Svalbard Science Conference 2021 - Book of Abstracts

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Title	**Arctic Ocean change witnessed by long-term ocean observatories in the Eurasian Arctic**

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The Arctic Ocean is subject to significant wide-spread changes in sea ice cover and sea ice thickness, ocean freshwater and heat content, and ocean stratification. With surface air temperature anomalies in the Arctic being double the global temperature anomalies, the effects are large. The Atlantic Water that flows into the Arctic through the Barents Sea and the eastern Fram Strait forms a large source of subsurface heat. The Atlantic Water is kept away from the surface by the fresher Polar Water above it, however, increased temperature and shoaling of Atlantic Water threatens this stable configuration and can break down the Arctic halocline, thereby allowing more ocean heat to reach the surface and melt ice. With sea ice declining, solar radiation increases the surface heat content in summer, thereby contributing to further ice thinning and extending the ice-free season in the open ocean and in coastal areas around Svalbard. Besides increasing sea ice melt and glacial run off, there is increasing supply of freshwater from the Siberian rivers as well as through fresher Pacific inflow, all contributing to the freshening of the upper Arctic Ocean. Large changes in export of freshwater from the Arctic has the potential to alter the ocean density structure further south, and thereby impact the Atlantic Overturning Circulation as well as ecosystem structure. In this talk we present an overview of observations from various long-term monitoring systems in the Eurasian Arctic documenting oceanic variability over the last one to two decades, and focus in particular on recent significant changes. These findings demonstrate the need to monitor the Arctic in a consistent and sustained way in order to address how climate change impacts the Arctic and how feedbacks in the system can accelerate these changes.

1005

Title	**Putting Svalbard fjords into perspective - International and transdisciplinary co-operation for co-management of Arctic fjord systems**

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Svalbard, and in particular, Ny-Ålesund have a long tradition in international and interdisciplinary research cooperation, which has been fostered by the increasing interaction of the four flagship programs featured by NySMaC. One critical challenge for the research being conducted at the Ny-Ålesund Research and Monitoring facility has been the integration of research findings from Kongsfjorden in a pan-Arctic perspective. Initiated by the Kongsfjord Ecosystem flagship the EU-funded Horizon2020 project "The future of Arctic coastal ecosystems - Identifying transitions in fjord systems and adjacent coastal areas" (**FACE-IT**) sets out to provide the first large-scale systematic comparison of coastal areas under variable degrees of cryosphere loss to address its consequences to Arctic marine biodiversity and Arctic societies in Greenland, Svalbard and Finnmark, Northern Norway. The underlying two-pronged hypothesis is (1) that the biodiversity of Arctic coastal zones is changing in accordance with the rates of cryosphere changes, and (2) that these changes affect local communities, food production, livelihoods and other ecosystem services. FACE-IT approaches European Arctic fjords as local social-ecological systems and includes the participation of Arctic stakeholders to ensure that Indigenous and local knowledges, perceptions and concerns about ongoing changes are taken into account in defining innovative and adaptive co-management approaches towards a more sustainable future. FACE-IT will integrate the research conducted by 14 institutions from eight different countries and will investigate seven fjord systems across the European Arctic along a gradient of borealization and cryosphere loss. This presentation will stress that not only international, but also transdisciplinary co-operation is key to enhance the significance and impact of research conducted at Svalbard.

2001

Title	**Global governance in Arctic waters** – new times, new stressors – catching up with pharmaceuticals.

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Arctic ecosystems are increasingly under pressure, not only from climate change and the long-range transport of persistent organic pollutants, but of late from pharmaceuticals and personal care products (PPCP). In Svalbard alone, urbanization and expanded tourism by the cruise industry has exacerbated the issue of PPCPs accumulation in the Arctic. The primary source of PPCP into aquatic ecosystems stems from sewage and wastewater treatment plants. PPCPs for human consumption such as ibuprofen and anti-depressants have been discovered at alarming rates in biota samples collected in Ny-Ålesund. This study applies research surrounding sources of hazardous bioaccumulation while providing mitigation alternatives for PPCPs within a governance and humanities framework. Few regulations regarding human waste disposal are enforced in the Arctic. Currently discharge is regulated by "Svalbardmiljøloven" and pollution is governed by both UNCLOS and MARPOL. This study uses in-depth interviews while applying the snowball method to identify participants comprised of locals and government officials in Longyearbyen and Ny Ålesund. Though a qualitative study, the interviews will be followed by an analysis using fuzzy cognitive mapping for scenario development and weighing of variables, which will later be presented to the informants for validation and if necessary, further calibration. These informed interviews and stakeholder driven future scenarios will provide concrete policy action potentials surrounding the governance of pharmaceuticals in the marine environment encompassing Svalbard. The various levels of analysis will also be employed to explain policy action limitations and adaption alternatives on PPCP pollution in the Arctic. Our previous cross-disciplinary work on this subject has determined PPCP concentrations in the Arctic biota, by monitoring the release of PPCP in 2018. This summer we will compare the previous samples to 2021 and couple these findings with the qualitative research of how the Svalbard community is affected by and can mitigate the hazardous waste of PPCPs.

2002

Title	Understanding Svalbard's glacier flow instabilities and related hazards from space

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Many glaciers on Svalbard have shown or are currently showing some kind of ice flow instability, such as associated with glacier surging or retreat of tidewater glaciers. Svalbard is a natural laboratory to investigate such strong variations in glacier movement, the potential influence of climate change on these variations, and the impacts they have on human activities and natural systems. Increasing meltwater availability at the glacier beds, changing ice-thermal regimes, and increasing frontal melt from warming ocean water are able to cause increasing ice flow variability and can trigger instabilities such as surges. The temporarily enhanced calving flux associated with glacier flow instabilities sends freshwater pulses into the ocean, and may lead to irreversibly fast glacier mass loss. In addition to the increased number of icebergs, glacier flow instabilities typically lead to massively enhanced glacier crevassing, impacting strongly on human travel and transportation over the glaciers of Svalbard. In this contribution, we combine high-frequency Svalbard-wide glacier surface velocities with a novel method for satellite-derived year-round detection of changes in glacier crevassing. We draw conclusions about the spatio-temporal pattern of ice flow instabilities on Svalbard, the different mechanisms of these instabilities, possible influences by climate change, and their significance for hazard management related to human surface travel and transportation. Our methods are mainly based on repeat satellite radar data, such as from the European Sentinel-1 constellation, so that we can monitor independent of cloud and day-light conditions.

2004

Title	**Depletion of crude oil and fuel in the Arctic. Summer field studies with immobilized oil in seawater at Svalbard**

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Oil exploration and production and new shipping routes in marine Arctic areas increase the risk of accidents and accidental oil spills. Degradation of oil by natural or stimulated methods is an important part of oil spill risk assessment, but field data on oil degradation processes like photo-oxidation and biodegradation are limited, particularly for the seawater column. This project aims to fill essential knowledge and data gaps on field-based degradation of oil in Arctic regions. The focus will be on the degradation of immobilized oil, prepared as thin films on hydrophobic adsorbents. Lab studies have shown that biodegradation of oil compounds in these immobilized films may relate to degradation of oil dispersions. Oil dispersions are formed from oil slicks by wave conditions, or by the use of chemical dispersants used for removal of oil spills from the surface, and small droplet dispersions will enlarge the surface to volume ratio of the oil, making it more accessible to natural degradation processes such as photooxidation and microbial biodegradation. Natural degradation processes play a major role in the fate of toxic oil compounds. The oil-coated adsorbents will be mounted in frames and deployed in Arctic seawater at the harbour in Longyearbyen during the summer of 2021 for a period of 8 weeks. Light-exposed and covered frames will be deployed for investigation of natural photo-oxidation and biodegradation of oil compounds, in combination with characterization of microbial community successions during the degradation processes. Data achieved by this project will be compared to results from previous field studies from different regions and seasons to point out the effects of related factors, such as temperature, light regime and varying microbial communities.

2005

Title	Resistivity and Induced Polarization investigations in the context of arctic landfills

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Variations in ground temperature affect the physical properties of permafrost, such as amount of unfrozen water and ice content. In the context of arctic landfills, it is important to understand to which extent permafrost acts as a geological barrier. This applies to both existing landfills for waste from local communities and mining activities, as well as for the planning of future landfills.

Here, we present three examples where combined Electrical Resistivity Tomography (ERT) measurements and Induced Polarization-surveying (IP) was used to detect the interface between sediments and bedrock within permafrost ground, and to investigate potential environmental hazards related to run-off paths from existing and planned landfills. Study sites were an active landfill near the town of Longyearbyen, and two potentially new landfills near Longyearbyen and Barentsburg (the latter one for surplus masses resulting from coal mining). As permafrost traditionally had been considered as a natural flow barrier for such landfills, understanding its degradation owing to climate change is key in the planning of future sites. Eight profiles were carried out in September 2018, when expected active layer thicknesses were at their maxima. Two-dimensional inversion was performed with the commercial software RES2DINV for the resistivity data and Ahrusinv for the chargeability data. The results of our case studies show the benefit of simultaneous ERT- and IP-measurements, to both map active layer depths and determine sediment depths in permafrost areas. They also gave valuable insights in understanding potential environmental hazards related to run-off from the landfill, as a consequence of water entering the landfill in the summer period. ERT/IP surveys are flexible and relatively easy to deploy. The technique is non-destructive and is, therefore, also suitable for planning and maintenance activities in vulnerable arctic tundra environments.

2006

Title	A geophysical insight into near-surface stratigraphy of the Svalbard

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Svalbard is warming rapidly due to climate change and soil temperatures are rising. The design capacity for buildings with older foundations that are reliant on frozen soil strength, are at risk with continued climate change. This study aims to identify the extents of overpressure brine pockets within the saline permafrost soils in Adventdalen.

To address this problem, Direct Current (DC) Resistivity and Induced Polarization (IP) response of six profiles were measured using the gradient array. In addition, Wenner array data was collected for selected profiles. The inversion response of the DCIP data was calculated using two different softwares. Physical properties of the sediments including porosity, water saturation, water salinity, freezing temperature and sample grain size were also incorporated, in order to investigate the correlation between geoelectrical and physical properties of the sediments.

Based on the results from the DCIP measurements, four distinct zones were identified: (i) top active layer, mainly composed of silt and sand, (ii) frozen silty sand and cryopegs, (iii) brine pockets with high salt contents, and (iv) unfrozen soil, mainly composed of clay. The IP data contributed in delineating a low chargeability zone near the surface from a high chargeability zone which denotes the active layer, lower parts of unfrozen soil and cryopegs. A good correlation was observed between the physical properties of the sediments and the DC resistivity data. For example, the interface between the high and low resistivity part coincided well with the sedimentary composition, with intermediate to fine grainsizes, high porosity, high water saturation and salt content. Our results suggest that a suitable choice for the DCIP survey design coupled with integration of the sediment's physical properties, can be successfully applied to characterize the near-surface morphology of the sedimentary composition in the Arctic.

2007

Title	CRYOCARB – Impact of cryospheric melt-down on submarine slope stability and carbon release in a warmer Arctic

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CRYOCARB will establish an inter-disciplinary network of experts to address our overarching goal of maximizing knowledge of the impact of cryospheric melt-down on Arctic slope stability and release of old carbon storages to the atmosphere in a warm climate. To achieve this, the CRYOCARB group has identified the time prior to intensification of the last glaciation, ca. 30-40.000 years ago, which was a period of significantly reduced ice extent, where one of the uncertainties relates to the extent and thickness of ice across Svalbard and the northern Barents Sea. It was likely corroborated by a megaslide event along the northern Svalbard margin implying a direct response of melting glacial ice on slope stability and, thus, the potential release of submarine stored old carbon reservoirs to the atmosphere.

CRYOCARB combines marine and terrestrial expertise from various institutions with permanent research stations on Svalbard in one research project. With an initial (virtual) workshop in 2021 we will stimulate a baseline discussion on the overall topic and research questions. During a planned field reconnaissance on Nordaustlandet in 2022 we will inspect pre-Late Weichselian raised shorelines and sediment sections to establish ownership of the group to start planning a large-scale research program. The novelty of CRYOCARB lies in its overarching inter-disciplinary approach. We are bringing together experts of various disciplines (geo-bio, marine, terrestrial, chronology) for discussing not only theoretically (virtual meetings), but more importantly, practically in the field to create ownership to the scientific problem and to define the key questions to be addressed during the planned full research proposal.

2008

Title	InnovateGLOF: Interdisciplinary observations of the Setevatnet glacier lake outburst flood

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Glacier lake outburst floods (GLOFs) are sudden floods caused by the failure of an ice damn followed by lake drainage. They represent an imminent risk to downstream settlements and infrastructure and cause ice acceleration. As such, they have received only very little attention on Svalbard so far. Setevatnet is a small ice marginal lake forming annually, with the onset of the melt season near Ny-Ålesund. It comprises both a supra- and a subglacial part, causing flotation of an ice tongue of Kongsvegen, followed by sudden drainage between late-June and late-July. The water drains thereby through the subglacial system of Kongsvegen and exits into Kongsfjorden. In this project we study the processes involved in the 2021 drainage event. In particularly we try to understand ice damn failure mechanisms and a potential link to the surge initaition of Kongsvegen. We further investigate the role of groundwater during lake filling, the configuration of the subglacial drainage system its changes during the drainage event. As the lake drains into the fjord, it supplies nutrients, both to the subglacial, as well as the marine ecosystem. Our project therefore assesses these nutrient fluxes and estimates the nutrient contribution of the GLOF to the total nutrient concentration close to the tidewater front to investigate the effects the GLOF has on the marine ecosystem. As outburst floods from Setevatnet have been described since 1975, they can likely be traced in the marine geological record. We therefore investigate the imprint on the geological record of the 2021 early melt season GLOF. To obtain our objectives we draw back to a wealth of available remote sensing data, employ a multitude of different methods and develop and apply several new technologies. Overall this pilot study fosters and stimulates international, interdisciplinary cross-flagship activity around Ny-Ålesund.

2009

Title	Concentration and distribution of emerging pollutants in north western Spitsbergen snow

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The presence of pollutants of emerging concern, such as Fragrance Materials, Current Used Pesticides, and organic UV filters, was identified in biotic and abiotic matrices in the Arctic.
Little is known about their distribution in snow matrix in polar regions, and further research is needed to better understand their effects on wildlife and human health. During the past years, both the European Commission and the AMAP highlighted the importance to improve the research and the monitoring of these new contaminants to implement effective regulations in Europe and worldwide.
This study focused on six fragrances and three compounds of interest for the European Union already included in the first watchlist under the Environmental Quality Standards Directive: Ambrofix, Benzyl salicylate, Amyl salicylate, Hexyl salicylate, Oranger Crystals, Peonile®, Butylated Hydroxytoluene (BHT), 2-Ethylhexyl 4-methoxycinnamate (EHMC), and Triallate.
The spatial and altitudinal distribution of selected pollutants was investigated in the annual snowpack in the north-western Spitsbergen, to identify if they come from either local or long-distance sources, and to investigate the atmospheric transport processes. Snow samples were collected in April 2021 in five glaciers in north-western Spitsbergen: Edithbreen, Midtre Lovenbreen, Austre Brøggerbreen, Kongsvegen and Holtedahlfonna. The sampling locations were selected considering their spatial distribution and their different elevation. Three sites are close to Ny Ålesund (Edithbreen, Midtre Lovenbreen, Austre Brøggerbreen), the other two are more isolated sites (Kongsvegen, Holtedahlfonna). This way, it is possible to make a comparison between areas close to human settlements and more isolated areas. During Winter, the boundary layer in the Arctic is at about 600 m. The elevation of the selected glaciers ranges between 400 and 1120 m. The distribution of the pollutants is studied at different elevations to better understand the role of the boundary layer in their transport in the atmosphere.

2010

Title	Quantification and simultaneous identification of small microplastics (≤ 100µm) and other microlitter components in snow from Svalbard Islands: sampling, pre-treatment procedures, and first analysis

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Microplastics are recognized as ubiquitous global contaminants, and they have been observed in every compartment and at every latitude, including Polar Regions. These emerging contaminants may enter these regions following ocean, atmospheric transport, and local input, although their pathways and sources are still investigated. While these challenges posed by microplastics to the polar environment remain uncertain, ingestions have been observed for different kinds of organisms according to the size of their mouthparts; usually, invertebrates can ingest food particles around or less than 100 µm. Hence small MPs (SMPs, ≤ 100 µm) can be easily ingested, posing a threat to the trophic web and human health. While MPs (≥100µm) have been explored worldwide, SMPs are neglected, especially in the atmospheric compartment. Moreover, there is a significant lack of standardized sampling, pre-treatment procedures, and identification methods on SMPs, and more investigations on this polar compartment are needed. Rain and snowfall events are considering the current scavenging mechanisms for SMPs that can be accumulated in snow due to atmospheric depositions. Hence, different snow samples were collected at the Gruvebadet site (E433374, N8762566, Svalbard Islands) to study SMPs' temporal variability. Samples were also collected during snowfall events. A specific sampling procedure was developed to avoid any plastic contamination, and different field blacks were collected. A method for the quantification and simultaneous identification of SMPs and other microlitter components (i.e., additives, plasticizers, non-plastic fibers) was developed using MicroFTIR. Additives and plasticizers can be relevant proxies of the presence of SMPs and can help with the evaluation of pathways and sources. Preliminary results were evaluated. The results will be extremely useful to expand the understanding of these emerging pollutants concerning their behavior and transport in the atmospheric compartment.

2011

Title	**Eating plastic at Svalbard Islands: quantification and polymer identification of small microplastics (< 100 µm) and other components of microlitter ingested by benthic invertebrates**

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The primary environmental risk associated with microplastics is their bioavailability for marine organisms. Since microplastics and other components of micro-litter (i.e., natural and non-plastic synthetic fibers, plasticizers) can be easily mistaken as food particles, they can be ingested by marine invertebrates in relation to the size of their mouthparts. Besides, these particles can accumulate and be transferred to higher trophic levels raising concern about detrimental implications for bioaccumulation from one trophic level to the next. Ingestion of microplastics and other components of microlitter has been observed in different invertebrates (Corami et al., 2020, Iannilli et al., 2020; Lusher et al., 2017; Sfriso et al., 2020); evidence of microplastics' ingestion in invertebrates of Artic Svalbards has been observed as well (Iannilli et al., 2019). Benthic invertebrates are important components of the food web in any environment, including the Arctic polar environment. Different benthic invertebrates were collected at Ny Ålesund to investigate the ingestion of small microplastics (< 100 µm, SMPs), additives, plasticizers, natural fibers, and non-plastic synthetic fibers (APFs). SMPs and APFs were extracted, purified, filtered, and then analyzed. The analysis via MicroFTIR allowed quantification of these particles (microscopic counting) and simultaneous polymer identification. Additives and plasticizers, among which there are some compounds recognized as potential toxicants toward humans and biota, can be polymer-specific. These compounds can be employed as a proxy of SMPs and can provide a better understanding of the sources and pathways of SMPs, and their impacts on the environment and biota.

2012

Title	Extreme precipitation over Svalbard and its relation to the recent decline of sea-ice

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Extreme precipitation over the Svalbard Archipelago in the Arctic can have severe consequences for the ecosystem and society. Those extremes are connected to atmospheric rivers, which bring warm and moist air towards higher latitudes and have a significant contribution to the annual polar moisture transport. In recent years several extreme precipitation events have been observed at Ny Ålesund, a weather station in the northern part of the Svalbard Archipelago. The most recent observed events in the years 2012, 2016, and 2018 were the highest events in the entire precipitation record from 1974 till today. The key question of our study is whether those recently observed extremes are part of a climate change signal or are a random accumulation of extremes. We apply a novel approach, which allows us to study the non-stationarity of climate extremes and to identify the key processes that are drivers for changes in extreme Arctic precipitation. We find that the likelihood of occurrence for extreme precipitation over Svalbard has indeed increased over the last four decades. We provide evidence that this change can be partly attributed to the reduction in sea-ice extent in the Greenland, Barents, and Kara Seas. The analysis of our large ensemble, which includes in total 1800 extreme weather events, shows that during low sea ice conditions the atmospheric flow is less zonal oriented, which leads to a more efficient transport of moisture towards Svalbard.

2013

Title	The microplastic signal for an anthropogenic epoch in a changing arctic

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Freshly exposed paraglacial sediments are being eroded and transported to the fjord and shelf zones of Svalbard, Norway at an increased rate by mass wasting, glaciofluvial processes, and precipitation events. The glaciofluvial sediments transported to the coast are then reworked into coastal landforms, for example, tidal flats, barriers, and spits. How microplastics (plastic debris < 5 mm) are incorporated into such processes is unknown. Sampling efforts related to high Arctic microplastic pollution have been uncoordinated to date, and although monitoring programs are frequently recommended, there has been little follow-up on investigation of year-on-year variability, or the treatment of results when different environmental compartments are investigated, even where consistent methodologies and research teams are employed. We present results from our ongoing investigation of microplastics in glaciofluvial, coastal, and distal glaciomarine sediments in the glaciated catchment and coastal system of Longyeardalen, Spitsbergen. End of season snow profiles from the glaciers of Longyearbreen and Larsbreen, which form part of this catchment, were collected in April 2021. Sediment samples from moraine, glacial forefields, Longyearelva river, and Adventfjorden were collected in September of 2020 (and will be again in September 2021). The primary aim of this study is to investigate how microplastics are incorporated into ´pristine´ glaciogenic sediments and how assemblages of microplastics (concentration, polymer, morphology) vary within a populated high Arctic catchment. Potential entry points and accumulation hotspots for microplastic pollution in this setting will also be documented.

2014

Title	A novel remote sensing framework for geohazard assessment and relief in Svalbard

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As the frequency and intensity of natural disasters both increase due to the warming earth, automated mechanisms to assess the damage caused become more necessary and effective. Specifically, having machine learning-based methods for assessing the damage incurred by disasters on infrastructure aids in the timely allocation of resources and personnel. In Svalbard, settlements and landscapes are prone to several types of natural hazards, including earthquakes and floods. However, to develop deep learning-based algorithms that remotely sense damage, there is not sufficient data on the island alone to curate the large-scale datasets that are associated with machine learning and artificial intelligence ("big" data). Therefore, we employ a strategy called transfer learning, which is a research problem that focuses on storing knowledge gained while solving one problem and applying it to a different but closely related problem. We take the approach of training supervised convolutional neural networks (CNNs) on multitemporal satellite imagery around the world, including data from pre-disaster and post-disaster of natural disasters such as earthquakes, hurricanes, wildfires, and floods from North America, Europe, Asia, and Africa. The labeled data includes instances of buildings and other structures such that the output of the model uses change detection to categorize the severity of damage in buildings from 0 to 4. We utilize the ResNet architecture, the cross-entropy loss function as the criterion for optimization. For transfer learning, we harness a Markov logic network framework. The aim of this ongoing work is to develop systems that allow for an efficient and targeted humanitarian assistance and disaster response in extreme weather and seismic events in Svalbard, with the potential to save human lives and minimize economic loss.

2015

Title	**Developing a permafrost and meteorological climate change response system to build resilience in Arctic communities (PermaMeteoCommunity)**

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The interdisciplinary scientific PermaMeteoCommunity project develops resilience in Arctic communities via a geoscientifically developed coupled permafrost and meteorological climate change response system. This system will assist decision making by providing real-time key geoscientific observations affected by the increasing climatic changes that especially the high Arctic environment such as Svalbard experiences. Longyearbyen is an excellent test site for developing such forward-looking technology to provide safer and better living conditions for the inhabitants. The developed response system shall be exportable to other polar or cold climatic areas, with permafrost or seasonal frost, which are most affected by climate change.

We investigate permafrost in the different landforms that the Longyearbyen area is built upon by 1) using different geophysical and geotechnical measurements and 2) performing permafrost drillings collecting cores from the active layer and permafrost analyzing the ground ice content and type, thermal properties, age and grain-size. These studies allow interpretation of the types of sediment infilling the Longyeardalen valley, and to produce ground ice content and saline sediment maps. This will enable selecting the most critical sites to be equipped with observation instrumentation for observing in real-time changes in key parameters affecting slope and building stability (content of water in the active layer, the ground permafrost temperature, air temperature, amount of precipitation and wind). All observations will be transferred in real time to 'the climate change response system', which will be excellently suited for use in preparedness. The growing amount of data in the system will encompass a broad range of extreme climatic situations (such as warm seasons, wet seasons, long lasting summers which means late ground refreezing in autumn). In the future, we see the potential for using novel machine learning and artificial intelligence technology to statistically forecast future extreme events based on its comprehensive database, thereby given authorities early warnings.

2016

Title	**Plastic ingestion by the northern fulmar *Fulmarus glacialis* from Kongsfjorden**

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The Svalbard archipelago is polluted by plastic coming from different sources. Those sources, both local and distant, release high amounts of plastics which may then be ingested by local fauna. The northern fulmar Fulmarus glacialis (hereafter fulmar) is one of the few species studied in the frame of plastic pollution in Svalbard. The fulmar is an OSPAR species used for biomonitoring of plastic pollution in the North Sea and is well studied in the Arctic. However, data are lacking in some regions (including Svalbard) and for some life stages. The objectives of this study were to investigate the plastics ingested by fulmars collected in Kongsfjorden among two age categories: adults and fledglings (~50 days old) investigated for the first time for the purpose of plastic pollution. Almost all birds (95%) had at least one piece of plastic in their stomach. On average, 36 pieces and 0.21 gram of plastic were found per bird but the highest number was 381 pieces in a single fledgling. Polyethylene and fragment were the most common polymer and shape, respectively, across both life stages. Half of the birds (46%) exceeded the limit set by OSPAR (0.1 g of plastic) and fledglings showed significant higher number and mass than adults. The reported values are higher than previous data collected in 2015 in fulmars from Isfjorden that reporded 15.3 pieces and 0.08 g per individual, and 22.5% of birds above the OSPAR limit. Our results therefore do not support the hypothesis of a lesser plastic exposure to fulmars in the northern part of the Arctic. We also showed that all the fledglings sampled had ingested plastic pieces, often in high numbers, and could therefore suffer from both mechanical (stomach obstruction) and toxicological (pollutant leaching) negative impacts.

2018

Title	Permafrost Trapped Shallow Gas in Svalbard: A Ticking Timebomb?

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Unprecedented warming in the Arctic is causing widespread permafrost thawing. Thawing permafrost is associated with the release of methane, a potent greenhouse gas, from the shallow parts of permafrost. However, the processes happening at the base of the permafrost are poorly constrained, largely because studying it requires drilling boreholes through the entire permafrost interval. Fortunately, in Svalbard, with its history of coal and hydrocarbon exploration coupled with recent CO2 storage research boreholes, there is a wealth of relevant data. Throughout the archipelago we see evidence of large accumulations of methane trapped below the permafrost. In the 1960s a large accumulation of methane was unexpectedly encountered below the permafrost in Adventdalen in a coal exploration borehole. The approximately 100 metre-deep borehole went on to produce more than 2.5 million cubic metres of methane and continued to flow for eight years until it was shut-in, though it can still flow methane today. Further boreholes in the following decades highlight that these permafrost-trapped gas accumulations are very common and regionally widespread, with numerous examples from coal exploration areas in central Spitsbergen in addition to cases from Hopen, Tromsøbreen, Gipsdalen and Billefjorden. Gas migration is also seen at natural pathways through the permafrost at pingos and perennial springs and as flares in Isfjorden (where there is no permafrost to trap it).

These accumulations pose a hazard to any operations involving penetrating the permafrost interval, but arguably more importantly poses a risk in providing a feedback to climatic warming when it is released by the thawing permafrost cap. Because methane is an extremely potent greenhouse gas, it is vital that more work is carried out to better constrain the volumes of the trapped methane the rate it is likely to leak into the atmosphere with thawing permafrost, and whether this is a wide-spread pan-Arctic phenomenon.

3001

Title	Urban heat island: Does it impact the Arctic towns?

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The Arctic population is largely concentrated in cities and towns. Such urbanized areas are characterized by strong anthropogenic heat fluxes, enhanced atmospheric mixing, and modified surface heat balances. These factors collectively create persistent local temperature anomalies – the urban heat island (UHI). Even small settlements reveal intense UHI in the cold Arctic climate. We found 1 to 3 degree C (up to 6 deg. C) warmer mean land surface temperature in all 118 circum-Arctic towns. We argue that the surface UHI intensity could be used as an accessible and reliable indicator of a multitude of urban environmental and even societal processes. The UHI impact is of specific concern in towns on permafrost, such as Longyearbyen on Svalbard. Persistent warm temperature anomalies weaken soil stability and increase thickness of the seasonally active soil there. UHI correlates with air quality, enhanced biological production and more generally with quality of urban environment. As an indicator, UHI reflects different aspects of socio-environmental interactions, e.g., use of blue, green, and white public space by urban dwellers. Dense cities support more intense UHIs and known to be less resilient and sustainable. Although urban climate anomalies are highly localized, their footprints extend beyond the built-up area. It opens an opportunity to investigate ecosystem response to climate change. Our study of climate analogues suggests that Arctic urban areas could exhibit climatic features corresponding to the areas 300-600 to the away from their location. We conclude the UHI is an important socio-environmental indicator of the urbanized Arctic that deserves further investigation and analysis.

3002

Title	Polish documentaries about Svalbard scientists: Societal relevance

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Scientists need media to explain to the general public the purpose, meaning and possible impact of scientific research, in order to secure public knowledge, support and funding. The role of popular science documentaries in this process has always been significant. Now that the visual media are gaining an upper hand over the printed, film has become more important than ever before. To measure its societal relevance, one should take into consideration the number and content of film reviews, the viewing figures and results of specially designed opinion polls, if available. Poland has been chosen as a case study because this is a non-polar country that has achieved remarkable success in polar research over the past century or so, partly thanks to memorable documentaries about Polish polar research, historically linked to Svalbard, where Poland has had several research bases. Węsławski 2020 shows that in 2018, over 80% of Polish polar researchers with a PhD degree, engaged full time in the field of environmental and earth sciences and aged between 30 and 65, have answered "movies" to the question of what inspired them to undertake polar research.

The first Polish film about Svalbard scientists, *Do ziemi Torella* (To Torell Land), was released in 1936 as a visual report on the 1934 Polish expedition that had mapped previously unchartered areas in the south-east of the Spitsbergen island. Since then, some fifty documentaries (often in the genre of visual natural history) have been made in Poland to account for the diverse activity of Polish and other scientists on the archipelago, with the research station in Hornsund as the focal centre. The dominant trends in these documentaries will be outlined in illustration of the theoretical concept of consilience by E. O. Wilson, which argues for a unity of knowledge between sciences, humanities and the arts.

3003

Title	Teenagers without land: Ethnographic study on non-Norwegian youth in Longyearbyen

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There are tens of children living in Longyearbyen who joined their parents migrating to the High Arctic from Thailand, the Philippines, South America, and other places. Thanks to Svalbard Treaty, there is no visa or work permit required for those who search for a better life, but Norwegian laws related to the country's welfare model do not apply here, resulting in limited rigths for the children. Some of the teenagers eventually lose the connection to the parents' country of origin, speak fluent Norwegian and feel as locals. Others miss the place they come from but do not intend to move back because chances for a dignified life seem higher in Norway. Their legal status is precarious, capacity to gain Norwegian citizenship scarce and once turning 18, no rights related to the Norwegian social security system await them. With hybrid and transnational identity, they are lost in the vacuum caused by the delicate legal status of Svalbard. The project is financed by SSF (Arctic Field Grant), and the poster presents preliminary results of the research (fieldwork March-May 2021). Through listening to the voices of the teenagers themselves but also their parents, friends and teachers, and through interviews with experts, the aim of the research is to find out what the local response is to an unforeseen consequence of globalisation in Svalbard.

3004

Title	**Adventure-based cruise tourism and emergency response: Training for increased polar-water emergency management competence.**

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Nature-based tourism on Svalbard has increased significantly in recent years. The special segment adventure travel has doubled in size, from 10 to 20 percent of the international tourism market. This type of tourism is characterized by visiting remote and spectacular areas, and uniqueness. One of the most popular type of adventure-based travel is expedition cruise. This includes the number of cruise vessels visiting the High North and Svalbard. The polar regions are characterized by challenging weather, a lack of infrastructure and equipment, as well as a vulnerable environment. Accidents in this area could therefore be devastating. Focus on risk reducing efforts are thus of importance and polar water competence is a crucial factor for safe operation and efficient emergency response.

This abstract highlights how exercises can be used to train crisis emergency personnel to reduce risks of life and environment disasters. Therefore, we made "Exercise Isfjord", a cruise ship in distress with the need for mass evacuation. The findings were based on qualitative interviews of key crisis personnel operating as mentors, and master students, who participated at the exercise at NORDLAB, Nord University's emergency management laboratory.

Factors such as use of mentors, and degree of realism, were found to be of importance for the learning outcome and future optimalization. Trust among the actors were found essential, as well as adapting the exercise to previous knowledge on operational context and the emergency response system. This underlines the need for meeting arenas and tailor-made training schemes.

Conclusion: Training for managing large scale accidents is crucial for saving life, environment, and values in the demanding polar context. Tailor-made computer assisted exercises with simulators and active use of mentors were found to be an efficient combination for advanced learning to meet a broad range of crises, and to collaborate efficiently.

3005

Title	CAPARDUS: Capacity-building in Arctic Standardisation Development

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CAPARDUS is a Coordination and Support Action under H2020 with the goal to explore ongoing processes of developing standards in selected topics of importance in the Arctic. The project is preparing a Comprehensive Framework Model for development of standards, guidelines and practices related to observing systems and data sharing in the Arctic, with focus on community-based observations and citizen science initiatives. This is done as a collaborative effort between scientists, local communities and other stakeholder groups involved in the regional case studies in Greenland, Svalbard, Alaska and Yakutia in Russia. Furthermore, the project is designing an Arctic Practice System (APS), which will be a repository of documents (or other communication media) that is searchable on titles, keywords and content. The APS is based on technologies developed in Ocean Best Practice System (OBPS; www.oceanbestpractices.org). The APS will be a tool for co-production of knowledge between scientists, local communities and other stakeholder groups involved in the case studies of the project. Project activities are focused on natural resource management, safety, community planning and decision making and tourism. Local community members are involved in the case studies after signing an informed consent agreement. Other data related topics of importance for Arctic communities will be addressed when relevant in the cases studies.

3006

Title	**Towards an environmental memory of Svalbard: co-produced narratives, scientific data and local experiences**

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There are many sources of understanding how the environment in Svalbard is changing. But are they compatible? Is there overlap between long-term environmental monitoring and stories that people who live, work or travel in Svalbard tell? And can they be brought together as multilayered knowledge and benefit people and organisations on or connected to Svalbard? These are the guiding questions of SVALUR, an international research project with social and natural scientists working under the title "Understanding Resilience and Long-Term Environmental Change in the High Arctic: Narrative-Based Analyses from Svalbard". In a patchwork mode, we present three facets of this endeavour: 1) a study of knowledge-making by natural scientists and technicians involved in long-term environmental monitoring and research programmes - what do we learn about production of knowledge of a changing ecosystem by talking to the knowledge holders? 2) A maptionnaire that we use to encourage people to report on observed changes (or lack thereof), and share micro-blogs and images from places they visit in Svalbard - Is it possible to obtain insights into environmental change that may complement monitoring and make the latter yet more relevant to people's lives? 3) Existing methods and new, creative, ways of collaboration across the interdisciplinary team - How can we combine maps, scientific data, and narratives into storytelling? What are the assets and pitfalls of co-creation?

3007

Title	Arctic risk paradoxes: Understanding activity trends and safety in Svalbard waters

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The Arctic in general, and Svalbard in particular, is undergoing rapid and mutually reinforcing environmental and socio-economic change. Interdisciplinary research is required to understand these transformations and their implications, and to build a knowledge base for anticipatory governance toward safe and sustainable development.

This paper analyzes the implications of maritime transformations for risk and safety in Svalbard waters. As a first step, we integrate monitoring and vessel-tracking data with environmental information about weather and sea ice conditions. This gives a comprehensive picture of ongoing trends, and provides an overall image of an increasing volume and diversity of activities. Secondly, we review studies focusing on the future of maritime activity around Svalbard to provide a better understanding of the drivers of change and their potential implications. Third, we assess the impact of these transformations through an analysis of the complex emergency preparedness and response system, and give an overview of alluded needs and recent initiatives for enhancement of these capacities.

We reflect on the implications and paradoxes of these transformations. Although risk assessments are largely anticipatory by taking into account future needs, governance is often designed in response to past crises. In the context of maritime development in Svalbard, we argue that risk governance relies strongly on the principle of self-accountability, as the formalized system will not be able to handle a major event. This comes with an inherent paradox that risky operations will be safer the more operators are willing to take those risks. Although decision support systems can make operations more predictable, they come with uncertainties that need to be better understood through interdisciplinary research. The paper concludes with a discussion about the societal relevance of such research for sustainable Arctic development.

3008

Title	The physiological response of an Arctic key species Polar cod, Boreogadus saida, to environmental hypoxia: critical oxygen levels and swimming performance

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Higher atmospheric temperatures have already caused various environmental changes, including a loss of almost 50% sea ice coverage in the Arctic, within the last two decades of the 20th century. This loss of sea ice will weaken thermohaline circulation in winter, possibly resulting in local hypoxia in the bottom water layers. Especially the protected semi-closed fjord systems of the Svalbard archipelago are at risk from long-lasting stratification and oxygen consumption over more than one season. Thus, the present study investigates the hypoxia tolerance of Polar cod, Boreogadus saida, one of the main Arctic key species. We measured respiratory capacity (standard and maximum metabolic rates, (baseline) SMR, MMR) and swimming performance at decreasing oxygen concentrations (100% to 5% air saturation) via flow-through and swim tunnel respirometry. The calculated baseline SMR for Polar cod accounted for 0.37 µmol O2·g -1 ·h -1 at full oxygen saturation. The SMR followed an oxygen regulating pattern, yet never fell below baseline SMR until the fish lost equilibrium at about 3% PO2. Under exercise, Polar cod were able to retain a steady MMR until a threshold of 45 % PO2 was reached, after which MMR decreased in a linear fashion to reach baseline SMR at about 5% PO2. Ugait (the speed at which the fish changed to anaerobically fuelled swimming (bursts)) was not significantly affected by hypoxia, albeit the total number of anaerobic bursts ($p = 0.025$) and total active swimming time ($p = 0.017$) significantly decreased with decreasing oxygen saturation. Our study revealed that Polar cod is an extremely hypoxia tolerant fish species, which is able to handle oxygen saturations down to a Pcrit of 5.91 % PO2 over several days. The loss of anaerobic swimming capacity under severe hypoxia however may endanger this species in regard to predator-prey-interactions and loss of escape reactions.

3009

Title	Svalbard science in times of pandemic: learned lessons, failed attempts, and efforts that worked

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Over three million deaths and approaching 2% of the world's population infected by April 2021, Covid-19 pandemic has shaken the world since March 2020. Svalbard research has been hard-hit by the Covid-19 pandemic in several ways. When Norway declared a nationwide lockdown on 12th March 2020 to decrease the rate of spread of the COVID-19 in the community, even more strict measures were taken to protect the Svalbard community from the potential spread of the disease. Due to the lockdown, travel restrictions, and quarantine regulations declared by many nations, most physical meetings, training courses, conferences, and workshops worldwide were cancelled by the first week of March 2020 leading to fewer opportunities for networking. Additionally, field campaigns to polar regions, including Svalbard, were and remain severely affected. Since the beginning of the pandemic, SIOS kept a closer eye on the changing situation and adapted its activities to support the research community in difficult times to save long term measurements in Svalbard. these activities include; (1) bringing the community together, (2) logistics support during pandemic times, (3) Earth observation and remote sensing support to fill data gaps, (4) assessing impacts of Covid-19 on Svalbard research. Even though the pandemic has changed our regular activities for the unforeseeable time, a few positive examples show that the Svalbard research community continues in its resilience under the extraordinary and unparalleled current circumstances. Our talk will highlight the summary of SIOS's activities conducted in response to Covid-19 and outcomes of our survey to assess the impacts of Covid-19 on Svalbard research. Since the pandemic is still ongoing, we have more lessons to learn in 2021. From a long-term perspective, our experiences and lessons learned in times of pandemic will help us prepare for future similar events and possibly increase the efficiency of activities in more normal conditions. We hope that our practical services, experiences, and activities implemented in these difficult times will motivate other similar monitoring programs and observing systems to respond to future disruptions to research activity.

3010

Title	A path towards more social science and interdisciplinary research in Svalbard – the work and ambitions of the Svalbard Social Science Initiative

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Scientific research in Svalbard is increasingly taking on a cross-cutting disciplinary nature. Due to the rapidly changing climate in the Arctic, different scientific research approaches need to be considered concurrently to better understand the environmental changes that are happening in Svalbard. However, a strictly physical science approach is simply not enough to understand the context in Svalbard, nor is it enough to provide sufficient information for the outlook and future of Svalbard. Anthropogenic impact, globally and locally, plays an ever-growing role, impacting the region both today and into the future. Therefore, an increased focus on developing and fostering social science approaches and research activities are necessary to holistically understand the environmental and ecosystem changes taking place as well as their impact on the local community.

In this session, we will present on behalf of the Svalbard Social Science Initiative (SSSI), which seeks to develop a comprehensive and collaborative network of social science researchers interested in, and research activities about, Svalbard. Importantly, the work of SSSI highlights the large variety of perspectives and research activities that stress the importance of human impacts, societal needs, narratives, and perspectives when it comes to Svalbard. Simply put, SSSI is not limited to just the discipline of social science, but rather, it offers a multi-disciplinary forum for social scientists, anthropologist, artists, and other human-focused researchers to come together to discuss pressing questions regarding Svalbard. In addition to the general aims of SSSI, several ongoing research projects will be presented as well as a reflection on the importance of interdisciplinary research when it comes to scientific endeavors in Svalbard. We will discuss the benefits of and how social science can be better integrated in physical science research campaigns as well as the necessity of social science research in Svalbard as a stand-alone endeavor.

3012

Title	Observations for sustainability in the Arctic

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Designing observation systems requires careful consideration of the goals of the observations. Environmental monitoring often seeks to detect what is perceived as human perturbation of a system of natural variability. The sustainable development goals (SDG) emphasize human (and life) survival and wellbeing on our planet. Observations for SDG goals rather than pure scientific goals (e.g. Earth System Science) or simpler (e.g. single species management goals) is a shift in perspective that prompts a scrutiny of the entire observational production chain to produce data and knowledge as well as management advice. Our ability to resolve change in the Earth system has bearing on the scales at which it is possible to monitor nature which in turn limits the scales and rate of societal and management, evidence, based decisions. Transactional elements (tradeable entities) dominate contemporary evaluation of success, and monitoring has consequently been designed to detect how humans and the effects of transactions influence the environment. We deduce that non-transactional elements (e.g. nature, wilderness, climate, culture, happiness) are required for sustainability which will require a wider set of information to evaluate. The consequences of these perspectives on a monitoring system are tentatively explored through a case study in Svalbard. Some concrete examples on how Svalbard Integrated Earth Observing System (SIOS) should reconsider optimization evaluations in its future work are suggested. Long-term measurement programs need to be broad such that unknown future societal questions can extract information from our present contributions. This work also touches upon the meaning of "sustainability" itself. How do we create a sustainable sustainability? This is a continuous process and has no end. We identify the role of culture to entice continued pursuit of values elating sustainability and the role of education to empower humans to master the challenges of sustainability as key for a meaningful future.

3013

Title	Multi-criteria risk assessment of waste disposal sites under Arctic conditions

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Management of waste from both human settlements and mining activities has been a major challenge in the Arctic region. Historic practice has relied on permafrost conditions in the soil to stabilize waste and prevent contaminants from being released into the environment. Now that the climate is warming, especially in the Arctic region, this might result in mobilization of contaminants from historic waste. In addition, the traditional approaches to handling of mine waste are no long valid and new solutions should be developed.

To address these challenges a multi criteria risk assessment approach has been developed taking into account the various processes that can pose pressure or act as a driver on a waste site system:

- Future climate and change in precipitation patterns triggers erosion.
- Permafrost is expected to lose its role as a geological barrier for the containment of contaminants.
- Landslides and avalanches impact stability and safety at the site.
- Geotechnical stability will govern mass movement of the stored waste and release of contaminants.
- Hydrological conditions guide the functioning of barriers between waste and the environment and are being corrupted.
- Waste properties are drivers for the release of contaminants and their potential impact on the ecosystem, requiring a clear classification.

These factors are interrelated, and the risk posed can be addressed by combining their probability of occurrence and the consequences in a risk matrix. This integration allows both a qualitative as well as a quantitative approach of the involved risks to both human and the environment. Thereby it is possible to find solutions which will be sustainable under the future scenario we are expecting in the Arctic. In our presentation we show how this approach can be applied to historic and future waste sites in the Longyearbyen region.

3014

Title	Improved weather prediction in the Arctic – The Alertness project

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Climate change leads to increased activity in the Arctic, and the high-impact weather in these areas is hazardous to marine operations and industrial development. The ambition of the Alertness project (funded by Forskningsrådet) is to improve the capacity for the delivery of reliable and accurate Arctic weather forecasts for the benefit of maritime operations, business and society. In this science for services and society approach, Alertness develops the numerical weather prediction (NWP) model AROME-Arctic, which is operational at the Norwegian Meteorological Institute.

The Arctic forecast capabilities are challenged by small-scale spatial variability and uncertainty. AROME-Arctic performs well compared to other forecast systems, but all existing NWP systems have common weaknesses (e.g. the representation of low temperatures in the stable boundary layer). Experiments covering the Year of Polar Prediction (YOPP) special observing periods further show that we are not only able to make more accurate forecasts than the leading global ensemble, but we are also able to better quantify the uncertainty in the forecasts at smaller spatial scales than is currently available.

Alertness enhances the use of existing Arctic observation systems in data assimilation to improve the weather forecast initialization and accuracy, e.g., we show the relative impact of different observations on forecast accuracy, disentangling the benefits of observations on local forecast accuracy. Furthermore, Alertness addresses the small scales and uncertainty by using higher spatial resolution and ensemble systems. The latter also gauge the influence of the uncertainty in sea ice and sea surface temperature on forecast reliability. Alertness also scrutinizes the representation of the stable atmospheric boundary layer, one of the identified common weaknesses in all forecast systems.

Alertness cooperates with a multitude of international projects. Of special importance is our contributions to YOPPsiteMIP, a coordinated process-based model evaluation project based on high-frequency multivariate observations at selected Arctic supersites.

3015

Title	Research on renewable energy in Svalbard

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Svalbard's society is changing fast. Within five years, Longyearbyen's power plant must move from today's coal dependency to a more sustainable and environmentally friendly energy source and the coal mine will shut down shortly after. Many establishments in Svalbard also desire to move towards the use of local renewable energy supplies. This, in combination with that the companies in Svalbard are implementing new and alternative business plans, has sparked an increasing demand for renewable energy solutions that are adapted to the Arctic. As a consequence, there is an intensifying demand for research to underpin this move.

The University Centre in Svalbard (UNIS) is therefore developing renewable energy as a new subject to aid the transition. This is undertaken in close cooperation with local partners in Longyearbyen, as well as research partners and industry on the mainland. Since renewable energy is a cross-disciplinary subject, all four departments at UNIS are involved with their expertise on Arctic natural science and technology.

The long-term goal is to develop Svalbard as a test site for Arctic renewable energy and to build a competence and knowledge centre based in Longyearbyen to gather expertise on Arctic energy together. This science for society aims moreover to support a viable, active Norwegian settlement in Svalbard.

UNIS' future plans and current research on the subject will be presented.

3016

Title	Tipping+ inducing positive tipping points in Svalbard and other coal and carbon-intensive regions

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This presentation reports on preliminary findings and future work in the EU-project Tipping+, enabling positive tipping points in coal and carbon intensive regions (CCIR). Tipping points are usually considered in the natural sciences, while demographic, cultural, political, socio-phychological, and economic aspects have received less attention. Svalbard is one of numeorous case studies in this project where we are investigating the societal processes allowing a transition away from carbon intensive economies. Unlike other world regions, Svalbard's particular political and economic conditions have permitted the phasing out of coal without the concerns that life-cycle communities have for populism and political instability following the closure of coal mines. This makes Svalbard a particularly salient case to study how society and the economy respond to the cessation of coal, with lessons for the rest of the world seeking pathways into the post-carbon economy and culture. Preliminary work shows what are likely tipping points in demographic dimensions leading up to and following the decision to close the coal mines. For instance, the number of female residents increased markedly following 2015. Another potential tipping point reported in the media is a change in the culture and cohesion of the Longyearbyen community following the shift from coal mining toward tourism, education, and research as the economic foundation. To find how this decision to close the coal mines is experienced by Svalbard residents, and to investigate sustainable pathways past their closure, the project will involve visits to Svalbard and discussions with residents. Svalbard will offer many useful insights into challenges and possibilities for other regions seeking transitions to post-carbon sustainable societies.

3017

Title	**Open Polar – a global open access portal to research on the polar regions**

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Research activities and research output, in general, have increased, and keep increasing vastly, and so too is research on the polar regions including Svalbard in the Arctic. Major commercial publishers have built subscription-based services which present research literature for a fee. As Open Science and open access to literature and data is gaining momentum, there is a distinct need for powerful discovery tools that can harvest and present research literature and datasets in open access form - free of charge. Moreover, sharing of underlying data in open access form is becoming the new norm. So, to integrate research papers and datasets in the same search, helps speed up the discovery processes as well as fostering the transparency of research, and minimize duplication of fieldwork and experiments.

Open Polar (https://openpolar.no/) is developed by UiT The Arctic University of Norway, and is a free to use discovery tool for open access publications and research data specifically targeting research output on the polar regions, across all subject areas, and irrespective of where the research originates. Through a carefully designed algorithm, Open Polar is extracting metadata (including URL to the landing page of the full text) from more than 4600 sources worldwide and making these accessible through a user-friendly search service - including an option to search via geolocations on a map, and with systematic search features. The algorithm used picks up relevant research located in the most remote content providers and sources. Thus, searching in Open Polar will result in records purely of relevance to the polar regions.

In this contribution, we will present the many advantageous features of Open Polar, and show how Open Polar is supporting Open Science and research integrity-enhancing procedures, by enabling search and access to research data as well as research papers.

3018

Title	Geothermal heat extraction in Longyearbyen – an applied concept study

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Svalbard is an area with high geothermal potential. The geothermal gradient (i.e. the temperature increase with depth) varies regionally but is generally high compared to e.g. mainland Norway. Below Longyearbyen, temperature rises with up to 45 °C/km.

From 2013-2016, Longyearbyen-based company Store Norske led a RCN-financed pilot study which mapped the geothermal potential of the archipelago, based on data from oil, gas and coal-wells. Today, a consortium consisting of Store Norske, UNIS and GTML is performing a concept study to evaluate geothermal heating of a new school building in Longyearbyen. The group is currently assessing the feasibility of drilling wells between 1000 and 2000 m deep where temperatures between 35 and 80 °C are expected. Special challenges identified are the preservation of the permafrost around the production well, potential gas below permafrost and within the rocks, fractured horizons, and high logistic costs. If the study shows positive results and appears economically feasible, drilling of the first geothermal well in Svalbard might start as early as 2022. A successful project might pave the way for even deeper geothermal wells in Svalbard, having the potential to supply heat for entire communities. The project is also a showcase for how basic arctic research provides essential knowledge which eventually results in applied industry projects in renewable energy.

In our presentation, we'll give a status update on the project and provide information about the preliminary results.

3019

Title	Introducing the Svalbard Social Science Initiative (SSSI)

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The Svalbard Social Science Initiative was launched in 2018 as a bottom-up initiative by several researchers studying the human dimensions of the dynamic changes currently underway in Svalbard. The aim of the network is to create linkages among social scientists working with issues related to Svalbard, establish a platform for coordinating research activities, and to facilitate the communication with local communities and other scientists. The SSSI has today 23 active members from different disciplines including anthropology, political sciences, cultural studies, geography, planning and urban development, and the arts. Collaboration, co-creation, and community involvement are our core values, expressed through ongoing dialogue with local stakeholders and inhabitants in Svalbard settlements, as well as activities such as community dialogues and collaborative projects.

A key aim of the SSSI is to make research concerning Svalbard accessible both to Svalbard communities and the scientific community. This poster introduces readers to the SSSI. It describes the aims and functioning of the network, highlighting the important role of the social sciences and humanities for research on/in Svalbard. QR-codes direct readers to the SSSI website, to its profiles on social media platforms, and to online reports, and invite readers to get in touch.

3020

Title	**“Filling in the blanks”: Geomorphological maps in Svalbard and how extensive rock slope deformations were newly identified through remote sensing and landform interpretation, reshaping our understanding of Arctic slopes**

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Mapping has long been a tool for filling the white spaces in our understanding of geo- and biosciences as well as the topographical image of our world. Mapping bedrock, sediment cover and landforms enable us to identify and locate potential hazards, local resources, understand permafrost etc. Landform and sediment maps allow us to decipher long- and short-term changes in climate and climate-driven processes such as glacier variations, coastal changes, and slope processes. Svalbard, as the rest of the arctic, is however still largely unmapped with respect to surface sediments and landforms in a scale useful for society.

To map arctic sediments and landforms we must first understand all the geomorphological processes acting presently and through landscape history. All pieces of the puzzle must be known to construct the whole picture. Snow avalanches, rock falls, debris flows and solifluction are the most well-known slope processes on Svalbard. They have been mapped in smaller areas through, among others, UNIS and NGU research activities the last 10 years. Recently a relatively unknown larger scale landform process was identified and “put on the map”. This new process is large slow rock slope deformation, which is shown to have reshaped multiple slope sections in Nordenskiöld land where we have made an inventory based on aerial photographs and digital terrain data. To identify these large rock slope deformations, we use knowledge of all the “normal” slope processes and landforms without large rock deformations. We investigate how the large deformations have affected and controlled the other slope processes to create new understanding of the interlinked factors in the landscape.

This project contributes to both the specific understanding of arctic slopes, but also points to how far we still have to go when it comes to mapping the Arctic for the overall needs of society.

3021

Title	Benefits of co-creation in planning for safety, equity and sustainability on Svalbard

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Planning for sustainable development, environmental protection and safety for all citizens is challenging for local communities to manage, also in the Arctic. This is caused partly by climate change and more frequent extreme weather conditions and disasters. Changes in international relations, demography and economy, are also framing the context of planning and development. Svalbard is experiencing rapid climate change, flux in the population, and uncertainty connecting to planning, housing and future jobs. Linking topdown, governmental initiatives and plans with bottom-up approaches and planning initiatives from the community level, and knowledge from best practice from citizen science and community based monitoring programs (CBM) is not always easy. Based on the research and experience from the INTAROS and Capardus projects, and an ogoing public Sector Phd project at AHO, an attempt is made to look for possibilities of co-creation connected to planning and urban development in Longyearbyen/ on Svalbard. Co-creation and co-production of kowledge has been address over the recent years in public sector and public management. It has not been addressed in the same way connected to planning and coordination of research topics across actors and sectors.What benefits does co-creation provide in planning processes in the Arctic in general, and on Svalbard specifically? Participatory planning processes, and co-creation of scientifict knowledge and local knowledge, could provide a framework for coordinated place leadership and management. In the ongoing work I argue that co-creation, a coordinated place-leadership and kowledge-based planning of the future is required, as well as co-creation in the environmental monitoring. A broad, inclusive and holistic place leadership approach is enabling flexibility, innovation as well as rapid and effective responses to sudden incidents. A participatory and asset based community development approach needs to be built on trust and long term collaboration to strengthen the social capital among the actors. This provides benefits for society and all actors involved. In this presentation I share and discuss outcomes of CBM projects and ongoing co-creation processes, as well as methods and tools relevant to succeed in the task to collaborate for sustainable planning and development, as well as the monitoring of environmental and cultural resources. (UN Goal 17).

3022

Title	Dynamics of the Svalbard coastline in a changing climate

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Coastal change in Svalbard happens on the order of several m in a year in some areas and is known to cause problems for modern infrastructure as well as cultural heritage. In addition, coastal wetlands and sediment-rich discharge into fjords affects terrestrial and marine ecosystems. Distribution of coastal sediments is also relevant for microplastic and pollution risk assessments. Baseline data of coastal terrain and geomorphology is essential for assessments of future change and understanding how different coastal types respond to physical variables such as changing sea ice, permafrost, wave climate and runoff is important for predicting sensitivity to change or planning mitigation strategies. Until recently only very limited and local data of this type existed.

Under the DynaCoast project, we have mapped the coastal zone of Isfjorden from the shoreline to 500 m inland. Digitising was done in 1:3000 scale based on orthorectified aerial photographs and a 20 m resolution digital elevation model. Key sites were followed up with field studies. We followed the Norwegian SOSI classification system for sediment types and line or point features in surface sediment maps. This provides standardized data sets comparable to other areas in Norway. Additional sediment codes have been developed within this project for Svalbard to account for sediment types or features not common on the mainland. We now provide baseline data in 1:30 000 scale or better for Isfjorden and are expanding the work northwards in summer 2021.

Based on the baseline map data we have established categories of coastal settings, each with unique combinations of geomorphology, sediment composition and relation to physical processes. This provides a classification system for Svalbard coasts, that can be used to pinpoint areas most sensitive to change. Rates of change is currently being investigated from InSAR data.

3023

Title	Permafrost Carbon Feedback Cycle: Thermokarst Lakes as Carbon Source and Sink

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Permafrost hosts a significant amount of carbon (C) which may start to be released to the atmosphere in carbon dioxide (CO2) and methane (CH4) form as an abrupt thawing increase by warming globally compared to previous centuries. This procedure provides permafrost carbon feedback to climate that needs to be considered as one of the most important carbon-cycle feedbacks in the climate models. In addition, another significant amount of C (25-30%) is stored deeper (> 3 m depth) thanks to unique processes which bury C in permafrost region soils. Besides, Siberia and Alaska remained primarily frozen since the last glacial period, where abrupt thawing of permafrost led to ground subsidence as thermokarst and lake formation. As a result of this, thermokarst lakes accumulated more C as lake ecosystems developed.

Predicting the magnitude of the feedback system needs an insight of how variations in environmental conditions post-thaw, especially hydrological conditions, manage the rate at which C is released to the atmosphere. While the questions about thermokarst lakes ongoing about being both net source of atmospheric CH4 and CO2, and sequester C. Nevertheless, the carbon in perennially frozen drained lake sediments might become vulnerable to mineralization because permafrost disappears and thermokarst lakes become potential to corrupt climate stabilization in late Holocene. These ecosystems are very important for not only understanding the Pleistocene epoch, but also highlighting the future of permafrost thawing and determining the carbon balance, especially including other climate parameters. Therefore, the study will be focusing on thermokarst lakes and their role in permafrost carbon feedback cycle.

3024

Title	Construction of bioreactor for low-temperature biomass production of polar microalgae; Cultivation test in Central Europe spring conditions

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The adaptation mechanisms of polar microalgae (including cyanobacteria and eukaryotic microalgae) evolved to withstand the harsh polar environment characterized by low temperature, freeze-thaw cycles, desiccation, salinity, and high and variable photosynthetically active and ultraviolet radiation. Hence, polar microalgae developed ecological, physiological, and molecular defensive and adaptive strategies, which include the synthesis of a tremendous diversity of compounds originating from different metabolic pathways which protect them against the abovementioned stresses. A prospective microalgal strain for polar biotechnology should be characterized by (1) high growth rates at low temperatures ranging from 0 to +10 °C, (2) at least short-term tolerance of high temperatures above 20 °C, (3) tolerance to freezing, (4) minimum requirements for nutrient additions, and (5) high photosynthetic rates across a broad temperature range. Microalgal mass cultivation in polar regions requires development of new types of photobioreactors to provide suitable and controlled conditions for microalgal growth and/or biologically active compound production.

We have constructed and tested the closed type photobioreactor of maximum volume of 20L, flat panel type, aerated by air + CO_2 mixture bioreactor in spring conditions at the Institute of Botany, Třeboň, Central Europe. The cultivation has continued since March 31, 2021, and the soil microalga *Neochloris* sp. isolated in Svalbard has been used for this test. The suspension and air temperature, and photosynthetically active radiation are recorded by dataloggers in 10 minutes interval. Once a day, the optical density is measured to observe culture growth and photosynthetic activity is monitored using variable chlorophyll fluorescence approach. Once a week, a bulk sample is taken for detailed biochemical analyses of lipid and photosynthetic pigment composition.

On base of cultivation test provided in Central Europe we would like to test bioreactor cultivation technique and microalgae strains origination from Svalbard in field conditions of Longyearbyen in following years.

6002

Title	Multidisciplinary study on the role of glacier crevasses in context of rising air temperatures

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Crevasses are altering the surface roughness of glaciers. A crevassed glacier surface has a larger surface area and offers more obstacles for the wind compared to a smooth surface. These two effects can increase the rate at which the glacier body is exchanging heat with the atmosphere. In other words, crevasses increase the aerodynamic surface roughness lengths and thus increase turbulent heat fluxes. In the context of rapidly rising air temperatures in the Arctic, this may be a potent mechanism to increase glacier melt rates.

In our research, we are following a multidisciplinary approach to investigate the role of crevasses on aerodynamic roughness lengths. We are following three, that will be presented. The first approach uses drone-based mapping techniques to generate high-resolution digital elevation models (DEMs) of crevassed glaciers in Svalbard. These DEMs are then used to calculate aerodynamic roughness lengths using several different semi-empirical models that have been developed previously in the literature.

The second approach uses the same DEMs to conduct computational fluid dynamic (CFD) simulations to directly simulate the atmospheric boundary layer near the glacier surface. These simulations show how katabatic winds interact with the crevasses surface and how the increased turbulence influences heat transfer rates with the atmosphere.

The third approach uses a novel method to use a multirotor drone for wind measurements based on its inertial measurement unit (IMU) data. Pitch angle, yaw angle, and thrust variables can be used to estimate wind speed and wind direction while the drone is holding its position. Wind profile measurements above crevassed glacier surfaces can be used to estimate the aerodynamic roughness lengths from their logarithmic form.

In summary, we will present three novel methods from the fields of glaciology, meteorology, computational fluid dynamics, and drone technology for the application of crevassed glaciers.

6005

Title	Macroalgal biodiversity and biomass of Kongsfjorden through time and space

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Macroalgae are major primary producers and ecosystem engineers along rocky shores of the Arctic. With Svalbard being a hotspot of global warming, macroalgal species distribution and biomass is undergoing rapid changes, presumably affecting all associated life forms. The overall retreat of the yearly ice cover is only the centerpiece in a complex interplay of environmental drivers noticeably altering light availability, disturbance regimes and nutrient supply for Arctic seaweeds. Between 1996/1998 and 2012/2013 ecosystem changes were observed at our study site Hansneset in Kongsfjorden, as algal biomass in the littoral zone doubled and the macroalgal biomass peak, as well as the lower distribution limit of most dominating kelp species, shifted upwards by several meters. In summer 2021, we seek to complement these datasets. Our interdisciplinary group will repeat the quantitative monitoring study to examine how the community pattern of seaweeds and their associated fauna has changed since the last expedition. In detail, we will quantify macroalgal biomass and biodiversity, the age structure and fertility of kelp species, and the biomass and biodiversity of associated animals along a depth gradient between 0 and 15 m. Incorporated into the European Horizon 2020 project FACE-IT and two associated Svalbard Science Forum field grants, our superior aim is to analyse the response of benthic macroalgal assemblages to observed cryosphere changes in a broad context. In this talk, we will share the first results from this year's field samplings and show how abundances, biomass and species diversity of macroalgae have changed over the last decades at

our investigation site and what this means in general for the development of macroalgae on Arctic coasts.

6006

Title	Effects of sea ice and glaciers on marine littoral biodiversity and spatial abundance in High Arctic fjords

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Climate change in Arctic coastal systems leads to declining sea ice and sea-terminating glaciers, and these changes are expected to modify biodiversity and ecosystem functioning in the littoral fjord areas in Svalbard. In addition, influx of Atlantic water and invasive species, which may compete with and displace Arctic species, may change community composition and spatial distribution. A cross-disciplinary approach from land to ocean is necessary to fully understand these mechanisms. As part of the EU project FACE-IT, this study aims to map the bathymetry, nutrients, temperature and salinity of littoral areas, and link them to the spatial distribution of biodiversity and abundance, with a focus on macroalgae communities and littoral fish distribution. The main research site in Billefjorden is characterized by both Arctic and Atlantic water, as well as a surface layer with sea-ice, high freshwater input from rivers and sea-terminating glaciers. The Billefjorden sites are compared to the more Atlantic water influenced system of Isfjorden. In the study, we use an Unmanned Surface Vehicle (USV) with an autonomous sonar system, CTD measurements and image analysis, validated with transect samplings of macroalgae and marine fauna. This study contributes to a better understanding of the links between marine biodiversity, land influx and changes in the cryosphere, addressing the ongoing climate change mechanisms in the High Arctic land to sea interactions.

6007

Title	High Arctic Bryophytes: A green blanket?

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While climate change is warming the Arctic and degrading permafrost, plants could play a role in mediating the vicious cycle of permafrost degradation and release of greenhouse gases in the Arctic. Vegetation, especially mosses play an important role in insulating the soil from increasing air temperatures, potentially reducing permafrost thaw, thus leading to a reduced active layer depth (ALT). This has already been shown in studies in lower arctic regions. However, we have relatively little understanding of how plant communities affect the active layer on Svalbard throughout the summer. Furthermore, scale is often crucial in identifying drivers in ecological studies, and (a-)biotic drivers at small scale may not be the same as found at larger scales. Our aim is to unveil the spatial and temporal differences in active layer development under varying vegetation communities. We established frost tubes for season-long monitoring of active layer depth in 4 grids containing 20 plots each, with varying vegetation communities. Detailed data on vegetation composition and height in these plots is known from 2020. Additionally, snow melt, soil moisture and -temperature in these plots will be monitored together with active layer depth.

6008

Title	Historic changes in diversity, abundance, and biomass of seaweed-associated fauna in Svalbard

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The effects of climate change on ecosystems are especially strong in the Arctic. While the mean annual air temperature in Svalbard has increased about three times faster than the global average, average areal ice extent and mean length of the ice season have almost halved at the study site, Kongsfjorden, since 2006. These rapid changes are likely to affect the ecology of coastal arctic ecosystems. Empirical and modelling work suggests, for instance, improved irradiance regimes and growth of kelp forests on Arctic coastal rocky shores. This study is a continuation of a time series to estimate historic developments in abundance, biomass, and diversity of seaweed-associated fauna, comparing data from 2021 with data from 2012/13 and 1996/98. At each point in time, seaweed samples were collected along the same gradient from the intertidal down to 15 m water depth at Hansneset, Kongsfjorden, and the abundance and biomass of associated fauna was determined separately for each encountered taxon. In 1996/98, the biomass of seaweed-associated fauna, monotonically increased with depth. Contrarily, biomass of associated fauna decreased with depth in 2012/13. At the same time, the biomass peak of kelp shifted upwards from 5 m in 1996/98 to 2.5 m in 2012/13. An increase in seaweed biomass may positively affect the associated fauna, as seaweed provides living space for these animals. Here, we will present the latest data from the summer 2021 sampling and explore whether and at what magnitude recently observed trends in the abundance and diversity of kelp-associated fauna continued or changed in Arctic coastal systems.

6009

Title	More jellyfish (and less fish) in Tomorrow's Arctic? Exploring jellyfish' range shifts, their role in pelagic and benthic food webs and interactions with fish stocks

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Jellyfish (ctenophores and cnidarians) are known to be major drivers of ecosystem changes. Increases in biomass, referred to as "jellification", have been observed in several marine ecosystems, causing, amongst others, the collapse of major fisheries. For the Arctic, comprehensive datasets on jellyfish are currently missing, impeding our ability to detect changes of a similar magnitude. The Helmholtz Young Investigator Group "ARJEL" aims to combine the most recent technologies in optics and environmental DNA analyses, to better understand the role of jellies in the Arctic seas. We apply species and community distribution models to a broad set of archived and newly obtained data to understand distribution patterns and to predict range and community shifts under future climate-change scenarios. The role of jellies in the Arctic food web, their seasonal and regional variation in feeding habits and their importance as prey for planktonic predators and fish is assessed with DNA metabarcoding and biomarker studies. We investigate the role of "jelly-falls" in sustaining the benthic food web. Experimental studies will determine jellyfish' thermal windows and resilience. The outcomes of the models, trophic data, and insights into the connectivity and adaptability of jellyfish species, will allow us to improve food web and ecosystem models, currently neglecting jellyfish. An understanding of jellyfish-fish interactions, and how these will be impacted by climate-change driven range shifts, will shed light on the fate of commercially exploited Arctic fish stocks.

We will present the project aims and first results, as well as our planned research activities during our stay at AWIPEV, Kongsfjorden, in January 2022. Our ongoing foci include: i) the comparison of jellyfish' communities in Arctic vs. Atlantic-influenced Svalbard fjords to forecast the impact of the ongoing Atlantification; ii) the comparison between various methods for assessing jellyfish diversity; iii) the ecology of overwintering jellyfish in Kongsfjorden.

6010

Title	Recent warming in Svalbard and Franz Josef Land

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The Arctic has warmed three times faster than the global average since 1971. The causes of this "Arctic amplification" are still under debate. According to reanalyses data, the greatest temperature increase is found in the Svalbard – Franz Josef Land region. However, scarcity of validation data hampers the confidence of model simulations and reanalyses in this region.

In this contribution, we analyze a large number of unpublished surface air temperature (SAT) data from eastern and northern Svalbard and Franz Josef Land. The main objective is to establish consistent, high-quality datasets and study the warming and SAT variability over the past 20-40 years in the northern Barents Sea and relate this pattern to variations in sea ice concentration (SIC) and sea surface temperature (SST).

Specifically, we address the following three research questions: 1) How are the trends in SAT in the northern and eastern Svalbard and Franz Josef Land area compared to western Svalbard? 2) How much of the SAT variability is coupled to the SIC and SST variability? 3) How well do reanalyses describe SAT-climatology and -trends in the high Arctic, especially for sites and periods without SAT observations available for assimilation?

The study is based on Russian-Norwegian collaboration (AARI/SPbSU-MET Norway). The new Russian-Norwegian joint SAT dataset coverage is denser, and the time series are longer than those used by the scientific community so far. The quality of the SAT series has further improved by using modern homogenization methods, and by extensive quality control and use of metadata from the archives. The trend results are evaluated against SIC and SST data from Global data sets (EUMETSAT OSI SAF) and high-resolution ice charts (MET Norway), and compared to the SAT data from the most recent ECMWF reanalysis data set (ERA5), and the high-resolution C3S Arctic Regional ReAnalysis (CARRA).

6011

Title	What you always wanted to know about hydrological changes in Svalbard, but didn't know how to find out..

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Hydrological changes in the High Arctic are of core interest to environmental scientists in the polar regions. Warming Arctic, has already experienced increasing amount of precipitation, change in ground thermal regime as well as glacier coverage.

In the meantime, Svalbard, a place that used to be named a canary in the coalmine for climate change, reached the point of no return and the title has been passed to Greenland. However, the question of the hydrological response to conitnously rising air temperature remains unanswered.

We still ask whether High Arctic fjords are receiving/will receive different amounts of freshwater that can affect their circulation; how much of that terrestrial discharge can be expected to be delivered every summer; how quickly we will see the effects of this climate driven change on the marine ecosystem?

Modelling studies put an effort to answer some of these burning questions, yet even those have their limits caused by insufficient data, resolution or simple lack of coverage across the island.

To remedy that marked knowledge gap in our understanding of the hydrological changes in Svalbard, SvalHydro initiative compiled an almost half of the century of data from long-term atmospheric, hydrological and glacier mass balance monitoring across the archipelago.

We have investigated every component of the water balance equation, and compared the changes in glacierised catchements of various sizes to non-glacierized watersheds.

Our study resulted in a surprising discovery, revealing the magnitude and the direction of hydrological changes across Svalbard.

The talk will present the results of the SvalHydro investigation, discuss shortcomings of the current hydrological knowledge in the High Arctic, and suggest solutions that could close the gaps in the current hydrological research across the island.

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6012

Title	Critical Zones in critical environments

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Arctic ecosystems are exposed to significant changes generated by the fast temperature increase. In the case of terrestrial ecosystems, a crucial point is to unravel the drivers of carbon fluxes between soil, vegetation and atmosphere in the so called "Critical Zone" (CZ, i.e. the thin layer between the bedrock and the canopy where "rock meets life"), and the associated changes in Arctic carbon pools. Recent results suggest that it is unlikely that the expected shift in composition and widening of the vegetative season and plant phenology will offset the increase of soil respiration induced by temperature rise, pointing to the need for better quantifying the contribution of the different drivers to CO_2 fluxes in the tundra. In this work, we discuss a multi-regression model to estimate the contribution of the main biotic and abiotic drivers of CO_2 emissions (Ecosystem Respiration, ER), and CO_2 uptake (Gross Primary Production, GPP), in the Arctic tundra. During summer 2019, we extensively measured CO_2 fluxes at the soil-vegetation-atmosphere interface, meteoclimatic variables and ecological descriptors at the Critical Zone Observatory in the Bayelva catchment (CZO@Bayelva), near Ny Ålesund, Spitzbergen (NO). CO_2 fluxes were measured by a portable flux chamber across a large number of sample points and by eddy covariance. Soil temperature and humidity and air temperature, pressure and humidity were measured at each point. Vegetation cover was obtained from digital RGB pictures. We used multi regression models to relate flux data to environmental parameters and vegetation cover and type, thus obtaining empirical data-driven models for the coupled dynamics of soil, vegetation, water and atmospheric processes that contribute to the carbon cycle in the Arctic CZ. This work may help in assessing the future evolution of high-Arctic environment under projected changes in vegetation community composition and abiotic parameters.

6013

Title	Rapid climate change drives soil temperature warming and permafrost thaw on Svalbard

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Svalbard is a hotspot of climate change in the rapidly warming Arctic. The strong air temperature warming coincides with a multitude of changes in other climate variables such as liquid precipitation, snow cover, and the surface energy budget components. These changes have highly complex effects on the soil temperature and freezing conditions. We investigate seasonal patterns of change in climate and soil conditions at the Bayelva study site close to Ny-Ålesund, Svalbard for the period 1998-2020. We use Bayesian inference to estimate trends in monthly mean values of air and soil temperature, radiation fluxes, sensible and latent heat flux, liquid precipitation, snow depth, and soil moisture. We then apply PCMCI+, a recently developed causal inference framework, in order to quantify the contributions of all meteorological variables to soil warming. Air temperature at the Bayelva site rose in all months of the year in the last 23 years (1998-2020). This trend has been particularly strong in April (1.3°C/10years), September (1.5°C/10years) and October (1.9°C/10years). The strong changes in spring and autumn led to earlier snowmelt (-14 days/10 years, 2007-2020) and more snow free days (+26 days/10years, 2007-2020). We observe later soil freezing in October and lower snow depth. Furthermore, strong rain events have become more frequent in winter, which contributed to soil warming. As a result of changes in air temperature, water fluxes, and the energy budget, top soil temperature increased in particular during spring (May/June 1.4°C/10years, 1998-2020). Our results illustrate how rapid climate change drives soil warming and permafrost thaw. They can help to validate results from climate and land surface models as well as aid in future predictions of landscape changes in Svalbard.

6014

Title	Water Masses Variability in Inner Kongsfjorden (Svalbard) in the 2010-2020 decade

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Kongsfjorden is an Arctic fjord located in the Svalbard archipelago. Its hydrography is influenced by the warm and saline Atlantic Waters (AW) in the West Spitsbergen Current and the cold and fresh Polar Waters circulating on the shelf. We assessed the Atlantification of Kongsfjorden by examining changes in water properties and water masses variability in the 2010-2020 decade. We utilised long-term observations from mooring MDI and summer CTD data. Depth-averaged temperatures have increased by 1 °C in 2010-2020. Temperatures rose significantly in the warmest months of the year by 0.26 °C/yr, whereas they appear relatively stable in the coolest months. Highly diluted AW are found at the beginning of the decade, which give way to more and more pure AW in following years, culminating in extensive intrusions in 2016, 2017 and 2019. The long-lasting AW intrusions in 2016 and 2017 individuate the warmest and most saline conditions over the decade in inner Kongsfjorden. Winters in the 2010-2020 decade feature little/no sea-ice and intermediate-shallow intrusions of warm waters, while before 2006 winters had continuously extended sea-ice and low surface temperatures. Observations confirm that Kongsfjorden had undergone a transition from an Arctic-like fjord to an Atlantic-like fjord in the last decades. Although single intrusions of AW are associated with dynamical events on the shelf, the long-term evolution of sea-water temperatures in inner Kongsfjorden is consistent with the heat transport of the West Spitsbergen Current.

6015

Title	**Atlantic cod (*Gadus morhua*) in Svalbard waters**

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The Arctic is a hotspot for climate change induced global warming. Changes in environmental conditions such as increasing water temperatures are challenging for the local marine ecosystem. The Arctic community is facing substantial changes in species distribution and occurrence driven by a northward shift in the distribution of Arctic species along with an invasion of boreal species into Arctic waters. Atlantic cod (*Gadus morhua*), one of most important commercial fish species of the Northern hemisphere will potentially be an ecological key species in the borealization process of Arctic waters. Increasing abundances of Atlantic cod have already been observed over the last years in Svalbard waters while it is postulated that *G. morhua* might face habitat and spawning ground loss in Norwegian coastal waters due to warming scenarios and an overall population movement northwards following its thermal optimal range. Both, migrating Northeast Arctic cod and non-migrating Norwegian Coastal cod are potentially affected whereby alterations of physical conditions around Svalbard could provide alternative spawning grounds and increased habitat availability over the next decades. The expected effects on the local Arctic community are still unclear. Polar Cod as Arctic key species is not only facing increased predation from Atlantic cod but also habitat loss due to sea ice reduction. The overall increase in distribution of Atlantic cod in Svalbard waters also provides new insights into population structure as it could be shown recently for the first time that non-migrating Atlantic cod could be found in Svalbard fjords. Further investigations are needed to improve our knowledge about the occurrence of Atlantic cod in Svalbard waters and if Coastal cod might have found a new habitat in Svalbard fjords as result of a changing Arctic climate.

6017

Title	Particles fluxes at south-eastern Fram Strait (Svalbard)

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Water masses in the eastern Fram Strait are strongly influenced by the interaction between Atlantic and Arctic waters, and by atmospheric forcing, thus contributing to drive the global thermohaline circulation. There is considerable variability in the system due to different forcing (e.g., atmospheric, internal, tidal, shelf dynamics) that play an important role especially in the uppermost layer of the ocean. On the contrary, it is not entirely clear which processes are responsible for the inter-annual and seasonal variability of the deep flow in the western Spitsbergen region.

The oceanographic deep-sea mooring S1 has been deployed since 2014 on the continental slope offshore Storfjorden at a water depth of approx. 1000 m. In 2014-2016 and 2017-2018, a twin mooring (ID2) was also placed 140 km north of S1 at approximately the same depth in order to monitor spatial differences of the properties and dynamics of the water along continental slope.

Short-term fluctuations of thermohaline properties and currents at 1000 m depth were repeatedly measured both at S1 and ID2 in different years. The possible sources of these fluctuations are internal oscillations modulated by atmospheric forcing or episodic cascading of dense shelf waters, which in turn can trigger intrusions of AW into the deep layer, with tricky effects on ecosystem functioning.

Similarl to thermohaline properties, spatial and temporal fluctuations in total mass fluxes were recorded. Peak values of particle fluxes occurred in late winter-early summer, in the same season of maximum variability of thermohaline properties. But, they were not perfectly synchronous with turbidity peaks. Annual particle fluxes ranged between 67 and 198 g m^{-2} y^{-1} at site S1, and ID2 had approximatively twice the values of S1. Here, we discuss the drivers influencing the particle sources and the downward fluxes in the eastern Fram strait.

6018

Title	Sea ice controls on Arctic water vapor content and transport: Discoveries from MOSAiC's Arctic Water Isotope Network (AWIN)

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The loss of Arctic sea ice, through its impact on ocean-atmosphere interactions is one of the key consequences of changing climates. Enhanced evaporation under open-water conditions is widespread from places and periods previously precluded by perennial sea ice cover, leading to an increase in vapor injection into the Arctic's hydrological cycle. However, the response of the ocean-atmosphere system to sea ice loss varies significantly over time and space. To quantify these variations, the Arctic Water Isotope Network (AWIN) has been established to make continuous water vapor isotope measurements (δD, $\delta^{18}O$, and d-excess) at stations from Barrow, Alaska to Ny Alesund, Svalbard. This network has been supplemented by continuous mobile isotope data from the Polarstern ice-breaker throughout the MOSAiC "Arctic-drift" expedition. With this network, we comprehensively track water vapor from its source to sink, thereby demonstrating how it varies simultaneously across the Arctic Basin.

By monitoring vapor isotopic changes in air masses advected from one site to another, we are able to track how much moisture is added along a given trajectory. We investigate several primary vapor transport pathways into the Arctic, including the North Atlantic/Greenland Sea, Baffin Bay, and the Bering Strait, and track the geochemical signature of this vapor as it transits along these storm pathways into and within the Arctic. By quantifying isotopic changes between our sites we: 1) identify the distinct isotopic fingerprint of moisture sourced by evaporation from Arctic seas that are dependent on variable sea ice, 2) detect moisture addition into storm tracks as they transit across the Arctic, and 3) determine the spatial variability of this enhanced Arctic-sourced evaporation and

moisture. We find that for every major storm track observed, the Arctic Ocean and surrounding seas are significant sources of enhanced moisture uptake, acting within an amplified water cycle.

6019

Title	An observational approach to determine a sliding law for glaciers: the MAMMAMIA project

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Glaciers display a wide variety of different velocity variations, spanning from slow creep of cold ice to sliding-dominated surges, ice-streaming and even avalanche-like detachments. In light of global sea-level rise, a potential climate control on acceleration of ice-discharge from glaciers and ice-sheets into the sea is of particular concern. Assessments of future ice discharge are highly sensitive to the form of the used sliding law but are subject to large uncertainty because available theoretically-derived relations yield different behavior. Better understanding of the sliding motion is therefore urgently needed. Observational constraints on the form of the sliding law require measurements covering glacier behavior in different velocity regimes and over a multitude of spatial and temporal scales.

The RCN-funded MAMMAMIA project (Multiscale-multimethod analysis of mechanisms causing ice acceleration) aims at collecting and analyzing a dataset that is suited to shed light on the sliding relation over a variety of spatial and temporal scales. A blend of different technologies is the backbone of our observational program, mutually compensating each other's strengths and weaknesses to provide a coherent picture of glacier velocity variations. While up-to-date remote sensing products deliver velocity fields on the scale of entire glacier regions, their temporal resolution is limited to about one week. In-situ satellite navigation systems (GNSS) provide (sub)daily velocity measurements at the point-scale but theory and observations suggest that slip-events happen over much shorter timescales (seconds). Although not a direct velocity measurement, cryoseismology provides a window into these processes, by scanning seismicity at sub-second intervals. To ease interpretation of our dataset, we elucidate its geophysical context by complementing records of subglacial water pressure, ice temperature and surface meltwater generation.

We have selected the surge-type glacier Kongsvegen in vicinity of Ny Ålesund, that displays seasonal and shorter velocity variations. Recent velocity measurements show that it has started accelerating in its upper part, suggesting that a new surge may be imminent. An observational record of a surge

onset would provide a coherent picture of glacier dynamics covering more than one order of velocity magnitudes and thus enable better constraints on the sliding law. The presentation reports about the field-activity and results of the first field season.

6020

Title	Dynamic and temporal evolution of Total Dissolved Inorganic Carbon inside Kongsfjorden waters

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The study of gases concentrations and fluxes in the climate system ocean-atmosphere-land represents a suitable and valid tool to monitor the climate conditions and its evolution and effects at global scale. Polar regions, represent a suitable natural laboratory to monitor the global changes in the equilibrium of greenhouse gases within ocean-atmosphere-land ecosystem.

Together with carbonate and bicarbonate ions and carbonic acid, the dissolved CO2 contributes to the Total Dissolved Inorganic Carbon (TDIC). Therefore, TDIC represents one of the most important parameters to study and monitor the ocean acidification process and the temporal evolution of the ocean carbonate chemistry in relation to the variation of atmospheric CO2 concentration. In this framework, our project (AR-DIS-CO2 - RiS 11079) tackles the dynamics of dissolved gases in the ocean water of the Kongsfjorden (Svalbard islands, W archipelago). Focus of the research activities is to monitor and understand the processes involving major dissolved gas species.

Since 2016 we have performed TDIC measurements along vertical profiles in selected sites of the Kongfjorden, together with measurements of T, pH, Electrical Conductivity, Turbidity using a multiprobe and portable instruments. Moreover, preliminary samplings and analyses of dissolved gas from two sites of the fjord along a vertical profile were performed in 2018 and 2019.

First results highlight the relationships between the dynamic and distribution of fresh cold water coming from molten glacier inside the fjord and geochemical signal measured in vertical profiles. In particular, the decreasing of T and electrical conductivity associated to increasing in values of turbidity, dissolved oxygen and TDIC concentration highlight an inflow of molten water discharged by the Bayelva river, which evolves inside the fjord. The dynamic of these processes depends of course from seasonal variations and longer period of observation is needed for its better understanding.

6021

Title	Simulations of mass balance and runoff from Svalbard, 1998-present

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The Svalbard archipelago is undergoing increased warming compared to the global mean, which has major implications for freshwater runoff into the oceans from seasonal snow and glaciers. We use the land surface model CRYOGRID, which includes a coupled energy balance-snow/firn model, to quantify the climatic glacier mass balance (cmb) and freshwater runoff from Svalbard from 1998-present at a 2.5 km spatial resolution. For glaciers, the temperature, density, refreezing, and water content are simulated for snow, firn and ice down to a depth of > 30 m. For land, a seasonal snow routine is coupled to a soil model, which simulates the ground temperatures. The simulation is forced by meteorological input from the CARRA reanalysis product from 1998-2019. The results are compared to available surface mass balance (smb) records and automatic weather stations from different regions in Svalbard. Comparison with smb records show an average root-mean-square error of 0.17 m for the winter mass balance and 0.35 m for the summer mass balance.

An additional simulation using AROME-ARCTIC forecasts as forcing is conducted from 2016-present. From this, we assess if the forecasts can be used to give reliable, continuous updates on the state of glaciers in Svalbard. Comparison with smb observations show similar results as for CARRA (root-mean-square of 0.23 m and 0.33 m for winter and summer, respectively).

Finally, we use high-resolution digital elevation models of the glacier surface and bottom topography to delineate runoff basins and estimate the spatial distribution of runoff. Using these results, we investigate the changes in runoff into the Arctic Ocean and the Barents, Greenland, and Norwegian Seas, and the fraction of runoff coming from seasonal snow and glacier melt.

6022

Title	Isotopic fingerprinting (H, O, B, Sr) of glacial melting water and precipitation: First evidences from Kongsfjorden area

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In the Kongsfjorden area, a network of glacio-drainage system develops and remains active in the period June-September as a consequence of glacier melting. In June 2018 we performed a field campaign (supported by the Italian base) collecting water samples from Kongsvegen (KGV), Austre (ABG) and Vestre Brøggerbreen (VBG), and Midtre Lovénbreen (MLB) glaciers. One of the purposes of the research was to apply a multi-isotopic approach to trace sources and processes of melting dynamic coupling chemistry, stable isotopes of water molecule and dissolved trace elements (boron and strontium).

Sampling sites were selected on each glacier to be representative of the water flow both of minor drainages produced at different elevations, and of the main stream that enters the Kongsfjorden. Isotopic signatures of precipitation events in 2021 were also added to the study. Analyses were performed at IGG laboratories in Pisa, using ICP-MS for trace elements, and ICP-MC-MS for boron and strontium isotopes after chemical purification in clean room (class100).

Isotope signatures of boron and strontium from the four drainage systems indicate that Sr source from crystalline lithologies at KGV, ABG and MLB, and from a mixed carbonate + silicate facies at VBG. The lithologic signature highlighted by Sr isotopes appears in general subordinated to the marine aerosol component, and it indicates low chemical weathering processes during water interaction with moraines. This evidence is also supported by the isotopic signature of boron, dominated by the meteoric source. Hence, our preliminary study could suggest the role played by dry deposition of marine origin in the Kongsfjorden area, as reported in the literatures.

6023

Title	Quantification of flow rate and suspended solids from glaciers to Kongfjorden and their impact on the geochemistry of seawater

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Most of the Svalbard fjords are affected by freshwater and sedimentation from glaciers and riverine inflow, as well as sea-ice dynamics from seasonal ice formation and melt. The changes in glacier volume and snow cover, and the corresponding changes in downstream runoff, are especially important in the Arctic, where ~58% of the world's glaciers are located and climate change is most intense.

To study the transfers of freshwater, major ions and suspended solids to the Arctic Ocean, we started an isotopic and physical-chemical monitoring of inland glacier drainages and ocean water into the Kongsfjorden in 2015.

Here, we discuss data on water flow rate transferring from the main glaciers to Kongsfjorden and their interactions with seawater at different depths. The results highlight the effect of the freshwater contribute into the fjord, starting from the southern coastline where one of the major glacial drainage system (the Bayelva river) transfers millions of cubic meters of melt water. The mixing of freshwater-seawater seems to become increasingly evident along the well-known seawater counter clockwise current, as suggested by the changes of isotopic signature tied to melt water inputs from several glacier drainages. Results concerning meltwater underline chemical and isotopic differentiation both among various glacier systems and within the same system, confirming the efficiency of this tools for understanding the glacial melting dynamics.

Different signals (particularly for isotope signature) observed among systems seem to suggest several melting evolutions, which are likely tied to the peculiar physical features of the systems and affecting the rate of melting and subsequent downstream processes. This highlights that the monitoring of glacial meltwaters can represent a valid tool for tracing changes on climate conditions and their effects.

6024

Title	**Kongsfjorden Flagship: working together to understand an Arctic sentinel fjord**

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Kongsfjorden, on the west coast of Svalbard, is a hotspot both for marine biomass production and for arctic research, due to its vicinity to the permanent Ny-Ålesund research station. As a point of integration of oceanographic inputs from northward flowing Atlantic waters, local Arctic waters, and meltwater from tidewater glaciers and permafrost, it also is a prime location to study many of the key drivers of the marine environment that are relevant across the Arctic. Researchers from many nations and institutions have studied Kongsfjorden for decades, observing and understanding the significant physical, chemical, and biological shifts that are occurring in the fjord due to ongoing climate change in the Arctic. Since 2008, marine researchers who work in Kongsfjorden have formed the Kongsfjorden System Flagship, allowing for collaboration, synergies, and knowledge sharing toward the aim of world-class Arctic research. In the framework of the Flagship community, joint dataset and publications can be produced, larger projects that benefit the entire marine research community can be developed and achieved, workshops on overarching themes can be explored from all angles, and research proposals can be developed. All researchers who work in the marine realm of Kongsfjorden, from ocean chemistry and hydrography, via plankton and sediments, to sea mammals are welcome, and encouraged, to take part in the Flagship.

6025

Title	The continuous geochemical monitoring of Bayelva river

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Forecasting changes in freshwater flows due to alteration of glaciers with the present and future warmer climate is one of the major challenges for modern hydrology. In this study, we investigate the dynamic processes of the glacial melting in the Kongsfjorden area, in particular in the Bayelva catchment. Several studies focused on Bayelva catchment, which includes Austre and Vestre Brøggerbreen glaciers, highlighting changes in the weathering environments and drainage network.

The main goals of this work are: (1) gain more knowledge about the complexity of the distributed drainage system; (2) investigate flow provenance especially at the beginning of snowmelt phase and at the end of melt season; 3) quantify the contribution of Bayelva river to the ocean as freshwater discharge and total suspended solids.

The activities consist of periodical monitoring of isotopic and physical-chemical parameters and flow rate measurements. Since 2016, a system for continuous monitoring of temperature (T), electrical conductivity (EC) and water pressure has been installed in the Bayelva River (VBG7 site) in order to study the variability of these parameter at high resolution temporal scale.

A substantial variation is observed at monitoring station VBG 7 for both daily and seasonal time scales. In particular, significant variations were observed for EC and T values, both seasonally and daily in the Bayelva river at VBG7 station, which is not constant during the melting season. Moreover, during days higher values of water level (i.e. flow rate) occurred a few later than higher T values and concurrently with lower EC values. The evolution of parameters clearly highlights the high complexity of these systems and their high sensitivity to the meteo-climatic regimes.

6026

Title	Seasonal plankton trends in Kongsfjorden, Svalbard during two consecutive years with a warm and cold spring

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Seasonal plankton time-series data are presented from Kongsfjorden on the west coast of Spitsbergen (79°N) from two years with contrasting spring conditions. Kongsfjorden integrates inputs from Atlantic and Arctic waters, and glacier run-off, and is thus a prime location to study key environmental drivers that are relevant across the Arctic. Despite the extensive research in Kongsfjorden over the last decades, seasonally resolved data are scarce. From early May to early September 2019 and 2020, we conducted field sampling at a mid-fjord station at weekly to bi-weekly resolution investigating the environmental drivers of phyto- and zooplankton phenology. Spring 2019 was warm with water temperatures >1°C throughout the upper 250 m of the water column and little sea ice in the fjord while spring 2020 was characterised by sub-zero water temperatures and relatively extensive sea ice cover. The most striking contrast between the two years was the difference in phytoplankton spring bloom composition. In 2019 the spring bloom was dominated by the colonial stage of the haptophyte Phaeocystis pouchetii, while in 2020, the diatoms Thalassiosira spp. and Chaetoceros spp. dominated. In addition, the spring bloom in 2019 commenced about one week earlier and lasted for over one month compared to two weeks in 2020, and summer phytoplankton biomass was higher in 2019 than in 2020. In 2019 the early nauplii stages of the dominant Calanus copepods coincided with the spring bloom, suggesting good feeding conditions for copepod larval growth. The zooplankton samples from 2020 are currently being analysed. Our data provide a first glimpse into the environmental drivers of plankton phenology and underline that high-resolution monitoring over many annual cycles is required to resolve the ephemeral variations of plankton populations against the backdrop of climate change.

6027

Title	Do depth gradients in glacier-influenced Arctic waters shape vertical distribution of zooplankton?

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During Arctic summer, intensified glacial melt discharges particulate matter to the surrounding waters, and affects the penetration of light through the water column. Despite limited ability of zooplankton to control their horizontal position, they can, to a large extent, regulate their vertical distribution in response to such changes in seawater optical properties. Hence, darkening of the Arctic coastal waters may affect patchiness of zooplankton as they adapt an efficient strategy for coping with the highly variable depth gradients in food availability and predation risk. The aim of the present study was to examine how depth of change of underwater light regime and stratification constrains due to glacial and riverine discharge influence the vertical distribution of zooplankton. To test this, we studied hydrographical conditions (CTD) and optical properties in the West Spitsbergen coastal waters in late July and August 2019. Simultaneously, the concentrations of chlorophyll a and suspended particulate matter as well as distribution of particles and zooplankton were examined. Our results show that the relative position of turbidity and fluorescence peaks has an influence on zooplankton distribution in the water column. Notably, turbid subsurface plumes most likely create stratification constrains for protists, and zooplankton tends to accumulate beneath this water layer. In muddy waters where turbidity is high only at the surface or throughout the whole water column, the abundance of dominant zooplankton taxa is usually lower than in clear waters, but it does not always affect their vertical distribution in such direct way.

6028

Title	**Automated observations of den emergence behaviour of polar bear families in Svalbard, Norway.**

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Natal denning affords an extended period of critical protection and development for the offspring of a wide range of species that give birth to altricial young. Protections afforded by denning include a buffer from environmental conditions, protection from predation, and presumably, reduction of the energetic costs of excessive wakefulness associated with vigilance or fear. In the Arctic, greenhouse gas emissions from human activities drive increases in air temperatures twice that of the global average. Arctic species--including polar bears--dependent on denning in the snow or sea ice, atmospheric and oceanic warming are causing significant losses to these critical habitat features. Here we assess the first five years of a study focused on polar bear maternal den emergence behaviour on Svalbard. Through behavioural observations, we infer polar bears' vulnerability or resilience to environmental conditions. We describe the variation in the timing of den breakout, the number and duration of emergence events, maternal and cub behaviour while outside the den, and den-site departure timing. We correlate the timing of den emergence and den departure with prevailing regional weather and sea ice patterns in the months prior to den entry, and at the time of emergence and den departure. We also examine weather patterns in the area during the denning period, notably rain/freeze events, to gain further insights into the influence of weather on den stability. Finally, we correlate our observational data with those data captured by collar-mounted sensors, specifically accelerometer and temperature. We suggest that behavioural monitoring efforts continue to evaluate the influence of climate on cub readiness for life outside the den.

6029

Title	Warming of Atlantic Water in three West Spitsbergen fjords: recent patterns and century-long trends

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We investigated the recent warming of summer Atlantic Water in relation to the century-long trends in maximum temperature in three West Spitsbergen fjords: Isfjorden, Grønfjorden, and Billefjorden. Based on repeated along-fjord transects in late summer 2003-2019, we found that the warming has been pronounced not only in the outer but also in the inner domain of Isfjorden, where the presence of waters of Atlantic origin was registered more frequently after 2011 compared to the early 2000s. Furthermore, there was more frequent occurrence of Atlantic waters in the bottom layers in the inner part of the fjord. In all the investigated fjords, the year 2014 was the warmest and saltiest during the period 2003-2019, which is consistent with previous reports for other West Spitsbergen fjords. In 2014, the mean temperature and salinity in Isfjorden and Grønfjorden exceeded 4.9 ℃ and 34.7 (in Billefjorden, 4.0 ℃ and 34.67, respectively). With the new data for 2010-2019, we extended the time-series of maximum Atlantic Water temperature in Isfjorden and Grønfjorden, covering 1912-2009, reported previously in Pavlov et al. 2013. For the period 1912-2019, the average long-term trend of Atlantic Water maximum temperature is 0.25 ℃/decade and 0.22 ℃/decade in the outer part of Isfjorden and Grønfjorden, respectively. In the first two decades of the 21st century, the warming trend is steeper, compared to the 20th century: 0.78 ℃/decade in Isfjorden and 0.56 ℃/decade in Grønfjorden, thus highlighting the strength of the ongoing "atlantification" of West Spitsbergen fjords.

6030

Title	Seasonal changes in photosynthesis and biochemical composition in Arctic macroalgae undergoing a climatic transition

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Seasonal physiology of the algal community in Kongsfjorden sublittoral ecosystem is expected to be affected by Global Climate Change. We characterized the photosynthetic performance (by means of chlorophyll a fluorescence, O2 evolution and 14C fixation) and biochemical composition (pigments, soluble carbohydrates, soluble proteins, lipids and total C and N) of five common macroalgae of Kongsfjorden, from early autumn 2016 to late summer 2017. The studied species were the ochrophytes Saccharina latissima and Alaria esculenta, the rhodophytes Phycodrys rubens and Ptilota gunneri, and the chlorophyte Monostroma aff. arcticum (not present in March). Fluorescence results endorse the previously reported higher values of maximum quantum yield (Fv/Fm) and electron transport rates (ETRmax) in brown and green species than in red ones. In addition, a decrease in ETRmax and lower saturation irradiances in brown and green algae in summer suggest more sensitivity to continuous irradiation than in rhodophytes. Photosynthetic parameters calculated from O2 measurements show that brown species have a better photosynthetic performance in March in response to increasing irradiance, while red and green species did in September. In general, 14C fixation at saturating light was higher in September, except for A. esculenta (in March). The loss of photosynthetic capacity of macroalgae in summer could be attributed to a decrease in pigment concentration, except for M. arcticum. Composition also varied along seasons; in summer, under continuous illumination, brown and green species accumulated more soluble carbohydrates, while rhodophytes did in early autumn. In most species lipids presented minimum values in March and proteins did not show a clear temporal pattern. In general, high N content in March and high C content in August reveal a seasonal pattern in elemental composition, related to nutrient and light availability along the year. Seasonal responses are species-specific and likely related to their particular adaptive features to the Arctic environment.

6031

Title	Warming modifies the seasonal photophysiology and productivity of Arctic macroalgae

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Warming is affecting Kongsfjorden ecosystem with special intensity due to the influence of oceanic currents altered by Global Change. The effects of this stressor on the ecophysiology of Arctic seaweeds have been widely investigated, but mostly restricted to summer. However, Arctic coastal ecosystems experience strong seasonal changes in environmental light conditions from 24-hours of darkness in winter to 24-hours of light in summer, which likely alter the photosynthetic performance of macroalgae. In order to understand how increasing temperature will affect Kongsfjorden ecosystem dynamics it is crucial to analyze the effect of seasonal photoperiod on the responses of Arctic seaweeds to warming. Thus, we carried out experiments in September (fall equinox), March (spring equinox) and August (24h of light) to compare the photophysiological responses of common seaweed species of Kongsfjorden after acclimation to continuous light and 12:12 light:darkness at 4ºC, as well as the responses to increased temperature (8ºC) at the corresponding seasonal photoperiod.

Due to 24-hours light stress in summer, macroalgae generally showed reduced photosynthetic capacity when compared to the equinoxes. Additionally, higher photoinhibition along with higher respiration rates were induced when seaweeds were exposed to continuous light in the equinoxes, whereas macroalgae exposed to 12:12 light/dark cycles in summer showed no changes in the photosynthetic capacities and respiratory rates, indicating that seaweeds cyclically acclimate to the seasonal light conditions in the Arctic. These differences were observed when photosynthetic light reactions were assessed, but were reduced or even disappeared when 14CO2 fixation was measured. The increase in temperature frequently enhanced 14CO2 fixation and respiration rates, while growth rates were mostly unaltered, but season-specific and species-specific effects were observed. These results are highly valuable for constructing primary productivity models of the macrophytobenthos for the whole fjord, which can serve to make accurate predictions of productivity and ecosystem functioning in near-future scenarios.

6032

Title	Timing and magnitude of ice algal biomass in land fast sea ice in Svalbard

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The diverse climatic conditions in Svalbard, with strong gradients in sea ice and snow depth over short geographical distances, make it an excellent study location to investigate the main driving environmental factors determining the onset of sea ice algae bloom and magnitude. The timing of the bloom and chlorophyll a biomass may also give an insight into the roles of ice algae versus phytoplankton in seasonal ice- covered fjords. Sea ice algae are considered to play a key role in Arctic marine food webs, yet minimal data exists due to the challenge of sampling ice algae frequently enough due to logistical constrains. Multiple environmental parameters including light, snow depth, nutrients, water temperature and salinity control growth and development of ice algae. In this study we have compiled ice algal data from 2007 to 2021 to secure sufficient data to determine the main steering environmental factors determining the timing and magnitude of ice algae biomass in land fast sea ice in Svalbard. Ice cores collected from various fjords in western, eastern, and northern Svalbard from early March to June, with ice thicknesses ranging from 30 to 130 cm and snow depth from 0 to 40cm were investigated. Preliminary results show snow cover to have a significant impact on timing and magnitude of ice algal biomass as well as significant variations on a geospatial scale.

The ongoing environmental changes in the Arctic will impact the algal community composition significantly, with more fjords being subjected for the process of Atlantification and changes in precipitation/snow cover and seasonal duration. Assessing sea ice algae abundance and distribution generates important knowledge on how these primary producers are likely to respond to warmer climate and reduction of their sea ice habitat. Consequences of a warmer climate on sea ice algae in Svalbard may be applied to other Arctic regions to predict future consequences of global warming on broader Arctic marine primary production.

6033

Title	Influence of dissolved organic matter on an Arctic marine microbial community – a mesocosm study

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Climate change is affecting Arctic regions faster than the rest of the globe. A consequence of climate change is the enhanced erosion of soils and glacial melt. Both processes lead to an increased release of dissolved organic matter (DOM) into marine environments. This DOM can impact the physio-chemical environment and components of marine microbial communities, and understanding these impacts are essential for predicting future responses to climate change. Mesocosm experiments provide a balance between lab and field-based observations. By encapsulating water in an outdoor experimental system, we can manipulate the levels of DOM and observe how microbial components change over time, whilst still being exposed to natural environmental conditions.

In this study, a mesocosm experiment was conducted in Ny-Ålesund during June 2020. Six bags were filled with fjord water, with 3 of them receiving a DOM substance known as HuminFeed, to mimic enhanced runoff from land to the marine environment. A second land-based experiment was also conducted using the same experimental set up. We followed the components of the microbial ecosystem using a combination of flow cytometry, FlowCAM and 18s rRNA metabarcoding measurements. Addition of HuminFeed led to enhanced abundances of autotrophic phytoplankton, particularly small picoeukaryotes, within both the mesocosm and tank experiment. We also observed a reduced abundance of heterotrophic nanoflagellates and ciliate predators with the addition of HuminFeed relative to the control treatment.

This data suggests heterotrophic organisms may be more susceptible to negative effects of DOM addition to Arctic fjord environments. A consequence of this is a greater abundance of autotrophic prey organisms. Molecular metabarcoding of communities provided greater resolution on which organisms responded to DOM input. Observing differing impacts using HuminFeed can enhance our understanding of how continued DOM input to Arctic environments will impact aquatic ecosystems.

6034

Title	Ecosystems in transition: how to monitore changes in coastal environments in Svalbard?

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Coastal waters are the most productive regions in the Arctic. These nearshore waters are critical breeding and foraging grounds for many invertebrates, fish, bird and marine mammals, and provide a valuable host of ecosystem services explaining why 95% of the human settlements in the Arctic are located by the coast. Arctic coastal nature types (= coastscapes) and biodiversity is under growing pressure as climate change and human activities increases. Tidewater glaciers shrink and move onto land, seasonal sea ice does not form, and more wave exposure and coastal erosion combined with increased river runoff change the water quality and underwater light regime. Svalbard archipelago is warming more rapidly than anywhere else. There is a huge potential for increased colonization of boreal species with potential negative impacts on the "native" species assemblages and food webs. For government managers, industries, conservation organizations and communities there is an urgent need for access to timely and complete biodiversity status and trend data to predict future challenges and opportunities as climate gets warmer and sea ice disappears. Here we present recommendations for how to monitor the highly dynamic and divers coastal environments in Svalbard. These recommendations were prepared by several nations, institutes and disciplines during a Sustainable Svalbard Coasts workshop in Longyearbyen, February 2020. Further we evaluated the applicabilty of the Arctic Coastal Monitoring plan, initiated by the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF, www.caff.is), for Svalbard.

6035

Title	Assessing darkening of Svalbard fjords waters from space during 1997-2019

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Global warming is rarely discussed in the aspect of light availability deacrease within the water column. However, the three main factors that are influenced by climate changes which are the sea ice albedo feedback, glacier melt-water runoff and marine primary production in the Arctic Ocean control also the light regimes. Changes in light availability and water transparency of coastal waters is one of the important manifestations of the climate change, but longer time-series are required to describe such changes. To this day, very few reports have been published on multi-year variability of seawater optical properties in Svalbard fjords and adjacent waters. In this study, we aimed to fill the knowledge gap by analyzing ocean color remote sensing data archives using the developed, and locally optimized, algorithms for retrieval of optical parameters from space. Based on a satellite data series during 1997 – 2019 we report long-term changes of the three commonly used optical characteristics Chla, atot(443), and Kd(490) within the Svalbard fjords and on the West Spitsbergen Shelf. We revealed evident positive trends in summer (July – September) in the Isfjorden, the Kongsfjorden, the Hornsund fjord, and the Bellsund. Moreover, between 1997 and 2019 at the majority of locations we observed a regime shift towards darker waters. Our research provides the first documented record of ongoing "darkening" in Svalbard fjords and adjacent shelf waters which may be an indication of profound transformations in the environment. Our findings provide an essential background information for a wide range of ecological studies and will advance our understanding of effects of climate change on Svalbard system, which is needed to develop the environmental management plans on Svalbard.

6036

Title	**Inputs from land drive physical, biogeochemial and ecological responses in a high Arctic fjord system (Isfjorden, Svalbard)**

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Climate change is resulting in permafrost thaw, melting glaciers, and altered precipitation and runoff patterns; leading to altered inputs of freshwater and terrigenous material (sediments, nutrients, organic matter, and contaminants) from land to sea. However, there remain critical knowledge gaps related to how inputs from land shape Arctic coastal ecosystem structure and function, making it difficult to assess how future changes in these inputs could impact productive and important coastal ecosystems. Here we present results from an interdisciplinary study in a river- and glacier-influenced high Arctic fjord system (Isfjorden, Svalbard). Through extensive sampling during the 2018 melt season, we characterized inputs of sediments, nutrients, organic matter and contaminants from land to sea for five rivers and two marine terminating glaciers, and studied impacts of these inputs on: 1) physical and chemical conditions in coastal waters and sediments, 2) benthic and pelagic community structure, 3) main food sources for coastal biota and 4) food web accumulation of mercury and persistent organic pollutants. We found that inputs from land played a key role in determining availability of light, nutrients and organic matter in the fjord. Freshwater influence was associated with increased stratification, turbidity, light attenuation, and concentrations of particulate nutrients, silicate, nitrate and terrigenous organic matter. These physical and chemical changes drove differences in benthic and pelagic community structure, e.g. with high environmental stress in river estuaries and at glacier fronts leading to reduced benthic biodiversity compared to sites less influenced by inputs from land. We also observed seasonal changes in particulate and dissolved organic matter quality, main energy sources for coastal biota, and food web accumulation of contaminants as the melt season progressed. These results highlight the potential for increasing inputs from land to sea to have widespread implications for Arctic coastal ecosystems, and point to future research needs.

6037

Title	Climate change induced shifts in sea ice algae nutrient content: species, community and trophic implications.

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The Arctic is experiencing one of the most accelerated rates of warming on the planet, driving a persistent trend in the reduction of Arctic sea ice extent with the prediction of sea-ice free summers within decades, and substantial changes to snow cover. Yet the biological ramifications of these changes remain largely unexplored. Understanding the implications of climate change on sea ice algae is particularly important, as sea ice algae contribute significantly to primary production in seasonally ice-covered waters. As sea ice algae are limited by a range of environmental factors, including light availability, the ongoing environmental changes in the Arctic will shape the algal community composition, impact their phenology and influence the macromolecular composition of the individual species. Combined, these effects alter the nutrients supplied to higher trophic levels. Even small changes in nutrient availability at the production level can have large cascading effects on higher trophic organisms. This study traces the changes in community composition and individual physiologies of sea ice algae as a result of environmental change. Specifically, we use FTIR-microspectroscopy to perform single-cell analyses to investigate how sea ice algae shift in carbon partitioning between the macromolecular storage of proteins, lipids and carbohydrates in response to natural variation in light due to changes in ice thickness and snow depth. This variation is captured from a gradient in snow depth of 0-40cm and ice thickness of 30-100cm, during March – May 2021, in land-fast ice in a variety of fjords in western, eastern and northern Svalbard. As the phytoplankton-zooplankton link is the key to secondary production in polar oceans, these changes to the nutritional quality of primary producers are expected to have broad, cascading effects on food web dynamics in the polar marine ecosystems.

7103

Title	Can Norway and Russia coordinate efforts in healthcare and emergency preparedness on Svalbard?

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For the last decades, Svalbard has transformed from being a male-dominated society based on coal mining, to becoming a modern family community with relatively well-developed health services and welfare facilities resembling a mainland municipality (Irtun, 1997). Tourism and research activities have to a large degree replaced coal mining as the main industries on the archipelago.

This socioeconomic change is reflected in the health challenges on Svalbard. Earlier, the main health challenges were work-related or caused by traffic accidents. Today, the health challenges are more often related to tourism than to occupational hazards (Wæhler, 2021). Svalbard's unique location and status entail particular challenges regarding healthcare and emergency preparedness. Long distances, harsh climatic conditions and limited access to healthcare and rescue personnel are among the main issues. These challenges are shared by Norway and Russia, the two countries with permanent settlements on the archipelago.

The existing knowledge about health challenges on Svalbard reveals that Norway and Russia indeed cooperate with regard to healthcare and emergency preparedness, for instance during large accidents such as with the Maxim Gorkiy cruise ship on its way to Magdalenefjorden in 1989 and with Vnukovo Airlines Flight 2801 near Operafjellet in 1996. However, the joint infrastructure for healthcare and emergency preparedness is limited and there is a low level of cooperation between the Barentsburg and Longyearbyen hospitals (Norwegian Ministry of Health and Care Services, 2013).

Cooperation and coordination is believed to make the system for healthcare and emergency preparedness on Svalbard even better. Looking at how Norway and Russia have cooperated and coordinated their efforts in healthcare and emergency preparedness earlier, will be useful to determine how future strategies and policies for healthcare and emergency preparedness on Svalbard should be developed.

7104

Title	The occurrence of Nematoda in coastal sea ice on Svalbard (European Arctic) determined with the 18S small subunit rRNA gene

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Understanding the diversity and functioning of Arctic sea ice ecosystems is vital to evaluate and predict the impact of current and future climate change. In the microscopic communities inhabiting the brine channels inside sea ice, nematodes often dominate numerically and act as bacterivores and herbivores. Despite nematodes great abundances and known ecological roles, molecular tools have not been applied to investigate their species diversity in sea ice. In an attempt to begin establishing a molecular baseline for species diversity of sea ice nematodes, we Sanger sequenced 74 specimens from four locations around Svalbard (European Arctic), using the 18S rRNA barcode. Currently available nucleotide reference databases are both underpopulated with representative marine nematode taxa and contain a substantial number of misidentified organisms. Together, these limitations inhibited the ability to identify marine specimens collected in this study with certainty. Nevertheless, our molecular data indicate the presence of two genera in sea ice on Svalbard—*Theristus* and *Halomonhystera.* While it is possible that the latter represents a novel ice nematode species, future studies, including morphometric analysis, are needed to verify our molecular findings. We leverage the assignment of molecular information to robustly identify nematodes and provide the first insight into the diversity of sea ice nematodes in the European Arctic. We advocate for an intensified cooperation between molecular and morphological taxonomists to expedite the establishment

7105

Title	**Using time series to predict the future: quantifying the effects of borealization on polar cod (*Boreogadus saida*)**

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As a result of global change, the Barents Sea is undergoing environmental changes defined as a "borealization" of this Northern marine ecosystem. Endemic Arctic species which are adapted to life in seasonally sea-ice covered waters experience a decrease in sea-ice covered area, an increase in sea temperature, and immigration of boreal species increasing predation and competition. Many knowledge gaps remain regarding how "borealization" influences the dynamics of Arctic populations. Here we focus on polar cod (*Boreogadus saida*): a key marine fish species with a pan-Arctic distribution and adapted to life in Arctic seas. We developed a Bayesian state-space model to analyze the population dynamics of the Barents Sea (BS) polar cod. Using a 30-years long time series (1986-2015) of abundance, we first modelled, the effects of abiotic variables, i.e. temperature and sea ice cover, and biotic variables, i.e. prey biomasses and predation pressure index on the fish stock. Then we used the model to run environmental scenarios on the population data to quantify potential consequences of an increased borealization. Our results show that in a warmer and low sea-ice Barents Sea, the BS polar cod stock would be reduced by 34% with a clear detrimental effect on young individuals. Moreover, our results predicted a decreased survival of the older individuals and a reduction of the stock by 28% in case of increased predation. However, the effects of changes in predation were less evident than changes in sea-ice and temperature. In a rapidly changing Barents Sea, our analyses and our methods contribute to the effort to understand and quantify the reaction of Arctic ecosystem to current and future environmental changes.

7106

Title	Climate changes under a previous period of icehouse condition; the Carboniferous Permian rock record in Svalbard.

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The more than 600 million years of sedimentary rock record in the Svalbard archipelago is a unique library to study climate changes back in time. Most variations are caused by continental drift. But changes linked to global and astronomic influence are also evident, and during the last 65 million years climate has varied from warm temperate to cold Arctic at Svalbard despite its almost stationary position.

An example is the partly abrupt variations in facies associations from the uppermost Devonian to end of Permian succession in Svalbard. This was a period when global climate was comparable to the last 35 million years, i.e. icehouse condition: The Late Paleozoic Icehouse (360 to 260 million years ago). Sedimentary rocks from this period reveal a shift from warm humid tropical climate during the early Carboniferous to warm subtropical and arid climate during the late Carboniferous and early Permian to temperate during the later parts of the Permian.

The shift in Carboniferous-Permian climate can be linked to the northwards plate wandering of the Eurasian continental plate; from near Equator in the middle Devonian to near 50^0 C north at the end of Permian. Superimposed on this gross shift of climate are higher frequency changes e.g. from warm humid tropical to warm semi-arid and vice versa allowing studies of the sedimentary response to both gradual and abrupt transitions in climate.

Studies of ancient depositional systems in Svalbard may help to understand and differentiate the relative importance of the changes imposed to the modern systems.

7107

Title	The IsA time series- a high-Arctic model system for climate change.

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The Isfjorden-Adventfjorden (IsA) marine time series station in the high-Arctic Svalbard is an excellent model site for studying the ecosystem effects of climate change (Atlantification). The station is periodically flooded by warm Atlantic Water, and thus alternates between "cold" arctic and "warm" Atlantic states, the latter predicted to become more dominant in the future. We have analysed 8 years (2011-2019) of high temporal resolution data (sampled weekly to monthly), focusing on microbial eukaryotes. DNA metabarcoding of 18S rDNA and flow cytometric counts from water-samples collected at 15 and 75m depth revealed a highly seasonal community composition, with recurring annual patterns but also with large interannual differences. We here discuss the data in relation to measured environmental parameters (temperature, salinity, light, photosynthetic biomass, nutrients), with the aim of identifying environmental drivers and predicting ecosystem responses to future climatic scenarios.

7108

Title	Hornsund in the Holocene: a fjord or a strait?

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Analyzing the "warmer than present" phases of the Holocene glacier history of Svalbard may shed new light on the future changes triggered by the ongoing warming of the Arctic. Due to the rapid recession of Hornbreen-Hambergbreen glaciers in Hornsund, the next few decades are likely to witness the separation of Sørkapp Land from Spitsbergen and opening of the strait between the Greenland and the Barents Seas. Here we present new evidence for existence of this strait also earlier in the Holocene. Radiocarbon dating of molluscs shells from the shell-bearing till at the forefield of Hornbreen indicates the glaciers retreat in the early-middle Holocene and during the Medieval Warm Period. Nowadays the strait has been closed since the LIA as a result of subsequent glaciers advances. The clearly visible gradual changes in the size of the shell fragments – from tiny particles near the glacier terminus to intact valves in the farther part of the forefield – suggest their reworking in the subglacial conditions during several glacier surge episodes. The last strong surge of Hornbreen occurred at the end of the LIA. Analysis of the Landsat satellite images and calculated morphometric coefficients characterizing the frontal zones, together with the previous results, indicate five possible advances of Hornbreen and one surge of Hambergbreen in the 20th century. Our results support the idea of applying the environmental conditions in the early Holocene as a potential benchmark for future predictions. On the other hand, the contemporary state of the Svalbard glaciers may act as a reference for the older periods of climate warming.

7109

Title	**Depositional and Paleoenvironmental Evolution of the Forlandsundet Graben, Prins Karls Forland, Svalbard - Preliminary Results**

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The Fram Strait, situated between Svalbard and northeast Greenland, is the only deep oceanic gateway connecting the Arctic Ocean with the Atlantic Ocean. Our modern climate system in Europe, Greenland, and the Arctic is strongly influenced by the thermohaline circulation through the Fram Strait. Warm, Atlantic surface water flows into the Arctic Ocean, while cold, Arctic deep-water returns southwards to the Greenland Sea. Even though it is generally known that the Fram Strait opened following the seafloor spreading between Greenland and Svalbard, the precise timing and exact sequence of this opening, and thus the onset of its influence on the climate system, is still poorly understood. A key area to understand the sedimentological record during this geological evolution is located on the eastern side of the Fram Strait: onshore Forlandsundet, the West Spitsbergen continental margin. The sedimentary infill of the Forlandsundet Graben is cropping out on the western and eastern side of Forlandsundet as a possible exhumed part of a Proto-Fram Strait. A field campaign during the summer of 2021 will focus on the sedimentology and paleoenvironmental reconstruction of the Aberdeenflya Formation to test if an early connection between the North Atlantic and the Arctic Ocean existed prior to the Miocene. Here we present the preliminary results of our fieldwork.

7111

Title	Long-term reference values of sea ice northeast of Svalbard

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Today's environmental changes in the Arctic make it important to obtain information on natural variations of sea ice. Sea ice cover and its thickness have rapidly changed in recent decades. Knowledge of the sea ice cover of the past is important for establishing natural reference values and evaluating causes of current changes. In order to obtain more precise climate forecasts, it is not only necessary to know the sea ice boundaries in the past and present, but also details of the seasonality. In our study, we have used so-called "biomarkers" from sea ice algae and fossil plankton from marine sediment cores to reconstruct past sea ice variations northeast of Svalbard. The study clearly shows that there has been continuous seasonal sea ice NE of Svalbard since the last ice age. The youngest data point in this study is from 1905, so this reconstruction does not show development over the last approx. 100 years. Modern observations show that over the past 10 years sea ice is disappearing earlier in the season than has been previously observed and the geographical extent of the sea ice cover is shrinking. Historical long-term reference values from this study indicate that the current sea ice situation could be similar to the conditions immediately after the last ice age, but opposite to this period (approx. 9500-9000 years before our era) the current reduction of sea ice cannot be explained solely by natural forcing by the atmosphere or ocean.

7112

Title	**Atmospheric deposition of polychlorinated biphenyls to seasonal surface snow at four glacier sites on Svalbard, 2013-2014**

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We collected one-season surface snow during spring 2014 from four glacial ice core drilling sites on Svalbard, approximately trending from west to east, and analyzed them for 209 polychlorinated biphenyl (PCB) congeners. The sites were Holtedahlfonna, Kongsvegen, Lomonosovfonna and Austfonna. Holtedahlfonna and Lomonosovfonna are both at altitude above 1100 m.a.s.l. and are above the tropospheric boundary layer (BL) all year, restricting inputs from local sources. The western sites had the highest ∑PCB flux (26.7 pg cm-2 yr-1 at Kongsvegen) while the lowest was at Lomonosovfonna (14.4 pg cm-2 yr-1). The greatest difference between sites was the trichlorobiphenyl homologue which was nearly four times greater at Kongsvegen than at Austfonna. The most concentrated congeners at each site were PCB-52, 70+74, 95, 101, 110, and in each sample comprised between 32 and 39% of ∑PCB, similar to Clophen 40 which is comprised 27% of these congeners. The variance of these congeners was similar in samples and Clophen 40, verified by principal components analysis. Air mass back trajectories for all sites were similar, indicating no difference in frequency of PCB distribution from long-distance sources, suggesting local sources contributed to higher flux values at Kongsvegen. We found 2,3-DiCB (PCB-5) and 3,3'-DiCB (PCB-11) at all sites; neither was found in western commercial PCB mixtures. We assume that PCB-5 is from the Russian PCB product "Trichlorobiphenyl" or is residue from production of pigment violet 23. PCB-11 may come from waste incineration in northern Europe, and may result from production of yellow, orange, blue and green pigments. The Lomonosovfonna sample ∑PCB flux, even though the lowest, was more than three times what we measured in an ice core segment from the site dated 1989 – 1998 (5.5 pg cm-2 yr-1), suggesting that PCB inputs are variable and are not declining over time.

7113

Title	NW Barents Sea Ice Sheet dynamics during the last glaciation inferred from submarine landforms east of Spitsbergen

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The seafloor east of Spitsbergen includes two major troughs: the north-south oriented Kvitøya Trough terminating in the Arctic Ocean, and the Kong Karls Trough (not previously named) continuing eastwards from the Erik Eriksen Strait, a tributary to the much larger Franz-Viktoria Trough, also terminating in the Arctic Ocean. We present submarine landforms from Kong Karls Trough identified from multibeam swath-bathymetry and Topas seismic (Nansen Legacy data). These reveal that this trough was a pathway for ice sheet drainage through the last glacial-deglaciation.

Several generations of superposing ridge complexes (10 m high, 400 m wide) are oriented transverse to the Kong Karls Trough. These are interpreted to be moraine ridges formed during a stepwise retreat of the ice front. To the west, a sedimentary wedge (50 m high and 20 km long) with a smooth surface morphology partly buries the moraine ridges. This wedge is interpreted to be a grounding zone wedge formed during a re-advance interrupting the deglaciation.

The submarine landforms clearly demonstrate drainage from, and decay of, an ice dome to the west, likely situated over Spitsbergen. Given this eastwards ice drainage, it seems unlikely that there was a major northwards flow of ice from Erik Eriksen Strait to Kvitøya Trough during this phase. Instead, a marine ice dome located in the Kvitøya-Nordaustlandet area likely drained through the Kvitøya Trough during full glacial conditions. The details on the dynamics of the eastward ice drainage through Kong Karls Trough during the last glacial-deglaciation will be discussed, as well as the drivers for the decay of the marine-based part of the NW Barents Sea Ice Sheet.

7114

Title	Sedimentary facies and architecture of syn-rift alluvial fan systems in Billefjorden Trough

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Deposits of alluvial fans are common within the Upper Carboniferous, mixed siliciclastic-carbonate-evaporite fill of the Billefjorden Trough in central Spitsbergen. The syn-rift succession formed in arid and semi-arid environment when Svalbard was in sub-tropical latitudes. The fan systems are located along the eastern flank of the Billefjorden Fault Zone. The larger systems entered the basin along the relay ramp while smaller alluvial fans spread out from the fault footwall blocks. This study aims to increase current knowledge about sedimentary evolution of the Billefjorden Trough by determining the position and sedimentary architecture of the alluvial fan systems.

In this contribution we present the data collected in Billefjorden during the field campaign in summer 2021. The three targeted locations that stretch in N-S direction along the Billefjorden Fault Zone were chosen in order to assess and compare facies and internal architecture of diverse alluvial fan systems. Firstly, slopes of the Mumien and Svenbrehøgda mountains in Petuniabukta expose deposits of an alluvial fan coming down directly from the footwall of the Odelfjellet fault. Second study case focus on well-known alluvial fan deposits located along a relay ramp between the Odellfjelllet and Balliolbreen faults at Pyramiden mountain. Finally, beach outcrops near to Lykteneset expose previously unstudied succession comprising alluvial fan deposits located in a deeper part of the basin. The dataset includes sedimentary logs, measurements of orientation of bedding and paleo-transport indicators. Moreover, drone-based digital models of outcrop were processed. The studied successions consist of poorly sorted, immature sandstones interfingering with conglomerates and mudstones. The sediments are typically red due to coating of grains with hematite which indicates to the arid climate conditions. Future work will focus on mapping of the lateral extends of individual facies bodies on the digital outcrop models and large-scale alluvial fan architecture.

7115

Title	Summarize Svalbard accident history for society safety

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Long history of Svalbard exploration and society development is rich by remarkable experiences. The events did not always happen as we would like and there were accidents, sometimes tragic. Many nations have a saying - Learn from the mistakes of others. For resilient existence, we must examine accidents data, make the cases known and draw conclusions. In the frame of projects devoted to safety and preparedness in the Arctic (MARPART, MAREC) information on previous accidents, national and international exercises was collected and presented in online Geographical Information System (GIS) called MarEmAr. MarEmAr stands for Marine Emergencies in the Arctic. As a web-resource where it is possible to investigate previous accidents and natural conditions, MarEmAr is a database of cases, a teaching tools and a networking platform at the same time. Hyperlinks give opportunity to dive into the details of presented cases and Copyright issues. Visualization of event descriptions on the map improves data availability and perception to ensure the proper response to the emergency situation and social awareness about possible outcome of dangerous situation.

There are several online layers in the GIS, dedicated to the particular regions and accident types. "Case study story maps" reveal the most famous and instructive events combining maps with narrative text, images, and multimedia content. One of the MarEmAr part features Svalbard and will be presented on the conference. It is important both for local safety improvement and for extrapolation of experience to the other Arctic areas.

Possible inclusion into the existing web-map services, like Svalbardkartet will make data even more accessible and requested. It will contribute to emergency management competence and increase response capacities, via innovative training and knowledge dissemination.

7116

Title	**Terrigenous biomarkers in a marine sedimentary record from Kongsfjorden (Svalbard) and inferred environmental changes during the post-Little Ice Age.**

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Fjords are unique marine ecosystems particularly sensitive to anthropogenic pressure and represent a key area where to investigate how climate warming can perturb the ocean-land-glacier continuum. Under suitable conditions, high sediment accumulation rates in fjords allow the high-resolution paleoecological studies of both marine and terrestrial-derived components, to reveal past and present environmental changes. Here we explored the response of Kongsfjorden (N-W Svalbard) and surrounding terrestrial environment to the post-Little Ice Age (LIA) climate change by using a suite of bulk geochemical proxies and terrigenous biomarkers (n-alkanes, fatty acids, glycerol dialkyl glycerol tetraethers, lignin phenols, and cutin acids) from a high-resolution marine sediment core archive. C:N ratio and 13C data suggested a predominant input of marine organic carbon into the fjord, which was also confirmed by low values of the branched and isoprenoid tetraether index. In contrast, the depleted bulk radiocarbon content indicated a significant contribution of fossil and/or petrogenic organic matter to the marine sediments likely from tide-water glaciers. Low carbon preference index (CPI) and average chain length (ACL) of lipids also suggested substantial input of ancient organic matter, but with a complex temporal trend during the LIA. The post-LIA phase, instead, showed distinct mobilization of n-alkanes marked by low CPI and ACL value, which confirmed the reburial of mature organic matter as an important process in Kongsfjorden. Finally, plant-specific proxies (i.e., lignin phenols and cutin acids) showed a decline during the LIA coldest phase, followed by a steeper increasing trend in the early-twentieth century. The reason of this recent mobilization of plant materials from the terrestrial source to marine sedimentary sink is under investigation, however it is likely a signal of the warming and glacier retreat that has drastically affected the extent of tundra vegetation during the transition from the LIA to the modern era.

7117

Title	Solid rock geochronology of Svalbard

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Geologists often state that the bedrock of Svalbard represents long sections of Earth's history and therefore is a great place to study it. I will present a compilation of the solid rock geochronology data and the outline of Svalbard's geological history that they record.

Geochronology is the science of measuring geological time. Since the discovery of radioactivity around 130 years ago and that certain naturally occurring isotopes decay with a constant rate, geochronology has been the key tool for Earth scientists to understand the natural history of the planet. Geochronological data are about understanding processes of change, such as evolution of life, the environment and continents through time. The first absolute radiometric ages from Svalbard rocks were published in 19621.

Compiled regional sets of data are dominated by major orogenic episodes. In Svalbard we see Neoarchaean, Palaeoproterozoic, Neoproterozoic and several Palaeozoic events that has allowed the archipelago to be placed in regional and global context of continental evolution. Important episodes of volcanism and intrusion in the Mesozoic and Cenozoic are recorded. Detrital zircon data from sedimentary rocks of all ages give an idea of the source areas available for erosion.

The Caledonian orogeny is an important feature of both bedrock and geochronology data in Svalbard. A full Wilson cycle is evident: Opening of the Iapetus ocean, its closure and subduction, regional metamorphism and granite intrusion of the continental crust, followed by a collapse of the orogen, are now all recorded by recent U-Pb and K/Ar-data. The database gives an interesting perspective on how the thinking around this current "model" evolved from the earliest measurements as new data continues to be added.

7118

Title	Arthropods and the CAFF State of Arctic Terrestrial Biodiversity Report 2021

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In 2013 the Arctic Council working group Conservation of Arctic Flora and Fauna (CAFF) produced the Circumpolar Biodiversity Monitoring Plan (CBMP). In May 2021 the follow-up State of Arctic Terrestrial Biodiversity (START) report was released. This report is based on 15 articles considering the state of Arctic terrestrial biodiversity appearing in an Ambio special issue (2020). Key findings of the report include increased growth and encroachment of shrubs and trees in parts of the low Arctic, while moss and lichen cover more typical of a high Arctic environment has decreased. More than half of all shorebird species are declining (with great variation across flyways), and nearly half of geese species are increasing, but that circumpolar populations of caribou/reindeer have declined since the 1990s, especially for migratory tundra and forest caribou/reindeer populations although some island or mountain populations remain stable.

Chief amongst the findings for the arthropods is that while they are highly diverse, serve as important connections between trophic levels, and while being important indicators of climate change, they are also grossly under-studied. The START reports on six focal ecological components (FECs): pollinators, decomposers, herbivores, prey for vertebrates, blood-feeding insects, and predators and parasitoids. However, only a few localized trends can be identified due to high interannual variability and lack of long-term monitoring. Among the trends so far described are the decreasing abundances of some Diptera species involved in pollination services. Improved knowledge of the responses of these key communities to environmental change is required to better understand an ecosystem in flux. To resolve this and provide the data required to determine trends in populations and communities the START makes several recommendations. This presentation will outline the current state of knowledge of the arthropod populations in Arctic regions and the START recommendations concerning this group.

7119

Title	Same but different: looking at the human history in Svalbard through different disciplinary lenses

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The benchmarks of the human history in Svalbard are well known and much loved, yet imperfectly understood. Anecdotes about journeys of discovery, whaling and trapping, early tourism, mining, and more are commonly retold, but they frequently lack the necessary detail to discern the underlying drivers of the waning and waxing of past and present human activities let alone their modern and future implications.

In her current project, the author returns to historical and archaeological sources in search for higher-resolution data on past human exploitation and subsequent ecosystem change. She will introduce some of her findings in this presentation.

The overarching purpose of the presentation, however, is to take a fresh look at a host of related disciplines in the natural and cultural sciences, who may not be aware that their own high-resolution data of the past five centuries is crucial to complete the combined image of Svalbard's historical ecology.

With luck, this talk may be held towards the end of the session, so the author can directly draw on opportunities that presented themselves throughout and incorporate them in her lessons for future environmental strategists.

7120

Title	**Seasonal variation in the biochemical composition of Arctic macroalgae: Effect of warming and photoperiod.**

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The effect of temperature and photoperiod along the year on the composition of 5 macroalgal species representative of the sublittoral system of Kongsfjorden was studied in laboratory conditions. These species were the ochrophytes Saccharina latissima and Alaria esculenta, the rhodophytes Phycodrys rubens and Ptilota gunneri, and the chlorophyte Monostroma aff. arcticum (only present from summer to early autumn). Three different seasons were compared: early March, early August and late September. Two temperatures were tested (4 and 8°C) as well as continuous irradiation (CL - simulating summer) and 12:12 h light:dark photoperiod (simulating equinoxes). Total carbon was not affected by warming or photoperiod, except in S. latissima in autumn under CL and 4°C, being 40% higher than with photoperiod. Nitrogen content generally increased by photoperiod, the highest being found in 12:12 L/D in all seasons. Carbohydrates were maximal in CL conditions in all species, indicating that their synthesis is light-stimulated, mainly in the equinoxes. In general, warming did not induce significant changes in carbohydrate content. Lipid content was affected by photoperiod only in brown algae. In S. latissima lipids presented maximum values in CL in the autumn equinox, while in A. esculenta was under photoperiod in summer. Protein content did not change with warming or photoperiod in three out of the five species, and only in S. latissima and P. gunneri proteins were higher in CL than under photoperiod in the autumn equinox. In summary, the results indicate that only isolated changes in the composition of these representative macrophytes may be expected under warming conditions in near-future scenarios, while a general increase in carbon, carbohydrates and proteins under CL was observed mainly in the autumn equinox. The relation of this increase with light utilisation performance will be discussed.

7122

Title	Modeling frost cracking intensity of a blockfield on Svalbard based on field observations

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The blockfield landform remains enigmatic regarding genesis and origin, internal structure and movement processes and glaciological implications. They are found across the Arctic and Subarctic in high elevation, low relief mountain terrain (plateaus) and exhibit an atypical stratigraphy of boulders and blocks with large air-filled pore spaces in the top layer, followed by a sandy, silty and gravelly matrix with some blocks below, before the bedrock layer enqueues. On Svalbard we find plateau landscapes around Isfjorden, Åsgardfonna, as well as parts of Edgeøya and Barentsøya.

We present a 1D numerical model that uses near-surface temperatures and snow depths measured between summer 2018 and winter 2021 to calculate frost-cracking windows and frost-cracking intensities (FCI) within the ground column and across ~1 km2 a large study area in the Platåberget blockfield, just above Longyearbyen. About 30 miniature temperature loggers have been distributed in various settings across the blockfield. For the model, the frost cracking window is defined at -3 to -8 °C and frost cracking intensities are calculated from a combination of temperature gradient and water availability, with a penalty function for gradient direction and distance to water across cells.

All sensors on Platåberget reached the frost-cracking window during the yearly cycle and the FCI shows entirely non-zero, but extremely low values (0.0004 to 0.001), because of water availability due to permafrost occurrence and because surface and near-surface temperatures stay below the frost-cracking window for 3/4 of the year.

Those values do not yet give any rates of weathering or erosion but give a relative view of the differences of ground material for frost cracking sensibility and can partly explain the persistence of the blockfield landform throughout long time scales and multiple glacial cycles. Additionally, implications for glaciation patterns, erosion and the internal thermal regime of former ice sheets can be inferred.

7123

Title	Interdisciplinary Arctic research: lessons learnt from ARCEx

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The Research Centre for Arctic Petroleum Exploration (ARCEx) is a nationwide interdisciplinary research centre connecting higher education and research institutions with industry and authorities (the triple helix). The three main groups of collaborating scientists in ARCEx are geologists, environmental specialists, and technologists. A multitude of cross- and multi-disciplinary challenges in petroleum research and development in the Arctic have been addressed, with risk reduction in the broadest sense as the overarching theme. Some of the specialized topics for our scientists have been tectonics and basin formation, uplift and subsidence, erosion and sedimentation, marine ecosystems, sensitivity of Arctic key species, risk assessment and management, eco-safe exploration, and seismic on ice and snow.

In this presentation, I will highlight some of the most important scientific findings from the centre, in particular those that involve time evolution and spatio-temporal dynamics. I will point to several interesting instances of cross-transfer of methodologies from petroleum exploration to climate and cryosphere research. The emerging field of environmental seismology, where passive observations of spontaneous natural sources and ambient noise can be used to estimate properties of the subsurface, has given us new important tools. Passive geophone array measurements on Svalbard have demonstrated that accurate positioning and timing of frost quakes in the permafrost can be used to estimate and track key permafrost parameters. A cryoseismology based toolset excellently suited for time lapse studies of changes in the permafrost has been developed. The transition from active acoustics to passive listening is important and will influence geomechanics and geohazard detection in the future.

Throughout the project period, Svalbard, Bjørnøya, and the Barents Sea have served as our main laboratory and focus for our field work and research cruises.

7124

Title	**Where the arctic river meets the sea; Complex landscape-process interactions and post-glacial development affecting a coastal cultural heritage site at Russekeila, Svalbard**

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Cultural heritages on Svalbard are generally physically fragile and thus vulnerable to different, and possibly accelerating, landscape processes in the arctic climate. This study is conducted within the multi-disciplinary project CULTCOAST, focussing on vulnerable coastal cultural heritage sites in northern Norway and Svalbard. To understand present and future threats to the cultural heritage we need to identify, map and quantify changes in the environment around the heritages.

Detailed geomorphological and sedimentological maps of the landscape surrounding the former Russian hunting and whaling site Russekeila, indicate a complex landscape development. The changes over time have been controlled by isostatic uplift, permafrost dependent fast- and slow slope processes, and a dynamic fluvial and coastal setting where the Linné-river meets the sea. The hydrological and sedimentological setting of arctic river mouths is the result of a balance between discharge and sediment transport in the river reaching the wave-controlled coastal environment. Changes in the dominating wave-direction at the coastline have in the last one or two centuries shifted the river mouth in different directions. This shift is presently causing a very rapid erosion of an uplifted coastal bluff west of the river mouth, damaging the cultural heritage on top of it. The main geomorphological process on the east side of the river mouth today is solifluction (soil creep), which is slowly deforming old Russian grave sites. The heritage on the east side is potentially also threatened by retrogressive landslides (thaw slumps) in uplifted marine sediments. The latter process has been more active in earlier times, which is demonstrated by many landslide scars mapped along the river. The documented geomorphological changes in recent years highlight the complexity of interacting processes in the environment by Arctic rivers and coasts, which also houses many of the cultural heritage sites.

7126

Title	Coal the ice core of the warm past

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The geological record of Svalbard allows glimpses into past climates and environments that can serve as analogues for future conditions. The youngest part of the geological history of Svalbard is particularly interesting in this respect as it offers a view into a warm Arctic world. During the Paleocene (66-56 mio years BP) the global temperatures were 5-7 degrees warmer than present and Svalbard, located at c. 82 degrees N, had forests and vast peatlands, yet also a polar night.

The Paleogene foreland basin (The central Tertiary basin) exposed in central Spitsbergen and penetrated by hundreds of drill cores from coal exploration provides a unique time-laboratory to study this time interval with direct relevance for future climate conditions in a warmer world. High resolution studies of geochemistry (XRF elemental composition and isotopes), coal macerals and palynology) combined with a new age model for the coal seams deposited as peat yields information on atmospheric transport of inorganic particles, vegetation patterns, ground water level and implications for precipitation and occurrence of forest fires. The unique spatial control on this ancient landscape through boreholes allows understanding of where vegetation developed relative to highs and lows and test the landscape response to changing sea levels and climatic change.

We present data from the coal seam in Mine 7, and discuss implications for palaeoclimate and potential for studying landscape response to a warm Arctic climate in the Paleogene basin in Spitsbergen.

7127

Title	**Why do glaciers surge? A machine learning approach to understand the controlling parameters in Svalbard**

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Surge-type glaciers are present in many glacierized areas in the world including the Svalbard archipelago. Surging glaciers experience a dramatic increase in velocity over short time periods followed by an extended period of slow movement known as the quiescent phase. These surges nucleate at trigger zones due to a deacrease in local friction leading to rapid basal sliding. Currently, both the physics of surging glaciers and the localization of trigger zones are poorly understood. Svalbard represents an excellent region for investigating surges given its long history of field observations, complemented by remote sensing and numerical simulations. This monitoring has generated a substantial amount of data. Machine learning has been a recent disruptive force across science due to its abilities to recognize complex patterns in large data sets and to reproduce non-linear predictions. By comparing the performance of logistic regression, random forests, and extreme gradient boosted (XGBoost) models in a newly combined database of the Svalbard region, we computed surge probabilities along glacier centerlines. In addition, through looking at the contribution of the input variables in the best model (XGBoost), we find that slope, width, ice thickness, and runoff along the glacier centerline are significant predictors for our surge classification. By determining probabilities distributed along the centerline of each glacier, we can identify trigger zones. Combined with the analysis of Shapley Additive exPlanations (SHAP) values, this study provides a new insight into the surge-type mechanisms in Svalbard.

7128

Title	**Moving out of town? The status of alien plants in high-Arctic Svalbard, and a method for monitoring of alien flora in high-risk, polar environments**

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Rising human activity in the Arctic, combined with a warming climate, increases the probability of introduction and establishment of alien plant species. While settlements are known hotspots for persistent populations, little is known about colonization of particularly susceptible natural habitats. Systematic monitoring is lacking and available survey methods vary greatly. Here, we present the most comprehensive survey of alien vascular plant species in the high-Arctic archipelago of Svalbard to date, aimed at (i) providing a status within settlements; (ii) surveying high-risk habitats such as those with high visitor numbers and nutrient enrichment from sea bird colonies; (iii) presenting a systematic monitoring method that can be implemented in future work on alien plant species in Arctic environments; and (iv) discuss possibilities for mapping alien plant habitats using unmanned aerial vehicles. The systematic grid survey, covering 1.7 km2 over three settlements and six bird cliffs, detected 36 alien plant species. Alien plant species were exclusively found in areas of human activity, particularly areas associated with current or historic animal husbandry. The survey identified the successful eradication of Anthriscus sylvestris in Barentsburg, as well as the rapid expansion of Taraxacum sect. Ruderalia over the last few decades. As there is currently no consistent method for monitoring alien plant species tailored to polar environments, we propose a systematic methodology that could be implemented within a structured monitoring regime as part of an adaptive monitoring strategy towards alien species in the Arctic.

7201

Title	Energetic particle precipitation impact on the atmosphere and regional climate

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Energetic particles of solar origin, mostly protons and electrons, precipitate into the Earth's polar atmosphere during different types of energetic particle precipitation (EPP) events. The particles are accelerated by different processes in the Earth's magnetosphere and interplanetary space resulting in different energy distributions, durations, and rates of the events. As the particles precipitate into the atmosphere, they ionise and dissociate atmospheric neutral species contributing to the characteristics of the Earth's ionosphere and starting ion chemical reaction chains in the middle atmosphere. This leads to changes in the atmospheric ozone balance which in turn can lead to changes in the middle atmosphere's thermal balance and dynamics. These changes can propagate downwards to the troposphere possibly affecting regional polar climate and thus coupling the entire vertical atmospheric column to space weather phenomena. This presentation gives a short description of the current understanding of the effects of EPP on the neutral atmosphere, and an overview of research done at The University Centre in Svalbard (UNIS) in the topic area.

7202

Title	**Marine cold air outbreaks in the Svalbard region: Effects on ocean-atmosphere fluxes and the vertical structure of the troposphere**

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Marine Cold Air Outbreaks (MCAOs) are large-scale events in which cold and dry air masses are advected over ice-free ocean, accounting for a large fraction of the wintertime oceanic heat loss in the Nordic Seas. Particularly the Fram Strait region west of Svalbard is a hot spot area for very strong MCAOs. A recent study using the global reanalysis ERA5 has shown that MCAOs in March have a positive 1979-2020 trend in this region with impact on the observed Svalbard climate changes. Yet, the effects on the ocean-atmosphere turbulent heat fluxes and the vertical structure of the troposphere remain unknown. Using data from ERA5 as well as its regional counterpart CARRA and radiosondes launched from Ny-Ålesund in western Svalbard, we therefore plan to investigate the influence of the occurrence and changes in MCAOs on these fluxes. Moreover, variables like humidity, wind and temperature will be analysed throughout the troposphere in order to provide insight into the vertical fingerprint of MCAOs in the Svalbard region. In addition, ERA5 and CARRA will be compared and evaluated against the Ny-Ålesund radiosonde data.

7203

Title	The new Svalbard SuperDARN radar

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SuperDARN is a low-powered HR radar which is used primarily to study the structure and dynamics of the global high-latitude ionospheric plasma convection. It can also be used to study substorms, dayside aurora, gravity waves, HF radio wave propagation, ionospheric irregularities and structures. The Svalbard SuperDARN is part of an international scientific radar network, consisting of 35 radars located both in the Northern and Southern hemisphere. Using data from all radars in the two hemispheres, the global plasma convection pattern (i.e. the flow-velocity of the F-region plasma) can be determined. The Svalbard SuperDARN radar was constructed in 2015, and went through its first and second testing phase until October 2016, from when it became fully operational. The data is freely available, and uploaded to a server at British Antarctic Survey, UK. October 2018, a combination of ice and wind loads brought down both the main antenna array (~300 meters) and the interferometer array (~100 meters). Since then, UNIS has been working on plans to rebuild the array. Using several contractors, a new mast design has been developed, and the parts are now in place in Longyearbyen. We expect to start a new test phase with the rebuild facility during 2021.

7204

Title	Marine cold air outbreaks in Fram Strait and their footprint in Svalbard western coastal regions

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The Fram Strait waters west of Svalbard are a hot spot for Marine Cold Air Outbreaks (MCAOs). These are several day-long events characterized by strong vertical temperature gradients and excessive air-sea heat fluxes, and they play an important role in shaping the local atmospheric boundary layer and severe weather events in the affected region. Based on daily data of the ERA5 reanalysis product, a comprehensive assessment of the 1979-2020 MCAO climatology and trend in Fram Strait is conducted. Strongest MCAO events are found in the winter and spring seasons, and are associated with a dipole-like sea level pressure pattern in all seasons. It consists of anomalous low pressure over the Barents/Kara Seas and anomalous high pressure over Greenland/Iceland, which yields a strong zonal pressure gradient across Fram Strait. It is found that MCAOs have decreasing trends in December and January, but have increased in March. Given that the zonal pressure gradient across Fram Strait has increased only in March as well, it is concluded that the MCAO increase in March is primarily dynamically driven, while the MCAO decrease in December and January is mainly driven by the differing pace of warming in the atmospheric versus sea surface temperature.

With Svalbard's western coastal regions being under the potential influence of Fram Strait MCAOs, these findings are consistent with other studies documenting the excessive warming on the archipelago in mid-winter. In comparison to mid-winter, Svalbard warming in March has been reported to be much weaker – in fact March has recently become the coldest month of the year on average at many stations, and the MCAO increase found in this study may have contributed to that.

7205

Title	The microclimate of Isfjorden – Observations and Model Analyses

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During the last couple of decades the sea-ice cover on Isfjorden at the west coast of Spitsbergen in Svalbard has seen a dramatic reduction, which has been linked to, amongst others, regional and local changes in weather patterns. As Isfjorden is the most heavily trafficked fjord in Svalbard, these changes directly impact all kinds of operations at sea. Therefore, good information about the atmospheric state over the fjord system does not only enhance our scientific understanding of air-ice-sea interactions and the local processes leading to the formation of sea ice, but furthermore contribute to planning and conducting field activities in a safer manner.

With a horizontal resolution of 2.5 km, the current operational version of the AROME-Arctic (AA) weather forecasting model of the Norwegian Meteorological Institute can provide a good overall representation of the atmospheric state over the fjord system. However, the complex topography, as well as fine-scale variations in the surface cover and the sea surface temperature connected to the oceanographic circulation within the fjord, lead to local variabilities of atmospheric variables, which are typically only poorly resolved by the model.

We will present observations of the marine boundary layer over the fjord using a wind lidar and all-in-one weather stations deployed onboard cruise ships sailing across Isfjorden. The mobile weather stations provide high-resolution insights into the small-scale variations in the surface fields of the main meteorological variables. The vertical wind profiles measured with the lidar give insights into the coupling of the flow fields at the surface with higher levels. The measurements are used for direct model evaluation of AA as well as statistical analysis of the local microclimate of wind, temperature and humidity. Real-time data transfer of the weather station measurements via the cellular network additionally provides very valuable information for planning and execution of field activities.

7206

Title	Role of clouds and water vapor in the Arctic radiative energy budget

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The increase in the near-surface air temperature in the Arctic is strongly pronounced compared to the global mean. This so-called Arctic Amplification is related to complex feedback mechanisms whose relative importance is still unclear. This is partly associated to the fact that many processes are not well understood yet. In particular water vapor, i.e. the most important greenhouse gas, and clouds play a crucial role in the Arctic climate system. For example, they have a direct impact on the radiative energy budget by modifying shortwave (SW) and longwave (LW) fluxes in the atmosphere. In particular in the Arctic, the interaction of clouds and radiation can be quite complex due to the prevailing boundary and atmospheric characteristics. In order to better understand cloud-radiation and water vapor-radiation interactions in the Arctic, cloud, thermodynamic and boundary conditions thus need to be well known. Such detailed information can be provided by ground-based remote sensing observations. In this contribution, we present results based on measurements from Ny-Ålesund where a comprehensive suite of remote sensing instruments is operated at AWIPEV research base. In particular, we want to answer following questions: 1) What is the impact of clouds on the atmospheric radiative fluxes and heating rates? 2) How does water vapor influence the LW downward radiation? For the second question, we also make use of the ERA5 reanalysis which allows to extend the view from the local (Ny-Ålesund) to the pan-Arctic scale.

7207

Title	Cloud microphysical processes during ISLAS 2020 campaign in Ny-Ålesund

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Arctic clouds are associated with a range of processes that contribute to uncertainty in the numerical weather prediction and climate models. In order to improve our understanding of cloud microphysical processes, the stable water isotopes can be utilized, since their composition in vapour and precipitation reflects phase changes during cloud formation, within and below the clouds. During the ISLAS campaign in spring 2020 in Ny-Ålesund and at the mainland of Norway, we conducted water vapour isotope measurements from evapouration to precipitation in cold-air outbreaks (CAOs) and warm air intrusions (WAIs). The thermodynamic conditions during several CAO and WAI regimes were studied using ground-based measurements, Cloudnet and radiosonde profiles.

During the CAOs, local ice nucleation events and formation of shallow stratiform clouds were observed. The ice particles formed via vapour deposition on the ice nuclei, and additional riming was detected when supercooled droplets were present on the top of the atmospheric boundary layer (ABL).

During the WAIs, the temperature and cloud top height increased, and a thin layer of cloud droplets was identified on the top of the supercooled droplets and ice clouds. In unstable stratification, the supercooled droplets were mixed with ice particles facilitating spontaneous riming within the cloud. The isotopic composition of the equilibrium vapour from the precipitation samples showed strong correlation with the vapour measured at the Zeppelin station at 474 m a.s.l. Snow was more depleted in heavy isotopes than surface vapour, indicating that a large portion was formed aloft at colder temperatures. Irrespective of the regime defined based on the ground-based observations, the strongest discrepancy between the precipitation and vapour data was observed during the presence of clouds and specific humidity inversions above the ABL. Both features indicate the importance of considering contribution from different vapour sources during snow formation for interpretation of precipitation samples.

7208

Title	**Gas hydrate stability and distribution in the fjords of Western Spitsbergen, Svalbard archipelago. An assessment based on indirect hydrate indicators.**

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This study assesses the natural gas hydrate (NGH) distribution in the main fjords of Western Spitsbergen, Svalbard, based on indirect hydrate indicators (geophysical attributes to the presence of gas or seepage). While methane seepage and NGH distribution in the offshore provinces of Vestnesa Ridge on the continental slope west of Svalbard and Prinz Karl Forland are extensively studied, their potential distribution in the Isfjorden and Van Mijenfjorden fjords is poorly constrained. 2D seismic interpretation enabled mapping the major stratigraphic units and structural elements of the fjords and further identify the distribution of potential source rocks. We also recognized different migration pathways such as faults and acoustic chimneys, which could presumably transport the gas to the seabed. In addition, analysis of hydrographic datasets acquired in August 2015 and June 2021, allowed the quantification and description of gas flares in the fjords and the comparison of the gas system characteristics over the late spring and early autumn seasons. Furthermore, different seabed morphologic expressions, such as pockmarks, were spatially correlated with the seepage detected in the fjords. Finally, we analyzed the methane concentration in surface water samples and the lower part of the atmosphere along Isfjorden, relating it to high flare activity areas. This relation could indicate methane flux via diffusion between the surface waters and the atmosphere, contributing to the atmospheric carbon pool.

7209

Title	Linking Lagrangian model simulations with stable water isotope measurements in Arctic weather systems during ISLAS2020

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The atmospheric water cycle in the Nordic Seas is strongly modulated by cold air outbreaks (CAOs) that are confined to a limited area. The region can therefore be used as a natural laboratory for hydrometeorological studies for understanding the processes involved in the water cycle. In spring 2020, the ISLAS project performed such a study with a field campaign based at Ny-Ålesund on Svalbard. We apply Lagrangian models together with observations taken during the field campaign for characterising source-sink relationships in the water cycle. During the field campaign, we observed an alternating sequence of CAOs and warm air intrusions (WAI) over the key measurement sites of Svalbard and northern Norway. Meteorological and stable water isotope measurements have been collected at multiple sites both upstream and downstream of the CAOs and WAIs. The Lagrangian model FLEXPART is run with the input data from the regional convection-permitting numerical weather prediction model AROME-Arctic at 2.5 km resolution to investigate transport patterns.The combination of observations and model simulations allows us to quantify the connection between source and sink for different weather systems, as well as the link between large-scale transport and stable water isotopes. Mixing of air between the boundary layer and free atmosphere is an important factor influencing the conservation of the stable water isotopes during transport. We perform a range of sensitivity studies with different turbulent modes affecting mixing and boundary layer growth to assess the dependency of conservation on model parameterizations. Our findings can thereby contribute to a better understanding of processes in the water cycle and the degree of conservation of isotopic signals during transport.

7210

Title	**Destiny of newly formed Carbon in High Acrtic tundra: a 13C labelling approach**

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More accurate models for climate scenarios are needed. The contribution of vegetation and soil microbial communities should be considered because of their substantial impact on Carbon (C) fluxes. Moreover, to evaluate properly such contributions the effects of the already ongoing climate change should be considered on the metabolic processes of C sequestration and emission. These processes, in Arctic regions, are very relevant since both plant traits and phenology are affected by changes in air and soil temperature, in atmospheric CO2 concentration and soil moisture, with consequent effects on C fluxes.

To study the contribution of vegetation and soil microbial communities to Arctic C fluxes, we assessed the distribution of newly assimilated C between plant tissues and soil, including respiratory fluxes, as well as between different metabolic compounds. This allows defining the residence time of newly assimilated C in the plant/soil continuum prior the C will return back into the atmosphere. We used an isotope labelling approach allowing portions of tundra to assimilate 13C-CO2 and "chasing" the distribution in plant and soil components and plant and soil microbial respiration. Obtained results show that in general, label 13C remains preferably in above-ground tissues, with roots being just slightly enriched. Analyses on the labelling to soil and microbial community seems to confirm these results. On the other hand, difference in residence time and in the portion of newly C sequestered and emitted show differences among the species analysed. In conclusion, different tundra plant species contributed differently to the local C balance. This opens several scenarios connected, to the different changes Arctic terrestrial ecosystems will undergo in the next future, in special way, to the change of active layer and hence to soil temperature, soil water and nutrient availability and to the changes in plant and soil microbial biodiversity and in their spatial distribution.

7211

Title	Local processes modifying atmospheric humidity around Ny-Ålesund, Kongsfjorden

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Water vapor plays an important role in the Arctic climate system as part of the hydrological cycle and by modifying the energy budget via latent heat and radiative transfer. Water vapor is likely contributing to the amplified warming in the Arctic, but the relative importance of different feedback processes involving water vapor are unclear. The Svalbard archipelago is influenced by relatively large mean transport of moisture and heat from the lower latitudes. Locally, the atmospheric humidity content is modified by evaporation and condensation, linking water vapor with surface properties and cloud formation and precipitation. We investigate local scale variability in water vapor by using measurements carried out at the AWIPEV research base in Ny-Ålesund, Svalbard. By studying the influence of orography, heterogeneous surface properties (glaciers, seasonal snow cover, and open water) and local atmospheric conditions on the spatial distribution of humidity, we aim for a better understanding of the processes modifying atmospheric moisture around Ny-Ålesund.

We study the spatial variability in integrated water vapor by utilizing azimuth scans performed by the microwave radiometer HATPRO. Since October 2016, two scans per hour are performed at 30º elevation angle. Areas of increased (decreased) moisture were identified based on deviations from the mean. With the support of the finely resolved numerical model ICON-LEM and auxiliary measurements, the variability in humidity is associated with wind direction, boundary layer dynamics and surface conditions. Furthermore, the local scale variability is put in context with large scale transport. In the future, the HATPRO scans will also be used to study the variability of cloud liquid water around Ny-Ålesund, providing further insights on linkages between surface-atmosphere interactions, humidity and clouds.

7212

Title	Moisture transport tracked by stable isotopes in the Arctic Seas north of Svalbard

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The extensive sea-ice cover in the Arctic currently limits local evaporation. In the context of climate change, local evaporation is likely to increase as sea-ice retreats. It has been hypothesized that transport of moisture from the North Atlantic could also increase due to more meandering of the jet stream, that can favor establishment of blocking situations, associated with more direct vapor transport into the Arctic.

Here, we combine in-situ measurements of vapor isotope composition to analysis of back-trajectories, to reconstruct the pathway of vapor transport in different synoptic situations during two cruises north of Svalbard in 2018 and 2019. A first distinction is made between North Atlantic air masses and Arctic air masses, based on the main isotope parameter dD, which quantifies the degree of distillation of water vapor after evaporation. Water vapor measurements within an atmospheric river intercepted on 29 August 2019 shows that North Atlantic air is characterized by high humidity and high dD values, opposite to Arctic air. The secondary parameter d-excess varies with evaporation conditions at the source. We find a high d-excess in air from the western Arctic, indicative of intense evaporation at low relative humidity above the water, probably in Cold Air Outbreak situations. Oppositely, we find a relatively low d-excess in air coming from the Barents Sea.

This study highlights the potential use of isotopes in water vapour for identifying moisture sources in the high Arctic. The measurements from ship cruises are a valuable complement of simultaneous measurements at land-based stations around the Arctic Ocean. Thus, a full budget of Arctic water vapor will be enabled through international measurements and data sharing, use of isotope-enabled models, as well as satellite observations of vapor dD values.

7213

Title	Black carbon long term measurements at Gruvebadet

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Black carbon in the polar regions is a key climate forcer. BC contributes to absorption of incoming solar radiation, acts as cloud condensation nuclei altering cloud properties, and accelerates snow and ice melting after deposition.

Light absorption coefficient, used to derive black carbon concentration, has been measured for ten years at the Gruvebadet observatory (78.918°N, 11.895°E; 61m above sea level), at about 1 km from Ny-Alesund, with a Particle Soot Absorption Photometer (PSAP) operating at three wavelengths. Absorption coefficient data were corrected according to Virkkula et al., 2005 (AST, 39:68–83, 2005). In addition, from October 2019 till October 2020, a Multi Angle Absorption Photometer (MAAP) has measured absorption coefficient at 670 nm in parallel with the PSAP, allowing an inter-comparison exercise.

PSAP and MAAP absorption coefficients agreed within the experimental uncertainty of the light absorption photometers (about 10%). Equivalent black carbon (eBC) is derived from the absorption coefficient at 660 nm, assuming a mass absorption cross section of 7.2 m2/g (Zanatta et al., ACP, 18:14037–14057, 2018). eBC is characterized by higher values during the haze period (up to 116 ng/m3) in agreement with an efficient transport of polluted air masses form lower latitudes and limited losses by wet deposition (Abbat et al., ACP, 19:2527–2560, 2019). The absorption Angstrom exponent is larger in summer and fall, likely due to the influence of wildfire emissions during the non-haze period. Mann-Kendall's tau and the Sen's slopes for each season were estimated to investigate potential time tendency. The results indicate that there was no significant trend, in agreement with observations reported by other Arctic long term monitoring sites over the same time frame.

Black carbon concentration is analysed at the light of meteorological parameters to investigate the relative contribution of sources and meteorology and short-term and long-term eBC variability.

7214

Title	Integrated studies of the polar ionosphere and space weather over Svalbard

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In the polar regions, the Earth's ionosphere is often subject to plasma instabilities and turbulence which result in plasma density irregularities at various scales. They can influence the propagation of radio signals, and hence degrade communication or positioning with the Global Navigation Satellite Systems (GNSS). As such, ionospheric plasma irregularities at high latitudes are an important aspect of the space weather system. Their understanding is important for modelling of the state of the ionosphere and building the capability of predicting and mitigating severe space weather effects in the polar regions.

Combining the ground-based observations with the in-situ and remote studies by sounding rockets and satellites gives a comprehensive understanding of processes in the polar ionosphere. In this talk, we will demonstrate these synergistic effects with the selected results from the recent rockets campaigns, and with examples from coordinated efforts in Svalbard for the studies of dynamics of plasma irregularities and related GNSS scintillations. We will also discuss results from recent climatological studies of the polar cap patches and ionospheric irregularities in the polar regions based on satellite measurements with Swarm, using the IPIR data product. Ground-based and satellite observations can be combined to develop physics-based models for plasma irregularities, and we will present ongoing initiatives, which aim to develop such models for the polar regions, their status and prospects.

7215

Title	Determinants of spatial variation in land surface temperature (LST) on Svalbard on the example of two test areas

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The physical basis of the heat balance of the land surface is well defined. Its field variability is much less known, especially in areas with highly contrasted landscape systems and a rare network of stationary meteorological measurements. Research on this topic may enable better mapping of topoclimatic variability in Polar Regions, as well as the creation of more realistic climate forecasts by downscaling of global climate models predictions.

The following questions were asked. What is the relative importance of factors influencing LST spatial variability in the High Arctic? How does this change depending on the type of landscape? With what accuracy can LST spatial variability be predicted? Is the LST forecast error distribution random? If not, what could it depend on?

The analyzes used (1) Landsat satellite images (5, 7 and 8) obtained in 1985-2020 and (2) spatial databases of the Svalbard archipelago provided by the Norwegian Polar Data Center (DEM, vector and raster land cover maps). The analyzes used: (1) thermal bands processing procedures, (2) bands in VNIR spectral range processing procedures, (3) GIS spatial calculations, (4) empirical modeling methods – Boosted Tree Regression (BTR). Modeling was carried out for two test areas of approximately 130 km^2 each: the Kaffiøra plain basin and the central part of Prins Karl Forland. These areas differed primarily in the share of the glaciation surface, as well as in the characteristics of the terrain.

The BTR technique enables forecasting of the LST spatial distribution with an accuracy below 1°C. The errors are partly due to differences in the actual resolution of the data used for modeling. The relative role of factors influencing the LST spatial distribution was similar, but not identical, for both analyzed plots. The differences found are mainly the result of a different scale and system of land relief units (coastal plains, valleys and mountain ridges), as well as the vicinity of reservoirs with different thermal conditions.

7301

Title	A Changing Arctic – summer school and MOOC

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The circum-Arctic has gained increased public, political, commercial, and academic interest over the last decade. From climate change, ecosystems, shipping routes and to indigenous knowledge, there is an increasing demand for state-of-the-art knowledge and educational resources. These wide-ranging Arctic topics can be addressed individually, within their associated disciplines (e.g. via natural sciences, humanities and law courses and modules). However, there is also a strong case for developing truly interdisciplinary courses that integrate across viewpoints and incorporate multi-scale perspectives. Higher educational-based teaching exists in many different forms and the COVID pandemic has further highlighted the need for high quality, accessible, digital resources. This abstract presents a course "A Changing Arctic" which is a 6-week Masters-level course (15 ECTS) held at the International Summer School at the University of Oslo. The course was run in-person from 2014-2015 and for 2021 will be held digitally. Between 15-30 international students take the course each year, and have a range of personal and professional backgrounds. The students are welcomed by a core team of course leaders, administrative and technical staff, as well as numerous international guest lecturers. Furthermore, we have received funding and support to transform this course into a MOOC – a "massive open online course" which would be free and available to anyone in the world. This particularly exciting avenue for reaching people in remote Arctic areas, those who do not fit the traditional university-admissions profiles, as well as people in the global south who may not be familiar with northern processes. We will share some of the practicalities, pedagogical experiences and cross-disciplinary teachings from this course, both in-person and digitally. We will also focus on elements related to blending (natural) science and non-science thematics – which is truly necessary for understanding a changing Arctic but not without a challenge.

7302

Title	Engaging students in meteorological field campaigns in Svalbard

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We showcase meteorological field campaigns in which students are engaged in an active learning setting through the collection and analysis of observational and weather model data. The field campaigns are conducted every year as a part of undergraduate and graduate-level classes at the University Centre in Svalbard. In these campaigns, we address several phenomena typical for the arctic atmospheric boundary layer using both observational and numerical means, making use of the unique setting Svalbard offers as a "natural laboratory" for combining education and research.

On the observational side, we utilise a number of sensors and instrumentation platforms, all of which the students get training on and operate alongside teachers. These include portable weather stations, an anchored weather balloon, sonic anemometers, automatic weather stations, drones and remote sensing atmospheric profilers. The resulting observations represent unique model-independent data of high scientific quality from a region where such observations are otherwise sparse.

On the model side, we utilise data from the high-resolution AROME-Arctic weather prediction model (AA). AA is run operationally by the Norwegian Meteorological Institute for a domain covering Northern Fennoscandia, larger parts of the Barents Sea, and Svalbard. In the operational mode, AA is run with a horizontal grid spacing of 2.5 km. However, for two of these field campaigns, the model has also been run at a substantially higher resolution of 500 m. We use the weather model data both to plan our fieldwork and for interpreting our observations. In turn, we use the observations for improving our understanding of the observed atmospheric phenomena and also for validating the weather model. First results from comparing the 2.5 km and 500 m simulations against our observations, which have recently been published with students on the author list, demonstrate the added benefits of the higher horizontal grid resolution.

7303

Title	**Using knowledge of the past emergency response operations on Svalbard for competence development efforts. Implications from the project "Marec: Inter-organizational coordination of mass rescue operations in complex environments"**

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The management of SAR operations in Svalbard may be challenging because of the need of fast mobilization and coordination between the scarce emergency response capacities. High Arctic conditions may include poorly charted waters and remoteness, in addition to ice, cold and unpredictable weather, and darkness in winter months. In addition, underdeveloped infrastructure in the High North for maritime shipping creates extra challenges, for example limited and unstable radio/satellite communication.

In the project Marec "Inter-organizational coordination of mass rescue operations in complex environments" we focus on the lessons learnt for more effective emergency prevention and preparedness activities. In this project we focus on the coordination of major rescue operations both at sea and land. We elaborate on the managerial challenges of joint operations with a large group of institutions and personnel from a range of local and national actors, private and government, as well as professionals and volunteers.

Learning from past events may provide an increased understanding of inter-organizational coordination of emergency organizations with a high degree of variability. Tight operational coordination between institutions with diverse organizational systems and professional platforms may be a challenge. Past events and exercises may be a valuable foundation for case studies, training, exercising and providing recommendations when it comes to competence development efforts.

Looking closer at different types of dissemination methods, an online Geographical Information System (GIS) called MarEmAr ("Marine Emergencies in the Arctic") is being developed. Our presentation focuses on the implications of using of the online map resource for education, including courses and simulator training, as well as research within emergency management of response operations in complex environments like Svalbard. The map with a database of experiences from exercises and incidents at the Svalbard region can be used as a tool for education in the Arctic regions with similar operational challenges.

7304

Title	Long-term research-based educational activities within space weather

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Recently, several activities on research-based education and student mobility focusing on space weather have been implemented between Norway and other countries. The projects have been related to space instrumentation, data analysis from ground based and satellite measurements, sounding rockets for space weather, and numerical modeling of space plasmas. The projects include various student activities, such as intensive courses and schools, mobility of students and staff, or student placements abroad. All of them have significant hands-on education components and have been related to ongoing research projects. Over the last five years, several hundred students have participated in these activities.

In this talk, we will focus on two selected long-term initiatives. i) The collaboration in space simulations between Norway and Japan have had so far more than 120 participants and resulted in several joint research papers as well as master and PhD thesis. ii) As a result of collaboration between Norway and Russia we have now established the Arctic Space TRAining (ASTRA) platform, which in the last two years provided hands-on education for more than one hundred undergraduate and graduate students through intensive schools and student mobility. Both of these projects include significant component related to activities in the high Arctic and in particular Svalbard.

We will discuss how such externally funded projects help in establishing long-term relationships within student education and research between the institutions and how to achieve sustainable results. We will present different success and risk factors, and organizational and cultural challenges in long-term partnerships that include several institutions.

7305

Title	Bridging Science and Education: A Sustainable Outreach with Students

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The heat budget of the Earth is balanced by heat from the Sun and the cooling of the Earth to space. Regarding heat, Polar regions may also be known as the balance of the global ecosystem, in another way, barometers of the planet and the places where climate parameters connect globally. Acceleration on sea level rise, ocean acidification, ozone depletion bring severe risk to billions of people worldwide. In addition much of the key scientific researches are being conducted in the Arctic and Antarctic. Therefore, Polar regions provide a unique platform to both appreciate its crucial role on Earth's climate system and observe the variabilities of these ecosystems due to climate crisis. Additionally, anthropogenic effect on the Polar environment needs to be considered in helping create green and sustainable actions among the public globally.

An initial way forward in bridging the gap between science and education is to develop basic activities for student participation that highlight important Polar processes. The Polar Research Institute of The Scientific and Technological Council of Turkey (TUBITAK), which works on sustaining public engagement in Polar regions at all levels, increases student involvement by linking fascination with poles to improving curriculum and other teaching resources. Particularly, encouraging lifelong scientific literacy through building awareness on nature by making connections between science and society and reinforcing those connections via varied media. One of the best examples of outreach activities is virtual public questionnaires, which are made and distributed during selected days such as the Polar Weeks and the Antarctica Day. The surveys give main information about Polar/-related facts and expect participants to answer by developing comments on multiple choices. The study will be focusing on the positive effects of questionnaires for the students, their creativity, and knowledge to empower taking sustainable actions for the environment.

7306

Title	An interplay between experience, reflection and reality – it`s role in students` perception during the fieldwork

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Fieldwork as a learning activity was analyzed from the perspective of post-structuralism, constructivism, experiential learning, and self-reliant leaning. Implications from these theories and conceptions were integrated into a framework that could guide the development of new tools for teaching and learning and their integration into the fieldwork. Each element of the framework explains how fieldwork affects students` perception of the reality. In this context fieldwork is considered as a subjective experience that will inevitably be unique for every student because even similar experience is perceived differently by individuals with different personal background. Special attention is paid to predicting and explaining the problems that students may face during their fieldwork.

The research was conducted at UNIS. Interviews with teaching staff were used as a starting point to collect insights about frequent problems that biology, geology, paleontology and physic students face during their fieldwork in Svalbard. Those insights were analyzed through the prism of the aforementioned theories. A set of practical implications was developed as a result. It could be used as a bridge between theory and practice ensuring that design of new tool for teaching and learning during the fieldwork has a theoretical foundation. In particular, it could be useful to guide the development, testing and integration of learning tools based on reflection.

Fieldwork is considered simultaneously to mitigate a gap between students` expectations (based on textbooks, lectures etc.) and reality, as playground for practicing experiential learning cycle, as a way for students to express their agency and learn to be self-reliant and as activity that helps students to reflect about theoretical concepts and link them to their experience. Each of those expects does not exist in isolation it is supplemented by others. That is why it needs a coherent theoretical framework, that explains the role and interplay between those elements.

7307

Title	How to teach about the Arctic outside the Arctic

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At the University of Groningen, we teach students of various disciplines in an interdisciplinary 30 ECTS English program on Arctic and Antarctic Studies. Interdisciplinary means integrating knowledge and methods from different disciplines, using a real synthesis of approaches. The program is called a minor and is meant for third year students in their first semester. Student backgrounds range from studies in biology, history, spatial sciences, anthropology, archaeology, climate studies or international law. The topics in the course have a similar wide range and the lecturers have been in the Arctic and/or Antarctic for doing field work as part of their own research. The minor exists of two sets of three simultaneous courses. In each of these three courses the students function in a different capacity, either as student, teacher or scientist. The first set is focusing on inhabitants of polar regions (animals, plants, indigenous peoples), while the second set has exploitation of polar regions (hunting, mining, tourism, legislation, geopolitics) as its theme. Our philosophy is that the circumpolar polar regions are very suitable for understanding the advantage of an interdisciplinary approach and that interdisciplinarity helps to address the full scope of any issue. Furthermore, the consequences of climate change as observed under arctic amplification play an important role preparing students for their future world.

For more than 20 years we have given this minor for groups of 25 university students and now adapted this program to a one week winterschool in January 2022 for professionals who have or plan jobs linked to the polar regions.

7308

Title	Developing the UNIS Arctic Geology Alumni Club membership database

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The University Centre in Svalbard (UNIS), located in Longyearbyen, Svalbard at 78°N, is the world's northernmost institution for higher education. UNIS provides research-based education of the next generation of Arctic experts in biology, geology, geophysics and technology. UNIS hosts students from Norwegian and international universities, but does not provide full studies, making our alumni different from most other universities. The UNIS Arctic Geology (AG) Alumni Club was initiated in 2019. It is topic-specific in geoscience and aims to promote and further develop an open networking among alumni. The AG Alumni Club further aims to foster professional development of alumni after graduation, to facilitate recruitment by employers within the network, and to enhance the research and learning environments at UNIS.

All present and former students and staff are welcome to join the UNIS AG Alumni Club. Members are spread over Norway, the Nordic countries, Europe and the rest of the world. In June 2021, the AG Alumni Club has close to 200 registered members and more than 360 followers on social media. In 2020-2021, we distributed three newsletters, had three webinars and one hybrid seminar at UNIS. The need for and function of a membership database has been identified as a key topic for connecting the alumni. This led to an iEarth application to develop a searchable web-based membership database to facilitate communication amongst alumni, between alumni and UNIS, and between alumni and potential employers. During 2021 an online map-based database with the registered data will be developed for the members. The development of an online membership GIS database is considered instrumental for our function and activities in the coming years, and we consider it vital to involve current students in this project to optimise the functionality of the database.

7309

Title	Assessing student fieldwork competencies in challenging environments – Arctic field assessment at UNIS as part of the iEarth project

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The field experience is central to university student training and development across the Environmental Sciences, serving as a vital direct experiential teaching setting, exposing students to specific skills, and building individual and cohort confidence and identity. This is particularly true of courses delivered at UNIS, with its strong focus on student-driven field-based learning and in-depth logistic support and safety training.

However, the traditional model at many institutions has been to evaluate knowledge gained from fieldwork through summative assessment of reports, papers, and final examinations that integrate field experiences with data analysis and broader academic conceptual knowledge. Whilst there is great value in such an approach, it does not recognise or evaluate specific valuable and transferable competences that students develop as part of their field activities.

As part of the iEarth project to improve geoscience teaching in Norway, UNIS has been leading Project Domaine 4, focussed on field learning. Central to this is the exploration of how students develop skills in field settings and how the acquisition of such skills can be identified, documented, and evaluated in a way that provide the student, instructor, and (potentially) future employer with a clear sense of the skillset they have honed in the environment.

Several projects, lead by instructors within the Arctic Geophysics and Arctic Geology departments, are currently underway at UNIS to develop effects means to highlight and evaluated student field skills within courses in a way that adds to the student learning experience in what is an extreme and challenging environment. This talk highlights several of those ongoing projects, exploring the different approaches used, the definition and specificity of field skills themselves, and how such skillsets can be assessed and evaluated in a course setting.

7310

Title	Exploring iVR as a digital field learning tool in Svalbard

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We are living in a time of a major revolution in geosciences – the era of digital geology, where current advancements in the use of digital spatial data to represent geoscientific relevant venues are becoming commonplace in many areas. The usage of Digital Outcrop Models (DOM) is currently the cornerstone of this digital revolution, actively being used to integrate field observations and facilitate fieldwork and quantitative research, being shared with the wider audience through online platforms like Sketchfab, Svalbox, V3Geo, Mosis HUB, Virtual Australia, and e-Rock.

At UNIS, teaching geology with DOMs is improving students' learning experience by extending field access to spectacular outcrops in Svalbard, visited amongst others by students attending the AG-222 course ("Integrated Geological Methods: from outcrop to geomodel"), through the Svalbox online platform. However, these 3D models and information are still commonly projected in 2D computer screens, providing outstanding yet limited visualization and sense of the presence of the field and its surroundings. Consequently, immersive virtual reality (iVR) systems (i.e 3DGaia, VRGS, Mosis Xp, Google Earth VR) may alter these emotional experiences by significantly enhancing students' sense of being in the virtual field.

This study aims to break this paradigm by developing a fully immersive virtual field trip of a common field location, the renowned Festningen profile, capable of virtually teleporting geology students to the field, this aims to improve student's appreciation of scale and 3D architectures in the classroom while in preparation to the actual field trip or revisiting it afterwards. We here provide a first glance at how immersive technological advances facilitate extending Svalbard's limited geological field season, and how spatial thinking can be improved through active use of iVR. Then we present our plans for quantifying the impact of such emerging technologies on student field learning within the iEarth project, with applications for courses at UNIS and beyond.

7402

Title	Aggregated Marine Data Products for Svalbard

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It has been several years since the widespread adoption of **FAIR** data principals in science, which has led to the widespread **F**indability, **A**vailability, **I**nteroperability, and **R**euseability of data. This is particularly evident in Svalbard thanks in part to the dedicated data portals at SIOS and the NPDC. With these, and other less geographically focused data portals like PANGAEA, researchers have a wealth of *in situ* collected data available to them for a very wide range of investigations. For research with a very narrow scope, the data portals as they exist now will suffice. However, should an investigation require the use of multiple different variables (e.g. temperature, oxygen, sea ice thickness) researchers very quickly find themselves inundated with many disparate data files and could potentially spend more time with data wrangling than with research. This is a stumbling block in the **R**euseability of these data currently hosted online. As part of the Horizon2020 project FACE-IT, experts across many fields of social and natural sciences identified a list of important drivers of change in Arctic fjords and adjacent coastal socio-ecological systems. Here we report on the progress of the accumulation of these data from multiple sources into a central meta-database and as combined data products that allow for the investigation of drivers of change without the need to first spend months with data wrangling. The use of these data products for analyses in Kongsfjorden is highlighted to provide an example of the utility of this deliverable from the FACE-IT project.

7403

Title	Reanalysis-based glacier mass balance monitoring: case study of Western Grønfjord Glacier (Nordenskiöld Land)

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Regular direct mass balance measurements were started on Svalbard in the mid-60s. Since then, the geography of these surveys widespread within the archipelago, however, some of it's parts are still poorly covered with observations. In the vicinity of Barentsburg Town (central part of Western Spitsbergen Island) the only reported and known to the public ongoing observational row was established in 2014 and refers to the Eastern Grønfiord Glacier.

We propose another mass balance series from the neighbouring Western Grønfjord Glacier (16.4 km^2), where the annual and seasonal studies have been carried out since September 2013. As the results are sensitive to systematic errors which accumulate linearly with the number of years, we decided to reanalyse them using a framework, proposed in Zemp et al. (2013), after the first pentad of observations. In order to do so, we had carried out a topographic survey at the end of the ablation season of 2019 and compared its results with the ArcticDEM strip for mid-July 2015 (the only available without major gaps). As the mismatch between cumulative mass balances for the same period, defined by the glaciological method (–5.66±0.47 m w. e.) and computed from geodetic differencing (–5.52±0.40 m w. e.), lies within the uncertainty limits, no calibration of the mass balance series is needed.

We found geodetic and glaciological methods to be complementary (not replacing each other) and we intend to continue our monitoring combining them. A validation at annual intervals may miss a bias, hence we suppose a five year period being rational for repeating topographic surveys. Glaciological reanalysis may become a standard procedure for every mass balance monitoring programme on Svalbard, improving the quality of output data.

7404

Title	Behind the scenes: Metadata from Ny-Ålesund weather station

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Ny-Ålesund weather station was established around 1950, and regular observations of all common elements required for an official surface synoptic network station started in 1969. The station provides one of only a few valuable long-term series in Svalbard and is therefore widely used to document the rapid change in the Arctic climate over the last decades.

The station is run as a cooperation between the Norwegian Meteorological institute (MET Norway), the Norwegian Polar institute and the Alfred Wegener Institute for Polar and Marine research. MET Norway is responsible for the data transfer, quality control and long-term storage of data and metadata of this unique climate data set. Those data are distributed worldwide by WMO's Global Telecommunication System (GTS) in near real-time and the long term data series are publically available via MET Norway's free and open data platforms seklima.no og frost.met.no.

Since Ny-Ålesund weather station became operational, its location has been changed, instruments have been replaced and new measurement and processing methods have been introduced several times. For any scientifically sound analysis of the long term data series, especially when assessing climate variability and change in the high-Arctic, metadata describing any changes are indispensable.

This poster will describe the metadata from Ny-Ålesund weather station. In case of parallel measurements, information on the available time series and their differences will be provided. Trend analyses for selected time series and information on how to access the time series will be presented.

7405

Title	Cryosphere monitoring at MET Norway through cryo.met.no

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Cryosphere is the collective term for places on Earth with frozen water or permanently frozen ground, like snow, ice, and permafrost. The Norwegian Meteorological Institute (MET Norway) has long experience in monitoring the cryosphere through remote sensing and surface-based automatic and manual observations. All of the cryosphere products are gathered in the web portal cryo.met.no which is maintained by the cryosphere team at MET Norway.

The monitoring includes many perspectives of the global and regional sea ice conditions such as the sea ice concentration, sea ice drift, ice types, surface emissivity and temperature. Also the navigational ice charts from the Norwegian Ice Service are provided in different formats here. And finally the terrestrial snow cover and depth, and permafrost observations in Svalbard and mainland Norway are important contributions of the monitoring. At regular intervals News stories are released by the team.

This presentation will provide information about the different types of products and on data accessibility at cryo.met.no. In addition we will present updated visualisations of the latest cryospheric conditions which are compared with a normal period (climatology) or shorter period averages to put this year's variability and development in a long-term climate context.

7406

Title	Endocrine-disrupting compounds and emerging contaminants in the sediment of Kongsfjorden (Svalbard, Norway)

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Arctic is one of the largest and most pristine regions of the world characterized by cold climate, ice and long period darkness, where climate change is occurring much faster than elsewhere on our planet. Multiple drivers influenced the chain of events defined as "Arctic amplification", causing an increase of contaminant inputs in the marine environment and their circulation in the abiotic (seawater, sediment) compartment, with potentially adverse effects on the polar ecosystem.

Previous studies have investigated the long-range transport of persistent organic pollutants (POPs) from lower latitudes. Now the impacts of climate change on the occurrence of less investigated contaminants such as the bioactive molecules of pharmaceuticals and personal care products (PPCPs) and endocrine-disrupting compounds (EDCs) need more in-deep analysis.

This study aims to evaluate the multi-annual occurrence of endocrine-disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), as indicators of anthropogenic contamination, along a transect of Kongsfjorden (Svalbard, 79°N 12°E).

Surface sediments, sampled on July 2018 and 2019 and September 2020, were analysed by LC-MS/MS to detect EDCs such as 4-nonylphenol (4-NP), its mono- (NP1EO) and di- (NP2EO) ethoxylated precursors and bisphenol A (BPA) and PPCPs (i.e. paracetamol, ibuprofen, diclofenac, clofibric acid, triclosan, amoxicillin, sulfamethoxazole, ciprofloxacin and caffeine). BPA concentrations ranged between < LOD to 10 ng/g, while 4-NP, NP1EO and NP2EO ranged from < LOD to few tens of ng/g. The lack of a spatial trend in EDC distribution in the sediment along the transect investigated, suggested that several processes (i.e. marine currents, atmospheric transport and glacier melting) can affect their occurrence in the Kongsfjorden. PPCP concentrations ranged from < LOD to few ng/g and their higher values were detected in the sediments collected near Ny-Ålesund, (78°55'N 11°55'E), confirming that the small human settlements cause a release of these chemicals in the adjacent marine environments.

7407

Title	Calibration of sea ice drift forecasts using random forest algorithms

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Developing accurate sea ice drift forecasts is essential to support decision making of maritime end-users operating in the Arctic. In this study, two calibration methods have been developed for improving 10-day sea ice drift forecasts from an operational sea ice prediction system (TOPAZ4). The methods are based on random forest models (supervised machine learning) which were trained using target variables either from drifting buoy or synthetic-aperture radar (SAR) observations. Depending on the calibration method, the mean absolute error is reduced, on average, between 3.6 % and 8.1 % for the direction, and between 2.7 % and 7.1 % for the speed of sea ice drift. Overall, the algorithms trained with buoy observations have the best performances when the forecasts are evaluated using drifting buoys as reference. However, there is a large spatial variability in these results, and the models trained with buoy observations have particularly poor performances for predicting the speed of sea ice drift near the Greenland and Russian coastlines compared to the models trained with SAR observations.

7409

Title	Disturbance Detection and Classification with UAV Images as a Tool in Ecosystem Monitoring – A Case Study from High Arctic Tundra

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Unmanned aerial vehicles (UAVs) are increasingly used as a tool in ecology and may be especially valuable in rapidly changing and remote landscapes such as in the Arctic. For effective applications, decisions of both ecological and technical character are needed. Yet, ecologists often lack the knowledge required. We provide a decision-making workflow for the use of UAVs in developing vegetation maps that can also include disturbance classes as a tool in ecological monitoring. We implement this workflow in a case study of the Arctic tundra in Svalbard, and generated a high-resolution map of tundra vegetation, using a random forest (RF) classifier with four spectral bands, a vegetation index (NDVI) and terrain. To obtain ground-cover classes that can describe vegetation state changes we included classes describing vegetation disturbances by herbivory and winter weather events. We detected goose grubbing, winter damaged areas, and distinguished 12 selected ground-cover classes. Areas affected by grubbing or winter damage had lower NDVI values than their undisturbed associated ground-cover classes. However, we registered an overestimation of the grubbing class in parts of moss tundra terrain, which needs to be refined in future studies. The predictive ability of site-specific models was good (macro-F1 scores between 83-85%), but classifier transfer between the study sites was not possible (F1 macro scores under 50%) without applying algorithm transfer functions which was outside the scope of our study. We show that UAV image analysis can be a valuable asset in studying vegetation state changes in Arctic tundra ecosystems, given a tailored workflow for this purpose, and encourage ecologist to integrate UAV work into their monitoring programs.

7410

Title	**Establishing long-term surface air temperature series from the High Arctic archipelago Franz Joseph Land from 1929 to the present (2017)**

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Electronic archives of data from standard meteorological observations (mean daily/monthly surface air temperatures - SAT) at the meteorological stations at "Bukhta Tikhaya" (Hooker Island) and "Krenkel Observatory" (Hayes Island) on Franz Josef Land (FJL) are presented. The data of a parallel series of SAT made in 1958 and 1959 on both meteorological stations were analyzed. The methodology for obtaining linear regression equations, allowing to extrapolate observational data representative for "Krenkel Observatory" for the period 1929-1957 is described. The series of extrapolated data obtained using various techniques are presented. The resulting series (1929-2017) will allow us to correctly assess changes and variability in long-term temperature series on the FJL and compare with available temperature series for Svalbard and Novaya Zemlya. The main conclusions that follow from our preliminary study are:

- The total warming in the FJL archipelago was 1.6-1.8 °C (0,2 °C/decade) for the entire available period of instrumental observations (1929-2017);
- The highest rates of warming were recorded in March-April and amounted to 0.6 °C/decade;
- A particular strong warming at the FJL has been observed since the 1990s. The annual temperature increased by 6,3 °C (2,2°C/decade) for the period 1990-2017 and 5,2 °C (2,9 °C//decade) for the period 2000-2017;
- For the period 1990-2017 the maximum rate of warming occurred between October to February with 4,4 °C/decade;
- For the period 2000-2017 the maximum rate of warming occurred between January to April and from November to December with 5,6 °C/decade;
- The main nature seasons of the year are "*winter*" (November-April), "*spring*" (May), "*summer*" (June-September) and "*autumn*" (October);
- Over the entire observation period the greatest temperature increase was observed in the "*winter*" season. During the period of "*modern*" warming (1990-2017), the greatest temperature increase was observed in "*winter*" and "*autumn*".

7411

Title	EPOS-Norway: New Seismic Arrays for the European Arctic

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As part of the EPOS-Norway infrastructure project, NORSAR received funding from the Research Council of Norway for a new small-aperture, regional seismic array on Bjørnøya (Bear Island) in the European Arctic.

After a long planning phase, a six-element broadband array was installed by NORSAR staff in August 2019 and has been providing data to NORSAR in near real-time since then. Due to several logistical and administrative constraints the 6-element array has an aperture of only 300 m. All sites are equipped with MBB-2 sensors and Earth Data EDR-209 digitizers that are installed in near-surface vaults. Data are automatically copied to the Norwegian node of the European Integrated Data Archive (EIDA) and are openly available.

Due to environmental restrictions less than the planned 9 array sites could be installed on Bjørnøya and the non-used instruments are now available to extend the broadband station HSPB to another small aperture broadband array, also with 6 sites. HSPB had been jointly installed at the Polish Polar Station Hornsund, Southern Spitsbergen, by NORSAR and the Geophysical Institute of the Polish Academy of Sciences during the International Polar Year 2007-2008. The new array will also be jointly installed, However, due to the ongoing pandemic this is now postponed to 2022.

This talk will report on planning and installation of the Bjørnøya (BEAR) array and on first data-analysis results. We will try to answer the following questions: How is the array performance of the new station? What are the noise conditions on Bjørnøya? How are the seismic monitoring capabilities in the region changing? How are data from this new installation complementing data from the seismic arrays (ARCES, SPITS and Apatity) already installed in the European Arctic when feeding them in the Generalized Beam Forming (GBF) algorithm?

7412

Title	A 23-year long seismicity record for the European Arctic

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Recent years have shown an increased interest in Polar research and in particular in understanding tectonics and seismic hazards in the Arctic. To understand the seismic activity in the European Arctic, the seismic bulletins should be as complete as possible. We present a new seismic event bulletin for the European Arctic (70° – 90° N, -15° – 75° E), for the 24-year long period 1990 – 2013. The presentation will describe in detail the merging of the different sources taken in account for the compilation, the homogenization of the data and the relocation of the seismic events. With respect to the ISC bulletin for this region, the new bulletin contains 5,957 new seismic events and 58,242 new seismic onset readings from stations mostly located at regional distances. The gains are distributed over the entire study region, with the most significant contributions across the Svalbard Archipelago, along the Knipovich and northern Mohns Ridges, as well as northern Fennoscandia.

7413

Title	From Space Down to the Tundra: Novel High Resolution Satellite Data for the High Arctic

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Satellite images provide valuable long-term and spatially extended datasets in the Arctic, where acquiring vast and remote data is particularly challenging. These precious data allow assessing the tundra soil-vegetation dynamics and capacity to act as a carbon sink, as well as the spatiotemporal changes in vegetation biomass. Specifically, vegetation's gross primary production (GPP) is an important Arctic Essential Variable for evaluating the status and changes in terrestrial ecosystems. However, the combined limited numbers of cloud-free days and satellite passages is a substantial limitation of satellites, such as Landsat and Sentinel-2 since their revisit time is too long to guarantee an adequate number of cloud-free scenes that capture the vegetative phenology. Therefore, the acquisition of 1-day revisit-time in the visible and NIR spectra regions by the VENµS satellite (https://venus.cnes.fr/en/VENUS/index.htm) along with the 4-m spatial resolution in a place where land cover heterogeneity is high, are significant advantages. We will acquire VENµS images for the entire Brøgger peninsula for summer 2022 and 2023, aiming at developing new indices for (a) assessing the GPP; (b) estimating the start and end of the growing season; and (c) exploiting the four VENµS red-edge bands for calculating several other specific vegetation indices. VENµS data and derived products will be open and respond to FAIR principles. GPP indices will be validated with ground-based eddy covariance and flux-chamber data. Moreover, through VENµS data, we will have the opportunity (1) to compare the spatial extent and vegetation biomass between VENµS and Sentinel-2 derived products; and (2) to generalise the results in other remote sites of the Brøegger peninsula.

7414

Title	Feature detection in glacial water flow using machine learning

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In this project I aim to expand the spatial and temporal range of supraglacial channel measurements and to investigate the potential of machine learning to detect morphological features and to improve geometric reconstructions of glacial channels based on the data collected with a drifter platform.

The data will be gathered from channels on the Kongsvegen glacier on Svalbard, from the beginning of June to mid July. During my field tests I will use two different drifter platforms. One submersible multimodal drifter recording the water pressure, as well as three components each of linear acceleration, rotation rate and the magnetic field strength. And one GNSS enabled surface drifter platform. The drifters float passively with the current and require no user input. This allows profiling of long channel segments and of subglacial systems.

Different features present in supraglacial channels, like meander bends and step-risers, yield characteristic signals. Classifying these signals using machine learning will allow for faster processing of large amounts of data and reconstruction of the subglacial hydrologic system

7416

Title	Upcoming implementation of Mooring Dirigibile Italia (MDI) in inner Kongsfjorden

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The Italian oceanographic mooring MDI has been deployed in the inner part of Kongsfjorden at about 100 meter depth since 2010. It is a permanent array run by CNR to measure: i) time series of physical properties of the water column to study the interactions between Atlantic water, melting glacier water and local winter water; ii) land-to-ocean fluxes of particulate matter (temporal flux variability, particle sources and delivery mechanisms). Data are regularly downloaded from self-recording instruments and sampling devices in late summer when the fjord is ice free. A QA/QC procedure is carried out and data are delivered to the Italian Arctic Data Center (IADC). Instruments are checked and then re-deployed for another year of observations.

After 11 years, CNR is planning to upgrade this research infrastructure, according to the following lines of action:

a) A surface buoy will be deployed to collect time series at the sea surface (T, S, DO, turbidity, currents, waves) and in the atmosphere (weather station with T, °C, pressure, relative humidity, winds). The possibility of near-real time data transmission is envisaged; sea ice may limit the working period.
b) The MDI array will be improved with new instruments, such as microplastics collection devices, acoustic recorder, camera and video recorder, automatic DGT sampler, 24-bottle sediment trap, sensors of nitrate, PAR, fluorescence, pH and pCO_2;
c) A reusable ballast system is planned to reduce the impact of the mooring activity on the fjord system.

The upgrade will begin in 2021 and will hopefully be completed in a couple of years through a phased implementation plan. The proposed strategy will contribute to the strengthening of the research infrastructures envisaged by SIOS (Svalbard Integrated Arctic Earth Observing System). The new infrastructure will be available to international collaborations to expand the monitoring capabilities of the fjord.

7417

Title	Arctic Observatories - An online visualisation portal to access long term earth science data from Svalbard

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The collection of earth science and in particular oceanographic data over long periods of time is of great importance for the understanding of marine ecosystems, as well as for monitoring the effects of a changing climate on local environments. Making these data available for scientific and educational purposes is equally important. Long-term marine observatories are operated in Svalbard (Kongsfjorden since 2002 and Rijpfjorden since 2006) in a cooperation between UiT The Arctic University of Tromsø, the Scottish Association for Marine Science and the University Centre in Svalbard. These moored instrumentations record hydrographic properties throughout the water column and are serviced once a year. The ArcLight Observatory in Ny-Ålesund was established by UiT and the Norwegian University of Science and Technology in 2017 and is measuring biological relevant atmospheric light year round. Here we present an online visualisation portal through which both the long term hydrographic data collected from the two Svalbard fjords as well as light data from the ArcLight observatory are made open and freely accessible. The "Arctic Observatories" portal is implemented by adapting Enlighten-web, a web application developed by NORCE. The web portal implements interactive visual analysis and co-visualization of data sets. The user can interactively select a subset of the data, download the data, or create and store their own plots for further analysis, making it easy to explore datasets for scientific and educational purposes. The user can also easily produce maps with stations plotted, as well as overlay the maps with WMS live data streams (e.g. ice charts). In the long run, data from several other observatories will be made available through the portal, once the data is quality controlled. Our poster will be interactive, providing an opportunity for the audience to explore the portal on site.

7418

Title	Improving calving event detection at Kronebreen using advanced seismic array processing and machine learning

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Cryoseismology is a rapidly developing research area in Earth Sciences with many applications in Polar regions and high mountain areas. The seismic monitoring infrastructure in Svalbard has shown to be particularly useful to map and study the spatiotemporal distribution of near-regional glacier-induced seismic events, benefiting from long observation periods of more than two decades. For example, seismic observations calibrated with satellite and terrestrial remote-sensing observations of iceberg calving allowed us to estimate glacier frontal ablation rates at Kronebreen with unprecedented high temporal resolution. These observations help in better understanding processes at the ice-ocean interface. Here, we further improve the previously implemented method to measure frontal ablation at Kronebreen by combining advance seismic array processing at the SPITS array in Adventdalen and deep machine learning using Convolutional Neural Networks (CNNs) for seismic waveform classification at station KBS in Ny Ålesund. The classifier is trained using classes of confirmed calving signals from four different glaciers in the Kongsfjord region, seismic noise examples, and regional tectonic seismic events. We show that this new approach reduces the number of false detections and increases the number of true events compared to the baseline method. This allows increasing confidence in the ice loss estimated from seismic observations using the previously developed empirical model for Kronebreen. The CNN classifier yields a recognition rate of 89% on average. This is encouragingly high given the complex nature of calving signals and their visually dissimilar waveforms. Subsequently, we process continuous seismic data to produce an updated time series of glacier calving, including previously unprocessed observations of recent years.

7419

Title	Project Overview: **P**hysical drivers of ice algal **HOT**spots in a changing **A**rctic Ocean (**PHOTA**) - Towards improved understanding of bio-physical sea ice processes using state-of-the-art technologies

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Rapid decline in Arctic sea ice coverage and thickness represents one of the most visible indicators of climate change to-date, with profound consequences for global climate, Arctic ecosystems and its inhabitants. PHOTA works towards improving our understanding of climate change impacts in ice-covered regions. The main goal of PHOTA is to provide a better understanding of spatio-temporal relationships between physical and biological properties of both level and ridged sea ice using innovative technologies, and by integrating extensive field-based studies and innovative laboratory experiments. Here we present an overview of the PHOTA project to-date focusing on two main field campaigns and laboratory based experiments. Field work was conducted on pack ice in the central Arctic Ocean during MOSAiC (June-Aug 2020, as part of RCN funded HAVOC), and in two Svalbard fjords, Tempelfjorden and Van Mijenfjorden (April 2021). We will present preliminary results from the deployment of an underwater hyperspectral imager (UHI) integrated with a Remotely Operated Vehicle during MOSAiC. In the Svalbard fjords we used an under-ice arm to conduct UHI surveys and extracted collocated ice cores for calibration of bio-optical algorithms. The UHI enables high resolution mapping of spectral light transmitted through the ice, which can be used to estimate ice algal biomass on very small spatial scales, not possible through traditional destructive techniques. The Svalbard field work was complemented by additional extensive photo-physiological experiments, and taxonomic and biogeochemical analyses of sea ice and under-ice water. These detailed analyses of the Svalbard field work will be presented in three other presentations/posters. We will also present laboratory based experimental work focusing on the radiometric calibration of the UHI

instrument using state-of-the-art methods, and UHI surveys of 6 individual tanks with transparent bottoms containing monocultures of algae of varying biomass concentrations.

7420

Title	**Building integrated Arctic observing systems from in situ platforms**

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INTAROS is a H2020 project with objective to advance the development of an integrated Arctic Observation System covering ocean, atmosphere and terrestrial systems with the special focus on their *in situ* components. While polar orbiting satellites produce vast amounts of data from the Arctic every day, there is a large gap in the observing systems on the ground and in the ice-covered ocean. A major challenge is the implementation of robust platforms and sensors for use in the hostile Arctic environment. The issues are high costs of the platforms, power supply to operate autonomously over long time, and data transmission especially from underwater platforms. Another challenge is the access to many Arctic land and ocean areas due to lack of transport and other infrastructure services. This limits the deployment and operation of in situ systems in large parts of the Arctic. The INTAROS project has demonstrated how an integrated Arctic observation system is built on many observing sensors and platforms. For land-based observations, a number of in situ systems are operated from stations around the Arctic. For ocean-based observations, there is a significant difference between ice-free and ice-covered areas. In open ocean, ships, floats, moorings and various surface platforms are commonly used, but in the ice-covered areas it is required to use icebreakers which can deploy ice-based platforms and underwater moorings. The data from the observing systems represent the first step in the data value-chain from raw data to higher-level information products. The data is the basis for scientific analysis including modeling, development of remote sensing algorithms, and as validation data for models and satellite products. In addition to scientific observing systems, there are Community-Based Monitoring (CBM) systems where data are collected by local communities to support their requirements for information about climate change, natural resources, and other topics.

7421

Title	Spatial-temporal evolution of sorted periglacial circles

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Svalbard (Norway) hosts one of the best examples of sorted soil circles on Earth, located at the westernmost tip of the Brøgger peninsula. Sorted soil circles are a form of periglacial patterned ground, i.e. morphological features that occur in the soil layer subject to intense and repeated freezing and thawing actions generally in association with permafrost.

Several studies aimed to understand the mechanisms responsible for the origin of sorted circles, as well as their internal structures and the relationships between ground structure and the geometry of the patterned ground. However, many aspects of their dynamics remain unresolved. The main problem of current studies is the lack of information over a longer period and on a larger scale that is needed to better understand the processes over time and to facilitate their use as an indicator for present and past environmental conditions in cold regions.

To address these research gaps, this study aims to use multi-temporal very high spatial resolution remote sensing data such as airborne aerial images, terrestrial images, and terrestrial laser scanning over nine periods from 2007 to 2021 to detect active and inactive sorted circles and analyse horizontal and vertical changes over time, as well as changes in geometry. In addition, airborne hyperspectral data will be collected in the summer of 2021 to explore the variety of layers and quantify bare soil properties or infer soil properties from spectral responses of ground vegetation.

Our preliminary results showed that at yearly scale, the sorted circles are still active and the system is not in balance as demonstrated by the propagation of neighbour circles. Overall, our study contributes to verifying the hypothesis that sorted circles at low elevation are not in dynamic equilibrium and thus to understand the factors and time scale at which balancing condition occurs.

7422

Title	**Comparing the photophysiology and primary production of bottom-ice algal communities from two Svalbard fjords of contrasting salinities.**

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The melting of Arctic sea ice due to climate change has led to decreases in salinities over large parts of the Arctic that are likely to affect the photophysiology and primary production of bottom sea ice algae. Coupled to these changes are the impacts of reduced salinity experienced by ice algae during the melt of sea ice samples prior to analysis. It is therefore crucial to understand how bottom-ice algae potentially acclimate to different salinities. In this work of the PHOTA (**P**hysical drivers of ice algal **HOT**spots in a changing **A**rctic Ocean) project, we investigate the photophysiology of bottom-ice algal communities from two Svalbard fjords of contrasting salinities, the glacially-influenced Tempelfjorden and the riverine-influenced Van Mijenfjorden. The study sites were located in Tempelfjorden and Van Mijenfjorden of level ice with snow covers ranging between 3-8 cm and 3-16 cm respectively, and sea ice thickness between 28-34 cm and 37-57 cm respectively and bottom-ice salinities of approximately 4 and 8 psu respectively. To estimate algal photophysiology, melted ice samples were incubated with a ^{14}C radioactive tracer. The results of this project will help predict future changes in sea ice primary production with freshening of the Arctic Ocean and will provide insights for best practice of sea ice sample melt.

7423

Title	Monitoring of Longyearelva catchment system, Svalbard

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The interest in understanding the Arctic has increased due to the significant influence of climate change on the environment dominated by episodic and dynamic processes. Arctic hydrogeological systems are particularly influenced by this. Previously collected data in the Arctic is often incoherent, making it difficult to develop a sufficient understanding of the systems. In 2019 a long-term project in cooperation with UNIS, NGU and master students from NTNU was developed to investigate hydrological and geomorphological changes occurring in Longyeardalen. The main objective is to monitor and investigate (1) the hydrology of Longyearelva, (2) the suspended sediment and bedload transport in Longyearelva, (3) riverbed erosion, and (4) glacier recession upon 1-3. During the melting season of 2021 two master students will repeat methods to study the system, thereby establishing community-based monitoring.

Monitoring will be done using a range of techniques and technologies. This includes, but is not limited to, bed-load monitoring using controlled-size rocks, suspended sediment collection, discharge measurements using salt dilution method, drone photography, and GPS. Additionally, a river-gauging station with a range of loggers and sensors will be used. Drone photography will benefit the project as a modern technology with great potential for studies in the Arctic. Advantages of using drones for monitoring and mapping are accessibility, repeatability, and that they are cheap and safe to use. This is particularly relevant in Arctic observation as locations may be difficult and dangerous to reach.

An important aspect of this project is to collect data in a way that can be of cross-disciplinary use. The data may be valuable for infrastructure planning in Longyearbyen, and other scientific fields such as biology, geohazards, and oceanography. Creating long-time data series can significantly improve the scientific understanding of how and why climate change is impacting the Arctic.

7424

Title	Multi-purpose Autonomous Surface vessel for Polar marine research (MASP)

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Acquisition of oceanographic and bathymetric data in Polar regions poses specific challenges related to persistent ice conditions. Particularly challenging are the uncharted shallow-water coastal areas and areas near the tidewater calving glacier margins. Collecting data in these remote environments with traditional methods (i.e. manned surface vessels) is time-consuming and costly.

Advances in marine autonomous survey technology and navigation systems have resulted in widespread development of unmanned platforms for surface and subsurface investigations. The current challenges are mainly related to the integration of appropriate hardware and development of algorithms that are best suited for specific tasks in a specific environment. Off-the-shelf unmanned platforms have usually relatively short mission time due to the limited energy storage, especially in cold climate. They are also reliant on pre-programmed (waypoint based) survey plans and often fail to efficiently tackle the complex task of navigating iceberg-infested waters with unknown and rapidly changing water depth.

Here we present the "*MASP*" project, which has a goal to develop a low-cost, light-weight unmanned surface platform adapted for marine survey applications in glacial environments. The focus is on the robustness of the hardware that does not rely on heavy transport for deployments in remote locations, and adaptable machine-learning navigation algorithms that require minimal human interference when mapping the harsh, iceberg infested shallow seas and lakes in the Polar environments. The key features are modularity in both hardware and software facilitating (1) easy transport to remote areas; (2) adaptation to a variety of payload configurations; and (3) navigation and mapping algorithms adjustable to survey area and goal.

We discuss our experience of mapping lakes and fjords in the Arctic Sweden and in Svalbard with an autonomous maritime robot "Maribot *Duckling*" and present the outline and status of development of the next generation autonomous surface vessel "Maribot *ANKA*".

7425

Title	SIOS Data Management System - progress, current state and future challenges.

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Svalbard Integrated Arctic Earth Observing System (SIOS) is an international consortium to develop and maintain a regional observing system in Svalbard and the associated waters. SIOS brings together the existing infrastructure and data of its members into a multidisciplinary network dedicated to answering Earth System Science (ESS) questions related to global change. The Observing System is built around "SIOS core data" – long-term data series collected by SIOS partners.

SIOS Data Management System (SDMS) is dedicated to harvesting information on historical and current datasets from collaborating thematic and institutional data centres and making them available to users. A central data access portal is linked to the data repositories maintained by SIOS partners,

which manage and distribute data sets and their associated metadata. Integrity of the information and harmonisation of data is based on internationally accepted protocols assuring interoperability of data, standardised documentation of data through use of metadata and standardised interfaces by data systems through discovery of metadata.

SIOS service includes the Observation Facility Catalogue (OFC) and SIOS Data Access Portal. The OFC allows collecting and sharing information about research infrastructures distributed in Svalbard. The purpose of the OFC is to make better use of the existing research infrastructures by facilitating the search for given parameters and their location. In this way, duplication can be avoided, and new measurements can be co-located with existing ones. The catalogue has a map interface and advanced search function. The SIOS Data Access Portal gives access to data and metadata by the SIOS Data Management System that working towards FAIR data compliance (making data findable, accessible, interoperable and reusable), among other initiatives through the H2020 funded ENVRI-FAIR project (http://envri.eu/envri-fair/).

7426

Title	Observations and infrastructure at Ny-Ålesund Research Station

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Ny-Ålesund Research Station is one of the world's northernmost year-round research communities. The station, located at 79°N, is a unique platform for studies of climate change, and is a key location for natural science research and environmental monitoring in the high Arctic. While remote, it is easily accessible, and offers extensive research infrastructure.

Ny-Ålesund, and the area around is especially attractive for arctic research since almost any topic can be studied there: glaciers, bird cliffs, land mammals, clean arctic air, and marine research of any kind.

Research in Ny-Ålesund is characterized by a high degree of international collaboration. In Ny-Ålesund more than 20 research institutions are engaged in long-term research and monitoring activities. On top of the more than 50 years of Norwegian research, environmental monitoring and infrastructure investments in Ny-Ålesund, the diverse international presence on site provides unique opportunities for collaboration.

This poster gives an overview of what Ny-Ålesund Research Station can offer for both new and more established researchers, by presenting:

The four Ny-Ålesund flagship programs as arenas for research collaboration and networking.

The Ny-Ålesund GIS system providing an overview of instruments, installations and field-sites in the area

The Researchers Guide to Ny-Ålesund as the natural starting point when looking for detailed information about the research station from a researchers' perspective, whether it is for booking facilities in Ny-Ålesund, or for useful information when on-site

The shared laboratory facilities including the advanced Marine Laboratory equipped with systems to control experimental variables like air and seawater temperature.

The SIOS data portal which provides easy access to some core environmental data sets in Svalbard.

7427

Title	**Ground-based remote sensing of aerosol properties using the Emission FTIR NYAEMFT and the Raman-Lidar KARL in Ny-Ålesund, Spitsbergen**

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Abstract: Arctic amplification, the phenomenon that the Arctic is warming faster than the global mean is still not fully understood. The Transregional Collaborative Research Centre TR 172 -- Arctic Amplification: Climate Relevant Atmospheric and Surface Processes (AC3) funded by the DFG contributes towards this research topic.

This excessive Arctic warming is both a consequence and a driver of rapid changes in the Arctic and in part created by aerosol feedbacks. Since different aerosol types have different climate effects, the observation of aerosols is urgently needed in the Arctic. Thus, for the purpose of measuring aerosols in the troposphere, a Fourier-Transform InfraRed spectrometer (FTS) for measuring down-welling emission measurements and a Raman-Lidar are operated at the AWIPEV research base in Ny-Ålesund, Spitsbergen (78°N).

The height of the aerosol layer, aerosol backscatter, extinction, depolarization, the lidar ratio and the color ratio are measured by the Raman-Lidar. Based on that information, a retrieval algorithm, LBLDIS, for aerosol types (dust, sea salt, black carbon and sulfate), optical thickness and effective radius is modified and used for analyzing the emission spectra measured by the FTS.

Combining the two observations, the aerosols can be observed more comprehensively. The most probable origin of the dominant aerosol types is explored by tracking the origin of air masses through back-trajectory calculations using the FLEXPART atmospheric transport model.

7428

Title	Small-scale biophysical characterization of Tempelfjorden and Van Mijenfjorden sea ice using an underwater hyperspectral imager

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There are substantial gaps in understanding the impact of climate change on rapidly changing sea ice ecosystems. Traditional methods, such as physical collection of ice cores, only provide data for a single point in time and space, and they cannot accurately represent spatial or temporal variability of the ice algal community. Therefore, the development of effective and non-invasive methods for obtaining data is a key step to resolve current knowledge gaps on the bio-physical properties of Arctic sea ice. Underwater hyperspectral imagers (UHI) have potential for addressing this challenge, as they provide high spatial resolution of spectral irradiance data at the same time as sea ice algal chlorophyll without causing destruction to the habitat. In this study we used an UHI to survey the underside of the sea ice covering two Svalbard fjords in order to investigate the effect of sea ice algae abundance and potentially species composition on the spectral signature of transmitted light.

UHI surveys were conducted under level ice in Tempelfjorden and in Van Mijenfjorden, with snow covers ranging between 3-16 cm and ice thicknesses between 28-57 cm. Ice cores were extracted from within the UHI survey area, and the spectral information of the UHI images will be compared to the ice algal pigment composition obtained through HPLC analysis. This calibration step allows estimation of the spatial distribution of algal biomass and the most abundant pigments. The results provide a unique understanding of the biological response to physical parameters, such as sea ice thickness, snow depth and micro-scale (<cm) ice structure as they relate to transmitted light intensity. Our conclusions are also valuable in the further development of such imaging technology for non-invasive quantification of ice algal communities.

7429

Title	A high Arctic marine time series from Rijpfjorden, Svalbard

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Rijpfjorden at 800N on Svalbard, Norway, is a north-facing fjord open towards the Arctic Ocean. The fjord is characterized by an annual cover of fast ice (Wallace et al 2010) and a zooplankton community dominated mainly by true Arctic species (Falk-Petersen et al., 2008). There is little evidence of Atlantic water masses penetrating into the fjord, and the annual mean temperature range has remained more or less stable during the 15 year observation period. This apparent stability contrasts with the contemporary narrative of 'Atlantification' of the Arctic (Hop and Wiencke, 2019; Cottier and Porter, 2020) and highlights the fjord's potential importance as a reference site for a high-Arctic marine environment. The collection of background oceanographic data over long periods of time is of great importance for the understanding of marine ecosystems, as well as for monitoring effects of a changing climate on local environments. In a cooperation between UiT The Arctic University of Norway, the Scottish Association for Marine Science and the University Centre in Svalbard, we have been operating a long-term marine observatory in Rijpfjorden since 2006. Data collected include temperature, salinity, light, fluorescence (chlorophyll a), and an acoustic monitoring of the water column using an ADCP. All data are collected continuously in situ and are made fully open access (CC-BY) available in files covering a full year deployment from autumn to autumn. The data are provided in NetCDF format through the Norwegian Infrastructure for Research Data (NIRD) archive, and is also accessible through the Svalbard Integrated Observatory System (SIOS) portal and a dedicated data portal through UiT.

7430

Title	Sea ice diatom species-specific growth rates in relation to different light levels

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Sea ice diatoms are an important component of the Arctic marine food web through their contribution to sea ice primary production, the biological carbon pump and nutrient cycles. To estimate climate change effects on the ice-associated ecosystem, the response of sea ice diatom growth dynamics to the ongoing changes in sea ice and light conditions are crucial. Traditional productivity assessments are not able to evaluate species-specific activities, despite the known high diversity of ice algal communities. This study tested for the first time the use of a fluorescent stain (PDMPO) on natural sea-ice diatom communities incubated in vivo. This technique is based on the staining of newly formed siliceous frustules in diatoms. Species-specific growth rates of sea ice diatom communities from two different Svalbard fjords (Van Mijenfjorden and Tempelfjorden) were estimated under different light exposures and in darkness. Beyond the methodological novelty, this study will provide sea ice diatom growth dynamics at the species level from natural sea ice communities, helping to improve our predictions on how changes in sea ice habitats impact primary production. It also provides the foundation for the application of this staining approach under in-situ conditions during field experiments.

7431

Title	A distributed time-lapse camera network to track vegetation phenology with high temporal detail and at varying scales

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Near-surface remote sensing techniques are essential monitoring tools to provide spatial and temporal resolutions beyond the capabilities of orbital methods. This high level of detail is especially helpful to monitor specific plant communities and to accurately time the phenological stages of vegetation – which satellites can miss by days or weeks in frequently clouded areas such as the Arctic. Therefore, we established a measurement network that is distributed across varying plant communities in the high Arctic valley of Adventdalen on the Svalbard archipelago, with the aim to monitor vegetation phenology. The network consists of ten racks equipped with sensors that measure NDVI (Normalized Difference Vegetation Index), soil temperature and moisture, as well as time-lapse RGB cameras. Three additional time-lapse cameras are placed on nearby mountain tops to provide an overview of the valley. From these RGB photos we derived the vegetation index GCC (Green Chromatic Channel), which has similar applications as NDVI but at a fraction of the cost of NDVI imaging sensors. To create a robust timeseries for GCC, each set of photos was adjusted for unwanted movement of the camera with a stabilizing algorithm that enhances the spatial precision of these measurements. We show how this data can be used to monitor different vegetation communities in the landscape and that this can form the basis for a direct comparison to space-borne observations and further upscaling. The data collected by this setup is publicly available through SIOS.

7432

Title	Standardized monitoring of permafrost thaw: a user-friendly, multi-parameter protocol (T-MOSAiC)

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Climate change is destabilizing permafrost landscapes, affecting infrastructure, ecosystems and human livelihoods. The rate of permafrost thaw is affected by surface and subsurface properties and processes, all of which are potentially linked with each other. Yet, no standardized protocol exists for measuring permafrost thaw and related processes and properties in a linked manner. The permafrost thaw action group of the Terrestrial Multidisciplinary distributed Observatories for the Study of the Arctic Connections (T-MOSAiC) project has developed a protocol, for use by non-specialist scientists and technicians, citizen scientists and indigenous groups, to collect standardized metadata and data on permafrost thaw. The protocol introduced here addresses the need to jointly measure permafrost thaw and the associated surface and subsurface environmental conditions. The parameters along transects are: snow depth, thaw depth, and vegetation height, soil texture and water level. The metadata collection includes data on timing of data collection, geographical coordinates, land surface characteristics (vegetation, ground surface, water conditions), as well as photographs. The comprehensive description and management of all data with metadata, central data storage and controlled data access is applied through the Observation to Archives (O2A) dataflow framework. Through this standardized procedure, data can be monitored in near-real time and their spatial distribution visualized. The dedicated user-friendly application (app) myThaw facilitates the data entry of field measurements and provides standardized data collection and documentation. We started our first measurements during March 2021 with snow depth measurements at the Bayelva site along a 10 meter transect. Several INTERACT sites in Svalbard, Alaska, Canada and Siberia have also agreed to start this data collection. This openly available dataset will also be highly valuable for validation and parameterization of numerical and conceptual models, thus to the broad community represented by the T-MOSAIC project.

7433

Title	**Emerging Arctic pollutants are helping to close the gap on local pollutants in Svalbard**

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For several decades already, only selected high-profile pollutants like persistent organic semi-volatile persistent pollutants (POPs) have been monitored in Polar environments. The early studies on POPs in the Arctic atmosphere revealed long-range atmospheric long-range transport (LRAT) as the major pollutant source into the Arctic. Further, recent findings showed that some emerging contaminants might reach the pristine Polar environments through ocean current and sea aerosol. Recently, highly sensitive trace analytical methods enabled the identification and quantification of an increasing number of contaminants of emerging concern in the Arctic environment (CEAC = contaminants of emerging Arctic concern). The recently published and updated Arctic Monitoring and Assessment Programme (AMAP) report on CEACs is an impressive testimony of the wide array of contaminants currently investigated and monitored in the Arctic environment. The resulting research on CEACs (including microplastics) revealed that local sources also contribute to the pollutant profile in Arctic environments. The comprehensive environmental profiling of POPs and CEACs allows a comprehensive evaluation of the human footprint in the Arctic. A series of recent studies in Svalbard elucidated the presence and consequences of CEACs in the local environment. Such results provide important information on local pollutant sources and their potential consequences on the environment and the local populations. Illustrated by several examples, the potential of such a comparative approach will be highlighted and discussed. Possible implications of these complex research and assessment strategies for Polar environmental research, regional screening, monitoring activities, remediation challenges and regulatory strategies for the Arctic environment and beyond will be provided. The close linkage between modern environmental chemistry, toxicology, fate modelling on the one side and monitoring, environmental assessment, and regulation on the other is crucial to generate balanced and sustainable pollution regulations in the Arctic. Potential conflict

scenarios between environmental concerns and geopolitical, economic, and strategic interests in the region will be addressed.

7434

Title	An overview of arctic water cycle studies during the ISLAS2020 field campaign, Feb-March 2020

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The hydrological cycle is a large source of uncertainty in numerical weather and climate modelling. One cause is that sub-grid scale processes, such as evaporation and precipitation, can lead to unnoticed compensating errors. These processes can be investigated with stable water isotopes (SWI), as they are an integrated tracer for processes that atmospheric moisture has undergone. Water vapour observed at Ny Ålesund can have either a relatively short lifetime in the atmosphere with local evaporation, or be subject to long-range transport from the mid-latitudes.

The ISLAS2020 measurement campaign during Feb-Mar 2020 in Ny-Ålesund primarily focused on evaporation processes. During a three-week period, we obtained multiple near-surface SWI profiles over open water and snowpack, using a SWI analyser in a prototype deployment platform and inlet system. These profiles exemplify evaporation and deposition in arctic conditions, as most profiles made were in very cold and dry conditions (below -20℃). Our profiles are complemented by numerous water samples from snowpack, fjord, and precipitation around Ny-Ålesund, providing context about the local conditions under which profiles were collected. Isotopic connections on the synoptic scale are achieved by linking Ny-Ålesund observations with precipitation sampling at downstream locations (Longyearbyen, Tromsø, Andenes, Ålesund, and Bergen) during cold-air outbreak conditions using the Lagrangian transport model, FLEXPART. Additionally, a dedicated forecast system based on operational output from AROME Arctic supported day-to-day operations, in addition to helping identify intensive observational periods.

The comprehensive stable water isotope observations collected during ISLAS2020 have resulted in a unique dataset of the Arctic water cycle. With the possibility to be supplemented by datasets from existing SWI and meteorological measurements in Ny-Ålesund, such a dataset will facilitate the study of phase change processes and transport of water vapour in the Svalbard region, and serve as an important background for forthcoming aircraft campaigns.

7435

Title	**Near real-time observations of snow water equivalent for SIOS on Svalbard – (SWESOS)**

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Snow is an important component of the Svalbard permafrost and hydrological system due to its water storage and insulation properties. Continuous observations of snow properties in high-latitude such as Svalbard are almost non-existent, making it difficult to calibrate the current generation of snow, permafrost and hydrologic models, for these areas. The quantity of water contained within a snowpack, termed snow water equivalent (SWE), is an important variable to consider, but it is a difficult and time-consuming task to accurately measure and model SWE over broad spatial areas. Automated methods of SWE measurement can increase the ease with which seasonal SWE patterns can be monitored. We here evaluate an automated monitoring technique for measuring SWE using a passive gamma ray sensor at the Bayelva site (near Ny-Ålesund) installed in August 2019, validated with field data from 2019/2020 and 2020/2021. In March 2021 we performed a detailed SWE survey inside the sensor footprint that confirms a high spatial variability in the snowpack. Using independent wind, temperature and radiation data and automated photos from the nearby climate station, we could verify the onset and end of the snow-covered season as well as strong changes in snow depth and SWE as indicated by the new automated sensors. Thus, we conclude the new automated measurement system reliably captures the general evolution of these snow properties over the snow-covered season. One difficulty in comparing the automated and manual SWE measurements is the high spatial variability of SWE and snow depth within the footprint area of the sensor due to uneven snow cover associated with uneven terrain, wind drift and discontinuous snow cover due to patchy snow melt. Nevertheless, we see the automatic sensor as a good option to record continuous SWE data series in remote areas and with that fill data gaps to answer modeling questions.

7436

Title	A hyperspectral sensor for monitoring vegetation phenology and Sun-Induced Fluorescence (SIF) in High Arctic tundra

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A hyperspectral sensor (FLoX) for monitoring vegetation phenology and Sun-Induced Fluorescence (SIF) in High Arctic tundra was established in Adventdalen in 2019 as part of The Svalbard Integrated Arctic Earth Observing System (SIOS instrument #49). The location of the sensor is within the foot-print of the EddyCovariance tower (carbon-flux measurements) and is connected to the automatic system for monitoring vegetation and environmental seasonal changes (phenology) on Svalbard (AsMovEn). Amongst all parameters that this instrument can measure is the Sun-Induced Fluorescence (SIF), which is a new global proxy for GPP (Gross Primary Production) as well as carbon-flux. SIF and vegetation indices like EVI and NDVI showed higher mean values in 2020 as compared to 2019, which is consistent with higher summer temperatures in 2020 than in 2019. In spring 2019, MERIS Terrestrial Chlorophyll Index (MTCI) and other vegetation indices like NDVI and EVI were reduced , which was probably due to reduced vitality of the vegetation following a winter warming caused ground-icing event during winter 2018-2019. This is also an additional causal explanation of the significant of most parameters between years. The data collected by this instrument is publicly available through SIOS.

7438

Title	**Trends of ocean acidification and CO_2 fluxes on the West Spitsbergen shelf**

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The West Spitsbergen Shelf are influenced by the warm Atlantic water (AW) intrusions and mixing with fresher colder water transported in the East Spitsbergen Current, as well as local processes such as sea ice formation and melt. This region is also experiencing some of the largest change related to warming and sea ice loss, but little is known about the potential change in the marine environment. In addition, being an efficient CO2 sink, it is likely that this area will foresee changes in the marine environment such as ocean acidification (pH and aragonite saturation) and potential changes in nutrient concentrations and carbon to nutrient ratios. Here, we use water column biogeochemistry data collected annually in July-August on the West Spitsbergen shelf between 2011 to 2019 to investigate interannual variability in the carbonate system and nutrient chemistry. Based on annual means at different depth layers we investigate trends of pH and aragonite saturation state and stoichiometric nutrient ratios. Preliminary data suggest decreasing pH and aragonite saturation in the bottom waters on the WSC compare to other ocean regions. The observed variability and trends are discussed in the context of climate change and potential effects on the marine environment focusing on the biogeochemical processes.

7439

Title	Deriving vegetation indices and detecting plant communities in the Arctic by means of hyperspectral imaging data

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Remote sensing data is our most important source of information on the status and development of phenomena and processes on the earth's surface. There is now a trend from satellite-based multispectral imaging sensors toward the application of hyperspectral ones. The latter has significantly higher spectral resolution and many more channels than the traditional environmental observation satellites such as MODIS, Landsat and QuickBird.

In this study, we look at the possibilities and limitations of using hyperspectral image data for the purpose of deriving vegetation indices and detecting and classifying Arctic plant communities. Data we used originate from the hyperspectral camera, HySpex VNIR-1800, which is mounted on an aircraft. The camera has a spectral resolution of 5 nm in the range 400-1000 nm. Data were collected early in the 2020 growing season in Adventdalen, Spitsbergen. Extracted data like vegetation indices are analyzed and compared with the existing SIOS-instruments on the ground (# 44 NDVI-racks and # 49 Hyperspectral Sensor monitoring – FLoX) as well as satellite based data from MODIS and Sentinel-2 (up-scaling).

7440

Title	SIOS Core Data - foundations for the optimisation of the observation system.

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Svalbard Integrated Arctic Earth Observing System (SIOS) is an international consortium for developing and maintaining a regional observing system in Svalbard and the associated waters. SIOS brings together the existing infrastructure and data from its members into a multidisciplinary network dedicated to answering Earth System Science (ESS) questions related to global change. The Observing System is built around "SIOS Core Data" – long-term data series collected by SIOS partners. SIOS Core Data (SCD) are data that fulfil the following defined criteria: to be relevant for answering key Earth System Science questions (scientific requirements), to be available according to the FAIR principles (data availability), to be secured by members for more than 5 years (member commitment).

The first set of SIOS core data variables has been identified by The Science Optimisation Advisory Group (SOAG) in cooperation with the Research Infrastructure Coordination Committee (RICC) and scientific experts. Many (but not all) SIOS core data variables are selected or derived from the Essential Climate Variables (ECVs) defined by The Global Climate Observing System (GCOS), and are described by WMO standards and the Global Change Master Directory (GCMD) Keywords. SIOS core data variables are critical for characterising the climate system and its changes in the Arctic, and answering the ESS science questions outlined in the SIOS Infrastructure Optimization Report. SIOS activities related to SCD are in line with SAON's Roadmap for Arctic Observing and Data Systems process as well as the new EC ArcticPASSION project and the idea of a set of Arctic Shared Variables.

7441

Title	**Seasonal sea ice scenarios in recent years for Kongsfjorden, Svalbard, and related physical, biological and biogeochemical properties and processes**

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Longterm monitoring of sea ice in Kongsfjorden, Svalbard, has revealed that the fjord ice has been less extensive in space and time since the mid-2000s, compared with the late 1990s and early 2000s. The sea ice has also become thinner. However, single years can deviate from these trends, as it was the case for e.g. spring 2020. Seasonal sea ice in Kongsfjorden consists of both landfast and drifting sea ice, and the represented ice types are young ice and first-year ice. Here, we summarize the seasonal development and some key properties for recent years. Observations are usually conducted with a focused field campaign in late April/early May, at the time the sea ice is thickest. Measurements include ice thickness, snow thickness and freeboard surveys, combined with ice core, snow and water sampling. The in-situ work is supplemented with additional visits by Ny-Ålesund Research Station personnel later in spring, depending on logistical possibilities and duration of sea ice present in the fjord. Beyond that, also satellite remote sensing observations are used to aid and complement the field observations. Here, we will present results from physical sea ice properties for the recent years, along with preliminary data on biogeochemical and biological properties. Several of the physical sea ice and snow processes have direct impacts on hydrography, biology and biogeochemistry. Ice formation and melt affects salinity and other water properties in the fjord water below the sea ice, and the amount and nature of snow controls the light conditions in the ice and water beneath. Along with data presented, an outlook of next steps and future plans of this research and monitoring will be given.

7442

Title	Expedition cruise and citizen science: Powerful tools to collect valuable polar data and increase nature awareness

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Public nature awareness is a key factor for increased willingness towards conservation of pristine polar areas and understanding the complex climate changes. Hurtigruten Expeditions, a member of the Association of Arctic Expedition Cruise Operators (AECO) and the International Association of Antarctica Tour Operators (IAATO), has witnessed first-hand the effects climate change and increasing ocean pollution in the polar areas over time. As a part of our engagement to better understand and champion for their conservation of these areas, we support scientific communities by transporting researchers and their equipment to study sites in both polar regions. This has led to the establishment of collaborations with scientific institutions around the world.

We operate in the polar regions for extended periods of time, year after year, providing an ideal platform for research, specifically for long-term spatial and temporal studies. Our ships have been equipped with state-of-the-art Science Centers. These resources, combined with our lecture programs and hosting projects from scientific institutions, allow guests to have greater exposure to scientific research and are ideal for collaborating scientists to perform preliminary examination of specimens and analysis of data. In addition, participation in citizen science projects allows scientists to easily collect data in remote areas while giving travellers the opportunity to directly engage in science and increase their awareness of fragile environments.

We will present results from two collaborations in the Arctic. A FerryBox from NIVA, equipped with sensors measuring classic oceanographic parameters is installed on board MS Roald Amundsen. This system also includes a microplastic sampling unit. Preliminary results from samples collected in the Arctic were comparable with published results.

In the UNIS project CRUISE#SCIENCE, guests are involved in a long-term time series of marine sampling in Svalbard. These samplings are accomplished together with lab demonstrations and theoretical lectures. The project goal is to increase the understanding of scientific methodology and results, using the principles of active learning supported by scientific personnel. Understanding the ocean and the climate changes thus become a practical, personal experience for guests, leading to increased awareness of our environment.

7443

Title	**Carbon degradation in active layer permafrost, Ny Ålesund, Svalbard (79°N), shown through isolates, geochemistry, enzymatic activity, metagenomes and isotopes.**

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The active layer of permafrost in Ny Ålesund, Svalbard (79°N), is growing at a rate of ~1 vertical centimeter per year in most locations around the Bayelva River in the Leirhaugen glacier moraine. We combined cultures, metagenomes, soil geochemistry and maximum potential enzymatic activity to study the organisms that live in these expanding active layers. The cultured isolates from these soils would have representation in the metagenomic libraries. Here we present soil geochemical, enzymatic, and isotopic data paired with ten unknown Pseudomonas spp. and metagenomic libraries of two short active layer cores from Ny Ålesund, Svalbard. Isotopic difference between the two study sites indicates a different microbial metabolism; heterotrophic signatures dominate in BPF1 while the glacial melt water river location has more autotrophic metabolic evidence. Further, ezymatic activities of xylobiase, N-acetyl-□-D-glucosaminidase show cold adaptation of enzymatic activities. This multifaceted approach lays the groundwork to understand how the active layer will become a hot spot for microbial activity as the climate continues to warm.

7444

Title	**Improving the use of satellite observations in high latitude regional NWP: Overview of the data assimilation activities in the Alertness project**

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In the Arctic where conventional observations are sparse, the use of remote-sensing observations in numerical weather prediction (NWP) is crucial. Furthermore, the existing assimilation systems are usually conservative and use only a part of the available remote-sensing data.

In the framework of the Alertness project, a series of observing system experiments (OSE) was conducted to assess the role of observations in the operational MET Norway's NWP system called AROME-Arctic. In a dedicated study, built on top of a classic regional impact study, we also investigate impacts of Arctic and mid-latitude observations through the lateral boundary conditions. Apart of the OSE experiments, efforts are committed to utilize more satellite radiances in the AROME-Arctic operational systems, e.g. adding data from ATMS, MWHS2 and CrIS instruments.

In the same Arctic data assimilation system, the implementation of "all-sky" approach was introduced in order to assimilate cloudy and rainy radiances from satellite observations. Also a more advanced observation operator was developed to take into account the footprint of the satellite instruments and to constrain relevant spatial scales in the assimilation procedure.

Finally, a surface data assimilation scheme was implemented for sea-ice temperature using the bias-aware extended Kalman filter approach.

In this overview talk, we would like to briefly present the aforementioned developments which have been done within the data assimilation work package of the Alertness project.

7445

Title	How can passive acoustic monitoring contribute to understanding baleen whales?

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Facing the current and dynamic changes occurring in the Arctic Ocean, both in human and animal use, long-term and continuous monitoring methods are crucial. Complementary to other sensing techniques, passive acoustic monitoring (PAM) has been proven to be an economical, robust and non-intrusive approach for conducting baleen whale surveys offshore using their low-frequency vocalizations all over the globe. It is also an incredible asset for monitoring remote and difficult-to-access areas such as Svalbard. The collected acoustic data can then be used for conservation purposes, from monitoring baleen whales post-exploitation recovery to improving our understanding of these endangered species, their habitats and threats.

First, this work will discuss the potential of opportunistic acoustic sensing such as broadband ocean bottom seismometer. Highly beneficial to baleen whales studies as they regularly record their stereotyped calls, ocean bottom seismometers offer unprecedented data collection locations. The data can be analyzed by automatic processing, e.g. using, detection, localization and tracking to draw distributions and abundance or study the impact of ship traffic.

We will also discuss the potential of acoustic bio-logging (1) to exploit animal-borne multi-sensor information to complement the acoustic recordings and bridge the contextual gaps of vocalizations (2) to describe and characterize baleen whale's habitat soundscapes from the animal's perspective, identifying both natural and anthropogenic sound sources. It will give an outlook on using tag data to establish noise exposure levels and study possible masking effects of human-made noises on animal acoustic communication.

7446

Title	Sounding rocket studies of ionospheric turbulence above Svalbard

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Every morning between about 06 UT and 11 UT, Svalbard rotates just below the cusps (dayside aurora), where direct coupling between the solar wind, magnetosphere and ionosphere occurs. This provides a unique window to study the dayside aurora and the highly dynamic processes associated with it, examples of which include electron and ion precipitation and heating, electrostatic and electromagnetic waves, as well as turbulence.

In this work, we focus on the turbulence which, alongside with being of pure scientific interest, can also have societal impacts. Indeed, the "irregular" electron density structures associated with it can affect our technology infrastructures by for instance degrading High Frequency (HF) communication and Global Navigation Satellite Systems (GNSS) signals.

After briefly reviewing some of the mechanisms believed to be important in the development of turbulence in the high-latitude ionosphere, we present recent observations of density irregularities obtained by sounding rockets above Svalbard. We focus on measurements made as a part of the Grand Challenge Initiative (GCI) Cusp, an international project combining sounding rockets missions and ground-based instruments to study the cusps. We show detailed characterization of the nature of the irregularities including their phase velocity and wavelengths, helping shedding light onto the process(es) involved in their formation, especially at the scales important for Space weather applications.

7447

Title	Glacial meltwater enhances ocean CO_2 uptake and ocean acidification in Svalbard fjords

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Svalbard fjords with tidewater glaciers are affected by glacial meltwater and on-going glacier retreat. Due to climate change and warming, these tidewater glaciers are expected to further retreat and contribute to increased meltwater and may also change to land-terminating glaciers. These changes impact the marine chemistry and biogeochemical processes in the fjords with increase in ocean CO2 uptake and ocean acidification. In this study, we show seasonal and interannual variability in ocean acidification state and drivers in different Svalbard fjords, such as Kongsfjorden, Tempelfjorden, with focus on the glacier front. In addition to meltwater sources, west-Spitsbergen fjords are also affected by Atlantic water inflow which contributes to warmer and more saline seawater to the fjord. We focus on late-winter and summer conditions and contrasting years, warm and cold years, and the variability in air-sea CO2 fluxes. Results showed that carbonate ions and nutrients at the glacier front were diluted by glacial meltwater, hence affecting the biogeochemical processes and increasing ocean acidification. In the climatically sensitive Kongsfjorden, glacial water decreased calcium carbonate saturation (Ω) by the same amount as the biological effect increased Ω. The seasonal increase in temperature only played a minor role on the increase of Ω. Overall, we found that increased freshwater supply decreased Ω, pH and total alkalinity (AT). On the other hand, we observed higher AT relative to salinity in the freshwater end-member in mild and rainy winters in Tempelfjorden.

7448

Title	The Arctic Data Centre – bridging science and operations

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The Arctic Data Centre (ADC) is a service provided by the Norwegian Meteorological institute (MET) and is a legacy of the International Polar Year (IPY) when MET coordinated operational data streams internationally and research data nationally. The national data management for IPY was organised through a project, DOKIPY, funded by the Research Council of Norway (RCN) serving as a virtual data centre integrating data collections at the Institute of Marine Research, the Norwegian Polar Institute and the Norwegian Meteorological Institute. The Norwegian Institute for Air Research was contributing to the coordination, but not to the virtual data centre. Following IPY, MET got engaged in the development of the WMO Information System and promoted ADC as a WMO Data Collection and Production Centre (DCPC). Currently ADC does not operate as a WMO DCPC, but act as the MET catalogue interfacing the WMO Information System through the Global Information System Centre operated by the Deutsche Wetterdienst.

IPY was the starting point for distributed data management within geosciences in Norway, followed by relevant efforts like the Norwegian Satellite Earth Observation Database for Marine and Polar Research (NORMAP), Norwegian Marine Data Centre (NMDC) and Norwegian Scientific Data Network (NorDataNet). The toolbox providing functionalities within ADC is developed through research projects funded by RCN (Infrastructure programme), European Union (FP6, FP7, and H2020 projects like Damocles, Access, APPLICATE, ENVRI-FAIR, Arctic Passion), Norwegian Space Agency (CryoClim, NBS) and ESA (CryoClim, CVL). This focuses on distributed data management built upon the FAIR guiding principles and bridging scientific and operational perspectives on data management. Particular focus is put on persistent identifiers, provenance and quality statements and semantic approaches necessary to improve data discovery from a user perspective.

While projects may vary in duration, ADC is the long term service which serves the project catalogues beyond the project lifetime.

7449

Title	Environmental monitoring in Svalbard through citizen science and expedition cruises

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The environment in the Arctic is changing fast, largely due to increasing temperatures and human activities. The continuous wilderness areas and the cultural heritage sites in Svalbard need to be managed based on a solid understanding of the ongoing changes. Tourists and researchers visit these remote areas on a regular basis, allowing for a continuous contribution of observations that can strengthen the basis for the environmental management.

A workshop for enhancing the environmental monitoring efforts of expedition cruises was held in Longyearbyen in March 2019, facilitated by INTAROS and AECO (https://intaros.nersc.no/content/cruise-expedition-monitoring-workshop). The participants agreed on a pilot assessment of monitoring programs during 2019 to better understand how visitors can be mobilized to report observations and how these observations can support environmental management decisions. Subsequently, a virtual workshop was facilitated by the CAPARDUS and CULTCOAST projects in March 2021 to explore the possibility to use citizen science for documentation of cultural heritage sites (https://capardus.nersc.no/node/73/).

The provisional findings of the pilot assessment suggest that expedition cruises gather significant and relevant data, contributing mainly to an improved understanding of the status and distribution of wildlife trough eBird, iNaturalist and Happywhale via websites and apps. In 2019, there were to our knowledge no citizen science programmes for observations related to cultural heritage in Svalbard, although that year the CULTCOAST project started gathering data from both tourists and residents on the subject (https://www.niku.no/prosjekter/cultcoast/).

Citizen science programs collect data on status and distribution of wildlife that are valuable for the scientific community and for public decision-makers in Svalbard. Useful data on status of and threats to cultural heritage sites may be gathered as well. Improved communication between citizen science programs and those responsible for environmental management decisions is likely to increase the quantity of relevant information that reaches public decision makers.

7450

Title	CO2 emission resulting from rain-on-snow events amounts to 10% of yearly soil CO2 emission in Ny-Ålesund

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CO_2 emission resulting from rain-on-snow events amounts to 10% of yearly soil CO_2 emission in Ny-Ålesund

Polar soil is critically subject to global warming much more than soils at mid-latitudes or tropics and its transformation and degradation resulting from the global warming is one of critical issues for humankind. To make clear mechanisms behind the transformation, we took soil samples in soil depths within 50 cm at Tundra fields at Ny-Ålesund in Spitzbergen, Norway. Then, we investigated soil respiration rates under incubated conditions at -7°C, -2°C, 5°C and 15°C in laboratory as parameters of soil carbon decomposition to simulate actual range of soil temperature--the temperature dependences of negative temperatures were much higher than those of positive temperatures. Amount of soil carbon was also analyzed by CN analyzer. Vertically-integrated soil respiration during August 2016 to July 2017 using soil temperature in fields were estimated. Soil respiration of the 0-10 cm layer explained about 64.4% of the soil respiration integrated over 0-50 cm. Soil respiration rate during periods of two rain-on-snow events were estimated to enhance 10% of the yearly-integrated soil respiration, showing the importance of the increasing frequency of rain-on-snow events which might be predicted to be accelerated due to global warming.

7452

Title	Large and systematic differences in monthly temperature distribution in Svalbard: Sval_Imp versus MODIS LST

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Recently, scientists studying long-term trends in changes in the environment of the Svalbard archipelago have at their disposal **Sval_Imp** – a grid meteorological database covering the years 1957-2017 with a time resolution of 6 hours and a spatial resolution of 1 km (**Schuler, Østby 2020**).

Unfortunately, the quality of **Sval_Imp** raises considerable doubts. This study highlights large and systematic errors in air temperature (**AT**) values, limitations of the validation and the lack of area assessments.

The goal was therefore to independently validate **Sval_Imp** temperature data based on satellite land surface temperature (**LST**) measurements. The timely data from the MODIS sensor (4 measurements a day) from the period March 2000 – December 2017 was used for this. The analyzes carried out so far have shown that after aggregating the data into monthly periods, LST MODIS can be successfully used to model the spatial distribution of air temperature in Svalbard. Model errors are low, not systematic, and their distribution is random. Although AT and LST are strongly correlated with each other, they are different characteristics of the heat level in the landscape. For this reason, the analysis was performed using relative data – standardized values.

The spatial distribution of the differences in standardized monthly mean values LST and AT is not random and shows repetitive spatial patterns. The absolute values of the differences are significant and cannot be explained by the cumulative effect of measurement errors and their propagation during multi-stage processing.

Separated 13 types of spatial distribution of differences in standardized average monthly LST and AT, that in the analyzed period 213 months, repeated 3 to 37 times. Their seasonal distribution is not random. There is no doubt that the distinguished types of spatial distribution of LST and AT differences are strongly related to the dominant circulation conditions. Significant relationships were also found in the types that were rare in the studied period.

8001

Title	Teaming up research institutions with the Norwegian coast guard - a success story

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The Norwegian Coast Guard has provided ship time in assistance to research programs through open calls administrated jointly with the Research Council of Norway. The Nansen Center and many other institutions in Norway and other countries have benefited from this provision over many years.

In 2019 a Pan Arctic acoustic observing network was installed as part of the US-Norway project CAATEX - Coordinate Arctic Acoustic Thermometry Experiment. The system comprised an array of six deep water moorings across the central Arctic from the Nansen Basin to the Beaufort Sea. Each mooring was anchored to the bottom 4 kilometers below a floatation sphere keeping the mooring steady and vertical in the water masses. To support CAATEX three major field experiments were carried to deploy and recover the observing system using the icebreaker KV Svalbard. As part of CAATEX and previous projects a unique expertise in large scale underwater ocean observing systems in ice covered regions has been built up in Norway and USA.

Another consequence is that the Norwegian Coast Guard is now in the forefront in smart sea ice navigation, and complex operations in ice covered regions of the Arctic.

Our CAATEX story shows how collaboration and coordination can make a large step forward in observing the ocean under the ice and operation in ice covered regions.