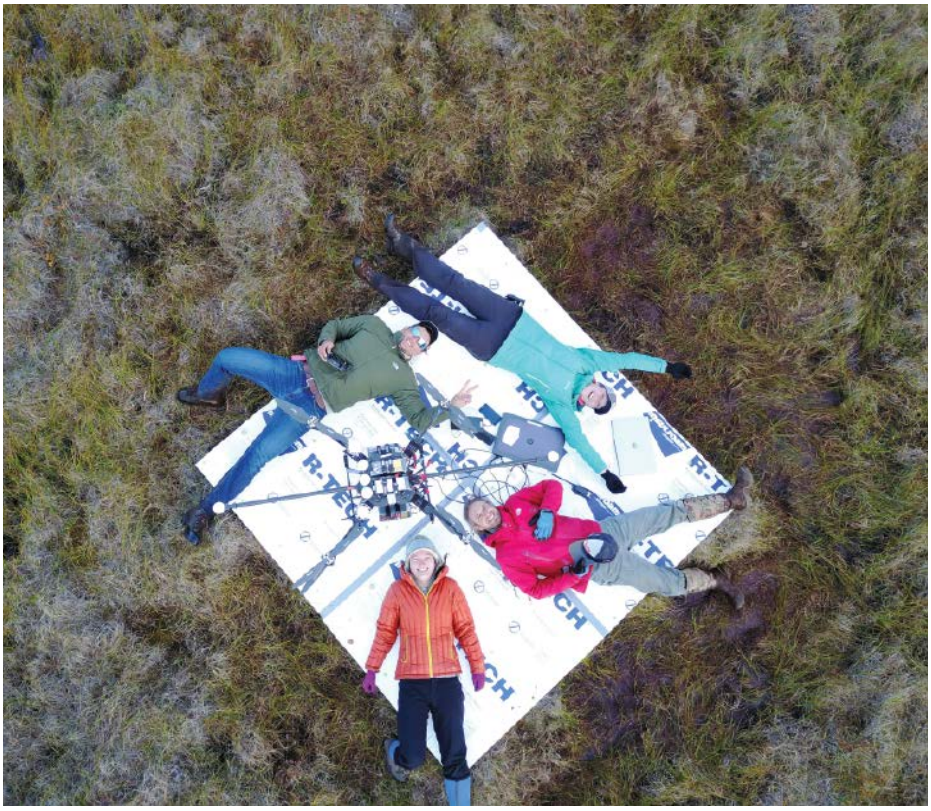
Building a Culture of Safety and Trust in Team Science



Members of the Next-Generation Ecosystem Experiments–Arctic (NGEE Arctic) aerial laser alti-meter team (Christian Andresen, Lauren Charsley-Groffman, Adam Collins, and Erika Swanson) take a break on a portable drone landing pad at a field site outside Nome, Alaska. Credit: Christian Andresen, University of Wisconsin–Madison

Some of the most scientifically exciting places are also some of the most difficult to study. The Arctic, for example, is rapidly changing, as evidenced by melting sea ice, thawing permafrost, disappearing glaciers, and greening hillslopes. Increasingly, scientists from around the world and across a wide spectrum of disciplines are working together to advance our understanding of this vulnerable and globally important biome.

As scientists become part of larger teams and join broader and more diverse scientific endeavors, they all must become leaders in creating cultures of safety, inclusion, and trust. Ideally, all participants on such teams, as well as local communities and other stakeholders, feel that their views, concerns, and efforts are acknowledged and respected. Such a culture facilitates the physical and emotional well-being of individuals on scientific teams and in the local communities where scientists work.

Here we share lessons learned from an "experiment within an experiment" begun as part of a large-scale, decade-long research project in Alaska. The experiment was focused on answering the question, How can we intentionally create a project-wide culture of safety, inclusion, and trust that facilitates strong cross-disciplinary collaboration and exciting scientific discoveries?

Who We Are and What We Do

Our team of more than 150 people includes empiricists, modelers, and data scientists from four U.S. Department of Energy national laboratories and from the University of Alaska Fairbanks (UAF), all working together on the Next Generation Ecosystem Experiments–Arctic (NGEE Arctic) project. Our overarching goal with the project, which began in 2012 and is now in its third phase, is to improve physical representations of the tundra in the virtual space of Earth system models that predict the future of the Arctic and the world.

NGEE Arctic team members make observations at field sites ranging from the wet, cold North Slope of Alaska to the warmer hillslopes that span the accessible road systems of the Seward Peninsula. We work separately in smaller teams, fanning out across the tundra (or, in the case of the modelers on the team, across the rugged terrain of computer clusters). We also come together for annual "all-hands" meetings to share our work and tend to our long-distance collaborations.

Since the project began, team members have published more than 200 papers and have released nearly 150 data sets. Equally important, we have grieved together for lost loved ones and joyfully celebrated the birth of 18 babies. These shared personal experiences have strengthened the professional relationships among our team members.

A Culture of Safety and Security

Many scientists work in remote places. They say good-bye to families; get on a plane, bus, or boat; and travel to patches of land or water to collect data and make discoveries that advance our understanding of the natural world.

These endeavors often require working for long hours in environments that include unique physical hazards—as well as living for weeks or months in crowded spaces that often lack basic amenities. The NGEE Arctic team, underpinned by a strong safety culture at our national laboratories and our partner institutions, has made the safety of individuals and of the team its number one concern before, during, and after field and laboratory campaigns.

We do this by encouraging rigorous planning and continuous dialogue and by questioning our assumptions regarding team safety and security. Early in the project, we spent many hours discussing and developing a culture of safety, and we prioritized listening sessions with local Alaskan institutions (e.g., our partners at the University of Alaska, Fairbanks) and scientific support groups (e.g., UIC Science in Utqiaġvik, Alaska), as well as Native corporations and the Indigenous community, to determine best practices and to learn more about the place they call home. We encoded these discussions into documents—short field and laboratory manuals, safety plans and checklists, and codes of conduct—that are required annual reading for

our scientists and that established shared expectations across the team (In some cases, these provided the foundation for improved culture at individual institutions.)

Our field manual covers topics ranging from using a buddy system and emergency communication devices to negotiating rough terrain, getting necessary permits, conducting daily safety and planning meetings, and the need for respectful interactions with the surrounding communities. Our laboratory safety manual covers the planning, preparation, and training needed prior to working in on-site laboratories, as well as chemical disposal and how to appropriately store and ship samples home. Safety checklists and codes of conduct are unique to each institution but set expectations for safe, secure, and successful science. Accompanying videos emphasize how to dress for the harsh environmental conditions of the Arctic and what to do if you encounter a bear. (Hint: It depends on the bear!)

In turn, each team member is empowered to freely voice his or her opinion, up to and including an emphatic "stop" if something doesn't seem right. For instance, if a team member voices a safety concern, fieldwork is immediately suspended until a solution is found. "Stop" can also mean discontinuing an escalating discussion or even canceling a series of sampling campaigns. For example, the leadership team made the difficult decision this spring to suspend travel to Alaska given uncertainties surrounding the spread of COVID-19; we placed the safety of our team members and the surrounding communities where we live or work (especially those that may be particularly vulnerable) ahead of scientific observations.

Although the documents we created were an important part of the process, the enduring legacies are the adoption of a safety mindset that underlies all our work, a heightened understanding of the need for respect and common purpose, and a broad set of values endorsed by everyone.

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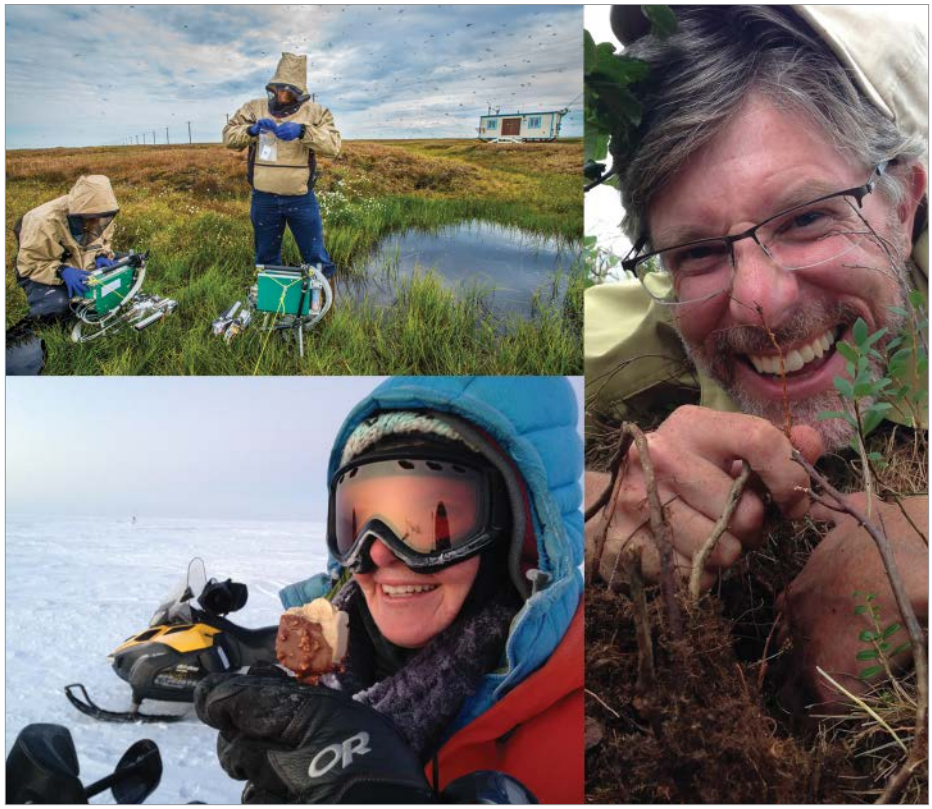


The scientific interests of the NGEE Arctic team range from geomorphology to greenhouse gas fluxes, from permafrost thaw to photosynthesis, from snow cover to shrubification, and from remote sensing to root-soil interactions. Credits: Roy Kaltschmidt, Lawrence Berkeley National Laboratory (top left); Stan D. Wullschleger, Oak Ridge National Laboratory (bottom left, right)

Summarized, our values promote safe and harassment-free work environments, respect for local culture and knowledge of the environment in areas and communities where we are guests, and collaboration and open science.

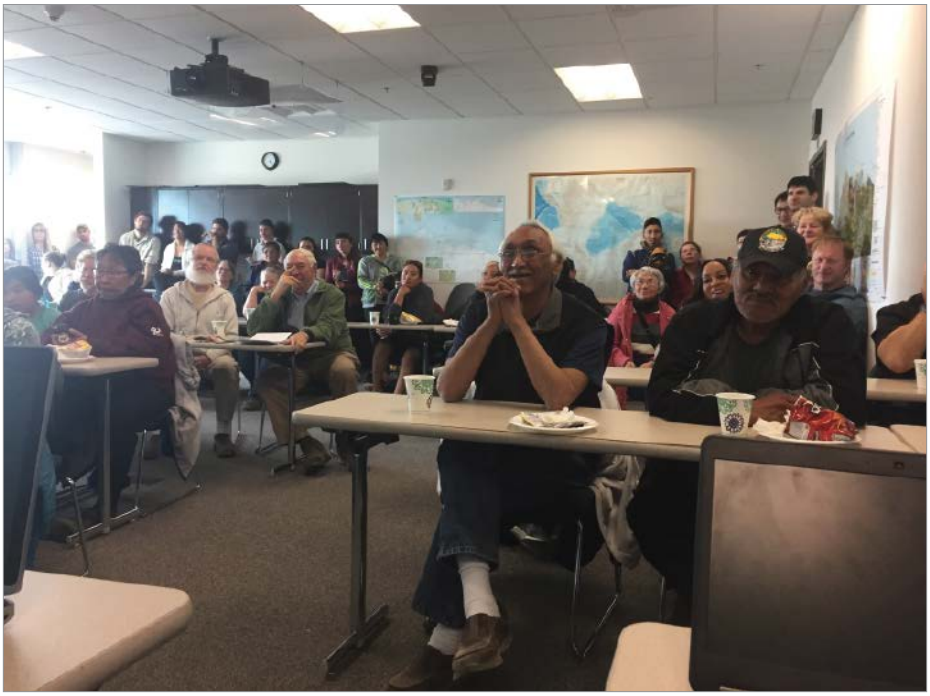
A Safe and Harassment-Free Work Environment

Scientific discovery is increasingly facilitated by cross-disciplinary collaboration and the inclusion of scientists from diverse backgrounds, but fostering these positive attributes in teams requires a culture in which all voices are welcomed and respected. To achieve this goal, the leadership team, along with the team members within each of the major project tasks, frequently talks about how to achieve a safe, secure, diverse, and inclusive science environment.

The leadership team has learned to listen when team members suggest improvements in culture and attitude. For example, we realized that we needed to be more transparent in our decision-making, more explicit in valuing and empowering each team member, and more inclusive in choosing the voices to guide the scientific conversation at our annual meetings. We grew to realize that uncomfortable conversations are an opportunity to grow as a team rather than something to be avoided.

Even so, there have been rare instances of inappropriate behavior in our remote field settings. Some examples include inappropriate conversations or crude humor during fieldwork, actual or perceived bullying among team members, and unwanted sexual advances or innuendos from local residents or scientists involved with other projects. These instances are recognized, acknowledged, and handled immediately.

Issues are resolved over the phone, through in-person discussions upon return from the field, or, in extreme cases, through removal from the field. The leadership team has also recognized the importance of including the injured party in decisions made to resolve a bad situation. And when appropriate and



The first annual "BARC-becue"—a combined barbeque and science fair—was hosted by UIC Science at the Barrow Arctic Research Center (BARC) building to facilitate interactions among scientists and local and Indigenous communities in Utqiaġvik, Alaska, in 2018. Credit: Ravenna Koenig/KTOO

safe, we have found that the team leader or another member of the leadership team can facilitate group discussions while scientists are still in the field to help to resolve potential interpersonal conflicts and restore and strengthen trust.

We further recommend that project safety protocols explicitly address workplace harassment and bullying. Protocols that clearly address these issues were highlighted by a National Academies of Sciences, Engineering, and Medicine report (bit.ly/NASEM-report) about combating sexual harassment and have been developed for other situations in which scientists are working in proximity at remote locations.

We Are Guests in the Arctic

As the Arctic thaws at a worrying rate, Indigenous and other local communities are visited by increasing numbers of scientists, entrepreneurs, and businesses from warmer climates. It is important that we tread lightly in these communities where we are privileged to be guests and that we conduct ourselves and our science in ways that are both ethical and inclusive.

Prior to the development of scientific research plans for the NGEE Arctic project, team members spent time with the local and Indigenous communities and Native corporation landholders to better understand their intimate knowledge of the natural processes in their world, the areas of land available for scientific endeavor and the permits needed to work in those areas, and how we could communicate our findings to the local community. In the years since, we have participated in community outreach by giving talks and teaching workshops or classes, participating in local science fairs, and providing annual reports to the Native corporations that provide us land use permits.

Recently, we invited an Indigenous Knowledge holder, Kaare Erickson of UIC Science, to speak at our annual all-hands meeting. He gave us a history of Indigenous communities in Alaska from "time immemorial" and suggested ways to improve our interactions with local and Indigenous communities. An overarching message was that Indigenous Knowledges and Western science are complementary and not competing and that Western scientists should engage Indigenous Knowledge holders before, during, and after each scientific endeavor. Echoing these conclusions, we recommend early and frequent engagement with local communities.

Prioritizing Collaboration and Open Science

The increasingly cross-disciplinary and global nature of scientific collaborations requires new ways of communicating. At the outset of our project, our sponsor in the U.S. Department of Energy's Office of Science set an expectation for ongoing and iterative cross-disciplinary collaboration between empiricists making observations in the field and in the laboratory and the modelers encoding those hard-won observations into mathematical algorithms that improve physical representations of the tundra in Earth system models.

Over time, this model-experiment interaction philosophy has become central to the way we think, plan experiments, and communicate findings. Modelers are embedded within teams addressing overarching science questions, and they often travel to the field, where they learn firsthand the complexity of natural ecosystems and the importance of good boots and duct tape. In turn, empiricists have learned to speak the mathematical language of models and are helping to guide the development of next-generation models that more faithfully simulate the processes they study.

Furthermore, across the project, we respect and value intellectual input, whether it comes from summer students or senior scientists, and we facilitate cross-project interactions in monthly conference calls. Our annual all-hands meetings feature a variety of brief "lightning" talks in which students and scientists speak about their individual research projects in formats ranging from 2-minute sales pitches, to 5-minute "Ignite" presentations featuring quick-hitting slides, to "Up-Goer Five" descriptions in which speakers use only the most commonly used words in the English language to describe their work. We also hand out awards for safety and data contributions and host "Arctic cafe" roundtables, small group discussions during which team members shuffle among tables to encourage all voices to be heard and new ideas to be considered. These activities both communicate our science and celebrate our scientists.

We underpin these new and nurtured collaborations with a philosophy of open science. Data, once collected, are immediately uploaded to a data portal where they are available to other scientists within the project. Then, when the data are published, they become freely available to scientists and citizens around the world.

We implemented a required project-wide data sharing policy very early in the project,

but we were slow to recognize the way in which it could facilitate trust and collaboration among team members. For example, our data portal, which was built by our data scientists but can be accessed by anyone, is a living record of the teams that have shared their observations, simulations, or synthesized data. But it is also a feedback system that notifies data owners when data are downloaded for use by other team members or the broader community, helping to jumpstart conversations about collaboration and coauthorship. We recommend both formalizing a data management plan at the outset of a project and allocating enough resources to ensure its success; our success has been underpinned by a system that tracks both data sharing and data use.

Central to our culture is the trust that all staff have in our leadership and in each other.

Lessons Learned

Over a decade of working at remote field sites in the Alaskan Arctic, NGEE Arctic team members have learned a lot about project and safety planning, inclusive and collaborative team building, and open and immediate data sharing that we believe can be extrapolated to other scientific endeavors. Our success in these efforts emerged not only because of expectations set at the start by our sponsor and our project leaders but also because of the work of our team across many years to create systemic changes in our science culture and the way our scientists work. This success is quantified through continuous feedback—from students to mentors, from team members to the leadership team, and between the leadership team and our sponsor.

Central to our culture is the trust that all staff have in our leadership and in each other: trust to question the status quo, trust that alternative views and approaches will be heard and validated, and trust to share ideas and data. Our experiment within an experiment continues.

Acknowledgments

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