

Arctic Sciences GPRA Highlights, FY 2004

Arctic System Synthesis

Nugget ID: 8732

In 2003 the ARCSS Program began a process to synthesize its knowledge of the Arctic in order to approach a system understanding. A weeklong workshop was held in a major first step towards an arctic system synthesis that would assemble the immense amount of knowledge from various components of the Arctic into a more holistic image of the system. Throughout the week, 25 scientists from a wide variety of disciplines representing components of the Arctic system worked together, each offering their own expertise, to try to understand whether, in fact, the Arctic system is moving to a new state outside the envelope of the natural glacial-interglacial cycle. This amalgamation of perspectives led to the realization that Arctic change is pervasive, widespread, and dramatic. Discussions addressed the Arctic's role in the global system, what its change means for life as we know it, and identified a number of key questions: 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 focussed on one component of the ecosphere, but require a broad, system-wide view, both past- and future-looking, that incorporates interactions among the ocean, atmosphere, biology, and human society. By the end of the week, near unanimous agreement was reached that the evidence points strongly to a conclusion that the Arctic is likely moving outside the envelope of past experience, possibly towards a new state, the nature of which we do not yet understand.

This work is notable because:

This is the start of a major effort to synthesis information across disciplines in the ARCSS program.

Goal Indicators:

11, 12, 13, 16

Other Indicators:

OI-1: This work involves innovative, risky or multidisciplinary research.

It is inherently multi-disciplinary as it involves all aspects of the Arctic system.

O/D/OPP 2004

Program Officer: Neil Swanberg

NSF Award Numbers:

0101279

Award Title: Organizational Support to the U.S. Arctic Science Program

PI Name: Wendy Warnick

Institution Name: Arctic Research Consortium of the U.S.

PE Code: 5205

Entered on 02/27/2004 by Neil R. Swanberg
OPP: Approved 03/01/2004 by Altie H. Metcalf
O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf

Collaborative LExEn Research on the Role of Exopolymers in Arctic Sea Ice: Habitat Alteration and Microbial Cryoprotection

Nugget ID: 8755

With support from the Life in Extreme Environments (LEn) Program, investigators Christopher Krembs, Hajo Eicken and Jody Deming have been studying how muco-polysaccharide produced and excreted (hence exopolymeric substances, EPS) by microorganisms living in Arctic sea ice protect microbial communities from encroaching ice crystals through alteration of their microhabitat. The research, which involved sampling the sea ice in northern Alaska during the coldest part of the winter with temperatures dropping to below $-40\text{ }^{\circ}\text{C}$, has yielded a number of interesting results that are of relevance well beyond the original aims of the study. Apart from finding EPS throughout the ice cover in copious amounts, more was learned about its little known contribution to organic carbon cycling in sea ice. Furthermore, the polysaccharide slime matrix appears to be an important component in allowing diatoms and other microorganisms to survive and remain viable at temperatures below $-10\text{ }^{\circ}\text{C}$. Relying on in-situ staining techniques developed during these and related studies, the team was able to show that a large fraction of the algal population in Arctic sea ice is enveloped in a slimy matrix of EPS which creates a transparent and flexible physical barrier between the organism and its environment. Apart from its extracellular cryoprotective properties, the polymers may also benefit other organisms and extracellular enzymes once temperatures drop to $-15\text{ }^{\circ}\text{C}$ and below as related research by the group and colleagues showed. Building on their finding that EPS modifies the shape and connectivity of pore space in the ice as fluid inclusions containing microalgae shrink with dropping temperatures, the research team started to investigate other impacts of EPS on the physical properties of ice. This work has led to interesting insights concerning potential industrial applications of EPS and related classes of polymer compounds which modulate physical properties of ice. Currently, Krembs and Eicken hold a provisional patent that covers potential applications ranging from the frozen food industry to cold-regions engineering and are pursuing further research to shed more light on the processes that underlie both the cryoprotective benefits extended to microorganisms and their impacts on sea ice at geophysical scales.

This work is notable because:

This project extended traditional microscopic analysis to temperatures of $-20\text{ }^{\circ}\text{C}$ and below to examine living microorganisms and their protective polymer gels in their natural micro-habitat at in-situ temperatures. The work demonstrated the hitherto unrecognized importance of polymer exudation as an adaptation to life in sea ice and their importance for alteration of the microstructure and physical properties of the ice matrix. Extrapolating from natural processes of habitat alteration to different applied, industrial settings has led to development of a provisional patent that covers a broader range of applications ranging from frozen food to Arctic engineering problems.

Goal Indicators:

12, 13, 16

Other Indicators:

OI-1: This work involves innovative, risky or multidisciplinary research.

This work involved collaboration between the fields of microbiology, chemistry, and ice physics.

O/D/OPP 2004

Program Officer: William Wiseman

NSF Award Numbers:

0085457

Award Title: Collaborative LEXEn Research on the Role of Exopolymers in Arctic Sea Ice: Habitat Alteration and Microbial Cryoprotection

PI Name: Jody Deming

Institution Name: University of Washington

PE Code: 5280

Entered on 02/27/2004 by William J. Wiseman

OPP: Approved 03/01/2004 by Altie H. Metcalf

O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf

Documenting the Cultural Geography, Biogeography, and Traditional Ecological Knowledge of King Island, Alaska

Nugget ID: 8703

This is an award to a young Inupiat anthropologist, Dr. Deanna Kingston, to return to her ancestral community of King Island, Alaska accompanied by Elders and other residents to research the cultural and biogeography of the island in order to shed light on social science theory of place names, memory, cultural meaning, communities in Diaspora and geography. What makes this project so remarkable is that it will be the first time many King Islanders have been to the island that they consider their home. King Island was depopulated by the 1970's when most families moved to Nome, Alaska. Some residents remember leaving the island under duress, pushed to place their children in government schools, others left the island seeking better medical care and jobs. Although living in Nome surrounded by other Inupiaq people, King Islanders maintain a separate identity. This makes them ideally suited to answer questions concerning identity formation in Diaspora and the association between memory and place, as well as recording ecological knowledge, geographic knowledge and place names not previously collected. In addition, Dr. Kingston will be training young King Islanders, many of whom will be going to their homeland for the first time, in scientific methodology and analysis.

This work is notable because:

The PI is a young female Inupiaq anthropologist, so this project promotes diversity and increases opportunities for underrepresented groups. In addition, it has an extensive science education and training component for young King Islanders, this too promotes opportunities for underrepresented groups. The project is also cross disciplines, anthropology, geography, ecology and biology and as well as promoting collaboration with various indigenous organizations in the region.

Goal Indicators:

P1, P3, I2, I4

Other Indicators:

OI-1: This work involves innovative, risky or multidisciplinary research.

This is the first time a group of scientist will be returning to King Island with up to 50 community members of varying ages. The risk is logistical, whether this is even possible, this will be mitigated with a trip this field season with the PIs and the logistics provider. In addition, it is innovative, in that it involves an entire Diaspora community in the research itself, in the rediscovery of indigenous knowledge - the program is not aware of any other project that has attempted to do this type of research at this scale.

O/D/OPP 2004

Program Officer: Anna Kerttula

NSF Award Numbers:

0328234

Award Title: Documenting the Cultural Geography, Biogeography, and Traditional Ecological Knowledge (TEK) of King Island, Alaska

PI Name: Deanna Kingston

Institution Name: Oregon State University

PE Code: 5221

Entered on 02/26/2004 by Anna Kerttula

OPP: Approved 03/01/2004 by Altie H. Metcalf

O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf

Freshwater fluxes in Nares Strait

Nugget ID: 8741

This project is investigating the variability and forcing of freshwater fluxes from the Arctic Ocean through the northern Canadian Archipelago by deploying a mooring array in Nares Strait (between Greenland and Ellesmere Island, Canada) to examine fluxes of water and ice through the strait and to document the pressure field within the strait over a 3.5 year period. The group is also conducting hydrographic measurements in Northern Baffin Bay and Nares Strait, examining annual and decadal scale variability using bi-valve shells as recorders of water properties and collecting long piston cores as a contribution to the development of longer-term records of flow and climate variability in the region. The project had a highly successful cruise in the US Coast Guard Vessel Healy, and met all its priority science objectives and many additional ones as well. Seventy-nine casts of the CTD-rosette package were made to produce detailed hydrographic sections and additional casts were made in the heretofore un-sampled Peterman Glacier Fiord and in deep Hall Basin. Four piston cores that appear to extend to the last glacial were taken over the slope off of Bylot Island and a gravity core was taken in deep Hall Basin. Eighteen moorings were deployed in southern Kennedy Channel to monitor current speed and direction as well as temperature and conductivity and ice draft. Five shallow pressure sensor moorings were deployed from a small boat with the assistance of divers at sites well distributed along and across Nares Strait. Bivalves were successfully collected at all of these sites for a project aimed at using shell layers to reconstruct chemical conditions in the strait over the past few decades. ADCP data were logged all along the track, more importantly directed surveys were conducted at several locations including the coastal current near Thule, Smith Sound, Kennedy Channel, Robeson Channel and the Peterman Glacier Fiord sill. In addition to these priorities, the first swath bottom mapping data for the region were collected via the ship's Seabeam system and the underway thermosalinograph system was put to good use throughout much of the cruise. This group is committed to making its research program accessible to the public and accordingly undertook a range of activities to do so. They invited the

participation of Pauloosie Akeegok of Grise Fiord, Nunavut, Canada on their cruise and found that Pauloosie made significant contributions to the science program. He also endeavored to teach the group some Inuktitut and gave an excellent presentation regarding the founding of Nunavut. Pauloosie was able to sensitize the science team to several issues in his written observations of activities on board, underscoring the need for Inuit participation as we move ahead in Arctic science. Teachers Gerhard Behrens and Robert McCarthy were also in the science party, sending daily web postings that brought home to many the nature of science and life aboard the Healy. A talented Canadian photojournalist, Lee Narraway, was also along to document much of the cruise. The Healy began her voyage in Seattle, went through the Panama Canal and up the East coast to get to St. Johns, Newfoundland in time to start the season, and after this voyage, continued to circumnavigate the N. American continent, passing through the Canadian Archipelago to Barrow, Alaska where it conducted more work before going south to its home port, Seattle.

This work is notable because:

Significant efforts were made successfully to engage arctic native people in the work, and opportunities provided to teachers to participate, including real time outreach efforts. This was the first time the Healy has worked in this area and the voyage was a PR success for NSF and the Coast Guard.

Goal Indicators:

P1, P2, P3, P4, I2, I4, T1, T2

Other Indicators:

OI-1: This work involves innovative, risky or multidisciplinary research.

Several scientific disciplines were involved. It is always risky trying an ambitious field agenda in the unpredictable arctic environment.

O/D/OPP 2004

Program Officer: Neil Swanberg

NSF Award Numbers:

0230354

Award Title: Collaborative Research: Variability and Forcing of Fluxes through Nares Strait and Jones Sound: A Freshwater Emphasis

PI Name: Kelly Falkner

Institution Name: Oregon State University

PE Code: 5219

0230236

Award Title: Collaborative Research: Variability and Forcing of Fluxes Through Nares Strait and Jones Sound, a Freshwater Emphasis

PI Name: Andreas Munchow

Institution Name: University of Delaware

PE Code: 5219

Entered on 02/27/2004 by Neil R. Swanberg

OPP: Approved 03/01/2004 by Altie H. Metcalf

O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf

Pan Arctic River Study

Nugget ID: 8736

In 2003 the ARCSS Program began a process to synthesize its knowledge of the Arctic in order to approach a system understanding. A weeklong workshop was held in a major first step towards an arctic system synthesis that would assemble the immense amount of knowledge from various components of the Arctic into a more holistic image of the system. Throughout the week, 25 scientists from a wide variety of disciplines representing components of the Arctic system worked together, each offering their own expertise, to try to understand whether, in fact, the Arctic system is moving to a new state outside the envelope of the natural glacial-interglacial cycle. This amalgamation of perspectives led to the realization that Arctic change is pervasive, widespread, and dramatic. Discussions addressed the Arctic's role in the global system, what its change means for life as we know it, and identified a number of key questions: 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 focussed on one component of the ecosphere, but require a broad, system-wide view, both past- and future-looking, that incorporates interactions among the ocean, atmosphere, biology, and human society. By the end of the week, near unanimous agreement was reached that the evidence points strongly to a conclusion that the Arctic is likely moving outside the envelope of past experience, possibly towards a new state, the nature of which we do not yet understand. The group had a keen eye for outreach, especially in Russia where they recruited the help of the Russian captain's 13-year-old daughter (Anya Suslova) on the Lena River. They reported that she did such a great job helping during sampling and sample processing that they set her up with a set of H218O sampling bottles for sample collection during fall and winter when they won't be sampling. The captain (Anya's father) is active on the Zhigansk "school board", and he is excited about the possibility of the PARTNERS project having a more formal interaction with students in the Zhigansk school. The group is exploring the possibility of returning to Zhigansk and the Lena River next spring during the time when school is in session, and talking with school classes etc., and is also trying to facilitate similar student involvement at the other PARTNERS rivers.

This work is notable because:

This is the first year of a five year project to study the six major rivers feeding the Arctic Basin. Significant advances were made in honing the tools needed to do this, and opportunities identified and seized to engage various groups in outreach.

Goal Indicators:

P1, P2, P5, I2, T4

Other Indicators:

No other indicators apply.

O/D/OPP 2004

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

Entered on 02/27/2004 by Neil R. Swanberg
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O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf

Shelf Basin Interactions

Nugget ID: 8742

The Shelf Basins Interactions project engaged in numerous outreach activities, particularly to the communities in Northern Alaska most affected by changes in the marine environment. The group continued its traditional outreach activities such as talking to students in their local (Tennessee) area, and intensive outreach to students following their sponsorship of a teacher who participated in a cruise for the SBI project. The PIs also prepared a presentation for display at the Alaska Eskimo Whaling Commission (AEWC)/Barrow Association of Whaling Captains (BAWC) meeting held in Barrow, Alaska to present the SBI project, and SBI data were presented to the Whaling Captains Associations in Barrow, Wainwright and Pt. Hope in Sept. 2003 during discussions about the importance of the SBI science and the projects needs for 2004 field planning efforts. SBI project-wide data and 2004 plans were presented to the Alaska Eskimo Whaling Commission meeting in Oct. 2003 for AEWC in Anchorage, AK. And at the 2004 AEWC mini-convention in Barrow, AK, in Feb. 2004.

This work is notable because:

Major efforts were made to engage in outreach to students and to communities in the North Slope of Alaska

Goal Indicators:

P1, P2, P3, P4

Other Indicators:

OI-1: This work involves innovative, risky or multidisciplinary research.

The work is inherently multi-disciplinary

O/D/OPP 2004

Program Officer: Neil Swanberg

NSF Award Numbers:

0215498

Award Title: Science Management for the Western Arctic Shelf-Basin Interactions (SBI) Project
Office

PI Name: Jacqueline Grebmeier

Institution Name: University of Tennessee Knoxville

PE Code: 5219

Entered on 02/27/2004 by Neil R. Swanberg
OPP: Approved 03/01/2004 by Altie H. Metcalf
O/D: Approved for O/D on 03/01/2004 by Altie H. Metcalf