelling groups to focus their priorities on the reduction of sea-ice thickness biases, as we provide physical evidence that Arctic sea-ice projections from models with unrealistic current thickness can robustly be distrusted. We finally show that because of the enhancement of the feedbacks as sea ice thins, the recent and future changes in sea-ice thickness induce a transition of the Arctic towards a state with increased seasonal-to-interannual variability and less persistence, in other words less predictability.

Fri_206_OS-4_804
A TEOS-10-based Sea Ice Thermodynamic Formulation

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Sea ice thermodynamics in Earth System Models have a well established physical basis, yet formulations are generally not fully consistent with the thermodynamics of the other components of the Earth System, in particular the ocean and continental ice sheets. The ocean components have recently adopted the International Thermodynamic Equation of Seawater 2010 (TEOS-10), which includes formulations for both seawater and pure ice.
Since sea ice is at typical temperatures composed of pure ice and concentrated seawater in brine inclusions, it seems natural to base sea ice thermodynamics on a combination of TEOS-10 standards for sea water and pure ice. Feistel and Hagen (1998) have proposed such an approach that can readily be used but should be updated following the recent TEOS-10 developments.
With derive a TEOS-10 thermodynamic formulation for sea ice and question: (i) how consistent the TEOS-10 based sea ice thermal properties are consistent with observations; (ii) how different a TEOS-10 sea ice formulation is from standard sea ice formulations in current Earth System Models; (iii) how this can be implemented in climate models.

Fri_207_OS-4_900
Impacts on Sea Ice of Increased Ice Shelf Meltwater over Centennial Timescales

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The West Antarctic Ice Sheet may already be undergoing an irreversible mass loss that would result in near complete melt within the next millennium. The sea ice and climate response to increased Antarctic meltwater over centennial timescales is investigated with simulations in the Community Earth System Model version 1, with the Community Atmosphere Model version 4 (CESM1-CAM4). To investigate the response to meltwater released at the base of ice shelves in a higher CO_2 warming world, meltwater was injected at the depth of the front of the ice shelves, while simultaneously cooling the ocean by an amount required to melt the ice. The amount of freshwater added increased linearly over time, to represent gradually increased basal melting of ice shelves. To isolate the effects of ice shelf meltwater from greenhouse gas forcings, a pre-industrial (1850s) run was subjected to the increased freshwater for 150 years, consistent with published literature on the timescales of future ice shelf melting. This was then compared with the trends in the response to 20th and 21st century climate change.

Fri_208_OS-4_904
Research on the Impacts of Freshwater in the New Zealand Earth System Model

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The New Zealand Earth System Model (NZESM) is being developed and used through the Deep South National Science Challenge. NZESM is based on the UKESM1 physical model HadGEM3-GC3.1, which is a fully coupled atmosphere, land, ocean and sea ice model. In our research, we will use the NZESM to investigate the coupled response of the sea ice module (CICE) and the ocean module (NEMO) to freshwater forcings, including accounting for the meltwater latent heat. Freshwater flux runs have not been run for the NZESM and its predecessors in coupled (atmosphere-ice-ocean) mode. Runs with the NZESM will therefore fill a critical knowledge gap in terms of coupled model behaviour. We will initially run icebergs only (surface freshwater) runs, using state-of-the-art parameterisations for 1 degree models with and without their associated latent heat fluxes, to allow direct comparison with standardised control runs and the results from other models. Next, we will perform simulations with freshwater injection at depth to see if this makes any difference to the results.

Fri_209_OS-4_1556
Robustness of Arctic Sea-ice Predictability in GCMs

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General circulation models have been amply used to quantify Arctic sea-ice predictability. While models show commonalities in the general tendency of predictability loss, there is significant disagreement in its magnitude and timing. Here we show that inter-model differences in predictability are linked to inter-model differences in the persistence timescales of sea-ice anomalies that are unique to each model. Given this result, and previous work showing that within a single model simulation the magnitude of persistence fluctuates between periods of high and low persistence that may last several years, we assess whether initial-value predictability is dependent on the persistence state of the initial conditions. We find that forecast spread predictability is not significantly different across high/low persistence periods, suggesting that predictability may be robust within an unchanging climate mean state. Our results also imply that annual periods of high/low persistence are not predictable and are mainly forced by the atmosphere rather than the ice-ocean system.

Fri_210_OS-4_1800
Combining Information from Models and Automatic Classifications for Ice Charting

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Sea ice concentration and thickness from numerical models as well as from automatic sea ice classification algorithms using satellite data are still not suitable for direct use in the production of operational sea ice charts. However, the usability depends strongly on time and location. For areas with high concentrations both products are very usable in winter but at low concentrations and/or if the ice is rotten the quality deteriorates. In addition numerical models have also problems with the fast ice edge. Nevertheless, models and satellite data can deliver parameters which are not yet, or only in rare cases, depicted in operational ice charts. These range from directly usable parameters like floe size and ridges to more generalized parameters like roughness and orientation of linear features. In order to explore the possibilities and challenges a method was incorporated into the ice analyst routine, which gives the analyst the ice parameter values from models and automated classifications within the drawn ice polygon to help him setting the appropriate parameters in the ice chart. This method will be used in the Baltic winter season of 2017/18 and we will give some first insights gained.

Fri_211_OS-4_1805
Improvement of Sea Ice Movement Information for Ship Route Optimization

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Beyond sea ice concentration and thickness, ice drift and deformation are the most important parameters for ships passing through sea ice covered regions. However, knowledge on drift and deformation is sparse due to the lag of suitable and sufficient satellite data. Therefore, the only regular information is based on models. Models do not only show the actual state of ice drift and deformation but also provide the opportunity to display near real time ice development, which is essential for ship route planning. By the optimization of models with respect of sea ice drift both a better representation of the ice situation in total and a decision support for ship route planning considering ice deformation processes and near future ice development can be realized in future. As a first step towards this future, we analyze the accuracy of the BSH ice model by comparing the model ice drift with an operational ice drift product based on satellite data in the sea ice covered regions of the Baltic Sea. This small region is covered frequently by diverse satellites so that the ice drift can be calculated generally with a high temporal resolution. Meteorological and oceanographic conditions are investigated in order to detect drivers for differences between both products and to eliminate weaknesses in the model. Once the development of the models and S411 has moved on sufficiently, ice drift may become worldwide additional information transferred to the ships in sea ice covered regions.

Fri_212_OS-4_1813
The Sea Ice Drift Forecast Experiment

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The Sea Ice Drift Forecast Experiment (SIDFEx) was launched in summer 2017. SIDFEx is a community effort to solicit, collect, and analyze sea ice drift forecasts, based on arbitrary methods, for a number of IABP sea-ice buoys on a regular basis. The YOPP initiative is inspired by increasing research and operational needs to forecast future positions of assets drifting in Arctic sea ice. An example is the need to determine an optimal start position for the MOSAiC drift. Specifically, it is unclear whether forecast systems that account for initial conditions can provide additional skill over drift forecasts made using historical sea ice velocity fields. The MOSAiC drift provides a template for assessing the capabilities to forecast sea-ice drift for a range of applications, ranging from logistics support for future field experiments to potential search and rescue operations. The examination of sea ice drift forecasts provides an integrated assessment of many aspects of the coupled atmosphere-ice-ocean system and will motivate in depth investigations into how key variables are measured, modeled, and forecast. We expect that a systematic assessment of real drift forecasting capabilities will improve our physical understanding of sea ice and enable us to identify and resolve model shortcomings. We will present the current design of SIDFEx, discuss results obtained from one year of SIDFEx submissions, and present future plans in association with the MOSAiC drift.

Fri_213_OS-4_1871
The Arctic Marine Forecasting Centre of the Copernicus Marine Services

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The Arctic Marine Forecasting Center (ARC MFC) provides 10-days forecasts of the ocean currents, sea ice, marine biogeochemistry and waves on a daily basis and a 25-year reanalysis of the Arctic Ocean updated every year. The ARC MFC is powered by the Topaz configuration of the HYCOM model, coupled to the sea ice model CICE, the ecosystem model ECOSMO, and assimilates the following data with the Ensemble Kalman Filter: along-track sea level anomalies, sea surface temperatures, sea ice concentrations, sea ice drift, sea ice thickness, in situ temperature and salinity profiles and (only in reanalysis mode) ocean colour data. Waves are forecasted using an Arctic configuration of the WAM model. We review the main achievements of the ARC MFC during the first 3 years of the services, the participation to model intercomparison exercises and the plans for its future developments.

Fri_214_OS-4_1872
Iceberg Meltwater Estimates for the Southern Ocean Including Giant Icebergs

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Iceberg calving is an important component of the mass balance of the Antarctic Ice Sheet, with recent estimates of ∼1300 Gt/year being on the same level as ice shelf basal melting. The iceberg mass is usually assumed to be evenly divided between giant icebergs (length >10km) and smaller ones, with some estimates even preferring giant icebergs (as high as 89%). However, it is still unclear what the best way is to include giant icebergs into model estimates of the Southern Ocean freshwater cycle.
Here, we estimate the iceberg meltwater input from a simulation of present-day Antarctic icebergs and compare it to the balance between precipitation and evaporation (P-E) and sea-ice production rates. For the first time, an iceberg model is initialized with a set of nearly 7000 satellite-observed iceberg positions and sizes. It reproduces typical drift patterns for a large spectrum of size classes, including typical routes taken by giant icebergs.
The associated meltwater input is generally on the order of 5-20% of the P-E balance in large areas of the Southern Ocean, especially around the coast, with local maxima even exceeding P-E. Furthermore, the freshwater flux from melting icebergs is on the order of 5-20% of coastal sea ice production rates and, thus, partly compensates the effect of brine rejection in the annual mean. Iceberg melting is also the largest vector of freshwater input from frozen ice along (and northward of) the sea-ice edge.

Fri_215_OS-4_1916
Improved Sea Ice Drift Estimates in Lagrangian Methods for Sea Ice Forecasting

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We have recently developed a Lagrangian Ice Tracking System (LITS) for the Arctic Ocean. The LITS tracks motion of sea ice in a Lagrangian framework using sea ice drifts. It has been used to develop a seasonal forecasting model of the minimum sea ice extent (Williams et al. 2016) based on observational drifts. In continuity, we are working on the seasonal predictability of the sea ice system on a regional scale. The current version of the LITS uses the Polar Pathfinder sea ice motion vectors (V3, Tschudi et al. 2016). However, the raw drift vectors used to construct Polar Pathfinder contain biases. The satellite-derived velocities (from SMMR, SSM/I, AMSRE, AVHRR) and free drift estimates present a low bias when compared to the buoy drift observations, taken to be essentially true. Biases are larger in the summer, when fewer satellite-derived drifts are available and the composite sea ice drift relies more heavily on the free drift estimates. While being useful for climatic studies and model validation (Sumata et al. 2015), the issues found in Polar Pathfinder become more apparent when building a regional forecasting model. To this end, we recompile a new optimally interpolated sea ice drift dataset, using bias-corrected and error-weighted raw drift vectors from Polar Pathfinder, buoy data, free drift estimates derived from reanalyses, and other available satellite-derived drifts.

Fri_216_OS-4_2173
Forecasts of 2017 Arctic Sea Ice States Using the Regional Arctic System Model

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The rate of Arctic climate warming has been at least twice as fast as the global mean. Increasing surface air temperatures and declining sea ice have been some of the main attributes of that change. Wide-ranging sub-seasonal to seasonal (S2S) year-around forecasts of sea ice and climate states are becoming increasingly vital to surging human operations in the area, however the advancement of their skill remains challenging. This presentation summarizes our approach and results on 2017 Arctic sea ice thickness and concentration S2S forecasts using the Regional Arctic System Model (RASM).
RASM is a fully coupled regional climate system model, including atmospheric, ocean, sea ice, and land-hydrology components and a flux coupler to connect them. RASM is used to dynamically downscale the Climate Forecasting System Reanalysis (CFSR) for 1979-2017 and to create consistent initial conditions for all model components for S2S ensemble forecasts for each month of 2017. After the initialization, forecasts are forced at the model boundaries with output from 9-month CFSv2 global forecasts. Their skill is assessed against available observations. In particular, the effects of lead time, initial conditions, and sea ice rheology on the skill of forecasts are investigated. Based on these findings, an approach for future forecasts, including increased resolution of the RASM atmospheric model, marine biogeochemistry predictions and larger ensemble will be also outlined.

Fri_217_OS-4_2273
Effect of Assimilating SST, SIC and SIT on Seasonal Prediction of Arctic Sea Ice

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The rapid changes in the Arctic sea ice raises increasing demands for seasonal sea ice prediction. However, there were large biases in the predicted sea ice extent and thickness due partly to the poorly-known initial sea ice conditions. In this study, a coupled regional ocean-sea ice model ROMS-CICE is applied to investigate the effect of assimilating sea surface temperature (SST), sea ice concentration (SIC) and sea ice thickness (SIT) on the seasonal prediction of September Arctic sea ice from April. The years 2011-2016 are chosen as the study period when all the observations of SST, SIC and SIT are available (although SIT is only available during winter period). The model is initialized with monthly mean ocean and sea ice state from the UK Met Office's Forecasting Ocean Assimilation Model (FOAM). A nudging scheme is employed to assimilate the SST, SIC and SIT, respectively. Both ERA-Interim and ERA5 atmospheric reanalysis are used to assess the effect of atmospheric impact.

Fri_218_OS-4_2297
Superimposed Ice Contribution to Arctic Sea-ice Mass in an Excessive Snow Region

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Snow on sea ice may delay or slow down the growth and melt of sea ice due to its strong insulative properties and high albedo. It also can directly contribute to sea-ice mass balance through superimposed ice. Superimposed ice is a layer of ice formed at the snow-ice interface from freezing water (e.g. melted snow, liquid precipitation) on contact with underlying cold sea ice. Its contribution to sea-ice mass is substantial in the Antarctic and sub-Arctic seas . It also forms in the Arctic, but has not attracted much attention. With the thinning of the Arctic sea ice, the warming of Arctic and possible increase in precipitation, superimposed ice may become more important. During the Norwegian young ICE expedition N-ICE2015, excessive amount of snow were found on sea ice north of Svalbard and the contribution of snow to sea-ice mass was up to 15%. Studies indicate that this might be typical for this region where frequent storms bring precipitation into the ice pack. During the N-ICE2015, an Ice Mass Balance buoy (IMB) was deployed at 82.2° N in late May 2015 and then drifted towards Fram Strait. The IMB recorded the evolution of snow and ice thickness until 6 July 2015 when it reached 78.9° N. Ice cores from Fram Strait in summer 2015 indicated that superimposed ice had been formed. Using 1-D sea ice models, we examine how snow depth, date of melt onset and other factors affects the formation and role of superimposed ice in Arctic sea-ice mass balance.

Fri_219_OS-4_2307
A Probabilistic Verification Score for Contours Applied to the Arctic Ice Edge

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We introduce a verification score for probabilistic forecasts of contours—the Spatial Probability Score (SPS). Defined as the spatial integral of local (Half) Brier Scores, the SPS can be considered the spatial analog of the Continuous Ranked Probability Score (CRPS). Applying the SPS to idealised ensemble forecasts of the Arctic sea-ice edge in a global coupled climate model, we demonstrate that the metric responds properly to ensemble size, spread, and bias. When applied to individual forecasts or ensemble means (or quantiles), the SPS is reduced to the 'volume' of mismatch, in case of the ice edge corresponding to the Integrated Ice Edge Error (IIEE). By comparing initialised forecasts with climatological and persistence forecasts, we confirm earlier findings on the potential predictability of the Arctic sea-ice edge from a probabilistic viewpoint. We conclude that the SPS is a promising probabilistic verification metric, for contour forecasts in general and for ice-edge forecasts in particular.

Fri_220_OS-4_2323
A Dataset of Linear Kinematic Features (LKFs) to Evaluate Sea Ice Deformation

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The Arctic sea ice deforms continuously due to stresses imposed by winds, ocean currents and interaction with coastlines. The most dominant features produced by this deformation in the ice cover are leads and pressure ridges that are often referred to as Linear Kinematic Features (LKFs). With increasing resolution of classical (viscous-plastic) sea ice models, or using new rheological frameworks (e.g. Maxwell elasto-brittle), sea-ice models start to resolve this small-scale deformation. Typical measures for evaluating the modelled LKFs include scaling properties of sea-ice deformation or lead area density. These metrics avoid the problem of detecting individual LKFs by applying statistics over continuous fields such as sea ice deformation or concentration. In this way, these statistical metrics can provide specific information, but lack a comprehensive description of LKFs. We detect individual LKFs in sea ice deformation fields from satellite observations with an object detection algorithm. Combining this information with the sea ice drift fields used to derive the deformation fields, the LKFs are tracked in time. In doing so, the spatial characteristics (density, length, orientation, intersection angle, curvature) and the temporal evolution can be extracted from the same data-set. Our algorithm can be applied to both observed and modelled sea-ice deformation and drift making possible a consistent comparison and thorough evaluation.

Fri_221_OS-4_2512
Improved Sea Ice Edge Prediction Based on Ice Chart Uncertainty Metrics

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Ice charts include a composite of near-real time sea ice information to provide consistent, reliable, and timely information for ship operators. With the onset of satellite sea ice record from 1979, data from ice charts have shown potential to improve the climatology record. There is the assumption that the methodology and data sources, and the resulting bias in the charts, has remained consistent. However, there have been significant improvements to sources going into ice charts. Information integrated into manual and automated operational ice products is often misunderstood because it is dependent on operational needs and these vary from those of the science community. The scientific community requires operational ice information that includes uncertainties. Uncertainties with human bias in ice charts are difficult to quantify, but can be accounted for by the data sources, "smearing" of the imagery into polygons, interpreter bias, and time difference between charting and data sources. A test algorithm has been developed to account for these uncertainty metrics. Imagery interpretation bias was prioritized due the potentially large contribution and little knowledge of this error source. A study was developed and tested with a training manual given to ice analysts to gauge their competency in evaluating ice information from various sources. The training results demonstrate the capability of the ice chart uncertainty metric to quantify the human bias and other uncertainties.

Fri_222_OS-4_2557
Multi-model Long-range Forecasting of Sea Ice through WMO's Arctic PRCC

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The World Meteorological Organization (WMO) is establishing a multi-node Arctic Polar Regional Climate Centre (PRCC) whose functions include long-range forecasting of Arctic sea ice. Through the YOPP-endorsed project "Forecasting Regional Arctic Sea Ice from a Month to Seasons" (FRAMS), capacity is being developed to produce multi-model, user-relevant sea ice forecast products. This presentation will describe developments that have occurred thus far under FRAMS and the anticipated next steps. Included in these initial developments is the extension of a procedure for producing probabilistic seasonal forecasts of local sea ice coverage to a multi-model forecasting framework. Such probabilistic forecasts that represent uncertainty can be essential for end-users who want to quantify risk and make decisions taking forecast uncertainty into account. This methodology consists of fitting single-model ensemble forecasts of local sea ice concentration to a well-suited probability distribution, and then calibrating these distributions using trend-adjusted quantile mapping. Here we report on the utility of this approach in the context of multi-model probabilistic forecasting by combining calibrated outputs from different models and comparing these forecasts against reference probabilistic forecasts based on simpler techniques.

Fri_223_OS-4_2567
The Statistical Seasonal Forecast Model of the Norwegian Ice Service

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The Norwegian Ice Service has developed and run since 2013 a statistical seasonal forecast model to predict the future sea ice area in waters around the Svalbard archipelago. The objective is to provide an indication to the ice service, and its users, of the likely severity of the next ice season in the area. This take as inputs sea ice data from the operational ice charts, and uses a combination of environmental input data including sea level pressure (SLP) data from the NCEP/NCAR Reanalysis 1 and sea surface temperature (SST) from the NOAA Extended Reconstructed Sea Surface Temperature V3b. This data has been run through the data mining software Weka to assess the utility of a number of machine learning techniques to seasonal prediction. Recently, the forecasts have also been forced up to 6 months in advance using SLP and SST ensemble predictions from the ECMWF Seasonal Forecast System to provide a spread of possible outcomes. We report here on the techniques used, and evaluate the effectiveness of the model forecasts.

Fri_224_OS-4_2573
A Network Model for Characterizing Brine Channels in Arctic Sea Ice

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The permeability of sea ice is a fundamental characteristic with implications in atmospheric chemistry, polar biology and oceanography. Permeability is controlled by a complex network of brine channels that develops as the ice forms and whose nature depends upon ice type, depth, and temperature.
Recent advances in three-dimensional imaging using x-ray micro-computed tomography have enabled the quantification of the brine network morphology and variability. Using imaging of first-year sea ice samples collected near Utqiaġvik, Alaska, we have collected statistics on brine channel geometry that have allowed us to parameterize the pore networks based on the variables mentioned above. This enables us to create a mathematical network model to characterize the topology and connectivity of brine channels. An initial set of nodes at the top of the sea ice column is selected, where the nodes have throat sizes consistent with the probability distribution found in natural sea ice. Branches can grow or shrink, split into multiple branches, join with other branches, remain constant, or stop, all with probabilities dependent upon the given node throat size, depth/temperature, and proximity to other nodes. The model produced can help address questions such as how fluid flow varies with depth and temperature and to what extent it is microstructure and path dependent.

Fri_225_OS-4_2665
Past, Present and Future of Arctic Based on Global Coupled Climate Models

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The response of Arctic region to an increase in atmospheric GHG concentrations simulated by climate models is investigated here using the Brazilian Earth System Model (BESM) and compared with CMIP5 models dataset. We evaluated the ability of climate models to represent the Arctic sea ice changes and climate sensitivity to the atmospheric Carbon dioxide (CO_2) forcing. To do this, we used decadal simulations (1980- 2012), Future scenarios with Representative Concentration Pathway RCP 4.5 and RCP 8.5 (2006-2100) and quadrupling of the atmospheric CO_2 concentration (2006-2300). We validated our results with satellite observations. BESM results for the Arctic sea ice seasonal cycle are consistent with CMIP5 models and observations. However, almost all models tend to overestimate Sea Ice Extent (SIE) in March compared to observations. Future scenarios show dramatic decrease in SIE as response to an increase in radiative forcing. The projected future sea ice loss is explained by the combined effects of both: the amplified warming in northern hemisphere and climate feedbacks. The quadrupling of CO2 concentration numerical experiment shows the amplified warming as response to CO2 forcing with strongest warming in winter and Autumn season. The interdisciplinar effects of Anthropogenic forcing in Arctic region still are considering a hot topic and lack conclusive answers.

Fri_226_OS-5_151
Impact of Snow Salinity on CryoSat-2 Arctic Sea Ice Freeboard Measurements

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The European Space Agency's CryoSat-2 satellite radar altimeter mission provides sea ice freeboard data that are used to derive estimates of sea ice thickness and volume. These data are crucial to understanding recent variability and changes in Arctic sea ice. Sea ice thickness retrievals at the CryoSat-2 frequency require accurate measurements of sea ice freeboard, assumed to be attainable when the main radar scattering horizon originates at the snow/sea ice interface. Using an extensive snow thermophysical property dataset from late winter conditions in the Canadian Arctic, we examine the role of saline snow on first-year sea ice (FYI), with respect to its impact on the location of the main radar scattering horizon, its potential ability to decrease radar penetration depth, and its subsequent impact on FYI thickness estimates. Based on the dielectric properties of saline snow commonly found on FYI, we quantify the vertical shift in the CryoSat-2 main scattering horizon. This is found to be approximately 0.07 m. We propose a thickness-dependent snow salinity correction factor for FYI freeboard estimates. This significantly reduces CryoSat-2 FYI thickness retrieval error. Relative error reductions of ~ 11% are found for an ice thickness of 0.95 m and ~ 25% for 0.7 m. Our method also helps to close the uncertainty gap between SMOS and CryoSat-2 thin ice thickness retrievals. Our results demonstrate that snow salinity should be considered for FYI freeboard estimates.

Fri_227_OS-5_172
Retrieving Sea Ice Surface Elevation and Total Freeboard from MABEL Data

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Multiple Altimeter Beam Experimental Lidar (MABEL), the simulator of NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2) to be launched in 2018, is the first of its kind to use a photon-counting technique for mapping ice surface elevation. In this paper, we will present the MABEL dataset collected over sea ice off Greenland (northwest, north, and northeast), describe its data processing, and discuss an application to the retrieval of sea ice elevation and sea ice total freeboard. The signal photons are first separated from noise photons using a histogram-based surface-finding algorithm provided by NASA. The resulting signal photons are then low-pass filtered with three different methods (Gaussian, Wavelet, and LOESS) to estimate the ice surface elevation. The Wavelet method seems to give better results than the other two. The open water/lead along the track are discriminated solely on the different photon numbers of signal and background, with open water/lead usually having much smaller number of signal and background photons than other surfaces. The total freeboard values of ice floe are then retrieved as the difference of surface elevation and water/lead elevation, after the correction of mean sea surface height is applied. It is expected that the data analysis procedures developed for MABEL data will serve as a guide for data processing and applications of ICESat-2 data.

Fri_228_OS-5_254
Snowmelt Processes on Antarctic Sea Ice Observed by Satellite Scatterometers

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Snowmelt processes on sea ice are the key drivers determining the seasonal sea-ice energy and mass budgets. While there is strong surface melt on Arctic sea ice, snowmelt on Antarctic sea ice is weak with most snow surviving the summer. Here, we compile time series of snowmelt onset dates on perennial Antarctic sea ice from 1992 to 2014 using active microwave observations from European Remote Sensing Satellite (ERS-1/2), Quick Scatterometer (QSCAT) and Advanced Scatterometer (ASCAT) radar scatterometers. Describing snow melt processes, we define two transition stages: A weak backscatter rise indicating the initial warming and metamorphosis of the snowpack (pre-melt), followed by a rapid rise indicating the onset of thaw-freeze cycles (snowmelt). Results show large interannual variability with average pre-melt and snowmelt onset dates of 29 November and 10 December, respectively, without any significant trends over the study period. Related to different signal frequencies, we show that QSCAT Ku-band (13.4 GHz signal frequency) derived pre-melt and snowmelt onset dates are earlier by 25 and 11 days, respectively, than ERS and ASCAT C-band (5.6 GHz) derived dates. This offset has been considered when constructing the time series. As different signal frequencies result in different penetration depths, we hypothesize that the different sensors respond to typical snowmelt processes in different depths within the snow cover.

Fri_229_OS-5_265
PIPERS: SAR backscatter parameters and co-located LiDAR scans in the Ross Sea

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The austral autumn sea ice cruise to the Ross Sea and Terra Nova Bay under the research project PIPERS (Polynyas, Ice Production and Seasonal Evolution in the Ross Sea) presented extraordinary opportunities to acquire co-located SARS imagery and terrestrial laser (LiDAR) scans of the sea ice surface during autumn freeze-up conditions. Numerous sites, representing mixed first-year ice types (nilas, consolidated pancakes, and ridged first year) were laser scanned at sub-centimeter scale using a Riegl VZ-1000 LiDAR scanner in both on-the-ice surveys from multiple scan positions and single-position scans from the high vantage point of the ship's (N.B. Palmer) bridge wing. Scans generally encompassed areas of at least 100m x 100m with sufficient point cloud returns to generate surface topography rasters at better than 5 cm resolution. SAR data from two high-resolution polar orbiting satellites (TerraSAR-X and Sentinal 1) were co-spatial and co-temporally acquired of the LiDAR survey sites. We present comparisons of raw backscatter, entropy, and roughness parameters from the polarimetric SAR data for direct comparison to sea ice topography and elevation-derived surface roughness parameters. Very thin or non-existent snow cover during the cruise period will negate some of the problematic volume scattering seen in other SAR imagery, and allow better interpretation of the backscatter signal from this imagery in terms of ice type.

Fri_230_OS-5_343
Snow Cover Observations on Antarctic Sea Ice from in-situ and Model Studies

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The snow cover on Antarctic sea ice impacts the energy, mass, and momentum balance of the sea ice cover. This strongly influences fluxes between ocean, sea ice, and atmosphere. The snow depth is qualified as an Essential Climate Variable, whereas the knowledge of the snow cover distribution and properties is still mostly vague and no large-scale snow depth data product is available. The Snow cover is characterized through a high spatial and temporal variability, and shows a highly heterogeneous internal stratification. This poses a challenge to air or space borne snow depth retrieval algorithms. Similarly, sea ice models are not yet able to resolve snow processes with enough accuracy.
Here we present measurements of snow depth and physical snow properties along drift trajectories of autonomous Snow Buoys, which were deployed in the Weddell Sea since 2014. Resulting time series of snow depth show an event driven snow accumulation even during austral summer, whereas melting and a significant decrease of snow depth is only observed along the marginal sea ice zone. Additional analysis with the 1D multi-layer thermodynamic snow model SNOWPACK provides insights into internal processes such as snow to ice development. For these studies the previous land-based snow model SNOWPACK has been extended with a sea ice module and is forced with re-analysis data. Comparisons between model and in-situ measurements show the capability of the model to reproduce the prevalent snow stratigraphy.

Fri_231_OS-5_407
Snow Depth Efficacy on the Retrieval of Arctic Sea Ice Thickness and Volume

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Accurate understanding of snow loading and snow depth is crucial to sea ice thickness and volume retrieval from satellite altimetry. This study accesses the efficacy of snow depth data in both radar and laser altimetry using high resolution airborne OIB observation for 2010-2016. In addition, three reanalysis datasets (ERA-Interim, JRA-55 and MERRA-2) are adopted to investigate long term changes in the snow loading and accumulation speed. We also review inter-annual variability of snow loading both from climatology and observations in the recent decade. Although there is potential for the retrieval of sea ice thickness distribution (ITD) with current satellite data due to their high spatial resolution, the retrieval in state of the art methods are compromised due to the lack of fine-scale snow depth and the covariability between snow depth and freeboard, which has profound influence on the thickest part of basin-scale ITD. The effects are more prominent in laser altimetry (ICESat). These results show that there exists lack of efficacy of existing snow loading and snow depth data for satellite altimetry, and small-scale variability plays an important role in retrieval for both types of altimetry.

Fri_232_OS-5_458
Snow Metamorphism at the Interface between Ice and Snow

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Temperature gradient snow metamorphism at the interface between ice and overlying snow shows a strongly different evolution compared to the structural evolution in the bulk snowpack under the same mean temperature gradient. We demonstrate that a positive temperature gradients leads to the formation of a new interfacial snow layer caused by the sublimation of the ice. We measured these processeses by time-lapes micro-tomography. Numerical simulations show a strong horizontal variability of the temperature gradient at the sub-millimeter scale. This explains the macroscopically observed "enhanced" temperature gradient at such interfaces. We conclude that this process is relevant for the evolution of the energy balance of a snowpack on ice, but also for the chemical properties of the snowpack.

Fri_233_OS-5_541
Retrieval of Snow Depth on Sea Ice from FY3B MWRI in the Arctic

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Given the high albedo and low thermal conductivity, Snow on sea ice is regarded as one of the key reasons for the amplification of the warming in polar regions. This study focused on the retrieval of snow depth on sea ice from brightness temperatures of the Microwave Radiation Imager (MWRI) on board the FengYun (FY)-3B satellite during the period from December 1, 2010 to April 30, 2011. After cross calibrated to the Advanced Microwave Scanning Radiometer-EOS (AMSR-E) Level 2A data, the MWRI brightness temperatures were applied to calculate the sea ice concentrations based on the Arctic Radiation and Turbulence Interaction Study Sea Ice (ASI) algorithm. The snow depths were derived according to the proportional relationship between the snow depth and the surface scattering in 18.7 and 36.5 GHz. In order to eliminate the influence of uncertainties in grain sizes of snow as well as sporadic weather effects, the seven-day averaged snow depths were calculated. Then the results were compared with the snow depths from two data sets: IceBridge ICDIS4 data set and the AMSR-E Level 3 Sea Ice products. The bias and standard deviation of differences between the MWRI snow depth and the IceBridge data are 3.34 cm and 2.79 cm for a total of 52 matchups, respectively. And the biases between the MWRI and the AMSR-E Level 3 products are ranged between -1.09 and -0.32 cm. It is proved that the method taken in this study is feasible and the results are reasonable.

Fri_234_OS-5_674
Snow Depth on Arctic Sea Ice from Passive Microwave Radiometers

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Snow depth on Arctic sea ice is one of the key parameters to describe and understand changes in the Arctic climate. Due to its low thermal conductivity, snow strongly influences the growth and melt of Arctic sea ice. Snow has a high albedo and is therefore important for the Arctic energy budged. Sea ice thickness retrievals from altimetry rely on accurate snow depth and density estimations.
Observations from satellite radiometers provide a great tool to monitor the Arctic region on a daily and Arctic-wide scale. The first retrieval for snow depth on sea ice was developed by Marcus and Cavalieri and is based on passive microwave satellite observations at 19 and 37 GHz. However, in the Arctic, the retrieval is limited to seasonal ice and snow depths below 50 cm. In addition, rough ice and snow metamorphism can strongly influence the retrieval.
In this study, a new retrieval for snow on Arctic sea ice is derived using multiple AMSR-E/2 frequency combinations. The retrieval is trained with airborne snow depth measurements obtained from the NASA Operation IceBridge campaigns. First results indicate a good performance of the retrieval over seasonal ice and a reasonable performance over multiyear ice. In a study with the Microwave Emission Model MEMLS, the theoretical influences of different snow and ice properties on the retrieval are investigated using in situ measurements from the N-ICE2015 campaign. Additionally, the effects of salty snow and snow metamorphism are analyzed.

Fri_235_OS-5_706
Snow Depth on Arctic Sea Ice from Historical in Situ Data

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The snow layer on top of the sea ice plays an important in the retrieval of ice freeboard and thickness from satellite altimeter data. In situ observations of the snow layer is needed as input to the retrieval algorithms and for validation of the resulting thickness estimates. In this study snow data from the Soviet airborne expeditions Sever have been analyzed for the period 1959-1986, combined with data from the North Pole Drifting stations, in order to estimate the snow depth climatology for March, April, and May. The data covers the essential parts of the Arctic sea ice areas, with most data in the Eurasian seas. The following snow parameters have been analyzed: average snow depth on the level ice, height, and area of sastrugi, depth of snow dunes attached to ice ridges and depth of snow on hummocks. The research resulted in a new snow depth climatology for the winter months, showing lower values compared to the Warren climatology in the central Arctic and more detailed estimates for the Eurasian seas. The analysis of the Sever data showed that the average depth of undisturbed snow on the level ice varied from 9.8 cm in the Laptev Sea to 15.3 cm in the East Siberian Sea. The highest values in the East Siberian Sea are explained by the larger proportion of multiyear ice which generally has thicker snow layer than first-year ice. The new climatology of snow depth will be a useful reference data against which new observations can be compared.

Fri_236_OS-5_835
Deformed ice and Level Ice Distinction from Dual-polarized Sentinel-1

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SAR is the most promising technique for observing sea ice conditions in polar regions due to its all-weather and all-day availability. Sea ice consists of level and deformed ice floes covering the polar sea zone. It is significant to understand the relationships between deformed ice and thickness redistribution when Arctic sea ice thinning since deformed ice including ridges and brash ice over first year and multiyear ice dominates Arctic surface topography, which alludes to importance of ice deformation distribution in the total ice volume. Although different scattering mechanisms of deformed ice and level ice provide the proxy for sea ice type distinction, level ice and deformed ice distinction can only rely on SAR backscatter intensity from Sentinel-1. An operational algorithm is developed in combination with rich features to capture texture pattern of deformed ice and level ice. The rich features to depict the deformation ice pattern including ridges, brash ice and rubble surface field include ridging density, deformation pattern geometry characteristic, GLCM texture and surface roughness. We focus on Fram Strait, where is a faster export of sea ice allowing larger drifting speed and deformation using Sentinel-1 dual polarization data from October, 2014 to October, 2017 for ice deformation identification based on the SVM by feeding rich features. The deformation distribution will be used to retrieve snow depth over sea ice with different roughness surface.

Fri_237_OS-5_970
Impact of Melting Snow and Melt Ponds on AMSR-E Sea-ice Concentrations

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Brightness temperatures (TB) observed by satellite microwave radiometers allow us to retrieve the sea-ice area fraction (sea-ice concentration or SIC) with an accuracy of ~ 2% during winter. The accuracy during the melting season is unknown. Once melting of the snow cover on sea ice commences, TBs change - first due to the snow wetness and/or an elevated snow grain size due to melt-refreeze cycles, later due to the formation of melt ponds, i.e. puddles of melt water on the snow or ice surface. Because the penetration depth of microwave radiation into liquid water is about a few millimeters, melt ponds have the same radiometric signature as open water in leads and openings between ice floes. Consequently, SIC retrieved over sea ice covered with melt ponds should represent the net ice surface fraction (ISF). Here we show results of our analysis of the joint EUMETSAT OSISAF - ESA CCI SIC data products. Time-series of SIC suggest an increase in fractions of SIC near 100% during early melt (May/June) indicative of the impact of wet snow. Inter-comparison with melt-pond fraction (MPF), 1 minus open-water fraction from leads and openings (SIC_M), and ISF derived from MODIS optical data reveals an overall negative bias between SIC and SIC_M of only ~1%. However, from a more detailed analysis we find regional biases between SIC and SIC_M ranging from -20% to +10%. We also find that SIC exceeds ISF by up to 35%; this over-estimation often but not always equals the MPF.

Fri_238_OS-5_1267
Studying a Full Year of Snow on Arctic Sea Ice - Plans for MOSAiC 2019/20

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The snow cover on sea ice dominates many exchange processes and properties of the ice covered polar oceans. While it is known for its extraordinarily large spatial and temporal variability, snow properties and even snow depth distributions are among the least known and most difficult to observe climate variables. Starting in autumn 2019 and ending in autumn 2020, the international MOSAiC drift experiment will allow to observe the evolution of a snow pack on Arctic sea ice over a full annual cycle. During the drift with one ice floe along the transpolar drift, we will be able to perform most comprehensive studies on seasonal sea ice and relate them to previous expeditions and parallel observations at different locations. Here we present the current status of our planning of the MOSAiC snow program. The field program will include regular manual observations and sampling on the main floe of the central observatory, autonomous recordings in a distributed network, airborne observations in the surrounding, and retrievals of satellite remote sensing products. Along with the field program, numerical simulations of the MOSAiC snow cover will be performed on different scales, including large-scale interaction with the atmosphere and the sea ice. The snow studies will also bridge between the different disciplines, including physical, chemical, biological, and biogeochemical measurements, samples, and fluxes.

Fri_239_OS-5_1286
Impact of Sea Ice Thickness and Freeboard Products on Forecast Performance

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The A+5 project of ESA's Arctic+ initiative has constructed a flexible system for Arctic Mission Benefit Analysis (ArcMBA) that evaluates in a mathematically rigorous fashion the observational constraints imposed by individual and groups of EO data products in using the quantitative network design (QND) approach.
The assessment of the observation impact (added value) is performed in terms of the uncertainty reduction in a four-week forecast of sea ice and snow volumes for three regions along the Northern Sea Route.
The assessments covered seven EO products, three real products and four hypothetical products.
The real products are monthly sea ice thickness (SIT), sea ice freeboard (SIFB), and radar freeboard (RFB), all derived from CryoSat-2 by AWI. These are complemented by two hypothetical laser freeboard products and two hypothetical snow depth products.
On the basis of the per-pixel uncertainty ranges that are provided with the CryoSat-2 products, the SIT achieves the best performance for SIV forecasts. For SNV, the performance of RFB is better. A hypothetical laser freeboard (LFB) product with low accuracy has a similar impact as RFB on both SIV and SNV. A reduction in the uncertainty of the LFB product yields a significant increase in performance.
Combining with a hypothetical snow depth product achieves a significant performance.

Fri_240_OS-5_1287
Snow on Sea Ice from Models and Measurements

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Variability in thickness, density and emissivity of snow on sea ice is a major limiting factor for the accuracy of sea ice thickness retrievals from laser and radar altimetry as well as for ice concentration retrievals from microwave radiometer measurements.
In addition, snow plays a significant role in sea ice thermodynamics by limiting sea ice growth rates due to its strong insulating effect.
In this study, we have compared a number of datasets for snow on sea ice obtained from operational ice/ocean models, climate models and remote sensing observations. We have compared the snow thicknesses obtained by the different methods to radar snow depth measurements from NASAs Operation Ice Bridge (OIB) and we find significant differences between models as well as between observation datasets.

Fri_241_OS-5_1806
Sea Ice Concentration Observed Low Microwave Frequency Radiometers

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The launch of the Soil Moisture and Ocean Salinity (SMOS) mission, in 2009, marked the dawn of a new type of space-based microwave observations. Although the mission was originally conceived for hydrological and oceanographic studies, SMOS is also making inroads in the cryospheric sciences by measuring the thin ice thickness. SMOS carries an L-band (1.4 GHz), passive interferometric radiometer (the so-called MIRAS) that measures the electromagnetic radiation emitted by the Earth's surface, at about 50 km spatial resolution, continuous multi-angle viewing, large wide swath (1200-km), and with a 3-day revisit time at the equator, but more frequently at the poles. AMSR-2 instrument is on JAXA´s GCOM-W1 spacecraft, and was launched on 2012. AMSR-2 have radiometers working at several bands: 6.9, 7.3, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz.
An assessment on the differences on the sea ice concentration (SIC) maps obtained from low microwave frequencies radiometers, 6.9GHz (from AMSR-2) and SMOS, versus higher frequency (19Ghz and 37GHz) radiometers are presented. Despite its lower spatial resolution relative higher frequencies, SMOS-derived SIC products are little affected by the atmosphere and the snow (almost transparent at L-band). Moreover L-band measurements are more robust in front of the accelerated metamorphosis and melt processes during summer affecting the ice surface fraction measurements.

Fri_242_OS-5_1828
Potential of Snow-ice Formation in the Arctic

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As a consequence of a general thinning of Arctic sea ice the snow depth to sea-ice thickness ratio is increasing. At some point, this will result in more widespread negative freeboard in parts of the Arctic, where the snow depth at a given time in a season stays constant or increases. These areas could potentially be flooded in case of mechanical breaking of ice due to deformation or when sea ice becomes permeable. Flooding of sea ice can create new habitats for snow infiltrating phytoplankton communities. Flooding also effects remote sensing applications, like radar based sea-ice thickness retrievals from CryoSat-2, by biasing the retrieved sea ice thickness towards higher values. In colder months this flooded layer will freeze, creating snow-ice. Snow-ice formation will release additional heat from the ocean to the atmosphere and contribute to the sea-ice mass balance. These processes are widespread on seasonal sea ice in Antarctica. However, recent studies show a significant occurrence of snow-ice in the Arctic Ocean north of Svalbard in 2015, due to the high precipitation in this region compared with other parts of the Arctic. In this study we examine the potential of flooding and subsequent snow-ice formation in different regions of the Arctic Ocean with respect to inter-annual variability of snow precipitation and sea-ice thickness, by using a 1D-snow/ice thermodynamic model forced with sea ice drift and reanalysis data.

Fri_243_OS-5_1925
Construction of Snow Depth Statistical Model Based on IMB Data on Arctic Sea Ice

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Snow cover on Arctic sea ice is crucial to the global climate system through snow-ice albedo feedback mechanism. In order to solve the issue of lacking of snow depth information on Arctic sea ice at a large spatial scale, we constructed the snow depth model using the Ice Mass Balance buoys measurements in the Arctic, compared with previous snow depth model, and analyzed the variation of monthly average snow depth on the Arctic sea ice. The results show that the snow depth model built up in this paper efficiently reflects the distribution of snow depth on Arctic sea ice, with the bias varies from -0.3 to 1.0cm, and -5% to 12% for mean relative error. Monthly average snow depth calculated from the model indicates that the snow depth on the Arctic sea ice rose gently from January to March, and stabilized in April and May, continued to decrease from June to July and fell to the minimum in August. In September and October, the snow depth increased rapidly in the Canadian Arctic Archipelago and Northern Greenland. The snow depth model constructed in this paper can provide basic information and reference for the study of sea ice and global climate change.

Fri_244_OS-5_2072
White Snow Is Not White noise (Unfortunately)

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In this contribution, the authors consider snow not as a (suite of) parameter(s) to be measured, but as an impediment to the accurate retrieval of Sea Ice Concentration (SIC) and Type (SIType) from space-borne Passive Microwave Radiometers (PMR). In the Arctic winter the accuracy of SIC and SIType retrieval algorithms is at present limited by the lack of knowledge of snow characteristics such as depth, grain size, wetness, density, layering and emissivity. State-of-the-art SIC algorithms allow retrieval uncertainties in the order of 3-5% (1-sigma), but should aim to 0.5-1% to really be useful for constraining the heat fluxes through cracks and leads.
We investigate the patterns of the noise observed in the recent EUMETSAT OSI SAF and ESA CCI SIC data records, and link these to snow and upper sea ice properties. We also use emission models to illustrate how snow contributes to the inaccuracies of SIC algorithms, and how the impact differs between the algorithms. Inaccurate first-year/multi-year sea ice classification due to snow is also investigated in the Copernicus Climate Change (C3S) sea ice type data record. We show how lack of knowledge of the snow parameters propagates as non-white noise for the retrieval of SIC and SIType.
Finally, we show results from early attempts to either mitigate the influence of snow in the SIC algorithms, or to jointly retrieve concentration, type, and snow parameters from multi-channels PMR such as the JAXA's AMSR2.

Fri_245_OS-5_2399
About a Way to Improve Snow-depth Retrieval for Antarctic Sea Ice

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Snow on Antarctic sea ice is known for its large spatiotemporal variability. High cyclone activity causes a deeper snow cover in the Antarctica. Physical properties like density, grain size, liquid water content, and salinity are more diverse comparing to Arctic. This provides big challenges for the retrieval of sea ice concentration and sea ice thickness from satellite observations. Particularly there is still an accurate data set of snow depth on sea ice needed.
Satellite microwave radiometry (MWR) permits to retrieve snow depth on sea ice on hemispheric scale. Several studies demonstrated, however, that these snow depth estimates are biased depending on various snow and sea-ice properties. One of these is surface roughness. Combination of satellite MWR with surface roughness information from altimetry was shown to mitigate this bias. We elaborated on this approach and combine the along-track variability of total (sea ice and snow) freeboard estimates from ICESat laser altimeter observations with the classic approach to compute snow depth because such surface roughness data is not available for the entire satellite MWR. Therefore, we analyze a unique data set of ICESat roughness, satellite scatterometer data, satellite microwave brightness temperatures (other than those used in the classic retrieval), meteorological data from reanalysis, and ship-based observations of sea ice and snow properties to find a proxy for the surface roughness.

Fri_246_OS-5_2501
Physical and Optical Properties of Snow over Melting Arctic Sea Ice

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Snow cover is a common and important feature in polar regions. It strongly affects the radiative transfer of Arctic sea ice by increasing its reflectance and drastically reducing the amount of light reaching the water column. As a consequence, the snow layer plays a crucial role with ocean primary production which is mainly light limited before the onset of melt. Observing snow properties and sea ice optics is thus a fundamental key to a better understanding of the links between snow and ocean biology.
Intensive snow samplings, covering the entire melt season, were conducted during GreenEdge campaigns in 2015 and 2016 over landfast sea ice near Qikiqtarjuaq community in Baffin Island. Optical properties such as albedo, vertical profile of irradiance in snow and transmittance through the ice were measured as well as physical properties including stratigraphy observations and vertical profiles of snow density and snow specific surface area.
Based on these observations, the melt season can be divided in four main phases with very different signatures in albedo spectra as a consequence of snow metamorphism. Among all parameters, snow height was the main factor controlling transmittance. An ice algae bloom was observed in 2015, and its intensity depended on the snow history which was derived from the vertical profile of snow physical properties. The onset of melting marked the end of this bloom.

Fri_247_OS-5_2622
Improving Observations and Understanding of Snow on Arctic Sea Ice: ESA Arctic+

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Only satellite remote sensing can provide the pan-Arctic view required to fully understand changes to the Earth's sea ice fields but important observational gaps remain which limit both our interpretation of remote-sensing data and our understanding of the Arctic climate system. In that regard, snow on sea ice represents both a major source of uncertainty in sea ice concentration and thickness retrievals from satellite data, and a poorly resolved quantity of climatic importance. The overarching objective of this proposal is to address these issues and to produce a state of the art now on sea ice thickness and density product. To achieve this goal we will use data from the most advanced and recent EO missions.
We will utilize a comprehensive array of airborne and in-situ snow measurements to develop and validate two independent approaches to snow thickness retrieval on Arctic sea ice. In the Dual-altimeter Snow Thickness (DuST) product, we will utilize data from multiple contemporary satellite altimeters to derive information about the snow layer. In the SNOw on Drifting Sea Ice (SnoDSI) product we will utilize satellite-derived sea ice drift and precipitation from atmospheric reanalysis to build a package that accumulates, redistributes and melts snow on individually tracked ice parcels at daily resolution. Because of the impact of the snow thickness and density estimates for sea ice thickness retrievals this proposal will feed in the Arctic+ Theme 2: Sea Ice Mass project.

Fri_248_OS-5_1230
Snow Depth on Antarctic Sea Ice from Satellite: Time Series and Trends 2002 - 2017

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The high albedo and low heat conductivity of snow on sea ice strongly influence polar radiative processes and heat transfer, needed for climate and numerical weather prediction models. Furthermore, accurate snow depth data are required to retrieve sea ice thickness from altimeter freeboard measurements. Only passive microwave sensors on satellites offer the possibility to continuously retrieve snow depth on Antarctic scale independent of daylight and cloud cover. However, in the Antarctic specific processes (flooding, melting and refreezing) together with sea ice ridges and leads cause highly variable snow properties so that often the accuracy of the retrieved snow depth is not known.
Here the empirical snow-depth retrieval algorithm by Markus and Cavalieri (1998), later adapted to AMSR-E (Advanced Microwave Scanning Radiometer for EOS) data by conversion of AMSR-E brightness temperatures to SSM/I equivalent brightness temperatures (Comiso et al., 2003, Brucker and Markus, 2013) is re-calibrated using visual ship-based observations from an extended ASPeCt data set (Worby and Allison, 1999, Worby et al., 2008) on a monthly basis and by Antarctic sectors so that the resulting algorithm is directly applicable. A data set for the years 2002-2017 will be presented together with a physical analysis of monthly average snow depths sea ice concentration and air temperature, as well as their trends and correlations.

Fri_249_OS-7_79
Vertical Ocean Heat Redistribution Sustaining Sea-Ice Trends in the Ross Sea

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Several processes have been hypothesized to explain the slight overall expansion of Antarctic sea ice over the satellite observation era, including externally forced changes in local winds or in the Southern Ocean's hydrological cycle, as well as internal climate variability. Here, we show the critical influence of an ocean-sea-ice feedback. Once initiated by an external perturbation, it may be sufficient to sustain the observed sea-ice expansion in the Ross Sea, the region with the largest and most significant expansion. We quantify the heat trapped at the base of the ocean mixed layer and demonstrate that it is of the same order of magnitude as the latent heat storage due to the long-term changes in sea-ice volume. The evidence thus suggests that the recent ice coverage increase in the Ross Sea could have been achieved through a reorganization of energy within the near-surface ice-ocean system.

Fri_250_OS-7_131
Holocene Sea Ice Variability Driven by Wind and Polynya Efficency in Ross Sea

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The causes of the recent increase in Antarctic sea ice extent, characterised by large regional contrasts and decadal variations, remain unclear. In the Ross Sea, where such a sea ice increase is reported, 50% of the sea ice is produced within wind-sustained latent-heat polynyas. Combining information from marine diatom records and sea-salt sodium and water isotope ice core records, we here document contrasting patterns in sea ice variations between coastal and open sea areas in Western Ross Sea over the current interglacial period. Since about 3600 years Before Present, an increase in the efficiency of regional latent-heat polynyas resulted in more coastal sea ice, while sea ice extent decreased overall. These past changes coincide with remarkable optima or minima in the abundances of penguins, silverfish and seal remains, confirming the high sensitivity of marine ecosystems to environmental and especially coastal sea ice conditions.

Fri_251_OS-7_300
Sea-ice Production in Arctic Polynyas between 2002 and 2017

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In this study, a high-resolution (2 km) MODIS thermal infrared satellite data set featuring spatial and temporal characteristics of 17 Arctic polynya regions is presented for winter seasons 2002/2003 to 2016/2017. The data set features the most recent updates of the employed MOD/MYD29 sea ice product (Col. 6) which includes improvements to the cloud masking and land/ocean separation. Thin-ice thickness distributions are calculated from MODIS ice-surface temperatures, combined with ECMWF ERA-Interim atmospheric reanalysis data in an energy balance model. Daily thin-ice thickness composites are subsequently computed. A gap-filling approach is applied to account for clouds and missing data in the thermal infrared imagery. The most recent winter season in the data set (2016/17) features the so far highest annual sea-ice production with a volume of 2258 km^3, presumably originating from highly active polynyas throughout the eastern Arctic and/or a particularly thin and less extensive wintertime sea-ice coverage that season. Thin-ice thicknesses from an AMSR-E passive microwave data set are used to evaluate and quantify sensor-specific capabilities and error sources for a large-scale pan-Arctic polynya monitoring. Despite obvious differences, such as the acquired signal at the sensor, varying spatial resolutions or the individual sensitivity for cloud cover, both data sets are coherent in terms of capturing the general properties of Arctic polynyas for an overlapping 9-yr period.

Fri_252_OS-7_321
The Impact of Snowmelt on the Arctic Ocean Heat Budget

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The ocean surface heat flux is typically calculated from the sum of longwave radiation, shortwave radiation, sensible heat flux, and evaporative heat flux. In polar oceans, an additional heat sink may also arise through the melting of snowfall. In this study, we use Cloudsat measurements and ECMWF-ERA interim reanalysis to quantify the impacts of snowmelt in the Arctic Ocean. Focusing on the freeze-up season, we find that the cooling from snowmelt can provide a cooling in the order of 1-10% of the net ocean heat flux on month-long time scales. During heavy snowstorms, the cooling from snowmelt may represent the dominating factor in oceanic heat flux.

Fri_253_OS-7_356
Water Isotopes Signature in Surface Antarctica (COMBINISO Project)

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The aim of the COMBINISO project is to disentangle the different influences on the water isotope composition on the East Antarctic plateau to provide more faithful reconstruction of climate and water source origin from the snow cores over the last decades. A wealth of isotopic measurements have been acquired at the continuum between surface snow, subsurface snow and atmosphere mainly at the Dome C station showing how precipitation, temperature and metamorphism influences the snow surface isotopic composition. In parallel, a huge modeling effort have been deployed both at the global scale and at the local scale by (1) implementing tritium in the atmospheric model equipped with stable water isotopes LMDZ-iso and (2) implementing water vapor transport and water stable isotopes in the snowpack model CROCUS. Finally, an array of snow cores analyzed at different Antarctic stations are interpreted together with modeling outputs to provide insight on the recent evolution of climate and moisture source, including stratospheric input in very dry regions of the East Antarctic plateau.

Fri_254_OS-7_399
Circumpolar Deep Water Upwelling and Suppressed Sea Ice Production in Prydz Bay

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Strengthened Circumpolar Deep Water (CDW) intrusion into shelf region around Antarctic can increase oceanic heat supply on the shelf, enhancing ice shelf basal melt and suppressing sea ice production synchronously. In Prydz Bay, highly modified CDW (mCDW) upwells to subsurface in the southeastern embayment, where relative warm mCDW inflow encounters with extremely cold denser shelf water. Strengthened convection during ice freezing season extends to as deep as 300 m, bringing the upwelled warm water to surface. Accumulated upward heat supply through convection from intermediate mCDW to surface during March-August is estimated at 3.9×10^{15} kJ, which can reduce sea ice production by 12.7 km^3, approximate half of the ice production volume in Davis Polynya. This study highlights the potential reversal of sea ice increasing trend in the southern ocean and further hindering of dense shelf water formation around Antarctic due to strengthened intrusion of CDW.

Fri_255_OS-7_473
How Much Submarine Melt Water from Greenland is in the Labrador Sea?

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Submarine melt of the Greenland Ice sheet (GrIS) is significantly contributing to the accelerating mass loss of GrIS. When this additional freshwater flows into the central Labrador Sea, the vertical density stratification could increase and weaken deep convection, and thus the meridional overturning circulation. How much submarine melt water (SMW) reaches the convection region and where it leaves the Greenland Boundary Current is up to now uncertain. Helium and Neon isotopes are unique tools to identify and quantify the fraction of SMW in the ocean down to fractions of 0.05%. Here we present SMW distributions from hydrographic and noble gas measurements in the Greenland Boundary Current and the Labrador Sea form historical data and samples taken in summer 2015.

Fri_256_OS-7_480
Frazil Ice Streaks on PIPERS: the Role of Sea Ice-Ocean Interactions

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In polar regions, open water areas (e.g., polynyas) are regions of high production rates of new sea ice. If the wind is sufficiently strong, streaks of frazil ice tend to form on the sea surface. Observations show that the streaks have several remarkable features: their spacing is irregular; there are sharp boundaries between regions with high and low frazil concentration; neighboring streaks tend to merge into larger ones, but they never split. These features make the Langmuir circulation an unlikely explanation for the formation of frazil streaks. In this paper, we propose a model reproducing the overall behavior and evolution of frazil streaks, and we make an attempt to answer a question whether their formation is solely a result of upper-ocean turbulence, with ice crystals behaving as a passive tracer that accumulates in convergence zones, or, alternatively, whether the presence of ice itself affects the turbulence patterns in a way that further reinforces streak formation. Our results suggest that the second scenario is consistent with observations, and that growth rates of frazil clusters on the sea surface are enhanced by turbulence suppression within those clusters - which in turn is a consequence of enhanced viscosity in areas of high frazil concentration and lowered effective restitution coefficient between colliding crystals. This last property speeds up transition of frazil/grease ice into pancake ice, thus substantially influencing the evolution of the ice cover.

Fri_257_OS-7_491
Linking Precipitation Deuterium Excess and the Occurrence of Cyclones

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Deuterium excess is an important second order isotope parameter that has been widely used for paleoclimate reconstructions mainly of sea surface temperature but also of relative humidity. Deuterium excess is a particularly powerful tracer for moisture source properties, because it is intrinsically sensitive to non-equilibrium conditions occurring in unsaturated (i.e. strongly evaporative) environments and thus allows to quantify the deviation from thermodynamic equilibrium during phase changes. To first order, the deuterium excess of water vapour is conserved during transport and moderate rain out along an air parcel's trajectory. On this poster, a robust process-based link is established between cold advection induced by the occurrence of cyclones and the interannual variability of precipitation deuterium excess at four stations of the Global Network of Isotopes in Precipitation (GNIP) in the North Atlantic. Positive anomalies of annual precipitation deuterium excess are found to be linked with positive anomalies of strong ocean evaporation in the moisture source region of the respective station's precipitation. Furthermore, a strong signal is also detected in the occurrence frequencies of cyclones located to the northwest of the moisture source region. The possible implications of these results for the use of precipitation deuterium excess as a proxy for the location of the storm track are discussed.

Fri_258_OS-7_544
Changes in Sea Ice Deformation and Impact of the Wind Forcing

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An increase in Arctic sea ice speed during recent decades by 10-15% per decade has been observed from buoy and satellite observations.Higher resolution Synthetic Aperture Radar(SAR) observations are best suited for sea ice deformation retrieval,but they were not yet fully analysed for long-term ice deformation changes.How much the different components in the sea ice force balance have contributed to the observed changes in sea ice dynamics is not fully understood.
Sea ice motion fields from SAR observations can be used to obtain sea ice strain rates i.e. sea ice deformation fields.Currently,there is no SAR satellite sea ice deformation datasets covering the complete Arctic Basin available.The RGPS data mainly covers the Canadian Arctic region(1996-2008) and the ENVISAT dataset covers the European Arctic region(2007-2012).Since 2015 Sentinel-1 offers a better coverage of the Arctic basin.Available SAR datasets are analysed for the changes in space and time.Findings will contribute to better quantify the changes in Arctic sea ice dynamics and evaluate sea-ice models.
Observed sea ice deformation changes are compared to Atmospheric reanalysis to gain understanding of causes.On short time scale wind is the main driver of sea ice drift.Studies show that for most of the Arctic Basin changes in wind speed cannot explain the increase in sea ice drift speed.In this study we compare sea ice deformation fields from satellites to wind forcing from reanalysis to quantify their relation.

Fri_259_OS-7_567
The Platelet-affected under-Ice Boundary Layer

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The influence of the ice shelf cavities on sea ice processes has not been quantified at any scale. Here we focus on processes in the upper ocean boundary layer in a region of Ice Shelf Water (ISW) outflow. Accumulations of platelet ice, up to several metres thick, form the physical boundary structure through most of the year in Western McMurdo Sound in the Ross Sea. Recent observations have revealed an amplified ocean response to the modified boundary in excess of 30 m deep. We interpret these observations as multiple modes contributing to effective drag of up to two orders of magnitude greater than is presently used in regional ocean models. Here we suggest quantifiable relationships between the upstream and ambient conditions; the thickness of the platelet layer; and the longevity of supercooled ISW front the calving front; which are intended to inform under-ice boundary layer parameterisations.

Fri_260_OS-7_817
Albedo and Energy Balance of Melt Pond During Late Summer in the Central Arctic

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In order to understand the thermodynamical process on the melt pond surface in the Arctic, in situ observations of the melt pond radiation have been carried out in the Central Arctic during the Chinese Arctic Surveys in 2012, 2014 and 2016. Based on the surface state of melt pond, we categorize the melt pond into five types: original melt pond (ORMP), water-ice covered melt pond (WIMP), thin snow covered melt pond (TSMP, snow depth is less than 1cm), moderate snow covered melt pond (MSMP, snow depth is between 1 to 2cm) and deep snow covered melt pond (DSMP, snow depth is more than 2cm). The albedos of the five types of melt pond are 0.1-0.2 for the ORMP, 0.2-0.35 for the WIMP, 0.35-0.55 for the TSMP, 0.55-0.8 for the MSMP and 0.8-0.95 for the DSMP. Moreover, the albedos of ORMP and WIMP decrease gradually with the increased depth of melt pond. On the contrary, the albedos of TSMP, MSMP and DSMP are not affected by the depth of melt pond but the covered ice thickness that increase the albedo with ice growing. During the late summer, solar shortwave radiation is still the main energy resource for the melt pond developing. The partitioning of solar radiation into the melt pond system has been calculated based on previous theory and in situ measurements. The covered ice cap has absorbed less then 5% of the solar radiation, while about 60% of them has been absorbed by the melt water and 35% by the underlying ice and ocean.

Fri_262_OS-7_895
Mercury and Organic Aerosols Cycling Response to Sea Ice Change in the Polar Sea

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Sea ice change in the Southern Ocean and the Arctic Ocean influences the pollutant, gases and particles across the air/sea/ice interface and ultimately interactions and feedbacks with the climate and ecological system. One of the discoveries response to dynamic of sea ice in these regions is the mercury cycling. Atmospheric chemistry occurring on and above sea ice is found to destroy mercury in the marine boundary layer in the austral summertime, and increase or retreat of sea ice influences the air-sea exchange of mercury. A lot of saturated mercury in the seawater below the ice, and will be released with the ice melts. Such kinds of chemical and physical processes are important to understand and evaluate the risk of ecosystem exposed to this toxic element. Sea ice will also influence on the biological activities, which will contribute a substantial organic fraction of the atmospheric aerosol. The concentration of bacterium over the floating sea ice region was higher than found over the open sea areas. Temporal and spatial change in biological particles including primary organic aerosol, secondary organic aerosol and associated biogenic volatile compounds (e.g. isoprene, halocarbon, and DMS) for atmospheric processes and air/sea/ice interfaces are thus urgent to fully investigate. These results will provide constraint for model simulation of climate change in the regional scale.

Fri_263_OS-7_931
Linking Water Isotopes and Air-sea Interactions: Two Southern Ocean Case Studies

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Stable water isotopes (SWI) have been used as climate proxies for several decades. At the synoptic time-scale, SWI serve as tracers to investigate moist processes associated with weather systems. In this presentation, we link hourly signals of boundary layer vapour SWI with air-sea fluxes induced by the synoptic-scale flow. For this the measurements performed in the framework of the Antarctic Circumnavigation Expedition (ACE) are used. During this international campaign in the austral summer 2016/2017, SWI in atmospheric water vapour, precipitation and ocean surface waters were measured on board the Russian research vessel Akademik Tryoshnikov. Together with radio sonde profiles, radar observations and high-resolution humidity measurements a comprehensive data set is available to study the Southern Ocean fresh water cycle. In order to put the measurements in a spatial context, the SWI measurements are combined with operational analysis data of the European Centre for Medium-Range Weather Forecasts and simulations from the isotope-enabled regional numerical model COSMOiso.
Here we present two cases studies of one cold and one warm advection event, in which we highlight the relevant processes that influence the strongly contrasting SWI signatures associated with these events. A composite analysis of ~20 temperature advection events shows that cold, respectively warm advection, is associated with distinct SWI signatures of the near-surface water vapour.

Fri_264_OS-7_989
Surface Drag over Arctic Sea Ice: Direct Observations from an Icebreaker

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The surface drag, or roughness, over sea ice is prescribed in numerical weather prediction, climate and Earth system models in order to determine atmosphere-ice/ocean momentum exchange. There are few direct observations of surface drag available to develop drag parameterisations from. This is particularly the case for both the Marginal Ice Zone (MIZ), and for modern Arctic conditions.
Here we present direct eddy covariance and inertial dissipation estimates of surface momentum exchange obtained in the Arctic Ocean from the icebreaker *Oden* during two expeditions; the Arctic Clouds in Summer Experiment (ACSE) in 2014 and Arctic Ocean 2016. The extensive data set spans a range of surface conditions during the Arctic summer and autumn, with both melting and freezing periods, ice-free to ice-covered ocean with a large fraction of measurements within the MIZ, and 10-minute average winds up to 22 m/s.
The wind measurements are corrected for platform motion and for flow distortion using computational fluid dynamic modelling of the airflow over *Oden.* Surface conditions are characterised using ship-based digital imagery and infrared temperature sensors, as well as satellite-based estimates of sea ice concentration. The dependence of the measured drag on surface conditions is analysed and compared to published parameterisations.

Fri_265_OS-7_991
Sea-air Flux and Transfer Velocity of CH4 / CO2 Measured on the Siberian Shelf

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The East Siberian Arctic Shelf (ESAS) seas have been proposed as a substantial source of methane (CH_4) to the atmosphere, and are an important sink for atmospheric CO_2. We report extensive direct eddy covariance observations of CO_2 and CH_4 fluxes between the sea and the atmosphere, from a ship in the ESAS seas during July-August 2014.
Our results show that that sea emissions of CH4 leading to atmospheric enhancements of CH4 above the ESAS are regionally explainable by wind-driven diffusive fluxes. Based on our measurements, we estimate an annual sea-air flux of 1.49 Tg yr^{-1} for the entire ESAS. Areas of enhanced flux from seafloor-released bubbles transferring CH_4 directly into the atmosphere were observed but had limited spatial extent. For example in one location in the East Siberian Sea, we observed sea-air CH_4 fluxes exceeding 600 mg m^{-2} d^{-1}, over an area of ~100 m^2. Although locally impressively large, such fluxes make a negligible contribution to total ESAS CH^4 emissions.
We also present direct determination of the CO_2 and CH_4 air-sea gas transfer velocity in a wide range of Arctic sea ice conditions. We show that the gas transfer velocity increases near linearly with decreasing sea ice concentration and that previous modeling approaches may overestimate gas transfer rates in sea ice regions.

Fri_266_OS-7_993
Multi-annual Observations of Tropospheric BrO at Two Antarctic Stations

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The presence of high amounts of bromine monoxide (BrO) each spring in Polar Regions has a substantial impact on the oxidative capacity of the polar boundary layer. Released by autocatalytic processes on saline surfaces, such as sea ice, snow and aerosols, BrO frequently leads to a virtually complete destruction of near-surface ozone. Furthermore, the oxidation of DMS by BrO can have a potential impact on climate. The oxidation of elemental mercury by BrO leads to an enhanced influx of this toxic compound into the polar biosphere.
Here we present multi-decadal observations of the vertical distribution of tropospheric BrO and aerosols using Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) measurements performed at the New Zealand Antarctic Observatory Arrival Heights (78°S) since 1998 and at the German Antarctic Station Neumayer (70°S) since 2003. By detection of absorption structures of atmospheric constituents in scattered sunlight from different directions, this technique allows for the reconstruction of vertical profiles of trace gases and aerosols in the armospheric boundary layer. We present a detailed statistical analysis of the amount, frequency, and vertical distribution of BrO in the Antarctic boundary layer, enabling the identification of possible source regions and the impact of blowing snow and aerosols on the release of BrO, as well as transport processes, such as an influx of reactive bromine from the boundary layer into the free troposphere.

Fri_267_OS-7_1016
Observed Greenland Ice Sheet Run-off Distribution in the Greenland Sea

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The mass loss from the Greenland Ice Sheet (GrIS) is one of the main sources for the global sea level rise and almost quadrupled from 1992-2000 to 2000-2011. The additional freshwater could influence the formation of components of the North Atlantic Deep Water and thereby might alter the strength of the climate relevant Atlantic Meridional Overturning Circulation. The accelerated run-off is influenced by an intrusion of warm water onto the shelf near the outlet glaciers and an increased atmospheric warming impacting surface melt. The drainage basin of the Northeast Greenland Ice Stream covers 16% of the GrIS. Main outlets of this ice stream are the Nioghalvfjerdsfjorden Glacier with a calving front of around 30 km and the Zachariae Isstrøm, both are located near the Fram Strait and the Greenland Sea. We identify and quantify the submarine and surface melt water distribution in the near- and far-field of these glaciers by analyzing the low soluble noble gases helium and neon. They are used in an Optimum Multiparameter analysis in combination with hydrographic data to calculate the submarine and surface melt water fractions. Early results show strong glacial melt water outflow from the cavity below the marine-terminated Nioghalvfjerdsfjorden Glacier into the upper 200 m, indicated by high noble gas concentrations in front of the glacier.

Fri_268_OS-7_1023
Importance of Deformed Ice in the Polar Regions for the Climate Models

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Sea ice comes in a variety of sizes and shapes depending on the mechanical and thermodynamical events it has undergone. New ice offers little resistance to the winds and currents, while deformed ice contains hummocks and ridges that influence how heat and momentum are transferred at the atmosphere-ice-ocean interfaces. In most climate models, the surface fluxes are determined from "bulk formulas" with constant drag coefficients based on roughness length estimates. Therefore, these formulations do not account for the space-time variability of transfer coefficients due to variations in ice roughness. However, the ice roughness can be estimated from the models by quantifying the amount of deformed ice (Tsamados et al, 2013). To study the effect of ice deformation on the surface fluxes and the associated impact on the sea ice, we implement a tracer of deformed ice into the ocean-ice model NEMO-LIM3 v3.6 and modify the drag coefficients accordingly. From a run of NEMO-LIM3 between 1958 and 2015 at 1 degree resolution, we examine the spatial and temporal evolution of the drag coefficients in the Arctic and Antarctic regions. We investigate the effects on the surface fluxes and impacts on the sea ice state. This study allows us to formulate an initial assessment on the importance of deformed ice variability for the current climate models.

Fri_269_OS-7_1100
Hydrodynamics between Prydz Bay and India Bay (Antarctica) during 2012 - 2017

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Under India's project "Monitoring of hydrodynamics of coastal Antarctica between Prydz Bay (69S, 76°E) and India Bay (66°S, 9°E)," vertical profiles of density were recorded at every 1° longitude apart using Expendable CTD probes during austral summer of 2012-2017 onboard cargo ships chartered for Indian Antarctic Expedition. The thermohaline structure showed mixed layer thickness of about 50 m on average which deepened to 80 m due to anomalous environmental forcing such as storms in 2017. High salinity winter water (>34.5 psu) dominantly occupied the water column all along the Prydz Bay -India Bay. It is inferred that bottom topographic features and coastal geometry influenced the thermohaline structure. The depth integrated heat content revealed high values (>840 x 10^9 Jm^2) at 42°E, while low value were encountered at India Bay and Prydz Bay due to large influx of melt water. T-S diagrams revealed freshening signatures of water masses at most hydrographic stations. The distribution of different water masses is as follows: Antarctic Surface Water was confined to the upper 25 m, Ice Shelf Water was detected between 350 and 500 m, Continental Shelf Water was identified between 350 and 700 m, while Circumpolar Deep Water was confined to below 900m. We address the role of air-sea heat fluxes and winds on the evolution of thermohaline structure and its inter-annual changes. The observational program will continue to generate a long time series for unraveling climate signals.

Fri_270_OS-7_1105
Atmospheric Drivers of Antarctic Regional Sea Ice Extent Variability

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Polar sea ice plays a major role in Earth's climate system. Sea ice growth and decay is governed by complex feedbacks between sea ice, the atmosphere, and the ocean. Sea ice is, however, more responsive to atmospheric forcing, seasonal changes in air temperature being the main driver. Moreover, a high correlation exists between anomalies in sea ice extent and mean sea level pressure as shown by previous studies.
Polar lows are intense maritime mesocyclones forming at high latitudes, extending over hundreds of kilometers, and are associated with high surface wind speeds and large heat fluxes out of the ocean. As a result of strong air-sea fluxes, sea ice conditions are impacted. The extent to which polar storms impact sea ice conditions has been, however, hardly investigated previously.
This study proposes a long term (1996-2017), monthly analysis of major polar lows as derived from ERA-Interim reanalysis data. The reanalysis will be evaluated against the monthly sea ice extent obtained from spaceborne observations. The overall aim is to assess the impact of storms on regional sea ice extent and identify regions that are prone to a greater change as a result of atmospheric forcing. During the 2016 spring, the Antarctic sea ice extent was at its lowest since the late 1970s, with pronounced regional sea ice extent anomalies. Investigations will be carried out to determine the possibility of anomalous sea ice extent during different seasons being impacted by polar storms.

Fri_271_OS-7_1154
Seasonal Impact of the Southern Annular Mode on Antarctic Sea Ice Extent

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Through analysis of remotely-sensed sea surface temperature (SST) and sea ice concentration data we investigate the impact of winds related to the Southern Annular Mode (SAM) on sea ice extent around Antarctica. We show that positive SAM anomalies in the austral summer are associated with anomalously cold SSTs that persist and lead to anomalous ice growth in the following autumn, while negative SAM anomalies precede warm SSTs and a reduction in sea ice extent during autumn. The largest effect occurs in April, when a unit change in the detrended summertime SAM is followed by a $1.8 \pm 0.6 \times 10^5$ km^2 change in detrended sea ice extent. We find no evidence that sea ice extent anomalies related to the summertime SAM affect the wintertime sea ice extent maximum. Our analysis shows that the wind anomalies related to the negative SAM during the 2016/17 austral summer contributed to the record minimum Antarctic sea ice extent observed in March 2017.

Fri_272_OS-7_1227
Seasonality of Antarctic Microseisms: A Window on Sea Ice Variability

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When ocean waves interact with the solid Earth, they generate seismic signals called microseisms that peak in two different period bands between 1 and 20 seconds. These peaks are visible on most station noise spectra worldwide; they tend to amplify during winter due to stronger storm activity in the oceans. Using data recorded between 2001 and 2009, Grob et al. (2011) showed that Antarctic noise spectra behave differently: they tend to attenuate during winter due to the presence of sea ice. They also proved that Antarctic microseisms exhibit seasonal behavior that correlates directly with the local sea-ice conditions near the recording station. We aim to monitor sea-ice formation and its variability at key locations along the Antarctic coast, such as the Dumont d'Urville station, by extending the Grob et al. (2011) study to data recorded between 2010 and 2017.

Fri_273_OS-7_1249
Carbon Dynamics during the Formation of Sea Ice at Different Growth Rates

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Given the potentially important contribution of sea ice to sequestration of inorganic carbon (TIC) in deep waters, relatively little is known about the distribution of TIC during the formation of sea ice or how different ice growth rates might affect the allocation of carbon to ice, water, or air. To illuminate these carbon dynamics, we grew ice in an experimental seawater tank (1 m^3) under abiotic conditions up to a thickness of 20 cm at three different air temperatures (-40 °C, -25 °C, -15°C). Carbonate system parameters were determined by discrete sampling of ice cores and water, as well as continuous measurements by multiple sensors deployed mainly in the water phase. A budgetary approach revealed that of the initial TIC content of the water, only 5 % was located in the ice phase by the end of the experiment at the slowest growth rate (1 cm/d), while for the fastest growth rate (12 cm/d), this value increased to over 10 %. Exchange with air appeared to be negligible, with the majority of the TIC remaining in the under-ice water (90-95 %). Along with a good correlation between salinity and TIC in the ice and water samples, these observations highlight the importance of brine drainage to TIC redistribution during ice formation. For experiments without mixing of the under-ice water, the sensor data further suggested a stronger stratification, and thus potentially larger carbon sequestration for ice grown at a colder temperature and faster growth rate.

Fri_274_OS-7_1269
Unexpected Halogen Activation during Fall at Neumayer III/Antarctica

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The influence of Reactive Halogen Species (IO, BrO, ClO, etc.) on the lower polar troposphere has been subject of intense research for over three decades. Ozone Depletion Events or the oxidation of gaseous elemental mercury are well observed phenomena that occur during the respective springtime in both Arctic and Antarctic. While an autocatalytic release mechanism from salty surfaces (sea ice or aerosols), the so-called *bromine explosion*, has been identified as the likely cause of the rapid increase of inorganic bromine mixing ratios, many other aspects of the atmospheric halogen chemistry, like chlorine release, remain unclear.
Since January 2016, we are operating a fully automated Long-Path DOAS instrument at Neumayer III in coastal Antarctica. It can detect a wide range of trace gases including ClO, BrO, OClO, IO, and NO_2 at a temporal resolution of 5-30 minutes.
The analysis of two years of observations shows several surprising findings which give new insights into polar halogen chemistry. For instance, we detect unexpectedly strong bromine activity in late summer and autumn (in addition to springtime events) with BrO mixing ratios frequently exceeding 20 ppt and peaks up to unprecedented 110 ppt. Furthermore, ClO mixing ratios up to 90 ppt and OClO up to 10 ppt could be detected - the source mechanism for reactive chlorine, however, remains unclear. We will give an overview of the time series and discuss interesting case studies with regard to chemistry and meteorology.

Fri_275_OS-7_1296
A Scaling Law for the Floe Size Distribution of Pancake Ice

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In the pancake ice region of the marginal ice zone (MIZ), the sea ice cover begins to affect the momentum exchange between atmosphere and ocean. Moreover, the ice cover begins dissipating energy of surface waves travelling through it. However, remote sensing techniques often fail to provide accurate informations on the geometrical properties of the small floes (i.e. diameter less than 10 meters). In this context, bridge based observations are necessary to improve and calibrate all other techniques. The Antarctic Sea Ice Processes and Climate (ASPeCt) protocol provides a streamlined methodology to classify sea ice, however, there is a certain degree of subjectivity on the data quality that relies on the ability of the trained observer. The S.A. Agulhas II sailed the Southern Ocean in the austral winter of 2017. During the cruise, the icebreaker encountered a large patch of pancake ice that extended for more than 150 km from the edge of the MIZ. The sea-ice was digitally recorded with a camera installed on the monkey bridge. A MATLAB algorithm has been developed to analyse the digital images and extract the ice concentration and the floe size distribution. It was found that the pancake size exceedance probability follows two distinct power laws, with the exponent changing for pancake diameters roughly equal to 3 meters.

Fri_276_OS-7_1299
Modeling Modified Circumpolar Deep Water Intrusions onto Prydz Bay

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An eddy-resolving coupled regional ocean-sea ice-ice shelf model is employed to locate the hot spots where modified Circumpolar Deep Water (mCDW) intrudes onto the continental shelf within Prydz Bay, and locate the paths through which mCDW is transported to the Amery Ice Shelf (AIS) calving front. Evaluation of the model output is with satellite, hydrographic and borehole data. Two critical windows responsible for mCDW intrusions are identified. The first is the eastern branch of the cyclonic Prydz Bay gyre (PBG) that carries mCDW to the ice front line, accounting for an annual mean heat transport of ~8.7 $\times 10^{11}$ J s^{-1}. The second is located to the east of the Four Ladies Bank (FLB) where mCDW is channeled through submarine troughs, accounting for an annual mean heat transport of ~16.2 $\times 10^{11}$ J s^{-1}. The eddy-induced heat transport accounts for ~23% in the path of the PBG and ~52% in the path of the eastern coastal current, with respect to their total onshore heat transport. The seasonal pulsing of mCDW intrusions is greatly dependent on the seasonal cycle of the Antarctic Slope Current (ASC) that peaks with a maximum of ~29.3 Sv at 75°E in June. In austral winter, mCDW is allowed to access the eastern flank of the AIS calving front with potential consequences for the basal mass balance of the AIS. The dynamic effects of small-scale troughs on the longshore ASC play an important role in the onshore mCDW transport.

Fri_277_OS-7_1320
Seasonality of Antarctic Sea-ice and Snow Properties from Autonomous Systems

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Studying seasonally varying snow and sea-ice properties in the ice-covered oceans is a key element for investigations of processes between atmosphere, sea ice, and ocean. A dominant characteristic of Antarctic sea ice is the year-round snow cover, which substantially impacts the sea-ice energy and mass budgets by, e.g., preventing surface melt in summer, and amplifying sea-ice growth through extensive snow-ice formation. However, substantial observational gaps in the description of year-round Antarctic pack ice and its snow cover lead to a limited understanding of important processes between atmosphere, sea ice and ocean.
Here, we introduce a unique observational dataset comprised of a number of critical parameters relevant to the snow/ice and ice/ocean interface, recorded by a suite of snow and ice-mass balance buoys (IMBs) deployed in the Weddell Sea between 2013 and 2018.
From these data we infer seasonal snow accumulation rates, which allow to describe the spatial distribution and temporal evolution of the Antarctic snowpack. Vertical temperature profiles from co-deployed IMBs are used to validate these findings, and to calculate energy budgets across the atmosphere-ocean boundary.
Our results highlight that data from autonomous, ice-based platforms are a key element in better understanding sea-ice and snow properties, processes and their seasonal evolution.

Fri_278_OS-7_1325

Dissolved Gas Properties and Water Formation in a Coastal Polynya during PIPERS

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Antarctic sea ice production is thought to be fundamental to determining the strength of the southern hemisphere meridional overturning circulation and the solubility pump, through its control of air-sea exchange, and through brine rejection. The unbuffered gases (He, Ne, N_2,O_2, N_2,Ar, Kr, and Xe), dissolved in seawater, contain a fingerprint of sea ice and other bio-physical processes that ultimately determine gas content in the deep ocean. We collected discrete noble gas samples and in-situ gas measurements using an Underwater Mass Spectrometer (UMS) attached to the CTD rosette, during the the PIPERS cruise between April 11 to June 14 2017 in the Ross Sea. The UMS is an early prototype of instrumentation that has the potential to expand the spatial and temporal coverage of in-situ dissolved gases such as N_2 and Ar. These measurements reveal glacial meltwater effluents that are incorporated into subsurface waters before those waters exit the continental shelf along the abyssal troughs in the Ross Sea. Within the mixed layer, persistent under-saturation in all the dissolved gases reflects heat loss that fast exceeds the rate of air-sea and air-ice gas exchange, leading to shelf waters that do not convey their entire gas burden into the deep sea during their transformation into deep water. We use the gases and hydrography to reflect on the competing effects between secular freshening in the Ross Sea and the salination process of shelf water during polynya ice production.

Fri_279_OS-7_1329
Mapping Antarctic Peninsula Iceberg Melt Variability with Satellite Imagery

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Warming air and ocean temperatures have led to a global increase in glacier and ice sheet melt, impacting the amount of freshwater being added to the oceans. Along the Antarctic Peninsula climate warming is responsible for the break-up of ice shelves that formerly buttressed the flow of ice from marine-terminating glaciers to the ocean. Both ice shelf collapse and subsequent acceleration of glaciers that previously fed the shelves has resulted in increased iceberg discharge to neighboring ocean basins. In order to fully understand the impacts of increased iceberg discharge on local-to-global ocean properties, iceberg freshwater fluxes must be quantified. Patterns in Antarctic iceberg melt can be mapped through the differencing of repeat high-resolution digital elevation models (DEMs), as has been recently demonstrated around Greenland. Specifically, here we use repeat very high-resolution WorldView satellite images to create iceberg DEMs, then difference the iceberg elevations in time to construct estimates of iceberg melting from 2011 to 2018. Spatial and temporal variations in iceberg melting are analyzed in order to determine whether iceberg meltwater fluxes have varied considerably in the past decade.

Fri_280_OS-7_1333
Evidence of Polynya Frazil Ice Growth over Tens of Vertical Meters during PIPERS

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Strong katabatic winds and subzero air temperatures drive extreme oceanic heat loss in coastal polynyas, during the polar night. We observed repeated katabatic wind events in the Terra Nova Bay polynya of the Ross Sea, during the PIPERS cruise, which occurred between April 11 and June 14, 2017. During these conditions, mixed layer depth extended to 600 m and mixed layer temperatures were driven to or below the freezing point. Yet, temperature and salinity profiles were not perfectly homogenous throughout the mixed layer. Instead, we observed an apparent source of heat and salt in the top tens of meters, evident as a warmer saltier bulge in the CTD profiles. Considering both the colder air above and water below, we surmise that the increase in temperature and salinity reflects latent heat and salt release during unconsolidated ice production throughout the upper water column. We use the thermodynamic state equations and models of frazil ice production to test whether frazil ice production could lead to the observed thermohaline anomalies. Conversely, we use simple heat and salt budgets to put bounds on the amount of frazil ice production that is implied by these observations. These and related measurements provide insight to the boundary conditions for the dense water that is produced in coastal polynyas, and eventually incorporated into Antarctic Bottom Water.

Fri_281_OS-7_1378
Southern Ocean Polar Mesocyclones Dynamics from WRF High Resolution Hindcast

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Mesocyclones (MC) in high latitudes are important maritime atmospheric phenomena, characterized by strong wind speeds and surface heat fluxes. The lack of assimilated observational data in Southern Hemisphere (SH) in the global ocean and atmospheric models and also the rough resolution of the latter does not allow realistic representation of MCin these datasets. Most of modern studies of the MC activity in SH are using tracking algorithms based on reanalyses data, significantly underestimating number of MC and their intensity (Irving et al., 2010; Pezza et al., 2015). Thus, dynamical characterization of MC, developed in these studies covers only a fraction of mesocyclone population.
In this study, we present thermodynamical and lifecycle characteristics of polar MC in SH, basing on the high-resolution (10 km) Weather Research and Forecasting model regional hindcast for winter 2004. The hindcast is validated involving different observational data: satellite-derived integral water vapor content (AMSR-E), surface winds (QuikSCAT), AMRC AAWSP weather stations data. The WRF reproduced 95% of polar MC of satellite-based dataset of the Southern Ocean MC tracks (Verezemskaya et al., 2017).
Dynamical characteristics of polar MCs from satellite database such as surface fluxes, CAPE/CIN, existence of cold/warm core, Eady rate, potential vorticity anomalies are calculated for different types of MCs according to their cloudiness pattern type and large-scale background conditions.

Fri_282_OS-7_1418
PIPERS: Fall-winter Observations of Dissolved Iron in the Ross Sea Polynyas

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Primary production on the Ross Sea continental shelf is thought to be limited by the supply of dissolved iron (DFe), which is derived from melting of sea ice and glacial ice, intrusion and upwelling of Circumpolar Deep Water, and vertical resupply from the benthos. The latter will be most important during winter, when katabatic winds drive sea ice formation and convective overturn in coastal polynyas, although the impact of these processes on the water-column distribution of DFe has not been previously documented. As part of the project Polynyas and Ice Production Evolution in the Ross Sea (PIPERS), we collected hydrographic data and water-column samples for DFe analysis in the Terra Nova Bay (TNB) and Ross Ice Shelf (RIS) polynyas during April-June 2017 (fall-early winter). We observed several intense katabatic wind events in the TNB polynya, where the surface mixed layer varied from ~250 m to ~600 m depth over lateral distances of ~10 km. Stations occupied in the RIS polynya, where weather conditions were less extreme, revealed surface mixed layer depths < 300 m. These observations and our preliminary DFe data suggest that convective overturn progresses slowly and episodically over winter, perhaps earlier in the TNB polynya, where there is also evidence of substantial DFe inputs associated with Ice Shelf Water.

Fri_283_OS-7_1530
High Heat Flux Events and the Role of Sea Ice in the Iceland Greenland Seas

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The Iceland Greenland seas Project (IGP) represents a coordinated meteorological and oceanographic study of the Iceland and southern Greenland Seas. The aim being to characterise the atmospheric forcing and the ocean response of coupled atmosphere-ocean processes; in particular cold-air outbreaks in the vicinity of the marginal-ice-zone and their triggering of oceanic heat loss and the generation of dense water masses. Within the project a climatological assessment using regional climate modelling tools of changes in the distribution late winter/early spring (January-February-March-April) sea ice concentration will be undertaken. The modelling will focus on how changes in the location of the sea ice front over the duration of the satellite record have impacted on location, magnitude and frequency of cold air outbreaks and high heat flux events. Here we present the initial analysis of these modelling studies, using three fixed sea ice conditions representative of the maximum (1986), minimum (2016) and median (2004) sea ice concentrations. Our results will focus on the changes in the distribution and frequency of high heat flux events and an initial assessment of how these will change into the future.

Fri_284_OS-7_1542
Contrasting Carbon Monoxide Cycles in the North Pacific and the Amundsen Sea

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To investigate how the CO budget in the mixed layer governs the CO emission from sea to air, we measured air-sea gas exchange, microbial consumption rate, and CDOM on-board during two expeditions in the Amundsen Sea and the North Pacific in summer season of 2012. Dark incubation experiments revealed that microbial consumption rate in the North Pacific was 4.5 nM d^{-1} whilst 0.8 nM d^{-1} in the Amundsen Sea. Also CO production rate was about 3.5-times higher in the North Pacific (2.4 nM d^{-1}) due mainly to inefficient dilution by shallow mixed layer in the region. It seems that this different CO budget between the two regions causes different amplitude of diurnal variation of dissolved CO. That is, compared to the Amundsen Sea, CO is produced faster in daytime and removed faster throughout the day in the North Pacific where the amplitude of CO cycle is larger. In both regions, sea-to-air flux density was insignificant (about 0.1 nM d^{-1} for the both regions) compared to microbial consumption which covers above over 95% of CO. Our observations indicate that the source strength of the ocean was evenly weak regardless of the scale of CO budget in the ocean. That is, marine biota can be thought as a main control of CO in the atmosphere, the important trace gas for the global climate change.

Fri_285_OS-7_1563
Impact of Winter Storms in a Thinner Arctic Sea-ice Regime

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The integrative effects of increased winter storm activity in the Arctic's Atlantic sector were studied using a collection of field observations and analyses. In early 2015, during the six-month N-ICE2015 expedition in the pack ice north of Svalbard, we observed a chain of events in the atmosphere-ice-ocean system that was triggered by several powerful winter storms. Our unique, interdisciplinary observations show that these winter storms entail significant effects that last much longer than the short-lived storm events themselves. The rapid warm and moist air advection associated with the storms contributed to a deep snow-pack and ice surface warming that inhibited thermodynamic sea-ice growth. Instead, the heavy snow-load promoted flooding and formation of snow-ice. The strong winds deformed the sea ice, opening up leads, increased air-to-sea CO_2 fluxes by a factor of 20 and increased the concentration of sea-salt aerosols. The storms also enhanced ocean mixing, with ocean-to-ice heat fluxes that were 17 times larger than background values when warm Atlantic Water was near the surface. This resulted in mid-winter bottom-ice melt rates of 5-25 cm/day. In spring, the aggregate effect of winter storms promoted algal growth at the flooded snow-ice interface, produced ice algal hotspots in pressure ridges, and the light transmission through leads set off an extensive under-ice phytoplankton bloom. Frequent winter storms have profound impacts in a thinner Arctic sea-ice regime.

Fri_286_OS-7_1585
Global Research Challenges and CATCH - The Cryosphere and ATmospheric CHemistry

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The cold regions on Earth are undergoing significant climate change. Yet many underlying chemical, biological, and physical processes and feedbacks are still poorly understood strongly motivating continued research in cold regions. Such research inherently requires cooperation among researchers and programs across national boundaries to achieve science objectives. CATCH is an emerging activity of the IGAC (International Global Atmospheric Chemistry) project and is endorsed by SOLAS (Surface Ocean-Lower Atmosphere Study). CATCH facilitates interdisciplinary and international research with a focus on interactions between snow, ice, ocean, aerosols, and clouds in cold regions. CATCH science addresses cold region research challenges to help reduce model uncertainties and improve climate predictions. Here we give an overview of scientific aims and strategy to develop collaborative research teams and projects. Particular areas of interest include: sea ice changes, atmosphere-ice-ocean interactions and their impacts on atmospheric chemistry; feedbacks between climate change and atmospheric chemistry mediated by changes in the cryosphere; the production, processing and climate impacts of aerosols and cloud precursors; ice cores as archives of past environmental change, and the influence of background atmospheric chemistry on the fate of pollution. CATCH seeks to link research on a fundamental, molecular level with larger scales targeted by field and satellite observations.

On behalf of the CATCH Implementation Team, IGAC, http://www.igacproject.org/activities/CATCH, Boulder, United States

Fri_287_OS-7_1623
Evaporation at 2 Poles: Moisture & Sensible Heat Flux in the Arctic & Antarctic

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The process of evaporation provides water vapor from the surface to the atmosphere, where it becomes the most radiatively important and abundant greenhouse gas altering the Earth's energy balance and water cycle. However, it is often poorly captured because surface in-situ measurements of evaporation are scarce, especially over the Polar Regions.
The sea ice at both poles acts as a barrier between the ocean and atmosphere inhibiting the exchange of heat, momentum, and moisture. However, variations in the sea ice cover could lead to changes in the amount of heat and moisture supplied to the atmosphere. Since the Arctic and Antarctic sea ice have been behaving very differently over the satellite record, it is crucial to study these changes on the moisture and sensible heat fluxes. These variations could affect surface energy budgets, larger occurrences of low-level clouds, and higher near-surface humidity and temperatures.
Little research has been done looking at the moisture and sensible heat flux from the Arctic and Antarctic sea ice pack. This work will use data from NASA's AIRS and the scheme from Boisvert et al., 2013, which utilizes the Monin-Obukhov Similarity Theory. Changes have been made to the boundary layer parameterizations specifically for sea ice in order to produce a 2003-2016 moisture and sensible heat flux product. Regional and seasonal differences will be addressed along with any trends and interannual variability.

Fri_288_OS-7_1711
Surface Heat Budgets in the Ross and Weddell Seas and Global Climate Variability

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The monthly mean surface heat budgets, over last fifty years, in the Ross and Weddell Seas have been estimated using meteorological parameters provided by the ECMWF and sea ice information from SSM/I data and SIT (sea ice thickness) algorithm.
The areas show opposite variations before 1998 and synchronous behaviour after 1999. This may be explained by the global climate variability expressed by ENSO, SAM and wavenumber-3 pattern or by combination among them. Also ACW could be involved. The interaction among these signals can imply a different behaviour of surface heat budgets in the two areas.
Our results show that circumpolar SLP and SST signals exhibit coherent components on interannual whereas covarying significant energy between SAM and ENSO variability is observed. This implies that SAM and ENSO modes play a superimposed role interfering constructively or destructively on interannual scale. Furthermore, the hovmoller diagrams for interannual SLP anomalies exhibits two stronger ACW cycles around 1982-1991. Before 1982 and after 1991 the absence of ACW seems to be related to the dominant signature of SAM in modulating circumpolar variability.
Also CEOF analysis show that the SAM has assumed a leading role between 1972-81 and 1991-2000 determining no ACW events. Starting from 2003 until present a wavenumber-3 pattern could have played a role in continuing the phase relationship between heat fluxes in the two Antarctic sectors.

Fri_289_OS-7_1748
Terra Nova Bay Polynya Evolution by MODIS Imagery during Winter 2003 - 2016

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Remote sensing is essential for monitoring polynyas dynamics. On regional scales, passive microwave (PM) radiometers provide useful information about their extent. Their coarse resolution often limits an accurate separation of open water from ice cover. Despite their sensitivity to the presence of clouds, thermal infrared (TIR) Moderate Resolution Imaging Spectroradiometers (MODIS) provide high resolution information (typically 1 Km) at large swath widths, several times per day.
In this study we apply a new methodology that combines a sequence of MODIS swath-based scenes to examine the TNB evolution in the winter season during the last 14 years (2003-2016). Results have been validated through the comparison with a huge set of SAR images acquired by ENVISAT, SENTINEL and COSMO-SkyMed satellites. The good agreement with most of the analyzed SAR images demonstrated the potential of this tool for the continuous monitoring of the polynya extent and the consequent estimation of ice production rates. A comparison with TNB polynya extent estimations retrieved by other MODIS and PM based tools has also been carried out and differences discussed. Furthermore, the polynya events identified through our technique have been compared to the katabatic events captured by the automatic weather stations located along the TNB coast, and their interannual variability analyzed.

Fri_290_OS-7_1766
Biogenic Aerosol in Central Antarctica: The Ocean-atmosphere Interaction

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Ten years data of atmospheric oxidised sulphur compounds (methanesulphonic acid (MSA) and non-sea salt sulphate, nssSO4) from the east Antarctic Plateau at Dome C (75° 06' S, 123° 20' E, 3220 m a.s.l. and 1100 km away from the nearest coast) are here presented. Biogenic sulphur aerosol is produced by the oxidation of the dimethylsulphyde produced by phytoplankton. The two sulphur-derived species exhibit a seasonal cycle characterised by maxima in the summer from October to March. In particular MSA presents two summer maxima the first one in November and the second in February, the latter with MSA concentrations higher than the first-one. The two maxima are characterized by different size distribution and seem to be related to different source area of DMS characterized by different timing of primary production. The two maxima of MSA are analysed also as function of sea ice extent and area of ice free in the marginal ice zone in the two different source areas. Sea ice is an important parameter affecting polar primary production. It regulates primary production in the shelves by:
(i) providing a substrate for algal growth on the underside of the ice;
(ii) limiting the photosynthetic radiation available to primary producers;
(iii) limiting the development of thermal or fresh water stratification in the freezing season; and
(iv) enhancing water stratification during the melting season, therefore regulating the amount of available nutrients in the euphotic layer.

Fri_291_OS-7_1767
Ross Sea Shelf Water Variability and Interactions with the Atmospheric Forcing

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The Antarctic Bottom Water (AABW), the densest and coldest water that occupies the bottom layer of the world ocean, is formed in few areas around Antarctica. The production of the AABW plays a major role in determining the strength of the Meridional Overturning Circulation.
Observations within the Southern Ocean's Pacific sector indicate a decadal trend of reduced salinity of both the AABW and shelf waters.
CTD data and moored time-series collected in the Ross Sea from 1995 to 2017 in the framework of the Italian National Antarctic Research Program (PNRA) show strong changes in the thermohaline characteristics of the dense shelf water (SW), a precursor of the AABW.
We observe a freshening of about 0.05 per decade in the western Ross Sea both at the SW formation area (Terra Nova Bay polynya - TNBp) and at the Ross Sea shelf break near Cape Adare (CA) where the AABW is formed and exits the Ross Sea. Besides the negative salinity trend, we note a periodical variability of the salinity time series of about 6-7 years in the TNBp and of 4-5 years at CA.
The physical processes driving the SW interannual variability in the Ross Sea are poorly understood, here we investigate the relationship of the complex interaction among the atmospheric forcing, sea ice production, and ocean thermohaline variability.

Fri_292_OS-7_1815
Shelf and Slope Dynamics Offshore the West Svalbard Continental Margin

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The large-scale circulation and dense water formation (DWF) in the Svalbard archipelago influence the thermohaline circulation in the whole Arctic. DWF depends on the rate of cooling and homogenisation of the Atlantic water along its northward pathway, brine rejection, boundary convection on shelves and slopes, and open-ocean convection. This study focuses on the shelf and slope dynamics and the entrainment processes, which occur along the west Spitsbergen margin. Two short (~140m) moorings (**S1** and **ID2**), deployed at a depth of ~1040 m over the slope, collected multiannual (2014-2017) time-series in an area of interaction between the West Spitsbergen Current and the descending shelf plumes. Time-series revealed a large thermohaline and current variability between October and April. Data highlight the presence of Norwegian Sea Deep Water ($\boldsymbol{\theta}$ = -0.90°C, **S** = 34.90, $\boldsymbol{\sigma_\theta}$ = 28.07 kg m^{-3}) influenced by occasional intrusions of warmer (up to +2°C), saltier (up to ~35), less dense (down to 27.98 kg m^{-3}), and more oxygenated water during fall-winter periods. The result is the injection of heat into the deep sea. Notably, such intrusions occur simultaneously at both sites 170km apart, suggesting that strong winds could trigger the formation of gravity plumes but is the particulate matter that renders them more energetic and heavier than pure TS plumes. Here we discuss the origin, timing, and role of such plumes in a period characterized by a general warming and ice reduction of the Arctic.

Fri_293_OS-7_1823
The Seesaw between Oceanic and Atmospheric Heat Fluxes in the Barents Sea Region

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Observations and model results suggest existence of a negative feedback between the intensity of the oceanic and the atmospheric heat fluxes at scales of 30-year and longer time scale,- the so called Bjerknes compensation. The link between the oceanic and atmospheric fluxes is maintained through ocean-atmosphere heat exchange, mostly over the north Greenland Sea and the Barents Sea. A local positive feedback in the ocean-ice-atmosphere system makes the latter to strongly amplify the intensity of the forced fluctuations.
In this work, variations of convergence of advective heat fluxes in the ocean (dQ_{oc}) and in the atmosphere (dQ_{atm}) in the regions were investigated for time scales of 1-10 years, using model results and observations. In both, dQ_{oc} and dQ_{atm} data, the 2-4-year and 5-8 year cycles were detected. Cross-wavelet analysis of dQ_{oc} and dQ_{atm} showed nearly out-of-phase variations of dQ_{oc} and dQ_{atm} in the Barents Sea region at 5-8 year scales. This was not the case for dQ_{oc} and dQ_{atm} for the north Greenland Sea region. The results suggest a significance of ocean-atmosphere exchange over the Barents Sea in maintenance of the Bjerknes compensation mechanism in the Arctic.
The research was supported by RSF project 17-17-01151

Fri_294_OS-7_1849
Antarctic Sea Ice Region as a Source of Biogenic Organic Nitrogen in Aerosols

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Climate warming affects the development and distribution of sea ice, but at present the evidence of polar ecosystem feedbacks on climate through changes in the atmosphere is sparse. By means of synergistic atmospheric and oceanic measurements in the Southern Ocean near Antarctica, we present evidence that the microbiota of sea ice and sea ice-influenced ocean are a previously unknown significant source of atmospheric organic nitrogen, including low molecular weight alkyl-amines. Given the keystone role of nitrogen compounds in aerosol formation, growth and neutralization, our findings call for greater chemical and source diversity in the modelling efforts linking the marine ecosystem to aerosol-mediated climate effects in the Southern Ocean.

On behalf of the PEGASO Team

Fri_295_OS-7_1883
Long-term Measurements of CO_2 Flux over Sea Ice in the Canadian Arctic

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The Arctic marine environment plays and important role in the global carbon cycle. However there remain large uncertainties in how sea ice, in particular spring melt and autumn freeze-up, affect air-sea fluxes of carbon dioxide (CO_2). To test the impact of these ice regimes measurements of CO_2 flux (as well as momentum, sensible and latent heat) were collected from a 10 m eddy covariance tower installed on Qikirtaarjuk Island (a small rock outcrop in the Dease Strait located roughly 35 km southwest of Cambridge Bay, Nunavut in the Canadian Arctic). The study area exhibited open water in the summer and full sea ice cover in the winter months, making it possible to study the transitional ice periods in the spring and autumn. The system incorporated recent developments in the field of air-sea gas exchange by measuring CO_2 mixing ratio using a closed-path infrared gas analyzer system with a dried airstream, thus avoiding the known water vapor issues associated with using open-path gas analyzers in low flux environments. The results from one year of continuous flux measurements will be shown, highlighting the seasonal trends in gas exchange and comparing flux magnitudes during melt and freeze-up to those found in laboratory experiments and previous field studies.

Fri_296_OS-7_1902
Changes in Heat Content and Melt-water at Maxwell Bay, King George Island

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Ocean processes controlling the oceanic heat flux to the ice face of Antarctic tidewater glaciers are crucial to understand the reduction of the Antarctic ice-shelves. With the support of Instituto Antártico Chileno (INACH), we carried out a field campaign in Maxwell Bay, King George Island, in February 2016. These measurements provided a valuable dataset of current oceanographic conditions, which we compared with the oceanographic conditions measured in a previous campaign carried out by the Korea Polar Research Institute (KOPRI) in December 2000. From that comparison, we found warming and freshening of the upper part of the water column in Maxwell Bay. These hydrographic changes might be explained by the intra-seasonal cycle (February versus December) or might be due to interdecadal changes (i.e. an increased penetration of warmer subsurface waters into the Maxwell Bay area and an increased freshwater input from the surrounding tidewater glaciers). The origin of these changes will be discussed in the light of the new measurements to be obtained during our next field campaign in December 2017.

Fri_297_OS-7_1997
Interannual to Decadal Labrador Sea Ice Variability due to Local-scale Processes

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Processes affecting the surface state of the Labrador Sea are of wider interest due to its role as a site of water mass formation. Sea ice can modify the surface state; however, the processes by which its variability is forced are unclear in this region. Motivated by this, the mechanisms responsible for the interannual- to decadal-scale variability of the Labrador Sea ice in winter are analysed, drawing on observations, an ice-ocean model, and a fully-coupled simulation from the CMIP5 archive. A coherent series of mechanisms is found in all cases. The highest values of sea ice area occur when the northern Labrador Sea is ice covered. The sea ice in this region is found to be primarily thermodynamically forced, with growth occurring in response to anomalously fresh surface conditions. Positive freshwater anomalies propagate rapidly to the region from a source area off the southeast Greenland coast and originate from sea ice melt, associated with the enhanced offshore transport of sea ice here. The sea ice transport is in turn driven by local atmospheric wind conditions, which are strongly correlated with Greenland blocking. A further link is found both with the sea ice transport through the Denmark Strait in the preceding autumn, representing a dependence on the availability of sea ice to be melted, and also, at longer time scales, with the Atlantic Multidecadal Oscillation, suggesting a multidecadal-scale link to wider sea surface temperature conditions.

Fri_298_OS-7_2183
Heat Loss Variability and Subantarctic Mode Water at Southern Ocean OOI Mooring

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The Ocean Observatories (OOI) air-sea flux mooring, deployed in February 2015 at 54S, 90W, in the southeast Pacific sector of the Southern Ocean, is the furthest south open ocean mooring ever deployed. Observations analyzed here (Feb 2015-Aug 2017) provide the first accurate quantification of the annual cycle of net air-sea heat exchange and the wind stress from one of the prime Subantarctic Mode Water (SAMW) formation regions. We find that extreme turbulent heat loss events reaching a daily mean of -290 W m^{-2} promote the formation of deep winter mixed layers up to 600 m deep. Extreme heat loss events are associated with winds from the southwest bringing relatively cold, dry air to the mooring location leading to large air-sea temperature and humidity differences. There is large interannual variability in the frequency of wintertime extreme heat loss events and associated mixed layer deepening, with strong heat loss in winter 2015 and weak heat loss in 2016. These results have important implications for the role of turbulent heat loss in Subantarctic Mode Water (SAMW) formation.

Fri_299_OS-7_2192
Observations of Significant CO_2 Uptake in Antarctic Polynyas

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We present the first direct observations of ocean and atmospheric pCO_2 measured at the Korean Antarctic base, Jang Bogo, locating near the Terra Nova Bay (TNB) polynya in the Ross Sea since February, 2015. The TNB polynya opens a small area (~1000 km^2) in the winter. In contrast, the area exposed to the atmosphere in the summer is greater than 8 times the winter polynya, therefore, significantly enhancing air-sea gas exchange. The pCO_2 in seawater swung from ~120 matm in February to ~425 matm in early October. In November, the pCO_2 suddenly dropped as much as ~100 matm in a week. This decrease of pCO_2 continued until late February when the sea-ice concentration was minimal. With growing sea ice, the pCO_2 increased in parallel catching the atmospheric concentration in June/July, depending on the year, and continued to increase until October. Daily mean of air-sea CO_2 flux in the TNB polynya widely varied from ~-70 mmol m^{-2} d^{-1} to ~20 mmol m^{-2} d^{-1}. Based on these observations of pCO_2 in the TNB polynya, the annual uptake of CO_2 came up with ~9 g C m^{-2}, which takes into account the fraction of sea-ice concentrations estimated from AMSR2 microwave emission imagery. Extrapolating to all polynyas surrounding Antarctica, we expect the annual uptake of ~ 9.5 Tg C of CO_2 from the atmosphere. This is comparable to the amount of CO_2 degassed into the atmosphere south of the Antarctic Polar Front (62°S).

Fri_300_OS-7_2201
Monitoring Subsurface Meltwaters from Surface Observation in Nares Strait

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Petermann Glacier, one of the largest marine-terminating glaciers of Greenland, loses the majority of its mass through basal melt by the comparatively warm ocean. The fate of this meltwater is virtually unknown, for it circulates more than 100 m below the surface and cannot easily be monitored. Ocean surface currents and sea ice drift in contrast can be retrieved continuously through satellite remote sensing. We here investigate whether remote sensing monitoring of the meltwater layer could be possible.
Using an MITgcm simulation validated by a unique new dataset of surface drifters and hydrographic profiles from the I/B Oden Petermann2015 expedition, we quantify the relationship between the surface currents and the circulation of the meltwater in Petermann Fjord and surrounding Nares Strait. A series of sensitivity experiments determines whether this relationship is most pronounced in specific wind and/or sea ice conditions.
Year-round monitoring of glacial meltwater flows around Greenland, and ultimately into the North Atlantic, is a prerequisite to understand the particular role of meltwaters on the global ocean circulation.

Fri_301_OS-7_2206
Connecting the Spring Atmospheric Pacific-arctic Mode to Summer Beaufort Ice

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We identify a spring atmospheric Pacific-Arctic mode (PAM) and investigate its connections to summer Beaufort Sea ice. PAM is the second EOF mode of seasonal sea level pressure poleward of 20^{o}N with a variance of 12%. A positive PAM has a negative anomaly in the subpolar Pacific and positive anomalies in the Beaufort-Chukchi region of the Arctic and the midlatitude Pacific, exhibiting an intensified Aleutian Low and North Pacific High, and a northward displaced Beaufort Sea High. PAM is associated with the distribution of cyclone activity and tracks and warm (polar) air advection due to modulation of the tropospheric circulation anomalies associated with the East Asian trough and the Pacific side of the polar vortex. PAM accounts for 16% of the internal variability of the following September Beaufort sea ice coverage. A positive PAD leads to increased open water days in the Beaufort Sea during spring and summer. During positive PAM, strong easterly winds in the Beaufort Sea enhance ice advection and reduce ice thickness, due to the associated intensified and northward extended Aleutian Low. Moreover, the increased solar radiation further accelerates ice melt, due to reduced cloud cover and water content associated with fewer cyclones in the Beaufort Seas. Thinner ice and increased open water foster a stronger summer ice-albedo feedback resulting in accelerated early-summer ice melt. PAM is a potential predictor for Beaufort Sea ice melting.

Fri_302_OS-7_2394
Evaluation of Wind Products with Wave Glider Observations in the Southern Ocean

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Surface ocean wind datasets are required to be of high spatial-temporal resolution and precision to accurately force or be assimilated into coupled numerical models and to understand ocean-atmospheric processes. In situ observed surface winds from the Southern Ocean are scarce and, consequently, the validity of models is often questioned. Multiple wind products were compared to the first high-resolution in situ measurements of wind speed from Wave Glider (WG) deployments in the Southern Ocean to determine which blended product best represents the magnitude and variability of the observed wind field. Results show that the ECMWF product is the most accurate in representing the temporal variability of winds, exhibiting consistently higher correlation coefficients with in situ data across all wind speed categories. However, NCEP-II Reanalysis matches in situ trends of deviation from the mean and performs best in depicting the mean wind state, especially at high winds. ECMWF also leads to smaller differences in wind speeds from the in situ data, while CFSv2 showed higher biases and a greater RMSE. The SeaWinds (SW) product performed poorly at representing the mean or wind stress variability compared to WG observations. Overall, the study shows autonomous surface vehicles provide valuable observations by which to validate, understand, and potentially assist in correcting satellite/reanalysis products, particularly in remote regions, where few in situ estimates exist.

Fri_303_OS-7_2475
Factors Controlling Water Mass Variations over the Chukchi Borderland, Arctic

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We have carried out hydrographic surveys since 2010 to monitor the Pacific-orign waters over the Chukchi Borderland (CBL) in the western Arctic Ocean. Based on CTD data analysis, the heat content from the Pacific Summer Water (PSW) is highly correlated with sea ice extent reduction over the region. Yearlong mooring and numerical simulation data are analyzed to verify what factors lead the PSW variation. We found two factors controlling the variation of PSW over the region: variation of summer waters incoming through the Bering Strait (BS) and variation of local winds over the East Siberian Sea (ESS) shelf. Temporal variation of PSW temperature over CBL is in-phase with that of the Alaskan Coastal Water (ACW) temperature even if there is a time lag. Relatively cold water over the ESS shelf is transported to the CBL by local winds and subducted into the PSW layer by the thermohaline intrusion.

Fri_304_OS-7_2558
Remote in situ Measurements of Sea Ice Evolution

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We present the results of field experiments in Elson Lagoon (Utqiaġvik, Alaska), designed to test our ability to remotely monitor the onset of freezing, freezing rate and ice type in natural sea ice in real time. Two Microstructure in situ Salinity and Temperature (MIST) buoys were launched in open water in October 2017 and allowed to freeze into the developing sea ice. Each buoy carried two vertical arrays of wire harps (Notz, Wettlaufer and Worster, 2005), developed to make in situ measurements of salinity and solid fraction profiles in growing sea ice. The technique measures temperature and impedance as sea ice grows downward across regularly spaced wire pairs, and is based on the principle that pure solid ice is a good insulator whereas interstitial saltwater brine is a good conductor. Impedance and temperature data, along with air temperature, GPS location, and buoy tilt was transmitted hourly via iridium. Salinity of the interstitial brine was inferred from the liquidus relationship (Cox and Weeks, 1986) and combined with the measured solid mass fraction to give the time resolved bulk salinity profile of the growing sea ice.
We examined the sea ice growth process and the effect of changes in surface temperature and salinity on growth rate and microstructure. To interpret the data, we also conducted laboratory experiments on heat transfer in sea ice using the ICE-MITT, a purpose built refrigeration system that holds ice cores at user-defined temperature gradients.

Fri_305_OS-7_2585
Modeling the Formation and Persistence of an Open Ocean Polynya

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The recent appearance of the Weddell Polynya has motivated the need for a better understanding of this phenomenon. Climate models must be able to represent this phenomenon correctly, since it has the potential to affect bottom water formation and, therefore, impact the large-scale ocean circulation. The initial development of the Weddell Polynya has been explained by interactions between the large-scale oceanic flow and a seamount (Maud Rise). However, the environmental conditions necessary for the persistence of the polynya remain elusive. Here, we use numerical simulations in idealized geometric configurations to investigate how changes in atmospheric forcing and model parameters (e.g., grid resolution, boundary layer scheme and vertical coordinate) impact the formation, propagation and persistence of an open ocean polynya. The experiments are conducted using an ocean model (MOM6) coupled with a sea ice model (SIS2). We show that the formation and persistence of the polynya is strongly influenced by surface buoyancy fluxes. The threshold in buoyancy gain above which the polynya does not form varies depending on model parameters. Our results provide insights into the model parameters necessary to correctly represent an open ocean polynya in climate models.

Fri_306_OS-7_2597
Arctic Layer Salinity Controls Vertical Mixing with Deep Atlantic Layer

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The Arctic Ocean is cold, stratified and sea ice covered due to the presence of a cold and relatively fresh upper layer, here called the Arctic layer, which suppresses direct influence from the subsurface layer of warm and saline Atlantic Water below (the Atlantic layer). It is largely unknown if, how and to what extent heat and salt is transferred up from the deep Atlantic layer.
Based on an extensive observational hydrographic data set covering the northern Barents Sea from 1970-2016, we find that there is considerable vertical mixing of heat and salt between the Arctic and Atlantic layers, causing year-to-year variations in the Atlantic layer temperature. We show that the Arctic layer salinity largely controls the stratification, vertical mixing and upward heat and salt fluxes from the Atlantic layer.
Our findings demonstrate that vertical mixing between the Arctic and Atlantic layers is key to the Arctic environment, as it controls the rate of heat transfer from the deep Atlantic layer towards the surface, where it can influence sea ice concentration and lower troposphere temperatures.
The corresponding upward salt flux constitutes a positive feedback, as increased salinity in the Arctic layer will weaken the stratification and enhance the mixing. This positive feedback mechanism is likely operating in larger parts of the Arctic Ocean, emphasizing the need for monitoring the changes in the water column to understand and predict the rapid climate transition in the Arctic.

Fri_307_OS-7_2683
Oceanic Emissions of Aerosol-forming Substances in Antarctica and Subantarctic

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Climate warming affects the development and distribution of sea ice around Antarctica and its associated ecosystems, but at present the evidence of feedbacks on climate through ecosystem-derived changes in the atmosphere is sparse. The PEGASO cruise visited the Antarctic region of the South Orkney Islands at the northern edge of the Weddell Sea, and the Subantarctic region of the South Georgia Island, in summer 2015. Each region was studied intensively in lagrangian mode over a few days and diel cycles. Oceanic measurements of plankton abundance, diversity, activity and physiology, plus organic matter characteristics, aerosol-forming organic volatile compounds (dimethylsulfide, methylamines, isoprene, halomethanes) and nutrient concentrations, were compared with simultaneous atmospheric measurements of aerosol numbers, size and composition. Samples of surface seawater and melted sea ice were bubbled in an aerosol-generation tank and the characteristics of the sprayed aerosol were monitored. This integrated study allowed to link phytoplankton bloom stages and the emission of aerosol-forming particulate and gaseous substances. Our findings call for greater chemical and source diversity in the modeling efforts linking the marine ecosystem to aerosol-mediated climate effects in the Southern Ocean.

Fri_308_SH-8_211
Lake Bonney Narrows: 114 Years of Observations Started by Scott Himself

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Lake Bonney, in Taylor Valley, has two distinct lobes separated by a relatively shallow sill in a narrow channel referred to as the Bonny Narrows. Robert Falcon Scott passed through the Bonney Narrows in 1903 on his first expedition in the area, and made a measurement of the channel's width that has been used to estimate lake level at the time in order to extend our lake level record for Lake Bonney to well over 100 years now. Lake level has risen between December 1903 and January 2017 by ~16 m, on average 0.14 m/yr. The sill depth was at most a meter deep during Scott's visit and the two lobes had only joined in the years prior to Scott's visit. Photographs taken by Griffith Taylor's party on Scott's second expedition show that there was a dramatic lake level rise between 1903 and 1911 of almost 3 m. The sill is now an important physical control of the geochemistry and ecology of the two lobes. West Lake Bonney (WLB) has a hypersaline brine bottom water which is held back from East Lake Bonney (ELB) by the sill. The brine is displaced over the sill, by a mechanism referred to as “chemocline leakage”. The brine sinks on the ELB side following a former river channel until if finds it´s neutral buoyancy in ELB, about 4 to 5 m below the sill depth. In this presentation, I will review the history of the connectivity between the two lobes of Lake Bonney as indicated by geochemical proxies and physical evidence collected from the lake surface and through recent diving operations.

Fri_309_SH-8_450
Air Temperature in Franz Josef Land Archipelago from 1899 to 1940

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The results of an investigation into the air temperature conditions in Franz Josef Land Archipelago (FJL) from 1899 to 1940, on the basis of all available early instrumental data gathered during exploratory and scientific expeditions, are presented. Traditional analysis based on mean monthly data was supplemented by an approach less popular in the scientific literature, i.e. the additional use of daily data (MAX, MEAN, MIN, DTR). Such rich sets of data allowed for more comprehensive and precise recognition of air temperature conditions in the FJL. Based on these kinds of daily data, it was also possible to calculate the number of so-called 'characteristic days' (i.e. the number of days with temperatures exceeding specified thresholds) and day-to-day temperature variability and, for the first time, to determine different characteristics of thermal seasons (duration, onset and end dates). The results were compared with contemporary temperature conditions (climate normals 1961-1990 and 1981-2010) to estimate the range of their changes between historical and present times.
The research work was supported by a grant entitled 'Causes of the early 20th century Arctic warming', funded by the National Science Centre, Poland (Grant No. 2015/19/B/ST10/02933) and a grant entitled 'Variability of the Russian Arctic and Subarctic Climate in the Last Three Hundred Years', funded by the National Science Centre, Poland (Decision No.DEC-2012/07/B/ST10/04002).

Fri_310_SH-8_1349
Mapping the Dispersion of Airborne Microorganisms in Byers Peninsula, Antarctica

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A new unsupervised classification method is proposed for exploring dispersal and colonization capacity of microorganisms in Antarctica with a large multivariate functional data set, which includes more than 88M observations from a combination of geographic positioning and meteorological variables. Definitions of the appropriate distance and standardization are crucial and is done taking into account the nature of the data as functions. The method is applied to clustering back-trajectories arriving to Byers Peninsula (Livingston Is, Antarctica) to establish the dispersal capability of microorganisms susceptible of colonizing newly exposed locations in a climate change scenario. Twelve years of 5-day back trajectories every six hours, computed with the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, are clustered in groups that circulate in nearby regions, regardless of the moment they pass, and with similar environmental conditions (temperature, humidity, etc.). Main air transport patterns capture seasonal differences and rare events that influence in the microorganism viability, but do not take into account the speed at which propagules move. Another set of trajectories passing over Byers Peninsula and with origin in some of the terrestrial regions near Antarctica, are considered. The two clusters combination provides a map of airborne microorganism dispersion to be associated to in-situ captured propagules.

Fri_311_SH-8_1355
Data Mining Cloud Regimes for the Purpose of Model Validation

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Modern climate models have long standing problems with the representation of cloud that result in large radiative biases over many regions of the globe, such as the Southern Ocean. To investigate these issues, cloud regimes are derived from satellite data and then compared to model output. In particular, cloud top pressure - cloud optical thickness joint histograms from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite are clustered using the self organizing maps (SOMs) clustering methodology. This results in the identification of 12 distinct cloud regimes from the MODIS data.
These regimes were then used to cluster output from the HadGem3 GA7 atmosphere only model. This allowed for comparisons between the behaviour of the regimes in observational data and in model output to be undertaken. These comparisons initially focused on the rate at which a given regime occurs and how that occurrence rate changes between different regions. Further analysis investigated the mean cloud properties associated with a given regime. One of these properties was the cloud radiative effect (CRE) derived from CERES satellite observations, these are then compared with model output for each of the identified regimes. The overall CRE bias within the model was then attributed to each of the regimes, clearly identifying which regimes caused the largest problems in the model. This approach was also extended to other variables such as cloud phase and aerosol optical depth.

Fri_312_SH-8_1538
FAIR Data Management in the Polar Regions

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According to the description, this session aims at bringing together different communities of data users and emphasizes the integration of data and information from various sources and disciplines.
However, before these goals of data integration across disciplines can be achieved, the data should be made available. The data from polar research should be easily **F**indable for all users, should be **A**ccessible without impeding barriers, should be **I**nteroperable to allow data to be used in different applications and should be **R**e-usable to enable new, interdisciplinary science. In short, the data should be FAIR.
Fortunately, since about two decades, international groups of data managers have been building global data access infrastructures, which implement these FAIR-principles and cover most data types and all disciplines in the polar regions. A few examples are the systems built by SCAR's Standing Committee on Antarctic Data Management (SCADM), by the Sustainable Arctic Observing Network (SAON) and by the Southern Ocean Observing System (SOOS).
This presentation will provide a comprehensive overview of the existing data access infrastructures in all disciplines. It will also address the current, joint effort by SCADM, SOOS and the Arctic Data Committee (ADC) to develop a federated search mechanism across existing infrastructures, linking these infrastructures to one point of entry and allowing users to re-use data which are easily findable, accessible and interoperable.

Fri_313_SH-8_1608

A Comparison of ISCCP D and ISCCP H Clouds over the Southern Ocean using SOMs

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Clouds play an important role in the global energy budget, with strong regional variations in cloud cover evident. One region of concern is the Southern Ocean, due to a short wave (SW) bias in the cloud radiative effect (CRE) from climate models when compared to satellite observations. This long standing problem is compounded by a sparse observational record in that region, other than satellite observations, which makes identification of the specific drivers of these biases difficult to determine. We use satellite data to compare with model output and test new methodologies for classifying the data to gain quantitative metrics which can help to identify particular model issues.

The International Cloud Climatology Project (ISCCP) was established to improve the understanding of clouds and their role in the climate system. Cloud top pressure and optical depth joint histograms from the ISCCP D1 dataset have been used with the Self-Organising Map (SOM) data mining methodology to determine 15 cloud regimes. The ISCCP D1 data set ended in 2009 and has been recently superseded by ISCCP H.

This study presents a comparison between the ISCCP D1 and ISCCP H datasets which is undertaken using SOMs. The relative frequency of Occurrence (RFO) and total cloud fraction (TCF) of these cloud regimes are determined, with regards to the Southern Ocean. We also compare these two satellite datasets against results from the COSP satellite simulator applied to output from the HadGem3 GA7 model.

Fri_314_SH-8_1739
Arctic and Southern Ocean Mean States in Ten Reanalyses

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Even after a number of targeted field expeditions and improved satellite coverage, the polar ocean observations remain sparse and time series short. Given these circumstances, one could argue that reanalysis descriptions of polar oceans are the most complete ones. Therefore global and regional ocean reanalysis products (ORAs) are increasingly used in polar research, but their quality remains to be systematically assessed. To address this, the Polar ORA Intercomparison Project (Polar ORA-IP) has been established following on from the ORA-IP project. Several aspects of ten selected ORAs in the Arctic and Antarctic were addressed by concentrating on comparing their mean states in terms of snow, sea ice, ocean transports and hydrography. Most polar diagnostics were carried out for the first time for a such an extensive set of ORAs. In this presentation we focus on liquid ocean diagnostics, while Iovino and co-authors present sea-ice diagnostics. For the multi-ORA mean state, we found that deviations from observations were typically smaller than individual ORA anomalies, often attributed to offsetting biases of individual ORAs. The ORA ensemble mean therefore appears to be a useful product and, while knowing its main anomalies and recognising its restrictions, it can be used to gain useful information on the physical state of the polar marine environment.

Fri_315_SH-8_1792
Scientific Archives in Polar Data Science: The Archive for German Polar Research

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Inside archives of polar research institutions records are preserved with historical scientific data. Taking the example of the Archive for German Polar Research (AGPR) of the Alfred-Wegener-Institute this talk will show

- what kind of records from polar research contexts contains scientific data,
- how the these holdings found their way into the AGPR,
- how they are there conserved, preserved and described for a future use by scientists,
- what kind of efforts are made to provide the accessibility of these data for the scientific community and
- how far the cooperation between archives and data repositories is developed.

All these questions are discussed in the context of the history of archiving German polar Research and the AGPR's tasks, resources and contents. Even the legal frame, the tradition of archival work and the archival organization and networks in Germany are considered.

Fri_316_SH-8_1946
A Comparison of Surface Winds over the Ross Sea Region Using Cluster Analysis

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We compare the statistics of surface wind regimes in reanalyses, general circulation models and remotely sensed observations using cluster analysis. In particular, we use the Self Organizing Map and k-means clustering approaches to identify representative wind regimes over the Ross Sea. These regimes are derived from reanalysis output from the ERA-20CM ensemble and the 20th Century Reanalysis version 2 ensemble. We then compare these patterns with the Coggins types which are derived from ERA-Interim reanalyses using a k-means scheme. The frequency of occurrence of specific patterns for the different ensemble members and the two different reanalyses are used to identify uncertainties in these occurrence rates, also comparing to the Coggins types. Variations in the frequencies derived as a function of time are also examined to identify trends in the surface winds over the Ross Sea. We then validate the representativeness of the various regimes relative to observations of surface wind velocity from the WindSat dataset and surface weather stations over a subset of the reanalysis period. We also examine whether frequencies derived from CMIP5 model output over the historical period compares with the reanalyses derived frequencies. Finally, we decompose the differences observed between the reanalyses derived patterns and the model output derived patterns into pattern variations and frequency changes to gain a greater understanding of the reasons for the observed differences.

Fri_317_SH-8_2217
Digitization and Analysis of the SPRI-NSF-TUD Radar Data Archive

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Between 1967 and 1979, airborne RES surveys were taken of Antarctica in a collaboration between the Scott Polar Research Institute (SPRI), the National Science Foundation (NSF), and the Technical University of Denmark (TUD), known as the SPRI-NSF-TUD surveys. These 400,000 km of surveys are the oldest observations of internal and subglacial features in Antarctica and provide the opportunity for comparison with modern RES campaigns in order to study temporal changes in the ice sheet over the last 50 years. However, the SPRI-NSF-TUD survey was recorded on 35 mm film and the resolution of existing prints makes it difficult for such comparisons to be made. We used Hollywood film scanning equipment to digitize this collection and obtain over two million high resolution images. We elaborate on the methods used to digitize and position this data and present our observations of features including internal layers, volcanic ash layers, subglacial channels, accretion plumes, grounding lines, and subglacial lakes. These are interpreted in the context of glaciological and geological processes.

Fri_319_SH-8_2408
Training a Machine Learning Model to Find Polar Data on the Web

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Increasing amounts of data about the polar environment are being made available on the Web. This includes the huge volumes of data coming from Earth observing sensor systems but also smaller, unique data sets from individual investigations, modeling experiments and data rescue operations. While finding these data in well-curated major repositories is straightforward, finding data that is published in journal papers, posted to investigators' websites or appearing in blogs is much more challenging. The "Polar Deep Insights" project, funded by the United States (US) National Science Foundation (NSF), is developing polar-specific indexing and search paradigms for improved content discovery, information extraction and exploration, while extending search capabilities to the deep web and nontraditional (e.g. multimedia) content. These next-generation search technologies are making it possible to understand people, places, things and the connections between them through analysis of unstructured text as well as online images, videos, web pop-ups, online forms, web scripts and other ways information is presented on the web. Interactive tools make it possible for domain experts to construct machine-learning (ML) models used by the crawler to identify web content of potential interest. In this presentation we give an overview of the project and provide example applications whereby historical information about the polar regions is made findable.

Fri_320_SH-8_2625
Historic Antarctic Peninsula Maps and Diary Accounts Linked to GIS Data Bases

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The north-eastern side of the Antarctic Peninsula was scientifically explored from 1901-03 by the Swedish Antarctic expedition under Otto Nordenskjoeld. From this expedition originate a number of maps which show and illustrate in combination with diary accounts the state of the environment at the turn form the 19th to the 20th century. We relate the maps and described locations to present day satellite data and observations. This is achieved by a semi-automatic process identifying features in the drawings, diaries, and images. We interpret the expedition accounts based on our comparison, and we try to better identify features based on diary entries. Our result gives new insight in the outstanding observational achievements of the time, and in environmental change in space and time since then. We focus on changes in the cryosphere by confining past snow and ice areas as a baseline for climate change studies.

Fri_321_SH-9_11
Viewing Ice: Cognitive Frames and the Construction of the Polar Regions

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Both polar regions in themselves and taken together are characterized by the existence of a set of closely intertwined epistemic communities with a strong natural science core interacting with political, economic, and legal actors and systems (and, to a lesser degree, the social sciences). These epistemic communities do not participate in one, but in a range of partly overlapping but distinct discourses, contributing to providing sometimes overlapping, sometimes diverging cognitive frames that allow different kinds of actors to address the Artic and/or the Antarctic as relevant objects within their respective discursive settings. Recursively, these discourses frame research priorities, political agendas, as well as the evolution and density of research communities).
The proposed paper will at first elaborate on the relation between epistemic communities and the evolution of cognitive frames conceptually. In a second step it will provide some illustrations particularly pertaining to the Arctic, demonstrating how various cycles of cognitive framing are connected to shifting (geo-)political representations. A final section will sketch a research project that aims at studying natural science research communities as core contributors to epistemic communities.

Fri_322_SH-9_36
Stable Isotopes Meet Shakespeare: Antarctic Science in Literature

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Antarctica has undergone a shift from Terra Australis Incognita to the continent for science and a global laboratory. Yet it has also encouraged authors to fill the icy wastes with their own ideas, stories, dreams and visions. Literature and the science dealing with Antarctica, however, do not have to exist in mutually exclusive worlds; they can co-operate and benefit from each other.
This paper aims to discern how Antarctic science has inspired and been depicted in the literary output from the seventh continent - and how literature can in turn inspire science.
From underwater lakes to remote sensing and ice core drilling, scientific projects populate the written page. Dystopian scenarios of climate change and highly spectacular findings are just as well fictionally played out as well-researched and detailed descriptions of scientific processes. These texts can be produced by literary inclined scientists, but most often they stem from authors interested in the subject matter and consequently wanting to engage their readership in the discourse.
I will look at the forms and functions these excursions into the world of science have in literature. Antarctic literature can bring both the science and the continent it is conducted on closer to the rest of the world. In short, science and literature should work together to promote Antarctica, its values, fragility and importance to a wider audience.

Fri_324_SH-9_218
Valuing Antarctic Visual Arts: An Examination of their Impact

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The creation of objects and imagery is a fundamental aspect of human intellect and expression. Though the cultural diversity of artistic expression is vast, a common thread is the compulsion to create and communicate. In Antarctica where there is no indigenous population and no indigenous cultural production is there value in importing cultural expression and representation? And if so, what is the value of artists' presence?
Since the earliest days of Antarctic exploration visual artists were essential members of expedition teams. They had a valuable role in documenting topography, flora, fauna, expedition activities and environmental conditions for purposes specific to science, navigation, sovereignty claims and fundraising. With the development of photography, visual arts have evolved and diversified to offer ways of viewing and understanding Antarctica beyond documentary representation.
Visual artists from many countries continue to secure passage to Antarctica. Several national Antarctic programmes support artist residencies. The diversity of Antarctic arts production is wide having evolved out of different socio-cultural and political histories over hundreds, even thousands, of years. This paper will discuss methods to assess the value of artists working in Antarctica. Preliminary findings show that diverse cultural and artistic responses to Antarctica advance human understanding of and relationships with the continent and the wider world.

Fri_325_SH-9_236
Methodological Challenges of Participant-produced Video Diaries in Antarctica

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Although participant-produced videos provide many methodological benefits, this critical reflection provides fellow researchers with insights into the challenges faced when using such methods in a remote polar environment. To do so, we draw on our study of a leadership program for women in STEMM conducted on a ship in Antarctica. The remote location of this study raised methodological beyond the routine issues associated with video diaries. For instance, we discuss methodological challenges that arose throughout the research period including managing the burden of research participation in Antarctica, underestimating participant technological skills, lack of privacy and time to make videos, and data loss. To conclude, we highlight implications for using participatory video methods in other remote settings.

Fri_327_SH-9_525
Helplessness in Antarctica: A Psychanalytic Approach on the Social Bonding

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Here we reflect on the feeling of solitude and helplessness that silently permeates the sense of union among people in the Antarctic expeditions, based on our own experiences in Antarctica field and in interviews with other participants of diverse nationalities. It is our interest to discuss the individual's experiences in Antarctica focusing in helplessness, under the view of psychanalysis. One aspect is related to the features of Antarctica living condition and the singular socialization processes to deal with the threatening environment, the confinement and precarious condition of life. Helplessness, according to its theoretical development in psychoanalytic theory emphasizes its origin in the human newborn immaturity and impotence to deal bodily and psychically with the life demands. This helplessness emerges in Antarctic context as a sense of profound solitude, impotence against the nature and dependence on the others. Our civilization was built as a strategy to diminish our impotency against nature forces, life enigmas and our own death. We propose that in isolated and threatening situation such as experienced in Antarctica, the reduction of narcissistic defenses exposes the subject to a profound feeling of solitude and helplessness, as well as to a prominent anguish by depending on the others. *The helplessness inaugurates the need of the other, the ability to desire, and the construction of social bondage that affects so many antarcticians and their discourses.*

Fri_328_SH-9_605
Human and Social Capacity of the Arctic Region of Neo-industrial Development

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The beginning of the new stage of industrial development of the Russian Arctic, the implementation of a large-scale investment projects (oil and gas development, the construction of plants for the production of liquefied natural gas) actualized the problem of the demand of human resources with the required qualification and absence of social infrastructure.
The authors, on the basis of many years studying of the social situation in the Tyumen North, conducted a complex study of the human capacity required for the successful implementation of the planned investment projects.
Human capacity was considered not only as a recruitment opportunity to develop the Arctic region, but also as the formed actual capabilities of the personnel, demanded and necessary for the practical solving of specific tasks. First of all, these are the following interrelated indicators: socio-demographic characteristics of the quantity and quality of people who intend to live and (or) work in the Arctic; their professional competences; their physical, mental and social health, which are taken in the scales of the sociological dimension.
The results of the mass surveys of northerners and in-depth interviews of experts on polar issues are presented differentially in the context of four social groups of neo-industrial development: old residents of the Northern region, with the exception of the indigenous peoples of the North; representatives of indigenous ethnic groups; new residents; shift workers.

Fri_329_SH-9_628
Antarctic Legacy of South Africa (ALSA): Past Decade, Approaches and Challenges

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Is there a place for an entity as ALSA within a South Africa National Antarctic Programme(SANAP) as well as the global Antarctic environment? This presentation will look at the activities of ALSA for the past decade and how it evolved to be an essential part of SANAP. The project has faced many challenges on different levels to maintain sustainability. The role that the ALSA has played in the past decade within the research community will be outlined. The importance of keeping record of human activity in the Antarctic region will be emphasised and how the project is preserving these records of human contribution and engagement. The evolving of the project in itself is not merely as a research medium and digital archive, but is of utmost importance for the contributions by the human involvement and interaction in the Antarctic region and their valuable contribution towards this region. The insights gained from the human interactions led to a much more comprehensive project in the last few years. The project started out as a novel approach in the history, humanities and social sciences, but developed into a project that can span collaboration on an international level. The management, including approach and challenges of the digital archive especially regarding collection and storage of data will form an essential part of the presentation. South Africa can contribute the knowledge and experience of an open accessed platform with its challenges to the wider polar community.

Fri_330_SH-9_912
Internationalization of National Polar Policy through Policy Integration Theory

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The internalization of environmental protection policy into the core of economic development strategies and policies of a state will be best applied through the Policy Integration Theory. The Policy Integration Theory enhanced the role plays by Antarctica in stabilizing the planetary raising temperature due to global warming from the negative impact of urbanization activities through The Antarctic Treaty 1959 and the Environmental Protocol of 1991. Today, this theory becomes a compromise used to reinforcing State standard on environmental protection policy which previously governed by the economic actors. This Theory adopted the international environmental protection policy initiated through AntarcticaTreaty and its Environmental Protocol to be practiced and activated voluntarily by State in their quest for better quality of life from the aspects of environmental concerns and its economy. It is often suggested, there is an inherent conflict of interest between protecting the environment and promoting economic growth. Thus, Theory on Policy Integration may be the possible suggestion in pursuing the compromise. The paper will discuss, the effectiveness of Antarctica science diplomacy in National Polar Policy, The Policy Integration Theory in enhancing states economic sectors. Lastly, the key factors restraining the full potential of Antarctica science and its diplomacy in igniting an economic burst of the state member.

Fri_331_SH-9_1252
Impacts of Cryosphere Change in the Hindu Kush Himalaya on Humans and Society

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There is increasing concern on how the change in the cryosphere in the Hindu Kush Himalaya (HKH) will impact downstream populations and society. The majority of studies refer to retreat in glaciated areas and reduction of glacial mass, although there are unique exceptions in the Karakoram region where glaciers are stagnant or increasing in mass. Most studies refer in very general terms to "downstream populations" without specific information on how and to which extent the population would be impacted. Neither is there a comprehensive analysis on the number of people affected, or the socio-economic impact at stake. This presentation synthesises the existing body of literature on the human impacts of changing meltwater regimes from transborder glacier-fed and snow-fed river systems in the HKH. The presentation relies mostly on a recently peer-reviewed publication of the same name and distinguishes five main strands of existing research of cryosphere change in the HKH: socioeconomic impacts; hydropower; agriculture, irrigation and food security, and; cultural impacts. The review also reviews acute glacier-related hazards considering research in the field of glacier lake outburst floods (GLOFs) has gained attention. Each research stream is discussed and key case studies described, highlighting important methodologies and results found. Finally, an outline of topics requiring further research is offered.

Fri_332_SH-9_1578
Innovative Methods for Unpacking Team Process Dynamics

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Psychologists have studied small group and team effectiveness for decades and, although there has been considerable progress, there remain significant challenges. Meta-analyses and systematic research provide solid evidence for team psycho-social processes (cognitive, motivational, affective, and behavioral) that contribute to team effectiveness *and* empirical support for interventions that enhance team processes (team design, composition, training, and leadership). Yet, there are also concerns that team processes, which are inherently dynamic, have primarily been assessed as static constructs. Team-level processes and outcomes are multilevel phenomena that emerge, bottom-up from the interactions among team members over time, under the shifting demands of a work context. Thus, research to understand the emergence and evolution of team processes must capture their dynamics over time and over long durations. Our research, funded by NASA, is using several innovative methods to study individual and team psycho-social functioning in the Antarctic and in NASA mission simulations. The methods employed include daily ratings (experience sampling methods [ESM]) to assess team psycho-social functioning, linguistic analyses of daily journals to augment ESM ratings, and electronic sensors to capture team interaction networks and reactions (physiological, psychological). The presentation will highlight the intersection of these innovative methods and challenges for unpacking team dynamics.

Fri_333_SH-9_1945
In from the Cold? Interdisciplinary Perspectives on the Case of Sidney Jeffryes

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Bringing together the expertise of researchers from Psychology, English, and History, this paper takes an interdisciplinary approach to examining the account of Sidney Jeffryes - an Australian Antarctic expedition member who demonstrated significant mental decline during his tenure 'on the ice', and following his return to Australia. Based on historical documents, hypotheses are proposed for the psychological diagnosis of Jeffryes' condition and factors (both interpersonal and intrapersonal) that precipitated it. Analysis of texts written by Jeffryes and those associated with him are examined to provide more context in understanding Jeffryes' experience during and after the expedition, shedding light on why this has remained a largely 'untold' piece of Antarctic history.

Fri_334_SH-9_2405
Anthropological Study of Cultural Heritage in French Subantarctic Places

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Since its discovery, a large number of experiences took place in have been the theater of a diversity of experiences the Antarctic sector and sub Antarctic territory administered by France (Terres Australes et Antarctiques Françaises, TAAF). Their manifestations, past and contemporary, illustrate the determination of man to appropriate that area. Keeping a memory of its origin is a sociological mechanism that structures the relationship between human being and their history. In the Southern, such a mechanism takes on particular significance since the place is apriori suitable for nobody. In the TAAF, remoteness and isolation have always constrained human settlement. Nevertheless, the associated activity subsists and daily life unfolds. Material and immaterial production, past and present, illustrates the ability of human to always transcend the constraints imposed due to the environment. It is this legacy specific to the heritage that constitutes the scientific object of this study. We question this issue from the anthropological point of view and from the point of view of the management of material associated with Sub-Antarctic and Antarctic cultural heritage.

Fri_335_SH-9_2433
Climate Awareness in Popular Culture

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Climate change and climate awareness have been rising during the last decades. Earlier popular culture representations of arctic or antarctic areas e.g. in the 1950ies were often still centered around Science fiction scenario´s that emphasized the foreignness and often hostility of those areas. From the 1990ies onward, there are several reflections of the climate change discourse both in film, comics, thrillers, even picturebooks or digital representations in the wider sense, which shape a more diversified and open image of the polar areas. Some of them rely heavily on emotional appeals, e.g. the cuteness factor of penguins, or the tragic situation for polar bear cubs. Others translate climate change threats into various plots of human interference with what is perceived as unspoiled nature or pristine surroundings. The way in which popular culture and multimedial approaches represent scientific developments, and the way they reflect on for instance climate change awareness are at the core of this paper, which combines cultural studies, multimedia studies, gender and postcolonial theory. The paper will conclude with a look at the Disney film Frozen and its allusions to polar discovery, (sub)arctic milieu and the influence of humans on climate developments. The medial and popular culture images of the polar areas including climate change then again trigger a broader discourse on the anthropocene, and may reflect back on how scientific approaches to climate change are viewed.

Fri_336_SH-9_2439
Cryosalide - A New Generation of Human-environment Observatory

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This new generation Observatory has the mission to collect, archive and promote Antarctic related elements in the broader sense : the Antarctic Treaty area including the Southern ocean and the Southern islands. Extending this concept, the Observatory will also consider other oecumene areas which share a system of common values, transcending national and academic frontiers.
It is a new generation Observatory considering its missions in the fields of academy, education, knowledge and arts dedicated to question the notions of committment and empowerment. Because of the diversity of actors related to Antarctica, this Observatory will gather different perceptions which will sometimes confront each other, bring value or transcend each other, making a link with the paradox of this continent as pristine and void from Antarctic people. Exploring the idea of « Antarctic people » will question about the relation, the standing and the place of Humanity in the circle of life.
This observatory is based on numerous corpus:
1) existing but scattered
2) being collected
3) to be imagined ...that will be presented in the framework of POLAR 2018.

Fri_337_SY-1_24
A Free Service for Precise Positioning in Polar Regions (CSRS-PPP)

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Global Navigation Satellite System (GNSS) Precise Point Positioning (PPP) services enable geoscientists to obtain high quality position information in regions where no local surveying infrastructure exists. The Canadian government provides one such service, known as the Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP) Service which works at any location on Earth and is free to the user.
For management purposes CSRS-PPP log files containing information about the location of surveys, and some technical parameters are retained. Utilizing these files we see very substantial usage in polar regions, where such services would appear to be an excellent tool for geoscience. Prior to October 2015, over 64,000 GNSS files had been processed in the North Atlantic region (including Greenland), and 144,000 files had been processed in Antarctica. In general these observations were conducted with high quality dual-frequency equipment, with long observation times for cm-level positioning. Gridded maps of these observations are presented, showing continental-scale experiments, coastal studies, etc.
The CSRS-PPP service currently process over 1400 files each day on average, with the majority of these files for geoscience purposes, and the majority of the data obtained in a location outside Canada. Intended for the surveying community in Canada, the CSRS-PPP now also serves a global, geoscientific, clientele.

Fri_338_SY-1_190
A New Bathymetry Compilation for the Cape Darnley Region, East Antarctica

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We present the first detailed bathymetry compilation for the Cape Darnley region in East Antarctica. This region is of broad scientific interest as it is a key location for understanding the Cretaceous breakup of central Gondwana, basins on the continental shelf contain valuable paleoenvironmental records, the shelf is an important marine habitat, and the Cape Darnley polynya is one of only four sites of Antarctic Bottom Water production - a cold, dense, nutrient-rich water mass that forms on the continental shelf and sinks to abyssal depths, driving ocean currents around the world. However, oceanographic and ecosystem models in this region are poorly constrained by lack of detailed bathymetry.
Single beam and multibeam bathymetry datasets were compiled from multiple marine science voyages undertaken over several decades. The data were held by several institutes and were of varying resolution and quality. The new dataset improves previous regional bathymetric representations and enables visualization of shelf and slope morphology in unprecedented detail. The compilation provides important baseline information underpinning a range of scientific applications. In particular, the bathymetry provides the first detailed insights into potential bottom water transport pathways from the Cape Darnley polynya into the global deep ocean circulation system. Geomorphic interpretation of the bathymetry data provides insights into past glacial dynamics and contemporary seafloor processes.

Fri_339_SY-1_192
Real-time Imaging Flow of High-resolution Ice-sounding Radar

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Ice-sounding radar is an established technique for probing ice masses and remotely sensing the basal conditions with sufficient resolution over a large area in a comparatively short period. Regarding the signal processing of ice-sounding radar, focused synthetic aperture radar (SAR) imaging techniques have been applied to ice-sounding data to improve the gain and resolution for many years. However, direct implementation of the imaging algorithms are still computationally expensive. At the moment, we are developing a real-time processor by using a modern commercial DSP chip named TMS320C6678. Therefore, it is essential to develop an appropriate real-time imaging algorithm which is adapted to the real-time processor based on DSP. Based on the comparison of the previous imaging algorithms, a range-Doppler algorithm (RDA) integrated with shift-and-correlate (SAC) algorithm is proposed for the real-time implementation of high-resolution ice-sounding radar imaging on the designed real-time processor. To clarify the practical feasibility of the RDA integrated with SAC algorithm, theoretical analysis is carried out in detail. In addition, the hardware architecture of the designed real-time processor, and the implementation of the proposed algorithm on the processor are demonstrated. The real-time imaging is carried on the data collected during the 33th Chinese National Antarctic Research Expedition (CHINARE 33) over Princess Elizabeth Land (PEL) via ice-sounding radar called HiCARS.

Fri_340_SY-1_318
Understanding Outgoing Long-wave Radiation from the Antarctic Atmosphere

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Antarctica´s heat budget defines how it will respond to climate change. Antarctica cools itself mainly by emitting longwave infrared radiation. Approximately 50% of the emission happens at wavelengths beyond 15 µm. Because measurements made at these long wavelengths are scarce, it is not possible to model with confidence the response of Antarctica to changes in climate. This presentation outlines a process for developing site atmospheric state best estimates of temperature and water vapour to constrain a state-of-the-art radiative transfer model. The sensitivity to changes in the surface emissivity can then be tested using the radiative transfer model. Such a robust analysis of the problem is an essential first step before attempting to mitigate the knowledge gap through a measurement campaign. The presentation will outline our collaboration with international partners to design a campaign to measure the far-infrared emissivity above Antarctica.

Fri_341_SY-1_359
iCUPE - Integrative and Comprehensive Understanding on Polar Environments

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iCUPE (Integrative and Comprehensive Understanding on Polar Environments) is a 3-year project that answers to ERA-PLANET (European network for observing our changing planet) thematic strand 4 (Polar areas and natural resources).
The vision of iCUPE is to establish and maintain long-term, coherent and coordinated observations and research activities on environmental quality and natural resources in polar areas. The core idea of iCUPE is the development of novel, integrated, quality-controlled and harmonized in-situ observations and satellite data in the polar areas, as well as data products to the end users. iCUPE combines the integrated in-situ and satellite Earth Observation with a modelling platform. It
1) synthesizes data from comprehensive long-term measurements, intensive campaigns and satellites, collected during the project or provided by on-going international initiatives,
2) relates the observed parameters to impacts, and
3) delivers novel data products, metrics and indicators to the stakeholders concerning the environmental status, availability and extraction of natural resources in the polar areas.
The project will improve our understanding of the pollution sources and sinks, environmental and anthropogenic changes and elements of the cryosphere in polar areas by conducting high-level and high impact research by analyzing these integrated data together with the modelling frameworks.

On behalf of the iCUPE Consortium, Helsinki, Finland.

Fri_342_SY-1_383
Pacific Central Arctic Ocean (CAO) Observing System (K-AOOS)

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Sea ice-covered area in Pacific Central Arctic Ocean (CAO) is a major study site of the Korean Arctic program, regularly visited by its flagship and an icebreaker, *Araon*. Annually conducted ocean-going expeditions occupy a number of oceanographic stations and place a few moorings, focusing on baseline oceanography, sea ice dynamics and lower trophic level. Mid trophic level and fish, however, are yet to be the principal targets of the project. But fisheries potential in the Central Arctic Ocean and the basis for its sound management are of interest to Korea, as a party to the recent negotiation of the proposed fisheries agreement in the CAO. Korea-Arctic Ocean Observing System (K-AOOS) program has developed as a platform of international cooperation, welcoming numerous foreign scientists on board and providing instrument deployment opportunities. Currently K-AOOS Araon's field program is designed for ecosystem and climate change focused researches. Efforts to engage more scientists from the national and international research communities are being made and especially collaborations between Korea Polar Research Institute and others are going well at individual and institutional scientist levels. K-AOOS advocates a data policy that promotes a wide sharing of validated and calibrated data. K-AOOS takes a view that a dedicated scientific leadership in the CAO is warranted that can coordinate multi-national and multi-partner field expeditions and maximize the scientific output.

Fri_343_SY-1_563
Persys-WebGIS-based Permafrost Data Visualisation System for ESA GlobPermafrost

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ESA GlobPermafrost (www.globpermafrost.info) provides a remote sensing data service for permafrost research and applications. This service comprises data product generation for various regions and spatial scales as well as specific infrastructures for visualisation and access to datasets.
PerSys is the open access geospatial information system for dissemination and visualisation of remote sensing data derived within the ESA GlobPermafrost project. The data products are visualised in the PerSys WebGIS and are described and searchable in the PerSys Data Catalogue. The PerSys Data Catalogue is a core component of the Arctic Permafrost Geospatial Centre (APGC), set up within ERC PETA-CARB at AWI[1].
The visualisation employs the AWI WebGIS infrastructure maps@awi (http://maps.awi.de), relying on OGC-standardized Web Mapping/Feature Services (WMS, WFS).
The WebGIS supports the project specific visualisation of raster and vector data products such as land cover, Landsat multispectral index trends, InSAR-based land surface deformations, rock glacier velocities, and permafrost model outputs.
The WebGIS projects are adapted to the products specific spatial scales, e.g. the Arctic WebGIS visualizes Circum-Artic products as well as other large-scale data products. Rock-glacier data products of higher spatial resolution are visualised on regional scale in the WebGIS projects Alps, Andes and Central Asia.
PerSys is accessible via the GlobPermafrost project webpage.

Fri_345_SY-1_1126
Mapping Surface Facies of Midtre Lovénbreen, Svalbard using WorldView-3 Imagery

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Monitoring the spatial variability in snow and ice surface facies on ice sheets can improve our understanding of surface albedo variations and mass balance feedback mechanisms. Using high-resolution multispectral (MS) and shortwave infrared (SWIR) imageries captured by WorldView-3 and stereo digital elevation model (DEM) data, we map glacier surfaces of Midtre Lovénbreen, Ny-Ålesund, Svalbard. The objective of this study is to implement MS image for characterization of the glacier surfaces in Arctic region. We used geographical object-based image analysis (GEOBIA) methods by designing four spectral band ratios for glacier facies mapping: (a) Near Infra-Red (NIR) Ratio (NIRR) using NIR-1 and NIR-2, (b) traditional Normalized Difference Snow Index (NDSI) using green band and SWIR, (c) Normalized Difference Snow/Ice Index NDSII) using red band and SWIR, and (d) Normalized Difference Glacier Index (NDGI) using traditional green and red bands. Seven glacier facies were identified, viz., fresh snow, wet snow glacier ice, melting ice, dirty ice, debris and shadowed ice. Accuracies of derived glacier facies maps were assessed using ground truth data collected during the 9th Indian Arctic Expedition. Results indicate that the object-oriented classification scheme yields 93% accuracy for mapping surface facies of Midtre Lovénbreen. Our future research would focus on spatiotemporal glacier surface change detection studies in the Arctic.

Fri_346_SY-1_1223
Evolution of the Concordia Seismological Observatory Station

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Concordia (75°S 123°E) is a scientific base located at Dome C, on the East Antarctica ice sheet. It is run by the French polar institute and the Italian Antarctic Program, and hosts a seismological observatory that is jointly operated by EOST (Strasbourg) and INGV (Roma). Concordia's seismometers have provided ten years of observatory-quality data from this remote and strategic location. The station was integrated into the GEOSCOPE network in 2008; its data are streamed in real time to the GEOSCOPE and IRIS datacenters under the station code CCD.
Concordia's seismometers - a Trillium T240 and a Streckeisen STS2 - currently operate in an artificial vault at ~12 m depth. The vault was constructed from shipping containers buried in snow, it is thermally stable, but it deforms due to the hydrostatic pressure of the snow. Its proximity to the base causes strong diurnal noise (~40 dB) at frequencies above 1 Hz, especially during the summer season; the ~100 m thick firn (snow) layer forms a waveguide that traps anthropic noise from the base and transmits it to the seismometers.
We are planning to upgrade the station by placing a posthole sensor at a depth of approximately 130 meters, i.e. below the firn layer waveguide and the ice pinch-out depth. This installation should minimize noise from thermal effects, from tilting, and from anthropogenic activity. Drilling is scheduled to start in January 2018. We shall present updates from the drilling and from in-situ instrument tests.

Fri_348_SY-1_1410
West Antarctica Digital Geological Dataset for Cross-discipline Use

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The SCAR GeoMAP Project has produced a digital geological dataset of West Antarctica, a tectonically active region of thin crust that is undergoing rapid glaciological change. Suitable for reproduction at 1:250 000 scale or more detailed, the dataset covers the on-continent coastal area bordering the southern Pacific Ocean. Supraglacial features and glacial till, seasonal water and blue ice are mapped using DigitalGlobe high resolution satellite imagery. These provide a baseline for past and future icesheet fluctuation. Sparse bedrock exposures are classified using data from published geological maps and literature, ground-based geological data, and firsthand observations. The bedrock data aid in evaluation of potential geological influences upon the cryosphere, such as bedrock roughness, subglacial volcanism and/or geothermal flux which may affect icesheet stability and the position and velocity of outlet glaciers. The database features links to bibliographic source files for primary literature and published maps. International GeoSciML data protocols are used for feature classification, making the database attribute-rich, queriable, and compatible with national/international geoinformatics and BigData programmes. The development of the resource is timely in respect to several international scientific research programmes, including IODP 379 in the Amundsen Sea, the Thwaites Glacier Project, and ongoing oceanographic surveys along the southern Pacific margin.

Fri_349_SY-1_1504
Estimation of Velocity of Polar Record Glacier, Antarctica using InSAR Technique

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The ice flow velocity is a critical variable in understanding the glacier dynamics. The Synthetic Aperture Radar Interferometry (InSAR) is a robust technique to monitor Earth´s surface mainly to measure its topography and deformation. The phase information from two or more interferogram further helps to extract information about height and displacement of the surface. We used this technique to derive glacier velocity for Polar Record Glacier (PRG), East Antarctica using Sentinel-1 Single Look Complex images captured in Interferometric Wide mode. The PRG is located in the Prydz Bay area on the eastern side of the Amery Ice Shelf. It is the largest outlet glacier along the Ingrid Christensen Coast, bounded by Meknattane Nunataks and Dodd Island. For velocity estimation, Persistent Scatterer interferometry (PS-InSAR) method has been applied. This method uses time coherent of permanent pixel of master images and correlates to same pixel of the slave image to get displacement by tracking the intensity of that pixels. C-band sensor of European Space Agency, Sentinel-1A and 1B data were used in this study. Estimated average velocity of the PRG is approximated to be ≈400 m/year which varies from ≈100 to ≈700 m/year. This study found that PRG moves with a velocity of ≈700 m/year in lower part whereas the upper inland area flowing with ≈200 m/year. The western part of the glacier is moving faster in comparison with the eastern part of the glacier.

Fri_350_SY-1_1743
Low-cost Autonomous Stations for Measuring Impacts of Climate Change on Glaciers

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The project aims at proposing new methods for monitoring glaciers by means of a network of sensors based on a situational awareness model. Glaciers have a very important role in the planet's climate, and changes in their behavior can trigger extreme weather events, change the climate and affect the level of the oceans and their ecosystems. Therefore, efforts to monitor the planet's ice behavior have been increasingly necessary in order to better understand how glaciers interact with the atmosphere and oceans.
The idea is to implement a set of sensors, with a good spatial distribution, to collect data remotely, verifying the changes that occur throughout the ice masses. This approach would allow assessment of the melting rate of glaciers and their relation to climatic events.
Based on these characteristics, this project created two prototype network sensors to monitor glacier parameters and meteorological data on glacier surfaces in an integrated way. The edge sensor set consists of an Automatic Weather Station (AWS) and two ablation electronics (eAS) stations, both using the Arduino prototyping platform.
AWS were built to withstand extreme weather conditions, combining materials such as carbon fiber and stainless steel, being extremely portable and maintaining a low assembly cost. The eAS are an evolution of traditional ice stakes and use RFID technology to improve space-temporal resolution of ablation measurements.

Fri_351_SY-1_1881
Lessons Learned from Interdisciplinary Snow Research in Svalbard

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For decades, the Svalbard archipelago has been an area of interest for physical, chemical and biological investigations of snow and ice, due to its vulnerable location for climatic interactions and air-mass transport pathways. However, despite the many and demanding field campaigns carried out during the last decades, it has been difficult to link the findings from different projects to obtain the larger picture of snow research in Svalbard, and therefore its importance to the Arctic system is likely underestimated. This is in part related to the heterogeneity of sampling locations and sampling times, which does not promote direct comparisons between the different projects and also to the often mono-disciplinary nature of the research being carried out. Here, we present some of the lessons learned during SnowNet, a collaborative research initiative, developed to foster interdisciplinary Arctic field research. We will discuss key aspects to ensure that the collected data are consistent and comparable, ranging from protocol development, sample collection strategies and data processing and formatting, as well as some of the difficulties encountered. By coordinating our efforts in the field, we can optimize the use of logistics and financial resources, while minimizing our environmental footprint.

Fri_352_SY-1_1890
Understanding Variability of Arctic Methane Fluxes and Addressing Knowledge Gaps

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Methane emissions from Arctic permafrost soils could result in substantial global warming, as permafrost soils store 1300-1370 Pg of organic carbon, two times the current atmospheric stock. The Arctic is warming at twice the rate of the global mean, causing the southernmost border of permafrost to steadily recedes northwards. The main difficulties hindering an accurate baseline estimate are the high spatiotemporal variability in methane emissions, and the poor data available from these systems. Arctic wetlands are in fact extremely heterogeneous and methane fluxes can differ significantly between sites only meters apart.
Here we evaluate the effect of footprint variability on the methane fluxes from two eddy covariance sites located on the large wetland area in the North Slope of Alaska. The local domain of each of these sites contains well developed polygonal tundra, as well as, other thermorkarst features such as drained lake basins and their drainage channels. We found that the footprint variability, has a significantly influence on the observed methane fluxes, contributing to about 10% of the unexplained variability in CH_4 fluxes. We present and discuss the sources of this spatial variability and the remote sensing data required to assess the influence of this spatial variability on the CH_4 fluxes across the Arctic. This study highlights the data gaps and needs to be able to refine our understanding of the controls on the greenhouse gas fluxes across the Arctic.

Fri_353_SY-1_1994
Acoustic Networks - The Key to Observing the Ocean under the Arctic Sea Ice

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The weakest component of the overall Arctic observing system is the in situ ocean observing system. Advanced drifting ice-ocean observatories provide multi-disciplinary data in near real time, but they require stable ice conditions. Profiling floats and gliders, frequently used in open ocean, have to surface to transmit data, update their clocks, and geo-position via satellite. In ice covered regions floats may not be able to surface for many months. During this time the sensors will collect data, but the positions where the data are taken will be unknown and the clocks will not be accurate.

Multipurpose acoustic networks will be an important contribution to the development of a sustainable Arctic Ocean Observing System. A network of fixed mooring systems with acoustic transceivers in the Arctic Ocean will provide an underwater geo-positioning system for all users in direct analogy with GPS positioning. The same system will provide ocean observation through acoustic thermometry, passive acoustic monitoring, and oceanographic point measurements. Moored multipurpose acoustic networks have been implemented in a sequence of year-long research experiments in the Fram Strait and in the Beaufort Sea. New initiatives for establishing acoustic networks in the interior of the Arctic have begun. These initiatives are timely given the several Arctic projects recently funded by the EU's research program HORIZON 2020 and a number of national programs.

Fri_354_SY-1_2080
Enhancement of *in situ* Observing systems in the Arctic under the INTAROS Project

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The H2020 project Integrated Arctic Observation System (INTAROS) aspires to increase the temporal and geographic coverage of *in situ* observations and add new key geophysical and biogeochemical variables in selected regions of the Arctic. Using a combination of mature and new instruments and sensors to be integrated with existing observatories, INTAROS aims to fill selected gaps in the present-day system and build additional capacity of pan-Arctic monitoring networks.
Three reference sites have been selected as key locations for monitoring ongoing Arctic changes: Costal Greenland, paramount for freshwater output from the Greenland ice sheet; North of Svalbard (shelf to deep basin) - the hot-spot for ocean-air-sea ice interactions, and heat and biological energy input to the European Arctic; and Fram Strait - the critical gateway for exchanges between the Arctic and the World oceans. Two distributed observatories: for ocean and sea ice and for terrestrial and atmospheric measurements will be extended with multidisciplinary observations, still missing from the central Arctic and remote coastal areas. New sensors, integrated platforms and experimental set-ups will be implemented during a two-year long deployment phase (2018-2020) with an aim for sustained use in a future iAOS. New observations will be used for integration of new data products, demonstration studies and stakeholder consultations and contribute to ongoing and future long-term initiatives (e.g. OSPAR, SAON, YOPP).

Fri_355_SY-1_2383
Best Practices for a New Network to Monitor the Cryosphere

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Global Cryosphere Watch, a cross cutting WMO initiative, aims at bringing together operational and scientific networks to monitor all components of the cryosphere and make this data available to all interested communities in near real time. CryoNet stations forming the core of this network are required to comply with best practices developed in common by the operational and scientific community. These best practices are based on existing guidelines. They will help homogenise measurement procedures and reporting to ensure that high quality data is collected worldwide on selected variables of each cryospheric component. This is the basis for a global exchange of cryospheric data that will lead to a better understanding of cryospheric processes but also contribute to deliver improved services to society. In this contribution we will present the status of our compilation of best practices and describe how we have integrated input and feedback from various scientific and operational communities to develop these documents. The future vision is to have an ongoing open but controlled update mechanism for these best practices, reflecting continuously new developments in measurement techniques and technologies.

Fri_356_SY-1_2507
Common Metadata Scheme for Translating between Metadata Dialects

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There is a demand to share metadata across polar data centers. However, a variety of metadata catalogues and standards makes this task challengeable. Presently the ISO 19115 is a key standard for sharing metadata. Unfortunately, due to its complexity it is not widely used among the community.
A common set of metadata elements relevant across polar sciences has been developed to facilitate interoperability and sharing between polar data repositories and online portals. We analyzed the metadata schemas for a set of catalogues (GCMD, Polar Data Catalogue, IPY, NSIDC, etc.) and found existing metadata elements common to all or many of the schemas. This set is proposed as a preliminary community recommendation for catalogue publishers to improve interoperability across catalogues.

Fri_357_SY-1_2623
The National Polar Metadata Infrastructure

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In the Arctic complex interactions between atmosphere, ocean, cryosphere and biosphere on a broad spectrum of temporal and spatial scales, are largely responsible for "arctic amplification".Measurements are fundamental to answer relevant questions on climate system variability.The CNR is in charge to managing and disseminate scientific results of Italian activities carried out either in the Arctic and in the frame of PNRA. In this contest, CNR is establishing the **National Polar Metadata Infrastructure**, using technologies based on brokering approach, to provide to the polar scientific community, instruments through which easily manage historical and real-time data and metadata. The infrastructure will ensure data discovery through the interconnection of the system with the most common ones, integration with the global environmental observation network of GEOSS, and will contribute to increase the entire GEO community.In this approach, different servers (called “nodes”) are connected to “brokering nodes”, hosting metadata and data. Every node communicates with the brokering system that allows data integration and interoperability between different kinds of servers.The Italian research activity in the arctic region has increased in the recent years and the CNR developed the infrastructure IADC a system to easily manage real-time data and metadata.

Fri_358_TE-2_155
Development of Antarctic Seismo-acoustic Station: Results from ICE-VOLC Project

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Scientific instrumentations installed in Antarctic regions will face the most extreme climate on the planet, so they have to be tolerant of very low temperatures and robust enough to survive extreme wind speeds. Furthermore, one of the most challenging task is powering a remote system year round at polar latitudes because of following factors: i) solar radiation varies through time from 24 hours during the Antarctic summers to no light during winters;
ii) the high winds are often unpredictable in duration and in strength;
iii) cold temperatures of the polar nights reduce the capacity of batteries.
In the framework of the ICEVOLC project (www.icevolc-project.com), a permanent seismo-acoustic station was developed able to face the aforementioned issues. Sensors and digital acquisition system were chosen to be rugged and operative at very low temperature. Hybrid powering system, integrating solar panel and wind generator, to guarantee continuous batteries charging in every weather conditions and Antarctic seasons, was chosen. Energy produced is managed by two controllers operating in synergy. In particular FASEL controller specifically designed for the project and another commercial controller carry out the following tasks:
i) ensure correct charging batteries,
ii) maintain temperature inside the battery case making use of heaters powered by extra energy,
iii) switches off the instruments in case of measured low battery package voltage to preserve batteries to deep discharges.

Fri_359_TE-2_161
Low-temperature Tests of Ice Friction

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Ice friction is one of the major technological issue in almost every application that involves moving parts one of which is ice, such as glacier movements, design of offshore structures, different ice sports, drilling in the ice, ice/snow vehicles, icebreakers, aircraft on icy runway, etc. High friction on ice is desired for vehicles in winter road conditions and shoes on ice, while low friction is desired in ice sports and some parts of the ice breaker or drills. The main parameters influenced on the ice friction are temperature, sliding velocity, applied normal force, contact area, humidity, thermal conductivity and surface roughness, structure and hydrophobicity of slider and ice. Even numerous ice friction studies were focused on effect of temperature, most of them were done at temperatures above -25 °C which is not low enough to apply for some extreme environment as cold as polar regions. Thus, we investigated promising materials that can be used to decrease or increase friction in the wide temperature range from -60 °C to 0 °C using a linear friction tester by varying several impact factors.

Fri_360_TE-2_219
Multi-Functional Ice Drills Testing Facility

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The first stages of drilling equipment development is most sensibly tested in a laboratory facility prior to using it out in the field. A multi-functional Ice Drill Testing Facility (IDTF) allows to test all kinds of mechanical and thermal ice drills throughout the year including electromechanical cable-suspended drills, hot-water drills, rapid air drills, thermal sondes for subglacial lake exploration, and others. The IDTF consists of several systems:
(1) ice well and freezing system;
(2) heat-insulated building and cooling system;
(3) rotary drilling platform.
The liner of ice well made of steel cylinder (Ø1 m) is sunk into the shaft (Ø2.6 m) to a depth of 12.5 m below the ground. According to different operating mode, the different sub-glacial conditions can be imitated in the ice well by freezing system. A two-room, heat-insulated building, containing a tall hall (6×6×15.2 m) with air-cooling system and an entrance hall (3×6×4.5 m), was constructed above the ice well. A rotary drilling platform on the second level of the tall hall allows for the drilling of at least nine holes with a diameter of 130-150 mm around the perimeter of the ice well. The refrigerators were chosen by freezing the ice well within 72 hours. The temperature of artificial ice can be adjusted from -5 to -30 °C and the lowest temperature of ambient air in the IDTF can be controlled to -20 °C. The first tests performed in the IDTF illustrated the facility's convenient performance for ice drill testing.

Fri_361_TE-2_228
Environment Monitoring Demonstration Networks on Prydz Bay

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China promoted and implemented environmental monitoring programs and arrayed multi-discipline monitoring sensors on Prydz Bay since early 1990s. Multi-discipline data was collected including hydrological, meteorological, geophysical and biological data. A rapid data transmission network was framed connecting R/V Xuelong, polar Stations and domestic berth. For forecasting and prediction based on long-term monitoring, China designed a long-term environmental monitoring network on Prydz Bay based on the existing work. All the conventional monitoring works in China were covered in the design objectives in this network. We also expanded the monitoring works according to new international developments and long-term plans. This design has been proved performable and exemplary especially in the ice-breaking navigation work on Prydz Bay.

Fri_362_TE-2_432
Small-diameter Vibrocorer for Sediment Coring Beneath Antarctic Ice Shelves

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Sediments beneath the Antarctic ice shelves contain important paleo-climatic and paleo-environmental records, which will offer a long-term perspective on Antarctic ice sheet retreat history and sub-ice shelf ocean circulation patterns. We designed a vibrocorer which could collect sediments from beneath Antarctic ice shelves through an access hole formed with the hot-water drill. This vibrocorer includes four units: water-proof pressure chamber, vibrator, core-barrel unit and spring buffer. For the vibrator, we utilize the self-synchronous theory of dual-mass vibrating machine which allows to compress radial size of the vibrocorer. Actuating motors, whose power are supplied by 36V DC lithium battery, rotating in opposite directions can generate vertical, horizontal, or alternative vibrations. The configuration of vibrocorer is 270 mm in maximal radial size, 7.5m in total length and 300kg in total weight, which aims to get the sediment core with max 6m in length and 108mm in diameter. The vibrocorer has been proved to work functionally during laboratory testing and is prepared for field testing in the season 2017-2018 at the Ekströmisen, Dronning Maud Land, Antarctica.

Fri_363_TE-2_438
A Shallow Hot-water Drill

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To get shallow access holes in high mountain glaciers and polar ice caps and sheets, the hot-water drilling is a meaningful method for temperature observation, ice dynamics study, etc. Hot-water drill is considered as one of the most effective non-core drilling methods in ice because of the high rate of penetration and low environment impact. However, there is no complete theoretical base for designing of hot-water drilling systems and for choosing of optimal drilling parameters. Thus, the drilling process is mainly controlled by the experience of drillers. Theoretical estimations were done to predict hot-water temperature at the bottom of the borehole, diameter of the borehole, rate of penetration, required power for ice melting and the total pressure loss in water circulation system. The shallow drill system, designed and produced in Polar Research Center, includes a high-pressure washer, a winch with 100 m high-pressure hose, mast, dead weight, nozzle and sensors (temperature sensors, load cells, encoder, flowmeter, and pressure gauge). Experiments with shallow hot-water drill were taken at the low temperature test drilling facility with the main aim to find relationship between rate of penetration and borehole diameter from diameter and type of nozzle, water temperature and flow rate. Theoretically, the drill is capable to produce access borehole with diameter near 100 mm at rate of 30 m/h. These parameters have been proved during testing in 10 m deep ice-well.

Fri_364_TE-2_501
Hot-Water Coring System with PDM Motor

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Subglacial rocks and ice-rock interface plays a key role in the dynamics of the overlying ice sheet. Samples of basal and subglacial material can give unique information for paleo-climatic and paleo-environmental records, microbiological study, geology and tectonics. Hot water drilling system is considered to be the fastest way to reach the target depth. To get core sample, the drill nozzle will be changed to the coring part combination, positive displacement motor (PDM) with core barrel and drill bit. PDM motor is used to transform hydraulic pressure of hot water flow to the rotation and torque, and also balanced by anti-torque system. Core barrel is used to protect the core samples from the hot temperature environment and mechanical erosion. The type of drill bits will be chosen according to the material being drilled. Gravity chips chamber will be included into downhole assembly while coring the ice with rock or soil. If only ice coring, the system can work without chips chamber, because the hot water circulation will melt all ice chips. It is planned to test the temperature and flow rate distribution in the system on the testing stand. The detailed concept of ice and subglacial bedrock PDM corer is being worked out.

Fri_372_BE-5_1696
Algal Biomass Production in Central European Non-summer and Arctic Conditions

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Arctic under present climatic changes brings new opportunities for industrial developments (oil and gas resources, fish and fisheries management, shipping in the Arctic ocean, etc.). Urbanisation and development all technological support for humen life is one of the most glabolly urgent tast for future. Low temperature biotechnology and explore the biotechnological potential of polar and other low temperature adapted cyanobacteria and microalgae (micro-algae), which can produce valuable metabolites in Central European non-summer and Arctic conditions is great challenge for Czech Science. Microalgae and cyanobacteria are a rich source of bioactive molecules with many potential uses such as components in human/animal nutrition, pharmaceuticals, nutraceuticals, cosmetics, biopesticides, phytohormones, etc. Many of metabolites from microalgae have been shown to possess varied bioactivities. Microalgal bioactive molecules thus hold a bright and promising future in scientific research including a great opportunity for drug discovery. In proposed lecture, the non-marine environmental conditions in Arctic environments and microalgal adaptations will be introduced with respect to possible biotechnological applications. The presentation also provides a survey of the possible compounds to be exploited from Arctic microalgae. Possible constructions of photobioreactors for mass cultivation of microalgae are proposed for operations in the Arctic.

Fri_365_TE-2_595
Hydraulic Fracturing in Ice Drilling Borehole: Theory and Tests

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Hydraulic fracturing initiated by increasing the fluid pressure in the borehole to the point where the smallest principal stress at the borehole becomes tensile has been used commercially as a stimulation technique in the petroleum industry since the early fifties. The same situations potentially can happen under condition when drilling fluid pressure exceeds ice pressure at certain depth while drilling in ice sheets and glaciers. We propose an estimation of overpressure that causes the hydraulic fracture in ice on the base of theory of rocks fracturing. This estimation reveals the critical relationship between the drilling depth and density of the drilling fluid at which hydraulic fracturing occurs and provides the theoretical basis of adjusting the density of drilling fluid. Several hydraulic fracturing tests were carried out to simulate ice fracturing on the borehole wall with artificial ice samples under a special three-axis hydraulic fracturing test system. Based on combining with theory consideration and experimental results, this study supports the hypothesis that hydraulic fracture is a plausible mechanism for the possible phenomenon in ice drilling borehole.

Fri_366_TE-2_654
Experimental Research of Hot-water Ice Coring Drill

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How to acquire ice cores efficiently is becoming an increasingly key problem due to abundant information of climatic variation in intact ice cores. Compared with the traditional coring drill by armor cable, hot water drilling has its unique advantages: drill rapidly and environmental friendly. This paper proposed a hot-water ice coring drill, which is used in combination with the hot-water drilling system and can get ice cores at any depth. The hot water is supplied by the same hydraulic hose that is used for the hot-water drilling. 3.25m long drill includes core barrel, guiding tubes, core catchers and drill head with 36 nozzles 1mm in diameter. The core barrel (96 mm inner diameter) is 3m long. The hot water passes through 4 guiding tubes (4mm inner diameter) fixed along outside of the core barrel to the drill head. The prototype of the drill is produced and experiments in ice drill testing facility are carried out. The ice cores are obtained successfully with a special optimal drilling parameter.

Fri_367_TE-2_847
IBED Drill Testing in Ice and Bedrock

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To drill through ice and bedrock in Antarctic, a new, modified version of the cable-suspended Ice and Bedrock Electromechanical Drill (IBED) was designed and tested in Polar Research Center, Jilin University. The IBED can drill in ice, debris-rich ice and rock by changing different module that permits the accomplishment of two different tasks: (1) an ice-core drill; and (2) a bedrock core drill. The upper part is almost the same and includes four sections: cable termination; a slip-rings section; an antitorque system; and an electronic pressure chamber. The ice drill could penetrate successfully 800 mm of artificial ice with nearly 100% recovery rate. The cutting load was about 400 N, and the average ROP - 12.7 m/h. Testing of bedrock drill on drilling of granite samples showed that the toothed diamond drill bit could penetrate 1m and at a rate of 1-1.5 m h^{-1} at low load (< 2 kN) and torque (< 30 N m). In addition, tests of the double drill pipe was questionable as the drill was stuck after penetration of 300-400 mm. The reason of stucking was not clear, and additional tests are planning in the near future.

Fri_368_TE-2_902
An Introduction to a New Inland Traverse Project (2017 - 2026) by KOPRI

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Korea Polar Research Institute (KOPRI) opened the second Antarctic research station, Jang Bogo Station, at Terra Nova Bay, Ross Sea area in 2014, and many scientific expeditions are currently operated including geology (KAGEX), geophysics (EGG), meteorite searching (KOREAMET), ecosystem monitoring (CEMP) and shallow ice coring. From 2017, KOPRI started a new inland traverse project during ten years with multidisciplinary purpose. The project includes 1) finding a safe and reliable traverse route, 2) developing a 2,000m hot water drilling co-project with British Antarctic Survey for subglacial lake expedition and 3) developing a 3,000m deep ice core drilling technology. Using previous results by satellite altimetry and airborne radar surveys, the existence of subglacial lakes at the upstream of David Glacier is getting clear. During 2017 austral summer season, a traverse team will approach the possible candidate lake site and conduct a ground radar survey. The results of 2017 season expedition and long-term project plan will be presented at the meeting.

Fri_369_TE-2_1953
Experiments on Electric-heated Hotpoints for Boring in Ice

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The electric-heated hotpoints are used for boring in ice to install ablation sticks, to determine ice thickness, to locate englacial and subglacial streams, to deploy sensors and tools under ice shelves, to measure temperatures, closure rates and other internals of glaciers like variation with depth of ice flow velocity, identification of dust layers, video observation and so on. Recently, interest in hotpoint using was rekindled in connection with proposed projects for subglacial environment exploration at the Earth and other planets. Hotpoint melting rate depends on the following variables:
(1) input power;
(2) cross-sectional area of the thermal tip;
(3) axial load (in the limited range);
(4) temperature of the drilled ice and
(5) design features like material and shape of the tip, properties of thermal element, etc.
To study relationship between input power, axial load and shape of the thermal tip, a 0.8-m long hotpoint with changeable thermal tips and computer-controlled testing stand were designed. Series of tests were carried out in artificial ice with temperature of -20 °C. Totally, 14 copper melting tips with different shapes and the same outer diameter of 55 mm were tested. The heat was provided by five diametrically installed cartridge heaters with total rated power of 2.4 kW. The results of the presented experiments provide the prominent reference for hotpoint optimization.

Morning Plenary IV
23.06.2018 07:50-09:00, A Davos

Keynote Lecture VII
The need for coordinated observations to inform responses to rapid Arctic change

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Rapid Arctic change poses challenges from the local to the global scale, whether it involves Arctic residents and ecosystems adapting to changing land-, sea-, and icescapes or the development of global policy frameworks to mitigate drivers of change such as greenhouse gas forcing. Informed responses to Arctic change require sustained, coordinated observations of essential variables that describe the present state of the system, inform predictions of future states, and serve as indicators of major transitions or changes in state, and support policy and decision-makers.
Over the past decade or so, a rich diversity of different implementation approaches, networks, and platforms has emerged, covering a range of observational scales from the local to the regional to the pan-Arctic. A key question – central to the Arctic Observing Summit 2018 – is how to foster structured coordination of these efforts, whether driven by bottom-up aggregation of, e.g., community-based monitoring or top-down organization through, e.g., global observing system frameworks.
This presentation illustrates how such structured coordination may be brought about by (i) drawing on toolkits developed for the design of regional or global observing systems, (ii) translating to the local scale the broader concept of societal benefits derived from services provided by the Arctic system, and (iii) focusing on the aim of informed response as a way to encourage convergence of different activities and approaches.

Morning Plenary IV
23.06.2018 07:50-09:00, A Davos

Keynote Lecture VIII
The Southern Ocean – globally important, surprisingly unknown

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The Southern Ocean is fundamental to global climate, marine biomass, and sea-level change. Its storage of heat and carbon and its redistribution of physical and biogeochemical properties affects all oceans. It is also one of the least known sectors of planet Earth with large unexplored areas. The fate of the West Antarctic Ice Sheet is considered the greatest remaining unsolved problem when predicting future global sea level. This giant ice sheet is drained by glaciers that terminate in the ocean, where they form floating ice shelves overlying vast sub-ice cavities. Physical processes in these cavities are key for the melting and break-up of the ice sheet. However, due to the lack of data for boundary conditions, forcing, and validation of theories and models, these environments are still very poorly understood. Another main knowledge gap is the seasonally sea-ice covered parts of the Southern Ocean, an area larger than the South American continent. The Southern Ocean accounts for about 50% of the oceans uptake of CO2. Observations of the ice-covered regions remain mostly non-existent because of its remoteness and harsh environment. The ice prevents satellite-based remote sensing of the sea, available in other regions. Data is obtained at great logistical cost and elevated risk, and it is vital that the international community work together to create sustainable and efficient observing systems in this area. Without a clear understanding and long-term observations of the air-sea-ice fluxes, we are unable to supply climate models with correct process descriptions and validation. As a result, we currently hold a poor understanding of the key ocean processes. This presentation will outline major knowledge gaps existing in the Southern Ocean and recent advances addressing them within the Southern Ocean Observing System (SOOS).

BE-9g - Life distribution and responses to environmental changes in Polar ecosystems 23.06.2018 09:00-10:30, C Aspen

121
Long-term Dietary Trends and Resiliency of Pacific Walruses to Climate Change

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Sea ice loss threatens Arctic species, such as Pacific walruses (*Odobenus rosmarus divergens*). Long-term dietary studies are useful in assessing impacts of climate change. We obtained stable isotope data ($\delta^{15}N$, $\delta^{13}C$) from cementum growth layers in walrus teeth to assess diet variability. By documenting changes over individual lifetimes and population-wide trends, we investigate resiliency and vulnerability of walruses to environmental change. Partnering with museums and subsistence users, we chose teeth collected from 1880-2016. A generalized additive model shows $\delta^{15}N$ and $\delta^{13}C$ decrease over time, while expressing cyclical, but inverse patterns. Walrus trophic level reached a low in the 1960s and peaked in the 1990s, followed by a recent decline; this may correlate with population size. When sexes were analyzed separately, this pattern was different for females, who reached a $\delta^{15}N$ peak in the 1980s. Declines in $\delta^{13}C$ through time may link with large-scale environmental trends and mirror observations in marine species in other biogeographic regions, including Antarctica. Autocorrelation functions show short- and long-term oscillations of $\delta^{15}N$ and short-term oscillations of $\delta^{13}C$ through time, suggesting biotic influences on diet (e.g., mollusk depletion and repopulation). High variability in $\delta^{13}C$ and $\delta^{15}N$ indicates walruses are generalist predators consuming varying proportions of pelagic and benthic prey. Walruses may thus have potential resiliency in the face of climate change.

496
Genetic Selection in Antarctic fur Seals - Effects of Prey and Sealing

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Antarctic fur seals, *Arctocephalus gazella*, breed on sub-Antarctic islands around the continent. This discrete, yet circumpolar, distribution is an ideal natural laboratory for exploring genetic selection. All of the islands inhabited by *A. gazella* are near the polar front, but they differ in key parameters, notably in the composition of available prey and in the degree of commercial harvesting each colony experienced. In terms of prey, krill form the majority of *A. gazella*'s diet in West Antarctica, whereas further east myctophid fish form the bulk of the diet. In terms of harvest pressure, more readily accessible islands, such as South Georgia, suffered high rates of exploitation during sealing, while more remote and inaccessible islands, such as Bouvetøya, were harvested at much lower levels. How then have these disparate pressures driven genetic selection in *A. gazella*? To address this question, we sequenced 100,000 loci across the genomes of 97 individuals from 8 major colonies across the circumpolar breeding distribution. By comparing the frequencies of genetic changes, and mapping changes back onto annotated genomes, we can begin to unravel the effects of these natural and anthropogenic selective forces on *A. gazella* at a molecular level. Understanding the evolutionary consequences of sealing, and the ongoing selective pressure of different prey regimes may provide insight to guide management of this species within a rapidly changing Southern Ocean.

1033
Post-weaning Dispersal of Antarctic Fur Seal young of the Year

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First-year survival (FYS) is a critical parameter driving trends in abundance and recruitment in vertebrate populations and can be a substantial driver of life-time reproductive success. FYS of Antarctic fur seals (AFS) in the South Shetland Islands is highly variable and declining. Newly-weaned AFS are shallow divers that likely depend upon highly productive areas with high-density prey to survive an abrupt transition to nutritional independence. This critical time in pinniped life history is under-studied. Our objective was to investigate habitat use and dispersal patterns for AFS young-of-the-year using satellite-linked telemetry. We instrumented 39 AFS pups over three years. Pups were tracked from their natal colony on average 64 d (±67.0). Over 21,000 ARGOS locations were processed with a continuous-time correlated random walk model. One pup which was recaptured the following year spent 93.2% of its winter migration (251d) south of the Polar Front. Some pups spent their post-weaning months in the Bransfield Strait, the location of an extensive and growing winter fishery for Antarctic krill. The overlap between this critical period in AFS life history and the winter krill fishery is a concern for the conservation of this and other krill-dependent species. More studies of distribution and foraging ecology of young of the year are necessary to understand the full extent of the impact of the fishery.

1243
Acoustic Monitoring of Top Predators in the Ross Sea Marine Protected Area (MPA)

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The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is expected to officially declare the Ross Sea region Marine Protected Area (MPA), located in a pristine and ecologically important area of the Southern Ocean, in December 2017. CCAMLR requires ongoing monitoring of the MPA to ensure objectives are met, specifically prevention of ecosystem effects as a result of fishing for Antarctic toothfish. The focus of proposed research and monitoring for the MPA is on toothfish predators, including Weddell seals and Type-C killer whales. These and other top predators are valuable indicators of ecosystem status, since their presence, diversity, and abundance integrate multiple external drivers acting on the ecosystem.
The aim of our study was to establish the methodology for comprehensive passive acoustic monitoring of marine mammals in the MPA. During January 2018, we deployed a series of 'sound traps' with a 288KHz sample rate in an area used by killer whales and other marine mammals to generate presence/absence data, diel activity patterns, and abundance information. Concurrent video was also obtained using underwater 'camera traps' to correlate various calls to observed behaviors, individual identity, and group structure. The findings obtained will inform the design of passive acoustic monitoring networks in the Ross Sea region MPA and greatly contribute to our understanding of the ecology of key top predators in that ecosystem.

2047
Assessing Global Change Influences on the Distribution of Antarctic fur Seals

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Antarctic fur seals are a numerous, adaptable and far-ranging circumpolar species. While krill forms a significant component of their diet in the South Atlantic, individuals in the southern Pacific and Indian Oceans rely on mesopelagic fish and squid. Over the last ten years, we have studied the winter habitat requirements of Antarctic fur seals at Marion Island. One of the primary aims has been to assess how the predicted southwards movement of Southern Ocean fronts and the intensification of westerly winds (positive Southern Annular Mode) may influence the distribution and foraging success of pelagic Southern Ocean marine predators. Since 2008, the post-breeding movements of over three hundred female Antarctic fur seals from Marion Island have been studied using flipper-tag geolocation tags. Movement analysis of this unique and extensive time series has been conducted using freely available, customised software (bsam and SGAT R packages). This approach has enabled the detection of key individual and aggregated annual foraging areas during this ten-year period (2008-2017). Predicted inter-annual southwards shifts in prime foraging areas were assessed in relation to mean and annual frontal positioning and sea-ice extent. Understanding how changes in the foraging behaviour and success of higher trophic level species relate to signals of global change, will enable better predictions of ecosystem change and population level response in the Southern Ocean into the future.

2187
Life in the Fast Lane: Fur Seal Foraging at the Edge of their Distribution

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At its most southerly breeding range, the Antarctic fur seal (AFS) operates at its highest field metabolic rate in an environment challenging the physiological limits for energy acquisition. Currently, we have little understanding on how edge colonies, already coping with high environmental variability, may deal with additional variation contributed by specific atmospheric events. By using a combination of diet estimates and biologging we evaluated how additional environmental variability (2014/15 EL NINO year against regular years) may affect the behavior of these colonies. Foraging behavior was compared between all years using 18 variables that represent five categories: trip duration, recovery time (time ashore and surface time), diving effort, habitat use and diet. Differences were found in trip duration (longer trips), recovery time (shorter time ashore) and habitat use between 2014/15 and normal years. No differences were found in diving effort since colonies are already operating at their physiological maximum. Diet was no different between years. This suggest that, in critical years, individuals will not take decisions that may risk the success of capturing prey (longer but close to shore trips and shorter time ashore) differing from other AFS colonies under critical conditions. Adaptive mechanisms may be shaping the behavior of these colonies highlighting the importance of research on evolutionary patterns in colonies living constantly in the fast lane of life.

1572
Reconstructing Holocene Climate and Deglaciation from Antarctic Lake Sediments

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We present quantitative reconstructions of past temperature change from Antarctic and sub-Antarctic lake sediments using temperature-sensitive membrane-spanning glycerol dialkyl glycerol tetraether (GDGT) lipids of Archaea/Bacteria, and examine Holocene palaeoclimate change and the deglaciation of ice-free areas on the Antarctic Peninsula (AP) and South Georgia (SG). Global GDGT calibrations do not perform well for low temperature/high latitude lake sediments because GDGT presence, type and provenance is largely unstudied. To address this, we quantified modern-day environmental controls on GDGT compositional abundance in surface sediments of 38 (sub-)Antarctic lakes. GDGT compounds were found in 37 lakes, with branched GDGT (brGDGT) compounds dominant. Mean summer air temperature (MSAT) explained most variance in the brGDGT data allowing development of a new brGDGT-summer temperature calibration for (sub-)Antarctic lakes with significantly improved statistical performance at low temperatures. Reconstructed summer temperatures from three strategically-located palaeolimnological records reveal that deglaciation near to present limits was likely completed by or during a late Holocene temperature maxima, centred on c. 4-3 ka, with a significant cooling trend into, and minor glacial readvances during, the C16-19th Southern Hemisphere (SH) 'Little Ice Age'. We link Holocene temperature shifts and regional lags to variations in SH insolation and Westerly wind strength.

1797
A 43 ka Multi-proxy Record of Paleoenvironments from an East Antarctic Lake

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Lakes situated in polar regions are quite sensitive to slight variations in the climate, and therefore can be effectively used to reconstruct past variations in the environmental conditions arising due to climate change. Schirmacher Oasis (SO) is one of the ice-free regions in East Antarctica and is bestowed with several freshwater lakes. In this work, we present a multi-proxy work carried out on a 79-cm sediment core from L-49 Lake. The core has an age-span of ~43 cal ka B.P. which is constrained by five AMS radiocarbon dates. A range of environmental magnetic measurements were made in addition to estimation of the total organic matter content for the samples. The iron-bearing minerals are mainly derived from the catchment as there is no obliteration of the magnetic signal due to magnetic dissolution, bacterial magnetite and authigenic greigite. The magnetic properties are high during the last glacial period indicating a fairly high concentration of coarse-grained magnetite. Such high values are indicative of extremely cold climatic conditions in the SO. During the Holocene, the values are quite low, suggesting relatively warmer climatic conditions. This is also supported by the high values of organic matter content indicating an increase in productivity in the lake system. Deglaciation in the SO began at around 20 cal ka B.P. which is fairly consistent with other paleoclimatic records from the region as well as other ice-free regions in East Antarctica.

1186
Groundwater and Thaw Legacy of a Large Paleolake in Taylor Valley, Antarctica

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The McMurdo Dry Valleys (MDVs) in East Antarctica contain a number of perennial ice-covered lakes fed by ephemeral meltwater streams. Paleodeltas and paleoshorelines throughout Fryxell Basin in Taylor Valley provide evidence of significant lake level change occurring since the Last Glacial Maximum (LGM). During the LGM, grounded ice in the Ross Sea extended into the eastern portion of Taylor Valley, creating a large ice dammed paleolake referred to as Glacial Lake Washburn (GLW). Airborne resistivity data collected by SkyTEM, a time-domain airborne electromagnetic sensor system, was used to map groundwater systems in the lake basin. A large low resistivity region indicative of liquid water extends hundreds of meters away from the modern lake extent which is consistent with the presence of a degrading thaw bulb from GLW. As lake level in Fryxell Basin fell to modern levels, the newly exposed saturated sediment surrounding the lake began to freeze. We hypothesize that this process is ongoing and will continue until equilibrium is reached between the geothermal gradient and atmospheric temperatures.
Though groundwater systems were previously thought to be minimal or nonexistent in the MDVs, regional resistivity data now show that extensive reservoirs exist beneath these lakes. The presence of deep groundwater systems beneath MDV lakes has important implications for hydrologic and ecosystem connectivity in an environment largely driven by the availability of liquid water.

1034
Assessing the Impacts of Antarctic Bases on Fildes Peninsula Aquatic Ecosystems

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The Fildes Peninsula (King George Island, South Shetland Islands) has been the site of year-round human presence since the construction of Bellingshausen Station in 1968. The peninsula is now home to six permanent bases, creating one of Antarctica's densest human concentrations. Substantial infrastructure supports these bases, including an airport, roads, pipelines, and diesel generators. The construction and operation of these facilities has caused considerable disturbances, although the precise nature of the effects on most ecosystems is still poorly understood.
In 2016 and 2017, eight lakes were sampled to determine nutrient and metal concentrations as well as basic water column properties. Short sediment cores were also retrieved to determine lake conditions prior to human presence on the peninsula, and to develop records of how anthropogenic pollutants have affected the lakes since bases were established. XRF core scanner, x-ray diffraction, and CT-Scan images have been used to determine how the deposition of pollutants to the lakes has changed in the past. Biological indicators, including diatoms and fossil pigments, will be employed to determine how aquatic communities have changed over time and if they been affected by local human activities. By comparing our study lakes situated near and distant from bases, we will determine what observed changes can be attributed to natural changes and thus quantify anthropogenic effects on Fildes Peninsula aquatic ecosystems.

2614
Reconstructing Westerly Wind Variability Using Sub-Antarctic Lake Sediments

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The position and strength of the Southern Hemisphere westerly winds (SHW) is important for temperature and rainfall variability from the mid- to high-latitudes of the Southern Hemisphere. The SHW also influence Southern Ocean circulation, regulate ocean-atmosphere CO_2 degassing, and influence sea ice extent around Antarctica. While observations since the 1950s show the winds have strengthened and shifted southwards, this period is too short to understand their natural variability, especially as stratospheric ozone depletion and rising greenhouse gases from anthropogenic activities are considered to be driving these changes. Here, we present SHW strength reconstructions spanning the last 12,000 years from sub-Antarctic Macquarie Island (54°S, 158°E) based on independent proxies that track the changing inputs of sea salt aerosols and minerogenic particles into lake sediments. Our reconstructions show close agreement with temperature, sea ice and atmospheric CO_2 records from Antarctic ice cores for the last 12,000 years, and southern South American temperature for much of the last Millennium.

1029
Sub-antarctic Peats as Recorders of Westerly Wind Changes. Preliminary Results

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Peatlands are important terrestrial archives of past environmental change and human impact. Some peatlands are only fed by atmospheric inputs and therefore have the potential to record a more global or hemispheric signature than other continental deposits. Easily datable, they can produce high-resolution, precisely dated records covering the Holocene and beyond. Peatlands located on high-latitude sub-Antarctic Islands are heavily influenced by the prevailing Southern Hemisphere Westerly winds (SHW) and provide excellent archives in areas of the Southern Ocean where terrestrial palaeorecords are otherwise scarce. In particular, they are excellent traps for particulate material (dust) transported in the atmosphere and provide information about past changes in the SHW. Changes in the relative strength and latitudinal position of the SHW are thought to be both spatially- and temporally- variable, influencing the Southern Ocean circulation and controlling how much carbon-rich deep water reaches the ocean surface. To better understand changes in the SHW and its impact on carbon exchange between the ocean-atmosphere over millennial-centennial timescales, we sampled peatlands from several islands located within the SHW core belt. Here, we reconstruct past (decadal to millennial) changes in the SHW position and strength from proxy records of wind-driven particulates and develop a more complete understanding of how the SHW modulate the oceanic uptake of CO_2.

BE-12a - Functional ecology of polar microbial communities in a changing world
23.06.2018 09:00-10:30, A Forum

440
Functional Succession from Ice to Developed Soils in the Arctic

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Glaciers in the Northern Hemisphere are retreating and their forefields present a unique opportunity to investigate the initial phases of soil weathering/formation and microbial succession in terrestrial cold habitats. In Arctic environments, the relative importance of primary autotrophic microbial colonisers (e.g. cyanobacteria and chemolithotrophs), input of allochthonous sources and recycling of ancient organic carbon during the initial phase of soil establishment is still debated. In this study, the functional microbial diversity of four Arctic glacier forefields was investigated using metagenomic analysis. In total, 72 soil samples were collected and sequenced using the Illumina Next-Seq 500. The annotated assembled metagenomes were used in a newly developed pipeline to provide a quantitative approach to investigate selected ecologically relevant genes. Our study shows a succession of processes with age, whereby communities in soils previously overridden ice, strongly represented by a C-fixation metabolism, are gradually replaced by a metabolism involved in the degradation of complex organic carbon. Genes associated with N-fixation were significantly high only in forefields where total nitrogen content was low. The metabolic diversity observed in our chronosequence gives insights into feedback mechanisms between geochemistry and microbial colonisation during soil development after glacial retreat.

330
Temperature Sensitivity of the High Alpine Soil icrobiome

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Climate change leads to rapid warming of arctic and alpine environments with strong impacts on the soil microbiome. However, the effects of elevated temperature on soil microbial diversity and functions and the link between them are still poorly understood.
To assess the temperature adaptation, we incubated eight high-alpine soils adapted to different altitudes and aspects at five temperatures between 4 - 35 °C for one month. Sequencing of the bacterial 16S rRNA gene at the DNA and RNA level as well as 3H-leucine incorporation as a measure for bacterial growth were used to investigate shifts of abundance, activity and optimal growth temperature.
All soils intrinsically exhibited an optimal temperature for bacterial growth of 25 - 30 °C. Only incubation above 25 °C led to a shift of the growth optimum towards the incubation temperature. Conversely, preliminary results indicate a gradual shift of the bacterial community structures in response to temperature over all incubation temperatures. Changes at the DNA level might indicate enrichment of taxa adapted to the respective treatment temperature in the community as they may gain a selective advantage leading to enhanced turnover relative to less well adapted taxa. On the contrary, shifts in abundance at the RNA level only suggest increase and decrease of activity without concurrent turnover as an important mechanism of temperature adaptation.

431
Greenhouse Gas Fluxes and Microbial Activities in Dry and Wet High-arctic Soils

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High-arctic tundra-soil ecosystems are particularly sensible to global changes due to their proximity to freezing, snow cover, light availability and scarcity of vegetation. Hydrological fluctuations in these soils are also important, where drier soils are expected to be less buffered to temperature, directly impacting the soil biological activity. Yet, little is known on the effects of soil moisture in the regulation of microbial activities in high-arctic soils and their impact on greenhouses gas exchanges with the atmosphere. In a study part of the CLIMARCTIC consortium, the fluxes of greenhouse gases (CO_2, CH_4 and N_2O) were assessed along a moisture gradient (30 - 70 %) in high-arctic tundra soils near Ny-Ålesund (Svalbard) and linked to microbial activities and community structures. Fluxes of CO_2 were highest in dry soils, indicating higher respiration compared to wetter soils in which CO_2 fixation was more important than respiration. Methane (CH_4) was mostly consumed except for the wettest soils where CH_4 was emitted. Comparing these results with microbial functional diversity such as abundance of functional genes or extracellular enzymes activities involved in C and N-cycling will allow to highlight the importance of soil moisture in tundra soils for microbial activities and their impact on greenhouse gases fluxes.

504
The Microbiome of the High-alpine Permafrost and its Response to Warming

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The microbiome of temperate mountain permafrost is still poorly understood. Here we present the results of a pioneering metagenomic study on the permafrost microbial communities from the Swiss Alps. Samples taken in the ridge of "Muot-da-Barba-Peider" (N 46.49634 E 9.93145, 2979 m. a. s. l) revealed a unique, highly diverse microbial community enriched in bacterial members of the novel Patescibacteria superphylum and with a significant proportion (14%) of poorly characterized fungi. Based on these results, we established an *in situ* experiment in which permafrost soils at a depth of 1.6m were placed into the surface active layer in order to simulate thawing of permafrost as a consequence of warming. After one year, DNA content as a proxy for microbial biomass in the transferred permafrost soil increased. This may imply changes in the microbial community structures and functions with potential impacts on the C- and N- cycles in these soils. All together our results contribute to a better understanding of the future status of the permafrost microbiome subjected to warming and its implications for the high mountain ecosystem functioning.

1631
Biostimulation of Antarctic Soil on a Freeze-thaw Regime: A Promising Approach

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Several studies have applied and evaluated bioremediation treatments on Antarctic soils; however, most of them take place during the summer to take advantage of higher temperatures. The Antarctic continent is constantly subject to temperature fluctuations, and summer periods are short and not enough to achieve the biodegradation goals. Recently, a few studies have shown the possibility of developing a bioremediation treatment over freezing periods with significant hydrocarbon degradation ratios. However, none of those studies compared a conventional summer bioremediation treatment against a freeze-thaw cycle (FTC) with temperatures varying between negative and positive, which frequently occur in Antarctica. A 75-day experiment was performed aiming to evaluate the differences in bacterial communities in a nutrient-amended treatment (BS) at 4°C against a FTC nutrient-amended treatment (FBS) (temperatures from -20 to 4°C) in contaminated soil by diesel oil. Our results revealed that 35.9% of OTUs found in FTC samples were shared between control and nutrient-amended treatments, relative to 4.3% of OTUs for the same treatments in unfrozen soils. Predicted functional pathways analysis showed that 12 out of 16 related xenobiotic biodegradation pathways were at least twice higher in FTC nutrient-amended soil compared to all other treatments. Based on the results, FBS treatment might represent a new effective, fast, and conservative strategy for bioremediation in Antarctica.

1213
Methane Producing Archaea in Siberian Permafrost and their Response to Thaw

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Methane production in thawing permafrost can be substantial but often evolves after long lag phases or is lacking, potentially a result of low or absent methanogenic community or limited substrate. We investigated samples of a permafrost core of Kurungnakh Island, Siberia, seeking an explanation on the contrasting evolution of methane production after permafrost thaw. Subsamples were incubated anaerobically at 4°C for 7 years. The enumeration of methanogenic *mcrA* gene copies was performed by quantitative PCR (qPCR), and the community composition was determined by amplicon based sequencing. The initial community of the upper layer of the core, formed during cold and dry conditions was dominated by Thaumarchaota. These samples did not show methane production by the end of the incubation experiment. In contrast, the layers below 9m deposited under warm and wet conditions established methane production and were dominated by Euryarchaeota, with a high abundance of methanogens (47-78%). During the incubation the diversity of these samples decreased to a dominance of *Methanomicrobiales*. Based on methane production, community analysis and qPCR results, we conclude that thaw stimulated methanogenesis in permafrost environments where an initial active methanogenic community was present. The response of the methanogenic community appears to depend on the conditions, under which the soil was formed, with warmer and wetter conditions enhancing the activity of methanogens after thaw.

ME-1_ME-2a - Human Adaptation to High Altitude & Human Science from the Extreme Poles
23.06.2018 09:00-10:30, A Schwarzhorn

111
Human Hemoglobin and Hematocrit Values at Varying Altitude

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Living at and travelling to high altitude including Antartica is a physiological challenge. While lowlanders have to acclimatize to reduced oxygen supply (and cold) by increasing red blood cell production, highlanders living in different regions of the world have developed various adaptive mechanisms to cope with these harsh conditions. Indeed, in contrast to South American Highlanders (Quechua and Aymaras), Tibetans only moderately elevate their hematocrit and hemoglobin at high altitude. We recently asked the question if an elevation lower than 1500 m above sea level shows an impact on Hb levels in men. To answer this question, we analyzed blood from 70,000 Swiss men aged 18-22 years and observed a significant increase of Hb values for every 300 meters of augmented altitude. Our data provides convincing evidence that even altitudes below 1500 m must be considered when defining normal hemoglobin and hematocrit values.

113
Regulating Iron and Hemoglobin Levels at High Altitude

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At high altitude erythropoiesis is increased to allow for the elevated demand of oxygen. In red blood cells oxygen is bound to iron within the hemoglobin molecule to circulate in the human body. Thus, iron levels have to be sufficient to maintain adequate tissue oxygenation at high altitude. Iron metabolism is controlled by hypoxia at various levels that will be discussed in my presentation. The level of hemoglobin defines anemia that adversely affects various aspects of human health including cognitive performance, work productivity as well as complications during pregnancy affecting mother and fetus. We analyzed 'high altitude' as a well-established modifier of Hb concentration and show that Hb values in South American inhabitants increase more dramatically with altitude compared to all other regions of the world. By contrast, individuals of Tibetan origin show a significantly lower Hb concentration at all altitudes. All other ethnicities studied showed a comparable increase of Hb in response to altitude. We provide a multiple meta-regression-model revealing the change in hemoglobin concentration with increasing altitude in dependence of sex and ethnicity in adults.

344
Lactate Metabolism in Tibetans

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Upon acclimatization to severe hypoxia, Caucasian lowlanders undergo an apparent blunting of anaerobic glycolysis, the so-called "lactate paradox" (LP) (the finding that at the same fraction of the maximum work rate, blood lactate increases at high altitude to a lesser extent than at sea level attaining lower peak levels ($[La_b]_{peak}$) at voluntary exhaustion. With regard to high-altitude natives, $[La_b]_{peak}$ at altitude has been reported to be lower in Sherpas and in Quechuas and in the same range of that of acclimatized lowlanders. Moreover, the persistence of low $[La_b]_{peaks}$ 6 weeks after descent from altitude to sea level, has induced to hypothesize that in Quechuas the LP may have become a fixed metabolic feature.
In order to gain a better insight into the glycolytic capacity of altitude natives, we have assessed blood lactate concentration at exhaustion in Tibetans with different altitude exposure history: a) in a group of native Tibetans living at Shegar (4,300 m); b) in a group of Tibetan highlander migrants born and living between 3,500 and 4,500 m until 2-32 days prior to the descent to Kathmandu (Nepal, 1,300 m); c) in a group of Tibetan lowlanders, born and living in Kathmandu.
In all investigated groups, $[La_b]_{peak}$ values were of the same order of magnitude as those observed in Caucasians at sea level (10 to 13 mM). The present results seem to indicate that the LP might not be a constant feature of high altitude acclimatization.

549
The Effect of Normobaric and Hypobaric Hypoxia on Peripheral Perfusion

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According to the equivalent air altitude (EAA) theory, the physiological responses observed during exposure to normobaric and hypobaric hypoxia are similar. This study evaluated the EAA theory on the basis of the circadian rhythm of proximal-distal skin temperature gradient. Specifically, we assessed the effect of hypoxia on daytime and nocturnal peripheral perfusion and whether the effect was modified by the ambient pressure. Data from three separate experimental trials were analysed:
1) Acute trial: 10-day (N = 14 males) confinement in a normobaric hypoxia (simulated altitude = 4170m;
2) Adaptation trial: 21-day (N = 11 males) confinement to a normobaric hypoxia (simulated altitude = 4,000m, and
3) Chronic trial: 12-month assignment (N=16 males and 2 females) at the Antarctic research base Concordia.
We monitored the proximal-distal skin temperature gradient (ΔTc-t), an index of peripheral perfusion, during the day and night. Nocturnal ΔTc-t was not different between the groups and was below the vasoconstriction threshold, thus reflecting a tendency for nocturnal cutaneous vasodilatation. Sleep onset is highly dependent on peripheral skin temperature, and as there was no difference in ΔTc-t between the groups, there appears to be no effect of ambient pressure on nocturnal peripheral perfusion.

1507
Cerebral Deoxygenation and Cognitive Performance in Different Hypoxic Conditions

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Introduction: Mountaineers and pilots are regularly exposed to hypobaric hypoxia (HH) conditions. For safety reasons, it is paramount to investigate how concentration and cognition may be affected and the influence of cerebral deoxygenation. The aim of this study was to investigate how cognitive performance was altered and its relation with cerebral oxygenation in different normobaric and hypobaric hypoxic conditions.
Methods: Sixteen pilots trainees (26 ± 4 years old) performed a concentration test (KLT) in five randomized conditions [Normobaric Normoxia, NN; HH at 3000m and 5500m; Normobaric Hypoxia NH and Hypobaric Normoxia HN at 5500m]. During each KLT, tissue oxygenation index (TOI) was measured by near-infrared spectroscopy. Cerebral oxygen delivery (cDO_2) was calculated with measured cerebral middle artery velocity by transcranial Doppler, hemoglobin concentration and earlobe oxygen saturation.
Results: Percentage of error (%Err) on KLT was higher at 5500m in HH (16.3 ± 13.3%, P=0.002) and NH (14.2 ± 9.2%, P=0.025) but not in HN (6.8 ± 6.0%) and 3000m HH (10.4 ± 11.1%), compared to NN (7.2 ± 3.9%). TOI was impaired at 5500m in HH (68.2 ± 7.1, P< 0.001) and in NH (72.2 ± 6.3) but was similar between all other conditions (NN: 80.8 ± 6.5; 3000m HH: 77.2 ± 6.1 and 5500 HN: 79.7 ± 6.6). cDO_2 was similar in all conditions. No significant relationships between percent change from NN to any condition in cDo2 or TOI and %Err was observed, suggesting a complex regulation.

1747
Sleep and Perfomance in Humans Exposed to Extreme Photoperiods at High Altitude

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Crewmembers of polar expeditions often face difficulties initiating and maintaining sleep and show decreased rapid eye movement (REMS) and slow-wave sleep, as well as circadian phase delays, poor sleep quality and increased sleep fragmentation. 13 males took part in a winter-over campaign at Dome C and completed 8 measurement cycles every 6 weeks including a.o. polysomnography (PSG), actigraphy, subjective sleep, sleepiness and fatigue assessments and psychomotor vigilance testing. A control group (n=13; 2 females) performed a single measurement cycle in normobaric normoxia. Overall, results indicate that Hivernauts present with increased sleep onset latencies and reduced sleep efficiency. Latencies to REMS appear to be shorter, REMS duration increase and light sleep decreases. Hivernauts all show periodic breathing, significantly impacting sleep fragmentation. Cognitive speed is reduced in Hivernauts and associated to higher sleep fragmentation. Phase-delays are observed in crewmembers subjected to fixed bedtimes, while the remainder show free-running sleep-wake activity. Situational sleepiness is moderate in Hivernauts, but higher than in controls. Except increased obstructive respiratory events towards the end of the campaign, sleep, sleepiness and psychomotor performance variables, show to be fairly robust and stable over time. Results from the largest PSG dataset to date in Antarctica suggest that the sleep-related individual differences are phenotypic in nature.

CR-5a - Interactions between ice mass balance, the solid Earth, and sea-level changes
23.06.2018 09:00-10:30, A Seehorn

2546
What Is Important to Get Right When Modelling the Greenland Ice Sheet?

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Ice sheet and glacier models need accurate surface mass balance inputs to reproduce ice sheet extent and likely evolution. Different regional climate models (RCMs) produce subtly different estimates of ice sheet surface mass balance (SMB) for the Greenland ice sheet. While the total ice sheet SMB number is similar, there can be substantial differences spatially and in terms of the components of surface mass balance: precipitation, melt, runoff, retention and sublimation with potentially large knock-on effects for ice sheet dynamical models. Similarly, SMB generated from coarser resolution GCMs is often used (for example in ISMIP6) to force ice sheet models using simplified SMB schemes.
We use the Devon Ice Cap as a model glacier to show that ice sheet dynamical models are strongly sensitive to choices made in producing SMB forcing when using the same climate model.
Similarly, using carefully designed sensitivity experiments we explore the importance of albedo, orography and retention parameter choices in calculating SMB using output from a GCM, EC-Earth and an RCM, HIRHAM5, run at 5km resolution over Greenland. The experiments emphasise that albedo remains a significant source of uncertainty in estimates of rates of melt and runoff and sea level rise but also that accounting for topographic changes on centennial to millennial timescales is likely to be important in estimating the rate of ice sheet mass loss.

1528
Interest of a Regional Climate Model for Doing future Projections over Greenland

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With the aim of evaluating the added value of a regional climate model in downscaled future projections over the Greenland Ice Sheet, we have compared the surface fields (snowfall and summer near-surface temperature) coming from the “best” CMIP5 and CMIP6 global models (GCMs) with these fields simulated by the MAR model forced by the same GCMs.
These "best" GCMS were selected according to their ability to simulate the summer temperature at 700 hPa and the general circulation at 500 hPa over Greenland with respect to ERA-Interim over 1980-1999. However, despite their ability to correctly represent the free atmosphere, the selected GCMs present significant biases at the surface of the ice sheet. The comparison shows that MAR is however able to strongly reduce these GCM surface biases. We then forced the lateral boundaries of MAR with ERA-Interim to which we applied temperature corrections of +1°C and +2°C. The outputs were compared to MAR forced by GCM future projections corresponding to a climate about 1 and 2°C warmer than the current climate. The results of the different GCM-forced runs and sensitivity experiments are very similar to each other as the GCMs do not project general circulation changes. Moreover, the sensitivity experiments forced by modified ERA-Interim reveal that the projected SMB decrease is exponentially amplified if the increased occurrence of blocking events over Greenland in summer that has been observed since the 2000´s continues in the future.

1987
Reduced Firn Refreezing Capacity Endangers Arctic Glaciers and Ice Caps

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Melting of the Greenland ice sheet (GrIS) and its peripheral glaciers and ice caps (GICs) significantly contributes to ongoing sea level rise. Exploiting a novel, 1 km surface mass balance product, statistically downscaled from the output of the regional climate model RACMO2.3 and evaluated against in-situ and remote sensing data, we identify 1997 as a tipping point for GICs mass balance. That year marks the onset of a rapid deterioration in the GICs firn capacity to refreeze meltwater. Consequently, GICs runoff increases faster than meltwater production, tripling the pre-1997 mass loss.
Similar processes are at play in the neighbouring Canadian Arctic Archipelago (CAA). During the last two decades, ice masses in northern and southern CAA have experienced warmer conditions resulting in enhanced surface melt, tripling and doubling the pre-1996 mass loss, respectively. While the interior of the northern ice caps can still buffer most of the additional melt in extensive accumulation zones, the lack of a perennial firn area over the low-lying southern glaciers caused uninterrupted mass loss since the 1980s.
In the absence of significant refreezing, this indicates inevitable disappearance of these highly sensitive Arctic glaciers and ice caps in the near future.

2375
Separating Cryospheric and Oceanic Mass Changes in GRACE Monthly Solutions

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For the period 2002 - 2017, mass changes in the Earth´s subsystems can be derived from time-variable gravity field solutions provided by the GRACE mission. We present a regional integration approach based on directly tailored sensitivity kernels, derived by a formal optimization procedure that minimizes the sum of propagated GRACE solution errors and leakage errors. This approach ensures consistency between mass change estimates for individual regions (e.g. ice sheet drainage basins) and the corresponding estimates for their aggregations. The proposed approach has been successfully applied within ESA´s Climate Change Initiative (CCI) projects on the Antarctic Ice Sheet and the Greenland Ice Sheet for the mass change products for both ice sheets. The CCI products comprise mass change time series for individual drainage basins and aggregations (basin products). In addition, time series of mass change grids with a formal resolution of 50x50km² (gridded product) are derived. The algorithm has been adapted for oceanic applications in the frame of the CCI Sea Level Budget Closure project. Special emphasis is placed on the separation of mass signals at the ice-ocean interface. Therefore, a-priori information on the spatial mass change patterns to be expected in both sub-systems is introduced into kernel tailoring algorithm. First results of the ocean mass change time series and grids, which are consistent with the latest CCI ice sheet products, are presented and discussed.

1755
Ice Sheet - Solid Earth - Climate Interactions during the Last Deglaciation

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We study the last deglaciation in a new modeling system that encompasses a wide range of interactions between ice sheets, their mass balance, the solid Earth and the climate. The system consists of the modified Parallel Ice Sheet Model (mPISM), the Viscoelastic Lithosphere and Mantle model (VILMA), and the Max Planck Institute Earth System Model (MPI-ESM). The surface mass balance of the ice sheets is computed with an energy balance model, shelf basal melt from temperature and salinity of the adjacent ocean. By applying VILMA, sea-level change due to ice loads is calculated considering surface deformation, eustasy and geoid change. In MPI-ESM, glaciers, topography, rivers, coastlines and bathymetry adapt to changes in ice sheets and topography. The model system is forced only with transient orbital parameters and greenhouse gas concentrations.
In our experiments, the retreating ice sheets leave behind vast periglacial lakes and marginal seas. Gigantic ice sheet surges into these basins lead to the formation of large ice shelves with low surface elevations causing strong melt. Where the basins are connected to the open ocean, basal melt and calving increase the ice loss at the shelves. Over time, the retarded sea-level response shrinks the periglacial basins again. This study presents first experiments that include the full range of interactions between ice sheets, solid Earth, atmosphere and ocean circulation.

1331
The Land-ice Contribution to SLR Since 1992

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Within several projects aimed at constraining the mass balance of glaciers, ice caps (GIC) and the ice sheets, we have developed consistent, rigorous estimates of land ice mass trends over the satellite era from the early 1990s to the present day. Our results combine satellite laser and radar altimetry including ERS, ENVISat, ICESat and CryoSat, along with GRACE data from 2003 onward. We have separate time series for Greenland, Antarctica and North Atlantic GIC. The latter represents about half the GIC contribution to SLR over the period of interest. For GIC outside of this region, we utilise existing analyses of ICESat and GRACE data combined with terrestrial geodetic methods and modelled surface mass balance to extend the time series backwards.
For 2003-2015, we obtain mean rates of 84±22 Gt/yr, 269±18 Gt/yr and 135±15 Gt/yr for Antarctica, Greenland and Arctic GIC respectively. Our preliminary estimate for other GIC contributions is 140 Gt/yr giving a total land ice contribution of 623 Gt/yr, which has a sea level equivalent of 1.73 mm/yr. This is, however, not necessarily the same as the contribution to sea level rise, nor the ocean mass trend measured by GRACE, for example land-locked GIC may or may not contribute to SLR. We note that the trend in mass exchange with the ocean is not linear in time. Finally, we present the trends from the early 1990s, which have larger uncertainties and assess these estimates in relation to the sea level budget for the same time period.

SH-8 - Data science for polar environments – discovery, rescue, and mining
23.06.2018 09:00-10:30, A Wisshorn

483
Technical and Social Systems for Data Reuse on Human Ecodynamics in the Arctic

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An inherent challenge of interdisciplinary work is that it requires us to engage with data and information collected and analyzed by other researchers who specialize in different types of data analysis. Doing so can be laborious, requiring extended explanation and discussion of each domain's assumptions, resulting in barriers to large-scale, temporally deep analysis. dataARC is attempting to support interdisciplinary work by developing a data discovery tool that provides intentionally interdisciplinary search result sets and contextualizes the results from each domain - including archaeology, paleoecology, and the humanities - within a shared conceptual model. In practice, the project is creating a data discovery tool that provides results directly related to a search and connected results, and provides explanations for the links between them. The creation of structured and contextualized, intentionally interdisciplinary result sets requires that we define the levels of granularity at which data elements operate, connections among data elements to form basic ideas, and connections among specific ideas and broader, overarching concepts. This paper presents the data structure and knowledge model developed within the dataARC project and discusses the challenges encountered in operationalizing these structures to produce useful, intelligible search results that can enable interdisciplinary teams to share their data and understandings of that data with more confidence and clarity.

520
Atmospheric River Impacts on Greenland: A Self-organizing Map Analysis

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The Greenland Ice Sheet (GrIS) has been losing mass during the past few decades in part due to negative surface mass balance (SMB). Several recent episodes of rapid GrIS mass loss have coincided with anomalous poleward moisture transport by atmospheric rivers (ARs). ARs likely contribute to GrIS melt through the greenhouse effect of water vapor, radiative effects of clouds, latent heat release within upstream air masses, and energy from liquid precipitation. ARs may also provide positive inputs to SMB through snow accumulation. We compile a long-term record of moisture transport events affecting Greenland by applying a self-organizing map (SOM) classification as well as a conventional object-based AR identification algorithm to integrated water vapor transport (IVT) data from multiple atmospheric reanalyses. We then analyze AR effects on GrIS melt and SMB using passive microwave melt data and the Modèle Atmosphérique Régional (MAR) regional climate model.
The SOM and object-based AR results closely agree on the temporal and spatial variability of moisture transport affecting Greenland. AR events result in widespread anomalous GrIS melt during the warm season, and there is a robust relationship between annually accumulated IVT and melt. Moisture transport impacts on SMB are more complex, as ARs induce strong negative SMB anomalies in the warm season ablation zone but enhance accumulation in higher elevations during the warm season and everywhere during the cold season.

624
Antarctic Legacy of South Africa (ALSA) Preserve Human Data, what is the Value?

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ALSA's main aim is to preserve information/data of the human involvement from South Africa by maintaining a digital data repository. This presentation will show the criteria for assessment and selection of historical data of personal and official nature for the digital repository. The following questions will be answered; do human personal experiences add any value and significant meaning to environmental research? Is digital material such as narratives, images, maps and diaries easy accessible? Will the material add to the visualization and interpretation of information? In order to answer these questions, the presentation will look at a few examples to illustrate the value of human experiences. It will emphasise the importance to ensure that personal experiences are documented and preserved for the legacy of a country, but also to preserve it for the substantial amount of scientific deductions and analysis that can be gained from preserving the information. Therefore, the personal data has to be discovered, retained and be made accessible for mining of information. An in depth look into the preserving through a digital repository will be done and to demonstrate that new possibilities and additions can be added on as needs change and differ in the future. The contributions of human involvement therefore is much more than just a few pictures and diaries left behind, their work and life can enhance our perceptions of the environment in the polar regions to preserve the future.

985
Creation of a Historical Southern Ocean Climate Dataset from Ships' Logbooks

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Historical ship's logbooks can provide meteorological observations in the Southern Ocean (SO), one of the largest climate data-deficient regions on Earth. In this study, we capture data from logbooks of whaling ships operating in the Weddell Sea and Indian Ocean sector of the SO, from the 1930s to the 1960s. We attempt to extract meteorological information and create a gridded climate dataset. We discuss the effectiveness of various data extraction techniques used to deal with historical climate documents, and develop new and improve existing methods for working with historical data. Meteorological variables such as wind strength and direction, air and sea temperatures are standardised and converted into consistent modern units of measurement. Extensive quality checks are made for completeness and accuracy, and to eliminate known measurement bias from the observations. Cross-validation of the data is possible when independent observations were found for ships in close proximity. Finally, the dataset is structured according to the internationally accepted International Maritime Meteorological Archive format, which includes the most commonly reported meteorological variables, including the time, location, and ship related metadata. Further analysis of resulting meteorological dataset is useful to understand long-term changes in SO climate. Dataset can be fed as forcing and boundary conditions to global climate models to improve parametrisations, hence simulated results.

1048

Documentary Evidence of 19th c. Sea Ice Extent in the Davis Strait & Baffin Bay

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Historical observations obtained from British Arctic whaling logbooks kept during voyages in the Arctic waters of the Davis Strait & Baffin Bay constitute a rare subset of environmental data that provide a unique view of the regions past climate. Approximately 6000 voyages left British ports to engage in Arctic whaling over the 300 years it was practiced. The latter part of this enduring endeavour, executed throughout the 19th and into the early 20th c. was focussed in in this locality; less than 150 documents from this period are known to exist. British whalers circumnavigated this region annually between April and October, actively seeking out the sea ice edge; for it was here they pursued their prize - the bowhead whale (*Balaena mysticetus*). These surviving documents contain detailed, daily observations of meteorological conditions (wind direction/speed, precipitation), sea ice, icebergs and fauna encountered. This research has made near exhaustive use of the known surviving collection with 117 documents (1809-1911) from British whaling in the region being identified and digitally imaged. Digitization of the ~25000 days of observations has been completed with the assistance of citizen science volunteers. Preliminary results illustrate that ice observations can be used to reconstruct average monthly sea ice edge positions for the entire summer melt season, extending the current known seasonal sea ice climatology for the region back to the early 19th century.

2308
Arctic and Antarctic Sea Ice in Ten Ocean Reanalyses

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Polar regions are key components of the climate system whose understanding can largely benefit from merging observation-based estimates with advanced numerical models. Global and regional Ocean Reanalyses (ORA) products are increasingly used in polar research. To assess the quality of ORA products in representing the sea ice-ocean state over recent decades, the Polar ORA Intercomparison Project has been established, following on from the ORA-IP project.
Ten selected ORAs (among which 7 include sea ice data assimilation) are considered, extensively analysed and evaluated in the Arctic and Antarctic regions by comparing snow, sea ice, ocean transports and hydrography with available data sets. This is the first time that most sea ice diagnostics are performed for such a large set of ORAs. This presentation presents sea-ice diagnostics, while the presentation by Uotila and co-authors focuses on liquid ocean diagnostics. ORA product biases against observed data and their mutual spread are quantified, and possible reasons for discrepancies investigated. Particular attention is given to the comparison of the MultiModel ensemble Mean (MMM) with individual products and the identifications of outliers, aiming to identify physical mechanisms causing common and individual ORA sea-ice biases. Monthly data for the 1993-2010 period are considered. The importance of the atmospheric forcing, air-ocean coupling protocol and sea-ice data assimilation for the sea-ice performance is also discussed.

SY-1a - Earth Observation: Solutions for data collection, compilation and dissemination
23.06.2018 09:00-10:30, B Pischa

2586
Integrated Arctic Observation System Development under Horizon 2020

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INTAROS is a research and innovation action under the H2020-BG-09 aiming to develop an integrated Arctic Observation System (iAOS). INTAROS will extend, improve and unify existing systems in the different regions of the Arctic. The project has focus on integration of data from atmosphere, ocean, cryosphere and terrestrial sciences, provided by institutions in Europe, North America and Asia. Satellite earth observation (EO) data plays an increasingly important role in such observing systems, because the amount of EO data for observing the global climate and environment grows year by year. EO data will therefore be integrated into iAOS based on existing products and databases. In situ observing systems are much more limited due to logistical and technological constraints. The sparseness of in situ data is therefore the largest gap in the overall observing system. INTAROS is currently assessing strengths and weaknesses of existing observing systems and contributes with more sensors and platforms to enhance the in situ network. Building sustainable Arctic observing systems requires coordination, mobilization and cooperation between available infrastructures, modeling communities and relevant stakeholder groups. INTAROS also includes development of community-based observing systems, which are combined with scientific data. Thereby, INTAROS will contribute to better-informed decisions related to economic activities, environmental regulations and development in local communities.

1495
Exploitation of the Existing Arctic Observing Systems under the INTAROS Project

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In the framework of the H2020 project "Integrated Arctic Observation System" (INTAROS), the existing Arctic observing systems and selected in situ and satellite data products are assessed, exploited, and standardized to enable their delivery to a multidisciplinary, integrated Arctic Observing System (iAOS) through established databases. The assessment and exploitation addressed observations of the ocean, atmosphere, cryosphere and land including physical, chemical, and biological parameters.
Strengths, weaknesses, gaps in spatial/temporal coverage, missing monitoring parameters, sustainability, and data management of the existing in situ observation networks are analyzed. Moreover, coverage, resolution, timeliness, uncertainty, format, and metadata of selected in situ and satellite data collections are assessed with respect to the requirements needed for applications within weather prediction and sea ice services, hazard risk assessment and prevention, climate, environmental protection. The quality and the processing of selected datasets are improved to meet the highest standards set by the European and international organizations. New products resulting from the exploitation of available data are provided, and sparse data are made accessible through the existing repositories.
The main result is the enhanced quality, quantity, accessibility and documentation of existing Arctic observations, which are then ready to be ingested into the iAOS.

1714
Sea-ice Observations: Recommended Protocols for Data Collection & Dissemination

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CryoNet forms the core of the Global Cryosphere Watch [GCW]'s surface network, leveraging on existing cryospheric observatories and promoting the upgrade of other suitable facilities. The aim is to build a sustained network of environmental observing stations, that will yield routine high-quality data and are committed to comply in its methods, quality control and data dissemination with agreed GCW practices. To ensure consistent quality data within CryoNet, the GCW is currently developing best practices for its observatories, including those for sea ice. These Best Practices will form the official recommendations on necessary sea ice variables required for the science and operational sea ice community and WMO sampling requirements. For the Sea-Ice Best Practices a set of required and desired variables has been compiled, acknowledging that remotely-sensed products are the only effective means to provide information on some of the sea-ice variables. Here we present observational rules for key sea-ice parameters and how to obtain consistent long-term data while reducing measurement uncertainties. We also discuss challenges of observing sea ice, which seasonally and regionally is highly variable and covers large expanses. Using the example of the ASPeCt and ASSIST underway sea-ice observations we demonstrate the virtue of accepting Lagrangian observatories into CryoNet as well as how digital data recording reduces recording errors while enabling near-real time data distribution.

2452
Connecting CryoNet Stations with WMO Systems, an Interoperability Effort of GCW

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The WMO Global Cryosphere Watch (GCW) is an international mechanism for supporting all key cryospheric in-situ and remote sensing observations. To meet the needs of WMO Members and partners in delivering services to users a global network of "CryoNet" stations is being established. These stations monitor the state of the cryosphere and report to the GCW dataportal. Data are identified through discovery metadata which includes access mechanisms for data. The GCW data management is decentralised in the sense that the data centres of the CryoNet stations host the data, but expose discovery metadata to central catalogue which makes these searchable. The GCW Data Portal will also serve real-time data from the stations into WMO Information System (WIS/GTS) if required by the user community.
To date 120 stations have been approved as CryoNet and Contributing stations of the GCW surface observing network; more than 50% of these are operated by universities and research organizations, which are not familiar with the WMO metadata and data exchange mechanisms and do not have the resources to adopt them. These are often significant barriers to entry.
Here we present a data interoperability tool that enables GCW to add value by being the "blackbox" whereby research scientists are not exposed to operational details (and costs) of WMO while WMO receives a standardised product and is not exposed to the true diversity of formats, standards etc. at the individual station level.

1923
The International Arctic Systems for Observing the Atmosphere (IASOA) Framework

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The International Arctic Systems for Observing the Atmosphere (www.iasoa.org) was launched during the International Polar Year and is a consortium that combines the observing assets and expertise from multiple Arctic Observatories distributed around the Arctic Ocean Three significant facilitating tools developed by IASOA include a data portal that has informed and been coordinated with the data portal developed by Global Cryosphere Watch, development of graphical datagrams that substantially extend the information about the end-to-end collection/processing of in-situ instruments and support of thematic science working groups that produce concrete outcomes such as processed, calibrated, interoperable datasets and collaborative cross observatory research results. The IASOA framework is described and proposed as a template for new international coordination programs such as T-MOSAiC (land-based studies during the MOSAiC Arctic Ocean Campaign). The general theme discussed is the task of creating effective, high yield, networked observing systems in the Arctic - requirements and challenges.

1547
The National Polar Data Centers as Linking Pins between Data Providers and Users

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Nowadays, many countries with a National Polar Research Program require all data collected within that program to be submitted to a National Polar Data Centre (NPDC). These NPDCs carry out different roles. For data originating from the domain of the data centre, the NPDC will manage the data. For data from other domains for which a national domain specific data centre exists, the NPDC will play a coordinating role, while for data without a domain-specific host the NPDC will perform basic data management tasks. As a result, the NPDC will have a complete overview of all polar data within a national Polar program.
The NPDC is also the gateway to various international data access infrastructures, offering the user access to a wealth of integrated data from all disciplines. NPDCs from around the world cooperate in SCAR's Standing Committee on Antarctic Data Management (SCADM) and IASC-SAON's Arctic Data Committee (ADC). These two committees manage and maintain data access infrastructures for the Antarctic resp. Arctic regions.
This presentation will describe the work done by SCADM and ADC and will specifically address how data are distributed using portals such as the Antarctic Master Directory (AMD). Current initiatives for further data integration will be highlighted.

EN-2a - Contamination in Polar and High Altitude Environments
23.06.2018 09:00-10:30, B Parsenn

2372
Microplastic Pollution in the Greenland Sea and Selective Intake by a Seabird

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Microplastics (MPs) are found everywhere on earth. Despite Arctic remoteness from major sources of plastics, recent studies suggest that Arctic sea-ice is a sink for MPs, and several Arctic seabirds are already contaminated. However, very few data exist for this area. Our aims were to quantify MPs in little auk (*Alle alle*) foraging area and diet. Little auks are zooplanktivorous and dive between 0-50m. They are expected to be less contaminated than filter or surface feeders. Our study was conducted in East Greenland where data on MP were inexistent, for two breeding seasons with different sea-ice concentrations (SIC): 2005 (high SIC) and 2014 (low SIC). Despite the Arctic origins of the water masses in our study area, MP abundances were similar to those of other oceans, with $0.99 \pm 0.62 m^{-3}$ in 2005 (high SIC), and $2.38 \pm 1.11 m^{-3}$ in 2014 (very low SIC). MP rise between 2005 and 2014 might be linked to a global increase in plastic pollution or to lower SIC in 2014, if MPs are released to the water column once sea-ice melts. All chick meals contained plastic filaments, with 9.99 and 8.99 pieces per meal in 2005 and 2014 respectively. Importantly, little auks ate more light colored MPs than darker ones, strongly suggesting an active contamination with birds mistaking MPs for their prey. Overall, we stress the great vulnerability of Arctic marine ecosystems to MP pollution in a warming Arctic, where sea-ice melting could release high amounts of trapped debris.

2659
Microplastic Contamination in Sea Ice from the Arctic Ocean

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Sea ice in polar oceans has been identified as a potential sink for microplastics. In the context of a changing climate, these sea ice sinks can possibly function as microplastic sources when the ice melts. Assessments regarding microplastics in sea ice are particularly important as they provide an understanding of the microplastics that polar organisms may be exposed to in the future. The present study, investigated the abundance, distribution and composition of microplastics in sea ice and water beneath ice in the Arctic Central Basin. During the Arctic Ocean 2016 expedition onboard Swedish icebreaker Oden, there were twenty-five stations at which sea ice cores were retrieved and water pumped from beneath the ice was filtered. Cores were sectioned, melted and filtered. Potential microplastics from samples are in the process of being isolated and analyzed using Fourier Transform Infrared Spectroscopy (FT-IR).

1860
Microplastics in the Surface Ocean of the Canadian Arctic Archipelago

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The Arctic is already one of the most environmentally stressed regions in the world owing to the rate of ocean warming, acidification and sea ice melt. This makes the Arctic marine ecosystem particularly vulnerable to the additional threat posed by plastic pollution. Approximately 12.7 million tonnes of plastic litter enter the World's oceans each year. Whilst data on the spatial and temporal spread of plastics in the Canadian Arctic Archipelago is limited, recent studies have shown plastics present in surface waters at both a visible and microscopic scale. Microplastics (< 5mm) have been shown to be bioavailable and entering the ecosystem by ingestion from small zooplankton. On *CCGS Amundsen* Expedition 2017 Leg 2B, surface waters were opportunistically sampled to collect microplastics from seven stations using a HydroBios Neuston net (300 µm aperture mesh) within Baffin Bay and the Canadian Archipelago. This study aims to provide insight into the concentration of plastics and properties of different polymer types in the region. Secondly, based upon counts of amphipods versus microplastics found in each sample, we will present a ratio of zooplankton: microplastics, providing environmental context for microplastics occurrence. These findings come at a time of vital importance for developing a baseline for monitoring the extent of plastic pollution in the Arctic.

2422
The 'Mother-ships' of Microplastics on Sub-Antarctic beaches

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Beaches in King George and Elephant Islands, South Shetland Islands, were opportunistically sampled for macroplastics (>0.5 cm) during expeditions from the Brazilian Antarctic Program in 2014 (OPERANTAR XXXII, Project Penguins & Skuas) and 2016 (OPERANTAR XXXV, Project INTERBIOTA). 608 items were counted, measured and analysed in relation to the type of material, degradation and biofouling. Ordinary plastics (PET, PP; 60%), expanded polystyrene (27%) and rubber (11%) were mostly sampled. All are synthetic materials that slowly break down and accumulate in the environment. 73 items were whole objects measuring 32±101 cm and included PET bottles and packaging, but also nautical ropes and buoys. Few are labelled indicating their origins; others accumulated organisms in their surfaces, suggesting long-rage transport in the sea. However, 88% were fragments from larger objects, measuring 5±8 cm. Polystyrene pieces were recurrent on beaches, as also observed in other sub-Antarctic islands. Potential sources are nautical buoys and protective packaging from electronic equipment. On beaches, these fragments will eventually become microplastics (< 5 mm) with rounded shapes, small enough to be ingested by organisms in marine food chains. As source identification is one of the major challenges on microplastic pollution research, the positive recognition of their 'mother-ships' allow the implementation of effective measures to minimize microplastic releases into the Antarctic environment.

710
Microplastic Pollution in the Southern Ocean

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It is estimated that there are up to 5 trillion pieces of plastic in the oceans (Erikssen et al., 2014). Microplastic pollution (particles < 5mm) is recognised as a major problem in the world ocean, with much of it accumulating in oceanic gyres (Cozar et al., 2014). Antarctica is generally thought of as a pristine and isolated wilderness, free of most of the anthropogenic stressors found in populated regions of the world. However, recent studies in the Southern Ocean have reported microplastics in deep-sea sediments (Van Cauwenberg et al., 2013) and surface waters (Cincinelli et al., 2017). We present our predictions of microplastic contamination in the Southern Ocean, based on quantifiable data from research stations, cruise ships and fishing effort. Our findings suggest that at an Ocean basin level concentrations should be insignificant, but that at point sources the contamination may be high. We report the detection of the first microplastics in shallow benthic sediments close to a number of research stations on King George Island. Worryingly, our predictions of primary microplastic concentrations from local sources are five orders of magnitude lower than levels reported in published sampling surveys, some of which were comparable to levels found in highly populated areas of the world (Erikssen et al., 2014; Adventurescience, 2016). We speculate that plastic contamination originating outside the Southern Ocean is crossing the Polar Front and contributing to the problem.

91
Plastic Pollution Around Antarctica: Preliminary Results from the ACE Expedition

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The Antarctic Circumnavigation Expedition (ACE) sampled micro, meso and macroplastic litter around Antarctica from December 2016 to March 2017. No mesoplastic items were found in plankton samples collected with a 200 µm Neuston net and only 22 macrolitter items were observed floating south of the Subtropical Front in almost 15,000 km of transect counts, confirming that the Southern Ocean is the ocean least polluted by plastics globally. Nevertheless, anthropogenic debris was found in two seabed Agassiz trawls and macroplastic items were recovered from most beach landings, though quantity varied with location. Small numbers of fibers were found in beach sediments from Antarctic and sub-Antarctic sites and synthetic microfibres were detected in virtually all bulk water samples collected around Antarctica. Surprisingly, there was no marked gradient in these fibres as we approached continental source areas. Confirmation of the identity of these fibres is still pending, but if they prove to be synthetic, they suggest that all the world's surface waters apparently carry low concentrations of microfibre pollutants, at a density of ~0.1-1 fibres per litre.

OS-5a - The role of snow on sea ice for sea-ice parameter retrieval and variability
23.06.2018 09:00-10:30, B Jakobshorn

781
Towards Producing a Daily Snow-on-Sea Ice Data Set

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Estimates of ice thickness across the Arctic Ocean have become available over the past 20 years based on data from ERS-1/2, Envisat, ICESat, CryoSat-2 satellites and Operation IceBridge aircraft campaigns. However, the different measurement approaches, sensor technologies and spatial coverage present formidable challenges in producing a comprehensive view of long-term sea ice thickness changes. Key among these is that measurement techniques do not measure ice thickness directly - retrievals also require snow depth and density.
A sophisticated snow accumulation model is tested in a Lagrangian framework to map daily snow depths across the Arctic sea ice cover using different atmospheric reanalysis data as input. Accuracy of the snow accumulation is assessed through comparison with Operation IceBridge data and ice mass balance buoys (IMBs).

1850
Assessing Precipitation and Snow Accumulation in the Arctic and Southern Oceans

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Precipitation over the Arctic and Southern Oceans is a key component of the ocean fresh water budget, while the magnitude of snow accumulation over sea ice controls the strength of the snows insulative properties. However, precipitation from reanalysis over the polar regions show large uncertainties in both frequency and magnitude, due to the lack of in situ data for validation in these regions and differing model schemes representing cloud physics. Introducing problems for those modeling snow accumulation on sea ice, specifically for use in estimating sea ice thickness from laser altimetry data.
In recent years, the Arctic has become warmer and wetter, which leads to the questions: Is more precipitation falling and more of this as rain in the Arctic, is more precipitation or rainfall also occurring in the Antarctic? What are the implications of more frequent rainfall on modeling snow depth on sea ice? For example, rain events will modify the existing snow pack by causing large changes in the insulating properties and surface albedo.
In this work we compare precipitation from 8 different reanalysis: MERRA, MERRA2, NCEP-R1, NCEP-R2, ERA-Interim, CFSR, ASR and JRA-55 over the Arctic and Southern Oceans. We assess the annual, seasonal, and regional differences and compare results with Ice Mass Balance Buoy data to explore sources of discrepancies between products during observed snowfall and rainfall events in the Arctic and Southern Oceans.

2668
A New Snow on Sea Ice Budget Model and Snow Depth Dataset over the Polar Oceans

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Poor knowledge of snow on sea ice over the polar oceans provides a key source of uncertainty in our understanding of freshwater budgets and the estimation of sea ice thickness from satellite altimetry. Here we present a new, open-source, two-layer Eulerian snow budget model developed to improve the representation of snow on sea ice across both poles. The model includes several parameterizations to represent various sources and sinks of snow on sea ice through the accumulation season (September through April), e.g. wind compaction and blowing snow lost to leads. The model is forced with daily reanalysis-derived snowfall and winds, and satellite-derived ice concentration and drifts. We explore the sensitivity of the modelled snow depths to the input forcing data and model parameters, and compare the results with observations where possible (e.g. field data from 1979-1991, 1997-1998, buoy data from 2000-present and NASA´s Operation IceBridge data from 2009 to present). We demonstrate the utility of the new snow depth product (available daily) to produce updated sea ice thickness estimates from ESA´s CryoSat-2 mission (2008 onwards) and look ahead to the upcoming launch of ICESat-2 (summer 2018). It is our hope that the open source framework will encourage community involvement in possible improvements and additions to the model physics (e.g. rain-on-snow, snow ice formation, snow melt processes), especially as new forcing/validation datasets are made available.

260
A Dynamic Snow Load Model for Satellite Altimeter Sea Ice Thickness Retrievals

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Satellite radar altimeter data are now widely used to produce estimates of sea ice thickness across the Arctic Ocean. However, these estimates rely to varying degrees on the use of a snow climatology in the conversion of sea ice freeboard to thickness. The application of a climatological snow load is currently the largest source of uncertainty in the ice thickness estimates that we produce at the UK Centre for Polar Observation and Modelling (CPOM) from CryoSat-2 data. To reduce this uncertainty, we have developed a dynamic snow load for application with our sea ice processor that enables us to account for inter-annual and spatial variations in the snow cover. The dynamic snow load model is initialised using precipitation and evaporation data from reanalysis, and developed with a dependence on sea ice concentration, drift, and atmospheric temperature. The When applied to CryoSat-2 sea ice observations, the dynamic snow load results in a decrease in ice thickness compared with climatological estimates by up to 70 cm in regions of seasonal ice cover such as Baffin Bay and the Siberian Shelf Seas. This demonstrates the ability of CryoSat-2 to measure ice thickness over thinner (< 0.5 m) ice regimes than previously thought. Here we summarise the development of our dynamic snow load, and evaluate using in situ campaign data. We then assess its impact on spatial and inter-annual variations in Arctic-wide sea ice thickness and volume estimates compared with a snow climatology.

76
The Role of Snow Distribution on the Antarctic Sea Ice Mass and Energy Balance

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Snow on sea ice is increasingly recognized as a key component of the sea ice system. The snow cover substantially impacts the mass and energy balance of sea ice, but exhibits high variability in space and time. As in-situ measurements are scarce and many remote sensing products show large uncertainties, the use of physics-based snow and sea ice models is attractive. Here, we present spatially explicit simulations of the snow-sea ice system using the recently developed sea ice module for the physics based SNOWPACK model for three floes of different age, that were visited in July and August 2013 in the Weddell Sea. Terrestrial laser scans of the snow surface, combined with highly spatially resolved ice thickness and snow depth measurements, are used to initialize the model. The simulations are then forced by meteorological observations provided by weather station buoys left on the ice, augmented by AMPS Polar WRF reanalysis data. The resulting simulated sea ice energy and mass balance is verified by Ice Mass Balance (IMB) buoys installed on the floes. Results show that the snowpack provides a strong control on the energy and mass balance and that taking into account the snow cover distribution enables an accurate simulation of the total sea ice mass balance. Simulated ice growth rates correspond well with the IMB buoy data. These results illustrate that physics based models of the snow-sea ice system provide accurate assessments of the spatial and temporal evolution of sea ice.

397
Satellite Remote Sensing of Large-scale Arctic Sea Ice Thickness and Snow Depth

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Large-scale retrieval is carried out for sea ice thickness (Hi) and snow depth over sea ice (Hs), based on concurrent radar altimetry of CryoSat-2 satellite and L-band (1.4 GHz) passive radiometry based on SMOS satellite. Two physical models, the L-band radiation model for the sea ice cover, and the hydrostatic relationship based on buoyancy model, are adopted. Verification for the retrieval is carried out with CryoVEx airborne data, which co-registers with CryoSat-2 tracks. Results also show reduced uncertainties for both Hi and Hs. Especially, the uncertainty involving the climatological snow loading and the potential lack of efficacy for radar altimetry in current era is addressed, with much lower and spatially uncorrelated uncertainty and better estimation of ice volume. The retrieved large-scale Hi and Hs fields provide new perspective for investigating Arctic climate change.

CR-8e - Latest highlights from high altitude and polar ice cores
23.06.2018 09:00-10:30, C Sanada I

2442
Basal Ice Properties in Two-million-Year-old Allan Hills Cores

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Currently the longest continuous ice core record, capped at 800 thousand years (kyr) old, comes from the EPICA Dome C. Concerted efforts in the ice core community are underway to find and retrieve stratigraphically continuous deep ice cores older than 800 kyr. A complimentary approach to deep coring is shallow drilling in Blue Ice Areas (BIAs), where ancient ice is brought to the surface by a combination of glacial flow and subglacial topography. Discontinuous ice as old as two million years has been found in two adjacent drill holes in the Allan Hills BIA. Here we report the elemental and isotopic composition of the trapped gases (N_2, O_2, Ar, and CO_2), along with high-resolution stable water isotopes, in > 2 million year old basal ice from the two cores. Our data indicate that the ice is deformed and that mixing takes place at sub-meter length scales. In addition, although much of the ice older than 800 kyr appears to contain pristine greenhouse gases, the oldest basal ice contains both elevated CH4 and CO_2 as high as 1200 ppm. High CO_2 samples are associated with depleted (< -10 ‰) $\delta^{13}C$ of CO_2, consistent with contributions from the respiration of organic carbon ($\delta^{13}C$ ~-25‰). Alternative approaches for determining paleo-atmospheric CO2 (e.g. $\Delta^{17}O$ of O_2) will be discussed.

789
Is there 1.5 Million-year Old Ice Near Dome C, Antarctica?

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Ice sheets provide exceptional archives of past changes in polar climate, regional environment and global atmospheric composition. The oldest dated deep ice core drilled in Antarctica has been retrieved at EPICA Dome C (EDC), reaching ~800,000 years. Obtaining an older paleoclimatic record from Antarctica is one of the greatest challenges of the ice core community. Here, we use internal isochrones, identified from airborne radar coupled to ice-flow modelling to estimate the age of basal ice along transects in the Dome C area. Three glaciological properties are inferred from isochrones: surface accumulation rate; geothermal flux; and the exponent of the Lliboutry velocity profile. We find that old ice (>1.5 Myr, 1.5 million years) likely exists in two regions: one ~40km south-west of Dome C along the ice divide to Vostok, close to a secondary dome that we name “Little Dome C” (LDC); and a second region named “North Patch” (NP) located 10-30 km north-east of Dome C, in a region where the geothermal flux is apparently relatively low. Our work demonstrates the value of combining radar observations with ice flow modelling to accurately represent the true nature of ice flow, and understand the formation of ice-sheet architecture, in the centre of large ice sheets.

1672
An Essay to Reconstruct MIS-11 Climate from 4 Water Isotopologues in Vostok Ice

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A strong limitation of the stable water isotope method to reconstruct past temperature changes is related to the fact that the isotopic composition of a polar ice core depends both on local conditions and conditions in the moisture source. There have been attempts to use a second-order parameter, dxs = dD - 8*d18O, in parallel to the isotopic composition itself (dD or d18O), in order to discriminate between both factors. It has been shown that the results strongly depend on the sensitivity of dxs to the condensation temperature, which is poorly known. Recently a new parameter, 17O-excess = ln(d17O)-0.528*ln(d18O), has been developed, that was initially thought to depend only on the air humidity in the moisture source. However it was soon demonstrated that the variability of 17O-excess in deep Antarctic ice cores would imply unrealistically strong humidity oscillations in the past, which means that other factors (primarily, local conditions during condensation in ice clouds) play a role, too. Here we present a new, detailed isotopic record for the MIS-11 epoch (370-440 ka BP) reconstructed from the Vostok ice core, and for the first time attempt a climatic paleo-reconstruction based on 3 independent parameters (dD, dxs and 17O-excess). Our results (including the past variability of air humidity in the moisture source) are consistent with the published data, and demonstrate that this approach has the potential to improve the ice core-based paleo-reconstructions.

1285
Temperature and Circulation Changes in the Ross Sea over the Last 1000 Years

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The Antarctic has an unusual climate history compared to other continents for the past 2000 years : unlike other regions, the last 50 years are not unusually warm, and the period around 1850 is not unusually cold. All of Antarctic 2000-year climate records are derived from water isotopes from ice cores. Could it be that water isotopes are not a faithful temperature recorder, or is it that Antarctica has a distinct climate variability over this time period?
Here we compare a temperature reconstruction derived from the analysis of inert gas isotopes ($\delta^{15}N$ and $\delta^{40}Ar$) with water isotopes to provide multiple constraints on the climate history of the past 1000 years at Talos Dome, Antarctica. Talos Dome is a peripheral dome located in the South Pacific/Ross Sea sector of the East Antarctic Plateau. It receives air masses mainly from the Indian and secondarily from Pacific sectors of the Southern Ocean. As a result, its climate presents similarities both to West Antarctica and to the East Antarctic plateau sites of Dome C and Vostok.
We find that inert gas isotopes indicate a long term cooling trend at the site, which is not recorded in the δD signal. We use the climate model ECHAM5-wiso to link the d-excess to change in the atmospheric circulation over the Ross Sea, which can explain the discrepancy between δD and temperature. These results provide new constraints on the changes in the circulation associated with the Little Ice Age cooling in West Antarctica.

888
Characterisation of AIM Events in the Ross Sea Region from the RICE Ice Core

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The last glacial in Antarctica is punctuated by several episodes of warm events, when air temperature rose between 1-3°C, which are referred to as 'Antarctic Isotope Maxima' (AIM) events.The comparison of Antarctica and Greenland ice core records shows an out of phase relationship between AIM events and their northern counterparts- Dansgaard/Oeschger events, referred to as the 'Bipolar Seesaw'. Possible explanations include oceanic teleconnections via a shift in strength of the Atlantic Meridional Overturning Circulation and Antarctic Bottom Water formation.
Roosevelt Island is a local ice rise at the northern edge of the Ross Ice Shelf. A 764m deep Roosevelt Island Climate Evolution (RICE) ice core was obtained between 2011-2013. Due to its proximity to Ross Sea, the RICE records have the potential to provide new insights into the drivers and consequences during the evolution of AIM events.
Here, we present the highly resolved major ion record of the RICE core spanning the time period between 83,000 to 25,000 years B.P., presented on the RICE17 age scale.The major ion record, including sodium, methyl sulphonic acid, and calcium provide useful indicators of past environmental conditions such as changes in sea ice extent, primary productivity and latitudinal shifts in circumpolar westerlies.The record will also be correlated with existing Antarctic ice cores to gain insights into the regional heterogeneity in the environmental conditions during the evolution of AIM events.

444
Sequences of Events over Terminations II and III in the Dome C Ice Core

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Glacial-interglacial transitions are recorded in various climatic archives over the Quaternary. The EPICA Dome C (EDC) ice core provides high latitude climate reconstructions based on water isotopes as well as global proxy records such as greenhouse gases concentrations, and low latitudes tracers $\delta^{18}O_{atm}$
(i.e. $\delta^{18}O$ of atmospheric O_2) or d-excess over the last 800 ka. These high-resolution records illustrate the variety of glacial-interglacial transitions observed under different orbital and sea level contexts.
We present here new detailed measurements of $\delta^{18}O_{atm}$, $\delta^{15}N$ and d-excess on the EDC ice core over Terminations II and III. First, we analyze the millennial variability superimposed to the orbital signal in the different isotopic records, and describe the different sequences of events for these two deglaciations. Termination III is associated with several millennial-scale events while Termination II is depicted by only one major Heinrich event. Second, we compare our new high-resolution $\delta^{18}O_{atm}$ profile to East Asian $\delta^{18}O_{calcite}$, which presents similar orbital and millennial variations related to the monsoon activity or shifts in the InterTropical Convergence Zone position to propose an improved way of using $\delta^{18}O_{atm}$ to constrain ice core chronologies. Finally, we present such an application refining the ice core dating of MIS5.

OS-7g - Atmosphere-Ice-Ocean interactions in the Polar Regions
23.06.2018 09:00-10:30, C Sanada II

70
Role of Polar Anticyclones for Arctic Sea Ice Melting in Summer

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Annual minima in Arctic sea ice extent and volume are decreasing rapidly since the late 1970ies, with substantial interannual variability. It was shown that summers with a particularly strong reduction of Arctic sea ice extent are characterized by anticyclonic flow anomalies from the surface to the upper troposphere. Here we adopt a weather-system perspective to investigate the origin of these seasonal circulation anomalies and show that they are caused by an increased occurrence of episodic upper-level induced Arctic anticyclones. Sea ice reduction is systematically enhanced during these transient episodes with Arctic anticyclones and the seasonal reduction of sea ice volume correlates with the area averaged frequency of Arctic anticyclones poleward of 70°N (correlation coefficient of 0.57). A trajectory analysis reveals that these anticyclones result from extratropical cyclones injecting extratropical air masses with low potential vorticity into the Arctic upper troposphere. Our results emphasize the fundamental role of extratropical cyclones and associated diabatic processes in establishing Arctic anticyclones and in turn seasonal circulation anomalies, which are of key importance for understanding the variability of summertime Arctic sea ice melting.

476
Airmass Transport and Dynamical Drivers of an Extreme Arctic Winter Warm Event

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During a one-week episode at the turn of the years 2015/2016, maximum surface air temperature in the Arctic reached record high values of more than 0°C, which led to pronounced, widespread sea-ice melting in the middle of the cold season. In this study, we adopt a Lagrangian perspective to investigate the origin of the warm air masses and the meteorological processes that allowed them to reach the North Pole. We show that (i) the extreme event resulted from a complex chain of extraordinary dynamical and physical processes, (ii) three fundamentally different airstreams contributed to the high Arctic temperatures, of which two airstreams were initially extremely cold and located either in the Arctic lower troposphere and subsequently heated by intense surface fluxes, or in the midlatitude upper troposphere and subsequently heated by adiabatic compression, (iii) the poleward transport of these warm airstreams occurred along an exceptionally intense low-level jet that established between a sequence of Icelandic lows and a strong Scandinavian anticyclone, and (iv) the setup and persistence of this dipolar pattern was supported by continuous warm conveyor belt ascent into the upper part of the anticyclone. The findings emphasise the combined role of multiple transport processes and transient synoptic-scale dynamics for establishing an extreme Arctic heat and melt event.

1601
Turbulent Fluxes Near an Advancing Sea-ice Edge

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In the marginal ice zone (MIZ), it is expected that the turbulent fluxes of momentum and sensible heat are dependent on a number of surface characteristics and processes that impact the surface roughness and the stability in the atmospheric surface layer. These include ice concentration, ice thickness, ice freeboard, floe sizes, and ocean wave characteristics (height and period). The range of length scales over which these parameters vary in the MIZ is large. The relationship between some of these characteristics and the turbulent fluxes are represented by recent bulk flux parameterization schemes (e.g., Andreas et al, 2010; Lüpkes et al 2012; Lüpkes and Gryanik 2015). During the Sea State field program in the Beaufort and Chukchi Seas from Oct 3 to Nov 5, 2015, direct covariance and inertial dissipation measurements of the turbulent fluxes were made from the bow of the icebreaker R/V Siquliak, while many of the surface characteristics were also measured from various platforms on board. Hence, this data set provides a good opportunity to explore the relationships between surface characteristics and the turbulent fluxes in the advancing marginal ice zone.
This presentation will show the complex surface environment encountered during Sea State, and demonstrate the extent to which existing bulk flux parameterizations can represent the directly measured turbulent fluxes of sensible heat and momentum in this environment.

81

Cold air Outbreaks in the Nordic Seas: Climatology and Link to Large-scale Flow

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Marine cold air outbreaks (CAOs) at high latitudes are harbingers of severe weather such as polar lows and they lead to intense air-sea heat fluxes. We first present a 35-year long Lagrangian climatology of wintertime CAO air masses in the Nordic Seas including the Irminger and the Barents Seas. Based on this climatology we study

(1) the origin and pathways of CAO airmasses,

(2) their thermodynamic evolution, and

(3) their contribution to winter mean air-sea heat fluxes.

Specifically, we show that CAOs in the Nordic Seas originate largely in the interior Arctic, entering the Nordic Seas via Fram Strait. In addition, also flows across southern Greenland and katabatic drainage contribute. As we show further, the spatio-temporal variability of CAO air masses is essentially dictated by the frequency of CAOs. Second, we investigate the linkage of CAO formation with the low-frequency variability of the large-scale flow using a weather regime classification. We show that each regime is characterised by a typical CAO frequency anomaly pattern and a corresponding imprint in CAO airmass pathways and air-sea heat fluxes. Thereby, the strength and location of the storm tracks in each regime are found to be decisive for the pathways of CAO air masses and, thus, for CAO occurrence. The mechanistic linkage between CAOs and weather regimes may help to better understand variability in open ocean convections, as well as forecasting the occurrence of polar lows.

585
Formation of Convergence Zones in Cold Air Outbreaks

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During cold air outbreaks, low-level atmospheric convergence zones often emerge over relatively warmer seas downstream of coastlines, sea ice edges, and mountains. We investigate the formation mechanism of such convergence zones using idealized numerical experiments and analytic theory. In the numerical experiments, a cold air outbreak is simulated in a simplified setup including a coastline and a mountain, where the former has a kink. The numerical simulations show that varying the angle of the kink in the coastline as well as changing the height of the mountain, or removing it, cause a difference in the fetch (traveling distance over sea) of the cold airmass. A warm wedge is formed due to the difference of the fetch, because the longer fetch causes more warming by the sensible heat flux. Hydrostatically, this results in a low pressure trough, which induces a pressure gradient force towards the warmest area. The turbulent momentum transport in the convectively mixed layer is important for the formation of the convergence zone, because it enhances frictional convergence into the pressure trough. The moisture enhances the convergence by intensifying vertical motion due to diabatic heating. We also present an analytic model for the setup with the kink in the coastline using the basic state flow and the bulk formula for the surface sensible heat flux. The theoretical estimates of the pressure trough and convergence agree well with the results of the numerical experiments.

1001
Influence of Surface Fluxes on Polar Low Development: Idealised Simulations

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Excursions of cold air masses from the ice-covered high-latitude area into oceanic regions are frequently accompanied by the development of intense mesoscale cyclones. This particular ocean-atmosphere configuration exhibits favorable conditions for relative large surface turbulence exchange of momentum, moisture, and heat. In this study, we examine the impact of this air-sea-exchange on the development of polar lows.
We utilise an idealised numerical channel model to gain insight into the role of surface heat and moisture fluxes on the dynamical evolution of polar lows. The initial setup consists of a baroclinic jet in thermal wind balance. To mimic cold air outbreaks we prescribe sea surface temperatures that are higher than the low-level air temperature. This setup enables a systematic investigation of the relative contributions from surface sensible and latent heat fluxes on polar low development by varying the intensity of the initial baroclinicity, moisture, and air-sea temperature difference. In addition we investigate the relative role of sensible and latent heat fluxes by gradually changing the intensity of surface exchange in a set of sensitivity experiments. Identification of moisture sources and sinks further illustrates the role of surface heat and moisture exchange on the intensification of polar lows.

BE-9h - Life distribution and responses to environmental changes in Polar ecosystems
23.06.2018 11:00-12:30, C Aspen

1382
Habitat Suitability and Conservation of McMurdo Dry Valley Soil Biodiversity

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Antarctica's McMurdo Dry Valleys (MDV) are the continent's largest ice-free area, containing soil biodiversity that has not been considered in conservation planning. This biodiversity consists of soil-inhabiting microbes, nematodes, rotifers, tardigrades, springtails and mites. While specific habitat requirements vary by species, abiotic factors (e.g., water and carbon availability, temperature, and soil geochemistry) are known to drive distributions. Yet, soils are highly heterogeneous and these abiotic factors vary greatly landscape-wide. Furthermore, climate-driven changes in lake and stream hydrology are already occurring, producing immediate impacts on surrounding soil environment and communities. Given their vulnerability to such changes, including soils and dependant biodiversity in conservation planning is critical.
We obtained an *Antarctic Science International Bursary* to undertake a collaborative project to examine the drivers of soil biota in the MDV and build habitat suitability models to predict current and future distributions. Soil biodiversity and chemistry data were gathered from the MDV Long Term Ecological Research Project (US NSF) and compiled into a spatially explicit dataset. With this dataset, we modelled habitat suitability by taxon, confirming that environmental drivers of species distributions vary. We used the models to spatially predict species distributions and then combined them to identify sites of conservation priority across the MDV.

2037
Soil Changes in 10 Years of Environmental Change in Victoria Land (Antarctica)

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In Victoria Land, continental Antarctica, across a latitudinal gradient between Apostrophe Island (73°) and Finger Point (77°S) in the period 2002-2013 were detected significant environmental changes involving climate, active layer thickness, vegetation abundance and composition and soil chemistry. In particular, despite air temperature did not change, there was an increase of incoming radiation and active layer thickness. In response to these environmental change, soils exhibited a large decrease of water content (more pronounced at deeper depths), and a general pH increase associated to an increase of conductivity (more pronounced in ornithogenic soils). Opposite trends were observed for most inorganic compounds comparing ornithogenic and not-ornithogenic soils. The changes in soil chemistry reflect concomitant changes in climate and active layer and vegetation cover, with a decrease of mosses and a concomitant increase of lichens in most sites. These changes may be due to soil evolution processes or to different dynamics of the active layer. The observed changes in soil chemistry did not appear to be strictly related to the aeolian dust deposition or to the Southern Oscillation Index.

418
Polar Soil Fungi in a Changing Climate

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Climate change in polar regions has negatively affected top predator species such as the polar bear and has caused the expansion of higher plant communities, but the effects of altered temperature and water availability on microbes at the bases of polar food webs, such as the fungi, which drive vital ecosystem processes, have largely been ignored. Here, 16 fungi, including the widespread *Pseudogymnoascus pannorum*, were isolated from soil collected from the Arctic and Antarctic and screened for the production of enzymes. The effects of altered water availability and temperature on the growth and enzyme activities of the isolates were then measured in laboratory experiments. All 16 isolates produced cellulase, chitinase, phosphatases and esterase. The data obtained from the growth rate experiments suggested that increased temperature and reduced water availability have differing effects on the growth and enzyme production of the fungal species tested.

2111
Penguins as Drivers of Microbial Diversity in Maritime Antarctic Soils

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Penguin activity affects microbial communities in Antarctica soils. Previous studies have shown distinct microbial communities in penguin-colonized ornithogenic soils, in relic ornithogenic soils, and in mineral soils. At Cape Adare, northern Victoria Land, we conducted a survey across Ridley beach (the site of the largest Adélie penguin rookery in Antarctica) to test the hypothesis that within a penguin colony distinct patterns of microbial communities could be seen. Analysis of prokaryotic community composition were based on sequencing of 16S rRNA gene PCR amplicons, and analysis of soil geochemistry were based on ammonium, phosphate, C and N content, electrical conductivity (EC), and pH in a total of 26 sites. The highest concentrations of phosphate, EC, C, and N were seen at the beach´s central sites, radially decreasing towards the Adare Peninsula and the ocean. These parameters were strongly positively correlated and were significant environmental drivers of community composition. Ordination of the sampling sites showed they could be separated into two groups: those for which the most abundant OTU had a relative abundance higher than 20% and the ones for which it was lower. Up to six different OTUs were present at a given site with an abundance >20%, highlighting a high level of plasticity in a geographically confined place with homogeneous soil geochemistry, and suggesting a differentiating penguin influence across the sites of a rookery.

120
Long-term Ecological Research on King George Island, Antarctica

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Baton Peninsula, King George Island (KGI) is the focus of a Korean-lead study on the effects of environmental changes on the terrestrial ecosystem since 2009. It harbors diverse organisms and micro-ecosystems including representative local ecosystems: wet coastal environments with diverse mosses and lichens; dry inland environments with only a few lichen species; and patterned ground with exposed mineral soil and limited vegetation on rocks. In 2015, a vegetation base map was developed for Barton Peninsula using satellite images, UAV images, and field surveys. As well as diversity of microorganisms and invertebrates, our long-term monitoring includes microclimate, light intensity, soil temperature and moisture. Different micro-environments act on different genotypes of the same lichen species. While water availability is the most important factor for all organisms, photosynthetic lichens and mosses are also affected by snow cover due to its protection from sunlight and light availability. Lake sediment core records of during last 3,000 years revealed the variation of abundant fungi, microalgae and invertebrate depending on the depth. It implies KGI in the Antarctic Peninsula is one of the most vulnerable ecosystems in a changing climate. As a hotspot of ANTOS and LAPES, the map and database of KGI long-term monitoring as well as biological responses in molecular level will allow a comprehensive understanding of ecosystem in space and time in environmental changes.

1901
Survivors or Colonizers? Case Study of the Freshwater Copepod B*oeckella poppei*

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The Quaternary brought numerous cycles of ice sheet extension and contraction across the Antarctic continent, resulting in major disruption of terrestrial habitats and the extinction of diverse taxa. Currently there are two main hypotheses to explain the present-day occurrence of freshwater biota in Antarctica
(1) recent colonization from lower latitudes during inter-glacial periods;
(2) persistence in refugia within Antarctica.
The genus *Boeckella* has a Gondwanan distribution, and *B. poppei* is unique as the only terrestrial or freshwater invertebrate that occurs in all three of the generally recognized Antarctic biogeographic regions. We describe population structuring and divergence times across the maritime Antarctic, sub-Antarctic South Georgia and Patagonia. We used a combination of molecular approaches targeting one mitochondrial fast-evolving (cox1) and two nuclear slow-evolving markers (28S and ITS), and traditional morphological taxonomy. Our data clearly support the refugial hypothesis, with two independent regional recolonization events from putative refugia in the southern Antarctic Peninsula and the South Orkney Islands. Molecular phylogenetic reconstruction showed two distinct clades,
(1) Patagonian and
(2) Antarctica, separating 3 Mya.
Within Antarctica two haplogroups were present,
(1) sub-Antarctic + southern Antarctic Peninsula and
(2) northern Antarctic Peninsula, separating 1 Mya.

EN-6b - Reconstructing past environmental change in the Polar Regions
23.06.2018 11:00-12:30, A Studio

189
Miniature Old-growth Moss Forests as Proxies for Microclimates in Antarctica

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Terrestrial flora of Antarctica's frozen continent is dominated by bryophytes (mosses, liverworts) restricted to the limited ice-free areas. These plants constantly battle against sub-zero temperatures, extreme winds, reduced water availability and high levels of damaging ultraviolet radiation due to reduced stratospheric ozone; all impacting the ability of Antarctic species to survive and grow. Thus, it is imperative that we monitor Antarctic flora in response to changes in climate, in particular to ozone depletion. Furthermore, there is a substantial need for regional climate proxies given the sparse distribution, limitations and short record of Antarctic meteorological stations. As resilient plants with simple structures, mosses are suitable candidates for proxy development as they can preserve long-term records of their immediate microclimate in their chemical signatures; for example, sunscreen compounds preserved in their cell walls. We aim to develop and use Antarctic mosses as biological proxies for climate around the Antarctic coast. This includes analysing sunscreens and stable isotopes of a range of Continental and Maritime mosses that have been dated using the radiocarbon bomb-pulse method. Long-term regional climate records, such as moss water availability and ozone levels, could be locked away as chemical signatures within old-growth moss shoots of up to 420 years old.

208
The Circumpolar Shrub *Cassiope tetragona*: an Archive of High Arctic Climate

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High Arctic instrumental meteorological data are often discontinuous and represent only a few decades, which limits interpolation and upscaling of climatic data in this part of the Arctic and reconstructions based on reliable climate proxies are needed to fill in observational gaps.
Annual growth of the evergreen circumpolar dwarf shrub species *Cassiope tetragona* represents such a climate proxy. Annual shoot length growth of this species can be accurately measured through the presence of so-called *wintermarksepta* (WMS), dark bands of meristem tissue in the white pith that demarcate the end of a growing season. WMS-distances offer an alternative to ring widths in the High Arctic, where trees and tall shrubs are absent. The growth chronologies developed for this long-lived (>150 years) species are the longest developed for the High Arctic so far. Intact subfossil specimens have been found, and small stem fragments found in soil cores may offer the possibility for longer-term reconstructions.
Annual growth of *C. tetragona* was found to be strongly limited by growing season temperatures at many High Arctic sites in experimental warming and dendroecological studies. Annual growth parameters of the species thus form a reliable proxy for past temperatures. Several examples of studies on *C. tetragona* as climate proxy will be presented, including from High Arctic sites such as the world's northernmost polar desert in North Greenland and sites in Svalbard.

1150
The Siberian Margin in the Context of Holocene Sea Level Rise and Climate

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After the Holocene sea-level highstand some 5-6 ka ago, a time of sedimentary stabilization commenced on the Siberian shelves. Drastic decreases in sedimentation rates in the Laptev Sea occurred at water depths >30 meters whereas in the inner shelf region deposition continued due to input from rivers and coastal erosion. Compared with that latter process, the Lena Delta should comprise a region of sediment catchment where aggradation wins over erosion. However, little is known about the detailed history of this delta during the second half of the Holocene. To gain more insight into this issue several islands within the Lena Delta were studied. All of these are comprised of massive peat of several meters in thickness. Using discrete specimens of water mosses, detailed radiocarbon-based chronologies of these peat sections were established. These show that the islands' history above the present-day delta sea level is c. 4000 yrs. old. Moreover, a major change in peat growth occurred after 2500 yrs BP in both, accumulation and species composition. Because these changes also correlate well in time with major shifts in ocean circulation and sea ice drift patterns elsewhere the environmental developments at the Siberian margin reflect the overall climate development witnessed around the Arctic during the late Holocene.

1481
The Potential for Using Arctic Carbonate Microfossils as Paleo-pH Proxies

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Modern ocean time-series indicate the Arctic Ocean is experiencing ocean acidification at an accelerated rate, and it is expected to experience the largest net decline in seawater pH globally during the coming century. Modern pH observations are especially limited in the Arctic Ocean, highlighting the importance of paleo-pH reconstructions from sediment records. Recent developments in boron-based paleo-pH proxies provide opportunities to reconstruct past carbonate chemistry of seawater but have yet to be applied to the Arctic sedimentary record. This work evaluates the pH proxy potential of boron to calcium (B/Ca) ratios in Arctic foraminifera and ostracodes preserved in Pacific Arctic surface sediments. B/Ca results are compared to in situ bottom water pH and saturation state (Ω) to develop modern species-specific calibrations that can be applied to paleo-pH reconstructions. The calibration sample set includes nearly 80 sediment core-tops distributed along a latitudinal gradient (62°N to 73°N) in the Bering and Chukchi Seas. The sampling locations represent a range of bottom water temperature (-1.5 to 4.9 °C) and pH (7.7 to 8.1) conditions, ideal for calibrating relations between various oceanographic parameters and shell chemistry. Results include trace element data for multiple species of benthic foraminifera (*Elphidium incertum* and *Nonion labradorica*) and ostracodes (*Sarsicytheridea bradii* and *Krithe* spp.) that are broadly distributed across the Arctic environment.

1862
Seafloor Methane Seepage at NW Svalbard Since the Last Glacial Maximum

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The amplification of global warming in the Arctic raises concern about the role of methane, a powerful greenhouse gas. A large amount of methane is present in continental margin sediments worldwide that may be released into the water column and atmosphere during future climate warming. Therefore, it is important to evaluate the character, timing, and triggers of past seafloor methane seepage to better understand future seepage dynamics.
Vestnesa Ridge, located at 79°N in 1200 m water depth offshore NW Svalbard, is one of the northernmost known active methane seep sites and is characterised by a subseafloor fluid flow system, numerous seafloor pockmarks, and gas flares in the water column.
Our study applies multiple proxies in the geological record to reconstruct past methane seepage variability on Vestnesa Ridge:
i) geochemical data from diagenetically altered fossil foraminiferal tests,
ii) mineralogical and stable isotope composition of methane-derived authigenic carbonate, and
iii) sediment geochemistry of multiple sediment cores.
We observe several seepage events that coincide with the Last Glacial Maximum extent of the Svalbard Barents Sea Ice Sheet, with the Heinrich Event 1 (ca. 18.5 cal ka BP), and multiple events in the early Holocene. Geological evidences for enhanced methane flux and seafloor methane seepage imply that glacio-isostatic adjustments during ice sheet advance and retreat may have triggered methane seepage at Vestnesa Ridge.

1184
Paleodynamics in Thaw Lakes: Accumulation of Aquatic vs Permafrost Carbon

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Permafrost deposits preserve organic matter which is decomposed and potentially released as greenhouse gases (CO_2 and CH_4) during thermokarst processes and in particular thaw lake development. Younger near-surface and older organic matter from slumping and expanding lake shores are deposited in the lake basin and contribute to the lacustrine carbon cycle. Bioproductivity within the lakes complements carbon accumulation in lacustrine deposits and provides an additional source of young carbon and greenhouse gases.
A set of lake sediment cores from Goldstream Valley in the discontinuous permafrost zone of Interior Alaska was studied for their origin of organic matter during the Holocene. With the aim to distinguish the provenance (terrestrial or aquatic) of carbon contributions to sediments over time, core samples were analyzed for their total organic carbon/total nitrogen ratio (C/N) as well as stable carbon isotopes.
The case study of Goldstream Valley Lake located in yedoma permafrost, indicates a dominance of aquatic plant material in the littoral zone with a mean C/N ratio as low as 8.7. Although a similar signal is found for sediments in the lake's central basin, a clear shift to a terrestrial carbon signal (C/N of 22) is presumably indicating the trash layer of the initial lake phase. Further, ongoing organic matter decomposition in talik sediments proves to be crucial to assess the contribution of thaw lakes to future climate change by mobilizing Pleistocene soil carbon.

BE-12b - Functional ecology of polar microbial communities in a changing world
23.06.2018 11:00-12:30, A Forum

257
High Alpine Lake Ecosystems in a Post-glacial Era

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The increased melt of ice in areas of retreating glaciers in High Mountain and polar environments creates new ecosystems and changes existing ones. Particles and attached compounds such as nutrients are released from the glacier and enter the fluvial system including glacier-fed lakes, which become impacted in their physical and chemical habitat properties. The disappearance of glaciers may fundamentally change these systems with unknown consequences on organismic diversity, nutrient cycling and resilience towards further changes. To understand the importance of glaciers for alpine lake ecosystems, we compared glacier-fed and permafrost-influenced lakes at three locations in the Swiss Alps in two field campaigns in 2016 / 2017. We analyzed microbial diversity as well as physical and chemical properties in lakes and in glacier forefields. Glacier-fed lakes had a higher turbidity, suspended sediment concentration, and conductivity than permafrost-influenced lakes. In contrast, nutrients (nitrate and phosphate) did not differ between the two. Microbial mats were found in both lake types, but microbial community compositions differed markedly. In glacier-fed streams they were similar to each other independent of the source glacier. In contrast, permafrost lakes showed high variability in microbial community compositions. Future work aims to better understand changes in the fluvial properties and project responses of High Mountain aquatic ecosystems in a possible post-glacial era.

258
Geochemical and Microbiological Co-succession in an Arctic Glacier Forefield

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The link between carbon cycling and weathering in recently deglaciated areas may result in important feedbacks on global warming and biogeochemical element cycles, particularly since glaciers are predicted to retreat at increasing rates in the future. In addition, recently deglaciated areas are unique environments to study the initial development soils and their associated terrestrial microbial ecosystems.
In newly formed proglacial soils, the scarcity of carbon and nutrients is thought to be the dominant limiting factor for microbial colonization and development. However, the processes controlling carbon and nutrient cycling in such settings remain poorly understood. To address this gap, we studied the functional linkages between soil mineralogy, weathering parameters carbon and nutrient distributions and microbial communities along a 150 years chronosequence in the glacier forefield of Fláajökull, south-east Iceland.
Our results show a clear decrease in pH, conductivity and soil grain size along the chronosequence which is accompanied by an increase in clay size contents. In this contribution, we will discuss the links between changes in weathering parameters and microbial community development along the chronosequence with the aim to better quantify the development of new soils upon glacier retreat.

110
Microbial Communities and Ecological Function in Dry Valley Lakes, Antarctica

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Permanently ice-covered lakes in the McMurdo Dry Valleys of Antarctica are physicochemically stratified along depth and have significant biological gradients. Despite the long-term ecological researches on these extreme environments, there remains a paucity of studies on microbial community structure and its ecological function. We conducted the comprehensive analysis of bacterial communities and additional biogeochemistry with depth profiles in five ice-covered lakes. Specific assemblages were confined exclusively to a certain environment. In Lake Bonney, 30 m depth of the East and West Lobe was dominated by two distinct *Firmicutes* classes. Candidate division WM88 occurred at 15 m depth of Lake Fryxell, whereas lineages of *Chlorobi* are detected only at the depth of 18 m in Lake Miers. Furthermore, Lake Fryxell was dominated by various uncultured bacterial lineages belonging to *Bacteroidetes*, *Actinobacteria*, *Planctomycetes* and candidate divisions JS1, WM88, and SAR 406. To study their ecological roles, shotgun metagenomics was carried out in all depths sampled and here we present significant results in order to implicate the microbial ecological function in this hypersaline ecosystem, Antarctica.

1540
Arctic 'Omics: Role of Molecular Ecology in Deciphering Arctic Ecosystems

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Climate change is rapidly altering the arctic sea and landscape to forms and functions not previously observed while our understanding of the importance of arctic microbial communities is just beginning. Molecular methods (*i.e*. through the use of extracted DNA, RNA and proteins) are playing a critical role in deciphering the current and changing function of these microbial communities by identifying members of the communities and their potential and expressed functions. The heterogeneity of the microbial community structure and the homogeneity of certain functions define an ecosystem with specific interactions that are currently being modified under selective pressure of the changing environment. The difficulties and rewards of exploring arctic microbial communities through molecular methods will be described with examples evaluating the role of atmospheric microorganisms in the snow and ice, the dynamics of the snow microbial communities, and the spatial heterogeneity of these arctic microbial communities. The functional future of these microbial communities will have a direct impact on the role of the Arctic in global geochemical cycling and arctic foodwebs.

1733
Monitoring Climate Change: Lichens do it Well in Antarctica

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Lichens grow on snow free sites throughout Antarctica from the Maritime to 85°S in the Ross Sea region, a span of round 22 degrees latitude. Lichens show two orders of magnitude difference in growth rate from the slowest yet known, 0.36 mm/century in the Dry Valleys (77.5°S) to around the fastest, 87 mm/century at Livingston Island (62.4°S). As a result, lichen growth rate appears to be possibly the best biological indicator of climate in Antarctica. Temperatures have been changing rapidly in the maritime Antarctic, increasing until 1998 and now declining. Lichen growth has tracked these changes and results from growth measurement over 38 years shows that they respond strongly to warming (26% increase over a 0.58° temperature rise for *Usnea antarctica*, 45% per 1°C increase). However, falling temperatures cause almost catastrophic declines not just from lower growth rates but with loss of complete thalli of some species due to snow kill. The latter follows loss in productivity when lichens remain covered in snow for long periods. Evidence suggests that snow kill may be an important factor forcing lichen community change throughout the continent. We also present a new data set from Cape Hallett that spans 51 years, one of the longest in Antarctica, and which is an important intermediate site between the two extremes. Whilst longer active periods from increasing precipitation probably drive productivity, actual growth rate is likely to be a response to temperature.

1855
Aerobiology over Antarctica

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The rate of dispersal to an ecosystem can significantly influence ecosystem dynamics. Aerial transport has also been identified as an important source of biological input to remote locations. However, the contribution of aerial dispersal in shaping patterns of biodiversity and ecosystem function remains poorly understood, mainly due to the lack of coordinated efforts in gathering data at appropriate temporal and spatial scales. In this study, circum-Antarctic samples were collected during the ACE cruise, to map aerobiological diversity around Antarctica, to identify the main input routes and sources, potential biodiversity hotspots and areas of special concern for biological conservation. This unique sample set has enabled the investigation of Antarctic atmospheric ecology from regional to continental scales.

ME-1_ME-2b - Human Adaptation to High Altitude & Human Science from the Extreme Poles
23.06.2018 11:00-12:30, A Schwarzhorn

119
Person-Environment Fit: Needs and Challenges in Antarctica

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Working in an isolated and confined environment (ICE), such as the Antarctic, presents a range of challenges for those who work there. While everyone copes differently with isolation and confinement, some key indicators might allow identification, prior to the deployment, of those better equipped to adjust well. In the present research, a Person-Environment fit theory, drawn from organisational psychology, has been used to investigate the interaction between the individuals' deployed to work at various Antarctic stations and the environment's characteristics, and how this interaction relates to measures of adjustment. The research included two studies. The first study (n=14) used a series of self-report questionnaires to gather data from winter-overs throughout their stay. The second study (n=59) employed a single, self-report questionnaire to record former winter-overs' recollection of their experience. Analysis of these data revealed the important role of needs for affiliation, intimacy and privacy, and their relationships to social adjustment within the station. Results also supported the hypothesis that such adjustment is negatively related to winter-over syndrome and positively related to job satisfaction. Overall, the results suggest that theoretical approaches that consider interactions between personal characteristics and defining environmental features lead to better understanding of human adaptation to extreme environments.

1941
Expeditioner Adjustment to Antarctic Employment: Does One Size Fit All?

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Limited research has been conducted outside the theoretical paradigm of the third-quarter phenomenon to examine patterns of expeditioner adjustment to Antarctic employment, and whether this is a primarily homogeneous experience. As such, an exploratory paradigm adopting latent growth curve analysis was utilised within the current research to determine whether such patterns could be quantitatively identified. 423 expeditioners within the Australian Antarctic Program provided data regarding mood prior to departure for Antarctica, each month they were 'on the ice', and upon return to Australia. The findings supported the long-standing postulated notion that the psychological adjustment in Antarctic expeditioners is primarily homogeneous. These finding can be utilised to guide the development of a new theoretical model to help explain the pattern of psychological adjustment in Antarctic expeditioners, as well as assist in development and implementation of intervention and prevention programs for Antarctic expeditioners.

22
Drugs in Antarctica; the Use of Expired Drugs at Extremes of Temperature

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Background: Medical provisions for BAS bases are ordered on an annual basis from the UK, and transported to the bases by non-refrigerated ship spending 1-2 months in the tropics enroute (approx 25-30C, RH 80-90%). Due to supply chain and expiry dating, products are often approaching expiry by the time of arrival on base and many expire prior to the following year's resupply. The lowest average temp is at Halley Station (-10°C in the summer, down to -55°C in the extreme).
Aim: To consider the use of expired drugs in a remote environment.
Methods:
1) Two separate literature reviews to establish current evidence on A) stability of expired drugs and B) stability of drugs stored outside recommended conditions.
2) Results of testing of stability of expired drugs returned from Antarctica by HPLC or RP-HPLC.
Five expired agents, returned from Antarctica, were analysed using stability indicating methods. These drugs may have been exposed to sub-zero temperatures on transporting from ship to base and back, and on the occasional periods when building temperature may drop below freezing, for example during power cuts. They were transported by sea through the tropics twice and were 15-51 months post expiry date.
Stability indicating HPLC or RP-HPLC analysis was used for each agent.
Results: There are several studies providing evidence that many drugs are stable post expiry. Heat tends to lead to more drug degradation than cold. All tested drugs were stable 15-51 months post expiry.

982
Personality Characteristics, Perception and Copy Patterns in Extreme Environment

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This paper concerns the results of the quantitative and qualitative analysis of the interviews and tests administered to the crews that took part, from 2004 to 2016, at the winter expeditions to Antarctica, at Concordia Station. The winterers are multicultural groups because they include Italian and French people. They are selected and trained by Italian and French specialists through specific psychological tests and training methods. Particularly there will be presented the results of some psychological tests used for the aptitude evaluation of Italian subjects who have participated in the last thirteen winter Expeditions to Antarctica and who have remained in a confined environment for one year at Concordia Station. Also there will be presented the results of the debriefing with the crewmembers of the last expeditions to Concordia Station. The debriefing was made using questionnaires, tests and interviews to assess the winterer's perception of psychological adaptation, coping strategies, feelings and mood. They were asked about what they found different from their expectations, what they preferred and what they didn't like, the quality of the interpersonal relationship, the existence of sub-groups, their evolution with time, the relationship with the leader and the outside environment (research's investigators, logistic support, etc.) The objective was to identify what is useful to do to improve future missions.

1575
“Ice-tronauts:” Antarctica as a Space Exploration Analog for Team Functioning

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The isolated, confined, and extreme (ICE) conditions that characterize polar exploration and research are excellent analogs for studying the effects of ICE stressors that will affect individual and team psycho-social functioning during long duration space exploration missions to the moon and Mars. This is critical because, although team effectiveness has been studied for well over 60 years, most of the research is static. While much is known regarding the psycho-social factors that contribute to team effectiveness (i.e., team cohesion, affect, conflict), relatively little is known about how they vary or fluctuate over time, trends that characterize long term changes, and factors that account for variance in psycho-social functioning. Our research, funded by NASA, is investigating ICE team functioning in winter-over and summer scientific missions in Antarctica (in collaboration with the Australian Antarctic Division and others), as well as in two NASA mission simulations. Mission durations range from a matter of a few weeks to upwards of one year, depending on the analog. The protocol across all analogs captures daily ratings on psycho-social factors which are analyzed to identify within person and within team variability, long term trends, and factors that account for changes. The presentation will discuss findings across these research locations, focusing on polar settings as an excellent analog for understanding space team functioning for long duration exploration missions.

1664
IMAgE: Interdisciplinary (bio)monitoring at Princess Elisabeth Station

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It is beyond doubt that a stay in space affects human physiology and health. Besides increased radiation levels and reduced gravity, health problems can be caused by other stress factors e.g. isolation and confinement and disturbed sleep. So far, the mechanisms of human adaptation to these environments are unknown. Since the number of space experiments is limited, ground-based platforms are useful to recreate aspects of the extreme space environment. Within IMAgE, the impact of extreme conditions on human physiology will be investigated at the Belgian Princess Elisabeth Station at Antarctica (PEA). The environmental part will specifically monitor ionizing radiation doses and ozone concentrations present in- and outside PEA. In addition, immune changes, stress-related hormones and oxidative stress will be measured in blood, saliva and urine from volunteers. Furthermore, heart and oxygen saturation will be monitored. In parallel, a study assessing the microbiome with/without *Spirulina* supplementation will be conducted. Besides experimental research, a considerable amount of time will be devoted to dissemination and education activities. In conclusion, the IMAgE project is a unique pilot study to perform multidisciplinary bio-monitoring. Obtained data can be compared with previous Antarctic studies, and will bring more insight into physiological changes in humans exposed to the PEA environment.

CR-5b - Interactions between ice mass balance, the solid Earth, and sea-level changes 23.06.2018 11:00-12:30, A Seehorn

104
Antarctic Snow Accumulation over the past 200 Years

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The Antarctic Ice Sheet (AIS) is the largest reservoir of fresh water on the planet, even small changes in its volume could have significant impacts on global mean sea level. Here we present Antarctic snow accumulation variability, at the regional scale, over the past 200 years based 79 ice core snow accumulation records. The records were evaluated against precipitation from ERA-interim reanalysis and converted to regional surface mass balance (SMB) by regressing onto the modelled SMB from RACMO2.3p2. Our results show that SMB for the total Antarctic ice sheet (including ice shelves) has increased at a rate of 7 +/- 0.13 Gt dec^{-1} since 1800 AD, representing a net reduction in sea level of ~ 0.02 mm dec^{-1} since 1800 and ~0.04 mm dec^{-1} since 1900 AD. The largest contribution is from the Antarctic Peninsula, where the annual average SMB during the most recent decade (2001-2010) is 123 +/- 44 Gt yr^{-1} higher than the annual average during the first decade of the 19th century.

857
Antarctic Ice Flow Line Map

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We generate a complete, accurate, high-resolution, digital mosaic flow line map for the whole Antarctica by a novel automatically tracking method based on surface ice flow velocity dataset. Multi-level and up to 10200-neighborhood (101 by 101) search windows are used to track directions along flow lines with high precision, and adapt to the spatial inconsistency of the original flow directions. A set of restrictions based on physical principle of ice flow are also taken in account. The flow lines obtained are highly consistent with the ice flow features revealed by the remote sensing images. This detailed flow line map give a clear divide of the ice sheet-ice shelf systems of the whole Antarctica. This view of ice sheet motion redefines our understanding of spatial distribution pattern and characteristics of Antarctic ice streams, and has far-reaching implications and application for the reconstruction and prediction of ice sheet evolution, ice mass supply and migration.

650
Mechanical Modelling of Iceberg Capsize Constrained by Seismic Inversion

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Iceberg calving is responsible for most of the mass loss occuring at the front of marine-terminating glaciers in Greenland. Capsizes of calved icebergs generate long-period seismic signals that are recorded by local and global stations. The emitted seismicity contains precious informations about the source mechanisms involved during the calving process. A versatile mechanical modelling of iceberg capsize has been developed by A. Sergeant et al. [2016]. Inversion of seismic signals provides constraints to the model and enables calculation of the iceberg volume and source dynamics. This model has been first tested on two particular events at the Helheim glacier, Greenland (25 July 2013 at 03:13 UTC and 31 July 2013 at 19:31 UTC) and the results are consistent with the iceberg volume measured separately using optical images. A difficulty of the capsize modelling lies in accurate models used for the strongly coupled iceberg-water interaction, as the iceberg dynamics strongly depends on the water flow initiated during the capsize. The models with and without drag force, with and without added mass will be considered, as well as models including immobile and deformable terminus. In this presentation, we will analyze how these different iceberg-ocean interaction models affect the resulting seismic signals. By comparing synthetic seismograms with data, the most adequate models will be selected.

1118
What is the Viscosity of the Mantle Beneath Antarctica, and why Do we Care?

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In traditional studies of glacial isostatic adjustment, mantle viscosity is inferred from observations of relative sea-level change or present-day uplift that reflect the solid Earth response to past (known) changes in ice and ocean loading. In Antarctica, we lack robust constraints on the surface loading history in many regions, and therefore recent studies have sought to use independent evidence to constrain the viscosity beneath Antarctica. In this presentation we review the different methods and data sets used to determine mantle viscosities across Antarctica, and we outline the range of values that are deduced under different rheological assumptions. Finally, we discuss the implications of the emerging viscosity distribution for past and future ice sheet dynamics, and highlight areas that we recommend should be the focus of future research.

1450
Ice Dynamic Model with Laterally Varying Relaxation Time

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The elevation of an ice sheet controls its mass balance, either through the influence on temperature or because local sea level changes. Elevation depends on the ice thickness and the relaxation of the bedrock, which in ice sheet models is often modelled by assuming a constant relaxation time. However, it is known that mantle viscosity varies with location, hence also bedrock relaxation times will vary across the Earth's surface. The goal of this study is to include variations in relaxation time in an ice sheet model and study the effect on the equilibrium state in areas where large variations in relaxation time are expected, such as Antarctica.
We use the ANICE ice-sheet model with a bedrock relaxation module adapted to compute bedrock deformation for a location specific relaxation time. The reference case is constant relaxation time with a value of 3000 years. For a realistic ice dynamic simulation a 3D map of relaxation times should be used. However, we only have estimates of viscosity that are derived from a global seismic model in combination with parameters for olivine rheology. Relaxation time maps are obtained by varying relaxation time to obtain the same bedrock deformation as predicted with the viscosity map in a GIA model. Results for a dynamic ice sheet based on the relaxation time maps show that the small relaxation times in West Antarctica result in a 2.5% smaller LGM ice sheet and 10% variation in ice volume that melted between LGM and present.

2468
Reconciled Model Projections for the Antarctic Contribution to Sea Level Rise

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Recent estimates for sea level rise from Antarctica in coming centuries span near-zero to several metres, with the huge range arising largely from possible socio-economic pathways. But within any particular pathway, high rates of mass loss are driven by the controversial marine ice cliff instability (MICI) mechanism. We find MICI is not required to reproduce past Antarctic sea level rise (1992-2011; Last Interglacial, 130,000-115,000 years ago; Mid-Pliocene, 3 million years ago). With MICI, Antarctica is most likely to produce 40 cm sea level rise by 2100; without, it is unlikely to exceed this. We cannot, however, firmly rule MICI out.

SH-9a - Polar research in the humanities and social sciences: approaches and challenges 23.06.2018 11:00-12:30, A Wisshorn

2688
The Arctic Science Agreement Propels Science Diplomacy

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The presentation will share perspectives reported in *Science* magazine on 3 November 2017 (Volume **358:** 596-598). The *Agreement on Enhancing International Arctic Scientific Cooperation*, signed on 11 May 2017 by foreign ministers of the eight Arctic States, including the United States and Russia, as well as Greenland and the Faroe Islands, is a strong signal reaffirming the global relevance of science as a tool of diplomacy, reflecting a common interest to promote scientific cooperation even when diplomatic channels among nations are unstable. Although the Arctic States are the signatories, the "Arctic Science Agreement" emphasizes that these States "may continue to enhance and facilitate cooperation with non-Parties with regard to Arctic science." This holistic (international, interdisciplinary, and inclusive) science cooperation broadens the scope of the Arctic Science Agreement beyond its defined area to address "common Arctic issues," in particular, "sustainable development and environmental protection" as established by the Arctic Council, balancing economic prosperity, environmental protection and societal well-being with the "best available knowledge for decision-making." With science defined broadly as the study of change to include natural and social sciences as well as indigenous knowledge, such science diplomacy helps to balance national interests and common interests for the lasting benefit of all on Earth with hope and inspiration across generations.

1360
Impact before Madrid: Cultures of Antarctic Environmental Protection pre-1991

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Environmental impact assessment is a central regulatory process in contemporary Antarctic governance as determined by the Madrid Protocol of 1991. The centrality of the EIA process in Antarctic affairs mirrors a broader development in which EIA has come to be the central regulatory tool in environmental policy worldwide, since its first introduction in the United States in 1969. This paper investigates the place of ideas and policies relating to 'environmental impact' in the Antarctic Treaty System before the signing of the Madrid Protocol in 1991. It will look at three case studies. First, the EIA process of the United States National Science Foundation in the McMurdo Dry Valleys in the 1970s. Secondly, the discussions about 'impact' in the CRAMRA negotiations between 1982 and 1988. And thirdly, the rhetoric and practices of impact in the Greenpeace World Park Base of the 1980s. Each of these cases will build into a larger picture of the contours and limits of the idea of 'impact', especially as it related to potential or actual bureaucratic processes in that period. This paper contributes not only to polar history, but to the broader discipline of environmental history to understand one of the fundamental structures of modern environmental protection that has hitherto remained under-studied.

2667
Changing Ice at the Poles: Ramifications for Legal and Social Boundaries

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The problem of changing ice in the Arctic and Antarctic is central to the research of polar scientists. Yet scientists are not the only scholars who can bring critical perspectives to polar ice. Social scientists and humanities scholars, like environmental historians, can also contribute to the debate about ice and our understanding of the ice-ocean interface. This paper draws on a developing field of literature to argue that ice in the Southern and Arctic Oceans muddles the borders that legal and diplomatic institutions attempt to create. International regulatory regimes like the United Nations Convention on the Law of the Sea and the Antarctic Treaty have attempted to construct legal boundaries that do not necessarily acknowledge or adapt to the complexities of the polar environments. Ice shelves, icebergs, and sea ice undermine human-imposed boundaries when they obscure the shoreline in Antarctica, move between national jurisdictions in the North Atlantic, or melt to reveal new borders of untapped oil resources in the Arctic. When ice changes, nations are left to negotiate in terms of realpolitik the circumstances under which they may share oceanic resources. As scientists continue to study changing trends of ice at the poles, the humanities and social sciences are well positioned to determine the social and legal ramifications of such environmental change.

381

Defining Values: In a Word, who we Are

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The concept of values has been one of significant interest to polar social scientists in the last decade, yet there has been a puzzling lack of a clear and explicit definition of the concept in many of the publications and other academic output from this research. In the rare instance where a definition of “value” is offered by a researcher - explicitly or, more usually, implicitly - it can deviate markedly from those used by researchers in other disciplines. The lack of consensus for such a critical, theoretical term hinders collaborative, interdisciplinary work, and hampers direct comparison of research findings. This leads to a pervasive and regrettable inefficiency in the study of this important area. This paper presents common themes and key differences in several definitions of 'values' drawn from the general, social science literature and, where they can be found, more specific definitions from studies of 'polar values'. The paper then proposes a working definition as a starting point for discussion amongst polar researchers.

1294
Framing Antarctica as Fragile

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Antarctica has been framed in many ways over the course of its human history: as a place for profit; a place for heroes; the ultimate testing ground; a place of purity, or a place of transformation. In recent times Antarctica has come to be cast as a fragile place. Although dominant in modern Western discourse, the view of Antarctica as a place that requires protection is not inevitable. This paper examines how the idea of Antarctic "fragility" manifests not only in a policy setting, but also the realm of cultural production. It asks how the "fragility" theme has appeared at different times, for various audiences, and uses media and advertising to trace links between public opinion, policy, publicity, and protection over the past century. By analysing representations of Antarctica in the media and contextualising these temporally and nationally, it traces how popular attitudes towards the continent have evolved over time. Gaining a comprehensive understanding of how framing of Antarctica has shifted - from a place of danger to be conquered to a place requiring protection - also reveals why we care about the place. Most people will never visit Antarctica, so their imagined versions of the far south are far more vivid than the ice itself. In the context of climate change, it is more important than ever to gain an understanding of human interactions with and conceptions of the far south. Analysis of media texts helps illuminate the discourse behind framing Antarctica as fragile.

310
New Critical Realities: Indigenous Film in the Time of Climate Change

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This paper draws on writing done for my book project **Polar Art and the Climate Crisis: Witnessing the Anthropocene.** The book addresses polar art and film not just as an illustration of planetary demise and a call for action. But as a challenge to our imagination. Much of this work brings into being new forms of seeing, feeling, and sociality, that are connected to living through this kind of slow-moving disaster inflicted by environmental and climate breakdown. How very different these emotions of precariousness are from the old flag-planting heroism of explorations to "the ends of the earth" of an earlier epoch.
This presentation focuses on indigenous filmmakers to shift our view of the polar regions from the heroic to the climatic, from the white, male explorer's perspective of remote wildernesses to the Inuit/Indigenous perspective that frames the land and the people of the land as a mix of human and non-human forces. It focuses on the experimental film, "Qapirangajuq: Inuit Knowledge and Climate Change," (2010) by Nunavut-based director Zacharias Kunuk and Ian Munroe, the first documentary in the Igloolik-based language that explores how a northern indigenous community is affected by climate change from an indigenous perspective. My analysis calls attention to how this film replaces the sublime aesthetic of the polar heroic age with an alternative aesthetic - one that is a counter aesthetic (anti-heroic), focuses on the everyday (quotidian), and is indigenous (Inuit).

SY-1b - Earth Observation: Solutions for data collection, compilation and dissemination 23.06.2018 11:00-12:30, B Pischa

2333
Establishing a Data Stewardship Model for Arctic Observing through Collaboration

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In November of 2014 the International Arctic Science Committee (IASC) and the Sustaining Arctic Observing Networks (SAON) established the Arctic Data Committee (ADC). The ADC comprises national and other organizational members who participate in working groups on a variety of different topics including federated search, vocabularies and semantics, eduction and others. In addition to actively engaging in working groups that directly support practice, the ADC works to ensure a better understanding of the Arctic data system as a whole and the policies, funding and societal drivers that underpin Arctic and polar data management and stewardship.
Most recently, the ADC took a leadership role in bringing together more than ten active polar data programs, initiatives and actors to focus on work planning and coordination of effort. This meeting complemented past workshops and fora (e.g. IPY, Polar Data Forums etc.) that have been effective in defining important community challenges and technical issues. The focus of the meeting was to generate detailed plans on how best to mobilise existing and pending funded activities to develop a particular international data sharing case study.
Collaboratively engaging with the diverse actors, projects and programs in the Arctic and elsewhere is the priority of the ADC moving forward.

1794
Putting Antarctica on the Map: 25 Years of the Antarctic Digital Database

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The SCAR Antarctic Digital Database is a seamless compilation of international topographic data covering Antarctica south of 60°S. It is the primary source of map data for coastlines, rock-outcrop and contours, and has been used extensively for cartography, science and logistics since its launch in 1993.
Over the last 25 years it has documented both the evolution of knowledge about the topography of Antarctica and major changes in the physical landscape.
Here we summarise key changes captured in the ADD over the last quarter century, and current developments to ensure its relevance in the digital landscape of the next decade.
The initial baseline data came from 200+ regional scale maps from 11 national mapping agencies, later supplemented by newer vector data. Recently significant sources of new information are continent-wide, automatically-generated datasets from remote sensing.
Delivery has changed from release on CD in 1993 to a web application which allows selection and download of data in a range of formats and resolutions, and provides web services for other systems.
The availability of more remote sensing data has driven demand for more up-to-date information. We now intend to provide more frequent updates to capture the dynamic nature of Antarctic topography. Including continent-wide datasets from new sources has required updating metadata attributes, improving quality control procedures and more automated ways to generalize the lower-resolution datasets.

1720
Polar Thematic Exploitation Platform

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The volume and variety of Earth Observation (EO) data available for the polar regions is growing rapidly, providing opportunities for more complex investigations by the polar research community. With this increase in data and plans for new polar observing satellites, there are challenges to fully process, analyse, disseminate and exploit these new EO data.
The European Space Agency has established the Polar Thematic Exploitation Platform (PTEP) which provides the necessary collaborative computing environment for polar researchers. The PTEP projects address present challenges and opportunities in scientific data exploitation by collocating data, processing capabilities and ICT infrastructure, providing a complete cloud based work-environment.
This presentation will describe the Polar TEP concept and the range of potential uses it will support. We will present details of the platform where users can bring their algorithms and applications directly to the data. It will also cover the rich set of polar EO datasets, toolboxes and processing capabilities, plus functionality to allow deployment of user defined workflows and processing environments.
We will also outline a pilot project which demonstrates the use of Polar TEP to investigate current and future iceberg risk in Baffin Bay. The pilot project integrates a diverse set of data, processors and models, allowing investigation of linkages between iceberg trajectories, changes in ice sheet velocity and glacier calving rates.

637
Quantarctica 3: A Cross-platform, Full-featured Open GIS for Antarctic Research

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Version 3 of the open GIS package “Quantarctica” was released in early 2018 (http://quantarctica.npolar.no). This geospatial data package is built on the free, open-source, cross-platform QGIS software, is capable of operating entirely offline, and includes a wide range of cartographic basemap layers, scientific datasets, and satellite imagery. Version 1 Quantarctica was first released in 2013, and it became a SCAR product in 2014. For this latest version, the Quantarctica Editorial Board selected peer-reviewed datasets for a wide range of Antarctic users, adding over 130 new basemap and scientific data layers and widening the thematic coverage from Glaciology and Geophysics to other themes such as Atmospheric Science, Biology, Oceanography, Social Sciences, and more. We also expanded the project's extent and data coverage to 40°S, including sub-Antarctic islands.
Here, we briefly revisit the development process and accomplishments of the Quantarctica project, before showcasing Quantarctica 3's expanded and deepened data coverage, new features, and practical applications in Antarctic research, logistics, education, and outreach. We also present our ongoing efforts and experiences with the Antarctic science community, including workshops, data solicitation and open data sharing, and direct engagement with Antarctic researchers in the field, in the office, and on social media.

510
A MODIS and Machine Learning Based Daily air Temperature Dataset for Antarctica

Hanna Meyer[1] (hanna.meyer@geo.uni-marburg.de), Marwan Katurji[2], Thomas Nauß[1], Pierre Roudier[3], Peyman Zawar-Reza[2]
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Air temperature is an important baseline parameter for a range of scientific studies in Antarctica, e.g. climatology, hydrology or ecology. Climate stations provide sub-daily measurements, however, their low spatial density does not allow for comprehensive spatio-temporal analysis. While climate models can be used to fill these gaps, their coarse spatial resolution only allows capturing broad scale patterns. The application of remote sensing technology, on the other hand, provides fine resolution proxies for air temperature that make it possible to assess small-scale dynamics. The application of remote sensing data and methods is therefore inevitable.
This study uses time series of the MODIS Terra and Aqua sensors to estimate daily air temperature at 1 km spatial resolution. Machine learning algorithms are used to relate MODIS as well as process specific auxiliary predictors to measured air temperature recorded by 70 climate stations distributed over Antarctica. In this context, new modelling strategies are applied that account for the spatio-temporal autocorrelation in the data hence allowing for an adequate training of the model.
The resulting data set is unique as it provides daily air temperature at 1km spatial resolution for the entire continent. The new product therefore presents a baseline for temperature pattern and trend analysis at an adequate resolution to study both, regional and local scale climate variability.

607
The GeoMAP Dataset of Antarctic Rock Exposures

Simon Christopher Cox[1] (s.cox@gns.cri.nz), Belinda Smith-Lyttle[1], Christine Siddoway[2], Gianni Capponi[3], Synnøve Elvevold[4], Alex Burton-Johnson[5], Jacqueline Halpin[6], Paul Morin[7], David Elliot[8], Geomap Action Group[9]
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The SCAR GeoMap action group has been building a detailed digital geological dataset of Antarctica. We have been capturing existing geological map data, refining its spatial reliability, improving representation of glacial sequences and geomorphology. The initiative is aimed towards continent-wide perspectives and for cross-discipline use, our international team is collaboratively classifying and describing around 72,000 distinct areas that cover 51,000 km^2. The dataset will describe 'known geology' of rock exposures rather than 'interpreted' sub-ice features. Glacial deposits are an important focus for their potential to contain records of ice fluctuations of relevance to climate change. Here we present background on:
(1) Completion, or very near-completion, of the first version of a continent-wide dataset. All rock outcrops will have geological attributes assigned to them in GeoSciML suitable for use at 1:250,000 (or more-regional) scale.
(2) The large number of hard-copy geological maps and data sources, which range in scale and quality.
(3) Development of local legends, which highlight geological variation across the region.
(4) Progress towards a unified classification scheme.
(5) Bibliographic links referencing authors of key original work.
(6) Potential for the dataset to provide fresh perspectives, for example, through combined geological legends and interrogation of continent-wide time-space plots.

EN-2b - Contamination in Polar and High Altitude Environments
23.06.2018 11:00-12:30, B Parsenn

2099
Arctic Sea Ice: A Transport Vehicle and Temporal Sink for Microplastic!

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Microplastics (MP) are a problem of growing environmental concern and have been acknowledged in polar oceans with particularly high concentrations in Arctic sea ice. Sea ice has long been recognised as a transport vehicle for contaminants from both distant and local sources. The Fram Strait represents a major gateway for both the inflow of warm Atlantic water with anthropogenic imprints, and the outflow of sea ice originating from the Siberian shelves and carried south via the Transpolar Drift. The MP content and composition from sea ice cores collected by RV Polarstern in 2014 and 2015 at five different locations along the Transpolar Drift allow for studying the various imprints of MP pollution. Through focal plane array detector-based micro-fourier-transform infrared imaging we recorded MP concentrations of up to 1.2×10^7 m^{-3}. Most particles were smaller than 50µm. Separate analyses of the various ice core horizons showed a strong shift in polymer distribution, depending on the source area and drifting paths of the sea ice, highlighting the transport capacities of sea ice for MP. The quantities found exceed previous reports by several orders of magnitude underlining the importance of sea ice as a temporary sink for MP. The role of focal sources versus long-range transport of MP particles will be discussed in the context of upcoming exploration of the Arctic Ocean due to climate change.

1340
Assessment of Pollution from Two Ice Cores from Col du Dome, French Alps

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Ice cores extracted from high altitude glaciers have proven to be important archives of human impacts on the free troposphere over continents. Measurements of heavy metals, sulfur, nitrate, ammonium, and black carbon in ice cores have previously been used to quantify pollution sources including coal, oil, and mining and to determine the relative contributions of pollutants with time.
Here we present recent results from two ice cores extracted at the Col du Dome site (4250 m above sea level) located in the French Alps: the C10 core (126 m long) drilled in 1994 and the CDM core (140 m long) drilled in 2012. Nearly 30 trace elements and chemical species were analyzed at the Desert Research Institute via the continuous flow analysis system allowing for sub-annual resolution of many of the pollutants of interest. Based on the ammonium record that exhibits a well-marked seasonal cycle with a winter minima, seasonally resolved trends of various pollutants were determined for the 1890-2000 C.E. time period. Primary Matrix Factorization (PMF) was used to assess the apportionment of trace elements and chemical species to specific pollution sources. The PMF results are compared to available pollution emission estimates and to other ice core records to determine the influence of transport and deposition processes of pollutants to the Alps over the past.

1803
Photochemical Reactions in Freshwater: Mountain vs. Polar Environments

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Sunlight illumination of surface waters induces photochemical reactions with transformation of naturally occurring compounds and xenobiotics, inactivation of pathogens, and effects on biogeochemical cycles. These reactions consist of direct photolysis of sunlight-absorbing molecules, and of indirect phototransformation. In the latter case, sunlight is absorbed by naturally-occurring photosensitisers (e.g. chromophoric dissolved organic matter or CDOM, nitrate and nitrite) to produce several reactive transient species that trigger transformation reactions. The transients include, among others, the hydroxyl ($^{\cdot}OH$) and carbonate ($CO_3^{\cdot-}$) radicals, singlet oxygen ($^1O_2$) and CDOM triplet states ($^3CDOM^*$). Their occurrence in surface waters depends on sunlight irradiance and on key water parameters such as chemistry and depth. In mountain environments, the nature and photoreactivity of CDOM is strongly affected by the vegetation surrounding the water body (forests, alpine meadows or bare rocks). Moreover, the duration of the ice-cover period could strongly affect photochemistry. As we recently demonstrated, the latter phenomenon is thought to play a key role in Antarctic lakes, also because ice protects CDOM from sunlight-induced photobleaching and ensures the occurrence of very photoreactive CDOM in lake water soon after the ice melt. Therefore, Antarctic lakes are very efficient photoreactors towards xenobiotics contained in the ice, which could reach lake water as the ice melts.

2202
New Forensic Methods to Quantify Unseen Human Impact on Terrestrial Antarctica

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Under the Antarctic Treaty System of 1959, National Antarctic Programs and individuals have an obligation to keep the Antarctic continent in a 'pristine' state. The current definition of 'pristine' focuses on visible physical and chemical impacts without regard to the unseen remnants of human activities. The McMurdo Dry Valleys (MDV) is a microorganism-dominated ecosystem, where the effects and risks of releasing DNA from human and human-associated microbiota as part of routine activities are unknown. Using forensics-grade techniques and newly developed ultra-sensitive methodologies based on digital PCR, human trace DNA has been detected in field camps after habitation. We will present assessments of impact from human and human-associated microbial genetic materials for a range of sites, from highly impacted to previously unvisited locations. We will elucidate the relationship between the degree of detectable impact with the level of documented activities, and these results can potentially be developed as tools to detect undocumented activities and impact across the Antarctic continent. This research is part of the Dry Valley Ecosystem Resilience (DryVER) programme, funded by the New Zealand Ministry of Business, Innovation and Employment, that aims to provide evidence-based risk management of the McMurdo Dry Valleys. The data generated from these tools will be used to produce an "impact index" to inform the review of current environmental management guidelines.

213
Anthropogenic Trace Elements (Bi, Cd, Cr, Pb) Emissions in the West Antarctica

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Atmospheric concentrations of trace elements are influenced by natural and anthropogenic processes. Most anthropogenic sources (fossil fuel combustion, smelting, industry, agriculture, and large-scale land use) have increased since the late 19th century becoming a worldwide issue for humans and the environment. Here, we present long-term Bi, Cd, Cr, Pb records in West Antarctica during the period 1882-2015 based on ice-core concentration analyses from Pine Island Glacier ice divide. Two Mount Johns ice cores (79°55´28" S, 94°23´18" W, 2100 m a.s.l) were recovered in the austral summer of 2008/2009 (91.20 m depth) and 2015 (19.12 m depth). Trace element concentrations were determined using inductively coupled plasma mass spectrometry (CCI/UMaine). The results of enrichment factor and principal component analysis revealed that anthropogenic activities were likely important contributors to those trace element records. We find that Bi, Cd, Cr, and Pb emissions increased after 1884 reaching a maximum by 1900. Concentrations remained high until the late 1920s, with a temporary low during the Great Depression (1931) and again at the end of World War II (1948) when concentrations dropped to background levels. Concentrations increased after 1960 and remained high until the present. Concentrations during the early 21th century were lower than the peak of the 20th century concentrations but well above background levels.

2132
Mercury in the Southern Ocean: Pathway from Primary Producers to Top Predators

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Although Antarctica is seen as the remote and pristine continent, the levels of contaminants in the Southern Ocean have increased significantly. Mercury is one of the pollutants that it's found in higher concentration than expected in Antarctic waters. With this study, we aim to better understand the concentration of mercury and its pathway along the Southern Ocean marine trophic web.
Samples were collected along several taxonomic groups from microalgae, crustacean, fish, cephalopods and top predators, between 2015 to 2017 on the Scotia Sea, one of the most productive areas of the Southern Ocean. Plankton and nekton were collected around South Georgia and South Orkneys. Predator samples were collected by colleagues in the islands.
This presentation will be focused in the path that mercury since it gets absorbed in the micro algae to the levels that it reaches in the long living top predators, using stable isotopes analyses as proxy for trophic level.
Establishing the base levels of mercury in the Southern Ocean food web is crucial to better understand how this pollutant will may affect the Antarctic ecosystems.

OS-5b - The role of snow on sea ice for sea-ice parameter retrieval and variability
23.06.2018 11:00-12:30, B Jakobshorn

2106
Snow Depth and Sea Ice Thickness in the Antarctic

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Determining ice thickness distribution from satellites in the Antarctic is difficult in large part because of challenges with estimating the snow depth distribution. At present, current satellite ice thickness products cover a wide range of thickness estimates due to differences in how snow cover is treated. We present a comparison of NASA IceBridge snow depths and surface topography with in situ measurements of three-dimensional “layer-cakes” of surface topography, snow depth, and ice thickness for Antarctic sea ice in late spring. First, we present a method to extend sparse radar retrievals of snow depth across sea ice floes. Next, using relationships between snow freeboard, snow depth and ice thickness from the field data, we calculate ice thickness for IceBridge data in the Antarctic, with an estimate of the error. These results are compared to other methods for estimating these relationships. Consistent with prior analysis, these data suggest a significantly thicker sea ice cover in near coastal Antarctica than has been suggested from shipboard estimates of the broader pack.

2083
Exploiting Digital Imagery for Snow Surface Retrieval on Sea Ice

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We show how imagery from uncalibrated airborne cameras can be used to reconstruct the snow/air interface on Antarctic sea ice, using data collected on the SIPEX-II research voyage during austral spring 2012. Imagery collected by an airborne surveying package was used to develop a 3D surface model using a structure-from-motion approach. This model was validated using coincident airborne LiDAR and in situ observation of total freeboard. Our study demonstrates that equivalent surveys may be obtained using unmanned vehicles (drones) carrying only a camera and basic navigation equipment. Using this method, detailed floe-to-multifloe scale models of snow topography may be derived without logistically intensive airborne surveying programs. In turn, this allows for quick repeat surveys - simplifying the capture of a surface topography time series at any given field research site. It also allows for highly detailed analysis of relationships between surface features and how the evolve over time. Finally, we show how different surveying scenarios affect data quality and the ability to easily co-register surface models with other coincident datasets. We discuss how future surveys should be planned, which data need to be collected alongside the imagery used to generate 3D models, and where future development should be aimed at in terms of uncertainty computations and data quality assessment.

65
GPR for Rapid and Accurate Snow-thickness Measurements on Antarctic Sea Ice

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Snow thickness on sea ice is not known on the regional scales and to the accuracy required for climate analysis and to assess its significant role in the Earth's cryosphere mass balance. The thickness of snow on sea ice is a largely under-sampled, but crucially important parameter when estimating sea-ice thickness from space-borne sensors. Traditional sampling methods comprise meter-stick measurements or snow probes, which yield highly accurate data but are sparse in space and time, whereas remote sensing data have the potential to cover large areas but exhibit large uncertainties. To increase the local data volume and to apply as an intermediate level for remote-sensing data validation, we present non-destructive ground-penetrating radar (GPR) snow-thickness data of remarkable accuracy (millimetre to centimetre) when compared to in-situ data. The semi-regional data collected during two Antarctic campaigns in late winter/early spring confirm the underestimation of snow thickness on sea ice using remote-sensing methods by roughly 30%. The radar wave propagation was found to be rather constant in snow (+/- 6%), supporting the applicability of GPR for regional snow thickness surveys of snow thicker than 10cm, which was the detection limit of the off-the-shelf GPR setup used in this study.

252
Vertical Snow Structures from Local to Regional Scale

Stefanie Arndt[1] (stefanie.arndt@awi.de), Nicolas Stoll[1,2], Stephan Paul[1]
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Snow on sea ice alters the properties of the underlying ice cover as well as associated exchange processes at the interfaces between atmosphere, sea ice and ocean. As Antarctic snow cover persists during most of the year, it contributes significantly to the sea-ice mass budget due to comprehensive physical (seasonal) transition processes within the snowpack. It is therefore necessary to locate and quantify internal snowmelt, snow metamorphism, and snow-ice formation in the Antarctic snowpack on different spatial scales. Doing so, we present here in-situ observations of physical snow properties from point measurements and transect lines during recent expeditions in the Weddell Sea from 2013 to 2018, covering summer and winter conditions. Analysis of snow pit measurements on both small (< 100m) and floe-size (< 2km) scales reveal significant variations in the horizontal snowpack structure. In order to describe internal snow processes on regional scales, we grouped the observed snow conditions, differentiating for snow conditions between eastern (seasonal sea ice) and western Weddell Sea (perennial sea ice). While the thick perennial snowpack is highly metamorphous with a large number of internal layers, the seasonal snowpack is less stratified. Results of the study will improve our understanding on processes and interactions in the snowpack as well as at the snow/ice interface associated with seasonal and inter-annual variations in the sea-ice mass budget of the Southern Ocean.

1770
Comparison of Winter Field Data to Ice Thickness from ALS, ASIRAS and CryoSat-2

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Current freeboard and associated sea-ice thickness retrievals from the SIRAL radar altimeter on the CryoSat-2 satellite rely on the premise that the return signal measured is from the ice surface. However, it has been indicated that where a thick, layered, wet, or saline snow cover is present this return may arise from somewhere within the snowpack rather than from the snow-ice interface. We present a case study for winter conditions in which co-located freeboard measurements from airborne laser scanner (ALS), the Airborne Synthetic Aperture and Interferometric Radar Altimeter System (ASIRAS) and CryoSat-2 are compared to ice thickness measurements from both helicopter-borne and ground based electromagnetic-sounding, and to point measurements of ice and snow properties. This case study was performed in the Arctic Ocean in April 2015 in the region north of Svalbard. This study adds to a body of evidence that documents the complexity of sea-ice freeboard retrievals from radar altimetry. It particularly highlights that radar penetration of the snow on sea ice can be low and variable even at temperatures as low as -15°C. While this knowledge can have far-reaching consequences for radar based sea-ice thickness and consequently total Arctic sea ice volume estimates, we can use this information to improve altimetry processing routines, reduce uncertainty assessments for freeboard retrievals, and thus increase the accuracy of derived ice thickness information.

2642
Dual Frequency Airborne Radar Measurement for Potential Estimates of Snow Depth

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Snow on sea ice is difficult to measure from space. As snow introduces one of the largest uncertainties in the error budget of the sea ice freeboard to thickness conversion, it is important to find a solution to obtain reliable Arctic wide snow depths. The ESA CryoSat-2 validation experiment (CryoVEx) 2016 airborne fall campaign was the first to fly combined Ka- and Ku-band radars on the same platform. Where the CryoVEx 2016 fall campaign was dedicated to the Greenland Ice Sheet a campaign in the spring 2017 was covering sea ice in different regions representing different sea ice types. The airborne instruments are the ESA Ku-band radar altimeter (ASIRAS), MetaSensing Ka-band radar altimeter (KAREN), together near-infrared Airborne Laser Scanner (ALS). Even though some studies has indicated that ASIRAS reflects from the air-snow surface and do not penetrate down to the snow-ice surface, as typically assumed by Ku-band radars in dry cold snow conditions, the waveform turns out to be more complex, and often show dual peaked waveforms, potentially reflecting from the air-snow and snow-ice surface. The Ka-band radar is expected to reflect from the air-snow surface. Both radars are tied together with the ALS observations of the air-snow surface. Here we present an analysis of waveforms from the Ka/Ku-band airborne radars in different sea ice regions, to investigate the potential for estimating snow depths in support of future dual-frequency satellite missions.

AC-6_AC-7a - Across the Southern Ocean: Atmospheric and ice mass changes & Seeing the Future: Predicting Variability and Change of the Polar Climate and Environment
23.06.2018 11:00-12:30, C Sanada I

556
Significant Mass Loss Recorded for Bahía del Diablo Glacier, Antarctic Peninsula

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During 2015 and 2016 austral winters a lack of precipitation was observed in the north-eastern Antarctic Peninsula compared to previous years. This condition led to very negative mass balances in both glaciological years for Bahía del Diablo glacier.
After 6 years of positive or near zero mass balances, -380 mm w. eq. (2016/17) and -605 mm w. eq. (2015/16) were determined, being the latter the highest loss registered for the whole series. Annual precipitation of ~100 mm water equivalent at sea level and ~300 mm water equivalent at 650 m a.s.l. were recorded for this both periods, which are both less than the mean for the previous 12 years of ~290 mm and ~510 mm respectively. The mass balance for Bahía del Diablo glacier has a very high negative correlation with the mean summer air temperature (MSAT) recorded by an automatic weather station nearby the glacier. During 2016 and 2017 summers the recorded values for MSAT were not between the warmest of the series and were not warm enough to be the main driver for the negative mass balances. Only the lack of precipitation was the main factor that led to the very low mass balance recorded.

667
Geodetic Mass Balances from InSAR-remote Sensing for Fuego-patagonia

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We provide an overview of the development of glaciated area in the region from 45° to 56°S in South America over the last decade. With Cordillera Darwin, Gran Campo Nevado and the two Patagonia Ice Fields the region includes the major ice masses of the southern hemisphere outside the large polar ice sheets. Many of its glaciers are reported to retreat by large rates and contribute to sea level rise, however, mass balance measurements are sparse. We provide geodetic glacier mass balance measurements using InSAR products from the missions TanDEM-X and SRTM. Our database comprises digital elevation models from 2000 and 2011-2016 from which we derive surface elevation changes and convert results to mass changes. Our analysis provides glacier specific changes and hence leads to a better interpretation of on-going processes evoking the observed changes. Consistent methods also enable comparability of specific mass loss rates of the different sub-regions.

843
Sediment Records of Climate Variability from the Subantarctic Auckland Islands

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The Southern Hemisphere westerly winds (SHWW) are a fundamental component of global oceanic and atmospheric circulation, and play a primary role in regulating CO_2 flux in the mid to high southern latitudes. Situated within the core of the SHWW, and with multiple protected fjord sub-basins, deep lakes, and peatlands, the New Zealand subantarctic Auckland Islands (50°S) are uniquely positioned for the development of high-resolution records of ocean and atmospheric change. We will present a record of SHWW variability using fjord sediment cores, supported by records from peatlands and lake cores, to create a multi-proxy and multi-site reconstruction of past climate change associated with the SHWW. Modern process and paleoclimate studies suggest that in lacustrine and fjord settings, mixing of the water column, and precipitation-driven erosion within catchments is linked to an increase in SHWW strength over the Auckland Islands. Between 13 and 9 ka, an overall increase in redox-sensitive elements in the fjord sediment cores and elevated n-alkane δD values from peatlands signal a combination of reduced SHWW strength and warmer atmospheric temperatures. Since 5.5 ka, we interpret declining n-alkane δD values to indicate enhanced SHWW flow. We will discuss these results within the context of other SHWW paleoclimate records including terrestrial records developed from southern South America and the South Island of New Zealand in order to evaluate SHWW change across the Pacfic basin.

1253
Multi Temporal Mass Balance of the NPI (1975-2016) & Links with Regional Climate

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The northern Patagonian Icefield (NPI) is the second largest ice mass in Patagonia (3740 km²). Several estimates of recent volume changes confirm an acceleration of ice loss in the last decades compared to the long term loss since the Little Ice Age. However, glacier-climate relationships are still poorly understood and the drivers of the accelerated mass wastage are still unclear. We will compare five digital elevation models of the Northern Patagonian Icefield (NPI) generated from the Shuttle Radar Topography Mission in 2000, SPOT5-HRS sensor for 2005 and 2012, SPOT6 and SPOT7 stereo-imagery for 2016, and earlier Chilean cartography for 1975, to assess multi-temporal mass balance changes of the 38 largest NPI glaciers. We will then analyze the glacier volume changes over these sub-periods together with climate trends observed from nearby stations and downscaled regional climate models. We will also compare the observed glacier changes with recent variations in the Antarctic Oscillation (AO) and the Pacific Decadal Oscillation (IPO), known to have an important role in modulating climate in Patagonia. Our study will improve our understanding of the climatic causes behind the recent glacier wastage in this region using up-to-date estimates of ice mass loss at the NPI.

1330
Patagonian Surface Mass Balance Sensitivity to Regional Climatic Changes

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Patagonian icefields are the largest ice-covered regions in the Southern Hemisphere after Antarctica. They are under the influence of the westerlies coming from the southern Pacific Ocean. Estimations of total mass balance from different sources show the acceleration of mass losses over the last decades compared to the mean value since the Little Ice Age. In the global climate changes context, the causes of this accelerated waste are generally related to regional warming although there is still uncertainty in temperature and precipitation trends in Patagonia. Indeed, in this zone, the equilibrium line altitude (ELA) is located at an altitude that correspond to vast and flat plateaus. This characteristic makes the icefields surface mass balance (SMB) particularly sensitive to small shifts in the ELA. Here, we estimate the Patagonian Icefields SMB using the regional circulation model MAR forced with the Era-Interim reanalysis for the period 1979-2012. MAR is coupled with the surface model SISVAT that includes a snow surface module. We analyze the sensitivity of the SMB to atmospheric variables to assess the causes of glacier wastage. Particularly, we analyze the impact of temperature and moisture changes on the final SMB.

1707
The Signature of Atmospheric Circulation Patterns in Antarctic Precipitation

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We analyse the relationships between large-scale patterns of Southern Hemisphere climate variability and the detailed spatial structure of Antarctic precipitation. Linkages between the high spatial resolution (27 km) daily precipitation from the RACMO2 regional atmospheric model and four patterns of large-scale Southern Hemisphere climate variability are examined: these are the southern baroclinic annular mode (BAM), the southern annular mode (SAM), and the two Pacific-South American (PSA) teleconnection patterns. We find that variations in all four patterns influence the spatial configuration of precipitation across Antarctica, consistent with their signatures in high-latitude meridional moisture fluxes. They impact not only the mean but also the incidence of extreme precipitation events. In addition, seasonal trends in some of the circulation patterns have contributed significantly to precipitation trends in areas of the continent: for example, the SAM on the opposing wetting and drying trends on the western and eastern sides of the Antarctic Peninsula. Although current coupled-climate models are able to reproduce all four patterns of atmospheric variability, they often struggle to correctly replicate their regional impacts on Antarctic climate. Thus, linking these patterns directly to Antarctic precipitation variability may allow a better estimate of future changes in precipitation than using model output alone.

983
Atmospheric Response to Marginal-ice-Zone Drag Parameterisation

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A physically-based parameterization of atmospheric surface drag over the marginal-ice-zone (MIZ) has recently been validated and tuned based on a large set of observations of surface stress from the Barents Sea and Fram Strait. This parameterization has now been implemented in the Met Office Unified Model (MetUM) and is available for both weather and climate applications. Here we present model simulations of a collection of cold-air outbreak cases in the vicinity of the MIZ from the 'ACCACIA' field campaign, and for a standard global model test suite of cases. Our focus is on the response of the atmosphere to changes in surface drag. The new parameterization has a significant impact on simulated boundary layer conditions; for example changing temperatures by 2-3 K. Comparisons with aircraft observations over and downwind of the MIZ show that simulations with the new sea-ice drag scheme generally have the lowest bias and lowest root-mean-square errors. Notably the wind speed and temperature biases are reduced to less than 0.1 m s^{-1} and 0.1 K respectively. The atmospheric response is relatively widespread - impacting most of the Arctic and Antarctic sea-ice areas - with the largest changes in the vicinity of the MIZ and affecting the entire atmospheric boundary layer.

1736
Wind Stress Forcing in the Arctic and North Atlantic Oceans

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One of the key processes responsible for driving the circulation of ocean waters is the wind stress. This important air-sea interaction stands for the imparting of atmospheric momentum to the ocean. The prevailing wind patterns largely influence the velocity in the top Ekman layer in the ocean, sustaining the observed system of surface currents. Given the internal variability of the wind climate, these surface currents are subject to anomalies in space and time that can have large scale effects on oceanic processes.
This is particularly true in the Arctic and the subpolar North Atlantic oceans that play a key role in the global ocean circulation, and are influenced by variations of wind stress forcing associated with large scale atmospheric modes in these regions.
In this study we examine the sensitivity of surface currents, ice cover, freshwater and heat content in these ocean basins to wind stress forcing through numerical experiments. The tool for this is the Modini-system, a partial coupling technique that allows flexible experiments with prescribed wind stress fields for the ocean in the otherwise fully coupled Earth System Model of the Max Planck Institute. In this work we present our results investigating the role of wind stress forcing in shaping the distribution and exchanges of state variables in and between the Arctic and North Atlantic oceans by comparing our model results using external wind stress forcing with the Modini-system, and fully coupled runs.

299
The Potential Impact of Polar Lows on the North Atlantic Ocean

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Polar lows (PLs) are intense mesoscale cyclones (diameter of 200-600 km) that form at high latitudes during winter. Their wind speeds (above 15 $m.s^{-1}$) can substantially impact on and offshore activities. A previous ocean model study, where 238 PLs/month were parameterized in the surface forcing over the north-east Atlantic Ocean, indicated that the wind speeds and heat fluxes associated with PLs may have a strong impact on deep-water formation in the Nordic Seas and increase the Atlantic Meridional Overturning Circulation. To explicitly investigate this possible link, we use the 98-year high-resolution simulations (present day forcings) from the MetOffice HadGEM3-GC2 coupled climate model (horizontal resolution of 25 km in the atmosphere and 0.25° in the ocean). We first track and identify PLs in the model over the Nordic Seas. HadGEM-GC2 shows a similar representation of PLs compared to observations and reanalyses, with a mean of 2.75 PLs/month compared to 2.25 PLs/month from the CFSR reanalysis and with no obvious inter-annual or seasonal pattern or trend. A clear link is found between PLs and surface heat fluxes: the higher the PL numbers the higher the heat fluxes. However, this relationship is too weak (mean increase of +15 $W.m^{-2}$ for high PL numbers years) to impact the ocean circulation. Subsequently, almost no correlation occurs between PL numbers and the ocean density, suggesting that the previously hypothesized mechanism is not found in HadGEM3-GC2.

1190
Recent Regional Variabilities Reflected in Kongsfjorden: An IndARC Perspective

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The time series IndARC multisensor subsurface mooring data from July 2014 to July 2017 and the summer-fall CTD profiles collected in a biweekly interval at Kongsfjorden (an open fjord on the north-west coast of Spitsbergen in the Svalbard archipelago with its mouth located at 79 °N and 11 °E exhibiting a sub Arctic nature) had been analyzed along with the atmospheric observations, reanalysis, model and remote sensing datasets to delineate the regional variabilities captured and to understand the dynamics. The temperature, salinity, dissolved oxygen; photosynthetically active radiation, fluorescence; turbidity and nitrate were recorded at an hourly interval while the currents at half an hour interval at defined depths below 20 meters in the mooring line. The interannual as well as intraseasonal atmospheric-fjord processes, Atlantic water intrusions, glacial melt and the interactions during the observational period had been studied in detail. Besides the prominent intraseasonal variability on a biweekly scale that was found driven by the local winds, the physical and biochemical processes showed a strong coupling even at higher frequencies as evident from the high resolution data. The present study could be considered as substantiation that showed that the regional variabilities were quite well captured in the fjord system which makes it a hotspot to conduct the climate scale regional studies.

2670
Drivers of Atmospheric Warming and Melt in Larsen C Ice Shelf Inlets

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Foehn winds generated by westerly flow across the Antarctic Peninsula have a dominant influence on the climate and surface energy balance over Larsen C Ice Shelf. Satellite observations have shown that the greatest annual ice shelf melt is found in inlets prone to the strongest foehn winds (foehn jets). However, this pattern is not reproduced in single-case numerical model experiments.

High resolution Met Office Unified Model experiments have been conducted covering two recent 6-month periods; the melt seasons of 2014-15 and 15-16. The model output is validated against new observations from an automatic weather station located in one of the major inlets. The combination of ideally-located surface observations and the extended-period simulations afford the first comprehensive characterisation of air-ice interactions in Larsen inlets.

The range of conditions - both foehn and non-foehn - responsible for leeside warming and inlet ice melt are evaluated. The variability in surface fluxes in the immediate lee of the Peninsula is examined, with links drawn to the orographically forced flow dynamics; in particular the jet/wake foehn structure. The net energy available for melt is revealed to be governed by the two large and opposite-signed surface turbulent heat fluxes (downward sensible and upward latent), the balance of which varies diurnally and spatially. Successful prediction of leeside melt is contingent on the model's ability to correctly reproduce this delicate balance.

1440
Surprising Atmosphere-ice-Ocean Feedback Response to Drake Passage Closure

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The response of the climate system to Drake Passage (DP) closure is examined using a coupled ocean-atmosphere-ice model. Upon DP closure the initial response is consistent with previous ocean-only studies, with an invigoration of Antarctic overturning and a collapse of North Atlantic Deep Water (NADW) production. This results in a dominance of southward heat transport and Antarctic sinking when DP is closed. However, within just a decade, the increased southward heat transport has melted back much of Antarctic sea-ice and weakened the subpolar westerlies. These effects, not captured in models without ice-atmosphere feedbacks, combine to force Antarctic Bottom Water to warm and freshen, to the point that this water mass becomes less dense than NADW. This leads to a contraction of Antarctic overturning, allowing NADW to ventilate the deep ocean once more. Poleward heat transport also settles back to values very similar to the unperturbed DP open case. Yet remarkably the equilibrium climate retains a strong Southern Hemisphere warming. Here it is ocean-atmosphere-ice feedbacks, particularly the sea-ice albedo feedback, not southern sinking, that maintain the warm polar oceans when DP is closed. We further find that DP closure leads to warming that is sufficient to inhibit ice sheet growth over West Antarctica. This highlights the importance of the DP gap, Antarctic sea-ice and the associated ice-albedo feedback in maintaining the present-day glacial state over Antarctica.

GG-1e - Magmatic, tectonic, and geodynamic investigations of the Polar Regions
23.06.2018 14:00-15:30, C Aspen

1934
The Magmatic Evolution of the Antarctic Peninsula Crustal Block

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The interpretation of the Eastern Palmer Land Shear Zone as a suture between an autochthonous gondwanan block with an allochthonous arc that collided at ca. 105 Ma, (Vaughan and Storey, 2000) contradicts the former interpretation that the arc products of the Antarctic Peninsula were an in-situ record of the 'Andean' subduction during the Mesozoic and part of the Cenozoic (Suarez, 1976). In the last two decades it has been published new dataset that have argued against the consistency of the 'accretionary model' (e.g. Burton-Johnson and Riley, 2015). However, a dense framework of data is required to tackle such a regional-scale problematic.

We present a new dataset of geochronology, isotopic tracing and geochemical studies of the Antarctic Peninsula Batholith and the Antarctic Peninsula Volcanic Group; in localities that are spread over 1000 km. We have collected over 100 U-Pb zircon ages, 40 Ar/Ar ages in groundmass and biotite, which are combined with isotopic tracing of Sr-Nd-Pb in whole-rock and Hf in zircons. These results are also compared with the previous works conducted in the region.

Burton-Johnson and Riley. Journal of the Geological Society. 172 (6), 822-835.

Suarez. 1976. Geology. 4, 211-214.

Vaughan and Storey. 2000. Journal of the Geological Society. 157, 1243-1256.

2016

South Georgia Island Current Tectonic Setting from GPS and Marine Seismic Data

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The South Georgia microcontinent (SGM) is an allochthonous block from south-east Tierra del Fuego that has been transported over the past 80-100 My as part of Scotia Plate (SP) development. While its trajectory is poorly constrained, SGM is now located on the east end of the North Scotia Ridge (NSR) approximately 1600 km east of its original position. West of SGM, NSR forms the South America plate (SAP) - SP boundary. Based on Scotia Arc bathymetric morphology and geological history, SGM has been considered part of the SP, with the plate boundary along its northern side. SGM seismic activity, while very low, is concentrated along its southern border and interpreted, based on a few small thrust mechanisms, to represent underthrusting and uplift of South Georgia Island on an NSR restraining bend on the north-eastern margin of SGM. More recently, also based on this seismicity, the plate boundary has been placed on SGM's south side, suggesting SGM has, or is being, transferred to SAP. We report on marine seismic reflection surveys north and south of the island, and results from a 4 station continuous GPS network on the island, to determine the block's current tectonic affinity with respect to the SAP and SP, and examine SGM for internal deformation. We will present preliminary geodetic results, based on 3 years of continuous GPS data indicating SGM motion and deformation, and multi-channel seismic reflection profiles across the margins of SGM showing indications of compression.

2369

Mantle Anisotropy in Tierra del Fuego from MT Data: Scotia Arc Development

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The Scotia Arc was formed by the eastwards migration and dispersion of the continental fragments that connected South America and the Antarctic Peninsula. In this process the Drake Passage constituted a narrow gateway that facilitates the eastward flow of the mantle from the Pacific towards the Atlantic. Tierra del Fuego, northwards of Drake Passage, is a key area to study the effect in the upper mantle of this major tectonic event. 18 long period magnetotelluric sites were recorded along 2 profiles using LEMI-417 stations the 3 magnetic and 2 telluric field components in the frequency range of 4 Hz to investigate the deep crustal and upper mantle conductivity. Standard robust processing was performed yielding high quality transfer functions. The interpretation of phase tensor invariants and tipper vectors was undertaken by 3D anisotropic modeling using the Frankfurt group software based on Comsol Multiphysics 5.2™. GEBCO database was considered to take into account the effect of surrounding seawater. A main NW-SE oriented anisotropy is determined in the upper mantle. This anisotropy may be consequence of former mantle anisotropies parallel to the Andes Cordillera rotated during the development of the northern branch of the Scotia Arc. However, the most suitable interpretation suggests that this remarkable anisotropy may be related to the eastwards mantle flow across the Drake Passage during the development of the Scotia Arc.

2379

Magnetic Anomalies in Ona Basin: Early Seafloor Spreading in Drake Passage

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Opening of the Drake Passage and Scotia Sea since the Eocene/Early Oligocene constitutes one of the most relevant tectonic events that determined the instauration of the Antartic Circumpolar Current. Ona Basin, in the southwestern Scotia Sea, included two sectors of NW-SE linear magnetic anomalies that evidence the early stages of oceanic spreading. The western sector, near the corner of Shackleton Fracture Zone, included 3 sequences of N120^{0}E trending linear anomalies characterized by amplitudes from 80 to 170 nT and 15-30 km wavelengths. They are interrupted by two orthogonal fractures zones. The best fitting of measured and theoretical profiles suggest a correspondence with A9-A16. Spreading process started near the time of chron C16n.1r (35.892-36.051 my) and ceased in time of chron C9r (27.439-27.859 my). Average spreading velocity is about 0.8 cm/ yr. Moreover, in the eastern Ona Basin, bounded by the Terror Rise, N130^{0}E linear magnetic anomalies of 50-100 nT amplitudes and 20-50 km wavelength, affected by one transform fault, are possible related to anomalies A18-A20. Spreading process started near the time of chron C20n (42.301-43.432 my) and ceased in time of chron C18n.1r (39.627-39.698 my). Average spreading velocity is no more than 1.7 cm/ yr. These sets of anomalies are oblique to more recent NE-SW linear anomalies related to the younger spreading of the West Scotia Ridge.

892
The Characteristic of Geophysical Fields around the Prydz Bay, Antarctica

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During 2011~2017, geophysical survey was curried out around Prydz Bay under the project of Chinese National Antarctica Research Expedition. More than 30000km marine gravity data, as well as magnetic data, has been collected by R/V XUELONG. In addition, 5 sites of OBS data has been obtained. The characteristic of gravity and magnetic fields, the thickness and anisotropy of crust can be discussed.

448
Seafloor Spreading Process in the Cosmonauts Sea, off East Antarctica

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The Cosmonauts Sea in the western Enderby Basin, off East Antarctica, had been formed as a result of opening between Antarctica and Sri Lanka/India/Madagascar. The seafloor spreading history of this region is still poorly understood because of sparse marine geophysical data. No obvious magnetic anomaly lineations are observed in a Japanese/German aero geophysical survey of the N-S observation lines, and this area is considered to be created by seafloor spreading during the Cretaceous Normal Superchron. We carried out systematic vector geomagnetic survey including the SE-NW oriented four track lines in the Cosmonauts Sea using the Japanese icebreaker Shirase during the 54th Japanese Antarctic Research Expedition (JARE). We analyzed these data combined with previous data obtained in other JARE cruises.
The isochrons M10N-M3n with the almost NW-SE spreading direction were newly identified with several small segments in the south of the Cosmonauts Sea. The wide-spreading continental ocean transition zone was inferred by the magnetic boundary strikes, as well as satellite gravity data. The transition of seafloor spreading direction was observed at 65°S seafloor, which likely formed during chron M3n-M0r. It suggests that NNE-SSW oriented seafloor spreading started since the chron M0 in the north of the Cosmonauts Sea. We will show clear magnetic anomalies related seafloor spreading in the Cosmonaut Sea and present initial breakup process between Sri Lanka/India and Antarctica.

1173
What Polar Data Do you Need, and how Would you Like to Access and Use Them?

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Using examples from Canada's polar research and data community and the Polar Data Catalogue, this presentation will highlight a selection of users' evolving expectations regarding polar data and some of the challenges to making curated data collections truly accessible and usable. We will describe issues with providing efficient access to datasets resulting from disparate collection and recording methods, designing a friendly user interface for both novice and advanced users, providing streamlined access to complex datasets containing Terabytes of files, protecting sensitive data, and other examples. We will provide an opportunity for direct feedback from the audience on functions and interfaces which serve the needs of the polar research community and other targeted users.
The Polar Data Catalogue (PDC, https://polardata.ca) is one of Canada's primary online sources for data and information about the Arctic and Antarctica. With over 2,500 metadata descriptions of projects and datasets and almost 3 million data files, the PDC contains data on physical, social, and health science and other research in Canada and globally, including significant collections from the ArcticNet Network of Centres of Excellence, the International Polar Year, satellite imagery from the RADARSAT-1 and RADARSAT-2 missions, and hundreds of metadata from the Circumpolar Biodiversity Monitoring Programme. The PDC is a member of the World Data System and is Canada's National Antarctic Data Centre.

1344

Mapping Information Landscape in the Context of Disaster Diplomacy in the Arctic

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Disaster resilience is a common interest and goal throughout the Arctic region. Building resilience foremost requires a thorough understanding of the physical and social processes behind the key components of disasters - hazards, risks, and vulnerability. This requires collaborations among disaster experts, including practitioners, natural and social scientists, and local knowledge holders. Expert collaborations across the Arctic nations significantly expand the data and knowledge pools. Disaster diplomacy encourages and facilitates such collaborations. To inform decision-making, produced data needs to be readily available to the policymakers in a useable to them format. By developing a disaster-relevant information e-cosystem model we were able to map relevant information flow and identify gaps in it. The ecosystem metaphor allowed us to identify key data sources (e.g. scientific projects and data centers) and information users (e.g. policymakers, emergency managers, and communities at risk) in the field of Arctic disasters, and map the flow of information between them. The corpus analyzed as a foundation for the model included assessments and reports published by the working groups of the Arctic Council - an intergovernmental forum that promotes cooperation among the Arctic States and indigenous communities on issues of sustainable development. Lessons learned from this analysis will be beneficial to other pan-Arctic collaborations that depended on data sharing.

1240
Data Management for Model Output: What Are the Issues?

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Procedures around data deposition and access for observational data that relate to marine and Antarctic environments are now fairly well established. However, despite an increasing expectation that model output will be generally available as part of publication of scientific research, the corresponding procedures relating to model output are yet to be clearly defined. Data repositories allow for permanent storage and curation of data/model output while also encouraging increased re-use by the general community. This is beneficial for observations, which are bound to a fixed time and place, but how well does this system work for model output?

In this presentation, we will discuss a number of scenarios involving the cataloguing of model output. Specific issues raised include

· Ensuring model currency: what happens to my output when I update my model?

· Does model output have a half-life?

· My model is global, but my study is regional. Should model output outside of the original study region be archived?

· Models are a representation of a system, based on certain assumptions, defined to answer specific questions. What are my responsibilities to ensure future users understand these restrictions upon the output?

· Model output or modelling environment? When should I archive just the output, and when is a code repository or virtual machine the better choice?

2230

Developing an Environmental Data Portal: Characteristics and Design Principles

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The Swiss Federal Research Institute WSL is developing EnviDat, an overarching environmental data portal for facilitating the management, search and access to its rich data reservoir. EnviDat is designed to publish, connect and search existing data, while data curation and quality control remain with the experts. The current EnviDat Beta version provides access to several polar data sets such as the high resolution sea ice surface topography from the SIPEX-2 expedition, East Antarctica, 2012 (www.envidat.ch/dataset/10-16904-9). More polar and high-altitude research data will be incorporated into EnviDat, including the Greenland Climate Network (GC-Net).

The EnviDat design principles focus on usability and user-friendliness, with easy search and find, availability of relevant data filters, and ideally one click access to the data source. The portal´s functional requirements include metadata and map search, the publishing of datasets with DOIs, and the provision of a data repository. Non-functional requirements such as reliability, security and maintainability are taken into account through a multi-server architecture. Moreover, the interoperability with the wider data management community is achieved by leveraging community software such as CKAN and by adopting best practices in data sharing. Based on the above characteristics and design principles, EnviDat represents an important WSL initiative dedicated to addressing the challenges related to data sharing with the community.

1143
CASEarth Poles: A Big Earth Data Platform for Three Poles

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Unprecedented changes on climate and environment have been observed in the three poles, including Arctica, Antarctica and the Tibetan plateau (the so-called Third Pole). The three poles are relatively data-scarce regions due to the data accessibility and hard living environment though numerous earth observation data have been collected. And consequences of these changes on global environment and human being remain poorly known. To address these challenges, there is an urgent need for better data acquisition, integration, curation, and service, and use these data to better support fundamental scientific research and sustainable development for the three poles.

The CASEarth Poles, a project within the framework of “Big Earth Data Science and Engineering” program of Chinese Academy of Sciences, aims to construct a comprehensive big data platform of the three poles. This project will devote to: (1) breaking the bottleneck of polar data integration, curation, and sharing, (2) developing high resolution remote sensing products over the three poles, (3) generating atmospheric reanalysis datasets for polar regions, (4) exploring synchronization, asynchronization, and teleconnection of environmental changes in the three poles, (5) investigating the dynamics of climate, water cycle, and ecosystem, and interactions among multi-spheres in polar regions and their effects globally, (6) supporting the decision-making on sea ice forecast, polar development and governance.

1625

Southern Ocean Data Sharing Tools in a Global Data Management Community

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The Southern Ocean Observing System (SOOS) bridges many divides - among communities, scientific disciplines, National Antarctic Programs, logistics personnel, and scientists. Each of these groups has a history of data sharing through online systems that have been built up to meet their needs through decades of negotiation and effort. Data management for this disparate community must build on the existing data sharing infrastructure and behavioral norms of its constituent groups.

To support the SOOS 20-year vision, the SOOS Data Management Sub-Committee is tasked with developing an integrated data management system to collect the marine observing datasets from around Antarctica, document them, make them discoverable, accessible,and compile them into composite datasets that can be fed into circumpolar models. This is a task that is well beyond the capacity of any small group of data managers to implement and one that can only be fulfilled by working within a global ecosystem of data integration efforts.

In this presentation, we will describe the new tools that SOOS has developed to date and the community relationships through which we hope to accomplish this vision.

39

Diseases Threatening Polar Seabirds: From Immuno-ecology to Conservation

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Infectious diseases are a relatively neglected but potentially important threat to wild populations, especially in polar areas where global changes may facilitate the introduction of new parasites. In addition, the life histories of seabirds, combining long lifespan and high site fidelity, raises the possibility that their immune system may have evolved special features to protect them against potential recurrent exposure to parasites at the breeding site. This is notably the case for species breeding in dense aggregations which can be subject to recurrent epizootics, as observed in Arctic and Subantarctic populations of seabirds hit by avian cholera. In this context, we combined observational and experimental data to undertake basic immune-ecological investigations that led us to some original findings with potential implications for conservation. Our results, obtained in collaboration with several groups of biologists in Arctic and Subantarctic, particularly highlight the dynamics of Lyme disease *Borrelia* in Arctic and Antarctic seabird colonies and of avian cholera in an albatross colony. They also stress that the persistence of maternally inherited immunity varies between seabird species, being especially long in Procellariiforms. These results thus open some promising venue for the use of vaccination in the wild in some critical situations.

2154
From "-omics" to Behavior of Reproduction in a Top Antarctic Predator

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From 2010-2017, we used a suite of molecular, physiological, and behavioral tools to study factors influencing reproduction in adult female Weddell seals (*Leptonychotes weddellii*; n=291) in Erebus Bay, Antarctica. Metabolomics approaches were used to determine biochemical pathways critical to establishing a successful pregnancy, and were paired with early pregnancy diagnosis via ultrasound (embryos ≥3mm diameter). Pregnancy rates were high (82%), yet Weddell seals are known to have low birth rates (65%) relative to other pinnipeds. Energy balance in late gestation is likely important to carrying the embryo to term. Indeed, constructed embryo growth curves revealed that Weddell seals have a protracted placental gestation (~10.5 months), which would spread the energetic costs of pregnancy over a longer timeframe. Remarkably, neither mass nor body condition influenced the probability of embryo loss or pupping. However, increased foraging effort (dive duration, depth, exceeding aerobic capacities) across gestation influenced the probability of pupping the next year. Despite intense foraging, Weddell seals exhibited low rates of energy acquisition, gaining only 15% of the mass and lipid stores typically acquired by other phocid seal species during gestation. In combination, this integrative approach suggests that the Weddell seal's life history has been shaped by energetic constraints, and may also make this top predator particularly vulnerable to environmental perturbations.

2049
Detecting and Mitigating Health Threats to Muskoxen in a Changing Arctic

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Rapid climate change in the arctic is posing increasing threats to wildlife health and sustainability, and by extension, the health and socio-economic well-being of northern communities. During the past decade, muskoxen, which are integral to the culture, food system and economy of communities in many parts of the Arctic, are experiencing widespread disease, mortality, and regional population declines. This has resulted in significant concerns about muskox health and sustainability as well as the food safety and security for local people. We are using a combination of scientific, traditional, and local knowledge to evaluate and monitor the health and vulnerability of muskoxen in a rapidly changing Arctic. Specifically, we are
(i) determining the current health status of muskoxen in parts of the Inuvialuit and Kitikmeot regions, Canada,
(ii) investigating the ecology and drivers of three emerging parasitic, bacterial, and viral diseases,
(iii) developing indicators of health to incorporate into muskox monitoring programs.
Our goal is to establish and implement an integrative and responsive muskox health surveillance system that can pro-actively inform wildlife management, public health, and land-use policy. Tools, techniques, and programs developed will lead to improved technical and human resources for health monitoring not only of muskoxen, but other arctic wildlife, and will contribute to conservation and improved food safety and security across the North.

52

Plasticity of Female Humpback Whale Fertility to Variable Nutritional Condition

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The southern hemisphere humpback whale (HW), *Megaptera novaenangliae*, have evolved to optimise energy intake and expenditure by breeding at equatorial latitudes in winter, and feeding on Antarctic krill in summer. During their migration journey, pregnant HW give birth and nurse a single calf, only relying on their previously accumulated fat. The recording of HW vocalisation in Antarctica, and an observation of a 2.4 male to female gender ratio among migrating individuals has led to the hypothesis that not all females engage in the migration annually. As the mating also takes place during the migration, it is plausible that a number of females would not participate back out of the migration and incorporate one or more years of rest between pregnancies to replenish their energy reserves. Accordingly, the female inter-calving period may vary as a function of summer feeding conditions.

This work combines blubber steroid hormonal profiles with histological measurements of the adipocytes of 36 free-roaming, migrating female HW to test the expectation that the individual's reproductive state and nutritional condition correlate. Reproductive state is assessed by liquid chromatography tandem mass spectrometry (LC-MS/MS) measurement of testosterone, androstenedione and progesterone from remotely collected biopsies. This work contributes new knowledge regarding HW reproductive habits, and provides insight into the resilience of female fertility to years of variable krill availability.

2046
Factors Determining the Gastrointestinal Microbiota in Chinstrap Penguin Chicks

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The gastrointestinal microbiota is composed by a complex community which depends of different factors, external/ internal and environmental/genetics. We carried out a cross-fostering experiment in nesting chinstrap penguins. In experimental nests one of the chicks was exchanged at seven days old with a chick from another nest with the same hatching date. In control nests, chicks were briefly removed and put back in the nest again. After twenty days we collected cloacal samples of adults and chicks and carried out sequencing of the V1-V3 region of the 16S rDNA by Illumina. We did not find any effect of chick manipulation in bacteria diversity as no differences were found between experimental and control chicks. We found differences in bacteria diversity between adults and biological chicks but not with adopted chicks. We did not find significant relationships of bacteria diversity between chicks reared in the same nest but from different parents and either between siblings reared in different nests. Moreover, we did not find significant relationships between parents and the biological chicks or the adopted chicks. This suggests that chick bacteria diversity is not dependent of the parents or external factors and should be dependent of chick intrinsic factors.

485

Range Expansion of Protostrongylid Nematodes in Response to Arctic Warming

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Protostrongylids, *Umingmakstrongylus pallikuukensis* (UP) and *Varestrongylus eleguneniensis* (VE), are pathogenic parasites of northern ungulates. These parasites are of interest not only because of their possible impacts on their hosts but also because their recent and rapid northern range expansion associated with Arctic warming provides a model system for understanding the impacts of climate change on parasitic nematodes in general. We aimed to

i). determine the diversity and distribution of protostrongylids in muskoxen and caribou in the Canadian Arctic, and

ii). assess climate warming as a potential driver for their range expansion.

We performed widespread fecal surveys across the Canadian Arctic from 2013-2017; conducted lab experiments on the thermal sensitivities of UP and VE, and modelled the suitable habitat for these parasites using the field, laboratory data, with satellite-derived climate data from historical to future period. We found that protostrongylid diversity in muskoxen and caribou varies geographically. On Victoria Island, UP and VE are expanding rapidly northwards, but at differential rates. UP is expanding faster over a broader geographical range. Predictive habitat modelling using the parasite's physiological data and the Arctic climate data shows a significant expansion of suitable habitat for both the lungworms, but greater for UP. Similarly, models predict the possibility of a future invasion of other Arctic islands currently free of lungworms.

2254
Monitoring Genetic Adaptation in Humans Using Ingenuity Pathway Analyses (IPA®)

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Adaptation to changing environments has been critical to survive. A hallmark of adaptive responses to environmental pressure is genetic regulation. Antarctica is providing a unique, space-analogue environment to investigate such adaption. The CHOICE study took place in 2 overwintering crews at the Antarctic station Concordia (3200m) and was complemented by a simulated microgravity study in Slovenia. Here a similar sized group was exposed for 21d to 3 conditions of hypoxia and bedrest (PlanHab). Transcriptomics were performed in blood (Affymetrix Human Gene2.0ST) and analyzed through "Array Studio" (OmicSoft,NC,USA) and IPA. Comparisons of the earlier time point (3-4 wks upon arrival) to baseline revealed in both Concordia seasons prominent changes of ~790-850 genes (FC2,FDR< 0.01). The exposition to a comparable condition in an experimental setup in PLanHab under hypoxia resulted in 360 gene alterations, while combination of hypoxia+immobilization showed a much higher number of significant gene changes (~2500). Between both Concordia seasons and the PlanHab hypoxic ambulatory condition 1072 or 1182 common genes were detected. Several top canonical pathways were identified by IPA® and included immune and metabolic related pathways.
Grants & support from ESA ELIPS 3/4 programs, NASA HRP, IPEV, PNRA, AWI, BelSPO, DLR and the European Union Programme FP7 and all the wintering over Crews and volunteers (PlanHab) who supported with outstanding professionalism.

2684

Sleep during an Antarctic Winter: Summer Is the Answer

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According to the literature, sleep disturbances are worse in the Antarctic winter, the period of isolation and constant darkness (latitude dependent). This is confirmed by results on much larger samples from Arctic regions. However, there is still no consensus on the causal mechanisms, and there is a lack of investigations during the period of constant illumination.
The current project investigated sleep and its circadian regulation at the height of summer and at the height of winter in two winterover crews. To disentangle the effect of time on station and the effect of seasonality, 1 crew had the summer measurements during their second summer on station, whereas the other was measured during the first summer on station.
The results show the same sleep disturbances for both summer and winter when it was measured after 6 months on site. When summer measurements were recorded after 1 month on site, the results paint a slightly different picture: sleep onset latency is similarly disturbed, but the amount of slow wave sleep and sleep efficiency are less affected. A melatonin phase delay was present at all seasons in both groups. These results underscore that there is more to sleep in Antarctica than a disturbed photoperiodicity: the duration of time-on-station has a major effect on the psychophysiological adaptation. Overall, the present results show the need for a specific support to personnel from both summer and winter campaigns in terms of sleep and fatigue management.

2160
Extreme Epidemiology & Innovation: Australian Antarctic Health Register-1986-2018

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Antarctica is an isolated, confined and extreme environment. Australia has conducted expeditions to Antarctica since 1911, and the Australian Antarctic Division (AAD) has maintained a permanent presence in Australia´s Antarctic Territory since 1948, with three continental stations and one subantarctic station. Medical support for expeditions was initially informed with access to paper based medical logs and research reports. In 1986, the AAD developed a unique and innovative electronic health register, now called the Australian Antarctic Health Register (AAHR), to capture longitudinal epidemiology including expeditioner medical history, medical fitness, all health events and treatment, and importantly, person-years of exposure to the extreme expedition environments. This unique evidence base informs Australia´s Antarctic expedition medical and safety policy development. It is integral to medical screening, research and support. Online access from Antarctic stations via satellite enabled confidential data entry utilising ICD9 and specific Antarctic coding. In 2009, the AAHR was integrated with a program wide electronic health record for all clinical and telemedicine support. This paper highlights 30 years of experience with the AAHR and the importance of epidemiology and electronic health records in ensuring the safety and wellbeing of those travelling and living in polar and extreme environments such as Antarctica, the Arctic and those contemplating long term space missions.

1891

POWER - Physiological AdaptatiOns in Women during a North PolE exploRation

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The earth's Polar Regions offer a unique set of challenges and hazards including extreme temperatures, blizzards, difficult and changing terrain due to the shifting icepack, and disrupted circadian patterns due to the extended hours of day light. Due to the geography and remoteness of the Arctic, deep access is restricted to walking or cross-country skiing. These modes of locomotion impose a very high energy expenditure which, coupled with the extreme conditions, pose a challenge to health. The extent to which this extreme environment impacts the human body is poorly understood. Few men have been studied during Arctic explorations but no data exist for women.

The objective of this research project was to take advantage of an all-female polar expedition to examine the metabolic and physiological adaptations to extreme conditions in women skiing to the North Pole (http://www.euroarabianexpedition.com/, April 2018). Specifically, we examined changes in

1) energy needs (free-living total energy expenditure, metabolic rates and body composition),

2) biological rhythms (pattern of physical activity, sleep, body temperature and melanocortin) and

3) physiological stress (saliva cortisol).

This study shows how collaboration between scientists and explorers provides an exceptional opportunity to better understand the physiological flexibility of humans when facing extreme environmental conditions. Energetics data will be analyzed prior to the congress.

1584

Antarctic Research Enabling Space Exploration

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This presentation will address some of the most currently pressing research questions, countermeasures and training that make Antarctica an excellent space mission analog.

2390
A 30-year Analysis of Medical Evacuation Case in Korean Antarctic Station

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One of the biggest challenges facing the antarctic station is medical evacuation (Medevac) in case of unpredictable emergency. Since its establishment in 1988, Korea Antarctic King Sejong Station (62°13´S, 58°47´W) is operated by winter-over team consisting of about 17 people each year. In case of Medevac, it is transferred initially to Chilean Frei base in King George Island using a helicopter or Zodiac, and subsequently transported to the flight to Punta Arenas.

In this study, we collected 22 Medevac cases (24 people) in the past 30 years (1988-2017). It is compared with other previous studies, and also seasonal difference to Antarctic winter and summer. Orthopedic problems due to trauma had the highest proportion of the entire Medevac cases, else there were distress and frostbite, burns, tooth problems, head trauma, gastritis, tuberculosis, eye problem, decompression sickness, and malignancy work-up, etc.

Since the Medevac system in Antarctica is directly related to the member's safety issue, it is essential to prepare for specified emergencies. It could be done by case-specific scenario, guidelines, and regular training considered each Medevac steps: first aid, waiting Medevac, rapid transfer, proper treatment. Additionally, it needs to be considered along with the efforts of such pre-screening, safety education to prevent these Medevac situations in advance.

(This article is revised and updated version of the 2016 COMNAP symposium proceeding.)

CR-5c - Interactions between ice mass balance, the solid Earth, and sea-level changes
23.06.2018 14:00-15:30, A Seehorn

1336
A Programme to Understand Thwaites Glacier and its Contribution to Sea Level

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Since the 1990s, satellites have shown accelerating ice loss in the glaciers draining central West Antarctica into the Amundsen Sea. The rate of ice loss now accounts for about 10 percent of global sea-level rise. Pine Island Glacier, which has the highest rate of ice loss, was the focus of the UK-NERC iSTAR Programme and US-NSF funded projects during the past decade. Recent studies indicate that the greatest uncertainty and risk for future rapid sea-level rise now arises from Thwaites Glacier. Rapid changes are already underway and there is concern that ice sheet loss from the Thwaites Glacier basin will become irreversible, if it is not already.
The need to characterize the potential range and uncertainty in Antarctic contributions to sea-level rise on decadal to multi-century timescales was underscored by the SCAR in its "Horizon Scan 2020", and by U.S. National Academy of Sciences, Engineering, and Medicine. Building on this priority, and recognizing the high logistic and scientific demands call for an international endeavour, the US-NSF and the UK-NERC have begun a joint initiative focusing on Thwaites Glacier and the adjacent Amundsen Sea, involving ~30 UK and US institutes, and international partners. The program will improve understanding of the stability of marine ice sheets, the processes of thinning, retreat, and acceleration, and the role of oceans in driving change. It will require shipborne, aircraft, and over-snow research in the austral summers of 2018-2021.

572

A New Heat Flux Model Incorporating Variable Crustal Radiogenic Heat Production

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We present findings recently published in GRL (Burton-Johnson et al., 2017) on the variability of Antarctic sub-glacial heat flux and the impact from upper crustal geology.

Our new method reveals that the upper crust contributes up to 70% of the Antarctic Peninsula's subglacial heat flux, and that heat flux values are more variable at smaller spatial resolutions than geophysical methods can resolve. Results indicate a higher heat flux on the east and south of the Peninsula (mean 81 mWm-2) where silicic rocks predominate, than on the west and north (mean 67 mWm-2) where volcanic arc and quartzose sediments are dominant. Whilst the data supports the contribution of HPE-enriched granitic rocks to high heat flux values, sedimentary rocks can be comparable dependent on their provenance and petrography. Models of subglacial heat flux must utilize a heterogeneous upper crust with variable radioactive heat production if they are to accurately predict basal conditions of the ice sheet. Our new methodology and dataset facilitate improved numerical model simulations of ice sheet dynamics.

The most significant challenge faced remains accurate determination of crustal structure, particularly the depths of the HPE-enriched sedimentary basins and the sub-glacial geology away from exposed outcrops. Continuing research (particularly detailed geophysical interpretation) will better constrain these unknowns and the effect of upper crustal geology on the Antarctic ice sheet.

850

Combining Upper Crust and Lithosphere Contributions to Heat Flow Models

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Geothermal heat supplied to the base of Antarctic ice sheets, and the spatial variation of supplied heat, is an important input model parameter in ice sheet models. Continental models of heat flow (usually referred to in the cryosphere research community as heat flux density, abbreviated to heat flux) may be generated using seismic wavespeed tomography maps or by inference from other geophysical observables. Upper crustal models, however, are generated directly from measuring the heat production of dominant or particularly radiogenic lithologies.

In this contribution, we combine upper crust and lithosphere contributions to heat flow models with a focus on East Antarctica, including the continental interior which is covered by ice of several kilometres thickness. We review alternative approaches to combining low resolution information on the deeper lithosphere with broad spatial coverage, and high resolution information with very limited spatial coverage relating to the upper crustal. Providing effective estimates of the heat supplied by the upper crust is an important research goal due to the significance of small pockets of elevated heat flow on ice sheet models. Our model for East Antarctica represents a step towards future probabilistic approaches to solid Earth constraints for ice sheet models.

1390
The Sensitivity of GIA in West Antarctica to a Laterally Varying Earth Structure

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The one-dimensional Earth structure adopted in many glacial isostatic adjustment (GIA) models leads to bias in model predictions in regions where rheological parameters differ significantly from the 1D structure used. The advancement of 3D GIA modelling techniques in recent years has led to improvements in the representation of the Earth through the incorporation of laterally varying structure. This study investigates the influence of 3D Earth structure on deformation rates in West Antarctica using a finite element GIA model with power-law rheology, where the effective mantle viscosity depends on stress. We use a high resolution model of seismic velocity to infer temperatures and derive creep parameters from a flow law for the crust and upper mantle with the aim of determining a data-driven model of Earth rheology across Antarctica. We investigate the range of plausible mantle viscosities this model predicts, given uncertainties in the input parameters to the flow law. Furthermore, we consider the differences in model-predicted vertical deformation rates when compared to an equivalent 1D Earth structure.

1885
Utilizing GPS to Investigate Ice History and Earth Model Inputs to GIA Models

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ANET (Antarctic Network) GPS observations from the Polar Earth Observing Network (POLENET) record solid earth deformation in response to ice mass change. In the Transantarctic Mountains (TAM) region, observed horizontal motions are towards modelled West Antarctic centers of ice mass loss, opposite to the radially outward pattern expected. We investigate alternative ice history and earth structure inputs to GIA models in an attempt to reproduce observed motions in the region. The W12 ice history model is altered to include unloading in the Wilkes Subglacial Basin based on glaciological records indicating LGM ice thicknesses greater than present. These scenarios, along with the unmodified W12 ice history, are coupled with 60 radially varying (1D) earth model combinations. Additionally, the influence of laterally heterogeneous earth structure is investigated by coupling loading scenarios with earth models that permit two different viscosity profiles on either side of a longitudinal boundary bisecting East and West Antarctica. For both the 1D and laterally heterogeneous case, resulting model-predicted motions fit ANET GPS-derived crustal motions in the northern and central TAM region for a suite of earth model combinations. Further south, observed and predicted motions do not agree. Best fitting ice history and earth models are presented, including preferred upper mantle viscosity values.

687
A New Global GPS Dataset for Testing and Improving Modelled GIA Uplift Rates

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Permanent GPS stations provide a globally distributed record of long-term signatures of glacial isostatic adjustment (GIA). In this study, we use about 4000 GPS vertical velocities as an observational estimate of global GIA uplift rates, after correcting for major elastic deformation effects. A novel fully automatic strategy is developed to post-process the GPS time series and to correct for non-GIA artifacts. Before estimating vertical velocities and uncertainties, we detected outliers and jumps, and corrected for atmospheric mass loading displacements. We corrected the resulting velocities for the elastic response of the solid Earth to global changes in ice sheets and glaciers, as well as for changes in the Earth's rotational pole relative to the 20th Century average. We applied a spatial median filter to remove sites reflecting local effects and to arrive at the ~4000 GPS site velocities.
The novel global GPS dataset shows a clean GIA signal at all post-processed stations and is therefore suitable to investigate the behaviour of global GIA forward models. The dataset is compared with 13 global GIA solutions considering differences in reference frame origins. Furthermore, we use the novel dataset to update global forward model solutions within a Bayesian Hierarchical Modelling framework to identify statistically significant deviations between the observations and the models, which may be due to either uncertain mantle rheology and/or ice loading history or GPS errors.

SH-9b - Polar research in the humanities and social sciences: approaches and challenges
23.06.2018 14:00-15:30, A Wisshorn

1438
Creative Antarctica: Towards a Critical Evaluation of Residency Programs

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Interdisciplinary collaboration is crucial to addressing threats to the Antarctic region, including global warming, growing tourist numbers and marine harvesting. Currently, creative artists and non-scientific researchers can visit Antarctic bases primarily through national residency programs. Such residencies have long existed, but began to be consolidated into formal state-sponsored schemes in the late twentieth century. The structure and format of residency programs vary considerably with national context, with each emphasizing a different (and often uneasy) combination of artistic merit, promotion, communication, education and public accessibility. Given the financial investment that many states make in these residencies, it is worth critically evaluating their purpose and effectiveness. In preparation for a larger research project, this paper explores ways in which such an evaluation might be undertaken. We briefly compare several residency programs, before posing a series of questions. How does access to Antarctica impact on creative artists and the scientists they work alongside? What innovations arise from the residencies? What can we learn from other residency models, such as those in scientific institutions or wilderness environments? What do several decades of residencies teach us about the most productive options for the future? We conclude by outlining some methods we plan to use to address these questions and expected benefits for key stakeholders.

2526
Feminist Institutional Research: Challenges, Opportunities for Antarctic Science

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Scholars in Antarctic humanities and social sciences are increasingly turning to gendered histories. Thanks to scholarship in a range of disciplines, it is well understood that Antarctic activity has always been deeply gendered (eg Glasberg, Lewander, Dodds). Still, much remains to be done. In particular, we have a limited understanding of the processes through which women gained access to Antarctic field opportunities after being categorically excluded through much of the twentieth century, and we insufficiently understand how national contexts contributed to sometimes dramatic variation in women's access to the continent. Drawing on archival work and interviews dealing with the British Antarctic Survey and the US Antarctic Program, as well as existing literature on several other national Antarctic programs, this paper examines the potential of a feminist institutional framework to address current gaps. It asks: how can the tools of feminist institutionalism help us unpack the historical exclusion of women from Antarctica and the factors that contributed to progress? What trends, connections, and contingencies are revealed? What weaknesses are identified, and what lessons can be learned? It is argued that this approach offers valuable insights into several dimensions of Antarctic activity, from scientific and sociocultural to geopolitical. Inspired by Traweek and others, this paper issues a call for international discourse on Antarctica's gendered institutional histories.

2295
Collaborators, Competitors or Window Shoppers

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Collaborators, competitors or window shoppers: perception of Asian Arctic observers determined by media coverage and public commentaries

The emergence of Asian actors in the Arctic affairs is attracting attention from many stakeholders in the Arctic, ever since the 2013 Kiruna Ministerial Meeting.

As most of the region in the Arctic Circle is under sovereignty or sovereign right of the eight Arctic states, non-Arctic players generally look for invitations from the Arctic, which in turn renders their overall perception by the Arctic community a matter of significance.

This study aims to provide empirical answers to the following questions:

(a) What activities of Asian observer states, and at what time draw the attention of the eight Arctic states and become featured in Arctic media and commented by key Arctic figures?

(b) What is the attitude toward the activity in each case - positive, negative, or neutral?

(c) Can the background of the respective attitudes be determined?

From selected Arctic media, we collected and analyzed articles that cover Arctic activities of these Asian Arctic observers, since May 2013. The articles were classified by issue areas (i.e. research/education; environmental conservation; regional development; shipping/routes; resources; and strategy/military), and then sorted by the nature of the stances expressed therein. The perception conveyed by these articles did not always correspond with the public statements of the observers in question.

163
A Gap in the Antarctic humanities, and why it Should Be Filled

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Most analyses of Antarctic politics and geopolitics so far have taken a descriptive approach and presented matter-of-factly what actors there are, what goals they have, and what tensions and challenges this will bring to the Antarctic Treaty System. In this presentation, I suggest that such a descriptive approach should be complemented by a normative one, where assessments are made concerning—among other topics—the status of territorial claims and the external legitimacy of the Antarctic Treaty System. Starting from the assumption that politics is not just a matter of force and rhetoric, but also a matter of following certain basic moral principles, such a normative assessment is urgently needed in a time where global pressure over living and non-living natural resources in Antarctica will keep mounting. Its practical purpose, ultimately, should be to foster peaceful knowledge-based management and policy-making in the White Continent.

1892
Antarctica and Space as Environmental Analogues

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Antarctic stations have for decades been used as research analogues of spacecraft, especially space stations such as Skylab, *Mir*, and the International Space Station. The two environments share isolation, confinement, novelty, discomfort, danger, and remoteness. They are attractive analogues because research in space is expensive, complex, and limited in research time, facilities, and subjects. It is time to review this practice. Analogues should not merely look similar, they should have similar effects. Is this true of Antarctica and space? Data, some of them unpublished, from multi-year studies conducted in the two environments are reviewed to compare the stressful and adverse (pathogenic) and healthful, positive (salutogenic) effects of the two environments on human physiology and psychology in order to evaluate this question.

1911
Arctic Horizons and IASSA: The State and the Future of Arctic Social Sciences

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This presentation will offer an overview of the Arctic Horizons report that outlines major milestones, trends and priorities in Arctic social sciences research. The report resulted from a series of workshops with primarily US researchers devoted to identifying strengths, weaknesses, emerging science questions and funding priorities for social sciences in the Arctic. These findings are placed in the broader international context from the positions of the International Arctic Social Sciences Association (IASSA).

SY-1c - Earth Observation: Solutions for data collection, compilation and dissemination
23.06.2018 14:00-15:30, B Pischa

2401
Towards Cross-weaving of Knowledge for Better Decisions

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Arctic people observe the environment all year round. Their knowledge is critical for effective resource management. Yet, while approaches to data collection with community members have been well described, means of disseminating and using local knowledge for decision-making have received less attention. Here, we discuss lessons learned and tools developed from Greenland. Our case is the Piniakkanik Sumiiffinni Nalunaarsuineq (PISUNA) approach in Greenland. Here, in communities where there is interest, the village residents establish a Natural Resource Council comprising hunters and fishers. They decide which species and resource uses should be observed. Together, they compile data on species and resource uses during their hunting and fishing activities. Every three months, data are summarised and analysed, and possible management interventions discussed. The proposed management interventions and supporting data are forwarded to the government. The Council uses matrices that encourage self-interpretation and validation and, at the same time, they promote discussion of resource management actions. With 2-3 keystrokes, decision-makers can access trend-information and management proposals at PISUNA-net, a searchable icon-based database developed with SIZO-net and ELOKA projects. This approach combines local knowledge with digital technology, providing an opportunity for the community members' insights and knowledge to be used and their voices heard.

2177
Community-based Monitoring Networks, Data Sharing, and Earth Observation

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Community-based monitoring and observing programs exist around the Arctic, drawing on both Indigenous methods of observation, protocols developed by scientists, and combinations of the two. These programs use a variety of data collection methods, ranging from interviews to field diaries to handheld computers and digital devices. In this paper, we examine challenges and opportunities related to data collection, compilation, and dissemination for community-based monitoring programs. Community-based monitoring offers unique, in situ observational data that can contribute to management of natural resources as well to large scale observing systems. Management of CBM data requires an understanding of the context in which community members engage in both formal and informal observing, with implications for design of infrastructures and networks for data sharing. We draw on information gathered through workshops with community-based monitoring practitioners held in Alaska, Canada, and Russia, organized under the INTAROS project, and a student field trip to Svalbard, organized by INTAROS and REGIMES. Practitioners gathered at the workshops identified good practices and specific needs for establishing and sustaining CBM programs and connecting them to natural resource management and decision-making. Participants also discussed CBM in relation to broader themes such as access to resources, health of subsistence species, and unusual events.

1116
The Earth Radiation Budget Explorer (EAGER) Mission Concept

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It is widely accepted that a significant net-influx of radiative energy of about 1 Wm^{-2} to the Earth's atmosphere is mainly responsible for global warming. However, instruments and methods used to determine the global radiative energy budget at the top of the atmosphere (TOA) are so far not able to accurately resolve this small difference between the incoming and outgoing radiation. The relevant radiative components include the Total Solar Irradiance (TSI), the Spectral Solar Irradiance (SSI), the Reflected Solar Radiation (RSR) and the Earth's Infrared Emission (EIE).

The Earth Radiation Budget Explorer (EAGER) mission concept planned by PMOD/WRC together with the University of Leipzig, the Fraunhofer Institute for Physical Measurement Techniques and the Royal Observatory of Belgium aims for providing direct measurements of all four components required for detecting the energy budget imbalance with unpreceded accuracy. We present the instrumental approach and technical challenges of the EAGER mission concept consisting of two Sun and four Earth oriented instruments on an Airbus satellite platform: i) A Digital Absolute Radiometer (DARA) for measuring TSI, ii) an Extreme-UV and Infrared (EUV/IR) Spectrometer (SolACER) for measuring SSI, iii) three Bolometric Oscillation Sensors (BOS) for measuring RSR and EIE, and iv) a DARA Albedo Earth Sensor (DARA-AES) for periodically recalibrating the BOS instruments.

1617
An International Observing System for the Southern Ocean

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The Southern Ocean and its related atmo-, cryo-, geo- and bio-sphere, has a profound influence on the global Earth system. Although geographically remote, it directly impacts global societies through, for example, its role in maintaining Earth's heat and carbon budgets and storage, provision of food, and in providing intrinsic value for conservation and tourism. Moreover, the ocean-ice-atmosphere interactions will have far-reaching consequences for the globe through sea-level rise. Yet, the Southern Ocean remains one of the most under-observed regions in the world. The IPCC has identified uncertainties in estimations of future state of Southern Ocean processes, and highlighted that a sustained system for observing trends in physics, chemistry and biology is urgent for this region, to reduce those uncertainties. The Southern Ocean Observing System (SOOS) developed over the last decade to fill this urgent need. SOOS has established regional and capability working groups to coordinate the contributions of Antarctic nations in delivering a system for observing essential variables, and to provide data streams to the scientific community, stakeholders and policy-makers. SOOS also provides a hub for accessing data repositories, linking data from satellites, remote in-situ observations, and in-field activities. In this paper, we outline the vision for SOOS and, in particular, highlight new products that facilitate fieldwork planning and coordination, and data discovery and sharing.

1232
ICEBERG: Imagery Cyberinfrastructure to Enhance Research in Geosciences

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ICEBERG: Imagery Cyberinfrastructure and Extensible Building Blocks to Enhance Research in the Geosciences
Satellite imagery is rapidly transforming the way we see the planet, including our ability to study the most remote parts of the Arctic and Antarctic. Satellite imagery can help us map networks of rivers, study changes in the flow and thickness of glaciers, identify rock and soil types, and even find animals like penguins and seals. Because the availability of imagery in polar areas has increased rapidly over the last decade, we are now faced with a challenge: How do we scale-up the scientific discoveries that have been enabled by satellite imagery to larger spatial scales? Moving from small pilot-studies to pan-Arctic or pan-Antarctic analyses of geological and biological processes requires new infrastructure to link scientists, satellite imagery, and high-performance computers. This new imagery-computing superhighway will make it easier for scientists to study processes at much larger spatial scales than has been previously possible. Our project, called ICEBERG — Imagery Cyberinfrastructure and Extensible Building-Blocks to Enhance Research in the Geosciences, aims to build the cyberinfrastructure required to make the most of satellite imagery for geosciences, starting with researcher working in polar areas, where much of this science is already underway, and then branching out to the entire EarthCube community.
ICEBERG is supported by the NSF EarthCube program

1683
Geoinformation System for Environmental Monitoring of the Arctic Ocean

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Continuous collection of environmental data about the Arctic ocean, involving algorithms and models for the analysis of its characteristics is essential not only for operational monitoring and enforcing economic activities, but also to explore different-scale natural processes in the atmosphere and ocean, their dynamics.
The presentation discusses the establishment of a comprehensive geographic information system based on open source satellite data, combining the processes of assessment of ice conditions and primary productivity of the ocean. The core algorithms are developed and implemented methods for automated classification of types of sea ice, ice drift fields retrieving, ice deformations retrieving, iceberg detection and calculations of various characteristics of biological productivity.
Collecting and processing of data consolidated in a integrated information system that is accessed via standard protocols with two types of interfaces - web portal NIERSC Data Center and desktop application NIERSC QGIS ToolBox implemented as an extension to the open source desktop GIS QGIS. Deployment of desktop solution is automated with the virtual machines hypervisor Oracle VirtualBox and Vagrant software with storing the source codes of the algorithms on GitHub.
Development of data processing methods and access interfaces allows to explore natural environment of the Arctic ocean more deeply with every step.

1837
Temporal Trends of PCBs and OCPs in Landlocked Char from High Arctic Lakes

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Temporal trends and climate related parameters affecting the fate of legacy persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs), organochlorine pesticides (HCHs, DDTs and HCB) and toxaphene were examined in landlocked Arctic char from six lakes in the Canadian Arctic located on Cornwallis Island (Resolute, Char, Amituk Lakes), Ellesmere Island (Lake Hazen) and two paired lakes in Melville Island (West and East Lakes). Research performed over the past 10 years in the study area has revealed ongoing permafrost disturbances, which are of significant magnitude and importance on the West Lake watershed and lake (Melville Island). Adult char were collected in late July from almost every year from 2001 to 2016, by gill netting or by jigging through the ice at a rate of 7 to 25 adult fish per lake and year. All fish were dissected in situ and subsamples of muscle+skin, liver, otoliths and GI tract were kept frozen for transport and storage in an ultra clean freezer (-30ºC). In total, more than 500 samples from muscle+skin arctic char were collected and analyzed for POPs in this study with the aim of i) examining the trends of legacy POPs such as PCBs and OCPs (DDTs, HCHs and HCB) and toxaphene, ii) study which parameters are affecting the occurrence of POPs in Arctic char and iii) investigate whether or not climatic parameters and climatic oscillation patterns may affect the temporal trends of POPs in Arctic Char.

1541
Emerging and Legacy POPs in Norwegian Marine Sediments: The MAREANO Program

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The Norwegian national program of seabed mapping, MAREANO, has been carried out on a yearly basis for over a decade in remote open-sea areas of the Norwegian Arctic. Several groups of organic contaminants in surface and subsurface sediments from shelf areas of the Barents and the Norwegian Seas have been mapped. The hydrocarbons are the most abundant among all the studied types of contaminants due to natural presence in the marine environment. Analyses of 48 separate PAH compounds in dated sediment cores, together with grain size and total organic carbon contents, allow to distinguish the natural background from anthropogenic inputs and discuss possible sources. While pyrogenic PAHs dominate the PAH composition of most samples, petrogenic and biogenic PAHs are sometimes also found in significant amounts. The geographical distribution of manmade legacy POPs (PCBs, five types of chlorinated pesticides, PBDEs) in surface sediments shows some variations at low levels throughout the area. The first results of analyses of several groups of emerging contaminants (PFAS, PFR, siloxanes), as well as alkylphenols, alkylphenol ethoxylates and bisphenol A, indicate trace amounts of some of these compounds in surface sediments. A pilot study of microplastics in a small selection of samples from the same areas have revealed the presence of different quantities of several types of plastics in the µm range in all the analysed samples. However, several methodological challenges remain.

1444

Anthropogenic Effects on the Marine Environment at Palmer Station, Antarctica

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Palmer Station is a small US research base (15-40 people) north of the Antarctic Circle (64.8°S). In 1989, the Argentine supply vessel Bahia Paraiso ran aground and eventually sunk, leaking an estimated half a million liters of diesel and other hydrocarbons. Subsequent impact monitoring from 1989 to 1992 determined that some marine sediments were contaminated, along with bioaccumulation in, and mortality of, intertidal limpets (*Nacella concinna*). However, an assessment of local anthropogenic effects on the marine environment had not been conducted since 1992. In 2014 and 2015, marine sediments were collected to quantify the extent and effects of any potential contamination on deep (18 to 24 m), soft-sediment benthic macrofauna from both the Bahia Paraiso, and from Palmer Station itself. Intertidal and subtidal limpet tissues were also sampled to determine any potential contamination effects in shallow areas (< 10 m) where hard substrate dominates. Preliminary results show that Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the sediment have decreased since 1991, however high concentrations exist at three sites within the vicinity of Palmer Station. PAH concentrations in limpet tissues have also decreased over time, however concentrations are still high in limpet tissues at the Bahia Paraiso and at some sites close to Palmer Station. The status of human impacts on the marine benthos, and comparisons with the 1989 to 1992 assessments will be presented.

95

First Detection of SCCPs in Humpback Whales Foraging in Antarctic Waters

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Chlorinated paraffins are industrial mixtures of polychlorinated-*n*-alkanes. Their synthesis started in the 1900s when they were used in the preparation of an antiseptic solution during World War I. They can be released through production, storage, transportation, usage and disposal of, plastics, adhesives, rubber, sealants, liquor leathering and metal cutting fluids. Short chain chlorinated paraffins (SCCPs; C_{10-13}) are of particular interest because they have been detected in remote environments, such as the poles of the earth, demonstrating their capacity for long range transport. Further, their persistence, capacity for bioaccumulation in lipids and long-range transport, led to their inclusion in the persistent organic pollutants (POPs) list, under the Stockholm Convention, in May 2017. Here we report for the first time, the detection of SCCPs in the blubber of humpback whales (n=10), belonging to the southern hemisphere E1 population known to feed on Antarctic krill (*Euphausia superba*) in Antarctic waters. The blubber samples were collected from humpback whales stranded along Australian coasts between 2008-2012 and approximately 2g of blubber from each specimen was dedicated to the analysis. As long-lived cetaceans with a large proportion of body lipid mass, humpback whales represent suitable bioindicators of Antarctic lipophilic chemical pollution. The study serves as a further proof of the ubiquity and bioaccumulation potential of these newly listed POPs.

419

Persistent Pollutants in Arctic and Antarctic Krill and in Commercial Krill Oil

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Krill are considered key-species of marine ecosystems of the Polar Regions, being main food source for fish, marine mammals and birds in the Southern Ocean and in Arctic seawaters. Through ingestion, persistent organic pollutants accumulated in their body could be transferred to their predators due to biomagnification process and may cause effects in the entire trophic web. We studied krill from the Arctic and Antarctic seawaters in order to assess the toxic risk for their predators. Recently, the krill oil has been used in commercial preparation of pills for supplying unsaturated fatty acids, hence including humans in the list of krill predators. In order to assess the contaminant level and toxic risk for predators, the presence of some persistent organic pollutants was determined by gaschromatography-mass spectrometry in Antarctic and Arctic krill samples and commercial pills. The sum of 4 congeners of mono- and 8 congeners of non-*ortho* polychlorinated biphenyls was < 0.001-0.471 and < 0.001-0.499 ng/g wet wt in the Antarctic and Arctic krill, respectively. HCHs and DDTs were more abundant in the Arctic krill (0.856±0.315 ng/g wet wt) while the sum of 23 congeners of polybrominated diphenyl ether predominated in the Antarctic krill (0.121±0.074 ng/g wet wt), with BDE47 making up most of the residue. The same contaminants were detected in the krill oil pills; the assessed TDI was below the limit suggested by the World Health Organization.

2244
Adelie Penguins as Indicators of Persistent Organic Pollutants (POPs)

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Persistent organic pollutant (POP) exposure in Adelie penguins (*Pygoscelis adeliae*) may reflect local or regional conditions better than other seabird groups as they are highly constrained within their foraging habitat and remain south of 60^{o}S during winter. While POP contamination within Antarctica is largely caused by long-range atmospheric transport, Antarctic research bases have been shown to be local sources of emerging POPs such as polybrominated diphenyl ethers (PBDEs). In addition, Antarctic soil concentrations near Adelie penguin colonies have shown elevated concentrations of legacy POPs such as organochlorine pesticides (OCPs) and polycholorinated biphenyls (PCBs), suggesting guano and bird remains may contribute substantially to local contamination levels. This study aims to evaluate Adelie penguin colonies as indicators of local contamination of POPs within east Antarctica. Soil samples (n=68) were collected from Adelie colonies within close proximity to Australian research stations Mawson and Davis as well as further afield during the 2016/17 austral summer. Samples are being analysed for OCPs, PCBs, PBDEs and novel flame retardants using selective pressurised liquid extraction (S-PLE) and gas chromatography coupled to tandem mass spectrometry (GC-MS/MS). Results will provide baseline data for regional POP contamination with Adelie species local to east Antarctica, as well as provide an assessment of potential station-derived impacts.

AC-6_AC-7b - Across the Southern Ocean: Atmospheric and ice mass changes & Seeing the Future: Predicting Variability and Change of the Polar Climate and Environment 23.06.2018 14:00-15:30, C Sanada I

2293
Understanding Diversity in CMIP5 Projections of Winds over the Southern Ocean

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The CMIP5 climate models simulate a robust poleward shift and strengthening of the main eddy-driven belt of Southern Hemisphere (SH) mid-latitude near-surface westerly winds ('westerly jet' or 'jet') as part of the climate change response to increasing greenhouse gases. Such changes have wide-reaching implications both regionally and globally relating to impacts on, for example, uptake of heat and CO_2 in the Southern Ocean and ice-ocean interactions around Antarctica. However, there is a large inter-model spread in the magnitude of jet responses.

The focus of this presentation will on linkages between diversity in simulated CMIP5 sea ice area (SIA), Antarctic amplification and diversity in projected 21st century changes in the westerly jet. Broadly it is found that model diversity in projected 21st century jet strengthening is much more highly correlated with sea ice area (SIA) (and associated Antarctic amplification) than diversity in jet shift. Specifically, CMIP5 models with larger simulated present-day SIA broadly exhibit more sea-ice retreat and less jet strengthening in future projections. To help disentangle cause and effect in the coupled model analysis, output from uncoupled atmosphere-only fixed sea-surface experiments from CMIP5 was also evaluated. This analysis points to a coupled link between simulated present-day jet strength biases and projected future jet strengthening.

2400
Increasing the Predictability of Arctic land Surface Energy Fluxes

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The energy budget of Arctic land surfaces is expected to change significantly under future climate warming. All components of the energy budget might undergo shifts under increasing air temperature and precipitation. Examples include changes of irradiance due to alterations in cloud cover; of albedo as a response to changing snow cover, water surface extent, plant composition and structure; and of ground heat fluxes in response to changing thermal conductivity related to increasing or decreasing soil moisture. However, predictions of most of these changes are still highly uncertain, as well as their combined effect onto the energy budget.
Based on our recent observational and modelling studies of land surface energy budget components in the northeastern Siberian Arctic tundra and recent literature, I will synthesize the status and needs to improve the predictability of land surface energy fluxes in the Arctic. Discussed aspects include observations, experiments, and modelling from local to regional scale. A special emphasis will be on how we can predict the effects of vegetation change on shortwave energy fluxes through experimental evidence, linking plant traits to vegetation-light interaction, from leaf to landscape scale.

1858

Observational Evidence for Predictive Skill from Arctic Summer Sea-ice Extent

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We investigate the lead/lag linkages between summertime Arctic sea ice extent (SIE) and high-latitude climate. Arctic SIE anomalies exhibit notable persistence from midsummer (~July) through autumn (~October). The persistence of summertime Arctic SIE anomalies extends to Arctic temperature, geopotential height, and mid-tropospheric zonal flow. Hence, summertime SIE anomalies are significantly linked to Arctic climate variability up to three months in advance. The inferred skill that derives from summertime SIE is robust over the Arctic basin, but does not appear to extend to midlatitudes. It is theorized that the lagged relationships between summertime SIE and autumn Arctic climate derive from a combination of

1) the persistence of SIE anomalies from summer to autumn and

2) the anomalous surface fluxes of heat and moisture that accompany the persistent SIE anomalies.

454
Modulation of Arctic Climate Change by Atlantic Multidecadal Variability

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Arctic sea ice has undergone a substantial decline since the beginning of satellite observations (Stroeve et al. 2014), a negative trend that is modulated by internal variability on decadal time scales, which complicates near-term predictions of Arctic climate (Swart et al. 2015). We focus here on the modulation of Arctic sea ice response to CO2 by Atlantic Multidecadal Variability (AMV) using the following sensitivity experiments done with the CNRM-CM5 climate model:
1-Control (CTL): Twin ensemble experiments (13 members of 30 years) started from a strong (AMV+) and weak (AMV-) AMV state, respectively, with fixed external forcing.
2-Abrupt CO2: Same as CTL except that CO2 is instantaneously doubled at the beginning of the simulation and then hold fixed.
3-Transient CO2: Same as CTL except that CO2 is increased by 2% per year.
We present climate differences in terms of air temperature, surface heat fluxes, winds and sea ice in the AMV+ and AMV- ensembles and analyze the variability of oceanic heat transport through the main Arctic gateways. Previous studies suggested an increased ocean heat transport into the Arctic in response to climate change because of an enhanced heat flux into the Barents Sea (Koenigk et al. 2013). We show that such transport can be modulated by the AMV in agreement with previous studies (Zhang 2015, Arthun and Eldevik 2016). We highlight the importance of better understanding ocean decadal variability for improved predictions of Arctic climate.

2358
Sub-seasonal Predictability of Cold Air Outbreaks

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Rapid propagation of cold polar air masses into middle or lower latitudes known as cold air outbreaks (CAOs) leads to the formation of extreme negative anomalies of air temperature over large areas. The most persistent CAOs may have a period of a few weeks, which is in the sub-seasonal forecasting range. Here, we investigate the potential of a seasonal prediction system to provide a skilful prediction of long-term CAOs on sub-seasonal scales. We use the seasonal prediction system based on the mixed resolution CMIP5 version of the Max Planck Institute for Meteorology Earth System Model (MPI-ESM-MR). In our analysis of 30-members ensemble hindcasts we focus on strong and most persistent CAOs in the period from 1982 to 2017. Prediction skill of sub-seasonal CAOs as well as background parameters such as surface and 850 hPa air temperature will be presented.

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AUTHOR INDEX

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