2004

POLAR RESEARCH IN TROMSØ

EDITORIAL
RESEARCH NOTES
PROFILE
IN BRIEF
RECENT DOCTORATES
USEFUL CONTACTS

POLARMILJØSENTERET

Svalbard draws attention

US Senators John McCain and Hillary Clinton have been there. The EU Minister of the Environment was there. Ministers of the Environment from all over the world have visited. The Norwegian Crown Prince was there a couple of years ago. Scientists go there. High-ranking members of various international boards and committees visit regularly. Norwegian politicians make their way up quite frequently. Where to? Svalbard, of course. The archipelago between 74° and 81° northern latitude where so much Norwegian and international polar research takes place. Although *Polar Research in Tromsø* presents polar activities and disseminates new knowledge with Tromsø as its origin, much of the field work is carried out in Svalbard.

Climate Change: Investigating the Arctic

In November 2004 the Arctic Climate Impact Assessment (ACIA) Overview report was released. The main scientific report is yet to come, with contributions from Tromsø-based scientists affiliated with the University of Tromsø (Alf H. Hoel, Rolf A. Ims and Siri Kvernmo), the Norwegian School of Veterinary Science (Svein D. Mathiesen) and the Norwegian Polar Institute (Kit M. Kovacs). Norway has put substantial effort into the ACIA process, which defines the Arctic broadly, including the Svalbard archipelago and the three northernmost counties in Norway. The national ACIA secretariat is situated at the Norwegian Polar Institute, and the NPI is also responsible for the follow-up of the reports. We foresee exciting times ahead, which will bring more attention and more resources to Arctic research.

IPY – an ocean of opportunities

We should also remember that the International Polar Year 2007-08 (IPY) is right around the corner and is expected to inspire major scientific projects. Much of the research during the IPY is expected to focus on the oceans, and Norway has a long tradition related to various forms of marine research. We hope to be able to report on much work done along this path in future editions of *Polar Research in Tromsø*. In the meantime, we hope you enjoy this issue, where we present results achieved in 2004.

Tromsø, January 2005,
The editors

Polar Research in Tromsø

Polar Research in Tromsø is published once a year by the Roald Amundsen Centre for Arctic Research at the University of Tromsø, the Norwegian Polar Institute and the Polar Environmental Centre, Tromsø, Norway. Its aim is to describe all manner of education and research in polar (chiefly Arctic) studies at these institutions and at those research institutes and companies in the Tromsø area with which these have close ties.

It is sent on request and free of charge to all persons who are interested in polar studies.

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Historical trends in contaminant supply to Lake Ellasjøen, Bjørnøya, Norway

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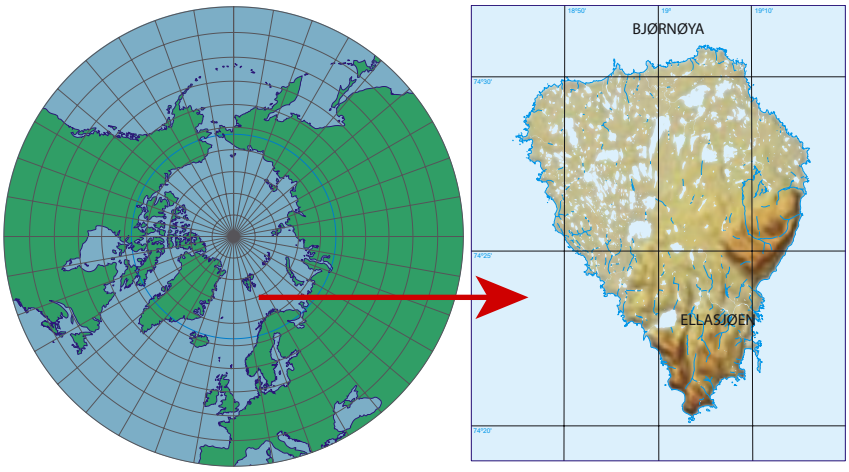
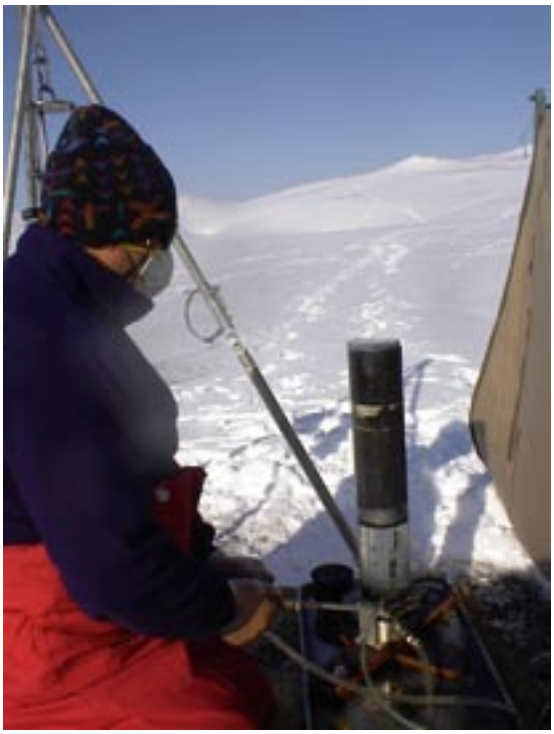


Figure 1.
Map illustrating the localisation of Bjørnøya with Lake Ellasjøen.



Sediment sampling in Lake Ellasjøen, Bjørnøya.

During recent years, multidisciplinary studies have been carried out on Bjørnøya (Figure 1) to elucidate the presence and fate of persistent organic pollutants in this remote and heretofore considered pristine Arctic environment. Some of the highest concentrations of persistent organic pollutants (POPs), e.g., polychlorinated biphenyls (PCBs) and dichlorodiphenyl-dichlorethane (DDE), ever measured in the Arctic have been found in sediment and biota from Ellasjøen, Bjørnøya. It has also been recently shown that levels of presently-manufactured compounds, such as brominated flame retardants are high in biota from the lake.

An important issue regarding contaminants in the Arctic is to determine historical patterns of contaminant deposition. This is best addressed through analyses of sediment cores from the limnic environment. In a sediment core, the uppermost layers represent the most recent inputs, and the lower sections are older. If the core is long enough, the deeper sediments can represent pre-industrial times. In order to assess the input of selected POPs to Lake Ellasjøen over time, we undertook an investigation of sediment accumulation rates and contaminant concentrations in one sediment core from the lake. The core was dated by using the two independent radiotracers 137Cs and 210Pb. Selected depth intervals of the core were analysed for PCBs, DDT, brominated flame retardants (polyBDEs and HBCDDs) and heavy metals.

The results from the sediment dating showed that the sedimentation rate is relatively high in Lake Ellasjøen, compared to other Arctic lakes. The sedimentation rate was estimated to be 0.7 mm/year, or 620 g/m^2/year. Relatively high organic carbon content (5.96 %) was also measured in the sediment. The high sedimentation rate and the high organic carbon content are caused by enhanced production in the lake due to input of nutrients from seabird guano.

High concentrations of PCB and DDT were measured in the sediment. The concentrations of these contaminants increased from the 1920s until the 1970s (max. sum PCB 94 ng/g dry weight (dw), max. sum DDT 4.0 ng/g dw) (Figure 2). From the 1970s the concentrations of PCB and DDT have decreased, and are currently 62 ng/g dw and 1.6 ng/g dw, respectively, in surface sediment. It is clear from this data that regulations regarding pro-

duction and use of PCB and DDT enforced in the beginning of 1970s have resulted in a decreased input of these contaminants to Lake Ellasjøen.

Polybrominated diphenyl ethers (polyBDEs) were also detected in the sediments (sumBDE in surface sediment 0.73 ng/g dw). The concentration of polyBDEs has increased in recent years. Generally, the concentration in sediment from Lake Ellasjøen has doubled every 15 years since the introduction of these chemicals (Figure 3). However, levels of another brominated flame retardant, hexabromocyclododecane (HBCDD) were low.

For most of the metals (arsenic, cadmium, cobalt, nickel, zink and chromium), the concentrations increased from pre-industrial time (reference sediment) up to 1970. Thereafter the concentrations have decreased. Lead and vanadium did not show any clear trends over time. The levels of mercury increased gradually from pre-industrial time and to the present. The highest enrichment factors (concentration in surface sediment/concentration in reference sediment) were recorded for cobalt and nickel with 3.92 and 2.76, respectively.

The levels of PCB and DDT in the environment are mostly a legacy of past emissions, and given enough time they will decline. However, the results from this study indicate that the levels of some contaminants that are still in use are increasing. The Arctic acts like a sink for persistent contaminants transported over large distances by air streams and ocean currents. From large-scale assessment studies (e.g. the Arctic Monitoring and Assessment Programme (AMAP)), it has become evident that the pollution is not evenly distributed in Arctic areas, but that due to unique transport pathways, some areas contain (receive) more contaminants than others (so-called "hot-spot" areas). The high levels of contaminants that are found in Ellasjøen make this lake ideal for monitoring long-term trends. Information about the development in the contaminant status in Arctic areas is very important to managing authorities in developing international conventions regarding production and use of new contaminants, as well in the assessment of already enforced restrictions.

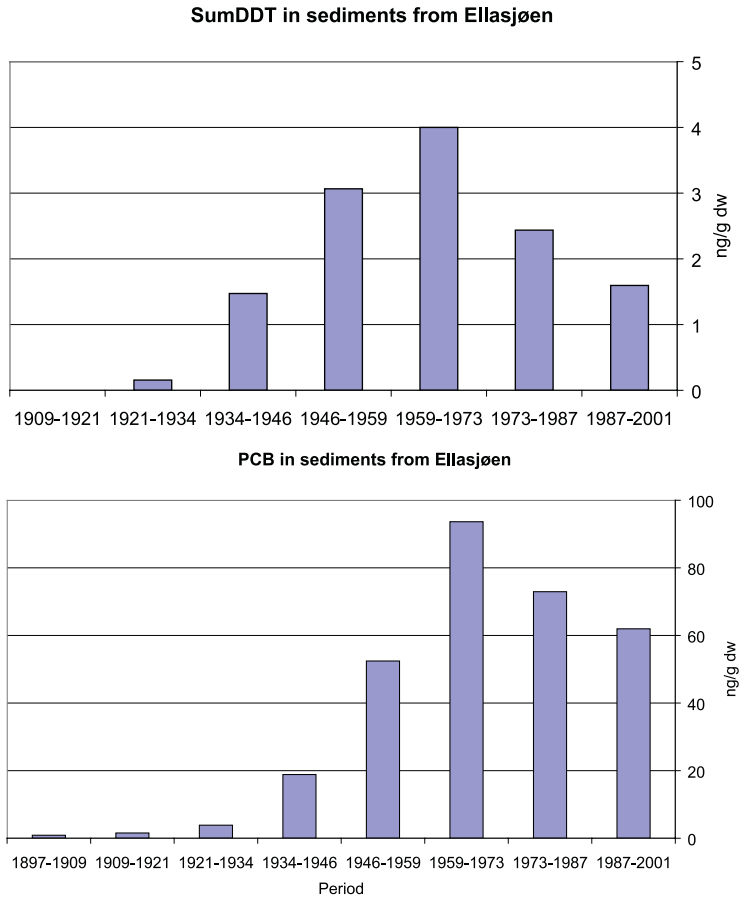


Figure 2. Temporal trends in concentrations of ΣDDT and ΣPCB in sediment from Lake Ellasjøen, Bjørnøya.

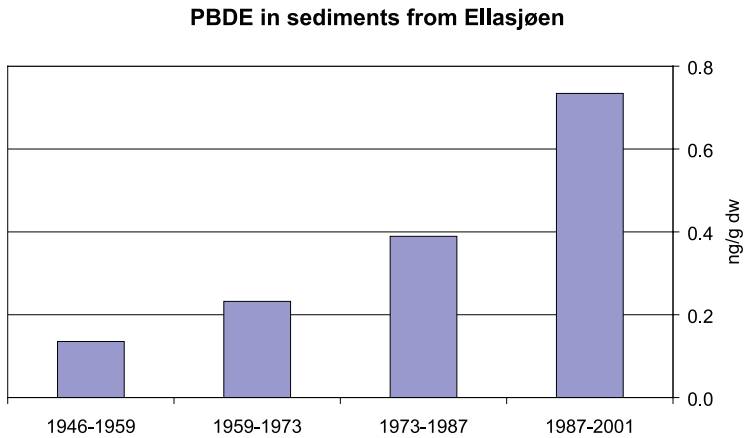


Figure 3. Temporal trends in concentration of sum polyBDE (ng/g dry weight) in sediment from Ellasjøen, Bjørnøya.

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Assessing the effects of offshore discharges from the petroleum industry on cold-water zooplankton

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Exploration and development of petroleum reserves is moving further north into areas that are viewed as highly susceptible to environmental perturbations caused by human impacts. To responsibly develop the Arctic's vast natural resources, we must know the effects of oil-related discharges on individual species and how petroleum-associated components affect ecosystem processes.

Crustacean zooplankton such as e.g. copepods and euphausiids form the keystone link between primary producers and fish stocks in the Arctic. However, field-based attempts to assess the responses of zooplankton to operational petroleum discharges have not yet been successful and hence we know very little of the sublethal tolerance and response of zooplankton to this type of stress. A multi-generation cultivation system has been established as a means of studying such long-term biological effects.

Conditions for maintaining cultures of *Calanus finmarchicus* in the laboratory were established at the Tromsø Aquaculture Research Station (Kårvika facility). The system was developed by scientists at Akvaplan-niva, Polar Environmental Centre, Tromsø, together with the Norwegian Institute for Water Research in Oslo. The work was sponsored by The Research Council of Norway through the programme "Long term effects of discharges to the sea from the offshore sector", which addressed the sensitivity of arctic ecosystems to oil and chemicals from the petroleum industry.

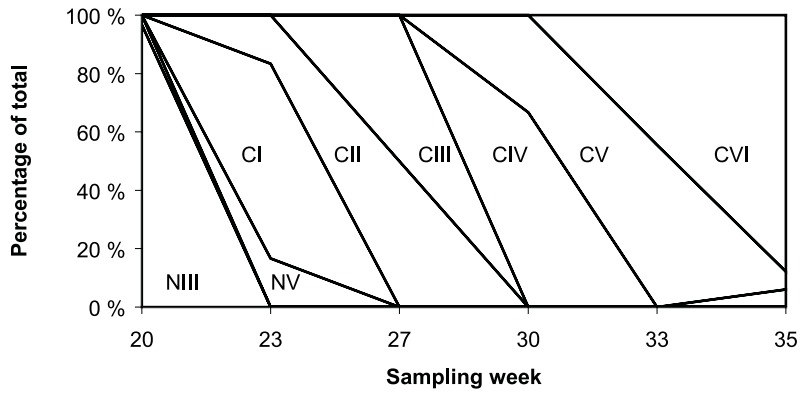

Figure 1: Stage development of *Calanus finmarchicus*. Eggs were collected in week 18 from maternal cultures, and the development was monitored through nauplie stages (NIII-NV) and copedodites (CI-CVI) until most were adults (CVI).

The main emphasis is on the cold-water species *C. finmarchicus* as this copepod species is ecologically the most important zooplankton species along the Norwegian shelf and in the southern part of the Barents Sea. Animals were collected in Grøtsund near Tromsø and transferred to the facility where they were maintained under controlled temperature and light regimes.

A series of manipulation experiments were performed using the cultivation system and effects on food assimilation, and egg and fecal pellet production were studied in order to establish the optimum conditions for the maintenance of *C. finmarchicus* cultures in the laboratory. An additional aim was to control the egg production of females so that sufficient quantities of eggs would be available to conduct ecotoxicological investigations. Based on the results, sustained egg production over time was achieved by feeding *C. finmarchicus* a combination of two different species of diatom (*Chaetoceros socialis* and *Thalassiosira weisflogii*). Hatching success correlated with food concentration offered to adult females with optimal concentrations resulting in a high hatching percentage for eggs (mean±st.dev. = 91.9 ± 6.8 %).

Using the methods thus established for handling zooplankton cultures in the laboratory, a population of *C. finmarchicus* was successfully maintained and monitored through all stages (Eggs – CVI (adults) – Eggs) (Figure 1). Preliminary ecotoxicology experiments have been performed using these cultures, thus demonstrating that this system will provide a useful tool for advancing the understanding of long-term biological effects of operational discharges from the petroleum industry.

Figure 2: Adult female of *Calanus finmarchicus*. An egg is visible on the urosome.

Ny-Ålesund – a watchtower for human induced climate change

Figure 1: The Zeppelin station is an excellent site for atmospheric research, with minimal contamination from the local settlement and infrastructure.

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The Arctic is the area where climate models indicate that the earliest and largest climate change is to be expected. The Arctic is a key area for observations of species with potential of causing climate change, both atmospheric aerosols and greenhouse gases. Svalbard is located at the "top" of the world in a pristine environment but surrounded in all directions by continents with industrialized activities. This makes the archipelago instrumental to serving as an early warning site for human-induced environmental change. The Norwegian Institute for Air Research in Tromsø conducts research on these environmental issues which are of paramount importance.

Monitoring at the Zeppelin station

The foundation of the research is the monitoring studies in Ny-Ålesund (79°N, 12°E). Long-term measurements of trace gases and aerosols in the European Arctic atmosphere have been performed at the Zeppelin station since 1989. The Zeppelin monitoring station is located on a mountain ridge 474 m above sea level approximately two kilometers south of Ny-Ålesund. NILU is the scientific mentor institution of the station. The long-term scientific programs are conducted in close collaboration with Stockholm University. The Norwegian Polar Institute operates and maintains the station. The Zeppelin station (Fig. 1) is an excellent site for atmospheric research, with minimal contamination from the local settlement and infrastructure.

Climate change pollutants

The energy balance on Earth is largely determined by the so called greenhouse gases, which occur naturally in the atmosphere - mainly water vapor, carbon dioxide, methane, ozone and nitrous oxide. These gases hamper Earth's heat radiation from escaping into space. Without this natural greenhouse effect a thick sheet of ice would probably cover our planet. But mankind has during the past two centuries increased the amount of greenhouse gases in the atmoshpere. Carbon dioxide (CO_2), methane (CH_4) and dinitrogenoxide (N_2O) show large increases due to usage of fossil fuel and land-use changes. Additional greenhouse gases produced by the chemical industry, such as chlorofluorocarbons (CFCs), have also accumulated in the atmosphere over the past decades and added to the enhanced greenhouse effect.

Whereas the greenhouse gases warm the Earth, the aerosols – particles in the atmosphere – have a cooling effect on the climate. When sunlight hits the particles in the atmosphere, light is scattered in all directions. This means that less of the direct sun radiation hits the ground. The most effective scattering occurs when

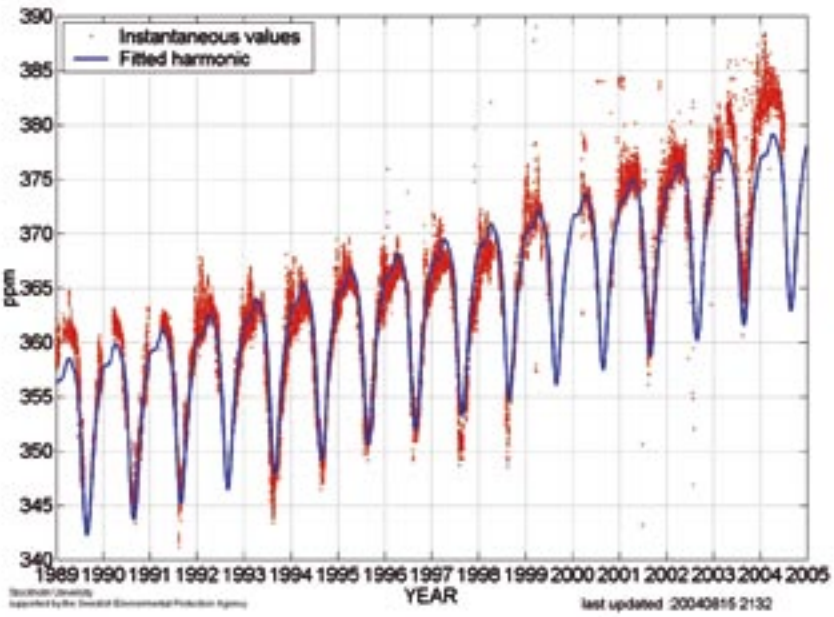

Figure 2: Zeppelin carbon dioxide record showing a clear increasing trend. The scatter in the winter (the yearly peaks) is indicative of the strong transport of pollutants from Europe and Russia into the Arctic during the winter season.

the particles have the same size as the wavelength of the sunlight, that is, approximately half of a micrometre. By coincidence most of the atmospheric particles are in this size range, both natural and particles formed from human emissions. The particle concentration is highly variable, contrary to greenhouse gases, which stay in the atmosphere for a long time and are almost equally distributed over the world. Studying the particle formation and distribution in space and time is a central element of the Zeppelin station scientific program.

Circulation changes can cause changes in pollutant levels

Concentration variations at an observation site are sometimes not due to changes in emissions but rather caused by shifts in air mass transport due to climatic fluctuations. To quantify this effect one tool used at NILU in Tromsø is trajectories calculated from wind fields in weather prediction models. Trajectories arriving at Ny-Ålesund at 850 hPa were calculated twice daily (00 and 12 UTC) during the 10-year period 1992-2001. The transport climatology for Ny-Ålesund during 1992-2001 is shown in Figure 3. The trajectories are grouped in clusters through a mathematical technique and are depicted as mean trajectories, describing potential source areas within a 5-day transport time to Ny-Ålesund. Each cluster is assigned an identification number (1-8). Clusters 1-4 represent transport across the Arctic Basin, whereas clusters 5-8 comprise trajectories originating from the Eurasian continent and the Atlantic. The caption of Figure 3 shows the mean frequency of occurrence of the transport clusters.

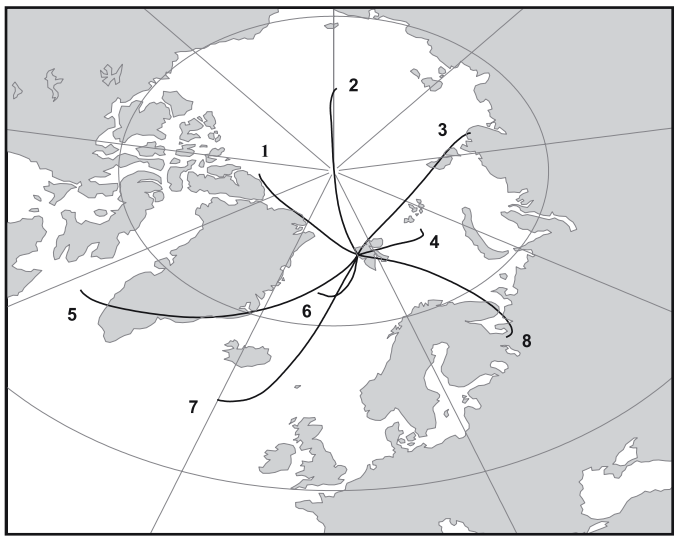

Figure 3: Transport paths to Ny-Ålesund illustrated by cluster mean trajectories, denoted 1-8. Percent occurrence of trajectories within each cluster is as follows: cluster 1, 17%; cluster 2, 9%; cluster 3, 15%; cluster 4, 11%; cluster 5, 9%; cluster 6, 17%; cluster 7, 8%; and cluster 8, 13%.

The atmospheric transport to Svalbard is dominated by the Atlantic storm tracks (clusters 5-8) in winter, whereas transport pathways from and across the Arctic Basin are more common during spring and summer. The strongest pollution events in Svalbard are associated with cluster 8 during the winter months. A small year-to-year variability of the atmospheric transport pathways during the 10 years of study is seen, but there may be a greater variability and/or trend over longer time-scales. It is essential to monitor such variations in transport since the shift in air mass statistics at a monitoring station can otherwise easily be interpreted as a trend in sources and sinks.

Identifying trends in climatically active species and climate thus demands extensive understanding both of atmospheric chemistry and atmospheric circulation. To understand the effects of such trends they must be seen in the context of other scientific fields like glaciology and biology. The Polar Environmental Centre in Tromsø comprises a unique scientific environment for these necessary interdisciplinary assessments.

Cryosat calibration and validation on Austfonna in Svalbard

Installation of a corner reflector for airborne radar altimetry profiles on Austfonna.

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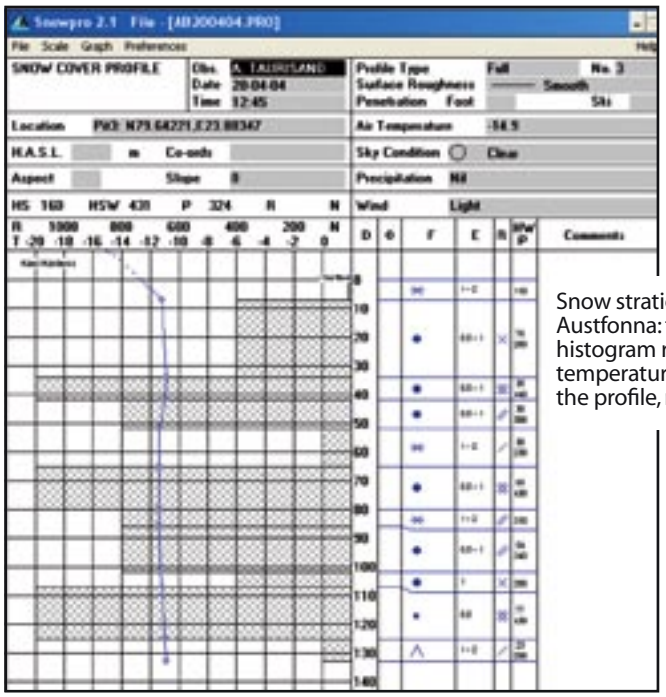
In 1999, in response to the current debate on climate change and its effect on the large polar ice masses, the European Space Agency approved the Cryosat mission. This is the first satellite entirely dedicated to moni-



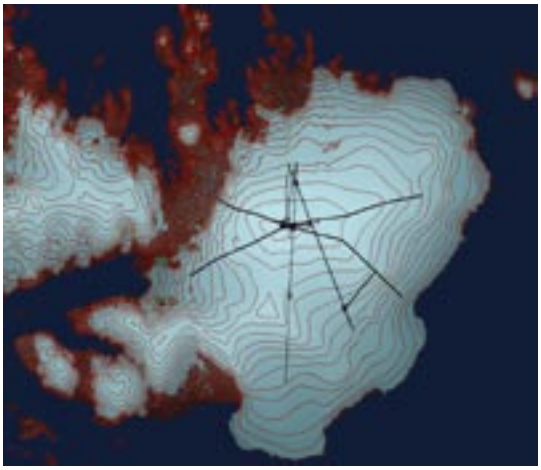
Snow stratigraphy from Austfonna: the blue line and the histogram refer to snow layer temperature and hardness along the profile, respectively.

toring changes in thickness of polar ice sheets, ice caps and sea ice over a three year operation period. It is to have an unprecedented accuracy of 1-3 cm/year. Such ambitious mission requirements are expected to enable precise mass balance measurements over inland polar ice sheets, where accumulation is low and where uncertainty still persists as to whether a positive or negative trend is ongoing. The cryosphere-oriented design and orbit characteristics of the new satellite, scheduled for launch on 25 March 2005, will also allow measurements over the steeper and dynamically active margins of the ice sheets and up to 88 degrees latitude, thus filling the gap left by currently orbiting satellites such as the ERSs and Envisat.

To meet these mission objectives, the ESA promoted a programme aimed at the calibration and validation of Cryosat products through an assessment of the uncertainty in the radar-based measurements of sea ice thickness and land ice elevation changes. This problem is now being tackled by means of dedicated ground-based and airborne campaigns conducted over a selected number of test areas. Among them, the Austfonna ice cap, in Svalbard, is particularly interesting because of its favourable combination of simple-dome geometry and ideal geographical position with respect to the future Cryosat orbit tracks. The overall objective of the Austfonna calibration-validation activities, carried out jointly by the Norwegian Polar Institute and the University of Oslo, is to perform accurate ground-based measurements of snowpack properties relevant to the electromagnetic scattering and to monitor elevation changes due to snowfall fluctuations and snow/firn densification processes. Therefore, spatial variations in snow surface roughness, near-surface density, snowpack layering and snowfall fluctuations need to be measured along transects over the ice cap by using a combination of Ground Penetrating Radar, snow-pit stratigraphy work and shallow snow/firn cores.

The first stage of these investigations was successfully conducted during a field campaign in the spring of 2004. The ground-based work done by the Norwegian team was complemented with airborne laser/radar altimetry profiles simultaneously collected by cal-val investigators from the Alfred Wegener Institute for Marine Research in Bremerhaven, Germany. Further field campaigns to be carried out during the lifespan of the Cryosat mission are now being planned, and the data collected in 2004 are being processed. Particularly relevant information is expected from the comparison of airborne laser and radar altimetry profiles, whose results are to be interpreted in light of the snow-pit stratigraphic data. These reveal large spatial variability in snow density over the ice cap, both vertically and horizontally, and particularly in areas where catabatic winds are frequent: here, wind crusts and snow densities up to 0.48 g/cm^3 are relatively common features. Such density variations may significantly affect the radar backscatter and thus the altimetric data to be delivered by the new ESA mission. In addition to the intrinsic value of this detailed characterization of the internal structure of snow, the low penetration of Cryosat radar pulses at 14 GHz makes it necessary to concentrate the validation efforts on detecting and mapping the firn-ice transition. On Austfonna this transition zone lies only a few metres deep due to the diffuse occurrence of summer melting, and the superimposed ice zone that is a major factor in the mass balance of the ice cap.

The Cryosat validation fieldwork on Austfonna will continue in 2005 and 2006 and will assume even greater relevance as the space mission will then be providing simultaneous altimetry datasets, first to the calibration and validation investigators and soon to the scientific community as a whole.



Digital Elevation Model of Austfonna, Svalbard, showing the transects along which field investigations were performed during spring 2004.

Svalbard glaciers as archives of organic contaminant history

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Ice cores from polar ice sheets have contributed to our understanding of climate change over broad time scales ranging from glacial cycles to annual variability. Most of the focus has been on ice cores from Greenland and Antarctica while the many smaller glaciers elsewhere in the polar regions have not received as much attention. Some smaller glaciers experience surface melting during the summer season which can alter the original ice core record and make data interpretation difficult.

Svalbard is 60% covered by glaciers providing a great potential for ice core studies. These glaciers experience some summer melting and have therefore been given little attention by the climate community. Despite this, many ice cores have been recovered from Svalbard glaciers during the last few decades and have proven to be useful for climate studies.

Svalbard ice cores are also useful archives of atmospheric contamination delivered by long distance transport from industrial areas. They show increased levels of acidity (from sulphate and nitrate released from industrial activity) beginning in the 1800s and accelerating during the second half of the 1900s. A recent approach with Svalbard ice cores has been to investigate organic contaminant input history. We have analysed a large number of the most commonly researched organic compounds including PCBs and DDT in two recently drilled ice cores from Lomonosovfonna and Austfonna in Svalbard (see map, figure 1). These results show that the maximum concentrations of many "legacy" organochlorine (OC) contaminants occur below the snow surface, indicating that inputs have declined in recent years in response to use restrictions or bans in many countries. High concentrations of DDT in recent snow in Svalbard may reflect local use (although not likely as the use of DDT is prohibited in Norway) as well as transport from Russia and Asia. Dieldrin and chlordane concentrations are lower relative to DDT group compounds and HCHs and, when compared with results for the North American Arctic, indicate greater use of pesticides in the US and Canada. Restrictions on the use

Fig. 1 Map of Svalbard with the two ice core sites on Lomonosovfonna and Austfonna mentioned in this article.

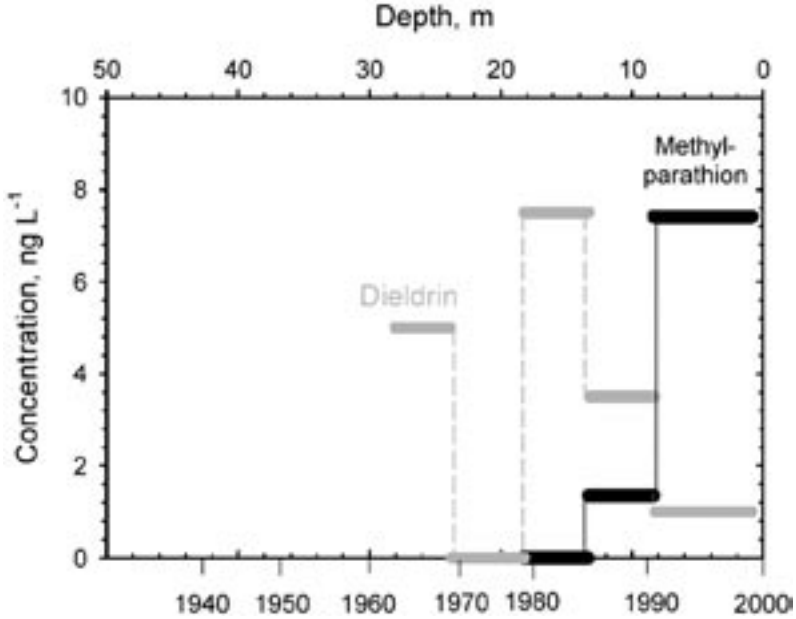

Fig. 2. Profiles of methylparathion (a compound used in insecticides) and dieldrin in one ice core from Austfonna (Svalbard) drilled in 1998. The relatively high concentrations of methylparathion in near-surface layers suggest a current use and growing inputs of these compounds while dieldrin shows declining input since the late 1970s after it was banned.

Fig. 3. Snow sampling for PCB studies on Lomonsovfonna, Svalbard. The white suit is important to prevent contamination of the samples with particles from field clothing.

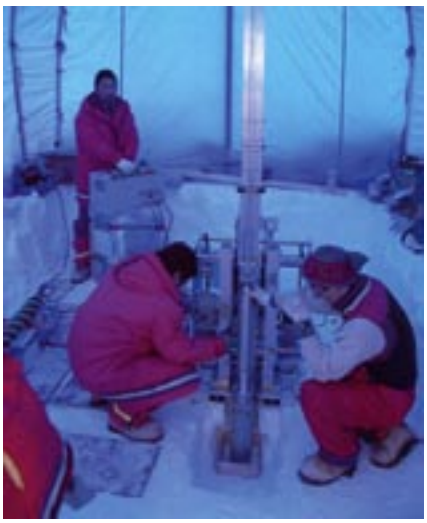

Fig. 4. Ice core drilling on Austfonna.

of dieldrin in many countries has resulted in declining inputs to the 1998 ice core from Austfonna as shown in Fig. 2. Some organophosphorus (OP) pesticides and various herbicides - often called "current use pesticides" even though some are banned - have been analysed in the same core. Methyl-parathion, an OP used in recent years in many places (Europe, North America, Russia), shows growing concentrations in near-surface layers of the same core (Fig. 2).

The Stockholm Convention on Persistent Organic Pollutants (2001) calls for global bans on a number of OC pesticides and industrial compounds and reductions of use and emissions. Some efforts are underway to extend the list to include additional compounds. Svalbard glaciers will be a valuable tool in identifying the effects of these restrictions. We are currently planning analysis of some of the "new" pollutants such as toxaphene, brominated flame retardants, polychlorinated naphthalenes and perfluorooctane sulfonate (PFOS).

Digestive adaptations in the polar bear – an anatomical study of the gastrointestinal system of the polar bear related to its ability to adapt to future climatic changes in the Arctic

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Implemented calculations indicate that global mean temperature is expected to rise during the next century, and existing climate models show that the warming will be especially pronounced in the Arctic regions. These expected climatic changes are likely to result in reduced thickness and distribution of the sea ice in the Arctic. Polar bears (*Ursus maritimus*) are thought to be strict carnivores. The polar bear population at Svalbard feeds almost exclusively on seals (mainly *Phoca hispida*) on the sea ice. A reduction in the sea ice extent, with reduced possibilities for hunting, would potentially force the polar bear to become an omnivore like the brown bear (*Ursus arctos*). Very little is known, however, about the digestive anatomy and physiology of polar bears, and hence whether they will be able to digest plant material in addition to meat. We therefore wanted to conduct an anatomical study of the gastrointestinal system of the supposedly strict carnivore polar bear, compare the results with known information regarding the more omnivorous brown bear, and then – if possible – make predic-

tions on whether the polar bear could adapt to a warmer climate and a more herbivorous diet.

The study is based on gastrointestinal tracts collected from 10 polar bears shot in the Svalbard / Spitsbergen area in 2000-2004 (Figure 1) and from one brown bear found dead in captivity in northern Norway in February 2004. Gross anatomy (length, diameter, area, and tissue wet weight) were recorded for the different segments of the gastrointestinal tract (oesophagus, stomach, small intestine, large intestine). Also, tissue samples were collected from the different sections of the gastrointestinal tract from five polar bears for microscopical examinations.

Figure 1. The post-mortem examinations of the polar bears were done in Svalbard in collaboration with environmental advisor Øystein Overrein representing the Governor of Svalbard, who is acknowledged for all his help in sampling the animals. This photo was taken in Svalbard April 2004 and shows Overrein, Larsen and Marhaug with one of the animals examined.

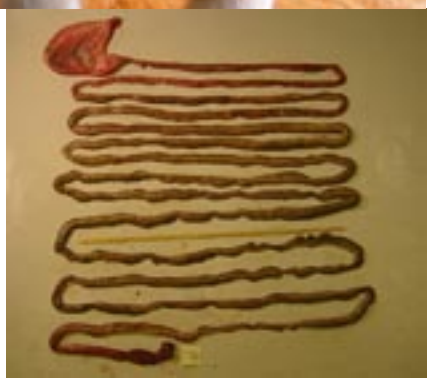

Figure 2. The gross anatomy of the gastrointestinal system of the polar bear. Scale bar = 1 m.

The polar bear has a monogastric digestive system with a simple and relatively short intestine typical of a carnivorous animal, and with the caecum completely lacking (Figure 2). The histological examination demonstrated that the microanatomy of the digestive tract resembled that of other carnivorous species. The anatomy of the digestive system of the omnivorous brown bear was similar to that of the polar bear, despite different habitats and life strategies in the two species, and despite the recent evolution (about 250 000 years) towards a carnivorous life strategy in the polar bear. In fact, digestibility trials indicate that the polar bear is equally good at utilizing vegetation as forage compared to the brown bear and the black bear (*Ursus americanus*). Consequently, the polar bear should have the same possibility to digest and utilize a selective plant diet as the brown bear given the same living conditions and the same access to food.

Making predictions about how the changing climate will influence the polar bear diet is difficult, but based on the anatomical design and the physiological digestive adaptations of the polar bear, it would be reasonable to assume that the polar bear could survive in the same habitat as the brown bear. On the other hand, there are a number of other factors that will have an impact on the survival of the species if the climate changes as predicted.

Ebeltofthamna – a brief history of Svalbard

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Ebeltofthamna has been known since 1610, when an English crew went ashore in a calm bay in the seaward approach to Krossfjorden on Svalbard. The crew, led by captain Jonas Poole, named the bay "Crosse Road" and placed a cross "upon the side of a hill, a mile to the westwards of the Road".

This bay has continued to attract visitors for nearly 400 years. It has been the main station for English whalers, and a base for Russian hunters and trappers, Norwegian trappers, German meteorological researchers and other visitors. Some of the visitors never left: there are four different graveyards in the bay, spanning its history.

A project of the University Museum, University of Tromsø, focuses on how the different nations and trades have made use of the landscape and resources of Ebeltofthamna. Our aim

Remains of modern activity – empty beer-cans – on the door-step of a norwegian hunting hut from the 1930s. Photo: Marit Anne Hauan

is to uncover how the different perceptions of nature and differing cultural preferences of the groups and nationalities working in the area have influenced both the way in which they have interacted with the surroundings and the way in which they have exploited the natural resources available. After the English period, newcomers had to relate to both the landscape and the cultural remains, in particular to the graves – constant reminders of earlier use of the bay. Meeting with the past can be understood as a cultural meeting. As a cultural melting pot the bay has experienced renaming and resettlement, and it has been a place for both hopes and losses. Through a cross-survey of the area, our aim was to identify the cultural traces left by the different nations in order to write the history of Ebeltofthamna, and through this history shed light on the broad international presence in the Svalbard archipelago.

In our fieldwork in the summer of 2004, the main intention was to identify cultural remains that could be attributed to the different nations using Ebeltofthamna or Cross Road.

From written sources we know that, to begin with, Cross Road was used as a harbour exclusively by the English, and that it was in fact the first centre of whaling off the coast of Svalbard. The reports of successful voyages and "full cargo" by the earliest English expeditions are considered to be the cause of the great influx of foreign "interlopers" – mainly Dutch – on Svalbard waters. Through negotiations in 1614 the Dutch agreed to clear out of Cross Road and leave it exclusively to the English.

Based on our fieldwork, we conclude that Ebeltofthamna remained an English stronghold at least until the 1660s, when there is reason to believe that the area was used as a graveyard by the Dutch. Cultural remains from the English whaling activities can today be identified in the form of blubber ovens and remnants of a working tent. Some of the 22 graves from the whaling period are also thought to be those of English whalers.

Our fieldwork also identified four main hunting stations used by Russian hunters from the White Sea, who had Svalbard as their main hunting area between 1710 and 1850. The stations consist of several buildings, graves and crosses. We were also able to identify three large middens containing ceramics, leather, bone and other remains of the Russian activity in the area.

Some of the Russian houses have later been occupied by Norwegians and there is also reason to believe that the Norwegians used the old Russian graveyards as the graves show a mixed character.

The results of the research will be presented in scientific papers and on a website which is currently under construction.

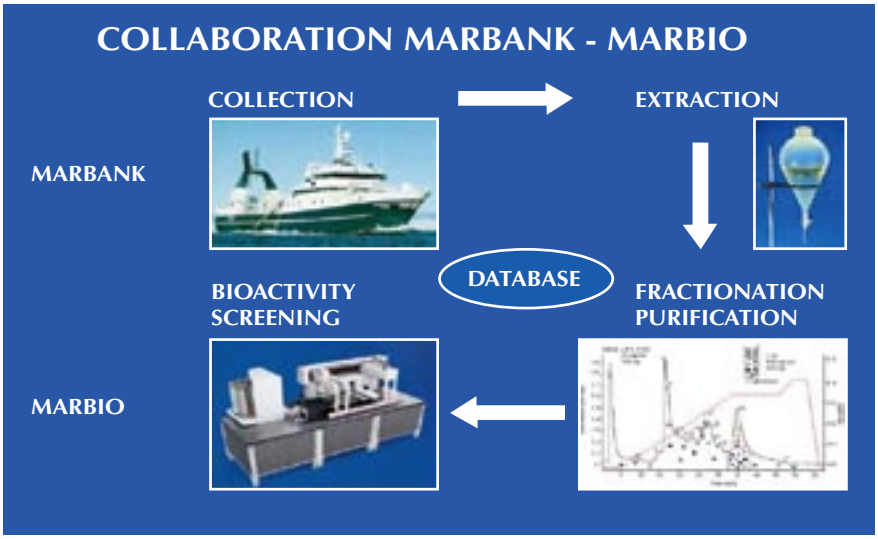
Marbank and Marbio

– A repository of marine resources and a platform for screening and exploration of unique bioactivities in marine organisms

Marbank and Marbio are two new infrastructure facilities of importance for on-going and future initiatives within the area of marine bioprospecting, i.e. the search for interesting and unique genes, biomolecules and organisms from the marine environment. Marbank is a marine repository that will have a national responsibility for collection and preservation of marine organisms for research, commercial and exploitation purposes. Marbio is a medium/high-throughput analytical platform with the aim of bioprospecting a large number of marine organisms for potential drugs and/or lead compounds. Marbank and Marbio work in close cooperation and are co-located in Tromsø Science Park.

The material to be archived and stored in the Marbank repository will include genetic and biological material from marine microorganisms, plankton, algae, invertebrates and vertebrates. The mission of Marbank is to provide an accessible repository of frozen marine biological samples, collected and maintained under rigorously controlled conditions. All information connected to the marine samples will be stored in a database. Marbank will store data about geographic collection sites, routines and procedures used when sampling, taxonomic determination, laboratory preparation and about long-term storage at low temperatures. Access to samples and data information will be regulated by a set of policies. R&D institutions and industry can gain access to the material after describing the scientific purposes.

The ocean is a rich repository of biological and chemical diversity. Marine organisms, with their vast genetic variety, offer a wealth of different and unique chemical compounds with biological activities. The marine environment represents an untapped resource for discovering novel pharmaceutical compounds. The Marbio platform is a full-fledged screening platform with the capacity to extract and purify molecules with unique bioactivities within the most important drug areas, including antibacterial, antiviral, anticancer and immunostimulatory or antiinflammatory action, in addition to various enzyme activities. Marbio is based on a tight interaction of the combined resources from several scientific groups at the University of Tromsø, the University Hospital of North-Norway and industry.



Although some novel compounds have been identified in the high latitude seas, the primary focus on marine bioprospecting has been on organisms living in the tropics. Marbank and Marbio will focus on collection and screening of marine samples from the Arctic and sub-Arctic regions. Species from the Arctic environment live under extreme conditions and are likely to have developed a multitude of molecular strategies for their survival, thereby representing one of the few remaining unexplored natural sources not only for novel molecules, but also molecules that act through novel mechanisms. The potential for use of marine organisms from cold areas as sources for unique exploitable biomolecules seems promising and Marbank and Marbio will be important contributors to the field of Norwegian marine biotechnology.

The Marbank repository has been established on initiative from the University of Tromsø, the Norwegian Polar Institute, the Norwegian Institute of Fisheries and Aquaculture Research and the Institute of Marine Research (Tromsø). Marbank has funding from the Norwegian Ministry of Fisheries, Troms County Council and the MABIT programme. The Marbio programme is a research project funded by the Research Council of Norway, the University of Tromsø and local biotechnology companies.

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Books & maps

Tromsø-based scientists were involved in several publications during 2004. Bjørn Gulliksen and Erling Svendsen's "SVALBARD and Life in Polar Oceans" is a popular scientific presentation of marine organisms and marine ecology in polar waters. The book comprises 160 pages and includes outstanding photographs. Gulliksen is a marine biologist and professor at the Norwegian College of Fisheries, University of Tromsø.

Norwegian Polar Institute scientists Kit M. Kovacs and Christian Lydersen, alongside Ian Gjertz, published "Marine Mammals of Svalbard". This easy-to-follow, handy little book is intended as a field identication guide. It includes an ID sheet to take along on deck and a registration sheet. Travellers to Svalbard waters are requested to report sightings of marine mammals and have them registered in NPI's Marine Mammal Sighting Data Base.

"Hekkefuglatlas for Troms" (Norwegian only) is an atlas of breeding birds in Troms, between 68°-70° northern latitude. This is the first complete guide ever to birds in the county of Troms. Authors are Karl-Birger Strann of the Norwegian Institute for Nature Research at the Polar Environmental Centre in Tromsø, and Vidar Bakken.

The Norwegian Polar Institute published a new tourist map of Svalbard, 1:1000 000 series. The map is complemented with a series of nature photographs from the archipelago.

Anniversary: The world's northernmost botanical gardens

In July 2004, the Arctic-Alpine botanical gardens of the University of Tromsø celebrated its 10th anniversary, and new facilities and signboards were set up. The garden covers 1.6 ha, and although the latitude suggests an extreme Arctic climate, temperatures are relatively mild in winter (January mean -4.4 °C). The summers are fairly cool (July mean +11.8 °C), but from 15 May until 27 July the sun is constantly over the horizon. This compensates for the low temperatures and the short growing season normally lasting only between the end of May and mid-October.

The gardens display plants from many parts of the world, such as south-west China, the Himalayas, North America, the Alps and northern Norway. There also is a separate collection of plants from South America, not just because many fine and hardy plants are found there, but also because botanists at the University of Tromsø have studied the flora in southern Chile.

Hillary Clinton taking a closer look at the memorial of Norwegian Arctic explorer Roald Amundsen in Ny-Ålesund, Svalbard, together with NPI director Olav Orheim and Norway's Minister of Foreign Affairs, Jan Petersen. Photo: T. Bergsaker

Hillary Clinton and John McCain in Svalbard

In August 2004, a group of US senators visited Svalbard to learn more about the Arctic and global climate. NPI director Olav Orheim – a climate scientist himself – was among their hosts. The senators were very knowledgeable and interested visitors, according to Orheim. John Mc Cain said to the Norwegian paper "Aftenposten" that the research done in Svalbard had convincingly demonstrated the problems that arise through emissions of greenhouse gases.

Joined forces

The University of Tromsø and the Norwegian Polar Institute have formalized their co-operation in an agreement. Both the Minister of the Environment, Knut-Arild Hareide, and the Minister of Education and Research, Kristin Clemet, expressed their satisfaction when the agreement was signed in October 2004. Their view was that this further contributes to co-ordinating the competence available within Norway's leading environment for polar research.

Three thousand polar bears

The first estimate of polar bears belonging to the joint Norwegian–Russian population, the Barents Sea Population, was carried out by the Norwegian Polar Institute in 2004. The census found about 3000 polar bears. This is at the low end of earlier rough estimates suggesting between 3000 and 5000 animals. A population of 3000 animals is fairly large, but polar bears are threatened by global warming and exposed to environmental toxins brought to the High North by air and ocean currents. It is therefore vital that scientists keep a close watch on how the population develops. Partners of the NPI were VNII-PRODA in Moscow, the University of St. Andrews, Scotland, and the University of Oslo, Norway.

Doctorates in polar studies at the University of Tromsø

Dr. art.

Irene Andreassen
"Tainariksi kuttuthaan se steimpiitti täälä" [Tainari kaller vi steinbiten her]. En studie av kvenske fiske- og sjødyrnavn i Varanger, Porsanger og Alta
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Dr. med.

Beate Lupton
Intervensjonsstudien i Finnmark : evaluering av lokalsamfunnsbasert hjerte- og karforebygging i kystkommunene Båtsfjord og Nordkapp
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Dr. scient.

Roar Jørgensen
The effects of behaviour on the acoustic target strength of capelin (*Mallotus villosus*) and implications for acoustic abundance estimation
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Hanno Sandvik
Life-history and breeding biology of seabirds in changing environment: a comparative approach
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Anja Strømme
Naturally Enhanced Wave Modes Observed with the EISCAT Svalbard Radar
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Øyvind Aas-Hansen
Smoltification in Arctic charr, Salvelinus alpinus: regulatory mechanisms and integrated effects of nutritional status and PCBs
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Hanne Ebbesen
Sea surface variations in the northeastern Nordic Seas during the last 15.000 years
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Tor Haug
Marine bioprospecting : marine invertebrates and algae: a potential source for the discovery of novel antibiotics.
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Jo J. Aarseth
Pineal gland and melatonin in arctic seals: a hormonal system primarily of fetal importance
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Espen Hansen
Toxin production by the marine phytoplankter Phaeocystis pouchetii (Hariot) Lagerheim
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Jofrid Skarðhamar
Variability in circulation and hydrography in North Norwegian coastal waters
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Simon H. H. Nielsen
Southern Ocean Climate Variability (joint supervision with the Norwegian Polar Institute)
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Magritt Brustad
Vitamin D security in Northern Norway in relation to marine food traditions
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Matthias Zielke
Diversity and nitrogen fixation activity of cyanobacterial communities in terrestrial arctic ecosystems
matthias.zielke@ib.uit.no

Dr. philos.

Børge Holte
The benthic macrofauna in North Norwegian and Svalbard fjord sediments: a study of organically polluted vs. various unpolluted marine environments
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Doctorates in polar studies at other universities, with Tromsø affiliation

Dr. scient.

Lars I. Karlöf
"Temporal and spatial variability of snow accumulation and redistribution, and its impact on the interpretation of ice cores". Universtity of Oslo (joint supervision with the Norwegian Polar Institute)
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Max König
"Observing glaciers from space: surface type detection and mass balance monitoring using SAR satellite images". University of Oslo (joint supervision with the Norwegian Polar Institute)
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