Witness the ARCTIC

Chronicles of the NSF Arctic Science Section Summer 2018, Volume 22 Number 1

In this Issue

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ARCUS Member Highlight: Woods Hole Research Center

Note: "Witness the Arctic" regularly features the research and related programs of ARCUS member institutions. This article spotlights the Woods Hole Research Center, located in Falmouth, Massachusetts, that has been an ARCUS member institution since 2006.

The Woods Hole Research (WHRC (http://whrc.org/)), founded in 1985 by ecologist George Woodwell, is an independent research institute with a mission to advance scientific discovery and seek science-based solutions for the world's environmental and economic challenges through research and education.

The work of WHRC is centered on land-based carbon: where it is stored, where it is changing and at risk of being released. WHRC scientists combine fieldwork, satellite data, and computer simulations to examine the land-climate connection – how changes in land use effect the climate system and how the changing climate is altering systems on land such as forests, ecosystems, and agriculture.

WHRC scientist Max Holmes peers over the edge of a bluff of permafrost – dense stores of soil carbon which contain high volumes of carbon. Photo courtesy of Sue Natali.

From thawing permafrost in the Arctic, to expanding industrial agriculture driving deforestation in

Indonesia and Brazil, to changing agricultural practices in the United States, WHRC scientists work around the globe in places where vast pools of carbon stored on land are at risk, threatening to cause climatic and societal disruption.

By studying chemical and biological changes to the Arctic environment, WHRC scientists are able to understand how trends of change in the Arctic may affect the stores of permafrost that lie beneath its surface. Photo courtesy of John Schade.

The threat of climate change in the Arctic is clear; warming is occurring twice as fast in this region than anywhere else. Consequences are already occurring through global sea level rise, widespread wildfires, permafrost thaw, and extreme weather. WHRC researchers investigate related consequences through a range of programs that address the global impacts of a warming Arctic. (http://whrc.org/our-work/research-program-areas/arctic/)

Arctic Great Rivers

Permafrost thaw, fires, and other effects of climate change impact rivers in the Arctic and the people who depend on them. WHRC scientists are improving the understanding of how climate change is impacting rivers and their watersheds. Much as human health can be evaluated by analyzing blood chemistry, so too can watershed health be assessed by monitoring water chemistry.

In 2003, Woods Hole Research Center scientist Dr. Max Holmes was in Siberia – taking water samples from the Lena River and laying the groundwork for the environmental monitoring network known as the Arctic Great Rivers Observatory.

Holmes and his team had chartered a ride from a local riverboat captain in the small town of Zhigansk. As the vessel navigated down the river the captain's 13-year-old daughter hovered near the scientists. The girl – Anya Suslova – watched their work, and despite not speaking English, she communicated her interest in the science.

The next year, when Holmes returned, he found out that Anya had been keeping the sampling project going.

WHRC scientists Anya Suslova (left) and Max Holmes (right) traverse the Alaskan tundra. Their regional focus, the Arctic, is warming at twice the rate of global averages. Photo courtesy of Alison Smart.

Fifteen years later, she had learned English, earned two science degrees, and joined the Arctic Rivers team at the Woods Hole Research Center. Now Suslova, Holmes, and their colleagues are monitoring the chemistry of the Ob', Lena, Yenisey, and Kolyma Rivers in Siberia, the Yukon River in Alaska, and the Mackenzie River in Canada.

Holmes compares the water monitoring to a doctor taking a blood sample to assess a patient's health. The chemistry of the rivers gives a picture of the health of that watershed and ecosystem. The team shares those data freely, encouraging scientists or government officials to use the research results to inform their work.

River monitoring is just one part of Woods Hole Research Center's research on a changing Arctic. WHRC scientists study the warming Arctic and associated impacts – such as permafrost thaw and increased wildfires. WHRC also has a mission, however, of taking that science and using it to educate policy makers

and the public.

Permafrost (http://whrc.org/project/arctic-permafrost/)

WHRC scientist Dr. Sue Natali travels to the Arctic frequently, as part of her work to better understand how quickly permafrost is thawing, how greenhouse gases are being emitted, and what that means for local communities and the global climate.

WHRC students of the Polaris program cut soil from the tundra's surface for sampling. Photo: John Schade

One of her favorite trips, however, is with the Polaris Project. That initiative brings undergraduate students to the Yukon-Kuskokwim Delta in Alaska to study permafrost. The research advances permafrost science, but it also develops the next generation of Arctic scientists. With two weeks in the field, and then two more at WHRC to analyze samples and process data, the students become well versed in Arctic climate issues quickly.

The Polaris Project is a WHRC-run hands-on education program in which students travel to the Yukon-Kuskokwim Delta in western Alaska to conduct fieldwork in the warming Arctic. Photo courtesy of John Schade.

Fire and the Arctic Climate

Wildfires are a clear climate change impact – around the world – and the Arctic and boreal regions are no exception. Earlier springs, longer fire seasons, and extreme fire weather are fueling a major increase in fires across the Arctic. The three largest fire years ever recorded in Alaska have happened since 2004. WHRC scientist Dr. Brendan Rogers focuses his research on northern boreal forests, and the impact of wildfire there. One challenge with more frequent and more intense fires is that the carbon-rich soil of the forests burns along with the trees. This generates enormous emissions of carbon into the atmosphere, and thus a positive feedback to climate warming.

Soil samples are important stores of information on how warming temperatures and wildfires are altering the geochemistry of the Arctic. Photo courtesy of John Schade.

Informing Policy

WHRC's science is designed to inform policy and answer specific policy questions. (http://whrc.org/our-work/policy/)
The results of the research, on rivers, permafrost, and forests, are brought to policy makers at national and international levels – to inform climate models and policy using policy briefs (http://whrc.org/publications-data/policy-briefs/) and one-page infographic documents.(See WHRC Permafrost & Global Climate Change (http://whrc.org/wp-content/uploads/2015/06/Permafrost_Infographic.pdf) They also serve as an important warning, that climate change impacts are happening now and require immediate attention. (see Policy Briefs)

Further information about WHRC is available on their website: http://whrc.org

For questions about WHRC, contact Dave McGlinchey (dmcglinchey@whrc.org) or Max Holmes (rmholmes@whrc.org)

Or, look for information on their Facebook page (https://www.facebook.com/woodsholeresearchcenter1)

About the Authors

Dave McGlinchey is responsible for communicating Woods Hole Research Center science to the public and to policymakers. He was trained as a journalist and lawyer, and, prior to joining WHRC, he served as the director of communications and marketing for the Manomet Center for Conservation Sciences. He is an avid birder, hiker, and skier, and is passionate about effective climate change policy. Dave is also the author of Final Flight: 10 Northeastern Birding Spots at Risk from Climate Change. He earned his B.A. from Wake Forest University and his J.D. from Suffolk University Law School.

Max Holmes is an earth system scientist who studies rivers and their watersheds and how climate change and other disturbances are impacting the cycles of water and chemicals in the environment. He is particularly interested in the fate of the vast quantities of ancient carbon locked in permafrost in the Arctic, which may be released as permafrost thaws, exacerbating global warming. Dr. Holmes has ongoing projects in the Russian, Canadian, and Alaskan Arctic, and in the tropics in the Amazon and the Congo. He is committed to engaging students in his research projects and to communicating the results and implications of his research to the public and to policy makers. Dr. Holmes previously served for two years as Program Director of the National Science Foundation's Arctic System Science Program and in 2015 was named National Fellow of the Explorers Club.

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SEARCH Program Updates

By: Brendan P. Kelly, SEARCH Executive Director

Science Steering Committee Member Rotation

In September SEARCH will welcome four new Science Steering Committee (SSC) members: Gifford Wong (U.S. Department of State), Kit Kovacs (Norwegian Polar Institute), Francis Wiese (Stantec), and Leah Braithwaite (ArcticNet). Courtney Carothers (University of Alaska Fairbanks) and Dee Williams (U.S. Geological Survey) will rotate off of the committee and, hopefully, remain engaged in SEARCH activities. Their service on the committee and to the community is greatly appreciated. The SSC elected Marika Holland (National Center for Atmospheric Research) to serve as the SSC Chair, George Kling (University of Michigan) as Vice Chair, and Caspar Ammann (National Center for Atmospheric Research) as Past Chair.

Arctic Carbon Exchange

The Permafrost Carbon Network (http://www.permafrostcarbon.org/index.html)'s Synthesis Working Group held a workshop to 'Reconcile historical and contemporary trends in terrestrial carbon exchange of the northern permafrost-zone' with support from the Arctic Data Center on 28-30 April 2018, in Santa Barbara, California. The goal of this activity was to assemble data products of high latitude permafrost CO2 flux measurements to update understanding of how the carbon balance of these systems has changed over time. A second workshop to advance these efforts will be held in October of 2018. More details about the workshop activities can be found on the Arctic Data Center webpage (https://arcticdata.io/reconciling-historical-and-contemporary-trends-in-terrestrial-carbon-exchange-of-the-northern-permafrost-zone/)

Arctic Futures 2050: Briefs, Scenarios Workshop, and Science to Inform Decisions

SEARCH's Arctic Futures 2050 initiative (https://www.searcharcticscience.org/arctic-2050) comprises

three related activities: Arctic Answers, science briefs answering specific questions about the changing Arctic; a scenarios workshop held in April 2018; and Arctic Futures 2050: Science to Inform Decisions, a conference that will bring together Arctic scientists and decision makers to jointly explore research needed to address the changing Arctic in the coming decades.

Arctic Answers briefs are reviewed by scientific experts and policy staff in local, state, and federal government offices. Three new Arctic Answers briefs (https://www.searcharcticscience.org/arctic-answers) are now available on the SEARCH website to provide answers to the following policy-relevant questions:

- How will the diminishing sea ice affect commercial fishing in the Bering Sea? Download PDF (https://www.searcharcticscience.org/files/pyramid/assets/aa013_july_2018_commercial_fisheries.pdf)
- How will the changing Arctic affect subsistence (or traditional) fisheries? Download PDF (https://www.searcharcticscience.org/files/pyramid/assets/aa015_july_2018_subsistence_fisheries_v2.pdf)
- Arctic meltdown and unruly tropical storms: are they connected? Download PDF (https://www.searcharcticscience.org/files/pyramid/assets/aa012_july_2018_arctic_meltdown.pdf) To suggest topics for additional briefs or to volunteer to serve as a brief author, please contact Brendan Kelly (bpkelly@alaska.edu).

The Arctic Futures 2050 Scenarios Workshop addressed the question "What information is needed to effectively respond to a changing Arctic by 2050?" Thirty-five scientists and decision makers, including policy staff from all levels of government, co-developed 16 key factors expected to drive Arctic change and projected how those factors might develop in the future (future projections).

During these workshops participants will determine the plausibility of the future projections and their consistency with one another. Scenarios will be considered robust if they are both plausible and consistent. Finally, narratives of plausible scenarios will be the basis of white papers intended to focus discussions about research need to aid decision making in the coming decades.

One venue for such discussions will be the Arctic Futures 2050: Science to Inform Decisions conference. The conference will bring together Arctic scientists and decision makers at the National Academy of Science in Washington on 4-6 September 2019 to explore:

- What we currently know (and don't know) about the changing Arctic and why it matters?
- What challenges confront decision makers in the rapidly changing Arctic?
- What basic research (e.g., process studies) is needed to inform responses to Arctic change?
- What applied research (e.g., impact studies) is needed to inform responses to change?
- What tools can facilitate informing decision making with science?
- What opportunities exist for partnerships between decision makers and scientists?

Next Phase of SEARCH

Over the next year, SEARCH is seeking input on future activities that will advance Arctic science in ways that increase our understanding of the system and inform decision making. Please consider participating in our town hall, "Where Does Arctic Research and SEARCH Go Next?" at the Fall meeting of the American Geophysical Union (https://fallmeeting.agu.org/2018/), 10-14 December 2018. The town hall will explore with interested scientists where the program has provided benefit and—more importantly—where it could do so in the future. How can the Arctic research community best advance actionable and discovery science? What could or should a multi-disciplinary effort accomplish that otherwise would not get done? Whether or not you participate in the town hall, please contact Brendan Kelly (bpkelly@alaska.edu) with thoughts about SEARCH and the future of Arctic research.

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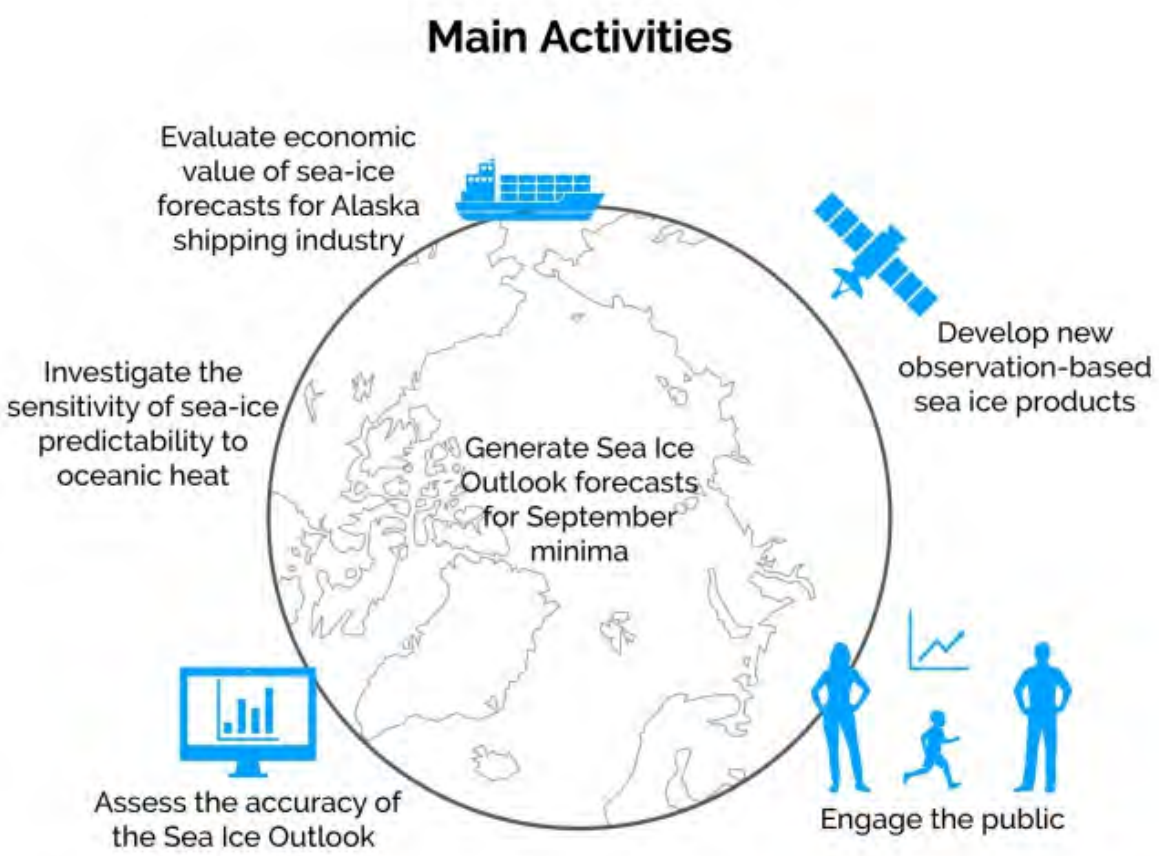
Sea Ice Prediction Network–Phase 2 (SIPN2) – Advancing Research to Improve Sea Ice Forecasting

By: Betsy Turner-Bogren, ARCUS Project Manager

The Sea Ice Prediction Network–Phase 2 (SIPN2) is a network of U.S. and international members working to advance research on the processes driving sea ice predictability, the production of operational products, and the communication of findings to interested stakeholders. With funding provided by NSF-Arctic Sciences Section and the U.K. Natural Environment Research Council (NERC) and additional support and in-kind contributions by several organizations, SIPN2 efforts commenced in early 2018 and will continue through 2022.

Building on the success of the Sea Ice Prediction Network (SIPN) efforts during 2014-2017, SIPN2 will improve Arctic sea ice forecasts using a multi-disciplinary approach that includes modeling, new products, data analysis, and scientific networks. Stakeholder engagement and partnerships are fostered through the open Sea Ice Outlook (SIO) process, action teams, webinars, and workshops.



SIPN2 Activities

SIPN2 Activities

Expanding the Sea Ice Outlook (SIO)

The annual Sea Ice Outlook (SIO) has provided an open process for those interested in Arctic sea ice to share ideas about the September minimum sea ice extent since 2008. Now part of SIPN2, the SIO produces reports in June, July, and August containing a variety of perspectives on Arctic sea ice—from observations of current conditions, to advanced numerical models, to qualitative perspectives from citizen scientists. Post-season reports provide in-depth analyses of factors driving sea ice, explore the scientific methods for predicting seasonal ice extent, and advance understanding of the impact of variables such as initial sea ice thickness, melt pond fraction, timing of melt onset and ice retreat, Bering Strait heat inflow, and weather. The goal of SIPN was to enhance scientific discussion on the physics that control summer sea ice extents. In SIPN2 there is a further analysis of quantitatively comparing model forecast output, investigating the role of oceanic heat on the limits of subseasonal-to-seasonal sea-ice predictability, and an effort to explore the economic value of two-week to seasonal scale predictions.

SIPN Data Portal

The SIPN Data Portal (https://www.atmos.uw.edu/sipn) enables computation of sea ice probability (SIP) and the first ice-free day (IFD), along with other regional metrics from data provided by SIO contributors whose methods provide spatial information on sea ice conditions.

Outreach Activities

SIPN2 convened the Arctic Sea Ice Prediction Stakeholders Workshop in January 2018 in conjunction with the Arctic Frontiers Conference in Tromsø, Norway. This workshop brought together sea ice stakeholders and forecasters to assess the value of forecasts by the user community, determine if and how ice forecasts are currently being used in decision making and discuss which metrics are needed by various stakeholders and communicate the limits and opportunities of current forecasting systems.

The SIPN2 webinar series launched with a July webinar that provided an overview of the SIPN2 main activities and an overview of the SIPN Data Portal for sea ice prediction. A second webinar on 11 September 2018 will provide an overview of the interdisciplinary international MOSAiC program and ongoing work on the causes and consequences of an evolving and diminished Arctic sea ice cover. Webinar presentations are archived on the SIPN2 website (https://www.arcus.org/sipn/meetings/webinars).

Further information about SIPN2 and the Sea Ice Outlook (SIO) (https://www.arcus.org/sipn)

For questions, contact Betsy Turner-Bogren, ARCUS (betsy@arcus.org)

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Beavers as New Ecosystem Engineers in the Arctic

By: Ken Tape, Research Associate Professor at the University of Alaska Fairbanks

Beavers are ecosystem engineers that alter hydrology and impact many aspects of stream and surrounding ecosystems. Because herbivores, including moose and snowshoe hares, have moved from the boreal forest into increasing Arctic tundra shrub habitat during the last century, we thought it would be interesting to explore whether beavers would soon be following them from the forest to the tundra. We struck on the notion that the formation or disappearance of beaver ponds could be detected through time using satellite imagery, thus possibly allowing us to map beaver encroachment or emigration in tundra regions. We assembled a team of researchers with experience detecting change in the tundra environment, particularly with Arctic lakes, which related to our beaver question. Ken Tape, Benjamin Jones, and Christopher Arp at the University of Alaska Fairbanks developed the idea and approach; Ingmar Nitze and Guido Grosse at the Alfred Wegener Institute in Germany provided insight and remote sensing support. The project was funded in part by a National Science Foundation (NSF) Alaska Established Program to Stimulate Competitive Research (EPSCoR) grant, the State of Alaska, the European Research Coucil, a Hemholz Association Initiative and Networking Fund grant, the European Space Agency GlobPermafrost, and the University of Alaska Fairbanks Office of the Vice Chancellor for Research.

We developed an approach that used Landsat wetting and drying temporal trends between 1999 and 2014 to locate potential sites of beaver pond formation (wetting) or disappearance (drying). Wetting locations were further constrained using a suite of geographic filters to reduce the number of wetting locations that were not due to beaver pond construction but were instead due to other natural wetting processes. We then used high-resolution satellite imagery to confirm whether the wetting or drying locations were due to beavers or other causes. This powerful technique allowed us to detect beaver pond formation and drying across an 18,000+ km2 predominantly tundra area in the western Brooks Range of Alaska. We eventually identified 56 new beaver ponds using this method, which indicated that beavers are moving from treeline into Arctic tundra regions. In Figure 1, the orange line approximates treeline, which was historically considered to be the range limit of beavers (Bockstoce, 2009; McCulloch and Hopkins, 1966). Yellow arrows denote known beaver colonization routes since 1999, including an observation of a new dam on the Babbage River in Canada (Jung et al. 2017), and evidence of many new dams and ponds in the white box covering the western Brooks Range. The white arrows speculate future colonization routes, and plus signs indicate observations of beaver ponds beyond the treeline on the Seward Peninsula.

Figure 1. Map of recent beaver colonization in Arctic tundra of Alaska and northwestern Canada. Orange line approximates treeline, which was historically considered to be the range limit of beavers. Yellow arrows denote known beaver colonization routes since 1999. White arrows speculate future colonization routes and the plus signs indicate observed beaver ponds beyond treeline. Image courtesy of Tape et al.

It remains unclear whether this colonization of the tundra by beavers is the result of increasing shrub habitat, as well as increasing unfrozen water in winter, or whether it is a population rebound from over-trapping a century ago, and they are reoccupying their former range. We are working with the National Park Service to examine archaeological and anthropological records to explore this issue.

The more pressing question to us is, how will beavers impact the tundra permafrost environment, and what will be unique compared to their impacts in temperate ecosystems? From the review of time series imagery, it is striking to our team how immediately and dramatically the changes occur when beavers arrive. The time series of high-resolution satellite imagery show that streams turn into a series of interconnected channels and ponds resembling a wetland, and lateral permafrost thaw is evident around the newly-inundated locations (see Figure 2). Our understanding of physical impacts resulting from inundation and deeper water (ponding) suggests that the observed lateral permafrost thaw is accompanied by permafrost thaw underneath the new pond because water transfers heat more efficiently than the preexisting tundra vegetation. Deeper water in winter also translates to later ice formation and warmer water, which exacerbates underlying permafrost thaw. Warmer water also leaks downstream, creating more unfrozen water in winter. In this way, the footprint of thermal (and likely biological) impact of beavers could be considered local to the area surrounding engineered ponds, but with a tail of uncertain length where warmer water extends downstream.

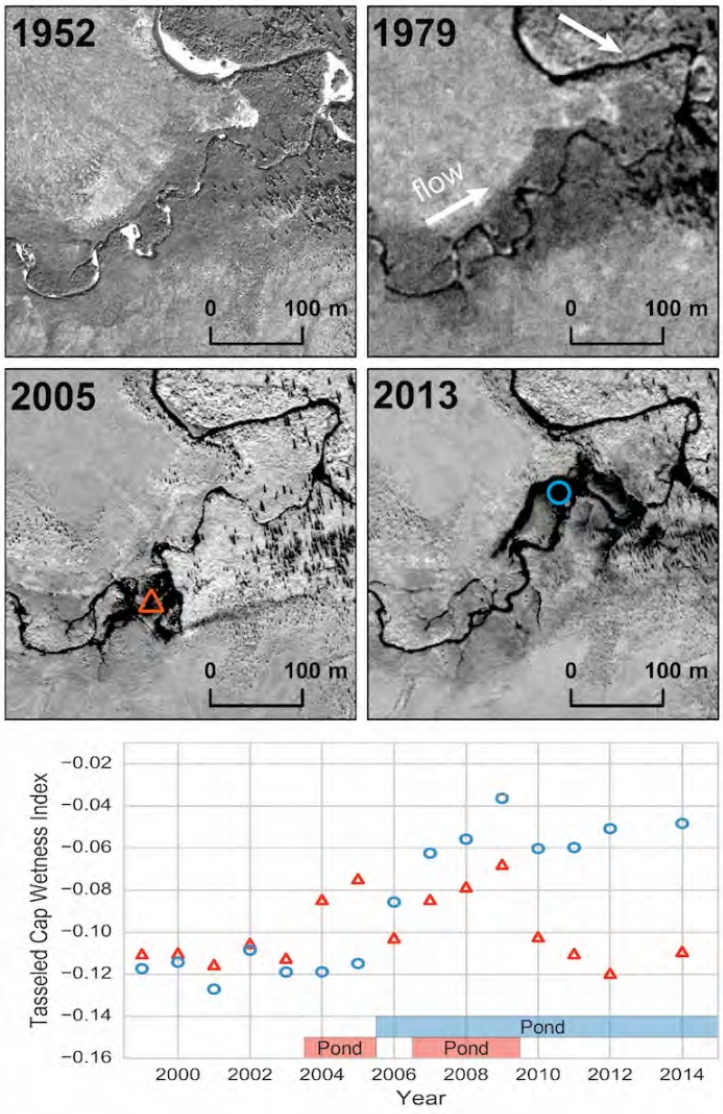

Figure 2. Time series of high-resolution imagery showing a relatively stable stream channel prior to beaver colonization evident in 2005 image. Dam construction, pond formation (2005 imagery), and pond relocation (2013 imagery) demonstrate the rapid change and disturbance imposed by beavers on Arctic stream ecosystems. Image time series consists of aerial photography (1952 and 1979), Digital Globe Inc. Quickbird imagery (2005), and Worldview 2 imagery (2013); spruce trees dot the right part of the images. Graph shows time series of Landsat tasseled cap wetness index indicating timing of pond formation and duration for the two beaver ponds shown in imagery. N 67°40.33', W 163°7.31'. Image courtesy of Tape et al.

The impacts of beavers in the Arctic tundra had not been studied prior to our exploratory results. Physical impacts, such as permafrost thaw or warmer water, are more reliable because this process has been studied in the Arctic for over a half-century. Our predictions of biological impacts, however, are much more uncertain due to their complexity and lack of study. We think that warmer water in winter and more varied aquatic habitat created by beavers will create oases in the Arctic, replete with shrubbier vegetation, more unfrozen water in winter, enhanced aquatic productivity and biodiversity, and likely new species, including fish. Because beavers impact so many aspects of terrestrial and aquatic ecosystems, and because these impacts can vary from one beaver pond to the next, it will be challenging to quantify and summarize their current and future impacts on the Arctic tundra biome.

Our current efforts are to map changes in beaver pond location in the Arctic over the last 20 years, as well as to substantiate our understanding of beaver impacts with a multitude of field measurements. The best analog for beavers and their impacts in the Arctic tundra might be wildfire. Both of these ecological disturbances seem to have been rare or absent in the tundra prior to their recent appearance, and their arrival appears like a hammer to the system in comparison with some of the incremental changes that we are more familiar with, such as permafrost thaw or shrub expansion. Further study is needed to better understand the role of beaver colonization in tundra shrub habitat, which constitutes a new and dramatic disturbance that could accelerate the changes already underway in the Arctic.

Ken Tape is a Research Associate Professor at the University of Alaska Fairbanks with broad interests in the Arctic natural sciences. His research describes the impacts of climate warming during the 20th century on various components of the Arctic ecosystems, including the vegetation, permafrost, hydrology, and wildlife. He enjoys boating, skiing, snowmachining, dog-mushing, photographing, studying, and writing about the major river systems in northern Alaska.

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From Sea Ice to Volcanoes: EarthScope Transportable Array Provides a Wealth of New Data

By Beth Grassi, EarthScope National Office

From seismic rumblings to meteorological measurements, the EarthScope Transportable Array (http://www.usarray.org/alaska) (TA) of seismic stations collects earthquake data and much more. EarthScope's primary goal is to explore the geological structure and formation of the North American continent. Other instruments sometimes accompany the high-quality seismometers, such as strong-motion (large earthquake) sensors, infrasound microphones, meteorological sensors, and soil-temperature gauges. The TA grid of 280 stations across Alaska and western Canada, spaced about 85 km apart, covers areas that previously had sparse or no monitoring, especially southwestern Alaska, the Yukon basin, and Alaska's North Slope.

EarthScope partner Incorporated Research Institutions for Seismology (IRIS) handles TA installations and data management—integrating the data flow and format in ways that are usable and familiar within different fields. (Time-lapse video of an installation (https://www.youtube.com/watch?v=4-7jwS8RTVQ&feature=youtu.be)) All EarthScope data (http://ds.iris.edu/ds/nodes/dmc/earthscope/usarray/) are available online for free. Instruments record continuously and most data is uploaded in near real-time.

Photo of TA station E22K, located near Anaktuvuk Pass in the Brooks Range, on 18 July 2018. On this service trip, IRIS staff installed two additional lithium batteries and a wind turbine for extra power (the black cylinder on the left). The box in the foreground marks the top of the seismometer borehole. Photo by Max Enders, IRIS

Deployment of the TA leapfrogged across the U.S. in two-year increments, starting on the West Coast in 2004. The array is currently scheduled for removal by 2020. Ongoing discussions with several agencies and organizations relate to extending the deployment.

Seismic Sea Ice

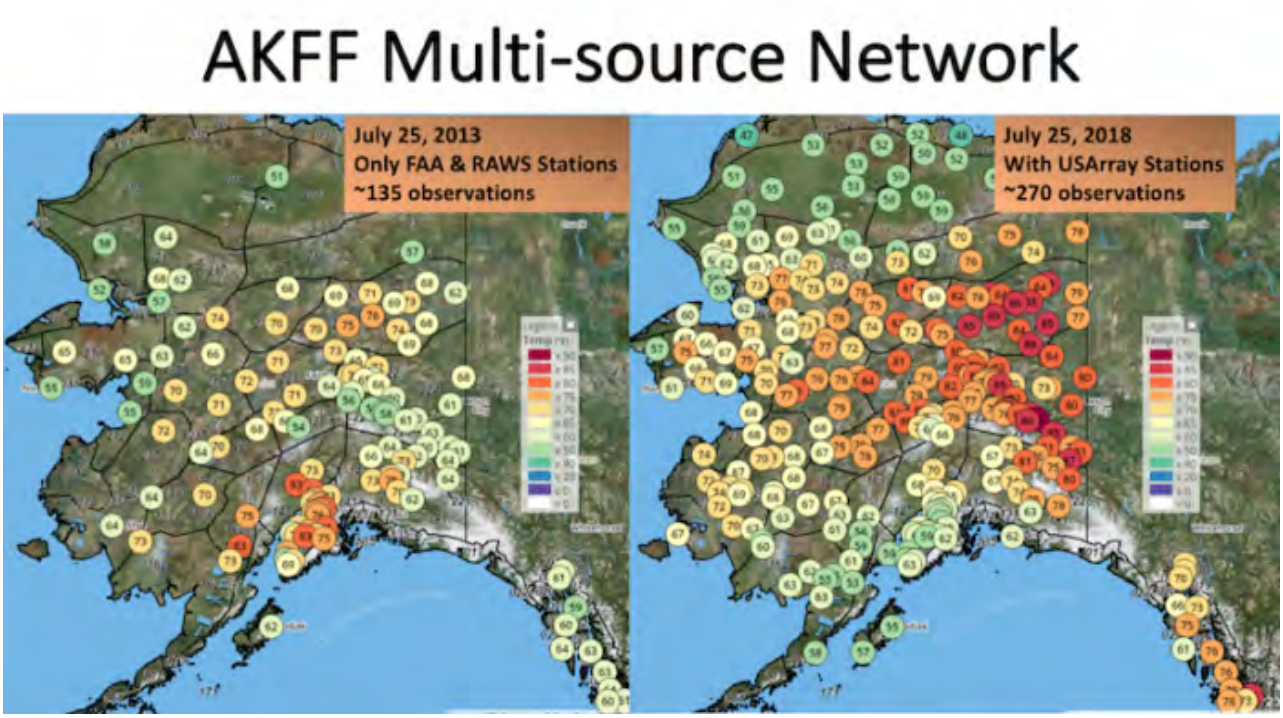
A photo from Utqiagvik on the shore-fast ice, looking out from the edge of the fast ice to the flaw lead (open water), in June 2016. One of the TA stations is near Utqiagvik. Often the edge of the shore-fast ice in that area is broken into blocks (deformed ice) due to the wind and the ocean current flowing along the flaw lead (known as the Alaskan Coastal Current). Photo by Sinéad Farrell

Recent National Oceanic and Atmospheric Administration (NOAA) research using Arctic coastal TA stations (https://www.star.nesdis.noaa.gov/sod/lsa/SeaIce/) explores how microseism data could improve sea-ice monitoring. Ocean waves beating against the shore or ocean bottom generate microseismic signals that are modulated by the sea ice.

The continuous data from TA stations could allow for detailed monitoring of sea-ice coverage and thickness, potentially pinpointing events such as freeze-up in fall and short-term, open-water events more accurately than satellite images taken weeks apart. The TA stations also avoid data gaps from clouds blocking satellite imagery. This information is critical to evaluating safe sea-ice access and expanding understanding of climate change effects. "The end goal is to improve sea-ice forecasts in increments of hours, weeks, months, and longer for modeling," says Sinéad Farrell, a visiting scientist at NOAA from University of Maryland.

Forecasting for Wildfire Management

During Alaska's wildfire season, Heidi Strader, the Predictive Services Fire Weather Program Manager of the Alaska Interagency Coordination Center, presents daily fire-danger forecasts to half a dozen state and federal agencies, fire managers, and smokejumpers. The Alaska Fire and Fuels forecast maps (https://akff.mesowest.org/map/#/c6337,-14900,4/g1/mc/vtemp/sAK/n/zt) are available online, including data for past seasons. Fire-danger forecasts combine temperature, relative humidity, 24-hour precipitation, and wind speed to calculate various fuels indices. Fire managers may pre-position fire crews based on the fire-danger forecast.



The Alaska Fire and Fuels database is enhanced when it can pull station data such as the TA into the network. This image illustrates how much the TA has allowed the network to expand. Image courtesy of Alaska Fire and Fuels

The TA stations nearly doubled the weather data available to fire managers. Without coverage, fire forecasters have to assume one weather station is representative of an entire area. "But you can have a high danger next to moderate, so the landscape is more complex," says Strader. Asked ff the TA deployment could be extended, Strader commented: "We'd like to be able to build a historical database. We say a minimum of 5 years, and by 20 years you can start seeing trends."

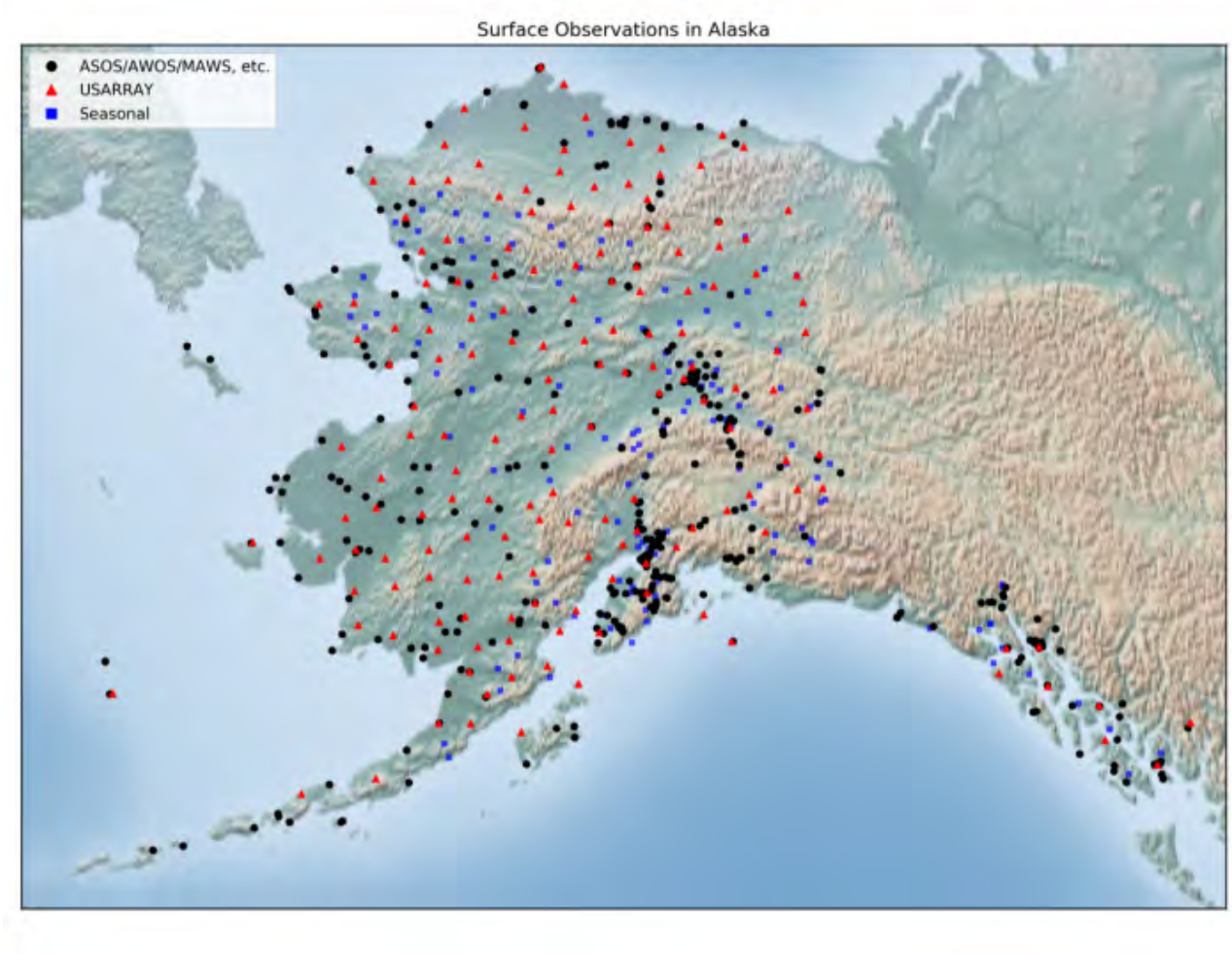
Permafrost Monitoring

NASA's Arctic-Boreal Vulnerability Experiment (ABoVE) (https://above.nasa.gov/) contributed soil-temperature gauges to the TA stations to monitor permafrost distribution. The gauges don't broadcast data, so in June 2018 IRIS technicians collected the first data in person and researchers will soon process it.

The TA stations have expanded both the geographic range and landscape-type coverage of the ABoVE permafrost study. "Historically, we were collecting data along roads and close to villages and populated centers," says Dmitry Nicolsky, University of Alaska Fairbanks (UAF) faculty and ABoVE researcher who studies permafrost. The TA stations extend coverage to remote sites in the Yukon basin and southwest Alaska. While previous studies focused on shrub, tundra, or forest habitat, TA stations are drilled into accessible bedrock, providing a more complete picture across diverse habitats. This stage of the ABoVE research will provide a baseline for the present climate and help with modeling verification.

Weather Forecasting

Weather forecasts are crucial for many Alaskans. According to Carven Scott, the National Weather Service's (NWS) Alaska Region Director, Alaska's three forecast offices cover an area that would have fifty offices in the Lower 48.



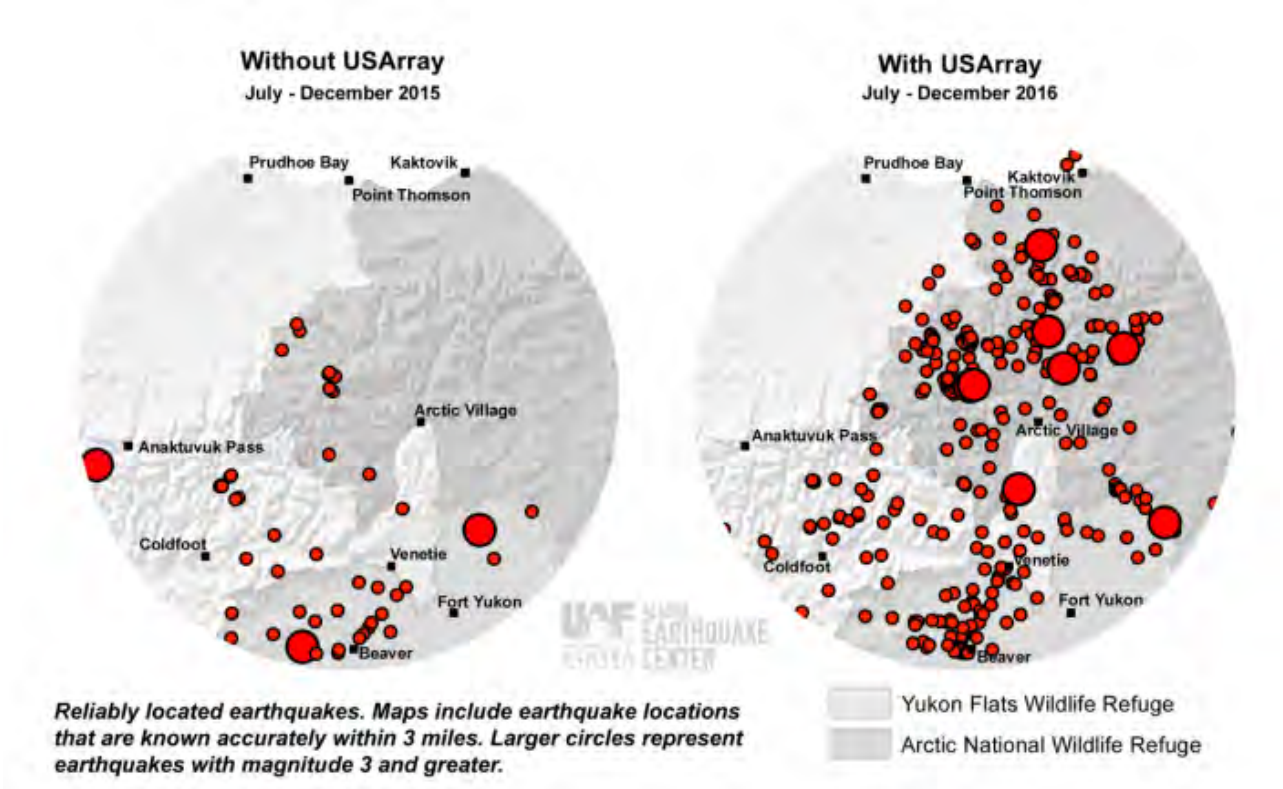
National Weather Service observation sites in Alaska, including TA stations. Image courtesy of the National Weather Service.

The TA stations have helped fill data gaps in northern Alaska, "where we have never had surface observations since the weather service has been in Alaska," says Scott. "It's given us insight into what's going on up there, and it's been invaluable." The TA data is fully integrated into the NWS forecasting

system in near real-time, available on the MesoWest website (http://meso1.chpc.utah.edu/usarray/). The TA data have improved analysis and documentation of extreme events, such as the September 2017 heavy rains in northwestern Alaska. Some of the TA sites in the Brooks Range and North Slope directly improve the forecast by verifying the freezing level, helping meteorologists determine if precipitation will fall as snow or rain.

Changing the View of Alaska's Earthquakes

The primary instruments of the TA stations—seismometers—provide high-resolution seismic data. The array has increased the number of earthquakes detected in northern Alaska, especially smaller-magnitude events (see Figure 5). The TA is regularly detecting magnitude 4 earthquakes north of the Brooks Range. Recently, the TA captured the North Slope's strongest recorded earthquake, a magnitude 6.4 (https://twitter.com/AKearthquake/status/1028737591791644672).



A sample of the increase of detected earthquakes on a portion of Alaska's North Slope with the expanded coverage of the TA stations, which are part of the USArray. Image courtesy of the Alaska Earthquake Center

Carl Tape, a professor at University of Alaska Fairbanks (UAF) and Co–Principal Investigator (Co–PI) for the EarthScope National Office (ESNO), used TA data to supplement a smaller seismic network placed in central Alaska. The TA instruments detected very low-frequency seismic waves, the first time this type of earthquake was detected outside of a subduction zone (https://www.nature.com/articles/s41561-018-0144-2). "We're taught most earthquake activity is at plate boundaries, but we're detecting earthquakes and exotic events 700 km from the boundary," says Tape.

Monitoring Volcanoes Using Infrasound

Infrasound is nature's sub-subwoofer, consisting of sound waves below the limit of human hearing (below 20 Hertz). David Fee, a professor at UAF and Co-PI for ESNO, uses infrasound to monitor volcanic eruptions (https://avo.alaska.edu/about/infrasound.php). The TA infrasound instruments captured the unexpected 2016 eruption of the Pavlof volcano. Fee's team found some stations detected infrasound better than others based on proximity to the source and how background noise interferes with the signal. "In Interior Alaska, where it's not very windy, we may have a better chance of picking up an infrasound signal than on the windy coast. Site selection is really important," says Fee.

The goal is creating an algorithm that can process infrasound data and backtrack to locate the source. Once the algorithm is accurate, the next step is to test it as a near real-time eruption detector.
"The TA stations are like a Swiss army knife—they aren't just weather stations or seismic stations, you could add more sensors," says Scott. "For example, methane or black carbon sensors to measure changes in the Arctic. A lot of what you can do with the TA is limited only by scientists' imagination."

Learn More

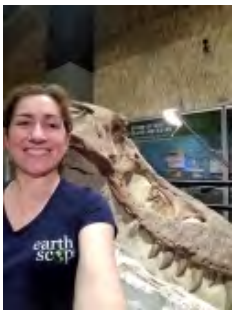
Further information about the TA deployment to Alaska and Western Canada is available on the USArray webpage (http://www.usarray.org/alaska).

Access TA station data on the IRIS website (http://ds.iris.edu/ds/nodes/dmc/earthscope/usarray/).

More about the possibility of extending the TA operation beyond 2020 is available on the UAF Alaska Earthquake Center webpage (https://earthquake.alaska.edu/usarray-sustainability).

For questions, please contact Bob Busby, TA Manager at IRIS, busby@iris.edu or Mike West, State Seismologist, at the Alaska Earthquake Center, mewest@alaska.edu.

Author Bio



Beth Grassi is the science writer for the EarthScope National Office, which is housed at the University of Alaska Fairbanks. She has worked as a science writer for various organizations in Alaska for nearly 15 years, covering topics from ecology to earth science. At EarthScope, she works with scientists that are funded by EarthScope or that use EarthScope data, creating appealing, non-technical accounts of their research (http://www.earthscope.org/results). She also produces the quarterly inSights (http://www.earthscope.org/newsroom/newsletters) newsletter, writes Humans of EarthScope (http://www.earthscope.org/public/HuofES) articles to encourage a new generation of earth

scientists to join the field, and works with the media. To learn more about EarthScope science and education projects, email Beth at bagrassi@alaska.edu or visit www.earthscope.org (http://www.earthscope.org/).

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Recent Study Shows Amplified Arctic Temperature Increase during Perceived Haitus in Global Warming

By Xiangdong Zhang, International Arctic Research Center and Department of Atmospheric Sciences, University of Alaska Fairbanks

Amplification of Arctic surface air temperature (SAT) increase, at more than twice the rate of average global temperatures since the mid-twentieth century, has been well-recognized (e.g., Serreze et al. 2011; Cohen et al. 2014). Recently, a large number of studies and the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5) suggested a hiatus or slow-down of global warming from 1998–2012. However, accurate estimates of Arctic warming have been limited due to sparse observational networks in this remote, harsh, and climatically sensitive area and representation of the Arctic observations in global SAT data sets is problematic. U.S. and Chinese government agencies, including the National Science Foundation, supported recent work by our group of researchers at University of Alaska Fairbanks and Tsinghua University in Beijing, China, that revealed gaps in the spatial and temporal observation datasets analyzed in the earlier global warming studies. Even though various extrapolation approaches were employed in constructing those datasets, the gaps may have caused a biased estimate of contributions of the Arctic warming amplification to the global warming.

Our collaborative groups reconstructed a new global dataset with improved spatial and temporal representation of the Arctic SATs (Huang et al. 2017). In the reconstruction, we employed Arctic-specific observations (i.e., data from the International Arctic Buoy Programme/Polar Exchange at the Sea Surface for the period of 1979–2004; IABP/POLES; Rigor et al. 2000). We also employed the Data Interpolating Empirical Orthogonal Functions (DINEOF) method for reconstruction of the dataset, which is constrained by the available Arctic observations both spatially and temporally.

By analyzing this newly reconstructed global SAT dataset, we found that the Arctic warming amplification has significantly contributed to the global warming trend, causing a continued and even accelerated increase in global mean SAT, rather than a hiatus or slowdown of the trend as earlier studies suggested. The newly estimated rate of global SAT for 1998–2012 is around 0.112°C/decade, instead of 0.05°C/decade from IPCC AR5 (see Figure 1). In extending the analysis time period to the beginning of the twentieth century, we found a global warming rate at 0.091°C/decade from 1900–2014. A comparison with the rate of 0.075°C/decade and 0.089°C/decade from 1900–1998 and 1900–2012, respectively, suggests that global warming has even accelerated. Further analysis indicates that the Arctic SAT has increased at a rate of 0.755°C/decade during 1998–2012, which is more than six times the global average for the same time period. This indicates that the Arctic amplification has also been further enhanced.

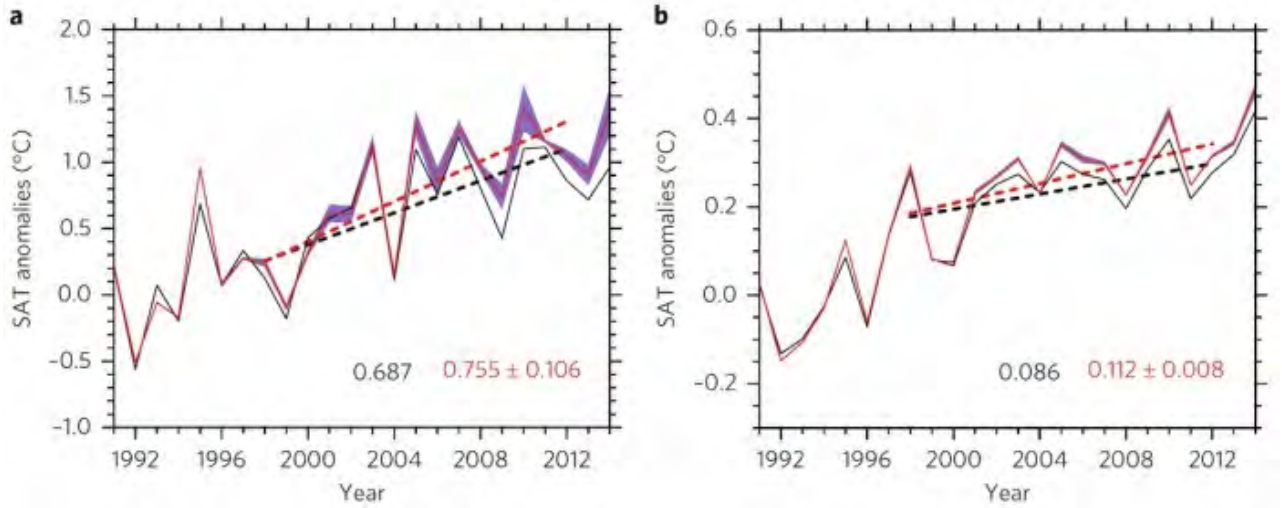

Figure 1. Annual mean SAT anomalies (solid lines) relative to 1979–2004 climatology and their linear trends (dashed lines) over 1998–2012 for (a) the Arctic region (60–90°N) and (b) the globe. In (a), the black lines are the results using the conventional Kriging interpolation, the red lines are the mean of two reconstructed datasets using the new method of DINEOF, and the blue shading represents the range of the two reconstructed datasets. In (b), the black lines show the results using global SATs from Karl et al. (2015), and the red lines and blue shading are the same as in (a) but for the globe. The numbers in the panels are the trends corresponding to the two dashed lines in the same colors. Figure courtesy of Huang et al. (2017).

Along with the enhanced Arctic warming amplification, the frequency of occurrence of extreme climate and weather events has ostensibly increased across the Northern Hemisphere mid-latitudes, including adverse cold spells, severe heat waves, destructive floods, and persistent droughts (see Figure 2). The coincidence of the changes between the Arctic and mid-latitudes has stimulated broad interest in their possible linkages in the climate community, the general public, media agencies, and decision-makers. There is also a particular interest in changes of occurrence frequency of future extreme events considering the model-projected continuation and acceleration of Arctic warming and associated sea ice loss into the next several decades (e.g., Zhang and Walsh 2006; Wang and Overland 2012; Stroeve et al. 2012). So, it is hypothesized that Arctic warming amplification can influence the mid-latitudes through a number of pathways, including change in the atmospheric circulation, wavier jet stream, and troposphere-stratosphere coupling[1], (e.g., a U.S. Climate Variability and Predictability Program (CLIVAR) white paper by Cohen et al. 2018; as well as review papers by Vihma 2014; Cohen et al. 2014; Overland et al. 2016; and Zhang et al. 2018). However, a strong debate emerged and continues in the studies on the topic due to controversial results, especially regarding inconsistencies of atmospheric circulation response to the changed Arctic sea ice.

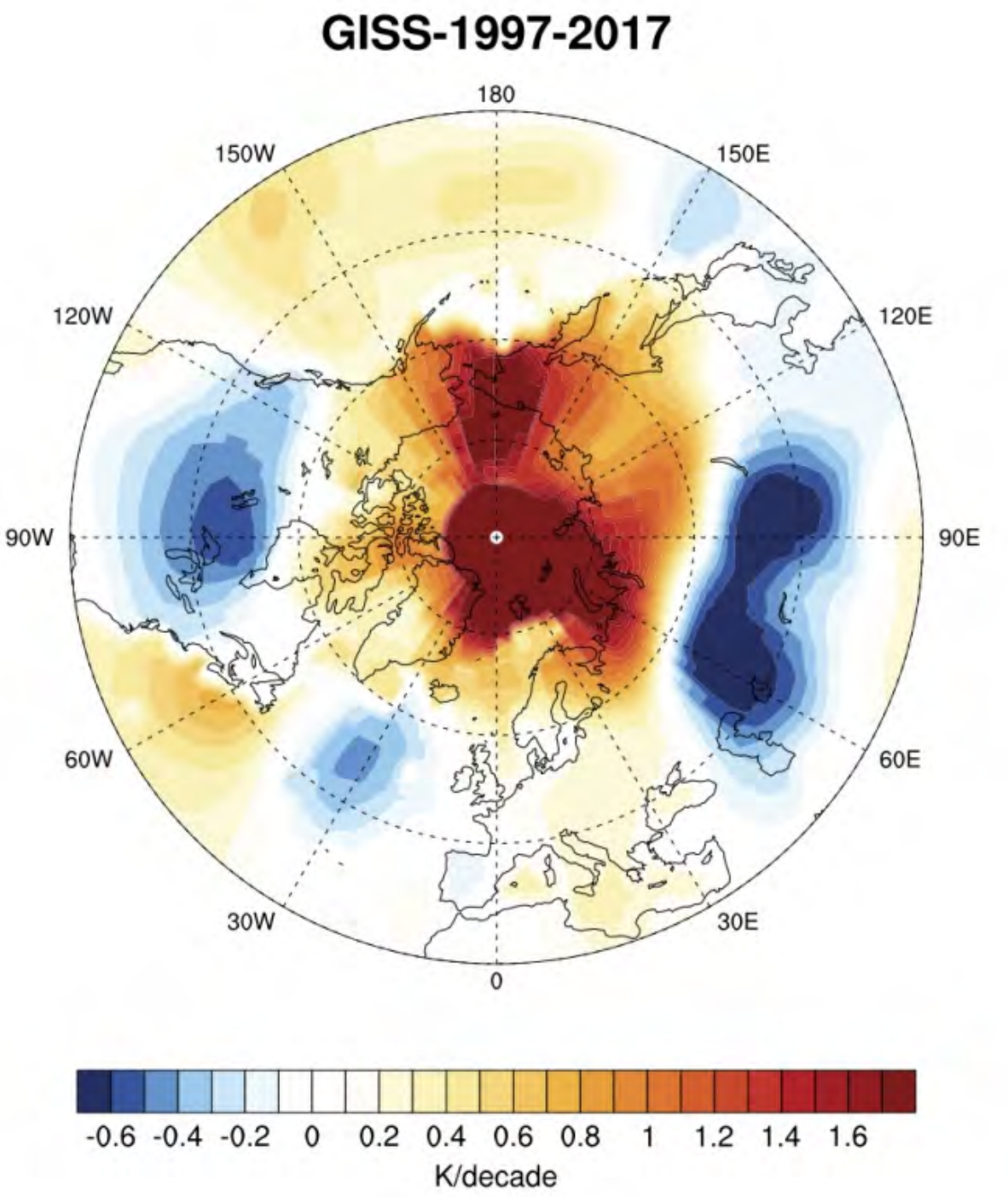

Figure 2. Linear trend of winter (December–January–February) seasonal mean surface temperatures over the Northern Hemisphere mid- and high-latitudes from 1997–2017. Arctic warming is amplified but cooling occurs in the North American and Eurasian mid-latitudes. The data used for this analysis is from the Goddard Institute for Space Studies (GISS) Surface Temperature Analysis (GISTEMP; GISTEMP Team, 2018). Figure courtesy of Xiangdong Zhang and Liran Peng.

To understand where consensus has been reached and discrepancies continuously exist, we recently participated in a collaborative effort with international groups to synthesize the results from the latest modeling experiments, especially those from the recent fully coupled[2] climate modeling experiments (Screen et al. 2018). The fully coupled climate models unanimously show an Arctic warming amplification and Arctic-mid-latitude linkage in response to Arctic sea ice loss, though there are large diversities in

atmosphere-only models. The changes in Northern Hemisphere and Arctic sea level pressure or the surface atmospheric circulation/wind pattern resemble the negative phase of the Arctic Rapid change Pattern (ARP; Zhang et al. 2008), which is characterized by an intensified Siberian High and Aleutian Low and plays a driving role in amplification of Arctic warming and acceleration in sea ice decrease.

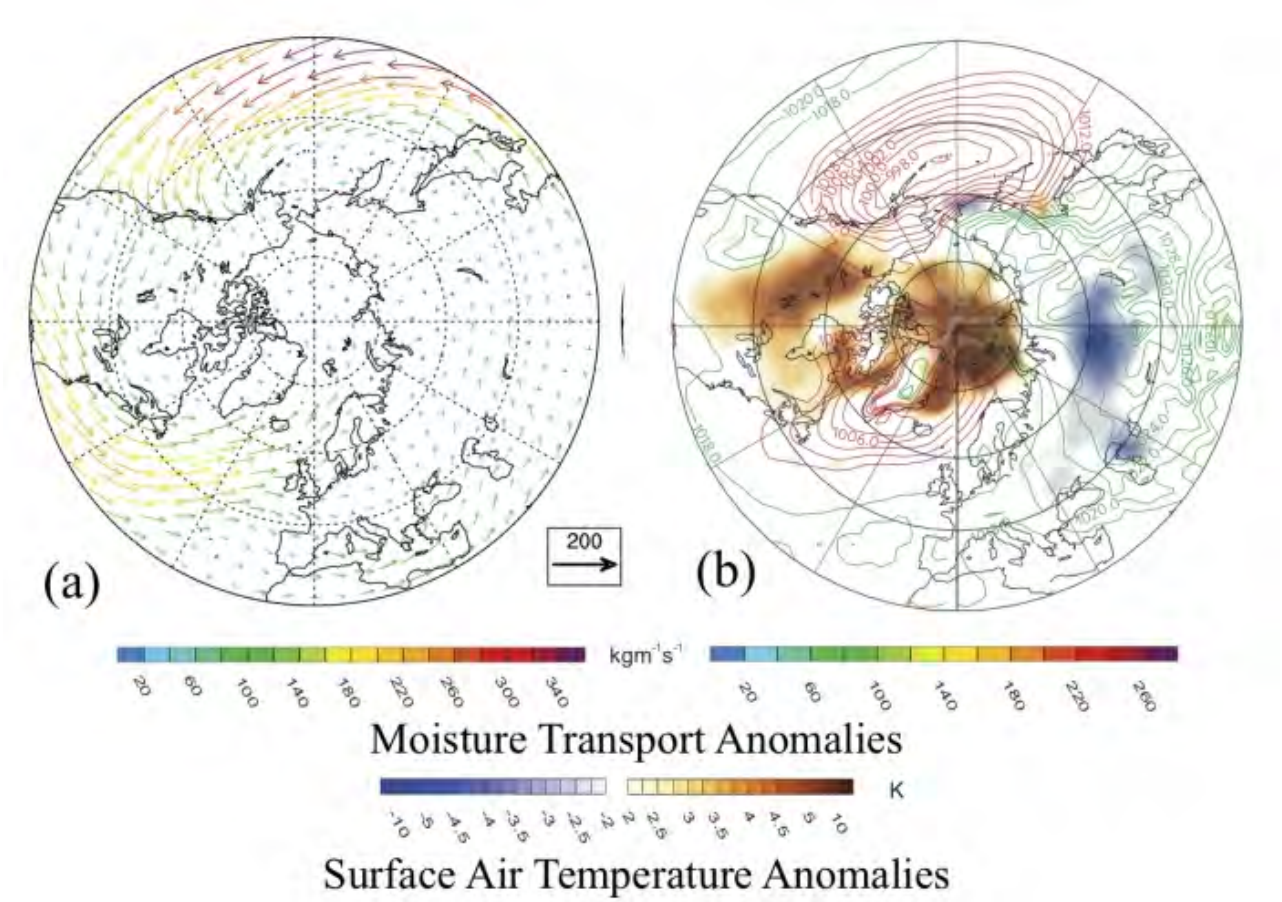

Figure 3. (a) Atmospheric moisture transport (color arrows) associated with a shifted atmospheric circulation pattern (and (b) corresponding surface air temperature anomalies (red and blue color shadings) and sea level pressures (red and green contours). Changes in the atmospheric circulation enhance moisture transport into the Arctic Ocean, contributing to an increase in surface air temperature (adapted from Zhang et al. 2013). Image courtesy of Xiangdong Zhang.

The improvement in Arctic SAT representation highlighted above (Huang et al. 2017) further indicates the importance to continue and enhance current efforts to improve the spatial and temporal coverage of Arctic observations and reduce observational and data processing biases. Improved observations are not only crucial for monitoring, assessing, and predicting/projecting Arctic regional climate change, but also global climate change, for example the Arctic-mid-latitude linkages.

Although the recent synthesis, based on the existing fully coupled modeling experiments, exhibits consistency in atmospheric circulation response to sea ice loss (Screen et al. 2018), discrepancies still exist, including signs, strength, and patterns of the simulated temperature anomalies across the models. In particular, physical mechanisms causing the spatially shifted atmospheric circulation structure still remains unknown, though this shift has been identified previously (Zhang et al. 2008) and simulated by the latest fully coupled models. The U.S. CLIVAR Arctic–mid-latitude working group has proposed coordinated

modeling experiments, the Polar Amplification Model Intercomparison Project (PAMIP; a U.S. CLIVAR White Paper by Cohen et al. 2018; Smith et al. 2018), which would be an excellent venue to address the need for further study.

For more information about this work, please see "Recently amplified arctic warming has contributed to a continual global warming trend" (https://www.nature.com/articles/s41558-017-0009-5) and "Consistency and discrepancy in the atmospheric response to Arctic sea-ice loss across climate models" (https://www.nature.com/articles/s41561-018-0059-y).

Author Bio

Xiangdong Zhang is a professor at the International Arctic Research Center and the Department of Atmospheric Sciences, University of Alaska Fairbanks. His research interests include weather and climate extremes in the present and projected future climate, Arctic-lower latitude interactions, Arctic freshwater and sea ice and their roles in global climate, and development of climate model and improvement of physical treatments.

Footnotes

[1] Editor's Note: Coupling of the troposphere-stratosphere refers to interaction between the troposphere from the earth's surface to about 3.7–6.2 miles (6–10 km) and the stratosphere just above the troposphere.

[2] Editor's Note: Coupling of refers to communication and interchange of information between models.

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IARPC Seeks Public Comment on the Revised Principles for Conducting Research in the Arctic

By: Renee D. Crain, Arctic Research Support & Logistics Program Manager, Office of Polar Programs, National Science Foundation and Roberto Delgado, Arctic Observing Network Program Director, Office of Polar Programs, National Science Foundation and edited by Jessica Rohde, Web Manager/Communications Officer at IARPC

The Interagency Arctic Research Policy Committee (IARPC) is seeking comment from the public on the newly revised Principles for Conducting Research in the Arctic.

History of the Principles for Conducting Research in the Arctic

In 1990, IARPC developed the Principles for the Conduct of Research in the Arctic (1990) (https://www.nsf.gov/geo/opp/arctic/conduct.jsp) to provide guidance for researchers in the physical, biological, behavioral, health, economic, political, and social sciences and the humanities. The Social Science Task Force of IARPC prepared the document with approval by IARPC on 28 June 1990, and published by IARPC in volume 9, (Spring, 1995, pp.56-57) of the journal "Arctic Research of the United States" (https://www.arctic.gov/publications/related/arotus.html).

The National Oceanic and Atmospheric Administration's (NOAA) Barrow Observatory in Utqiagvik is one of several research facilities used by federal agencies in Alaska's Arctic. The Interagency Arctic Research Policy Committee is working on revised guidelines for those agencies. Photo courtesy of NOAA.

The Process of Revising the Principles

The Principles Revision Working Group undertook a year-long process to update the 1990 version to reflect approaches to collaboration and to be applicable across scientific disciplines. The process included a comprehensive literature review and seeking and receiving diverse input from Alaska Natives, Federal, State, and local agency representatives, and researchers by a variety of methods, including listening sessions at scientific conferences, through a Federal Register Notice, and targeted interviews with Alaska residents and researchers. The revised draft version is now available for comment and has been renamed Principles for Conducting Research in the Arctic (https://www.iarpccollaborations.org/principles.html), hereafter referred to as the "Principles". The audience for the Principles includes federally-funded researchers and may be useful to academic, federal, state, local, tribal researchers, and other entities conducting research in the Arctic. The Principles will be finalized for approval of the IARPC agencies in fall 2018. The revised Principles are intended to be a deliverable at the Arctic Science Ministerial 2 and to contribute to the discussion in that forum on the ethical conduct of research in the Arctic.

How to Comment on the Principles

IARPC is interested in all comments on the updated Principles document

(https://www.iarpccollaborations.org/uploads/cms/documents/draft_principles_for_frn_review_july_2018.pdf), including the core principles and approaches that researchers are encouraged to adopt across all stages of research. The core Principles for Conducting Research in the Arctic are:

- Be Accountable,
- Establish Effective Two-way Communication,
- Respect Local Culture and Knowledge ,
- Build and Sustain Relationships, and
- Pursue Responsible Environmental Stewardship

Public comments are due by 4 September 2018.

Please submit comments in one of the following ways:

- Submit a comment via email to iarpcprinciples@nsf.gov,
- Submit a comment on the IARPC Facebook page (https://www.facebook.com/iarpccollaborations),
- Comment through the Federal Register (https://www.federalregister.gov/documents/2018/07/11/2018-14802/request-for-feedback-on-the-interagency-arctic-research-policy-committees-draft-principles-for), or
- Contact the working group chairpersons Renee Crain (rcrain@nsf.gov) or Roberto Delgado (robdelga@nsf.gov).

What is IARPC?

The IARPC consists of principals from 14 agencies, departments, and offices across the U.S. Federal government and is charged with enhancing both the scientific monitoring of and research on local, regional, and global environmental issues in the Arctic.

In order to connect Federal government and non-Federal government researchers and other stakeholders, IARPC created an open, collaborative platform known as IARPC Collaborations. Open to anyone who can contribute, IARPC Collaborations has realized an unprecedented degree of interagency communication, coordination, and collaboration that has advanced Arctic science. The web platform includes the participation of over 1800 members of the Arctic research community, including those from State, academic, non-governmental, industry, Indigenous, and international organizations. The nine Collaboration Teams meet approximately monthly via teleconference to advance research priorities. Please join the dialog by requesting an account at www.iarpccollaborations.org (http://www.iarpccollaborations.org/).

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Lively Panel Discussion on Perspectives of Women in Polar Research at POLAR2018

By: Sandy Starkweather, Executive Director of the U.S. Arctic Observing Network

An international panel discussion, "From Entering the Field to Taking the Helm, Perspectives of Women in Polar Research," convened during June 2018 in coordination with the POLAR2018 conference held in in Davos, Switzerland. Panelists explored the accomplishments, challenges, quality of work experiences, insights, recommendations, and prospects for women in polar research. The event was organized by Sandy Starkweather (U.S. National Oceanic and Atmospheric Administration), Renuka Badhe (European Polar Board), Sara Bowden (Interagency Arctic Research Policy Committee), and Allen Pope (International Arctic Science Committee).

Registration for the "Taking the Helm" panel discussion with more than 300 participants, representing 32 countries. Photo courtesy of Stephen Curtain.

More than 300 participants representing 32 countries engaged in a vibrant, interactive dialog with the panelists: Susan Barr, International Arctic Science Committee (IASC); HongKum Lee, Korean Polar Research Institute (KOPRI); Chandy Nath, Scientific Committee on Antarctic Research (SCAR); Morgan Seag, Cambridge University; and Colleen Strawhacker, National Snow & Ice Data Center (NSIDC). The discussion was initiated with interview questions formulated by the event moderator Hannah Hoag, independent journalist. An estimated half of all participants were early career scientist; more than 200 participants agreed to be contacted related to a community culture survey (See recommendations).

Discussion panelist HongKum Lee, KOPRI (on left) responds to a question from the audience. Photo courtesy of Stephen Curtain.

The five panelists contributed with insight and humor into their feelings of accomplishment, their perceptions of the challenges of engaging in polar research as women, and their joy in and deep appreciation for this type of work. Audience questions honed in on and amplified those sentiments of the panelists focused on barriers and challenges. Multiple audience comments focused on the low numbers of men present in the audience, who accounted for about 5% of the participants.

The event generated a strong response across social media platforms, where hundreds participated in the virtual conversation following the hashtag #PolarWomen2018, eventually reaching a Twitter audience of more than 800,000. The additional perspectives of women featured on the Women in Polar Science Instagram feed (@polarwomen)—40 profiles and growing—further enriches our understanding of the plurality of experiences, potentials, and aspirations of a generation of women poised to impact the world.

Some specific recommendations that the event has generated include:

- Future polar "Diversity and Inclusion" efforts should explore formats that will inspire more balanced participation;
- Continue to develop social media platforms and encourage more Arctic engagement in the Women in Polar Science network (a well-established group, founded by Antarctic scientists);
- Explore the role that a community climate survey could play;
- Consider ways to better integrate inclusivity dialogues into polar meeting programs, encouraging all attendees to participate, and to develop and enforce codes of conduct for polar organizations; and
- Support and encourage efforts like the Forum of Arctic Research Operators and the Council of Managers of National Antarctic Programs to play a role in preventing and responding to sexual

harassment in polar field settings.

Event organizers recognize that the innovations required for the next generation of polar research questions surpass the bounds of the physical, chemical, or biological sciences alone. Future challenges will require systems thinking, inclusive collaboration, and the dismantling of socially enmeshed barriers to progress. Improving awareness and equity within our own community is an excellent way to prepare a generation of scientists to meet the challenges posed by rapid ecological change, the complexities of the much-needed interdisciplinary work, and the paradigmatic shift towards knowledge co-production.

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2018 Anchorage Arctic Research Day Fosters New Connections

By: Betsy Turner-Bogren, ARCUS Project Manager

The 2018 Anchorage Arctic Research Day was held at the Anchorage Museum in late April as part of the 2018 North by North Festival. This event, organized by ARCUS, the University of Alaska Anchorage, the Anchorage Museum, and the Institute of the North; brought together members of the Anchorage-area Arctic research community to share information about the diverse research and creative activity being conducted by a broad array of organizations, and to foster new connections and collaborations.

Participants at the 2018 Anchorage Arctic Research Day and North by North Festival network during the evening reception in the Anchorage Museum. Photo courtesy of Institute of the North.

The event was attended by over 100 participants from government, corporate, academic, not-for-profit, and Indigenous groups. The morning session was opened by Anchorage Mayor Ethan Berkowitz who issued a call for more direct communication between the research community and policy-makers. University of Alaska Anchorage Chancellor Sam Gingerich opened the afternoon session with observations on Anchorage's contributions to Arctic research.

TED-style presentations offered fast-paced reports by leading researchers across the natural and social

sciences, health, engineering, humanities, the arts, and governance. Synopses of broader Arctic research program and activities were provided by leaders from several Alaska- and Arctic- focused programs. Operational and user needs for Arctic research were explored in a panel discussion organized by Arctic Domain Awareness Center, Executive Director Randy "Church" Kee. The future of Arctic Research was addressed during an interactive dialogue, moderated by Fran Ulmer, Chair of the U.S. Arctic Research Commission.

The day also featured a range of activities to encourage networking, including a research "speed dating" session and robust roundtable discussions to encourage collaborations across the boundaries of discipline, organization, and sector.

The full agenda for the event is available on the North by North website (https://nxnfestival.com/program/arctic-research/aard-program)

For questions, contact Betsy Turner-Bogren, ARCUS (betsy@arcus.org)

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Update from the U. S. Arctic Research Commission

By: John Farrell, Executive Director, U.S. Arctic Research Commission

Commission meeting. The 110th public meeting of the USARC will be held 5-7 September in northwestern Alaska. Input from this meeting will help inform the USARC's recommendations to the President and Congress on Arctic research. Commissioners, staff, and invited guests will meet publicly in the Northwest Arctic Borough Assembly chambers in Kotzebue on 5 September. The day-long gathering will start with a semi-structured discussion with local residents directly involved in research. This will be followed by in-depth presentations on the topics of health and community wellness, infrastructure and adaptation, and on scientific research projects currently being conducted in the region. A detailed agenda, including speakers and topics, is available on the USARC website (https://www.arctic.gov/upcoming_meetings.html). On 6 September, the Commission will visit the villages of Selawik (population ~830) and Buckland (population ~430) to compare and contrast the water and sanitation services and related infrastructure. The USARC encourages applied research on these topics and helps facilitate the [Alaska Rural Water and Sanitation Working Group]
(https://www.arctic.gov/water-san/index.html) that is advancing research to maximize the health benefits of in-home running water and sanitation services in rural Alaska. On 7 September, to better understand the importance of research associated with natural resources, the Commission will conduct a site visit to the Red Dog Mine, the world's second largest source of zinc ore.

Production facilities at the Red Dog Mine located in northwestern Alaska, in the Western Brooks Range, approximately 82 miles north of Kotzebue and 46 miles inland from the coast of the Chukchi Sea, on land owned by NANA Regional Corporation. Photo courtesy of John Farrell.

Second Arctic Science Ministerial. Given the success of the inaugural [Arctic Science Ministerial] (https://www.arctic.gov/publications/other/supporting_arctic_science.html, organized and hosted by the United States in September 2016, at the White House, a second ministerial has been scheduled for 26 October 2018, in Berlin, Germany. The organizers of this effort are the European Union, Germany, and Finland. The ministerial will be preceded on the 25th by an Arctic Science Forum that will involve 10-12 scientists from each participating country, as well as five representatives from each of six Indigenous peoples groups, and one representative each from about 10 other international organizations. The ministerial will have three themes: (1) Strengthening, integrating and sustaining Arctic observations, facilitating access to Arctic data and sharing Arctic research infrastructure; (2) Understanding regional and global dynamics of Arctic change; and (3) Assessing vulnerability and building resilience of Arctic environments and societies. The US delegation to the ministerial will be headed by Dr. France Cordova, the NSF Director. She will be joined by Dr. Tim Gallaudet, Acting Administrator of NOAA, and the Honorable Fran Ulmer, Chair of the USARC. As with the first ministerial, the main outcome from the second ministerial will be a "Joint Statement of Ministers," the drafting of which has been in progress for months.

Inaugural Arctic Science Ministerial meetings in 2016 convened in the Indian Treaty Room of the White House Eisenhower Executive Office Building in Washington D.C. Seated top from the left is NSF Director France A. Cordova (white); John Holdren, Director of the White House Office of Science and Technology Policy under President Obama; Fran Ulmer, Chair of the U.S. Arctic Research Commission; and Mark Brzezinski, Makena Capital, LLC. Photo courtesy of John Farrell.

USARC's "Report on the Goals and Objectives for Arctic Research 2019-2020." As required by law (the Arctic Research and Policy Act of 1984), one of USARC's primary duties is a biennial report to the President and Congress. The Commission will release this report in January 2019. The content of the report is collected from public meetings, and sought from scientific researchers, policymakers, and the general public in Alaska, throughout the United States, and in a growing number of nations with Arctic interests. The report will contain five major goals: (1) Observe, understand, and forecast environmental change; (2) Community health and wellbeing; (3) Advance Arctic infrastructure; (4) Assess Arctic natural resources; and (5) "Enhance international scientific cooperation in the Arctic. The report will refer to White House guidance on science and technology (specifically the fiscal year 2019 and 2020 "Administration Research and Development Budget Priorities" here: https://www.whitehouse.gov/ostp/documents-and-reports/), strengthen links to the 2017-2021 Interagency Arctic Research Policy Committee Arctic Research Plan (here: https://www.iarpccollaborations.org/plan/index.html), and will identify emerging topics in Arctic research.

John Farrell is the Executive Director of the U.S. Arctic Research Commission, an independent federal agency of Presidential appointees that advises the White House and Congress on Arctic research matters and works with executive branch agencies to establish and execute a national Arctic research plan. The Commission also facilitates cooperation with local and state governments and recommends means for developing international scientific cooperation in the Arctic.

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Welcoming Arctic Indigenous Scholarship to Washington, DC

By: Robert H. Rich, Ph.D., CAE, Executive Director, ARCUS

There are significant gaps in communication, culture, connections, knowledge systems, and (of course) distance between remote Arctic villages and the U.S. capital in Washington, D.C. Through our work in the Arctic, we have encountered many outstanding scholars who often go unheard in the centers of power, with information to share and stories to tell.

To begin to bridge those gaps and to support Arctic Indigenous scholarship in informing policy and decision-making, ARCUS and the Inuit Circumpolar Council-Alaska this year partnered to organize a pilot program "Empowering Arctic Indigenous Scholarship and Making Connections." We convened a distinguished selection committee of Arctic Indigenous experts and leaders, policy-makers, and researchers to select two outstanding scholars from among the many applications we received. We then worked with the scholars to plan meetings and activities that would support their priorities during a five-day trip to our nation's capital. For the purpose of this program, we define scholarship as a person who is an expert within their own knowledge system. No formal education is required.

In this article, I'd like to share some personal reflections on the visits, of which I was privileged to be a part. The two scholars are inspiring and articulate observers and communicators of the Arctic as experienced by their communities.

Dr. Rosemary Ahtuanguarak is a community health aide from Nuiqsut, who has held a variety of local leadership positions and is an advocate of community rights in light of the oil development occurring in close proximity to her village. She speaks of dramatic health effects and impacts on subsistence activities that she has seen throughout her community, many of which correlate with emissions, pollution, and development. Located in the central North Slope, Nuiqsut is close to the center of current development projects, including Alpine and Greater Moose's Tooth 1 and 2.

Dr. Theresa Arevgaq John is an Associate Professor at the University of Alaska, Fairbanks with strong roots in her village of Toksook Bay on Nelson Island in Southwest Alaska. She has seen her community stressed by climate change, including recent deaths of two youths traveling on the ice, and the suicide of two others. She bears witness to the haul-out of thousands of walrus on her island this summer, driven by declining sea ice in the region. She speaks of how this behavior is highly unusual, unknown to elders in

any past experience, and how it is having devastating effects on subsistence.

The visit to D.C. was planned for 22 - 26 May 2018 on the ground here, with about a day's travel from both remote communities before and after. As often happens with Arctic travel, Rosemary's flights were cancelled and delayed due to weather (in both directions), causing her to be in the air during the time of our planned webinar/seminar featuring them both. As it was, Theresa did a magnificent job presenting at the seminar held in the ARCUS D.C. Office, which was attended by officials from IARPC, other stakeholders, and decision-makers, as well as people from around world by webinar. The recording is available on our website (https://www.arcus.org/research-seminar-series/archive). We expect to schedule a future webinar featuring Rosemary.

Theresa and I met with program officers from the National Science Foundation in Polar Programs, who are very supportive of Arctic Indigenous scholarship. They had great ideas to further enhance their impact and make connections. We also met with officials from the Environmental Protection Agency, who engaged in productive discussions around better tying community environment needs in Indigenous villages with scholarship and research.

Rosemary arrived later that night, and we began the second day of the visit at the U.S. State Department, whose Office of Ocean and Polar Affairs was interested in thinking about the international implications of the Scholars' work. At the Smithsonian Museum's Arctic Studies Center, all of the scholars there had a vibrant interaction around the Scholars' stories, and how they can be connected with the Museum's activities that engage local expert knowledge, both in D.C. and in Anchorage. The Scholars were met by a very warm welcome by Senator Lisa Murkowski (R-AK) and many of her staff up on Capitol Hill. She agreed to help with and look into several of their concerns, and introductions were made to relevant Senate committee staff as well. I took the attached picture of the Scholars with the Senator.

Scholars, Rosemary Ahtuanguarak (left) and Theresa Arevgaq John (right) meeting with Senator Lisa Murkowksi in her office. Photo courtesy of Robert Rich.

On the third day, we traveled out to Bethesda, Maryland, to visit with leaders from the National Institute of Environmental Health Sciences. Further possibilities for scholarship and communication about local environmental health issues were discussed. A highlight of the visit was the warm welcome that the Scholars received from the Office of the Secretary of the U.S. Department of the Interior, who hosted a private seminar for Department officials, held several private meetings with key officials, and basically introduced the Scholars to all the available senior people in the building. We even got to tour the office of the Secretary of the Interior.

Scholarsm Rosemary Ahtuanguarak (left) and Theresa Arevgaq John (right) at Secretary of Interior's private balcony. Photo courtesy of Robert Rich.

As I reflect on the visit of the pilot pair of scholars, I'm very thankful that we could use the network of ARCUS and our partners to empower these impressive and passionate Scholars and to help to open the doors that allow them to make connections and develop relationships with decision-makers here. We learned a few things along the way to help with the next round of Scholars' visits, which we hope to announce later this year. Flexibility was certainly key, as the travel delays created some unforeseen hiccups. Overall, I am more convinced than before that scholarship being done by Arctic Indigenous people needs more visibility, the resources to be made available, and champions to strengthen their connections. The Scholars made a significant contribution to knowledge and awareness of the Arctic research and D.C. policy communities, from the attendees on the webinar to the inner reaches of the Department of the Interior to Capitol Hill. We are all better off for their having made the trip.

This program was made possible by generous financial support from the National Science Foundation Office of Polar Programs, and I want to thank Carolina Behe from the Inuit Circumpolar Council-Alaska, our selection committee volunteers, the many officials who opened their doors to the visiting Scholars. Particular thanks go to ARCUS colleagues Lisa Sheffield-Guy and Asma Shethwala, for their tireless efforts to make the visits happen.

Welcome New ARCUS Members (Since December 2017)

Canadian Studies Center at Michigan State University

Plus nine new individual members!

ARCUS Membership Information (https://www.arcus.org/arcus/member-information)

ARCUS - Responsive to Changes in the Arctic Research Environment

ARCUS was well represented at the POLAR2018 conference last June that convened Davos, Switzerland. I attended along with ARCUS Executive Director Bob Rich, Education Program Manager Janet Warburton, and Community Development Manager Alex Thornton. ARCUS board members Diane Hirshberg, Howie Epstein, Carolina Behe, Maribeth Murray, John Farrell, and Mark Ivey were also in attendance. POLAR2018 was a joint open science meeting of the Scientific Committee on Antarctic Research (SCAR) and the International Arctic Science Committee (IASC). SCAR and IASC are also hosted their regular business meetings during this time, and the 2018 Arctic Science Summit Week and the 2018 Arctic Observing Summit were held before and after the main meeting. In short, there were a huge number of people interested in polar science that came together in Davos, Switzerland last June.

In my mind, this conference mirrors what is currently happening in the Arctic research community in general: we are seeing more people interested in collaborating to understand what is changing in the Arctic, from melting glaciers and new wildlife migration patterns to altered social dynamics in communities and increased acceptance of and reliance on co-produced knowledge. At the same time, there are changes in the political and funding climates within the U.S. — as well as in the public's view of science. Some of these trends are alarming, but others are very positive. At ARCUS, we do our best to stay on top of these trends as part of our mission to connect and support the Arctic research community.

ARCUS held an all-hands retreat in Anchorage for our board and staff in April of this year. Following that retreat, we worked to revamp our strategic plan to better reflect what ARCUS excels at doing for the research community: networking, communication, education, research support, and as an overarching priority, advocating for the inclusion of Indigenous peoples and perspectives in all aspects of Arctic research, education, and policy. We will ultimately be asking the research community to help us refine these priority goals into specific activities we should pursue in order to achieve our mission, so expect to hear from us as we work to keep ARCUS responsive to the changes we see in the overall Arctic research

environment writ large.

Thank you for being a part of this community and for your support of ARCUS as we work to support you. And as always, don't hesitate to let us know how we can help accomplish your Arctic research and education related goals!

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Meet the Board of Directors - Charlene Stern

Charlene Stern is an ARCUS Board Member elected in 2017. Her term expires in 2020.

Charlene Stern is an Assistant Professor in the Department of Alaska Native Studies and Rural Development at the University of Alaska Fairbanks. Her doctoral research focused on the Neets'ąįį Gwich'in, whose traditional territory is located in the northeastern interior of Alaska, and their experiences with planning and development in a pre and post-settlement context.

Originally from Arctic Village, Alaska, Charlene is an enrolled member of the Native Village of Venetie Tribal Government. As an Indigenous researcher, she is passionate about changing the paradigm of Arctic research to be more responsive to the needs of Indigenous communities. Charlene is a staunch advocate of Indigenous self-determination and believes in the right of local communities to meaningfully engage in research that is relevant to their citizens as well as the lands and resources upon which they depend.

She joined the board of ARCUS in 2018 in order to contribute to the organization's ongoing work within the Arctic research community. As a well-established consortium, Charlene believes that ARCUS has an opportunity to become a leader in helping to elevate the voices of Indigenous peoples in research.

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Meet the Board of Directors - Diane Hirshberg

Diane Hirshberg is an ARCUS Board Member and Chair of the Development Committee. She was elected in 2017, and her term expires in 2020.

When not working on ARCUS activities, Diane is Professor of Education Policy at the Institute of Social and Economic Research at the University of Alaska Anchorage (UAA), and Advisor to the UAA Chancellor on Arctic Research and Education. Diane sits on the International Arctic Social Sciences Association Council and is active with the UArctic Thematic Network on Teacher Education for Social Justice and Diversity. Her research interests include education policy analysis, Indigenous education, circumpolar education issues, and the role of education in sustainable development. She has studied the boarding school experiences of Alaska Native students, teacher supply, demand and turnover, and co-authored the Education chapter for the Arctic Human Development Report II. In addition to working on Alaska-focused education evaluations and studies, she is the North America lead for the Arctic Youth - Sustainable Futures project, funded by the Nordic Council of Ministers. She was part of the UArctic Research Analytics Task Force, helping author several publications on the landscape of Arctic research funding and publications.

Diane first realized that her work fit under the Arctic research umbrella when she attended the International Conference on Arctic Research Planning II (ICARP II) in 2004. She also learned (much to her frustration) of the narrow view of education research many Arctic researchers hold, that Arctic education is simply about disseminating their findings to students. Through the International Arctic Social Sciences Association, however, she found a community of researchers who shared her view of the importance of education, not just as a vehicle for disseminating research findings, but as a crucial element in building the capacity of communities to create their own futures in the face of rapid social, economic, cultural, and environmental change. Her research agenda is now shifting toward understanding how both institutional and non-institutional education systems can support sustainable development in the Arctic, as well as how the needs of Arctic youth can best be met.

Diane is excited by the work ARCUS does to connect researchers across sectors, disciplines, and geographies. She helped ARCUS organize the first two Anchorage Arctic Research Days, and believes that such events, focused on building relationships among researchers from academic, government, Indigenous, private, and non-profit entities, strengthens the ability of the research community to do good work while avoiding some of the problems that arise when we stay siloed in our work. Moreover, she views ARCUS' goal of connecting Alaska's Arctic communities and Arctic researchers as crucial to ensuring that Arctic research addresses in relevant and meaningful ways the challenges facing Arctic communities.

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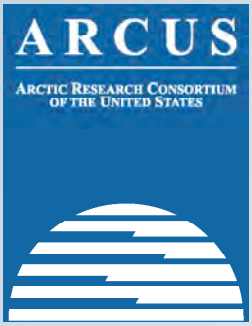

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