The Svalbard Science Conference 2017

Alphabetical List of Abstracts

by first author

(Tentative)

List of abstracts

Coupled Atmosphere – Climatic Mass Balance Modeling of Svalbard Glaciers (id 140)

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Here we present results from simulations of the climatic mass balance of Svalbard glaciers with a coupled atmosphere-glacier model. The model system consists of a full dynamical atmospheric model (WRF) coupled to a climatic mass balance model (CMB). Results from the recent past (2003-2013) are produced by downscaling of the ERA-Interim reanalysis to 3 km, and has been compared with a comprehensive set of mass balance, meteorological and satellite measurements (Aas et al. 2016). Model temperature biases of 0.19 and -1.9 °C are found at two glacier automatic weather station sites. Simulated climatic mass balance is mostly within about 100 mm w.e. yr^{-1} of stake measurements, and simulated winter accumulation at the Austfonna ice cap shows mean absolute errors of 47 and 67 mm w.e. y^{-1} when compared to radar-derived values for the selected years 2004 and 2006 (Figure 1). Comparison of modelled surface height changes from 2003 to 2008, and satellite altimetry reveals good agreement in both mean values and regional differences, showing that the model system compares well with a wide range of measurements from the recent past.

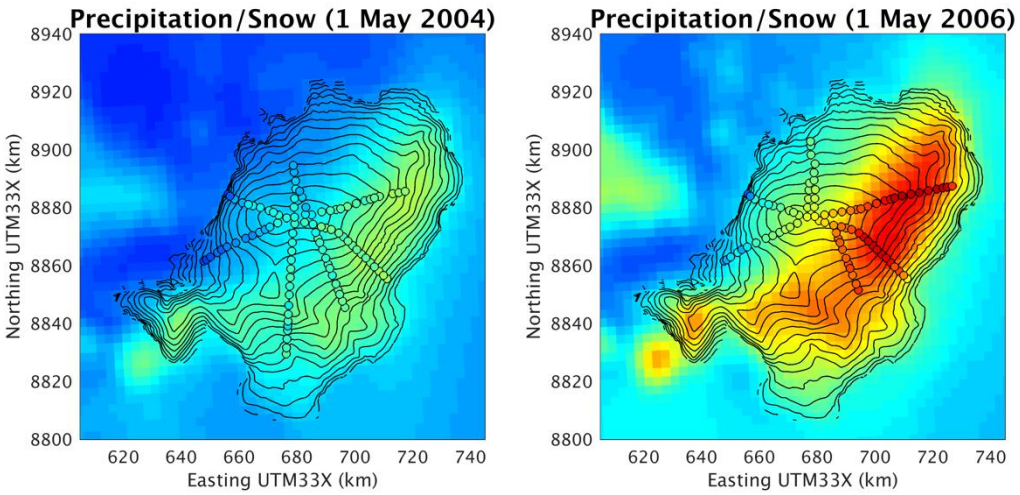

Figure 1: Simulated and GPR-derived winter accumulation at Austfonna 1 May 2004 (left) and 1 May 2006 (right). From Aas et al. 2016.

Preliminary results from the same model system applied to a future climate scenario is also presented. Bias corrected output from the Community Earth System model (CESM) RCP8.5 ("business as usual") future scenario is downscaled with WRFCMB to 9 km. A novel technique for producing high-resolution, bias corrected SST and sea ice fields from coarse resolution model output is applied, to produce lower boundary conditions for the model simulations. The results

are compared with the ERA-Interim based results to assess the performance of this model setup for the current climate, as well as to project possible future evolution of Svalbard glaciers.
Finally, we present some of the possible applications of the produced data sets, which consist of surface meteorological fields (four radiation components, humidity, wind speed and direction, temperature and solid and liquid precipitation) and mass balance fluxes at sub-daily temporal resolution and 3 km (present) or 9 km (future) spatial resolutions.

Reference:
Aas, K. S., T. Dunse, E. Collier, T. V. Schuler, T. K. Berntsen, J. Kohler and B. Luks (2016). "The climatic mass balance of Svalbard glaciers: a 10-year simulation with a coupled atmosphere-glacier mass balance model." The Cryosphere **10**(3): 1089-104.

Dynamics of legacy and emerging organic pollutants in the seawater from Kongsfjorden (Svalbard, Norway) (id 85)

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Recent climate changes are much faster than previous long-term ones, causing stress on polar marine ecosystems resulting in changes in atmosphere/ocean exchanges, ocean properties, sea ice cover and thickness. These phenomena, associated with anthropogenic emissions are triggering shifts in global biogeochemical cycles and marine ecosystem (Guldberg, 2010). Consequently, ecosystems are rapidly changing. The polar oceans are the final sink for many semi-volatile organic contaminants, which, thanks to the atmospheric transport and to the cold condensation, concentrate in these areas. The decrease of sea ice, as well as the presence of snow and the mechanism of ice formation/melting, can have a big impact on the carbon cycle, on the mobility of contaminants and on biodiversity loss (VandenBrink, 2011). Moreover, the list of chemicals found in arctic ecosystems continuous to grow, and increasing temporal trends have been reported for some current-use chemicals (NCP, 2013). The study of the composition of Dissolved Organic Carbon (DOC) and the occurrence of organic contaminants together with the biodegradation capability of natural microbial communities, is of strategic importance to describe the circulation of nutrients and the impact of allochthones sources on the marine ecosystem. Anthropogenic impacts can change the quality of the natural DOC, with repercussions on the spread, persistence and bioavailability of allochtonous organic matter, including the fate and the toxic effects exerted by some persistent organic pollutants. Two campaigns were carried out in the Arctic Station “Dirigibile Italia” (Ny-Ålesund, Svalbard, 79° N 12° E) in two different seasons: June 2016 and March 2017. The Kongsfjorden Bay ecosystem is

a high –latitude (sub)-Arctic fjord. Its waters are influenced by both the Atlantic water masses of the WSC as well as the Arctic-type coastal waters, and a glacial input of melt water (Svendsen et al., 2002). The experimental design was projected to sample surface water along a transect in the Kongsfjorden (approximately 100 liters for each sampling point) in order to determinate persistent and emerging contaminants: PCBs; PAHs; nonylphenols (NPs) and bisphenol A (BPA). At the same time, with the ultrafiltration tangential-flow technique, dissolved organic matter (DOM) was characterized according to size fractions (colloidal and truly dissolved) to evaluate if the transport of contaminants is affected by DOC dimensions. The degree of contamination was evaluated together with microbial community biomass (first link in the heterotrophic food web) and its metabolic activity (mineralization rates). Statistical evaluation of microorganic contaminants, DOC, DOM and the biomass of the microbial community was performed. The PAH concentrations measured in the whole water in the summer period varied from 2.9 to 40.4 ng/L, the minimum value was found in the offshore points while the maximum in the Ny-Ålesund harbor. Along thetransect from the harbor to the glaciers the PAH levels were quite similar although we observed an upward trend moving to the glaciers. This find is consistent also with the change in the composition of DOC due to the material given by the snow/ice melting. The pattern showed the predominance of petrogenic PAHs, likely due to coal, crude oil and atmospheric dust. Unexpectedly, values founded at the end of the polar winter (8-20 March 2017) were slightly lower with a maximum of 37.3 ng/L in the harbor and a minimum of 1.9 ng/L offshore, while PAH concentrations ranged from 13.1 to 17.7 ng/L in the sampling points versus the glacier. The absence of solar irradiation and the lower temperature of seawater inhibiting the degradation of these xenobiotics competed with the greater anthropogenic pressure and the sea/ice melting, typical factors of the spring-summer period. As expected the concentrations of NPs showed the higher values (23.42 and 10.42 ng/L in June and March respectively) in the seawater sampled near the waste water treatment plant. No significant differences were found in the BPA levels along the transect in both the sampling periods (0.71 and 0.45 ng/L in June and March respectively). Understanding the interactions between the ecological effects of climate change and anthropogenic pressures, it is a priority for the identification of possible alterations and long-term effects of these vulnerable marine ecosystems, by correlating the presence of contaminants, the characteristics of organic matter and the impact on carbon fluxes.

A radio wave velocity model contributing to precise ice volume estimation on Svalbard glaciers (id 184)

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The glaciers in Svalbard are mostly polythermal type. On these polythermal glaciers, the radio wave velocity (RWV) of ground penetrating radar (GPR) is variable according to the glacial environment, while the RWV is an important parameter for the ice volume estimation. However, the ice volume estimation usually uses a single RWV on a whole glacier in order to simplify the calculation. How about the difference between the actual ice volume and the estimated result?

We used a RWV model, derived from common mid-point (CMP) profiles of GPR measurement, to simulate the RWV for each GPR trace on Pedersenbreen in Svalbard. Then a relative accurate volume of glacier Pedersenbreen was acquired. From which we found the difference among those volumes calculated from a single RWV, three RWVs and our RWV model. Our RWV model for polythermal glaciers refined the volume estimation and enhanced the precision in mass change study. And the difference between different models could raise an error up to 10% of the volume results. Moreover, the fixed RWV usually used was probably larger than the actual one in those polythermal glaciers.

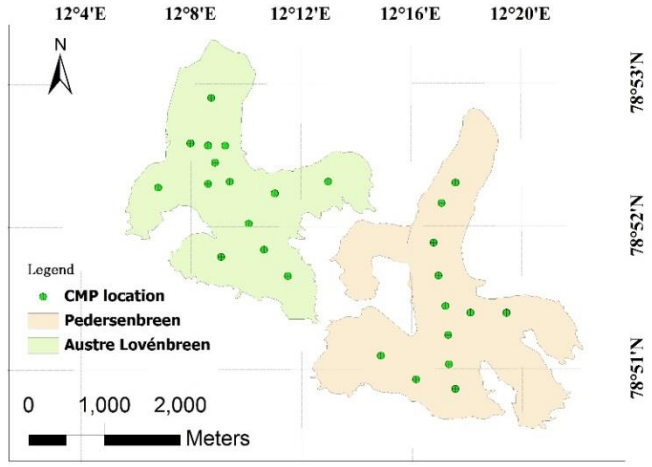

Figure 1. The distribution of CMP profiles

Acknowledgements:
This work was supported by the National Natural Science Foundation of China (41476162, 41531069) and the Chinese Polar Environment Comprehensive Investigation and Assessment Programmes (CHINARE2017). Thanks to the Chinese Arctic and Antarctic Administration for supporting in-situ expeditions.

Glacier front detection through mass continuity and remote sensing (id 88)

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A large portion of the glaciers and ice-caps on Svalbard are marine terminating. Frontal ice loss is influenced by processes which operate both on large and small, spatial and temporal scales. Enhancement in our understanding of this phenomenon can be gained by mapping the timing and extent of frontal ice loss. Nowadays this can be documented effectively through optical or RADAR remote sensing satellite data.

Such methodologies can be highly automated, which is of utterly importance as mapping efforts such as in Svalbard cover large spatial extent and the revisit rate of acquisitions are currently at a daily resolution. The resulting ice loss inventories can be useful data to test and validate calving models, on local or regional scale. Furthermore, the localization of ice-fronts is of importance for the quality insurance of base maps, as glacier fronts are dynamic in extent and thus need a more regular update.

In this study we introduce a simple methodology to automatically extract the front of tide water and land terminating glaciers. This component is up to now a manual step, hence a missing piece towards the goal of an automatic mapping pipeline. The input data for this study are glacier outlines and a velocity field. Our method exploits the property of mass continuity and in this study both a local and global implementation is tested. The methodology is demonstrated over a section of Southern Spitsbergen. Because of its simple implementation, this method can be easily integrated into a regional mapping pipeline for operational use. With the resulting glacier snout localization, studies on glacier calving can be implemented, or automated monitoring of glacier length becomes possible.

Pan-Arctic GNSS research and monitoring infrastructure and examples of space weather effects on GNSS system. (id 120)

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The Norwegian Mapping Authority owns and operates several receivers tracking the Global Navigation Satellite systems (GNSS) GPS, Galileo and GLONASS on Svalbard, Hopen, Bjørnøya, Jan Mayen and Iceland. We are also involved in projects with other institutions operating GNSS receivers on Greenland and Svalbard.

These receivers are used to monitor both the performance of the GNSS systems themselves, and the impact of space weather on the GNSS signals and support systems.

Data from our receiver network is also contributing to the European Space Agency (ESA) Space Weather Portal and the data is used in several space weather related studies.

Maritime and Aviation users are often dependent on satellite navigation for positioning and navigation in the Arctic, and are thus vulnerable to disruptions caused by space weather impact on the GNSS satellites or signals. As the activity in the Arctic areas increases these issues becomes more and more relevant. More knowledge of the space weather effects and other disturbances can increase our understanding of the phenomenas as well as contribute to improving the systems.

We will give an overview of the relevant space weather effects and the GNSS infrastructure, and present some examples of observations of space weather related disturbances of the GNSS signals and support systems.

Methane release related to retreat of the Svalbard – Barents Sea Ice Sheet. (id 191)

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Arctic continental shelves and land areas host vast amounts of methane trapped within hydrates, ice-like solids mixtures of gas and water and within permafrost. Methane is a potent greenhouse gas, and sustaining warming in the Arctic has increased the awareness that future destabilization of these shallow carbon reservoirs could affect the climate and environment. Scientists at *CAGE, Centre for Gas Hydrate, Environment and Climate* investigate the processes, sources and fluxes involved in natural gas releases from the Arctic over time scales spanning from contemporary monitoring to thousands and millions of years.

Here we document two contrasting processes of natural methane emissions from marine areas around Svalbard. Abundant gas flares acoustically imaged in the water column (Fig. 1) reveal slow, gradual release of methane bubbles, a process that is commonly documented from areas elsewhere in the Arctic and along continental margins worldwide. Conversely, giant craters, up to 1 km wide (Fig. 1) indicate a very different process. We propose that these are blow-out craters, formed through catastrophic methane expulsion induced when gas hydrates destabilized after the former Svalbard - Barents Sea Ice Sheet retreated from the area.

Empirical observations and analyses are combined with numerical modelling of ice sheet, sea level and gas hydrate evolution over the past 30.000 years and indicate that during glaciation, natural gas migrating from underlying reservoirs was stored as subglacial gas hydrates. On ice sheet retreat, methane from these hydrate reservoirs built up to form giant mounds, so-called gas hydrate pingos, which eventually abruptly collapsed, releasing the gas and forming the giant craters observed today.

We propose that these processes were likely widespread across past glaciated petroleum provinces and that they also provide an analog for the potential future destabilization of gas hydrate reservoirs beneath and in front of the world's contemporary ice sheets. Gas-leaking hydrate pingos south of Svalbard could dissociate rapidly in response to warming water.

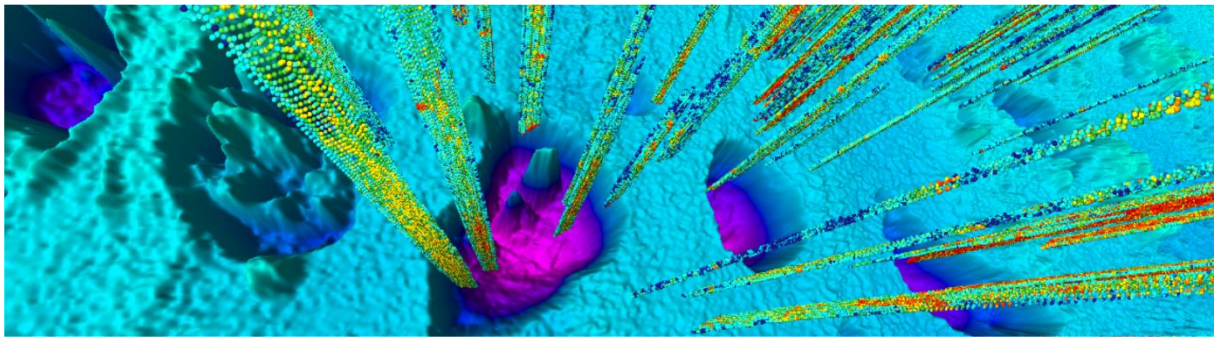

Fig. 1. Giant seafloor craters and mounds, and gas flares in the water (orange and red columns), image by Plaza Faverola.

This work was supported by the Research Council of Norway through its Centres of Excellence funding scheme, project no. 223259.

European Plate Observing System – Norway (EPOS-N) (id 144)

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The *European Plate Observing System* (EPOS) aims to create a pan-European infrastructure for solid Earth science to support a safe and sustainable society. EPOS is in its Implementation Phase (EPOS-IP – EU Horison2020 – InfraDev Programme – Project no. 676564). The main vision of the European Plate Observing System (EPOS) is to address the three basic challenges in Earth Science: (i) unravelling the Earth's deformational processes which are part of the Earth system evolution in time, (ii) understanding geo-hazards and their implications to society, and (iii) contributing to the safe and sustainable use of geo-resources. The mission of EPOS-Norway (RCN-Infrastructure Programme - Project no. 245763) is therefore in line with the European vision of EPOS, i.e. monitor and understand the dynamic and complex Earth system by relying on new e-science opportunities and integrating diverse and advanced research infrastructures for solid Earth science.

The EPOS-Norway project started in January 2016 with a national consortium consisting of six institutions: University of Bergen (Coordinator), NORSAR, Norwegian Mapping Authority, Geological Survey of Norway, Christian Michelsen Research and the University of Oslo. EPOS-N will during the next five years focus on the implementation of three main components: (i) Developing a Norwegian e-Infrastructure to integrate the Norwegian Solid Earth data from the seismological and geodetic networks, as well as the data from the geological and geophysical data repositories, (ii) Improving the monitoring capacity in the Arctic, including Northern Norway and the Arctic islands, and (iii) Establishing a national Solid Earth Science Forum providing a constant feedback mechanism for improved integration of multidisciplinary data, as well as training of young scientists for future utilization of all available solid Earth observational data through a single e-infrastructure.

In order to enhance the monitoring capacity in the Arctic, 17 new seismological and geodetic stations will be co-located in selected sites in Northern Norway, Jan Mayen and Svalbard, as well as a new seismic array on Bear Island. An aeromagnetic survey along the Knipovich Ridge will also be conducted this year. Svalbard is currently experiencing increased seismic activity in clusters near Storfjorden and Nordaustlandet. EPOS-Norway plans on installing six new stations to monitor this new activity, and the preparatory site visits will already be conducted in August-September 2017.
EPOS is a research infrastructure project that will integrate solid Earth data from research institutions all over Europe, making them available through a single e-infrastructure. This will greatly improve the process of working with multidisciplinary datasets.

Photosynthetic performances and isotopic signature in Arctic plant species (id 132)

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Climate change may turn cold biomes from sinks into sources for CO2 depending on the balance between ecosystem photosynthesis and respiration. One of the most important effect of global warming, in Arctic regions is, indeed, the permafrost degradation with consequent increase of soil active layer. A possible consequence of such degradation may be an increase in soil respiration with release of organic carbon. On the other hand, climate change and, in particular, increasing temperature and atmospheric CO_2 concentration, may have positive feedbacks on photosynthetic activity. Photosynthetic capacity is species-specific and it is important to quantify the contribution of different target species in the Arctic regions such as Svalbard Islands.

We focused our attention on the most representative species present at Ny Alesund and, in particular, at the site near the Amundsen-Nobile Climate Change Tower. Photosynthetic performances at different atmospheric CO_2 concentration, light intensity and air temperature were measured on four species: *Salix Polaris, Dryas octopetala, Saxifraga oppositifolia, Carex rupestris*. On the same species, ^{13}C isotope composition was analysed, to obtain an overview of the photosynthetic performances of those species during the season. The photosynthetic parameters of the different species shown that *S. polaris* and *D. octopetala* exhibited the highest assimilation rates, while *S. oppositifolia* showed the lowest. The high value of *A* in *D. octopetala* could be explained with the high stomatal conductance (g_s) recorded for this species. The same, but in opposite sense, is valid for *S. oppositifolia* which present the lowest value of *A* and g_s. The assimilation rates measured at increasing atmospheric CO_2 concentration, at constant light and temperature shown for the four selected species a similar behavior. Despite all species reached remarkable values of *A* (ranging between 15 and 20 μmol $m^{-2}s^{-1}$), none of them showed a clear saturation of *A* to increasing CO_2 concentration. The CO_2 assimilation rate measured at different light intensities showed significant differences among species. Independently of light intensity, *S. oppositifolia* exhibited the lowest *A* values, while *D. octopetala* and *S. polaris* always exhibited the highest values although, at saturating light levels. When looking at the dependence of the assimilation rate from leaf temperature, all species show a clear decrease of *A* at increasing leaf temperatures, although with species-specific patterns.

All species considered are perennial vascular plants and dicotyledons (except *C. rupestris*, which is monocot). Their values of carbon isotope composition ($\delta^{13}C$) measured on above- and below-ground parts of the plants show that they are all C_3 species. The $\delta^{13}C$ value, indeed, varied between -28 and -31‰ in the above-ground dry matter and it was about -29 ‰ in below-ground matter. Moreover, the selected species showed variations in carbon isotope discrimination (Δ), reflecting differences in the ratio C_i/C_a integrated in the period of development of the plant material analysed and then photosynthetic performances.

To conclude, the photosynthetic performances indicated different species responses to light intensity and potential positive species responses to future increases in atmospheric CO_2 concentrations. Species-specific metabolism adaptation to low temperatures could trigger significant feedbacks in a climate change context. This highlight the need to quantify the role of dominant species to the C cycle (sinks or sources) as changes of vegetation or species phenology in response to climate change.

Evolution of pro-deltas: a print of glacier melt processes (id 129)

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In Svalbard, from 1969 to 2012, the annual mean air temperatures increased around 2°C. A strong increase in rainfall was also measured during this period. In the Kongsfjorden area, the Austre Lovenbreen and Midtre Lovenbreen experienced, respectively, a retreat of -19 m/y^{-1} from 1948 to 2012 and -15 m/y^{-1}. Since 2008, the retreat of both glaciers has clearly slowed down but their negative mass balance has been dramatically boosted. Photo-interpretation combined with several field works reveals a shoreline progradation of +16 m/y^{-1} from 1996 to 2016. Moreover, the hydrological system stemming from the glacier shows a decreasing drainage density from 5.5 km/km^{-2} in 1966 to 3.3 km/km^{-2} in 1990. This hydrological network appears less complex and more concentrated. The hypothesis of a more powerful flow must be still demonstrated.

Post-Little Ice Age (LIA) retreating glaciers and destabilization of glacial landforms have released a substantial amount of heterogeneous sediments, which is reworked by runoff and form large coastal sandur deltas. This study aims to understand the evolution of the submarine part of the low-lying coastal zone. The pro-deltas, which are the submarine part of coastal sandur deltas, are source of sediments redistributed by marine processes along the coast. Their study was carried out using the analogic side scan sonar Edgetech 272 TD, characterized by a 100 kHz frequency. It provided underwater acoustic imagery profiles, merged into an acoustic mosaic inserted into a GIS. Five side scan sonar surveys were conducted from 2009 to 2017 along the southern coast of the Kongsfjorden in front of the two glaciers. The comparison of these mosaics reveals a global increase of the surface of the pro-deltas. Nevertheless, these last years, the increase of the pro-deltas seems to be only localized near the main rivers outlet modeled by an eastward littoral drift.

The pro-deltas constitute the final deposit of a “source-to-sink” global system composed by *i*) glaciers, *ii*) sandurs and rivers, *iii*) progradation delta and lastly, *iv*) submarine pro-deltas. Their study should help to estimate the sedimentary volume directly transferred into the fjord and gives new information about coastal sedimentary transfer in Kongsfjorden. These pristine pro-deltas create new coastal environment, which may be colonized by marine benthic organisms that were not present previously.

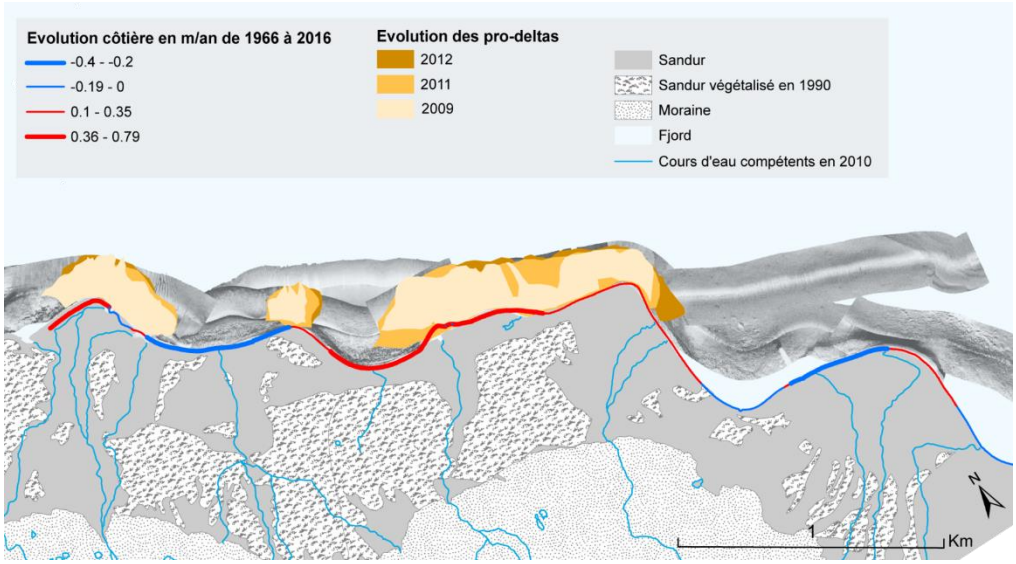

Figure 1 : example of the evolution of the pro-deltas from 2009 to 2012 (*from Bourriquen et al., 2015*)

Black carbon and nanoparticles profiles along glaciers in the Spitsbergen (Svalbard) region. (id 106)

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Atmospheric nanoparticles and black carbon concentrations were investigated using an innovative approach along the elevation profile of glaciers in a non-free atmosphere. The main aim of this investigation was to better understand black carbon and dry dust depositions on the glacier surface, because these processes might have an impact on the melting of glaciers as well to better define the elements and compounds distribution over the glacier surface. Data were acquired using low weight and fast response sensors, installed on a snowmobile: two micro-aethalometers for black carbon measurements and a miniature Diffusion Size Classifier (miniDisc) for total aerosol concentration (airborne particles) in the 14-260 nm range. The experiments were conducted in four glaciers in the Spitsbergen region (Svalbard Islands) in Springs 2016 and 2017.During spring 2016, the Austre Brøggerbreen and Edithbreen glaciers were used as test to optimize the sampling strategy and to identify some basic experimental artefacts. Kongsvegen and Holtedahfonna glaciers were chosen as case study, considering their orographic and geographical features. Kongsvegen glacier extend from the Kongsfjorden coast to roughly 700 m above sea level for a total length of ca. 25 km and with a nearly constant elevation gradient. Holtedahlfonna glacier is the largest ice field (c.a. 300 km^2) on the north-western Spitsbergen island, distributed over an elevation range of 0-1441m a.s.l.

The profile of black carbon and nanoparticles concentrations were determined along the Kongsvegen glacier in both years. During the first campaign nanoparticles concentration showed an increase with altitude, indicating a very active secondary aerosol formation at the highest elevations. On the other side, higher concentrations of black carbon were recorded at the lower altitudes (close to the moraine) of the glacier. This observation suggested that black carbon might have accumulated in the bottom of the glacier atmosphere due to the effect of katabatic winds flow along the glacier profile or reflect the Ny-Alesund emission in the Kongsfjord. Some spikes of nanoparticles were observed due to the crossing of a snow mobile and might for intrusions of air masses from the Dronningpasset. During the 2017 campaign (beginning of April) the profiles of nanoparticles and black carbon were substantially different reflecting mainly the provenience of the air masses at the different altitude of the glacier.

The profile along Holtedahlfonna glacier were studied in the 2017 campaign and the data were acquired from 600 to 1100 m a.s.l.. The highest concentration of nanoparticles were obtained at the begging of the experiment suggesting an accumulation of atmospheric particles in the Holtedahlfonna plateau at about 600 m a.s.l.. A rapid decreasing in nanoparticles concentration have been recorded with increasing the altitude following by several oscillation that reflected the temperature stratification. A plausible correlation between nanoparticles and temperature can suggest that the concentration were influenced by the intrusion of specific air masses from north-east. The black carbon measurements seem also correlated with the temperature oscillations, corroborating that air masses blowing from north-east produced a stratification over the atmosphere surrounding the glacier. These air masses were able to influence the atmospheric composition.

During the 2017 campaign also intense monitoring measurements were conducted in the Brøgger Peninsula to better define the influences of Ny-Ålesund activities on the local atmospheric composition.

An integrated approach to study the sources of Arctic aerosol using water soluble organic and inorganic compounds as chemical markers. (id 105)

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Aerosol samples were collected with 6-days resolution at Ny-Alesund in the Svalbard Islands (78°55'07''N, 11°53'30''E) from 19 April to 14 September 2010. Water soluble organic compounds (amino acids, phenolic compounds and anhydrosugars), trace elements and rare earth elements were investigated in size-segregated airborne particulate matter to better understand their distributions and the transport processes of aerosol towards the Arctic regions.

Water Soluble Organic Compounds (WSOCs) are a substantial component of Arctic aerosol and they may have a great relevance as molecular tracers to investigate the effect of climatic change. Biomass burning sources were studied using levoglucosan and phenolic compounds as specific markers. Levoglucosan had a mean concentration of 0.065 ng m^{-3}, mainly distributed in the <1.5 μm fraction. Phenolic compounds levels in the Ny-Alesund atmosphere in different size fractions reflected both long-range transport linked to biomass burning and a terrigenous local source (Zangrando et al., 2013). Biogenic aerosol was investigated using free amino acids and the results suggested two specific sources: (1) regional and long-range transport from marine areas and (2) the influence of local sources such as marine primary production. Arctic Ocean is a significant source of bioderived aerosol and amino acids can be used as tracer of this aerosol (Scalabrin et al., 2012).

Thirty-nine elements (Ag, Al, As, Ba, Be, Bi, Cd, Co, Cr, Cu, Fe, Ga, K, Li, Mn, Mo, Na, Ni, Pb, Sb, Th, Tl, U, V, Zn, and rare earth elements) were determined and enrichment factors (EFs) were used to distinguish between natural and anthropogenic sources. High EFs values for elements from Cd to Ni were calculated for <0.49 fraction samples collected between 20 July and 24 August, suggesting a substantial long-range input from areas of northern hemisphere. These samples are characterized by fire events in Russian areas. EF values of Li, Bi, Cu, U, V, Tl indicated a stronger relationship with crustal input while the EF values of Fe, Mn, Co suggested soil as the most important source (Turetta et al., 2016). The chemometric method of Principal Component Analysis was used to discriminate the sources of trace elements, rare earth elements and water soluble organic compounds in the aerosol samples with the aim to recognize anthropogenic input and inputs deriving from extreme and/or natural peculiar events (Turetta et al., 2016).

References; Scalabrin, E., Zangrando, R., Barbaro, E., Kehrwald, N. M., Gabrieli J., Barbante C., GambaroA., 2012. Atmopheric Chemistry and Physics, 12, 10453–10463.; Turetta, C., Zangrando, R., Barbaro, E., Gabrieli, J., Scalabrin, E., Zennaro, P., Gambaro, A., Toscano, G., Barbante, C., 2016. Water-soluble trace, rare earth elements and organic compounds in Arctic aerosol. Rendiconti Lincei, 27, 95-103.; Zangrando, R., Barbaro, E., Zennaro, P., Rossi, S., Kehrwald, N.M., Gabrieli, J.,

Barbante, C., Gambaro, A., 2013. Molecular Markers of Biomass Burning in Arctic Aerosols.Environmental Science &Technology, 47, 8565−8574

The study of Svalbard local moss diversity and possbilities for cooperation with other researches. (id 56)

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Bryophytes are an important component of the natural ecosystems of Svalbard. Aboveground phytomass of bryophytes in low-shrab-moss communities accounts for up to 73% of their total overground phytomass (Shmakova, 2005; Shmakova et al., 2008).

Complex expeditions of the Polar-Alpine Botanical Garden and Institute have been studying local moss floras of Svalbard since 2005. We explored areas on: West Spitsbergen (Bockfjorden, Forlandsundet south of St. Jonsfjorden, Trygghamna, Ymerbukta, Pyramiden surroundings, Grønfjorden, Linnédalen, Reindalen, Colesbukta, Agardhdalen,), Nordauslandet (Prins Oscars Land, Duverfjorden, Innvika, Kinnvika, Nordvika), Barentsøya and Prins Karls Forland. Lists of species were compiled for many of them, some new species were found, species distribution within the archipelago, including in protected areas, was clarified. We applied some results to evaluate expertly the recreational potential of Pyramiden (contract № 30/07-2013). Later, our team suggested 5 tourist routes and published the popular guide book "Bryophytes, lichens and cyanoprokaryotes in surroundings of Pyramiden (Svalbard): a concise guide-book" (the grant of Svalbard Environmental Protection Fund 2013-2015). Now, in cooperation with Norwegian University of Technology and Science we make the Svalbard Red List of Bryophytes (grant of the Research Council of Norway 2015-2018).

Prospects for cooperation with other specialists. 1) *Plant physiologists*. Comparison of the total amount of photosynthetic pigments in moss shoots of the same species in the Murmansk Region (Khibiny Mts.) and in West Spitsbergen (Barentsburg) revealed that when moving to the north, the total amount of pigments declined by 2-3 times, mostly due to chlorophylls. The ratio of chlorophylls/carotenoids decreases by 1.3-1.6 times, that indicates an increasing importance of carotenoids in protecting the photosynthetic apparatus in Svalbard plants (Shmakova, Markovskaya, 2010; 2012). The cooperation of bryologists and physiologists will be useful for further studies of the bryophyte adaptation to the hard conditions of the high Arctic.

Also the process of CO_2 gas exchange in mosses and annual productivity has been investigated in the tundra communities in Khibiny for a long time (Shmakova, 1990, 2005; Ushakova et al.,

2004). Combination of such experiments in archipelago with bryological data on species composition, major dominants, and frequency of occurrence will give an understanding of gas exchange and productivity in different communities in various regions. We'll able to work with Norwegian Polar Institute, UNIS and other groups where similar research programs exist.

2) *Glaciologists*. An interesting phenomenon was discovered – "glacier mice" – the emergence and long-term existence of moss populations on 9 melting glaciers of Spitsbergen. On 4 glaciers the species composition was determined, on two ones the populations were examined more closely (Belkina, Mavlyudov, 2010; Belkina, Vilnet, 2015). After the glacier' tongues melt, mosses will become part of the terrestrial local flora.

Continuation of these surveys was the study (by the transect method) of settlement of mosses on area, which was exposed after the retreating Aldegondabreen (Belkina, 2012). Different species need different time to settle in the new territory. Depending on chemical composition of bedrocks and relief, the substrate will be occupied by diverse mosses. Every species has specific growth-form and morphology of gametophytes. The height of the mosses, the spatial structure of shoots, various water-holding capacity affect the thermal conductivity of the moss layer and, accordingly, the depth of thawing of the permafrost (Osokin et al, 2010; Tishkov et al., 2013). Knowing the species composition of the bryoflora on surrounding area and the ecological preferences of mosses, it is possible to predict the species composition of mosses that will inhabit the ice-free territory, and, further, - the soil temperature regime and process of melting permafrost. In turn, the rate of decomposition of organic remains, the formation of the organogenic horizon of the soil and all associated processes depend on the temperature of the soil ("cascade effect").

Dense water plumes SW off Spitsbergen Archipelago (Arctic) in 2014-2017. (id 18)

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In the last decades, the Arctic region has gained a large interest because of climate changes and relevant effects on ice melting and global warming. Abrupt changes in the atmosphere are responsible for significant changes in ocean water masses and large-scale circulation patterns,

which in turn affect the global climate. Studying ocean circulation and related processes along the west Svalbard slope and within the Storfjorden (south Svalbard Archipelago) is essential to describe the thermohaline circulation and the dense water formation (DWF) in the Arctic, and the way they contribute to the global thermohaline circulation. DWF processes in this region depend on the rate of cooling and homogenisation of the Atlantic water along its northwards pathway, brine rejection phenomena, boundary convection on the Arctic Ocean shelves and slopes, and deep open-ocean convection in the central gyres of the Greenland and Iceland Seas. This study focuses on brine rejection, shelf convection and entrainment processes, which occur on the west Svalbard margin and in the Storfjorden during the winter season.

Two short (~140m) moorings (named S1 and ID2, figure 1) were deployed ~1000m deep along the slope in 2014, to collect multiannual time-series in an area of potential interaction between the West Spitsbergen Current and the descending dense shelf plumes. Four oceanographic cruises were carried out between 2014 and 2017 to integrate time-series with CTD (conductivity temperature-depth) casts in the area.

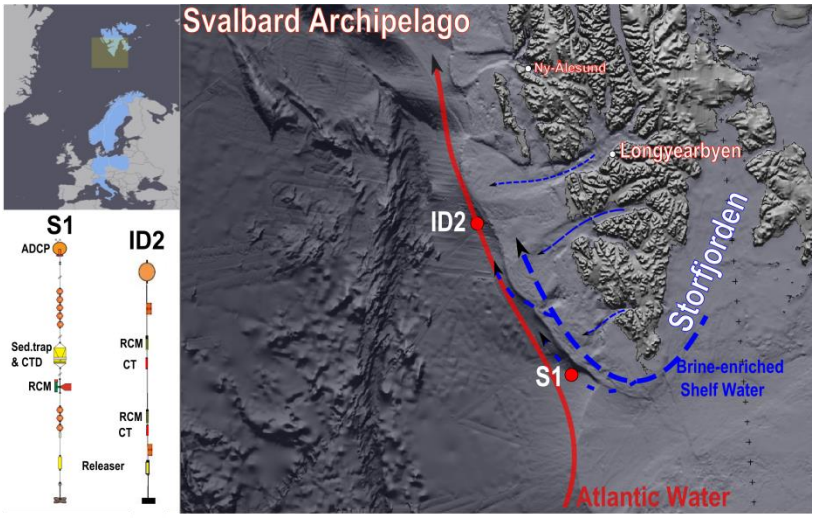

Figure 1 – Study area and moorings (S1 and ID2) location.

One purpose of this research activity was to study the role played by bottom currents in the formation of two sediment drifts (Isfjorden and Bellsund). At S1 and ID2, time-series revealed a large thermohaline and current variability during the winter period, from October to April. Our data highlight the presence of a stable signal of Norwegian Sea Deep Water ($\boldsymbol{\theta}$ = -0.90°C, **S** = 34.90, $\boldsymbol{\sigma_\theta}$ = 28.07 kg m^{-3}) at 1000m depth, influenced by occasional intrusions of warmer (up to +2°C), saltier (up to ~35), and less dense (down to 27.98 kg m^{-3}) water during fall-winter periods. Interestingly, such intrusions occur simultaneously at both sites, despite their distance (~170km), suggesting also that winter meteorological perturbations play an important role in triggering dense shelf plumes. In this paper, the origin, timing, and role of shelf turbidity plumes (denser than TS plumes), which descend along the slope and undergo a strong entrainment process that modify their properties will be discussed. The role of possible mesoscale processes and land-sea atmosphere interactions will also be investigated.

Studying the analogy between terrestrial rock glaciers and Martian Glacier-Like Forms (GLFs) at high-resolutions. (id 25)

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To date, precisely 1293 glacier-like forms (GLFs) have been reported in the mid-latitudes of Mars (Brough et al., 2016). These GLFs are predominantly ice-debris complexes (Bhardwaj and Martín-Torres, 2016), visually similar to terrestrial rock glaciers (Bhardwaj et al., 2016a), and display viscous deformations and glacial geomorphology (Hubbard et al., 2014). However, our knowledge of their mass balances, ice dynamics, landscape evolutions, and hydrology is significantly poor (Hubbard et al., 2014), mainly due to insufficient coverage of the Martian terrain at high resolutions (Bhardwaj and Martín-Torres, 2016). A multi-parametric investigation of GLFs on Mars through their analogous terrestrial counterparts, i.e., rock glaciers, is thus essential to: (i) study the Martian landscape evolution; (ii) understand the presence and phase state of surficial water; and (iii) comprehend the major climatic shifts. An improved understanding of the qualitative and quantitative estimates of water forms is predominantly expected to impact both, future manned Mars exploration and search for Martian life forms (Bhardwaj and Martín-Torres, 2016).

Svalbard is well-known for its variety of mostly active rock glaciers made by talus creep with at least 500 reported across the Svalbard archipelago (Sollid and Sørbel, 1992). Our preliminary analyses of the Svalbard rock glaciers using medium resolution satellite images have suggested striking geomorphological similarities with the Martian GLFs. However, a significant limitation while studying the terrestrial landforms is the unavailability of freely available high-resolution remote sensing images and highly accurate Digital Elevation Models (DEMs). While in the past decade, there has been a significant improvement in the quality and quantity of high-resolution remotely sensed images of Mars with the availability of sub-meter resolution High Resolution Imaging Science Experiment (HiRISE) camera images and DEMs in public domain, a similarly spectacular terrain data is missing in the terrestrial context. In such scenarios, we identify the advent of Unmanned Aerial Vehicles (UAVs) in glaciology in recent years (Bhardwaj et al., 2016b) as a significant step towards unraveling the rock glacier dynamics at high-resolutions. Following that reasoning, we have developed a customizable low-cost, high-performance UAV for cryospheric and atmospheric data collection with a scope for multiple sensor payloads and goals such as, high-resolution 2D imaging and 3D terrain mapping, and albedo measurements. We see the Svalbard Science Conference (2017) as an exceptional opportunity to find collaborators with similar research interests and who are active in the region. We plan to share

our preliminary results of the geomorphological analogy between Svalbard rock glaciers and Martian GLFs and we further look forward to establish collaborations which can provide us the logistic supports for future field campaigns and UAV-based aerial surveys. We have a detailed outline of our planned activities that we would share through our presentation in the conference.

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Variation of phytoplankton assemblages of Kongsfjorden in early autumn 2012: A microscopic and pigment ratio based assessment. (id 206)

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Phytoplankton species distribution and composition was determined by using microscopy and pigment ratios in the Kongsfjorden during early autumn 2012. Variation in sea surface temperature (SST) was minimal and matched well with satellite derived SST. Nutrients were generally limited. Surface phytoplankton abundance ranged from 0.21 $x10^3$ cells L^{-1} to 10.28 $x10^3$ cells L^{-1}. Phytoplankton abundance decreased with depth and did not show any significant correlation with chlorophyll *a* (chl *a*). Column integrated phytoplankton cell counts (PCC) ranged from 94.3 $x10^6$ cells m^{-2} to 13.7 $x10^6$ cells m^{-2}, while chl *a* was lowest at inner part of the fjord (6.3 mg m^{-2}) and highest towards the mouth (24.83 mg m^{-2}). Biomass from Prymnesiophytes and Raphidophytes dominated at surface and 10 m, respectively. Contribution of Bacillariophyceae to biomass was low. Generally, heterotrophic dinoflagellates were great in abundance (12.82 %) and ubiquitous in nature, and were major contributors to biomass.

Various chl pigments (chl *b*, chl *c*, phaeopigments (phaeo)) were measured to obtain pigment/chl *a* ratios to ascertain phytoplankton composition. Phaeo were observed only in inner fjord. Chl *b:a* ratios and microscopic observations indicated dominance of Chlorophyceae at greater depths than surface. Furthermore, microscopic observations confirmed dominance of chl *c* containing algae throughout the fjord. The study indicates that pigment ratios can be used as a tool for preliminary identification of major phytoplankton groups. However, under the presence of large number of heterotrophic dinoflagellates such as *Gymnodinium* sp. and *Gyrodinium* sp. pigment signatures need to be supplemented by microscopic observations.

Keywords: Phytoplankton abundance; species distribution; Chlorophyll a; pigment ratio; spectrophotometric; Kongsfjorden.

Svalbard fjords as harbingers of the future Arctic: A call for interdisciplinary research on interconnected ecosystems. (id 190)

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Progressing atlantification, retreat of tidal glaciers, and changing contaminant loads are impacting Svalbard fjord systems. This is particularly true for the western shores of the archipelago. In Kongsfjorden, recent hydrographic changes produced a pronounced influx of Atlantic water into the fjord system during winter, which have driven the cold system (prior to 2006) to a "warm system", with winter temperatures above freezing and little landfast ice in the fjord. As a consequence, the locally adapted flora and fauna will progressively need to compete with boreal species. Given the large amplitude of variability in physico/chemical conditions the system already experiences it might be considered as an early warning indicator of future changes.

Kongsfjorden represents one of the best-studied Arctic fjord systems. However, research conducted to date has concentrated largely on small disciplinary projects, prompting the need for a higher level of integration of future research activities. Integrating interdisciplinary knowledge on the marine coastal systems of Svalbard is identified as essential element to increase the significance of research in Svalbard in a pan-Arctic perspective. Within the Kongsfjord Ecosystem flagship the following priority topics have, thus, been identified as critical to advance our understanding of Arctic fjord ecosystems: Physical, chemical and ecological observations; Contaminant transport and deposition; Land-sea-atmosphere interactions; Seasonal control of the nutrient regime; Response to key environmental drivers

and potential for acclimation and adaptation; Approaches in modelling of marine ecosystems. The presentation will provide a review on the state of marine research in Svalbard fjords and the recent changes observed in the system, in order to identify the critical gaps in knowledge calling for increased interdisciplinary research.

Diversity of Arctic Phytoplankton Community During Summer 2015 in Costal Water of Kongsfjorden in NyAlesund, Svalbard. (id 31)

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A study on the diversity in phytoplankton community was carried out in the coastal surface water of Kongsfjorden and some glacial lakes in Ny Ålesund, Svalbard, Arctic in June-July 2015 during the meso-microcosm studies in the frame of OC project (Ocean Food-web Patrol – Climate Effects: Reducing Targeted_FP7-ENV-2013-6.1-1; no: 603773). The aim of the present study identify the diversity and composition of natural phytoplankton populations by determining the species abundance and diversity by recording the physical parameters in order to be able to compare the communities in the fjord and two different glacial lakes as possible baseline compositions for the communities to be developed in meso-microcosms. The phytoplankton community in the fjord was mainly dominated by small sized cells of Bacillariophyceae (=Diatoms), Cryptophyceae and different Stomatocyst species (Chrysophyceae). Thus, the Scanned Electron Microscopic (SEM) images were also obtained in addition to Light Microscopic (LM) images. The most abundant diatoms were the some small single cell species of Genus Cyclotella, *i.e.*, *C. atomus* (4,13-5,86 µm), *C. atomus var. atomus* (4,28-4,57) *C. atomus var. marina* (3,01-3,80 µm) and particularly *C. ocellata* (range of 4,34-11,74 µm) which is a good indicator for the environments in which shorter ice covers and longer growing seasons happen. A secondary prominent centric diatom was *Thalassiosira sp*. (5–10 µm). Among pennate species those belong the genera Fragilaria, Navicula, Achnanthes, Cocconeis and Diploneis were the abundant ones. More than about 90% of species composing the phytoplankton community was 1–5 µm and 5–10 µm in size and the species > 15 µm size complete the community's size distribution in the fjord. As a paleo-limnological indicator, about 21 different types of Chrysophycean stomatocyst, which ranged between 3,34-15,46 µm in size were found in the fjord, while the number was about 15 different types which ranged between 3,45-10,68 µm in size in the lakes . Another point of remark for the glacial lakes was the occurrences of species of several pennate genera, *i.e.*, Navicula, Fragilaria, Diatoma, Achnanthes, Diploneis and Cymbella whereas Genus Cyclotella were represented with C. ocellata and *C. antiqua* (9,38-12,19 µm) where the latter was only found in the lake. Moreover, the only *Pseudo-nitzschia sp* and *Prorocentrum micans* were

observed as a potential toxic /nuisance species in Kongfjorden. Considering the remarkable increase in the frequency of occurrences of small sized phytoplankton species from polar to subtropical seas and particularly members of Genus Cyclotella originally which widely common in freshwaters, seems as an important question to be challenged by phytoplankton ecologists.

Fresh water input to the Hornsund Fiord (Southern Spitsbergen). (id 75)

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Significant retreat and mass loss of glaciers has been observed during the last decades in the drainage basin of the Hornsund Fjord (Southern Spitsbergen, Svalbard), similarly to the whole archipelago. That influence the fresh water supply to the fiord. Freshwater impact on fjord waters is very important for their physical properties, water circulation and marine ecosystems.

This study presents the total water budget of the Hornsund hydro-glaciological basin including frontal ablation of tidewater glaciers and surface mass balance of the entire glaciated area. Additionally, input from liquid precipitation and from melted snow cover over unglaciated catchments were estimated, to indicate the major and minor sources of fresh water supply to the fiord.

Glaciological and meteorological data from the period 2006-2015 were used for evaluation of average fresh water input components. Average frontal ablation was estimated based on velocity derived from intensity tracking of repeat-pass TerraSAR-X satellite radar images, bathymetry data and average changes in glaciers termini positions derived from winter SAR images. Surface mass balance for glaciers in Hornsund Fiord basin has been modeled basing upon mass balance measurements on Hansbreen, Storebreen and Flatbreen/Hornbreen. Estimation of liquid precipitation were based on totals daily precipitation and notation of meteorological phenomenon from Hornsund station located at 77°11'N, 17°33'E (8 m a.s.l.). Amount of water coming from snow cover of unglaciated area was investigated based on data from meteorological station in Hornsund and measurements of snow cover thickness and density near the Polish Polar Station.

Moreover, problems related to studies, results validation, and sources of uncertainty are also highlighted in the presentation.

Results show the leading and minor sources of the freshwater supply to the Hornsund Fiord. Total average input of fresh water has been calculated as 2.1 Gta^{-1}. Main components are surface

ablation of glaciers – c. 46 % and their frontal ablation – c. 30 %. Liquid precipitation and melting of snow cover on unglaciated area have smaller contribution, 15 % and 9% respectively. Presented study is a part of activity within the INTAROS: Integrated Arctic Observation System – H2020 Project.

The Bayelva high Arctic permafrost long-term observation site: an opportunity for joint international research on permafrost, atmosphere, ecology and snow. (id 216)

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At present, the Arctic climate is changing much more rapidly than the rest of the globe, and yet observational data available in the region is poor. The positive feedback between climate warming and permafrost carbon emissions depends on changing land-atmosphere energy and mass exchanges. There is thus a great need to understand links between the energy balance, which can vary rapidly over hourly to annual time scales, and permafrost, which changes over longer time periods. This understanding mandates long-term observational data sets. There is also a need to realistically incorporate permafrost into global modelling frameworks such as Earth System Models. Evaluating and parameterising of process-based models require simultaneous measurements of interacting variables. Here we present an example of such a long-term data set, from the Bayelva site at Ny-Ålesund, Svalbard, where meteorology, energy balance components and subsurface observations have been made for the last 20 years. Since the data provide observations of temporally variable parameters that mitigate energy fluxes between permafrost and atmosphere, such as snow depth and soil moisture content, they are suitable for use in integrating, and testing permafrost as a component in Earth System Models. There is a great need for continuous monitoring at more sites, to span the full range of permafrost conditions. The data show that mean annual, summer and winter soil temperature data from shallow to deeper depths have been warming over the period of record, indicating the degradation of permafrost at this site.

Effects of simulated pink-footed goose grubbing and climate warming on ecosystem process rates of three High Arctic plant communities. (id 164)

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Global climate change is unequivocal and Arctic regions have been subjected to the highest rates of warming. However, the extent to which Arctic ecosystems respond to climate change may be modulated by biotic interactions and vertebrate herbivores may play a fundamental role in this context. In the archipelago of Svalbard, pink-footed goose population has notably risen over the last decades. As a consequence, geese started exploiting less suitable habitats raising the issue of how different plant communities respond to the combination of higher temperatures and herbivore perturbations. Goose foraging for belowground plant organs in spring (grubbing) is particularly destructive for vegetation and can cause a widespread disturbance in the fragile high Arctic tundra, which in turn may impact nutrient and carbon cycling of these nutrient limited ecosystems. Despite the increasing number of studies concerning the possible impacts of global change and herbivory on Arctic ecosystems, the interactions between these two different components and related community-specific responses are still poorly understood.
The overall aim of this project is twofold: 1) to study how pink-footed goose grazing may interact with higher temperatures in modifying temporal and spatial ecological stoichiometry – nitrogen (N) and phosphorous (P) contents – in different functional types of tundra plants (PFTs) and 2) to scale up from variation in PFTs nutrient contents to ecosystem functions, encompassing carbon (CO2) fluxes between ecosystem and atmosphere as well as decomposition processes. Understanding the coupling of carbon and nutrient (N and P) cycles under changing conditions is fundamental to predict possible consequences of climate change on ecosystem processes and functioning.

A fully factorial randomized block design with and without simulated goose grubbing (and feces addition) and ambient and elevated temperature was established in Adventdalen (Svalbard) in May 2016. Seven sites were identified as main replication in the experiment. At each site, three plant communities distributed along a soil moisture gradient were selected (relatively dry community, moist, and wet) and an experimental block (each one composed by 4 different plots randomly assigned to the 4 different treatment combinations) was established in each community. Mechanical experimental grubbing was implemented once in early summer 2016 and 2017 (2-year experiment) and was based upon detailed observation of naturally grubbed areas and the successful study conducted by Speed *et al*. (2010). Experimental warming was obtained by using hexagonal Open Top Chambers (OTCs). All plots were caged off to avoid the confounding factor of natural herbivory.

We are here presenting the preliminary results of the 2 main overarching questions of this project.

Geodetic constraints on ice-mass changes on Svalbard. (id 98)

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Modern geodetic observations have been conducted in Ny-Ålesund, Svalbard, over nearly 30 years. This instrumental record includes observations from GNSS (Global Navigation Satellite Systems), VLBI (Very Long Baseline Interferometry), DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite), gravimeters, and a tide gauge. With the new geodetic core station about to be completed, the Norwegian Mapping Authority facilitates for future geodetic research and continuation of existing data records. Over time, the instrumental records allow sub millimeter crustal deformations to be studied as well as associated changes in the gravity field. The high accuracy of modern geodetic instruments makes them sensitive to geodynamic processes like glacial isostatic adjustment and variation in hydrology and snow cover. Basically, historic ice-mass changes introduce linear trends in time series of height, gravity, and sea-level while seasonal and interannual variation arise due to present day changes in the ice-masses, snow cover, and hydrology. The existence of such signals in the observational records makes them valuable for monitoring effects of climate change in a glaciated area like Svalbard. Here we present the geodetic instruments located in Ny-Ålesund and the records of observations they have provided over the last three decades. We review how the signals in height and gravity time series due to ice-mass changes can be modeled and how geodetic observations are used to compute constraints on ice-mass changes. The aim of this review, is to make the research community aware of the unique geodetic records from Ny-Ålesund. We envisage that the geodetic data in the future to an even greater extent may be combined with other types of in-situ and satellite observations.

Multidisciplinary cooperation of this type is important because 1) geodetic observations combined with independent ground and satellite data contribute to an improved understanding of present ice-mass changes on Svalbard; and 2) independent non-geodetic observations are required to isolate the signal of historic ice-mass changes in the geodetic records. This, in turn, may shed light on the ice-history and rheology of the Svalbard archipelago.

The challenge and the benefit of geophysical mapping in the Norwegian high arctic: a comparison of potential field data acquisition from various platforms. (id 48)

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Fixed wing airborne magnetic and gravity data acquisition is a fast and economic method to map large areas to gain geological and tectonic information. In the Arctic and in particular in the Svalbard-Bjørnøya area, however, steep topography and extreme external condition like high magnetic diurnals and fast changing weather conditions can hamper such an effective data acquisition. Platforms like unmanned aerial vehicles (UAV) or ground borne acquisition are potential alternatives to partly overcome these challenges and was tested on the island of Bjørnøya to acquire magnetic data.

Bjørnøya (Bear Island) is a 178 km^2 large island emerging in the western Barents Sea about half way between northern Norway and Spitsbergen. The island is characterized by mostly vertical cliffs along the coast of at least a few tens of meters high, whilst its topography is predominantly characterized by a large flat plain extending from the north to the southwest, with plenty of lakes and rocky areas in between. Mountainous areas appear with elevation up to 440 m in the south (Antarcticfjellet) and more than 500 m elevation (i.e. Miseryfjellet) in the eastern part of the island. The island is covered in fog for commonly more than 200 days a year, which makes it nearly impossible to map the area with an aircraft at low altitude.

On the other hand the island represents an important outcrop of the Barents Sea shelf geology. The exposed rocks on Bjørnøya represent sedimentary strata of Devonian to Late Triassic age. They are underlain by an Ordovician to late Precambrian basement (Hecla Hoek) consisting of dolomites, limestones and quartzites. The stratigraphic development and the observed orientation of structural elements in an almost N–S direction are very similar to the geology and structural settings of Spitsbergen. Furthermore coal and mineral ore discoveries in the beginning of the 20th century resulted in extensive geological mapping. Stratigraphic layering and structural elements are nicely exposed along the steep coastal cliffs, whilst exposures of litho-stratigraphic contacts and faults across the island are often covered by overburden or hidden in extensive blockfields and cannot be mapped continuously. Due to a lack of geophysical data the first geological map from 1928 is still valid for the most part of the island and shows large uncertainties regarding the distribution and context of geological and tectonic elements. We will present magnetic field data from three field campaigns, where we acquired data with an

airplane, a multicopter drone and ground borne carrying a magnetic system across the island. The experience with these three different platforms applied in the arctic are discussed and evaluated regarding specific demands for geophysical research in such an environment.

Influence of environmental parameters on the use and spatio-temporal distribution of Arctic seal Erignathus barbatus vocalizations in Kongsfjorden, Svalbard Islands. (id 38)

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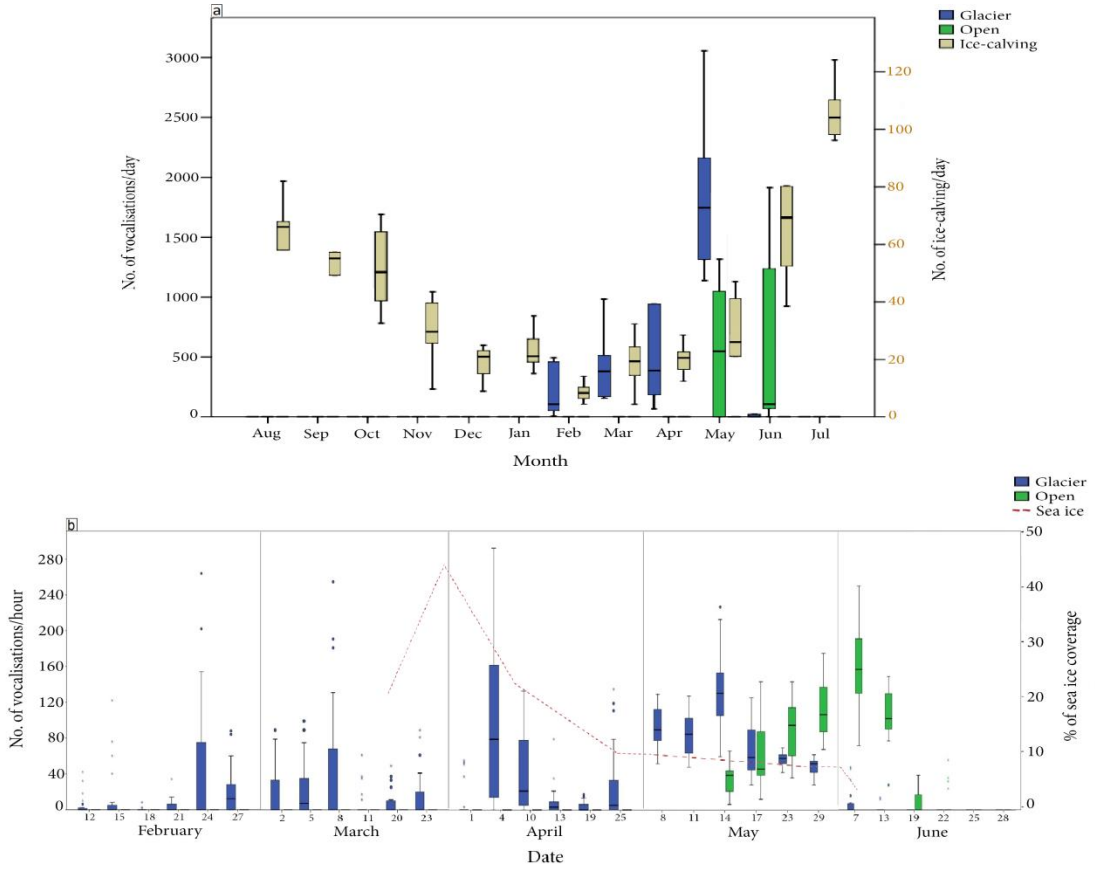
The climate-induced changes in the Arctic marine ecosystem are influencing the occurrence and behavioural activity of many ice-obligate pinnipeds species. In order to improve knowledge about the effect of changing conditions on species, we used Passive Acoustic Methods (PAM) to investigate the relation between ice presence (sea ice and glacier iceberg) and light cycle with the use and spatio-temporal distribution of *Erignathus barbatus* vocalizations. Two autonomous passive acoustic recorders were deployed between August 2014 and July 2015, in the inner and outer parts of the Kongsfjorden (Svalbard Islands, Norway). 1728 hours and 17 220 vocal emissions were recorded. The emission rate of vocalisations varied significantly daily and monthly in relation to the light and darkness turnover. Bearded seal vocalizations intensified with ice coverage peak but continued also during ice retreat, coinciding with the mating season. A spatial displacement was highlighted from the inner to the external part of the Kongsfjorden. The occurrence of vocalizations only at the open site recorder corresponds to sea ice disappearance within the fjord. Furthermore, a shift of two months in the onset of the vocal emissions was identified compared to fifteen years ago. Considering the premature melting season of the Arctic fjord occurring in the last decades, both the anticipation of the vocal activity and the spatial occurrence of acoustic signals could reflect an adaptation to sea-ice changes. Results of this study shed light on the importance of external parameters on the bearded seal biological activity and suggest possible scenarios in relation to ongoing changes in the Arctic ecosystem.



NextGEOSS Cold Region pilot – cross-disciplinary data integration for better science and decision-making. (id 142)

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The GEO Cold Regions initiative coordinates global efforts to provide Earth Observation (EO) products and services to science, decision- and policy-makers with a vested interest in the cryosphere (in particular) and the environment (in general) of polar regions and mountain areas around the world. The H2020 project NextGEOSS's Cold Regions Pilot focuses on three areas: (1) the Arctic/Svalbard region, (2) Antarctica, and (3) the Himalayan glaciers, and addresses the existing shortage in accessing in situ data in GEOSS. The pilot liaise with ongoing initiatives such as SIOS, GEO-CRI, WMO GCW, as well as national programs in Antarctica.

The NextGEOSS project is all about providing the data and resources to the users communities, together with access to Cloud infrastructures, seamlessly connected to provide an integrated ecosystem for supporting applications. NextGEOSS has a special focus on encouraging and stimulating data exploitation. Capacity building is also at the heart of NextGEOSS, through the

identification of training needs, to encourage wider user-engagement with EO data and unlocking its potential. The Cloud readiness of existing data infrastructures is also being accessed together with the support of a federated solution taking in consideration data product accessibility. Through the additional engagement activities promoted by the project as well as the communication and training activities and material made available, NextGEOSS seeks to widen significantly its base of supporters, providers and users, into becoming the preferred European hub for data access and distribution by the European GEO community. This presentation will explore how NextGEOSS and particularly the Cold Region pilot can contribute to and support the current activities on Svalbard.

A special focus will be on showcasing examples of products for selected areas in Cold Regions, combining remote sensing data, in situ data and model products from relevant European infrastructures and international frameworks. Discussion on how the products can be made available through the NextGEOSS Data Hub, for users and stakeholders in the GEO community, polar research and education and thus contribute to enlargen the reach of the current Svalbard activities such as SIOS. An initial list of products includes:

- Sea ice type and drift maps for the Fram Strait, based on Sentinel-1 SAR data.
- Sea ice concentration for the Arctic, based on satellite altimeter and passive microwave data.
- CMEMS product Arctic Ocean physics analysis and forecast product.
- Near-surface atmospheric aerosol properties (near-real-time) at Zeppelin station, Svalbard.
- Near-surface atmospheric aerosol properties (near-real-time) at Troll station, Queen Maud Land, Antarctica.
- CAMS aerosol optical depth forecast product.

Additional products are being defined in dialogue with stakeholders during the course of the project, in close collaboration and dialogue with users and stakeholders in the GEO community. This opens up for many collaborations with the Svalbard communities.

This presentation aims to engage scientists on Svalbard in the NextGEOSS pilot, increasing data and modelling resources across disciplines.

Mathematical Tool for a closure study of aerosol microphysical property retrieval using lidar, photometer and in situ particle counter data. (id 133)

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We present a future project combining lidar, photometer and in situ particle counter data taken in Ny Ålesund, Svalbard, as well as a mathematical regularization software tool for a closure study of aerosol microphysical property retrieval.

The model relating the optical parameters $\Gamma(\lambda)$ with the volume size distribution $v(r)$ is described by a Fredholm integral operator T of the 1st kind

$$(Tv)(\lambda) = \int_{r_{\min}}^{r_{\max}} K(r,\lambda;m)v(r)\mathrm{d}r = \int_{r_{\min}}^{r_{\max}} \frac{3}{4r} Q(r,\lambda;m)v(r)\mathrm{d}r = \Gamma(\lambda),$$

where λ is the wavelength, r is the radius, m is the complex Refractive Index (RI), $\Gamma(\lambda)$ denotes either the extinction or backscatter coefficients, and Q stands for either the extinction or the backscatter (dimensionless) Mie efficiencies respectively, i.e. the particle cross sections divided by the geometrical cross section of a sphere. The integral limits $r_{\min}$ and $r_{\max}$ are appropriate lower and upper radii which are describing the specific measurement event but have also to respect the restriction of the physical model.

The wavelengths in the case of lidar data can take three discrete values 355, 532, and 1064 nm since the multi-wavelength Raman lidar KARL forms only data sets of 3 backscatter coefficients in all three wavelengths and 2 extinction coefficients in the first two. Identifying $\Gamma(\lambda)$ as our measurement data and $v(r)$ as the unknown distribution, the problem reduces to the inversion of the operator T. Knowing the volume size distribution, we can then extract the following microphysical parameters:

- total surface-area concentration $a_t = 3\int \frac{v(r)}{r}\mathrm{d}r$ ($\mu m^2 cm^{-3}$)
- total volume concentration $v_t = \int v(r)\mathrm{d}r$ ($\mu m^3 cm^{-3}$)
- effective radius $r_{eff} = v_t/a_t$ (μm)
- total number concentration $n_t = \frac{3}{4\pi}\int \frac{v(r)}{r^3}\mathrm{d}r$ (cm^{-3}).

In addition, the complex refractive index $m=m_R+i\,m_I$ with the Real part $\mathrm{Re}(m)=m_R$ and Imaginary part $\mathrm{Im}(m)=m_I$ as well as the Single Scattering Albedo (SSA) in 355nm and 532nm are retrieved. Note that in this work the common assumption of wavelength independent RI is made, as a member of a predefined refractive index grid, see Figure 1. Solving the above integral equation requires discretization, regularization and a parameter choice rule.

Additionally, the mathematical software is able to include more backscatter and extinction coefficients at arbitrary wavelengths. Since photometer data are available at 10 wavelengths the

AODs can be transformed into extinction coefficients for the whole column. Combining lidar and photometer data improves the microphysical retrieval.

Finally, the mathematically retrieved size distribution can be compared as a closure study with the retrieved size distribution of an in situ particle counter launched with a balloon in Ny Ålesund.

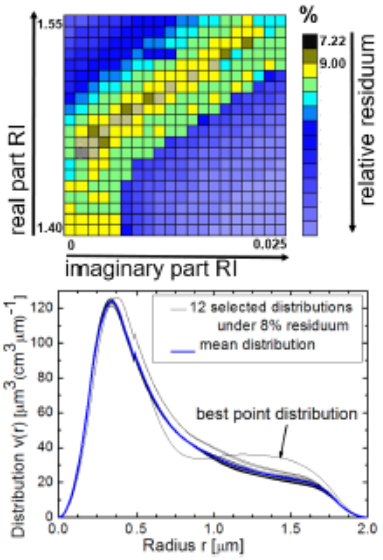

Figure 1: Example of a mathematical retrieval result: Used RI-grid to find a mean refractive index and the inverted volume size distribution via regularization.

Dominant bacteria genera of Kongsfjorden reflected by water masses in summer. (id 203)

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During the summer 2012, a total of 14 samples from five stations were collected. Bacterioplankton diversity was investigated by Pyrosequencing, and nutrients chlorophyll *a* (Chl *a*), *in situ* temperature and salinity were also measured.

Totally, 34,644 sequences were classified into 1010 OTUs after quality checking and trimming of the original sequences. Seventeen of 33 identified genera were observed with relative abundance >0.1%, and they accounted for more than half of the sequenced reads.

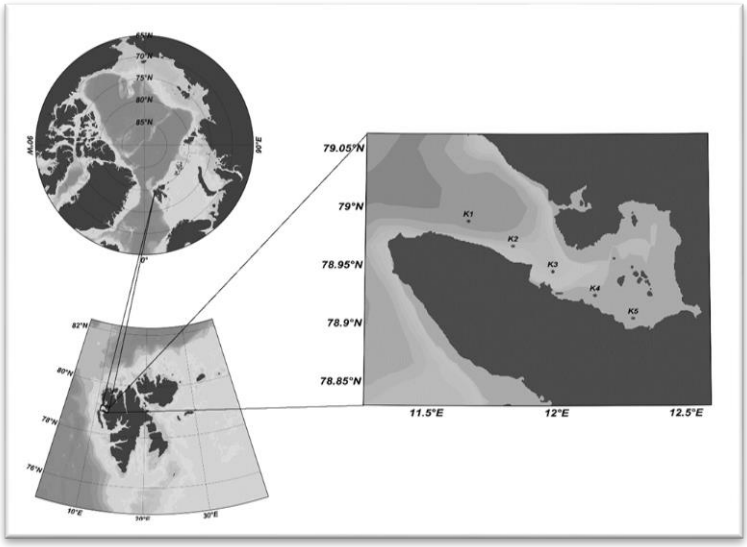
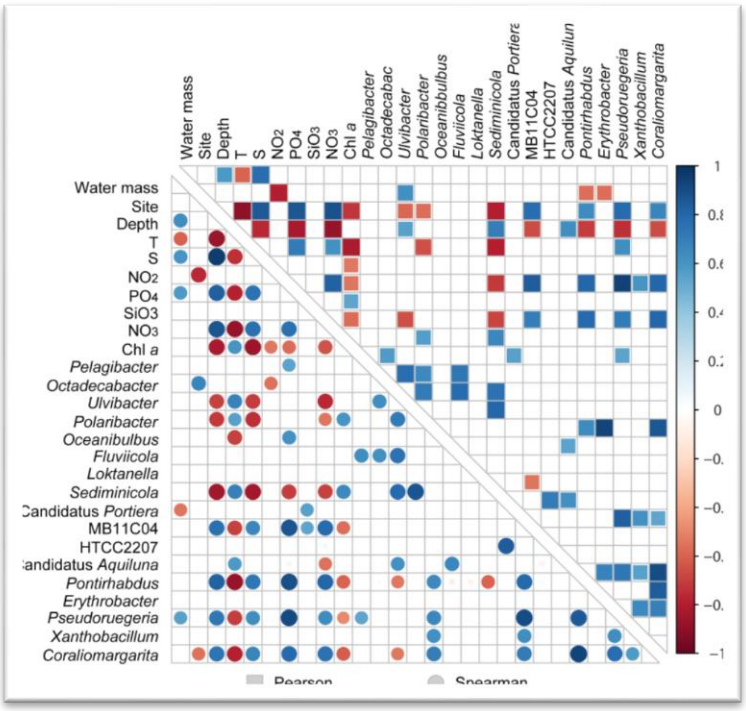


Figure 2 Pairwise comparisons of environmental factors and bacterioplankton genera abundance with a color gradient denoting Pearson (block) and Spearman's (dot) correlation coefficients.The insignificant correlations were not shown.

73.02% of the bacterioplankton community variance could be explained by environment parameters (RDA). And most of the abundant bacterioplankton genera were observed significant correlations with environment parameters.

Furthermore, analysis of variance revealed that environment parameters varied significantly with water mass, also the abundance of top nine identified bacterioplankton genera differed

with water mass significantly.



Kongsfjorden is an ideal natural laboratory for studying bacteria and plankton distribution and community structure in Artic, especially under the background of climate change. Based on the analysis above, we speculated that environmental factors, especially water mass, had key influence on bacteria and plankton distribution at genus level. The genera with relative abundance ranged from 0.1-1% such as pontirhabdus, were sensitive to environmental change. Considering the high sensitivity to environmental change and lower error rate in identification, bacteria and plankton at genus level could be good candidate bio-markers for monitoring environmental change.

Aerosol vertical profiles in the Arctic. (id 168)

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Primary objective of this activity is to contribute to build a climatology of the lower troposphere composition in terms of aerosol particles in the Kongsfjorden area. This can be achieved by means of scientific payloads that can be lifted up to about 1000-2000 m by various tethered balloons. First experiments were performed in the 2011 spring and 2012 summer (1-3). Since

then a novel airborne gondola has been developed. A number of aerosol instrumentation have been customized and deployed in the gondola and four successive campaigns conducted in Ny-Ålesund in September 2014 and April-May 2015, 2016 and 2017. Secondary objectives of present work are are the detection of long-range transport events such as the prolonged and exceptionally intense air mass advection event transporting biomass burning aerosols generated in Alaska that affected Ny-Ålesund in the mid of July 2015 (6, 7) and the study of mixing processes from the surface to the troposphere (1, 2, 7).

The instrumental gondola AGAP (Atmospheric Gondola for Aerosol Profiling) has been designed and realized in Italy during summer 2014. The mechanical part has been manufactured in Perugia by assembling aluminium parts cut with a precision laser techniques. The electronics and the instruments assembling has been realized at ISAC-CNR in Bologna. The aerosol instrumentations have been provided by both the Perugia and the ISAC-CNR laboratories from independent funding and previous projects. It includes a Radiance Research nephelometer M903, an AethLabs micro aethalometer model AE51, an OPC produced by FAI instruments and an ozone monitor 2B Technologies, besides meteorological sensors. Various different, usually smaller, instrumental payloads have been also exploited to test new instruments and also to conduct parallel measurements with a second tethered balloon system within the iAREA campaign.

A total of more than 400 profiles have been obtained for the full 2011-2017 period, which will allow the definition of typical situations, as well as to identify specific episodes. Preliminary results have been already published (3,4,7). The activities of AGAP will be continued in the Arctic during next years. Future instrumental developments will included the implementation of a miniaturized PSAP (Aerosol Photometer) and instrumentation for cloud measurements, in collaboration with the KOPRI research group active in Ny Alesund.

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Morphodynamics and sedimentary processes in arctic transitional environments: Dicksonfjorden, Svalbard. (id 139)

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Despite its role as an interface between terrestrial and marine systems, transition zone between marine and fluvial environments is least understood partly because of the lack of understanding about various physical processes that govern sediment flux and transport over time and space. This is particularly the case for arctic coastal areas, where thawing permafrost and sea-ice loss facilitate rapid environmental changes such as coastal erosion due to climate change. This study aims to understand processes controlling sediment distribution and morphologic changes in arctic transitional environments in Dicksonfjorden by conducting repeated morphological survey using RTK-GPS and UAV and sedimentological analysis. With seasonal freshet and a 2-m spring tidal range, about 7 km-long transitional environments are developed in Dicksonfjorden. Actively migrating braided channels are predominant in the fluvially-dominated upstream area and near the alluvial fans. The braided channels merged into fewer sinuous meandering channels in the downstream area, where extensive tidal flats are developed. Sediments overall fine downstream, reflecting fluvial and ebb dominance. Highly concentrated suspended sediments are being transported over tidal cycles. Locally over 30 cm-thick sediments are deposited in the tidal channels during ice-free seasons. However, their preservation potential seems to be low presumably due to entrainment by subsequent freshet during next year. A series of spits and cheniers, consisting of gravels and coarse sands, along the margin in the downstream area indicate longshore and landward transport of coarse-grained sediments by storm waves during spring high tides and/or high-discharge period. DoD (Difference of DEM) analysis indicate spits in the downstream area migrated as much as 10 m between 2016 and 2017, suggesting active coarse-grained sediment transport and coastal erosion along the fjord shoreline in the downstream area. This reconnaissance study highlights the spatio-temporal variability and complexity of sediment transport in Dicksonfjorden, warranting further coordinated research to understand sedimentary processes in the fjord and to properly address future changes therein.

The influence of permafrost on slope dynamics in Svalbard. (id 169)

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Svalbard is classified as an Arctic desert with around 200 mm of annual precipitation having a 'High Arctic Maritime Snow Climate'. The high relief landscape with continuous permafrost means that directly precipitation controlled slope processes are mainly slow moving such as rock glaciers, solifluction sheets and lobes, and rockwall weathering. However, snow cornices are known to be able to cause quick slope activity by triggering slab avalanches if enough snow has accumulated during winter on the slopes below the extensive plateaus where cornices accumulate mainly in central Svalbard. Snow avalanching is, however, normally only happening during mid to late winter when enough snow have accumulated. Therefore immediate, direct slope response to large precipitation amounts in autumn is traditionally seldom in the high Arctic landscape.

The effect of two autumn rainstorms happening in October and November 2016 was studied in the high Arctic landscape around Longyearbyen, the main settlement in the Svalbard archipelago, with focus on slope dynamics. In addition to the slopes being exposed and affected, also the coastal environment was influenced due to high wind speeds. We did geomorphological mapping, analysed the meteorological situation, established and analysed local precipitation measurements, analysed ground temperature measurements in combination with active layer dynamics data, performed terrestrial laser scanning to quantify slope sediment transport and used radar satellite observations for upscaling to larger parts of the landscape in Svalbard.

The two large storms transported warm weather to Svalbard 14-15 October and 7-8 November 2016, and affected the landscape by bringing rainfall to the lowlands and snow in the uplands. During the first storm, 18-20 mm of rain was recorded in the Longyearbyen area with an intensity of up to 2.8 mm/hour over a period of about 12 hours. Numerous slope failures including slumps, active-layer detachment slides, and mudflows resulted on hillslopes in and around Longyearbyen. One large mudflow, initiated from an active-layer detachment slide high on a mountain side, crossed a main road in the Longyearbyen area. 5000m^3 of sediment was deposited during this event. During the second storm, we recorded 75.3 mm rain in Longyearbyen, with intensities up to 8.3 mm/hour. The most exposed areas of Longyearbyen were evacuated as a precaution as slope activity was expected prior to the second storm. Snow fell during this event, and extensive avalanching was observed from the radar satellite monitoring of the uplands surrounding the Longyearbyen area. The Longyearbyen dog yard was partly damaged by a medium-sized slump.

Despite the second storm happening during the polar night, with only minimum light available for observing, visual field surveys from the air and ground indicated much less slope activity following this storm, despite the greater recorded precipitation during the latter event. Extensive slope failure during the second event was likely prevented because the top of the active layer had started refreezing preventing water infiltration into the sediments. In contrast, the entire active layer was still thawed during the first rainstorm, due to the exceptionally warm autumn weather on Svalbard in September and October, which allowed rapid infiltration and saturation of the active layer above the hydraulically impermeable permafrost table.

Monitoring Glacier Displacement in Western Svalbard Using Landsat 8 and Sentinel-1 Data. (id 202)

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Velocity is an important parameter in glacier dynamics and mass balance studies. Methodologies based on cross-correlation tracking algorithm using different optical and SAR images between two dates are mainly employed to estimate ice flow velocities. The launch of new satellites, Landsat 8 and Sentinel-1, opened up new opportunities for regular monitoring of typical glacier velocities since 2013. Landsat 8 has better radiometric resolution, geolocation accuracy and image acquisition rates, which is beneficial to extract annual ice velocities. The Sentinel-1 mission allows for nearly continuous monitoring of the motion of ice masses at high spatial and temporal resolution. In this study, we assess the possibility and capability to utilize Landsat 8 optical data and Sentinel-1 SAR data comprehensively for ice velocity determination in Western Svalbard. Velocities of glaciers monitored in this study can often be well estimated using a tracking algorithm when the displacements are more than 20 m/yr. The results based on SAR data depend largely on the coherence of SAR pairs. And we estimate velocities of several glaciers near the Chinese Yellow River Station in Svalbard, using Landsat 8 and Sentinel-1 time series data from 2013 to 2017. Landsat 8 images are employed to extract annual ice velocities from 2014 to 2016 with feature tracking method. And several Sentinel-1 images are used to calculate velocities in different seasons between 2015 and 2017 using offset tracking. Annual velocities of most outlet glaciers perform similar spatial features through different front position epochs, from 2013 to 2017.

The importance of annual and shorter term temperature patterns and variation in the surface levels of polar soils for polar terrestrial biota. (id 112)

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Ground surface and sub-surface temperatures in the top few centimetres of the soil profile are key in many environmental and biological processes yet remain very poorly documented, especially in the polar regions or over longer timescales. They can vary greatly seasonally and at various spatial scales across the often highly complex and heterogeneous polar landscapes. It is challenging and often impossible to extrapolate soil profile temperatures from meteorological air temperature records. Furthermore, at present and to our knowledge, and despite the justifiably considerable profile given to contemporary large-scale climate change trends, no biological microclimate datasets exist that are of sufficient duration to allow robust linkage and comparison with these large-scale trends. However, it is also clear that the responses of the soil-associated biota of the polar regions to both the existing climate and to projected climate change cannot be adequately understood without improved knowledge of how landscape heterogeneity affects ground and sub-surface biological microclimates, and of baseline descriptions of these microclimates and their patterns and trends at biologically relevant physical and temporal scales. Such data are also important in the physical sciences for determination of the surface energy budget and turbulent exchange processes between the air and the land. To stimulate discussion and research in this field, we introduce and provide an overview of multi-annual temperature records at biologically-relevant scale from 20 High Arctic (Svalbard) and maritime Antarctic (Antarctic Peninsula and Scotia Arc) sites, including a range of ground surface and sub-surface habitats. We highlight general features in the datasets that are likely to have important influences and impacts for biology in polar terrestrial ecosystems, including (a) summer ground and sub-surface temperatures vary much more than those of the air; (b) winter ground temperatures are generally uncoupled from atmospheric temperatures; (c) the ground thawing period may be considerably shorter than that of positive air temperatures; (d) ground freeze-thaw event patterns differ between Arctic and Antarctic; (e) rates of ground temperature change are generally low; (f) accumulated thermal sum in the ground usually greatly exceeds air cumulative degree days. While many of these statements may seem unsurprising in themselves, we highlight the previous lack of such datasets available to the research community, and the utility and fundamental biological importance of such data.

Integrated Observations: traditional time series and new technologies (id 141)

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Observation technologies are evolving rapidly, yet our ability to detect change requires the maintenance of established time series. Therefore we are faced with sustaining traditional observations whilst embracing the capabilities of new technologies. Here we describe the contribution made to our understanding of the Svalbard marine system from 15 years of a marine observatory in Kongsfjorden and 10 years of a comparable observatory in Rijpfjorden. We demonstrate the wide application of such data series and their integration with new observation technologies. We take examples from physical oceanography, glaciology, fisheries and palaeo studies. With well coordinated and instrumented observation infrastructure, there is enormous potential to support many areas of marine science in Svalbard.

The AC3 project: why is the Arctic warming faster than the mid latitudes? (id 183)

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The strong changes in the Arctic climate and the apparent lack of knowledge to explain those motivated the launch of the Transregional Collaborative Research Center (TR 172) called "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms $(AC)^3$" funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG). In January 2016 three German universities (Leipzig, Bremen, Cologne) and the Alfred-Wegener-Institute for Polar and Marine Research, and the Leibniz Institute for Tropospheric Research started a comprehensive research program to identify, investigate, and evaluate the key processes contributing to Arctic Amplification, to improve our understanding of the major feedback mechanisms, and to quantify their relative importance for Arctic Amplification. The program initially funded for four years is envisioned for a total of 12 years and organized in clusters that cover various aspects and bridge various observations and modelling approaches: A. fluxes in the Arctic boundary layer, B. clouds, aerosols & water vapor, C. surface atmosphere interactions, D. atmospheric circulation & transport. Specific emphasis is put on synthesis and integration in cluster E as a coherent picture needs to emerge from a manifold of observations and models. Observations range from high resolution measurements on the local scale via regional measurements addressed during campaigns to the Arctic wide scale captured by satellites. A hierarchy of process, regional, and global models is used to bridge the spatio-temporal scales, from local processes to appropriate global and long-term climate indicators. Research conducted in and around Svalbard plays a key role in $(AC)^3$. The partners joined forces to further increase the long-term continuous measurements at the AWIPEV research base in Ny-Ålesund providing novel insight into clouds and their microphysical aspects as well as trace gas profiles. Overflights over Ny-Ålesund and nearby glaciers were also a key component during the

recent ACLOUD (Arctic Clouds–Characterization of Ice, aerosol Particles and Energy fluxes) campaign in May–June 2017. Here, the Polar 5 and Polar 6 aircraft were heavily instrumented and operated for 25 flights out of Longyearbyen. At the same time, the research vessel Polarstern performed an ice camp north west of Svalbard in the framework of the PASCAL (Physical feedback of Arctic Atmospheric Boundary Layer, Sea ice, Cloud and Aerosol) project.

ANTHROPOGENIC RADIONUCLIDES IN HIGH ARCTIC TUNDRA. (id 87)

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An important group of environmental pollution are radioactive elements. Their presence is related to both the natural processes and human activity. Resulting radioactive contaminants have been spread globally and locally through the atmo- and hydrosphere, reaching even polar environment of the Northern Hemisphere. Arctic region is extremely sensitive to contamination. It is a result of relatively short food chains, efficient transfer of contaminants between different organisms and close relationship with the terrestrial and marine ecosystems. Moreover, observed warming temperature, changes in precipitation type and amount, may contribute to the increase mobility of radioactive substances in the Arctic. Extremely useful tool to conducting research in radioecology comprise - lichens and mosses - the dominant representatives of Arctic tundra. Because of lichens and mosses do not have vax cuticle and root systems they have to uptake of nutrients from the atmosphere and surface water together with inherent contaminants. Furthermore a relatively slow growth rates and long lifespan results in the incorporation of large amounts of impurities in their intracellular structure with time. This is a potential threat for local ecosystems that are exposed to penetration of toxic radioactive elements through the food chain. The main aim of presented study is assessment of contamination level of artificial radioisotopes such as: $^{238,239+240}$Pu, ^{134,137}Cs and identification their sources in lichens and mosses from Western Arctic territory. The research focuses on the vast coastal zone of Western Greenland, Northern Canada and Alaska, USA. Samples of lichens and mosses were collected during scientific expedition in 2012 and 2013. There were used different methods of nuclear spectrometry (alpha, gamma) and radiochemistry procedure in experimental part of the investigations. On the basis of obtained results and analysis we can conclude that the global fallout is a dominant source of contamination. Although in several samples ^{134}Cs is present, what points to Fukushima as noticeable additional source.

Comparative analysis of soundscape of chosen valleys in Spitsbergen during summer and winter. (id 135)

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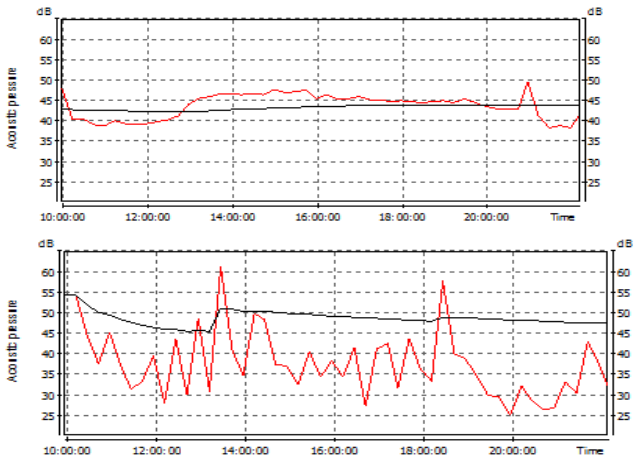
Unique Spitsbergen soundscape is characterized by the lack of noise pollution that is typical of continental Europe. Acoustic environment, in which geophonies dominate and antropophonies and biophonies occur sporadically, is very interesting for researcher. Moreover, global warming and climate changes that strongly affect these areas, also cause acoustic environment changes. First step to observe soundscape changes is registration and study of the present Spitsbergen soundscape for the posterity and determination of baseline values for further investigation. During 2 one-week research expedition a number of measurements in 3 valleys near Longyearbyen and on Sarkofagen were made. Sound pressure level measurements using sound meter SVAN 971 were made. Furthermore, ambisonic recording in format-A and format-B using 1st order ambisonic microphones: Soundfield ST350 and SPS200 and handy recorder ZOOM H6 with calibrated input gains were made. In Longyeardalen long-term noise measurements using outdoor monitoring system SV277 PRO were made.

Base on recorded data average sound levels and sounds dominating during summer and winter in measurements points were determined. Comparisons were made for summer and winter results. Exemplary results from the Longyeardalen Valley, in which the city Longyearbyen is located, are shown in the figure below. Measurements were made in Nybyen in the suburban area. This place is the starting point for hiking trips to the Longyear and Lars glacier and the popular peaks Sarkofagen and Trollenstain. During winter this is also a trip out of scooters towards the glaciers and the pass, and towards Barentsburg. The average winter noise level is considerably higher than the summer due to the noise of snowmobiles.

Noise monitoring in Nybyean



Further research will be done to supplement recorded data. Long-term measurements should be completed outside Longyearbyen and acoustic measurements of the daily activity of bird breeding colonies during polar day should be made. In addition, it would be worthwhile to make measurements during transitional periods: in spring when there is intense melting of snow and ice and in Spitsbergen there are bird colonies and in autumn when streams and rivers begin to freeze.

From the dark side - polar night research in Kongsfjorden. (id 214)

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On Svalbard, the polar night last for up to 4 month. This period has traditionally been regarded as a time of year when biological activities are reduced to a minimum due to a reduced food supply. Over the last 6 years we have conducted field campaigns in early January in Svalbard waters to study biodiversity, biological activity, and ecosystem functions across trophic levels, in both pelagic and benthic realms. Instead of an ecosystem that has entered a resting state, we have documented a system with high activity levels and biological interactions across most trophic levels. Here we highlight a number of observation made during the polar night in Svalbard with a particular focus on Kongsfjorden, which has been the centre of most of our multidisciplinary field campaigns. We present a system where zooplankton is active, benthic activity is high, visual predators are actively feeding, and even small variations in light can have an impact. Our observations unequivocally oppose the classical paradigm of an ecosystem in resting mode.

Contribution of Atmospheric Advection to the Amplified Winter Warming in the Arctic North Atlantic Region. (id 14)

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Arctic amplification of climate warming is caused by various feedback processes in the atmosphere-ocean-ice system, and yields the strongest temperature increase during winter in the Arctic North Atlantic region. Located in this key region, Svalbard is affected by increasing winter cyclone activity associated with warm and moist air advection from lower latitudes. In our study, we attempt to quantify the advective contribution to the recent observed atmospheric winter warming in the Svalbard area (1996 - 2016). Based on Ny-Ålesund radiosonde measurements during winter, a strong dependence of the tropospheric temperature on the synoptic flow direction is identified. Using FLEXTRA air backward trajectories, an increase in occurrence frequency of air with origin in the lower latitude Atlantic region is found, that is attributed to a change in atmospheric circulation patterns involving an intensified Icelandic low and a pronounced Ural blocking high. Both the Scandinavian blocking and the Ural blocking high seem to play an important role in the context of advecting air from lower latitudes towards the Svalbard region, therefore our study is of particular relevance for aerosol and trace gas transport, and according measurements on Svalbard . Beyond that, the enhanced occurrence of the Ural blocking in the recent decade has been linked to sea ice retreat in the Barents/Kara Seas. Given that this link is robust, it would directly feed back on additional sea ice retreat in the region due both to anomalous advection of warm air masses from the south and mechanically pushing pack ice more northward, leaving more open water surfaces along the Svalbard coast. Regarding the circulation changes, we find that about one quarter (0.45 K per decade) of the observed tropospheric winter warming trend in the North Atlantic region of the Arctic (2 K per decade, Figure 1) is due to increased advection of warm and moist air from the lower latitude Atlantic region. Furthermore, the Ny-Ålesund radiosonde data evidence that the corresponding warming footprint extends significantly from the surface throughout the entire troposphere, with a vertically constant relative contribution to the overall warming. Essentially, the climate of the Svalbard region as center of the strongest recent winter warming is found to be particularly sensitive to changes in the atmospheric circulation compared to other regions of the Arctic.

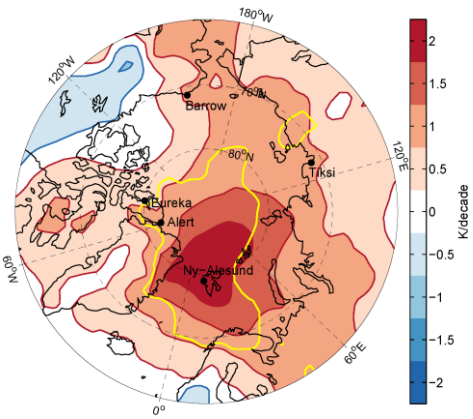

Figure 1. December-January-February mean (DJF) decadal temperature trend at the 850 hPa level using ERA-Interim 1996-2016. Regions of significant trends (95% confidence level) are bounded by a yellow line. (Dahlke and Maturilli; submitted to Advances in Meteorology, 2017)

Pan-Svalbard temperature differences: Trends, Seasonality and Shorter Scale events from station data (id 15)

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The effect of Arctic Amplification of surface temperature warming during winter maximizes in the Svalbard region and over the adjacent oceans, where recent winter warming trends are of the order of 2.3 degrees per decade. Given that the Svalbard archipelago is orographically inhomogeneous with deep fjord topography along the coastlines, glacier coverage over large parts of the land mass, and the sea ice cover reaching the north-eastern parts of the archipelago during winter, the temperature field can be expected to be heterogeneously distributed over the land mass. Here, we analyse the representativeness of individual sub-regions in the Svalbard archipelago and the processes that control local temperatures in these key regions.
In this study, we utilize a variety of station data from Svalbard to investigate pan-Svalbard differences in the near surface air temperature characteristics, including long term trends, characteristics of seasonal cycles and the effect of short-time events (passing cyclones) on different regions in Svalbard. In addition, decade-long records of sea ice data for Kongsfjord and the Svalbard coastal regions will be used to study the co-variability between sea ice variability and temperature over land.

Generally, stations located in the western or southern part of Svalbard are climatologically up to 5 degrees warmer in individual months than those in the northern and eastern parts, underlining the profound impact of the comparably warm ocean and the associated mild marine air masses. Stations at the west coast exhibit a much more maritime climate than those further inland (i. e. warmer winters, slightly colder summers), which demonstrates that the characteristics of local climate vary on small spatial scales across Svalbard.
We find that all stations with a long enough (at least since 1978) data record exhibit significant positive annual mean temperature trends between 0.71 (Barentsburg) and 1.26 K (Svalbard airport) per decade. Trends regarding only the winter period partially exceed 2.3 K, and lead to significant temperature increase in December, January and February (DJF) during the recent decades. Interestingly, this has induced a shift of the annual temperature cycle, so that in recent years March turns out to be the coldest month of the year.

Overall, the study is an attempt to integrate all available meteorological station data across Svalbard, from long-term manned stations to shorter period automated stations, including field experiments. So far, the analysis includes data provided by the Norwegian Metorological

Institute (met.no), the Norwegian Polar Institute (NP), the Polish Academy of Sciences (PAN), and the Arctic and Antarctic Research Institute (AARI, Russia). We encourage discussion on how to synthesize and interconnect research activities as well as data exchange in this context.

Study of ionospheric scintillations from conjugate sites at Ny-Ålesund and Zhongshan. (id 11)

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The high latitude ionosphere is a complex system in which several actors concur to establish the observed medium. Here, the coupling between the interplanetary magnetic field and the Earth's magnetic field determines a high degree of complexity of the ionospheric plasma. This coupling, which directly exposes the ionospheric plasma to the perturbation phenomena caused by solar events, determines a strong sensitivity of the polar ionosphere that may result in a wide variety of spatial and temporal dimensions of the plasma density irregularities.

The fluctuations of the electron density in the ionosphere cause severe scintillations on trans-ionospheric L-band signals at high latitudes of both hemispheres producing considerable effects on the performance of the satellite communication and navigation. In case of Global Navigation Satellite Systems (GNSS) signals, scintillation may reduce the accuracy of the pseudorange and of the phase measurements. Consequently, the positioning errors increase and, in extreme cases, the service can be unavailable. In fact, during intense scintillation events, the signal power can drop below the threshold limit, the receiver loses lock to the satellite and the GNSS positioning is not possible. Scintillation events, hence, may affect the use of modern technology causing also economic damage.

At high latitudes, the ionospheric impact on GNSS signal propagation is due to the presence of fast moving small-scale plasma irregularities. The understanding of the physical mechanisms driving the formation and the dynamics of such irregularities is crucial to develop reliable prediction models and mitigation techniques able to tackle the space weather effect on GNSS-reliant services.
In this context, we investigate the origin of the ionospheric irregularities causing scintillations, reconstructing the ionospheric background due to magnetosphere's condition during the main phase of the two most intense storms of the solar cycle 24th: the 2015 St. Patrick's Day storm and the 2015 June 22nd storm.

In particular, we investigate on the ionosphere-magnetosphere-solar wind coupling to understand how it is translated in the observed scintillation events. Starting from scintillation observations and by using a modified Tsyganenko and Sitnov (2005) model, we reconstruct the configuration assumed by the magnetosphere in consequence of the arrival of the perturbations coming from the Sun. The scope is to understand how stormy magnetospheric configuration triggered the ionospheric conditions that caused the observed scintillations. Hence, we analyse scintillations recorded at two pairs of nominally magnetic conjugate sites: Ny-Ålesund (78.92 °N, 11.98 °E) and Zhongshan (69.37 °S, 76.37 °E). Specifically, these stations are located in the polar cusps under quiet geomagnetic conditions. We interpret the hemispheric behaviour of the scintillation occurrence in terms of the magnetospheric field geometry and configuration induced by the interplanetary shocks impinging the magnetopause. In this paper, we describe the ionospheric scintillation observed at the two chosen conjugate sites discussing the role played by the magnetosphere configuration in the behaviour observed on the ionospheric scintillations occurrence.

Monitoring of nitrogen oxides at Svalbard: measurements in Adventdalen (id 108)

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Impacts from the emissions of nitrogen oxides (NO_x) to the air are multiple. High concentration of NO_x may lead to soil and water acidification, while nitrates produced from NO_x can act as fertilizers if deposited over nutrients limited areas. In addition to this, NO_x take part in the formation of tropospheric ozone, which is in itself an air pollutant and greenhouse gas. Besides, they are precursors for particle formation, and thus increase atmospheric aerosol concentration. According to the distribution of emissions within the Svalbard zone in 2007, NO_x emissions from snowmobiles are almost three times higher than from gasoline cars. Moreover, in agreement with safety instructions, snowmobiles should follow one after another forming a motorcade during fieldwork, therefore the time for dispersion of air pollutants emitted with the snowmobile exhaust is quite limited. Besides, there are emissions from the coal power plant, cars and ship traffic, which add to the total concentration of air pollutants in and around the town of Longyearbyen.

In addition to this, during winter and spring the atmospheric conditions at Svalbard may promote accumulation of pollutants in the atmospheric boundary layer. The archipelago has

complex topography, and wind is often channelled along valleys and fjords. Thus, concentration of pollutants may be highly dependent on local meteorological conditions.

Main aim of the research project "Monitoring of nitrogen oxides at Svalbard" is to quantify the effect of emissions from snowmobiles, cars and coal power plant on the background concentration of NO_x in Longyearbyen and around the settlement. Three short-term measurement campaigns were organized in the scope of the project. The first one took place in the Adventdalen valley near Longyearbyen. Main snowmobile route to the east coast of Spitzbergen from the town goes through the valley along the road, and therefore there is daily snowmobile traffic in spring season lasting from the end of March to the beginning of May. The chemiluminescence $NO/NO_2/NO_x$ Analyzer (model T200) was installed in the UNIS CO_2 lab near UNIS automatic weather station (AWS) for the period from 23.03.2017 to 15.05.2017. The sensor was calibrated against span and null concentrations weekly, and the data was scaled to avoid zero drift. The meteorological data from UNIS AWS was analysed together with NO_x data. Average daytime (from 7:00 UTC to 19:00 UTC) NO and NO_2 hourly concentrations were 0.4 $\mu g \cdot m^{-3}$ and 1.7 $\mu g \cdot m^{-3}$, respectively, while nighttime (from 19:00 UTC to 7:00 UTC) concentrations were very low, 0.0 $\mu g \cdot m^{-3}$ and 0.9 $\mu g \cdot m^{-3}$, respectively (here the daytime and nighttime are defined based on snowmobile traffic pattern in the valley).

Local wind speed measured at 2m height correlates stronger during daytime both with NO ($r = -0.37$, $p<0.001$) and NO_2 ($r = -0.38$, $p<0.001$) concentrations because the emissions from snowmobiles and road traffic near the UNIS CO_2 lab prevail during daytime. There is no significant correlation with NO ($r = -0.08$, $p=0.04$) during nighttime in absence of freshly emitted NO. However, correlation with NO_2 at nighttime is weak but still significant ($r = -0.21$, $p<0.001$). Moreover, there is a difference in the distribution of average NO and NO_2 concentrations over the wind directions. The highest average daytime NO and NO_2 concentrations were observed when the wind was from NE and SE. In contrast, the highest average nighttime NO_2 concentrations were detected when the wind was from NW, which reveals possible influence of power plant. The average nighttime concentrations of NO were very low regardless of wind direction.

According to t-test, the meteorological conditions were statistically different ($p<0.001$) during hours when daytime concentrations of NO and NO_2 were above average contra hours with concentrations below or equal to average: temperature was 4°C lower (-12°C vs -8°C) and wind speed was more than two times lower ($2 ms^{-1}$ vs $5 ms^{-1}$) for the first group of values contra the second one. For the nighttime statistically significant difference in temperatures ($p<0.01$) and

wind speed ($p<0.001$) was revealed only for NO_2, -12°C vs -10°C and 3ms^{-1} vs 4.5ms^{-1}, respectively.

Maximum hourly NO_2 concentration of 21.8 μg·m^{-3} was measured on Easter holiday, 13.04.2017. Combination of increased recreational traffic and mild weather conditions (wind speed below 1 ms^{-1} and air temperature -8°C) led to accumulation of concentration 13 times higher than daytime hourly average measured during the field campaign. Such low wind speed is untypical for the wind regime in Adventdalen (average wind speed during fieldwork was 4ms^{-1}), where normally ventilation is sufficient enough to remove NO_x emitted by the current amount of motorized traffic. However, with further development of tourist activities at Svalbard, there may appear zones where local wind regime and enhanced traffic could lead to concentrations of NO_2 over 30 μg·m^{-3}, which is annual average limit value, defined by the Norwegian legislation for the protection of vegetation.

Systemic pattern of environmental pollution: organoclorines and heavy metals in soils and plants of barentsburg and surrounding area. (id 76)

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Human activity has long been one of the most significant reasons of environmental pollution in the Arctic. And it leads to the importance of finding solutions aimed at improving the environmental situation. In this regard in different regions of the Arctic environmental monitoring programs are carried out to control and evaluate the level of pollution. One of those is the program of monitoring of the settlement of Barentsburg and surrounding areas provided by the North-West branch of RPA "Typhoon".

The settlement of Barentsburg is located in the Arctic on the Svalbard archipelago. Here, in Barentsburg, the coal mine and the power plant are the main sources of environmental contaminants, such as heavy metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organochlorine pesticides, etc. In this study we analyzed the results of tests for organochlorines and heavy metals in soils and plants, received over the past few years.

Convection resolving climate simulations over Svalbard (id 91)

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The regional climate model COSMO-CLM has been applied over Svalbard at a convection resolving resolution of approx. 2.5km (0.022°) with boundary data from ERA-Interim for the years 2004 to 2016. Additionally, the same setup has been used to provide MPI-ESM driven RCP8.5 simulations for the periods 1971-2000 and 2071-2100. Beside general information on possible climate changes, the model data may be used as hi-resolution input to impact models over Svalbard.

In this presentation, we want to give a general overview on the skill of the COSMO-CLM evaluation runs (2004-2016) at Svalbard with special focus on evaluating the representation of a recent extreme precipitation event in November 2016. First results show a high accuracy when compared to available observations., for instance in the number of melt and precipitation days at the location of the Svalbard airport.

Furthermore, statistics of extreme events are analysed in the MPI-ESM and ERA-Interim driven runs, and we show how the statistics are projected to change in the future projections.

Isotopic signatures, physical-chemical features and flow rates of glacial drainages in the Ny-Ålesund area, Svalbard (id 138)

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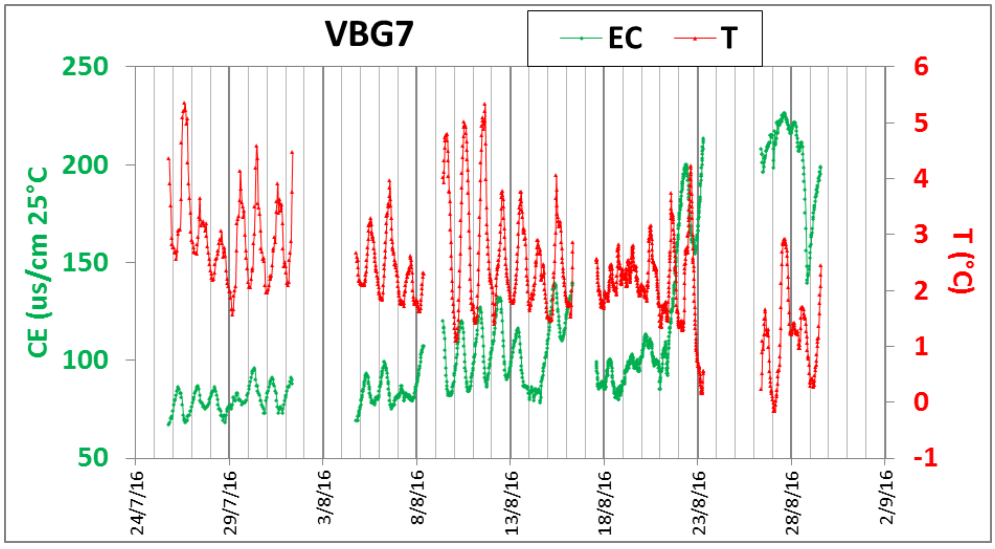
The monitoring of glacial meltwaters, which are transferred to the ocean, can represent a valid tool for tracing changes on climate conditions and their effects. In this framework, through the ISMOGLAC project (RIS 10298), we are investigating the dynamic processes of the glacial melting and the transfer of fresh water to the Arctic Ocean. The ongoing activities consist of a periodical monitoring of isotopic and physical-chemical parameters (water isotopes: $\delta^{18}O‰$, $\delta^{2}H‰$, ^{3}H; TDIC isotopes - $\delta^{13}C$ and $\delta^{18}O$ of the Total Dissolved Inorganic Carbon; temperature, electrical conductivity, pH, alkalinity, concentration of the major, minor and trace elements; Total Suspended Solids; carbon-stables isotopes of suspended solids), which are related to inland glacier drainages, snow and ocean water into Kongsfjorden. Furthermore, we carry out flow rate measurements on the glacial drainages in order to quantify the contribution of each drainage to the total stream water of glacial systems and to the ocean. Moreover, since 2016, a system for continuous monitoring of temperature and electrical conductivity has been installed

on the Bayelva River, which drains the meltwaters of the Vestre and Austre Broggerbreen glaciers.

Here, we focus on the glacial drainages with the aim to stimulate a discussion on their high sensitivity to climate change conditions, their role for studying the effect of climate change and the necessity to apply a multidisciplinary approach for understanding these complex systems.
The preliminary results of the ISMOGLAC project point out chemical and isotopic differentiation both among various glacier systems and within the same system, in relation to the sectors of the drainage network and the relative importance in term of flow rate. Moreover, a very significant variation is observed at each monitoring points at several time scales (seasonal to daily; see example in Fig. 1), in relation to meteo-climatic conditions. The evolution of flow rates, isotopes signatures and physical-chemical parameters seems to suggest different rates of mixing among different components of meltwater (e.g. supraglacial, englacial,-subglacial), which contribute to the total glacial streams. Hence, the dynamic processes of the glacial melting appear very complex and sensitive to climate. If from one hand such features enhance the role of glaciers as sentinels of climate change, on the other they highlight the difficulty to produce exhaustive data for achieving a better knowledge of changes in the Arctic glacier systems and their link with climate trends. A collective strategy of study, which ensures the integration of different approaches and methods, is therefore mandatory in order to address these issues.



Figue 1 – Example of evolution of the electrical conductivity (EC) and temperature (T) in the Bayelva River (station VBG7).

Nanoplankton community of Western Spitsbergen fjords in summer. (id 52)

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Spatial organization of nano-phytoplankton community in the water area of Western Spitsbergen fjords (Hornsund, Van Kelenfjord, Isfjord, Gronfjord) was investigated in summer of 2001-2003. Nanoplankton was taken into account in three size fractions: 1) 2-5 μm, 2) 5-10 μm, 3) 10-20 μm.

Hornsund. In outer and central parts of the fjord (up to the threshold of the inner basin) there are high indices of nano-algae quantitative development, maximum values are confined to the surface layer (from 1 million 50 thousand to 1 million 700 thousand cells / liter with biomass from 140 to 400 μg / l). Against the background of a steady decline in total abundance and biomass with depth, the proportion of the small size fraction within the nanoplankton community is increasing, which was confirmed by a direct analysis of the community size structure. Relative abundance of the size group 2-5 μm increases from 30-60% in abundance and 10-20% in biomass in the surface to 70-100% at depths greater than 50 m.

Van Kelen Fjord. Structure of the nanoplankton community in this case is determined by free water exchange with the adjacent water area in the estuary and influence of glacial runoff in fjord mounds. In the surface layer, the range of fluctuations in abundance and biomass of nano-algae is quite wide (590,000-2,200,000 cells / liter with biomass from 38 to 140 μg / l), with a mosaic distribution of dominant size fractions. Nano-algae vertical distribution pattern is determined by the tendency, as exemplified in the Hornsund Bay, to grind the community with depth, and is expressed in a stable abundance and biomass decrease with a simultaneous increase in the small size fraction share.

In Isfjord waters, the quantitative development of nano-phytoplankton is significantly lower than in two southern fjords (from 175 to 465 thousand cells / liter with biomass from 14 to 43 μg / l), and their maximum values are recorded in the subsurface layer at depth 20 m. The reason for "lowering" of community core development can be the water mass density structure in the fjord's water area. Previously, a similar phenomenon was mentioned in the work of Ross et al. (1993) for high-latitude fjords with respect to phytoplankton, maximum densities of which were noted precisely in the lower horizon of the surface layer, where removal rate is minimal. The nanoplankton size structure is characterized by absolute dominance of the small size fraction: its share in all cases is more than 70%.

In frontal zones of excretory glaciers (apex areas of the Van Kelen and Gronfjord), the maximum abundance of nano-algae (more than 1 million cells / liter) was recorded in the near-bottom horizon (5-10 m deep) directly in the terminal glacial formations region, where local upwelling zones are formed in conditions of constant fresh water intake and warming of the surface layer,

which causes plankton algae movement from the bottom to the surface horizon. Further, as we move to the central part of the fjord, a decline in quantitative indicators of the nanoplankton development in the whole water column is recorded. It is possible that these areas correspond to zones of terrigenous suspension sedimentation, where development of planktonic algae in insufficient illumination conditions is inhibited.

Sub-ice topography of Nordaustlandet, Svalbard derived from potential field modelling (id 90)

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Potential field methods such as gravity and magnetic interpretation provide valuable information to quantify the subsurface and are especially useful where geological exposures are sparse or in remote and difficult terrains. On the other hand studying the geology and ground topography in the Arctic is often challenging given its extensive ice and snow coverage. Gravity and magnetic acquisition is therefore a fast economical way to acquire additional knowledge in the polar regions.

With the ongoing climate change the ice caps in the polar regions are constantly changing and are often referred to as a principal visual expression for the warming of the Earth's atmosphere, which is why a comprehensive monitoring of the polar ice regions and ice thickness changes are of particular interest. Satellite missions are common methods to estimate ice sheet elevation change but fail to provide direct ice thickness measurements. Ground measurements with ice penetrating radar (IPR) can supply ice thickness but are arduous and time-consuming for large areas. Furthermore, ice thickness estimation from IPR is temperature-dependent, which can cause uncertainties. Using airborne gravity measurements, combined with accurate and reliable altimetry data, due to a significant density contrast between ice and bedrock, sub-ice topography and ice thickness can be effectively derived. Airborne gravity data have the advantage to be acquired efficiently over large areas in a short time frame.

Nordaustlandet, the second largest island on Svalbard archipelago and covered up to 80% by ice, has been investigated by the available aero-gravity and -magnetic data to retrieve the sub-ice topography and the geophysical properties of the subsurface. Aero-gravity survey, SAG-99 was acquired above North East Greenland coast and Svalbard, including Nordaustlandet by KMS (Kort & Matrikelstyrelsen) and UiB (Universitet i Bergen).

For the forward modelling, initial average densities of 2.67 g/cm^3 and 0.97 g/cm^3 for the

bedrock and ice, respectively were input, and topographic measurements were used for constraints. The synthetic modelled signal output was compared to the free-air anomaly. Therefore, the ice thickness model relied primarily on the gravity data. Furthermore, the magnetic signature is an indicator of the presence of crystalline rocks and provides an extra insight of the basement distribution. This contributes to refine the range of density expected under the ice and allow the improvement of the sub-ice model. Therefore, the magnetic and gravity interpretation also yielded to a better understanding of the geology and offered a better control of the physical properties of the bedrock underneath Vestfonna and Austfonna, Nordaustlandet.

From the model, the ice thickness and the bedrock topography were extracted. For accuracy and resolution assessment, our results were compared to independent bed elevation map previously produced by radio echo sounding data acquired on Austfonna.

Glacier-freshwater runoff: a possible driver of autumn phytoplankton blooms in seas around Svalbard (id 43)

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Socio-economic impacts of glacier-mass loss are not limited to sea-level rise. Glacial freshwater discharge into the ocean also affects the physical and chemical properties of the fjord systems and adjacent shelves and enhances estuarine circulation and nutrient input, with effects on biological productivity. Ocean primary production, i.e. the production rate of organic carbon or phytoplankton, is an important measure of biological productivity and its dynamics commonly linked to seasonal changes in sea ice cover and solar radiation.

Here, we focus on Svalbard in the Eurasian Arctic. 34000 km2 or 57% of the total land area on Svalbard is covered by glaciers and ice caps. 68% of the glacierized area drains through tidewater glaciers with a total calving-front length of ~740 km. A 10-year simulation of the climatic mass balance of Svalbard-glaciers using the Weather Research and Forecasting model (WRF) coupled to a climatic mass balance model shows large interannual variation, especially in terms of the summer balance. This variability is also reflected in annual runoff curves, computed for 14 hydrological subregions of the archipelago. Primary production in Svalbard fjord systems and adjacent shelves was low in summer 2008, coincident with low rates of meltwater runoff, whereas it was high and more widespread in August 2013, coincident with high rates of meltwater runoff. To confirm the possible correlation of meltwater runoff and ocean primary production we also consider changes in sea-ice fraction, sea-surface temperature and mixed-

layer thickness. Statistical analysis yields significant positive correlation between meltwater runoff and late-summer chlorophyll in five out of 14 regions, namely regions dominated by sheltered fjord systems. Chlorophyll concentrations in open coastal regions seem to be controlled by other factors, such as sea-surface temperature.

Towards a better understanding of Arctic clouds using observations and high-resolution modelling (id 13)

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In order to better understand the processes related to Arctic clouds and their role in affecting the Arctic climate, high quality cloud observations are needed. Only a few sites exist in the Arctic, where continuous cloud observations with a high vertical resolution are performed. Within the Transregional Collaborative Research Centre TR172 "ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms (AC)3" (www.ac3-tr.de), a new 94 GHz cloud radar has been installed at the French - German Arctic Research Base AWIPEV at Ny-Ålesund / Spitsbergen in June 2016. In combination with the existing instrumentation at AWIPEV, clouds and related physical processes can now be characterized in Ny-Ålesund much more comprehensively than before.

The knowledge gained from such observations is crucial to improve cloud parameterizations in numerical weather prediction and climate models. In order to bridge the link between the small scales (e.g. related to the observations) and large scale models, high-resolution modelling studies with large eddy simulations (LES) are a powerful tool. Since point observations often only provide information about the temporal variability of atmospheric variables, LES can also describe the spatial variability. It can also be used as virtual lab to test our understanding of cloud processes.

In addition to the new observational capabilities for clouds at Ny-Ålesund, we will also present first results of model simulations at Ny-Ålesund with the new high resolution model ICON-LEM. We will demonstrate the potential of such simulations which are in this case particular challenging due to the complex topography around the site. A first basic comparison with the observations is done in order to evaluate the representation of the mean thermodynamical structure and clouds by the model. This evaluation is essential to show that the setup can be

used to gain insight into cloud processes by combining point measurements with high-resolution model runs.

In future, the combination of the in-situ cloud observations performed at Mount Zeppelin with the remotely observed cloud properties at the AWIPEV atmospheric observatory could provide additional insight into cloud processes. In this way, we could also get a better idea of the uncertatiny related to the assumptions made in remote sensing retrieval algorithms.

Skillful prediction of northern climate provided by the ocean. (id 173)

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Already more than 100 years ago Helland-Hansen and Nansen envisioned a predictable northern climate and ecosystem provided by the ocean. The degree of predictability nevertheless remains unresolved, particularly to what extent variable ocean heat is imprinted on the atmosphere to realize its predictive potential over land. Here we assess from observations whether anomalous heat in the Gulf Stream's northern extension provides predictability of northwestern European and Arctic climate. We show that variations in ocean temperature in the high latitude North Atlantic and Nordic Seas are reflected – predictably – in the climate of northwestern Europe and in winter Arctic sea ice extent. The talk will specifically project such Arctic–Atlantic cause-and-effect on climate change as recently manifested on Svalbard. Svalbard's "marginal" climate at the gateway between a cold Arctic and a temperate Atlantic will be further highlighted using paleoclimatic examples. Finally, if time permits, a comprehensive and future outlook on seasonal and regional manifestation of Arctic sea ice loss will be provided.

Integrated network service for managing sensor and data acquisition. (id 156)

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The continuous and rapid technological development, direct towards the use of new sensors, new measurement techniques and data analysis methods is requiring more and more resource to manage increasing amounts of data and to make accessible thes datasets to the scientific community. Many infrastructures for management the data have conceived to collect, manage, publish and disseminate the results of scientific research in the arctic. But many researchers do not have infrastructure for realtime data collection, analysis and visualization, and have difficulty to integrate their innovative and experimental sensors in the existing digital infrastructure, with consequent delay of making information available.

The IADC system has been basically structured with the aim to manage the italian reseach activity and the data collected by different type of sensors in the Arctic, in particular in Ny Alesund. An implementation of the system consists on the possibility to integrate new sensors into the data management system by an automatic recognition of the acquisition system by the management system. The implementation allows to directly manage the sensor, and by a constant monitor of data acquisition status, a contunous check is provided with warnings in case of anomaly. When communication network is not available the system will handle the sensor according to the information provided by the user at the set up while the metadata transfer to IADC when network connection will be available. The wizard will configure the acquisition tool suitable to the type of sensor to manage.

The system can be configured to automatically to collect the data from the sensors provided for this purpose in real time mode by means of input /output webservices for interfacing sensors with the infrastructure.

The user must only enter the information that characterize the sensor and data acquisition (identification, extent, quality, spatial and temporal, spatial reference…) that will be recorded and transfer to the metadata and data management system.

A protptype of this system applied to the Snow Cam installed at the CCT in Ny Alesund is illustrated.

Possibilities for biotechnology in the Arctic (id 35)

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Microalgae remain at the beginning of plant evolution. They are widespread in all polar environments, including extremes, and frequently produce visible biomass. Their combined biomass represents a sizeable pool of global fixed carbon, influencing mineral cycling and energy flow, and affects the mineral and biological development of polar ecosystems. Microalgae, due to their evolutionary antiquity are widely adapted to all extremes related with changes in geological time. The seasonal and diurnal variations of polar terrestrial environments represent a series of water availability gradients ranging from aquatic to dry habitats. These patterns initiate a number of different ecological and physiological acclimation and adaptation responses. To survive and grow successfully in polar environments, microalgae have evolved a complex range of adaptations of their all cellular constituents, which enable to compensate for the negative effect of stressful conditions on biochemical reactions. Consequently, a wide range of metabolic activities has been detected in polar ecosystems. In this respect, particular attention has been paid to the metabolic facilities of psychrotolerant terrestrial micro-algae and their

cellular constituents or products which could provide a large biotechnological potential. Lecture will bring information about present Czech polar phycological research and Czech Arctic Research Infrastructure "Josef Svoboda Station" in Svalbard in above mentioned directions.

Settlements on Svalbard as sources for emerging contaminants (id 115)

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The main source for contaminants found in the Arctic are atmospheric and oceanic long-range transport. However, the Arctic environment can also be influenced by contaminants from local settlements. Modern settlements can be sources for different legacy persistent organic pollutants, such as polychlorinated biphenyls (PCBs, e.g. from old waste dumps, building materials) and polybrominated diphenyl ethers (PBDEs), but also for contaminants of emerging concern, such as organophosphorous flame retardants (OPFRs) and per- and polyfluoroalkyl substances (PFAS). Little is known about levels and effects of emerging contaminants in the Svalbard environment. Therefore, the aim of the study presented here was to investigate if local pollution of PBDEs, OPFRs, and PFAS occurs outside the settlements Longyearbyen and Barentsburg.

Sediment and biota was sampled in Adventfjorden (outside Longyearbyen), Grønfjorden (outside Barentsburg) and at a reference site in Kongsfjorden in 2015 and 2016. Sediment samples have been analysed for the PBDEs, OPFRs, and PFAS, and analyses of biota samples will be finalized during autumn 2017.

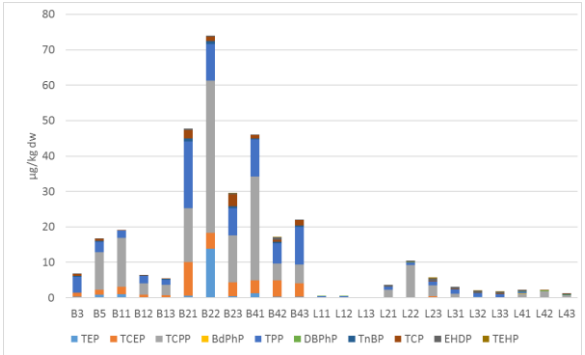

Figure 1. OPFRs in sediment collected in Grønfjorden (B) and Adventfjorden (L), September 2015 (Olsson 2016).

Of the PBDEs only 2,2´,4,4´,5-pentabromodiphenyl ether (BDE99) was detected, with median concentration of 28.8 pg/g dw and 6.7 pg/g dw in Adventfjorden and Grønfjorden respectively. The PBDE-concentrations were lower than those measured in a previous study in Adventfjorden.

Relatively high levels of OPFRs (∑OPFR up to 74 ng/g dw) was measured in sediment collected in Grønfjorden. The levels were significantly lower (∑OPFR up to 10 ng/g dw) in Adventfjorden (Figure 1), although more compounds were detected there than in Grønfjorden.

The results indicate that local pollution contribute for 10 and 8 out of 13 analysed OPFR-compounds in Adventfjorden and Grønfjorden, respectively. Tris(2-chloro-1-methylethyl) phosphate (TCPP) was the dominant compound with median concentrations of 3.17 ng/g dw in Adventfjorden and 15.2 ng/g dw in Grønfjorden. The reasons for the differences between the two fjords are unknown, and should be investigated further. OPFRs have also been detected in biota collected at more remote sites on Svalbard, which indicates that they might undergo long-range transport. However, long-range transport cannot explain the large difference between Grønfjorden and Adventfjorden, nor the high levels in Grønfjorden.

Comparable levels of PFAS was measured in sediment from Adventfjorden and Grønfjorden, but different compounds dominated in the two areas. Perfluorooctansulfonic acid (PFOS) had the highest median concentration in Adventfjorden (0.18 ng/g dw), while perfluorotetradecanoic acid (PFTeA) had the highest median concentration in Grønfjorden (0.49 ng/g dw). Three of 21 analysed PFAS were assumed to originate from local sources, such as fire-fighting foams used during fire training at airports in Barentsburg and Longyearbyen.

Seals like plumes (id 40)

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Plumes of subglacial discharge are frequently observed at marine-terminating glaciers. These plumes sit at the ice-ocean boundary, forming the link between the complex subglacial hydrological system of tidewater glaciers and the fjords into which they drain. Plumes of subglacial discharge have been shown to enhance submarine melting, play a role in glacier calving and terminus morphology, contribute to fjord circulation, and have been used to infer the morphology of the subglacial hydrological system. Here, we present data collected from ringed seals instrumented with GPS-equipped Conductivity, Temperature and Depth Satellite Relay Data Loggers (GPS-CTD-SRDLs) in Kongsfjorden, Svalbard during 2012. We show that these ringed seals respond to temporal and spatial variations of the plume at the terminus of Kronebreen. Additionally, the data collected shows that the seals enter and collect data from within the plumes themselves. The data collected by these GPS-CTD-SRDLs provides a valuable new insight into the behaviour of subglacial discharge plumes and our understanding of their glaciological, oceanographic and biological implications. The continued retreat of Kronebreen, and other tidewater glaciers in Svalbard, will eventually lead to the loss of these marine-termini as the glaciers retreat onto land. This technique presents a vital tool for understanding the drivers and implications of this future habitat loss.

Seismic and infrasonic monitoring of glacier destruction (id 163)

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It is known that glacier activity, in particular, destruction of glacier terminus (calving) provides seismic signals – icequakes and strong acoustic signals. The icequakes can be observed at seismic station recordings both at local and teleseismic distances. The acoustic signals accompanying the icequakes can propagate over long distances and be registered in the infrasonic frequency band.

In this work we show the possibility of using a single seismic station records to determine the intensity of the process of destruction of glaciers and the possibility of a joint seismic-infrasound method for accurate location and type-indicating of processes like crevassing or calving. Svalbard seismic stations record a huge number of icequakes during a year. For automatic processing of their data we use two detectors developed for single station data analysis. The first one is based on polarization analysis for phase type determination (P or S) and backazimuth calculation with autoregressive technique for accurate phase arrival time picking. This procedure generates detection lists and estimations coordinates of found events. The second detector is simple SNR-detector based on statistical determination of ambient noise level and targeted to the frequency band, specific for icequakes.

We have processed data of three local permanent seismic stations (HSPB, KBS, SPI) for period of time from 2010 to 2015. Additionally we used data of two temporal stations located in Piramida settlement and in the vicinity of Esmark glacier, which were in operation for different time periods from 2012 to 2015.

The results of the data processing show similar time distributions of number of icequakes for HSPB and KBS. The events have occurred mostly in closest glacier areas. Number of the events increases in June, reaches its maximum in August – September and decreases in winter months. But the distribution of glacier-related events obtained by SPI station data has one month shift - increased in July with maximum in September-October. For some glaciers close to HSPB station short cases of seismic activations in winter months were observed. We assume that these activations are associated

with the glacier surge processes. Annual number of icequakes varies from year to year and can vary up to 2 times or more.

For joint seismic and infrasonic observations two seismo-infrasound microarrays (Barentsburg and Piramiden) were used.

Joint using of seismic and infrasonic records was tested for the first time in 2010-2014 for the events occured on the shore of Isfjorden near Barentsburg to evaluate the ability of the method to observe destruction processes in outlet glaciers in the Arctic. It was revealed that the combination of infrasound pulse signals with seismic records can bring appropriate and reliable information on location and features of destructive events into glaciers, which generate couples of seismic and acoustic waves. Based on the preliminary results, the improved type of joint seismic and infrasound array "PYR" was installed in June 2015 in the Russian settlement Pyramiden in 12 km of the terminus of the largest outlet glacier on Svalbard – the Nordenskioldbreen. The PYR array consists of three microphones for infrasound recordings and broadband 3-component seismic station Guralp 6T. During summer-autumn 2015 PYR has recorded more than 3000 infrasound events in the outlet tongue close to the glacier terminus. More than 100 of them were accompanied by seismic signals which were recorded by PYR seismic station. In 2016 these works was extended by installation a video camera close to the glacier terminus. A technique for joined location of seismo-infrasound events is proposed and some examples of using the obtained data for indicating of crevassing and calving processes are presented. The case study provides a new tool for improving the regional geophysical network for monitoring of natural hazards in the Arctic, including icequakes and icebergs calving.

Tundra shrubs in a warming climate: even simple sampling can be used for understanding integrated implications across the Arctic (id 217)

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The accelerating decrease in the Arctic sea-ice extent provides a novel and warmer setting for marine as well as terrestrial ecosystems across the Arctic. It has become increasingly important to obtain observations that may be used in a circum-Arctic preparedness to contemplate predicted future changes. Here, I show how observations of the growth of Arctic tundra shrubs may have the potential to increase our knowledge of how warming will affect Arctic species. Indeed, measuring annual tree-ring growth will give us comprehensive information on the effects of the changing terrestrial environment across the Arctic. Using 128 specimens of willow (*Salix arctica*, *S. glauca*) and birch (*Betula nana*) collected across Greenland to Svalbard, an overall negative effect of the retreating June sea-ice extent was found on their annual growth. Specifically, the negative effect of the retreating June sea-ice was observed for younger

individuals with large annual growth allocations and with little or no trade-off between previous and current year's growth.

Svalgreen: Integrating research and higher education across the steepest climatic gradient in the Arctic between warm Svalbard and cold Greenland (id 179)

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Presently, there is only little focus on Arctic research and higher education collaboration between the Nordic countries in the Arctic. This is despite that our part of the Arctic contains the largest climatic gradient in the Arctic. The gradient is developed since the opening of the Atlantic and Greenland Seas relatively recently in geological time during the Palaeogene app. 50 million years ago. Before then Svalbard and northern Greenland formed part of the same continent and thus the geology of both regions is fundamentally the same, and this provides interesting possibilities for different types of geological studies. The geological development has caused the distribution of sea currents in the area with the East Greenland Current transporting cold water from the Arctic Basin down south along the east coast of Greenland, while the North-West Atlantic Current brings warm water up along the west coast of Svalbard. This then influence the mean annual air temperature, which has been up close to 0°C in Svalbard recently, while at St. Nord in northernmost Greenland (81°31'N) the mean annual air temperature is typically around -16°C.

We have developed the SVALGREEN initiative to target increased collaboration across this steepest climatic gradient in the high Arctic between warm Svalbard and cold Greenland within both geo- and biosciences. In both Greenland and Svalbard, long-term observations are being collected as part of different activities such as SIOS (Svalbard Integrated Arctic Earth Observing System), GEM (Greenland Ecological Monitoring) and for the terrestrial biome, in particular in the large-scale monitoring programme COAT (Climate-ecological Observatory for Arctic Tundra). However, these observation systems have never been used together directly for research and higher education. These established networks provide a unique possibility within the Nordic area to coordinate current national research and higher education on how long-term geological processes set the scene for divergent modern short-term ecosystem, atmospheric and cryospheric processes.

Therefore, in May 2017 we organised a first SVALGREEN workshop in Svalbard, funded by Svalbard Science Forum and hosted at UNIS, to start establishing and developing a research and

education plan using the possibilities that the steep climatic gradient from Svalbard to northern Greenland provides. This was done mainly by merging the comprehensive national research and educational activities of Svalbard and northern Greenland, but also by placing the SVALGREEN gradient among other Arctic transects in North America and Russia. The aim of SVALGREEN is to establish and develop a regional network of process studies within the cryosphere, the biosphere, the atmosphere and in the ocean across the SVALGREEN gradient that can be combined both for research and higher education purposes in the coastal and terrestrial environments in Svalbard and northern Greenland.

Seasonal changes in ocean acidification state in Kongsfjorden: Implications for calcifying organisms (id 162)

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Seasonal changes (April to July) in ocean acidification (OA) state, calcium carbonate ($CaCO_3$) saturation of aragonite (Ωa) and calcite (Ωc) and biogeochemical processes were investigated in 2013 and 2014 in Kongsfjorden, Svalbard. We investigated total alkalinity, dissolved inorganic carbon, pH, fCO_2, nutrients, salinity and temperature in the water column from the glacier front in the fjord to the west Spitsbergen shelf. The average range of Ωa in the upper 50 m in the fjord in winter was 1.5 and in summer 1.65–2.66. The lowest Ωa (1.5) was close to the reported critical threshold for aragonite-forming organisms such as the pteropod *Limacina helicina*. In 2013,Ωa, pH and salinity were generally lower than in 2014 as a result of a larger influence of high-CO_2 water from the coastal current, less Atlantic water and more freshwater. The fjord was influenced by glacial water in summer that decreased Ωa by 0.7. Biological CO_2 consumption based on a winter-to summer decrease in nitrate had similar strength but opposite effect on Ω. The seasonal increase in temperature only played a minor role on the increase of Ωa. Based on this study, we suggest that changes in the inflow of different water masses and freshwater directly influence OA state, and indirectly influence the biological drivers of carbonate chemistry in the fjord. Biological CO_2 consumption mitigates partly to the decrease in $CaCO_3$ saturation states due to freshening similar as we found in other fjords.

Past and future climate development in Longyearbyen, Svalbard (id 78)

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Buildings and constructions in the Longyearbyen area are vulnerable to the observed and projected warming in the Svalbard region. To improve the knowledge on how climate change will affect permafrost and impact on existing and new infrastructure, relevant critical factors in projected climate changes were studied; - emphasizing changes in temperature, precipitation, snow and wind. The study was based on assessment of existing data and knowledge, as well as novel local climate simulations for the Longyearbyen area. The study is part of an assignment consultant project, «Construction and management in Svalbard in a long-term climate perspective», financially supported by Statsbygg.

Present climate and climate development since 1900 will be briefly presented, but the main emphasis will be on future climate changes based on projections up to the end of this century under different emission scenarios (RCP2.6, RCP4.5 and RCP8.5). Challenges in establishing robust climate change projections in the Arctic will be addressed; - e.g. uncertainties in climate modeling, limited climate series for validating climate model results, measuring errors, as well as misleading temperature projections from global climate models caused by erroneous sea-ice description.

Present climate and climate development since 1900 will be briefly presented, but the main emphasis will be on future climate changes based on projections up to the end of this century under different emission scenarios (RCP2.6, RCP4.5 and RCP8.5). Challenges in establishing robust climate change projections in the Arctic will be addressed; - e.g. uncertainties in climate modeling, limited climate series for validating climate model results, measuring errors, as well as misleading temperature projections from global climate models caused by erroneous sea-ice description.

The projected rise in air temperatures is very likely to cause substantial warming of the permafrost in Longyearbyen area. Since 2000, ground temperature at 20-m depth at some sites in the Longyearbyen area has increased by ca. 0.8 degC/decade. Permafrost degradation is modeled by the end of the century in areas where the permafrost is warmest at present, i.e. in low-lying areas close to sea level.

The study revealed several serious problems and specific error sources in establishing robust climate projections for Svalbard. The Norwegian Centre for Climate Services (NCCS) has recently initiated a comprehensive assessment of past and future climate in the Svalbard region. The results will be compiled in a report where all major Norwegian institutions involved in polar

climate studies will contribute. The report will also include local information on present and future climate and hydrology; produced by a MET Norway regional climate model with spatial resolution of 2,5 km.

Spatial distribution of impurity content, physical and chemical properties of seasonal snow across Svalbard (id 32)

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Snow covers up to 50% of the land surface area in the northern hemisphere during the boreal winter. The snowpack is an interface that substantially modulates energy and mass exchange between the atmosphere and the underlying substrate (land,glacier ice, sea ice). Understanding snowpack properties is important because it largely controls the inter-annual variability of high-latitude planetary albedo, land surface temperature and hence climate. So far, the role of the snowpack in linking biogeochemical cycles to climate has been largely neglected although it may have considerable significance. In particular, physical, chemical, and biological processes involving carbon in snow have major impacts on most atmospheric and biogeochemical cycles. However, linking the findings from the many field studies conducted over the years remains a major challenge, due to the lack of synchronized observations and incoherent protocols for sampling and analysis between different studies at different sites.

To address the issues mentioned above, a pilot field study was conducted to samplesnow in spring 2016 on seven glacier locations spread across Svalbard (Ny-Ålesund, Hornsund, Lomonosovfonna and Austfonna), within a short period of time and following standardized protocols for sampling and analysis. We will present preliminary results in term of variability of physical and chemical seasonal snow properties as well as its black carbon and dust contents (and microbiology upon data availability). To this end, we coordinated field activities and group expertises of already existing field programs, although each of them had a different purpose. In doing so it was possible to optimize the use of existing field research infrastructure and reduce costs. This allows us to achieve a broader, integrative view on the role of snow in biogeochemical cycles and climate; and this strategy is to be further developed in the near future within the scope of the Svalbard Integrated Observation System project.

Monitoring of snow physics, chemistry and biology at Ny-Alesund: coordinated measurements at Gruvebådet (id 33)

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Snow covers up to 50% of land during the boreal winter, is an interface that modifies energy and mass exchange between land, the atmosphere, and other parts of the cryosphere (glaciers, sea ice). Understanding snow pack properties is important because it largely controls the inter-annual variability of high-latitude planetary albedo and climate. So far, the role of the snow pack in linking biogeochemical cycles to climate has been largely neglected although it may have considerable significance. In particular, physical, chemical, and biological processes involving carbon in snow have major impacts on a number of atmospheric and biogeochemical cycles. However, linking the findings from the many field studies conducted over the years at Ny-Ålesund remains a major challenge, due to the lack of coordinated observations and standardized sampling and analytical protocols between different studies at different sites. To address the issues mentioned above, the Ny-Ålesund Atmosphere flagship working group on snow is currently developing a common snow field sampling in Ny-Ålesund close to the building named Gruvebådet in order to monitor:

the basic snow parameters as snow depth, snow water equivalent and snow stratigraphy
the basic snow chemistry composition as major and minor sea salt ions and nitrate
the impurity content of the snow pack (dust and black carbon)
the microbiology content of the snow pack

This work is aligned with the recent strategies of Svalbard Science Forum and the Svalbard Integrated Observatory System project of coordinating activities between groups in order to reduce cost activities and human footprint and that provides basic information on snow properties in Ny-Ålesund that ultimately could be shared among the users. Furthermore, the Gruvebådet building has been renovated recently and is now offering good facilities for developing and deploying instruments measuring aerosols properties in Ny-Ålesund. By sampling and concentrating our efforts in Gruvebådet, we have the possibility to develop a unique site high in the Arctic to monitor year round the concentration, deposition and evolution of the aerosols content in snow and in the atmosphere, with a focus on the deposition processes, a crucial need for better understanding the effect of aerosols on climate and helping out modeling studies. Thus, larger and focused pure research project on snow-atmosphere interaction could be developed in Ny-Ålesund, using the background data collected at Gruvebådet. The work is on development and we plan to initiate the weekly sampling this winter (2017) beginning with the first snow fall and until complete melting of the snow pack. We will

present our planned activities and discuss with all the people interested by this work/ideas, possible contributions of any kind, development and planned of on-going and future activities.

Changes and variability of fast ice extent and thickness over the last two decades in Kongsfjorden, Svalbard (id 6)

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Sea ice in the Arctic affects the energy exchange at the atmosphere-ocean interface, and it is crucial for the Arctic marine ecosystem. Beyond that, the existence and changes of Arctic sea ice have also direct implications for the society. Observations at coastal sites and fjords with relatively easy access give the possibility to study and monitor Arctic sea ice in more detail over months and years under conditions where thermodynamic ice growth dominates versus dynamic growth, than it is usually possible from shipbased expeditions. Inner Kongsfjorden is covered with seasonal landfast sea ice at times in winter and spring. Scientists from the Norwegian Polar Institute have observed fast ice in Kongsfjorden systematically since 2003. From some earlier years, sporadic information from process studies exists. Key elements of the monitoring at Kongsfjorden are sea ice extent observations, in-situ sea ice thickness, snow thickness and freeboard measurements. Occasionally, additional data are collected and samples are taken, often as a part of process studies. In recent years, the duration of time with sea ice in Kongsfjorden has been shorter, the extent less. Ice has been thinner than earlier, and there has been less snow covering the ice. However, interannual variability of fast ice scenarios in Kongsfjorden is high. Therefore sea ice trends in Kongsfjorden cannot be detected with observation only over a few years. The observed changes have also consequences for the ice-associated ecosystem. The presentation will give an overview on the monitoring setup, and updated results of sea ice extend and thickness levels and trends will be presented. The results will be also set in context with observations at other Svalbard locations.

Improved image geometry of Sentinel-2 data for Norway and Svalbard (id 148)

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With the launch of Sentinel-2A and -2B satellites, the research community has been given two new platforms for multispectral monitoring of the environment. Yet, Sentinel-2 Level 2A data, which are made available online via the Copernicus SciHub website, have been orthorectified with a 90 meter (PlanetDEM 90) Digital Elevation Model (DEM). This DEM is insufficient for adequate image geometry in mountainous terrain. In particular, errors in geo-location and errors in terrain correction that lead to deformation are prominent. Thus, the Norwegian Space Centre has made an agreement with the European Space Agency to have Sentinel-2 Level 1C data reprocessed over Norway and Svalbard using the Norwegian 10 meter DEM over the Norwegian mainland and the 20 meter DEM over Svalbard. The Norwegian DEM is the official DEM delivered by the Norwegian Mapping Authority and the Svalbard DEM is delivered by the Norwegian Polar Institute. These products are denoted Level 1CN. Reprocessing is done by ESA. The reprocessed products will be made available through the Norwegian Ground Segment (SAFE and NetCDF) and through the Svalbard Integrated Arctic Earth Observing System (SIOS) web portal (NetCDF). Aggregation of individual products in time (e.g. time stack for a tile) or space (spatial combination of neighbour tiles) is not supported initially but will be in future.

Remote Sensing of plant functional diversity (id 124)

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To protect arctic ecosystems, we need a better understanding of spatial biodiversity patterns and quantitative methodologies to assess this biodiversity. This project aims to supply such a methodology, for characterizing alpha and beta functional diversity in polar ecosystems through remote sensing.

Historically, measures of biodiversity were made according to species identity, but more and more research has been using definitions based on functional characteristics (traits) of species or individuals, i.e. functional diversity. So far, multiple attempts to map biodiversity and traits using remote sensing have been made, with different extents of success. Using remote sensing to assess functional diversity is promising, as relating spectral data to canopy leaf traits (Asner et al. 2015; Elmendorf et al. 2012; Homolová et al. 2013; Roelofsen et al. 2013), or individual leaf traits (Roelofsen et al. 2014), is possible. For polar ecosystems, with sparse and small vegetation, spatial resolution can be a problem which is why we use UAVs. In the summer of 2017, several UAV flights were carried out in the Kongsfjorden area. We used a lightweigth UAV modified to use frequencies outside the radio silence range, equiped with a

Rikola hyperspectral camera. These flights resulted in reflectance images from 31 different wavelenghts between 400 and 1000 nm, with a pixel size of about 2cm. We measured functional diversity in 22 different plots in the flight area, and are using this (together with similar data gathered in 52 plots in Abisko, Sweden in 2016) to create a functional diversity model. In 2018 we aim to take measurements of a larger area of Brøggerhalvøya and create a functional diversity map. We would like to collaborate with other scientists working on remote sensing, to ensure as little flight movements and disturbances as possible.

Our method can improve monitoring extent and frequency of (sub-) arctic functional diversity. It closes the current gap between satellite and field observations, giving enough detail to measure local diversity and anticipating the launch of high resolution hyperspectral satellites. This will also create more possibilities for other scientists to connect functional diversity to their research.

Snow darkening and radiative effects of Black Carbon in the north Polar site Ny-Ålesund in Svalbard Archipelago (id 186)

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The arctic region, being the integral part of the global climate system, witnesses strong seasonal transformations in various components of the earth-atmosphere system. It requires long-term monitoring and research of various atmospheric, biospheric and cryospheric parameters to address the climate change related issues. In this regard, India has extended the concerted efforts on polar aerosol measurements from the Svalbard region of Norwegian Arctic (Ny-Ålesund; 79°N, 12°E, 8 m a.s.l.) and campaign mode observations from the coastal regions of Antarctica (Larsemann Hills; 69°S, 76°E, 48 m a.s.l.). In the present study, we have examined the snow darkening due to Black Carbon (BC) deposition at different sunlit seasons of Arctic and compared the values with those over the Antarctic. In addition, the radiative effects of BC are also examined. The study reveals that the inter-annual variability of BC snow is less erratic in the Arctic (~ 7% during northern hemispheric spring) in comparison to that over the Antarctica (~ 24% during southern hemispheric summer). However, the concentration of BC in Arctic snow remains much higher (~ 6.89 ppb during northern hemispheric summer) than the values at Antarctic (~ 2.44 ppb, during southern hemispheric summer). Concurrent with this, BC scavenging ratio (SR) also shows large temporal variability over both the poles, which indicates about several different processes (aerosol mixing, aging and size distribution) acting on the removal of BC from the atmosphere. The relatively lower values of SR over the Arctic (mean ~

80; during northern hemispheric spring) in comparison to that over the Antarctic (mean ~ 167; during southern hemispheric summer) clearly indicate the less efficient removal mechanisms of BC and significant influence of anthropogenic activities over the Arctic. In line with the above, the abundance of atmospheric BC mass concentration also remains relatively higher over the Arctic and peaks during the spring season (mean ~ 50 ng m-3). This shares a major fraction of total aerosol mass and influence the direct diabatic forcing of the atmosphere. Examination of the spectral properties of aerosol absorption coefficient puts insight in to the contribution of long-range transported biomass burning aerosols (~ 25%) to the enhanced light absorption in the Arctic spring. This when combined with dust transport to the Arctic atmosphere leads to the suppression of aerosol single scattering albedo. During summer, the abundant solar radiation and increased tourist activity (frequent ship arrivals and emission from that) leads to pronounced diurnal cycle and vertical distribution of BC concentrations.

Warming and Ocean Acidification Effects in the Seaweed Community of West Spitsbergen (id 136)

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Global change-related warming and ocean acidification (OA) are major threats to the Svalbard coastal ecosystem. Rock bottom areas are mainly dominated by dense forests of a multi-species community of seaweeds. Different species are shown to respond to warming and OA in different ways and degrees, posing a potential shift in community structure as the new scenario develops. An increase in CO_2 is shown to modify the carbon balance of two representative species in opposing ways. Growth rate of *Desmarestia aculeata* was negatively affected by CO_2 enrichment, while *Alaria esculenta* was positively affected, as a result of a different reorganization of the cellular carbon budget in both species. *D. aculeata* showed increased respiration, enhanced accumulation of storage biomolecules and elevated release of dissolved organic carbon, whereas *A. esculenta* showed decreased respiration and lower accumulation of storage biomolecules. Moreover, incubation of 6 species from Kongsfjorden at different CO_2 and temperature levels indicated that temperature affected mainly the photosynthetic performance as measured by PAM fluorescence, particularly the initial slope of ETR curves, the light saturation parameter (Ek), and Fv/Fm values, as well as the protein content, especially in the phaeophytes. On the other hand, CO_2 affected mainly the internal accumulation of carbohydrates and lipids. The C:N balance was largely unaffected. The resulting growth rate was not altered by the treatments in three out of the six species studied. For example, *Phycodris rubens* showed a positive effect of increasing temperature, while *Saccorhiza dermatodea* was positively affected by CO_2. Significant interactions between CO_2 and temperature were found in 20 % of the analyses. Whether

additive or synergistic, the co-occurrence of a higher temperature with other stressors such as elevated CO_2 increases the probability of community changes by modifying the performance of these species. To test whether this kind of responses was characteristic of Arctic populations, *Saccharina latissima* from Kongsfjorden was compared to the population from Helgoland (Germany). Ecotypic variations were revealed by a significantly higher O_2 production rate and an increase in Chl a, Rubisco, and D1 protein content in the Arctic population thalli, but a lower growth rate, in comparison to the Atlantic population. At 10 °C, the Arctic population had a higher content of total C, soluble carbohydrates, and lipids, whereas the N- and protein content was lower. Conclusively, the Arctic ecotype was more resilient to increased CO_2 than the temperate one, and both ecotypes differed in their response pattern to temperature. Overall, Arctic ecotypes of seaweeds have shown an array of responses pointing to an altered community as the "atlantification" and acidification of the West Spitsbergen coastal system take place. Further research will focus on potential alteration of the nutrient regime due to increased discharge from land and its consequences on seaweeds metabolic performance.

Seasonal and short-term variations in atmospheric potential oxygen at Ny-Ålesund, Svalbard (id 66)

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Oxygen in the atmosphere undergoes variations and changes in response to biospheric activities, ocean–atmosphere exchange, and fossil fuel combustion. To contribute to a better understanding of the global carbon cycle and air–sea O_2 exchange, continuous measurements of atmospheric O_2 (defined as $\delta(O_2/N_2)$) and CO_2 were started at the Japanese station in Ny-Ålesund in November 2012. This instrument setup is controlled remotely, as a first trial in the Arctic region, serviced annually by the personnel from Tohoku University and NIPR. Atmospheric potential oxygen (APO) calculated from the measured $\delta(O_2/N_2)$ and CO_2 show a clear seasonal cycle with a peak-to-peak amplitude of approximately 50 per meg. We also performed numerical simulations of APO using an atmospheric transport model (the JAMSTEC's ACTM) with prescribed oceanic O_2, N_2, and CO_2 fluxes. The seasonal cycle of APO simulated using the ACTM is in excellent agreement with the observed APO. However, in spring and early summer, high values of APO are observed irregularly on a timescale of hours to days. By comparing backward trajectories of air parcels released from the site with distributions of marine net primary production (NPP), and tagged tracer experiments made using the ACTM for APO, it is found that these high APO fluctuations are primarily attributable to O_2 emissions from

the Greenland Sea, the Norwegian Sea, and the Barents Sea, due to marine biological productivity. Marine net community production (NCP), estimated based on the sea-to-air O_2 flux derived from observed APO fluctuations, agrees with NPP obtained from satellite observations within an order of magnitude. The results obtained in this study have still some uncertainties, but our continuous observations of atmospheric $\delta(O_2/N_2)$ and CO_2 mole fraction at Ny-Ålesund can play an important role in detecting possible changes in the carbon cycle in the near future.

Dynamic graphics for improved data visualization (id 107)

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The use of graphics to visualize scientific data is probably the most effective way of interpreting and understanding data structure, data variability, relationships, co-occurrences, group comparisons and especially temporal and spatial patterns. Mostly, graphics are static and appear in static form in scientific publications, meetings and reports.

I want to show some examples of how data visualization can be made dynamic, when appropriate. Adding the time dimension through motion to graphics allows more data to be seen in a shorter time, where patterns and change can be discerned more easily, not only in time series data. Many multivariate methods rely on dimension reduction, almost always displayed in two dimensions. Motion graphics can allow a third dimension to be seen, and thus capture more explained variance.

The possibilities are many and the potential is great, especially when faced with large data sets. In this age of electronic publishing , there are no barriers to publishing moving data visualizations. For example, see Greenacre & Hastie (2010) and Greenacre (2016). Software availability is, however, still in its infancy. Most of the dynamic graphics I will show are all "handcrafted" for specific examples, using code written in R, and general software for wider use needs to be developed.

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High temporal and spatial interferometric radar measurements of Kronebreen, Spitsbergen (id 207)

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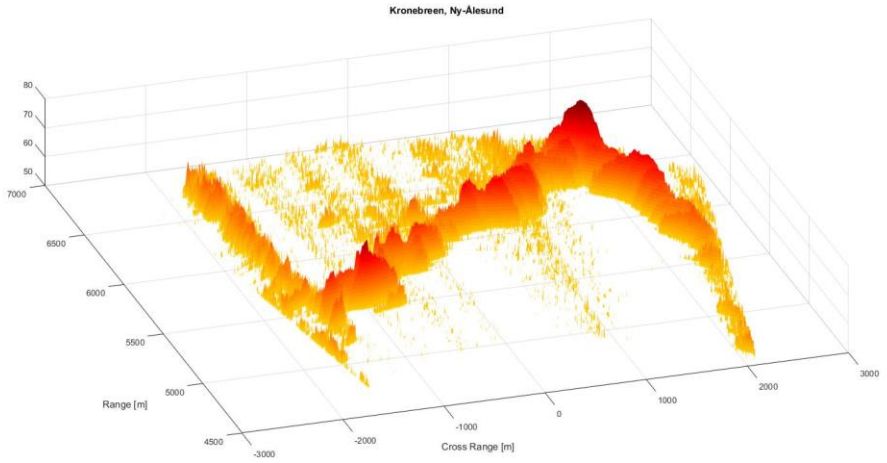
A new interferometric radar with high pulse repetition frequency and electronically steered antenna was used for measuring the front of the Kronebreen glacier. The results are very promising showing both the cross range position and the velocity of the front of the glacier thus making it possible to geolocate a transverse velocity field and major calving events. The presentation will show the first results of these measurements.



The history of direct mass balance time series in Spitsbergen, Svalbard (id 99)

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The history of direct mass balance measurements in Svalbard was started by Olav Liestøl on Finsterwalderbreen (11km^2) in Van Keulenfjorden in 1950. Every second year between 1950 and 1966 he visited the glacier and the net mass balance was calculated for biannual intervals. Only two of the periods show positive mass balance and the mean for the period 1950-1968 was - 0,25 m w.eq. During the summer 1966 the measurements were started on Austre

Brøggerbreen in Kongsfjorden in north-west Spitsbergen. The year after, in 1967, the measurements were started also on Midre Lovénbreen. Since then annual measurements of winter and summer balance have been done as part of the Norwegian Polar Institute monitoring program and is thus one of the longest continuous time series of mass balance in the Arctic. To obtain data covering a more representative hypsometry series were started on Kongsvegen in 1987. Kongsvegen has an area of ca. 102 km^2 and covers an altitude range from sea-level to 800 m a.s.l. The two small glaciers, both with size of ca. 5 km^2 cover an altitude range of 50 to 600 m a.s.l. and show a strong negative mass balance of -0,49 and -0,39 m w.eq. respectively over the last 50 years while Kongsvegen over the last 30 years show much less negative values with a mean of -0,08 m w.eq.

Polish researchers have carried out annual mass balance measurements on Hansbreen (57 km^2) in south-Spitsbergen since 1988. Russian scientists have studied five glaciers in west and central Spitsbergen over periods from 5 to 14 years in the 1970ies and 1980ies. The results that will be presented show significant variability but correlates well with the long time-series in Kongsfjorden.

Methylmercury mass budgets and distribution characteristics in the Kongsfjorden, Svalbard (id 157)

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The potential sources of methylmercury (MeHg) to the Arctic seawater remain uncertain, while MeHg accumulation in marine organisms of the Arctic Sea was reported to be higher than temperate marine environments. Here, we report the MeHg mass budgets for the Kongs Fjord estimated based on observation data from the Svalbard surveys carried out in August 2016 and 2017. The mean MeHg concentration in unfiltered seawater ranged from 0.03 to 0.53 pM with a mean value of 0.13 pM. The mass budget calculation showed that the major source of MeHg in surface water was a net methylation within the water column with a value of 300 nmol m^{-2} yr^{-1}. The MeHg input via river water and glacial discharge was a minor source with a value of < 10 nmol m^{-2} yr^{-1}. The in situ methylation flux of MeHg was mostly balanced by dark- and photo-demethylation, evasion of dimethylmercury to the atmosphere, and particle settling to the sediment. The flux variance agreed well with the concentration variation, such as a large increase of surface MeHg in the 10 to 50 m layer. We also found that terrestrial humic-like (C2) fluorescent dissolved organic matter (excitation peak at 285 and 370 nm; and emission peak at 514 nm) was enriched in the surface 0-50 m near the river discharge sites, and relatively high MeHg concentrations were found at the surface of the same site. The formation of colloidal

organic matter and associated microbial activity seemed to account for atypically large concentrations of MeHg in the surface seawater. We plan to demonstrate this hypothesis via measurements of the in situ methylation and demethylation rate constants in surface seawater using the Hg isotope dilution method in the 2017 survey. Overall, the MeHg flux estimation successfully identified major sources and sinks in the Kongs Fjord seawater. The results also demonstrate the applicability of excitation-emission matrix fluorescence spectroscopy in combination with mass flux model for characterizing MeHg dynamics in Arctic seawater.

New achievements on solar wind-magnetosphere-ionosphere coupling based on Auroral observation at Yellow River Station (id 185)

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Under the support from CHINARE, Polar Research Institute of China has carried out auroral observations at Yellow River Station since 2003. Based on these observations, we have obtained new results on two aspects. One is about dayside diffuse aurora and another is about a newly defiend auroral form, called 'throat aurora'. These new results have shed new light on many topics, such as how the cold plasmas in the dayside outer magnetosphere are distributed, generated, and interacting with the magnetopause, and how the transient processes generated in the magnetosheath can affact the solar wind-magnetosphere coupling. We thus proposed some new suggestions on these topics, but all of the suggestions need to be confirmed in the future study. In this meeting, we would like to introduce our recent studies in detail and wish to explore the potential collabrations with attendees from different fields and different groups.

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Coordinating and Integrating UV Observations in Svalbard (id 172)

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UV radiation is one of the important geophysical parameters influencing a wide range of life processes on a global scale. The discovery of the Antarctic ozone hole and ozone depletion in the Arctic triggered intense studies of the UV climate, especially at high latitudes. In Svalbard, total ozone and UV radiation have been measured periodically since 1950 (mostly in Longyearbyen) and continuously and systematically since the 1990s (in Ny-Ålesund). Gradually, further measurement programs were established in Hornsund and Barentsburg (see Fig.1). In summer

Fig. 1. Geographic position of the stations measuring solar UV irradiance and total ozone at Svalbard.

2017, a new radiation monitoring instrument was taken into operation in Longyearbyen. The techniques applied vary widely (Dobson spectrometer, Brewer spectrometer, SAOZ DOAS, GUV and UV-RAD filter radiometers) so that inter-comparison and homogenization of the resulting data series are of great importance. In the frame of the *UV Intercomparison and Integration in a High Arctic Environment (UV-ICARE)* project, all institutions performing UV measurements in Svalbard cooperate with the aim to homogenize the various measurement series, through both re-analysis/inter-comparison of existing data and the development of common operational routines as a consequence of an inter-comparison campaign. Such an activity is expected to create the basis for a Svalbard-wide network for monitoring of the UV

irradiance and ozone column and corresponds to the goals of the Work Group 6 (Variability in surface UV irradiance and ozone column) of the Atmosphere Research Flagship Programme that unites the efforts of scientists working in different fields of polar atmosphere research.

We will present the available data sets together with first results of the inter-comparison work that gives a preliminary estimate of the data quality. We will also outline the objectives of the inter-comparison campaign scheduled for spring 2018 in Ny-Ålesund.

Synchronous fluctuations but diverging trends: spatial patterns of Svalbard reindeer population dynamics under recent climate change (id 176)

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Population fluctuations of a wildlife species are expected to be synchronized in space due to climatic and environmental autocorrelations (the Moran effect). At the same time, the synchronizing effects of spatially autocorrelated climate drivers on population dynamics can be counteracted by spatial heterogeneity in the environment or in the local ecological responses. This is important from a conservationist perspective, and particularly under global warming, since strong spatial synchrony in population dynamics can reduce long-term species viability.

However, our understanding of how spatial heterogeneity modifies climate change impacts on spatial population synchrony and large-scale population dynamics is poor. For instance, rain-on-snow (ROS) and associated icing events appear to be an increasingly important driver of ungulate population fluctuations across the Arctic, while its role as a synchronizing agent is unknown. Here, we demonstrate how spatiotemporal variation in ROS causes spatial population synchrony over large distances, yet also diverging local population trends, in Svalbard reindeer. Based on counts (1997-2015) of ten populations with up to 330 km distance, we show that a density-dependent effect of annual ROS amount contributes significantly to the observed spatial synchrony in population growth rates. However, analysis of two high-quality population time-series that cover a longer time period (1978/79-2015) reveals that climate drivers have qualitatively similar effects on different populations' growth rates, while the relative strength of ROS versus other drivers varies between populations. In the coastal, wet Brøggerhalvøya (close to Ny-Ålesund), there was a strong negative (density-dependent) ROS effect and only a weak positive summer temperature effect on population growth rates. In contrast, the Adventdalen population (close to Longyearbyen) showed an opposite pattern in the relative strength of these climate drivers. Because of this, as well as slightly different local climate trends, the two populations' trends in abundance have diverged dramatically under recent climate warming. Accordingly, and contrary to common perceptions among managers and scientists, a model of annual "Svalbard reindeer abundance" based on all ten monitoring populations indicates no significant change in the total abundance of reindeer since 1997. Our study illustrates how spatial heterogeneity in ecological responses can buffer climate change effects, and the inherent danger in basing regional conservation and management decisions on data from single populations.

Very high nitrification and denitrification potentials of soils on the talus under a kittiwake-cliff in Ny-Ålesund (id 26)

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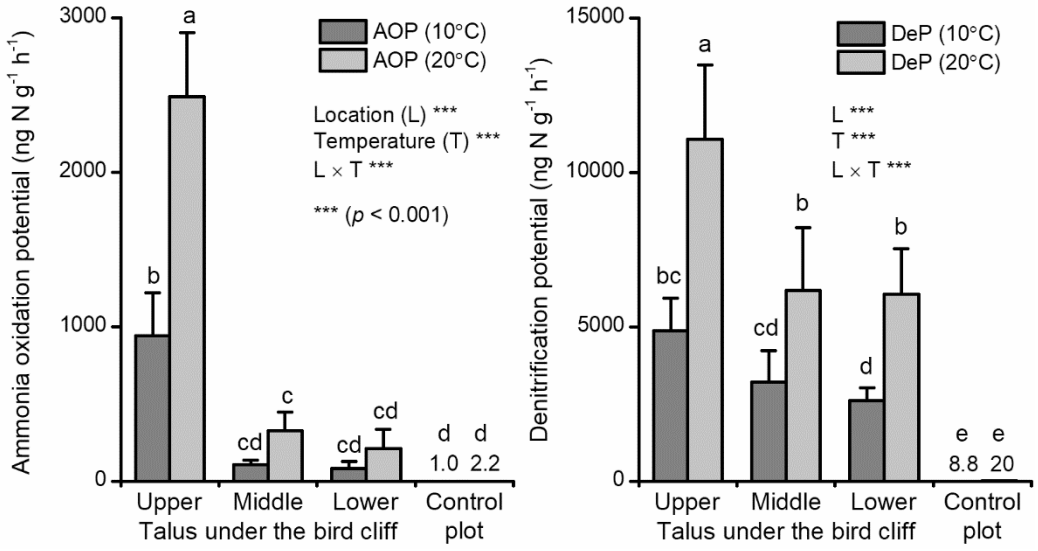
Carbon (C) balance of arctic soils is subject to biologically available nitrogen (N) because of its indispensableness as a macronutrient. Nitrification is a unique microbial process oxidizing ammonia into nitrate via nitrite. Denitrification is another microbial process but reducing nitrate into dinitrogen (if completed) through nitrite, nitrogen monoxide, and nitrous oxide. These processes strongly regulate soil N availability. In turn, bird activities such as nesting and defaecation also strongly affect soil N availability through input of organic matter. In bird rookeries, accumulation of organic matter from faeces and carcasses might boost the soil N and

C cycles. The purpose of the present study was to quantify nitrification and denitrification potentials of soils on the talus under a bird cliff in Blomstrand Peninsula, Ny-Ålesund. The field survey was conducted in July 2015. The cliff was inhabited by ca. 400 nesting pairs of kittiwakes (*Rissa tridactyla*). Sets of three plots were set on the upper, middle, and lower parts of the talus. Three control plots not directly affected by seabirds (ca. 300 m northeast from the cliff) were also set. The surface soil was collected from three points per plot and then combined into one sample. Ammonia oxidation potential (AOP) as the nitrite production rate and denitrification potential (DeP) as the nitrous oxide production rate were determined by shaking incubation with necessary conditions, substrates, and inhibitors. Incubation temperatures were 10 and 20 °C. Both AOP and DeP were very high on the talus (Fig. 1). Effects of location (L) and incubation temperature (T) and the interaction between L and T on AOP and DeP were all significant (p < 0.001). Thus, the bird cliff boosts the nitrification and denitrification in the surrounding soils, and temperature rise might facilitate this tendency.



Volatile halobenzene compounds in ice cores and surface snow from four glacier sites on Svalbard (id 49)

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Since 2000 we have analyzed 315 organic contaminants - in 5 different compound classes - in ice cores and surface snow samples from Svalbard. Among the classes of compounds are halobenzenes (HBs). During various sampling campaigns, different lists of HB target analytes

have been used: The most comprehensive list was analysis of 15 HBs in the Holtedahlfonna ice core in 2005, which included 9 chlorobenzenes, 3 bromobenzenes, pentachloroanisole, and 2 chloromethoxybenzenes. Other sampling campaigns, including Lomonosovfonna (ice core in 2000 and later surface snow), Austfonna (2012-2014) and Kongsfjorden (2014) have analyte lists that are a subset of this. None of these HB compounds are known to have been used on Svalbard. As a group, these compounds have vapor pressures (VP) higher than any others we have analyzed (which includes organochlorine and organophosphorus pesticides, brominated flame retardants, perfluoro alkyl substances, polychlorinated biphenyls (PCBs)): The least volatile of the HBs, hexachlorobenzene (HCB), has a vapor pressure more than twice as high as PCB70 (2,3',4',5-tetrachlorobiphenyl), a PCB congener common in Svalbard glacier ice, with similar molecular mass (291.99) to HCB (284.78). The other 14 HB compounds on our list have VP at least one order of magnitude greater than HCB. In general, these HBs are considered to be too volatile to condense from the atmosphere and accumulate on any surface. However, at least part of the time at high elevation on Svalbard, temperatures are apparently cold enough for these compounds to condense. The influence of atmospheric warming on Svalbard is likely to prevent some of these compounds from condensing from the atmosphere in the future. All of these 15 compounds have been found in at least one sample that we have collected on Svalbard indicating persistence and long-range transport. The most abundant compounds, including during the historic periods, are the dichlorobenzenes (DCB), which are also the most volatile: 1,4-DCB, is most abundant overall, once used in moth balls, among other things. Its abundance is followed by 1,3-DCB, and 1,2-DCB, both known to be used in termite treatment at one time. These compounds are followed in abundance by pentachloroanisole, a methylated metabolite of pentachlorophenol, then by 1,2,4-trichlorobenzene, once used in herbicides, termite treatments, and as a die carrier. The only other compound with a significant presence is 3,4,5,6-tetrachlorodimethoxybenzene (3,4,5,6-tetrachloroveratrol) which was known to be a residue from the bleach Kraft industry resulting from methylation of chloroguiacols, chlorinated compounds formed and released during delignification by chlorine gas during pulp production into the 1970s and 1980s. The most abundant of the HBs, again including the DCBs, are found in more historic ice core samples, suggesting that they are no longer being emitted from source regions or are not condensing.

Most other chlorobenzenes, found in lower abundance, were used as intermediates for other chemicals, but were produced in large quantities. Pentachlorobenzene (PeCB) and HCB and are among these compounds and are on the Stockholm Convention (none of the other 13 HBs are found on Stockholm).

The appearance of these highly volatile halobenzenes, some in high concentrations on Svalbard, suggests that routine measurement in the Arctic is necessary.

Effect of migration strategy on pollutant concentrations in eggs of Arctic breeding barnacle geese (Branta leucopsis) (id 165)

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In Arctic toxicology, most of our knowledge of mechanisms and processes is derived from the marine ecosystem. Accumulation and effects of pollutants within Arctic terrestrial ecosystems webs are much less understood. Barnacle geese (*Branta leucopsis*) are a terrestrial species that feed mostly on vegetation, migrate annually from wintering grounds in Scotland to breeding areas in the Arctic, including Svalbard.

Geese have been shown to utilise energy towards egg production from Scotland, northern Norway and Arctic tundra. Individuals can arrive at the breeding grounds prior to snow melt and utilise distant resources for egg laying. Alternatively geese can arrive later in the breeding season when local food is available on the Arctic tundra. Observations suggest that timing of egg laying for island populations in Kongsfjorden has shifted to an earlier date, which may affect the acquisition and allocation of pollutants to eggs. We were interested in how the timing of arrival and utilisation of vegetation along the flyway affects egg pollutant concentrations. We expected eggs of early arriving geese to contain more pollutants than late arriving geese.

We sampled 60 eggs from nests of Barnacle geese breeding in Storholmen, Kongsfjorden. We also calculated egg laying date by recording hatch dates of each nest sampled. We collected vegetation from four main areas along the goose's flyway, including: the breeding grounds in Scotland, staging area at Northern Norway, bird cliff and island tundra in Svalbard. As part of other projects, sightings of ringed individuals took place at the staging areas in northern

Norway, and this data was made available for the present study. Eggs and vegetation samples were analysed for pollutants at Norwegian Institute for Air Research in Tromsø, and included organochlorines (PCBs and HCB in eggs and vegetation), and perfluorinated substances (PFASs in eggs only). Stable isotopes of carbon and nitrogen were measured to provide insight on the dietary source used to fuel egg production.

We detected PCBs, HCBs and PFASs in all eggs, but found no relationship between pollutant concentrations and timing of egg laying. Dietary descriptors measured in vegetation did not reveal whether eggs were fuelled from one particular source or another. Although 2016 was the earliest hatch year on record, we only sampled from a single breeding season and colony. In order to further assess the mechanism of pollutant transfer to eggs and its relation to migration strategy, we would require a study over several seasons as well as samples from other breeding sites. This could include Adventdalen and colonies on the eastern coast of Spitsbergen. Such knowledge would increase our understanding on the interaction between climate and pollutants in Arctic terrestrial ecosystems.

Landscape change and the emission of greenhouse gases in Central Spitsbergen (id 171)

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This talk demonstrates how landscape change since the Last Glacial Maximum (LGM) exerts a crucial, long-term control upon greenhouse gas emissions to the atmosphere. The work reported formed the basis of the JPI-funded project: "More than methane: quantifying melt-driven biogas production and nutrient export from Eurasian Arctic lowland permafrost (LowPerm)." The influences of sea level change, permafrost aggradation, ground thaw and deglaciation will be shown to strongly influence the emission of methane and CO_2 from both the active layer and the sub-permafrost environment. This talk will therefore describe how sedimentary habitats which have formed within Svalbard's major valley systems over the last 10 k.a. are conducive to biogas emissions from their active layer, but have lower than expected methane generating potential due to a lack of organic matter and a dominant microbial community associated with iron cycling. Rates of organic matter accumulation in Svalbard are therefore crucial for understanding future methane emissions from the expansive wetlands that are found in its coastal lowlands. However, there also exists vast resources of methane in sub-permafrost

aquifers, whose rapid escape has been recently connected to the earlier stages of ice sheet retreat through the analysis of pockmark features on the fjord floor. This talk will therefore describe our recent research on the rapid ventilation of such methane directly to the atmosphere via groundwater seeps and open system pingos that are analogous to the pockmarks, but are now found above sea level following sea level change. The role of permafrost aggradation following emergence from the sea is crucial for understanding these hotspots of methane and CO_2 escape. How these fluid escape pathways will respond to contemporary climate change is unclear though, and will remain so until the water and gas source dynamics are better understood. However, what is clear is that the emission of methane and CO_2 from both the active layer and the sub-permafrost environment are intricately linked to landscape change since the LGM.

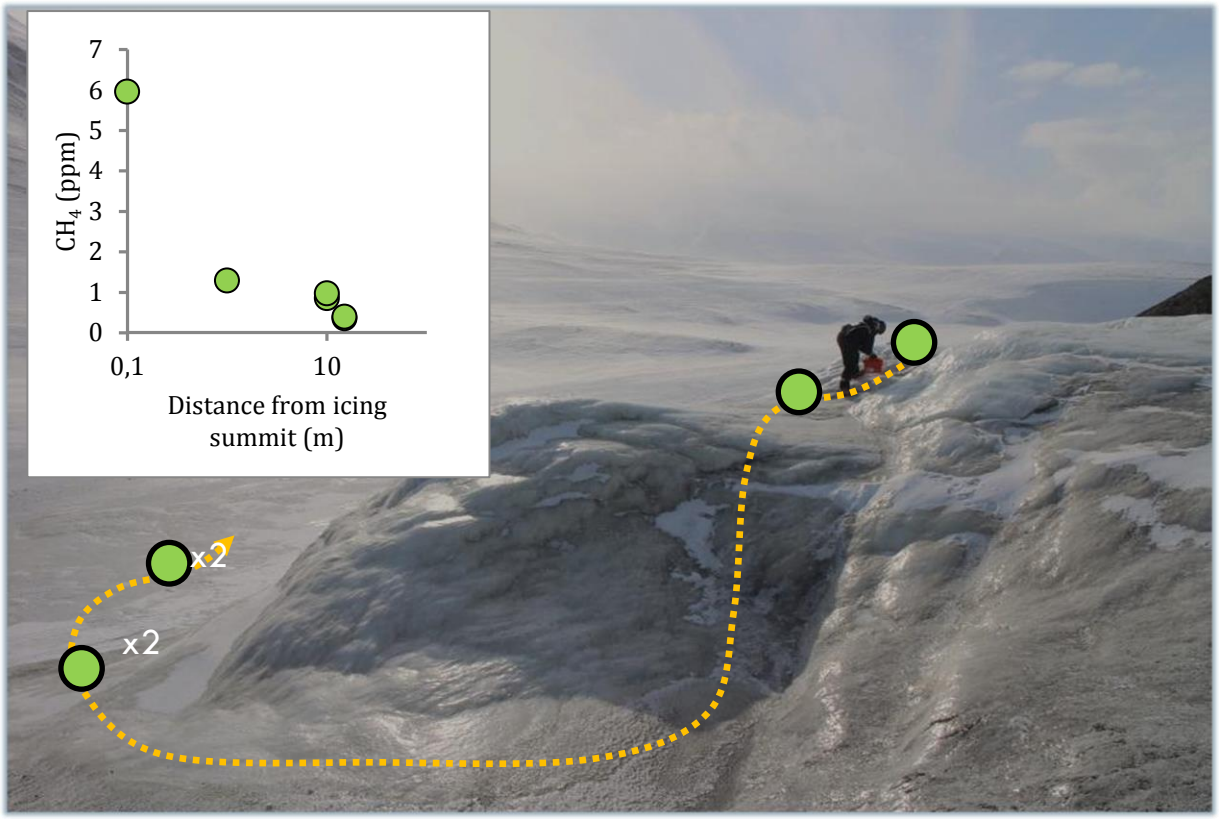

Figure 1. Innerhytte Pingo is an open system pingo that discharges saline groundwaters with up to 10 mg/L methane. Downstream sampling demonstrates rapid loss of the methane to the atmosphere and therefore emphasises the need to choose sampling points carefully.

New photogrammetric methods and the use of old photographs for quantitative analyses of glacier changes (id 57)

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In 2012-2016 we have digitalized a large number of old photographs taken 1861-1980 on glaciers in Sweden and on Svalbard. Many of these photos were taken from cairns easily found today. In order to make use of these old data for quantitative analyses our project aimed at photogrammetrical reconstructions and georeference the old photos in a 3D coordinate system. In a pilot study conducted in 2016 we mapped four Swedish glaciers and four on Svalbard with a drone, using Structure from Motion – Multi View Stereo reconstructions. In 2017 more than 10 glaciers were added from both these areas. Structure from Motion has also been applied on terrestrial and oblique aerial imagery, giving new uses for already existing data. With the scanned analog photographs, reconstructions as far back as the 1800's can be made, giving insight in the glaciers' thicknesses, shapes and appearances. By analyzing the fore field landforms using drone surveys we can retrieve information on past thermal structures of the glaciers and whether or not it is a surging glacier. This opens up new perspectives in analyzing glacier responses to climate change. Where ground control has not been collected in the field, digital terrain models of the present state in Sweden can be georeferenced using the LiDAR surveys made in 2015 by the Swedish Authority of Land Survey and models from Svalbard using recent aerial photographs taken by Norsk Polarinstitutt. The objectives of this project are: To improve and expand glacier monitoring by introducing new methods, to map and add new knowledge to our understanding of the dynamic response of glaciers and to make quantitative analyses of old photographs on glacier change. We are convinced that new useful conclusions can be drawn out of old data, by using new techniques.

Muddy Waters: Plankton and nutrient dynamics below the brown plumes in front of active tidewater glaciers in Kongsfjorden, Svalbard (id 121)

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Active tidewater glaciers in inner Kongsfjorden are spectacular with >30 m high glacial fronts and icebergs that frequently plunge into the brown water in front of the glaciers. Because of climate warming, many of the tidewater glaciers are retreating and some fronts have already retreated onto land. The brown plumes in front of the tidewater glaciers Kongsvegen, Kronebreen and Kongsbreen North have become foraging hotspots for seabirds such as Arctic terns, black-legged kittiwakes and northern fulmars, but what is below the brown plumes and the mechanisms that concentrate prey in these areas are not well understood. A combination of sampling with CTD and nets by research vessel and helicopter in early August 2016 and late July 2017 made it possible to obtain water and plankton samples from the inner fjord basins right up to the active glacial front, in order to unravel some of the secrets hidden below the brown plumes.

The brown plumes contain very high concentrations of total suspended matter (TSM) associated with the subglacial discharge of meltwater. As it rises to the surface, the fresh glacial meltwater discharge is vigorously mixed with marine water from the deeper part of Kongsfjorden, resulting in only slightly brackish conditions inside the plumes. This is supported by model results suggesting that katabatic winds enhance vertical mixing of the glacier discharge and fjord waters near the glacier front. The algal biomass, measured as chlorophyll-a, is very low because of the brown water with strongly reduced submarine light field. The organic carbon content of TSM is generally low, but because of the high TSM load of the ejected meltwater, particulate organic carbon concentrations become higher compared to those further out in the fjord despite the low phytoplankton biomass in the inhospitable light environment. Initial observations indicate a diverse protist community represented by smaller flagellates (including chlorophytes and chrysophytes), dinoflagellates and tintinnid ciliates with sediment particles attached to their loricae as well as a number of brackish species.

Nutrients seem to be relatively high in the glacial front area, particularly concerning ammonium and silicic acid. Simulations made with a 3D fjord model suggest that ammonium export with the glacial meltwater is a likely explanation for the high concentrations observed at the surface near the glacier front. High ammonium concentrations have also been found in pore water from sediment cores taken near the glacial front, and may contribute to the elevated ammonium concentration in the deeper water column depending on the flux of ammonium across the sediment-water interface.

Zooplankton tend to be concentrated in the brown plumes with higher abundance and biomass of mesozooplankton (1800 ind. m^{-3}) and macrozooplankton (160 ind. m^{-3}) recorded inside the

plume (in 2016). However, the values were not particularly high compared to outside the plume and lower than further out in Kongsfjorden, where the abundance may reach 3000-10,000 ind. m^{-3}. The percentage of dead zooplankton in the proposed osmotic "death trap" was typically < 5%. However, the "elevator" that brings zooplankton to the surface near the glacial front runs continuously and makes the prey in the muddy water easily accessible to surface feeding predators. Benthic scavengers, such as *Onisimus caricus* and *Anonyx nugax* are abundant near the brown plume as well as in the inner bay.

Arctic phytoplankton under multiple stressors : insights from 4 years of field work in Ny-Ålesund (id 53)

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The Arctic is already experiencing consequences of climate change, with rates of ocean warming and acidification being higher than in any other of the world's oceans. In some sense, the Kongsfjord system with its strong influence by Atlantic advection can be seen as a 'miners' canary' of changes to come elsewhere in Arctic coastal systems. The effects of these changes on phytoplankton as the main primary producers and base of the pelagic food web are expected to impact ecosystem functioning and biogeochemistry. In the last four years, we have combined different observational and experimental approaches to investigate the effects of these 'multiple stressors' on phytoplankton assemblages and isolates from Kongsfjorden. By connecting field sampling, experiments with natural assemblages as well as detailed physiological studies of freshly isolated strains from Kongsfjorden, we aimed at understanding the ecological and physiological underpinnings of observed changes and/or resilience. In the talk, some of our approaches and their results will be presented.

Past and present sedimentary environments in the Kongsfjorden system, Svalbard (id 45)

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Fjords are sediment traps, and investigations of Svalbard fjords have demonstrated that these possess sediment archives valuable to reconstruct past environmental changes and establishing baseline values for natural Arctic variability. The main heat source for the European Arctic is the extension of the northbound flow of warm, saline and nutrient-rich Atlantic Water via the North Atlantic Current. This current is a major regulator of environmental changes in the Arctic. The Atlantic Water flowing into the Arctic along Svalbard submerges near northwestern Svalbard and becomes a subsurface flow. It routinely enters Kongsfjorden on western Svalbard. Hence, the sedimentary archive in Kongsfjorden records past and current oceanographic variability. Previous studies show that the waters of Kongsfjorden became warmer between 2006 and 2008 due to an increased advection of Atlantic Water along western Svalbard (Cottier et al., 2007). The reconstruction of ocean temperatures and sea-ice distribution in the adjoining region show rising temperatures and waning sea-ice distribution ca 11.000 years ago, similar to recent conditions. The inflow of AW to the Kongsfjorden system also greatly influences the tidewater glaciers in the fjord system and may cause accelerated melting. A direct result of the accelerated glacial melting is an increase in the sediment flux from the glacial catchments into the Arctic fjord systems. Here we present a review of the current knowledge of the present and past marine sedimentary environment in Kongsfjorden documenting the natural ranges for change within Arctic glaciomarine environments.

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SIOS – What are the benefits for researchers? (id 150)

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The vision of SIOS is to tackle the big questions of Arctic Earth System Science in a framework of systematic long-term measurements.

SIOS builds on an extensive network of existing distributed research infrastructure and long-term data series in and around Svalbard. The focus is on processes within and interactions between the different spheres in Earth System Science. The SIOS network produces systematic observations which are stable over time, yet dynamic as new methods and questions from society arise.

The benefits to researchers are:

- Facilitated and improved research

SIOS closes gaps in the network of long-term data series - geographically, temporally and in terms of parameters. Researchers benefit from comprehensive and easily accessible data sets

- Coordinated efforts and large-scale campaigns

By facilitating cooperation SIOS enables researchers to contribute with individual studies to a holistic Earth System Science laboratory

- Increased value of data

SIOS develops tools to reformat, reproject, subset and combine data into new data sets

- Enhanced funding opportunities

Projects that align with the priorities of SIOS may benefit from new sources of funding through network, harmonisation and integration

- Easy access to data

A virtual data centre offers unified access to relevant data from all partners

- Broad logistical support

Better access to and advice on transportation, accommodation, storage facilities, workshops and equipment throughout Svalbard

- Better access to instruments

Researchers have easier access to the large variety of research instruments and facilities that already exist in and around Svalbard, and can propose new ones via the SIOS Science Optimisation Service

The SIOS Knowledge Centre in Longyearbyen coordinates data management, RI access, remote sensing resources, training programmes and communications services.

What is SIOS? (id 151)

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SIOS is an international research infrastructure for Arctic Earth System Science in and around Svalbard. Within SIOS, researchers can cooperate to access instruments, acquire data and address questions that would not be practical or cost effective for a single institution or nation alone.

The purpose of SIOS is to improve the Earth Observing System for Svalbard, to integrate the data from the distributed research infrastructure and to maintain systematic and sustainable measurements over a long period.

SIOS focuses on processes within and interactions between the different spheres in Earth System Science. The Observing System is built around “core data” – long-term data series collected by SIOS partners. The partners commit to continuing their long-term monitoring and

making their data available to others, thus reducing the need for duplication of data collection. The core data can then be used as basis for innovative research initiatives.

SIOS core data, and other relevant data sets, will be collected on the SIOS Data Portal. Here users will be able to discover what data are available, access metadata and find information on how data may be accessed.

An access programme facilitates access to the world class research infrastructure operated by SIOS members. The first access programme will be running in 2018 and there will be regular calls for access in the future.

SIOS will produce an annual report – State of Environmental Science in Svalbard (SESS). The SESS report will summarise the scientific activities within the SIOS consortium in the previous year, highlight questions that remain to be answered and make recommendations for future research priorities. SESS may also recommend future investments in the Observing System, e.g. new data series that are required or changes to the timing, location or frequency of monitoring. The first SESS report will be published in 2018 and there will be annual calls for contributions to subsequent reports.

The Knowledge Centre is the central node of SIOS. It is located in Longyearbyen and offers coordinated services in cooperation with representatives from SIOS member institutions through the working groups. The services are Data Management, Remote Sensing, Training, Communication and Outreach, Access and Logistics, and Science Optimisation.

SIOS is organised as consortium of international institutions that own research infrastructure in and around Svalbard and is funded by the Research Council of Norway and the member institutions.

Toward understanding the linkage between the Arctic amplification and North Atlantic variability (id 178)

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The Svalbard region is known for being at the heart of the observed effects of Arctic climate change, which include sea-ice decline, the Arctic amplification, the increase in North Atlantic water inflow, and extreme weather events over high and mid latitudes. How these observed changes are connected to phenomena in mid latitudes has recently become a high-intensity research topic. In the last 10 years, great attention has been paid to extreme weather events over the mid latitudes associated with Arctic sea-ice decline mainly in the Barents and Kara seas. Although many explanations have been proposed and discussed (e.g. a review by Vihma 2014), recent studies have focused on the role of mid-latitude atmospheric and oceanic variabilities,

especially in North Atlantic sector. Arctic warming during 1920-1940 has been attributed to the Atlantic multidecadal variability (e.g. Tokinaga et al. 2017). In contrast, current warming and moistening over the Svalbard region and cold events over Eurasia during winter seem to be related to the atmospheric circulation forced by sea surface temperature variability over the North Atlantic (Sato et al. 2014; Jung et al. 2017; Luo et al. 2017). In addition to this, the warm water inflow through the Barents Sea Opening is related to the sea-ice decline there (Nakanowatari et al. 2014; Årthun et al. 2017). Therefore, atmospheric and oceanic variabilities over the North Atlantic strongly affect the Arctic amplification and sea-ice reduction, suggesting that the warming observed in Svalbard (e.g. Maturilli and Kayser 2016) should be investigated on both shorter and longer time scales. In this session, we will discuss the importance of climate connections between Svalbard and the mid latitudes, from the observed meteorological changes to the atmospheric and oceanic pathways, leading to recent and upcoming international field campaigns and modeling efforts (e.g. AC3 (Wendisch et al. 2017), YOPP, and MOSAiC).

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The recent warming on Svalbard and its relation to atmospheric circulation and sea ice cover (id 204)

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Changes in temperature due to global warming are one of the most important drivers of change in natural systems in the Arctic. Other important climate associated drivers are retreat of sea-ice, decline in snow cover and increased gas emissions from stored carbon in permafrost soils. The interactions between some of these drivers have been studied for the Svalbard region; especially how the recent warming is related to variations in large-scale atmospheric circulation (AC), air mass characteristics, and sea ice concentration (SIC), both regionally around Svalbard and locally in three fjords. We find substantial warming for all AC patterns for all seasons, with greatest temperature increase in winter. A major part of the warming can be attributed to changes in air mass characteristics associated with cyclonic or anticyclonic air advection from north and east, and also for situations with no advection. In total, changes for six specific AC types (out of 21); - which occur on average 41% of days in a year,- contribute to approximately 80% of the recent warming. The relationship between the land-based surface air temperature (SAT) and the local and regional SIC was highly significant, particularly for the six specific AC types. The high correlation between SAT and SIC for air masses from east and north of Spitsbergen suggests that a major part of the atmospheric warming observed in Spitsbergen is driven by strong heat transfers from the larger open ocean areas in the Barents Sea and the region north of Spitsbergen. Finally, our results show that changes in frequencies of AC play a minor role to the total recent surface warming. Thus, the strong warming in Spitsbergen in the latest decades is not driven by increased frequencies of "warm" AC types but rather from sea ice decline, higher sea surface temperatures, and a general background warming.

Two decades of Svalbard ice core studies – progress and remaining challenges (id 128)

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Over the last two decades, ice cores have been retrieved from three major glacier-ice caps in Svalbard; Lomonosovfonna, Austfonna and Holtedahlfonna. The longest of these cores covers the past 1200 years. Thus, these cores provide information on both the spatial variability component, in addition to the temporal record, of both climate and pollution. We have used the $\delta^{18}O$ records to reconstruct the winter surface air temperatures utilizing techniques used in dendrochronology called 'scaling'. During the 1800s, which according to our results was the coldest century in Svalbard, the Little Ice Age winter cooling was of the order of 4˚C, compared

to the 1900s. One of the most striking features of the reconstruction is a lasting pre-1300 period of warm winters, where DJF temperatures were comparable to those that were observed in Svalbard in the 1930s and in the most recent decade. The rapid warming at the beginning of the 20th century is well documented in the instrumental data and was accompanied by a parallel decline of sea ice extent in the study area. Our results suggest that such a degree of melt as was observed in the Medieval times, has been exceeded only in the recent decades. Much effort has been dedicated to identifying the most important sources for pollutants; these data show a clear east-west zonal gradient across the archipelago, with the highest concentrations in the east, suggesting a different origin for air masses arriving in different sectors of Svalbard. Some of our recent work has been involving black carbon (BC). We have analyzed BC in ice cores from both Lomonosovfonna and Holtedahlfonna, using two different methods; a Single Particle Soot Photometer (SP2) was used to measure BC in the core from Lomonosovfonna, while a filter-based method was used to analyze EC (elemental carbon, proxy for BC) on Holtedahlfonna. Both these records clearly show an anthropogenic influence since the beginning of the industrial revolution, correlating with increases in nitrate and sulfate since 1850, which confirms the predominance of anthropogenic BC sources. Both these BC records follow the general history of use of coal and oil in industrial parts of the world. However, the trends of these records are not in agreement from ca. 1970 onward. The BC record from Lomonsovfonna is peaking between the 1950s and the 1980s, followed by a clear decline since ca. 1970, in agreement with the implementation of cleaner technologies and stricter environmental policies. Following a temporary low point around 1970 the record from Holtedahlfonna shows a pronounced increase in BC deposition from ca. 1970 to 2004, reaching unprecedented values in the 1990s. This increase contradicts the atmospheric monitoring records, among them nearby Zeppelin station. Chemical transport models results suggest that the increase may be caused by enhanced scavenging efficiency of BC due to higher temperatures and precipitation. It is evident that results retrieved from one ice core record cannot necessarily be extrapolated to a larger area, and more records are needed to confirm geographical distribution of various trends.

Sea ice conditions and regional climate in the Svalbard region during the “early” and “modern” warming periods (id 46)

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An analysis of the relationship between regional climate and sea ice conditions in the waters surrounding Svalbard (Fram Strait, "Whale Bay", areas of the Barents, Greenland and Norwegian Seas) was carried out. The following open data sources of sea ice and meteorological information were used:

- 7-days regional ice charts in SIGRID format from the AARI World Data Center archive (Greenland, Barents Seas for the period 1933-2015, http://wdc.aari.ru, on 0.25°x0.25° grid);
- Daily ASI algorithm total concentration patterns (based on the SSM/I-SSMIS data,12.5x12.5 km grid, 1991-2015, IFREMER, ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/psi-concentration /);
- Daily NASATEAM algorithm total concentration patterns (based on SSMR-SSM/I-SSMIS data, 25x25 km grid, 1978–2015, NSIDC, ftp://sidads.colorado.edu/DATASETS/nsidc0051_gsfc_nasateam_seaice/final-gsfc/);

- Monthly mean surface air temperature (SAT) at 6 Svalbard meteorological stations (Ny-Ålesund, Isfjord Radio, Barentsburg, Longyearbyen, Pyramiden, and Hornsund), derived from www.eklima.no, www.met.no,www.aari.ru,www.rp5.ru,www.meteo.ru

The waters surrounding Svalbard were divided into 6 quasi-homogeneous regions, and the sea ice conditions in these regions were analyzed. The analyses included linear trends of the ice extent around Svalbard and SAT for different seasons and areas (Barentsburg, Pyramiden, Ny-Ålesund, Longyearbyen, Isfjord Radio, and Hornsund). The results demonstrate the long-term variability of some basic parameters of the Svalbard climate system. In the waters surrounding Svalbard there has been a substantial decrease of sea ice over the past 35 years, both annually and for individual seasons. The total annual reduction amounts to 2600 km2calculated by linear trend analysis. Decrease of the absolute values of positive anomalies of ice cover is observed from 1979 to 1998, but from 1999 to the present time an increase in the absolute values of negative anomalies is observed. The annual and seasonal variability of ice cover is linked to the ocean circulation in the Svalbard area, and the study gives examples of differences and similarities of seasonal and long-term variability of ice cover of the waters around Svalbard. An increase of SAT by 2.9 degrees was estimated by linear regression for the entire period of instrumental observations on Svalbard (Longyearbyen, 1900-2014). The most significant increase of SAT is observed in February, March, April and November and is 4 - 5 deg/century. The rate of increase of SAT during the "early" warming (1920-1940) was 0.17 deg/year, in the "modern" period (1990-2014) is 0.11 deg/year. The analysis of the rate of SAT changes for individual months of the year showed that the most intensive growth of SAT is in February during the "early" warming period (0.45 deg/year), which is 2.5 times higher than for the average annual values for this period. Higher values of the rate of change in the SAT for the period of "modern" warming compared to the "early" warming were observed only in May and August. The

increase in the average annual values of SAT in the "modern" period, on average, is three times higher than similar estimates for the whole period of observations (1900-2014), which indicates an intensification of the climate warming process on Svalbard during recent decades. Preliminary estimates of continentality and anomaly of climate for the different areas of the Western Spitsbergen Island (Isfjorden) was obtained. This work was prepared within the joint MET-Norway-AARI project "Isfjorden - past and present climate", AARI project "A study of long-term changes in the hydrometeorological regime and the state of the environment of Svalbard", financial supported by the NRC programme "POLARPROG" and the Joint Science Program between MET-Norway and Roshydromet (Russia).

The features of the regional climate of the Svalbard during "first" and "moderate" warming and ice conditions in the surrounding waters (id 227)

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The analysis of the relationship between the ice conditions in the waters surrounding the archipelago of Svalbard (Fram Strait and "Whale Bay", areas of the Barents, Greenland and Norwegian Seas) and the special features of its regional climate was carried out. For this purpose the following open data sources of sea ice and meteorological information were used:

- 7-days regional ice charts in SIGRID format from the AARI World Data Center archive (Greenland, Barents Seas for the period 1933-2015, http://wdc.aari.ru, on 0.25°x0.25° grid);
- Daily ASI algorithm total concentration patterns (based on the SSM/I-SSMIS data,12.5x12.5 km grid, 1991-2015, IFREMER, ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/psi-concentration /);
- Daily NASATEAM algorithm total concentration patterns (based on SSMR-SSM/I-SSMIS data, 25x25 km grid, 1978–2015, NSIDC, ftp://sidads.colorado.edu/DATASETS/nsidc0051_gsfc_nasateam_seaice/final-gsfc/);
- Monthly mean surface air temperature (SAT) at 6 Svalbard meteorological stations (Ny-Ålesund, Isfjord Radio, Barentsburg, Longyearbyen, Pyramiden, and Hornsund), derived from www.Eklima.no, www.met.no,www.aari.ru,www.rp5.ru,www.meteo.ruarchives.

Assessments of the sea ice conditions variability in the form of spatially distributed basic and robust statistics (quantiles, frequency and distribution functions) were carried out. Divisions of the waters surrounding Svalbard into 6 quasi-homogeneous regions for subsequent calculations of ice extent were performed based on expert analysis of the gained statistics. Statistical analysis

of the produced data series and cross-correlation analysis of the sea ice extent and surface air temperature were accomplished. That included linear trends of the ice extent around Svalbard and surface air temperature for different seasons and areas (Barentsburg, Pyramiden, Ny-Ålesund, Longyearbyen, Isfjord Radio, and Hornsund). Gained estimates characterize the long-term variability of some basic parameters of the Svalbard climate system.

In the waters surrounding Svalbard, over the past 35 years there has been a stable trend of ice decrease, both on average for the year and for individual seasons. The total annual reduction of the ice cover amounts to 2600 km2 calculated by linear trend analysis (least square method). The nature of the seasonal variability of ice cover is due to the peculiarities of water and ice circulation in the Svalbard area. Reduction in the values of positive anomalies of ice cover is observed from 1979 to 1998, but from 1999 to the present time an increase in the values of negative anomalies is observed. Differences and similarities in the character of seasonal and long-term variability of ice cover are revealed for example of waters around Svalbard and Frantz Joseph Land.

The increase of SAT by 2.9 degrees was estimated by the linear regression coefficient for the entire period of instrumental observations on Svalbard. The most significant increase of SAT is observed in February, March, April and November and is 4 - 5 deg/century. The rate of increase of SAT during the "first" warming (1920-1940) was 0.17 deg/year, in the "modern" period (after 1990) - 0.11 deg/year. The analysis of the rate of SAT changes for individual months of the year showed that the most intensive growth of SAT is in February during the "first" warming - 0.45 deg/year, which is 2.5 times higher than for the average annual values for this period. Higher values of the rate of change in the PTV for the period of "modern" warming compared to the "first" warming were observed only in May and August. The increase in the average annual values of SAT in the "modern" period, on average, is three times higher than similar estimates for the whole period of observations (1947-2014), which indicates an intensification of the climate warming process on Svalbard during recent decades. Preliminary estimates of continentality and anomaly of climate for the different areas of the Western Spitsbergen Island (Isfjorden) were obtained.

This work was prepared within joint MET-Norway-AARI project "Isfjorden - past and present climate", AARI project "A study of long-term changes in the hydrometeorological regime and the state of the environment of Svalbard, financial supporter of NRC project "POLARPROG" and Joint Science Program between MET-Norway and Roshydromet (Russia).

How to get reliable precipitation data in the Arctic? (id 54)

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Liquid and solid precipitation are important climatic variables in the Arctic that are expected to have undergone significant changes in the past and will undergo further changes due to the changing climate. However, only a few arctic data sets of these variables are currently available. Due to the monitoring activities of different stations and location, Svalbard offers the possibility to generate a quality-controlled data set that may serve as a reference of precipitation for the analysis of the impact of a changing climate on the hydrological cycle, on cryospheric processes, on atmospheric chemistry or on the properties of the soil. However, it is well known that standard methods to measure solid precipitation can strongly be biased. We present initiatives to derive the most reliable time series for precipitation at different locations in Svalbard (e.g. Ny-Alesund, Barentsburg, Hornsund). These initiatives are based on different approaches like the correction of past measurements, new comparisons in the field of different instrumentation, and if possible on the application of new remote sensing methods. The goal will be to propose common methods for data correction and best methods for the quantification of liquid and solid precipitation for the different sites in Svalbard. Finally, uncorrected and corrected precipitation time series can be analyzed to study the impact of the corrections and to investigate if trends in solid and liquid precipitation for the past can be established.

On problems with mass balance studies of Svalbard tidewater glaciers (id 72)

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Tidewater glaciers respond to climate warming more distinctly than land based ones. They loss ice mass additionally due to calving and frontal melting. Glaciers ending down into the sea drain c. 60% of Svalbard's glacierized area. Therefore, their mass balance is very important for both deglaciation of the region and its contribution to the sea level rise.

Data on mass balance of Svalbard tidewater glaciers and elsewhere are sparse and very limited. Difficulties in measurements of the mass loss at ice cliffs of them are highlighted in the paper. To calculate the total frontal ablation the following parameters are needed: (1) actual cross profile area at the terminus, (2) glacier flow velocity integrated over this cross profile and (3) front position changes (retreat or advance). While the third one can be relatively easy obtained from remote sensing or terrestrial survey, the first and second needs much more efforts. The crucial ones concerns actual and accurate data on sea depths at the glacier terminus and ice-cliff elevation.

Additional problems related to studies of superficial mass balance of tidewater glaciers are also mentioned in this work.

A specific difficulty is related to duration of mass-balance year for tidewater glaciers, knowing that mass loss due to frontal ablation continues in Svalbard much longer (i.e. up to December/January) than superficial melting. Thus, the accumulation period over glacier surface is superimposed on the ablation time at the calving front.

Outcomes from studies on the total mass balance for Hansbreen a tidewater glacier in South Spitsbergen are presented with consideration of measurements accuracy of main parameters. Results show that the frontal ablation contrubute to the total mass loss of glacier in c. 38% as an average for the period 2009-2014, with fluctuations in the range 25% - 54% interannually.
Comparison with mass balance of the neighbor land based Werenskioldbreen has been done, demonstrating significantly higher total ablation from the marine terminating one.
Suggestions for solutions of reported problems and on widening of list of the monitored tidewater glaciers in Svalbard with unification of methods are presented as well.
Presented study is a part of activity within the INTAROS: Integrated Arctic Observation System – H2020 Project.

SIOS Knowledge Centre (id 147)

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The SIOS Knowledge Centre is the central node of SIOS and has been set up to deliver 6 core services: Data Management, Remote Sensing, Access and Logistics, Training, Communication and Outreach, and Science Optimisation. These services are being delivered by SIOS-KC staff in partnership with representatives from SIOS member institutes through the working groups. The SIOS Data Management System (SDMS) works on the principle of distributed data management. Datasets that are relevant for SIOS, as well as their associated metadata, are managed by physically distributed Data Centres. Each Data Centre has its own procedures for ingestion of new data, maintenance of the data sets and data curation. The SDMS service will enable data submission, discovery, access, and use and preservation of SIOS relevant data sets and metadata across these physically distributed data centres. The benefits of the SIOS data portal to the user are:

- Data discovery - finding relevant datasets across the contributing data centres
- Retrieval of data – access to data

- Visualisation of data - generating a graphical interpretation of a dataset (e.g. a map, a time series or similar)
  Transformation of data - reformatting, reprojecting, subsetting and combining different datasets into a new dataset

The SIOS Remote Sensing Service is designed to offer researchers a single-point of contact for satellite information for Svalbard while drawing on the combined knowledge of the network of SIOS partner institutions. The service will coordinate commissioned data processing and make these products available via our access point and advise researchers on their respective satellite data needs and also provide tailored training on remote sensing. In addition to delivering the workshop on Copernicus data in collaboration with the Training Service, RSS is also involved in the planning and delivery of the ESA Cryosphere Remote Sensing Course to be held at UNIS in June 2018.
The SIOS Access and Logistics Service is a single point of contact for information and support for SIOS members and other researchers wishing to gain access to SIOS research infrastructure. This service plans and facilitates the SIOS Access Programme and provides logistical advice before and during field campaigns.

The SIOS Training Service aims to stimulate creative collaboration, promoting interdisciplinary science partnerships. To help achieve this aim the service will provide researchers, technicians and other user communities with the necessary skills to make best use of the SIOS infrastructure and improve their Earth System Science knowledge. SIOS is currently developing a set of training modules that can be offered to target user groups. The first of these, "Data management as tool for scientists" has already been offered as an additional package to 3 workshops funded by the Svalbard Strategic Grant in 2017.

The SIOS Communication and Outreach service is responsible for establishing the visual profile of SIOS and communicating SIOS news to partners and others.

The Science Optimisation Service works with SIOS members to set the agenda for scientific prioritisation and investment is new research infrastructure. The annual State of Environmental Science in Svalbard report is the major output from the optimisation process.
The SIOS Knowledge Centre is funded by the Research Council of Norway for the next five years.

SIOS Research Infrastructure (id 149)

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SIOS is a distributed research infrastructure bringing together the existing world-class facilities of SIOS partners. The concept is based around international and cross-disciplinary cooperation and sharing of resources. Through collaboration and open sharing of data and infrastructure each researcher and institution can achieve more than would be possible than they could working in isolation. SIOS connects the existing infrastructure and facilitates access for researchers.

Land-fjord interaction and the impact of changing sedimentation rates on fjord environments – an integrated study of Arctic sediment transport from land to sea (id 130)

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The SSF funded project "Sediment flux from source to sink – the Coastal Link" is an international, multi-disciplinary research project aiming at understanding and quantifying sediment distribution patterns in Svalbard fjordids. The current project (2016-2017) focuses on Kongsfjorden and Dicksonfjorden as representatives for glacially and non-glacially influenced fjord types. The impact of abiotic factors, including the impact of terrestrial run-off and freshwater discharge on marine ecosystems are highlighted as important topics where little is done, and which should be prioritized, in the reports defining the currents aims for the Ny Ålesund flagship programmes (Report Ny Ålesund seminar september 2015, Terrestrial Flagship Programme and Report Ny Ålesund Seminar 2015, Kongsfjorden flagship group). On a global scale high latitude data on sediment and nutrient fluxes to the fjords and eventually oceans are underrepresented in earth systems models (Russell, 2014).

Previous studies of Svalbard fjords have typically been divided into either fjord or coastal studies, whereas links between coastal zone and sea floor records are few. This project is the

first comprehensive coordination of the physical fjord- and coast research taking place in Svalbard and the first time such a significant part of this community is working together towards joint aims. Through sharing of infrastructure and resources we have been able to study the coastal dynamics, sediment volumes and fjord bottom distribution of sediments along two land-sea transects in Kongsfjorden and Dicksonfjorden.

For Kongsfjorden the project includes a compilation of existing data as well as new studies of coastal dynamics and fjord bottom bathymetry and sediment sampling. For Dicksonfjorden no previous data existed from the coastal zone and the inner part of the fjord. Here we have carried out detailed mapping of the tidal delta and the sea floor in the inner fjord, hydrodynamic measurements and sedimentation in the tidal channels, coring onshore and offshore and sampling for foraminifera, nutrients and microbial abundances. Sediment accumulation rates are being assessed from ^{210}Pb and ^{137}Cs radionuclides. The aim is to calculate sediment volumes, fluxes and transport rates.

The long-term aim is to develop a system for obtaining comparable datasets on annual – decadal time scales on land – sea interaction for Svalbard, including expansion of the current pilot project to other fjord types. To reach this goal a better integration with research in other disciplines is needed, in order to develop shared strategies and exploit possibilities to share infrastructure. It also requires a systematic collection strategy and a robust data sharing praxis with the users of such data including projects and networks coordinating ecosystem research but also earth system modelers for example. This presentation will provide an overview of the ongoing research and preliminary results and discuss the potential for collaboration with other scientists and disciplines.

References

Russell , J.L., 2014. Control on the Latitudinal distribution of climate processes: Results from Earth System Model simulations. AAPG/SEPM Hedberg Research Conference “Latitudinal controls on stratigraphic models and sedimentary concepts, Banff, Alberta, Canada, September 28 – October 1, 2014, Abstract volume, 10-11.

The impact of geese on aquatic biodiversity in the high Arctic (id 161)

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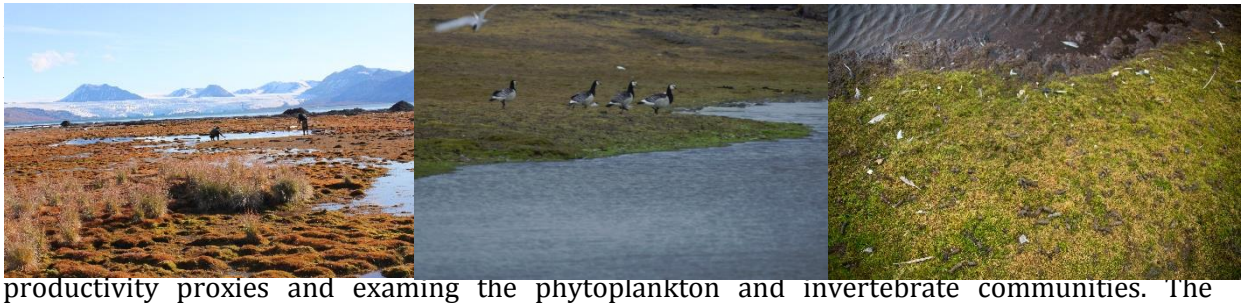
The high arctic has been exposed to a dramatic climate change and future scenarios predict that this development will only continue in the years to come. The Svalbard archipelago in the North Atlantic where climate recordings show a steady temperature increase over the last decades exemplifies this. Extended growing season, retreat of glaciers, thawing of permafrost, changes in hydrology and "greening" by increased vegetation cover are prominent effects in terrestrial habitats. Also the numerous small water-bodies, and many arctic lakes and ponds are in a transition due to direct warming and increased fluxes of organic carbon and nutrients from the surrounding landscape.

Adding to the direct and indirect climatic drivers, there is also an increased impact by birds on high latitude freshwaters. Migrating birds, particularly geese, have been observed in increasing numbers on the Svalbard archipelago during the second half of the last century, partly as a consequence of improved breeding conditions due to increased temperature and extended growing seasons, partly as a consequence of changes in land-use and hunting practices at overwintering sites in central Europe. The increasing population of breeding birds has also lead to range expansion of their breeding and grazing grounds within the archipelago. This has potential impacts on ponds and lakes and their biota. It can lead to increased inputs of nutrients and organic carbon from droppings, as well as affecting the vegetation. Increased bird migration may also affect the transport of small aquatic organisms and their resting eggs/-stages via gut content or sticking to feathers. This may promote the establishment of new species both between Svalbard localities and potentially also from mainland Europe to the Arctic. While a number of studies of bird impact of arctic freshwaters have addressed ecological



productivity proxies and examing the phytoplankton and invertebrate communities. The presentation will give the main results from the study. We will also discuss any differences of phytoplankton and invertebrate communities in response to increasing bird impact as well as potential mechanistic explanations for the observed patterns.

Left: Sampling in one of the investigated localities at Pyramiden, Svalbard. Middle: Barnacle geese (Branta leucopsis) resting on the lake shore at Ny Ålesund, Svalbard. Right: Geese

impacted site at Ny Ålesund, Svalbard. The vegetation on the lake shore is grazed by the geese and a high number of droppings left on the shore (Foto: I. Dimante-Deimantovica, NINA).

Identification of prior organic contaminants in effluent discharged from sewage treatment plant in Ny-Alesund (id 50)

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Ny-Alesund, located on southern shore of Kongsfjorden, is one of only 4 permanent settlements on Spitsbergen and has 30 ~ 120 residents/temporal visitors from several countries mostly for scientific research on the Arctic. As the dwellers use anthropogenic organic compounds including pharmaceuticals and personal care products (e.g., cosmetics, surfactants, etc), the generated sewage water, which is roughly treated in sewage treatment plant (STP) before discharge, is likely to be a point source of contamination in Kongsfjorden. However, information on contaminants in the Arctic region and their origins are limited. The aim of present study is to identify prior contaminants in the effluent from STP and the shoreline nearby using highly selective/sensitive analytical instrument (i.e., High resolution mass spectrometry coupled with liquid chromatography (LC-HRMS)) and advanced data-mining approach (i.e., suspect/nontarget screening method)

In July 2016, 6 effluent samples and 8 shoreline seawater samples were collected for 3 consecutive days and immediately pretreated via solid phase extraction method. The prepared samples were then analyzed with LC-HRMS(Orbitrap, Thermo Scienctific). The post data analysis was conducted via suspect/nontarget screening approach to identify primary compounds measured with relatively high intensity.

As the results, through suspect/nontarget screening method, 24 compounds were tentatively identified even without relevant reference standards. These identified primary compounds were prioritized according to their risk indices such as toxicity, occurrence frequency, peak intensity, etc. Afterwards, reference standards for highly ranked compounds were purchased and analyzed for the confirmation of compound. The confirmed compounds are classified into diverse chemical groups such as pharmaceuticals (antipyrin, metoprolol, methoxsalen, 2-acetamidophenol, theophylline), surfactants (xylenesulfonate), pesticides (icaridine, carbendazim, pyrimethanil), perfluorinated chemicals(PFOS, PFHxS), and etc (caffeine, 5,6-dimethylbenzimidazole, N,N-dimethyl-N-phenylsulfamide, benzotriazole). These 15 compounds are suggested as prior organic contaminants discharged from Ny-Alesund to Kongsfjorden, and to be monitored/controlled to protect the pristine environment. Further studies on unconfirmed compounds and concentrations of confirmed prior

contaminant in effluents and ambient seawater should be carried out to assess ecotoxicological risk in Kongsfjorden.

Risk Assessment of Toxic Metals in Marine Sediments from the Arctic Ocean Using a Modified BCR-sequential Extraction Procedure (id 196)

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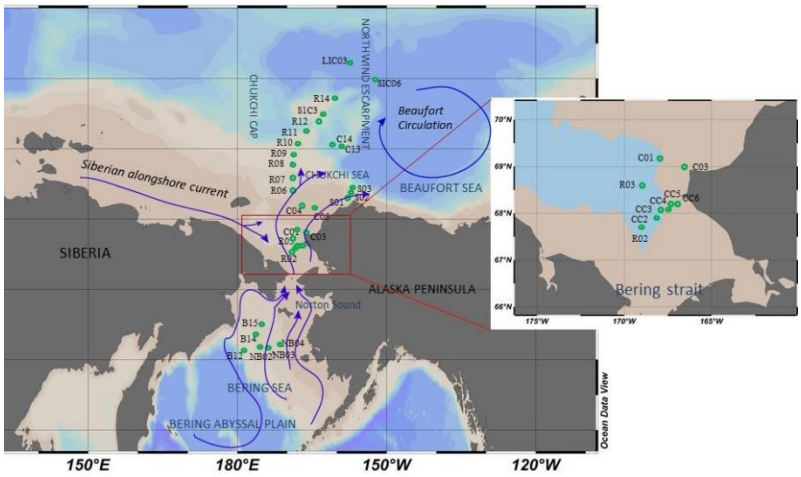
Literature survey was conducted in this paper upon the concentration, speciation and ecological risk assessment of six toxic metals (Cd, Cr, Cu, Ni, Pb, Zn) in marine sediments from the Arctic Ocean by using a modified BCR-sequential extraction procedure. All of 33 surface sediments from the pacific sector of Arctic Ocean and Bering Strait during the 6th Arctic expedition are sampled.



The results show that Cd presents the highest percentage in the acid-soluble fraction, and Pb and Cu present the highest percentages in the Fe-Mn oxidate fraction. The highest percentages of Cr ，Ni，Zn were found in the residual fraction. The mobility order of the toxic metals studied on the basis of nonresidual content of the element is Cd>Pb>Cu>Zn>Ni>Cr. Compared to total metal concentration analysis, the BCR-sequential extraction method is a better indicator of bioavailability, mobility or toxicity.

The assessment results on potential ecological risk based on two traditional methods (SQGs and RACs) are also under discussion. SQGs reveal that toxic metals like Cr, Ni are of concern in the present study area and which may frequently be associated with adverse biological effects. Risk assessment code (RAC) suggests that concentration of Cd is posing a high risk to the

environment at most sites in the study area. While metals such as Cr, Cu, Ni and Pb in the surface sediments come under medium risk in the sampling sites.

Both the method can contribute to inconsistencies in the risk assessment and mislead to inaccurate evaluation results. Therefore a new evaluation method to assess ecological risk in marine sediment is proposed. Based on the AHP theory, the SQGs and RAC evaluation methods are combined and the importance of the two methods is weighted. The new potential ERA method revises the relations between heavy metal availability and total metal contents, and puts forward the thought of innovative ecological risk assessment methods. The evaluation results show that the ecological risk of the six toxic metals in the region is more serious for the Ni, at moderate risk. Followed by Zn, Cu, Cr, and Pb and Cd are all at low risk.
The new method to assess ecological risk of metals in sediment can be used as a valuable tool to provide information on the mobility, bioavailability and potential toxicity of trace metals in Arctic environment.

New ways of finding collaborators through RiS (id 167)

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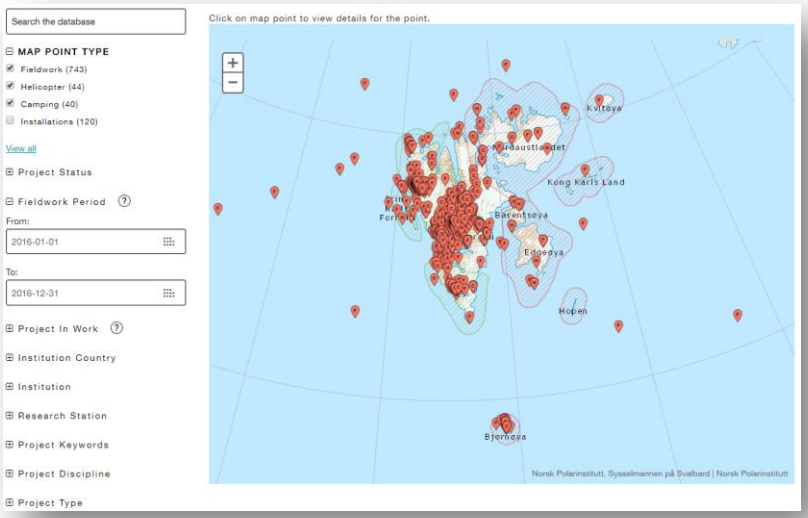
Are you sure you know what everyone in your field of research is doing in Svalbard? RiS contains 3212 projects, 12 305 publications and 404 datasets. About one third of these projects are listed as projects with fieldwork in Svalbard. In 2016, 406 projects registered that they had fieldwork that year. Could you maybe find some new partners? Maybe you could save the environment and some money by coordinating your fieldwork logistics with other researchers working on completely different things? RiS is here to help you with this and looking at this map it should be possible to find new collaborators.



Fieldwork sites in Svalbard in 2016.

There are many ways of finding opportunities in RiS, and during this talk SSF will try to inspire you to use RiS for more than just booking your flight to Ny-Ålesund and apply for permission from the Governor.

Geodetic measurements at Svalbard. Implications for glaciology and solid Earth sciences (id 73)

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The modern geodetic history at Svalbard started with the construction of the geodetic observatory in Ny-Ålesund in the early 1990s. The observatory measures the Earth's rotation, crustal deformation and gravity changes with high precision. It has a key role in the international geodetic network and provide data for important research on the interplay of land uplift, gravity field, ice-mass changes and the rheology of the Earth.

Today a new geodetic observatory is about to be completed in Ny-Ålesund. It will confirm the observatory's status as one of the most important stations in the global geodetic network. In addition, we have a regional network of GNSS stations. With the planned new GNSS and seismic stations in the EPOS-N project, the regional geodetic network will cover most of Svalbard. The Svalbard archipelago is exposed for a number of geophysical processes affecting the Earth's crust. The uplift varies and increases in line with the deglaciation due to climate change.

However, models of the crustal response on historic and present day ice-mass changes can not explain the measured uplift alone. The tectonic processes due to the vicinity to the mid-Atlantic ridge is unknown and an increased seismic activity are found after the M6.1 earthquake in Storjorden in 2008.

This presentation will give an overview of previous geodetic findings at Svalbard, especially the interplay between crustal deformations and glacial mass balance. We will also discuss what we expect to achieve with the regional geodetic network expanded with the EPOS-N stations.

The Observed Relationship of Cloud to Surface Longwave Radiation and Air Temperature at Ny-Ålesund, Svalbard (id 117)

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10-year (2004-2013) observations of cloud and surface shortwave (SW) and longwave (LW) fluxes at Ny-Ålesund were analyzed to investigate monthly variations in cloudiness and their impacts on the surface LW radiation budget and near-surface temperature (T_s). The cloud fraction (CF) showed distinct monthly variations, high in summer (0.90) and low in winter (0.79). The downward SW flux increased from March and showed a peak (~200 W m^{-2}) in June. In contrast, the downward LW (LWD) flux increased from ~200 W m^{-2} in February to ~300 W m^{-2} in July. Both LWD and upward LW (LWU) fluxes and their difference (net LW) increased during winter as lowest cloud base height (LCBH) decreased and CF increased. T_s difference and both LW fluxes difference (in parenthesis), calculated as the difference in monthly mean T_s (LW) between all-sky and cloud-free conditions, were highly correlated (R^2=0.68 for LWD and R^2=0.92 for LWU). On the other hand, dramatic changes in T_s, CF and LW fluxes at Ny-Ålesund were closely associated with cold and warm air mass advection on a multi-day time scale. The average T_s under low-level clouds (LCBH ≤ 2km) was estimated as -7.4±6.1°C due to warm air masses advected from the North Atlantic Ocean and Barents Sea, whereas the average T_s on cloud-free days was -14.5±5.7°C because of cold air mass advection from the pole. However, the duration of low-level clouds may not be long enough to drive such large T_s variations. Approximately 80% of low-level cloud conditions at Ny-Ålesund persisted up to 2.5 days, whereas cloud-free conditions and high-altitude clouds (LCBH > 2km) lasted for approximately 1.0 and 0.5 day, respectively. This implies that cloud LW effects in this study region may not be as great as that estimated from monthly mean data due to switching cold and warm advection over Ny-Ålesund.

Long Term Underwater Sensing (LoTUS) at calving fronts in western Spitsbergen (id 143)

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Observations suggest that calving rates of fjord terminating glaciers vary strongly with ocean temperature, yet in-situ data supporting this hypothesis firmly is scarce. Long-term measurements of water temperatures close to calving fronts are lacking at many key sites in Svalbard.

Here, we present the Long Term Underwater Sensing (LoTUS) program. The first generation of LoTUS buoys are small, lightweight thermometers which acquire temperature at a specified water depth and predefined sampling frequency, and which surface at a user-defined date to transmit data collected to an on-shore recipient. First missions, as described below, are confined to short timescales of up to two years, however, LoTUS is designed for mission duration of ca ten years.

12 LoTUS buoys were deployed along the western and northern Svalbard margin in August 2016 from UNIS' research vessel Viking Explorer. Here, we report specifically on six LoTUS buoys deployed to acquire 12month-time series of water temperatures close to calving fronts. Two LoTUS buoys deployed in Kongsfjorden, at only 1200m distance to the calving front of Kronebreen, are programmed to surface in September 2017. In October 2017, four LoTUS buoys are expected to surface from their mooring sites in Ymerbukta (Esmarkbreen) and Billefjorden (Nordenskjöldbreen).

When used in combination with remote sensing data and modeling experiments, the dataseries collected wit LoTUS can help to better understand ice-ocean interplay at calving fronts along the Svalbard margin.

The Norwegian Mapping Authority's geodetic Earth observatory in Ny-Ålesund (id 100)

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The Norwegian Mapping Authority's (NMA) geodetic Earth observatory in Ny-Ålesund has for more than 20 years been a part of a global network of observatories that realize the Global Geodetic Reference Frame (GGRF). Because the Earth is in constant motion, an accurate point of reference is needed for making measurements. This reference frame is cruical for society's

satellite-based infrastructure as well as accurate climate monitoring. NMA's geodetic Earth observatory is being upgraded at an estimated cost of about NOK 300 million. As a part of this upgrade, a fibreoptic cable has been laid on the seabed to link Ny-Ålesund with Longyearbyen to the benefit of the whole scientific community in Ny-Ålesund. The upgraded observatory will contain two new Very Long Baseline Interferometry (VLBI) antennas, a Satellite Laser Ranging (SLR) instrument, an absolute and a superconducting gravimeter, several Global Navigation Satellite System (GNSS) stations, a tide gauge and a Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) beacons. Measurements from VLBI, SLR, GNSS and DORIS is directly used to realize the GGRF and determine the Earth's rotation and orientation in space. In addition, SLR and DORIS is crucial for determining high-precision orbits for Earth observation satellites. For instance, satellites that measure the global sea level or polar ice sheets. This poster will present the Norwegian Mapping Authority's (NMA) geodetic Earth observatory and some applications of the measurements made by the observatory.

MODIS albedo products used to detect ELA on Svalbard glaciers (id 193)

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MODIS L3 albedo products (MCD43A3) for the period 2000-2011 are used to derive a proxy for the equilibrium line altitude (ELA) using a simple threshold method to determine the location of the annual snow line on the glacier. This albedo-derived ELA proxy is then compared to ELA determined from glacier mass balance measurements made on selected glaciers in Svalbard, which range in size from 5-500 km2. There is a good 1:1 correlation between the proxy and observed ELA on the larger study glaciers, which are covered by many MODIS pixels, with no need for calibration of the relation. Detecting the snow line on the smaller glaciers, which are covered by only a small number of MODIS pixels, does not work as well. There is the expected negative relation between minimum albedo and ELA, but the relation must be calibrated for individual glaciers. Nevertheless, the distribution of icefields and large glaciers in Svalbard allows the threshold method to be used to determine the spatial distribution of ELA around the archipelago.

Russian investigation of lichens on Nordaustlandet (Svalbard) (id 79)

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Information about lichens on Nordaustlandet (Svalbard) remains insufficient to the present time due to its remoteness and inaccessibility, as well as the fact that almost the entire territory is covered by glaciers. The list of lichen species on literary and herbarium data included 223 species to the beginning of our investigations. Of these, 12 are not included in the latest edition of the Flora of lichens of Spitsbergen (Øvstedal et al., 2009) and require additional studying.

Diversity of lichens has been studied by us in 3 areas of Nordaustlandet in 2010-12, including Duvefjorden, Sætherbukta, Polarklubben; Innvika Bay, Prins Oskars Land; Murchisonfjorden, Kinnvika Bay. More than 3 thousand samples were collected in all available cenoses. We used the standard methods of sampling and identification of lichens. We collected lichens from all substrates and micro-habitats on the sample plots: soil, rocks, plant debris and wood.

A preliminary list of lichen species with annotations for Nordaustlandet has been prepared. To date, it includes 287 species, of which 73 are new to the island. 164 species have been confirmed by our data. At the present time Nordaustlandet included approximately 37% of known lichen biota of Svalbard archipelago. About a third of these species are rare in Svalbard, including: Lecidea umbonata (Hepp) Mudd., Peltigera kristinssonii Vitik., Protomicarea limosa (Ach.) Hafellner,

Rhizocarpon eupetraeoides (Nyl.) Blomb. & Forsell, Rimularia furvella (Nyl.) Hertel & Rambold, Solorina monospora Gyelnik, Verrucaria hydrela Ach. 10 species are known from a single location. In addition, we confirmed the herbarium material species previously known only from the literature: Caloplaca magni-filii Poelt, Lecidea umbonata (Hepp) Mudd, Peltigera polydactylon (Neck.) Hoffm. (Elvebakk, Hertel, 1996; Hertel, Ullrich, 1976; Øvstedal et al., 2009).

I am grateful to my colleagues working on Svalbard and head of Svalbard's expedition of the Polar-Alpine Botanical Garden and Institution Dr. Nadezda Konstantinova.

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Svalbard marine mammals and climate change (id 36)

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The northern Barents Sea/Svalbard Region is a climate change hot spot. Air and water temperatures have risen markedly over the past decades in and around the archipelago and sea ice losses have occurred at 2-4 times the rate of other Arctic areas. Ice-associated marine mammals are threatened by habitat loss in combination with "borealization" of traditionally Arctic marine food webs and increasing human traffic. Seasonally resident marine mammal species are expanding their distributions northward, increasing the risk for competition with resident marine mammals.

Among pinnipeds, responses to the warming that has taken place to date are highly varied. A small population of harbours seals that has resided in Svalbard close to 1000 years is rapidly expanding its distribution into fjords along the west coast of Spitsbergen - areas previously occupied only by ringed and bearded seals. The future consequences of such overlapping distributions is unknown because these species are not normally sympatric. Ringed seals are maintaining good body condition levels, but based on diving behaviour and migratory distances, they are working harder to gain access to food – diving more and resting less. Reproduction is undoubtedly reduced since the ice collapse in 2006, with many years having minimal pup survival. It is difficult to envisage how ringed seals will be able to maintain pup production, with insufficient snow and a lack of stable fjord ice, but this species is showing signs of quite

remarkable behavioural plasticity. Ringed seals normally haul out only on sea ice, but in Svalbard they are now resting on intertidal rocks and mud flats in west coast fjords, sometimes in association with harbour seals. Immediately following the sea ice collapse in 2006, bearded seals maintained reasonable pup production levels, utilizing glacier ice for birthing and nursing instead of annually formed sea ice. A lack of monitoring of this species leaves it uncertain as to whether they have continued to rear pups at normal levels since that time. Base-line data is lacking for all three of the ice-associated whales in Svalbard in terms of population numbers and relatively little is known regarding their ecologies. But, a current research programme has determined that bowheads (350 animals) and narwhals (800 animals) utilize sea-ice habitats (almost exclusively) north of Svalbard even during the summer months in the Barents region. A decade-long passive acoustic monitoring programme has demonstrated that the Fram Strait is a key bowhead breeding area, where elaborate singing takes place throughout the winter. Tagging in this area in 2017 shows that the Fram Strait bowheads spread broadly across the range of this population – from the Greenland shelf over to Franz Josef Land during the summer months. White whales in Svalbard are showing some changes in their foraging behaviour; they now target open-water schooling fishes in fjords, whereas their foraging behaviour in the past was associated only with glacier fronts. This suggests a prey shift from polar cod to other fishes; dietary studies are currently underway to explore this hypothesis. Seasonally resident whale species are expanding their distributions northward and appear to be spending longer periods in Svalbard waters, including coastal shelf areas where krill are increasingly common.

Conservative management regimes are allowing some populations to recover from earlier periods of extreme exploitation, resulting in counter-intuitive, positive population trajectories for some Arctic species despite negative changes taking place in their habitats. For example, walruses are increasing rapidly in number in Svalbard, and are re-establishing normal population structure, with more traditional haul-out sites occupied and more females with calves occurring at more sites, despite the fact that benthic community production is likely in decline because of a reduction in sympagic fall-out under the new, reduced ice-cover situation in the region. Similarly, polar bears are stable or increasing despite significant sea ice declines throughout the range of the Barents Sea population. Bears are spending more time on land and they are shifting their prey-base towards more terrestrial food (bird colonies in particular) in summer and autumn. During spring when some land-fast ice is available, they still target ringed seals (and bearded seals) heavily.

Monitoring marine mammal populations in Svalbard over the decade ahead will be essential to

determine the plasticity possessed by endemic Arctic species and to inform management and policy bodies regarding their status and conservation needs.

Barentsburg observatory of Polar Geophysical Institute: current state and plans (id 77)

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Scientific interests of Polar Geophysical Institute (PGI) embrace such problems, as solar-terrestrial relations, plasma processes in the magnetosphere-ionosphere system and processes in upper polar atmosphere. At Svalbard PGI conducts regular observations at Barentsburg observatory. The equipment installed around observatory buildings 5 km north of Barentsburg (various optical instruments, induction and fluxgate magnetometers, radio interferometer and the most poleward part of PGI radio tomographic array), and neutron monitor near PGI office in Barentsburg. The neutron monitor aimed to monitoring of the cosmic rays, which are high energy (~ 1GeV) protons and nuclei coming from space. With the use of PGI neutron monitor observations the initial characteristics (including energy spectra) of solar cosmic rays (SCR) are derived from the solution of inverse problem. Of primary interest are periods of solar flares and magnetic storms. The effects of cosmic rays in the atmospheric and climatic variations are being studied.

Identical induction magnetometers with a precise time reference, which were designed and constructed in PGI for observations of geomagnetic pulsations in the frequency range of 0.1-20 Hz, are installed at PGI observatories Barentzburg (Svalbard) Lovozero (Kola Peninsula) and Verhnetlomsky (Kola Peninsula), making possible to investigate the spatial propagation of geomagnetic disturbances in the ionospheric waveguide. Due to their high sensitivity, the magnetometers are also capable of detecting weak signals excited in the Shumann and Alfvén resonators. The induction magnetometer can be used in active experiments for registration of low-frequency (~ 1 Hz) modulations of the pumping wave. Influence of seismic events to the magnetic measurements is being studied.

Last decades a numerous satellite missions aimed to study the response of the Earth's space and atmospheric environment to solar drivers have been realized and are still planning. Successful use of the international near-Earth satellite mission data depends largely upon the ground-based observations in conjugate regions. The high-latitude regions have a key role in such observations as regions where varied processes in the magnetosphere, ionosphere, and atmosphere are the most prominent. We plan to imrove the data availability and traditional

internation cooperations with scientific community at Svalbard by participitation in coordinated observational campaigns and scientific exchange.

Climate Change and Unexpected Ecology Problem on Svalbard (id 159)

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In the last couple of years, the radionuclide station of International Monitoring system (IMS) RN49 located in Longyearbyen at the end of summer and early autumn registers the increased value of man-made isotopes such as Xe-133, Xe-135, TC-99 and some others, usually registered in the areas of nuclear power plants and enterprises producing medicines (Mo-99) for Nuclear pharmacology.

Knowing about the lack of such production on Spitsbergen, we tried to find a radionuclide contamination source. For each recorded case of an elevated radionuclide level, we applied the developed methodology using predictive calculations of atmospheric transportation to determine the probable regions in which the sources of radiation release to the atmosphere. The location can be estimated by analyzing the simulation results of reverse atmospheric transportation from the RN49 station for 1-6 days. Also the reversing trajectories from the station to sources were constructed. All sources were located on north-west of Greenland. Confirmation of it was made by same calculations for Iceland radionuclide station RN34 which recorded an increasing level of nuclides from this area.

The cause of it is probably the existence of the hidden "Camp Century" under the 35-meter layer of ice into northwestern coast of Greenland and melting ice nowadays. This military base was built by the US Army in 1959 during the Cold War. The base was supplied with power by a nuclear reactor. And although the reactor was dismantled in 1967 with the closure of the base, all the radioactive waste remained at the station. At a depth of 35 meters under ice there is an unknown amount of radioactive material. It was the early period of development of atomic technologies and the military base (Century) already had problems with radiation leakage (Clark, 1965).

The climate modeling carried out by Canadian scientists indicates that in several decades there will be a global melting of the glacier. And the military base will be "re-opened". The direction of atmospheric transportation in this region assumes dangerous values of radionuclide pollution during total melting of the glacier for Svalbard (Colgan, 2016).

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Incorporating biogeochemistry in the permafrost model cryogrid 3 (id 42)

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Permafrost ground contains vast amounts of carbon (C), and there is a well-known risk that increasing air temperatures and changes in precipitation can accelerate permafrost thaw and increase the decomposition of stored C. This may lead to increasing emissions of carbon dioxide (CO2) and methane (CH4) depending on the oxygen availability. Despite ongoing research efforts, the scale of this permafrost carbon feedback remains uncertain.

In this project, we incorporate biogeochemical processes into the land-surface model Cryogrid 3, which simulates the thermal state of permafrost, based on climate forcing and initial freeze-thaw conditions in the soil (Westermann et al. 2016). Our goal is to simulate the effects of surface temperature, precipitation, net primary production, carbon allocation and sedimentation on the rates of individual subsurface processes (e.g. heterotrophic respiration, methanogenesis and methanotrophy) and the resulting surface flux of CO2 and CH4.

The new model will simulate sedimentation and decomposition of organic carbon across the Holocene, in order to improve our understanding of the balance between permafrost formation and C sequestration and on the other hand the increasing decomposition driven by climate changes.

If the model is able to successfully reproduce local and/or regional carbon stocks, the resulting estimates can in the future be used as initial conditions for a simulation of the permafrost carbon feedback, given specific climate trajectories over the next century.

Because the project is in its beginning, we present model concepts and preliminary results.

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Pollution in terrestrial Arctic ecosystem: Collembolas as recipients of marine pollution via bird cliffs, and their susceptibility to effects (id 166)

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Persistent contaminants can bioaccumulate and biomagnify up the food web, and high concentrations are found in seabirds breeding in the Arctic. Seabirds function as efficient biovectors of energy and contaminants from marine to freshwater- and terrestrial systems, and the nutrient supply from seabird guano turns the tundra below bird cliffs into a favourable habitat for invertebrates such as *Collembola* (springtails). Collembolans play important roles in soil ecosystem processes, such as decomposition and mineralization, and have a particular important role in Polar Regions where other soil community organisms are scarce. The overall aim of this project was to determine whether collembolans collected under Arctic bird cliffs accumulate and are affected by contaminants transferred by the seabirds. The objectives are i) to quantify the concentrations of contaminants in collembolans and their habitat in locations affected by seabird colonies, human activity and terrestrial birds, and ii) to determine whether collembolans in the vicinity of seabird colonies are affected by the contaminants on a sub-lethal level (DNA damage). A third objective was to determine if the arctic population of the collembola *Hypogastrura viatica* is susceptible to uptake and effect of agricultural pesticides, neonicotinoids, in other to investigate the combined effect of climate change (temperature and drought) and pesticides. *Hypogastrura viatica* and *Megaphorura arctica* (*Collembola*) were sampled along with the moss/soil in which they were found, at 8 different locations in Kongsfjorden and Krossfjorden, Svalbard. The locations reflect different sources of impact as well as level of impact (number of breeding pairs, and species dominating the breeding colony). Habitat samples and collembolans have been analysed for Hg, PFAS, PBDEs and chlorinated pesticides (OCPs). The level of DNA damage in individual collembolans have been analysed through the comet assay (% DNA fragmentation) and micronucleus test (frequency of micronuclei). An experimental pilot study was run, exposing *H. viatica* to the neonicotinoid imidacloprid through i) soil and ii) diet for 14 days, before transferred to a clean habitat for 28 days for observation of effects. For the field study, the total relative contaminant load in habitat and collembolans are highly dominated by Hg. The majority of collembolan samples follow the trend of second largest contribution by ∑OCPs, followed by ∑PCBs, ∑PBDEs, and ∑PFAS, while for habitat, the contributions following Hg show a larger variation. The location impacted by human activity have the highest levels PBDEs for both matrices, and of PCBs in Collembola. PCBs were however reported the highest concentrations in bird cliffs for habitat. Heavier PCBs dominate habitat, while lighter dominate *Collembola*. p,p'-DDE in habitat are reported with the

highest levels in the site with human activity. DNA fragmentation was higher in *H. viatica* compared to *M. arctica*, and at some locations more sensitive to DNA strand breaks induced through H_2O_2 treatment (oxidative stress). *H. viatica* also had a higher frequency of micronuclei, compared to *M. arctica.* The levels of DNA damage at different locations show no consistent trend between the species. *H. viatica* exposed to neonicotenoid showed a rapid response, with increasing negative effects with increasing dose, in both the soil and diet exposure. The effects were increasing shaking and spasms followed by immobilisation and death, due to the neonicotinoids blocking the acetylcholine receptor. This study shows that arctic populations of Collembola are reliable models for studying the effect of multiple stressors (climate change and pollutants) on individual and population level, useful for predicting the effect on respiration and remineralization.

Long-term variability of total ozone over Svalbard for the period 1979-2016 based on the SBUV Merged Ozone Data Set (id 10)

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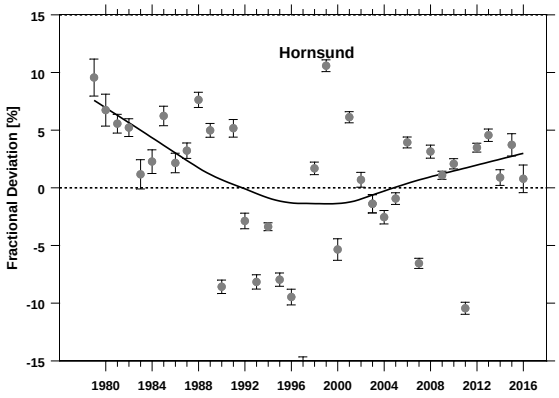
Included in session: Drivers of environmental changes - climatic and other human factors. The Presentation preference (poster). The ozone depletion appeared in the extratropical regions in the 1980s and 1990s due to high contamination of the stratosphere by anthropogenic ozone depleting substances (ODS). Montreal Protocol was signed in 1987 to protect the ozone layer. There were several amendments to the protocol and the ODS concentration decline has been observed since the mid-1990s. It is expected that during next 2-3 decades the stratospheric ozone will return to its level before strong anthropogenic forcing. Here we address a question - how much of column amount of ozone (total ozone) is presently recovered over Svalbard? Total ozone over Hornsund (77.0N,15.6E) and Ny-Alesund (78.9N,11.9E) are examined for the period 1979-2016 using the Solar Backscatter Ultraviolet (SBUV) Merged Ozone Data Set. The annual time series of spring, summer, and autumn total ozone, calculated by averaging daily SBUV data taken during the station's satellite overpasses, are smoothed to reveal a pattern of the long-term changes of total ozone. The total ozone depletion over the stations of about 10%, 2%, and 4% is found in spring, summer, and autumn, respectively, between the data beginning and the year of ozone minimum (1995-2000). We propose the ozone recovery index (ORI), i.e. ozone change since its minimum up to 2016 in percent of ozone change between the starting year and the year of ozone minimum, to estimate how much of the total ozone loss (between 1979 and the minimum year) is presently recovered. The statistical significance of ORI is derived using the Monte Carlo methodology. About 50% of the ozone loss has been recovered

over both stations in spring but the ozone leveling off (ORI close to 0%) is found in summer. In autumn, the ozone recovery is faster over Hornsund (ORI=49%) than over Ny-Alesund (ORI=17%). Thus, presently there is no threat of an excessive UV radiation related to the declined ozone level over Svalbard.

Figure. The annual total ozone fractional deviations in spring (March-April-May), i.e. the difference between annual means and pertaining long-term (2000-2016) mean in percent of the



long-term mean, for Hornsund, Svalbard, in the period 1979-2016. The curve shows the smoothed data and the bars represent the +/- 1 standard deviation range.

Water vapour measurements by lidar over Ny-Ålesund (id 27)

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Tropospheric water vapour is an important greenhouse gas, and affects aerosol properties through hygroscopic growth processes and cloud interactions. The Koldewey Aerosol Raman Lidar (KARL) in Ny-Ålesund has so far been used for aerosol research (e.g. Ritter et al. 2016). However, additionally, inelastic Raman scattering at 407 nm is being recorded to enable the measurement of water vapour. The method is well known (e.g. Whiteman et al.1992), but due to the weak Raman scattering return, it is usually employed at night time only. To receive reliable results for the water vapour volume mixing ratio, a careful calibration with a different, co-located instrument is required.

This work evaluates the capabilities of measuring water vapour with KARL's return signal at 407 nm. Data from the winter 2015/2016 was calibrated using co-located radio sounding data. We summarise the capabilities of KARL to record water vapour during night-time and twilight.

Special attention is paid to noise at different temporal and spatial resolutions and its dependence on the solar angle during measurements, as well as the general suitability of different radio soundings and signal-to-noise-ratio (SNR) and an examination of the parameters affecting it, the calibration is carried out. With a SNR threshold, a fairly stable calibration constant was found. There were variations in order of ten percent over the entire season at a 10 minute temporal resolution and 60 m spatial resolution.

Unlike data from passive remote-sensing systems, our Lidar data is flexible with regard to temporal and spatial resolution, allowing us to adjust them to either optimize the range or to analyse the small scale water vapour fluctuations. We found that we can measure detailed humidity profiles for altitudes above an overlap of 400m. Changes in the mixing ratio can be observed within the order of minutes.

Hence, the data might be suitable for comparison with aerosol properties obtained remotely, via in-situ or for investigations regarding the mixing of synoptic and boundary layer. With this contribution we would like to stimulate discussions on aerosol properties and their interaction with the local boundary layer.

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Monitoring the cryosphere on Svalbard using environmental seismology (id 92)

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Environmental seismology studies vibrations and variations in the seismic wave propagation medium that are caused by sources outside the solid earth, such as cryospheric processes and atmospheric forcings. We show how seismic data recorded on Svalbard can be used to address various issues in cryospherical research:

1) Calving quantification: Global glaciers and ice caps lose mass through calving, while existing models are currently not equipped to realistically predict dynamic ice loss. This is mainly because long-term continuous calving records with high temporal resolution do not exist, and yet are necessary to better understand fine scale processes and key climatic-dynamic feed-backs between calving, climate, terminus evolution and marine conditions. Combined passive seismic/acoustic monitoring is the only method able to capture rapid calving events continuously, independent of daylight or meteorological conditions. We have produced such a continuous calving record for Kronebreen, a tidewater glacier in Svalbard, using data from permanent seismic stations between 2001 and 2016. We use this record and independently, directly observed calving flux in a first attempt to quantify ice loss directly from seismic data. The direct observations are frontal ablation rates with weekly to monthly resolution derived from satellite remote sensing data between 2007 and 2013. We derive a statistical model that allows to model frontal ablation from seismic calving detections and, to take into account the varying detection threshold, indicators of the seismic noise level. This allows for the first time to estimate a time series of calving volumes more than one decade back in time (2001-2016) with weekly resolution. Improving our model requires to incorporate more precise, high-resolution calibration data. A new field campaign has been carried out in 2016 to combine innovative, multidisciplinary monitoring techniques to measure calving ice volumes and dynamic ice-ocean interactions simultaneously with terrestrial laser and radar scanning and a temporary seismic/underwater-acoustic network. We present preliminary models that relate seismic and underwater-acoustic signal properties to ice volumes of individual calving events.

2) Detection of glaciers surges: The glacier surges of Nathorstbreen (2008-2010) and Tunabreen (2003) can be observed in seismic data. This opens up new perspectives for near-real-time surge detection and for better understanding surge processes.

3) Sub-glacier changes from seismic noise and icequakes analysis: We present preliminary results of seismic noise analysis and seasonal changes in the icequakes distribution at Holtedalfonna. We explore the potential of using the Horizontal to Vertical Spectra Ratio (HVSR) method to map the glacier bed and to monitor changes in the sub-glacier conditions.

4) Seasonal changes in the permafrost active layer: We use auto-correlation of seismic data recorded at a single, coastal broadband station in Ny Ålesund to investigate the possibility of monitoring sub-surface changes over a time period of 15 years. For this approach a stable, localized noise source is used which is supposed to reduce the effect of changing noise source distribution. Seasonal changes in the seismic velocity are observed which are presumably related to the active permafrost layer.

Temporal variability of particle fluxes and physical water properties of Kongsfjorden (Svalbard) in 2010-2015 (id 30)

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Over the last three decades, the Arctic area has experienced heavier environmental changing, due to climate warming, than any other region on Earth. This Arctic amplification may be due to feedback mechanisms from loss of sea ice and changes in atmospheric and oceanic circulation. Kongsfjorden is a small fiord at 79°N in the western part of Spitsbergen (Svalbard archipelago, Fig.1). All glaciers reaching Kongsfjorden are rapidly retreating. There is ample evidence that land-to-ocean fluxes of particulate material along the Arctic coasts are changing, too.

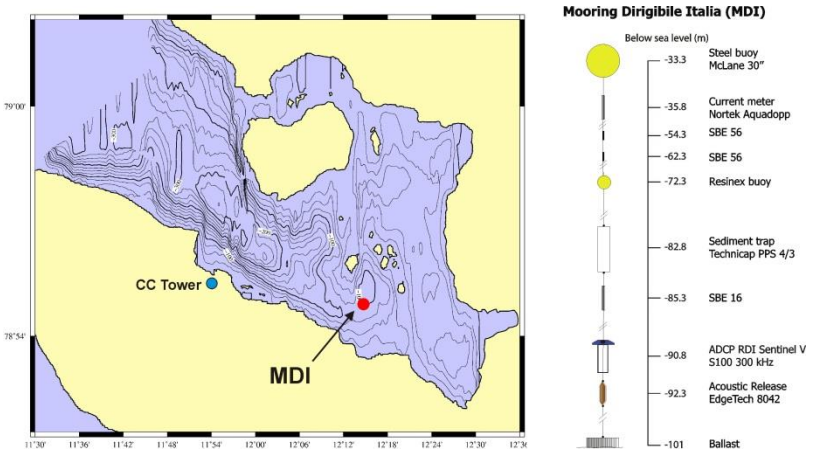

Figure 1 – Kongsfjorden map and configuration of mooring MDI.

One mooring (named MDI, Figure 1) was deployed 100m deep in the inner fjord, to collect multiannual time-series in an area of potential interaction between the entering mid-depth Atlantic Water, melting glacier water, and locally-formed winter waters. Wind and radiation data were obtained from CC tower of CNR-ISAC (http://www.isac.cnr.it/~radiclim/CCTower/?Data)

The aim of this research is to highlight the present-day environmental evolution of the fjord, detecting the main contributes of particle flux into Kongsfjorden waters and their provenance. Time-series of thermohaline properties reveal a large seasonal variability ($\boldsymbol{\theta}$ = -1.82 / 6.26°C, **S** = 34 / 35) with maximum intrusion of Atlantic water in November, sometimes connected with a higher wind regime (e.g., Nov. 2011). Water temperatures measured at mid-depth and near-bottom generally follow the same pattern, although periods of water stratification occurred: colder waters at the surface in winters 2011 and 2012, warmer surface waters in summers 2013 and 2014. From the beginning of the time-series temperature values show a slow but consistent increasing trend (0.07 °C y^{-1}) with more constant minima, and progressively higher warm peaks. Currents are generally below 10 cm/s.

The average total mass flux (TMF) is about 20 g m^{-2} d^{-1}, with the highest peaks recorded in summer-fall months (avg. flux, ~100 g m^{-2} d^{-1}) and reduced fluxes in autumn-winters (avg. flux, ~7 g m^{-2} day^{-1}). During May-June, the maximum content of organic matter and biogenic silica is

recorded, supported by less negative $\delta^{13}C$ values showing a higher contribution of marine organic matter by diatom production. In general, the %OC peaks, as result of the seasonal algal bloom, anticipate by a few weeks the TMF peaks. Furthermore, the organic carbon contents mirror the solar radiation peaks, further supporting the role of the sunlight in sustaining the photosynthesis process. During summer 2013, TMF reached the maximum flux of ~330 g m^{-2} d^{-1}. The most abundant component of particle flux is constituted by lithics, followed by detrital carbonate.

The highest terrestrial input is due to the melting of glacier terminations that generates an increasing of the detrital pathways, or to the surface runoff that introduces debris into the sea from the permafrost surface layer erosion. Lastly, the main marine particle input is due to the biological pump activity occurred in the photic layer of the water column.

Pan-Eurasian Experiment (PEEX) Program (id 225)

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The Eurasian Pan-Eurasian Experiment (PEEX) is a multidisciplinary, multi-scale program focused on solving grand challenges in northern Eurasia and China focusing in Arctic and boreal regions. PEEX will also help to develop service, adaptation and mitigation plans for societies to cope with global change. It is a bottom-up initiative by several European, Russian and Chinese research organizations and institutes with co-operation of US and Canadian organizations and Institutes. The PEEX approach emphasizes that solving challenges related to climate change, air quality and cryospheric change requires large-scale coordinated co-operation of the international research communities. Strong involvement and international collaboration between European, Russian and Chinese partners is needed to answer the climate policy challenge: how will northern societies cope with environmental changes? The promoter institutes of this initiative are the University of Helsinki and the Finnish Meteorological Institute in Finland; the Institute of Geography of Moscow State University, AEROCOSMOS, and the Institute of Atmospheric Optics (Siberian branch) of the Russian Academy of Sciences (RAS) in Russia; the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of

Sciences (CAS) and the institute for climate and global change research of Nanjing University in China. PEEX is built on collaboration by EU, Russian and Chinese parties, involving scientists from various disciplines, experimentalists and modelers, and international research projects funded by European, Russian and Chinese funding programs. The first active PEEX period is 2013-2033, though PEEX will continue until 2100. The first PEEX meeting was held in Helsinki in October 2012. PEEX is open for other institutes to join.

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Terrestrial and airborne remote sensing of calving glaciers in Svalbard (id 153)

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Tidewater glaciers terminate directly into the sea, and comprise a significant percentage of glaciers in the High Arctic. Ice is typically lost at the tidewater glacier front both through melting, and by calving as various size blocks shear off at the front.

Calving involves the interactions of several glaciological processes, each of which presents considerable research challenges. Calving observations are sparse, and there are very few datasets upon which to base a calving theory. Our understanding of calving and of ice-ocean interactions, in particular at tidewater glacier fronts, remains elusive. Global warming has led to

increases in melt and calving rates, while accumulation increases have been insufficient to offset the increased loss. As a result, most tidewater glaciers in the world are retreating. With further warming in the Arctic, we can expect continuing retreat of Svalbard glaciers, and resultant declines in the total length of calving fronts around Svalbard.

We present the main results from the SSF project "Terrestrial radar interferometry for monitoring tidewater glaciers in Ny-Ålesund and Hornsund". The main objective of the project was to explore and utilize a new terrestrial radar remote sensing technology to monitor calving processes of two tidewater glaciers (Kronebreen and Hansbreen) at two different research bases in Svalbard, Ny-Ålesund and Hornsund. The radar interferometer allows to remotely collecting images with minute resolution providing detailed deformation mapping with mm-level precision, all without having any personnel on the glacier, minimizing the risk for researchers and the environmental footprint.

The terrestrial radar acquisitions were performed during joint weekly long campaigns including repeated Unmanned Aircraft Vehicle (UAV) flights and Terrestrial Laser Scanning (TLS). The terrestrial radar interferometer allows detecting deformation at the glacier front with an unpresedented temporal sampling. This provides new insights into glacier dynamics before and after calving events. Furthermore, the UAV-generated orthophotos and digital elevation models provide new insights into the development of glacier crevasses, and allow volume estimations also of the crevasses which are not visible to the TLS, thereby providing very complementary information.

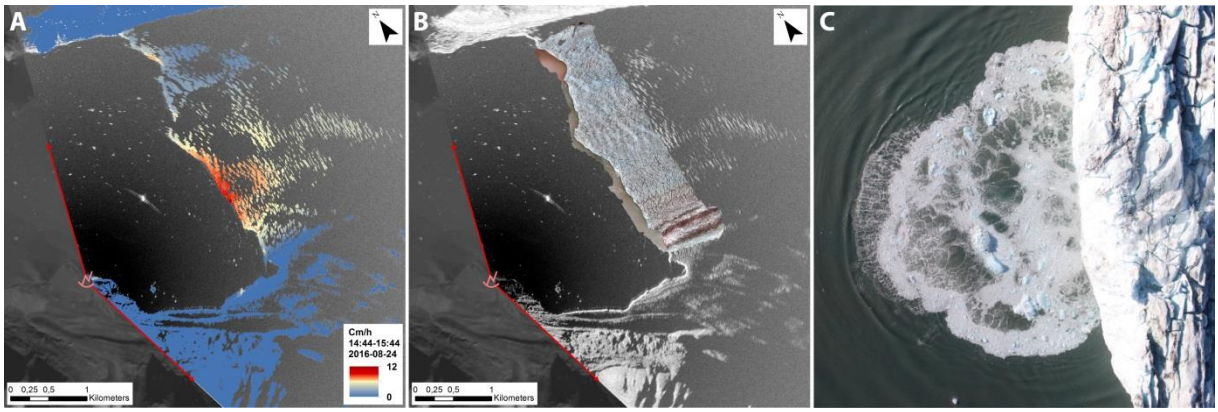

Figure 1. Examples of remote sensing observations of the Kronebreen and Hansbreen glacier. A) Terrestrial radar allows to detect glacier velocity with minute resolution. B) Example of UAV orthophoto of glacier front. C) Calving event at Hansbreen captured by UAV.

Density and climate interactions influence barnacle goose population dynamics (id 3)

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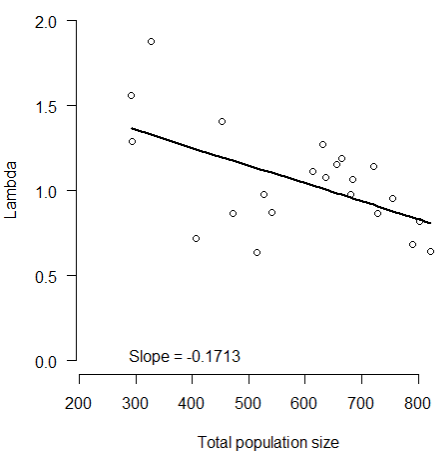
Population declines in response to climate change have been most profound in high arctic ecosystems (Wauchope, Shaw et al. 2017). Migratory species travelling to the high arctic are therefore highly vulnerable to such rapid changes in this ecosystem. Predicting species' responses to climate change can be complex however, due to interactions with top-down and bottom-up processes. Additionally, density dependent and independent processes can regulate population dynamics in different ways, by regulating survival and reproduction in different ways.

Thus, a population's response to changes in climate and other interacting species is highly dependent on its life history and to what extent it is intrinsically regulated by density dependence. We present a demographic analysis of 22 years of individual-based data on a population of barnacle geese, *branta leucopsis*, which migrates to Kongsfjorden, Svalbard in summer. The study population, which breeds and forages close to Ny-Ålesund, settled in the early 1980s and expanded rapidly until reaching maximum population density in the late 1990s. We used an integrated population model (Abadi, Gimenez et al. 2010) to model annual changes in age-specific numbers of individuals, and to investigate the variation in age-specific vital rates (survival and recruitment) as well as their contribution to population growth. Furthermore, we modelled vital rates as functions of climate variables, population size and abundances of interacting species to show the nature of which barnacle geese are regulated intrinsically (density dependence) and by their environment. Using these results, we can predict how this population will respond to future changes in the Svalbard ecosystem.



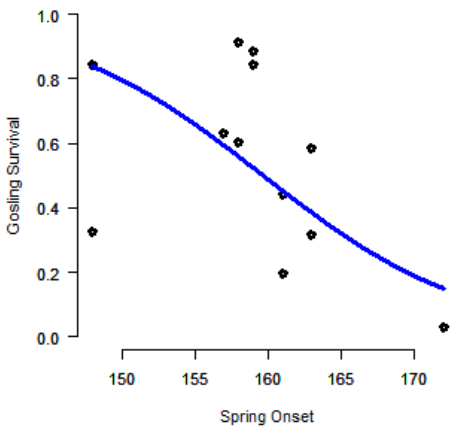


Figure 1. The effect of population size on the annual population growth rate (left) and the influence of the timing of spring onset on the survival of goslings during their first two months of life (right).

The impact of pollution on pathogen prevalence and host infection resistance in the Arctic ecosystem: the black-legged kittiwake (Rissa tridactyla) as a model species (id 47)

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Mounting evidence suggests that climate change is already altering patterns of disease in northern ecosystems. As warming continues, emergent pathogens may pose new threats to sensitive Arctic species, already under pressure from climate-driven ecological shifts and additional anthropogenic challenges.

One such additional challenge is exposure to immunomodulatory contaminants. Synergistic effects between new disease threats and pollution-linked immune dysfunction may have significant negative impacts on Arctic avian species in the near future. Characterizing this relationship is necessary to develop a more complete understanding of how climate change will impact Arctic birds.

In this study, the relationship between contaminant load and several biomarkers of immune function were established in Svalbard kittiwakes (*Rissa tridactyla*). Thirteen individuals were sampled in July 2017: once early in the nesting season and again approximately one week later. Levels of several contaminants were quantified in each individual at each time point. We then assessed the prevalence of climate driven relevant pathogens and host resistance assays were conducted *in vitro* to confirm relationships between pollutants and host resistance to pathogens. These results were used to assess the relationship between pollutant burden and immune

function, as well as to look for any changes in pollutant load or immune function over the incubation period.

Characterising size and frequency of calving events based on high temporal time-lapse and automatic image processing (id 114)

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Calving is a process through which glaciers and ice caps lose mass in contact with the ocean. Monitoring calving is important to understand the ice physics, fjord circulation and marine life near the glacier front, and predict future changes in glacier mass balance. It is also needed to verify long term parameterization of glacier volume loss with seismic records of calving. The mechanisms causing the ice to break off are various and difficult to study directly hence the use of remote sensing instruments. Time-lapse images were collected between 24th August and 3rd September in 2016 at the tidewater glacier Kronebreen, Svalbard as part of the CalvingSEIS experiment.

We present a semi-automatic method and workflow to detect, characterise and quantify calving events based on high temporal time lapse imagery (one picture every 2 seconds). There is a need for automatic detection methods as this manual task is laborious and time-consuming. The method uses variations in the front physical properties such as local changes in surface roughness (image texture), and albedo (pixel brightness). The calving detector is developed based on visual characteristics of calving. As the ice breaks off and hit the water, water splash saturates the pixel brightness near the front. Our method consists of stacking lines of pixels at the glacier front over time in order to produce a space-time image, and identifying rapid changes in pixel brightness as calving events. The characteristics of the identified calving events are then retrieved based on differencing of images before and after (brightness) or a loss in correlation (texture).

The final result is a database of the calving events. The data are further investigated to find statistical relationships between calving properties and seismic signal characteristics retrieved for the same events. This database is an improvement compared to subjective defined size and classes of calving as the ice block size and geometry are directly extracted from the image. It is then possible to use these physical variables to understand the mechanisms causing seismic signals generated by or related to calving.

FAABulous: Future Arctic Algae Blooms – and their role in the context of climate change (id 28)

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Peygham Ghaffari, Klara Wolf, Björn Rost, Zofia Smoła, Andre Staalstrøm, Vigdis Tverberg, Janne Søreide, Thomas Brown, Marcel Nicolaus, Dirk Notz, Marit Reigstad, Martin Graeve, Jørgen Berge
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The Arctic marine environment is changing rapidly as a response to ongoing climate warming. The consequences for marine ecosystems are far from understood, and difficult to predict due to complex interactions and cascading effects. Sea ice algae and phytoplankton constitute the basis of the food web, and their growth and occurrence is controlled by their environment and their grazers. The FAABulous project (2015-2020, funded by the RCN) uses two Svalbard fjords as model systems with contrasting characteristics to study the impact of climate change on the phenology of Arctic algal blooms in sea ice and water. Kongsfjorden, which has been almost completely ice-free during the past decade, serves as a future scenario, whereas Van Mijenfjorden allows us to study a system that is still seasonally ice-covered. Extensive seasonal sampling campaigns over two years were combined with continuous measurements of background data by means of autonomous platforms in the water column and in sea ice. Bloom timing, intensity and species composition differ between these two locations, not the least due to the differences in advection of Atlantic water into the systems. The mechanistic aspect of the physical-biological coupling was studied in several experiments, both in the laboratory and *in situ*. The development of a high-resolution 3D oceanographic model for the entire western Spitsbergen area will allow us to synthesize our findings and improve our understanding of the environmental control of Arctic algal blooms.

Airborne contaminants in terrestrial environments in Svalbard (id 59)

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Polar regions suffer the most pronounced environmental effects of the global climate change. Retreating glaciers uncover areas that are sites of intense biogeochemical and geomorphic activity. The main effect of glacier retreat is remobilization of airborne contaminants from long-range global transport (AMAP 2015) stored on and in the glacier ice. Recent findings show that the behaviour of metallic contaminants during glacier retreat may be linked to their incorporation into cryoconites (aggregates of mineral dust, organic matter and living microorganisms on the surface of glacier) that are able to concentrate trace metal up to very

high levels (Łokas et al. 2016; Tiber et al. 2009). This study presents observations of activity concnetrations of the fallout radionuclides (^{137}Cs, ^{238,239,240}Pu and ^{210}Pb) in proglacial zones of Arctic glaciers (Werenskiold, Scott and Renard) and in cryoconites from the nine glaciers (Waldemar, Blomli, Recherche, Tjørndals, Renard, Scott, Werenskiold, Hans and Stor). The research was carried out in four areas of Spitsbergen (Kaffiøyra, Bellsund, Hornsund, Petuniabukta). Samples were analysed by gamma (^{137}Cs, ^{210}Pb) and alpha (^{238,239,240}Pu) spectrometry. Results obtained in this study revealed a large range of activity concentrations of the fallout radionuclides from the undetectable to the very high levels found in a few profiles from the proglacial zones. Concentration of these initially airborne radionuclides in the proglacial zone soils is related to their accumulation in cryoconites that have a large ability to concentrate trace metals. Activity concentrations of all radionuclides in the studied cryoconites exceeded or were comparable to the concentrations found in soils from proglacial zone of glaciers (Łokas et al. 2014; Łokas et al. 2016). ^{210}Pb activity concentrations in cryoconites reach high value, being about 10 times higher than in soils of SW Spitsbergen. Activity ratios of ^{238}Pu/$^{239+240}$Pu, $^{239+240}$Pu/^{137}Cs are commonly used to identify and distinguish between global and regional sources of these radionuclides. The ^{238}Pu/$^{239+240}$Pu activity ratios in some soils from the proglacial zones and in cryoconites from the adjacent glaciers are consistently higher than the value representative for global fallout (0.025), suggesting contributions from other than the global fallout sources of plutonium. The $^{239+240}$Pu/^{137}Cs ratios are much lower than the decay-corrected value of ~0.05 expected for the year 2012. Activity concentrations of ^{137}Cs, ^{238}Pu, $^{239+240}$Pu, ^{210}Pb in cryoconites exceed activity concentrations in Arctic peats, tundra soils and lakes and are lower or comparable to soils from the proglacial zones of glaciers. Transfer of cryoconite material from glacier surface constitutes an additional pathway for the atmospheric contaminants to the proglacial zones and further to the terrestrial and aquatic ecosystems. Results of this study are important for identification of sources, migration and accumulation of radionuclides in proglacial zones of retreating glaciers.

Joining forces to strengthen our science and terrestrial research in Svalbard (id 220)

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Terrestrial research is not an easy umbrella as it covers a wide range of topics like geology and geomorphology, permafrost and soil formation, plant physiology and vegetation composition, microbes and insects or geese and reindeer. Colonization and succession, nutrient and carbon cycling, population dynamics and biodiversity are relevant for all these topics. And lakes are also considered part of the terrestrial environment. Many interactions exist between the land and other components covered in the marine, glaciology and atmosphere flagships, and climate warming is rapidly changing it all.

This presentation will give a short introduction on the variety of topics under study in Ny-Ålesund, linked to the terrestrial flagship and will be a tasting of what is presented in the parallel session.

The goal of the flagship is to facilitate cooperation, investments and interaction among scientists. We have to improve our planning on site preservation, experimentation, laboratory facilities and monitoring, based on a longer timeline than the few years of a funded specific project. We have to share information and connect to other sites on Svalbard and Greenland to understand different temporal and spatial scales. Let us use this conference to align our goals and plan joint projects and publications in the near future.

Why do Arctic Terns winter in Antarctica? (id 221)

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The Arctic Tern (Sterna paradisaea) is world champion with the longest migration from the breeding grounds in the Arctic to Antarctic wintering. While the bird weighs only 100 grammes, the migration route is tracked with a geolocator of 0.65 gram. This computer stores a light profile over an annual cycle which makes it possible to calculate the daily position with a 200 km accuracy. The geolocator also stores environmental data over a 4-hour period: the number of dives, the conductivity while in the water , the minimum and the maximum temperature. Birds are caught during incubation and geolocators need to be retrieved in a following breeding season. Positions during migration have been linked to global maps on fytoplankton biomass, wind patterns and sea surface temperature.

Earlier data have shown different flyways for terns from different breeding grounds. The southern breeding arctic terns, breeding in the Netherlands, fly furthest east after passing South Africa. We are able to understand this pattern based on timing and wind profiles. On the poster,we will show migration patterns and the analysis of the environmental variables during

migration.

Catching incubating Arctic Terns in a colony near Ny-Ålesund. Photo by Esther Kokmeijer, also shown on the cover of the International Arctic Science Committee 2017 bulletin.

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Barnacle Geese in Kongsfjorden adapt slowly to climate warming (id 222)

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Anthropogenic climate warming is most prominent in the Arctic, posing a problem on the timing of arctic bird migration flying north to the breeding grounds. While geese normally time their migration to follow the green wave of high quality spring grasses, flying north they experience earlier spring and as a consequence lower protein content in the grasses. Arctic breeding geese are traditional capital breeders, building up fat reserves at stop over sites for migration, laying and incubation. But for barnacle geese migrating from Scotland via the Norwegian coast to Spitsbergen, the changes at their destinations are impossible to assess beforehand.

Only over a thirty year period we were able to observe an adaptation in the timing of spring migration and breeding to climate warming. In this poster we will show the evidence and explain the speed of adaptation.

Figure 1. The hatch date of Barnacle Geese in Kongsfjorden shows little variation with the date on which the tundra becomes snow free. Data of snow free tundra kindly provided by Marion Maturilli (AWI) Theor Appl Climatol (2015) 120:331–339)

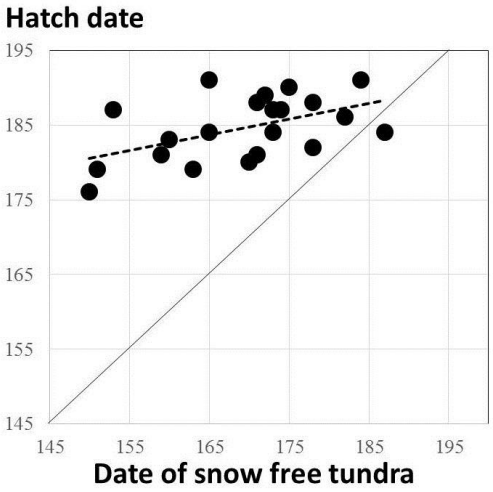

Figure 2. Noting hatch dates of Barnacle Geese

The temporal and spatial precipitation variation of Qinghai-Tibet Plateau area in China related to the variation of Arctic Sea Ice Extent from 1979-2016 (id 199)

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Based on the sea ice data and China meteorological monthly data set, the paper analyzes the change of Arctic sea ice extent during 1979-2016 and spatial and temporal variation of precipitation in about 50 years in Qinghai-Tibet Plateau, which contains 108 stations in Sichuan, Qinghai, Yunnan, Gansu, Tibet and Xinjiang province. It also studies delayed correlation analysis between Arctic sea ice and Qinghai-Tibet Plateau precipitation. The analysis shows that: in the past 38 years, Arctic sea ice is decreasing and reached the lowest record in 2016; in a year, sea ice extent is largest in March while smallest in September. Mean annual precipitation of Qinghai-Tibet Plateau decreases from southeast to northwest, which shows obvious spatial difference; the precipitation during 1961-2005 featured the oscillation from positive to negative anomaly

but on the whole had slight increasing trend. In a year, precipitation is largest in Summer, and then Autumn, Spring, finally Winter. The delayed correlation analysis shows that the Arctic sea ice's influence on Qinghai-Tibet Plateau has a 12 months cycle and has the largest positive correlation when delayed 3-5 months and negative correlation when delayed 9-11 months. Based on the above information, Qinghai-Tibet Plateau can be divided into 4 parts, which are the southeast plateau, the east plateau, Qaidam Basin area and the west plateau, they are influenced by Indian Monsoon, East Monsoon, Plateau Monsoon, westerlies and subtropical circulation respectively. The paper selected four representative stations in each area to do further correlation and the result showed that : summer precipitation of the southeast plateau has significant negative correlation with previous sea ice in July-September; winter precipitation of the east plateau has significant positive correlation with previous sea ice in August-October; summer precipitation of Qaidam Basin area has significant negative correlation with previous sea ice in February-April; winter precipitation of the west plateau has significant negative correlation with previous sea ice in September-November.

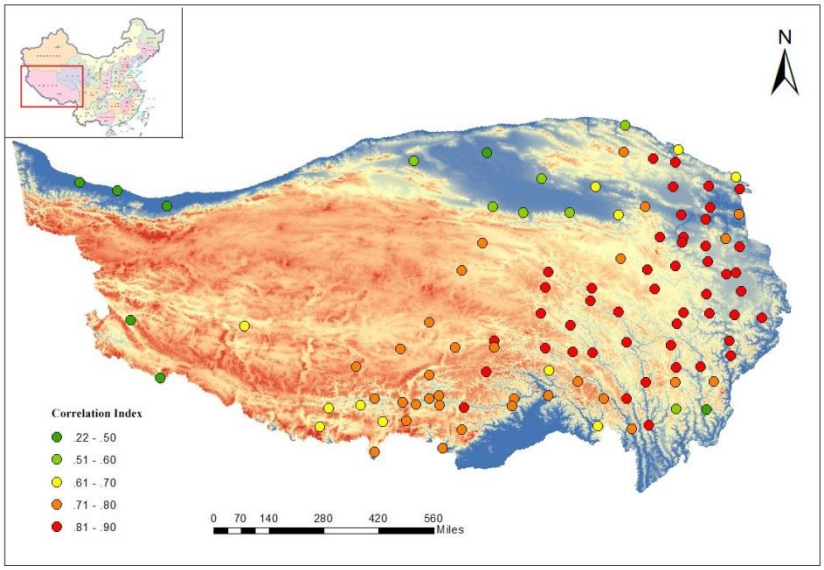

Figure. Maxmium correlation index between Arctic sea ice and delayed precipitation

Circumpolar spatial distribution of Chlorophyll a and its relationship to the in situ status of the Arctic Ocean marine environment (id 200)

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Chlorophyll *a* is very important in global climate change and marine ecosystems. Although continuous *in situ* monitoring of chlorophyll *a* is useful for the correction and validation of satellite data, the availability for Arctic is limited because of the harsh environmental conditions. we analyzed sea-surface chlorophyll a, temperature, and salinity in the Arctic Ocean Pacific sector obtained from Xue Long underway measurement during the 6th, 7th Chinese Arctic Scientific Expedition. Chlorophyll a concentration variation range during the two Chinese Arctic Scientific Expedition are very large, between which the chlorophyll a concentration variation range of the 6th Chinese Arctic Scientific Expedition was 0.054~8.283 mg m-3, and average value was 1.166 mg m -3, the 7th Chinese Arctic Scientific Expedition variation range was 0.018~5.166 mg m-3, average value was 0.699 mg m-3. Chlorophyll a concentration level of the 7th Chinese Arctic Scientific Expedition was significantly less than the 6th Chinese Arctic Scientific Expedition, the phenomenon is most obvious in Bering sea basin. In the two-navigation process, chlorophyll a concentration, temperature and salinity all decreased obviously from south to north in the Arctic Ocean Pacific sector. The principal causes of this phenomenon is that the sea area was affected by Anadyr Water (AW), Bering Shelf Water (BSW), the two currents with higher nutrient, temperature and salinity flow from south to north, respectively corresponding to the chlorophyll a concentration, temperature and salinity descending from south to north.

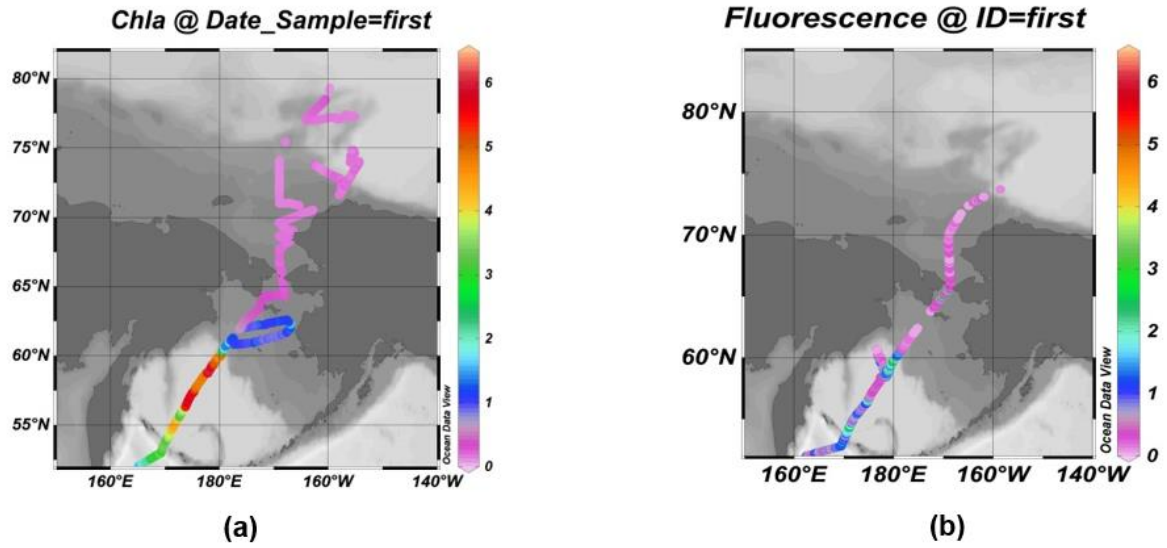

Figure. Arctic Ocean Pacific Sector surface seawater chlorophyll *a* concentrations during the 6th(a, Sep. 2014), 7th(b, Sep. 2016) Chinese Arctic Scientific Expedition, generated with Ocean Data View 4.6.4 (http://odv.awi.de, 2014)

Immunomodulation by legacy and emerging pollutants in the black-legged kittiwake (Rissa tridactyla) at Svalbard (id 61)

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The Arctic has been shown to be a sink for various global pollutants, such as pesticides, industrial chemicals and combustion by-products due to long-range transport from lower latitudes (AMAP, 2017). Climate change can further alter the transportation and distribution of these compounds in the Arctic (Ma et al., 2016), and this region is of special concern as instrumental observations indicate that the Arctic has changed faster than any other region in the Northern hemisphere over the past decades (Nadal et al., 2015). Many of the chemicals that reach the Arctic have shown to have an immunomodulatory effect on various wildlife (e.g. Feng et al., 2016), which could increase their susceptibility to infectious diseases. Despite wildlife being highly exposed, the documentation on immunosuppressive effects of pollutants in Arctic species is sparse. There is a critical need for more information about the potential immunotoxicity of these environmental chemicals, especially the emerging chemicals replacing legacy chemicals known to be harmful to environment and biota. This project compared the immunomodulation by various contaminants on free-living black-legged kittiwakes (*Rissa tridactyla*) breeding at Svalbard. The effects of pollutants on both the innate and adaptive immune response were investigated. This project is a part of a larger research framework investigating the combined effects of pollution and climate change on disease resistance in polar regions.

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Ground-based MAX-DOAS Observations and the source investigations of boundary layer BrO in Ny-Ålesund, Arctic (id 188)

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Bromine monoxide is a reactive halogen species which has profound impact on the chemistry of the tropospheric polar boundary layer. During polar spring, BrO enhancement can be detected in both northern and southern Polar Regions, while the boundary layer ozone depletion events occur. A considerable challenge for understanding enhanced BrO and the associated ODEs is the difficulty of real-time observations. In this study, we found a typical process of enhanced bromine and depleted ozone in Ny-Ålesund boundary layer using ground based MAX-DOAS techniques in April. The slant columns showed as high as 8E14 molecular cm^{-2} BrO columns, which is a very high level compared to other time at this place. Considering meteorology, sea ice and air mass historys, the sea ice floating in the Kings Bay area was considered as the major source of this bromine enhancement event. During the BrO enhancement event, the boundary layer ozone and gaseous mercury has synchronously reduced by 85% and 90% separately. The key role of bromine on the atmospheric oxidation and the ecosystem will be further discussed.

From vision to action: New SIOS products for ESS research (id 146)

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SIOS has existed as a concept for ten years and during its preparatory phase detailed plans were made for how it would work in practice. Now that SIOS is reaching the end of the interim phase and moving towards being fully operational it is time to put these plans into action. The SIOS Knowledge Centre has been set up to deliver 6 core services: Data Management, Remote Sensing, Access and Logistics, Training, Communication and Outreach, and Science Optimisation. These services are being delivered by SIOS-KC staff in partnership with representatives from SIOS member institutes through the working groups.

Services that are already being offered by the SIOS Data Management System (SDMS) include discovery of metadata and transformation services for some Norwegian data sets. Data transformation for all remaining SIOS core data is planned for the near future.
The SIOS Training Service has offered two training courses in 2017: “Application of Copernicus satellite data for snow and ice research” and “Data management as tool for scientists”. The latter is a one day course appended onto three workshops funded by the Svalbard Strategic Grant in 2017.
The Remote Sensing Service (RSS) offers advice on the availability and application of satellite data for ESS research. In addition to delivering the workshop on Copernicus data in collaboration with the Training Service, RSS is also involved in the planning and delivery of the ESA Cryosphere Remote Sensing Course to be held at UNIS in June 2018. Through the Remote Sensing Working Group SIOS is

working towards better integrating satellite data into ESS research, identifying knowledge gaps and collaborating with partners to plug such gaps.

The Logistics Service is already offering the first services to researchers visiting Longyearbyen – a guest office and storage and freezer space in Svalbard Science Centre. Advice and support for researchers travelling to any part of Svalbard is also offered through this service. The Communication and Outreach Service is sharing SIOS news with our partners and other through the website, Twitter, and regular newsletters.

In 2017 the Science Optimisation Service and Access Service are jointly offering funding for researchers through the SIOS pilot call. A total of 2 million NOK was offered and the deadline for proposals was 1 October 2017. The outcome of the pilot programme is twofold: the first part of the call is focused on delivering the State of Environmental Science in Svalbard (SESS) report. This will be the first of the annual reports produced by SIOS to summarise the status of and propose the future direction of ESS research in Svalbard. SIOS is offering access to existing data sets and funding for data analysis and report writing to researchers contributing to the first report. The second part of the call is focused on providing access to the existing research infrastructure owned by SIOS members. SIOS is offering free access to these facilities, as well as funding towards travel costs and logistical support. Upon completion of the pilot programme SIOS will issue regular SESS and Access Calls.

The core services provided by SIOS-KC will continue to grow and mature as we move into the operational phase.

Wave attenuation in the MIZ (id 103)

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Exploration drilling for hydrocarbons in the Norwegian sector of the Barents Sea has in 2017 taken place as far North as 74º30'N 36ºE, known as the Korpfjell prospect. This site is located north of the 10^{-2} contour lines for both sea ice and iceberg occurrence and in case of future production this may take place in the so-called Marginal Ice Zone (MIZ). Thus, both presence of sea ice and potential iceberg must be considered in both structural design and operations. When ocean waves penetrate and partly form the MIZ, which is the transition area where the ice cover is significantly affected by waves and open-ocean processes, waves are attenuated. The paper reports on modelling of and field measurements near Svalbard of the motion of several ice floes in the MIZ to study the process of wave attenuation in ice. The heave motion amplitudes registered by Inertial Measurement Units (IMUs)

deployed on the ice were used to interpret the wave amplitude. Arctic shipping and engineering developments require knowledge on how ocean waves and ice may alter each other's properties. This knowledge is also needed for improving numerical models with respect to their capabilities to predict Arctic marine conditions.

Deploying sensors on Ice Floe #3 (left) and the same floe during retrieval of the sensors about 10 hours later (right). The latter photo shows that Floe #3 had split during the experiment (Tsarau et al., 2017).

KEY WORDS: Marine Research, Arctic Marine Technology

Spatial and temporal variability of ablation based on the Waldemar Glacier (Kaffiøyra, Svalbard) (id 4)

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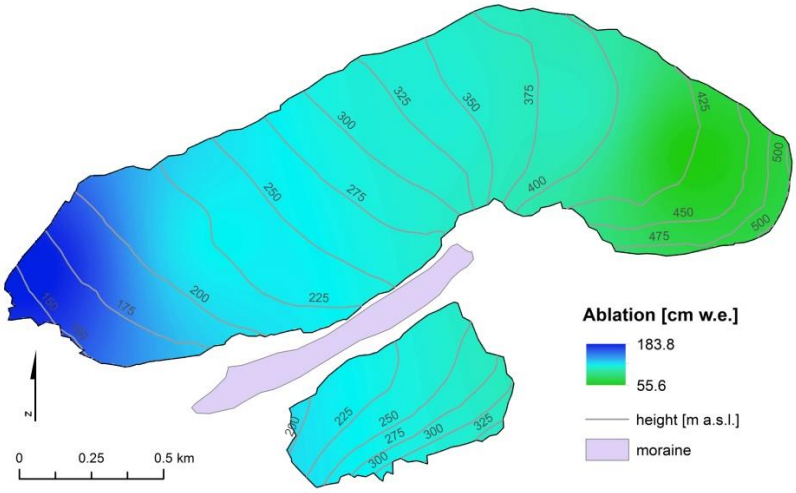
Changes of glaciers are one of the most vital subjects in modern glaciology, especially in the wake of global warming. The ablation and the accumulation of snow are fundamental processes, the relationships of them allow us to estimate changes in the mass balance of the glaciers. Ablation is a major factor in the loss of glacier mass. Its measurements at the Waldemar Glacier have been conducted regularly since 1996. Ablation shows distinct temporal and spatial variability. Its intensity is influenced mainly by atmospheric conditions (air temperature, precipitation, wind direction and velocity), density of the supraglacial streams, exposure and slope of the glacier.

Waldemar Glacier is located in the north of Kaffiøyra region, in the north-western Spitsbergen. It is a small alpine valley glacier. In 1996-2009 the average summer balance of the Waldemar

Glacier was -106.9 cm w.e. The largest loss of glacier mass was observed in 2009 (-136.5 cm w.e.), the lowest in 2000 (-63.5 cm w.e.). Waldemar glacier was characterized by average daily ablations ranging from 2.3 to 2.8 cm w.e. The largest ablation was recorded in the area below 250 m a.s.l. The average gradient of ablation for the Waldemar Glacier in the period 1996-2009 was 41 cm w.e. at 100 m height [(1)]. In recent years, the upward ablation's trend has been predominantly related to increasing mean, maximum, and minimum air temperatures. In the summer of 2016 the highest values of ablation were recorded at the glacier terminus (183.9 cm w.e.), the lowest at the accumulation zone (55.5 cm w.e.) (Fig.1) The average air temperature from 1st of July to 5th of September 2016 was 6.0 ºC.



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Thermal conductivity and water content of firn at Lomonosovfonna derived from subsurface temperature measurements (id 94)

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Subsurface fluxes of energy and mass are closely linked with the processes at the surface and to a great extent define the properties of subsurface profile. We used multiple thermistor strings for measuring the firn temperature at Lomonosovfonna, Svalbard, during April 2015 – July 2015 along with density measurements in two firn cores to derive thermal conductivity (k) values for 2-4 ca 2 m thick layers. For that a 1-dimensional heat conduction model constrained by the measured initial and boundary conditions is complimented by an optimization routine comparing the simulated and measured subsurface temperature evolution. The resulting k values vary from 0.6 to 1.3 J $(s\ m\ K)^{-1}$ and consistently increase with depth. Compared to thermal conductivities calculated as a function of density measurements following published

parameterizations our optimized k values are generally higher, particularly in the lower part of the profile. Optimized k values are then used to derive the firn water content during the autumn season by comparing the rate of freezing front penetration. We find that the mass of water is less than 4 grav. % with significantly lower values (<1 grav. %) below the level of previous summer surface.

Starting of new sun-sky-lunar photometer aerosol observations in the Artic Ny-Ålesund base (id 93)

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The Arctic is expected to be very sensitive to global changes in climate; however, there is a lack of knowledge about the spatio-temporal distribution of Polar atmospheric aerosols. The high variability they present makes it necessary the establishment of continuous monitoring networks with the aim of obtaining long-term databases. The Atmospheric Optics Group (GOA) of the University of Valladolid and the Alfred Wegener Institute (AWI) have started a joint research project which included the installation of a new generation Cimel sun-sky-lunar radiometer (CE318-T) at Ny-Ålesund. This kind of instrument, in the framework of the worldwide AERosol ROBotic NETwork (AERONET), can provide aerosol properties during summer (sun) and winter (moon) time. This instrument also follows all the standardized AERONET daylight observations and gives a large set of aerosol properties that can be combined with lidar and other collocated instruments using novel algorithms such as GRASP (Generalized Retrieval of Atmosphere and Surface Properties) open source code.

We present here the preliminary results of the starting of CIMEL optical and microphysical observations in the French and German joint facility AWIPEV in Ny-Ålesund. The instrument is operational since June 1st, 2017. Hence, more than 1,500 raw observations are available. The existing database at the AWIPEV site will allow comparison with the long-term instrumentation already installed on the site. For instance, the aerosol optical depth time series from a Schulz sun photometer (operating since 1991) can be linked to the CIMEL sun photometer series. A first comparison of the two collocated instruments using the first week of data exhibits a notable agreement between both instruments, in particular, for those channels between 380 and 675 nm. Further studies can infer some corrections for certain spectral channels which could need to be adjusted.

This work was supported by project POLARMOON (CTM2015-66742-R) of Spanish Government

(MINECO), EU-H2020 under Grant Agreement Nr. 654109 [ACTRIS 2], and VA100U14 of Consejería de Educación of Junta de Castilla y León. We also are grateful to Spanish MINECO for IJCI-2014-19477 and PTA2014-09522-I grants. Thanks to station crew: W. Ruhe, P. Kupiszewski, B. Laurent, and R. Merceron. We also thank the support by RIS-ID 10745 project.

Marine ecosystem research in the area of Svalbard: experience of Murmansk marine biological Institute (id 104)

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Murmansk Marine Biological Institute has been conducting scientific research in the area of the Svalbard Archipelago since the 1960s. Since the 1990s research has become comprehensive and ecosystem-based and includes all the components of marine ecosystems, from plankton to polar bears. The studies have been conducted from MMBI's research vessels "*Dalnie Zelentsy*" and "*Pomor*" and from research vessels of friendly scientific organizations, "*Jan Mayen*", "*Polarstern*", etc (Figure 1).

During these cruises large scientific data were collected, analysis of which has allowed obtaining new information about the status, structure and functioning of abiotic and biotic components of ecosystems in the Greenland and Barents Seas off Svalbard. Unique data on the functioning of pelagic and benthic communities in different seasons and years have been obtained. Data on the structure of seabird populations, soil microarthropods and parasites have been collected and analyzed. Evaluation of modern sedimentation in Grønfjorden has been made.

In order for integrated ecosystem-based studies in the vicinities of Grønfjorden to be continued, a biogeostation was built near the town of Barentsburg in 2012. It includes two buildings, a laboratory block and a boat garage. The laboratory block is equipped with lab equipment for the preliminary analysis of biologic samples and processing of data. Besides, there is a container for a motor boat and other equipment to conduct field studies.

Since 2015, together with UNIS, MMBI has been involved in the IMOS (Isfjorden Marine Observatory Svalbard) project aimed at studying marine plankton. The project includes regular filed studies in Isfjorden. MMBI is responsible for the collection of samples in Grønfjorden Bay. Besides, in December 2015 and July 2017 together with scientists at UNIS integrated surveys in Isfjorden were conducted on board research vessel "*Dalnie Zelentsy*" using up-to-date scientific equipment. The next integrated survey in Isfjorden on board the R/V "*Dalnie Zelentsy*" is

scheduled for November 2017.

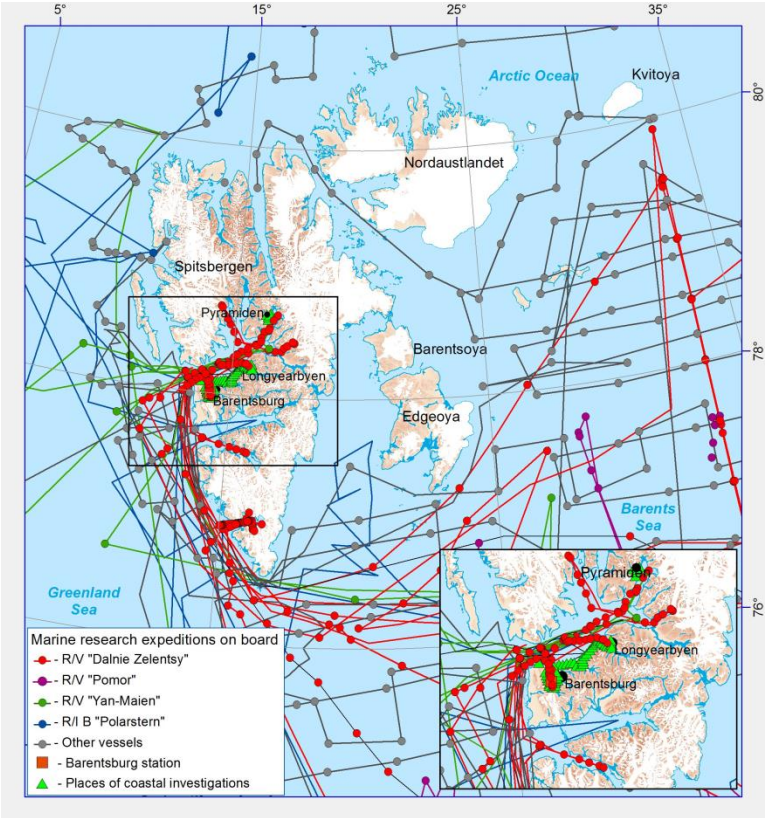

Figure 1. MMBI marine studies in the area of Svalbard in 1990–2017

Symptoms of Arctic Amplification observed in Ny-Ålesund (id 12)

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Over the recent decades, temperature increase in the Arctic has been almost twice as large as the global average. This amplification of global warming is attributed to various feedback mechanisms present in the Arctic environment. Some processes are locally confined to the diminishing sea ice cover of the Arctic ocean, particularly the sea ice – albedo effect during polar day. Other amplifying processes related to the increasing open water surface of the Arctic ocean include e.g. the increasing heat flux from the ocean to the atmosphere. The resulting latent heat flux and augmenting evaporation contribute to an increasing atmospheric moisture content, which affects the longwave downward radiation directly or via changing cloud microphysics. Furthermore, atmospheric moisture and heat are more frequently advected from lower latitudes into the Arctic in relation to changes in the atmospheric circulation. During the dark period of polar night, the Arctic warming trend is not homogenously distributed over the polar cap, but occurs strongest at the surface in the Barents / Kara Seas and in the free

troposphere of the Arctic North Atlantic sector. Thus, Svalbard is located in a key region of climate change. Observations from Ny-Ålesund at the west coast of the Svalbard archipelago show an annual temperature increase of 1.4 K per decade since the 1990s, with an average temperature that by now exceeds those observed during the early Arctic warming period in the 1920 to 1940s. The recent winter warming is even twice as high, and is accompanied by an increase in atmospheric moisture. Surface radiation observations in winter further indicate a change in cloudiness along with an increase in net longwave radiation. Although the winter warming is bottom-amplified, radiosonde observations show that the increasing temperature signal occurs over the entire troposphere. Indeed, part of the Svalbard winter warming is associated with enhanced warm and moist air advection in the free troposphere caused by increased cyclonic activity related to changes in atmospheric circulation patterns.

The various processes contributing to Arctic amplification of climate warming link the local observations from Ny-Ålesund with processes occurring both in the Arctic and in the northern hemispheric mid-latitudes.

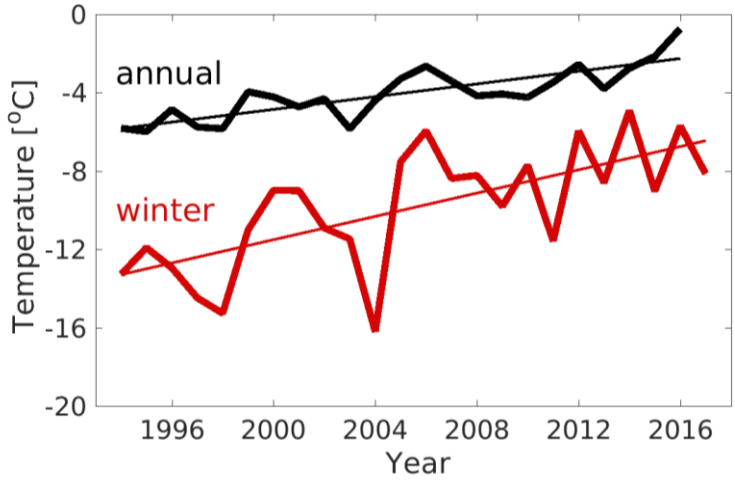

Fig.1: Annual and winter (Dec-Jan-Feb) average 2-m temperature measured at the AWIPEV research base in Ny-Ålesund, Svalbard.

Short-term dynamics of nutrients, planktonic abundance and microbial respiratory activity in relation to a massive suspended sediment load in the Arctic Kongsfjorden (id 125)

Azzaro Maurizio, Aliani Stefano, Azzaro Filippo, Caroppo Carmela, Giglio Federico, Langone Leonardo, Maimone Giovanna, Mancuso Monique, Miserocchi Stefano, Cabral Anderson S., Paranhos Rodolfo, Vitale Vito, La Ferla Rosabruna

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The Kongsfjorden (Spitsbergen, Svalbard, Arctic) is affected by the inflow of Atlantic water and by the input of sediment-rich glacial meltwater. This last process is increasing with the global climate warming affecting surface salinity, water column turbidity and light penetration. In late summer 2013, the short-term dynamics of abiotic (light, temperature, salinity, nutrients, total suspended matter, particulate inorganic and organic carbon) and biotic (viruses, bacteria, microphytoplankton abundances and microbial respiration) parameters in the fjord were investigated in a coastal station (water depth ~102 m) influenced by the freshwater runoff from land and glaciers. During the study, three water masses (Surface, Intermediate and Atlantic waters) were identified in the water column. The extension of Intermediate water into Kongsfjorden, strongly changed within a week of sampling, with clear implications also on the extension of Surface and Atlantic waters. Additionally, we explored if the planktonic components were correlated to the variability of the hydrodynamic regime. Viruses were highly correlated to the environmental parameters. Moreover, a low viruses/bacteria ratio was found compared to the other seas, and such evidence was probably linked to the high sedimentation of particles of this study site. Microphytoplankton was correlated with viruses, and its abundance was low (below 10×10^3 cells l^{-1}), with the exception of three bloom events (maximum values 13×10^6 cells l^{-1}; monospecific) observed at three different depths.

Relationship between Viral and prokaryotic abundance along a transect from the Kronebreen Glacier to offshore in the Kongsfjorden (Svalbard Islands) (id 126)

Azzaro Maurizio, La Ferla Rosabruna, Maimone Giovanna, Azzaro Filippo, Caruso Gabriella, Cabral Anderson S., Paranhos Rodolfo, Vitale Vito, Zappalà Giuseppe, Bruzzone Gabriele

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The poles are warming faster than other parts of the Earth and this has brought to a rapid environmental change which is increasingly evident in the observations of many geophysical and biological properties. Advanced technologies for marine monitoring are needed to monitor environmental changes, especially those related to ice melting. Measurements of near-ice (< 300 m) ecology are lacking, due in large part to the difficulty in working at the margin of calving glaciers.

In the framework of the ARCA project (ARctic: present Climatic change and pAst extreme events) aimed at studying the hydrological cycle and its consequences on the climate in the boreal hemisphere, a first prototype of automatic equipment was specifically designed to perform discrete sampling of waters in the area close to a glacier. The Shark USSV (Unmanned Semi-Submersible Vehicle) designed and built by CNR-ISSIA was used for collecting samples in the stretch of sea near the Kronebreen glacier (Kongsfjorden); this was the first time that an autonomous sampling was carried out near the front of the glacier. Shark was used to tow along a transect and via an adequate rope a small catamaran carrying an Automatic Water Multisampler built by CNR-IAMC. In June 2015, surface water samples were collected by the automatic Multisampler along a transect of 6 stations from the glacier to the open sea. This research reports the results of the first in situ application of this device related to the study of the distributions of nutrients, virus-like particles and prokaryotes. Significant spatial differences were recorded in the parameters studied, with high prokaryotic abundances close to the glacier. Viruses had an opposite trend to prokaryotes. A low viruses/prokaryotes ratio was found compared to the other marine ecosystems.

In-situ detection of nutrients in Kongsfjorden, Svalbard Islands using a cost effective nutrient sensor (id 177)

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Nutrients such as phosphate, nitrate and nitrite are central in many environmental processes within the marine environment, including several microbial, plant and animal metabolic processes. A cost effective sensor for the detection of phosphate in natural waters was developed as part of the COMMON SENSE FP7 project The project focuses on descriptors of the MSFD, using sensors for the monitoring of nutrients, pH, contaminants, microplastic and underwater noise. The developed sensors are tested on different platforms, fixed or floating, surface or underwater, in all European seas including the Arctic. The nutrient sensor developed at DCU for the detection of phosphate, nitrate and nitrite in marine and freshwater environments is based on a combination of microfluidic analytical systems, chemical colorimetric reagents and optical detection using a low-cost LED detection and wireless communications. During system testing in Svalbard over 180 water samples were collected using Niskin bottles in different stations from the boat along the Kongsfjorden Fjord. Samples were aquired at different depths from the surface to the bottom (surface, mid depth and bottom). The samples were analysed for nitrate nitrite and phosphate at the CNR reaseach base Ny Aselund using the nutrient sensor. Subsamples of each sample were returned to DCU for subsequent analysis and system validation.

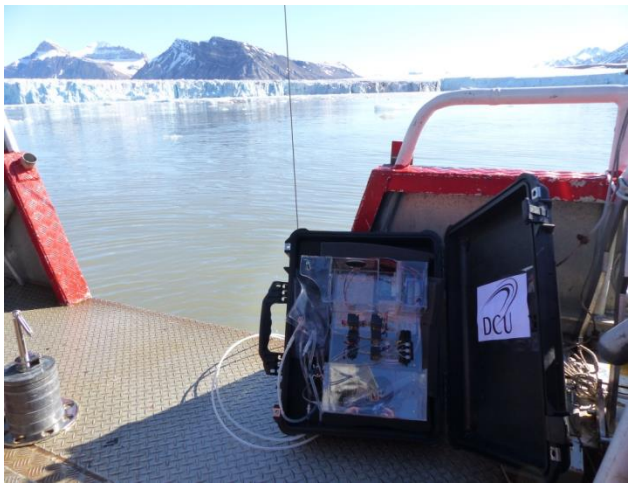

Figure 1: Nutrient sensor acquiring sample

The metrology laboratory in Ny-Ålesund for Arctic Environment (id 70)

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Climate change represents a global challenge with very considerable impact, influence and connections with several other major environmental and social emergencies. This is particularly through in the Arctic where peculiar characteristics and conditions amplify climate change signals and consequences. The Arctic region is a fundamental observation area for climate change evaluation: climate change comes first and comes faster in the Arctic. Multitudes of measurements are needed to understand the environment and its evolution. In recent years, a growing interaction between the metrology community and the meteorology and climatology communities, including researchers working on atmospheric, oceanic and terrestrial observations, has been established. The higher accuracy required to quickly capture trends; the extreme range and conditions of sensors exposure; a robust comparability asked by the different measurement networks; the need of dedicated calibration procedures, together with the logistical problems associated with such remote location, motivate the proposal for a joint effort to address metrology experience and activities for arctic research applications. The Ny-Ålesund international research base and community offers a unique infrastructure to directly link metrological traceability to on site polar measurements. The contribution reports some achievements on metrology laboratory set in Ny-Ålesund focusing on specific calibration procedures, metrological validation of measurements and instrument tests, uncertainties evaluations including quantities of influence, based on the calibration activities performed in spring 2017.

Glacier products for Svalbard using Sentinel-2 (id 212)

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Copernicus Glacier Service is a Norwegian collaborative project between the Norwegian Polar Institute (NPI), the Norwegian Water Resources and Energy directorate (NVE), and the University of Oslo. The project aims to provide glacier products over Svalbard and mainland Norway using data from the Copernicus Sentinel-2 satellite. Within this project NPI is responsible for all products over Svalbard. Here we present velocity datasets from both Sentinel-2A and 2B for all of Svalbard. We compare Landsat-8 examples with the higher resolution Sentinel-2 products. We also assess newly terrain corrected Sentinel-2 imagery and products. These scenes have been corrected with a new NPI Svalbard DEM. We compare these to the

standard ESA processing with a global DEM over key regions of interest, such as the Kongsfjorden glacier complex.

Bioerosion patterns in a polar carbonate factory (Mosselbukta, Svalbard) (id 160)

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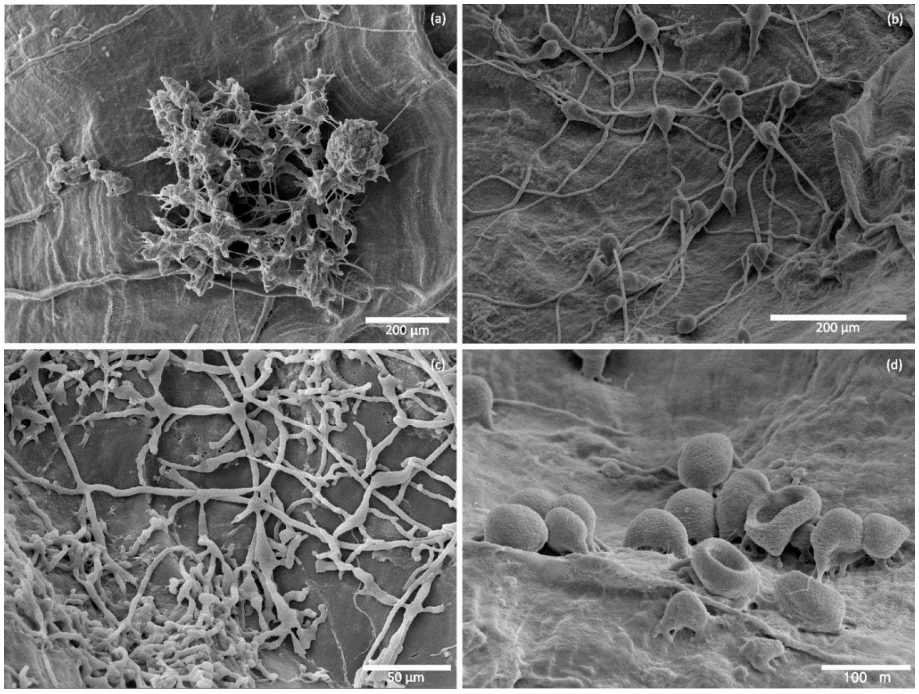
This study is the first comprehensive investigation of microbioerosion traces in an Arctic carbonate depositional environment and attempts to foster the knowledge on the diversity of bioeroding agents in Mosselbukta, N-Spitsbergen, Svalbard. To study this polar carbonate factory, calcareous skeletons of barnacles were collected from the intertidal down to 125 m water depth in 25 m intervals during the Maria S. Merian cruise 55 in 2016. The analysis is based on scanning electron microscopy of microborings in resin casts obtained via cast-embedding-technique. The inventory of microendolithic traces revealed a comparatively low ichnodiversity of 20 different ichnotaxa within 71 samples. Microendolithic traces were produced by cyanobacteria (3), chlorophytes (2), rhodophytes (2), sponges (1), foraminifera (1), fungi (5), and some unidentified trace makers (6). Strong temperature fluctuations, an extreme seasonality of light levels, and sea ice cover lead to a low ichnodiversity in the intertidal. The investigated trace fossil assemblage is dominated by ichnotaxa formed by cyanobacteria and fungi. This outcome contrasts with the highest ichnodiversity at the 50-m station, where much steadier, albeit still extreme environmental conditions prevailed, and a dominance of traces produced by chlorophytes occurred. The ichnodiversity remained almost consistent from 25 m on downwards, whereas the composition of encountered bioerosion trace assemblage varied. Borings of organotrophic organisms were mainly in samples from aphotic regions, indicating their preference for steady environmental conditions. A lack of several typically common ichnogenera like Scolecia, produced by cyanobacteria or Rhopalia, made by chlorophytes, was observed. Those locally missing trace makers are here interpreted as stenotherm. Their absence led to emerging niches, being locally occupied by bioeroders that generated yet undescribed bioerosion traces. These include ‘Saccomorpha-form 1’, created by a fungus, or two forms of Conchocelichnus seilacheri, formed by rhodophytes. Flagrichnus baiulus, Entobia mikra, Semidendrina pulchra, and ‘Saccomorpha-form 1’ were common and are potential indicators for cold-water environments. A comparison of bioerosion studies from different latitudes suggested a general decrease in ichnodiversity with increasing latitude.



Some of the investigated micro-bioerosion traces found at Mosselbukta, Svalbard. (a) Semidendrina pulchra from 100 m water depth (b) 'Saccomorpha-form 1' from 100 m water depth (c) 'Conchocelichnus seilacheri-form 1' from 14 m water depth (d) Cavernula pediculata from 0 m water depth.

Permafrost Thaw on Svalbard: Adaptation and Mitigation (id 209)

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Degrading permafrost as a result of climate change is posing a significant challenge to arctic infrastructure (Instanes et al. 2005; Larsen et al. 2014: 1591ff.). Infrastructure on Svalbard is particularly exposed, as it is built upon permafrost (Øseth 2010: 34, 100ff.; Vikhamar-Schuler et al. 2016: 11). Coastal infrastructure may be especially affected, as degrading permafrost in combination with increased wave activity might cause coastal erosion. This poster will present a planned project on adaptation and mitigation in relation to permafrost thaw on Svalbard. The project forms part of the Horizon 2020 Project Nunataryuk: Permafrost thaw and the changing arctic coast: science for socio-economic adaptation that will begin in November 2017.

The planned project will address the socio-economic impacts of permafrost thaw on Svalbard and investigate possible responses. Its main objectives are to (1) analyze the threats and

challenges permafrost thaw poses to Svalbard and to (2) investigate what responses could be most effective in reducing impacts or harm. In the course of the project, key risks associated with permafrost thaw will be identified and current and potential adaptation and mitigation strategies will be analyzed. The project will be based on anthropological fieldwork on Svalbard including qualitative empirical research (participant observation and interviews).
As the project is still in its exploratory phase, the poster will present a short description of the project and its main aims, and present some open questions regarding future steps and the development of the project.

Past ocean surface conditions in two fjords of western Svalbard over the last two millennia (id 01)

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Our joint Indo-Norwegian research project OCTEL aims to explore the ocean, sea-ice and atmosphere interactions both in the Southern Ocean and the northern North Atlantic in order to assess the manifestation of interhemispheric teleconnections and their influence on climate during last 11 700 years (the Holocene) with a special focus on the last 2 000 years. One of the primary objects of the OCTEL project is to reconstruct paleo ocean surface conditions from the selected fjords of Svalbard over the last two millennia.

Here we present preliminary results achieved from marine sediment cores taken from two fjords (Kongsfjorden and Krossfjorden) located in western Svalbard. Kongsfjorden and Krossfjorden are oceanographically and climatically important sensitive fjords as they are persistently influenced by the northernmost North Atlantic Current. We anticipate that the ongoing studies will be able to show the variations of different water masses and sea-ice variability in the area associated with the Atlantic water inflow over the last two millennia. Our research is primarily based on subfossil planktonic diatoms as they are good indicators of surface water conditions (such as sea surface temperature (SST) and sea-ice). In addition, a combination of different methods including benthic foraminifera (bottom water conditions), geochemical (^{13}C and ^{15}N isotopes, IP_{25}) and grainsize analyses is/will be used for the selected sediment cores in order to get additional information on paleo environment.

Late Cenozoic geodynamics in Svalbard: interplay of glaciation, seafloor spreading and mantle convection (id 58)

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Svalbard has experienced tectonic reactivation since Miocene times including a regional uplift, volcanism and fault movements associated with an unusually strong earthquake activity. Previous studies attributed this activity to thermal and/or mechanical effects related to the proximity to the Mid-Atlantic Ridge. However, it has remained unclear i) how these effects could affect a large region over a distance of >500 km and ii) why the tectonic activity has accelerated over time while the ridge occupied a progressively more distant location with seafloor spreading. In this work, we combine seismological models of the lithosphere, recent satellite gravity data, relative sea level data covering the last 11 ka, and numerical modeling. We map a triangular region of strongly thermally attenuated lithosphere roughly corresponding to Spitsbergen and Nordaustlandet. We show that the thermal weakening of the Svalbard upper mantle can be resolved from the relative sea level data indicating that the viscous relaxation times halve over a distance of 500 km toward the margin. Our thermal modeling suggests that the lateral heat conduction from the Knipovich Ridge was only significant within a distance of 100-150 km from the margin, and mainly affected the upper 70 km of the lithosphere, and cannot explain this observation. The model of plate-driven mantle upwelling may explain a first-order spatial distribution of magmatism along the ridges and a component of ridge parallel flow. However, it fails explaining the strongly localized western volcanic zone at the Gakkel Ridge and significant mantle delamination beneath Svalbard. Branching upside-down drainage of the Iceland plume material has been previously invoked to explain the reactivation of the Mid-Norwegian margin and British Isles in Miocene times. The third arm directed towards Svalbard along the plate boundary is clearly mapped both from gravity and seismic data. The study of the Late Cenozoic geodynamics in Svalbard provides an example on how the mantle dynamics shapes plate tectonics processes.

In particular, the combination of lateral heat conduction at the ultraslow Knipovich Ridge and hot mantle beneath western Svalbard controls the seismicity pattern and the distribution of crustal deformation. The effective elastic thickness of the lithosphere of 15-30 km recently measured by locating the earthquake depths at the ultraslow Knipovich ridge is comparable to or larger of the values calculated for Svalbard suggesting a diffused or migrating plate boundary between the North American and Eurasian plates in the study region.

Calibration and validation of interferometric synthetic aperture radar altimetry for mass balance estimation in Svalbard – preliminary results (id 82)

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Cryospheric applications of radar altimetry are hampered by spatiotemporal variability in the penetration of the signal into the snowpack, and uncertainties in the location of the 'Point of Closest Approach' (POCA) over sloping glaciers, ice caps, and the margins of the ice sheets. The Synthetic Aperture Interferometric mode (SARIn) of the SIRAL instrument onboard ESA's CryoSat-2 utilises Doppler and Interferometric processing in an attempt to overcome the latter limitation, providing spatially extensive measurements of glacial ice elevation. However, strong backscatter from ice layers and density variations within the snowpack, as well as underlying firn and glacial ice has the potential to lead to a 'radar elevation' which is below the physical surface. Airborne and field-based calibration and validation campaigns are necessary to assess the degree of signal penetration, allowing more precise calculation of elevation change and mass balance. Here, we present initial results from the 'Radar altimetry for ice mass balance – impact of melting and refreezing in the snowpack (AltMelt)' project, which aims to derive optimum techniques for elevation-change estimation over glaciers and ice caps in different climatic regimes, using Austfonna, Svalbard as an analogue for melt-affected snowpacks in the Arctic and coastal Greenland, and ice rises on Fimbulisen, Antarctica as an analogue for dry snowpacks in Antarctica and the interior of Greenland. In order to assess the degree of signal penetration into the snowpack, we compare elevation measurements from CryoSat-2 with co-located measurements from GPS transects collected as part of long-running field campaigns on Austfonna. We also discuss optimum techniques for the processing of CryoSat-2 data. Finally, we present maps of elevation change and estimates of mass balance for the Svalbard archipelago derived from CryoSat-2 radar altimetry.

Medium-range forecast skill of summertime sea ice conditions over the East Siberian Sea: Importance of synoptic-scale atmospheric fluctuations (id 24)

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Accelerated retreat of Arctic Ocean summertime sea ice has focused attention on the potential use of the Northern Sea Route (NSR), for which sea ice thickness (SIT) information is crucial for safe maritime navigation. This study evaluated the medium-range forecast skill of summertime

SIT, with special emphasis on the East Siberian Sea (ESS), based on the Towards an Operational Prediction system for the North Atlantic European coastal Zones ver. 4 (TOPAZ4) data assimilation system. Intercomparison between all available observed (in situ and satellite) and operational model SIT data showed that TOPAZ4 reanalysis data reproduces the observed seasonal cycle (maximum in May and minimum in October) for the entire Arctic Ocean, with an average negative bias of ~30 cm. For the ESS, the TOPAZ4-SIT data also showed realistic SIT variations on seasonal timescale with negative biases smaller than the central basin. These results support the reliability of the TOPAZ4 SIT in melting season over the ESS. Examination of vessel-tracking data and TOPAZ4 reanalysis data suggests the significant delay in vessel speed that occurred in July 2014 during passage of the ESS was caused by northwestward sea ice drift (~20 cm s^{-1}) as well as significant SIT (~150 cm). To explore the mechanism controlling the summertime (July) sea ice motions, we examined the speed and direction based on free-drift theory (Lepalant, 2005). The estimated values of the wind factor and the deviation angle are approximately within the range of typical surface wind parameters of 2 % for the wind factor and 30° for the deviation angle in the Arctic Ocean (Thorndike and Colony, 1982). Forecast data of TOPAZ4 indicates northward sea ice drift occured in July 8, 2014 can be predicted skillfully with a lead-time of 5 days. The ECMWF medium-range forecast data show that the forecasts of the ensemble members spread after July 8 and the ensemble mean values are notably different from the analysis values. These results demonstrate the skill in the prediction of sea ice motion is attributable to that of the atmospheric wind condition. Therefore, TOPAZ4 data assimilation system could provide useful medium-range sea ice forecasts for summertime maritime navigation of the NSR. Recently, it was reported that additional radiosonde observations over the Arctic Ocean have had considerable impact on the prediction skill in synoptic-scale fluctuations (Inoue et al., 2015; Yamazaki et al., 2015; Ono et al., 2016). Therefore, it is possible that radiosonde observations in the Arctic Ocean could lead to further extension of the lead-time for predictions of summertime sea ice.

Ecosystem carbon cycle in Brøgger Peninsula, Ny-Ålesund, Svalbard (id 34)

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The recent climate change, especially warming trend which is widely observed in the Arctic, is likely to profoundly influence ecosystem carbon pools by changing the rate of carbon flows. Quantitative assessments of carbon pools and flows are absolutely essential to predict the impact of climate change on Arctic ecosystems. Since 1994, we have conducted a project to clarify the pattern of ecosystem carbon cycle and the factors controlling the cycle in Ny-Ålesund,

Svalbard.

As the first step, we examined major carbon pools and flows along a primary successional gradient within the glacier foreland of Austre Brøggerbreen (East Brøgger Glacier) in Ny-Ålesund. Vegetation cover and soil carbon pools tended to increase with the progress of succession though development of vegetation cover and accumulation of soil carbon appeared to be very slow. However, a non-negligible amount of organic carbon, including ancient organic carbon, is distributed in soils of the latter stages of succession (Yoshitake et al. 2011). Photosynthesis of vascular plants, especially that of polar willow (*Salix polaris*), was the major pathway of carbon fixation. Although cryptogams (mosses and lichens) contributed the major proportion of phytomass in the latter stages, their net primary production was much smaller than that of the vascular plant because of water limitation (Nakatsubo et al. 2005). Using observations of carbon cycle processes, we constructed a simple ecological process-based model to assess how the carbon balance will be altered by ongoing climate change and possible biological changing factors. Model analysis indicated that rising temperature did not always have positive effects on carbon sequestration because of enhanced respiration in the later part of the growing season under low light condition (Uchida et al. 2016).

Moss tundra accumulating a thick peat layer is another important type of vegetation in this area. In order to know the current carbon cycle of the moss tundra, we estimated carbon accumulation rates, CO_2 and CH_4 fluxes, and dissolved organic carbon (DOC) flow at moss tundra where about 5 km western place from Ny-Ålesund (Stuphallet; 78°57'N, 11°39-40'E). The area was covered with a thick peat layer dominated by various moss species (Nakatsubo et al., 2015). Apparent rates of carbon accumulation was estimated based on the ^{14}C age and amount of peat in the active layer. The calibrated age of peat from the bottom of the active layer (20-30 cm) ranged from 81 to 701 cal yr BP. Based on the total carbon (4.5-9.2 kgC m^{-2}), we estimated the apparent rate of carbon accumulation in the active layer as 9.0-19.2 g C m^{-2} yr^{-1}, which is similar to or greater than the net ecosystem production or net primary production reported for other vegetation types in this area (Nakatsubo et al. 2015). This suggests that the moss tundra plays an important role in carbon sequestration in this area.

In the future study, we need to conduct a larger scale assessment of ecosystem carbon cycle by the remote sensing technique in order to know the overall response of ecosystem carbon cycle to climate change in this area. In addition, considering the variation in the climatic condition within Svalbard, comparative studies along climatic gradient would be an effective approach for evaluating the consequences of climate change.

On the potential of GPS tracking of fjord ice features for remote-sensing validation (id 116)

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Climate change in the Arctic induces strong modification in precipitation and freezing regimes. In this context the monitoring of young thin sea ice is a key question. But the thinnest ice is also the most challenging to investigate, both in the field, because scientists cannot always step on it to sample it, and from satellites, as the low signal-to-noise ratio makes it difficult to distinguish from open water. Beyond that, thin sea ice is not a very stable feature: within a relatively short time it either grows and becomes thicker (first-year ice), or it gets broken up or melts. To monitor the changes of Arctic sea ice on various time scales, satellite remote sensing techniques remain preferable versus in situ work for reasons of cost, and spatial and temporal sampling. However, fieldwork remains crucial for the mandatory validation and calibration of these data. In April 2016 an Arctic fieldwork campaign was conducted at Kongsfjorden, Svalbard. This campaign was carried out in the framework of the Norwegian Polar Institute's long-term monitoring of Svalbard fjord ice, in collaboration with the Center for Integrated Remote Sensing and Forecasting for Arctic operations (CIRFA).The field work has been an opportunity to combine various techniques to record properties of sea ice in an Arctic fjord ranging from local field measurements and sampling (ice coring and thickness drilling) to the broader ground radar (Ku-band radar sweeping the fjord every 2 min) and satellite radar remote sensing (acquisition of four Radarsat-2 high-resolution quad-pol scenes) of the fjord. The combination of the various techniques offers an opportunity to cross-validate all the data collected and investigate the capacities and limits of each. While visiting field sites in the fjords for sea ice studies, a hand-held GPS was set up for tracking the entire track of the small boat used. Beyond the support of the documentation of the fieldwork and operational support, the constant tracking offered a good opportunity to assess the limits of radar identification of small icebergs and thin ice. A total of 17 icebergs and the tracking of two thin ice edges were achieved over the week of fieldwork. The comparison of ice edge and transition mapping with the classification of the Radarsat-2 scenes resulted for different cases in both agreement and contrasting results. Here, we will discuss these results, along with a view on the next steps towards further development of such studies.

The Atmosphere Flagship Programme for Ny-Aalesund (id 22)

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It is well known that changes in atmospheric composition and circulation are one of the main reasons for global climate change. In the Polar Regions, these changes affect the atmosphere by modifying meteorological parameters and dynamic circulation, and through a wide range of processes involving other components of the climate system. As atmospheric conditions force processes in the cryosphere, like melting glaciers or diminishing sea ice (including fjords land-fast ice), those processes interact again with the atmosphere by positive (negative) feedbacks. The same interdependency holds for interactions between the surface (of the ice covered or ice free ocean, or land) and the atmosphere, and processes deeper down, like within the permafrost soil, radiation active layer of snow-ice covers, or the ocean mixing layer itself. Additionally, the atmosphere determines or influences the living conditions for most of the Arctic biota. Accordingly, the atmosphere constitutes a fast acting link between all these compartments. The Atmosphere Flagship Programme, which originates from a NySMAC activity, is an initiative to connect the various research groups active in this field. A major goal is to observe and analyze key climate variables with the aim to monitor the status of the Arctic atmosphere, and climatic trends in the Svalbard archipelago. By investigating e.g. the coupling processes we intend to reduce uncertainties about future scenarios for climate in the Archipelago as well as in the Arctic. The linking of the atmosphere with the other compartments of the climate system is well reflected in the strong interaction of the Atmosphere Flagship programme and the other flagship programmes, namely the marine ecosystem, the terrestrial flagship and the glaciology flagship, and will be a central topic for this presentation.

The current Atmosphere Flagship programme addresses various specific topics referring to details of the above mentioned connections. These include analyses of long term meteorological observations, the interaction between the surface and the atmospheric boundary layer, the composition of the atmosphere with respect to climate active trace substances like aerosols or green house gases, as well as pollutants, the role of clouds in the Arctic atmosphere, interactions of the atmosphere with the snow covered ground, land-fast and drifting sea ice, surface UV spectral fluxes and its dependency on specific conditions in the stratosphere (ozone) as well as troposphere (clouds). Recently, the role of biogenic aerosols and the observation of black carbon in snow and atmosphere received particular attention.

As atmospheric processes are comparatively fast and some are independent from location, while others are specifically influenced by topography, it is quite natural to connect atmosphere

research activities across all locations on Svalbard. Within the Ny-Aalesund Atmosphere Flagship, we particularly highlight the connections to observations at Barentsburg, Pyramiden, and Hornsund, as well as the pan Svalbard meteorological network.

Looking to the vertical, atmosphere research goes well beyond the region more directly affected by climate changes. The polar atmosphere holds a wealth of specific phenomena, which attract human interest and attention, the aurora borealis being the most prominent one. These scientific activities shall be included in the flagship programme as well.

The Russian Scientific Center on Spitsbergen, Laboratory for chemical analysis in Barentsburg: International cooperation in frame of the BARELAB project (id 81)

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– The newly established research facility for chemical analysis in Barentsburg is a part of the Russian Scientific Center in Barentsburg managed by Russian Arctic and Antarctic Research institute (AARI). The laboratory is set-up in a dedicated facility on 300 m2 of lab space and includes a modern analytical instrumentation incl. chromatographs (LC-MS-MS, GC-MS, 2xLC, GC), element analysers (AAS & TCN) and photometers as major equipment for ultra-trace chemical analysis.

  The research laboratory is an essential partner of the BARELAB project (Integration of the New Lab Facility for Chemical Analyses in Barentsburg into International Cooperation in the Arctic, RCN project no. 246744/E10). BARELAB is a collaborative project funded by the Research Council of Norway (RCN). AARI, North-Western branch of Typhoon (Russia), NILU, NMBU and UNIS (Norway) are planning to establish a state-of-the-art environmental analytical laboratory in Barentsburg and coordinate their research priorities with similar facilities on Svalbard.

  The BARELAB deliverables includes a variety of joint experimental work, intercalibration exercises, technology transfer, educational activity and research training. In the future, it should allow development of scientific collaborations and involvement in relevant international project initiatives.

  In the initial phase of BARELAB, several collaborative activities were initiated and performed through training and research visits, participation in conferences and educational activities: Participation in NORMAN Workshop, NIVA, Oslo, March 2016;

- Introduction into laboratory management, QA/QC acquaintance: UiT, UNN, NILU, NMBU, Tromsø – Oslo, June 2016;
- Passive air sampling in Barentsburg in collaboration with NILU, June-September 2016;
- Passive water sampling in the Grønfjorden area with NIVA, July-September 2016;
- Attending the DIOXIN-2016 Symposium, Florence, Italy, August 2016;
- Introductory lecture at UNIS, September 2016;
- Participation in 6th Norwegian Environmental Toxicology Symposium, Oslo, October 2016;
- Joining the Workshop "Adaptation to environmental changes in the Arctic", Tromsø, October 2016;
- Hosting the field work of the UNIS postgraduate course AT-324/824 "Techniques for the Detection of Organo-Chemical Pollutants in the Arctic Environment" (responsible Prof. Roland Kallenborn, UNIS), January 2017;
- Attending the 16th International Conference on Chemistry and the Environment (ICCE-2017), Oslo, June 2017;
- Sample preparation and LC-MS-MS for PFAS analysis. Training at NILU laboratory, Tromsø, July 2017;

During the past two years, the establishment of an advanced laboratory for trace analysis in Barentsburg faced a number of challenges in particular with respect to logistics, laboratory supplies agreements, communication, instrument expertise and analytical methods. Our experience suggests that not only science-related issues, but also management-related aspects need to be addressed in order to maintain a suitable frame for analytical laboratory working environment in the Arctic. Further development and efficient use of the laboratory facility seems manageable mainly through broad involvement and collaboration as well as focusing on integrating the planned scientific work into the relevant international research initiatives and projects.

Acknowledgement: Financing of the BARELAB project by The Research Council of Norway (project no. 246744/E10) is gratefully acknowledged.

Characterization of the cloud conditions at Ny-Ålesund using sensor synergy and representativeness of the observed clouds across Arctic sites (id 41)

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Clouds are one of the crucial components of the hydrological and energy cycles and thus affecting the global climate. Their special importance in Arctic regions is defined by cloud's

influence on the radiation budget. Arctic clouds usually occur at low altitudes and often contain highly concentrated tiny liquid drops. During winter, spring, and autumn periods such clouds tend to conserve the long-wave radiation in the atmosphere and, thus, produce warming of the Arctic climate. In summer though clouds efficiently scatter the solar radiation back to space and, therefore, induce a cooling effect. An accurate characterization of the net effect of clouds on the Arctic climate requires long-term and precise observations. However, only a few measurement sites exist which perform continuous, vertically resolved observations of clouds in the Arctic, e.g. in Alaska, Canada, and Greenland. These sites typically make use of a combination of different ground-based remote sensing instruments, e.g. cloud radar, ceilometer and microwave radiometer in order to characterize clouds.

Within the Transregional Collaborative Research Center (TR 172) "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms $(AC)^3$" (www.ac3-tr.de) comprehensive observations of the atmospheric column are performed at the German-French Research Station AWIPEV at Ny-Ålesund, Svalbard. Ny-Ålesund is located in the warmest part of the Arctic where climate is significantly influenced by adiabatic heating from the warm ocean (Maturilli, et al., 2016). Thus, measurements at Ny-Ålesund will complement our understanding of cloud formation and development in the Arctic.

This particular study is devoted to the characterization of the cloud macro- and microphysical properties at Ny-Ålesund and of the atmospheric conditions, under which these clouds form and develop. To this end, the information of the various instrumentation at the AWIPEV observatory is synergistically analysed: information about the thermodynamic structure of the atmosphere is obtained from long-term radiosonde launches. In addition, continuous vertical profiles of temperature and humidity are provided by the microwave radiometer HATPRO. A set of active remote sensing instruments performs cloud observations at Ny-Ålesund: a ceilometer and a Doppler lidar operating since 2011 and 2013, respectively, are now complemented with a novel 94 GHz FMCW cloud radar. As a first step, the CLOUDNET algorithms, including a target categorization and classification, are applied to the observations (Illingworth et al., 2007). In this study, we will present a first analysis of cloud properties at Ny-Ålesund including for example cloud occurrence, cloud geometry (cloud base, cloud top, and thickness) and cloud type (liquid, ice, mixed-phase). The different types of clouds are set into context to the environmental conditions such as temperature, amount of water vapour, and liquid water. We also expect that the cloud properties strongly depend on the wind direction. The first results of this analysis will be also shown.

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Geophysical seafloor mapping applications in the fjords and shelf of Svalbar. (id 137)

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High-resolution multibeam mapping of the seafloor is widely used in modern sedimentological and glaciological research as well as paleoenvironmental and climate reconstructions, in addition to its more traditional use in hydrographic surveying for ensuring safe navigation depth. Over the past decade, a number of universities as well as public organizations have contributed to the acquisition of the multibeam bathymetric data from the waters around Svalbard.

At UNIS, the seafloor geophysical mapping methods are tightly integrated in undergraduate as well as graduate education, and form one of the basic tools in marine geological and geophysical research.

The geophysical data collected mainly from the UNIS' 15 m long research vessel Viking Explorer have been the basis for reconstruction of the extent and dynamics of the former glaciers in the fjords and ice streams out on the shelf. These data have also been used for imaging the retreat of the modern tidewater glacier margins and linking the glacier dynamics to the seafloor geological records. High-resolution images of the submerged glacier fronts have helped understanding of the glacier calving processes, the subglacial meltwater drainage as well as ice marginal sedimentary environments.

In this paper, we highlight some of our recent marine geological research projects and their link to paleo as well as modern glaciological and oceanographic research in the fjords and on the continental margin of Svalbard.

What Controls recent trend in temperature and precipitation at Ny Alesund? (id 210)

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During winter of 2015, the atmospheric conditions at NY Alesund were characterised by heavy precipitation and high temperatures, predominantly during the last week of December 2015. Investigating the causes, we find that the temperature and precipitation at NY Alesund may be linked to many aspects that include decadal scale variability, sea-ice loss and even tropical SST variability. On interannual time scales, the winter time temperature and precipitation may be linked to the Atlantic multidecadal Oscillation and sea-ice loss, whereas on daily time scales the interaction of synoptic events with the decadal forcings is visible. Microwave radiometer data show that these events influence the entire tropospheric column. Such kind of sporadic events mostly have a duration of 3-4 days and have consequences for the Fjord environment also during summer. During the last week of December 2015, wave trains emanating from the tropical Pacific region were noticed, potentially affecting the atmospheric circulation in the North Atlantic Arctic region. Thus local and remote forcings may interact and influence Ny Alesund. We analyse these aspects in the present study

The CalvingSEIS project: Glacier dynamic ice loss quantified through seismic eye. (id 96)

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About 40% of global glaciers and ice caps (excluding Greenland and Antarctica) loose mass through iceberg calving, while current models (e.g. in the IPCC) are currently not equipped to realistically predict dynamic ice loss, mainly because long-term continuous calving records are inexistent. Combined seismic/acoustic strategies are the only technique able to capture rapid calving events, continuously, and back through time over decades. CalvingSEIS aims to produce high temporal resolution, continuous calving records for the glaciers in Kongsfjord, Svalbard, and in particular for the Kronebreen glacier laboratory. Through innovative, multi-disciplinary monitoring techniques combining fields of seismology and bioacoustics, individual calving events will be detected and located autonomously and methods to quantify calving ice volumes

directly from the seismic and acoustic signals will be developed. Scaling seismic/acoustic signals to calving ice volumes require calibration. CalvingSEIS will thus generate a detailed catalogue of calving events employing state-of-the-art terrestrial remote sensing techniques to measure calving ice volumes, velocities, and ice-ocean interactions.

In August 2016, an in-situ measurement campaign at the front of Kronebreen, Svalbard brought together 14 people from 6 nations and 9 nationalities over a 2 week period to measure processes and properties of individual calving events, their volumes, and their signals recorded on passive seismic and underwater acoustic instrumentation. With the overarching goal to create a calibration dataset from which to relate the passive calving signals directly to ice volumes and fluxes, the datasets collected in the CalvingSEIS Experiment reveal fine scale processes occurring at the glacier/ocean boundary. Besides the passive seismic and bioacoustics sensors deployed, the team used terrestrial lidar to measure the volumes of individual calving events and terrestrial radar to measure the precise (mm per second) velocities of the ice front. Multiple time lapse cameras were deployed to visualize and classify the individual calving events, and further to assess potentially safe distances from the calving front which boats must maintain. Side looking sonar was used to map the subsea terminus of the glacier multiple times as well as the subsurface topography within the recently exposed area from glacier retreat. The compilation of these datasets makes up a unique encyclopedia of calving events and their specific properties that will form the basis to calibrate the passive records. Moreover, a number of fine scale processes at the calving front were observed, marine mammals and birds are visible on our time lapse imagery helping to train the bioacoustic signatures, and an amazing collection of radar images expose the fjord surface water circulation patterns close to the glacier front during the experiment, all of which provide an immense potential towards characterizing the components, connections and feedbacks involved in the transition zone from tidewater glacier to fjord.

Dynamics of snow cover characteristics exerting influence on stability of the permafrost on Svalbard (id 158)

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Climate variations result in changes of the snow cover characteristics, which have a certain influence upon thermal state and stability of permafrost. Analysis of data of meteorological station Barentsburg (Svalbard) and our own observations has revealed small change in the snow cover thickness for the period 1984–2015. At the same time, duration of the snow cover presence has shortened by 8%. In recent years, more than 60% of the snow cover thickness was

formed during the early third of the cold season, which adversely affects a rate of the ground freezing. Durations of thaws increased from 12 to 22 days, and the rainfall amount decreased during the cold period from 60 to 120 mm. The largest increase in the thaw duration and decrease of the rainfall amount fall on January and February. Summing up of the thaw duration and the rainfall amount for the 5-year periods demonstrated significant growth of both. It should be noted also that, according to data of the Barentsburg station and our ones, in a few last years, these parameters reached anomalously high values. Appearance of anomalous values of the snow cover thickness as well as of the dates of its onset became more frequent. For the last decade, recurrence of anomalous values of the snow cover thickness increased: one event for 2.4 years before 2000, and one occurrence of anomalous thickness for 1.4 years since 2001. The later onset of snow cover resulted in shortening of duration of its presence. Occurrence of anomalous duration of the snow cover presence was observed once for 4.3 years before 2001, and once for 3.3 years after 2000.

Bjerknes Compensation around Svalbard (id 39)

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A fundamental component for maintaining Earth's climate is the meridional transport of heat through both the ocean and atmosphere. Understanding the decadal to multi-decadal changes of these transports provides an insight into the natural variability of the climate system, while the geographical patterns of variability associated with these changes allows us to identify the regions of greatest sensitivity. The total energy transported by the climate system should remain approximately constant if the ocean heat storage and fluxes at the top-of-the-atmosphere are unchanging [Bjerknes, 1964]. Since heat is transported in the climate system through the atmosphere and ocean, any large anomalies in the ocean heat transport should be balanced by opposing variations in the atmospheric heat transport, and vice versa; a process that has since been named Bjerknes Compensation.

Bjerknes compensation has been identified in the 600-year control run of the Bergen Climate Model by examining the anomalies of the implied meridional heat transports in both the ocean and atmosphere. These anomalies show strong anti-correlation ($r=-0.72$, $p \leq 0.05$), and a multi-decadal variability with a period of approximately 60 years. Spatial patterns associated with this multi-decadal variability highlight part of the underlying mechanism, which occurs through changes in the sea-ice cover in the seas around Svalbard, leading to strong ocean-atmosphere fluxes, and sharp changes in the regional surface air temperature (Figure 1). These temperature

changes are shown to give rise to upstream and downstream changes in the sea level pressure, which change the large-scale flow over the Northern Hemisphere. Bjerknes Compensation is further identified in both the pre-industrial control runs and historical runs of fifteen CMIP5 models, the comparison of which provide insight into how Bjerknes Compensation will evolve in response to changing external forcings. The identification of Bjerknes Compensation in paleo data is an open challenge, one for which Svalbard is uniquely situated to provide invaluable data.

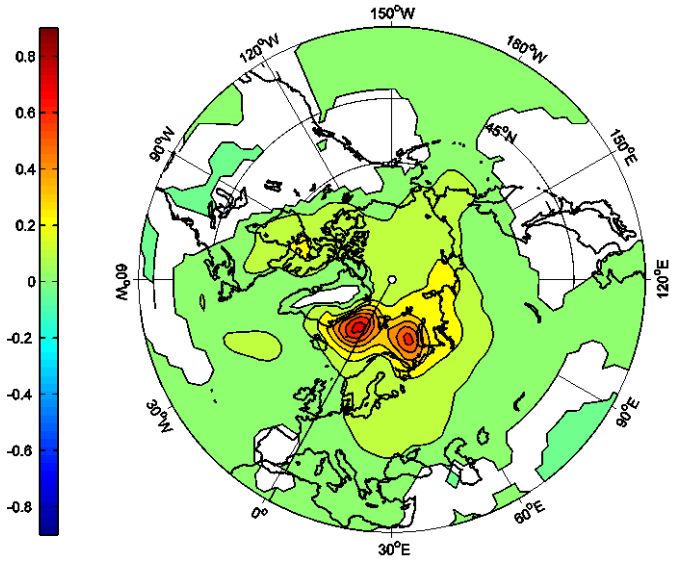

Figure 1. Regression of oceanic heat transport anomomlies aossciated with Bjerknes Comensation onto surface air temperature, in the 500-year pre-indsutrial control run of the Bergen Cliamte Model [K/std of H_0]. This highlights the importance of the waters around Svalbard for studying the multi-decadal variability of temperature in the Northern Hemispehre, and the impact of Bjerknes Compensation on Svalbard's surface air temperautre.

Variability of near-inertial waves in Kongsfjorden, an Arctic fjord in Svalbard (id 208)

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Arctic ocean is known for weak near inertial waves (NIW) due to the presence of sea ice, which acts as a barrier between surface wind and the ocean and restricts momentum transfer from atmosphere to ocean. Arctic sea ice has been undergoing substantial melting during the last decade. This leads ocean surface to become more exposed to wind energy. Since the last decade south-western Svalbard, south of 80 degree, is free of sea-ice mainly due to the warm Atlantic water intrusion, and the region is increasingly vulnerable to wind action. These changes may lead to the formation of NIW. In this study we examine near-inertial currents in the Kongsfjorden, an Arctic fjord in Svalbard, using year long ADCP and CTD observations. The ADCP mooring was deployed at 192 m at the centre of the fjord with 6 CT sensors at different depths. Data was collected in the year of 2014-2015. The separation of internal tide and near-inertial

waves is rather difficult in the location, as the period of both waves are very close. However internal tides are very weak inside the fjord (< 2 cm/s). A part of internal tide was removed by harmonic analysis and rest can be neglected. The range of velocity of near-inertial currents in the Kongsfjorden was 5-9 cm/s. The wind data from Ny-Ålesund weather station showed storm activity during the occurrence of NIW. The vertically averaged rotary spectra showed the predominance of clockwise energy with the presence of weak counterclockwise energy at near-inertial band. This shows that NIW is not purely polar, instead elliptical in nature. NIW shows standing mode vertical structure (in August 2014) and downward propagating signal (in June 2015). EOF analysis shows the dominance of first baroclinic mode structure, which explains 17-40% of total variance. In winter, storms are more frequent with more energy, but NIW is relatively weak. In summer, weak storm triggers relatively strong NIW. This may be attributed to the seasonal variation of stratification and mixed layer depth, where water column is well stratified during summer with shallow mixed layer, and homogenous in winter with almost no mixed layer. Satellite data show that the Kongsfjorden is ice free during the observational period.There is no evidence of presence of ice cover in winter inside the fjord to obstruct the wind stress. So that we can rule out the possibility of ice cover to diminish the NIW energy. It is expected that in warming conditions Arctic become more stratified and ice free. Both these conditions may have an impact on NIW and may contribute more to the ocean dynamics in future.

Ongoing research on Arctic cloud-aerosol-boundary layer by Korea Polar Research Institute (id 122)

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KOPRI has carried out a research project in Ny-Alesund focusing on the Arctic cloud and its interactions with aerosol and boundary layer. The project aims to better simulate Arctic climate system and thereby weather and climate in mid-latitude regions including East Asia. For the study of boundary layer wind structure and effect of turbulence on the Arctic cloud, we have been operating Doppler wind lidar from October 2016. After six-months of test operation on the roof of Koldewey station, the wind lidar was relocated to near the Climate Change Tower in April 2017. Since then, we are obtaining continuous vertical profiles of wind every half-hour. Here we expect construction of wind profile from the ground surface to about 1.5km by combining 34-m CCT and wind lidar as well as to-be-installed SODAR.

In addition, we are preparing to install a cloud droplet probe on the Zeppelin observatory to

measure cloud droplet properties such as size, number concentration, and liquid water content. These data will help us to study microphysical properties of the Arctic clouds in every season. Moreover, combination of the cloud data with various information of aerosol would enhance our understanding in terms of aerosol-cloud interaction and the Arctic climate system. In the talk, I would like to present some preliminary data of the wind lidar as well as cloud droplet probe. Also, expected cooperation with other research teams would be solicited.

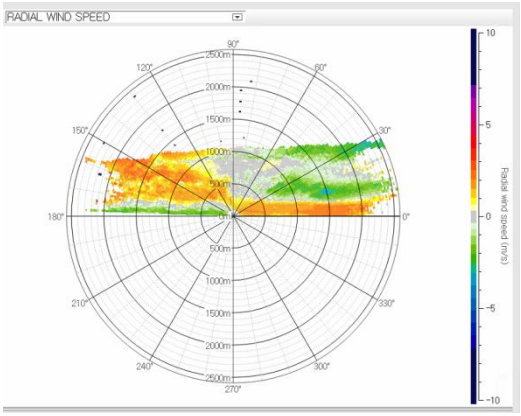

Figure. An example of North-South cross section of radial wind speed on April 27, 2017. Positive value means wind is approaching to the wind lidar and vice versa.

Snow-vegetation-permafrost interactions on Svalbard, insights from a snow manipulation experiment and remote sensing (id 123)

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The arctic climate is changing rapidly, which has a strong and diverse impact on snow cover, vegetation and permafrost. Warmer winters and increased precipitation alter snow depth, growing seasons lengthen, and permafrost is thawing. The many interactions between these processes, however, make it difficult to predict what the combined outcome on the phenology, composition and productivity of arctic vegetation and associated climate feedbacks will be. Over a decade ago, therefore, a snow manipulation experiment was established by UiT – The Arctic University of Norway in Adventdalen on Svalbard to study the effects of increased snow depth on the tundra ecosystem. Over the past years, as part of the RCN-funded SnoEco project, nutrient conditions, phenology and NDVI have been monitored in detail at these plots to track the changes induced by the manipulation experiment. Remarkably, the increased snow depth from the experiment has led to strong surface subsidence at one of the snow fences, which fully eroded an ice wedge, leading to strong export of sediment and carbon. Sudden and large effects from snow-vegetation-permafrost interactions, such as these, indicate the strong need for an

interdisciplinary observation program that to connect meteorology, hydrology, ecology and geomorphology together.

Remote sensing tools are an important tool to monitor arctic changes in an integrated manner. Therefore, the SnoEco project set up small rigs with near-ground remote sensing tools throughout the valley to monitor vegetation productivity under ambient conditions. Automatic RGB cameras on these rigs track the green-up and senescence of vegetation while NDVI and PRI are measured in parallel. In addition, cameras mounted on the mountain side in the valley provide an overview at a larger scale that can be compared to satellite data, and to the CO_2 fluxes measured at an eddy covariance tower in the valley, operated by Lund University. These observations were supplemented with UAV-based aerial mapping of the area in the summer of 2017. Together, these tools are used to track the response of the tundra ecosystem to recent extreme events, such as rain-on-snow events in mid-winter that form thick ice layers and damage vegetation.

The unique combination in SnoEco of remote sensing tools, detailed vegetation monitoring, and a snow manipulation experiment provides an extensive insight into the functioning and interaction of processes related to snow, vegetation and permafrost. The interdisciplinary nature of the project encourages cooperation with other research fields and modeling efforts to predict the future state of the high arctic ecosystems on Svalbard and the rest of the Arctic.

Climate-Ecological Observatory for Arctic Tundra (COAT) (id 5)

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The Climate-Ecological Observatory for Arctic Tundra (COAT) is an ecosystem-based observation system aiming at real time detection, documentation and understanding of climate impacts on terrestrial ecosystems in the Norwegian sector of the terrestrial Arctic (www.coat.no). COAT uses the adaptive monitoring approach, having question and hypothesis-driven conceptual “climate impact path models” at the core of the program. COAT aims to establish causal relations between food web components that are important to ecosystem functioning and/or management (response targets) and climate and management drivers (predictor targets). The models encompass key species, functional groups within the food webs and their mutual linkages. COAT builds on and expands the ongoing research and long-term

monitoring with methods ranging from field observations to remote sensing. Presently, we develop a network of automated weather stations for the COAT sites, Nordenskiöld Land and Brøgger Peninsula and surroundings, which will generate open access data. A key issue in COAT is to understand how weather variability generate landscape scale, temporal variation in snow and ice conditions, and the associated consequences for the terrestrial ecosystem on Svalbard. To achieve this goal the COAT team comprises multi-disciplinary competence within geophysics and ecology, and includes sites and research teams from other locations in the Arctic. We present a status and the direction of the current and future work.

Correlates of spatiotemporal variation in ground ice in Spitsbergen, Svalbard (id 170)

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Warm spells and rain (often termed rain-on-snow, ROS) events in winter are becoming increasingly frequent across the Arctic as a consequence of global warming. This causes changes in snowpack properties and, possibly, more frequent and more extensive ground icing, which may strongly affect vegetation, soil invertebrates and populations of herbivores. However, a general lack of spatiotemporally replicated data has often forced biologists to use weather proxies (such as ROS amount) from the nearest weather station as a surrogate for variation in icing, usually without field validation. In this study, we combine long-term ground ice time-series (n = 37 - 422 sampling sites per year) from multiple locations in coastal (Ny-Ålesund area; 2000-2015) and central Spitsbergen (Nordenskiöld Land; 2010-2015) to (1) examine the level and scaling of spatial synchrony in ground icing; (2) assess how ground ice varies locally according to topographical properties; (3) evaluate how well weather proxies reflect annual variation in ground ice conditions; and (4) predict historical variation in ground ice occurrence and thickness based on weather records. There was a strong spatial synchrony in late winter ground ice thickness across the 150 km distances covered by the sampling sites (average regional correlation $\rho = 0.59$). This spatial synchrony could be largely explained by the spatial synchrony in annual amount of winter rain (mm, Nov-Mar) recorded at weather stations across Svalbard ($\rho = 0.56$ over 410 km). Locally, ice thickness (given ice present) decreased with increasing slope and elevation, while ice occurrence decreased with increasing elevation, but not slope. The amount of winter rain (log(mm)) recorded locally (Ny-Ålesund or Svalbard airport) was the best single weather predictor of annual variation in ice occurrence (binomial model) as well as ground ice thickness, with a strong positive linear effect that decreased with elevation. As such, we confirm that the amount of winter rain (ROS) alone is a suitable proxy for ice

formation. However, including recorded snowfall amount (log(mm), accumulated up to the peak ROS event) improved the model fit for ice occurrence (but not thickness), suggesting an additive negative effect of snow amount on the probability of icing. Predictions from our best-ranked models indicate a sudden regime shift in ground icing in the late nineties. Rain- and ice-free winters occurred on average every third-fourth year before 1999, but never since. We discuss how the results from this first extensive spatiotemporal study of the ground-icing phenomenon may be applicable across disciplines.

A high-resolution dataset of climatic mass balance, snow conditions and runoff in Svalbard between 1957 and 2017 (id 68)

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The climate in Svalbard is undergoing amplified change compared to the global mean. This has major implications for discharge from glaciers and seasonal snow. We use a coupled energy balance – snow/firn model to simultaneously model the climatic mass balance of glaciers, as well as the seasonal snow pack development on land across the entire Svalbard archipelago. The simulation with a 1-km spatial and 3-hourly temporal resolution covers the period 1957-2017. A surface energy balance model is coupled to a multi-layer subsurface routine simulating the evolution of temperature, density and water content. On glaciers, snow, firn and ice evolution are modelled down to tens of meters below the surface, while on land, a seasonal snow routine is coupled to a soil model. Meteorological input is provided by HIRLAM regional climate model output, downscaled to the 1-km grid resolution by means of interpolation and elevation-dependent functions. Available stake mass balance records and automatic weather station (AWS) data from different regions in Svalbard are used for model calibration and validation. Based on the output, we first quantify spatiotemporal variability and trends of climatic mass balance and snow/firn conditions of all glaciers in Svalbard. In a next step, we analyze the multi-decadal development of seasonal snow conditions on land by quantifying trends in snow characteristics, such as date of snow onset and disappearance, minimum and maximum snow depth, and ground ice formation. Finally, we quantify runoff from both glacier- and land-covered areas, and discuss relative contributions. Altogether, the output of the simulation provides a dataset that may be of use in a wide range of applications ranging from runoff modelling, to ground ice studies to ecosystem studies. With regional climate model output becoming available with a monthly frequency, we also investigate the potential of generating a continuously updated online dataset of climatic mass balance and snow conditions in Svalbard.

The properties of flower microbiota in Ny-Ålesund region, Arctic (id 192)

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The flowers provide unique habitats to microorganisms, and the interactions between flower microbes, their plant hosts, and pollinators should play an important role in the arctic terrestrial ecosystem. In July 2014, seven kinds of flower samples (Cerastium arcticum, Silene acaulis, Saxifraga oppositifolia, Cassiope tetragona, Pedicularis hirsuta, Dryas octopetala, Draba oxycarpa) were collected from Ny-Ålesund, Arctic. As the isolation and purification, 273 yeast strains affiliated to 6 genera were obtained, the dominant genera were Mrakia (78.39%), Rhodotorula (15.02%) and Cryptococcus (4.15%); 173 bacteria strains belonged to 9 genera were isolated, the dominant genera were Pseudomonas (39.31%) and *Erwinia* (39.31%); 10 mycelial fungi strains were isolated and affiliated to seven genera, the dominant genera were Cladosporium (33%) and Phialocephala (22%).

The physical and chemical properties of eleven yeast strains were detected, including the range of growth temperature, sucrose tolerance, enzyme activity, the pattern of fatty acid and the metabolites during the utilization of sucrose. It revealed that these yeasts generally failed to grow at or above 25 ℃ and at sucrose concentration above 70% except Cryptococcus tephrensis and Rhodotorula mucilaginosa. However, even at low temperatures (4-10℃), some yeast were also shown the urease, amylase and lipase activity, and could grow at 50% sucrose. The main type of fatty acid was unsaturated fatty acids, such as 18:2 cis-9, 12/18:0a, 20:2 cis-11, 14 (ω6). The metabolites of strains during sucrose utilization were detected by SPME GC-MS and found that contained large amounts of Benzaldehyde, 2(3H)-Furanone, Hexadecanoic acid, Benzeneethanol and 2 Octenal, the common compositions of the scent of flower. However, the detected unusual metabolites, such as 1-Pentanol, 1-Hexanol, Phthalic acid, isobutyl octadecyl ester and 9, 12, 15-Octadecatrienoic acid may supply flowers with unique scents that enhance or decrease floral attractiveness to pollinators, and hence may indirectly affect plant fitness in the Arctic region.

iCUPE – Integrative and Comprehensive Understanding on Polar Environments (id 226)

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iCUPE (Integrative and Comprehensive Understanding on Polar Environments) is a 3-year project that answers to ERA-PLANET (European network for observing our changing planet) thematic strand 4 (Polar areas and natural resources).

The vision of iCUPE is to establish and maintain long-term, coherent and coordinated observations and research activities on environmental quality and natural resources in polar areas. The core idea of iCUPE is the development of novel, integrated, quality-controlled and harmonized in-situ observations and satellite data in the polar areas, as well as data products to the end users. iCUPE combines the integrated in-situ and satellite Earth Observation with a modelling platform. It 1) synthesizes data from comprehensive long-term measurements, intensive campaigns and satellites, collected during the project or provided by on-going international initiatives, 2) relates the observed parameters to impacts, and 3) delivers novel data products, metrics and indicators to the stakeholders concerning the environmental status, availability and extraction of natural resources in the polar areas.

The project will improve our understanding of the pollution sources and sinks, environmental and anthropogenic changes and elements of the cryosphere in polar areas by conducting high-level and high impact research by analyzing these integrated data together with the modelling frameworks.

Interdisciplinary education and research at Svalbard (id 44)

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One of the main purposes of the Norwegian Scientific Academy for Polar Research (NVP) is to promote research, education and sustainability in the Polar Regions through international cooperation and professional interactions across disciplinary and sectorial boundaries. In operationalizing this objective the NVP has in cooperation with partners hosted four interdisciplinary PhD and Post-doc summer schools in Longyearbyen since 2011, namely:

- Impact of climate change– on resources, maritime transport and geopolitics in the Arctic and the Svalbard area in 2011,
- Shipping in Arctic Water - the interaction of sea ice, ship technology, climate change, economy and other operational conditions in 2013
- Impact of climate change– on resources, maritime transport and geopolitics in the Arctic and the Svalbard area in 2015, and
- The Arctic Ocean and the marginal ice zone (MIZ) in 2017.

The society has problems and universities have disciplines, which is an ironic heart-felt sigh reflecting the lack of coherence between what societies perceive to be problematic and the way

universities are organized and work to meet the needs of society. Whereas disciplinary research focuses on the properties of the elements in systems, interdisciplinarity focuses on the relationship between the components. Interdisciplinarity require cooperation, not only between individuals and institutions, but also across gender, cultural and ethnic barriers. The interdisciplinary approaches and holistic insights supplement activities at universities and research institutions, which traditionally have disciplinary priorities, have been challenged during these NVP summer schools.

The paper will address how interdiciplinarity can contribute to the four state of the art challenges in the Arctic providing supplementary knowledge to that of disciplinary research. The interdisciplinary research requires multidisciplinary cooperation on all levels to create horizontal (or interdisciplinary) curiosity that requires further communication across different disciplinary traditions and specialized terminology. This interdisciplinary approach is applied on the knowledge integration across the gorge between nature and society addressing challenges in the Arctic.

The student participants at all four NVP summer schools have during the course of the week at Svalbard prepared a scientific report that they after each summer school has expanded in to a scientific peer review article addressing the topics of the respective summer school.

Identification of soundscape components in the Arctic settlements: Longyearbyen and Pyramiden (id 9)

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One of the goals of our study was to identify the components of the acoustic climate of two arctic settlements Longyearbyen and Pyramiden. Longyearbyen is a small town in the Svalbard Archipelago and it is one of the northernmost towns in the world. Longyearbyen is the largest settlement and the administrative center of Svalbard. The town has a population of just over 2,100 people.

You can distinguish the three main components of soundscape in Longyerbyen and Pyramiden: sounds of an inanimate nature, biological sounds and anthropogenic noise. Sounds of inanimate nature are: the river flow of the glacier, the waterfall and the wind. Biophonic sources such as: birds songs, barking of dogs. Anthropogenic origin sources are: roadway traffic noise, airport and an air traffic noise, marine traffic noise, energy facilities (power station, trafo stations, heat exchangers), footsteps and conversations of people, machines and equipment on buildings (fans,

pumps) etc. In winter, some sound sources disappear: streams and waterfalls freeze; no birds but appear new other: snowmobiles, snow plows, dog sleds, man footsteps on frozen snow. A 24-hour observation of the change in the sound pressure level in the middle of Longyearbyen city on a summer day and night is shown in Figure 1. Next settlement – Pyramiden is an abondoned town. It is a Russian settlement and coal-mining community on the archipelago of Svalbard. While Pyramiden has no permanent residents, a few workers maintain the rebuilt infrastructure, run hotel and guide tourists. There are 4 people during winter and about 15 man in summer time. Here we have identified four sources of noise of various origins: wind noise, seagull screams, power generator and fans of the hotel. Measurements of noise in Pyramiden were done only in the summer.

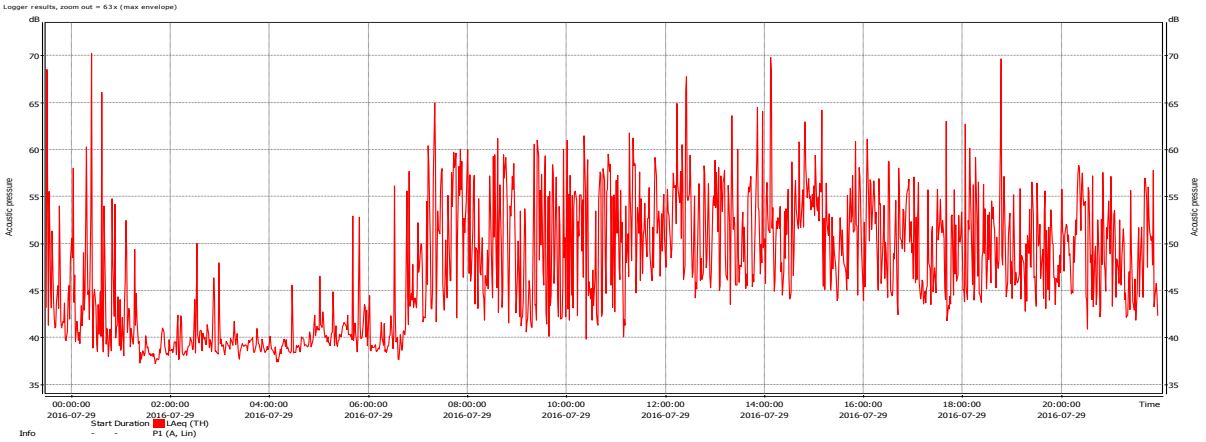

Fig.1. Record of 24-hour L_{eqA} sound level changes in the middle of Longyearbyen city (summer 28 / 29.07.2016)

Continuing research, we plan to make measurements in the winter time in Pyramiden and also during the summer and winter season in Barentsburg.

Silence is one of the most precious values of the landscape. Increasing influence of civilization on Svalbard makes it necessary now to think over reducing the impact of noise, which is caused by man and his activities. We would like to study how climate, land transformations, biodiversity patterns, timing of life events and human activities create and change the dynamic soundscape.

The land-atmosphere exchange of methane and carbon dioxide at the Adventdalen ice-wedge site, Svalbard (id 111)

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In 2011, we established continuous flux measurements at an ice-wedge polygon site in Adventdalen valley, central Svalbard to study the land-atmosphere exchange of methane (CH4)

and carbon dioxide (CO2) in high Arctic tundra. Our measurements employ eddy covariance and automatic closed-chamber systems that have similarly been used by the Greenland Ecosystem Monitoring program. We find that the total seasonal emission of CH4 during summertime in Adventdalen is comparable to the high Arctic tundra at the Greenlandic sites, but the temporal pattern in Adventdalen is wider and less distinct. During the cold season, the snowpack in Adventdalen can feature several ice layers, which suppress the expected gas emissions to the atmosphere, and conversely lead to large gas accumulations in the snowpack. Our year-round CO2 flux measurements indicate that the Adventdalen ice-wedge site is a strong sink for CO2 (around -82 gC m-2 yr-1). Due to differences in light-use efficiency, wetter areas with low-centered polygons sequestered 47% more CO2 than drier areas with flat-centered polygons. While Svalbard has experienced an increase in mean annual air temperature of more than 2 K in the last few decades, historical aerial photographs from the site indicate no sign of ice-wedge degradation over the last seven decades. Apparently, warming has thus far not been sufficient to initiate this process, possibly due to the absence of extreme summer heat episodes in the maritime climate on Svalbard. However, in Arctic regions where ice-wedge degradation has already initiated the associated drying of landscapes, our flux measurements from Adventdalen suggest a weakening of the CO2 sink of polygonal tundra.

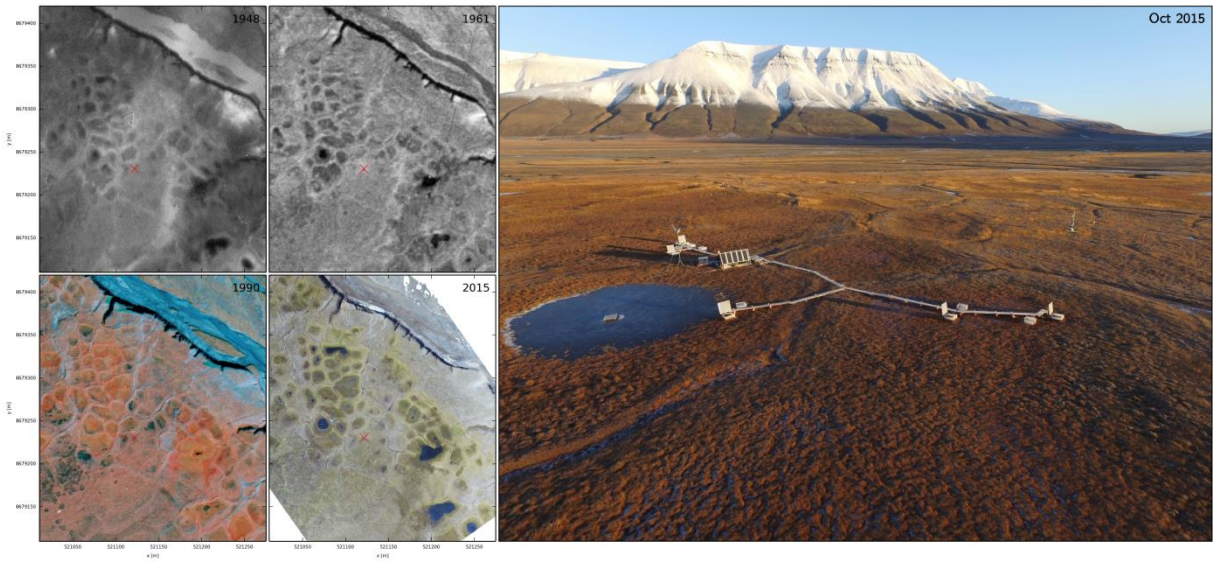

Figure 2: Aerial photographs of the Adventdalen ice-wedge site

Earthquake activity in Storfjorden, Svalbard: current knowledge and implications (id 84)

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The area of Svalbard, situated between the branches of the Arctic mid-ocean ridge system, is considered a stable continental region of low to moderate tectonic seismicity. During the last decade, a gradual enhancement of the seismic networks in Svalbard and the European Arctic took place, providing the seismological community active in the region with increased resolution when studying the regional seismic activity, although the network does not yet deliver adequate resolution for detailed seismotectonic studies. These new possibilities, seen together with the occurrence of the long earthquake series in the offshore area of Storfjorden that persist since the large, magnitude 6 earthquake of 21 February 2008, reveal a different picture. While major, mapped fault zones that have long been considered the most plausible candidates for larger magnitude earthquake generation in the region have remained completely inactive during the prolonged activity, previously unknown tectonic structures have emerged through the analysis of related seismic data as the activated fault(s).

The 2008 – 2017 activity in Storfjorden delineates a NE-SW trending active zone, extending about 170 km from the southeastern part of the fjord to the western shore of Edgeøya. Whether this is one continuous fault or a complex of sub-parallel ruptures cannot be established with the resolution achieved by the current seismic station configuration. Apart from this main rupture, an abundance of peripheral structures was secondarily activated during this activity, suggesting a complex geotectonic regime. Regardless of the specific geometries in the activated volume, these findings signify the discovery of a new source region, capable of earthquakes up to magnitude 6, with potential to cause damage to vulnerable infrastructure, as e.g. in the case of old buildings in the Barentsburg settlement in 2008, or trigger rock falls and landslides. The larger earthquakes caused alarm in the local community, the magnitude 5.3 event near Edgeøya in March 2016 raising also concerns regarding the potential of such earthquakes to inflict damage on the permafrost layer.

An additional result that takes clearer shape with increasing observation time by the enhanced regional seismic network is the underestimation of the background levels of natural, tectonic seismicity in Svalbard. Prior knowledge was often based on temporary, local-scale deployments of seismic stations that could only achieve spatial resolution for a limited source region over a short interval.

As new results stream in, the need for a reappraisal of the seismic hazard in Svalbard becomes pressing. The necessity is heightened by the increased human presence and activity in the Archipelago, as well as the need to map out processes acting on the fragile polar environment.

Detection of Svalbard glaciers on satellite imagery with subpixel accuracy (id 64)

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Multispectral imagery from Landsat 8 OLI instrument was used for detection of snow and ice surfaces in Spitsbergen. The detection was performed with a digital algorithm designed for this study with aim of delineating borders of ice and snow areas with sub-pixel accuracy. The presentation describes the process of development of the algorithm and its performance in glaciological mapping and change detection.

The method relies on techniques of digital image manipulation. It includes resampling of satellite image to 5 m/pixel spatial resolution, sharpening with Kuwahara filter, calculation of NDSI indicator and global thresholding of the resulting image. This set of operations has emerged as optimal from a test of different values of resampling magnitude, and different base images and edge detection techniques. Terrestrial Laser Scanning data obtained in the Ariebreen area, south Spitsbergen, by employees of Institute of Geophysics, Polish Academy of Sciences, were used as reference dataset for assessment of quality of detection. Goodness of result was measured as spatial accuracy of the resulting glacier outline as compared to the reference outline derived from the point cloud. The optimal procedure is capable of ice and snow detection with mean difference from the reference line of 9.25 m, compared to 17.78 m of accuracy when unresampled image was subject to the same procedure.

The methodology was used for mapping and change detection of several Spitsbergen glaciers. Multi-temporal dataset consisting of imagery created during Landsat 5, 7 and 8 missions was used to map extent of the chosen ice bodies over the years and explore challenges related to the methodology's usage. The satellite images used in this part of the study were precisely coregistered, additionally to their embedded georegistration, to reduce errors, as the detection accuracy of the algorithm is greater, than the georegistration error between two images. The algorithm in question was developed in the Python programming language and uses simple image processing techniques to achieve good results. It is therefore more accessible to users without extensive backround in mathematics or image processing software. In the future it will be possible to publish the algorithm for general use in GIS programs.

Biogeochemistry of sea water and bottom sediments exposed to coastal runoff and glacial melting (studies in the Templefjord, Spitsbergen) (id 131)

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The aim of this work was to assess the current chemical regime of sea wates and bottom sedimentsexposed to coastal runoff and glacial melting and an analysis of the possible consequences associated with climate warming (melting of glaciers, permafrost thawing). The work is based on chemical studies of sea water, fresh water, sea ice, fresh ice, glacier, bottom sediments, soil and permafrost, carried out at different intervals within the framework of the Norwegian Research Council POLRES program Norwegian-Russian grants CARSIC (http://www.niva.no/carsic) and POMPA (https://pompaproject.wordpress.com).

Totally there were performed 5 expeditions: in February 2011, in September 2011, in March 2014, in June 2015 and in June 2017. We studies distributions of nutrients, carbonate system parameters, metals, including mercury and methyl mercury, and POPs. Chemical analyses were made in parallel in Norwegian and, when possible, in Russian laboratories. An example of the distributions of chemical parameters in winter and in wummer in the water column is shown in Figure.

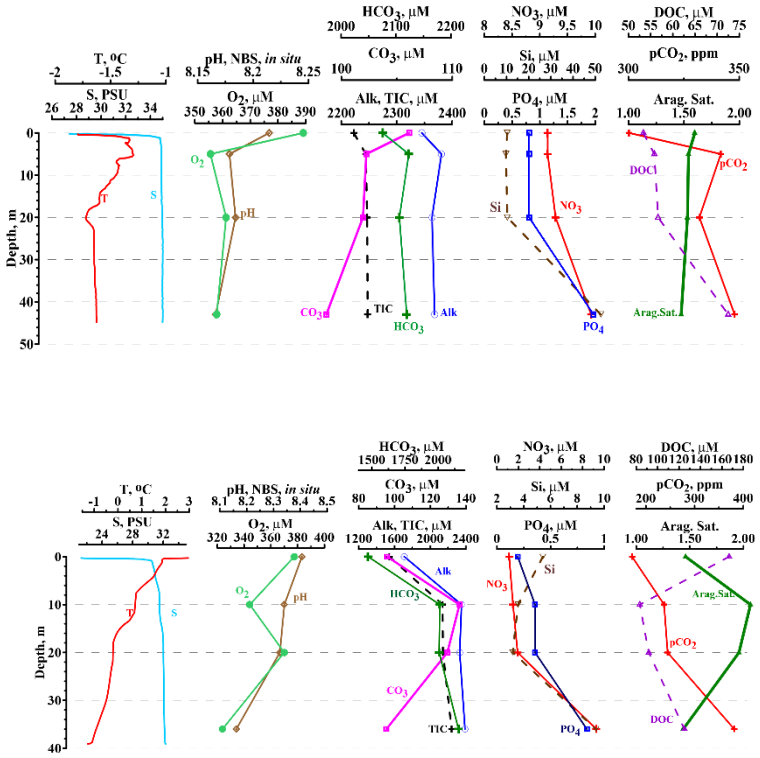

Figure.*Vertical distributions of physical and chemical parameters in the Templefjord in Winter (top) and in Summer (bottom).*

The data received allowed to estimate the characteristic ranges or concentrations of the studied parameters, estimate their seasonal changes, that can be used for the model validations.

The mass balance of Nordenskiöldbreen and Lomonosovfonna 2006-2017 (id 119)

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The mass balance of the outlet glacier Nordenskiöldbreen and its accumulation area on the ice field Lomonosovfonna has been studied by Uppsala and Utrecht universities since 2006. The primary data of the mass balance is from stake readings performed each spring, and has been interpolated using an energy balance model, and by tracing reflections of snow and firn layers using GPR. The mass balance shows an increasing loss of mass in the lower ablation area, and, a small growth in the upper accumulation area. An interesting feature with the mass balance time series is a bi-annual variability in the net balance. This is reflected in the calculated equilibrium line altitude (ELA) (Figure 1), where the bi-annual variability is much larger than a linear trend. We will present the results, and discuss this bi-annual mode in the net balance, as well as if the ice flux of Nordenskiöldbreen is adjusting to the steepening slope of the glacier.

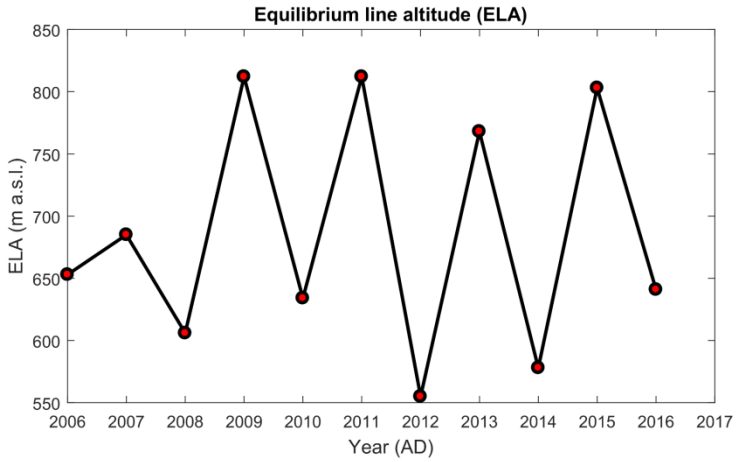

Figure 1. Equilibrium line altitude of Nordenskiöldbreen 2006-2016.

Were land meets sea: Effects of terrestrial inputs on Svalbard's coastal ecosystems (id 145)

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Arctic coastal ecosystems are in transition, with multiple (often interrelated) stressors leading to substantial and long-term environmental change. Thawing permafrost, melting glaciers, changes in precipitation and runoff patterns and land-use changes related to increasing human activity in northern regions can lead to changes in the movement of water, nutrients, organic matter and contaminants across the land-ocean interface.

Here, we present a new Norwegian Research Council project ("Where land meets sea: Effects of terrestrial inputs on contaminant dynamics in Arctic coastal ecosystems (TerrACE)"). The TerrACE project focuses on generating quantitative information about terrestrial inputs to coastal waters in Svalbard, and how these inputs can directly and indirectly affect coastal water

chemistry, food web interactions and concentrations of contaminants such as mercury and PCBs in coastal organisms.

Key project components include: 1) characterization of riverine water chemistry in the Isfjorden region of Svalbard, 2) a detailed survey of physicochemical conditions (and abiotic contaminants concentrations) along gradients in the influence of terrestrial inputs (i.e. river-fjord and glacier-fjord transects, and sites adjacent to seabird colonies), 3) a quantitative assessment of the effect of terrestrial inputs on energy and contaminant flow through coastal food webs, and 4) the development of a spatially applied Bayesian Network model tool describing the direct and indirect effects of terrestrial inputs on contaminant accumulation in coastal food webs. In this presentation, we will also highlight key research needs, priorities and collaborative opportunities related to land-ocean interactions on Svalbard and the pan-Arctic, and will present a preliminary conceptual model for the complex interplay between terrestrial inputs to Arctic coastal waters and coastal biogeochemistry, ecology, and contaminant dynamics (transport, fate and food web accumulation).

Subglacial hydrology and spatiotemporal variation of fresh water flux to Kongsfjorden (id 97)

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Different dynamic behavior and subglacial discharge inferred from observational plume data lead to analyze subglacial hydrology of tidewater glaciers of Kongsfjord basin, northwest Svalbard. Melt water runoff and dynamics of glaciers of Kongsfjord basin is well studied with modelling and satellite data, but hydrology of entire region is poorly understood. Here, we present subglacial hydrological analysis of three adjacent glaciers that predicts subglacial pathway of surficial melt water once it enters the bed. Our analysis show that there is possibility of substantial water piracy between two adjacent glaciers which is supported by observational plume at the glacier front of those two glaciers. In this study, we also aim to estimate spatial and temporal influx of fresh water to the Kongsfjord from its surrounding glacierized and non-glacierized area. A surface energy balance model has been used to simulate spatial distribution of runoff from entire Kongsfjord basin. Furthermore, we implement a simple routing model to simulate discharge hydrograph at the major outlets of glaciers at Kongsfjord basin. The modelled hydrograph at two major outlet points have been compared with observational data. Plume data has been used as proxy to discharge measurement at Kronebreen outlet and to evaluate the

model. We find good correlation between direct discharge measurement of proglacial stream of a land terminating glacier and the modelled hydrograph.

Mass balance, dynamics and isotopic study of selected glaciers in Spitsbergen, Svalbard (id 16)

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Around 60 % of Svalbard's land area is covered by glaciers. Direct glaciological method has been using for calculating the glacial mass balance and surface ice velocity estimation of the Vestre Broggerbreen (VB) and Feiringbreen glaciers. Surface ice velocity is almost between 2 and 3 m/annum at most of the points. However there are few points in VB where velocity is much higher than expectation (10-20 m/annum). Ground Penetrating Radar (GPR) survey has been performed to measure ice thickness. The average snow water equivalent (SWE) for the years 2014, 2015, and 2016 was 697.9±185 kg m^{-2}, 603.4±162 kg m^{-2}, and 376.8±172 kg m^{-2} over the VB respectively, while for the Feiringbreen it was 381.9±187 kg m^{-2} in the year 2016. Different types of water samples i.e. fresh snow, meltwater, lake water, and snow and rain water were collected to trace the isotopic variation in liquid and solid phases samples. We have performed addition measurement of $\delta^{17}O$ to derive a new tracer, ^{17}O-excess which is relatively insensitive to temperature as compare to the d-excess. All samples fall on the line of 0.524 which is lower compared to the GMWL (global meteoric Water line), due, in part, to the evaporative loss. The lake water $\delta\,^{17}O$ and $\delta\,^{18}O$ are enriched as compared to the fresh snow and melt water which could be due to the evaporative loss. However rain water sample shows the most depleted values. The second order parameter ^{17}O-excess and d-excess for meltwater and rainwater is 27 (permeg) & 8.3 (‰) and 36 (permeg) and 3.9 (‰) respectively. Since we have measured smaller sample size (n=7, year 2015) large sample sets are needed to better conclusive statements from isotopic perspective.

Climate-Ecological Observatory for Arctic Tundra (COAT) (id 175)

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The Climate-Ecological Observatory for Arctic Tundra (COAT) is an ecosystem-based observation system aiming at real time detection, documentation and understanding of climate impacts on terrestrial ecosystems in the Norwegian terrestrial Arctic (www.coat.no). COAT uses the adaptive monitoring approach, having question and hypothesis-driven conceptual “climate impact path models” at the core of the program. The program aims to establish causal relations between food web components that are important to ecosystem functioning and/or

management (response targets) and climate and management drivers (predictor targets). Here we present an example of our monitoring design, based on ongoing and planned monitoring, of ecologically relevant state variables in the Svalbard terrestrial ecosystem. We give examples of state-variables and their trophic and non-trophic links and interactions across monitoring modules and ecosystems, to demonstrate the COAT-approach to ecosystem-based ecological monitoring. We present the moss tundra-monitoring module and its state variables, and how these variables link to other focal ecosystem components described in the other four COAT monitoring modules (Arctic fox, Svalbard reindeer, Svalbard rock ptarmigan and Geese*)* and the climate observational network*.* This study design, replicated at landscape level in the COAT study sites around Brøgger Peninsula (and surroundings) and on Nordenskiöld Land, will be the basis for the monitoring of 'plant-herbivore-climate' interactions. Currently, COAT is implementing research infrastructure (2016-2020) for the long-term ecosystem-based monitoring. We hope that this talk may be a basis for discussing future needs for monitoring of focal ecosystem components not yet covered.

Climate and surface energy balance of Nordenskiöldbreen, Svalbard: 10 years of in situ observations (id 80)

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In spring 2006 a climate monitoring program on Nordenskiöldbreen, Svalbard, was initiated, which is still on going. The program focuses on the dynamics and mass budget of the glacier, and includes mass balance (stake and sonic height ranger) and automatic weather station (AWS) observations (AWS since 2009).

At the AWS site (±550 m a.s.l.) the average annual temperature is about -8.0°C. Annual mean wind speed is about 4.5 ms^{-1} and is predominantly directed down glacier with a directional constancy of about 0.59, a predominant katabatic wind. The annual mean temperature on the glacier over this period (2009-2016) increases with 0.40°C/year. However, this increase is not significant because of the short observational period and large inter-annual variability. The AWS observations are used to calculate the individual surface energy fluxes using a surface energy balance model. Results show that throughout the year the sensible heat flux is mostly positive due to a constant surface based temperature inversion. From May to September this temperature inversion is caused by cooling of the surface by long wave radiation while in the summer months the surface temperature is limited to 0°C, the temperature of a melting surface. At the AWS site the amount of melt energy available in the summer months corresponds to

about 1.3 m w.e. snow and ice melt. This is comparable to derived from the observations: 1.2 m w.e. of which 0.9 m w.e. is ice melt. The inter-annual variability in melt is such that no trends are observed. However, the melt season increases in length, especially due to melt occurring later in the autumn and even in winter. This is likely related to the decrease in sea ice in the fjord in front of the glacier.

Figure: Photo of the Automatic weather station on Nordenskiöldbreen in April 2011. (Photo: A. Waxegard).

Svalbard's glaciers in a changing climate (id 213)

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About 5% of the global glaciated area can be found in glaciers and ice caps outside of the large ice sheets of Greenland and Antarctica. Although this only represents at most 0.6% of the total global land ice volume, the melting of glaciers and ice caps contribute about 25% to the present on-going sea level rise of 3.2 ± 0.4 mm yr^{-1}. In the Arctic region, the Svalbard archipelago is covered for about 60% of its total surface area by glaciers and ice caps. With an estimated volume of ~7000 km^3 these glaciers represent in total about ~2 cm sea level rise. Glaciers on Svalbard are sensitive to climate change due to the location of the Archipelago in the North

Atlantic at the northernmost tip of the North Atlantic Drift, and at the current boundary of the maximum winter sea ice extent. The majority of Svalbard glaciers have been retreating since the late 19th century, and glacier thinning is evident for most glaciers over the past decades. Monitoring Svalbard's glaciers occurs on different spatial and temporal scales, using different techniques. In situ observations and remote sensing products play a pivotal role in monitoring the current state of the glaciers, and are also indispensable in the evaluation and validation of climate and energy balance models. These models make it possible to study the key processes affecting the mass budget of the glaciers, from increased air temperature to decreased sea ice extent, for the recent past and in a future changing climate.

This presentation will highlight the current tools and possibilities to monitor Svalbard's glaciers in a changing climate.

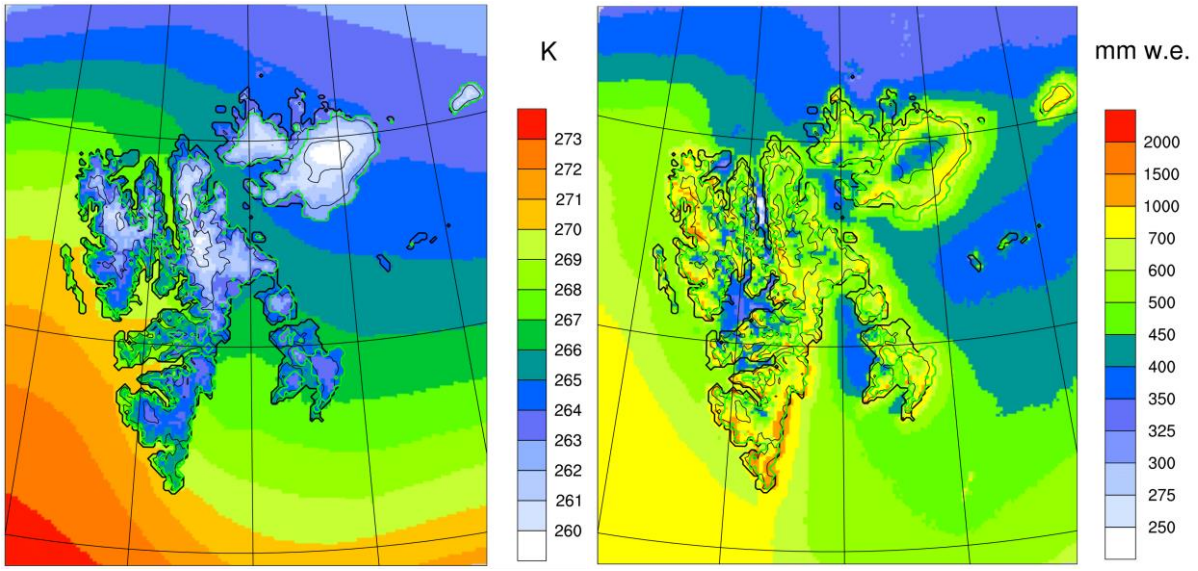

Figure: Annual mean (1970-2014) 2 m air temperature (left) and total precipitation (right) based on output from the regional atmospheric climate model RACMO2.3.

Holocene glacier fluctuations reconstructed from lake sediment at Kløsa and Vårfluesjøen, Spitsbergen (id 182)

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The Arctic region has experienced a significantly larger warming during the last decades compared to the rest of the world, and model simulations indicate a continued amplification of future global warming in the Polar Regions. A better understanding of natural climate variability

in the Arctic is much needed to provide a better context for the observed warming trend. By utilising proxy data it is possible to obtain palaeoclimatic records beyond the range of instrumental observations, which increase our understanding of long-term Arctic climate change. Here, we present a continuous record of past changes in Equilibrium-Line Altitude (ELA) for the alpine glacier Karlbreen, located on the northwest of Spitsbergen (79^{o} N), based on sediment analyses from the distal glacier-fed lake Kløsa. We compare this to ongoing research on the north coast of Svalbard where multiple glaciers in the catchment of Vårfluesjøen is reconstructed. A multivariate statistical analysis suggests that the concentration of geochemical elements Ti, Si and K in the lake sediments, together with the physical parameter dry-bulk-density (DBD), reflect changes in the amount of inorganic detrital input to Kløsa, which is closely linked to the size and ELA of the upstream glacier Karlbreen. A linear regression model based on historically documented glacier extents was used to calculate continuous ELA changes back to ~3500 cal. yr. BP. From about 9200 to 3500 cal. yr. BP, the sedimentary record indicates that Karlbreen was very small or had completely melted away. Karlbreen was probably close to its maximum Holocene extent several times during the Neoglacial, first around 1700 cal. yr. BP, then later at 225 and 135 cal. yr. BP. An ice-cored moraine system in front of Karlbreen extends well into the main basin of Kløsa, and it is difficult to explain how this moraine could have formed without disturbing the sedimentary record in the lake (e.g. through slumping events). The sedimentary record in Kløsa is continuous and undisturbed over the past 6700 years, suggesting that the outermost moraine formed prior to this time and that it most likely survived the Holocene Thermal Maximum (HTM) on Svalbard.

Unmanned continuous reflectance monitoring of snowed surfaces (id 29)

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The monitoring of the cryosphere is mandatory to the comprehension of climate changes in polar areas. The analysis of the snowed surfaces, coupling remote sensed images and field data, can offer the best option to monitor the cryosphere changes through time. The availability of ground-truth observations concerning the spectral albedo, in the wavelength between 400 and 2500nm, can support remote sensing analysis not only to derive the spatial distribution of snow/ice covers, but also to supply information about their physical characteristics. The continuous monitoring of the snowed surface offers an effective tool to gather integrated information about the evolution of cold regions in response to daily/hourly variations. However, the availability of continuous observations in polar areas is limited, especially considering the difficulty of obtaining multi or hyper spectral images without cloud cover. While measurements

of broadband albedo are performed continuously from different polar observatories, information about the spectral albedo are still limited, for logistical reasons, to short periods. For this reason, in the framework of the CNR-ARCA project, it was developed an activity devoted to implement the CCTower facilities with an innovative instrument (SnowIce CReM – Snow and Ice Continuous Reflectance Monitor) aimed to obtain continuous narrow bands albedo at 860, 1240 and 1640 nm. These bands were selected in order to support also the estimation of the Normalized Difference Snow Index (NDSI). This parameter, defined as the normalized ratio between visible and short-wave infrared bands, is usually computed by remote sensed data for investigating snowed areas.

This instrument was initially deployed at the CCTower during the 2015 field campaign together with the Fieldspec spectrometer, installed on a tilting platform, in order to estimate the performance of the system. The device was moved in September 2015 to an undisturbed site close to the CCT and it is actually running. The data analysis of the melting seasons is an ongoing activity and the preliminary results seems to indicate that the evolution of the NDSI is strictly related to the snow aging associated with the snow-depth reduction in the first part of the season. In addition to that, steep NDSI values increments can occur in correspondence to precipitation events or to strong-wind conditions.

High-time resolved radon-progeny measurements in Ny Alesund: results and potentialities (id 63)

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The estimation of radon progeny in the Arctic region represents a scientific challenge due to the required low limit of detection in consideration of the limited radon emanation associated with permafrost dynamics. This preliminary study highlighted, for the first time, the possibility to monitor radon progeny in the Arctic region with a higher time resolution. The composition of the radon progeny supported the identification of air masses dominated by long-range transport (with life up to 20 days and more than 20 days) in presence or not of near-constant radionuclides instead of long and short lived progenies. This study supports to extend this approach from the definition of the accumulation processes involving isotopes present in the lower atmosphere, to the identification of the stability conditions of the lower atmosphere, to gather information about air masses and the soil-exhalation conditions. Two different emanation periods were defined in accordance to the permafrost occurrence at the ground. Furthermore,

accumulation windows were recognized coherently to the meteo-climatic conditions occurring at the study site (Ny Alesund – Gruvebadet observatory). The composition of the radon progeny offered the opportunity to identify air masses dominated by long-range transport, in presence or not of near-constant radon progeny instead of long and short lived progenies. Furthermore, the different ratio between radon and thoron progenies evidenced the contributions of local emissions and atmospheric stability. While soil radon exhalation was modeled using ground measurements in the Bayelva borehole [Paulik et al 2014] and remote sensed data [Eumetsat 2015], natural radioactivity was measured using a single-filter system [Salzano et al 2016]. This preliminary attempt must be continued with a longer time series in order to statistically analyze the correlation between radioactivity and mixing state of the lower atmosphere. However, we are confident that coupling this method with traditional chemical determinations on gases and aerosols, a more complete picture of pollutant dynamics in the Arctic region can be achieved.

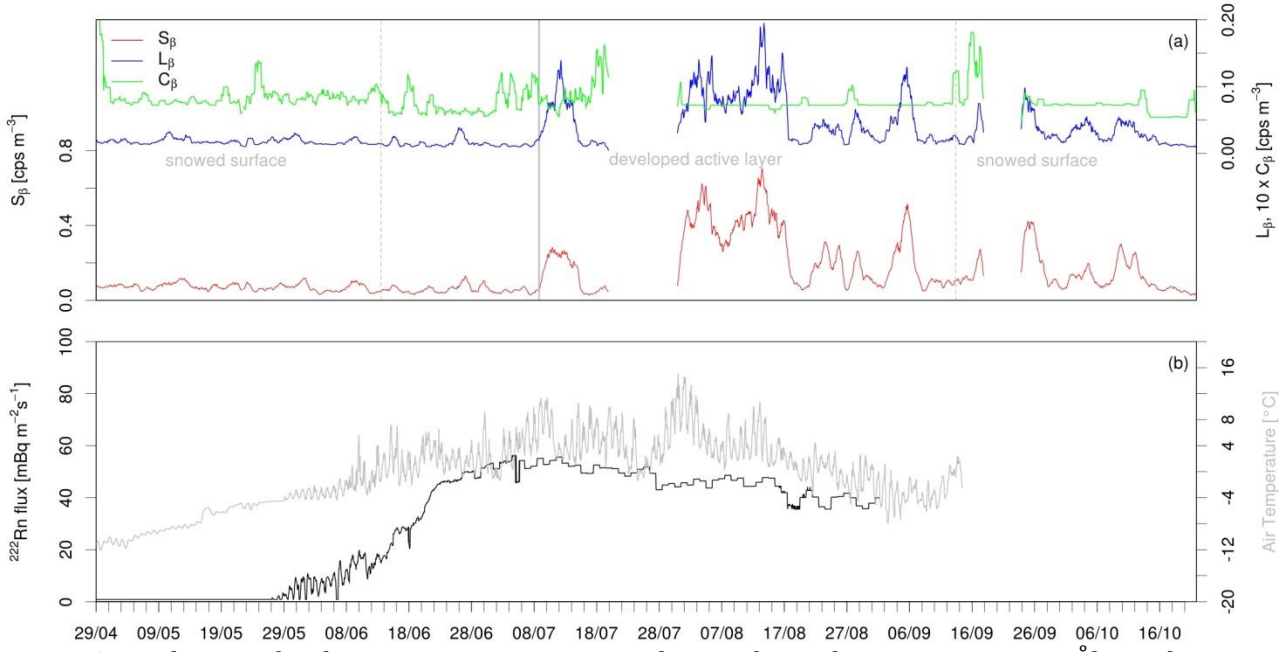

Figure 1: Evolution of radon-progeny components during the melting season in Ny-Ålesund in 2015.

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INTAROS – development of a multidisciplinary Pan-Arctic observation systems (id 154)

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The objective of INTAROS is to develop an integrated Arctic Observation System (iAOS) by extending, improving and unifying existing systems in the different regions of the Arctic. INTAROS has a strong multidisciplinary focus with emphasis on developing integrated Arctic Observing System (iAOS) including data from atmosphere, ocean, cryosphere and terrestrial sciences, provided by institutions in Europe, North America and Asia.

INTAROS is carrying out survey of established networks/observing systems as well as individual measurement campaigns and projects. The survey will first be conducted among the INTAROS partners, in particular those who will provide data to the iAOS to be used in stakeholder defined applications. After that, the survey will be extended to scientists and data managers also outside the INTAROS consortium. This will increase the value of the survey and contribute to develop Pan-Arctic Observing System, and contribute to development and implementation of innovative solutions to fill some of the critical gaps in the in situ observing network and data management systems.

INTAROS has a strong focus on contributing to the in-situ observing system, and is now planning the main fieldwork period 2018-2020 in coordination with national and international initiatives. The field-work will take place in different regions of the Arctic both on land and in ocean. In Svalbard, INTAROS participates in the Kongsfjorden underwater monitoring station. INTAROS will connect data collected in the Svalbard region to a Pan-Arctic Observation System in collaboration with other projects and infrastructures such as SIOS, ENVRI-PLUS, ICOS, and EPOS. Furthermore, INTAROS aims to engage local communities to contribute to observing systems both in Greenland and Svalbard. As part of INTAROS and REGIMES projects, high school students from Bergen visited Longyearbyen. The goal was to eyewitness the environmental change in

Svalbard, and to interview people in Lonyearbyen - how they observe and feel about the climate change in Svalbard.

INTAROS has organized a first Stakeholder workshop to support the evolution into a sustainable Pan Arctic observation system. Several workshops will be organized to support the coordination, mobilization and cooperation between the existing European and international infrastructures, the modeling communities and relevant stakeholder groups. This where will enable better-informed decisions and better-documented processes within key sectors (e.g. local communities, shipping, tourism, fishing), in order to strengthen the societal and economic role of the Arctic region.

Influence of high-latitude atmospheric circulation changes on wintertime Arctic sea ice and climate (id 174)

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Our analysis is focused on the remarkable climate anomalies observed in the Arctic fall-winter 2016, marked by record loss of Arctic sea ice cover and record warm surface air temperatures [1]. Understanding such climate anomalies requires to unveil the respective roles of atmospheric circulation from local (e.g. albedo/sea-ice) feedbacks [2]. Here, we investigate the influence of atmospheric circulation on regional climate anomalies using water vapour isotopic composition to trace moisture origin, combined with information from atmospheric reanalyses, backtrajectory calculations, and atmospheric modelling.

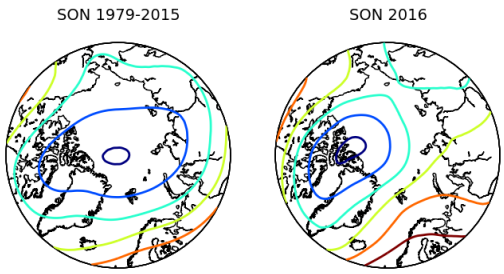

Figure 1: Geopotential height at 500 hPa

Using Greenland summer data, Steen-Larsen et al [3] related high d-excess levels in surface vapour to the advection of moisture from the Arctic sea ice margin, where strong kinetic fractionation occurs at evaporation. Here, we extend these results using datasets from several Arctic sites (Svalbard, North West Greenland, Polastern ship) and identify joint anomalies of d-excess and $\delta^{18}O$ to characterize atmospheric transport pathways. We further use the warm

Arctic climate anomalies of fall and winter 2016 to explore intra-seasonal isotope-temperature relationships for climate warmer than in the present days during e.g. the last interglacial period or future climate change. We use these data to benchmark an isotopically-enabled atmospheric model.

Impact of radiosonde observations over the Arctic on weather forecast (id 71)

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In December 2016, the Arctic cyclone caused anomalous warming over the Arctic Ocean. During December 2016, additional Arctic radiosonde observations are made at existing land stations. We investigated the impact of the radiosonde data from the Arctic land stations on forecasting of Arctic anomalous warming event using the AFES-LETKF experimental ensemble reanalysis version2 (ALERA2) data set. ALERA2 was used as the reference reanalysis (CTL) while the observing-system experiment (OSE) assimilated the same observational data set, except for the additional radiosonde data obtained by Arctic land stations. Using these two reanalysis data as initial values, ensemble forecast experiments with 63 members were performed. Comparing these ensemble forecasts, there were large differences in the position and depth of a predicted Arctic cyclone. In the CTL forecast, a surface cyclone was situated west of Svalbard, similar to that in reanalysis data. Southerly wind associated with sea level pressure gradient induced warm advection over the Svalbard. In the OSE forecast, in contrast, a predicted Arctic cyclone was located east of Svalbard, causing the cold advection from Arctic to Svalbard. This result suggested that the radiosonde observations over the Arctic would improve the skill of weather forecasts during winter.

Current status of Svalbard glacier mass balance and needs for future assessments (id 65)

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To date, assessing the mass balance evolution of all glaciers on Svalbard has been achieved by either regionalization of direct measurements or remotely sensed ice volume changes. Both methods have their disadvantages regarding representativeness of point measurements or temporal coverage. In recent years, spatially and temporally gapless meteorological data has become available at resolution appropriate (1-5 km) for process modelling. This enables the use

of meteorologically-forced mass balance models; especially energy-balance based methods have shown strong skills in simulating the climatic mass balance of glaciers.

In this presentation, we review available meteorologically-driven glacier mass balance simulations for entire Svalbard, compare the results and discuss their usefulness for a wider community. The complete spatial coverage of the climatic mass balance fields allows regional differentiation showing a pronounced gradient of mass balances across the archipelago, from slightly positive values in the Northeast towards more negative values in the Southwest. We outline requirements for further improving glacier mass balance assessments, especially the need for tailored field measurements to evaluate simulated features that are not captured by conventional monitoring programs. Furthermore, to quantify the total glacier mass loss and hence, the contribution to sea-level rise, the climatic mass balance must be completed with frequently updated assessments of ice discharge.

Synthesis of boundary layer measurements in Svalbard (id 127)

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The planetary boundary layer is the interaction zone between the Earth's surface and the lowermost part of the Earth's atmosphere within mass (constituents), energy and momentum is exchanged. Due to the different climatological conditions in the Arctic, the boundary layer exchange processes differ considerably compared to mid-latitude regions. Especially the turbulent transport and vertical mixing is strongly modified by the predominant stable atmospheric stratification. This results in a high sensitivity of the local boundary characteristics on the synoptic forcing and the surface properties as well as its temporal variability. Hence, a comprehensive analysis of the entire boundary layer is indispensable to improve the understanding of the prevailing physical processes. This implies measurements of all relevant quantities of the surface energy balance as well as the measurement of the conditions in the atmospheric column above. These measurements were operationally conducted with in-situ and remote-sensing instruments at the AWIPEV station in Ny-Ålesund.

In this presentation an analysis of the temporal variability of the boundary layer properties during a low pressure system passage over Ny-Ålesund based on the synthesis of different measurements is presented. The case study demonstrates the high sensitivity of the local boundary layer on the synoptic forcing. Especially the high temporal variability of the turbulent exchange and the boundary layer height is emphasized. This kind of analysis provides a

diagnostic tool for the boundary layer state, which can also be applied for interpretation of aerosol measurements within the local boundary layer. The presented example of composite data set analysis highlights the benefit of the synthesis of various measurements, which can be further improved by coordinated inter-institutional measurements.

Furthermore, the boundary layer properties vary considerably between different sites in the Svalbard region due to the strongly structured landscape. For the assessment of individual measurements concerning its spatial representativeness, it is necessary to compare and to combine spatially distributed measurements. This includes not only the synthesis of inter-institutional boundary layer measurements in Ny-Ålesund, but also the comparison with other sites in Svalbard. For that purpose, a comparison campaign of the annual cycle of the surface energy balance from Barentsburg and Ny-Ålesund was initiated. This Pan-Svalbard cooperation campaign corresponds to the work package 1 of the German–Russian QUARCCS* project (RIS 10806), which was granted in spring 2017. The aim of this QUARCCS work package and its contribution to other's research is presented.

* QUAntifying Rapid Climate Change in the Arctic: regional feedback**S** and large-scale impacts – QUARCCS

A New Seismic Bulletin for Svalbard and the European Arctic (id 83)

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During the years 2014 – 2016, a NORRUSS project between the four partners NORSAR in Kjeller, Norway, the Federal Center for Integrated Arctic Research of the Ural Branch of RAS in Arkhangelsk, Russia, the Kola Branch of the Geophysical Survey of RAS in Apatity, Russia and the University of Oslo, was jointly financed by Norwegian and Russian research agencies. One task of this project was to compile a joint seismic bulletin for the European Arctic for the last decades. The main sources for this new bulletin were the data collected at the International Seismological Centre (ISC), the analyst reviewed bulletins of NORSAR and the two Russian project partners, the bulletins of the IDC in Vienna and its forerunners, the Nordic Bulletin compiled at the University of Helsinki, and the bulletins collected at the University of Bergen. In addition, seismic onsets from permanent and temporary stations read at NORSAR within different projects as e.g., during the IPY 2007–2008, and readings from the seismic stations on Greenland were added to the new bulletin compilation. The greatest challenge for this new unified bulletin was removing all the onset readings from

different agencies analyzing the same seismic stations: due to international data exchange, data from the permanent stations in the European Arctic are in between analyzed by five or more institutions and then reported into the international databases. These institutes are not only processing the data differently, but they may even use different rules to name the seismic onsets. All these data entries were homogenized, to achieve a unified bulletin. The new bulletin contains the most complete collection of seismic events observed in the European Arctic north of latitude 70 degrees for the time period 1990 – 2013.

In this talk, the temporary development of the seismic activity on and around Svalbard since 1990 will be presented and discussed with respect to monitoring capabilities, location uncertainties and open questions.

Mercury stable isotope compositions in soils from the Arctic (id 197)

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Mercury(Hg) can deposit in the polar regions via long range transport. Hg has been detected in various samples collected from the Antarctic such as sea ice, soils, guano, and biological tissues. Because Hg can be released from both natural and anthropogenic sources, it is difficult to identify the sources of Hg in the polar regions using concentration-based observations. Hg stable isotope analysis can provide new insight for understanding the biogeochemistry and sources of Hg in the polar regions.

In this study, soil samples were collected from 5 sites in the arctic. The isotope compositions of Hg were determined with cold vapor generation (CVG) coupled with multicollector inductively coupled plasma mass spectrometry (MC-ICP/MS). The average concentration of THg in soil samples was 16.1ng/g. The δ^{202}Hg was in the range -1.3‰ to -1.2‰ and the average was -1.3±0.08‰. All the δ^{xxx}Hg values of the soils were negative, suggesting the enrichment of light isotopes. There was no mass independent fractionation (MIF) of even isotopes. The MIF of odd isotopes was observed. There were mainly two chemical processes that cause the MIF of odd Hg isotopes- the photoreduction of inorganic Hg and the photodegradation of methylmercury. The ratios of Δ^{199}Hg/Δ^{201}Hg in theses 5 soil samples indicated that the photoreduction of inorganic Hg was probably the main process which caused the Hg stable isotope fractionation in soils.

Investigation of aerosol optical depth of the atmosphere and microphysical characteristics of near-ground aerosol in Barentsburg (Spitsbergen) in 2011-2016 (id 60)

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The Arctic region is a very important indicator of global climate changes occurring on our planet. The detailed monitoring of spatial-temporal peculiarities of aerosol optical depth of the atmosphere, aerosol and Black Carbon mass concentrations for Arctic region allows one to determine such radiative important characteristics of carbonaceous aerosol as single scattering albedo (SSA) and others main derived parameters of radiative forcing used for assessment of climate changes.

Since 2011, the Arctic and Antarctic Research Institute of the Russian Federal Service for Hydrometeorology and Environmental Monitoring (AARI) and the Institute of Atmospheric Optics (IAO SB RAS) conduct field studies of spectral aerosol optical depth and near-ground aerosol characteristics at the Spitsbergen archipelago (Barentsburg, 78.1° N, 14.2° E). The following parameters were measured during polar day for spring, summer and autumn: atmospheric aerosol optical depth AOD in the wavelength range of 0.34-2.14 μm; aerosol particle number density N_A (diameter d >0.4μm) and volume particle size distribution dV/dR; mass concentrations of aerosol M_A (d >0.4 μm) and absorbing matter (black carbon) M_{BC} (μg/m^3). The experimental findings obtained in 2011–2016 are reported. Peculiarities of the seasonal and year-to-year variability of the aerosol characteristics are revealed. As compared to the preceding (pre-2011) period, we noted a closer correspondence in the average AOD values between spring and summer, primarily due to decrease of the content of fine-mode aerosol during spring and its increase during summer. The summertime AOD growth in 2015 is most likely due to episodic outflows of smoke aerosol from boreal zones of Eurasia and North America.

The ranges of variability of the mean annual aerosol concentrations for the full period since 2011 till2016 are M_A = 0.70÷5.90 μg/m^3, N_A = 1.36÷2.90 cm^{-3} and M_{BC} = 0.10÷0.25 μg/m^3. In the inter-annual dynamics, the maximum concentrations were observed in 2013 and 2015. The influence of the long- range transport of the forest fire smokes on aerosol concentrations was revealed in the summer periods of 2015 and 2016. In seasonal dynamics there is a steady decrease in the concentration of N_A fine particles from spring to autumn. However, the variability of the average seasonal mass concentrations of aerosol M_A and M_{BC} for the total

measurement period is characterized by an increase of these values during the transition from spring to summer. In the conditions of a smoke-free atmosphere, the summer maximum is connected with an increase in the contribution of coarsely dispersed particles to the aerosol composition due to their entry into the air from a surface of the earth. Analysis of the aerosol size distributions had showed that in summer the ratio of the coarse particles concentration with diameters greater than 1 μm to the concentration of finely dispersed particles increases, on the average, from 5 to 8%. For the first time, estimates of the seasonal dynamics of normalized (by daily average concentrations) daily behaviors of M_A and M_{BC} were made. A significant variability in the shape of the daily behavior of concentrations during the transition from spring to summer has been established.

Molecular steps of secondary aerosol formation in Svalbard (id 113)

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Formation of new aerosol particles by gas – to – particle conversion is a major source of cloud condensation nuclei (CCN) globally. Due to lack of anthropogenic primary aerosol sources, secondary mechanisms leading to CCN formation is of special importance in polar arctic and Antarctic atmospheres. However, the exact molecular steps that how and which atmospheric vapours nucleate to form initial small ca. 1 nm sized molecular clusters, and which vapours condense on clusters and grow them eventually toward CCN relevant 50-100 nm sizes have only been resolved in a very few locations (e.g. Sipilä et al. (2016)). Though sulfuric acid (H_2SO_4) has been suggested to have a major role in secondary aerosol nucleation globally, the details of the nucleation process involving sulfuric acid have not been resolved in ambient atmosphere. Polar oceans are major sources of dimethyl sulfide (DMS). DMS originates from marine phytoplankton metabolism. DMS is oxidized in the gas phase leading to formation of methane sulfonic acid (MSA) and sulfuric acid. As demonstrated by recent laboratory studies by CLOUD – CERN, sulfuric acid efficiently forms particles if stabilizing compounds, such as ammonia or amines are present (e.g. Almeida et al., 2013). Also ionization of air by galactic cosmic radiation promotes new particle formation from sulfuric acid vapours.

We resolved the molecular steps of secondary aerosol formation in Svalbard area during a campaign in Ny Ålesund in March – August 2017. We deployed a suite of state-of-the-art chemical ionization mass spectrometers and aerosol instrumentation for detection and quantification of potential aerosol precursor vapours (H_2SO_4, MSA, iodic acid, highly oxidized organic molecules), chemical composition of fresh, ~1-2 nm molecular ion clusters as well as concentration and size distribution of aerosol particles from ~1 nm clusters to CCN sizes and

above. With that setup, we were able to follow the production of precursor vapours and subsequent cluster formation molecule by molecule. Via simultaneous measurement of precursor concentrations and particle growth rates we were able to make a closure between the condensing gases and new particle growth. We also revealed the role of air ions (and thus cosmic radiation) in the process. Our results, which we will report in detail during the conference, highlight the importance of ecosystems (phytoplankton, bird colonies, …) as the primary source of secondary aerosol precursors and thus secondary aerosol and CCN in the arctic atmosphere and supports the recent proposal related to connection between sea ice loss and new particle formation (Dall'Osto et al., 2017). Our findings also demonstrate the need and value of cross disciplinary research in producing scientific knowledge on vulnerable arctic Earth system.

Long-time biollogically active solar UV radiationon observations at the Polish Polar Station, Hornsund. Homogenization of the measured and reconstructed data (id 74)

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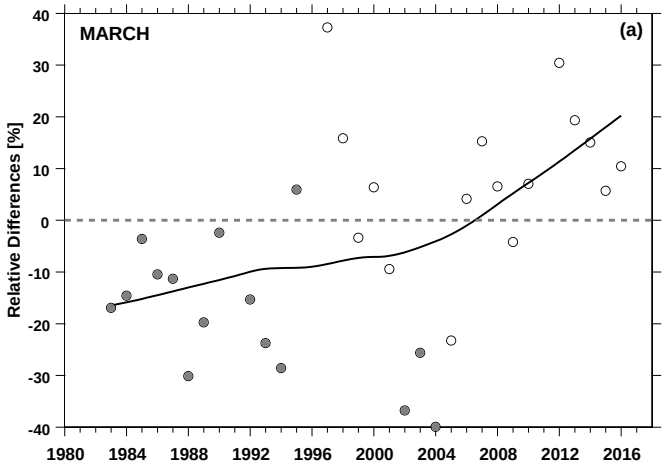
UV measurements at Hornsund started in 1996 and were continued until 2001 using the SL biometer then were restarted in 2005 using the Kipp and Zonen biometer. To estimate instrument sensitivity decline due to its aging the UV data have been homogenized by a comparison of the observed erythemal dose rates taken during clear-sky days in spring with the hypothetical ones based on the radiative model simulations. The following input data were used for the calculation of correction factor: daily values of total ozone (from NOAA satellite observations), aerosol optical depth (from ground based observations by the collocated CIMEL solar photometer), and prescribed values of ground albedo (depending on the snow depths). The daily erythemal doses, since 1983, are reconstructed using the all-sky model with the data of the column ozone from the satellite measurements (SBUV merged ozone data set), and measurements from Polish Polar Station, i.e.: daily snow depth (for ground albedo estimation), and the daily sunshine duration. The trends analysis based on the observed data, since 1996 show declining tendencies during spring (March-April-May) of ~1%/yr. Trend analyses of the monthly and yearly time series comprising of the both -reconstructed and observed doses reveals statistically significant trend only in March (~1%/yr) in the whole period. Analysis of sources of the yearly dose variability, since 1983, shows that cloud cover changes are responsible for the long-term UV trends.



Time series of monthly fractional deviation of erythemal doses consisting of observed (open circles) and modeled (full circles) data. The solid curve represents the smoothed data by the LOWESS low-pass filter

What's Svalbard snow can tell us (id 101)

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The annual snow layer, during the winter, covers most of the Svalbard archipelago, becoming one of the most important factors influencing the Svalbard environment. The annual snow layer is an extremely dynamic portion of the Cryosphere and can be defined as the snow accumulated and present on the ground during the year. The characteristics of the annual snow strata are strongly dependent on climate conditions and can influence the access to food, particularly for animals who rely on food sources below the snow strata. From a chemical point of view, snow depositions during the winter are a sink for an impressive amount of chemical compounds (natural and anthropogenic) and elements trapped in the snow layers. Particularly, compounds and elements that can be photo-activated accumulate during the winter and can be re-emitted in the atmosphere, taking part in numerous geochemical and biological cycles during the spring. However, elements that can be photo-activated are not the only ones to be released from the annual snow strata. During the melting phase, all elements and compounds that are still present in the snow can be released in the melting water, accumulate in the ground or be discharged in the sea, affecting biological productivity or, in the case of anthropogenic compounds, causing a spotted contamination of the surrounding environment.

The snow research conducted in the Svalbard is fundamental to better understand the whole natural dynamics that characterize the archipelago.

Evaluate the photo-activation and re-emission processes can improve our comprehension of seasonal (and daily) atmospheric oscillation not fully understood for specific elements; Improve our knowledge about the chemical composition of annual snow layer can bring important information in which atmospheric, transport and climate processes are affecting the annual snow composition; Evaluate the effect of the specific meteorological events in the chemical and physical structure of the annual snow layer contributed (such as rain occurrences and snow melting events due to rapid temperature oscillations) to understanding the evolution of the snow proprieties; Collect ice core archives from the glacier summit help us in evaluate the recent changing occurring in the higher Arctic.

The studies conducted until now contributed to understanding the evolution of the snow's chemical proprieties as a consequence of the climate changes affecting the archipelago and better define the role of specific meteorological events. Snow research is relevant for the future evaluations of the interaction between snow, atmosphere and better define post-depositional processes able to re-emit and introduce in the arctic food chain specific elements and compounds, including anthropogenic contaminants.

Svalbard snow is an unique environment to be studied giving extremely important information regarding a) The biogeochemical cycle of elements and compounds (natural and anthropogenic) b) understand the impact of the local and abroad human activities c) reconstruct the past atmospheric and climate conditions.

The location of the Svalbard is unique for its position close to the North Pole and for its environmental characteristic. The snow research, from a chemical and physical point of view, in the Svalbard archipelago, is crucial and complementary to the other research activities for improve our comprehension of the rapidly changes occurring at the higher latitudes.

MODIS data based analysis of land surface temperature (LST) over Svalbard Archipelago (id 20)

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Svalbard Archipelago is an international research training ground of high-arctic natural environment state and changes tendencies, encompassing cryosphere, landforms, Earth surface processes and ecosystems. The knowledge of climate conditions in various spatial and temporal

scales is a base of such investigations. However, the dimensions and diversification of the archipelago is causing large variety of climate characteristics. Contemporaneously, available climate parameters data series are in majority short and restricted to about a dozen points on the archipelago area, located mainly in coastal zones.

Land Surface Temperature – LST is a key physical parameter of processes taking place on the terrain surface, connecting effects of all relations on the boundary between land surface and atmosphere, and energy fluxes transferred among them. Satellite thermal sensors facilitate spatially synchronous LST assessment in regional and global scales. It is especially valuable in the vast and difficult to access Arctic landscapes, where LST observation sites are very sparse and their spatial representativeness is strongly limited.

LST assessment from the level of satellite orbit is most frequently done by the recalculation of radiance registered by sensors in the range of thermal infrared. Using LST data from MODIS sensor of Terra and Aqua satellites form years 2000-2016, its spatial and temporal changeability over Svalbard Archipelago was described. As the final effect of this elaboration, the repartition of the surveyed area based on this parameter is presented.

The most important results of the undertaken work may be summed up in the following points:

Thermal conditions variability on the whole archipelago were obtained with a distinctly higher resolution, not only in relation to elaborations done on the base of air temperature measurements, but also those done with use of models.

- LST data aggregation to monthly periods allows to reduce the influence of LST data lack caused by cloudiness. LST may be used with success to model spatial distribution of air temperature (AT) over Svalbard. Simple regression AT-LST model based on data from 24 points (about 1800 months) is unbiased and the estimation standard error is about 2.5°C.
- Average annual LST for Svalbard is -12.7°C and varies between -3.6 and -18.1°C.
- Extreme LST values in the analyzed multi-annual period were noted on the largest archipelago island – Spitsbergen. They were -72.6 and +31.5°C. However, 99% of the variability is in the range between -56.8 and +26.5°C.
- The LST field classification allowed to distinguish 6 areas characterized by the differences in absolute values and seasonal LST statistics courses. Three of them are covering heterogeneous landscape types. Their preliminary identification is as following:

(1) summit parts of ice caps (average annual LST = -15,1°C and LST standard deviation = 10.9°C),

(2) glaciers cirques and strongly inclined parts of ice caps (-13,5 and 9,6°C),

(3) marginal parts of ice caps (-13,0 and 10,1°C),

(4) lower fragments of large valleys and “cold” northern coastal plains (-12,0 and 10,8°C),

(5) plateau and slopes of mountain ranges with sparse contribution of glaciers coverage (-11,4 and 9,1°C),

(6) “warm”, southern coastal plains (-9,8 and 10,0°C).

Spatial variability of XXI century land surface temperature (LST) trends on Svalbard based on MODIS data (id 21)

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Land Surface Temperature – LST is reflecting joint surface properties and weather conditions, that together adjust energy fluxes between atmosphere and ground. In polar areas LST is one of the most important factors influencing the distribution and character of permafrost, glaciers mass balance and ecosystems dynamics. Satellites thermal sensors enable LST synchronous aerial assessment in regional and global scales. It is especially important in relation to vast and difficult to access Arctic landscapes, where direct LST measurements are very rare and their spatial representativeness is strongly limited.

Using LST data from MODIS sensor of Terra and Aqua satellites from years 2000-2016, aggregated to monthly periods, tendency analyses of changes within Svalbard archipelago were performed. The study covered average and standard deviation values trends as well as seasonal cycle characteristics. Because it was calculated on temporal series of raster maps, as a basic tool to assess intensity and significance of trends, a “contextual” Mann-Kendall test, taking into account LST values spatial autocorrelation, was used (Neeti, Eastman 2011). During the analyzed multi-annual period, a meaningful LST rise appeared. For 93.6% of accounted area the probability that positive LST changes trend is random is lower than 0.001. The contribution of area with no significant LST trends is only 0.2%. Statistically significant LST decrease trend appeared on the area occupying merely 0.035% of Svalbard area. On dominating part of the archipelago LST increased at the rate of 1.5-2.5°C per decade. The quickest increase rate was detected in its north-eastern part – on the islands Nordaustlandet, Kvitøya, Edgeøya and Kong Karls Land. The most spatially coherent are warming tendencies in coastal areas. The lowest increase rate (0.5-1.0°C/decade) were noted on summit parts of Spitsbergen ice caps, especially in southern part of Ny Friesland, in the vicinity of Newtontoppen. For three stations having a complete series of air temperature measurements from years 2000-2016 (Ny-Ålesund, Svalbard Lufthavn, Hornsund) it was found that the LST increase was from 0.35 to 0.5°C per decade faster than the increase in air temperature. Warming was the most marked with LST rise in March and during the fall (SEP-NOV), and

generally with the decrease of annual cycle amplitude, without phase shift. LST changeability, expressed by standard deviation, decreased especially in the northern part of Spitsbergen (Albert I Land, Haakon VII Land, northern part of Ny Friesland), in western part of Kvitøya and over the whole Edgeøya.

The area over which a significant LST decrease was detected is located close to the head of Van Keulen Fiord. The anomaly may be explained by the occurrence of Nathorst glacier system surge in the years 2008-2013, right in this area (Sund et al. 2014).

A distinct inverse proportionate relation between the island area within the archipelago and LST increase rate in the years 2000-2016 was denoted (R^2= 0.707, p=0.0023). The relation is of power character. Its existence and mathematical form are pointing on the dominating influence of surrounding seas thermal regime changes on the LST rise over Svalbard archipelago.
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Sund, M., Lauknes, T. R., & Eiken, T. (2014). Surge dynamics in the Nathorstbreen glacier system, Svalbard. Cryosphere, 8(2), 623–638.

The importance of tidewater glaciers on the Kongsfjorden system: proposal for a new working group under the Kongsfjorden system flagship (id 110)

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Tidewater glaciers shape the physical and biological environment enabling arctic specialists to forage and reproduce at the terminus. Such glaciers are especially important in a warming world since they provide local Arctic environments in an otherwise boreal world at higher latitudes. This “climatic Noah’s Ark” is under pressure since the tidewater glaciers are retreating in Svalbard and especially in Kongsfjorden.

Tidewater glaciers change the fjord circulation, the marine ecosystem composition and functioning affecting marine and terrestrial top predators. The aim of the TWICE project is to coordinate and foster a large coordinated effort into studying all aspects of the tidewater system using Kongsfjorden as model system. During the talk we will briefly present the TWICE project and an outline for a new working group within the Kongsfjorden System Flagship focusing on the effects of tidewater glaciers. Such a

working group will draw on the existing ones, but the multidisciplinarity of the problem suggest a separate working group.

Authors
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Integrated system of recent fault movement monitoring, Hornsund, SW Spitsbergen (id 152)

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The monitoring network for measurement of recent tectonic movements has been established in Hornsund fjord in SW Spitsbergen in 2009. It consists of 3 precise 3-D optical-mechanical extensometers of TM-71 type, installed across significant faults on northern shore of the Hornsund fjord. Later, 6 GNSS monitoring points were installed around Hornsund fjord, evenly distributed along both shores of the Hornsund fjord from its western part to the recently unglaciated eastern side in 2012. Finally, 4 Gefran PZ linear dilatometers were placed across two remarkable dip-slip faults on both sides of the fjord in 2016. The Hornsund network is part of the world-wide fault movement monitoring network TecNet, managed by IRSM CAS (for more detail see www.tecnet.cz).

Two of the TM-71extensometers were equipped with automatic reading device, recording the data with a daily frequency, third one is recorded manually once per month. The GNSS measurements are recorded annually during summer season field campaigns, always at least 72 continuous hours long. Afterwards, data are post-processed using Bernese software. The linear dilatometers record data with 1 hour frequency.

Since 2009, two remarkable compressional events have been recorded here. Both events show that the locally prevailing long-term extensional regime, according to previous research expected in whole Hornsund area, can rapidly change to a short-term compression. We observed these compressional events between September 2011 and May 2012 (Stemberk et al. 2015) and at the break of 2014/2015. As concerns the first event, the compression orientation (W-E to WSW-ENE striking compressional component of the stress field) corresponds to previously published in-situ stress measurements and fault plane solutions from Svalbard. We suggest that these stress events resulted from deep -seated processes based within the deeper parts of the

Earth´s crust or even in the asthenosphere, most likely reflecting the ridge push from the Mid-Atlantic ridge. This process was manifested for example by the M=5.2 earthquake on 8th February 2012. The second event was recorded at break of 2014/2015 and it corresponds to the tectonic pulse which affected whole European tectonic plate as was observed by Briestenský et al. (under review) in Southern, Eastern and Central Europe. This compressional regime lasts until nowadays (mid of 2017). The preliminary results of GNSS monitoring show uneven uplift of the whole Hornsund area, supposedly due the deglaciation, however, the role of recent tectonics in the uplift differences is recently analyzed.

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Holocene Rockfall at Hornsund, SW Spitsbergen (id 155)

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Generally, rock block foothill accumulations are very common on Svalbard. These landforms are traditionally regarded as rock glaciers, however, their development may be more complicated and other processes may be involved (Hartvich et al. 2017). On the southern coast of the Hornsund fjord at SW Svalbard, large rock block accumulation known as Stonehengesteinane is situated on a marine terrace at the foot of northern wall of the Tsjebysevfjellet (920 m a.s.l.). In this study, morphometric profiling, UAV DEM analyses, geophysical measurements using electric resistivity tomography, radiocarbon dating and geodetic measurements using terrestrial LiDAR were used to clarify the origin of the block accumulation. The conclusion of this study is that the rock block accumulation is a large rockfall, however, with several specific properties. Firstly, the morphometric analysis of a detailed UAV DEM and relief profiles showed distinctly different mrphology and weathering of the blocks is very different from other rock block accumulations in Hornsund area. The extreme crushing and weathering of the blocks is due to the immense impact energy, as the length of the free fall of the collapsed marmor cliff exceeded 500 m. The electric resistivity tomography results together with UAV DEM revealed a thickness of accumulation and its total volume. Based on the results of AMS radiocarbon dating of

decomposed mosses from the base of a sedimentary basin within the accumulation, the rockfall age was estimated to be at least 2500 years, which places the event into Late Holocene Revdalen glacier advance.

References:

Hartvich, F., Blahůt, J. and Stemberk, J. (2017): Rock avalanche and rock glacier: A compound landform study from Hornsund, Svalbard. . Geomorphology, Vol. 276, pp 244-256

Short-lived climate forcers in the Arctic – a Svalbard perspective (id 180)

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This talk will interpret observations of so-called short-lived climate forcers (SLCFs, including methane and black carbon) in the Arctic, as measured on Svalbard and elsewhere in the Arctic. We will compare the measurements with model simulations and discuss the sources contributing to the atmospheric concentrations on Svalbard. One focus will be on the relevance of within-Arctic sources compared to long-range transport from extra-Arctic sources. This will include, for instance, effect of local ship emissions around Svalbard on black carbon on Svalbard; impact of high-latitude gas flaring on Arctic black carbon; and impact of oceanic methane emissions from methane hydrate deposits around Svalbard on Arctic methane. Some perspectives will also be given with respect to use of Svalbard data in pan-Arctic and global studies.

Short-lived climate forcers in the Arctic – a Svalbard perspective – the importance of monitoring (id 215)

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This talk will discuss the importance of short-lived climate forcers (SLCFs) for air quality and climate in the Arctic. Focus will be given to the use of monitoring data for assessing the atmospheric concentration levels, the source types and source regions contributing to the observed concentrations, and the trends of SLCFs in the Arctic. The presentation will also stress the importance of integrating Svalbard long-term measurements into pan-Arctic networks, as single-site observations can only provide a very limited view on pan-Arctic sources and processes. Typically, only the combined use of data from several sites and the joint use of models can give a more complete picture.

The presentation will focus on methane, black carbon and mineral dust and give examples where Svalbard observations were important to obtain findings. It will, however, also identify an important gap in the monitoring with respect to mineral dust.

There and back again. An illustration of needs for cross-scale and cross-discipline collaboration and data sharing (id 218)

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Tidewater glaciers are a large, but highly variable, source of freshwater to the coastal environment in Svalbard. This presentation will show how the analysis of observations from the vicinity of a glacier front is dependent on a number of other measurements. Following the glacial meltwater as it flows out of the fjord we look at how the integrated runoff from different glaciers influence coastal circulation, sea ice cover and exchange with the offshore Atlantic water current. These more distant factors, in turn, affect the atmospheric conditions over the glaciers, which finally determine snow accumulation in winter and, to complete the circuit, melting and runoff in summer. Development of reliable modelling tools for understanding the basic processes as well as the reasons for the ongoing change thus depends on aggregated data sets from a number of disciplines and from larger areas than individual projects and institutes can cover.

Isfjorden Marine Observatory Svalbard (id 89)

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Isfjorden Marine Observatory Svalbard (IMOS) aims to establish a long-term plankton time series from the largest fjord system in Svalbard. The outer part of Isfjorden to the innermost part of Billefjorden is a transect along a climate gradient from ice-free warmer Atlantic waters to locally formed cold water and seasonal ice cover. The permanent settlements in Isfjorden with a marine research station in Barentsburg, a university centre in Longyearbyen and the many research ships visiting year-round facilitates regular sampling without large extra costs and efforts –prerequisites for maintaining long time series. At present almost 20 years of plankton data exist from Isfjorden, and since 2011 bi-weekly to monthly plankton data have been collected. These historical and new protist and zooplankton data have been synthesized to determine potential impacts of climate change on high latitude plankton communities. The unique high resolution seasonal coverage of this time series allows differensiation between

natural seasonal variability and persistent changes in plankton communities due to global warming. A standardized sample and analyses protocol has been established within the IMOS project and we are currently working on how to secure the data in user-friendly searchable databases. The next step within IMOS is to increase spatial and temporal coverage by equipping the oceanographic moorings in Isfjorden with relevant biological instrumentation and to actively include satellite information in our monitoring of the plankton dynamics in Isfjorden.

Mass balance observation of Aldegonda Glacier and West Grønfjord Glacier, West Svalbard (id 62)

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This study is focused on mass balance observations 2014-2016 of Aldegonda and West Grønfjord glaciers, that are located to the south-west of Grønfjord Bay, 7 km from the base of Russian Arctic Expedition – Spitsbergen (RAE-S) in Barentsburg. The glaciological observations were performed by specialists of Arctic and Antarctic Research Institute in the frames of the RAE-S field work for several years in the spring and summer periods, that allowed to obtain information on accumulation and loss of glaciers masses; the data had obtained during 2014-2016 are the most complete and representative for analysis. In addition, the local meteorological observation has been carrying out since the meteorological station (HOBO U30) installed in 2015 near Aldegonda Glacier tongue. Finally, the mass balance research results were supported by the data of RAE-S hydrological measurements. The complex analysis of received data highlights the intensity of glacier degradation. It was established, that Aldegonda Glacier retreats more rapidly compared with West Grønfjord Glacier as result of its higher ablation rates and lower heights (450 m and 591 m above sea level correspondingly). The mass balance of both glaciers is constantly negative. May be supposed, that Aldegonda and West Grønfjord glaciers could disappear in near decades in case of the tendency continuation.
It is planned that the mentioned researches will be supplemented in following years by geophysical measurements of glacier body and detalization of glacier degradation process.

10 years of monitoring in the Austre Lovénbreen catchment: results, cooperations and perspectives (id 23)

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Research has been conducted by French teams in the Austre Lovén glacier basin since the 1960's. Even though they were discontinuous, these efforts formed the foundation of the renewed efforts that started in 2007. Since then, glaciological and hydrological studies were undertaken, using both traditional methods like ablation stakes, and recent remote sensing tools photogrammetry or lidar. Over a decade, mass balance measurements were acquired every year and the high density of the stakes network offers a precise insight into the glacier dynamics over that period. To complement these measurements, an extensive network of automatic temperature loggers and automatic cameras was deployed. Together, these complementary data acquisition devices allowed for the observation of glaciological processes at fine scales, and the factors driving the changes observed. 10 years appears to be a minimum when attempting to identify the ongoing evolutions. Extreme years with a very negative mass balance seem to become more frequent, and this is essentially caused by the lack of winter snow accumulation. Studying snow cover is a clear challenge in Arctic environments and efforts have been made to measure snow dynamics on the glacier but also in the moraine and in the slopes surrounding the glacier. Photogrammetry, using pictures acquired from the ground or from a drone, is being used to evaluate snow cover extension and volume. A collaboration with an Austrian colleague, Alexander Prokop, led to the use of terrestrial laser scanning to monitor snow, and specifically snow on slopes. Other ongoing cooperation with Chinese colleagues is aiming at harmonizing radar data acquired on the glacier and at optimizing the data acquisition protocols that are currently ongoing in our common study area. These new links offer a wide range of perspectives for future collaborative works.

Variation of phytoplankton assemblages of Kongsfjorden in early autumn 2012: A microscopic and pigment ratio based assessment (id 189)

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Phytoplankton species distribution and composition was determined by using microscopy and pigment ratios in the Kongsfjorden during early autumn 2012. Variation in sea surface temperature (SST) was minimal and matched well with satellite derived SST. Nutrients were generally limited.

Surface phytoplankton abundance ranged from 0.21 x103 cells L-1 to 10.28 x103 cells L-1. Phytoplankton abundance decreased with depth and did not show any significant correlation with chlorophyll a (chl a). Column integrated phytoplankton cell counts (PCC) ranged from 94.3 x106 cells m-2 to 13.7 x106 cells m-2, while chl a was lowest at inner part of the fjord (6.3 mg m-2) and highest towards the mouth (24.83 mg m-2). Biomass from Prymnesiophytes and Raphidophytes dominated at surface and 10 m, respectively. Contribution of Bacillariophyceae to biomass was low. Generally, heterotrophic dinoflagellates were great in abundance (12.82 %) and ubiquitous in nature, and were major contributors to biomass. Various chl pigments (chl b, chl c, phaeopigments (phaeo)) were measured to obtain pigment/chl a ratios to ascertain phytoplankton composition. Phaeo were observed only in inner fjord. Chl b:a ratios and microscopic observations indicated dominance of Chlorophyceae at greater depths than surface. Furthermore, microscopic observations confirmed dominance of chl c containing algae throughout the fjord. The study indicates that pigment ratios can be used as a tool for preliminary identification of major phytoplankton groups. However, under the presence of large number of heterotrophic dinoflagellates such as Gymnodinium sp. and Gyrodinium sp. pigment signatures need to be supplemented by microscopic observations.

Keywords: Phytoplankton abundance; species distribution; Chlorophyll a; pigment ratio; spectrophotometric; Kongsfjorden.

Preliminary report for measurements of soil CO2 concentrations throughout the year at Ny-Ålesund (id 102)

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The Arctic terrestrial carbon balance is still unknown. Climate change might result in significant increase of CO_2 emissions to the atmosphere because of thawing of previously frozen soil organic matter. Soil respiration is a major flux in the carbon cycle. Although there are some reports that significant soil respiration occurred during winter season (Elberling 2007; Björkman et al. 2010), continuous measurements during winter is difficult in the Arctic because of harsh environmental condition. In order to estimate more accurate annual soil respiration to evaluate annual carbon balance, continuous soil respiration measurement throughout the year is required.

In order to estimate soil respiration throughout the year, we have installed Vaisala CO_2 sensors from 0 cm to 50 cm into the soil in the summer season of 2016 at deglaciated area in the forefront of the East Brøgger Glacier near Ny-Ålesund. The study site can be characterized a

semi-desert ecosystem (Uchida et al., 2009) with dominant vascular plants and mosses at the study site such as *Salix polaris*, Sanionia uncinata and Hylocomium splendens. Based on year round eddy covariance measurements, a low but persistent CO_2 release occurs during winter and spring (snow-covered ground), over-layed by considerable CO_2 exchange events in both directions associated with high wind speed and changes of air masses and atmospheric air pressure.

Electricity for the censors was supplied from AWIPEV enclosure about 70m distance from our study site. The CO_2 concentrations were recorded every hour by a data logger. We show preliminary results of the first winter and summer soil CO_2 concentration (July 2016 - July 2017). Soil CO_2 concentration tended to decrease from autumn to winter at most of depths in the soil. The CO_2 concentration fluctuated during the snow melting season in 2017. Those fluctuation patterns were different among soil depths. We will analyze the relationship between environmental factors and soil CO_2 concentrations. Furthermore, our analysis will include seasonal fluctuations of soil CO_2 concentration in each soil layer and the potential driving factors, such as thawing and freezing of soil and snow cover dynamics.

Comparative analysis of different precipitation gauges, measurements in Barentsburg, Western Spitsbergen (id 51)

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In the framework of joint Norwegian-Russian project (Norwegian Meteorological Institute and Arctic and Antarctic Research Institute), parallel precipitation measurements done by two different gauges - (Tretyakov gauge and Geonor T200-B – were obtained in Barentsburg settlement, Western Spitsbergen. Comparative analysis of records of two gauges with different windshields was done only for solid precipitation (September 2014 – July 2016). Typically for the Arctic climate snowfall are under strong winds and blizzards conditions throughout the entire cold period. Under these conditions, fresh snow from the earth surface can be blowing up into the bucket (or opposite – blowing out of the bucket). All collected data was divided into 2 groups according to wind speed ranges: 0-5 m/s and 6-10 m/s. The last stage of study consisted of Tretyakov gauge's time series adjustment to GEONOR T200-B data, using method of linear regression. Mann-Kendall (MK) test were used to test if the slope of the estimated linear regression line is different from zero.

Parallel measurements of two different precipitation gauges at meteorological site in Barentsburg settlement make it possible to make some preliminary conclusions and define unsolved questions that needed to be solved in future studies.

According to comparative analysis of precipitation time series the records of both gauges are similar. However, there are particular differences:

In case when precipitation is not intensive, wind speed is less than 5 m/s, some of precipitation can evaporate from the bottom of the bucket of Tretyakov gauge; it leads to underestimating of precipitation amount. As contrasted with Geonor T200-B, this has special antifreeze compound and oil covering the measuring bucket. That prevents evaporation of melted snow from the surface and makes it possible to record even smaller amount of precipitation.

- For the Arctic climate, snowfalls are typical under strong winds (< 6 m/s) and blizzard conditions. It leads to "overcatch" of Tretyakov gauge due to false precipitation raised by the wind from the snow surface and caught by the gauge. This statement was confirmed by the results of comparative analysis. Indeed, Tretyakov gauge under these conditions is prone to overestimate amount of solid precipitations.
- For further research, we should develop more accurate correction method not only for solid type of precipitation, but also, topographic features of site and temperature conditions should be considered.
- Additional fieldwork in spring should be done to make more accurate determination: to estimate the errors caused by aerodynamic factors in the measurement of solid precipitation, snow surveys should be performed near (but without disturbing consistency of surrounding snow surface) to the official meteorological station in Barentsburg.

Diversity and Phylogeny of the cyanobacterium Nostoc cf commune from Svalbard and Greenland (id 223)

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Nostoc cf *commune* is a filamentous, heterocytous cyanobacterium that forms gummy curled lamina that are green, brown or black and extend over large areas. It is easy to identify and detach from the substrate. It is highly diffused over a wide range of habitats and is capable of withstanding desiccation without loosing its vitality. It is reported to be widespread in the High Arctic, and well known in Svalbard too, where it grows in water saturated habitats or even in shallow ponds and streams. The aim of our research conducted with the gelatinous laminar macrocolonies is manifold, but, overall, it aimed to verify the distribution and diversity of this species through the High Arctic and beyond its borders. At first, we set forth to verify the structure of the population of this species- that is, to verify if the population of a single macrocolony is actually clonal or polyclonal (several strains that are cohabiting). Next we

analysed the genetic diversity of different macrocolonies collected at intervals ranging from a few centimetres to a few meters. The High Arctic is highly populated by *Nostoc* cf *commune* and we delved further into the question of zonal diversity within the Arctic. Furthermore we compared structural data and specific genetic markers of our samples with those found in different countries to fathom if *Nostoc* cf *commune* is geographically ubiquitous or not and to find a trend of biogeographic diversity. Lastly, our research aimed to verify the origin of the macrocolonial population as well as the species by using the molecular phylogeny approach. We initiated with a large collection of lamina samples from several locations in Svalbard, followed by sampling in Greenland and went on with the successful isolation of strains of *Nostoc* cf *commune* from the various laminae collected from the Zackenberg Valley, North-Eastern Greenland. The DNA we extracted from each of the laminae was analysed with the help of the ARISA method. From the comparison of the ARISA chromatograms, we were able to conclude that laminar macrocolonies of *Nostoc* cf *commune* comprise of clonal populations that are capable of diffusing over quite a distance, well beyond the physical boundaries of the colonies visible to the naked eye. Moreover, the majority of samples analysed comprised of clones having two ribosomal operons while others had just one. This conforms to known data on *Nostoc*, i.e, the existence of several variants with a variable number of copies of the ribosomal operon in the genome. The length of the ITS fragments was highly conserved not only through the High Arctic, but even beyond its geographic and climatic borders, leading to the conclusion that the laminar populations of *Nostoc* cf *commune* are very similar if not identical irrespective of climatic conditions and varying habitat properties. Those laminae of colonies found in close vicinity were identical as per our study.

Finally we extracted DNA from the strains isolated so as to carry out a phylogenetic analysis by sequencing the 16SrRNA gene. We found that most of the isolated strains morphologically resembled *Nostoc* and fell under the cluster of *Nostoc commune* in the phylogenetic tree. While the cyanobacterial taxonomy is still evolving, we can conclude that most of the strains that we obtained belong to *Nostoc commune* and others lie very near its cluster on the phylogenetic tree. We can also conclude that the species *Nostoc commune* is ubiquitous and not restricted to the High Arctic, and able to thrive in a wide range of habitats, from polar to temperate climates.

The links between variations of oceanic heat flux trough the fram strait and the sea ice conditions to the north of Svalbard Archipelago (id 95)

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The Fram Strait is a key area in the context of heat exchange between the subarctic seas and the central part of the Arctic Basin. On the way from the Nordic Seas to the Arctic Ocean, warm and saline Atlantic waters (AW) interacts and mixes with other water masses that affect ice extent and deep waters formation. The heat, transported with the AW, has a significant effect on the local climate of the Svalbard archipelago.

Over the past 60 years, the temperature of the Atlantic Water increased by 1.2ºC, but the most intensive changes occur since 1990s. During this period, along the western shelf of the Spitsbergen archipelago, the annual mean temperatures reached its maximum. Unfortunately, in spite of a fairly well developed net of observations in this region, the data coverage is inhomogeneous and have a number of gaps.

For a more detailed study of the time variations of thermodynamics variables in the West-Spitsbergen Current from 1993 to 2016, ARMOR3D data set was used (E.U. Copernicus Marine Service Information). ARMOR3D is a relatively new global product, formed as a combination of satellite data and in-situ measurements. The methodology allows extrapolating the satellite observations to standard depth levels down to 1500 m. The resulting 3D distributions of temperature, salinity and geostrophic current velocity are gridded at a uniform mesh with the spatial resolution of 0.25°.

Using the combined in situ data series and the ARMOR3D data, variations of temperature along the West-Spitsbergen Current were estimated. The advective heat flux through the zonal section at 78.8ºN was also computed. Heat fluxes from the ARMOR3D data set were compared with the fluxes obtained from the eddy-resolving ocean model of the Massachusetts Institute of Technology (MIT), as well as with the results of in-situ measurements at moorings in the Fram Strait (1997 - 2010).

The Atlantic Water, coming with West-Spitsbergen Current, also has a significant impact on the area north of Svalbard, known as "the Whalers Bay". Based on the archive of the AARI ice charts and Global sea ice concentration climate data records from 1978 to 2015 (v1.2, 2015 http://osisaf.met.no), ice conditions in the study region were divided into four main classes: 1 -

closed ice around Svalbard; 2 - open waterway to the Barents Sea around Svalbard; 3 - ice edge north of Svalbard; 4 - typical “Whalers Bay” polynya exists. Ice conditions in this region are characterized by high synoptic and interannual variability. The years with the lightest ice conditions were identified.

The correspondence between variations of the oceanic heat fluxes to the north and changes in the ice conditions in the sub-regions was analyzed.

The research on fluxes computation and analysis was supported by RSF (project No. 17-17-01151).

This paper was prepared with financial support of joint project between Arctic University of Norway (UiT) and Saint-Petersburg State University “Oceanographic regime of Svalbard fiord on example Grønfjorden and Billefjorden” (2016-2018), in frame of AARI project “A study of long-term changes in the hydrometeorological regime and the state of the environment of Svalbard” (2017-2019) and Joint Science Program between Met-Norway and Roshydromet (2016-2019).

The Connections between changes of oceanic heat fluxes in the Fram strait and variability of the sea ice conditions to the north of Svalbard (id 181)

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The Fram Strait is a key area in the context of heat exchange between the subarctic seas and the central part of the Arctic Basin. On the way from the Nordic Seas to the Arctic Ocean, warm and saline Atlantic waters (AW) undergo cooling, freezing, and melting processes that result in fresh water, ice and saline deep waters formation. The heat inflow coming to the north with the AW has a significant effect on the local climate of Svalbard. Over the past 60 years, the temperature of AW has increased by 1.2ºC, but the most intensive changes occur during the period since 1990s to the present time. At this time, at the points along the western shelf of Svalbard, the maximum average annual temperatures are observed. Unfortunately, field observations, although they have a fairly well-developed net in this region, have inhomogeneities and gaps. For a more detailed study of the processes taking place in the region of the West-Spitsbergen Current (WSC) during the period 1990th-present, ARMOR3D array data were used. ARMOR3D is a relatively new global product based on ocean observations, which is a combination between satellite data and in-situ measurements. The result of combining satellite observations and vertical fields of thermohaline characteristics are "synthetic" fields of temperature, salinity and

geostrophic velocities of currents at standard levels from 0 to 5500 meters with a spatial resolution of 0.25° since 1993. The changes in temperature along the path of WSC were estimated. The advective heat flux passing through the section of 78.8ºN was also calculated. Heat fluxes calculated from the ARMOR3D data and using the eddy-resolving ocean model of the Massachusetts Institute of Technology (MIT), as well as with the results of in-situ measurements from moorings installed in the Fram Strait (1997 - 2010) were compared. The AW coming with WSC has a significant impact on the area north of Svalbard, which is also known as "Whalers Bay". Based on the archive of the AARI ice charts and Global sea ice concentration climate data records 1978-2015 (v1.2, 2015) ice conditions were divided into four main classes: 1 - closed ice around Svalbard; 2 - open waterway to the Barents Sea near Svalbard; 3 - ice edge to the north from Svalbard and does not reach it; 4 - typical polynya presents, the ice edge approaches the shore of Svalbard. Ice conditions in this region are characterized by high synoptic and interannual variability. The years with the lightest ice conditions were highlighted. The relationship between changes in heat fluxes directed to the north and changes in the ice conditions was analyzed.

Data sources:

- in-situ values of temperature and salinity 1950 – 2014 AARI “Nordic Seas” database;
- the Global ARMOR3D L4 Reprocessed dataset, CMEMS, E.U. Copernicus Marine Service Information;
- 7-days regional ice charts in SIGRID format from the AARI World Data Center archive (Greenland, Barents Seas for the period 1933-2015, http://wdc.aari.ru, on 0.25°x0.25° grid);
- Global sea ice concentration climate data records 1978-2015(v1.2, 2015), EUMETSAT Ocean and Sea Ice Satellite Application Facility, Norwegian and Danish Meteorological Institutes, available data from http://osisaf.met.no

This paper was prepared with financial supporter of joint project between Arctic University of Norway (UiT) and Saint-Petersburg State University “Oceanographic regime of Svalbard fiord on example Grønfjorden and Billefjorden” (2016-2018), in frame of AARI project “A study of long-term changes in the hydrometeorological regime and the state of the environment of Svalbard” (2017-2019) and Joint Science Program between Met-Norway and Roshydromet (2016-2019) and was supported by RSF (project No. 17-17-01151)

Black-legged kittiwakes as messengers of Atlantification in Kongsfjorden (id 118)

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Climate warming is rapidly altering Arctic marine ecosystems towards a more boreal state. The fjords on the west coast of Svalbard have experienced gradual reductions in sea ice and warmer water temperatures throughout the last decades. As a result, physical conditions in fjords, such as Kongsfjorden, approach those in the North Atlantic. This "Atlantification" is likely reflected in fjordic ecosystems, but long-term datasets are rare. We present a 19-year time series (1982–2016) of diet samples from black-legged kittiwakes (*Rissa tridactyla*) breeding in Kongsfjorden. Our results highlight a shift from Arctic prey dominance (*Boreogadus saida*, *Themisto libellula*, and *Nereis* spp.) until 2006 to a more mixed diet with high contribution of Atlantic fishes (*Mallotus villosus*, *Clupea harengus* and *Gadus morhua*). Capelin, an Atlantic species, dominated the diet composition in 2007, marking a shift in the food web. The occurrence of polar cod, a key Arctic species, positively correlated ($r = 0.72$, $p < 0.01$) with sea ice index, whereas Atlantic fish demonstrated the opposite correlation ($r = -0.57$, $p = 0.01$) indicating that the diet shift was likely connected with recent climate warming. Regurgitate mass from captured kittiwakes decreased together with the contribution of polar cod throughout the period. The decrease did not correlate with breeding success or population size indicating that kittiwakes on Svalbard may substitute energy-rich prey in their diet. Kittiwakes, which gather available fish and zooplankton near the sea surface to feed their chicks, can act as messengers of ecosystem change. Changes in their diet reveal that the Kongsfjord system has drifted in an Atlantic direction over the last decade.

Achievements on features of the atmospheric boundary layer and on the surface processes in Ny-Ålesund, Svalbard (id 69)

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The climate change is affecting the Arctic faster than other region of the planet. The models still fail in forecasting the variability of the climate system. More attention has to be paid to study the processes to allow better parameterization into the models as well as more integrated and

checked data must be provided. The Amundsen-Nobile Climate Change Tower (CCT) is an important scientific platform implemented in Ny-Ålesund (Svalbard) by CNR with the aim to investigate coupling processes involving atmosphere, cryosphere, biosphere at and near their interface (www.isac.cnr.it/~radiclim/CCTower).

Standard and fast response meteorological instruments located along the tower at seven different levels allow to measure continuously wind, T and RH vertical gradients, as well as turbulence second order moments to study the ABL dynamics, in different atmospheric stability conditions. Broadband radiometers located at 33 m of height collect information on downwelling and upwelling radiation fluxes and average surface albedo on a large area. Surface heat fluxes, snow depth and skin temperature, permafrost temperature profiles, vegetation coverage and characteristics, are also monitored thanks to the instrumentation on the CCT and sensors installed on a CALM grid and in a deep borehole 50 m deep. Some of the parameters observed since 2009 are presented to describe the thermodynamic characteristic of the lower layers of the atmosphere and the variability of processes at the surface. Recent result on the attempt to answer to questions about the structure of the Stable Boundary Layers and the modification of the turbulent features for different wind conditions is also given.

Modelling seasonal changes in Bacteria – Microalgae interactions in sea ice and open water (id 109)

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Marine primary productivity is the main carbon source for the marine and terrestrial food webs around Svalbard. Microalgae growth are mostly controlled by light and nutrient inputs, which are changing drastically through the year with absence of light in the polar night and nutrient depletions after algae blooms (e.g. Wassmann et al., 2010). With climate change related declining sea ice and increased stratification, the dynamics of light and nutrient are changing. Other controls are related to grazing, competition, and interactions with bacteria (e.g. Wassmann et al., 2010). The role of bacteria for microalgae growth is hardly understood. Bacteria may compete for nutrients, or provide nutrients depending on grazing pressure and inorganic nutrient supply (van der Meersche et al., 2011). They may act as prey for mixotrophic algae, or as parasites for different algae groups, and interfere with dissolved organic matter excretion (Amin et al. 2012). Bacteria are also crucial for the nitrogen cycle and can be responsible for nitrogen fixation, and nitrification, changing the concentration and speciation of inorganic nitrogen available for microalgae growth (Amin et al. 2012). Pulse chase experiments after van der Meersche et al. (2011) are the main experiments to track

the fate of carbon and nitrogen through the microbial food web in summer, when nutrients are limiting, in winter, when light is not accessible, and in the spring bloom. In mesocosms with labelled ($^{13}C/^{15}N$) and unlabeled ($^{12}C/^{14}N$) carbon and nitrogen supply, C and N will be tracked through different compartments of the microbial food web, such as particulate and dissolved organic matter and dissolved inorganic N, lipid biomarkers for algae, bacteria, archaea and fungi, and mesozooplankton. CARD FISH and Metatranscriptomics are used for investigating mixotrophic processes in microalgae, such as osmotrophy and phagotrophy. The same experiments and measurements will be done in Northeast Svalbard in summer and winter 2017 and in van Mijen Fjorden in winter 2017 and spring 2018.
The C and N fluxes through the microbial food web will be implemented into a dynamic ecosystem model. The model will be able to describe bacteria – algae interactions in more detail, including the processes, such as mixotrophy, nitrification, commensalism, and competition, which are lacking in most current models. Integration of additional data around the Arctic may help to extend the model to higher trophic levels and a wider geographical range. The model can then be used to predict potential effects of climate change, such as nutrient limitations due to increased stratification, and changing light over different seasons.
Amin, S. A., Parker, M. S., & Armbrust, E. V. (2012). Interactions between diatoms and bacteria. Microbiology and Molecular Biology Reviews, 76(3), 667-684.
Van den Meersche, K., Soetaert, K., & Middelburg, J. J. (2011). Plankton dynamics in an estuarine plume: a mesocosm 13C and 15N tracer study. Marine Ecology Progress Series, 429, 29-43.
Wassmann, P., Slagstad, D., & Ellingsen, I. (2010). Primary production and climatic variability in the European sector of the Arctic Ocean prior to 2007: preliminary results. Polar Biology, 33(12), 1641-1650.

Diversity and composition of bacterial community in soils and lake sediments from an Arctic lake area (id 195)

Nengfei Wang, Tao Zhang, Yong Yu, Yudong Guo and Jiaye Zang, et al.
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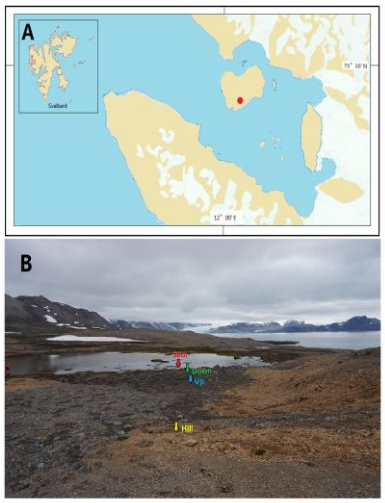
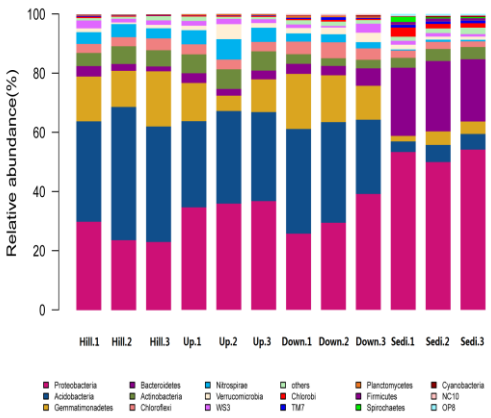
Thaw lakes and ponds can be viewed as sentinels of climate changes in the Arctic. During summer, the shallow lakes are supplied by meltwater from the lake ice and snow cover melt which runoff by the hillslope. Arctic microbes in soil and water are sensitive to environmental changes in the Arctic ecosystem. So we assessed the diversity and composition of bacterial communities within soils and lake sediments from an Arctic lake area (London Island, Svalbard). A total of 2,987 operational taxonomic units were identified by high-throughput sequencing, targeting bacterial 16S rRNA gene. The samples from four sites (from the hillside to the lake and

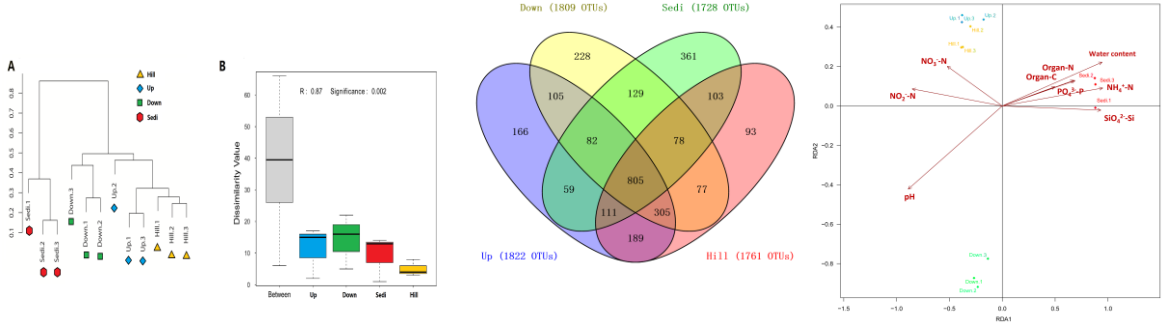
three samples in each site) were significantly different in geochemical properties and bacterial community composition.

Proteobacteria and Acidobacteria were abundant phyla in the nine soil samples, whereas Proteobacteria and Bacteroidetes were abundant phyla in the three sediment samples. Furthermore, Actinobacteria, Chlorobi, Chloroflexi, Elusimicrobia, Firmicutes, Gemmatimonadetes, Nitrospirae, Planctomycetes, Proteobacteria significantly varied in their abundance among the four sampling sites. Additionally, members of the dominant genera, such as *Clostridium*, *Luteolibacter*, *Methylibium*, *Rhodococcus*, and *Rhodoplanes*, were significantly different in their abundance among the four sampling sites. Besides, distance-based redundancy analysis revealed that pH ($p < 0.001$), water content ($p < 0.01$), ammonium nitrogen (NH_4^+-N, $p < 0.01$), silicate silicon (SiO_4^{2-}-Si, $p < 0.01$), nitrite nitrogen (NO_2^--N, $p < 0.05$), organic carbon ($p < 0.05$), and organic nitrogen ($p < 0.05$) were the most significant factors that correlated with the bacterial community composition.

The results suggest soils and sediments from a lake area in the Arctic harbor a high diversity of bacterial communities, which are influenced by many geochemical factors of Arctic environments. It also provide the possible consequences of the climate changes on the soil properties and bacterial communities in the High Arctic lake area.







The season variation of the aerosol in Ny-Alesund (id 201)

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Fourteen bulk volume aerosol samples were collected in summer 2016 and thirteen bulk volume aerosol samples were collected in winter 2016. The ions of F^-, Cl^-, NO_3^-, SO_4^{2-}, MSA, Na^+, Ca^{2+}, K^+, Mg^{2+}, NH_4^+, and heavy metals of Cr, Cu, Zn, Fe, As, Pb, Cd were analyzed of the samples. There were stong seasonal variations for most ions including Cl^-, NO_3^-, SO_4^{2-}, Na^+, Ca^{2+}, K^+, Mg^{2+} while there is almost no discrepencies in the concentration of NH_4^+. The concentrations of Cl^-, NO_3^-, SO_4^{2-}, Na^+, Ca^{2+}, K^+, Mg^{2+} in summer is much lower than those in winter. However the winter concentrations of NH_4^+ is at the same level to those in summer. The concentrations of heavey metals in winter is normally higher than in summer. The impacts of the meterogical condition, petrolum consumption, vessels were allpie to analyze the changes of the characteristics of the aersols.

A (first) permafrost carbon map of Spitsbergen (id 67)

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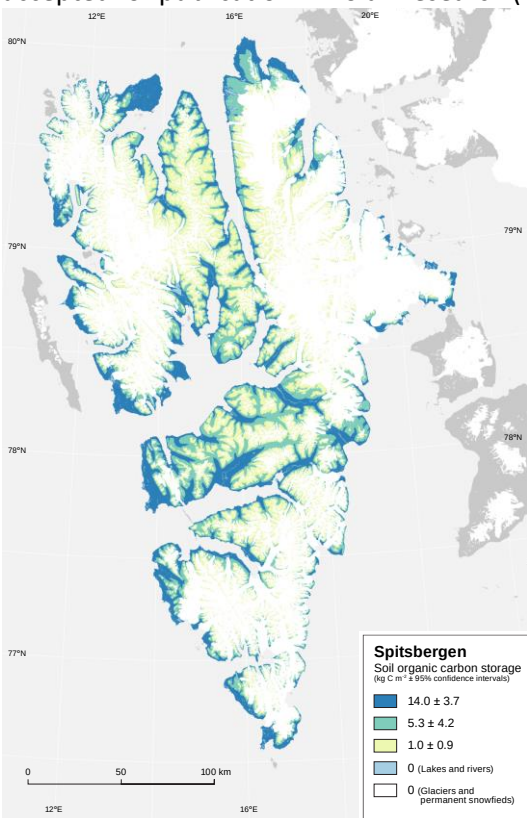
Accurate quantity and distribution estimates of permafrost soil organic carbon (SOC) stocks are needed to project potential feedbacks to climate change. Still, upscaling from local field observations to regional estimates to circumarctic assessments remains a challenge. We explored elevation-based upscaling techniques for High Arctic permafrost SOC stocks on Spitsbergen. We combined two detailed, high resolution SOC inventories performed in the summer of 2013 (in Adventdalen and on the Brøgger Peninsula) with additional validation data collected throughout central Spitsbergen in the winter of 2014. We found a clear relationship between elevation and SOC content and used this as an upscaling model. The map that we developed is, as far as we know, the first integral permafrost SOC map of Spitsbergen. With additional observations and model adjustment, the spatial SOC distribution on Spitsbergen, or even the entire Svalbard Archipelago, could relatively easily be improved. However, the intrinsically simple model presented in this study is a promising tool to assess extensive High Arctic permafrost regions that are less accessible and data-rich than Svalbard. We estimate the total amount of SOC currently stored in permafrost soils on Spitsbergen to be 105.36 Tg (0.11

Pg), with a mean SOC content of 2.84 ± 0.74 kg C m^{-2}. This is considerably lower than the what is currently estimated for this region, for example 3.8 kg C m^{-2} in the Northern Circumpolar Soil Carbon Database (NCSCDv2). Excluding glaciers and permanent snowfields, we estimate exposed land to contain 6.26 ± 1.47 kg C m^{-2}.

This study, funded by the Research Council of Norway (Arctic Field Grant; RiS ID: 6650), is currently accepted for publication in Polar Research (Weiss et al., in press).



Consilience – the unity of sciences for the Svalbard research (id 219)

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Numerous, international and interdisciplinary Svalbard environmental studies are by large linked to the question «How fast and in what direction the Arctic environment changes?». For this we need to understand how representative Svalbard is for the Arctic region and what are the basic mechanisms of the observed changes. The key feature of marine ecosystem in Svalbard archipelago is the advective character of the change – it comes from the south with the Atlantic waters, contrary to other Arctic regions, where the local phenomena are decisive, compared to the import. Large scale, complex environmental phenomena – like biogeochemical cycles are leaving traces in the sediments – so the paleoceanography may tell us about the chain of events in the past – how similar or how different they were compared to present situation. The key questions are those about the interactions between physical environment and the biota. What is the pattern in observed changes? Are we facing a tipping point, a regime shift, or maybe the maturation of the ecosystem? To address these, we need an ecosystem wide approach, the unifying efforts of physics, chemists, biologists and geologists: atmosphere, cryosphere, biosphere realms to understand the logic of events. Svalbard is both large enough and on other hand small enough, to allow the studies of warm (west) and cold (east) parts of the archipelago, all of similar geomorphology and all within very high latitudes. Svalbard is thus an excellent platform for comparative studies and unique opportunity to understand governing processes.

Spatially distributed monitoring of snow covered area and ground thermal regime around Ny-Ålesund (id 86)

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The seasonal snow cover and the thermal regime of the ground are crucial drivers for terrestrial ecosystems on Svalbard, strongly influencing not only vegetation and carbon cycle, but also stream runoff and slope stability. However, they both feature a strong variability in space and time which is insufficiently captured by traditional point measurements.

Here we present spatially distributed measurements of snow covered area and near-surface ground temperatures conducted for more than five years in the Bayelva catchement near Ny-Ålesund which were initiated in the SMACS project funded by a Svalbard Science Forum Strategic Grant. An automatic time-lapse camera system located near the summit of Scheteligfjellet is used to monitor the snow-covered area in spring and summer, capturing the

period from the beginning of the ablation season to the disappearance of the last snow drifts. The raw images are orthorectified and georeferenced which yields snow maps of high spatial (1-20m) and temporal (1 day and less) resolutions. These maps are produced for an area of several square kilometers, covering most of the Bayelva catchement including the area around the Amundsen-Nobile Climate Change Tower (CCT) and the Bayelva soil and climate monitoring station (AWI Potsdam). The raw and orthorectified images are freely available through the Pangaea database for a number of years (www.pangaea.de).

A similar camera system is deployed near the Polish Polar station in Hornsund so that standardized, comparable data sets on the snow covered area are now available for two Svalbard key research sites. They offer considerable potential for e.g. atmospheric research (e.g. snow cover in the footprint of eddy covariance measurements), geomorphological studies, or investigations on ecology and carbon cycle. As example applications, we present ground truthing of satellite measurements of snow covered area, as well as validation of Earth System Modeling results.

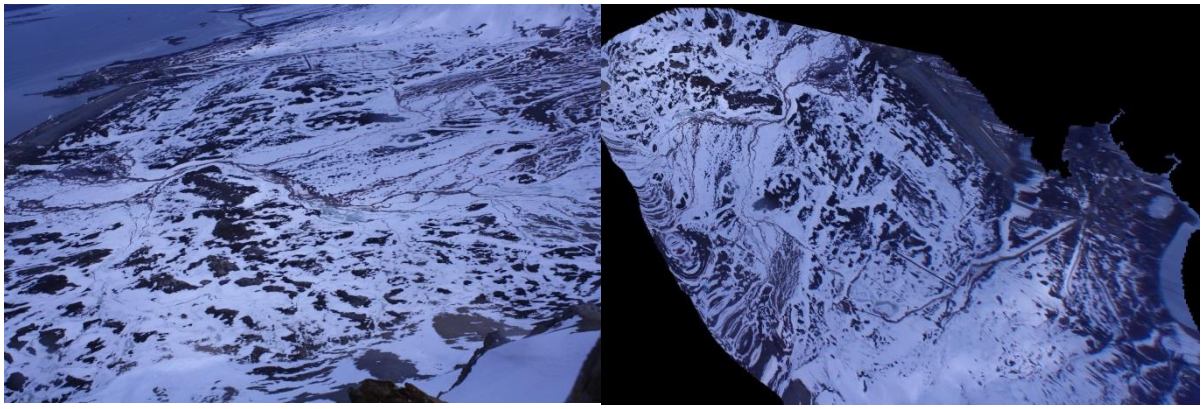

Fig. 1: Raw (left) and orthorectified (right, resolution 2m) image from 14th June 2012 taken by the camera system on Scheteligfjellet. The village of Ny-Ålesund and the airport are located in the upper left and upper right corner, respectively (source: www.pangaea.de)

To complement the snow cover data sets, systematic measurements on the distributions of snow depth and near-surface ground temperatures are conducted in the Bayelva catchement. For this purpose, an array of more than 100 miniature temperature loggers has been deployed in an area of half a square kilometer around the Bayelva soil and climate monitoring stations. The loggers are installed at a depth of 5cm, thus yielding near-surface ground temperatures relevant for plant growth – furthermore, numerical modeling can be used to estimate permafrost temperatures from the surface signal. Until now, a time series of five years has accumulated which shows a spatial variability of annual average temperatures of more than 5°C, as well as a distinct warming in the monitored period. While almost all loggers displayed annual average temperatures of less than 0°C in the first years, almost a third of the loggers featured positive

temperatures in some of the recent years. This might suggest onset of permafrost disappearance at localized spots which is not captured by traditional point measurements.

Soundscape of Spitsbergen – realized and future research (id 8)

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Sound is a part of our cultural heritage and deserve to be studied, according to UNESCO, even as "intangible cultural heritage". Svalbard archipelago is one of the spaces in the world which is so unique and special that there is a need to investigate it deeply. As well as Svalbard is one of the last places where complex and extensive acoustic research has not been conducted. Constant climate and environmental changes, as well as concern about the future generations, oblige us to preserve, or at least, to record the current state, along with the natural soundscape. In addition, the growth of human activity as well as the increase of tourism generates new sound or noise sources. Therefore, it is necessary to start recording sounds for future generations as well as noise monitoring in important places. So far, the acoustic research carried out by the scientists mainly concerned on the underwater acoustics: sounds generated by small Arctic birds diving for food (J. Szczucka, 2009, 2011), soundscape of the shallow water of Arctic sea (G. Buscaino et al., 2014), ambient noise in an Arctic tidewater glacier bay (G.B.Deane et al. 2014), noise in an underwater environment (J. Tegowski, 2012). Max Eastley made recordings of: ice; wind; bearded seal; kittiwake; little auk; walrus:; Barentsberg coal mine during voyages to the Arctic 2003 - 2005 and used them in some unique art forms.
Two one-week researchers expedition have been completed by the AGH-UST team in the summer (2016) and winter (2017). The measurements were carried out in: Sarkofagen, Longyearbyen, Piramiden, valleys (Bjorndalen, Longyeardalen, Grumantdalen (Fig.1.), Endalen,Adventdalen), glacier (Larsbreen, on the sea close to Nordensildbreen) and Sarkofagen). Classical acoustic and soundscape methodologies, based on quantitative acoustic measurements (sound pressure level) and qualitative measurements (ambisonic sounds recordings), were used to check spatial-temporal dynamics, a human impacts on the soundscape and the soundscape impacts on humans. Total 262 hours of SPL recordings in 200 measurement points and 9 hours of B - format ambisonic recordings are collected. Recording ambisonic sounds allows very accurate sound field reproduction by sound field synthesis using spherical harmonic functions.

Map from:

- stream in the distance and the wind
L_{Aeq} = 36.8 dB
- seabirds colony and underground stream
L_{Aeq} = 42.2 dB
- seashore (waves) and seabirds colony
L_{Aeq} = 41.9 dB

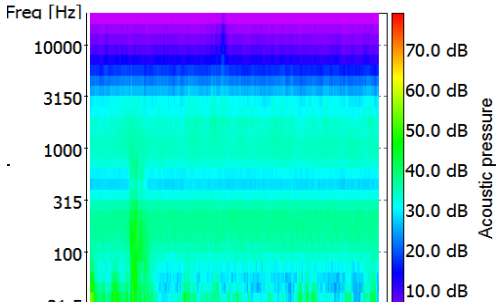

Figure 1: SPL measurements in Grumantdalen

Possible further routes of research:

1. Recordings and archive the soundscape for future generations.

2. Assessment of the impact of snowmobiles noise on the environment - proposals for regulation; the designation of routes in order to minimize the noise impact on the environment.

3. Synergistic assessment of changes in the glaciers: acoustic emission of the calving glacier, temperature, solar radiation UVA and UVB rays, volume study.

4. Long term acoustic monitoring of nesting bird colonies (in cooperation with ornithologists), Birds Sound classification. Sound source localization.

5. The impact of tourism traffic on the acoustic comfort (i.e. by noise maps) in Longyearbyen

Ice cold parasites – Interactions of bacteria and trematodes in their arctic bivalve host (id 17)

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Parasites are everywhere – and in temperate marine environments, filter feeders like bivalves readily accumulate a multitude of parasites. However, little is known from extreme environments like the Arctic. Apart from one-dimensional parasite-host interactions, additional complexity arises, as several parasite species often co-occur within the same host. Our study aims to elucidate the presence, as well as the interaction of macro- and microparasites in arctic bivalves of the Kongsfjord, Spitzbergen Preliminary results show that one of the most abundant macroparasites was the trematode Gymnophallus spp., which uses the bivalve *Liocyma fluctuosa* as a 1st intermediate host. In shallow, tidal areas *Liocyma fluctuosa, Macoma calcarea* and *Mya truncata* also serve as second intermediate hosts but infections are comparatively rare in deeper regions of the fjord. This points to a non-marine, avian end host, like waders or eider ducks. Microparasitic activity in the bivalves, such as infections with vibrio bacteria, seems to have a negative effect on trematode infections, but not vice versa. Utilizing the depth-dependency of trematode infections in combination with an antibiotic treatment of the bivalves, we investigated the interaction between micro- and macroparasites in a field experiment during the main infection period in summer. With this set-up, we can 1) measure the transmission rate of

the parasite for its principal host species, 2) investigate the trematode life cycle abbreviation within the 1st intermediate host as adaptation to shortened summer seasons, 3) show the limitation of trematode infections by prior infections with vibrio bacteria and, 4) ultimately explore the underrated ecological role of parasites in arctic soft bottom communities.

Long-range transport and temporal trends of emerging organic contaminants in the Arctic-impacted by human activities and climate change (id 19)

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Emerging organic contaminants (EOCs) may reach ecologically sensitive Arctic environment via atmospheric and/or oceanic long range transport. They are subject to a variety of processes in the Arctic environment such as degradation, bioaccumulation and interaction between the atmosphere, snow, water and soil. Additionally, climate change may significantly influence the transport and environment fate of EOCs in the Arctic. As a part of collaborative German-French program at joint French-German Arctic Research Base (AWIPEV) in Ny-Alesund, Svalbard, this project is proposed to investigate the occurrence and long term trends of EOCs in Arctic air, water and snow.

Integrated high-volume air samples were taken on the platform of German Atmospheric Observatory using a high-volume pump operated for 7 days to obtain a volume of ~2500 m3. A glass fiber filter is used to trap the airborne particles and the gaseous contaminants are collected with a PUF/XAD-2 resin column. Surface snow samples were collected on the glaciers around Ny-Alesund and seawater samples were obtained in Kongs Fjord from 2011 to 2016. EOCs including poly- and perfluoro alkyl substances (PFASs), brominated flame retardants (BFRs), organophosphate esters (OPEs), phthalate esters (PEs) and current-use pesticides (CUPs) have been determined in all air, seawater and snow samples. Data achieved from this study may improve models to predict the environmental progression and assess the effect of human activities and climate change on remobilization and phase exchange for EOCs in the Arctic ecosystem.

Characteristics of species composition and community structure on Austre Lovénbreen Glacier foreland, Svalbard (id 187)

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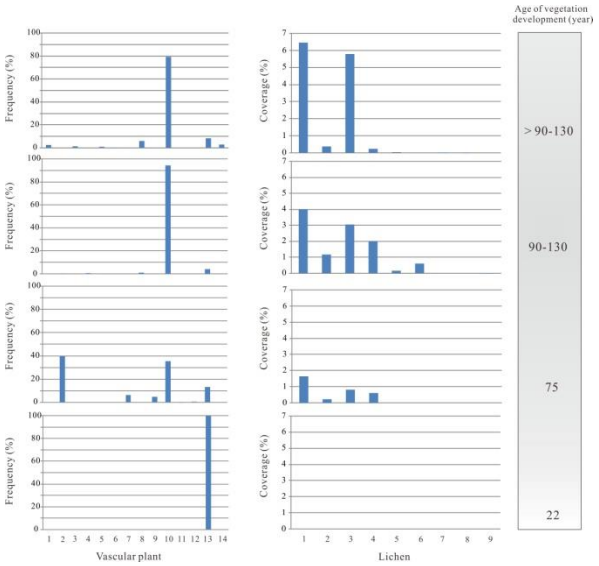
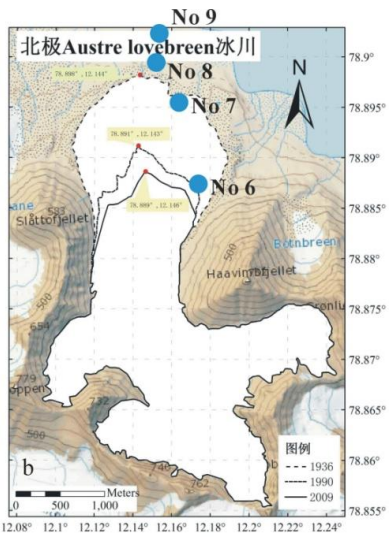
Arctic regions are undergoing fast global warming, which will pronouncedly influence the arctic terrestrial ecosystem and alter the rate of vegetation succession. To understand how tundra vegetation responds to glacier retreat under the global warming scenario, four permanent plots were established in 2012 at different terminus of Austre Lovénbreen glacier along a time sequence (1990, 1936, Little Ice Age, beyond LIA) in Ny-Ålesund, Svalbard. Here, we present a preliminary investigation on species composition and community structure of these plots. Only the pioneer plant, *Saxifraga oppositifolia*, was found in plot No. 6 at the location of the Austre Lovénbreen glacier terminus in 1990, representing the early stage of vegetation succession. Overall, the vegetation was dominated by *Salix polaris*, *Draba bellii*, and crustose lichens such as *Ochrolechia frigida* and *Pertusaria* sp., and there were increasing numbers of individual plants in plot No. 7, reflecting the vegetation composition after 75 years of glacier retreat. Over time following glacier retreat, the composition of the vegetation changes and develops to a mature type. *Salix polaris* predominated in the mature plots, coupled with the occurrence of foliose lichens like *Flavocetraria nivalis* and *Cetraria aculeata*. In addition, lichen diversity and coverage increased. The present study indicates that species composition and community structure on the Austre Lovénbreen glacier foreland have changed over time following glacier retreat.





History of heavy metal accumulation in the Svalbard area: distribution, origin and transport pathways (id 7)

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The Arctic has been recognized as a sink of contaminants emitted in the northern hemisphere. In marine waters, metals readily sorb onto sinking organic and fine mineral matter and are deposited on the sea bed. In this study temporal changes of Pb, Zn, Cd and Cu concentrations were studied in 19 dated sediment cores collected from Svalbard fjords and the Barents Sea. The main aim was to study spatial and historical variations in heavy metal concentrations, deposition rates and sources in the context of different metal transport pathways. Metal concentrations ranged from 5.7 to 45.8 $mg \cdot kg^{-1}$ for Pb, from 13.4 to 54.5 $mg \cdot kg^{-1}$ for Cu, from 0.01 to 0.90 $mg \cdot kg^{-1}$ for Cd and from 55.6 to 130.4 $mg \cdot kg^{-1}$ for Zn. Some fjords were unpolluted by heavy metals while in others a clear signal of metal enrichment was found (outer Kongsfjorden, Hornsund, Adventfjorden). Large-scale processes such as atmospheric and oceanic transport were found to be important drivers of heavy metal contaminant distribution. The significance of global drivers varied among the fjords, due to coupling with local processes. Outer fjord parts, the most impacted by oceanic transport, were characterized by the excess $^{206}Pb/^{207}Pb$ values of ~1.17, while the inner basins were characterized by the excess $^{206}Pb/^{207}Pb$ of ~1.14 suggesting possible different importance of Pb sources (marine currents and atmospheric transport). High calculated excess $^{206}Pb/^{207}Pb$ (of ~1.20) in northern Svalbard fjord sediments can suggest a contribution possible from North American Pb sources.

Investigating the source of aerosols deposited in snow across the Svalbard archipelago in the 2015-16 winter (id 55)

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In the spring that followed the winter 2015-16, a coordinated snow survey across Svalbard was organized under the multinational (Community Coordinated Snow Study in Svalbard) C2S3 project. The goals of the survey were to investigate the spatial variability of the seasonal snow cover, including physical, chemical and biological properties, over a wide array of sites at three different altitude levels (**Fig. 1**) and using standardized protocols. A particular focus of the project was directed at black carbon (BC) deposition in snow, in order to better constrain estimates of its impact on snow albedo.

In order to interpret results of this survey, knowledge of the climatology and air transport patterns to the different sampling sites is needed. Such knowledge is essential to determine how

typical or atypical the 2015-16 winter was with respect to snow conditions, and to identify the most probable source regions for aerosols deposited in snow during this period. Accordingly, an analysis was performed of surface climatological conditions and synoptic air flow patterns during the period of interest using atmospheric reanalysis products, satellite imagery, and air back- trajectory modeling. This presentation will report on the results, with special emphasis on those findings most relevant to BC transport and deposition in Svalbard snow.

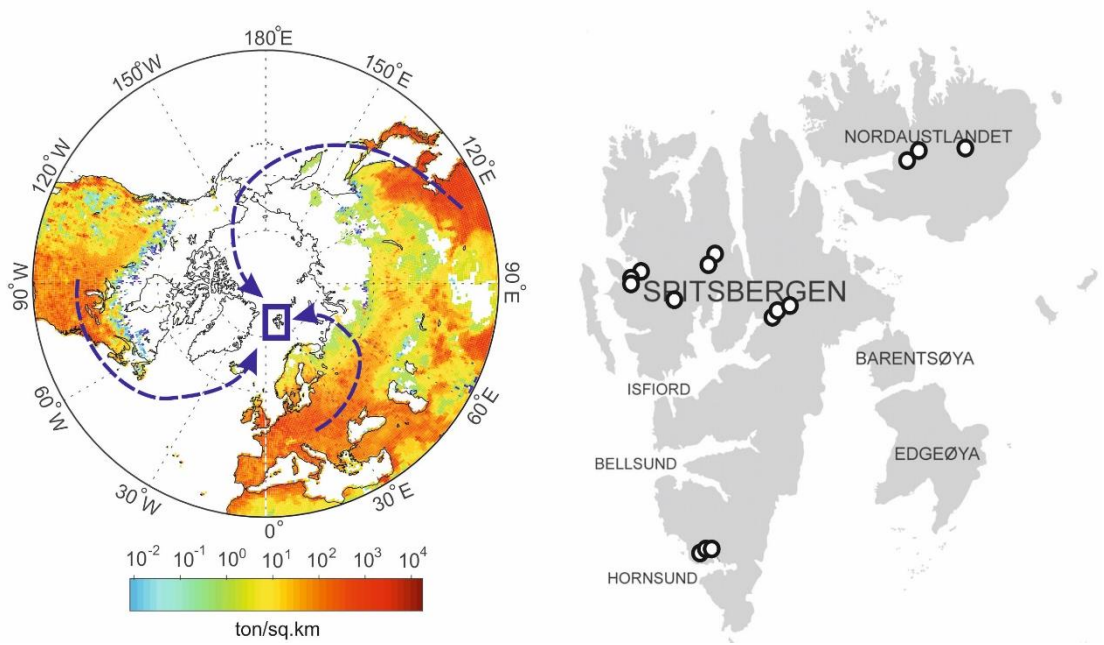

Fig. 1. Left: Present-day Northern Hemisphere emissions of BC to the atmosphere from anthropogenic activities, from the EDGAR database. Some potential transport vectors of BC aerosols to Svalbard (blue rectangle) are shown. **Right:** Locations of the sites surveyed for snowpack properties at the end of the winter 2015-16 across Svalbard.

Five-year air monitoring of persistent organic pollutants in Arctic using XAD-2 resin passive air sampler (id 198)

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Annual air samples were collected at seven sites of Ny-Ålesund during 2011-2015 using XAD-2 resin passive air sampler to investigate occurrence, temporal trends and potential sources of both legacy and novel persistent organic pollutants (POPs) in the atmosphere of Arctic. The air concentrations of PCBs, PBDEs and OCPs ranged 1.9-20.6 pg/m^3, 0.1-0.3 pg/m^3 and 88.3-560 pg/m^3, respectively. PCB-11 and BDE-47 were obviously dominated congeners of $\sum_{19}$PCBs and $\sum_{12}$PBDEs. Hexachlorobenzene (HCB) (56.5-432.6 pg/m^3) was the most predominant OCPs, followed by α-HCH (3.4-11.2 pg/m^3) and α-Endosulfan (0.5-2.2 pg/m^3). Concentrations of PCBs and PBDEs showed decreasing temporal trend. The ratios of high brominated BDEs were

decreasing whereas low brominated BDEs increased from 2011 to 2015. Increasing temporal trends of α-/γ-HCH indicated that re-volatilization might be the potential source of α-HCH and the *p,p'*-DDE/ *p,p'*-DDT ratios >1 implied the impact of aged DDTs. No increasing or decreasing trends of HCB and Endosulfans were observed in Arctic air. Long-range atmospheric transport was still the key factor which influences the occurrence of POPs in Arctic air.

Long-term glacier mass-balance monitoring of Austre Lovénbreen glacier in Ny-Ålesund Svalbard (id 205)

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As a linkage between glacier and climate or/and hydrology processes, glacier mass balance is key element in Arctic glaciology. Ny-Ålesund, Svalbard is an ideal site for long-term mass balance monitoring due to its excellent logistical base and diversity of glaciers. To create a long-term Arctic mass balance time series and therefore to provide an ground-trothing platform for the researches of glacier mass balance and dynamic modelling, as well as Hydro-glaciology, a mass balance investigating campaign on Austre Lovénbreen glacier in Ny-Ålesund was launched in 2004 by Chinese scientists based on Yellow River Station. Our study for the first time presents the primary results of the mass balance measurement.

Glaciological method was employed for the mass balance measurement of Austre Lovénbreen glacier, a small polythermal glacier. This method provides quantitative results at high temporal resolution, which are essential for understanding climate-glacier processes and for allowing the spatial and temporal variability of the glacier mass balance to be captured. Mass balance network containing 22-24 stakes has been established on the glacier since 2004. Field data are obtained during two visits to the glaciers a year in the spring and in the autumn. Specific mass balances are achieved from every single stakes. Annual mass balances converted from specific mass balance dataset by both isocline method and contouring method.

Our study reveals that the result of isocline method depends on the number of observation stakes, and error was generated in any area where the data are not available, such as steep slopes, margin and the ice crevasses areas etc. The contouring method may overestimate the mass balance in high and steep area, but underestimate the mass balance of the whole glacier because using the linear function of mass balance with elevation. Spatial heterogeneity of annual mass balance contour pattern was small. Inter-annual fluctuation of mass balance was significant, which is likely controlled by summer temperature and winter precipitation.

The Arctic Land-air Energy Exchange and Atmospheric Boundary Layer in the Global Change and the Impacts on the Weather and Climate in China (id 2)

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The Arctic as the cold source of the global atmosphere is experiencing an extremely fast change, which would have fundamental impacts on the global atmospheric circulations. Clear evidence shows that an extreme warming up in the European section of the Arctic would enhance the East Asian trough and therefore bring an extreme cold winter in China. As the driving force to the atmospheric motions, the land-air energy exchange and related boundary layer processes play important role in the European Arctic change. Therefore, it is necessary to study the land-air exchange and boundary layer in the European Arctic. For better understanding the land-air energy exchange and the boundary layer, their change and physical mechanism, in the European Arctic; and their impacts on the weather and climate in China, an field observation will be carried out in Svalbard, mainly over Svalbard islands and neighboring ocean, including the soil/grass, glacier and sea surface, Ny Alesund and surrounding regions, from fall of 2017 to fall of 2018. The observation includes the surface atmosphere, solar and atmospheric radiations, surface parameters, land-air energy exchanges, atmospheric dynamic and thermal structures. The instruments include wind profile lidar, temperature profile lidar, ultrasonic coherence flux instruments, automatic weather station, unmanned meteorological plane (5 m wing) etc.. During May 19-29, 2017, we have visited Svalbard and Ny Alesund and made a preliminary investigation, including the selection of observation site, the future cooperation and data share with other research faculties.

Organic carbon and composition in Arctic valley glaciers: Examples from the Bayelva River and adjacent Kongsfjorden (id 194)

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In the face of ongoing global warming and glacier retreat, the composition and flux of organic matter in glacier-fjord systems are key variables for updating the carbon cycle and budget, whereas the role of Arctic valley glaciers seems unimportant when compared with the huge Greenland Ice Sheet. Our field observations of the glacier-fed Bayelva River, Svalbard, and the adjacent Kongsfjorden allowed us to determine the compositions of particulate organic matter from glacier to fjord and also to estimate the flux of organic carbon, both for the river and for Svalbard in general.

Particulate organic carbon (POC) and dissolved organic carbon (DOC) in the Bayelva River averaged 56 μM and 73 μM, respectively, in August, 2012. Amino acids (AAs) and phytoplankton carbon accounted for ~10% of the bulk POC in the Bayelva River, while AAs represented >90% of particulate nitrogen (PN) in fjord surface water, suggesting the strong in situ assimilation of organic matter. Bacteria accounted for 13% and 19% of the POC in the Bayelva River and the Kongsfjorden, respectively, while values for PN were much higher (i.e., 36% in Kongsfjorden).

The total discharge from the Bayelva River in 2012 was 29×10^6 m^3. Furthermore, we calculated the annual POC, DOC, and PN fluxes for the river as 20 ± 1.6 tons, 25 ± 5.6 tons, and 4.7 ± 0.75 tons, respectively. Using the POC content and DOC concentration data, we then estimated the annual POC and DOC fluxes for Svalbard glaciers. Although the estimated POC ($0.056 \pm 0.02 \times 10^6$ t/yr) and DOC ($0.02 \pm 0.01 \times 10^6$ t/yr) fluxes of Svalbard glaciers are small in amount, its discharge-weighted flux of DOC was over twice higher than other pan-arctic glacier systems, suggesting its important role as a terrestrial DOC source.