07

Årsbok Yearbook 2007

Polarforskningssekretariatet

Swedish Polar Research Secretariat

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Omslag *Cover*

Isbrytaren Oden anlöpte Antarktis för första gången någonsin under 2007, efter många framgångsrika expeditioner i Arktis.

During 2007, the icebreaker Oden made its first ever voyage to Antarctica, following many successful expeditions in the Arctic.

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Glaciären Eqalorutsit kangigdlît sermiat kalvar längst in i Bredefjord, även kallad Nordre Sermilik, på södra Grönland.

The Eqalorutsit Kangigdlît Sermiat glacier calving in the inner reaches of Bredefjord, also known as Nordre Sermilik, on southern Greenland.

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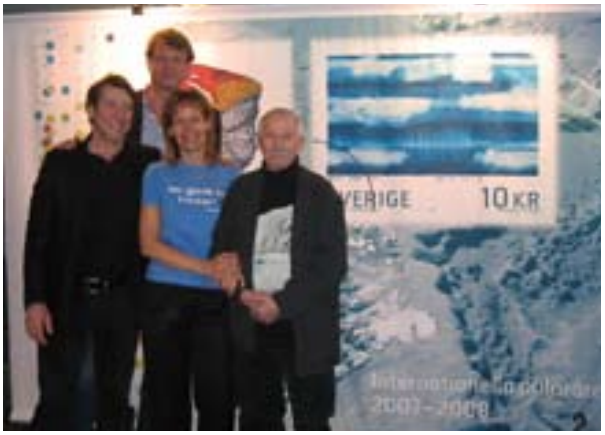


Förord

Britt-Marie Danestig
Styrelseordförande
Polarforskningssekretariatet

Bild övre vänster *Figure top left*
Under expeditionen LOMROG hade isbrytaren Oden sällskap med den ryska atomisbrytaren 50 let Pobedy.

During the LOMROG expedition the ice-breaker Oden was accompanied by the Russian nuclear icebreaker 50 let Pobedy.

Bild övre höger *Figure top right*
Gravör Martin Mörck, konstnär Johan Petterson, informationssekreterare Eva Grönlund och konstnär Svenerik Jakobsson, som alla har arbetat med det svenska frimärket för Internationella polaråret 2007–2008.

Engraver Martin Mörck, artist Johan Petterson, information officer Eva Grönlund and artist Svenerik Jakobsson, who have worked together on the Swedish stamp commemorating the International Polar Year 2007–2008.

Bild nedre *Figure bottom*
Svalbardrenar i sommardräkt.

Svalbard reindeer with summer coats.

2007 var året då polarområdena tillsammans med Carl von Linné stod i fokus. Verksamheten har i hög grad präglats av det Internationella polaråret 2007–2008 (IPY), som i Sverige invigdes den 1 mars på Icehotel i Jukkasjärvi. Den internationella invigningen gick av stapeln i Paris samma dag. Intresset för polarforskning har varit och är stort. EU-parlamentet ägnade en hel dag i Strasbourg åt att diskutera polarforskningen och hur den berör Europas folk.

För att synliggöra polaråret för allmänheten har åtta av de arktiska länderna samarbetat kring en frimärksutgåva. Sekretariatet har tillsammans med Posten tagit fram två frimärken efter förlagor av Svenerik Jakobsson och Johan Petterson, vilka båda deltagit i polarexpeditioner genom sekretariatets konstnärsprogram.

Installationen av ett multibeam-ekolodsystem på isbrytaren Oden blev klart under våren, och fartyget blev därmed ett av världens bäst utrustade forskningsfartyg. I Köpenhamn besökte IPY:s nationella beskyddare – de svenska och danska tronföljarna – fartyget och därefter avseglade Oden till ett av de mest svårtillgängliga områdena på jorden: Ishavet norr om Grönland, där inga ytgående fartyg tidigare har varit. De svenska och danska forskarna inom forskningsprogrammet LOMROG har där bedrivit vetenskapliga undersökningar inom maringeologi, geofysik, oceanografi och marinkemi. De högupplösta bilder av havsbotten och dess underliggande sedimentlager som det nya ekolodet möjliggjort, har gett forskarna nya pusselbitar från delar av Arktis som är i det närmaste outforskade.

Polarforskningssekretariatet har under året framgångsrikt börjat med en internationell tjänsteexport av sitt kunnande. Detta har bl.a. möjliggjort expeditionen AGAVE, men det har också inneburit ett delvis förändrat arbetssätt och tagit mycket av personalens tid i anspråk.

Den gamla forskningsstationen Kinnvika på Svalbard – som byggdes under Internationella geofysiska året 1957–1958 och som bara använts sporadiskt under nästan femtio år – har med anledning av IPY åter tagits i fullt bruk. Trots stormar och oväder har forskningen där varit framgångsrik och den kommer att fortsätta två säsonger till.

I slutet av november avslutades Odens långa transitresa till Antarktis när isbrytaren för andra gången gick till Antarktis i ett lyckat samarbete med den amerikanske forskningsfinansiären NSF. Den svenska gruppen inom den japansk-svenska samarbetstraversen JASE påbörjade ungefär samtidigt en sedan länge planerad 300 mil lång resa över högplatån för att möta den japanska gruppen i juletid.

Året som gått har varit framgångsrikt för polarforskningen och vi ser med tillförsikt och spänning fram emot fortsättningen av IPY.

Foreword

2007 was a year in which the spotlight was on the Polar Regions and Linnaeus. Our activities have largely borne the imprint of the International Polar Year 2007–2008 (IPY), which was inaugurated in Sweden on 1 March at the Icehotel in Jukkasjärvi. The international inauguration took place in Paris that same day. Interest in polar research has been and remains strong. The EU Parliament dedicated an entire day in Strasbourg to discussing polar research and how it affects the peoples of Europe.

To raise public awareness of the International Polar Year, eight Arctic nations have come together to collaborate on a stamp issue. Working together with the Swedish Postal Service, the Secretariat has designed two stamps based on original artwork by Svenerik Jakobsson and Johan Petterson, both of whom have participated in polar expeditions under the auspices of the Secretariat's Artist Programme.

The installation of a multi-beam echo sounding system on the icebreaker Oden was completed during the spring, making her one of the best-equipped research vessels in the world. In Copenhagen, IPY's national patrons – the successors to the Swedish and Danish crowns – paid a visit to the Oden, after which she set sail for one of the most inaccessible regions on earth: the Arctic Ocean north of Greenland, where no surface vessel has ever been before. Swedish and Danish researchers from the LOMROG research program have conducted studies there in the fields of marine geology, geophysics, oceanography and marine chemistry. The high-resolution pictures of the seabed and the underlying sediment layers made possible by the new echo sounder have given researchers new pieces of the puzzle from parts of the Arctic that are practically unexplored.

During the year, the Swedish Polar Research Secretariat successfully began exporting its knowledge services internationally. This made the AGAVE expedition possible, but it has also changed our working methods to some extent, and demanded much of the staff's time.

The old Kinnvika research station on Svalbard, which was built during the International Geophysical Year (1957–1958) and has been used only sporadically over the last fifty years, has been restored to full use as part of the IPY activities. Despite storms and bad weather, the research there has been successful, and will continue for two more seasons.

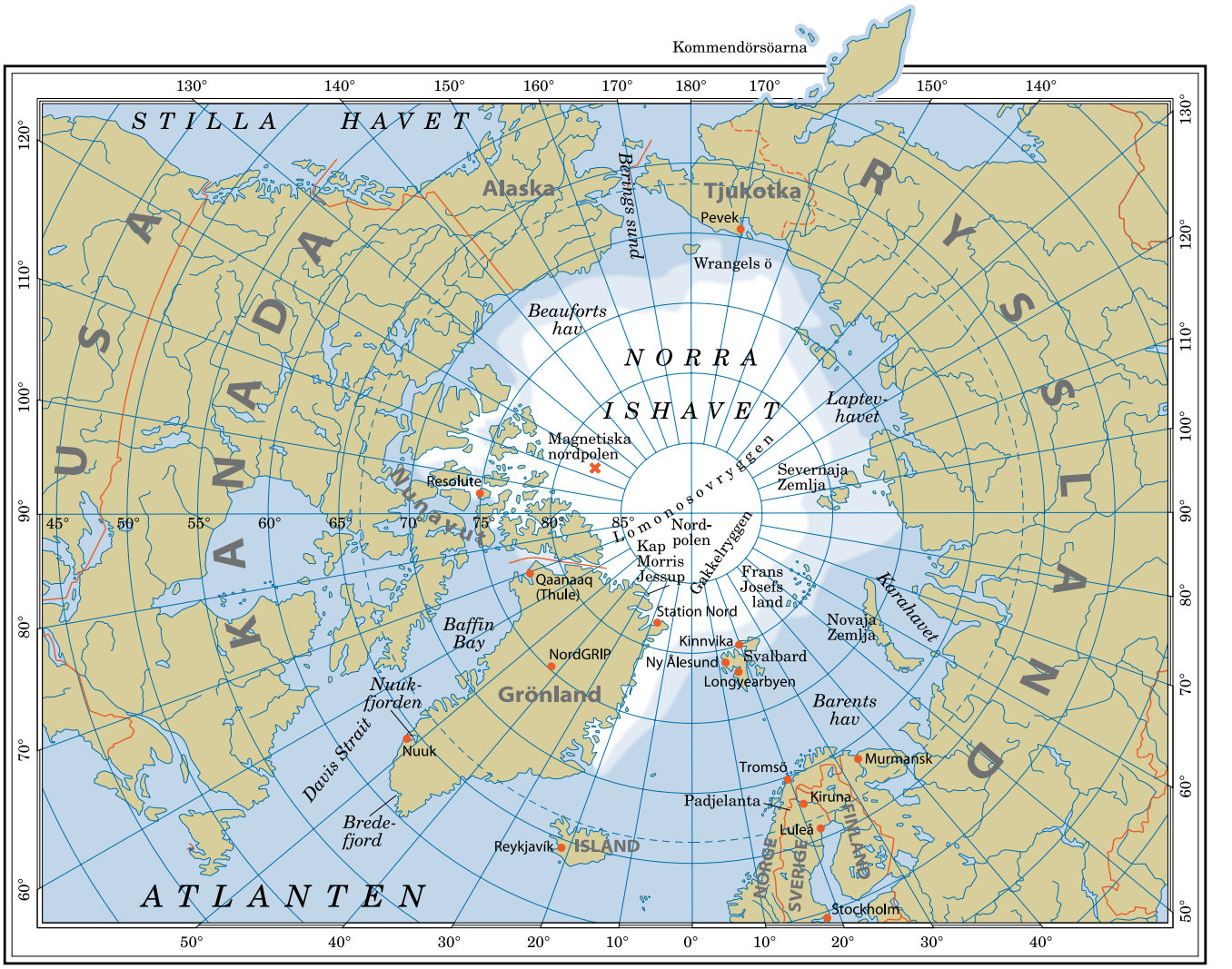
The Oden concluded its long trip to the Antarctic in late November, returning to the region for the second time as part of a successful cooperative arrangement with the American research financier NSF. At roughly the same time, the Swedish contingent of the Japanese–Swedish cooperative expedition JASE set out on its long-planned 3,000 kilometre trek across the high plateau to meet the Japanese team in Christmas time.

The past year has been a successful one for polar research, and we look forward with confidence and excitement to the continuation of the IPY.

Britt-Marie Danestig
Chair of the Board
Swedish Polar Research Secretariat

Bild *Figure*
Invigningen av Internationella polaråret 2007–2008 firades 1 mars i Jukkasjärvi.

The inauguration of the International Polar Year 2007–2008 was celebrated on 1 March in Jukkasjärvi.


Kommendörsöarna
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Resolute
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Lomonosovryggen
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Kap Morris Jessup
Gakkelryggen
Frans Josefs land
Qaanaaq (Thule)
Baffin Bay
Station Nord
Novaja Zemlja
Karahavet
Kinnvika
NordGRIP
Svalbard
Ny Ålesund
Longyearbyen
Nuuk-fjorden
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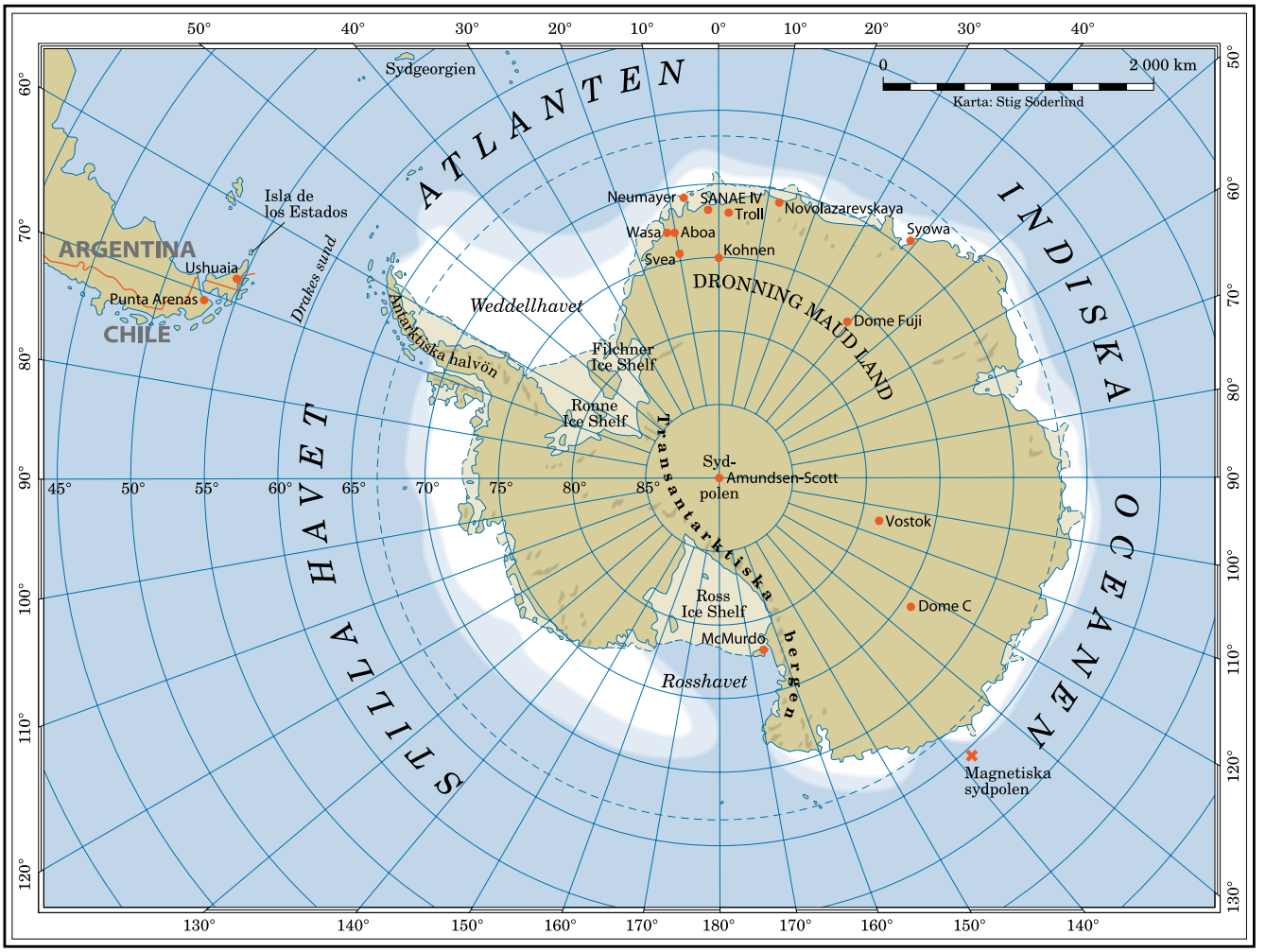
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Ronne Ice Shelf
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Syd-polen
Amundsen-Scott
Vostok
Ross Ice Shelf
Dome C
McMurdo
Rosshavet
Magnetiska sydpolen
STILLA HAVET
INDISKA OCEANEN

Polaråret som gått

En årsbok om polarforskning blir år 2007 till stor del en krönika över det Internationella polaråret (IPY, International Polar Year). Eftersom IPY, i motsats till våra vanliga kalenderår, sträcker sig från första mars 2007 ända till sista februari 2009, blir denna skrivning snarast något av en lägesrapport. Polarforskning har uppmärksammats flitigt i media detta år. Det gäller inte minst ett av polarforskningens kärnområden – klimatet. Klimatets förändring berör oss alla och illustrerar tydligt polarområdenas globala betydelse. Denna uppmärksamhet har skapat möjlighet för forskningen att nå ut till en ny publik och intresset för polarfärder och den speciella miljö som vi möter i Arktis och Antarktis fascinerar ständigt. Fascinationen för polarområdena och för rymden går hand i hand.

Hur har då detta polarår och den pågående uppmärksamheten kring klimatfrågan satt sin prägel på forskningen och på Polarforskningssekretariatets verksamhet? I mångt och mycket är forskning ett mödosamt hantverk, där dramatiska genombrott eller paradigmskiften är sällsynta händelser. Polarforskarna sysslar i allmänhet med långa tidsskalor inom områden där data är bristfälliga och observationer glesa. I det perspektivet har 2007 varit ett år med ”business as usual” där kontinuitet både bakåt i tiden och med planer för framtiden präglat verksamheten. Detta år har också inneburit en intensiv period av arbete, där såväl resurser som uppmärksamhet mobiliserats utöver det vanliga. Det finns således mycket att berätta om, vilket torde framgå av allt som redovisas i denna årsbok.

Forskning stöds av teknik och tekniska innovationer. Nya tekniska hjälpmedel ger forskarna nya möjligheter att lösa gamla uppgifter med nya metoder, som ibland ger upphov till nya problemställningar. Det nya avancerade flerstrålande multibeam-ekolodet som har installerats på den svenska isbrytaren Oden har inneburit ett sådant tekniskt genombrott. Tekniken är inte revolutionerande ny, men däremot är det en stor utmaning och ett pionjärarbete att

Anders Karlqvist
Chef
Polarforskningssekretariatet

Bild *Figure*

Från vänster till höger: Ingvar Eliasson släpper en tofslunnefågel efter provtagning. Michail Grudinin, ledare av den ryska gruppen under expeditionen till Kommandörsöarna och förste fågelfångare. Maria Pisareva, som höll noggrann ordning på märkning och förvaring av de insamlade proverna. Anders Wallensten i bakgrunden.

From left to right: Ingvar Eliasson releases a Tufted puffin after sampling. Michail Grudinin, expedition leader of the Russian team in the Commander Islands and premiere bird catcher. Maria Pisareva, who kept meticulous control of the marking and storage of the collected specimens. Anders Wallensten in the background.

Bild *Figure*

En isbjörn i närheten av isbytaren Oden under polarforskningsexpeditionen LOMROG.

A polar bear in the vicinity of the icebreaker Oden during the LOMROG polar research expedition.

applicera ett sådant instrument på en isbrytare och att använda det i den arktiska packisen. Det var således en stor händelse när Oden under expeditionen LOMROG fick möjlighet att kartlägga tidigare helt okända delar av den arktiska bassängen. Projektet leddes av docent Martin Jakobsson från Stockholms universitet, som med finansiering av Wallenbergstiftelsen och Vetenskapsrådet hade fått möjlighet att införskaffa denna multibeam-anläggning. Expeditionen kunde bokstavligen skriva historia genom att rita om kartan över havsbotten – i vilket det ingår att flytta på berg och introducera nya – samt kasta nytt ljus över den arktiska glacialhistorien. Tidigare under sommaren gick Oden på en färd med ett amerikanskt forskningsprogram, Arctic Gakkel Vents – AGAVE – med uppgift att undersöka varma källor på havsbotten med avseende på liv av olika slag. Livsformer i hydrotermala utsläpp är kända från olika områden i världshaven, men har tidigare inte studerats i Arktis. Kunskapen kan ha bäring på vår förståelse av liv på andra planeter i universum. Den särskilda teknik som användes under expeditionen, i form av autonoma undervattensfarkoster, har rymdtekniska applikationer, och var i detta sammanhang ett högteknologiskt inslag som vi inte kommit i kontakt med tidigare i svensk polarforskning.

Det internationella inslaget i Polarforskningssekretariatets verksamhet har varit betydande. IPY har inspirerat, men internationaliseringen kan också ses som ett tecken i tiden och en tendens som av såväl vetenskapliga, tekniska och resursmässiga skäl växer sig allt starkare. Det praktiska samarbetet ackompanjeras av en livlig mötesverksamhet, där möten som Arctic Science Summit Week, Antarktisfördraget, COMNAP och SCAR är årligt återkommande händelser och innebär resande till olika ställen i världen under alla tänkbara årstider. Därtill fylls almanackan av det som på diplomatisk jargong går under benämningen ”intersessional meetings”, dvs. arbetsgrupper och förberedande aktiviteter som äger rum mellan och inför större konferenser och förhandlingar. För Polarforskningssekretariatets del är det särskilt att notera de bilaterala relationer som etablerats med forskningsfinansiären och -arrangören National Science Foundation (NSF) i USA, samt det givande samarbete som ägt rum genom LOMROG med De Nationale Geologiske Undersøgelser for Danmark og Grønland (GEUS) och indirekt med Ryssland, genom charter av atomisbrytare från Murmansk Shipping som support till isbrytaren Oden under LOMROG-expeditionen.

Med NSF slöt Sverige i juli månad, genom Polarforskningssekretariatet och Vetenskapsrådet, ett samarbetsavtal om polarforskning. Isbrytaren Oden bidrar med isbrytning och assistans för transporter till den amerikanska forskningsbasen McMurdo. Den uppgiften kombineras med forskning på färden från Sydamerika till Antarktis. Ett forskningsprogram i mindre skala genomfördes säsongen 2006/07 och innevarande säsong 2007/08 har en större grupp svenska och amerikanska forskare haft tillfälle att utnyttja Oden som plattform för marin forskning i Bellingshausen- och Amundsenhaven. Samarbetet kommer förhoppningsvis att utvidgas ytterligare under kommande år. En utmaning är att finna lämpliga former för att synkronisera den logistiska och vetenskapliga planeringen mellan forskningsorganisationerna i våra två länder.

Samarbetet med Japan kring den stora pågående glaciologiska traversen JASE (Japanese Swedish Antarctic Expedition) är ett annat nytt och spännande inslag i Polarforskningssekretariatets verksamhet. Svenska glaciologer arbetar efter en rutt från stationen Wasa österut, som knyts ihop med japanernas färdväg från basen Syowa och västerut. I tre månader är svenska forskare och personal från Polarforskningssekretariatet ute på denna expedition. Det gemensamma forskningsprogrammet ingår som en del i en serie traverser som genomförs av ett antal länder under IPY.

Den samlade kunskapen om polarområdena, och förmedling av denna kunskap, är också ett viktigt inslag i IPY, även om forskningen står i centrum under IPY. Polarforskningssekretariatet har en lång tradition vad avser utåtriktade aktiviteter och har med lärare, skolor, konstnärer, media etc. under året varit intensivt engagerat i olika IPY-projekt.

Under 2007 har det också firats att det är 300 år sedan den svenske vetenskapsmannen Carl von Linné föddes. Linnéåret avslutades med en ceremoni i Jukkasjärvi 15 december där en symbolisk stafett överlämnades till Internationella polaråret, med uppdraget att inspirera svenska ungdomar till att föra svensk polarforskning vidare i Linnés anda. Det är min förhoppning att Polarforskningssekretariatet och den verksamhet som redovisas i denna årsbok också kan bidra i detta uppdrag.

Bild *Figure*

Helikoptern användes för att placera forskare på isstationer och för isrekognoscering under expeditionen LOMROG.

The helicopter was used to transfer researchers to ice stations and for ice reconnaissance during the LOMROG expedition.

The past polar year

Anders Karlqvist
Director-General
Swedish Polar Research Secretariat

Bild *Figure*
Linda Randsalu och Dan Zwartz vid en kalvande glaciär i Bredefjord på södra Grönland.

Linda Randsalu and Dan Zwartz by a calving glacier in Bredefjord on southern Greenland.

A yearbook about polar research in 2007 will tend largely to be a chronicle of the International Polar Year (IPY). Because the IPY, in contrast to our normal calendar year, runs from March 1, 2007 to February 28, 2009, this edition is more in the nature of a status report. Polar research has received frequent media attention this year, and not least with respect to one of the core areas of polar research – the climate. Climate change affects everyone, and clearly illustrates the global importance of the polar regions. This attention has created an opportunity for polar research to reach out to a new audience and fostered interest in polar expeditions, and the special environments we encounter in the Arctic and Antarctic are ever fascinating. The fascination of the polar regions and outer space go hand in hand.

How have the IPY and the ongoing attention given to climate issues influenced the research and activities of the Swedish Polar Research Secretariat? Research is, by and large, a laborious craft, and dramatic breakthroughs and paradigm shifts are rare. Polar researchers are generally concerned with long time scales in fields where data are lacking and observations scarce. From that standpoint 2007 has been a year of "business as usual", and its research activities have been characterised by continuity both backward in time and in terms of plans for the future. The year has, however, brought with it a period of intense work, with both our resources and our attention mobilised beyond the ordinary. As a result, there is a lot to report, as should be evident from all the things presented in this yearbook.

Research is supported by technology and technical innovations. New technical tools give researchers new means of solving old problems with new methods, which sometimes give rise to new problem sets. The advanced new multi-beam echo sounder that has been installed on the Swedish icebreaker Oden represents one such technological breakthrough. The technology involved is not revolutionary per se, but applying such instrumentation on an icebreaker and using it in the Arctic pack ice represents a major challenge, and a pioneering effort. It was thus a major event when, during the LOMROG expedition, the Oden got an opportunity to map heretofore entirely uncharted parts of the Arctic basin. The project is headed by Senior

Bild *Figure*
Under AGAVE-expeditionen användes fjärrstyrda robotar för att undersöka havsbotten.

Remotely operated robots were used during the AGAVE-expedition to explore the ocean floor.

Bild *Figure*
Radovan Krejci omgiven av nyfikna pingviner under sitt arbete vid den tyska Antarktisstationen Neumayer.

Radovan Krejci surrounded by inquisitive penguins during his work at the German Antarctic station Neumayer.

Lecturer Martin Jakobsson from Stockholm University, who was able to procure the multi-beam system with financing from the Wallenberg Foundation and the Swedish Research Council. The expedition was able to literally write history by redrawing the map of the seabed, which included moving mountains and adding new ones, and shed new light on the glacial history of the Arctic. Earlier during the summer the Oden sailed as part of an American research programme, Arctic Gakkel Vents (AGAVE), whose mission is to study heat sources in the seabed to look for life of various types. Such life forms in hydrothermal vents are known from various locations in the world's oceans, but have never been studied in the Arctic until now. The knowledge gained could have a bearing on our understanding of life on other planets in the universe. The specialised technology used during the expedition in the form of autonomous underwater vehicles has aerospace applications and, in this context, represented a high-tech element with which we had not previously come in contact in Swedish polar research.

The Swedish Polar Research Secretariat's activities have had a significantly international flavour. The IPY has inspired this, but the process of internationalisation can also be viewed as a sign of the times, and represent a trend that will, for scientific, technical and resource-related reasons, continue to grow. The practical cooperation was accompanied by a lively slate of meetings that included regular annual events such as Arctic Science Summit Week, the Antarctic Treaty, COMNAP and SCAR and involved travel to all manner of places in the world throughout the entire year. The almanac was also full of what are referred to in diplomatic jargon as "intersessional meetings", that is work groups and preparatory activities that take place between and in advance of major conferences and negotiations. With respect to the Swedish Polar Research Secretariat in particular, we should note the bilateral relationships that have been established with the National Science Foundation (NSF), a research financier and organiser in the USA, as well as the rewarding cooperation that has occurred with the Geological Survey of Denmark and Greenland (GEUS) via LOMROG and, indirectly, with Russia, through our charter of an atom-powered icebreaker from Murmansk Shipping to support the Oden during the LOMROG expedition.

In July Sweden signed, via the Swedish

Bild *Figure*
Övervintrarna på Sydpolsstationen 2007. Längst till höger syns Sven Lidström med en svensk flagga.

Overwinterers at the South Pole station in 2007. At the far right Sven Lidström is visible sporting a Swedish flag.

Polar Research Secretariat and the Swedish Research Council, a cooperative agreement with the NSF regarding polar research. The Oden is contributing icebreaking and support services for shipments to the American McMurdo research base. This mission is combined with research activities on the voyage from South America to the Antarctic. A smaller scale research programme was completed during the 2006/07 season, while the current 2007/08 season is giving a larger group of Swedish and American researchers opportunities to use the Oden as a platform for marine research in the Bellingshausen and Amundsen seas. This cooperative relationship will hopefully continue to expand in the years ahead. One challenge we face is that of finding suitable ways of synchronising logistical and scientific planning between the research organisations in our two countries.

Our cooperation with Japan in the form of the major glaciological traverse JASE (Japanese Swedish Antarctic Expedition) currently under way is a new and exciting part of the Swedish Polar Research Secretariat's activities. Swedish glaciologists are following a route from the Wasa station eastward that links with the Japanese route from the Syowa base westward. Swedish researchers and staff from the Swedish Polar Research Secretariat will spend three months on this expedition. The joint research programme is part of a series of traverses being carried out by a number of countries during the IPY.

The knowledge amassed about the polar regions and the dissemination of that knowledge is another important part of the IPY, even though it is the research that is the main focal point of the year. The Swedish Polar Research Secretariat has a long tradition of outreach activities and, through teachers, schools, artists, the media, etc., has been heavily involved in various IPY projects.

2007 also marked the celebration of the tercentenary of the birth of Swedish scientist Linnaeus. The Linnaeus Year ended with a ceremony in Jukkasjärvi on 15 December at which a symbolic baton was passed to the International Polar Year to help inspire Sweden's young people to push Swedish polar research forward in the spirit of Linnaeus. It is my hope that the Swedish Polar Research Secretariat and the activities recounted in this yearbook can also contribute to advance that cause.

Anton Rolandson Martin – Linnélärjunge och Sveriges första polarforskare

Andreas Jemn
Idéhistoriker och journalistuderande
Lunds universitet

Bild *Figure*
Stranden vid Slettnesbukta på Svalbard. I bakgrunden syns udden Kapp Martin, döpt efter Linnélärjungen Anton Rolandson Martin.

The beach at Slettnesbukta on Svalbard. In the background Kapp Martin point is visible, named after Linnaeus's pupil, Anton Rolandson Martin.

Polarforskningen och dess utövare omges av en historisk mystik. Emellertid gäller inte det Sveriges första vetenskapliga polarfarare Anton Rolandson Martin, som istället nästan helt glömts bort. För att bäst beskriva Martin bör han placeras i ett historiskt sammanhang som omfattar nästan 500 år av internationella expeditioner till Arktis. Under de sekler som förflutit har anledningarna till polarfärder förändrats väsentligt. Fram till och med 1700-talet utfördes polarexpeditioner av köpmän och valfångare, mestadels från England och Nederländerna. Syftet med färderna var i första hand de naturtillgångar som fanns i Arktis – främst valfångst – men också att försöka finna nya sjövägar, dvs. handelsvägar, till andra kontinenter. Nordostpassagen var en sådan färdväg som lockade sjöfararna redan under 1500-talet.

Under 1700-talet börjar polarresandet att få en vetenskaplig prägel. Fortfarande var de ekonomiska motiven helt dominerande, men under upplysningstidens vurm för vetenskapens nyttoeffekter i samhället kom ekonomin och naturvetenskapen att samordnas för att skapa en allmän välfärd. På så sätt kom naturvetenskapsmän att följa med på resorna till Arktis i syfte att noggrannare utforska polartrakterna. Vetenskapsmännen förväntades att undersöka den arktiska naturens alla sidor och göra valfångsten mer effektiv.

För svenskt vidkommande var den senare delen av 1800-talet en riktig guldålder för polarforskningsexpeditioner. Epoken inleddes med Sven Lovéns och Otto Toréns undersökningar på Spetsbergen efter fossiler i avsikt att verifiera glacialteorier. Därefter följde en period med framgångsrika svenska polarexpeditioner, med framförallt Adolf Erik Nordenskjölds segling genom Nordostpassagen 1878–1880 som höjdpunkt. En annan spektakulär händelse var Andréexpeditionen 1897 under ledning av överingenjören Salomon August Andrée från Gränna. Tillsammans med Nils Strindberg och Knut Fraenkel hade han för avsikt att flyga över Nordpolen med luftballongen Örnen, men expeditionen misslyckades och deltagarna förolyckades. 1930 återfördes deras kroppar och begravdes under högtidliga former i Stockholm.

En, som redan nämnts, ganska bortglömd svensk polarfarare och pionjär var Anton Rolandson Martin (1729–1785) född i Reval (Tallinn) och student i Åbo under en av Carl von Linnés första resande apostlar, Pehr Kalm. Martin kom därefter att studera i Uppsala för Linné själv och disputerade den 22 juni 1757 på en avhandling om mossarten Buxbaumia ”dess beskrifvning och naturalie historie”. Den lyckade disputationen resulterade i en förfrågan från Linné om Martin var villig att resa med valfångstfartyg till ”Nårrpolen”, som det stavades då, och där undersöka samt hemföra naturalier. Martin blev Sveriges första

Arktis-resande vetenskapsman då han följande år, 1758, reste norrut med fartyget ”De Visser”, (på svenska: Fiskaren), som köpts in av handelsmannen Peter Samuelsson Bagge i Göteborg och Svenska Grönländska Kompaniet i Hamburg. Mellan Martin och Andrée finns vissa liknande personlighetsdrag som avspeglas i den vetenskapliga gärningen. Martin var hängiven naturvetenskapen och ville bevisa hur människan kunde exploatera naturen. Andrée drevs av en förhoppning om att visa hur den tekniskt upplysta människan kunde resa över Nordpolen. För dem båda var polarexpeditionerna produkter av en tidsanda. De delade en stor tro till tekniska och vetenskapliga framsteg, men de skilda tidsåldrar de levde i gav olika förutsättningar. En annan likhet var att såväl Martin som Andrée drevs fram av samtidens sociala och vetenskapliga krav och deras personliga ärelystnad var säkert en av de faktorer som gjorde dem till polarfarare.

Bakgrunden till den expedition Martin kom att delta i stod att finna i Bagges vurm för den svenska fiskerinäringens modernisering och en förhoppning om valjakt. Han hade under flera år försökt påverka Kungliga Vetenskapsakademiens sekreterare Pehr Wilhelm Wargentin om att denna skulle be Linné om hjälp att finna en lämplig naturvetenskapsman. Linné, som var av känslig natur, hade i sin tur ett särskilt gott öga till den fattiga och märkliga ”finnen” Martin. Under studierna i Uppsala hade Martin gjort sig känd som något av ett spektakel, ständigt mager och med omaka skor och för stor peruk drev han omkring i staden och letade efter mossa att studera för sin avhandling. Då Linné bad honom resa tvekade han inte för en sekund.

De Visser lämnar Göteborg anonymt 17 april, 1758, visar lösen vid Elfsborg, seglar ”höger om Vinga”, skriver Martin, ut mot Nordsjön och vidare mot Arktis. När Andrée-expeditionen reste från Göteborg 149 år senare var kajen fylld av hurrande människor.

Valfångsten skedde uteslutande sommartid och omkring 200 fartyg från flera olika nationer användes, dock flest från England och Nederländerna. Det fartyg som Martin medföljde var det enda svenska men det hade en holländsk besättning då den specialkompetens som krävdes för att segla i isen och fånga val inte gick att uppbringa i Sverige. Före resan hade Anton Rolandson Martin fått instruktioner av Linné och ledamöterna i Kungliga Vetenskapsakademien i Stockholm, där man önskade sig observationer om allt från vattentemperaturer till naturalier och mineraler. Av Akademiens sekreterare Pehr Wargentin fick Martin en termometer som han senare råkade förstöra. Kungliga Vetenskapsakademien har sedan Martins resa varit en viktig aktör i den svenska polarforskningen. Initiativ till Martins, Andrées och Nordenskiölds resor förankrades i det nav inom svensk vetenskap och forskning som Akademien varit sedan dess instiftande 1738.

Fartyget rullade starkt och det blev värre ju längre norrut man kom. Den 25 april passerade man Island och Martin upplevde att han kom allt längre in i ett ”mystiskt land” som han skriver i sina självbiografiska anteckningar. Havet skiftade färg och blev svartare medan vågorna slog allt kraftigare. Under de följande dagarna avlöste stormarna vararandra och besättningen blev orolig. Men lugnet avlöste stormen och allt blev stilla den 28 april, då De Visser gungade sakta på ett öde men lugnt hav. Samtidigt kröp termometern allt längre ner och visade minusgrader under aprils sista dagar. 5 maj passerades den norra polcirkeln.

Isens konturer liknade människor, björnar och hus, tyckte Martin och reflekterade också över hur djurlivet förändrades i takt med att fartyget trängde allt längre norrut, där sälar och fåglar blev vanligare att se från däcket. Kaptenen ombord gav order om att hissa storseglet och beordrade de två harpunerarna upp i stormasten för att hålla utkik efter och varsla om isberg. Farorna med arktiska seglatser var många och besättningen var hela tiden uppmärksam på att överge skeppet om de kolliderade med drivande is. Om så skedde fanns två möjligheter att undkomma, antingen i de små skeppsbåtar som fanns ombord eller genom att nå fram till ett isberg. Drivande is fanns såväl synligt ovan havsytan såväl som under vattenytan, men den sistnämnda var ofta större, hävdade Martin, och givetvis än svårare att undvika.

Den 11 maj nådde De Visser 78° nordlig latitud, kylan blev allt strängare och havet omkring dem började frysa till. Det blev så kallt att de ombord på fartyget var tvungna att sätta en glödgad ring kring tappen på brännvinsbehållaren. Martin konstaterade att klockorna dessutom gick fem minuter långsammare vid strängare kyla, men hur han kunde göra ett sådant konstaterande är svårt att avgöra. Här upptäcktes valar och ”anstalt gjorde för att fånga dem”. Skeppsbåtarna sattes ut med en styrman, fyra roddare och en harpunerare i varje, men de fick vänta i vattnet i flera timmar

Bild *Figure*
En gråvingad trut spanar efter föda.

A glaucous-winged gull on the lookout for food.

Bild *Figure*
En pälssälkoloni på Kommendörsöarna.

A fur seal colony on the Commander Islands.

Bild *Figure*
Utsikt från Zeppelinstationen i Ny-Ålesund på Svalbard där man bl.a. mäter aerosoler i luften.

The view from the Zeppelin station in Ny-Ålesund on Svalbard, where one activity of many is to measure atmospheric aerosols.

innan två valar dök upp inom räckhåll. Den ena dök ner under De Visser medan den andra slog med stjärten så att en skeppsbåt nästan förliste. Hela incidenten är ganska typisk för denna expedition, där besättningen inte var vidare kompetent till att fånga val men drevs av vinstintresse. Emellertid hade ett engelskt valfångstfartyg i närheten lyckats bättre och Martin tilläts där observera slakten, som han noggrant redovisade.

Fartyget De Visser, med Martin och besättning ombord, nådde som mest 80° nordlig bredd vid Grönlands kust utan någon jaktlycka för egen del. Därifrån seglade de mot Spetsbergen under försommarens pingsthelg, och på fjärde dagen med den nya rutten blåste det upp till storm. Martin berättar att hela havet kom i gungning och att fartygets kapten navigerade tappert för att undvika isbergen. Under tiden låg Martin själv under däck med psalmboken och inväntade slutet, men stormen bedarrade slutligen. ”Den dagen glömmor vi aldrig”, skriver han senare i sina självbiografiska anteckningar, med tillägget att elva andra valfångare hade förlist i samma storm.

Vid månadsskiftet juni–juli hade isen kring Spetsbergen fortfarande inte smält denna sommar, vilket skapade goda möjligheter för Martin att umgås med besättningarna på andra fartyg. Eftersom fartygen ankrade längs isen var det som att ligga vid en mycket enslig hamn, besättningarna kunde gå över isen till varandra. På fångstfartyget Chatarina från Nederländerna kunde besättningen visa upp skinnen av två isbjörnar. ”Utmärkt” noterade Martin i sin resedagbok, eftersom han av Linné blivit ombedd att undersöka den vita polarbjörnen. Björnarna lockades till fartygen genom valkött som lades på glöd. Då de ätit av köttet lade de sig för att sova bakom någon isklippa, varpå någon eller några ur besättningen passade på att skjuta dem. Martin skriver också att om björnen inte dör av skottet tar den snö och stoppar i såret för att därefter springa sin väg. Det var heller inte helt ovanligt att besättningsmän tog med sig isbjörnsungar ombord och hem, eller sålde dem i närmaste hamn. Andra djur som observeras på isen är polarräv och

ismåsar. De sistnämnda jagades och infångades i ganska stort antal för att ätas av skeppsbesättningarna. En viktig del i det uppdrag Martin tilldelats av Vetenskapsakademien var att undersöka samtliga aspekter av valfångst i Arktis och bland annat möjligheterna att använda kött som föda till sjöfolk.

De Visser ankrade sedan längs Grönlandskusten i sin jakt på val och i sin förundran över naturen konstaterar Martin att isen liknar kristall. En västanvind öppnade en passage genom isen som De Visser utnyttjade för att åter segla till Spetsbergen. Nätterna och dagarna flöt in i varandra och Martin fick rimfrost i skägget, hela upplevelsen av att vara unik och att kunna göra en speciell vetenskaplig observation drev honom i stor utsträckning framåt. När Spetsbergen syntes föröver, bildade dess berg en prismatisk vy och utgjorde bakgrund till sju stora isberg som gav hela sceneriet en magnifik inramning. Martin noterade att de vid Spetsbergen hade det bästa vädret under hela resan, temperaturen stod över fryspunkten hela tiden och ofta omkring +8 grader. Fartyget ankrade på lämplig redd och därifrån kunde Martin bege sig ut på exkursioner.

Ombord fanns det emellertid ett utbrett missnöje mot företagets dåliga utkomst, ingen fångst innebar uteblivna löner för matroserna. Kaptenen var beredd att ge Martin tid och möjlighet att bese hela Spetsbergen, vilket de övriga i besättningen inte gick med på. Till slut fick matroserna sin vilja igenom och Martin tvingades återvända till Göteborg efter att bara ha tillbringat några timmar på fast mark på Spetsbergen. Han hade i alla fall ägnat denna tid åt noggranna och flitiga observationer som han trodde att Linné skulle uppskatta. Med sig hem hade han prover från valar, mossor, insekter samt en död stormfågel som han tyckte mycket om. I ett anfall av inställsamhet och generositet skulle fågeln senare skänkas till Linné. Därtill medförde Martin kontinuerliga termometriska undersökningar, vattenprover och analyser av mineraler; Vetenskapsakademiens ledamöter hade inte glömt något inom naturvetenskapen som borde undersökas när han väl befann sig i Arktis. Nu började den långa resan hem till

Bild *Figure*
De få växter som klarar sig i Nordostlandets polaröken måste anpassa sig till både kyla och torka.

The few plants that survive in the Nordaustlandet polar desert have to be adaptable to both cold and drought.

Bild *Figure*
Anton Rolandson Martins rapport till Vetenskapsakademien om den fågel han fört med sig från Svalbard.

Anton Rolandson Martin's report to the Royal Swedish Academy of Sciences on the bird he had brought with him from Svalbard.

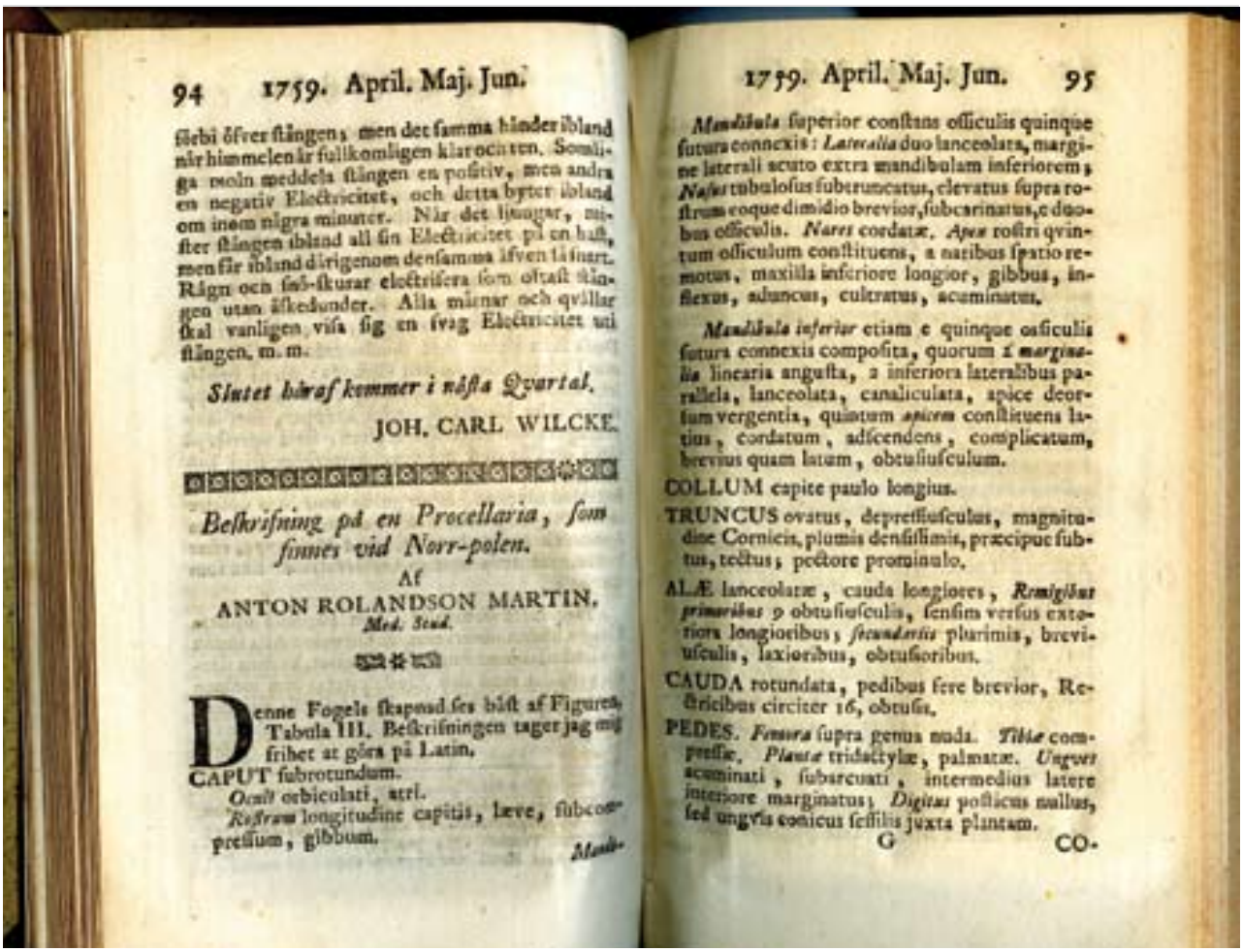
Uppsala men först måste De Visser angöra Göteborg där man träffade en besviken entreprenör, Peter Samuelsson Bagge.

Martin reste direkt från Göteborg till Skåne för att han ville besöka universitetet i Lund. Där hade Linné själv studerat, och det vore inte dumt att stoltsera med en vistelse i Lund när han senare skulle samtala med honom om resan. Bönderna skrattade åt honom när han fotvandrade genom landet under skördetid i augusti, iklädd sin slitna polarutrustning och med en stor död stormfågel under armen.

Alla utom Martin var besvikna på resultatet av expeditionen. Han var mycket belåten med resan som hade gett honom en unik erfarenhet och observationer som han var ensam om bland Linnéanerna. Då Bagge fick reda på att Martin var nöjd med den misslyckade expeditionen blev han purken och skrev till Wargentin den 16 september 1758: ”Att Herr Martin äro nöider med resan är ett bevis på spaka sinnelag.” Bagge tillade också att eftersom Martin inte var särskilt dyr i drift kunde han likväl skickas iväg igen följande sommar. Tyvärr kom det inte till Martins kännedom att man hade för avsikt att ge honom en ytterligare möjlighet att utforska Arktis. Istället reste han till Norge för att undersöka sillens vandringar och fjälljordbrukens förutsättningar. Om han känt till Bagges föresats hade han alldeles säkert inväntat kommande års expedition och stannat hemma i Uppsala för att förbereda sig.

Efter en tids sjukdom i Stockholm återvände Martin till Finland 1763. Anton Rolandson Martin avled i Åbo 1785 i en ålder av 56 år, då han var utblottad, utmattad och sjuklig, delvis genom upprepade naturvetenskapliga experiment på sig själv. Bland annat åt han flugsvamp för att observera kroppens reaktioner och temperaturväxlingar.

Skillnaden mellan Martin och de efterkommande svenska upptäcktsresenärerna under 1800-talet är enorm. Martin dör för att sedan glömmas bort, medan Nordenskjöld och Andrée hyllas av hela nationen. Idag är detta historia, men även de mindre lyckliga sådana kan ge oss en bild av de sociala och kulturella förutsättningarna som rådde under den svenska polarforskningens inledningsperiod.



94 1759. April. Maj. Jun.

flebi öfver ſtången; men det ſamma hinder ibland när himmelen är fullkomligen klar och ren. Somliga moln meddela ſtången en poſitiv, men andra en negativ Electricitet, och detta byter ibland om inom några minuter. När det ljungar, miſter ſtången ibland all ſin Electricitet på en half, men får ibland dirigenom denſamma ifven lå finart. Rägn och ſnö-ſkurar electriſera ſom oftaſt ſtången utan åſkedunder. Alla månar och qvällar ſkal vanligen viſa ſig en ſvag Electricitet uti ſtången, m. m.

Slutet häraf kommer i näſta Qvartal.

JOH. CARL WILCKE.

Beſkrifning på en Procellaria, ſom finnes vid Norr-polen.

Af

ANTON ROLANDSON MARTIN.
Med. Stud.

Denne Fogels ſkapnad ſes bäſt af Figuren, Tabula III. Beſkrifningen tager jag mig frihet at göra på Latin.

CAPUT ſubrotundum.
Oculi orbiculati, ſtri.
Roſtrum longitudine capitis, læve, ſubcompreſſum, gibbum.

Mandibula

1759. April. Maj. Jun. 95

Mandibula ſuperior conſtans oſſiculis quinque ſuturâ connexis: *Lateralia* duo lanceolata, margine laterali acuto extra mandibulam inferiorem; *Naſus* tubuloſus ſubtruncatus, elevatus ſupra roſtrum eoque dimidio brevior, ſubcarinatus, e duobus oſſiculis. *Nares* cordatæ. *Apex* roſtri qvintum oſſiculum conſtituens, a naribus ſpatio remotus, maxilla inferiore longior, gibbus, inflexus, aduncus, cultratus, acuminatus.

Mandibula inferior etiam e quinque oſſiculis ſuturâ connexis compoſita, quorum 2 *marginalia* linearia angusta, a inferiora lateralibus parallela, lanceolata, canaliculata, apice deorſum vergentia, quintum *apicem* conſtituens latius, cordatum, adſcendens, complicatum, brevius quam latum, obtuſiuſculum.

COLLUM capite paulo longius.

TRUNCUS ovatus, depreſſiuſculus, magnitudine Cornicis, plumis denſiſſimis, præcipue ſubtus, tectus; pectore prominulo.

ALÆ lanceolatæ, cauda longiores, *Remigibus primoribus* 9 obtuſiuſculis, ſenſim verſus exteriora longioribus; *ſecundariis* plurimis, breviuſculis, laxioribus, obtuſioribus.

CAUDA rotundata, pedibus fere brevior, Rectricibus circiter 16, obtuſis.

PEDES. *Femora* ſupra genua nuda. *Tibiæ* compreſſæ. *Plantæ* tridactylæ, palmatæ. *Ungues* acuminati, ſubarcuati, intermedius latere interiore marginatus; *Digitus* poſticus nullus, ſed unguis conicus ſeſſilis juxta plantam.

G CO-

Anton Rolandson Martin – Linnaeus apprentice and Sweden's first polar scientist

Andreas Jemn
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Polar research and explorers are enveloped in a historical mystique. However, that is not true of Sweden's first scientific polar explorer, Anton Rolandson Martin, who has been almost entirely forgotten. To best understand Martin, he should be put into a historical context that extends over nearly 500 years of international expeditions to the Arctic region. The reasons for making polar expeditions have changed significantly over the centuries. Up until the end of the 1700s polar expeditions were conducted by merchants and whale hunters, mainly from England and the Netherlands. The primary aim of those expeditions was to exploit the natural resources found in the Arctic region, mainly whales, but the explorers were also searching for new sea lanes, trading routes that is, to other continents. The Northeast Passage was one such route that attracted seafarers as early as the 1500s.

Polar travel began to take on a more scientific cast during the 1700s. Financial motivations were still dominant, but the Enlightenment's passion for the beneficial effects of science on society led to a coordination of financial considerations and the natural sciences in order to promote the public welfare. Natural scientists began to accompany Arctic explorers so that they could study the polar region more carefully. These scientists were expected to study every aspect of the nature in the Arctic region, and to help make whale hunting more efficient.

From a Swedish standpoint, the latter part of the 1800s was a golden age for polar research expeditions. The era began with Sven Lovén's and Otto Torén's searches for fossils on Spitsbergen to verify glacial theories. These were followed by a period of successful Swedish polar expeditions, highlighted by Adolf Erik Nordenskjöld's voyage through the Northeast Passage in 1878–1880. Another spectacular event was the André Expedition of 1897, conducted under the leadership of chief engineer Salomon August Andrée from Gränna. Together with Nils Strindberg and Knut Fraenkel, he had intended to fly over the North Pole in a balloon, Örnen, ("The Eagle") but the expedition was unsuccessful and the participants were lost. Their bodies were recovered in 1930 and given a ceremonial burial in Stockholm.

As noted above, one Swedish polar explorer and pioneer who has been quite forgotten is Anton Rolandson Martin (1729–1785), who was born in Tallinn and studied in Åbo under

Bild *Figure*

Cochlearia groenlandica, vardagligt kallad grönländsk skörbjuggsört, som den ser ut levande och växande i naturen.

Cochlearia groenlandica, commonly known as Greenland scurvy grass, as it looks when thriving in its natural habitat.

Bild *Figure*

Den *Cochlearia groenlandica* som Anton Rolandson Martin förde med sig från Svalbard till Linné, och som nu finns på Naturhistoriska Riksmuséet i Stockholm.

The *Cochlearia groenlandica* that Anton Rolandson Martin retrieved from Svalbard for Linnaeus, and which is now housed in Stockholm at the Swedish Museum of Natural History.

Bild *Figure*
En underkäke av fjällräv på Svalbard.

The lower jaw of an arctic fox on Svalbard.

one of Linnaeus's early disciples, Pehr Kalm. Martin later studied in Uppsala under Linnaeus himself, defending a thesis on the moss species Buxbaumia, "its description and natural history" there on 22 June 1757. The successful thesis defence led Linnaeus to ask Martin if he would be willing to travel along with a whaler to the North Pole, and to study and bring back nature specimens. Martin became Sweden's first scientific traveller to the Arctic the following year, 1758, when he travelled north with the ship De Visser ("The Fisher"), which had been purchased by merchant Samuelsson Bagge of Gothenburg and the Swedish Greenland Company in Hamburg. Martin and Andrée shared certain similarities of personality that were reflected in their scientific activities. Martin was devoted to the natural sciences, and wanted to show how man could exploit nature. Andrée was motivated by the hope of showing how technically enlightened mankind could travel across the North Pole. Polar expeditions were, for both men, a product of the spirit of their times. They shared a strong faith in technical and scientific progress, although the different times in which they lived entailed that they operated under different conditions and assumptions. Another similarity was that both Martin and Andrée were driven by the social and scientific demands of their respective eras, and their desire for personal glory was certainly one of the factors that made them become polar explorers.

The expedition in which Martin came to take part was motivated by Bagge's eagerness to modernise the Swedish fishing industry, and by hopes of a whale hunt. For several years he had tried to convince the secretary of the Swedish Royal Academy of Sciences, Pehr Wilhelm Wargentin, to ask Linnaeus for help in finding a suitable natural scientist. Linnaeus, who was of a sensitive nature, had a special appreciation for the impoverished and remarkable Finn, Anton Rolandson Martin. During his studies in Uppsala, Martin had become known as something of a spectacle, running around the city looking for mosses to study for his thesis, painfully thin, wearing shoes that did not match and an oversize wig. When Linnaeus asked him to take the trip, Martin did not hesitate for a second.

The De Visser left Gothenburg anonymously on 17 April, 1758, displayed the countersign at Elfsborg, and sailed "to starboard around Vinga," writes Martin, heading out toward the North Sea and on toward the Arctic. When the André Expedition left Gothenburg 149 years later, the wharf was filled with people cheering.

The whale harvest happened exclusively during the summer months, and some 200 vessels from various other nations were involved, although most of them came from England or the Netherlands. The vessel that Martin was on board was the only Swedish one, although it had a Dutch crew because the specialised expertise required to sail in the ice and catch whales was not to be had in Sweden. Linnaeus and the members of the Royal Swedish Academy of Sciences in Stockholm gave instructions to Anton Rolandson Martin before he departed, as they wanted him to make observations of everything from water temperatures to flora, fauna and minerals. Academy secretary Pehr Wargentin obtained for Martin a thermometer, which he later ended up breaking. Since Martin's voyage, the Royal Swedish Academy of Sciences has been an important actor in Swedish polar research. The impetus for the expeditions made by Martin, Andrée and Nordenskiöld was rooted in the Swedish science and research hub that the Academy has served as since it was founded in 1738.

The vessel rolled heavily, and things got worse the farther north she went. They passed Iceland on 25 April, and Martin observed that he was penetrating deeper and deeper into a "mystical land," as he described it in his autobiographical notes. The ocean changed colours, turning blacker, as the waves continued to increase in force. The storms followed one after another over the ensuing days, and the crew grew uneasy. But calm replaced the storms on 28 April, and everything became still, as the De Visser rocked slowly across a desolate but peaceful sea. The thermometer continued to drop, reading below zero in the last days of April. The De Visser crossed the Arctic Circle on 5 May.

Martin thought that the contours of the ice resembled people, bears and houses, and he also reflected on how the fauna changed as the vessel pushed ever farther northward, where seals and birds were observed from the deck with increasing frequency. The captain gave the order to raise the mainsail, and ordered his two harpooners to climb the mainmast and stay on the lookout for icebergs. Sailing in the Arctic posed many hazards, and the crew were always ready to abandon the ship if it should collide with driving ice. If it did, there were two options available: one could escape in the small lifeboats that were kept on board, or try to

Bild *Figure*
En vy över stationen Kinnvika på Nordostlandet, Svalbard.

A view of Kinnvika station on Nordaustlandet, Svalbard.

reach an iceberg. Driving ice occurred both in visible form above the ocean surface and below it, but the latter ice formations were often bigger, according to Martin, and of course harder to avoid.

The De Visser reached 78° north latitude on 11 May; the cold grew ever stronger, and the sea around them began to freeze. It got so cold that those on board were forced to put a red-hot ring around the tap on the brandy container. Martin noticed that the clocks also ran five minutes slow in the severe cold, although it is difficult to imagine how such an observation could actually be made. Whales were spotted, and "arrangements made to capture them." The ships were put out with one steersman, four rowers and a harpooner in each, but they had to sit and wait in the water for several hours before two whales finally surfaced within range. One dove beneath the De Visser, while the other one struck the water so hard with its tail that one of the boats nearly capsized. The entire incident was fairly typical of the expedition, as the crew was not really skilled in catching whales, although it was driven by a desire for profit. However, a nearby English whaler had better success, and Martin was allowed to observe the slaughter, which he described in detail.

With Martin and the crew onboard, the De Visser reached 80° north along the coast of Greenland without enjoying any hunting success. From there they sailed toward Spitsbergen during Whitsuntide in late spring, and a storm blew up on their fourth day on the new course. Martin reported that the entire ocean was rocking, while the ship's captain navigated bravely to avoid icebergs. Martin himself stayed below deck with his psalm book and waited for the end, but the storm finally abated. "We'll never forget that day," he wrote later in his autobiographical notes, adding that eleven other whalers had been lost in that same storm.

The ice around Spitsbergen still had not thawed by late June/early July of that summer, giving Martin ample opportunity to socialise with the crews from other vessels. Because the ships were anchored along the ice, it was as if they lay in a very isolated harbour, and the crews could walk across the ice to one another. The crew of the Dutch hunting ship Chatarina showed off the skins of two polar bears. "Excellent" noted Martin in his trip log, as Linnaeus had asked him to study the white polar bears. The bears were lured to the vessels by putting whale meat on glowing coals. After the bears ate the meat, they lay down to sleep behind an ice cliff, and the crew went and shot them. Martin also wrote that if a bear were not killed upon

Bild *Figure*
Illustration i Martins rapport till Vetenskapsakademien.

An illustration in Martin's report to the Royal Swedish Academy of Sciences.

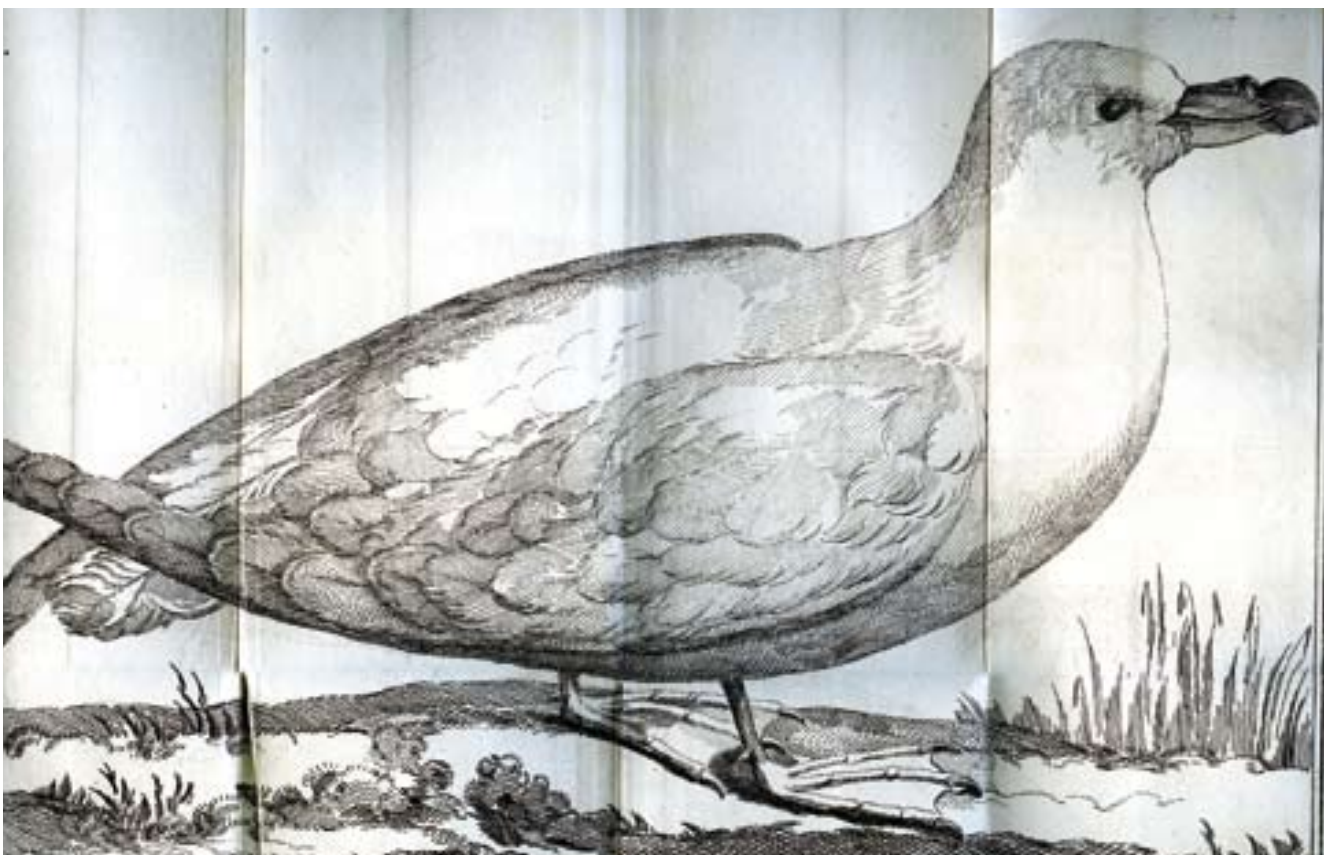

Bild *Figure*
En fjällräv som håller koll på kameran.

A polar fox checking out the camera.

being shot, it would take snow and plug up the wound before running away. It was not uncommon for crewmembers to take polar bear cubs on board and then home, or to sell them in the nearest port. Other animals that were observed included polar foxes and ivory gulls. The gulls were hunted and captured in fairly large numbers to be eaten by the ships' crews. One of the main tasks given Martin by the Royal Swedish Academy of Sciences was to study all facets of the Arctic whale hunt, including the possibilities of using meat to feed seafarers.

The De Visser was later anchored along the Greenland coast to hunt whales and, in his wonderment at the natural surroundings, Martin reported that the ice was like crystal. A westerly wind opened a passage through the ice, allowing the De Visser to sail to Spitsbergen once again. The days and nights blurred into one another, and Martin had rime in his beard; he was driven largely by the entire experience of being unique, and of being able to make his own special scientific observations. At the sight of Spitsbergen ahead of them, its mountains formed a prismatic view against a backdrop of seven large icebergs, which framed the entire scene in a magnificent way. Martin noted that they enjoyed the best weather of the whole voyage at Spitsbergen; the temperature remained consistently above freezing, often reaching +8°. The ship rode at anchor, and Martin was able to get away on excursions from there.

However, dissatisfaction with the company's poor results was widespread on board, as the lack of a catch meant less pay for the sailors. The captain was prepared to give Martin time and opportunity to see all of Spitsbergen, but others among the crew were opposed. The wishes of the sailors finally prevailed, and Martin was forced to return to Gothenburg after having spent only a few hours on solid land at Spitsbergen. At least he had spent that time diligently making careful observations that he thought Linnaeus would appreciate. He brought home with him whale, moss and insect specimens, plus a dead fulmar of which he thought a great deal. The bird would later be given to Linnaeus as a gift, in a surfeit of gratitude and generosity. Martin also conducted continuous thermometric tests, collected water samples and analysed minerals; the members of the Royal Swedish Academy of Sciences had omitted nothing in terms of the aspects of natural science Martin was to study while in the Arctic region. Now began the long journey home to Uppsala, but the De Visser first had to make port at Gothenburg, where they were greeted by a disappointed entrepreneur, Peter Samuelsson Bagge.

Martin travelled directly from Gothenburg to Skåne, as he wished to visit the university in Lund. Linneaus had studied there, and it would be a good idea to be able to boast a stay in Lund when Martin later met with Linnaeus to discuss the journey. The farmers laughed at Martin as he roamed through the countryside on foot during the August harvest, clad in his threadbare polar gear, with a stuffed fulmar under his arm.

Everyone except Martin was disappointed with the results of the expedition. He was highly pleased with the trip, which had afforded him a unique experience and enabled him to make observations that only he, among all of Linnaeus's disciples, could claim. When Bagge heard that Martin was pleased with the failed expedition, he grew sullen and wrote to Wargentin on 16 September 1758: "That Mr Martin is pleased with the trip is evidence of a weak disposition." Bagge added that, because Martin was not particularly costly to have along, he could nevertheless ship out again the following summer. Unfortunately, Martin never learned of Bagge's intention to give him another opportunity to research the Arctic regions. Martin travelled instead to Norway to study herring migrations and farming conditions in the mountains. Had he known of Bagge's intentions, he would most certainly have looked forward to the next year's expedition and stayed at home in Uppsala to make preparations.

After a period of illness in Stockholm, Martin returned to Finland in 1763. Anton Rolandson Martin died in Åbo in 1785 at the age of 56; destitute, exhausted and sickly, partly as a result of the repeated science experiments to which he had subjected himself, including eating fly agaric to observe his body's reactions and temperature changes.

The differences between Martin and the Swedish explorers that followed during the 1800s were enormous. Martin died and was forgotten, while Nordenskjöld and Andrée won the praises of the entire country. Today this is all history, but even the less successful explorers can give us an idea of the social and cultural conditions that prevailed in the early days of Swedish polar research.

Bild *Figure*
Moderna polarforskare använder ofta flygplan istället för valfångstfartyg, här en Dornier 228-200 turboprop i Antarktis som ägs av tyska Alfred Wegener Institut.

Modern day polar researchers often use airplanes instead of whalers, in this case a Dornier 228-200 turboprop in Antarctica, owned by the German Alfred Wegener Institute.

Innehåll Årsredovisning 2007

Resultatredovisning 2007

Ur regleringsbrev för 2007

Politikområde	Verksamhetsområde	Verksamhetsgren
Forskningspolitik	Forskningens infrastruktur	Polarforskningsexpeditioner

Mål:

Sverige skall vara en ledande forskningsnation, där forskning bedrivs med hög vetenskaplig kvalitet.
Polarforskningssekretariatets verksamhetsområde – Forskningens infrastruktur

Mål:

En effektiv infrastruktur som ger goda förutsättningar för forskning.

Återrapportering:

Polarforskningssekretariatet skall redovisa en samlad bedömning av hur sekretariatets verksamhet bidragit till målet för verksamhetsområdet.

POLARÅRET 2007

Målet för Polarforskningssekretariatets expeditionsverksamhet är att tillhandahålla goda logistiska och operativa förutsättningar för polarforskning. Den huvudsakliga inriktningen på verksamheten har varit planering och genomförande av forskningsexpeditioner. Därigenom har Polarforskningssekretariatet fortsatt med de långsiktiga åtaganden som krävs för att svensk polarforskning skall kunna bedrivas på ett kostnadseffektivt sätt. Utvecklingen har gått mot allt mer tekniskt stöd allteftersom forskningen blivit mer komplex och tekniskt avancerad. Detta ställer ökade krav på teknisk kompetens hos personalen, vilket delvis har mötts genom nyrekrytering och genom projektanställningar för expeditioner.

Polarforskningssekretariatet har sedan 2006 ett tioårigt samarbetsavtal med Sjöfartsverket om förhyrning av isbrytaren Oden. Oden har upprustats och moderniserats främst avseende elektronik och IT, för att ge forskarna effektivare hjälpmedel. En genomgripande förändring på Oden gjordes våren 2007, när ett flerstråligt (multibeam-) ekolod installerades. Detta instrument finansierades av Knut och Alice Wallenbergs Stiftelse, Vetenskapsrådet och med stöd från Sjöfartsverket. För drift och underhåll har Polarforskningssekretariatet en viktig roll, i samarbete med forskare på Stockholms universitet. För sekretariatet betyder det bland annat ett ökat engagemang både personellt och för datahanteringen.

Odens attraktionskraft på den internationella marknaden, delvis beroende på den nya multibeam-anläggningen, har medfört en ökning av aktiviteter både i norr och i söder. Forskning med Oden som plattform har därför under det senaste året expanderat till en mer eller mindre kontinuerlig verksamhet året om. Det har betytt ett allt mer intensivt internationellt engagemang med samarbetsavtal, samfinansiering med partners från andra länder och forskningssamarbete. En stor del av Odenexpeditionerna finansieras från externa källor, vilket återspeglas i utvecklingen av Polarforskningssekretariatets omslutning. Tjänsteexporten har under året varit nästan tre gånger större än det statliga myndighetsanslagets storlek.

I juli undertecknade Polarforskningssekretariatet tillsammans med Vetenskapsrådet ett samarbetsavtal om polarforskningssamarbete med National Science Foundation (NSF). Kärnan i avtalet gäller utnyttjandet av Oden i Antarktis för isbrytning till den amerikanska forskningsstationen McMurdo och för marin forskning. Säsongen 2006/07 gjordes en mycket lyckosam pionjärresa, som nu följdes upp med en ny forskningsexpedition i svensk-amerikanskt samarbete. Syftet är att detta arrangemang skall fortsätta under kommande år.

Oden tjänade också som plattform för två stora arktiska expeditioner under sommaren 2007. I det ena fallet var fartyget inhyrt av National Science Foundation, i det andra handlade det om ett samarbete mellan svenska forskare och Danmarks og Grønlands Geologiske Undersøgelse (GEUS) för maringeologiska studier norr om Grönland. För denna senare expeditionen hade också hyrts in en rysk isbrytare som isbrytarhjälp.

Samarbetet med Vetenskapsrådet (VR) för forskningsplanering och finansiering av forskning har skett genom olika kanaler. Ämnesråden på VR har ett ansvar för kvalitetsgranskning och finansiering av forskningsprojekt och flertalet av polarforskningens program faller inom dessa ramar. Vetenskapsrådets kommitté för forskningens infrastrukturer (KFI) har ansvar för polarforskning och flera projekt bereds därför inom KFI. Ett specifikt exempel är datahantering. Slutligen ingår den Svenska kommittén för internationella polaråret (IPY), under det Internationella polaråret fram till sista februari 2009, i VR:s organisation. IPY-kommitténs insatser har haft en betoning på utåtriktad verksamhet i enlighet med IPY:s övergripande syften.

Polarforskningssekretariatets relationer med de forskningsplanerande och forskningsfinansierande delarna av systemet har således varit mer mångfacetterat än tidigare. Forskarkontakterna med andra mer tillämpade områden samt näringsliv och samhälle har inte varit lika framträdande. Polarforskningssekretariatets insatser för utåtriktad verksamhet har varit synnerligen intensiva och framgångsrika. IPY har bidragit till att skapa goda förutsättningar för sådana insatser. Även i det sammanhanget har kontakterna med VR och andra forskningsorganisationer, nationellt och internationellt, varit betydelsefulla.

Under 2007 har ett antal initiativ tagits av statsmakterna som rör forskningspolitik, finansiering och myndighetsstruktur. Dessa utredningar berör eller kan komma att beröra

Polarforskningssekretariatet på olika sätt. Vid årsskiftet 2007/08 blev Polarforskningssekretariatet en enrådighetsmyndighet, vilket innebär att myndighetens chef ensam har ledningsansvaret och att styrelsen avskaffades. Andra åtgärder som kan påverka organisation och verksamhet torde bli tydliggjorda i samband med den forskningsproposition, som regeringen avser att lägga under 2008. Självfallet kommer då också polarforskningens framtid att influeras av hur forskningsrådens och universitetssystemets organisation, resurser och spelregler kommer att utformas. I denna årsredovisning lämnas dessa framtidsperspektiv därhän.

Verksamheten under året och det som genomförts av forskningsinsatser i Arktis och Antarktis under säsongen 2007/08, som redovisas i nästa års årsredovisning, uppfyller väl de mål som Polarforskningssekretariatet har haft att verka för. En fylligare presentation av innehållet i dessa aktiviteter finns som vanligt att hämta i årsboken där också denna årsredovisning kommer att ingå.

Organisation

Styrelsen

Styrelsen med sju ledamöter inklusive chefen för sekretariatet har under året haft sex styrelsesammanträden, varav ett var telefonmöte och ett var per capsulam. Från och med årsskiftet 2007/08 entledigades styrelsen i och med att myndigheten blev en enrådighetsmyndighet.

Intern organisation

Den interna organisationen är indelad i enheterna ledning, administration, information och dokumentation, miljö och logistik medan planeringen av expeditioner sker i projektform.

Personal och kompetensförsörjning

De personella resurserna utgörs av en grupp tillsvidareanställd personal som kompletteras med extern kompetens för att tillgodose särskilda bemanningsbehov, framför allt i samband med genomförande av expeditioner. Sedan flera år tillbaka har sekretariatet en grupp personer med specifik kompetens som projektanställs för expeditioner eller anlitas för andra särskilda uppgifter för att komplettera den fasta personalens kompetens.

I december 2007 var 15 personer tillsvidareanställda, sex kvinnor och nio män. En av dessa var tjänstledig för annat arbete. Förutom den fasta personalen var 10 personer, tre kvinnor och sju män anställda för särskilda projekt under året eller som vikarie. Tre av dessa arbetar inom sekretariatet för International Arctic Science Committee, som Polarforskningssekretariatet är värd för sedan 2006. Åldersfördelningen bland personalen, inklusive tillfälligt anställda och tjänstlediga är spridd mellan 27 och 64 år. Sjukfrånvaron har under året varit på samma nivå som förra året, dvs. 0,8 %.

Vid rekrytering av fast eller tillfällig personal har det inte varit några svårigheter att finna kompetent personal. Däremot har det varit svårare att bryta traditionella könsmönster i yrkesgrupper. Vid rekrytering strävar sekretariatet efter mångfald där medarbetarnas bakgrund,erfarenheter, kunskaper och personligheter kommer att berika verksamheten.

För de närmaste åren förutses en fortsatt efterfrågan på teknikkompetens för att möta forskningens ökande krav på tekniskt stöd samt IT, liksom att tjänsteexportverksamheten ställer nya krav på teknisk kompetens. Under 2007, liksom året innan, gjordes en förstärkning av sekretariatets IT-funktion. Det förutses ett utökat behov av personal inom enheterna för information/kommunikation och administration.

Examensarbeten, praktikanter

Polarforskningssekretariatet fortsätter att erbjuda studenter möjlighet att utföra examensarbeten inom olika områden. Under 2007 har två studenter från Kungliga Tekniska högskolan (KTH) arbetat med examensarbeten; ett inom geografiska informationssystem i Antarktis och ett inom miljöövervakning. Under året har en person haft sin arbetsträning/praktik förlagd till sekretariatet.

Lokaler och infrastruktur

Polarforskningssekretariatet har sina lokaler hos Kungl. Vetenskapsakademien i Stockholm. Logistikenheten flyttade hösten 2006 från Järfälla till Kräftriket inom Stockholms universitets område. Syftet med flytten har framför allt varit att anpassa lokalernas storlek till nuvarande logistikverksamhet samt att få en ökad närhet mellan logistikenheten och övriga enheter.

I Antarktis finns två svenska forskningsstationer, Wasa och Svea, med infrastruktur i form av fordon, forskningsmoduler och annan fältutrustning, som under 2006 förstärktes med en ny bandvagn. Investeringen var nödvändig för att kunna genomföra den japansk-svenska expeditionen, JASE (Japanese-Swedish Antarctic Expedition).

Utrustning som används ombord på Oden, bland annat containrar som är avsedda för laboratorier och vinschar för oceanografisk provtagning, förvaras mellan expeditionerna i hamn i anslutning till fartyget.

Miljöledning

Polarforskningssekretariatet har som statlig myndighet fått regeringens uppdrag att införa miljöledningssystem. Sekretariatets miljöledningssystem har strukturerats i enlighet med ISO 14 001 och regeringens riktlinjer. En miljöpolicy har antagits under 2007 och en miljöplan med övergripande miljömål håller på att tas fram. Dessa styrdokument är integrerade till det sedan tidigare pågående miljöarbetet under expeditioner som syftar till att minimera miljöpåverkan från Polarforskningssekretariatets aktiviteter såväl i polartrakterna som i Sverige.

Uppdrag

I regleringsbreven för 2006 och för 2007 har sekretariatet fått regeringens uppdrag att upprätta en handlingsplan för hur lokalerna, verksamheterna och informationen vid

myndigheten skall bli tillgänglig för personer med funktionshinder. Planen redovisades till Myndigheten för handikappolitisk samordning (Handisam) i början av 2007. Arbete med anpassning av informationen på webbplatsen (se avsnitt Information och dokumentation) har prioriterats.

Verksamhetens intäkter och kostnader

Intäkterna och kostnaderna varierar stort mellan åren beroende på expeditionernas storlek och inriktning. Forskningssatsningar med omfattande samordning och tung logistik dominerar. Mindre krävande logistik och annat stöd är viktigt för enstaka projekt och återkommande program. Finansiering av de stora expeditionerna har under flera år möjliggjorts genom att anslagssparande från ett år har fått användas under ett senare år. Så var fallet under 2005 då sekretariatet disponerade hela sitt anslagssparande från 2004 för Beringia 2005. Under 2006 användes en stor del av anslaget för utgifter i anslutning till Beringiaexpeditionen. Sekretariatet fick också extra medel, 2 500 tkr från anslaget 26:11 Särskilda utgifter för forskningsändamål för att täcka oförutsedda kostnader i samband med 2005 års expedition. Av anslaget för 2007 har 2 351 tkr av utgifterna avsett Beringia 2005.

Ramanslag med anslagssparande (tkr)

	2007	2006	2005	2004	2003
Ramanslag	*31 766	25 526	25 203	25 080	24 169
Anslags-sparande från föregående år	-151	420	5 357	3 610	757
Disponibelt belopp	**31 615**	**25 946**	**30 560**	**28 690**	**24 926**

* 6 000 tkr i extra anslag 2007

Utgiftsprognoser för anslaget har, i enlighet med regleringsbrevet, lämnats vid fem tillfällen till informationssystemet Hermes. Övriga intäkter är bidrag från Utrikesdepartementet samt andra bidrag och avgiftsintäkter i enlighet med 4§ avgiftsförordningen. Sekretariatet har sedan 2006 haft möjlighet att bedriva tjänsteexport.

Verksamhetens intäkter exklusive anslaget (tkr)

	2007	2006	2005	2004	2003
Bidrag från Utrikes-departementet	160	160	160	160	165
Bidrag från internationella organisationer	149	0	448	34 465	723
Intäkter av avgifter enligt 4§	178	821	4 598	387	54
Intäkter av tjänsteexport*	79 998	26 898	0	0	0
Övriga bidrag	1 897	3 781	0	0	254
Finansiella intäkter	961	42	88	280	212
Totalt	**83 343**	**31 702**	**5 294**	**35 220**	**1 408**

* Exkl. finansiella intäkter

De ekonomiska resurserna har under den senaste treårsperioden utnyttjats maximalt eftersom flera stora expeditioner har genomförts. Under 2007 har verksamhet bedrivits i Antarktis genom SWEDARP 2006/07; Oden Southern Ocean och Dronning Maud Land och i Arktis SWEDARCTIC 2007; AGAVE och LOMROG samt en expedition till forskningsstationen Kinnvika på Svalbard. Under året har expeditionerna SWEDARP 2007/08 med expeditionerna JASE, Dronning Maud Land samt Oden Southern Ocean till Antarktis planerats och genomförandet startade i november 2007.

Expeditionsverksamheten är den helt dominerande verksamheten där ca 95 % av de totala kostnaderna hänförs till planerade och genomförda expeditioner. I kostnaderna för Internationellt samarbete ingår (från och med) 2006 kostnaderna för sekretariatet för International Arctic Science Committee (IASC) som Polarforskningssekretariatet är värd för och som finansieras av Vetenskapsrådet. Det internationella arbetet har varit mer omfattande under året, liksom förra året, beroende på aktivt deltagande i arbetet med Internationella polaråret samt andra internationella åtaganden, till exempel arbete under och inför Antarktisfördragets årliga möte (ATCM).

Verksamhetens kostnader (tkr)

	2007	2006	2005	2004	2003
Expeditioner	115 551	20 846	53 223	54 230	14 524
Miljö	234	334	366	316	408
Internationellt samarbete	3 537	4 358	1 677	1 168	2 389
Information och dokumentation	2 238	2 455	1 850	2 885	2 248
Totalt	**121 560**	**27 993**	**57 116**	**58 599**	**19 569**

Tjänsteexport

Intäkterna har under året dominerats av tjänsteexportverksamheten som vida överstiger anslaget. Under 2006 fick sekretariatet i regleringsbrevet möjlighet att bedriva tjänsteexport mot bakgrund av att de planerade samarbetena inom expeditionsverksamheten med samutnyttjande och samfinansiering överstiger de möjligheter som 4§ avgiftsförordningen ger statliga myndigheter, dvs. ”att tjänsteexporten ska vara av tillfälligt natur och uppgå till mindre belopp”. Bakgrunden till sekretariatets begäran till regeringen om att få bedriva tjänsteexport var dels det planerade samarbetet med National Science Foundation om förhyrning av Oden i Antarktis under säsongen 2006/07, dels ett samarbete med Danmarks og Grønlands Geologiske Undersøgelse (GEUS) om en maringeologisk expedition till Arktis sommaren 2007 och därefter preliminärt 2009 och 2011. Tjänsteexporten har varit av två typer, dels samarbeten med olika finansieringsgrad från samarbetspartnern och från

sekretariatet, dels renodlad tjänsteverksamhet. Expeditioner som hänförs till tjänsteexport beskrivs under de olika forskningsprogrammen.

En ekonomisk resultatrapport för tjänsteexporten presenteras nedan. Tjänsteexporten med anknytning till Antarktis går alltid över kalenderårsskiftet.

I årsredovisningen för 2006 hade sekretariatet inte redovisat upplupna kostnader på 14 200 tkr avseende tjänsteexport. Detta fick till följd att årets kapitalförändring 2006 var för högt redovisad samt att kostnaderna avseende tjänsteexport var för lågt redovisade med motsvarande belopp. Faktura avseende detta har kostnadsförts 2007 vilket medför att de redovisade kostnaderna för 2007 avseende tjänsteexporten är för högt redovisade med 14 400 tkr efter valutaomräkning samt att kapitalförändringen är för lågt redovisad. Överskottet från verksamheten kommer att användas för underhåll och nyanskaffning av sekretariatets utrustning ombord på Oden.

Tjänsteexport (tkr)

Verksamhet Polarforsknings-expeditioner	+/- 2006	Intäkter 2007	Kostnader 2007	+/- 2007	Ack +/- utgående 2007
DROMLAN 2005/06	10	0	0	0	10
Oden Southern Ocean 2006/07	14 113	28 654	41 645	-12 991	1 122
AGAVE	0	20 784	17 803	2 981	2 981
LOMROG	0	21 241	20 316	925	925
Oden Southern Ocean 2007/08	0	9 684	10 677	-993	-993
Totalt	**14 123**	**80 363**	**90 441**	**-10 078**	**4 045**

VERKSAMHETSGREN POLARFORSKNINGS-EXPEDITIONER

Mål 1:

Polarforskningssekretariatet skall tillhandahålla logistik och utrustning för planering och genomförande av polarforskningsexpeditioner av hög internationell klass.

Återrapportering:

- vilka polarexpeditioner som sekretariatet bidragit till, fördelade på expeditioner med svenskt respektive utländskt logistikansvar,
- antalet expeditionsdeltagare, fördelade på forskare och logistikpersonal, och uppdelade efter kön, och
- kostnaderna under året för varje planerad och genomförd expedition, fördelad på personal och utrustning.

Återrapporteringen inom de olika verksamheterna skall där så är möjligt ske i form av tidsserier över de tre senaste budgetåren.

Polarforskning – genomförda expeditioner

Polarforskningssekretariatet har i huvudsak två plattformar för expeditionslogistik. Den ena är forskningsstationerna Wasa och Svea tillsammans med fordon och annan infrastruktur i Antarktis. Den andra är isbrytaren Oden, som är tillgänglig för forskningsexpeditioner i polarområdena i och med det tioåriga samarbetsavtalet med Sjöfartsverket.

Forskningsprogrammen SWEDARP (Swedish Antarctic Research Programme) och SWEDARCTIC (Swedish Arctic Research Programme) fastställs för varje säsong i samråd med Vetenskapsrådets Polarforskningskommitté, som inför Internationella polaråret ersatts av den Svenska kommittén för internationella polaråret (IPY-kommittén). För 2005, 2006 och delvis för 2007 ligger prioriteringarna från Polarforskningskommittén till grund för expeditionsverksamheten. Fastställande av forskningsprogram och urval av deltagare i forskningsprojekt är en lång process som sker genom en fortlöpande dialog med forskarsamhället och berörda forskningsråd. Den vetenskapliga inriktningen bestäms av forskningens egen dynamik så som den kommer till uttryck i forskarnas idéer och val av forskningsområden. Expeditionsplaneringen ställer stora krav på samarbete mellan forskare, forskningsfinansiärer och internationella aktörer inom polarforskning. De vetenskapliga prioriteringarna är styrande för den forskning som utförs under expeditionerna. Planeringen av expeditionsverksamhet kräver lång tid och från idé till genomförande av en expedition är tidsrymden ofta två till fyra år. Beslut behöver tas tidigt, likaså försäkringar om tillräcklig finansiering av verksamheten.

En sammanfattning av genomförda expeditioner framgår av bilaga 1, Genomförda expeditioner 2005–2007.

Samtliga expeditioner, oavsett om de är del av de svenska programmen eller om de är tjänsteexport redovisas nedan. Tidigare års expeditioner beskrivs kortfattat.

SWEDARCTIC 2005

Beringia 2005

Beringia 2005 var den mest omfattande och komplexa expedition som sekretariatet genomfört. Expeditionen bestod av sex olika delar och genomfördes med isbrytaren Oden, det amerikanska forskningsfartyget Healy samt landbaserade fältläger i Tjukotka, Kamtjatka och Alaska med samarbetspartners från Ryssland, Kanada och USA. Totalt deltog drygt 200 forskare, personal, flyg- och fartygsbesättning från sammanlagt 15 nationer. Många olika forskningsdiscipliner var representerade under Beringia 2005, bland annat ekologi, evolution, klimatforskning, maringeologi och oceanografi. Expeditionen har beskrivits i tidigare årsredovisningar och i årsbok för 2005. Planering, genomförande och efterarbete har genererat kostnader under flera år och den sista utbetalningen som belastade anslaget gjordes 2007.

SWEDARP 2005/06

Säsongen 2005/06 genomfördes ingen expedition till forskningsstationen Wasa. Däremot fick några projekt logistikstöd i samband med aktiviteter i Antarktis:

- Dronning Maud Land – monitoring i samarbete med Finland
- AMANDA/IceCube – neutrinodetektion
- EPICA – klimathistoria
- Staten Island, sydöstra delen av Sydamerika – klimathistoria

DROMLAN

Dronning Maud Land Air Network, DROMLAN, bildades 2001 och har till syfte att försörja medlemsländerna Belgien, Finland, Indien, Japan, Nederländerna, Norge, Ryssland, Sydafrika, Sverige, Storbritannien och Tyskland med flygtransporter till, från och inom Dronning Maud Land i Antarktis.

Under säsongen 2005/06 gjordes en flygning med ett svenskt Herculesplan från Flygvapnet på uppdrag av DROMLAN inom ramen för tjänsteexporten. Flygningen gjordes från Kapstaden i Sydafrika till den norska forskningsstationen Troll.

Aktiviteterna inom DROMLAN redovisas under expeditionsverksamheten eftersom samarbetet inom organisationen är en förutsättning för genomförande av expeditioner till Dronning Maud Land.

SWEDARCTIC 2006

Sommaren 2006 genomförde sekretariatet inte några egna expeditioner i Arktis eftersom resursutrymmet var mycket begränsat efter Beringia 2005. Däremot lämnades stöd i form av fält- och kommunikationsutrustning till expeditioner där logistikansvaret hade tagits av andra länders polarorganisationer eller av forskarna själva. Geografiska områden och forskningsinriktning som fick stöd var:

- Wrangels ö – geologi
- Svalbard – industrihistoria
- Norra Grönland – klimatvariationer
- Östra Grönland – kvartärgeologi
- Svalbard – meteorologi
- Svalbard – paleontologi

SWEDARCTIC 2006 – logistikansvar och antal expeditionsdeltagare

Expedition	Logistikansvar	Forskare		Totalt
		Kvinnor	Män	
SWEDARCTIC 2006, övriga	Varierande	7	19	**26**

SWEDARP 2006/07

Satsningen i Antarktis har i huvudsak varit inriktad på aktiviteter i anslutning till stationen Wasa samt med mycket kort varsel möjlighet till forskning i samband med isbrytaren Odens första resa till Antarktis.

Dronning Maud Land

Verksamheten i Dronning Maud Land säsongen 2006/07 var den första i en serie på tre säsonger avseende forskningsplanering, kunskapsuppbyggnad och förberedelser kring logistik samt utplacering och utprovning av material. Den första säsongen vid forskningsstationen Wasa har varit inriktad på det atmosfärsfysiska projektet Moveable Atmospheric Radar in Antarctica (MARA), underhållsarbete på stationen samt förberedelser inför kommande forskningsprogram, bland annat Japanese-Swedish Antarctic Expedition (JASE). Det tredje året blir en nedtrappning och avslutning av projekten. Forskare och logistikpersonal anlände med flyg från Kapstaden via den ryska stationen Novolazarevskaja till Wasa i november 2006.

Logistiskt sett var expeditionen 2006/07 indelad i två etapper; den första var under två månader inriktad på underhållsarbeten på stationen. Dessutom utfördes transporter av utrustning och förnödenheter mellan fartyget Ivan Papanin och forskningsstationen Wasa samt den närbelägna finska forskningsstationen Aboa. Bland annat forslades en ny bandvagn, 25 ton bränsle och ytterligare 40 ton utrustning till Wasa, en sträcka på 400 kilometer. Till fartyget transporterades avfall från gångna säsonger från de svenska och finska stationerna. Transporterna blev mycket tidsödande beroende på bandvagnshaveri och lossnings- och lastningssvårigheter på grund av besvärliga is- och väderförhållanden.

De svenska och finska forskningsprogrammen strävar efter ökad logistisk samordning för att vara kostnadseffektiva och har under året samarbetat kring de omfattande transporterna. Det finska programmet, FINNARP, svarade

SWEDARP 2005/06 – logistikansvar och antal expeditionsdeltagare

Expedition	Logistikansvar	Forskare		Logistik		Totalt
		Kvinnor	Män	Kvinnor	Män	
Dronning Maud Land	Finland	0	0	0	0	**0**
AMANDA/IceCube	USA	1	5	0	0	**6**
EPICA	Tyskland	0	1	0	0	**1**
DROMLAN	Sverige	0	0	1	1	**2**
SWEDARP 2005/06, övriga	Argentina, Tyskland	1	4	0	0	**5**
Summa		**2**	**10**	**1**	**1**	**14**

SWEDARP 2006/07 – logistikansvar och antal expeditionsdeltagare

Expedition	Logistikansvar	Forskare		Logistik		Totalt
		Kvinnor	Män	Kvinnor	Män	
Dronning Maud Land ANTSYO II/ AGAMES	Tyskland	0	1	0	0	**1**
Dronning Maud Land	Sverige	0	3	1	5	**9**
AMANDA/IceCube	USA	0	9	0	0	**9**
Oden Southern Ocean	Sverige	10	8	1	2	**21**
Summa		**10**	**21**	**2**	**7**	**40**

för chartern av fartyg medan det svenska programmet ansvarade för landtransporter mellan fartyget och forskningsstationerna Wasa och Aboa.

Under den andra delen av expeditionen installerade forskarna från MARA-projektet en 50 m × 50 m meter stor radarantenn, som under flera år skall studera partiklar och vågor i atmosfären och troposfären samt vissa meteorologiska fenomen över Antarktis.

Monitoringverksamheten fortsatte med utplacering och underhåll av instrument på Wasa och Svea.

Den geodetiska utrustningen vid Svea har efter ett år med goda resultat antagits som permanent observationspunkt i ett pan-antarktiskt geodetiskt nätverk.

Ett långsiktigt meteorologiprojekt vid Wasa och Svea fortsatte i samarbete med holländska forskare.

En flygning till stationen Svea gjordes för att i samarbete med tyska Alfred-Wegener-Institut installera en seismograf, som utgör ett första steg till att etablera en fullskalig seismografstation. Ännu en transport genomfördes från Svea för underhåll av forskningsstationen och transport av de finska forskarnas isprover.

Sekretariatet stödde även en forskare som deltog i ett svensk-tysk-japanskt projekt, ANTSYO II/AGAMES, i Dronning Maud Land där Tyskland och Japan ansvarade för logistiken. Med avancerad instrumentering ombord på flygplan studerades bland annat hur solinstrålningen reflekteras och växelverkar med partiklar i troposfären.

Oden Southern Ocean

Säsongen 2006/07 gjorde isbrytaren Oden sin premiärtur till Antarktis. Genom ett avtal med amerikanska National Science Foundation, Polarforskningssekretariatet och Sjöfartsverket fick Oden uppdraget att bryta en isränna fram till den amerikanska forskningsstationen McMurdo. Isrännan är nödvändig för fartyg som transporterar utrustning och förnödenheter till forskningsstationen vid Rosshavet. Genom avtalet möjliggjordes även ett forskningsprogram under transiten från Sydamerika till den antarktiska kontinenten. Svenska, amerikanska och chilenska forskare arbetade med marin forskning, främst kring koldioxidsystemet och biogeokemiska processer i ytvattnet, marinbiologi bland annat med studier av marina däggdjur, och havsisens utbredning samt ett projekt om organiska miljögifter i havsvattnet. Ombord fanns även ett program för utåtriktad verksamhet, där fyra lärare och en journalist deltog i expeditionen.

AMANDA/IceCube

Den svenska forskningen inom det internationella projektet IceCube har under säsongen 2006/07 fått fortsatt stöd. Sekretariatet har sedan 1994 bidragit till uppbyggnad och genomförande av neutrinodetektorn AMANDA vid Amundsen-Scottbasen vid Sydpolen, det största vetenskapliga projektet i Antarktis. Projektet är nu inne i en ny fas i och med skapandet av den en kubikkilometer stora neutrinodetektorn IceCube. I projektet deltog även en medarbetare vid Polarforskningssekretariatet som har tjänstledigt för att arbeta på Sydpolen i 15 månader. Han är den andre svensken någonsin som har övervintrat på Sydpolen.

SWEDARCTIC 2007

Sommaren 2007 har varit mycket intensiv med ett omfattande program för isbrytaren Oden med två komplexa expeditioner som föregåtts av testturer. Även landbaserade expeditioner har fått logistiskt stöd.

AGAVE – Arctic Gakkel Vents

AGAVE var sekretariatets andra stora uppdrag inom tjänsteexportverksamheten efter Odens färd till Antarktis 2006/07. National Science Foundation svarade även denna gång för finansieringen och en forskargrupp från Woods Hole Oceanographic Institution, USA ledde projektet som undersökte livsformer i de hydrotermala utloppen från jordens kärna på havsbotten. Studien genomfördes med en ny teknik – en slags miniubåtar, eller ”autonomous underwater vehicles” (AUV), som opererade under isen.

Planeringen av expeditionen påbörjades i början av 2007 – en ovanligt kort planeringstid. Projektet var mycket teknikkrävande och använde sig av helt ny utrustning, vilket också ställde särskilda krav på den befintliga infrastrukturen ombord på Oden.

Under expeditionen ansvarade sekretariatet för expeditionsledning, väderprognoser och istjänst. Fartyget förväntades att driva medan provtagningsutrustningen sänktes ned, för att då provtagaren nått botten driva en meter ovanför och passera inom några meter från den beräknade platsen för öppningen i havsbotten där utflödet sker.

Tidtabell för isbrytaren Oden sommaren 2007

Expedition	Från–till	Tidpunkt	Anm.
Test-LOMROG och multibeam-test	Landskrona–Tromsö	15 maj–26 maj	Via Köpenhamn
Test-AGAVE	Tromsö–Longyearbyen	27 maj–6 juni	Norr om Svalbard
AGAVE	Longyearbyen–Tromsö	30 juni–11 augusti	Gakkelryggen
LOMROG	Tromsö–Longyearbyen	11 augusti–17 september	Norr om Grönland

SWEDARCTIC 2007 – logistikansvar och antal expeditionsdeltagare

Expedition	Logistikansvar	Forskare		Logistik		Totalt
		Kvinnor	Män	Kvinnor	Män	
Kinnvika	Sverige	7	21	0	3	**31**
Test-AGAVE	Sverige	2	23	2	8	**35**
Test-LOMROG	Sverige	0	14	0	4	**18**
AGAVE	Sverige	9	21	0	9	**39**
LOMROG	Sverige	11	23	1	6	**41**
SWEDARCTIC 2007, övriga	Varierande	12	28	0	0	**40**
Summa		**41**	**130**	**3**	**30**	**204**

Sekretariatet ansvarade också för helikopter, IT, logistik, läkare, multibeam-operatörer och CTD-tekniker.

Parallellt med arbetet med AGAVE pågick förberedelserna inför den svensk-danska expeditionen LOMROG, Lomonosov Ridge off Greenland. De båda expeditionerna var mycket logistikkrävande och hade ny utrustning som inte tidigare prövats i arktiska förhållanden, varför de var beroende av att göra tester innan expeditionen genomfördes. Även det nyinstallerade multibeam-ekolodet behövde testas. Sommaren 2007 genomfördes därför fyra expeditioner inklusive tester av utrustning med isbrytaren Oden.

AGAVE finansierades helt av National Science Foundation. I expeditionen deltog 30 forskare och forskningstekniker. Polarforskningssekretariatets personal, inkl. helikopterpersonal uppgick till 9 personer.

LOMROG – Lomonosov Ridge off Greenland

Expeditionen LOMROG planerades och genomfördes i samarbete med Danmarks og Grønlands Geologiske Undersøgelse (GEUS) och svenska forskare. Expeditionen finansierades delvis av GEUS, som en del inom tjänsteexporten, delvis av anslagsmedel. Sekretariatet ansvarade för ledningsfunktion, IT-support, logistik, läkare och helikopter.

Expeditionens uppgift var att göra maringeologiska och oceanografiska undersökningar i området norr om Grönland och mot Lomonosovryggen i den Arktiska bassängen. De västligaste delarna av området är svårforcerade på grund av mycket tjock flerårsis. För att nå de önskade områdena chartrade sekretariatet, på uppdrag av GEUS, en rysk atomisbrytare ”50 let Pobedy” av det ryska statsägda företaget Murmansk Shipping Company. Expeditionen kartlade tidigare delvis okända områden på havsbottnen. De geologiska undersökningarna åtföljdes av kemisk och fysisk oceanografi, både i nya områden och som en uppföljning av tidigare års provtagning mellan Grönland och Svalbard.

Kinnvika

Under det förra polaråret, International Geophysical Year (IGY) 1957–58, etablerades den svensk-finsk-schweiziska stationen Kinnvika på Nordostlandet, Svalbard. År 2007 nystartartades verksamheten där genom ett tvärvetenskapligt projekt som under IPY utnyttjar stationen för expeditioner till och kring glaciärerna Aust- och Vestfonna. Polarforskningssekretariatet har ett huvudansvar för logistiken i projektet, i samverkan med övriga deltagande länder, främst Finland, Polen och Norge. En inledande vårkampanj 2007 följdes av en större expedition i juli och augusti, då stationen togs i bruk och skotrar, vindgeneratorer, proviant och en mängd utrustning fraktades dit. Stationen kommer att användas för totalt fem olika vinter- och sommarexpeditioner under Internationella polaråret. Forskningen omfattar en rad områden såsom glaciologi, klimatförändringar, mikrobiologi och ekotoxikologi.

SWEDARCTIC 2007, övrigt

För den enskilda forskaren/forskargruppen är det ofta viktigt med logistiskt stöd eller annat stöd för att kunna genomföra eller underlätta genomförandet av sitt projekt.

Polarforskningssekretariatet har under sommarsäsongen 2007 gett stöd till ett antal projekt genom lån av utrustning, myndighetskontakter, rådgivning och liknande:

- Ett projekt som ursprungligen ingick i Beringia 2005 kunde genomföras som en egen expedition sommaren 2007. Det var en ekologisk-medicinsk undersökning av fågelinfluensa och andra virus, bakterier och parasiter hos vilda flyttfåglar på de svårtillgängliga Kommendörsöarna utanför Kamtjatka i Ryssland. År 2005 avbröts förberedelserna på ett sent stadium eftersom forskarna inte fick tillstånd för export av proverna. Forskarna har nu byggt upp ett långsiktigt samarbete med Influensainstitutet i St. Petersburg och en lyckad expedition genomfördes i samverkan med det ryska institutet.

- På Zeppelin-stationen i Ny-Ålesund på Svalbard fortsätter de svenska mätningarna av luftburna partiklar, svaveldioxid och andra föroreningar.
- På Grönlands nordspets genomfördes en dansk-svensk expedition som undersökte långsiktiga klimatvariationer och glaciärhistoria.
- På södra Grönland genomfördes ett projekt som syftar till att rekonstruera isavsmältningshistorien i i Bredefjordsområdet.
- På Västgrönland genomfördes ett arkeologiskt projekt om handels- och utbytessystem, med isotopbaserade undersökningar av täljsten.
- Vid Grönfjorden på Svalbard genomfördes en kartläggning av historiska lämningar, vilket ingår i det långsiktiga svensk-holländska projektet LASHIPA som studerar polarområdenas industrihistoria.
- I Adventfjorden på Svalbard studerades bäckraviner, som en jämförelse med strukturer som har observerats på planeten Mars.
- Som ett led i förberedelserna för Antarktistraversen JASE gjordes tester och utprovning i Tarfaladalen och på Svalbard.
- Stöd lämnades till en studie av klimateffekter på rovfåglar i Padjelanta nationalpark.

Kostnader genomförda expeditioner 2005–2007
Kostnaderna för expeditionerna varierar stort mellan åren beroende på expeditionernas omfattning och inriktning. Expeditionerna tenderar att bli allt mer personalkrävande i takt med sekretariatets ökade teknikstöd till forskarna. Kostnader för varje expedition redovisas fördelade på personal och utrustning. I kostnaden för personal ingår direkta och indirekta gemensamma personalkostnader. I kostnaden för utrustning ingår varor och tjänster, avskrivningar och fördelade gemensamma övriga kostnader.

SWEDARCTIC 2005, Beringia 2005 – kostnader (tkr)

	2006	2005	2004	2000–2003	Summa
Personal	107	6 281	2 526	1 492	**10 406**
Utrustning	450	45 661	2 157	122	**48 390**
Totalt	**557**	**51 942**	**4 683**	**1 614**	**58 796**

Beringia 2005 var en mycket omfattande expedition, utgifterna har belastat åren 2004–2007, medan kostnaderna i huvudsak är under förberedelserna 2004 och genomförandet 2005.

SWEDARCTIC 2006 – kostnader (tkr)

Expedition	Kostnad 2007		Kostnad 2006		Totalt
	Personal	Utrustning	Personal	Utrustning	
SWEDARCTIC 2006, övriga	0	5	54	31	**90**

Sommaren 2006 bestod verksamheten av logistiskt stöd.

SWEDARP 2005/06 – kostnader (tkr)

Expedition	Kostnad 2006		Kostnad 2005		Summa		Totalt
	Personal	Utrustning	Personal	Utrustning	Personal	Utrustning	
Dronning Maud Land	0	121	0	0	0	121	**121**
AMANDA/IceCube	3	1	2	1	5	2	**7**
DROMLAN	353	2 109	97	15	450	2 124	**2 574**
EPICA	3	1	0	0	3	1	**4**
SWEDARP 2005/06, övriga	41	22	0	0	41	22	**63**
Totalt	**400**	**2 254**	**99**	**16**	**499**	**2 270**	**2 769**

DROMLAN 2005/06 är den största kostnadsposten och hänförs i stort sett helt till tjänsteexporten.

SWEDARP 2006/07 – kostnader (tkr)

Expedition	Kostnad 2007		Kostnad 2006		Summa		Totalt
	Personal	Utrustning	Personal	Utrustning	Personal	Utrustning	
Dronning Maud Land	734	3 106	1 995	1 926	2 729	5 032	**7 761**
Oden Southern Ocean	75	41 674	708	11 197	783	52 871	**53 654**
AMANDA/IceCube	7	3	3	1	10	4	**14**
DROMLAN	30	21	158	79	188	100	**288**
SWEDARP 2006/07, övriga	0	0	79	45	79	45	**124**
Totalt	**846**	**44 804**	**2 943**	**13 248**	**3 789**	**58 052**	**61 841**

Säsongen 2006/07 har kostnader både under 2006 och 2007 eftersom aktiviteterna i Antarktis sker över årsskiftet.

Kostnaderna för expeditionerna sommaren 2007 redovisas nedan. AGAVE och delvis LOMROG är del av tjänsteexporten, se resultatrapporten ovan.

SWEDARCTIC 2007 – kostnader (tkr)

Expedition	Kostnad 2007		Kostnad 2006		Summa		Totalt
	Personal	Utrustning	Personal	Utrustning	Personal	Utrustning	
AGAVE	1 211	16 592	0	0	1 211	16 412	**17 623**
LOMROG	1 468	29 205	517	211	1 985	29 595	**31 580**
Kinnvika	548	399	30	12	578	411	**989**
Norra Sverige	27	13	121	51	148	64	**212**
SWEDARCTIC 2007, övriga	146	85	80	32	226	117	**343**
Totalt	**3 400**	**46 294**	**748**	**306**	**4 148**	**46 600**	**50 748**

Polarforskning – planerade expeditioner

En sammanfattning av planerade expeditioner framgår av bilaga 2, Planerade expeditioner 2007/08–2008/09.

I detta avsnitt redovisas expeditioner som pågick säsongen 2007/08 och som planeras till och med sommaren 2008. Dessutom beskrivs långsiktiga planer och samarbeten inom forskning, logistik och expeditioner liksom olika expeditionsinitiativ. Vissa expeditioner kräver en lång framförhållning, andra kan genomföras med kortare planeringstider.

Hösten 2006 samlade sekretariatet ett trettiotal svenska forskare med intresse för arbete i norra Sverige för att undersöka möjligheten till samordning mellan olika projekt och resurser. Under 2007 har planer växt fram för en gemensam fältinsats under sommaren 2008, som kommer att ledas och samordnas av sekretariatet. Projektet stöds även av den svenska IPY-kommittén.

På liknande sätt samlades ett tjugotal svenska forskare med intresse av forskning i Antarktis och möjligheten till samordnade insatser kring isbrytaren Odens kommande verksamhet i Antarktis. Den fortsatta planeringen kommer att ske i samarbete med Vetenskapsrådet och amerikanska National Science Foundation.

SWEDARP 2007/08

SWEDARP 2007/08 domineras av den japansk-svenska expeditionen i Dronning Maud Land och av isbrytarexpeditionen Oden Southern Ocean i samarbete med amerikanska forskare.

Dronning Maud Land

Under säsongen genomförs JASE, en japansk-svensk bandvagnstravers som förberetts under sju år. Denna glaciologiska expedition ingår i ITASE, International Trans-Antarctic Scientific Expedition, ett internationellt nätverk av traverser som kartlägger Antarktis. De övergripande frågeställningarna rör klimatvariationer under de senaste istiderna. Den japansk-svenska expeditionen ska med hjälp av snö- och isradarsystem på bandvagnarna, fjärranalys samt provtagning av is och snö undersöka processer såsom snöackumulation och glaciärbildning, isrörelser, samt markförhållanden och sjösystem under inlandsisen. Den svenska bandvagnskaravanen utgår från Wasa för att uppe på Antarktisplatån möta den japanska expeditionen som utgår från den japanska stationen Syowa. Efter utväxling av viss utrustning och personal vänder karavanerna för att slutföra den cirka 65 dagar och 3 000 km långa färden.

Atmosfärsfysikerna fortsätter förra säsongens framgångsrika datainsamling om meteorologiska fenomen, partiklar och vågor i atmosfären och troposfären, med hjälp av radaranläggningen MARA vid Wasa. Samarbetet med det finska programmet fortsätter i och med att de svenska deltagarna i MARA bor vid den finska forskningsstationen Aboa.

För monitoringverksamheten sker underhåll av instrument och insamling av loggade data vid Wasa och Svea. Traversteamet och de finska kollegorna vid Aboa kommer att se till den geodetiska utrustningen vid Svea, liksom utrustningen för meteorologi respektive seismologi vid Wasa och Svea.

IceCube

Polarforskningssekretariatet kommer under åren 2007–2009 att ge fortsatt stöd till de svenska forskarna inom det internationella projektet IceCube, en kubikkilometer stor neutrinodetektor som skapas vid Amundsen-Scottbasen vid Sydpolen.

Oden Southern Ocean

Isbrytaren Oden återvänder till Antarktis, denna gång med ett brett svensk-amerikanskt forskningsprogram. Det amerikanska forskningsrådet National Science Foundation chartrar Oden för att bryta en isränna till forskningsstationen McMurdo. På överfarten från Sydamerika till McMurdo och under ytterligare 20 forskardygn, totalt cirka 37 dagar, kommer svenska och amerikanska forskare att i Amundsen- och Rosshaven undersöka bl.a. koldioxidsystemet och biogeokemiska processer, halogenerade kolväten och ozonnedbrytning, persistenta organiska miljögifter, kemosyntetiska organismer på valben, marina bakterier och pikoplankton.

SWEDARCTIC 2008 och 2009

ASCOS

Sommaren 2008 genomförs, med Oden som plattform, en studie av molnbildning vid det inre av Arktiska oceanen. Denna studie leds av svenska forskare men har deltagare från ett flertal länder, främst USA, Finland, Schweiz och Storbritannien. ASCOS, Arctic Summer Ocean-Cloud Study, är ett tvärvetenskapligt forskningsprogram som inrymmer oceanografi och marinbiologi i havet och i isen, atmosfärkemi, aerosolkemi och fysik samt meteorologi. Målet är att förstå viktiga klimatprocesser i centrala Arktis med påverkan på det globala klimatet.

International Siberian Shelf Study

I samarbete med ryska Vetenskapsakademien planerar svenska forskare en studie av land-shelf-djupbassäng-systemet längs den sibiriska ishavskusten. Expeditionen genomförs sommaren 2008 med en rysk isbrytare och Polarforskningssekretariatet bistår med planering, internationella avtal, utrustning och mobilisering av fartyget samt utåtriktad verksamhet. De svenska projekten studerar klimatpåverkan och flödet av organiska ämnen från de sibiriska floderna genom att undersöka fysisk och kemisk oceanografi, växthusgaser, marinbiologi, spårämnen och järnisotoper.

Kinnvika

Kinnvikaprojektet fortsätter med expeditioner under vårvintern och under sommaren 2008. Eventuellt sker även verksamhet våren 2009 innan IPY-projektet avslutas sommaren 2009. Expeditionerna genomförs som ett samarbete mellan Polarforskningssekretariatet, projektledningen vid Uppsala universitet, polska Vetenskapsakademien och Arctic Center i Finland. Samarbetet genererar också andra samarbeten, exempelvis med universitetetscentret UNIS på Svalbard och Norsk Polarinstitutt.

Arktiska Sverige (tidigare benämnt Norra Sverige)

Svenska forskare har ledande roller inom ett flertal IPY-projekt som gäller landbaserad forskning i norra Sverige och på Nordkalotten. I samarbete med svenska IPY-kommittén kommer sekretariatet att sommaren 2008 medverka till en övergripande kraftsamling kring de befintliga forskningsplattformarna i svenska fjällkedjan, från Abisko i norr till Helagsfjällen i söder och med fältläger på strategiska platser.

Övrigt

Vid Zeppelinstationen i Ny-Ålesund på Svalbard fortsätter under de kommande åren monitoringverksamheten och atmosfärskemiska studier året runt. Det industrihistoriska projektet LASHIPA fortsätter undersökningarna på Svalbard. Projektet om bäckraviner på Svalbard kan förväntas fortsätta sommaren 2008, liksom flera av de geologiska och arkeologiska studier som inletts på Grönland. För sommaren 2009 finns även önskemål om expeditioner till Tajmyrhalvön för att studera plattektonik och den Arktiska oceanens utvecklingshistoria, liksom en studie av Tajmyrs glaciationshistoria.

SWEDARP 2008/09 och 2009/10

Efter den stora kraftsamlingen kring bandvagnstraversen 2007/08 kommer verksamheten i Dronning Maud Land att vara minimal under säsongen 2008/09. Verksamheten vid Wasa och Svea avses framöver att i allt högre grad präglas av samarbete med FINNARP och den närbelägna finska forskningsstationen Aboa, i syfte att effektivisera resursutnyttjandet inom såväl forskning som logistik. Sekretariatet planerar för att monitoringverksamheten i huvudsak kan upprätthållas genom detta samarbete. Studierna av atmosfärsfysik vid Wasa ligger nere 2008/09, för att efter ytterligare en aktiv säsong 2009/10 troligen flyttas till annan plats i Antarktis. NORMED, det medicinska samarbetsprogrammet i Antarktis mellan Sverige, Norge och Finland, ger ökad säkerhet och minskade kostnader för alla parter.

Det industrihistoriska projektet LASHIPA har uttryckt önskemål om att under säsongen 2008/09 genomföra en expedition till Sydgeorgien, samt att 2009/10 genomföra arkeologiska undersökningar på Deception Island i Sydshetlandsöarna.

Projektet IceCube vid Sydpolen byggs fortsatt ut under de kommande åren, med medverkan från svenska forskare. Under vintern 2008 kommer svenska och amerikanska forskare att utarbeta ett gemensamt forskningsprogram för de kommande årens expeditioner till Antarktis. Oden Southern Ocean-expeditionerna planeras att årligen genomföras inom ramen för samarbetsavtalet om forskningsinfrastruktur mellan Sverige och USA och ett utökat framtida samarbete mellan Polarforskningssekretariatet och Vetenskapsrådet.

Kostnader planerade expeditioner 2007–2009

Nedan presenteras planeringskostnader för kommande expeditioner. Antarktisexpeditionerna belastar minst två budgetår eftersom expeditionen sker över två budgetår.

SWEDARP 2007/08 – kostnader (tkr)

Expedition	Kostnad 2007		Kostnad 2006		Beräknat 2008
	Personal	Utrustning	Personal	Utrustning	Personal Utrustning
Dronning Maud Land inkl. JASE	1 299	4 751	96	98	2 000
Oden Southern Ocean	2 124	11 515	0	0	50 000
IceCube	3	1	0	0	0
DROMLAN	11	13	0	0	0
SWEDARP 2007/08, övriga	3	1	0	0	0
Totalt	**3 440**	**16 281**	**96**	**98**	**52 000**

SWEDARCTIC 2008 – kostnader (tkr)

Expedition	Kostnad 2007		Beräknat 2008
	Personal	Utrustning	Personal Utrustning
ASCOS	175	89	23 500
International Siberian Shelf Study	0	0	1 000
Kinnvika	53	31	750
Arktiska Sverige	87	46	1 000
Totalt	**315**	**166**	**27 250**

MILJÖVERKSAMHET I POLARTRAKTERNA

Mål 2:

Polarforskningssekretariatet skall minimera den miljöpåverkan i polartrakterna som sker i samband med svenska verksamheter.

Återrapportering:

Polarforskningssekretariatet skall redovisa och utvärdera sitt arbete för att skydda miljön i polartrakterna i samband med svenska verksamheter och översiktligt beskriva den internationella miljöverksamheten. Sekretariatet skall redovisa antalet ansökningar om tillstånd för vistelse i Antarktis och antalet beviljade tillstånd fördelade på forskning respektive annan verksamhet. Kostnaderna för verksamhet relaterad till internationella åtaganden, för tillståndsprovning samt för tillsyn över svensk verksamhet i Antarktis skall redovisas.

Tre miljökonsekvensbeskrivningar (MKB) har gjorts under 2007 för de svenska verksamheterna i Antarktis:

- för den japansk-svenska bandvagnstraversen, JASE
- för den marina forskningen ombord på Oden i Antarktis, och
- för MARA-projektet (Moveable Atmospheric Radar in Antarctica), en atmosfärsradar vid den svenska stationen Wasa.

Miljöövervakningsprogrammet för de svenska forskningsstationerna i Antarktis håller på att revideras. En student från Kungliga Tekniska högskolan i Stockholm har påbörjat ett examensarbetarbete för att ta fram lämpliga indikatorer och parametrar som skall ingå i miljöövervakningen.

Den internationella miljöverksamheten består i att delta i arbetsgrupper som rör miljöfrågor inom COMNAP (Council of Managers of National Antarctic Programs) och bistå regeringskansliet med råd inför Antarktisfördragets årliga konsultativa möten. Den praktiska internationella miljöverksamheten bestod under året till största delen av expeditionsplanering i samarbete mellan de länder som deltar på expeditionerna som ordnas av Polarforskningssekretariatet.

Tillstånd att vistas i Antarktis

Den nya lagen (SFS 2006:924) om Antarktis som trädde i kraft den 1 oktober 2006 har inneburit att tillståndsproceduren har ändrats. Tidigare har Polarforskningssekretariatet utfärdat ett svenskt tillstånd för samtliga svenska medborgare som planerade att besöka Antarktis. Den nya proceduren innebär alltjämt att alla svenska medborgare i Antarktis skall ha tillstånd för att besöka Antarktis, men det behöver inte nödvändigtvis vara ett svenskt tillstånd. Ett tillstånd utfärdat av en stat som är medlem i Antarktisfördraget, gäller även för svenska medborgare.

Tillståndsproceduren är dessutom fokuserad på aktivitetens miljöpåverkan, inte på antalet deltagare och deras nationalitet. Antalet utfärdade tillstånd har därför minskat under 2007, och skall inte jämföras med tidigare års statistik, som är baserat på antalet personer. Under året har två tillståndsärenden inkommit för svenska medborgare att vistas i Antarktis, och tre tillståndsärenden har behandlat Polarforskningssekretariatets egna aktiviteter (det vill säga samma ärenden som för MKB ovan).

Ingen tillsynsverksamhet för svensk verksamhet i Antarktis har förekommit under året. Däremot har en inspektion i enlighet med Antarktisfördraget gjorts, som redovisas under Internationellt samarbete nedan.

Antal tillstånd och kostnad (tkr) för tillstånd 2005–2007

	*2007		2006		2005	
	Forskning	Övriga	Forskning	Övriga	Forskning	Övriga
Antalet tillstånd	3	2	57	120	10	144
Kostnad för tillstånd	9	20	55	103	10	34
Kostnad för tillsyn		17		58		19

* Statistiken för 2007 och tidigare år är inte jämförbara eftersom antalet tillstånd beräknas på annat sätt än tidigare då varje individ räknades.

INTERNATIONELLT SAMARBETE

Mål 3:

Polarforskningssekretariatet skall bidra till att svensk polarforskning ges goda förutsättningar till internationellt samarbete.

Återrapportering:

Polarforskningssekretariatet skall översiktligt redovisa internationell verksamhet där sekretariatet medverkat och internationella förhandlingar där sekretariatet deltar i en rådgivande funktion.

Internationella polaråret (IPY) har stått på agendan för de flesta internationella möten som ägt rum under året och i vilka Polarforskningssekretariatet deltagit. Det arktiska samarbetet har som vanligt haft fokus i Arctic Science Summit Week (ASSW) som i mars detta år hölls i Hanover, New Hampshire, USA. IPY inleddes 1 mars 2007, en händelse som manifesterades med invigningscermonier i många länder. I Sverige skedde detta i Jukkasjärvi under stor bevakning från medierna.

Antarktisfördragets årliga konsultativa möte hölls i New Delhi i april och Polarforskningssekretariatet var representerat med flera personer i rådgivande funktion till den svenska delegationen. Vid mötet framlades också en rapport från den inspektion som Sverige tillsammans med Frankrike och USA gjorde i Antarktis i januari 2007. Vid denna inspektion (enligt Antarktisfördragets och miljöprotokollets bestämmelser) besöktes forskningsstationerna Dome Concordia och Amundsen-Scott. Det är värt att notera att denna inspektion, under Polarforskningssekretariatets operativa ledning, var unik, dels genom sin multinationella sammansättning, dels genom att de forskningsstationer som besöktes sällan eller aldrig inspekterats.

COMNAP:s årliga möte hölls i Washington, DC, USA i juli månad. I anslutning till mötet avhölls en ceremoni på svenska ambassaden med undertecknandet av ett samarbetsavtal om polarforskning mellan Sverige och USA. Parter är National Science Foundation, Vetenskapsrådet och Polarforskningssekretariatet. I centrum för detta avtal står utnyttjandet av isbrytaren Oden för isbrytning till den amerikanska forskningsstationen McMurdo i Antarktis och forskning under resan från Sydamerika till McMurdo. Den framgångsrika insats som gjordes med Oden i december–januari 2006/07 upprepas med en ny expedition 2007/08, denna gång med ett större svensk-amerikanskt forskningsprogram ombord. Planeringen av denna expedition och strategi för framtida bilaterala svensk-amerikanska satsningar har varit ett betydande inslag i Polarforskningssekretariatets internationella engagemang.

Ett annat bilateralt projekt är bandvagnstraversen, JASE, som genomförs tillsammans med Japan. Det är det första organiserade polarforskningssamarbetet där en japansk och en svensk grupp samordnar sin forskning och möts på polarplatån efter att ha kört från respektive forskningsstation Syowa och Wasa.

Internationellt samarbete inom expeditionsverksamheten har som beskrivits ovan dessutom skett med framför allt Danmark, Ryssland, Norge och Finland.

I övrigt har den europeiska verksamheten med European Polar Board (ESF) och Polar Consortium inom EU upptagit en betydande del av Polarforskningssekretariatets internationella engagemang. I detta, liksom i det bredare internationella samarbetet, spelar den nordiska samordningen en väsentlig roll.

Sverige och Polarforskningssekretariatet är sedan 2006 värd för sekretariatet för International Arctic Science Committee (IASC) som finansieras av Vetenskapsrådet.

Representation i internationella organisationer 2007

Organisation/nätverk	Uppgift
COMNAP – Council of Managers of National Antarctic Programs	Ledamot
COMNAP Working Groups	
ENAMNET – Energy Management Officers Network	Ledamot
INFONET – Information Officers Network	
IPYCG – International Polar Year Coordinating Group	Ordförande
NAEON/AEON – (Nordic) Antarctic Environmental Officers Network	Ledamot
SCALOP – Standing Committee on Antarctic Logistics and Operations	Ledamot
STADM – Joint SCAR/COMNAP Steering Committee for Data Management	Ledamot
TANGO – Working Group on Tourism and Non-Government Operations in Antarctica	Ledamot
DROMLAN - Dronning Maud Land Air Network	Ledamot
DROMLAN Operations Group	Ledamot
DROMSHIP – Dronning Maud Land Ship Network	Ledamot
FARO – Forum of Arctic Research Operators	Ledamot
IASC Regional Board – International Arctic Science Committee	Ledamot
ISIRA – International Science Initiative in the Russian Arctic	Ledamot
EPB – European Polar Board	Styrelseledamot
EOC – Education Outreach Communication Taskforce	Ledamot
EPC – European Polar Consortium	Ledamot

INFORMATION OCH DOKUMENTATION

Mål 4:

Utförare och användare av forskning samt en intresserad allmänhet skall genom Polarforskningssekretariatet ha god tillgång till information om sekretariatets expeditionsverksamhet.

Återrapportering:

Polarforskningssekretariatet skall redogöra för inriktning och omfattning av informationsverksamheten samt kostnader och målgrupp för respektive informationskanal. Sekretariatet skall vidare analysera insatsernas effekt.

Information om Polarforskningssekretariatets expeditionsverksamhet är tillgängligt för allmänheten och forskare via olika informationskanaler, t.ex. webbplatsen www.polar.se, årsbok, broschyrer, nyhetsbrev och pressmeddelanden. Målgrupper och samarbetspartner som prioriteras i arbetet med att sprida information och kunskap om polarforskning är lärare, barn och ungdomar, museer och kulturorganisationer samt konstnärer.

Analysen av informationsverksamhetens effektivitet görs bland annat i samarbete med de arrangörer av utåtriktade aktiviteter som sekretariatet samarbetar med och där Polarforskningssekretariatets deltagande ofta väcker stor uppmärksamhet. Ett ökat intresse för polarforskningsfrågor märks tydligt genom det ökade antalet frågor som ställs till myndigheten. Frågorna är också mer specificerade än tidigare, medvetenheten om betydelsen av dessa frågor har ökat markant. Åtgången på trycksaker har också ökat och i samband med en modernare webbplats kommer ett avancerat statistikverktyg för antal besökare att börja användas.

Kontaktverksamhet

Deltagande i utställningar och mässor, lärarprogram och konstnärsprogram samt kontakter med medier och den intresserade allmänheten inryms i kontaktverksamheten.

Under isbrytaren Odens första antarktisexpedition, Oden Southern Ocean, arbetade fyra lärare tillsammans med forskarna ombord. Den internationella lärargruppen, från Sverige, Chile och USA, genomförde telefonkonferenser till skolor i respektive land. Genom det europeiska samarbetet inom European Polar Board (EPB) kunde en tysk lärare erbjudas plats ombord på Oden under en tvåveckors förberedande tur för AGAVE-forskarna i Norra ishavet. Inom det amerikanska forskningsprogrammet deltog även en amerikansk lärare genom PolarTREC-programmet. Inom sekretariatets eget lärarprogram deltog en svensk lärare i LOMROG-expeditionen och arbetade tillsammans med maringeologerna ombord.

Internationella polaråret målsättning att öka kunskapen om och förståelsen för polarområdena genomsyrar informationsarbetet. Under året har informationsenheten haft ett nära samarbete med svenska IPY-kommitténs informatör och med arbetsgruppen för utåtriktade aktiviteter, IPY-utåt. Både Internationella polaråret och Linnéjubiléet arbetar för att öka ungdomars intresse för naturvetenskap. Informationsenheten har under året samarbetat med jubileumssekretariatet för Linné2007 vilket bland annat resulterade i tävlingen Polarresan där gymnasieelever bjöds in att tävla med ett projektarbete med inriktning mot miljökemi som ledande tema. De två vinnande eleverna fick motta sina pris ur Kungens hand på Linnéjubileets avslutning i Jukkasjärvi och kommer under sommaren 2008 att delta ombord på isbrytaren Oden.

De populärvetenskapliga arrangemang som sekretariatet deltar i sker ofta i samarrangemang med andra organisationer, och under 2007 var de extra många:

- Observatoriekullens dag
- Geologins dag
- ForskarFredag
- Forskartorget på Bok & Bibliotek
- Kunskapstorget på Skolforum
- Grenna museums föreläsningsserie med polarforskare
- Onsdagsakademin Tema: Polar, en föreläsningsserie vid Stockholms universitet
- Arrangemanget Stora vattendagen på Kulturhuset i Stockholm

Utställningen Alla tiders poler om aktuell svensk polarforskning producerades av Teknikens Hus i Luleå och byggde delvis på den utställning som togs fram 2005 av Polarforskningssekretariatet och Tekniska museet. Utställningen invigdes på svenska ambassaden i Washington, House of Sweden, som ett av bidragen under temaperioden Water and Environment. Under sommaren återkom utställningen till Luleå och vid två tillfällen fick museibesökarna tillfälle att ha direktkontakt med forskarna ombord på isbrytaren Oden i Arktis.

Årets expeditioner har haft en intensiv bevakning av medier, både ombord och från redaktioner i Sverige och utomlands. En välbesökt presskonferens hölls ombord på isbrytaren Oden i Köpenhamn inför avresan i maj mot Arktiska oceanen. Journalister och filmare arbetade på isbrytaren under expeditionerna Oden Southern Ocean, AGAVE och LOMROG samt vid Kinnvikastationen på Svalbard. Forskare och expeditionsledning har intervjuats av radiostationer via satellittelefon från Arktis och Antarktis samt deltagit i TV-kanalernas morgon-, nyhets- och vetenskapsprogram.

Under hösten utsågs en illustratör och författare till konstnärsstipendiat som ska delta i SWEDARP 2007/08, Oden Southern Ocean. I januari lanserades de nationella IPY-frimärkena som producerats av Posten Frimärken i samarbete med Polarforskningssekretariatet. Motiven har tagits fram efter förlagor av två konstnärer som båda har deltagit i expeditioner inom Polarforskningssekretariatets konstnärsprogram.

Polarforskningssekretariatet representeras i internationella nätverk för utåtriktade aktiviteter, bl.a. inom European Polar Board (EPB) och INFONET (Antarctic Information Officers Network).

Sekretariatet har också bidragit till svensk närvaro i en Antarktisutställning på Natural History Museum i London med bilder, text och svenska polarforskares blå-gula profilplagg.

Webbplats och trycksaker

Under året har arbete pågått med att modernisera webbplatsens layout samt att anpassa den enligt myndighetens tillgänglighetsplan. En speciell sida med lättläst information om myndigheten och dess verksamhet har också producerats. Den nya layouten och den lättlästa informationen kommer att publiceras under början av 2008.

Forskningsprogrammen SWEDARP 2006/07 och SWEDARCTIC 2007 har presenterats på egna webbplatser med beskrivning av forskningsprojekten, kartor samt rapporter och bilder från arbetet ombord och i fält. Regelbundna resebrev från den svenske övervintraren på Sydpolen har också publicerats på webbplatsen.

I en film som gjordes under arbetsprocessen med IPY-frimärkena berättar konstnärerna, gravören och en forskare om sina arbeten. Filmen har publicerats på sekretariatets webbplats.

Den japansk-svenska Antarktisexpeditionen, JASE, presenterades i en trespråkig folder (engelska, svenska och japanska) samt i en mindre vykortserie.

En rapport för den internationella inspektionsgrupp som besökte forskningsstationerna Amundsen-Scott och Dome Concordia för Antarktisfördragets räkning har producerats. Informationsenheten deltog också i arbetet med en gemensam nordisk IPY-tidskrift.

Årsboken för 2006 utkom i mars. Nyhetsbrevet Polaraktualiteter har utkommit med åtta nummer.

Dokumentation

Supplementet till Swedish Polar Bibliography för 2006 färdigställdes och publicerades under året på webbplatsen. Supplementet innehåller vetenskapliga publikationer som har med svensk polarforskning att göra, främst med anknytning till forskningsprogrammen SWEDARCTIC och SWEDARP. Supplement för 2007 är under förberedelse och inkluderar publikationer som inkommit till sekretariatet i tryckt eller elektronisk form. Merparten av publikationerna är från åren 2006 och 2007.

I Supplement för 2007 ingår fem doktorsavhandlingar, som helt eller delvis bygger på data från SWEDARCTIC och SWEDARP. Vissa publikationer bygger på data från flera expeditioner och är sålunda dubbelklassade. Några av publikationerna ingår även som delar i doktorsavhandlingarna. Vissa av dem är accepterade för publicering i peer-rewied tidskrifter under början av 2008.

Information och dokumentation (tkr)

	2007	2006	2005	2004
Kontaktverksamhet	597	557	406	1 204
Webbplats	424	291	282	198
Trycksaker	729	1 045	681	1 045
Bibliotek och dokumentation	488	562	481	437
Totalt	**2 238**	**2 455**	**1 850**	**2 885**

ÖVRIGA MÅL OCH ÅTERRAPPORTERINGSKRAV

Internationella polaråret

Polarforskningssekretariatet skall redovisa hur och i vilken omfattning sekretariatet medverkat i det internationella polaråret (IPY).

Perioden 1 mars 2007–1 mars 2009 är utlyst till International Polar Year (IPY) av International Council for Science (ICSU) och World Meteorological Organization (WMO) för att sätta fokus på forskning i polarområdena. Det är också 125 år sedan det första Internationella polaråret 1882–83, 75 år sedan det andra och 50 år sedan det Internationella geofysiska året 1957–58.

IPY genomsyrar nu hela Polarforskningssekretariatets verksamhet, både i den egna expeditionsverksamheten och i samverkan med andra nationer och internationella organ. Den svenska verksamheten under IPY bygger på expeditioner och samarbeten som planerats sedan länge, samt på den svenska nationella IPY-strategin. Sverige har identifierat forskningsstationerna Wasa och Svea i Antarktis, isbrytaren Oden och forskningsstationerna Abisko och Tarfala som viktiga svenska forskningsplattformar. För både SWEDARP och SWEDARCTIC innebär 2007 och 2008 kulmen på de stora IPY-satsningarna, följt av mindre fältverksamhet från hösten 2008 till hösten 2009.

Det Internationella polaråret innebär också en fortsättning på samfinansiering av expeditioner med andra länder och möjligheten att bedriva tjänsteexport är av avgörande betydelse.

Internationella polaråret har varit integrerat i all verksamhet under året avseende expeditionsverksamhet, miljöverksamhet, internationellt samarbete och information och dokumentation. Personalen har varit aktiva i arbetsgrupper och organisationer som arbetat med IPY-relaterad verksamhet. Sekretariatet har också aktivt deltagit i Svenska kommittén för internationella polaråret 2007–2008 och chefen för sekretariatet ingår både i kommittén och i dess verkställande utskott. Sekretariatet är också representerad i arbetsgruppen för logistik och i arbetsgruppen för utåtriktade aktiviteter, IPY-utåt (se avsnittet Information och dokumentation).

Resultaträkning

(tkr)	Not	2007	2006
Verksamhetens intäkter			
Intäkter av anslag	1	30 342	26 097
Intäkter av avgifter och andra ersättningar	2	80 220	27 720
Intäkter av bidrag	3	2 162	3 941
Finansiella intäkter	4	961	41
Summa		**113 685**	**57 799**
Verksamhetens kostnader			
Kostnader för personal	5	-11 659	-9 280
Kostnader för lokaler		-1 267	-1 190
Övriga driftkostnader	6	-106 507	-15 283
Finansiella kostnader	7	-961	-1 185
Avskrivningar och nedskrivningar		-1 166	-1 055
Summa		**-121 560**	**-27 993**
Verksamhetsutfall		**-7 875**	**29 806**
Årets kapitalförändring	8	**-7 875**	**29 806**

Balansräkning

(tkr)	Not	2007-12-31	2006-12-31
TILLGÅNGAR			
Materiella anläggningstillgångar			
Byggnader, mark och annan fast egendom	9	0	50
Maskiner, inventarier, installationer m.m.	10	5 021	5 915
Summa		**5 021**	**5 965**
Fordringar			
Kundfordringar	11	156	14 307
Fordringar hos andra myndigheter		422	185
Övriga fordringar		18	5
Summa		**596**	**14 497**
Periodavgränsningsposter			
Förutbetalda kostnader		373	311
Övriga upplupna intäkter		0	18
Summa		**373**	**329**
Avräkning med statsverket			
Avräkning med statsverket	12	-390	151
Summa		**-390**	**151**
Kassa och bank			
Behållning räntekonto i Riksgäldskontoret		6 491	10 131
Kassa, postgiro och bank	13	3 303	1 823
Summa		**9 794**	**11 954**
SUMMA TILLGÅNGAR		**15 394**	**32 896**
KAPITAL OCH SKULDER			
Myndighetskapital			
Balanserad kapitalförändring	14	10 451	-20 238
Kapitalförändring enligt resultaträkningen		-7 875	29 806
Summa		**2 576**	**9 568**
Skulder m.m.			
Lån i Riksgäldskontoret	15	4 979	5 965
Skulder till andra myndigheter	16	1 234	9 870
Leverantörsskulder		393	318
Övriga skulder	17	3 533	2 068
Summa		**10 139**	**18 221**
Periodavgränsningsposter			
Upplupna kostnader	18	1 518	3 706
Oförbrukade bidrag	19	1 149	1 154
Övriga förutbetalda intäkter	20	11	247
Summa		**2 678**	**5 107**
SUMMA KAPITAL OCH SKULDER		**15 394**	**32 896**

Anslagsredovisning

Redovisning mot anslag

Anslag (tkr)	Not	Ing. överförings-belopp	Årets tilldelning enl. regl. brev	Totalt disponibelt belopp	Utgifter	Utgående överförings-belopp
Uo 16 26:6 ap. 1						
Ramanslag		-151	31 766	31 615	31 225	390
Polarforskningssekretariatet						
Summa	21	**-151**	**31 766**	**31 615**	**31 225**	**390**

Tilläggsupplysningar och noter

(Belopp i tusental kronor där ej annat anges)

TILLÄGGSUPPLYSNINGAR

Redovisningsprinciper

Tillämpade redovisningsprinciper

Myndighetens redovisning följer god redovisningssed och årsredovisningen är upprättad i enlighet med förordningen (2000:605) om årsredovisning och budgetunderlag samt ESV:s föreskrifter och allmänna råd till denna.

Bokföringen följer förordningen (2000:606) om myndigheters bokföring samt ESV:s föreskrifter och allmänna råd till denna.

Efter brytdagen har fakturor överstigande 10 tkr bokförts som periodavgränsningsposter.

Upplysningar om avvikelser

Avvikelser från ekonomiadministrativa regler

I enlighet med regleringsbrevet för 2007 får Polarforskningssekretariatet ta ut avgifter för polarforskningsexpeditioner utan den begränsning som följer av 4 § andra stycket avgiftsförordningen (1992:191). Avgifterna skall beräknas så att minst full kostnadstäckning uppnås.

Upplysningar om redovisning av tjänsteexport

Fr.o.m. 2006 driver Polarforskningssekretariatet tjänsteexport i enlighet med regeringsbeslut 2006-10-26, Utbildnings- och kulturdepartementet U2006/6441/F, och U2006/7054/F.

I årsredovisningen för år 2006 hade Polarforskningssekretariatet inte redovisat upplupna kostnader på 14 243 tkr avseende tjänsteexport. Detta fick till följd att årets kapitalförändring 2006 var för högt redovisad samt att kostnaderna avseende tjänsteexport var för lågt redovisade med motsvarande belopp. Faktura avseende detta har kostnadsförts 2007 vilket medför att de redovisade kostnaderna för 2007 avseende tjänsteexporten är för högt redovisade med 14 427 tkr efter valutaomräkning samt att kapitalförändringen är för lågt redovisad.

Värderingsprinciper

Anläggningstillgångar

Som anläggningstillgångar redovisas byggnader samt maskiner och inventarier som har ett anskaffningsvärde om minst 10 tkr och en beräknad ekonomisk livslängd som uppgår till lägst tre år.

Avskrivning under anskaffningsåret sker från den månad tillgången tas i bruk

Tillämpade avskrivningstider

3 år	Elektriska apparater Datorer och kringutrustning Övriga kontorsmaskiner
5 år	Maskiner, fordon och inredning Bostadsmodul
10 år	Byggnader (stationen Wasa i Antarktis)

Tillämpad avskrivningstid för datorer gäller inte bärbara datorer eller datorer som används under expeditioner. Dessa kostnadsförs vid anskaffningstillfället. Avvikande avskrivningstid, 10 år, gäller för en maskin inköpt 2005 samt ett fordon köpt 2006.

Omsättningstillgångar

Fordringarna har tagits upp till det belopp som de efter individuell prövning beräknas bli betalda.

Övriga omsättningstillgångar har tagits upp till anskaffningsvärdet enligt lägsta värdets princip.

Skulder

Skulderna har tagits upp till nominellt belopp.

Ersättningar och andra förmåner

Styrelseledamöter / andra styrelseuppdrag	Ersättning
Britt-Marie Danestig Linköpings universitet (t.o.m. maj 2007)	6
Désirée Edmar Internationella meteorologiska institutet i Stockholm (t.o.m. juni 2007), Lärarhögskolan i Stockholm	3
Håkan Jorikson	2
Lars-Erik Liljelund Naturvårdsverket, Skogsstyrelsen, Miljövårdsberedningen, MISTRA, NEFCO, EEA	2
Per Tegnér Rymdstyrelsen	2
Eva Olsson	2
Ledande befattningshavare / styrelseuppdrag	**Lön**
Anders Karlqvist	676

Anställdas sjukfrånvaro

I tabellen redovisas anställdas totala sjukfrånvaro i förhållande till den sammanlagda ordinarie arbetstiden. Vidare redovisas andel av totala sjukfrånvaron under en sammanhängande tid av 60 dagar eller mer. Sjukfrånvaron redovisas i procent.

Sjukfrånvaro	2007	2006
Totalt	0,8	0,8
Andel 60 dagar eller mer	35,4	0,0

Sjukfrånvaro för kön och för olika åldersgrupper lämnas inte när antalet anställda i grupperna är högst tio eller om uppgiften kan hänföras till en enskild individ.

Noter
(tkr)
Resultaträkning

		2007	2006
Not 1	**Intäkter av anslag**		
	Intäkter av anslag	30 342	26 097
	Summa	**30 342**	**26 097**

Differens 883 tkr jämfört med utgifter enligt anslagsredovisningen 2007 beror på korrigering av bokföringsfel tidigare år, 1995/96-2005, som har inträffat i samband med periodiseringar. Se även not 14.

		2007	2006
Not 2	**Intäkter av avgifter och andra ersättningar**		
	Intäkter av avgifter enligt 4 § avgiftsförordningen	178	678
	Intäkter av uppdragsverksamhet, tjänsteexport	79 998	26 899
	Övriga intäkter av avgifter och andra ersättningar	44	143
	Summa	**80 220**	**27 720**
Not 3	**Intäkter av bidrag**		
	Intäkter av bidrag från Utrikesdepartementet	160	160
	Intäkter av bidrag från Vetenskapsrådet	1 673	1 361
	Intäkter av bidrag från Kammarkollegiet	180	2 420
	Intäkter av bidrag från internationella organisationer	149	0
	Summa	**2 162**	**3 941**
Not 4	**Finansiella intäkter**		
	Ränteintäkter räntekonto i Riksgäldskontoret	521	32
	Valutakursvinster	440	9
	Summa	**961**	**41**
Not 5	**Kostnader för personal**		
	Lönekostnader (exkl. arbetsgivaravgifter, pensionspremier och andra avgifter enligt lag och avtal)	7 563	6 052
	Övriga kostnader för personal	4 096	3 228
	Summa	**11 659**	**9 280**
Not 6	**Övriga driftkostnader**		
	Hyra av isbrytaren Oden, Sjöfartsverket	85 373	9 487
	Övriga driftkostnader	21 134	5 796
	Summa	**106 507**	**15 283**

Av årets kostnader för hyra av isbrytaren Oden avser 14 427 tkr kostnader hänförliga till 2006 avseende tjänsteexporten.

Driftkostnaderna 2007 har varit betydligt högre än tidigare år mot bakgrund av att verksamheten, både inom den ordinarie expeditionsverksamheten och tjänsteexporten, varit betydligt mer omfattande under året än föregående år beroende på aktiviteter med anknytning till Internationella polaråret.

		2007	2006
Not 7	**Finansiella kostnader**		
	Räntekostnader avseende räntekonto i Riksgäldskontoret	0	18
	Räntekostnader avseende lån i Riksgäldskontoret	198	98
	Valutakursförluster	763	1 069
	Summa	**961**	**1 185**
Not 8	**Årets kapitalförändring**	**2007**	**2006**
	Avgiftsfinansierad verksamhet, tjänsteexport, underskott	-10 078	14 123
	Periodiseringsdifferenser	2 203	15 683
	Summa	**-7 875**	**29 806**

Årets kapitalförändring avseende tjänsteexporten är för lågt redovisat 2007 med 14 427 tkr p.g.a. för lågt redovisade kostnader föregående år. Se även not 6.

Tjänsteexportens resultat borde ha varit ett underskott på 305 tkr år 2006 och ett överskott på 4 349 tkr år 2007.

Noter
(tkr)
Balansräkning

		2007-12-31	2006-12-31
Not 9	**Byggnader, mark och annan fast egendom**		
	Ingående anskaffningsvärde	5 300	5 300
	Summa anskaffningsvärde	**5 300**	**5 300**
	Ingående ackumulerade avskrivningar	-5 250	-5 190
	Årets avskrivningar	-50	-60
	Summa ackumulerade avskrivningar	**-5 300**	**-5 250**
	Utgående bokfört värde	**0**	**50**
Not 10	**Maskiner, inventarier, installationer m.m.**		
	Ingående anskaffningsvärde	10 609	6 041
	Årets anskaffningar	221	4 637
	Årets utrangeringar, anskaffningsvärde	-294	-69
	Summa anskaffningsvärde	**10 536**	**10 609**
	Ingående ackumulerade avskrivningar	-4 694	-3 768
	Årets avskrivningar	-1 115	-995
	Årets utrangeringar, ackumulerade avskrivningar	294	69
	Summa ackumulerade avskrivningar	**-5 515**	**-4 694**
	Utgående bokfört värde	**5 021**	**5 915**
Not 11	**Kundfordringar**		
	Kundfordringar avseende tjänsteexport	0	14 243
	Övriga kundfordringar	156	64
	Summa	**156**	**14 307**
Not 12	**Avräkning med statsverket**		
	Ingående balans	151	-420
	Avräknat mot statsbudgeten:		
	Anslag	31 225	26 097
	Avräknat mot statsverkets checkräkning:		
	Anslagsmedel som tillförts räntekonto	-31 766	-25 526
	Utgående balans	**-390**	**151**
Not 13	**Kassa, postgiro och bank**		
	Saldot avser behållning på valutakonton avseende International Arctic Science Committe, General Fund samt tjänsteexport.	3 303	1823
	Summa	**3 303**	**1823**
Not 14	**Balanserad kapitalförändring**		
	Periodiseringsdifferenser	9 568	-20 238
	Korrigering avseende tidigare år	883	0
	Summa	**10 451**	**-20 238**
	Korrigering avseende tidigare år, 1995/96-2005, enligt not 1.		
		2007-12-31	**2006-12-31**
Not 15	**Lån i Riksgäldskontoret**		
	Avser lån för investeringar i anläggningstillgångar.		
	Ingående balans	5 965	2 383
	Under året nyupptagna lån	180	4 637
	Årets amorteringar	-1 166	-1 055
	Utgående balans	**4 979**	**5 965**
	Beviljad låneram enligt regleringsbrev	6 000	6 000

Not 16	**Skulder till andra myndigheter**		
	Faktura Sjöfartsverket avseende hyra av Oden	762	9 487
	Övriga skulder till andra myndigheter	472	383
	Summa	**1 234**	**9 870**
Not 17	**Övriga skulder**		
	Personalens källskatt	230	247
	Övriga skulder, avräkningskonto till valutakonto	3 303	1 821
	Summa	**3 533**	**2 068**
Not 18	**Upplupna kostnader**		
	Slutbetalning avseende hyra av Oden i samband med Beringia 2005.	0	2 351
	Upplupna semesterlöner och löner inklusive sociala avgifter	993	976
	Övriga upplupna kostnader	525	379
	Summa	**1 518**	**3 706**

Upplupna kostnader år 2006 borde ha varit 14 243 tkr högre (enligt balansdagens kurs). En faktura avseende kostnader för tjänsteexporten kostnadsfördes först under 2007.

Not 19	**Oförbrukade bidrag**		
	Bidrag som erhållits från annan statlig myndighet, Vetenskapsrådet och Forskningsrådsnämnden	159	252
	Bidrag som erhållits från icke-statliga organisationer, University Corporation for Atmospheric Research (UCAR) och Australian Antarctic Division	990	902
	Summa	**1 149**	**1 154**
Not 20	**Övriga förutbetalda intäkter**		
	Förutbetalda intäkter från Australian Antarctic Division	0	236
	Övriga förutbetalda intäkter	11	11
	Summa	**11**	**247**

Resterande medel från Australian Antarctic Division redovisas under Oförbrukade bidrag fr.o.m. 2007.

Anslagsredovisning

Not 21 **Polarforskningssekretariatet**

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Enligt regleringsbrev för 2007 disponerar Polarforskningssekretariatet en anslagskredit på 1 288 tkr.

6 000 tkr av tilldelade medel har anvisats på tilläggsbudget 2 för 2007 (regeringsbeslut U2007/7349/SAM) med anledning av Internationella polaråret. Enligt regleringsbrevet ska medlen användas till finansiering av operativa insatser inom polarforskning. Medlen har använts för att komplettera det ordinarie anslaget för finansieringen av expeditioner till Arktis och Antarktis.

Väsentliga uppgifter

(tkr)	2007	2006	2005	2004	2003
Låneram Riksgäldskontoret					
Beviljad	6 000	6 000	4 000	4 000	3 000
Utnyttjad	4 979	5 965	2 383	1 801	1 567
Kontokrediter Riksgäldskontoret					
Beviljad	5 490	3 803	3 803	2 508	2 417
Maximalt utnyttjad	770	3 199	2 598	0	2 366
Räntekonto Riksgäldskontoret					
Ränteintäkter	521	32	75	141	68
Räntekostnader	0	18	6	0	20
Avgiftsintäkter					
Avgiftsintäkter som disponeras					
Beräknat belopp enligt regleringsbrev *	29 900	50 050	0	0	0
Avgiftsintäkter *	79 998	26 899	0	0	0
Övriga avgiftsintäkter	222	821	4 598	387	54
Anslagskredit					
Beviljad	1 288	1 276	0	752	363
Utnyttjad	0	151	0	0	0
Anslag					
Ramanslag					
Anslagssparande	390	0	420	5 357	3 610
varav intecknat	0	0	420	5 357	3 610
Bemyndiganden - Ej tillämpligt					
Personal					
Antalet årsarbetskrafter (st)	19	17	14	14	14
Medelantalet anställda (st)	23	17	15	15	14
Driftkostnad per årsarbetskraft**	6 286	1 515	4 108	4 054	1 376
Kapitalförändring					
Årets	- 7875	29 806	-21 682	-46	3 154
Balanserad***	10 451	-20 238	1 444	1 490	-1 664

* Avser tjänsteexport fr.o.m. 2006
** Antalet årsarbetskrafter och driftkostnad per årsarbetskraft påverkas av expeditionsverksamhetens omfattning respektive år.
*** Differens 883 tkr avseende Balanserad kapitalförändring 2007 beror på korrigering av tidigare fel.

Undertecknande

Polarforskningssekretariatet fastställer årsredovisningen för 2007 innehållande resultatredovisning, resultaträkning, balansräkning, anslagsredovisning och övriga finansiella delar den 18 februari 2008.

Stockholm den 18 februari 2008

Anders Karlqvist
Föreståndare

Bilaga 1

Genomförda expeditioner 2005–2007

År	Program	Expedition/ projekt	Syfte	Plats	Deltagare Kv	Deltagare M	Samarbetspartners
2005	SWEDARCTIC	Beringia 2005	Terrester och marin forskning	Nordvästpassagen, Tjuktjerhavet, Arktiska oceanen, Kamtjatka, Tjukotka, Alaska	61	124	USA, Ryssland, Kanada
2005/06	SWEDARP	DML	Monitoring	Wasa och Svea, DML	0	0	Finland
2005/06	SWEDARP	AMANDA/ IceCube	Neutrinodetektion	Amundsen-Scott, Sydpolen	1	5	USA
2005/06	SWEDARP	EPICA	Klimathistoria	Kohnen Station	0	1	Frankrike, Italien, Tyskland
2005/06	SWEDARP	Staten Island	Klimathistoria	Staten Island	1	4	Argentina
2005/06	SWEDARP	DROMLAN	Logistiksamarbete	Dronning Maud Land	1	1	Norge
2006	SWEDARCTIC	CASP: Circum-Arctic Sediment Provenance	Geologi	Wrangelön, Axel Heibergön, Grönland	3	5	Ryssland, Danmark
2006	SWEDARCTIC	Grönland	Klimatvariationer	Grönland	0	3	Danmark
2006	SWEDARCTIC	LASHIPA 3	Industrihistoria	Svalbard	0	5	
2006	SWEDARCTIC	Sassendalen	Paleontologi	Svalbard	0	3	
2006	SWEDARCTIC	Grönland	Kvartärgeologi	Grönland	2	0	
2006	SWEDARCTIC	Zeppelin	Meteorologi	Ny-Ålesund, Svalbard	2	3	Norge
2006/07	SWEDARP	DML-AGAMES/ ANTSYO II	Atmosfärskemi	Wasa och Svea, DML	1	8	Tyskland, Japan
2006/07	SWEDARP	DML-AWS	Monitoring meteorologi	Wasa och Svea, DML	0	1	Holland
2006/07	SWEDARP	DML-DROMNET	Monitoring seismik	Wasa och Svea, DML	0	2	Tyskland
2006/07	SWEDARP	DML-GIANT	Monitoring geodesi	Svea, DML	0	0	
2006/07	SWEDARP	DML-MARA	Atmosfärsfysik	Wasa, DML	0	2	
2006/07	SWEDARP	AMANDA/ IceCube	Neutrinodetektion	Amundsen-Scott, Sydpolen	0	9	USA
2006/07	SWEDARP	Oden Southern Ocean	Marin kemi	Södra ishavet	11	10	USA
2007	SWEDARCTIC	Kinnvika vårvinter	Tvärvetenskap	Nordostlandet, Svalbard	1	3	Polen, Finland, Norge
2007	SWEDARCTIC	Kinnvika sommar	Tvärvetenskap	Nordostlandet, Svalbard	6	18	Polen, Finland, Norge
2007	SWEDARCTIC	Test-LOMROG	Maringeologi, oceanografi	Köpenhamn–Svalbard	0	18	
2007	SWEDARCTIC	LOMROG, Oden	Maringeologi, oceanografi	Svalbard, Grönland, Arktiska oceanen (Lomonosovryggen)	11	23	Danmark, Grönland
2007	SWEDARCTIC	Test-AGAVE	Hydro-termala källor	Norra ishavet	4	31	
2007	Tjänsteexport	AGAVE, Oden	Hydro-termala källor	Arktiska oceanen (Gakkelryggen)	9	21	USA
2007	SWEDARCTIC	Sydgrönlands glaciationshistoria	Kvartärgeologi	Bredefjorden, S Grönland	2	4	Australien, Danmark
2007	SWEDARCTIC	Zeppelin	Atmosfärskemi	Ny-Ålesund, Svalbard	3	3	Norge
2007	SWEDARCTIC	Kommendörsöarna	Fågelsjukdomar	Ryssland	1	3	Ryssland
2007	SWEDARCTIC	SOAP	Arkeologi	Nuukfjorden, V Grönland	1	3	Danmark, Grönland
2007	SWEDARCTIC	LASHIPA 4	Industrihistoria	Grönfjorden, Svalbard	2	8	Holland, Ryssland
2007	SWEDARCTIC	Bäckraviner	Astrobiologi	Adventfjorden, Svalbard	1	2	
2007	SWEDARCTIC	LongTerm	Kvartärgeologi	N Grönland	1	3	Danmark, Grönland
2007	SWEDARCTIC	JASAT	Glaciologi	Tarfala	1	1	
2007	SWEDARCTIC	Rovfåglar och klimat	Ekologi	Padjelanta, Sverige	0	1	

Bilaga 2

Planerade expeditioner 2007/08–2008/09

År	Program	Expedition/ projekt	Syfte	Plats	Samarbetspartners
2007/08	SWEDARP	JASE	Glaciologisk travers	Wasa-Kohnen-Fuji, DML	Japan
2007/08	SWEDARP	DML-MARA	Atmosfärsfysik	Wasa, DML	
2007/08	SWEDARP	DML-övrigt	Monitoring meteorologi, seismik, geodesi	Wasa och Svea, DML	Holland, Tyskland
2007/08	SWEDARP	IceCube	Neutrinodetektion	Amundsen-Scott, Sydpolen	USA
2007/08	SWEDARP	Oden Southern Ocean	Tvärvetenskap	Södra ishavet	USA
2008	SWEDARCTIC	ASCOS	Meteorologi, atmosfärskemi	Arktiska oceanen	
2008	SWEDARCTIC	International Siberian Shelf Study	Oceanografi, marin kemi	Östra Sibiriens kust	Ryssland
2008	SWEDARCTIC	Arktiska Sverige	Tvärvetenskap	Norra Sverige	
2008	SWEDARCTIC	Kinnvika vårvinter	Tvärvetenskap	Nordostlandet, Svalbard	Polen, Finland, Norge
2008	SWEDARCTIC	Kinnvika sommar	Tvärvetenskap	Nordostlandet, Svalbard	Polen, Finland, Norge
2008	SWEDARCTIC	LASHIPA 6	Industrihistoria	Grönfjorden, Svalbard	Holland, Ryssland
2008	SWEDARCTIC	Zeppelin	Atmosfärskemi	Ny-Ålesund, Svalbard	Sverige
2008/09	SWEDARP	Oden Southern Ocean	Tvärvetenskap	Södra ishavet	USA

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SWEDARP 2006/07

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Ship-based observations and remotely sensed data for the evaluation of the carbon dioxide system in the Southern Ocean

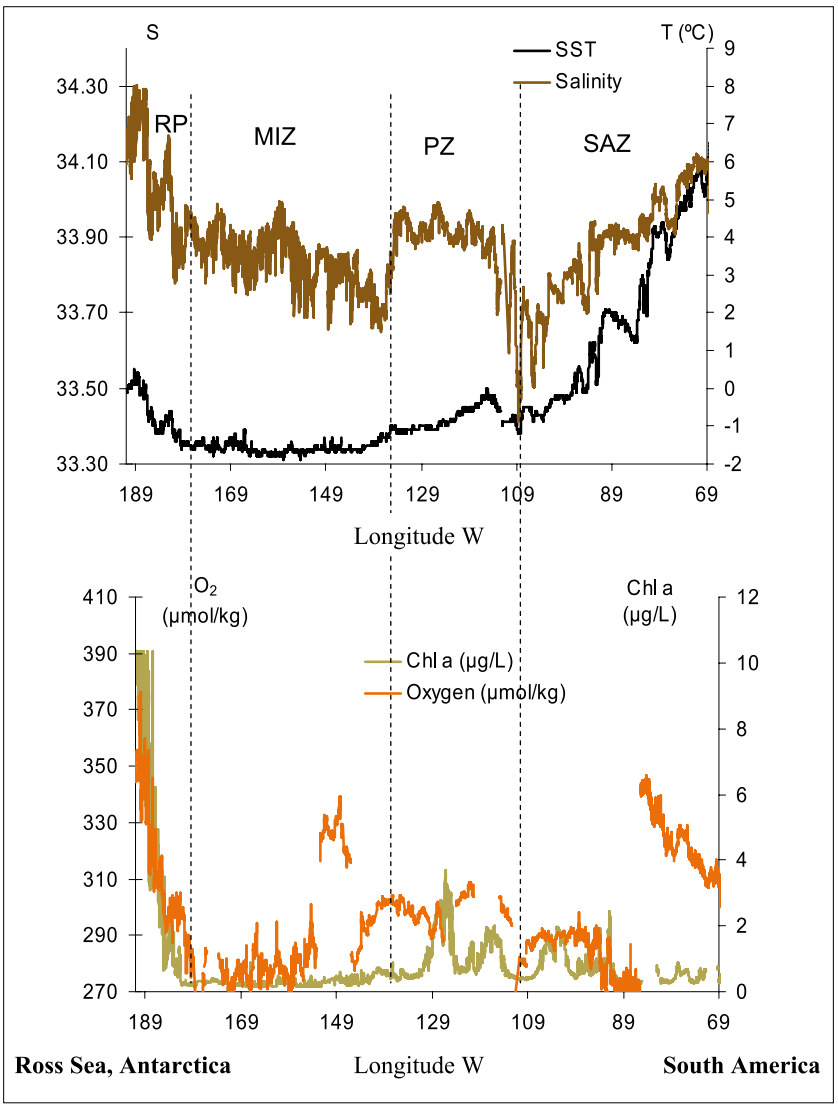


Figure 1
The variability of salinity (S), sea surface temperature (SST, °C), chlorophyll *a* fluorescence (chl, µg/l) and oxygen (µmol/kg) along the cruise track. Indications (dotted lines) show the approximate locations of the Sub Antarctic Zone (SAZ), Polar Zone (PZ), Marginal Ice Zone (MIZ) and the Ross Sea Polynya (RP) along the cruise track.

Aim

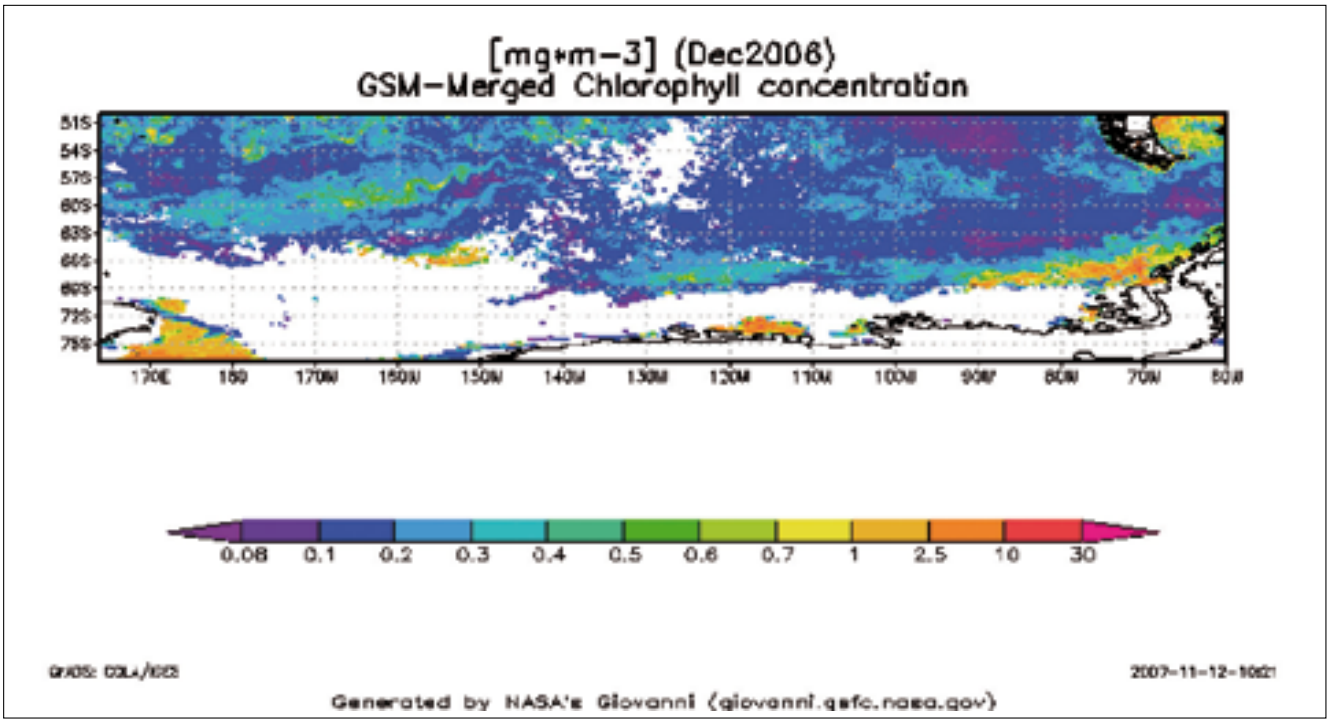
The overall aim for the proposed project is to evaluate algorithms with multiple regression for the estimation of surface water CO_2 using remotely sensed data together with ship-based measurements of chlorophyll *a*, oxygen, sea surface temperature and the fugacity of CO_2 in the surface water (fCO_2, collaboration with Dr. Fransson [page 55]). Thus, the project will give relevant information on the feedback processes affecting the air–sea CO_2 flux, and provide necessary insight into how a changing environment may alter the carbon cycle in the Southern Ocean.

Background

Recent climate assessment reports (IPCC, ACIA) have shown that the high-latitude oceans are particularly sensitive to global warming caused by the increased content of greenhouse gases in the atmosphere induced by anthropogenic activities. Polar oceans, such as the seas surrounding Antarctica, play a role as sinks of atmospheric carbon dioxide. However, little is known regarding the temporal and spatial variability of the processes driving the CO_2 system due to a lack of data coverage. Remotely sensed data provides an unprecedented sampling coverage and satellite borne sensors provide near synoptic global coverage of parameters such as wind speed over the ocean, sea surface temperature, and chlorophyll.

Methods and approach

Measurements on chlorophyll *a* (chl) fluorescence, dissolved oxygen (O_2), sea surface temperature (SST) and salinity (S) were performed underway every minute from 14 to 26 December 2006 from Punta Arenas, Chile to the Ross Sea, Antarctica onboard the icebreaker Oden. Surface seawater samples (~90 samples) were also taken for the determination of nutrients (phosphate, nitrate, silicic acid), total dissolved inorganic carbon (CT) and total alkalinity (AT). These samples were preserved for post-cruise analyses at the



Department of Chemistry, Göteborg University in March 2007.

Remotely-sensed chlorophyll *a* (chl) data provided by NASA, based on the merged product from MODIS and SeaWiFS (http://oceancolor.gsfc.nasa.gov), was downloaded after the cruise and will be compared with ship-based measured chlorophyll and on-line fluorescence for verification and algorithm development. The chlorophyll *a* fluorescence sensor (Minitracka II) was checked and calibrated against filtered and extracted chlorophyll *a* after the cruise.

Preliminary results

During our transit across the Drake Passage, the oxygen concentration (O_2) increased gradually (Fig. 1), which was probably due to the effect of increased solubility as the salinity and temperature decreased (Fig. 1). In the Sub Antarctic Zone (SAZ) the chlorophyll *a* fluorescence (chl) was generally low and between 0 and 1 µg/l. Dramatic changes were observed as we entered the Polar frontal Zone (PZ), where the chl and O_2 drastically increased, which suggests that the ship passed through several phytoplankton blooms in this area. Chl and oxygen concentrations decreased in the Marginal Ice Zone (MIZ), indicating less biological production. However, in the MIZ, we passed through large areas where the sea ice was green-brown coloured, thus implying extensive sea ice algae production, which could not be captured by underway measurements at a depth of 8 m. Polynyas are known to be sites for high biological activity, and in the Ross Sea Polynya (RP), we found maximum chl values of about 10 µg/l coinciding with the highest oxygen concentrations of 400 µmol/kg found along the cruise track (Fig. 1).

Figure 2
Remotely sensed Chlorophyll *a* concentration (µg/l) for December 2006.

Fartygsbaserade observationer och fjärranalysdata för utvärdering av koldioxidsystemet i Södra ishavet

Målet med projektet ombord på Oden Southern Ocean 2006/07 var att finna algoritmer för att bestämma koldioxidhalten i ytvattnen med hjälp av en kombination av satellitdata och fartygsbaserade mätningar på parametrar såsom klorofyll, temperatur, salthalt, syrgashalt, koldioxid. Under expeditionen Oden Southern Ocean 2006/07 mättes dessa parametrar varje minut under två veckors tid fram tills expeditionens slut i Rosshavet, Antarktis. Satellitdata av klorofyll och temperatur från dessa veckor har i efterhand erhållits från NASA och används tillsammans med multilinjär regression för att utvärdera algoritmer för att beräkna koldioxidhalten i ytvattnet. De beräknade värdena valideras gentemot uppmätta koldioxidhalter (samarbete med Dr. A Fransson [sid 55]).

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Deployment of a seismic recording station at Svea, Dronning Maud Land, Antarctica

Introduction

In December 2006, a seismic recording station was deployed at the Swedish research facility Svea in western Dronning Maud Land (DML). This project was established as part of our DROMNET initiative and was realized by cooperation between the Alfred Wegener Institute and the Swedish Polar Research Secretariat. DROMNET is intended to establish a permanently operating large-scale regional seismographic network in Dronning Maud Land. Each station, whether permanently operating or operative during summer only, will be equipped with a modern seismographic broadband station (Fig. 1). These stations will form the permanent backbone of DROMNET while additional temporarily operating stations deployed at variable locations will complement the network.

The scientific background

The international network of seismic monitoring stations is still rather wide meshed in the whole of Antarctica. In greater Dronning Maud Land there are currently only 5 seismographic stations in operation at a selection of the permanently manned bases: Syowa (Japan), Novolazarevskaya (Russia), Maitri (India), Sanae IV (South Africa), Neumayer (Germany). This sparse station density constitutes a number of relatively severe limitations to seismological research in Dronning Maud Land. In particular, the monitoring of local and regional seismotectonic activities, and thus the investigation of geodynamic neo-tectonics in Dronning Maud Land, are considerably restricted by this handicap. Consequently, it is possible that the deployment of more seismograph stations in Dronning Maud Land will facilitate the mapping of the basic tectonic features, especially if evaluation of seismic data is combined with other geophysical data such as aeromagnetics and aerogravity.

DROMNET is intended to make possible the investigation of seismic activities and neotectonic processes in DML in more detail on a regional scale. Recordings from DROMNET may also be used to provide further information about the structure and physical properties of the Earth's crust and upper mantle in different tectonic regions. This will lead to a better understanding of the tectonic evolution of this region. These results are of particular scientific importance as DML was the central region for the disintegration of the former supercontinent Gondwana. The scientific goals can be summarized as follows:

- A detailed mapping of the seismotectonic active areas may reveal the basic recent neotectonic processes in DML.
- The examination of source mechanisms

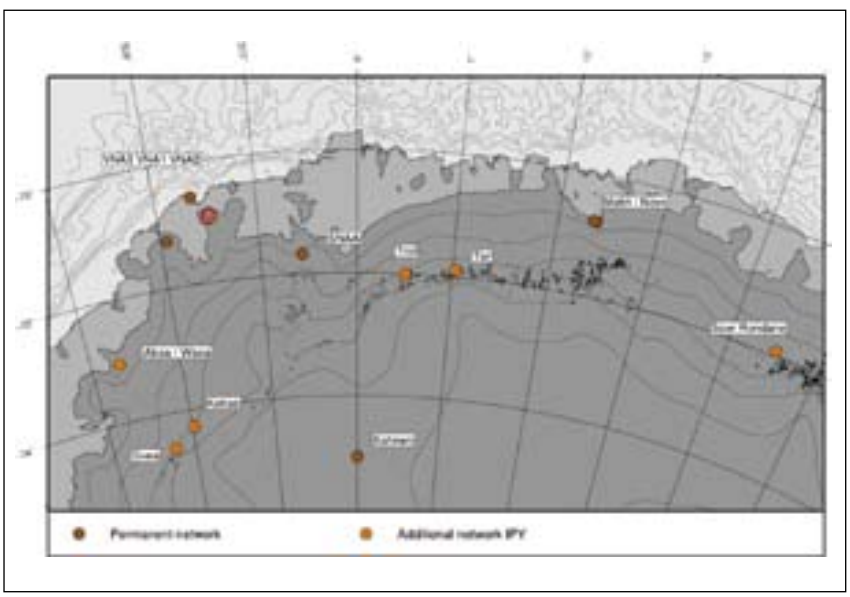

Figure 1
Map of Dronning Maud Land showing existing and possible future seismographic stations.

may provide an insight into the relative movement of tectonic blocks and units.

- The analysis of the interconnection between postglacial lithospheric rebound due to deglaciation and seismicity along the continental margin will provide constraints for models of mantle viscosity.
- A detailed imaging of crustal and lithospheric structures in different tectonic units on a regional scale will become realizable by the deployment of additional temporary seismographic stations and the application of suitable seismological methods (receiver functions, inverse waveform modelling).
- Seismic tomography may become feasible and thus higher resolution models for the Earth's deeper interior may be derived.
- The combination of models for lithospheric structures from seismological investigations with aeromagnetic and aerogravity measurements in DML will enable a comprehensive mapping of derived basic tectonic features on a regional scale.
- New insights can be achieved in the tectonic evolution of different tectonic units, especially in consideration of seismic anisotropy from shear-wave splitting analysis.

Implementation of the scientific equipment

On the morning of 27 December 2006, the equipment and personnel were carried by the aircraft Polar 2 (a Dornier 228-200 turboprop aircraft) via the Swedish station Wasa to Svea for installation of the seismic recording system.

Seismic station information

Geogr. coordinates:	74°34.561'S
	11°13.508'W
Elevation:	1 259 m
Geology:	Gneiss
Start of recording:	27 December 2006
Sensor:	Lennartz LE-3D/20s
Data acquisition:	Reftek DAS-130
Sample rate:	40 sps continuous
Data storage:	2 × 2 GB flash discs

Site description

A site just beneath the Svea hut was chosen as the best location for the seismometer (Fig. 2), since the flat surface provided by the exposed bedrock was particularly favourable for installation. The seismometer was sheltered with insulation foam and then completely covered by rocks as protection against heavy winds (Fig. 3). The insulation is intended to retain some of the seismometers internal heat dissipation and also reduce wind-induced

Figure 2
View of Svea from the north. The seismometer is deployed as indicated by the arrow, in front of and to the right of the rocky outcrop. The Reftek data acquisition system including power supply is housed inside the hut. The GPS-antenna for time keeping is mounted on the roof of the hut. Photo: Christian Müller.

Figure 3
The seismometer is deployed on solid rock. It is protected by insulation foam, which was fitted to the contours of the surrounding rocks. Photo: Christian Müller.

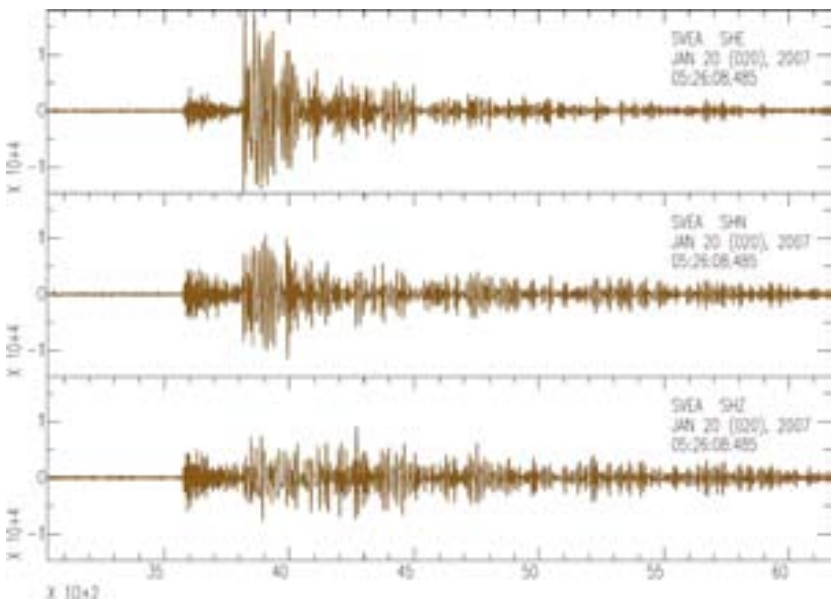

Figure 4
Example of regional event recording: A magnitude Mw = 6.2 earthquake with epicentre near the South Sandwich Islands recorded on 21 January 2007.

noise. The Reftek DAS-130 recording station was installed inside the hut and connected to the hut's solar charged power supply. The system's GPS antenna for time-control was mounted on the roof of the hut and a cable entrance in the roof of the hut was used for GPS and seismometer cables. The cables were fixed to the roof and seismometer cable was buried by rocks.

In the late afternoon of 27 December 2006, the seismograph system was put into operation. Disk capacities and chosen recording parameters should allow a duration of operation of approximately 400 days. In case of power shortage, the Reftek system will shut itself down and start operation again when sufficient power is resumed.

On 16 November 2007, the aircraft Polar 5 visited Svea to download the recorded seismic data. Unfortunately, the acquisition system recorded successfully for a period of only 41 days. The acquisition stopped for unknown reasons on 5 February 2007, the "state of health"-logs however having reported no problem until immediately before termination of data acquisition. Data acquisition has been started again but since we now expect hardware problems with the data acquisition system our aim is to exchange the system at the next possible visit. Figure 4 shows an example of a regional earthquake recording in January 2007. Nevertheless, despite the early interruption of data acquisition, a large number of earthquakes could be recorded including several events that can be used for studying the structure of the Earth's crust and mantle.

Installationen av en seismisk mätstation vid Svea, Dronning Maud Land, Antarktis
I december 2006 placerades en seismisk mätstation vid den svenska forskningsstationen Svea i västra Dronning Maud Land (DML) på Antarktis. Detta projekt började som en del av DROMNET-initiativet och förverkligades som ett samarbete mellan tyska Alfred Wegener Institute och Polarforskningssekretariatet. Tanken bakom DROMNET är att etablera ett permanent storskaligt och regionalt seismografiskt nätverk i Dronning Maud Land. Inom DROMNET-projektet inbegriper de vetenskapliga målen med placeringen vid Svea detektion av seismisk aktivitet och neotektoniska processer i DML. Dessutom kommer de seismografiska upptagningarna från Svea att användas för att ge ytterligare information om strukturer och fysiska egenskaper i jordskorpan och i övre jordmanteln under stationen.

Variability of the carbon dioxide system, oxygen and biogeochemical processes in the Southern Ocean

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Project participant

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Aim

The aim of this project is to study the effect of sea ice on the carbon dioxide (CO_2) system and dissolved oxygen in the surface waters of the Southern Ocean as well as the biogeochemical processes that drive this system during the productive summer season. The ocean fronts, the marginal ice zone, and the ice edge constitute interesting areas of study because of the relatively high level of biological production, resulting in high biological CO_2 uptake. As a result of variations in sea-ice cover, caused by the production and melting of sea-ice, a variable environment is created for biological production and CO_2 fluxes. The CO_2 gas exchange between sea and atmosphere (sea–air) is estimated and related to the physical and biological characteristics of the surface water. Furthermore, the importance of sea ice for CO_2 fluxes in the sea–ice–air interface will be investigated.

Background

Variation in extension of The Southern Ocean sea ice cover is largely attributed to melting in summer and freezing again in winter. The seasonality in sea ice conditions affects biological production and CO_2 fluxes. Due to the sea ice melt in spring and summer, strong surface water stratification is created, and in combination with nutrient availability and sufficient light, biological CO_2 drawdown will take place. Previously, sea ice has been considered to act as a protecting lid, preventing gas exchange between water and atmosphere. However, recent studies have indicated that sea ice is permeable to gases.

Ship-based work

Measurements commenced soon after departing the Strait of Magellan in the austral summer 2006 and proceeded successfully onboard icebreaker Oden both in open water and in sea ice until the McMurdo Sound. The project used on-line, high-frequency measurements of surface water partial pressure of CO_2 (pCO_2), dissolved oxygen, chlorophyll fluorescence (in collaboration with Dr. M. Chierici), salinity and temperature. Samples for total dissolved inorganic carbon (DIC), total alkalinity (AT) and nutrients (phosphate, nitrate, silicate) were collected and measured on shore (Fig. 1). This project is closely coordinated with Dr. Chierici's project [page 50].

The automated pCO_2 instrument was successfully used for sea ice conditions for the first time in the Arctic expedition Beringia 2005, and was now used for measurements in the Southern Ocean. Seawater was pumped with a flow rate of approx. 15 l/min into a CO_2 equilibrator (tandem type combined with a static mixer type manufactured by Kimoto Electric Co., LTD (Kimoto and Harashima

Figure 1
The author filters the seawater sample for nutrient analyses. Photo: Melissa Chierici.

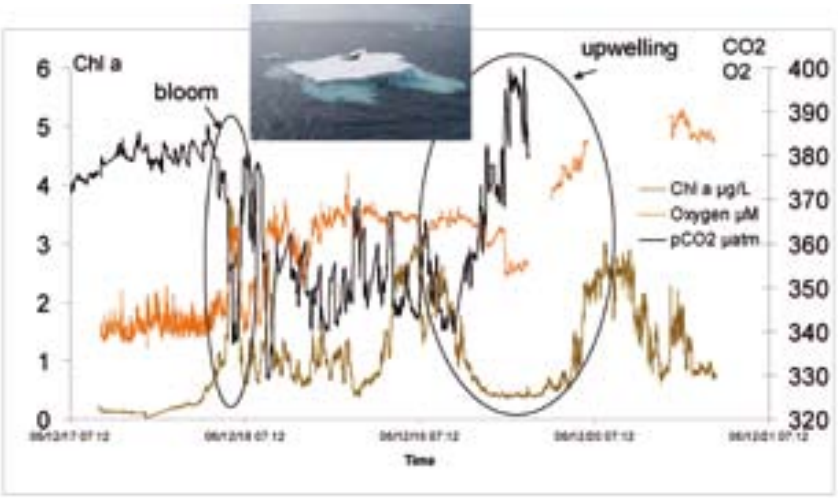

Figure 2
Time series of 1-minute data from 17 to 21 December 2006 for partial pressure of carbon dioxide (*p*CO2, ppm), dissolved oxygen (O2, µmol/kg) and chlorophyll-*a* fluorescence (Chl *a*, µg/l). Special features (phytoplankton bloom and upwelling) are indicated with circles. The photo (by Agneta Fransson) shows a crabeater seal on an ice flow in the suggested upwelling region.

1993, Harashima et al. 1997), passing through a thermosalinograph for continuous pCO_2 measurements. The mole fraction of CO_2 (xCO_2) in dry air, expressed by part per million (ppm), was continuously measured every minute by a non-dispersive infrared detector (NDIR, LiCOR®, model 6262, Lincoln, USA). Four CO_2 standard gases and zero gas (0, 250, 350, 450, 550 µatm) were used for calibration and pCO_2 in air was alternately measured with the same instrument. Sea surface salinity and temperature were continuously measured and an oxygen sensor (Aanderaa) was used to measure dissolved oxygen every minute. The oxygen values were compared to the values obtained from the discrete samples analysed with the Winkler method.

Preliminary results

Along the sailing route, from open water to marginal sea ice, variability in surface water *p*CO2 and oxygen was observed using 1-minute readings (Fig. 2). Preliminary analyses indicate that there was a substantial decline in pCO_2 and increase in oxygen (Fig. 2) and correlative peaks in chlorophyll a (Chl *a*) on the 17 and 18 December, suggesting that the ship passed through a phytoplankton bloom. The most striking feature was the high pCO_2 values, i.e. CO_2 oversaturation relative to the atmospheric level, observed for the first time since departing from Punta Arenas. It is probable that this was due to vertical mixing of CO_2-rich subsurface water with the surface, which is confirmed by the low oxygen values. The Chl *a* showed the lowest values during the time period, indicating low primary production. Coincident with this specific time point, the ship also passed through an area of pack ice and moderate densities of Crabeater seals and Adelie penguins which are feeding on zooplankton, which in turn feed on phytoplankton living under the sea ice. In general, pCO_2 was below atmospheric values, and the lowest pCO_2 values in combination with the highest oxygen and Chl *a* values were measured in the Ross Sea polynya, implying intense biological CO_2 drawdown.

Acknowledgement

Swedish Research Council, Formas and US National Science Foundation.

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Kimoto, T. and Harashima, A. 1993. High resolution time/space monitoring of the surface seawater CO_2 partial pressure by ship-of-opportunity. In: *Fourth International Carbon Dioxide Conference Abstracts*. Carqueiranne, France, pp. 88–91.

Växlingar i koldioxidsystem, syre och biogeokemiska processer i Södra ishavet

Polarhavet i Södra Oceanen har ett istäcke som varierar i storlek beroende på säsong, då isen bildas eller smälter. Denna variation påverkar förhållandena i ytvattnet för biologisk produktion och koldioxidflöden (CO_2). Målsättningen med projektet är att studera effekten av havsis på CO_2-systemet och löst syrgas i ytvattnet och de biogeokemiska processerna som styr detta system under sommarsäsongen. Genom kontinuerliga mätningar av ytvattnets partialtryck CO_2 (pCO_2), total alkalinitet och löst oorganiskt kol kunde CO_2-systemet och CO_2-flöden mellan hav och atmosfär bestämmas, från Punta Arenas (Chile) via Rosshavet till McMurdo Sound i Antarktis. Ytterligare mätningar av syrgashalt, klorofyll a, närsalter, salthalt och temperatur behövdes för att studera bl.a. biologisk produktion och fysiska processer. Preliminära resultat visar att pCO_2, syrgas och klorofyll varierar från öppet hav till havsisområden. En minskning i pCO_2 och ökad syrgas korrelerar med ökad klorofyll, vilket tyder på en planktonblomning. Övermättnaden av CO_2 i havet i förhållande till i atmosfären vid ett tillfälle, då det var delvis istäckt, kan bero på en vertikal omblandning då vatten berikat med CO_2 och näringsämnen kommer upp till ytan från undre vattenlager. Vid samma tidpunkt passerade vi isflak med många krabbätarsälar och adeliepingviner, vilka gynnas av produktionen av de djurplankton som lever av växtplankton under isen, som i sin tur gynnas av det näringsrika vattnet.

The neutrino telescope IceCube at the South Pole

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* not participating in the field

The aim of IceCube

During the 1990s, the AMANDA collaboration demonstrated the feasibility of using transparent ice at large depths in Antarctica for neutrino telescopes. The scientific goals set for these telescopes are to use neutrino particles from space to investigate the "dark matter" of the Universe and to search for the sources of the highest energy cosmic rays. Neutrino particles are extremely penetrative and interact very rarely with matter. It is anticipated that the neutrinos are produced by different violent processes in the Universe, and the ability to detect high-energy neutrino sources will open a new window through which to study the Cosmos. In order to compensate for the extremely low probability of neutrinos interacting with matter very large detectors have to be used. The neutrino telescopes are sensitive to the Cherenkov light emitted from electrically charged particles created by neutrino interactions deep in the ice. The transparent ice at the South Pole, where the ice sheet is 2 900 m deep and extremely transparent at large depths (Askebjer et al. 1997, Askebjer et al. 1998), is a very suitable detector medium for a neutrino telescope. The AMANDA neutrino telescope was constructed between 1995 and 2000, mainly at depths of between 1 500 m and 2 000 m, and the optical modules were deployed in holes drilled by pressurized hot water. The AMANDA detector has been successfully operative and is registering data since February 2000. As a result of the success of AMANDA the large IceCube Neutrino Observatory is now under construction at the same location.

The construction of IceCube began in January 2005. The complete observatory will consist of 4 800 optical modules deployed between depths of 1 450 m and 2 450 m in 80 strings monitoring a volume of about 1 km^3. The digital optical modules for IceCube (DOMs) are considerably more advanced than those used in AMANDA, digitising the photomultiplier signals and transmitting all information in digital form to the surface. Timing calibration, which was performed manually and took several weeks for AMANDA, occurs automatically every two seconds for the whole IceCube array. On the surface above the neutrino telescope an air shower array, IceTop,

Figure 1
Mounting an IceCube optical module to the main cable. The hole below the module is 2 500 m deep and filled with water up to about 50 m below snow surface. Photo: National Science Foundation.

Figure 2
The IceCube laboratory building at the South Pole. The cables enter the building through the two towers. Picture taken in April 2007 at full moon after the station has been closed for the summer season and when the Sun is below the horizon. Photo: Sven Lidström (the first Swede in 40 years to overwinter at the South Pole).

will detect air showers from cosmic rays interacting in the atmosphere. The combination of IceTop and the detectors in the ice will allow calibration of IceCube using atmospheric muons as well as facilitate analysis of the chemical composition of the incoming cosmic rays. The AMANDA telescope is an integrated part of the IceCube observatory following the merger of the AMANDA collaboration with the new IceCube collaboration in 2005.

The IceCube project is a collaboration between:

- Aachen University, Germany
- University of Alaska, Anchorage, USA
- University of Gent, Belgium
- MPI Heidelberg, Germany
- Chiba University, Japan
- Clark-Atlanta University, USA
- University of Maryland, USA
- Université Libre de Bruxelles, Belgium
- Vrije Universiteit Brussels, Belgium
- University of Mons-Hainaut, Mons, Belgium
- University of California, Berkeley, USA
- Lawrence Berkeley National Laboratory, USA
- Bartol Research Institute, University of Delaware, USA
- University of Kansas, USA
- Southern University, Baton Rouge, USA
- Humboldt University, Berlin, Germany
- University of California, Irvine, USA
- Pennsylvania State University, USA
- University of Mainz, Germany
- University of Dortmund, Germany
- Stockholm University, Sweden
- Uppsala University, Sweden
- DESY-Zeuthen, Germany
- University of Wisconsin, Madison, USA
- University of Wisconsin-River Falls, USA
- University of Wuppertal, Germany
- Oxford University, UK
- Utrecht University, The Netherlands
- University of Canterbury, New Zealand

The ice work

Personnel and scientific equipment are transported by air from Christchurch, New Zealand to the American base McMurdo on Ross Island, and then to the Amundsen-Scott station at the geographical South Pole by Hercules aircraft. Heavy equipment can also be transported by sea once a year arriving at McMurdo in January–February.

The construction of the new IceCube Neutrino Observatory continued during the 2006/07 summer season. The drill for IceCube has a heating power of 5 MW compared with 2 MW for the AMANDA drill; it is more advanced and is designed to drill a 60 cm diameter hole in the ice down to 2 500 m in less than 40 hours. Despite the higher power and the larger depth of the holes the consumption of fuel per hole is less than for AMANDA. One IceCube string with 60 optical modules was successfully deployed in January 2005, and another eight strings were deployed during the 2005/06 season. In the season 2006/07 the hot water drill was slightly modified, based on experience gained during the previous season, in order to improve the performance. Thirteen new strings were deployed, giving a total of 22 IceCube strings in the ice of the 80 aimed for. In addition ten new IceTop stations were successfully deployed giving in total 26 running stations. The equipped ice volume of the 22 IceCube strings is already about five times larger than the volume

of AMANDA. The telescope is modular and newly deployed strings are commissioned at the end of the season. The sensitivity of the observatory to detect neutrinos will thus continuously increase during the deployment period. The last string of IceCube is expected to be deployed in January 2011. For the next season, 2007/08, the aim is to deploy another 14–18 strings.

During the season of 2006/07 Sweden contributed with two technicians for the drilling operation and three scientists for testing and deployment of the modules. The Swedish scientists also participated in the installation of acoustic detectors into the ice as a test for a possible future extension of IceCube. While IceCube is not expected to be large enough for the highest energy neutrinos, by using an acoustic technique it may be possible to monitor a larger volume of ice than is possible with light detectors. A test array with three strings, each having seven transmitters and 7 × 3 sensors, were deployed at seven depths between 80 m and 400 m in three of the water filled IceCube holes immediately after the optical modules had been deployed.

Swedish Sven Lidström, who has been a driller for many years for AMANDA/IceCube, was one of three IceCube personnel to remain at the station over the winter season, arriving at the South Pole at the end of October 2006 and staying until November 2007. In total, 54 people stayed over the winter season 2007 experiencing temperatures down to -75°C.

Preliminary results

The 22 IceCube strings are performing very well and are registering data together with the AMANDA array. A report on the performance of the first string deployed (Achterberg et al. 2006a) as well as the first results on atmospheric neutrinos amassed from the data taken by the 9-string detector during 2006 (Achterberg et al. 2007a) have already been published showing that the new IceCube technology works very well.

The analysis of data taken by the AMANDA telescope is still in progress. A general paper on principles and first results was published in Nature (Andrés et al. 2001). More than 4 000 neutrino candidates have been recorded, but so far, no evidence for extraterrestrial neutrinos has been found. About 30 scientific papers in refereed journals have been published. These include papers on:

- the search for neutrino point sources during the five years AMANDA has been running (Achterberg et al. 2007b)
- the search for neutrinos from dark matter annihilations in the Sun and in the Earth (Ackermann et al. 2006b, Ackermann et al. 2006c)
- the ice properties in the AMANDA volume (Ackermann et al. 2006d)
- the search for neutrinos from Gamma Ray Bursts (GRB), which are the most powerful explosions in the universe (Achterberg et al. 2006e, Achterberg et al. 2007c).

The acoustic test system has been functional and data has been recorded continuously. Analysis of the data is ongoing but while the noise level appears to be favourable there still remain questions regarding the characterisation of the noise and the acoustic properties of the ice.

Figure 3
Sven Lidström, the first Swede to overwinter at the South Pole for 40 years. Photo: Tomas Gustafsson.

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Neutrinoteleskopet IceCube vid Sydpolen

Konstruktionen av det nya neutrinobservatoriet IceCube pågår intensivt vid Amundsen-Scott stationen vid den geografiska sydpolen på Antarktis. Observatoriet byggs på samma plats som neutrinoteleskopet AMANDA som färdigställdes år 2000. Teleskopen består av en mängd ljusdetektorer som sänkts ned i isen på 1 500–2 500 meters djup med hjälp av en varmvattenborr. Totalt kommer en kubikkilometer av isen att instrumenteras med 4 800 ljusdetektorer. Dessa detektorer registrerar den mycket svaga ljusblixt som bildas då neutrinopartiklar kolliderar med en atom nere i isen. Teleskopen kan bestämma riktningen på den inkommande neutrinon inom någon grads noggrannhet. Målsättningen är att observera neutriner från kosmiska källor som aktiva galaxer (AGN), gammablixtar (GRB), och universums mörka materia. Under säsongen 2006/07 installerades 13 nya detektorsträngar med 60 ljusdetektorer vardera. När säsongen avslutades bestod IceCube av 22 strängar av de planerade 80. De installerade ljusdetektorerna fungerar mycket bra och atmosfäriska neutriner har redan observerats. IceCube beräknas vara färdiginstallerat 2011.

Sverige bidrog med två borrare och tre forskare vid årets expedition. Ytterligare två svenskar var anställda av USA som borrare. En av dem, Sven Lidström, övervintrade på sydpolsbasen som första svensk på 40 år. Tillsammans med 53 andra övervintrare fick han uppleva 180 dagar av mörker och temperaturer på ned till -75°C.

MARA – Moveable Atmospheric Radar for Antarctica

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MARA is an atmospheric radar which measures echoes from dusty plasma close to the summer mesopause (80–90 km heights), and from small-scale structures in the air in the troposphere and lowermost stratosphere (300 m – ca 12,000 m heights). The echoes can be used to measure wind profiles, to study the characteristics of the dusty plasma, and to study waves, turbulence and air-mass temperature gradients. Examples of the measurements are shown in Figures 3 and 4.

The summer mesopause, at polar latitudes, is the coldest place in the Earth's atmosphere, with temperatures of -150°C or lower. Even though the water content of the upper atmosphere is very low, such extremely low temperatures are enough to cause ice-clouds to form. The clouds, known as noctilucent clouds, can be seen from the ground when the sun is just below the horizon – they are then lit from underneath and the light, scattered at a low angle, picks out the many waves which cross the cloud layer. They are often observed from moderately high northern latitudes (~ 50°–60°N), which are high enough for the clouds to occur and low enough that the sun is below the horizon during the summer season. Noctilucent clouds are rarely seen from the ground in the southern hemisphere due to the lack of habitation at corresponding southern latitudes.

It is expected that changes in the amounts of carbon dioxide and methane in the atmosphere will lead to changes in noctilucent

Figure 1
Hans Nilsson and Ingemar Wolf at work setting up the MARA antenna field. Photo: Hans Nilsson.

Figure 2
MARA antenna field – the radar electronics is housed in the small module beside the antenna field. Photo: Hans Nilsson.

clouds. Increased methane is expected to lead to higher water vapour concentrations in the upper atmosphere, where methane is broken apart by ultraviolet radiation and the hydrogen released forms water vapour. At the same time, increased carbon dioxide concentrations will lead to increased radiative cooling of the upper atmosphere and potentially lower temperatures. Ground based observations of noctilucent clouds have not found any significant increase over the last 40 years (Kirkwood et al. 2003 and 2007, Dalin et al. 2006) while analysis of satellite data (DeLand et al. 2007) has suggested a significant increase. However, the satellite-based results depend on assumptions regarding the daily (tidal) variation of clouds, which are hard to test. Altogether it has become more and more apparent that noctilucent clouds are very sensitive not only to mean conditions but also to atmospheric waves and tides, and they provide a valuable tool to test our understanding of the atmospheric response to composition change in relation to those waves, as well as in mean terms.

Atmospheric radars offer many advantages over visual observation for studying noctilucent clouds – they can observe regardless of tropospheric weather, they can observe all day round, they can be accurately calibrated, and they provide simultaneous and collocated information on winds and waves. They have been used for more than a decade at Arctic latitudes and the relationship between radar echoes (PMSE – polar mesosphere summer echoes) and noctilucent clouds is well established and fairly well understood. Far fewer observations have been made at Antarctic latitudes. The first attempts to observe PMSE in the Antarctic Peninsula were unsuccessful, and even though later attempts did detect some echoes, it was suggested that there is a large difference in mean conditions between the Arctic and Antarctica (Balsley et al. 1993, Woodman et al. 1999). Since 2003 a radar at the Australian Antarctic station Davis has regularly observed PMSE and qualitative comparisons have suggested that differences between the hemispheres were not so large (Morris et al. 2006 and 2007). Up to the end of 2006, however, no quantitative comparison between PMSE in the two hemispheres had been made, neither regarding mean conditions nor wave effects.

During August 2006, the MARA radar was set up to measure PMSE in Kiruna, Sweden (68°N, 21°E). This allowed an accurate cross-calibration with the ESRAD radar in Kiruna, which has been operating since 1996. After further technical testing in September, MARA was shipped to Antarctica where it reached Wasa at the end of December. On 7 January 2007, work was started to install MARA at Wasa. The radar consists of a control computer,

transmitter and receiver electronics, and a large antenna field (in fact, 3 adjacent fields each with a 4 × 4 array of dipole antennas). The antennas are supported on an aluminium framework, forming a grid with antennas centred above each cross-point in the grid, where there are also adjustable support legs down to the ground. A ground-plane of wire was stretched over the whole grid. Each square in the grid is 4 × 4 m and the antenna field stretches over 36 m in both N–S and E–W directions, all accurately aligned and levelled. The computer and electronics are housed in a small module adjacent to the antenna field and power was provided during the field campaign by a generator. Installation of the radar took 11 days and data was collected on 16 days between 18 January and 5 February. On 6 February the antennas and cables were demounted and stored in the container. The supporting framework was left in place to allow rapid start-up of operations next season.

Echoes from the dusty plasma close to the mesosphere (PMSE) were detected which were as strong as the strongest seen in Kiruna, and the overall PMSE occurrence rates were about 30% higher at Wasa (Figs. 3 and 5). The results of this first accurately-calibrated cross-comparison have been published in Geophysical Research Letters in August (Kirkwood et al. 2007). Preliminary results from a cross-comparison with Davis (69°S, 78°E) show stronger and more frequent echoes at Wasa than at Davis (Fig. 4). This is in qualitative agreement with a recently published comparison between Davis and Andenes (69°N, 16°E) that found less PMSE at Davis than at Andenes (Latteck et al. 2007). The comparison between Davis and Wasa provides the first evidence that geographic, rather than geomagnetic, latitude is the most important influence on PMSE. (Davis is at a higher geomagnetic latitude than Wasa and it has been speculated that PMSE are most sensitive to energetic particle precipitation, which increases with geomagnetic rather than geographic latitude. In the Arctic, geomagnetic and geographic latitudes are almost the same, whereas in Antarctica, they are widely different due to the large offset between the geographic and geomagnetic poles).

Echoes from the troposphere (Fig. 4) show many features that are similar to those seen in Kiruna. The strength of the radar echo (upper panel) depends on humidity and (potential) temperature gradients. Easily discernable are the areas of increased power at an altitude of between 8–10 km corresponding to air immediately above the tropopause, which varies between 8 and 10 km in altitude. This is similar to the situation in Kiruna, except that the tropopause is sometimes very indistinct over Wasa. Wind speeds in the upper troposphere (middle panel) are relatively low, while winds in the lower troposphere are rather high. There is a period of higher wind strength at all heights on 28–30 January, which is also characterized by high levels of turbulence in the air (lowest panel). The wind is from a different direction (northeast) compared to the rest of the period (mostly southwest), and measurements of vertical wind (not shown) show strong waves in the lower troposphere at this point in time. It is probably that these are mountain waves caused by Basen (the mountain on which Wasa stands).

Acknowledgements

This project has been made possible by grants from the Knut and Alice Wallenberg Foundation and from the Swedish Research Council, and by technical and logistic support from the Swedish Polar Research Secretariat and Swedish Space Corporation, Esrange.

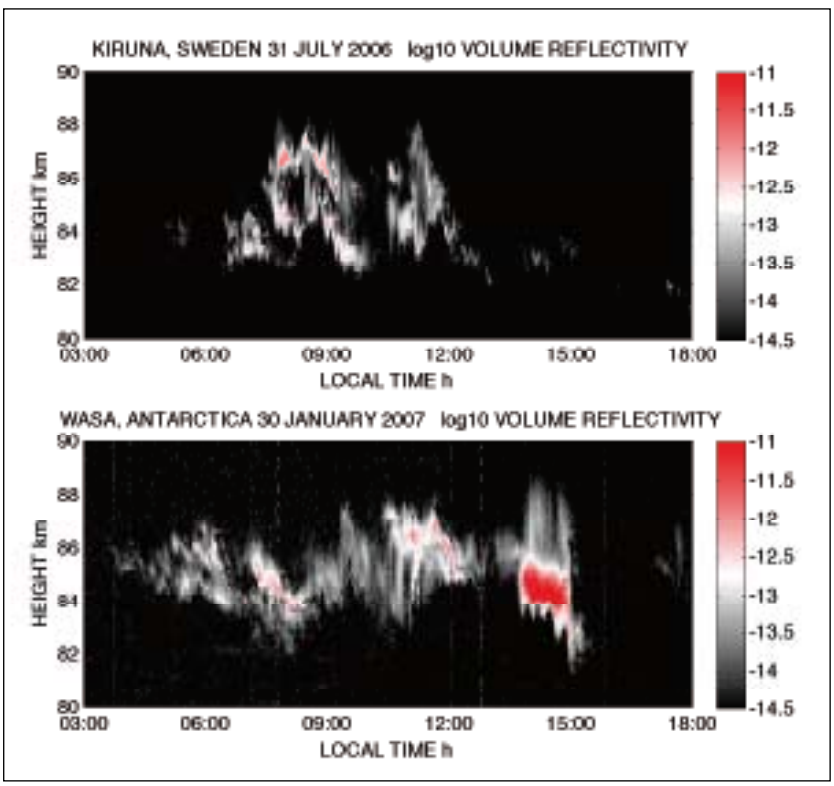
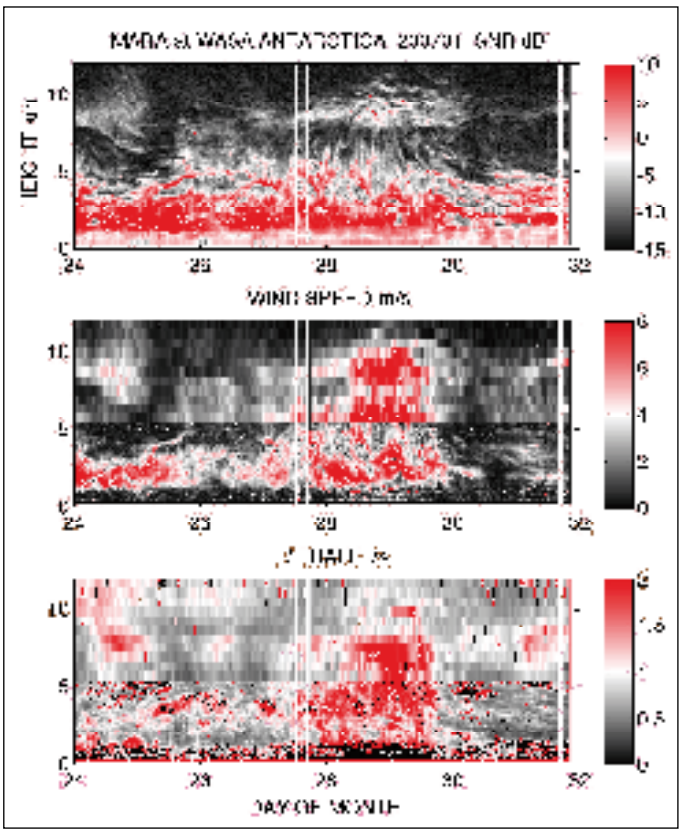


Figure 3
Radar echoes from the dusty plasma at the mesopause (PMSE). The echoes are so strong that only 100 Watts of radar output power (average) were needed to take these measurements.



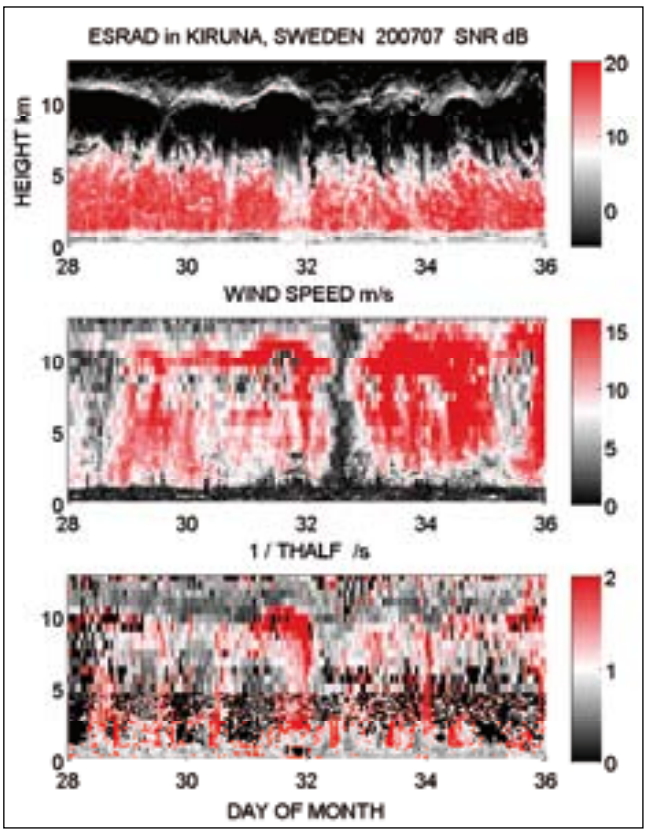


Figure 4a left
Measurements from the Antarctic troposphere between 24–31 January 2007. The upper panel shows echo strength, the middle panel wind speed and the lower panel the level of turbulence in the air.

Figure 4b right
Similar to Fig. 4a, but for the Arctic troposphere, also in late summer.

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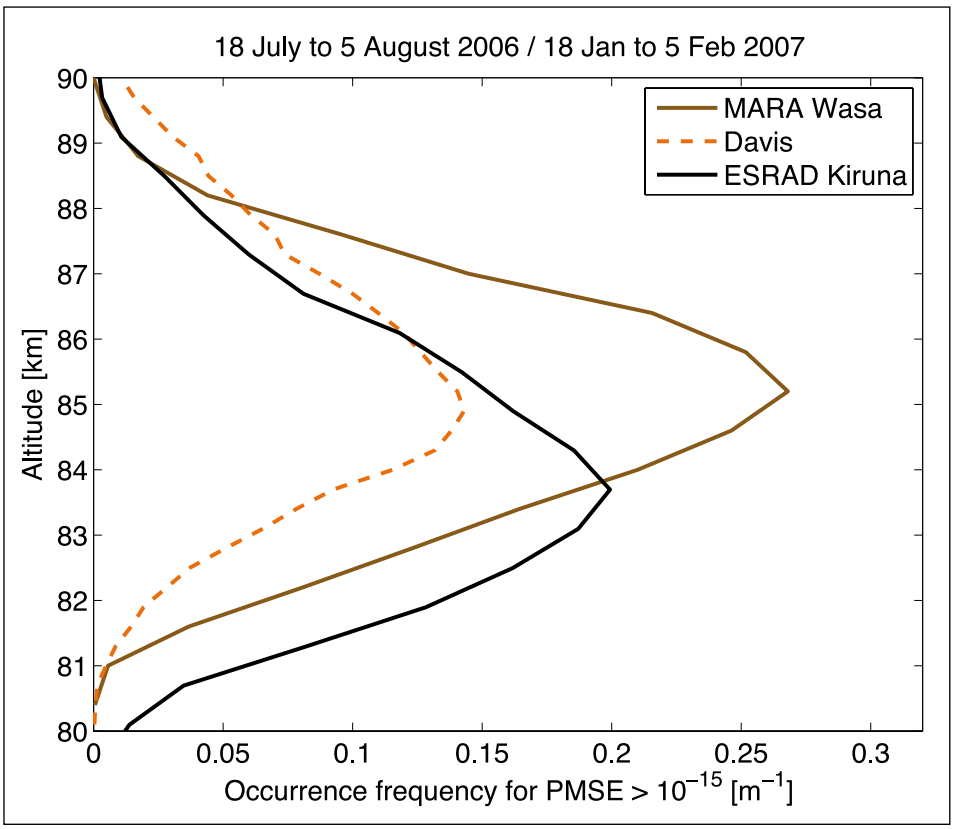

Figure 5
Comparison of PMSE occurrence rates at Kiruna (Sweden), Wasa and Davis (Antarctica). (Davis data courtesy of R. Morris, Australian Antarctic Division and R. Latteck, IAP Kuhlungsborn).

MARA – en flyttbar atmosfärsradar för Antarktis

MARA är en atmosfärsradar som mäter ekon från dammiga plasman (en blandning av jon/elektron plasma och laddade partiklar av is och/eller annat stoft) vid mesopausen (80–90 km höjd) samt ekon från troposfären och lägre stratosfären (300–12 000 m). Från radarekona kan man få information om vindprofiler, dammiga plasmans egenskaper, vågor, turbulens, samt temperaturgradienter i luftmassor. Ekona från mesopausen uppträder endast sommartid och är nära besläktade med nattlysande moln. Tidiga mätningar indikerade stor skillnad mellan norra och södra hemisfärerna, men genom att MARA först använts i Kiruna innan den skickades till Antarktis kan en god kvantitativ jämförelse göras. De mätningar som gjordes under SWEDARP 2006/07 visar att PMSE är ungefär lika starkt och ofta förekommande vid Wasa som i Kiruna. En preliminär analys av radardatat från troposfären visar på många likheter med vad som ses över Kiruna. Dock tycks tropopausen oftare ha en otydlig signatur i radardatat över Wasa. Vindarna var oftast från sydväst. Under en period med kraftiga vindar från nordost sågs mycket turbulens och kraftiga vertikala vindar. Dessa vertikala vindar var sannolikt lävågor orsakade av Basen, det berg MARA och Wasa är placerat på.

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Antarctic tropospheric aerosol physical and chemical properties

Aim

The joint German-Japanese-Swedish AGAMES (Antarctic Trace Gas and Aerosol Airborne Measurement Study) aircraft field experiment was conducted during the Antarctic summer season December/January 2006/07. It represents a unique effort by delivering the first ever comprehensive atmospheric aerosol measurements over Antarctica using an airplane as an observational platform. The objectives of the experiment are:

- Characterization of the tropospheric aerosol physical, chemical and optical properties, its vertical distribution, transport pathways and life cycle over coastal Antarctica as well as above the continental ice sheet.
- Investigate composition and mixing state of atmospheric aerosol by means of size segregated volatility measurements and single particle analysis.
- Investigate the origin of aerosol particles deposited on the Antarctic Plateau with special emphasis on the relative importance of local sources, long-range transport and stratosphere-troposphere exchange.
- Investigate to what extent ground-based long-term monitoring measurements at Syowa, Neumayer, Troll, Aboa and Wasa/Svea stations are representative on a regional/continental scale.

Further details about the AGAMES experiment can be found at www.pa.op.dlr.de/aerosol/agames/.

In general, aerosols consist of a mixture of tiny particles suspended in the air, having special physical and chemical properties that depend on sources, transport and deposition processes in the atmosphere as well as on their size distribution and concentration. Aerosol effects on atmospheric radiation remain a point of major uncertainty in understanding past and present climates and in predicting the future climate. The particles have a direct influence on the atmosphere by scattering and absorbing solar and terrestrial short-wave and long-wave radiation. This may lead to heating or cooling depending on the aerosol properties, the surface albedo, and the cloud cover. They also indirectly effect the radiation and the water budget of the atmosphere by influencing cloud characteristics. Furthermore they are part of many heterogeneous chemical reaction chains. With respect to climate, the importance of the polar regions reaches far beyond our present civilization as ice cores provide information about long-term variations in aerosols and trace gases.

To assess present, past and future impacts of aerosols in a changing atmosphere we need to understand the processes that determine the physical and chemical character of the aerosol particles at a particular place and time. The knowledge about aerosol properties and distribution over Antarctica is fairly limited and based only on relatively few ground-based measurements. They are mostly confined to the coastal regions, which are to a large degree influenced by marine aerosol originating from the surrounding Southern Ocean. Origin and properties of the aerosol over the Antarctic plateau, which reaches elevations of more than 3 km, are much less clear. Gas to particle conversion of the sulphur bearing gases of marine origin is likely to play a role, as well as long-range transport of aerosol particles via the middle and upper troposphere. The aerosol vertical distribution in the Antarctic

troposphere, and therefore aerosol transport patterns and life cycle in general, cannot be sufficiently described based on ground-based observations alone. This gap in knowledge also considerably limits the ability to decipher Antarctic ice core records of past climate and palaeoenvironments. Furthermore, detailed understanding of the air–snow transfer of aerosol particles requires knowledge of their chemical composition as well as concentration and size distribution.

Research platforms and observations

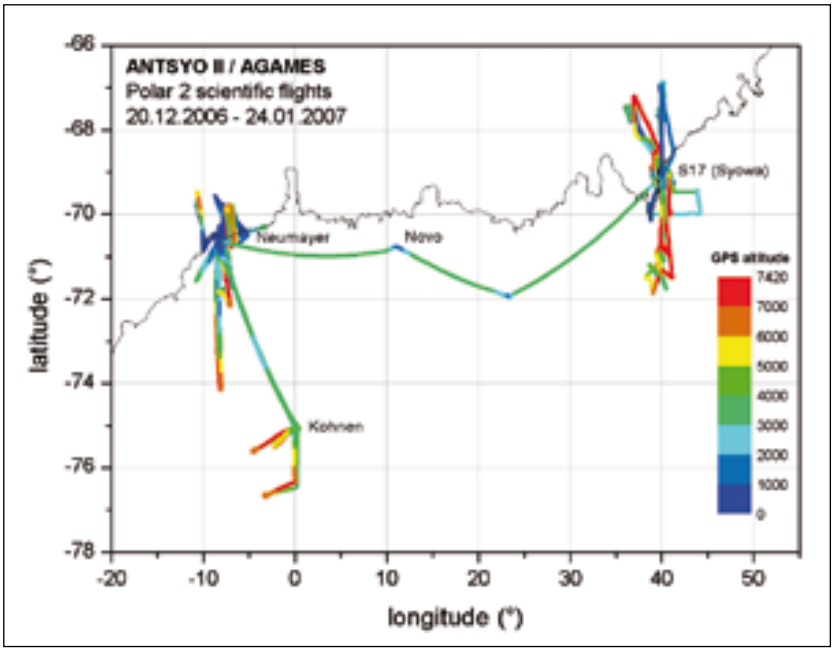
The AGAMES experiment took place in December 2006 and January 2007. The base for the first half of the project was the German Antarctic base Georg von Neumayer (70°39'S, 8°15' W). The second half of the experiment was based at the summer field camp S17 (69°01'S, 40°06'E) located approximately 30 km east of the Japanese station Syowa.

The aircraft used in this study was a Dornier 228-200 turboprop (POLAR 2) belonging to the Alfred Wegener Institute for Polar and Marine Research (AWI) in Bremerhaven. Altogether 36 flights were performed mainly between Neumayer and Syowa between 20 December 2006 and 26 January 2007. Measurements were also carried out during ferry flights between Neumayer and Syowa (Camp S17) with stops at the Russian station Novolazarevskaya and the Belgian station Belaren. Information in respect of the aerosol properties and vertical distribution deep over the continental ice sheet were obtained during two flights operating with refuelling stops at the German station Kohnen (75°S, 4°E) (Fig. 1). Typical duration of the flights was between 2 and 3 hours with flights operating at an altitude range from surface (Fig. 2) up to 7 300 m. In total, almost 100 hours of airborne data is available. With an average cruising speed of around 80 m/s a distance close to 30,000 km was covered (Fig. 3).

The scientific instrumentation on board the POLAR 2 aircraft delivered measurements of aerosol number density for particles of various sizes. Several instruments located inside the cabin as well as mounted directly on the aircraft wing delivered aerosol size distribution between 0.004 and 30 µm. In addition, aerosol light scattering and light absorption properties were also measured. Aerosol chemical composition was investigated in two ways. The size dependent measurements of the mixing state of aerosol particles were accompanied by filter sampling for consecutive analysis of the single particle chemical composition using scanning and transmission electron microscope techniques. Populations of aerosol particles can be formed by aerosols of the same composition (homogeneously mixed aerosol) or by particles of different composition (heterogeneously mixed aerosol). Information about the single particle composition and mixing state can be used to shed light on the origin and age of the aerosol particles and to assist in assessing the degree

Figure 1
Refuelling the POLAR 2 aircraft during a stop at Kohnen station at almost 3 km altitude on the Antarctic continental ice sheet. Aerosol probes mounted directly under the wing are clearly visible as well as the main aerosol inlet on top of the cabin. Photo: Radovan Krejci.

Figure 2
Measurements in katabatic wind layer some 15 meters above ground in the vicinity of Neumayer station. Photo: Radovan Krejci.



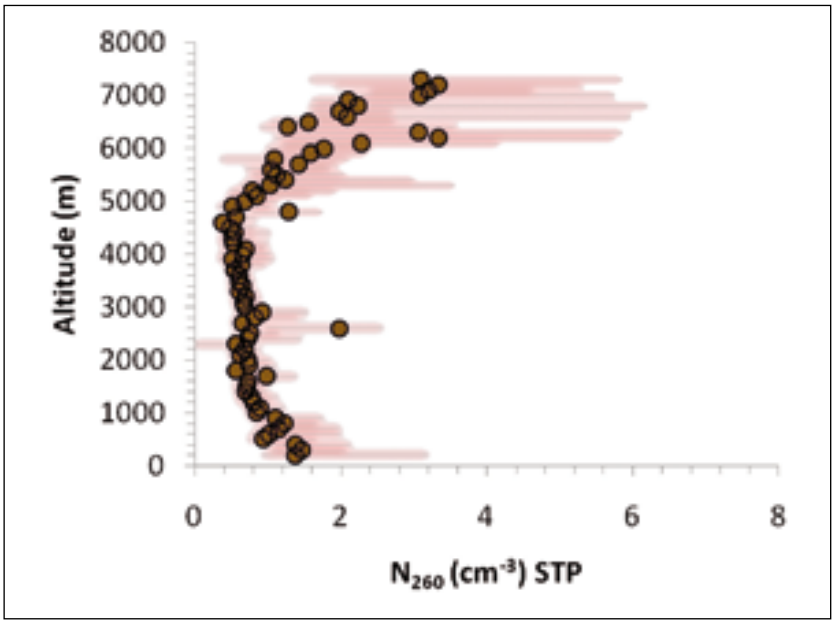


Figure 3 top
The POLAR 2 aircraft flight tracks during AGAMES project.

Figure 4 bottom
Vertical profiles of number concentrations of accumulation mode particles (>0.26 µm) measured during 15 research flights in the Neumayer area, Antarctica, during AGAMES in December 2006. Median number densities are indicated by red spots. Shadowing indicates range between lower and upper quartiles.

of contribution from natural and anthropogenic sources, as well as local and long-range transported aerosol.

Data analysis is currently in progress, but already even at this early stage interesting information about the Antarctic tropospheric aerosol has become apparent. It has been found that the vertical variability of aerosol concentrations is relatively small if compared to mid-latitude observations, but the vertical distribution is less homogeneous than expected based on earlier data. Aerosol layers or distinct vertical gradients in aerosol concentrations were observed during several flights. This feature is especially pronounced for accumulation mode particles (Fig. 4), where strong enhancement was repeatedly observed in the upper troposphere.

The AGAMES project represents an important contribution in our effort to better understand atmospheric aerosol distribution and properties and the role they play in the climate system. Our long-term strategy is to gain knowledge about their sources and sinks, transport and transformation processes, and their interactions with clouds and climate on a global pole-to-pole scale.

The AGAMES experiment was funded jointly by the Alfred Wegener Institute, Germany, and the National Institute for Polar Research, Japan. Swedish participants gratefully acknowledge the support of the Swedish Polar Research Secretariat. DLR was also supported by the Deutsche Forschungsgemeinschaft.

AGAMES – flygburen forskning efter fysiska och kemiska egenskaper hos aerosoler i Antarktis troposfär

Antarktis är det geografiska område som ligger längst bort från mänskliga utsläpp av gaser och partiklar som påverkar vår miljö. Trots avståndet från källorna så är det just denna kontinent av snö och is som förväntas bli mest påverkad till följd av en förändring i klimatet. De luftburna partiklarnas, eller aerosolernas, betydelse för Jordens energibalans har på senare tid lyfts fram som en av de mest osäkra faktorerna när det gäller att förutse hur en förändring av atmosfärens sammansättning påverkar Jordens klimat. Partiklar deltar direkt i strålningsbalansen genom att absorbera och sprida ljus från solen, men aerosolen är även en integrerad del av molnbildningsprocessen. Partiklar i Antarktis är också av intresse ur ett historiskt perspektiv. Variationer av mängden stoft som lagrats i iskärnor som borrats upp på Antarktis har använts för att säga något om hur medelvinden har ändrats till följd av ett ändrat klimat. Trots att aerosolen kan hjälpa oss att förstå klimatet både framåt och bakåt i tiden så vet vi väldigt lite om de processer som bestämmer aerosolens egenskaper i en viss plats vid en viss tid.

Projektet syftar till att karakterisera aerosolen i Antarktis med avseende på dess fysikaliska och kemiska natur som funktion av höjden genom flygplansmätningar. Dessa observationer kopplas till fjärrmätningar från marken och från rymden, samt till långtidsövervakning av aerosolens egenskaper. De grundläggande frågorna är: Vad kontrollerar den naturliga aerosolens livscykel i Antarktis? Till vilken grad påverkas aerosolen i Antarktis av långväga transport?

UU/IMAU AWS in Dronning Maud Land, 2006/07 activities

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Aim of the work

Since 1997/98 IMAU has been operating Automatic Weather Stations (AWS) in western Dronning Maud Land, of which one is situated close to Wasa (AWS 5) and another near Svea (AWS 6). The locations of the IMAU AWS are given in Table 1, page 71. The data from the stations have a wide range of applications, from model validation, energy balance and mass balance calculations to supporting logistic operations. Funding for the operation of the AWS is secured until 2012. Data from AWS 5 and 6 are also available on GTS (Global Telecommunication System, used by weather forecasters to collect meteorological data around the world) for weather forecasting and logistics purposes. Online data from the IMAU AWS data are available from the website http://www.phys.uu.nl/~wwwimau/research/ice_climate/aws/.

Fieldwork 2006/07

During the season 2006/07 the maintenance of AWS 5 and 6 was planned to concur with detailed meteorological measurements and an isotope diffusion experiment close to AWS 5. The AWS were visited by IMAU scientist Paul Smeets, supported by personnel and vehicles

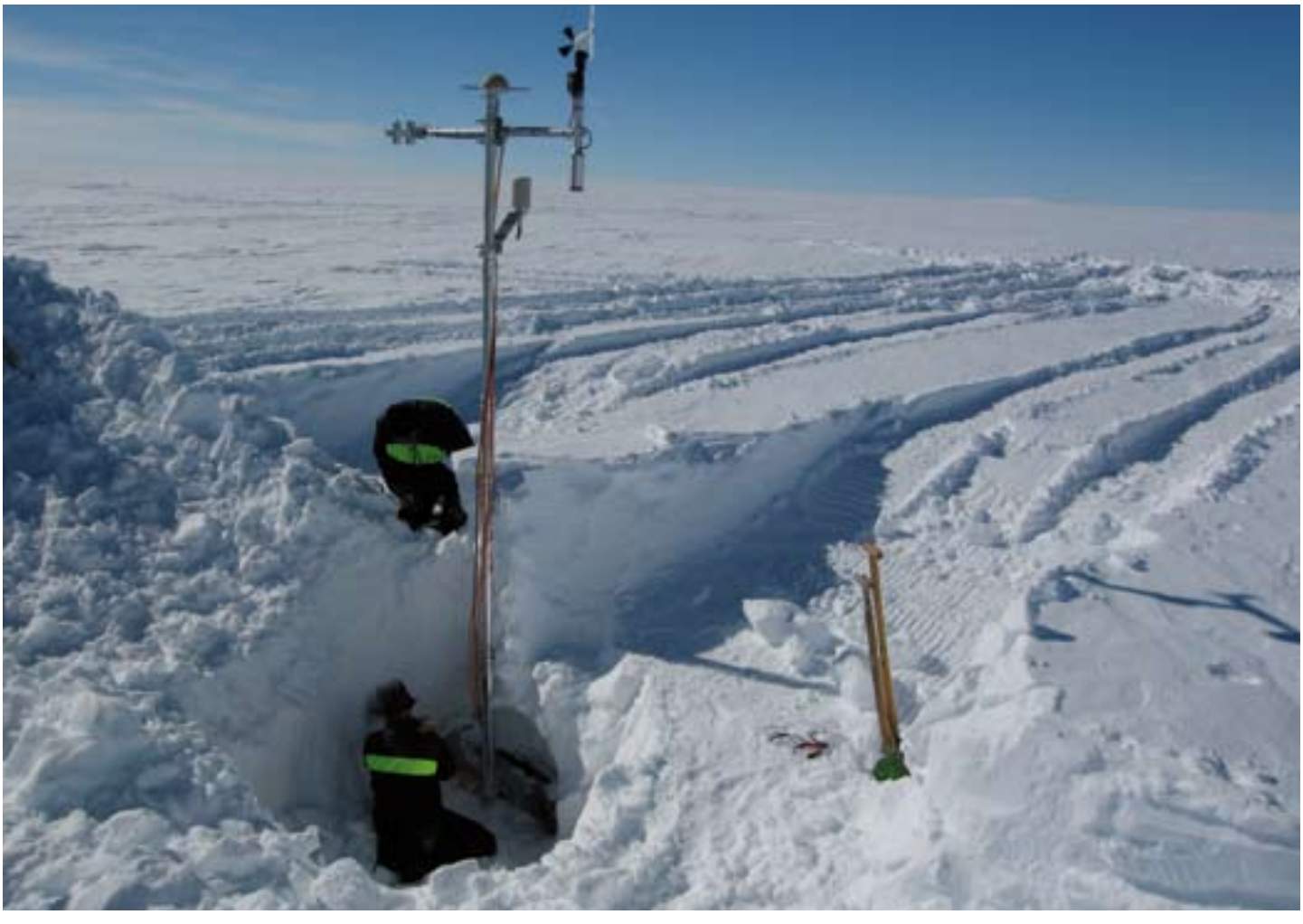


Figure 1
Digging out the AWS and doing maintenance. Photo: Paul Smeets.

Figure 2
The 11 m tall mast close to AWS 5.
Photo: Paul Smeets.

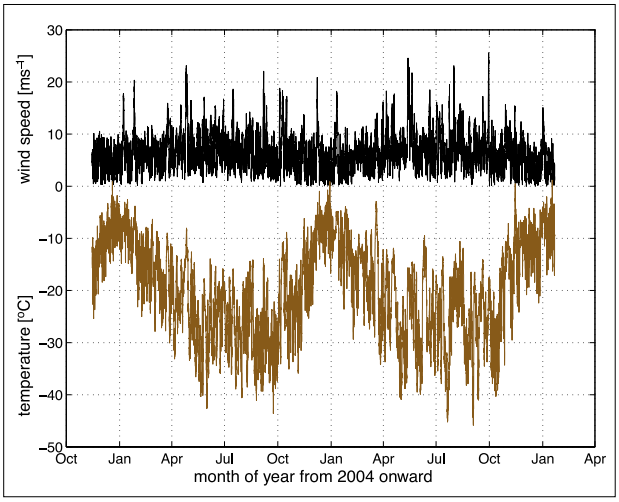
from the Swedish Polar Research Secretariat (Fig. 1). The AWS memory modules were exchanged, battery packs replaced and the masts extended. The wind and temperature/humidity sensors were replaced and new snow temperature sensors were placed at depths of 0.05, 0.1, 0.2, 0.4 and 0.8 m below the surface (Fig. 1).

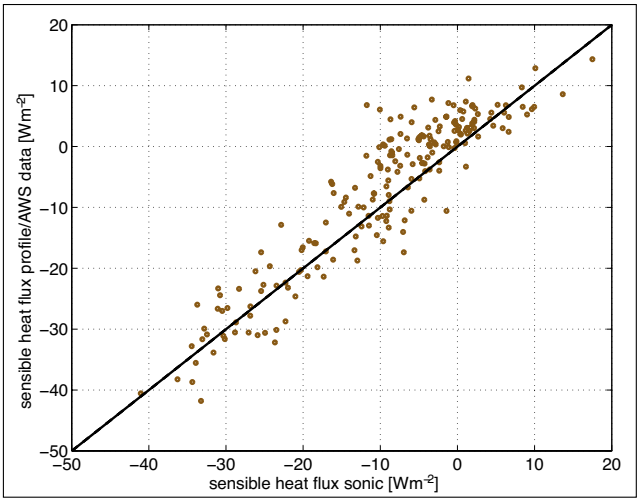
As well as the regular maintenance of the AWS, additional experiments were performed close to AWS 5 to aid interpretation of the AWS data. During the field work an 11 m high profile mast with 6 level wind speed and 5 level temperature measurements was installed close to AWS 5 by IMAU scientist Paul Smeets and personnel from the Swedish Polar Research Secretariat (Fig. 2). A turbulence sensor (sonic anemometer) was mounted at AWS 5 to record year-round eddy correlation measurements. A similar set-up of meteorological measurements was run during the same period by personnel of the Finnish Meteorological Institute and the University of Helsinki (i.e. Timo Vihma and Roberta Pirazzini) close to Basen and benefiting from mutual interests and collaboration, IMAU scientist Paul Smeets was housed during the fieldwork at the nearby Finnish station Aboa. Combining a profile mast and a turbulence sensor enables a detailed study of the lower 10% of the Atmospheric Boundary Layer (ABL), the so-called surface layer (SL). For the isotope diffusion experiment a layer of isotopically-enriched snow was sprayed on top of the actual snow cover in a controlled fashion in a small field (6 × 6 m) marked with stakes close to AWS 5. After deposition the isotopic peak signal of the artificial snow is gradually damped over the years as a consequence of isotope diffusion in firn. Drilling a small core at regular intervals in the years to come will enable us to study the temporal diffusion of this layer into the firn (Fig. 2).

Throughout the season, location AWS 5 was visited on a regular basis to collect data, check the equipment or perform experiments. A safe and comfortable stay was ensured by the small shelter (Fig. 2) erected by personnel of the Swedish Polar Research Secretariat. The Swedish Polar Research Secretariat also facilitated transport between Wasa and AWS 5 of all the equipment for the experiments.

Some results

AWS 5 and 6 are the most reliable IMAU AWS because persistent katabatic winds prevent ice accretion. The data retrieved from both AWS showed continuous time series without any flaws. As a result, nearly continuous measurement sequences are now available dating from the beginning of 1998, i.e. covering about 9 years. As an example, Figure 3 shows the hourly means of wind speed and temperature from AWS 6. The clear annual cycle in temperature is also reflected in the wind speed signal, with higher values during winter. In winter we also





observe the largest temperature variations. Periods with low wind speeds are associated with a large negative long wave radiation deficit and hence low temperatures. When the wind speed is high, downward mixing of warmer air from higher altitudes results in much higher temperatures. During summer, continuous incoming short wave radiation partially compensates the long wave radiation deficit, giving rise to much less temperature variability. In Figure 4 we show preliminary results for sensible heat fluxes derived from the sonic anemometer and plotted against those calculated from the AWS data. The data shown were obtained during fair weather periods and line up nicely along the 1:1 line. However, more detailed observation reveals a small offset when the fluxes are small. This disagreement necessitates further study of the combined data from AWS, the profile mast, and sonic anemometer.

Data availability

The AWS data are available for research purposes free of charge (certain conditions apply when data are used in publications: contact Michiel van de Broeke). Those interested in working with the data should contact Michiel van den Broeke (broeke@phys.uu.nl), Carleen Reijmer (c.h.reijmer@phys.uu.nl) or Paul Smeets (c.j.p.p.smeets@phys.uu.nl).

Acknowledgements

We thank all those involved from the Swedish Polar Research Secretariat in the 2006/07 maintenance of AWS 5 and 6, and in the additional meteorological and isotope experiments performed near AWS 5, especially those that supported the field work. Also many thanks to FINNARP and those who accompanied Paul's stay at the Finnish station Aboa.

More information

For more information about IMAU AWS and online data, go to: http://www.phys.uu.nl/~wwwimau/research/ice_climate/aws/.

Figure 3 left
Hourly means of wind speed and temperature from AWS 6 (Svea).

Figure 4 right
Preliminary results for sensible heat fluxes.

Table 1. IMAU AWS locations in western Dronning Maud Land, Antarctica.

AWS name	Location	Coordinates and elevation
AWS 5	Camp Maudheimvidda	73°06'19"S, 13°09'53"W, 363 m a.s.l.
AWS 6	Svea Cross	74°08'89"S, 11°31'06"W, 1100 m a.s.l.

Automatiska väderstationer i Dronning Maud Land

De automatiska väderstationerna AWS 5 (nära Wasa) och AWS 6 (nära Svea) levererar meteorologiska observationer nästan oavbrutet sedan 9 år tillbaka. AWS:erna sköts av Utrecht University i nära samarbete med Polarforskningssekretariatet. Under säsongen 2006/07 utfördes underhåll på båda väderstationerna och de teleskopiska masterna förlängdes. AWS 5 utrustades med en turbulenssensor för året-runt-mätningar för att underlätta tolkningen av data, och under säsongen gjordes också profilmätningar av vindhastigheter och temperatur vid en 11 m hög mast. För att förbättra förståelsen av stabila isotoper i iskärnor utfördes också ett experiment på isotopdiffusion vid AWS 5.

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Oden Southern Ocean Expedition 2006/07

The United States National Science Foundation (NSF) chartered the Swedish Polar Icebreaker Oden in late 2006 to provide ice-breaking support to cut a channel through the seasonal fast ice in McMurdo Sound and facilitate re-supply and refuelling by ship of the U.S. Antarctic research base at McMurdo Station on Ross Island in the western Ross Sea. Though the Oden's primary mission was to establish the re-supply channel into McMurdo Station in late December 2006 and early January 2007, the ship's transit from Punta Arenas, Chile to McMurdo Sound provided a platform of opportunity for scientists from Sweden, the United States, and Chile to conduct limited, collaborative ship-based research through the Amundsen, Bellingshausen, and Ross seas. The science programme

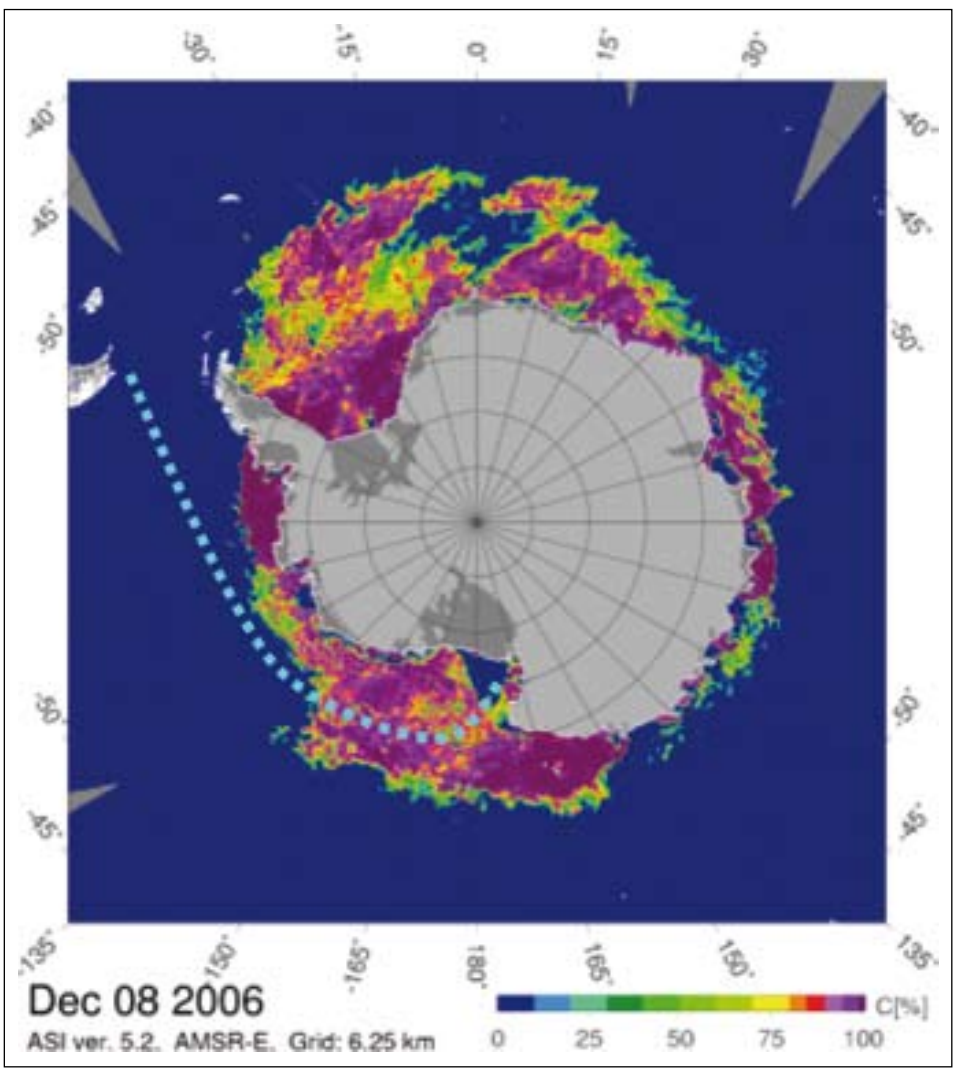

Figure 1
Approximate transit route of the Oden from South America to McMurdo Station, Ross Island between 12 and 27 December 2006.

consisted of nine research projects involving 17 scientists and technicians including 3 from Sweden (2 on-board), 12 from the United States (8 on-board), and 2 from Chile.

An extensive education and outreach program was also developed and executed during the expedition's transit. It included five educators (Ingela Hagström from Uddevalla gymnasieskola in Sweden, Ute Kaden from Homer High School in the U.S., Valentine Kass and Allan Miller from the U.S. National Science Foundation, and Sandra Williams Pinto from the University of Concepción in Chile) who collaborated with each other on the various national activities, and one science journalist (Daniel Grossman from the United States). Nine satellite-linked telephone calls and teleconferences were made to the U.S. and to Sweden during the transit. Two were PolarTREC tele-conferences with schools in the U.S., three were direct calls to U.S. schools which engaged a total of 19 schools throughout continental U.S. and Alaska, three were direct calls to Swedish schools and one was a direct call to a Chilean school. The science journalist was interviewed during a satellite phone call by an Australian public radio science show on 22 December and by a radio station in the United States when the Oden arrived at McMurdo Station. The public was allowed to follow the Oden's progress in real-time by opening this link (www.novator.consult.se/GMS/Oden.kml) with the free software Google Earth (http://earth.google.com).

A reception for the crew, scientists, educators and local media was hosted by the Antarctic Institute of Chile (INACh) on 10 December in anticipation of the Oden's departure and inauguration of the 2007–2009 International Polar Year (IPY). A number of newspaper stories subsequently appeared in the Chilean press and press releases were issued by the Chilean, Swedish, and U.S. national science programs.

The Oden departed Punta Arenas, Chile, on 12 December 2006, passed Cape Horn on 14 December then crossed the Antarctic Circle on early afternoon of 18 December, followed by a festive crossing ceremony. The Oden's course continued well offshore and outside of the pack ice from 18 through early on 20 December owing to continued good weather and the need to make good speed for a timely arrival at the ice edge near Ross Island. A small ice field was encountered on 20 December and traversed within several hours. Waters remained clear of pack ice, though large tabular icebergs were common, until around just after midnight on 22 December when the eastern margin of the main ice field of the Ross Sea and western Amundsen Sea was reached. Large tabular bergs remained common until around 1300 hrs on 23 December when multi-year pack ice began to dominate and icebergs became rare. The pack ice increased through 23 December and was extensive, mostly first year ice with patches of second and multi-year ice scattered, until the Oden cleared the ice field into the

Figure 2
The education programme participants.
Photo: Mattias Peterson.

Figure 3
An Antarctic iceberg.
Photo: Ute Kaden.

Figure 4
The crew, science team, educator, and journalist participants of SWEDARP Oden Southern Ocean Expedition 2006/07 (with Explorers Club Flag No. 84). Photo: Brent Stewart.

Ross Polynya late on 26 December. Several Christmas celebrations were held on board between 23 and 25 December.

The Oden arrived at the fast ice edge just north of Cape Royds, Ross Island, around 1430 hrs on 27 December and immediately began cutting the ship channel into McMurdo Station until stopping just west of Cape Evans and north of the Delbridge Islands at 1700 hrs to receive a briefing delegation from McMurdo Station. The ship then turned north, cut another swath to the ice edge and then returned south to cut a third swath arriving back just off Cape Evans by 0600 hrs on 28 December. All scientists and educators were transported by helicopter from the Oden to McMurdo station between 0830 hrs and 1100 hrs on 28 December, then departed McMurdo on a C-17 jet flight to Christchurch, New Zealand at ca 1430 hrs, arriving at Christchurch at ca 2200 hrs.

Science projects

United States

Diversity, distribution, and relative abundance of marine mammals, penguins, and seabirds from South America to McMurdo Sound during the 2006 transit of the Icebreaker Oden.

Project Participants:
Brent S. Stewart, Ph.D., J.D. (P.I.)
Pamela K. Yochem, M.S., D.V.M. (Co-P.I.)
William T. Everett, M.S.

The aim of this project was to document the diversity, distribution and relative abundance of pinnipeds, cetaceans, seabirds, and penguins using systematic distance sampling methods during a platform-of-opportunity expedition through a vast but poorly known region of Antarctica. The surveys began shortly after departing Punta Arenas and continued virtually continuously through 26 December, with joint collaboration of the U.S. and Chilean survey teams. Overall, sightings were made of 29 species of seabirds and 7 species of marine mammals. The analyses of these sighting data will involve correlating them with ecological data collected by other ship-based research projects (e.g. biological and physical oceanographic data) and with remotely-sensed data on geostrophic currents, sea ice characteristics, sea level height, sea-surface temperature and chlorophyll concentration. The data collected during this expedition will also be compared with regional biological and oceanographic data available from previous studies conducted along the Antarctic Peninsula and recent research expeditions to various areas in the Bellingshausen, Amundsen, and Ross Seas. Moreover, the results will permit ad-hoc hypothesis generation and testing of the biotic and abiotic factors that affect and determine the diversity, distribution, relative abundance, and community structure of these predators in the Drake Passage, along the Antarctic Peninsula, and through the Bellingshausen, Amundsen, and Ross Seas and provide a foundation and guide for future directed marine scientific research in west Antarctica. Analyses will assess variability in the diversity, distributions and relative abundances of marine mammals, penguins and seabirds relative to variation in ocean climate, ice distribution and concentration, and biological oceanography.

There was a substantial change in the seabird fauna at the Antarctic Convergence and another shift just south of the Antarctic Circle and only snow petrels were common after the pack ice was reached on 23 December. Marine

mammal sightings were rare from South America through the deep waters of the Bellingshausen and then Amundsen Abyssal Plains. Relatively moderate numbers of crabeater seals and Adelie penguins occurred throughout the small pack ice field encountered on 20 December. Crabeater seals and Adelie penguins were common again on pack ice floes (mostly first year ice) beginning around 0430 hrs (ca 0800 hrs local solar time) on 23 December and throughout the day. About a dozen each of emperor penguins and Ross seals were also seen through early afternoon on 23 December. Crabeater seals were common and Ross seals were also relatively numerous in the pack ice areas. Weddell seals were observed as the ship approached and then travelled over the continental shelf. Adelie and emperor penguins were also common and minke whales and fin whales were seen on occasion throughout the pack ice. Several killer whales were observed at the fast ice edge in McMurdo Sound on 28 December.

Primary and secondary production measurements along the western Antarctic coastline on the Oden platform of opportunity cruise.
Project participants:
Scott Gallager, Ph.D. (P.I.) (not on board)
Emily Miller (Co-P.I.)
Cooper Quest, Technician

The aim of this project was to conduct underway measurements of primary and secondary production to establish a baseline for future cruises and as support for the marine mammal, sea bird and ice observations being conducted concurrently. The underway seawater stream was digitally sampled for temperature, salinity, total chlorophyll, pH, dissolved oxygen, CDOM fluorescence, nitrate, phosphate, iron, and zoo and phytoplankton. Discrete samples were also taken for total carbon, micro-plankton, and pigment structure by HPLC. A second system monitored water nutrients (nitrates, phosphates, silicates, iron) independently. MODIS remote sensing data was independently obtained for the cruise period to allow cross calibration with *in situ* pigment data and then cross-referenced with meteorological data recorded underway. The overall goal is to understand how the sea ice edge dynamics influence both primary and secondary production and especially larval krill dynamics.

Measurements of all nutrient elements remained constant throughout the transit voyage except for silicates and phosphates, which appeared to increase with distance from South America. In particular there was an interesting signal in temperature, conductivity, dissolved oxygen, pH, nitrate, and chlorophyll levels between 0600 hrs on 18 December (GMT) and late evening 19 December. At that time there were correlative spectral peaks in the frequency of images made by the water flow through the video plankton recorder. Another signal in temperature, conductivity, dissolved oxygen, pH, and chlorophyll levels developed when the Oden entered the main Amundsen and Ross pack ice field on 23 December and remained positive until observations ended on 27 December. There was an increase in gelatinous plankton on 26 and 27 December as the Oden exited the pack ice and entered the Ross Polynya.

Sea-ice observations in the Bellingshausen, Amundsen, and Ross Seas.
Project Participants:
Stephen Ackley (P.I.) (not on board)
Hongjie Xie, Ph.D. (Co-P.I.)
Bercu Cicek (Co-P.I.)

The objective of this project was to collect systematic, comparative observational data on sea ice morphology and distribution as the polar icebreaker Oden transited through the Bellingshausen, Amundsen and Ross Seas. The data collected included ice concentration, ice type, ice thickness, floe size, topology, and snow cover (snow type and thickness) using the ASPeCt protocol standards. Meteorological data, including sea temperature, air temperature, true wind speed, true wind direction, cloud cover (octas), and visibility, were recorded and summarized and transmitted every six hours to user websites for weather forecasting and navigation assistance. The first 4 parameters were obtained directly from the instruments on the Oden (every 5 seconds) and averaged to approximately the same time scale as concurrent ice observations. All collected data were entered into the ASPeCt software program for detailed statistical analysis and will be shared with the research community through the ASPeCt database. They will also be used to ground truth and validate satellite-derived geophysical products of sea ice like those from

Figure 5
An XBT being deployed. Photo: Allan Miller.

Figures 6 and 7
Antarctic Circle crossing ceremony aboard the Oden, 18 December 2006. Photos: Ute Kaden.

Figure 8
The Oden just after arrival at the fast ice edge in McMurdo Sound on 27 December. Photo: Ute Kaden.

Figure 9
Swedish icebreaker Oden close to McMurdo Station. Photo: Sven Lidström.

AMSR-E/Aqua, ICESat, and MODIS, and aimed at improving extant algorithms.

Real-time transfer of weather information began on 17 December 2006 and transfers to the NOAA tele-communication system were made at six-hour intervals. The Oden traveled through the pack ice zone of the Amundsen and Ross seas from 23 to 26 December. Air and water temperatures declined until the pack ice was exited on 26 December when water temperature increased. While in the pack ice, average hourly seawater temperature was -1.59°C (range -1.16 to -1.80) and average hourly air temperature was -2.64°C (range -1.17 to -4.65). The dominant sea ice encountered was first year ice, consisting mostly of large floes, though multi-year ice and newly formed ice were also present in the ice field. Of 133 ice observations made, the average ice concentration was 50%, ice thickness was 107,8 cm, and snow thickness was 30 cm.

Tracking Southern Ocean temperature fields.
Project Participants:
Stan Jacobs, Ph.D. (P.I.) (not on board)
Kevin Pedigo, Technician

The aim of this project was to map the thermal field in the upper ocean during the spring to summer transition of 2006/07. This work complements transects that are more commonly occupied across the Drake Passage along the WOCE SR3 line south of Tasmania, and between New Zealand and the Ross Sea. The project will provide the scientific coordination and subsequent analysis of expendable bathythermograph (XBT) casts made in the Southern Ocean from the icebreaker Oden en route to the southwest Ross Sea during the 2006/07 austral summer. A large number of XBTs were dropped along the transit track starting when the Oden reached the sea ice edge. The acquired data will be edited, cont-oured and compared with historical observations from the same region. Particular attention will be paid to temporal and spatial changes in temperature and mixed layer depth versus connections to seasonal and inter-annual variability of the sea ice cover and the state of atmospheric forcing. Measurements will be reported to the appropriate archives, and provided to interested investigators with related Oden projects. We anticipate results that could help to address the nature of warming in the Southern Ocean, along with the effectiveness of icebreakers-of-opportunity to collect these data.

A total of 156 XBTs were deployed through 1700 hrs on 26 December with the last deployment dropped just before the Oden exited the pack ice. Most of the XBTs provided complete records with only about 10% yielding partial records owing to snagging of the transmission wires on ice before they reached their depth limits.

SOLO float studies of depth-structured temperature and salinity profiles in the Southern Ocean
Project Participants:
Breck Owens, Ph.D. (P.I.) (not on board)
Kevin Pedigo, Technician

The aim of this project was to deploy six SOLO floats at two locations: near 60°S latitude, and

Figure 10, 11 and 12
Crabeater seals.
Ross seal.
Weddell seal.
Photos: Brent Stewart.

close to the ice edge near 150°W longitude as the Oden transits from South America to McMurdo Station. These floats measure temperature and salinity at particular depths. They record profiles of seawater temperature and salinity to approximately 1800 dbars (or 1800 m) every 10 days. Once the float is deployed, it immediately descends to its maximum depth, takes a profile, ascends to the surface and then transmits the data using satellite communications. After sending the data back the first time, the float descends again to about 1 000 m, drifts for about nine days, descends to 1 800 m and records a profile as it ascends to the surface and transmits the data to orbiting satellites. Each float will repeat this latter cycle until the batteries expire after about four to five years. The first three floats deployed (at 59, 60 and 61°S) transmitted data via the Service Argos Data Collection and Location System (DCLS) while at the sea surface for about eight hours. The second set of three floats used the Global Positioning System (GPS) constellation of satellites to calculate geographic location of the float when at the surface and the Iridium satellite system to transmit data back to users. The data is processed within a few hours after it is received and then transferred to the GTS data system that distributes the meteorological and oceanographic data to all weather and climate prediction centres around the world. The data are also sent to the Argo Global Data Acquisition Centres (GDACs) and are available at these websites: http://www.coriolis.eu.org//cdc/argo.htm and http://www.usgodae.org/cgi-bin/argo_select.pl.

The last (5th of 6; the 2nd SOLO failed before deployment) of the SOLO floats was deployed on 22 December.

Sweden

Variability of the carbon dioxide system, oxygen and biogeochemical processes in the Southern Ocean.

Project Participants:
Agneta Fransson, Ph.D. (P.I.) (See page 55)

Ship-based observations and remotely sensed data for the evaluation of the carbon dioxide system along the Marginal Ice Zone in the Southern Ocean.

Project Participants:
Melissa Chierici, Ph.D. (P.I.). (See page 50)

Chile

Records of Antarctic marine vertebrates between Magellan Strait and McMurdo Station

Project Participants:
Veronica Vallejos Marsten, M.S (P.I.)

The aim of this project was to document the occurrence of marine mammals and seabirds in the waters of western Antarctica from South America to McMurdo Station, and particularly from Cape Horn to 90°W longitude, by collaborating with a team of researchers from the United States of America who planned to collect similar systematic data.

The Chilean and U.S. research teams functioned as a single integrated collaborative research effort for marine mammal and seabird surveys (see summary above).

Table 1: Geographic and hydrographic information

Station ID	Long W	Lat S	Ext. temp (°C)	Water temp (°C)	Salinity
SO-1	77°27'	61°21'	2,7	3.6	33,94114
SO-2	84°37'	63°42'	0,7	1,4	33,89610
SO-3	93°70'	65°54'	0,4	0,7	33,87010
SO-Blank					
SO-4	110°58'	67°51'	-1,8	-0,5	33,69100
SO-5	115°53'	67°47'	-2,0	-0,3	33,85960

Persistent organic pollutants in remote areas: Pesticide residues in the Southern Ocean

Project Participants:
Victor Hernandez-Santander (Co-P.I.)
Henrik Kylin (Co-P.I.) (not on board), Swedish University of Agricultural Sciences, Department of Environmental Assessment, Uppsala, Sweden

The aim of this study was to collect samples of organic compound pollutants along the transit of the Oden through relatively unvisited areas where anthropogenic impact is presumed to be minor, to help understand how these pollutants may be transported from warm to cold areas. There are few data existing on persistent organic pollutants (POPs) in seawater from the Southern Ocean. In contrast to the Arctic, data from the Antarctic is too sparse to allow temporal analyses. Comparative data from both areas are needed to develop and check models of the global distribution of these pollutants. There has been only one other campaign in West Antarctica to sample for these pollutants, in the Australian sector in 1989–1990. Considering the latest sampling on the African side on these latitudes, we would expect 10–50 pg/l of hexachlorohexanes (HCHs) in the stations sampled in this track, before the convergence point, between 77°21' W longitude and 61°19'S latitude through, perhaps, 170°W longitude and 75°S latitude in the Ross Sea. The sampling effort conducted during the Oden Southern Ocean Expedition therefore filled a gap in the knowledge about the extent of pollution in Antarctic systems.

The project collected measurements of hexachlorohexane (HCH) residues in Southern Ocean surface waters during the transit of the Oden from South America to McMurdo Station. Solid phase extraction (SPE) was used to pre-concentrate larger quantities of water and then to dialyze and analyze them using gas chromatography to qualify and quantify their presence in these relatively poorly known areas. Water samples were collected via a fresh seawater inlet at the bottom of the ship, at roughly 8 m below the surface. This water was extracted by means of a SPE with ENV+ cartridges (Polystyrene di-vinylbenzene copolymer) in volumes of 10 l per sample. The samples were pulled by the cartridge with a peristaltic pump from a pressurized steel can and then filtered with a Whatman filter, 47 mm in diameter, nominal cutoff 0,47 µm (see summary of data in Table 1). Blank samples were run with de-ionized water. The collection of water samples continued through 26 December. The collection cartridges were subsequently analyzed in laboratories in Chile and in Sweden.

Expeditionen Oden Southern Ocean 2006/07

USA:s stora forskningsfinansiär National Science Foundation (NSF) chartrade den svenska isbrytaren Oden under vintern 2006 och början av 2007 för att bryta en isränna, och därmed underlätta transporter till den amerikanska Antarktisstationen McMurdo. Transitresan 12–28 december 2006 från Punta Arenas i Chile till McMurdo-sundet utgjorde en unik möjlighet och en ny forskningsplattform för forskare från Sverige, USA och Chile. De utförde fartygsbaserad forskning i Amundsen-, Bellingshausen- och Ross-haven. Expeditionsledningen bestod av Polarforskningssekretariatets egen personal och isbrytaren Oden, som för första gången seglade till Antarktis, hade sin ordinarie besättning ombord.

Forskningsprogrammet bestod av nio forskningsprojekt (inom marinzoologi, marinbiologi, marinkemi, miljökemi, meteorologi och oceanografi) omfattade totalt 17 forskare och tekniker. Till detta knöts ett omfattande lärar- och informationsprogram som utfördes under expeditionens gång. Fem lärare från de tre medverkande forskningsländerna – däribland Ingela Hagström från Uddevalla gymnasieskola – samarbetade med varandra och med forskarna. En amerikansk vetenskapsjournalist deltog också. Lärarna genomförde nio satellittelefonsamtal och telefonkonferenser till USA och Sverige under resans gång. Två av dessa var kopplade till det amerikanska PolarTREC-programmet.

En webbsida togs fram av Polarforskningssekretariatet där man kunde följa Odens resa i realtid genom gratisprogrammet Google Earth, som visar jorden genom satellitbilder.

SWEDARCTIC 2007

Forskarrapporter Cruise Reports

LASHIPA 4 – Natural resources and geo-politics from 1600 to the present, cases from Grønfjorden, Svalbard

Project leaders

Louwrens Hacquebord
Expedition leader and team leader
West Grønfjorden group

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Ben Bekooy
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University of Groningen
The Netherlands

Cameron Hartnell
Seth DePasqual
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Michigan Technological University
Houghton, Michigan, USA

Introduction – aim, questions, research problems, methods and theoretical approaches

The LASHIPA project (Large Scale HIstorical Exploitation of Polar Areas) is an endorsed and financed research project within the International Polar Year 2007–2008, with participants from the Netherlands, Sweden, USA, Great Britain, Norway and Russia (www.lashipa.nl). The aim of the project is to explain the development of natural resource exploitation in the polar areas from the 17th century until today, and the ensuing consequences for the geopolitical situation and the local environment. The main research questions are: why, how and under what economical and geopolitical circumstances have the natural resources in the Polar Regions been explored and exploited? What was the role of the industrial settlements and stations in this process? What were the economic results and what were the consequences for the natural environment and the geopolitical situation? The project seeks its explanations and understandings from an international comparative and bi-polar perspective, breaking away from national frameworks common in previous research on polar history. It is a multidisciplinary project, with its emphasis on the disciplines of Historical Archaeology and Industrial Archaeology (Avango, Hacquebord et al. 2006).

The research is based both on documentary evidence from the archives of commercial companies and governments, and on archaeological investigations of material remains of the exploitation activities in the polar areas. The LASHIPA project has selected three areas as targets for case studies – Spitsbergen in the Arctic (sealing, whaling and hunting in the 17th and 20th century, mining in the 20th–21st century, oil and gas in the 20th century), and South Georgia and Deception Island in the Antarctic (sealing and whaling in the 20th century). These areas have been focal points for international competition over both natural resources and political influence through the course of their history. Moreover, they contain rich archaeological remains. Therefore, these are areas where the research problems outlined by the LASHIPA project can be addressed in a limited geographical context.

The LASHIPA project has conducted three Spitsbergen field campaigns previous to 2007: In August 2004, the LASHIPA 1 expedition mapped remains of mining camps in the Isfjorden region. In August 2005 the LASHIPA 2 expedition mapped remains of mining and whaling sites at Bohemanneset and Grønfjorden. In August 2006 the LASHIPA 3 expedition mapped whaling, hunting and mining stations in various locations in the Isfjorden and

Figure 1
Field work areas of LASHIPA 4. 1) Adventfjorden, 2) Finneset, 3) Barentsburg, 4) Kokerineset, 5) Russekeila, 6) Sandefjordneset and 7) Kap Laila.

Bellsund regions, in order to identify and select sites that could be used for archaeological investigations during the International Polar Year. At least three more field campaigns are planned within the project: LASHIPA 5 at Grønfjorden on Spitsbergen in the summer of 2008, LASHIPA 6 at South Georgia in March 2009 and LASHIPA 7 at South Shetland in 2010 (Avango, Martin et al. 2005; Avango and Hacquebord 2006; Avango, Hacquebord et al. 2007).

The data from the field campaigns are used to deal with several of the main research problems in the LASHIPA project. Two of those concern transfer of technology and the design of technology. We want to know what strategies were used to adapt technology from the temperate zone to the harsh natural conditions of the polar areas and why? Closely related problems concern the design of industrial communities and the social organisation of production. Here, we are interested in how different national actors tried to establish social order under no-man's-land conditions and isolated geographical circumstances and why they made the choices they did. Another important research problem concerns the strategies employed by different actors to establish and legitimize claims to natural resources, and the manner in which they sought to achieve national influence by using symbols and rituals of possession in the polar landscapes. Finally, an important research problem concerns the impact of exploitation activities on the local natural environment. Using a comparative approach, we are studying different attitudes towards natural resources before and after the industrial revolution, and different approaches to the natural environment between actors from different nations. What was the impact of the different approaches to the environment, and what can we learn from this knowledge?

The specific objectives of the LASHIPA 4 expedition in August 2007 were to gather archaeological evidence from whaling and mining sites at Grønfjorden and Adventdalen. The scientific aims were closely tied to the overall objectives and research questions of LASHIPA (described above), as well as to the individual sub-projects of the participants (PhD theses, post-doc projects etc. For more information visit www.lashipa.nl). The expedition team was subdivided into three task groups – one mapping remains of mining in Adventdalen, the second mapping remains of whaling and mining on the east side of Grønfjorden and the third conducting an archaeological excavation of a hunters and whaling station at Kokerineset on the western side of the same fiord.

Fieldwork at the Longyear and Advent Valleys

The fieldwork in Longyeardalen and Adventdalen was first and foremost a part of the research of the team members from the Michigan Technological University (MTU). The team focused its efforts on the historical remains of a US company, the Arctic Coal

Figure 2
Ypie Aalders, Seth DePasqual and Ulf Gustafsson mapping remains of Arctic Coal Company test pits at the northwestern entrance of Adventdalen, as part of the field research of LASHIPA participants from MTU. Photo: Dag Avango.

Figure 3
Remains of the flensing plane at Finneset whaling station. The whales were first pulled up on to the floor for cutting, and then further processed in the different production units of the station. Photo: Dag Avango.

Figure 4
Remains of the Finneset radio station – an important asset for the mining and whaling companies active on Spitsbergen in the early 20th century and a valuable tool for Norwegian diplomacy in the struggle over the future status of the no-man's-land. Photo: Dag Avango.

Company (ACC), which was active on Spitsbergen between 1905 and 1916. Their investigations built on the results of the LASHIPA 1 field campaign in 2004, when much of the remains of the former Longyear settlement and the ACC mine nr. 1 were documented. This year's survey efforts examined the way the company analyzed the extension of the coal seams in the landscape surrounding Longyearbyen and how they were used for mining. The surveys covered large areas around the Longyear and Advent Valleys, mapping remains of prospecting mines and claim huts. All finds were mapped using a TRIMBLE GeoXT GPS and some structures were also mapped with a Total Station.

Fieldwork on the east bank of Grønfjorden

The LASHIPA team on the east side of Grønfjorden consisted of Swedish, Dutch and American historians and archaeologists. The team was stationed at the Research Station Barentsburg (belonging to the Kola Science Centre of the Russian Academy of Sciences). The team worked in Barentsburg and its surroundings from 5 to 23 August and consisted of Dr. Dag Avango (project/team leader), doctoral students Ulf Gustafsson, Hidde De Haas (all from Arctic Centre, University of Groningen) and doctoral student Cameron Hartnell and master student Seth DePasqual (MTU). The team had a total of five main tasks to accomplish in the field.

The first task was to document an early 20th century whaling station at Finneset, as a part of the PhD thesis work of Ulf Gustafsson. The station was built in 1905, in the wake of the 1904 national ban on whaling on mainland Norway, and was in operation until 1912 (and again in 1920 and 1926–27). During the course of these years, the station at Finneset underwent several technical and constructional changes.

The second fieldwork task at Finneset (and part of the post-doc research of Dag Avango) was to document the remains of a radio station, erected in 1911 by the Norwegian telegraph company. The radio station provided the first communication service between Spitsbergen and the Scandinavian mainland, and was therefore of great importance to the mining companies operating on Western Spitsbergen. Moreover, the radio station were used by the Norwegian government to strengthen its position in the ongoing negotiations in the 1910s about the legal status of Spitsbergen, which was then a no-man's-land. Firstly, the sites were carefully surveyed, structures were identified and functions established with the aid of historical documents and photographs. Secondly, all foundations and structures were measured and sketched. Finally, all remains were mapped with a TRIMBLE GeoXT GPS as well as with a Total Station. Moreover, the stations were carefully photo documented.

The third task in the Finneset area was to map the remains of coal mining on the hill slopes between Finneset and Grøndalen, with a special focus on the remains of the Arctic Coal Company's activities there between 1905 and 1913. Cameron Hartnell and Seth Depasqual from MTU found several mine entrances in the area. Two of them could be identified as remains of Arctic Coal Company mines and at least one as the remains of a mine used by The Green Harbour Coal Company – another mining company competing for the coal in the area in the early 20th century. All mines (including the remains of adjacent transport systems), coal stockpiles and house foundations were documented with a TRIMBLE GeoXT GPS. In addition, all remains of Arctic Coal Company and Green Harbour Coal Company activities were mapped with a Total Station.

The team on the east side of Grønfjorden also had several tasks to accomplish in the mining town of Barentsburg. As part of the PhD thesis work of Hidde De Haas, the fourth task was to map buildings, mines and mining installations built and used by the Dutch coal mining company Nederlandsche Spitsbergen Compagnie (NESPICO). NESPICO was the company that established Barentsburg and was active there between 1921 and 1932. With the

help of historical photographs and maps, Hidde De Haas and Dag Avango carefully surveyed the entire mining town and found several structures remaining from the NESPICO mining period. A careful documentation was made with GPS technology and digital cameras, as well as measuring tape and sketch blocks. In addition, some of the building remains were documented with a Total Station.

The fifth task, as part of the comparative research conducted by Dag Avango, was to document standing buildings, mines and mining installations built and used by the Russian company Trust Arktikugol, from the Second World War to the present. The functions of the buildings and technological systems were documented by description and digital photographs.

Archaeological research on Kokerineset and the west side of Grønfjorden

The LASHIPA team on the west side of Grønfjorden included three Dutch researchers: Prof. Dr. Louwrens Hacquebord (expedition and project leader), M.A. Ypie Aalders (excavation leader), bachelor student Sara Drescher and two technical assistants, Erwin Bolhuis and photographer Ben Bekooy. Furthermore, the team included five Russian researchers: Prof. Dr. Vadim Starkov (Archaeologist, Russian team leader) Vitali Anufriev (Historian), Dr. Victor Derzhavin (Archaeologist), Maxim Derbenev (Technical assistant) and Vladimir Prokurnov (Translator, assistant).

The Kokerineset site was discovered during the LASHIPA 2 expedition in August 2005. Traces of both whaling and hunting activities were revealed. The site was preliminarily interpreted as a whaling station from the 17th century, overlayered by a Russian Pomor hunter's camp from the 18th and 19th century. The objective of the excavation in August 2007 was not only to test this hypothesis, but also to obtain information in regard of the way man exploited natural resources in the High Arctic during the pre-industrial period, and thus open the possibility for comparison with exploitation of natural resources in the region during the industrial period. Moreover, the study should provide an insight into the way people of two totally different cultures (17th–18th century European whalers and 18th–19th century Russian hunters) were exploiting natural resources during the pre-industrial exploitation period of Spitsbergen and into the nature of their contact with each other.

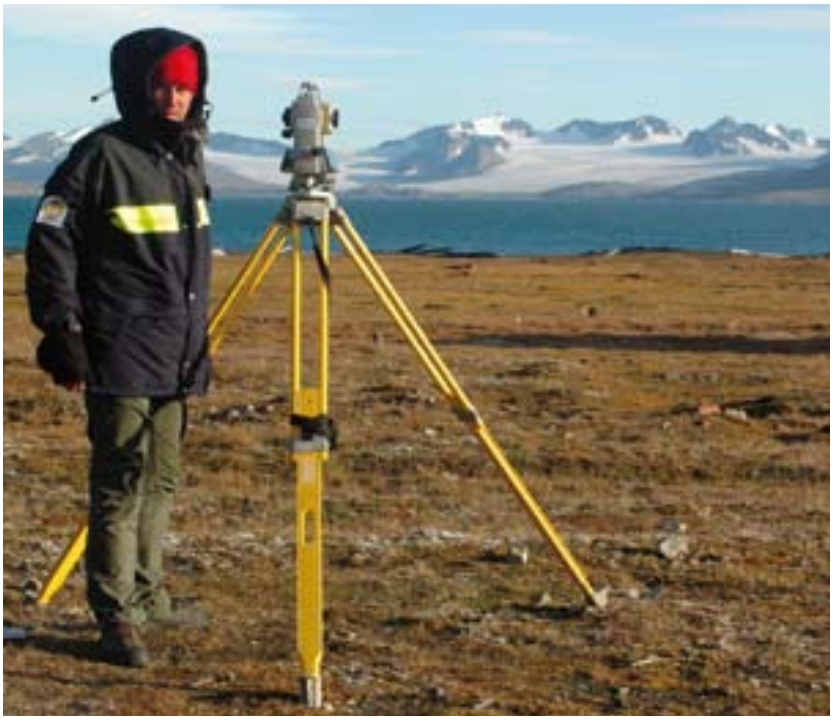

Figure 5
Erwin Bolhuis mapping the Finneset whaling station with a total station. Photo: Dag Avango.

The archaeological research conducted at Kokerineset was focused on the excavation and documentation of the Pomor hunting station. Two trenches of 10 m² each were set out at the site of this hunting station. During the excavation the remains of two log houses were uncovered. Both houses form part of a larger complex of structures that were occupied during different periods. The broad contours of these structures can be traced in the landscape.

At least two culture layers could be distinguished. The finds of the lowest and oldest culture layer consisted of (mostly black) pottery shards, fragmented pieces of bone and pieces of leather and metal. The find assemblage of this layer indicates Pomor occupation. The layer further consisted of a very compact layer of bark and small pieces of wood that was situated under the floor of the log houses, indicating it was older. The second and younger culture layer contained more pieces of glazed ware that are likely to be of West-European origin, which might indicate that the Pomors bartered with the European whalers. This layer belongs to the period when the two log houses were built, probably the 19th century.

An interesting aspect was that the houses were built on a terrace that has been extended by the inhabitants towards the sea in subsequent periods. Because of this it is most plausible that the youngest structures on the terrace are situated closest to the sea and that the oldest structures are situated farthest inland. To test this theory however more research at the site will be needed.

An important aspect of the research was the mapping of the topography of the area

Figure 6
Remains of the concrete foundation for the coal crane of the Nederlandsche Spitsbergen Compagnie from the mid-1920s, re-used today for a conveyer belt by the Russian mining company Trust Arktikugol. Photo: Dag Avango.

Figure 7
Workers housing in Barentsburg, built during the 1980s, during the Soviet era. By comparing the design of mining communities in the High Arctic, we can understand different strategies for establishing social control in isolated industrial communities, as well as strategies for symbolically manifesting national presence and perhaps political systems. Photo: Dag Avango.

Figure 8 bottom left
Professor Louwrens Hacquebord and Ypie Aalders excavating the Pomor hunters station at Kokerineset. Photo: Ben Bekooy.

Figure 9 bottom right
Remains of log houses revealed in the excavation. Photo: Ben Beekoy.

together with visible archaeological remains and other characteristic features of the landscape by using a Total Station. In this way a very detailed map of the area was created.

The surveys: Kap Laila, Sandefjord Point and Russekeila

The LASHIPA 4 team also conducted three surveys. One at Kap Laila at the western entrance to the Coles Bay, with the objective of finding remains of a number of buildings erected there by the NESPICO in the 1920s. The area around Kap Laila was searched in a pedestrian reconnaissance mode, but no remains were found. The result can partly be explained by severe weather conditions. The second survey was made at Sandefjord point, a cape located on the west side of Grønfjorden, south of Kokerineset. The site was used as a fresh water resource by the whaling company active on Finneset, which also had plans to move its whaling station there. In line with our expectations, we found remains of claim boards and facilities for fresh water collection. The third survey was carried out at Russekeila, where remains of a Russian Pomor hunting station was mapped, as well as buildings and features that may pertain to mining projects conducted there in the early 20th century.

Preliminary results

Some tentative conclusions can be made from the results of the field investigations during LASHIPA 4. From the mapping of the Finneset whaling station, most of its production line could be re-constructed and explained, as well as the function and design of its different parts. It also became clear that the plan of the station featured a strict separation between production and lodging. The station plan also expressed a social hierarchy. In addition, we revealed some of the rationale for locating the station at Finneset – favourable harbour conditions with relatively deep water close to the shoreline, protection from winds from the north and a relatively flat landscape suitable for hauling

Figure 9
Survey along the riverbed at Sandefjord Point on the southwest side of Grønfjorden, in search of claim boards and remains of water collecting devices. The river coming down from the mountain was used as a fresh water source for the Finneset whaling station. Photo: Dag Avango.

whales on shore and for erecting buildings and technical installations. Moreover, Grønfjorden is one of the most accessible fiords on Spitsbergen because of the relatively long length of its ice-free season and its location near the entrance to Isfjorden and the open sea.

Many of the same qualities are relevant for understanding the rationale for locating the Norwegian radio station at Finneset. The site was within easy distance from most mining settlements of scale on Spitsbergen in 1911 and a natural place to stop over en route to or from the European mainland. Last but not least, it is well known that the Norwegian government had political ambitions invested in the radio station to further its goal to establish national sovereignty over Spitsbergen. It is therefore worth noting that Finneset was the neighbourhood of several Norwegian companies, guaranteeing the station access to a harbour and to coal (for energy), as well as strengthening the impression of Norwegian effective occupation in the area.

The investigations in Barentsburg also yielded valuable results. It has been generally believed that the remains of NESPICO's Barentsburg are, with some notable exceptions, impossible to find because of the massive destruction of the town in 1943 by the German North Atlantic fleet. However, the survey yielded impressive and unexpected results. Remains of numerous pre-war structures were found and documented, which will facilitate an understanding of the main production line and the general plan of the community, with the help of historic maps and photographs.

The mapping of Barentsburg also yielded important data for understanding the development of the town from the 1930s until today. The different time layers of the settlement revealed different Soviet architectural trends over the course of the 20th century. Moreover, it revealed different phases of re-construction and investment, most likely reflecting fluctuations in the relative importance of Spitsbergen in Russia – economically, politically and strategically. However, at this point we cannot explain the driving forces behind the different construction phases without further archival research and comparative analyses, nor the contextual meanings or symbolic values of the buildings and the settlement itself. These are important tasks for further research.

Finally, the Kokerineset excavation yielded important results as well as bases for a plan for continued excavations of the site. The excavation revealed the remains of two log cabins and under those the remains of an older period of settlement. Both cultural layers clearly indicate a Russian Pomor occupation. However, the site was also used by European whalers, which the remains of a blubber furnace near the beach clearly shows. Most likely these whalers were British, as is indicated by its design. Apart from the furnace, the excavation team found no further indication of a European presence at Kokerineset in the 17th and 18th centuries. Remains of whalers' dwellings are expected to be found to the north or west of the 2007 excavation trenches.

The fragments of glazed- and slipware found in the upper layer point to barter between Western European whalers and Russian Pomor hunters. However, it is also possible, but not likely, that the Pomors brought the pottery from their home countries where they also engaged in barter with Europeans.

The animal bone material collected at the site was analysed in Groningen in the autumn of 2007. It provides some insight into which species the Pomors hunted. However, it is a relatively small sample. In order to answer questions in regard of the seasons during which the Pomors were hunting and the relative amounts of and uses for animals they killed, more bone material needs to be collected from a larger area. A cow bone and the Plum stones found in the excavation make barter between Pomors and the European whalers appear very likely.

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LASHIPA 4 – Naturresurser och geopolitik från 1600-talet till våra dagar

LASHIPA (Large Scale Historical Industrial exploitation of Polar Areas) är ett internationellt historisk-arkeologiskt forskningsprojekt inom ramen för Internationella polaråret (IPY) 2007–2008. Projektets syfte är att förklara utvecklingen av industri i polartrakterna från 1600-talet till idag, samt industrins konsekvenser för den geopolitiska situationen och för den lokala miljön där. Syftet med LASHIPA 4-expeditionen i augusti 2007 var nära knutet till projektets övergripande syfte, liksom till problemställningarna i de individuella delprojekten inom LASHIPA (doktorand- och post-doc-projekt etc. – se webbplatsen www.lashipa.nl för mer information).

Fältundersökningarna genomfördes av tre expeditionsgrupper vid olika lokaler på västra Spetsbergen. Vid Kokerineset, Grönfjorden, genomfördes en arkeologisk utgrävning av en fångststation (1600–1700-tal). På östra sidan av Grönfjorden dokumenterades lämningarna av en valfångststation, en radiostation samt ett antal gruvanläggningar och vid Adventfjorden kartlades lämningar av gruvdrift (1900-tal).

Finding Mars on Svalbard: A study of Martian gullies on Earth

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Background

Water is a prerequisite for life as we know it. Without water the present life on Earth would not exist. The quest for water on other celestial bodies beyond Earth has therefore become an imperative in space research. The planet Mars has been known to harbour abundances of frozen water trapped in its polar caps and the regolith. However, due to the low atmospheric pressure and temperature, water cannot exist in a liquid and stable form on the surface. The discovery of water-related geological features, known as gullies (Malin and Edgett 2000), constituted a turning point in the debate regarding the existence of liquid water on the Martian surface. The discovery implied that water could exist on the surface of Mars during favourable conditions. However, identifying the exact formation processes that have been involved in the formation of these gullies has proved to be a point of contention. Different models have been proposed, including dry landslides (Treiman 2003), liquid carbon dioxide (Musselwhite et al. 2001), snow melt (Christensen 2003), melting ground ice (Costard et al. 2002), deep aquifers (Gaidos 2001) and shallow water aquifers (Mellon and Phillips 2001). So far the science community only has access to remote sensing data from satellites which, at present, cannot for certain determine the true eroding agent of the gullies.

Martian analogue gullies on Earth

On a scouting mission to Svalbard in 2006, we found gullies that bear striking similarities to the Martian gullies. The left side of Figure 1 shows a gully found on Svalbard (Adventfjorden) while the right side displays a typical Martian gully. These gullies, which originate from two different planets, exhibit the same kind of characteristic features such as alcove, channel and debris apron. The theatre-shaped alcove tapers down slope where the V-shaped channel commences. Many gullies on Svalbard have consolidated strata layers in the alcove regions, which also have been detected for some of the Martian alcoves. Moreover, the channels of the gullies on Svalbard tend to streamline around obstacles in the same way as some of the Martian gullies do, which indicates that water could be one of the eroding agents on Mars as well. Another similarity is the occurrence of debris aprons in the lower part of the gullies that are triangle shaped, broadening down slope.

Methodology

The discovery of the similar morphology of the gullies became the starting point of our Expedition Svalbard 2007 and 2008. We hypothesized that terrestrial gullies in the polar regions could be an equitable analogue for the Martian gullies due to the cold climate, and a comparative analysis could help solve

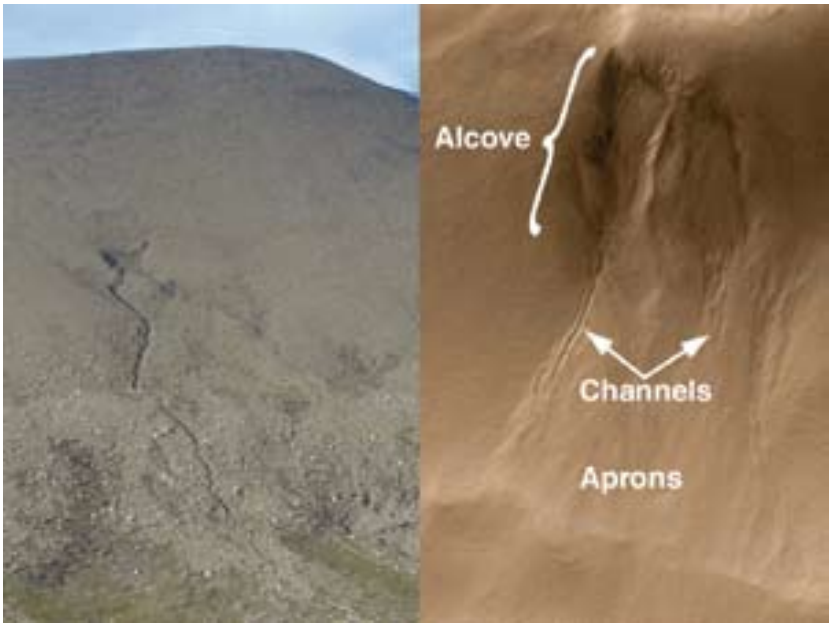

Figure 1
The left side of the figure shows a terrestrial gully on Svalbard (Adventfjorden) while the right side shows a Martian gully. Left side photo: Ella Carlsson. Right side photo: NASA/MSSS.

Figure 2
Andreas Johnsson climbing up in the gully he named Balder. Photo: Expedition Svalbard 2007.

the discrepancies regarding the formation mechanisms of the Martian gullies and shed light on their true eroding agent.

In the study we will analyse satellite remote sensing data of analogue gully locales on Svalbard by using similar methodologies to those used in previous studies of Martian gullies (Heldmann et al. 2004 and 2007). The results will then be compared with measurements made *in situ* on Svalbard in order to validate the conclusions drawn from the satellite data. In addition, an extensive set of measurements, which cannot be conducted from orbit, will be made on site at Svalbard. The knowledge gained from this comparison will be used to make a qualitative evaluation of the conclusions drawn from previous studies of gully formation on Mars, where only remote sensing data is available.

Expedition Svalbard 2007 and 2008

In the summer of 2007, as part of SWEDARCTIC 2007, we first flew to Longyearbyen and initially set up camp at the camping site close to the airport. On the other side of Adventfjorden we were sometimes able to discern the gullies through the low clouds. We were standing at the shore, admiring the view, eager to reach the opposite side of the bay and begin our study.

The first couple of days were spent making sure that we had all the right equipment to survive without support for two weeks in a polar environment. We also checked our instruments to see that everything was in order after the flight.

We were then transported to the other side of Adventfjorden using a small open boat, operated by the Norwegian Polar Institute. We disembarked between Adventcity and Hjorthamn and set up our tents some hundred meters from the shoreline. Even though we could see Longyearbyen on the other side of the fjord, we knew we were in the wild and humble guests in the land of the mighty polar bears.

During the next couple of days we climbed the hills to reach the gullies. Initially, we started to study a rather small gully (250 m), which we named Idun, after one of the gods from Norse mythology. After measuring lengths, widths, depths and slope angles of the different parts of the gully, we deployed our data logging instruments. These loggers are going to measure temperature, humidity and water occurrence in the soil and air, for the next twelve months. With the use of a WADI device, which measures the magnetic component of the electromagnetic field emitted by long-distance radio transmitters, we also looked for signs of underground structures where water could be enclosed.

Little did we know that Idun was just a precursor of what was to follow.

Not far from Idun we found another interesting gully, which we named Balder, Idun's mythological brother. The gully Balder is at least four times longer than Idun and in some places, twice as steep so our exploration of Balder was mixed with emotions of fear and a sense of true happiness. It was a remarkable experience for us to be able to stand inside such a mighty gully, since the larger part of our party had only studied gullies on satellite images taken from high orbit around Mars. Our ultimate goal in exploring Balder was to closely observe the strata layers in the upper part of the alcove of the gully, from where the sapping water originated, but due to the very active top layer of the gully we found it impossible to reach this point, fearing that this layer could collapse. We therefore decided to revisit Balder next year with suitable climbing equipment (and helmets) in order to lower ourselves down from the top of the mountain.

Figure 2
Ella Carlsson and Henrik Johansson analyzing the mountain underneath the surface using a WADI device. Photo: Expedition Svalbard 2007.

After a week the Norwegian Polar Institute arrived to collect us, and this time our target was the shore of Sassenfjorden. Unfortunately the weather situation began to deteriorate and the journey crossing Isfjorden in an open and very small boat took on nightmare proportions in the high and windswept sea. While in the boat, we saw other gullies along the shoreline and we decided to cut our trip short and head for those instead, which took us to the area of the Diabas peninsula.

It took us some time to find a spot with ground sufficiently horizontal to raise our tents. It was a genuine adventure trying to set up the tents and trip wire flares (polar bear warning system) in a polar rainstorm. After a couple of hours of hard work we could finally catch some rest in our sleeping bags and we managed to fall asleep surprisingly quickly in spite of the roaring wind that strove to tear our tents apart.

When we awoke in the morning the raging noise was transformed into a strange and unidentifiable swishing sound. Emerging from our tents the sea greeted us with a calm surface and above us we could see Northern Fulmars gently riding on the breeze along the shoreline, making the swishing sound when passing over us. We all stood in awe of these magnificent birds and the surrounding breathtaking polar landscape of Svalbard that we were so fortunate to visit and study.

We plan to return to Svalbard in the summer of 2008 to retrieve the data loggers and make additional sets of measurements, which we require in order to complete our comparative study. This will hopefully help us to better understand the conundrum of the Martian gullies.

This project is also part of the IPY (International Polar Year) project # 432, where the polar regions of Earth will be investigated in order to facilitate the interpretation of the data from the Phoenix Lander on Mars.

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Mars på Svalbard: en studie av marsianska bäckraviner på Jorden

Eftersom allt liv som vi känner till idag kräver vatten för att överleva, är ibland sökandet efter liv på andra planeter starkt förknippat med ett sökande efter vatten. Att det finns vatten i form av is på vår grannplanet Mars har varit känt under många år, men på grund av de låga temperaturerna och det mycket låga atmosfärstrycket är flytande vatten inte stabilt på ytan. Därför kom det som en stor överraskning när amerikanska forskare år 2000 upptäckte bäckraviner i satellitfoton tagna på Mars yta. Sedan deras upptäckt har det pågått en stor debatt om huruvida vatten kan ha varit inblandad i bäckravinernas uppkomst. Frågan står fortfarande olöst, mycket p.g.a. att den enda information som finns tillgänglig är insamlat av satelliter. För att bättre förstå pålitligheten i de tolkningar som har gjorts har vi påbörjat en studie av bäckraviner på Svalbard.

På Svalbard finns bäckraviner som till utseendet är slående lika dem man har sett på Mars. Detta, tillsammans med det kalla polarklimatet, gör att vi tror oss kunna anta att Svalbard utgör en skälig analog för Mars. Syftet med vår studie är att utföra motsvarande satellitmätningar på bäckravinerna på Svalbard som man har gjort på deras motsvarigheter på Mars, samt komplettera dessa med mätningar gjorda på plats på Svalbard.

Under sommaren 2007 tillbringade vi två veckor på Svalbard där vi utförde mätningar och placerade ut instrument. Under sommaren 2008 planerar vi att återvända till Svalbard för att samla in instrumenten, samt utföra ytterligare mätningar, som vi behöver för att slutföra vår studie. Detta kommer förhoppningsvis att hjälpa till att sprida ljus över det mysterium som de marsianska bäckravinerna utgör.

Joint Russian and Swedish investigations into zoonotic pathogens on the Commander Islands

During the month of July 2007 a joint Russian and Swedish research expedition set out to investigate the presence of microbial agents of zoonotic potential in the fauna of the Commander Islands, a small group of islands bordering the Bering Sea in the North Pacific Ocean. The geographic position of the Commander Islands is of key interest as they are isolated from the North East Asian mainland, but are in close proximity to the North American continent forming a continuation of the Aleutian chain of islands.

In December 2002 the Commander Islands received the status of an international biosphere reserve and are thus considered a part of the world's natural heritage. The coastal waters of the islands are inhabited by many species of whales and cetaceans, while the islands themselves support large colonies of fur seals and sea lions, great numbers of sea otters as well as over 500,000 rare northern birds. The islands host large populations of both migratory and stationary bird species. Due to isolation, some populations have even developed into subspecies found only on these islands, such as subspecies of Rock Sandpiper (*Calidris ptilocnemis quarta*), Commander Rock Ptarmigan (*Lagopus mutus ridgwayi Stejneger*) and Winter Wren (*Troglodytes troglodytes pallescens Ridgw.*). Many marine birds such as auks, gulls, fulmars and shearwaters come to the islands in thousands to breed while others such as the emperor goose use the islands as wintering ground.

In search of avian flu viruses

The expedition's main focus of interest was to screen for the presence of influenza viruses among the large marine bird populations on the islands. Influenza viruses exist in different types and subtypes and cause disease in many different species of animals (Webster et al. 1992, Stone 2000 and 2002, Wallensten 2007a). The seasonal and occasional pandemic (world wide) spread of influenza virus in humans is of major public health importance. The subject has received massive attention since the start of the outbreak of highly pathogenic avian influenza subtype H5N1 in poultry in South East Asia in 2003. This outbreak has had an enormous negative impact on the poultry industry worldwide. It has also proved to be highly lethal when transmitted to humans and has raised concerns over an imminent pandemic (Wallensten et al. 2007b). Historically influenza pandemics have had a devastating impact. The worst known pandemic, the Spanish Influenza of 1918, is thought to have caused the death of more than 40 million people (Oxford 2000). Although stable lineages of influenza viruses exist in different species such as humans, horses and pigs, all influenza viruses in these species are thought to have originated from those circulating in wild birds (Ito and Kawaoka 2000). Wild birds have been shown to harbour a multitude of different influenza viruses but only a few of these have been involved in outbreaks in other species. Influenza viruses have been isolated from several bird species, but are most frequently isolated from dabbling ducks such as mallards and in some parts of the world from certain species of waders (Olsen et al. 2006, Wallensten et al. 2007c). Influenza viruses are isolated from these species around the world and there has even been serological evidence of infection in Antarctic penguins (Wallensten et al. 2006). Very little is known about the circulation in marine birds such as shearwaters and auks although there have

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Figure 1
Sea Otters were abundant in the coastal waters of Bering Island. Photo: Ingvar Eliasson.

Figure 2
Bering Island and sampling sites. Bering Island (55°0'N, 166°15'E) is approximately 90 km long by 20 km wide, which makes it the largest of the Commander Islands. It is situated very close to the International Date Line. The island is treeless, foggy and prone to storms and earthquakes. The only populated area is the small village Nikolskoye. The western sampling sites were reached by jeep and by foot, while the sites on the east side – as well as Toporkov Island – were only accessible by Zodiac (red lines). Old Harbour was not a sampling site but the starting point of the long Zodiac ride down to Peregryobnaya Bay via Buyan Bay. The hand-drawn map was hanging on the wall of the community centre in Nikolskoye. Otherwise, maps of this island are hard to come by.

Figure 3
Larisa Zelenskaya in the tent. During our visit to Toporkov Island, we met two Russian ornithologists, Yuri Artukhin and Larisa Zelenskaya, stationed at this small island during the whole bird-nesting period. They were both very helpful, allowing us to use their tent for shelter and providing us with useful information on the bird population and on handling the birds. Photo: Ingvar Eliasson.

been sporadic reports (Wallensten et al. 2005, Sazonov et al. 1977, Mackenzie et al. 1984, Yamnikova et al. 2003), but the relevance of these sporadic findings in marine birds in relation to the total circulation of influenza viruses in wild birds is still unclear. Many marine bird species live nomadic lives at sea and are therefore difficult to catch other than on their breeding grounds. Therefore breeding places such as the Commander Islands are ideal for sampling marine birds. The relative isolation of the Commander Islands from the mainland East Asian migratory bird flyways and the limited impact of poultry production also make these islands interesting for sampling. The current expedition aimed to fill the final gap in an influenza screening project that was part of the multidisciplinary research expedition named "Beringia 2005", organized by the Swedish Polar Research Secretariat in collaboration with Russian and American authorities. During Beringia 2005, sampling for influenza took place on the Russian mainland further north including Wrangel Island and also at the Alaskan coast, in order to map the prevalence of influenza viruses in the Bering Sea area.

Zoonotic gut bacteria and antibiotic resistance

However, influenza A viruses are not the only agents of zoonotic potential that birds can harbour and during both Beringia 2005 and the current expedition, simultaneous sampling for bacterial agents were also performed in order to benefit studies on the prevalence of *Campylobacter, Salmonella* and *Chlamydophila psittaci* among wild birds. These samples will also be used for studies on the presence of antibiotic resistance in bacteria from these remote echo systems. Previous studies by Professor Olsen's group have discovered antibiotic resistance in bacteria from other remote places such as the South Georgian Islands, in spite of the limited human presence on those islands (Olsen et al. 1996, Palmgren et al. 2000, Broman et al. 2000).

Seabirds perpetuate specific bird-tick borrelia cycles

In addition, ticks were collected from birds and from the birds' nests. Ticks will be analysed for the presence of *Borrelia burgdorferi sensu lato,* tick-borne spirochetes that can cause Lyme borreliosis in humans. Migratory birds have been shown to act as long distance vectors for *Borrelia* and different sea birds, nesting in large colonies, are known to perpetuate specific bird–tick *Borrelia* cycles with dedicated tick species (Olsen, Jaenson et al. 1993, Olsen, Duffy et al. 1995, Comstedt, Bergstrom et al. 2006). Mapping *Borrelia* isolates from these remote islands and comparing them to strains isolated from birds and rodents as well as humans can provide new knowledge on the global distribution and spread of the *Borrelia* spirochetes.

Field work

The expedition was carried out by participants from the Institute of Influenza in Saint Petersburg and a joint Swedish crew with representatives from Kalmar University, Lund University and Umeå University. The team was fortunate to have stable weather during the whole expedition (not always the case on these misty and cold islands) and with expert help from the rangers of the reserve, they managed to capture and sample birds from both the east and west coast of Bering Island, as well as from the small Toporkov Island (for sampling sites, see Fig. 2). In addition, a smaller number of specimens were collected from black-headed gulls in the river delta of Petropavlovsk. All together, specimens from some 530 birds of different key species were collected, as well as a large number of ticks, mainly from birds' nests. As a side project, Dr. Marina Stukova also

performed voluntary blood sampling of the local population at Bering Island for seroepidemiological investigations.

All specimens were put in appropriate protective media in the field, and then placed in stainless steel dewars of liquid nitrogen at a temperature of about -197°C. The dewars provided a simple and effective means of rapid freezing and safe storage during fieldwork and transportation across the 11 time zones back to Sweden. Laboratory investigations regarding Influenza viruses and Influenza serology will be carried out as a collaboration between Kalmar and Saint Petersburg, while ticks and bacterial specimens will be processed in Umeå and Kalmar, respectively. All results will be published jointly and feedback on the outcome of the investigations also provided to the Director of the Komandorskiy State Nature Biosphere Reserve for reference.

In conclusion, this international, multidisciplinary research expedition may provide new knowledge in several important areas of research regarding silvatic zoonotic diseases, i.e. infectious diseases and propagation of infectious agents in wild animals that can eventually affect humans. Knowledge about the propagation of antibiotic-resistant bacteria from human and agricultural sources back into nature is also of major concern in the context of the long-term usefulness of antibiotics in the battle against infectious diseases.

Supporting organisations

Research Institute of Influenza
Russian Academy of Medical Sciences
Swedish Polar Research Secretariat
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Figure 4
Fur Seal colony at the North West Rookery. Photo: Ingvar Eliasson.

Figure 5
Tufted Puffin (*Fratercula cirrhata*), captured at Toporkov Island. Photo: Anders Wallensten.

Figure 6
The Red-legged kittiwake (*Rissa brevirostris*), only breed on the Commander Islands and a few more islands in the Bering Sea. Photo: Ingvar Eliasson.

Figure 7, 8, 9, 10
Red-faced cormorant (*Phalacrocorax urile*).

A large mixed colony, mainly consisting of kittiwakes.

Red-legged kittiwake (*Rissa brevirostris*).

Bering Island's Arctic fox (*Alopex lagopus beringensis*) were abundant and often curious. Photos: Ingvar Eliasson.

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Gemensamma ryska och svenska undersökningar av zoonotiska patogener på Kommendörsöarna

Kommendörsöarna är en isolerad ögrupp utanför Kamtjatka i östra Ryssland. Den är kanske mest känd för att den store polarforskaren kommendör Vitus Bering dog där under en dramatisk upptäcktsresa i området. Kommendörsöarna sjuder av djur- och fågelliv och på grund av dess isolerade läge finns flera endemiska arter. Sommaren 2007 genomförde vi med stöd av Polarforskningssekretariatet en svensk-rysk expedition till Kommendörsöarna för att kartlägga förekomsten av zoonotiska mikroorganismer hos framförallt havsfåglar. Avföringsprover samlades in för påvisande av influensavirus, *Salmonella* och *Campylobacter* och fästingar från fåglarna samlades in för att studera *Borrelia*-bakterier. Förekomsten av dessa organismer hos havsfåglar och vilken roll fåglarna spelar i spridningen i naturen är i stort okänd.

Use of soapstone from the first settlement of Greenland until the present day

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Background

Recent research in archaeology has drastically improved our perception of the prehistory and history of the Arctic. These advances have demonstrated that Arctic peoples possess rich, interconnected and complex histories.

Movement is regarded as an important concept both for describing changes in human societies and for understanding human relationships with the natural and social environment. Firstly, the concept of movement encompasses human actions ranging from seasonal mobility constituted by small-scale movements within a region, to long-term, inter-regional migrations. Secondly, it refers to the movement of resources and cultural artefacts through trade and exchange between regions that serves to level out uneven resource distribution in both space and time, and it can also symbolise social connections. Participation in regional and inter-regional communication networks is also central to long-term Arctic history, as rational choices can only be made with access to information about the social and natural environments outside the local and regional areas. These networks may be embedded in trade or exchange, or based on ideological or social connections and alliances. The ultimate objective of the project is to bring about an understanding of the dynamic strategies of movement, communication, and other social actions that Arctic peoples generate when interacting with their social, cultural, and natural environments. These strategies can operate at multiple levels, including individual agents, families or households, local groups, and all people of a given cultural tradition. In particular, connections between these levels are expected to be important in identifying the multifarious life-strategies employed by individuals and societies.

In cold climates, sources of heat have necessarily been of major importance. In large areas of Greenland soapstone was used in order to make lamps and other containers that were used for heating food as well as providing light for the dwellings.

The western coast of Greenland was primarily settled by members of the Saqqaq culture at around 2500 BC and initially driftwood was used for heating dwellings. However, when primary sources for fuelling fire were exhausted, people started to make soapstone lamps filling them with bladder oil from seals. Soapstone is abundant in the Nuuk region of Western Greenland, and of high quality while only a few quarries have been identified in other parts of Greenland, and consequently soapstone became an important commodity for exchange. It has been ascertained that raw material was exchanged over long distances since we know that special metamorphic slate, *killiaq*, was extensively used in the Nuuk region for making tools although the source is located in Disco Bay some 650 km to the north.

In 2005 a project was initiated with the purpose of developing a new and more integrated understanding of Arctic cultural history. The

Figure 1
A view of the small fjord Urjarassuit pavat with the base camp for the archaeologists. Photo: Lars Larsson.

Figure 2
The documentation of soap stone quarries in progress. Photo: Fredrik Larsson.

intention was to promote an international orientation for the project based on the composition of the group of research members and to strengthen the development of an internationally based education and exchange programme on Arctic prehistory and history.

The point of departure for this project is to initiate archaeological investigations of the Nuuk area's renowned but under-documented steatite quarry sites. The ambition is to combine the substantial historical and ethnographical source material to develop a number of solidly founded models for the historical trade and exchange in soapstone and to trace its imprint in the archaeological record. The main commodity in this study is soapstone but other raw materials such as minerals for making tools as well as a variety of reindeer products have been of importance in long-term as well as short-term exchange networks.

Today the traditional use of soapstone for vessels, lamps and weights for line fishing is all but obsolete, the mineral now having quite a different use as a material for artists to carve figures, which are attractive for tourists to buy.

There is also an interesting gender perspective related to soapstone. According to local oral tradition, prior to the historic period which dates from 1722 when the first Danes settled in Greenland, soapstone was known to be a raw material pertaining to women on account of the fact that it was the women who formed the soapstone items and subsequently kept the profit from soapstone trading for themselves.

The title of the project is "The Steatite Objects Analysis Project" (S.O.A.P.). The initiative became one of the sub-projects under the International Polar Year project "Dynamics of Social Strategies in Arctic Environments: Long-Term Perspectives on Movement and Communication".

Previous fieldwork

In 2005 the fieldwork mainly involved surveying for soapstone quarries. Soapstone quarries had been observed at a number of sites along the coastline of the entire Nuuk fjord. These sites were visited and the quarries documented in order to look for suitable sites for further investigation. The fieldwork in 2006 was concentrated to the inner part of the Nuuk fjord with a calving glacier just a few kilometres away. Traces of a settlement were identified at Nassatsiaq on a small cape damaged by the heavy currents that are caused by the pronounced variation of the tide. In the nearby mountains several soap-stone outcrops and quarries were documented. Diagnostic extraction marks after quarrying lamps and pots suggested that most of these sites were used intensively during the 18th century, but also show evidence of activity from the very earliest presence of the Thule people (the ancestors of present-day Inuit) in the area in the 14th century. During the excavation of one of the quarrying sites a small hearth was found in lower layers of soapstone waste. Dating of charcoal from the hearth indicated quarrying activities at this site had already been initiated by the Norse (Viking) settlers in the area as early as in the 11th century. This is not surprising since the Nassatsiaq site is located in the hearth of the Norse Western settlement, hosting the remains of more than 100 farms.

On the small cape immediately below the quarries, excavations revealed the presence of substantial occupation layers and dwelling-features. The lowermost layer belonged to the Saqqaq culture and a fireplace located at this settlement dated the earliest settlement of Western Greenland to about 2500 BC. Thick "pockets" of talcum (soapstone-dust) in connection to the dated hearth clearly indicates that lamps were manufactured on the site by the Saqqaq-people. Finds and waste from other layers show that the manufacture of

Figure 3
A soapstone quarry with preforms for vessels still in place. Photo: Krister Kàm Tayanin.

soapstone artefacts was carried out well into the 17th and 18th centuries. Several types of artefacts from these later layers indicate that Inuit connected to the Moravian Mission station – called Uummannaq and located some 40 km from Nassatsiaq – may well have quarried the soapstone. A partly preserved wooden and turf house can still be seen at the site. The house was built in the early 1950s by a well-known reindeer hunter and soapstone carver and subsequently abandoned sometime during the 1970s.

Fieldwork

In 2007 the project reached its full potential with a total of some 25 members from Denmark, Sweden, Germany, Switzerland, Canada and Greenland. A small fjord, Ujarassuit pavat, a tributary fjord of the large Nuuk fjord, became the main area of research since information existed about a soapstone quarry in the inner part of the small fjord. By surveying the area a considerable number of quarries were identified and later documented. This area holds the largest outcrops of soapstone in all Greenland, most of which have been extensively quarried, leaving large heaps of waste and the extracted area partly filled with water. At a few locations traces of the use of a chain saw proved that the quarries were still in use.

On the other side of the fjord a Norse farm named Anavik is located. This is one of the largest farms in the Western Settlement, with several houses including a pack house and a church. The church is one of only four churches in the Western settlement, and provides evidence of the prominent position of the Anavik farm. This is further supported by the presence of the heavily built pack house, otherwise referred to in Greenlandic archaeology as "safety deposit boxes", as they are thought to have been used for storing especially valuable commodities. This type of pack house is rare in Greenland. The farm is located just a few kilometres from the inland ice and the limited area suitable for grazing is surprising given the seemingly high status of the farm. However, a large ice-free region immediately north of Anavik suggests that reindeer hunting and fur-animal trapping, for example arctic foxes, have been of major importance, as was the case until recent years. Furthermore, it is possible that the farm's position close to soapstone sources may also have been important. Excavations at some of the soapstone quarries show that large blocks have been extracted by the Norse that were suitable not only for vessels, but probably also for building material. In some quarries almost all soapstone has been extracted by the Norse, while members of the preceding Thule culture (1000–1700 AD) restricted quarrying to removing soapstone in the exterior part of the soapstone crops. As vessels of soapstone in many cases replaced the clay vessels familiar in Iceland and northern Scandinavia, the Norse extraction may well have been highly profitable for the members of the Anavik farm.

At a site close to the coastline and below the quarries, heaps of soapstone refuse were found. Preforms and broken pieces of soapstone show that intensive manufacture of lamps and vessels was in progress during the Thule culture and probably during periods of the Dorset culture (500 BC–AD) and Saqqaq culture (2500–800 BC). A site from the latter culture was found at a cape (know by local inhabitants as Putukkut Nuua) about 1 km

Figure 4
Excavation of a small camp from the earliest settlement of Western Greenland. Photo: Krister Kàm Tayanin.

Figure 5
An arrowhead made of quartzite for reindeer hunting. Photo: Krister Kàm Tayanin.

Figure 6
The pack house from the Norse settlement of Anavik. Photo: Krister Kåm Tayanin.

away although the only artefact made of soapstone was a preform of a lamp. Finds include a number of arrowheads that attest to Puttukut Nuua's use as a special-purpose camp combined with reindeer hunting. The same cape has later been used for different purposes. A wall of stone may belong to a Norse building and close to it three graves were documented, one containing two individuals from the Thule culture. Even in spite of climate change, localities with a good position in relation to different resources have been used over long periods of time. At the site of a river estuary close to our camp a considerable number of stone rings, the remains of supports for tents, were visible. The removal of stones from such circles proves that the site has been inhabited during the reindeer hunting season for a large number of generations. Parts of tents and modern equipment show that it is now used for recreational hunting.

The information accumulated over the three years of work has been substantial and has changed our perception of parts of the cultural history of this region. The project has also given rise to important theoretical and methodological considerations on how to bridge archaeology with other scientific disciplines, as well as revealing various uses of the landscape over time. The next step is to analyse all the data – a task that will be significantly inspired by the multi-facetted approaches represented by the international mixture of professors and students from six countries.

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Användning av täljsten från den första bosättningen i Grönland till idag

En viktig förutsättning för bosättningen i Grönland var att det existerade väl fungerade kontakter mellan olika grupper såväl inom en region som inom betydande delar av öns kustområden. Ett tydligt exempel på dessa kontakter är att vissa råvaror har förmedlats över betydande sträckor, exempelvis har vissa mineraler som använts vid redskapstillverkning utbytts över sträckor på mer än 650 km.

Det aktuella projektet har inriktats på täljsten. Det är ett viktigt material för framställning av lampor och kokkärl och förekommer rikligt runt Nuukfjorden på Västgrönland. Omfattande inventeringar efter täljstensbrott har genomförts. Dessa har blivit föremål för dokumentation och begränsade arkeologiska undersökningar. Under 2007 undersöktes en ansamling av täljstensbrott i en bifjord inom Nuukfjordens inre del i närheten av landisen. De visade sig vara de mest omfattande som hittills har påträffats i Grönland.

Täljsten bröts redan av de äldsta bosättarna i Västgrönland (Saqqaqkulturen 2500–800 f.Kr.). Under nordborbosättningen (1000–1350 e.Kr.) har brytningen varit mycket omfattande. Även under Thulekulturen (1000–1700 e.Kr.) har brotten använts. Spår efter att täljsten har skurits fram med motorsåg visar på att förekomsten fortfarande utnyttjas.

Utgrävningar av boplatser i täljstensbrottens närhet visade att föremål av täljsten har framställts på vissa lägerplatser medan andra utnyttjats vid renjakt som har varit omfattande i området.

Svalbard's Caledonian Terranes revisited, Nordaustlandet 2007

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Between 1990 and 1998 international geoscientific expeditions to northernmost Svalbard have been carried out with the logistic support of the Swedish Polar Research Secretariat within the framework of the SWEDARCTIC programme (see also cruise reports in the respective yearbooks). During this period, scientists from the Polar Marine Geosurvey Expedition in Lomonosov, Russia, have participated in these expeditions establishing a long-term collaboration that has resulted in a considerable number of joint-publications. The aim of this work was to gather knowledge about the Precambrian and Caledonian tectonic evolution of Svalbard's eastern terranes and to establish their relationships to each other, to Greenland and other parts of the Eurasian High Arctic. One fundamental result was the finding that the Caledonian deformation and metamorphism influenced the Nordaustlandet Terrane's late Grenville age (ca 950 Ma) basement and the unconformably overlying Neoproterozoic sedimentary successions. The intensity of this overprint increases eastwards towards Kvitøya, the archipelago's easternmost island. Together with the evidence of the close correlation of the eastern Svalbard terranes with the East Greenland nappes, this indicates that the main Caledonian suture is located offshore, east of the Svalbard Archipelago.

In the late 1990s, the focus of our research moved eastwards, and the expeditions visited key areas in the Timanides, polar Urals, Taymyr, Severnaya Zemlya and Novaya Zemlya. But after almost a decade central Nordaustlandet was revisited in order to investigate one of the remaining major geological enigmas of this area: the migmatite complex of central Nordaustlandet in innermost Duvefjorden, and the timing of intrusive episodes in the area. This time the Swedish group was invited to join the Russian operations, whose many field parties covered large areas of northern Svalbard for regional geological mapping in collaboration with the Norwegian Polar Institute. The Swedish Polar Research Secretariat

Figure 1
The field camp in Innvika, innermost Rijpfjorden. In the background part of the Vestfonna icecap. Photo: Henning Lorenz.

provided equipment, weapons and weapon training for the Swedish group.

Transport from Longyearbyen was organised with the Russian helicopter on one of its regular flights to visit the Russian field parties, to move camp and supply provisions, and on 1 August the Swedish party joined the Russian camp at Innvika (Fig. 1). Fieldwork concentrated on the local stratigraphy of the Neoproterozoic sedimentary successions (Fig. 4) with the purpose to investigate how far these were affected by the different intrusive phases (Fig. 3) (metamorphic grade and migmatisation) and the associated deformation episodes, as well as the relationship of the intrusive rocks to each other (relative age, Fig. 2). Sampling for isotope age determinations of the magmatic rocks and for detrital zircons studies (sediment provenance) of the sedimentary rocks complemented the survey.

However, the early approach of the winter interfered with the helicopter schedule and when on 13 August the weather situation improved sufficiently for helicopter traffic, the Swedish field party withdrew to Longyearbyen, after visiting a selection of geological key locations in northern Nordaustlandet together with Russian colleagues.

Figure 2 top right
Augen gneiss intruded by a granite dyke. Photo: Henning Lorenz.

Figure 3
Pieces of schists from the Svartrabbane group "swim" in granite. Photo: Henning Lorenz.

Figure 4
Quartzites of the Murchisonfjorden supergroup (foreground) unconformably overlie volcanics of the Svartrabbane group (below snowfield). At least the latter are involved in the migmatisation. Photo: Henning Lorenz.

Återbesök av Svalbards Kaledonska jordplattor

Mellan 1990 och 1998 genomfördes internationella geovetenskapliga expeditioner till Svalbards nordligaste delar, med logistikstöd från Polarforskningssekretariatet (se rapporter i årsböckerna). Forskare från det statliga ryska företaget Polar Marine Geosurvey Expedition har deltagit i expeditionerna och det långa samarbetet har gett upphov till en mängd gemensamma publikationer. Syftet med dessa expeditioner har varit att samla kunskap om Svalbards östra delar och att fastställa deras geologiska relation till varandra, till Grönland och andra delar av det eurasiska Högarktis.

Under det sena 1990-talet flyttades forskningsfokus österut och gruppen besökte Timaniderna, de polara Uralbergen, Tajmyr, Severnaja Zemlja och Novaja Zemlja. Därefter återbesöktes Nordostlandet för att undersöka en av de återstående geologiska gåtorna i området, nämligen migmatit-komplexet (av metamorft omvandlad bergart) i centrala Nordostlandet, i det innersta av Duvefjorden. Den här gången bjöds den svenska gruppen in att delta i den ryska expeditionen, som också samarbetade med Norsk Polarinstitutt. Polarforskningssekretariatet bidrog med utrustning, vapen och vapenträning för de svenska deltagarna.

Where the northernmost world ends – fieldwork on Johannes V. Jensen Land, northern Greenland, to resolve its glacial and palaeo-environmental history – part 2

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Background

In recent years the importance of the Arctic region for global climate change has often been stressed both in the scientific community and the media. It has been suggested that a cold arctic region with an ice covered Arctic Ocean is crucial for a north–south climate gradient sufficiently steep to drive the meridional energy exchange that is an integral part of the Earth's climate today, and that furthermore, rapid greenhouse warming threatens to destroy this phenomenon. However, the case for rapid change rests to a large extent on satellite observations and – in the case of rapidly diminishing sea ice – from measurements made by nuclear submarines over the last 30 years. There is therefore a need for an assessment of the long-term "natural" variability of such complex and powerful agents as sea ice and glaciation along the Arctic Ocean coast.

Greenland's north coast constitutes the northernmost area of land in the world, and one of the few remaining coastlines that still faces permanent sea-ice cover. Owing to its inaccessibility it is also among the world's least explored regions. The LongTerm project has been launched in order to perform a broad-spectred investigation of the interplay between climate, sea-ice cover, and glaciation over a time scale from the Holocene and back through the last glacial cycle, with the aim of contributing to a long-term record of variability and sensitivity of this extreme environment. In the overall project, the variation in conditions for Greenland's earliest cultures is also taken into consideration, as well as the evolution of the fauna. However, since there was no Swe-dish participation in those aspects of the project they are not covered in this particular re-port, which instead concentrates on the geo-logical programme.

LongTerm has been initiated by Svend Funder and Kurt Kjær from the Geological Museum in Copenhagen, Denmark, who also are the principal project leaders. Due to the long-standing cooperation between the Geological Museum and the Department of Geology at Copenhagen University, and the Department of Geology at Lund University, a group of Swedish glacial geologists was invited to take part in the project's work in 2006 and 2007, which also forms a part of the research programme SWEDARCTIC 2007. The LongTerm project is a subproject within the umbrella project APEX (Arctic Palaeoclimate and its EXtremes), which has been named a "lead project" for IPY (International Polar Year 2007–2009). A number of other APEX projects have been established during 2007 along the Eurasian and Greenland Arctic Ocean coastlines (see for example Jakobsson et al. in this yearbook p. 133), and are planned to continue in 2008 and 2009.

Aim and scope

The target area for fieldwork was the coastal plain along the Arctic Ocean, its tributary valleys and valley glaciers (Fig. 1). Featuring altitudes below 100 m and a width of up to 20 km this coastal plain fringes the Arctic Ocean for roughly 100 km in Johannes V. Jensen Land. Unique to Greenland, the plain

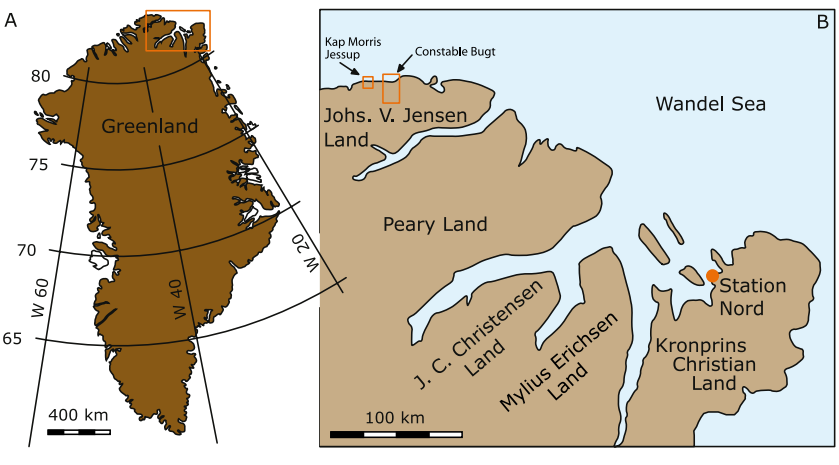


Figure 1
Overview map of Greenland (A). Coloured box indicates insert map (B), showing the investigation areas for team 2 on the northern coast of Johannes V. Jensen Land.

Figure 2
Twin Otter in for landing. Photo: Per Möller.

probably originated as an ancient marine abrasion terrace. It is covered by a continuous layer of Quaternary sediment, and reconnaissance fieldwork in the snow-melt season has indicated that this sediment provides a record of glacial and marine events as well as sea level change that date back more than 40,000 years (Funder and Hjort 1980, Funder and Larsen 1982, Dawes 1986). The aim of the LongTerm project is to study sediments, landforms and lakes – as well as remains of former human habitation – on the coastal plain and along valleys leading into the alpine mountains to the south, supplemented with studies on processes along present glaciers. More specifically, the project aims to:

- Establish a glaciation record for northernmost Greenland, and to investigate the dynamic interplay between alpine and ice sheet glaciations and their sensitivity to changes in sea ice cover.

This will be achieved by surveying present valley glaciers and sedimentological processes along their margins, combined with installation of data loggers. Further, traditional field mapping of landforms and logging of sediment sections, combined with analyses of glacial geomorphological elements in satellite imagery and aerial photographs will provide a record of past glacier behaviour.

- Reconstruct the sea ice and sea level history of northernmost Greenland.

This will be achieved by studies of raised marine sediments on the coastal plain and wave- to non-wave generated beaches. Important information on these aspects is also provided by dating driftwood as this gives an indication of periods of open water along the coasts and of partially open water along the passage in the Arctic Ocean.

- Establish a precise chronology of the environmental change.

Precise dating is a prerequisite for all types of records. Here we use the same methods that we developed during our QUEEN project in northern Russia for dating similar records: AMS ^{14}C-dating of organic remains, OSL (Optically Stimulated Luminescence) datings of sediments, and exposure datings of rock and boulder surfaces by ^{10}Be and possibly other cosmogenic nuclides.

The fieldwork

The LongTerm expedition in 2007 was part of a field campaign set up by the Danish Polar Centre with a logistic platform based on Station Nord (Fig. 1B). The LongTerm field party took the regular flight on 24 July from Copenhagen to Longyearbyen, Svalbard, and were subsequently flown on the same and following day in two groups across the Greenland Sea to Station Nord by an Icelandic-chartered Twin Otter. The original plan included helicopter transports to base camps. However, as no landing permit was given for a chartered Russian Antonov aircraft, planned to carry the helicopter to Station Nord, this option had to be eliminated at a late stage of planning. We were thus totally dependent on Twin Otter transport, which meant rethinking possible landing/camp sites as compared to the original expedition plan. The expedition members were split up in three regional teams, of which team 2 with the Swedish participants aimed towards the northernmost Johannes V. Jensen Land coast between Kap Morris Jessup and Constable Bugt (Fig. 1B).

Beautiful weather awaited us at Station Nord and team 2 was directly deployed in one Twin Otter flight to the first field camp at Kap Morris Jessup (Fig. 2). When turning to approach the tiny landing strip we realized that we were not alone; a polar bear with cub were taking a stroll along the beach! We set up camp at 83°39.305'N, 33°23.949'W and hearing the Twin Otter disappear behind the mountains in the south, we realized we were the absolutely northernmost men and women with solid ground beneath our feet!

A week passed with the most fantastic Arctic weather imaginable; just blue skies and a slightly chilly wind from the permanent ice cover in the north, holding the temperature at a maximum of +4°C. However, just climbing

Figure 3
Camp along the Sifs River on a nice day. Photo: Per Möller.

some 50 m up on the valley slopes improved the temperature considerably. Geologically speaking, Kap Moris Jessup was a disappointment; the few sections available were soon finished and we decided to relocate to the Sifs Valley–Constable Bugt area at the earliest possible occasion. We had worked in that particular area during the 2006 field season, but unsolved scientific questions still remained in regard of the interaction between large shelf-based ice in the north and valley glacier expansions from the south.

At three o'clock in the morning on 1 August we received a message: "The Twin Otter is on its way". All our equipment was hurriedly packed and the tents were taken down in the bitter cold night (-3°C, but the arctic summer sun shone as usual in the blue sky). We were more or less ready when the Twin Otter broke through the low fog lying at the shoreline. At eight o'clock in the morning the new camp was ready in the Sifs Valley at 83°34.36'N, 32°1.55'W (Fig. 1B) in beautiful morning sun (Fig. 3). The camp was situated roughly 5 km from the coast behind a prominent end moraine ridge, protecting us somewhat from coastal fog and chilly winds. The wildlife in Sifs Valley is plentiful, like an Arctic "Garden of Eden". Muskoxen are abundant, from small herds with cows and calves, to the lonely bull, sometimes being a bit aggressive (but usually just "showing-off"). Geese arrived in flocks of fifty to hundreds and arctic hare were abundant and totally unafraid (Fig. 4).

What was planned to be a week or so of hectic fieldwork before a new relocation, turned out to be a prolonged stay until the end of the expedition! The beautiful weather just continued, peaking around 7 August with strong warm winds from the south, a föhn wind raising the temperature to an astonishing +22°C two afternoons in a row! Two days later we started to see the result of the warm weather. At five o'clock in the morning we woke up with water in our tents. The camp was situated only about 70 cm above Sifs River, and we could see the water quickly rising, some 3–4 cm per hour! The situation was such that 20 km south of our camp the Sifs Glacier comes out from an ice field, totally blocking the valley and damming a lake at 217 m a.s.l. What we first thought was just an enhanced melting due to the föhn wind turned out to be much more serious. The upper lake was actually overflowing and had started to cut a large canyon through the glacier snout in which we saw water cascading down into our valley; we slowly realized that we were in the middle of a so called "jökellopp"! The next few days were a race against time and rising water: three times we relocated the camp to suitably higher positions and three days later we saw the last gravel bar disappear beneath the water that was by now 2.5 m higher than before (Fig. 5). We carried our +1000 kg camp equipment up the side of the valley 800 m from our first location. Most problematic was that the landing strip for the Twin Otter was submerged, and we didn't know for how long! Food supplies also started to dwindle, and as planned re-supplying was not possible in the ordinary manner, we were "food bombed" on 12 August, when a plane dropped canisters at low altitude in the river. When opened, some canisters turned out to be a nice mixture of rice, muesli and mayonnaise! Otherwise the mostly beautiful summer weather continued

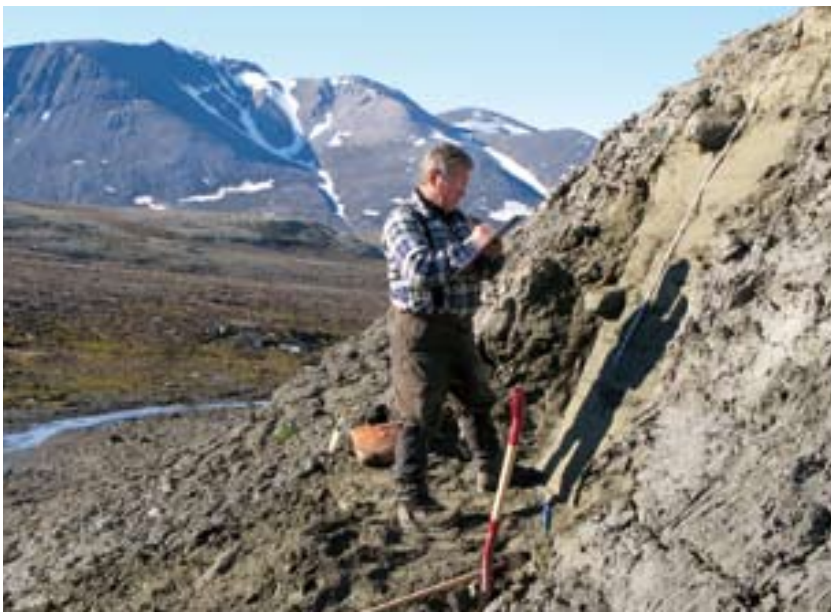
Figure 4
Who is watching who? Close encounter with arctic hares in Sifs Valley. Photo: Nikolaj K. Larsen.

Figure 5
In the middle of a jökellopp. Evacuation of the second gravel bar that was totally flooded within four hours! Photo: Henriette Linge.

and most of our planned geologic fieldwork proceeded in an excellent fashion (Fig. 6).

On 15 August there was a dramatic weather shift, and from this point on the weather was characterized by the passage of a long row of low pressure systems featuring strong winds, rain and snow, with the occasional nice day in between. On such nice days we had majestic snow-covered mountains around us and also snow far down in the valley, accumulated in the lee of large boulders (Fig. 7). Team 1 was actually worse off; five days of wind not below 25 m/s and the tents covered in one metre of snow! On 25 August our kitchen tent finally gave in and the toilet blew away, making camp life less comfortable, to say the least. However, the "rescue operation" had then started, which involved the Twin Otter flying up from Iceland to Station Nord, trying to get in between the low-pressure passages in order to retrieve the three teams from field. This turned out to be a slow operation. After two more storms and one failed attempt – just hearing the Twin Otter high above us in the clouds – we were finally picked up on 28 August as the last team. Fortunately the river had abated the preceding few days and the landing strip was useable again. However, when approaching Station Nord the clouds were down to ground level again, and after one landing attempt the plane returned north, heading for Kap Moltke to wait for better weather. A small weather window turned up the next day, and we just managed to slip in below low clouds. Station Nord was like heaven, with hot showers and cold beer after almost six weeks in the field! After three more days stuck at Station Nord due to the bad weather, we finally left in pleasant weather, flying along the east Greenland coast down to Constable Punt and then over the Greenland Sea to Akureyri on Iceland. We landed at Kastrup airport 1 September, just in time to start lecturing on glacial geology the following day, which was the first day of the autumn term! This quite adventurous field season is described in some more detail on www.geol.lu.se/personal/prm/Blogg_Longterm_2007.htm.

Figure 6
Per Möller logging excavated glaciolacustrine sediments in Sifs Valley. Photo: Nicolaj K. Larsen.



Some scientific results

Even though the expedition was not able to follow the initial plans due to the described difficulties, we were actually able to retrieve some fantastic field data that will be published in due course. From Sifs Valley we have firm proof of a shelf glaciation, meaning a large ice sheet moving along the coast from the west and penetrating into the valleys leading up to the alpine mountains in the south. At deglaciation a marine environment – i.e. the sea – penetrated into these valleys, but due to

land uplift these gradually turned into dry land. However – as opposed to the case today – somewhat later in the early Holocene the sea surface was not covered by permanent sea ice, as indicated from the occurrence of high-energy beach ridges. What particularly astonished us already during the 2006 field season, and for which we gathered more proof in 2007, was the indication of not just one but possibly two valley glacier advances out of the Sifs Valley (and other nearby valleys) towards the coast in the early to middle Holocene. In this case it is not cold climate that governs ice advances, but moisture! The moisture source having been provided by an open Arctic basin that later was closed over. However, with global warming this sea-ice cover is now rapidly shrinking over the Arctic basin. So maybe we will not have melting glaciers along the north Greenland coast in the future, but instead glacier advances?

Figure 7
White-clad mountains after an August storm in Sifs Valley. Photo: Per Möller.

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Hjort, C. et al. 2000. Eurasian ice sheets – Taymyr Peninsula 1999. In: Grönlund, E. (ed.). *Polarforskningssekretariets årsbok 1999*. Stockholm: Polarforskningssekretariatet.

Där jorden tar slut – fältarbete på Johannes V. Jensen Land om dess glaciala historia och miljöutveckling

Löpsedlarna ropar ut: den arktiska bassängens havsis smälter på grund av den globala uppvärmningen och isbjörnarna är hotade! Mer viktigt är hur en framtida isfri arktisk bassäng påverkar det globala klimatet. Vår forskning påvisar en troligen isfri arktisk ocean under den tidiga delen av vår nuvarande mellanistid, och detta klarade björnarna av. Det gäller emellertid att förstå den naturliga variabiliteten av så komplexa saker som utbredningen av havsis och dess samverkan med landbaserade istäcken för att kunna skilja ut människans påverkan i det hela. För detta måste vi ha kunskap om, och förståelse för, utvecklingen över en längre tidsperiod. Data för detta finns i våra geologiska arkiv, t.ex. i sedimentsekvenser blottade i flod- och kustskärningar eller i sjöbassängernas sediment. Vårt projekt LongTerm syftar till att samla information om just dessa saker. Projektet genomförde sin andra expedition under sommaren 2007 till det nordligaste landområdet på Moder Jord: Johannes V. Jensen Land på nordligaste Grönland (83.5° nordlig bredd; bara en 700 km lång promenad över havsisen till Nordpolen). Syftet med expeditionen var

1 att få data i tid och rum över variationerna av nordligaste Grönlands istäcken och det dynamiska samspelet mellan alpina och landisbaserade glaciationer och deras sensitivitet i förhållande till havsisutbredning,
2 att rekonstruera förändringar över tiden i havsnivåer och havsisutbredning för nordligaste Grönland, samt
3 att genom många och noggranna dateringar tidsbestämma dessa förändringar.

Expeditionen genomfördes med den danska Station Nord (81°43'N och 17°50'W) som bas, varifrån expeditionsmedlemmarna transporterades ut och senare omgrupperades med flygplan (Twin Otter som kan landa på helt obegripliga platser med 150 m start/landningssträcka). Den glacialgeologiska forskningen för de svenska deltagarna utfördes inom två olika områden (se Figur 1) och all insamlad data håller nu på att bearbetas!

KINNVIKA – A multidisciplinary and multinational platform for arctic warming and impact research during the fourth International Polar Year

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Elisabet Frerot
Ulf Jacobson
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Nyheterna, TV 4

Background

The International Council for Science (ICSU) has declared 2007–2009 the fourth International Polar Year, marking the 50-year anniversary of the last Polar Year. It is anticipated that technical developments will permit many novel ways to study the polar areas, and a specific focus will be upon concern that the global warming we are witnessing today will bring large effects to the polar areas. On the Nordic horizon, representatives of the Nordic countries' polar authorities have formulated this into a question: will the Arctic survive in its present form? And furthermore, how will changes in the Arctic influence the global climate, and are the signals read today truly persistent?

Records accumulated over the past decades provide ample evidence that the warming of the Arctic is a fact, the most striking change being characterized by the decrease of the Arctic pack ice. Without doubt, the continuation of this transgressive trend will have a significant impact on Arctic ecosystems as well as on human societies in the Artic region. According to the predictions generated by models of the Earth's climate system, one of the most vulnerable regions of climatic change in the Arctic is the northernmost Atlantic Ocean, an area including the Greenland and Barents Seas, and the adjacent Svalbard Archipelago. The reason for this is the excess of heat from the tropics that is advected by the North Atlantic Drift up to latitudes of 80°N, which produces large shifts in the edge of the Arctic Ocean pack ice between cold and warm years, a phenomenon further corroborated by the fact that the largest pull-back of the Artic Ocean sea ice is normally in this sector. Consequently, the Svalbard Archipelago provides a suitably strategic position for the task of recording information on the current direction of changes.

Since Svalbard forms the northernmost land in the European sector of the Arctic, and Nordaustlandet is the northernmost larger terrane in Svalbard, it is likely that changes in progress in this location will propagate southwards, both as physical processes and as a result of economical and political feedback, which makes the changes occurring in this region of utmost relevance for the Nordic countries. Important scientific questions to focus on are:

- Climate change and impact research
- Climate- and environmental monitoring
- Mapping of bio- and geosystems
- The history of human activities and settlements in the High Arctic
- Outreach and Education

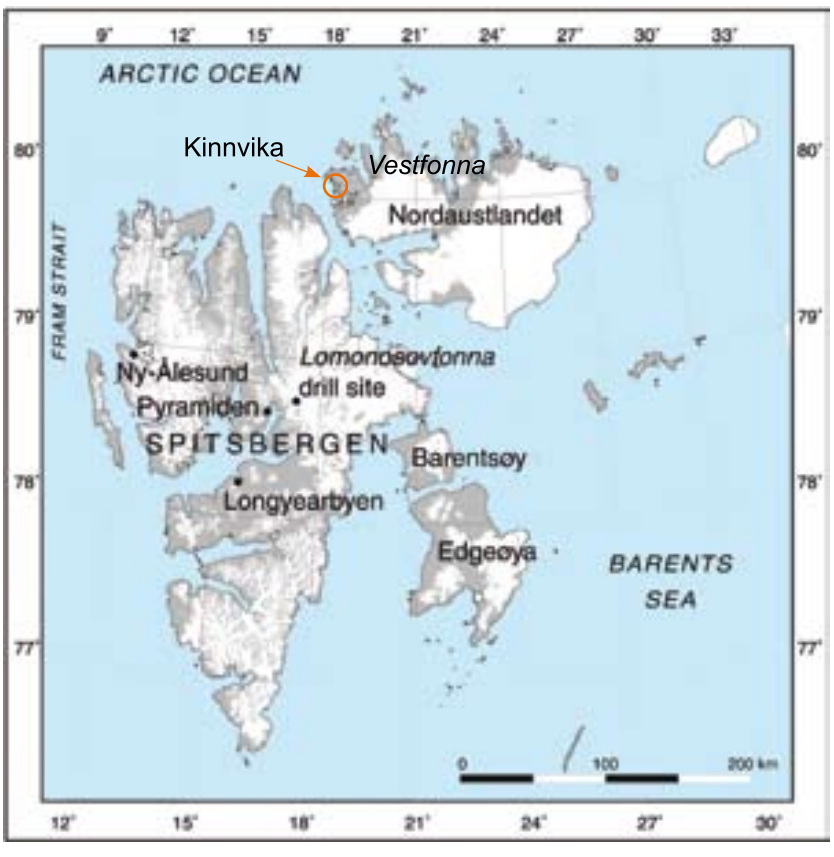


Figure 1
Map of Svalbard, Nordaustlandet, the ice cap Vestfonna and Kinnvika. ©Norsk Polarinstitutt.

The Svalbard region has been the focus of Nordic polar research for a considerable length of time. The French corvette La Recherche that navigated the Svalbard waters between 1838 and 1840 carried a handful of Nordic scientists, and with the expeditions conducted by A.E. Nordenskiöld to Svalbard during the first polar year 1882, research in this area has been characterized by a tradition of Nordic influence. From a Swedish perspective commitments during the two first polar years were solidly focused on Svalbard. For the third polar year in 1957, Swedish, Finnish and Swiss scientists and authorities received permission from the Norwegian Governor of Svalbard to build a research station in Murchinson Bay, then called the SFS-station after the participating countries, and later renamed as the Kinnvika station. The main objectives for building the station on Nordaustlandet were most probably similar to the objectives we have today: to put a monitoring station as far north as possible in the High Arctic. The short distances to larger and seasonally ice-free ports, and the relative warm conditions in the west of Nordaustlandet, have been a deciding factor both now, and then. This station dating from the previous polar year has been used as the centre of our polar year project and apart from providing superior shelter from weather and scavenging animals in comparison to temporary camps, it also facilitates storage space for long-time depots and the necessary work shops for maintenance and scientific work.

We are today roughly 55 scientists engaged in the KINNVIKA project. A majority of the attendees are from the Nordic countries, and we also have a strong component of Polish participants.

General project outline for IPY-KINNVIKA

Our focus is on research activities that fall within the framework of the IPY on the High Arctic island of Nordaustlandet, the northernmost major part of the Svalbard Archipelago. The island is 90% ice-covered, and polar desert and semi-desert ecosystems, underlain by continuous permafrost, dominate the unglaciated terrain. Because of its position, the climate in Nordaustlandet is substantially more influenced by arctic air and therefore more extreme than the other parts of Svalbard. We chose Nordaustlandet as our study site for several reasons:

- Being the northernmost sizeable terrestrial platform in the European sector of the Arctic, Nordaustlandet is the area that will first be subject to the large sets of changes generated by warming that has already been sensed and that is expected to continue in the future.

In contrast to a variety of extensive research and monitoring activities in southern and western Svalbard, very little research has focused on the northeastern part of Svalbard during the last decades. This is probably due to difficult access and logistics. However, large gradients in climatic and environmental regimes across Svalbard are to be expected while the relatively small impact of the human footprint in the area constitutes another important reason to conduct an IPY project on Nordaustlandet.

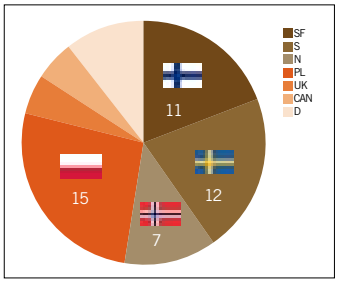
- Being farthest away from Eurasian pollutant sources and from the influence of the northeastern North Atlantic Drift, Kinnvika can provide unique monitoring of meteorological and environmental parameters.

Several IPY programmes are active in the monitoring of meteorological and environmental parameters. On Svalbard the sites established for these activities are Hornsund, Longyearbyen and Ny-Ålesund, all three located on the island Spitsbergen. Kinnvika therefore offers a complementary platform that will extend the monitoring network over Svalbard, by adding a northeastern tangent. Kinnvika constitutes the location of most significant arctic influence among the various stations, which is important for analysis of gradients across the archipelago.

- Being sparsely studied, Nordaustlandet is relatively poorly mapped in regard of ecosystems, terrestrial deposits and geological sequences.

Figure 2
Picture of the Kinnvika station from MS Farm September 2005. Photo: Veijo Pohjola.

Figure 3
The distribution of different nationalities in the KINNVIKA project.



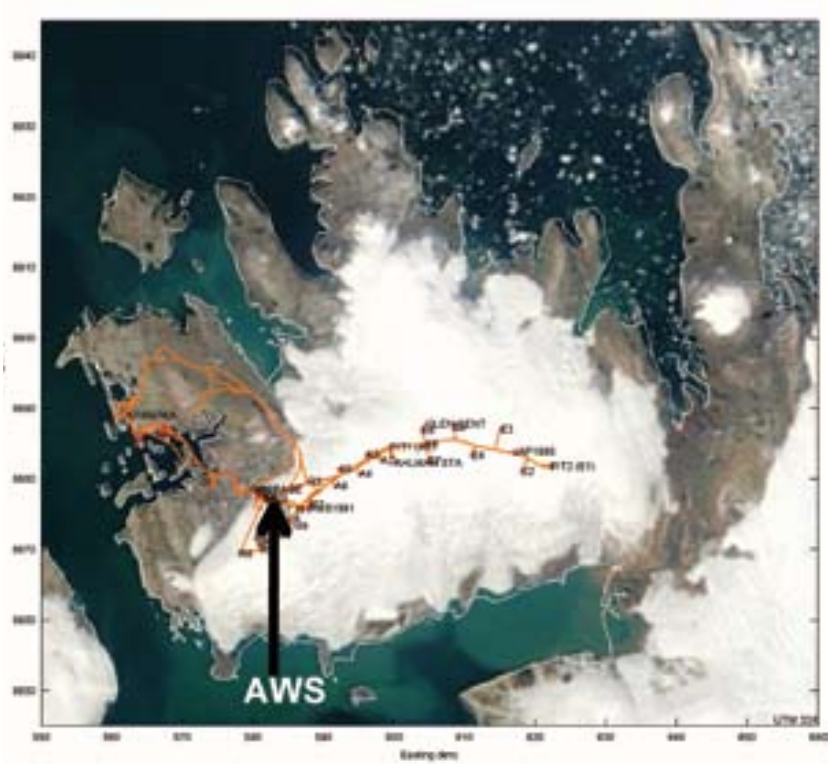


Figure 4
The Ice Cap Vestfonna, snowmobile routes and the stations placed on the ice cap during spring 2007. The arrow marks the AWS described in the text.

Nordaustlandet is a national park implementing the strictest environmental policy in Svalbard, a factor that has restricted extensive taxonomical and geological exploration on the island. Consequently, while environmental policy has preserved pristine environments, it has also hampered the mapping of the area.

- Svalbard plays an important part in Nordic polar history, and Nordaustlandet has featured as a centre for whaling and hunting activities, as well as the early polar exploration efforts.

Traces of these activities will be set in perspective to the environmental data we gather, and in this way used as keys to understanding the human activities of the past, and perhaps also give a prediction of how human activities in this Arctic archipelago may change in the future. In general, our initiative provides a broad scientific and logistic platform around which a number of research and monitoring activities may be performed in a truly interdisciplinary manner. Due to difficult access and logistics in this remote northern part of Svalbard as compared to the southern and western areas, we consider the framework of IPY ideal, if not essential, for dedicated, effective, multi-disciplinary and international research and monitoring collaboration of Nordaustlandet.

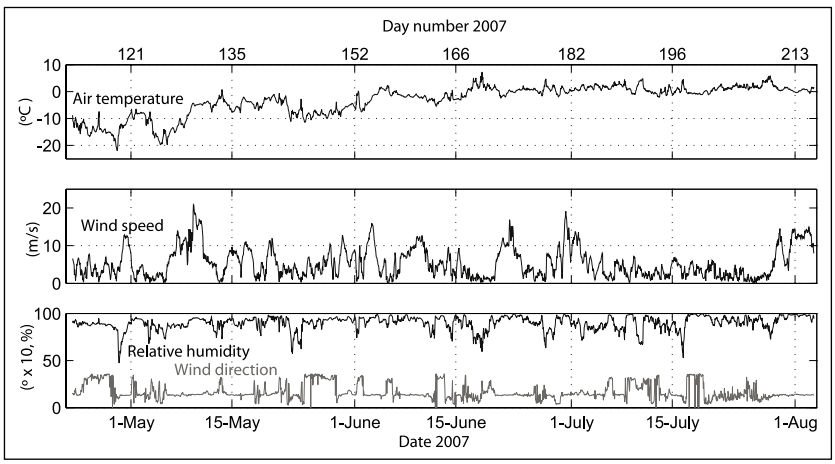


Figure 5
Hourly mean air temperature, wind speed, relative humidity wind direction from the Vestfonna AWS (preliminary data).

Summary of KINNVIKA activities 2007

Two KINNVIKA expeditions were launched in 2007, totally comprising 29 persons and 383 man-days at Kinnvika. Table 1 below show the distribution of the participating personnel into the thematic type of activities in KINNVIKA.

Table 1	
Atmo- and cryosphere	6
Biosphere	5
Environment	1
Geosphere	7
Outreach	4
Logistics	6

In this report we will provide a brief summary of the overall operations. More detailed reports are found at www.kinnvika.net and reports from the Swedish scientific teams are included at the end of this report.

The first expedition was between 19 April and 10 May and comprised four glaciologists: Emilie Beaudon and John Moore from the Finnish University of Lapland, and Veijo Pohjola and Ulf Jonsell from Uppsala University, who were flown in and out by Airlift helicopters from Longyearbyen. The bulk of the equipment was shipped in by RV Lance by the kind assistance of colleagues from University Centre in Svalbard (UNIS) one day earlier. In short, the activities were focused on the ice cap Vestfonna, where an automatic weather station (AWS) and a large number of mass balance and ice velocity position markers were installed. We also took snow samples in two snow pits and drilled two shallow ice cores (12 and 6 m deep) as a pilot study in order to investigate the information potential in the ice archives for planned deep ice core drillings during spring 2008.

The second expedition was brought to Kinnvika by the Polish ship RV Horyzont II on 28 July and the last personnel were shipped out from Kinnvika by MS Farm on 21 August. The summer expedition involved a total of 26 persons. Seven helicopter flights, from Airlift and from IB Oden/Kallaxflyg,

transported personnel between camps on Nordaustlandet and between Longyearbyen and Kinnvika. Most of the science projects used Kinnvika as a base, but one of the projects utilized a satellite camp at Snaddvika ca 20 km southeast of Kinnvika. After the arrival of RV Horyzont II in Kinnvika roughly 10 tonnes of cargo were unloaded and landed at the beach for transport and storage in the Kinnvika station, to form the backbone for the coming expeditions. It is interesting to note that this amount of cargo is dwarfed by the 500 tonnes that HMS Älvsnabben brought to Kinnvika in 1957, to supply the station for one year of activities during the previous polar year.

There were two outreach projects, which were permanently based onboard the ship: A team from Swedish TV4 made reportages of the expedition, the old station and about the status of global change in general for news documentaries. They filmed the debarkation of the equipment and setting the station to life, as well as interviews with participating personnel. The reports were later aired on prime time TV4 news over one week in the early autumn, and the issues studied in Kinnvika were placed as primary issues in the news hierarchy. The other outreach project was part of a larger approach making a full sized documentary film about the interaction between humans and nature in the High Arctic. A team from the Finnish film production company WildFin documented the initial stages of the build up of the station, and they will probably be back in the coming years to gather more footage.

When RV Horyzont II left Kinnvika the seven different projects started their operations (see www.kinnvika.net/images/20071004123606.pdf for details):

- **A study of black soot and microbes in cryoconite holes on the Vestfonna ice cap**, by Carl Egede Bøggild from UNIS and Andy Hodson from University of Sheffield. The aim was to study how small melt pools on glacier ice interact with changes in albedo and therefore influence glacier melt. Their specific interest was to find how microbial life and atmospherically derived soot determine the properties of the cryoconite holes.
- **Vestfonna glaciology** by Ulf Jonsell from Uppsala University and Olli-Pekka Mattila from Helsinki University. Ulf Jonsell and Olli-Pekka Mattila conducted maintenance on and downloaded data from the weather station, surveyed the mass balance station and installed spectrometers at the stations.
- **Sedimentology and stratigraphy in Murchinson Bay,** by the Helsinki University team Veli-Pekka Salonen, Anu Kaakinen and Frauke Kubischta. The team scouted and mapped glacial stratigraphical sequences along the coasts of Snaddvika and Heimbukta, and has reported at least three documented glacial advances in southeast Murchinson Bay, over land that today is ice-free.
- **Pollution in Kinnvika.** The Kinnvika station was sampled by Bartek Luks, from the Polish Academy of Science to analyse the amount of metallic and ionic contaminants. The aim is to investigate how the level of contaminants accumulated during the previous expeditions has changed in comparison with levels recorded during our expedition.
- **The geodetical net of Kinnvika** was surveyed and improved by Leszek Kolondra from the University of Silesia, which will result in the production of an orthophoto map of Kinnvika and Vestfonna.
- **Invertebrate and vegetation diversity of Murchinson Bay** was studied by Steve Coulson, Elisabeth Cooper, María Luisa Ávila Jiménez and Allison Bailey from UNIS whose objective was to produce a taxonomical map showing the occurrence of flora and invertebrate species in the area. The biology of Nordaustlandet is poorly described and preliminary results indicate far more life than is preliminarily assumed by viewing this cold and barren High Arctic landscape.

All the projects described above are ongoing and we expect approximately 55 scientists to be involved in KINNVIKA expeditions during

Figure 6
6-hourly mean air temperatures from the Vestfonna AWS (black line) and NCEP/NCAR reanalysis surface temperature (grey line) (preliminary data).

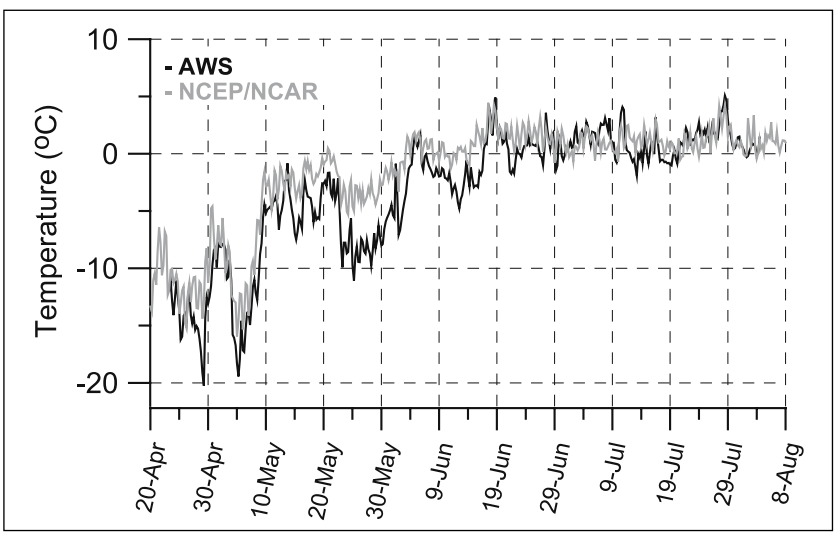


Figure 7
Ulf Jonsell at the AWS on Vestfonna.
Photo: Veijo Pohjola.

the coming two years. During the spring about half of this number will be participating in glaciological projects in the ice cap Vestfonna. The rest are involved in projects that will be in progress in Kinnvika next summer, partly ship-borne projects utilizing RV Horyzont II, and partly terrestrial projects.

Glaciology on Vestfonna, by Ulf Jonsell and Veijo Pohjola

The glaciology projects on Vestfonna under IPY-KINNVIKA are encompassed in the overall project "State and fate of the ice cap Vestfonna" which links the work within the IPY project GLACIODYN and the focus on the dynamic state of the Svalbard ice masses. Regional models predict that the average warming over the High Arctic is likely to be in the range of 5–7°C during the present century. The current rate of sea level increase is 3.2 mm/yr, which is attributed to a large extent to the melting ice caps. In respect of the projected increase in warming of the Arctic, areas closer to the advection pathways of heat will initially be more affected than areas more isolated to the exchange of heat. Svalbard constitutes such a sensitive area, due to the proximity to the North Atlantic Drift, and may be expected to display considerable changes with future warming.

Svalbard is to a large extent glaciated, with the amount of glaciation increasing towards the northeastern part of the archipelago (Fig. 1), due to the predominant easterly airflow during precipitation events. The total ice coverage of Svalbard constitutes twice the ice coverage on the rest of Europe (including Iceland) and stores ~5 cm of global sea level. The largest proportion of this ice is stored in the Nordaustlandet ice caps Austfonna and Vestfonna.

Our group is made up of roughly 20 glaciologists from different countries that will focus on the glaciology of Vestfonna over the polar year. This year's expedition was to pave the way for the larger expeditions, scout safe routes and make basic installations that will be utilized during coming years of activities. These installations comprised one automatic weather station (AWS) placed on the western slope of Vestfonna at 330 m a.s.l. (Fig. 4). We further drilled 29 aluminium stakes into the accumulation and ablation areas of Vestfonna to be used as markers to determine mass changes over the ice cap during the runtime of the project. These markers will also be used to determine the ice flow of the ice cap, as shown in Figure 4. The markers were measured after drilling using differential GPS to give positions with cm precision. We also levelled the surface of Vestfonna during the transport with snowmobiles between the mass balance/GPS markers using kinematic GPS. This levelling "on the go" can be compared with earlier measurements on topogra-phic maps and from air borne laser levelling that was conducted by colleagues in

1996 and 2002. Preliminary data shows that the summit of Vestfonna has decreased some 30 m since the previous polar year in 1957, and that a third of this decrease may have taken place during the last decade.

The AWS is equipped in order to obtain data for energy balance calculations and carries sensors for air temperature, relative humidity, short and long wave radiation, wind speed, wind direction, and relative surface height. Snow and ice temperatures are measured at even 0.5 m intervals down to 9 m depth. The energy fluxes at the glacier surface can be quantified from the AWS data and by calibration with the measured ablation this data will be used to construct an ablation model for Vestfonna ice cap. The AWS was revisited in early August and four months of data was downloaded (Figure 5). Sensors and loggers had been working properly and the data is of very good quality. Powered up with new batteries, we hope to have a full year of data after the next field visit in April 2008. In addition to the AWS, a temperature sensor was installed in April at the summit of the ice cap in order to obtain temperature lapse rates on the ice cap, which will be used in forthcoming distributed ablation modelling.

The constant ice temperature depth was located at 8 m with a temperature of -7.0°C. The ice above the constant temperature depth increased on average 2.5°C during the period of melt. In an ablation model of a cold glacier (i.e. ice temperatures are below 0°C) the energy surplus at the glacier surface must be apportioned between the ice heat flux and the snow and ice melt flux. Results from preliminary energy balance calculations based on the data available so far show that a proportionally high energy flux is used for heating the ice, probably because of substantial refreezing of melt water at the ice surface with the subsequent release of latent heat.

The meteorological data from the AWS will, when longer time series are available, be used to construct transfer functions between reanalysis of meteorological data (i.e. historical meteorological data processed and interpolated into grid cells with modern forecasting techniques). The objective is to reconstruct historical ablation rates and mass balance by driving the mass balance models with reanalysis data. A preliminary comparison between the NCEP/NCAR reanalysis surface air temperature data (Kalnay et al. 1996) and the so far available temperature series from the AWS, show surprisingly good correlation (Fig. 6), considering that the reanalysis data is obtained from interpolation into 2.5°×2.5° grid cells.

References

Kalnay, E., Kanamitsu, M. et al. 1996. The NCEP/NCAR 40-year reanalysis project, *Bulletin of the American Meteorological Society*, 77 (3), 437–471.

KINNVIKA – en multidisciplinär och multinationell forskningsplattform för Arktis uppvärmning och påverkan under det fjärde Internationella polaråret

Vid det förra internationella polaråret 1957–1958 upprättades en svensk-finsk-schweizisk forskningsstation på Nordostlandet, Svalbard. Stationen användes som en året-runt station under två år, och efter denna period som bas för ett antal svenska sommarexpeditioner. Inför det fjärde polaråret gick nordiska forskare samman i ett initiativ att använda stationen som bas för verksamheter under det nuvarande polaråret. Idag är vi 55 forskare från sju länder som är aktiva inom IPY-projektet KINNVIKA. Under 2007 hade vi två expeditioner till Kinnvika, den ena var en svensk-finsk glaciologisk expedition på fyra personer som under våren satte ut mätstationer som skall användas för arbetena på glaciären Västisen (eller Vestfonna) under perioden 2007–2010. Sommaren 2007 användes det polska forskningsskeppet Horyzont II för att skeppa utrustning och förnödenheter till Kinnvika inför sommarens och den kommande vårens aktiviteter. Under sommaren 2007 var 26 personer aktiva med forskning och logistik vid den 50 år gamla stationen Kinnvika, som med detta väcktes upp ur sin törnrosasömn.

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The Arctic Gakkel Vents (AGAVE) Expedition July 1 – August 10, 2007

Introduction

The AGAVE expedition had two sets of complimentary objectives. The scientific objective was to study the geological, chemical, and biological characteristics of volcanic activity and hydrothermal venting on the Gakkel Ridge. The engineering objective was to develop new technologies for deep-sea research in ice-covered oceans. The expedition was an International Polar Year (IPY) collaboration between scientists from the USA, Sweden, Germany and Japan (Fig. 1).

The Gakkel Ridge in the Eastern Arctic Basin is the ultra-slow spreading end-member in the global mid-ocean ridge (MOR) system. The North American and Eurasian plates diverge at (full) rates of 3–7 mm/year along the Gakkel Ridge, nearly two orders of magnitude slower than the fast spreading end-member (southern East Pacific Rise). This ultra-slow divergence accounts for the specific geologic nature of the ridge. Whereas a relatively uniform layer of crust is accreted at most MORs, volcanic activity along the Gakkel Ridge is focused into discrete areas. As a result, long stretches of the ridge experience no volcanic activity at all, with extension accommodated via the exhumation of primitive mantle rocks, while other sections represent massive volcanic centres. The impact of these variations on hydrothermal processes is poorly understood, but preliminary evidence suggests there may be profound differences between hydrothermal discharge at ultra-slow ridges compared to the rest of the MOR system, both in terms of fluid chemistry and the distribution of vent fields.

The biological organisms that inhabit deep-sea vent fields have a biogeographic distribution along the global MOR system. For example, tubeworms are endemic to MORs in the Pacific Ocean, while shrimp are endemic to the Atlantic Ocean. Until now we have not had the tools to discover what kind of organisms inhabit vent fields in the Arctic Ocean, which is of particular interest because it is hydrographically isolated from the rest of the world's oceans.

Figure 1
Group photo of all AGAVE participants. Photo: Chris Linder.

In order to address these issues, the team behind the AGAVE expedition developed new technologies to enable deep-sea research in the ice-covered Arctic Ocean. The ice cover inhibits or precludes many of the standard oceanographic and deep-sea technologies employed to find and study hydrothermal systems in the open ocean. In particular, remotely operated vehicle (ROV) operations are not presently feasible in ice-covered bodies of water, and submersible operations are considered too risky, owing to the difficulties of recovery through the ice. The motivation to develop novel under-ice survey capabilities is not limited to missions on Earth. The search for life on other planets includes the possibility of volcanically hosted vent fields beneath the ice-covered ocean of Europa, a moon of Jupiter. The search for vent fields under the Arctic ice cap on Earth thus presents a technical analogy for similar missions on Europa.

To solve these problems the AGAVE expedition developed two new deep-sea robots (a.k.a. AUVs – autonomous underwater vehicles), called PUMA and JAGUAR (Fig. 2), which can be deployed and recovered from an icebreaker within the ice pack. The AUVs dived to depths of 4 200 m and performed a variety of missions, including plume mapping and high-resolution bathymetric mapping of the Gakkel Ridge. Furthermore, the AUVs allowed scientists to pinpoint the location where hydrothermal fluids were discharging from the deep seafloor.

Sample acquisition is a key scientific objective for hydrothermal research that is not presently feasible with AUVs, and this necessitated the development of the camera and sampling platform (CAMPER) (Fig. 4). The CAMPER was attached to the icebreaker via an armoured, fibre-optic cable that allowed scientists to "fly" the vehicle just above the

Figure 2 left
The PUMA AUV on the ship's crane prior to an under-ice mission. Photo: Björn Eriksson.

Figure 3 right
Unconsolidated pyroclastic deposits blanketing a pillow lava.

Figure 4
The CAMPER lowered into the pack ice by crane from Oden's aft deck. Photo: Chris Linder.

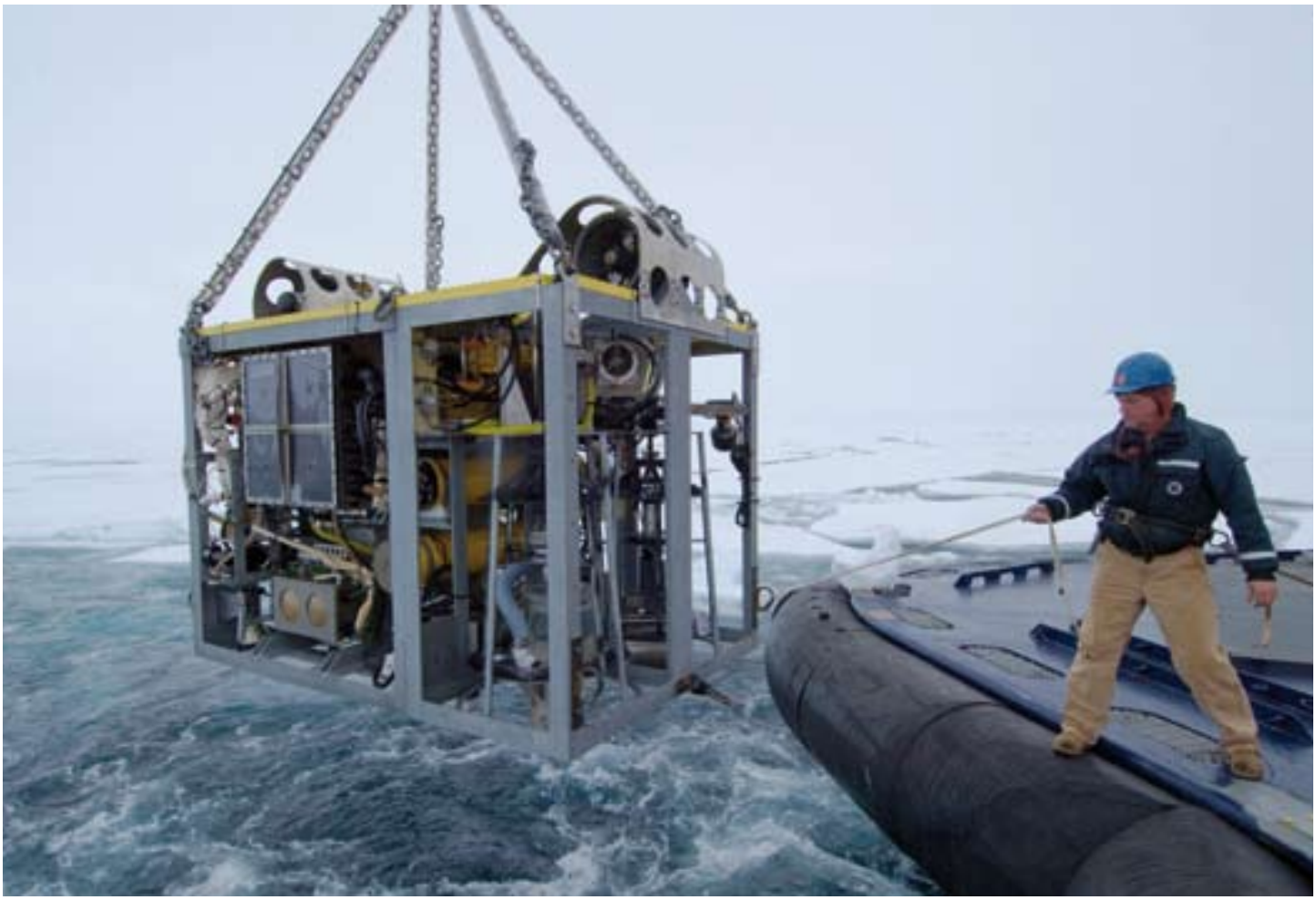

Figure 5
The CAMPER wireline vehicle being lowered over the side during a test dive off Bear Island. Photo: Björn Eriksson.

rocky seafloor, and to acquire real-time imagery and samples. The CAMPER imagery was fed into the Oden's computer network, allowing scientists to watch the dives from anywhere on the ship, including "TV dinners" in the galley, which were quite popular.

The AGAVE expedition made a number of exciting discoveries on the Gakkel Ridge, and one of the most surprising was the fact that the axial valley at the 85°E segment is blanketed in pyroclastic deposits – the largest unconsolidated deposits ever found on the seafloor (Fig. 3). These deposits are caused by explosive volcanic eruptions, which many scientists had assumed were impossible in the deep ocean because of the great pressures at such depths. The AGAVE observations turn this idea upside down, and demonstrate that volcanic activity at the 85°E site has been accompanied by the catastrophic discharge of magmatic volatiles. These pyroclastic deposits are being analyzed to determine their age and composition in order to better understand this surprising result. The deposits were found around a previously unknown chain of volcanoes, which were named the Asgard Chain – Oden, Thor, and Loke, in honor of the outstanding scientific support provided by the officers and crew of IB Oden.

Arctic Gakkel Vents – AGAVE-expeditionen 1 juli–10 augusti 2007

AGAVE-expeditionen hade två kompletterande mål. Det naturvetenskapliga målet var att undersöka de geologiska, kemiska och biologiska egenskaperna i de hydrotermala utsläppen vid Gakkelryggen, en undervattensbergsrygg i Norra ishavet. Det teknologiska målet var att utveckla ny teknik för djuphavsforskning i istäckta hav, vilket också finns på Jupiters måne Europa. Teknikutvecklingen inför AGAVE kan vara ett första steg till motsvarande expeditioner dit.

Inför AGAVE utvecklades två nya djuphavsrobotar, eller AUV:er (autonomous underwater vehicles), som kan styras och tas upp från en isbrytare i packisen. AUV:erna tog prover, utförde kartläggningar och lokaliserade de hydrotermala utsläppen.

Under AGAVE-expeditionen gjordes en mängd upptäckter, men den största är nog att axialklyftan vid 85°E på Gakkelryggen är täckt av pyroklastiska avlagringar (material från vulkanutbrott), och det är den största enskilda pyroklastiska avlagringen som någonsin hittats på havsbotten.

Expeditionen var ett samarbete mellan forskare från USA, Sverige, Tyskland och Japan inom ramen för det Internationella polaråret 2007–2008.

Could the Bredefjord area be the key to understanding the palaeoclimatic and glacial changes in southern Greenland?

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Background and aim

A number of natural processes interact to cause sea level changes. The sea level position is at every point of time and space determined by the volume and shape of the oceans, re-distribution of water within the ocean basins and vertical movements of the coastal areas. These parameters are driven by internal Earth processes such as movement in the mantle and flexure or movement in the crust as well as by external processes like ice sheet growth and decay, sediment deposition in the oceans basins (infilling) and on a smaller scale also temperature changes of the ocean water. These various processes act on different temporal and spatial scales, thus creating a complex pattern of local sea level changes.

During the transition from the Last Glacial Maximum (LGM) to the Holocene period, large and rapid climatic changes caused most of the northern Hemisphere's ice sheets to decay. Although the Greenland ice sheet experienced considerable reduction in its size during this global deglaciation, it is today the only remaining ice sheet in the northern Hemisphere.

The southern part of Greenland is a key area in understanding the interplay between the different Earth system components affecting climate. In this area, many of these Earth system components meet and interact with each other in a complex manner. Studying the area's glacial history will give insights into palaeoclimatic and sea level changes and subsequent environmental responses. Knowledge in regard to these changes is highly relevant to predictions of future change in the global climate.

The changing climate caused complete or partial disappearance of the large continental ice sheets following the Last Glacial Maximum (LGM, ca. 22 ka BP). Significant vertical uplift of the formerly ice-covered areas occurred due to glacial-isostatic adjustment, which has resulted in relative sea-level changes. Sea-level changes outside ice-covered areas are largely caused by the redistribution of water between continents and ocean basins as a consequence of glacial growth and decay. Observations of relative sea-level fall since the LGM until the present day from formerly glaciated regions help to reconstruct local ice-volume changes and their retreat/growth history.

A recent research project investigating sea-level changes and modelling glacial-isostatic adjustment showed that earlier ice sheet models underestimate the ice thickness and/or the extent of ice sheets in southern Greenland during the LGM (Bennike et al. 2002, Sparrenbom 2006).

Several ice sheet scenarios were tested and the results suggest: that the margin of the

Figure 1
Maps showing the investigation area of southwest Greenland (A), Bredefjord (B) and the fourteen sites cored (C).

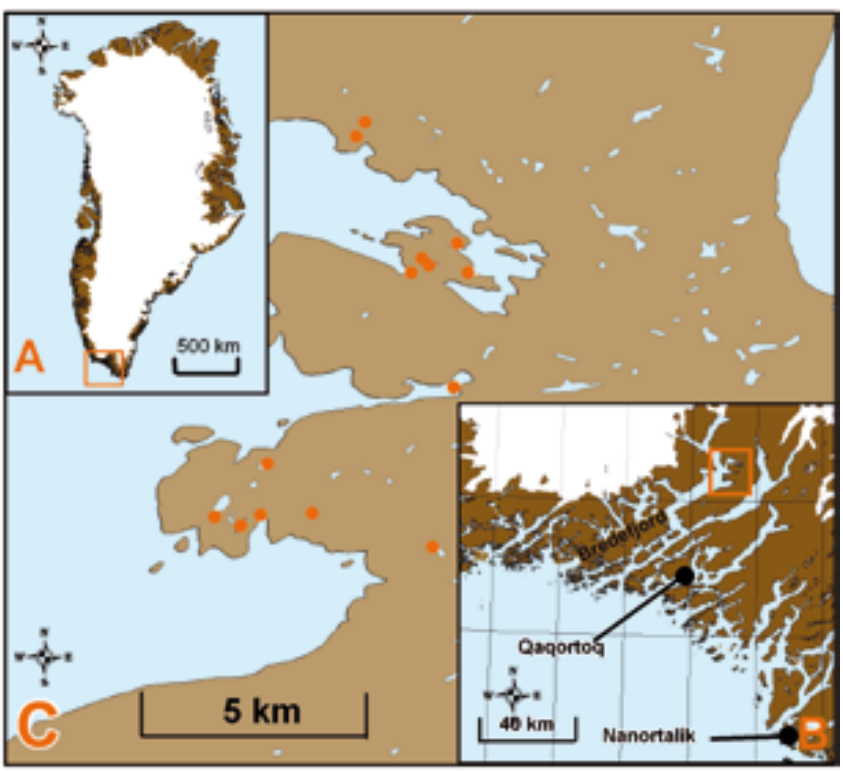

Figure 2
Sites 3 and 4 close to the Kangerlua camp. Photo: Dan Zwartz.

Greenland ice sheet extended all the way out to the shelf edge during the LGM; that ice sheet recession began early (ca. 22 000 cal. years BP); and that the ice-margin recession proceeded quickly (Sparrenbom 2006). By 12 000 cal. years BP, the ice margin was inland of the present-day outer coast and by 10 500 cal. years BP it had reached the present margin. The ice sheet was smaller than at present from 10 500 cal. years BP and reached a minimum at 30 km inland of the present-day margin at 9 000 cal. years BP. The neo-glacial re-advance started before 6 500 cal. years BP and the present-day margin was reached by 5 500 cal. year BP. The ice thickness in central southern Greenland during the LGM must have been of the order of 4 000–4 500 m (Sparrenbom 2006).

Recent data collected in the area around Bredefjord (Sparrenbom et al. 2006a) could, however, imply that the ice sheet was thinner in this specific area and that the fjord acted as a major drainage path for the southern part of the Greenland Ice Sheet. Bredefjord is also located in southwest Greenland, and in some places reaches depths over 600 m. The Bredefjord region appears to be the key area for the drainage of the ice sheet in the south but only few data were available before the expedition carried out in the summer of 2007.

This project aims to reconstruct the relative sea-level history of the Bredefjord area (see map in Fig. 1). This will enable us to model the evolution of the southern part of the Greenland Ice Sheet and the ice sheet drainage mechanisms. To do this, we have cored and retrieved sediment sequences from eleven lakes and three marine basins.

Fieldwork

To obtain records of past relative sea level changes, we have cored sediments in small local basins, i.e. lakes, lagoons and bays with appropriate thresholds (see Fig. 2 for a view of sites Ka3 and Ka4). During the course of their development, the studied basins should have been isolated/uplifted from the sea and/or inundated by seawater. Basins situated below the past marine limit have been isolated as a consequence of land uplift following deglaciation after LGM. Basins at low altitude have, in their fairly recent history, been submerged. This late relative sea level rise is a consequence of several processes: a mid-late Holocene Greenlandic glacial growth, decay of the American inland ice sheet and/or ocean warming (water expansion) and melting of non-polar ice. Different kinds of evidence for a late glacial and early Holocene regression and a late Holocene submergence have already been found at several sites from different parts of Greenland (Sparrenbom et al. 2006a and 2006b, Bennike et al. 2002, Long et al. 1999 and Kuijpers et al. 1999).

During three weeks in August we worked in the Tasiusaq–Kangerlua area in the inner

Figure 3
Linda Randsalu, Daniel Fredh and Ole Bennike on reconnaissance in Bredefjorden in one of the large Zodiacs. Photo: Dan Zwartz.

part of Bredefjord. Our first "camp" was established in the youth hostel in Tasiusaq and our second camp at the farmhouse in Kangerlua. Using a Russian corer, multiple core sediment sequences were collected from a total of fourteen basins at altitudes between -5.5 m and 54 m. Two large Zodiacs and, on a number of occasions, a speedboat, were used for reconnaissance work in the area and for the transportation of coring equipment and people to the different coring sites (Fig. 3). The bathymetry of the basins was investigated from a Zodiac with an echo sounder in order to find suitable sites for coring and to estimate threshold depths for the submarine basins. Heights above sea level were measured with differential GPS. A small specially designed Zodiac, in which a funnel hole has been constructed through the bottom, was used as a coring platform. Transport on land was mainly by foot, car and tractor.

Preliminary results

Based on preliminary interpretations of the fourteen multiple core sediment sequences collected, ten or eleven sequences show isolation contacts with marine sediments in the bottom and with an upward transition into brackish and freshwater deposits. This is visible to the naked eye in terms of sediment colours, grain-size, and macrofossils. Generally, the colours shift from greenish grey in the marine segment, to more blackish dark-brown signifying brackish conditions, and to lighter brown colours in the fresh water depositional environment (Fig. 4). Both textures and macrofossils reveal the same story and in the marine sediments we find marine fossils, for example marine algae and molluscs, while the lake deposited sediments contain remains of freshwater algae and freshwater bryozoans. Our first results from the XRF core scanning and macrofossil analyses are shown from site Ta1 in Figures 5 and 6. The ^{14}C-analyses show that this site was isolated at ca. 8 900 cal. years BP, which is younger than earlier results from the area have suggested (cf. Sparrenbom et al. 2006).

In addition, two of the ten isolation sequences show at least one transgression close to the top of the sedimentary column. To establish the course of events properly, the sediments from the other sites are currently being analysed in detail in the laboratory and more macrofossils are being selected for ^{14}C dating. Three of the sites will be presented as two Master theses (D. Fredh and L. Randsalu) in early 2008. The remaining analyses will be completed in the winter-spring of 2008 and will then be used for the ensuing geophysical modelling.

We would like to thank the following for financing the project:

The Australian Research Council, the Australian National University and the Swedish Polar Research Secretariat.

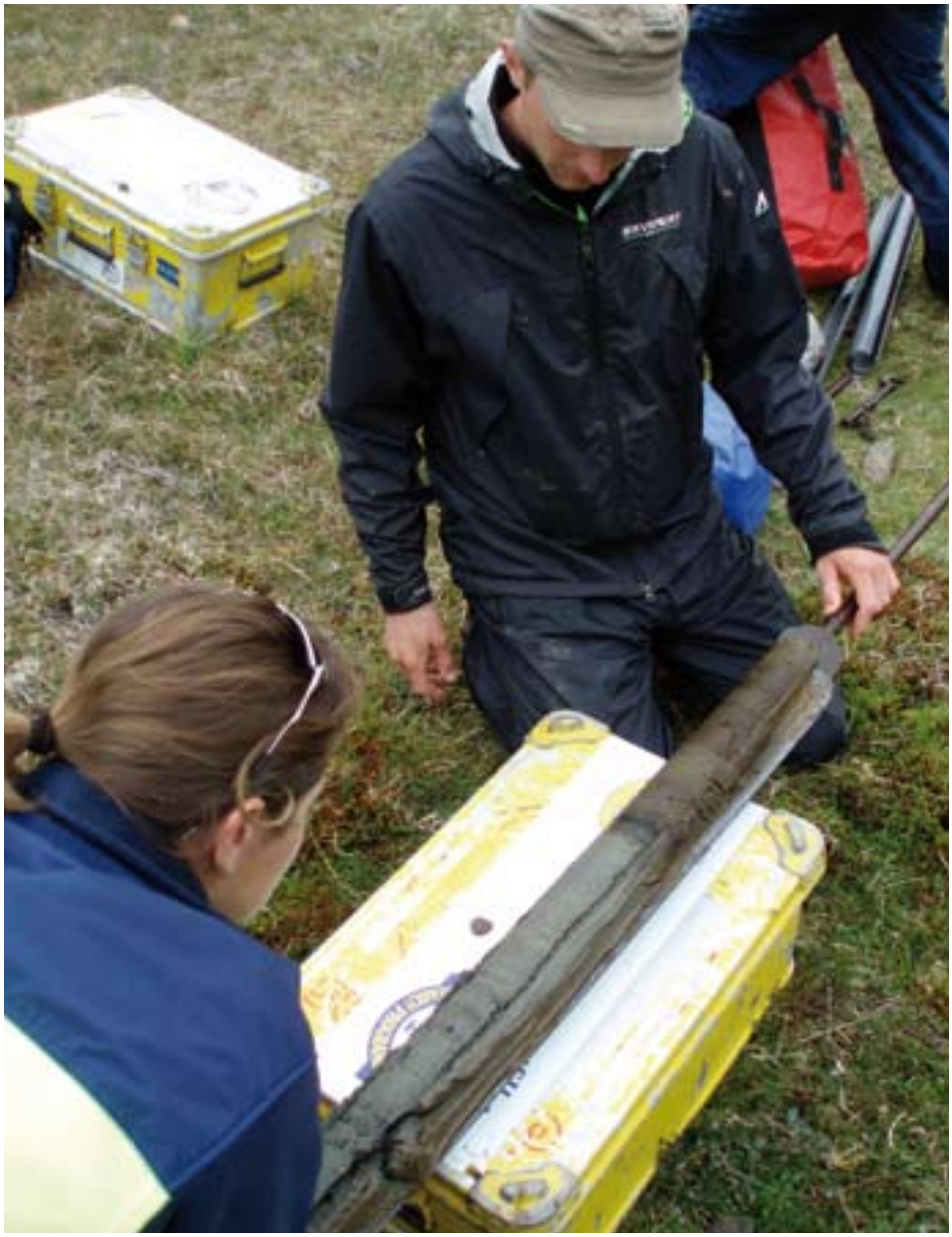

Figure 4
Daniel Fredh and Charlotte Sparrenbom discuss the sediments from one of the ten isolation sequences retrieved during our fieldwork. Note the grey sediment transition into blackish and brown sediments. Photo: Dan Zwartz.

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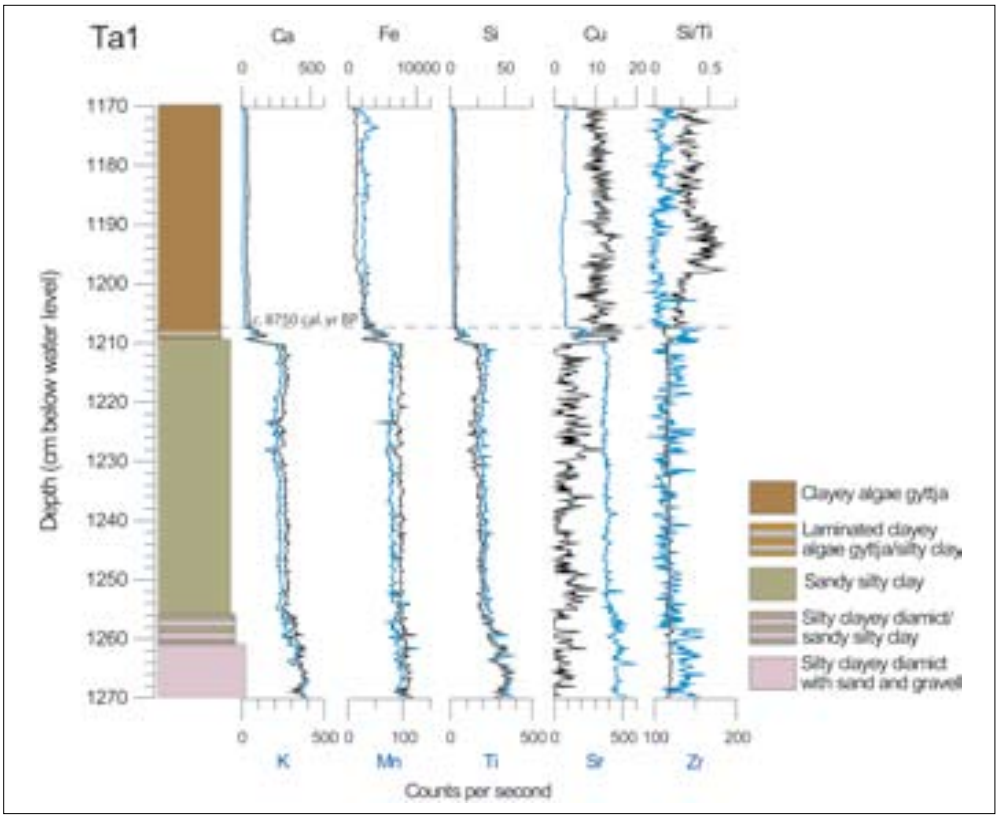

Figure 5
Core log and results from X-ray fluorescence measurements for site Ta1. Note the different scales for the different elements.

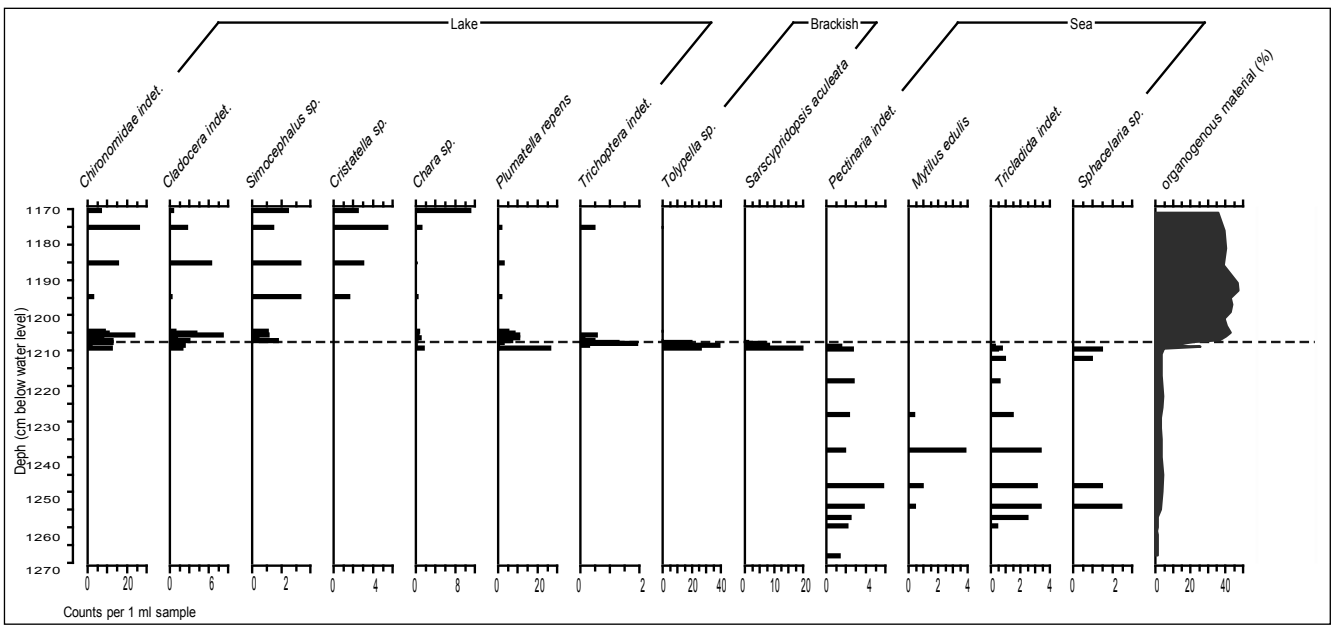

Figure 6
Simplified macrofossil diagram showing results from the macrofossil analyses of site Ta1. Note the different scales for the different taxa.

Kan Bredefjorden vara ett nyckelområde för att förstå klimatutveckling och glaciologiska förändringar i södra Grönland?

Jordens havsnivåer förändras kontinuerligt; i längre geologiska tidsperspektiv styrs förändringarna av processer i jordens inre, men i kortare tidsperspektiv spelar yttre processer, såsom tillväxt och avsmältning av inlandsisar, stor roll för havets nivåförändringar. Det grönländska istäcket är idag norra halvklotets enda inlandsis och dess tillväxt och avsmältningshistoria är fortfarande relativt okänd. Genom rekonstruktion av de relativa havsnivåförändringarna, kan vi analysera hur inlandsisens utbredning och tjocklek har varierat. För denna rekonstruktion använder vi oss av sedimentkärnor från sjö- och havsviksbassänger på södra Grönland. I sedimenten finns förändringar som visar hur dessa bassänger har utvecklats från t.ex. marin- till färskvattensmiljöer. Detta kan visas genom t.ex.förändringar i den fossila floran och faunan. Genom höjdmätning av bassängernas trösklar och kol-14-analys av fossil i sedimenten kan vi datera havsnivåförändringarna. En expedition arbetade i augusti 2007 med datainsamling för detta projekt i den inre delen av Bredefjorden, sydvästra Grönland.

Properties of aerosol particles in polar regions and trends in background CO_2 levels: Long-term monitoring and aircraft measurements

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Aim

The aim of the research is to combine long-term monitoring observations and detailed process studies to better understand the role of aerosols and trace gases upon the Arctic atmosphere and climate. An understanding of these atmospheric constituents, their sources and sinks, transport and transformation processes, is a prerequisite to being able to make credible predictions of a future polar atmosphere and climate.

The energy budget on Earth is largely determined by the so-called greenhouse gases, which occur naturally in the atmosphere. By burning fossil fuel and changing the use of land, humans alter the atmospheric concentration of these gases, which results in the warming of the climate. Whereas the greenhouse gases warm the Earth, particles in the atmosphere generally, but not always, have a cooling effect on the climate. As the aerosols tend to scatter more light than they absorb, more aerosols in the atmosphere means that more radiation from the sun is reflected back to space. This means that less of the sun's radiation reaches the ground. Particles also cool the planet through modifying the droplet size distribution of clouds. Alternation of the cloud droplets to smaller sizes makes the cloud brighter, in other words scatters more radiation back to space. Black particles such as soot tend to warm the atmosphere. One particular feature of black particles that has gained considerable interest recently, is the effect these particles have on the brightness of snow and ice. By making the snow darker, these particles enhance the melting of ice and snow.

By observing these trace gases and aerosols on different temporal and spatial scales we work to acquire a better understanding of the processes controlling their characteristics and their influence on the Arctic atmosphere and climate.

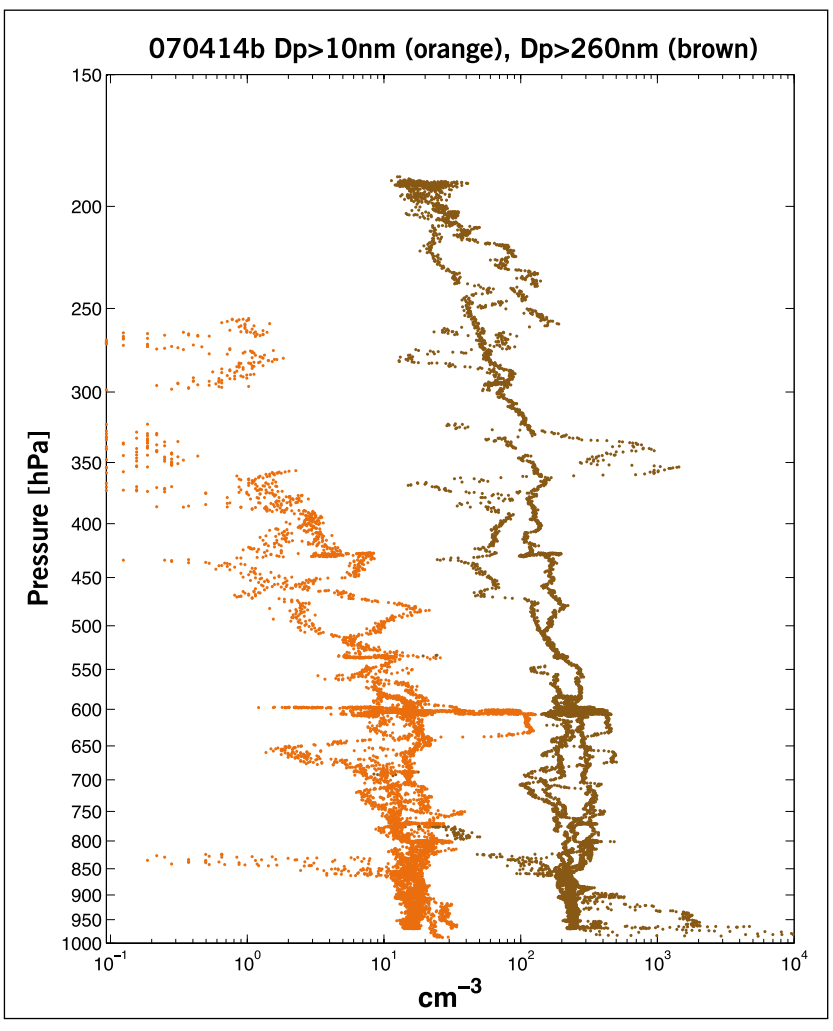
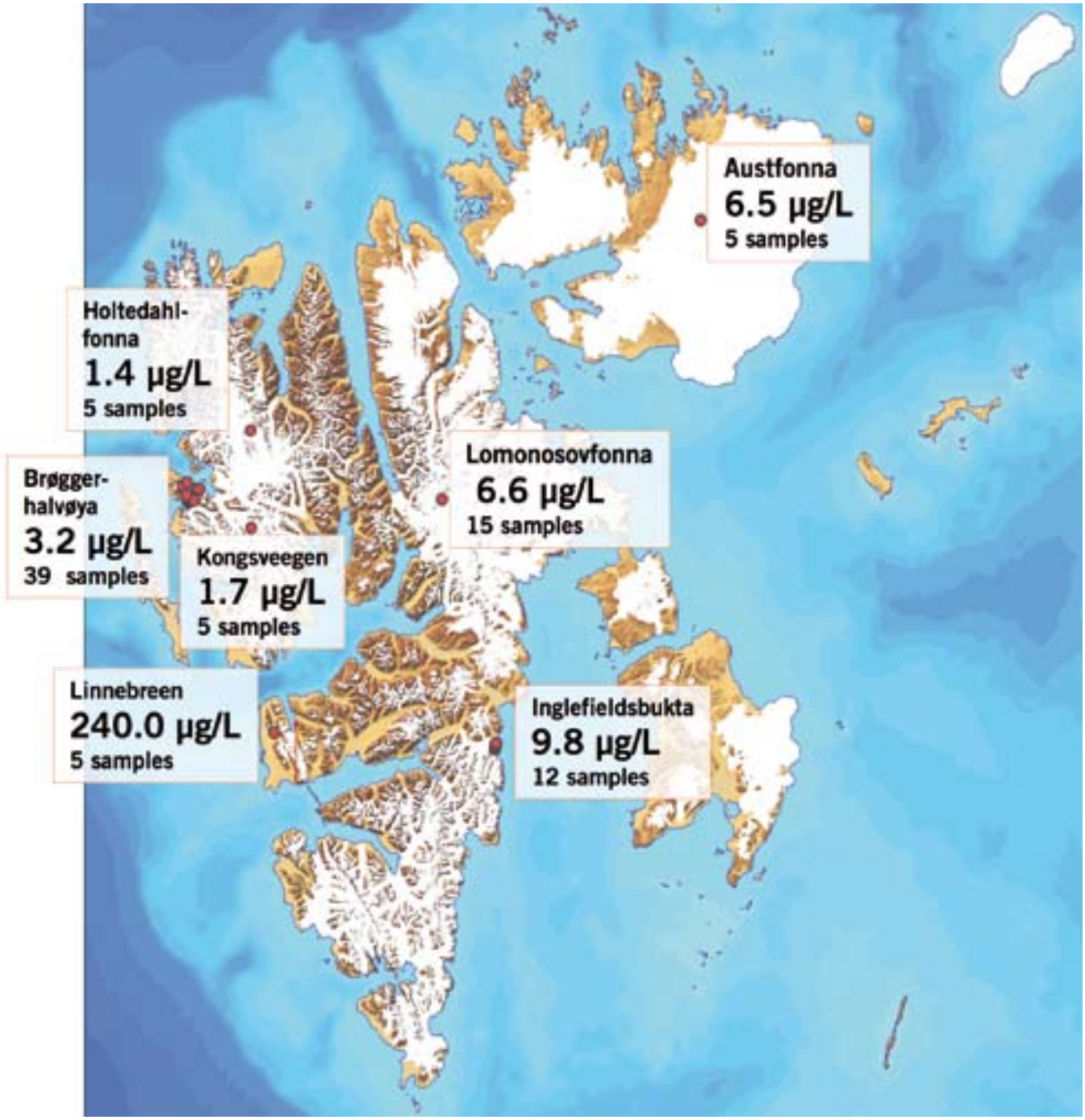


Figure 1
Data points depict the vertical distribution of particle number density for the ASTAR flight conducted 14 April 2007 (Brown: particles larger than 260 nm in diameter, orange; particles larger than 10 nm in diameter).

Research platforms and observations

The Zeppelin station

The long-term observations are conducted at the Zeppelin station in Ny-Ålesund, Svalbard. The station is located at 78°54'N and 11°53'E, at about 475 m above mean sea level on the Zeppelin Mountain ridge. Although the station is owned by the Norwegian Polar Research Institute, the two main users are Stockholm University and the Norwegian



Institute for Atmospheric Research (NILU) and the monitoring work is supported by the Swedish Environmental Protection Agency. The continuous observations at the Zeppelin station include aerosol number density, aerosol size distribution, aerosol light scattering and light absorption properties, particle carbon composition and gaseous CO_2. Radon 222 is also observed in collaboration with University of Heidelberg in Germany. For more information about the monitoring work at the Zeppelin station please visit www.itm.su.se/zeppelin. For a current view from the station looking down towards the village of Ny-Ålesund, please visit www.nilu.no/onlinebilder/zeppelin/zeppelin.jpg.

The Zeppelin station is also used for campaign-based observations. During 2007 two campaigns were conducted, one in spring and one in summer. The main focus was to study the temporal evolution of sulphur dioxide (SO_2). Photochemical processes convert SO_2 to gaseous H_2SO_4 that may condense onto pre-existing particles or actually nucleate to form new particles. By observing the tracer with high temporal resolution we may interpret the data with respect to the source, which may be both of natural or anthropogenic origin.

Figure 2
Concentrations of elemental carbon (black carbon) in melted snow and ice.

ASTAR – Airborne measurements

The international aircraft experiment ASTAR 2007 was conducted during March and April. The main focus of ASTAR (Arctic Study of Tropospheric Aerosols, Clouds and Radiation) is to gain information about the vertical distribution of aerosols and precursor gases.

The time period was chosen to capture some of the anthropogenic pollutants that enter the Arctic during late winter and spring, the so-called Arctic Haze. The importance of information in the vertical air column is illustrated by data from the flight on 14 April 2007. Data for two particle size ranges are presented. Data in brown show the number density of particles with a diameter larger than 260 nm in diameter and data in orange show the number density of particles with a diameter larger than 10 nm in diameter. Note the layer of the larger particles around a pressure of 600 hPa (roughly 4 km altitude), which shows a concentration of about 3 times what was observed near the surface. The small particles form a layer around a pressure of about 350 hPa (roughly 7 km altitude). The number density in this layer is comparable to the concentrations near the surface.

Snow sampling

As a collaborative effort with the Norwegian Polar Institute, snow samples around Svalbard were collected and analyzed for the content of elementary carbon (black carbon). Figure 2 shows the median concentration at the different locations. We note that the Russian settlement Barentsburg influences the amount of black carbon in the snow at Linnebreen and that there appears to be an east–west gradient in the concentrations. More samples are under way and we also intend to gather more information over time.

Participating organisations

- Norwegian Polar Institute (NPI)
- University Centre in Svalbard (UNIS)
- Norwegian Institute for Air Research (NILU)
- National Institute of Polar Research, Japan (NIPR)
- Alfred Wegener Institute, Germany (AWI)
- Korea Polar Research Institute (KOPRI)

Supporting organisations

The activities at the Zeppelin station are mainly supported by the Swedish Environmental Protection Agency with support from the Swedish Polar Research Secretariat. A contract from the Swedish Research Council and support from the EU project ARCFAC (European Centre for Arctic Environmental Research in Ny-Ålesund) also made additional campaign based observations possible.

Egenskaper hos aerosolpartiklar i polarområdena och trender i koldioxidhalter: Långtidsövervakning och luftburna mätningar

Temperaturökningen går dubbelt så snabbt i Arktis jämfört med resten av världen. Resultatet är högst påtagligt i bl.a. minskad utbredning av glaciärer och ändrade is- och markförhållanden. Orsaken till en förändring i temperaturen kan vara flera, men sedan industrialismens början har mänskliga aktiviteter ändrat atmosfärens sammansättning genom utsläpp av partiklar och gaser, vilket i sin tur förskjutit Jordens energibalans mot en högre medeltemperatur. Målet med vår forskning är att studera dessa klimatpåverkande ämnen som genom direkta eller indirekta processer påverkar Jordens energibalans och därmed atmosfärens temperatur. Vi gör detta dels genom att studera långa tidsserier observerade från Zeppelinstationen i Ny-Ålesund på Svalbard samt detaljerade rumsliga observationer gjorda från flygplan. Förutom att de långa tidsserierna är det enda sättet att studera nutida trender så skapar det ett ramverk för att placera kortare mätkampanjer i ett större sammanhang.

Project leader

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Effects of global warming on the reproductive biology of birds in Swedish sub-arctic areas

Background

Birds are excellent indicators of environmental change, such as biologically important effects of climate change, and consequently studies of birds can be used to predict the development over large areas. This project there-fore aims to study effects of climate change on the reproductive biology of birds in Padjelanta, the most species-rich area of the World Heritage Site Laponia in northern Sweden. In Padjelanta, climatic factors limit the distribution and breeding performance of many bird species, which makes it easier to quantify the effects of global warming on reproduction, population dynamics and food supply and predation.

Between 1971 and 1995, a number of studies have been made of Fieldfares (*Turdus pilaris*), Merlins (*Falco columbarius*), Hooded Crows (*Corvus corone*) and the bird communities in the birch forest and on the tundra. As the current project focuses on the effects of global warming on the reproductive biology of some of the species included in the previous study period, the present study thus comprises a period of some 35 years, a period that is adequately long to measure climatic effects in biological systems. In 2007, the field studies were mainly directed towards the collection of data on the breeding phenology of Merlins and Hooded Crows and the occurrence of new species in the study area.

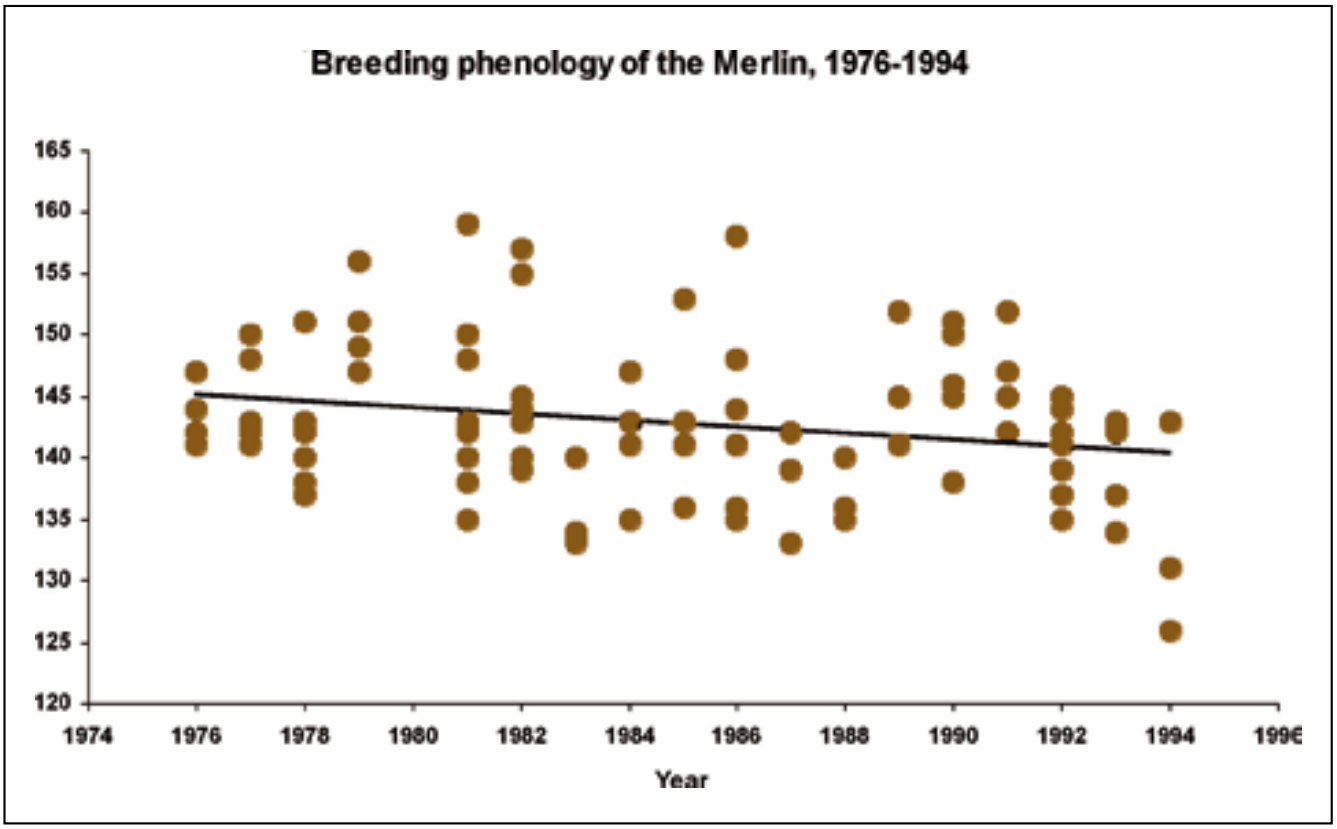


Figure 1
The breeding phenology of the Merlin *Falco columbarius* in the Staloluokta area, central Padjelanta (Laponia) from 1976 to 1994. There is a significantly advancing trend ($p < 0.05$) in the date of laying the first egg.

The fieldwork

Field studies were carried out throughout June and early July 2007, in the surroundings of Staloluokta, Padjelanta National Park, Laponia, Sweden. During this year, it was unusually hot and dry in the study area. The area was searched for nesting Merlins and Hooded Crows and the reproductive performance of Merlins was studied by recording clutch size, number of eggs hatched and nestling survival until the chicks were at least 10 days old. Earlier studies have indicated that chicks normally survive to fledging age: among several hundred nests controlled during the period 1971 to 1995, there is only one record indicating that chicks at this stage of development or older succumbed. Body mass and the length of a primary were determined for each chick on at least one occasion making it possible to determine when the eggs had hatched by using previous and detailed studies of chick growth. To estimate reproductive performance by the Hooded Crow a sample of the breeding population of Hooded Crows can be used.

To estimate the exact location of nest sites of both Merlins and Hooded Crows a Global Positioning System (GPS) was used. The GPS coordinates will be used to determine the densities of breeding Merlins and breeding Hooded Crows in the study area. Furthermore, the GPS coordinates will be used to calculate the distance between the nest of a breeding Merlin pair and the nearest breeding pair of Hooded Crows. The Hooded Crows are the most important predators on birds' eggs and chicks, including breeding Merlins, in this area. In addition, the nests used by Merlins for breeding are actually nests built by Hooded Crows and previous studies have showed that Merlins prefer to use a nest of good quality for breeding, i.e. one-year-old crow nests.

Results

In the study area, 8 pairs of Merlins and 13 pairs of Hooded Crows were breeding. Two Merlin pairs failed to produce chicks due to predation before the eggs hatched. All Hooded Crow pairs produced fledglings, numbering between one and four chicks per pair.

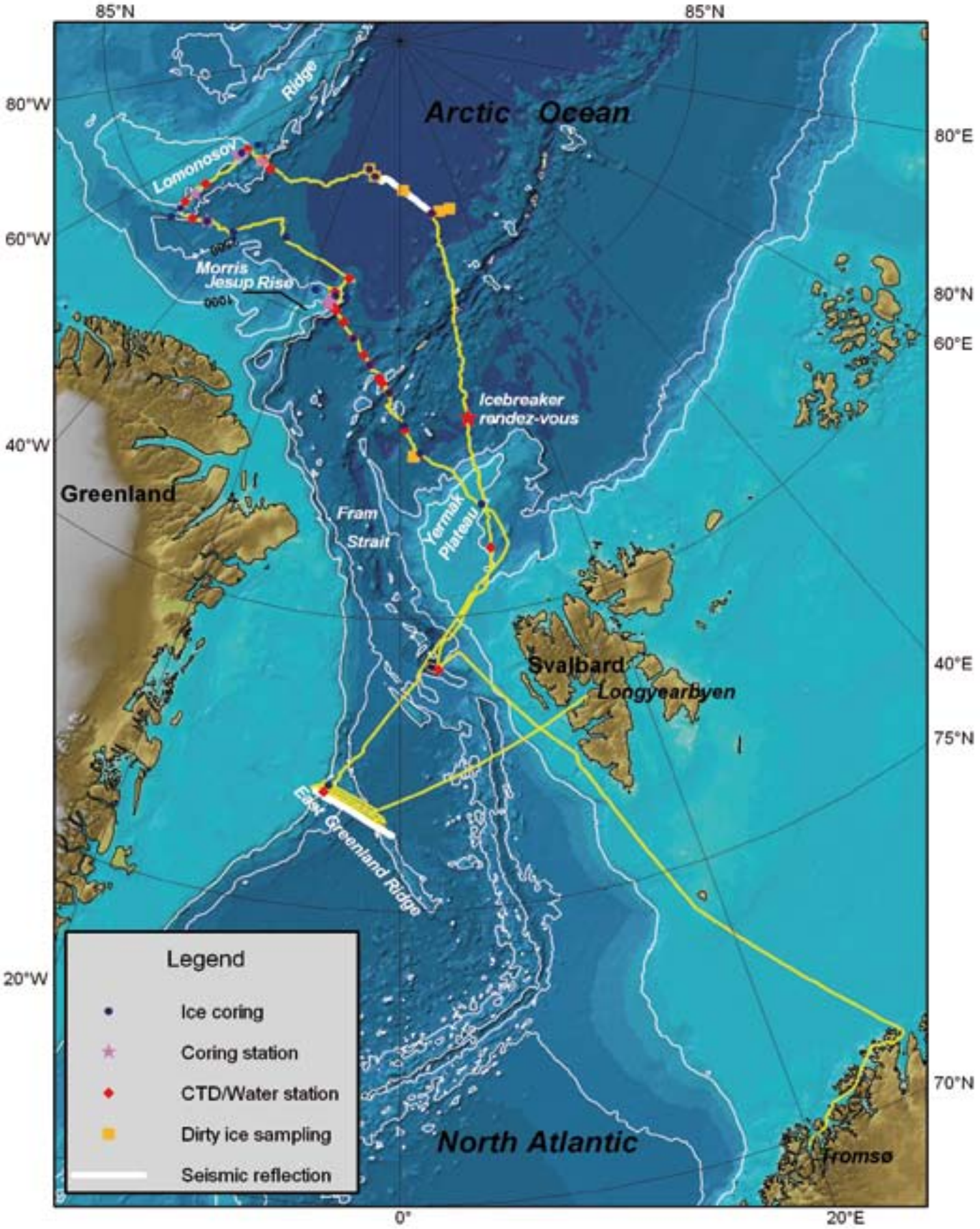
An analysis of the start of the breeding among Merlins has been made using data from the first study period alone, which shows a trend of clutch initiation starting successively earlier during the 1980s and 1990s (Fig. 1). In comparison with data from 2007 it appears that this trend remains and may even be slightly more pronounced. However, there was a large variation in the breeding start among the Merlin pairs in 2007 and therefore, a more careful analysis of the start of laying in different territories is required before reliable conclusions can be made on how much earlier Merlins start to breed in the early part of this century in comparison with the 1970s.

Effekter av global uppvärmning på reproduktionsbiologin hos fåglar i svenska Subarktis

Under sommaren 2007 undersöktes området runt Staloluokta, Padjelanta Nationalpark, med avseende på häckande stenfalkar och kråkor. I undersökningsområdet häckade åtta par av stenfalk och 13 par av kråka. Sex av stenfalksparen producerade ungar som också blev flygfärdiga. Alla kråkparen producerade ungar, mellan 1 och 4 ungar per par. Under den tidigare undersökningsperioden konstaterades att starten för stenfalkarnas äggläggning successivt hade tidigarelagts under 1980- och 1990-talen (se Fig. 1). När 2007 års data inkluderades i analysen fanns trenden kvar och den hade även stärkts. Starten för äggläggningen varierade dock mycket mellan olika stenfalkspar. Därför krävs ytterligare analyser av både äldre och nya data.

LOMROG 2007

Forskarrapporter Cruise Reports



LOMROG expedition route and scientific station work.

Lomonosov Ridge off Greenland (LOMROG) 2007: Chemical and physical oceanography

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The oceanographic component of LOMROG focuses on constraining and understanding the pathways of the Atlantic water and deep water across the Lomonosov Ridge, between the Eurasian Basin and Canadian Basin and through the western Fram Strait. A deep water pathway may exist between the Lomonosov Ridge and the Northern Greenland shelf, and thus knowledge of the shape of the seafloor in this area is also of interest for the oceanography programme. The LOMROG oceanography programme is an extension of the 2005 scientific programme conducted during the Healy-Oden Trans-Arctic expedition (HOTRAX) in 2005 when oceanographic station work was carried out from the icebreaker Oden and multibeam mapping from USCGC Healy. The data from HOTRAX showed that water overflow from the Makarov Basin (part of the Canadian Basin) to the Amundsen Basin (part of the Eurasian Basin) takes place across a 1 870 m deep sill in the central Lomonosov Ridge at about 88°25'N, 150°E (Björk et al. 2007). This water appears to follow the Lomonosov Ridge slope southwards towards Greenland but uncertainty remains in regard of whether it can be traced on the southernmost tip of the ridge and how the circulation continues from this point and onwards.

Data acquisition

Conductivity Temperature Depth (CTD) and water sampling were carried out at 26 stations covering parts of the western Eurasian Basin and one station at the East Greenland continental margin. Water was collected using a 24-bottle rosette sampler equipped with 7.5 l Niskin type bottles and a CTD (Sea Bird 911+) (Fig. 1). When brought back onboard the rosette was moved into a heated double container as quickly as possible to avoid freezing the samples. Water samples were immediately drawn for the individual parameters to be determined in the following order: CFCs, oxygen, dissolved inorganic carbon/pH/total alkalinity, nutrients, oxygen-18, and salinity. Number of samples analysed for the different constituents are given in Table 1.

Shipboard processing

The CTD data were processed through the standard Sea-Bird software routines (data conversion, cell thermal mass, filter, loop edit, derive and bin average). The final data is averaged in 1 dbar bins. Salinities were also determined in each Niskin bottle using an Autosal lab-salinometer. The temperature in the clean room inside the laboratory on the foredeck fluctuated significantly and therefore conditions were not ideal for the salinity analyses, but were nevertheless manageable. The final bottle salinity data should be of good quality with an accuracy of ±0.001 psu. The bottle salinities were then compared with the CTD bottle file data in order to check the accuracy of the CTD system. The comparison with bottle data showed an offset of about -0.0044 psu between the CTD and Autosal salinities, inferring that the CTD sensor values were too low. The final CTD data were corrected by determining an average salinity offset using bottles with salinity > 34.8 psu and excluding outliers outside 1 SDA. One sample was then identified (Station 20, 4 000 dbar) as having identical offset as the average offset. The Autosal conductivity for this sample was determined for the same temperature and pressure when the bottle was tripped (P=4 000 dbar, T=-0.6708°C). The Autosal conductivity divided by the CTD conductivity then gives a slope correction of 1.000119, which has been used

Figure 1
The CTD/rosette sampler on its way back from the water. Photo: Sofia Rickberg.

Figure 2
Sara Jutterström collecting water for the determination of DIC. Photo: Leif Anderson.

to post-process the data according to Sea-Bird recommendations.

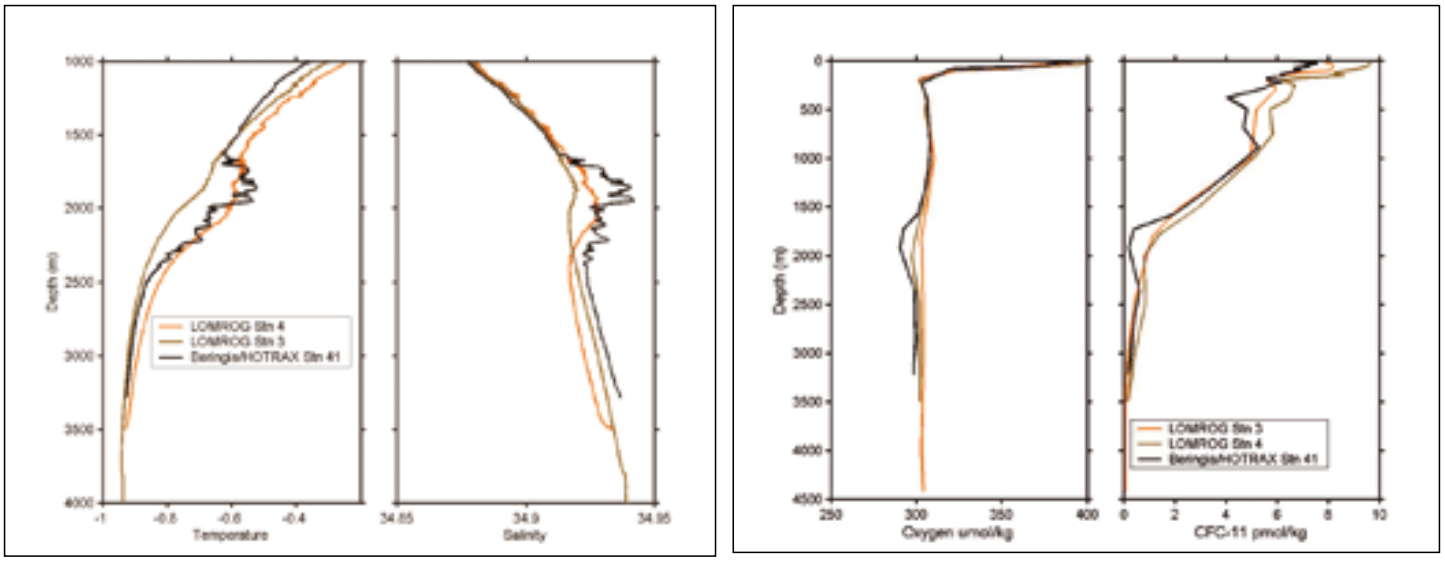
Water for chemical analysis was drawn from water samplers directly after the rosette was brought on board and analysed within hours of sampling. The precisions given below were computed as standard deviations of duplicate analyses. Samples for CFCs were drawn from the bottles on the rosette with glass syringes, which were kept under cold water until analysis (within a few hours). They were measured by purge-and-trap extraction and pre-concentration, gas chromatographic separation on a capillary column, and electron capture detection calibrated against a standard gas mixture. The precision was in the order of 1% and the accuracy was about 0.02 pmol/kg. Oxygen was determined using automatic Winkler titration system, precision ~1 µmol/kg. Total dissolved inorganic carbon (DIC) was determined by a coulometric titration method having a precision of ~1 µmol/kg, with the accuracy set by calibration against certified reference materials (CRM), supplied by A. Dickson, Scripps Institution of Oceanography (USA). Total alkalinity (TA) was determined by potentiometric titration, precision ~1 µmol/kg, (Haraldsson et al. 1997), with the accuracy set in the same way as for DIC. The determination of pH was performed by the use of a diode-array spectrophotometer using a sulphonephtalein dye, m-cresol purple, as indicator (Clayton and Byrne 1993, Lee and Millero 1995), and measured in a 1 cm flowcell thermostated to 15°C (pH15). The precision and accuracy for the pH15 measurements were ±0.0005 and ±0.002 pH units, respectively. pH in situ was calculated from TA, pH15 and in situ temperature by using the CO_2-system program by Lewis and Wallace (1998). For these calculations the carbon dioxide constants of Roy et al. (1993 and 1994) were applied, and the pH was on the total hydrogen ion scale. The nutrients (phosphate, nitrate, and silicate) were determined using a SMARTCHEM auto-analyser applying standard analytical protocol giving a precision near 1% at full scale.

Preliminary results

The observations at the Amundsen Basin slope of the Lomonosov Ridge (Stations 4, 9 and 10) show a clear signal of Canadian Basin Deep Water (CBDW) at around 2 000 m with similar characteristics to a station (Station 41) in the vicinity of the 1 870 m deep channel in the central Lomonosov Ridge at about 88°25'N, 150°E found during the Beringia/HOTRAX 2005 expedition (Björk et al. 2007) (see also Figure 3 for some selected station data). A vertically broad CBDW signal was also clearly visible at the flanks of the Morris Jesup Plateau (Stations 12, 17, 18 and 19). A more vertically narrow and weaker signal was observed over the western Amundsen Basin (Stations 3 and 21–25). The observations

Table 1. Station numbers with positions and bottom depth, and number of data per individual constituent and station.

Station	Latitude	Longitude	Bottom depth	CFC	Oxygen	Mercury	DIC	pH	TA	Nutrients	O-18	Salinity
1	79.121	3.411	5160	3	3	3	0	3	0	0	0	0
2	81.113	9.854	1573	15	15	10	13	15	14	15	0	15
3	86.968	10.168	4338	23	23	12	22	23	23	23	10	23
4	86.883	-44.628	3444	23	23	12	23	23	23	23	10	23
5	86.899	-48.236	1807	18	18	6	18	4	18	18	10	18
6	86.816	-53.826	967	16	16	4	16	16	16	16	10	16
7	85.892	-52.919	749	21	21	8	21	21	21	21	15	18
8	85.432	-52.383	1189	22	22	8	21	22	22	22	12	19
9	85.345	-48.708	2433	19	19	12	19	19	19	19	8	19
10	85.493	-46.189	3005	0	0	10			14	20	0	
11	85.803	-11.723	3985	24	24	12	24	24	24	24	12	23
12	85.519	-14.178	3061	21	21	12	21	21	21		12	21
13	85.479	-13.865	2113	23	23	8	23	23	23	23	?	23
14	85.410	-14.303	1340	19	19	0	19	19	19	19	10	19
15	85.294	-14.936	1004	17	17	0	17	17	17	17	10	17
16	85.269	-13.875	1074	20	20	10	20	20	20	19	12	19
17	85.212	-13.173	2473	22	22	12	22	22	22	22	12	20
18	85.211	-12.997	3360	23	24	12	24	24	24	24	12	21
19	85.041	-11.106	3890	24	24	0	24	24	24		12	24
20	84.790	-8.703	3989	24	24	0	24	23	24		11	24
21	84.531	-6.399	4081	24	24	12	24	24	24	24	12	24
22	84.369	-5.196	3915	24	24	0	24	24	23	24	12	24
23	84.154	-3.431	3003	22	22	0	22	22	22	22	12	22
24	84.074	-2.929	2616	21	21	11	21	21	21	21	12	21
25	83.911	-1.682	3139	23	24	0	24	24	24	24	12	24
26	83.273	0.651	3742			8						



during LOMROG infer that the major inflow of CBDW to the Amundsen Basin indeed occurs at the central Lomonosov Ridge channel and that the flow continues along the slope of the ridge towards Greenland. The further circulation follows the Greenland continental slope towards the southeast to the Morris Jesup Plateau where eventually some of the flow leaves the continental slope, becomes interleaved, and can be identified as a weak salinity maximum over the central Amundsen Basin.

Figure 3
Temperature and salinity data showing the structure of the CBDW signal seen as a temperature and salinity maximum at around 2 000 m depth. The CBDW water is also less ventilated ("older") which is seen in the oxygen and CFC-11 signals. The Beringia/HOTRAX station 41 is from the central Lomonosov Ridge, LOMROG Station 4 is further towards Greenland at the Amundsen Basin flank of the ridge, and LOMROG Station 3 is from the central Amundsen Basin.

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LOMROG: Kemisk och fysisk oceanografi

Målsättningen med det oceanografiska projektet under expeditionen Lomonosov Ridge off Greenland (LOMROG) var att samla information för att dels bättre förstå hur olika vattenmassor strömmar över Lomonosovryggen och efter Grönlands nordostkust mot de Nordiska haven, dels upprepa en del av de undersökningar som gjordes under expeditionen Arctic Ocean 1991. Motiveringen är att studera hur vattnen i den Arktiska oceanen samverkar med Nordatlanten i en tid av förändrat klimat, och om det finns förändringar som redan kan observeras norr om Grönland. För dessa undersökningar samlades djupprofiler från 26 stationer där vattenprover togs för bestämning av flera olika kemiska parametrar ombord på Oden. De första resultaten visar en tydlig signal av vatten från den Kanadensiska bassängen kring 2 000 m vattendjup efter Lomonosovryggen i den Eurasiska bassängen och på flanken av Morris Jesup-platån. Längs sektionen sydöst om Morris Jesup-platån är det tydligt hur signalen av antropogen koldioxid har växt till sig i de översta 2 000 metrarna. Denna signal är också tydlig i kemiska parametrar som uttrycker hur länge sedan ett vatten var i kontakt med atmosfären, dvs. var vid ytan.

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Lomonosov Ridge off Greenland (LOMROG) 2007: Accumulation of mercury in the Arctic Ocean

Emissions of mercury

As a consequence of long-range transport of manmade emissions into the atmosphere, the Polar Regions are nowadays contaminated with highly neurotoxic mercury (Hg). About 6 000 tonnes of Hg are present in the atmosphere today, mainly originating from anthropogenic emissions in the industrialized part of the world. Mercury is one of the most dangerous environmental pollutants, and since it is an element, it cannot be destroyed. Mercury poisoning of the planet could best be reduced by curbing pollution from power stations, since coal-fired power stations and waste incinerators account for around 70 percent of new, quantified manmade mercury emissions to the atmosphere (UNEP 2002).

Mercury is biomagnified in marine wildlife

The most toxic form of mercury is monomethylmercury (MMHg), which is formed in aquatic environments after deposition of inorganic mercury. MMHg is bioaccumulated in fish, and fish contaminated with MMHg is hazardous to eat because MMHg passes the blood brain barrier and the placenta in pregnant women, and can therefore be dangerous to the foetus.

The level of Hg found in marine mammals in the Canadian Arctic exceeds guideline limits for Hg contamination of food for human consumption. Moreover, Hg levels in Arctic ringed seals and beluga whales have increased by a factor of up to four over last the 25 years and the levels recorded in indigenous people living in the Arctic exceed those in people from more temperate, industrial regions. In a study on 7-year-old children in the Faeroe Islands, it has been shown that prenatal methyl mercury exposure may lead to neuropsychological dysfunctions, such as problems in language acquisition, attention and memory deficit (Grandjean 1997). According to exposure data published by the U.S. Center for Disease Control and Prevention, the number of babies at risk in the U.S. could be as high as 300,000. On a global scale, that number can be increased to several million (UNEP 2002).

Long-range transport and chemical transformation contributes to deposition of mercury in the Arctic

Atmospheric deposition of Hg in the Arctic is post-industrially driven, and high Hg concentrations in the upper layer of polar lake sediments have been found (Steffen et al. 2007 and references therein). Ice core samples confirm these results, and the same trends are also observable in, for example, peat from southern Greenland.

Enhanced mercury deposition is observed in the arctic environment, and one important factor influencing the deposition of the species is so-called atmospheric mercury depletion events (AMDE). These events occur during the polar spring and a substantial amount of the global atmospheric Hg pool, that is to say, approximately 300 tonnes per year, is deposited in the arctic environment (Ariya et al. 2004, Skov et al. 2004, Sommar

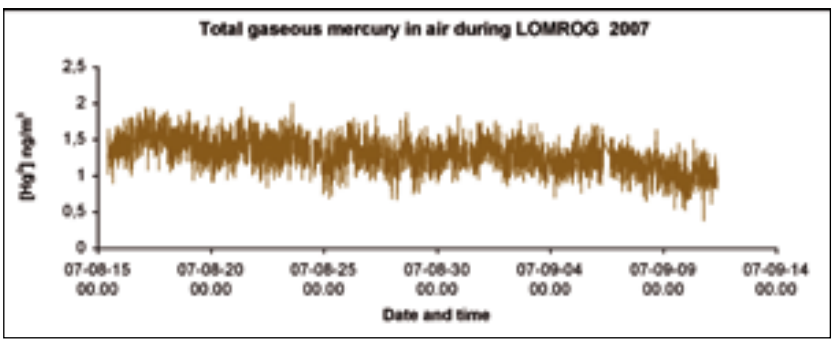

Figure 1
Total Gaseous Mercury (TGM) measured in air at 20 m above sea level during the LOMROG expedition.

et al. 2007). In addition to atmospheric deposition of Hg, the species may also enter the polar basin via oceanic currents and river input. However, while land based measurements of Hg species are represented in literature, information is lacking on the relative importance of various sources of mercury to the polar basin today. Our work contributes to an extensive investigation on water and air masses, aiming at an assessment of mercury sources and sinks in the Polar Basin. The measurements have been conducted under the umbrella of the LOMROG and Beringia expeditions, both arranged by the Swedish Polar Research Secretariat in 2007 and 2005 respectively.

Mercury sampling in Arctic seawater and air

To estimate the input and accumulation of mercury in Arctic marine waters, about 200 samples for determination of total mercury (Hgtot) and MMHg were taken at some 20 stations along the LOMROG 2007 expedition route, and around 500 samples were taken for the same species at 48 stations during the expedition Beringia 2005. Continuous measurements of total gaseous mercury (TGM) in air were also conducted during both expeditions using a Tekran 2537A mercury vapour detector, and a portable mercury analyser i.e. LUMEX Mercury Analyzer RA-915+. Figure 1 presents data on concentrations of elemental mercury in air recorded during the LOMROG expedition over a period of 22 days, between 15 August and 6 September 2007. The average concentration of TGM during this period was 1.3 ± 0.2 ng/m^3. The data will be further analysed with respect to a number of ambient parameters, such as wind conditions and sea ice coverage.

The mercury sampling in water was designed as profile measurements at various latitudinal sites at the LOMROG and Beringia CTD water stations sites respectively, and will be analysed in combination with data on movements of the water masses. In addition, a transect for sampling of surface water using the water sample system in the boat were performed when crossing the Greenland Sea from 76°44'N and 1°22'E to 78°06'N and 13°24'E off the west coast of Svalbard. For each sample, 125 ml of seawater was collected in acid washed Teflon bottles and these are currently being analysed for Hgtot by purge and trap technique as described in Gårdfeldt (2002). Determination of MMHg content in the samples is conducted after derivatisation by an ethylating agent using the gas chromatography CVAFS technique as described in Lee et al. (1994).

During the Beringia 2005 expedition continuous measurements of dissolved gaseous mercury (DGM) were performed using a new method first described in Andersson et al. (2007a). Part of the data from these measurements is presented in Figure 2, and is thoroughly described in Andersson et al. (2007b and 2007c).

Multiphase investigations combining oceanography and mercury speciation, as performed during the LOMROG 2007 and Beringia 2005 expeditions, comprise a unique series of Hg sampling. The data archived will help to assess the Hg sources, the accumulation and the long-term fate of mercury in the polar ecosystem. Preliminary results from our measurements show that the enhanced deposition and river input of mercury species, in combination with restricted evasion at northern latitudes compared to more southern latitudes, result in an accumulation of mercury in the polar water body. For example, the concentration of dissolved gaseous mercury is up to ten times higher in the Arctic Basin compared to the North Atlantic Ocean.

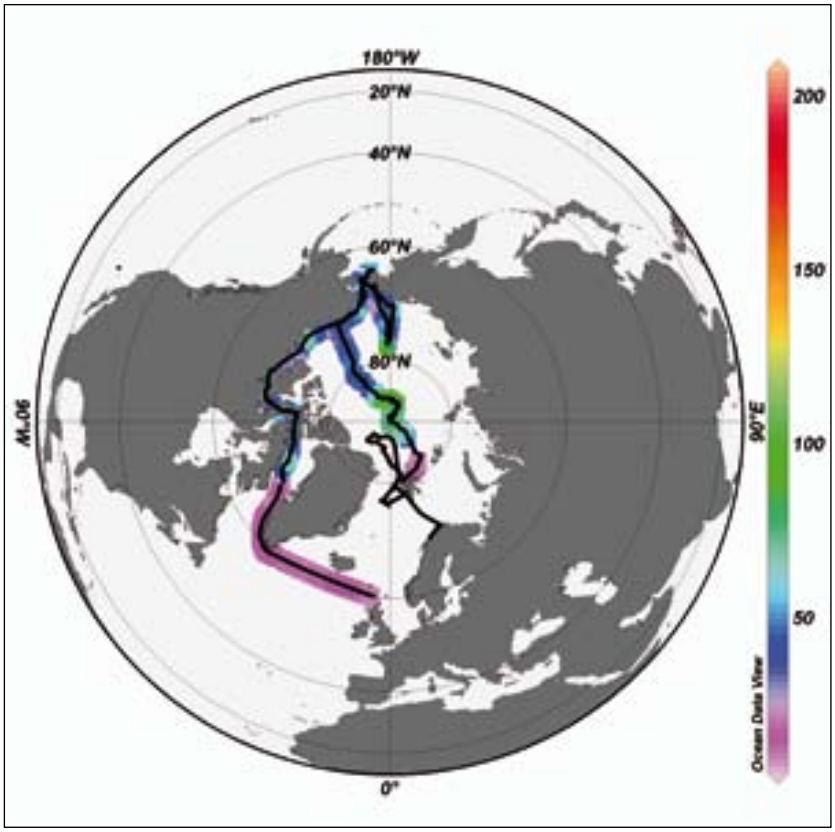

Figure 2
Continuous measurements of total gaseous mercury in air (black line) and dissolved gaseous mercury in surface water (line in colours) during the expeditions Beringia 2005 and LOMROG 2007. Schlitzer, R., Ocean Data View, http://odv.awi-bremer-haven.de, 2004.

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LOMROG: Ackumulationen av kvicksilver i Arktiska oceanen

Som en följd av förbränning av kol och olja i världen sprids kvicksilver genom luften och årligen deponeras 100-tals ton av metallen i Arktis. Organiskt kvicksilver, som kan bildas efter deposition av luftburet kvicksilver, är mycket giftigt och bioackumuleras i fisk och däggdjur. Under de två expeditionerna Beringia 2005 och LOMROG 2007 har vi gjort mätningar på luft, vatten, snö och is som syftar till att uppskatta ackumulationen av kvicksilver i Arktis. Våra mätningar visar att halterna av vissa former av kvicksilver i Arktiska oceanen är kraftigt förhöjda jämfört med andra havsområden. Halten av löst gasformigt kvicksilver i ytvatten är t.ex. upp till 10 gånger så höga i den Arktiska bassängen som i norra Atlanten.

Lomonosov Ridge off Greenland (LOMROG) 2007: Coring and high-resolution geophysical mapping

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Introduction and background

The Arctic Ocean north of Greenland is virtually unexplored due to predominantly heavy sea ice conditions that have made the area by and large inaccessible. Icebreakers have previously never attempted to reach the southern tip of the submarine Lomonosov Ridge that extends towards the northern Greenland continental margin. Among the scientific ice drift stations, only the GreenICE camp in 2004 has investigated a fragment of the southwesternmost part of the ridge (Kristoffersen and Mikkelsen 2006). This ice-infested area of the Arctic Ocean was the focus for the Lomonosov Ridge off Greenland (LOMROG) 2007 expedition as it is probable that it holds answers to key questions regarding ocean circulation and glacial history, such as the question whether immense Antarctic style ice shelves existed in the Arctic Ocean during past glacial periods. Previous expeditions to the Lomonosov Ridge with Swedish icebreaker *Oden* in 1996 and the US nuclear submarine *Hawkbill* in 1999 demonstrated the occurrence of glacial ice grounding down to 1 000 m present water depth at about 87°N (Siberian side) on the ridge crest (Jakobsson 1999, Polyak et al. 2001). If this ice grounding event resulted from a much debated (e.g. Mercer 1970), but supposedly coherent and large floating ice shelf, the Lomonosov Ridge north of Greenland should also be scoured. To test the hypothesis of a huge Arctic Ocean ice shelf, LOMROG mapped the Lomonosov Ridge and Morris Jesup Rise north of Greenland as well as the Yermak Plateau north of Svalbard using the new multibeam bathymetric sonar and chirp subbottom profiling system installed on the Oden during the spring of 2007 (Fig. 1). In addition, sediment cores were taken from the surveyed areas for palaeoceanographic studies, and sediment samples were collected from "dirty" patches of drifting ice floes for modern provenance studies. With this material, the history of the Arctic Ocean circulation and sea ice cover will be addressed, such scientific questions being of particular relevance in the context of the present trend of diminishing Arctic Ocean sea ice cover, where September in the year of 2007 showed the aerially smallest extent ever measured over the last 28 years (National Snow and Ice data Center: http://nsidc.org).

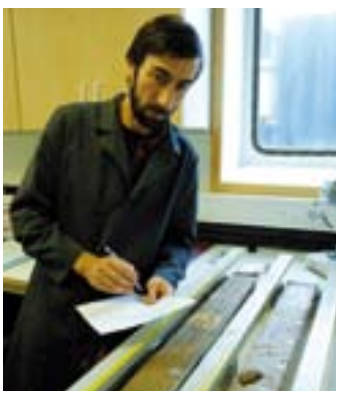
However, it should be noted that in the LOMROG operating area north of Greenland severe sea ice conditions were encountered with 10/10 ice cover and sometimes ~4 m thick multiyear floes.

The second major component of the LOMROG expedition consisted of the Danish Continental Shelf Project (Marcussen et al. this volume). This project collected seismic reflection profiles and bathymetry in order to acquire the base data needed to eventually put forward an Article 76 of United Nations Convention of the Law of the Sea (UNCLOS) claim for a new legal definition of Denmark's continental margin north of Greenland. Furthermore, LOMROG included a number of scientific subprojects. These comprised studies of the return flow of Atlantic water and deep water exchange between the Eurasian and Amerasian Arctic Ocean basins (Anderson et al. this volume), the role of sea ice in the transport of CO_2 from the atmosphere to the ocean (Rysgaard et al. this volume), distribution of mercury in the atmosphere and ocean (Gårdfeldt et al. this volume), and the Arctic Ocean gravity field (Marcussen et al. this volume).

The LOMROG expedition constitutes a project in the Arctic Palaeoclimate and its Extremes (APEX) research network programme

Figure 1
Overview of the coring operations on the Oden's aft deck. The up to 12 m long and 1.5-ton heavy piston corer was launched using a cradle gliding on a rail mounted on the aft deck. This new launching system was installed just prior to the expedition in Landskrona while Oden was in dry dock. It proved to be excellent and significantly reduced the coring station times compared to previous expeditions. Photo: Martin Jakobsson.

Figure 2
Leonid Polyak describing a section of a sediment core. Photo: Martin Jakobsson.



endorsed by the International Arctic Science Committee (IASC) and the ICSU/WMO Joint Committee for the International Polar Year 2007–2008 (IPY).

LOMROG ship based work and preliminary results

Despite severe sea ice conditions Oden, supported by the newest Russian nuclear icebreaker 50 let Pobedy, managed to reach the previously unexplored southernmost tip of the Lomonosov Ridge north of Greenland to conduct scientific work (See map p. 126 and Fig. 1). Large pressure ridges and thick multiyear sea ice prevented mapping with the multibeam and subbottom profiler along straight predefined tracks. The surveys were instead dictated by the few existing crack systems in the sea ice and openings in the large pressure ridges that allowed 50 let Pobedy and Oden to break through. Another problem for the acoustic mapping was the crushed ice in the wake of 50 let Podedy, which reduced the data quality significantly, in addition to the noise from the icebreaking. This ice slush was pressed underneath the hull of Oden and occasionally completely covered the hull-mounted multibeam and subbottom acoustic transducers. However, even though LOMROG faced certain difficulties in the sea ice over the Lomonosov Ridge, valuable geophysical data were collected. In addition, six sediment cores were retrieved from this area, both from the shallow ridge crest and the slope towards Amundsen Basin (see map p. 126). Preliminary analysis of the multibeam and subbottom data show glacial erosion at water depths shallower than approximately 800 m on the Lomonosov Ridge and the sediment cores retrieved from the glacially scoured sea floor contained diamicton. A first hand analysis seems to support the hypothesis of glacial ice grounding on the shallow ridge crest.

The Lomonosov Ridge programme was shortened due to damage of 50 let Pobedy's propeller blade in the hard ice conditions. The next target for LOMROG was the Morris Jesup Rise where Oden had to operate without support from the Russian nuclear icebreaker. The sea ice cover was here 10/10 as in the Lomonosov Ridge area, although large pressure ridges were less abundant. A completely new multibeam survey technique was invented that proved very successful in extreme ice conditions. This technique, named "pirouette surveying", involved Oden stopping and turning around in a half circle while acquiring multibeam data whenever an open to semi-open lead in the pack ice was encountered (Fig. 4). The idea was to cover a 360° sector around the ship equal to the multibeam swath width, which was commonly between 3–4 times the water depths, although sometimes we achieved a swath up to 5 times the water depth. Occasionally the ship was rotated 360° to increase the resolution of the mapped area underneath the ship. After one "pirouette" was completed, Oden broke ice using its full capacity to the end of the multibeam swath coverage, where a new pirouette was carried out. The Morris Jesup Rise's northern slope and shallow crest was successfully mapped using this technique. The data reveal large iceberg scours down to a water depth of approximately 1 050 m, so far the largest and deepest iceberg scours mapped in the Arctic Ocean (Fig. 2). The coring programme on the Morris Jesup Rise targeted undisturbed sediment sections for palaeoceanographic studies as well as the largest ice scour ever mapped. The purpose of coring the ice

Figure 3
The new Russian nuclear icebreaker 50 let Podedy supporting Oden in the areas of the Arctic Ocean north of Greenland. Photo: Martin Jakobsson.

scour was to investigate the age of the ice-grounding event that caused it. This can be achieved by dating the sediments that accumulated since the scouring event. The newly installed chirp sonar profiler provided the critical data in order to precisely locate optimal coring sites. Altogether, four cores were retrieved from the Morris Jesup Rise. All sediment cores were directly logged on board Oden with a Multi Sensor Track Core Logger (MSCL) measuring sediment bulk density, p-wave velocity and magnetic susceptibility. After core logging, the cores were split and described.

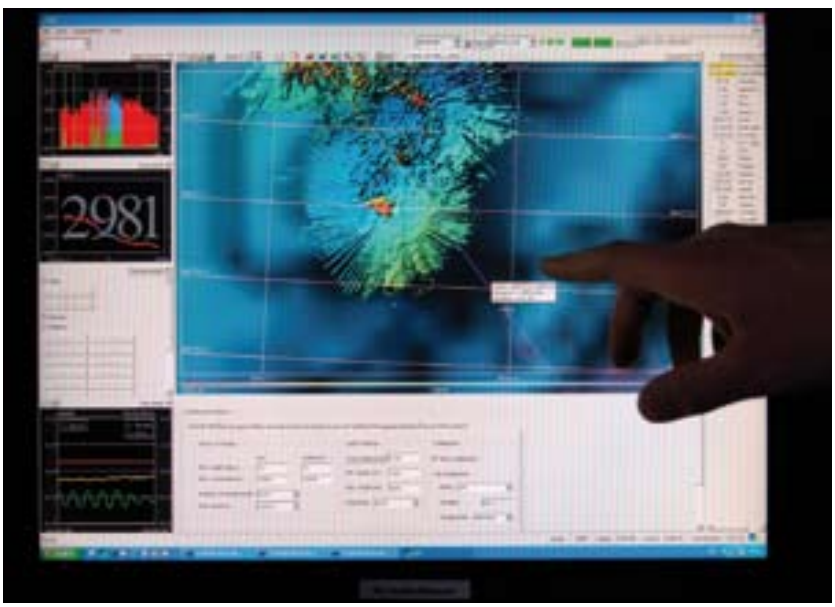
After completion of the scientific programme on the Morris Jesup Rise, an oceanographic section across the western Fram Strait was conducted. Conductivity Temperature Depth (CTD) measurements and water sampling were carried out along this section at regularly spaced stations (see map p. 126 and Anderson et al. this volume). The marine geological/geophysical programme was working in close cooperation with the oceanographic component, for example, the CTD data are used to calculate sound speed profiles of the water column that, in turn, are used to calibrate the multibeam sonar in order to get "true" depths of the sea floor.

In 2005, the US icebreaker Healy crossed the Yermak Plateau during the Healy-Oden Trans Arctic Expedition (HOTRAX) and the Beringia expedition and mapped portions of the shallow crest with their Seabeam 2112 multibeam sonar (Darby et al. 2005, Jakobsson et al. 2005). On the way to the next LOMROG major survey area, the East Greenland Ridge, Oden's route was carefully offset to the Healy 2005 track on the Yermak Plateau in order to extend the previous multibeam survey. The new geophysical mapping data collected with Oden's EM120 multibeam and SBP120 chirp sonar profiler revealed details that were previously not seen and further analysis may elucidate the behaviour of the Barents and Kara Sea ice sheet during previous glaciations.

The last area to be surveyed during the LOMROG expedition was the East Greenland Ridge (see map p. 126) where a large part of the geophysical survey was carried out in open sea with only some occasional scattered ice floes. Only in the western part of the surveyed area close to the shelf break, was ice-breaking required in 7 to 9/10 sea ice cover. The East Greenland Ridge survey was entirely a part of the Danish Continental Shelf Project and consequently those results are further reported by Marcussen et al. (this volume).

The LOMROG expedition, which started 11 August in Tromsö, Norway, was completed on 16 September in Longyearbyen, Svalbard. The multibeam sonar and subbottom profiler were operated continuously along the

Figure 4
Photo showing the data acquisition window of Oden's EM120 multibeam system. The example shows how bathymetric data was collected in a 360° sector around the ship, referred to as "pirouette surveying" (see text for explanation). This way of carrying out multibeam mapping worked well in hard ice conditions where the heavy ice breaking otherwise significantly disturbed the data acquisition. Photo: Martin Jakobsson.



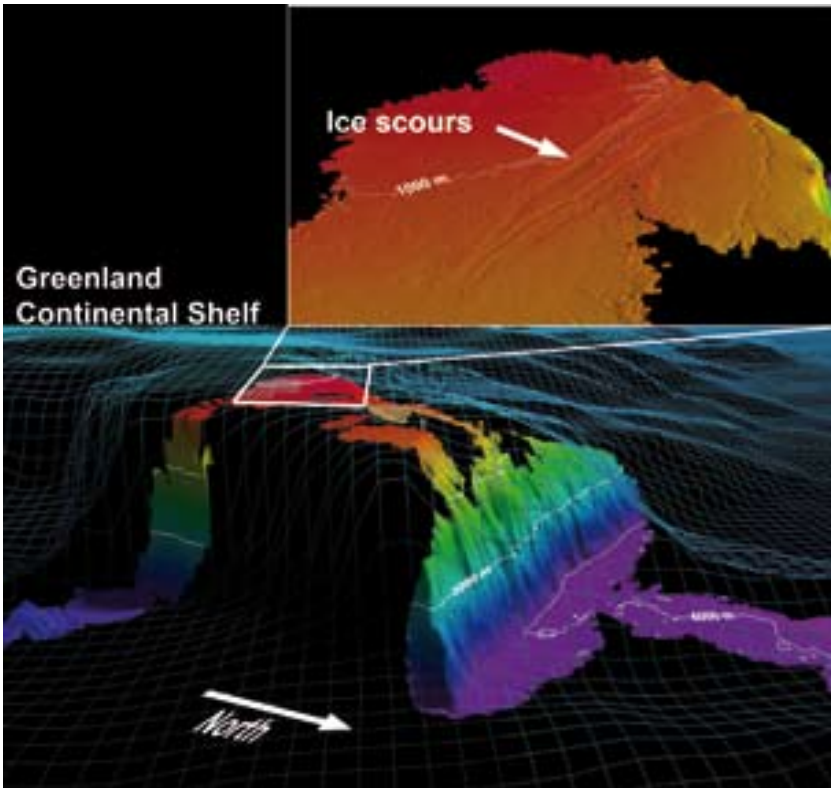


Figure 5
3D-view of the multibeam mapped Morris Jesup Rise (see Fig. 1 for general location). The International Bathymetric Chart of the Arctic Ocean (IBCAO) grid model is shown (blue grid) as a comparison to the new detailed multibeam bathymetry.

approximately 6 900 km long expedition track. Two multibeam operators were always on watch 24 hours 7 days a week and the Swedish and Danish teams collaborated by assigning personnel to this task from both groups. The data quality vary largely with the sea ice conditions; although we learned that high quality data can be collected even during the hardest possible conditions using the "pirouette technique". LOMROG was the first icebreaker expedition to reach the southern Lomonosov Ridge north of Greenland.

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LOMROG: Sedimentprovtagning och högupplöst geofysisk kartering

Norr om Grönland ligger Arktiska oceanens mest svårtillgängliga område. Havsisen är här mer kompakt än i de centrala delarna och stora tryckryggar tornar upp sig i islandskapet. Inget ytgående fartyg har tidigare opererat i området där den submarina Lomonosovryggens sydligaste del sträcker sig mot den Grönländska kontinentalshelfen. Detta område var målet för expeditionen Lomonosov Ridge off Greenland (LOMROG). Med hjälp av den nya ryska isbrytaren 50 let Pobedy (50 år av seger) nådde Oden Lomonosovryggens sydligaste spets som första ytgående fartyg. Syftet var att med hjälp av Oden's nya multibeam- och sedimentekolod samt sedimentprovtagning undersöka Arktiska oceanens glaciations- och cirkulationshistoria. Bakgrunden är att tidigare fragmentariska data – insamlat från området av ubåtar och isdriftstationer – pekar på att ryggen här når grundare än tusen meter, och att dess form påminner om de centrala delarna av ryggen där spår av glacial iserosion hittats ända ned till 1 000 meters vattendjup. Detta gör området mycket intressant för frågeställningen om det någon gång under tidigare istider funnits nära 1km tjocka shelfisar i den Arktiska oceanen. De nya LOMROG-mätningarna påvisade glacialerosion ner till omkring 800 m på Lomonosovryggen norr om Grönland. Multibeam och sedimentekolodning genomfördes också på Morris Jesup-platån, som skjuter ut från den grönländska kontinentalsockeln. Här upptäcktes isbergsspår ner till mer än 1 000 m vattendjup vilket är djupare än vad som tidigare uppmätts i centrala Arktiska oceanen.

Lomonosov Ridge off Greenland (LOMROG) 2007: Danish Continental Shelf Project

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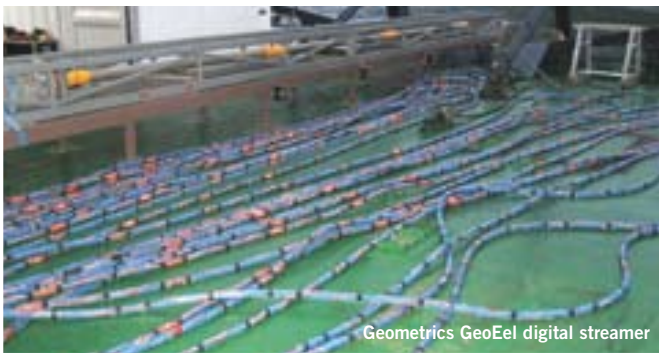
Introduction and background

The area north of Greenland is one of three potential areas off Greenland for extension of the continental shelf beyond 200 nautical miles according to the United Nations Convention on the Law of the Sea (UNCLOS), article 76 (Marcussen et al. 2004). The technical data needed for a submission to the Commission on the Limits of the Continental Shelf (CLCS) include geodetic, bathymetric, geophysical and geological data. Acquisition of the necessary data poses substantial logistical problems due to the ice conditions in the area north of Greenland.

As the Danish part of the LOMROG expedition was the first Danish ship borne activity in the Arctic Ocean ever, one of the main goals of the expedition was to test the data acquisition concepts and especially the new reflection seismic equipment on board Oden under severe ice conditions (10/10 of several meters thick multi-year sea ice under compression). It was furthermore planned to acquire as much bathymetric data as possible to support the delineation of the foot of the continental slope, to map the sediment thickness in the Amundsen Basin and to investigate the bathymetric trough between the Lomonosov Ridge and the Canada/Greenland shelf. The Canadian Continental Shelf project participated with a small bathymetric programme planned in Canadian waters. Finally, acquisition of gravity data was planned to support the mapping of the sediment thickness.

The Danish Continental Shelf Project (www.a76.dk) funded half of the costs for Oden and the full costs for the Russian nuclear icebreaker 50 let Pobedy.


Sercel 605 cu in. linear air gun cluster


Geometrics GeoEel digital streamer


Winch container


Inside view of recording container

Figure 1
Seismic equipment used during the LOMROG cruise. Photos: Thomas Vangkilde-Pedersen.

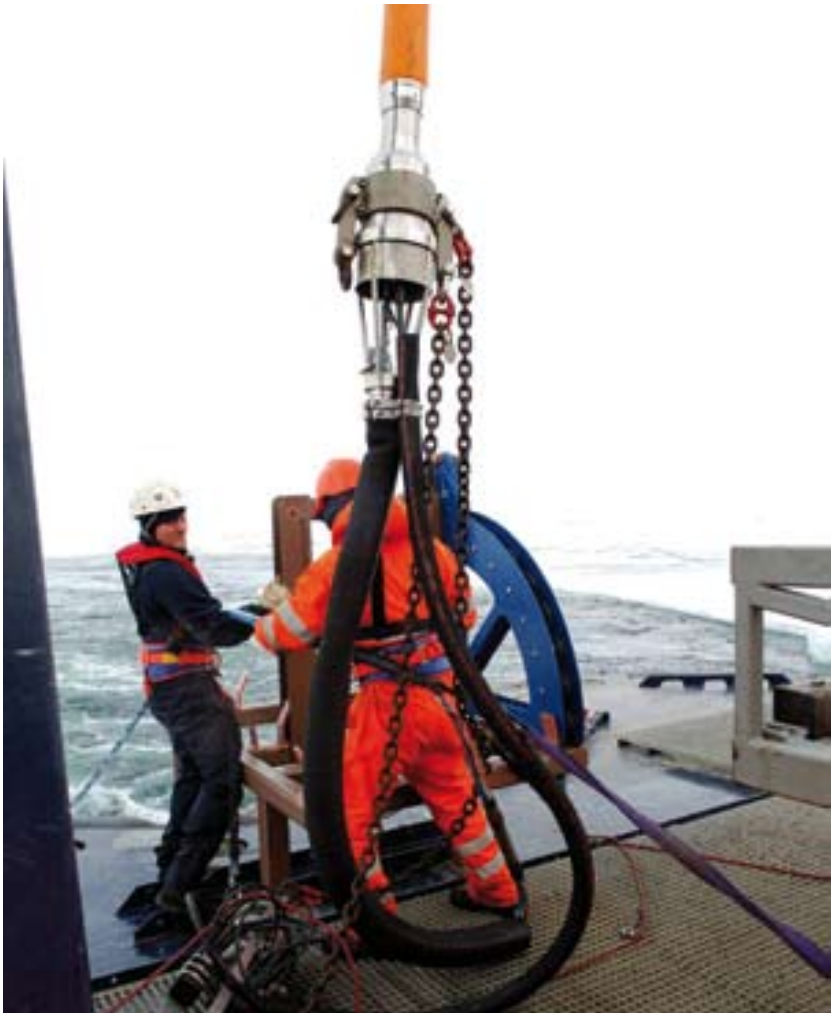


Figure 2
Launching of the seismic equipment: Airgun cluster lower left and umbilical head above the two participants. Photo: Trine Dahl-Jensen.

Table 1	Summary of acquisition parameters
Source	**2 Sercel G and 1 Sercel GI gun**
Chamber volume	605 cu inch (250 + 250 + 105)
Pressure	200 bar (3000 psi)
Mechanical delay	16 ms
Nominal tow depth	20 m
Streamer	**Geometrics GeoEel**
Length of tow cable	43 m
Length of stretch section	50 m
No. of active sections	6 / 5 / 4 / 3
Length of active sections	300 / 250 / 200 / 150 m
No. of groups in each section	8
Total no. of groups	48 / 40 / 32 / 24
Group interval	6.25 m
No. of hydrophones in each group	8
Depth sensor	In each section
Nominal tow depth	20 m
Acquisition system	**Geometrics GeoEel controller**
Sample rate	1 ms
Low-cut filter	Out
High-cut filter	Anti-alias (=500 Hz)
Gain setting	6 dB
No. of recording channels	48 / 40 / 32 / 24
No. of auxiliary channels	4
Shot spacing	25 m
Record length	Variable between 8.5 and 11 s

Seismic data acquisition

The seismic reflection equipment used during the LOMROG cruise has been developed in co-operation with the Department of Earth Science, University of Aarhus, and is based on the experience gained by various people who have acquired reflection seismic data in the Arctic Ocean from icebreakers since 1991 (especially Yngve Kristoffersen, Art Grantz and Wilfried Jokat).

The crucial issue of seismic data acquisition in ice covered waters is to protect the seismic equipment from being damaged by sea ice while simultaneously acquiring useful data in this very noisy environment. It was therefore decided to tow both airgun and streamer at a suitable depth (approximately 20 meters below water surface), to ensure that the equipment would stay clear from the propeller wash behind the ship. However, at such a large source depth the surface ghost reflections will cause undesirable notches in the source spectrum at 30 Hz and 60 Hz.

The seismic equipment is fully containerized and consists of a winch container with three winches, a compressor container, a recording container and a storage container. A heavy duty umbilical both feeds the airguns with compressed air and connects with the seismic streamer. For smooth launch and retrieval of the equipment the winches and Oden's A-frame were used. Acquisition parameters are summarized in Table 1.

Due to the short length of the seismic streamer, velocity information from the sedimentary units is very limited. However, sediment velocities are important for the documentation of the sediment thickness of the extended continental shelf, if the 1%-sediment-thickness formula (Gardiner line) has to be applied. Therefore, sonobuoys were deployed along the seismic lines to record the seismic signals at larger offsets.

On-board processing (using ProMax software) concentrated on the evaluation of data quality, noise reduction and acquisition parameters. It showed that the noise level after processing is acceptable considering the conditions under which the data were acquired. Analysis of subsets of the seismic data indicated that a streamer with four sections instead of six sections would provide record sections with only slightly reduced data quality.

Seismic data acquisition started in the Amundsen Basin, where an approximately

130 km long profile was acquired over the course of two days. A brute stack section from onboard data processing is shown in Figure 3 (see map p. 126 for location). At the southern part of the Lomonosov Ridge area only 15 km of seismic data were acquired due to severe ice conditions. The most vulnerable part of the seismic equipment is the streamer and due to the ice conditions parts of the streamer were lost on two occasions. Finally a 165 km long seismic line supplemented by seven sonobuoys was acquired in the area where the East Greenland Ridge abuts on the North East Greenland shelf.

Bathymetric data acquisition

During LOMROG, bathymetric data were recorded continuously along the ship's passage. The areas of specific bathymetric interest to the Danish Continental Shelf Project were:

a) the Amundsen Basin,
b) the slope of the Lomonosov Ridge, where the exact location of the foot of the continental slope was identified,
c) the crest of the Lomonosov Ridge, where the general outline of the Lomonosov Ridge was mapped and verified,
d) the zone where the Greenland shelf and the Lomonosov Ridge connect, for which very few bathymetric data exist,
e) the Morris Jesup Rise, where the precise location of the foot of the slope was mapped,
f) and finally, the East Greenland Ridge, where a high-resolution full-coverage multibeam survey was carried out in order to reveal the morphological features of the shelf-ridge complex.

Data quality was very dependent on the ice conditions. At the Lomonosov Ridge, where the ice thickness was up to 4 m with abundant pressure ridges, it was impossible to acquire data during ice-breaking and hence, alternative hydrographical surveying methods had to be employed (e.g. the "pirouette method", see Jakobsson et al. this volume). These methods are, however, more time consuming.

The East Greenland Ridge survey area was partly in open water and partly covered by polar drift ice. The data coverage was almost 100% in all areas including the outer shelf, the slope, the abyssal plain and the central part of the East Greenland Ridge. Five lines extending from the upper shelf break and across the ridge were surveyed with the multibeam echo sounder. Figure 5 shows a bathymetric map that was compiled from portions of two of the surveyed multibeam lines. The multibeam data from the East Greenland Ridge reveal important details of significant value for the interpretation of the area and for planning of additional work.

Gravimetric data acquisition

Gravity measurements were carried out with a marine gravimeter of type Ultrasys Lacoste and Romberg (Serial no. S-38). The gravimeter was

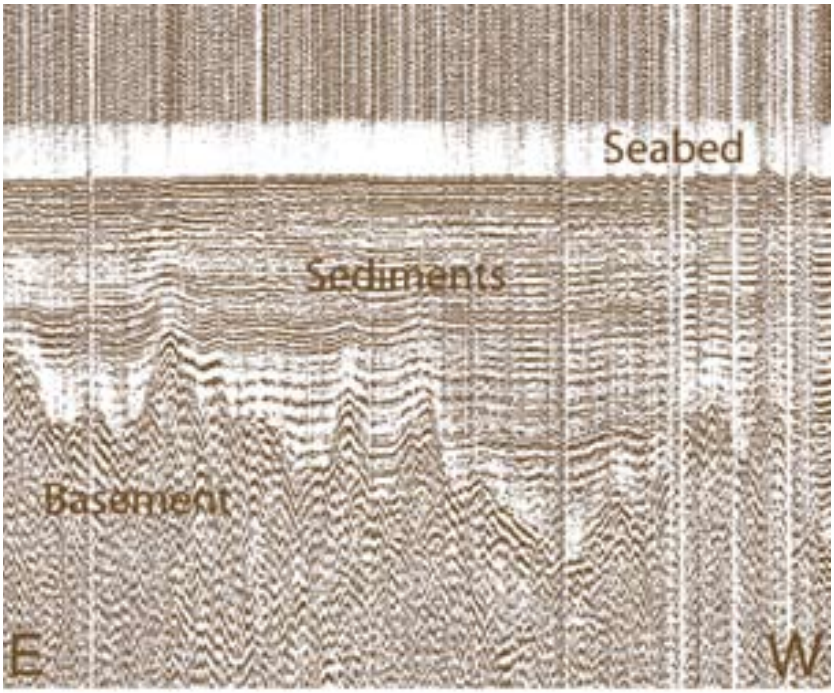


Figure 3
Part of seismic line acquired in the Amundsen Basin (water depth approximately 4 000 m).

Figure 4
Left: 50 let Pobedy under way alongside Oden to break the ice.
Right: 50 let Pobedy reversing to "pick up" Oden.
These operations occurred often during seismic data acquisition due to the severe ice conditions in the area of investigation.
Photos: Thomas Vangkilde-Pedersen.

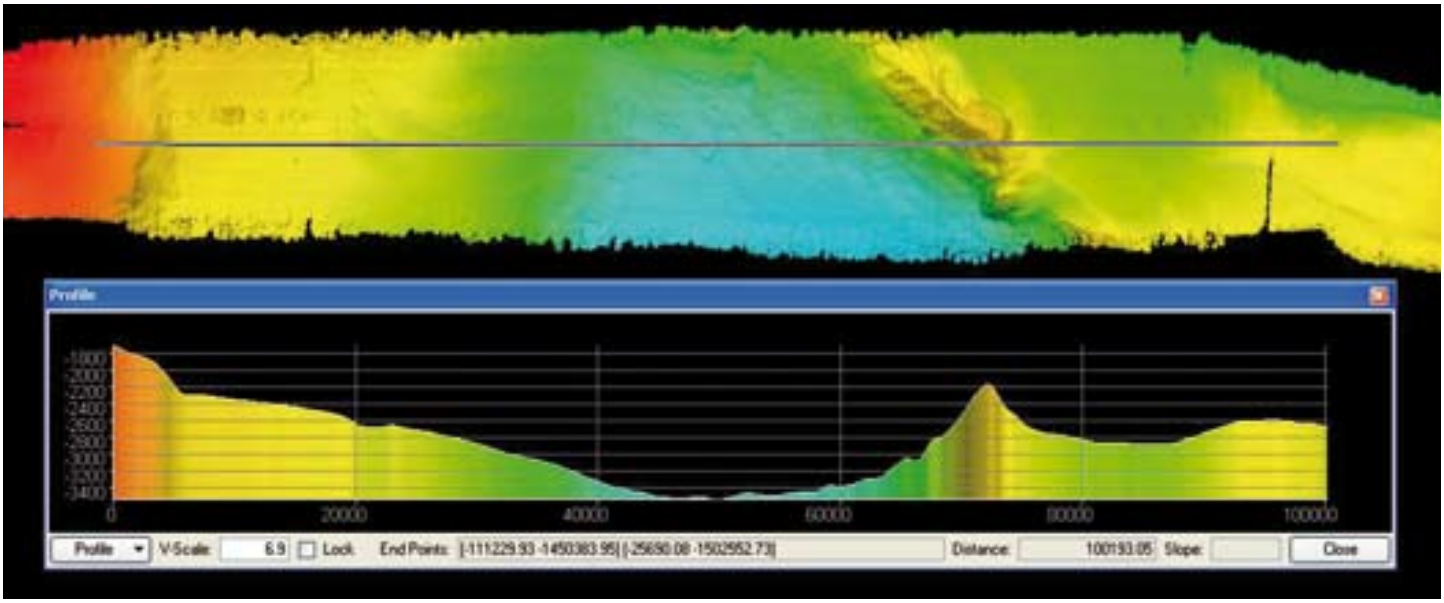


Figure 5
Top: Part of the bathymetric grid in the East Greenland Ridge area based on two of the surveyed multibeam lines. Bottom: Bathymetric profile – units in meters.

Figure 6
Marine gravimeter mounted in the engine room on board Oden. Photo: Rene Forsberg.

mounted in the engine room close to the centre of mass of Oden (Fig. 6). The system records data every 10 sec, which after processing and reference measurements in the harbours of Tromsø and Svalbard yield gravity values at an accuracy of approximately 1 mgal and 2–500 m resolution, depending on the speed of Oden and ice conditions.

As a complement to the marine gravity data, the ship's helicopter was used to make measurements with land gravimeters along profiles across the flanks of the Lomonosov Ridge and the Morris Jesup Rise (Fig. 7).

Gravimeter data collected on Oden were processed using the DNSC marine software "eotvos", that incorporates Eötvös corrections from the ship's GPS navigation (logged at 5 s intervals), outlier and spike detection, and a zero-phase filtering scheme. Some minor data gaps occurred for a short period of time due to some serial communications problems. However, most gaps were sufficiently short (a few minutes) to allow interpolation.

Oden provided an excellent platform for marine gravity measurements, and measurements in the ice were superior to data from many other icebreakers or even submarines, in spite of the irregular navigation with frequent course and speed changes. The Ultrasys Lacoste Romberg gravimeter employed proved stable and reliable with only a small drift and the gravimetric data collected will be useful both in connection with the Danish UNCLOS project, as well as an important new data contribution to the Arctic Gravity Project (http://earth-info.nga.mil/GandG/wgs84/agp/hist_agp.html).

The helicopter measurements were swift and efficient, but limited by the range of the helicopter and by the weather (frequent white-out conditions). However, with a functioning echo sounder and an increased operation range, this could be an efficient way to collect relevant additional geophysical data on future cruises.

Other activities

A research project with the aim of investigating and quantifying the importance of sea ice in transporting carbon dioxide from the atmosphere to the ocean in areas with different types of sea ice has been associated with the Danish part of the LOMROG cruise (see Rysgaard et al. this volume for details). Furthermore a Danish film crew (Suvi Helminen and Kenneth Sorento) from STV Nature and Science was stationed on board Oden during the LOMROG cruise to document the project and the cruise.

Conclusion

The LOMROG cruise demonstrated that acquisition of bathymetric and seismic data of sufficient quality for substantiating a claim according to article 76 of UNCLOS by a two ship operation is possible under the severe ice conditions that prevail in the area north of Greenland, and data acquisition would not have been feasible without the competent support from the Russian nuclear icebreaker 50 let Pobedy.

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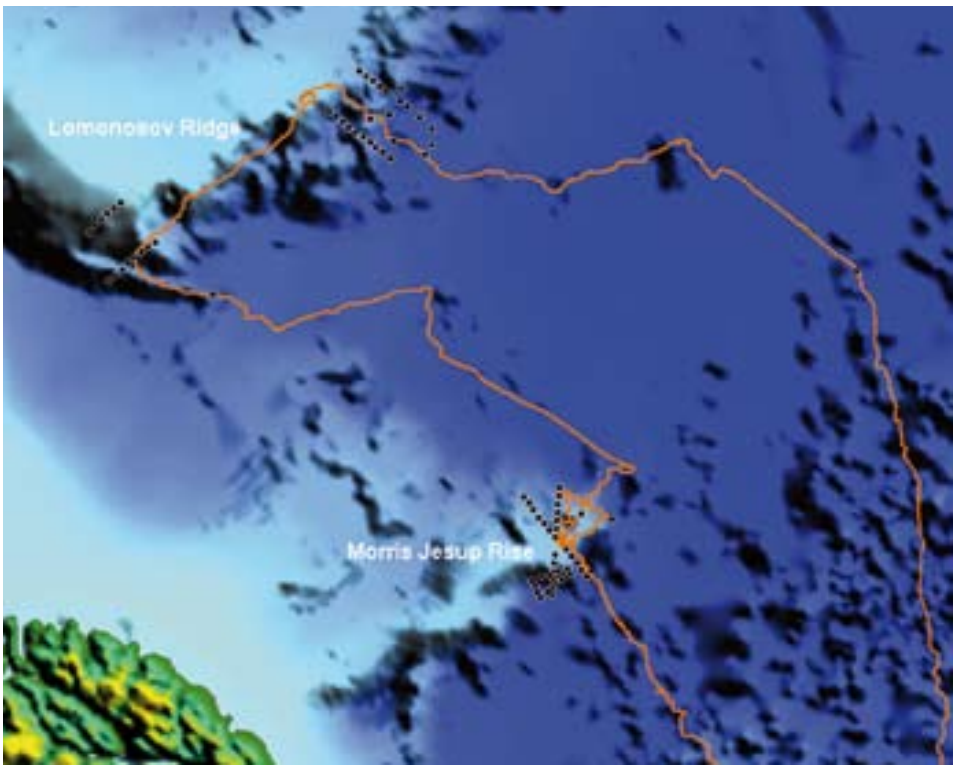

Figure 7
Location of the off-ship helicopter gravity profiles. Greenland at lower left.

LOMROG: Det danska Kontinentalsockelprojektet

Den danska delen av expeditionen LOMROG var ett led i Kontinentalsockelprojektet, som har till uppgift att ta fram det tekniska underlaget för en eventuell utvidgning av det danska territoriella kontinentalsockelområdet norr om Grönland, utöver de 200 sjömil som man idag gör anspråk på i enlighet med FN:s Havsrättskonvention.

Isförhållandena i undersökningsområdet hör till de svåraste i den Arktiska oceanen och utgör en stor utmaning för datainsamlingen. Syftet med LOMROG var således att testa datainsamlingskonceptet under dessa svåra isförhållanden och speciellt den nyutvecklade seismiska utrustningen.

Under LOMROG expeditionen insamlades följande data:

- Batymetriska data i Amundsenbassängen och upp på Lomonosovryggen, en batymetrisk kartläggning av yttersta spetsen på Morris Jesup-platån samt en kartläggning av det område där Östgrönlandsryggen möter den östgrönländska shelfen. Insamling av multibeamdata och subbottomprofiler har skett i tätt samarbete med de svenska forskningsgrupperna.
- Seismiska data längs en ca. 130 km lång profil i Amundsenbassängen, en 15 km lång profil på sydspetsen av Lomonosovryggen samt en 165 km lång profil vid Östgrönlandsryggen.
- Under hela expeditionen samlades kontinuerligt gravimetriska data samt gravimetriska punktdata med hjälp av Odens helikopter.

LOMROG-expeditionen har visat att insamling av batymetriska och seismiska data som kan användas i det danska Kontinentalsockelprojektet är möjligt trots de svåra isförhållanden som råder i området norr om Grönland. Datainsamlingen skulle dock inte ha varit möjligt utan den mycket kompetenta hjälpen från den ryska isbrytaren 50 let Pobedy.

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Lomonosov Ridge off Greenland (LOMROG) 2007: Sea ice and climate

The Arctic Ocean plays a critical part in global oceanic circulation, in that it modulates the formation of deep water in the North Atlantic via ice formation. The extent of Arctic sea ice undergoes seasonal changes with an average maximum of 15 × 106 km² and an average minimum of 8 × 106 km² (Gloersen and Campbell 1991). Due to warming of the world oceans (Levitus et al. 2000) the sea ice cover in the Arctic has decreased by ~10% in extent since the 1970s (Johannessen et al. 1999). Climate change due to the anthropogenic greenhouse emission is expected to be significant and relatively large in the Arctic region compared to other areas in the world and the consensus view is that within 70 years, the average annual temperature of the Arctic is predicted to increase by at least 4°C and in some places by more than 8°C. This increase implies that the sea ice thickness and distribution in the Arctic will decrease markedly and thus alter the heat and mass exchange as well as ocean stratification in the future and hence, research in sea ice areas is urgently needed in order to obtain a basic understanding of the processes and organisms being affected by the expected dramatic alterations in sea ice distribution.

Figure 1
Drilling ice cores with Kovacs drill at 85°N. Photo: Hans Ramløv.

Deep-water formation in the Arctic Ocean and the Greenland Sea contributes to the overflow water in the Denmark Strait and the Faroe Bank Channel (Buch et al. 1996, Hansen et al. 2001), which constitutes the origin of the North Atlantic Deep Water (Reid and Lynn 1971). In addition, high-latitude areas act as a sink for atmospheric CO_2 and thereby represent a direct pathway for CO_2 exchange between the atmosphere and the deep ocean (Takahashi et al. 2002). The difference between pCO_2 in surface water and the overlying air represents the thermodynamic driving potential for air-sea CO_2 gas exchange, which influences the surface concentrations of dissolved inorganic carbon (DIC). Surface-water pCO_2 levels are regulated by temperature, salinity and DIC and total alkalinity (TA) concentrations. DIC and TA have hitherto been considered to be controlled primarily by biological processes (i.e. photosynthesis, respiration and calcification), upwelling of subsurface water enriched in respired CO_2 and nutrients, and air–sea exchange (Takahashi et al. 2002). However, our recent work suggests that besides oxygen, DIC is also rejected from growing sea ice together with brine (Glud et al. 2002, Rysgaard et al. 2007). In addition, we have observed very low DIC and TA concentrations in Arctic first-year and multi-year sea ice as well as significant fractionation of DIC and TA compared to surface-water conditions (Rysgaard et al. 2007). Downward rejection of CO_2 from growing sea ice together with brine has not been considered previously, and nor has the resulting atmosphere-ice-ocean exchange of carbon resulting from this sea-ice driven DIC pump been quantified. Our first preliminary model calculations show that this DIC pump affects the surface-water pCO_2 significantly

in the polar seas and potentially sequesters large amounts of CO_2 in the deep ocean. Brine-mediated DIC transport into the deep ocean may be significant in the global carbon cycle, and variations in sea ice formation under past climatic conditions might help explain variations in atmospheric CO_2 levels.

A number of studies have revealed that ice algae can modify their environment in the sea ice so that they are able to exploit the interior of the sea ice as a habitat. The modifications are presumed to be mediated by the algae synthesizing ice active substances that at least can inhibit the growth of the ice surrounding the algae, but which possibly also widen the spaces by a non-colligative melting of the ice surface around the algae. The substances synthesized by the ice algae have several properties in common with the so called "antifreeze proteins" that are synthesized by a number of cold tolerant ectothermic animals. These proteins can recognize ice surfaces and bind to them, and are thereby able to inhibit the growth of ice crystal. To understand the total CO_2 budget of the sea ice, investigations of these ice associated algae and their physiology is needed. Likewise, future decrease in global sea ice cover may reduce the world oceans' capacity for taking up atmospheric CO_2. Assessing changes in future sea ice conditions as projected by climate models will allow for a more quantitative analysis of this hypothesis. Thus, more research on this process is urgently needed.

Aim

The aim is to investigate and quantify the importance of sea ice in transporting carbon dioxide from the atmosphere to the ocean in areas with different types of sea ice. Furthermore, our recent discoveries of anoxic conditions and bacterial denitrification/anammox activity in sea ice show that sea ice may play an important role in the removal of nitrogen. More investigations from multi-year sea ice are, however, needed to increase our understanding of its significance in the Arctic and its role in the global nitrogen cycle. Furthermore, sea ice formation may play a far more important role in transporting carbon dioxide (CO_2) from the atmosphere to the ocean than previously assumed. Our preliminary studies on first-year sea ice from northeast Greenland and northern Canada have indicated that ice growth during winter rejects large amounts of CO_2, which sink together with dense brine to intermediate and deep water layers. Subsequent sea ice melt during summer enhances the uptake of CO_2 from the atmosphere, as the resulting meltwater is undersaturated with respect to CO_2. As the transport mechanism is dependent on sea ice formation, future decrease in global sea ice cover may reduce the oceanic capacity for taking up atmospheric CO_2.

During the LOMROG expedition, sea ice samples were acquired by drilling ice cores along the expedition path with the aim of measuring the total concentration of inorganic dissolved carbon (TIC or TCO_2) and total alkalinity (TA). In addition to the physical and chemical measurements of the sea ice, the occurrence of algae in the ice was also investigated. The reason for this is that the role of the algae, concerning the chemical conditions in the context of the CO_2 in the ice, is not well known. Thus it is of importance to investigate the algae and their physiology. Ice algae synthesize some substances that can modify the ice surface and optimise the environment in the ice in which the algae are found. It is therefore also one of the aims of the present study to investigate the algae and the synthesized substances.

Methods

Ice coring

Different types of sea ice were collected using a 7 cm KOVACS ice core drill fitted with a battery driven hand drill. 10 cm pieces from the top, middle and bottom of the ice core were cut out and transferred to plastic containers. Before collecting the 10 cm pieces the temperature along the core was measured at 10 cm intervals.

Physical measurements

The physical parameters air temperature, snow depth, snow temperature (5 cm intervals), ice surface temperature, ice density and total ice salinity (melted ice core) were measured at each drill hole and ice core piece.

Density of the core pieces was determined from top, middle and bottom, where possible, by measuring and weighing the core piece.

Preparation of ice cores for measurements of TCO_2, total alkalinity (TA), salinity and chlorophyll a

The collected core pieces were taken to the laboratory and cleaved. One half was transferred to a gas proof plastic bag (Würgler bag (Würgler Hansen et al. 2000)) and sealed. The ice was melted in the bag and the melt water

Figure 2
Taking ice core samples for the measurement of CO_2 and alkalinity in the sea ice at 85°N. Photo: Hans Ramløv.

transferred to gas tight containers, preserved with $HgCl_2$ and then brought to the laboratory in Nuuk (Greenland) where the final measurements are to be done.

The other half was melted; some melt water was transferred to a plastic vial for the measure-ment of salinity and the rest was filtered through a glass filter and the filter was thereafter frozen for the later determination of the chlorophyll *a* content of the filtrate (i.e. the ice). In addition to the ice cores, water samples from 10 m depth were acquired from the CTD that was operated by one of the Swedish groups participating on the expedition (see Andersson and Björk in this volume).

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LOMROG: Havsisen och klimatet

Den Arktiska oceanen spelar en viktig roll i den globala havscirkulationen. Bl.a. påverkar den bildningen av bottenvattnet i Nordatlanten via isbildningen på hösten och vintern. På grund av den globala uppvärmningen har istäcket i den Arktiska oceanen krympt med ca 10 % sedan 1970-talet. Det förutspås att under de nästkommande 70 åren kommer temperaturen i den Arktiska oceanen att stiga med mellan 4°C och 8°C, och på det följer ett ytterligare minskande istäcke.

Då havsområden på höga breddgrader fungerar som magasin för atmosfärisk CO_2, och då upprinnelsen i det nordatlantiska djupvattnet är "överflödet" från djupvattnet i Danmarkssträdet och Kanalen vid Färöbanken, är dessa direkt medverkande till överföringen av atmosfärisk CO_2 (koldioxid) till djuphavet. Den drivande kraften bakom utväxlingen av CO_2 mellan luft och vatten är skillnaden i CO_2-partialtrycket mellan vattnet och den överliggande luften. Ytvattnets CO_2-partialtryck bestäms av temperatur, salinitet, upplöst oorganiskt kol (DIC) samt den totala alkaliniteten (TA). Tidigare har man antagit att DIC och TA kontrollerades av den fysiska nerkylningen av vattnet samt av biologiska processer, men det har visat sig att CO_2 skiljs ut under isbildningen och upplöses i det salta vattnet som blir till som en följd av fryskoncentrationen i fickor i isen (brine-bildning). Denna mekanism kan ge anledning till en stor förflyttning av mycket salt och CO_2-berikat vatten till de djupliggande vattenlagren, som inte tidigare har funnits med i modellberäkningar över CO_2-utväxlingen i Arktiska oceanen. Under LOMROG-expeditionen samlades 28 × 3 iskärnor, vari TA, DIC och salinitet blev undersökt. Ytterligare ett antal iskärnor samlades in och transporterades i fruset skick till Grönlands Naturinstitut. Där ska de användas till undersökningar av isens pH-värde, innehåll av kalciumkarbonat och isalgernas inflytande på isens CO_2-innehåll samt hur isalgerna påverkar isytan där de finns.

Polarforskningssekretariatet är en statlig myndighet med uppgift att främja och samordna svensk polarforskning. Det innebär bl.a. att följa och planera forskning och utvecklingsarbete samt organisera och genomföra forskningsexpeditioner i Arktis och Antarktis.

Polarforskningssekretariatet är förvaltningsmyndighet för lagen (2006:924) om Antarktis och prövar frågor om tillstånd för vistelse eller verksamhet i enlighet med lagen.

The task of the Swedish Polar Research Secretariat is to promote and co-ordinate Swedish polar research. This means e.g. to follow and plan research and development and to organise and lead research expeditions to the Arctic and Antarctic regions.

The Swedish Polar Research Secretariat is the administrative authority for the Act on Antarctica (2006:924) and handles permit issues for visits or activities in accordance with the Act.

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