Witness The
ARCTIC

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SBI Project Completes Four Cruises in First Field Season

by Jacqueline M. Grebmeier

Funded through the NSF Arctic System Science (ARCSS) Program and the Office of Naval Research, the Western Arctic Shelf-Basin Interactions (SBI) project began in 1999 (see *Witness* Autumn 2001). The goal of the SBI project is to investigate the production, transformation, and fate of carbon at the shelf-slope interface in the Arctic, both seasonally and interannually, as a prelude to understanding the impacts of a potential warming of the Arctic.

A considerable body of evidence indicates that climate change will significantly impact the physical and biological linkages between the arctic shelves and adjacent ocean basins. Nutrient-rich Pacific water enters the region through Bering Strait and is modified as it transits over the Chukchi and Beaufort shelves and slopes to the Arctic Basin. Seasonal ice formation produces brine that is entrained in this northward flow and helps maintain the current ice cover in the Arctic. Any environmental change that reduces the extent and thickness of the sea ice in the Chukchi and Beaufort Seas will coincidently influence hydrographic and ecosystem structure, both on regional and global scales. Research supported by SBI therefore focuses on the outer shelf, shelf break, and slope, where key processes control water mass exchange and biogeochemical cycles, and where the greatest responses to climate changes are expected to occur.

Each of the two process cruises in 2002 sampled at 30–50 stations on the Chukchi and Beaufort shelves and along four main shelf-basin transect lines, including two lines from the Chukchi outer shelf to the Arctic Basin, one line from the head to the mouth of Barrow Canyon, and one line from the shelf to basin in the Beaufort Sea. Figure by Joint Office of Science Support.

Phase I of SBI used retrospective research and analyses, opportunistic sampling studies, and modeling to prepare for Phase II fieldwork in the Chukchi and Beaufort Seas. SBI Phase II involves 40 principal and co-principal investigators on 14 integrated projects working in the Bering Strait region and over the outer shelf and slope of the Chukchi and Beaufort Seas into the Arctic Basin from 2002 to 2006. SBI investigators recently completed four successful missions in their first year of fieldwork using three vessels (see map):

- USCGC *Healy* for two intensive process cruises—one in spring (5 May–15 June) and one in summer (17 July–26 August),
- RV *Alpha Helix* for a mooring cruise 20–29 June in Bering Strait, and
- USCGC *Polar Star* for a mooring cruise 15 July–13 August in the Chukchi and Beaufort Seas.

Each of the four cruises enlisted up to 39 scientists from 19 institutions in the U.S., Bermuda, Canada, and Europe in this interdisciplinary scientific endeavor, applying a broad array of physical, biogeochemical, and biological measurements.

Process Cruises

The SBI spring and summer process cruises involved a variety of studies, ranging from hydrographic measurements to biological studies of different trophic levels. Sampling techniques at the stations of the two process cruises (see map) included:

- a CTD (conductivity-temperature-depth)/rosette bottle system for physical

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and hydrobiochemical measurements in the water column;
- subsamples from multiple CTD/rosette bottle casts for primary production, bacterial respiration and production, chlorophyll content, nutrients, particulate carbon, inorganic carbon, carbon biomarkers, microzooplankton, and stable- and radioisotopes;
- various nets (vertical, bongo) for size fractions of micro-, macro-, and mesozooplankton for both population and experimental purposes;
- benthic grabs and cores to collect fauna and sediment for population, community structure, food web, tracer chemistry, and metabolism studies; and
- in-situ pumps to measure the activities of particle-reactive radionuclides.

The spring cruise on the new icebreaker USCGC *Healy* (see page 14) was the first interdisciplinary research cruise to this region at this time of year. Scientists on both the spring and summer cruises found unusually low ice cover and high sediment content in the first-year ice. These sediments can accelerate melting of sea ice and impact light levels and nutrient content that influence algal primary production in the ice layers and underlying water.

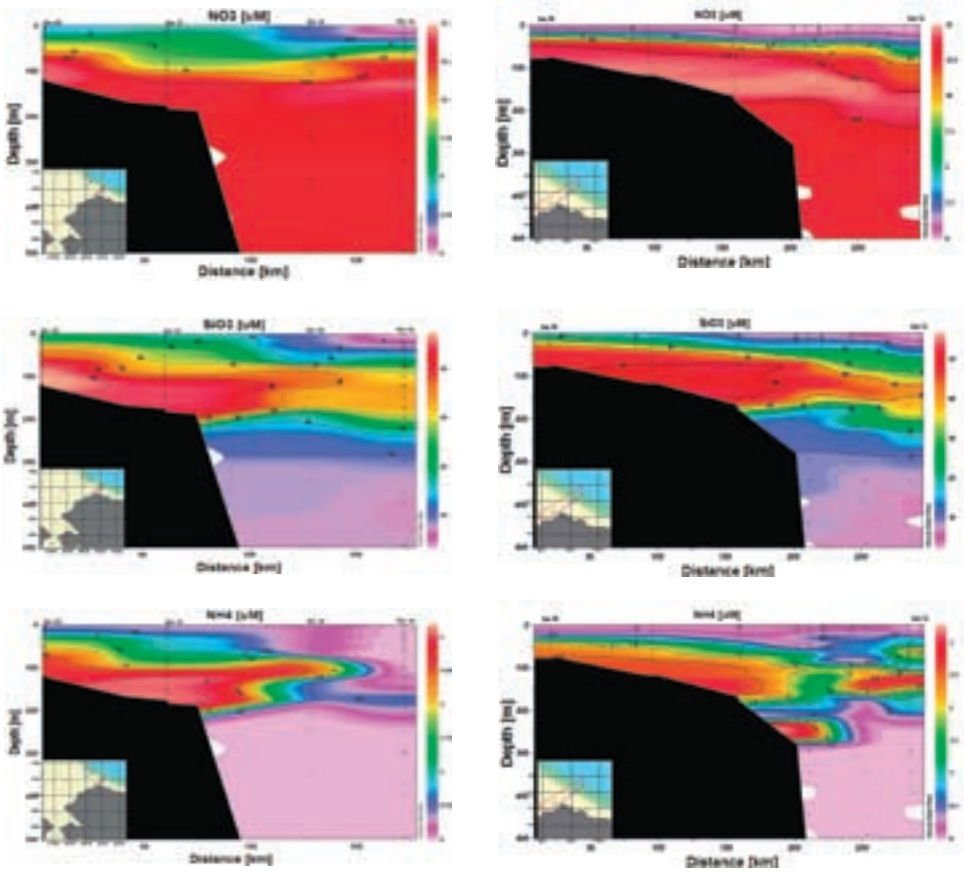
During the spring cruise, the surface waters over the shelf near Bering Strait had high concentrations of nutrients, indicating that the main phytoplankton bloom had not yet begun. Although there was some variability, nitrate was relatively abundant over the shelf, with a declining gradient as the *Healy* moved over the slope to the Arctic Basin. This lack of nitrate in offshore waters was somewhat surprising and may indicate an unusually early bloom in this region. Because observations on productivity in this region are scarce, it is difficult to know if this early bloom is "normal" or related to the recent warming of the Arctic.

By comparison, surface nutrient concentrations were low throughout the summer cruise, coincident with the highest water column chlorophyll level (an indicator of plant growth) near the bottom, suggesting post-bloom conditions. Microscopic analyses of plankton also indicated post-bloom conditions. Higher levels of bacteria and bacteria-consuming flagellates occurred in the upper water column in the summer, whereas large diatoms (phytoplankton) occurred in a deeper chlorophyll maximum layer. This accumulation and decay of diatoms at depth suggests that plankton grazers are not able to consume most of the spring bloom; instead, the bulk of the phytoplankton bloom is either decomposed by microbes or sinks to the benthos.

Observations of sediment processes indicate varying patterns of sediment focusing and carbon recycling in the SBI study region. High rates of sediment carbon metabolism and nutrient flux (indicators of carbon supply) occur on the shelves, with a general trend of high to low rates observed from shelf to deep basin. Benthic macrofaunal populations also indicate a declining trend in carbon deposition as one moves offshore into the Arctic Basin. Both radioisotope and sediment tracer studies indicate that phytodetritus labeled during the spring cruise rapidly moved offshore and was found at depths as great as 1000 m by the summer along the East Barrow (EB) and Barrow Canyon (BC) regions of the SBI study area. In contrast, similar studies to the west of BC on the East Hanna Shoal shelf-to-basin line indicate relatively low productivity and consequently low carbon transport offshore and to the sediments.

Modification of waters over the shelf, both in the water column and via sediments, and the subsequent transport of biogenic signals from the shelf to the basin, were observed during all cross-shelf sections for every SBI cruise on the main transects. By the time of the summer SBI process cruise, most of the production had settled downwards in the water column and undergone transformation in the water and sediments.

In support of the SBI field program, the Joint Office of Science Support (JOSS; see page 7) maintained a shipboard field data catalog during both process cruises on the *Healy,* providing real-time data to scientists on the ship; select data were also available



Nutrient concentrations measured along the Barrow Canyon line for nitrate (NO_3), silicate (SiO_3), and ammonium (NH_4) in spring and summer 2002 during the SBI field project. It is notable that when comparing spring vs. summer data from the same hydrographic sections we see an increase of 5 to 10 micromolar in maximum silicate concentrations in the plume originating over the shelf in Barrow Canyon, as well as pulses of ammonium moving off the shelf to the deep basin. These nutrient values were higher than those seen coming in through Bering Strait, suggesting fairly rapid settling and remineralization of diatoms produced by the spring bloom over the shelf. Figure by SBI hydrographic team.

to onshore PIs. Products included satellite images, ship tracking, weather, CTD data from the hydrographic group and associated bottle data, and shipboard event logs.

Mooring Cruises

The Bering Strait mooring cruise on the RV *Alpha Helix* (see *Witness* Autumn 2001) deployed three moorings in Bering Strait during June to investigate hydrographic and flow properties of Pacific-origin water transiting northward through Bering Strait. These moorings map upstream boundary conditions for the SBI project as well as continuing the time-series records of three moorings that have been maintained in Bering Strait for the last decade. The cruise included both hydrographic and acoustic Doppler current profiling (ADCP) surveys and deployed a number of instruments, including:

- hydrographic sensors,
- nutrient samplers,
- optical instruments,
- upward-looking sonar, and
- upward-looking ADCP.

The Chukchi/Beaufort mooring cruise on the USCGC *Polar Star* deployed:

- three moorings in the Chukchi Sea as part of the Chukchi outflow mooring array, including sensors to measure ocean physics and optical and biochemical parameters;
- The Beaufort Shelf Mooring Array, a tightly spaced (3–5 km spacing) line of eight moorings with profiling instrumentation, across the Beaufort continental slope east of Barrow, Alaska; and
- an acoustic recording package to record sounds of marine mammals along the Beaufort slope, part of a joint effort with the NOAA National Marine Mammal Laboratory in Seattle and Scripps Institution of Oceanography.

Investigators on the *Polar Star* also performed intense hydrographic sampling around each mooring deployment and within Barrow Canyon. Preliminary data on the origin and fate of the shelf-edge boundary currents indicate the outer shelf of the Herald Valley outflow site is filled with cold, dense, Pacific-origin winter water as it flows eastward, forming a shelf-break jet. The high turbidity seen in this bottom water may be due to sediments drawn into the water mass as it crosses the shelf. Small lenses of water observed at the shelf edge appear to be the beginnings of eddies. For example, a subsurface eddy comprised of cold, turbid, Pacific-origin winter water was observed on the eastern transect of the study region (East Barrow line). The same type of eddy has been observed repeatedly throughout the interior of the Canada Basin, suggesting that these eddies emanate from the shelf-edge boundary current. The results of the mooring cruise indicate the western arctic boundary current system is an "eddy factory," and SBI scientists are investigating why this shelf-edge system is so wildly unstable. Eddy formation is obviously of critical importance for shelf-basin flux of physical and biogeochemical products, and in particular, for the ventilation of the interior Arctic.

Outreach and Education

The SBI field program received excellent media coverage. A broadcast crew from CBS News, a reporter from *USA Today,* and a reporter from the Associated Press were aboard the *Healy* during the summer cruise transit of Barrow Canyon. Other media outlets that covered SBI included the *Nome Nugget* and KBRW-AM/FM, a National Public Radio affiliate in Barrow.

As part of the NSF Teachers Experiencing Antarctica and the Arctic program (TEA; see page 29 and *Witness* Winter 2000/2001), Betty Carvellas, a Vermont high school science teacher, worked on the summer process cruise on the *Healy.* In addition to serving on a benthic project team, Carvellas provided daily updates on research and ship operations, including spotlights on individual research groups. Other SBI outreach activities during the field program included:

- a tour of the *Healy* for students from the Anvil City Science Academy (a public magnet school in Nome); and
- summaries of cruise activities sent via INMARSAT telephone to a district-wide teachers in-service at Essex High School and to a public forum at the Burnham Library, both in Colchester, Vermont.

The U.S. Fish and Wildlife Service in Anchorage, Alaska, collaborated with SBI to survey marine mammals and seabirds during the spring process cruise. In mid-June, wildlife biologist Marc Webber took high-resolution digital photographs of more than 40 groups of walrus. Analyses of these photos will be used to develop correction factors for future surveys using remote sensing systems. Photo courtesy Marc Webber, U.S. Fish and Wildlife Service.

Future Field Seasons

Plans for 2003 include:

- a helicopter survey and field sampling project in the SBI study region in March,
- participation by some SBI PIs in an April ice camp sponsored by the Office of Naval Research,
- the annual Bering Strait mooring cruise,
- a hydrographic and sampling survey cruise in July–August, and
- a mooring cruise in September.

In 2004, four cruises similar to those undertaken in 2002 will allow interannual comparison of processes in the SBI sampling region. The last SBI mooring will be retrieved in 2004. Phase II of SBI will continue through 2006 with data synthesis. The final chapter of SBI (Phase III, 2007–2009) will focus on using the new understanding of this productive arctic ecosystem to model and develop scenarios of the potential impacts of climate change on shelf-basin interactions.

The author would like to acknowledge all the SBI Phase II participants for providing many of the concepts and results outlined in this article. For more information see the SBI web site (http://utk-biogw.bio.utk.edu/SBI.nsf), the JOSS web site (http://www.joss.ucar.edu/sbi/), the WHOI web site (http://www.whoi.edu/science/PO/arcticedge), or the TEA web site (http://tea.rice.edu/tea_carvellasfrontpage. html), or contact Jackie Grebmeier, director, SBI Project Office in Knoxville, TN (865/974-2592; fax 865/974-7896; jgrebmei@utk.edu).

Jackie Grebmeier is a research professor in the Marine Biogeochemistry and Ecology Group, Department of Ecology and Evolutionary Biology at the University of Tennessee.

NSF Highlights Broader Impacts, Environmental Systems

NSF has announced two items of importance to the arctic research community. One is critical to getting proposals reviewed; the other is a report that recommends major directions in NSF-sponsored interdisciplinary environmental research and education for the next decade.

Proposals Must Identify Broader Impacts

Proposals submitted to the NSF are evaluated on two merit review criteria, which all proposals must address:

1. the intellectual merit of the proposed activity, and
2. the broader impacts of the activity.

In July 2002, NSF announced that, beginning in October 2002, proposals that did not explicitly address so-called criterion 2, the broader impacts of the proposed activity, would be immediately rejected without review. Broader impacts must be addressed in a separate section in the project summary and described as an integral part of the project description narrative.

Criterion 2 includes:

- How well does the activity advance discovery and understanding while promoting teaching, training, and learning?
- How well does the proposed activity broaden the participation of underrepresented groups?
- To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?
- Will the results be disseminated broadly to enhance scientific and technological understanding?
- What may be the benefits of the proposed activity to society?

Some examples of how this criterion might be addressed include:

- integrating teachers and students into the research or integrating research into the classroom,
- broadening participation of underrepresented minorities and women,
- enhancing the infrastructure for research and education,
- disseminating information to broaden public understanding of science and technology, or
- contributing to society in some way, such as improving understanding of the environment, helping public policy, improving health and welfare, etc.

The NSF grant proposal guide is available at http://www.nsf.gov/pubsys/ods/getpub.cfm?gpg. More information and examples of ways to meet criterion 2 are at http://www.nsf.gov/od/opp/opp_advisory/oaccrit2.htm.

Environmental Research and Education Report Released

In January 2003, the NSF Advisory Committee on Environmental Research and Education (AC-ERE) released *10-Year Outlook: Complex Environmental Systems Synthesis for Earth, Life and Society in the 21st Century*. The report gives guidance to NSF about environmental research and education.

In 2000, NSF established the Advisory Committee for Environmental Research and Education to:

- provide advice, recommendations, and oversight for the NSF's environmental research and education portfolio;
- be a base of contact with the scientific community;
- serve as a forum for consideration of interdisciplinary environmental topics as well as environmental activities in a wide range of disciplines;
- provide broad input into long-range plans and partnership opportunities; and
- oversee program management, overall balance, and other aspects of environmental research and education activities.

The AC-ERE focuses on the coordination, integration, and management of environmental programs across the foundation, but is particularly concerned with aspects that affect multiple disciplines, such as cyberinfrastructure, digital libraries, and interdisciplinary programs, centers, and major instrumentation.

For more information or to download the summary report, see the AC-ERE web site (http://www.nsf.gov/geo/ere/ereweb/advisory.cfm). To obtain copies of either the full report or the summary report, send an e-mail to ere-info@nsf.gov.

Issue of *Arctic Research* Focuses on Wildlife

On behalf of the Interagency Arctic Research Policy Committee (IARPC), NSF has published *Arctic Research of the United States* twice a year since 1987. Aimed at national and international audiences of government officials, scientists, engineers, educators, private and public groups, and residents of the Arctic, *Arctic Research* contains

- reports on current and planned federal research in the Arctic;
- reports of IARPC meetings; and
- summaries of other current and planned arctic research.

The current issue of *Arctic Research of the United States* focuses on wildlife research in Alaska. Much of the federal land in Alaska is preserved as parks, wildlife refuges, and wilderness areas. Scientific research and study provides the information needed to manage these lands and resources. Scientists supported by several agencies work to ensure that the resources currently enjoyed by Alaskans and visitors will be available to future generations.

The current issue illustrates some of the research conducted in Alaska by scientists from the U.S. Fish and Wildlife Service, National Park Service, and the U.S. Geological Survey. It features articles about some of the fascinating animals of Alaska, ranging from the whales and sea lions of southern Alaska waters to the muskoxen of the north, as well as several smaller but no less interesting animals, including sea otters, migratory birds, and resident small mammals. The issue also provides an overview of the ecosystems of Alaska and an introduction to the diversity of humans who have lived and flourished in Alaska for many thousands of years.

To receive a copy, send your name and address to Editor, *Arctic Research of the United States,* National Science Foundation, Office of Polar Programs, 4201 Wilson Boulevard, Arlington, VA 22230. For more information, contact Charles E. Myers at OPP (703/292-8029; fax 703/292-9082; cmyers@nsf.gov).

Space Weather Strongly Affects Arctic Upper Atmosphere

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

Space weather refers to conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems. Modern society increasingly relies on space-based technologies for communications, environmental monitoring, mapping, navigation, and other applications, but detailed understanding of the processes and interactions involved in space weather is just emerging.

This is relevant to the Arctic because the magnetic polar regions can be strongly affected by solar plasma. While the upper atmosphere is largely protected from the Sun's energetic protons and electrons by the Earth's magnetic field, at high magnetic latitudes this shielding is much less effective at ionospheric and atmospheric altitudes. The aurora borealis and aurora australis manifest this incursion of solar plasma energy on the atmosphere (see *Witness* Autumn 2001). Aurorae, which result primarily from accelerated electrons and ions impinging upon the upper atmosphere's neutral gasses, can carry significant amounts of energy and impact atmospheric chemistry and dynamics down to altitudes of roughly 90 kilometers.

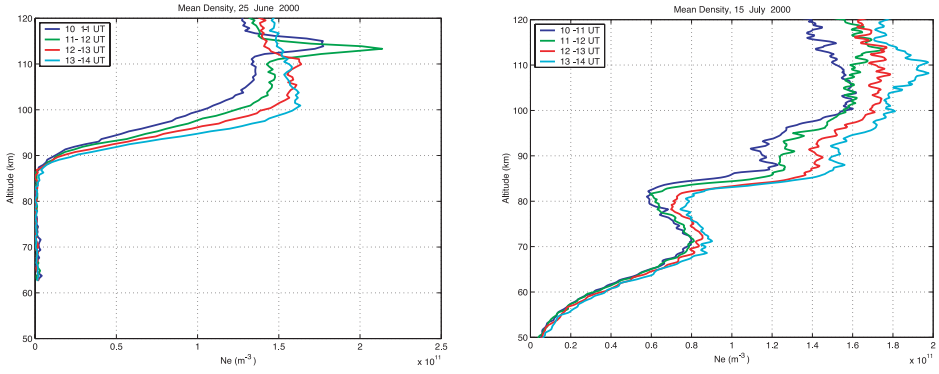
Solar storms can impact the entirety of both polar regions. During solar storms the solar wind plasma can contain large fluxes of very energetic protons, in the range of tens to hundreds of million electron volts (MeV). When these protons reach the poles, they blanket the regions with significant ionization to quite low altitudes. Termed polar cap absorption (PCA) events because they absorb HF radio waves very efficiently (due to the large numbers of collisions between ionospheric electrons and neutral atoms at the lower altitudes at which they occur), these can cause communication blackouts in the HF bands and influence the chemistry of the polar atmosphere. The plasma in the polar cap can be very highly structured, especially during active conditions, resulting in communication difficulties between Earth-based and satellite-based transceivers.

Space weathermen need to derive a predictive understanding of the various phenomena to help develop mitigation strategies, but our current knowledge can be likened to the tropospheric weather prediction capabilities of the 1950s. We know, in a broad sense, how the plasma ejected from the Sun affects the Earth's magnetosphere and, ultimately, the upper atmosphere, but not the details of that interaction. To address these problems with a coordinated effort, in 1996 several federal agencies initiated the National Space Weather Program (NSWP), a joint program involving NSF, NOAA, USAF, NASA, DOI, and DOE. Although the NSWP has made progress toward forecasting space weather, the present generation of models remain inadequate, measurements of critical parameters are scanty, and the scale of the problem is tremendous.

Variability in space weather must be traced back to variability in the Sun, and upstream measurements are necessarily limited due to the enormous volume over which the physical interactions take place. Progress is being made largely through innovative active and passive remote sensing techniques as well as strategically placed in-situ measurements and increasingly sophisticated assimilative models. Starting at the Sun, spacecraft observations include those made by the Solar and Heliospheric Observatory (a joint NASA and ESA project), located 1.5 million km sunward of the Earth. Earth-orbiting spacecraft, such as the Wind and Polar spacecraft from the International Solar-Terrestrial Physics program at NASA, supply measurements of the solar wind and magnetospheric plasma. The Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) spacecraft provides views of the entire inner magnetosphere for the first time. The Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) satellite measures energy inputs and select ion and neutral species from ionospheric altitudes.

Several existing and planned ground-based observatories measure the ionospheric plasma variability. The incoherent scatter radars in Kangerlussuaq, Greenland (NSF's Søndrestrøm Radar); in northern Scandinavia (European Incoherent SCATter radar); and in Svalbard, Norway (EISCAT Svalbard Radar) allow the diagnosis of most important plasma parameters. NSF's planned Advanced Modular Incoherent Scatter Radar (AMISR) should significantly extend and enhance this coverage from several locations in the Arctic, using a phased array antenna and distributed transmitter/receiver approach. Designed for remote and continuous operation, the AMISR will include three separate, relocatable phased-array radars. The proposed initial locations are near Fairbanks, Alaska, for auroral studies, and Resolute Bay, Nunavut, Canada, for studies of the central polar cap region.

For more information, see the NSWP web site (http://www.spacescience.org/SWOP/NSWP), or contact Craig Heinselman at SRI International in Menlo Park, CA (650/859-3777; fax 650/322-2318; craig.heinselman@sri.com).



The dramatic increase of ionization from the 2000 Bastille Day storm. Left: quiet-time measurements of electron density as a function of altitude from the NSF Søndrestrøm Incoherent Scatter Radar in Greenland. Solar illumination produces E-region ionization down to approximately 90 kilometers altitude. Two profiles also show thin sporadic E layers at just under 115 km; these layers consist of monatomic metal ions left behind by meteor ablation. Right: the impact of high energy protons, showing a distinct peak in ionization at 70 km lasting for many hours, and significant ionization enhancements to below 50 km. Figure by C. Heinselman.

ARCSS Committee Aims for Long-term Synthesis

By Jonathan Overpeck

2002 was a big year for the Arctic as well as for ARCSS. For the Arctic, unprecedented summer warmth and sea ice retreat highlighted why arctic research is so timely and important. For ARCSS, partnership with the Study of Environmental Arctic Change (SEARCH) program (see page 20–21) generated a major increase in funding (see page 22). The ARCSS Program also has new leadership. We offer thanks and best wishes to Mike Ledbetter, and welcome Neil Swanberg as the new program director. Neil brings a wealth of experience in interdisciplinary science and already has built a good working relationship with the ARCSS Committee (AC). His rich involvement with the International Geosphere-Biosphere Program (IGBP) will be a big help in making ARCSS even stronger than before.

In 2002, I began serving as the chair of the AC. We owe great thanks to Jack Kruse for the job he's done since 1997. ARCSS is a strong, well-funded program with interdisciplinary strength that is better and broader than ever. I look forward to working with Neil, the AC, and the entire ARCSS community to build on the strong foundation that Jack and Mike organized.

The next year will be busy for the AC and ARCSS Program leadership, with the charge to produce the next Five Year ARCSS Science Plan, as well as to ensure a smooth transition to this next stage of ARCSS research. The process is as important as the product. Building on the 2002 ARCSS All-Hands meeting (see *Witness* Spring 2002), and the other activities over the past year, the AC will focus on:

- First, a one-plus year arctic system synthesis, intended to be an intellectual exercise as well as the process by which the next ARCSS science plan is generated.
- Second, setting the stage for a new longer term research-intensive arctic system synthesis to ensure that we understand how the entire integrated system works, and how this understanding best meets the needs of society.
- Third, doing all it can to help NSF and the arctic science community maintain a smoothly running and well-subscribed NSF science program.

I'd like to thank the members of the scientific community who've contributed their intellect, experience, and energy to strengthen the ARCSS Program. Feel free to continue bringing issues and ideas to individual AC members (including the chair!) or your program leadership. Communication is key to a vibrant ARCSS.

Jonathan Overpeck is director of Institute for the Study of Planet Earth and a professor in the Department of Geosciences at the University of Arizona (520/622-9065; fax 520/792-8795; jto@u.arizona.edu)

New NSF ARCSS Program Director Reviews Progress

By Neil Swanberg

By all accounts 2002 has been an important year for the Arctic System Science (ARCSS) program.

The second ARCSS All-Hands workshop in February opened a vital discussion in the ARCSS community about the current and future structure of the ARCSS Program (see *Witness* Spring 2002). The Land Shelf Initiative (LSI; see page 12) and Pan-Arctic Cycles, Transitions, and Sustainability (PACTS; see page 9) emerged as strong new concepts in ARCSS. The proceedings of the meeting will be published by ARCUS in March 2003.

Over the summer, SBI had a highly productive field year, completing four scientific cruises (see page 1).

ARCSS held a special competition on the arctic freshwater cycle for proposals addressing freshwater and hydrological issues in the science plans of:

- the Pan-Arctic Community-wide Hydrological Analysis and Modeling Program (CHAMP; see page 11),
- Arctic/Subarctic Ocean Fluxes (ASOF, see *Witness* Winter 2000/2001), and
- the Study of Environmental Arctic Change (SEARCH; see page 21).

The broad topic required care to ensure program balance in all the key areas of the freshwater cycle.

Over the summer, discussions among the ARCSS leadership and in an ARCSS Committee meeting made clear that the ARCSS Program would benefit from a system-level synthesis effort. This would be science-driven and take two forms:

- a short-term effort that would support a reorganization of the program and develop a model of the arctic system;
- a longer term effort that would lead to a variety of deeper, research-based synthesis activities that would produce a substantial scientific product.

The Land-Atmosphere-Ice Interactions (LAII) project Arctic Transitions in the Land-Atmosphere System (ATLAS; see page 9 and *Witness* Autumn 1998) and the Ocean-Atmosphere-Ice Interactions (OAII) project Surface Heat Budget of the Arctic (SHEBA, see *Witness* Spring 2000) held their own synthesis workshops during the fall. As science management entities, LAII and OAII are also likely to wind down in their current form but will continue to support the ARCSS research community until a new science management structure is in place.

The arctic paleoscience community organized in Paleoenvironmental Arctic Sciences (PARCS; see page 10) is encouraged to compete under the NSF Earth Systems History (ESH) banner now and in future years. Under a new arrangement with the ESH program, ARCSS has access to the ESH process without an irrevocable commitment: i.e., ARCSS support will be contingent on successful arctic proposals.

Investigators funded through the Human Dimensions of the Arctic System (HARC) initiated several efforts to reinforce the community of HARC researchers (see page 12 and *Witness* Spring 2002).

At the end of 2002, I became permanent director of the ARCSS Program. My guess is that next year will be as exciting as this one was.

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

JOSS On-line Field Catalog Supports SBI Cruises

Integrated data management is important to the success of large, multiinvestigator projects like SBI (see page 1). The ARCSS Program funded the University Corporation for Atmospheric Research (UCAR) Joint Office for Science Support (JOSS) to produce a comprehensive data management strategy for the SBI Project, in cooperation with the SBI Project Office and investigators. This strategy provides project investigators and the general science community with timely access to a complete project database and associated documentation. A major component of this strategy is the implementation of an on-line field catalog during cruises to provide near-real-time documentation and browsing of operational data.

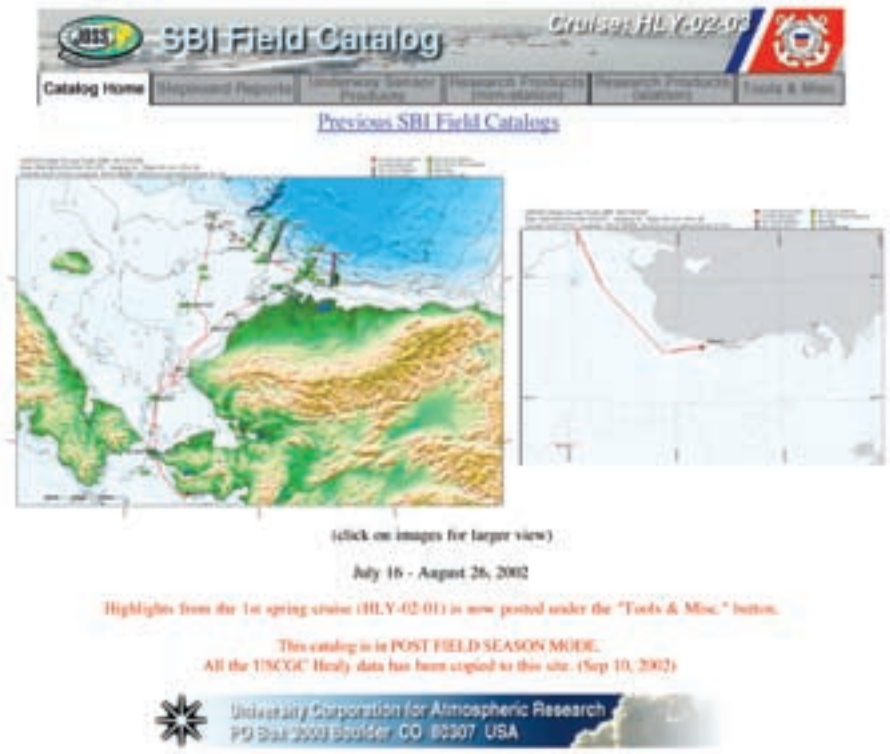
Field Catalog

Previously deployed in the Arctic for the Surface Heat Budget of the Arctic (SHEBA; see *Witness* Spring 2000) project, the on-line field catalog (see figure) is a valuable tool for reporting and monitoring operational activities and a permanent archive of cruise activities. JOSS field catalogs were installed onboard the USCGC *Healy* (see *Witness* Spring/Autumn 1999) for both the spring and summer SBI process cruises. The catalog organizes data and documentation for use in the field and acts as a detailed field report after operations have ended. It facilitates communication during fieldwork by keeping participants abreast of ongoing operations. Because a portion of the shipboard catalog content is routinely uplinked via satellite to the JOSS Boulder facilities, land-based scientific co-workers and others can monitor the ship's operation and progress. During both cruises, the catalog was used by project participants aboard ship and ashore as well as by USCG staff and families at home, the Alaska Eskimo Whaling Commission, and others interested in the ship's operations.

Catalog Products

Two components of the field catalog were especially popular during SBI:

- a ship track plot, updated every 15 to 30 minutes, showing station locations, moorings, and bathymetry (data from the International Bathymetric Chart of the Arctic Ocean; see *Witness* Spring 2000);



The SBI field catalog front page can be found at http://www.joss.ucar.edu/sbi/catalog.

- an event log detailing station activities, including in-water and on-deck times and Seabeam water depth from the daily logs generated by the Coast Guard.

During the spring cruise, a part of the field catalog allowed researchers to log detailed ice observations complete with digital photos and automatically incorporated current data from the ship, including position, water depth, and current weather parameters. Other products available through the field catalog included:

- satellite products from NOAA and Defense Meteorological Satellite Program (DMSP) polar orbiters;
- weather and related data, updated twice daily, including 24-hour time-series plots of temperature, winds, pressure, humidity, and water depth;
- CTD data in two standard formats, including temperature, salinity, oxygen, transmittance, photosynthetically active radiation (PAR), and fluorometer measurements, vertical section plots of various parameters for station transects, and comments on each cast;
- bottle data, including bottle hydrographic reports and synthesized vertical section plots of specific variables for various station transects; and
- reports, including the daily operational summaries, Teachers Experiencing Antarctica and the Arctic (TEA; see page 29 and *Witness* Winter 2000/2001) daily journals, summary reports, cruise summary, and science reports.

Post-Cruise Catalog Use

Near the end of each cruise, JOSS personnel onboard the *Healy* worked with service team members to produce a CD for each PI of the catalog station products as well as all service data and ancillary PI datasets. U.S. Coast Guard crewmembers also made a CD copy of the ship's underway data files available.

As part of JOSS's data management services, several additional underway datasets were archived to tape for availability through the SBI data archive at JOSS.

For more information, see the complete field catalogs for both cruises, which are now available at JOSS (http://www.joss.ucar.edu/sbi/catalog), or contact James A. Moore (303/497-8635; fax 303/497-8158; jmoore@ucar.edu).

Metadata is Vital to Long-term Utility of Data

The NSF Arctic System Science (ARCSS) Program's effectiveness requires the integration of knowledge from various disciplines, which in turn depends on the accessibility and exchange of data among the scientific community. The ARCSS Program requires its awardees to submit data and metadata to the ADCC after an interval allowing for analysis and publication.

The ARCSS Program funded the establishment of the ARCSS Data Coordination Center (ADCC) at the National Snow and Ice Data Center (NSIDC) of the University of Colorado at Boulder in 1994. The ADCC is the permanent long-term data archive for all components of the ARCSS Program. The ADCC, through long-term data archiving and documentation, strives to promote knowledge synthesis and exchange among the research scientists who study the response of the Arctic to global climate change.

Because researchers can use raw data for purposes that may differ from the original reason the data were collected, the long-term archive of ARCSS data may have a much broader audience than just ARCSS investigators. Data that lack adequate documentation (metadata) can effectively become "lost." Technology will continue to provide access to data in the future, but the usefulness of data is limited without accompanying metadata. Complete documentation, including metadata (information about data), is key to ensuring the long-term preservation of data.

The ADCC collects metadata from scientists working on ARCSS-funded and related projects. Metadata describe the "who, what, where, when, why, and how" of the data set and are crucial to an investigator looking for suitable data sets to answer specific research questions. The ARCSS Data Policy (http://arcss.colorado.edu/arcss/protocol/protocol.html) describes minimum metadata requirements, which help to ensure thorough and accurate metadata and archiving in a way that facilitates data use and access. By providing high-level information about a specific data set, metadata enable users to assess a data set's characteristics and applicability to their research, focus their data searches, and retrieve the appropriate data sets.

To help ARCSS principal investigators meet metadata requirements, the ADCC produces two types of data set documentation, based on information that PIs submit with their data: a data interchange format (DIF) file and a summary document. Both act to standardize a given data set's metadata, increase ease of use, and allow future access to that data set. In addition, the ADCC submits metadata to the Global Change Master Directory (GCMD) and ensures that all ARCSS Program metadata are complete and meet Federal Geographic Data Committee (FGDC) standards.

For more information see the ADCC web site (http://arcss.colorado.edu/) or contact Rudy Dichtl at the National Snow and Ice Data Center, Boulder, CO (303/492-5532; dichtl@kryos.colorado.edu).

New CD Compiles ATLAS Materials

A new CD documents life in the field for the Arctic Transitions in the Land-Atmosphere System (ATLAS) project at Ivotuk, Alaska (see *Witness* Autumn 1998; page 9). The data, collected at the Ivotuk site by more than 30 researchers from January 1998 through June 2000, are archived on the ATLAS Project Ivotuk Site CD, published by the University Corporation for Atmospheric Research Joint Office for Science Support (UCAR/JOSS; see page 7), under the auspices of ATLAS. The main purpose of the Ivotuk CD is to provide a single archive source for the multidisciplinary data collected at the site. James Moore, Greg Stossmeister, and Don Stott of JOSS worked with a number of ATLAS investigators to determine the size and scope of the CD.

The research at Ivotuk focuses on

- the exchange of energy and mass between the tundra surface and the atmosphere, and
- developing models and parameterizations to allow extrapolation of how changes in climate could affect these fluxes.

Researchers collected data on components of the system, including permafrost, soil, vegetation, atmosphere, and water—as liquid, vapor, and solid ice and snow. The fluxes between the various components are primarily energy, moisture, and trace gases (CO_2 and methane). The Ivotuk CD interface can access the data through an interactive map or by

- discipline (active layer/permafrost, flux, hydrology, meteorology, snow, soil, and vegetation);
- working group (snow, shrubs, and weather; hydrological response; energy and trace gas flux; substrate and vegetation; permafrost soils; trace gas fluxes; active layer and permafrost geophysics);
- site (any of five grid study areas, four study lines, or two meteorological sites); or
- year.

The Ivotuk CD also includes an overview of the project, providing background information with slide shows contributed by the researchers, abstracts and field reports, and an interview with Terry Chapin by Robert Hannon of Alaska Public Radio's "Alaska Edition."

A zoom sequence comprising 95 USGS topographic grids orients the viewer to Ivotuk's geography. Snow-melt sequences provide graphic evidence of the progression of the seasons. The CD also shows the human side of the research, including living quarters, shared meals, and hikes across the vast landscape. A PowerPoint "movie" presents University of Virginia graduate student Monika Calef's unique take on her Ivotuk experience.

The CD is available at the UCAR/JOSS web site (http://www.joss.ucar.edu/atlas). For more information contact Don Stott in Boulder, CO (303/497-8154; fax 303/497-8158; stott@ucar.edu).

ATLAS Research Enters Synthesis Phase

The Arctic Transitions in the Land-Atmosphere System Project (ATLAS; see *Witness* Autumn 2001), which is a major part of the Land-Atmosphere-Ice Interactions (LAII) component of the ARCSS Program, has entered a synthesis phase after four years of intensive fieldwork. During the field component of the project, researchers representing more than a dozen institutions and universities with expertise ranging from ecology and soil science to atmospheric dynamics and hydrology compared sites in northern Alaska, near Barrow, Atqasuk, and Ivotuk; in western Alaska, near Nome; and in Siberia, near Cherskii.

The goal of the field program was to document the role of the arctic terrestrial system in global climate change, and more particularly, to explore how feedbacks in the land-atmosphere system might impact arctic ecology and human society. The field campaigns focused on processes occurring in two specific and critical arctic transition zones—the forest to tundra transition, and the shrub to tundra transition.

The ATLAS synthesis has already produced some interesting products. A CD containing the data collected by all the projects that worked at Ivotuk, on the North Slope of Alaska, is available (see page 8). A half-hour video on ATLAS research entitled "A Changing Landscape: Investigating a Warming Arctic" has been produced by KUAC-TV (University of Alaska) to air on West Coast TV affiliates in 2003. A special issue of the *Journal of Geophysical Research* containing nine papers from the ATLAS project was published in late January 2003.

As part of the synthesis, ATLAS researchers met in October 2002 near Victoria, British Columbia, to explore the connections between their research efforts. Several important themes emerged that form the basis of papers being prepared for publication. Three papers focus on the winter processes taking place in the snow and soil, examining how these processes interact and how they impact the growth of shrubs and other plants and the winter release of CO_2. These papers validate one of the key findings of ATLAS: that research must extend beyond the traditional growing season to understand biotic-abiotic feedbacks in the Arctic. Another manuscript documents the dramatic changes that have occurred in the arctic terrestrial system over the past 30 years, including:

- changes in vegetation (increasing shrubs and northward migration of treeline),
- changes in the date of freeze-up of the tundra on the North Slope of Alaska (more than 60 days later than in the 1960s), and
- changes in discharge of arctic rivers (flow has increased by as much as 10%).

In Victoria, ATLAS researchers also looked to the future, finishing a science plan for a new research program—Pan-Arctic Cycles, Transitions, and Sustainability (PACTS; see *Witness* Spring 2002)—concentrated on transitions and changes in arctic biophysical, biogeochemical, and social systems. PACTS proposes to investigate the interaction of physical and living systems (e.g., the hydrological cycle and the tundra ecosystem), rather than individual systems themselves, using the concepts of sustainability and the assessment of vulnerability in human and natural systems as guiding principles to ensure that future research will be relevant to the identification of potential adaptive strategies in the face of a changing climate.

While it builds on ideas and accomplishments from LAII research, the PACTS science plan more explicitly emphasizes biotic and abiotic interactions. Its scale and scope are larger as well, with a regional viewpoint that seeks to understand the Pan-Arctic as a large complex system. The plan provides a bridge between the past disciplinary and geographically organized research and a more thematic structure that cuts across disciplines and geographic boundaries. The LAII science steering committee took the lead in developing the plan, which was reviewed by a broad segment of the ARCSS science community. The major objectives of the plan are:

- Using new knowledge generated during LAII and other ARCSS programs, identify important unanswered questions related to arctic biophysical and biogeochemical systems, and from these questions, define the critical areas of research that will best advance knowledge of the Arctic System as a whole;
- Provide a strategy and approach that can guide how the new integrated research will address the critical questions; and
- Create a mechanism for the implementation of PACTS.

For more information, see the LAII web site (http://www.laii.uaf.edu/) or contact LAII science steering committee chair Matthew Sturm (907/353-5183; fax 907/353-5142; msturm@crrel.usace.army.mil). To obtain a copy of or to broadcast the video "The Changing Landscape," contact KUAC (907/474-7491; fax 907/474-5064; s.duran@uaf.edu). For more information on the JGR special issue, contact A. David McGuire (907/474-6242; fax 907/474-6716; ffadm@uaf.edu).

The sculpted snow near a tributary to the Oumalik River, 80 miles southeast of Atqasuk, reflects the intimate relationship between snow, topography, vegetation, and wind. Photo by Ken Tape.

Working Group Meetings Advance PARCS Research Themes

The Paleoenvironmental Arctic Sciences (PARCS; see *Witness* Spring 2002) research community seeks to understand past changes in the arctic environment and how they relate to global change. Discussions among PARCS investigators recently identified two integrative and urgent research themes:

- modes of natural climatic variability within the Arctic, and
- past warm arctic climates and their consequences.

Following discussions between the NSF Earth Systems History Program (ESH), ARCSS, and PARCS, these two themes form the basis of a new effort within the ESH Program. A coordinated paleoscience research initiative of the U.S. Global Change Research Program, the ESH program is supported by the NSF Divisions of Atmospheric Sciences, Earth Sciences, and Ocean Sciences, and the Office of Polar Programs, as well as the National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs. The ESH Program Announcement released in October 2002 included "Modes of Arctic Climate Variability and Warmth" as one of four areas of research interest.

As the first step in addressing these two research themes, PARCS sponsored three working group meetings this fall to review the current state of knowledge and to generate summary articles to disseminate this knowledge to the wider arctic research community.

Modes of Climatic Variability

Understanding the full range of modes of climatic variability in the Arctic, their relation to climate states at lower latitudes, and the degree to which they are predictable requires the development of a network of high-resolution (annual to decadal) paleoenvironmental records that span 2,000 years and extend through the 20th century. This network will be used to address questions such as the periodicity and persistence of recognized climatic phenomena within the Arctic (e.g., the Arctic Oscillation) and their interrelation with the global climate system. Longer records spanning the entire Holocene (last 10,000 years) at centennial resolution are also being investigated to assess whether the millennial-scale variability identified in the North Atlantic region is a widespread feature of Holocene climate.

About a dozen members of the PARCS Working Group on High-Resolution Records met in Boulder, Colorado, on 30 October–2 November 2002 to analyze the spatial and temporal patterns of temperature reconstructed from around the Arctic. The group

- compiled annual to subdecadal records of summer temperature for the last 400 years using a variety of paleorecords;
- identified three principal modes of variability;
- analyzed instrumental data to infer physical mechanisms and circulation patterns associated with these modes; and
- discussed strategies for long-term reconstructions of the hypothesized mechanisms and circulation patterns.

A major goal is to extend the high-resolution records beyond 1,000 years to allow investigators to characterize climate prior to the Little Ice Age.

Warm Arctic Climates and Their Consequence

Studies aimed at understanding the state of marine, terrestrial, and biological systems during previous periods when the Arctic shifted toward and experienced warmer conditions concentrate on three periods of warmer-than-present conditions:

- intervals during the last two millennia;
- other warm intervals of the current interglacial period (Holocene), and
- the last interglaciation.

Twenty-eight members of the PARCS Working Group on the Holocene Thermal Maximum (HTM) met concurrently with the High-Resolution Records Group in Boulder to present and discuss:

- summaries of the major mechanisms and feedbacks responsible for the HTM (ca 8,000 years ago), and
- records from around the Arctic that attest to warmth and its environmental consequences.

Considerable discussion focused on the utility and sensitivity of the various climatic proxies now available. A general pattern of early warming in Beringia and later warming eastward from central Canada to the northwestern North Atlantic was clear, but quantitative estimates of temperature were too sparse to determine the relative magnitude of warming among the regions. Northern Eurasia appears to have displayed a more synchronous thermal history. Where quantitative estimates are available, temperatures were generally 2 ± 1°C higher than average 20th-century values. Participants developed a preliminary synthesis showing the spatial-temporal pattern of the HTM. The data compilation will form the foundation of one or more summary articles.

Arctic warmth was also the focus of a meeting in Maine in October 2002 on the last interglaciation, cosponsored by PARCS and the International Geosphere-Biosphere Programme—CircumArctic PaleoEnvironments (IGBP-CAPE). Twenty-five paleoscientists reviewed quantitative evidence for the extent of summer warmth in terrestrial and marine settings ca 125,000 years ago. Boreal forest reached the Arctic Ocean coast everywhere except the North Slope of Alaska. All Northern Hemisphere glacier ice except the Greenland Ice Sheet and on mountains >5 km disappeared, and even Greenland's ice sheet was half its current size. Coupled GCM experiments indicate substantial warming from insolation forcing but slightly less than the observed magnitude in paleorecords. The group plans to write one or more papers that compare model and data results and that review the status of the Arctic during the last interglaciation and its significance for understanding extreme warmth in the Arctic.

For more information, see the PARCS web site (http://www.ngdc.noaa.gov/paleo/parcs), or the ESH Program Announcement (http://www.nsf.gov/geo/egch/gc_esh.html), or contact PARCS co-chairs Darrell Kaufman at Northern Arizona University (928/523-7192; fax 928/523-9220; darrell.kaufman@nau.edu) or Glen MacDonald at the University of California, Los Angeles (310/825-2568; fax 310/206-5976; macdonal@geog.ucla.edu).

New Program Links Freshwater to Ocean Dynamics

In September 2000, a strategy[1] for identifying, documenting, and understanding changes in arctic hydrological processes and their interactions with climate, ecosystem dynamics, and marine processes was developed by a group of more than 30 arctic scientists. The Pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP) was developed under guidance from NSF's Arctic System Science Program and a recently formed Science Steering Committee.

In January 2002, NSF released a $30 million announcement of opportunity to study the freshwater cycle in the Arctic and to address some of the issues raised in the strategy document and in a complementary international program, Arctic/Subarctic Ocean Fluxes (ASOF; see *Witness* Winter 2000/2001). The joint initiative constitutes an NSF contribution to the multiagency Study of Environmental Arctic Change (SEARCH; see page 21) initiative.

To date, 18 projects have been funded (see box) to quantify the freshwater balance of the Arctic Basin and to elucidate how changes in the freshwater cycle may impact the arctic system. The focus is on decades-to-century time scales; collectively these projects seek to articulate the interconnections between the freshwater hydrologic cycle and ocean/sea-ice dynamics. This is inherently a synthesis effort, based on the conjunction of routine observations, process-based field studies, and modeling.

The program held a meeting of principal investigators 18–19 February 2003, in Boulder, Colorado, to support program integration by:

- introducing each research project to the CHAMP/ASOF community;
- identifying gaps, overlaps, and opportunities for collaborative research;
- articulating the contents of an initial plan for integration and synthesis research within CHAMP, ASOF, and SEARCH; and
- soliciting input from project investigators on coordination and on partnership with ASOF and SEARCH.

For more information, contact Larry Hinzman at University of Alaska Fairbanks (907/474-7331; fax 907/474-7979; ffldh@uaf.edu) or Charles Vörösmarty at the University of New Hampshire (603/862-0850; fax 603/862-0587; charles.vorosmarty@unh.edu). For more information on ASOF, see http://asof.npolar.no.

Notes

1. Vörösmarty et al. 2001. *The Hydrological Cycle and its Role in Arctic and Global Environmental Change: A Rationale and Strategy for Synthesis Study.* Fairbanks, Alaska: ARCUS.

Freshwater Projects Funded in 2002

Variability and Forcing of Fluxes Through Nares Strait and Jones Sound: A Freshwater Emphasis—K. Falkner, M. Torres, R. Samelson (Oregon State Univ.), A. Munchow and K-C. Wong (Univ. Delaware) *$3,385,912*

Detection and Attribution of Changes in the Hydrologic Regimes of the Mackenzie, the Kuparuk and the Lena River Basins—L. Hinzman, M. Nolan, D. L. Kane, and K. Yoshikawa (Univ. Alaska Fairbanks), J. Cassano and A. Lynch (Univ. Colorado), and W. Gutowski (Iowa State Univ.) *$2,578,642*

Synthesis of Water Balance Data from Northern Experimental Watersheds—D. L. Kane and D. Yang (Univ. Alaska Fairbanks) *$214,673*

Decadal to Centennial History of Lena River Discharge to the Arctic Ocean—E. Karabanov and D. F. Williams (Univ. S. Carolina) *$724,986*

An Observational Array for High Resolution, Year-round Measurements of Volume, Freshwater, and Ice Flux Variability in Davis Strait—C. Lee, R. Moritz, J. Gobat (Univ. Washington), K. F. Drinkwater (Bedford Institute of Oceanography) *$3,483,000*

The Role of Spatial and Temporal Variability of Pan-Arctic River Discharge and Surface Hydrologic Processes on Climate—D. Lettenmaier (Univ. Washington) and E. Wood (Princeton Univ.) *$1,255,682*

Biogeochemical Tracers in Arctic Rivers: Linking the Pan-Arctic Watershed to the Arctic Ocean—B. Peterson and R. Holmes (Marine Biological Lab.) *$1,648,366*

Winter Precipitation, Sublimation, and Snow-Depth in the Pan-Arctic: Critical Processes and a Half Century of Change—R. Pielke Sr. and G. E. Liston (Colorado State Univ.), L. J. Mahrt (Oregon State Univ.), and M. Sturm (Cold Regions Res. and Eng. Lab.) *$1,556,546*

Beaufort Gyre Freshwater Experiment: Study of Freshwater Accumulation and Release Mechanism and the Role of Fresh Water in Arctic Climate Variability—A. Proshutinsky (Woods Hole Oceanographic Institution) *$1,701,276*

Connections Among Atmospheric Forcing, Runoff and Conditions in the Laptev and East-Siberian Seas—I. Semiletov and G. E. Weller (Univ. Alaska Fairbanks) *$187,390*

A Land Surface Model Hind-Cast for the Terrestrial Arctic Drainage System—M. Serreze (Univ. Colorado), D. Lettenmaier (Univ. Washington), and S. Ackerman and J. R. Key (Univ. Wisconsin) *$654,802*

River Discharge from the Russian Federation: An Understanding of Contemporary Trends and Their Placement in a Holocene Context—L. Smith and G. M. MacDonald (Univ. California LA) *$583,114*

Circulation in the Freshwater Switchyard of the Arctic Ocean—M. Steele (Univ. Washington), P. Schlosser, W. M. Smethie (Columbia Univ.), and R. Kwok (Jet Propulsion Lab.) *$1,046,505*

Freshwater Budget of the Arctic and High Latitude Mode of Atmospheric Variability—B. Tremblay (Columbia Univ.) *$236,078*

An Integrated Assessment of the Pan-Arctic Freshwater System: Analysis of Retrospective and Contemporary Conditions—C. Vörösmarty, R. Lammers, E. Linder, S. Frolking, M. Fahnestock (Univ. New Hampshire), M. Serreze (Univ. Colorado), and M. Steele (Univ. Washington) *$2,335,649*

Development of Bias-Corrected Precipitation Database and Climatology for the Arctic Regions—D. Yang and D. L. Kane (Univ. Alaska Fairbanks) and D. R. Legates (Univ. Delaware) *$497,216*

Assessing the Long-Term Contribution of Landfast Ice to the Arctic Freshwater Budget—Y. Yu (Univ. Washington) *$242,900*

Changes in Freeze-Thaw and Permafrost Dynamics and Their Hydrological Implication Over the Russian Arctic Drainage Basin—T. Zhang and R. G. Barry (Univ. Colorado) *$681,285*

Land-Shelf Interactions Science Plan Moves Forward

Work continued in 2002 on development of a science plan for the Land-Shelf Interactions (LSI) Initiative, which is meant to improve opportunities for research across the land-sea boundary in the Arctic. LSI grew out of research implementation efforts within the Russian-American Initiative for Shelf-Land Environments in the Arctic (RAISE), and from the recognition that recent ARCSS research has not adequately addressed coastal processes (see *Witness* Spring 2002). The plan aims to lay the groundwork for a coordinated, interdisciplinary research opportunity in the Arctic that would

- focus on the coastal zone, and
- support land, river, and sea-based researchers using coordinated logistical capabilities that otherwise would be unavailable.

The overarching goal of the Land-Shelf Initiative is to improve understanding of the biogeochemical, physical, and hydrological processes that occur in the near-shore zone of the arctic shelf and its adjoining shoreline with respect to changes in the global climate system. Important potential research topics include freshwater runoff, the rate of coastal erosion or accretion, and the impacts of climate warming on coastal features and processes such as

- near-shore and offshore permafrost,
- sea-ice formation and melt,
- atmospheric gas exchange, and
- biological communities.

Because of the concentration of human activity in the arctic coastal zone, human dimensions will play an important role in the implementation of LSI research.

As part of the science planning efforts, the RAISE project management office and science steering committee have been reconfigured as the RAISE/LSI Project Management Office, which is now located at the University of Tennessee. Approximately 100 members of the arctic research community have contributed to developing the LSI science plan through:

- participation in two on-line forums,
- joining working groups at the February 2002 ARCSS All-Hands Workshop (see *Witness* Spring 2002), or
- commenting on the draft science plan.

Progress this year on science plan development has been reported to the ARCSS Committee at its October 2002 meeting in Arlington, Virginia, and to the joint meeting of the ARCSS components science steering committees that met in San Francisco in December 2002. Information on LSI also has been shared in 2002 at relevant international meetings including:

- the International Arctic Science Committee's Initiative for Scientific Research in the Russian Arctic (Moscow, October 2002),
- the Land-Ocean Initiative in the Russian Arctic (Moscow, November 2002),
- the Land-Ocean Interactions in the Coastal Zone Synthesis and Futures Meeting (Miami, May), and
- the Swedish Polar Secretariat's *Oden* 2005 Expedition Planning Meeting (Stockholm, November).

The science plan will be completed and support requested from the ARCSS Committee and ARCSS Program management at NSF to implement of the LSI initiative.

For more information, see the RAISE/LSI web site (http://arctic.bio.utk.edu/#RAISE) or contact Lee Cooper at the University of Tennessee (865/974-2990; fax 865/974-7896; lcooper1@utk.edu) or Ken Dunton at the University of Texas (361/749-6744; fax 361/749-6777; dunton@utmsi.utexas.edu).

Special Issue of *Arctic* and Workshop Explore HARC Topics

The Human Dimensions of the Arctic System (HARC) Science Management Office (SMO) made several strides this year in developing a HARC community of researchers and in integrating the HARC initiative more fully into the ARCSS Program. Two major HARC activities have added to this effort:

- contributions by HARC PIs to a forthcoming dedicated issue of *Arctic,* and
- a workshop on HARC and Biocomplexity in the environment.

Henry Huntington, the HARC SMO director, is coordinating manuscript submissions from HARC PIs for an issue of the journal *Arctic* dedicated to human dimensions research in the Arctic. The papers will highlight arctic research on the interactions of people with global change. These manuscripts will begin the peer review process in early 2003, and the human dimensions special issue is expected to be published in late 2003 or early 2004.

The HARC SMO held a workshop in Anchorage, Alaska, in October 2002, sponsored by the NSF Biocomplexity in the Environment (BE) program (see *Witness* Spring 2002). The workshop had three primary goals:

- to bring together interdisciplinary teams to focus on questions and challenges facing researchers doing integrated human dimensions research,
- to foster coordination and cross-fertilization among teams, and
- to support and develop work on HARC and/or BE projects.

Eight interdisciplinary research teams were represented at the workshop. The plenary discussions focused on two topics:

- encouraging integrated, interdisciplinary research and interaction between investigators and projects, and
- stimulating further development of the HARC initiative.

The discussions yielded a thoughtful series of recommendations concerning both topics for the ARCSS Committee (see page 6).

For more information, see the HARC SMO web page (http://www.arcus.org/HARC) or contact Henry Huntington in Eagle River, AK (907/696-3564; fax 907/696-3565; hph@alaska.net) or Dan Ferguson at ARCUS in Fairbanks, AK (907/474-1600; fax 907/474-1604; dan@arcus.org).

Workshop Outlines New Photochemistry Studies

Recent field studies in the Arctic, Antarctic, and in mid-latitudes have shown that sunlight illumination of snow releases a host of trace gases to the atmospheric boundary layer. These gases include nitric oxide (NO), nitrogen dioxide (NO_2), bromine (Br_2), bromine chloride (BrCl), carboxylic acids, aldehydes, and other species that influence chemistry and composition of both the atmosphere and snowpack (see *Witness* Spring 2000). Effects include rapid tropospheric ozone depletion and depletion/mobilization of mercury.

For example, sea-salt particles, one of the most abundant aerosol types (by mass), are important sources of reactive halogen gases, such as Br_2 and BrCl, to the gas phase. These photolyze to form reactive halogen radicals (e.g., Br and bromine oxide), which react with important tropospheric gases such as ozone, mercury, dimethyl sulfide, and hydrocarbons. These reactions alter the composition of the atmosphere and can also affect climate.

At the Ocean-Atmosphere-Ice-Interactions (OAII) All-Hands meeting in November 2001, the OAII science steering committee recognized the need for a better understanding of these emerging research issues and recommended that the ARCSS Program support a workshop to synthesize information and evaluate critically important unresolved issues, the means for pursuing those issues, and the logistics and support needed for research on air-snow-ice-water chemical exchange and its influence on climate.

A three-day community workshop, Changing Environmental Controls on Coupled Chemical Exchange Between the Ocean, Ice, and Atmosphere in the Arctic, convened in November 2002 at Purdue University. The workshop brought together 24 investigators working on issues in high-latitude chemistry and photochemistry to

- identify prospective collaborators;
- determine and prioritize current and future science needs;
- discuss creative logistics solutions; and
- develop recommendations toward a coordinated study of these processes.

The workshop participants will produce a preliminary research plan defining the objectives and logistical needs for a series of field campaigns, model development studies, and laboratory studies, under the proposed project name OASIS.

For more information, see the workshop's web site (http://www.chem.purdue.edu/arctic/arcticworkshop.htm) or contact Paul Shepson at Purdue University (765/494-7441; fax: 765/496-2874; pshepson@purdue.edu).

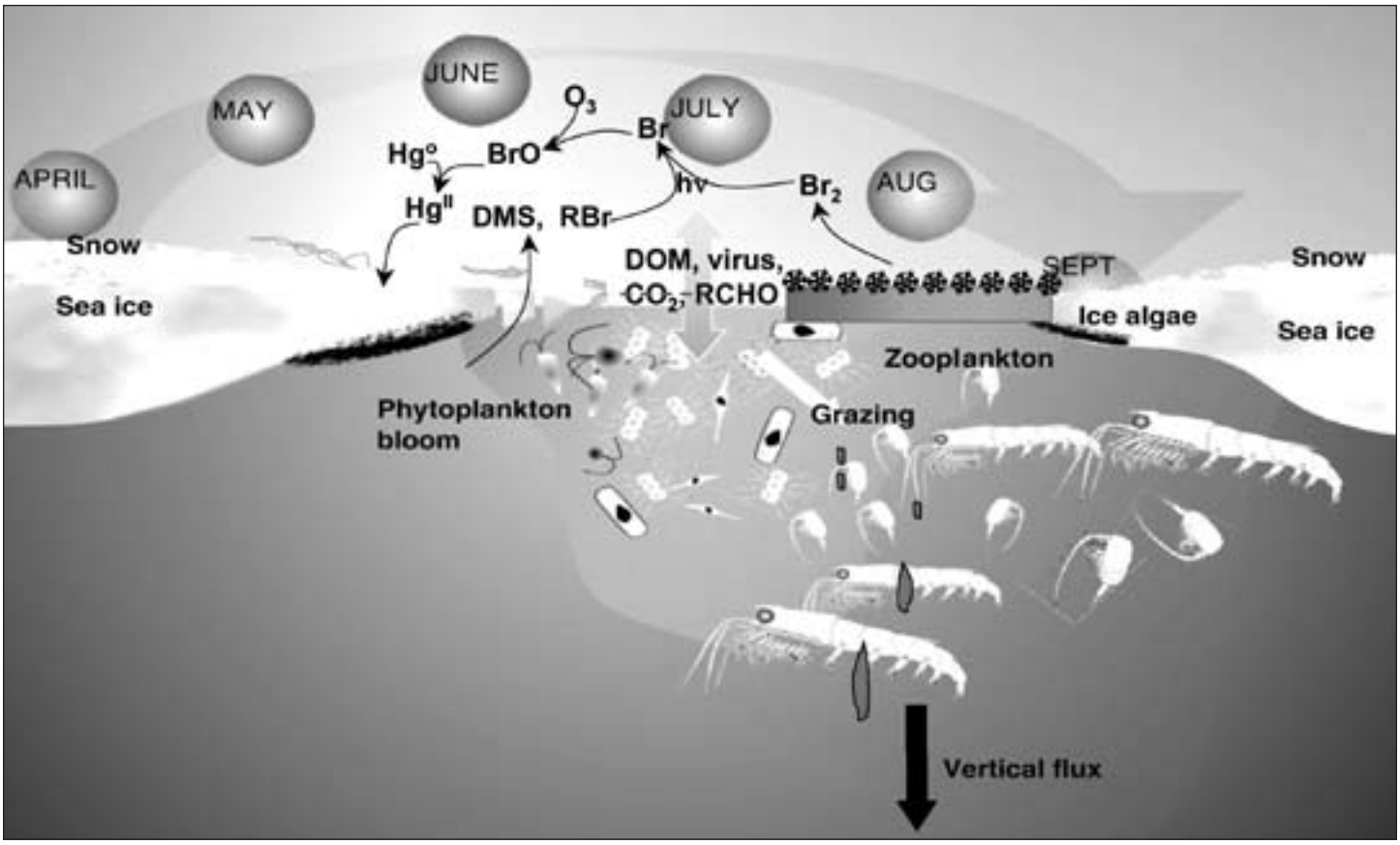


Figure shows the exchange of gases, particles, and particle precursors between the ocean, snowpack, and frozen ocean surface, and the atmosphere, all important issues in the proposed OASIS project. Among those processes known to be important are the exchange of photochemically reactive halogen gases that lead to free radical consumption of atmospheric gases such as ozone, mercury, and volatile organic compounds. This chemistry can lead to particle production (a part of Arctic Haze), and subsequent deposition of the products to the surface. Many of these processes are known in qualitative terms, but are poorly understood quantitatively. Redrawn by P. Shepson from a figure by M. Fukuchi and P. Wassmann.

VPR Supports Complex Work on Alaska Glaciers

VECO Polar Resources (VPR; see *Witness* Spring 2002), NSF's contractor for arctic logistics, supported the research projects of 100 groups of investigators across the Arctic in 2002. VPR worked in Alaska, Canada, Greenland, Iceland, and Russia to fill researchers' needs, ranging from a single Iridium satellite phone to complete field camps and air support. Challenges of the 2002 season included the complex arrangements required to support drilling into Alaska's mountain glaciers.

Funded by the Arctic Natural Sciences Program (ANS; see pages 15–17), Keith Echelmeyer and a team of scientists from the University of Alaska Fairbanks spent the spring studying the motion of Black Rapids Glacier in the Alaska Range near Delta. Echelmeyer and his collaborators instrumented boreholes on the glacier to allow continuous monitoring of deformation and basal water pressure, to reveal information about glacial dynamics and present-day climate. VPR provided and coordinated their field camp and gear and arranged for two helicopters and a turbine single Otter from Ultima Thule Lodge to fly over 30,000 pounds of gear from historic Black Rapids Roadhouse to the glacier. Although late-season snowstorms bogged down work and access to the airstrip, Echelmeyer and fellow researchers Will Harrison and Martin Truffer reported a successful season.

Working to the south at the same time, Lonnie Thompson and Ellen Mosley Thompson of the Ohio State University set up another drilling camp in the wilderness area of Wrangell-St. Elias Park and Preserve. Also funded by ANS, the Thompsons drilled 450 m (1500 feet) into the glacial saddle between Mt. Bona and Mt. Churchill to extract the first high-quality ice core records from Alaska. The 15,300 foot altitude of the drill site added considerable complications to the logistics arrangements. Team members had to be acclimatized at a mid-level camp and snowmachines and generators had to be specially tuned for the thinner air. The project required 30,000 pounds of gear, including gallons of 200-proof alcohol (used to lubricate the drill head and keep the drill hole from filling in) and two refrigerated trailer vans for storing the 20,000 pounds of ice core. A specially stripped down A-Star helicopter moved people to the drill site, while Paul Klaus expertly piloted the turbine Otter to the hard-packed ice saddle. After more than a month of fieldwork, every snowmachine, generator, and piece of equipment was flown back off the mountain and the core trucked away to the Byrd Polar Research Center. These high-resolution records, which may extend up to 18,000 years ago, fill a significant void in the global suite of ice-core records of Earth's past climate and environmental variations.

VPR develops specific solutions for field projects using a global network of service providers; VPR's services are available to NSF-funded investigators working in the Arctic.

For more information, see the VPR web site (http://www.vecopolar.com), or contact Marin Kuizenga at the VPR Fairbanks Office (907/455-4214; fax 907/455-4126; marin.kuizenga@veco.com).

USCGC *Healy* and *Polar Star* Cruise the Western Arctic

The U.S. Coast Guard Cutters *Healy* and *Polar Star* completed successful summer 2002 field seasons in the western Arctic. *Healy* supported two large programs: the Shelf-Basin Interactions (SBI) project (see page 1) and a series of coring surveys throughout the Bering and Chukchi Seas, focused on developing a high-resolution record of sea level since the last glacial maximum (see *Witness* Spring 2002). The *Polar Star* also supported two missions: a mooring support cruise for the SBI program (see http://www.whoi.edu/science/PO/arcticedge/arctic_west02/expedition/index.html) and an investigation of the hydrography of the Chukchi Borderlands region (see *Witness* Spring 2002).

The USCGC Polar class icebreakers have been used for science support for approximately 30 years. The *Polar Star* (http://www.polarstar.org) and her sister ship, the *Polar Sea* (http://www.uscg.mil/d13/dpa/background/ships/uscgc_polar_sea.htm) support science in both the Arctic and Antarctic, with one of the two ships traveling south each winter to support the break-out of the U.S. bases in Antarctica. Each vessel has undergone significant refits to improve their science capabilities. As the ships approach the ripe old age of 30, the USCG is forming plans for their midlife refits. The Arctic Icebreaker Coordinating Committee (AICC; see *Witness* Winter 2000/2001) will likely be hosting a workshop to discuss improvements to the Polar-class ships this summer. More information will be available soon.

The AICC will also be coordinating a series of science assessments for all four of the summer 2002 deployments. Assessments serve as a forum for information exchange between the scientists, the ships and their support programs, the funding agencies, and the AICC. Discussion of the assessments is now the main agenda topic for the winter AICC meeting, which was held in Seattle in February 2003. The AICC will prioritize issues raised in the assessments to improve science operations on board the USCGC icebreakers.

The AICC held its fall meeting in Washington, DC, in September 2002. In addition to the above, discussions included:

- improving communications between ocean-going scientists, funding agencies, and concerned members of Alaska coastal communities;
- engaging the scientific community in expeditionary planning; and
- maximizing collection of underway data in conjunction with ongoing science mission activities.

For more information on the AICC, including copies of minutes from meetings, see the UNOLS web site (http://www.unols.org) or contact AICC chair Lisa Clough (252/328-1834; fax 252/328-4178; cloughl@mail.ecu.edu) or the UNOLS Office (office@unols.org).

Station Upgrades Continue as Toolik Population Grows

Science use of the Toolik Field Station (TFS; see *Witness* Autumn 2001) on Alaska's North Slope continues to increase. TFS supported 6,089 science days in 2002, up 10% from 5,569 days in 2001. Projections for 2003 exceed 6,200. The station is now staffed from 1 April to 31 September, and use outside the operational season can be arranged as needed.

During peak use throughout July 2002, TFS supported between 80 and 98 researchers each day, although the residence trailers offer only 44 beds. The station's population exceeded 44 continuously from 23 May to 24 August. Polar tents accommodated the overflow population.

The Toolik Lake area has been the focus of long-term, intensive, and integrated research in the Arctic since 1975. TFS currently supports the Arctic Long Term Ecological Research (LTER) program, based at the Ecosystem Center, Marine Biological Laboratory, Woods Hole, Massachusetts. In 2002, 36 additional arctic research projects from 48 different universities and institutions covered aquatic and terrestrial ecology and the physiology of arctic breeding birds, mammals, and insects. Forty-six principal investigators, 49 graduate students, and 19 undergraduates participated in research this season.

The modules for the new dormitory were constructed in Sedro Wooley, WA, by Skagit Pacific and trucked to TFS in August 2002. When completed, the dorm will accommodate 16 people in eight bedrooms, a common room with chairs and table, a storage room, bathrooms with sinks, toilets, lockers and shower, and decking. The station plans to add a total of six similar dorms over the next several years. Photo by M. Abels.

Facility Upgrades

As part of the continuing upgrades planned for TFS, the NSF Arctic Research Support and Logistics Program funded installation of a new 16-person, year-round residence facility. Construction of the modular unit began this summer and is expected to be complete in the spring of 2003. Other upgrade projects completed this summer included:

- temporary expansion of the kitchen, including new ovens, range, steamer, walk-in coolers, and a storage tent;
- an incubation research facility with six 92-gallon, temperature- and light-controlled circulating water tanks;
- a drainage project that resurfaced the station gravel pad;
- a new dock to support research boats;
- safety equipment; and
- a new modular bathhouse with showers and sinks.

The Institute of Arctic Biology (IAB) at the University of Alaska Fairbanks, which owns and manages TFS, worked with VECO Polar Resources (see page 14) and VECO Alaska on the upgrade projects. Future expansion plans include a year-round science support building, new laboratories, a new dining hall, and expanded workshop facilities.

Science Oversight

The TFS management team receives information and advice from the TFS Steering Committee and Science Users' Group, which represent both organizational interests and individual users of the station. IAB Director Brian Barnes serves as the TFS science director, and IAB Research Associate Syndonia (Donie) Bret-Harte was recently appointed as associate science director. Bret-Harte, who has worked at TFS since 1993, will act as a liaison between TFS science users and TFS management.

For more information, see the TFS web site (http://www.uaf.edu/toolik), or contact Mike Abels in Fairbanks, AK (907/474-5063; fax 907/474-5513; fnmaa@uaf.edu), Brian Barnes (brian.barnes@uaf.edu), or Donie Bret-Harte (syndonia.bretharte@uaf.edu).

The Arctic Natural Sciences Program

The NSF Arctic Natural Sciences Program (ANS) provides core support for basic disciplinary research in the atmospheric, biological, and earth sciences, glaciology, and oceanography. Areas of special interest include: ozone depletion in the Arctic (see *Witness* Winter 2000/2001), exploration of the Arctic Ocean (see *Witness* Spring 2002), and environmental processes (see *Witness* Spring 2002).

Recent notable research funded by the ANS Program includes investigations of

- photochemistry of snow (see *Witness* Spring 2000),
- sea level rise in the Arctic Ocean,
- glacier dynamics (see page 17),
- the influence of the Chukchi Borderland on Arctic Ocean circulation (see *Witness* Spring 2002),
- the unusual coccolithophore blooms in the Bering Sea, and
- paleogenetics of arctic animals.

Pages 16 and 17 showcase two projects recently funded by the ANS Program.

Jane Dionne is the program manager for ANS. The former co-program manager, Neil Swanberg, recently accepted a permanent appointment as program manager for the Arctic System Science (ARCSS) Program (see page 6). OPP has begun a search for a new ANS program manager.

For more information, contact Program Manager Jane Dionne in Arlington, VA (703/292-8029; fax 703/292-9082; jdionne@nsf.gov; http://www.nsf.gov/od/opp/arctic/natural.htm).

Eruptions Release Clues to Bering Sea Tectonic History

The Bering Sea Volcanic Province, from northwestern Alaska through the Bering Sea to the northern part of the Russian Far East, is located between two major plates (Eurasia and North America). The complex geological history of this area involved subduction events as crustal blocks of various affinities amalgamated to form the landmasses and continental shelf we see today. There also is field evidence for rifting, indicating that stress regimes changed through time.

Because details of the tectonic setting of the Bering Sea region and Alaska mainland remain ambiguous, the sources and causes of magmatism outside of the Aleutian Arc proper are not clearly understood. Convergent zone (arc) volcanism, associated with subduction of plates, is fundamentally different from magmatism associated with mantle melting due to decompression along divergent plate boundaries. Arc melting involves fluxing with water derived from the subducted slab. The presence of water in arc magmas often leads to violent and devastating eruptions. It also is not known whether the mantle in the Bering Sea region still retains memory of water addition by the subduction that occurred during the assembly of circum-Bering Sea terranes during the Cretaceous Period (over 100 million years ago).

Lava flows in the Bering Sea region are of particular geologic interest because they contain inclusions of peridotite believed to originate in the upper mantle, providing the only direct examples of rocks from 40 km or more below the surface. These peridotite inclusions contain geochemical information that can be used to deduce tectonic evolution, and their host volcanic rocks provide isotopic age information about the frequency of eruptions. The Arctic Natural Sciences Program has funded Samuel Mukasa and Alex Andronikov of the Department of Geological Sciences at the University of Michigan to use these peridotite inclusions and their host lavas to describe the composition, structure, and evolutionary history of the Earth's upper mantle in the Bering Sea region.

With help from the Nome National Park Service office and bush pilots from Nome, Kotzebue, and Aniak, the researchers collected samples from several young volcanic fields, including:

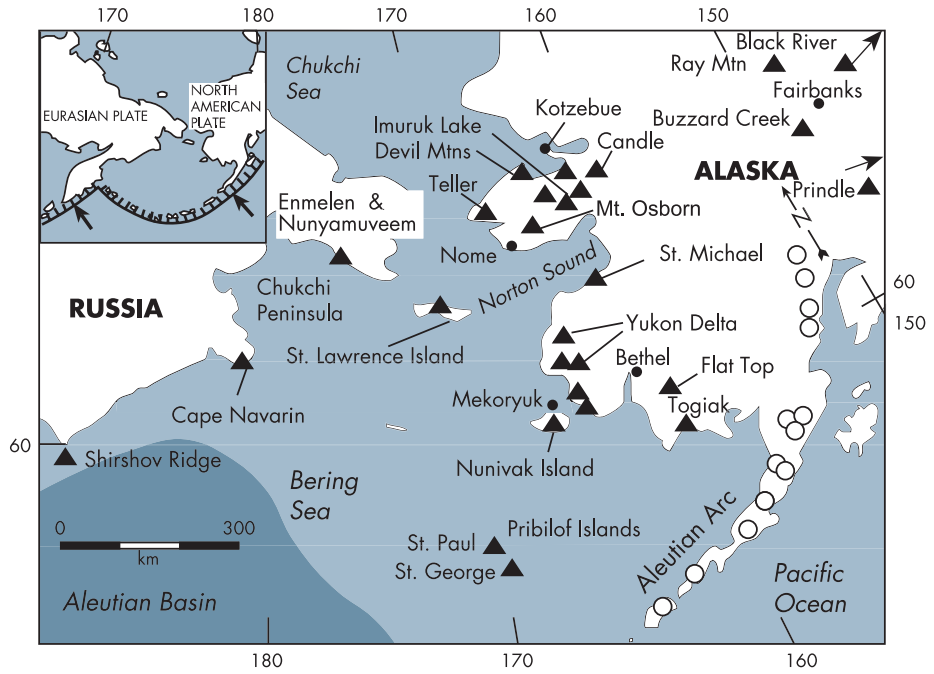
- Cloud Lake and Imuruk Lake, near the eastern edge of the Bering Land Bridge National Preserve,
- the Grand Central Valley near the peak of Mt. Osborn,
- St. Michael,
- the three prominent volcanic peaks across Grantley Harbor from Teller,
- "Lake 277" on Nunivak Island, and
- St. Paul and St. George in the Pribilof Islands.

Mukasa and Andronikov hope to collect additional materials on future expeditions to volcanic fields around Bethel, as well as in interior Alaska. They will generate major oxide, trace element, and isotopic data on minerals separated from the peridotite inclusions in their attempts to decipher the tectonic evolution of the region. They will also obtain $^{40}Ar/^{39}Ar$ and ^{14}C data to compute the eruption ages of morphologically young lava flows to establish the temporal and spatial variation of volcanism. A subset of the volcanic samples younger than 50,000 years will be processed for trace element concentrations as well as Sr, Nd, and U-series isotopic data to address the following:

- What are the possible mantle sources of the lavas?
- How do these mantle sources vary temporally and spatially?
- Is the recent volcanism related to subduction or decompressional processes affecting the mantle sources?
- What is the interplay, if any, between the volcanism in the Bering Sea and interior Alaska and arc volcanism in the Aleutian Arc?
- What can we infer about future volcanic hazards?

This work will contribute to a mandate of the Arctic Natural Sciences Program by improving understanding of the tectonic development of the Arctic, recognized to be an important boundary condition for other studies, including climate change, environmental change, and life/lithosphere interactions. Understanding the processes that control lithospheric evolution during extension will provide important constraints on thermomechanical models of rifting and on the chemical evolution of the mantle beneath continents.

For more information, contact Samuel B. Mukasa at the University of Michigan in Ann Arbor (734/936-3227; fax 734/763-4690; mukasa@umich.edu).



Location map for the Bering Sea Volcanic Province (BSVP) and interior Alaska. Young volcanic fields to be studied in this project are shown with black triangles. The inset map (top left) shows the BSVP in relation to the Aleutian Arc (dark line with half-track pattern) and the Eurasian and North American Plates. Arrows show the relative motion of the Pacific plate. Modified after Moll-Stalcup, E. J. (1996). The origin of the Bering Sea Basalt Province, Western Alaska. Geol. Pac. Ocean *12, 671–690.*

Glacier Behavior Linked to Seasonal Hydrology

Temperate glaciers transmit large volumes of melt water each summer through a dynamic subglacial drainage system of conduits and cavities. Much of glacier behavior is linked to the annual evolution of this subglacial plumbing—especially in spring when the system is too small to handle the growing inputs from snow melt. Melt water enters the glacier through crevasses and vertical pipes called moulins, ultimately reaching the glacier bed. Much of the year a distributed system of linked cavities slowly drains the bed; this is augmented in summer by a network of river-like conduits in which water flow velocities are high. The conduits close due to viscous creep of the ice under the weight of the overlying glacier when counteracting water pressures are low—which occurs with waning melt in the fall, or possibly during cold spells in the summer. The continually evolving nature of this conduit system impacts all aspects of glacier behavior, from glacier sliding to solute flux, and potentially to outburst flood initiation, through poorly understood effects on water pressure and water storage within the glacier.

Two Alaskan glacier projects funded by the NSF Arctic Natural Sciences Program share glacial hydrology as an integrating theme, although the projects focus on different glaciological problems. At Bench Glacier in the Chugach Range, a group from the University of California, Santa Cruz (UCSC), and University of Washington works on glacier dynamics and erosion, while at Kennicott Glacier in the Wrangell Mountains, a group from UCSC, Portland State University, and the U.S. Geological Survey monitors annual jökulhlaups (glacier outburst floods) from an ice-dammed lake.

By surveying targets on the 7-km-long Bench Glacier, researchers identified a wave of relatively high sliding velocity that propagates upglacier in early summer. The maximum sliding velocities coincide with a peak in water storage within the glacier. The high temporal resolution of horizontal and vertical displacements provided by five differential GPS receivers (from the University NAVSTAR Consortium [UNAVCO; see *Witness* Spring 2002]) on the glacier in summer of 2002 allowed detailed analysis of glacier movement. Meltwater inputs exceeded water outputs throughout a subtle sliding event in late May, during which water storage at the bed in growing subglacial cavities can be inferred from the vertical uplift of the glacier surface. Two exceptionally warm days in mid-June caused stream discharge to more than quadruple about 12 hours after sliding velocities increased simultaneously across the glacier. The first sliding event appeared to open up cavities at the bed but did not awaken the stream system, and high water pressures were maintained. The second event promoted development of a conduit system, which drained the stored water.

Water chemistry can be used to probe the subglacial hydrologic system. Fast-flowing water in conduits, with little opportunity to react with bed materials, has low dissolved ion concentrations. The higher solute concentrations of the water within the distributed flow system reflect its greater residence time at the bed in contact with ground-up rock particles. At Bench Glacier, solute concentrations suggest that average subglacial residence time of water declines through the summer, as expected for an increasingly efficient drainage system. At the much larger and thicker Kennicott Glacier, river chemistry undergoes long-period cycles lagged relative to discharge variations. The chemistry reflects water pressure fields that alternately promote and prevent drainage of high solute water from the distributed flow system.

Ice-dammed Hidden Creek Lake at Kennicott Glacier drains through a 16-km-long subglacial conduit each summer, permitting planned monitoring of an extreme event. For two field seasons, the Kennicott Glacier team measured lake level and ice-dam deformation, drilled boreholes, and gauged the glacier outlet stream. These data yielded the first complete pair of hydrographs—one of flow out of the lake, one of flow out of the glacier—through a glacier outburst flood, or jökulhlaup. Observations of the water level in the lake at the time of drainage, and of the discharge in the Kennicott River prior to drainage, point to the importance of dynamic subglacial hydrology in triggering lake drainage. The outlet river chemistry suggests that lake drainage occurs when water pressures are higher in the distributed system than in conduits—conditions that presumably promote conduit extension. Prerequisites for the outburst appear to include both that the lake reach a threshold level and that a subglacial conduit system be in place nearby the lake. Models that link water pressures, water balance, glacier sliding, and conduit growth are being developed to explain the Bench and Kennicott Glacier observations.

For more information, see http://es.ucsc.edu/~spa/SPAnderson.research.html and http://www.geol.pdx.edu/Glaciers/Kennicott/, or contact Suzanne Anderson at the University of California, Santa Cruz (831/459-5827; fax 831/459-3074; spa@earthsci.ucsc.edu).

When a glacier slides over its bed—as opposed to normal slow deformation—it attains higher speeds and, importantly, both drags rocks along the bed, causing abrasion, and promotes crack growth leading to quarrying. At Bench Glacier, the wave of sliding in the spring moves the ice ~1 m and produces most of the present-day ~1 mm per year erosion of the rock bed, demonstrating the extreme efficiency of glacial erosion. Although the high water pressures that precede the opening of a subglacial conduit are important in promoting sliding and therefore in eroding the bed, sediment delivery to the terminus is associated with transport in fast-flowing conduits, particularly as the conduits first open up. Photo by Suzanne P. Anderson.

Ethnicity and Trust are Key to Russian Transition

Authoritarian regimes (particularly the Soviet regime) are thought to produce social atomization, in which people are unlikely to trust one another. As societies emerge from authoritarianism, however, trust is important in shaping both democracy and markets. In the political realm, interpersonal trust promotes civic engagement and community building, and institutional trust helps overcome the dilemmas of collective action. In the economic sphere, interpersonal trust reduces transaction costs for exchange and facilitates cooperation.

The Arctic Social Sciences Program has funded a project to measure levels of trust in two Russian republics in transition. Donna Bahry (Political Science, Vanderbilt University) and Rick Wilson (Political Science, Rice University) are investigating whether individuals rely on personal networks or use ethnic attachments and whether new political and economic institutions are used to build trust.

Bahry and Wilson completed fieldwork for "Collaborative Research on Ethnicity and Transition in Russia" in Tatarstan and Sakha. Both republics are leaders in the campaign for republic sovereignty and for interethnic accommodation and represent critical cases for the study of interethnic relations. Both experienced indigenous ethnic mobilization in the late 1980s and early 1990s, and both governments promote ethnic accommodation between the titular group and local Russians. The two Republics also provide powerful contrasts. Tatarstan is better integrated into the Russian transportation and market system and has a fairly dense population. Sakha has rich natural resources but lies largely within the Arctic Circle, has very low population density, and has exceedingly limited transportation networks.

The project brings together two distinct types of data collection. The first involved a two-hour face-to-face survey of a stratified cluster sample of citizens of Tatarstan and Sakha. Approximately 1200 individuals in each republic were asked about their workplace experiences, political activity, ethnicity, experiences with ethnic discrimination, trust of and experiences with a variety of political and economic institutions, and an array of social and demographic characteristics. The survey data were collected by Demoscope, housed in the Institute of Sociology of the Russian Academy of Sciences.

The second part of the research brought a subsample of the interviewees together to participate in controlled, laboratory experiments to test concepts of fairness, equity, risk orientation, and trust. As an example, a typical experiment involved 14 individuals in the same room. Subjects had a private workspace (a cardboard box at their desk) and were given money, which they kept, with which they made decisions. On average, subjects made almost 550 rubles ($18) for two hours in the lab, equivalent to anywhere from half a day's wage to many months' pension for subjects. A total of 651 subjects participated in 47 experimental sessions.

In the trust game, half the subjects (the trusters) were handed an envelope containing eight 10-ruble bank notes and eight blank slips of paper the size of a bank note. They were asked to put eight objects in the envelope and keep the remaining eight objects. The envelope then would be given to another subject. Before being handed to that person, however, any money in the envelope would be tripled. The second person (the trustee) then opened the envelope and returned whatever he or she wished. Whatever remained in the envelope was returned to the truster. This experiment taps both trust and trustworthiness. Any amount that the truster sends risks being taken by the trustee. Because subjects are randomly paired and never know with whom they are paired, the truster has to believe that the other subjects are trustworthy. There are real rewards for trusting: a subject sending 80 rubles (about one third of a day's wage in Sakha), has that amount tripled to 240 rubles. So long as a trustee returns at least 90 rubles, the truster is better off. On the other hand, the truster risks losing everything sent if the trustee is not trustworthy. This portion of the experiment posed a real dilemma, and subjects spent a good deal of time contemplating their choices.

The research team has begun to analyze these data. Preliminary results indicate that levels of trust are higher than were originally expected. The Russian subjects are trusting at rates similar to those reported in the U.S. for comparable types of experiments. The team is looking at whether this trust is confined to networks of close friends, centered in ethnic groups, or widespread. While most subjects are trustworthy, the amounts reciprocated are slightly less than what is sent. Again, such findings are common in similar experiments conducted in the U.S. In future analyses combining the rich attitudinal data from the surveys with the behavioral data, it will be possible to test hypotheses about the sources of trust and the impact of transitional institutions on the levels of trust in these societies.

For more information, see the project web page (http://brl.rice.edu/Siberia/), or contact Rick Wilson at Rice University in Houston, TX (713/348-3352; fax 713/348-5273; rkw@rice.edu).

Bahry and Wilson worked in several villages in Sakha and Tatarstan. This village was approximately 140 kilometers east-northeast of Yakutsk, in Sakha. The forest fires raging throughout Sakha had created a haze in the air. The teepee in the center of the picture was prepared for a celebration of the summer solstice. Photo by Rick Wilson.

Mixed Siberian Communities Defy Ethnic Categorization

"We are locals. We do not have a nation ..."
—a 72-year-old woman in Russkoe Ust'e, Sakha, 1999.

The quote above, from a resident of Russkoe Ust'e, refers to the problems faced by members of ethnically and linguistically mixed communities of northeastern Siberia when trying to define themselves in terms of state-approved ethnic labels. Russkoe Ust'e is a village of slightly more than 200 inhabitants located at 71° N in the delta of the Indigirka River in the northeastern part of the Republic of Sakha (Yakutia). The majority of local residents have been registered as "Russians" by representatives of the state bureaucracy, while their favorite self-designation—"locals"—is not recognized beyond colloquial and spatially circumscribed contexts. Similarly, the broad label "Native," which is applied to most communities neighboring Russkoe Ust'e, is unavailable to the "locals," despite their often close resemblances in subsistence techniques, spiritual beliefs, and physical appearance.

The Russian scholarly literature refers to these people as *starozhily,* which literally means "long-time residents" and is commonly translated as "Old Settlers." Old Settlers is a broad label applied to several groups of Russian descent who have lived in various Asian parts of the former Russian Empire since at least the 19th century. The existence of Old Settler groups is tied to the process of Russian colonization of North Asia, reaching back to the 16th and 17th centuries. Many of the early Russian settlers married indigenous women. Their ethnically mixed descendants developed distinctive religious, economic, and social practices that share elements adopted from neighboring indigenous groups.

In 1998, the Arctic Social Sciences Program funded Peter P. Schweitzer of the University of Alaska Fairbanks and Nikolai B. Vakhtin and Evgeniy V. Golovko, both of the European University at St. Petersburg, to compare past and present processes of social and cultural exchange in three Old Settler communities in northeastern Siberia. In addition to Russkoe Ust'e, the collaborators conducted fieldwork in the communities of Pokhodsk and Markovo. Pokhodsk, similar to Russkoe Ust'e, is a small village located in a tundra environment along the Kolyma River, close to the shores of the Arctic Ocean in northeastern Sakha. Markovo is a slightly bigger regional center situated on the Anadyr River in the forest tundra zone of western Chukotka.

Focused on issues of history, power, and ethnicity, study methods included archival research, semistructured interviews, collection of oral histories, and participant observation. Data analysis is in the final stages, and a Russian book on the subject will appear in 2003. Notable findings include:

- All communities under consideration define themselves in varying degrees through their mixed heritage.
- This mixed heritage puts them in a category separate from "Russians" (or "colonizers") and "Natives" (or "colonized"). Various individuals and groups differ significantly, however, in where they place themselves on such a "continuum of identities."
- Ethnic labels—both as self-designations and designations by others—play an important role in these processes of ethnic identity.
- The current situation of these communities cannot be understood without considering their historical genesis. Conversely, the current situation does not necessarily represent previous epochs.
- The Soviet period of the region's history was particularly influential in triggering social, cultural, and economic changes.
- While "isolation" has been a characteristic feature of the genesis and historical development of these communities, longstanding social relations with a limited number of neighboring groups was a precondition for the sustained existence of these communities. The three study communities belonged to two distinct regional networks.
- The study communities held changing positions in regional hierarchies of political power and social status. Generally speaking, the predominant group status was, until recently, that of middlemen and/or cultural brokers between "Russians" and "Natives."
- The current cultural and social conditions led to the gradual disappearance of the cultural elements that had characterized mixed communities in northeastern Siberia for centuries. At the same time, the global processes of cultural commodification make these disappearing—and previously low-esteemed—traits into emblems of cultural identity.

To clarify whether the specific qualities and problems of mixed communities in northeastern Siberia are idiosyncratic or typical for a wider range of northern communities, Schweitzer co-organized and chaired a session at the 2002 meeting of the American Anthropological Association entitled *Creole Identities? The Predicaments of Mixed Communities in the Circumpolar North.* Case studies from Greenland, Canada, Alaska, and Siberia revealed a remarkable number of commonalities. In addition to making their results available to an English-speaking audience, Schweitzer and colleagues will focus future endeavors on developing a broadly comparative and circumpolar perspective.

For more information contact Peter P. Schweitzer at the University of Alaska Fairbanks (907/474-5015; fax 907/474-7453; ffpps@uaf.edu), Nikolai B. Vakhtin (nik@eu.spb.ru), or Evgeniy V. Golovko (golovko@ag3609.spb.edu), the latter two at the European University at St. Petersburg, Russia.

The "harbor" of Russkoe Ust'e: the boats are used to check fishing nets on the Indigirka River. Riverine fishing is the primary subsistence activity for the Old Settlers of the region. Photo by Peter Schweitzer.

New Program Manager Joins Arctic Social Sciences

By Anna Kerttula

As the new program manager for the NSF Arctic Social Sciences Program, I would like to introduce myself and some of my goals for the program. I grew up in Alaska and received my baccalaureate and masters degrees from the University of Alaska and my PhD in anthropology from the University of Michigan, Ann Arbor. My fieldwork included extensive research in Alaska, but my PhD work was in Chukotka, Russia, where I worked in the village of Sireniki on the Bering Sea coast from 1989–91 on social and cultural group formation and change among the Chukchi and Yup'ik during the Soviet period. After I returned to the U.S., I became the special assistant for Russian affairs to Senator Ted Stevens. For the last five years I have been the associate director for the Alaska Governor's Office in Washington, DC. After my stint in public policy, I looked for a way to return to academia and had the good fortune to be chosen by NSF for this position.

I feel fortunate to join the Arctic Social Sciences Program (ASSP) at this propitious time. The past decade has been remarkable in expanding social science research in the Arctic. In the last 10 years, several programs at NSF have contributed resources to further social scientific understanding and education in the Arctic—over $20 million through OPP alone. Currently the ASSP is funded at about $1.9 million a year. The annual mean award over the last five years is $65,000. Now we should build on this investment and take the program into new and exciting research areas.

NSF's founding legislation includes a broad vision of education, social policy, international goals, and national defense, along with basic research. In other words, ASSP can fund education, international collaborations, policy research, etc., as well as traditional social science research projects. In addition to this expansive mission statement, the current NSF leadership's vision is very pertinent to ASSP. At a recent meeting, Deputy Director Joseph Bordogna talked about "science at the frontier." The frontier is not just your research site but the frontier of your intellect and imagination. Research in the Arctic is in an extreme environment, and our ideas should always be at the frontier of science. We need to find new questions about humans in the Arctic and new ways to answer those questions. We need to collaborate not only with natural and physical scientists but among our own disciplines as well to gain greater insight into arctic systems and change. Larger interdisciplinary programs offer opportunities for this type of work that ASSP can't support alone; these programs include Human Dimensions of the Arctic System (HARC; see page 12); Coupled Natural and Human Systems (CNH), part of the Biocomplexity in the Environment Initiative (BE; see *Witness* Spring 2002); and the Study of Environmental Arctic Change (SEARCH; see page 21).

The fields of archaeology and ethnology dominate current ASSP awards—we need to expand this to other fields such as sociology, philosophy, history, economics, psychology, political science, etc. ASSP receives four times as many proposals from men as from women, and minority researchers are practically nonexistent. You can help change this by mentoring undergraduate and graduate students. Take them to the field and encourage them to do research in the Arctic. For my part, I hope to encourage students in arctic social sciences by funding more student research, by providing more support for students to participate in workshops and conferences, and by finding other programs at NSF that can fund educational activities.

I encourage everyone in the research community to contact me with your ideas. I am a permanent federal hire at NSF and plan to be here for the long haul; together we can build a strong, sustainable Arctic Social Sciences Program. I look forward to it.

For more information, see the ASSP web page (http://www.nsf.gov/od/opp/arctic/social.htm), or contact Anna Kerttula at OPP (703/292-8029; fax 703/292-9082; akerttul@nsf.gov).

First SEARCH Open Science Meeting Set for October 2003

The Office of Polar Programs is sponsoring an open science meeting in support of the Study of Environmental Arctic Change (SEARCH; see facing page) program. Planned for 27–30 October 2003 in Seattle, Washington, the meeting will focus on science with addresses from keynote speakers, posters, and working groups discussing the state of our knowledge on SEARCH research themes and activity areas.

The planning phase for the U.S. SEARCH effort is now complete:

- a large number of scientists contributed to the development of the SEARCH Science and Implementation Plans (http://psc.apl.washington.edu/search/) through an open process in a comprehensive series of disciplinary meetings, and
- the plans have been or soon will be approved by the sponsor, an Interagency Working Group of federal agencies.

SEARCH plans and successes will be presented to the community in an open meeting, a symposium focused on current understanding of the science of environmental change in the Arctic, with the goal of informing and engaging the broad arctic research community in the activities contributing to SEARCH, both in the U.S. and international arenas.

An organizing committee established by ARCUS is working with the SEARCH Science Steering Committee, the Interagency Working Group, and the International Arctic Science Committee (IASC; see page 26), to determine the broad themes and format of the meeting and to enrich international involvement in SEARCH science planning.

The sponsoring agencies and organizing committee invite anyone interested in the potential of the SEARCH effort, particularly students and colleagues from outside of the U.S., to participate in the discussions. We expect about 300 participants. There will be a registration fee of approximately $200 (USD).

For more information about the SEARCH open science meeting, or to preregister, see the ARCUS web site at http://www.arcus.org/SEARCH/search.html.

SEARCH Develops Implementation Strategy

A broad, interdisciplinary program, the Study of Environmental Arctic Change (SEARCH; see *Witness* Spring 2002) seeks to understand the complex of significant, interrelated changes that have occurred in the Arctic in recent decades. To describe this complex of atmospheric, oceanic, and terrestrial changes, SEARCH uses the term Unaami, from the Yup'ik word for "tomorrow." SEARCH is envisioned as a long-term interagency effort of observations, modeling, process studies, and applications devoted to understanding Unaami, its relation to global climate, and its impacts on ecosystems and society. Following the 2001 publication of the SEARCH Science Plan, SEARCH is beginning implementation with the funding of the first SEARCH projects and release of a draft implementation strategy.

NSF announced the first major SEARCH funding opportunity, the Freshwater Initiative, in February 2002 (see page 11). Twenty-seven proposals were awarded funding totaling $30 million over five years; 18 separate projects will examine the arctic freshwater cycle, including hydrology, Arctic Ocean freshwater pathways, and freshwater fluxes to and impacts on subarctic seas.

The SEARCH Science Steering Committee (SSC), Interagency Working Group (IWG), and Project Office have developed a draft implementation strategy based on the science plan, community input, and the IWG's FY 2003 Funding Implementation Framework (see *Witness* Autumn 2001). Contributions to the SEARCH implementation strategy came from discussions at many community meetings and workshops, including:

- the 2000 Hydrology Workshop,
- the 2001 Atmospheric and Cryospheric Change in the Arctic (ACCA) Workshop,
- the June 2002 Arctic Ocean Measurements and Modeling Workshop,
- the September 2002 Bering Sea Workshop,
- the October 2002 SEARCH Terrestrial and Marine Ecosystem Workshop,
- the October 2002 SEARCH Human Dimension Workshop, and
- two joint SEARCH IWG-SSC meetings.

The Draft SEARCH Implementation Strategy is available for community comment on the SEARCH web site. The strategy includes a description of science questions arising from the key SEARCH hypotheses, an organization plan, a detailed list of activities required to address the SEARCH goals, priority and schedules for these activities, and summary recommendations. The activities are grouped into eight areas. These are:

- Arctic System Reanalysis will assimilate data into models of various components of the arctic system to produce optimum estimates of key variables.
- Detecting and Quantifying Unaami and Related Modes of Variability will use paleoclimate, historical, and archeological records as well as more recent observations to better define the scope of Unaami and its relation to other decadal modes of variability.
- Social and Economic Interactions will examine the interactions of the physical and biological elements of Unaami with social and economic systems.
- Large-scale Atmospheric Observatories will make large-scale atmospheric observations.
- Distributed Marine Observatories will make large-scale surface atmospheric, oceanographic, sea ice, and ecosystem observations in the marine environment.
- Distributed Terrestrial Observatories will make large-scale surface atmospheric, hydrological, glaciological, and ecosystem observations in the terrestrial environment.
- Linkages and Global Coupling will use modeling and analysis to elucidate the connections between Unaami and global climate and the connections within the arctic system as they pertain to Unaami.
- Social Response will research social and economic adaptation to climate change in the past and apply research on Unaami to economic and social concerns in the future.

Given the decline of several historically important observing systems, the highest implementation priority has always been to establish a program of long-term observations. The implementation strategy establishes a three-tiered scheduling guideline. The strategy recommends that the earliest first-tier efforts include:

- establishing the operational organizational structure of SEARCH,
- maintaining existing observational programs of the Large-scale Atmospheric, Distributed Marine, and Distributed Terrestrial Observatories, and
- beginning the Arctic System Reanalysis and elements of Detecting and Quantifying Unaami and Social and Economic Interactions.

These actions will provide overarching SEARCH activities to keep future activities coordinated and spur further work.

The second-tier actions focus on closing observational gaps by building up the Large-scale Atmospheric, Distributed Marine, and Distributed Terrestrial Observatories. The highest priority activities in this tier mainly seek to augment existing programs and extend observations into strategic areas that will allow us to learn the full scope of Unaami and begin to understand linkages within the arctic system and with global climate.

The third-tier actions include beginning the Linkages and Global Coupling and Social Response activities. The Linkages and Global Coupling activity area will test key hypotheses by undertaking analysis and modeling efforts aimed at the various linkages within the arctic system and with global climate. These efforts will take advantage of the analysis and observational activities in tiers 1 and 2. The Social Response activity area will investigate social and economic adaptation to climate change in the past and apply this knowledge to the future. To do this, Social and Economic Interactions and Social Response will establish a system of coordinated local and traditional knowledge co-ops and community data networks to connect with communities and industries.

For more information, including copies of the SEARCH science plan and draft implementation strategy, see the SEARCH web site (http://psc.apl.washington.edu/search/) or contact SEARCH SSC chair Jamie Morison at the University of Washington (206/543-1394; fax 206/616-3142; morison@apl.washington.edu).

Bill Authorizes Doubled NSF Budget by Fiscal Year 2007

In November 2002, Congress approved a compromise bill to authorize NSF and double its budget over five years, with the last two increases contingent on evaluations of the agency's progress toward management goals. Authorization bills are intended to provide guidance to the appropriations process, when actual funding levels are determined (see below).

The president signed the National Science Foundation Authorization Act of 2002, P.L. 107-368 (see *Witness* Spring 2002) on 19 December. The compromise bill, which includes language from several NSF-related bills, authorizes an NSF budget of:

- $5.5 billion for FY '03,
- $6.4 billion for FY '04,
- $7.4 billion for FY '05,
- $8.5 billion for FY '06, and
- $9.8 billion for FY '07.

The bill stipulates that FY '06 and FY '07 funding increases be tied to a congressional review of NSF progress toward meeting management goals in:

- "strategic management of human capital,"
- "competitive sourcing,"
- "improved financial performance,"
- "expanded electronic government," and
- "budget and performance integration."

Further, it states that in making the determination to grant the funding increases, Congress should take into consideration whether OMB certifies NSF has "overall, made successful progress toward meeting those goals." The bill also

- requires the NSF director to prepare a plan showing where and how the funds will be used during the following year, and
- contains provisions strengthening National Science Board oversight capabilities as NSF's governing body.

The 2003 and 2004 Budgets

The 2003 federal fiscal year began 1 October 2002 with only two of the 13 FY '03 appropriations bills enacted; those two bills fund defense and military construction. In February 2003 the new Congress resolved the 11 deadlocked FY '03 bills with an omnibus appropriation bill (H.J. Res. 2). The bill funds NSF at $5.3 billion, an increase of $501 million (10.4%) over FY '02.

The FY '03 budget increases the Research and Related Activities (R&RA) account, which funds most of NSF's research and development, to $4.1 billion, 12.7% or $458 million more than FY '02. Polar Programs receives $319 million, an increase of $18 million (6.1%) over FY 2002. Each program within the R&RA account receives at least a 12% increase above FY '02, except Polar Programs and Social, Behavioral and Economic Sciences (up 3.9%).

Within the R&RA account, Integrative Activities receives $147 million, up $41 million (39%). Programs supported by Integrative Activities include:

- Major Research Instrumentation,
- Science and Technology Centers,
- Science of Learning Centers,
- the Science and Technology Policy Institute,
- Partnerships for Innovation, and
- Disaster Response Research Teams.

The president's FY '04 budget request, released in February 2003, provides a modest overall increase for federal spending on research and development; most of the increase would go to defense development. The president's FY '04 request for NSF is $5.48 billion, a 9% increase over his FY '03 request, but considerably less than the $6.4 billion authorized under P.L. 107-368.

For more information, see the NSF web site (http://www.nsf.gov), the Library of Congress legislative information web site (http://thomas.loc.gov), the American Institute of Physics web site (http://www.aip.org), and the American Association for the Advancement of Science web site (http://www.aaas.org).

Over 1300 People Meet to Review Climate Change Plan

In November 2002, the Bush Administration issued a draft strategic plan to guide its climate change research strategy and directions. Over 1300 scientists, government officials, and other stakeholders, both domestic and international, gathered 3–5 December at a workshop to review the draft plan and provide comments and suggestions to the Climate Change Science Program (CCSP). The CCSP accepted additional public comments on the draft "Strategic Plan for the Climate Change Science Program" into January 2003. More than 250 individuals and organizations submitted comments.

The federal government has several ongoing, interrelated multiagency initiatives to address global warming and climate change. In February 2002, President Bush established the CCSP as a management structure to balance broad-based fundamental research with a near-term focus on key issues needed for policy decisions. The strategic plan is intended as a roadmap for these efforts.

While acknowledging that "humans have become agents of environmental change," the draft plan points to "inconsistencies in the observational record" and calls for more and better observations in order to discern human-induced changes against a background of natural variability. It also calls for additional research in many areas to reduce uncertainties and improve current climate models.

The draft plan sets out a series of major research questions addressing how the components of the Earth's environmental system function and are affected by human and natural forcing, and the implications for natural environments and human activities. These research areas include:

- atmospheric composition,
- climate variability and change,
- global water and carbon cycles,
- ecosystems,
- land use and land cover change,
- human contributions and responses to environmental change, and
- grand challenges in modeling, observations, and information systems.

An ad-hoc committee of the National Academy of Sciences reviewed the draft plan, the results of the workshop, and the comments received. A final version of the strategic plan is expected to be published in April 2003.

For more information, see the CCSP web site (http://www.climatescience.gov).

USARC Promotes Arctic Research on Many Fronts

The U.S. Arctic Research Commission (USARC) continues its efforts to assess survey needs, particularly the need for submarine surveys, toward defining the boundaries of the arctic continental shelf under Article 76 of the U.N. Convention on the Law of the Sea. In the past several months, representatives of the USARC met with several groups on this issue, including:

- researchers from the northeast U.S.,
- an interagency meeting at the State Department,
- a representative of the National Security Council, and
- the Danish Hydrographic Office.

In addition, USARC representatives attended multiple meetings to address other arctic research issues, including:

- testifying on arctic initiatives before the U.S. Commission on Ocean Policy;
- exploring the use of high endurance geophysical mapping autonomous undersea vehicles to replace the mapping done by SCICEX (see *Witness* Autumn 2001);
- discussing site surveys for Arctic Ocean drilling planned to begin in late 2003 under the Joint European Ocean Drilling Initiative;
- assisting the Arctic Icebreaker Coordinating Committee (AICC; see page 14) in the formation of a working group, headed by Larry Mayer (University of New Hampshire), to oversee operation and data availability of SWATH mapping sonar on the USCGC *Healy*; and
- attending the planning workshop to discuss the new strategic plan for the U.S. Climate Change Science Program (see page 22).

For more information, see the new USARC web site (http://www.arctic.gov), or contact USARC Executive Director Garry Brass in Arlington, VA (800/AURORAB or 703/525-0111; fax 703/525-0114; g.brass@arctic.gov).

PRB Guides Long-term Research Plans in Gulf of Alaska

If you had funding to study an ecosystem for 100 years, what would you do? The *Exxon Valdez* Oil Spill Trustee Council faces this question as it plans the Gulf Ecosystem Monitoring (GEM) Program. In 1999, the Trustee Council set aside $120 million of the $900 million 1991 civil settlement in a trust fund for long-term support of the GEM program. As envisioned, the program's annual budget of $5–6 million will offer an unparalleled opportunity to increase understanding of how large marine ecosystems in general, and Prince William Sound and the Gulf of Alaska in particular, function and change over time. As part of its planning, the Trustee Council asked the Polar Research Board (PRB) for advice, and over the past two years a PRB committee has provided two interim reports and now a final volume, "A Century of Ecosystem Science: Planning Long-Term Research in the Gulf of Alaska."

The report reviews GEM draft planning documents, but more importantly it addresses general issues related to planning long-term ecosystem science, including

- development of a clear conceptual foundation for the program,
- early definition of a geographic scope and focus for study,
- an organizational structure led by a qualified chief scientist,
- involvement of stakeholders in the planning process and research,
- attention to data management to ensure safekeeping and accessibility, and
- periodic assessment of progress through synthesis and evaluation.

Overall the committee found that GEM planners have made good efforts to involve the science community and a solid start on plans to use modeling effectively and in developing a data management strategy. Although it may seem obvious, many of these positive strides have occurred because the Trustee Council and GEM staff have set up a planning process and are allowing adequate time for input, discussion, and revision. Community involvement remains a challenge.

Because GEM offers the prospect of a century-long time horizon, GEM planners have an obligation to craft a research plan that can endure over time. The committee hopes the GEM plan will lead to a core set of measurements that can be taken consistently and indefinitely, as well as some flexibility to adjust to changes in conceptual understanding and research interests. Some of the elements that contribute to successful long-term science programs include:

- clearly defining program goals and anticipated management products;
- recognizing the differences between physical and biological monitoring;
- accommodating differences in space-time scales among ecosystems as they affect sampling design;
- developing an effective archival and data dissemination strategy;
- developing data products that will be useful to decision makers;
- providing for periodic program review and flexibility in program design; and
- establishing a stable funding base and management infrastructure.

The committee was composed of Michael Roman (chair), University of Maryland; Don Bowen, Bedford Institute of Oceanography; Adria Elskus, University of Kentucky; John Goering, University of Alaska Fairbanks (emeritus); George Hunt, University of California Irvine; Seth Macinko, University of Connecticut; Donal Manahan, University of Southern California; Brenda Norcross, University of Alaska Fairbanks; Steven Picou, University of South Alabama; Tom Royer, Old Dominion University; Jennifer Ruesink, University of Washington; and Karl Turekian, Yale University.

"A Century of Ecosystem Science" is available at http://www.nap.edu. For more information, see the PRB web site (http://national-academies.org/prb), or contact PRB Executive Director Chris Elfring in Washington, DC (202/334-3479; fax 202/334-1477; celfring@nas.edu).

Iceland Takes Helm of Arctic Council

Ministers from the eight member countries of the Arctic Council (see *Witness* Spring 2002), together with representatives from the council's six permanent participants, which represent arctic indigenous populations, gathered 9–10 October in Saariselka, Finland, for the Third Ministerial Meeting of the Arctic Council. The meeting, hosted by Finnish Foreign Minister Erkki Tuomioja, was the culmination of Finland's two-year chairmanship of the council and set the stage for the coming two years under Icelandic leadership.

Undersecretary of State for Global Affairs Paula Dobriansky led the U.S. delegation, stressing U.S. commitment to the council and praising the forum as an excellent example of the voluntary partnerships the U.S. championed at the 2002 United Nations World Summit on Sustainable Development in Johannesburg. The foreign ministers of Canada, Iceland, and Sweden participated in the Third Ministerial meeting.

Iceland's Plans

In assuming chairmanship of the council, Iceland announced that it would focus the council's attention on improving the lives of arctic residents through enhanced communications infrastructure and support for economic and social development initiatives. In support of these aims, Iceland will:

- develop an assessment of human development in the region,
- sponsor an international conference on information technology in the Arctic, and
- host Arctic Science Summit Week (see page 26) in spring 2004.

Iceland also intends to maintain the council's commitment to environmental protection and to work with member countries and permanent participants to facilitate the successful completion of the Arctic Climate Impact Assessment (ACIA; see *Witness* Winter 2000/2001).

New AMAP Findings

Immediately prior to the ministerial meeting, the council's Arctic Monitoring and Assessment Program (AMAP; see *Witness* Spring 2002) hosted the second International Symposium on Environmental Pollution of the Arctic from 1–4 October in Rovaniemi, Finland. A followup to the first AMAP symposium in 1997, the forum reviewed changes in levels of contaminants such as persistent organic pollutants (POPs), heavy metals (mercury, lead, and cadmium), and radionuclides and culminated in the presentation of a report entitled *Arctic Pollution 2002.* The report summarized evidence that:

- Most pollution reaches the Arctic via long-range transport.
- The Arctic's unique geographical features, food webs, and cultures make the region particularly vulnerable to the accumulation and effects of contaminants.
- The routes and mechanisms by which contaminants reach the Arctic are strongly influenced by climate variability and global climate change.
- Levels of some POPs are decreasing in most species and media as their release is reduced but are declining slowly in marine biota due to large oceanic reservoirs.
- Certain regions and species in the Arctic have elevated levels of heavy metals.
- Levels of radionuclides in the Arctic are generally declining but remain of concern.

The report identifies the Inuit populations of Greenland and Canada as facing potentially hazardous exposure to contaminants because of their high intake of marine mammals. The AMAP Secretariat emphasized that the overall health benefits of traditional diets to indigenous people of the Arctic currently outweigh the risks. The Arctic Council supports continued monitoring of levels of contaminants in traditional foods and their effects on human health.

During its chairmanship, Iceland will use the AMAP report as a roadmap for "environmental threats to be faced" by the council. Based on the report, a number of members hoped that the council could add its voice to those calling for a global reduction of mercury emissions. Some members also suggested that the council advocate adding more substances in current use (brominated flame-retardants and some pesticides) to the POPs banned by the Stockholm Convention.

Interim Report from ACIA

The U.S. presented interim results of the Arctic Climate Impact Assessment (ACIA; see *Witness* Spring 2000). The ministers were concerned by the ongoing significant warming of most of the Arctic and recognized that the impacts of global climate change and increased possibilities of extreme weather events will have large consequences in the Arctic. Norway's State Secretary Kim Traavik invited all Arctic Council ministers to an inter-sessional meeting on climate change in Svalbard in August of 2003. He asserted that policymakers should not wait for the ACIA results and policy recommendations to be presented at the Fourth Ministerial Meeting in 2004. The foreign ministers from Canada and Sweden as well as the representative from Russia accepted Norway's invitation on the spot.

For more information, see the Arctic Council web site (http://www.arctic-council.org), or contact Sally Brandel at the Department of State in Washington, DC (202/647-3264; fax 202/647-4353; brandelsk@state.gov).

The members of the Arctic Council are Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the U.S. The Permanent Participants of the Arctic Council include the:

- Association of Indigenous Minorities of the North, Siberia and the Far East of the Russian Federation,
- Inuit Circumpolar Conference,
- Saami Council,
- Aleut International Association,
- Arctic Athabaskan Council, and
- Gwich'in Council International.

The category of Permanent Participant provides for the active participation and full consultation with arctic indigenous representatives within the Arctic Council.

France, Germany, the Netherlands, Poland, and the United Kingdom are observer countries. Currently, 18 international and nongovernmental organizations representing a variety of interests also have observer status.

ACUNS Celebrates 25 Years of Northern Studies

The Association of Canadian Universities for Northern Studies is a nonprofit member organization that advocates on behalf of northern research, encourages the development of future researchers, and facilitates communication and cooperation. Founded in 1977, ACUNS now has 39 member institutions—Canadian universities and colleges involved in northern and arctic studies. In 2003, the Association will celebrate its 25th anniversary, with two linked international conferences in Edmonton.

The triennial National Student Conference will be held 24–26 October 2003 (http://scns.onware.ca), to be followed immediately by the International Conference on Canada's Northern Research Capacity (27–28 October).

Other ACUNS activities include:

- "Ethical Principles for Conduct of Research in the North," a key international guide to northern and polar research ethics, is available in French, English, and Inuktitut in hard copy. A new edition (2003) will include a Russian translation.
- The association is a member of the Council of University of the Arctic (http://www.uarctic.org) and chairs the Council's Membership and Nominations Committee, providing a direct connection between the University of the Arctic's activities and Canadian northern studies institutions, experts, and programs.
- The Canadian Northern Studies Trust (CNST), the scholarship arm of ACUNS, was established in 1982 to encourage young scholars to undertake northern research. The trust relies upon donations from a number of sources, including the Royal Canadian Geographical Society, the Canadian Polar Commission, the Meterological Service of Canada, the Beverly and Qamanirjuaq Caribou Management Board, Arctic Cooperatives Limited, as well as anonymous donors, to provide scholarships to northerners and southerners at all levels of postsecondary education.

For more information, see the ACUNS web site (http://www.cyberus.ca/~acuns), or contact ACUNS Executive Director Denis Wall in Edmonton, Alberta (613/562-0515; fax 613/562-0533; deniswall@cyberus.ca).

Oden to Undertake Beringia Expedition in 2005

The Swedish Polar Research Secretariat is organizing a research expedition to the Beringia region in the summer of 2005 on the icebreaker *Oden.* The scientific focus and logistical framework for the expedition are based on interests expressed by the Swedish research community and by scientists and representatives of research organizations in Russia and the U.S. An international workshop for the design of the Beringia 2005 expedition was held in Stockholm in November 2002.

A continuation and expansion of the Swedish Tundra Ecology Expeditions in 1994 and 1999 to northern Russia and the Canadian Arctic, the 2005 expedition will focus on Beringia, including the Chukotka Peninsula, Kamchatka, and Alaska, with both terrestrial and marine research. Beringia 2005 terrestrial research activities will focus on causal processes of Beringian biocomplexity, including:

- biodiversity—patterns and evolution,
- ecosystem trophic interactions,
- migration,
- biogeography—past and present, and
- human dimensions.

Marine research will investigate the role of the Arctic Ocean in the climate system, including:

- water mass variability and circulation patterns,
- atmosphere-ocean interactions,
- geology and geophysics of the Arctic Ocean,
- biogeochemical cycles, and
- land-shelf-basin interactions.

A call for proposals has been distributed among the scientific community in Sweden, and the Swedish Polar Research Secretariat will select from Swedish candidate projects in spring 2003. The secretariat

- expects to give space on the expedition to a diverse group of researchers, including ecologists, geologists, and cultural researchers,
- seeks to make this an international venture and to develop collaborative arrangements with arctic organizations operating in this region, and
- encourages interested scientists to communicate with Swedish colleagues and to approach their own organizations toward establishing direct relations with the secretariat to work out joint agreements.

Preliminary Route and Time Frames

Leg 1, from the beginning of June through mid July, will include marine research during the transit from Scandinavia along the northern sea route to the Pevek/Chukotka Peninsula, but little or no station time.

During leg 2, from mid July to mid August, scientists will do terrestrial research during two- to three-day visits at selected sites along the north slope of the Chukotka Peninsula, including Wrangel Island and the north slope of Alaska, possibly including St. Lawrence Island. Marine research from the ship may be possible in the area.

From the beginning of July to mid August, the ship will be at selected sites on the east coasts of Kamchatka and the Chukotka Peninsula, including islands in the area. There will be short visits at sites ashore from the vessel or by air transport from Petropavlovsk and Anadyr. During July and August there will also be semipermanent camps in western Alaska and on the Chukotka Peninsula.

Leg 3 of the cruise will include marine research along a transect from northern Alaska over the polar basin to Scandinavia from mid August to the end of September.

For more information, see http://www.polar.se/english/expeditions/beringia2005, or contact scientific coordinator Magnus Tannerfeldt at the Swedish Polar Research Secretariat (magnus.tannerfeldt@polar.se).

IASC Fosters International Opportunities

Founded in 1990, the International Arctic Science Committee (IASC; see *Witness* Winter 2000/2001) is a non-governmental organization whose aim is to encourage and facilitate cooperation among all countries engaged in arctic research. Eighteen countries are presently represented on the IASC Council.

The members of the IASC Council are national science organizations involved in all fields of arctic research; each member organization has a representative on the Council. In the U.S., the Polar Research Board (PRB; see page 23) is the member organization and principal contact point between U.S. scientists and IASC. The present U.S. representative to the IASC Council is Patrick Webber of Michigan State University (see *Witness* Spring/Autumn 1999), who was recently elected president of IASC.

In addition to the Council, IASC has a Regional Board comprised of government representatives from the eight arctic countries. The U.S. representative is Karl Erb, director of the NSF Office of Polar Programs. The current chair of the Regional Board is Niels Einarsson, director of the Stefansson Arctic Institute in Akureyri, Iceland.

IASC has a modest operating budget from annual member contributions to meet common expenses; this general fund is used to encourage international science research planning and activities concerned with urgent arctic and global science issues. The Norwegian government funds the IASC Secretariat, which is located in Oslo. The executive secretary, Odd Rogne, has managed the Secretariat since the establishment of IASC.

The main activity of IASC is to develop arctic research projects for which circumarctic or international cooperation is required. IASC gives priority to multidisciplinary projects and draws on its Council to identify scientific priorities and to select from among competing proposals. IASC projects tap contributions from multiple funding agencies in member countries.

Current IASC Projects

The IASC Project Catalogue, an annual summary available on the IASC web site, provides information on the objectives, planning, funding, and achievements of current IASC projects, which include:

- Arctic Coastal Dynamics (see *Witness* Winter 2000/2001),
- Arctic Climate Impact Assessment (ACIA; see *Witness* Winter 2000/2001),
- Feedbacks of Climate Change on Arctic Terrestrial Ecology,
- Human Role in Caribou/Reindeer Grazing Systems,
- Contaminants and Human Health in the Arctic,
- Land-Ocean Interactions in the Russian Arctic,
- Map of Arctic Sediment Thickness,
- Mass Balance of Arctic Glaciers and Ice Sheets,
- Nutrition and Health of the Northern Indigenous Peoples,
- Sustainable Use of Living Marine Resources in the Arctic, and
- Tundra-Taiga Interface.

Arctic Science Summit Week (ASSW)

IASC is a major participant in the planning of the annual Arctic Science Summit Week (ASSW; see *Witness* Autumn 2001). ASSW is organized around the business meetings of

- IASC,
- the Arctic Ocean Sciences Board (AOSB),
- European Polar Board (EPB), and
- the Forum of Arctic Research Operators (FARO; see *Witness* Spring/Autumn 1999).

ASSW draws other arctic science groups as well. Almost 200 people attended ASSW 2002, held in Groningen, the Netherlands. In addition to the group meetings, ASSW 2002 included two day-long plenary sessions: Project Day and Science Day, with the theme of "Interactions Between the Arctic and the Temperate Zones."

In addition to the formal meetings and programs, the ASSW allows ample opportunities to exchange information, establish contacts, and participate in informal discussions. ASSW 2003 will be held in Kiruna, Sweden, from 31 March to 4 April. The theme of the Science Day will be "Space and Polar Research." Details of the program are available at http://www.polar.se/assw.

Travel Support to Younger Scientists

The IASC Council supports modest travel grants for younger scientists to enable them to participate in IASC projects. This opportunity is available to investigators under 40 years of age working on key scientific issues relevant to an IASC project. Candidates should identify an appropriate project and contact the project leader or IASC Secretariat, briefly summarizing their scientific background and how their work could contribute to the IASC project. The project leader, in consultation with project group members, evaluates the proposals.

Other Activities

IASC is the principal science advisor to the Arctic Council (see page 24). IASC also advises investigators and groups regarding funding opportunities and proposal preparation.

An IASC Group of Funding Specialists published a report on funding strategies and sources for arctic research in 1996. This group is now discussing the possibility of a special funding web site, which is likely to become available towards the end of 2003.

On occasion IASC convenes major conferences to plan future directions for arctic science. IASC anticipates that its next large conference will be held in 2005, following the 2004 publication of the ACIA reports (see page 24 and *Witness* Spring 2000).

IASC also publishes a quarterly newsletter "Progress," available both in print and online, that documents developments in IASC and international arctic science. "Progress" includes a selection of Survey of Arctic Meetings (SAM), a comprehensive listing of forthcoming arctic meetings. A full SAM listing is available on the IASC web site, http://www.iasc.no. Groups can have their meetings included in SAM by contacting the IASC Secretariat.

For more information, see the IASC web site (http://www.iasc.no), or contact IASC President Patrick Webber in East Lansing, Michigan (517/355-1284; fax 517/432-2150; webber@msu.edu) or Executive Secretary Odd Rogne in Oslo, Norway (+47/2295 9900; fax +47/2295 9901; iasc@iasc.no).

International Project Excavates Icelandic Settlements

The North Atlantic Biocultural Organization (NABO) is an international, interdisciplinary research cooperative set up a decade ago through a grant from the NSF Arctic Social Sciences Program (see page 20 and *Witness* Autumn 1998). Among other projects, NABO has promoted collaboration among Icelandic, U.K., Norwegian, Polish, U.S., and Canadian scholars under the direction of the Archaeological Institute Iceland (FSÍ) since 1996. The NABO/FSÍ long-term investigation "Landscapes of Settlement in Northern Iceland" is supported by grants from the NSF Archaeology Program, OPP, and the Icelandic Research Council (RANNÍS). The Landscapes of Settlement project uses an interdisciplinary combination of historical documents, geoarchaeology, zooarchaeology, and archaeobotany to reveal the complex interactions among human management, natural environmental variability, climate change, and evolving local and regional economy in the creation of the modern landscape of northern Iceland.

Initially focused on excavations of the chieftain's great hall at Hofstaðir near lake Mývatn, the project has expanded into a broader investigation of the formation of a cultural landscape from previously uninhabited wilderness. In part because the Hofstaðir great hall is about four times the size of the average Viking-age long hall, it has long been (controversially) claimed as a pagan temple site. Excavations have confirmed that the site was definitely a working farm with extensive animal husbandry and iron working.

Surveys have located a dozen other sites in the region, which can be tied together by a new regional tephrochronology. The sites of Sveigakot and Hrísheimar in the highland zone south of Mývatn were founded shortly after the deposition of tephra that dates to AD 871+/-2 (through correlation with the GISP2 ice cores; see *Witness* Spring 1998). By AD 950, the sites were prosperous middle-sized farms, with substantial numbers of cattle and pigs as well as sheep and goat bones in their middens. Root casts and abundant charcoal indicate that this now treeless and heavily eroded inland zone was largely covered with dwarf birch forest. Pollen records show that up to 90% of the original Icelandic forest was cleared before AD 1000. Around the same time the number of animal bones declined at these interior farms, indicating that the inhabitants struggled before abandoning the farms around AD 1100—probably victims of their own success in land clearance. Soil profiles dated by multiple tephra reveal that this inland zone was highly unstable for centuries prior to human occupation. The period of Norse settlement of Iceland (the Landnám, from around AD 870–930) may have followed a brief period of unusual landscape stabilization, which was soon disrupted by the grazing impact of the imported European domestic stock.

Other interactions of humans and natural resources seem to have had happier outcomes. Modern Mývatn residents have sustained a harvest of 10,000 waterfowl eggs per year for at least a century by regulating the number of eggs taken from each nest and rarely killing adult birds. The zooarchaeological evidence of egg shells but few bird bones suggests that this traditional resource management has roots extending back over a millennium.

The Landscapes of Settlement project has tested several new interdisciplinary approaches, including using:

- lipid residues to identify animal dung,
- soil thin sections to localize traffic patterns on dirt floors,
- scanning electron microscopic imagery of wear on sheep teeth to indicate changing amounts of grit in fodder,
- DNA studies to track origins of Viking livestock.

Perhaps the project's most successful spin-off has been in education. The NABO field school associated with the Landscapes of Settlement project has attracted graduate students from 23 nations, providing one-to-one staff-to-student ratios and an intensive program of lectures, student projects, field trips, and hands-on lab modules as well as experience in excavation and survey. Part of the international University of the Arctic (see page 28), the program is an academic collaboration of

- the City University of New York (CUNY) Northern Science and Education Center,
- the University of Oslo's Viking and Medieval Studies Center, and
- FSÍ.

Since 2000, an innovative OPP Research Experience for Undergraduates (REU) program has involved inner-city CUNY students in a combination of two semesters of class and lab experience, supervised individual projects, and Icelandic summer fieldwork. This program has already attracted several students to northern doctoral programs and energized interest in northern science on the CUNY campus. The Landscapes of Settlement project is also supported by the Professional Staff Congress-CUNY grants program, National Geographic Society, and the U.K. Leverhulme Trust.

For more information, see the NABO web site (http://www.geo.ed.ac.uk/nabo/) or contact Tom McGovern (212/772-5410; fax 212/772-5423; nabo@voicenet.com) or Sophia Perdikaris (718/951-4192; fax 718/951-3169; sophiap@brooklyn.cuny.edu), both at CUNY.

The great hall at Hofstaðir seen from the north. Turf walls provided insulation for what was probably a largely timber construction. Modern farm buildings in the background are near the later Christian chapel and churchyard. Photo by Tom McGovern.

Graduate Students Analyze Regional Impacts in the North

Recognizing the need to train young scientists in interdisciplinary global change research, the European Commission, under its Fifth Framework Programme, funded an Advanced Study Course from 21 July–3 August 2002, as part of the University of the Arctic Field School Program (see box). Thirty graduate students from 12 European countries and 26 eminent scientists from around the world participated in Integrated Regional Impact Studies in the European North: Basic Issues, Methodologies and Regional Climate Modelling (IRISEN-II) at Abisko Research Station in northern Sweden. Twenty-five students from 13 countries participated in the first IRISEN course offered at Abisko in 1999.

The 2002 course addressed the issue of regional climate change and its impacts on the one hand and the methodologies for regional climate modeling and integrated climate impact studies on the other, with the following objectives:

- to explain major regional climate change impacts on natural and societal systems in the European North,
- to discuss methods to identify and assess climate change impacts for natural-resource-dependent sectors and for residents and stakeholders in the region,
- to discuss possible responses,
- to clarify the interconnections and feedbacks of natural and societal systems to climate change and to demonstrate the need for interdisciplinary research in order to tackle these issues, and
- to stimulate multidisciplinary studies during the course to motivate participants to pursue interdisciplinary research.

While largely built on classroom teaching, the course included a number of field trips. The group work encouraged interdisciplinary discussions and cross-cultural exchange between students. Groups of participants from different scientific backgrounds were asked to prepare an integrated regional impact assessment and to design adaptation and mitigation strategies for a specific northern European region affected by climate change. Papers from these presentations and the lecturers' contributions will be published as course proceedings.

The feedback received from the students was overwhelmingly positive. Being exposed to a variety of disciplines and research fields as well as participants from a wide spectrum of backgrounds was an important factor in the success of IRISEN-II. The course clearly demonstrated the usefulness of interdisciplinary cooperation in integrated regional impact studies as well as the need to involve stakeholders in all phases of the research. As one of the students said: "IRISEN opened my eyes to the fact that global change research needs interdisciplinarity and requires close attention to the interests of the people being subjected to climate change."

Although both students and lecturers recommend that there be more courses like IRISEN-II, this will depend on appropriate funding. Depending on the funding source, it may be possible for U.S. students to participate in future courses.

For more information, see IRISEN-II web site (http://www.uni-muenster.de/Umweltforschung/irisen/index.html), or contact Manfred Lange (+49/251-833-3591; fax +49/251-833-6100; langema@uni-muenster.de) or Dörte Poszig (+49/251-833-8465; fax +49/251-833-8464; poszig@uni-muenster.de) in Münster, Germany.

University of the Arctic Unites Field Courses

The University of the Arctic, a cooperating network of universities, colleges, and other organizations concerned with higher education and research, celebrated its official launch in 2001 (see *Witness* Autumn 2001 and Spring/Autumn 1999). Members share resources, facilities, and expertise to develop postsecondary educational opportunities that are relevant and accessible to northern students. These include formal courses or degree programs, such as the bachelor of circumpolar studies, which provide education on northern issues. These formal courses and programs are complemented by more informal courses focusing on specific themes or subjects, which frequently include fieldwork. The field courses affiliated with the University of the Arctic are organized under the umbrella of a UArctic Field School.

To promote cooperation between courses and foster circumpolar exchange, the UArctic Field School provides an organizational hub for individual field courses, including streamlining application procedures, engaging in cooperative activities, developing common funding approaches, providing assistance in identifying students, and creating broader student networking between courses.

Most of the field courses existed independently before becoming affiliated with UArctic. These include Integrated Regional Impact Studies in the European North (IRISEN-II; see article this page), the North Atlantic Biocultural Organization International Field School (NABO; see page 27), the Circumpolar Arctic Social Sciences (CASS) and Circumpolar Arctic Environmental Studies (CAES) PhD networks (see *Witness* Autumn 2001), and GlacioEuroLab.

Additional UArctic field courses are under development. The Field School is committed to community involvement in its courses to improve access to higher education for northern residents, especially indigenous youth.

The Field School plans to publish an online and print a field school catalogue to broaden the exposure of the courses, providing relevant information on each field course. Other northern field courses that have not previously been affiliated with UArctic may be included in the catalogue, provided they are also open to students at UArctic member institutions.

For more information, see the UArctic web site (http://www.uarctic.org/fieldschool), or contact the UArctic Circumpolar Coordination Office in Rovaniemi, Finland (+358/16 341-2716; fax +358/16 341-2777; cco@uarctic.org).

Five Teachers Set to Experience the Arctic

The NSF Teachers Experiencing Antarctica and the Arctic (TEA) Program began in 1992; the program's centerpiece is a research experience in which a K–12 teacher participates in a NSF-sponsored polar research expedition. Working closely with scientists on cutting-edge research, the TEA teacher is immersed in the process of science. Enveloping this field experience is a diversity of professional development opportunities through which TEA teachers increase content knowledge, enhance teaching skills, transfer the research experience to the classroom, assume leadership roles, and collaborate with a network of researchers and education colleagues.

A partnership between teachers, researchers, students, school districts, and communities, TEA is sponsored by the NSF Division of Elementary, Secondary, and Informal Education in the Directorate of Education and Human Resources and the Office of Polar Programs and facilitated by Rice University, the Cold Regions Research and Engineering Laboratory, and the American Museum of Natural History.

Five teachers have been selected to work with arctic research projects in the 2003–04 academic year:

Dora Nelson of Carolina Day School in Asheville, North Carolina, will work with Judy Curry of the Georgia Institute of Technology, using a robotic Aerosonde airplane for remote sensing of environmental/weather factors to study the human dimensions of climate change in the Arctic.

Jim Rogers of Polson High School in Polson, Montana, will work with Jim Swift of Scripps Institution of Oceanography. Rogers will assist with service measurements in support of the Shelf-Basin Interactions (SBI) Phase II program (see page 1).

David Brown of St. Peter School in Quincy, Illinois, will work with Lee Cooper of the University of Tennessee at the Bering Strait Environmental Observatory on Little Diomede Island, Alaska. Brown will

- help collect data on water flowing north into the Arctic Ocean,
- interact with the teachers and students at the Diomede School, and
- join the project's annual sampling trip on the Canadian Coast Guard Service ship *Sir Wilfrid Laurier.*

Amie Foster of Simmons Middle School in Aurora, Illinois, will work with Lisa Clough of East Carolina University on an interdisciplinary study combining scientific ecological knowledge and the traditional ecological knowledge of the Inupiat people to develop an ecological profile of Kotzebue Sound, Alaska.

Lars Long of DeLong Middle School in Eau Claire, Wisconsin, will work with Joe McConnell of the Desert Research Institute in May to collect two ~150 m ice cores in regions of high snow accumulation in west-central Greenland, the highest resolution, multicentury glaciochemical records ever developed for Greenland.

For more information, see the TEA web site (http://tea.rice.edu) or contact Deb Meese at Cold Regions Research and Engineering Laboratory (603/646-4594; fax 603/646-4644; dmeese@crrel.usace.army.mil).

Visiting Speakers Share Knowledge Across the Arctic

Now in its third year, the Arctic Visiting Speakers' Series is designed to increase communication and collaboration among the dispersed arctic research community, nurture better understanding and communication between arctic researchers and arctic community residents, and improve the general public's understanding of the importance of arctic research.

Funded by the NSF Office of Polar Programs Arctic Sciences Section, the program sponsors distinguished scholars and experts on the Arctic to visit academic institutions and community organizations for seminars, lectures, and discussions. The program covers travel costs and a modest honorarium for the visiting speaker. Speakers may travel within the U.S. or between the U.S. and other countries.

Between April 2002 and February 2003, seven presenters addressed a variety of audiences at graduate and undergraduate university seminars, in K–12 schools, and the public. Speakers have covered topics including anthropology, geology, arctic marine law, linguistics, oral history, geography, and reindeer herding.

In October 2002, Leonid Baskin, a reindeer herder, biologist, and senior scientist for the Institute of Ecology and Evolution at the Russian Academy of Sciences, visited Anchorage, Fairbanks, Nome, and Kotzebue, hosted by the State of Alaska Department of Fish and Game (ADF&G). His visit made the 24 October 2002 headlines of *The Arctic Sounder:* "Reindeer Expert Visits Kotzebue." Baskin addressed the Kawerak Reindeer Herders Association in Nome and public radio listeners in both Nome and Kotzebue. For Baskin, the trip was an opportunity to learn about reindeer herding and tracking techniques used on the Seward Peninsula. He also shared his knowledge about both domestic and wild reindeer herds in Russia with ADF&G biologists, University of Alaska students and researchers, and the general public.

In May 2002, Kathleen Osgood Dana of the Center for Northern Studies in Wolcott, Vermont, travelled to Sakha State University in Yakutsk, Siberia, to present her doctoral research about circumpolar Native literature. The majority of students at the university are indigenous—Sakha (earlier, Yakut), Even, Evenk, and Dolgan.

She was able to deliver a series of five lectures emphasizing Native American literature curricula and an in-depth exploration of Sámi (earlier, Lapp) poet and artist Nils-Aslak Valkeapää. The University of Washington Press also contributed a number of contemporary northern Native titles to the Sakha State University. Since her visit, the university is revamping their literature programs and working on a curriculum that will emphasize Siberian and other northern, Native contemporary literatures.

For more information about the series, see http://www.arcus.org/arctic_speaker/ or contact ARCUS Project Manager Janet Warburton (907/474-1600; fax 907/474-1604; janet@arcus.org).

Barrow Students Focus on Endangered Wildlife

Eider Journey is a comprehensive education and stewardship program addressing issues of conservation and management of wildlife populations. Based around the threatened North American breeding population of Steller's eiders *(Polysticta stelleri),* Eider Journey builds upon an existing collaboration among two entities of the U.S. Fish and Wildlife Service (USFWS)—Fairbanks Fish and Wildlife Office and Izembek National Wildlife Refuge, the Alaska North Slope Borough Department of Wildlife Management, the Alaska North Slope Borough School District, the Barrow Arctic Science Consortium (BASC), the NSF Office of Polar Programs, and ARCUS.

The North American population of Steller's eiders has been listed as a threatened species under the Endangered Species Act of 1973. The only known regularly occupied nesting area of Steller's eiders in North America is near Barrow, the largest rural community in northern Alaska. The community of Barrow is currently expanding into eider nesting areas, raising issues of human intrusion into preferred habitat.

Each fall, the Steller's eiders migrate from Barrow southwest to the Alaska Peninsula. Izembek Lagoon, about 40 miles from the western end of the Alaska Peninsula, is an important site for molting and wintering Steller's eiders. The lagoon contains one of the largest eelgrass beds in the world, providing habitat for the small invertebrates eaten by the eiders. In Izembek Lagoon, the concern is to protect the shallow and biologically productive waters from oil spills and other pollution from vessels traveling through the Bering Sea.

To help North Slope communities become more aware of the species' status and develop a protective attitude toward the local eider population, Eider Journey highlights the significance of the species through local partnerships and an education program that reflects local needs and community issues. Eider Journey exposes students to research that addresses issues of conservation and management of wildlife populations. The multifaceted and developing project has four long-term goals:

- inform the public about Steller's eiders and involve communities in the decision-making processes related to eider conservation issues;
- provide first-hand experience in the field research that informs agency management decisions;
- promote sciences, particularly wildlife sciences, as a career; and
- provide quality resources and information for educators and their students.

2002 Activities

Each year since 1999, a USFWS research team has surveyed the eider pairs breeding in the Barrow area. In June 2002, four Barrow high school students helped USFWS in the survey, covering approximately 180 square kilometers in and around the village of Barrow. Students were assigned to three- or four-person teams, responsible for searching a different area each day. Teams searched large areas on foot, recording and mapping all occurrences of Steller's or spectacled eiders, as well as predators such as gulls, jaegers, and foxes. Students learned to identify birds, orient and map using aerial photos, and classify habitat. The annual pair surveys provide data about the dramatic year-to-year changes in Steller's eider breeding and information on distribution of Steller's eiders in the Barrow area.

In September 2002, a USFWS biologist, a Barrow science teacher, and the high school students traveled to Izembek National Wildlife Refuge. During the field trip, students worked with Peter McRoy of the Institute of Marine Science, University of Alaska Fairbanks, to learn about Izembek Lagoon's eelgrass beds and their importance to eiders. The group collected and processed eelgrass samples and participated in banding eiders. Later, McRoy and USFWS staff traveled to Barrow to work with the students and help them summarize the data and prepare presentations to classes and the general public about what they had learned about eiders.

To complement the students' experience, ARCUS is developing an Eider Journey education guide focused on Steller's eiders and the Izembek Lagoon eelgrass ecosystem. It provides both information and activities that incorporate the concepts of endangered and threatened species, stewardship, and ecological principles. The guide can be used in conjunction with field trips or as part of a regular classroom study.

Future Plans

Pending funding, ARCUS and USFWS plan to continue the program in 2003. In future years, the program may bring students from the Alaska Peninsula to participate in fieldwork in Barrow. An Eider Journey web page is under construction.

For more information, contact ARCUS Project Manager Janet Warburton (907/474-1600; fax 907/474-1604; janet@arcus.org) or U.S. Fish and Wildlife Service Biologist Philip Martin (907/456-0325; fax 907/456-0208; philip_martin@fws.gov), both in Fairbanks, AK.

Left: Barrow High School students Lillian Maupin, Elijah Arey, and Andrew Bounyavong and science teacher Tim Buckley prepare the holding pot for the banding drive by putting eelgrass around the edges to hold the net down and prevent birds from being tangled or escaping.

Right: Barrow High School students Lillian Maupin, Elijah Arey, Andrew Bounyavong, Clyde Hugo, and Joanna Leavitt, and science teacher Tim Buckley work with Peter McRoy to process the eelgrass that they collected earlier in the day. Photos by Neesha Wendling.

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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 the Alaska Federation of Natives, by the National Fish and Wildlife Foundation, and by membership dues.

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

Calendar

April 7–11 International Ice Charting Working Group Fourth Meeting (IICWG-IV). Arctic and Antarctic Research Institute (AARI), St. Petersburg, Russia. For more information on the IICWG-IV, see http://www.aari.nw.ru/projects/iicwg_iv/. Information on the International Ice Charting Working Group is available at http://nsidc.org/noaa/iicwg.

April 7–11 European Geophysical Society (EGS), American Geophysical Union (AGU), and the European Union of Geoscience (EUG) Joint Assembly. Nice, France. For more information, see http://www.copernicus.org/egsagueug/ or contact EGS Office (+49/5556-1440; fax +49/5556-4709; egs.abstracts@copernicus.org, egs.registration@copernicus.org, egs.membership@copernicus.org, or egs@copernicus.org).

April 28–30 ARCUS 15th Annual Meeting and Arctic Forum. Washington, DC. For more information, see http://www.arcus.org or contact ARCUS in Fairbanks, AK (907/474-1600; fax 907/474-1604).

May 5–8 Second Annual Carbon Sequestration Conference. Washington, DC. For more information, see http://www.carbonsq.com.

May 11–14 Cold Adaptations of Aquatic Microorganisms Workshop. Max Planck Institute for Marine Microbiology, Bremen, Germany. For more information, see http://www.mpi-bremen.de (under "Seminars and Workshops").

May 12–16 Seventh Conference on Polar Meteorology and Oceanography and Joint Symposium on High-Latitude Climate Variations. Hyannis, Massachusetts. For more information, see the AMS website (http://www.ametsoc.org/AMS) (under "AMS Upcoming Meetings").

May 19–21 Earth Cryosphere as a Habitat and an Object for Nature Management. Pushchino, Russia. For more information contact David Gilichinsky, Institute of Physico-Chemical and Biological Problems in Soil Science, Russian Academy of Sciences (+0967-732604; fax: +0967-790595; gilichin@issp.serpukhov.su).

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

Publications

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Koivurova, Timo. 2002. *Environmental Impact Assessment in the Arctic: A Study of International Legal Norms.* Ashgate Publishing; http://www.ashgate.com. ISBN 0-7546-2283-5; 450 pp.; $99.95 U.S.

Lee, Molly, and Gregory A. Reinhardt. 2003. *Eskimo Architecture: Dwelling and Structure in the Early Historic Period.* University of Alaska Press, P.O. Box 756240, Fairbanks, AK; ISBN 1-889963-22-4; $45 U.S.

Lehtola, Veli-Pekka (Translated by Linna Weber Müller-Wille). 2002. *The Sámi People: Traditions in Transition.* With a preface by Ludger Müller-Wille. Kustannus-Puntsi Publishers, Aanaar/Inari, Sápmi, Finland. http://www.puntsi.fi/sami.htm. ISBN 952-5343-11-1.

Sejersen, Frank. 2002. *Local Knowledge, Sustainability and Visionscapes in Greenland.* ISBN: 87-87874-20-4/ISSN: 1601-9385. Department of Eskimology fax +45/3532-9661, http://www.hum.ku.dk/eskimo/english/; eskimologi@hum.ku.dk.

A Note From the ARCUS President

In my note in the previous edition of *Witness the Arctic,* I described some of the challenges faced by Alaska Native villages and government agencies in trying to control erosion, and how arctic system research might contribute to that effort. In this column, I would like to explore a related question: do arctic system scientists and agency personnel have overlapping interests, and if so, how can they collaborate?

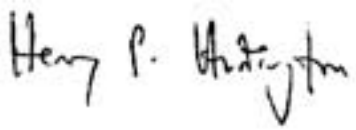
Arctic system science addresses all aspects of the northern environment, particularly the interactions among the different natural and human components that determine how the system functions and how its influence is felt. From wildlife management to construction permits, various government agencies regulate, monitor, and otherwise work on many of the same connections that system scientists study. In some respects, the agency-scientist connection seems obvious, and some partnerships have been established. Overall, however, the links are weak or nonexistent.

A variety of factors are at work. First, there are mismatches in time frame and expectations. System scientists typically take a long-term view, whereas agencies usually need to respond in the short term. System scientists are used to uncertainty, whereas agencies and their constituents may be less willing to act when the need to do so is unclear.

Second, there is often a perceived cultural divide between "basic" research done in academia and the "applied" work done in government agencies. I suspect this difference is largely superficial: both sides have similar interests but little real appreciation for what the other group actually does.

Third, there are few incentives for overcoming these two barriers. Both scientists and agency personnel rarely have the time or funding to make connections and explore collaborative opportunities. Where interactions do occur, they are all too often at the tail end of a project, amounting to little more than sharing of information instead of real collaboration.

And yet, I think we are all missing something in not putting more effort in this direction. System science has made great strides in understanding the interactions that comprise the arctic system and in exploring the implications of those interactions and the changes they are undergoing. Agency personnel have a great deal of practical experience with the environment itself and with the people who live in and use it. Both sides stand to gain from creating real partnerships built on their complementary and mutually useful perspectives.



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