Forskningsrådet

Monitoring at Zackenberg -lessons for Svalbard

Workshop Report, January 2013
Svalbard Science Forum - SSF

The Research Council of Norway
P.O.Box 2700 St. Hanshaugen
N–0131 OSLO
Telephone: +47 22 03 70 00
Telefax: +47 22 03 70 01
bibliotek@rcn.no
www.rcn.no/english

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P.O.Box 506
NO-9171 Longyearbyen
Telephone: +47 79 02 64 87
ssf@rcn.no
www.svalbardscienceforum.no

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SSF Cooperation Workshop No 4:

Monitoring at Zackenberg – lessons for Svalbard

Results from the Svalbard Science Forum workshop, 5-7 February 2013, Copenhagen.
Editors: Roland Neuber, Morten Rasch, Geir Wing Gabrielsen & Karoline Bælum

Participating institutions and organisations:
Czech Republic: *Centre for Polar Ecology;* ***Denmark:*** *Aarhus University; Copenhagen University, Danish Energy Agency, Greenland Ecosystem Monitoring Program (GEM), Zackenberg* Research Station*;* ***France****: Centre for Functional and Evolutionary Ecology****; Germany:*** *Alfred Wegner Institute*; ***Italy****: National Research Council;* ***Japan:*** *National Institute of Polar Research;* ***Korea****: Korea Polar Research Institute;* ***Netherlands:*** *University of Groningen;* ***Norway:*** *Norwegian Polar Institute, University Centre in Svalbard, University of Tromsø; Norwegian Institute for Air Research, Kings Bay A/S;* ***Poland:*** *Polish Academy of Sciences, Polish Polar station Hornsund;* ***United Kingdom:*** *British Antarctic Survey, Natural Environment Research Council (NERC);* **International organisations and projects***: Sustaining Arctic Observing Networks (SAON), Ny-Ålesund Science Managers Committee (NySMAC), Arctic Monitoring and Assessment Program (AMAP), Svalbard Integrated Arctic Earth Observing System (*SIOS), Svalbard Science Forum (SSF); **Not able to attend:** *University of Groningen (Netherlands), Arctic and Antarctic Research Institute of Roshydromet (AARI)(Russia);*

Workshop planning group
- Dr Roland Neuber, Alfred-Wegner-Institute, Germany (leader)
- Dr Morten Rasch, Århus University, Denmark
- Dr Geir W. Gabrielsen, Norwegian Polar Institute, Norway
- Dr Karoline Bælum, Svalbard Science Forum, Norway

Workshop report
Part 1: Priorities and recommendations. The group discussions were structured around the three topics, the links between them, and the identification of common ground for possible joint projects and collaboration in the future.
Part 2 (appendices): Workshop participants, abstracts and workshop programme

The workshop was organised and financed by:

SVALBARD SCIENCE FORUM

The Research Council of Norway

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1 Introduction

SSF Cooperation Workshop No 4 brought together 28 representatives from a variety of institutions and organisations all working in Svalbard and Greenland. It was held near Copenhagen, Denmark, from 5-7 February 2013.

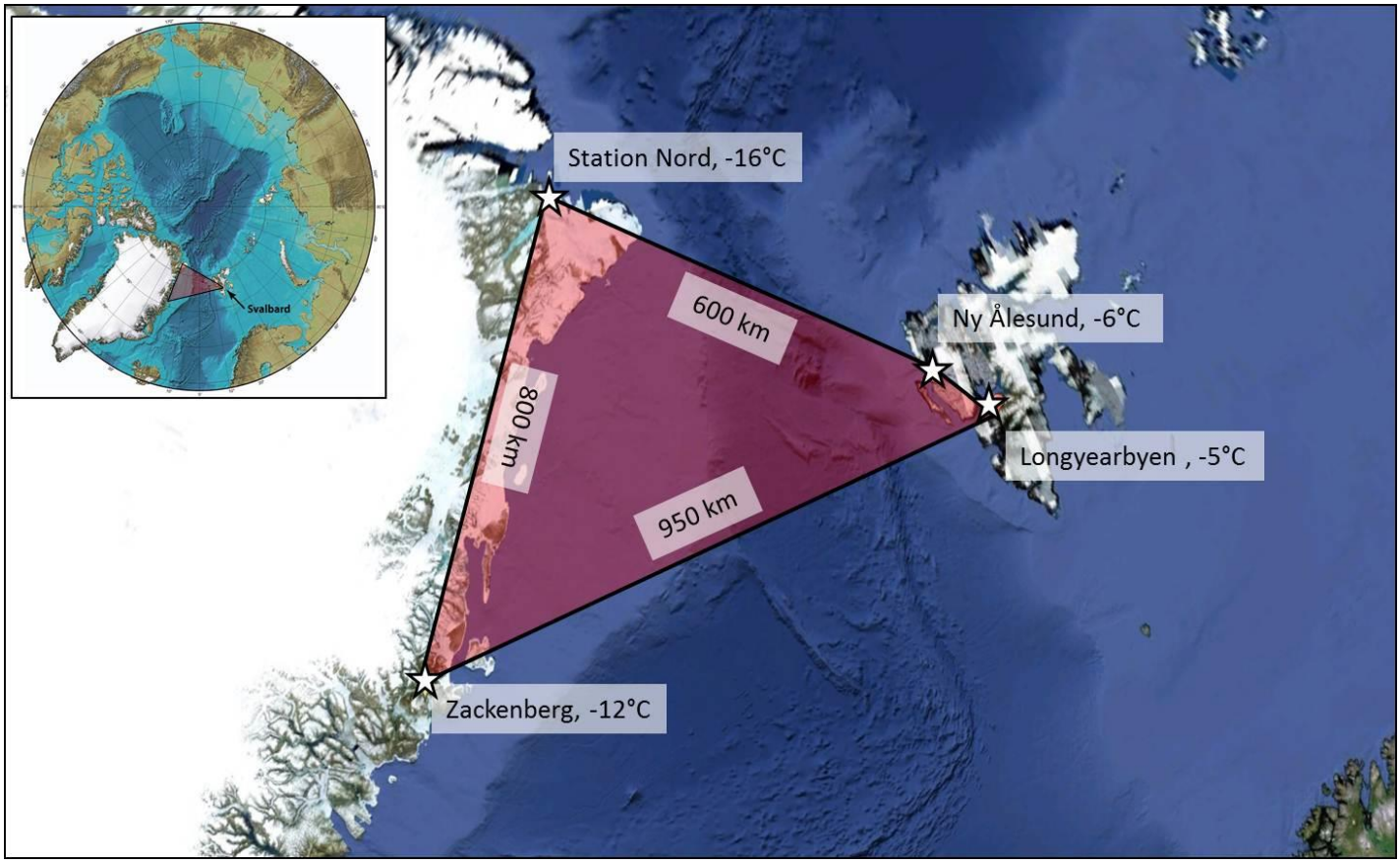
The Svalbard Science Forum (SSF) is part of the Research Council of Norway. SSF promotes coordination of and collaboration on research activities in Svalbard. SSF´s objective is to contribute towards the development of Svalbard as a platform for international research cooperation in the Arctic.

SSF's tasks include managing the database 'Research in Svalbard' (RiS), which contains information relating to more than two thousand Svalbard-based projects.

The SSF organises workshops and administers funding schemes aimed at the polar research community, while continuously endeavouring to minimise the environmental footprint of research activities.

SSF Strategic Objectives:

- Increased scientific cooperation within Svalbard research
- Increased coordination of activities
- Open sharing of data
- Reduced environmental impact



Map depicting the distances between and mean annual air temperatures at key localities. From Google Earth.

1.1 Workshop goals

In preparation for the workshop, the participants had been presented with the question '*What can be learned from Zackenberg Research Station?*' and the goals listed below. (The participants were also asked to submit abstracts highlighting their experiences and suggestions within the listed topics, Appendix 2.)

In addition to learning about the various aspects of the success of the Zackenberg Research station, another aspect quickly emerged that became very important for the outcome of the workshop, namely the need to facilitate joint research projects and programmes between the sites on Svalbard and Zackenberg and other stations on Greenland. In particular, the introduction of the new scientific base at Station Nord, on the north-eastern tip of Greenland, triggered ideas for combining research activities across the Fram Strait. Some research projects have already been undertaken on both Svalbard and Greenland, but they face considerable logistical and organisational obstacles despite the close spatial proximity of the locations on a hemispheric scale. Future management activities need to overcome these obstacles, and logistical efforts are required to establish new logistical bridges (air links) between Svalbard and Greenland. Potential research topics are listed towards the end of the next chapter.

The workshop concluded with a set of recommendations for the three topics Science, Management, and Logistics, as well as some general ones, as described in Chapter 2.

Workshop goals

1. Status of the monitoring sites at Zackenberg and Svalbard
    a. Main lessons, good and bad, to be learned from the existing infrastructure
    b. Cooperation and conflicts between research, monitoring and logistics
2. Organisational development of monitoring sites and networks
    a. Models for the organisation and administration of interdisciplinary, cross-institutional, multinational monitoring sites like Zackenberg and Ny-Ålesund
    b. Models for the organisation and administration of interdisciplinary, cross-institutional, multinational networks (SIOS, SAON, AMAP and CALM as examples)
    c. Different models for future coordinated, long-term monitoring and research in the Arctic (e.g. single-site versus multi-site, supersites versus smaller sites, interdisciplinary versus single discipline)
3. Collaboration outlook
    a. Possibilities of future collaboration across the Fram Strait in relation to science and logistics coordination and identifying potential areas for cooperation.
    b. Exchange of information about ongoing research activities and projects
    c. Data sharing and project cooperation
4. Workshop report

1.2 Background for the workshop

The Fram Strait, the section of the Atlantic Ocean between Greenland and Spitsbergen, constitutes the area with the greatest climatological gradients in the latitudinal band 70 – 80 N, if not in the entire northern hemisphere (see, e.g., Furevik & Nilsen, 2005). The warm North-West Atlantic Current on the western shore of Spitsbergen and the cold East Greenland Current (EGC) on Greenland's eastern shore produce strong temperature differences, which are also stabilised by the strong southward ice transport along the EGC. Zackenberg Research Station at 74°N and the Spitsbergen sites from 77°N (Hornsund) to 79°N (Ny-Ålesund) are located at the opposite ends of this gradient field. The research stations on both sides of the Fram Strait are a natural laboratory formed by huge temperature gradients, awaiting more intensive study by combined scientific investigations at each end of and across this gradient.

Zackenberg Research Station is an ecosystem research and monitoring facility at Zackenberg (74°30'N / 21°00'W) in North-East Greenland, 25 km north-west of Daneborg.

A long-term monitoring programme, Zackenberg Basic, was initiated in 1995 as an integrated activity at Zackenberg, and it was fully implemented for the terrestrial part of the ecosystem in 1996. The objective of the programme is to provide long time series of data on the natural innate oscillations and plasticity of a high Arctic ecosystem. This is accomplished through monitoring selected biotic parameters and elements (BioBasis and MarineBasis), as well as climatic (ClimateBasis and GlacioBasis) and other abiotic (GeoBasis and MarineBasis) parameters and elements, throughout the year on a long-term basis.

The aim of Zackenberg Basic is to provide new knowledge about ecosystem function, ecosystem changes due to climate warming, and ecosystem feedbacks to climate change. The Zackenberg Basic programme is the monitoring part of the Zackenberg Ecological Research Operations (ZERO) research programme. It also encompasses experimental research and logistics.

All data from Zackenberg Basic are provided free of charge to anyone interested in using the data.

For further information about the long-term monitoring at Zackenberg, please visit the homepage: www.zackenberg.dk.

2 Recommendations

2.1 Science group

International long-term monitoring across the region is crucial in order to answer key research/management questions and improve our understanding of Global Change and its effects. The added value of international scientific collaboration across the gradient gives a fuller perspective on responses to change.

Suggestions:

- Supersites are the natural starting points for monitoring and can be expanded by adding satellites sites.
- Develop and apply common tools/technology across sites
- Continuity of long-term observations must be ensured
- Encourage the exchange of researchers and students between Svalbard and Greenland
- Facilitate the dialogue between research, monitoring, logistics and stakeholders
- Annual reports (or similar overview products) could in future be produced by the SIOS knowledge centre
- Global collaboration is needed to monitor and understand processes that are important to earth system science
- Monitoring and data archiving should follow international standards
- Produce a long-term observation review report/synthesis/paper (in Svalbard). This should be based on existing documents/analysis (SIOS, Envinet).
- Use this review to identify gaps in the monitoring programme in Svalbard
- Review the list of existing research projects working across the gradient, and identify gaps and potentials, and propose recommendations for filling the gaps
- Promote and hold/organise workshops on specific scientific and multidisciplinary topics for the Svalbard and Greenland area. The goal should be to develop common projects/programmes across the region (internationally).

2.2 Management group

Today, we have high quality research and monitoring in Svalbard and Greenland. These activities have emerged through very different dynamics (single-national leadership in Zackenberg vs. multinational and distributed decisions in Ny-Ålesund). Sharing experiences and best practices is an obvious opportunity beyond the scientific needs identified at this workshop. Historically, arctic research in Denmark has been strongly associated with Greenland and in Norway with Svalbard, but the science issues go east-west across the Fram Strait. To facilitate and achieve these goals, we see the following points as pertinent:

Suggestions:

- Funding cycles and structures: National and international funding possibilities
    - Differences in the timing, structures and funding models can impair multinational cooperation projects. There is therefore a need for stronger cooperation between Denmark, Norway and Greenland. Large-scale cross-Fram Strait studies are a good subject for large international studies. Joint calls for proposals and funding programmes will help in this process.
- Information exchange across the Fram Strait and internally in Svalbard and Greenland
    - The SSF-managed database Research in Svalbard (RiS) is the main tool for coordination and for maintaining an overview of research in Svalbard. As the Danish Polar Centre has been discontinued, there is currently no organisation collecting information on ongoing research in Greenland. A RiS-inspired and possibly linked database would be valuable to the research community, funding agencies and stakeholders alike.
- Ny-Ålesund basic monitoring programme.
    - Ny-Ålesund is an International science community with a high level of independence. Some science strategy had been developed and, with the help of SSF, four flagship programmes, but the overview of all research activities is limited and not regularly updated. Some duplication of measurements has been found, as well as gaps in long-term data sets.
    - Work towards establishing a Ny-Ålesund basic monitoring programme and creating a one-stop portal for long-term measurements. The individual stations take responsibility for different parts of the programme. A basic monitoring programme inspired by the Zackenberg model would ensure long-term monitoring of crucial environmental factors.
    - The SSF-initiated Ny-Ålesund flagship programmes are an integrated part of this suggestion.
    - Promote the use of existing databases (Pangaea, IPY-doc etc.) and existing standards for measurements (WMO, ICAP, GLIMS), and create new ones where needed.
- On a more regional scale, other Arctic areas must be considered. The research bases in Hornsund and Barentsburg are key factors in ensuring that research in Svalbard and Greenland is linked to the rest of the Arctic, especially eastwards.

- Identify concrete projects that could be used to initiate and strengthen cross-Fram Straight initiatives. Possible candidates include:
    - Ny-Ålesund flagship on atmospheric research and the new station at Station Nord
    - Ny-Ålesund Terrestrial flagship and the GEM monitoring in Zackenberg
- Collaboration agreements and memorandums of cooperation between GEM and SIOS.
    - SIOS strategy for collaboration, with regional-scale connections

The plans for establishing a SIOS core observation programme in and around Svalbard, and the services provided by its Knowledge Centre (knowledge management, logistics, access, education and data) should include better coordination and management of the existing international research and monitoring activities in the region. SIOS should consider and recognise the quality of the long-term research and monitoring activities performed in Zackenberg. The plans to set up a new research station at Station Nord, and the many international research and monitoring activities carried out in Svalbard, will lead to new opportunities. A coordination agreement between SIOS and GEM should be considered.

2.3 Logistics group

Establishing a high mutual level of information between logistics operators is important in relation to operational planning and best-practice exchange. Further, Economicsin Arctic logistics can produce substantial - or even huge - cost reductions. This is a very important added value of cooperation.

Suggestions:

- Establish a forum for annual information exchange on logistics issues across the Fram Strait. Such a forum could be embedded in the existing pan-Arctic project INTERACT.
- Ensure the exchange of relevant Svalbard and Greenland flight schedules and cruise plans and make them easy accessible to the scientific community.
- Look into the possibility of developing a coordinated pan-Arctic transport system for air cargo between research stations in the Arctic. This system could be based on a larger aircraft circulating around the Arctic twice every year to pick up and deliver cargo at relevant sites.

SSF can provide a webpage containing information about logistics can be collected. All institutions and organisations are responsible for sending this information to the SSF. SSF will ensure that relevant information from INTERACT (reports, minutes of meetings etc.) is made easily accessible to logisticians, scientists and stakeholders in both Greenland and Svalbard through the SSF homepage.

2.4 Workshop recommendations

The workshop concluded with a series of recommendations that would add value to the current research through increased cooperation and joint efforts. The recommendations all have the potential to fill gaps in knowledge, combine different fields of research and create more cooperation and collaboration across the largest climatic gradient in the Arctic. The recommendations will be part of the SSF priorities that are relevant in relation to strategic funding. The recommendations are (in non-prioritised order):

Ny-Ålesund basic monitoring programme

The establishment of a Ny-Ålesund basic monitoring programme inspired by the Zackenberg model would add significant value to Svalbard as a scientific platform.

Information exchange

Establishing a forum for annual information exchange on scientific and logistics issues across the Fram Strait.

Cross-Fram Strait studies

Facilitate and initiate common projects/programmes across the region and encourage exchanges of researchers and students between Svalbard and Greenland. Large-scale, cross-Fram Strait studies are good candidates for large international projects.

Joint funding programmes

Differences in the timing and structures of national funding models can impair cooperative efforts. Joint Greenlandic-Norwegian-Danish calls for funding and cooperation agreements are key to initiating international and interdisciplinary regional studies.

Develop and apply common tools/technology across sites

The continuity of long-term observations must be ensured, and monitoring and data archiving should follow international standards.

Produce a long-term observation review report/synthesis/paper for Svalbard

A review will identify gaps in the existing cross-gradient research and current monitoring in Svalbard, and help to identify new possibilities for cooperation projects.

Potential Cross-Fram Strait Research Topics

The workshop participants suggested the following examples as potential cross-Fram Strait research topics:

- Snow monitoring
- Sea ice investigations
- Melting of Greenland and Svalbard glaciers
- Sea bird observations, e.g. Ivory Gulls and their contamination by pollutants
- Vegetation (e.g. ITEX programme)
- Biodiversity in Svalbard and Greenland fjords
- Multi-location satellite validation
- Remote sensing of climate gradients on land (glaciers, permafrost, soil, vegetation etc.)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Appendix 1: Workshop participants

	Name	Institution	e-mail
1	**Christian Wiencke**	Alfred Wergner Institute, Germany	christian.wiencke@awi.de
2	**David Gremillet**	CEFE/CNRS	david.gremillet@cefe.cnrs.fr
3	**Elisabeth Cooper**	ITEX /University in Tromsø	elisabeth.cooper@uit.no
4	**Elisabeth Råstad**	Kings Bay, Ny-Ålesund	research@kingsbay.no
5	**Fred S Hansen**	UNIS	fred.skancke.hansen@unis.no
6	**Geir Wing Gabrielsen**	Norwegian Polar institute (NPI) / NySMAC	geir.wing.gabrielsen@npolar.no
7	**Georg Hansen**	Norwegian Institute for Air Research (NILU)	Georg.H.Hansen@nilu.no
8	**Hanne Christiansen**	UNIS / CENPERM	hanne.christiansen@unis.no
9	**Inger Solheim**	Norwegian Polar institute (NPI)	inger.solheim@npolar.no
10	**Jan Rene Larsen**	SAON	jan@jrl.dk
11	**Jon Børre Ørbæk**	Norwegian Research Counsil /SIOS	jbo@forskningsradet.no
12	**Josef Elster**	Centre for Polar Ecology	jelster@butbn.cas.cz
13	**Kaja H. Davidsen**	SSF	Khd@rcn.no
14	**Karoline Bælum**	SSF	kab@rcn.no
15	**Kim Holmén**	Norwegian Polar institute (NPI) /SIOS	kim.holmen@npolar.no
16	**Mads Forchhammer**	Institute for Bioscience - Arctic Research Centre, Roskilde	mcf@dmu.dk
17	**Masataka Shiobara**	National Institute of Polar Research Japan (NIPR) /NySMAC	uchida@nipr.ac.jp
18	**Masaki Uchida**	NIPR	shio@nipr.ac.jp
19	**Henrik Spanggaard Munch**	Aarhus University/Zackenberg	hsp@dmu.dk
20	**Morten Rasch**	DMU /Zackenberg	mras@dmu.dk
21	**Morten Skovgaard Olsen**	AMAP/ Danish Energy Agency	mso@ens.dk
22	**Nick Cox**	BAS/ NERC / NySMAC	nc@bas.ac.uk
23	**Niels Martin Schmidt**	Aarhus University/ Zackenberg	nms@dmu.dk
24	**Piotr Glowacki**	Polish Polar station, Hornsund	glowacki@igf.edu.pl
25	**Roland Neuber**	Alfred Wegner Institute, Germany /NySMAC	roland.neuber@awi.de
26	**Stephen Hudson**	Norwegian Polar institute (NPI)	hudson@npolar.no
27	**Vito Vitale**	Station Dirigibile Italia /NySMAC	v.vitale@isac.cnr.it
28	**Yoo Kyung Lee**	Korea Polar Research Institute (KOPRI) / Ny Ålesund	yklee@kopri.re.kr

Appendix 2: Abstracts

Improved terrestrial research collaboration between Svalbard and NE Greenland

Hanne H. Christiansen
Arctic Geology Department, UNIS, Norway. hanne.christiansen@unis.no CENPERM, Institute of Geography and Geology, University of Copenhagen, Denmark.

Research and logistics collaboration across the Fram Strait

Scientifically the area of NE Greenland and Svalbard is a highly interesting research area. This is so due as this area contains the largest climatic gradient from warm Svalbard to cold NE Greenland. Svalbard is in the Arctic the warmest area this far north, due to it extreme maritime location. N and NE Greenland is significantly colder due to its more continental climate created also due to the East Greenlandic Current exporting ice from the Arctic Basin south along the Greenlandic East coast. To be able to perform research across this gradient has so far only been possible for marine based projects, which use ships as research platforms. Presently, there is no logistical collaboration and thus no logistical coordination of projects that wants to work in both of the terrestrial ends of this gradient. Thus such research projects become extremely expensive, difficult to perform and very time consuming to plan and run. So sharing large-scale and/or expensive scientific equipment across this gradient is thus close to impossible. This is a pity, and hopefully the planned workshop could start some kind of cooperation primarily on logistics, as we already have some research projects that include this entire region and typically more, and to make this region more attractive as a key Arctic research region. If a joint logistical platform could be provided, most likely this rather important geographical research area would become much more attractive to work in. Such a platform could consist of (as a minimum) an overview of flights in the region, potentially direct summer flights between the two areas (most likely from Longyearbyen airport via Station Nord and/or Danmarkshavn to Zackenberg) but potentially simply a summer flight connection between Svalbard and N Greenland, and then researchers could simply use the domestic flights in Svalbard and Greenland to get to different research areas/stations/sites. If such a joint Greenland-Svalbard logistical platform would exits, this would then most likely also call for some exchange of information and data. As it is today, SSF exist in Svalbard and Greenland has different station platforms informing about activities. However, simply combining what is already there would probably work as a start. Research and monitoring data from both areas are already in or on their way to national, but primarily international databases, so there should be no direct need for developing any new databases.

Monitoring and research in Zackenberg and in Svalbard.

It is very useful to have long-term, well organized monitoring programmes as is exiting at Zackenberg with all the Basis programmes, some of which are already providing more than 10 years of data. Data is organized in a database and available to all, so clearly a very good background for performing research. In Svalbard there is also long-term monitoring, but it is not yet coordinated into one programme. Potentially the SIOS observation system will in the future provide this. However, Svalbard is geographically a much larger research area, and not delimited to one drainage area as Zackenberg is. Thus a system will have to be much larger than in Zackenberg. To initiate new research in Zackenberg, your project research activities will be 'controlled' by all the basis programmes despite it already being funded and thus evaluated scientifically. This means that several research projects have been either rejected from operation in Zackenberg if their activities do not comply with all the different Basis programme activities, or reduced in their activities. So in reality this means that the monitoring programmes control the research activity. This management structure prioritizes the monitoring to research.

Logistics in the two sites

Presently the two sites are operating very differently with respect to logistical support. In Zackenberg the logistical staff is the safety staff as well and have control on all researchers incl. that they have the necessary safety training to handle riffles and signal pistols, when working at Zackenberg. It is largely also the same staff that is responsible for the travel to and from Zackenberg, cargo transport and payments for the use of the Zackenberg Research station. In Svalbard researchers have to find out themselves how to get safety training, organize it, book their travel to and from Svalbard and organize their accommodation, plus internal transport in Svalbard if needed. Again the difference is mainly due to the size of the research areas, Zackenberg being a smaller research station designed for a maximum of 20 scientists, while Svalbard has several different research bases, stations and areas with various facilities.

Impact of warming on *Nostoc* colonies (Cyanobacteria) in a wet hummock meadow, Svalbard

Josef Elster[1,2*], Jana Kvíderová[1,2*], Tomáš Hájek[1,2], Kamil Láska[1,4] and Miloslav Šimek[1,3]

[1]Centre for Polar Ecology, Department of Ecosystem Biology, Faculty of Science, University of South Bohemia, Branišovka 31, České Budějovice, Czech Republic, jelster@butbn.cas.cz [2]Institue of Botany ASCR, Třeboň, [3]Institute of Soil Biology, Biology Centre AS CR, České Budějovice [4]Masaryk University, Faculty of Science, Brno,

In order to simulate the warming effects on Arctic wetlands, three passive open-top chambers (OTCs) and three control cage-like structures (CCSs) equipped with soil temperature and soil volumetric water content (VWC) probes for continuous microclimatic measurements were installed in a wet hummock meadow, Petuniabukta, Billefjorden, Central Svalbard, in 2009. The warming effects on primary productivity were investigated in cyanobacterial colonies of *Nostoc commune* s.l., which plays an important role in the local carbon and nitrogen cycles, during summer seasons 2009 and 2010. The microclimatic data indicated that the effect of OTCs was dependent on micro topography. During winter, two short-term snow-thaw episodes occurred, so that liquid water was available for *Nostoc* communities. Because of the warming, the OTC hummock bases remained unfrozen three weeks longer in comparison to the CCSs and, in spring, the OTC hummock tops and bases exceeded 0°C several days earlier than CCS ones. Mean summer temperature differences were 1.6°C in OTC and CCS hummock tops, and 0.3°C in OTC and CCS hummock bases. The hummock tops were drier than their bases; however the VWC difference between the OTCs and CCSs was small. Due to the only minor differences in the microclimate of OTC and CCS hummock bases, where the *Nostoc* colonies were located, no differences in ecophysiological characteristics of *Nostoc* colonies expressed as photochemistry parameters and nitrogenase activities were detected after two years exposition. Long-term monitoring of *Nostoc* ecophysiology in a manipulated environment is necessary for understanding their development under climate warming.

Environmental and geophysical monitoring at polish polar station in Hornsund

Piotr Glowacki[(1)], Adam Nawrot[(1)], Bartlomiej Luks[(1)]
[(1)] Institute of Geophysics Polish Academy of Sciences, Ksiecia Janusza 64, 01-452 Warsaw, Poland, glowacki@igf.edu.pl

Polish Polar Station is located in Hornsund (77°00'N, 15°33'E), southernmost fiord of Spitsbergen island. Station was established in 1957. Since 1978 it conducts all year round environmental and geophysical monitoring. This station is one of very few in polar regions and northernmost of all.

Main environmental monitoring research consists of:

Meteorology – meteorological station (number 01003) in Hornsund works as part of World Meteorological Organization network. Automatic meteorological observations are doubled by 2 qualified meteorological observers and sent to WMO data centre every 4 hours.
Precipitation chemical composition - samples are taken from every precipitation event (rain and snow). Additionally after every heavy snowfall, snow samples are collected in vertical profile at Hansbreen glacier. All chemical analyses are conducted in station's chemical laboratories. Analysis include: specific conductivity, pH and HPLC chromatography (Na^{+}, K^{+}, NH_4^{+}, Ca^{2+}, Mg^{2+}, F^{-}, Cl^{-}, NO_3^{-}, NO_2^{-}, Br^{-}, SO_4^{2-}).
Hansbreen glaciological monitoring – Surface velocities are measured at 17 ablation stakes, covering accumulation and ablation zones of Hans glacier (56 sq. km). Snow depth measurement for mass balance calculations are taken at same stakes. All measurement are taken twice a month (weather depending), except stake IV (Equilibrium Line - ELA), where permanent all year round Differential GPS unit and Automatic Weather Station are installed.
Atmospheric aerosols and steam concentration monitoring (LiDAR) – since 2010 Polish Polar Station using Light Detection and Ranging (LiDAR) methods. Measurements are taken several times per month (weather depending). Pollutant sources are defined for each event with air masses back trajectories calculated with HYSPLIT model (HYbrid Single-Particle Lagrangian Integrated Trajectory). Modelling is based on collected data and GDAS (Global Data Assimilation System) archives.
Radionuclides monitoring - Radioactive monitoring of radionuclides at ground level air is done at Polish Polar Station at Hornsund –Spitsbergen using high volume aerosol sampling station AZA 1000 built in former Institute for Nuclear Studies, since 2002.
Ornithology – Since late 80's ornithologists from University of Gdansk, have been working on the biggest at South Spitsbergen *Little Auks* colony. Research focus on ecology and birds behaviour.

Main geophysical monitoring research consists of:
Seismology – permanent monitoring of Earth and Glacier quakes using network of ground seismometers and one broadband seismometer.
Terrestrial magnetism – Since 1978 Hornsund Station belongs to IAGA (International Association of Geomagnetism and Aeronomy) network. In 2002 observatory joined world network of digital geomagnetic observatories INTERMAGNET (International Real-time Magnetic Observatory Network). Currently, the observatory records continuous digital data on three components of the intensity of the geomagnetical field, sampled every second. From digital recording of indirect values, as well as from absolute measurements of field elements, direct values are calculated of the horizontal component X, directed to geographical north; horizontal component Y, directed to geographic east; and the vertical component Z.
Atmospheric aerosols and steam concentration monitoring (LiDAR) – since 2010 Polish Polar Station using Light Detection and Ranging (LiDAR) methods. Measurements are taken several times per month (weather depending). Pollutant sources are defined for each event with air masses back trajectories calculated with HYSPLIT model (HYbrid Single-Particle Lagrangian Integrated Trajectory). Modelling is based on collected data and GDAS (Global Data Assimilation System) archives.
Ionosphere – Space Research Centre of Polish Academy of Sciences conducts monitoring of ionospheric activity. All data from Hornsund Station are send to IDCE (Ionospheric Despatch Centre in Europe).
A**tmospheric electricity** - Since 1989 Polish Polar Station started permanent monitoring of atmospheric electricity parameters, like: magnetic field strength and Maxwell current density**.**

Studying seabird responses to arctic climate change – the importance of multisite, long-term approaches

David Grémillet[(1)]
[(1)]*Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, 1919 route de Mende, F-34292 Montpellier, France , E-mail:david.gremillet@cefe.cnrs.fr*

Abstract

Understanding how Arctic organisms cope (or not) with climate change is a major goal, which I have been pursuing in collaboration with French, Norwegian, American, Polish, British and Danish colleagues over the past ten years. We focus on seabirds, especially in little auks (*Alle alle*), which are an important component of Arctic marine food webs and a good indicator species of the impact of global warming since they feed on zooplankton (mainly copepods) and hence participate in a very short food web. With support from the French Polar Institute, the US National Science Foundation and the Research Council of Norway, we have been studying responses of little auks to a gradient of ocean temperatures across the Greenland Sea, with a focus on three study sites: Kap Hoegh (East Greenland), Hornsund (Svalbard) and Kongsfjorden (Svalbard). We want to understand how little will cope with warmer oceanic conditions in the 21st century, but since we cannot wait for decades to study this phenomenon in time we study it in space: indeed, there is currently a >5°C sea surface temperature gradient in summer between our coldest study site in Greenland and the warmest on Svalbard, due to contrasted ocean circulation. Such temperature changes profoundly alter little auk foraging conditions since colder water favour larger, lipid-rich copepods, whereas warmer water favour smaller, leaner copepod species which are far less profitable to foraging little auks. Using this natural experiment, we investigated all key parameters of little auk ecophysiology in parallel at the three study sites and in three years (2005, 2006 and 2007) using standardized protocols for (1) adult diet, through sampling of the prey items brought back to the colony by the birds, (2) adult foraging behaviour using miniaturised electronic devices recording flight and diving activity, (3) adult energy expenditure with the doubly-labelled water technique, (4) chick growth rates and reproductive performance, (5) adult body condition, and (6) adult survival via a capture-mark-recapture study. Contrary to our prediction, little auks showed an astonishing capability to buffer contrasted sea surface temperature conditions across our study area: they altered their diet; feeding predominantly on larger, fat-rich copepods in colder waters and on smaller, leaner copepods in warmer water. Crucially, they also doubled their foraging effort in warmer waters compared to colder waters, yet managed to keep their overall energy expenditure at the same level, probably through a reorganisation of their daily time budget. The reproductive performance of adult birds, their body condition and year-to-year survival remained unaffected by different ocean temperature conditions.

Our case study therefore strongly suggests that little auks have the capacity to buffer the impact of >5°C sea-surface warming in the North Atlantic, and it demonstrates the great importance to study the ecological impact of climate change over a network of Arctic field sites. Further, our multisite design is a surrogate for a longitudinal study of the impact of climate change on marine planktivorous species such as little auks, but it certainly does not replace long-term ecological studies. My conclusion is that we have to work towards establishing and maintaining international networks of long-term ecological studies aiming at evaluating the impact of environmental change on Arctic organisms in space and time.

Reference (click on title to access PDF):

Gremillet, D., Welcker, J., Karnovsky, N.J., Walkusz, W., Hall, M.E., Fort, J., Brown, Z.W., Speakman, J.R. & Harding, A.M.A. (2012). Little auks buffer the impact of current Arctic climate change - Marine Ecology Progress Series 454: 197-206.

Comparison of AT-50 and M-80 Russian radiation instruments to modern sensors specified by the Baseline Surface Radiation Network (BSRN) program: Implications for utilizing historical Russian radiation records for climate research

Vasilii Y. Kustov[(1)], A.P. Makshtas[(1)]
[(1)] [1]Arctic and Antarctic Research Institute, Saint Petersburg, Russia, Bering str. 38:kustov@aari.ru

Abstract

The Baseline Surface Radiation Network (BSRN) Program was developed in 1992 to provide a worldwide network to continuously measure short-wave and long-wave radiative fluxes at the Earth's surface with standardized and rigorously calibrated measurements suitable for climate monitoring. As of 2008 BSRN had 43 stations reported. The Former Soviet Union operated 160 actinometric stations starting in 1955 with similar motivations of characterizing solar direct and diffuse radiation properties for environmental monitoring. In Tiksi, Russia at the new International Hydrometeorological Observatory, radiation measurements are being made with both standard Russian radiation sensors and a full BSRN suite of sensors. This study presents inter-comparison of the measurements of direct, total, and diffuse solar radiation. These results had be used to evaluate the usability of the extensive and multi-decadal Russian radiation network as a foundation for long-term Arctic climate studies.

Sustaining Arctic Observing NetworkS (SAON) – expectations in Arctic Council for a future coordinated data collection in the Arctic

Jan René Larsen[(1)]
[(1)]SAON Secretary, AMAP Deputy Executive Secretary, Gaustadalléen 21, N-0349 Oslo, Norway, E-mail: jan.rene.larsen@amap.no

SAON Mandate and Vision

"Recognize the importance of the Sustaining Arctic Observing Networks (SAON) process as a major legacy of the International Polar Year for enhancing scientific observations and data sharing" (Ministerial Meeting Declaration, Nuuk, December 2011)

SAON promotes the vision of well-defined observing networks that enable users to have access to free, open and high quality data that will realize pan-Arctic and global value-added services and provide societal benefits. Attaining this vision, requires an enhancement of Arctic-wide observing activities through coordination and integration and to promote sharing and synthesis of data and information.

SAON Priority Area: Data Management

SAON should help arctic observing networks advance and sustain toward providing ethically open, well-described, useful, well-preserved data.

Relevant SAON Tasks (projects):

- Polar Metadata Profile and Recommended Vocabularies
- Role of Remote Sensing in Arctic Monitoring
- Establishing an Arctic network on environmental monitoring of hazardous substances
- Polar data and information management principles and practice
- Coordination of existing Arctic relevant Meta-databases and Project Directories
- INTERACT
- A Research Coordination Network for Very Interdisciplinary Arctic Data and Information

Characteristics of vegetation, microbes, and soil following snow/glacier melting disturbances in Svalbard

Ji Young Jung[(1)], Kyoo Lee[(2)], Ok-sun Kim[(1)], Hye Young Kwon[(1)], Dong Uk Han[(2)], Eun Ju Lee[(2)], **Yoo Kyung Lee***[(1)]

[(1)] Division of Life Sciences, Korea Polar Research Institute, 12 Gaetbeol-ro, Yeonsu-gu, Incheon 406-840, Korea
[(2)] School of Biological Science, Seoul National University, 56-1 Shillim-dong, Kwanak-gu, Seoul 151-742, Korea,

Rapid melting of snow and/or glacier in early spring in high Arctic can lead to massive water movements temporarily. As the global warming may accelerate this melting, it is essential to advance our understanding of consequences of melting disturbances on ecosystems. Thus, the objective of this study is to understand the characteristics of vegetation, microbes, and soil in the affected areas with different disturbances intensities in Svalbard. Soil was collected from three sites (High: outside of glacial moraine; Mid: a reference site; Low: influenced by snow/glacier melting water) near Vestre Lovenbreen in August 2011. Plant cover and aboveground biomass were measured, soil bacteria community structure was investigated through pyrosequencing, and several soil physical and chemical properties were analyzed. Aboveground biomass in the High site was comparable to that in the Mid site where the aboveground biomass was the highest. Soil organic carbon (SOC) was the highest in the Mid site (127.3 mg C g-1 soil). Microbial community analysis and other soil chemical properties are under way. After combining all processed data, we expect to describe the characteristics of abiotic and biotic components in high Arctic and to explain the effects of snow/glacier melting on ecosystem establishments.

Lessons learned from the monitoring at Zackenberg

Niels Martin Schmidt [(1)], Morten Rasch[(2)]

[(1)]Arctic Research Centre, Department of Bioscience, Aarhus University, Frederiksborgvej 399, DK-4000 Roskilde, nms@dmu.dk [(2)] Department of Bioscience, Aarhus University, Frederiksborgvej 399, DK-4000 Roskilde, mras@dmu.d

Status of the monitoring at Zackenberg

The ecosystem-based monitoring program Zackenberg Basic was established in 1995 and fully implemented in 1996. The program initially consisted of four subprograms (ClimateBasis, GeoBasis, BioBasis and MarinBasis), but was supplemented with the GlacioBasis subprogram in 2009.

From the very start the monitoring within Zackenberg Basic had a true ecosystem approach. Hence, the monitoring encompasses a host of abiotic and biotic compartments and processes. This approach enables Zackenberg Basic to determine the linkages between the various ecosystem compartments and the feedback mechanisms, and hence allows for a more holistic evaluation of the status and trends in the ecosystem.

Since its implementation, Zackenberg Basic has developed continuously through internal and external evaluations, and through the continuous dialogue between the people involved in monitoring, the people involved in research, and the relevant stake holders (Figure 1). This adaptive monitoring approach has helped focusing both the monitoring programs and the research projects at Zackenberg. The inter-disciplinary, inter-institutional approach is also evident in the newly approved strategy for the period 2011-2015.

Zackenberg Basic has been highly successful in securing funding for running the monitoring programs, though still funded on an annual basis, as well as for the infrastructure.

Organizational development and networks

Initially, a ZERO working group was established as an inter-disciplinary, inter-institutional forum coordinating the monitoring and research activities at Zackenberg. This structure was altered in 2007 with the establishment of the overarching program Greenland Ecosystem Monitoring (GEM) (Figure 2). GEM initially covered 2 localities (Zackenberg and Kobbefjord at Nuuk), but is currently being expanded to include 2 more Greenlandic stations (Arctic Station and Sermilik Station). Hence, through coordinated monitoring efforts GEM is increasingly capable of scaling up central ecosystem parameters. The scaling capacity will also in the strategy period 2011-15 be increased through shorter-term field campaigns in relevant geographical areas of Greenland, as well as increased focus on remote sensing and modelling.

Zackenberg Basic already participates in a large number of international networks (e.g. CALM, ICOS, ITEX, CBMP), and will continue to do so actively. Zackenberg Research Station is also a central member of the Scannet / InterAct station network.

Collaboration outlook

Both in terms of research and logistics, Zackenberg Basic could benefit from a close collaboration with SIOS. Coordinated monitoring activities at two high arctic sites as well as the possibility for making comparable research studies at the two sites would be highly beneficial for both sites.

Atmospheric measurements operated by NIPR in Ny-Ålesund for monitoring greenhouse gases, aerosol and clouds

Masataka Shiobara[(1)] and Shinji Morimoto[(2)]
[(1)]*National Institute of Polar Research, Midoricho 10-3, Tachikawa, Tokyo 190-8518, JAPAN, E-mail: shio@nipr.ac.jp*

Abstract

National Institute of Polar Research (NIPR) operates the atmospheric measurements in Ny-Ålesund for monitoring greenhouse gases, aerosol and clouds on a long-term continuous basis since establishing a Japanese research base at Rabben in 1991.

To elucidate temporal variations of the atmospheric greenhouse gases and their sources and sinks, we have maintained systematic observations of the concentrations of CO2, CH4, N2O and SF6, the stable isotope ratios of CO2, CH4 and O2/N2 ratio by using weekly air samples collected at Rabben. Recently, we started continuous measurement of the atmospheric CO2 concentration and O2/N2 ratio at Rabben station. We have a plan to set up a Cavity Ring Down Spectroscopy (CRDS) system at the station to start continuous measurement of the atmospheric CO2, CH4 and CO concentrations in the spring of 2013.

For long-term monitoring of the aerosol optical properties and the cloud appearance statistics, we are operating ground-based remote-sensing instruments including a Prede POM-02 Sky-radiometer (SRM), a Prede PSV-100 All-sky camera system (ASC), and a NASA-upgraded SESI Micro-pulse Lidar (MPL). SRM acquires spectral data of the direct solar attenuation and the sky brightness distribution. ASC acquires jpeg data of all-sky images. Both SRM and ASC are placed on the rooftop of Rabben station. MPL acquires vertical profiles of backscatter signal at 523 nm wavelength from zenith-suspended aerosol and clouds with one minute interval and 30 m range resolution. MPL is operated at the AWIPEV station as a unique Arctic site of MPLNET. To strengthen cloud studies, we employ a polarization MPL and a 95GHz cloud radar to start collocated measurements in 2013 at Rabben.

The atmospheric monitoring is essential for climate change research, and international collaboration is indispensable. It is important to exchange information on the measurement and data available for collaborative research works, and also to share efforts to maintain long-term monitoring measurements among research communities.

Monitoring observation at Japanese station

Masaki Uchida[(1)]
[(1)]National Institute of Polar Research, 10-3, Midori-cho, Tachikawa-shi, Tokyo 190-8518, JAPAN, E-mail:uchida@nipr.ac.jp

NIPR has started monitoring observation since the early 1990s. Mainly, scientists of atmospheric science and terrestrial biology monitors GHGs, cloud and vegetation condition in Ny-Ålesund. Since NIPR does not employ a station manager, almost monitoring observations have help from other station's people, especially NPI and AWI. So other station's cooperation is vital for us.

Although Japanese station will move into the town in the future, some monitoring observations would like to stay at Rabben to avoid contamination. Therefore, we will rent a part of current station even after we move into the town. Similar case is occurred for upper atmospheric observation. Since there are many lights in the town, it is hard to monitor upper atmospheric observation. Kings Bay kindly gave us offered to build shared observation facility outside of the town. I think that this Kings Bay's idea will support future monitoring system in Ny-Ålesund.

For my case, our group set five permanent plots of 1 m x 1 m quadrat in Ny-Ålesund to monitor vegetation change by one square centimetre resolution. We observe species and coverage change of vegetation every four or five years.

The AWIPEV underwater observatory at Ny-Ålesund, an important monitoring station for shallow-water biological investigations

Christian Wiencke [1], Philipp Fischer[(2)], Ragnhild Asmus[(3)]
[(1)]Department Seaweed Biology, Section Functional Ecology, Alfred Wegener Institute, Am Handelshafen 12, D-27570 Bremerhaven, Germany, E-mail:christian.wiencke@awi.de [(2)] Center for Scientific Diving, Biologische Anstalt Helgoland, Alfred Wegener Institute, Kurpromenade 207, D-27498 Helgoland, Germany, E-mail:philipp.fischer@awi.de
[(3)] *Section Functional Ecology, Coastal Ecology, Wadden Sea Station, Hafenstraße 43, D-25992 List/Sylt, Germany, E-mail: ragnhild.asmus@awi.de*

In June 2012, the AWIPEV underwater monitoring station was established in the near shore waters close to Ny Ålesund according to the plan outlined in: 'The Kongsfjorden System – a flagship programme for Ny Ålesund 2008". The aim of this project is a year round long-term online underwater monitoring of the fjord ecosystem at the Old Pier in Kongsfjorden. The station comprises a remotely controlled FerryBox, equipped with front-end sensoric measuring salinity, oxygen, turbidity, chl-a, fluorescence and pH with 1Hz year round in 12 m water depth. It comprises also a profiling underwater unit (10 – 3 m) with a CTD and ADCP measuring temperature, salinity, depth, turbidity (Seapoint), oxygen (optode, Anderraa), chl-a fluorescence (Turner), also with 1 Hz current. The underwater system is also equipped with standard video and a state-of-the-art 3D videogrammetric camera system allowing the assessment of temporal and spatial dynamics of processes on different levels of the food web incl. top predatory fish, crustaceans and jellyfish in near shore waters.

Without any doubt, there are large gaps in the knowledge of the abiotic and biotic processes in the Arctic. This is mainly due to the restricted access of sampling and measuring technology for hydrographic and biotic data because of ice coverage and temporally limited access to the field. Over the last decade, technology has made large steps in remote operated sensor systems which are nowadays operated or at least under construction all over the world. These systems, if working properly, provide data in a temporal resolution which has NOT been possible so far but has been spotted as most crucial for understanding, modelling and also finally forecasting possible scenarios e.g. with respect to environmental changes due to climatic change.

The Arctic Sea is, according to the present climate models, prone to climate change but also quite challenging when coming to the required data assessments. With the new technologies developed over the last decade, we are now able to close these gaps in data assessment and therefore also significantly increase our understanding in the processes within the Arctic system. The first half year of operation of the fjord observatory already revealed data which have not been available so far. The data especially show a temporal dynamic in hydrographic (i.e. temperature and salinity) and ecological data (fish and jellyfish occurrence), which provided new insights in the dynamic and functioning of the system. Together with other short–term sampled data from deeper water layers and the open sea, these year round available long-term data sampled continuously with 1 Hz in front of the Old Pier provide a unique insight a polar system and the underlying processes.

Appendix 4: Workshop programme

11:45	Pickup from Kastrup Airport
13:00-13:45	Lunch at Sonnerupgård
13:45-14:15	Check-in
14:15-16:00	Session 1, introduction
16:00-16:15	Coffee break
16:15-18:30	Session 1, introduction
19:00-	Dinner

Wednesday 6/2 2013

07:30-08:30	Breakfast
08:30-10:00	Session 2, Introduction and topics for the group discussions Group 1: Large scale coordination and management Group 2: Logistics Group 3: Scientific cooperation
10:00-10:15	Coffee break
10:00-13:00	Session 3, group discussions
13:00-13:45	Lunch
13:45-15:00	Session 3, group discussions
15:00-16:00	Walk in the woods and park around Sonnerupgård
16:00-16:15	Coffee break
16:15-18:30	Session 3, group discussions
19:00-	Dinner

Thursday 7/2 2013

07:30-08:30	Breakfast and check-out
08:30-10:00	Session 4, results from group sessions
10:00-10:15	Coffee break
10:00-13:00	Session 5, recommendations for the report
13:00-13:45	Lunch
13:45-14:45	Session 6, Sum up and conclusions
15:00-16:00	Transport to Kastrup airport