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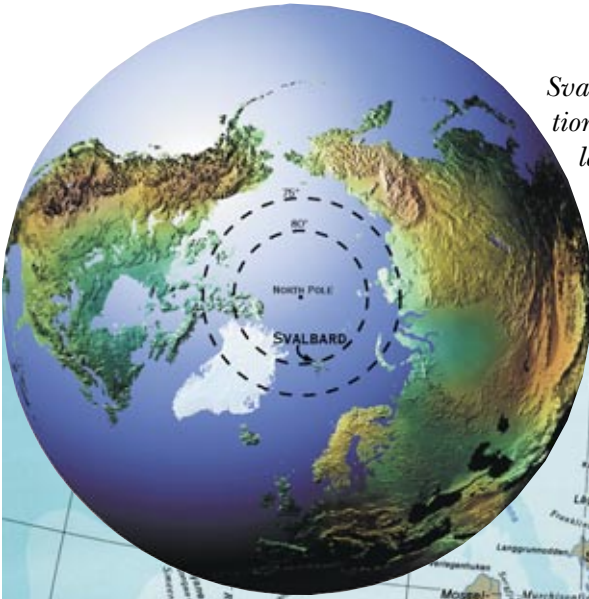


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Svalbard is the location of some of the most northerly international research stations in the world. It is easily accessible by regularly scheduled commercial airline flights. (Globe by Mountain High Maps, modified by Sue Mitchell; map by Norwegian Polar Institute, 1983.)



EXECUTIVE SUMMARY

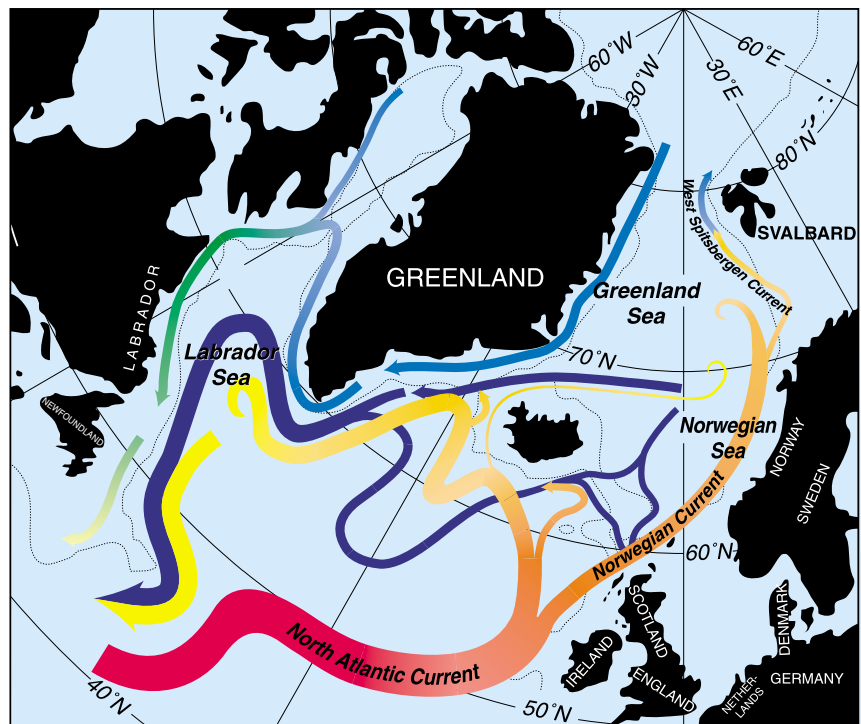
The Svalbard archipelago lies in the high Arctic between 74° and 81° N, midway between mainland Norway and the North Pole. The islands' abundant wildlife attracted whalers and trappers from a number of European nations beginning in the 17th century. Despite competing claims, the islands remained a no man's land until the Svalbard Treaty of 1920. The treaty, signed by 42 nations including the U.S., gave sovereignty over the islands to Norway and mandated that they remain demilitarized and that all signatory nations have equal rights to conduct business on Svalbard. Permanent Norwegian and Russian settlements developed on Svalbard in the 20th century to mine coal.

Since 1968, major Norwegian and international research efforts have been based in the archipelago. Svalbard is an excellent laboratory for studying the environment of the high Arctic because:

- Half of Svalbard's area is now protected as national park, nature reserve, plant protection reserve, or bird sanctuary.
- Svalbard's location offers access to Fram Strait, glacier fields, and other features that are important to global systems.
- It also contains relatively diverse animal and plant communities that are adapted to extreme latitude photoperiod and seasonality somewhat decoupled from extreme climate.
- Svalbard is the world's northernmost territory with modern research facilities and infrastructure.

In 1999, investigators from 14 nations conducted research on Svalbard, primarily based in Longyearbyen, the main municipality, and Ny-Ålesund, an international base for research in the natural sciences. The research effort in Svalbard is complemented by an educational program, University Studies on Svalbard (UNIS), a foundation which offers university-level courses in arctic sciences.

The Arctic is the first place that climate change is likely to be observed. The Arctic is experiencing significant change,



Currents in the North Atlantic. The West Spitsbergen current keeps western Svalbard considerably warmer than eastern Svalbard. From McCartney, Curry, and Bezdek, 1996.

which will have repercussions far beyond the region. Svalbard lies in the Atlantic portal to the circumarctic regions, at the northern end of the Gulf Stream's critical ocean/atmosphere heat pump. Shared scientific study of the Svalbard region, in the context of understanding past and present physical processes across the ocean/atmosphere/geosphere/biosphere system, is critical to understanding large climate and geophysical feedbacks on global scales (1996 IPCC Scientific Assessment). Svalbard is also the only readily accessible high-latitude site that underlies almost all geophysical phenomena triggered by interactions of cosmic particles with the Earth's magnetic field. In addition, like other Arctic regions, Svalbard is a "last frontier" for exploration and resource extraction, inviting northern engineering and comparative social science research.

As two of the eight arctic nations, Norway and the United States are major participants in circumarctic research and have complementary access and capabilities. The two nations have collaborated on many research projects in the past: The U.S. National Science Foundation (NSF) lists approximately 31 funded projects in Svalbard alone, and NSF has funded projects in other parts of the Norwegian Arctic. Other U.S. and Norwegian agencies also participate in collaborative research.

A multidisciplinary scientific workshop held on Svalbard August 16–19, 1999, provided an opportunity for American and Norwegian investigators to discuss a range of possibilities for enhanced collaborative research. This workshop was initiated to increase U.S./Norwegian collaborations in conducting arctic research and developing and using research infrastructure, collaborations which had decreased since the development of the European Union. Scientists from the U.S. will benefit from improved circumarctic access opportunities, ice-free ports, and modern logistical facilities at higher latitudes. Scientists from both

nations will benefit from shared research goals, integration of findings, and joint use of facilities. Before the workshop, U.S. delegates solicited recommendations about collaborative research opportunities in Svalbard from their colleagues to provide a broad community perspective to the discussions.

The major task for workshop participants was to discuss research needs and priorities and develop recommendations for potential collaboration and strengthened scientific cooperation on and around Svalbard. Participants from both countries recognized that the scope of potential research topics for U.S./Norwegian



Research in Svalbard includes work with polar bears. Here Dr. Andrew Derocher, Norwegian Polar Institute (NPI), tattoos the lip of a polar bear so that it can be identified if recaptured later. Tattooing is more reliable than ear tags and other devices that can get lost. Photo by Kit Kovacs and Christian Lydersen, NPI.

collaboration in Svalbard is necessarily expansive. The Svalbard region has a long tradition of interdisciplinary research, from studies of the cosmos to the sequestration of carbon in the polar marine food web. Workshop participants discussed several multidisciplinary questions appropriate for broader bilateral cooperation in Svalbard, including:

1. How will climate change be mediated by ocean processes and what will be the effect on carbon cycles?
2. How are mesoscale atmospheric circulations and ocean stratification affected by large exchanges of sensible and latent heat in the high-latitude North Atlantic?
3. How will climatic changes interact with stratospheric ozone dynamics and UV radiation?
4. How are soil thermal regime, carbon storage, and biological processes affected by climate change?
5. How can we exploit the synergistic co-location of powerful observational facilities of upper atmospheric processes on Svalbard to study how these processes affect consumer, business, and defense satellite communications?

In order to identify specific topics appropriate for U.S./Norwegian collaborative research efforts based in Svalbard, working groups were organized into five working groups, addressing studies in upper atmosphere; lower atmosphere; oceanography and geophysics; paleoclimatology; and biology.

Although a formal social sciences working group was not organized during the workshop, the U.S. delegation included several social scientists who worked with an informal network of international social scientists via e-mail to contribute social sciences recommendations to this report.



Iceberg in Kongsfjorden (King's Fjord) near Ny-Ålesund, a major site for international arctic research. Photo by Dag Hessen.



Spring research travel in Svalbard. Photo by Kit Kovacs and Christian Lydersen, NPI.

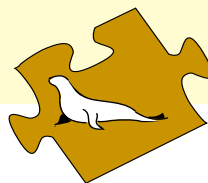
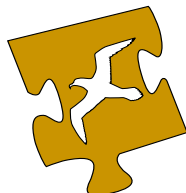
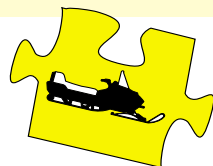
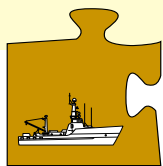
RECOMMENDATIONS

Multidisciplinary, international research cannot take place productively without many elements in their proper places: infrastructure, logistics, agreements between governments, funding, innovative ideas and research questions in many disciplines, and collaborative connections between individual researchers. Many recommendations for science priorities and improvements to logistics infrastructure were developed during this workshop and refined during the review process and are included in this report. A summary of the key science priorities and infrastructure recommendations is included here.

COLLABORATION AND IMPROVEMENTS TO INFRASTRUCTURE

The United States and Norway should work together to:

- Continue and expand the collaboration outlined in the “Statement of Cooperation Between National Science Foundation Office of Polar Programs and Norsk Polarinstitut, September 13, 1999,” included in full in Appendix A (page 38).
- Establish a dedicated U.S. research station at Ny-Ålesund, including laboratory and storage space, necessary transportation and safety equipment for fieldwork, and permanent staff to fulfill sampling and data collection needs.
- Negotiate access for the USCG *Healy* to perform work in the Svalbard area, with ship time available on a regular, expanded basis.
- Plan and construct a new marine lab in Ny-Ålesund, through international cooperation.
- Upgrade outdated remote sensing facilities and electro-optical systems.
- Relocate and optimize EISCAT services.
- Upgrade SOUSY magnetosphere/stratosphere/troposphere radar on Svalbard.
- Establish a rocket launching facility at Ny-Ålesund.
- Develop methods to improve safe, expeditious, and cost-effective shipping for scientific equipment, supplies, and samples to and from Svalbard.



RESEARCH OPPORTUNITIES IN SVALBARD

General

- Synthesize research information on a circumarctic scale

The Changing Environment

- Implement a regional climate model for improving environmental management of the Svalbard area
- Study atmospheric contaminants, including persistent or toxic industrial compounds and pesticides, in snow and ice as in Canada;
- Investigate lipid metabolism in arctic food webs and its consequences for the transfer and accumulation of persistent and toxic organic compounds

Paleoenvironmental Studies

- Extract high-resolution paleoclimate information from marginal ice zones and shelves via longer sediment records, which will lead to the further development of proxies for sea ice, glacial, and meltwater variability from sedimentary and paleobiological records
- Continue glaciological and tide-water geological/oceanographic studies; measure sediment flux rates from different environments to help understand the stratigraphic record and quantify modern process studies, along with the role of subglacial processes on past events of paleoclimatic significance. Such work provides opportunities for remote sensing of ice flow and glacier dynamics
- Study ice core records from high-precipitation areas to evaluate late glacial/Holocene change for comparisons with Greenland and the Canadian Arctic
- Extrapolate shallow slope studies via programs similar to SCICEX, using ship-borne and submarine vehicles and geophysical instrumentation

Atmospheric Sciences

- Seek to understand the physics of air-sea-ice interactions, especially the importance of the West Spitsbergen Current and the historical fluctuations in the Arctic Oscillation and North Atlantic Oscillation

- Extend the field measurements of cloud-radiative interaction to an arctic region in which surface fluxes are much larger than in the SHEBA region and in which cloud-radiative interactions may be quite different from those in the central Arctic
- Study cloud chemistry and meridional flux of contaminants along with vertical profiling of the atmosphere for study of climate and the carbon cycle
- Measure sea ice and ozone depletion trace gases using remote sensing and surface and aircraft-based measurements
- Study surface fluxes at marginal ice zones
- Expand programs for study of geophysical phenomena, including the auroral oval
- Study satellite communications and air density changes that contribute to satellite orbital decay
- Investigate meridional transport of natural and man-made constituents and environmental meteorological effects (stratospheric warming)
- Use radar and optical methods to study arctic summer mesosphere phenomena
- Analyze remote sensing data from SVALSAT in real time
- Study ozone concentrations and spatial variability through long polar night

Oceanography

- Determine the long-term variability of transport and water properties in Fram Strait
- Examine the effect on the Arctic Ocean of variability in Fram Strait transport and water properties, including possible feedbacks to lower latitudes
- Determine the role of Fram Strait in biogeochemical budgets of the Arctic Ocean, including their sensitivity to variability in the strait
- Investigate selected fjords and shelf regions in Svalbard as models for important processes on high-latitude shelves, including convection, the flux and transformation of carbon, nutrient cycling and primary productivity, and the role of terrestrial fluxes and ice on marine productivity

Earth Sciences

- Investigate unfrozen water and soil thermal processes in warm permafrost
- Study the effect of rain-on-snow events on soil thermal processes, soil chemistry, and ground ice development
- Measure deep permafrost temperatures as archives of paleoclimate
- Study the process of extremely well-developed sorted circles to establish dating control for Martian surfaces covered with similar features

Glaciology

- Initiate joint U.S.-Norwegian programs to study Svalbard's ice caps, either by innovative field programs or satellite remote sensing
- Investigate the role of alpine glaciers in Svalbard as cold traps of toxic contaminants that may be released into surrounding seas by climatic warming
- Perform process and comparative studies between western U.S. and Svalbard on rock glaciers

Biology

- Study extremophile biology and exobiology, especially in subglacial and marine sedimentary environments
- Examine high-arctic extremes in photoperiod and seasonality, decoupled from extreme high Arctic climate, including studies of sleep-wake rhythms, seasonal affective disorder, annual cycles of reproduction, growth, and molt
- Investigate physical and biological controls of biodiversity and ecosystem function on a spec-

trum of scales, ranging from prokaryotes to plants and animals, including life history and demography studies

- Study the influence of benthic community composition on sedimentary carbon and nutrient regeneration
- Analyze the effects of temperature anomalies, climate change, and increased UV radiation on arctic biota, both terrestrial and marine
- Extend the Circumpolar Arctic Vegetation Map (CAVM)

Social Sciences

- Survey the historical archaeology on the records of 400 years of human exploitation and exploration
- Prevent and predict site deterioration under the impacts of climate and tourism
- Compare human behavior and adaptation in extreme environments

Education

- Foster greater awareness of UNIS in the international arctic research community
- Encourage and support U.S. student participation at UNIS, including stipends for living expenses and transportation
- Support U.S.-Norwegian post-doctoral and faculty exchanges, using UNIS and programs at U.S. universities and research institutes
- Encourage American guest lecturers at UNIS by providing partial support for their participation