FEATURES

DIRECTORS' MESSAGE

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Record warmth. The last reporting period for the AK CSC (2015) saw Alaska set a new record for its warmest year ever, surpassing even the previous record warmth of 2014. This warm trend continued into 2016 — with this year ultimately besting the short-lived 2015 record. These climatic changes and their impacts provided a dramatic backdrop for a time in which the AK CSC demonstrated its maturation with several significant outcomes and milestones accomplished.

New products & support. In this issue, you'll learn about our continued efforts to provide downscaled climate information and products as well as new applications of the Alaska Integrated Ecosystem Model. These keystone research activities now support scientific efforts throughout Alaska, and inform decision making at local, regional, and international levels. Producing actionable science in a region that is warming so rapidly is critical for improving understanding of the links between climate and the ecosystems that define Alaska, as well as for making informed decisions about the natural resources that those landscapes provide.

Fellows Program. We continue to focus on training a new generation of scientists through our Fellows Program. These early career scientists are tackling challenging scientific issues and developing the leadership skills required to effectively manage our natural resources in an ever more complex social-ecological context. Here, we highlight some of their recent activities.

We hope you enjoy learning more about the AK CSC. We encourage you to visit us online or contact us directly to further discuss our research, education, and outreach activities.

AK CSC
Alaska Climate Science Center

ANNUAL REPORT 2016

In 2016, using 29 years of data from Landsat satellites, NASA researchers found extensive greening in the vegetation across Alaska and Canada. Rapidly increasing temperatures in the Arctic have led to longer growing seasons and changing soil for plants. (Cindy Starr/NASA Goddard Space Flight Center)

NORTHERN NOTES

AK CSC SCIENTIST RECEIVES INTERNATIONAL AWARD

John Walsh, AK CSC researcher and chief scientist at the International Arctic Research Center at the University of Alaska Fairbanks, received the **2016 International Arctic Science Committee (IASC) Medal.**

IASC awarded the prestigious medal to recognize Walsh's exceptional and sustained contributions to modeling and evaluating climate change impacts in the Arctic, and his outstanding record of service and leadership to the Arctic science, education, and policy community.

Walsh was awarded the IASC Medal in March 2016 during Arctic Science Summit Week, which was held in Fairbanks, AK.

PUBLICATIONS

AK CSC researchers published 60 peer-reviewed papers in 2016.

AK CSC DIRECTOR APPOINTED TO NATIONAL COMMITTEE

AK CSC University Director **Scott Rupp** was appointed to the **Advisory Committee on Climate Change and Natural Resource Management,** which advises the Secretary of the Interior on matters pertaining to the National Climate Change and Wildlife Science Center and CSCs. Rupp was appointed in April 2016.

Joanna Young. *(photo: Girls on Ice)*

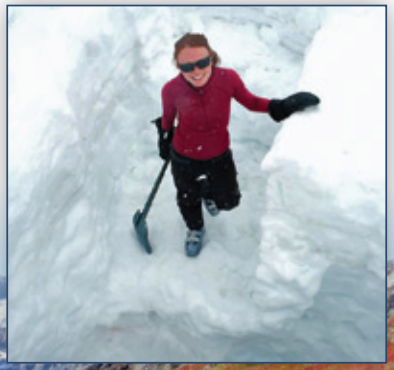
AK CSC graduate fellow selected to participate in expedition to Antarctica

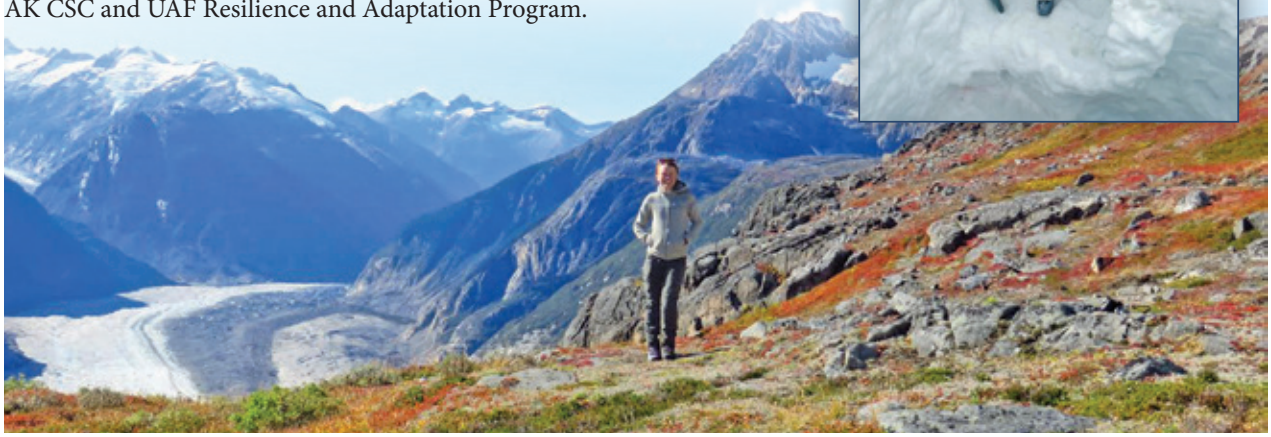
Seventy-eight women researchers are preparing to go where few have ventured. Among them, **Joanna Young,** a geophysics graduate fellow at AK CSC has been given the opportunity to participate in a Homeward Bound expedition to Antarctica. "I've always wanted to go," says Young, "to see an entire continent covered in ice is just amazing."

Young's research is dedicated to studying glaciers in the Juneau area. She is also a lead instructor for the AK CSC-sponsored Girls on Ice Alaska program, which leads high school girls on glacier expeditions to learn about climate change, mountaineering, and building confidence. The Homeward Bound expedition goes beyond addressing climate change. "The focus is less on science and more on leadership development," says Young. "There's a lack of women's voices at the leadership table."

Homeward Bound participants will spend three weeks working together to address female leadership in science, and building confidence to take on leadership roles in the science community themselves. These women will also be given the chance to collaborate on complex Arctic concerns. Young says she will be learning about strategies for taking an idea and developing a plan to put that idea into effect.

Joanna Young's participation in this expedition was made possible by the AK CSC and UAF Resilience and Adaptation Program.





Meet Abraham Endalamaw

Since interactions between water and climate are major concerns for Alaska and the Arctic region, it was no surprise — though no less an adventure — for **Abraham Endalamaw's** project work to lead him to Alaska.

Endalamaw focuses on improving large-scale hydrological modeling. Within the complex hydrology of interior Alaska, he conceives a wide range of scientific methods for identifying which smaller features among the region's soil and vegetation to include and emphasize in larger-scale models.

The models that his discipline designs and employs must operate at a large scale in order to be effective and applicable. But to be accurate, they must also represent consequential small-scale factors like soil, vegetation, and permafrost.

To present a smaller and more specific portrait of how water flows and permafrost is distributed, Endalamaw created a unique series of direction-based data maps based on satellite topography. His work has been able to clearly show, for example, that permafrost zones experience greater watershed runoff than do other areas.

Currently, Endalamaw is focused on quantifying indirect impacts of climate change on hydrology such as potential changes to vegetation and permafrost distribution, and to assess how changes in land surface contribute to the hydrology of interior Alaska. He plans to finish his PhD in atmospheric science in 2017.

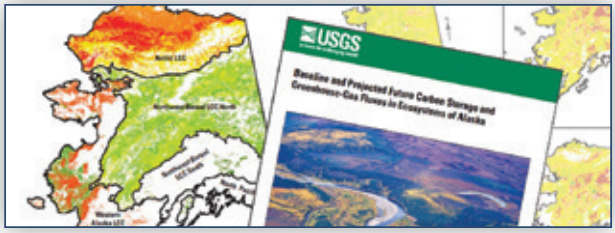
Featured publications from 2016

Bieniek PA, Bhatt US, Walsh JE, Rupp TS, Zhang J, Krieger JR, Lader RT. 2016. Dynamical downscaling of ERA-Interim temperature and precipitation for Alaska. J Appl Meteorol Clim 55:635–654. doi:10.1175/JAMC-D-15-0153.1.

Lara MF, Genet H, McGuire AD, Euskirchen ES, Zhang Y, Brown DRN, Jorgensen MT, Romanovsky VM, Breen A, Bolton WR. 2016. Thermokarst rates intensify due to climate change and forest fragmentation in an Alaskan boreal forest lowland. Global Change Biol 22:816-829. doi:10.1111/gcb.13124.

O'Neel S, Hood E, Bidlack A, Fleing S, Arimitsu M, Arendt A, Burgess E, Sergeant C, Beaudreau A, Timm K, Hayward G, Reynolds J, Pyare S. 2015. Icefield-to-ocean linkages across the northern Pacific coastal temperate rainforest ecosystem. Bioscience 65:499-512. doi:10.1093/biosci/biv027.

New report calculates Alaska's greenhouse gas potential



Historically, national assessments of carbon stock and greenhouse gas levels have not included Alaska because of its size, lack of roads and meager field data.

Scientists at the UAF, U.S. Geological Survey (USGS), and U.S. Forest Service assessed ecosystem carbon stocks and fluxes of Alaska ecosystems using the Integrated Ecosystem Model (IEM). The results will help inform national climate and carbon management policies.

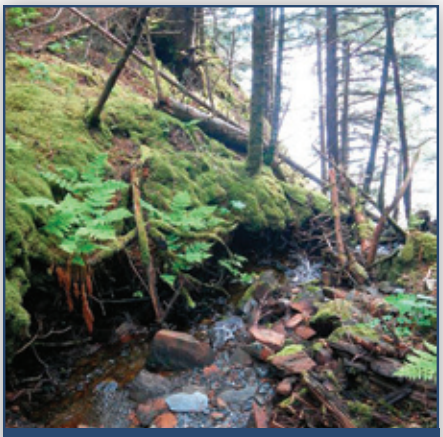
Currently Alaska's ecosystems capture as much carbon as they lose to the atmosphere. However, with rising temperatures, more wildfires, and thawing permafrost, Alaska could become a net source of carbon to the atmosphere. Should that happen, further increases in Earth's surface temperature could also occur, as the concentration of greenhouse gases increases and traps more of the sun's energy.

"The most important message is that Alaska, in general, has been a sink (reservoir) of greenhouse gases over the last 50 years," said **David McGuire,** lead researcher for the IEM project, scientist with the USGS and the UAF Institute of Arctic Biology, and affiliate scientist with AK CSC.

Ninety-one percent of Alaska's carbon is locked in frozen soils. Although the report found that Arctic plant growth is expected to store more carbon than is released from soils through 2100, scientists are concerned about how this carbon could be converted to greenhouse gases by warming temperatures, thawing permafrost, increasing wildfires, and changing streamflow.

Carbon released by more wildfires will partially counter plant absorption, especially in the boreal forests of Alaska's interior. With projected increases in temperature, wildfires and permafrost thaw, carbon releases beyond 2100 may be greater than those prior to 2100. "Models for permafrost thaw between 2100 and 2200 tend to show a great loss of carbon, and that may be the case for Alaska," said McGuire.

The distribution of plants in Alaska is also changing and will continue to change. "There will be quite a substantial shift from coniferous forest to deciduous forest," said co-author **Scott Rupp,** forest ecologist and AK CSC University Director. "And the tundra will continue to shift from grass to shrub."



Temperate rainforest near Kodiak.
(Photo: Brook Gamble)

Southeast Alaska Climate and Water Resources Workshop reveals answers … and new questions

Changes in climate are altering Alaska's landscapes, and the Tongass National Forest is no exception.

The Tongass National Forest is the largest national forest in the United States, spanning 17 million acres. This temperate rain forest is intertwined with lakes, rivers, and streams, home to a variety of freshwater and saltwater fish.

In April 2016, stakeholders, community leaders, and researchers gathered to discuss how hydrological changes in the Tongass National Forest could impact water and other natural resources in the region.

"All aspects of hydrology are going to be affected by climate change," says **Jeremy Littell,** research ecologist at USGS and lead research scientist at AK CSC.

For example, increasing air and water temperatures could result in a delay in ice formation, and earlier ice melt. Changes in the rate and timing of ice melt are significant, as higher inputs of freshwater could be flushed into the stream systems. This could alter water temperatures, water currents, and the availability of valuable nutrients for fish populations.

Subsistence was another key topic discussed at the workshop. The variety of fish in this region are used by many Southeast Alaskans as a primary food source. Research presented during the workshop revealed that certain species of fish, such as salmon, are migrating earlier due to changes in water conditions.

Participants also discussed the observed changes in the size of sockeye salmon. Littell explains that very little data exists for streams over a long period of time, for researchers to determine if these changes relate to climate change.

Through discussion, participants were able to identify and bridge some gaps in available data and information, brought together by researchers, land managers, locals, and other workshop attendees.

Toohey RC, Herman-Mercer NM, Schuster PF, Mutter EA, Koch JC. 2016. Multidecadal increases in the Yukon River Basin of chemical fluxes as indicators of changing flowpaths, groundwater, and permafrost. Geophys Res Lett 43:12120–12130. doi:10.1002/2016GL070817.

Zhu Z and McGuire AD, eds. 2016. Baseline and projected future carbon storage and greenhouse-gas fluxes in ecosystems of Alaska. US Geological Survey Professional Paper 1826. 196 p.

▲ Browse all publications at csc.alaska.edu/publications.

NORTHERN NOTES

"FROM ICEFIELD TO OCEAN" RECEIVES AWARD FOR EXTERNAL COMMUNICATIONS

AK CSC colleagues **Eran Hood, Shad O'Neel, and Kristin Timm** received the 2015 Eugene M. Shoemaker Communication Award for their poster "From Icefield to Ocean," which illustrates links between glaciers and the ocean.

The **Shoemaker Awards for External Communications** recognize USGS products that are extraordinarily effective in translating complex scientific concepts into words and pictures that capture public interest and imagination.

JANE WOLKEN,

a research fellow at the Scenarios Network for Alaska + Arctic Planning, now coordinates the AK CSC program.

PACIFIC ISLANDERS AND ALASKANS UNITE FOR CLIMATE SOLUTIONS

Six faculty, staff and students from AK CSC and the Alaska Center for Climate Assessment and Policy participated in the **2016 Island Sustainability Conference** held in April 2016 in Tumon, Guam.

The theme of the conference was *Islanded Communities*. Participants discussed shared challenges and opportunities related to high energy costs, acute climate impacts, and the urgent need for research, collaboration, and solutions.

Scientists build a foundation for climate adaptation in Alaska

Like the foundation of a house, the construction of a climate model is the product of thousands of small choices. Whether it's placing the nails and leveling the blocks, or determining which module to include or how to treat a model discrepancy, every decision is essential when you are building a complex base, stable enough to support something much bigger.

Led by scientists **John Walsh, Uma Bhatt,** and **Scott Rupp,** a team at the International Arctic Research Center and the Scenarios Network for Alaska and Arctic Planning has undertaken a three-year effort to create a model for better estimating climate and weather conditions across Alaska for the next 100 years.

This dynamically downscaled model takes climate and weather information available at a large scale and transforms it to a smaller scale. In this case, the team takes global climate model information for an area approximately 150 miles on one side and downscales it to an area about one-tenth that size. The downscaling process generates information useful for making decisions and adapting for impacts of climate change on a local or regional scale, especially in coastal or mountainous areas that are not modeled accurately by coarse global-scale models.

Big news for Alaska resource managers, planners, and decision-makers

This information will help them understand how changes to temperature, precipitation, and extreme weather events will affect the state's natural resources, wildlife, and infrastructure. Similar information has been readily available for other regions of the U.S. and the rest of the world for the past decade.

"The model provides the most locally relevant data for the state of Alaska," explained **Peter Bieniek,** a member of the project team and a research associate at IARC. "We have laid the groundwork. Now we can develop new products that meet specific stakeholder needs."

Joel Reynolds, the science coordinator for the Western Alaska Landscape Conservation Cooperative, is interested in the model's ability to estimate the frequency of rain on snow events in the future. "These events cannot be prevented," he said, "but this information can help wildlife managers and biologists understand how to manage wildlife populations if rain on snow events become more frequent in the future."

The National Park Service (NPS) is also excited about the new information. "We have 17 weather stations covering 19 million acres of NPS land in the northern part of the state," explained **Pam Sousanes,** a physical scientist for NPS. "That isn't adequate when you are trying to understand local ecosystem processes. Downscaling helps us understand whether what we are seeing at the weather stations is happening throughout the entire National Park or Preserve."

A process of collaboration, time, and resources

With so many potential needs and applications, why haven't these data already been produced for Alaska? Dynamical downscaling requires a more significant investment of time, expertise, and computational resources than statistically downscaled data — which SNAP has produced for Alaska for nearly a decade, but which is more limited in its forecasting ability.

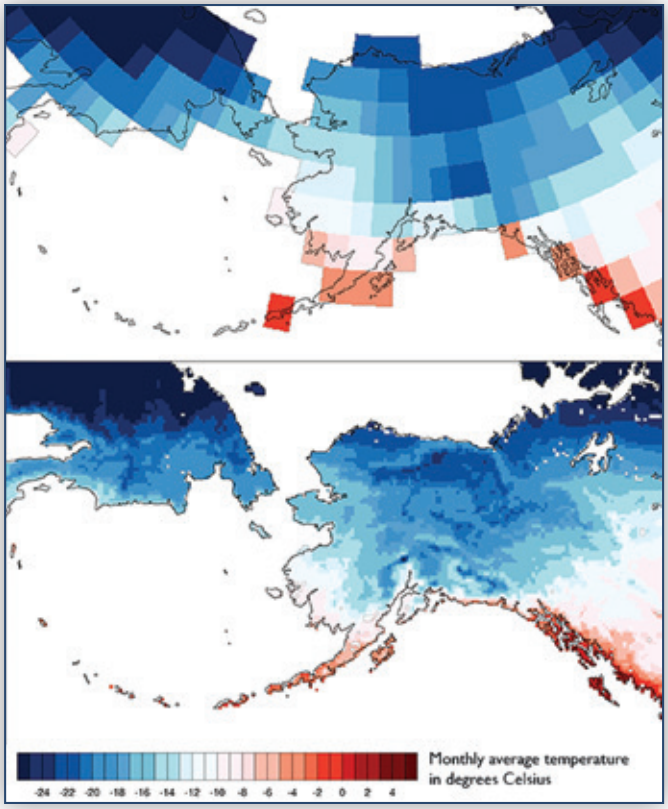
Before, during, and after the model runs, there is a lot of work to do. Producing modeled data for a 100-year period can take months on a supercomputer. The scientists must watch for errors and things that look abnormal and continually make adjustments to the model. "It's the ultimate mix of man and machine," explained Bieniek. "Human decision-making is a large part of the modeling process."

Weekly research team meetings often involve the team poring over maps and diagrams, discussing the latest model outputs for variables like precipitation amounts per day for 50 or 100 years in the future.

However, applying the model to a specific decision-making process also takes time. "This process is a marathon and not a sprint," explained Reynolds. "We're getting closer to being able to work through identifying the impacts on these species and harvest management, but we need to get the right people talking to each other to make this work."

Ongoing conversations are essential, as these different groups of people work together to identify suitable questions for the model and the data, to aid in decision-making. "You have to be able to bridge the realities of the model to the kind of information that the user can work with," Walsh said.

Building a dynamically downscaled climate model may have been a slow process for Alaska, but the effort is moving in the right direction. This work is a foundation upon which solutions to more challenging, real-world problems can be built, to address future climate change adaptation in Alaska.



Dynamically downscaled data (lower) captures realistic temperature patterns while the global model (upper) data is too coarse to use for villages or even cities in Alaska. In the global model, each square is about 150 miles on one side. In the dynamically downscaled data, each square is about 12 miles on one side. Dynamically downscaled data are produced at a scale that shows the fine differences in conditions from one location to the next.

Visit the Alaska Climate Science Center online at **csc.alaska.edu** or **nccwsc.usgs.gov/alaska-csc.**

The project described in this publication is supported by Grant/Cooperative Agreement Number GIOAC00588 from the United States Geological Survey.