Witness The
ARCTIC

Chronicles of the NSF Arctic Sciences Program — Spring 2004, Volume 11 Number 1

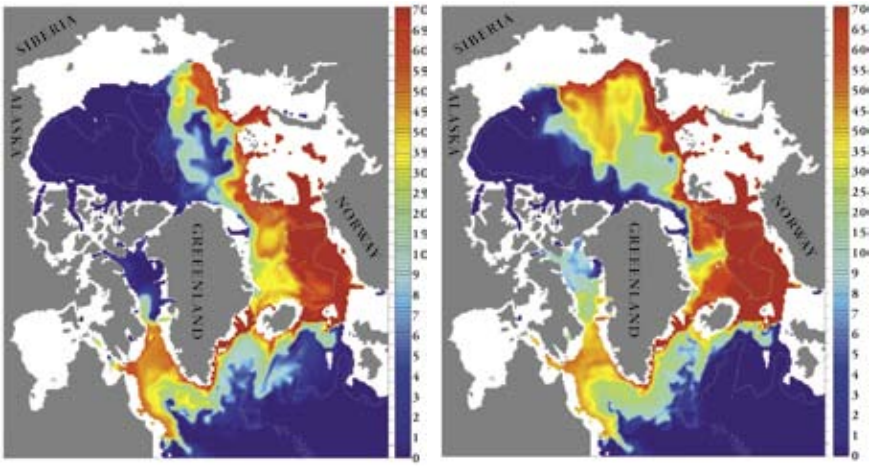
International Meeting Explores Change in the Arctic

Researchers from around the world presented and discussed evidence of rapid environmental change in the Arctic at the first Study of Environmental Arctic Change (SEARCH) Open Science Meeting (OSM), held 27–30 October 2003 in Seattle, Washington. Over 440 social and natural scientists, policy makers, and stakeholders from 18 countries explored the basic premise of SEARCH—that a complex of interrelated changes is occurring across arctic terrestrial, oceanic, atmospheric, and human systems.

SEARCH is an interagency effort to understand the causes, connections, and consequences of recent arctic environmental changes, emphasizing their interactions with global climate change and potential impacts on the biosphere, including human social and economic well-being. Currently more than 40 projects are funded as SEARCH activities by U.S. agencies. Many more projects relevant to SEARCH objectives are supported through other programs. SEARCH is developing cooperative relationships with many of the pertinent arctic science programs sponsored by other nations and international groups (see International Plans, page 3).

The SEARCH Open Science Meeting's goals were to encourage scientists from a range of disciplines to

- share evidence of environmental change in the Arctic,
- identify results from individual research projects that could inform the overall SEARCH objectives, and
- contribute to the SEARCH program either through linking their ongoing work to this program or through the design of new projects.



Data collected during several cruises in 1993–95 suggested that in the late 1980s, warm Atlantic water moved rapidly into the Arctic Ocean (right panel), a major change compared with its previous distribution (left panel). These observations were so startling and had such potentially important ramifications that they prompted members of the scientific community to begin organizing the Study of Environmental Arctic Change (SEARCH; see box page 2). The model illustrated depicts the change in distribution of Atlantic water at 280–360 m below sea level. (Maslowski et al. 2000. Geophysical Research Letters *27 (22): 3743)*

The National Science Foundation Office of Polar Programs (NSF-OPP) sponsored the OSM, with additional support from the International Arctic Science Committee (IASC) and the U.S. agencies in the SEARCH Interagency Working Group (IWG; see box page 2).

All of the OSM sessions were enriched by the valuable participation of undergraduate and graduate students. A student scholarship program, sponsored by OPP, NASA, the Department of Energy Atmospheric Radiation Measurement Program, the Alaska Native Science Commission, and ARCUS, provided full or partial funding of conference expenses for 45 students, and a student poster competition awarded winners sponsorship to attend a future scientific conference. The contributions of these young investigators were critical to the success of the SEARCH OSM.

Presentations and Discussions

Organized around the broad themes of Changes and Impacts, Feedbacks, and Drivers and Causes, the OSM included over 280 oral and poster presentations. With input from a diverse international and interdisciplinary community, the meeting's agenda included a variety of sessions, including

- keynote talks,
- concurrent science sessions with contributed papers,
- panel discussions, and
- poster sessions.

Keynote talks, including a point–counterpoint session, provided a broad overview of the scientific and policy issues of arctic change. Two moderated panel discussions provided opportunities to examine key

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questions, to reflect on previous sessions, and to discuss issues such as the nature of interdisciplinary research, local and indigenous knowledge, and media communication and public perception of science.

Eight parallel science sessions included over 75 contributed papers covering a large range of topics. Two poster sessions featuring nearly 200 posters offered informal opportunities for participants to share results and ideas on all aspects of environmental arctic change; topics included the documentation of observed changes, relevance of changes for arctic ecosystems and communities, larger global implications, and analytical issues such as techniques in data analysis and modeling.

Open Science Meeting participants reported on a variety of investigations, including direct observations, proxy records, modeling studies, and community projects. Many of these studies provided evidence of widespread and potentially interrelated changes in a number of aspects of the arctic environment, including:

- lower sea-level atmospheric pressure,
- increased surface air temperatures,
- increased soil temperatures,
- thawing permafrost,
- negative glacier mass balance,
- growth responses in vegetation,
- shifts in species composition of arctic and subarctic ecosystems,
- decrease in sea ice, and
- changing patterns in community subsistence activities.

Presentations on climate modeling and paleoclimate studies examined patterns of variability of climate and environmental change. Investigations of spatial and temporal variability provided insight into the relative contributions of both natural and anthropogenic drivers of arctic environmental change.

Several sessions focused on feedbacks —both within the Arctic and to the global system—as critical components in the development of a fundamental understanding of current changes and predictions of future change. Many of the feedbacks discussed, such as the snow/ice albedo feedback, have the potential to increase the pace of change.

Presentations from arctic residents and human dimensions researchers underscored the immediate impacts environmental

The Evolution of the SEARCH Effort

Development of the SEARCH program began in the mid-1990s, as a number of scientists became concerned about the magnitude of the changes they were observing in arctic ocean and atmospheric conditions (figure page 1). Led by James Morison at the University of Washington's Polar Science Center, the group circulated an open letter to the scientific community proposing a program to track and understand major changes in the arctic environment. By April 1997, 40 scientists from 25 institutions had signed the letter, which called for an international effort, initially called the "Study of Arctic Change," to investigate those changes through measurement, data analysis, and modeling. The letter was endorsed by the NSF Arctic System Science (ARCSS) Ocean–Atmosphere–Ice Interactions Science Steering Committee.

With support from the ARCSS Program, the University of Washington hosted an open workshop in November 1997 on the Study of Arctic Change. More than 70 scientists reported on recent ocean and atmospheric changes in the Arctic, corroborating earlier observations of change and suggesting a related suite of changes that were arctic-wide. As the effort developed, its name changed to the Study of Environmental Arctic Change (SEARCH), and SEARCH advanced beyond sponsorship by the ARCSS Program to a broader initiative involving several federal agencies.

At a 1999 workshop, 39 researchers began to draft the SEARCH Science Plan. Published in 2001, the Science Plan summarizes observed changes; presents the SEARCH hypotheses, objectives, and strategies; and recommends a broad multidisciplinary program aimed at understanding the interrelated arctic changes and their implications.

As the science plan developed, SEARCH gained increasing recognition. In 1999, the Interagency Arctic Research Policy Committee (IARPC) included SEARCH as "ready for immediate attention" in the U.S. Arctic Research Plan, and a SEARCH Interagency Working Group (IWG) chaired by NOAA was established and tasked. The IWG consists of the eight federal agencies responsible for scientific research in the Arctic that have agreed to work together on SEARCH:

- Department of Agriculture
- Department of Defense
- Department of Energy
- Department of Interior
- National Aeronautics and Space Administration
- National Oceanic and Atmospheric Administration
- National Science Foundation (current IWG chair)
- Smithsonian Institution

In addition, collaborative arrangements were initiated with international research programs such as the Arctic Climate System Study (ACSYS), the Climate and Cryosphere Project (CLiC), and the Climate Variability and Predictability (CLIVAR) program. The international aspects of SEARCH continue to develop (see International Plans, page 3).

The SEARCH Implementation Strategy, outlining science questions, program organization, and implementation activities and priorities, was published by the SEARCH SSC and IWG in October 2003 and widely circulated at the Open Science Meeting.

At the North Pole, an international research team is collecting observations needed to document and understand arctic change. Every spring since 2000, the team has established a group of unmanned scientific platforms at the North Pole Environmental Observatory (NPEO), supported by NSF. Right, Kelly Falkner of Oregon State University and James Morison of the University of Washington drill through the sea ice with help from co-pilot Dave Hanberg during the NPEO airborne hydrographic surveys in May 2003. A winch is mounted on the floor of the Twin Otter, allowing the team to lower instruments and sample bottles through the ice. Morison is past chair of the SEARCH science steering committee and the NPEO's principal investigator (see http://psc.apl.washington.edu/northpole). Photo by Jim Haffey.

changes are having on human communities in the context of other political, economic, social, and environmental forces of change. Several approaches to working with communities and incorporating residents' contributions were presented as models to integrate social science and local knowledge into arctic change research.

Connections and Collaboration

The SEARCH OSM fostered connections between individual researchers, programs, and research initiatives across the Arctic through the 24 associated meetings held in conjunction with the OSM and through the informal discussions that occurred throughout the meeting. Representing a variety of topics, organizations, and disciplines, the associated meetings ranged from small impromptu gatherings to more formal town hall meetings. Several of these meetings are reported on in this issue of *Witness the Arctic,* including:

- The Human Dimensions of the Arctic System (HARC) Patterns, Connections, and Methods Workshop (page 11),
- The Bering Ecosystem Study (BEST) Town Meeting (page 30),
- SEARCH's role in International Polar Year (IPY) 2007–2008 (page 23),
- the Second International Conference for Arctic Research Planning (ICARP II) Town Meeting (page 21), and
- meetings on Arctic Geospatial Information Infrastructure (page 6).

International Plans

Approximately one-fifth of the participants at the OSM came from countries outside the U.S. In all, 18 countries, including all of the eight arctic nations, were represented. Several associated meetings, in addition to those listed above, had an international focus, including

- a U.S.–China Panel on Polar Science, and
- a meeting of the International Arctic Science Committee (IASC) Pacific Arctic Group.

On the final day of the OSM, a half-day International Implementation Forum reviewed and discussed international efforts relevant to SEARCH. At the conclusion of this discussion, the Arctic Ocean Sciences Board (AOSB) and IASC offered to explore developing the international dimensions of SEARCH, including the possibility of establishing an international SEARCH science planning group. The SEARCH Science Steering Committee (see box this page) accepted this offer.

Following the SEARCH OSM, Patrick Webber, president of IASC, and Tom Pyle, chair of AOSB, invited their respective bodies to nominate individuals to serve on an international planning group for SEARCH science. In March, IASC and AOSB named the 13-member interim science planning group of the International Study of Arctic Change (ISAC), chaired by Leif Anderson of Göteborg University in Sweden. The group met at the Arctic Science Summit Week in April (see page 20). As part of their charge developed by IASC and AOSB, the science planning group will develop an international science overview. The group expects to conclude their findings and report to IASC and AOSB by late summer 2004. More information will be made available through the IASC web site: www.iasc.no, or the AOSB web site: www.aosb.org.

Public Awareness and Education

Several members of the news media, including reporters from the *New York Times,* the *Seattle Times,* the *Seattle Post-Intelligencer,* and Alaska Public Radio, attended the OSM. A press conference was held simultaneously in Seattle, in Washington, D.C., and streamed online. Media coverage of the conference resulted in a significant number of print, radio, television, and Internet stories, which are available through the ARCUS web site: www.arcus.org/SEARCH/OSM/media.html.

Meeting proceedings are planned for publication in spring 2004. For more information on the SEARCH Open Science Meeting, including sponsors and organizers, agenda, participant list, video webcasts, abstracts, presentations, and student participation, see the ARCUS web site: www.arcus.org/SEARCH/search.html, or contact Helen Wiggins at ARCUS (907-474-1600; fax 907-474-1604; helen@arcus.org).

For more information on the SEARCH program, see the SEARCH project office web site: http://psc.apl.washington.edu/search, or contact Peter Schlosser at Columbia University (845-365-8707; fax 845-365-8155; schlosser@ldeo.columbia.edu).

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NSF Seeks New Director, Plans for Cyberinfrastructure

On February 11, Rita Colwell announced her resignation as director of the National Science Foundation (NSF), effective February 21. The third longest-serving director in NSF's 54-year history, Colwell has been director of NSF since 1998. Her six-year term would have expired in August 2004. During her tenure at NSF, Colwell oversaw a major increase in support of environmental research through such initiatives as Biocomplexity in the Environment.

Arden L. Bement, Jr., the director of the National Institute of Standards and Technology (NIST), is acting as interim NSF director and has indicated that this is to be a short-term appointment. The process of identifying a permanent NSF director is already under way. Bement expects to return to NIST full time once a new NSF director is appointed.

Before becoming director of NIST in 2001, Bement was professor of nuclear engineering at Purdue University. He has held a variety of positions in academia, industry, and government, including senior positions with the Department of Defense. Bement has served on the National Science Board, the governing board of the NSF.

After leaving NSF, Colwell became chairman of Canon U.S. Life Sciences, Inc. She also holds faculty appointments at the University of Maryland, College Park, and The John Hopkins Bloomberg School of Public Health.

Cyberinfrastructure Plans

Following on a number of workshops and reports on the future of instrumentation, data-handling, and computation capabilities, the heads of two NSF directorates organized special sessions on cyberinfrastructure at the AAAS Annual Meeting in Seattle in February 2004. Presenters described a future convergence of information and communication technologies into a national cyberinfrastructure.

Margaret Leinen, head of NSF's Geosciences directorate, and Peter Freeman, head of the NSF's Computer and Information Science and Engineering (CISE) directorate, co-organized the sessions in Seattle; the sessions were co-chaired by the new CISE division director for Shared Cyberinfrastructure, Sangtae Kim.

In February 2003, a report from the NSF Advisory Committee for Cyberinfrastructure recommended that NSF establish and lead a large-scale, interagency, and internationally coordinated Advanced Cyberinfrastructure Program, with an estimated cost of $1 billion annually. Cyberinfrastructure has become a common theme throughout NSF, and every directorate has funded or is exploring cyberinfrastructure-related projects. The NSF's larger goal for a national cyberinfrastructure is to provide appropriate information technology and knowledge management resources for all science and engineering disciplines.

To ensure that all science and engineering communities are prepared to inform the development of and effectively use the broad, evolving cyberinfrastructure, NSF plans to hold an open competition during FY 2004 that will ultimately support a comprehensive set of education, training, and outreach awards.

For more information on the AAAS cyberinfrastructure sessions, see: http://php.aaas.org/meetings/MPE_01.php?detail=10060 and http://php.aaas.org/meetings/MPE_01.php?detail=10061. To download a copy of the cyberinfrastructure report, see: www.cise.nsf.gov/sci/reports/toc.cfm.

Arctic Sciences Section at NSF

The Arctic Sciences Section of the NSF Office of Polar Programs includes four program areas, which are featured in the following pages:
Arctic Research Support and Logistics (pages 5–7),
Arctic System Science (ARCSS; pages 7–11),
Arctic Natural Sciences (page 12), and
Arctic Social Sciences (page 13).

For more information about the Arctic Sciences Section, see the Office of Polar Programs web site: www.nsf.gov/od/opp.

New Arctic Sciences Section Personnel

In August 2003, William J. Wiseman, Jr., joined Jane Dionne as a program officer in the Arctic Natural Sciences program. Bill Wiseman is a physical oceanographer who studied coastal processes along the Alaska North Slope and in Svalbard in the 1970s (see *Witness* Spring 2002 member insert). He has recently been involved in interdisciplinary studies around large river mouths. He earned degrees in electrical engineering and oceanography from Johns Hopkins University and taught at the University of New Hampshire (1969–1971) and Louisiana State University (1971–2003). He holds emeritus status at LSU, where he served as chair of the Department of Oceanography and Coastal Sciences (formerly the Department of Marine Sciences) from 1977–79, 1984–86, and 2002–03; chair of the Department of Geology and Geophysics from 1987–90; assistant director of the Coastal Studies Institute from 1992–95; and director of the Coastal Studies Institute from 1995–99. He also served as a rotator in the Physical Oceanography program at NSF from 2000–2002. Both Dionne and Wiseman hold permanent appointments at NSF. Wiseman can be contacted at 703-292-8029; fax 703-292-9082; wwiseman@nsf.gov.

In October 2003, Dennis Conlon joined the Arctic Sciences Section on a two-year detail from the Office of Naval Research. Conlon is a physical oceanographer with experience in management of both science programs and classified ocean systems and sensors. He will focus on improving cyber- and other infrastructure in the Arctic and will assist office-wide efforts in this area (see article this page). Conlon may be contacted at 703-292-4658; fax 703-292-9082; dconlon@nsf.gov.

New Logistics Report Available

In October 2003, ARCUS published *Arctic Research Support and Logistics: Strategies and Recommendations for System-scale Studies in a Changing Environment,* which updates *Logistics Recommendations for an Improved U.S. Arctic Research Capability,* published in 1997. Members of the Research Support and Logistics Working Group prepared the new report, using information provided by the broader arctic research community, gathered through survey responses, discussions at meetings and workshops, and review comments on a draft of the report.

The research community identified environmental change as the most important arctic science priority for the next decade, requiring logistical and research support that enables large-scale, long-term observations and system-scale synthesis and modeling. The report outlines three broad strategies to meet the current range of arctic research support and logistics needs:

- supply critical components for development of a pan-arctic perspective;
- support the basic infrastructure for safe and efficient research; and
- maximize resources and cooperation.

The report is intended to provide guidance to all federal agencies with interests in the Arctic, as well as to Congress, in developing and improving arctic research support. As a living document, the report will require future updates as research priorities change and logistics and research-support assets continue to improve.

The NSF Office of Polar Programs sponsored the working group, co-chaired by Peter Schlosser of Lamont-Doherty Earth Observatory and Terry Tucker of Cold Regions Research and Engineering Laboratory. Copies are available by e-mailing subscriptions@arcus.org, or as a PDF on the ARCUS web site: www.arcus.org/Logistics/logistics03.html. For more information, contact Alison York at ARCUS (907-474-1600; fax 907-474-1604; york@arcus.org).

VPR Unites Resources, Expertise to Support Researchers

The Global Change Research Group (GCRG) at San Diego State University, led by Walt Oechel, has collected data on year-round CO_2 flux from tundra ecosystems for almost two decades. In 2003, Oechel requested assistance from the NSF Arctic Research Logistics and Support Services (ARLSS) contractor, VECO Polar Resources (VPR), to place a new eddy covariance tower at Ivotuk, Alaska, in the remote foothills of the western Brooks Range. Funded by the NSF ARCSS Program (see pages 7–11), Oechel's research objectives presented substantial logistical challenges, including requirements for autonomous power, de-icing, and data transfer.

VECO Polar Resources is a business union of three separate companies:

- VECO,
- Polar Field Services, and
- SRI International.

Each of the three companies offers complementary resources and expertise, providing the capabilities needed for major projects such as Oechel's, while allowing VPR itself to remain a small group.

VECO, a multinational corporation based in Alaska, provides project management, engineering, procurement, construction, operations, and maintenance expertise to industry and the public sector (see www.veco.com). For Oechel's project, VECO supplied heavy equipment, a project test site at Prudhoe Bay, and skilled labor.

Polar Field Services, Inc. (PFS), the core of VPR, provides all of the direct science planning and support (see http://polarfield.com). PFS has 11 employees with experience supporting researchers in the Arctic and the Antarctic. PFS planned and furnished much of the specific logistical support that Oechel's project needed, including food, camping gear, land permits, and contracting a small armada of airplanes to move people and gear, as well as developing, contracting, and testing a unique diesel/battery power system.

SRI International is an independent, nonprofit research institute, with expertise in communications and engineering technology. SRI has gained arctic experience through operating facilities in Greenland and the Canadian high Arctic (see www.sri.com). SRI project managers were key to developing the Ivotuk project's de-icing capabilities and the communications system for data retrieval and system control (see http://transport.sri.com/ivotuk). SRI identified a satellite system capable of providing two-way, real-time Internet connectivity to meet the project's needs for high rates of data transfer.

A team of VECO technicians, PFS staff, GCRG personnel, and SRI staff tested the power, de-icing, and communication systems at Prudhoe Bay from mid-February to mid-April 2003. To capture data during the spring melt season, VPR provisioned a two-person camp at Ivotuk to support a May 2003 deployment of the tower and completed installation of the power and data transfer systems in June of 2003. VPR will conduct scheduled maintenance of the power and data communications systems in future years.

VPR is entering the fifth and final year of its Arctic Research Logistics and Support Services (ARLSS) contract. NSF will be accepting new bids for the contract in 2004. VPR expects to be an applicant.

For more information, see the VPR web site: www.vecopolar.com, or contact Marin Kuizenga (907-455-4214; 907-455-4126; marin@polarfield.com).

Arctic Projects Demonstrate Power, Potential of GIS

Arctic researchers are increasingly making use of Geographic Information Systems (GIS) as a research tool, building on the availability of geospatial data and revealing the need for improvements in geospatial information infrastructure (GII) for the Arctic. Geospatial information infrastructure or spatial data infrastructure (SDI) includes not only GIS data layers, but the hardware, software, data standards, networking and other essential components that make spatial data useful to groups of users.

Encouraged by interest from the research community, the Arctic Research Support and Logistics (RSL) program sponsored the Arctic GIS Workshop in January 2001. Over 100 participants met to discuss applications and needs for GIS in arctic research (see *Witness* Winter 2000/2001). With the guidance of an organizing committee, the participants developed foundational recommendations and identified steps for implementing more integration, structure, and stability for arctic SDI. The group recommended both a top-down organized approach to continued SDI development in support of circumarctic research and, at the same time, growing regional or topical demonstration projects from the bottom up, resulting in geospatial data sets linked through arctic SDI.

The recommendations from the 2001 workshop continue to drive NSF support of arctic GIS and SDI efforts, and groups of researchers, GIS experts, research support providers, and others have made advancements in arctic SDI. Three major avenues of development are:

- regional or topical data nodes,
- SDI to link nodes together and provide basic information to a wide audience, and
- SDI for decision support applications in arctic logistics and planning.

Examples of such efforts can be seen in

- the Barrow Area Information Database Internet Map Server (BAID-IMS; see figure and http://ims.arcticscience.org),
- the Circumpolar Arctic Geobotanical Atlas (see page 27 and www.geobotany.uaf.edu/arcticgeobot), and
- online maps of projects supported by the Arctic Sciences Section at NSF (see www.vecopolar.com).

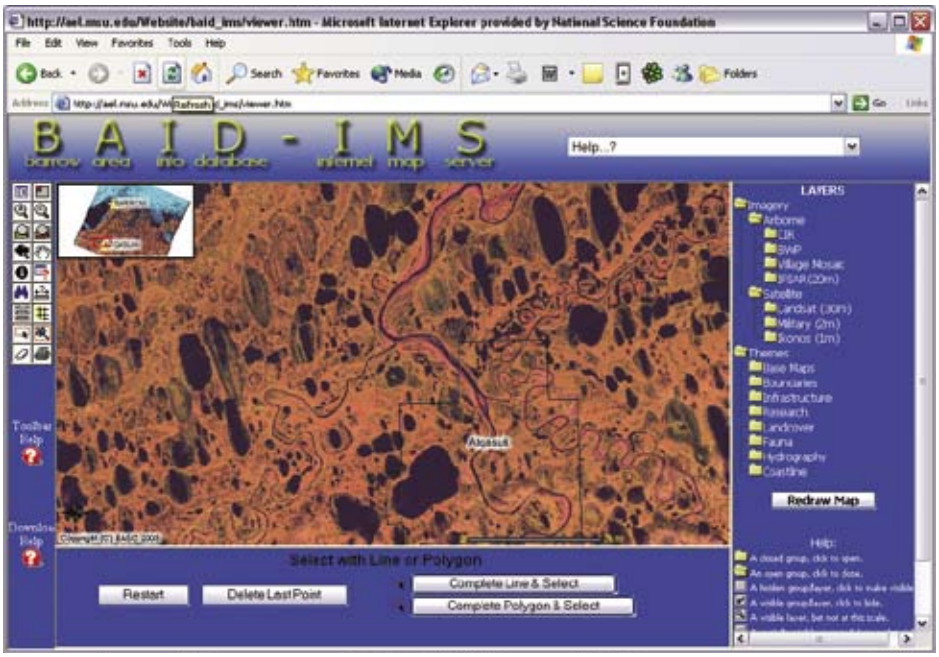
These efforts and others like them are driven by small groups of researchers and spatial data experts working together on focused activities. Since the 2001 workshop, two additional meetings have discussed future directions of arctic SDI, both regionally and encompassing the circumpolar Arctic. A meeting of opportunity was held on 30 October 2003 in Seattle, Washington, in conjunction with the SEARCH Open Science Meeting (see page 1) to discuss and gather input on implementation plans for improvements in arctic SDI, building on the 2001 meeting. The following day, a group of researchers and SDI experts met to discuss SDI advances specifically for the North Slope of Alaska. Summaries and information from these two meetings are available on the Arctic GIS web site (www.arcus.org/gis).

The Arctic GIS web site provides a platform for the exchange of information and ideas to encourage and catalyze further discussion and planning. The site includes:

- information from meetings convened to discuss arctic GII, including workshop reports and summaries, presentations, and agendas;
- annotated lists of relevant web sites;
- an online discussion forum for exchanging information and ideas, including open-ended, user-defined discussion threads and an avenue for moderated thematic discussions; and
- news and events.

The web site and other ongoing efforts in arctic SDI are supported by the RSL program, which funds SDI projects with potentially broad benefits to research or research support under the general solicitation for the Arctic Sciences Section (www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf03574).

For more information, see the Arctic GIS web site: www.arcus.org/gis, or contact Helen Wiggins at ARCUS (907-474-1600; fax 907-474-1604; helen@arcus.org) or Renée Crain at NSF (703-292-8029; fax 703-292-9082; rcrain@nsf.gov).



An example screen shot from the Barrow Area Information Database Internet Map Server (BAID-IMS; http://ims.arcticscience.org). Internet map server projects such as the BAID-IMS allow anyone with Internet access the ability to view, query, and analyze geospatial data in a simple graphical interface. This type of on-line GIS resource represents one of the many applications possible through arctic spatial data infrastructure (SDI) development.

Plans Move Forward for Alaska Region Research Vessel

Plans for securing a multicapable research vessel for the Alaska region are moving forward. The National Science Foundation successfully presented the Alaska Region Research Vessel (ARRV) to the National Science Board, and as a result it was approved for inclusion in the Major Research Equipment (MRE) budget request for FY05 or beyond.

With the preliminary design for the ARRV completed, NSF is supporting the preparation of the contract design. The design team from the Woods Hole Oceanographic Institution and the University of Alaska Fairbanks is working with The Glosten Associates of Seattle, with advice from a broad-based user committee. Plans call for completion of this phase by midsummer 2004.

The ARRV is proposed to replace the R/V *Alpha Helix*, which was commissioned in 1966 (see *Witness* Autumn 2001). The new ship will have many capabilities—fisheries research, oceanographic research, and coring among them. Specifically designed for working in Alaskan waters, the ARRV will be able to support scientific research from the seasonal pack ice of the Arctic Ocean to the stormy open waters of the Gulf of Alaska. It will measure 72 m (236 feet) in length, displace more than 3,150 metric tons, and accommodate up to 28 investigators. A major feature is the ability to work within seasonal sea ice year round. The ARRV will be able to slice through first-year sea ice up to 0.75 m (2.5 feet) thick and will easily transit ice ridges up to 2.1 m (7 feet) thick. Officially, the ARRV is rated as a Polar Class 5 ship under criteria proposed by the International Association of Classification Societies (IACS).

Powering the ship is an integrated diesel–electric power plant that generates AC power for the ship's electrical needs and delivers 5,750 horsepower to the ship's two ice-rated azimuthing Z-drive propellers. Each propeller is more than 2.4 m (8 feet) in diameter and is made of ice-rated stainless steel. A single 800-horsepower bow thruster gives the vessel the capability to maneuver in tight places or hold precise station in rough seas. The ship will be able to stay at sea for at least 45 days while spending 20–25% of the time in ice.

For more information contact Vera Alexander at the University of Alaska Fairbanks (907-474-7210; fax 907-474-7204; vera@sfos.uaf.edu).

This view of the ARRV concept design shows the ice-capable hull form, retractable centerboard for transducers, and twin azimuthing propellers. Illustration by John Farmer, Farmer Marine Design Services.

Arctic System Science Program Guided by Community

The Arctic System Science (ARCSS) Program began in 1989 as one of the 22 Global Change Research programs at NSF. An interdisciplinary program, ARCSS currently funds more than 120 projects. Most of its funding is directed to large integrated research projects that are proposed and implemented in response to science plans developed through community planning processes such as workshops, peer review of draft plans, and the work of science steering committees. The program as a whole is guided by the scientific community through the ARCSS Committee (see page 8).

Following the ARCSS All-Hands meeting in February 2002 (see *Witness* Spring 2002), the ARCSS Program began a transition from studies developed and overseen by disciplinary groups to an integrated research program directed more toward synthesis (see page 8). The following pages include information about the ARCSS synthesis process as well as the current status of several of the ongoing scientific initiatives supported by the ARCSS Program:

- the Western Arctic Shelf-Basin Interactions (SBI; see page 10),
- the Human Dimensions of the Arctic System (HARC; see page 11), and
- Pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP) and the allied Freshwater Initiative (see page 9).

A new ARCSS solicitation for Study of the Northern Alaska Coastal System (SNACS; see page 10) will also contribute to the Study of Environmental Arctic Change (SEARCH; see page 1).

For more information about the ARCSS Program, see the NSF web site: www.nsf.gov/od/opp/arctic/system.htm, or contact Program Director Neil Swanberg (703-292-8029; fax 703-292-9081; nswanber@nsf.gov).

Arctic System Synthesis Encourages Program Integration

Is the arctic system moving to a new state outside the envelope of the natural glacial–interglacial cycle? This "Big Question" emerged from the week-long retreat of 25 scientists representing most of the scientific disciplines working in the NSF Arctic System Science (ARCSS) Program. The August 2003 retreat in Big Sky, Montana, was an important step in the program's shift from component-oriented research to a primary emphasis on scientific synthesis.

Begun in 1989, the ARCSS Program's body of research now has matured sufficiently to begin assembling a true systems view of the Arctic. Participants at the February 2002 ARCSS All-Hands Workshop (see *Witness* Spring 2002) and the October 2002 ARCSS Committee meeting agreed that, with more than twelve years of research on various aspects of the arctic system, ARCSS is well-poised to undertake a focused synthesis. The fundamental goals of the ARCSS synthesis are to gain a more clear understanding of how the Arctic works as a system and as a component of the global system. The synthesis phase includes both a scientific synthesis and increasingly integrated implementation of the overall ARCSS Program.

The process of synthesizing the community's collective knowledge of the arctic system began at the All-Hands Workshop, with more than 300 ARCSS researchers participating, and continued with the Big Sky Retreat in August 2003. The retreat's goal was to distill and integrate available knowledge into a more holistic perspective of the arctic system. Scientists from a variety of disciplines investigating many components of the arctic system attended, and for most it was a tremendous learning experience—an opportunity to discuss commonalities and linkages with researchers who rarely cross paths: marine biologists with permafrost experts, atmospheric modelers with soil scientists, oceanographers with sociologists. This amalgamation of knowledge led to the realization that arctic change is pervasive, widespread, and dramatic, and hence to the "Big Question." Throughout the week, the participants worked together, each offering their own expertise and perspective, to determine whether, in fact, the Arctic is moving toward a new state. By the end of the week, participants reached near-unanimous agreement that the Arctic is likely moving outside the envelope of past experience—possibly toward a new state—and that we do not yet understand the implications for the Arctic, the global climate system, or human society. Participants also agreed that a state change could include major surprises and non-linearities, and that the implications could be wide-ranging and substantial for humans.

An important product from the retreat is a paper (in preparation) describing the motivation for the synthesis approach, as well as new insights from discussions at the Big Sky gathering. Discussions centered on the interwoven complexity of recent arctic change, how this fabric of change is tied to the larger global system, how it will unfold in coming years, and what the implications for humans may be.

Major questions raised at the retreat included: What are the primary drivers of the change? Which components of the system will experience the greatest impacts and what will they be? What are the dominant feedbacks among the key components, and will those feedbacks change if the Arctic shifts to a new state? Are we approaching a threshold in the climate system that may trigger an abrupt shift? Can we identify negative feedbacks that are strong enough to counteract observed changes during recent decades? Answers to these questions will not come from investigations targeting one component of the ecosphere. They require a broad, system-wide perspective, both past- and future-looking, that considers interactions among the ocean, atmosphere, biology, and human society.

Results from the Big Sky retreat were presented in a keynote address to the Study of Environmental Arctic Change (SEARCH) Open Science Meeting in October 2003 (see page 1) by Jonathan Overpeck on behalf of the ARCSS Committee and retreat participants. The presentation provided an overview of the ARCSS vision for synthesis and described the three main results from the retreat:

(1) a contrast between the arctic system state of today and the possible future scenario of a seasonally ice-free state,
(2) the current system-wide pattern of observed changes is a harbinger of a possible new system state, and positive feedbacks (and threshold responses) could accelerate state change in the future, and
(3) the research community should look outside the arctic system for thermostats and reining mechanisms that could retard or reverse arctic change.

The presentation ended with an outline of what the synthesis view could mean for society both within and outside the Arctic.

ARCSS Program Integration and Coordination

In concert with these scientific synthesis activities, in 2003 and early 2004 the ARCSS Committee and Neil Swanberg, the NSF program director, began the process of reorganizing the ARCSS Program with the overall goal of a more interdisciplinary, synthesis-based approach to understanding the arctic system through better integration of the many scientific disciplines contributing to ARCSS research.

The ARCSS Committee (AC) met for four days in February 2004 to discuss the ARCSS science goals for the next several years and strategies for a more integrated management and coordination structure. The committee recommended that the ARCSS Program emphasize an overview that the AC believes to be achievable only through interdisciplinary collaboration and that the program lower the emphasis on independent component studies developed by disciplinary groups, thus continuing the trends of increasing central coordination and decreasing support of disciplinary activities. The details of how this concept will be realized are still being developed. Over the next six to nine months, however, many of the day-to-day coordination and management tasks now being handled by various ARCSS science management offices will be gathered in a new ARCSS Management Office.

Centralized ARCSS coordination and management structures will not replace the

continued on next page

community-level science development that has been the hallmark of ARCSS over the years. Much thought is being given to processes that will enable individual ARCSS researchers and networked research communities to work together to bring forward ideas for consideration for ARCSS Program implementation. Developing a centralized coordination and management structure is intended to create clear, direct pathways for coordination and planning within the ARCSS research community, as well as with the ARCSS Committee and the NSF ARCSS Program.

The mechanisms through which the ARCSS Program will adopt research initiatives for implementation will include the emergence of key questions and identified priorities for research from the community, both informally and, at times, with more direct involvement of the AC. The AC will work directly with the community groups that are shaping research ideas into implementation plans and will guide the further development of the plans that will serve as the basis for ARCSS Program announcements of opportunity. The AC will prioritize recommendations from various communities, identifying research needs from an arctic system perspective, and will oversee the development of ARCSS research from the first stages of recommendations developed at the community level to implementation, the generation of data sets, synthesis of results, communication to the scientific and other communities, and integration into an overall understanding of the Arctic, its role in the global system, and the implications of change for human society.

For more information, see the ARCSS Committee web site: www.arcus.org/ARCSS/ARCSS.html, or contact Dan Ferguson (907-474-1600; fax 907-474-1604; dan@arcus.org).

The current members of the ARCSS Committee are:
Jonathan Overpeck (chair), University of Arizona;
Jennifer Francis, Rutgers University;
Lawrence Hamilton, University of New Hampshire;
Marika Holland, Nat'l Center for Atmospheric Research;
Glen MacDonald, University of California;
Craig Nicolson, University of Massachusetts;
Don Perovich, Cold Regions Research and Engineering Laboratory (CRREL), New Hampshire;
Mark Serreze, University of Colorado;
Matthew Sturm, CRREL, Alaska;
Charles Vörösmarty, University of New Hampshire, and
John Weatherly, CRREL, New Hampshire.
Neil Swanberg is the NSF ARCSS Program Director.

Arctic-CHAMP Coordinates Freshwater Initiative Projects

With support from the ARCSS Program (see page 7), the Science Management Office (SMO) for the Pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP) opened in June 2003. NSF established the Arctic-CHAMP program in 2001 (see *Witness* Spring 2003) to:

- improve understanding of arctic hydrology and its linkages with closely related atmospheric, terrestrial, and oceanic processes and cycles, and
- foster collaboration with the many relevant U.S. and international arctic research initiatives.

The first Arctic-CHAMP projects, funded in 2002 under the title Arctic Freshwater Cycle: Land/Upper-Ocean Linkages (also known as the Freshwater Initiative [FWI]), link NSF contributions across three programs:

- Arctic-CHAMP,
- the Arctic/Sub-Arctic Ocean Fluxes (ASOF) Programme (see *Witness* Winter 2000/2001), and
- the Study of Environmental Arctic Change (SEARCH; see page 1).

The 18 FWI projects, with four additional collaborative projects funded under other NSF programs, bring together atmospheric, terrestrial, and marine researchers to study the sources, fates, and variations in the pan-arctic freshwater cycle. The FWI projects represent an ARCSS contribution to SEARCH that will:

- explore decade-to-century variability of the arctic water cycle, and
- link land dynamics to ocean water mass and circulation through the stocks and fluxes of freshwater.

FWI synthesis projects focus on key components of the arctic freshwater cycle, including atmosphere, ocean, ice, snow, rivers, land, and modeling efforts.

Meetings and Plans

More than 45 people, including graduate students and technicians, attended a meeting of FWI investigators held in association with the SEARCH Open Science Meeting in Seattle in October 2003 (see page 1). The purpose of the meeting was to coordinate ongoing program activities and plan future integration efforts, and its minutes and agenda are available on the Arctic-CHAMP web site (http://arcticchamp.sr.unh.edu/newsandnotes.shtml).

The Arctic-CHAMP Science Steering Committee (SSC), co-chaired by Larry Hinzman at the University of Alaska Fairbanks and Charles Vörösmarty at the University of New Hampshire, met in December 2004 at the American Geophysical Union meeting in San Francisco. The 14 members of the SSC discussed:

- the status of the interdisciplinary implementation plan, due to be completed in early 2004,
- updates from the Science Management Office, and
- future synthesis efforts and products.

Ideas for future synthesis activities include a book focusing on the arctic freshwater cycle and a Freshwater Initiative Education Institute for undergraduate and graduate students interested in studying the arctic region.

The Arctic-CHAMP SMO is planning for a Freshwater Initiative All-Hands meeting 4–7 May 2004 in Woods Hole, Massachusetts. More information on the meeting is available on the Arctic-CHAMP web site.

For more information, see the Arctic-CHAMP web site: http://arcticchamp.sr.unh.edu, or contact SMO Executive Director Jonathan Pundsack (603-862-0552; fax 603-862-0587; jonathan.pundsack@unh.edu), Larry Hinzman (907-474-7331; fax 907-474-7979; ffldh@uaf.edu), or Charles Vörösmarty (603-862-0850; fax 603-862-0587; charles.vorosmarty@unh.edu). ■

Three SBI Cruises Collect New Data

The Western Arctic Shelf–Basin Interactions (SBI) is a multiyear, interdisciplinary program to investigate the impact of global change on physical, biological, and geochemical processes, including the production, transformation, and fate of carbon, over the Chukchi and Beaufort Sea shelf–basin region (see *Witness* Spring 2003). The project completed its second year of Phase II field work with three cruises in 2003:

- a Bering Strait mooring cruise in June,
- a survey cruise in July–August and
- a mooring turn-around cruise in September–October.

During the June cruise, investigators on the *Alpha Helix* recovered and redeployed three moorings originally deployed in the Bering Strait region during the first SBI mooring cruise in 2002. The year-long data from these moorings, along with high-resolution transects, will provide crucial information for understanding the input function of water types entering the Arctic Ocean through Bering Strait.

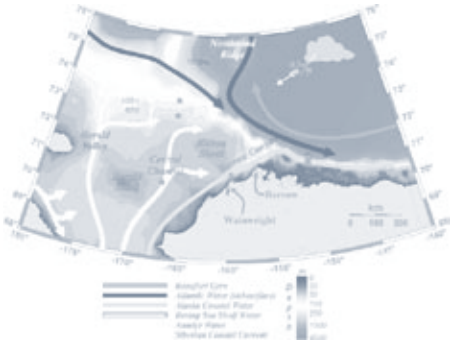
The high-resolution SBI survey cruise in July and August used the AARV *Nathaniel B. Palmer,* the first time that this Antarctic-based science vessel has worked in the Arctic. The cruise gathered data from more than 300 hydrographic stations in the Chukchi and Beaufort Seas and into the Canada Basin, providing unprecedented coverage of mid-summer physical and biochemical processes in the region. Key results confirm that Barrow Canyon is a focal point for biochemical products to be transported offshore, in addition to facilitating shelf-break transport. Off-slope in the Canada Basin, investigators observed very large water mass features, much larger than an eddy, with currents moving westward at over one knot. Cold core eddies, about 20 km wide, were also observed in temperature plots, indicating cold, Pacific-derived shelf waters entrained in offshore basin waters.

The third cruise aboard the USCGC *Healy* recovered and redeployed 12 moorings deployed in 2002 in the Chukchi and Beaufort Seas. The cruise also conducted surveys of the region, including net tows and plankton measurements, and recovered and redeployed acoustic recording devices for whale studies.

SBI investigators presented results at several meetings, including:

- the Alaska Eskimo Whaling Commission meeting in October 2003;
- the third SBI pan-Arctic meeting in November 2003;
- the American Geophysical Union Ocean Sciences meeting in January 2004; and
- a special SBI session at the Ocean Research Conference in February 2004.

Results indicate that high springtime sea ice and open-water-column algal production in the SBI region is transported



The circulation over the Chukchi Sea and Beaufort/ Chukchi slope, showing the three branches of inflowing Pacific water. SBI cruises are deploying moorings on transects across these currents. Illustration from S. Danielson and T. Weingartner, 2003.

to shelf ecosystems and offshore to the Arctic Basin during the summer through a variety of transport mechanisms and biological pathways. "Hot spots" of biological activity occur in regions of reduced current flow over the shelf and at the shelf break. How carbon produced in this system is transformed as it transits the shelf and slope and how its ultimate fate may change with changing ice conditions due to climate warming are key questions for the SBI study.

The intensive final SBI field season in 2004 will include an April helicopter survey, another cruise on the RV *Alpha Helix* in the Bering Strait, and three research cruises on the USCGC *Healy* from May–October. For more information, see the SBI web site: http://sbi.utk.edu, or contact Jackie Grebmeier (865-974-2592; fax 865-974-7896; jgrebmei@utk.edu).

New Program Directed at Coastal Zone of Arctic Alaska

The National Science Foundation has announced a new program entitled Study of the Northern Alaska Coastal System (SNACS). This solicitation seeks proposals focused on the arctic coastal zone of Alaska addressing one or more aspects of two coupled themes:

- How vulnerable are the natural, human, and living systems of the coastal zone to current and future environmental changes in the Arctic?
- How do biogeochemical and biogeophysical feedbacks in the coastal zone amplify or dampen change locally and at the pan-arctic and global levels?

Particular emphasis is placed on

- how coastal ecosystems (including human societies) respond to change originating from outside of the strictly defined coastal region, and
- how these responses feed back to the larger arctic and global systems.

This solicitation draws on the community planning embodied in the following science plans but should not be considered a replacement for, or the full implementation of, either plan:

- Land-Shelf Interactions Initiative (LSI): http://arctic.bio.utk.edu/screen_LSI_science_plan.pdf
- Pan-Arctic Cycles, Transitions, and Sustainability (PACTS): www.laii.uaf.edu/pubs/PACTS_Plan_screen.pdf

The research efforts resulting from this competition are expected to be a partial contribution to the Study of Environmental Arctic Change (SEARCH; see page 1).

The deadline for proposals was Thursday, 22 April 2004. For the full program announcement, see: www.nsf.gov/pubs/2004/nsf04545/nsf04545.htm.

For more information, contact Neil R. Swanberg (703-292-8029; fax 703-292-9081; nswanber@nsf.gov).

HARC Activities Develop Cohesive Research Community

The ARCSS Human Dimensions of the Arctic System (HARC) program has made significant progress in its evolution toward a robust and integrated contribution to arctic system science. Planning for a human dimensions component of the ARCSS Program began in the mid-1990s, and a community prospectus for research was published in 1997. The first NSF announcement of opportunity was issued in 1999 and the first HARC science management office (SMO) funded in 2001.

In addition to a growing body of published results from HARC research, several community-based activities have contributed to defining the HARC research agenda. Since its inception, the HARC SMO has worked with ARCSS researchers, human dimensions investigators, and arctic residents to identify important research on human–environment interactions in the Arctic; to improve the integration of HARC research into the ARCSS Program; and to link more effectively to the international human-dimensions research community.

A series of online workshops initiated in 2001 stimulated discussion among researchers, educators, and arctic residents and began the development of a set of thematic HARC research questions. An Integrated Analysis workshop in May 2003 identified approaches for integrating HARC research across disciplines, discussed methods for cultivating and planning synthesis, and forwarded suggestions for improving the preparation and review of interdisciplinary proposals to the ARCSS Committee and NSF. This process of articulating the scientific basis for HARC research, which is still underway, will result in several products, including a synthesis paper by several HARC PIs (in process) and a brochure describing HARC in the context of ARCSS as well as global human dimensions research (available summer 2004). The HARC research community also plans:

- a special session for the Fifth International Congress of Arctic Social Sciences in May 2004 (see page 14), and
- a dedicated issue of the interdisciplinary journal *Arctic* for spring 2005.

At a workshop on Patterns, Connections, and Methods in Human/Environment Interactions Research (see box) convened in conjunction with the SEARCH Open Science Meeting (see page 1) in October 2003, more than 100 participants discussed findings and identified promising directions for future research. The workshop planning committee, which includes arctic and non-arctic investigators with varied interests in human-dimensions research, has continued to advise on the development of HARC and has prepared recommendations to the ARCSS Committee (see page 8) on fostering and organizing human-dimensions research in ARCSS and on strengthening ties to the international human-dimensions research community.

Two of the three ARCSS projects funded in 2003 place significant emphasis on human dimensions of the arctic system. Both projects comprise interdisciplinary teams linking experienced ARCSS researchers and social scientists to address complex questions that are central to the themes of ARCSS and provide excellent examples of integrated HARC research:

- *Fire-Mediated Changes in the Arctic System: Interactions of Changing Climate and Human Activities*—F. S. Chapin, T. S. Rupp, A. D. McGuire, University of Alaska Fairbanks, and
- *The Intersection between Climate Change, Water Resources, and Humans in the Arctic*—D. M. White, L. D. Hinzman, L. Alessa, P. P. Schweitzer, University of Alaska Fairbanks and Anchorage.

The collective contributions of HARC researchers to date, shared most recently at the October 2003 workshop and synthesized in various forms, provide a solid foundation for human-dimensions research within ARCSS and for arctic researchers to be active contributors to the global human dimensions community. After three years of successful incubation activities, plans are underway for HARC science management to transition to a new home with direction and guidance more strongly centered within the research community.

For more information, see the HARC SMO web site: www.arcus.org/harc, or contact Dan Ferguson (907-474-1600; fax 907-474-1604; dan@arcus.org).

Workshop Explores Arctic Human Dimensions Research

The ARCSS Human Dimensions of the Arctic System (HARC) Program sponsored an interdisciplinary workshop entitled Patterns, Connections, and Methods in Human/Environment Interactions Research held 25–26 October 2003 in Seattle, Washington, to:

- identify challenges, compare experiences, and discuss ideas about conducting interdisciplinary human-dimensions research in the Arctic,
- provide a common forum for investigators to present ongoing research, share results, and receive feedback from colleagues, and
- compare theoretical and practical observations of diverse methodological and conceptual approaches applied to human–environment interactions in the Arctic.

The workshop aimed to articulate specific scientific challenges in the field of arctic human dimensions research, strengthen the community of researchers in that field, and identify connections to human dimensions research elsewhere in the world.

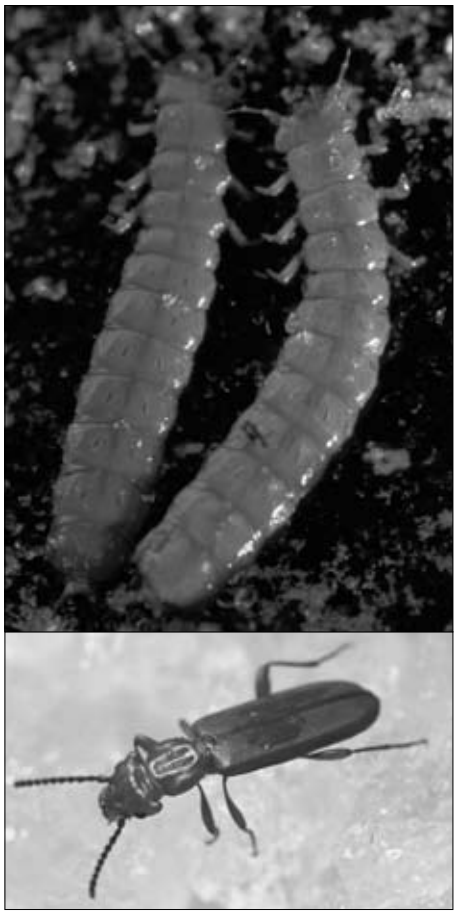
The 100 participants, 25 of whom were students, reflected a growing community of established scientists, arctic residents, and young investigators who share an interest in investigating how human interactions with the environment fit into the arctic system. Several investigators who work outside the Arctic participated in the workshop. The meeting's final report is available on the HARC web site (below).

For more information, see the HARC web site: www.arcus.org/harc, or contact Dan Ferguson (907-474-1600; fax 907-474-1604; dan@arcus.org.

Antifreeze Helps Insects Survive Arctic Winters

In cold regions, animals that cannot produce internal body heat survive subzero temperatures either by becoming freeze tolerant (able to freeze and survive) or by preventing freezing (freeze avoidance). Many freeze-avoiding animals produce antifreeze proteins (AFPs), first reported in Antarctic fish by DeVries in 1969. Since then, AFPs have been identified in a number of terrestrial arthropods, including spiders, mites, centipedes, and insects (Duman, 2001).

AFPs lower the freezing point of water in the presence of ice while not affecting the melting point; this difference between the freezing and melting points is termed thermal hysteresis. The magnitude of thermal hysteresis depends on the specific activity of the AFP, its concentration, and in some cases the presence of enhancers. AFPs lower the freezing point by adsorbing onto preferred surfaces of potential seed ice crystals, inhibiting their growth. AFPs also bind to, and thereby inhibit, ice nucleators, thus extending the organism's ability to supercool. A range of substances, including many proteins, can act as ice nucleators, which are surfaces on which an ice crystal can grow.



Flat bark beetles (C. clavipes) *can overwinter both as larvae (above) and as adults (below), but larvae are much more common. Observations indicate the beetle requires at least two years, probably more, to complete its life cycle in Alaska. Photos by Øivind Toien.*

No terrestrial arthropods from anywhere in the Arctic had been shown to have AFPs until the Arctic Natural Sciences Program funded Jack Duman of the University of Notre Dame, in collaboration with Brian Barnes at the University of Alaska Fairbanks, to investigate overwintering mechanisms in insects from arctic and subarctic environments. Integrating physiological ecology with biochemistry and molecular studies of highly cold-adapted organisms, their work demonstrates that AFPs are fairly common in insects, spiders, and centipedes from arctic and subarctic Alaska; about 30% of 77 species of Alaskan arthropods tested had AFPs. While most of these species avoid freezing, some are freeze tolerant to temperatures as low as –70°C. The function of the AFPs is not well understood in these freeze tolerant organisms, but the ability of AFPs to prevent recrystallization of ice is likely to be part of the answer.

Duman and Barnes have focused much of their effort on the flat bark beetle *Cucujus clavipes,* which Duman previously studied in northern Indiana. Because *C. calvipes* has an extremely wide latitudinal range—from Kentucky to latitudinal tree line in the Brooks Range in Alaska—they were able to compare populations from Alaska and Indiana. Mean supercooling points (SCPs, the temperature at which spontaneous freezing occurs) of both populations in summer are around –8°C. In winter, SCPs of larvae from northern Indiana decrease to only about –24°C, while those from Fairbanks had a mean SCP of –42°C, with some individuals freezing as low as –58°C. Even more amazing were *C. clavipes* from further north, near Wiseman on the south side of the Brooks Range. None of these larvae tested in the winter froze at –80°C, the lowest temperature of the laboratory freezing bath.

In addition to a number of AFPs, overwintering Alaskan populations produce high levels of cryoprotectant polyols (such as glycerol), greatly reduce their metabolism, and drastically dehydrate their tissues. Alaskan *C. clavipes* desiccate from 63.1% body water (1.70 g water/g dry weight) in August to 35.2% (0.53 g water/g dry weight) in January. While this 3.2-fold reduction in body water may cause water stress, it may also promote supercooling by both reducing water available for freezing and concentrating antifreezes. In fact, thermal hysteresis activity in the dehydrated *C. clavipes* is nearly twice that ever measured in any other organism.

Thus far, Duman's group has identified and sequenced seven different *C. clavipes* AFPs. Five of these have a structure that is quite similar to AFPs of other beetles that have been studied. They consist of repeated sequences of 12 and 13 amino acids in which certain positions are highly conserved. A repeating pattern of cysteine and threonine appears regularly on one side of the ß-helical protein. This structure allows the protein to adsorb to ice crystals because the hydroxyl residues of the threonines are spaced to provide a lattice match to oxygens on the prism and basal planes of ice. The sequences of the two other *C. clavipes* AFPs resemble this basic structure, but show some interesting differences that may account for the higher thermal hysteresis activity seen in this species.

Additional AFPs are likely to be identified in *C. clavipes* and other arctic arthropods. Possible applications of AFPs include cryopreservation of biomedical materials, food preservation, and agriculture. AFPs from Alaskan insects could prove to be outstanding candidates for these types of applications as well as excellent model systems for future studies.

For more information, contact Jack Duman (219-631-7496; fax: 219-631-7413; duman.1@nd.edu).

References

DeVries, A. L. (1969) Freezing resistance in some Antarctic fishes. *Science* 163:1073–1075.

Duman, J. G. (2001) Antifreeze and ice nucleator proteins in terrestrial arthropods. *Ann. Rev. Physiol.* 63:327–357.

Project Compares Changes in Bering Strait Communities

Funded by the Arctic Social Sciences Program, Change and Its Impact on Culture, Economy, and Identity in Three North Bering Strait Alaskan Iñupiat Societies is a comparative, multigenerational study of change over the past 70 years in the communities of Little Diomede Island, King Island, and Wales. The three communities are distinguished by

- individual sociocultural, political, and economic histories;
- access to resources; and
- location.

The Wales Native community lives on Wales (Kingegan) homeland territory on the northwestern edge of the Seward Peninsula. The Diomede Native community resides in the homeland village of Ingaliq on Little Diomede Island's western shore, a mile from the Russian border and International Dateline. Members of the King Island Native diaspora began to leave King Island in the late 1950s and now live in the regional center of Nome and elsewhere.

To provide temporal, cultural, and comparative depth, the collaborative project's research team employs an array of sociocultural data-collecting methods, including extensive audiotaping of interviews and archival research on past tradition and practice in the three communities. Project director Carol Jolles (University of Washington) leads the Diomede component, Deanna Kingston (Oregon State University), who is a King Island Native descendant, leads the King Island component, and Wales Native Herbert Anungazuk (National Park Service) leads the Wales component. Local community consultants contribute to the project by recording their subsistence learning experiences and helping to produce subsistence-resources charts, cultural maps, and drawings that reflect physical changes over several decades. By working with elders, young to middle-aged adults, and teenagers, investigators hope to reveal generational differences in each community, while comparisons among the three study communities will detect differences in cultural change across the region.

Because the research focuses particularly on changes in subsistence practices and on the transmission of subsistence-related knowledge that impacts identity, interviews highlight changes in cultural expressions of identity such as dance and song, changes in direct attachment to and reliance upon local landscapes, and especially, changes in domestic hunting economies. For example, interviews indicate that members of the Nome-based King Island Native community rely on Nome's two supermarkets for food but travel seasonally by truck or car to the community's camp at Cape Woolley, 40 miles north of Nome, to hunt and fish. Wales hunters, who once depended on walrus as a major resource, now feed their families on a diet that includes muskoxen, reintroduced onto the Seward Peninsula in the 1980s, seal, bearded seal, the occasional walrus, and reindeer meat supplied to the Wales Native Store by the owners of the Wales reindeer herd. While Wales men still hunt, both hunters and their wives depend on wage employment for cash to purchase imported groceries and reindeer meat. Hunters in the Diomede community rely quite heavily on marine mammal hunting, but no longer routinely take to the ice on foot to search for seals and *ugruuk* (bearded seal), preferring instead to hunt from motorized boats and snowmobiles, a practice that limits the hunting season and changes the social dynamics of the hunt.

Project consultant Arthur Ahkinga of Diomede shows a pair of traditional mukluks. Photo courtesy of Carol Zane Jolles.

The research team has completed nine trips since the project's inception in October 2001 and has several more planned for Year 3 of the project. Committed to full data exchange, the researchers return data notebooks of transcribed interviews, maps, and drawings co-produced by the research team and community consultants to all households in the constituent communities. These are distributed to each household, to local agencies and schools, and to the Bering Strait School District. The research has contributed to school curriculum design and generated a potential researcher–community educational partnership with the school district. Other education and outreach components include working with Diomede and Wales classes on social science activities and exposing constituent households and students to social science research.

The project also hosted Dena Gershon, a teacher from North Hollywood, California, as part of the 2001–02 Teachers Experiencing Antarctica and the Arctic (TEA; see *Witness* Spring 2003) Program. Gershon's journal of her experiences with the project is available at http://tea.rice.edu/tea_gershonfrontpage.html#calendar.

For more information contact Carol Zane Jolles (206-543-7397; fax 206-543-3285; cjolles@u.washington.edu).

Workshop to Focus on Community-Research Partnerships

Partnerships Between Researchers and Arctic Communities, a special workshop session during the International Arctic Social Sciences Association (IASSA) Fifth International Congress of Arctic Social Sciences (ICASS V), will focus on the many valuable collaborations between arctic communities and researchers. Sponsored by the NSF Arctic Social Sciences Program and scheduled for 22–23 May 2004 in Fairbanks, Alaska, the workshop is organized through a partnership between the Alaska Native Science Commission (ANSC) and the Arctic Research Consortium of the U.S. (ARCUS). ICASS V meets 19–23 May 2004 on the University of Alaska Fairbanks campus.

As the social and physical environments of the Arctic change rapidly and access to areas of the former Soviet Union improves, arctic communities have been the subject of increasing research interest, with scientific agendas driven not only by the interests of outside investigators but by arctic residents themselves. Instead of objects of study, arctic communities have become full partners in research with specific needs and objectives.

Partnerships Between Researchers and Arctic Communities will examine the process of partnership: how it works, what the challenges are, how partners complement each other, and what the successes and failures are from each partner's point of view—rather than focusing on research results. Several teams working with arctic communities on projects that serve the goals and interests of both will discuss their partnering experiences at the workshop.

Other ICASS V Sessions

The ICASS V theme is Connections: Local and Global Aspects of Arctic Social Systems. In addition to the partnership workshop, the meeting will feature panels on:

- planning for the International Polar Year 2007–08 (see page 23), and
- Considerations for Human Subject Protection.

Individual sessions will include Circumpolar Perspectives on People and Deer, Gender Issues, Globalization and Self-Determination, Locating Circumpolar Environmental Change, Paleolithic and Mesolithic Prehistory, and Social Conditions in the Arctic.

Keynote speakers for ICASS V include:

- Larissa Abryutina, Russian Association of Indigenous Peoples of the North;
- Fikret Berkes, University of Manitoba;
- Dalee Sambo Dorough, Inuit Circumpolar Conference Advisory Committee on United Nation Issues;
- Tim Ingold, University of Aberdeen; and
- Georgianna Lincoln, state senator from Rampart, AK.

IASSA organizes international congresses every three years to share ideas about social science research in the Arctic. More than 300 participants from 17 different countries attended ICASS IV, in Quebec City, Canada, in May 2001.

For more information on the Partnership workshop, see the ARCUS web site: www.arcus.org/ASSP_workshop/2004_workshop.html, or contact Sue Mitchell at ARCUS (907-474-1600; fax 907-474-1604; sue@arcus.org) or Patricia Cochran at ANSC (907-258-2672; fax 907-258-2652; pcochran@aknsc.org).

For more information on ICASS V, see the IASSA web site: www.uaf.edu/anthro/iassa, or contact conference coordinator Pips Veazey (907-474-5171; fax 907-474-6370; fyicass@uaf.edu) or IASSA executive officer Anne Sudkamp (907-474-6367; fax 907-474-6370; fyiassa@uaf.edu).

NSF Solicits Proposals for Studies in Human and Social Dynamics

NSF has released an announcement for a new research priority area of interest to social scientists. The Human and Social Dynamics (HSD) priority area aims to foster breakthroughs in knowledge about human action and development as well as organizational, cultural, and societal adaptation and change. One of the crosscutting programs at NSF, the HSD priority area will extend for five years.

HSD aims to increase our collective ability to anticipate the complex consequences of change, to better understand the dynamics of human and social behavior at all levels, to better understand the cognitive and social structures that create and define change, and to help people and organizations better manage profound or rapid change. Accomplishing these goals requires a comprehensive, multidisciplinary approach across the sciences, engineering, and education, including the development of infrastructure that can support such efforts.

The FY 2004 competition will include three topical emphasis areas:

- Agents of Change,
- Dynamics of Human Behavior, and
- Decision Making and Risk.

It will also include three resource-related emphasis areas:

- Spatial Social Science,
- Modeling Human and Social Dynamics, and
- Instrumentation and Data Resource Development.

Support will be provided for research-focused, education-focused, infrastructure-focused, and exploratory projects. NSF estimates that 40 to 60 awards will be granted across all emphasis areas, including 16 to 20 research-focused awards, 8 to 14 education-focused awards, 4 to 6 infrastructure-focused awards, and 12 to 20 exploratory awards. A total of $18 million will be awarded.

Letters of intent were required by 3 March 2004, followed by full proposals on 30 March 2004. The announcement of opportunity is available on the NSF web site: www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04537.

For more information, contact Arctic Social Sciences Program Director Anna Kerttula (703-292-8029; fax 703-292-9082; akerttul@nsf.gov).

U.S. Arctic Research Commission Opens Alaska Office

The U.S. Arctic Research Commission (USARC) saw many changes in 2003, including opening a new office in Alaska, moving the headquarters office in Virginia, and welcoming two new commissioners to the organization.

In August 2003, Susan Sugai joined the commission. Sugai earned her Ph.D. in oceanography at the University of Alaska where she is now associate director of the Alaska Sea Grant College Program and is on the research faculty, studying the biogeochemical cycling of natural and anthropogenic compounds in marine, aquatic, and terrestrial ecosystems in Alaska.

In November, the addition of Duane Laible completed the commission's roster. Laible chairs the board of The Glosten Associates, a consulting engineering firm that he joined in 1971. The firm serves the major oceanographic research institutions and has helped the Office of Naval Research and NSF in defining requirements for next-generation research vessels (see page 7). Laible has also served as an advisor to USARC.

The USARC opened a new Alaska office in Anchorage in August 2003, with Lawson Brigham as its director. In November, the USARC headquarters moved to a new office in the same building in Arlington, Virginia. Current contact information is available on the USARC web site.

While USARC continues to address the goals in its biannual Report on Goals and Objectives for Arctic Research, two major issues were central to the work of the commission in 2003. Regarding the U.N. Convention on the Law of the Sea (UNCLOS; see page 25), USARC participated in two Congressional hearings and meetings at the U.S. Department of State, at the U.S. Navy, and with industry and environmental groups. At the end of the second Congressional hearing, Senator Lugar (R-Indiana) announced he will act early in 2004 to encourage the U.S. Senate to ratify the treaty, thus allowing the U.S. to join UNCLOS. Emphasizing the issue's importance, USARC Executive Director Garry Brass said, "the coming year will be the first year that the treaty will be open for amendments. The U.S. should be a member of UNCLOS, then we'll have 10 years to file claims for extensions to continental margins under U.N. Article 76. Gathering data to support U.S. claims in the Arctic is a major issue that the commission supports."

The second major issue is polar class icebreakers. NSF conducted a town meeting at the December 2003 American Geophysical Union meeting to discuss the possible design and construction of a new Antarctic icebreaker. This could potentially benefit arctic science if the need for the USCGC *Healy* in the Antarctic is decreased and if the new icebreaker is configured to be used for arctic cruises as well.

For more information, see the USARC web site: www.arctic.gov, or contact Garry Brass (703-525-0111; fax 703-525-0114; g.brass@arctic.gov).

PRB Reports Address Effects of Oil and Gas, Polar Biology

Two recent reports from the National Academies' Polar Research Board (PRB) have relevance to arctic researchers and residents:

Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope is a comprehensive examination of the known and probable future cumulative effects of oil and gas exploration and development on the physical, biological, and human environment. Clearly, northern Alaska's environment and culture have been significantly affected by oil infrastructure and activities. Benefits to North Slope residents include jobs and improved medical care and schools, but have been accompanied by environmental and social consequences, including the effects of roads, infrastructure, and related activities on the land, plants, animals, and peoples of the North Slope and adjacent marine environment. Which of these impacts are cumulative? This report looks in detail at issues such as the impacts of roads and pipelines, damage to tundra from off-road travel, effects on specific animal populations (including whales and caribou), social changes in North Slope communities, and aesthetic, cultural, and spiritual consequences. Its findings and recommendations are diverse; they identify major cumulative effects, probable future effects, and highlight knowledge gaps.

Frontiers in Polar Biology in the Genomic Era examines the study of biology in polar regions and how the maturing of genomic science and other technologies will revolutionize polar biology. These new tools allow the study of an incredible array of important questions, both fundamental and practical, including the evolution of organisms that thrive in extreme cold, their interactions as biological systems, and their capacity to adapt to change. The report identifies key questions in polar biology related to the evolution and biodiversity of polar organisms, polar physiology and biochemistry, polar microbial communities, and assessment and remediation of human impact on polar ecosystems. The report also addresses enabling technologies, facilities, and infrastructure. Its findings and recommendations lead to a call for a polar genome science initiative.

For more information, see the PRB web site: http://national-academies.org/prb, or contact Chris Elfring (202-334-3426; fax 202-334-1477; celfring@nas.edu). National Academies reports are available at www.nap.edu or 800-624-6242.

Final 2004 NSF Budget Increases 3.9%

On January 23, President Bush signed the omnibus appropriations bill that includes the FY 2004 NSF budget. The bill provides $5.6 billion for NSF, an increase of 3.9% or $208 million over FY 2003 and $97 million more than the president's 2004 budget request. Although the 2002 NSF Authorization Act calls for a doubling of the NSF budget between FY 2002 and FY 2007 (see *Witness* Spring 2002), the FY 2004 appropriation falls $1 billion short of the authorized $6.6 billion funding level.

The Research and Related Activities account receives $4.3 billion, 5.5% or $222 million more than FY 2003. The research directorates receive increases between 3% and 7.4%. The Office of Polar Programs receives $343 million, an increase of 7.4% or $24 million. Of this, the Arctic Research Program's estimated budget of $44 million is a 14.6% increase over FY 2003. This increase consists largely of $5.8 million designated by the Senate "to support SEARCH [Study of Environmental Arctic Change] infrastructure needs, including research support for the Barrow Arctic Research Facility" (Senate Report 108-143). The Arctic Research Support and Logistics Program increases by 3.5% to $31.4 million. The relevant Conference Committee report (H.R. 108-401) directs NSF to "provide details on the funding levels for research and logistics within the U.S. Polar Research Programs in the FY 2004 operating plan."

NSF's Education and Human Resources (EHR) programs receive $939 million, 0.4% above FY 2003, including $140 million for Math and Science Partnerships, $95 million for the Experimental Program to Stimulate Competitive Research (EPSCoR), and $25 million for the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP). Started last year with a budget of $2 million, the STEP program seeks to increase the number of U.S. citizens or permanent residents earning undergraduate degrees in science, technology, engineering, and mathematics.

Funding for the Major Research Equipment and Facilities Construction (MREFC) account is $155 million in FY 2004, below the $202 million request, and funds five of seven requested projects, including the IceCube Neutrino Detector Observatory in Antarctica ($42 million) and construction on South Pole Station ($1.3 million). Congress declined to fund two MREFC projects: the High-Performance Instrumented Airborne Platform (HIAPER) and the National Ecological Observatories Network (NEON), a system of research facilities and instruments for integrated environmental observations (see *Witness* Spring 2000). The Major Research Instrumentation program within Integrative Activities receives $110 million, a $27 million increase.

FY 2005 Budget Request

In early February, the president submitted his FY 2005 budget request to Congress. The NSF request is $5.745 billion, a 3% overall increase above the FY 2004 budget. The 2005 request for the Research and Related Activities account increases by 4.7% to $4.452 billion.

The budget request for Polar Programs is $350 million, an increase of 2.2% over FY 2004. The request for the Arctic Research Program is $44.9 million, a 2% increase, and the request for the Arctic Research Support and Logistics Program is $32.12 million, an increase of 2.3%.

The 2005 NSF budget seeks funding for six major research facilities:

- $12 million for NEON,
- $40.85 million to outfit a new research vessel to support the international Integrated Ocean Drilling Program,
- $30 million for the Rare Symmetry Violating Process project at the Brookhaven National Laboratory,
- $49.67 million for the Atacama Large Millimeter Array in Chile,
- $33.4 million for the IceCube Neutrino Observatory, and
- $47.35 million for Earthscope, a nationwide geological observatory network.

The 2005 budget request also includes a 14.6% increase for the Long Term Ecological Research Program, to $18 million, and $363 million for Organizational Excellence, an NSF strategic goal that emphasizes the use of sound business practices in administration.

NSB Calls for $19 Billion Budget

According to a report from the National Science Board (NSB) released in February, the NSF budget must reach $19 billion to bring the federal investment in basic research and education to a level that will sustain future U.S. leadership in science and technology. The report responds to Section 22 of the 2002 NSF Authorization Act (see *Witness* Spring 2002), which directs the NSB to address and examine the budgetary and programmatic growth provided for by the act. That act authorizes increasing NSF funding to $9.8 billion by FY 2007. The NSB report identifies six priority recommendations for NSF investment if the authorized funding increase is appropriated:

- improve the productivity of researchers and expand opportunities for students, primarily by increasing the size and duration of awards;
- open new frontiers in research and education, including exploring novel research approaches and developing technologies;
- build a diverse, competitive, and globally engaged U.S. science and engineering workforce;
- increase the number and diversity of institutions that participate in NSF-funded activities;
- provide scientists and engineers with advanced tools, facilities, and cyberinfrastructure (see page 4); and
- maintain NSF's excellence in management.

The report also analyzes the full extent of the research and education needs that are not currently being met and determines that the NSF budget must be increased to nearly $19 billion to address them fully.

The NSB is made up of 24 members appointed by the president to provide advice on U.S. science and technology issues to Congress and the president.

For more information on the NSF FY 2004 and 2005 budgets, see the NSF Budget Division web site: www.nsf.gov/bfa/bud. For more information on the NSB report, see the NSB web site: www.nsf.gov/nsb.

Polar Attraction: Linking Polar Science with Education

At the American Geophysical Union meeting in December 2003, a special session titled Polar Attraction: Linking Polar Science with Education and Outreach explored the potential of using polar research to engage people in understanding and appreciating science. The session brought polar authors, journalists, and museum curators together with scientists, educators, and NSF program managers.

Presentations focused on how to produce effective programs that engage different audiences: K–12, undergraduate, and the general public. Presenters recommended linking research with the broader themes of exploration, discovery, adventure, isolation, hardship, passion, self-reliance, and exotic landscapes and biota. For example, Mary Miller, of the San Francisco Exploratorium and "Live from Antarctica," demonstrated how effective it can be to connect museum visitors with an adventure and the passions of scientists for their research.

Robert Wharton, of the NSF Office of Polar Programs, presented a suite of options for funding and encouraged the polar scientific communities to look for additional avenues to bridge their research with education. Don Perovich, Cold Regions Research and Engineering Laboratory, said, "Don't just talk about things, find ways to get kids involved in doing them." The poster session highlighted a number of other approaches to linking polar science with education and outreach and provided an opportunity for participants to discuss successes and failures and to brainstorm on future directions.

NSF has funded a workshop planned for June 2004 called Bridging the Poles: Education Linked with Research to build on the information gained in this special session and in two previous workshops on similar topics (one on polar K–12 education in 1997, and one on arctic science education in 2000; see *Witness* Spring 1998 and Spring 2002). The objective of the new workshop is to develop a strategy that will

- enable polar scientists to conduct meaningful education and outreach, and
- help educators to include polar research in their classrooms.

The workshop will define future directions for polar education, including needed infrastructure, that will also maximize the educational impact of the International Polar Year beginning in 2007 (see page 23). The goal is to build stronger partnerships between the arctic and Antarctic scientific communities, and between education and polar research, in order to engage the next generation of scientists, engineers, and leaders as well as to educate the general public about polar regions.

For more information, contact Stephanie Pfirman (212-854-5120; spfirman@barnard.columbia.edu) or Robin Bell (robinb@ldeo.columbia.edu).

A young student prepares for an arctic field experiment. Photo by Don Perovich.

New Program Brings Teachers to Field Research

In February 2004, ARCUS initiated a new program supporting research experiences for educators called Teachers and Researchers Exploring and Collaborating (TREC). Ten K–12 teachers were selected to join TREC, working closely with scientists on arctic field research projects. To begin their collaborations, the research teams and teachers participated in orientation "webinars" (web-based seminars) held in March.

Each teacher will travel to a project's field site to collaborate with investigators, integrating research and education and infusing inquiry-based science into classrooms and communities. Teachers will share their experiences through online journals and other information posted on the TREC web site, which also includes relevant curriculum resources and learning activities. This collaboration invigorates science teaching and learning and instills in young people an enthusiasm for science, inquiry, and working together to address questions important to their communities.

TREC provides professional development for teachers who participate in field research projects as well as educators who connect through the Internet. TREC teachers participate in a collaborative learning community of educators and researchers through a reciprocal exchange of experience and knowledge between researchers and educators.

TREC is an interim program, building on the valuable lessons of the Teachers Experiencing Antarctica and the Arctic (TEA) program, which was funded by the NSF Education and Human Resources Directorate and the Office of Polar Programs (OPP). Funding for TREC is provided by OPP, with logistical support from VECO Polar Resources (see page 5).

For more information, see the TREC web site: www.arcus.org/trec, or contact Helen Wiggins at ARCUS (907-474-1600; fax 907-474-1604; helen@arcus.org).

UArctic's north2north Student Mobility Program Grows

Launched in June 2001, the University of the Arctic (UArctic) is a cooperating network of universities, colleges, and other organizations committed to higher education and research in the Arctic (see *Witness* Spring 2003). The nearly 60 UArctic members from across the circumpolar North share resources, facilities, and expertise to build postsecondary education programs that are relevant and accessible to northern students. UArctic programs promote the development of shared knowledge and understanding, access to education, and sustainable practices in the Arctic. UArctic initiatives currently underway include:

- online undergraduate courses about the North for circumpolar students,
- an online catalog of northern field courses, and
- circumpolar Ph.D. networks in environmental and social sciences.

As part of its efforts in improving access and mobility, UArctic developed north2north student mobility, a multilateral exchange program for students registered at any of 23 participating UArctic institutions (see box). Through an international network of national agencies, north2north supports exchanges for periods from 3–12 months. Course credits transfer from the host institution to the student's home institution. North2north aims specifically to include:

- undergraduate students, who are still developing their ideas about the Arctic;
- students from smaller communities; and
- indigenous students.

The pilot phase of the program began in September 2002. Sixteen students participated in north2north in 2002–03, and more than 23 in 2003–04. Following completion of the two-year pilot phase, representatives of participating students, institutions, national agencies, and governments met in January 2004 to begin an internal evaluation of the program. The evaluation report will be released this spring.

Also in January 2004, the first Canadian students joined north2north, beginning exchanges at UArctic institutions in Finland and Norway. About 50 students are expected to participate in 2004–05, the program's first full year of operation.

The Arctic Research Consortium of the United States (ARCUS) recently agreed to serve as the U.S. national agency for the north2north program. More information, including eligibility, guidelines, and applications for the north2north program, is available on the UArctic web site (www.uarctic.org). Applications for north2north are due on 15 January each year.

Institutions Participating in UArctic's north2north Mobility Program

Canada
- Lakehead University, Thunder Bay, Ontario
- Nunavut Arctic College, Arviat
- Université Laval, Quebec City
- University of Northern British Columbia, Prince George
- University of Saskatchewan, Saskatoon
- Yukon College, Whitehorse

Finland
- Kemi-Tornio Polytechnic
- Oulu Polytechnic
- Rovaniemi Polytechnic
- Saami Education Center, Inari
- University of Lapland, Rovaniemi
- University of Oulu

Iceland
- University of Akureyri

Norway
- Bodø Regional University
- Finnmark University College, Alta
- Saami University College, Kautokeino
- The University College of Tromsø
- University of Tromsø

Russia
- Murmansk Humanities Institute
- Sakha State University, Yakutsk

Sweden
- Luleå University of Technology
- Umeå University

USA
- University of Alaska Fairbanks

Funding sources

UArctic's funding strategy is based on a model of core funding shared among the eight arctic states, and this approach is showing some success, including:

- Finland's support for the UArctic International Secretariat since the network's founding;
- in December 2003, the Norwegian Parliament allocated €535,000 (about $643,000 USD) for UArctic activities, including north2north; and
- in November 2003 Human Resources Development Canada announced $441,474 CDN (about $328,000 USD) designated to support Canadian students' participation in north2north.

U.S. and European Community (EC) UArctic institutions plan to seek support for north2north exchanges from the EC/US Cooperation Program in Higher Education and Vocational Education and Training, a joint program of the U.S. Department of Education and the EC Directorate General for Education and Culture.

Other UArctic Exchange Programs

North2north is one of UArctic's emerging set of circumpolar mobility programs, which offer opportunities for students and faculty to gain first-hand experience of other northern regions and homelands. The mobility program for faculty, which is currently under development, will be known as the Northern Teaching Resources Exchange (northTREX). A Mobile Faculty Roster—a catalogue of scholars interested in short- or long-term teaching residencies on UArctic campuses—also facilitates the exchange of northern educators.

The UArctic Council, which directs program development and delivery, will meet on the University of Alaska Fairbanks campus 15–19 May 2004. The council includes representatives of all UArctic member institutions.

For more information, see the UArctic web site: www.uarctic.org, or contact Kayt Sunwood at ARCUS (907-474-1600; fax 907-474-1604; sunwood@arcus.org).

BASC Brings Science to Schoolyard Saturday

Since starting its Schoolyard Saturday program in April 2002, the Barrow Arctic Science Consortium (BASC) has organized more than 75 Saturday afternoon presentations for students and the public on the North Slope of Alaska. Aiming to make science accessible and relevant to students, the presentations focus on scientific issues of interest to the Barrow community and are usually given by an investigator with an active local research project.

Each presenter is paired with a local teacher, who assists in the presentation if necessary and helps in advance to plan it on a level suitable for students. Sometimes the teacher's job has added responsibilities, as when one student fainted during a seal dissection. About 20 educators have worked with Schoolyard Saturday presenters to date.

Attendance has risen as the program has started to become a community institution; from November 2002–November 2003 recorded attendance was 1,277—about 28% of the Barrow population. Actual attendance is higher, since not everyone signs in at these informal events. Average attendance in 2003 has been 32 people, usually about one-third of them students.

Recent Schoolyard Saturday presenters and topics have included:

- Klaus Meiners on mucus in marine habitats;
- Kathy Turco on arctic acoustics;
- Kathleen Crane on arctic exploration in the 21st century;
- Ron Greeley on solar system exploration;
- Geoff Carroll on musk ox reintroduction;
- Ben Holt on sea ice thickness; and
- Matthew Sturm and Jim Maslanik on ice and snow measurement from satellites.

Local author and school board member Debbie Edwardson and translator Ida Olemaun, also a school board member, recently read the Iñupiaq and English versions of Debbie's book *Whale Snow.*

Schoolyard is part of BASC's extensive efforts to bring scientists and the community together. Funding comes from the NSF Arctic Long-Term Ecological Research program, based at Toolik Field Station, and the NSF Cooperative Agreement with BASC. Hopson Middle School teacher Jill Exe serves as Schoolyard Saturday coordinator for BASC. BASC provides transportation for Schoolyard Saturday from town to the UIC Science Center at the UIC–NARL Facility, which is several miles north of Barrow. ARCUS and BASC hope to begin remote videocasts of Schoolyard Saturday in 2004.

Klaus Meiners (Yale) takes a core sample of the ice on the Arctic Ocean as part of Christopher Krembs' (University of Washington) ongoing project to study the impact of sea ice microbes on sea ice properties. Scotty Oyagak (BASC), and Isabel Edwardson (Barrow High School) look on. Photo by Leslie Pierce.

Schoolyard Saturday sponsors field activities for students as well. Barrow High School students have an ongoing effort based in the Barrow Environmental Observatory (BEO) that includes a year-round meteorological station and a growing-season climate change experiment modeled on one at Toolik Field Station. Recently some of the students and a science teacher visited Toolik on a familiarization tour. The students have produced a science poster and presented it at a national education meeting.

BASC also organizes evening presentations by researchers, places local students with field research projects, takes scientists into schools across the North Slope, and works with village schools in Chukotka, Russia. BASC provides several NSF-related traveling exhibits to the UIC Science Center and coordinates collection of scientific materials there. Researchers planning to visit the North Slope are encouraged to contact BASC and participate in its educational and outreach activities.

For more information, including previous speakers and topics, see the BASC web site: www.arcticscience.org, or contact BASC Executive Director Glenn Sheehan (907-852-4881; fax 907-852-4882; basc@arcticscience.org).

Science for Alaska Lectures Draw Record Crowds

For twelve years, the University of Alaska Fairbanks Geophysical Institute has hosted the Science for Alaska free public lecture series, with additional financial support from the University of Alaska and the Alaska Science and Technology Foundation. A record-breaking 8,800 Alaskans attended the lectures in January through March 2003, and judging from the capacity crowds in early 2004, it appears that record is about to be broken.

Lectures in 2004 include presentations on the aurora, bears, wolves, astronomy, earthquakes, and lightning and fire. The lecture series was designed to bring cutting-edge research to the general public. Lecturers travel to Anchorage, Fairbanks, and Juneau to share their expertise.

In addition to the education outreach effort, teachers attending the lecture series in Fairbanks and Anchorage can earn credit toward maintaining their teaching certificates through participation in a training workshop. This special course is designed to train educators in how to incorporate the research featured at the lectures effectively into classroom lessons and activities. This opportunity increases the skills of Alaska's teachers and brings current scientific research to Alaska's primary and secondary schools.

For more information, see: www.scienceforalaska.com, or contact Amy Hartley at the UAF Geophysical Institute Public Information and Education Outreach Office (907-474-5823; fax 907-474-7344; info@gi.alaska.edu).

Center for Northern Studies Merges with Sterling College

The Center for Northern Studies, a 30-year-old, nonprofit institution in Vermont for research and education on all aspects of the far North, recently merged with Sterling College, a private, four-year, environmental college offering academic programs in northern studies, outdoor education and leadership, sustainable agriculture, and wildlands ecology and management. The newly established Center for Northern Studies at Sterling College will continue to:

- offer study-away options to students from other colleges,
- provide additional course options to current Sterling College students, and
- attract students from international and indigenous communities of the North.

In addition, the center will provide opportunities for educators and other community members to learn more about northern studies through:

- a local lecture series,
- access to a resource library specializing in the North, and
- enrollment in courses and field-study programs.

Mission

The Center for Northern Studies at Sterling College integrates field research with educational programs addressing the ecosystems and people of arctic and subarctic environments and the challenges of sustainable interaction in a global society.

The center's educational philosophy is founded upon the belief that individuals who help in deciding the future of northern regions must bridge traditional disciplines. The center offers a personal academic experience that combines formal academic work in natural science, anthropology, political economy, law, and humanities with comprehensive fieldwork. The center campus, located close to Sterling College, includes the 350-acre Bear Swamp, an exceptional example of boreal forest and muskeg. This accessible site provides an ideal environment for investigation of regions that are geographically much farther north. Field-study programs to Iceland, Labrador, Newfoundland, and the Scottish Isles provide hands-on experience and immersion in northern culture. An excellent faculty with more than three decades of experience in northern research and education facilitate this unique and intensive opportunity to investigate the environment, peoples, and cultures of the circumpolar North.

For more information, see the Center for Northern Studies at Sterling College web site: www.sterlingcollege.edu/cns, or contact Erik Hansen (800-648-3591; fax 802-586-2596; north@sterlingcollege.edu or ehansen@sterlingcollege.edu).

Iceland Hosts Arctic Science Summit Week 2004

The Icelandic Centre for Research (RANNIS) organized the 2004 Arctic Science Summit Week (ASSW) in Reykjavik, Iceland, 21–28 April 2004, with support from the Icelandic Chairmanship of the Arctic Council, which has placed arctic research cooperation at the heart of its chairmanship program. The International Arctic Science Committee (IASC) initiated ASSW, which now involves a number of other arctic science organizations (see box).

Most of the ASSW events comprise the annual meetings of various circumarctic science organizations, bringing many representatives into one place at the same time and facilitating crosscutting contacts and cooperation. In addition, joint meetings, such as the Project Day and the Science Day, bring science issues of common interest to the agenda.

The theme for the ASSW 2004 is Sustainable Development in the Arctic. The Project Day includes three topics of broad international interest:

- Arctic Climate Impact Assessment (ACIA; see page 21);
- Second International Conference for Arctic Research Planning (ICARP II; see page 21); and
- International Polar Year 2007–2008 (IPY 2007–2008; see page 23).

The overarching theme for the Science Day is Adaptation to Climate Change. Information on speakers and topics is available on the ASSW web site.

Previous ASSWs have been held in:

- Tromsø, Norway,
- Cambridge, UK,
- Iqaluit, Canada,
- Groningen, Netherlands, and
- Kiruna, Sweden.

For more information, see the ASSW web site: www.congress.is/assw, or contact Kristjan Kristjansson (+354-515 5800; fax: +354-552 9814; kristjank@rannis.is).

Organizations Participating in ASSW 2004

International Arctic Science Committee (IASC)
European Science Foundation / European Polar Board (ESF/EPB)
Forum of Arctic Research Operators (FARO)
Arctic Ocean Science Board (AOSB)
Nordic Polar Group (NPG)
Ny-Ålesund Science Managers Committee (NySMAC)
Northern Research Forum (NRF)
International Permafrost Association (IPA)

ACIA Plans for Delivery, Discussions in 2004

The Arctic Climate Impact Assessment (ACIA; see *Witness* Winter 2000/2001), an international project of the Arctic Council and the International Arctic Science Committee (IASC), commenced in 2000. The assessment will evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences, including possible future impacts on:

- the environment and its living resources,
- human health, and
- buildings, roads, and other infrastructure.

The assessment is expected to provide useful and reliable information to the governments, organizations, and peoples of the Arctic on policy options to meet such changes.

More than 250 scientists and six circumpolar indigenous organizations have participated in ACIA, which will produce:

- a peer-reviewed scientific assessment, and
- a synthesis/overview document summarizing results.

These documents will be delivered to the ministers at the Arctic Council Ministerial Conference in Reykjavik, Iceland, in November 2004.

Immediately preceding the Ministerial Conference, the background and scientific results of ACIA will be discussed at the ACIA International Scientific Symposium on 9–12 November 2004, also in Reykjavik. The symposium's participants will include

- scientists working on arctic and climate change issues,
- local and regional administrators, managers, and decision-makers,
- indigenous peoples' organizations, and
- representatives of industries and international and nongovernmental organizations with interests in the Arctic.

The ACIA scientific assessment will be under consideration at the symposium. The scientific results and background, including indigenous peoples' perspectives and observations, will be presented and discussed in an integrated circumpolar context. The assessment will also be discussed in the context of global, regional, and sub-regional environmental management and policy development. Identification of knowledge gaps and the need for new research and monitoring will be an important issue at the symposium. Presentations on topics not directly dealt with by the ACIA, but of relevance to climate change in the Arctic, are welcome.

The symposium will be an important part of the process by which the ACIA will communicate its results and conclusions to arctic stakeholders and to politicians. A summary report from the discussions and presentations will be delivered to the ministers at their meeting in the week following the symposium. Abstracts were due 1 April 2004.

For more information, see the ACIA web site: www.acia.uaf.edu, or contact Gunter Weller (907-474-7371; fax 907-474-6722; gunter@gi.alaska.edu).

Conference on Arctic Research Planning Set for 2005

In 1995, over 300 participants from 18 nations developed plans to tackle critical arctic science problems at the first International Conference for Arctic Research Planning (ICARP), held in Hanover, New Hampshire (see *Witness* Spring 1996). Ten international working groups drafted initial science plans for potential circumarctic research projects, which were discussed and reviewed at the conference. Since 1995, almost all of the plans have been implemented, contributing significantly to current understanding of the Arctic.

The 200 participants at the 2003 Arctic Science Summit Week (see page 20) reached a broad consensus that the timing was right for a second ICARP to identify and address the science problems of today and the next decade. Scheduled for the fall of 2005 in Copenhagen, Denmark, ICARP II aims to bring together arctic residents, senior and young scholars, policy experts, and science and land managers to discuss and formulate physical, biological, and social science projects and implementation strategies that can guide international cooperation over the next five to ten years to address:

- problems, priorities, and concerns of those who live in or near the Arctic,
- the linkages between arctic and global processes, and
- issues concerning arctic natural resources and environmental quality.

At present, 15 major arctic research user organizations have endorsed and are taking part in the ICARP II planning process. The ICARP II Steering Group held its first meeting in October 2003, in association with the SEARCH Open Science Meeting (see page 1). The Steering Group plans to form 10 thematic working groups to explore scientific issues and develop strategies for the future. The deliberations of these working groups will form the basis for the conference.

To generate themes reflecting the interests and needs of the arctic scientific and user communities, the Steering Group solicited proposals for themes from all of the ICARP II sponsors and encouraged them to extend this invitation as broadly as possible. Proposals were due by 15 December 2003. The Steering Group proposed a potential overarching theme for the conference: Understanding the Arctic System: Regional Sustainable Development and Global Connections.

The Steering Group met in January 2004 to select working group themes and begin appointing members to the working groups. The working groups will operate throughout 2004 and into early 2005 and circulate the outcome of their deliberations well in advance of the conference.

For more information, see the ICARP II web site: www.dpc.dk/Res&Log/ICARP, or contact Patrick Webber (517-355-1284; fax 517-432-2150; webber@msu.edu).

CEON Initiative Gathers Support

The concept of a terrestrial Circumarctic Environmental Observatories Network (CEON; see *Witness* Winter 2000/2001) was first raised at the 2000 Arctic Science Summit Week (ASSW; see page 20) at a meeting of the Forum of Arctic Research Operators (FARO; see *Witness* Spring/Autumn 1999 and www.faro-arctic.org). FARO members supported the CEON concept, advocating that CEON be developed to promote measurement of environmental observations and dissemination of these to arctic researchers, while encompassing and building on the strengths of existing stations and environmental observatory networks within the Arctic. Since 2000, the CEON concept has received increasing support, including endorsement from the International Arctic Science Committee (IASC; see www.iasc.no) as an initiative focused on facilitating ongoing and future long-term international research endeavors in the Arctic.

To contact and collect feedback from potential CEON stakeholder and user groups, the CEON concept has been presented at meetings of various networks, research collaborations, and polar organizations in Europe, Russia, and the U.S. Presentations have focused on the necessity for the CEON initiative to meet the needs of the participating research community, science administrators, policy makers, industry, education, and indigenous communities while providing:

- linkages among disciplines and existing networks, and
- connectivity spanning regional to circumarctic and global scales.

To prevent introduction of national, disciplinary, or institutional bias, presentations of the CEON concept have deliberately not mentioned or suggested specific measurements or processes that should or could be made or investigated. Instead, audiences have been asked to answer the following question: "What would you do if you had the opportunity to conduct standardized long-term, integrated measurements across multiple research stations and networks in the Arctic?" It is hoped that this "bottom-up" approach will facilitate the development and scope of CEON based on the experience, needs, and future directions of a broad range of potential CEON stakeholder and user groups.

The rationale that has emerged for CEON includes the following issues:

- Relative to other regions on the globe, the Arctic is experiencing dramatic changes in climate and patterns of human land use. Environmental and socioeconomic drivers associated with these changes originate both within and outside of the arctic system.
- Change detection and predictive power of these changes are low and are limited and threatened by the loss of sustained environmental observation time series in northern high latitudes.
- A circumarctic environmental observatories network that can provide adequate, diverse, and sustained time series observations has the potential to dramatically improve our understanding of the arctic system and how it may continue to respond to a variety of environmental and societal changes forecast for the region.
- There is a well-established science infrastructure and a tremendous amount of research and monitoring in the Arctic. Generally, the broader international and multidisciplinary impacts of these efforts are not fully tapped due to limitations associated with research exposure, communication, data availability, and differences in technologies and sampling methods between sites. Reinforcing and improving the broader impacts of this existing and ongoing effort should be the primary starting point for CEON.

In October 2003, an initial planning meeting for CEON was convened at the Royal Swedish Academy of Sciences. Financial support for this meeting was provided by:

- the U.S. National Science Foundation,
- the Royal Swedish Academy of Sciences' Abisko Scientific Research Station,
- the Scandinavian–North European Network of Terrestrial Field Bases (SCANNET, www.envicat.com/scannet/Scannet), and
- a grant to Abisko Scientific Research Station (www.ans.kiruna.se) from the Swedish Environmental Protection Agency (www.internat.environ.se/index.php3) for its participation in the Arctic Climate Impact Assessment (ACIA, www.acia.uaf.edu; see page 21).

Many participants also generously provided whole or partial funding to support their attendance at this meeting. A total of 34 participants attended the meeting and represented all eight arctic nations and 11 of the 18 IASC member countries. Disciplinary interests of participants spanned science administration, ecology, climatology, biogeochemistry, remote sensing, policy and management, human and physical geography, and modeling. Interests of indigenous peoples of the North and traditional ecological knowledge were represented in several disciplines. Participants also represented a range of research sites, monitoring networks, research collaborations, and science-based programs and organizations, spanning local, circumarctic, and international scales.

The October planning meeting has helped to focus the development of CEON and identify a central theme for its mission—to strengthen the capacity for emerging monitoring, research, and policy needs at high northern latitudes by making data available that are adequate and suitable for answering a series of well-defined key scientific questions and uncertainties.

It is intended that a larger international CEON meeting will be convened in late 2004 to facilitate the formation of key working groups and conduct elections for seats of office. Feedback for the future development of CEON and the CEON web site, which hosts a new circumarctic online and interactive geographic information system/Internet map server, is welcomed.

For more information, see the CEON web site: http://ceoninfo.org, or contact Craig Tweedie (517-355-1285; fax 517-432-2150; tweedie@msu.edu).

Groups Plan for International Polar Year 2007–2008

Momentum is building for an International Polar Year in 2007–2008, timed to celebrate several international scientific anniversaries (see box). IPY 2007–2008 is envisioned as a campaign of coordinated polar observations and analyses that are bipolar in focus, multidisciplinary in scope, and international in participation. Its scientific program will incorporate elements of exploration, studies of polar processes, and activities to monitor and understand change and its human dimensions. Its goals include galvanizing new and innovative observations and research, building on and enhancing existing programs and initiatives, attracting and developing the next generation of polar scientists and science leaders, and creating an exciting range of education and outreach activities to engage the public.

IPY 2007–2008 has received strong endorsements from the International Council for Science (ICSU), the Scientific Committee on Antarctic Research, the International Arctic Science Committee (IASC), the Arctic Ocean Studies Board, the European Polar Board, the U.S. Polar Research Board (PRB; see page 15), the World Meteorological Organization, and other government and nongovernmental organizations.

IPY planners have established an international structure to involve many nations in development of a coherent IPY strategy. In May 2003, the ICSU Executive Committee formed an IPY Planning Group, which met in July and December 2003. The IPY Planning Group invited all nations wishing to be involved to form a national committee to facilitate communication, to help define the overall science themes, and to steer their own national efforts.

In the U.S., the PRB established the U.S. National Committee for IPY 2007–2008, chaired by Mary Albert of the Cold Regions Research and Engineering Laboratory. This group is using an interactive web site, meetings, and other mechanisms to spread the word about IPY. The new web site (http://us-ipy.org) hosts a variety of information on IPY, including history, planning documents, announcements of opportunities, etc. The U.S. Committee is preparing a report that will lay out the case for IPY 2007–2008 and help focus U.S. activities, and a draft will be posted on the site for comment in mid-2004.

At the international level, the ICSU IPY Planning Group delivered a preliminary progress report to ICSU in February 2004. Assuming ICSU approval, the planning group will oversee development of an IPY science plan through an open process, including sorting the many ideas generated to date into main themes so that the IPY effort can be coordinated.

For more information, see the U.S. IPY web site: http://us-ipy.org, or contact Sheldon Drobot (202-334-1942; fax 202-334-1477; sdrobot@nas.edu).

Balfour Watson Currie (1902–1981) of the University of Saskatchewan measuring atmospheric potential gradient at Chesterfield Inlet, Nunavut, Canada, during the second IPY (1932–1933). Photo courtesy of University of Saskatchewan Archives, Physics fonds, A-22.

A Brief History of the International Polar Years

2007–2008 will mark the 125th anniversary of the First International Polar Year (1882–1883), the 75th anniversary of the Second Polar Year (1932–1933), and the 50th anniversary of the International Geophysical Year (1957–1958). The IPYs and IGY were major initiatives that generated significant new insights into global processes and led to decades of invaluable polar research. The IGY resulted directly in the establishment of the Antarctic Treaty System. In spite of substantial investments in polar exploration and research over the years, both by individual nations and through international programs, the relative inaccessibility and challenging environments of these regions have left them less well explored and studied than other key regions of the planet. IPY 2007–2008 will focus attention on the importance of the Arctic and Antarctic in the Earth system and their many significant connections to issues of global climate, sea level, biogeochemical cycles, and marine and terrestrial ecosystems.

1882–1883: Karl Weyprecht, an officer with the Austro-Hungarian navy, inspired the First International Polar Year. Weyprecht argued that polar expeditions should include teams of scientists who could make observations on aurorae, geomagnetism, and meteorological conditions. Planning for the IPY, which was the first major international science collaboration, took seven years. Although Weyprecht died before the IPY, 11 countries participated in 15 polar expeditions (12 to the Arctic and 3 to the Antarctic), heralding a new age of scientific discovery.

1932–1933: The Second International Polar Year was proposed in 1928 at an international conference of meteorological service directors. Forty nations participated in arctic research from 1932–1933 (the 25th anniversary of the first IPY), largely in the fields of meteorology, magnetism, aurorae, and radio science. Due to the worldwide depression, however, the second IPY was smaller than originally envisioned.

1957–1958: What might have been the Third International Polar Year was expanded and named the International Geophysical Year (IGY). Proposed in 1952 by the International Council of Scientific Unions following a suggestion by National Academy of Sciences member Lloyd Berkner, the IGY included significant work in the Antarctic and some in the Arctic, as well as geophysical work around the globe. Sixty-seven nations conducted research during the IGY, including 12 nations that established and maintained 65 stations in Antarctica.

Canada Launches Research Icebreaker *Amundsen*

In a major development for arctic science in Canada, the Canada Foundation for Innovation (CFI) and the Department of Fisheries and Oceans Canada provided funding to transform the 98-m Canadian Coast Guard icebreaker *Sir John Franklin* into a state-of-the-art research icebreaker at a cost of $31 million (CDN). The CFI grant also covered equipment acquisition and a portion of the vessel's first five years of operation.

Re-christened *Amundsen*, the icebreaker began its first deployment in September 2003, supporting the ongoing Canadian-led Arctic Shelf Exchange Study (CASES, 2002–2007). Funded by the Natural Sciences and Engineering Research Council, CASES' goal is to understand and model the response of biogeochemical and ecological cycles to atmospheric, oceanic, and continental forcing of sea-ice cover variability on the Mackenzie Shelf. Researchers from 11 countries are taking turns as the ship over-winters in the Beaufort Sea (see www.cases.quebec-ocean.ulaval.ca).

Within the framework of ArcticNet (see box), the *Amundsen* will support several other major programs in the Canadian sector of the Arctic Ocean over the next ten years. For example:

The **International Observatories of Arctic Canadian Seas** will gather long-term physical, biological, and biogeochemical variables in the Arctic Basin (Mackenzie Shelf) and the Canadian outflow of the Arctic Ocean (North Water), starting in 2004–2005.

Ice Information and Navigation in the NW Passage. The Northwest Passage could open to intercontinental navigation by 2015–2025. This project will build predictive ice dynamics and distribution models to develop strategies for decreasing the risk of marine disasters while maximizing the potential shipping season.

Northern Regional Sensitivity to Climate Change focuses on a transect analysis of Canadian coastal environments from 55°N (Kuujjuarapik) to 80°N (Ellesmere Island) to determine the potential response of terrestrial northern ecosystems to warming. The research icebreaker will serve as a moving base, with access to coastal sites by launch and helicopter.

The refurbished Amundsen *includes features such as an internal moon pool, providing an opening to the sea from inside the ship, fully equipped wet and dry labs, a fast-launch davit, and an acoustic well. Photo by Gérald Darnis (CASES).*

Role of Ice in the Morphodynamics of Arctic Coasts will anticipate the response of the Arctic Coast to climate-induced changes in ice cover, wave generation, and storm surge.

Climate Change and Public Health in the Canadian Arctic (2003–2008) will examine the influence of climate on human health and develop strategies for adapting to its potential impacts in northern communities. The icebreaker will provide access to remote communities and facilities for interviews and examinations.

For more information, see the *Amundsen* web site: www.amundsen.quebec-ocean.ulaval.ca, or contact Louis Fortier (418-656-5646; fax 418-656-2339; louis.fortier@bio.ulaval.ca).

Canada's Arctic Research Efforts Gain Ground

Canada's northern research efforts have consistently dwindled over the past 20 years. The Task Force on Northern Research appointed by the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) released a report in 2000 that called for renewing the historic Canadian leadership in arctic science (Hutchinson et al., 2000, *From Crisis to Opportunity: Rebuilding Canada's Role in Northern Research*). Canada has recently taken steps to increase its research efforts in the Arctic, including refurbishing an icebreaker for scientific work (see this page) and establishing a national Network of Centres of Excellence focused on the impacts of climate change in the marine and coastal Arctic.

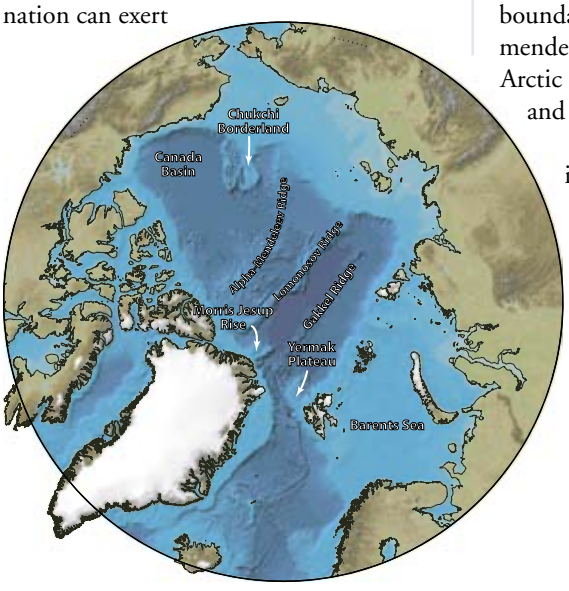
Launched in July 2003, ArcticNet connects 21 Canadian and 20 international universities, two industries, and 27 governmental and nongovernmental organizations in a cross-sectoral network involving natural, social, and health scientists. ArcticNet's goal is to develop knowledge needed to formulate impact assessments, national policies, and adaptation strategies to help Canada face the environmental and socioeconomic consequences of a warming Arctic and address the concerns of northerners, including the rate of change of the arctic environment; the reduction of human vulnerability to hazardous events; the adaptation of the public health system to change; the protection of key animal species; maritime transport in an ice-free Canadian Arctic; and the economic impacts of environmental change in the Arctic. The direct involvement of northern residents in the scientific process is a primary goal of the network, which is funded for $25.7 million (CDN) for four years.

For more information, see the ArcticNet web site: www.arcticnet.ulaval.ca, or contact Martin Fortier (418-656-5233; fax 418-656-2339; martin.fortier@giroq.ulaval.ca).

UN Law of the Sea May Alter Arctic Ocean Boundaries

The boundaries of the Exclusive Economic Zones in the Arctic Ocean may change in the next decade, as nations attempt to redefine their claims to sovereign rights for exploration and development of resources under the 1982 United Nations Convention on Law of the Sea (UNCLOS). Under Article 76 of UNCLOS, coastal states may choose from among several criteria—based variously on distance from the coastline, distance from selected isobaths or the foot of the continental slope, or even the ratio between sediment thickness and shortest distance from the foot of the continental slope—to project their jurisdiction beyond the usual 200 nautical miles seaward of the coast. This area, which may extend up to 150 miles beyond the 200-mile limit or even farther under some circumstances, is referred to as the juridical continental shelf, which may or may not correspond to the physiographic continental shelf.

UNCLOS requires individual nations to submit any claims for extended jurisdiction to the Commission on the Limits of the Continental Shelf (CLCS), an elected body of 21 experts in geology, geophysics, or hydrography, within 10 years of the nation's ratifying UNCLOS. The CLCS then reviews the submission and issues recommendations to the submitting state. If the submission is approved, the coastal nation can exert sovereign rights in the extended region, including jurisdiction over the exploration and exploitation of both the living and nonliving natural resources above and below the seabed; control over the placement and use of submarine cables, pipelines, and other structures; regulation over drilling; control and prevention of marine pollution; and regulation of marine scientific research.



International Bathyspheric Chart of the Arctic Ocean (www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html), graphic depiction modified by Sue Mitchell.

The Arctic Ocean is surrounded by some of the largest continental shelves in the world, and these shelves are almost certain to contain many economically important deposits of petroleum and other minerals. Of the five nations bordering the Arctic Ocean, Canada, Norway, and Russia have ratified the UNCLOS. Denmark and the U.S. have not ratified the treaty and therefore cannot be elected to the CLCS. In December 2001, Russia presented a submission to the CLCS, seeking jurisdiction over a wide area of the central Arctic Ocean, including portions of the Lomonosov and Alpha-Mendeleev ridges and fringing deep seabed.

Canada, Denmark, and the U.S. objected to this submission, questioning its supporting data. Earlier in 2001, a Canadian team reviewed the available public data on the bathymetry of the Arctic Ocean and drew noticeably different boundaries. In 2002, the CLCS recommended that Russia revise the central Arctic Ocean component of its submission and provide additional supporting data.

In 2003, two conferences examined this complex issue:

Legal and Scientific Aspects of Continental Shelf Limits; Reykjavik, June 25–27: Participants representing more than 40 nations and the UN focused on the intersection of science, law, and politics created by UNCLOS. A session examined current issues before the CLCS, including the Russian submission. Arthur Grantz, with the Department of Geological and Environmental Sciences at Stanford University, presented evidence that the Yermak Plateau, Morris Jesup Borderlands, and Chukchi Borderlands are spurs projecting from the continental shelf and therefore should be considered part of the juridical continental shelves under Article 76. Grantz concluded, however, that the Gakkel, Lomonosov, and Alpha-Mendeleev ridges lack islands and are bathymetrically isolated from the circumarctic continents. They are therefore part of the ocean floor of the central Arctic Ocean, and thus not subject to claim under Article 76. More information on the meeting is available at http://virginia.edu/colp/iceland1.pdf.

Controversial Scientific Issues in the Context of UNCLOS Article 76 in the Arctic; St. Petersburg, 30 June–4 July: This conference, sponsored by the Russian Ministry of Natural Resources, focused on the scientific underpinnings of Article 76 implementation in the Arctic. The 36 papers presented articulated a range of viewpoints and exposed significant differences of opinion between those who considered the Lomonosov and Mendeleev Ridges as natural prolongations of the Russian landmass and those who did not.

Available data about the Arctic Ocean may be inadequate to resolve these issues definitively. Because of the limitations of current data sets and the ambiguous requirements of Article 76, the issue of the exact jurisdictional boundaries of the Arctic Ocean is likely to remain unresolved for some time.

For more information, see the UNCLOS web site: www.un.org/depts/los, or contact Arthur Grantz (650-329-5709; fax 650-329-5134; agrantz@usgs.gov) or Ron Macnab (902-463-3963; fax 902-463-0908; ron.macnab@ns.sympatico.ca).

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Researchers will Explore Beringia Aboard *Oden* in 2005

The Swedish Polar Research Secretariat (SPRS), in cooperation with its counterparts in Russia and the U.S., is organizing the Beringia 2005 expedition, using the Swedish icebreaker *Oden*. The expedition will include several legs supporting both marine and terrestrial research in Beringia, the area with the highest species diversity in the Arctic. Over four months, the *Oden* will follow the northern coasts of Siberia, Chukotka, and Alaska, make a transect across the Arctic Ocean, and pass by the North Pole. In parallel, there will be a number of terrestrial research sites from southern Kamchatka to south-central Chukotka, and a semipermanent camp in the Yukon–Kuskokwim Delta of Alaska. Scientists can join or leave the *Oden* expedition in Chukotka and Alaska.

Twenty-five Swedish projects form the basis for the scientific program of Beringia 2005, which builds on the results of the international Tundra Ecology 1994 and Tundra Northwest 1999 expeditions. Russian, Swedish, and American investigators outlined the overall aims of the 2005 expedition at an international workshop in 2002. Terrestrial research will emphasize biodiversity patterns and evolution, ecosystem trophic interactions, migration, and historical biogeography. Marine work will focus on water mass variability and circulation, biogeochemical cycles, geology and geophysics, ocean-floor morphology, atmosphere–ocean interactions, and land–shelf–basin interactions.

The SPRS encourages international cooperation and collaborations. Decisions on international participation in the expedition will be made during the spring of 2004, in cooperation with the Russian Academy of Sciences and the U.S. National Science Foundation. For non-Swedish scientists, there are three routes for establishing cooperation with the expedition:

1. Contact a Swedish project to discuss joining their program.
2. Ask your own institution to contact the SPRS to establish a mutual cooperation agreement.
3. Contact the SPRS directly, if your project can provide a substantial input to the overall scientific aims of the program, or if you have specific knowledge about the areas to be visited.

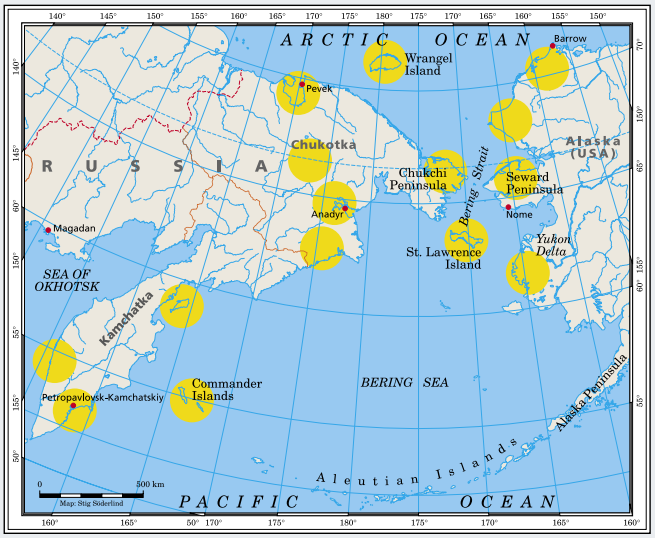
For more information, see the expedition's web site: www.polar.se/beringia, or contact Magnus Tannerfeldt (magnus.tannerfeldt@polar.se).

Above: The proposed track of the Oden *on the Beringia 2005 expedition. Below: Specific areas of investigation. Maps by Stig Söderlind, courtesy Swedish Polar Research Secretariat.*

Oden's Route

Scandinavia–Pevek, Leg 1: Early June–mid July. Marine research during *Oden*'s transit from Scandinavia to Chukotka. No or limited station time reserved. Research activities basically restricted to water and air sampling and bird observations en route.

Pevek–Barrow, Legs 2A (terrestrial) and 2B (ship-based): Mid July–mid August. Some projects will work mostly ashore, while others will be confined to the ship or will work both ashore and onboard. Sampling visits of two or three days at terrestrial sites in northern Chukotka, Wrangel Island, and northern Alaska.



Kamchatka-Chukotka, Leg 2C: Mid July–mid August. Emphasis on terrestrial biology. Six to ten sites will be visited in the Kamchatka Peninsula, Commander and Karaginsky Islands, and the Anadyr area in Chukotka. Petropavlovsk–Kamchatsky will be the base for the southern part of Leg 2C, and Anadyr for the northern part. From each base, land, sea, or air transport will be arranged for 2–5 day field site visits.

Yukon Delta, Leg 2D: Mid July–mid October. Based in field stations belonging to Yukon Delta National Wildlife Refuge, in close co-operation with the U.S. Fish and Wildlife Service and U.S. Geological Survey, researchers will focus on trapping, sampling, and tagging migrating birds.

Barrow–North Pole–Scandinavia, Leg 3: Mid August–late September. Emphasis on marine research, coordinating scientific and logistic activities with the U.S. Coast Guard Cutter *Healy*. The work on *Oden* will emphasize oceanographic and biogeochemical research, with some 24 days of station time. Investigators on the *Healy* will focus on geophysics and marine geology, using sediment sampling and seismic investigations.

AINA Funds Young Investigators with Grants-in-Aid

The Arctic Institute of North America (AINA) was established jointly in Canada and the U.S. in 1945 to contribute to the understanding of the North through research, professional services, teaching and information. AINA is headquartered in Calgary, Alberta, and Fairbanks, Alaska. It publishes the quarterly journal *Arctic,* which is focused on the arctic region, rather than on a particular discipline.

One of AINA's mechanisms to help young researchers is the Grant-in-Aid Program. Inactive for a number of years, the Grant-in-Aid program was reactivated in 1994 and began supporting projects in the North American Arctic and subarctic.

AINA has funded 78 of 134 proposals (58%) submitted to the program, amounting to a total distribution of about $51,000 from both the Calgary and Fairbanks offices. The program has maintained a binational flavor among its recipients, with 42 awards to Canadian and 34 to U.S. citizens. Thus far, AINA members have contributed all funds distributed by the Grant-in-Aid program. These contributions are used only to support investigators; none are used for administrative costs. As a result of a recent board meeting, plans are underway to expand Grant-in-Aid program funds through solicitations from various organizations.

AINA reinstated the program knowing that today's young investigators, particularly graduate students, could benefit from it just as many current members did during the early years of their careers. Chaired by Erich Follmann of the University of Alaska Fairbanks, the Grant-in-Aid Committee has members in both the U.S. and Canada. Applications for the program are due 1 February annually.

For more information, see the AINA web site: www.ucalgary.ca/AINA, or contact Erich Follmann (907-474-7338; fax 907-474-6967; ffehf@uaf.edu,) or Carl Benson (907-474-7450; fax 907-474-7290; aina@alaska.edu).

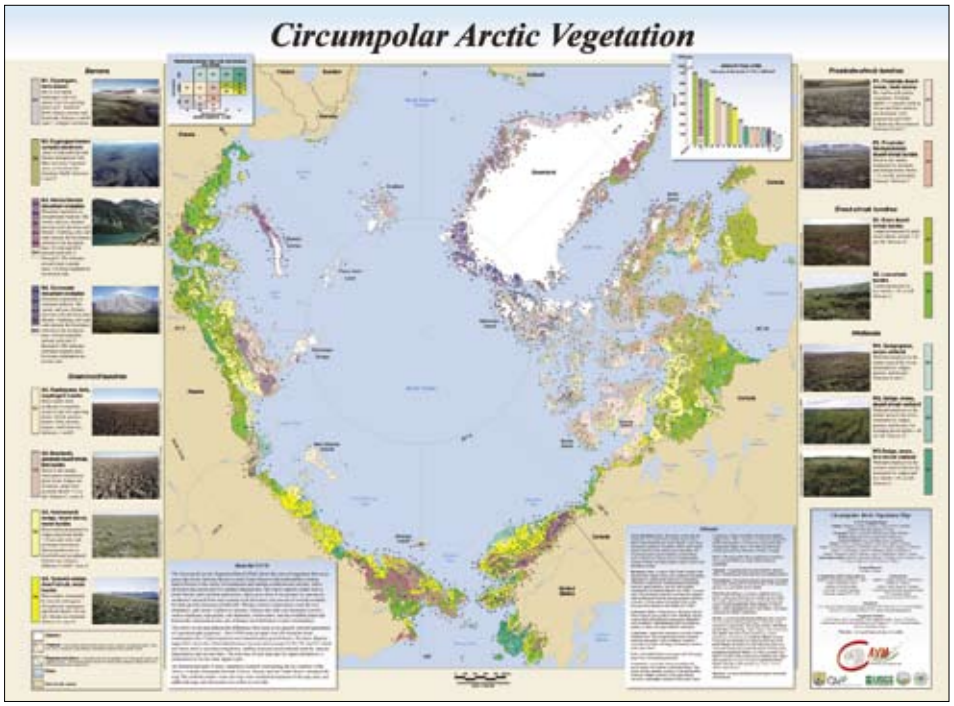
Circumpolar Arctic Vegetation Map Now Available

In October 2003, an international team published the Circumpolar Arctic Vegetation Map (CAVM)—the first map of an entire global biome at such a level of detail. The 11-year CAVM project enlisted more than 30 scientists from six arctic countries (Canada, Greenland, Iceland, Norway, Russia, and the U.S.) to map the vegetation and associated characteristics of the circumpolar region, using a common base map.

The two-sided map is printed on synthetic paper, making it waterproof, tear-proof, and field-work-ready. The base map is a false-color infrared image created from Advanced Very High Resolution Radiometer (AVHRR) satellite data, covering the arctic bioclimate subzone north of the arctic tree line. The CAVM team grouped over 400 described plant communities into 15 different physiognomic units based on plant growth forms. The front of the map shows the circumpolar Arctic color-coded by physiognomic unit and includes color photographs of examples of each unit. The back of the map includes detailed vegetative descriptions, a brief history of the map's origin, and maps of the bioclimate subzones, floristic provinces, landscapes, percent lake cover, substrate pH, and plant biomass.

The CAVM is the first such map to cover the entire Arctic at a reasonable level of detail using a common legend approach. Previous similar maps were produced using a wide variety of national mapping traditions, legend systems, and map scales. The CAVM project was funded by the NSF Office of Polar Programs, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the U.S. Bureau of Land Management and was directed by Skip Walker at the University of Alaska Fairbanks.

Copies of the map are available on either synthetic or regular paper by contacting Christine Martin at the Alaska Geobotany Center (907-474-2459; fax 907-474-6967; fncrm@uaf.edu. For more information, see: www.geobotany.uaf.edu/cavm, or contact Skip Walker 907-474-2460; fax 907-474-6967; ffdaw@uaf.edu).



CAVM Team. 2003. Circumpolar Arctic Vegetation Map. Scale 1:7,500,000. Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska

Polar Vortex Dynamics Disturb Arctic Upper Atmosphere

This article continues our series on topics in current arctic upper atmospheric research.

The polar vortex is a spatially extensive and highly dynamic atmospheric whirlpool that forms annually in the winter stratosphere around the poles. It circulates like a gigantic low-pressure system about 20–50 km above the surface. In the northern hemisphere, the cold cyclonic vortex forms near the North Pole in December, isolating the arctic air mass from the lower latitudes. The huge whirlpool is very dynamic, shifting its rotation center over the arctic region. The effects of its dynamics during the winter period, and its eventual collapse in early spring, are varied. Polar vortex dynamics impact the arctic upper atmosphere at all heights, extending from about 20 km above the surface in the stratosphere to 90 km altitude and higher in the mesopause–lower thermosphere (MLT) region, which extends from about 80–110 km. Two effects of broad scientific interest are:

- the decrease in the ozone layer, and
- the warming of the stratosphere.

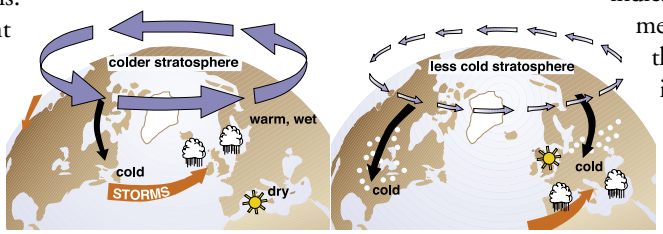
Polar ozone depletion is thought to result from three processes associated with the polar vortex. The first process is the growth, at very low temperature, of polar stratospheric clouds (PCS) during the dark polar winter (see *Witness* Winter 2000/2001). These high altitude clouds condense within the polar vortex from water vapor and trace acids from man-made chemicals. Second, many tiny droplets and crystals grow in PCS; their surfaces are coated with anthropogenic chlorine. The third process begins in early spring when sunlight photochemically releases the chlorine from the droplets and crystals. The chlorine then attacks the ambient ozone, causing ozone depletion.

The second effect of the polar vortex derives from its dynamics. The oscillatory wanderings and eventual collapse of the polar vortex generate a variety of wave-like disturbances. As these waves propagate throughout the arctic upper atmosphere, they are associated with various energy transfer processes through their interactions with the mean (undisturbed) air mass. Such interactions involve large-scale, topographically forced stationary planetary waves. Normally, planetary waves transport heat northward. Under certain atmospheric conditions unique to the polar stratosphere, the upward transport of energy by various waves is blocked. The result is a relatively rapid warming of the lower stratosphere (around 20 km) and a cooling of the upper stratosphere as well as the mesopause (around 87 km). This polar phenomenon is widely referred to as a stratospheric warming event (SWE). Much of the scientific literature on SWEs pertains to the Arctic, leaving the impression that SWEs are rare in the Antarctic. Observations at NSF's South Pole Station over the past six years indicate, however, that SWEs are equally common in the Antarctic, occurring about three to four times per winter.

The disturbances generated by SWEs modulate temperature and density of the higher altitude atmosphere, particularly in the MLT region. A significant objective of current arctic upper atmosphere research centers around quantitative investigation of the linkage and effects of SWEs on physical processes in the arctic MLT region. Supported by grants from the Arctic Section of the NSF Office of Polar Programs, the Aeronomy Program of the NSF Division of Atmospheric Sciences, and the NASA Supporting Research and Technology Program, these studies use an array of state-of-the-art electro-optical remote sensing facilities operated continuously during the local winter at several polar locations. Major observatories operate in Canada at Eureka (80° N) and Resolute Bay (76° N), in Svalbard at Longyearbyen (78° N), in Greenland at Søndrestrømfjord (67° N), and in Antarctica at South Pole Station (90° S). The NSF-funded facilities at these five stations monitor the optical signatures of disturbances in the MLT regions.

The propagation of planetary, tidal, and gravity waves in the MLT cause periodic changes in the polar air density and temperature around 80–100 km height. Optical signatures of such changes appear in the airglow band emissions of minor constituents, such as hydroxyl molecules (OH). These free radicals are produced by chemical interactions of ozone (O_3) molecules and hydrogen atoms (H) in the mesopause (80–90 km). Detailed spectrophotometric and interferometric observations and analyses of the extremely weak airglow light from the minor constituents of the MLT provide information about the amplitudes and periods of these waves.

Planetary, tidal, and gravity waves propagate most of the time throughout the upper atmosphere, changing MLT air density and temperature by a few percent from the mean values. Waves generated by polar vortex dynamics, however, cause much larger changes in MLT temperature. Recent observations show that the mesopause cools by about the same amount (roughly 40 K) as the lower stratosphere warms during SWEs. Mesospheric cooling during major and minor SWEs has been observed both in the Arctic and the Antarctic. Concurrent LIDAR soundings of the atmosphere from about 10–75 km height at Eureka, Søndrestrømfjord, and Longyearbyen corroborate these findings. Measurements also indicate that a cooling trend begins in the mesopause region a couple of days before the stratosphere starts to warm up during SWEs. Hence, remote sensing of physical processes in the polar mesopause could alert researchers pursuing investigations of atmospheric dynamics to an impending SWE.



The strength of the polar vortex varies during the winter; these variations are reflected as changes in the Arctic Oscillation (AO), a large scale pattern of extra-tropical climate variability. A strong polar vortex is associated with the positive phase of the AO (left), while a weak polar vortex is associated with the negative phase of the AO (right). Figure courtesy of D. Thompson, Colorado State University, and J.M. Wallace and K. Dewar, University of Washington.

For more information, contact Gulamabas Sivjee at Embry-Riddle Aeronautical University (386-226-6711; fax: 386-226-6713; sivjee@erau.edu).

Broad Science Initiative Outlined for North Slope

The Bureau of Land Management (BLM) is planning and providing for resource development in the National Petroleum Reserve-Alaska (NPRA), a 23-million-acre area on the North Slope of Alaska. While examining the natural systems in NPRA, BLM and Department of Interior staff have:

- recognized that many of the relevant issues transcend administrative boundaries and are applicable to the entire North Slope, and
- identified a need for improved inventory, monitoring, and research information to support resource development decisions.

In response to this need, federal, state, and local agencies are developing a North Slope Science Initiative (NSSI) to provide a consistent approach to inventory, monitoring, and research on the terrestrial, aquatic, and marine ecosystems of the North Slope. BLM has provided seed funding to begin the development of an NSSI science plan and decision-support system over the next 12 months. Altarum Institute and Argonne National Laboratory have been brought in to assist in this planning activity. Longer-term funding for this initiative is being sought from a variety of sources.

The NSSI plans to coordinate with federal, state, and borough agencies; the general public; and stakeholders, including nongovernmental organizations, industry, and academia. The NSSI's overall goals are to:

- improve the understanding of North Slope terrestrial, aquatic, and marine ecosystem dynamics;
- provide integration of research and monitoring activities;
- develop a common data collection and analysis system useful to all research and monitoring efforts; and
- enhance the ability to forecast and respond to the effects of natural and anthropogenic change on the basis of a scientific understanding of causal relationships.

The NSSI organizational structure will include a North Slope Management Oversight Group (NSMOG) to develop and implement the science initiative. The NSMOG will include executive membership from agencies that have land trust responsibilities across the North Slope, including

- the U.S. Fish and Wildlife Service,
- the Bureau of Land Management,
- the Minerals Management Service,
- the Alaska Department of Fish and Game,
- the Alaska Department of Natural Resources, and
- the North Slope Borough.

The NSMOG will emphasize coordination and cooperation in supporting inventory, monitoring, and research activities. A Science Technical Advisory Panel will provide the NSMOG with technical advice on proposed inventory, monitoring, and research functions.

Planned components of the NSSI include:

Information Needs Assessment: a high-level assessment of scientific information needs for the North Slope. Establishment of infrastructure and communication pathways to support the continued exchange of information.

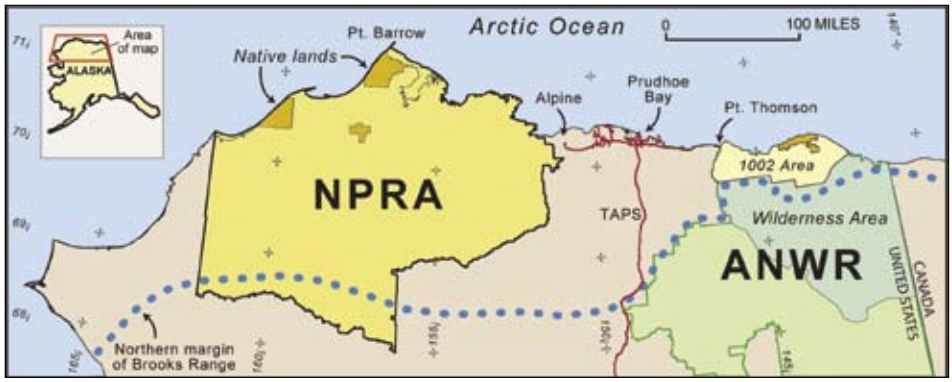
NSSI Portal: a dedicated, focused web site providing background, historical, research, and policy information as well as dynamic environmental data. The portal will also serve as a means of communication and collaboration among the stakeholders. The portal can be found at www.northslope.org.

North Slope Data Management and Analysis System: a comprehensive database of all data and metadata relevant to the North Slope. This database will supplement a geographic information system (GIS) containing core datasets such as political boundaries, U.S. Census demographics, road networks, hydrography, digital elevation models (DEMs), and coastline bathymetry, as well as more specific datasets such as a detailed vegetation raster of the NPRA. The system will maximize data access and exchange of information amongst stakeholders and be designed to directly support decision making.

Sponsored Projects: Based on availability of funds and priorities established in the ongoing science planning, additional inventory, monitoring, and research projects will be initiated to fill identified gaps.

To assist in initial coordination and issue development, the NSSI conducted an information needs assessment, including a series of information exchange workshops in Anchorage, Fairbanks, and Barrow in January 2004. Workshop presentations and initial summary results can be found on the NSSI portal. Biannual public workshops are planned to provide an opportunity for stakeholders, including those that do not have trust responsibilities on the North Slope, to participate and voice important natural resource, cultural, and economic issues relating to the management of North Slope resources.

For more information, see the North Slope Science Initiative web site: www.northslope.org, or contact John Payne (907-271-3431; fax 907-271-5479; John_F_Payne@ak.blm.gov).



The National Petroleum Reserve-Alaska is in the northwest corner of Alaska and is managed by the Bureau of Land Management. Map from U.S. Geological Survey, http://energy.usgs.gov/npraimages.html.

Ecosystem Studies Planned for Eastern Bering Sea

Recent, unprecedented changes in the marine ecosystems of the eastern Bering Sea and the lack of information about the possible linkages between these changes and climate forcing have raised significant concerns among the scientific community and the region's residents. These concerns resulted in a planning process to assess needs and plan for a large-scale, integrated study of the Bering Sea. Supported by the NSF Office of Polar Programs, the process began with an international workshop in Laguna Beach, California, in September 2002. The 13 workshop participants agreed that:

- further research is needed on linkages between climate variability and ecosystem responses of the Bering Sea, and
- the effort should emphasize the eastern Bering Sea—in particular the eastern continental shelf and shelf-slope region, where U.S. commercial and subsistence activities are focused, and where earlier research programs, such as the Outer Continental Shelf Environmental Assessment Program (OCSEAP) and Processes and Resources of the Bering Shelf (PROBES), have concentrated.

This workshop provided a strong basis for developing comprehensive regional studies, as detailed in the workshop report, which is available at www.arcus.org/bering.

In March 2003, a second planning workshop convened in Seattle, Washington, to outline a multiyear research initiative designed to improve understanding of the effects of climate variability, at multiple temporal and spatial scales, on eastern Bering Sea ecosystems. This initiative, known as the Bering Ecosystem Study (BEST), proposes studies focused on the mechanisms and processes that determine biological production and the fate of this production as it is transferred through the ecosystem to upper-trophic-level consumers, including humans.

Currently in development, the BEST Science Plan provides background information and frames science questions to guide future integrated, interdisciplinary studies. The BEST Program will be a major effort requiring, as part of integrated field programs, collaborative research among multiple institutions and disciplines, including international collaboration, the deployment of multiple ships and in situ long-term instrument arrays, and satellite-based remote sensing studies. Mathematical modeling studies will be an integral part of BEST from the outset, and they will provide frameworks for testing program hypotheses and sampling scenarios. Such an ambitious effort will of necessity require capacity building through targeted training programs, the involvement of social scientists, and strong public outreach efforts.

The BEST Program plans to interface with other national and international programs investigating the effects of climate change on high-latitude marine ecosystems. BEST is a component of

- Study of Environmental Arctic Change (SEARCH, see page 1) and
- Ecosystem Studies of Sub-arctic Seas (ESSAS), a proposed regional program under Global Ocean Ecosystem Dynamics (GLOBEC).

BEST will also interact with

- Arctic/Sub-Arctic Ocean Fluxes (ASOF),
- Climate Variability and Predictability (CLIVAR), and
- North Pacific Marine Science Organization (PICES).

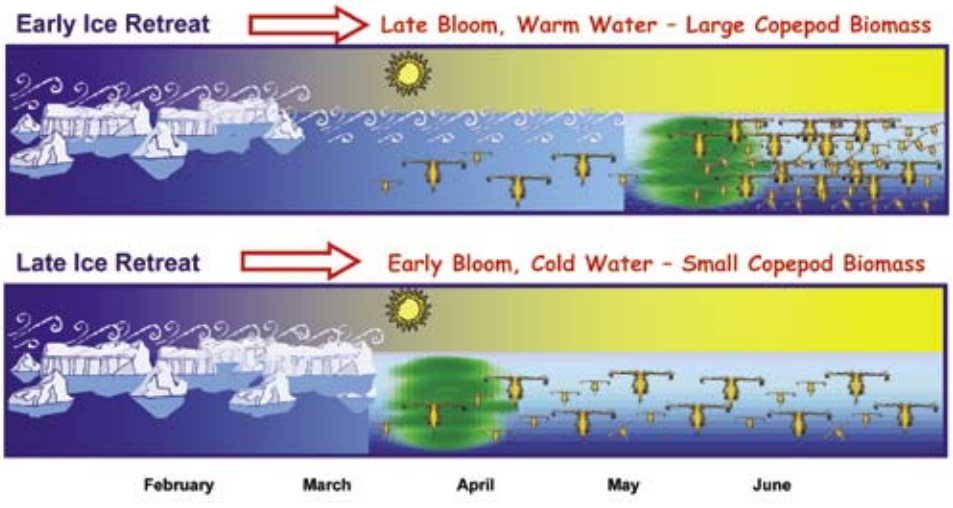
Moreover, the recent multidisciplinary studies of the Southern Ocean, undertaken as part of the Southern Ocean Global Ocean Ecosystem Dynamics (SO GLOBEC) Program, provide an opportunity for BEST to compare two high-latitude marine systems.

The BEST Draft Science Plan has circulated widely in the national and international science communities for review and has been the topic of a series of town hall meetings at relevant conferences:

- the October 2003 SEARCH Open Science Meeting (see page 1);
- the December 2003 American Geophysical Union meeting; and
- the February 2004 American Society of Limnology and Oceanography and the Oceanography Society (ASLO/TOS) Ocean Research Conference.

ARCUS will publish the BEST science plan in summer 2004. It is anticipated that the science plan will be followed by an implementation planning process and that, if funding and ships are available, the field program could begin in summer 2006.

For more information, see the ARCUS web site: www.arcus.org/bering, or contact George Hunt (949-497-1914; fax 949-824-2181; glhunt@uci.edu).



In the southeastern Bering Sea, the timing and magnitude of the spring plankton bloom and the species involved correlate strongly with the extent and condition of the sea ice on the shelf during the winter and spring. Early ice retreat leads to a late bloom in warm water and high copepod production (top), while late ice retreat leads to an early, ice-associated bloom in cold water and weak copepod production (bottom). Primary productivity in the Bering Sea thus has a strong relationship with sea ice conditions on the shelf, and climate forcing effects on sea ice can be transmitted to the biota. After Hunt et al., 2002.

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ARCUS is a nonprofit organization consisting of institutions organized and operated for educational, professional, or scientific purposes. Established by its member institutions in 1988 with the primary mission of strengthening arctic research, ARCUS activities are funded through a cooperative agreement with NSF, by grants from the Alaska Federation of Natives and the National Park Service, and by membership dues.

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wit·ness (wit nis) *n.* **1.a.** One who has heard or seen something. **b.** One who furnishes evidence. **2.** Anything that serves as evidence; a sign. **3.** An attestation to a fact, statement, or event. —*v. tr.* **1.** To be present at or have personal knowledge of. **2.** To provide or serve as evidence of. **3.** To testify to; bear witness. —*intr.* To furnish or serve as evidence; testify. [Middle English *witnes(se),* Old English *witnes*, witness, knowledge, from *wit,* knowledge, wit.]

Calendar

April 21–27 Arctic Science Summit Week. Reykjavik, Iceland. For more information, see: www.congress.is/assw/forsida.htm

May 3–6 Climate Disturbance Interactions in Boreal Forest Ecosystems Conference. Fairbanks, Alaska. For more information, see: www.lter.uaf.edu/ibfra

May 10–14 Dynamics of Northern Societies. Copenhagen, Denmark. For more information, see: www.dpc.dk/dynamics

May 13–14 ARCUS 16th Annual Meeting and Arctic Forum 2004. Washington, DC. For more information, see: www.arcus.org/annual_meetings/2004/index.html

May 19–23 5th International Congress of Arctic Social Sciences. Fairbanks, Alaska. For more information, see: www.uaf.edu/anthro/iassa

May 24–26 Arctic Geology, Hydrocarbon Resources and Environmental Challenges 2004. Tromsø, Norway. For more information, see: www.geologi.no/cgi-bin/geologi/imaker?id=1658

May 24–28 XIII Glaciological Symposium: Shrinkage of Glaciosphere: Facts and Analysis. St Petersburg, Russia. For more information, see: http://icemass.narod.ru/symp.htm

June 8–12 8th Circumpolar Symposium on Remote Sensing of Polar Environments. Chamonix, France. For more information, see: http://mti.univ-fcomte.fr/thema/circum_polar/default.html

June 28–30 Arctic Observing Based on Ice-Tethered Platforms. Woods Hole, Massachusetts. For more information, see: www.whoi.edu/ipworkshop/ipworkshop.html

July 25–31 Life in the Cold 2004 International Conference. Vancouver BC–Seward, AK, Inside Passage. For more information, see: www.alaska.edu/litc

For more events, check the Calendar on the ARCUS web site (http://www.arcus.org/misc/fr_calendar.html).

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A Note From the ARCUS President

I am delighted to have this opportunity to add a few words about ARCUS to this issue of *Witness the Arctic.* I recently rejoined ARCUS as president after being off the board of directors for a few years.

ARCUS has developed areas of impressive strength, among them the ability to host and lead research program planning efforts. An example is the recent SEARCH Open Science Meeting in Seattle in October 2003 (see page 1). Planning and coordinating this meeting required enormous effort from the ARCUS executive director and staff, but the investment should be worthwhile. The SEARCH program promises to address the most critical question facing arctic science—environmental change in all its manifestations, including the human impacts and potential societal adaptations. The breadth of the program is impressive, and it is important that it receive timely and adequate support. Broad scientific input and exchange is important to the evolution of the program.

There are other recent notable arctic developments as well. Joint Russian/U.S. cruises are planned for the Chukchi Sea and further north, with support from the Far East Branch of the Russian Academy of Sciences and the NOAA Arctic Program. The Census of Marine Life, a 10-year international program, is planning an arctic project. Also, further in the future, an International Polar Year (IPY) and International Heliophysical Year (IHY) is proposed for 2007, with the Polar Research Board of the National Research Council taking the lead in coordinating the planning. The arctic focus engendered by the IPY is already evident, with the emergence of many related programs and activities (see page 23).

ARCUS will be involved in these activities in many ways, and I am excited about the contributions ARCUS will make to arctic science in the future. At the same time, as a membership organization, ARCUS must be aware of and address the needs and concerns of our 44 member institutions. We must ensure, with help from the representatives of those institutions, that their priorities move ahead in parallel with ARCUS work in program planning and management.

To help ARCUS maintain both its organizational excellence and an appropriate balance among its responsibilities to its member institutions and to the wider arctic research community, the ARCUS board of directors is pursuing a strategic planning process. I will be reporting on the progress and recommendations of this planning effort at the ARCUS annual meeting in May 2004.

—Vera Alexander

Inside

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