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IPY History Reflects Progress in Science and Society

The upcoming International Polar Year (IPY) 2007–2008 is the fourth time scientists have planned a coordinated international campaign to advance understanding of the polar regions and their interactions with the global system. The histories of the three previous polar years show the development of science and technology over the past 125 years. Science, once the occupation of only a few educated individuals, is now a large-scale endeavor involving professional societies, international initiatives, and government agencies. Modern communications and transportation now allow investigators to control instruments and collect observations remotely; members of the first IPY expeditions spent more time on their own survival than gathering data. Above all, these histories show science as a human endeavor set in a specfic social and economic context, whose success depends on the behavior of the individuals and groups involved in its planning and implementation. Our current understanding of the Earth's poles, awareness of their unique features, and appreciation for their global importance has been made possible by the cumulative effort of generations of explorers and investigators.

First IPY: 1882–1883

Karl Weyprecht (1838–1881), who is credited with the idea for the first IPY, was a naval officer who led the Austro-Hungarian North Pole Expedition of 1872–1874. The expedition was considered a success: the crew spent two winters in the pack ice of the Barents Sea, discovered and explored Franz Josef Land, collected thousands of meteorological, oceanographic, and biological observations, and reached 82°N. Weyprecht, however, realized that their results, and those of similar exploratory expeditions, were of limited scientific use:


Illustrirtes Wiener
Extrablatt.
Die Führer der Nordpol-Expedition.

The cover page of the Illustriertes Wiener Extrablatt (Viennese Illustrated Special Edition) *for 25 September 1874 heralding the triumphant return of the leaders of the Austro-Hungarian North Pole Expedition, Julius Payer (left) and Karl Weyprecht (right). Weyprecht was formulating his ideas for coordinated polar research expeditions at this time.*

> The key to many secrets of Nature... (I need only refer to magnetism and electricity, the greatest problems of meterology) is certainly to be sought for near the Poles. But as long as Polar Expeditions are looked upon merely as a sort of international steeplechase, which is primarily to confer honour upon this flag or the other, and their main object is to exceed by a few miles the latitude reached by a predecessor, these mysteries will remain unsolved…Decisive scientific results can only be attained through a series of synchronous expeditions, whose task it would be to distribute themselves over the Arctic regions and to obtain one year's series of observations made according to the same method.

Frustrated with the inadequate scientific yield of past expeditions, Weyprecht became an advocate for systematic exploration of polar regions through international collaboration. His efforts coincided with the substantial economic benefits from the previous century of rapid progress in science and engineering and the associated Industrial Revolution. Important advances in science during this period included:

- increased acceptance of Darwin's 1859 theory of evolution by natural selection;
- improved understanding of physics, culminating in James Clerk Maxwell's 1864 equations describing the behavior of electric and magnetic fields;
- inventions such as the telegraph (1844), telephone (1876), and electric light (1879).

These advances were accompanied by growth in international scientific organizations, as scientists realized that they needed to share their results and pursue their interests collectively. In 1873, for example, the weather services of several nations formed the International Meteorological Organization (IMO), which later became the World Meteorological Organization (WMO). Between 1875 and 1879, Weyprecht addressed several scientific societies, including the IMO, on "Fundamental Principles of Arctic Research," urging them to establish observatories at a minimum of eight locations in the Arctic to gather simultaneous meteorological and magnetic measurements for at least one year.

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Recognizing the importance of Weyprecht's proposal, the IMO endorsed his plan at its second congress in 1879; at the urging of Georg Neumayer, director of the Deutsche Seewarte (German Naval Observatory), they also discussed including observations from high southern latitudes. Later that year, the first International Polar Conference met in Hamburg to plan a campaign that included work in both polar regions and to establish a new International Polar Commission to oversee it. The U.S. joined the group at its third meeting in 1881.

The first IPY began in August 1882 and continued to September 1883, with 12 nations participating in 15 coordinated expeditions to the Arctic and Antarctic. Each expedition was led by a single nation. Meteorological stations and naval and merchant ships also recorded geomagnetic observations on predetermined dates of each month, inaugurating the practice of "world days," now used by many international science programs. Funding was provided by the participating government agencies, in most cases the military, supplemented by private support. The expeditions collected data according to a handbook by Weyprecht, who died in 1881, before seeing his plan fully realized.

The U.S. Army Signal Corps, which was responsible for federal meteorological services, organized the two American expeditions: one to Barrow, Alaska, and one to Lady Franklin Bay on northeastern Ellesmere Island. With the help of the local Iñupiat population, the Barrow expedition successfully completed its scientific mission and amassed considerable information about the region and its people. The Lady Franklin Bay expedition, led by Adolphus Greely, was not so fortunate. Greely's expedition established a station and collected observations according to the IPY plan but decided to retreat south after two successive resupply ships did not arrive as expected. The party was stranded for eight months, still on Ellesmere Island, and 19 of the 25 crew members died waiting for rescue.

Although the IPY expeditions gathered their data according to Weyprecht's specifications, instead of the coordinated analysis he envisioned, each nation published its observations independently. Before dissolving in 1891, the International Polar Commission was not able to undertake a synthesis of the results but did direct that copies of all IPY publications be archived at the Central Physical Observatory in St. Petersburg, Russia. The simultaneous meteorological data from the first IPY were only recently collated and analysed to form the synoptic view Weyprecht originally sought (Wood and Overland 2006). This analysis, which offers a unique glimpse into the circumpolar environment before the current era of climate warming. clearly shows the influence of large-scale atmospheric circulation patterns such as the North Atlantic Oscillation on climate variability. For more information on the analysis or data, see: www.arctic.noaa.gov/aro/ipy-1/index.htm.

The first IPY ended with many successful expeditions having amassed considerable data, but its scientific value suffered from a disjointed publication effort and lack of institutional commitment. Both lessons would be remembered 50 years later.

Second IPY: 1932–1933

The second IPY also originated with the efforts of an individual whose arctic research activities convinced him of the need for international collaboration. While conducting high-altitude weather balloon observations in northern Iceland in 1926–1927, Johannes Georgi, meteorologist of the Deutsche Seewarte, detected extremely strong winds at a height of 10 to 15 km. Others had observed these stratospheric westerly winds, which seemed to be independent of surface pressure conditions, around the same time. In Japan, Wasaburo Ooishi had noted the same phenomenon while monitoring weather balloons near Mount Fuji, and aviator Wiley Post reported a "strong river of air" encountered during a high-altitude flight across Siberia.

At a 1927 meeting of the Deutsche Seewarte, Georgi called for a pan-arctic study of this phenomenon, known today as the jet stream, proposing a coordinated, international research effort to study this and other subjects that would commence on the 50th anniversary of the first IPY. In 1929, the IMO endorsed the effort and formed a commission to undertake planning for a second IPY.

The time was ripe for a revival of Weyprecht's vision. Public interest in the polar regions had been maintained by the thrilling stories of Americans Robert Peary and Matthew Henson reaching the North Pole in 1909 and Norwegian Roald Amundsen besting Robert Scott of Britain in the race for the South Pole in 1911. Einstein's work had revolutionized physics. The mechanized warfare used during World War I convinced governments that scientific research had military value. The war also ended the old imperial world order (two of the first four nations to commit to the first IPY—the Austro-Hungarian and Russian Empires—no longer existed), and post-war governments sought internationalist opportunities such as the League of Nations to improve relations and prevent future conflicts. The internal combustion engine, used in the automobile, airplane, and motorized sea transport, enabled people and goods to move on a heretofore unknown scale, while radio made communication possible over vast distances. Mysterious disruptions in radio transmissions, as well as in electric and telephone lines, indicated that studies of the newly described ionosphere were needed.

In forming the Commission for the Polar Year, the IMO wrote that:

> magnetic, auroral and meteorological observations, to be undertaken at a network of stations in the Arctic and Antarctic…for one whole year, would materially advance the knowledge and understanding…not only within the polar regions, but in general…and…have practical application in…terrestrial magnetism, marine and air navigation, wireless telegraphy and weather forecasting.

When the second IPY officially began in August 1932, a total of 44 countries were participating, 16 of which had formed their own special committees and 22 of which organized expeditions or established stations beyond their own borders. This level of participation, however, had been scaled back from the original IPY proposal due to the severe worldwide economic depression that began in 1929. In 1931, as it became clear many countries would be unable to provide funds promised for the IPY effort, the Commission for the Polar Year debated whether to postpone the entire enterprise indefinitely. Believing, however, that a postponement would irrevocably stall momentum for IPY and that the already secured participation would

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advance many scientific fields, the commissioners voted unanimously to proceed. Scientific associations and philanthropic organizations subsequently provided some funding; six months before the start of IPY, for example, the Rockefeller Foundation contributed $40,000 to purchase equipment for magnetic and electrical measurements and provided later grants to support data analysis and publication.

The main research areas of the second IPY included meteorology, the aurora and its relationship to terrestrial magnetism, and atmospheric science, particularly studies of the ionosphere. The number of magnetic stations north of 60° increased from 7 to 30. A total of 94 research stations were maintained in the Arctic during the second IPY, 40 of which remained in use following the conclusion of the program. Britain re-established its Fort Rae research station on Canada's Great Slave Lake, while the U.S. sent another team of scientists to Barrow, Alaska; both locations had been research sites in the first IPY. Congress appropriated $30,000 to fund an observatory in Fairbanks, Alaska. In Antarctica, the U.S. established the first inland station on the Ross Ice Shelf, 125 miles from the coast. Other stations established in lower latitudes included meteorological stations in equatorial Africa and magnetic observatories in India, Japan, and Peru.

From its inception, the Commission for the Polar Year emphasized coordinated collection and publication of data and results from the various IPY activities. The commission established an official repository for IPY material at the Danish Meteorological Institute in Copenhagen. Despite limited funds and the disruptions of World War II (including the loss of some meteorological records), the Copenhagen office published the *Bibliography for the Second International Polar Year* in 1951. This effort, a considerable improvement over the very limited archiving efforts of the first IPY, served as a forerunner of the World Data Centers that would be established to archive data of the 1957–1958 IGY.

The research programs of the second IPY, undertaken for both scientific and practical purposes, produced voluminous data and results, particularly in magnetism and meteorology, that improved air and marine navigation, radio operations, and weather forecasting. The second IPY ended without definitive explanations of Georgi's observations of high-altitude winds, though the pan-arctic research program he initiated set the foundation for such an understanding. In 1939, the name "jet stream" was given to the phenomenon; by the 1950s, scientists still working collaboratively under the IMO described the jet stream's origin in the atmospheric pressure and temperature differences between polar and equatorial regions. These advances in meteorology became a vital component of weather forecasting and revolutionized commercial and military air travel, again demonstrating the social, economic, and political impacts of science.

"The two younger chaps, Stuart McVeigh and John Rae, took care of most of the meteorological work, which included balloon flights and kite flights with meteorographs. They flew a series of four kites on piano wire into the cloud level, and then we all had to get together to wind them in, especially if the wind picked up…McVeigh would try to catch one of the kites with a meteorograph on it as it came down. If he could not catch it, it would crash on the rocks and he would have to repair it before he could use it again. We had a machine with a winder for incoming wire when we were pulling in the kite...A major requirement of any expedition then was fitness: you had to be prepared to do physical work most of the time, and to squeeze scientific work into about 10 per cent of the time left over." - Frank Davies

Members of the Canadian team at Chesterfield Inlet on Hudson Bay during the second IPY. Photos courtesy University of Saskatchewan Archives, Department of Physics fonds, Balfour W. Currie collection.

Third IPY: IGY 1957–1958

The beginning of the third IPY can be very precisely dated. On 5 April 1950, James Van Allen, then at the Applied Physics Lab at Johns Hopkins University, invited several American physicists to his home to meet Sydney Chapman, visiting from Oxford University. All of the guests had been deeply involved in research for military application during World War II and recognized that the technologies they had helped to develop, including rockets and radar, had significant potential to advance basic geophysical research. Lloyd Berkner of the Carnegie Institution of Washington suggested that the time was right for another IPY on the 75th and 25th anniversaries of the previous IPYs, which would fall in 1957–1958 and coincide with an expected sunspot maximum.

The International Council of Scientific Unions (ICSU) endorsed the proposal and appointed a special organizing committee headed by Chapman. By 1952, the committee had broadened the project's scope to include studies of the whole Earth and termed it the International Geophysical Year (IGY). The subjects studied during the previous IPYs—weather, the aurora, the Earth's magnetic changes, and the ionosphere—were also broadened to include investigations of cosmic radiation and detailed observations of the sun.

The organization of IGY coincided with the maturing capabilities of the institutions founded in the post-war years to advance public interest issues such as international cooperation and scientific research. IGY provided a specific focus for the efforts of organizations such as ICSU and the United Nations (UN). In the U.S., the National Science Foundation (NSF), established in 1950 to support all fields of fundamental science and engineering, led the campaign for IGY funding; between 1953 and 1958 Congress appropriated a total of $43.5 million for IGY, which was

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considerably augmented by operational and logistical support from many organizations. Additional funding for the IGY came from ICSU member institutions (mostly national academies of science), national governments, and international organizations such as the UN Educational, Scientific and Cultural Organization (UNESCO).

More than 10,000 scientists from 67 nations participated in the highly successful IGY program from July 1957 to December 1958. Highlights included:

- the Soviet Union's launch of Sputnik, the first artificial satellite, followed four months later by the first U.S. satellite;
- the beginning of the long-term record of atmospheric carbon dioxide collected at Mauna Loa, Hawaii;
- delineating the system of mid-ocean ridges and confirming the theory of plate tectonics; and
- discovery of the Van Allen radiation belts, a torus of charged particles around Earth that are trapped by the planet's magnetic field.

The IGY took advantage of the logistical capabilities developed during and after World War II to emphasize intensive research in Antarctica; 12 nations worked at 40 stations on the continent and 20 on the sub-Antarctic islands. The continent's strategic value and economic potential could easily have derailed international scientific cooperation in favor of advancing territorial claims, but in spite of Cold War tensions, the IGY effort in Antarctica was considered a success. This positive outcome led to the ratification of the Antarctic Treaty in 1961, setting aside the continent for international research.

The IGY also established the current system of World Data Centers (WDCs). Cold War considerations led both the U.S. and USSR to establish their own WDCs for each of the 14 IGY disciplines; these were identified as WDC-A and WDC-B, respectively. Other countries hosted WDCs (known as WDC-C) for specific disciplines. Since 1968, a special ICSU panel has coordinated the evolving WDC system. As of 2003, 52 WDCs are operating in Australia, China, Europe, India, Japan, Russia, and the U.S.

In addition to its scientific and political breakthroughs, IGY broke new ground in science education and outreach. The popular media provided extensive coverage of IGY activities. Specially developed materials, including films, pamphlets, and comic books were widely used in schools and had a broad impact in sparking students' interest in science.

The success of the IGY despite its daunting scale and complexity provided a model for subsequent science programs that is still widely followed today.

IPY 2007–2009

Fifty years have passed since IGY; once again the research community is organizing an international science campaign to improve understanding of the polar regions. The planning for IPY 2007-2008 has evolved in a bottom up fashion, using modern communications technologies to integrate ideas and develop a broad base of support. The ICSU and WMO appointed an IPY planning group in 2003 and an IPY joint committee in 2004 to coordinate international efforts. ICSU and WMO established the IPY International Programme Office (IPO) in 2004 at the British Antarctic Survey (BAS), with support from the UK Natural Environment Research Council. Investigators from 63 nations have submitted more than 1,100 expressions of intent to participate in IPY to the IPO since November 2004. Funding for IPY activities is expected to come from international organizations and through national science funding mechanisms.

U.S. Efforts

NSF is designated as the lead U.S. agency for the IPY. A series of congressional hearings in 2006 explored plans for U.S. contributions to the campaign. The NSF budget requested $62 million for IPY in FY 2007 and $59 million in FY 2008 (see page 9). NSF has released two program solicitations for IPY activities; the first, released in January 2006, identified two education and three research emphasis areas. Awards for nine education projects were announced in September 2006 (see page 24). Research awards are currently being made and are expected to total about $12 million (see page 12). The second solicitation, released in December 2006, seeks proposals emphasizing understanding environmental change in polar regions, human and biotic systems in polar regions, and education and outreach. Proposals were due 16 March 2007; NSF anticipates funding up to 70 projects totalling about $40 million.

Compared to previous IPYs, women will be more prominent during the 2007–2008 campaign. Above, Agneta Fransson and Melissa Chierici of Göteborg University in Sweden collect data on carbon dioxide levels in water samples from the Ross Sea. Fransson and Chierici were part of an international team of scientists and teachers sailing aboard the Swedish icebreaker Oden *in December 2006 on one of the first expeditions of the fourth IPY, sponsored by NSF. Photo by Allan Miller, PolarTREC.*

For more information, see the U.S. IPY site: www.us-ipy.gov, or the IPY International Programme Office site: www.ipy.org.

This article was developed by members of the ARCUS staff: Sarah Behr, Ross Coen, Wendy K. Warnick, Helen Wiggins, and Alison York.

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VPR Offers a Wide Range of Logistical Support Services

VECO Polar Resources (VPR) offers a range of logistical support services for projects funded by the NSF Office of Polar Programs Division of Arctic Sciences. This year, in addition to providing direct research support, VPR worked with personnel at the University of Texas at El Paso, Nuna Technologies, and the University of Colorado to develop the Arctic Research Mapping Application (ARMAP; www.armap.org). ARMAP is an online tool that allows users to navigate to areas of interest in the Arctic, view a variety of map layers, and explore NSF research projects by location, year, funding program, discipline, keywords, and other variables. Project information is displayed in the application with links providing more details. ARMAP also identifies IPY projects and is useful for science planners, scientists, educators, and the public.

In 2006, VPR supported approximately 125 research projects at field sites across the Arctic by providing a wide range of services such as chartering aircraft, boats, and vehicles; arranging travel and lodging; purchasing and transporting supplies and equipment; providing technical, construction, medical, and operational support; and setting up camps, stations, and outposts with personnel who provide on-site assistance to researchers.

VPR supported 49 projects in Greenland, which involved making flight arrangements with 12 different helicopter and fixed-wing contractors. For studies involving the massive Jakobshavn Glacier in southwestern Greenland, VPR outfitted researchers with necessary gear, transported them and their equipment to field sites, and later resupplied the science teams with food and fuel before moving them onward to the next study site.

VPR also operates Summit Station, located at the peak of Greenland's ice cap, with research guidance from the Summit Science Coordination Office (see *Witness* Winter 2004/2005). Peak population at the station last summer increased by one-third to about 60 people, due in part to researchers working around-the-clock to test a drill for the West Antarctica Ice Sheet (WAIS) Divide Ice Core Project. VPR supported these researchers by erecting the drill structure, adjusting station operations and infrastructure to support 24-hour services for the drill team, and shipping the project's cargo to and from the station. The Antarctic core, which will be extracted over the next four years, will be compared with deep cores previously obtained from Greenland to better understand global climate patterns over the past 100,000 years (www.waisdivide.unh.edu).

Caribou in the Ivotuk Hills, located in northern Alaska, in August 2006. VPR maintains a hybrid communication and power system for researchers at U.S. institutions conducting carbon flux and other experiments at the site. Photo by Roy Stehle.

In addition to supporting one-time campaigns and ongoing experiments, VPR is developing a proof-of-concept, renewable, low-emission power-generation system at Summit Station to reduce the impact of local pollutants on experiments at the site and to reduce the environmental toll of working on the ice cap. VPR has begun to build and test the infrastructure needed to support wind-power generation systems, which, along with solar systems, could augment or replace traditional power systems.

The Summit upgrades are part of a larger undertaking by VPR to use renewable and alternative energy sources in support of arctic research. VPR works continuously with researchers to develop light and portable solar energy systems to power their experiments in remote locations (www.polarpower.org). Solar and wind energy sources are used at Camp Raven, the Air National Guard's training facility in Greenland. At Ivotuk, located in northern Alaska, VPR maintains a hybrid power and communications system used to transmit carbon flux and other data to academic and agency scientists. The project website includes a webcam and current information on temperature, wind speed, humidity, and barometric pressure and is accessed by a variety of users, including bush pilots interested in weather conditions (http://transport.sri.com/ivotuk).

In Alaska, VPR supported 62 projects. Flight coordination for 26 of those projects involved 510 helicopter and 230 fixed-wing hours. VPR designed, built, and staffed a field camp atop King Island, located off the western coast of Alaska, to support a multi-institutional collaborative project on the island's cultural geography, biogeography, and traditional ecological knowledge. VPR completed an extensive risk assessment and implemented safety precautions; chartered helicopters, boats, and trucks; and provided camp food and gear, communications, safety, and power equipment.

VPR supported six projects in Russia in 2006. Activities included identifying and negotiating with Russian logistics providers to secure support, handling permitting requirements, arranging for shipment of samples into the U.S. and to appropriate institutions, as well as travel coordination and provision of gear. VPR also worked with the Russian logistics provider, Polus, which operates the North Pole Drifting Station, to furnish user days, air support, medical kits, and fuel to a team investigating environmental change. Science team activities included deploying and retrieving mooring and drifting stations and conducting CTD and hydrographic surveys, and airborne sampling transects.

VPR supported 12 projects in Canada. For scientists investigating a series of small ice caps on Canada's Baffin Island, VPR outfitted the research team with snowmachines, camping consumables, and field, communications, and safety equipment; provided local guides; and arranged for shipment of frozen samples to the U.S.

For more information, go to: www.vecopolar.com, or contact Kip Rithner (kip@polarfield.com; 303-621-4658).

New Modular Radar is Designed to Observe Polar Cap

The regions above the Earth's magnetic poles, called the polar caps, are extremely susceptible to the interactions between the solar wind and the Earth's magnetic field, whose field lines converge at the poles. The most familiar result of these interactions is the aurora. Research into the mechanisms of these interactions is motivated by the need to improve understanding of upper atmospheric processes and prediction of space weather events, which can disrupt modern communications and power systems (see *Witness* Autumn 2001 and Spring 2003). In 2003, the NSF Division of Atmospheric Sciences awarded $44 million over four years to SRI International to lead the design and construction of a new system to support these studies, known as the Advanced Modular Incoherent Scatter Radar (AMISR).

Incoherent Scatter Radar (ISR) is the most powerful ground-based technique for observing the upper atmosphere, magnetosphere, and solar wind. The electromagnetic energy of the ISR radar signal is scattered by electrons in a target region, returning a weak reflection (termed "incoherent" in comparison to the coherent reflection from a solid target). The return signals' characteristics can be used to derive temperature, composition, density, and velocity of electrons and ions from the top of the atmosphere to thousands of kilometers into space.

When complete, the new AMISR system will consist of three "faces," each of which can vary in size and be configured separately or together, depending on the science objective. Each face contains up to 128 panels, with each panel holding 32 identical Antenna Element Units (AEU) to form a phased array antenna. A phased array is a group of antennas in which the phase of the signal from each antenna can be electronically adjusted to "steer" the signal in a desired direction. Each completed 128-panel face of AMISR will measure about 32 m x 32 m.

The implementation of AMISR will significantly improve observational capabilities in high latitudes, which the upper atmospheric research community has long identified as an important priority.

In the early 1990s, a Polar Cap Observatory (PCO) was proposed as a crucial link needed in a chain of existing NSF ISR observatories in Peru, Puerto Rico, Massachusetts, and Greenland. The plans called for the PCO to be located in Resolute, Canada, close to the magnetic north pole, where solar plasma energy has particularly intense effects on the Earth's atmosphere and magnetic field. Although NSF requested funds for the PCO in FY 1998 and 1999, Congress did not approve the request. The community revised its plans for the polar observatory, taking advantage of a new concept to develop a modular radar system that could be relocated as needed.

The AMISR design has three major functional advantages over the existing fixed radars operated by NSF:

- the solid-state design eliminates the need for large klystrons (high-frequency amplifiers for generating microwaves), facilitating remote operations and more flexibility in scheduling and conducting experiments;
- the radar beam can be steered almost instantaneously in response to rapidly changing conditions; and
- the system can be disassembled and moved with relative ease; all components can be placed in standard 40 ft containers. Relocation of the system, which is expected to require about six months, will enable observations almost anywhere they are needed.

In 2005, two AMISR prototype systems, each consisting of eight panels, were tested at the Jicamarca Radio Observatory in Peru and the High Frequency Active Auroral Research Program Station near Gakona, Alaska. The first 32-panel face of the AMISR was erected in November 2005 at the University of Alaska's Poker Flat Research Range near Fairbanks. Scientists from SRI, Cornell University, and the University of Alaska presented data from all three sites at the April 2006 Ionospheric Interactions Workshop in Santa Fe, New Mexico.

The first complete face of the system was erected at Poker Flat in November 2006. Operations began in January 2007 when the radar took measurements coordinated with several sounding rocket campaigns funded by the National Aeronautics and Space Administration. The remaining two faces will be installed at Resolute by summer 2008. In late 2005, NSF announced four awards totaling about $350,000 per year for three years to support graduate student research using the new AMISR systems; this opportunity will be repeated in 2009.

With support from NSF, SRI organized a workshop in October 2006 to explore the science objectives that can be achieved with the new system at Poker Flat. Sixty investigators attended the meeting in Asilomar, California. Annual AMISR workshops are planned to address future science goals as the radar is deployed to new locations.

For more information, see: www.amisr.com, or contact John Kelly (kelly@sri.com; 650-859-3749) or Bob Robinson (rmrobins@nsf.gov; 703-292-8529).

The first complete face of the AMISR system at Poker Flat in October 2006. Since each face of AMISR can function independently, when the system is completed it can be deployed in up to three separate locations at the same time. The first AMISR face is expected to remain at Poker Flat until at least 2010. Photo courtesy Craig Heinselman.

New Research Facility in Barrow Will Open in Early 2007

A major multi-user arctic research facility is under construction in Barrow, Alaska, under the auspices of Ukpeagvik Iñupiat Corporation (UIC) and the Barrow Arctic Science Consortium (BASC). Located south of the former Naval Arctic Research Laboratory (NARL) facility, which is now owned by UIC, the Barrow Global Climate Change Research Facility (BGCCRF) project comprises five phases:

- Phase I: Research and Education Facility. 20,930 square feet. 7 laboratories, 9 offices, an 80-person class/meeting room, electronics workshop, and IT spaces.
- Phase II: Staging, Maintenance, and Warehousing Space. 16,000 square feet. 5 staging bays, 4 storage bays, 2 maintenance bays, general and all-terrain vehicle storage, and science support.
- Phase III: Research and Support Spaces. 20,000 square feet. Laboratories, support areas, conference areas, dining facilities, and shipping and receiving.
- Phase IV (second floor of Phase III): Research Laboratories. 20,000 square feet. Laboratories and support spaces.
- Phase V: Housing. 12,000 square feet. Single, double, and quad rooms (total 40 beds), recreation and laundry rooms.

Multiple agencies conduct arctic research in the area, and each phase of the new BGCCRF will significantly improve science support capabilities available to them in Barrow. The facility's grand opening, tentatively scheduled for June 2007, will coincide with the beginning of the International Polar Year (see page 1). Phase II construction is expected to begin later in 2007. Congress authorized up to $61 million for BGCCRF design and construction in the FY 2005 Energy Bill (HR 6), and the construction schedule for subsequent phases will depend on continued Congressional support and funding.

An aerial view showing the location of UIC-NARL and the five phases of the new Barrow Global Climate Change Research Facility (BGCCRF). Courtesy of LCMF LLC. Photograph © AEROMAP US.

Appropriations for Phase I construction total $17 million and were provided to UIC through a cooperative agreement with the National Oceanic and Atmospheric Administration. Local organizations have also supported the project, including the North Slope Borough, UIC and its subsidiaries, BASC, and the Arctic Slope Regional Corporation. UIC subsidiary companies BTS Professional Services LLC and LCMF LLC have provided planning and design services for the project since 2003. UIC Construction provided constructability review and cost estimates during the design phase and is currently completing construction of Phase I. As part of its contributions to the facility's development, NSF is providing about $450,000 to UIC for IT improvements, including additional data cabling and upgraded security and access control, and BASC has submitted a proposal to NSF for other IT support requested by the science community to enable wireless connectivity to the nearshore environment and over the Barrow Environmental Observatory (BEO).

With support and input from NSF, the research community gathered at several workshops to ensure that the BGCCRF will meet a range of science needs while taking advantage of the exceptional opportunities offered by its location in Barrow (ARCUS 1999, BASC 2002). UIC will own and maintain the new facility, and BASC will manage and facilitate its use. Financial and logistical arrangements will be modeled after current BASC policies for research use of existing UIC-NARL facilities. Use by NSF-funded researchers will be covered under the BASC cooperative agreement with NSF. Other investigators will pay for access on a negotiated basis. BASC expects that users will provide most of their own scientific equipment.

Other developments in science infrastructure in Barrow include:

- UIC and BASC are seeking funding to develop a master plan for the UIC-NARL campus;
- NSF is funding installation of trails, instrument towers, and electricity in the BEO in support of a tundra manipulation project supported by the NSF Biocomplexity and the Environment program; and
- NSF is supporting continued development of the Barrow Area Information Database (www.baidims.org), a source of information on over 5,000 research sites.

The history of collaboration between the Iñupiat Eskimo people of northern Alaska and scientists began during the first International Polar Year with a U.S. Army Signal Corps expedition to Barrow from 1881 to 1883 (see page 2) and continued through operations at NARL from 1947 to 1980 (see *Witness* Autumn 1997). In keeping with this long tradition of local support for science, several Barrow-based organizations established BASC in 1995 as a non-profit logistical support and community coordinating organization. BASC has provided logistical support since 1997 to NSF-funded researchers through a cooperative agreement and to others on a fee-for-service basis. BASC personnel assisted 55 NSF projects in 2005, 29 projects in 2006, and 44 in the first part of 2007. BASC also manages the BEO, an 11 square-mile area dedicated to research in 1992 by UIC, the local Alaska Native Claims Settlement Act corporation.

For more information, see the BASC website: www.arcticscience.org, or contact Glenn Sheehan (basc@arcticscience.org; 907-852-4881) or Richard Reich (rreich@lcmf.com; 907-273-1808).

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BASC 2002. *Arctic Science in the Barrow Region: Recommendations for Future Facilities.* Barrow, AK. 67 pp.

Toolik Field Station Begins Year-round Operations

Toolik Field Station (TFS), a research facility located on Alaska's North Slope and operated by the Institute of Arctic Biology at the University of Alaska Fairbanks, has begun year-round operations providing continuous access for arctic researchers to housing, laboratory space, and other logistical services (see *Witness* Winter 2004/2005).

The move to year-round operations at TFS is a key recommendation of *Science Support at the Toolik Field Station, Alaska: Directions for the Next 10 Years*, a report summarizing the findings of an NSF-funded strategic planning workshop. Thirty-five scientists at the December 2004 meeting identified a number of long-term goals for science based at TFS that require continuous station operation. Year-round operation will enable investigators to expand their research efforts and environmental observations, including those obtained by autonomous instrumentation, into a long part of the year that has been understudied and in which conditions are changing rapidly as climate warms.

With support from the NSF Arctic Research Support and Logistics Program, TFS is now staffed continuously throughout the winter months of October through April and will maintain uninterrupted power, heat, and communications, including Internet connectivity, providing science support for up to 20 researchers. TFS will maintain its regular summer schedule from May through September, furnishing support for up to 125 scientists and staff. There were 5,017 userdays logged at TFS in summer 2005 and 5,882 in 2006.

Other recommendations from the TFS planning document, published in October 2006, include:

Environmental monitoring and preservation of long-term control areas and research sites. With the goal of expanding collection of baseline environmental data and making the data readily available to the research community, participants recommended a five-year plan of enhanced environmental monitoring to complement data collected by the Arctic Long-Term Ecological Research (LTER; see *Witness* Spring 2002) program and other TFS studies, including hiring a new environmental monitoring technician. Participants also proposed expanding the protected area around TFS. Currently the Bureau of Land Management recognizes the Toolik Lake watershed and Kuparuk River headwaters as a Research Natural Area to be protected from non-scientific human disturbance. The long-term TFS plan calls for increasing the area protected for research to include the upper Kuparuk River basin and areas of state land to the west through cooperative agreements with the various landowners.

Toolik Field Station, located on Alaska's North Slope, has begun year-round operations and can support up to 20 researchers during the winter months of October through April. Photo taken by Scott Houghton in January 2007.

Core laboratories and scientific services. Participants identified expanded scientific services, particularly in analytical chemistry and environmental monitoring, as priorities for TFS. Specific recommendations include developing a three-season analytical chemistry laboratory, a modular system of connected, general-use laboratories to replace the current stand-alone labs, more vehicles for use during summer months, a system for shipping ultra-cold (-80 °C) samples, and animal care facilities with controlled temperature and photoperiod. The recommendations also include upgrading lab equipment, providing for its calibration, trouble-shooting, repair, and fabrication, and hiring two new staff members responsible for general science support.

Data management and Geographic Information Systems (GIS)/Information Technology (IT) services. Workshop participants recommended that TFS provide enhanced data management services, including a TFS-centric database, online data delivery, and GIS-integrated networks that link to data from other field stations. Infrastructure requirements for these data management improvements include year-round power and communications, on-site data storage backup, and wireless Internet capability with at least a 15 km range for sensor transmission from the field. Repeater towers for transmission from more distant sites may also be required.

In addition to year-round operations, TFS is also currently implementing the enhanced environmental monitoring program and will act on other recommendations as funding becomes available.

The report also highlighted potential education opportunities at TFS, proposing that academic programs be structured around existing research projects, enabling students to learn from and contribute to ongoing research. Recognizing the need to minimize conflicts of space and scheduling, workshop participants recommended separate lecture and lab space dedicated exclusively for classes and an on-site course coordinator so the burden of instruction does not fall directly on researchers.

TFS encourages community participation in decision-making at the station. This participatory model resembles one employed by Zackenberg Research Station in Greenland where scientists coordinate research and monitoring projects as well as facility logistics. As recommended by the community, TFS is moving toward a greater integration of research, monitoring, and logistics along the Zackenberg model.

The National Ecological Observatory Network (NEON; see *Witness* Spring 2000) recently announced that TFS is a core site in the network plan that will be submitted this spring to NSF as a proposed Major Equipment and Facilities Construction (see page 9) project.

For more information, see the TFS website: www.uaf.edu/toolik, or contact Mike Abels (fnmaa@uaf.edu; 907-474-5063), Brian Barnes (ffbmb@uaf.edu; 907-474-7649), or Donie Bret-Harte (ffmsb@uaf.edu; 907-474-5434).

NSF Reviews Alaska Region Research Vessel Proposals

NSF is reviewing proposals from organizations to oversee construction and operation of an Alaska Region Research Vessel (ARRV), which has been approved as a Major Research Equipment and Facilities Construction (MREFC) project.

The MREFC account was established by Congress in 1995 to provide funding for construction and acquisition of major infrastructure so that large periodic expenditures do not disrupt the budgets of individual NSF directorates. Before being included in a budget request to Congress, projects submitted by an originating NSF directorate must be approved by the MREFC Panel, the NSF Director, and the National Science Board (NSB).

In 2000, NSF funded the University of Alaska Fairbanks in collaboration with Woods Hole Oceanographic Institution to develop the concept, preliminary, and construction designs for an ARRV to replace the aging *Alpha Helix*, which has limited arctic capabilities. The *Helix* was constructed in 1966 and has been operated for NSF by the University of Alaska since 1980. Acquisition of an ARRV was approved by NSF management and the NSB as a MREFC project in 2003, and the design and construction funds were included in the President's FY 2007 and 2008 budget requests (see below). The current funding request, contingent upon Congressional appropriations, is $123 million over a period of three years for vessel construction and associated activities. Annual costs of operating the vessel following construction will be supported through a separate cooperative agreement.

The vessel will be a 236-foot multipurpose oceanographic research ship capable of year-round operation in seasonal sea ice and open ocean regions around Alaska, primarily the Chukchi, Beaufort, and Bering seas, Gulf of Alaska, coastal southeast Alaska, and Prince William Sound.

The ARRV solicitation, which was released in November 2006 by the NSF Division of Ocean Sciences Integrative Programs Section, sought proposals to oversee construction using the existing design. Once construction is completed, the contracting organization will manage vessel operations to support NSF and other federally funded science activities. Proposals were due 29 January 2007. If funding is available on schedule, sea trials for the vessel would be expected in late 2010.

The contracting organization must seek membership in the University-National Oceanographic Laboratory System (UNOLS), an organization of 62 academic institutions and laboratories involved in oceanographic research and joined for the purpose of coordinating oceanographic ships' schedules and research facilities. Use of the ARRV will be scheduled through the UNOLS scheduling process in order to ensure equal access to the platform. The *Helix* was recently retired from the UNOLS fleet and will be sold with proceeds going towards equipping the ARRV.

For more information, contact Dolly Dieter at NSF (edieter@nsf.gov; 703-292-7586).

FY 2007 NSF R&RA Budget Increases $335 Million

Shortly after the release of the proposed fiscal year (FY) 2008 budget in February, Congress and the President finalized the FY 2007 appropriations process left unfinished by the 109th Congress. The resulting joint resolution (Public Law 110-5) provides funding for most domestic programs at FY 2006 funding levels but provides increases for selected programs, including NSF, which will receive $5.916 billion, an increase of $335 million (6.0%) over current year funding of $5.581 billion. The increase is entirely allocated to the Research and Related Activities (R&RA) budget, which receives the full amount requested by the administration (7.7%), to a total of $4.666 billion.

Within R&RA, the budget for the Office of Polar Programs will increase 12.1% over FY 2006 to $438 million, with $89.6 million allocated to the Division of Arctic Sciences. Funding to support International Polar Year (IPY; see page 1) activities will total $62 million, shared among several directorates ($2 million to Biological Sciences [BIO], $5 million to Geosciences [GEO], $300,000 to the Office of International Science and Engineering [OISE], $47 million to OPP, $5 million to Social, Behavioral and Economic Sciences [SBE], and $2 million to Education and Human Resources [EHR]).

The FY 2007 budgets for other NSF accounts, including Major Research Equipment and Facilities Construction, will remain at FY 2006 levels. NSF intends, however, to seek approval from Congressional appropriations committees to initiate construction of the Alaska Region Research Vessel (see page 9) this fiscal year.

FY 2008 Budget Request

The administration's request for the FY 2008 NSF budget is $6.43 billion, an increase of $510 million (8.6%) over the amount appropriated for FY 2007. The budget for R&RA would increase by 7.7% to $5.13 billion. The budget request for OPP is $465 million, an increase of 6.1%; the Division of Arctic Sciences request is $96.3 million, an increase of 7.5%. The request for FY 2008 IPY activities is $59 million, with a distribution similar to that in FY 2007, except that the IPY funding for SBE would drop to $2 million.

For more information, see the NSF Budget Division website: www.nsf.gov/about/budget, or the American Association for the Advancement of Science website: www.aaas.org/spp/rd.

Korsmo, Jeffries, Kelly, Weale Join OPP Staff

Several personnel recently joined the NSF Office of Polar Programs (OPP).

Korsmo Returns to OPP

In January 2007, Fae Korsmo filled a new permanent position in OPP as senior staff associate to the director, Karl Erb. Among other responsibilities, Korsmo will assume duties associated with NSF's designation as lead federal agency for arctic research, coordinating the work of the Interagency Arctic Research Policy Committee, which includes representatives of the 14 federal agencies with missions and programs relevant to the Arctic, and leading their effort to produce the biennial arctic research plan mandated by Congress. These duties were previously the responsibility of Charles (Chuck) Myers, who retired as head of interagency arctic staff in December 2006.

Korsmo came to NSF in 1997 and has held positions in several offices, including:

- staff associate in the Office of Integrative Activities from 2003–2007;
- program director in the Experimental Program to Stimulate Competitive Research (EPSCoR) from 2001–2003; and
- director of the OPP Arctic Social Sciences Program and Science Education Liaison from 1997–2001.

Korsmo earned a B.A. in comparative literature from the University of Washington in 1980, an M.A. in international affairs from George Washington University in 1984, and a Ph.D. in political science from the University of New Mexico in 1992. She served on the faculty at the University of Alaska Fairbanks (UAF) from 1992 to 2000.

New Program Director for Arctic Observing Network

In October 2006, Martin Jeffries joined OPP as the Arctic Observing Network program director on a two-year Intergovernmental Personnel Act (IPA) assignment from UAF, where he has been on the faculty since 1985. Jeffries has worked on interactions between climate and sea ice and lake ice in both the Arctic and Antarctic. He is a co-founder of the Alaska Lake Ice and Snow Observatory Network (ALISON; see *Witness* Winter 2004/2005), a project that trains teachers and students across Alaska to establish observatories and monitor climate and ice parameters to study conductive heat flow in lake ice.

Jeffries earned a B.A. in geography at the University of Sheffield, an M.S. in geography at the University of Manchester in 1981, and a Ph.D. in geography at the University of Calgary in 1985.

New Program Manager for Arctic Biology

Brendan P. Kelly joined OPP in January 2007 as a new Arctic Natural Sciences (ANS) program manager for biology on a two-year IPA assignment from the University of Alaska (UA), where he is associate vice president for research.

Kelly will work with program managers Jane Dionne, a glaciologist, and William Wiseman, a physical oceanographer, to manage the broad ANS portfolio. Adding a third ANS program officer was recommended by a 1998 National Academies report outlining future directions for the program (see *Witness* Spring 1998).

Kelly earned a B.A. in biology from the University of California, Santa Cruz, in 1975, an M.S. in biology from UAF in 1979, and a Ph.D. in biology from Purdue University in 1996. A behavioral ecologist with an interest in ice-associated marine mammals, Kelly has held positions with the National Marine Mammal Laboratory and Alaska Department of Fish and Game. He joined the research staff at UAF in 1982 and the faculty at both the Fairbanks and Southeast campuses in 1996. At UA Southeast, he served as dean of arts and sciences and vice provost for research from 2003–2007.

Technical Assistance for Arctic Research Support and Logistics (RSL)

Jason Weale, P.E., of the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) joined OPP in November 2006 through a memorandum of understanding with CRREL to provide technical expertise on projects. Weale has worked with the Antarctic Infrastructure and Logistics (formerly Polar Research Support Services) Division on numerous cold regions engineering projects, including the traverse from McMurdo Station to South Pole Station. Weale will work with the Arctic Sciences Division through 2007 and beyond on science support, engineering, and infrastructure design projects. Weale earned his BSCE from the University of Vermont in in 1995 and joined CRREL as a Research Civil Engineer in 2001.

Former RSL manager Simon Stephenson became head of the OPP Division of Arctic Sciences in April 2006. OPP began searching for his replacement in August 2006. Assistant program officer Renée Crain is serving as acting RSL program officer in the interim. For more information, see the OPP website: www.nsf.gov/dir/index.jsp?org=OPP.

NSF Offers Annual Funding Opportunity

In September 2006, NSF released the annual Arctic Research Opportunities program solicitation, which includes funding opportunities for the programs in the Office of Polar Programs (OPP) Division of Arctic Sciences:

- Arctic Research Support and Logistics (see pages 5–9),
- Arctic System Science (see pages 16–18),
- Arctic Natural Sciences (see pages 19–20),
- Arctic Social Sciences (see pages 21–22), and
- Arctic Research and Education (see pages 24–25).

Proposals were due in December 2006. NSF expects to fund approximately 40 awards totaling $16 million. The next deadline for this solicitation will be 10 November 2007. Other recent NSF funding opportunities are summarized on pages 1, 9, 12, and 24. For more information, see the full solicitation at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06603.

Polar Research Board Releases Icebreaker Study

In September 2006, the Polar Research Board completed a congressionally mandated assessment of the current and future needs for polar icebreakers, *Polar Icebreakers in a Changing World: An Assessment of U.S. Needs* (see *Witness* Spring 2006). The report committee found that the U.S. will require icebreakers capable of operating in a variety of challenging conditions to maintain its leadership in polar science and protect its national and strategic interests in both the Arctic and Antarctic. The U.S. will need icebreakers in the north as economic activity and human presence increase with the decreasing extent of the arctic ice pack. In the south, support and re-supply of the U.S. Antarctic Program (USAP)'s three permanent scientific stations requires reliable icebreaker capability.

The U.S. currently has a fleet of four icebreakers: one single-mission ship, the *Nathaniel B. Palmer*, operated by NSF to support research, and three multi-mission ships, the *Polar Sea*, *Polar Star*, and *Healy*, operated by the U.S. Coast Guard (USCG) to support both research and USCG missions. With the *Polar Sea* and *Polar Star* at the end of their 30-year service lives and the fact that icebreaker operations and maintenance have been underfunded for many years, the U.S. risks being unable to meet its polar icebreaking needs. The *Polar Sea*, recently repaired at a cost of $30 million, is expected to be mission capable for the next several years. The *Polar Star* has been placed in indefinite caretaker status with a reduced crew of 35. The *Healy*, which is primarily dedicated to arctic research, was built to complement the *Polars* and cannot operate independently in some ice conditions.

Although demand for icebreaking capability is predicted to increase, the committee judged that a fleet of four ships can still meet the nation's needs, but the U.S. needs to build two new icebreakers to replace the aging *Polars*.

The committee also considered icebreaker management and funding. Research and USCG missions can be, in many cases, compatibly performed using the same ship; multi-mission ships will yield more capability and be more cost-effective than if agencies independently acquire icebreaking ships. Although NSF currently has budget authority for the polar icebreaking program, the report states that the USCG should have funds and authority to perform mission responsibilities in ice-covered waters of the Arctic and that other agencies should reimburse incremental costs associated with, for instance, scientific tasks. The committee considered alternatives to USCG operations for USAP support and re-supply and believes that this mission requires reliably controlled icebreaker capability that can be ensured over decades. The mission need not necessarily be operated by the Coast Guard, but would be best served by a U.S. flagged, owned, and operated icebreaker.

Over the eight to ten years while new ships are being constructed, the nation needs a transition strategy to assure reliable icebreaker capability. Continued maintenance and repair of the *Polar Sea* will be needed until the first new ship enters service. The *Polar Star* should be kept in caretaker status as a back-up, and other ships may need to be chartered.

The report is available online at www.nap.edu/catalog/11753.html. For more information, contact study director Maria Uhle (muhle@nas.edu; 202-334-3531).

New Chairman and Members Appointed to USARC

In August 2006, President Bush designated a new chair and appointed two new members to the U.S. Arctic Research Commission (USARC). Mead Treadwell, originally appointed to the commission in 2001, is the incoming chair, and he is joined by new commissioners Vera Kingeekuk-Metcalf and Charles J. Vörösmarty.

Treadwell is a senior fellow at the Institute of the North and is chairman and chief executive officer of Venture Ad Astra, an Anchorage-based firm developing geospatial positioning and imaging technologies. His term continues through February 2009. Treadwell succeeds George B. Newton, Jr., who has served on the commission since 1992 and as chair since 1996.

Metcalf is director of the Eskimo Walrus Commission, created in 1978 by Kawerak, Inc., in Nome, Alaska, to work on resource co-management issues on behalf of Alaska Natives. She will serve as the indigenous representative on the USARC through February 2009 and succeeds Mary Jane Fate of Rampart and Fairbanks, who served on the commission since 2001.

Vörösmarty, a professor at the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire and the director of the Water Systems Analysis Group, will serve through February 2008.

USARC was established by the Arctic Research and Policy Act of 1984. Its principal duties are to develop and recommend an integrated national arctic research policy and assist in establishing a national arctic research program plan to implement the policy. Commissioners also facilitate cooperation between federal, state, and local governments, and other nations with respect to basic and applied arctic research.

The commission published its biennial report on goals and objectives for arctic research in April 2007. In addition to identifying high priority research topics, the report highlights two new pursuits: revitalizing the federal process by which arctic research is organized and implemented and a new focus on Indigenous Languages, Identities, and Cultures.

For more information, see: www.arctic.gov or contact Kathy Farrow (k.farrow@arctic.gov; 703-525- 0111).

SEARCH Observing System Planning Continues

Recent activities in support of the interagency Study of Environmental Arctic Change (SEARCH) include a Science Steering Committee (SSC) meeting and collaboration with international partners.

SEARCH SSC Meeting

The SEARCH SSC met in Arlington, Virginia, in late November 2006 with representatives of the Observing, Understanding, and Responding to Change implementation panels and agency personnel in attendance. The agenda included updates on national and international programs related to SEARCH, science highlights from each of the panels, and International Polar Year (IPY; see page 1) planning and implementation.

During the meeting, three ad hoc working groups, established in May 2005 at the SEARCH Implementation Workshop, became standing working groups:

- data management (chaired by David McGuire, University of Alaska Fairbanks),
- paleoenvironment (chaired by Konrad Steffen, University of Colorado), and
- education and outreach (chaired by Max Holmes, Woods Hole Research Center).

Membership, specific tasks, and Terms of Reference are being developed for the paleoenvironment and education and outreach working groups. The data management working group, in collaboration with the SSC and Interagency Program Management Committee (IPMC), is currently drafting a SEARCH data policy and data management plan and will circulate the documents for community review.

SEARCH and IPY

Environmental change and observing systems are focal points of both the SEARCH program and the IPY. The first NSF solicitation for IPY was released in January 2006; under the research theme of an Arctic Observing Network (AON; see *Witness* Spring 2006), the solicitation focused on the efforts needed to develop and deploy a pan-arctic observing system that will enable SEARCH by measuring the interrelated arctic changes underway. Award decisions for this emphasis area were recently announced (see box).

continued on next page

Arctic Observing Network Awards 2007

- State of the Arctic Sea Ice Cover: An Integrated Seasonal Ice Zone Observing Network (SIZONET). D. Perovich, M. Sturm (Cold Regions Research and Engineering Lab [CRREL]), H. Eicken, M. Johnson, R. Gradinger, A. Lovecraft, T. Heinrichs (University of Alaska Fairbanks [UAF]). *$495,245.*
- Ice Mass Balance Buoy Network: Coordination with DAMOCLES. J. Richter-Menge, D. Perovich (CRREL). *$393,665.*
- A Modular Approach to Building an Arctic Observing System for the IPY and Beyond in the Switchyard Region of the Arctic Ocean. P. Schlosser, W. Smethie, D. Chayes (Columbia University), M. Steele, C. Lee, J. Gobat (University of Washington [UW]), R. Kwok (Jet Propulsion Lab). *$493,339.*
- An Innovative Observational Network for Critical Arctic Gateways—Understanding Exchanges through Davis and Fram Straits. C. Lee, R. Moritz, J. Gobat, K. Stafford (UW). *$714,538.*
- The Pacific Gateway to the Arctic: Quantifying and Understanding Bering Strait Oceanic Fluxes. T. Weingartner, T. Whitledge (UAF), R. Woodgate, R. Lindsay (UW). *$626,887.*
- Observing the Dynamics of the Deepest Waters in the Arctic Ocean. M. Timmermans, L. Rainville (Woods Hole Oceanographic Institution [WHOI]). *$89,718.*
- An Array of Ice-Tethered Profilers to Sample the Upper Ocean Water Properties during the IPY. J. Toole, C. Ashjian, A. Proshutinsky, R. Krishfield (WHOI). *$743,156.*
- An Array of Surface Buoys to Sample Turbulent Ocean Heat and Salt Fluxes during the IPY. T. Stanton, W. Shaw (Naval Postgraduate School). *$483,777.*
- Cloud Properties Across the Arctic Basin from Surface and Satellite Measurements. V. Walden (University of Idaho), M. Shupe (University of Colorado [CU]). *$123,173.*
- Pan-Arctic Studies of the Coupled Tropospheric, Stratospheric and Mesospheric Circulation. R. Collins, D. Atkinson (UAF). *$270,307.*
- Development of Data Products for the University of Wisconsin High Spectral Resolution Lidar. E. Eloranta (University of Wisconsin). *$158,787.*
- A Prototype Network for Measuring Arctic Winter Precipitation and Snow Cover (Snow-Net). M. Sturm (CRREL), D. Kane, D. Yang, S. Berezovskaya (UAF), G. Liston, C. Hiemstra (Colorado State University [CSU]). *$463,048.*
- Development of a Network of Permafrost Observatories in North America and Russia. V. Romanovsky (UAF). *$313,871.*
- Carbon, Water and Energy Balance of Arctic Landscapes at Flagship Observatories and in a Pan-Arctic Network. G. Shaver, J. Hobbie, E. Rastetter (Marine Biological Laboratory), S. Bret-Harte, B. Barnes, S. Zimov (UAF). *$1,104,000.*
- Study of Arctic Ecosystem Changes in the IPY using the International Tundra Experiment. J. Klein (CSU), J. Welker, B. Sveinbjornsson, P. Sullivan, K. Boggs (University of Alaska Anchorage [UAA]), R. Hollister (Grand Valley State University), S. Oberbauer, W. Gould, C. Lewis (Florida International University). *$455,599.*
- Is the Arctic Human Environment Moving to a New State? J. Kruse (UAA), L. Hamilton, C. Duncan, R. Lammers (University of New Hampshire). *$552,455.*
- Exchange for Local Observations and Knowledge of the Arctic (ELOKA). S. Gearheard, R. Barry, H. Huntington, M. Holm, M. Parsons (CU). *$212,539.*
- A Cooperative Arctic Data and Information Service (CADIS). R. Barry (CU), J. Moore, M. Ramamurthy, D. Middleton (University Corporation for Atmospheric Research [UCAR]). *$656,051.*

In addition to the projects funded under the AON solicitation in 2007, projects previously funded through Arctic Long Term Observations are participating in observing system development. Several short- and mid-term activities are underway to ensure broad communication and coordinated implementation of SEARCH during the IPY period. As an international observing system takes shape, the SEARCH SSC and panels will examine its alignment with SEARCH science objectives and help both existing and newly funded components of the SEARCH Observing System coordinate their efforts and contributions to wider networks.

A searchable online multi-agency Project Catalog is being developed to allow the research community to share information about SEARCH-related projects in IPY and beyond. The catalog, which will be launched in April 2007, will include project scientific focus, location, data, education and outreach activities, and other relevant information.

In addition, SEARCH is in the initial planning stages for a State of the Arctic Conference, tentatively scheduled for October 2008, to gather the broad community for presentations and discussion on arctic change.

International Activities

A partnership has been formed between SEARCH and the Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies (DAMOCLES) project. DAMOCLES is a European consortium of 45 institutions working to develop an arctic atmosphere-ice-ocean observing system. Opportunities presented by the SEARCH for DAMOCLES (S4D) partnership include enhanced acquisition of pan-arctic data sets, dissemination of results, and public awareness. Meetings were held in October and December 2006 to discuss collaborative opportunities between the two partners.

Development of the International Study of Arctic Change (ISAC), formed by the Arctic Ocean Sciences Board (AOSB) and the International Arctic Science Committee (IASC) to support international interest in SEARCH, continues. Efforts are underway to establish an ISAC International Program Office. IASC and AOSB finalized appointments to the Science Steering Group, which is responsible for oversight of planning and implementation of ISAC science activities (see box).

For more information, see: www.arcus.org/search, or contact Peter Schlosser (schlosser@ldeo.columbia.edu), Neil Swanberg (nswanber@nsf.gov), or Helen Wiggins (helen@arcus.org; 907-474-1600). A listserve providing updates has also been established; subscription information is available on the website or by contacting Helen Wiggins.

NSF Funds Five BEST Projects, Partners with NPRB

The Arctic Research Opportunities solicitation released by NSF in September 2005 included a section requesting proposals to address the goals of the Bering Ecosystem Study (BEST; see *Witness* Spring 2006), which focus on understanding how climate variability could influence the ecosystems of the eastern Bering Sea. In response, NSF received 68 proposals for 37 projects totaling $43 million and awarded five projects a total of $3.36 million:

- Nitrogen Supply for New Production and its Relation to Climatic Conditions on the Eastern Bering Sea Shelf. Ray Sambrotto (Columbia University), Daniel Sigman (Princeton University) *$1,541,144.*
- Denitrification and Global Change in Bering Sea Shelf Sediments. David Shull (Western Washington University), Allan Devol (University of Washington [UW]) *$866,336.*
- The Impact of Changes in Sea Ice on the Physical Forcings of the Eastern Bering Ecosystem: Retrospective Investigation and Future Projection. Jinlun Zhang, Rebecca Woodgate (UW) *$460,127.*
- The Role of Ice Melting in Providing Available Iron to the Surface Water of the Eastern Bering Sea Shelf. Jingfeng Wu (University of Alaska Fairbanks) *$273,098.*
- Nelson Island Natural and Cultural Knowledge Project. Mark John, Ann Fienup-Riordan (Calista Elders Council) *$221,024.*

The funded principal investigators met at NSF in Arlington, Virginia, in September 2006 to coordinate their efforts. Personnel from three BEST projects are participating in a cruise from 10 April–12 May 2007 in the eastern Bering Sea aboard the U.S. Coast Guard Cutter *Healy*. In addition to sampling in the eastern Bering Sea, cruise participants will visit the Pribilof communities of St. Paul and St. George. The cruise includes substantial collaboration with National Oceanic and Atmospheric Administration (NOAA) programs. Personnel affiliated with the NOAA North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) and Loss of Sea Ice (LOSI) programs are aboard the *Healy* directly collaborating with BEST investigators. The NOAA research vessel *Miller Freeman* will also carry out joint physical and biological sampling with the *Healy*.

NSF released a second solicitation for BEST proposals in December 2006; proposals were due 15 March 2007. NSF coordinated this solicitation with the North Pacific Research Board (NPRB), which released its own solicitation for a Bering Sea Integrated Ecosystem Research Program in October 2006. After receiving pre-proposals, NPRB invited two groups to submit full proposals by 15 March 2007. The coordinated NSF-NPRB program will support a comprehensive vertically integrated investigation of the Bering Sea ecosystem, based on the BEST science and implementation plans and the NPRB science plan, that is expected to total about $35 million over six years including ship time. NSF and NPRB have released a joint management plan that identifies the responsibilities and intentions of each organization.

For more information, see the ARCUS website: www.arcus.org/Bering/index.html, the BEST planning office website: www.fish.washington.edu/research/best, the NPRB website: www.nprb.org, or contact William Wiseman (wwiseman@nsf.gov; 703-292-8029).

Norway Begins Chairmanship of Arctic Council

Norway assumed chairmanship of the Arctic Council at the 5th Ministerial Meeting in Salekhard, Russia, in October 2006. Delegates from the eight arctic nations, observer states, and indigenous peoples' organizations gathered to recognize the achievements of the outgoing Russian chairmanship, receive the program for the Norwegian chairmanship, approve the program of work for the next two years, and celebrate the 10th anniversary of the Arctic Council. Norway's program lists the priorities of its chairmanship, while the Council as a whole must approve via consensus all work activities.

Jonas Gahr Støre, Norway's Minister of Foreign Affairs, will serve as chair of the Arctic Council, with the Secretariat based at the Norwegian Polar Institute in Tromsø. The priorities of the Norwegian program include sustainable use of natural resources based on integrated resource management and addressing global climate change.

> Until now, the main emphasis has been on sustainable development and environmental protection. . . . However, it will not be possible to maintain settlement patterns and ensure growth and welfare without economic activity. Therefore, the Council should also initiate broad political debate on all issues [including] economic activity in the energy, fisheries, and mining sectors and other matters of joint interest related to social and economic development.
>
> — Excerpt from *Programme for the Norwegian Chairmanship of the Arctic Council 2006–2008*

Integrated Resource Management

Norway's program for 2006–2008 seeks to continue the Arctic Council's long-term focus on sustainable development and protection of the environment. Each chairmanship brings a different contextual approach to these areas of the Council's mandate. Norway calls for attention to these issues in the context of economic activity, including the energy, fisheries, and mining industries. The principle of integrated resource management is based on the importance of healthy and productive ecosystems as the long-term basis for economic development.

Norway cites its own experience with integrated management plans as a framework for developing common approaches to ecosystem-based management of natural resources in the Arctic. The Barents Sea–Lofoten Islands management plan, for example, was designed to ensure balance between petroleum development, increasing maritime transport, use of living marine resources (including the fisheries industry), and the need for environmental protection.

Norway's priorities for addressing resource management issues in the Arctic include developing common criteria for identifying ecologically valuable and vulnerable areas where there is high potential for conflict between economic, societal, and environmental interests, and coordinating environmental standards and management guidelines across member states to facilitate harmonious implementation among the respective national authorities. Norway also proposes that the Council establish guidelines for responsible development of petroleum and mineral resources in the Arctic, with consideration given to other activities such as tourism, shipping, infrastructure, and waste management.

Under Norway's chairmanship, the Arctic Council will oversee completion of two key reports currently being prepared by Council working groups: *Assessment of Oil and Gas Activities In the Arctic* under the Arctic Monitoring and Assessment Program (AMAP) working group and *Arctic Marine Shipping Assessment* under Protection of the Arctic Marine Environment (PAME) working group. Norway will also host a conference to explore integrated resource management and its relevance for the Arctic.

Climate Change

Recognizing that global climate change will continue to result in major physical, ecological, social, and economic changes throughout the Arctic, Norway proposes that the Council initiate new studies and assessments in three priority areas:

- bolstering climate change research and monitoring;
- strengthening the adaptive capacities of arctic residents and identifying the most vulnerable sectors of society; and
- consideration of initiatives and measures to reduce emissions and enhance removals of greenhouse gases in the region.

While the global foundation for reducing greenhouse gas emissions is the UN Framework Convention on Climate Change, within the Arctic Council Norway proposes that priority be given to implementing the recommendations of the Arctic Climate Impact Assessment (ACIA), the Reykjavik Ministerial Declaration, and the ACIA Policy Document from Reykjavik. These documents call for member states to take mitigation and adaptation measures and propose further research, observation, monitoring, modeling, and outreach efforts.

The chair of the Arctic Council rotates among member states every two years. Denmark and Sweden will assume the chairmanship in 2008 and 2010, respectively, and will coordinate with Norway on a set of common priorities for the six-year period from 2006 to 2012, including indigenous peoples and local living conditions, resource management, and the organizational structure of the Council. The Arctic Council Secretariat will be based in Tromsø for the duration of the three Nordic chairmanships in order to maintain a continued focus on the common priorities and foster development of institutional memory. Six international organizations representing indigenous peoples have the status of Permanent Participants and work in full consultation with governments of the member states.

Founded in Ottawa, Canada, in 1996, the Arctic Council replaced the Arctic Environmental Protection Strategy established in Rovaniemi, Finland, five years earlier and serves as an intergovernmental forum for addressing many of the common concerns and challenges faced by the arctic states.

For more information, see the Arctic Council website: www.arctic-council.org; or contact the Secretariat (AC-chair11@npolar.no; +47-22-24-32-43).

IASC Secretariat Now Located in Stockholm, Sweden

The International Arctic Science Committee (IASC) Secretariat moved from Oslo, Norway, to Stockholm, Sweden, in January 2006. The new IASC Secretariat is hosted by the Swedish Polar Research Secretariat, a government authority that plans and coordinates Swedish research activities in the Arctic and Antarctic, and is supported by the Swedish Research Council. The office is located at the Royal Swedish Academy of Sciences.

Also in January 2006, Volker Rachold was appointed the new IASC executive secretary. Rachold earned his Ph.D. in geochemistry from the University of Göttingen in 1994, then worked as a senior scientist at the Alfred Wegener Institute for Polar and Marine Research in Potsdam and Bremerhaven, Germany.

Rachold's research background is focused on arctic land-ocean interactions and their links to climate change. He has extensive field experience in the Siberian Arctic; he was the expedition leader of several land- and ship-based Russian-German expeditions to Siberian rivers, river deltas, and coastal and shelf regions.

For the past five years, Rachold's research activities have concentrated on arctic coastal processes with a focus on the dynamics of permafrost coasts. He was the leader of the IASC project Arctic Coastal Dynamics (ACD), chair of the Arctic Coastal Processes Working Group of the 2nd International Conference on Arctic Research Planning (ICARP II; see *Witness* Winter 2004/2005), and co-chair of the Coastal and Offshore Permafrost Working Group of the International Permafrost Association.

Rachold is assisted by Anna Sundin, who earned her B.A. at Stockholm and Uppsala Universities. Before she came to IASC, Sundin worked in music publishing and university administration.

The previous executive secretary of IASC, Odd Rogne, retired at the end of 2005. Rogne had served as executive secretary since the founding of IASC in 1990. He is now serving as a senior advisor to the IPY International Programme Office (see page 4) and to the Arctic Monitoring and Assessment Programme (AMAP).

For more information, see: www.iasc.se or contact the IASC Secretariat (iasc@iasc.se; +46-8-6739613).

U.S. Hosts Arctic Science Summit Week 2007

Arctic Science Summit Week (ASSW) 2007 was held at Dartmouth College in Hanover, New Hampshire, on 14–20 March 2007.

ASSW is an annual event, organized by the International Arctic Science Committee (IASC) and other scientific organizations, that represents an opportunity for coordination, collaboration, and cooperation in all areas of arctic science. The meeting also provides a platform for the host country to present information on its arctic research programs.

This year marks the first time ASSW has been held in the U.S. The Hanover meeting falls at the beginning of the International Polar Year (IPY; see page 1) and was convened as one of the inaugural events for U.S. participation in the global research effort. The IPY International Program Office endorsed the meeting as part of the Dartmouth IPY project, Arctic Change: An Interdisciplinary Dialog Between the Academy, Northern Peoples, and Policy Makers.

The program for ASSW 2007 included an opening presentation by U.S. government officials on new international partnerships for arctic and polar science, along with Science and Project Days featuring invited speakers, poster presentations, and discussions on science issues driving the need for new international collaboration in many areas of polar science.

ASSW 2007 was hosted by the Institute of Arctic Studies at the John Sloan Dickey Center for International Understanding at Dartmouth College and the U.S. Army Cold Regions Research and Engineering Laboratory. Sponsoring organizations include IASC, Arctic Ocean Sciences Board, European Polar Board, Pacific Arctic Group, and Forum of Arctic Research Operators.

Past meetings have been held in Potsdam, Germany; Tromsø, Norway; Cambridge, UK; Iqaluit, Canada; Groningen, The Netherlands; Kiruna, Sweden; Reykjavik, Iceland; and Kunming, China.

For more information, see the ASSW 2007 website: www.assw2007.org, or contact the conference organizers (Institute.of.Arctic.Studies@dartmouth.edu; 603-646-1278).

International Opening Ceremony for IPY

The official international opening ceremony launching the International Polar Year (IPY) was held on 1 March 2007 at the Palais de la Decouverte, a science museum in Paris, France. The International Council for Science and the World Meteorological Organization (WMO), the co-sponsors of IPY, hosted the event. For more information, contact Mark Oliver at the WMO (moliver@wmo.int).

Other kick-off events on 1 March 2007 were held at:

- Danish Polar Centre in Copenhagen, Denmark. Contact Poul-Erik Philbert (pep@dpc.dk).
- Arctic Centre in Rovaniemi, Finland. Contact Riku Lavia (riku.lavia@ulapland.fi).
- Lagenbeck Virchow Haus in Berlin, Germany. Contact Margarete Pauls (m.pauls@awi-bremerhaven.de).
- Science Council of Japan in Tokyo. Contact Hajime Ito (ipy2007@nipr.ac.jp).
- Icehotel in Jukkasjärvi, Sweden. Contact Camilla Hansen (camilla.hansen@vr.se).

For information on other IPY opening events, see the IPY International Program Office website: www.ipy.org.

ARCSS Community Addresses Varied Research Needs

The Arctic System Science (ARCSS) Program supports both field work and research that synthesizes existing data and knowledge to advance understanding of the arctic system and its role in the global system and society. The ARCSS Committee (AC) takes a proactive approach on behalf of the research community in facilitating the development of the ARCSS Program. Appointed by ARCUS, which currently serves as the ARCSS Science Management Office (SMO), the AC is not an official NSF advisory committee but offers a mechanism through which NSF can stay informed of community interests. Chaired by Josh Schimel (University of California, Santa Barbara), the AC is currently composed of 12 investigators with broad scientific viewpoints and expertise.

ARCSS Committee Meeting

AC members met in Seattle, Washington, in early November 2006 to discuss ARCSS research and community planning activities, including news from NSF, ongoing ARCSS research, and data management efforts. Notes from the meeting are available online at: www.arcus.org/ARCSS/message_111606.html.

ARCSS Data Management

ARCSS synthesis requires data and modeling approaches to support novel modes of inquiry, such as intercomparison studies, data integration and assimilation, arctic and Earth system modeling, and cross-disciplinary data merging.

Community-based planning activities to formulate new ARCSS data management strategies are underway. An ARCSS workshop, Arctic System Synthesis: New Perspectives through Data Discovery and Modeling, was held 2-4 April 2007 in Seattle. 58 representatives of both the data provider and data user communities met to identify new approaches for uniting data management and assimilation, developments in technology, and modeling activities that will advance synthesis studies of the arctic system and broadly disseminate knowledge of the Arctic. The workshop, co-chaired by Charles Vörösmarty (University of New Hampshire) and David McGuire (University of Alaska Fairbanks), will result in a community-reviewed report summarizing key issues, common challenges, general lessons, and ideas for steps forward that emerged during the workshop as well as suggestions for possible NSF investments in this arena. The community was able to participate in discussions through several pre-workshop eTown Meetings, a Town Meeting at the Fall 2006 AGU meeting, and live interactive streaming of the workshop proceedings.

For more information, see: www.arcus.org/ARCSS/2007_data/index.html.

Ongoing ARCSS Research Activities

Organized research efforts supported by ARCSS include Synthesis of Arctic System Science (SASS), Study of Northern Alaska Coastal System (SNACS), Freshwater Integration Study (FWI), Western Arctic Shelf-Basin Interactions (SBI), and Human Dimensions of the Arctic System (HARC; see page 17).

Synthesis of Arctic System Science (SASS) Projects. SASS contributes to achieving an integrated understanding of the arctic system by focusing on the interactions occurring among multiple components and processes across a range of temporal and spatial scales. NSF has released two SASS program solicitations. Nine science projects were funded through a solicitation released in late 2004 (see *Witness* Spring 2006). In response to a second SASS solicitation in December 2005, NSF received 44 proposals in 20 separate projects totaling $16 million. In 2006, 8 projects were funded totaling $7.5 million:

- Understanding Change in the Climate and Hydrology of the Arctic Land Region: Synthesizing the Results of the ARCSS Fresh Water Initiative Projects. E. Wood (Princeton Univ.), C. Vörösmarty (Univ. New Hampshire), J. Cassano (Univ. Colorado [CU]), D. Lettenmaier (Univ. Washington [UW]). *$1,237,998*.
- The Impact of Changes in Arctic Sea Ice on the Marine Planktonic Ecosystem—Synthesis and Modeling of Retrospective and Future Conditions. Y. Spitz (Oregon State Univ.), J. Zhang (UW), C. Ashjian (Woods Hole Oceanographic Institution [WHOI]), R. Campbell (Univ. of Rhode Island). *$1,076,734*.
- Producing an Updated Synthesis of the Arctic's Marine Primary Production Regime and its Controls. M. Steele (UW), P. Matrai (Bigelow Laboratory for Ocean Sciences), R. Zimmerman (Old Dominion Univ.), L. Codispoti (Univ. Maryland). *$1,040,088*.
- Toward Reanalysis of the Arctic Climate System—Sea Ice and Ocean Reconstruction with Data Assimilation. J. Zhang (UW), A. Proshutinsky (WHOI), G. Panteleev (Univ. Alaska Fairbanks), D. Nechaev (Univ. Southern Mississippi). *$987,239*.
- The White Arctic: A Snow-Impacts Synthesis for the Terrestrial Arctic. M. Sturm (Cold Regions Research and Engineering Laboratory), G. Liston (Colorado State Univ.). *$839,616*.
- The Roles of Clouds and their Accomplices in Modulating the Trajectory of the Arctic System. S. Vavrus (Univ. Wisconsin-Madison), A. Schweiger (UW), J. Francis (Rutgers Univ.). *$757,806*.
- Synthesis of Sea Ice, Climate, and Human Systems in the Arctic and Subarctic. A. Ogilvie (CU), J. Rogers (Ohio State Univ). *$668,021*.
- Climate Response to Future Changes in Arctic Snow Cover and Sea Ice: A New Perspective from the High-Resolution NCAR CCSM3. C. Deser (Univ. Corp. Atmospheric Research). *$477,948*.

For more information see: www.arcus.org/ARCSS/synthesis_projects.html.

Freshwater Integration Study (FWI). Since 2002, FWI has focused on understanding the arctic hydrological cycle from an interdisciplinary perspective. FWI investigators hope to contribute to International Polar Year (IPY) Arctic-HYDRA, an international effort employing observations, models, process studies, and data assimilation techniques to characterize variability in the arctic hydrological cycle. In early November 2006, 22 participants from nine nations attended the 2nd IPY Arctic-HYDRA International Planning Meeting in St. Petersburg, Russia, to continue work

continued on next page

on the Arctic-HYDRA Science Plan and to outline activities for the IPY period.

FWI investigators held an All-Hands meeting in June 2006 in Estes Park, Colorado, to discuss synthesis strategies and products, updates from FWI working groups, and topics to focus on during the final two years of FWI projects. The next FWI All-Hands meeting will be held in California 6–8 June 2007. For more information, see: http://arcticchamp.sr.unh.edu.

Study of Northern Alaska Coastal System (SNACS). Funded in 2004, the six SNACS projects, focused on understanding how interactions and linkages in arctic coastal regions affect arctic and global systems, are entering their third and final year. At the 2006 AGU Fall meeting, 16 posters based on SNACS research were presented, and an oral session, Coastal Systems and Processes, was attended by approximately 50 people. An investigator meeting is planned for mid-2007 to focus on three major synthesis themes: fluxes from rivers and shoreline erosion as nutrient sources in the coastal zone, impacts of cryospheric changes on the coast, and potential rapid regime shifts controlled by atmospheric and meteorological processes. Ongoing outreach efforts include presentations to local officials and schools in Barrow and Atqasuk, Alaska. For more information, see: www.arcus.org/arcss/snacs.

Western Arctic Shelf-Basin Interactions (SBI). SBI research focuses on physical and biological linkages between arctic shelves and adjacent ocean basins toward an enhanced predictive capability for global change impacts in the Arctic. In December 2006, NSF released a solicitation intended to support the third and final phase of SBI, which has accumulated nearly ten years of field data and analyses. The solicitation calls for research aimed at understanding how the Arctic Ocean margins function within the arctic system as a whole. Priority will be placed on efforts that focus on data integration, synthesis, and modeling activities that lead to new system-level understanding, rather than projects that generate new data from field studies. Proposals were due 9 March 2007. For more information, see: http://sbi.utk.edu.

Communities of Practice

The AC continues to encourage the submission of Community of Practice (Co-oP) concept papers. Co-oPs are groups of researchers organized around a set of arctic system science questions. Co-oPs work with the AC, ARCSS SMO, and broader research community to develop science questions that align with and advance ARCSS Program goals and may ultimately form the basis of future ARCSS research opportunities.

Several Co-oPs are currently interacting with the AC, including the Near Surface Processes Co-oP, chaired by Andrea Lloyd (Middlebury College), which submitted a prospectus to explore how changing surface conditions (ice, snow, vegetation, infrastructure, and human patterns of population) affect the linkages between arctic system components. This Co-oP worked with the AC and community to develop the prospectus into a proposed implementation plan, entitled Surface Transformations in the Arctic Environment (STATE), to advance understanding of the trajectories and impacts of such changes. The AC is now developing a document describing these ideas for NSF to consider for future funding opportunities. For more information on this Co-oP or to submit a Co-oP concept paper, see: www.arcus.org/ARCSS/cop.html.

For more information on the ARCSS Program, see: www.arcus.org/ARCSS, or contact Josh Schimel (schimel@lifesci.ucsb.edu), Neil Swanberg (nswanber@nsf.gov), or Helen Wiggins (helen@arcus.org; 907-474-1600).

HARC Builds Capacity of Human Dimensions Research

Human Dimensions of the Arctic System (HARC) was created in 1997 as a component of the ARCSS Program to better understand human interactions with environmental change in the Arctic. With the guidance of the HARC Steering Committee, the HARC core office works to integrate human dimensions research into the ARCSS Program. Maribeth Murray, an associate professor of anthropology at the University of Alaska Fairbanks (UAF), directs the core office, which has been hosted at UAF's Center for Global Change since 2004. Recent core office activities have expanded the capacity of human dimensions research and conveyed research results to scientific and public audiences.

The core office hosted a special session at the October 2006 American Association for the Advancement of Science meeting in Fairbanks, Alaska. The session focused on the contribution of human dimensions research to observing and understanding the current state of the Arctic. Several presentations compared human dimensions research in the Arctic and in Africa.

The core office hosted an open meeting at the Fall 2006 American Geophysical Union Meeting, which included discussions on emerging needs of HARC research, approaches that will advance HARC goals, and efforts to integrate HARC research into larger ARCSS efforts.

The HARC core office agenda for the International Polar Year (IPY; see page 1) will be available in March and includes:

- a number of sessions at IPY-related meetings, beginning with the Arctic Forum in Washington, DC, 23–25 May 2007; and
- plans to sponsor travel awards for student research presentations at meetings during IPY.

Participants at the November 2006 ARCSS Committee (AC) Meeting in Seattle, Washington (see page 16), discussed the continued desire to see HARC research integrated into ARCSS projects and proposals through close cooperation with the core office. The AC suggested that the ARCSS Program support the core office for at least an additional year.

Current members of the HARC Steering Committee include: Maribeth Murray (UAF), Barbara Morehouse (Univ. Arizona), Ben Fitzhugh (Univ. Washington), Craig Nicolson (Univ. Massachusetts), Larry Hinzman (UAF), Alexey Voinov (Univ. Vermont), Larry Hamilton (Univ. New Hampshire), and Henry Huntington (Huntington Consulting).

For more information, see www.arcus.org/harc/index.html, or contact Maribeth Murray (ffmsm@uaf.edu).

Paper Charts Strengthen Submarine Record of Sea-Ice Draft

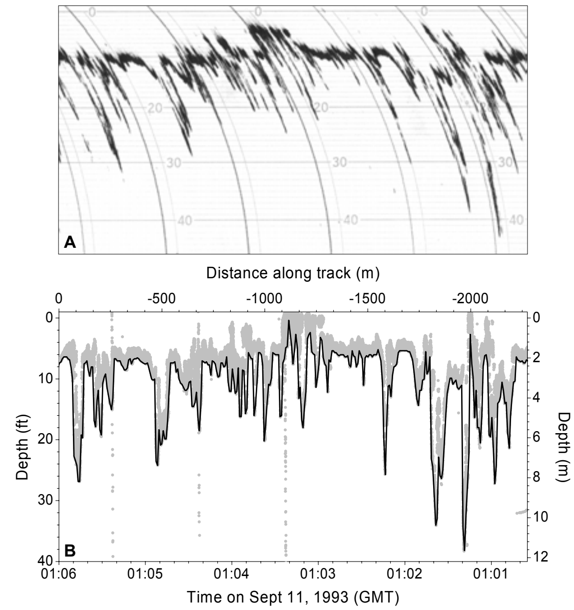
For nearly five decades, U.S. Navy and British Royal Navy submarines working in the Arctic Ocean have used upward looking sonar systems to take continuous measurements of sea-ice draft. Draft, the submerged portion of floating ice, represents about 89% of ice thickness.

Because of the scientific value of these records, the navies have over the years declassified and released ice draft data from past cruises. Digitally recorded data were available from 15 cruises between 1986 and 1994 and a single cruise in 1976. Most of these records were released between 1999 and 2004 and archived at the National Snow and Ice Data Center (NSIDC) after processing at the Cold Regions Research and Engineering Lab. From 1993 to 1999, the six cruises of the Scientific Ice Expeditions (SCICEX; see *Witness* Autumn 2001) program collected and released digital ice draft data specifically for research use. During 17 submarine cruises to the Arctic between 1975 and 2000, however, ice draft data were collected only on analog paper charts and required additional processing before they could be added to the public archive.

With funding from the Arctic System Science (ARCSS) Program, Drew Rothrock and Mark Wensnahan at the Applied Physics Laboratory at the University of Washington worked with Diane Bentley and other staff of the Arctic Submarine Laboratory to recover these paper records, digitize, and validate them (see figure this page). The procedure for extracting data from the charts was devised carefully to ensure that the results would be consistent with the digitally recorded data; two cruises with data recorded by both types of media were used to compare analog and digital records (Wensnahan and Rothrock 2005).

The newly digitized records became available through NSIDC in September 2006. The NSIDC now holds data from over 120,000 km (about 75,000 miles) of 37 U.S. Navy and 2 Royal Navy submarine cruises. The archives cover roughly the central half of the Arctic Ocean, a region that is perennially ice covered, with sampling from both the spring thickness maximum and the autumn minimum. Before the analog records were added, the archive was weighted toward the spring, with a spring to autumn ratio of nearly 2 to 1. With the new data, the spring to autumn ratio of the full 39 cruises is 1.16 to 1. The new cruises also greatly strengthen the long-term perspective of a record that was weak prior to 1986, adding data from nine cruises in the decade from 1975 to 1984.

The measured ice draft ranges from zero to over six meters. The mean and median draft both change by about one meter from the spring maximum to autumn minimum. Because the standard deviation of combined measurement errors from U.S. submarines is only 22 cm (Rothrock and Wensnahan, forthcoming), the much larger regional, seasonal, and interannual variations in draft can be resolved with reasonable accuracy. The submarine data are systematically biased about 30 cm thicker than the true draft, due primarily to the finite beamwidth of the sonar. This bias is important to consider when comparing drafts from U.S. submarines with models and with data measured by other methods.



Sea-ice draft data from submarine paper (analog) charts. (a) Segment of a chart, as scanned digitally to yield a bitmap image. (b) Digital transformation of chart image into rectilinear coordinates, showing the trace from the chart (grey), and the data trace (solid line) extracted and archived. The lines running from top to bottom of the chart are time marks, nominally one minute apart. Navigation data and ship's logs provide the speed by which time is converted to distance. At typical speeds, the system provides a spatial profile of draft data at about a one-meter spacing. Figure courtesy of M. Wensnahan.

These archived data provide a valuable 26-year record applicable to several problems in arctic science and observations. Portions of the data have been used to look for signs of interannual change in ice thickness, often in limited regions and over limited time periods; the entire record now provides a richer resource for such studies. There have been a few comparisons between submarine ice draft observations and the thickness produced in sea-ice models; many more such checks on model efficacy are now possible and would be a stimulus for model improvement. Although this data set is still relatively sparse, the possibility exists for assimilating these data into ice models; because ice thickness changes relatively slowly, even sparse data may provide a strong constraint on modeled thickness. Lastly, this record can be used for validating other technologies for observing ice thickness, such as autonomous vehicles, moored sonars, satellite altimeters, and electromagnetic sounding.

For more information, see the ice draft data on the NSIDC website: http://nsidc.org/data/g01360.html and http://nsidc.org/data/g01962.html, or contact Drew Rothrock (rothrock@apl.washington.edu; 206-685-2262) or Mark Wensnahan (thinice@apl.washington.edu; 206-685-7912).

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Wensnahan, M. and D. A. Rothrock. 2005. Sea-ice draft from submarine-based sonar: Establishing a consistent record from analog and digitally recorded data. *Geophysical Research Letters* 32, L11502, doi:10:1029/2005GL022507.

Frozen Arctic Soils Harbor Hardy Microbes

Looking at the bleak landscape of the Arctic during winter, it would be easy to assume that tundra ecosystems, caught between the cold air above them and the permafrost below, are frozen into complete stasis until the spring thaw. For many years, that assumption guided research on high latitude ecosystems, and investigators studied them primarily in the summer.

The assumption that tundra is biologically inactive in winter is incorrect, however. Microbial activity does not stop when soils freeze. Even in frozen soil, films of water on soil particles allow bacteria and fungi to remain physiologically active. Although microbial activity diminishes with decreasing temperature and is fairly low in frozen soil, the total amount of microbial activity over the long arctic winter is ecologically significant. As much as one-third of total annual decomposition and CO_2 release occurs during the nine months of winter. Because this is enough to shift tundra ecosystems from a net sink to a source of atmospheric CO_2, it is key to correctly assessing the tundra's role in the global carbon cycle. Seasonal changes in microbial ecology also appear to have important effects on nutrient availability for plant growth.

Josh Schimel of the University of California, Santa Barbara, and his team have been investigating tundra microbial ecosystems since 1998 with funding from the NSF Arctic System Science (ARCSS) Program's Arctic Transitions in Land-Atmosphere Systems (ATLAS) project (see *Witness* Spring 2003), the Arctic Natural Sciences Program, an Office of Polar Programs postdoctoral fellowship to Matthew Wallenstein, and the Mellon Foundation. They have been evaluating the nature of wintertime microbial processes, how carbon and nitrogen cycling are coupled differently during summer and winter, the chemical substrates microbes use, and how microbial communities change through the winter. They have conducted most of these studies at Toolik Field Station in Alaska (see page 8) and have done some work in the high Arctic at Thule, Greenland (see *Witness* Autumn 1997).

To describe seasonal changes in microbial communities and their physiology, Schimel's team has collected samples throughout the year, including in November, after soil freeze-up, and in May, before snowmelt. The work uses a combination of approaches, including:

- DNA-based techniques to analyze the composition of the soil microbial community;
- laboratory assays to evaluate microbial activity and physiology at temperatures down to -10 °C; and
- incubations following the flow of ^{13}C-labeled compounds into specific microbial fatty acids to identify which organisms use which substrates under different conditions.

Not surprisingly, many aspects of microbial processes change as soil temperatures decrease. During the summer, soil microbes primarily process plant litter, which is relatively low in nitrogen and high in carbon. The microbes also limit the nitrogen supply to growing plants in the summer by competing with them for the available nitrogen in the soil.

With the onset of winter, however, microbes acclimate to low temperatures with a suite of physiological changes, including a greater reliance on recycling nitrogen-rich microbial detritus as a metabolic fuel. On a nitrogen-rich winter diet, the microbes release unused nitrogen to the soil in a form plants can use. This shift to a winter metabolic mode occurs above 0 °C, before soils actually freeze and while microbial activity is still relatively high. Arctic soils remain at these temperatures for an extended period each fall during freeze up. As climate change results in warming across the Arctic, tundra soil temperatures hover for a longer time in this range where soil microbes are both in their winter mode and relatively active. These processes appear to tie into the observed increase in shrubbiness of the Arctic with a positive feedback: a longer period at near-freezing temperatures causes an increase in nitrogen availability, which stimulates shrub growth (particularly birch), trapping snow and warming the soil further. This increase in shrubbiness changes everything about the tundra, from its effects on climate to its ability to support foraging caribou.

Changes in the composition of microbial populations are associated with, and perhaps driving, the seasonal and vegetation changes. Bacterial and fungal populations differ in the soil of different tundra plant communities; for example, in all seasons, microorganisms normally associated with low quality substrates (e.g., Acidobacteria) dominate tussock tundra soils but are almost absent in shrub tundra soils. At high taxonomic levels (class for bacteria, division for fungi), these communities seem to be relatively stable across seasons. The particular species found within these larger taxonomic groups, however, do appear to change from summer to winter, especially the fungal species. Thus, the overlying vegetation appears to be the primary control on the functional groups of organisms present, but soil temperature controls which species within those groups are actually dominant. These changes in community composition may explain at least some of the seasonal shift in metabolic patterns observed in these microbial populations.

For more information, contact Josh Schimel (schimel@lifesci.ucsb.edu; 805-893-7688).

Shawna McMahon (left) and Josh Schimel (right) take a soil core from frozen tundra at Toolik Field Station in November 2005 to evaluate microbial community composition and function in wintertime soils. Photo by Colin Tucker.

Abundant Microbial Polymers Affect Sea Ice Structure

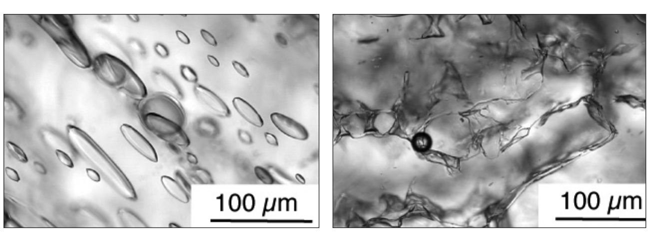
Sea ice provides a habitat for many polar organisms. A cold-adapted community of microorganisms and invertebrates, dominated by sea ice algae, lives in the ice itself within brine-filled pores and channels. Ice algae provide a significant fraction of yearly primary production in polar seas, and a layer of algae is often visible near the bottom of sea ice cores collected during springtime. Growth of ice algae begins in early spring, as soon as light is available, often several months before significant primary production in the water column. Much of the biomass and organic matter produced by the algae accumulates within the ice during the spring and is exported to the underlying water when the ice melts.

Many algae and bacteria, including those in sea ice, release extracellular polymeric substances (EPS), a complex mix of organic macromolecules, dominated by polysaccharides but also including lipids, nucleic acids, and proteins. EPS are sticky and form an extracellular matrix that can bind microbes together to form free-floating aggregates or biofilms on surfaces. In many environments, microbes depend on EPS to attach to surfaces; EPS are also known to alter the physical properties of sediments, rocks, aquifers, and the rheological properties of fluids. As evidence accumulates that EPS are important in microbial physiology and aquatic ecology, the NSF Arctic Natural Sciences (ANS) Program has funded three studies to investigate EPS production, function, and fate in arctic sea ice. Recent results indicate that EPS are ecologically significant in high latitude marine systems and essential to rendering sea ice habitable for algae.

Christopher Krembs and Dale Weinbrenner, both of the University of Washington's Applied Physics Laboratory, studied the evolution of EPS in sea ice near Barrow, Alaska. Cores of seasonal sea ice were collected from December 2003 through June 2004 to measure dissolved and particulate EPS concentrations, using several independent colorimetric methods, and variables such as salinity, chlorophyll, nutrients, and dissolved and particulate organic matter concentrations. They found that EPS accounted for 20–60% of the organic matter in sea ice. EPS were present in the ice as early as December, suggesting that EPS originally in the water became incorporated into the ice during freezing, a process that probably continued as the ice layer thickened each year. EPS concentrations within the ice changed over the season in response to several processes, including in-situ production by algae and bacteria and incorporation of sediment particles carrying large quantities of EPS. Melting snow also transferred a significant amount of EPS, probably derived from sea water aerosols, to the ice surface.

In addition to comprising a large fraction of the organic matter pool, the presence of EPS fundamentally affects the structure and physical properties of sea ice. The figure shows the regular pore structure of EPS-free, salt-water ice grown in the lab (left panel). By contrast, pores are irregular and convoluted in ice with EPS (right panel). EPS incorporation into ice appears to increase salt retention, increasing bulk salinity and surface roughness and decreasing ice strength. The complex, irregular pore structures filled with EPS create microhabitats and predation refuges for algal and bacterial cells and may also promote anchoring of cells to the ice.

When sea ice freezes, a large fraction of the salts are excluded from the ice crystal structure, producing high salinity, dense brine that sinks and overturns the under-ice boundary layer. When the ice melts, it releases relatively low salinity, low density water that tends to stratify the upper water column. In another ANS-sponsored project, Krembs is collaborating with Andrew Juhl of Lamont-Doherty Earth Observatory to study the interplay among ice physics, biomass export, and these seasonal cycles of salt content and export. By manipulating snow depth on the ice surface, they changed the underlying light availability and consequent growth rate of ice algae. Initial results indicate that higher algal growth resulted in greater EPS concentration within the bottom portion of the ice, which, in turn, increased bulk salinity of the ice. By retaining salt within the ice, EPS from ice microorganisms may facilitate attachment to the frozen habitat and influence convective exchange and vertical circulation near sea ice.



Left. Microscopic photograph depicting brine pores of laboratory grown EPS-free sea ice. Right. Ice grown in the presence of diatom EPS illustrating the effect on physical properties of ice. Photos courtesy C. Krembs.

With support from ANS, Michael Lizotte of the University of Wisconsin Oshkosh is investigating the effects of nutrient stress on EPS production, in collaboration with Michel Gosselin of the University of Quebec at Rimouski and the Canadian Arctic Shelf Exchange Study (CASES; see *Witness* Spring 2004). Although ice algae excrete a major portion of their carbon production, it is not known how much of the excreted material is EPS or another organic material. Lizotte measured carbon fixation by ice algae during the spring bloom of 2004. Early in the bloom, nearly all the photosynthetic products remained in cells. As the bloom peaked, however, 25–60% of photosynthetic production was excreted as EPS. This seasonal shift coincided with decreased photosynthetic efficiency, which is often seen in nutrient limited systems. Adding nitrogen to the algae in lab experiments improved photosynthetic rates, efficiency, and cell growth, but did not decrease the fraction of carbon excreted as EPS. Confirming that excreted photosynthetic products are mostly EPS is important for understanding carbon flow in arctic food webs, as EPS associated with cells are consumed by different organisms than consume dissolved organic material.

For more information, see: http://psc.apl.washington.edu/CKrembs/home.html, or contact Christopher Krembs (ckrembs@apl.washington.edu), Andrew Juhl (andyjuhl@ldeo.columbia.edu), or Michael Lizotte (lizotte@uwosh.edu).

Study Explores Ceramic Production in Coastal Alaska

Although archaeologists seldom think of the Alaskan Arctic when studying prehistoric pottery, Native people in this region produced clay cooking vessels for some 2,500 years, with production ceasing in the late 19th century.

The presence of clay cooking pots in Alaska is surprising for several reasons. First, with few exceptions, preindustrial ceramic production was limited to areas of the world with a warm and dry climate for at least part of the year, due to the difficulty of making pottery in cool and wet conditions. Second, cross-cultural data indicate that the use of ceramic cooking pots is typically associated with agricultural societies, presumably because of the lengthy cooking process needed to render starchy seeds digestible. Finally, the shape and textures of Alaskan cooking pots (flat-bottomed, open-mouthed, and thick-walled; see figure) are puzzling because these characteristics seemingly would have been poorly suited to most cooking activities. Experimental research has shown that vessels with these attributes are slow to heat and highly susceptible to cracking during the heating and cooling process.

With funding from the NSF Arctic Social Sciences Program, Lisa Frink and Karen Harry, both of the University of Nevada, Las Vegas, are investigating historic ceramic cooking vessels from the Thule period (beginning in A.D. 1000) using archival, ethnographic, and oral history sources and experimental research. Although whole cooking vessels are rare in museum and archaeological collections, they were able to document two such artifacts from the Nelson Island region in western Alaska, which are now housed at the University of Alaska Museum of the North in Fairbanks. The results of this effort confirmed the specific characteristics of the arctic cooking vessels. The vessels are very small compared to most ceramic cooking pots used throughout the world, capable of holding only about a pint or two of contents. Ethnographic and oral history data were used to gain insight into the reasons behind the pots' size and shape.

A ceramic cook pot from Nelson Island, which is located in western Alaska, next to a standard coffee cup. The pot is 18.5 cm tall by 16.5 cm in diameter at the rim. The walls are 5–6 cm thick. This pot is housed at the University of Alaska Museum of the North in Fairbanks. Photo courtesy of Lisa Frink.

The field portion of the project was carried out in summer 2005 in the village of Tununak on Nelson Island and consisted of interviews with elders and the experimental replication of pottery using traditional techniques and materials. Tununak is historically known to have been a primary source of the clay, or *qikut*, used to produce pottery along the Yukon-Kuskokwim delta coast. Although none of the Tununak elders had ever witnessed a clay cooking pot being used and very few of them remembered ever seeing one produced, they nonetheless had important knowledge about the properties of island clays and traditional cooking techniques that had been used. Additionally, many were familiar with how the cooking pots had been produced because of information that had been passed down through the generations. For example, several elders reported that after being shaped, the pots would have been coated with seal blood and slowly dried by an open fire.

After collecting locally available clays reported to have been used in ceramic production, the team, along with expert hand-mold potters Clint Swink and Cory Dangerfield, attempted to make cooking pots using the traditional techniques. The results suggest that although the shape and size of the vessels initially might seem poorly suited for cooking activities, they did in fact work well using indigenous cooking methods. Traditional cooking techniques did not require a lengthy cooking process. Instead, meats were parboiled or lightly heated using a fondue-like technique. Given this cooking technique, the small size and open mouth of the pot would have been advantageous since it required less fuel to heat and allowed the cook to easily move food into and out of the pot. Additionally, they found that the shape and other technical attributes of the pot were necessitated by the challenges of making pots under cool and humid conditions. Pots having other shapes and textures proved too difficult to produce in the cool and wet conditions of coastal Alaska.

Controlled laboratory experiments are currently underway to further evaluate the functional characteristics of Alaskan pottery and to investigate what performance characteristics, if any, might have been enhanced by the use of traditional techniques such as the addition of seal blood. A presentation of the project findings was given to the village in December 2005, and future outreach activities are planned upon completion of the project.

For more information, contact Lisa Frink (lisa.frink@unlv.edu; 702-895-1114) or Karen Harry (karen.harry@unlv.edu 702-895-2534).

Project Uncovers History of Norse Settlement

As Scandinavian (Norse) colonization moved westward from approximately A.D. 800–1000, northern European economic systems and domestic mammals were introduced to islands in the North Atlantic, specifically the Faroe Islands, Iceland, and Greenland. In each place, the outcome of the evolutionary interactions between colonizers and their environments proved radically different. These three contrasting island cases provide lessons for modern landscape management and illuminate the history of settlement in the region.

As part of a project funded by the NSF Arctic Social Sciences Program, Thomas McGovern of the North Atlantic Biocultural Organization (NABO) and City University of New York worked with an international team of researchers, also of NABO, to complete excavation and survey work on ancient Scandinavian sites in each of these arctic islands. The team is investigating the ecological impacts of human settlement in these areas to provide a better understanding of how past social and ecological factors have shaped the current landscape. With logistical support from VECO Polar Resources (VPR; see page 5), the project has applied a multidisciplinary approach combining zooarchaeology, archaeobotany, geoarchaeology, extensive modeling, and close cooperation with local communities to elucidate the reasons behind land use choices and their often unintended consequences.

A North Atlantic Biocultural Organization research team excavates a site at Brattahlið, an ancient Norse settlement in southern Greenland. Approximately 250 residents live in the modern day community of Qassiarsuk, which is located right beside this site. Photo courtesy of Thomas McGovern.

Early in their colonization of the Faroes, the Norse achieved a sustainable balance between trading economy, pasture productivity, and climate variability that has been effectively maintained to the present. Evidence of heavy use of wild resources, especially puffins and other sea birds, extends throughout the record of occupation, indicating reduced livestock grazing pressure on the landscape and successful community management.

In Iceland, humans caused massive environmental impact—over 90% of the forest cover and 40% of the soils present at the time of first settlement (around A.D. 871) have been lost. NABO research, however, has uncovered evidence of successful long-term waterfowl conservation around Lake Mývatn, a shallow lake located in northern Iceland. Today, Mývatn is a biological world heritage site where large numbers of migratory waterfowl come from both Europe and North America to nest around the lake. The team used historical and ethnographic accounts extending back approximately 150 years to show that local farmers sustainably harvested up to 40,000 waterfowl eggs per year, with clear rules for taking only a few eggs per nest and sparing adult birds.

Six archaeological sites in the Mývatn area, dating back to the 9th century settlement, indicate that these practices began early on. Excavations revealed heavy concentrations of egg shells from ducks, ptarmigan, and some sea birds. Few bird bones were recovered from these early Viking age deposits, and those that were excavated are nearly all ptarmigan rather than migratory waterfowl. Although settlement of the inland Mývatn district eventually triggered large scale soil erosion, the sustainable community level management of this rich but fragile natural resource now can be shown to extend back over 1,200 years.

The research team also discovered substantial quantities of fish bone at the Mývatn basin sites, which are located 50–70 km inland from the Arctic Ocean. The fish, without heads and upper vertebrae, included a mix of haddock, cod, saithe, and ling. The presence of processed, preserved marine fish located far inland hints at a wider economic network connecting multiple regions in Iceland from the earliest days of the Viking settlement onwards, predating the earliest inland distribution of dried fish in Britain by over a century. This evidence for 9th and 10th century economic integration of coastal and far inland sites suggests a larger scale community migration than previously thought.

Despite early success in establishing a mixed hunting and farming economy in Greenland, the Norse settlements were mysteriously abandoned by 1450. Since 2005, NABO has worked collaboratively with Greenland Museum and Archives (NKA), local museums at Narsaq and Qaqortoq, and the Danish SILA Arctic Center to sponsor archaeological excavations and surveys. Two seasons of excavation in 2005–2006 centered on stratified midden (refuse) deposits outside a chieftain's farm at Brattahlið, which remained after a 1932 excavation of the structures (see photo). In 2006, NABO worked closely with NKA and VPR in a rescue excavation of a site located inland from Brattahlið, which was scheduled to be flooded due to hydroelectric dam construction. The successful rescue work documented a Viking-age long hall beneath the ruin. McGovern and the team are still analyzing the findings, but early results indicate extensive walrus hunting and ivory processing at Brattahlið, as well as consumption of cattle and caribou.

The emerging story of long-term human resource management in these islands is proving unexpectedly rich, with a complex dynamic mix of sustainable and eventually unsustainable human economic strategies set against fluctuating climate.

Further description of this work can be found in recent issues of the journal *Environmental Archaeology* and in the March 2007 issue of *American Anthropologist*. For more information, contact Thomas McGovern (nabo@voicenet.com; 212-772-5410).

Scientists and Educators Find Uses for Virtual Globes

Online, interactive 3D models of the Earth, or virtual globes (VGs), continue to emerge as useful tools for both researchers and educators. VGs enable users to move freely, or "fly," over a digital representation of the planet. Models may include multiple views of features such as topography, atmospheric layers, ocean bathymetry, and man-made structures, as well as visual representations of parameters such as biological diversity and population density. Scientists may also overlay the terrain with field data and links to external websites.

From a user's perspective, no single VG or set of digital mapping tools is suitable for every potential application. Programs such as World Wind, EarthSLOT, ArcGIS Explorer, and Google Earth are each suitable for multiple functions, and which one a scientist or educator uses depends on exactly what they want to accomplish.

Developed by NASA, World Wind employs satellite imagery and U.S. Geological Survey aerial photography to form 3D models of the Earth, Moon, Mars, and other bodies in the solar system. EarthSLOT is an NSF-funded VG that focuses on the Arctic and includes Digital Elevation Models and science applications not readily available elsewhere. ArcGIS Explorer allows display, analysis, and integration of data in 2D and 3D views. Google Earth, a popular VG application credited with spurring public interest in VGs, combines satellite imagery, maps, aerial photography, and its own search engine to create 3D models that can be searched for addresses or driving directions. Providers of software enabling users to create custom VGs include Skyline, ESRI, and GeoFusion.

The First Annual Virtual Globes Scientific Users meeting was held in July 2006 as a first step toward establishing a network of users to discuss and promote VG technology in support of Earth sciences. Over 70 scientists, educators, programmers, data archival experts, and others assembled in Boulder, Colorado, to assess the present state of VGs and focus on future development and potential applications. Organized by Matt Nolan of the University of Alaska Fairbanks, the meeting was sponsored by the Arctic Region Supercomputing Center and the National Snow and Ice Data Center (NSIDC).

Research uses of VGs often involve integrating a VG interface with open-source tools and project-specific data to achieve custom visual representations. The Alaska Volcano Observatory (AVO), for example, adds thermal satellite image overlays to a Google Earth model for integrative, real-time volcano monitoring capability. AVO investigators can use this VG to look for pre-eruption increases in ground temperature and create hazard scenario models with 3D animation of probable ash plumes and fallout locations.

VGs are also a user-friendly tool for distributing data. Data sets can be archived as Keyhole Markup Language files, the emerging standard, and downloaded and opened using most VG applications. Data may also be embedded directly within the 3D map window via links corresponding to the geographic locations where the data were collected. For example, NSIDC archives on its website a number of cryospheric data sets related to glaciers, permafrost, snow, and ice that can be viewed using Google Earth. EarthSLOT similarly features 3D visualizations of glaciers and research stations with links to corresponding data (see *Witness* Winter 2004/2005).

As tools for educational outreach, VGs appear to have great potential for use in several settings (see box). "Windows on Earth," an NSF-funded museum exhibit to be installed at the Smithsonian National Air and Space Museum and other locations in the U.S., simulates the experience of an astronaut viewing the Earth through a window on the International Space Station.

The Second Annual Virtual Globes Scientific Users Conference will be held as part of the 5th International Symposium on Digital Earth (www.isde5.org) in San Francisco in June 2007.

For more information on use of VGs in arctic applications, see: www.earthslot.org, or contact Matt Nolan (matt.nolan@uaf.edu; 907-474-2467). ■

Middle School Students "Fly" to the Arctic

The visual and interactive nature of VGs makes them ideal tools for educational outreach, particularly in helping students comprehend otherwise complex scientific processes. One hundred and eighty middle school students from Boulder, Colorado, experienced this firsthand at the Institute of Arctic and Alpine Research (INSTAAR) when William Manley, a fellow of the institute, took them on a virtual tour of the Arctic to learn about climate change.

The students "flew" into the North American Arctic where a series of geographic placemarks conveyed key findings from the 2004 Arctic Climate Impact Assessment (see *Witness* Winter 2004/05). An embedded link at each placemark opened a custom web page with graphics, photographs, and concise take-home messages. The broad range of topics included reduced sea ice, melting glaciers, coastal erosion, and changes in animal and plant populations, among others.

The tour ended by zooming from the Arctic all the way to the students' middle school, establishing for them a direct connection between their home and the North. Manley noted how the geographic structure of the lesson enabled a smooth visual transition between interrelated topics and that the information became most relevant when the students flew to a locale they knew personally.

The tour was part of the 2006 INSTAAR Open House, an annual event held each spring with NSIDC to highlight Earth and environmental research through lab tours and activities for K–12 students. VG demonstrations have become a regular feature of the open houses, and their popularity illustrates the potential of VGs in the classroom.

For more information, contact William Manley (william.manley@colorado.edu; 303-735-1300). ■

NSF Funds Nine IPY Education Projects

In response to the education theme within the joint Office of Polar Programs and Education and Human Resources solicitation for the International Polar Year released in January 2006, NSF received 64 proposals requesting over $50 million. In September, NSF funded nine projects totaling $5.8 million in two categories:

- informal science education, and
- formal science education for undergraduate or graduate students or K–12 teachers and students.

Informal Science Education Awards

POLAR-PALOOZA. $1,250,001. G. Haines-Stiles, Geoff Haines-Stiles Productions. This two-year project, which is jointly funded by NASA, will support polar scientists, Alaska Natives, and other experts and artists to share their "stories from a changing planet" at more than 25 science centers, museums, and libraries, and large numbers of schools across North America. High definition video footage from the Arctic and Antarctic, audio and video podcasts, and education and outreach activities for targeted audiences will be available online to augment the live presentations. See the initial website at: http://passporttoknowledge.com/polar-palooza.

Engaging Antarctica. $1,168,014. J. Farrell, University of Nebraska-Lincoln. This three-year project will produce a one-hour Public Broadcasting Service television documentary to air on NOVA in fall 2008. Focusing on ice sheet dynamics in Antarctica and featuring the Antarctic Geological Drilling and West Antarctic Ice Sheet projects, the documentary will be supplemented by geoscience outreach materials accessible via the Internet, including images, video and audio files of scientists' stories, and inquiry-based activities.

Live from the Poles: A Multimedia Educational Experience. $483,955. C. Linder, Woods Hole Oceanographic Institution. $97,202. P. Fontaine, Museum of Science Boston. This two-year collaborative project will bring researchers, science centers, and broadcast media reporters together to convey the story of four polar research expeditions to public and classroom audiences. Daily webcasts will be posted on an expedition website modeled after the successful Dive and Discover website of Woods Hole Oceanographic Institution, and audiences at museums, science centers, radio and television stations, and student reporters writing for Scholastic Online will participate in several scheduled real-time phone calls from the field.

Pole to Pole. $579,087. M. Rankin, Soundprint Media Center, Inc. This two-year project will include radio documentaries and short radio features on topics relevant to IPY broadcast by public and satellite radio stations in the U.S., British Broadcasting Corporation, Australian Broadcasting Corporation, Deutsche-Welle, and Radio New Zealand. A clearinghouse of the radio programs, interviews, and sounds will be available online for use by public and professional audiences.

Formal Science Education Awards

IPY-ROAM: International Polar Year Research and Education Opportunities in Antarctica for Minorities. $452,108. C. Tweedie, University of Texas at El Paso. This two-year project will support minority students and educators to participate in an Antarctic field class focused on system science. Fifteen undergraduates, five graduate students, and five high-school science teachers will complete an online lecture series and travel to the Antarctic Peninsula to learn about exploration and history, past and ongoing research, policy and tourism, and to conduct hands-on research. Live video feeds will convey the field experience to radio and classroom audiences.

Fostering Collaborative Interdisciplinary Relationships Among the New Generation of Polar Researchers Participating in the IPY. $190,311. S. Weiler, Whitman College. $35,429. S. Drobot, University of Colorado at Boulder. This 2.5-year collaborative project will bring together past, current, and new polar investigators from diverse natural and social science disciplines for a symposium to cultivate cross-disciplinary interactions during IPY. The Next Generation Polar Research Symposium, to be held on 4–11 May 2008 in Colorado Springs, Colorado, will provide new researchers with a common sense of history and purpose, increased understanding of each others' work, and insight into conveying the essence of polar regions and research beyond academia. The event will also promote connections among researchers during IPY and in the future. See: http://ccar.colorado.edu/ngpr.

Adapting SENCER to the Arctic: Improving Polar Science Education as a Legacy. $72,354. L. Duffy, University of Alaska Fairbanks (UAF). For this project, UAF will develop an undergraduate course entitled Environmental Radioactivity, Stewardship, and People in the North. The course structure will be based on the Science Education for New Civic Engagements and Responsibilities (SENCER) model. It will teach the science of radioactivity and its effects on the people and cultures of Alaska and increase community engagement through service projects. The course is being offered for the first time in spring 2007 and is designed to be relevant and engaging to Alaska Native students.

PolarTREC–Teachers and Researchers Exploring and Collaborating. $372,962. (continuing grant) W. Warnick, Arctic Research Consortium of the U.S. See page 25.

Teachers Domain: Polar Sciences. $199,893. T. Sicker, WGBH Educational Foundation. This project will develop a prototype digital library collection of polar video segments, interactive activities, and other multimedia resources from WGBH archives and IPY projects, which will be accompanied by lesson plans and student activities that integrate these resources and address curricular needs at middle- and high-school grade levels. This initiative builds upon and expands the power, scope, and user base of WGBH Teachers' Domain (www.teachersdomain.org), a portal providing multimedia resources for the classroom and professional development.

NSF released a second IPY solicitation in December 2006. Education and outreach was an emphasis area within the announcement, and full proposals were due 16 March 2007.

More IPY information for the education and research communities is available at: www.nsf.gov/od/opp/ipy/ipyinfo.jsp.

Teachers will "TREC" to Both Poles during IPY

PolarTREC—Teachers and Researchers Exploring and Collaborating—is a teacher research experience project, funded by an NSF International Polar Year (IPY) education award (see page 24), in which K–12 teachers participate in field research in the Arctic and Antarctic, as a pathway to improving science education. Over the next three years, PolarTREC will enable 36 U.S. teachers to spend two to six weeks working closely with researchers and communicating extensively with their colleagues, communities, and students of all ages around the globe. The polar regions naturally engage classroom and public audiences; IPY presents an opportunity for scientists and teachers to share their research experiences in these unique environments.

During the first PolarTREC expedition in December 2006, teachers Ute Kaden and Allan Miller spent 17 days aboard the Swedish icebreaker *Oden*, working with scientists from Sweden, Chile, and the U.S. collecting data around Antarctica. Expedition activities included monitoring wildlife; mapping the chemical, thermal, and bathymetric properties of the ocean; and measuring the abundance of plankton. Kaden, Miller, and other members of the expedition team participated in two live calls from the ship reaching nearly 330 students and educators. In April 2007, teacher Robert Harris worked with Cathleen Geiger and colleagues on the Sea-ice Experiment: Dynamic Nature of the Arctic (SEDNA) project at an ice camp in the Beaufort Sea. Three science education programs joined the first Bering Ecosystem Study (BEST; see page 13) cruise in April: teacher Maggie Prevenas (supported by PolarTREC and the National Oceanic and Atmospheric Administration [NOAA] Teachers at Sea program), graduate student Emily Davenport (supported by the NSF GK–12 program [see *Witness* Autumn 2001]), and museum educator Robyn Staup (supported by PolarTREC) are collaborating and sharing PolarTREC resources to communicate their experiences aboard the USGCG *Healy* in the eastern Bering Sea.

Deployment for other PolarTREC expeditions is currently underway with a total of 15 teachers accompanying researchers into the field during the 2007 arctic and 2007/2008 Antarctic field seasons. A total of 155 teachers applied for the first year of the program; selected teachers participated in a program orientation, including safety and communications training, in March 2007.

PolarTREC builds and expands on the TREC program (Teachers and Researchers Exploring and Collaborating in the Arctic), which completed its third and final year in 2006. Since its inception in 2004, TREC engaged 26 teachers in unique learning experiences, sending them to arctic field locations as integral members of scientific research teams and initiating sustained teacher-researcher collaborations (see *Witness* Winter 2004/2005). TREC teachers used satellite phones, online journals, photographs, podcasts, and interactive "live from the field" events to relay their experiences in remote field locations to classroom and public audiences. During the live presentations teacher-researcher teams connected with over 800 students and 700 teachers and administrators across the nation, increasing student and public interest and engagement in arctic science. Although the expedition phase of TREC has ended, teachers continue to share what they have learned through curriculum development and peer mentoring. More information about TREC is available at www.arcus.org/TREC.

PolarTREC is administered by ARCUS with logistical support from arctic and Antarctic logistics providers. For more information, see: www.polartrec.com, or contact Katie Breen or Janet Warburton at ARCUS (breen@arcus.org, warburton@arcus.org, 907-474-1600).

Students participating in a climate change research project through the NSF Research Experiences for Undergraduates program gather to view a year's worth of data downloaded from a weather station near Lake Linne in Svalbard, Norway. The photo was taken by Robert Oddo, a high school science teacher from New York, who participated in the project through the TREC Program.

Agencies Collaborate on IPY Education

NSF is contributing to an interagency effort with the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) to organize symposia focused on IPY science at two National Science Teachers Association (NSTA) meetings.

With over 55,000 members, NSTA is the largest and oldest national organization of K–12 science teachers. Each year, NSTA holds a national meeting with over 30,000 participants, as well as regional meetings offering information on science content, teaching strategies, and research. These meetings present ideal opportunities to involve educators in IPY science and provide them with resources to leverage interest in polar regions while teaching science content aligned with national standards.

Three IPY symposia were included in the NSTA 2007 national meeting held in St. Louis, Missouri on 28 March–1 April, focusing on one of three themes: ice, life, and water and air. NSTA staff and researchers supported by NSF, NASA, and NOAA developed content for the symposia by tying current polar research approaches and results to relevant national science teaching standards. All NSTA symposia include follow-on web seminars and discussion listserves to allow participants to revisit their experience and share ideas with others.

For more information, see: www.nsta.org/conferences.

UArctic Celebrates Fifth Anniversary, Prepares for IPY

The University of the Arctic (UArctic) celebrated its fifth anniversary in June 2006 at its annual council meeting in Bodø, Norway, by recalling its achievements and honoring its first graduating class.

The concept of "a university without walls" dedicated to the study of northern subjects originated in 1997 with a Circumpolar Universities Association working group and received formal encouragement at the Arctic Council Ministerial Meeting in Iqaluit, Canada, the following year. In 2001, 200 educators, administrators, and government and indigenous representatives gathered in Rovaniemi, Finland, to mark the official opening of UArctic as a cooperative network of universities, colleges, research institutes, and other organizations that share resources to offer post-secondary education opportunities to northern students.

Currently 101 member institutions located across the circumpolar north participate in UArctic. Students registered at any member institution may take part in UArctic's programs, which include distance education classes, hands-on field research, and exchange programs (see *Witness* Spring 2003).

In its first five years of operation, UArctic has registered 1,700 students for classes in its Circumpolar Studies Program, a curriculum comprised of the Bachelor of Circumpolar Studies (BCS) Core and Advanced Emphases. The BCS Core includes an introductory course and six additional courses in three interdisciplinary fields that provide students with a broad understanding of the people, cultures, land, and contemporary issues in the circumpolar North. Advanced Emphases include upper-level courses with a comprehensive focus on a particular area of study related to the Arctic. Students may take these courses online, via video conference, and in the classroom at their home institution or while on exchange at a member institution.

UArctic held its first graduation ceremony at the Bodø meeting and honored the inaugural class of 17 students who received baccalaureate degrees in Circumpolar Studies. Because UArctic is not a degree-granting institution, the students' diplomas were each conferred by the member institutions where they were registered. With all but two of the graduating class in attendance, the commencement offered a chance for the assembled educators to celebrate the students' achievement and reflect on the program's success.

Another UArctic program, north2north, allows students enrolled at one member institution to travel and study at another member institution for a period of 3–12 months (see *Witness* Spring 2004). Sixteen students participated in north2north in 2002, the first year of the program. That number has increased every year since, to a high of 101 students in the 2005–2006 academic year. In total, north2north has sent 236 students on exchange programs around the Arctic.

UArctic is a cooperative network of 101 universities, colleges, and other organizations that provides post-secondary education programs, including distance education classes, hands-on field research, and exchange programs, to students in the circumpolar North.

UArctic's newest program is GoNorth, an initiative to promote northern educational institutions and opportunities for study in the Arctic to those living outside the region. The multi-year plan for the program seeks to encourage students from non-member institutions to participate in exchange programs at member institutions in the Arctic.

With financial support from the United Nations Environment Programme (UNEP) and a focus on outreach and increased accessibility, UArctic recently began posting its course catalog online. Intended as an annotated list of all arctic-related courses, the catalog currently lists 200 courses offered at 14 member institutions. UArctic plans to compile a complete online list in 2007.

UArctic will have a key role in higher education and outreach activities during the International Polar Year (IPY), which begins in March 2007. Hosted at the University of Alaska Fairbanks, the UArctic Office for IPY Education and Outreach will administer a suite of IPY-themed programs that include education and research opportunities for undergraduate and graduate students, professional development for instructors, and science education projects for the general public.

UArctic is a decentralized organization with its administrative and programmatic centers hosted by various member institutions. The International Secretariat, responsible for administrative coordination and information services such as the monthly newsletter, website, and media relations, is currently hosted by the University of Lapland in Rovaniemi, Finland. The President, currently Lars Kullerud of UNEP/GRID-Arendal in Norway, serves as the chief executive officer and is the head of UArctic's academic programs.

The highest governing body of UArctic is the 11-member Board of Governors, chaired since 2001 by Oran R. Young of the University of California, Santa Barbara. Member institutions are represented on the Council of UArctic, which oversees program development and elects governors to the board. The next meetings of the council will be held in Arkhangelsk, Russia, 4–8 June 2007, and Edmonton, Canada, in spring 2008.

While member institutions currently cover costs of localized student services, UArctic's funding plan calls for stable, long-term contributions from the eight arctic nations to support administrative operations, student exchange programs, and online course management. Norway, Finland, and Canada have consistently committed to the plan's long-term goals, the last doubling its 2006 contribution to $750,000 CDN. In fall 2006, the U.S. State Department also allocated multi-year funds to UArctic.

For more information, see the UArctic website: www.uarctic.org, or contact Outi Snellman (secretariat@uarctic.org; +358-40-5010209).

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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

May 2–5, 2007 37th International Arctic Workshop. Freysnes, Iceland. For more information, see: www.earthice.hi.is/page/arctic.

May 3–4, 2007 Smithsonian at the Poles: Contributions to International Polar Year Science. Washington, DC. For more information, see: www.si.edu/ipy.

May 4–9, 2007 Greenland IPY 2007 Space Science Symposium. Kangerlussuaq, Greenland. For more information, see: www.gsss-2007.org.

May 23–25, 2007 ARCUS 19th Annual Meeting and Arctic Forum 2007. Washington, DC. For more information, see: www.arcus.org/annual_meetings/2007/index.html.

May 30–June 2, 2007 Climate Change Impacts on Boreal Forest Disturbance Regimes: VI International Conference of Disturbance Dynamics in Boreal Forests. Fairbanks, Alaska. For more information, see: www.icddbf.uaf.edu.

June 4–5, 2007 World Environment Day 2007: Melting Ice - A Hot Topic? Tromsø, Norway. For more information, see: www.wed.npolar.no.

June 11–15, 2007 Cryogenic Resources of Polar Regions International Conference. Salekhard City, Russia. For more information, see: www.ikz.ru/permafrost.

August 20–24, 2007 IPY GeoNorth 2007: First International Circumpolar Conference on Geospatial Sciences and Applications. Yellowknife, Northwest Territories, Canada. For more information, see: http://ess.nrcan.gc.ca/ipygeonorth.

September 11–14, 2007 High Latitude Terrestrial and Freshwater Ecosystems: Interactions and Response to Environmental Change Workshop. Abisko, Sweden. For more information, see: www.emg.umu.se/circ/workshop.

June 29–July 3, 2008 9th International Conference on Permafrost. Fairbanks, Alaska. For more information, see: www.nicop.org.

For more events, see the Calendar on the ARCUS website: www.arcus.org/ARCUS/Calendar/index.html.

Publications

Akbalian, E., Golubchikova, V., and Khvtisiashvili, Z. 2006. *Practical Dictionary of Siberia and the North*. European Publications. 1,104 pages. ISBN: 5-98797-002-4. €100. See the Ruslania Books website: www.ruslania.com.

Belanger, Dian Olson. 2006. *Deep Freeze: The United States, the International Geophysical Year, and the Origins of Antarctica's Age of Science*. University Press of Colorado. 544 pages. ISBN: 978-0-87081-830-1. $29.95 USD. See the University Press of Colorado website: www.upcolorado.com.

Johannessen, Ola M., et al. 2006. *Remote Sensing of Sea Ice in the Northern Sea Route: Studies and Applications*. Springer Praxis Books. 472 pages. ISBN: 3-540-24448-4. $199 USD. See the Springer website: www.springer.com.

Laugrand, F., Oosten, J., and Trudel, F. 2006. *Apostle to the Inuit: The Journals and Ethnographic Notes of Edmund James Peck—The Baffin Years, 1894–1905*. University of Toronto Press (UTP). 420 pages. ISBN: 0802090427. $75 USD. See the UTP website: www.utppublishing.com/pubstore.

Marcy, Suzanne. 2006. *Alaska Region Science Strategy*. National Park Service (NPS). 92 pages. See the NPS Alaska Region website: www.nps.gov/akso.

Parsons, Mark A., et al. 2006. *International Polar Year Data Management Workshop, 3-4 March 2006. Cambridge, UK*. Glaciological Data Series, GD-33. National Snow and Ice Data Center (NSIDC). 41 pages. See the NSIDC website: http://nsidc.org.

Richter-Menge, J., et al. 2006. *State of the Arctic Report*. NOAA OAR Special Report. NOAA/OAR/PMEL. Seattle, Washington. 36 pages. Contact Jim Overland (206-526-6239; James.E.Overland@noaa.gov).

Stokke, Olav Schram, and Hønneland, Geir, eds. 2007. *International Cooperation and Arctic Governance: Regime Effectiveness and Northern Region Building*. Routledge. 224 pages. ISBN: 0415399343. $120 USD. See the Routledge website: www.routledge.co.uk.

Stuckenberger, A. Nicole. 2007. *Thin Ice: Inuit Traditions within a Changing Environment*. University Press of New England (UPNE). 80 pages. ISBN: 0-944722-33-4. $24.95 USD. See the UPNE website: www.upne.com.

A Note From the ARCUS President

The sky is falling! I refer to the accelerated environmental change that has been documented throughout the Arctic. In my mind, the biggest difference between the upcoming International Polar Year (IPY) 2007–2008 and the International Geophysical Year of half a century ago is that today we have a clear mandate for understanding the polar regions in the context of the long-term habitability of our planet.

U.S. participation will be critical in the success of IPY. Efforts that stand to make significant contributions to the overall IPY research enterprise include the Arctic Observing Network (AON), Study of Environmental Arctic Change (SEARCH), Bering Ecosystem Study (BEST), Ecosystem Studies of SubArctic Seas (ESSAS), Arctic Ocean Biodiversity (ArcOD), and the Arctic Human Health Initiative (AHHI)—a veritable alphabet soup of acronyms. Despite the promise of these programs, however, the extent of U.S. involvement in IPY activities was unclear until very recently. It has been difficult for U.S. scientists to take leadership roles and make firm commitments to potential international partners because of uncertain funding.

Those of us watching the federal budget process had some tense moments. Congress adjourned in December 2006 without passing appropriations bills funding NSF and other science agencies. The incoming congressional leadership announced plans to extend a Continuing Resolution (CR) for the rest of fiscal year 2007. A year-long CR would have eliminated a $400 million increase to the NSF budget, including $62 million designated for IPY activities.

Fortunately, in February 2007 Congress adjusted the CR, boosting funding for NSF, as well as several other science agencies (see page 9). Although this round of the budget process turned out well for NSF, some science agencies and programs, including the National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and the Climate Change Science Program (CCSP), are slated for budget cuts in fiscal year 2008. These agencies are important contributors to the nation's arctic research portfolio.

The ARCUS Board of Directors is concerned about this and other issues. Recognizing that a focused effort is needed on behalf of the arctic science community, the Board recently established a Public Policy Committee (PPC) to identify policies related to arctic research, disseminate policy information to ARCUS members and others, and advocate for science and research in the political context. Advocating for U.S. leadership in IPY has been the first action undertaken by the PPC, which will regularly report to the Board on policy, funding, and communications topics—one more way for ARCUS to support the arctic research community's important efforts.

—Vera Alexander

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