UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

# ARCTIC STATION

## Annual Report 2014

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*Field work in Blæsedalen*
*Photo Kent Pørksen*

# Chairman's Welcome

*Professor Bo Elberling*

**Arctic research is both nationally and internationally in a rapid development. Not the least due to the importance of Arctic areas' in relation to climate change. Climate change will lead to both new opportunities and new challenges in the Arctic. There is therefore an urgent need to provide both research-based new knowledge but also training of a new workforce with specialized knowledge in this field.**

Arctic Station is situated on the border of High and Low Arctic. It is a quite unique station, which has given Arctic researcher´s the opportunity to study one of the most diverse Arctic ecosystem in Greenland year-round. At the same time Arctic Station has functioned as a platform for teaching graduate students for more than four decades.

A major task in 2014, and to be continued in the future, has been to develop an ecosystem monitoring programme, which can be integrated and support the ongoing research at the station and as such go hand in hand with teaching. This is a key ambition to be developed in the near future.

A new and expanded monitoring programme was running in 2014 and now includes a new climate station, snow and sea ice monitoring, vegetation and lake monitoring as well as marine profiling. The previous monitoring included at climate station documenting that the climate since 1991 has changed dramatically: winter temperatures are increasing and the extent of sea ice and snow on land is significantly reduced.

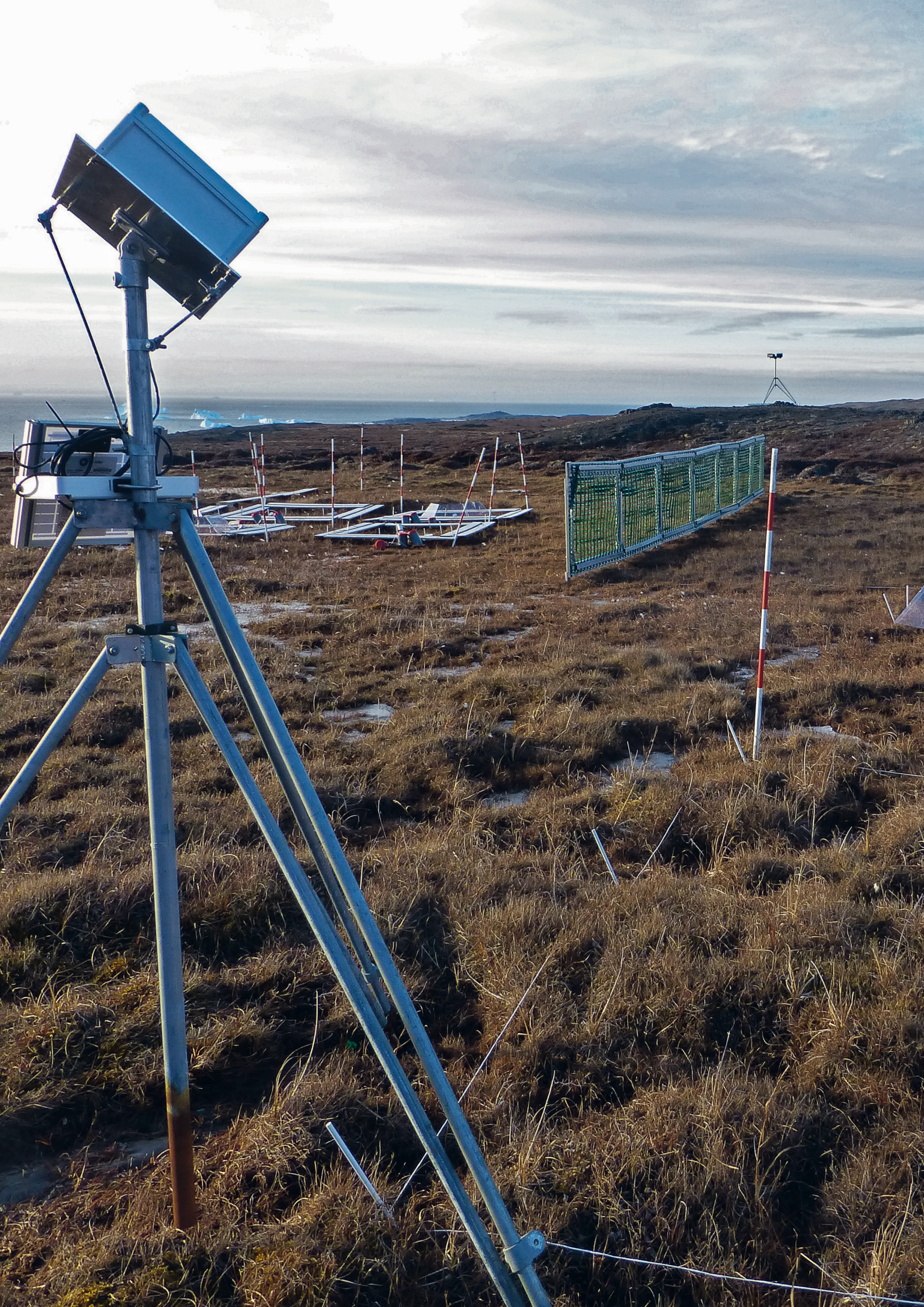
The station is not only located on the border between the so-called Low and High Arctic zones but also represent a pearl in the string of field stations, where the climate and the link to the physical and biological processes today can be monitored as part of GEM (Greenland ecosystem monitoring programme). In this annual report you can get a touch of the type of data being collected as part of this new so-called DiskoBasis monitoring programme which is partly funded by the Danish Ministry of Energy and very much appreciated.

The station is staffed year-round with a scientific leader, a chief of logistics and a captain for Porsild. I would like to acknowledge the excellent and hard work from these permanent staff members in Qeqertarsuaq. The staff is making it possible to conduct studies also in the dark winter months at Arctic Station. In September 2014 our new scientific leader, Christian Juncher Jørgensen took over the position after the former scientific leader Ole Stecher. The scientific leader is a 3 years position whereas the two other are permanent positions.

Most scientific groups have presented their work in this report, thank you for that and for considering Arctic Station and the Disko area for your research – in many cases research has been made in collaboration with the board of Arctic Station. Finally I would like to thank the board for a fruitful collaboration in 2014 and Gitte Henriksen for being a very qualified and enthusiastic administrator supporting the board and the Station.

Enjoy reading

Bo Elberling



# DiskoBasis Monitoring

*Charlotte Sigsgaard, Christian Juncher Jørgensen, Magnus Lund, Kirsten Seestern Christoffersen, Ole Stecher, Kjeld Akaaraq Mølgaard, Birger Ulf Hansen, Mathias Madsen & Bo Elberling*

DiskoBasis is the name of the ecosystem monitoring programme at Arctic Station. The programme extends and complements the ongoing monitoring carried out at the station by including several new activities, especially within the terrestrial and hydrological field. Since 2013, DiskoBasis has been partly financed by the Danish Ministry of Energy. In this section, selected parameters from 2014 will be summarized. For additional information about DiskoBasis, please refer to the homepage www.arktiskstation.ku.dk/research/monitoring

## New implementations 2014

Six new automatic cameras were installed during the summer. The cameras were placed in Blæsedalen at the experimental site run by CENPERM. Three cameras were installed in a relatively dry heath vegetation and three cameras in a wet fen vegetation (Figure 1). Each camera is pointing at the vegetation from two meters height. Daily photos from the cameras will be used in the monitoring of vegetation phenology, timing of emergence, greenness and senescence within different plant communities.

## Weather and Climate

Weather data have been collected automatically at Arctic Station since 1991. An increasing trend in air temperature has been observed after 1991, mainly in the nineties and primarily due to increasing winter temperatures (Figure 2). The mean annual air temperature (MAAT) measured in 2014 was -1.9°C, which is in line with the last couple of years and above the average MAAT of -2.9°C for the period 1991-2014. January 2014 was exceptional warm with a mean monthly air temperature of -5.3°C which is the warmest registered within the last 23 years (Figure 3). Several episodes of 'above zero' temperatures were registered during winter. The increasing air temperatures are of great concern since this area is facing the limit/boundary for permafrost, corresponding to MAAT -1°C to -2°C (Brown, 1960). Within the period from 1991 this area has moved from being located at the limit between continuous and discontinuous permafrost (corresponding to a MAAT about -6 to -8°C) to now being an area where only sporadic permafrost is expected.

***Figure 1.*** *Automatic photo monitoring of vegetation in a fen area in Blæsedalen. Photo Charlotte Sigsgaard*

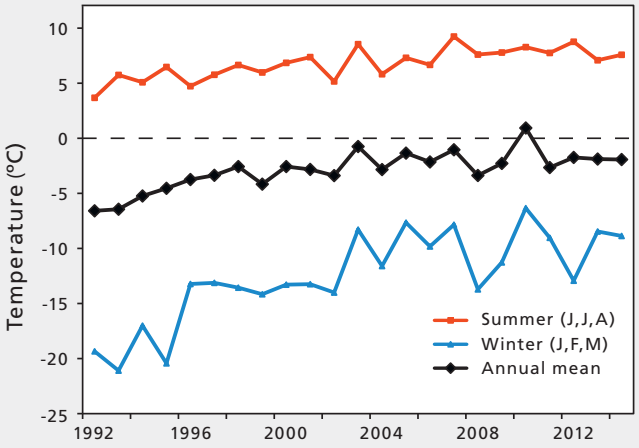



***Figure 2.*** *Annual mean air temperatures at Arctic Station from 1992 to 2014 and mean air temperatures for the warmest months (June, July and August) and the coldest months (January, February and March).*

Ground temperatures are measured at 5, 60 and 175 cm depths. A significant warming of the soil/ground has been observed over the study period, especially after 1995. From 1991 to 1995 the soil temperature at 175 cm just reached 0°C at its maximum (perennially frozen soil). The ground temperature increased after 1995 and annual frost free periods were recorded, which means that permafrost is no longer present at this depth (Figure 5). In 2014, ground temperatures at 175 cm´s depth remained above zero from 10 July to 2 December and reached a maximum temperature of 1.9°C (7 September). Additional ground temperature measurements have been included in the programme after 2012, and now temperatures are monitored at three boreholes in Østerlien

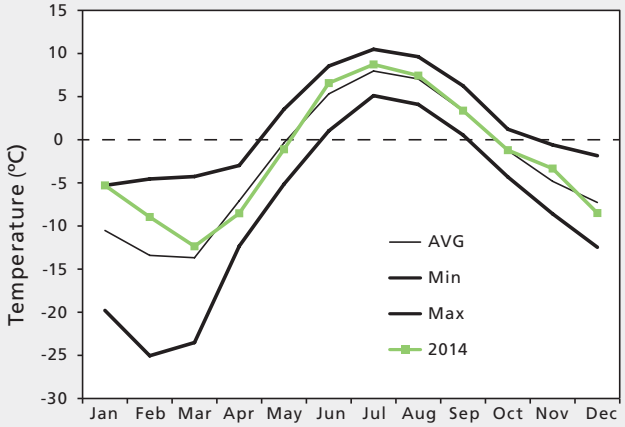



***Figure 3.*** *Mean monthly air temperatures in 2014 compared to minimum, maximum and average for the period 1992-2014.*

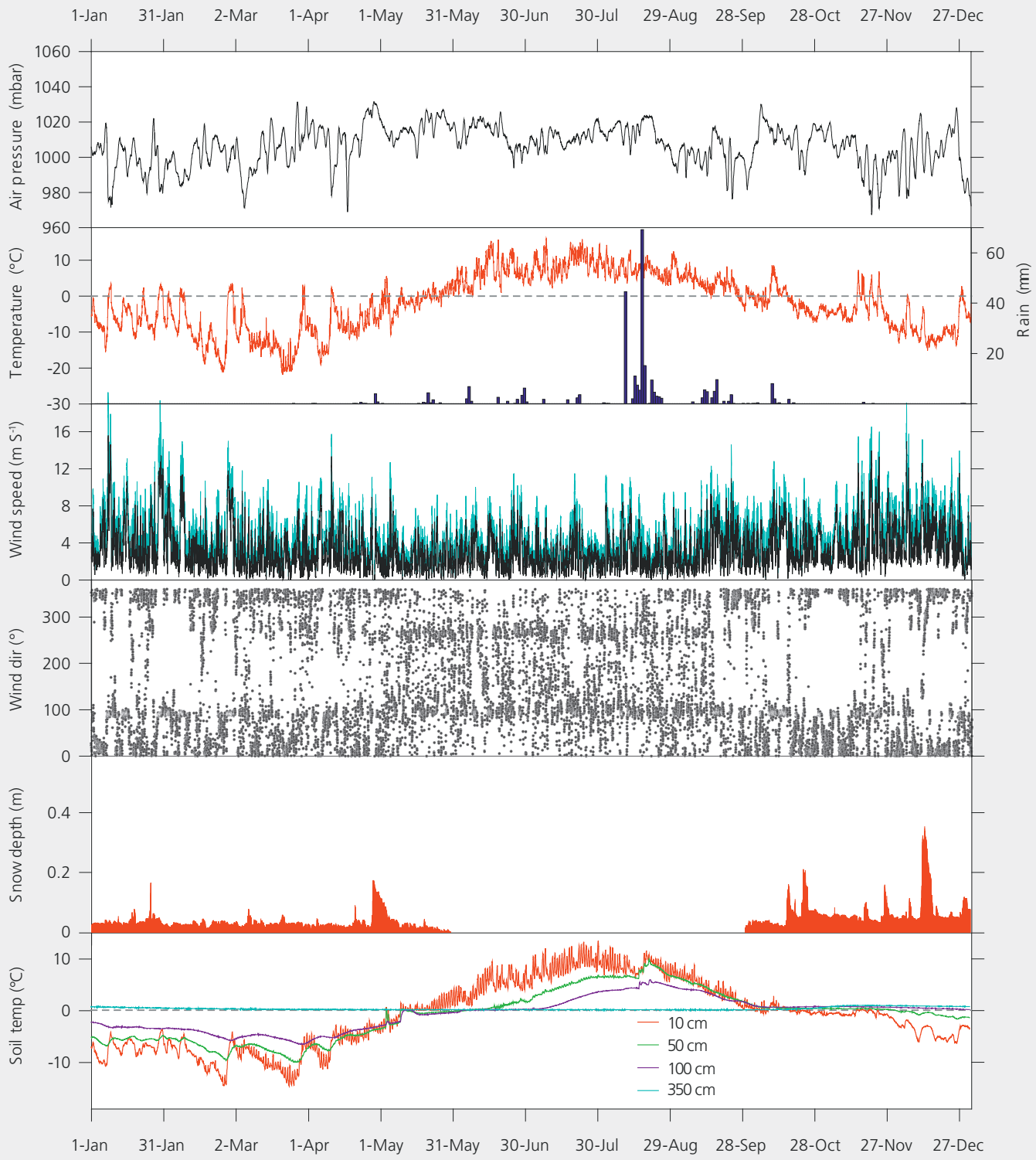



***Figure 4.*** *Temporal variations of selected parameters from the automatic weather station (AWS-2) in Østerlien 2014 (data logged every 30 min). Air pressure, Air temperature, Precipitation (rain measured at AWS-1), Wind speed (mean and max), Wind direction, Snow depth and Soil temperatures from 10, 50, 100 and 350 cm.*

as well. The deepest sensor is placed 350 cm below ground surface (Figure 4). Temperatures from the boreholes reveal that no permafrost is present within the upper 350 cm in Østerlien and no seasonal freezing is registered below 200 cm.

In general, August and September are the 'wettest' months in this area. In 2014, liquid precipitation/rain reached a total of 280 mm of which 177 mm was registered in August (Figure 4). A total amount of 50 mm was recorded on the 9 August and just one week later on the 16 August another 70 mm was registered (90 mm recorded in Blæsedalen). These heavy rain events caused large floodings in the area and erosion along the river banks (Figure 8). The water supply for Qeqertarsuaq was disabled for days when

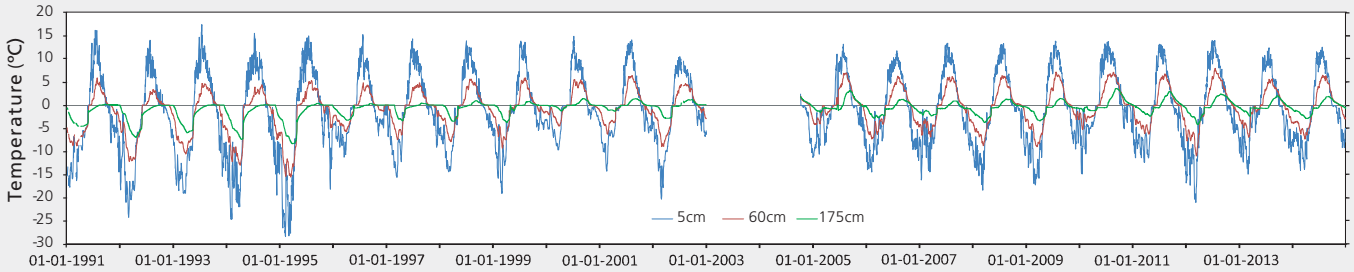



*Figure 5. Diurnal mean soil temperatures from AWS-1 (1991-2014) at 5, 60, 175 cm depths.*

mudflows damaged the water pipelines from Lyngmarksfjeldet.

## Carbon dioxide gas exchange

Measurements of carbon dioxide ($CO_2$) exchange rates between land and atmosphere were initiated in Østerlien in November 2012. Data are collected continuously using the eddy covariance technique. The location next to Arctic Station makes year-round measurements possible because the instruments can be powered by cables from the station and permanent staff is available to service the station throughout the winter. High frequency raw data has been processed in the EddyPro software (Li-Cor Inc, USA), and post-processed using standard flux community procedures. Unfortunately, several heavy rain events in August 2014 flooded the system and the gas analyzer had to be returned to the company for repair. Therefore, the measurement record extends only to 8 August. During winter and until late May, the area was covered by a few centimetres of snow. $CO_2$ emissions were generally low (<1 gC $m^{-2}$ $d^{-1}$) within this period. A gap in data, from 21 May until 20 June, due to erroneous calibration, prevents analysis of the snow melt and pre-green season. This period has been gap-filled based on average fluxes 5 days before and after the gap (Figure 6). Maximum daily $CO_2$ uptake occurred in mid to late July with peak values of about -3.3 gC $m^{-2}$ $d^{-1}$.

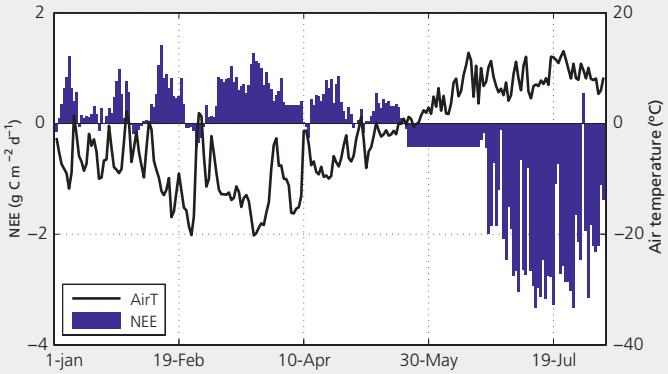



*Figure 6. Temporal variation of diurnal net ecosystem exchange (NEE) and air temperature measured in Østerlien 2014. NEE refers to the sum of all $CO_2$ exchange processes, including photosynthetic $CO_2$ uptake by plants, plant respiration and microbial decomposition. The sign convention is the standard for micrometeorological measurements; fluxes directed from the surface to the atmosphere are positive whereas fluxes directed from the atmosphere to the surface are negative.*

## River water discharge and suspended sediment

Monitoring of the hydrology in the river Røde Elv (Kuussuaq) was included in DiskoBasis in 2013. Runoff from Røde Elv drainage basin (approximately 101 $km^2$) is an important part of the water balance and an essential tool to estimate the total output of freshwater, sediment and nutrients from land to ocean. To avoid influence from the tide, the multisonde was moved from the bridge where it was located in 2013 to a position further upstream in 2014 (69.256835° N, 53.498346° W, elevation: 25 m asl).

At the new location, data were collected in the period from 30 June to 2 October 2014. The early part of the runoff season/spring break-up was not covered as snow drifts along the river made mounting of the sonde problematic. Three distinct peaks in water level were observed as a response to the large amounts of rain in August (Figure 7). During the flood on 16 August 2014, the water level increased by more than 2 meters in less than 12 hours (Figure 7 and 8). The multisonde was flushed away from its fixed position and several of the sensors were damaged.

A significant correlation was found between automatic registered turbidity and the measured suspended sediment concentration in manual derived water samples collected twice a week. The heavy rain in August 2014 increased the suspended sediment concentration/turbidity on 9, 12 and 16 August, respectively. An extreme amount of sediment was carried through the system at these occasions and the capacity/range of the turbidity sensor was exceeded at all three peaks. However, manual collected samples from 9 August 2014 showed suspended sediment concentrations of up to 11,000 mg $l^{-1}$. Before the flood, the sediment concentrations were in the range 20- 400 mg $l^{-1}$ with a distinct diurnal pattern (highest concentrations in the evening and lowest in the morning

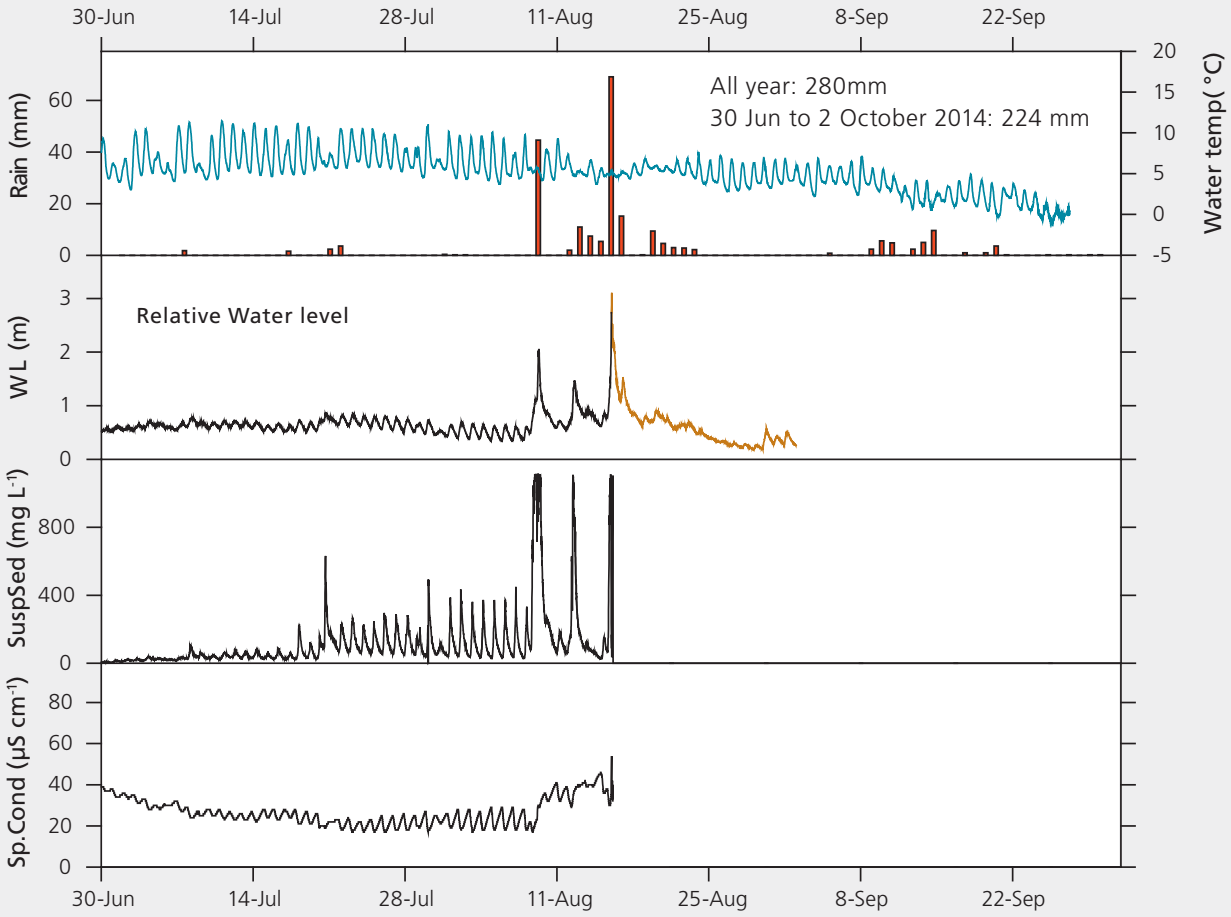



*Figure 7. Selected parameters from Røde Elv 2014. Several sensors were damaged in the flood and data from the last part of the season are therefore missing or affected by some uncertainty.*

## Lake monitoring (Moræneso)

Moræneso is situated at the entrance to Blæsedalen. It has been part of the monitoring program since 2010. The lake has a maximum depth of 5 m and an estimated average depth of 1.5 m. The catchment area is very small with the majority of the water coming from the nearby moraine hills via a small inlet in the eastern side. An outlet in the western side drains into Røde Elv. The lake is typically ice and snow covered from November to June. The biota includes mosses, plankton and invertebrates. There are no fish.

The monitoring concept includes submerged sensors mounted on a rig (Figure 9) placed at the deepest part of the lake combined with few manual sampling events taking place during summer and winter for determination of nutrients and identification of biota. This provides continuously measurements of light, temperature, conductivity, pH, oxygen, chlorophyll-a and accumulation of sediment material as well as information on abundance of phytoplankton, zooplankton, mosses and benthic invertebrates.

Temperature data from the loggers showed that the lake in 2014 was ice covered until the end of June and again from early October (Figure 10). Light was able to penetrate the ice until mid-October when snow covered most of the lake. The water temperature reached a maximum of 16°C in early August and a minimum during freeze-in. The water temperature ranged from 2-4°C throughout the winter when ice

*Figure 8. Røde Elv during the flood on 16 August 2014. Photo Louise Sprotte-Hansen*

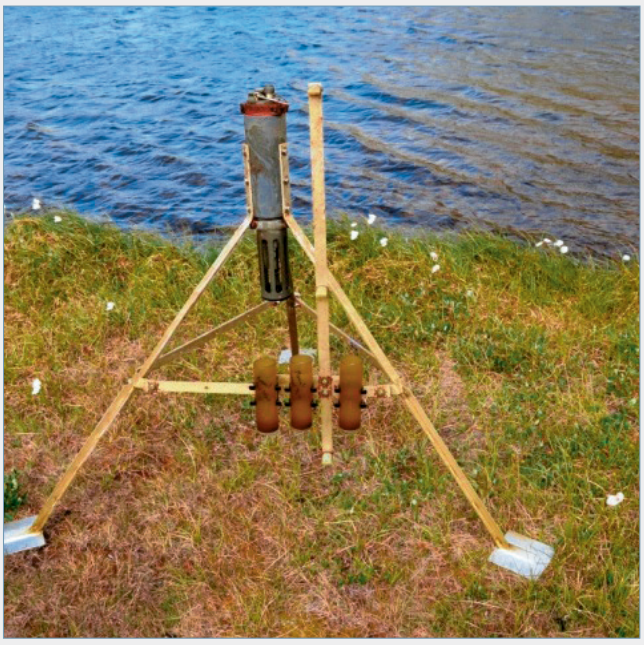


*Figure 9. The underwater rig mounted with a multisonde, HOBO loggers and sediment traps. Photo Kirsten S. Christoffersen*

covered the lake. Due to some technical problems with some of the sensors there are only sporadic data for rest of the parameters.

The manual samplings were performed twice during winter (February and October) and provided information on ice and snow thickness, occurrence of plankton and concentrations of chlorophyll.

## Marine monitoring

Measurement of selected ocean water properties have been part of the marine monitoring at Arctic Station since 2001. However, several of the measured parameters have a longer history. For instance, water temperature and salinity data from this area dates back to 1924.
Depth specific measurements of ocean water temperature, salinity, conductivity, density, oxygen content and fluorescence are performed with a CTD-probe (Figure 12). The measurements are carried out on a monthly basis at three fixed positions –the deepest profile extends to 300 meters. Seasonal variations based on measurements carried out from April to December 2014 at the deepest site "Fast Station" are shown in Figure 11.

Besides monitoring of the physical properties of the ocean water, oxygen ($O_2$) concentration and fluorescence are measured providing information of the seasonal variations in the timing and magnitude of plankton bloom which is of vital importance for the structure of the marine food web. Being photosynthetic organisms, the growth of phyto-plankton is heavily influenced by the light conditions in the upper water masses and thereby by the seasonal variation in sea ice coverage. In the monitoring data from 2014, the timing of the early season algae bloom after break-up of the sea-ice is clearly visible in the elevated fluorescence and $O_2$ values in April and May.

## Data access

All DiskoBasis data are public domain, and after internal quality assurance, validated data will be available from the Department of Geosciences and Natural Resource Management, University of Copenhagen. Contact Charlotte Sigsgaard (cs@ign.ku.dk).

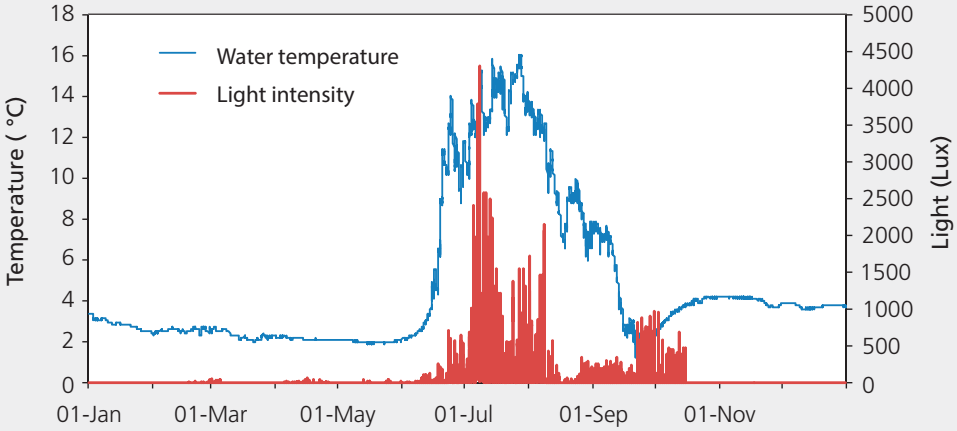



*Figure 10. Water temperature and light intensity measured 2 m above the bottom in Morænesø.*

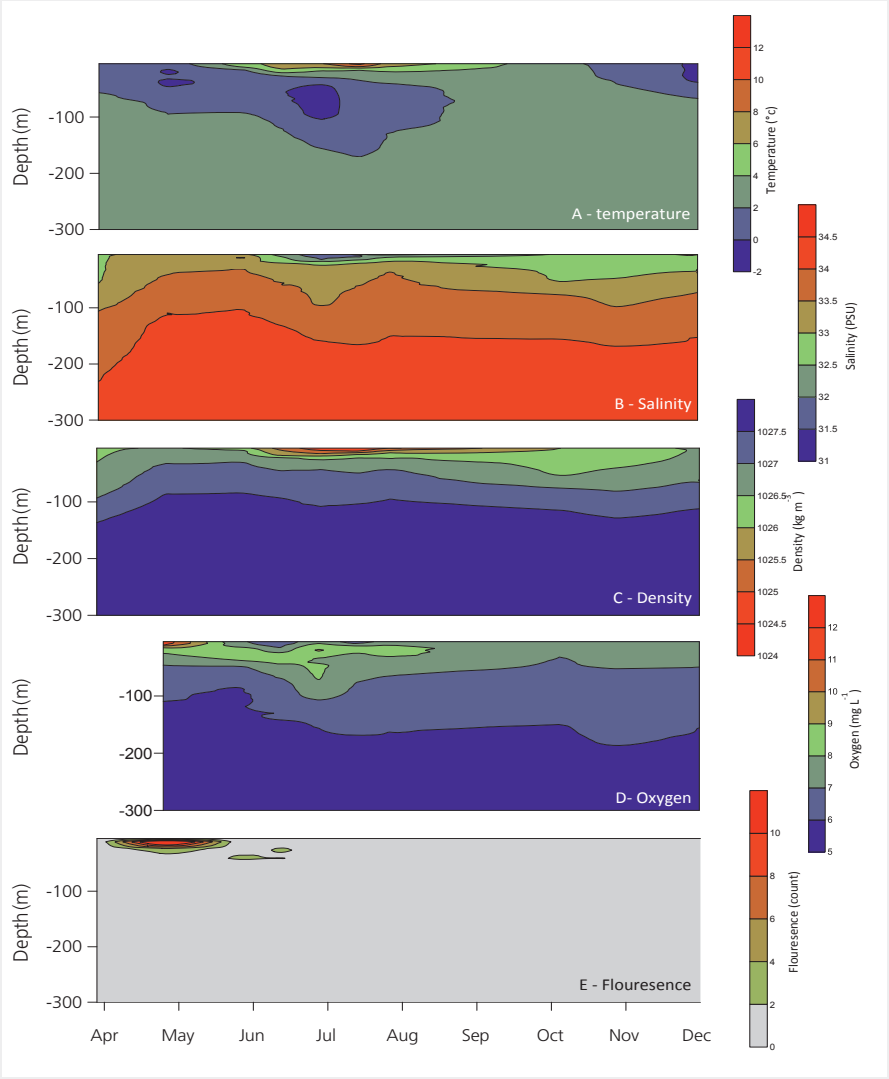



***Figure 11.*** *Contour maps of CTD profiles showing the seasonal development over the 2014 monitoring season in a) temperature, b) salinity, c) density, d) oxygen content and e) fluorescence of the seawater at "Fast station".*

***Figure 12.*** *CTD probe is gradually lowered at a speed of 5 minutes per 100 meters depth to obtain stable measurements. Photo Christian J. Jørgensen*

# Research Projects

## Biology of the Greenland shark, *Somniosus microcephalus*

*John Fleng Stefensen, Kristian Vedel, Julius Nielsen, University of Copenhagen, Denmark, Peter Bushnell, Indiana University South Bend, USA, Richard Martin, Den Blå Planet, Denmark*

The purpose of the project was to obtain information about the whereabouts of Greenland sharks – are they stationary or migratory? It was based on data-storage-satellite-pop-up-tags mounted on sharks in Disko Bay and programmed to be released 3 to 12 months later. In addition, tissue samples for population genetics studies and age determination were collected. Stomach content was also collected with the purpose of determining if the sharks were predators or scavengers. Finally, the behavior of free swimming sharks was filmed at depths down to 75 meters in collaboration with the 'Under The Pole Explorer Expedition' (http://www.underthepole.com/explorer/eng/ the Greenland shark).

## pH and the possible buffering role of the expanding marine vegetation against ocean acidification in coastal waters of Greenland (DANCEA-funded project)

*Dorte Krause-Jensen, Arctic Research Centre and Department of Bioscience, Arhus University, Denmark; Carlos M. Duarte, Department of Global Change Research, IMEDEA (CSIC-UIB), Spain and The UWA Oceans Institute and School of Plant Biology, University of Western Australia, Australia*

Ocean acidification, the progressive decline in pH as anthropogenic $CO_2$ accumulates in ocean waters, is believed to become a major threat to arctic marine ecosystems. However, kelp forests can exhibit large diurnal excursions in pH as $CO_2$-uptake by photosynthesis increases pH during the day while respiration causes declines in pH during night. Algal photosynthesis may potentially maintain pH high in kelp forests during the arctic summer, the critical period for growth and development of calcifiers. The kelp forests are important habitats for many organisms including blue mussel and other bivalves that must deposit calcium carbonate minerals to produce their shells. They are therefore favored by pH-levels that are sufficiently high to ensure a positive saturation state of carbonate minerals. The kelp forests may provide refuge for bivalves in a potentially more acidic Arctic Ocean if they maintain pH high during the arctic summer. As kelps are expanding poleward with warming their role as coastal habitat is likely to increase in the future. Our purpose was to test the hypothesis that kelp forests may maintain pH and the saturation state of calcium carbonate high during the arctic mid-summer and thereby have the potential to provide refuge for calcifiers in a more acidic Arctic Ocean.

## Bowhead whale singing behavior – now from the back of the whale

*Outi Tervo, Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources, Greenland, Susanna Blackwell, Greeneridge Ltd, USA, Mads Fage Christoffersen, Nukissiorfiit, Greenland, Silje Rekdal, Natural History Museum, Norway*

Singing behavior of bowhead whales in Disko Bay has been studied intensively in the last years. Despite valuable insights into the acoustic behavior of these whales, behavioral data on an individual level is still lacking. The main objective of this study was to investigate the singing behavior of bowhead whales in order to describe the diving behavior of singing whales, individual repertoires and sex of the singers. The second objective was to test a new deployment method of the Acousonde recorder, which allows long term deployments and collection of highly detailed 3D accelerometer data on the movements of the whale. The third objective we had was to continue the collection of biopsies from bowhead whales in Disko Bay.

Acousonde is a sophisticated behavioral recorder that measures underwater sounds, light, temperature, depth and 3D accelerometer and magnetometer data. The instrument is deployed on a whale using a 4 m long pole and small barbs that penetrate the skin. The deployments were done with the help of local hunters Abel Brandt, Johannes Mølgaard, Tarfi Mølgaard and Ado Isaksen. We tagged two bowhead whales with Acousonde recorders in April 2014. The deployment method was successful and the recorders were released from the whales after 3 days of deployment as planned. Unfortunately, only one of the recorders was retrieved due to sudden cold weather and increasing ice coverage.


*Mooring recovery from the research vessel Porsild. Photo David M. Holland*

## AMAP Core (Arctic Monitoring and Assessment Program)

*Anders Galatius, Department of Bioscience, University of Aarhus, Denmark*

The purpose of this stay at Arctic Station was collection of tissue samples of ringed seal, blue mussel and sculpin for the ongoing AMAP (Arctic Monitoring and Assessment Programme) monitoring of pollutants in these organisms. The collection of samples was done in cooperation with local hunters. Seals were hunted with rifle or nets while mussels were collected below the high water line at low tide. Sculpins were caught using fishing rods. Results of the analyses are not currently available. AMAP will release a report presenting time trends of pollutants in Arctic organisms in 2016 where results from the samples collected during the stay will be incorporated. The current AMAP programme runs in the years 2014-2016. Monitoring of pollutants in the Arctic under AMAP was initiated in 1998.

## Early Life Stages of fishes in Disko Island, with emphasis on capelin *Mallotus villosus* (Müller, 1776) larvae

*Evandro Malanski, Torkel Gissel Nielsen, Peter Munk, Birgit Søborg, Danish Institute of Aquatic Resources, Denmark & Science without Borders, Brazil*

The purpose of this project was to describe the ecology of capelin larvae in the arctic environment of Disko Bay. In total, nine oceanographic cruises were performed along Qeqertarsuaq, investigating 15 stations from 5 transects perpendicular to the coast. Ichthyoplankton was collected in the upper 25 meters of the water column using a bongo net and capelin larvae was sorted out from all samples. Stations were not necessarily revisited in each cruise, and other specific methodology was used to investigate distribution of fish larvae by water depth layer, which totalized 166 plankton samples collected. Zooplankton was also collected in the upper 25 meters of water column. CTD was collected in all stations (temperature, conductivity, salinity, density, pressure, depth, dissolved oxygen, fluorescence, turbidity, irradiance), and water (chemical parameters) and chlorophyll-a was only collected in a specific station at the central transect. Water temperature was warmer in the upper

15 meters water layer, varying from 8 to 14°C, and below 20 meters depth the water was around 2°C. Salinity did not vary a lot, around 34 PSU, however the upper 10 meters layer was around 32, probably influenced by the melting of icebergs around Disko Bay. The peak of chlorophyll-a was observed in 25 meters depth, also observed by the higher fluorescence between 20 and 30 meters depth from the CTD. Coincidently, the vertical investigation of distribution of fish larvae showed peak density around 25 meters depth. Capelin larvae could also be found deeper. However, its density was always highest in the 25 meters depth layer. These details could be correlated to better surviving conditions in higher primary production, and/or less predation in capelin larvae because more food were available to the trophic chain. This result shows the main pattern of capelin larvae around Disko Island. Correlation between food preferences and ichthyoplankton will be investigated during 2015, to explain details from the early life stages of capelin around the area.

## Greenland glaciers contribution to global sea level change

*David M. Holland, Denise Holland, Brian Rougeux, New York University, USA and New York University Abu Dhabi, Center for Sea-Level Change, Margaret Lindeman, Bowdoin College, USA*

The purpose of our visit at Arctic Station was: 1) to build a data set to understand the Greenland glaciers contribution to global sea level change; 2) to introduce students to working with CTD instrumentation in a hands-on manner; 3) to allow students to experience the types of research being carried out at Arctic Station; 4) to make scientific connections with researchers at Arctic Station; 5) to have students to gather data and write reports on their trip and also present their experiences back to other undergraduate students who are interested in participating in future years; 6) to learn students about new cultures, as well as the flora and fauna of the region.

We used three main types of oceanograpic equipment: CTD, moorings and gliders. For CTD, we deployed a SeaBird 19Vplus, outfitted with oxygen, turbidity, and fluorescence sensors. Surveys were conducted across the width and breadth of the Disko Bay. For mooring, we attempted to recover a mooring at the mid-mouth of Disko Bay that we had deployed the previous summer, and were successful. For glider, we deployed a Slocum glider, outfitted with CTD, DVL, and turbidity sensors. This was our first experience in deploying a glider, and gave us some basic piloting experience with the vehicle. Our cruise on Porsild was deemed to be a big success both by us, the organizers, and our student, judging by the enthusiastic feedback we received. The undergraduate student has gained considerable knowledge in synoptic oceanography, both through theory via lectures we held on the ship, and practically through the data we collected. Our data set will be archived in the National Oceanographic Data Center (NODC) in the USA and will be made freely available to researchers worldwide. Such data collection and archiving is critical to understanding the long term evolution of the Greenland Ice Sheet, and it contribution to global sea level change.

## Methylation of mercury in the anoxic gut of the copepod *Calanus hyperboreus*

*Kang Wang, University of Manitoba, Canada, Peter Stief, University of Southern Denmark, Denmark*

Our hypothesis is that mercury compounds ingested together with food items are methylated inside the anoxic gut of copepods. High copepod abundances might thus explain the subsurface concentration peaks of methylmercury previously observed in the Arctic Ocean. The methylmercury formation associated with the model organism *Calanus hyperboreus* was investigated during the spring bloom in Disko Bay. Methylmercury formation associated with *Calanus hyperboreus* was investigated by incubating living copepods fed with algae that were pretreated with isotopically labeled mercury. The seawater in the incubation vials was adjusted to different algal densities and oxygen concentrations and rotated on a plankton wheel. Water, fecal pellet, and copepod samples were taken in a time-series mode. Methylmercury concentrations are currently being measured at the University of Manitoba.

## Grazer-Phytoplankton Interactions in the Arctic Ecosystem

*Nina Lundholm, Sara Hardardottir, The Natural History Museum of Denmark, Uwe John, Sylke Wohlrab, Alfred-Wegener Institute, Germany, Lis M Frederiksen, Department of Biology, University of Copenhagen, Denmark, Anna Miesner, Technical University of Denmark Aqua, Rasmus Nørregaard, The Natural History Museum of Denmark.*

We explore interactions between phytoplankton and grazers, mainly physiological responses and gene expression patterns. We expect that grazing by zooplankton like copepods of the genus *Calanus* elicit a response in the phytoplankton, and similarly that different phytoplankton induce different responses

in the grazers. In one part of the studies we explored whether the temporal grazing pattern of the copepods will be affected when grazing on toxic phytoplankton. In another part of the study we compared the response of single diatom species, as well as the natural community when exposed to grazers; i.e. which genes are up and down regulated. In a third part we explored whether toxins produced by diatoms affect copepod fecundity, i.e. egg-production and hatching rate of nauplii when the copepods are grazing on a natural community versus when they are grazing on a natural community including toxic diatoms. Seawater, phytoplankton and grazers were collected using plankton net tows and Niskin water bottles from Porsild. Phyto- and zooplankton were isolated in the microscope and kept in the cooling container at 4°C. Experiments were performed on plankton wheel in special containers where phyto- and zooplankton can be separated by a mesh. Samples were analyzed for toxin content and samples for genes expression analyses were gathered. The preliminary results show that the copepods were grazing on all diets of algae and that the toxic algae enhanced toxin production as a response to the grazing. The samples are currently being processed. The samples for gene expression patterns are currently being sequenced at the Alfred Wegener Institute in Germany.

## Microbial nitrogen cycling associated with living copepods, their fecal pellets, and carcasses

*Peter Stief, Department of Biology, University of Southern Denmark, Denmark*

Copepods are microbial hotspots of nitrogen cycling in the pelagic due to the dense colonization of the exoskeleton, gut, fecal pellets, and carcasses with bacteria and other microbes. The distinct activities of these microbial communities were investigated for the copepod *Calanus hyperboreus* caught in Disko Bay as a model organism. The nitrogen cycling activities associated with *Calanus hyperboreus* were investigated with $^{15}N$-stable isotope incubation experiments. The animals were incubated in seawater enriched with isotopically labeled nitrate, the incubation vials were rotated on a plankton wheel, and samples were taken in a time-series mode. Dissolved inorganic nitrogen species and their $^{15}N$-isotopes in the water samples were analyzed after return to the University of Southern Denmark. Living copepods as well as their fecal pellets and carcasses proved to be sites of active nitrogen cycling. Amongst others, indications for nitrification, denitrification, and nitrous oxide production were found. Deeper analysis of samples and data are still in progress.

## Integrated Biotechnological Solutions for Combating Marine Oil Spills (Kill•Spill)

*Jens Aamand, Louise Feld, The Geological Survey of Denmark and Greenland, Anne Gorm Hansen, Jan H. Christensen, Linus Malmquist, University of Copenhagen, Denmark*

The principal objective of the EU-funded project Kill•Spill is to develop highly efficient economically and environmentally viable solutions for the clean-up of oil spills caused by maritime transport or offshore oil exploration and related processes. GEUS and University of Copenhagen has developed a method for trapping marine oil-degrading bacteria (BIOTRAPS), and to evaluate the effect of the bacteria present in situ on the oil composition. The method is tested in the Disko Bay, the North Sea and the Mediterranean Sea. The BIOTRAPS consist of carbon material coated with raw oil, filled in tubes with holes. When the BIOTRAPS are set up in the marine environment, oil is released slowly making the compounds accessible to oil degrading bacteria. The BIOTRAPS has been submerged at different depths (3-60 m) into the sea around Disko. At defined times the BIOTRAPS were harvested and analyzed for colonization of oil degrading bacteria and degradation of oil components. Preliminary results show that it is possible to trap oil degrading bacteria by the technique and the number of oil degraders colonizing the BIOTRAPS increase with the time the BIOTRAPS are submerged in the sea. Changes in the composition of the oil remaining in the BIOTRAPS have not yet been analyzed.

## Biodegradation of crude oil in water samples from three depths down to 800 m in the arctic marine environment

*Katrine Scheibye, Department of Plant and Environmental Sciences, Faculty of Science, University of Copenhagen, Denmark*

The objective of this project was to assess the potential for biodegradation of crude oil in the marine environment in the Disko Bay off the western shore of Greenland and to compare it with the potential for biodegradation in an area pre-exposed to oil such as the Mexican Gulf or the Mediterranean Sea. Research questions are: Is the potential for biodegradation of oil lower in the water column in western Greenland than in the Mexican Gulf/Mediterranean Sea? To what extent are naturally occurring micro-organisms in the water column able to break down the complex mixture of > 100,000 components of crude oil in West Greenland and the Mexican Gulf/Medi-


*Extracting soil gas in the fen. Photo Charlotte Sigsgaard*

terranean Sea? Are the differences in oil degradation capacity reflected in the composition of microbial communities? The water samples are used to setup microcosm experiments. After a time of incubtion microbial counts and DNA analysis are carried out and the chemical fingerprint of the oil examined by gas chromatography (GC)-mass spectrometry (MS). Water column samples were gathered at three sites at 200, 600, and 800 m depth by use of a 10 L Niskin water sampler, this was performed from the research vessel Porsild. A CTD measurement was also performed at each sampling site. About 250 L was sampled and transported to laboratories in Copenhagen where microcosms were set up to expose natural indigenous microorganisms to oil at a low and environmentally relevant concentration of 5 ppm. After 0, 7, 14, 28, 56, and 77 days of incubation compounds were extracted from microcosms and GC-MS analysis will be performed to obtain the oil fingerprint. Additionally, water samples from each depth were taken prior to microcosm set up for microbiological testing at GEUS. This testing included most probable number (MPN) enumeration, $^{14}C$ radiotracer MPN enumeration, and mineralization experiments.

## Effect of simulated warming on soil microbial communities

*Jana Voriskova, Center for Permafrost, University of Copenhagen and The Geological Survey of Denmark and Greenland.*

The project is part of a snow fence experiment that has been established in Blæsedalen in the summers of 2012 and 2013 in a dry and wet tundra area, respectively. During summer 2014, topsoil samples were collected from sites with simulated winter warming treatment and from control sites. Soil cores were collected at four times across the vegetative period in order to assess also seasonal variations in microbial community composition. Whole communities of bacteria and fungi will be compared by the analysis of DNA and RNA that were extracted in Arctic Station laboratory. Further analysis will also include assessment of microbial biomass, measurement of enzyme activity and analysis of microbial gene encoding for enzymes catalyzing important decomposition processes.

## Methane dynamics in an arctic wetland under varying climatic conditions

*Cecilie Skov Nielsen, Bo Elberling, Anders Michelsen, Imre Banyasz, Center for Permafrost, University of Copenhagen, Denmark*

The aim of the project was to investigate the effect of summer warming, winter snow addition and shrub removal on methane ($CH_4$) fluxes from an arctic wetland. We hypothesized that 1) snow addition will increase $CH_4$ fluxes from the wetland by increasing soil moisture; 2) snow addition will delay growing season; 3) summer warming will increase $CH_4$ fluxes by increasing soil temperature; and 4) shrub removal will increase soil temperature by increasing the amount of photons reaching the soil surface. We measured $CH_4$ fluxes on ecosystem and individual plant tiller level using an Ultraportable Greenhouse Gas Analyzer (Los Gatos Research Inc., Mountain View, USA). We measured concentrations and isotopic signal ($\delta^{13}C$) of dissolved $CO_2$ and $CH_4$ in soil water by extracting gas from buried silicone tubes and analyzing it on a Picarro G2201-i analyzer (Picarro Inc., Santa Clara, USA). Finally we sampled soil water and analyzed it for concentration of organic acids (acetate, formate and oxalate).

We obtained data from a full growing season with measurements of fluxes, dissolved gasses, and organic acid concentration about every 14 days. We measured on control plot (non-manipulated) and seven treatments: summer warming, winter warming by snow addition, and shrub removal, and all combinations of these.

## Temperature control of biogenic volatile organic compound emission from dry and wet tundra

*Frida Lindwall, Lars Lindstein, Riikka Rinnan, Department of Biology and Center for Permafrost, University of Copenhagen, Denmark*

The biogenic volatile organic compound (BVOC) emissions from arctic ecosystems are poorly understood, and the changes in the quantity and quality of these emissions due to climate change are even less understood. The purpose of our work was to increase the understanding about temperature controls of BVOC emissions from dry and wet tundra surfaces in the Arctic. We conducted measurements from the beginning of June to late August in large-scale manipulation experiments on a dry and wet tundra site in order to assess how increased summer and/or winter temperatures affect BVOC emissions. The experiments consisted of factorial summer warming (open-top chambers), winter warming (snow fences) and shrub removal treatments. In connection with the BVOC measurements, we monitored air, soil and surface temperatures.

We expected that both summer and winter warming would increase the emissions due to alleviation of temperature limitation for plants and soil microorganisms. Based on earlier results from the Subarctic, BVOC emissions from these cold environments are more temperature sensitive than elsewhere. Thus, we aimed to use the detailed temperature data to get insight on temperature controls of the arctic BVOC emissions. We also expected a seasonal effect on the emission patterns due to changes in plant development and environmental conditions.

BVOC emissions were sampled from whole-ecosystem plots, including both plants and soil, using a push-pull chamber technique. Air was circulated through the chamber and the BVOCs were trapped in absorbent cartridges. The cartridges were transported to Copenhagen for analysis by thermal desorption and gas chromatography-mass spectrometry. Temperature measurements were done using shaded i-Wire Hygrochrons (Maxim Integrated) for air temperature and a handheld infrared thermometer for surface temperature.
The BVOC emission data are currently being analyzed. Based on the temperature data collected, we expect there to be drastic differences in emission rates depending on the surface temperature. On the dry tundra site, surface temperature averaged for all dates and treatments was 10.7°C warmer than air temperature at 1.5 meter height ($P<0.001$, $n=312$). On most dates, surface temperature was significantly warmer in the plots warmed by open top chambers, and in the shrub removal plots, compared to control plots.

## How are litter decomposition rates and microbial decomposer communities affected by landscape type, litter quality, shrub presence and seasonal warming?

*Daan Blok, Merian Skouw Haugwitz, Center for Permafrost, University of Copenhagen, Denmark*

Litterbags with leaf litters from control, tall and fertilized patches of *Betula glandulosa* (shrub birch) have been incubated in full factorial experiments involving winter warming, summer warming and shrub removal treatments in dry and wet tundra areas in Blæsedalen for one full year. During summer 2014, litterbags were harvested and analysed for mass loss and microbial community composition. First results show that decomposition rates are much higher in the fertilized litter, with higher decomposition rates measured in the wet than in the dry snow fence site. Snow addition increased decomposition, but summer warming reduced decomposition rates dramatically, especially in the dry snow fence site. We observed no effect of shrub cover on litter decomposition rates. During further analyses, fungal colonization of the litter will be assessed using quantitative PCR (Polymerase Chain Reaction) of the fungal ITS (Internal Transcribed Spacer) region and the fungal community compositions will be compared by illumnia sequencing of the PCR amplified fungal ITS region.

## Shrub expansion in the Arctic: an experimental and dendroecological analysis on community level

*Stef Weijers, Department of Geography, University of Bonn, Germany, Lennard van Rij, the Netherlands*

Evidence from satellite observations, dendrochronologies, and long-term vegetation surveys suggests that shrubs are expanding in large parts of the Arctic. We will study species-specific responses to climate change using dendroecological methods, stable

*Field work in the wet snow fence site in Blæsedalen. Photo Kent Pørksen*

C- and N-isotopes analysis, and phenological and reproduction measurements in an experimental setup in which snow cover and temperature are manipulated to get a better understanding of the causes of arctic greening. In July 2012, a full-factorial design experiment (summer warming with Open Top Chambers (OTC), shrub removal, and snow addition; 48 plots) was started at a dry shrub heath in Blæsedalen near Arctic Station, by researchers from the Center for Permafrost, University of Copenhagen.

We will construct one control and one snow treatment 'ring-width/shoot length' chronology for each of six dominant shrub species to test the influence of increased snow accumulation and delayed snow melt. During the growing season of 2014, three individuals of each of the six most dominant shrub species in the area *(Betula nana, Cassiope tetragona, Empetrum nigrum ssp., E.hermaphroditum, Ledum palustre, Salix glauca, and Vaccinium uliginosum)* were harvested in front (control) and behind (snow addition) 6 snow fences. In addition the flowers/fruits were counted for each of the six species in the control, summer warming (OTC), snow addition, and snow addition OTC plots (n=6, 24 plots in total). The diameter of each *E.hermaphroditum* berry found in these 24 plots was also measured. For the development of a long (>150 years) growth chronology of *Cassiope tetragona* 20 additional shrubs, as complete as possible, were harvested from a nearby site. Coordinates were taken of all the sampling and measurement locations, as well as pictures of the locations and their surrounding area.

## Element cycling of nitrogen, including nitrogen fixation, mineralization and denitrification rates in arctic landscapes

*Anders Michelsen, Anders Priemé, Bo Elberling, Christian Muff-Westergaard, Kristine Dyrnum, Center for Permafrost, University of Copenhagen, Denmark*

Arctic ecosystems are often nitrogen limited, and quantifying the nitrogen fluxes, pools and internal movement or transformation in the system may help us to better predict the feedback of the system to global change. The overall aim of this project is to explore the element cycling of nitrogen in Arctic ecosystems. To assess parts of the nitrogen cycling in Arctic ecosystems, three experiments were carried out in Blæsedalen, in connection with our stay at Arctic Station. Two of the experiments focused on biological nitrogen fixation, either in moss as part of the CENPERM snow fence experiment, or in soil of different vegetation types to estimate landscape

*Coast at Flakkerhuk, eastern Disko Island. Photo Mikkel Fruergaard*

input of nitrogen by biological nitrogen fixation. In connection with the landscape experiment we additionally assessed the soil and microbial nitrogen content, and fluxes of carbon dioxide, methane and nitrous oxide between the ecosystem and the atmosphere. The third experiment aims to discover the fate of inorganic nitrogen released from thawing permafrost; that is, whether it is moved within the landscape via lateral water flow, or if the above biosphere is able to utilize the released nitrogen.

In addition, we performed a similar experiment in Peary Land, Greenland. This was likewise carried out in August, and will be sampled in 2016, so that movement of inorganic nitrogen via lateral flow can be compared for ecosystems of very different climate.

## Sedimentological and morphological response of coastal lagoons to a changing sea-level

*Mikkel Fruergaard, Martin Lauenborg Hansen, Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark*

The relative sea-level (RSL) at Disko, Greenland has decreased by more than 90 meters during the Holocene. However, studies from Disko have found indications that RSL may have been increased the last ca. 2.0 kyr. The timing and magnitude of this rise is however very poorly constrained and the driving dynamics not well-understood. Coastal lagoons accumulate sediments which are deposited close to mean sea-level. During the summer fieldwork we successfully collected 10 sediment cores from the coastal lagoon system at Flakkerhuk. We expect to reconstruct the recent RSL history of the study site and infer reasons for the change from RSL drop to RSL rise by applying facies analysis and high-resolution dating. For this study, we used sediment coring, DGPS measurements, sediment analysis, OSL, $^{14}C$ and $^{210}Pb$ dating and X-rays.

## Freshwater ecology

*Kirsten S. Christoffersen, Kirstine Thiemer, Emilie Kallenback, Dean Jacobsen, Freshwater Biological Laboratory, Department of Biology, University of Copenhagen, Denmark*

The project has two activities in 2014, focused on winter conditions in lakes and on basic conditions in streams. The primary production in seasonally ice-covered arctic lakes is determined by various physical and chemical variables with the amount of active photosynthetic radiation as the most important factor. Despite

this, primary production can take place below the ice even at low intensities of light. The purpose was to evaluate the possibility for autotrophic activity under the ice in two seasonally ice-covered lakes (Morænesø and Stationssø) through analyses of the physical-chemical conditions as well as algal production and species composition.

It was hypothesized, that the phytoplankton community is capable of utilizing low light intensities for photosynthesis during the transition from polar night to light. Due to logistics constrains such measurements have been rather few in the past. Both lakes had about 1 m ice-cover with a little snow on top. Water temperature was zero in the top and increased to 2°C in the bottom of Morænsesø. Stationssø only had approxiamately 35 cm unfrozen water and therefore no temperature gradient. In both lakes light could be detected although with low intensity. Nutrients were available and chlorophyll (indicator of algal biomass) was 0.2 to 1 µg $L^{-1}$. Thus, the hypothesis that early growth is possible seems to be confirmed.

The algae composition in Morænesø was dominated by picoplankton and diatoms while in Stationsø the algae composition exclusively consisted of diatoms with *Fragilaria* as the dominant genera (probably originating from the bottom) and close interaction between the sediment surface and the overlaying water is expected. The algae compositions support previous findings.

The inland freshwater monitoring of Arctic Station has so far been restricted to lakes. However, previous studies in several of the streams as well as the main river Røde Elv exist. The purpose of this part of the freshwater project is to get an update on the actual condition in a number of streams and to evaluate if they were suited to serve as monitoring sites in the DiskoBasis monitoring program. The sampling locations include three streams: 1) the stream next to Arctic Station; 2) one of the western tributaries to Røde Elv; 3) the outlet from Morænesø as well as one river (Røde Elv). The sites were visited during early October and none were ice covered yet. The streams had clear waters but ranged in size, velocity and other physical conditions. Two were fed by glaciers and had water temperatures between 0.2 and 1.4°C, while the outlet from Morænesø was slightly warmer. Røde Elv was turbid and around 0°C. It was concluded from the initial survey that all four sites would be relevant as monitoring sites.

## Maintenance of Qeqertarsuaq geomagnetic observatory and GreenT field work

*Jürgen Matzka, Technical University of Denmark Space*

GreenT is a magnetotellurics (MT) project funded by the Danish Research Council to make a geophysical investigation of the Nagssugtoqidian orogeny and to compare the results with same age orogenies in Canada and Scandinavia. The geomagnetic observatory in Qeqertarsuaq is a major geophysics and space physics research infrastructure, the geomagnetic field is recorded since 1926. MT experiments consist of measuring time series of naturally occurring magnetic and electric field changes.

We have made a long term MT-experiment at the geomagnetic observatory and this visit was to dismantle the MT equipment and send it to Kangerlussuaq for further measurements. Additionally, we have per

*Collection of samples in the stream next to Arctic Station. Photo Charlotte Sigsgaard*

formed maintenance work at the geomagnetic observatory and trained new observers. In particular, we have improved the thermal insulation of the absolute hut and optimized the use of time-controlled heating systems to save energy. The data of the geomagnetic observatory is published in near real time and in a quality controlled version at www.intermagnet.org

## The W-Greenland Volcanic Margin as a case study

*Laurent Geoffroy, Huixin Guan, IUEM, University of Brest, France, Camille Clerc, ISTO, University of Orleans, France, Xavier Rochy du Bernard, Anna Kwasniewski, TOTAL E&P, Pau, France, Philippe Werner, TOTAL E&P, Paris La Défense, France*

The objectives of this project were two-fold: 1) an introduction to the problematics of Volcanic Passive Margins from the W-Greenland margin to non-specialists from both the academic and industrial domains. The course was both theoretical (numerous presentations on computer both on board and in hotels) and practical with landscape analysis (tectonics, volcanic features) and numerous outcrop studies; 2) a preparation of new academic research projects in the investigated area with the possible support of industrial funding; note that this possible industrial support excludes any local investigation for possible natural resources. W-Greenland may be a template for the understanding of the structure and thermal evolution of Volcanic Passive Margins elsewhere in the world.

## Mercury background concentrations in picritic and tholeiitic lavas

*Richard Pokorný, Faculty of the Environment, Jan Evangelista Purkyně University, Czech Republic, Lukáš Krmíček, Brno University of Technology, Faculty of Civil Engineering, and Institute of Geology, Academy of Sciences of the Czech Republic*

Up to the present day, little is known about the background mercury (Hg) variations in basaltic rocks, especially in those areas which are dominated by mechanical weathering. The thick Paleocene basaltic volcanites exposed on Disko Island represents ideal lava succession for performing an Hg-focused geochemical study. During the research stay, nine representative rock samples were selected. They were represented by olivine-phyric and amygdaloidal olivine basalts and also by feldspar-phyric basalts and dolerites. The total mercury content in all samples was determined using an AMA-254 analyzer (Altec, Czech Republic). The mercury content varies between 1.1-3.8 μg $kg^{-1}$. This indicates a very low concentration of mercury in peridotitic mantle source. It seems that the input of mercury of geological origin into the polar ecosystem is significantly lower (approximately 2 orders of magnitude) than expected from previous works.

## Cretaceous Dinosaurs of West Greenland. Expedition # C-14-6

*Michael Ryan, Cleveland Museum of Natural History, USA, Matthew Lamanna, Carnegie Museum of Natural History, USA, Philip Currie, University of Alberta, Canada, Wendy Sloboda, Independent Photographer, Eva Koppelhus, Univeristy of Alberta, Canada*

The purpose of this project was prospecting for vertebrate fossils in the Atane Formation on south-east Nuussuaq, central West Greenland. It included daily hiking to local outcrops from a tent camp and we investigated previously collected fossil plant localities and new outcrops. Some small plant fossil samples of previously reported taxa were collected as reference fossils. We arrived and departed the Nuussuaq locality via Porsild and also camped at Skansen and prospected local outcrops there. Prospecting was conducted on foot. Primary prospecting equipment included cameras and hand-held rocks hammers. Collected material was limited to surface collecting loose rock samples. Plant fossils were found on previously reported plant fossil localities and we collected less than 2 kg in total of those. Preliminary investigation of the material does not indicate the presence of any new taxa. The material will be photographed and described for internal reports, and then returned to Denmark.

## Fluorine determinations

*Ole Stecher, Scientific leader, Arctic Station*

The project described the evolution of fluorine concentrations in rock samples from the well documented and classical Skærgaard Intrusion. From the early winter and throughout the summer numerous fluorine determinations were carried out on rocksamples from the Skærgaard Intrusion along with water- , snow- and ice samples from the area around Arctic Station. Results showed that fluorine is enriched through the magmatic evolution until the mineral apatite starts crystallizing. Even though fluorine normally is regarded as a volatile element, the enrichment patterns corresponded to the developments observed for elements enriched in the more evolved parts of the magma.

Samples were collected from the hot spring at Engelskmandens Havn just west of the Qeqertarsuaq harbour, the creek that runs next to Arctic Station and from the ice domes at the northern end of the Røde Elv

drainage basin. The hot spring at Engelskmandens Havn has a fluorine content that is markedly enriched relative to the other values found for water/snow/ice samples. Only the samples from Engelskmandens Havn have fluorine concentrations above the base level found in the area. Thus, no genetic connection can be deduced from the fluorine content of the 'hot springs' (temperatures above 10°C) and those of the 'homeothermic' springs (typically 3-4°C) in Blæsedalen and around Arctic Station.

## The people of Qeqertarsuaq's perception on recent climate change

*Nikka Grunnet Toft Sandvad, Center for Permafrost, University of Copenhagen, Denmark*

The project is focused on how the inhabitants of Qeqertarsuaq experience and are affected by recent climate change. To investigate this, a number of informants were interviewed, questionnaires in Greenlandic were delivered to all the houses, and other relevant data collected. The material still requires processing and translation, but in general it can be concluded that the inhabitants have experienced changes in the nature. However, it is very individual how significant they value these changes. It seems that most emphasis is placed on factors affecting the food supply, recreational opportunities and security. In addition, data was collected regarding communication between the inhabitants and Arctic Station, with special focus on what kind of events the inhabitants are interested to participate in. In general, the citizens would like to have more contact and cooperation with Arctic Station.

*Rock samples sintered at 920°C for later dissolution, preparation and measurement. Photo Ole Stecher*

*Photo Kent Pørksen*

# Education

## Field course in Arctic Biology (5-31 July 2014)

*Teachers: Niels Daugbjerg, John Fleng Steffensen and Morten Bo Søndergaard Svendsen*

*Students: Aslak Kappel Hansen, David Bille Byriel, Mads Kristian Reinholdt Jensen, Emilie Maria Falk Kallenbach, Jesper Sonne, Nicolai Andreas Munk Fassel, Nadia Brogård Nord, Sofie Bjørnholt Mogensen, Eva Marie Nive Kleist Johansen, Liv Louise Victoria Backhaus, Ditte Bjerregaard Jensen, Jeppe Nedergaard Pedersen.*

*Department of Biology, University of Copenhagen, Denmark*

The aim of this MSc course was to focus on two major topics related to arctic marine biology: "fish physiology" and "phytoplankton diversity and ecology". Two projects covered each topic and all projects included experimental approaches and intense sampling programmes using R/V Porsild on a nearly daily basis. Additionally, we used most of the laboratory facilities including the cold container set at 4°C. The sampling at sea was mostly conducted at the Disko Bay area but also included campaigns to Disko Fjord and Mellem Fjord with overnight stays in the field. Water samples for phytoplankton were collected with a plankton net and a 4 L Niskin water bottle. Fish (e.g. Atlantic cod, wolffish and Arctic charr) were caught using long lines, gill nets or fishing rods. Most of the samples and experiments were completed in Greenland. However, samples for water chemistry were brought back to Copenhagen for further analyses. Following the return to Copenhagen the four student groups continued their work on the projects, which included analyses and interpretation of data with statistical tests. Finally, the students wrote scientific papers for the course report.

The following topics were covered

- Determining the optimum temperature for aerobic scope of a northern population of Arctic charr (*Salvelinus alpinus*) using maximum heart rate (Aslak K. Hansen, David B. Byriel & Mads K. R. Jensen)
- The muscle twitch, maximal swimming speed and optimal temperature of four species of fish living in the Arctic (Emilie M. F. Kallenbach, Jeppe N. Pedersen & E. M. Nive K. Johansen)
- The effect of low pH on an Arctic phytoplankton summer community in Disko Bay, West Greenland (Jesper Sonne, Sofie B. Mogensen & Nadia B. Nord)
- Identity, abundance and biomass of diatoms in Disko Bay and Disko Fjord, Western Greenland (Liv L. V. Backhaus, Ditte B. Jensen & Nicolai, A. M. Fassel)

The findings and conclusions based on the 4 student projects will be published in the report Arctic Biology Field Course - Qeqertarsuaq 2012. The report can be obtained from Niels Daugbjerg (n.daugbjerg@bio.ku.dk).

## Field and Methods Course in Physical Geography (1-15 August 2014)

*Teachers: Birger Ulf Hansen and Thor Markussen*

*Students: Jeppe Dalskov Frederiksen, Andreas Elmelund Hass, Andreas Hvam Hoffmann, Paulina Karkauskaite, Britt Gadsbølle Larsen, Tue Mariager, Ellen Lindholt Nissen and Marta Merino Ramos.*

*Department of Geoscience and Natural Resource Management, University of Copenhagen, Denmark*

The purpose of the field course was to organize and carry out geographical fieldwork independently in an arctic environment and to be able to analyse, evaluate, document and communicate the results of this study in a scientific way. Part of the course was directly linked to CENPERM – a center of excellence, which will integrate hypothesis-based studies of biogeochemical and physical processes in a "climate-vegetation-soilmicroorganism-permafrost" context.

The aim of the Course was to investigate:

1. Flocculation processes in the Disko Fjord area and cloudburst effects on the flocculation.
2. Edaphic Factor of Soils in Blæsedalen, Disko Island - A Pedological Study of the Abiotic Factors Controlling the Edaphic Factor.
3. Nt-factor for Disko Island based on NDVI.
4. Estimating Degree Days of Thaw for Disko Island using satellite imagery.
5. Potential Radiation Index for Disko Island.
6. Modelling of Active Layer Thickness of Disko Island.

The combination of these six parts can provide new insight with respect to the current and future sediment transport and permafrost thawing within the study area taken current and future climate trends into account. The southern part of Blæsedalen was chosen as the study area due to the fact that the landscape is fairly well-described and due to the presence of all landscape types representative for the Arctic environment. Most of the collected samples were analyzed in the laboratory, while some were only pre-treated at the Arctic Station and brought back to Copenhagen for further analysis. Students performed statistical analyses, GIS-modelling and wrote scientific papers for the course report during August and September.

Findings and conclusions can be found in the report "Field and Methods Course in Physical Geography in 2014 at Disko Island, Greenland", which can be obtained free of charge from Birger Ulf Hansen (buh@ign.ku.dk)

## Advanced Climate Dynamics Course on the "Dynamics of the Greenland Ice Sheet" - ACDC2014 (15-30 August 2014)

*Teachers: Camilla Snowman Andresen, The Geological Survey of Denmark and Greenland, David Battisti, University of Washington, USA/University of Bergen, Norway, Tore Furevik, University of Bergen, Norway, Jake Gebbie, Woods Hole Oceanographic Institute, USA, Patrick Heimbach, Massachusetts Institute of Technology, USA, Richard Hindmarsh, British Arctic Survey, UK, Kerim H. Nisancioglu, Bjerknes Centre for Climate Research, University of Bergen, Norway,Øyvind Paasche, University of Bergen/Bergen Marine Research Cluster, Norway, Gerard Roe, University of Washington, USA, Helene Seroussi, NASA JPL, USA),Fiamma Straneo WHOI, USA),Andreas Vieli University of Zürich, Switzerland*

*Students: Josefin Ahlkrona, Uppsala University, Sweden, Nicholas Beaird, Woods Hole Oceanographic Institution, USA, Johannes Heinrich Bondzio, Alfred Wegener Institute, Germany, Winnie Chu, Columbia University, USA, Anthony Coletti, University of Massachusetts - Amherst, USA, Laurence Dyke, Swansea University, UK, Anna FitzMaurice, Princeton University, USA, Thomas Goelles, University Centre in Svalbard, Norway, Signe Hillerup Larsen, Niels Bohr Institute/Copenhagen University, Denmark, Rebecca Jackson, Woods Hole Oceanographic Institution, USA, Mari Jensen, University of Bergen, Norway, Laura Levy, Dartmouth College, USA, Bradley Markle, University of Washington, USA, Ingrid Husøy Onarheim, University of Bergen, Norway, Alexander Robel, Harvard University, USA, Roberta Sciascia, Massachusetts Institute of Techonology, USA, Donald Slater, University of Edinburgh, UK,Laura Stevens, Massachusetts Institute of Technology/ Woods Hole Oceanographic Institution, USA, Désireé Treichler, University of Oslo, Norway, Judy Twedt, University of Washington, USA,Martin Wearing, University of Cambridge/British Antarctic Survey, UK*

The main focus of the 2014 summer school was the dynamics of the Greenland Ice Sheet using theory, models, observations and proxy data. The first three days of the summer school was spent in Ilulissat where the students embarked for research cruises with R/V Porsild. The majority of the lecturers and students spent the entire 15 days of the summer school together at the Arctic Station in Greenland with scientific talks, field excursions, discussions and social activities and networking. All students participated in a group project lead by one of the teachers. The project topics this year were analyzing sediment cores; analyzing oceanographic data; ice flow modelling; ice sheet modelling; and radar glaciology.

The purpose of the research stay was to educate a new generation of scientists in the interdisciplinary field of climate dynamics with a focus on understanding the Greenland ice sheet. We conducted field work on RV Porsild off Jakobshavn and Eqip Sermia taking sediment cores as well as water samples and multiple CTD sections. We also spent two days in the field together with the students surveying and discussing the geomorphology of Disko Island. During field work on Porsild we used a Ruhmor-lot corer from GEUS for taking sediment cores, as well as a CTD from WHOI with ADCP. We also recoverd two moorings south of Icefjorden. One of the sediment cores was split and sampled in the lab at AS together with the students.

The Advanced Climate Dynamics Courses (ACDC) is a series of annual summer schools aimed at advanced PhD students. The courses are coordinated by the University of Bergen in collaboration with Massachu-

setts Institute of Technology in Cambridge, and the University of Washington in Seattle. Core funding for the summer school is provided by a Norwegian Centre for International Cooperation in Education Partnership Program in higher education and the Norwegian Research School in Climate Dynamics, and this year also with additional funding from NASA. Detailed information regarding the summer school can be found at www.uib.no/en/rs/acdc.

## Workshop: Evaluation of Science Talents in Denmark

*Nils O. Andersen, University of Copenhagen, Jens Dybkjær Holbech, Aarhus University, Brian Krogh Christensen, Silkeborg Gymnasium, Per Præstholm, Sorø Akademis Skole, Kirsten Birkving, Egedalsskolen, Lone Skafte Jespersen, Krogårdskolen, Finn Skaarup, UV, Dorthe Compen Skødt and Hanne Hautop, ScienceTalenter, Denmark*

The Arctic Station hosted a three-day workshop- where the participants discussed the external evaluations of Science Talents in Denmark.

*Dog sledge in front of Arctic Station, 25 October 2014*
*Photo Charlotte Sigsgaard*

# Visits and public outreach

An evaluation group commissioned by the Danish Ministry for Climate, Energy and Buildings visited Arctic Station from 21 until 23 August. The group consisted of Professor Steve Albon (James Hutton Institute, UK), Jörn Thiede (Alfred Wegener Institute - Germany), and Kim Holmén (Norsk Polarinstitut, Norway). The visit was part of an evaluation of the Greenlandic Ecosystem Monitoring (GEM) programme.

The Danish minister of Climate, Energy and Buildings, Rasmus Helveg Petersen together with an entourage of ministerial staff, and officials from the Greenlandic Government, along with the Dean of the Faculty of Science at Copenhagen University, visited Arctic station on 16 and 17 August. The outgoing station leader, Ole Stecher informed on the scientific work at Arctic Station, and the newly arrived scientific leader Christian Juncher Jørgensen presented the CENPERM activities in Blæsedalen. Torkel Gissel Nielsen (Danish Technical University - Aqua) gave a lecture on copepod research.

The Greenland committee of the Danish Parliament visited Arctic station on 26 August. The committee members were given a tour along the facilities at Arctic station and discussed the scientific work performed at the station.


The presidium of the Greenlandic Inatsisartut and the Danish Parliament with their associated personnel together with Aqqaluk Lynge (former chairman of Inuit Circumpolar Conference) visited Arctic station on 27 August. They were given a lecture on the topic "The Greenlandic angakok and their political role" (freely cited) by Aqqaluk Lynge, followed by a lecture about ongoing scientific work at Arctic station by Ole Stecher.

## Public outreach

Arctic Station participated together with the Qeqertarsuaq Museum and the artist group 'Tura ya moya' in the Greenlandic event 'Culture in the Night' (25 January 2014). The artist group made an outdoor light show on the cliff east of Arctic Station. Arctic Station contributed with two display boards 1) The first conservation ruling of Greenland – the conservation of the Engelskmandens Havn and the Østerlien area around Arctic station, and 2) The Cape York meteorites and the Disko Iron found by Nordenskiöld.

The station leader of Arctic Station (Ole Stecher) gave a lecture at the Museum of Qeqertarsuaq on the Greenlandic National Day (21 June 2014) about on the scientific work performed at Arctic Station.

*1 Rasmus Helveg Petersen (Minister of Climate-, Energy and Buildings)*
*2 Thomas Egebo*
*3 Rikke Thoning*
*4 Janus Gohr Mørk*
*5 Jens Brandt-Sørensen*
*6 Louise Sprotte-Hansen*
*7 Marianne Thyrring*
*8 Carsten Eskebjerg*
*9 Johnny Fredericia*
*10 Flemming Getreuer Christiansen*
*11 Pernille Møller*
*12 John Renner Hansen*
*13 Kjeld Akaaraq Mølgaard*
*14 Christian Juncher Jørgensen*
*15 Ole Stecher.*

*Photo Torkel Gissel Nielsen*

*Photo Kent Pørksen*

# Publications

## Research papers


Andersen, O.G.N., Laidre, K.L., Heide-Jørgensen, M.P. (2014). Benthopelagic shrimp and associated pelagic and benthopelagic fauna on a bowhead whale foraging ground in Disko Bay, West Greenland. Marine Science 4(1): 10-20.

Andresen, C.S., Kjeldsen, K.K., Harden, B., Nørgaard-Pedersen, N., Kjær, K.H. (2014). *Outlet glacier dynamics and bathymetry at Upernavik Isstrøm and Upernavik Isfjord, North-West Greenland.* Geological Survey of Denmark and Greenland Bulletin 31: 79–82 (open access www.geus.dk/publications/bull).

Bekkouche, N., Kristensen, R.M., Hejnol, A., Sørensen, M.V., Worsaae, K. (2014). *Detailed reconstruction of the musculature in Limnognathia maerski (Micrognathozoa) and comparison with other Gnathifera.* Frontiers in Zoology, 11:71, doi: 10.1186/s12983-014-0071-z.

Damsholt, K. (2014). *The late Eva Clausen's collections from west and southwest Greenland 1955.* Lindbergia 37: 22–41.

Gladish, C., Holland, D., Rosing-Asvid, A., Behrens, J., Boje, J. (2015). *Oceanic boundary conditions for Jakobshavn Glacier. Part I: Variability and renewal of Ilulissat Icefjord waters, 2001–14.* Journal of Physical Oceanography 45: 3–32, doi:10.1175/JPO-D-14-0044.1.

Gladish, C., Holland, D., Lee, C. (2015). *Oceanic boundary conditions for Jakobshavn Glacier. Part II: Provenance and sources of variability of Disko Bay and Ilulissat Icefjord waters, 1990–2011.* Journal of Physical Oceanography 45: 33–63, doi:10.1175/JPO-D-14-0045.1.

Harðardóttir, S., Lundholm, N., Moestrup, Ø., Nielsen, T.G. (2014). *Description of Pyramimonas diskoicola sp. nov. and the importance of the flagellate Pyramimonas (Prasinophyceae) in Greenland sea ice during the winter–spring transition.* Polar Biology, doi: 10.1007/s00300-014-1538-2.

Krause-Jensen, D., Duarte, C.M. (2014). *Expansion of vegetated coastal ecosystems in the future Arctic.* Front. Marine Sciences 1:77, doi:10.3389/fmars.2014.00077.

Nielsen, T.G., Kjellerup, S., Smolina, I., Hoarau, G., Lindeque, P. (2014). *Live discrimination of Calanus glacialis and C. finmarchicus females: can we trust phenological differences?* Marine Biology 161: 1299-1306, doi: 10.1007/s00227-014-2419-5.

Nørregaard, R.D., Nielsen, T.G., Friis Møller, E., Strand, J., Espersen, L.S.K., Møhl, M. (2014). *Evaluating pyrene toxicity on Arctic key copepod species Calanus hyperboreus.* Ecotoxicology 23(2): 163-174.

Pagh, S. (2014). *Beregning af fisk i føden hos polarræv (VulpeslLagopus).* Flora og Fauna 119 (3+4): 120-122 (In Danish).

Pagh, S. (2014). *Sommerføde hos polarræve (Vulpes lagopus) i kyst- og indlandsområder i Disko bugt, Vestgronland.* Flora og Fauna 119 (3+4): 123-137 (In Danish).

Rinnan R., Steinke M., McGenity T., Loreto F. (2014). *Plant volatiles in extreme terrestrial and marine environments.* Plant, Cell & Environment 37: 1776–1789.

Sainmont, J., Gislason, A., Heuschele, J., Webster, C.N., Sylvander, P., Wang, M., Varpe, Ø. (2014). *Inter- and intra-specific diurnal habitat selection of zooplankton during the spring bloom observed by Video Plankton Recorder.* Marine Biology 161 (8): 1931-1941.

Škaloud, P., Škaloudova, M., Prochazkova, A., Nemcova, Y. (2014). *Morphological delineation and distribution patterns of four newly described species within the Synura petersenii species complex (Chrysophyceae, Stramenopiles).* European Journal of Phycology 49(2): 213–229.

Thoisen, C., Riisgaard, K., Lundholm, N., Nielsen, T.G., Hansen, P.J. (2015). *Effect of acidification on an Arctic phytoplankton community from Disko Bay, West Greenland.* Marine Ecology Progress Series 520: 21-34.

Thomsen, H.A., Østergaard, J.B. (2014). *Coccolithophorids in Polar Waters: Calciarcus spp. Revisited.* Acta Protozool 53: 145–157.

### Thesis

Kallenbach, E.M., Thiemer, K. (2014). *Variation in phytoplankton production, biomass and composition in two shallow lakes at Disk, Greenland, from the polar night to light.* Bachelor thesis, University of Copenhagen (in Danish).

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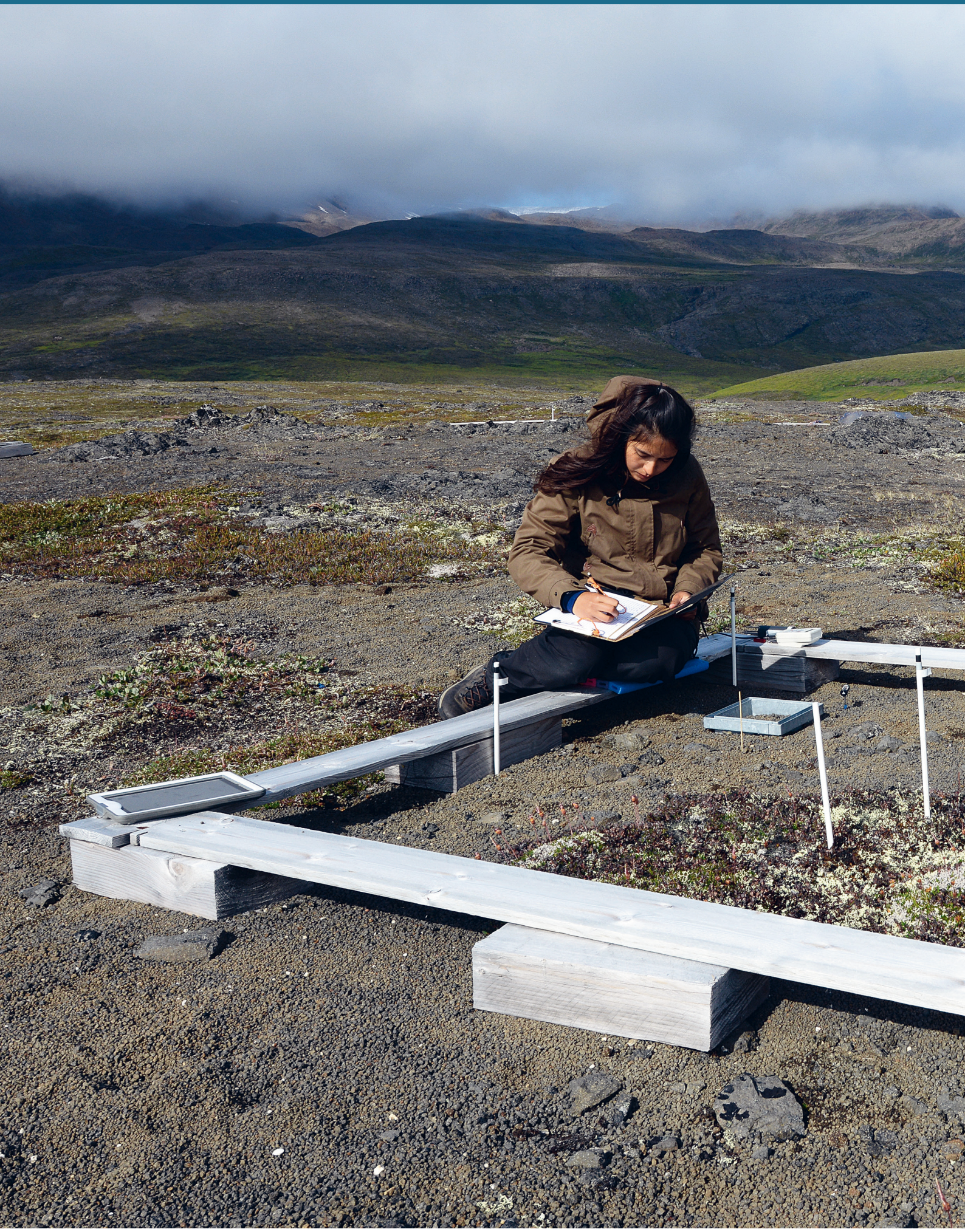


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