Arctic Sciences GPRA Highlights, FY 2005

An Observational Array for Arctic Oceanographic Measurements

Nugget ID: 11185

To help quantify the variability of fluxes connecting the Arctic and Atlantic Oceans and to understand the role played by the Arctic and sub-Arctic in steering decadal scale climate variability, scientists are developing and testing an integrated observing system to provide year-round measurements of volume, liquid freshwater and ice fluxes across Davis Strait between Greenland and Canada. Fluxes through the Strait represent the net integrated Canadian Archipelago throughflow, modified by terrestrial inputs and oceanic processes during its southward transit through Baffin Bay. Measurements at Davis Strait will be used to study how fluctuations in the Arctic freshwater system modulate deep water formation to the south, thus influencing the associated meridional overturning circulation (MOC). The system being deployed employs complementary techniques, combining mature technologies with recent developments in autonomous gliders to address all aspects of flow through Davis Strait, including some measurements that have not previously been technologically feasible. The components of the system include:

• A sparse array of subsurface moorings, each instrumented to provide time series of upper ocean currents, ice velocity and ice thickness. These measurements are used to estimate the ice component of freshwater flux, provide an absolute velocity reference for geostrophic shears calculated from Seaglider hydrographic sections, and derive error estimates for our lower-frequency flux calculations.

• Trawl and iceberg-resistant bottom landers, deployed across the Baffin and Greenland shelves and instrumented to quantify variability associated with strong, narrow coastal flows.

• Acoustically navigated Seagliders to provide year-round, repeated, high-resolution hydrographic sections across the Strait. The resulting sections are being combined with the moored array data to produce sections of absolute geostrophic velocity and to estimate volume and freshwater fluxes.

In addition to the immediate impacts of improved estimates of freshwater inputs to the Labrador Sea, the array will provide an initial data set with which to study the relationships between Arctic freshwater system variability and large scale atmospheric fluctuations. The combination of emerging and existing technologies implemented in the observing system may serve as a prototype for accurate long-term monitoring of freshwater and ice fluxes in high latitude environments subject to seasonal or permanent ice cover. Finally, acoustically navigated autonomous gliders capable of extended missions in ice covered environments are providing a significant new observational tool, opening important regions of high latitude oceans to intensive measurement programs.

This work is notable because:
This is a scientifically driven test of existing and new technology to move ocean observing into the ice-covered Arctic.

Primary Goal Indicator: Next generation facilities and platforms (AC/GPA selected)

Secondary Goal Indicators: Instrument technology

Other Indicators:

OI-2: This work involves high risk research.
This work involves new technology and deployement in high risk environments, so there is a risk of failure and loss.

OPP/ARC 2005

Program Officer: Neil Swanberg

NSF Award Numbers:
0230381
Award Title: An Observational Array for High Resolution, Year-round Measurements of Volume, Freshwater, and Ice Flux Variability in Davis Strait
PI Name: Craig Lee
Institution Name: University of Washington
PE Code: 5219

Submitted on 03/02/2005by Neil R. Swanberg
ARC: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Arctic River Transport

Nugget ID: 11160

The Pan-Arctic River Transport of Nutrients, Organic Matter, and Suspended Sediments (PARTNERS) project is a 5-year project (2002-2007), funded by the US National Science Foundation. The overall objective of the Project is to use river water chemistry as a means to study the origins and fates of continental runoff. Understanding sources and fates of river discharge is important because rivers make an enormous contribution to the freshwater budget of the Arctic Ocean. Selected parameters focusing on tracers of river water are being measured in the six largest rivers that drain the watershed of the Arctic Ocean: the Yenisey, Lena, Ob', Mackenzie, Yukon, and Kolyma rivers.

Analyses of long term data on river discharge into the Arctic show an increase over recent decades. If the change in river discharge is linked to global warming, future discharge increases could be large enough to impact Atlantic thermohaline circulation significantly. In this project, scientists are finding that dams on large Siberian rivers greatly impact the seasonality of discharge, but on an annual basis, neither dams nor forest fires are making significant contributions to the observed increases in Eurasian river discharge. The project includes representatives of government agencies responsible for discharge and water quality monitoring in Canada, Alaska, and Russia. This will lead to greater comparability of river hydrochemical data in the Arctic. The group have found through preliminary analyses of new river water samples that the arctic rivers are rather distinct chemically, suggesting that tracing the river water in the Arctic Ocean may be feasible.

In 2004, the group involved an undergraduate student in the work in Siberia, as well as two Russian undergraduate students and an elementary school teacher from Vermont (Amy Clapp, part of the TREC program). Amy went with Max Holmes and others to the Lena River in May / June 2004, and is continuing to work with the group. While in Zhigansk (Lena River), the group spent a considerable amount of time interacting with the local population (~95% indigenous peoples). They visited the local school, and the project was featured in the Zhigansk newspaper twice, as well as being on the television news throughout Yakutia. The project also received extensive US news coverage because of their enlistment of Anya Suslova, a 13-year-old girl living in Zhigansk to collect samples throughout the year.

Another major contribution of the project to research and education was to assist local hydrochemical laboratories in Russia to improve the quality of the data they produce. While impressed with the motivation of the laboratory personnel that they encountered, they also found that limited training, aging equipment, and insufficient supplies often led to poor quality data. They are striving to improve this situation by working closely with local laboratory analysts, teaching newer techniques, and where possible, providing access to better equipment and supplies. Already the PARTNERS project has shipped supplies and equipment to the Siberian river study sites to be

used by the project, but also available for use by the local laboratories. This helps the project and enhances local capacity significantly.

link to PARTNERS website

This work is notable because:
The PARTNERS project is reaching a large number of people, in the US, Canada, and in Russia. It has exposed US students to the concept of global climate change and the pivotal role of the Arctic in the global system, can have a lasting impact on the students and will contribute to their development as scientifically literate citizens.

Primary Goal Indicator: Global S&E workforce

Secondary Goal Indicators: Data collection/analysis

Other Indicators:

OI-3: This work involves multidisciplinary research.
This work involves natural scientists from a wide array of expertise.

OPP/ARC 2005

Program Officer: Neil Swanberg

NSF Award Numbers:
0229302
Award Title: Biogeochemical Tracers in Arctic Rivers: Linking the Pan-Arctic Watershed to the Arctic Ocean
PI Name: Bruce Peterson
Institution Name: Marine Biological Laboratory
PE Code: 5219

Submitted on 03/02/2005by Neil R. Swanberg
ARC: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Fractures as Main Pathways of Water Flow in Temperate Glaciers

Nugget ID: 11224

Understanding the flow of water through the body of a glacier is important, because the spatial distribution of water and the rate of infiltration to the glacier bottom is one control on water storage and pressure, glacier sliding and surging, and the release of glacial outburst floods. According to the current hypothesis, this water flow takes place in a network of tubular conduits. The Principal Investigators analysed video images from 48 boreholes drilled into the Swedish glacier Storglaciären, showing that the glacier's hydrological system is instead dominated by fractures that convey water at slow speeds. They detected hydraulically connected fractures at all depths, including near the glacier bottom. Their observations indicate that fractures provide the main pathways for surface water to reach deep within the glacier, whereas tubular conduits probably form only in special circumstances. A network of hydraulically linked fractures offers a simple explanation for the origin and evolution of the englacial water flow system and its seasonal regeneration. Such a fracture network also explains radar observations that reveal a complex pattern of echoes rather than a

system of conduits. Their findings may be important in understanding the catastrophic collapse of ice shelves and rapid hydraulic connection between the surface and bed of an ice sheet.

This work is notable because:
This is the first time that the hydraulically linked fractures have been studied to understand the origin and evolution of the englaicial water flow system.

Primary Goal Indicator: Identifying new opportunities

Secondary Goal Indicators:
Other Indicators:

OI-2: This work involves high risk research.
To drill 48 boreholes on a glacier can be very dangerous and risky.

OPP/ARC 2005

Program Officer: Jane Dionne

NSF Award Numbers:
0097137
Award Title: Collaborative Research: Investigation of Englacial Conduit Formation and Evolution
PI Name: Andrew Fountain
Institution Name: Portland State University
PE Code: 5280

Submitted on 03/07/2005by Jane V. Dionne
ARC: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Long term arctic vegetation change

Nugget ID: 11134

In a photo survey, a team finished taking repeat photographs on the North Slope of Alaska and moved into an analysis phase. Over 250 repeat pairs (one old and one new photograph) are in the archive. Of these about 80 were suitable for what is called a 'grid' analysis, wherein one overlays the old photo with an acetate grid, then transfers the grid to the new photo. Each grid cell is then analyzed for change. All 80 pairs have been analyzed. A further 122 photos were analyzed using a slightly modified version of the grid analysis, wherein the changes are assessed by landscape units (i.e., floodplain, cutbank, hillslope, terrace). Combined over 200 photos have now been assessed for change. The degree of change (scored 1 to 5) has been measured, as well as the percentage increase in shrub cover.

At virtually all locations examined in a rectangular area of Alaska over 800 km by 300 km in extent, shrubs are expanding in valley locations. The center of the most vigorous expansion is the Chandler and Ayiyak Rivers, SE of Umiat, Alaska. Three types of changes have been quantified: growth of individual shrubs, in-filling of shrub patch holes, and expansion of shrubs onto previously shrub-free areas. All three types of change were documented in most of the photographs. About 80% of all photos analyzed showed positive change. More subtle, but possibly as important, there has been an decrease in the extent of exposed gravel bars along rivers anc creeks, and a corresponding increase in riparian shrub coverage, suggesting that either the erosive power of the streams is diminshed since 1949, or the vigor of the riparian shrubs is higher. Combined, these data are the main evidence for landscape change in northern Alaska. A review of data of similar nature for other Arctic

areas indicates similar changes may be underway in Western Canada, but elsewhere the record is sketchy.

These results have appeared nationally and world-wide in the popular press. The graphic nature of the results is easily understood by the public and has help to convince them that change is taking place in the Arctic. Most recently, these results will appear in Scientific American Frontiers of Science on PBS and have been in Scientific American

The group are developing a traveling art exhibit based on the old (1949-1952) aerial photographs, many of which look like they were taken by Ansel Adams. We see these photographs as a national treasure...both in the quality of the photographs (lighting, starkness etc.) and the national interest lands they illustrate.

The travel exhibit, if it is picked up widely, will be a joint CRREL-USGS endeavor.

This work is notable because:
This is important research in its own light, but it also is an example of the rare kind of science that is so visually oriented it is readily understood by the public. This with the group's efforts at outreach make it significant.

Primary Goal Indicator: Public understanding of science

Secondary Goal Indicators: Data collection/analysis

Other Indicators:

OI-3: This work involves multidisciplinary research.
This involves a collaboration of physicists specializing in snow and botanists.

OPP/ARC 2005

Program Officer: Neil Swanberg

NSF Award Numbers:
0119374
Award Title: A Half-Century of Change in Arctic Alaskan Shrubs: A Photographic-Based Assessment
PI Name: Matthew Sturm
Institution Name: Department of Army Cold Regions Research & Engineering Lab
PE Code: 5219

Submitted on 03/01/2005by Neil R. Swanberg
ARC: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

NGRIP Basal Ice

Nugget ID: 11221

In July 2003, the Danish ice core drillers at North Grip Station in central Greenland hit bedrock at 3085 meters while obtaining an ice core with a 123,000 year record. When the drill was raised to the surface, subglacial basal water was revealed and the drill was covered with reddish frozen water. The camp remained open through 2004 to obtain a 45 meter long column of frozen basal water and 6 meters of glacial ice was obtained. This basal water has been isolated from the surface for several million years and may contain ancient biological material. The samples were divided at an

International meeting in Copenhagen in Nov. 2004 and investigators are analyzing pollen, pant macrofossils, DNA from plants and micro-organisms, and racemization. The final results are due in April 2005.

This work is notable because:
This research could be the first to show signs of life at 123,000 years ago

Primary Goal Indicator: Contributions

Secondary Goal Indicators:
Other Indicators:

OI-2: This work involves high risk research.
The final analysis may not yield any life at all

OPP/ARC 2005

Program Officer: Jane Dionne

NSF Award Numbers:
0413572
Award Title: SGER: Retrieval of Basal Water from the NorthGRIP Borehole
PI Name: James White
Institution Name: University of Colorado at Boulder
PE Code: 5280

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