Navigating The New Arctic

Online Investigators Meeting

16-17 April 2020

ZOOM Virtual Meeting URL : https://zoom.us/j/656502248

ZOOM Virtual Meeting Password : 221467

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Welcome!

We are delighted to welcome you to the first ever Navigating the New Arctic (NNA) PIs meeting! We are looking forward to learning about the entire portfolio of awards from the past three years, and hearing about the projects and people that make up this exciting program.

Navigating the New Arctic, one of NSF's 10 Big Ideas, embodies the Foundation's forward-looking response to the profound challenges of rapid changes in the Arctic. Specifically, NNA seeks innovations in Arctic observational networks and fundamental convergence research that address the intersection of natural, social, and built systems. NNA promotes initiatives that empower new research communities; diversify the next generation of Arctic researchers; integrate the co-production of knowledge; and engage partnerships, particularly among international stakeholders. NNA is also committed to STEM education and workforce development objectives.

Thank you for your hard work and input to this point. In the past few months, for this meeting alone, you have answered surveys, changed to a virtual venue, produced one-pagers and lightning talks, and prepared for this meeting by watching pre-recorded material. You did this while also dealing with major changes to your workplaces, homes, and society. We deeply appreciate this level of engagement. Your input was used to develop the agenda for this meeting so that it is useful to you.

We would like to thank ARCUS for doing a wonderful job with coordination, and Marion Smith for pulling the meeting together. We are also deeply grateful for the participation of many community members, on short notice, to share their perspectives and help with your discussions about Indigenous community engagement. This meeting will begin to bring the NNA community together, and we are planning for deeper interactions in a November meeting (hopefully in-person) with new awardees and a new Community Office coming online.

The NNA Working Group at NSF functions as a unified team. We cross geographic boundaries, organizational boundaries, and intellectual boundaries. We have worked hard to develop and guide this program, but ultimately it is the ideas, proposals, and projects of the community that make up the NNA program. The NNA community has certainly developed innovative ideas about how to understand the changing Arctic, but

important questions remain about how to connect diverse research communities for truly convergent research, and how to ensure that the influx of new science is beneficial for Arctic communities. Over the next few days, we are looking forward to hearing your thoughts about how to overcome the challenges and seize the opportunities available through the NNA program.

We thank you in advance for your thoughts and discussions over the next two days, and beyond this meeting, that will help shape the future of Arctic research.

— The NNA Working Group
National Science Foundation

Navigating the New Arctic (NNA) Virtual Meeting Land Acknowledgement

The circumpolar Arctic is the contemporary home to many different Indigenous Peoples. As researchers and others who are working in, or reside in, the Arctic we recognize these lands and waters as the mostly unceded traditional homelands of Indigenous Peoples. While now online, this Navigating the New Arctic meeting was originally scheduled to take place in Alexandria, VA., on the ancestral lands of the Anacostans (also documented as Nacotchtank) and, over time, the neighboring Piscataway people. Therefore, we honor and recognize the people of Washington D.C. - as well as the place-based knowledge of Arctic Indigenous Peoples, and their ancestral and contemporary stewardship of their homelands.

Navigating the New Arctic Program Goals

- Improved understanding of Arctic change and its local and global effects that capitalize on innovative and optimized observation infrastructure, advances in understanding of fundamental processes, and new approaches to modeling interactions among the natural environment, built environment, and social systems.

- New and enhanced research communities that are diverse, integrative, and well-positioned to carry out productive research on the interactions or connections between natural and built environments and social systems and how these connections inform our understanding of Arctic change and its local and global effects.

- Research outcomes that inform national security, economic development, and societal well-being, and enable resilient and sustainable Arctic communities.

- Enhanced efforts in formal and informal education that focus on the social, built, and natural impacts of Arctic change on multiple scales and broadly disseminate research outcomes.

Goals For The Virtual NNA Investigators Meeting

- To accelerate the rate of dissemination of ideas among researchers.

- To build an intellectual research core to address NNA challenges.

- To enable enhanced research collaborations.

Meeting Code of Conduct

ARCUS Commitment

The Arctic Research Consortium of the US (ARCUS) is committed to maintaining a safe, welcoming, and trusted meeting environment capable of supporting meaningful community dialogue and the professional exchange of information and ideas. To help promote these conditions, all meeting participants are expected to adhere to the meeting Code of Conduct. The purpose of this Code of Conduct is to communicate that sexual harassment, other forms of harassment, and sexual assault will not be tolerated, and every meeting participant is expected to conduct themselves in a professional, respectful, and responsible manner at all times. This Code of Conduct applies to all affiliated people and events relating to the Navigating the New Arctic Investigators Meeting, including those sponsored by other organizations.

What is Harassment?

Harassment includes speech or behavior that is not welcome or is personally offensive, whether it is based on ethnicity, gender, religion, age, body size, disability, veteran status, marital status, sexual orientation, gender identity, or any other reason not related to scientific merit. It includes stalking, unnecessary touching, and unwelcome attention.

Behavior that is acceptable to one person may not be acceptable to another, so use discretion to be sure that respect is communicated. Harassment conveyed in a joking manner still constitutes unacceptable behavior. Retaliation for reporting harassment is also a violation of this policy, as is reporting an incident in bad faith.

Expected Behavior

The following behavior is expected throughout the meeting:

- Treat all meeting participants, staff, and vendors with respect and consideration, valuing a diversity of views and opinions.
- Communicate openly and thoughtfully with others, being considerate of viewpoints different from your own and critiquing ideas rather than individuals.
- Avoid personal attacks directed toward other attendees, participants, staff, and vendors.
- Be mindful of your surroundings and of your fellow participants. Alert staff if you notice a dangerous situation or someone in distress.
- Respect the rules and policies of the meeting host organization.
- Alert meeting officials if you notice a dangerous situation or someone in distress.

Prohibited Conduct

The following behavior is prohibited throughout the meeting:

- Harassment and intimidation, including any verbal, written (including via texts, online chat, or social media), or physical conduct designed to threaten, intimidate, humiliate, or coerce another participant.
- Discrimination or other actions based on race, ethnicity, gender, gender identity or expression, sexual orientation, physical ability, nationality, age, socioeconomic status, or belief.
- Stalking or unwelcome or surreptitious photography or recording.
- Disruption of talks at any session.
- Unwelcome sexual attention, including but not limited to sexualized comments or jokes, displaying sexually explicit material, inappropriate touching, groping, or sexual advances.

How to Report & How Complaints Will Be Addressed

Anyone who feels unsafe or threatened is encouraged to seek immediate assistance from meeting staff, trusted colleagues, friends, or allies. To report a serious crime, please call 911.

If you are the subject of unacceptable behavior or have witnessed any such behavior during meeting events, please contact one of the virtual meeting planning committee members listed below to report your concerns:

- Helen Wiggins, ARCUS Executive Director - helen@arcus.org or 907-474-1600
- Roberto Delgado, NSF Program Manager - robdelga@nsf.gov or 703-292-2397
- Marion Smith, NNA Meeting Facilitator - marionsmith1@msn.com or 240-899-9938

Meeting officials will consult privately with the individual filing the complaint prior to taking any action.

To address complaints of inappropriate conduct, meeting officials may take any action deemed necessary and appropriate, including verbal warnings, immediate removal from the meeting, and the notification of appropriate authorities (e.g., employers or police).

Anyone requested to stop unacceptable behavior is expected to comply immediately. Retaliation toward complainants of inappropriate conduct will not be tolerated.

For any questions about this Code of Conduct policy, please contact ARCUS Executive Director, Helen Wiggins at helen@arcus.org.

Making A Commitment to Active Online Participation

Moving the NNA Investigators Meeting to a virtual format means that each participant must make an extra personal commitment to play an active and productive role during the online meeting.

Respect the Meeting - Please treat this online gathering with the same respect that you would an in-person conference. Come prepared, show up on time, and commit to being fully present and attentive to your colleagues.

Be an Active Listener - When you are on your computer, it's super easy to multi-task. It's up to you to do what you can to minimize distractions and remain focused on the meeting when we are in session. A great way to keep focus is by taking notes!

Be Inclusive - Be curious, considerate, respectful, and inclusive of diverse views and opinions. Use the meeting to actively seek input from your fellow attendees.

Do Your Homework - A lot of work has gone into developing the lightning talks and other preparatory materials for the meeting. By making a commitment to thoughtfully reviewing these materials in advance, you are helping to elevate the quality of break-out discussions and meeting outcomes.

Test Your Technology - Please test Zoom out in advance—especially if you have never used it before. In addition to making sure your audio/video settings are working correctly, we also want you to feel comfortable with your Zoom controls so you can easily share your thoughts and ask questions!

When In Doubt, Ask - Whether it's technical troubles, uncertainty around agenda activities, or some other issue that might be getting in the way of a productive meeting, please speak up! Using the private chat feature on Zoom to communicate with the meeting host is always a great way to get info and help whenever you need it.

Create a Safe Place for Sharing - Throughout the meeting, please help us create a safe space for sharing by honoring the idea that, "what is said here, stays here; what is learned here, leaves here".

Pre-meeting Assignments

Before the Navigating the New Arctic (NNA) Investigator meeting takes place on 16–17 April, we ask that all investigators planning to participate complete the following pre-meeting assignments:

1) Please watch the videos found on the Navigating the New Arctic (NNA) Virtual Meeting YouTube playlist.

   This playlist includes all the pre-recorded lightning talks that have been produced by NNA project teams. It will also include background presentations to introduce key topics that will be addressed in meeting break-out discussions.

2) Please review each of the written project updates found in this meeting program book starting on page 40.

3) As you review each of the lightning talk videos and project updates, please consider the following questions:

   - **What resonates with you about this NNA project?**
   - **Do you see any connections between this project and your current work?**
   - **What questions do you have for this project team?**

4) After you have reviewed all the lightning talks and project updates, we invite you to identify 2–3 priority projects/investigators to follow-up with in advance of the meeting. Help us “break the ice” of the upcoming virtual meeting by taking a few moments to personally say hello to these contacts via the Navigating the New Arctic (NNA) Slack workspace, by sending an email with a couple follow-up questions, or by inviting them to a virtual “coffee chat”, etc.

5) Please review the “Required” materials found on the Preparation for the Community Collaboration & Research Co-production break-out Session page of your program book.

6) Three of our Arctic Community Collaboration & Research Co-Production Advisors have generously offered to meet with NNA Investigators during two office-hour sessions outside of the virtual NNA meeting. Office-hour details are included in the Meeting Agenda. If you know you would like to participate, please consider signing up in advance by sending an email to Brit Myers at brit@arcus.org or letting her know on the NNA Slack workspace.

Order of Lightning Talks & Written Reports

1. Arctic Impacts and Reverberations of Expanding Global Maritime Trade Routes
2. Bridging the Atomistic Deformation Mechanism to the Microscopic Adhesive-to-Cohesive Fracture at the Ice-Metal Interfaces
3. Arctic Urban Risks and Adaptations (AURA)
4. Emergency Response in the Arctic
5. Pursuing Opportunities for Long-term Arctic Resilience for Infrastructure and Society (POLARIS)
6. ANCHOR - Arctic Network for Coastal Community Hazards, Observations, and Integrated Research
7. Facilitating Increased Engagement Between the Research Communities of Greenland and the US
8. Rain on Snow and Extreme Precipitation Events Across the Arctic and their Impacts on Social-Ecological Systems
9. Integrating Language Documentation and Computational Tools for Yupik, an Alaska Native Language
10. Co-production of Shorefast Ice Knowledge in Uummannaq Bay, Greenland
11. Sustainably Navigating Arctic Pollution - Through Engaging Communities (SNAP-TEC)
12. Peat Expansion in Arctic Tundra - Pattern, Process, and the Implication for the Carbon Cycle (TundraPEAT)
13. Dynamic Vehicle Terrain Modeling and Control of Lightweight Ground Robots in Snow and Sand
14. Navigating Disturbance Regimes in the New Arctic
15. Maritime Transportation in a Changing Arctic: Navigating Climate and Sea Ice Uncertainties

16. Developing Arctic Village Resilience to Future Water Cycle, River System, and Coastal Change

17. Remote Sensing of Arctic Sea Ice Using the Super Dual Auroral Radar Network

18. Landscape Evolution and Adapting to Change in Ice-Rich Permafrost Systems
    Note: This video titled, “Studying Permafrost in Point Lay” was originally created by the project to share with the Point Lay Community.

19. Preparing for a Northwest Passage: A Workshop on the Role of New England in Navigating the New Arctic

20. Unangam Ulaa Project: Culturally-informed Adaptation of the Ancient Aleutian Semi-subterranean Dwelling for Sustainable and Resilient Arctic Housing

21. The Circumpolar Active Layer Monitoring Network-CALM V (2019-2024): Long-term Observations on the Climate-Active Layer-Permafrost System

22. The Integrated Characterization of Clouds, Energy, Atmospheric state, and Precipitation at Summit, Aerosol-Cloud Experiment (ICECAPS-ACE)

23. Closing the Water Vapor Exchange Budget Between the Ice Sheets and Free Atmosphere

24. Interactions of Environmental and Land Surface Change, Animals, Infrastructure, and Peoples of the Arctic

25. Modeling Risk from Black Carbon in a Coupled Natural-Human System at the Arctic Ice Edge

26. Planning for Climate Resiliency Amid Changing Culture, Technology, Economics, and Governance

27. The Impact of Climate Change on Greenland's Glacial Fjords, Ecosystems, and Local Communities

28. Innovations in Energy Technologies and Empowerment in Arctic Fishing Communities

29. Predicting Coastal Responses to a Changing Greenland Ice Sheet

30. Responding to the Housing Crisis in the Arctic: A Transdisciplinary Approach Across Physical, Natural, and Social Systems

31. Developing Coordinated Monitoring Networks Across Alaska and Northwest Canada to Evaluate and Address Rapidly Changing Environments

32. Indigenous Foods Knowledges Network

33. Advanced Technology for Persistent, Long-Range, Autonomous Under-Ice Observations of Arctic Change

34. Interactions of the Microbial Iron and Methane Cycles in the Tundra Ecosystem

35. The Climate Impacts on Alaskan and Yukon Rivers, Fish, and Communities as Told Through Co-produced Scenarios

36. Soundscape Ecology to Assess Environmental and Anthropogenic Controls on Wildlife Behavior

37. ARC-NAV: Arctic Robust Communities-Navigating Adaptation to Variability

38. Atautchikkun Ilitchisukluta (Coming Together to Learn): Co-producing Knowledge Across the Northwest Passage

39. Origin and Fate of Harmful Algal Blooms in the Warming Chukchi Sea

40. The Permafrost Discovery Gateway: Navigating the New Arctic Tundra Through Big Data, Artificial Intelligence, and Cyberinfrastructure

41. Resilience and Adaptation to the Effects of Permafrost Degradation Induced Coastal Erosion

42. Adaptive Capacity and Resilience in the New Arctic: Identifying Pathways to Equitable, Desirable Outcomes for People and Nature Through Convergence

43. Coordinate a Transdisciplinary Research Network to Identify Challenges of and Solutions to Permafrost Coastal Erosion and Its Socioecological Impacts in the Arctic

44. The Arctic Carbon and Climate (ACCLIMATE) Observatory: Tundra Ecosystem Carbon Balance and Old Carbon Loss as a Consequence of Permafrost Degradation

45. Students Using Local, Traditional, and Science Knowledge Bases to Investigate Arctic Snow Processes

Preparation for the Community Collaboration & Research Co-Production Break-out Session

Required

To ensure all meeting participants share a similar frame of reference for our Community Collaboration break-out discussion, we ask that everyone take the time to review the following materials in advance of the virtual meeting:

- Co-Production of Knowledge Model (PDF - 1 MB)
- Understanding the Arctic Through a Co-Production of Knowledge (Video)
- Research Processes and Indigenous Communities in Western Alaska (PDF - 467 KB)
- An Indigenous Approach to Ocean Planning and Policy in the Bering Strait Region of Alaska (PDF - 406 KB)
- 2016 Arctic Observing Summit Synthesis (PDF - 229 KB)
- One additional short video will be added to the YouTube playlist and shared with meeting participants the week of 13 April 2020.

Recommended

The following materials also come highly recommended by our Community Collaboration & Research Co-Production Advisors:

- Lene Kielsen Holm's 2016 Arctic Observing Summit Speech [starts at minute 52:30] (Video)
- 2020 Arctic Observing Summit *draft* Synthesis (PDF - 2 MB)
- A Global Assessment of Indigenous Community Engagement in Climate Research (PDF - 1.7 MB)
- Two-Eyed Seeing and Other Lessons Learned with a Co-learning Journey of Bringing Together Indigenous and Mainstream Knowledges and Ways of Knowing (PDF - 692 KB)

Additional Resources

The following resources may also be helpful to the NNA Investigator community:

- Co-Production Model Presentation to ACCAP (VIDEO)
- Kaare Sikuaq Erickson Thesis Defense (VIDEO)
- Arctic Peoples: A Changing Climate, Changing Ways of Life (VIDEO)
- WEBSITES:
    - www.kawerak.org/knowledge
    - www.kawerak.org/socialsci
    - https://kawerak.org/natural-resources/marine-program/
    - http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects
- PODCASTS:
    - CBC Massey Lectures, All Our Relations: Finding the Path Forward
    - Putting science under an Indigenous microscope
- *Dear Qallunaat: Racism, Public Government and Inuit Nunanga*, Sandra Inutiq
- *Indigenous Ally Toolkit*, Montreal Urban Aboriginal Community Strategy Network
- *The Meaning of Ice: People and Sea Ice in Three Arctic Communities*, (book) edited by Shari Fox Gearheard, Lene Kielsen Holm, Andrew R. Mahoney, Henry Huntington, Joe Mello Leavitt
- *Braiding Sweetgrass*, (book) Robin Wall Kimmerer

Arctic Community Collaboration & Research Co-Production Advisors

The following guests will be participating in the NNA Virtual Investigators Meeting to share their insights and expertise in working with Arctic Indigenous and local communities and to advise NNA teams on how to adopt or implement a research co-production approach in their projects.

Carolina Behe is the Indigenous Knowledge/Science advisor for the Inuit Circumpolar Council Alaska. As part of the Inuit Circumpolar Council Alaska team, her work is diverse and ranges from topics within food security and biodiversity to management and policy. Within the past couple of years, Carolina has been part of a team with focus on Inuit food sovereignty. Internationally, Carolina acts as the Inuit Circumpolar Council Head of Delegation on the Conservation of Arctic Flora and Fauna working group board and brings forward ICC's positions within the Convention on Biological Diversity. Much of ICC's work within these international foras are focused on ensuring an Inuit perspective and interest are at the table. Additionally, a high amount of focus is placed on the involvement of Indigenous Knowledge and promoting the use of a co-production of knowledge approach to bring together Indigenous Knowledge and science. Carolina's work allows for her to work within two knowledge systems, Indigenous Knowledge and science. Indigenous Knowledge takes a holistic view and sees how many pieces fit together. Working with this understanding and way of knowing, combined with science, will aid in making adaptive ecosystem-based decisions.

Dr. Nikoosh Carlo is CEO of CNC North Consulting LLC. She has extensive experience working to advance community-based solutions to climate change. As founder and chief strategist at CNC North Consulting, Dr. Carlo helps clients develop a vision for their climate and Arctic priorities, build momentum to achieve change, and foster partnerships to drive forward movement. Dr. Carlo has a special interest in advancing initiatives that support climate equity and the health and well-being of Arctic residents and Indigenous peoples. Dr. Carlo previously served as senior advisor for climate and Arctic policy to the Governor of Alaska (2017-18), a senior advisor at the US State Department for the US Chairmanship of the Arctic Council (2015-17), and the executive director of the Alaska Arctic Policy Commission (2013-15). Dr. Carlo is Koyukon Athabascan and has deep roots in the Interior Alaska communities of Fairbanks and Tanana, where she was raised. Dr. Carlo received a PhD in neuroscience from the University of California San Diego and a BS in psychology from the University of Alaska Fairbanks.

Raychelle Aluaq Daniel grew up in Tuntutuliak, Alaska, a Yup'ik village along the Qinaq River by the Bering Sea coast. She collaborates with Indigenous Peoples and tribal communities on advancing policy and research priorities important for a subsistence way of life. Some of these issues include: bridging Indigenous knowledge and science in decision-making, advancing the co-production of knowledge, identifying policy priorities from an Indigenous perspective, and addressing the impacts from anthropogenic marine activities such as fisheries and Arctic shipping. She is currently with The Pew Charitable Trusts US Arctic Program based in Portland, Oregon.

Kaare Ray Sikuaq Erickson is the North Slope Science Liaison for UIC Science in Utqiaġvik, Alaska. Kaare was raised in several villages along the Bering Sea coast including Savoonga, Saint Michael, and Unalakleet. Kaare's father is a Scandinavian fisherman and school teacher raised in Unalakleet and his mother is Iñupiaq raised in Utqiaġvik. Kaare's childhood taught him to provide for his community through subsistence and leadership. Family members and Elders taught Kaare how to be aware of problems that face Arctic communities, as well as how to find creative, realistic, and effective ways to alleviate or solve these issues. Kaare spent a decade immersed in anthropological projects (cultural, historical, and archaeological) and studying Alaska Native history. Kaare's unique life history, his expertise in cross-cultural communication, and his deep knowledge of Arctic history and prehistory allows him to fulfill his role as North Slope Science Liaison for UIC Science, LLC.

Nagruk Harcharek is a lifelong Barrow resident, hunter, whaler, and artist. He earned his Bachelor of Science in Aeronautical Science from Embry Riddle Aeronautical University at Prescott, Arizona. His work experience includes serving as General Manager for UIC Science, LLC where he supervises and administratively manages the Barrow Arctic Research Center and the surrounding Charles Etok Edwardsen Jr. Environmental Observatory. He is a licensed pilot and has worked with Iḷisaġvik College during its Iñupiat Land Use and Resources Camp as a guide and vessel operator.

Brenden Raymond-Yakoubian, owner of Sandhill.Culture.Craft, is a social scientist who has worked in dozens of Alaskan communities over the past two-plus decades. Much of his current work focuses on knowledge sovereignty and indigenization in collaboration with Tribes and Tribal organizations.

Julie Raymond-Yakoubian is the Social Science Program Director for Kawerak, Inc. Kawerak is located in Nome and is the Alaska Native non-profit Tribal consortium for the 20 federally recognized Tribes of the Bering Strait region of Alaska. Julie has been living and working in Alaska for over 20 years, and working in the Bering Strait region for over 12 years. Her work is currently focused on collaborations with Tribes on topics such as the connections between subsistence and identity, the cultural importance and meaning of non-ordinary experiences and knowledge, a variety of Traditional Knowledge documentation and Knowledge application projects, and work on Tribal research sovereignty - including protocols, guidelines and toolkits related to research.

Navigating the New Arctic (NNA) Investigators Meeting

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Meeting Agenda (draft version 4/08/20)

Thursday, 16 April 2020
Day 1 Focus: Introductions & Peer Support

Session 1.1: Introductions

12:00pm ET **Welcome & Introduction**

- Welcome
- Introduction to the NNA Program from the Steering Committee Co-Chairs
    - *Kellina M. Craig-Henderson, Deputy Assistant Director, NSF Social, Behavioral, and Economic Sciences Directorate*
    - *Kelly Falkner, Director, NSF Office of Polar Programs*
    - *Robert B. Stone, Division Director, NSF Civil, Mechanical and Manufacturing Innovation Division*

- Introduction to the NNA Working Group members & goals for the NNA Virtual Investigators Meeting
    - *Roberto Delgado, NSF Program Director, Office of Polar Programs*
    - *Kendra McLauchlan, NSF Program Director*, *Division of Environmental Biology*

12:20pm ET **Plan for the Day**

- Agenda overview and introduction to the Session 1 peer support activity
  Marion Smith, NNA Meeting Facilitator

12:30-1:25pm ET **Peer Support Small Group Discussions**

- Meeting participants will split into groups of four participants to meet or connect with other members of the NNA Investigators community and to seek input and advice on any challenges they are facing within their NNA projects or with other relevant Arctic research activities. Each individual will have ~15 minutes to share and seek peer support. A timekeeper may also be present in some groups to assist with the peer support activity.
- **Desired Outcomes:**
    - Participants connect with other investigators and learn about their projects
    - Investigators learn about NNA community challenges and explore how they can support one other in overcoming them**.**
    - Individuals document common themes among their discussions that they can introduce in other meeting break-out discussions.

1:25pm ET **Session 1.1 Wrap-up**

1:30-2:00pm ET **Break**

Session 1.2: Enhancing Collaboration Capacity

2:00pm ET **Introduction to Session & Special Guests**

- Introduction to the two different thematic areas of the break-out session
  - "Community": Working with Arctic Indigenous communities
  - "Convergence": Facilitating convergence research

- Special guest introductions:
  - *Carolina Behe, Inuit Circumpolar Conference (ICC) Alaska*
  - *Nikoosh Carlo, CNC North Consulting*
  - *Raychelle Daniel, PEW Charitable Trusts*
  - *Kaare Erickson, Ukpeaġvik Iñupiat Corporation (UIC) Science*
  - *Nagruk Harcharek, Ukpeaġvik Iñupiat Corporation (UIC) Science*
  - *Brenden Raymond-Yakoubian, Sandhill.Culture.Craft*
  - *Julie Raymond-Yakoubian, Kawerak, Inc*

- Introduction to the break-out session process and desired outcomes

2:20 - 3:25pm ET **Break-out Group Discussions**

- Each participant assigns themselves to one of the two session themes and is moved into a Zoom break-out room to discuss the focus questions below.
- Break-out group facilitators will introduce the focus questions and assign one investigator to serve as the group's rapporteur during the Session 1.3 plenary.
  - **Community Theme Focus Questions:**
    - What does co-production of knowledge mean to you &/or the other investigators on your NNA project team?
    - How can you apply the concept of reciprocity in the context of research?
    - What kinds of resources and support do you need (and/or does the NNA community/larger Arctic research community need) to engage in collaborative and co-productive research with Arctic communities?
  - **Convergence Theme Focus Questions:**
    - What challenges do the NNA projects face with regard to working effectively across scientific disciplines to achieve the goal of research convergence?
    - What tools, techniques, or resources have been helpful in promoting successful research collaborations and how might they (or others) be applied to enhancing convergence outcomes and synthesis across the NNA projects?

    - How can the NNA community work together to overcome the existing barriers to convergence research and/or broader collaboration? (e.g. working internationally, working with business or policy sectors, connecting with other Arctic research efforts beyond NNA, etc.)
    - What support could be provided to help investigators successfully initiate, engage in, and foster convergence research?
- **Outcomes:**
    - Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google doc.
    - Discussion highlights are synthesized by the break-out group rapporteur and shared during 3-minute presentations during the Session 1.3 plenary.

3:25pm ET **Session 1.2 Wrap-up**

3:30-4:00pm ET **Break**

Session 1.3: Report Outs & Plenary Discussion

4:00pm ET **Session Introduction**

- Introduction to the order of reports and how the plenary Q&A will work

4:05-5:25pm ET **Break-Out Group Reports**

- Rapporteurs from the “Community” groups will give 3-minute report outs
- Rapporteurs from the “Convergence” groups will give 3-minute report outs
- Q&A, plenary discussion, and ID of cross-cutting themes

5:25pm ET **Session Wrap-up, Office Hours, & Virtual Happy Hour**

- Three of our meeting guests from today - Julie Raymond-Yakoubian, Kaare Erickson, and Raychelle Daniel - will be holding virtual "Office Hours" for interested investigators. These Office Hours are voluntary but are an opportunity to speak with Arctic community/Arctic research experts about your specific project or questions you may have about community engagement, collaborations, or partnerships. Julie, Kaare, and Raychelle will be available today from 5:45pm - 6:45pm ET on the following Zoom channel: https://zoom.us/j/9074501600**.** They will also be available tomorrow morning on the same Zoom channel from 10:45am-11:45am ET.
- Participants are also invited to spend a few more minutes following-up with each other informally before they leave for the day. We’ll keep this Zoom meeting room open until 7pm ET if there is anyone who might want to stay and socialize. The NNA Slack Channel is another great place to continue some of the conversations started today!

5:30pm ET **End of Day 1**

Navigating the New Arctic (NNA) Investigators Meeting

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Meeting Agenda (draft version 4/08/20)

Friday, 17 April 2020
Day 2 Focus: Future Planning

Optional "Office Hours" Meeting Opportunity

10:45-11:45am ET **Expert Consultation on Community Engagement**

- Julie Raymond-Yakoubian, Raychelle Daniel, and Kaare Erickson will be available to speak with NNA Investigators about your projects or other community collaboration questions during this optional "office hours" session. Zoom url: https://zoom.us/j/9074501600 (NOTE: this is a different Zoom url that we will use for the NNA virtual meeting)

Session 2.1: Addressing Current Challenges

12:00pm ET **Welcome, Reflections, and Plan for Day 2**

- Welcome and agenda overview for Day 2
  Marion Smith, NNA Meeting Facilitator

- Review of insights/outcomes from Day 1
  Katia Kontar, AAAS Science & Technology Policy Fellow, hosted by NSF Office of Polar Programs

- Introduction to the Day 2 focus of the meeting and the desired outcomes for the first break-out session.
  Roberto Delgado, NSF Program Director, Office of Polar Programs
  Kendra McLauchlan, NSF Program Director, Division of Environmental Biology

12:25 - 1:25pm ET **Break-out Group Discussions**

- Break-out group facilitators will introduce the focus questions and assign one investigator to serve as the group's rapporteur during the Session 2.2 plenary.
  - **Break-Out Group Focus Questions:**
    - How has COVID-19 disrupted your project or field research plans? How are you finding ways to adapt that could be relevant to others in the NNA community?
    - Do COVID-19 disruptions present any opportunities for the NNA community to do things differently or to strengthen collaborations?
    - How can you apply what you know/are learning about co-production and collaboration to this COVID19 situation? (i.e. in

terms of relationship building, on the ground collaborations with communities when field work is cancelled or uncertain, using this as an opportunity to create longer-term modifications to how research is done, etc.)
        - What could the NNA community achieve together over the next six months to a year given the current challenges and circumstances?
        - How can these activities/actions serve as a stepping stone to what the NNA community might achieve together over the next 5+ years?
    - **Outcomes:**
        - Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google Doc.
        - Discussion highlights are synthesized by the break-out group rapporteur so they can be shared during 3-minute presentations during the Session 2.2 plenary.

1:25pm ET **Session 2.1 Wrap-up**

1:30-2:00pm ET **Break**

Session 2.2: Report Outs & Plenary Discussion

2:00-3:25pm ET **Break-Out Group Reports**

- Rapporteurs give 3-minute report outs followed by a Q&A period/plenary discussion once all reports have been shared.

3:25pm ET **Session 2.2. Wrap-up**

3:30-4:00pm ET **Break**

Session 2.3: Data Sharing & NNA Community Office Requirements

4:00pm ET **Session Introduction & Report Out Plans**

- Introduction to the discussion questions, desired outcomes, and report out plans for the final break-out session

4:05-5:05pm ET **Break-out Group Discussions**

- Break-out group facilitators will introduce the focus questions, ensure key discussion points are documented in a shared Google Doc, and assign one Investigator to report out top take-away message via Zoom chat.
    - **Break-Out Group Focus Questions:**
        - What strategies for data sharing across the project teams are needed?

- What kinds of data/information do projects currently need to move their work forward?
- What additional data/information would be useful to help the NNA community produce new knowledge together?
- What other tools, activities, support services, etc. would the NNA Investigator community like to see implemented by the new NNA coordination office?
- How can the community stay connected and continue working together before the NNA coordination office is in place?
- What would you like to see happen at the next NNA community meeting being planned for the fall.

- **Outcomes:**
  - Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google Doc.
  - Break-out group rapporteurs share top take-away from their discussion with all meeting participants via Zoom chat.

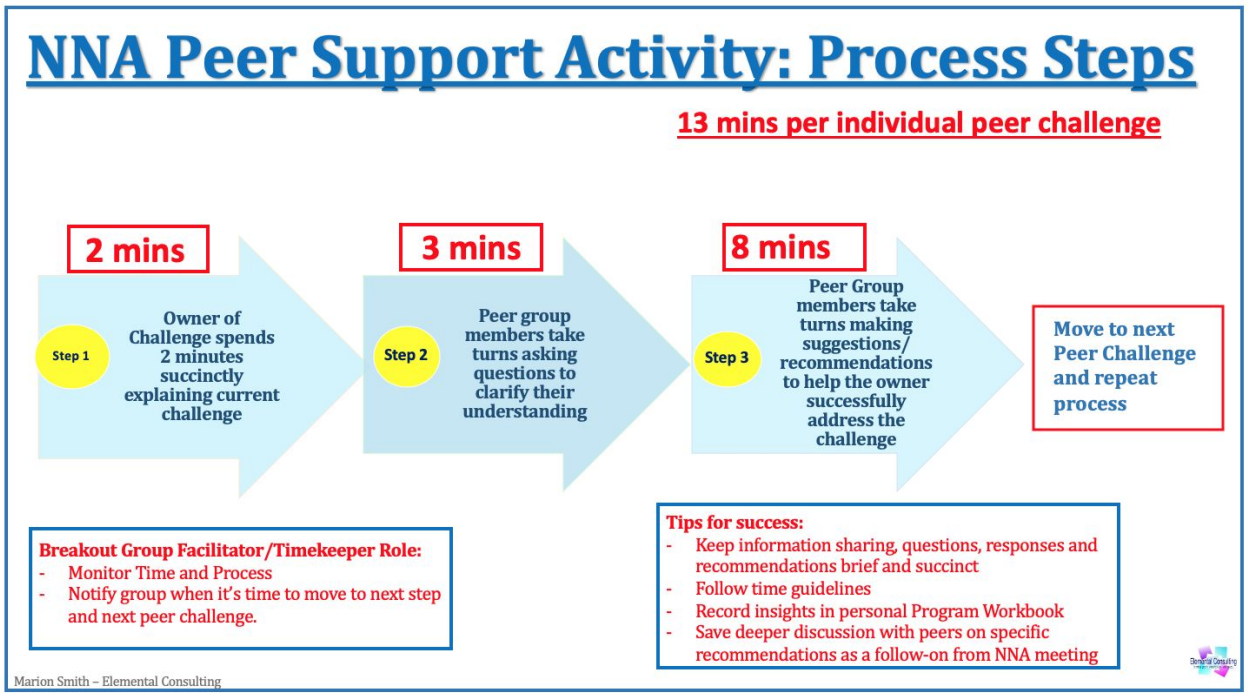
5:05pm ET **Meeting Wrap-Up & Concluding Remarks**

- Participants invited to share final reflections on the meeting
- Updates on the products, reports, and recommendations that will come out of the virtual meeting and how they will be shared.
- Reminder of tools & networking opportunities currently available to help the NNA Investigator community stay connected and continue developing their relationships with one another.

5:30pm ET **Meeting End**

Break-Out Session Guidance

1.1: Peer Support Break-Out Discussion



- When you first enter the break-out room, please switch on both your microphone and video as a courtesy to your colleagues. If anyone assigned to the break-out room is unresponsive or can't communicate with the group, please have someone in the group click the "Ask for Help" button to notify the meeting Host for assistance.
- Your break-out group will have four participants. A timekeeper may also be assigned. However, if nobody self-identifies themselves as the timekeeper for the group, please pick someone to play this role.
- Your break-out group timekeeper will introduce themselves at the top of the session & invite each member of the group to provide a brief self-introduction. Please share your name, NNA project, and the role you play in the project.
- Each participant will have 15 minutes to present a challenge they are currently facing within their NNA projects (or with other relevant Arctic research activities) and to consult with their break-out room colleagues.

To Start the Peer Support Activity:

- Identify the first 'Challenge Owner'

- The timekeeper will start timing '**2 minutes'** for challenge owner to succinctly explain key points of the challenge and **STOP** the challenge owner at 2-minute mark.
- The timekeeper will start timing '**3 minutes'** for peer group to take individual turns asking clarifying questions – encourage succinct answers by the 'Challenge Owner' – ensure all peers have opportunity to ask. The timekeeper will **STOP the questioning** process after 3 minutes.
- Take turns going around individual peers in the group to ask if they have possible recommendations / advice / solutions for the challenge presented. Challenge Owner remains quiet through this process. (**Note:** maximum **2 minutes** per recommendation).
- The Challenge Owner records their peer recommendations/ideas on the Session Program Workbook during peer recommendations.
- Continue to circle around peer group members for additional recommendations and **STOP** after 8 minutes.
- Immediately shift and **repeat** process with **next 'Challenge Owner'**
- At conclusion – all peers should have had the opportunity to present a challenge, consult with peers and leave session with recommendations / ideas.
- The Zoom meeting host will send a 1-minute alert to all group members before the end of the session.
- When the break-out interval is over, you will automatically return to the main Zoom meeting (no action on your part is needed).

Desired Outcomes for this Session:

- Participants connect with other investigators and learn about their projects
- Investigators learn about NNA community challenges and explore how they can support one other in overcoming them**.**
- Individuals document common themes so they can raise these issues and ideas in future meeting discussions and report-outs.

Session Notes: (Below is space to add your own notes, if you are printing this program book.)
Break-Out Group Members:

Peer Recommendation:

1.2: Collaboration Break-Out Discussion

- At the top of the Collaboration session, meeting participants will be asked to choose which break-out theme they would like to participate in: “1 - Community” or “2 - Convergence”.
- To assign yourself to a theme, please add a #1 or a #2 preceding your Zoom name. The meeting host will demonstrate how this is done.
- Once you have been moved into your assigned break-out room by the meeting host, please switch on both your microphone and video as a courtesy to your colleagues
- A facilitator has been assigned to assist you with this break-out discussion.
- At the beginning of the break-out your facilitator will introduce themselves & invite each member of the group to provide a brief self-introduction.
- The facilitator will also confirm that everyone in the group is assigned to the correct theme (1- Community or 2 - Convergence).
- The facilitator will ask one person to volunteer to be the group’s rapporteur.
- Rapporteurs will be responsible for giving a brief 3-minute report-out of the small-group discussion during the Session 1.3 plenary.
- The facilitator will document the group theme, the names of each break-out group participant, as well as the group’s rapporteur in a shared Google doc at the top of the break-out session.
- The group will have 1 hour to discuss the focus questions associated with their assigned theme (see questions outlined below).
- The Zoom host will alert the group when only 10 minutes remain in the break-out discussion interval.
- When the break-out interval is over, you will automatically return to the main Zoom meeting room (no action on your part is needed).
- The facilitator will serve as the official note-taker/note collector for the group, ensuring notes are compiled and entered into the shared Google doc at the end of the break-out. They may also take notes (or have another volunteer from the group take notes) directly into the shared Google doc during the session.

Desired Outcomes for this Session:

- Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google Doc.
- Discussion highlights are synthesized by the break-out group rapporteur so they can be shared during a 3-minute presentation at the Session 1.3 plenary.

Community Theme Focus Questions:

- What does co-production of knowledge mean to you &/or the other investigators on your NNA project team?
- How can you apply the concept of reciprocity in the context of research?

- What kinds of resources and support do you need (and/or does the NNA community/larger Arctic research community need) to engage in collaborative and co-productive research with Arctic communities?

Convergence Theme Focus Questions:

- What challenges do the NNA projects face with regard to working effectively across scientific disciplines to achieve the goal of research convergence?
- What tools, techniques, or resources have been helpful in promoting successful collaborations and how might they (or others) be applied to enhancing collaboration and synthesis across the NNA projects?
- How can the NNA community work together to overcome the existing barriers to convergence research and/or broader collaboration? (e.g. working internationally, working with business or policy sectors, connecting with other Arctic research efforts beyond NNA, etc.)
- What support could be provided to help PIs successfully initiate, engage in, and foster convergence research?

Session Notes: (Below is space to add your own notes, if you are printing this program book.)

Break-Out Group Theme:

Facilitator: Rapporteur:

Group Members:

Discussion Notes:

2.1: Addressing Current Challenges Break-Out Discussion

- Once you have been moved into your assigned break-out room by the meeting host, please switch on both your microphone and video as a courtesy to your colleagues.
- A facilitator has been assigned to assist you with this break-out discussion.
- Your break-out group facilitator will introduce themselves at the top of the session & invite each member of the group to provide a brief self-introduction.
- The facilitator will ask one person to volunteer to be the group's rapporteur.
- Rapporteurs will be responsible for giving a brief 3-minute report-out of the small-group discussion during the Session 2.2 plenary.
- The facilitator will document the names of each break-out group participant, as well as the group's rapporteur in a shared Google Doc at the top of the break-out session.
- The group will have 1 hour to discuss the focus questions associated with this session (see questions outlined below).
- The Zoom host will alert the group when only 10 minutes remain in the break-out discussion interval.
- When the break-out interval is over, you will automatically return to the main Zoom meeting room (no action on your part is needed).
- The facilitator will serve as the official note-taker/note collector for the group, ensuring notes are compiled and entered into the shared Google Doc at the end of the break-out. They may also take notes (or have another volunteer from the group take notes) directly into the shared Google Doc during the session.

Desired Outcomes for this Session:

- Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google Doc.
- Discussion highlights are synthesized by the break-out group rapporteur so they can be shared during 3-minute presentations during the Session 2.2 plenary.

Break-Out Group Focus Questions:

- Has COVID-19 disrupted your project or field research plans? If so, are you finding ways to adapt that could be relevant to others in the NNA community?
- Do COVID-19 disruptions present any opportunities for the NNA community to do things differently or to strengthen collaborations?
- What could the NNA community achieve together over the next six months to a year given the current challenges and circumstances?
- How can these activities/actions serve as a stepping stone to what the NNA community might achieve together over the next 5+ years?

Session Notes: (Below is space to add your own notes, if you are printing this program book.)
Facilitator: Rapporteur:
Group Members:

Discussion Notes:

2.3: Data Sharing & Community Office Discussion

- Once you have been moved into your assigned break-out room by the meeting host, please switch on both your microphone and video as a courtesy to your colleagues
- A facilitator has been assigned to assist you with this break-out discussion.
- Your break-out group facilitator will introduce themselves at the top of the session & invite each member of the group to provide a brief self-introduction.
- The facilitator will ask one person to volunteer to be the group's rapporteur.
- Rapporteurs for this session will be responsible for sharing the group's top take-away with other meeting participants via Zoom chat at the end of the break-out period.
- The facilitator will document the names of each break-out group participant, as well as the group's rapporteur in a shared Google Doc at the top of the break-out session.
- The group will have one hour to discuss the focus questions associated with this session (see questions outlined below).
- The Zoom host will alert the group when only 10 minutes remain in the break-out discussion interval.
- When the break-out interval is over, you will automatically return to the main Zoom meeting room (no action on your part is needed).
- The facilitator will serve as the official note-taker/note collector for the group, ensuring notes are compiled and entered into the shared Google Doc at the end

of the break-out. They may also take notes (or have another volunteer from the group take notes) directly into the shared Google Doc during the session.

Desired Outcomes for this Session:

- Key discussion points from each break-out are captured by the group facilitator or a designated note-taker in a shared Google Doc.
- Break-out group rapporteurs share top take-away from their discussion with all meeting participants via Zoom chat.

Break-Out Group Focus Questions:

- What strategies for data sharing across the project teams are needed?
- What kinds of data/information do projects currently need to move their work forward?
- What additional data/information would be useful to help the NNA community produce new knowledge together?
- What other tools, activities, support services, etc would the NNA Investigator community like to see implemented by the new NNA coordination office?
- How can the community stay connected and continue working together before the NNA coordination office is in place?
- What would you like to see happen at the next NNA community meeting being planned for the Fall?

Session Notes: (Below is space to add your own notes, if you are printing this program book.)

Break-Out Group Theme:

Facilitator: Rapporteur:

Group Members:

Discussion Notes:

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Zoom Guide for Meeting Participants

Before the Meeting Begins

Before the meeting, we encourage you to take the following steps:

- Download the Zoom app in advance of the meeting.
    - The web browser client will download automatically when you start or join your first Zoom meeting, and is also available for manual download here.
    - Although you can participate in the Zoom meeting using a Smartphone, we encourage you to join the meeting using a laptop, as Smartphone connections may limit the options you have available to see and share information.
- Join a test meeting to test out your audio/video settings, internet stability, and to familiarize yourself with the Zoom user controls.
    - If you have a slow internet connection or are experiencing other network issues, you may want to join the meeting audio by phone. If you choose this option, make sure both your Zoom mic and laptop audio are muted (otherwise you may end up with audio feedback!).
- For better audio quality, consider using a headset/headphones.
- Look for a place to connect that has good lighting and where you will not be back-lit. This will make it easier for other participants to see your video image.
- If you are interested in learning more about Zoom, a visit to the Zoom help website may also be helpful!

Joining the Meeting

ZOOM Virtual Meeting URL: https://zoom.us/j/656502248
ZOOM Virtual Meeting Password: 221467

Dial-in #s (To Join Audio By Phone)
Dial by your location
+1 346-248-7799 US (Houston)
+1 669-900-6833 US (San Jose)
+1 253-215-8782 US
+1 301-715-8592 US

+1 312-626-6799 US (Chicago)
+1 646-558-8656 US (New York)
855-880-1246 US Toll-free
877-369-0926 US Toll-free
Meeting ID: 656 502 248
Find your local number: https://zoom.us/u/aedYvcfgKr

Meeting ID# 656 502 248
Meeting Password: 221467
If prompted for participant ID, press #

During the Meeting

During the meeting, the following details and "how-to" instructions may be useful:

- When you enter the meeting, your video will be switched off and your audio will be muted by the Host.
- You may turn on your video or mic at any time. However, we do ask you to keep your microphone muted when you are not speaking to help prevent disruptions and background noise. If you are joining the meeting audio by phone you can unmute and mute yourself by pressing *6.
- Your Zoom controls (video, mic, chat, etc) can be found by hovering your mouse over the bottom of your Zoom window.
- In the upper right hand corner of your Zoom window, there are also tools that will allow you to toggle your screen between the Speaker View (which focuses the video on the person speaking) and Gallery View (so you can see multiple people at the same time).
- During the meeting, we invite you to chat with the hosts and other participants by using the "Chat" feature found in your control bar.
    - You will have the option to chat with "Everyone" who is participating in the meeting or you can chat privately with the Host or other meeting participants by selecting their name from the drop-down menu accessed through the chat panel.
- If you would like to alert the Host to the fact that you have a question or comment, you will also have the option to "raise your hand". To raise your hand, click the "Participants" icon on your control panel. On the bottom right side of the Participants screen, click the "Raise Hand" button. To lower your hand, click the same button (now labeled "Lower Hand"). People calling into the meeting can also use the raise hand feature by dialing *9 on their phone.

- During the meeting, the Host may ask participants to change their Zoom name as part of the process to move into break-out groups. You can do this by clicking the “Participants” icon in your control bar and then locating your own name in the participant list that appears. Hover your mouse over your name and click the blue “More” button that appears. Clicking this button will take you to a drop down menu where you can select the “Rename” control. When you do this, a window will open asking you to “Enter new name here”. Type your new name into the box and click “Rename”.

Consent to Be Recorded

The meeting organizers do plan to record the NNA Investigators Meeting plenary sessions (break-out sessions will not be recorded) as a way to supplement note-taking and inform the meeting report. These recordings will not be shared publicly, however, plenary session recordings may be made available to NNA project teams in the future. If you have any concerns about being recorded, please contact Brit Myers at brit@arcus.org.

Navigating the New Arctic (NNA) Slack Workspace

We have created a new **Navigating the New Arctic (NNA)** workspace on Slack for you to connect and engage with other NNA Investigators and project teams.

We invite you to use the Slack channels to introduce yourself, exchange ideas, and to make connections with one another before, during, and after the virtual NNA Investigators Meeting.

Please use the link below to join the Slack workspace - it only takes a minute to create an account if you don't already have one! If you are a brand new Slack user, we also invite you to review this helpful "getting started guide" and overview video.

Click here to join the NNA Slack Workspace

Navigating the New Arctic (NNA)
Project Updates

NNA Track 1: Arctic impacts and reverberations of expanding global maritime trade routes (Award# 1927785)

Key Project Contact(s):

Elise Miller-Hooks, George Mason University, miller@gmu.edu, PI
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Ralph Pundt, Maine Maritime Acad., ralph_pundt@mma.edu, Consultant

Tanker Richard G Matthiesen

Project Website:

arcticexpansion.vse.gmu.edu

Project Objectives:

As the Arctic thaws, new opportunities for resource exploration and the opening of new trade routes are expected. Increased passage of commodities through these routes and the related industrialization of the Arctic will introduce both opportunities and risks. These changes pose challenges to the Arctic governance system and international relations, as Arctic stakeholders work to maintain global stability and protect not only the commercial viability of the U.S. Arctic, but also the local peoples, environment, and natural resources. These new opportunities in the Arctic have impacts that reverberate across the globe. This interdisciplinary project integrates mathematical, geophysical, computational, and social science knowledge needed to understand how the changing Arctic impacts world trade flows and supply chains and to understand the risks to the Arctic's natural and social ecosystems and governance systems. The research supports U.S. national security interests, addresses global economic welfare, and facilitates greater resilience to new threats to Arctic communities while allowing for sustainable Arctic development and economic growth. Educational and outreach activities include the use of multimedia to disseminate findings to multiple audiences, both academic and non-academic. Also, the investigators plan to conduct dialogues with local stakeholders and conduct international workshops. Lastly, the project fosters the promotion and retention of women and underrepresented minorities in engineering, including native Alaskans.

Keywords: Global maritime trade; governance and conflict; ice physics; meteorology; coastal dynamics; Arctic communities; participatory approaches; knowledge co-production; Arctic infrastructure; melting permafrost; AIS data; community-based monitoring; Utqiagvik, Alaska, Port of Nome

Progress to Date/Future Plans: Data collection, community-based monitoring (coastal erosion, surge heights and barriers, permafrost, tundra green engineering), global maritime system model, mathematical models, algorithms and computational tools are under development.

Highlights or Expected Outcomes:

- Stochastic and deterministic optimization models of the global maritime shipping network with approximately 150 top container and bulk cargo ports
- Scalable, globally convergent algorithms for assessing changes in global maritime trade flows with opening of the Arctic passageways under potential future ice melt scenarios and risk computations
- Predictions of changing trade routes and supply chains
- Co-production of knowledge from local organizations to support Arctic community resilience
- Application of traditional multi-ethnic and indigenous storytelling among local organizations to share risk perceptions, interpretations, and behaviors about managed coastal migration and maritime traffic with participatory action narratives to assess early warnings about social ecological consequences/conflicts
- Conflict early warning (CEW) indicators and larger CEW system for predicting conflict escalation
- High-resolution sea-ice projections of Arctic sea ice thickness, ice ridge stability, storm surges, and risks posed to ships from icing

- High –resolution multi-modal, multi-scale, multi-physics hydrodynamics models to predict waves/storm conditions impacting navigation and port infrastructure
- Arctic X-Beach extension to predict geomorphic change by incorporating thermal and mechanical processes associated with Arctic conditions
- Attitudes/perceptions/behaviors of indigenous/multi-ethnic residents about risk and response
- Participatory geospatial survey of managed migration and maritime traffic concerns and long-term adaptation
- Model validation using data from permafrost monitoring of critical bluffs, erosion surveys and surge heights impacting critical infrastructure and facilities/resources for maritime shipping
- Summer camps, outreach through ADECA and ARMNet about mitigation strategies, workshops, Websites

NNA Community Collaboration and Research Coordination: We are partnering with officials and residents of Utqiagvik, Alaska. We hope to be in that area every summer. We would be especially excited to work with others working at a global scale, on work related to maritime infrastructure or the Port of Nome, or in Northern Alaska.

Advice for Overcoming NNA Project Challenges: Global-level data advice (satellite vs. ground-based) would be great to have!

Bridging the Atomistic Deformation Mechanisms to the Microscopic Adhesive-to-Cohesive Fracture at the Ice-Metal Interfaces

Key Project Contact: Liming Xiong (PI)
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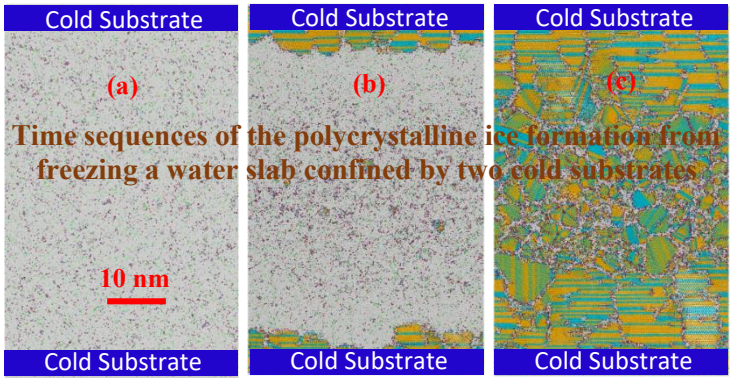
Project Website Urls & Social Media Accounts:
https://www.aere.iastate.edu/lmxiong/
https://www.aere.iastate.edu/~huhui/research.html

Project Objectives: Ice accretion over the surfaces of materials exposed to the cold environment is a topic of great concern for airplanes, wind turbines, and marine vessels sailing near the arctic area. However, a strategy of de-icing (detaching ice from cold surfaces) with minimal power cost is not well-established yet due to the lack of answers to a fundamental question on how the ice forms and sheds from a material surface. **The goal** of this project is to answer this question by identifying the atomistic mechanisms responsible for the fracture of the ice-metal interface. **Two specific aims** are: (i) to correlate the ice adhesion strength with the ice-metal interface structure; and (ii) to support the search of de-icing strategies that consume far less power than existing approaches. A series of high-fidelity computer simulations will be performed under a correspondence with the relevant experimental measurements in an Icing Research Tunnel at the PIs' institute. *This project will facilitate a rational design of materials that inhibit ice adhesion, with implications for safety-critical infrastructures operating in arctic areas, including telecommunication equipment, power lines, automotive vehicles, marine vessels, offshore oil platforms, and among many others*.

Keywords: icing and de-icing, ice-metal adhesion, crack propagation in ice, multiscale simulation



Progress to Date/Future Plans: through atomistic simulations, the PIs recently found a microstructure transition from "the columnar grain structure" to "the equiaxed grain structure" nearby the ice-substrate interface. Such a microstructure transition in turn, may dictate the commonly observed "adhesive-to-cohesive" fracture involved in a de-icing process. This is to be confirmed by experiments and higher length scale computer models in the next, which may be then utilized to guide the design of novel de-icing strategies.

Highlights of the Expected Outcomes: one main expected outcome of this research will be an integrated experimental and computational platform that can be used to understand how the ice is formed and how it should be removed from the surfaces of engineering infrastructures exposed to the cold environment in arctic areas.

NNA Community Collaboration and Research Coordination: the PIs do not conduct field experiments in any geographic areas nearby the arctic region yet, the gained knowledge thus far may not be directly applicable to understand the ice accretion on the infrastructures in arctic areas due to the lack of the information about the humidity, temperature, wind speed, water droplet size and chemistry in the field. If the support from the NNA community on this aspect is provided, an experimentally-validated computer software can be expected and will be delivered for predicting how the ice is formed from water freezing and how it fractures in arctic areas. This may also enable researchers to explore how the glacier fractures under current global warming conditions from the bottom up.

Advice for Overcoming NNA Project Challenges: if the support from the NNA community is not leveraged, it remains impossible for the PIs to directly use their platform on the infrastructures in arctic areas, although they have practiced in engineering, especially in computational mechanics of materials and experimental icing physics, for tens of years. The PIs believe that all the ongoing and overcoming NNA projects are multidisciplinary in nature, which remains as a challenge to each NNA project team, and should be clearly addressed whenever possible.

NNA Track 1: Collaborative Research: Arctic Urban Risks and Adaptations (AURA): a co-production framework for addressing multiple changing environmental hazards

Key Project Contact(s): Name, Institution, Email Address, & Role
Jennifer Schmidt, Institute of Social and Economic Research (ISER), University of Alaska Anchorage, jischimdt0@gmail.com, Principal Investigator

Project Website Urls & Social Media Accounts:
Website: https://www.respondtorisk.com/
Facebook Page:@respondtorisk
https://www.facebook.com/respondtorisk/
Facebook Group:

Respond to risk logo.

Project Objectives: Briefly explain the overall goals of the project, specific aims, methods, and broader impact activities/

Climate change is increasing vulnerability of arctic urban communities to natural hazards such as unstable permafrost, wildfire, and rain-in-winter events. These hazards put residents and property at risk and impose economic costs. Households, businesses, and governments must adapt to these multiple co-occurring hazards, which may have compound or off-setting interactions. The proposed research undertakes a spatially explicit assessment of the three natural hazards as they have evolved *simultaneously* in the Municipality of Anchorage and the Fairbanks North Star Borough, Alaska, and Whitehorse, Yukon, Canada over the past several decades, and how they might change over the next 40 years. Our interdisciplinary research team of economists, permafrost, fire, weather/climate, environmental scientists, and policy experts will conduct transdisciplinary research on arctic natural hazards and their impacts on the natural and built environments and society. The research team will work closely with local governments and non-governmental organizations (NGOs), Indigenous groups, insurance companies, and residents to co-produce knowledge on the costs, risks and actions taken to mitigate and adapt to these hazards. They will work with these stakeholders to identify trade-offs and interactions, develop a multiple-hazard risk assessment, and generate options for future adaptive planning. Research activities over four years include: (1) spatial modeling and mapping of natural hazards and their interactions; (2) gathering data to assess perceived risks, values at risk, and adaptation costs with interviews, property owner surveys, and citizen science; (3) economic modeling of costs and risks; and (4) developing in a series of scenario planning workshops an adaptive policy framework that can be used to adapt to and mitigate multiple hazards and reduce future costs and risks.

Keywords:
Arctic, risk, natural hazards, economics, urban, wildfire, permafrost, rain-in-winter

Progress to Date/Future Plans: Provide a brief research update describing progress to date or future plans.

We have created a website for the project and social media outlets (e.g. Facebook page and group). Monthly team meetings have been occurring since the start of the project and in November 2019 we had our in-person team kickoff meeting in Anchorage. A kickoff meeting

was also held with the Fairbanks North Star Borough. Kickoff meetings were scheduled with Anchorage and Whitehorse but have been called off due to the virus.

We have been working with Sustainable Earth, LCC. and the Anchorage Waterways Council, a NGO, to monitor water quality along Chester Creek in Anchorage since November. The goal is to assess the effect of chemicals used to treat icing on water quality. One November 22, 2019 we hosted a water quality monitor training with the Anchorage Watershed Council for residents and students to assist with data collection.

Highlights or Expected Outcomes: Provide a brief overview of any noteworthy deliverables or expected outcomes related to research or broader impacts.

We expect to produce vegetation and hazard maps showing location of historical and likely future permafrost thaw, annual fuel loads, and rain-in-winter frequency 10-year increments from 1980-2060. Then spatial data on the interaction of wildfire, permafrost, and rain-in-winter hazards with the social and built environment; measurements of environmental effects of actions to respond to rain-in-winter events; estimated total community costs associated with these hazards and maps showing the spatial distribution of costs and tax payments from property owners to cover estimated public costs; quantification of economic impacts on property values and risk associated with hazards at the individual property and community levels. By combining the hazards produce multiple hazard and risk maps; risk model that allows for the quantification of the effects, including interactions with other hazards, of actions taken to reduce risks; integrated costs of multiple hazards. Finally a consensus place-based management strategies for developing multiple-hazard plans, co-produced with stakeholders in each community.

NNA Community Collaboration and Research Coordination: What would you like to get from the NNA Community? Is there anything you would like to offer? Is your project working in any specific communities or geographic areas? When will you be there? What kind of resource sharing or project coordination opportunities would you like to explore?

Given that we are forced to do more distance-based interactions with communities what tools are there out there to help facilitate this new type of communication and outreach. From the NNA community I think we can learn valuable lessons on how to work with communities, both successes and struggles. It should be the responsibility of the PI/individual projects to gather feedback from communities and partners as to how the partnership is going. I would welcome advise about how to best do this so I can get real-time feedback without overwhelming them. A deeper reflectance on how community partnerships happened by an outside research project is appropriate after projects have been completed, but not during. The communities are already taxed enough and the COVID-19 virus is further limiting their resources. We work with Anchorage and Fairbanks Alaska and Whitehorse, Yukon. I had visits planned, but they are now postponed until an unknown time. Insights as to how to hold a community meeting virtually would be appreciated. This would include technology, but also how to keep them engaged and leave feeling the meeting was successful.

It seems that some of the projects might be using the same data and if we can find a way to share that data among projects without the communities having to compile the data for multiple

projects that would be in everyone's best interest. Some examples are property, real estate, historic infrastructure, etc. that might not be publicly available and thus require effort on the part of the community to get. Maybe a clearinghouse of data collected with the project/PI to contact about accessing.

Advice for Overcoming NNA Project Challenges: Are there any unique challenges that your project has had to overcome or is facing now? Are there any lessons learned or things you would suggest others do/do differently?

I am not sure why but providing funding from NSF to communities seems to be difficult for communities. Maybe one solution is to figure out a way money can go directly to communities rather than routed through universities. I don't have a good solution.

Emergency Response in the Arctic (ERA): Investments for Global Capacities and Local Benefits

Key Project Contacts: Engineering Team: Thomas Sharkey, Rensselaer Polytechnic Institute (RPI), sharkt@rpi.edu; Martha Grabowski, RPI, grabom@rpi.edu; Al Wallace, RPI, wallaw@rpi.edu; **Social Science Team:** Tom Birkland, North Carolina State University, tabirkla@ncsu.edu; Marie Lowe, University of Alaska Anchorage, mlowe@alaska.edu.

Project Objectives: Create operations research (OR) models that determine and co-produce knowledge on where, when, and how to build infrastructure that both (i) improves Emergency Response in the Arctic (ERA) and (ii) benefits local Arctic Alaska communities. In order to achieve this objective, we need to both understand how infrastructure improves ERA and how the local community would be impacted by the infrastructure (including the discourse around such investments). The team has formed community partnerships across Arctic Alaska in order to accomplish this research.

Keywords: Oil Spill Response, Search and Rescue, Mass Rescue, Governance, Infrastructure Planning, Community-Based Participatory Research

Progress to Date/Future Plans/Expected Outcomes:
Community-Based Research: We have formed an advisory committee of representatives from the North Slope Borough, the Northwest Arctic Borough, City of Nome, NANA Regional Corporation, the U.S. Coast Guard, and Alaska Clean Seas. The first meeting of this committee (March 2019) resulted in identifying several classes of "dual-use infrastructure" – infrastructure that both improves ERA and benefits communities – and community partners in Utqiagvik (visit in June 2019), Kotzebue (visit in July 2019), and Nome (visit in July 2019).

Dual-Use Infrastructure: In initial analysis and coding of community visits, *port infrastructure* and *telecommunications* emerged as both relevant and timely. Additional themes included the community's ability to maintain new infrastructure into the future and talked with us about how it might impact subsistence activities, either positively or negatively. Current research in this area is examining the discourse around Arctic infrastructure in the communities.

OR Modeling: We have created OR models to understand response capabilities to mass rescue events from cruise ships and oil spill response in remote regions. Our future plans are to model the benefits that different types of dual-use infrastructure bring to the community. We are creating an OR model that can assess how infrastructure development across the region could be accomplished that both benefits communities and improves ERA. The model will be able to answer "what-if" questions like "What level of (outside) investment is necessary in order to ensure that each community receives certain benefits?" The output of the OR modeling efforts will be validated through our community partners and adaptations will be made based on their concerns.

NNA Community Collaboration and Research Coordination: Our team would like to coordinate data, both from engineering and the social sciences, on discussions around infrastructure in Arctic Alaska. We are currently working in Utqiagvik, Kotzebue, and Nome; however, we have postponed visits to these communities until a vaccine for the coronavirus has been created.

Advice for Overcoming NNA Project Challenges: The key issue right now is altering our timeline in response to not visiting the communities. We are currently exploring remote visits (e.g., through Skype/Zoom/etc.); however, this can only partially address our research process as we seek to validate our research findings.

POLARIS: Pursuing Opportunities for Long-term Arctic Resilience for Infrastructure and Society (Award #1927827)

Key Project Contact(s): Guangqing Chi (gchi@psu.edu), Davin Holen (dlholen@alaska.edu), Lance Howe (elhowe@alaska.edu), Chris Maio (cvmaio@alaska.edu), Ann Tickamyer (art14@psu.edu)

Project Objectives:
Goal: POLARIS investigates how interconnected environmental stressors and infrastructure disruptions are affecting coastal Arctic Alaskan communities and identifies the important assets (social, environmental, infrastructural, institutional) to help them adapt and become more resilient to climate-related changes.
Specific Aim: We integrate our interconnected research pillars—(1) environmental hotspots of disruption to communities and infrastructure, (2) food in complex adaptive systems, and (3) migration and community relocation—to predict system responses and uncertainties under several socio-environmental scenarios.
Method: The team will combine data from proposed surveys, interviews, focus groups, and economic experiments with environmental and secondary social data, to be analyzed with a combination of spatial analysis, agent-based modeling, and scenario planning within a complex systems framework.
Broader Impact: POLARIS takes a deeply transdisciplinary approach to create significant impacts through the integration of research, education, outreach, community engagement, and international collaboration activities.

Keywords: Arctic, Indigenous communities, transdisciplinary, coastal, Alaska, convergence

Progress to Date/Future Plans: Progress: (1) The entire team has completed a successful trip to Dillingham, Alaska. We met with a panel of community leaders, held an evening community meeting and potluck for the community, and met with individual community members including educators and tribal representatives. (2) We are planning a scoping trip to Wainwright in Fall 2020 with data collection to begin in early Spring 2021. Plans: (1) We are also exploring multiple datasets, both publicly available and restricted data, for data analysis before we go to the field to collect quantitative and qualitative data. (2) We are in the process of developing questionnaires and interview instruments and securing IRB approval.

Highlights or Expected Outcomes: (1) A virtual museum of local Alaskan geography, landscape, and communities consisting of films (short 3-minute films for each community and one 30-minute film tying the project together), podcasts, photos, and 360° photos facilitated by a project website (arcticpolaris.org) and shared with other relevant sites. (2) Curricula to be co-developed with local teachers. (3) A user-friendly field protocol and training video module that provides a workflow to establish observation sites and conduct coastal hazard risk assessments.

NNA Community Collaboration and Research Coordination: POLARIS will have in-depth study of the Bristol Bay region and Wainwright, covering the sociological, demographic, economic, anthropological, and ecological aspects. We would like to collaborate with other projects in field work coordination and data sharing.

Advice for Overcoming NNA Project Challenges: One challenge is the possible resistance to scientists flooding into local communities. This is a challenge perhaps for all NNA projects especially given the ongoing COVID-19. One solution is that all NNA projects should be coordinated. We are happy to see that the NNA program is creating a center for this purpose.

Arctic Coastal Risk Network

Key Project Contact(s):

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Kevin Berry, University of Alaska Anchorage, kberry@alaska.edu, co-PI.

Project Website Urls & Social Media Accounts:

https://www.arcticcoastalrisk.net/

Community-engaged coastal research

Project Objectives: The overall project objective is to converge natural science, social science, and indigenous knowledge to define and communicate Arctic coastal risk. This objective is achieved with outreach activities at meetings and conferences, with the development of a project website where we communicate project activities, and with a demonstration project where we develop tools to define and communicate Arctic coastal risk. Broader impact activities include support of student research and direct engagement with coastal community members facing Arctic coastal hazards and risks.

Keywords: Arctic coastal risk, coastal hazards, community-engagement.

Progress to Date/Future Plans: Progress to date includes the following. (1) We have done outreach at conferences and meetings. (2) We have developed a project website (arcticcoastalrisk.net). (3) We have established a demonstration project at Hooper Bay Alaska, where we are developing methods to define and communicate Arctic coastal risk. In particular, following engagement with the Hooper Bay community, we have identified four critical coastal hazards/risks: coastal flooding, coastal erosion, permafrost thaw, and salinity intrusion. We are currently working to define the coastal flooding hazard, the risk (cost) of flooding to the community, and the risk reduction achieved by implementing countermeasures (raising the road elevation). We have simulated historic storm surge and flooding events and we have projected future flooding, identifying transportation infrastructure (roads) vulnerable to flooding. In the future, we will continue to develop methods to define and communicate Arctic coastal risk, including risks due to erosion, permafrost thaw, and salinity intrusion. We will also deepen our engagement with the community of Hooper Bay (site of demonstration project) to better understand their perception of risk.

Highlights or Expected Outcomes: The ongoing research incorporates indigenous knowledge and converges physical science and social science to define/project the Arctic coastal hazards and risks (costs) born by Arctic communities under both current and future conditions. The research will generate tools to support risk management and decision-making, in this rapidly changing environment.

NNA Community Collaboration and Research Coordination: There are a number of active NNA projects with a coastal focus. We would like to understand the efforts of these projects to achieve better collaboration and coordination. The PI's of five NNA RCN's are planning a joint workshop in 2021 entitled: "2021 Workshop on Arctic Coastal Communities, Hazards Remediation, and Resilience (2021 Arctic Coastal Workshop)", which will help to achieve this goal.

Advice for Overcoming NNA Project Challenges: Our project emphasizes collaboration with the Alaskan coastal community of Hooper Bay, which is a community of native Alaskans. We decided to develop a Memorandum of Understanding (MOU) with Hooper Bay entities in order to clarify the roles and contributions of the various parties in the collaborative relationship. An MOU was required for the Institutional Research Board (IRB) review of our project. Our advice to other researchers is to reach to research administrators to get advice on how to develop an MOU. Typically, researchers lack the authority to sign an MOU on their own.

Facilitating increased engagement between the research communities of Greenland and the U.S. (Award #1837806)

Key Project Contact(s):

Lauren E. Culler, Institute of Arctic Studies, Dartmouth, Lauren.E.Culler@dartmouth.edu, PI

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Sten Lund, Government of Greenland, stlu@nanoq.gl

Josephine Nymand, Greenland Institute of Natural Resources, Greenland Research Council, jony@natur.gl

Workshop leads (L to R) Lauren Culler, Ross Virginia, Josephine Nymand, and Sten Lund.

Project Website Urls & Social Media Accounts:

https://sites.google.com/dartmouth.edu/nuukworkshop

Project Objectives: The overarching goal of the project was to lead a workshop with researchers from the U.S. and Greenland to discuss how to increase and facilitate successful collaborations. Participants were tasked with setting priorities for future work and funding related to the following topics: Research and Co-produced Research; Public Outreach; and Education and Student Training.

Keywords: research collaborations, U.S.-Greenland, workshop, co-production, outreach, education

Progress To Date/Future Plans: A two-day workshop was held 27-28 August 2018 at Pinngortitaleriffik (Greenland Institute of Natural Resources, GINR), in Nuuk, Greenland, where researchers from the U.S. (19) and Greenland (29) explored possibilities for strengthening U.S.-Greenland collaborations. Workshop participants learned about research organization and infrastructure in Greenland (including U.S. research effort in Greenland), participated in interactive panels and discussed how to develop and facilitate successful collaborations. Participants also took part in an outreach event at Katuaq (the Nuuk cultural and community center).

Highlights or Expected Outcomes: Collectively, the group of workshop participants represents an initial U.S.-Greenland research network. The group was enthusiastic about working together and optimistic that research co-led by scientists from Greenland and the U.S. would be mutually beneficial. Participants agreed that more can be done by individuals, institutions, and funding agencies to overcome barriers for implementation of joint projects. We wrote a workshop report published in May 2019 that captures ideas and recommendations for improving the way that the U.S. and Greenland researchers collaborate on important Arctic projects (available on the website listed above). A translation to Kalaallisut (Greenlandic) is forthcoming in the next month. The workshop outcomes were presented at The Wilson Center in Washington, D.C. and at the Arctic Circle Assembly.

NNA Community Collaboration and Research Coordination: We offer ideas and suggestions regarding how U.S. researchers who work (or want to work) in Greenland can better engage with residents and researchers in Greenland. Our report contains descriptions of Greenland research institutions, links to websites with more information, and a list of Greenland researchers who were part of the workshop. We welcome contact from the NNA community regarding how to engage in research, outreach, and education in Greenland.

Advice for Overcoming NNA Project Challenges: We were very fortunate to have many Greenland researchers fully engaged in our workshop. What made this possible was hosting the workshop in Nuuk, which was logistically more complicated than hosting a workshop at our home institution. For projects that aim to engage Arctic residents and researchers, it is very important to make it easy for them to attend. Our report discusses this and other ideas for balancing participation of U.S. and Greenland in research projects.

NNA Track 1: A Systematic Pan-Arctic Analysis of Rain on Snow and Extreme Precipitation Events and their Impacts on Human-Environment Systems

Key Project Contact(s):
Mark C. Serreze, University of Colorado Boulder
Mark.Cerreze@colorado.edu, **PI**
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Shari.fox@nsidc.org, **Co-PI**


Mark C. Serreze

Project Website Urls & Social Media Accounts:
https://nsidc.org/rain-on-snow

Project Objectives: This project, a collaboration between the University of Colorado Boulder, the Alaska Pacific University and the University of Lapland, seeks to better understand the distribution, severity, and changes in the frequency of rain on snow (ROS) events and melt-refreeze events in the Arctic and their impacts, with a focus on hunting and in particular, reindeer herding livelihoods. By integrating with the NSF-funded ELOKA (Exchange for Local Observations and Knowledge of the Arctic) project, long-time research collaborations with Inuit hunters, communities in Northern Alaska, ecological research in Lapland and Russia, and language and cultural translation skills, this study will provide a truly pan-Arctic perspective of the effects of ROS and extreme precipitation events.

Keywords: Arctic, snow, rain, reindeer, hunting, Lapland, Alaska, Canada

Progress To Date/Future Plans: A project website has been set up. Papers were published on (1) quality of precipitation forecasts from atmospheric reanalyses and (2) ROS events over Alaska. A review paper is in preparation. Coordination has been initiated with the LEO project with Alaska Pacific University. ROS detection algorithms are under development.

Highlights or Expected Outcomes: A Data and Knowledge Hub, serving as the project website and a resource on knowledge regarding Arctic ROS and extreme precipitation events and their impacts, will also become the project's extension to the US Arctic Observing Network.

NNA Community Collaboration and Research Coordination: We are working with partners in Alaska, Canada and Lapland. We want to connect with other groups that may be involved with ungulate studies. ROS events also have impacts on hydrology, permafrost and sea ice conditions, and we want to connect with these groups in addition to climate modelers.

Advice for Overcoming NNA Project Challenges: None yet, provided that travel restrictions ease.

Integrating Language Documentation and Computational Tools for Yupik, an Alaska Native Language

St. Lawrence Island, Alaska

Key Project Contact(s):
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PI Sylvia L.R. Schreiner @ George Mason; sschrei2@gmu.edu

Project Website URLs & Social Media Accounts:
https://github.com/SaintLawrenceIslandYupik/
http://dowobeha.github.io/
http://www.sylvialrschreiner.com/research/yupik-project/

Project Objectives: Digitization, archiving, & community dissemination of legacy Yupik texts and audio. Development of foundational tools including finite-state morphological grammar & speech recognition system. Research to improve Yupik language documentation, including Yupik phonology, morphology, and syntax. Support of community-based language revitalization and education efforts.

Keywords: St. Lawrence Island, Alaska, Yupik, computational linguistics, language documentation, polysynthetic language, Bering Strait, phonology, morphology, syntax, morphosyntax

Progress to Date: Multiple trips to St. Lawrence Island for linguistic fieldwork & community consultation. Successful digitization of dozens of Yupik legacy texts & 100s of hours of audio. Successful development of 2 generations of finite-state morphological analyzer & prototype neural network-based analyzer. Preliminary work completed on speech technologies. Initial research on Yupik phonology, morphology, and syntax.
Successful creation of prototype interactive e-book delivered to local community school.

Future Plans: Continue language documentation efforts. Distribute technology & resources to local community.

Highlights or Expected Outcomes: Successful development of Yupik morphological analyzer coupled with successful use of this tool during fieldwork, resulting in quicker analyses of data & identification of gaps in existing language documentation.

NNA Community Collaboration and Research Coordination: We would like to connect with other researchers & communities involved in research and/or revitalization efforts involving other Inuit-Yupik languages.

Advice for Overcoming NNA Project Challenges: One extremely important factor contributing to the success of our project to date is the development and maintenance of strong personal connections with individuals and stakeholder groups in the local community where we conduct our research. We spent a non-trivial amount of time before the project began, at the beginning of the project, and continuing throughout the project, travelling to St. Lawrence Island and meeting with local stakeholder groups, talking with them about our proposed work, listening to their priorities and concerns, requesting their permission to conduct the research, and updating them throughout the project on project status. It is impossible to overstate the importance of actually spending time in the local community and taking the time to build relationships and earn the trust of the local community. There is a long and dark history of outside researchers swooping in, doing their work, and leaving without acknowledging or contributing to the local community and the local culture. As outside researchers, we have a crucial obligation to be highly cognizant of the negative history of colonialism, and to be proactive in shaping our research in such a way as to be highly sensitive to local Native culture, local Native needs, and to ensure that our research positively and concretely contributes to the local communities where we do our work in intentionally and actively anti-colonialist ways.

Co-production of shorefast ice knowledge in Uummannaq, Greenland

Key Project Contacts:
Johnny Ryan, Brown University, jonathan_ryan@brown.edu, PI
Sarah Cooley, Brown University, sarah_cooley@brown.edu
Amanda Lynch, Brown University, amanda_lynch@brown.edu, Co-I
Brigt Dale, Nordland Research Institute, bda@nforsk.no

Project Website Urls & Social Media Accounts:
Twitter: https://twitter.com/johnny_ryan_
Project summary: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1836473
Fieldwork: https://sarah-cooley.com/uummannaq-greenland-2019

Different modes of shorefast ice travel in Uummannaq Bay

Project Objectives: The overarching goal of the project is to understand the impacts of environmental change and how they matter to individuals, communities, and institutions in the Arctic by co-producing salient, timely and credible knowledge about shorefast ice in the Uummannaq region of West Greenland. To complete this goal, we will leverage large satellite remote sensing datasets, community-based monitoring and local and Indigenous knowledge. The involvement of residents and institutions in Uummannaq at all stages of the project, in combination with ongoing observations, will lay the foundations for ongoing community support and enable new insights into the complex repercussions of climate change. The findings will also enhance the ability of local residents and institutions to make informed and embedded choices concerning natural resource governance and management, as well as choices about individual and collective trajectories towards a desirable and sustainable future.

Keywords: sea ice, climate change, unmanned aerial vehicles (UAVs), drones, satellite remote sensing, community-based monitoring, Indigenous knowledge, Greenland

Progress To Date/Future Plans: Completed field campaign (April-May 2019) in Uummannaq which achieved many of the initial project goals. Made first major steps towards understanding the importance of shorefast ice for livelihoods and lifestyle of people in Uummannaq. Learned a lot from our outreach events and initiated some good relationships with local people. Conducted repeat drone surveys investigate shorefast ice melt and breakup at high spatial and temporal resolution. Documented shorefast ice breakup timing over the last twenty years in Uummannaq Bay using Landsat, Sentinel-2 and Moderate Resolution Imaging Spectroradiometer (MODIS).

Highlights or Expected Outcomes: Our satellite remote sensing research demonstrates that springtime air temperature is the dominant control on shorefast ice breakup, allowing us to make empirical predictions of shorefast ice breakup into the future using CMIP5 outputs. This work was recently accepted in Nature Climate Change, keep an eye out for the paper in May! One of the major findings of the fieldwork was learning that human activities may have an important impact on shorefast ice breakup in Uummannaq Bay. In some years, an ice-strengthened vessel breaks up the ice so that cargo ships can come to export frozen fish. The human impact on shorefast ice breakup was something we had not anticipated and adds another interesting dimension which may be important for understanding the impacts of environmental change in Uummannaq Bay.

NNA Community Collaboration and Research Coordination: We are working in Greenland and hope to be there every spring, although we had to cancel this year because of the virus. We have developed some good relationships with residents in Uummannaq and are interested to learn about how our experiences compare with other projects in other regions of the Arctic.

Advice for Overcoming NNA Project Challenges: Building relationships with local residents takes time. This can be difficult when there are other expectations of us as researchers (e.g. reports, articles, teaching). We would be interested to learn about ways of ensuring continuation of research and outreach activities beyond the 3-year project timeline. Perhaps some Navigating the New Arctic super-sites?

Sustainably Navigating Arctic Pollution – Through Engaging Communities (SNAP-TEC)

Key Project Contact(s): Bill Simpson, University of Alaska Fairbanks (UAF), wrsimpson@alaska.edu, lead PI, Jingqiu Mao, Nathan Kettle, Laura Conner, Krista Heeringa (UAF), Kerri Pratt (U. Mich.), Peter DeCarlo (JHU), Brent Williams (WUStL), Jochen Stutz (UCLA), Rodney Weber (GaTech)

Project Website Urls & Social Media Accounts: https://fairair.community.uaf.edu/; https://alpaca.community.uaf.edu/

Project Objectives: This project focuses on improving understanding of wintertime Arctic outdoor and indoor air pollution. The motivation for this study arose from public feedback from Fairbanks and North Pole residents, who are concerned about the air quality and spend large amounts of time indoors during cold winter months. We will address: 1) natural science aspects related to how pollution behaves under cold and dark conditions through a field study in Fairbanks, Alaska; 2) the built environment through sampling air from a house and comparing to outdoor air while varying indoor sources (e.g. wood / oil heat), and 3) social science aspects through surveys and a public participation in science (PPSR). These efforts focus on studying and co-producing knowledge about resident's attitudes, beliefs, and actions around air quality issues.

Keywords: Air pollution, Arctic, Communities, Societal attitudes, Co-production of Knowledge

Progress to Date/Future Plans: The project formally began in Fall 2019, although it has built from prior workshops and studies. Most of our current efforts have been building the framework for the various elements of the study and hosting two community meetings (one in Fairbanks, one in North Pole) in February 2020. These meetings started the process of identifying members to be involved in a community advisory group, finding people to be involved in the PPSR study, and identifying people / groups to be engaged in the survey development and deployment. We have now shifted to planning of the field intensive study, which was planned for Jan/Feb 2021. Due to the coronavirus situation, we are considering if a delay might be appropriate.

Highlights or Expected Outcomes: We expect the project will increase community engagement around air quality in Arctic cities, including developing appropriate solutions. Our field study will also deepen scientific understanding of pollution in cold and dark environments. The indoor air aspect will improve understanding of transformation of infiltrating particulate matter upon warming to indoor temperatures and how indoor sources affect indoor air quality. The results of the field study and social science work should help community planners with solving these air quality problems in locally appropriate ways.

NNA Community Collaboration and Research Coordination: We look forward to working with other NNA projects to understand implications of the changes to the New Arctic. We are interested in expanding our project, which has field studies in the Fairbanks North Star Borough, AK, to other communities and considering similarities and differences between communities that affect locally appropriate solutions to these problems.

Advice for Overcoming NNA Project Challenges: We are trying to determine how to do the field work and public meetings in the light of the coronavirus situation and needing to assure safety for participants and the community. Another challenge is that economic consequences of the shutdown could lead to increased woodburning and pollution, making the intended field study year an anomaly.

NNA: Collaborative Research: MSB-FRA: Peat Expansion in Arctic Tundra - Pattern, Process, and the Implication for the Carbon Cycle (TundraPEAT)

Key Project Contact(s): Julie Loisel, Texas A&M University, julieloisel@tamu.edu, PI and representative at the NNA meeting; other PIs: Zicheng Yu (lead), Steve Frolking, Phil Camill, Qianlai Zhuang.

Project Website Urls & Social Media Accounts: n/a.

Project Objectives: Overview: This new project looks at "peat patches", which have been observed in areas beyond the northern peatland biome limit. These patches may represent the initial stage of peatland formation under a warming climate. This warming-induced increase in belowground carbon storage can be seen as the equivalent of aboveground vegetation greening phenomenon. We want to find out how widespread these peat patches are, why they are there, and what factors control their formation, distribution, and dynamics. Main question: will the warming Arctic evolve into a peatland-rich landscape, as the boreal zone is now, or are there some essential conditions missing in a warming Arctic that will prevent this? Aims: (1) collect new data from multiple tundra sites along the northernmost peat-forming frontiers of the North American Arctic (north slope of Alaska 1 (Yu), Victoria Island (Loisel), Baffin Island (Camill); (2) perform lab incubations of soil and peat cores to analyze their decomposability under different temperatures (Loisel); (3) synthesize existing peat core data from the boreal and tundra biomes and develop empirical models (Yu and Loisel); (4) model ecosystem-scale peat accumulation process using HPM (Frolking) and P-TEM as well as LPJ-STM (Zhuang). Methodological approaches: (1) field observations, (2) lab analyses, (3) lab experiments, (4) data synthesis of existing literature, (5) ecosystem modeling, (6) data and model integration, (7) training, dissemination, and outreach. Broader impacts: STEM education and outreach includes a new project for the Texas Science Olympiads (for high school students) that will consist of calculating C stocks in soils from the Arctic on the basis of our own datasets, two to three annual visits to public schools to talk about climate change in the Arctic as well as the importance of science in addressing and mitigating the rapid climate changes, and an outreach symposium on what a greening Arctic means to the natural world and human cultures in collaboration with Bowdoin College's Peary-MacMillan Arctic Museum; we will also organize a photo exhibition at the museum. The team will also disseminate project information and results via townhalls and workshops (led by all PIs), and will present project results to conferences and in peer-reviewed literature.

Keywords: greening, carbon cycling, soil, recent warming, Toolik, Alaska, Cambridge Bay, Baffin, Canada.

Progress To Date/Future Plans: Completed/Progressing: (1) Field collection in Alaska and on Victoria Island (2019); (2) lab incubations and peat soil-core lab analysis (2019-20); (3) data synthesis (in progress); (4) HPM peatland simulations across a permafrost gradient (2019-20) and P-TEM peatland simulations (in progress). Future: (1) Field collection on Baffin Island (postponed to 2021 due to covid-19); (2) more lab incubations (2021) and soil-core lab analyses (2020-22); (3) continued development and validation of HPM, P-TEM, and LPJ-STM (2020-23); (4) model intercomparison and data-model integration (2021-23); (5) townhalls and outreach activities (2020-23).

Highlights or Expected Outcomes: we are still too early in the process to report any highlights!

NNA Community Collaboration and Research Coordination: we are interested in sharing datasets, expertise, and outreach material. The development of a framework within which datasets and other types of knowledge would be shared could benefit (and augment) everyone's work.

Advice for Overcoming NNA Project Challenges: work towards permits early! Have local contacts! A lot of the interactions we've had with local people are informal and difficult to plan for. Having extra time while in the field for unforeseen delays is key.

Dynamic Vehicle-Terrain Modeling and Control of Lightweight Ground Robots in Soft Terrain

Key Project Contact(s):
Laura Ray
Thayer School of Engineering, Dartmouth College
lray@dartmouth.edu
Principal Investigator

Project Website Urls & Social Media Accounts:
N/A

Project Objectives:
The objective of our research is to advance lightweight autonomous robots for long duration operation in soft terrain through an integrated approach to design, modeling, and control of such robots to *maximize mobility*. Specifically, we will advance vehicle-terrain interaction models for lightweight wheeled robots operating on low cohesion terrain, and we will develop approaches to control such robots based on these models that enable a robot to purposefully modify the terrain under its tractive elements and/or modulate a towed load to avoid immobilization. Advances in modeling and control for mobility in soft terrain will enable ground-based observing platforms to travel hundreds of kilometers with mobile instruments that measure physical change in snow-covered Arctic regions.

Keywords: Robotics, terramechanics, mobility

Progress To Date/Future Plans:
We have fabricated and fielded a low ground pressure robotic platform for developing and assessing vehicle-terrain interaction models for lightweight wheeled robots. We have completed our first field season this past winter in northern Quebec and are presently developing models to predict and avoid incipient immobilization.

Highlights or (Un)Expected Outcomes:
An international partnership organized through the Geological Survey of Denmark and Greenland (GEUS) provided an opportunity for team members to use robotic survey to find the fan hub of an Airbus A380 engine that failed in 2017 over the Greenland ice sheet in 2017. Robotic operations allowed the international team to safely find the buried part. With the failure identified, all A380 aircraft underwent rigorous inspection for and correction of the flaw.

NNA Community Collaboration and Research Coordination:
I am interested in collaborating with scientist whose Arctic fieldwork would benefit from long-distance robotic operations, e.g., towing scientific instruments to collect data over large spatial, temporal regions of the Greenland ice sheet or other Arctic regions.

Advice for Overcoming NNA Project Challenges:
Are there any unique challenges that your project has had to overcome or is facing now? Like others, we are currently faced with a pause owing to COVID-19. All graduate students are working from home. We are fortunate to have data from the winter field season during this time. Stay safe.

Navigating Disturbance Regimes in the New Arctic

(NSF Awards 1927772 and 1928048)

Key Project Contact(s):

Melissa L. Chipman, Assistant Professor, Syracuse University, mlchipma@syr.edu, Co-PI

Mark J. Lara, Assistant Professor, University of Illinois, mjlara@illinois.edu, Co-PI

Project Website Urls & Social Media Accounts:

https://mlchipma.expressions.syr.edu
http://go.illinois.edu/LaraLab
Twitter: @mchipman5 and @mjlara71

Project Objectives:

Objectives: The primary objective of our project is to evaluate the vulnerability and/or resilience of Arctic tundra in northern Alaska to multiple interacting disturbances. We will use a combination of ***remote sensing, chronosequence surveys, and lake-sediment archives*** to investigate the interactions between ***climate warming, wildfire, permafrost degradation, and shrub expansion*** in the Arctic on decadal to millennial time-scales.

Methods: (1) High-resolution time-series image analyses will detect permafrost degradation and tall shrub expansion over the past 70+ years, used to develop spatially explicit models of landscape evolution. (2) Above and belowground parameters measured from field to airborne (UAS hyperspectral/LiDAR) chronosequence surveys will unravel disturbance-climate interactions/feedbacks linked with landscape evolution. (3) Paleoecological reconstructions from lake sediments will be used to evaluate linkages between climate, wildfire, permafrost degradation, and shrub expansion, and to validate spatially-derived models.

Broader Impacts: We will develop tundra vulnerability maps for 18 Alaskan villages to optimize inter-village navigation, hunting routes, infrastructure development, and preservation of heritage sites. We will also develop STEM educational and outreach initiatives focused on training and collection of drone imagery to capture seasonal patterns of permafrost degradation processes using structure-from-motion photogrammetry techniques.

Keywords: wildfire, permafrost degradation, shrub expansion, time-series analysis, paleoecology

Progress to Date/Future Plans: We will focus on sample collection from two regions of the Alaskan Arctic. Our first field campaign will occur in late July 2020 and will include UAS acquisitions, soil/vegetation surveys, and lake-sediment coring from six sites near the Toolik Field Station. Our second field season is planned for summer 2021, and will repeat measurements in the Noatak River Watershed. Both PIs and 2-3 graduate students will conduct field activities. Additionally, we have launched a special issue in *Remote Sensing* entitled, "Dynamic Disturbance Processes in Permafrost Regions" and will be accepting submissions through 30 Sept. 2021.

Highlights or Expected Outcomes: Our research will result in several key deliverables, including new and extended spatial and temporal observations and interactions between permafrost degradation, wildfire, and shrub expansion in the Alaskan tundra. In addition, we will provide education, training, and technology to indigenous high school classrooms and provide new permafrost vulnerability products/maps to many Arctic communities.

NNA Community Collaboration and Research Coordination: Because one of the overall goals of this project is to advance knowledge of Arctic disturbances, we are very interested in leveraging the knowledge and experiences of other NNA scientists to learn of successful approaches for engaging with native Alaskan communities. We aim to develop synergistic educational and research activities with these communities to combine the perspectives of both scientists and residents in understanding these rapidly changing landscapes.

Advice for Overcoming NNA Project Challenges: N/A --this is a new project.

Maritime transportation in a changing Arctic:
Navigating climate and sea ice uncertainties

Key Project Contact(s):
Hiba Baroud, Vanderbilt University, hiba.baroud@vanderbilt.edu, PI
Alice DuVivier, University Corporation for Atmospheric Research (UCAR), duvivier@ucar.edu, PI
Ralf Bennartz, Vanderbilt University, ralf.bennartz@vanderbilt.edu, Co-PI.

Project Website Urls & Social Media Accounts:
https://www.nsf.gov/awardsearch/showAward?AWD_ID=1928112&HistoricalAwards=false
Twitter: @HibaBaroud

Project Objectives:
Goal: This project is developing and applying a risk-based framework integrating an analysis of environmental conditions, an assessment of navigation risk, and an evaluation of the consequences of incidents. Specific *Aim*: Identify climate and sea ice risk factors and calculate the likelihood and impact of Arctic maritime navigation incidents. *Method*: Probabilistic analysis of climate and sea ice projection models to evaluate environmental and navigability conditions. Predictive and economic models will integrate such projections with multiple data sources to evaluate the probability of an incident and assess the local and global economic impacts. *Broader Impact*: Support a safe, reliable, and resilient navigation system for shippers, emergency responders, local communities, and Arctic researchers.

Keywords:
Maritime navigation, sea ice, climate models, risk analysis, interdependent economic modeling

Progress to Date/Future Plans: We have started collecting and evaluating necessary model data (CESM-LE and others). Currently we are evaluating sea ice concentration in these climate projections against observed sea ice concentration for the period 1980-2019 to establish a baseline for the validity of the models in the context of this study.

Highlights or Expected Outcomes: Recommendations will be provided for how climate models can be useful to stakeholders assessing the risk and weighing the costs and benefits of Arctic navigation. The outcome of this research will guide the scientific community towards providing information to stakeholders on safe and reliable Arctic maritime expedition. While the focus of this proposal will be on specific Arctic routes, the framework can be applied to any maritime shipping route.

NNA Community Collaboration and Research Coordination: The NNA community can help us build a network of connections with shippers and other Arctic navigation stakeholders. Given the lack of data for such extreme events, some of the model parameters for the risk factors will rely on stakeholders' elicitation.

Advice for Overcoming NNA Project Challenges: The project just started, the main challenge at this point has been in the recruitment of personnel.

NNA Track [2] Planning Grant: Developing Arctic Village Resilience to Future Water Cycle, River Systems, and Coastal Change

Key Project Contact(s): Julie Brigham-Grette, Colin Gleason, James Temte University of Massachusetts-Amherst, and Alaska Native Tribal Health Consortium (ANTHC)/Alaska Pacific University (APU), Co-PIs. **juliebg@geo.umass.edu; cjgleason@umass.edu; jtemte@alaskapacific.edu**

Project Website Urls & Social Media Accounts: Facebook page and website planned. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1927644

Project Objectives: *Goal:* As arctic people navigate the new arctic, it is essential that communities chart a course that holistically considers both the physical world and human dimensions of these new realities. Accordingly, any rigorous study of the New Arctic must be grounded in the lived experience of its inhabitants and provide opportunity for tribes to take ownership over their own short- and long-term response to these grand challenges. *Aim:* This planning grant will set the foundation for a larger Phase 1 Navigating the New Arctic project to be proposed at the completion of this planning period *in collaboration with Native communities*. While the content of this future proposal is purposefully not set given the established need for planning and dialogue, we expect that our three focus areas will yield hypotheses and science goals that will answer important open science questions, while at the same time serving local communities as they look to the future. Specifically, we hope to gain a comprehensive view of community needs and prepare community members for responding to three areas of the New Arctic: (1) The impact of a changing climate on the municipal water cycle, (2) The impacts of coastal erosion, sea level rise, flooding, and river derived sediment delivery to harbor facilities, infrastructure, and health, and (3) The future of community water resources in an uncertain Arctic future. *Broader Impact:* This planning grant will identify new and exciting science questions as conceived by Arctic residents from their observations. In partnership, we will use the intersection of their knowledge and needs and our expertise to develop a integrated science plan that both addresses emerging issues but also serves to build capacity in the tribes and villages as the Arctic continues to change in the coming decades.

Keywords: NW Alaska, YK Delta, coastal erosion, river erosion, permafrost thaw, water supply, sanitation, managed retreat, education.

Progress to Date/Future Plans: Our planning process is now somewhat more challenging because of COVID-19. Given the planning that has already been done by villages and tribes and the current travel restrictions, we have worked by Zoom/email with community leaders already involved with planning and resilience issues. We are working through them to gather input on the greatest needs for research and observation that can be done as a future partnership and capacity building program.

Highlights or Expected Outcomes: Partnerships have been developed and zoom notes shared with all participants to maintain open dialog as we plan with communities using existing documentation.

NNA Community Collaboration and Research Coordination: We suggest starting with community needs and how an RFP might be focused on that. We are focused on the region of Kotzebue and the YK Delta. What protocols does NNA have for projects in the same regions?

Advice for Overcoming NNA Project Challenges: Our planning process is now somewhat more challenging because of COVID-19. We believe that the Kawerak et al. 2020 letter to NSF needs strong consideration for restructuring the proposal process.

Remote Sensing of Arctic Sea Ice Using the Super Dual Auroral Radar Network

Key Project Contact: Evan G. Thomas (Project Scientist)
Thayer School of Engineering
Dartmouth College, Hanover, NH
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Project Website Urls & Social Media Accounts:
N/A

Project Objectives:
Long-running observations of sea ice extent and characteristics are crucial to understanding environmental changes in the Arctic. The Super Dual Auroral Radar Network (SuperDARN) is an international network of ground-based, high-frequency (HF) space weather radars which have operated continuously in the Arctic and Antarctic regions for more than 30 years. The objectives of this project are to analyze historical and ongoing SuperDARN ground backscatter measurements for extraction of Arctic sea ice parameters. Comparisons will be made to sea ice measurements obtained from other remote sensing platforms such as space-based microwave sensors. An operational sea ice data product derived from SuperDARN HF radar observations will be submitted to the Arctic Data Center for long-term preservation and accessibility by the broader Arctic research community.

Keywords: remote sensing, high frequency, over-the-horizon radar, sea ice

Progress To Date/Future Plans:
We have retrieved the complete set of raw SuperDARN data files for the years 1993–2019, totaling more than 40 terabytes (TB) in size, from the online repository hosted at the British Antarctic Survey (BAS). We have processed these raw files using the standard SuperDARN analysis software to obtain fitted signal-to-noise ratio, line-of-sight Doppler velocity, and angle-of-arrival information necessary for accurate geolocation and separation of upper atmosphere versus ground backscatter returns. Further calibration of the ground backscatter mapping is underway, and real-time data links have been established to 17 of the 24 northern hemisphere radars. Next, we will begin comparisons of our radar-derived sea ice boundaries against independent data sets.

Highlights or Expected Outcomes:
The routine operation and maintenance of the more than 30 SuperDARN radars are supported by the funding agencies of 10 countries, including the National Science Foundation (NSF). This project will contribute to NSF's Arctic Observing Network by developing new techniques for the extraction of sea ice characteristics from a long-running data set collected by an existing network of space weather monitors.

NNA Community Collaboration and Research Coordination:
We would like to learn more about the other available Arctic observing platforms and how best to contribute our newly derived sea ice products for maximum benefit to the broader NNA community.

Advice for Overcoming NNA Project Challenges:
We are leveraging a large data set from an existing observational technology and network originally designed for upper atmosphere and space science research.

Navigating the New Arctic: Landscape evolution and adapting to change in ice-rich permafrost systems (NNA-IRPS)

Key Project Contact(s):

D.A. "Skip" Walker, UAF, dawalke@alaska.edu, PI

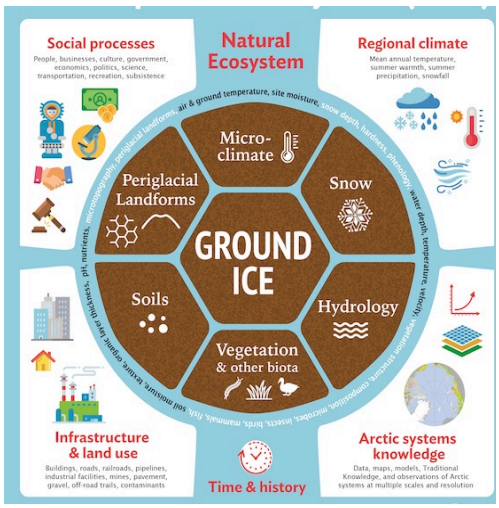
Jana Peirce, UAF, jlpeirce@alaska.edu, Project Coordinator

Project Website URL:

https://www.geobotany.uaf.edu/nna

Project Objectives (Briefly explain the overall goals of the project, specific aims, methods, and broader impact activities)**:**

Widespread thawing of ice-rich permafrost affects the entire Arctic ecosystem, making the ground unstable to build on and putting communities and infrastructure at risk. This National Science Foundation NNA project seeks to increase our understanding of ice-rich permafrost systems (IRPS) and their complex connections to the human, built and natural environments in Alaska and across the Arctic. From study sites in Prudhoe Bay and Point Lay, Alaska, the project will address questions of landscape evolution and adapting to change in ice-rich permafrost systems through the following activities.



Navigating the New Arctic with a focus on changing ground ice

Landscape Evolution: How do changes in climate, snow, water, disturbance, and time influence the thawing or stabilization of ground ice?

- Establish three new ice-rich permafrost observatories (IRPO) in roadside, natural, and village settings to study ground ice conditions and relationships with hydrology, vegetation and greenhouse-gas fluxes.
- Measure and monitor changes in permafrost by comparing on-the-ground observations with aerial and satellite imagery to determine how conditions have changed over time.
- Improve existing models and maps of permafrost extent and condition and the major environmental factors (temperature, hydrology, and vegetation) that impact them.

Adapting to Change: How can Arctic communities plan for and adapt to changes in these evolving permafrost landscapes?

- Work with the village of Point Lay and Cold Climate Housing Research Center to develop better solutions for designing and retrofitting housing foundations in areas at risk for thaw subsidence, in part by studying how past innovations have succeeded or failed.
- Work with Point Lay community to define community priorities for research questions and data to collect. Include community in project planning, research and reporting activities, and look for multiple ways to incorporate art and education into the project.
- Contribute to a synthesis of best practices for road and runway design, construction, and maintenance in areas of ice-rich permafrost. Host a permafrost symposium in 2021 with scientists and engineers from Alaska and Canada to address thaw subsidence-related issues in other critical village infrastructure.

The project partners will work with local residents, government agencies, the oil industry and the Alaska Department of Transportation and Public Facilities to develop best practices for road and house construction and related education materials. A post-doctoral student, a graduate student, and two undergraduate students will be part of the research team. A 17-day summer course field course "BIOL 495/695 Field Course: Arctic Alaska Vegetation, Permafrost, & Ecosystems" organized by the project will involve many of the NNA investigators in expeditions along the Elliott and Dalton Highways.

The project results will be communicated to circumpolar communities and the broader public and through numerous activities of the Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) action group of the International Arctic Science Committee (IASC) and the Terrestrial Multidisciplinary distributed Observatories for the Study of Arctic Connections (T-MOSAiC).

Keywords: Permafrost, ground ice, engineering, education, climate change, village infrastructure, housing foundations, adaptation, oilfield infrastructure, Point Lay, Alaska, Prudhoe Bay oilfield, Dalton Highway, RATIC, T-MOSAiC

Progress 2019-2020 (Provide a brief research update describing progress to date or future plans)**:**

- Bridging Science Art and Community in the New Arctic Workshop, UVa, 23-25 Sep 2019
- Reception for Point Lay tribal and village corporation representatives, Alaska Federation of Natives Convention, Fairbanks, 18 Oct 2019
- Recruitment of Post-doc (Dr. Helena Bergstedt, AWI) and graduate student (Emily Watson-Cook, U. North Carolina Chapel Hill)
- Undergraduate recruiting presentation, Alaska Native Science and Engineering Program, 4 Feb 2020
- Development of team science Project Collaboration Plan with Pips Veazy, Jan 2020
- IARPC, online NNA-IRPS presentation, 19 Feb 2020
- Kali Community/Regional Advisory Meeting, 21 Feb 2020 (teleconference with project partners and representatives from two other NSF projects working in Point Lay)
- Monthly NNA-IRPS project meetings, UAF

- Monthly Soup and Science project talks, UAF
- Development of summer research plan, Prudhoe Bay and Point Lay
- Created video to introduce project to Point Lay residents: https://www.youtube.com/watch?v=ZjhkoA2Ziww&feature=youtu.be
- Currently conducting literature and interview review of permafrost-related foundation issues and solutions across the circumpolar North
- Custom design and purchase of LiCor gas analyzer and compatible data logger connected to environmental data probes for field CO_2 and CH_4 flux measurements
- Zoom coordination meetings with RATIC and T-MOSAiC , 15 Nov, 18 Dec, 22 Jan, 26 Mar

Highlights or Expected Outcomes (Provide a brief overview of any noteworthy deliverables or expected outcomes related to research or broader impacts):

2020: Submit at least three articles to *Arctic Science* special issue for T-MOSAiC: "**Terrestrial Geosystems, Ecosystems and Human Systems in the Fast-Changing Arctic" https://nunataryuk.org/news/136-t-mosaic-special-issue-of-arctic-science:**

1. Walker, DA, Raynolds MK, Kanevskiy MZ, Shur Y. Jorgenson MT, et al. 2020 in prep. Cumulative effects of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska.
2. Kanevskiy M, Shur Y, Walker DA, Jorgenson MT, Raynolds MK, Wirth L M, et al. 2020 in prep. Cryostratigraphy of the upper permafrost and risk of ice-wedge thermokarst in relation to road infrastructure, Prudhoe Bay oilfield, Alaska.
3. Shur Y., Kanevskiy M., Walker DA, Jorgenson MT, Buchhorn M, Raynolds MK. 2016. Permafrost-related causes and consequences of Sagavanirktok River flooding in Spring 2015.

2021: Permafrost symposium in Point Lay, AK, with scientists and engineers from Alaska and Canada to address thaw subsidence-related issues for critical village infrastructure.

NNA-Community collaboration and research collaboration needs (What would you like to get from the NNA Community? Is there anything you would like to offer? Is your project working in any specific communities or geographic areas? When will you be there? What kind of resource sharing or project coordination opportunities would you like to explore?):

1. Development of a dialog with the oil industry in northern Alaska to better address the key questions related interactions between climate change and industry activities.
2. Greater involvement or coordination at the program level in addressing the policy dimensions of the Alaska and pan-Arctic issues that NNA projects are investigating.
3. Greater involvement at the program level in helping villages and communities to develop NNA research and coproduction of knowledge and in managing expectations (at the village level, within project teams, and at NSF) about the degree and range of coproduction to expect from remote Arctic communities.
4. Cross-project coordination of NNA research activities, especially in the villages to make sure that the science is addressing community needs and to minimize impacts to communities.

5. We will be working in Prudhoe Bay and in Point Lay, Alaska. We were to visit Point Lay in mid-April. That trip has been postponed. We have scheduled field work in Point Lay and Prudhoe Bay in August. We do no know if those trips will need to be postponed.
6. We are coordinating our research and community outreach plans with two other NSF projects working in Point Lay, and we will continue to do this.

Advice for Overcoming NNA Project Challenges (Are there any unique challenges that your project has had to overcome or is facing now? Are there any lessons learned or things you would suggest others do/do differently?)**:**

Coronavirus crisis caused cancellation of many planned summer-2020 activities, including the summer field course, first visit to Point Lay, and early-summer reconnaissance field activities, and is causing numerous other logistical rearrangements and coordination with CPS.

The Role of New England in Navigating the New Arctic

Key Project Contact(s):

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Jack Dibb, UNH, jack.dibb@unh.edu, SP
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2018 NSF Convergence NNA workshop at the University of New Hampshire

Project Website Urls & Social Media Accounts:

http://nearctic.net
facebook.com/neanconvergence; @neanconvergence

Project Objectives: Assess the socio-economic and bio-physical links between Arctic change and New England; identify transformational convergent research that will anticipate, prepare for, and adapt to future challenges and opportunities.

Keywords: Convergence, North Atlantic Arctic, Regional Network

Progress to Date/Future Plans: Continued progress underway in the following areas:

- *Predict Socioeconomic Scenarios* for New England and the Arctic during ongoing major Arctic change, *Strategically Balance* environmental ethics and social justice with economic considerations and fully *Engage Stakeholders* in the design and execution of research.
- Include the *knowledge of Indigenous peoples* and promote *citizen science* to understand the scale and rate of change of inter-linked systems in the Arctic and connected regions.
- Develop a *collaborative Regional Network* (New England Arctic Network, NEAN) to support research and informed decision-making in response to Arctic change.
- *Train the next generation of Arctic researchers,* including Arctic System Change, Convergence Research with community partners and field experiences in the Arctic.

Highlights or Expected Outcomes:

- Developed visions of how Arctic change might create opportunity, risks, and hazards along the eastern coast of North America over a continuum of time scales from urgent to intergenerational.
- Established a New England Arctic Network to prepare for multi-institutional convergent response to the coming cascade of changes across all systems in the broadly defined region.
- Created core collaborative teams in line with NSF Navigating the New Arctic.

NNA Community Collaboration and Research Coordination:

- There is a critical need to support large-scale research initiatives focused on changes in the North Atlantic sector of the Arctic and resultant impacts on communities in eastern North America, including Greenland.
- Continue building a collaborative regional New England hub of Arctic researchers and educators to bring greater understanding of the global impacts of Arctic change to all communities and community members.

Advice for Overcoming NNA Project Challenges:

The following are barriers and needs to ensure continued progress:

- Ways to secure funding for planning grants to engage Arctic communities with researchers who do not yet have solid community relationships in order to identify priorities and collaborations (capacity-building).
- New pathways for funding international research (cooperative agreements among nations to overcome the barrier that NSF is unable to fund international collaborators)
- Provide opportunities for funding interagency collaborations (e.g., research initiatives that include FFRDCs)

Project Unangam Ulaa

Project Update April 2020

APIA & NSF

Award #1928254

Detail from "*Natives of Oonalashka and their Habitations*" Webber 1778

Oral tradition says the Unangax people have lived in the Aleutian Islands since the beginning of time. Unangax created dwellings – Unangam Ulaa – from locally available resources (driftwood, whale ribs, grass, and dirt) that provided shelter and spiritual comfort for eons.

Key Project Contacts:

	Michael Livingston		Millie McKeown		Karen Pletnikoff		Vincent Tomalonis
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	Cultural Heritage		Cultural Heritage		Environmental		Cultural Heritage
	907-276-2700		907-276-2700		907-276-2700		907-276-2700

Aleutian Pribilof Islands Association (APIA*) 1131 East International Airport Road Anchorage, Alaska USA 99518

*APIA is an Alaska Native non-profit organization formed pursuant to the Federal Alaska Native Claims Settlement Act (ANCSA) of 1971

Project Website URLs & Social Media Accounts:

https://www.apiai.org/departments/cultural-heritage-department/culture-history/

https://www.facebook.com/APIAI/

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1928254&HistoricalAwards=false

Project Objectives: Briefly explain the overall goals of the project, specific aims, methods, and broader impact activities.

The hypothesis being tested in this project is whether ancient construction techniques of the Unangam Ulaa can be applied to modern materials to build energy efficient dwellings. We are in the two-year planning phase for the five-year field research. Our methods focus on interviewing elders and reviewing literature for strong cultural-based foundation; see outcomes below.

Keywords: Unangam Ulaa, Aleut Barabara, Traditional Sod House, Aleut, Aleutian, Pribilof, Unangaŷ

Progress to Date/Future Plans: Provide a brief research update describing progress to date or future plans.

For the two-year planning phrase, we have assembled a team of Unangaŷ/Aleut people, engineers, archaeologists, architects, and social scientists to form a strong cultural appreciation of the traditional dwelling and the surrounding spirituality. In Nov 2019, we all met, and everyone introduced themselves, talking about or "superpowers." We hired research assistant Vincent Tomalonis in Feb 2020. We presented a preliminary report at the Alaska Anthropological Association annual conference in Fairbanks in Feb 2020. Dr. Doug Veltre gave an awesome presentation of the archaeological history of the Unangam Ulaa in Feb 2020. We are working on our elder questionnaire, our community SWOT (strengths, weaknesses, opportunity, and threats) surveys. We are rough drafting our preliminary report to submit for publication. We are working on a rough draft of a web site and pushing ourselves to learn 3D animation (Blender 2.82a). We hope to soon interview elders and plan for field research. We are working on five papers (linguistic, archival, anthropological, construction, social science).

Highlights or Expected Outcomes: Provide a brief overview of any noteworthy deliverables or expected outcomes related to research or broader impacts.

If we can design and build an energy-efficient dwelling based upon a design from the Aleutians that is thousands of years old, these designs may be replicated in other regions to stave the decimation of Arctic villages with eons of cultural knowledge.

NNA Community Collaboration and Research Coordination: What would you like to get from the NNA Community? Is there anything you would like to offer? Is your project working in any specific communities or geographic areas? When will you be there? What kind of resource sharing or project coordination opportunities would you like to explore?

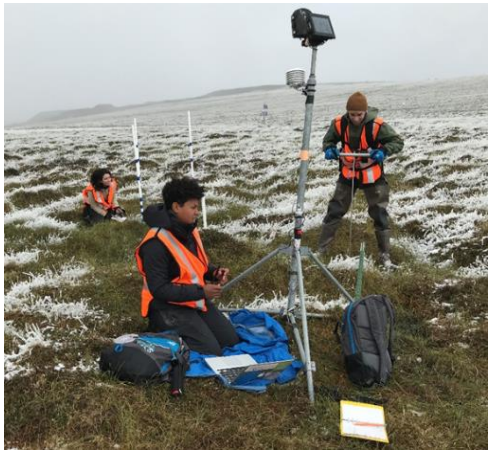
We would like to know more about the other projects, research questions, goals, challenges, how challenges overcame.

Advice for Overcoming NNA Project Challenges: Are there any unique challenges that your project has had to overcome or is facing now? Are there any lessons learned or things you would suggest others do/do differently? Advice Stay optimistic. Consult with optimistic people. (We really did not expect to win the award.) Don't pin yourself into the box. Don't say, "We will do A." Instead, say, "We will do A, but we also have Plan B and Plan C. Oh, and we also have Plan D and E." Challenges In Nov 2019, a plane crashed in Unalaska (first commercial plane fatality in US in ten years), stymying travel to our villages. In Mar 2020, COVID-19 struck, thwarting travel and causing concern for Unangaŷ elders.

Awards No: 1836377 and 1836381 **NNA Collaborative Research: The Circumpolar Active Layer Monitoring Network-CALM V (2019-2024): Long-term Observations on the Climate-Active Layer-Permafrost System**

Key Project Contact(s): Nikolay Shiklomanov, GWU, shikom@gwu.edu, (PI); Frederick E. Nelson, NMU, fnelson@udel.edu, (PI); Dmitry Streletskiy, GWU, strelets@gwu.edu (Co-PI); Nathan Moore, MSU, moorena@msu.edu (Co-PI); Anna Klene, UMT, Anna.Klene@umontana.edu; Kelsey Nyland, GWU, knyland@gwu.edu

Project Website Urls: https://www2.gwu.edu/~calm/; https://gtnp.arcticportal.org/



CALM V observations at one of the monitoring sites in Alaska.

Project Objectives: The Circumpolar Active Layer Monitoring (CALM) program, which is an integral part of the *Global Terrestrial Network for Permafrost*, represents the only coordinated program providing collection, standardization, open access, and dissemination of active-layer data. The NNA CALM project supports the active-layer observations at 32 Alaskan and 54 Eurasian sites. The objectives of the CALM project include standardized observations of the active layer, ground temperature, and thaw settlement measurements, integration of data to provide the basis for comprehensive assessments of changes in the active-layer and near-surface permafrost, and preparation and dissemination of data sets to assist detailed process studies, and in validating and developing climate-change, ecological, hydrological, and geocryological models. Educational and outreach activities are an integral part of the research. The project provides opportunities for field experience and educational participation at levels ranging from grade school through postdoctoral. The circum-Arctic nature of CALM fosters extensive international collaboration between students involved in project activities. An outreach component of the project includes extensive involvement of local, predominantly indigenous, people in observational program at remote Arctic sites.

Keywords: *permafrost; active-layer thickness; thaw settlement; ground temperature; long-term observations.*

Progress/Future Plans: During summer 2019, standardized active-layer and ground temperature observations were conducted at 29 Alaskan and 43 Russian sites. Detailed vegetation and landscape characterization at North Slope of Alaska sites is planned for summer 2020.

Highlights or Expected Outcomes: A quarter-century of continuous active-layer thickness records for Alaskan and Russian sites representing diverse climatic and environmental conditions.

NNA Community Collaboration and Research Coordination: The CALM V project and its predecessors have amassed a very large data set on active-layer thickness (ALT), nearly continuous high-resolution air and ground temperature records at many sites, and thaw settlement at selected sites. We offer unfettered access to these data sets, which can be useful for scientists working in the fields mentioned above. CALM field installations are actively collecting data throughout the Kuparuk River Basin, in the Barrow and Nome areas, and in many parts of northern Russia. The CALM V project is open to collaborative activities in any area of science or social science in which active layer data may be useful. We hope to be in the field during August 2020.

Advice for Overcoming NNA Project Challenges: Detailed and comprehensive field logistics planning; strong international coordination and collaboration; involvement of local communities; student training and involvement.

NNA: NSFGEO-NERC: Collaborative Research: The Integrated Characterization of Clouds, Energy, Atmospheric state, and Precipitation at Summit, Aerosol-Cloud Experiment (ICECAPS-ACE) - Award #: 1801764

Key Project Contact(s):

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Project Website URLs & Social Media Accounts:

https://psl.noaa.gov/arctic/observatories/summit/browser/
https://psl.noaa.gov/arctic/observatories/summit/
http://icecaps.ssec.wisc.edu/

Project Objectives:

This project is an international collaboration that between the original ICECAPS researchers through the U.S. National Science Foundation's Arctic Observing Network and a team of aerosol researchers through the U.K. Natural Environment Research Council. The ICECAPS project has continuously operated a suite of ground-based instruments at Summit Station, Greenland since 2010 for observing clouds, precipitation, and atmospheric structure. The project has significantly advanced understanding of cloud properties, radiation and surface energy, and precipitation processes over the Greenland Ice Sheet (GrIS), while also supporting process-based model evaluation, development of new measurement techniques, ground comparisons for multiple satellite measurements and aircraft missions, and operational radiosonde data for weather forecast models. The ICECAPS-ACE project is pursuing two new major goals between 2018 and 2021: 1) provide a better understanding of aerosol-cloud interactions over the GrIS and how they impact the surface energy budget, and 2) provide observations that can be used for numerical model assessment as part of the Year of Polar Prediction (YOPP).

As society begins to acknowledge the implications of climate change, it is necessary to understand how the physical climate system operates and evolves. Greenland is of critical importance to human society because it is currently a large contributor to sea-level rise, and the GrIS is melting at an accelerating rate. Providing a better understanding of the interactions between aerosols and clouds is of direct societal value because of their ultimate impact on the GrIS mass budget.

Keywords:

Greenland, Summit Station, clouds, aerosols, precipitation, surface energy budget, climate

Progress to Date/Future Plans:

Data archives:

- https://arcticdata.io/catalog (Search on PIs names)
- https://psl.noaa.gov/arctic/observatories/summit/browser/
- https://www.arm.gov/data (Search on "Summit Station")

Publication list:

- http://icecaps.ssec.wisc.edu/pubs.html

Highlights or Expected Outcomes:

- Description of ICECAPS concept and instrumentation (Shupe et al, 2013),
- Processes that affect the surface energy budget (Miller et al, 2017) including near-surface temperature inversions (Miller et al, 2013),
- Downwelling infrared radiation (Cox et al, 2014),
- Cloud radiative forcing (Miller et al, 2015),
- Humidity trends in the Arctic (Cox et al, 2015),
- Relationship to large-scale circulation (Gallagher et al, 2018),
- The annual cycle of snowfall at Summit (Castellani et al, 2015),
- Precipitation regimes over the GrIS and their relation to large-scale circulation (Pettersen et al, 2016; Pettersen et al, 2018),
- The importance of supercooled, liquid water clouds to the 2012 melt event (Bennartz et al., 2013; Van Tricht et al, 2016) and the GrIS and Arctic, in general.
- Importance of large-scale circulations and continental heat anomalies to Greenland melt events in 1889 and 2012 (Neff et al, 2014).

Currently working on research related to aerosol direct and indirect effects on cloud properties, aerosol radiative effect of the surface energy balance and the two surface melt events that occurred in 2019 at Summit Station.

NNA Community Collaboration and Research Coordination:

The ICECAPS-ACE research team has a long list of international collaborators that use ICECAPS data. The data are freely available in near-real time, and we encourage researchers to contact us if they have an interest in any of the ICECAPS data products or in collaborating with us on research projects that might benefit the larger NNA community.

Advice for Overcoming NNA Project Challenges:

Like many research field teams, we are facing the possibility of reduced field access and operations this summer (2020). These are present serious challenges to the continuation of certain aspects of our project.

Our team has a lot of experience with successfully operating instrumentation in low-temperature environments, so we would be happy to advise others that might be considering future instrument deployments in the Arctic.

Closing the Water Vapor Exchange Budget Between the Ice Sheets and Free Atmosphere

Key Project Contact(s):
Bruce Vaughn
INSTAAR, University of Colorado
Bruce.vaughn@colorado.edu
Principal Investigator NNA: AON: EAGER: #1833165

Project Website Urls & Social Media Accounts:
https://instaar.colorado.edu/people/bruce-h-vaughn/

Project Objectives: This project has deployed the first UAV with a gas-sampling pod optimized for water vapor collection and analysis in the field following flight. In doing so, the project stands to provide the first detailed and high-resolution airborne measurements of water vapor isotopes in the critical atmospheric boundary layer just above the Greenland Ice Sheet. The exchange processes across the interface between atmosphere and the surface of the ice sheet control the climate signal archived in ice cores, and vapor flux constrains sublimation and by extension, a portion of ice sheet mass balance.

Keywords: Water vapor, Isotopes, Arctic, Greenland ice sheet, Hydrology, Snow surface, Mass balance

Progress To Date/Future Plans: We have successfully deployed a multi-rotor UAV and a 3 meter fixed wing UAV aircraft for proof of concept to obtain profiles above the Greenland Ice sheet of temperature, pressure, humidity and made measurements of discrete samples for water vapor content and isotopic signature. Future plans include new and improved sample collection payload, better and faster temperature and humidity sensors, automated boundary layer detection, and improved flight control. Team has expanded to include expertise with MAR models and will return to Greenland for final season in 2021 to obtain high-resolution data in space and time.

Highlights or Expected Outcomes: We have helped pioneer the pathway for overcoming challenges associated with flying UAV aircraft in the cold and challenging high Arctic environment. We have identified and solved a number of hurdles in collecting and making accurate measurements of water vapor isotopes from the surface to 1500 m aloft including low humidity samples. This has potential applications to help validate other ground based and satellite measurements of water vapor (eg. TCCON). With the addition of more data, we hope to inform regional atmospheric models (MAR) for higher quality outputs. The sample collection method may also be applied to sampling other gases of interest. The fixed wing UAV with a modular configuration will also leverage new applications that can employ on-board instruments for in situ measurements, such as methane.

NNA Community Collaboration and Research Coordination: I am interested in connecting with other NNA researchers exploring water vapor isotopes, near surface atmospheric measurements or other surface processes. Since we have a proposal pending to extend our work to measuring methane other parts of the Arctic, I would be interested in leveraging projects of mutual interest that could couple our measurements with others at different scales across thermokarst environments.

Advice for Overcoming NNA Project Challenges: We've learned a bit about operating UAV aircraft in the Arctic environments and happy to share what we've learned. In general: Design, plan, fabricate, build, test, evaluate, and repeat until satisfied. A balance tenacity and patience is helpful.

NNA Track 2: Collaborative Research: Interactions of Environmental and Land Surface Change, Animals, Infrastructure, and Peoples of the Arctic

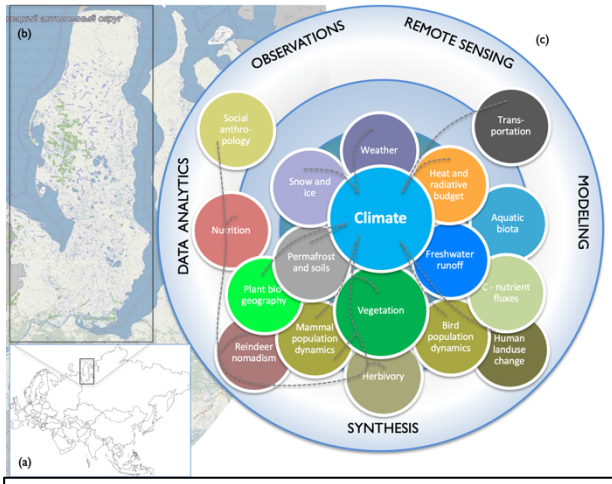
Key Project Contact(s): Name, Institution, Email Address, & Role

Valeriy Ivanov, University of Michigan, ivanov@umich.edu (PI, Abiotic systems & Infrastructure)

Peter Ungar, University of Arkansas, pungar@uark.edu (Co-PI, Biotic systems)

John Ziker, Boise State University, jziker@boisestate.edu (Co-PI, Social systems)

Project Website Urls & Social Media Accounts:
No centralized accounts but active on:
Ivanov: **Twitter**: @hydrowit
Instagram: valeriy_ivanov2208
Peter Ungar: **Twitter**: @PeterSUngar, @Ungarlab
Instagram: pungar
https://ungarlab.uark.edu/arctic-research/
Sokolov: **Instagram**: arctic_lab_yamal
Ziker: **Twitter**: @drziker



The study region of Yamal, Russia (a, b) and an overview of *land* Arctic system elements (c) specific to this region. The innermost circle (Level 1): connection between climate and geophysical processes. The second circle (Level 2): biological elements that respond to abiotic drivers with feedback mechanisms. The outer circle (Level 3): the elements of social system and built environment that interact with the abiotic and biotic constituents.

Project Objectives: Briefly explain the overall goals of the project, specific aims, methods, and broader impacts
The project aims at developing a Track 1 proposal for the study of the Yamal region of northern Russia as an ideal natural laboratory for transdisciplinary work to understand the complexity and adaptation of Arctic biotic and abiotic systems to climate change, and the feed-forward and feedback mechanisms modulating the co-evolution of human society and natural systems. The participants focus on developing research ideas and approaches for testing the hypothesis that displacing Arctic systems from their historic state of dynamic equilibrium under changing environment stimulates further changes to abiotic, biotic, and socio-cultural elements, particularly when combined with the spread of industry infrastructure, to increase the role of feed-forward and feedback mechanisms. Planned activities include two workshops, monthly virtual conferences, international capacity building, a synthesis paper, and the submission of Track 1 proposal in 2021. Broader impacts of this project. *Scientific community*: This project has strong international collaboration, engaging scientists representing various disciplines from USA, Europe, and Russia. *Education and outreach*: Our planned, on-site workshop will include outreach and educational programs for the public in Salekhard, Russia. We are developing curricula for a collaborative, transdisciplinary online inter-institutional course emphasizing a transdisciplinary view of Arctic science. The course will be team-taught by PI Ivanov and co-PIs Ungar and Ziker along with academic collaborators in the US, Europe, and Russia and having both classroom and online components. Registration for the Fall of 2020 has begun and the course is open to students at the University of Michigan, University of Arkansas, and Boise State University. *Community engagement*: this project will engage stakeholders, those representing government and industry in Yamal and the indigenous Nenets people of the region.

Keywords: Arctic, Yamal, reindeer, snow, permafrost, vegetation

Progress To Date/Future Plans: Provide a brief research update describing progress to date or future plans.
The team has been meeting virtually on a monthly basis between September 2019 and March 2020. We have developed comprehensive disciplinary summaries from numerous fields of expertise that are part of this planning project representing nearly 30 people (of which 22 are senior personnel). We have held a virtual 5-day project in late March synthesizing knowledge and crystallizing ideas and research threads for the Track 1 proposal. We will continue with monthly virtual meetings before a Workshop in Labytnangi, Russia, in October 2020.

Highlights or Expected Outcomes: Provide a brief overview of any noteworthy deliverables or expected outcomes related to research or broader impacts.

This planning project is developing ideas allowing the integration of earth system sciences, biological sciences, engineering, and social sciences within two outlined transdisciplinary "transects" of Arctic dynamics in the context of Yamal region: (1) gradual warming, and (2) extreme weather events. This project focuses on developing approaches related to feed-forward dependencies and feedbacks between 1) vegetation, snow, and the permafrost, 2) plant biogeography and changes in mammal – bird populations, including predator – prey relationships, 3) reindeer nomadism and nutritional status and livelihoods of indigenous communities and 4) their interactions with built environments.
We will continue with integration activities as planned, actively engaging students at peer institutions in synthesis and preliminary work. We are developing curricula for a collaborative, transdisciplinary online inter-institutional undergraduate and graduate course that will be administered at the University of Arkansas and co-taught at partner institutions.

NNA Community Collaboration and Research Coordination: What would you like to get from the NNA Community? Is there anything you would like to offer? Is your project working in any specific communities or geographic areas? When will you be there? What kind of resource sharing or project coordination opportunities would you like to explore?

- Best strategies for integration of social system, natural environment, and built-in environment components.
- Definition of "convergence research" in the context of NNA
- Definition of "built environment" – can reindeer economy represent this?
- What are priority funding areas for NNA (either geographically or topically)? In other words, are we better focusing on a confined set of questions/themes or trying to do it all in a circumscribed area?
- How can we best integrate international participants into the project in terms of funding? Work in the Russian Arctic requires logistics only possible with a large international team and formal partnerships with the Russian Academy of Sciences (Urals Branch, Arctic Research Station). Will substantive international participation put us at a competitive [dis]advantage?

Advice for Overcoming NNA Project Challenges: Are there any unique challenges that your project has had to overcome or is facing now? Are there any lessons learned or things you would suggest others do/do differently?
COVID-19 situation obviously has changed the landscape of project activities. We would like to learn how other groups are adjusting to the constraints.

Modeling Risk from Black Carbon in a Coupled Natural-Human System at the Arctic Ice Edge

Key Project Contacts:

Amanda Lynch, David Bailey, Michael Goldstein, Xueke Li, Scott Stephenson, Siri Veland

Project Website/Social Media:

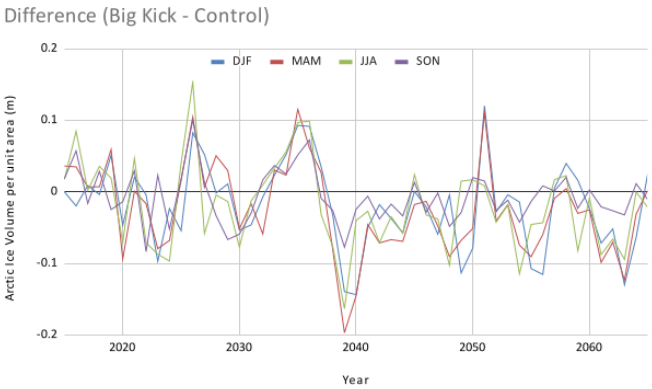
Some results have/will be posted at:
https://www.amandalynch.org/research/

Project Objectives:

The project is designed to address four hypotheses:

- BC emissions from all classes of shipping contribute a positive feedback affecting the rate of retreat of sea ice.
- Pricing the interannual variability in shipping access affects the financial risk and expected value of Arctic shipping and investments.
- Regulation of BC emissions will affect the near-term profitability of Arctic shipping routes.
- Expectations of Arctic shipping viability are conditioned on time scales that are influenced by natural system variability.

Time series of ice volume per unit area for control and "big kick" experiments.



Methods:

- Shipping modeling using ATAM (Stephenson et al. 2011)
- Climate modeling using CESM2 (Danabasoglu et al. 2020)
- Estimating financial risk using modified option pricing (Sturm et al. 2017)
- Interviews and surveys (Lynch et al. 2014)

Keywords: shipping, risk management, climate simulation and analysis

Progress To Date/Future Plans:

- First round interviews with shipping company managers, port operators, and financial services providers conducted in Oslo, Svalbard and Bodø.
- Winter Session field course held with 18 students (from Brown, Babson and Nord universities), one teaching assistant, and three professors. The experience was reported on in the following, among others (Wellesley local newspaper, newsbreak.com, etc):
  - https://www.brown.edu/academics/institute-environment-society/news/story/students-visit-arctic-pioneering-wintersession-course
  - https://www.browndailyherald.com/2020/01/30/newbury-wintersession-course/
- BC emissions for SSP scenarios refined.
- Control simulation and ensemble of BC perturbation experiments have been completed (see figure above) and are being analyzed.

Highlights or Expected Outcomes:

- Arctic-specific social and economic insight for investment and policy.
- Harvesting experience for risk management in systems with high natural variability.
- Training environmental sciences, finance and business students in inter-disciplinary complex systems analysis, using the Arctic as a natural laboratory.

NNA Community Collaboration and Research Coordination:

- Sharing of open source simulation capacity and data sets
- best practices for inclusive education
- facilitation of networking among Arctic communities

Advice for Overcoming NNA Project Challenges:

- hiring junior scientists with appropriate skills is a real challenge, especially in the context of slow and uncertain working visa processes.
- Regular virtual communication is obviously key.

NNA Track 2: Collaborative Research: Planning for Climate Resiliency Amid Changing Culture, Technology, Economics, and Governance

Key Project Contact(s):

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Heavy equipment being used to launch a boat big enough for large waves but too big for the boat ramp when the water is low at Utqiaġvik, Alaska

Project Website Urls & Social Media Accounts:

- N/A

Project Objectives:

As a research planning project, we are using a knowledge coproduction approach to assemble a body with the necessary expertise to identify the research needed to:

1) address the most significant challenges to subsistence activities faced by residents of communities in today's Arctic, where the rapid environmental change of recent decades is taking place against a backdrop of social and cultural change spanning multiple generations.
2) evaluate adaptation strategies that are being adopted or considered on an individual or community basis and identify which of these are driven by environmental change and which are likely to be effective or sustainable

Keywords: co-production, drivers of change, research plan, adaptation strategies,

Progress to Date/Future Plans:

- We have visited the communities of Kotzebue and Utqiaġvik, both located on the Alaska Arctic coast.
- We met with a variety of community members who are both involved in various aspects of subsistence harvesting and knowledgeable about the social and environmental changes taking place in their homeland.
- We sought residents who are familiar with NSF-style research projects as well as those not usually contacted by researchers. We spoke with both male and female residents from a variety of age groups.
- Our discussions were informal, largely unstructured, and primarily intended to inform the topics, structure, and participant list for a subsequent workshop involving members of both communities and academics with knowledge relevant to the issues identified by the communities.

Highlights or Expected Outcomes:

- Our most significant finding to date is a near-consensus from community members that environmental Arctic change is disrupting subsistence activity, but is not the source of the most pressing challenges they are facing.
- Compared to widespread problems related to health, wellbeing, cultural vitality and identity, education, economy, infrastructure, and transportation (none of which are new to the Arctic), community members seem to feel capable of adapting to climate change.

NNA Community Collaboration and Research Coordination:

- Coordination between different NNA research groups is essential to avoid "research fatigue" and other negative outcomes from the incoming tide of researchers to Arctic communities.
- The program solicitation and funding profile to date focus heavily on environmental change and its direct implications. This does not appear well aligned with concerns and challenges shared by community residents.

Advice for Overcoming NNA Project Challenges:

- We are learning that the NNA program may have missed the mark by tacitly focusing attention on the popular narrative that rapid environmental change is the primary driver of disruption in the Arctic
- It is unlikely that any single project, within NNA or otherwise, can fully address the information needs of Arctic residents, even on narrow topics. Aggregating results to better meet the needs of Arctic residents is imperative if NNA is to fill its promise of helping society navigate the uncharted waters of the new Arctic.

Impact of climate change on Greenland's glacial fjords, ecosystems, and local communities

Key Project Contact(s): Fiamma Straneo, Scripps-UCSD, fstraneo@ucsd.edu, lead-PI

Project Website Urls & Social Media Accounts:

N/A

Project Objectives: The overarching goal of this planning project is to understand the impact of interannual to multidecadal climate variability on two identified Greenlandic communities. Through discussions with Greenland scientists, government and industry representatives as well as community members, the research team will identify the most important climate impacts to each community (e.g. sea-ice cover, primary productivity and fish catch). The team will then assess: 1) linkages between climate impacts and Greenland/North Atlantic climate variability, and 2) the potential predictability of these impacts, using available oceanographic, glaciological and atmospheric data and model outputs. Results from this planning phase will be used to motivate a second (implementation) proposal that will involve targeted improvements in monitoring capacity and new model simulations.

Keywords: Greenland, glaciers, fjords, climate variability, marine ecosystems, Greenland communities, sea-ice, fisheries, engagement

Progress To Date/Future Plans:

To date:

1. Identified key contacts and potential collaborators in Nuuk.
2. Organized and cancelled a workshop in Nuuk in March 2020
3. Collected historical data and model output for SE Greenland.
4. Initiated analysis of relationships between climate and biological productivity, and between local and remote climate.
4. Held weekly virtual meetings to discuss analysis and project progress.

Future:

1. Organize virtual meetings with Greenlandic scientists and government representatives in May.
2. Identify variables of most interest to communities and connect with Greenlandic partners and end-users.
3. Re-organize workshop in Nuuk in the fall 2020, and if time and COVID-19 permits travel to the two communities, in which initial analyses will be shared Greenland scientists and industry, government and community representatives.
4. Consolidate plans for Track 1 NNA Proposal.

Highlights or Expected Outcomes:

Improved understanding of how interactions between the Greenland Ice Sheet, ocean, atmosphere, sea-ice and ecosystems manifest in tangible impacts at local scales and on Greenlandic communities. This understanding will be used to outline climate and ecosystem conditions that will be experienced by these communities, thereby facilitating sustainable planning and adaptation.

NNA Community Collaboration and Research Coordination:

Areas of interest: SE Greenland, Ammassalik/Tasiilaq region, and one additional to be defined region in West Greenland (possibly Qanaaq). We are interested in sharing of contacts, and strategies to develop relationships with and work with both Government representatives and local communities.

Advice for Overcoming NNA Project Challenges:

Challenging to establish contacts and collaborations due to travel restrictions in the present circumstances. Lessons learned: Key to establish Greenland collaborations and identify common interests in the early phases of the project. Common interests can vary significantly depending on whether the target is a small community or a larger entity, e.g. commercial fisheries.

Energy and Empowerment in Arctic Fishing Communities

Key Project Contact(s): Dr. Mary Albert, Professor at Dartmouth, Hanover, N.H., Mary.R.Albert@Dartmouth.edu, P.I. of this project

Project Objectives

Many small communities in the Arctic are reliant on expensive fossil fuel for their energy needs. In Avanersuaq, Greenland the joint impacts of energy cost, changes in fisheries and the environment, and a young self-rule national government are intertwined in ways that are currently threatening the culture and lifestyles of people who have long called the region home. An iterative, systems-based approach that is driven by stakeholder values and objectives is being used to define and solve energy and fishery-related research needs faced by communities in northern Greenland. Initiated by an invitation from local hunter-fishers to the P.I., this project represents stakeholder-driven science and engineering. Engineers, scientists, hunter-fishers, citizens, students, utility managers and local government representatives will collaborate to address challenging interdisciplinary problems in this region where planning and adaptation to environmental change is not already in place. Energy and fishery-related issues will be pursued in ways that will embrace energy self-reliance, identify an achievable and sustainable pathway to a resilient future, and contribute to capacity-building for engineering in changing conditions.

Keywords: Arctic, energy, fisheries, engineering, policy

Progress to Date/Future Plans

This project started on 1 April 2020. We had planned to travel to Qaanaaq this month for discussions and planning with community members, however due to the COVID19 pandemic, our first field trip has been postponed to late August or later. We are in the early stages of this project.

Highlights or Expected Outcomes

Using a systems approach this research will address interlinked cultural-technological-scientific-policy problems in order to discover resilient solutions that will support an achievable and affordable pathway to the future for small communities in a changing Arctic. Educational activities with local youth and schools in the Arctic include inquiry-based, societally-relevant hands-on activities for learning about renewable energy systems. Availability of affordable renewable energy will enable cultural continuity, enhance health and safety, build capacity, and will strengthen community resilience.

NNA Community Collaboration and Research Coordination

Our primary partners are in Qaanaaq, Greenland, but many of the challenges present there also exist in other small Arctic communities, so we are interested in sharing knowledge and research results with others working in small villages in the Arctic.

Greenland Rising: Predicting coastal responses to a changing Greenland ice sheet

Key Project Contact(s):

Robin Bell, LDEO – Columbia University, robinb@ldeo.columbia.edu Lead PI
Karl Zinglersen, Greenland Natural Resource Institute, kazi@natur.gl
Greenland Science Lead

Project Website Urls & Social Media Accounts:

https://www.ldeo.columbia.edu/polar-geophysics-group
https://www.facebook.com/PolarGeophysicsGroup
https://twitter.com/PolarGeophysics
https://www.instagram.com/polargeophysicsgroup/

Project Objectives:

Sea level changes throughout the Arctic are the combined response of solid Earth uplift or subsidence, oceanic circulation, and gravity field variations driven by changes in glaciers and ice sheets. Due to the adjacent ice sheet, the signals of shallow water change in Greenland may be large, as shown by the NSF-supported Greenland GPS Network (GNET), which has documented uplift rates up to 23 mm/year and subsidence rates of 5 mm/year in the southwest. The goal of this project is to bring together a convergent research team focusing on the integration of the natural, social, and built environments of four different Arctic communities proximal to a changing ice sheet. This focus permits the: (i) use of state of the art technologies to map shallow water environment and habitats; (ii) development of data-informed models and projections of how sea level has responded to changing ice in the past, present and future; and (iii) partnering with local communities in both needed data collection to improve the sea level models and the baseline bathymetric mapping to identify hot spots for future change where new infrastructure, fisheries, and other marine use may be susceptible to change.

Keywords: Sea level, Bathymetry, Ecology, Tides, GIA, Greenland

Progress To Date/Future Plans:

Progress

- In person meeting of project team in Nuuk, Greenland, January 2020
- Included participation in Kulturnat, presenting table-top science outreach to Nuuk community
- Developing educational material in partnership with educators in Nuuk
- 1.5 day zoom conference with collaborators to discuss ongoing and future work on past and present sea level and ice sheet change

Future plans (travel plans subject to health travel guidance)

- Community visits in Nuuk, Kullorsuaq, Aasiaat and Tasiilaq, Greenland (planned each year 2020-2023)
    - Survey planning
    - Educational activities
    - Tide Gauge installation and servicing
- Planned survey work
    - Bathymetry surveys in Nuuk region (planned 2020)
    - Bathymetry surveys in Kullorsuaq region (planned August 2020)
    - Bathymetry Surveys in Aasiaat and Tasiilaq regions (2021)

Highlights or Expected Outcomes:

- Improved GIA model for Greenland, improved estimates of present-day mass loss from GRACE, estimates of current and future sea level change around Greenland and their drivers, better constraints on the past evolution of the Greenland ice sheet, better understanding of the lithospheric structure and sublithospheric mantle below Greenland including mantle derived heatflow estimates.
- New maps of bathymetry and habitat near four different Greenlandic communities, vertical transects of habitat within the intertidal zone, new models of vulnerability and resilience of species to changing sea level.
- New continuous records of tidal variations from tide gauges installed at each community.
- Educational material and community engagement focused around changing sea level, including observations of tidal variations and shoreline life, community records of long-term changes in sea level.
- Developing a template for communities around the Arctic to adapt to the forthcoming change.

NNA Community Collaboration and Research Coordination:

- Combining community and education contacts to establish an ongoing framework that integrates different NNA projects working in similar regions.
- We will be working within four Greenlandic communities: Nuuk, Aasiaat Kullorsuaq and Tasiilaq, with visits in each year of the project.

Advice for Overcoming NNA Project Challenges:

- In person meeting was tremendously valuable for developing communication between international partners
- Investigating ways of contributing to distance learning, and developing/continuing partnerships remotely

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GNIR collaborators:

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NNA Track 2: Responding to the Housing Crisis in the Arctic: A Transdisciplinary Approach across Physical, Natural and Social Systems

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Project Objectives and Methods:

- Form a multi-disciplinary research team to assess housing vulnerabilities (biophysical changes and household exposure to substandard living conditions)
- Form community partnerships based on meetings with and approval of tribal councils
- Determine needs regarding household living conditions (i.e. indoor air quality) and vulnerabilities using interviews and surveys with external stakeholders (i.e. government agencies, non-profits, engineering firms, etc).
- Organize workshops with community partners and the research team to facilitate feedback on vulnerability assessments and create summary reports of issues and preliminary resolutions.
- Use climate model output to estimate future impacts of warming on permafrost and the resulting damage to infrastructure.
- Develop case study curriculum for civil engineers with education professors regarding the housing issues in the Arctic to support critical engagement by future engineers

Keywords: Housing Vulnerability, Climate Change, Community Based Participatory Research, Rural Alaska
Progress To Date/Future Plans:

- The research team has bi-weekly/monthly meetings to coordinate and to build cultural competency and capacity for community based participatory research. Meetings are being arranged to determine the communities that we plan to reach out to over the next year.
- The case study curriculum has being developed with a team of education scholars. The case study will be piloted in the Fall in one civil engineering course. The goal is to increase awareness of housing issues in the Arctic and to improve critical consciousness among civil engineers.
- Stakeholders who work with rural Alaska communities have being interviewed (N=25) to identify the climate change adaptation barriers and drivers to address issues of infrastructure/housing. Data has been coded and will be submitted to a conference in May Preliminary results of interviews indicate that external stakeholders believe community leadership, funding, inclusion of local knowledge, and baseline data of environmental risks are essential to addressing biophysical risks to infrastructure in rural Alaska.
- A questionnaire is being developed for community stakeholders to identify the

Highlights or Expected Outcomes: This research will support the development of multi-disciplinary, culturally appropriate research to address housing vulnerability in rural Alaska. By providing an integrative understanding of housing vulnerability, targeted responses can be developed to address key vulnerabilities. Further, this project will design a case study curriculum for civil engineers regarding the housing issues in the Arctic using critical pedagogy perspectives to support critical engagement by future engineers.

NNA Community Collaboration and Research Coordination: The NNA community provides a unique community to better understand the contextual needs of research in rural Alaska and existing projects for potential collaboration. We are interested in learning more about ways researchers are better supporting the priorities of rural communities through research. The reports developed through this planning grant will provide insight for other researchers into research priorities as identified by community representatives.

Advice for Overcoming NNA Project Challenges: Due to the remote nature of many Alaska communities and cultural diversity, our research team has spent additional time building cultural competency and forming intentional management plans to ensure appropriate engagement with tribal councils. Working with collaborators who have strong, existing relationships with rural communities has supported this process.

NNA Track 2: Developing Coordinated Monitoring Networks in the Arctic to Evaluate and Respond to Rapidly Changing Environments

Key Project Contact(s): Name, Institution, Email Address, & Role
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Network Program Officer
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Project Website Urls & Social Media Accounts:

None at this time.

Project Objectives: Briefly explain the overall goals of the project, specific aims, methods, and broader impact activities

Currently in Alaska and northern Canada there exist numerous environmental monitoring programs that are led and implemented by a diverse array of Indigenous communities, government agencies, and research institutions, often with little coordination or connection to one another. Led by a diverse team representing dozens of entities, this project will foster the development of coordinated monitoring networks by linking existing programs across Alaska and northern Canada. This project aims to achieve the following objectives: 1) to better understand important phenomena and dynamics (e.g. long-distance wildlife migration patterns, shifting climate patterns, species and habitat shifts) that can only be observed by collecting information across large landscapes; 2) to provide individual programs with the opportunity to address shared needs, while reducing duplication of effort and leveraging limited capacity and resources; 3) to support and strengthen community-based monitoring programs, which are led and/or implemented by Indigenous communities.

Keywords:

Environmental monitoring, community-led research, Indigenous and local knowledge, landscape-scale, network, coordinated monitoring

Progress To Date/Future Plans: Provide a brief research update describing progress to date or future plans.

We've secured 14 partners from U.S. and Canada-based entities including nonprofits, tribes/First Nations, Indigenous Organizations and Universities to co-develop our approach and assist us with implementation.

We've presented our project and asked for feedback on our approach and interest in participation at venues frequented by our target audience including: The Alaska Tribal Conference on Environmental Management; Bureau of Indian Affairs Tribal Providers Conference; Alaska's Just Transition Summit and the Alaska Forum on the Environment.

We had also organized our first workshop planned for late April of 2020 which is now being rescheduled for fall of 2020 and will be held ideally in person but we are exploring options to shift to a virtual platform as well.

Highlights or Expected Outcomes: Provide a brief overview of any noteworthy deliverables or expected outcomes related to research or broader impacts.

Over a period of two years, the team will regularly engage participants from multiple stakeholder groups involved in environmental and climate change monitoring programs, including Indigenous peoples, scientists, engineers, and resource managers. The project will provide opportunities for cross-border and cross-sector learning and networking through two in-person convenings.Together the group will co-develop coordinated monitoring networks that will bring together data and information collected across Alaska and western Canada, and apply this information toward tackling critical challenges linked to food security, infrastructure vulnerability, human safety, land and resource management, climate adaptation and planning, sustainable economic development, and Indigenous lifeways sustained by the land and resources.

Working groups will co-create and implement strategies to tackle commonly-shared challenges in order to leverage resources, build capacity and expertise, reduce duplication, and facilitate synergy among programs. Drawing from best practices and strategies developed through this project, an education curriculum containing tools, resources, and training will also be developed in order to strengthen community-based monitoring programs, including the ability for Indigenous communities and scientific researchers to successfully collaborate.

NNA Community Collaboration and Research Coordination: What would you like to get from the NNA Community? Is there anything you would like to offer? Is your project working in any specific communities or

geographic areas? When will you be there? What kind of resource sharing or project coordination opportunities would you like to explore?

Our project could benefit by becoming connected to NNA grantees who are also working with community-based environmental monitoring efforts, or would like to connect with such programs. We are working across Alaska, northwestern Canada and coastal British Columbia and we had initially planned two in-person workshops and would be asking participants to travel to a couple of centralized locations (Anchorage for one and the second in Canada, location TBD).

We are happy to share contacts for managers and scientists working in coll

Advice for Overcoming NNA Project Challenges: Are there any unique challenges that your project has had to overcome or is facing now? Are there any lessons learned or things you would suggest others do/do differently?

Our biggest challenge will be finding ways to safely bring workshop participants together from across our study region which would require travel from numerous communities in Alaska and Canada. We are considering virtual gatherings so hearing about meaningful ways others have conducted those successfully for diverse audiences (researchers, local observers, environmental managers, Indigenous Knowledge holders, etc.) would be helpful to us.

We also recognize the immense challenge in leveraging the precious time spent in workshops to facilitate the ability for numerous and diverse groups to bridge common needs and priorities, and establish tangible steps to coordinate their work. Any insights on facilitation approaches would be appreciated.

Indigenous Foods Knowledges Network

Key Project Contact(s):
Noor Johnson, Ph.D, Research Scientist, National Snow and Ice Data Center, University of Colorado, PI, IFKN Co-Lead
Mary Beth Jäger (Citizen Potawatomi Nation), MSW, Research Analyst, Native Nations Institute, University of Arizona, Research Coordination Team member, IFKN Co-Lead

Project Website Urls & Social Media Accounts:
https://ifkn.org/

Project Objectives:
Goal: The goal of the Indigenous Foods Knowledges Network (IFKN) is to develop a network in the Arctic and US Southwest comprised of Indigenous leaders, citizens, and scholars (both Indigenous and non-Indigenous) who are focused on research and community capacity related to food sovereignty and resilience, and who will collectively work to promote and carry out research that 1) utilizes the Indigenous research processes, 2) embraces and respects Indigenous Knowledge systems, and 3) supports Indigenous communities. See IFKN's charter to learn more about our guiding principles and specific goals. Methods: In-person meetings where we spend time on the land learning from demonstration projects; Zoom meetings and webinars; blog and satellite gatherings at conferences. Broader impact: Our network is building connections between Indigenous scholars and practitioners by focusing on concrete solutions and creating a space for shared learning and inspiration.

Keywords:
Indigenous Food Sovereignty, Governance, Arctic, Indigenous Knowledge, Networks, U.S. Southwest

Progress to Date/Future Plans: IFKN has hosted 3 in-person meetings at the in Gila River Indian Community (March 2018), Tohono O'Odham Nation (March 2019), Nay'dini'aa Na'Kayax (June 2019) and sent a delegation to the Festival of Northern Fishing in Torino, Finland (September 2018). In the spring of 2018, IFKN invited nine Indigenous Peoples from both regions to be part of the Steering Committee. IFKN has written a charter (Spring 2018) and published a commentary in the Journal of Agriculture, Food Systems, and Community Development (December 2019), and has a profile piece in Witness the Arctic Community Highlights. IFKN members have presented about the Network at various venues such as the American Geophysical Union Fall Meeting. r. IFKN has hosted two webinars this year. Due to the COVID-19 pandemic, we have suspended in-person meetings this year, but we plan on continuing the webinars and investigating other ways to stay in touch.

Highlights or Expected Outcomes: IFKN has found that meeting on the land facilitates deeper conversations and understanding of the relational foundation of food sovereignty than would occur in a conference room. Participants learn about each other's work, which can be helpful in their own work in their own communities. Commonalities have been found in multiple areas such as land and water rights and the key role of governance in limiting or facilitating community efforts. There is power in bringing together multiple Indigenous scholars in one space. The Network is yielding new connections and initiatives within as well as between regions - participants have spent time with each other at other meetings & endeavors.

NNA Community Collaboration and Research Coordination: It would be helpful to connect with other projects who are working with Indigenous communities to learn how they building relationships with Indigenous Peoples and implementing Indigenous research methods. If other projects have a significant focus on food and leadership from Indigenous communities, we may be interested in scheduling a webinar so we can exchange learnings.

Advice for Overcoming NNA Project Challenges: A strong component of our success has been to have an Indigenous steering committee and to invite community partners to plan and host our gatherings. Collectively developing a charter at the beginning of our work helped create a strong framework based on Indigenous, community-centered values.

Persistent, Long-Range, Autonomous Under-Ice Observations of Arctic Change

Key Project Contact(s):
Rich Camilli, Woods Hole Oceanographic Institution, rcamilli@whoi.edu (PI, vehicle systems design)
Ted Maksym, Woods Hole Oceanographic Institution, tmaksym@whoi.edu (Co-I, sea ice observations)
Brian William, Massachusetts Institute of Technology, williams@csail.mit.edu (Co-I, mission planning)

Project Website URLs & Social Media Accounts:
https://www.youtube.com/watch?v=JaIWi0HgdkA
https://www.whoi.edu/news-insights/content/navigating-the-changing-arctic/

Project Objectives: Build and trial a low cost, long-range hybrid autonomous vehicle for sustained under-ice operation. This includes key technological and operation advancements, including:

- Terrain-aided navigation during long-duration under ice operations without GPS or the need for acoustic beacons.
- Capability of operating in water with currents in excess of 1 m/s or rapidly changing ice cover
- Continuously optimized vehicle velocity enabling energy-efficient use of adaptive propulsion.
- Automated risk-aware mission replanning to rapidly adapt to evolving environmental conditions
- Low cost operation without need for icebreaker support, or acoustic transponder networks.

This will provide capability for:

- Continuous observation of ice-ocean interactions such as the seasonal ice advance and retreat
- Characterization of ice thickness variability along transects up to hundreds of kilometers
- Coincident observation ice thickness, waves, and upper ocean variability
- Eventual goal of sustained operation under ice over thousands of kilometers.

Broader Impacts – has involved several WHOI summer student fellows, 2 grad-students, and been incorporated into WHOI Summer Introduction to Engineering and Scientific Research (SIESR) for high school students in underserved communities.

Keywords: Hybrid underwater glider, sea ice, upper-ocean, sustained autonomous observations

Progress to Date/Future Plans:

- Vehicle built and sea trialed; mission planning computer installed; new nose cone with scanning sonar built; improved thruster designed and in production
- Demonstrated terrain-aided navigation during cruises of opportunity (simultaneous localization and mapping using Doppler sonar at Eastern Pacific shelf margin in Dec 2018 and within an active volcano in the Eastern Mediterranean Nov 2019)
- Completed initial lab and field testing for sonar detection and classification of ice (presence, thickness, and composition) as well as wave spectra (frequency, amplitude, and direction). This is important for science data gathering, surfacing for communication with satellites, and vehicle survivability.

Highlights or Expected Outcomes:

- Demonstrated unattended adaptive AUG operation in regions containing obstacles.
- Demonstrated improved AUG navigation (more than 10X decrease in navigation uncertainty).
- Demonstrated the ability of an automated process to quantify ice thickness to 2cm resolution, and ability to characterize marginal ice (ice floes in the presence of ice free areas) as well as frazil ice. This process is currently being integrated into the vehicle's onboard interpreter & mission planner to autonomously adapt mission plans in response to environmental state.

NNA Community Collaboration and Research Coordination: Currently funded for development and testing; science deployment will require subsequent funding. Are there marine projects we could leverage to expand scope of test deployment opportunities? Could provide some limited observations in return. Target is late summer 2020 in Beaufort/Chukchi, but flexible.

Advice for Overcoming NNA Project Challenges: Challenges in completing engineering and test deployments with COVID-19 restrictions.

NNA: Collaborative Research: Interactions of the Microbial Iron and Methane Cycles in the Tundra Ecosystem

Key Project Contact(s): David Emerson, Bigelow Laboratory for Ocean Sciences, demerson@bigelow.org, PI; Nicholas Record Bigelow Laboratory for Ocean Sciences, nrecord@bigelow.org, co-PI; William Bowden, University of Vermont, breck.bowden@uvm.edu, co-PI

Project Website Urls & Social Media Accounts:
https://www.bigelow.org/news/articles/2020-02-10.html

Project Objectives: The tundra is rusting due to production of biogenic iron oxides by iron-oxidizing bacteria. Our goal is to understand the role of microbes in the iron cycle both through oxidation of iron and it's reduction, and how this may impact the carbon cycle, and in particular the production of methane. Two key aims are: 1) to the identify the microbial communities driving the iron cycle and underlaying reasons for their ubiquity in the tundra ecosystem; 2) elucidate interactions of biogenic rust with carbon cycling in moist tundra and associated water bodies.

Keywords: microorganisms, iron, methane, active layer, permafrost, microbial community

Progress To Date/Future Plans: During the summer 2019 field season for 6 weeks we sampled a diversity of sites to monitor microbial community composition, along with associated samples for methane and iron quantification. All geochemical samples have been analyzed and samples for DNA-based microbial community analysis have been sequenced. The DNA sequence data are being analyzed. Our future plans are to use this data to better understand important ecological and biogeochemical associations among microbes, and design experiments to further test hypotheses we develop for the coming field season.

Highlights or Expected Outcomes: Our first field season demonstrated that iron cycling communities are prevalent in moist tundra, and host diverse microbial communities predominated by genera of iron-oxidizing and iron-reducing microbes. Methane-consuming genera were also abundant. Compared to temperate habitats, photosynthetic microbes were surprisingly abundant. Overall, our combined biogeochemical and microbial data show a tight coupling between iron cycling microbes, and provide hints about coupling to methane, as well as other important processes like phosphorus regeneration. A unique aspect of our broader impacts is a collaboration with local artists from Maine who accompanied us in the field and are producing a book and an exhibit of fine art that couple's rational explanation with impressionistic art to enhance our sense of the Arctic ecosystem and its importance, and covey this to the public.

NNA Community Collaboration and Research Coordination: Continuous permafrost and shallow (~<1m) active layer depths in the summer are likely to be hotspots of iron cycling. We hope to hear from many researchers, of all kinds, of reports of the tell-tale sign of biological iron oxidation, rusty plants, boots (see photo above). We believe these habitats and their biogeochemical importance is likely to be more widespread than previously considered. It would be of great interest if you would share a quick photo or story of where you found these rusty spots in the Arctic.

Advice for Overcoming NNA Project Challenges: There was a project funded to study very similar geochemical processes in the tundra ecosystem. Through an in-person meeting and a few zoom meetings the two

projects were able to more clearly define goals and locations of study. These collaborations and discussion before data collection will improve the science that results. This is was possible through collegiality from both projects.

Track 1 – Collaborative: The climate impacts on Alaskan and Yukon rivers, fish, and communities as told through co-produced scenarios

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Project investigators hold an artist's doodle sketch of our six-talk session at the 2020 Alaska Forum on the Environment.

Project Website Urls & Social Media Accounts:
Coming this June! Email: arcticrivers@colorado.edu

Project Objectives: Our goal is to converge indigenous knowledge and western science to strengthen collective understanding of terrestrial hydrologic change in the Arctic and the potential impacts on rivers, fish and Indigenous communities in Alaska and upstream western Canada. We use specific conductance and temperature measurements of major rivers to assess changes in groundwater contribution. The sensors innovate Indigenous community-based monitoring networks and the USGS AK gage network. Through ethnographic methods and a Arctic Rivers Summit (2022) we seek to collectively identify vulnerabilities of fish and river ice to climate change. Participatory mapping of fish habitat and river-transport corridors merges existing spatial information into a common geofabric of indigenous knowledge and western science. A physically based model chain consisting of the Regional Arctic System Model (RASM) and NCAR's Community Terrestrial Systems Model (CTSM), a dynamic streamflow routing model, a river ice and water temperature model, and a fish bioenergetics model are used to assess historical hydrologic conditions and possible future climate vulnerabilities of river ice and fish species. Guided by a Native Advisory Council consisting of Elders and indigenous community leaders, we co-develop descriptive and quantitative narratives, or storylines, of past and plausible future hydroclimatic, river ice, and fish conditions jointly based on Indigenous baseline knowledge and physical principles / western science. The project will support three Indigenous interns at the USGS Alaska Science Center and the Yukon River Inter-Tribal Watershed Council; a Ph.D. student, a postdoctoral associate, and numerous undergraduate researchers at CU Boulder; and one postdoctoral researcher at NCAR.

Keywords: Arctic rivers, Indigenous communities, Monitoring, Alaska, Yukon, Climate modeling, Groundwater, Hydrology, Fish, River ice

Progress to Date/Future Plans: We've successfully hired students and a postdoc despite the COVID-19 challenges. We convened a session of six project talks at the AFE in Feb., 2020 and 31 indigenous community members signed up for our new listserv: nna-arcticrivers@colorado.edu. We have successfully coupled RASM and CTSM models at the global scale and are preparing tests of high-resolution runs over Alaska and western Canada.

Highlights or Expected Outcomes: We expect to make important advances that include assessment of climate change impacts on river and groundwater transformation, the sustainability of arctic river fish populations, the reliability of winter river ice travel, and the integrated impacts on communities dependent upon the resources.

NNA Community Collaboration and Research Coordination: We seek to form a Native Advisory Council consisting of indigenous leaders and professionals over interior and northern Alaska and the Yukon.

Advice for Overcoming NNA Project Challenges: Tribal leadership requests compensation for their time.

Soundscape ecology to assess environmental & anthropogenic controls on wildlife behavior

Project Contact: Natalie Boelman,LDEO,Columbia Univ., nboelman@ldeo.columbia.edu, lead-PI

Project Objectives: Our goal is to gain a quantitative, regional-scale understanding of how both environmental dynamics and increasing anthropogenic activity influence the behavior and phenology of migratory caribou (*Rangifer tarandus*), waterfowl, and songbird communities in Arctic-boreal Alaska and northwestern Canada. We are developing a suite of novel automated analytical techniques to support regional-scale bioacoustic networks that will be paired with modelled times series of inaudible environmental conditions to both time series of habitat occupancy and migration phenology of avian communities, as well as habitat occupancy of caribou on their calving grounds. We use combination of field observations, modeling, and analyses that include: soundscape measurements; camera-trap observations; automated soundscape and camera-trap caribou observations; high-resolution modeling of environmental variables, and; statistical analyses of wildlife occupancy, diversity, and phenology modeling. We are incorporating co-production of knowledge with both local land managers and indigenous communities, and are advancing public participation the use of a human-computation game.

Keywords: birds; caribou; climate change; ecoacoustics; indigenous communities; industrial activity; machine learning; SnowModel; soundscape analysis

Progress to Date:

- developed preliminary automated analytical tools to for audio recordings
- installed a network of 25 automated recording units (ARUs) along two latitudinal transects in Alaska, Yukon/ NWT that enable quantitative characterization of avian community dynamics during both spring and fall migrations, as well as the breeding season
- installed ARUs at replicated unburned sites, and sites that burned 30 and 15 years ago to ask how 'time since fire' influences habitat use by avian communities in boreal ecosystems.
- installed 60 paired ARU-camera trap systems in 3 disparate caribou calving grounds experiencing varying degrees of development: Prudhoe Bay Oil Fields; 1002 area of ANWR; Ivvavik National Park
- modeled snow, and other environmental variables at 3km, every 5 days, over entire study region

Highlights or Expected Outcomes:

- utilized state of the art deep learning models in machine listening systems to predict the content of our recordings. We have generated preliminary time series of the proportion of each 2-hour recording segment containing songbird, water bird, airplane, insect, rain or running water sounds
- used Brainstem Auditory Evoked Response to discover that caribou hearing is more acute than previously thought and overlaps with industrial sounds, including seismic activity. These findings are valuable to the bigger study because they will help us understand caribou responses we will observe when attempting to relate camera data to ARU data

NNA Community Collaboration and Research Coordination:

- We would like to discuss/learn about best practices and shared resources for raw data storage and archiving
- we will be producing numerous snow and other environmental variables that may be of interest to other groups

ARC-NAV: Arctic Robust Communities-Navigating Adaptation to Variability

Key Project Contact(s): Arizona State University-PI Abigail York abigail.york@asu.edu, Co-PI Shauna Burnsilver, Co-PI John Marty Anderies, Co-PI Stephanie Pfirman; University of Northern Iowa- Co-PI Andrey Petrov, andrey.petrov@uni.edu, Co-PI Tatiana Degai; University of Alaska Fairbanks-Co-PI Andy Mahoney,armahoney@alaska.edu; Lamont-Doherty Earth Observatory of Columbia University, tremblay@ldeo.columbia.edu, Co-PI, Bruno Tremblay, Community Collaborators**:** Svetlana Isakova, Viktoria Petrasheva, Viktoria Sharakhmatova

Project Website Urls & Social Media Accounts:
https://nsf.gov/awardsearch/showAward?AWD_ID=1928235&HistoricalAwards=false

Project Objectives: *Goal*: Development of flexible governance and infrastructure to adapt to the changing Arctic. *Specific Aims*: Identify current and future hot spots of variability in Beringia sea ice landscapes, generate narratives of change, understand policy responses through networks from community to global scales. *Methods*: Convergent, community-engaged approach-cultural consensus analysis, network analysis, robustness modeling, analysis of Earth System Models, and observations. *Broader Impact*: Improve our understanding of complex systems experiencing rapid and variable change, and generate actionable information for decision-making and effective governance; stimulate research-community and community-to-community knowledge sharing.

Keywords: Beringia (Alaska, Chukotka, Kamchatka), Arctic Ocean, sea-ice extent variability, governance, policy networks, robustness, variability in seasonality, landfast ice area and stability

Progress to Date/Future Plans: Pilot community visits in Gambell and Point Hope, Alaska, regional meeting with community partners and scientists in Kamchatka, Russia; preliminary ice observations in Point Hope. Diagnostics for Community Earth System Model - Large Ensemble for the Beringia region, decade by decade, for the period 1920 to 2060: landfast ice area, false break-up and freeze-up of landfast ice area, interannual and decadal variability in sea ice extent in coastal waters and seasonality of variability in sea-ice extent. *Revised Project Plan*-Develop a conceptual framework with community input and secondary data. Cross-site trips with community members and science team in Russia (2021) and Alaska (2022), cultural consensus analysis, network analyses, and sea ice observations.

Highlights or Expected Outcomes: The team has produced four scientific presentations by investigators and two poster presentations (one poster by women, first-generation undergraduate researchers) and integrated best practices for coproduction of convergence research-community/scientist memorandums of understanding, community advisory board, external advisory board, team science meetings to facilitate colearning, and transdisciplinary fieldwork.

NNA Community Collaboration and Research Coordination: Community fieldwork will occur in Point Hope and Gambell (in Alaska) and Sireniki and Pakachi (in Kamchatka/Chukotka, Russia). The project team will prioritize coordination opportunities to minimize community research fatigue and to facilitate opportunities for cross-site and regional comparison.

Advice for Overcoming NNA Project Challenges: In response to COVID-19, we suggest a coordinated, equitable, and flexible response. Avoid travel to Arctic communities to prevent the spread of COVID-19 until all risks disappear, continuously engage local residents remotely to conduct research, provide support, including equipment and funding for improved connectivity, whenever possible, prioritize emergency support and relief for local/Arctic-based researchers, knowledge holders and project participants, include local/community logistics operators, collaborators and other partners, and if cuts or reallocations in funding are needed, prioritize community-based, student and early career funding.

Atautchikkun Iḷitchisukłuta
Coming Together to Learn

Key Project Team: *University of Alaska Fairbanks:* Courtney Carothers (clcarothers@alaska.edu), Jessica Black (Gwich'in), Peter Westley, Seth Danielson
First Alaskans Institute: Liz La quen náay Kat Saas Medicine Crow (Haida and Tlingit), Barbara'Wáahlaal Gidáak Blake (Ahtna, Haida and Tlingit)


Team meeting in Fairbanks, February 2020

Project Objectives

-Build and strengthen the relationships necessary to ethically and meaningfully engage western and Indigenous scientists fully in collaborative research to holistically understand Arctic change.
-Develop a mutually respectful process for co-creating research questions and conceptual model that will guide and form the centerpiece of a grant proposal.
-Provide a safe space for mutual learning through the inclusion and mentorship of Indigenous youth as the next generation of scientists and community leaders.

Keywords: Indigenous science, self-determination, decolonization, Beaufort Sea, Arctic coastal riverine domain

Progress To Date/Future Plans

Our project team and partners are spending our first year of this planning grant building and strengthening existing relationships between Indigenous and non-Indigenous university scientists, Indigenous Tribes and organizations, international collaborators, and communities in the Beaufort Sea regions of the U.S. and Canadian Arctic (visit to Inuvik and the Inuvialuit Game Council in December 2019). In collaboration with sovereign Tribal governments, we are planning a workshop and learning event, likely to be hosted in Utqiaġvik in winter 2021. This workshop will center on indigenizing and decolonizing approaches in Arctic sciences and practices, and considering how to best collaboratively develop an NNA Track 1 research proposal.

Highlights or Expected Outcomes

This approach sets the stage for building responsible and intentional relationships utilizing both Indigenous and western knowledge and science, co-conceiving how to most appropriately address the Arctic's most pressing questions and needs, and thus providing a roadmap towards the implementation of future research. This framework is intended to serve as a blueprint for developing other Arctic research activities that not only improve science, but work to advance Indigenous self-determination and wellness. Our early dialogues have revealed many tensions in this work that must be addressed, e.g., "*The word "co-production" is squirrelly. It feels like knowledge extraction.* ***The goal should be "plan not to plan" until you have the Native community in the room."*** We need to change the paradigm on how science happens. There are many examples of scientists taking ownership and design over Native knowledge. Addressing and healing historical and current racial traumas should be central in this work.

NNA Community Collaboration & Advice for Overcoming NNA Project Challenges

The premise of this program has been the topic of considerable discussion among our team. Team members have shared concern and frustration about the framing of the work as *Navigating the New Arctic*. From Indigenous experiences, it feels more like "*the Iñupiat of the Arctic experience the gold rush*." We need to reframe the relationship where the place of power is from the communities. We need to right the relationship. What would it look like to indigenize this? Indigenous solutions should be dictated by the Tribe and community. Indigenous team members see the potential transformation of this kind work, e.g., *"our young people don't have to be subjected to attacks on their psyche."* The discussion of abstract academic or scientific debates: "should villages continue?" or "debate whaling" are so offensive. We see a key need for Indigenous-led community liaison office for the NNA community. What will the Tribes require of scientists engaged in this initiative?

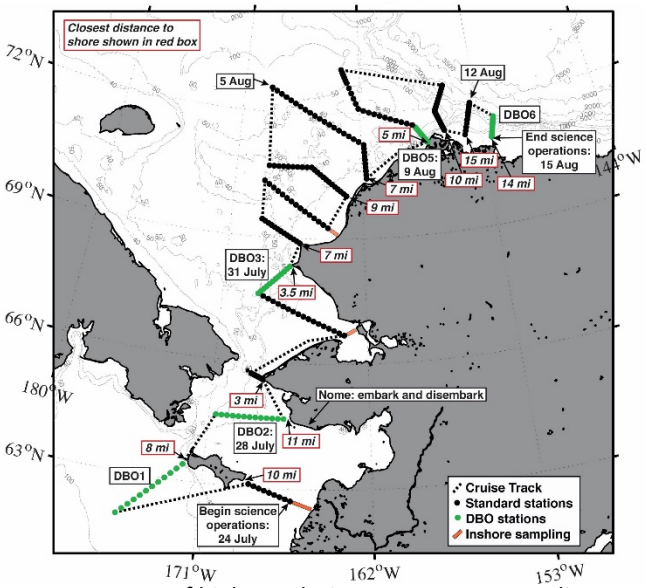
Origin and Fate of Harmful Algal Blooms in the Warming Chukchi Sea

Key Project Contacts: Donald Anderson, Robert Pickart, Woods Hole Oceanographic Institution, danderson@whoi.edu; rpickart@whoi.edu

Project Website URLs & Social Media Accounts:

https://www2.whoi.edu/site/andersonlab/current-projects/arctic-habs/

Project Objectives: Our project is a joint physical-biological field program to study the relationship between harmful algal bloom (HAB) species distribution/dynamics and the physical environment of the Chukchi Sea region. The overall goal is to determine how extensive HAB cell distributions are across the shelf, what their origins and dynamics are, and how long they have been in the region. The hypothesis is that HABs in Alaskan Arctic waters are not only advected from the south through Bering Strait but are now originating locally on the Chukchi shelf due to warming temperatures, circulation features, and water mass structure that influence bloom magnitude, duration, toxicity, and recurrence. In July-August 2020 we will conduct a 25-day cruise on the USCGC *Healy*, sampling from the northern Bering Sea to the western Beaufort Sea (see the Figure). This will be the first-ever field program undertaken in the Pacific Arctic dedicated to the study of HABs. For broader impacts, the cruise will include an outreach component with a writer, photographer, and teacher-at-sea, as well as multiple visits to indigenous communities to communicate project results.



Keywords: Harmful algal blooms; Cyst seedbeds; Circulation; Water masses; Alexandrium; Pseudo-nitzschia; saxitoxin; domoic acid; paralytic shellfish poisoning; PSP; amnesic shellfish poisoning; ASP

Progress to Date/Future Plans: The cruise will embark/disembark from Nome, AK. The tentative plan is to occupy a set of high-resolution transects proceeding south to north (see the Figure). This includes occupation of four Distributed Biological Observatory (DBO) lines. We will collect physical, chemical, and biological measurements of the water column using a CTD package, net tows, and underway systems. Benthic sampling will be done with van Veen grabs, box cores, and gravity cores. We will do adaptive sampling if/when HAB blooms are encountered, and using *Healy's* small boat we will extend several of the transects close to shore.

Highlights or Expected Outcomes: We expect to (1) document the prevalence of HAB species throughout the study region; (2) characterize the connectivity and fate of *A. catenella* and *Pseudo-nitzschia* populations using toxin profiling and molecular markers; (3) determine cyst deposition histories in sediments using radionuclide tracers; and (4) develop a conceptual model of the origin, transport, and fate of HABs in the Chukchi Sea region, emphasizing linkages to the flow pathways and characteristics of the different water masses.

NNA Community Collaboration and Research Coordination: We are accommodating numerous ancillary projects on the cruise, including: a study of mezoplankton and larval fish; a multi-tracer biogeochemical component; ocean acidification; nitrogen dynamics; sea bird and marine mammal observers; a study of atmospheric ice-nucleating particles; and deployments of floats and drifters. We will have an indigenous observer on the cruise who will interface between the science party and coastal communities along our sampling route. We also hope to benefit from cruises in the region conducted by other NAA projects. This would allow us to get water column and sediment samples that would complement the ones to be collected during our project. Note that we have only a single cruise scheduled for our project, but would benefit greatly from data from ships of opportunity in other years to sustain this important database of HAB species distribution and abundance.

Advice for Overcoming NNA Project Challenges: We suggest identifying platform/timing requirements early in the process.

Permafrost Discovery Gateway

Key Project Contact(s): Anna Liljedahl, Woods Hole Research Center, aliljedahl@whrc.org, Co-PI
Michael Brubaker, Local Env. Obs. Network, mbrubaker@anthc.org, Co-I, community environmental health
Amber Budden, NCEAS/Arctic Data Center, aebudden@nceas.ucsb.edu, Co-PI, community engagement
Jason Cervenec, Byrd Polar & Climate Research Center, cervenec.1@osu.edu, Co-PI, education & outreach
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Matt Jones, NCEAS/Arctic Data Center, jones@nceas.ucsb.edu, Co-PI, cyberinfrastructure
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Gala Wind, NASA GSFC, gala.wind@nasa.gov, Co-I, programmer geospatial data
Chandi Witharana, University of Connecticut, chandi.witharana@uconn.edu, Co-PI, remote sensing

Project Website Urls & Social Media Accounts:
permafrost.arcticdata.io
Permafrost Discovery Gateway on Facebook

Project Objectives: We aim to empower the broader Arctic community with an online platform, the Permafrost Discovery Gateway (PDG) that will make big imagery permafrost products accessible and discoverable to enable knowledge-generation by researchers and also the public. This will include 1) developing and optimizing automated remote sensing workflows that includes machine and deep learning techniques, 2) producing big imagery products of permafrost across the Arctic, and 3) enabling discovery and knowledge-generation through visualization and analysis tools designed with input from users of the PDG. We are building upon existing remote sensing, visualization (Fluid Earth Viewer, for example), and cyberinfrastructure tools (Clowder and the Arctic Data Center) and are tapping into the Local Environmental Observers Network, which is an established virtual environment for co-production of knowledge. Training of the future workforce will include the participation of graduate students, and postdocs, while the K-12 education community will receive online teaching resources.

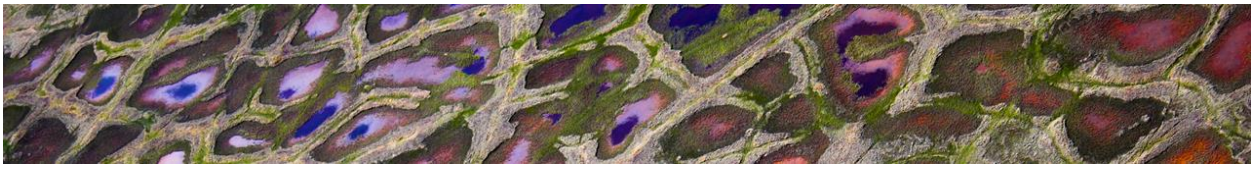
Keywords: Science gateway, big data, cyberinfrastructure, visualization, discovery

Progress To Date/Future Plans: The effort has centered on communication within the core-team, familiarizing team members with project components spanning modelling, visualization, machine learning, cyberinfrastructure and, from there, establishing a more detailed path of action/overall architecture to be implemented. The effort has thus far identified opportunities for workflow optimization in the big imagery remote sensing analyses and the project recently successfully gained access to a Leadership Resource Allocation at Texas Advanced Computing Center. We also listed existing geospatial data to ingest into the PDG and identified visualization tools to either bring in or to build upon.

Highlights or Expected Outcomes: The expected outcome will be a tool, accessible via a regular web browser that will enable science and informed decisions by making big imagery products discoverable, accessible and actionable.

NNA Community Collaboration and Research Coordination: The PDG can offer the NNA community a platform to access and explore big data from satellite imagery, while the NNA community can help make the PDG more effective by providing feedback on its content and design.

Advice for Overcoming NNA Project Challenges: PDG is a large and diverse team (~20 people, eight institutions) and as such bridging different expertise is key. We implemented bi-weekly Zoom meetings that center upon the technical, visualization, or outreach aspects of the project instead of having one large team meeting, aiming to identify the common architecture and team consensus for each aspect. As plans mature best practices with regards to development/deployment will additionally be employed across the team.



Resilience and Adaptation to the Effects of Permafrost Degradation-Induced Coastal Erosion: People-Infrastructure-PErmafrost-Resilience (PIPER)

Key Project Contact(s):

Ming Xiao, Penn State University, mzx102@psu.edu, project PI
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Lilian Alessa, University of Idaho, alessa@uidaho.edu, UIdaho PI
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Project Website Urls & Social Media Accounts:

http://www.nna-piper.org. The project website will be developed.

Project Objectives:

The **goal** of this research project is to understand the complex interrelationships and mutual impacts of continued climate change in the Arctic among the following components: permafrost degradation and coastal erosion, civil infrastructure and development, and community well-being and sociodemographic and cultural resilience.

The project includes five research tasks: (1) model and predict the rate, magnitude, and mechanisms of permafrost degradation and associated land loss within Alaska's North Slope Borough communities; (2) develop an infrastructur e hazards map of the northern Alaskan coastal region under the effects of permafrost degradation and coastal erosion; (3) identify and understand anthropological and cultural impacts of permafrost degradation and coastal erosion on coastal communities; (4) model the impacts of infrastructure disruptions on the sociodemographic resilience and population adaptation in coastal communities; and (5) predict the adaptations of infrastructure and sociodemographic and cultural resilience of communities to future permafrost degradation and coastal erosion. Four towns in the coastal region of Alaska North Slope Borough (Utqiaġvik, Wainwright, Kaktovik, and Point Lay) will be used for data collection, model development, and validation. The project team includes eight PI/co-PIs in natural science, social science, and engineering from four institutions.

The broader impacts of this research will be demonstrated and achieved in the following activities: (1) promote Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES) by involving local indigenous high school students in the field data collection, providing workshops in local communities to demonstrate how science and engineering can improve community well-being, providing students and early-career researchers with training and capacity-building opportunities in convergent research; (2) facilitate broader impacts on society and intergovernmental agencies by extending the research products to Department of Homeland Security and the US Army Corps of Engineers and capitalizing on two Arctic Research Coordination Networks (RCNs) currently led by the research team; (3) expand international collaboration through application of research methodology and outcomes to other circumpolar nations; (4) co-produce knowledge with Arctic indigenous communities and share research outcomes to inform their decision-making by conducting systematically designed social surveys and workshops in the communities; and (5) engage in outreach to the general public to inform them of the social, natural, and engineering importance of Navigating the New Arctic by working with news agencies to produce national news articles as well as radio and television segments.

Keywords: Arctic, permafrost degradation, coastal erosion, infrastructure, sociodemographic and cultural resilience, adaption.

Progress to Date/Future Plans:

(1) The project team visited two coastal communities (Utqiaġvik, Wainwright) to introduce the NNA project and solicited feedback in Feb 2020. Tasks 1 and 2 are underway. Field measurements and trips originally scheduled in summer 2020 are postponed to 2021.
(2) For Task 1, the UAF team has obtained high resolution spectral satellite imagery (2008 - 2018) from the Polar Geospatial Center for each of the communities and will be working with as well as historical imagery. This imagery will be used to map coastal change and permafrost degradation. The UAF team has selected preliminary sites for permafrost monitoring in each community. These requires further input from community members.
(3) For Task 2, the PSU team and MST team have started data collection and numerical modeling of infrastructure foundations in permafrost.

Highlights or Expected Outcomes: **The 5-year research project will yield the following intellectual products:** (1) a thermal model with high spatial resolution (130 m) to evaluate and predict the rate, extent, and mechanisms of permafrost degradation in the next century for the Alaska North Slope Borough (NSB) and a maximum entropy principle model to estimate the future rate of coastal and river bluff erosion and thermokarst development; (2) an infrastructure hazards map and model of the Alaska NSB under the effects of permafrost degradation and coastal erosion over the next century; (3) knowledge co-produced with Arctic indigenous communities on the most urgent issues relating to permafrost degradation and coastal erosion and flooding, as well as observations of these phenomena over an extended period of time; (4) a quantitative assessment model of sociodemographic resilience of Arctic communities to permafrost degradation; and (5) a predictive holistic model that will contribute to the adaptation of civil infrastructures and the sociodemographic and cultural resilience of Arctic communities under ongoing permafrost degradation and coastal erosion. This research will directly address three of NSF's ten Big Ideas: Navigating the New Arctic, Growing Convergence Research, and NSF INCLUDES.

NNA Community Collaboration and Research Coordination:

- What would you like to get from the NNA Community? Field trips co-organization, information and outcome sharing.
- Is there anything you would like to offer? Findings from the project.
- Is your project working in any specific communities or geographic areas? Yes, North Slope Borough.
- When will you be there? Multiple times in each year in various seasons.
- What kind of resource sharing or project coordination opportunities would you like to explore? Field trips co-organization and scheduling.

Advice for Overcoming NNA Project Challenges:

- Are there any unique challenges that your project has had to overcome or is facing now? Delayed field data collection; community visiting scheduling.
- Are there any lessons learned or things you would suggest others do/do differently? None so far.

Adaptive Capacity and Resilience in the New Arctic: Identifying Pathways to Equitable, Desirable Outcomes for People and Nature Through Convergence

Key Project Contact(s):
Craig R. Allen, University of Nebraska-Lincoln, PI.
allencr@unl.edu.

Project Website Urls & Social Media Accounts:
N/A

Project Objectives:
Our workshop goals are to convene disparate expertise on our thematic goals (below) with a diverse group of researchers, practitioners, and stakeholders in the Far North and mid-latitudes to understand how transformations in the New Arctic can be managed to reduce inequitable and undesirable outcomes for people and nature. This will be accomplished through convergence of expertise within a complex adaptive systems model of the New Arctic. This framework will integrate components from Indigenous Peoples' traditional knowledge, ecology, sociology, psychology, climate sciences, geosciences, computer science, economics, and human health. Importantly, as the Arctic continues to rapidly transform, there is a genuine risk of growing inequity. Indigenous Peoples' narratives surrounding social, cultural, and economic mechanisms to prevent such inequity are often underrepresented. The workshops address this by including a listening session with Indigenous and other local stakeholders at the outset of the workshop series, with stakeholders invited to attend part or all of the rest of the workshop presentations and discussions.

The overarching workshop objectives are to:

(1) Provide a venue where alternative viewpoints and traditional and disciplinary understanding may be voiced to enhance our knowledge of change in the New Arctic.
(2) Explore alternative scenarios resulting from the loss of Arctic resilience that have occurred or are underway, sources of adaptive capacity and pathways for transformation to desired states, and methods to enhance the resilience of desirable states.
(3) Develop a framework for assessing risk profiles associated with alternative scenarios for Indigenous Peoples' and non-indigenous communities
(4) Communicate our results with Indigenous and other local stakeholders in the Arctic, and, with local funding, in the mid-latitudes.

Keywords: adaptive capacity, resilience, transformation, traditional knowledge, biogeochemical cycling, spatial regimes, feedbacks

Progress To Date/Future Plans: We held three workshops, two in the arctic, two at mid-latitudes. We are currently completing a manuscript focused on convergence.

Highlights or Expected Outcomes: Our funding was for workshops, and from those considerable learning occurred across disciplines and peoples with varied backgrounds. We are also completing a convergence manuscript based on our workshops, and published a manuscript based focused on different ways of learning and reaching convergence: Angeler, D.G., C.R. Allen, and A. Carnaval. 2020. Convergence science in the Anthropocene: Navigating the known and unknown. People and Nature 2: 96-102.

NNA Community Collaboration and Research Coordination: Continued focus on arctic issues, especially as related to resilience in arctic social-ecological systems.

Advice for Overcoming NNA Project Challenges: N/A

Convergence NNA: Coordinate a Transdisciplinary Research Network to Identify Challenges of and Solutions to Permafrost Coastal Erosion and Its Socioecological Impacts in the Arctic:

Permafrost Coastal Erosion – Research Coordination Network (PCE-RCN)

Key Project Contact(s):

Ming Xiao, Penn State University, mzx102@psu.edu, PI
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Benjamin Jones, University of Alaska Fairbanks, bmjones3@alaska.edu, co-PI
Guangqing Chi, Penn State University, gfc5047@psu.edu, co-PI
Kathleen Halvorsen, Michigan Technological University, kehalvor@mtu.edu, co-PI

Project Website Urls & Social Media Accounts:

Website: www.PCE-RCN.org.
Twitter: https://twitter.com/arcticpcenetwrk
Facebook: https://www.facebook.com/groups/536775043373560/

Project Objectives:

The **goal** of this RCN project is to establish a transdisciplinary Permafrost Coastal Erosion Research Coordination Network (PCE-RCN) to identify challenges of and solutions to Arctic permafrost coastal erosion as well as its socioecological impacts by converging civil and coastal engineering, social sciences, and permafrost and climate sciences.

Keywords: Permafrost Coastal Erosion, Research Coordination Network, PCE-RCN

Progress to Date/Future Plans:

- Year 1: 2018 PCE-RCN Workshop was held at University of Alaska, Fairbanks in October 11 – 12, 2018. The goal of the workshop was to introduce PCE-RCN network members and begin the coordination of a transdisciplinary Research Network to identify challenges of and solutions to permafrost coastal erosion and its socioecological impacts in the Arctic. Workshop program is on: www.pce-rcn.org.
- Year 2: (1) Proposed Special Issue "Observations, Interactions, and Implications of Increasingly Dynamic Permafrost Coastal" to be published on *Frontiers in Earth Science*, section *Cryospheric Sciences*; (2) jointly organized two sessions on "Arctic Coastal Changes, Hazards, and Risks: Circumpolar Truths and Future Outcomes" with 7 oral and 17 poster presentations, at AGU 2019 meeting; (3) prepared, awarded, and initiated new NSF project "Collaborative Research: AccelNet: Permafrost Coastal Systems Network (PerCS-Net) – a circumpolar alliance for arctic coastal community information exchange," funded by NSF Accelerating Research through International Network-to-Network Collaborations (AccelNet), led by Benjamin Jones.
- Year 3: To jointly prepare for the 2021 Workshop on Arctic Coastal Communities, Hazards Remediation, and Resilience on Feb 4-6, 2021 in Anchorage, AK. Four Arctic RCN-related projects will jointly organize

the workshop. Year 4: To produce report of the 2021 Workshop, to produce *Environment Management* special issue, and to sustain activities and collaborations beyond NSF funding period.

Highlights or Expected Outcomes:

- Outcome #1: project website**:** www.PCE-RCN.org, and social media Twitter: https://twitter.com/arcticpcenetwrk and Facebook https://www.facebook.com/groups/536775043373560/
- Outcome #2: proposed a Special Publication Issue, to be published on ***Frontiers in Earth Science***, section *Cryospheric Sciences*. The special issue topic is: "Observations, Interactions, and Implications of Increasingly Dynamic Permafrost Coastal." Editors are Benjamin Jones, Louise Farquharson, Anna Irrgang, Nataliya Belova, and Scott Dallimore. Special issue website: https://www.frontiersin.org/research-topics/11168/observations-interactions-and-implications-of-increasingly-dynamic-permafrost-coastal-systems. So far, 60 authors have responded with intent to submit manuscripts. The abstract deadline was 01/31/2020 and full paper deadline is 09/30/2020.
- Outcome #3: Planning of 2021 joint RCN workshop: "2021 Workshop on Arctic Coastal Communities, Hazards Remediation, and Resilience (2021 Arctic Coastal Workshop)." The workshop is organized by four NSF Arctic network projects: (1) Permafrost Coastal Erosion – Research Coordination Network (PCE-RCN), (2) Arctic Network for Coastal Community Hazards, Observations, and Integrated Research (AHCHOR RCN), (3) Arctic COASTal Community and Environmental Resilience International Interdisciplinary Research Coordination Network (Arctic-COAST RCN), and (4) Permafrost Coastal Systems Network (PerCS-Net).
- Outcome #4: organized two sessions at AGU 2019: C12B - Arctic Coastal Changes, Hazards, and Risks: Circumpolar Truths and Future Outcomes I (oral session); C13D - Arctic Coastal Changes, Hazards, and Risks: Circumpolar Truths and Future Outcomes II (poster session).
- Outcome #5: Produced four publications.

NNA Community Collaboration and Research Coordination:

- What would you like to get from the NNA Community? Introduce the RCN to broader community and audience.
- Is there anything you would like to offer? Networking opportunities.
- Is your project working in any specific communities or geographic areas? No; permafrost coasts in general.
- When will you be there? No field trips planned for the rest of the project.
- What kind of resource sharing or project coordination opportunities would you like to explore? Social media.

Advice for Overcoming NNA Project Challenges:

- Are there any unique challenges that your project has had to overcome or is facing now? None so far.
- Are there any lessons learned or things you would suggest others do/do differently? None so far.

The Arctic Carbon and Climate (ACCLIMATE) Observatory: Tundra Ecosystem Carbon Balance and Old Carbon Loss as a Consequence of Permafrost Degradation (#1754839)

Key Project Contact(s):
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Project Website Urls & Social Media Accounts:
www2.nau.edu/schuurlab-p/; www.permafrostcarbon.org; ecoss.nau.edu

Project Objectives: Carbon release from the Arctic is a wildcard that could alter the future trajectory of climate change, a potential tipping point in the global carbon cycle that could accelerate sea-level rise, extreme weather, droughts, and impacts on agriculture, at rates beyond those currently projected by models.

The Arctic Carbon and Climate (ACCLIMATE) permafrost carbon observatory will use field observations to measure carbon fluxes, carbon isotope ratios, and ecosystem carbon pools in a tundra ecosystem in Interior Alaska that is undergoing rapid and irreversible change due to regional warming. The overall research plan is designed to answer three focal questions: **1)** Does warming and permafrost degradation cause a net release of carbon from the ecosystem to the atmosphere, and how does the magnitude change over years to decades? **2)** What proportion of this carbon release is derived from old carbon that comprises the bulk of the soil carbon pool, and will this increase as thaw progresses? **3)** How does change in surface hydrology interact with thawing to control old carbon losses and the partitioning of carbon dioxide and methane?

Public outreach is occurring through established collaborations with staff of the highly-visited Denali National Park, where this project will present public talks through the Murie Science and Learning Center, and by producing National Park Fact Sheets that are distributed to visitors. The site also hosts and links high school students from Vermont and Alaska as part of a capstone senior science class. This project will also interface with the science community through ongoing synthesis work organized by the Permafrost Carbon Network.

Keywords: permafrost, tundra, carbon dioxide, methane, climate feedback

Progress To Date/Future Plans: We continue to collect carbon dioxide and methane measurements at the site using the eddy covariance tower measurements. We hosted high school students at the site in 2019, but are re-evaluating those plans for 2020.

Highlights or Expected Outcomes: This tundra site is losing net carbon to the atmosphere on the order of at least 50 g m^{-2} $year^{-1}$ for a total of 750 g m^{-2}over our 15-year record. This is notable because tundra was historically accumulating carbon from the atmosphere in plant biomass and permafrost soils. Net carbon released from permafrost ecosystems to the atmosphere accelerates climate change.

NNA Community Collaboration and Research Coordination: This project is based near the town of Healy, Alaska just outside of Denali National Park. There are personnel located at the site all year, with increased activity in the May through September field season. Each summer we host a site field trip for the public, which all are invited to attend.

Advice for Overcoming NNA Project Challenges: Continuing field work plans at this time