

## Arctic System Synthesis Encourages Program Integration

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

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

The process of synthesizing the community’s collective knowledge of the arctic system began at the All-Hands Workshop, with more than 300 ARCSS researchers participating, and continued with the Big Sky Retreat in August 2003. The retreat’s goal was to distill and integrate available knowledge into a more holistic perspective of the arctic system. Scientists from a variety of disciplines investigating many components of the arctic system attended, and for most it was a tremendous learning experience—an opportunity to discuss commonalities and linkages with researchers who rarely cross paths: marine biologists with permafrost experts, atmospheric modelers with soil scientists, oceanographers with sociologists. This amalgamation of knowledge led to the realization that arctic change is pervasive, widespread, and dramatic, and hence to the “Big Question.” Throughout the week, the participants worked together, each offering their own expertise and perspective, to determine

whether, in fact, the Arctic is moving toward a new state. By the end of the week, participants reached near-unanimous agreement that the Arctic is likely moving outside the envelope of past experience—possibly toward a new state—and that we do not yet understand the implications for the Arctic, the global climate system, or human society. Participants also agreed that a state change could include major surprises and non-linearities, and that the implications could be wide-ranging and substantial for humans.

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

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

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

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

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

### ARCSS Program Integration and Coordination

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

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

Centralized ARCSS coordination and management structures will not replace the

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

The mechanisms through which the ARCSS Program will adopt research initiatives for implementation will include the emergence of key questions and identified priorities for research from the community,

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

and the implications of change for human society.

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

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

## Arctic-CHAMP Coordinates Freshwater Initiative Projects

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

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

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

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

The 18 FWI projects, with four additional collaborative projects funded under other NSF programs, bring together atmospheric, terrestrial, and marine researchers

to study the sources, fates, and variations in the pan-arctic freshwater cycle. The FWI projects represent an ARCSS contribution to SEARCH that will:

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

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

### Meetings and Plans

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

The Arctic-CHAMP Science Steering Committee (SSC), co-chaired by Larry Hinzman at the University of Alaska Fairbanks and Charles Vörösmarty at the University of New Hampshire, met in

December 2004 at the American Geophysical Union meeting in San Francisco. The 14 members of the SSC discussed:

- the status of the interdisciplinary implementation plan, due to be completed in early 2004,
  - updates from the Science Management Office, and
  - future synthesis efforts and products.
- Ideas for future synthesis activities include a book focusing on the arctic freshwater cycle and a Freshwater Initiative Education Institute for undergraduate and graduate students interested in studying the arctic region.

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

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