VILLUM
RESEARCH STATION, Station Nord

2018 ANNUAL REPORT

AARHUS UNIVERSITY

Grønlands Naturinstitut
Pinngortitaleriffik · Greenland Institute of Natural Resources

VILLUM RESEARCH STATION, Station Nord
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Photo: Bjarne Jensen.

CONTENT

INTRODUCTION

Dear Reader
Welcome to the annual report of the Villum Research Station 2018.

This is the fourth time, I write the introduction to the annual report of activities at the Villum Research Station at Station Nord (VRS). The year 2018 year was the most active year so far with 68 scientists visiting and all together, there were approx. 2,000 overnight stays. Most notable was the large campaign in March and April. About 30 researchers attended the joint field campaign from four countries. The subject was the climate effect from black carbon in the atmosphere and in snow, see later article for details. I myself, participated in the campaign and it was really a pleasure to see the professionalism and the good spirit that everybody showed during the entire campaign and how well the research facilities worked in supporting the activities. In the coming months, this will also lead to a long series of excellent scientific results and publications. A few previews into the activities are described here. Airborne measurements were made on board Polar 5 (a modified DC3 aircraft of Alfred Wegener Institute) both looking at surface morphology and air pollution at different altitudes. A tethered balloon was equipped with meteorological equipment and provided information about the low altitude meteorology and boundary layer height. Ground-based investigations focused on the influence of snow surface characteristics on the energy exchange between atmosphere and snow. Non-refractory aerosol components of black carbon were measured in parallel with continuous measurements that are ongoing at Villum Research Station. Furthermore, a series of other high level and interesting projects and campaigns carried out. Some of them are presented in articles in this annual report.

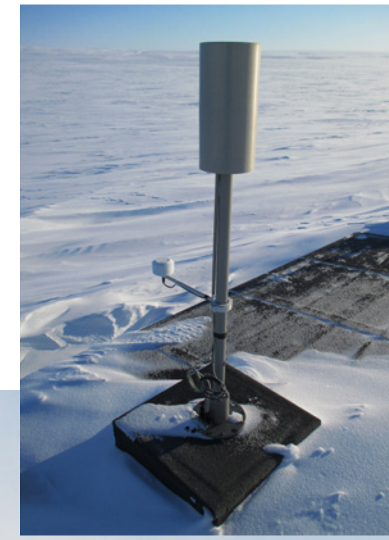
In 2018, a campaign was initiated at Krøyers Holme where important bird colonies were expected to be found, as was the case in 2017. A group from the Department of Bioscience at Aarhus University studied the foraging ecology of ivory gulls. A group completed meltwater and sediment sampling of two proglacial river systems draining the north-western outlet glacier of Flade Isblink icecap, as part of an INTERACT funded project, Glacial Meltwater Sediment Transformation in Arctic River systems (GLAMSTAR). In this context, let me mention the fantastic prospect that Interact will continue with an Interact III; this will allow the support of projects to still be possible.

Besides the projects and campaigns described above, continued monitoring are performed at the Villum Research Station. The monitoring is mainly financed by means of DANCEA, administered by the Danish Environmental Agency and the Danish Energy Agency. Examples will be shown later.

The first test flight of one of the larger drones financed by the Villum Foundation was performed in 2018 by DTU SPACE, INTEGRA and Aarhus University. There is a large perspective for the use of drones and the first joint campaign is planned to take place during summer 2019, where larger drones will be used.

Finally, I wish to thank all scientists that visited and used the Villum Research Station in 2018. Climate change is maybe the largest challenge humanity faces (as described in SDG 13 by UN) and you have all done great scientific work of great importance for the society in order to cope with these changes and by that contributing to the success of the station.

Best regards
Henrik Skov, Scientific Head of
Villum Research Station, Station Nord



Special heated inlet for particle measurements at the Air observatory. Photo: Henrik Skov.

Air observatory located two kilometers south of the central complex of Station Nord. Photo: Henrik Skov.

CONTINUOUS MONITORING ACTIVITIES AT THE VILLUM RESEARCH STATION

By Henrik Skov, Andreas H. Massling, Ingeborg E. Nielsen, Claus Nordstrøm, Rossana Bossi, Katrin Vorkamp, Jesper Christensen, Martin Mørk Larsen and Kaj Mantzius Hansen

iClimate and ARC, Department of Environmental Science

Since 1990, a selection of atmospheric pollutants has been measured at Station Nord with a break between 2002 and 2007, where the activities were moved to Nuuk on the west coast of Greenland. All through the years, activities have been financed by means of DANCEA (the first years by a predecessor of DANCEA) administered by the Danish Environmental Protection Agency and in the later years also by the Danish Energy Agency. We are very grateful for the DANCEA funding and by that, the trust that the agencies show us. This funding is the backbone for all the activities that we have at Villum Research Station (VRS). In 2013, we got a large grant from the Villum Foundation to build a new research infrastructure that made it possible to extend activities and host internationally recognized researchers. The complete list of measurements carried out at VRS is available at www.villumresearchstation.dk. Below is a few examples of results that we have obtained so far.

MONITORING OF POLLUTANTS

Lead (Pb) was extensively used in gasoline to increase the octane number of the fuel. In the late 80's, the use of lead was phased out and a general decrease in the concentration was observed – even at VRS where Pb is observed due to long range transport of air masses originated from mid latitudes.

In order to test that the observation is really an effect of decreasing emissions, the DEHM (Danish Eulerian Hemispheric Model) model was used to calculate the lead concentration using the meteorological data generated for each year but with emission inventories fixed for 1989. The measured and modelled results are shown in Figure 2.1. The ratio of measurement to model result is changing from 1.28 in 1991-1993 to 0.42 in 2012-2014 and becomes 0.28 in 2015-2016 i.e. (update from [Skov, 2017]). The measured and modelled concentrations are the result of emission strength of Pb, location of the sources as well as transport patterns.

The use of actual meteorology can be considered as a way to remove the meteorological signal from the ratio. The emission applied in the model was kept constant through the years. Therefore, the ratio between measured and modelled results represents a first estimate of the effect of changing emissions in the source regions [Heidam *et al.*, 2004]. The ratio has decreased by a factor of 4.6 due to reduced lead emissions in the source area in Eurasia.

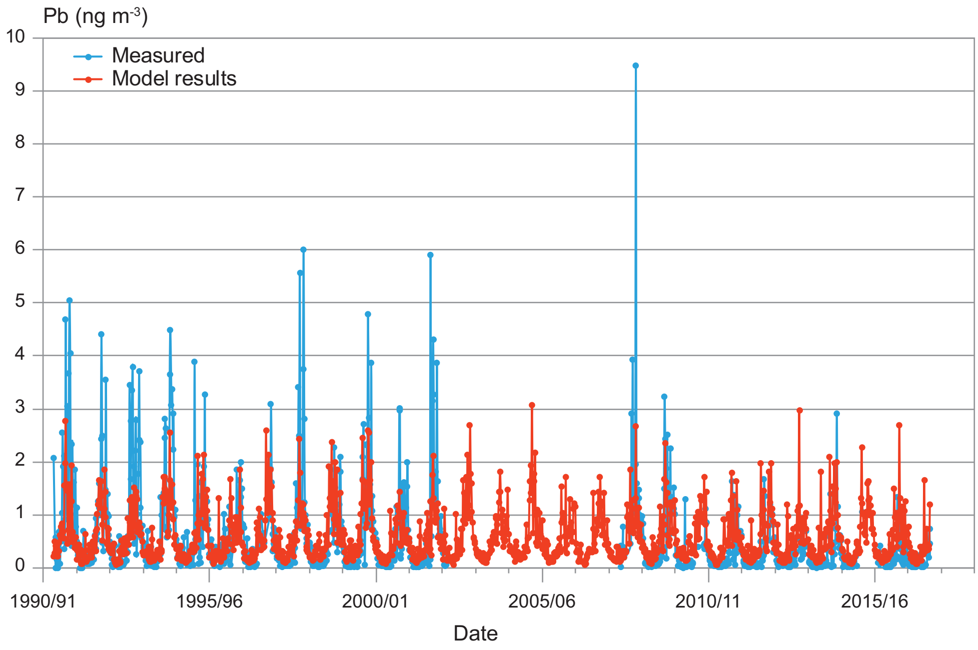


Figure 2.1. Measured concentrations and modelled results using the DEHM model for Pb.

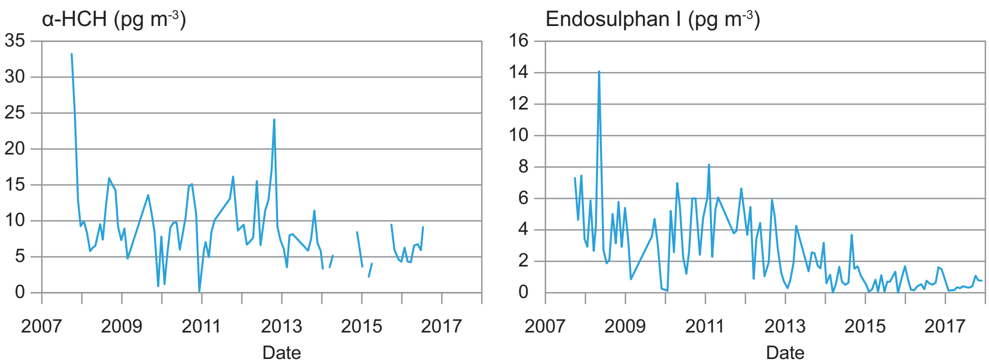


Figure 2.2.
Weekly average concentrations of α-HCH (left) and endosulfan I (right). Samples are taken once a month by collecting about 5,000 m^3 air through a quartz filter and thereafter a cartridge sandwich of PUF-XAD-PUF. Update from [Skov, 2017].

α-HCH and endosulfan I belong to the group of organochlorine pesticides that have had widespread use in the past decades but today they are banned by the ratification of the Stockholm Convention from 17 May 2004.

At VRS, α-HCH and endosulfan I have been measured since 2007, see Figure 2.2. α-HCH was found at yearly average concentrations from 8 to 11 pg m^{-3} in 2008-2010. Thereafter, concentrations decreased to around 5-6 pg m^{-3}, and then have been constant for the last four years. As air masses are mostly transported from Eurasia, no effect is observed from the emission reduction in North America. Significantly decreasing concentrations have been observed for endosulfan I after 2011. The peak in 2011 might be due to increased use of the pesticide stocks just before the phaseout. The contribution of long-range transported concentrations of endosulfan I from Asia is also expected to decrease, since China has implemented the Stockholm Convention from March 2014 [Skov, 2017]. Interestingly, α-HCH correlates for a three year period (2008-2010) with the inverse temperature following Clausius–Clapeyron equation and increases with decreasing sea ice cover [Bossi et al., 2013], which shows that there is a clear link to ice melting and consequent reemission of α-HCH trapped in the ice. As endosulfan I was still in use at that time, the same correlation with ice cover was not observed.

VRS is not only providing the needed scientific infrastructure and support to visiting scientists. All results from the monitoring activities at VRS are also available for collaborators. In this way, visitor's own data acquire higher scientific value and, on the other hand, additional parameters and scientific results add value to the monitoring activities. In this way, there is a mutual added value to all parties.

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AIRBORNE AND GROUND-BASED ATMOSPHERIC AND SEA ICE MEASUREMENTS IN NORTHERN GREENLAND

By Andreas Herber, André Ehrlich and Henrik Skov

INTERNATIONAL COLLABORATION

From mid-March to mid-April 2018, the large atmospheric and sea ice field campaign PAMARCMiP (Pan-Arctic Measurements and Arctic Climate Model Intercomparison Project), was hosted by the Villum Research Station and Station Nord Military Base. PAMARCMiP is a joint project of different international universities and research institutes from Germany, Japan, Netherlands and Denmark embedded in the Transregional Collaborative Research Centre TR 172 ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms (AC)³.

The general goal of PAMARCMiP was to obtain a comprehensive data set of atmospheric and sea ice properties that will be used to understand and quantify the interaction between atmospheric aerosol, surface optical properties and clouds in the central Arctic. Therefore, ground-based measurements at and in the vicinity of the Villum Research Station were carried out together with airborne measurements by the AWI (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research) research aircraft Polar 5 and profiling the atmosphere by tethered-balloon. The research was conducted by about 30 scientists.

Starting from 10 March, ground-based, balloon-borne and airborne measurements were set up to sample the aerosol and trace gas composition in the atmosphere and to characterize the snow and sea ice surface. In the first week of the campaign, the ground-based measurements were installed in the new facilities of the Villum Research Station providing two measurement huts outside the main camp. In the air observatory, continuous observations analyzing the chemical and physical properties of trace gases and aerosol particles, including black carbon were integrated and complemented the basic monitoring program of Aarhus University. Close by, in the so-called Flyers Hut, the balloon measurements were based. The balloon was equipped with different payloads for turbulent and radiative quantities and could reach about 1,500 m altitude. Almost every day one or two profiles could be obtained, in total 36, revealing the typical strong stratification of the lowest boundary layer with strong inversion layers. For one day, when a synoptic front passed the station, a 24h-measurement program of continuous profiling was made.

The snow surface optical properties were measured daily at different places along a 50 m sampling line and by a sledge equipped with different radiation sensors. Snow morphology was characterized by collecting snow samples at differ-

Group picture at Station Nord before Saturday evening dinner (courtesy Esther Horvath, AWI).

ent locations in the vicinity of the station. Two small expeditions were carried out on sea ice to extend the data set for the snow on sea ice.

After a delay of the ferry flight, due to bad weather, the airborne activities started in the second week of PARMARCMiP. In total the AWI research aircraft Polar 5 spend 55 hours in the air during 13 research flights, which covered different areas of sea ice north and east of Greenland. The instrumentation showed that the sea ice was highly variable in terms of roughness, thickness and surface albedo even if almost 100 % of the sea was covered by ice. The atmospheric measurements on board Polar 5 spotted several layers of pollution in higher altitudes, which were characterized by a higher concentration of black carbon particles and trace gases such as carbon monoxide.

The large data set of ground-based and airborne observations will be analyzed in the coming months and years to evaluate the main transport path of aerosol into the Arctic and to understand the variability of sea ice properties. These findings will support the development and evaluation of models forecasting these processes. Additionally, a media team of AWI accompanied the scientific activities and collected many pictures and videos of the scientific operations but also of the daily life at the station of which some are shown here.

Nora Fried and Marco Zanatta doing in situ sampling of snow on the sea ice (courtesy Esther Horvath, AWI).

Polar 5 aircraft – Prepration for airborne mission (courtesy Esther Horvath, AWI).

EXPLORING THE ATMOSPHERE ABOVE THE VILLUM RESEARCH STATION WITH A TETHERED BALLOON

By Holger Siebert, Ulrike Egerer, André Ehrlich, Matthias Gottschalk, Frank Stratmann, Jens Voigtländer, and Manfred Wendisch; Leibniz Institute for Tropospheric Research, Department for Experimental Aerosol and Cloud Microphysics, Leipzig, Germany

VERTICAL MEASURE-MENTS

Figure 4.1.
The 9 m^3-tethered balloon in front of Flyger's Hut ready to go. Photo by courtesy of Esther Horvath, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research.

The vertical structure and layering of the wintertime Arctic boundary layer is highly complex but key for understanding long-range advection of moisture, pollution and other quantities and their corresponding vertical mixing. Due to the lack of local sources during the wintertime period, observed moisture is often transported over long distances resulting in long persistent cloud layers or is finally mixed down to the ground levels. The same holds true for a certain fraction of the observed aerosol particles or pollution at ground. Therefore, it is natural to complement the detailed ground-based studies of aerosol properties and trace gases performed at the Villum Research Station (VRS) by vertical profiling.

During wintertime, the Arctic boundary layer (ABL) is typically shallow and only a few hundreds of meters in depth, often characterized by strong temperature inversions (increase of temperature with height) covering the lower most part of the ABL. That is, the coldest, and therefore most dense air is located close to the ground, which results in a very stable stratification with low turbulence, and vertical mixing is significantly damped. Under such conditions, the only source for turbulence production is wind shear that is a change of horizontal wind speed or direction with height. Such wind shear is often observed in coincidence with low-level jets (LLJ), a distinct wind maximum above ground causing long-range transport and effective vertical mixing.

Within the course of the PAMARC-MiP project (March/April 2018), the Institute for Tropospheric Research and the University of Leipzig deployed a small helium-filled tethered balloon (Fig 4.1) at "Flyger's Hut" about 2 km south of VRS. The balloon carries scientific payloads with a total weight of up to 3 kg to a maximum height of to 1 km. Vertical profiling of temperature, humidity, radiation properties, and wind speed and direction was possible. Furthermore, fast wind fluctuations could be resolved in order to quantify the intensity of turbulence. As one highlight of this short-term deployment, 15 subsequent balloon launches within 24 hours could be realized. Based on this data set, a complete diurnal cycle

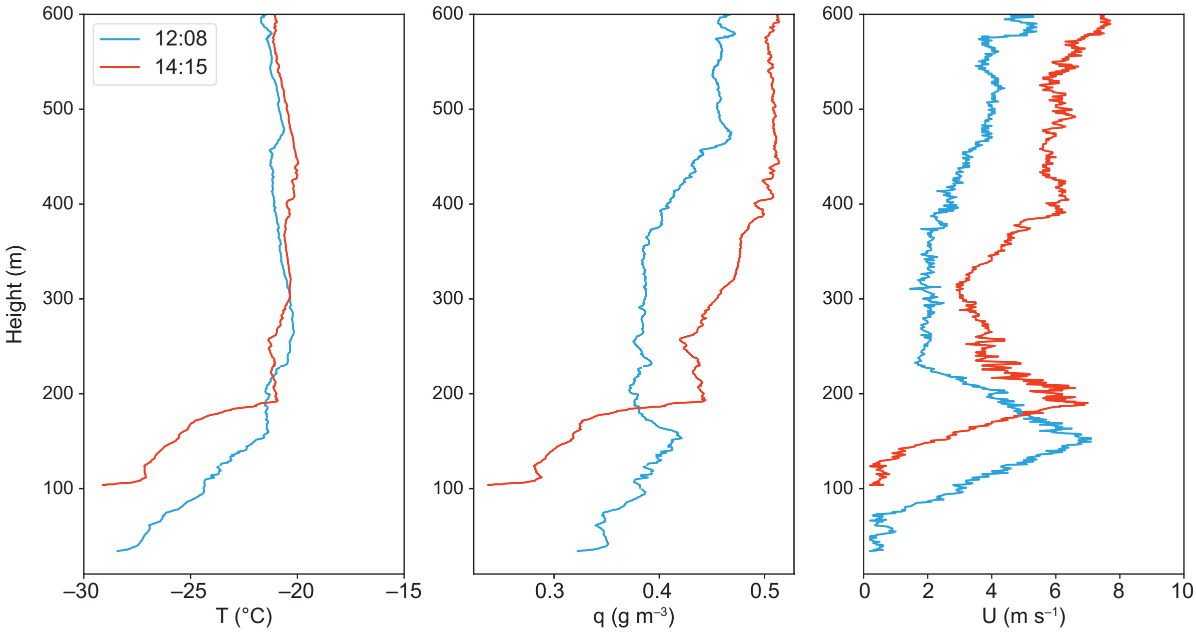


Figure 4.2.
Two selected profiles showing the actual temperature T, water vapor mixing ratio q, and horizontal wind speed U as observed on March 29th, 2018 at VRS.

can be analyzed. Figure 4.2 shows two selected vertical profiles of the temperature T, water vapor mixing ratio q (amount of water vapor per m³ of air), and the horizontal wind speed U. Lowest temperatures of almost -30 °C observed at ground but increasing with height up to 150 to 180 m indicate a quite stable stratification. In coincidence with these inversions, significant maxima of water vapor have been observed at the same height where the wind speed shows distinct maxima of more than 6 m s^{-1} compared to almost calm wind at ground level. For this case, it was clearly shown that low-level jets have the capability to advect moisture and mix it down to lower levels. The question remains how this mechanism influences the local ground-based observations of aerosol properties and trace gases at the monitoring station at VRS. To answer this question, further deployments of the balloon are planned for the future, including devices for filter sampler and aerosol characterization. However, these profiles already and clearly show that ground-based observations alone only tell us half of the story. Due to the remoteness of VRS with the absence of local sources of air pollution and almost negligible orographic influence, this location is the perfect place for such investigations.

TEMPORAL EVOLUTION OF SNOW GRAIN SIZE

By Gerit Birnbaum, Tobias Donth and Christine Pohl; Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

REFLECTIVITY OF SNOW

Figure 5.1.
SSA sampling by means of the IceCube System.

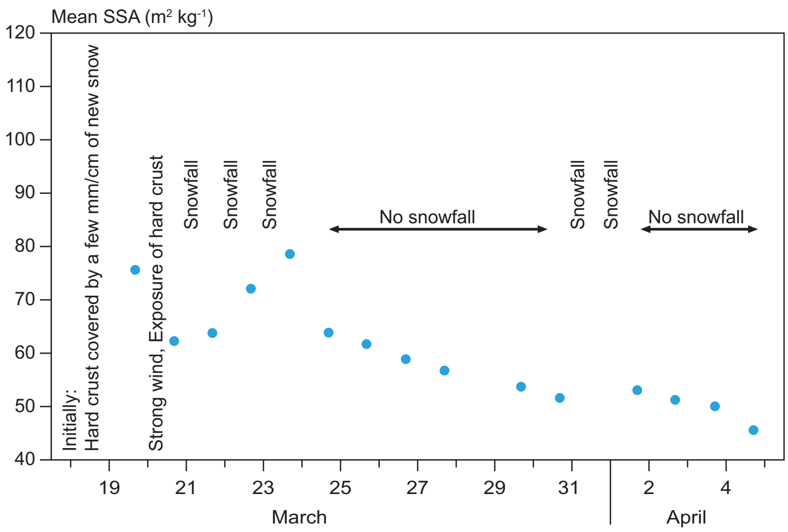


Figure 5.2.
Temporal evolution of snow specific surface area from 19th March to 4th April 2018 (mean value of 51 samples).

Introduction
In March/April 2018, an international team of scientists carried out ground-based and airborne measurements around the Villum Research Station in the framework of the campaign PAMARCMiP.

Our ground-based investigations focused on the influence of snow surface characteristics on the energy exchange between atmosphere and snow, particularly on the reflectivity of the snow surface. The spectral and the wavelength-integrated (broadband) albedo, which is the ratio of the downwelling to the upwelling hemispheric solar radiation flux, depends on the size of the snow grains. Fresh snow consists of small, irregular grains. Aging snow undergoes metamorphism leading to an increase in grain size. Snow consisting of large rounded grains scatters the incoming solar radiation further into the snowpack than snow consisting of small irregular grains. Hence, snow metamorphism causes broadband albedo to decrease.

Our studies
We determined the optical-equivalent snow grain size by means of the specific surface area (SSA) of snow. The SSA is defined as the surface area of snow grains per unit mass of snow, and it is reciprocally proportional to the optical-equivalent snow grain size. Hence, snowfall leads to an increase in SSA and consequently to an increase in broadband albedo. The aging of snow leads to a decrease in SSA and to a decrease in albedo.

SSA was measured by the IceCube System (see Fig. 5.1). Broadband albedo was calculated from downwelling and upwelling shortwave radiation fluxes measured with two pyranometers, which were mounted on a steel frame on a sledge.

SSA sampling was performed along a 100 m line; in total we took 51 samples nearly every day from 19th March till 4th April 2018. Figure 5.2 shows the temporal evolution of the mean value of the 51 samples. Overall, the time series shows a cascading decrease in SSA caused by snowfall events and two periods without snowfall.

Further analyses of the data will focus on the dependence of spectral and broadband albedo on snow grain size and other snow and atmospheric properties.

CARBON TRANSPORT IN ARCTIC GLACIAL MELTWATER SYSTEMS

By Kathryn Adamson and Tim Lane; Manchester Metropolitan University and Liverpool John Moores University, United Kingdom

Introduction

Glacial forelands contain large volumes of unconsolidated sediment that are temporarily stored in, and subsequently released from, landforms such as gravel bars, moraines, and proglacial lakes. Such landforms interrupt the sediment cascade from the ice margins to the ocean. Because foreland sediments are highly mobile, they can be easily eroded by meltwater streams or deflation by wind, especially under changing climate conditions and increased stream discharge. This has the potential to alter downstream mineral transport, and thus terrestrial and offshore chemistry and ecosystems, but these interactions are not fully understood.

GLACIER RETREAT

Proglacial zones are major sinks for organic carbon, which is evacuated from subglacial stores into the proglacial fluvial system, eroded from permafrost, and eventually transported offshore (Masson et al., 2010). Some of this carbon rapidly degasses into the atmosphere, but some is stored in proglacial sediment and permafrost, either temporarily or over longer geological periods. However, the quantity of stored carbon is unknown, and it is likely to vary spatially and temporally with proglacial sediment characteristics, and ecosystem change on a deglaciating foreland.

In the sensitive Arctic region, enhanced glacier melt is likely to increase meltwater discharge and proglacial erosion, and transform downstream mineral and carbon export. Quantifying the response of the dynamic proglacial environment to environmental change is therefore an important component of global mineral, water, and carbon cycles, but to date, there has been no systematic analysis of proglacial sediment mineralogy and carbon storage-release patterns in the High Arctic; our project will address this.

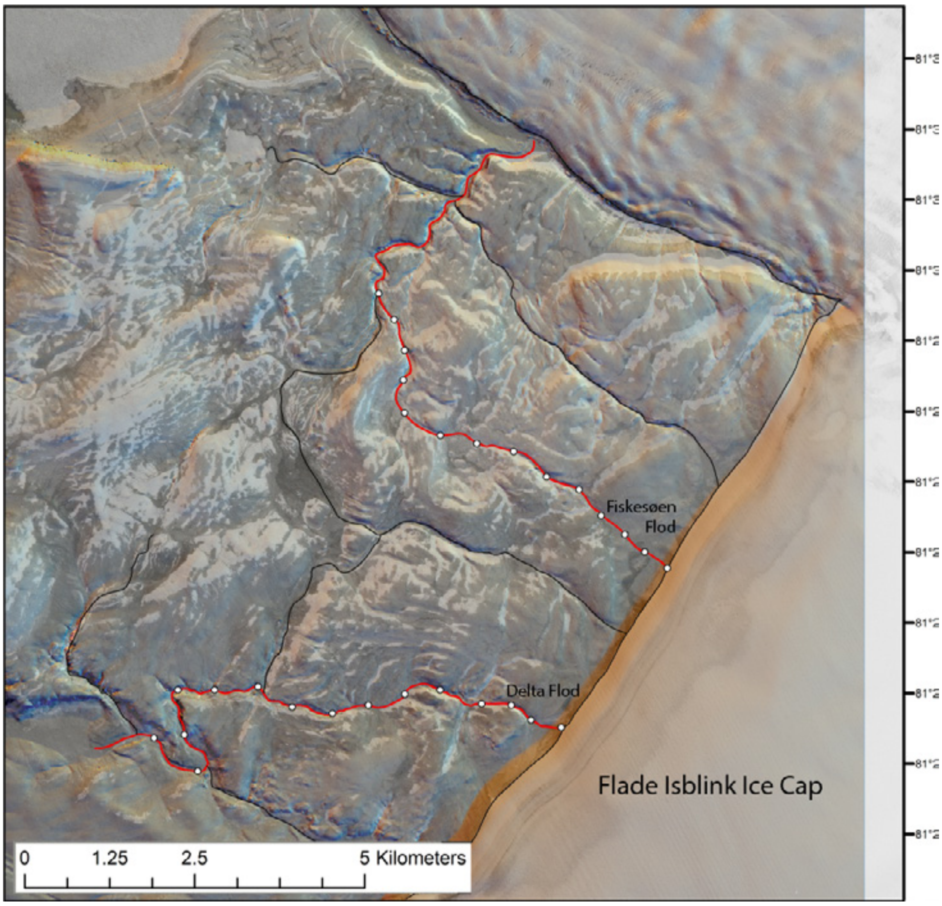


Figure 6.1.
Map of the study area at Flade Isblink, indicating the proglacial river systems, and sampling locations (white circles).

Figure 6.2.
Meltwater outlet at the margin of Flade Isblink.

Figure 6.3.
Sampling of gravel bars at Fiskesøen Flod.

Our analysis
In 2018 we completed meltwater and sediment sampling of two proglacial river systems draining the north-western outlet glacier of Flade Isblink icecap, as part of an INTERACT funded project Glacial Meltwater Sediment Transformation in Arctic River systems (GLAMSTAR). Meltwater and sediment samples were taken at intervals over a 5 km downstream transect from the ice margin. Sediment samples were obtained from gravel bars, stream-cut-exposures, bedload, and moraines. Meltwater samples were filtered to extract the suspended sediment load.

Sample analysis is on-going, and will include mineral analysis of the sediment to determine its composition and source bedrock. Total organic carbon analysis will be used to examine spatial patterns in carbon storage and transport in the meltwater system.

These datasets will be combined to establish if proglacial carbon flux and meltwater mineralogy change locally within individual forelands in the High Arctic. This detailed meltwater system analysis will help us to better understand, and predict, morphosedimentary and ecosystem response to glacier retreat. Our data from Flade Isblink icecap will directly complement data collected from Arctic Station (West Greenland) in 2017, and allow an investigation of changes in carbon flux and meltwater mineralogy latitudinally through the Arctic region.

BLACK CARBON MEASUREMENTS AT THE VILLUM RESEARCH STATION

By Makoto Koike; University of Tokyo, National Institute of Polar Research

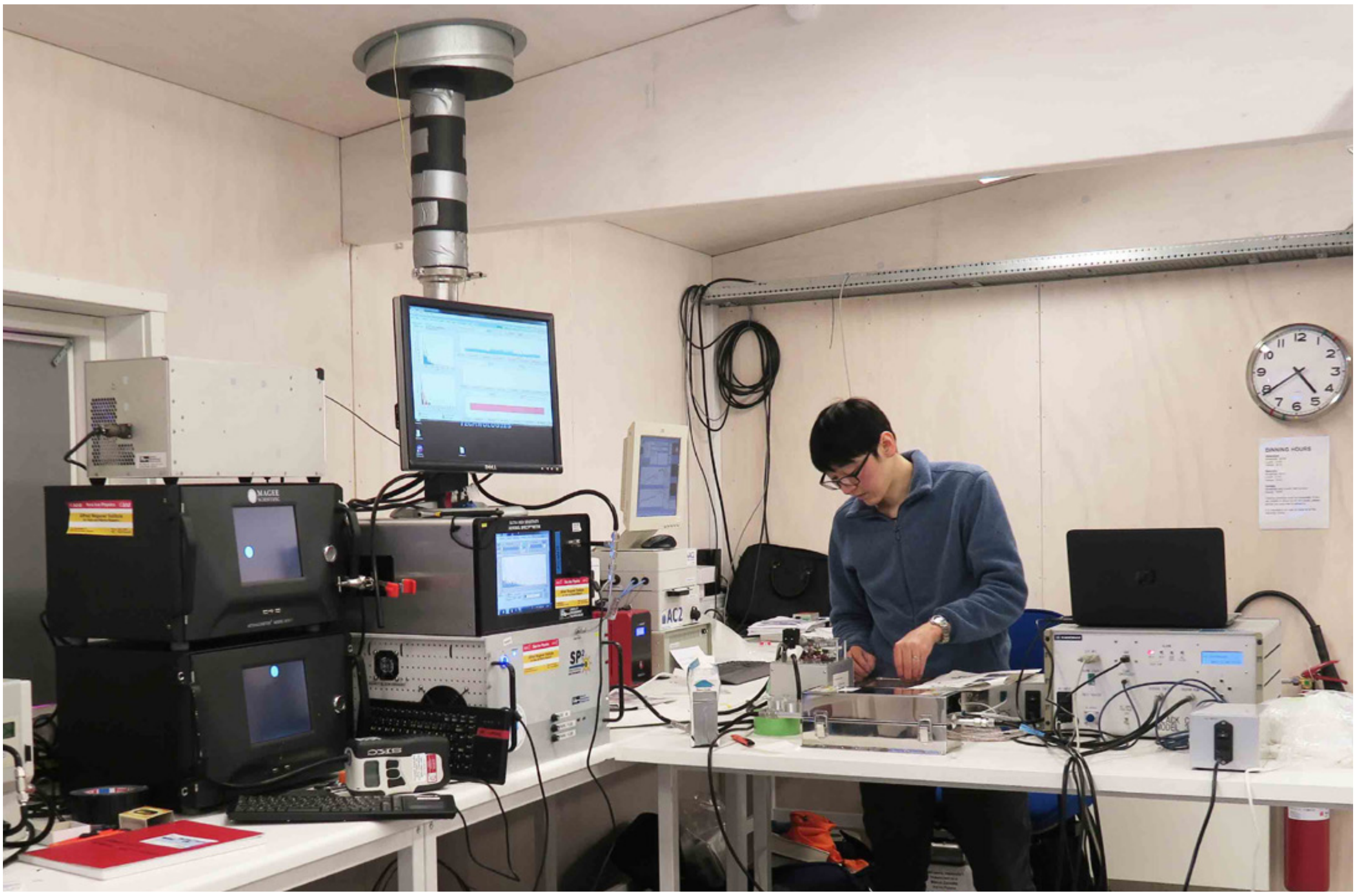
SOURCES OF BLACK CARBON

The annual average Arctic temperature has increased at almost twice the rate as that of the rest of the world over the past few decades. The main driver of this warming is an increase in the global concentration of carbon dioxide; however, various other climate forcers and feedback processes are amplifying the magnitude of warming in the Arctic. Black carbon (BC) particles, which strongly absorb solar radiation, could potentially make a large contribution to Arctic warming. These particles (aerosols) reduce snow and ice albedo once they deposit on snow/ice surfaces and this process may accelerate ice-albedo feedbacks. The Arctic atmosphere is so clean, therefore, small increases in BC concentrations could affect the Arctic climate. However, we do not well understand where the BC particles in the Arctic come from. Consequently, we do not know how we can reduce BC concentrations in the Arctic.

In March 2018, an instrument to continuously measure BC mass concentrations in the atmosphere, called COSMOS, was installed at the Air Monitoring House of the Villum Research Station (VRS). It uses a filter-based optical technique: BC particles are collected on a filter-surface by sucking ambient air through the filter and BC mass concentrations are derived by measuring light absorption through the filter [Sinha et al., 2017]. COSMOS is similar to conventional filter-based BC instrument, such as PSAP and Aethalometer; however, only COSMOS is equipped with an inlet heated at 300°C to remove non-refractory aerosol components. Although measurements with the conventional techniques need to be corrected for the effects of co-existing non-BC aerosol particles (non-refractory components) in the filter medium, COSMOS measurements are free from these interferences.

Preliminary results show that BC mass concentrations at the VRS were 20 – 40 ng m^{-3} in March 2018, which are only about 1/20 of levels observed in the East Asia. BC mass concentrations are also being measured by other research groups, namely, Aarhus University (Denmark) and Alfred Wegener Institute (Germany), using different techniques. It is important to compare these measurements to obtain BC concentrations, which are consistent among the measurements in the Arctic.

Air Monitoring House of the Villum Research Station (VRS).



Sho Ohata (research associate in Nagoya University, Japan, working on the COSMOS instrument installed in the VRS.

Using COSMOS, BC mass concentrations are being measured in other locations in the Arctic, such as Ny-Ålesund (Svalbard Is.), Barrow (Alaska), Cape Baranova (Russia), and Alert (Canada). It appears that BC mass concentrations are not uniform within the Arctic, likely due to differences in influences from various BC sources. BC particles are emitted from anthropogenic combustion and biomass burning. Aerosols containing BC could be transported from midlatitudes, such as Asia (via long-range transport), high latitudes (biomass burning), and within the Arctic (small sources, such as gas flaring). Observed temporal and spatial variations in Arctic BC concentrations will provide valuable information on BC sources and transport/removal processes. By making collaborative efforts among international researchers who make observations and numerical model calculations, interesting and useful results are expected to be obtained.

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FORAGING ECOLOGY OF A HIGH ARCTIC SPECIALIST, THE IVORY GULL

Figure 8.1.
An ivory gull appears out of the mist.
Photo: Henrik Haaning Nielsen.

THE IVORY GULL

By Morten Frederiksen, Henrik Haaning Nielsen and Jonas Koefoed Rømer; Department of Bioscience, Aarhus University

Among all the World's birds, the ivory gull is probably the most pronounced high Arctic specialist. It spends all year in areas with high sea ice cover, breeding in the far north of Greenland, Canada, Svalbard and Russia, and following the ice edge south during winter. Rarely seen in areas inhabited by humans or frequented by tourists, and with its almost ghostly appearance, this bird is for many birdwatchers an icon of the high, inaccessible North.

But how do ivory gulls manage to make a living from the icy, and often ice-covered, seas surrounding their remote breeding colonies? Little information exists, and most of it anecdotal. It is well known that ivory gulls are attracted by remains of the meals of other species, for example carcasses of seals killed by polar bears, or food scraps from kitchens at human settlements, bases or research stations. Yet, it is not known how important such food sources are to breeding ivory gulls, or how far the birds range from their colonies to obtain food for themselves and their young.

In the summer of 2018, we got the opportunity to investigate the foraging ecology of ivory gulls in North Greenland, as part of a large research programme aimed at improving our ecological understanding of the Greenland Sea in preparation for potential future oil exploration. First, we had to find some ivory gulls we could catch and track using GPS devices mounted on the birds' back. The original plan was to do this at Henrik Krøyer Holme, a small archipelago in the Greenland Sea. However, a brief visit showed that no ivory gulls bred on these islands in 2018. We therefore returned to our base at the Villum Research Station, and spent the next couple of weeks trying to catch gulls in that area.

Ivory gulls are daily visitors to the kitchen at Station Nord, where they feed on anything left over from the kitchen. This provided us with chances to capture the birds. After a bit of trial and error, we became quite successful in using our spring-loaded traps, baited with delicacies such as smoked fish or roast pork, to capture hungry gulls. Once caught, the birds were ringed, equipped with the GPS device, weighed and measured, and released. The devices are solar powered and include a small radio transmitter, and whenever the birds were within range of our receiving antenna mounted on a rooftop, they duly uploaded data obtained since their last visit. These data include GPS positions taken every 10 minutes, and bursts of three-dimensional accelerometer data that will

Figure 8.2.
The solar-powered GPS device has just been mounted on the back of this ivory gull – just about to be released to collect data!
Photo: Henrik Haaning Nielsen.

Figure 8.3.
The newly discovered ivory gull colony 18 km east of Station Nord. Around 100 pairs breed here, far from any predators that might be interested in their eggs or chicks.
Photo: Henrik Haaning Nielsen.

Figure 8.4.
The helicopter arrives to pick us up after our visit to the ivory gull colony. Landing a helicopter on soft snow is not advisable, so we're ready for a quick pick-up with rotors running.
Photo: Henrik Haaning Nielsen.

be used to classify the birds' behaviour (e.g. flying versus standing).

On a memorable day, we also got the chance to visit by helicopter a newly discovered ivory gull colony, 18 km east of the station. Here, the ivory gulls nest on a series of naked moraine knolls at the edge of the Flade Isblink glacier. Apart from these knolls, the entire landscape was completely covered by snow and sea ice; land and glacier were almost indistinguishable. In this bizarre scenery, about 100 pairs of ivory gulls were happily incubating their eggs or brooding their newly hatched chicks. We captured gulls in the same way here, except that the birds' nest took the place of bait (after we had swapped the eggs for wooden replicas to avoid damage).

So what did we find? It appears that the ivory gulls in this area use at least three different foraging strategies. Occasionally, they go on very long trips (up to one week) into the drift ice far offshore, often several hundred kilometres from the colony. We speculate that on these trips, the gulls search for seal carcasses, which represent a rich but rare food source, and that such trips are made mainly by birds which have failed in their breeding attempt. More commonly, birds travel to the nearest open water area, 50-100 km from the colony, where they presumably feed on fish and various invertebrates. Finally, a few individuals made a large number of trips to the calving glacier Marsk Stig Bræ SSW of Station Nord, where they presumably feed on crustaceans, which are killed by osmotic shock when sub-surface freshwater runoff is mixed with highly saline seawater. After further analyses, the results of our study will be used to identify areas that should be safeguarded to protect this vulnerable and declining Arctic icon.

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