

The Arctic Research Program, Fiscal 2006

John Calder¹, Kathleen Crane¹, Jacqueline Grebmeier², M. Zhdanov³, A. Ostrovskiy³, Jackie Richter-Menge⁴, James Overland⁵, Igor Polyakov⁶, Ignatius Rigor⁷, Taneil Uttal⁸, Tom Weingartner⁹ and Terry Whitedge⁹

¹ NOAA Climate Program Office, Arctic Research Program, Silver Spring, MD

² Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN

³ Group Alliance, Moscow, Russian Federation

⁴ U.S. Army ERDC-Cold Regions Research and Engineering Laboratory, Hanover, NH

⁵ NOAA Pacific Marine Environmental Laboratory, Seattle, WA

⁶ International Arctic Research Center, University of Alaska, Fairbanks, AK

⁷ Polar Science Center, Applied Physics Laboratory, University of Washington, Seattle, WA

⁸ NOAA Earth Systems Research Laboratory, Boulder, CO

⁹ School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks, AK

Program Description

The Arctic Research Program is a component of the NOAA Climate Observations and Analysis Program and focuses on climate-related observations of the broad Arctic region. The observations include both physical and ecosystem indicators of climate change in the Arctic and as such the program provides information to all the NOAA goal teams: ecosystem (changing ecosystems under conditions of reduced sea ice cover, Arctic climate change and global responses, Arctic climate change and its effect on North American weather and Arctic Climate Change, sea ice change and commerce in the Arctic region.

The program follows the advice of the Science Steering Committee and the implementation plan developed by the Interagency Study of Environmental Arctic Change SEARCH: plans for Implementation during the IPY and Beyond. Observations focus on atmospheric variables such as clouds, radiation and aerosols that influence Arctic climate; on sea ice thickness and motion; on ocean climate such as water column temperature and salinity structure and currents, primarily in the ocean gateways to the Arctic (including the Bering Strait, Chuckchi Sea region, and the passages from the Arctic to the Atlantic Ocean). and changing ocean chemistry and biology in these regions to detect the impacts of physical climate change on the Arctic ecosystems and the globe as a whole. Additionally, activities are undertaken to analyze and integrate observations of the program and historical data from diverse sources. The program conducts web-based outreach activities, is involve in museum Arctic Exhibit development (e.g The Museum of Natural History) and supports a State of the Arctic report. The program is active in international coordination of Arctic observation activities, working with the Arctic Council, the International Arctic Science Committee and on a bilateral basis with Canada, Norway, Russia, China and others.

Major Program Elements

1. Climate Observatory Network

The Arctic Research Program has undertaken an agency leadership role in the Implementation of the International Arctic System for Observing the Atmosphere (IASOA)- As part of the SEARCH implementation plan, the Arctic Research

Program will support with international partners 3-5 Observatories around the rim of the Arctic Ocean. Barrow, Alaska (Already supported by NOAA ESRL and the DOE Atmospheric Radiation Monitoring program). The second observatory in the network is at Eureka, Canada on Ellesmere Island. The third link in the planned network will be located at Tiksi in Siberia, Russia and preparatory work began there in 2006 with the completion of the first building for the observatory. NOAA will coordinate with an already established atmospheric observation program in Ny-Alesund, Norway and the Greenland, Summit Station to complete the circumpolar network. The goal of the observatory network is to provide long time-series data on clouds and cloud properties, aerosols, radiation, and trace gases. The data will support research on atmospheric climate processes, provide calibration/validation data for current and planned satellite sensors, and provide data to develop and test global and regional climate models with an end goal of answering questions of attribution.

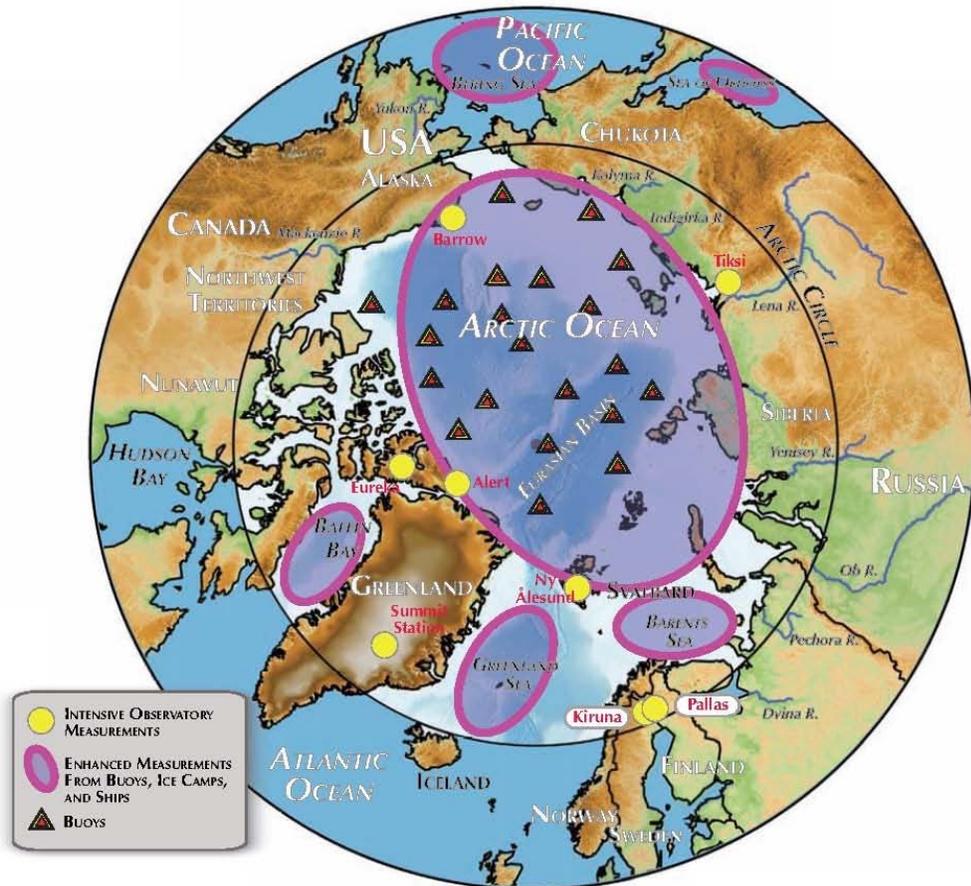


Figure 1. Priority areas for atmospheric observation activities. A SEARCH atmospheric observing program should include coordinated intensive observatory measurements (yellow dots) in Barrow, Alaska; Alert and Eureka, Canada; Ny-Ålesund, Norway; Tiksi, Russia; the Greenland Summit Station; Pallas, Finland; and Kiruna, Sweden, as well as the inclusion of upper air measurements within existing ocean data collection activities (pink circles), including those from potential buoy deployment areas (see Figure 2). Weather station networks, unmanned aerial vehicles (UAV), and satellite data represent additional sources of atmospheric observations (not shown). Coordination of efforts between atmospheric observatory programs, integration with other interdisciplinary activities, and international support to reinstate, enhance, and establish new atmospheric observations throughout Siberia north of the Arctic Circle will significantly enhance the potential for understanding regional differences of atmospheric changes in the Arctic.

2. Ocean and Sea Ice Observations

The NOAA Arctic Program is working with partners to implement the **Arctic Observing Network (AON)**. The NOAA portion of the AON will be a subcomponent of the NOAA Integrated Ocean Observing System and is represented in the SEARCH implementation plan figure 2. There are 3 NOAA-supported elements to the AON: 1) *oceanographic moorings* along the shelf and slope, in the deep basin of the Arctic Ocean (NABOS) and across the Pacific Gateway to the Arctic, the Bering Strait; 2) *ship-based* observations focused on ecosystem-physical interrelated indicators of climate change in the Northern Bering Sea and the Chukchi Sea. NOAA conducted its first Arctic Ocean research cruise with the Russian Academy of Sciences in summer 2004 through what has become known as the RUSsian-American Long-term Census of the Arctic (RUSALCA) project. One objective of RUSALCA is to document the changes in the physical state of the northern Bering Sea and Chukchi Sea, regions that have experienced significant change over the past few decades and that models predict will experience even greater change in the decades ahead. General ocean and atmospheric warming and loss of sea ice should be accompanied by changes in water column structure, and possible changes in circulation and flux through the Bering Strait, which may have implications for the entire Arctic and Atlantic Ocean beyond. A second objective of RUSALCA is to observe changes in ecosystem structure and productivity that result from the physical changes, and to identify a set of ecosystem indicators that might be applied throughout the Arctic marine region. Marine ecosystem alterations will affect Native subsistence harvests and possibly commercial fisheries and protected mammals and birds. Planning is underway for a major international research and observations expedition during the International Polar Year in 2008. The current strategy is to conduct a multidisciplinary cruise every 4 years with mooring and physical oceanographic based expeditions conducted annually. Additional RUSALCA goals are to, map and monitor fresh water and nutrient fluxes and pathways across the Pacific Gateway and into the Arctic Ocean, promote U.S. - Russian Federation and international cooperation in ocean and polar regions studies, and facilitate exploration and information gathering of this poorly mapped region of the climate system.

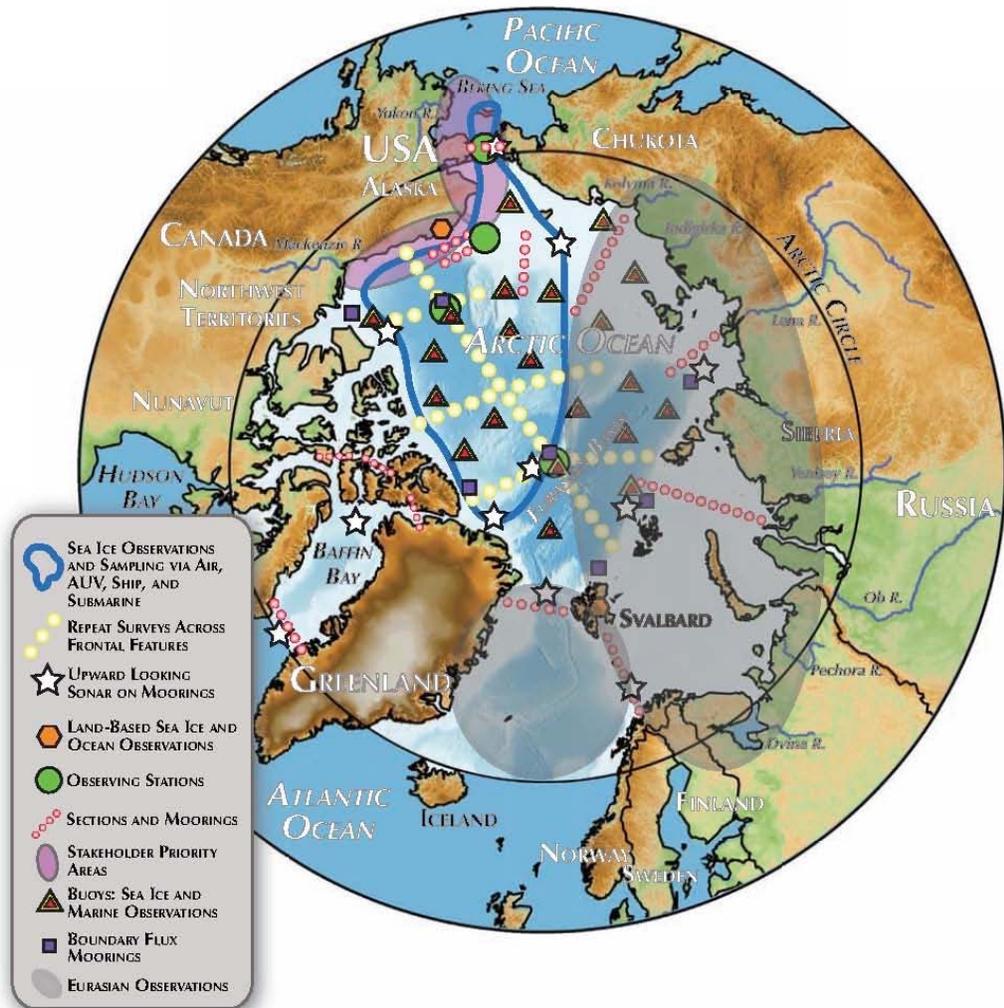
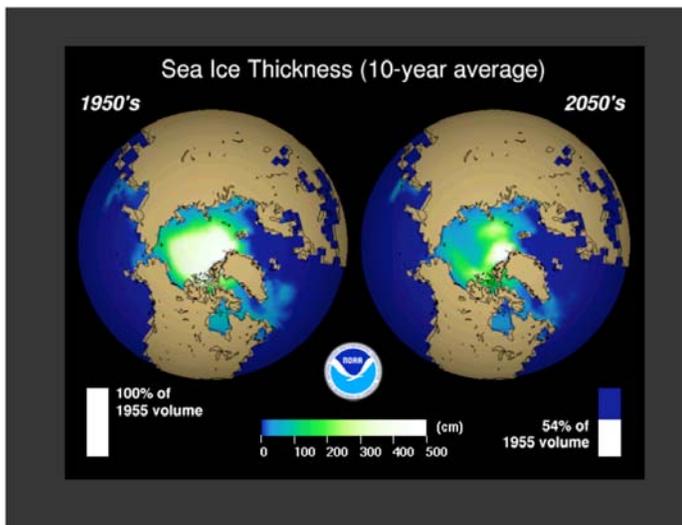


Figure 2. SEARCH priority areas for distributed ocean and sea ice observations. The highest priority for SEARCH is long-term and large-scale observations of environmental change. Observation requirements include those related to physical/chemical ocean, geophysical sea ice, biological/chemical, and stakeholder-relevant variables; sensors and measurements should be co-located to the extent possible. Key regions include: Beaufort Gyre, North Pole, Bering Strait, Canadian Archipelago, and Eurasian Basin slopes and shelves; Alaska near-shore observations in the Bering, Chukchi and Beaufort Seas (stakeholder priority areas, purple shading); and the Chukchi/Beaufort shelf-slope area. Priority observation activities include: repeat hydrographic/tracer surveys across frontal features (yellow dotted lines) and sea ice and ocean sampling along transects (blue line) via ship, aircraft, AUVs, and submarine; boundary flux sections (red dotted lines, additional boundary flux moorings denoted by purple squares); drifting buoys for marine and sea ice measurements (yellow/red triangles); sea ice and ocean observations via land-based platforms (orange polygons) and upward-looking sonar (ULS) on moorings (white stars); and long-term observing stations (green dots). Eurasian observations (gray shaded areas) will focus on Arctic/Atlantic linkages, with some explicit U.S. collaborations assumed. The locations of all SEARCH sections, buoys, and moorings in this figure are meant only as general suggestions of deployment schemes.

3) *ice-tethered buoys* in the perennial Arctic sea ice to measure sea ice drift, thickness and melt processes and basic meteorology; Monitoring changes in the volume or mass of the Arctic sea ice cover is crucial for developing our understanding of climate change processes and their impacts. Changes in the volume of the ice cover can result from changes in the ice extent (area) or ice thickness. The extent of the Arctic sea ice is effectively monitored by aircraft and from satellites. Monitoring the ice thickness is more challenging. Current satellites cannot measure ice thickness, therefore data sources are limited to on-ice mass balance measurements and submarine or seafloor-mounted upward looking sonars. Developing a coordinated network to monitor changes in the ice thickness of the ice cover is the focus of one aspect of the NOAA SEARCH initiative. A key objective of this study will be to establish international partnerships and to build upon existing programs such as at the North Pole Environmental Observatory (NPEO) and the International Arctic Buoy Program (IAPB).Ocean



3. Data Analysis and Dissemination

The NOAA Arctic Program supports the **Arctic Climate Change Detection Protocol**. Historical and current data from diverse sources is assembled to evaluate variability and change in Arctic climate. The Arctic System Reanalysis is envisioned as a framework for organizing historical

atmospheric, sea ice and ocean data into a data set that will be assimilated into coupled models to produce a reanalysis data set to support seasonal to interannual climate projections.

In addition, the Program contributes to preparation of a **State of the Arctic (SOA) Report**. Experts from several countries are preparing a report summarizing the current physical state of the Arctic. This is an update to the Arctic Climate Impact Assessment to include newer information not included in the ACIA.

For public education, the Program maintains the **NOAA Arctic Theme Page** (www.arctic.noaa.gov) as a mechanism for describing NOAA's Arctic programs and for providing a scientific resource to the public.

Partnerships

The Arctic Research Program is highly leveraged. All of the IAOOS activities described above and the IASOA site at Tiksi involve collaboration with the Russian Federation. NOAA Arctic Research has played a critical leadership role in developing and formalizing functional scientific linkages with Russian agencies and scientists. A Memorandum of Understanding between NOAA and the Russian Academy of Sciences on World Oceans and Polar Region studies was signed in December 2003, and this has proved to be a critical document for obtaining Russian support of our activities. This MOU under the U.S. – Russian Federation Science Technology Agreement is also an umbrella for NSF funded collaboration with Russia. Over the past few years, many meetings, teleconferences and e:mail exchanges were conducted with Russian officials and scientists to plan the joint activities, obtain the necessary formal “permissions” from involved Russian agencies and to arrange for visits by US scientists to Moscow, St. Petersburg, Tiksi, Petropavlosk and Vladivostok. The maintenance of good working relationships with Russia requires constant attention.

In addition to Russia, many other countries will be involved in establishment of Arctic Observing systems and the Arctic Research Program tries to collaborate with these countries. In particular, collaborative efforts with Canada, Finland and Norway are underdevelopment. China, Korea and Japan also have expressed interest in working with NOAA during the International Polar Year.

The Arctic Research Program has purposely designed observation programs to be interdisciplinary in scope to identify interactions between physical, chemical and biological processes that affect climate variability. The Arctic Research Program helps to facilitate interactions between modelers and observationalists to improve the ability to forecast weather and climate in the Arctic and the global environment.

To carry out its goals, the NOAA Arctic Research Program, COA, works with other NOAA groups, (NMFS, PMEL, ESRL), other U.S. agencies, such as NSF, and DOI, cooperative institutes at Woods Hole, University of Washington, University of Colorado, and the University of Alaska, Fairbanks. Numerous investigators have been funded to carry out the climate objectives of the Arctic Research Program (from the University of Alaska, the University of Washington, the University of Tennessee, the Smithsonian Institution, Woods Hole Oceanographic Institution and Pt. Stephens Research). Both the Bering Strait mooring network and the Tiksi Observatory are co-funded by the National Science Foundation

Arctic: A Friend Acting Strangely is an exhibit funded in part by the Arctic Research Program of NOAA. The exhibit opened in April 2006 and will run until the end of November, 2006. <http://www.mnh.si.edu/exhibits/arctic/>

2006 Achievements

1. Grand Opening of SEARCH Observatory in Eureka, Canada

The NOAA Earth System Research Laboratory (ESRL), in conjunction with the Canadian Network for Detection of Arctic Change (CANDAC) program, and the

Meteorological Service of Canada, co-hosted a grand opening of a research site located in Eureka, Nunavut on Ellesmere Island; one of the most northerly research stations in Canada. On July 24, 2006 scientists, government representatives, and media from Canada and the U.S. attended official activities and had the opportunity to visit an observatory established through the NOAA Atmospheric Observatory Program, funded through the Arctic Research Program, Canada's Polar Environment Atmospheric Research Laboratory (PEARL), the newly rebuilt meteorological Services Canada weather station, and experience the surroundings and wildlife of this remote region of Canada.

The NOAA observatory is operated in Canada's High Arctic by the NOAA Arctic Research Program through ESRL as a contribution to the U.S. Studies of Environmental Arctic Change (SEARCH) program. The observatory was established in August 2005 by the ESRL Physical Sciences Division and ESRL Global Monitoring Division in collaboration with the University of Wisconsin, the University of Idaho, and the CANDAC program.

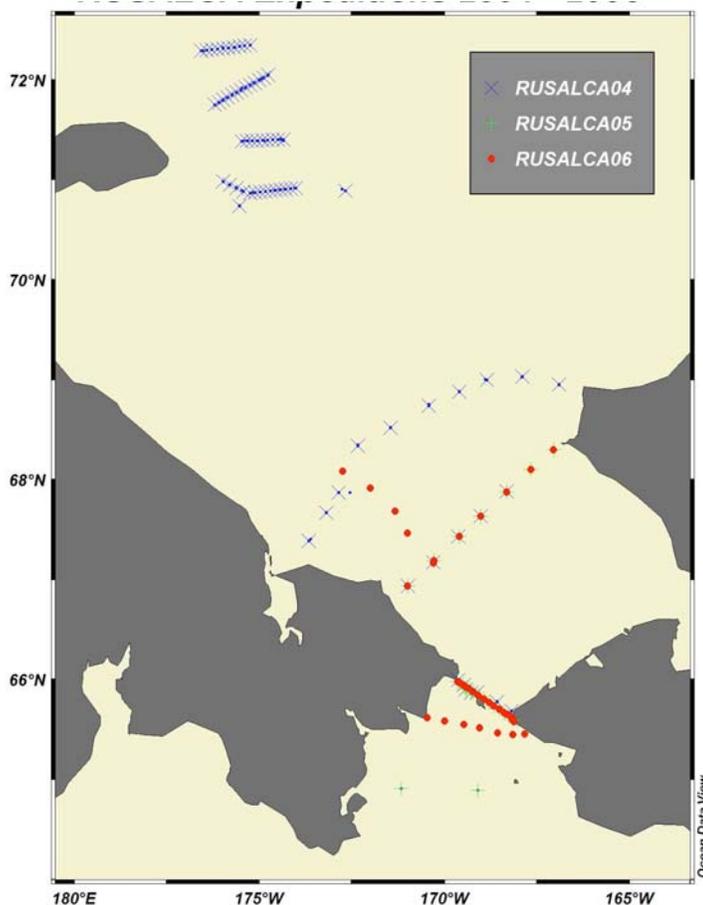


It was designed to make long-term climate measurements of Arctic clouds and aerosols. A collection of state-of-the-art scientific measurement equipment has been assembled at the site, including cloud radar, high spectral resolution lidar and spectral and narrow-band radiometers.

NOAA-SEARCH seeks to establish a number of intensive measurements that can be compared between Arctic regions. The emphasis of these activities will be on

determining attribution and developing databases and information that can be used for mitigation and adaptation strategies not only in the Arctic, but throughout the global climate system which is inextricably linked to Arctic changes. International cooperation and collaboration, as in this case with Canada, is a crucial component in successful and comprehensive global climate research. These activities support NOAA's mission goal of understanding climate variability and change to enhance society's ability to plan and respond.

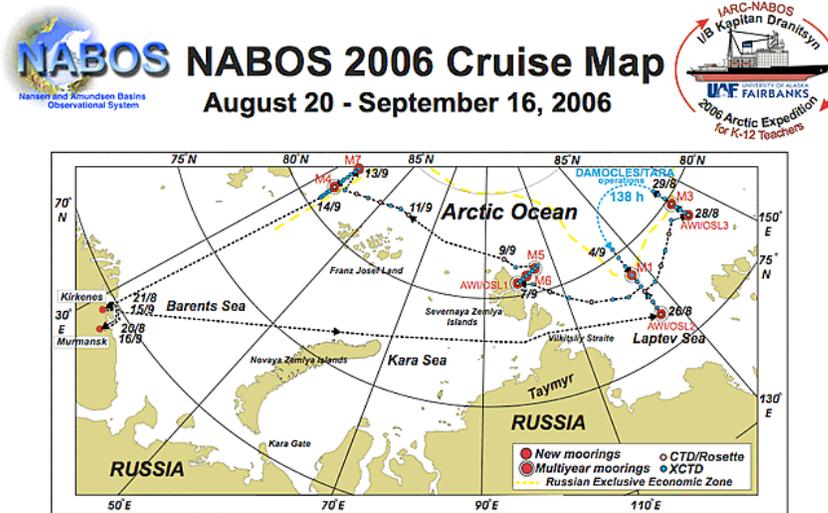
Implementation plans are developing for a state of the art climate observatory in Tiksi, Russia. The Program of Activities includes cooperation within the framework of the IPY,. This station has a long, although interrupted, history of earth science measurements, some of which date back to 1935, one of the longest in the Arctic. It will be a significant node in the GEOSS system, as it will become an interdisciplinary observation site for atmospheric, coastal, oceanographic, hydrological, terrestrial and biological observations. NSF, NOAA and Roshydromet are one year into the planning and creation of this Observatory. NOAA (Arctic Research Program) has made plans to begin operational measurements, which will support of the Climate Reference Network (CRN), WMO Global Atmospheric Watch (GAW), WMO Baseline Surface Radiation Network (BSRN), carbon cycle gases, and ozone. Finland and Norway are also partnering with the U.S. and Russia to support this Observatory. Contact: [Taneil Uttal](#), ESRL



2. The **RUSALCA** program continued to reap benefits from the Russian-American collaboration in monitoring the fluxes through the Pacific Gateway into the Arctic Ocean. Three moorings were deployed during the summer of 2005 and recovered during the summer of 2006 using the Russian hydrological vessel, SEVER. This is the first data of this type collected in the Russian waters of the Bering Strait since the 1990's. The U.S. section of the Bering Strait mooring line is also facilitated by the National Science Foundation. The combined mooring data provide a first time look at

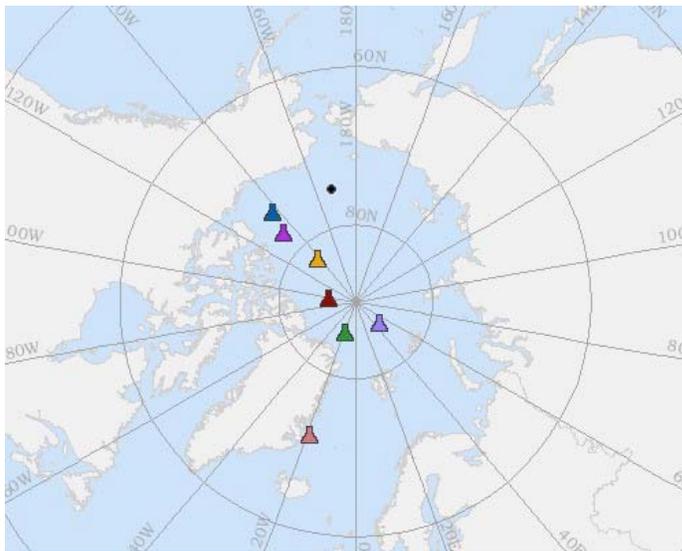
the critical fluxes and changes occurring across and through the Bering Strait.

3. The Arctic Research Program also managed an earmark to the International Arctic Research Center for the NABOS program. Moorings launched via the NABOS program are included in the ARP's overall contribution to the U.S. 100 % Arctic Ocean Observing



System (Arctic Observation Network). Five moorings along the Russian continental shelf were both recovered and redeployed during the 2006 NABOS expedition on the Russian icebreaker Kapitan Dranitsyn. With partners from Russia, Norway, Germany, Sweden, USA, and Canada

the analysis of mooring-based records and oceanographic surveys have provided evidence that the Arctic Ocean had entered a new warm state, with potential implications for the melting of arctic ice. NABOS is co-funded by NOAA and NSF in the United States.



4. A three year summary of *ice mass balance buoys* data is being prepared. Current ice mass balance buoy and mooring positions as of September 17, 2006 are illustrated below.

5. *Program data and information* were made available through the Arctic Theme Page, Change Detection Website, publications, presentations at conferences and through an exhibition developed with NOAA funding and guidance at the Smithsonian Institution's Museum of Natural

History "Arctic: A Friend Acting Strangely". <http://www.mnh.si.edu/exhibits/arctic/>

The exhibit ran at the museum until the end of November, 2006. Plans are developing for a traveling exhibit to other science centers across the country. The Arctic: A Friend Acting Strangely exhibit is part of the [Forces of Change Program](#) at the National Museum

of Natural History. The exhibit explored changes that have been observed in the Arctic, the Earth's northernmost region, and how they are monitored by scientists and polar residents. Native peoples of the Arctic have always lived with year-to-year fluctuations in weather and ice conditions. In recent decades, they have witnessed that the climate has become unpredictable, the land and sea unfamiliar. An elder in Arctic Canada recently described the weather as *uggianaqtuq*—an Inuit word that can suggest strange, unexpected behavior, sometimes described as that of “a friend acting strangely.”

The Arctic: A Friend Acting Strangely exhibit was made possible by a grant from the National Oceanic and Atmospheric Administration (NOAA)'s Arctic Research Office. Additional support and funding were provided by the Department of Energy, the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). Dr. John A. Calder and Dr. Kathleen Crane, NOAA Arctic Program Managers, Dr. Richard W. Spinrad, Assistant Administrator, NOAA Research, and scientists Drs. Richard Rosen, James Overland and Mark Serezze reviewed the script.

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