

SWEDARCTIC and  
SWEDARP 2011–2015:  
Prioritized projects of the  
Swedish Arctic and Antarctic  
research programmes



Vetenskapsrådet

**SWEDARCTIC and SWEDARP 2011–2015:**

**Prioritized projects of the Swedish Arctic and Antarctic research programmes**

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# From 2011: A roadmap for Swedish polar research

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The Swedish Polar Research Secretariat and Swedish Research Council share the responsibility for planning Swedish polar research. These governmental agencies have established a shared roadmap for support to research projects in polar regions outside Sweden. This roadmap will serve as the start of a long-term plan for Swedish polar research within the programmes SWEDARCTIC and SWEDARP. It is published to invite and inspire potential partners – national and international – to cooperate with the agencies and Swedish scientists to achieve global scientific goals.

Swedish Research Council and Swedish Polar Research Secretariat issued a call to the Swedish scientific community for logistic support to Arctic and Antarctic research in April 2010. The call was administered by Swedish Research Council and the final decisions on expeditions will be made by Swedish Polar Research Secretariat.

The call resulted in 27 applications, three of which were rated as *Outstanding* (world class), and ten as *Excellent* (leading nationwide), according to the evaluation criteria of Swedish Research Council.

Further calls will be issued on a regular basis to supplement and extend the planning of the roadmap. There may also be targeted calls, to give researchers the opportunity to join a planned expedition, or to participate in polar research programmes under bi- or multilateral agreements.

## HOW PROJECTS WERE SELECTED

### The call

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The call was open for logistical support in all fields of science, but did not include the possibility of including research grants in the application. Financing of the research projects should come from other sources, primarily via funding agencies' regular calls for applications. Applications from the field of natural sciences were predominant, ranging from minor logistic needs to large icebreaker expeditions.

### Evaluation

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Applications were evaluated by an *ad hoc* panel including representatives of Swedish Research Council's panels for evaluation of earth, ocean and atmospheric sciences, ecology and taxonomy, and representatives from Swedish Research Council's panel on infrastructures for earth and environmental sciences. The evaluation panel was complemented with Nordic experts in earth system modelling and in oceanography, with a strong background in polar research.

External reviewers were used when additional competence was needed. Panel members did not take part in evaluating applications if there was a risk of conflict of interest. In addition to Swedish Research Council's administrative staff, representatives of Swedish Polar Research Secretariat and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS) were present as observers at the meeting.

The panel primarily evaluated the scientific case for the proposed research, followed by the competence of the applicants. Second, the panel members were asked to consider the value of the research for understanding the Arctic and Antarctic systems and how the proposed research agrees with other international scientific efforts in the polar regions. As a third task, they were asked to comment on the logistical needs, but these comments were not included in the priorities and rankings. Each project was given a priority grade and a rank order, as a recommendation to Swedish Polar Research Secretariat.

## Categories

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Swedish Polar Research Secretariat separated the projects into two categories, A and B, based on their logistical needs and time schedules for planning:

*Category A* contains projects implementable within 1–3 years. These projects are accepted for operational planning and preparation of a project plan.

*Category B* contains projects with a 3–10 year time frame. The ranking threshold for Category B was set higher than for Category A, as these projects demand more extensive planning and imply significantly higher costs. Projects in Category B are accepted for initial planning and a feasibility study. This allows Swedish Polar Research Secretariat to analyse the possible implementation of the project in cooperation with the applicant and collaborators. The analysis can result in a decision to move forward into operational planning, and the preparation of a project plan.

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## II

## IMPLEMENTATION OF THE ROADMAP

This roadmap indicates the main direction for Swedish polar research in the years ahead (2011–2015). This plan will change dynamically over time, as expeditions are completed and new projects are added.

Polar programmes and operators from other nations are welcome to suggest collaborations that can create operational synergies, or supplement and enhance the scientific output from these plans. The projects listed below have been ranked and are now being considered for implementation.

### **Magnus Tannerfeldt**

*Research Manager*

*Swedish Polar Research Secretariat*

### **Magnus Friberg**

*Research Officer*

*Swedish Research Council*

## ABBREVIATIONS

**Outst** = Outstanding

**Exc** = Excellent

**VG** = Very good

**G** = Good

**GU** = University of Gothenburg

**IRF** = Swedish Institute of Space Physics

**LU** = Lund University

**NRM** = The Swedish Museum of Natural History

**SLU** = Swedish University of Agricultural Sciences

**SU** = Stockholm University

**UU** = Uppsala University

## Category A projects: Adopted for operational planning

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| Scientific evaluation | Main applicant           | Project title   |
|-----------------------|--------------------------|---|
| Outst                 | Victoria Pease, SU       | Tectonic evolution of the Amerasia Basin and CALE   |
| Exc                   | Per Möller, LU           | Taymyr revisited: A quest for former Eurasian Ice Sheet margins and megafauna extinction during the last glacial cycles               |
| Exc                   | Göran Thor, SLU          | Biomonitoring by re-examination of lichens and mosses within extant permanent plots in Antarctica                                     |
| Exc                   | Lars Holmer, UU          | Hot fossils in a cold land: Early Cambrian stem group bilaterian animals from Antarctica  |
| Exc                   | Lars Arneborg, GU        | Ocean-induced glacier melting in Greenland  |
| Exc                   | Sheila Kirkwood, IRF     | Moveable atmospheric radar for Antarctica (MARA): 2011 and beyond   |
| Exc                   | Anna Wåhlin, GU          | Physical oceanography of the Amundsen Sea, Antarctica   |
| VG                    | Pauline Snoeijs, SU      | Marine diazotrophic diversity in the polar oceans and its contribution to global nitrogen cycling                                     |
| VG                    | Henrik Kylin, SLU        | Persistent Organic Pollutants and current-use pesticides in a Changing Arctic (POPCA)   |
| VG                    | Henning Lorenz, UU       | Neoproterozoic orogeny in southern and central Svalbard (NOA-Svalbard)  |
| VG                    | Kajsa Tönnesson, GU      | The role of zooplankton in Arctic food webs   |
| VG                    | Richard Gyllencreutz, SU | The Lomonosov Ridge off Greenland: A Rosetta Stone for unifying Amerasian and Eurasian stratigraphies?                                |
| G                     | Thomas Mörs, NRM         | The frozen Garden of Eden: Palaeogene mammals from Seymour Island, Antarctica – evidence for Gondwanan biogeography and palaeoclimate |

III

## Category B projects: Adopted for initial planning

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| Scientific evaluation | Main applicant         | Project title  |
|-----------------------|------------------------|--|
| Outst                 | Örjan Gustafsson, SU   | International Siberian Shelf Study (ISSS): Permafrost degradation and greenhouse gas releases in the outer East Siberian Sea |
| Outst                 | Michael Tjernström, SU | Arctic Summer Cloud Experiment (ASCE): A post-RISSEARC project?  |
| Exc                   | Leif Anderson, GU      | Ridge and Slope Study of the Eastern Arctic Ocean (RISSEARC): Marine chemistry project                                       |
| Exc                   | Per Andersson, NRM     | The dynamics of trace metal biogeochemistry in the Arctic Ocean: A GEOTRACES cruise  |
| Exc                   | Martin Jakobsson, SU   | Ridge and Slope Study of the Eastern Arctic Ocean (RISSEARC): Marine geology and geophysics                                  |
| Exc                   | Arjen Stroeven, SU     | Changes in vertical ice extent in Dronning Maud Land as recorded by <i>in situ</i> produced cosmogenic radionuclides         |
| Exc                   | Caroline Leck, SU      | The life cycle of clouds in the High Arctic summer, with linkages to the microbiological life in ocean and ice               |

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# The Arctic

## ARCTIC MARINE SCIENCE

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### **The dynamics of trace metal biogeochemistry in the Arctic Ocean: A GEOTRACES cruise**

We propose a sampling programme with an icebreaker in the Arctic Ocean as a part of the international GEOTRACES project. The biogeochemistry of the Arctic Ocean is expected to undergo dramatic transformations due to climate change. This may lead to equally rapid changes in geochemical processes in the vast and shallow arctic shelf seas and at sea-ice margins, which could affect ocean biogeochemical cycles on a larger scale all across the Arctic. The overall purpose of the proposed project is to understand the behaviour and distribution of trace elements in the Arctic Ocean, building upon our previous studies and other results obtained during the International Polar Year. We will investigate:

- the sources of trace metals, nutrients, and key trace elements
- the roles of particles, biological activity, and sea-ice cover
- the relationship between trace metal and nutrient distributions and ocean circulation patterns.

We will also document how isotopic tracers reflect present Arctic conditions, in order to calibrate the sedimentary record and obtain data about palaeoceanographic conditions. The project comprises an international team of researchers using a trace metal clean water sampling system following the GEOTRACES protocol. The suggested cruise tracks are modified from those identified during the GEOTRACES Arctic planning workshop in 2009. Priorities include the East Siberian shelf, a deep ocean profile, and a section covering Pacific inflow waters.

**Classification:** *oceanography, climatology, exogenetic geochemistry*

**Key words:** *GEOTRACES, Arctic Ocean, trace elements, radioisotopes*



PHOTO: KAISA TÖNNERSSON

PHOTO: SWEDISH POLAR RESEARCH SECRETARIAT



PHOTO: BJÖRN ERIKSSON

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## **Ridge and Slope Study of the Eastern Arctic Ocean (RISSEARC): Marine chemistry project**

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The Arctic Ocean is in a state of rapid transition, best exemplified by the marked reduction in sea-ice cover over the last 30 years. The overall scientific objective of the RISSEARC expedition is to improve our understanding of the importance of the Arctic Ocean in the global climate system. RISSEARC will do this by investigating the following:

- the Arctic Ocean's physical and biogeochemical feedback mechanisms to the climate system
- the Arctic Ocean's contribution to the ventilation of global oceans, and its influences on cross latitudinal transport of heat and anthropogenic carbon, and on the global oceanic conveyor belt
- the history and evolution of the Arctic perennial sea ice cover and marine ice sheets.

The marine chemistry project specifically aims to improve our understanding of the feedbacks of the Arctic Ocean carbon system. This includes assessing:

- carbon transformation in large shelf areas
- the exchange between the deep central basins
- likely changes in the export of marine-produced organic matter to the deep central Arctic Ocean during the productive summer season when the sea-ice coverage is absent.

A summer-sea-ice-free Arctic Ocean will result in more sea-ice production (due to more open sea water exposed to freezing temperatures), and hence more brine formation; this contributes to deep-water formation, which affects the sequestration of anthropogenic CO<sub>2</sub>. We also aim to compare natural ocean acidification with acidification originating from uptake of anthropogenic CO<sub>2</sub>.

**Classification:** *oceanography*

**Key words:** *carbon, marine chemistry, climate*

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## **Ridge and Slope Study of the Eastern Arctic Ocean (RISSEARC): Marine geology and geophysics**

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The Arctic Ocean is now in a state of rapid transition. While this is best exemplified by the marked reduction in sea-ice cover over the last 30 years, there are fundamental physical oceanographic and biogeochemical changes that result from and affect regional and global climate change associated with sea-ice loss. The overall scientific objective of the RISSEARC expedition is to improve our understanding of the Arctic Ocean's role in the global climate system by addressing:

- the Arctic Ocean's physical and biogeochemical feedback mechanisms to the climate system
- the Arctic Ocean's contribution to the ventilation of global oceans, and its influences on the cross latitudinal transport of heat and anthropogenic carbon, and on the global oceanic conveyor belt
- the history and evolution of Arctic perennial sea-ice cover and marine ice sheets.

RISSEARC is cross disciplinary, integrating physical oceanography, marine chemistry, geology, and geophysics; it focuses on both the present situation and how the environment evolved during the last two glacial cycles. The eastern Arctic Ocean is the focus of RISSEARC data acquisition, which is proposed to involve two legs with an icebreaker, one capturing the winter oceanographic conditions (May) and the other conditions when minimum sea-ice extent prevails (from August). This proposal for the marine geology and geophysics component focuses on the history of the Arctic Ocean sea ice and marine ice sheets.

**Classification:** *quaternary geology, oceanography, other geology*

**Key words:** *Arctic, sea ice, palaeoceanography, ice shelves, marine geology*





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## **Arctic Summer Cloud Experiment (ASCE): A post-RISSEARC project?**

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ASCE could form part of the RISSEARC project and would benefit from its proposed track, passing through the Bering Strait early in the summer and transecting the Arctic during the peak of the melt season. This would allow us to acquire a substantial data set on Arctic clouds, which remain the Achilles heel of our understanding of the climate system.

Clouds consist of very small water droplets, ice crystals, or a mixture of both. The exact composition of clouds affects not only their formation and lifespan, but also how they interact with solar and terrestrial radiation. A common, and quite persistent, type of cloud in the Arctic is a mixed-phase cloud in which the liquid portion is spatially separate from the ice portion; the ice forming in the liquid layer but falling out of it. This configuration is unstable: ice particles grow at the expense of liquid droplets in a super-saturated environment and the liquid water disappears. Clouds are poorly modelled in climate models, although they are very important, especially in the Arctic. One reason for this weakness is a lack of observations, which ASCE is designed to alleviate.

**Classification:** *oceanography, meteorology, climatology*

**Key words:** *Arctic, meteorology, climate, clouds, ocean*

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## International Siberian Shelf Study (ISSS): Permafrost degradation and greenhouse gas releases in the outer East Siberian Sea

We propose a coherent research programme with the unifying theme of investigating the multi-process linkages between vulnerable permafrost carbon pools and greenhouse gas release, in the practically un-investigated outer East Siberian Sea. Air, seawater and sediments would be probed from an icebreaker equipped with a range of at-sea sensors, gas flux packages and state-of-the-art samplers, to provide information on:

- CH<sub>4</sub> sources and fluxes from subsea permafrost,
- geographically-displaced CO<sub>2</sub> fluxes from degradation in the ocean of organic matter originating from thaw-released terrestrial permafrost.

This ISSS research expedition builds on our recent findings on the inner shelf of extensive venting to the atmosphere of CH<sub>4</sub> from thawing subsea permafrost and from the non-conservative behaviour of old organic matter released from thawing terrestrial permafrost. Assessments by IGBP and IPCC stress that thawing permafrost is the key mechanism in the Earth system that could move substantial amount of carbon (as CO<sub>2</sub> and CH<sub>4</sub>) into the atmosphere as early as this century. Remobilization to the atmosphere of a few per cent of the CH<sub>4</sub> held in shallow subsea permafrost north of Siberia could trigger abrupt climate warming. With access to an icebreaker, the Swedish-US-Russian research team would be able to provide a preliminary assessment of these permafrost carbon-greenhouse gas-climate couplings on the vast outer East Siberian Sea.

**Classification:** *environmental chemistry, exogenetic geochemistry, oceanography*

**Key words:** *biogeochemistry, Arctic, carbon, climate, the ocean*





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## **The Lomonosov Ridge off Greenland: A Rosetta Stone for unifying Amerasian and Eurasian stratigraphies?**

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The Arctic plays an important role in the global climate system: snow and ice cover influence the Earth's albedo and controls how much solar radiation is reflected back into space; the exchange between various deep-water currents in the Arctic is fundamental to global thermohaline circulation. The Arctic Ocean is also the least explored ocean in the world. When considering that the Arctic region is the part of the world that is responding fastest to global warming, we obviously need an improved understanding of the factors governing climate change in the Arctic. The Danish Continental Shelf Project is planning a research expedition in the central Arctic Ocean with an icebreaker as a research platform. This presents a unique opportunity to acquire marine sediments from a largely unsampled area. The results of previous expeditions indicate that sediment cores from the Lomonosov Ridge can answer questions about how deep-water formation in the Arctic has changed over time. They can also provide information on how the balance between the Transpolar Drift (transporting ice from the Siberian shelves) and the Beaufort Gyre (transporting ice from the Amerasian Basin) has changed on glacial time scales. Other important questions we will address are how to calibrate sediment dating, and how the ice sheet dynamics have influenced global climate.

**Classification:** *sedimentology, historical geology and palaeontology, exogenetic geochemistry*

**Key words:** *Arctic Ocean, stratigraphy, Lomonosov Ridge, chronology, sea ice*

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## The role of zooplankton in Arctic food webs

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Predicting the dynamics of ecosystems entails understanding how trophic interactions respond to environmental change. In polar marine ecosystems, food web dynamics are inextricably linked to sea-ice conditions. The primary production – mainly comprising ice algae and pelagic phytoplankton – forms the base of the food web. The amount, and distribution, of phytoplankton is therefore likely to affect the behaviour and distribution of zooplankton. Herbivorous zooplanktons (i.e. copepods) are the primary grazers on the phytoplankton biomass. Zooplankton, both herbivores and carnivores, modify the prey community by grazing and predation. Zooplankton also have an impact on the benthic–pelagic coupling through sedimentation of organic aggregates. The proposed project focuses on how zooplankton function in the pelagic food web, and their role in structuring the pelagic community. By sampling and experimenting we will quantify:

- the grazing pressure of the most dominating copepods (*Calanus* spp. and *Metridia* sp.)
- the predation impact of invertebrate predators (ctenophores, chaetognaths and predatory copepods)
- zooplankton's contribution to the vertical flux.

The proposed work will be conducted on an icebreaker. A thorough understanding of the dynamics of polar food webs is a key to enabling accurate predictions of the effects on pelagic communities of global warming.

**Classification:** *marine ecology*

**Key words:** *zooplankton, climate, prediction, marine food webs, sedimentation*





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## **Persistent Organic Pollutants and current-use pesticides in a Changing Arctic (POPCA)**

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Persistent organic pollutants (POPs) come from sources mainly in industrialized areas and are transported all over the globe. They are now found even in the most pristine areas of the Earth. Due to temperature-driven processes towards the polar regions, many of these contaminants end up in the Arctic and may reach substantial concentrations in arctic biota at high trophic levels, including humans. Even though the concentrations of many POPs are now decreasing, it is important to understand the transport mechanisms of these compounds, and use this knowledge in regulatory work to prevent similar problems in the future. We propose an investigation of the concentrations of POPs in air, water, and ice to gain more insights into the transport mechanisms. In addition, we will analyse a number of “new” pollutants, such as persistent fluorinated and brominated compounds that behave similarly to the classical chlorinated compounds, but that, in contrast to them, are still increasing in the environment. We will also measure a number of currently used pesticides, particularly herbicides and insecticides, in the brine (melt water inside the ice) where the concentrations may be much higher than in the seawater. Previous investigations indicate that the concentrations reach levels that may affect ice algae and arthropods.

**Classification:** *environmental chemistry, persistent organic pollutants, exogenic geochemistry*

**Key words:** *persistent organic pollutants, current-use pesticides, Arctic environment, perfluorinated compounds, brominated compounds*

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## Marine diazotrophic diversity in the polar oceans and its contribution to global nitrogen cycling

Marine diazotrophs (nitrogen-fixing bacteria and cyanobacteria) are of documented significance in global nitrogen cycling. However, their significance in polar regions is largely unknown, despite the fact that nitrogen fixation is a major source of nitrogen input in polar terrestrial and freshwater systems. In samples taken during two previous Swedish cruises on icebreaker Oden to the Arctic Ocean (in 2002 and 2005), we identified a great diversity of diazotrophs. Our samples were small (0.5–1 L) but, despite the fact that *nifH* genes can be difficult to reveal because they occur in fewer copies than do, for example, 16S rRNA genes, we can hypothesize that *nifH* genes occur abundantly in the Arctic Ocean. From our previous samples, we cannot assess whether the *nifH* genes also are active, which is why we need to return to the Arctic ice. We would like to participate in upcoming expeditions to Arctic and Antarctic sea ice, preferably early in the season (May–June and November–December, respectively) before brine channels open up between seawater and atmosphere. This would enable us to study hypersaline brine, seawater and melting ponds on ice and snow. We will take large water samples for metagenomics (DNA) and metatranscriptomics (RNA) studies and to measure nitrogen fixation. The specific goals of this project are to address the following questions:

- a) How diverse are marine diazotrophs in polar sea ice?
- b) How important are marine diazotrophs in polar sea ice for global nitrogen cycling?

**Classification:** *marine ecology, other chemistry, functional genomics*

**Key words:** *nitrogen fixation, polar sea ice, global nitrogen cycle, genetic diversity, gene expression*



PHOTO: SWEDISH POLAR RESEARCH SECRETARIAT  
PHOTO: BENJAMIN HELL



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## **The life cycle of clouds in the High Arctic summer, with linkages to microbiological life in ocean and ice**

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The uncertainties of simulating future scenarios of arctic climate change relates to an inadequate description of several strong feedback mechanisms – involving the ocean, sea ice, snow, clouds, radiation and, not least, ocean biology – in our models. As none of these processes can be explicitly described in a climate model, they must be parameterized. The quality and the sensitivity of any climate model are critically dependent on how the parameterization is done, which relies on adequate and extensive observations when formulating and testing the parameters. The overall objective of the proposed programme is to provide high-quality data with which to identify and quantify the processes that control the evolution and properties of the atmospheric boundary layer and aerosol–cloud system in the Arctic region. These processes are also relevant to radiative forcing and general climate in the Arctic. The proposed programme is an integrated study extending from ocean surface, through the sea-ice interface, into the cloud layers, and would ideally be performed during an Arctic field experiment from mid-July through September. It includes multi-disciplinary scientists involved in boundary-layer meteorology, atmospheric chemistry and physics, as well as marine physics, chemistry, and biology. The value of an interdisciplinary approach has been well demonstrated by previous summer expeditions to the Arctic pack ice.

**Classification:** *marine ecology, meteorology, climatology*

**Key words:** *Arctic, clouds, aerosol, lead-surface-microlayer, feedback mechanisms*



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## Ocean-induced glacier melting in Greenland

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Since the 1990s, several of the glaciers draining the Greenland ice sheet have accelerated their export of ice dramatically, and there is significant evidence that increased ocean-induced melting is the major cause. The aim of this project is to obtain oceanographic observations from one or more fjords in East and North Greenland, to gain an understanding of the processes that govern the oceanic influence on glacier melting. The Greenland fjords are critical links between the large-scale ocean circulation and the glaciers. It is the functioning of these links that determines to what degree a general rise in ocean temperature will be reflected in increased glacier melting, and how a changing atmospheric forcing may alter local ocean/fjord circulation and thereby affect the melting processes. Oceanographic observations in Greenland fjords are sparse, especially on the east and north coasts where the ice conditions are difficult. We suggest summer icebreaker cruises, with CTD work and mooring deployments one year and CTD work and mooring recovery the following year. The Kangerlussuaq, the Petermann and Nioghalvfjærdsfjords are of interest: the first represents accelerating glaciers in southern Greenland that have lost most of their floating ice; the two others represent northern Greenland glaciers that still have large floating shelves, and where the ice export is still mainly balanced by melting below the shelves.

**Classification:** *oceanography*

**Key words:** *Greenland, glaciers, fjord circulation, basal melting*





## ARCTIC LAND-BASED SCIENCE

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### **Neoproterozoic orogeny in southern and central Svalbard (NOA-Svalbard)**

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The project Early Neoproterozoic Orogens in the Arctic (NOA) aims to investigate the nature of Early Neoproterozoic orogeny in the North Atlantic and Arctic regions. Based on previous work, we suggested the existence of a northerly continuation of the Grenvillian-Sveconorwegian orogen. However, recent interpretations of the dispersed occurrences of relicts after early Neoproterozoic orogeny are controversial, but the evidence is essential for plate tectonic reconstructions of the Neoproterozoic era and the interpretation of plate movements until their assembly during the Caledonian orogeny. Moreover, the trend of the late Neoproterozoic Timanide orogen beneath the sedimentary cover of the Barents Shelf is equivocal, and little is known about its involvement in the Caledonian orogeny. Svalbard is in a key position on the north-western corner of the Barents Shelf and is part of the Arctic Caledonides. The NOA-Svalbard fieldwork will investigate the Neoproterozoic deformed rocks, and rocks of potential Neoproterozoic age, in southern Svalbard by mapping and extensively sampling for sediment provenances (detrital zircon ages), and by studying metamorphism and deformation. The major aim is to integrate the still enigmatic Neoproterozoic episodes on Svalbard in a wider context of Neoproterozoic tectonics in the area of today's Arctic, and thereby learn more about the tectonic setting before the onset of the major Palaeozoic orogenies that formed the Caledonides and Urals.

**Classification:** *bedrock geology and petrology, mineralogy*

**Key words:** *Neoproterozoic, Svalbard, orogeny, tectonics, geochronology*

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## **Taymyr revisited: A quest for former Eurasian Ice Sheet margins and mega-fauna extinction during the last glacial cycles**

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This project aims to resolve the spatial and temporal distribution of Kara Sea-based ice sheets, research that is critical for making north–south/east–west correlations and for modelling of Eurasian Ice Sheets over time. Pinpointing the maximum ice sheet boundaries is of special interest – for the last glacial cycle and further back in time – as is extending our knowledge of the glaciation history of the southern part of the Taymyr Peninsula, Siberia. This will be done by combining satellite image-based glacial morphological mapping with detailed stratigraphical and sedimentological fieldwork, underpinned by a rigorous dating approach. The fieldwork will lead to glacial cycle-scale palaeoenvironmental reconstructions and improved understanding of the role of the Arctic in global climate change. Studies of environmental change in the Late Pleistocene and of Holocene flora and fauna are also integrated in the project. The fieldwork consists of sediment sampling from various stratigraphic units on the Taymyr Peninsula, after which the samples are analysed for mitochondrial and chloroplast DNA content. This approach makes it possible to monitor changes in species and population composition over time, even when no visible biological material can be found, i.e. through using macrofossils. The documented Late Quaternary megafauna “mass” extinction is of particular interest, and we believe that this approach will lead to major advances in our understanding of vegetation and environmental change around the times of fauna extinction.

**Classification:** *quaternary geology*

**Key words:** *Glaciation, evolution, genetics, ice age*





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## **Tectonic evolution of the Amerasia Basin and CALE**

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The tectonic development of the Amerasia Basin is one of the outstanding problems in tectonics and Arctic polar research today. This proposal focuses on some important issues, from both an on-shore and an off-shore perspective, related to understanding the Mesozoic spatial and temporal evolution of the Amerasia Basin. The primary hypotheses to be tested within this proposal relate to the Mesozoic development of the Amerasia Basin, and the timing and geometry associated with the synchronous rifting and crustal deformation of adjacent landmasses. These include:

- the timing, location and style of Mesozoic deformation in Taymyr and Verkhoyansk, and its relationship to the development of the Amerasia Basin
- the original size of the Arctic Alaska–Chukotka microplate (AACM) and the nature of its boundaries, including the timing and extent of the AACM and the location of the South Anyui Suture
- the age and composition of magmatism associated with the purported High Arctic large igneous province (HALIP) and its inferred relationship to the onset of rifting/spreading associated with the formation of the Amerasia Basin.

The results of this investigation gain added value through the international Circum-Arctic Lithosphere Evolution (CALE) programme and their application in linking on-shore geology with off-shore geophysics in the Arctic.

**Classification:** *bed rock geology and petrology, other geology, sedimentology*

**Key words:** *tectonics, Arctic, sediment, provenance, zircon*

## ANTARCTIC MARINE SCIENCE

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### Physical oceanography of the Amundsen Sea, Antarctica

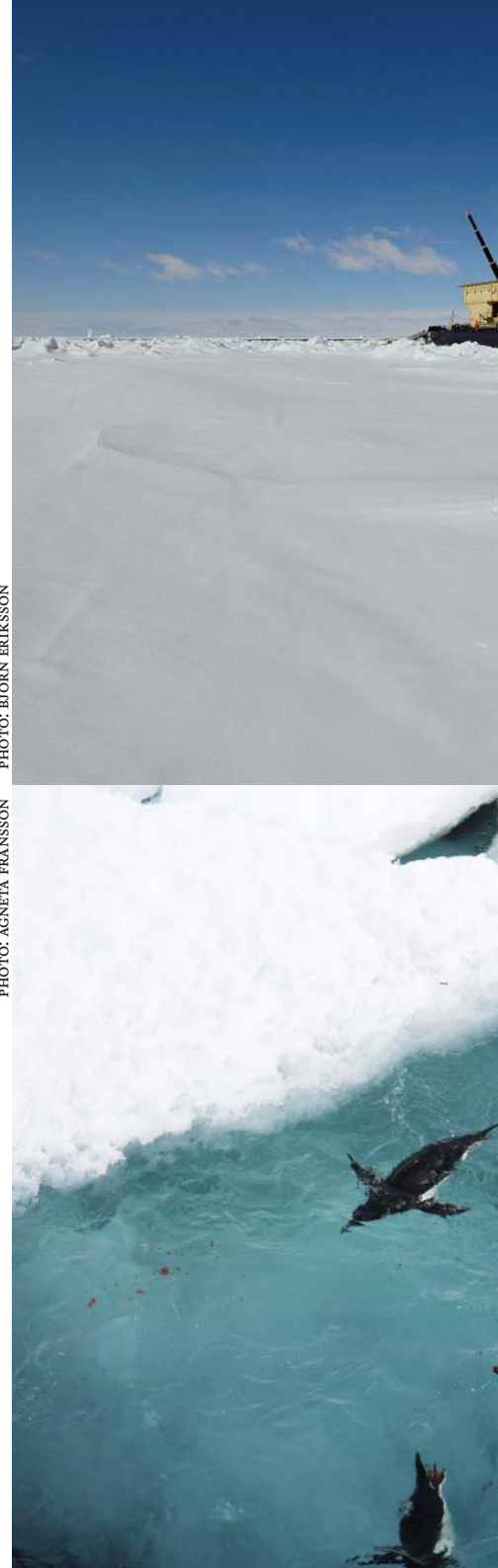
The ocean freshwater balance of the Antarctic shelves is currently changing, at least partly in response to the surging and melting of the West Antarctic Ice Sheet (WAIS). The most dramatic thinning of the WAIS has been recorded in several glaciers feeding the ice shelves in the Amundsen Sea. Understanding the ocean circulation in this area is central to our ability to predict the behaviour of the WAIS, the melting of which can in turn affect the global sea level. The Amundsen Sea remains one of the least sampled and understood of the circum-Antarctic marginal seas. The present project will use *in situ* measurements, remote sensing, and models to study the physical oceanography of the Amundsen Sea Shelf, and the subsurface melting of icebergs and ice shelves that the ocean circulation induces. The specific goals are:

- to identify the forcing mechanisms behind the flow of Circumpolar Deep Water (CDW) onto the shelf
- to characterize the time variability and trends in the CDW flow, and compare these with the growth rates of the glaciers draining in the region
- to assess the iceberg melt rate in the Amundsen Shelf region, and how this melt affects the ocean circulation in the area.

To achieve these aims, we wish to undertake two oceanographic icebreaker cruises. A somewhat reduced research programme could also be performed if only one cruise is undertaken.

**Classification:** *oceanography*

**Key words:** *Amundsen Sea, physical oceanography*





## ANTARCTIC LAND-BASED SCIENCE

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### **Hot fossils in a cold land: Early Cambrian stem group bilaterian animals from Antarctica**

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Earth's long history, spanning 4.6 billion years, includes events that may help to put the current threats to our biosphere into perspective. Most importantly, the geological record provides a window into milestone environmental and evolutionary events that shaped the planet as we know it today. One of the great unsolved evolutionary events in deep time relates to the origin and early relationships of the major animal phyla that appeared in the fossil record more than 540 million years ago, during the Cambrian Explosion. Although new molecular data have been very useful, we still have an incomplete understanding of the origins of most of the 15–30 phyla of bilaterian animals living on the planet today. The richly diverse, and often strange, fossils reflect this critical time in Earth's history, and they are particularly well exposed on the continents of Australia and Antarctica. Whereas well-preserved Cambrian fossils already have been intensely studied in Australia, very little is known about the record of Cambrian life in Antarctica. Published preliminary studies indicate an untapped source of very well-preserved fossil material. The proposed project can be expected to lead to a better understanding of this major diversification event in the history of animal life on Earth.

**Classification:** *historical geology, palaeontology*

**Key words:** *Cambrian, stem group, bilateria, Antarctica*

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## **Moveable Atmospheric Radar for Antarctica (MARA): 2011 and beyond**

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The project involves studies of mesospheric clouds and of vertical transport and mixing processes between the stratosphere, the land-ice surface, and the free troposphere, in Antarctica. Existing and new observations made by the MARA atmospheric radar and by high-resolution radiosondes will be used. The proposal concerns the relocation of MARA from the Swedish/Finnish research station Wasa/Aboa to the Norwegian research station Troll, and in the longer term, to the Indian research station Maitri. Ice particle properties measured by the US AIM satellite and surface aerosol and trace gas measurements will also be used, in collaboration with US, Norwegian, and Indian scientists. The project aims to provide a “landmark” of the characteristics of clouds in the polar summer mesosphere, which are expected to increase in extent in response to higher amounts of CO<sub>2</sub> and CH<sub>4</sub> in the atmosphere. The project will develop and test new independent calibration methods:

- to allow the recent decade’s observations of radar echoes from the clouds to be accurately compared with observations made in future decades
- to be used to determine cloud-ice characteristics.

At lower heights, we will study the processes occurring during mountain waves, tropopause folds, and turbulent mixing events. Public-domain models will be used to track air mass sources and destinations, and to examine the context of mixing events.

**Classification:** *meteorology, space physics, plasma physics*

**Key words:** *Antarctica, mesosphere, stratosphere, troposphere, radar*





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## **The frozen Garden of Eden: Palaeogene mammals from Seymour Island, Antarctica – Evidence for Gondwanan biogeography and palaeoclimate**

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The Early Cenozoic is a period of transition when global warm and wet Mesozoic climate led to the glaciation of Antarctica. The Palaeogene La Meseta Formation on Seymour Island is of immense scientific interest, since the only fossil mammals of Antarctica have been found there. The goal of this project is to explore rock sections for new mammal fossils. The record of Antarctic mammals is very sparse and new taxa can be expected. Seymour Island is the only ice-free area on the whole continent that exposes Palaeogene strata, allowing a keyhole view into the Early Cenozoic world of this land mass. It is therefore the only place that can help us understand the crucial biogeographical role of Antarctica during the Cretaceous–Tertiary mammalian transition. Seymour Island is also important as a dispersal corridor between South America and Australia. Any single find will add significantly to our knowledge of the poorly understood evolution and palaeobiogeography of Early Cenozoic mammals in the southern hemisphere. New mammal finds will make it possible to draw a more precise picture of Gondwanan biodiversity and palaeoecology before and during the Late Eocene glaciation of Antarctica. In addition, the project will provide new isotope data, which are important for the reconstruction of the palaeoclimate of southern high latitudes. The study will provide a much better understanding of the evolution, palaeobiogeography, and palaeoclimate of high-latitude mammals in Cenozoic Antarctica.

**Classification:** *historical geology and palaeontology, exogenetic geochemistry, systematics and phylogenetics*

**Key words:** *mammal palaeontology, palaeobiogeography, biodiversity, palaeoecology, palaeoclimate, Antarctica*

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## **Changes in vertical ice extent in Dronning Maud Land as recorded by in situ produced cosmogenic radionuclides**

The glacial history of the Dronning Maud Land (DML) margin of the Antarctic ice sheet has only been rudimentarily established. Onshore evidence for highstands comes from scattered observations of till- and ice-sheet-eroded bedrock on nunataks from the Shackleton Range to the Sør Rondane mountains. Except for cosmogenic nuclide (CN) work in the Sør Rondane mountains and the Shackleton Range, no age constraints are available for the 1000-km-wide margin of DML, our proposed study area, despite the fact that these nunataks are excellent dip-sticks for determining former ice-sheet thickness. We will address two principle hypotheses that have emerged from previous work on the DML margin:

- The DML margin last retreated from its maximum after 25 ka, when the ice surface had to be considerably higher in the area between the polar plateau and the grounding line, i.e. the area of the nunataks. The history of advance and retreat can be dated using CN methods.
- Tills with considerable weathering indicate long periods of subaerial exposure and, therefore, limits to maximum ice surface elevations.

This can also be tested with CN using multiple isotopes. Using isotopes  $^{10}\text{Be}$  and  $^{26}\text{Al}$  in quartz from glacially-eroded bedrock and boulders (in tills) deposited at elevations above the contemporary ice sheet surface, as well as the terrestrial CN age of meteorites sampled from blue-ice fields, will allow for rigorous testing of these two hypotheses.

**Classification:** *quaternary geology, physical geography, climatology*

**Key words:** *Antarctica, Dronning Maud Land, cosmogenic nuclides, meteorites, climate*





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## **Biomonitoring by re-examination of lichens and mosses within extant permanent plots in Antarctica**

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The highly specialized flora and fauna associated with Antarctica are endangered by climate change. The proposed project involves biomonitoring by re-examining of permanent plots of lichens and mosses in Heimefrontfjella and Vestfjella. Lichens are easy to monitor and can reveal both human impact from the Swedish research stations and the possible effects of climate change. The permanent plots for monitoring terrestrial lichen and moss vegetation were established in 1991–1992 and re-examined for the first time in 2001–2002. The application also includes a pilot study for a possible future PhD project on the origin of nitrogen (atmospheric or marine) in lichens and the mechanisms of lichen dispersal.

**Classification:** *systematics and phylogenetics, terrestrial ecology*

**Key words:** *biodiversity, lichens, ecology, biomonitoring*





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