VILLUM RESEARCH STATION
STATION NORD

2015 ANNUAL REPORT

AARHUS
UNIVERSITY

VILLUM RESEARCH STATION, STATION NORD
2015 ANNUAL REPORT

For further information, please contact:

Villum Research Station Secretariat
Department of Environmental Science
Aarhus University
Frederiksborgvej 399
4000 Roskilde
Denmark
E-mail: secretariat@villumresearchstation.au.dk
Phone: +45 2322 7110
villumresearchstation.dk

Head of Station
Professor Henrik Skov
Arctic Research Centre
Department of Environmental Science
Aarhus University
Phone: +45 8715 8524
E-mail: hsk@envs.au.dk

Logistics Coordinator
Jørgen Skafte
Aarhus University
Phone: +45 2322 7110
E-mail: jska@bios.au.dk

Station Coordinator
Niels Bohse Hendriksen
Department of Environmental Science
Aarhus University
Phone: +45 8715 8473
E-mail: nbh@envs.au.dk

CONTENT

VILLUM RESEARCH STATION OPENS ITS DOORS TO INTERNATIONAL RESEARCH

VILLUM RESEARCH STATION NEAR THE NORTH POLE IS A CRUCIAL BOOST TO CLIMATE CHANGE RESEARCH.

By Professor Henrik Skov,
Head of Station

It is a great pleasure to present Villum Research Station, Station Nord's very first annual report. The station officially opened on August 5, 2015 but had already been in use since January. Right from the beginning, the international research community has shown the station tremendous interest.

The aim of Villum Research Station, Station Nord is to provide unique state-of-the-art arctic research infrastructure for investigating climate change and its effects on atmospheric, oceanographic, biological, and geological conditions and processes in the High Arctic.

According to the Intergovernmental Panel on Climate Change, a scientific international body under the auspices of the United Nations, the temperature increase due to anthropogenic emissions of carbon dioxide is well established and the increase is expected to accelerate even further during the coming years.

Urgent need to improve understanding
The largest temperature increase will be in the Arctic; hence, there is an urgent need to improve understanding of how this increase will affect the environment on a local, regional, and global scale through its influence on ice sheets, sea-ice cover, permafrost, ecosystem functioning, and biodiversity. As a result, climate change also has consequences for local communities, industry, and international politics.

Unique arctic research station
The aim of the Villum Research Station, Station Nord is to provide unique state-of-the-art arctic research infrastructure for investigating climate change and its effects on atmospheric, oceanographic, biological, and geological conditions and processes in the High Arctic.

The infrastructure is envisioned as a novel platform for bringing together researchers across scientific disciplines to set new standards for arctic research. Internationally recognized experts will be gathered with the goal of significantly improving our understanding of how climate changes in the Arctic may induce change in the cryosphere, oceanosphere, geosphere, and atmosphere, consequently influencing ecosystems, biogeochemical processes, and biodiversity.

The knowledge gained will be extremely important in the effort to cope with the consequences of global warming and in the effort to develop needed abatement strategies, to adapt, and to identify and use new opportunities locally and internationally.

WELCOME

VILLUM FONDEN is a non-profit foundation established in 1971 by Villum Kann Rasmussen, an industrious Danish engineer who invented the VELUX skylight window.

Until recently, one of the limiting factors for doing the needed research in the High Arctic was a lack of research infrastructure. The situation has now changed thanks to a DKK 70.5 mil. grant from VILLUM FONDEN, which made construction of Villum Research Station, Station Nord possible.

Station attracts foreign researchers
During its first year of operation, 70 scientists used the station and a large number of impressive research projects have been carried out and will continue to be carried out in the future. An important goal for the station right from the beginning was to become an international research platform, which is why the administrative structure will ensure its implementation, not only in the Danish research community but also internationally.

The members of the station's Science Coordination Board represent nine nationalities, and projects conducted in 2015 received funding from Danish, Nordic, and European sources but also Canadian, Australian, and South Korean.

High quality activities
It is important that the quality of ongoing activities at the station is as high as possible to ensure Villum Research Station, Station Nord a strategic, central position in science, collaborations, and the station's use in the future. To achieve this aim the station is a member of international networks and projects. Another important aspect is that the station's activities are as visible as possible.

Laboratory and Accommodation House and the garage.
Photo: Stephan Bernberg

A new website, villumresearchstation.dk, contains practical information on access to the station and a description of its facilities and other parameters such as climate data. The activities planned for 2016-2017 are also available on the website.

The arctic sciences are central to Aarhus University, where the Arctic Research Centre (ARC) was established and involves three faculties and various departments. In 2015, ARC organized a large field campaign at Villum Research Station that was made possible by the Arctic Science Partnership and its members from Aarhus University, Greenland Institute of Natural Resources, and the University of Manitoba in Canada.

Backbone of the activities
Another campaign was carried out from the end of February 2015 to the end of August 2015 as part of the Nordic Centre of Excellence CRAICC project, which involved Danish and Finnish participants. A number of minor research projects were also carried out.

The continuous monitoring that takes place represents the backbone of the station's activities and is mostly funded by DANCEA, which is administered by the Danish Environmental Protection Agency and Energy Agency and is part of the Danish contribution to the Arctic Monitoring and Assessment Programme run by the Arctic Council.

Dedicated support deeply appreciated
We would like to acknowledge the immense dedication and hard work of the initial team of users during the station's first season. It will be a pleasure to follow future work on the assembled data, obtained results, and collected samples.

We would also like to recognize the members of the Steering Board, the Science Coordination Board, and the Daily Management Board, as well as the co-workers participating in the establishment and use of the station. Without you, it would not have been possible to have such a unique research station. Finally, we would like to express our gratitude to VILLUM FONDEN for the large grant we were awarded and the trust you have shown us.

Air Monitoring House.
Photo: Stephan Bernberg

INAGURATION OF THE NEW RESEARCH STATION ON THE TOP OF THE WORLD

THE KANN RASMUSSEN FAMILY'S LONG HISTORY WITH GREENLAND LED TO THE CREATION OF VILLUM RESEARCH STATION.

By Anders Correll, Head of Press and Communication, Aarhus University

With a generous DKK 70.5 mil. donation, VILLUM FONDEN and Aarhus University inaugurated an ultra modern research station on July 8, 2015 close to the North Pole. The new Villum Research Station paves the way for groundbreaking international climate research.

The forces of nature just 900 kilometers from the world's northernmost point are fierce, which is one reason why scientists from across the globe find the area around the North Pole so interesting.

Her Majesty Queen Margrethe II of Denmark and the Prime Minister of Greenland Kim Kielsen planned to attend the inauguration of Villum Research Station, but thick fog prevented them from landing.

Luckily, the fog lifted a few days later and Her Majesty was able to visit Villum Research Station, where Crown Prince Frederik two years earlier broke the first ground accompanied by the then chair of VILLUM FONDEN, Lars Kann-Rasmussen.

History dating back to 1933

Due to the Queen's delayed arrival, the present chair of VILLUM FONDEN, Jens Kann-Rasmussen undertook the inauguration in the presence of representatives from Aarhus University and the Defence Command representatives at Station Nord.

Proud and extremely pleased, Kann-Rasmussen revealed the name plate, his thoughts recollecting the enormous effort his father Lars Kann-Rasmussen put into establishing the research station, but also his grandfather, Villum Kann Rasmussen, who drove motorboats during the three-year Lauge Koch expedition to Greenland in 1933, sowing the seeds for the Kann Rasmussen family's close relationship to Greenland. Villum Kann Rasmussen was also the founder of VILLUM FONDEN.

"It's a great pleasure for me to stand here at the completed Villum Research Station that bears the name of my grandfather and the foundation. It very much represents what one could call his motto: An attempt is worth more than a thousand expert views", said Kann-Rasmussen, who was also looking forward with anticipation to the large-scale international research results the Villum Research Station would now produce.

GRAND OPENING

Chair of the board of VILLUM FONDEN, Jens Kann-Rasmussen, unveils the official inauguration plaque. Photo: Lasse Maltesen

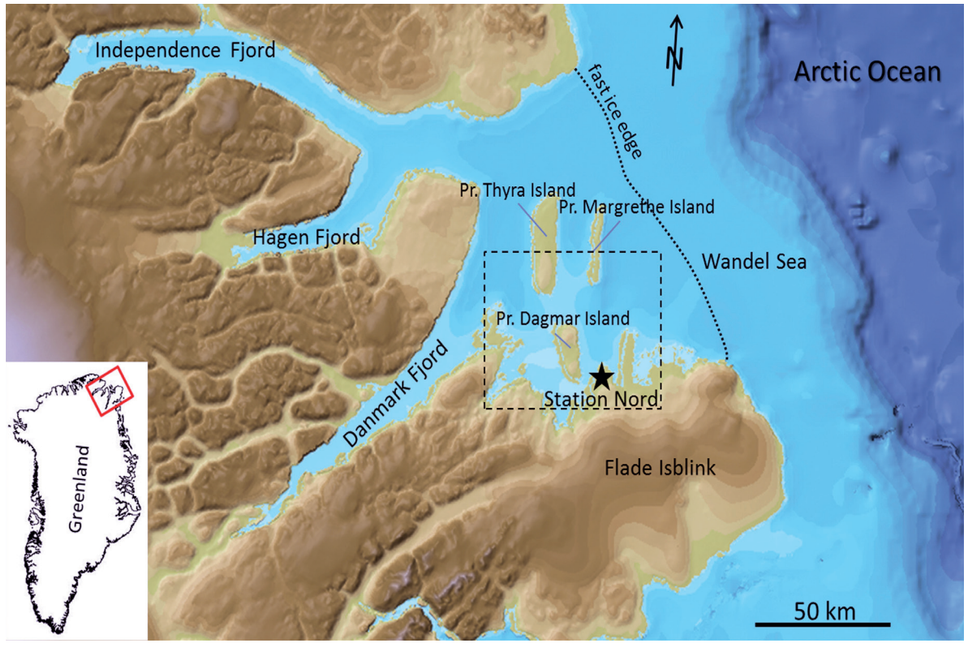
Kann-Rasmussen also stressed that VILLUM FONDEN puts emphasis not only on the importance of establishing a research station in Greenland at the entrance to the Arctic Ocean as far north as possible, but also on creating the best possible conditions for researchers working under extremely harsh climate conditions.

International attraction

"Thanks to Villum Research Station, scientists will not only have the opportunity to observe some of the largest and most dramatic climate change in the field, but they also have the opportunity to test and examine the samples in the newly established laboratories at the research station, thus ensuring that high standards of quality are met. The foundation and I hope that this research station will become an international attraction and help for those scientists who work to identify the causes and impacts of global warming, which we believe is our time's greatest challenge," stated Kann-Rasmussen, aware that many scientists worldwide had already booked the facilities at the station.

Research, however, is not possible without enthusiasts, which is why Kann-Rasmussen also recognized and praised Professor and Head of Station Henrik Skov and the other researchers at Aarhus University for the tremendous effort they put into building and operating the research station with crucial support from the Defence Command in terms of logistics and daily operations.

Finally, Jens Kann-Rasmussen thanked the government of Greenland for its excellent, constructive cooperation and support throughout the project. On behalf of VILLUM FONDEN, he handed over the buildings to the government of Greenland and the operation of the research station to Aarhus University with the hope that this state-of-the-art research station would become a hub for valuable research results for the benefit of the government of Greenland, the Danish Parliament and the international community.



Villum Research Station can be reached either by the Royal Danish Air Force, according to availability, or by a rented plane from Svalbard, which is where the majority of passengers arrive from. Map provided by Niels Nørgaard-Pedersen, Sofia Ribeiro, Naja Mikkelsen, Audrey Limoges, and Marit-Solveig Seidenkrantz, 2016, as published in the Geological Survey of Denmark and Greenland Bulletin.

Her Majesty the Queen of Denmark visited the station on July 8, 2015. Photo: Tuija Jokinen

Photo: Per Arne Bjeglerud

ADVANCED RESEARCH STATION OFFERS UNIQUE OPPORTUNITIES TO SCIENTISTS

VILLUM RESEARCH STATION, STATION NORD IN NORTHERNMOST GREENLAND OFFERS AN EXCELLENT LOCATION FOR INVESTIGATING CLIMATE CHANGE.

By Professor Henrik Skov, Senior Researcher Niels Bohse Hendriksen, and Logistics Coordinator Jørgen Skafte

Villum Research Station, Station Nord is a research facility located in the northeastern corner of Greenland at the military outpost Station Nord in the High Arctic of North Greenland (81°36' N, 16°40' W) on the small Princess Ingeborg's Peninsula.

The nearest town is Longyearbyen in Svalbard, Norway, 720 km east of Station Nord, while the nearest town in Greenland, Ittoqqortoormiit, lies 1,250 km to the south. Station Nord is a gateway to Northeast Greenland National Park Park, providing support and acting as a refurbishment base for Denmark's Sirius Sledge Patrol.

Station Nord is staffed year round by six soldiers who, among other duties, keep the landing strip open and, thanks to them, it is possible for Villum Research Station to be open year round for visitors, which is a unique asset for such a remote station.

Best possible location

The ice flow from the Arctic Ocean floats through the Fram Strait east of the Villum Research Station and means that multi-year and seasonal-ice is transported not far away along the coast of Greenland, thus making the study of ice morphology possible at a relatively modest cost.

During winter, pollutants are transported through the atmosphere from mid-latitudes, especially from Eurasia, to the station, whereas in the summer the air is pristine. This dynamic creates strong seasonality for many pollutants, making it an especially well-suited site to study long-range atmospheric transport of pollutants. Furthermore, large colonies of mammals and birds difficult to approach from other parts of Greenland are found in the area, which is a haul-out site in the summer for walrus cows with calves.

THE STATION

Princess Ingeborg's Peninsula is forbidding and characterized by sparse vegetation, but Villum Research Station serves as a stepping stone that now makes conducting studies in other parts of North Greenland, e.g., Perry Land and 79 Fjord, much easier.

Finally, the station offers a unique opportunity for studying the mech-

(Left) Winter conditions at Villum Research Station.. (Right) The snowmobiles are ready for an expedition. Photo: Niels Nørgaard-Pedersen

The living room and one of the bedrooms.
Photo: Henrik Skov

anisms governing arctic climate response to the greenhouse effect caused by a still higher atmospheric concentration of CO_2. Studies investigating these mechanisms are particularly necessary in the Arctic as the largest temperature increase will take place here. Studies will encompass the entire ocean-atmosphere-cryosphere system.

Facilities for interdisciplinary activities

In order to encompass various subjects and disciplines, Villum Research Station provides different types of laboratories and facilities, making it possible for interdisciplinary activities to be carried out.

Collaboration with Danish Defence

Villum Research Station, Station Nord collaborates closely with Danish Defence, which has, for example, committed to providing one person-year to serve and help researchers at the station with practical issues. All regular meals are eaten together with the military staff when possible.

This mutually beneficial collaboration makes maintenance of snowmobiles easier because both parties use the same type. The station provides highly efficient generators for the Station Nord complex that reduce energy consumption and the Danish Defence maintains them.

Villum Research Station's connection to Greenland is exceedingly important and close contacts were established right from the beginning between the Greenlandic government and the project coordinator, which is why it is natural that the Greenlandic Institute for Natural Resources, representing the government of Greenlandic, owns the station, which Aarhus University operates.

The station consists of three substations, i.e., a building with accommodations and four laboratories (380 m2), an air-monitoring house with two laboratories (110 m2), and a garage (110 m2).

Accessible year round, the station can host up to 14 scientists at a time and its facilities are described in detail on our website: villumresearch-station.dk

The substation with accommodations and laboratories contains seven bedrooms with bunk beds, a living room with a kitchenette, toilets, showers, an office for administrative purposes, and four laboratories.

The station is equipped with furniture in light colors and there is a music system, television, books, and various games available for entertainment.

The four laboratories include a:
- Dirty laboratory for dealing with, e.g., large biological and geological samples
- Chemical laboratory for sample preparation
- Microbiological laboratory for treating, e.g., DNA samples
- Clean laboratory for more demanding analytical work when contamination is a serious problem; access here is limited and requires special permission.

The Air Monitoring House contains two laboratories, one with limited access for continuous monitoring and the other openly available to all users. Both laboratories are equipped with a special inlet for gas sampling and another sampling inlet for particle measurements. Special inlets were also installed through the roof and external power is available to ensure that the building can be used as flexibly as possible and host diverse types of instruments and equipment.

The garage is heated and serves as storage for, e.g., vehicles (snowmobiles and all-terrain vehicles (ATVs)), field equipment, and tents belonging to the Mobile Station.

The Air Station, used for the first time in 2015, currently comprises two drones and a variety of advanced equipment. A map, shown below, of the more pristine areas of Princess Ingeborg's Peninsula was made using an eBee drone. Initial test flights were done with the larger Penguin B drone.

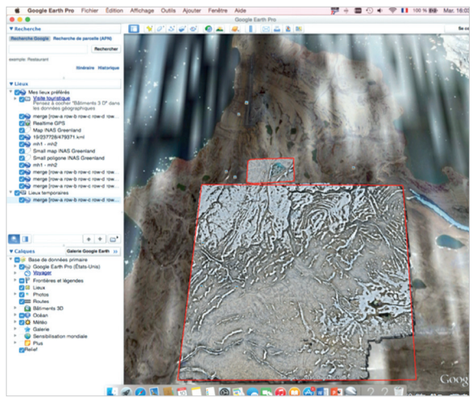
The Villum Research Station is in the process of purchasing, for example, various sensors, cameras, light detection and ranging (LIDAR) ceilometers for surface morphology measurements, an optical particle counter, and a condensation particle counter (CPC) for particle size distribution measurements. This equipment will be tested in 2016 and will be available on station drones in 2017.

As part of the Air Station, a small LIDAR ceilometer is already operating and provides data on the vertical distribution of particles in the atmosphere and the height of clouds. Two other remote ground-based sensors (multi-axial differential optical absorption photometers) are under construction and will be installed in 2016.

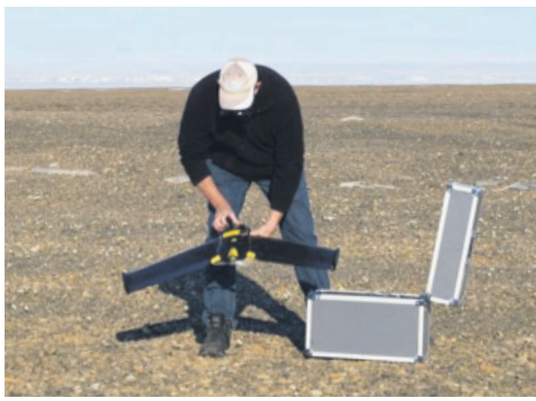
A large variety of data (climate and meteorological, contaminant, permafrost and active layer) is available. Some data, e.g., temperature, wind speed and direction, snow depth, and ozone and mercury levels, are available on the station's website. Other data are still offline and will be available from six months to two years after collection.

The Mobile Station, still under construction, will consist of a central complex of hexagonal tents built together and a number of individual tents for accommodation. This facility will be established in 2016, but vehicles, boats, and field equipment belonging to the Mobile Station were already used in 2015 for distances of up to 15 km from the station.

Nina Sarnela and Heikki Junninen, University of Helsinki, in front of their chemical characterization of aerosols equipment.
Photo: Henrik Skov



Andrew Burnet, Integra Consult A/S, launches an eBee drone. The camera captures high-resolution aerial photos (left) useful for describing the sparse vegetation on Princess Ingeborg's Peninsula.
Photo: Henrik Skov



Snowmobiles were used to drive onto the sea ice for sampling surface sediment and to study the interactions between sea ice cover and biota, and especially the dynamics of carbon uptake.

Similarly, sediment cores were collected from the lakes around Station Nord. In the summer, the three ATVs were also in use to access the nearby shore, where two rubber boats were used. During the summer campaign, conductivity, temperature, and depth (CTD) rosettes were employed, and an automated underwater vehicle was deployed equipped with a conductivity and temperature measuring device, pCO_2, pH sensor.

Ideal conditions for researchers
In addition to the various laboratories, the station has an extensive collection of research and expedition instruments and equipment available to visiting scientists. This reduces the cost of transportation for the individual researcher and optimizes the project budgets. The station's website contains a list of equipment: villumresearchstation.dk

On-line data of meteorology and selected atmospheric compounds are available for all users. Starting in September 2014, it became possible to download meteorological data free of charge on the website. Data on atmospheric measurements is available upon request from the scientist in charge (see station website). In this context, it is important to point out that Villum Research Station, Station Nord applies an open-source philosophy, which means that all data must be made available 1-2 years after a campaign is completed, though delays due to special circumstances can occur.

Future collaborators are welcome to contact the secretariat or the head of the station. Contact details are listed on the inside cover of this report.

Retrieval of a kajak sediment core from the sea floor after drilling through the ice. Photo: Sofia Ribeiro, GEUS

VILLUM RESEARCH STATION'S FIRST YEAR

SEVENTY RESEARCHERS, TECHNICIANS, AND STUDENTS SPENT 1,500 DAYS COMBINED AT THE STATION IN 2015.

By Professor Henrik Skov and Senior Researcher Niels Bohse Hendriksen

Villum Research Station was inaugurated on July 8, 2015 by Jens Kann-Rasmussen, chair of VILLUM FONDEN, in place of Her Majesty the Queen of Denmark Margrethe II, who was unable to offer her congratulations and discuss the future perspectives of the station until two days later due to poor weather.

Immense satisfaction
Research activities began in January 2015 and were carried out until September 2015 by 70 people comprising researchers, technicians, and students from nine countries who spent 1,500 days combined at the station. They completed a questionnaire and the results showed that the station functions exceptionally well as a state-of-the art research facility and that there was a high level of satisfaction with the station and its operation among users.

2015 HIGHLIGHTS

Top: Station Nord is staffed year round by six soldiers who keep the landing strip open. Thanks to them, it is possible for Villum Research Station to be open year round for visitors. Photo: Christel Christoffersen

Five research groups
The research covers five main topics: sea ice, atmosphere, limnic bodies of water, paleoclimate, and oceanography. Each research group has aims and activities of its own; however, collaboration and coordination takes place, mutual help and interaction occuring frequently during the stays.

Sea ice group
Primary sea ice topics:
• Photosynthesis, bacterial activity, and organic carbon dynamics in sea ice, as well as how organic carbon dynamics are affected by snow cover, ice age, and glacier melt
• Sea ice geochemistry, notably related to the mineral ikaite, which is the hexahydrate of calcium carbonate, mercury, and phosphorous
• Spatial and temporal variability of the fast ice around Station Nord
• Distribution and characteristics of sediments found in glacier ice, in the water column, and in sea ice

The researchers in this group comprised: Associate Professor Lars Chresten Lund-Hansen, Professor Søren Rysgaard, and Associate Professor Brian Sorrel from Aarhus University; Associate Dean David Barber, research scientist D. Babb, Professor Feiyue Wang, postdoc Yubin Hu, master's student Heather Kyle, research scientist Nicolas-Xavier Geilfus, postdoc Virginie Galindo, and Associate Professor Jens Ehn from University of Manitoba.

The atmospheric group
Major atmospheric aims were to:
• Study the physical properties and

Left: A Tapper corer is used for sampling sediments through the sea ice. Photo: Nicolaj Krogh Larsen

Right: Laboratory technician Bjarne Jensen works with a scanning mobility particle sizer to measure particle-size distribution. Photo: Henrik Skov

Associate Professor Tim Papakyriakou, University of Manitoba, installs equipment to measure fluxes of CO_2, CH_4 and water vapor. Phtoto: Lise Lotte Sørensen

chemical speciation of long-range, atmospheric transport of particles to identify their pathways

• Improve understanding of the processes controlling the magnitude and distribution of greenhouse gas uptake or release by arctic marine waters to clarify how the energy balance affects the flux of greenhouse gases

• Investigate the abundance and diversity of microorganisms in the air of a pristine environment to explain the importance of microorganisms for particle formation in the air

Particles were collected at the research station and characterized. Greenhouse gas exchange was measured over open water, and snow and ice covered marine waters, while microorganisms were collected at their current metabolic state for analysis by DNA and RNA sequencing.

The researchers in this group included: senior researcher Andreas Massling, Professor Merete Bilde, Marianne Glasius, Associate Professor Lise Lotte Sørensen, Professor Kai Finster, postdoc Tina Santl Temkiv and Professor Henrik Skov from Aarhus University; and Associate Professor Tim Papakyriakou from University of Manitoba.

The limnic and paleoclimate group

The objectives of the limnic and paleoclimate group were to reconstruct the past variability of sea ice

Director Jørgen Bendtsen, Assistant Professor Jens Ehn and Program Coordinator Lennert Kunuk studying sea ice geochemistry. They use a zodiac boat to find a channel through the ice to the sampling site. Photo: Yubin Hu

Postdoc Yubin Hu and Ph.D. student Wieter Boone prepare the automated underwater vehicle for action. Photo: Søren Rysgaard

in the Station Nord region to clarify its impact on biogeochemical cycles, especially plankton organisms, and to determine the timing and magnitude of past ice fluctuations in the High Arctic. To help achieve these objectives, sediment core sampling and analysis were undertaken.

The researchers involved included: Professor Marit-Solveig Seidenkrantz, senior researcher Niels Nørgaard, Sofia Ribeiro, Associate Professor Nicolaj Krog Larsen, and senior scientist Torben Linding Lauridsen from Aarhus University.

The oceanography group
The oceanography group concentrated its efforts on describing the nearshore dynamics, circulation, and hydrography around Station Nord, as well as the nearby ice tongue from the Flade Isblink glacier. The group also collected oceanographic data and considered the physical mechanisms that potentially impact fast ice and tidewater glaciers in the region. Instruments employed included CTDs and an ice-tethered profiler/CTD installed in the vicinity of the glacier-ocean contact zone. An automated underwater vehicle field was also tested, with promising results.

Participants included Research Professor Igor Dmitrenko and research scientist Sergei Kirillov from the University of Manitoba and Søren Rysgaard from Aarhus University.

Collaboration on cryosphere and atmosphere interaction
A special activity was completion of CRAICC, a six-month Nordic Centre of Excellence campaign. The cryosphere is portions of the Earth's surface where water is in solid form.

The aims were to:
• Quantify natural sources of primary aerosols and precursor gases for secondary aerosols
• Describe reaction pathways and effects on aerosol and ozone formation of the emitted gases
• Characterize aerosols formed from cryosphere-related sources

The Arctic Monitoring and Assessment Programme (AMAP)
Denmark is contributing to AMAP at the station through two projects, "AMAP CORE Atmosphere" and "AMAP Climate Forcers in the High Arctic", whose aims are to:
• Continue the monitoring of contaminants in the atmosphere in Greenland to detect temporal and geographical changes
• Understand the mechanisms, especially those related to climate
• Measure the most important greenhouse components: CO_2, CH_4, black carbon, and ozone.

NEW INSIGHT INTO IODINE'S IMPACT ON THE FORMATION OF NEW CLOUDS

FINNISH RESEARCHERS STUDY EARLIEST STAGES IN THE DEVELOPMENT OF CLOUDS IN THE ARCTIC.

Clouds are important to the arctic climate because they trap warm temperatures and reflect sunlight in spring and summer. In the previous two decades, cloud cover over the central Arctic has increased nearly linearly, exacerbating rising temperatures.

As a result, Villum Research Station decided to address the issue in 2015 in a measurement study of what happens initially at particle level when clouds are created.

New particle formation occurs when molecular clusters form from atmospheric vapors by condensation and, later, clusters can grow into larger particle sizes and act as cloud condensation nuclei. The composition of newly formed particles was not studied in the Arctic until recent years.

The new study at Villum Research Station by a Finnish research group has provided new insight into the iodine's impact on the formation of new clouds in the Arctic, which may be valuable knowledge when researchers estimate future temperature development in global climate models.

The Finnish research group's main objectives were to:
• Gain greater insight into new particle formation and nucleation processes in the Arctic
• Characterize arctic haze
• Indentify and characterize changes in atmospheric chemistry during the change from the dark to sunlight period
• Continuously measure meteorological parameters
The group conducted an intensive measurement campaign as part of CRAICC at Villum Research Station, which has an atmospheric observatory two km from the military outpost. The campaign started in February 2015 and ended in August 2015.

The Villum Research Station continuously measures meteorological parameters and ozone concentration. Over the last decade, gaseous elemental mercury, black carbon, and filter pack measurements have also been taken. A scanning mobility particle sizer has been used to measure particle size distribution of 10 – 900 nm since 2010.

During CRAICC, various mass spectrometers, particle spectrometers, and particle counters were used and continuous measurements were taken to study vapor and particle concentrations and new particle formation on the site.

A nitrate Chemical Ionization Atmospheric Pressure interface Time-Of-Flight (CI-APi-TOF) mass spectrometer was used to measure extremely low volatility vapors such as sulfuric acid and molecular clusters, while acetate-CI-APi-TOF (Bertram et al., 2011) was used to measure low volatility vapors such as formic acid. Ambient ions were measured with APi-TOF; article concentrations of 0.8 – 40 nm particles with an air ion spectrometer; sub-3 nm particles with a particle size magnifier, and the particle composition with an aerosol mass spectrometer.

Promising preliminary results
The measurement campaign was successful and furnished six months of data. From March to May, several ozone and mercury depletion events were observed, the former of which also showed increased concentrations of chlorine oxides.

In general, the aerosol particle concentrations were low during the measurement campaign, but occasionally elevated particle concentrations and some particle growth events were observed. Sub-3 nm particle concentrations were also observed during these events. Vapor concentrations varied between spring and summer.

High concentrations of iodic acid were detected in April and May when solar radiation was more intense. During the summer, snow started to melt and iodic acid concentrations decreased. According to the preliminary analysis, the composition of particles appeared to be different in spring compared to summer.

Iodine oxides appear to be important in springtime particle formation. Iodine oxide clusters were observed similar to those seen during particle events at a coastal site in Ireland. These results support the findings of earlier results, detecting iodine in arctic aerosols larger than 30 nm, but the Finish group's findings represent the first time that iodine oxide has been seen in molecular clusters in the Arctic.

When the snow started to melt, the role of iodine oxides appeared to decrease in particle formation but the role of sulfuric acid increased. The data analysis is still in progress and these results will be examined further.

SELECTED ACTIVITY

By postdoc Heikki Junninen; Ph.D. student Nina Sarnela; research assistant Lauri Ahonen; postdoc Tuija Jokinen; graduate student Joona Mikkilä, Ph.D. student Otso Peräkylä; postdoc Daniela Wimmer; Professor Tuukka Petaja; Professor Markku Kulmala, and postdoc Mikko Sipilä, Department of Physics, University of Helsinki, Finland.

DOES THE LONG-RANGE TRANSPORT OF MICRO-ORGANISMS IMPACT CLOUDS IN THE HIGH ARCTIC?

MICROORGANISMS MIGHT BE AN IMPORTANT MISSING LINK WHEN PREDICTING RADIATION BUDGETS IN THE ARCTIC.

By Tina Šantl-Temkiv, postdoc, Department of Bioscience, Aarhus University

The remote and extremely harsh conditions in the Arctic pose challenges for the study of the arctic atmosphere, which is why our understanding of the arctic atmosphere, meteorology, and climate is still limited.

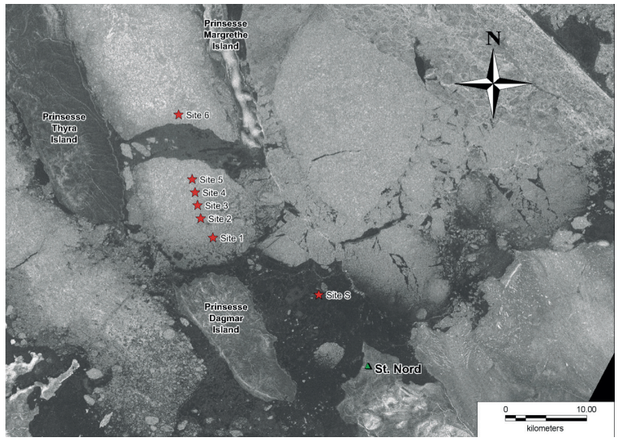
This especially accounts for the presence, composition. and activity of airborne microorganisms, i.e., bio-aerosols, in the arctic atmosphere. Aside from dust particles, bio-aerosols have properties that enable them to actively interact with the formation and development of clouds, rain, and snow.

Due to the poorly constrained concentrations, sources, and composition of bio-aerosols, their effects on the formation of clouds and precipitation are not clear.

Bio-aerosols might strongly impact both weather and climate as they are involved in the control of the lifetime and extent of clouds. This means that microorganisms might be an important missing link for predicting radiation budgets in the Arctic, calculating how much energy the Earth gets from the sun, and how much energy the Earth radiates back into outer space as invisible light.

Radiation budgets play a significant role for predicting the accumulation and melt of surface snow and sea ice. Despite indications that airborne microbes are important players in atmospheric processes and climate evolution, their numbers and physical properties in the High Arctic have yet to be thoroughly investigated.

SELECTED ACTIVITY



Snow samples were collected in a transect that stretched out 50 km from the station. Prepared by T. Santl-Temkiv with the help of N. Nørgaard-Pedersen.

Unique research equipment

The Villum Research Station, Station Nord provides unprecedented access and the necessary infrastructure for studying the effects of airborne microorganisms on cloud processes.

This project focused on the long distance transport and deposition of airborne microorganisms. Their impact on the coupling of atmospheric and terrestrial processes was also investigated. As part of ongoing research at Villum Research Station, Station Nord, there are campaigns aiming at understanding the formation of Arctic haze and the nucleation processes behind this formation. A state-of-the-art atmospheric observatory has been established that continuously monitors selected ions, organic compounds, and particulate matter, providing background information for the interpretation of our results.

The group joined the first research campaign at the Villum Research Station in April 2015, supported by the Arctic Science Partnership. This campaign gave a unique opportunity to collect a series of air and snow samples to be analyzed for microorganisms by traditional and molecular microbial methods and they were also analyzed for their ice nucleation abilities.

Arctic weather a challenge

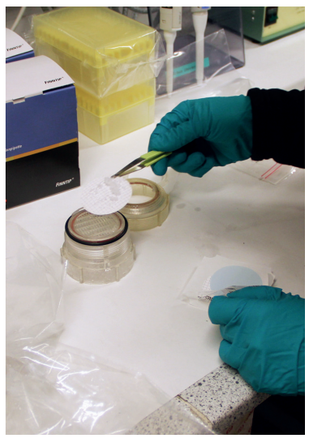
Ordinary tasks like reaching the sampling site or operating the samplers proved to be arduous at this High Arctic site. The group had two people, postdoc Tina Šantl-Temkiv and master's student Sissel Svendsen, both of whom worked at the specially-equipped air-measurement huts and in the field.

The field sites were established within 2.5 km from the station and could be reached on foot or by snow scooter but, as with the huts, required wearing specialized clothing to prevent the risk of frostbite, and required being armed with a rifle to ward off polar bears.

Postdoc Tina Santl-Temkiv at a temporary sampling site. Photo: D. Babb

Despite the taxing conditions, the group successfully collected samples using high-volume samplers and lower-volume filter sampling techniques. In addition to filter samples, they also collected surface snow samples up to 50 km away from the station. These samples were collected over a period of six weeks and especially during the presence of Arctic haze.

The samples were processed in the well-equipped laboratories at the research station. As these samples contain very low densities of microorganisms, it is crucial to take extreme care to avoid contamination. As a result, the clean laboratories with restricted access for processing clean samples were used for the preparative work and for handling the samples.



(Left) The Air Monitoring House, where the bio-aerosol sampling was set up ~ 1m above the roof of the hut. (Middle) Collecting the filter sample after 24 hours of continuous sampling. (Right) Storing the filter for later analysis. Photo: T. Santl-Temkiv and J. Lau Hansen

FIELD CAMPAIGN WITH NEW STATE-OF-THE-ART INSTRUMENT

A FIRST-HAND ACCOUNT OF DAILY WORK LIFE AT THE STATION.

By Ingeborg Elbæk Nielsen, Ph.D. Student

DAILY WORK LIFE

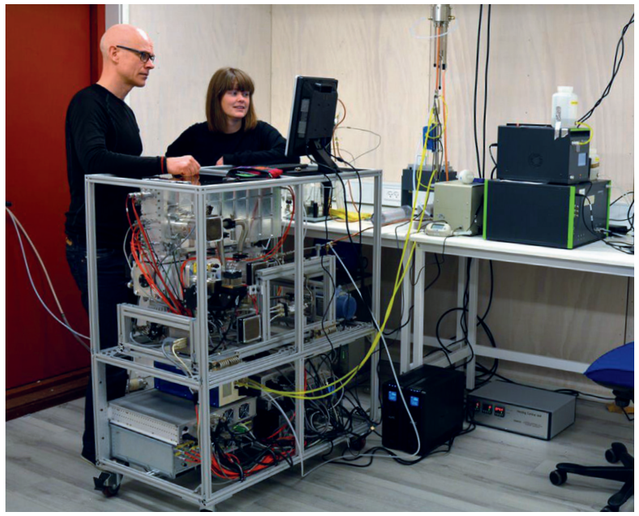
The Department of Environmental Science at Aarhus University has acquired an advanced instrument called a soot particle aerosol mass spectrometer (SP-AMS), designed for use during field campaigns at Villum Research Station. In this section, Ingeborg Elbæk Nielsen provides an account of the instrument's first journey at Villum Research Station during a campaign in spring 2015.

In the year that has passed since we received our new state-of-the-art SP-AMS, we have collected a large amount of data from laboratory experiments and field campaigns that is almost ready to be published. The SP-AMS can measure the chemical composition of ambient aerosols with a high time resolution. One of the main purposes of our new instrument is to measure the composition of small aerosols with a size of up to 1 µm at the station.

The instrument arrived at the station for a field campaign in the spring of 2015. A significant amount of work goes into planning a field campaign in the High Arctic and even when you think you've planned everything, something always goes awry.

Snow-blocked road

We were off to a good start and the instruments and scientists arrived at the station delayed by only one day. It didn't take long, however, before we encountered our first big problem: the insurmountable task of clearing the road to the air-measurement hut only 2.5 km away from the main station.



Ph.D. student Ingeborg Elbæk Nielsen and senior researcher Jacob Klenø-Nøjgaard at work. Photo: Henrik Skov

Yards and yards of snow blocked the way, preventing us from driving the SP-AMS to the measurement hut as originally planned. We simply had to come up with a new idea, quickly.

The SP-AMS is not only a delicate, sensitive instrument and, weighing in at almost 300 kg, is also quite big when its transportation box is included. Obviously, this complicates things since we couldn't just pick it up and trundle 2.5 km across deep snow in -35°C weather. After discussing it from various angles, we connected a sledge to a snow mobile to make the journey.

Darkness, cold air and deep snow

Two days of driving back, and forth with the sledge loaded with less expensive, fragile instruments finally created a clear track to the hut. Now it was time to move the SP-AMS. Two men ran along each side of the sledge loaded with the SP-AMS box to prevent it from tilting. We battled the darkness, cold air, and deep snow but finally reached the hut without damaging the SP-AMS.

After a couple of days, it was up and running. We were fortunate not to experience any other huge obstacles, just the usual power failures and Ski-Doo break downs that almost always occur during Arctic field campaigns.

Like any good fairy tale, this campaign also had a happy ending. I am now proudly in possession of three months of arctic SP-AMS data.

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Photo: Christel Christoffersen

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Skov, H. **A new research platform in the high Arctic – New research and possibilities within the new research station donated by VILLUM FONDEN.** Invited Speaker at The Division of Analytical Chemistry. The Danish Chemical Society Annual Meeting 2015. 11th of June 2015, Odense University of Southern Denmark.

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Skov, H. **A new research platform in the high Arctic – New research and possibilities within the new research station donated by the VILLUM FONDEN.** Invited Speaker at The Division of Analytical Chemistry. The Danish Chemical Society Annual Meeting 2015, 11th of June 2015, Odense University of Southern Denmark.

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Svendsen, S. B., Nguyen, Q. T., Skov, H., Massling, A. (2015) **Atmospheric Particle Number Size Distributions measured at Villum Research Station (VRS) at Station Nord (SN). North Greenland,** ARC annual meeting, 25th – 26th, Sandbjerg, Denmark, Poster.

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OUTREACH

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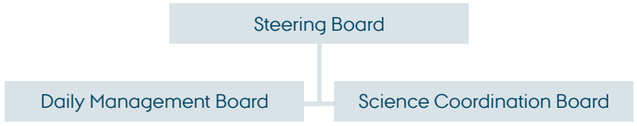
Photo: Christel Christoffersen

ORGANIZATION AND MEMBERS OF BOARDS

The administrative structure of Villum Research Station, Station Nord consists of a Steering Board, Daily Management Board, and Science Coordination Board.



STEERING BOARD

The Steering Board for Villum Research Station, Station Nord is responsible for:

- Ensuring that the infrastructure is constructed and organized in the best possible way within the framework laid out in the project description before and during the construction period
- Ensuring close collaboration between Villum Research Station, the government of Greenland, and the Defence Command in order to optimize Villum Research Station's work
- Carrying out the strategic planning of the use of the Villum Research Station in accordance with the above, taking the advice of the Scientific Board into consideration
- Overseeing activities of the Daily Management and Science Coordination Boards to ensure that the proper conditions exist for carrying out research at a high international level

Name	Title/Profession	Affiliation	E-mail
Niels Christian Nielsen, Chair	Professor, Dean	Aarhus University	dean@science.au.dk
Marit-Solveig Seidenkrantz	Professor	Aarhus University	mss@geo.au.dk
Lars Hansen	Director	VILLUM FONDEN	lha@veluxfoundations.dk
Thomas Sinkjær	Professor, Research Director	VILLUM FONDEN	tsi@veluxfoundations.dk
Henrik Skov	Professor	Aarhus University	hsk@envs.au.dk
Mikael Kristensen	Director	Government of Greenland	MKRI@nanoq.gl
Jens Heine Grauen Larsen	Commander	Defence Command	VFK-O-J5N07@fiin.dk or VFK-O-J5N07@mil.dk

DAILY MANAGEMENT BOARD

The Daily Management Board for Villum Research Station, Station Nord is responsible for:

- Day-to-day decision-making and carrying out practical work stipulated in the project description and determined by the Science Coordination and Steering Boards
- Developing risk and contingency plans when needed
- Developing a regularly updated interactive website with various features for, e.g.: communication, data sharing, news updates, available resources (e.g., expertise, equipment, special techniques, materials), publications, and relevant links. To enable the exchange of best practices and to maximize knowledge sharing, station users are under obligation to make results and other relevant information available on the website within one year after obtaining them
- Implementing a publication strategy to disseminate scientific accomplishments to the wider public

Name	Title/Profession	E-mail
Henrik Skov	Professor, Head of Station	hsk@envs.au.dk
Niels Bohse Hendriksen	Dr., Station Coordinator	nbh@envs.au.dk
Jørgen Skafte	Logistics Coordinator	jska@envs.au.dk
Andreas Massling	Dr., responsible for physical measurements	anma@envs.au.dk
Rossana Bossi	Dr., responsible for chemical measurements	rbo@envs.au.dk
Jacob Klenø Nøjgaard	Dr., responsible for determination of organics in aerosols	jakn@envs.au.dk

SCIENCE COORDINATION BOARD

The Science Coordination Board for Villum Research Station, Station Nord is responsible for:

• Ensuring that the infrastructure is constructed and organized in the best possible way within the framework laid out in the project description before and during the construction period

• Ensuring that interdisciplinary climate-related research at highest international level is given top priority

• Carrying out the strategic planning of research activities at Villum Research Station in accordance with the above, taking the advice of the International Advisory Board into consideration to facilitate the activities of the Daily Management Board

Name/e-mail	Title/Profession	Affiliation
Henrik Skov, Chair hsk@envs.au.dk	Professor, Head of Station	Department of Environmental Science, Aarhus University (AU)
Niels Bohse Hendriksen bnbh@envs.au.dk	Station Coordinator	Department of Environmental Science, AU
Lise-Lotte Sørensen LLS@bios.au.DK	Senior Researcher	Department of Bio-Science, AU
Søren Rysgaard rysgaard@bios.au.dk	Professor, Director of Arctic Research Centre (ARC)	ARC, AU
Signe Bech Andersen siba@geus.dk	Senior Scientist	Geological Survey of Denmark and Greenland (GEUS)
Niels Kroer nk@bio.ku.dk	Head of Department	Department of Biology, University of Copenhagen (KU)
Nicolai Krog Larsen nkl@geo.au.dk	Associate Professor	Department of Geoscience, Aarhus University
Matthew S. Johnson msj@kiku.dk	Professor	Department of Chemistry, KU
Bo Elberling be@geo.ku.dk	Professor	GEUS, KU
Rene Forsberg rf@space.dtu.dk	Head of Department	National Space Institute, DTU Space
Niels Larsen nl@dmi.dk	Head of Centre for Atmospheric Physics and Observations (CAO)	Danish Meteorological Institute
Mikala Klint mkl@MST.DK	Coordinator of Chemicals and the Arctic	Danish Environmental Protection Agency
Niels Martin Schmidt NMS@BIOS.AU.DK	Head of Zackenberg Station	Department of Bioscience, AU
Stefan Wacker swa@asiaq.gl	Project Manager	ASIAQ Greenland Survey
Dorthe Dahl-Jensen ddj@gfy.ku.dk	Professor Centre for Ice and Climate	Niels Bohr Institute, KU
Christel Ege-Johansen CEJ@DMU.DK	Secretary	Department of Environmental Science, AU
Bjarne Grønøw Bjarne.Gronnow@natmus.dk	Professor, Museum Director	National Museum of Denmark
Malene Juul Simon masi@natur.gl	Senior Researcher	Greenland Institute of Natural Resources