Witness the ARCTIC

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In this Issue

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Perspectives on Exploring the Greenland Ice Sheet

A Conversation between Carl Benson, Professor Emeritus at University Alaska Fairbanks, and Gifford Wong, PhD Candidate at Dartmouth College

Carl Benson, Professor Emeritus of Geology and Geophysics, Glacier Group, Geophysical Institute, UAF. Image courtesy of Geophysical Institute, UAF.

'Arctic Generations' is a new feature of *Witness the Arctic* in which an early career researcher interviews a scientist who has had a long, distinguished career. In this first article Gifford J. Wong, PhD candidate in the Department of Earth Sciences at Dartmouth College, interviewed Dr. Carl S. Benson, Professor Emeritus of Geology and Geophysics, Glacier Group at the University of Alaska Fairbanks' Geophysical Institute. In 1962, Benson produced a seminal study of snow stratigraphy on the Greenland ice sheet. His Research Report 70: Stratigraphic Studies in the Snow and Firn of the Greenland Ice Sheet (http://acwc.sdp.sirsi.net/client/search/asset/1001392) was published by the U.S. Army Snow, Ice and Permafrost Research Establishment (SIPRE) and reprinted in 1996. Wong, an early-career snow and ice researcher, has investigated how surface melting affects the geochemistry on the Greenland ice sheet (see: "Trace Element and Physical Response to Melt Percolation in Summit (Greenland) Snow" (http://www.igsoc.org/annals/54/63/a63A602 html)).

Wong asked Benson about his experiences participating and leading four traverses of the Greenland ice sheet in 1952-56. The following includes edited excerpts of that conversation:

Wong: The traverses between Thule Air Base and Summit Station in Greenland you made in the early 1950s resulted in the first comprehensive study of snow accumulation on the Greenland ice sheet, and in your 1962 report (http://acwc.sdp.sirsi.net/client/search/asset/1001392) of that study you defined the four zones (or facies) of a glacier. Could you share your perspective about current activities? What are the interesting stories being told by the Greenland ice sheet, what do you see as the next big questions to be addressed, and if you were to return to the ice sheet, what would you study?

Benson: Actually, the first extensive study of accumulation on the ice sheet was done by Alfred Wegener, a German geophysicist, and J.P. Koch, a Danish astronomer, in 1913. They started from northeast Greenland and made an east-west crossing ending near where our traverses ended. Wegener measured the young snow layer. He distinguished the hard dense winter snow from the loose fall/summer material below it, interpreted this as an annual unit, and traced it across his traverse—creating the first good long-distance record of snow accumulation.

Facies is a geologic term, which defines the different physical aspects of a sedimentary unit as it spans a range of depositional and post-depositional, or diagenetic, environments. To me, this was an ideal concept to apply to the study of the Greenland ice sheet where the mean annual temperatures are low: -30˚C at the center of the ice sheet. The changes in snow layers are caused by differing rates of deposition and near-surface conditions such as vapor pressure. So, annual deposition units can be identified, the boundaries between the facies can be mapped on a large scale, and the physical changes that occur over time can be observed.

The key piece from our work was recognizing that there is stratigraphy (layering) in snow. We did this by visiting the same sites over and over. We saw we could identify the annual units, the addition of new snow on the surface, and see the changes in the old snow.

The Greenland ice sheet is probably the best place in the world to study snow stratigraphy and it's perfect for observing changes. Right now we're seeing a very rapid change in physical processes because of the warming that's going on. The big question about the ice sheet is really, "What's happening because of climate change?"

If I went back to Greenland, I would want to go to selected places to see what changes have occurred in this half century, which has seen more rapid change than any of the periods before going back for many, many years. The fact that rapid changes are going on means that we are obliged to study them.

Locations of Benson's traverses on the Greenland ice sheet 1952-56. Image from Research Report 70 and courtesy of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), U. S. Army Corps of Engineers.

Wong: The Greenland ice sheet experienced a phenomenal melt event in the summer of 2012. Melt was observed across approximately 97% of the surface by remote sensing platforms. Did you see evidence of widespread melt events on your traverses? How would you describe the significance of the 2012 event?

Benson: The use of satellites for observing the melting events that are going on now has some problems. The satellite sensor observes just the surface of the ice sheet. We know a temperature of 0˚C is going to cause some melting but the

satellite data doesn’t show how deep that melt goes—it may be no more than a millimeter deep.

The extreme warm period in 2012 caused widespread surface melting, which was observed by satellites in space. The significance there I think goes along with what we’re seeing in the melting of sea ice and the changes in permafrost temperatures—these are real changes that are going on. And to study them we have the advantage of using Wegener's work, going back to 1913, and the work that we did from 1952 to 1955. This is a valuable database and using it can provide useful continuity.

We did see one really serious widespread melt event in July 1954. We saw a melt layer that was up to 1-2 cm (centimeters) thick and included ice percolation features (effects from melting) going down in "fingers" as far as 2 m (meters). We saw this in an area where ordinarily there wasn't any melt. In 1955 we traced that stratigraphic unit across different regions and we saw some of the physical response that depended on altitude and temperature: at altitudes of 1500-2000 m it included melt features, but at 3000 m altitude, in the center of the ice sheet, the unit consisted of a very hard wind-slab. By measuring the isotope ratios in that wind-slab and in the snow layers above and below we could confirm it was the same stratigraphic unit.

Wong: Do you think the summer of 1954 was as warm as the 2012 event?

Benson: The wind-slab from 1954 was quite thick, probably 10-15 cm thick in the interior of the ice sheet. It was the result of precipitation with high wind that accompanied a storm, which actually produced rain at the lower level altitudes. So, we traced that event across the ice sheet. Later, at the Geophysical Institute, I worked with a graduate student named Brian Hartman on a reanalysis. We found that the storm came out of North America between Colorado, Wyoming, and the Dakotas. It headed across Manitoba, Baffin Island, and into the northwest part of Greenland and had an effect that could be mapped all the way out to the center of the ice sheet. That event was quite different from the one in 2012. It looks like the 2012 event was a warm air mass over all of Greenland except for the 3% where the highest altitude is.

Backlighting a snowpit allows Gifford Wong to inspect deposition layers in the near surface snow. Winter and summer seasons are recorded as lower and higher density layers visible in high snow accumulation sites, like this one at the West Antarctic Ice Sheet Divide camp during January 2009. Image courtesy of Gifford Wong.

Wong: So starting with the work of Wegener and Koch, through your work, to the stratigraphy studies of today—do you see a way to merge those datasets with the recent datasets focused on the chemistry of the snow on the Greenland ice sheet?

Benson: That would be ideal, but the datasets with the chemistry weren't available before the traverses I was involved in. In 1954 and 1955, Sam Epstein of the California Institute of Technology (Caltech) and I discussed how to do the isotope sampling. I was very careful to sample within individual layered units, measure the layers, plot the layers in a diagram of the pit, and put the isotopes in that context. I think the work done in 1955 was the first time stable isotopes had been applied to the Greenland ice sheet. It was quite laborious at the time—each sample that was run had to first be equilibrated with a standard carbon dioxide source.

Other than measuring the properties of the snow layers themselves, the isotope work was the most detailed work we did. It was a very gratifying thing to see that the stratigraphy we'd worked out over the three previous years allowed us to establish excellent calibration for the stable isotopes samples.

Wong: Do you have a favorite memory or activity from the Greenland traverses?

Benson: The thing that made these expeditions possible was the vehicle called the Weasel and its ability to pull sleds. The Weasel was originally designed as an amphibious landing craft during World War II. It was meant for hauling stuff from the ship to the shore. In 1955 I was given authority to modify the Weasels for our traverse to make them much better for our cargo needs. We took the amphibious part out and ended up with quite a different vehicle. We extended the cab, changed the front and back pontoons so they could hold five-gallon gas cans, and we put on a roof rack—and we tied a lot of things on there.

On the 1955 traverse we had two Weasels that pulled two sleds each and two Weasels that only pulled one sled. We filled the sleds full of fuel and cargo and food. Space was very tight. Two people slept on platforms in the Weasels and then two others slept in a wannigan, which is basically a hut built on a sled. Two of the Weasels had wannigans, which were equipped with plywood boards that we'd lower down over one of the bunks to make a table. We used one wannigan as a mess-hall and the other for an office with a desk for calculating and plotting data.

Carl Benson, circa 1954, on the Greenland ice sheet. Image courtesy of Geophysical Institute, University of Alaska, Fairbanks.

I had laid out this long expedition in 1955 with plans to travel for half a day and then stop for two days. We'd start to work digging the snow pit the same night we arrived, cover it, then work on it the full first day. [Editor's note: snow pits are used to study stratigraphy below the surface of the snow.] In the morning of the second day the navigation Weasel and the mechanic's Weasel would start out to the next pit site. We would stay back with two more Weasels and finish working on the 4-meter deep pit and core below the bit bottom to the extent we could, and then travel up to the next site. All the pits were marked, right from the very first ones in 1952, so that you could revisit the same site year after year.

But the Weasels couldn't carry everything, even with the sleds. At Thule we set up four airdrops for the 1955 traverse. We put everything in 55-gallon drums and painted a letter and number on the side to identify which airdrop it belonged to. Most of the drops were fuel since the Weasels didn't get very many miles per gallon. The combination of airdrops working with Weasels was very efficient.

We adopted the airdrop techniques of "free drops" that I had learned from the French: the aircraft would fly so low that you couldn't be standing underneath it when it went by and they would just open the door and kick things out. The cargo would land and roll along until it lost its forward speed. The soft snow was enough to cushion the blows. In the period of four years that I was there, we'd dropped over 100,000 pounds of equipment and never broke anything.

But when we combined the Weasel and the airdrops we still had to cut weight down. The standard for this sort of campaign was military C-rations, which weighed 6.4 pounds per man/day in cargo, including all the packaging that goes with it. We worked with the Army Quartermaster Corps and were able to cut our ration weight to less than two pounds per man/day. They made boxes of dehydrated juice they called "fruit crystals," which were in little paper cans that were very light weight. So we had a juice supply—enough for six men for 120 days—that weighed next to nothing.

We had plenty of water; all we needed was gasoline to melt it. One of the reasons we redesigned the Weasel was to put five-gallon cans in places where snow would melt whenever we ran the vehicle. It would take half a day to get to the next pit and we'd stuff these cans with ice cores and snow so that when we got to the other end we had a fair amount of water melted. We really did spend a lot of time thinking about making this thing work.

Wong: It sounds like there was incredible emphasis on weight savings and efficiency and I'm curious, in all that attention to efficiency, did people on the traverse sneak on some sort of snack or favorite food as a treat?

Benson: Ha! I think I was the biggest crook in sneaking things. When we were in Thule the Army was very restrictive about what we could take and what we could do. But I got to know some of the people running the warehouse. There was

bread that's almost like shortcake in one of our food rations – and just before we left I thought, "Let's get some strawberries." They had these big five-gallon tins of frozen strawberries at the warehouse and the guy running it said, "Why don't you take a couple cases?" We did. So, we were having strawberry shortcakes out there on the ice sheet! There were lots of comedies like that when you look back on it.

Wong: Is there an activity from the traverses you're glad you'll never have to do again?

Benson: It was awfully frustrating at times. I think the worst frustration we had was with the Army and Air Force trying to work with the State Department to ask the Danes for clearance to move where we wanted to move. I talked to the Danish Island Commander and he'd say, "You know, we're happy to have you here—you can go anywhere you want. All we ask is let us know where you're going to go. We'll give you permission."

The first year's traverse was basically an equipment recovery mission, which I was able to join. The second year was planned and we wanted permission to follow a specific route. But the official request was never made so we had to cancel. The French had permission to do something and we were able to join their effort that year. The third year I had the traverse laid out but learned we didn't have the Danish clearance. We had clearance to go to the same places we'd been the year before. So, that's what I did, which is why we had a second year of repeated pits on that one whole traverse—over 170 miles of it. The fourth year we were planning the biggest expedition, from Thule to the center of the ice sheet then south along the center for 10° latitude then west out to the coast. The total length was 1900 kilometers—about 1200 miles—it was a long trek and took a lot of time. We wanted to make sure that clearance was secured and as soon as we knew we were going I asked people to do this. But when we arrived in Greenland to start that expedition the Danish people said, "Nobody asked us." We finally got something cleared. It wasn't exactly where I wanted to go, but I knew we'd do what we needed to do.

The longest trek was in 1955. We went up there in March and didn't get finished until almost September. I made a condition that I had to be able to hire all the people that went on the trip. For a radioman we found a student, Jim Holston, at Northwestern University who was an amateur radioman. He personally owned a radio set identical to the two sets we had with us. All our radio was going to be by Continuous Wave (CW), no voice, just dot-dash, which is Morse code. CW is a clear tone, not a complex signal like a voice. Many times it was very difficult to get good reception. But we could always get through with just this clear tone that we sent. For a mechanic I found Alan Skinrood, who had just finished his degree in mechanical engineering at Northwestern. He was an excellent mechanic, had done a lot of stock car racing and he knew the Studebaker, which is the company that made the Weasels. He also conducted experiments on vehicle traction on our expedition that became the subject of his M.S. degree at Northwestern University. And with my experience I had made up lists of what parts we might need to keep the Weasels operational. The navigator was George Wallerstein, an astrophysics PhD candidate at Caltech; in addition to being an excellent navigator, he completed two research projects: one on magnetic declination and another one on the sun's visibility below the horizon because of the refraction. For an expedition physician, Dr. Robert Christie, a pathologist, joined us. He carried out some interesting experiments: one was to take nasal cultures and skin cultures of everybody at the beginning of the traverse, then after 50 days, and again at the end of the traverse to see how germs spread in these conditions. With this group of people—things clicked professionally. Everyone had a project to do and there were a lot of interesting ideas and conversations. The assistant party leader, Richard H. Ragle (a close personal friend who I am sorry to report passed away in May 2013) was invaluable because of his extensive experience in operations under difficult conditions.

We had one accident on that trip. Alan Skinrood, the mechanic, who was really skilled—he dropped a little aluminum rivet down inside the cylinder on one of the Weasels. We were still north of 70˚ latitude at 3,000 meters altitude. We thought that we were going to lose this Weasel. But Alan took the head off, which has to be done very carefully because we didn't have a spare head gasket, got the piece out, put it back on, and it started up just fine. I was actually calculating how we would re-divide loads and what we would do with three instead of four Weasels while he was working on that. You asked what I would never like to do again—that's one.

Wong: Outside of the science, was there an activity that you did on the traverse that you miss?

Benson: I would say the intellectual stimulation of seeing the layering at one site—identify certain features and sample those with isotopes—go to the next pit, find the same features, and see how they had changed. I was following the strata as we went. For me it was a very exciting thing to do.

Wong: As a young researcher who's trying to break into the realm of academia and science research, I feel like I'm at a loss—there is no book that tells you how to manage this career. So, as a researcher who's had an incredible body of work, are there any perspectives or advice you'd be willing to share?

Benson: That's a tough question. I think the main thing is if you're working with natural phenomena, some background in geology is a good idea. In my work in geology, I got amazed with stratigraphic sequences and the conditions that made them exist. So, I had that philosophy behind me when I saw the way the snow layers were deposited and I thought, "Well, that's exactly what this is." I found that to be helpful.

Wong: You and your work, along with other "big brains" in glaciology, have inspired me to continue doing what it is that I'm doing. When you were coming up as a young researcher, did you have people that you looked up to as inspiration to motivate you in your science?

Benson: Yes, and there are several. One of them is a mathematician who taught a course I took when I came out of the Navy. He was the most inspirational teacher and we retained a friendship until he died a few years ago. Another was the late Robert P. Sharp, who was a geomorphologist at the University of Minnesota when I first went there. He had just been in the military during the war with a special intelligence group called the Arctic Desert Tropic Information Center. He worked on all kinds of interesting things like survival in the Arctic. He impressed on me the need for a background in physics, chemistry, and mathematics—and that is the underpinning of my geologic perspective. Sharp left the University of Minnesota and joined the faculty at Caltech; he was my mentor and major professor during my PhD studies. Another influential professor was the late W. C. (Charlie) Bell, also at the University of Minnesota, who told me: always look at any stratigraphic cross-section, the snow pits in this case, and say to yourself, "This is the last time I'll ever see this outcrop." Then, before you leave, go back and look at it again. Looking carefully in the field with as much analysis as you can before you leave is very important. And that was pretty much a guiding principle in what I did on the ice sheet. Another was Herbert E. Wright; Herb has a wide scope of experience and enormous patience. He taught me a lot about writing and continues to be a friend, although we don't see each other very often. These people make a big difference as you go along. I certainly haven't named them all, but some of them really stood out.

The philosophy that I saw at the American Geophysical Union in the late 1940s and 1950s was arguing the case that all things are interrelated. That's what they meant by the "Union." The ultra-specialization, you need it for some things, but keeping a broad perspective as you go on in life and in your science is the most important thing.

Wong: That's good advice. Sometimes as grad students we lose sight of that need for a broad base. It's also uplifting to know that there were people who inspired you when you were a young researcher.

Benson: I hope this has been useful to you— it's been interesting to me. There are so many interesting stories to tell. I just have to gloss over a lot of them.

Wong: Thank you so much for making time for this interview and answering my questions. This has been really great!

The complete copy of Carl Benson's 1962 Research Report 70, "Stratigraphic Studies in the Snow and Firn of the Greenland Ice Sheet" (http://acwc.sdp.sirsi net/client/search/asset/1001392) is available from the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)U. S. Army Corps of Engineers (http://www.crrel.usace.army mil/).

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Study of Environmental Arctic Change (SEARCH) News

SEARCH Implementation Planning

After gathering additional input from meetings and a Town Hall at the 2012 AGU Fall meeting (http://www.arcus.org/search/meetings/2012/agu), the SEARCH Science Steering Committee (http://www.arcus.org/search/sciencecoordination/ssc-committee) and the Arctic Research Consortium of the U.S. (ARCUS) submitted a proposal to NSF and other SEARCH Interagency Program Management Committee (http://www.arcus.org/search/sciencecoordination/ipmc) agencies in support of a new organizational structure and framework to translate the SEARCH vision into concrete tasks. Activities will focus on several themes, including the five-year science goals:

1. Improve Understanding, Advance Prediction, and Explore Consequences of Changing Arctic Sea Ice (http://www.arcus.org/search/sea-ice)
2. Document and Understand How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems (http://www.arcus.org/search/permafrost)
3. Improve Predictions of Future Land-ice Loss and Impacts on Sea Level (http://www.arcus.org/search/land-ice)
4. Analyze Societal and Policy Implications of Arctic Environmental Change (http://www.arcus.org/search/society)

In addition to the above science goals, activities will address cross-cutting themes of the Arctic Observing Network (http://www.arcus.org/search/aon) and "Arctic Futures 2050"—scenarios that describe plausible future states of the arctic system or its components based on recent trajectories and projected changes.

A document summarizing key elements of the new SEARCH activities and organizational structure is available online through the SEARCH website (http://www.arcus.org/search) (see “Summary of New SEARCH Framework & Plan”).

Sea Ice Outlook and Sea Ice for Walrus Outlook Launched

The 2013 Sea Ice for Walrus Outlook (SIWO) (http://www.arcus.org/search/siwo) was launched in April. The SIWO delivers online weekly reports with scientific information and local observations on weather and sea ice conditions in Alaska walrus hunting regions. The SIWO is a collaborative SEARCH project with the National Weather Service, the University of Alaska Fairbanks, the Eskimo Walrus Commission, NOAA’s Pacific Marine Environmental Lab, and ARCUS. The SIWO reports are available via the website (http://www.arcus.org/search/siwo) as well as Facebook (https://www.facebook.com/seaiceforwalrus) and Twitter (follow @ArcticResearch).

The organizers of the Sea Ice Outlook (http://www.arcus.org/search/seaiceoutlook) announced the call for contributions for pan-arctic and regional Outlooks for the first report of the 2013 season—the June report (based on May data). The full announcement can be found here (http://www.arcus.org/arctic-info/archive/19895). Submission deadline is Friday, 7 June.

Arctic Observing Network Activities

The final report from the U.S. Arctic Observing Coordination workshop, held 20-22 March 2012 in Anchorage, Alaska, was announced and is available here (http://www.arcus.org/search/aon). Hardcopies may be requested by emailing Reija Shnoro (reija@arcus.org). The workshop brought together over 100 researchers, agency representatives, and stakeholders to develop strategies for coordinating U.S. observing activities in the Arctic. The report includes descriptions of 11 "showcase projects" that would demonstrate effective approaches towards interagency collaboration. The report also summarizes recommendations on data management, challenges for building a coordinated network, and future directions and opportunities. The SEARCH SSC and Observing Change Panel (http://www.arcus.org/search/sciencecoordination/observing) will be working with relevant programs, organizations, and agencies to explore areas of mutual interest in the recommendations.

SEARCH was well represented at the Arctic Observing Summit 2013 meeting, including the contribution of a white paper on "Dual-purpose Arctic Observing Networks: Lessons from SEARCH on Frameworks for Prioritization and Coordination" (http://arcticobservingsummit.files.wordpress.com/2013/04/aos_search.pdf)). More information on the Arctic Observing Summit can be found here (http://www.arcus.org/witness-the-arctic/2013/2/article/19975).

For more information about SEARCH, please visit the website (http://www.arcus.org/search) or contact Helen Wiggins, ARCUS (SEARCH Project Office) at helen@arcus.org, or Hajo Eicken, UAF (SEARCH SSC Chair) at: hajo.eicken@gi.alaska.edu.

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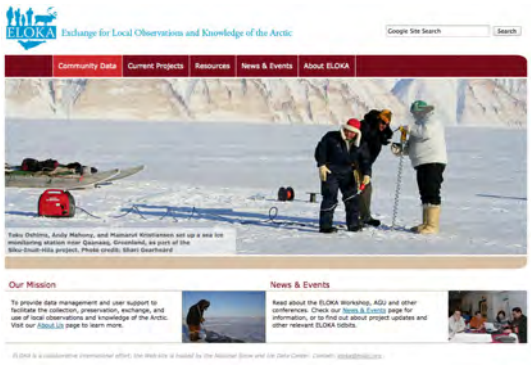
Local and Traditional Knowledge Stewardship: Managing Data and Information from the Arctic

By: Heidi McCann, National Snow and Ice Data Center

"I believe it is time for the harpoon and the computer to work together."
--Peter Katuk, Sanikiluaq, Nunavut

Heidi McCann is the ELOKA Knowledge Exchange Coordinator at the National Snow and Ice Data Center.

The Arctic has been home to Indigenous peoples for many generations. Out of the frozen landscape in which they dwell, Indigenous peoples have carved a productive, vital culture. From the learned experience and skills it is their local observations and knowledge that tell the story of drastic changes to the arctic climate—changes that have a global impact. Until recently, Indigenous local observations, knowledge, and involvement have been largely overlooked by science. Today, Indigenous peoples are acknowledged as investigators, partners, and collaborators. Their local knowledge and observations are being documented, collected, and preserved for use in arctic research, but this is not without its challenges, such as the preservation and transfer of knowledge.



The ELOKA website provides links to ELOKA Community Data, Current Projects, and other resources. Image courtesy of ELOKA.

Historically, oral transmission has been the dominant method for passing on knowledge in Indigenous culture. However, shifts in culture and adoption of innovative technologies over time have introduced new forms of preserving and learning. While useful, these modern forms of knowledge exchange and preservation cannot replace the intimacy that comes with practicing the use and understanding of acquired observations and knowledge of the environment. Collecting, preserving, and managing this knowledge outside of oral tradition needs to be a collaborative effort, while still respecting knowledge ownership. Developing data management tools and services through shared efforts that are effective, appropriate, and considerate to cultural sensitivity of collected information is critically important. At least one such project has emerged: the Exchange for Local Observations and Knowledge of the Arctic (ELOKA) (http://eloka-arctic.org/).

ELOKA, an NSF Arctic Observing Network (AON) (http://www.arcus.org/search/catalog/display/45) project, is a data management research support service that specializes in working with arctic communities and researchers in the collection, preservation, and use of local and traditional knowledge (LTK) and community-based monitoring (CBM) data and information.

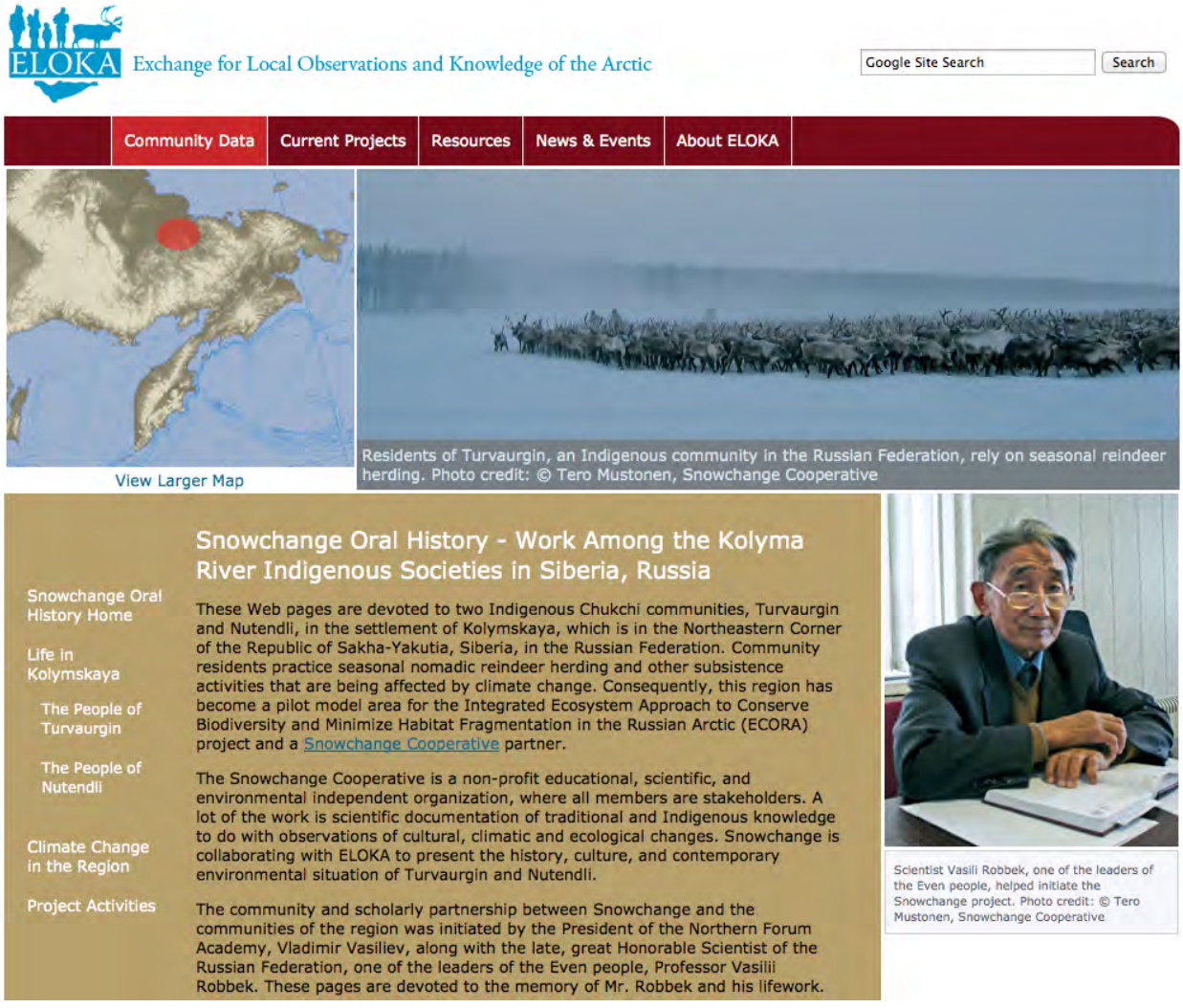
Launched during the International Polar Year (IPY) 2007-2008 and coordinated through the National Snow and Ice Data Center (NSIDC) (http://nsidc.org/) at the University of Colorado, Boulder, ELOKA currently works with knowledge holders to make available LTK and CBM datasets ranging from qualitative data such as map overlays, transcripts, and audio/videotape interviews of subsistence hunters who hold valuable knowledge on sea ice, to quantitative data such as snow and ice thickness, temperature, and wind velocity. Data and information comes from such places as the northeastern Russian Federation where the Indigenous Chukchi reside to the Inuit communities in northern Canada and Greenland.

Now in its third phase, ELOKA continues to provide data management services and support to arctic communities and others working with LTK or who are collecting data from CBM projects. ELOKA operates on the principle that all knowledge should be treated ethically, and intellectual property rights should be respected.

Current Community Datasets

ELOKA data and information resources represent international and interdisciplinary collaboration between the physical and social sciences and between researchers and communities. ELOKA also addresses cultural sensitivity issues that are not usually seen in standard physical science data management norms but are critically important when administering documented forms of LTK and CBM.

Current resources are overseen using a variety of methods and tools, as each project has different needs in presenting their data. Some will be simple with online data presentation, while others will require more advanced methods. An example of a dataset that requires simple technology in the form of a website is the *Snowchange Oral History—Work Among the Kolyma River Indigenous Societies in Siberia, Russia* (http://eloka-arctic.org/communities/russia/) product.



The website, 'Snowchange Oral History—Work Among the Kolyma River Indigenous Societies in Siberberia, Russia' is an example of products ELOKA provides to manage such datasets. Image courtesy of ELOKA.

These data present the oral history of two Indigenous Chukchi communities—Turvaurgin and Nutendii—located in the settlement of Kolymskaya, which is in the Northeastern Corner of the Republic of Sakha-Yakutia, Siberia, in the Russian

Federation. Documentation includes community lifestyle, maps, poems, and geographic and environmental information. The communities practice seasonal nomadic reindeer herding and other subsistence activities.

The Seasonal Ice Zone Observing Network (SIZONet) (http://eloka-arctic.org/sizonet) online application uses more advanced technological methods.

The Seasonal Ice Zone Observing Network (SIZONet) website was designed to be flexible and meet diverse user needs. Image courtesy of ELOKA.

In support of researchers at the University of Alaska Fairbanks and in a number of Alaskan coastal communities, the SIZONet application makes available a collection of local observations and traditional knowledge of sea ice, its use and change, and how this change is affecting community and cultural activities. Collected through the dedication of Iupiaq and Yup'ik sea ice experts, it was developed to serve as an interface between two distinct knowledge systems of western science and local and traditional knowledge, while at the same time preserving and passing on LTK through a user-friendly interface. The system serves as an archive and instructional tool for the collaborating hunters and their communities. The application is designed to be flexible enough to change in response to the evolving nature of the observations while providing a framework that allows researchers to track and compare specific climatic, environmental, and ecological features and events across geographic locations and over time.

These and other datasets and applications are available at the ELOKA website and can also be accessed through the NSIDC data catalog.

Impact of Indigenous Knowledge on Science

LTK has been a part of arctic research for some time. Early northern explorers sought the local knowledge of the Indigenous peoples and understood that their knowledge and advice could be the difference between life and death.

Today, LTK and CBM are receiving more respect and inclusiveness within modern science and policy. Use of Indigenous knowledge with western scientific measurement shows researchers that 'another way of knowing' offers improved understanding about what is happening in the Arctic. For example, using LTK and CBM, test climate models can be refined for better accuracy as well as provide new categories of information that need to be considered.

Indigenous peoples will continue to contribute local and traditional knowledge and data from community-based monitoring projects to improve our understanding of recent environmental, social, and cultural change. However, to foster the momentum and building of arctic resident participation and partnership in scientific research, while respecting knowledge ownership, ELOKA will maintain its current data management practices in an ethical manner in order to share observations and knowledge of the Arctic with future generations.

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For further information, see the ELOKA project website (http://eloka-arctic.org/) or contact Heidi McCann (heidi mccann@nsidc.org).

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Arctic System Science Program Update

By: Robert 'Max' Holmes and Neil R. Swanberg, NSF's Arctic System Science Program Directors

Change. This is perhaps the key word that describes the trajectory of the arctic system. It also applies to the Arctic System Science program (ARCSS) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13426), as it continually adapts to the changing conditions in the Arctic, in the research community, and at NSF. One recent change is that ARCSS has welcomed a new Program Director, Robert 'Max' Holmes from the Woods Hole Research Center, who will work alongside Neil Swanberg in managing ARCSS over the coming year or so (see accompanying article (http://www.arcus.org/witness-the-arctic/2013/2/article/19963)). Max has a long history studying the rivers in the U.S., Canadian, and Russian Arctic, as well as other large rivers globally. He is particularly interested in how climate change is impacting the discharge and chemistry of arctic rivers, what these changes tell us about their watersheds, and how these changes impact the receiving ocean waters. He is excited to be part of the NSF arctic team and looks forward to working with the research community to help shape and achieve ARCSS research priorities.

Another relatively recent change is that most ARCSS funding is now going to proposals submitted to the annual arctic competition instead of more narrowly focused special solicitations. Given the complexity of developing ARCSS proposals, which must contribute explicitly to the understanding of the arctic system as a whole, the reliability of a stable annual funding opportunity should facilitate the development of the ideas and research teams that are needed to prepare successful ARCSS proposals. We think this greater emphasis on the annual competition frees the research community to propose their best ideas to ARCSS, and thus improves our understanding of the current arctic system and our ability to predict its future states. Special calls will still occur and ARCSS will still participate in foundation-wide solicitations such as those for Earth System Modeling (EaSM) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503399) and Arctic Science, Engineering, and Education for Sustainability (SEES) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503604), but in the next few years ARCSS-generated special solicitations may become more the exception than the norm.

How will ARCSS identify research priorities? We will continue to listen to the discussions ongoing in the research communities and strive to identify strategic areas in which additional study is likely to lead to the greatest advances in our understanding of the arctic system. Fortunately, a number of recent activities involving scores of academic and government scientists have identified key near-term priorities for arctic research. For example, significant reports have recently been released by the Interagency Arctic Research and Policy Committee (IARPC) (http://www.nsf.gov/geo/plr/arctic/iarpc/start.jsp) and the Study of Environmental Arctic Change (SEARCH) (http://www.arcus.org/search). These and other community planning efforts will continue to influence ARCSS priorities. As before, synthesis to achieve system-level understanding will be central to ARCSS, and new priorities will emerge from synthesis activities.

How will ARCSS communicate its funding priorities to the research community without special solicitations? Although ARCSS will welcome any ARCSS-appropriate proposal to each of its annual competitions as detailed in the Arctic Research Opportunities solicitation (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5521&org=PLR&sel_org=PLR&from=fund), from time to time we may want to draw attention to topics of particular interest in a given year. One way that we may do this is through the use of "Dear Colleague Letters," which will be posted on the NSF

website at least three months prior to the proposal deadline. These Dear Colleague Letters can also be distributed electronically, such as through the ArcticInfo mailing list (http://www.arcus.org/arctic-info). In addition, we will continue to meet with and discuss research priorities with the research community at conferences, workshops, during university visits, and at NSF.

Both Neil Swanberg and Max Holmes encourage current and prospective ARCSS researchers to talk with them about their ideas for future proposals. We want to facilitate top-quality proposals that will lead to research to achieve arctic system understanding. We recognize that these are often complex multidisciplinary proposals and we are committed to fostering their development to the extent we are able. In a future issue of *Witness the Arctic*, we intend to explore some common elements of successful ARCSS proposals and how they may differ from those submitted to other programs in NSF's Arctic Section. In the mean time, talk to us—your ideas can help shape future ARCSS priorities.

For more information, contact Robert 'Max' Holmes (rholmes@nsf.gov) or Neil R. Swanberg (nswanber@nsf.gov).

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A Perspective on NSF's Arctic System Science Program

By: Robert 'Max' Holmes, ARCSS Program Director

Robert 'Max' Holmes, ARCSS Program Director.
Image courtesy of Chris Linder.

Having transitioned in January 2013 from being a scientist at the Woods Hole Research Center to a Program Director for NSF's Arctic System Science program (ARCSS) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13426), I thought it might be useful to share my initial impressions while they are still fresh on my mind. My dominant impression is one of respect for my new colleagues at NSF. They are all smart, hard working, and dedicated to funding the best science. They are also all scientists and they care deeply about scientific progress. They struggle, even agonize, about funding decisions and have to constantly weigh many competing priorities—internally and externally—that I am just now beginning to understand. Just as researchers can get demoralized by a string of unfunded proposals, so too are program directors impacted by having to decline so many strong proposals. But they keep at it, year after year, doing their absolute best to do the most with the resources they have. And I think it is safe to say that their greatest satisfaction is to play a role in the remarkable science that you do - so do great work and let your program officers know about it!

A surprise to me has been how much time program directors have to spend to get solid reviews for all the proposals they receive. Each proposal requires at least three reviews, and often you have to ask three people to get a single review. Thus, it is not unusual to have to contact more than ten reviewers to get the needed three reviews. I admit to now feeling guilty about all my late reviews in the past, or even worse, the review requests that somehow got buried in my inbox to which I never responded. I now also realize that each program director has ready access to my history as a reviewer—all of the times I've been contacted to do a review and all of the reviews that I've submitted. You develop a reputation as a reviewer—make it a good one. While the rating given to a proposal is important, the substantive comments about the proposal are far more important: little weight is given to ratings of "Excellent" or "Poor" if not supported with specific and substantive comments.

For my time at NSF, I plan to work most closely with Neil Swanberg to continue the evolution of ARCSS. As described in the companion article (http://www.arcus.org/witness-the-arctic/2013/2/article/19964), we will do our best to fund research that advances understanding of the arctic system, and we will continue to work closely with the research community to identify funding priorities. As all are aware, these are challenging times fiscally, but the importance of the research demands that we all forge onward and continue to unlock the mysteries of the Arctic. I consider it an honor to be at NSF and to work with my remarkable new colleagues. I certainly will have a new appreciation for what they do when I return to my life as a researcher.

For further information, contact Robert 'Max' Holmes (rholmes@nsf.gov).

Climate Change and Human Mobility in Indigenous Communities of the Russian North

By: Susan A. Crate, George Mason University

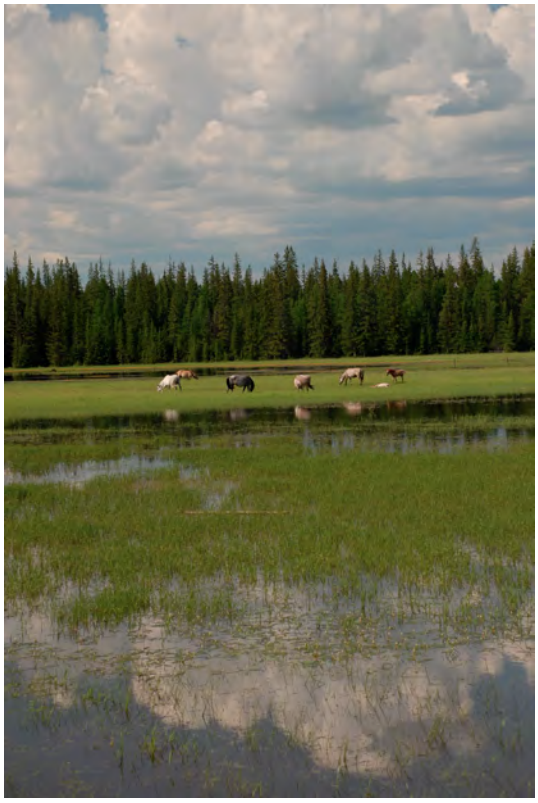

Figure 1. Increasing water on the land impedes Viliui Sakha's ability to paster their horses and cattle and also to harvest sufficient fodder to see their herds through the winter. Image courtesy of Susan Crate.

Mobility is central to the livelihoods of the diverse reindeer-herding, hunting/gathering, and pastoralist peoples inhabiting the circumpolar north. Like their circumpolar neighbors, today the livelihoods of Russia's indigenous peoples are challenged by the local effects of climate change and by other changes including industrial contamination, economic transformations, globalization and modernity, and alienation of their youth. In contrast, Russia's northern inhabitants bear the brunt of a unique historical legacy of 17th century colonization, Sovietization, and de-Sovietization, which works to hamper mobility, distance resources, and impede land rights. Based on NSF-funded longitudinal research in northern Russian communities since 1991, anthropologist Susan Crate (http://mason.gmu.edu/~scrate1/) of George Mason University analyzed issues of climate change and mobility for a Brookings Institution Report (http://www.brookings.edu/research/papers/2013/01/30-arctic-russia-crate). The report is based on Crate's findings in a case study of Viliui Sakha and supplemented with examples of relocation and mobility on a regional and national scale and discussions on indigenous and governmental response. The report shows how anthropological investigation provides a window into the complexity of local livelihoods and, among other things, how that perspective offers a crucial contribution to the policy debate on climate change. The following article highlights findings of that report.

Mobility is central to the livelihoods of many of the peoples inhabiting northern Eurasia. That mobility was hampered first by 17th century Russian colonization and most dramatically by 20th century Sovietization. Collectivization policies forced settlement and consolidation to account for production and to provide schooling. Resettlement divided families and separated inhabitants from their birth lands. The government relocated technical "specialists" from western Russia to the state farms, further altering the demographics of communities. After the 1991 fall of the Soviet Union, most state farm and collective activities ceased. Inhabitants today depend to a greater or lesser extent on pre-Soviet subsistence. In addition to these historical constraints affecting mobility, climate change is also beginning to affect northern Russia's indigenous livelihoods.

The effects of global warming in the Russian North include permafrost degradation; increasing ambient air temperatures, precipitation, and frequency of extreme events; and an overall "softening" of the climate, characterized by the lessening of the extreme cold of winters and sweltering heat of summers. These effects trigger altered seasonal timings (phenology) and ranges of animals and plants (Roshydromet 2008). In-country scientists report within the Sakha area an unprecedented increase in permafrost degradation, average annual precipitation rates, and air temperature in the last decade, all attributed to climate change (Fedorov and Konstantinov, 2009).

The case study of one northern group, Viliui Sakha, provides a close-up understanding of mobility, resettlement, and relocation in the face of contemporary climate change. Viliui Sakha are horse and cattle breeders, a livelihood brought from the south by their Turkic ancestors. In the Soviet period, they were gradually consolidated into larger and larger collective operations, which culminated in extensive agro-industrial state farms. Viliui Sakha adapted to the fall of the Soviet Union by developing household-level food production based on keeping cows and strengthening dependence on kin households, a strategy termed "cows and kin" (Crate 2006).

Soviet policies and the post-Soviet aftermath to date have had a much greater impact on Viliui Sakha livelihoods than climate change. However, regional scientific data and local observations show that the climate change trends, including permafrost degradation and increasing precipitation, will require Viliui Sakha to relocate if they intend to maintain their cow and horse breeding practices. Based on findings from Crate's NSF projects[1], inhabitants identify nine main changes (Crate 2011) and are most concerned about and affected by the increasing water on the land (see Figure 1 and Figure 3) and the changes in seasonal timing (see Figure 2).

Figure 2. Viliui Sakha perform their annual slaughter once ambient temperatures remain below freezing. With the elongated Fall, slaughter now is sometimes pushed one month later, meaning an extra month of foddering animals and delaying the replenishment of household meat stores. Image courtesy of Susan Crate.

Other cases further illustrate issues of mobility and relocation within the Sakha Republic. In the Republic 92 villages (15%), which are home to 136,000 inhabitants (7% of the total population), are in the direct path of flood incidents. In 1998 and 2001 the Republic had catastrophic floods. In 2002 the Sakha government passed a resolution to "relocate the most affected flooded villages," beginning in Kyllakh with plans to move the village from its original location on an island in the Lena River to a non-flooding terrace on the right bank. Residents remain on the island despite the state's efforts to relocate the community and despite continued and increasing flooding. Reasons they remain include the huge expense to move for individual households, the lack of pasture and fodder in the new location, and the difficulty of psycho-social adaptation to a new place.

Figure 3. The combination of increased precipitation, warming permafrost, and the relatively flat landscape of the Viliui regions has rendered many hayfields unusable. Image courtesy of Susan Crate.

The government is also responding through the Republic's Rescue Service, as specialists have developed an early warning system to evacuate areas that have an impending catastrophe. Rescue service experts claim that with this system in place, not a single person has died in floods since 2007.

Other indigenous peoples within the Sakha republic (e.g., Even, Evenk, Yukagir, Chukchi) are migrating for many reasons, including climate change. In contrast to Sakha, the herding,hunting, fishing, gathering populations have both advantages and limitations. Because their subsistence mode is based primarily on mobility, they have greater flexibility to move in the face of calamity to maintain subsistence. Conversely, the changes in climate and seasonal patterns negatively affect the wild resources essential to their livelihoods.

The lessons from these three examples are:

1. If a community such as Kyllakh must relocate, sufficient research—ideally in collaborative consultation with the affected communities—must inform an appropriate resettlement site where inhabitants can continue their livelihood practices.

2. Early warning systems are needed to enable evacuation of settlements in a timely fashion.

3. Livelihood type is a critical consideration in understanding a peoples' need to move or stay and their capacity to adapt to change.

Comparisons and Contrasts Across Northern Russia

This section of the report illustrates, through three mini-cases—the Nenets of Yamal, the Dolgan and Nganasan of Taimyr, and the Chukchi and Siberian Yupik of Chukotka—the diverse ways in which climate change affects mobility. In contrast to indigenous peoples of the rest of the circumpolar north, these groups all face the impact of climate change within the context of a common Soviet and post-Soviet legacy that limits their mobility options and adaptation to climate change. The full Brookings report (http://www.brookings.edu/research/papers/2013/01/30-arctic-russia-crate) examines both the commonalities and the diversity among northern Russia's indigenous peoples facing intersecting change factors, with an emphasis placed on how perceptions shape peoples' understandings and responses.

The cases in Russia illustrate the interaction of various factors of change, including oil and gas development of Yamal affecting Nenets' livelihoods; the restraints on hunters' mobility and access to wild resources of the Dolgan and Nganasan; and the relocation from optimal sea-mammal hunting camps and pastoral access of the Chukchi and Siberian Yupik. These cases also highlight the effects of climate in that mix and how perceptions are based in local understandings of the world.

The Indigenous Response

One major development for Russia's indigenous peoples has been the establishment of the Russian Association of Indigenous Peoples of the North, Siberia, and the Far East (RAIPON). But while RAIPON has made progress, the key to on-the-ground change for Russia's affected peoples is policy development and implementation, which is challenging (see full text of report (http://www.brookings.edu/research/papers/2013/01/30-arctic-russia-crate) for details). Other successes in indigenous response include collaboration between local communities and researchers. Additionally, to facilitate indigenous response, a great deal needs to be done in raising awareness among local communities about the impact of climate change. For example, research with Viliui Sakha found that while inhabitants observed changes in their environment and understood its effects on their livelihoods, they attributed most of the changes to sources other than climate change (Crate 2011).

Communities need first to be able to understand how climate change is affecting present and future livelihoods and how climate change interacts with the other change factors in their lives. To address this need, Crate explored with the Viliui Sakha communities a process of community-collaborative knowledge exchange, which aimed to establish dialogue between regional scientific data and local knowledge based in lifelong observations (Crate, in press). Such climate change literacy empowers local inhabitants and scientists alike. Inhabitants can be more proactive in engaging with local, regional, and federal representatives concerning the impacts on their livelihoods, including the likelihood that they will have to relocate. Regional scientists gain an intimate understanding of how a global phenomenon, in this case climate change, has a diversity of effects on ecosystems and human adaptation to a changing environment.

The Government Response

It would be too extreme to say that Russia's federal government is in climate denial, considering how far official policies have come in establishing climate change as a federal policy problem[2]. While there are still murmurs in federal boardrooms of "scientific uncertainties" and still many skeptical voices in Russia's media, the policy discourse has shifted from discussing causes of climate change to debating its economic and political costs and benefits. However, Russian governmental bodies at the regional level have been more responsive.

Here the international circumpolar community can help. At both the federal and regional governmental levels there is a great need for sharing experiences with other circumpolar countries, particularly in the areas of:

1. How to govern and redesign policy that accommodates indigenous livelihoods in the face of climate change, including implications for relocations and resettlements.
2. How to develop and sustain interdisciplinary research collaborations that bring together in-country and international natural and social science scholars for community-based projects to address issues of climate change and displacement.
3. How to further promote collective action/advocacy by arctic indigenous peoples.
4. How to create an enabling environment to promote understanding and thereby a greater capacity for action on the local level inclusive of research and policy communities.

Citations

[1] NSF National Science Foundation, Office of Polar Programs, Arctic Social Science Program Grant 0710935 "Assessing Knowledge, Resilience & Adaptation, and Policy Needs in Northern Russian Villages Experiencing Unprecedented Climate Change," and NSF National Science Foundation, Office of Polar Programs, Arctic Science Program Grant 0902146 "Understanding Climate-Driven Phenological Change: Observations, Adaptations, and Cultural Implications in Northeastern Siberia and Labrador/Nunatsiavut (PHENARC)."

[2] For example, see the 2009 Climate Doctrine (http://archive kremlin.ru/eng/text/docs/2009/12/223509.shtml).

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Thanks to all my collaborators in the Sakha Republic, the Brookings Institution, the National Science Foundation, and all colleagues who contributed (for a full detailed list of acknowledgements, please see Brookings full report (http://www.brookings.edu/research/papers/2013/01/30-arctic-russia-crate)).

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Understanding Arctic Indigenous Youth Resilience

By: Olga Ulturgasheva, Scott Polar Research Institute, University of Cambridge and Stacy M. Rasmus, Center for Alaska Native Health Research, University of Alaska Fairbanks.

The international and multidisciplinary project "Negotiating Pathways to Adulthood" explored the indigenous adolescent experience at the critical time of transition from adolescence to young adulthood among Alaskan Yup'ik, Alaskan Inupiat, Canadian Inuit, Norwegian Sami, and Siberian Eveny. Funded by NSF, this collaborative and multi-sited study examined the challenges these adolescents face and the resources and strategies they use to cope with hardship and adversity. The project developed insights into the family, community, and cultural contexts that support healthy youth and identified key protective factors that may promote development of effective culturally compatible prevention programs. Such prevention programs aim to reduce current disproportionately high rates of substance abuse and suicide, build indigenous research capacity, and develop a collaborative network of researchers and community members.

Youth participants in the 'Negotiating Pathways to Adulthood' study. Standing on far right at researchers Olga Ulturgasheva (in bright blue) and Stacy Rasmus. Image courtesy of Stacy Rasmus

The research process involved engaging, interviewing, and observing 100 indigenous young people across gender and across two age groups signifying early (11-14 years old) and late (15-18 years old) adolescence. The data from five communities was collected and analyzed by researchers at Siberian Eveny, Alaskan Yup'ik, and Norwegian Sami sites, and supplied by community collaborators and later processed by researchers at the Alaskan Inupiat and Canadian Inuit sites. The study highlights the need for social policy to be based on long-term ethnographic research and analysis at the community and family level. Conducting research in the community, participating in people's—especially young people—lives, speaking to them in person, and observing them in action, are pivotal to doing useful and effective community research in the Arctic.

The research findings point at assemblages of shared experiences among arctic youth in their transition to adulthood: common patterns in the spheres of schooling, subsistence practices, Indigenous identity construction, inter- and intra-generational relations, and violence and emotional hardship related to bullying and boredom. Project data show that the youth resilience strategies are shaped by and are an outcome of communal effort (i.e., family, kin, or peer-support). More specifically, researchers found that while facing situations of hardship and adversity, youth from each community deploy socially important and locally accessible resources such as local networks of sharing, extended and fluid households, grandparents and other important care-takers, kin/peer support, and subsistence activities (e.g., reindeer herding, hunting, and fishing) as strategies for being well and strong. Some of these resources cited by the youth—such as parents, school, and subsistence activities—at times also presented special challenges. This points to a complex model of negotiation enacted by youth as they determine how to live in their communities—using strategies that build in the necessary flexibility to maximize available, while not always reliable, local resources. Arctic indigenous youth still deploy culturally

integrated mechanisms of protection but give them fresh meanings as they put them to use in new situations and towards new ends.

Preliminary findings were shared and discussed by indigenous youth, community members, and university researchers at the international Circumpolar Indigenous Pathways to Adulthood (CIPA) study workshop at the Smithsonian Museum of Natural History in Washington, D.C. in October 2012 (see Figure 1). Prior to the workshop, two of the indigenous researchers on the circumpolar team (Ulturgasheva and Rasmus) had involved youth in the production of a digital community portrait and an auto-ethnographic video film, "One Day From My Life," which then were screened during the workshop. Digital presentations of the research findings provided contextual framework for understanding socialization patterns and resilience-shaping processes in the communities. The presentations also stimulated comparative discussion among the workshop participants from all sites.

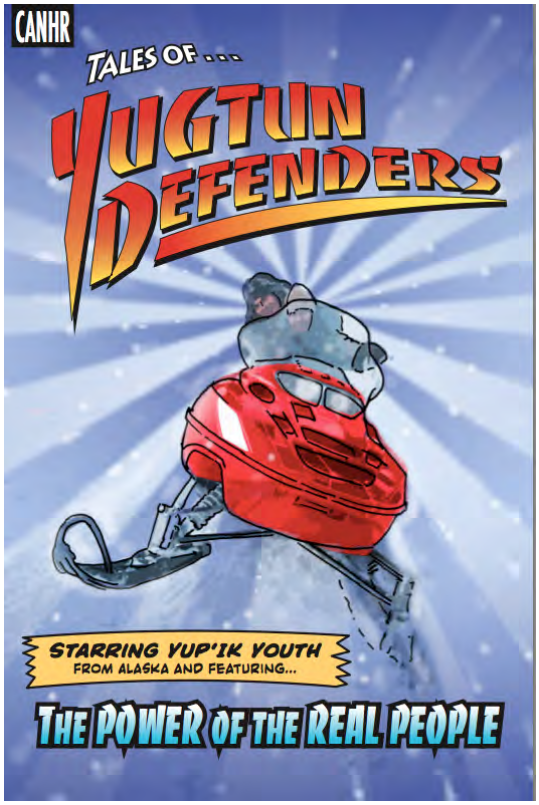


Figure 2. Circumpolar Indigenous Pathways to Adulthood workshop participants produced an innovative and youth-centered comic book-themed report for Yup'ik Alaska youth. Image courtesy of Stacy Rasmus.

Outcomes from this research include the development of innovative, indigenous, youth-centred research methodologies. These resulted in production of material that can be digitally disseminated for youth on the move in the Eveny reindeer herding communities and in the production of a comic book-themed research report for Yup'ik Alaska Native youth (see Figure 2). This project also contributed to transformative outcomes for the indigenous youth and for the university researchers involved in the participatory and co-learning research process. Most significantly, indigenous youth involved in the cross-site workshop left feeling stronger, more connected, and more confident and hopeful in their futures. One of the outcomes is collaboration between indigenous researchers from Alaska and Siberia. Rasmus and Ulturgasheva have recently launched a new study that examines the practice of indigenous researchers working with indigenous communities, both their own and others, and provides a critical new take on the traditional insider-outsider dilemma in social science research.

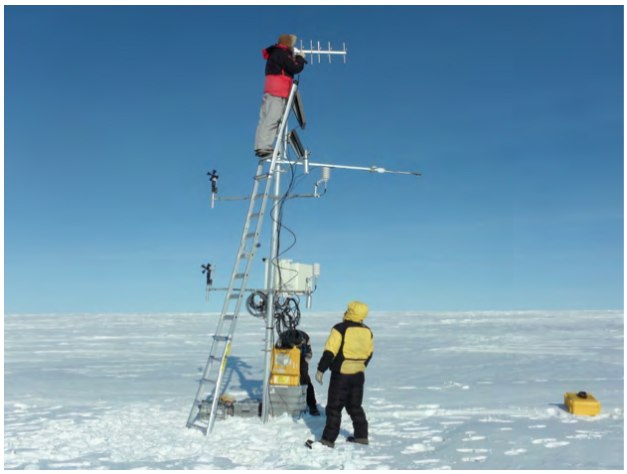
Rasmus and Ulturgasheva have continued to build relationships between Siberian Eveny and Alaskan Yup'ik with the goal of increasing local resources networks through the creation of an international arctic context for resilience.

For further information, please contact Olga Ulturgasheva (ou202@hermes.cam.ac.uk) and Stacy Rasmus (smrasmus@alaska.edu).

The projects featured in this article are supported by funding from the National Science Foundation.

Workshop on Needs in Arctic Research Support and Logistics

The NSF Arctic Research Support and Logistics (RSL) program is hosting a workshop on strategies and recommendations for arctic research support and logistics. The workshop is planned for 2.5 days, 7-9 October 2013 in the Washington, D.C. area and will be organized by the Arctic Research Consortium of the U.S. (ARCUS).



Researchers install a new satellite antenna for the NASA-U Automatic Weather Station on the Greenland Ice Sheet. Photo by Jim Pottinger (PolarTREC 2011), Image courtesy of ARCUS

The RSL program (http://www.nsf.gov/od/opp/arctic/res_log_sup.jsp) supports the field component of research projects as well as activities that have benefits for the arctic research community. Services from the RSL program are available to projects funded by science programs in the Arctic Sciences Section and in some cases projects funded by other programs at NSF and other agencies.

NSF conducted two previous planning processes to solicit guidance on arctic research support and logistics needs, with resulting reports in 1997 and 2003 (http://www.arcus.org/logistics/index.html). These reports had major impact on arctic research support; the 1997 report resulted in the creation of the NSF RSL program and the 2003 report catalyzed implementation of the Study of Environmental Arctic Change (SEARCH) (http://www.arcus.org/search) and the Arctic Observing Network (AON) (http://www.arcus.org/search/catalog/display/45). Since the last report, the research and research support landscapes have evolved considerably. As such, the NSF RSL program is convening a workshop that gathers representatives of the science community and agencies to discuss changing logistics support needs due to current and emerging scientific developments. The resulting report will inform the development of arctic research support to advance arctic research from the perspective of the research community.

Understanding that not everyone can participate in person, an online survey circulated prior to the workshop will gather input from the broader arctic science community to feed into the workshop discussion. All workshop updates will be announced via ArcticInfo (http://www.arcus.org/arctic-info).

For more information, please contact: Helen Wiggins (helen@arcus.org) or Kristina Creek (creek@arcus.org) at ARCUS, or Renée Crain (rcrain@nsf.gov) or Pat Haggerty (phaggert@nsf.gov) at the NSF RSL Program.

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Matthew Shupe, University of Colorado and NOAA Earth System Research Laboratory
Craig Tweedie, University of Texas at El Paso

ACADIS Data Management Services Expanded

The Advanced Cooperative Arctic Data and Information Service (ACADIS) (http://www.aoncadis.org/home.htm) team continued to expand data management planning, sharing, and preservation support for all projects funded by the Arctic Sciences Section in NSF's Division of Polar Programs (POL). ACADIS, a joint effort by the National Snow and Ice Data Center (NSIDC) (http://nsidc.org/) and the University Corporation for Atmospheric Research (UCAR) (http://www2.ucar.edu/), is entering the third year of a four-year continuing grant awarded by NSF in July 2011.

Recent ACADIS team activities were focused on simplifying data submission at the ACADIS Gateway (http://www.aoncadis.org/home htm). The improved services include:

- An improved tool to support authoring metadata.
- Expanded capabilities and control for authorized Principal Investigators.
- A new template to assist investigators in developing the Data Management Plan required for all NSF proposals.
- An updated guide for data providers featuring at-a-glance instructions on how to contribute data.
- The Arctic Data Explorer (ADE) (http://www nsidc.org/acadis/search), a new data search tool launched at the Arctic Observing Summit (AOS) (http://www.arcticobservingsummit.org/) in April 2013 .

To give feedback or submit data, contact ACADIS Support at: support@aoncadis.org.

ACADIS data management services were highlighted in two data management white paper submissions for the AOS2013 (http://www.arcticobservingsummit.org/users/white_papers.php) and in the U.S. Arctic Research Plan: FY2013-2017 (http://www.whitehouse.gov/sites/default/files/microsites/ostp/2013_arctic_research_plan.pdf).

For more information, see the ACADIS website (http://www.aoncadis.org/) or contact support@aoncadis.org.

Chukchi Sea Industry Data Now Available to the Public

A data-sharing agreement signed in August 2011 between the National Oceanic and Atmospheric Administration (NOAA) and three oil companies (Shell, ConocoPhillips, and Statoil) has laid the groundwork for the Alaska Ocean Observing System (AOOS) (http://www.aoos.org/) to provide public access to a wealth of oceanographic and environmental data collected between 2008 and 2012 in the Chukchi Sea.

By: Molly McCammon, Excutive Director, Alaska Ocean Observing System

A data-sharing agreement signed in August 2011 between the National Oceanic and Atmospheric Administration (NOAA) and three oil companies (Shell, ConocoPhillips, and Statoil) has laid the groundwork for the Alaska Ocean Observing System (AOOS) (http://www.aoos.org/) to provide public access to a wealth of oceanographic and environmental data collected between 2008 and 2012 in the Chukchi Sea.

Molly McCammon, Executive Director, AOOS. Image Courtesy of M. McCammon.

Industry builds external stakeholders' confidence in their research by making data transparent, according to Caryn Rea, Alaska environmental studies lead for ConocoPhillips. She calls the agreement "transformative, from the perspective of the oil and gas industry. This is the first ever agreement that I'm aware of where a private company has been supportive of ensuring full public use of the private investment in oceanographic and environmental studies that support our industry. ConocoPhillips widely shares annual reports prepared by consultants in support of its extensive onshore environmental studies to a variety of stakeholders including regulators, communities, and environmental organizations, but the sharing of a full suite of environmental data is a new endeavor."

When the umbrella agreement was first signed in 2011, Jane Lubchenco, former NOAA administrator and Undersecretary of Commerce for oceans and atmosphere, explained that "Despite the wealth of scientific research conducted on the arctic environment to date, much remains unknown, and no single government agency or entity has the resources or capacity to meet the task alone." She said the partnership "...will significantly expand NOAA's access to important data, enhance our understanding of the region, and improve the United States' ability to manage critical environmental issues efficiently and effectively as climate change continues to impact the Arctic."

The initial umbrella agreement calls for sharing several major datasets in the Chukchi Sea lease sale areas, including: real-time weather and ocean observations, environmental information, and sea ice and sea floor mapping data. Historic weather, oceanographic, and environmental studies data are now freely available through the AOOS Research Workspace (http://www.aoos.org/aoos-ocean-workspace/) , a password protected research collaborative managed by the AOOS data contractor, Axiom Consulting (see box below). Anyone can request access to these datasets by contacting Chris Turner at chris@axiomalaska.com. This process allows AOOS to track user access to the data and report on that usage to the three industry signatories and ensure that users are aware of the metadata associated with the data.

Industry Data to be Incorporated into AOOS Arctic Portal

The information now publicly available through AOOS is data collected as part of the ecosystem level study program and monitoring associated with exploration activities in the Chukchi Sea. The Environmental Studies data collection and quality control are estimated to represent about a $75 million research investment. Through the AOOS website, scientists can now access four years of multiple sets of biological, chemical, and physical data collected in the lease sale areas plus two years of monitoring data during seismic and/or shallow hazard surveys. Under the terms of the agreement, another year of data will be added to the collection each year. These data will help government agencies and the broader research community understand and monitor changes in climate, weather, and physical and biological ocean processes and help validate and improve forecast models.

What Kind of Data was Collected?

Details on the industry-collected data are available in annexes to the original agreement:

Annex 1 Met-Ocean Data (http://www.aoos.org/wp-content/uploads/2013/03/NOS-MOA-11-80-Arctic-Annex-1-Met-Ocean-and-Exhibit-final-signed.pdf) was the first detailed agreement and provides government and public access to the real-time meteorological and oceanographic data collected by industry-sponsored buoys deployed in the Chukchi Sea during the open water season. During the open water season, real-time data are available through the National Weather Service and the AOOS Sensor Map (http://data.aoos.org/maps/sensors). Shell also makes its Synthetic Aperture Radar (SAR) images of Chukchi and Beaufort sea ice available to NOAA's National Weather Service ice forecasting desk to use in fine-tuning the sea ice forecasts they provide to the public on a daily basis. All historic data are provided both to the National Ocean Data Center (NODC) and AOOS for archiving.

Annex 2: Environmental Studies Data (http://www.aoos.org/wp-content/uploads/2013/03/NOS-MOA-11-80-Annex-2-Exh-2A-Env-Data-signed-NOAA-Shell-CP-Statoil.pdf) was signed in December 2012 and includes physical, chemical, and biological data collected by the industry-sponsored Chukchi Sea Environmental Studies Program (CSESP) (http://chukchiscience.com/), a multi-year, interdisciplinary ecological study focused on areas in outer continental shelf oil and gas leases in the northern Chukchi Sea. An overview of the study's design, lead researchers, and discipline-specific information is available here. (http://www.chukchiscience.org/) The data runs the gamut from biological and physical data collected during cruises to acoustic recorder data.

Annex 3: Hydrographic Data - This annex is now under development with the goal of providing access to non-proprietary information collected by the three companies, primarily bathymetry and other hydrographic information that would be valuable for modeling and other scientific research projects.

What Industry-Funded Observing Assets are in the Water, and Where?

Industry-funded observing platforms and assets include buoys, research cruises, acoustic recorders, and radars. These are displayed on the AOOS Research Assets Map (http://data.aoos.org/maps/search/research-assets.php). Real-time data from industry met-ocean buoys stream live through the AOOS Sensor Map during the open water season and are archived at NODC.

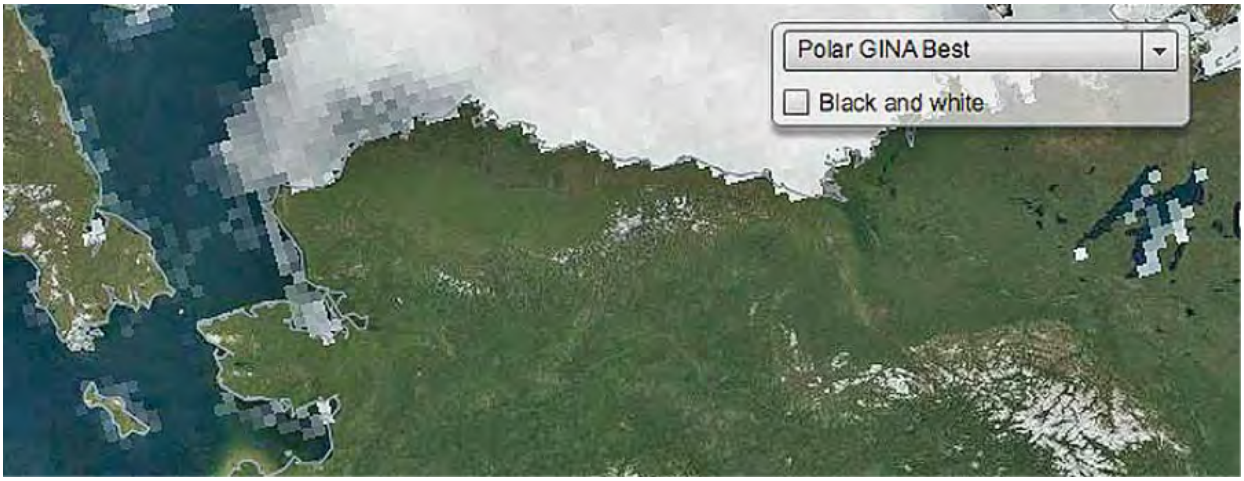
New AOOS Arctic Portal Ultimately to Display Industry Data

AOOS' ultimate goal is to incorporate the industry datasets into the new Arctic Data Integration Portal (http://dev.axiomalaska.com/maps/search/arctic html). This integrated application, developed with funding from NOAA's Regional Ocean Partnership Program as part of the AOOS Spatial Tools for Arctic Mapping and Planning (STAMP) Project (http://www.aoos.org/stamp), was publicly released in late January. It assimilates a broad variety of arctic data layers for research, planning and management and decision support. Users can combine Geographic Information Systems (GIS) data, real-time sensors, model forecasts, and satellite imagery on a single interface.

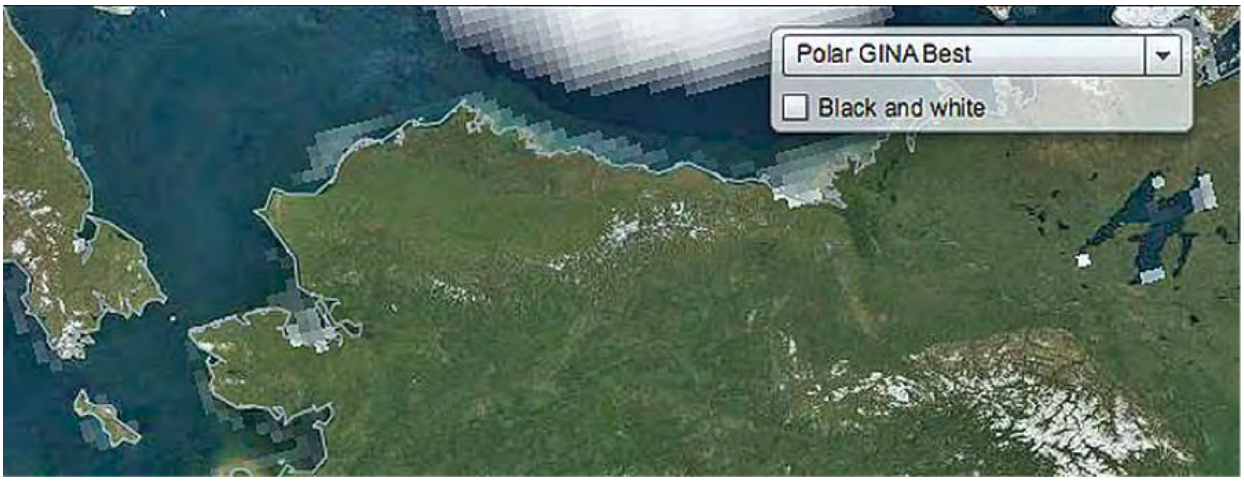
The Arctic Data Integration Portal has two components: a data layer catalog and an interactive map. The Data Layer Catalog has a library of data layers that include meteorological models (e.g., wind, waves, and currents), habitat and species information from field-based mapping projects, real-time sensors, and more. Users can browse datasets by category or keyword and search through metadata, or click to access brief project descriptions with links to original source data. Individual datasets can be stacked for viewing in the Arctic Data Integration Portal map display.

The interactive map-based portal integrates various types of arctic data from sensor feeds, operational oceanographic and atmospheric models, satellite observations, and GIS datasets describing the biological and physical characteristics of the arctic region. Users can graphically explore individual datasets such as temperature, currents, or precipitation, and drag and drop a "virtual sensor" to extract a time series at specific map locations. A feedback tab is located on the left side of the portal screen and users are encouraged to provide comments on the utility of this application.

As an example, users can scroll through or graph 34 years of daily sea ice extent and thickness from the National Snow and Ice Data Center (NSIDC) (http://nsidc.org/). This dataset shows the marked decrease in sea ice between October 1978 (top image, next page) and October 2012 (bottom image, next page).



Sea ice extent in October 1978. Image courtesy of AOOS.



Sea ice extent in October 2012. Image courtesy of AOOS.

Arctic Research Assets Map

This application was initially developed at the request of arctic researchers concerned that research equipment such as buoys and recorders may be hit or snagged by the increasing number of ships plying arctic waters. The map is intended to display the location of these assets, the funding source, and the implementing entity or research investigator. The map is searchable by sensor type, source, or study name. Metadata such as project information, deployment/pick-up dates, and key contacts is also available. Users can monitor plans of others prior to the field season and scroll through time to view instruments from past years. The tool is now widely used for planning purposes and to avoid duplication of efforts.

The AOOS data system employs interoperability systems, allowing data to be accessed and transmitted to geographically distributed research centers. Several tools are available through the AOOS website (http://www.aoos.org/aoos-data-resources/) for data discovery, retrieval, staging, stacking, layering, and analysis. Those interested in submitting data to be included in the AOOS data system should contact AOOS at info@aoos.org.

AOOS Research Workspace

The new web-based research collaborative "AOOS Research Workspace" (http://www.aoos.org/aoos-ocean-workspace/) is a prototype, web-based data management solution for assembling, storing, and sharing data among members of the biological and physical oceanography communities. The workspace offers users an intuitive interface to create projects and upload data and descriptive literature. File transfer can be done through an easy "drag and drop" process.

Several groups are already using the workspace, including:

- North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program
- Gulf Watch Alaska, the long term monitoring program of the Exxon Valdez Oil Spill Trustee Council
- Herring Research and Monitoring Program, a collaborative effort of the Exxon Valdez Oil Spill Trustee Council implemented by the Prince William Sound Science Center
- Russian-American Long Term Census of the Arctic (RUSALCA)

For further information, see the AOOS website (http://www.aoos.org/), or contact Molly McCammon (mccammon@aoos.org).

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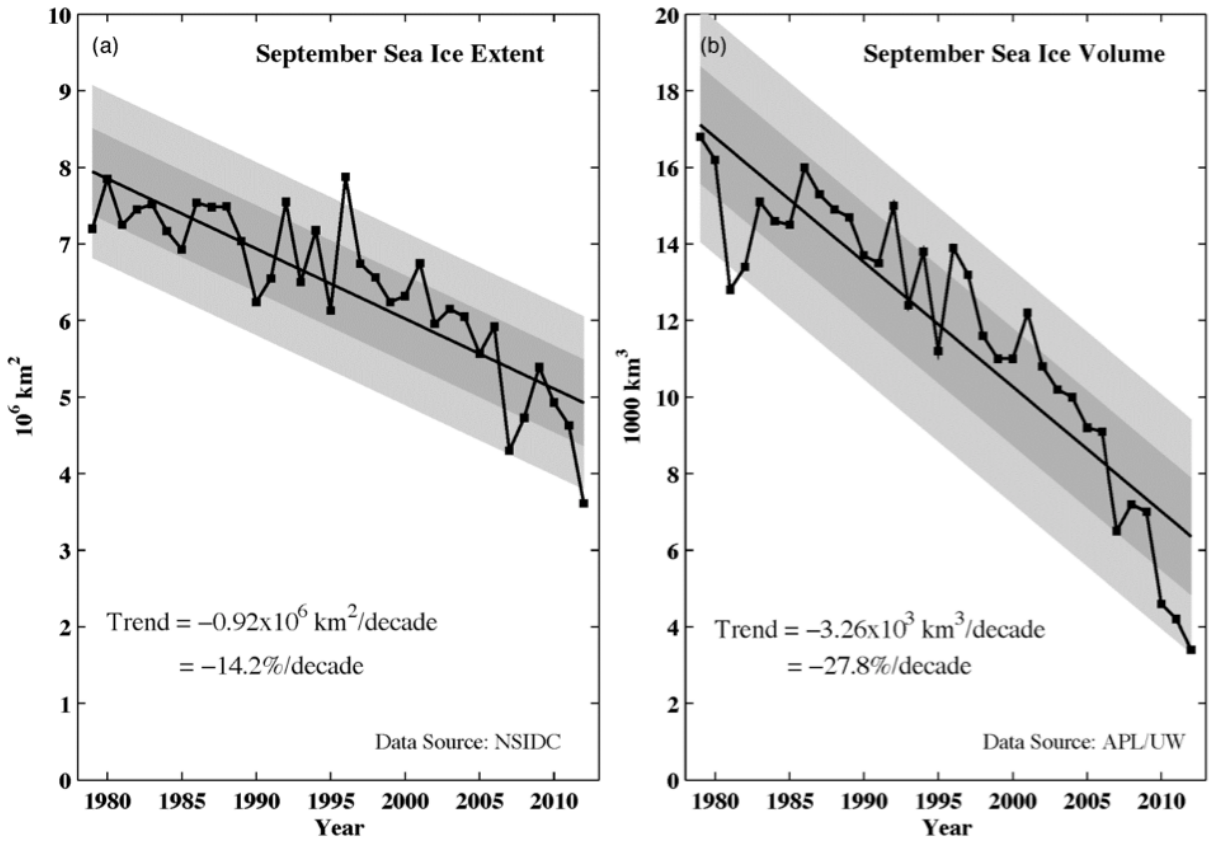
Arctic Nearly Free of Summer Sea Ice by Mid Century

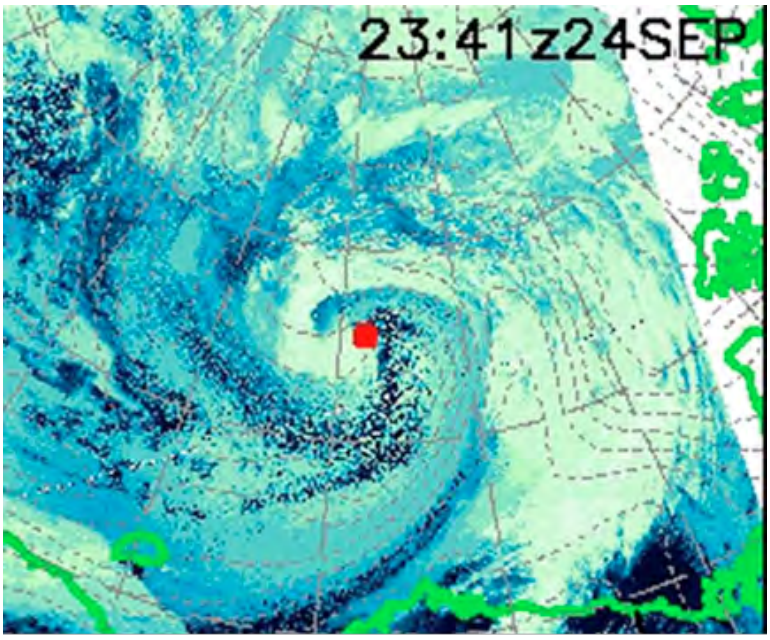
Prediction of when the Arctic Ocean will be nearly ice-free in summer is of interest to arctic and non-arctic science and resource management communities, since large shifts in the arctic environment represent indicators of global climate change. National Oceanic and Atmospheric Administration (NOAA) scientist James Overland, of NOAA's Pacific Marine Environmental Laboratory (http://www.pmel.noaa.gov/), and Muyin Wang, of the NOAA Joint Institute for the Study of Atmosphere and Ocean (http://jisao.washington.edu/) at the University of Washington, recently investigated a range of methods for predicting future sea ice loss and identified three groups of approaches: extrapolation of sea ice volume, analysis of rapid sea ice loss events due to ocean and weather conditions, and climate model results. They found each approach had strengths and weaknesses, but indicated nearly ice-free summers in the Arctic Ocean before the middle of the 21st century with a possibility of major loss within a decade or two—significantly earlier than previously accepted predictions.

Overland and Wang named the three predictive approaches trendsetters, stochasters, and modelers. Trendsetters analyzed observed sea ice trends. Overland and Wang confirmed the work of others—that sea ice volume is decreasing at a faster rate than sea ice extent, and conclude that ice volume is the better variable to use for predictions (see Figure 1). Data show that the total amount of sea ice has decreased rapidly since 2004, and the Arctic has lost 75% of its sea ice volume since the 1980s. Using those trends, this approach extrapolates to a nearly sea ice-free Arctic by 2020.



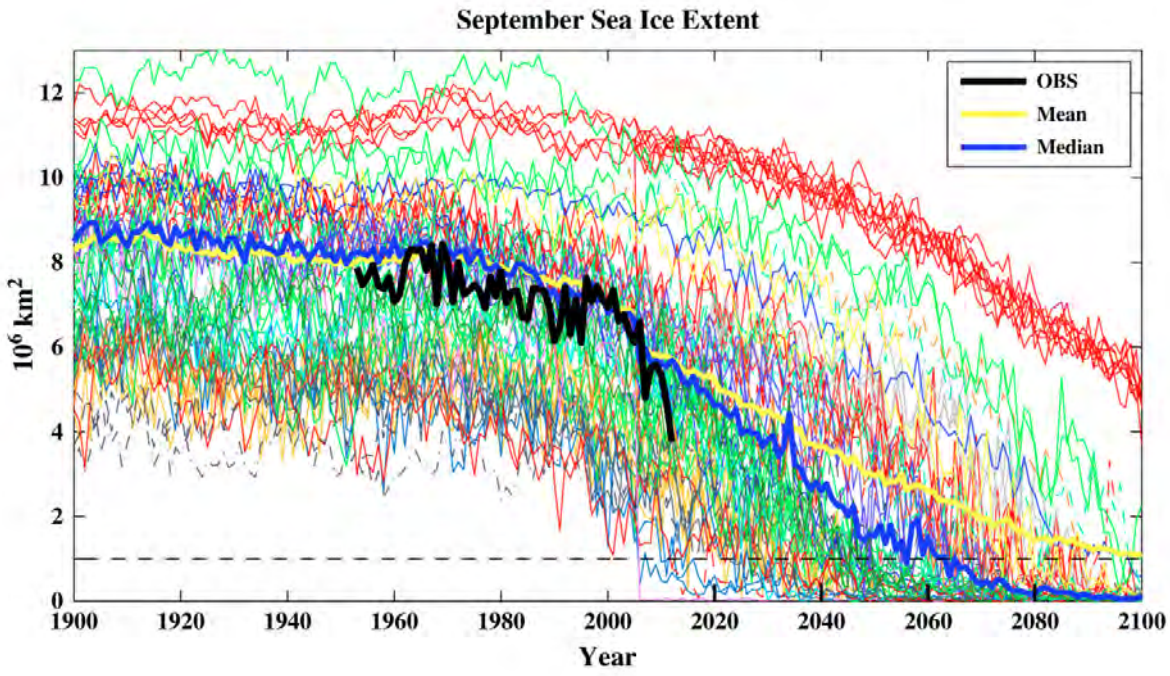
Time series of September arctic (a) sea ice extent from NSIDC, and (b) sea ice volume as computed from PIOMAS of APL/UW. The trend line for 1979-2012 is shown in solid black with shaded areas showing a one and two standard deviation from the trend. Units are in million square kilometers for (a), and thousand cubic kilometers for (b). When expressed in terms of percentage of change, the declining trend in the sea ice volume is larger than the sea ice extent. Image from Geophysical Research Letters article.

Stochasters assumed future multiple, but random in time, large sea ice loss events such as those that occurred in 2007 and 2012 (see Figure 2). This method estimates it would take several more of these events to reach the 1.0 million square kilometer sea ice extent threshold of a nearly sea ice-free state in the summer. Using the likelihood of such events, this approach suggests a nearly sea ice-free Arctic by about 2030 but with large uncertainty in timing.



The 'Stochasters' argue that timing of sea ice loss is modified by the influence of variably timed major disruptive events, such as this atmospheric storm of September 2010 in the northern Chucki Sea. Image courtesy of Jun Inoue.

Modelers used the large collection of global climate model (GCM) results to predict changes in sea ice conditions over time. GCMs are important quantitative tools to predict future climate projections based on physical laws and processes of the atmosphere, ocean, land, and sea ice. The median timing of sea ice loss in these models is close to 2060 (see Figure 3). The earliest possible loss of sea ice is projected to be around 2040 as greenhouse gas concentrations increase and the Arctic warms. But the observed rapid loss of thick, multi-year sea ice over the last decade and the September 2012 arctic sea ice extent reduction of 49% relative to the 1979-2000 climatology are inconsistent with GCM-based projections. There are several reasons to consider that median timing of sea ice loss in GCM based models may be too slow. Uncertainties introduced by parameterizations of clouds in different models and atmospheric dynamics may be more of a difficulty than modeling sea ice.



September sea ice extent based on 89 ensemble members from CMIP5. Thin colored lines represent an ensemble member. Thick yellow line is the arithmetic mean and thick blue line is median value of all ensemble members. Thick black line represents observations based on adjusted HadleyISST ice analysis 1953-1978 and NSIDC 1979-2012. Observation data provided by Meier, NSIDC. Horizontal black dashed line marks 1.0 M square kilometers value for nearly ice-free summer Arctic. Image from GRL article.

Indications are that the present and projected carbon dioxide loading will continue the climate forcing on the Arctic over the next several decades. CO_2 has increased 25% since 1970 and has just passed 400 ppm. Multiple feedback processes referred to as "arctic amplification" increase the impact from this external forcing but also add to the uncertainly in predictions.

Available evidence suggests that scientists have been conservative in their projections of climate change with a bias of late dates for change. The range among the multiple approaches suggests that it is very likely that the timing for future sea ice loss will be within the first half of the 21st century, with a possibility of major loss within a decade or two. According to Overland there is a great need for improved models, annual tracking of arctic changes, and planning the response to broader arctic changes.

A full report of this study, entitled "When will the Summer Arctic be Nearly Sea Ice Free?" (http://onlinelibrary.wiley.com /doi/10.1002/grl.50316/pdf) was published in March 2013 in Geophysical Research Letters.

For further information, please see the NOAA press release (http://www.noaanews noaa.gov/stories2013 //20130412_arcticseaice.html) or contact James Overland (james.e.overland@noaa.gov).

NSF Selects Five U.S. Students for 2013 Joint Science Education Program

NSF selected five high-school students from as many states nationwide to deploy to the Arctic this summer as part of a science-education and cultural-exchange program with their peers from Denmark and Greenland.

The students will participate in a three-week field experience in Greenland as part of the multinational Joint Science Education Project (JSEP) (http://www.arcus.org/jsep). The U.S. students were selected in a competitive process that drew 375 applications from all 50 states as well as Department of Defense schools abroad.

The 2013 U.S. JSEP participants are:

- Samuel Blair, an 11th-grader from Massachusetts.
- Chloe Fouilloux, an 11th-grader from Minnesota.
- Samantha Montoya, a 10th-grader from New Mexico.
- Ronin Ruerup, a 10th-grader from Alaska.
- Grace Wischmeyer, an 11th-grader from Illinois.

Fie Thorup Hansen, a 2012 JSEP student, launches a balloon carrying an ozonesonde at NSF's Summit Station in Greenland. Image courtesy of Lynn Foshee Reed, NSF.

JSEP, which began as an offshoot of the International Polar Year (IPY), reflects NSF's emphasis on the interaction between research and education as well as the close relationship between the participating nations needed to conduct field science in the remote and often harsh climate of Greenland. It is now in its sixth season.

JSEP is designed to allow students to work cooperatively on science projects and to work with researchers in the field. The 2013 program begins in early June. The first two weeks are conducted at the Kangerlussuaq Science Field School run by the Greenlandic government. During that session students will conduct their own measurements and interact with scientific parties, many supported by NSF and other U.S. science agencies.

A smaller group of students from the three nations then will spend several days during Science Education Week visiting NSF's Summit Station on the Greenland ice sheet, meeting with researchers there and observing long-term experiments related to snow- and ice-chemistry and atmospheric phenomena.

Kasper Busk and Lynn Foshee Reed, teachers from Denmark and the U.S., respectively, will work cooperatively during Field School. Reed, an Albert Einstein Distinguished Educator Fellow in the NSF Division of Polar Programs, will lead the Science Education Week.

For more information about JSEP and the 2013 program, see the NSF press release (http://www.nsf.gov/news/news_summ.jsp?cntn_id=127746) or *Witness*, Fall 2012 (http://www.arcus.org/witness-the-arctic/2012/3/article/19443) or contact Lynn Foshee Reed (lreed@nsf.gov).

Polar Science Weekend at Pacific Science Center: Eight Years of Outreach and Partnership

By: Harry Stern, Polar Science Center, Applied Physics Laboratory, University of Washington

Harry Stern, Senior Mathematician, Polar Science Center, Applied Physics Laboratory, University of Washington. Image courtesy of Harry Stern.

Public outreach is an important part of the mission of scientific agencies such as NSF and the National Aeronautics and Space Administration (NASA) (http://www.nasa.gov/home/index.html). While scientists are usually enthusiastic about their research they typically don't think about how to present it to general audiences and they may lack the time or confidence to seek out such opportunities. Partnerships with informal science education institutions offer scientists the chance to reach large public audiences and to develop the skills to communicate with them. The institutions benefit from the new content presented by the scientists that engages their visitors in face-to-face interactions. One such model is the Polar Science Weekend at Pacific Science Center (http://www.pacificsciencecenter.org/Research-Weekends/polar-science-weekend.html).

Polar Science Weekend (PSW) is an annual four-day event featuring a wide variety of hands-on activities and live demonstrations about the polar regions and current polar research. The event is presented by scientists from the University of Washington's Polar Science Center (http://psc.apl.washington.edu/wordpress/) and other departments, and held at Seattle's Pacific Science Center (http://www.pacificsciencecenter.org/), which is the most well-attended museum in the Pacific Northwest. PSW was conceived and organized by the Polar Science Center and the Pacific Science Center in 2005. The first PSW was held in March 2006. Attendance at Pacific Science Center during PSW is typically between 5,000 and 10,000 visitors. PSW brings students, teachers, and families face-to-face with active scientists who work in some of the most remote and challenging places on Earth to learn first-hand about polar research in a fun and informal setting.

An integral part of PSW is the *Science Communication Short Course* (http://www.ocean.washington.edu/story/Science+Communication+Short+Courses) given in the months preceding the event, in which scientists and graduate students are trained in how to explain their research to the public and how to design engaging activities. This series of workshops, conducted by professional staff from Pacific Science Center, has been found to effectively increase scientists' comfort and skills in working with the public. Pacific Science Center also offers a one-time "refresher" workshop for scientists to brush up on their communication skills. Effective communication with the public is increasingly recognized as an important skill for scientists to possess.

The motivation for the first PSW grew out of the Polar Science Center's desire to improve the "broader impacts" of its NSF-funded research. After the success of the first PSW, Pacific Science Center launched its *Portal to the Public*

Polar scientist Bonnie Light looks on as visitors learn about albedo (reflectivity) through a hands-on activity. Image courtesy of Kim Reading, APL-UW.

(http://www.pacificsciencecenter.org/Portal-to-the-Public/portal) project funded by NSF, whose purpose was to develop and test program models that engage scientists and public audiences in face-to-face interactions. This led to further "research weekends" at Pacific Science Center. This project was awarded the Roy L. Shafer Leading Edge Award for Visitor Experience by the Association of Science and Technology Centers in 2010. In 2012, Pacific Science Center won the National Medal for Museum and Library Service, the nation's highest honor conferred on museums and libraries for extraordinary community service and outreach. The award citation says (in part), "Pacific Science Center seeks to go beyond just teaching guests about science. Its *Portal to the Public* program connects the public with cutting-edge science by training scientists to demonstrate and explain their research." The concept began with Polar Science Weekend, which has continued every year since 2006.

Polar oceanographer Mike Steele wows the audience with his Extreme Cold demonstration involving liquid nitrogen. Image courtesy of Dan Clark, APL-UW.

A grant funded by NASA from 2010 to 2013 supported the annual PSW events and enabled the center to train 45 scientists and graduate students in science communication; design and construct an interactive exhibit at Pacific Science Center called "Investigating Arctic Ice Melt" that runs for several months each year; bring more than 1,000 students to Pacific Science Center free of charge, many from low-income districts; and provide professional evaluation of the event.

Popular activities at PSW include Glacier Flow, Polar Science Technology, Narwhal Mysteries, Sea Ice Thickness from Space, Salinity Taste Test, and dozens of others. Visitors pick up a *Passport to the Poles* that lists all the activities and stations at PSW, including a question for each station. Visitors take their passports to the various stations, talk to the scientists, write down the answers to the questions, and receive stamps in their passports. This stimulates inquiry, motivates kids to visit more stations, and promotes interactions between visitors and scientists. One visitor from the Renton High School Science Club wrote afterwards: "I loved the vast amount of exhibits/stations and all the passionate exhibitors/station managers! It made me really appreciate the scientific opportunities and gave me more options to consider in the future. This was the best exhibit type event that I've ever been to, and I am very interested in polar science now."

Dr. Meena Selvakumar is the Acting Vice President for Strategic Programs at Pacific Science Center where she directs the Portal to the Public initiative. Image courtesy of Meena Selvakumar.

Plans for the future, subject to funding, include developing polar activities for Pacific Science Center's *Science on Wheels* program, which brings science demonstrations to rural schools across the Pacific Northwest; a new exhibit about the Greenland and Antarctic ice sheets; subsidized transportation to bring underserved school groups to PSW; training for undergraduates to participate in PSW; linkages between PSW activities and the new *Next Generation Science Standards*; and more opportunities for scientists to interact with the public beyond PSW.

The next Polar Science Weekend at Pacific Science Center will be 6 - 9 March 2014. Organizers look forward to continuing the partnership between the polar research community and the informal science education community in Seattle.

For more information, see the Polar Science Center website (http://psc.apl.washington.edu/wordpress/) or contact Harry Stern (harry@apl.washington.edu) or Meena Selvakumar (MSelvakumar@pacsci.org).

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White House Announces National Strategy for the Arctic Region

On 10 May 2013 the Obama Administration released the National Strategy for the Arctic Region (http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf). Priorities identified in the strategy include: advancing U.S. security interests, pursuing responsible arctic region stewardship, and strengthening U.S. international cooperation.

On 10 May 2013 the Obama Administration released the National Strategy for the Arctic Region (http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf). Priorities identified in the strategy include: advancing U.S. security interests, pursuing responsible arctic region stewardship, and strengthening U.S. international cooperation.

According to the strategy, the Administration intends to advance these priorities in a manner that safeguards peace and stability in the region, utilizes the best available information for decisions, emphasizes the use of innovative arrangements, and underscores the importance of consulting and coordinating with Alaskan Native communities. The plan recognizes the existing policy structure as an ongoing effort by federal departments and agencies as well as Senators Mark Begich and Lisa Murkowski, Representative Don Young, the State of Alaska, and Alaskan Native communities. The Administration will develop an implementation plan as well as a document defining roles and responsibilities.

Administration officials plan to host roundtable discussions in Alaska in mid-June 2013 to discuss how best to move forward with implementation of the concepts laid out in the National Strategy. Dates and locations for those meetings are to be announced by the Administration.

In addition, on 21 May 2013 the "U.S. Coast Guard: Arctic Strategy" (http://www.uscg.mil/seniorleadership/DOCS/CG_Arctic_Strategy.pdf) was released. It provides a ten-year guide for U.S. Coast Guard efforts and aims to ensure safe, secure, and environmentally responsible maritime activity in the Arctic. The strategy outlines three key objectives over the next ten years: improving awareness, modernizing governance, and broadening partnerships.

The full National Strategy for the Arctic Region can be found here (http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf).

The full U.S. Coast Guard Arctic Strategy can be found here (http://www.uscg.mil/seniorleadership/DOCS/CG_Arctic_Strategy.pdf).

For further information about the National Strategy for the Arctic Region and source material for this article, see the White House press release (http://www.whitehouse.gov/the-press-office/2013/05/10/statement-press-secretary-national-strategy-arctic-region) or the related post on The White House Blog (http://www.whitehouse.gov/blog/2013/05/10/national-strategy-arctic-region-announced).

For further information about the U.S. Coast Guard Arctic Strategy and source material for this article, see the On the Homefront Blog (https://www.hsdl.org/hslog/?q=node/9922).

Suspension of the Postdoctoral Fellowships in NSF'S Polar Regions Research Programs

On 18 April the Division of Polar Programs issued a Dear Colleague Letter (NSF 13-086) (http://www nsf.gov/pubs/2013 /nsf13086/nsf13086.jsp) to announce the suspension of postdoctoral fellowships in the Polar Regions research program.

Full text of that letter follows:

It is with great regret that the Division of Polar Programs announces that a solicitation will not be re-issued at this time for the Postdoctoral Fellowships in Polar Regions Research Program. This was a difficult decision to reach as the Division is very supportive of postdoctoral fellows conducting research in polar regions.

The Division would like to encourage persons who may have been interested in proposing to this program to contact prospective mentors to discuss possibilities of becoming involved in polar regions research as a postdoctoral researcher through regular research proposals. Involving postdoctoral researchers in new proposals is common practice. Opportunities for involvement in existing projects are more restricted but might be possible in certain circumstances. The principal investigator for the existing project should contact their program officer to determine whether or not this avenue is feasible.

Recognizing the importance of postdoctoral scholars in polar research, the Division will reexamine this decision if circumstances change.

Thank you,

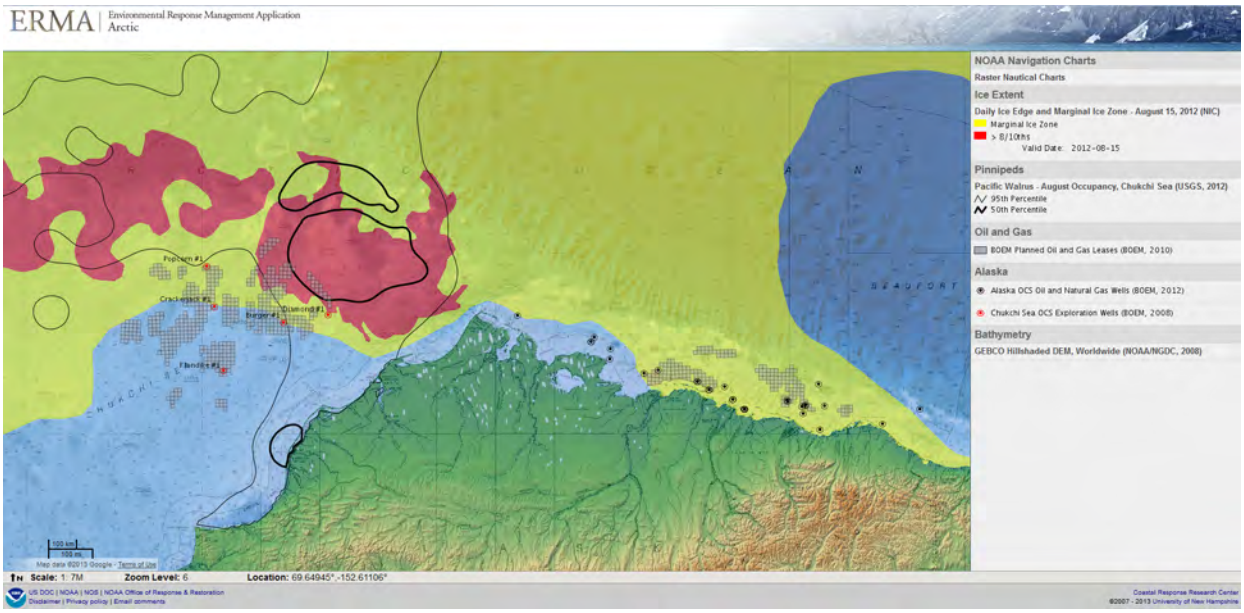
Scott Borg
Head, Antarctic Sciences Section
NSF/GEO/POLAR

Simon Stephenson
Head, Arctic Sciences Section
NSF/GEO/POLAR

New Tool for First Responders in the Arctic: Arctic ERMA

Background

The Arctic Environmental Response Management Application (ERMA®) is a web-based Geographic Information System (GIS) tool that assists emergency responders and environmental resource managers in dealing with incidents that may adversely impact the arctic environment. Arctic ERMA integrates various real-time and static datasets into a single interactive map to provide a visualization of the situation and improve communication and coordination among responders and stakeholders.



The map shows layers in ERMA depicting the daily ice edge, locations of walrus areas of occupancy, oil lease locations with active sites, with high-resolution bathymetry. Users can choose their own background and layers of interest. Image courtesy of Amy Merten, NOAA.

The Arctic ERMA was officially launched in July 2012 and is one of eight regional ERMA projects (http://response.restoration noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma) in the U.S. Arctic ERMA was designed as a tool for the Arctic's distinctive conditions, considering variables such as the extent and concentration of sea ice, locations of ports and pipelines, and vulnerable environmental resources.

The launch of Arctic ERMA is part of ongoing efforts by the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska (http://www.doi.gov/alaskaenergy/index.cfm), which President Obama established in July 2011. This working group aims to coordinate the federal agencies responsible for overseeing the safe and responsible development of onshore and offshore energy in Alaska.

Partners

Arctic ERMA is administered and funded primarily by the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (OR&R) (http://response.restoration.noaa.gov/), but many organizations were integral in the development of the Arctic ERMA and continue to contribute to its operation:

- University of New Hampshire (UNH) Coastal Response Research Center (http://www.crrc.unh.edu/) has been a co-developer and inventor of ERMA. Currently, UNH hosts ERMA and continues to be a partner in continued development. The UNH Coastal Response Research Center also hosts stakeholder workshops in arctic communities in order to have a direct conversation with potentially affected communities, and engages in other stakeholder input activities.

- Bureau of Safety and Environmental Enforcement (http://www.bsee.gov/) contributed funding to complete the website and to develop an ERMA prototype that will function as a stand-alone system without Internet connectivity. This prototype is now in its final stages and will be tested this summer.

- University of Alaska Geographic Information Network of Alaska (GINA) (http://www.gina.alaska.edu/) serves as a portal and repository of data and contributes imagery for the state of Alaska.

- Alaska Ocean Observing System (AOOS) (http://www.aoos.org/) also serves as a portal and repository for data. Types of data from AOOS include the shorebird atlas and salmon streams.

- Alaska ShoreZone Program (http://alaskafisheries.noaa.gov/shorezone/) shares data on coastal mapping and imagery of Alaska.

- Oil Spill Recovery Institute (OSRI) (http://www.pws-osri.org/) provided initial funding for Arctic ERMA.

- Inuvialuit Settlement Region Joint Secretariat (http://www.jointsecretariat.ca/) in Canada has provided in-kind funding as well as funding for a workshop as part of the effort with the Arctic Council's Emergency Prevention, Preparedness and Response (EPPR) (http://www.arctic-council.org/index.php/en/about-us/working-groups/emergency-prevention-preparedness-and-response-eppr) working group.

Datasets and Applications

Presently, Arctic ERMA is comprised of over 500 data layers. Examples of available datasets include weather and oceanographic information, ice extent and concentration, nautical charts, ship locations, locations of infrastructure and equipment, environmental sensitivity data, habitat locations, bathymetry, oil infrastructure, critical areas for marine mammals/birds, and satellite information.

Arctic ERMA was already in use before its official launch. In 2010, ERMA was used to monitor and prepare for a spill from the M/V *Golden Seas* near the Aleutian Islands. In January 2012, it was used to monitor and provide information to the State of Alaska for the U.S. Coast Guard *Healy* and Russian tanker *Renda's* fueling operation to Nome.

Since its official launch, it has been used in a few arctic exercises including an industry-sponsored training simulation of an oil spill in the Chukchi Sea in the summer of 2012. Arctic ERMA was also used to monitor the drill rig *Kulluk* for several days following 31 December 2012 when it ran aground near Kodiak Island. Over the past year, ERMA has been used to show where potential marine debris from the Japan tsunami has impacted Alaskan shores.

Future Plans

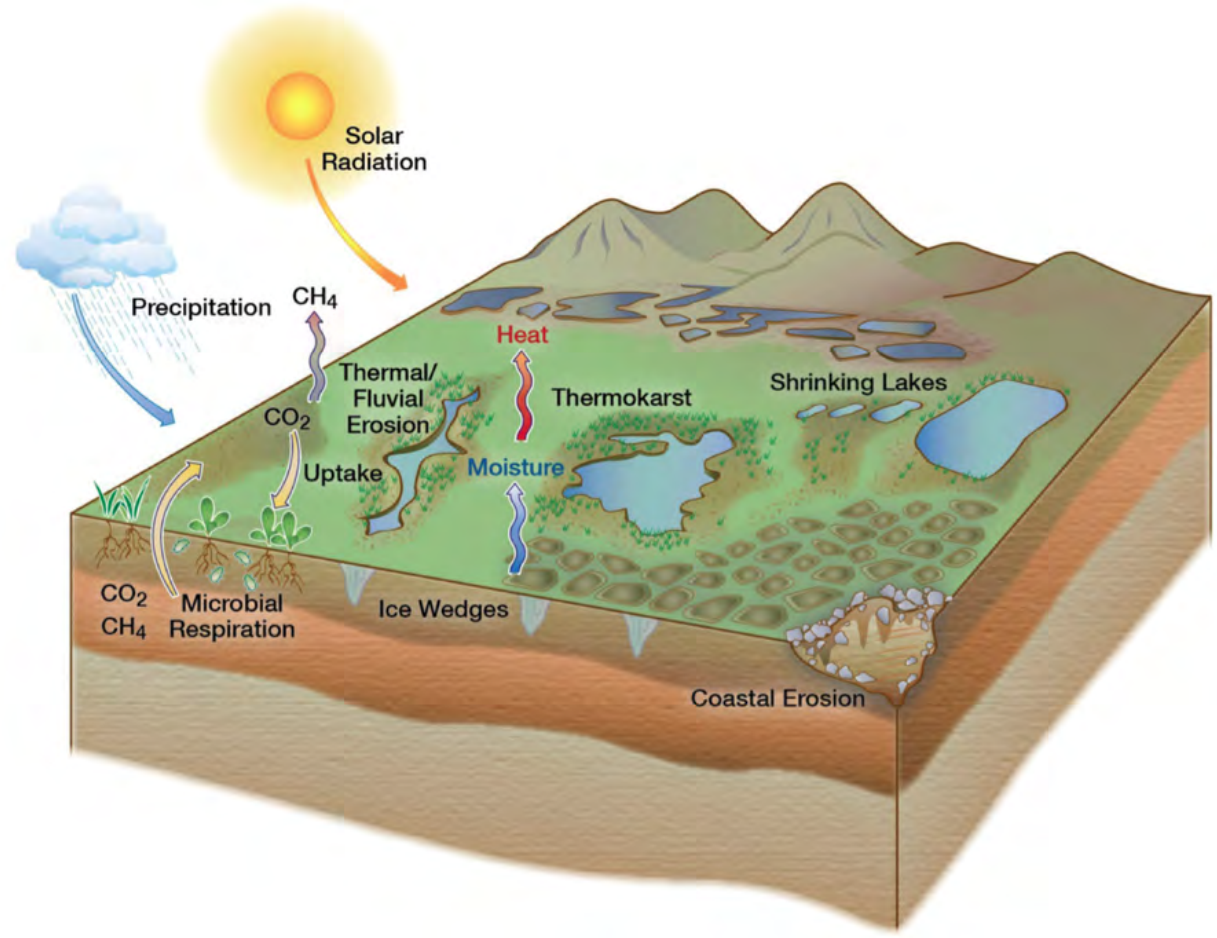
Future plans for Arctic ERMA consist of adding data (including local knowledge), keeping all data layers current, and continuing to ensure all metadata are compliant for public release of datasets. There are efforts to move the website into a government domain on cloud-computing resources. Also, this summer the stand-alone ERMA prototype will be completed with the capability of re-syncing once Internet access is secured at a field site.

For further information, see the Arctic ERMA website (https://www.erma.unh.edu/arctic) or contact Amy Merten, Chief, Spatial Data Branch, Office of Response and Restoration (Amy.Merten@noaa.gov).

Many thanks to Amy Merten for her contributions to this article.

Next-Generation Ecosystem Experiment Examines Arctic Landscape's Response to Climate Change

The Department of Energy (DOE) has developed a new accelerated approach to climate change research called Next-Generation Ecosystem Experiments (NGEE) (http://ngee-arctic.ornl.gov/). This strategy seeks to provide Earth System Models (ESMs) with improved representation of climatically sensitive and globally important ecosystem processes. Supported by the Terrestrial Ecosystem Science program within DOE's Office of Biological and Environmental Research (http://science.energy.gov/ber/), NGEEs connect modeling and field studies in an iterative approach so that model needs are considered in development of field studies whose outcomes in turn inform and improve the models. The first NGEE project, entitled NGEE Arctic Landscapes, studies ecosystems undergoing permafrost thaw. Future NGEE projects will target other ecosystems such as the tropics.



Arctic landscape in transition: A mechanistic understanding of what controls the rates, scales, and feedback of permafrost thaw is needed for system-scale prediction of permafrost dynamics in response to climate warming. NGEE Arctic Landscapes research activities are designed to identify and quantify the underlying processes that control carbon and energy transfer in the arctic biosphere and determine how those processes affect the changing arctic landscape. Image courtesy of Lawrence Berkeley National Laboratory.

The NGEE Arctic Landscapes project aims to advance predictive understanding of the structure and function of arctic terrestrial ecosystems in response to climate change. Efforts focus on understanding how thawing permafrost and the associated changes in landscape evolution, hydrology, soil biogeochemical processes, and plant community succession affect feedbacks to the climate system. Ultimately NGEE Arctic Landscapes will develop a high-resolution ecosystem model of the arctic tundra as it evolves in response to climate change.

NGEE Arctic Landscapes is designed as a ten-year project. Phase 1, an initial three years of work in Barrow, Alaska, is now in its second year. The team has established and instrumented field sites near the Barrow Environmental Observatory. Initial research has focused on hydrology, vegetation, and carbon cycle dynamics across polygonal landscapes. Ground penetrating radar, electrical resistivity, and other geophysical techniques have been used by Susan Hubbard and her team from Lawrence Berkeley National Laboratory to characterize subsurface properties of ice-rich polygonal landscapes, including detection of ice wedge size and distribution. Permafrost cores to a depth of several meters have been obtained and returned to Oak Ridge and Lawrence Berkeley National Laboratories for analysis, including determining carbon emissions and their relationship to the composition of the microbial community.

Alistair Rogers, a plant physiologist at Brookhaven National Laboratory, has measured leaf photosynthesis for plants growing on the arctic tundra. Rogers and others have compared these measurements to estimates used in climate models. Discrepancies in how climate models represent vegetation carbon uptake from the atmosphere suggest that improvements to models can be made fairly quickly in this specific area of research. Geophysical information on ice wedge size and distribution is being used to parameterize fine-scale models of permafrost thaw and degradation and evolution of arctic landscapes. Vladimir Romanovsky at University of Alaska Fairbanks is contributing to new model development in this effort. Additional funding for Phase 2 will expand work to other areas in northern Alaska.

NGEE Arctic Landscapes is a collaborative effort led by Oak Ridge National Laboratory, which includes scientists at Los Alamos National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, University of Alaska Fairbanks, and partners at other universities and federal agencies. Additional DOE programs contributing to this project include the Atmospheric Radiation Measurement Climate Research Facility, Atmospheric System Research program, Genomic Science program, and Climate and Earth System Modeling program.

The established field site in Barrow, Alaska offers collaboration opportunities for scientists conducting complementary research and the project website has a mechanism for other scientist to request soil, water, and plant samples. Funding opportunities for proposals specifically related to the NGEE Arctic Landscapes project, such as recent DOE Terrestrial Ecosystem Science program solicitations (http://tes.science.energy.gov/opportunities), may continue.

While the NGEE Arctic Landscapes project is committed to supporting the development of a process-rich land surface model for incorporation into advanced high-resolution climate models, realizing this goal can only be achieved by establishing strong international partnerships. Multiple international programs are addressing critical feedbacks between land surfaces and atmosphere in high-latitudes ecosystems [(e.g., The Arctic Boreal Vulnerability Experiment (ABoVE) (http://cce nasa.gov/terrestrial_ecology/above/), Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) (http://science nasa.gov/missions/carve/), and Changing Permafrost in the Arctic and its Global Effects in the 21st Century (PAGE21) (http://www.awi.de/en/research/research_divisions/geosciences/periglacial_research/projects/page21/)]. Participants in the NGEE Arctic Landscapes project are planning to work with others in the community to identify opportunities for collaboration. Systematic sampling strategies and a common framework for scaling are essential for

understanding ecosystem responses to climate change and informing models. In the harsh arctic environment, where climate change appears to be most rapidly affecting vulnerable, carbon-rich permafrost, filling critical gaps in observations is expensive and technically challenging, and must be strategically developed. Although the NGEE Arctic Landscapes project is currently conducting initial research in Barrow, Alaska, it has plans to include other sites in Alaska. This expansion will seek to encompass a unique set of permafrost investigations performed at field sites that span multiple bioclimatic zones. The challenges of understanding and accurately simulating the changes occurring in the arctic ecosystem, climate, and landscape are tremendous, but this goal can be achieved through coordinated partnerships amongst arctic researchers throughout the world.

For further information about the NGEE Arctic Landscapes project, see the NGEE - Arctic website (http://ngee-arctic.ornl.gov/) or contact Stan D. Wullschleger (wullschlegsd@ornl.gov) or Larry Hinzman (lhinzman@iarc.uaf.edu).

Many thanks to Stan D. Wullschleger, of Oak Ridge National Laboratory, and Larry Hinzman, of the International Arctic Research Center, for their contributions to this article.

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Community-Based Water-Quality Monitoring in the Yukon River Basin and the Kuskokwim Watershed

By: Nicole Herman-Mercer, Social Scientist, USGS National Research Program

Introduction

The unique partnership between the U.S. Geological Survey (USGS) (http://www.usgs.gov/) and the Yukon River Inter-Tribal Watershed Council (YRITWC) (http://www.yritwc.org/) yields critical data for the assessment of climate change effects in the Yukon River Basin (YRB). The YRITWC is an international, Indigenous, nonprofit organization, created in 1997 with the mission of monitoring, preserving, and protecting the YRB. Today, the YRITWC is guided by an Inter-Tribal accord, which has been signed by seventy of the Indigenous governments of the YRB in Canada and Alaska.

The YRB is the fourth largest drainage basin in North America. The basin, which is 855,000 km2, covers arctic and subarctic terrain roughly twice the size of California and is underlain by continuous and discontinuous permafrost. Climate warming in the Arctic and sub-arctic has been well recorded in recent years. Observations including a lengthening of the growing season, permafrost thaw and deepening of the active layer, thinner river ice, and warmer temperatures have all been documented. These environmental changes are anticipated to impact water chemistry, sediment loads, and river discharge over the coming decades. A better understanding of baseline trends and processes controlling the water-quality of the Yukon River and its tributaries will facilitate the proper management of resources as conditions alter in response to environmental change. The YRB is the largest undammed river system in the world and is considered relatively pristine. For these reasons, the YRB is an ideal natural laboratory to study climate change in the Arctic and sub-arctic.

From Government to Grassroots

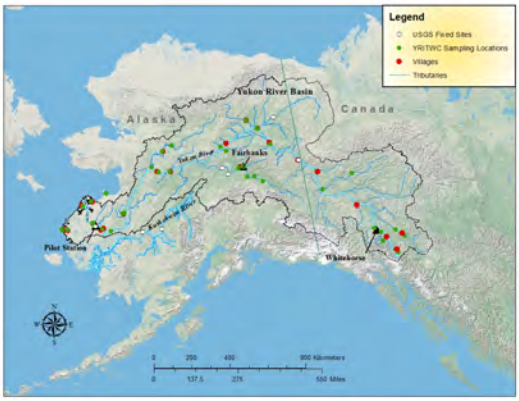

Figure 1: Map of the Yukon River Basin across Canada and Alaska and the Kuskokwim River Basin highlighting USGS fixed stations, YRITWC sampling locations, and villages. Base map from 2011 National Geographic Society, i-cubed and ESRI, Kuskoswim River from USGS Alaska Science Center, Alaska Albers Meters Projection, North American Datum of 1927. Image courtesy of USGS.

The USGS began a landmark study of the Yukon River and its major tributaries in 2000 with the objective of establishing a baseline water-quality dataset against which future changes in the YRB may be measured. The USGS YRB project collected its last sample in 2005. That same year a relationship was established between the USGS and YRITWC as the council was interested in beginning a community-based water-quality monitoring program. A growing concern over historical contamination and observations by community members that water conditions were changing led to an interest in monitoring the water. The USGS guided the YRITWC in the development and implementation of a basin-wide water-quality monitoring program modified from, and expanding upon, the USGS study. USGS scientists trained YRITWC staff and interested community members in water-quality sampling techniques following USGS protocols and in 2006 the YRITWC and community members began collecting samples at 20 sites throughout the basin.

Since 2006 the program has expanded, accumulating an increasing number of water samples and interacting with a

growing number of Yukon communities. Beginning with only 20 water-sampling sites in the Alaskan section of the basin, the YRITWC today has sites that continue from the headwaters of the Yukon River near Whitehorse in Yukon Territory, Canada, to the outlet of the Yukon River in Pilot Station, Alaska (see Figure 1). The enormous scale of the YRB presents a unique set of logistical challenges that have been met by the collaborative partnership between the USGS and the YRITWC.

Figure 2: Elli Matkin of the YRITWC trains a new water technician from the Yupiit of Andreasfski Tribe in the Alaska village of St. Mary's. Image courtesy of Leah Anderson, YRITWC.

During each field season since 2009 approximately 200 samples have been collected from roughly 40 sampling locations. Samples from seven to fifteen of these sites are collected by YRITWC staff—depending on levels of community participation, funding, and other support. Community members collect all other samples (see Figure 2). Community members participating in the water-quality program in Alaska are often Tribal Environmental Coordinators funded through the Environmental Protection Agency's Indian General Assistance Program. In Canada, participating community members typically work for the Lands and Resources department of their First Nation government. Water-quality field measurements include pH, specific conductance (a measure of the total ion load of the water), water temperature, and dissolved oxygen content—in addition to the collection and processing of a suite of water samples for laboratory analyses by the USGS. The YRITWC staff in Fairbanks, Alaska and Whitehorse, Yukon Territory, coordinate sample shipment from the communities and complete post-processing of the samples. The water-quality samples are then shipped to the USGS National Research Program laboratories in Boulder, Colorado where they are analyzed for dissolved organic carbon, greenhouse gases including carbon dioxide and methane, major ions, nitrogen species and phosphate, trace metals, and water isotopes.

Real Results

The USGS-YRITWC partnership has yielded six years of data collection thus far, adding to existing USGS datasets. This joint effort has resulted in a nearly continuous dataset since 1979 at some sampling locations and is augmenting hydrologic information collected at USGS fixed stations (see Figure 1). The USGS and YRITWC jointly published a USGS Open-File Report (http://pubs.er.usgs.gov/publication/ofr20101241) with data from all samples collected from 2006-2008 and plan to publish data from 2009-2012. In 2009 a Memorandum of Understanding (MOU) (http://www.usgs.gov/mou/docs/yritwc_mou.pdf) was signed by the acting director of the USGS and YRITWC board members reinforcing the partnership with renewal expected at the 2013 biennial YRITWC summit meeting (see Figure 3).

Figure 3: Signing of the MOU at the 2009 YRITWC biennial summit meeting in Whitehorse, Yukon Territory. From top left: Jon Waterhouse, Director of the YRITWC; Paul Schuster, USGS hydrologist; Rob Rosenfield, former director of YRITWC Canadian side of the basin; Suzette Kimball, acting director of the USGS; Clarence Alexander, YRITWC executive board member Alaska Region; Carl Sidney, YRITWC executive board member, Yukon Region. Image courtesy of Carol Hasburg, YRITWC.

New Partnerships on the Horizon

Based on the success of the USGS-YRITWC community-based water-quality monitoring program, USGS scientists are embarking on a new collaboration with an Indigenous nonprofit organization in the design, training, and implementation of a water-quality monitoring program. The Kuskokwim River Watershed Council (KRWC) was founded in 2005 when a Watershed Summit was held for people from across the river basin. At the summit, community members spoke of their concern for the health of the river. The Kuskokwim watershed is located in southwest Alaska, situated south of the Yukon River, and covers 58,000 square miles.

Much like the YRITWC in 2005, the KRWC is interested in designing a community-based water-quality monitoring program built around the concerns of community members. However, in addition to general contamination and climate

change concerns, the impetus of this program is an increasing concern in water-quality as mining interests move into the Kuskokwim watershed. The KRWC would like to begin collecting baseline data against which to measure any changes in water-quality generated by increased mining activity.

Scientists at the USGS National Research Program (NRP) (http://water.usgs.gov/nrp/) have applied to the USGS Office of Tribal Relations to secure funding to train community members in the Kuskokwim watershed to collect water-quality field measurements and assist the KRWC in designing their water-quality monitoring program. This program will begin with instantaneous measurements of physical and chemical water properties made by community members co-located with USGS fixed stations on the Kuskokwim River (see Figure 1) and sites of community concern on the river. In the future the KRWC may expand into sample collection for laboratory analysis. In addition to water-quality monitoring, the KRWC is interested in assessing invasive species in their area. NRP scientists are collaborating with scientists from the USGS Alaska Science Center (http://alaska.usgs.gov/) in designing a community-based invasive species protocol that will fit the needs of the KRWC. If funding is secured from the USGS Office of Tribal Relations, NRP and Alaska Science Center scientists will travel to two Kuskokwim watershed communities to train community members and KRWC staff in field water-quality measurements, sample collection, and invasive species monitoring.

Summary

The unique partnership between the USGS and the YRITWC provides mutual benefits by fostering outreach efforts that have been essential for community empowerment and by generating scientific data for prohibitively large and remote regions that would be challenging for USGS scientists to sample as robustly alone. The addition of a new partnership with the KRWC to create a community-based monitoring program will only increase these benefits by growing the spatial extent of data collection and empowering more people to take charge of important science in their own backyard.

More information about this project is available here (http://pubs.usgs.gov/fs/2010/3020/pdf/FS10-3020.pdf) or by contacting Nicole Herman-Mercer (nhmercer@usgs.gov).

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USARC Sets Goals and Objectives for Arctic Research 2013-14

By: Fran Ulmer, USARC Chair, and John Farrell, USARC Executive Director

The U.S. Arctic Research Commission (USARC) (http://www.arctic.gov/) biennial "Report on the Goals and Objectives for Arctic Research 2013-2014 for the U.S. Arctic Research Program" (http://www.arctic.gov/publications/2013-14_usarc_goals.html) recommends that U.S. scientific research focus on the following five major themes:

1. Observe, understand, and respond to environmental change.
2. Improve arctic human health.
3. Understand natural resources.
4. Advance civil infrastructure research.
5. Assess indigenous languages, identities, and cultures.

Fran Ulmer, appointed Chair of the Commission by President Obama, released the report on 21 March 2013 at USARC's 100th meeting held in Bethel, Alaska, the hometown of fellow Commissioner Mary Ciuniq Pete, who was recently reappointed to another four-year term on the USARC. The meeting included presentations by University of Alaska researchers and by arctic residents from the Yukon-Kuskokwim Delta region of Alaska.

In releasing the report, Ulmer said, "Dramatic changes in the arctic environment, and the pace of resource development, combine to make it very important that public and private decision makers have access to relevant research, including timely and comprehensive information and a more thorough understanding of arctic ecosystems, resources, and infrastructure challenges. The Commission strives to be an effective link between the people who do the research and those who need the results."

USARC staff and commissioners outside the University of Alaska Kuskokwim campus during the March 2013 meeting in Bethel, Alaska. From left: Deputy Director Cheryl Rosa and Commissioners James McCarthy, Mary Ciuniq Pete, Fran Ulmer, Chair, and Warren Zapol. Image courtesy of John Farrell, USARC.

The Commission's research goals help shape the national Arctic Research Plan, the most recent version of which was released by the White House on 19 February 2013, found here. (http://www.nsf.gov/od/opp/arctic/iarpc/arc_res_plan_index.jsp) Implementation of this plan, developed by the Interagency Arctic Research Policy Committee (IARPC) (http://www.nsf.gov/geo/plr/arctic/iarpc/start.jsp) under the auspices of the National Science and Technology Council (http://www.whitehouse.gov/administration/eop/ostp/nstc), involves 12 teams from 14 federal agencies and non-federal partners, constituting over 250 individuals.

USARC's mission is to develop and recommend U.S. arctic research policy to the President and to Congress' and to build cooperative links in arctic research within the federal government—with arctic residents, the State of Alaska, researchers, and international partners. USARC provides useful information about recent events, conferences, research initiatives, and international news via its daily electronic newsletter, the "Arctic Update." Subscription to the newsletter and further information about USARC, its meetings, workshops, and resources are available here. (http://www.arctic.gov/)

Summary of Recent USARC Activities

U.S. Arctic Research Commissioners and staff provide assistance to agencies, hold meetings, produce reports, and partner with other organizations that have similar goals of promoting and sharing scientific research on the Arctic. Here are some examples of recent activities.

1. Released the biennial "Report on the Goals and Objectives for Arctic Research 2013-2014 for the US Arctic Research Program" (http://www.arctic.gov/publications/2013-14_usarc_goals html) at the 100th USARC meeting held in Bethel, Alaska, March 2013.

2. Assisted the Interagency Arctic Research Policy Committee (IARPC) (http://www nsf.gov/geo/plr/arctic/iarpc /start.jsp), which recently released an interagency five-year Arctic Research Program Plan (http://www.nsf.gov /geo/plr/arctic/iarpc/arc_res_plan_index.jsp).
3. Provided advice to the interagency working group on Coordination of Domestic Energy Development and Permitting in Alaska (http://www.doi.gov/alaskaenergy/index.cfm), which produced in March 2013 the report to President Obama titled, "Managing for the Future in a Rapidly Changing Arctic." (http://www.doi.gov/news/upload /ArcticReport-03April2013PMsm.pdf)
4. Offered comments to the National Security Staff on the new National Strategy for the Arctic Region (http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf), which was released 10 May 2013.
5. Improved the "Arctic Science Portal" (http://www.arctic.gov/portal/index.html) on the USARC website.
6. Supported two studies being conducted by the National Academies (http://nationalacademies.org/) titled "Emerging Research Questions in the Arctic" (http://www8.nationalacademies.org/cp/projectview.aspx?key=49516) and "Responding to Oil Spills in Arctic Marine Environments." (http://www8 nationalacademies.org /cp/projectview.aspx?key=49479)
7. Met jointly with the Canadian Polar Commission (http://www.polarcom.gc.ca/) in Vancouver, Canada, and participated in the ArcticNet (http://www.arcticnet.ulaval.ca/) annual science meeting in December 2012.
8. At the invitation of the USCG Commandant, Admiral Papp, USARC joined the Interagency Coordinating Committee on Oil Pollution Research. (http://www.iccopr.uscg.gov/apex/f?p=118:20)
9. Gave invited talks at venues such as the IARPC Principals Meeting, the White House, Wakefield Symposium, Alaska Command, World Ocean Council, Arctic Parliamentarians, Pacific Northwest Economic Forum, Consortium for Ocean Leadership, and the European Institute.
10. Continued work on the Alaskan Water and Sanitation Retrospective and participated on the State of Alaska's Steering Committee response to the Water and Sanitation Innovation request for proposals.
11. Supported and served on the Steering Committee for the Northwest Arctic Borough's Workshop on Improving Local Involvement in Research.
12. Supported and assisted with planning for a pilot implementation of Automatic Identification System (AIS) technology availability for local subsistence vessels in the Bering Strait.
13. Participated on the Steering Committee/Workshop on Marine Debris in Cetaceans sponsored by the International Whaling Commission at Woods Hole Oceanographic Institute.
14. Supported ARCUS in sponsoring the 2013 Arctic Forum, titled "Arctic Change Research: U.S. Government Interagency Collaboration," at the AGU Science Policy Conference (http://spc.agu.org/2013/), in Washington D.C. on 25 June 2013.
15. Planned the "5th Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations," (http://www.star nesdis.noaa.gov/star/Ice2013.php) 16-18 July 2013 in Washington, D.C., to be co-hosted with the U.S. National Ice Center. (http://www.natice.noaa.gov/)
16. Planned the 101st USARC meeting in Unalaska, Alaska, in late August, in conjunction with a meeting of the Alaska State Arctic Policy Commission.
17. Continued to grow the readership of the daily "Arctic Update" (http://www.arctic.gov/arctic_update_archive /index_general.html) electronic newsletter.

Arctic Council Leadership Transition at Eighth Ministerial Meeting

The Eighth Ministerial Meeting of the Arctic Council was held 15 May 2013 in Kiruna, Sweden. Ministerial meetings are held every two years, marking the culmination of the Council's work under the current Chair and transition to new leadership. At the 2013 meeting the chair passed from Sweden to Canada, which will lead the Council through May 2015.

The Arctic Council is comprised of eight Member States (http://www.arctic-council.org/index.php/en/about-us/member-states) (the arctic nations), six Permanent Participants (http://www.arctic-council.org/index.php/en/about-us/permanent-participants) (Indigenous peoples' organizations such as the Inuit Circumpolar Council), and many Observers (http://www.arctic-council.org/index.php/en/about-us/arctic-council/observers) (non-arctic countries, intergovernmental/inter-parliamentary organizations, and NGOs). At the Kiruna meeting, the Arctic Council reviewed several applications and granted Observer status to China, India, Italy, Japan, Singapore, and South Korea. The diverse group of nations holding Observer status with the Arctic Council is reflective of widespread political and economic interest in the arctic region.

Carl Bildt hands over the Arctic Council gavel to Leona Aglukkaq, signifying the official transition to the Canadian Chairmanship. Photo courtesy of the Arctic Council Secretariat; photographer Martina Huber.

Proceedings during the Ministerial Meeting included signing the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, a legally binding document. The Agreement is designed to improve procedures for combatting oil spills in the Arctic. This is the second legally binding agreement in the Arctic Council's history, preceded by the 2011 Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (http://www.ifrc.org/docs/idrl/N813EN.pdf).

Arctic Council ministers sign the Kiruna Declaration at the Eighth Ministerial Meeting on 15 May 2013. Photo courtesy of the Arctic Council Secretariat.

Ministers also signed the Kiruna Declaration (http://www.state.gov/r/pa/prs/ps/2013/05/209405.htm), which sets out the work of the Council during the 2013-2015 Canadian Chairmanship. The theme of Canada's chairmanship is "development for people of the North." They have specified three priorities for their two-year term as Chair: responsible arctic resource development, safe arctic shipping, and sustainable circumpolar communities.

Three reports were presented during the Eighth Ministerial Meeting:

- The Arctic Biodiversity Assessment (http://www.arcticbiodiversity.is/index.php/the-report) produced by the Arctic Council's Conservation of Arctic Flora and Fauna working group presents the status and trends in arctic biodiversity and includes a synthesis, a report specifically for policymakers, and the full-length report.
- The Arctic Ocean Acidification Assessment produced by the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) looks at the potential impacts of acidification of the Arctic Ocean; the report includes a summary for policymakers and a key findings document, both available under the 'Publications online' link at the AMAP website (http://www.amap.no/).
- The Arctic Resilience Interim Report 2013 (http://www.arctic-council.org/arr/), led by the Stockholm Environment Institute and the Stockholm Resilience Centre at Stockholm University, considers how changes in climate, ecosystems, economics, and society interact. . In addition to the full report, a summary for policymakers is available.

Arctic Council Leadership

1998 Inauguration, Canada
1998-2000, United States of America
2000-2002, Finland
2002-2004, Iceland
2004-2006, Russian Federation
2006-2009, Norway
2009-2011, Denmark
2011-2013, Sweden
2013-2015, Canada
2015-2017, United States of America

An Arctic Council press release regarding the Kiruna meeting is available here (http://www.arctic-council.org/index.php/en/resources/news-and-press/press-room/733-press-release-15-may-kiruna-2).

For further information about the Arctic Council, please see their website (http://www.arctic-council.org/).

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Summit Gathers an International Audience to Discuss Sustained Arctic Observing Systems

Contributed by Maribeth Murray, International Study of Arctic Change (ISAC) Executive Director.

The first Arctic Observing Summit (AOS2013) (http://www.arcticobservingsummit.org/), held 30 April–2 May 2013 in Vancouver, BC, Canada, brought together a cross-section of the arctic community to deliberate on the design, implementation, coordination, and sustained long-term (decades) operation of an international network of arctic observing systems. The AOS is a task of the Sustaining Arctic Observing Networks (SAON) (http://www.arcticobserving.org/) process, which is led jointly by the Arctic Council (http://www.arctic-council.org/index.php/en/) and the International Arctic Science Committee (IASC) (http://www.iasc.info/). The International Study of Arctic Change (ISAC) (http://www.arcticchange.org/) is responsible for leading the AOS task.

The AOS2013 addressed four themes:

- The status of the current observing system.
- Observing system design and coordination.
- Stakeholder perspectives on observing system design and integration.
- Mechanisms for coordination of support, implementation, and operation of a sustained arctic observing system.

The format of the AOS was based on community-driven white papers, which were made available for online public comment. A total of 60 white papers and statements were posted. Synthesis papers were prepared for the issues of data management, stakeholder perspectives, and status of the current observing system. The white papers and synthesis documents are available online through the AOS website (http://www.arcticobservingsummit.org/users/white_papers.php). Videos of several of the talks and panel discussions are also available online (http://www.arcticobservingsummit.org/).

More than 170 participants from 12 nations represented funding agencies, northern residents, policy makers, industry, science planners, and a variety of scientific disciplines. Strong representation from China, Japan, and South Korea highlighted the importance of arctic observing programs for operational weather forecasts in eastern Asia as well as growing economic interests in the Arctic, particularly with respect to resource development and shipping activities. A panel on international collaboration brought together agency representatives from four countries and the European Union. This panel stimulated a vigorous question and answer session from AOS participants, particularly with respect to opportunities and limitations of funding strategies for international observing activities. Panel contributions by representatives from North American arctic indigenous organizations on stakeholder engagement with observing system design emphasized both the need and the benefits to be derived from an early engagement of these groups in the design and execution of an observing network that does more than pay "lip service" to information needs by arctic residents.

The ISAC International Program Office will release policy briefs and shorter articles derived from the AOS2013 over the coming months. The full report from the Arctic Observing Summit 2013 is expected in autumn 2013. Subsequent summits will be held in conjunction with the Arctic Science Summit Week (ASSW), starting with the ASSW in April 2014 in Helsinki, Finland, and thereafter biennially.

For more information, see the AOS website at http://www.arcticobservingsummit.org/ or contact Maribeth Murray at murray@arcticchange.org.

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A Tribute to Vera Alexander

ARCUS reaches a milestone this year with the retirement of Vera Alexander as President of the Board of Directors, a position she's held with distinction for the past ten years. A founding member of the organization, Vera's vision for and dedication to ARCUS and its mission in support of arctic research is unsurpassed.

In 1965 Vera became the first woman to receive a PhD from the University of Alaska Fairbanks (UAF). Upon obtaining her degree she quickly distinguished herself by receiving the appointment of Assistant Professor at the fledgling UAF Institute of Marine Science (IMS) (http://www.ims.uaf.edu/). By 1980 she became IMS Director. When UAF established the School of Fisheries and Ocean Sciences (http://www.sfos.uaf.edu/) in 1987 she became its first dean, serving for nearly 20 years before stepping down in 2004 to serve as Assistant to the Provost for Fisheries and Ocean Policy.

As a distinguished expert in the field of biological oceanography, she is recognized nationally and internationally for her research in the field of marine science. Her service to the science spans many organizations, most notably 16 years on the Marine Mammal Commission (http://www mmc.gov/), a founder of the North Pacific Marine Science Organization (PICES) (http://www.pices.int/) serving several years as the U.S. delegate and four years as chair, and 12 years on the International Scientific Steering Committee (SSC) of the Census of Marine Life (COML) (http://www.coml.org/). In 2011 the COML SSC received the prestigious International Cosmos Prize.

She has authored or coauthored over 70 papers published in refereed literature and received many honors, including elections as a Fellow of the American Association for the Advancement of Science (AAAS) (http://www.aaas.org/), to the Arctic Institute of North America (http://www.arctic.ucalgary.ca/), and to the Explorers Club (http://www.explorers.org/). She received an honorary Doctorate of Laws degree from Hokkaido University in recognition of her work promoting international scientific cooperation.

Of her many achievements the launch of the Research Vessel (R/V) *Sikuliaq* is signal. Vera's vision for and involvement in its concept and planning led to construction of the first ice-strengthened research vessel built by NSF. NSF rewarded her tenacity and commitment to making the R/V *Sikuliaq* a reality by inviting her to christen the ship on the occasion of its 2012 launch.

ARCUS will miss Vera's leadership, collegiality, deep commitment to arctic research, and especially her vision. She embodies ARCUS, making it the organization it is today. The board and staff wish her much success as she continues her distinguished career. We thank her for many years of service and especially for her many contributions to the work of ARCUS and arctic research.

— Susan E. Fox
Executive Director, ARCUS

Evolution of the Arctic Forum in Times of Change

"Times they are a-changing" would make a good theme song for the Arctic during the mid-twenty-first century. Changes, driven by global physical processes, have enormous political, social, and economic consequences within the arctic region. Until quite recently there was little interest in the Arctic. It was out there, perhaps exotic, perhaps worth studying for its own sake, but apart from strategic cold war considerations, not too important. One example of attitudes towards Alaskan studies was a review comment on a proposal submitted under NSF's Research for National Needs program approximately four decades ago. The proposal, a multidisciplinary study, would develop baseline information on Princes William Sound. Topics to be studied included: watershed, human populations, economics, biology, oceanography, etc. The proposal was not reviewed favorably—as one reviewer put it, "no one can be interested in this remote unimportant sea." A few years later the Exxon Valdez oil spill occurred and there was no baseline information available for the Prince William Sound.

ARCUS was formed in response to this lack of concern. At first the mission was primarily advocacy and information and the organization had successes in these areas. There was also emphasis on creating an arctic research community. Today, we don't really need to push for arctic research, although we can and do help to steer it. Yet the need for education and information has never been greater.

The Annual Meetings of the corporation have always been held in Washington D.C. For several years the occasion was used for member representatives and Board members to pay visits to congressional offices and also to visit agencies. The Arctic Forum was developed in conjunction with the Annual Meeting to bring together researchers, officials of NSF and other agencies, and educators. The first forum in conjunction with the Annual Meeting was held in 1994 and over the next few years the Forum was held during a portion of the meeting and preceded by a lunch speaker. An abstract volume was produced for the first time in 1998 and within a few years, the Forum had grown such that a larger venue was needed. Each year the Arctic Forum has attracted outstanding experts for the program, resulting in timely, state-of-the-art presentations.

This presence in D.C. became an important facet of ARCUS activities. The Forums had a packed hall and a lot of interest. Now, the Forum is undergoing a change once again. No Forum was held in 2009, 2010 or 2011, due to limited funds, although the State of the Arctic Conference held in Miami in the spring of 2010 fulfilled this function well. In 2012, however, ARCUS was able to join with the American Geophysical Union in hosting an Arctic Forum in conjunction with their Science Policy Conference (http://www.agu.org/sci_pol/asla/alerts/2012-23.shtml) in Washington D.C. This will happen once again 24-26 June 2013, with the Arctic Forum (http://spc.agu.org/2013/events/arctic-change-research-u-s-government-interagency-collaboration-i/) convening Tuesday, 25 June. This new partnership is allowing ARCUS to address scientific needs in support of policy, an ever-increasing need as the arctic physical and societal landscape changes. In this way, among others, ARCUS has evolved with the times.

— Vera Alexander
President, ARCUS Board of Directors

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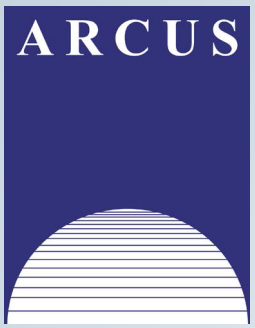

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