

# *Witness The* **ARCTIC**

Chronicles of the NSF Arctic Sciences Program

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## **Healy Prepares for Arctic Operations**

*by Jonathan Berkson and George Dupree*

USCGC *Healy*, the first polar icebreaker to be commissioned by the United States Coast Guard since 1978, was launched in 1997 (see *Witness* Spring and Autumn 1998) and delivered in November 1999.

The ship is named for Captain Michael A. Healy, a legendary figure of Alaskan history and Commanding Officer of the U.S. Revenue Cutters *Corwin* (1884–85) and *Bear* (1886–95); Captain Healy's voyages were important in early exploration and mapping of the Arctic.

USCGC *Healy* was designed as a high-latitude research platform for conducting a wide variety of research tasks in diverse fields of science and engineering, and for extended polar operations including the ability to winter over for planned science missions. The Coast Guard intends to operate the ship primarily as an arctic research vessel scheduled for up to 200

operational days per year. USCGC *Healy* is commanded by Captain Jeffrey Garrett.

Even before the U.S. Congress authorized funds to build the *Healy* in 1990, vessel requirements for a research icebreaker were developed with input from governmental, academic, and industrial groups. The detailed design and construction contract, managed by the Naval Sea Systems Command, was awarded to Avondale Industries, Inc. in July 1993. The program office consists of Naval Sea Systems Command officers, civilian employees, and Coast Guard officers. Coast Guard Captain Greg Johnson is the Program Manager. The Navy Supervisor of Shipbuilding in New Orleans, through a Coast Guard office of technical personnel, managed the construction contract, and will also manage the engineering shakedown, as well as the icebreaking and science trials.

To increase involvement of the scientific community during construction and testing, the University-National Oceanographic Laboratory System (UNOLS) Arctic Icebreaker Coordinating Committee (AICC) was formed in September 1996, with Dr. James H. Swift as Chairman (see *Witness* Spring 1997). The initial design of the scientific spaces on *Healy* was modified on the basis of input from scientists. The AICC, which is supported jointly by the U.S. Coast Guard and NSF, provided valuable input to the design of the science suite. It also provides advice for the planning and operation of arctic science support for the two Polar Class icebreakers *Polar Star* and *Polar Sea*.

### **Healy's Capabilities**

With a length of 420 feet, beam of 82 feet, and displacement of over 16,000 tons, *Healy* will be one of the world's largest non-nuclear polar icebreakers. The ship, built by Avondale Industries, Inc., New Orleans, Louisiana, has diesel electric propulsion with 30,000 shaft horsepower. The ship control systems include:

- an anti-roll stabilization tank,
- a bow thruster,
- two rudders,
- fixed pitch propellers, and

*continued on next page*



*The Healy is equipped with a highly automated engineering plant, a state-of-the-art array of navigational equipment, extensive communication and computer systems, a voyage-management system, and a modern suite of science systems (figure courtesy of the U.S. Coast Guard).*

## Laboratory and Science Support Spaces

(in square feet)

Main Laboratory	1,233
Wet Laboratory	390
Biological/Chemical Analysis Lab	310
Climate-Controlled Chambers (2)	200
Aloft Conning Station (Wildlife Observation Platform)	256
Meteorological Laboratory	64
Lounge/Library/Conference Room	300
Dive Locker Facilities	225
Photography Laboratory	105
Communications Center	62
Electronics/Computer Laboratory	528
Future Laboratory	475
Conning Station	439
Hazardous Materials Locker	100
Freezer	130
Refrigerator	130
Dry Assembly Area	152
Vestibule/Arctic Gear Locker	240

### Science Staging Areas

Starboard Staging Area	315
Aft Staging Area	315

### Exterior Support Spaces

Daylight Incubation Area	108
Forward Working Deck	820
Starboard Overside Handling Area	600
Aft Working Deck	3,000

- a bow wash-bow thruster system that can lubricate the hull during icebreaking operations.

The minimum icebreaking design requirements are 4.5 feet at 3 knots going ahead and 8 feet backing and ramming. The computerized, integrated navigation system will use electronic charts, an autopilot, and electronic positioning information to automate many ship control functions. A dynamic positioning system allows precise station-keeping and movement.

In addition to a variety of ship communication systems, a separate system will provide dedicated satellite communi-

cations for scientific work. *Healy* is also equipped with a ship-wide computerized data-logging system to record and store data from the navigation, oceanographic, engineering, and communications systems. *Healy* was designed specifically to accommodate scientific operations. For example:

- sonar hydrophones are flush-mounted in the hull,
- the ship's engines are located on the main deck to reduce noise for the sonar systems, and
- the ship has the ability to hold overboard discharges up to 24 hours to allow uncontaminated water sampling.

With a crew of 75 and maximum scientific party of 50, *Healy* accommodates more scientists than the Coast Guard's Polar Class icebreakers with half the crew. The ship normally will carry 35 scientists living two to a stateroom. Each science stateroom can accommodate a third person in a fold-down rack; this allows a surge capacity of 50 people. Living spaces dedicated to the science users include two conference rooms, a lounge, and library. In addition, all personnel have access to the central messroom, laundry, gym, the ship's store, and medical treatment.

*Healy* is well equipped for towing and for handling the wide variety of sensor arrays and oceanographic gear needed for ocean research. Deck equipment and five cranes are strategically located for:

- loading supplies and equipment,
- setting up experiments,
- positioning vans, and
- deploying/recovering scientific gear and boats.

Two separate ocean winches and a double-drum trawl/core winch are available for scientific operations. A-frames located on the stern and starboard quarter provide versatility for over-the-side operations. Two helicopters and five boats are available for aiding science operations and logistics. *Healy* has a helicopter deck, a hangar, and will normally carry two HH-65 helicopters. The ship can also carry:

- one 39-foot Arctic Survey (ABS) boat,
- two 36-foot LCVP cargo boats, and
- two 23-foot Rigid Hull Inflatable Boats.

Science systems and equipment on *Healy* include the:

- Acoustic Doppler Current Profiler (ADCP);

- Bathy2000 depth sounding and subbottom profiling system;
- SeaBeam 2112 multibeam sonar system;
- Oceanographic Data Acquisition System (ODAS) for expendable oceanographic probes (e.g., Expendable Bathothermographs);
- TeraScan weather satellite system;
- meteorological measurement system;
- Conductivity-Depth-Temperature (CDT) acquisition and analysis system;
- rosette water sampling system;
- a bow tower for clean air experiments;
- a dedicated area for daylight incubation experiments;
- a continuous flow, seawater sampling system; and
- a jumbo coring system.

Data will be stored and analyzed with the aid of a dedicated fiber optic Science Data Network (SDN) with computer jacks throughout the ship, including two in each stateroom. The SDN will date- and time-stamp all data collected from the 24 installed scientific, navigational, and engineering systems and will have the capability of handling 12 additional systems, such as other sensors that scientists may install. To minimize the effect of disk crashes, files will be simultaneously stored on two separate hard disks. For convenience of the scientists, the system will allow the use of Microsoft, OS-2, Apple, and UNIX operating systems. Data can be transferred by e-mail via INMAR-SAT through the dedicated science communications system.

### Performance Trials

*Healy* will start a series of warm water shakedown tests in the Gulf of Mexico and Caribbean Sea in early 2000. During these post-delivery tests, all scientific equipment will be tested, and the bottom mapping sonar will be calibrated. Following the warm water tests, *Healy* will begin a northward transit to the eastern Arctic to conduct six weeks of icebreaking performance trials followed by four weeks of science suite testing and evaluation. In conjunction with the AICC and the UNOLS Research Vessel Technical Enhancement Committee (RVTEC), chaired by John S. Freitag, the *Healy* project office has contracted with a group of engineers, scientists, and technicians to conduct rigorous

integrated testing of all science systems throughout the shakedown period. *Healy* will transit to her homeport of Seattle at the conclusion of the testing and trials program.

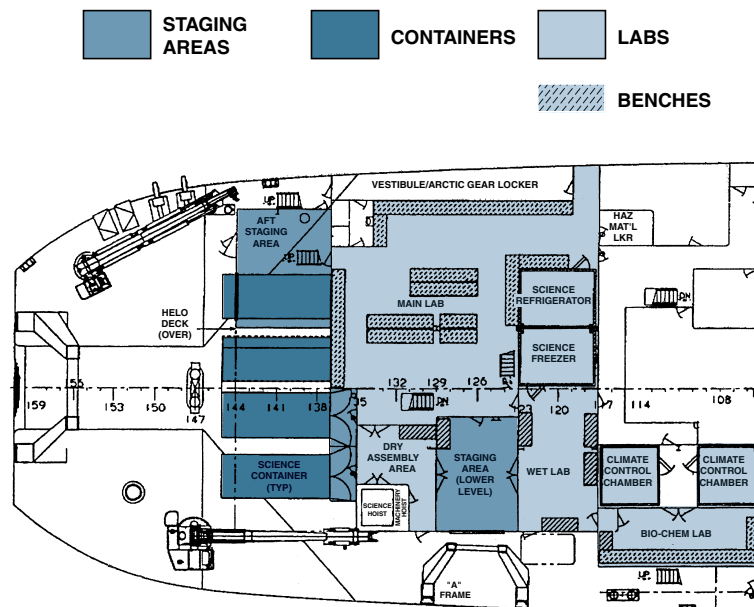
*Healy* will be operated by the Coast Guard as a dedicated research vessel for the diverse needs of the U.S. science community, with services equivalent to those provided on UNOLS large research vessels. During the shakedown cruises, the Coast Guard will refine administrative and operational procedures to optimize services. The complex array of science equipment will be operated by Coast Guard Marine Science Technicians with support from contracted specialists as required.

**Science Cruises**

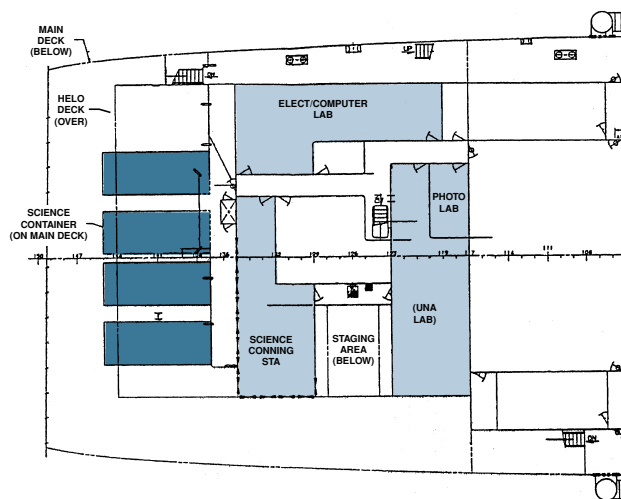
*Healy's* first unrestricted science cruise is anticipated for 2001, after completion of maintenance and warranty work required by shakedown operations. Efficient and full utilization of *Healy* in the Arctic will require expeditionary planning to identify and coordinate schedules and logistics, and to arrange for companion vessels when high-arctic missions are made. The AICC held the first annual arctic planning meeting in December 1999, at the annual fall American Geophysical Union meeting in San Francisco, to discuss a five-year rolling community-drafted plan for arctic marine science use of Coast Guard icebreakers. The advent of *Healy*, with its extensive capabilities and dedicated scientific mission signals an unprecedented era of research opportunity in the Arctic.

To schedule time on *Healy*, see the UNOLS web site <http://gso.uri.edu/unols/unols.html>. For more information, see the Coast Guard web page for *Healy* <http://www.uscg.mil/hq/g-a/Healy>. ■

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**Main Deck**



**01 Deck**

*There are over 5,000 square feet of interior science laboratories and science support rooms in addition to covered science staging areas and exterior space on the Healy. The main science lab is the scientific operations center and has immediate access to the wet lab, the dry assembly area, science vestibule, hazardous material locker, two of the science vans, the two science staging areas, and the after working deck. The layout allows scientists to move from the stateroom or mess area to the after working deck without going through the main science lab or the weather. The biological/chemical analysis lab and the climate-controlled chambers are also accessible from the interior of the ship without going through the main science lab. The three science cargo holds provide for up to 20,000 cubic feet of storage space with hoist. Each of the two staging areas for science operations has roller door access with a freezer curtain to the weather deck. In addition there are spaces for eight 20-foot science vans (two on the 01 level bow, two on the 02 level port and starboard, and four on the fantail, two of which open into the ship and two onto the fantail) and two 40-foot science vans (02 level port and starboard in the location of the science work boat and the LCVPs). The science van spaces are provided with most ship services, including telephone, Science Data Network, various water systems, and electrical power (figure courtesy of the U.S. Coast Guard and James Swift).*

## Research Support and Logistics Group Updates Priorities

In November 1999, the Arctic Research Support and Logistics Working Group (RSLWG) met to outline the scope and identify priorities for an update of arctic logistics needs and opportunities. ARCUS formed the RSLWG at the request of the Office of Polar Programs (OPP), to build upon the work of the former Logistics Working Group, convened in 1995 at the request of the U.S. Arctic Research Commission (USARC) and NSF. The new group's mission is to represent the arctic research community in providing for OPP long-term expertise and advice on arctic logistics and science-support issues.

The new working group will first reexamine science priorities and associated research support and logistics requirements, which have shifted in the past two years because of new research findings and improvements in logistical capability. The group will update *Logistics Recommendations for an Improved U.S. Arctic Research Capability*, the 1997 report that has provided guidance to the OPP Arctic Program in making logistics improvements. The report was designed to be a living document that would be updated periodically to reflect changing science priorities.

The working group will examine arctic research support issues from a thematic rather than disciplinary perspective.

Overarching research issues that transcend traditional disciplines and the support necessary to address those issues will be identified. The group also will:

- guide the development of an implementation plan for improving arctic logistics, working with the research community, the USARC, NSF, and other federal agencies;

- identify technical experts to review the development of specific capabilities;
- report to the arctic research community about logistics improvements and their potential impacts on science; and
- assist in the development of the Arctic Logistics Information Access Service (ALIAS) web site as a research support and logistics information resource.

For more information, see the ARCUS web site (<http://www.arcus.org>) or contact ARCUS ([arcus@arcus.org](mailto:arcus@arcus.org)). ■

## U.S. and Norway Sign Agreement to Promote Joint Polar Research

In October 1999, the NSF OPP signed a "Statement of Cooperation" (SOC) with the Norsk Polarinstitut in Tromsø, Norway to promote interactions among U.S. and Norwegian scientists in arctic and Antarctic research efforts. The SOC focuses on potential expanded U.S. efforts on Svalbard and potential U.S. presence at the archipelago's multinational facilities.

The two countries also co-sponsored an August 1999 community workshop,

organized by the Norwegian Research Council and ARCUS, to discuss joint science plans for Svalbard research. The 20-member American delegation worked with Norwegian colleagues to explore research activities, possibilities, policies, and infrastructure in both Longyearbyen, where major research installations are located, and in Ny-Ålesund, where several international research stations operate (see *Witness* Autumn 1998). The workshop emphasized the importance of long-term observations and research platforms. Participants discussed the potential for:

- cooperative projects in upper atmosphere research;
- collaborative work in global-change research, including new opportunities for U.S. researchers to participate in programs funded by the European Community;
- education of American students at University Courses on Svalbard (UNIS; see page 22),
- establishment of a U.S. observation platform in Svalbard; and
- collaborations among U.S., Russian, and Norwegian investigators for work in Russian waters.

For more information on the U.S.-Norway workshop, contact ARCUS. A draft of the workshop report will be available soon on the ARCUS web site (<http://www.arcus.org>). For information about Svalbard, see the Norsk Polarinstitut web site (<http://www.npolar.no/np/>). ■

## Stephenson Named Arctic Research Support and Logistics Program Manager

In June 1999, the NSF Office of Polar Programs (OPP) announced the appointment of Simon Stephenson as the Program Manager for Arctic Research Support and Logistics. Stephenson will provide leadership and serve as a liaison with the science community in improving research infrastructure to support first-class national and international arctic programs.

Stephenson comes to the Arctic Program with 21 years experience in polar research. He holds a Master of Philosophy in Glacier Geophysics from the Council for National Academic Awards, UK. He worked 11 years as a glacier geophysicist with British Antarctic Survey and then with a team based at NASA's Goddard Space Flight Center studying the dynamics of West Antarctic ice streams. In these roles, he participated in light, two-person field teams and large, integrated, multi-institutional field campaigns. More recently, Stephenson worked in OPP as the Research Support Manager for the Antarctic Program, leading development of support plans for more than 100 projects annually and research infrastructure in the disciplines of aeronomy, astrophysics, biology, geology, geophysics, climate studies, and oceanography.

Stephenson can be reached at NSF in Arlington, VA (703/306-1029; fax 703/306-0648; [sstephen@nsf.gov](mailto:sstephen@nsf.gov)). ■



## Northernmost Community Focuses on Research Support

In December 1998, at the request of the NSF Office of Polar Programs, ARCUS organized a community workshop to consider means and priorities to support science activities in the area serviced by Barrow, Alaska. The area around Barrow has supported marine, coastal, freshwater, terrestrial, and atmospheric research for more than 100 years.

Barrow is located at 72° N latitude, where the North Slope of the continent meets the Arctic Ocean. The predominantly Iñupiat community is the site of the former Naval Arctic Research Laboratory (NARL), which was established in 1947 and is now owned by the local Native corporation, Ukpeagvik Iñupiat Corporation (UIC). Adjacent to the former NARL is the Barrow Environmental Observatory (BEO), a 7,466-acre research preserve, which was set aside by UIC as a permanent site for scientific research in 1992. In addition to the natural resources and substantial infrastructure in the area, the human resources that the indigenous community has offered to scientists are the foundation for important research projects in the U.S. Arctic (see *Witness Autumn 1997*).

The Barrow Area Research Support (BARS) workshop, which convened in Marshall, California included 63 research scientists, Barrow residents, federal agency representatives, logistics providers, and regional government officials. The goal of the NSF and participants in this planning process is to increase the efficiency, effectiveness, and extent of research taking place in the Barrow area.

Participants recommended investments to build upon the rich combination of factors in Barrow for the benefit of research in the area. Expanded logistical capability will make possible the pursuit of new research opportunities in the Barrow area. Improved coordination of logistical and research support also could realize considerable economies of scale for the many researchers who now base fieldwork in Barrow. The federal agencies that were represented at the workshop indicated a desire to improve interagency cooperation in support of arctic research efforts in the Barrow area.



*The Arctic Research Facility (ARF) has been converted by the North Slope Borough Department of Wildlife Management into modest laboratory space and bunkhouse living quarters for visiting researchers. Since the closure of NARL, the ARF has been the only multipurpose facility available to assist individual investigators and its capacity of 20 persons is often exceeded during the summer field season. The skull in front and shoulder blades on the wall are from a bowhead whale (photo by Dave Ramey).*

Five overarching recommendations developed at the workshop were refined through community discussion. They are:

- Identify and fund an organization based in Barrow to provide research support, infrastructure development, and coordination.
- Evaluate regularly researchers' needs and the adequacy of facilities and resources to ensure that support evolves adequately and that investments are effectively shared among appropriate agencies.
- Promote, through coordination of research and data, integrated multidisciplinary and interdisciplinary studies that improve the scientific understanding of the arctic system.
- Promote interactions between the community and researchers to disseminate research plans and results, incorporate community participation, promote use of traditional knowledge, and develop collaborative projects.
- Provide educational opportunities for young researchers and local residents through internships and fellowships to encourage local involvement as well as the development of local scientific capabilities and a strong cohort of arctic researchers in the future.

In addition to these overarching recommendations and basic support (e.g., housing, transportation, field gear), participants cited several specific, high-priority needs. These include:

- The Arctic Research Facility at UIC-NARL must be supported in the short-term to provide some living and work space to visiting researchers.
- Planning should begin for construction of a dedicated multipurpose facility to support research.
- A master plan for use of the Barrow Environmental Observatory (BEO) should be prepared. The plan should address appropriate uses for the BEO, scientific research requirements, infrastructural needs, and environmental and cultural issues.
- A high-speed, high-capacity data link from Barrow to the lower 48 states should be installed. Hardware and software are needed to support the data link and to run a web site to provide logistical information.

Copies of *The Future of an Arctic Resource: Recommendations from the Barrow Area Research Support Workshop* are available from ARCUS and as a PDF file on the ARCUS web site (<http://www.arcus.org>). ■

## NSF Initiatives Open Doors for Arctic Research

In early 1999, NSF made several announcements that are expanding opportunities for arctic researchers. Although the deadlines for the 1999 competitions under these new announcements have passed, the programs are expected to continue in FY 2000. Two programs are agency-wide; two are within the Office of Polar Programs (OPP). In addition, OPP has made funding available to improve long-term observations in the Arctic and established an office in Moscow to facilitate logistics for collaborative research in the Russian Arctic.

### Biocomplexity in the Environment (BE)

An NSF-wide effort, Biocomplexity in the Environment (BE) includes both ongoing programs and focused initiatives designed to foster research and education on the complex interdependencies among the elements of specific environmental systems and interactions of different types of systems. Three overlapping and interactive categories of research activity describe NSF's ongoing efforts related to environmental sciences:

- Global and Environmental Change,
- Environment and the Human Dimension, and
- Biodiversity and Ecosystems Dynamics.

In the 1999 Biocomplexity: Phase I initiative, NSF solicited proposals that focused explicitly on the role that microorganisms play in structuring or controlling complex systems. In FY 2000, NSF has announced a special Biocomplexity competition to improve understanding of the complex interdependencies among living organisms and the environments that affect, sustain, and are modified by them. The multidisciplinary \$50 million Biocomplexity initiative will emphasize enhancing analytical and predictive capabilities in the study of environmental systems.

For more information on Biocomplexity in the Environment, see the NSF web site (<http://www.nsf.gov/home/crssprgm/be/start.htm>). For more information on the special Biocomplexity competition, see <http://www.nsf.gov/pubs/2000/nsf0022/nsf0022.htm>. Messages of intent to submit a proposal are due 31 January and full proposals 1 March 2000.

### Life in Extreme Environments (LEExEn)

Life in Extreme Environments (LEExEn) is an NSF-wide program of particular interest to arctic researchers that explores the relationships between organisms and the environments within which they exist, with a strong emphasis upon those life-supporting environments that exist near the extremes of planetary conditions. Examples include hydrothermal systems, high-radiation fields, sea ice and ice sheets, anoxic habitats, hypersaline lakes, high-altitude or polar deserts, and industrial environments.

LEExEn is focusing, at least initially, on microbial systems, their diversity, and the mechanisms that allow them to survive and alter extreme environments. The LEExEn program announcement is available at <http://www.nsf.gov/cgi-bin/getpub?nsf9943>. Seventeen proposals were funded in 1999, totaling \$7.4 million.

### Human Dimensions of the Arctic System

In February 1999, the OPP disseminated its first Announcement of Opportunity for Human Dimensions of the Arctic System (HARC) research, an ongoing addition to the Arctic System Science program (see *Witness* Autumn 1998 and <http://www.nsf.gov/cgi-bin/getpub?nsf9961>).

Two proposals were funded for a total of \$1.6 million. Future HARC proposals can be submitted at the regular Arctic Section deadlines (15 February and 1 August).

### Long-Term Observations in the Arctic

Based on recommendations formulated at the *Opportunities in Arctic Research* workshop in September 1998 (see *Witness* Autumn 1998), OPP announced a new program to improve the observational infrastructure in the Arctic, including:

- **Environmental Observatories**—The coordinated development of strategically placed facilities, equipped for on-site research and collection of year-round observations.
- **Remote/Autonomous Instruments**—Relevant activities not directly tied to specific environmental observatories include moorings, drifting and land- and ice-based sampling stations, hydro-

graphic surveys, observations of animal populations, submarine surveys of ice, monitoring of terrestrial and oceanic weather, atmospheric sampling, and snow measurements. Related needs include the development of improved sensing devices and deployment for better spatial and temporal coverage.

- **Sample Repositories**—Facilities for new arctic samples of particular value due to their rarity, importance for studies and education, or expense of re-collection.

The program solicitation is at <http://www.nsf.gov/cgi-bin/getpub?nsf99101>. Proposals were due in June 1999. Nine proposals were funded for a total of approximately \$14.3 million, with additional awards expected in the near future.

### Contaminant Behavior and Impact in Northern Polar Regions

Another program solicitation that developed from the *Opportunities in Arctic Research* workshop encourages research on the physical, chemical, and biological processes that sequester and disperse contaminants in arctic natural systems and on the socio-economic impacts and human responses to such contaminants.

The program solicitation can be found at <http://www.nsf.gov/pubs/1999/nsf9997/nsf9997.htm>. Proposals were due in May 1999. Approximately \$2.7 million has been awarded in 10 grants.

### Improving Logistics Coordination in Russia

The Arctic Sciences Section of OPP has established a science liaison office in Moscow to assist U.S. and Russian researchers conducting collaborative research in the geosciences and arctic research.

This support is the result of collaboration between OPP and two other branches of NSF—the Geosciences Directorate and the International Office—and the U.S. Civilian Research and Development Foundation (CRDF).

For more information, see the Arctic Info archive on the ARCUS web site (<http://www.arcus.org>) for the message posted on 30 March 1999. Investigators interested in using these services should contact their NSF Program Manager. ■

## ARCSS Committee Advances Integrative Agenda

The Arctic System Science (ARCSS) Committee (AC) met in Virginia Beach, Virginia in October 1999. The AC provides guidance to the ARCSS Program and acts as a liaison between the program and the arctic research community. At the 1999 meeting, the AC assessed progress on two evolving research agendas in ARCSS:

- interactions between global and arctic systems, and
- assessments of the effects of global changes on arctic and sub-arctic regions.

The AC discussed improving extrapolation, integration, and prediction in the ARCSS Program and developed strategies to advance the evolving research agenda.

The AC was briefed on several ARCSS

initiatives, including the Study of Environmental Arctic Change (see page 9) and the Western Arctic Shelf-Basin Interactions (see page 8). The AC also discussed:

- development of an ARCSS-wide education initiative,
  - encouragement of ARCSS-focused Biocomplexity proposals (see page 6),
  - the status of the Long-Term Observatories program (see page 6), and
  - strategies for improving response to the Human Dimensions of the Arctic System (HARC; see page 6) solicitation.
- Plans for immediate action include:
- Form a HARC Science Steering Committee to facilitate the development of effective proposals.

- Sponsor a workshop to develop an ARCSS-wide science-education initiative, including its focus, strategy, and partnerships.
- Plan for an ARCSS-wide All-Hands Meeting in 2001.

For more information about AC discussions and plans see the ARCUS web site (<http://www.arcus.org>).

For more information on the ARCSS Program, contact Program Director Mike Ledbetter (703/306-1029; fax 703/306-0648; [mledbett@nsf.gov](mailto:mledbett@nsf.gov)) or AC Chair Jack Kruse (413/367-2240; fax 413/367-0092; [jkruse@geo.umass.edu](mailto:jkruse@geo.umass.edu)) or see the ARCSS web site (<http://www.nsf.gov/od/opp/arctic/system.htm>). ■

## PARCS Research Encompasses PALE and ESH

Because arctic paleoclimatic research falls under both the ARCSS and Earth Systems History (ESH) Programs at NSF, the two programs are coordinating a new overarching effort—Paleoenvironmental Arctic Science (PARCS). A science and implementation plan for the program, *The Arctic Paleosciences in the Context of Global Change Research*, was recently published.

PARCS will foster new opportunities for interaction among the disciplines that are contributing to arctic paleo research. The Steering Committee will include representatives from:

- the Paleoclimates from Arctic Lakes and Estuaries (PALE) community, as well as
  - other essential PARCS research sectors (e.g., ice core, marine sediment, tree ring analysis, glacial and sea-level dynamics).
- PARCS will also build on the international collaborations developed under the GISP2 and PALE paleoenvironmental programs.

For more information about the initiative, see the recently released PARCS report (see Publications page 23).

### Ongoing PALE/PARCS Research Projects

The PALE program, which began in 1990, has established a solid network of paleo-sites in the Arctic. Some of the research that continues within the PARCS initiative is described below.

New climate-model simulations from the eastern Canadian Arctic and northwest North Atlantic confirm the important role of oceans in arctic climate change. With Icelandic colleagues, PALE researchers are documenting glacial and deglacial ice dynamics off the coast of Iceland, and research with Danish colleagues will describe high-frequency and long-term variability in the Labrador Sea region.

The Russian Arctic generally lacks data regarding past land-cover and climatic change. A lake-sediment core recently retrieved by an American-Russian-German team from far eastern Siberia promises a paleoclimate record spanning the Quaternary. This site will contribute substantially to the climate chronology for the Pacific sector. In European Russia, a project documenting treeline changes on the Kola Peninsula is filling a data gap in the post-glacial record of the arctic treeline.

PALE investigators have been collaborating with the Long-Term Ecological Research Program at Bonanza Creek in interior Alaska to examine the influence of hydrologic change on the boreal forest. With Canadian colleagues, they are developing a paleolimnological description of a transect of lakes from boreal forest to tundra as the basis for future integrated paleo-modern studies. Two groups are collabo-

rating with LAII investigators (see page 10) on long-term changes in land-cover on the North Slope and coastal plain of Alaska; the mutual interest of PARCS and LAII in merging long-term records of change with modern, process-oriented data promises to be an important future direction in ARCSS.

Work continues on development of new paleoclimate proxy indicators, including varve-based sediment records, fossil beetle assemblages, and alkenones in lake sediments.

Synoptic climate studies and data syntheses continue to underscore the regional heterogeneity in arctic climate patterns. Northeast Siberia, Beringia, and Alaska show clear differences in circulation features centered in the North Pacific sector; heterogeneity is also seen in past records and at smaller scales. This variability emphasizes the need for comprehensive site coverage, and has implications for scaling observations and for predictions about the Arctic's response to climate changes.

For more information, see the PARCS web site (<http://www.ngdc.noaa.gov/paleo/parcs/index.html>) or contact Mike Retelle, co-chair of the PARCS Steering Committee, in Lewiston, ME (207/786-6155; fax 207/786-8334; [mretelle@bates.edu](mailto:mretelle@bates.edu)). ■

## OAII Shares Results at Second All-Hands Meeting

The second Ocean-Atmosphere-Ice Interactions (OAII) All-Hands meeting convened in Virginia, in October 1999. More than 100 international scientists participated in briefings and sessions on logistics, with an emphasis on plans for *Healy* (see page 1), outreach and education, the Study of Environmental Arctic Change initiative (see page 9), SHEBA (see below), and the Western Arctic Shelf-Basin Interactions (SBI) initiative.

The All-Hands meeting was followed by the organizational meeting for SBI Phase I, which is beginning implementation. SBI is designed to improve understanding of shelf-basin exchange processes and lead to:

- an enhanced predictive capability for global change impacts in the Arctic, and

- an improved understanding of how arctic processes might cause or modulate global change (see *Witness Spring and Autumn* 1998).

The SBI program will include field and modeling studies to elucidate the physical and biological shelf and slope processes that influence the structure and function of the Arctic Ocean.

Eighteen SBI Phase I projects, with 31 principal investigators (PIs) and co-PIs and various international collaborators, were funded in the first competition. Funded projects include retrospective, experimental, and modeling studies in fields of biological, chemical, geological, and physical oceanography. An SBI Project Office is coordinated by Jackie Grebmeier and Terry Whitledge. For

more information, see the SBI web site (<http://utk-biogw.bio.utk.edu/SBI.nsf/pages/Arctic>), or contact Jackie Grebmeier in Knoxville, TN (423/974-2592; fax 423/974-3067; [jgreb@utkx.utk.edu](mailto:jgreb@utkx.utk.edu)).

The OAII Science Steering Committee (SSC) also met in October 1999. Lou Codispoti succeeded Jackie Grebmeier as chair of the SSC. Two new members of the SSC are Patricia Matrai (Bigelow Laboratory for Ocean Science) and Paul Shepson (Purdue University).

For more information on OAII, see the OAII web site (<http://arcss-oaii.hpl.umces.edu/index.html>) or contact Lou Codispoti at the University of Maryland's Horn Point Lab in Cambridge, MD (410/221-8479; fax 410/221-8390; [codispot@hpl.umces.edu](mailto:codispot@hpl.umces.edu)). ■

## SHEBA Researchers Plan Analysis of Data

In October 1999, data sets from the Surface Heat Budget of the Arctic Ocean (SHEBA) field experiment were submitted to the SHEBA data-management system. These unprecedented data sets simultaneously document the upper ocean, sea ice, and atmosphere as a continuous time series over a full year. They have already improved simulations of arctic climate using global climate models. The data sets will be archived at the National Snow and Ice Data Center.

The Office of Polar Programs (OPP) released the Program Solicitation for Phase 3 of SHEBA in December 1999 (see <http://www.nsf.gov/cgi-bin/getpub?nsf0019>). Proposals are due 8 March 2000. The goals of Phase 3 are to utilize data sets collected during the field program to:

- determine the ice-ocean-atmosphere processes that control the ice albedo feedback and cloud-radiation feedback mechanisms over an annual cycle, leading to improvement of models of arctic ocean-atmosphere-ice processes; and
- develop models that improve simulations of the present arctic climate, using coupled General Circulation Models.

To accomplish these goals, Phase 3 projects will combine modeling, synthesis,

and integration of the SHEBA data set to investigate feedback mechanisms and develop improved formulations for climate models. Results from the SHEBA experiment were discussed in more than 60 presentations at the December 1998 meeting of the American Geophysical Union (AGU) and the January 1999 meeting of the American Meteorological Society. Highlights included:

- On their arrival in Fall 1997, the sea ice was considerably thinner than SHEBA investigators expected, and instead of getting thicker over the year as predicted, the ice grew thinner by approximately 35 centimeters.
- Sea-ice cover in the study region remained greater than 90–95%.
- In winter, the snow-covered ice reflected about 80% of incoming solar radiation. Melt ponds, which have lower albedo than the ice itself, covered more than 20% of the study region during mid-late summer, lowering the reflectivity of the surface to approximately 40%.
- Liquid particles constituted approximately 20% of the cloud mass during the coldest season (November-January) and 100% during the peak melt season (late July).

- The SHEBA melt season was longer than normal; preliminary results suggest that net surface radiation was enhanced by cloud cover during the summer.
- Measurements by the Department of Energy Atmospheric Radiation Measurement (ARM) Program's Atmospheric Emitted Radiance Interferometer indicate that current models for clear-sky radiative transfer systematically underestimate the downward spectral irradiance in the water-vapor continuum absorption bands at the low temperatures of the arctic troposphere in winter.
- The insulative value of the snow cover on sea ice has been considerably underestimated in previous models.

Additional results from the SHEBA field experiment were presented in sessions at the December 1999 AGU meeting in San Francisco. Investigators will also be meeting with collaborators at a joint SHEBA/FIRE (First ISCCP Regional Experiment) workshop 17-20 April 2000.

For more information, see the SHEBA web site (<http://sheba.apl.washington.edu>) or contact Richard Moritz in Seattle, WA (206/543-8023; fax 206/543-3521; [dickm@apl.washington.edu](mailto:dickm@apl.washington.edu)). ■



## SEARCH Plan is Designed to Evolve with New Insights

In July 1999, 38 researchers from a wide range of fields gathered to draft a science plan for the Study of Environmental Arctic Change (SEARCH) program.

SEARCH is envisioned as a long-term program to investigate the changes associated with the increasing Arctic Oscillation (AO) index documented in the Arctic in the past decade (see *Witness* Autumn 1998). The AO appears to be a natural mode of atmospheric variation that is active over a broad range of time scales and is linked to global atmospheric and ocean circulation patterns. The recent complex of changes related to the AO may be part of an oscillation or the beginning of a long-term modal shift.

Because the increase in the AO index appears to be linked to many other environmental changes, workshop participants recommended a multidisciplinary program

focused on the air-ice-ocean variations that appear connected to the AO, rather than a program defined by discipline or scale. Participants proposed that this suite of changes be named *Onami*, or “tomorrow” in Inuit—much as the periodic disruption in the ocean-atmosphere system of the tropical Pacific is known as *El Niño*.

SEARCH aims to understand *Onami* and its implications. The recommended program includes long-term observations, modeling, process studies, and assessment in the physical, biological, and social sciences. Physical science efforts will try to elucidate the feedbacks between land, air, ice, and ocean that drive the *Onami* complex and couple it to the rest of the globe, with the goal of predicting the course of *Onami*. The biological science effort will look for the ecosystem changes that are driven by the physical changes, and the

social science efforts will examine the human impacts of the *Onami*.

Jamie Morison, who is leading the SEARCH planning effort, presented the draft plan at the Ocean-Atmosphere-Ice Interactions (OAIL) All-Hands meeting in October 1999 (see page 8). Participants in those discussions agreed that SEARCH should be an ARCSS-wide research program, rather than contained within OAIL.

SEARCH Science Steering Committee members are David Battisti, Ed Carmack, Lou Codispoti, Hajo Eicken, Doug Martinson, Jamie Morison, Jim Overland, Jonathan Overpeck, Peter Schlosser, Mark Serreze, and Charles Vörösmarty.

For information, see the SEARCH web site (<http://psc.apl.washington.edu/search/index.html>) or contact Jamie Morison in Seattle, WA (206/543-1394; fax 206/616-3142; [morison@apl.washington.edu](mailto:morison@apl.washington.edu)). ■

## First RAISE Projects Receive Funding

The objective of the Russian-American Initiative on Shelf-Land Environments in the Arctic (RAISE) is to facilitate collaborative research between Russian and American scientists in order to understand processes and events in terrestrial, shelf, and ocean environments in northern Eurasia (see *Witness* Spring 1996, Autumn 1997). RAISE was created in 1995 in accordance with an agreement between NSF and the Russian Foundation for Basic Research (RFBR).

The International RAISE Steering Committee met in November 1999 and made the following recommendations:

- Continue to inform Russian, American, and international arctic science communities about the RAISE program.
- Publish the RAISE “Prospectus” in Russian.
- Publish (in both languages) a list of scientific projects in the Arctic (with abstracts) funded by the NSF Office of Polar Programs and RFBR.
- Organize an international workshop in Russia in 2000, to present results of RAISE and other ARCSS projects.

- Create a mechanism of support for joint RAISE scientific expeditions.
- Prepare a draft of an intergovernmental agreement for scientific cooperation in the Russian Arctic.

For information, contact Vladimir Romanovsky in Fairbanks, AK (907/474-7459; fax 907/474-7290; [ffver@uaf.edu](mailto:ffver@uaf.edu)) or Steve Forman in Chicago, IL (312/413-9404; fax 312/413-2279; [slf@uic.edu](mailto:slf@uic.edu)). ■

### RAISE Proposals Funded in 1999

- An International Workshop on Arctic Coastline Dynamics (E. Bierly and J. Brown);
- The Late Pleistocene Glacial and Sea Level History of Wrangel Island, Northeast Siberia (P.M. Anderson, J.B. Grette, S.L. Vartanyan, A.V. Lozhkin, and L. Gualtieri);
- Linkages Between Riverine Freshwater Dispersal, Sea-Ice Formation, and Large-Scale Sediment Transport in the Central and East Siberian Arctic (H. Eicken and A.Y. Proshutinsky);
- Reconstructing the Limits of the Last Glaciation and Postglacial Environments in the Southeastern Barents and Southwestern Kara Seas (L. Polyak and S. Forman);
- Russian-American Initiative on Shelf-Land Environments in the Arctic (RAISE) Science Management Office (V.E. Romanovsky and S.L. Forman);
- Sensitivity of the West Siberian Lowland to Past and Present Climate (L.C. Smith, G. MacDonald, A. Velichko, and R. Foster); and
- Water and Constituent Fluxes Across the Eurasian Arctic: Evolving Land-Ocean Connections Over the Past 20,000 Years (B.J. Peterson, R.M. Holmes, C. Vörösmarty, C. Willmott, S. Forman, R. Lammers, V.V. Gordeev, M. Meybeck, and I. Shiklomanov). ■

## LAII Researchers Model the Response of Sub-Arctic Vegetation to Transient Climatic Change in Alaska

Understanding the responses of terrestrial ecosystems to climatic warming is problematic because of the complex interactions among climate, disturbance, and population changes across the landscape. Most models of the effects of climatic change on vegetation predict the future equilibrium distribution of vegetation on the basis of current relationships between climate and vegetation. The present challenge in global-change research is to simulate short-term transient changes in climate, disturbance regime, and recruitment that drive long-term vegetation distributions. These short-term, transient changes are controlled by inherently spatial processes (e.g., disturbance propagation, and seed dispersal).

LAII researchers Scott Rupp, Terry Chapin, and Anthony Starfield have developed a frame-based, spatially explicit model (ALFRESCO) that:

- simulates landscape-level response of vegetation to transient changes in climate, and
- explicitly represents the spatial processes of disturbance propagation and seed dispersal.

As part of LAII- and SIMS-funded research, ALFRESCO was used to simulate the transient response of sub-arctic vegetation to climatic warming on the Seward Peninsula (80,000 km<sup>2</sup>) in north-west Alaska. Model simulations indicated that a warming climate would lead to:

- slightly more frequent and much larger fires;
- expansion of forest into previously treeless tundra;
- changes in vegetation and fire regime continuing for centuries after cessation of the simulated climate warming;
- up to 228% increase in area burned per decade, leading to a landscape dominated by a more homogenous, early successional deciduous forest;
- development of a novel grassland-steppe ecosystem, following a single transient 40-year drought, that persisted indefinitely and caused permanent increases in fires in both the grassland and adjacent vegetation.

These simulated changes in vegetation and disturbance dynamics under a warming climate have important implications for regional carbon budgets and biotic feedbacks to regional climate.

The LAII researchers are also using ALFRESCO to investigate the interaction of mountain barriers and climate in the Holocene advance of spruce into western Alaska. The paleo data indicate that white spruce expanded rapidly from Canada into interior Alaska approximately 9,000 BP. Spruce reached the southern reaches of the Brooks Range but did not cross over the mountains to the North Slope. The fact that white spruce has never been north of its current limit in Alaska suggests that mountains (and their environments) act as major geographic barriers limiting species' migration responses to climatic change.

For more information, contact Scott Rupp (907/474-7019; fax 907/474-6184; psulions@alaska.net), Terry Chapin (907/474-7922; fax 907/474-6967; fschapin@lter.uaf.edu), or Anthony Starfield (612/625-5721; fax 612/624-6777; starf001@maroon.tc.umn.edu).

### LAII Meetings

In March 1999, seventy LAII investigators met in Seattle for the annual LAII workshop. Highlights included results from the first field season of Arctic Transitions in the Land-Atmosphere System (ATLAS) and discussions of international opportunities and ideas for enhanced integration between ARCSS components.

The LAII 2000 Science Workshop will be held in Seattle, WA, 23-26 February 2000. ITEX investigators plan to meet for the first three days, and ATLAS investigators for the final three days, allowing two days of overlap between the groups for presentation of results and planning for the development of a Biocomplexity initiative (see page 6). The LAII Science Steering Committee will meet at the workshop, focusing on the Biocomplexity initiative and long-term directions of the program.

For more information, see the LAII web site (<http://www.laii.uaf.edu/>) or contact Patricia A. Anderson at the LAII Science Management Office in Fairbanks, AK (907/474-5415; fax 907/474-6722; patricia@gi.alaska.edu). ■

### ITEX Shares Syntheses, Plans Future

Investigators with the International Tundra Experiment (ITEX) initiated the first major synthesis of their global data sets in 1996; the resulting meta-analysis of ITEX data produced in cooperation with the National Center for Ecological Analysis and Synthesis has been published in *Ecological Monographs*. One important result of this effort has been the general observation that the response of plants to warming decreases over time, suggesting alternative resource constraints on growth in tundra ecosystems. For more information, contact Marilyn Walker in Fairbanks, Alaska (907/474-2424; fax 907/474-6251; mwalker@lter.uaf.edu). The paper is also available at: <http://www.esajournals.org/esaonline/?request=get-issue&issn=0012-9615&volume=069&issue=04>.

The 9th ITEX meeting was held in East Lansing, Michigan in January 1999. The meeting established ten working groups on issues including metadata, soils, and linkages to other programs. These efforts will facilitate integration and synthesis within ITEX and among other research programs, including Arctic Transitions in the Land-Atmosphere System (see *Witness* Autumn 1998) and international programs such as Conservation of Arctic Flora and Fauna (see *Witness* Spring 1997 and page 18).

The proceedings of the meeting are available in hard copy. For more information, contact Bob Hollister in East Lansing, MI (517/432-2399; fax 517/432-2150; holliste@pilot.msu.edu; <http://www.cevl.msu.edu/acl/index.html>). ■

## Arctic Natural Sciences Program Funds Variety of Studies

Within the Office of Polar Programs (OPP), the Arctic Natural Sciences (ANS) Program provides core support for disciplinary research in the Arctic and coordinates arctic research with the Directorates for Geosciences and Biological Sciences. The program also helps facilitate OPP multidisciplinary, cross-disciplinary, and bipolar projects. Specifically, ANS supports research in atmospheric sciences, biological sciences, earth sciences, glaciology, and oceanography. Areas of special interest include:

- ozone depletion in the Arctic,
- space weather, and
- exploration of the Arctic Ocean and its environmental processes.

### Atmospheric Sciences

This research focuses on stratospheric and tropospheric processes, and arctic climate and meteorology. ANS has also supported research on past climates (*e.g.*, atmospheric gases preserved in snow and ice cores), and on atmosphere-sea and atmosphere-ice interactions.

### Biological Sciences

ANS supports projects emphasizing understanding of the adaptation of organisms to the arctic environment. Studies include:

- research in freshwater, marine, and terrestrial biology;
- organismal adaptation to the arctic environment;
- ecology;
- ecosystem structure and processes; and
- the biological consequences of ultraviolet radiation.

### Earth Sciences

This area of research includes all sub-disciplines of terrestrial and marine geology and geophysics. Special emphasis is on understanding geological processes important to the arctic regions and the geologic history dominated by those processes.

### Glaciology

OPP is the focal point for glaciological research within NSF. This includes study of the history and dynamics of all naturally occurring forms of snow and ice (*e.g.*, sea-

sonal snow, glaciers, the Greenland ice sheet). Program emphases include ice dynamics, numerical modeling, glacial geology, and remote sensing.

### Oceanography

Oceanographic research focuses on the structure of the Arctic Ocean and adjacent seas, their physical and biological interactions with the global hydrosphere, and the formation and maintenance of the arctic sea-ice cover. Areas of interest are:

- the distribution of life in high-latitude oceans;
- low-temperature life processes;
- the growth and decay of sea ice;
- the formation, movement, and mixing of arctic water masses;

- the exchange of salt and heat with the Atlantic Ocean and the Bering Sea;
- magnetic anomalies, heat flow, and gravity variations;
- sedimentary history; and
- the role of the Arctic Ocean and adjacent seas in global climate.

Several noteworthy projects funded by the Arctic Natural Sciences program are highlighted in the articles on this and the following two pages.

For more information about the program, see the ANS web site (<http://www.nsf.gov/od/opp/arctic/natural.htm>) or contact ANS Program Manager Jane Dionne at NSF in Arlington, VA (703/306-1029; fax 703/306-0648; [jdionne@nsf.gov](mailto:jdionne@nsf.gov)). ■

## SuperDARN Monitors Magnetic Field

One of the principal ways in which solar activity influences the Earth is through the effect of the solar wind on the magnetosphere and the upper atmosphere. Over the past several years, a global-scale network of high-latitude, high-frequency radars has begun to probe some of the key questions in solar-terrestrial research. The international network, known by the acronym SuperDARN (Super Dual Auroral Radar Network), is designed to measure global-scale magnetospheric convection by observing plasma motion in the Earth's upper atmosphere (ionosphere).

Plasma convection is controlled by interactions between the solar wind, the Earth's magnetosphere, and the ionosphere in the Arctic and Antarctic. Measuring this convection will contribute to a better understanding of:

- processes in the near-Earth space environment, and
- the importance of electromagnetic energy input to the high-latitude regions of Earth's upper atmosphere.

Currently, the northern hemisphere component of SuperDARN consists of six radars with coverage extending from Finland to central Canada. Three new radars will be added to the network in Canada and Alaska to complete coverage westward

to Siberia. In the Southern Hemisphere, four radars are operational, and two are under construction. Each radar covers 3,500 km in range and 56° in azimuth. The radars operate continuously and deliver images of the high-latitude convection pattern every two minutes.

Scientists from ten countries operate the network. U.S. participation is funded by NSF (through OPP-ANS and the Division of Atmospheric Sciences of the Directorate for Geosciences) and NASA.

SuperDARN is the only experiment that yields continuous, large-scale, direct observations of the high-latitude electrical field. The network provides insight into:

- the structure and evolution of high-latitude ionospheric convection patterns at a large scale;
- the effects of ionospheric convection on the structure and dynamics of the upper atmosphere;
- global distribution and transport of high-latitude ionospheric irregularities; and
- the large-scale distribution and propagation of gravity waves excited by high-latitude sources.

For more information, see the SuperDARN web site (<http://superdarn.jhuapl.edu>). ■

# Navy and Civilians Complete Submarine Science Series

In April 1999, researchers funded by the Arctic Natural Sciences Program sailed aboard the U.S. Navy submarine *USS Hawkbill* to map oceanic ridges and basins beneath the arctic ice cap and study ocean currents that may affect global climate.

This Scientific Ice Expeditions (SCICEX) '99 cruise was the last of a series of five annual missions that have employed Sturgeon Class nuclear submarines as research platforms for civilian scientists (see *Witness* Spring 1998). The U.S. Office of Naval Research has played a key, sustained role in this collaboration between the U.S. Navy and NSF.

SCICEX '99 was under the direction of Commander Robert H. Perry and Chief Scientist Margo H. Edwards (University of Hawaii). Research included:

- examination of the Gakkel Ridge, the slowest spreading mid-ocean ridge in the world, where scientists expect to

find an opportunity to better understand processes that contribute to the creation of oceanic crust;

- a search for glacial scouring on the Chukchi Borderland that could provide evidence of the extent and depth of ice cover during the last Ice Age;
- examination of the Lomonosov Ridge to obtain clues as to how the Amerasian basin may have formed;
- studies of undersea sediments on the Yermak Plateau; and
- monitoring of the temperature, salinity, and composition of the strong circumpolar current that flows around the boundary of the Arctic Ocean, transporting water from the Atlantic and Pacific oceans throughout the Arctic.

Edwards was the first woman to travel aboard a U.S. Navy submarine, and Rita Colwell was the first NSF director to visit a SCICEX cruise.

### The Future of Submarine Support

In June 1999, the report from the 1998 SCICEX 2000 workshop was published. The report summarizes scientific insights from the four SCICEX cruises that had been completed at that time and explores the future of submarine support for civilian research. According to Rear Admiral Winford Ellis, the Navy will have other obligations for its greatly reduced U.S. submarine force for at least the next few years.

NSF is working with the RAND Corporation to assess the feasibility of operating a decommissioned Sturgeon Class nuclear submarine as an unclassified oceanographic research vessel.

For more information, see the SCICEX web site (<http://www.ldeo.columbia.edu/scicex>) or the RAND Corporation web site (<http://www.rand.org/centers/stpi/special/meade.minutes.html>). ■

# Russian-American Team Determines Bering Strait's Age

For more than 100 million years, the Bering land bridge between Siberia and Alaska divided the Arctic Ocean from the North Pacific. Generations of paleontologists, biogeographers, and oceanographers have sought to assign a date to the flooding of the land bridge by the Bering Strait because of the strait's dual role in:

- terminating the interchange of mammals between Eurasia and the Americas; and
- enabling the migration of marine biotas between the North Pacific, Arctic, and North Atlantic oceans.

Discovery of fossil mollusks from southwestern Alaska in the collections at the California Academy of Sciences led to fieldwork on the Alaska Peninsula in August 1998 by a team of American and Russian paleontologists who assigned a well-founded age to the strait for the first time. Sponsored by OPP-ANS, Louie Marinovich (California Academy of Sciences), Anton Oleinik (Florida Atlantic University), and Konstantin Barinov (Russian Academy of Sciences Geological Institute) found *Astarte*, a clam that dwelled



*Konstantin Barinov (left) and Louie Marinovich (right) on Sandy Ridge. The strata between them contain white fossil clams, many of which are Astarte. An accurate date for the Bering Strait is relevant for numerical models of oceanographic and atmospheric circulation and their influences on global climate, as well as for understanding the evolution of mammalian and marine fauna (photo courtesy of Louie Marinovich).*

only in the Arctic and Atlantic oceans, in sandstone beds at Sandy Ridge near Port Moller on the north (Bering Sea) side of the Alaska Peninsula. The clam's presence clearly indicates an open Bering Strait.

Fossil diatoms from within the shells of *Astarte* were used to date them at 4.8–5.5 million years old, based on the diatoms' occurrences in North Pacific deep-sea cores. This age is considerably older than the 3.1–4.1 million year age for the Bering

Strait that was previously inferred from indirect evidence in Russia, Alaska, arctic Canada, and the high-latitude North Atlantic region. The Bering Strait is the last of the Pacific Ocean gateways to be assigned a precise age.

For more information, contact Louie Marinovich in San Francisco, CA (415/750-7110; fax 415/750-7090; [lmartin@best.com](mailto:lmartin@best.com)). ■



## International Efforts Focus on “Arctic Oasis”

Polynyas are areas of open water surrounded by sea ice. Polynyas occur in the midst of the ice pack that covers the Arctic Ocean and adjacent seas and can persist for nine or ten months of the year. Because some polynyas occur at the same time and place each year, animals have adapted their life histories to this regularity, making recurring polynyas of special ecological significance.

5,000 years ago Inuit peoples settled the area around Thule (then called Avangersuaq) in Greenland, because of its proximity to the resources of the North Water Polynya, the largest polynya in the Canadian Arctic. The North Water is an overwintering ground for belugas, walruses, and narwhals. In spring, cliffs and islands on the nearby coasts harbor immense populations of nesting marine birds such as thick-bill murres and doves. Explorer Robert Peary described the area’s “abundance of vegetable and animal life” as an “Arctic oasis”.

In January, the North Water area is almost completely covered with thin drifting ice. By late March or early April, the polynya has opened along the Greenland coast and begun to spread south and west, reaching its maximum extent in July (about 80,000 km<sup>2</sup>). Although the polynya has generally been considered to be due to currents removing the ice (latent heat polynya), new evidence suggests that upwelling of relatively warm water may contribute to the polynya’s existence and growth in winter and spring (sensible heat polynya).

The oceanographic and meteorological processes responsible for generating and maintaining the North Water are among the main scientific issues addressed by the International North Water Polynya Study (NOW), which is part of the International Arctic Polynya Programme (IAPP) of the Arctic Ocean Science Board (AOSB). The NOW Research Network links researchers from Belgium, Canada, Denmark, Japan, Mexico, Poland, the United Kingdom, and the United States. Work undertaken by the nine U.S. principal investigators in the NOW project is supported by NASA and by NSF through the Arctic Natural Sciences Program.

The central hypothesis of NOW is that the mechanism responsible for the opening of the North Water (latent *vs.* sensible heat) dictates the duration and intensity of biological productivity. The growth of algae starts as early as April in the NOW area. This biological productivity can last up to six months in the North Water, while it may last less than three months in adjacent areas such as Lancaster Sound, where ice break-up and the phytoplankton bloom occur typically in late July.

In addition to a long growth season, the surface stratification resulting from the melting of the ice cover in sensible-heat areas of the North Water accelerates the warming of surface waters by solar radiation. This longer production season and a warmer surface layer allow key metazoan species such as copepods, appendicularians, and arctic cod to flourish in the open waters. According to this hypothesis, the early and sustained availability of plankton would explain the abundance of mammals and birds in the North Water.

Another aspect of the NOW research is the study and modeling of carbon sequestration in the North Water. In seasonally frozen seas, the ice cover forming in early autumn prevents the CO<sub>2</sub> dissolved in the surface waters and assimilated in summer by microalgae from returning to the atmosphere in winter. Therefore, seasonally ice-covered areas (in particular around highly productive polynyas) could contribute disproportionately to the sequestration of atmospheric CO<sub>2</sub>.

Fieldwork for NOW began in 1997 with mooring of instrument lines in the North Water and preliminary biological sampling during a 14-day expedition of the Canadian Coast Guard icebreaker *Louis S. St. Laurent*. The moored instruments allowed scientists to record the physical and biological conditions that prevailed during the winter months preceding the vernal expansion of the polynya in 1998. The main field effort for NOW was carried out from April through July 1998, when more than 100 experts from five countries, distributed on four 28-day legs, combined forces for multidisciplinary study of the North Water on board the CCG icebreaker *Pierre Radisson*. Helicop-



*This image of the North Water Polynya area was derived from measurements of the Advanced Very High Resolution Radiometer on the NOAA-14 satellite on 5 June 1998. Thin cirrus cloud partially obscures the dark, open water of the polynya, bordered to the east by the coast of Greenland; to the west by the coast of Ellesmere Island, with some fast ice attached to the coast; and to the south by the pack ice in northern Baffin Bay. The northern boundary of the polynya is marked by a well-formed arch straddling Nares Strait, holding back the ice flow that would otherwise come down from the Arctic Ocean through Kane Basin. The picture is of reflected sunlight, at a wavelength of about 0.65 micron. The image has been rectified so north is to the top and is shown in a polar stereographic projection, centered at 77°N, 73°W, where the pixel resolution is 1 km square. There are 700x500 pixels in the image (figure courtesy of Peter Minnett, prepared at the University of Miami, Rosenstiel School of Marine and Atmospheric Science, from data downlinked at the Geophysical Institute, University of Alaska Fairbanks).*

ter surveys from the *Radisson*, as well as measurements taken from bases on the coastline and by automatic instruments set up on the polynya’s perimeter, extended the spatial range of the observations. Finally, a third international expedition, jointly funded by Canada, Japan, and the United States, was completed in October 1999, allowing an interannual comparison of the dynamics of the North Water and a first glimpse of autumnal processes as the polynya begins to close for the winter.

For more information, see the International NOW project web site (<http://www.fsg.ulaval.ca/giroq/nw/wel.htm>) or contact Jody Deming in Seattle, WA ([jdeming@u.washington.edu](mailto:jdeming@u.washington.edu)). ■

## Arctic Social Sciences Program Presents Opportunities

The OPP Arctic Social Sciences Program (ASSP) is a multidisciplinary and interdisciplinary program encompassing all social sciences supported by NSF. These include anthropology, archaeology, economics, geography, linguistics, political science, psychology, sociology, and related subjects.

In 1999, ARCUS published *Arctic Social Sciences: Opportunities in Arctic Research* on behalf of the ASSP, outlining

the opportunities and needs in the arctic social sciences. Research areas of particular focus include culture and environment; resources and economic change; development of social and political institutions; ethnic and regional identities; and knowledge systems.

The ASSP encourages projects that:

- include new investigators or indigenous peoples;
- are circumpolar and/or comparative;

- integrate social and natural sciences;
- are collaborations between researchers and those living in the Arctic;
- include traditional knowledge; or
- link disciplines, regions, researchers, communities, and/or students.

Building and maintaining relationships between arctic communities, researchers, and funding agencies requires scrupulous attention to sociopolitical and ethical considerations, but the returns are proving to be greatly valued. Examples of partnership approaches taken by arctic communities and researchers include:

- The Shishmaref Native Corporation and Susan Fair have documented place names along the Saniq coastline, including oral histories associated with place, graphic arts, and paintings produced by Iñupiaq inhabitants of the region.
- Henry Huntington has worked with communities in northwest Alaska to identify a feasible way to document traditional ecological knowledge of beluga whales (see *Witness* Spring 1997).
- Yup'ik elders and Ann Fienup-Riordan, in collaboration with the Association of Village Council Presidents, have researched an extensive collection of Yup'ik artifacts at a Berlin museum.

Several noteworthy ASSP projects are highlighted in the articles on this and the following two pages.

When appropriate, ASSP pursues joint review and funding with programs in the Directorate for Social, Behavioral and Economic Sciences (<http://www.nsf.gov/sbe>). Special funding opportunities also may be available through NSF-wide initiatives and activities, such as the Human Dimensions of Global Change (<http://www.nsf.gov/sbe/hdgc/hdgc.htm>) and Biocomplexity in the Environment (see page 6). Joint review of human dimensions proposals with the Arctic System Science (ARCSS) Program is also possible (<http://www.nsf.gov/od/opp/arctic/system.htm>).

For more information, contact ASSP Program Manager Fae Korsmo at NSF in Arlington, VA (703/306-1029; fax 703/306-0648; [fkorsmo@nsf.gov](mailto:fkorsmo@nsf.gov)) or see the ARCUS web site for a copy of *Arctic Social Sciences: Opportunities in Arctic Research* (<http://www.arcus.org>). ■

## Photos Preserve Northern History

The Peary-MacMillan Arctic Museum collection at Bowdoin College includes thousands of photographs taken by Donald MacMillan during nearly 50 years of work in Greenland, Labrador, and Baffin Island. MacMillan recorded places, natural history, and the lives of the people between 1908 and 1954, during the pivotal period when foreign cultures were first influencing indigenous people in the Arctic. Along with MacMillan's journals, publications, and collection of objects, these images are a rich source of historic, environmental, and ethnographic information.

In 1999, Genevieve LeMoine conducted anthropological fieldwork in Northwest Greenland using MacMillan's photographs to revisit the 20th-century history of the Greenland Inuit. The goals of the project, supported by the ASSP,

are to increase understanding of these important images and to make them more accessible to both researchers and the people whose lives they document.

Working with Thule Museum staff in Qaanaaq, LeMoine and an undergraduate conducted interviews with members of the communities where the photographs had been taken. They gathered information about people in the photos and the places with which they were associated (*e.g.*, their birthplaces; homes; fishing, hunting and gathering sites; the sites where the photos were taken). Such information represents a recovered history, deepening the historical and anthropological utility of the images.

For more information, contact Genevieve LeMoine in Brunswick, ME (207/725-3304; fax 207/725-3499; [glemoine@polar.bowdoin.edu](mailto:glemoine@polar.bowdoin.edu)). ■



*Itukasuk (far left), who worked extensively with Donald MacMillan, and his family over-wintered in 1923-24 in Refuge Harbor where MacMillan had frozen-in his schooner Bowdoin. The other family members in this photo from the spring of 1924 were identified by informants, including Ole Petersen, as Aviaq, Ane Petersen (wife of Itukasuk) holding Ole, and Qiajunuaq (photo courtesy of the Arctic Museum, Bowdoin College).*

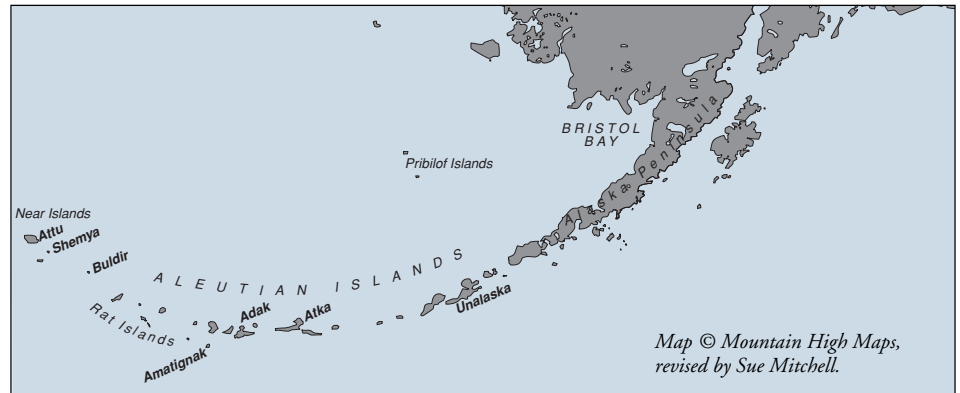
## Project Investigates Prehistoric and Modern Aleuts

The world today has no ethnographic or historic resources to document the unique lifestyles of the people of the Western Aleutians in any period of their history. An international team of researchers is now investigating the Near Island Aleuts, combining archaeology, historical ecology, molecular biology, and ethnography to better understand the history and environment of the isolated islands.

Since 1997, with funding from the Arctic Social Sciences Program, the Western Aleutians Archaeological and Paleobiological Project (WAAPP) has investigated the archaeology of Buldir and Attu Islands. Dixie West (University of Kansas), Christine Lefevre (Museum of Natural History, Paris), and Debra Corbett (U.S. Fish and Wildlife Service, Anchorage) serve as principal investigators for the research project. Arkady Savinetsky (Russian Academy of Sciences, Moscow) leads the historical ecologists.

Thus far, archaeological investigations of tools have shown that Aleuts from both the Rat and Near islands used Buldir, sometimes concurrently. Organic cultural remains have yielded dates from 240 BP to 2347 BP. Archaeologists discovered and excavated a feature, probably a culturally arranged superstructure, made of numerous whale ribs and long bones on Buldir—the only such structure excavated and documented for the Near Islands. Mixed in the collapsed bone rubble were a variety of cobbles with signs of use-wear, griddle-stones, stone lamps, and stone points. A partial whale skull was partially buried, snout down, in a shallow 2 m-wide pit that had been dug into the floor and lined with sea lion scapula. A large amorphous hearth occupied much of the northern edge of the excavated area, and three smaller pockets in the floor contained bones, needles, and fish hooks. Organic samples taken from the whale-bone structure suggest the feature was constructed during the 15th century AD.

Researchers recovered a rib bone of a Stellar sea cow in the midden on Buldir. This species, a large herbivorous sea mammal, was discovered by Russians in 1741 on Bering Island in the Commanders to the west. Within 27 years, Russian explor-



ers and trappers had exterminated the sea cows in the Commanders. While the early Russian explorers never reported sea cows in the Aleutians, discovery of bones in the Buldir midden suggests that these animals once lived in the Aleutians as well.

During the first field season on Attu in 1998, archaeologists surveyed, mapped, and tested ancient Aleut village sites in Nevidiskov Bay, Massacre Bay, and Austin Cove. Radiocarbon dates suggest that Attu was inhabited by 390 BC. The research team discovered a cave approximately 5 m wide and 48 m deep. Near the entrance of the cave are hearths, work areas with carved wood and a porcelain cup with a Chinese motif, and sleeping/sitting areas lined with dried grass. In the dark interior of the cave were two stone features and human bones, evidently associated with human burials. Until this discovery, no cave burials had been noted west of Amatignak Island.

The WAAPP archaeologists are working with the Aleut community and cultural organizations to preserve the history of the Western Aleuts. On Unalaska and Atka islands, Alice Petrivelli, a native Aleut and ethnographer affiliated with the Aleut Corporation, is interviewing the last surviving Aleuts who once lived in the Western Aleutians. Petrivelli is gathering data on:

- family histories;
- hunting, fishing, and collecting practices;
- Attuan history;
- women's activities including basket weaving and plant collecting; and
- concepts of identity.

This body of data should add greatly to understanding of ancient Attuans as well as preserving more recent history.

In the future, the archaeologists and historical ecologists will work in Austin Cove on the north shore of Attu. The Russian team will examine buried soils for information on changes in rainfall and temperature. Soil profiles will be compared with those from Shemya, Adak, and Buldir islands to develop a paleoenvironmental framework for the region.

Archaeologists will sample whale bone in house structures to establish temporal patterns of whale use. DNA analysis will allow the researchers to identify the species of whales used, which may allow inferences about prehistoric/historic whale hunting in the Near Islands.

Archaeologists will excavate house features to allow comparison of western and eastern Aleutian house construction. They also will carefully map the cave interior, and collect wood and animal bones for analyses. The Aleut Corporation has given West permission to collect human remains from the cave for radiocarbon dating and DNA analysis by molecular geneticists Michael Crawford (University of Kansas) and Dennis O'Rourke (University of Utah). The bone analyses also will provide information about the age, general health/nutritional condition, and cultural affiliation of the humans in the cave. In turn, this information will be integrated within a larger, regional framework for Aleut origins and distribution.

For more information, contact Dixie West in Lawrence, KS (785/864-4103; fax 785/864-5224; dlwest@ksu.edu). ■



## OMB Publishes New Regulations on Data Access

A rider attached to the FY 1999 omnibus appropriations bill by Senator Richard Shelby (R-AL) effectively subjects federal nonprofit grantees to the Freedom of Information Act (FOIA), essentially overturning a 1980 Supreme Court decision limiting FOIA to governmental agencies. The Shelby amendment makes “all data” produced under a grant subject to the procedures of FOIA and would permit the federal agency to impose a user fee on the requestor equaling the incremental cost of obtaining the data.

In accordance with the new law, the federal Office of Management and Budget (OMB) published draft revisions to its data-disclosure regulations (Circular A-110) in February and August 1999. After receiving comments on the drafts, OMB published the final revisions, some of which limited the scope of the law, in September 1999 (see box).

The scientific community has expressed concern about the extension of the FOIA to federal grantees. NSF Director Rita Colwell stated, in her February 1999 comments to OMB, that regulations

implementing the law “will likely harm the process of research in all fields.” In April 1999, the American Association for the Advancement of Science (AAAS) wrote that “the proposed revisions... represent a fundamental shift in federal policy that will create serious unintended consequences for scientists, their institutions, federal funding agencies, and the wider public.”

The late Congressman George Brown (D-CA) introduced legislation (HR 88)

to repeal the original rider; in July 1999, hearings were held on Brown’s bill, which had 54 co-sponsors, before the House Committee on Government Reform’s Subcommittee on Government Management, Information and Technology.

For more information, see the AAAS web site (<http://www.aaas.org/>), the OMB web site (<http://www.whitehouse.gov/omb/>), and the U.S. Congress web site (<http://thomas.loc.gov/>). ■

### Revision to OMB Circular A-110.36

The Federal Government has the right to (1) obtain, reproduce, publish or otherwise use the data first produced under an award, and (2) authorize others to receive, reproduce, publish, or otherwise use such data for Federal purposes. *In addition, in response to a FOIA request for data relating to published research findings produced under an award that were used by the Federal Government in developing an agency action that has the force and effect of law, the Federal awarding agency shall request and the recipient shall provide, within a reasonable time, the research data so that they can be made available to the public through the procedures established under the FOIA.*

## NSF Budget Increases in FY 2000

*This article has been abstracted from information on FY 2000 federal funding for research and development prepared each year by the American Association for the Advancement of Science (AAAS) Office of Science and Policy Programs. For more information, see the AAAS web site (<http://www.aaas.org/spp/R&D>).*

In October 1999, President Clinton signed into law an FY 2000 VA-HUD appropriations bill (HR 2684) that increases the NSF budget by 5.4% (\$202 million). Each NSF directorate receives an increase of at least 3%, and the Research and Related Accounts budget climbs 5.5% to \$2.9 billion. The budget agreement of 18 November 1999 applied an across-the-board cut of 0.38% to all appropriated programs, including NSF, to bring the budget technically in line with the FY 1997 spending caps.

Although growth in the NSF budget slowed in the mid-1990s, recent years have brought significant increases for the agency, and most disciplines have shared in this growth. Highlights of the FY 2000 research appropriations for NSF include:

- increased arctic research logistics funding to \$25 million, \$3 million more than the President’s budget request;
- \$50 million for the new Biocomplexity initiative (see page 6);
- a major increase in NSF’s investments in information technology (IT) research—The Clinton Administration has proposed a multi-agency Information Technology for the 21st Century (IT2) initiative in computing and IT research. Congress appropriated \$90 million for the NSF Directorate for Computer and Information Science and Engineering to take the lead on this initiative;
- \$95 million for Major Research Equip-

ment, \$10 million more than requested. The additional \$10 million will fund a new high-altitude research aircraft; and

- \$60 million for the third year of the Plant Genome Research Program.

The Education and Human Resources Directorate receives \$697 million, \$35 million more than FY 1999. This includes \$55 million, up from \$48 million, for the Experimental Program to Stimulate Competitive Research (EPSCoR), a program to improve the research competitiveness of 18 states (and Puerto Rico) traditionally under-represented as recipients of federal research funding. The final bill transfers the EPSCoR program and its funds to a new Office of Innovation Partnership; the bill also dedicates \$10 million beyond the EPSCoR funds for the new office to assist non-EPSCoR institutions that receive little federal research funding to expand their research capacity and competitiveness. ■



## The USARC Studies Arctic Infrastructure and Bering Sea

The U.S. Arctic Research Commission (USARC) met in July 1999 at the Institute for Arctic and Alpine Research (INSTAAR) at the University of Colorado in Boulder. Margo Edwards, Chief Scientist for the 1999 SCICEX expedition, briefed the Commissioners on the results of that submarine cruise (see page 12). The Commissioners were briefed on INSTAAR research activities and, during visits to their respective facilities, heard reports from:

- the National Snow and Ice Data Center,
- the National Geophysical Data Center,
- the National Ice Core Repository, and
- the National Center for Atmospheric Research.

The Commission met again in October 1999 in Arlington, Virginia to discuss infrastructure, including the basic and applied research needed to cope with the effects of climate change on arctic infra-

structure. Robert Perry, Commander of the 1999 SCICEX submarine, gave a detailed report on operations. Rita Colwell, Director of NSF and *ex officio* Commissioner, joined the meeting for a broad discussion of arctic research needs.

In December 1999, the Commissioners convened in Alaska to address research needs and progress in planning for the study of the Bering Sea ecosystem. A multiagency forum was held at the Alaska Resources Library and Information Services (ARLIS) in Anchorage; the Fisheries Industry Technology Center hosted the Kodiak segment of the meeting.

The USARC published the 1999 edition of its biennial *Report on Goals and Priorities for Arctic Research* (see *Witness* Spring 1998) in January 1999, providing guidance to the Interagency Arctic Research Policy Committee (IARPC) in its biennial revision of the National Arctic Research Plan. The Plan coordinates the

12 federal agencies engaged in arctic research—NSF (the IARPC lead agency); the Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Interior, State, and Transportation; as well as the National Aeronautics and Space Administration, the Environmental Protection Agency, and the Smithsonian Institution. For more information on IARPC, see <http://www.nsf.gov/od/opp/arctic/iarpc/start.htm>.

The January 2001 edition of the *Report on Goals and Priorities for Arctic Research* will be prepared during Spring and Summer 2000. The 1999 *Report* can be found on the USARC web site ([http://www.uaa.alaska.edu/enri/arc\\_web/archome.htm](http://www.uaa.alaska.edu/enri/arc_web/archome.htm)). Input from the arctic research community is welcomed.

For more information, contact Garry Brass in Arlington, VA (800-AURORAB or 703/525-0111; fax 703/525-0114; [g.brass@arctic.gov](mailto:g.brass@arctic.gov)). ■

## Polar Research Board

## PRB Stresses Importance of Ocean Drilling in the Arctic

In its most recent report, *Ocean Drilling Research: An Arctic Perspective* (see Publications page 23), the Polar Research Board (PRB) argues that the Arctic Ocean Basin should be included in any ocean-drilling research program that reaches past the current program's scheduled expiration in 2003.

According to the report, justification for the perpetuation of scientific ocean drilling should be based, at least in part, on the need for information from the last real frontier in ocean drilling. The Arctic Basin contains the Alpha-Mendeleyev Ridge system—the largest essentially unexplored geologic feature on Earth, and the basin itself is the only one in the world that has never been drilled. As a consequence, its geologic and climatologic histories are largely unknown. The report:

- reviews what is known about Earth's crust and paleoclimate in the Arctic;

- outlines questions about the origin and evolution of the Arctic Ocean Basin that remain unresolved;
- reviews the technical challenges that have historically prevented deep ocean drilling at arctic sites; and
- proposes ways that these might now be addressed.

The PRB has two new studies underway. At the request of the National Atmospheric and Space Administration (NASA), the committee is reviewing its polar geophysical data sets and providing advice to make them more useful. Another committee will review the Gulf of Alaska Ecosystem Monitoring Program for the *Exxon Valdez* Oil Spill Trustee Council.

Donal Manahan (University of Southern California) succeeded David Clark as Chair of the PRB in Spring 1999. Manahan is a marine environmental physiologist with extensive experience in Ant-

arctica as well as temperate oceans around the globe. His research addresses larval biology of marine invertebrates, environmental chemistry, and developmental changes in physiology. New members of the PRB are Henry Huntington (Huntington Consulting), P. Buford Price (University of California, Berkeley), and Marilyn Walker (University of Alaska Fairbanks).

Retiring members were John Anderson (Rice University), Walter Oechel (San Diego State University), Glenn Shaw (University of Alaska Fairbanks), and Robert Walker (Washington University).

For more information, contact Chris Elfring, PRB Director, in Washington, DC (202/334-3479; fax 202/334-1477; [celfring@nas.edu](mailto:celfring@nas.edu); <http://www4.nas.edu/cger/prb.nsf>). ■

## Arctic Council Meets Under U.S. Leadership

In November 1999, more than 150 delegates to the Arctic Council met in Washington, DC, under the chairmanship of the United States, to discuss cooperative measures to promote environmental protection and sustainable development in the Arctic. The meeting followed up on issues discussed at the previous Arctic Council meeting in Anchorage, Alaska in May 1999. Delegates included senior officials of the eight arctic nations, representatives of arctic indigenous organizations that have Permanent Participant status, and representatives of accredited observers.

The Arctic Council is a high-level, intergovernmental forum of the arctic nations established in 1996 (see *Witness* Spring 1997). The Council grew out of the groundwork initiated between 1991 and 1996 as those nations pioneered the Arctic Environmental Protection Strategy (see *Witness* Autumn 1997).

### Environmental Protection

Four of the Council's five working groups address environmental issues such as contaminants, conservation of living resources, and environmental threats. These groups—the Arctic Monitoring and Assessment Program; Conservation of Arctic Flora and Fauna; Emergency Prevention, Preparedness, and Response; and Protection of the Arctic Marine Environment—reported on progress they have made since the May 1999 meetings.

Delegates reviewed plans to further develop an Arctic Council Action Plan, which identifies priorities for reducing emissions and cleaning up contaminants. Efforts are also underway to develop a comprehensive Arctic Climate Impact Assessment to examine the implications of climate change and increased ultraviolet (UV) radiation on the Arctic. Delegates encouraged arctic states to ratify the protocols on persistent organic pollutants and heavy metals that are part of the United Nations' convention on long-range transboundary air pollution. Canada is the only nation to have ratified the protocols.

### Sustainable Development

The Council's newly established Sustainable Development Working Group

(SDWG), chaired by Ray Arnaudo of the U.S. State Department, held its first meetings in May and November 1999. Members reported on progress they have made in improving the well-being of arctic children and youth, managing regional fisheries, and expanding use of telemedicine on a circumpolar basis. The working group endorsed a project to promote cultural and eco-tourism and received an update on the comparative Survey of Living Conditions in the Arctic.

The SDWG heard presentations and proposals on health issues such as emerging infectious diseases, occupational health and safety in the fishing industry, and the health and environmental needs of indigenous communities. Fae Korsmo, director of the NSF Arctic Social Sciences Program (see pages 14-15), reviewed social science work in the Arctic, calling attention to several international joint projects and the participation of indigenous communities in such research.

The SDWG also discussed common themes and possible priorities for the Council's sustainable development program. The discussion advanced efforts to draft a framework document to guide its activities.

### Public Awareness, Education, and Outreach

A Council priority is public outreach concerning arctic issues within its mandate. Delegations were briefed on:

- the science education program Global Learning and Observation to Benefit the Environment (GLOBE), which links primary and secondary schools world-wide through the internet and collects valuable environmental data;
- progress in forming a University of the Arctic, which will promote use of internet and student/faculty exchanges among institutions of higher learning in the Arctic (see page 22);
- use of the Arctic Council web site to build an inventory of arctic research and other programmatic activities;
- the Arctic Environmental Data Directory; and
- the Arctic Environmental Atlas.

The Senior Arctic Officials will meet next in April 2000 in Fairbanks, Alaska.

For more information, see the Arctic Council web site (<http://arctic-council.usgs.gov>) or contact Tracy Hall at the State Department in Washington, DC (202/647-4972; fax 202/647-1106; [hallta@state.gov](mailto:hallta@state.gov)). ■

*The existence of the Arctic Council certainly recognizes that everyone here is neighbors. Alaska shares a common border with our neighbors to the east, in Canada...; less than three miles away at the closest point are our neighbors in Russia...; just over the top of the world are our European neighbors in Denmark, Finland, Norway, Sweden, Greenland, and Iceland. And certainly we are neighbors as well of...the Council's permanent participants: the Inuit Circumpolar Conference, the Saami Council, the Russian Association of Indigenous Peoples of the North, and the Aleut International Association.*

*"As we look to a prosperous society in the new century, I believe it must be built on the understanding that economic and environmental policies are not confrontational but are joined—that in progress, each is dependent on the other.... Part of our common work here stems from the legacy of past contamination. The work of the Arctic Monitoring and Assessment Program, the Russian PCB-sites assessment project, and the core blood monitoring study all point to the need to plan and prevent.... Responsible development provides the resources necessary to address our other priorities—educating our children, keeping police on our streets, plowing the snow from our roads, caring for our elders, and making the necessary investments to protect our environment."*

—Alaska Governor Tony Knowles  
from an address welcoming the Arctic Council  
4 May 1999

## Changing Climate for Arctic Research in Canada

At the same time that Canada is experiencing political devolution with the formation of separate territories of Nunavut and the Northwest Territories, several national initiatives on northern science and technology, research, and foreign policy are demonstrating an increased recognition of science needs in the Canadian North. The new territorial governments and land claims organizations in the North are, however, taking much of the lead in research, promoting research in a wide range of disciplines, developing research capacity within the communities, and stimulating economic activity.

In February 1999, a new Chair and Board were appointed to the Canadian Polar Commission, which serves as the link between the population of Canada and the federal government in both north and south polar affairs. The Chair is Michael Robinson, formerly executive director of the Arctic Institute of North America at the University of Calgary, and currently President and Chief Executive Officer of the Glenbow Museum. The northern residents on the Board are Richard Binder, a Native harvester and tourism entrepreneur from Inuvik; Josie Sias, an educator and former park interpreter from the Kluane region; and Jean Dupuis, who has been active in the regional government of Kativik in northern Quebec. The academic community is represented by Julie Cruikshank, a professor of Anthropology (University of British Columbia), and Peter Johnson, a professor of Physical Geography (University of Ottawa) and President of the Association of Canadian Universities for Northern Studies. Johnson was appointed Vice-Chair of the Board. Wayne Adams, a consultant and former cabinet minister in the government of Nova Scotia, completes the Board. In August 1999, Steven Bigras was appointed Executive Director of the Commission. The Canadian Polar Commission is now implementing a Canadian Polar Information Network (CPIN) and has established indicators to monitor the state of polar science in the country (see <http://www.polarcom.gc.ca>).

The Association of Canadian Universities for Northern Studies has established a communication system for northern

researchers, NORTHSCI, and has been working to promote northern research in academia and government (see <http://aix1.uottawa.ca/associations/aucen-acuns/>).

The Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) are collaborating on a task force on northern research which has been appointed by NSERC. The mandate of the task force is:

- to document the state of northern science in Canada, and
- to recommend ways in which the challenges of northern science might be addressed in the granting councils.

After extensive consultation with the university and northern communities, the final report is now being drafted.

A committee of Assistant Deputy Ministers from all federal government departments with an interest in the North, and representatives from the Canadian Polar Commission and the granting councils has been discussing a Northern Science and Technology Strategy for Canada. A working group established by this committee has drafted a framework for northern science and technology within the federal government.

In 1998, the Canadian Centre for Foreign Policy Development at the Department of Foreign Affairs and International Trade held a series of meetings, at the request of Minister Lloyd Axworthy, addressing the development of a northern foreign policy for Canada. These consultations, workshops, and expert panels resulted in recommendations on the structure of Canadian policy, which are being discussed in the government and will be submitted to the cabinet by Axworthy.

Members of a post-secondary education committee of the governing Liberal Party of Canada have toured a number of arctic research programs and communities. They have been active in elevating understanding of northern research and training among parliamentarians. Other initiatives on northern science and technology, such as hearings on arctic research by the Standing Committee on Industry and the increase in support for the Polar Continental Shelf Project in 1999, are further indications of a changing climate for northern research in Canada.

For more information, contact Peter Johnson in Ottawa, ON (613/562-5800 ext 1061; fax 613/562-5145; [peterj@aix1.uottawa.ca](mailto:peterj@aix1.uottawa.ca)). ■

## IASC Starts Forum of Arctic Operators

The International Arctic Science Committee (IASC) has led the development of a Forum of Arctic Research Operators (FARO). The Forum, which would be similar to the Council of Managers of National Antarctic Programmes, would assist communication and cooperation among the various entities involved in arctic research logistics management. An initial meeting, held in August 1998, was attended by 24 representatives from eleven countries who agreed to initiate the Forum, appointed a small group to draft terms of reference, and had an initial discussion about tasks.

The second FARO meeting, held during IASC's Arctic Science Summit Week in April 1999 in Tromsø, Norway also was well attended. Participants started

discussions on the terms of reference, membership, and tasks, which include developing:

- a circumarctic network of environmental observatories;
- uses of innovative technologies (*e.g.*, satellite observations) and seminars on arctic technologies; and
- a database for logistical information.

Participants also elected the FARO Executive Committee, whose main task will be to plan the development of FARO. The members are:

- Bonni Hrycyk, *Chair* (Canada),
- Anders Karlqvist (Sweden),
- Olav Orheim (Norway), and
- Tom Pyle (United States).

For more information, see the IASC web site (<http://www.iasc.no>). ■

## ARTERI Links European Research Efforts

The Arctic-Alpine Terrestrial Ecosystem Research Initiative (ARTERI) has just completed its three years (1996–99) of concerted action focusing on the interactive effects of changes in land-use, climate, and composition on arctic and alpine terrestrial ecosystems. The arctic-alpine focus was funded by the European Commission as a component of the Terrestrial Ecosystem Research Initiative (TERI) program. A final report is now available on the ARTERI web site (<http://www.dpc.dk/ARTERI.html>).

ARTERI based its work on the research plan developed by the International Arctic Science Commission (IASC) working group on Terrestrial Ecosystems and Feedbacks on Climate Change. Objectives of the latter included understanding the environmental and biological controls on, and spatial and temporal variation in:

- feedbacks from surface energy and water balances;
- feedbacks of cycling and storage of carbon and nutrients, and consequences for ecosystem structure;
- feedbacks from trace-gas fluxes; and
- redistribution of species and ecotones, and changes in biodiversity, focusing on causes and consequences of the changes.

ARTERI was not a research program

but was designed to enhance communication by providing a forum for the exchange of information and development of collaboration within the research community. ARTERI has involved approximately 200 researchers from at least 14 European countries and from Russia, Canada, and the United States. Nine workshops covered the following topics:

- climate-change impact scenarios in cold regions;
- a high-latitude terrestrial transect (SCANTRAN);
- a University of the Arctic (see page 22); and
- human-environment interactions.

Participants at four workshops focusing on the responses of plants, animals, soils, and landscapes to climate change in cold regions developed detailed climate-change impact scenarios. Participants attending the final ARTERI workshop in January 1999 developed:

- a summary of the predicted impacts of climate changes, and
- implications for policy.

The impact scenarios represent working hypotheses that can guide further research.

In collaboration with the International Geosphere Biosphere Programme, ARTERI contributed to three workshops

on the development of a collaborative network of high-latitude terrestrial research sites (SCANTRAN) to facilitate integrative and comparative research. The emerging SCANTRAN network, if it can be established, will contribute to activities of other international arctic research programs, including the Arctic Monitoring and Assessment Programme (AMAP) and Conservation of Arctic Flora and Fauna (CAFF) (see page 18), and the Barents Sea Impact Study.

An ARTERI workshop in October 1997 explored a case study of the environmental, social, cultural, and economic issues concerning Sami peoples in Upper Lapland. The workshop highlighted:

- the differences between official and local viewpoints, and
- perceptions of issues and research priorities.

The organization of the workshop also provided a model of participatory planning applicable to other situations where interaction between researchers and stakeholders are essential.

For more information, see the ARTERI web site (<http://www.dpc.dk/ARTERI.html>) or contact Bill Heal in Edinburgh, UK (+44/1968-674-927; fax +44/1968-674-927; [b.heal@ed.sac.ac.uk](mailto:b.heal@ed.sac.ac.uk)). ■

## ACSYS Broadens into Global Cryosphere

Since March 1997, the role of the Cryosphere in the climate system has been the subject of discussions within the World Climate Research Programme (WCRP).

In March 1998, the Arctic Climate System Study (ACSYS) Scientific Steering Group presented a paper at the annual meeting of the Joint Scientific Committee (JSC) for the WCRP:

- identifying gaps in knowledge of some cryospheric processes in the climate system, and
- summarizing the various options for the organization of cryospheric studies provided the basis for the endorsement.

On the basis of this summary, the JSC endorsed the idea of a broader program

on Climate and Cryosphere (CLIC) and established a Task Group to develop a science and coordination plan for presentation to the JSC in March 2000. At that time, the JSC will decide whether to initiate CLIC as a full WCRP project.

The draft science and coordination plan outlines requirements for:

- developing a globally integrated cryospheric component in the WCRP;
- including cryospheric elements of present global climate change programs;
- enhancing links among global and regional cryospheric studies;
- ensuring appropriate treatments of cryospheric processes in climate models;
- assembling global and regional cryospheric data sets;

• interacting with other WCRP efforts, particularly the Global Energy and Water Experiment (GEWEX) and the Climate Variability Project (CLIVAR); and

• identifying appropriate mechanisms for collaboration with other related projects.

The draft plan is now available for review and comment on the ACSYS CLIC web site ([http://www.npolar.no/acsys/CLIC/clic\\_draft.PDF](http://www.npolar.no/acsys/CLIC/clic_draft.PDF)).

For more information, see the ACSYS CLIC web site, or contact Howard Cattle in Bracknell, UK (+44/344-856-209; fax +44/344-854-898; [hcattle@meto.gov.uk](mailto:hcattle@meto.gov.uk)). ■



## Native Knowledge of Polar Bears Informs Three International Surveys

The first U.S. Fish and Wildlife Service (USFWS) survey that officially incorporated traditional ecological knowledge into a management decision document is now serving as the basis for a comparable survey on the Chukotka Peninsula in Russia.

Polar bears are difficult to study, because their ranges are large (e.g., in the Chukchi Sea up to 5,500 miles/year, or approximately 15 miles/day) and their habitat use in Alaska is not well documented. Native people who share habitat with polar bears, however, have specialized knowledge of the large arctic mammals that is useful for management purposes.

In 1994, hunters from 12 Alaskan villages along the coastline of the Bering, Chukchi, and Beaufort seas participated in a USFWS polar bear habitat-use survey. The hunters identified on maps areas used by the bears for denning, feeding, and seasonal movements. Agency representatives compiled the data, entered the information into a geographic information system (GIS), and met again with the villagers to confirm the data and report to the communities. The results of this work are documented in *Collection of Local Knowledge Regarding Polar Bear Habitat Use in Alaska* (see Publications page 23).

As a result of this study, a similar study is being initiated in Russia. Identifying polar bear habitat is part of a larger joint agreement between the United States and Russia for conservation of the shared Bering/Chukchi seas stock of polar bears. This agreement, commonly referred to as the Bilateral Agreement, is awaiting confirmation by the State Committee on Environment and the Duma in Russia, and ultimately by the U.S. Senate.

The National Park Service, under its Beringia Program, has joined efforts to promote polar bear conservation by providing funding to the Alaska Nanuuq Commission for conducting the polar bear habitat-use survey in Russia. The USFWS will provide technical assistance to the Alaska Nanuuq Commission and the Union of Marine Mammal Hunters in Chukotka, Russia as they conduct a three-

year study in an area near Anadyr and Pevek on the Chukotka Peninsula. Hunters will map habitat areas based on observations collected over their lifetimes.

The Alaska Nanuuq Commission was founded in 1994 to ensure polar bear conservation and subsistence opportunities for Native residents of coastal villages, as well as Alaska Native involvement in the

management of polar bear populations and representation at international meetings.

For more information, contact Charlie Johnson at the Nanuuq Commission in Nome, AK (907/443-5044; fax 907/443-5060; cjohnson@nook.net) or Susanne Kalxdorff at the USFWS in Anchorage (907/786-3828; fax 907/786-3816; susi\_kalxdorff@fws.gov). ■

### Webber is U.S. Delegate to IASC

Patrick J. Webber of Michigan State University has been appointed as the new U.S. delegate to the International Arctic Science Committee (IASC). He succeeds Oran Young of Dartmouth College, who served two three-year terms and made significant contributions to IASC in its formative years. Professor Young made major contributions to the planning and implementation of the IASC-sponsored First International Conference for Arctic Research Planning in 1995. He continues to advocate for integrating social dimensions into IASC-sponsored projects and will remain active in IASC affairs as a member of several science project committees.

IASC was founded in 1990 as a nongovernmental, international organization with the mission of encouraging, facilitating, and promoting the full range of basic and applied research in the Arctic, including "encouraging cooperation and integration of human, social, and natural sciences concerned with the Arctic at a circumarctic or international level and providing scientific advice on arctic issues."

Webber is a plant ecologist who is active in the International Tundra Experiment (ITEX; see page 10) and concerned with the synergism between climate change and surface disturbance from human activities. He was Director of the Institute of Arctic and Alpine Research at the University of Colorado from 1979 to 1986 and ARCSS Program Director at NSF from 1993 to 1995.

The U.S. Polar Research Board (PRB; see page 17) serves as the U.S. National Committee to IASC. Webber will be working closely with the PRB to improve and increase U.S. participation in and understanding of IASC activities. He is particularly keen to represent the broadest possible spectrum of U.S. scholarship to IASC and in the coming months will be attending as many national meetings as is possible in order to increase his effectiveness as a delegate. He is interested in hearing from U.S. arctic scholars.

The next meeting of IASC is scheduled for 2-7 April 2000 in Cambridge, United Kingdom (see Calendar page 23). This meeting will feature Arctic Science Summit Week 2000 (ASSW 2000) and back-to-back meetings of several organizations (e.g., Arctic Ocean Sciences Board, European Polar Board, and Forum of Arctic Research Operators). The first ASSW was held in Tromsø, Norway in 1999. A number of international arctic science organizations took part and many held their annual meetings during this week.

For more information on IASC and ASSW 2000, see the IASC web site (<http://www.iasc.no>) or the PRB web site (<http://www4.nationalacademies.org/cger/prb.nsf>) or contact Patrick Webber in East Lansing, MI (517/355-1284; fax 517/432-2150; webber@msu.edu). ■



## UNIS is “the Arctic Alternative” for University Students

University Courses on Svalbard (UNIS) is a private foundation established in 1994 by the Norwegian government in cooperation with Norway’s four universities to offer research-based education in the high Arctic (see *Witness* Autumn 1998). Because high-caliber fieldwork and cruises are the core of instruction, UNIS refers to itself as “the arctic alternative for [undergraduate, masters, and doctoral] students of biology, geology, geophysics, and technology.”

UNIS offers semester- and year-long programs of study to students from Norway and abroad. Courses are designed to complement the teaching available at mainland universities. Students typically have at least three years of experience in undergraduate science and/or engineering. They are expected to help plan and participate in real research projects under demanding polar conditions. As one researcher recently observed, “they tend to be a highly self-selected group.”

UNIS is located in Longyearbyen (78° N), in the Svalbard archipelago. Mean temperatures are relatively mild for this latitude, ranging from -14°C to +6°C in the summer; annual extremes reach -49°C and +21°C in town. Approximately 66% of Svalbard is glacier-covered, and permafrost is present elsewhere to depths of as much as 500 m. Even so, Svalbard hosts approximately 165 plant species. Reindeer and foxes frequent town, polar bears number 2,000 in the archipelago as a whole, and the largest bird colony in the North Atlantic is found in the archipelago.

Longyearbyen itself (pop. 1,500) is a modern town whose economy is based on tourism as well as coal mining. Eight weekly flights to Tromsø provide convenient access to and from the rest of the world. The established infrastructure in the context of arctic wilderness provides an exceptional setting for both field and laboratory work, both the collection and analysis of data.

Longyearbyen has been the staging point for many large multinational projects in the past (e.g., the Marginal Ice Zone Experiment [MIZEX] in 1983–84, the Cooperative East Arctic Research

Expedition [CEAREX] in 1988–89). Svalbard also offers opportunities for smaller, focused studies that would be difficult elsewhere. The logistics base and research facilities are stable, convenient, and relatively inexpensive. Furthermore, UNIS and the Norwegian Polar Institute provide an exceptional concentration of talented scientific personnel, in both permanent staff and transient lecturers.

The foundation is funded by the Norwegian government and Norwegian and international students pay no course fee. UNIS first offered courses in Autumn 1993; in 1999, it offered 33 different courses—16 at the graduate and doctoral levels—to approximately 220 students. UNIS aims to recruit up to half of its students from abroad. Faculty come to UNIS from all over the world. Instruction is in English.

Applications for one-year studies in arctic geology, geophysics, and technology are due in mid-April of each year. (Studies begin in August.) Applications for one-year studies in arctic biology are due in mid-October. (Studies begin in January.)

In addition to semester studies, UNIS hosts academic conferences and seminars, and is considering offering individual courses in the social sciences and humanities. Ultimately, the foundation will form the core of the Svalbard Science Centre, an international arctic center of expertise in research and education on Svalbard, which also will incorporate many other professional and scientific institutions on the archipelago.

For more information, see the UNIS web site (<http://www.unis.no>) or contact UNIS (+47/7902-3300; fax +47/7902-3301; [studadm@unis.no](mailto:studadm@unis.no)). ■

### University of the Arctic Moves into Implementation

The Interim Council of the University of the Arctic (UArctic) (see *Witness* Autumn 1998) met in Akureyri, Iceland in April 1999, hosted by the Stefansson Arctic Institute and the University of Akureyri, Iceland. Discussions related to UArctic implementation included:

- plans for a Bachelor of Circumpolar Studies interdisciplinary degree program;
- the proposed Governance System; and
- funding options and strategies.

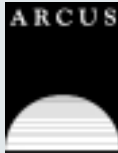
The Interim Council also discussed UArctic participation in:

- a joint workshop with AMAP in Rovaniemi in January 2000;
- field schools operating in the North;
- a Northern Research Forum; and
- a Circumpolar Mobility Forum.

With support from the Government of Finland, a circumpolar Coordination Office has been established at the Arctic Centre, University of Lapland, to support the Interim Council during the implementation period. The Coordination Office has developed a web site, electronic mailing list, and newsletter.

The UArctic co-sponsored a Workshop on Sustainable Development in the Arctic immediately prior to the Akureyri meeting, and gave a presentation to the Senior Arctic Officials at the Arctic Council meeting in Anchorage, Alaska in May 1999 (see page 18). A workshop on the UArctic also convened in June 1999 during the Sixth Circumpolar Universities Cooperation Conference in Aberdeen, Scotland. The Interim Council met on Svalbard in October 1999 and will meet next in May 2000 at the University of Northern British Columbia in Prince George, Canada.

For more information, see the UArctic web site (<http://www.urova.fi/home/uarctic>) or contact the Circumpolar Coordination Office in Rovaniemi, Finland (+358/16-341-2716; fax +358/16-341-2777; [uarctic@levi.urova.fi](mailto:uarctic@levi.urova.fi)). ■



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ARCUS is a nonprofit organization consisting of institutions organized and operated for educational, professional, or scientific purposes. ARCUS was established by its member institutions in 1988 with the primary mission of strengthening Arctic research to meet national needs. ARCUS activities are funded through a cooperative agreement with NSF; by DOE, AFN; and by membership dues.

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**witness** (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

**March 16-18** The 30th International Arctic Workshop. University of Colorado, Boulder, CO. Contact ([arcticws@colorado.edu](mailto:arcticws@colorado.edu); <http://instaar.colorado.edu/AW2000/>).

**April 2-7** Arctic Science Summit Week 2000. Cambridge, United Kingdom. Initial contact is the IASC Secretariat ([iasc@iasc.no](mailto:iasc@iasc.no); <http://www.iasc.no/default.htm>).

**April 26** Arctic Council Sustainable Development WG Meeting. Fairbanks, AK. Contact the Arctic Council Secretariat in Washington, DC (202/647-0241; fax 202/647-4353; [arctic@state.gov](mailto:arctic@state.gov); <http://arctic-council.usgs.gov/>).

**May 6-7** Sixth National Student Conference on Northern Studies. Université Laval, Québec, Canada. Contact the GÉTIC Office in Ste-Foy, Quebec, Canada (418/656-2131 ext 8365; [aba855@agora.ulaval.ca](mailto:aba855@agora.ulaval.ca); [http://www.uottawa.ca/associations/aucen-acuns/en/n\\_s\\_conf.html](http://www.uottawa.ca/associations/aucen-acuns/en/n_s_conf.html)).

**May 16-19** ARCUS 12th Annual Meeting and Arctic Forum. Arlington, VA. Contact ARCUS (907/474-1600; fax 907/474-1604; [arcus@arcus.org](mailto:arcus@arcus.org); <http://www.arcus.org>).

**May 30-June 3** American Geophysical Union (AGU) 2000 Spring Meeting. Washington, DC. Contact AGU in Washington, DC (800/966-2481; fax: 202/328-0566; [meetinginfo@agu.org](mailto:meetinginfo@agu.org) [Subject: Spring 2000 Meeting]; <http://www.agu.org>).

**June 2-6** CAPE 2000—Sea Ice in the Climate System—The Record of the North Atlantic Arctic. Kirkjubæjarklaustur, Iceland. Contact Organizing Committee Chair, Aslaug Geirsdottir ([age@rhi.hi.is](mailto:age@rhi.hi.is); <http://instaar.colorado.edu/~duvall/cape/cape2000.html>).

**June 12-17** 18th Polar Libraries Colloquy. Winnipeg, Manitoba, Canada. Contact the Conference Organizer Barbara Kelcey ([bekelcey@mb.sympatico.ca](mailto:bekelcey@mb.sympatico.ca)) or the Program Chair Anne Morton ([amorton@chc.gov.mb.ca](mailto:amorton@chc.gov.mb.ca); <http://www.gov.mb.ca/chc/archives/hbca/about/plc/polarpg.html>).

**June 19-23** International Glaciological Society Symposium on Sea Ice and its Interactions with the Ocean, Atmosphere, and Biosphere. Fairbanks, AK. Contact Secretary General, International Glaciological Society in Cambridge, UK (+44/1223-355-974; fax +44/1223-336-543; [Int\\_GLAC\\_Soc@compuserve.com](mailto:Int_GLAC_Soc@compuserve.com)) or Martin Jeffries in Fairbanks, AK (Chairman, Local Organizing Committee; [martin.jeffries@gi.alaska.edu](mailto:martin.jeffries@gi.alaska.edu); <http://www.gi.alaska.edu/seaicesymposium/>). ■

Check the ARCUS Web site Calendar (<http://www.arcus.org>) for more...

## Publications

*The Arctic Paleosciences in the Context of Global Change Research*. PARCS. 1999. Earth Systems History Secretariat, American Geophysical Union. Washington, DC. Available on the ARCUS web site ([http://www.arcus.org/parcs/fr\\_parcs.html](http://www.arcus.org/parcs/fr_parcs.html)).

*Collection of Local Knowledge Regarding Polar Bear Habitat Use in Alaska*. S. Kalxdorff. 1997. U.S. Fish and Wildlife Service, Technical Report MMM 97-2, Anchorage, AK. 72 pp.

*Impacts of Global Climate Change in the Arctic Regions*. Gunter Weller and Manfred Lange, editors. 1999. Report from a workshop on the Impacts of Global Change, April 25-26, 1999. International Arctic Science Committee. Center for Global Change and Arctic System Research, University of Alaska Fairbanks.

*Inuit, Whaling and Sustainability*. M. Milton, R. Freeman, L. Bogoslovskaya, R.A. Caulfield, I. Egede, I.I. Krupnik, and M.G. Stevenson. 1998. Contemporary Native American Series, Vol. 1. AltaMira Press, Walnut Creek, CA. Pb/hard \$25/\$52. (805/499-9774; fax 805/499-0871; [order@sagepub.com](mailto:order@sagepub.com); <http://www.altamirapress.com>).

*Ocean Drilling Research: An Arctic Perspective*. 1999. National Research Council, Polar Research Board, Commission on Geosciences, Environment and Resources. National Academy Press, Washington, DC. 9 pp. (<http://www.nap.edu/books/NI000766/html>). ■

# An Invitation to the ARCUS 12th Annual Meeting and Arctic Forum—2000

We are pleased to bring to you, through *Witness the Arctic*, information about notable arctic research efforts and scientific findings, improved logistical capability, and significant advances in our understanding of the Arctic as a region—these comprise important milestones of our progress in arctic research at the dawn of a new century.

Some significant scientific questions that we face include:

- What is the expected magnitude of climate change in the Arctic, and what threat does it pose?
- What is happening to the fisheries of the North Atlantic and North Pacific?
- How should governments deal with the aspirations and rights of First Nations people?
- What is the nature and magnitude of the threat of contaminants to arctic ecosystems and food webs?

Whether you think of the year 2000 as the end of the 20th century or the beginning of the 21st, and the beginning or end of a millennium, the first decades of the 21st century are likely to bring to arctic research more compelling questions, unexpected problems and tensions—and provocative and exciting findings. Such is the nature of the international, multi-disciplinary enterprise in which we are engaged, seeking to understand a part of the world about which relatively little is known, in a time of major environmental

and cultural change. In such an endeavor, a steady exchange of ideas is essential and the fellowship of colleagues vital.

The scientific tradition of printed literature and the nearly instantaneous electronic communications now possible are important to such exchanges. ARCUS emphasizes the value of going beyond these methods, however, by bringing together the disciplinarily diverse and geographically dispersed community of arctic researchers. While being in each others' presence does not guarantee interaction, opportunities for collaboration and integration are created that otherwise do not occur. One important gathering is the ARCUS Annual Meeting and *Arctic Forum*.

The ARCUS 12th Annual Meeting will take place 16–19 May 2000 in Arlington, Virginia. The annual meeting serves as an information clearinghouse at which participants discuss issues important to arctic research, develop recommendations on key questions, and plan strategies and activities to advance arctic research efforts. The *Arctic Forum*, a science symposium that includes oral and poster presentations, will focus this year on change in the Arctic, looking at significant aspects of observed and predicted environmental, social, economic, and cultural changes.

Other meeting activities will include:

- briefings from agency personnel;
- a panel discussion examining scientific priorities in arctic research, new

opportunities, and impediments to the arctic research enterprise; and

- information about international arctic research programs and initiatives.

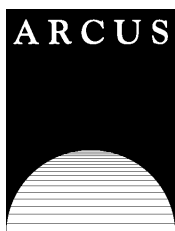
Meetings of the Council (representatives of the 35 ARCUS member institutions) and the 13-member ARCUS Board of Directors will focus on the direction and business of the organization.

We encourage community participation in these activities, and the involvement of agency personnel and legislators and their staffs. If you are interested in attending, please contact us. For more information about the meeting, see the ARCUS web site (<http://www.arcus.org>). Please join us.



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