

## **Study of Environmental Arctic Change (SEARCH) Knowledge Exchange Workshop on the Impacts of Arctic Sea Ice Loss**

September 14-15, 2016

Arctic Research Consortium of the U.S. (ARCUS) DC Office/  
Consortium for Ocean Leadership, 1201 New York Avenue, Washington, DC 20005

### Summary

Effective responses to diminishing Arctic sea ice require effective communication as well as collaborative and actionable science. In this workshop, scientific experts, decision-makers, Arctic residents, industry specialists, NGO's, and other stakeholders will define and address important societal questions raised by diminishing Arctic sea ice, and explore new approaches and partnerships for advancing awareness and understanding of the associated impacts.

This workshop is an activity of the **Study of Environmental Arctic Change (SEARCH) Sea Ice Action Team (SIAT; <https://www.arcus.org/search-program/sea-ice>)**, which is developing a coherent source of accessible, comprehensive, and timely information that synthesizes the connections between the science of Arctic sea ice loss, key societal issues, and stakeholder needs.

### Agenda

#### **Wednesday, Sept 14**

- |               |  |
|---------------|--|
| 8:00–8:30 AM  | Arrival (Light refreshments & coffee provided)   |
| 8:30–8:50 AM  | Welcome and Introductions – <i>SIAT Leadership &amp; Bob Rich, ARCUS</i>   |
| 8:50–9:05     | Overview of the Study of Environmental Arctic Change (SEARCH)<br>– <i>Brendan Kelly, SEARCH</i>  |
| 9:05–9:20 AM  | Overview of the SEARCH Sea Ice Action Team's mission to foster collaborative science, community engagement, and effective communication<br>– <i>Matthew Druckenmiller, Rutgers University and NSIDC</i>  |
| 9:20–10:40 AM | Connecting and Communicating with Diverse Audiences:<br><u>Across Science Disciplines</u> – <i>Marika Holland, NCAR</i><br><u>The Media</u> – <i>Brenda Ekwurzel, Union of Concerned Scientists</i><br><u>Policy Makers</u> – <i>Andrew Black, AAAS</i><br><u>Local/Regional Actors</u> – <i>Austin Ahmasuk, Kawerak, Inc.</i> |

10:40–11:00 AM	Break
11:00–12:00 AM	Overview Presentations on <b>Workshop Science Themes</b> . Fostering effective communication, collaborative science, and actionable knowledge regarding:  <u>Human activities in the Bering, Chukchi, and Beaufort Seas</u> – Henry Huntington, Huntington Consulting  <u>Arctic ecosystem change</u> – Brendan Kelly, Univ. of Alaska Fairbanks  <u>Arctic linkages to lower latitude weather</u> – Jennifer Francis, Rutgers University
12:00–1:30 PM	Lunch (On your own; No-host)
1:30–1:45 PM	Defining the state and opportunities for actionable science (Charge for the afternoon breakout groups)
1:45–4:15 PM	Breakout groups by science theme: <i>What do we know? What do we need to know? What is our message to other audiences?</i>
4:15–5:00 PM	Summaries and wrap-up
6:30PM–	Workshop dinner (No-host; location TBD)

### **Thursday, Sept 15**

8:00–8:30 AM	Arrival (Light refreshments & coffee provided)
8:30–9:00 AM	Synthesis through targeted communication (Charge for the morning break-out groups)
9:00–11:30 AM	Breakout groups by communication audience (Other science disciplines, the media, policy makers, local/regional actors): <i>How do we state what we know, clearly and accurately? How do we communicate what we know to various audiences? How do we support what we are saying?</i>
11:30–12:00 PM	Summaries
12:00–1:30 PM	Lunch (On your own; No-host)
1:30–3:30 PM	Discussion: Developing strategies for better understanding the consequences of and informing societal responses to sea ice loss
3:30–3:45 PM	Break
3:45–5:00 PM	Discussion on next steps: Tangible outcomes, Establishing a <i>Sea Ice Action Network</i> , etc.

### **Friday, Sept 16:** Meeting of the SEARCH Sea Ice Action Team (SIAT) only

8:30–9:00 AM	Arrival (Light refreshments & coffee provided)
9:00–12:00 PM	Meeting (Agenda TBD): Next Steps and Action Items

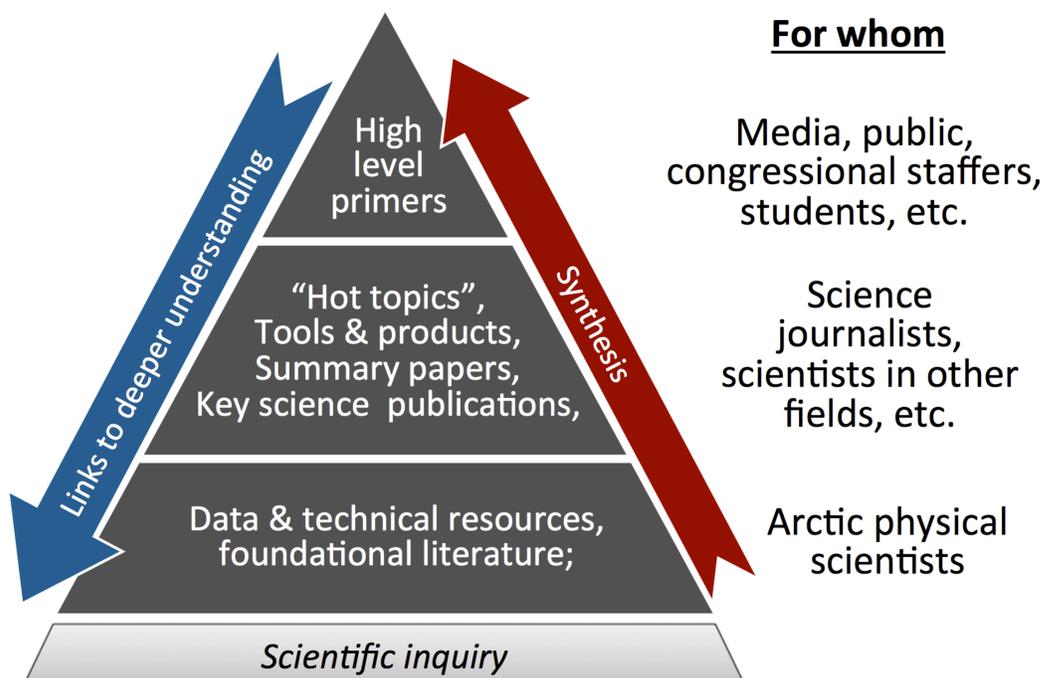
## Anticipated Workshop Outcomes

- Plans and draft sketches for constructing **Knowledge Pyramids**<sup>1</sup> for the three workshop science themes: the impacts of changing Arctic sea ice on (1) human activities in the Bering, Chukchi, and Beaufort Seas, (2) Arctic ecosystems, and (3) lower latitude weather.
- A refined strategy and recognition of critical challenges for supporting **Knowledge to Action**<sup>2</sup> through targeted synthesis, cross-community collaboration, and effective communication
- The basis and beginning of a **Sea Ice Action Network**<sup>3</sup> to support, demonstrate, and advance improved synthesis and communication of the science and consequences of Arctic sea ice loss.
- Several topics and outlines for short papers on the **State of the Science**<sup>4</sup> regarding the workshop's science themes

## Terms Defined

### 1. Knowledge Pyramids

*Knowledge Pyramids* provide tiered access to sea ice information, organized across a series of high-level topics via a hierarchical, pyramid structure based on increasing levels of scientific complexity. As a result, each level in the pyramid is developed with specific audiences in mind.



## **2. Knowledge to Action**

*Knowledge to action* is a collaborative process where scientists and “actors” (policy-makers, practitioners, arctic residents, and other stakeholders) collaboratively develop understanding and define an arena where science-based knowledge can inform decisions.

An iterative process follows:

- Information and knowledge are synthesized, adapted, and tailored for application;
- The use of information is monitored to identify barriers to effective use, establish links to deeper understanding, and assess outcomes; and
- A sustained process of providing *knowledge for action* is assessed in terms of broader impacts to decision-making frameworks, the use of science-based knowledge, and, ultimately, addressing the underlying issue (e.g., an impact from diminishing Arctic sea ice).

## **3. Sea Ice Action Network**

The proposed Action Network will facilitate *knowledge to action* in response to the various impacts of a diminishing Arctic sea ice cover. The Action Network will:

1. Focus on community building through different forms of collaboration and knowledge sharing;
2. Collaboratively identify key issues of societal importance, from local to global scales;
3. Co-communicate the impacts of diminishing sea ice;
4. Facilitate iterative engagement with key stakeholder groups and Arctic residents;
5. Synthesize scientific research and expert knowledge to develop accessible information for a range of users;
6. Identify new areas for scientific inquiry; and
7. Develop ways to incentive participation (the “carrots”); for example, by increasing the visibility of people’s work, creating easy pathways for collaboration across disciplines and expertise, and involvement in “big picture” research questions

## **4. State of the Science**

SEARCH plans to place “state of the science” briefs (or High level primers) at the top of the Knowledge Pyramids. Three examples are presented at the end of this document:

1. “A Warming Arctic Threatens Rural Community Resilience”
2. “Rapid Arctic Environmental Change Disrupts Marine Ecosystems”
3. “Effects of the Arctic Meltdown on U.S. Weather Patterns ”

## Participants

**Jennifer Francis** (SIAT co-lead), Rutgers University, Marion, MA  
**Henry Huntington** (SIAT co-lead), Huntington Consulting, Eagle River, AK  
**Matthew Druckenmiller** (SIAT), Rutgers; National Snow & Ice Data Center, Boulder, CO  
**Sarah Abdelrahim**, U.S. Department of the Interior, Washington, DC  
**Austin Ahmusuk**, Kawerak, Nome, AK  
**Andrew Black**, American Association for the Advancement of Science, Washington, DC  
**Neysa Call**, US Senator Reid's Office, Washington, DC  
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**Matthew Jull**, University of Virginia, Charlottesville, VA  
**Brendan Kelly**, University of Alaska Fairbanks, Fairbanks, AK  
**Mara Kimmel**, University of Alaska Anchorage, Anchorage, AK  
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## More information

**Sea Ice Action Team website:** <https://www.arcus.org/search-program/sea-ice/>

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## A Warming Arctic Threatens Rural Community Resilience

**THE ISSUE.** Loss of sea ice, thawing permafrost, reduced snow cover, and rising sea level are reducing hunting and fishing opportunities and degrading infrastructure for rural Arctic communities. Most Alaska Native communities are affected by erosion and flooding, with 31 communities imminently threatened and 12 planning to relocate. Local responses to these stresses are hampered by the nation's highest prices for food and fuel and widespread poverty across rural Alaska.

**WHY IT MATTERS.** Climate change amplifies challenges confronting Arctic communities, where 60-80% of households depend on wild game and fish for food, harvesting several hundred pounds per person annually. Already faced with economic, social, and cultural changes, traditional ways of life in rural Alaska are further threatened by climate change impacts on diminishing food security, deteriorating water and sewage systems, increasing risk of accidents, and greater expenditures to construct and maintain infrastructure. Government agencies and other institutions need to promote policies that reduce stresses on Arctic communities and foster responses consistent with local economies and cultures.

**STATE OF THE SCIENCE.** Arctic communities and scientists have worked together to document local observations of climate change; the associated impacts on hunting, fishing, safety, and food security; and the potential impacts of projected changes into the future. More recently, researchers have been assessing the efficacy of local responses. For example, subsistence whalers on St. Lawrence Island in the Bering Sea have initiated a fall harvest to help make up for spring whaling seasons made shorter by changing ice conditions. At Kivalina—a village that is also facing relocation due to erosion—changing spring ice conditions have prevented the harvest of bowhead whales for over 20 years. In other cases, changes can amplify one another. Limited time off from jobs means that whalers from Nuiqsut now have much shorter time available for whaling in fall. In Alaska's Arctic region, 78% of Native Iñupiat households combine jobs and subsistence to meet their economic, cultural, and nutritional needs. The benefits of employment are lessened, however, by the reduction in time devoted to harvesting wild foods. Less time to hunt means less chance to wait out fall storms or to adapt to other changes in weather or animal migration patterns. Those migration patterns may be further altered as diminishing sea ice opens opportunities for industrial activities (for example, shipping and offshore petroleum development). The cumulative effects of stresses and changes are broadly recognized but difficult to measure.



Map of the 11 Alaska traditional whaling communities, with the 2015 and 1981-2010 median September ice extents shown. (Courtesy: M. Druckenmiller)

**WHERE THE SCIENCE IS HEADED.** More work is needed to understand how local responses can be effective (such as the St. Lawrence Island fall whaling season) as well as how they fall short of what is needed (such as Kivalina's inability to hunt in spring). In addition, future research must address ways that policies exacerbate or mitigate such impacts, for example by imposing additional constraints on what communities can do, or by supporting flexibility and local initiative to solve problems. Actions made without adequate knowledge of local conditions, no matter how well intentioned, may undermine local well-being by promoting ineffective responses or fostering dependence on outside intervention rather than on local talent, capacity, and creativity. Ultimately, communities need support to identify local solutions.



Iñupiat hunters establish a whaling camp on coastal sea ice near Barrow, Alaska, where thinning ice and warming temperatures in Spring are reducing hunting opportunities and increasing risks to personal safety. (Courtesy: M. Druckenmiller)

## FURTHER READING

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Goldsmith, S., 2008. *Understanding Alaska's Remote Rural Economy*, UA Research Summary No. 10, Institute of Social and Economic Research, University of Alaska Anchorage. [Available online at: [http://www.iser.uaa.alaska.edu/Publications/researchsumm/UA\\_RS10.pdf](http://www.iser.uaa.alaska.edu/Publications/researchsumm/UA_RS10.pdf)]

### The Study of Environmental Arctic Change (SEARCH)

Advancing and communicating scientific understanding to help society respond to a rapidly changing Arctic.

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## Rapid Arctic Environmental Change Disrupts Marine Ecosystems

**THE ISSUE.** Diminishing sea ice, changing snow patterns, and increasing water temperatures threaten organisms—from algae to mammals—adapted to the sea ice ecosystem.

**WHY IT MATTERS.** Globally, climate change is decreasing biodiversity (variety of life) with the potential to cause the sixth mass extinction in the Earth's history<sup>1</sup>. Arctic marine organisms are particularly vulnerable owing to their dependence on snow and ice and to the rapid pace of warming in the region — at least twice the global average. The well-being and economies of Arctic people are disrupted by changes in the Arctic marine ecosystems on which they depend for food and cultural affirmation<sup>2</sup>. Changing ice conditions have already diminished indigenous hunters' access to whales and walrus in Alaska.

**STATE OF THE SCIENCE.** The timing and extent of sea ice directly and indirectly influence the abundance and seasonal behavior of many species<sup>3</sup>. In recent decades, rapid warming has contributed to a year-round decline in sea ice thickness and a 50% reduction in ice area during summer months. Models consistently forecast a continued reduction in ice coverage and thickness as greenhouse gases continue to accumulate. While Arctic sea ice likely will persist in the dark winter months, summers will see little ice cover in coming decades.



Algae growing on the underside of sea ice is visible in ice cores. (Credit: S. Carpenter)

Over half of the organisms capturing the sun's energy (primary producers) in the Arctic Ocean are algae and phytoplankton that grow on or under sea ice. As ice diminishes, so will these primary producers along with the higher-level organisms that depend on them. Other species of phytoplankton may increase as more light penetrates thinning ice, although the effect of increased light may be offset by decreased nutrients. A massive bloom of phytoplankton observed under ice in the Chukchi Sea in 2011 was believed to be enhanced by thinning ice<sup>4</sup>. Whether a new suite of phytoplankton will support an abundance of higher organisms will depend on timing, location, nutrient availability, and the ability of different species to adapt to polar environments. A consensus on the net impact on Arctic Ocean productivity has yet to emerge from ongoing research.

Changes in the physical Arctic environment will result in winners and losers; some sub-Arctic species will shift their ranges northward into Arctic waters while some current species will be displaced by these new migrants through competition or predation. For example, Arctic cod—a species key in the diet of many Arctic fish, birds, and mammals—is adapted to sea ice habitats and, as ice diminishes, the species is being displaced by an Atlantic Ocean cod<sup>5</sup>. On the other hand, a species of amphipod that specializes in feeding on ice algae, may be resilient in the face of diminishing ice due to an ability to ride pole-ward currents that keep them in the ice<sup>6</sup>.

More southerly species of marine mammals, such as Steller sea lions, are expanding northward as ice diminishes, while ice-dependent mammals are facing increasing challenges. Diminished sea ice has reduced food availability for some populations of polar bears<sup>7</sup> and walrus<sup>8</sup>. Walrus that

used to rest and nurse their young on sea ice in summer are now forced to come ashore in large aggregations on land where they are vulnerable to predation and trampling<sup>9</sup>. Declining ice and, especially, snow cover are projected to reduce the birthing habitat for ringed seals by 70% by 2100<sup>10</sup>.

The net impact of these dynamics on biodiversity of the region is uncertain. Increased primary production might favor increased biodiversity, while decreased habitat diversity would disfavor it. Adaptive strategies will, in part, be driven by genetic diversity and generation time (the average time between subsequent generations within a species). Species with high genetic diversity and short generation times have a greater likelihood of adapting to new environments. Conversely, species with unfavorably long generation times and low genetic diversity, such as the large marine mammals (polar bears, seals, whales, etc.), will be at greater risk.

**WHERE THE SCIENCE IS HEADED.** Ecological observations and models of the Arctic Ocean are sparse. While such studies have accelerated in recent decades, they are proceeding slowly relative to the pace of environmental change<sup>11</sup>. We know from more thoroughly studied regions that ecosystems can experience sudden and rapid reorganization when thresholds are exceeded. Such thresholds are inadequately known for the Arctic Ocean. Multi-disciplinary and multi-scale studies are needed to understand how diminishing sea-ice and warming waters will ultimately alter Arctic marine ecosystems, including the health and behavior of key species on which Arctic people depend.



Ringed seals rest, give birth, and nurse their young in snow caves above Arctic sea ice. Early snow melts have led to the deaths of large numbers of ringed seal pups by predation and freezing. (Credit: B. Kelly)

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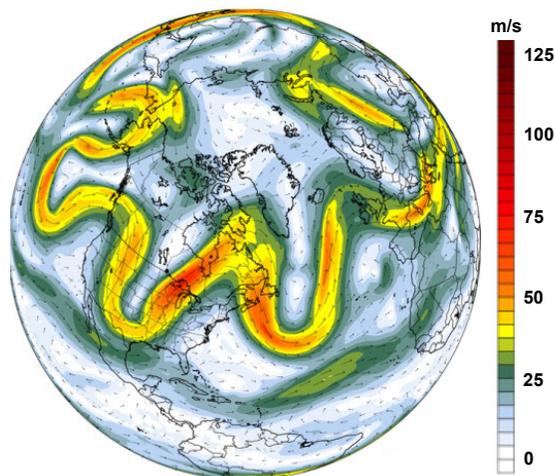
## Effects of the Arctic Meltdown on U.S. Weather Patterns

**THE ISSUE.** In recent decades, the pace of Arctic warming was at least double that of the globe. A growing body of research suggests this differential warming will increase the frequency of extreme weather events in the United States and elsewhere in the northern hemisphere.

**WHY IT MATTERS.** Extreme weather events cause billions of dollars in damage, scores of deaths and injuries, and thousands of disrupted lives each year. The frequency of these events is increasing, and certain types have clear links to climate change. Rapid Arctic warming is expected to cause more persistent weather regimes that can lead to devastating drought, heat waves, fire seasons, stormy winters, and flooding, many of which have been prominent weather stories across the U.S. in recent years.

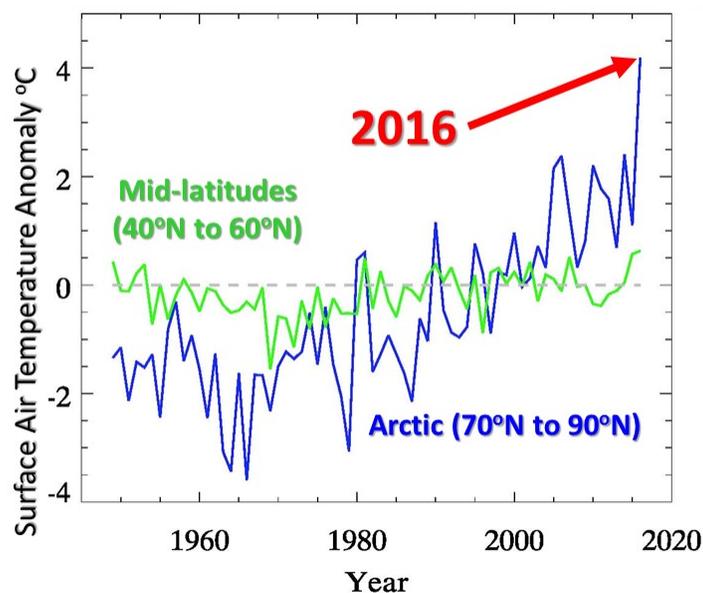
**STATE OF THE SCIENCE.** The major wind systems of the globe are driven by temperature differences; the jet stream exists because the Arctic is much colder than regions farther south, the so-called mid-latitudes. The larger the temperature difference, the stronger the jet stream. Any changes that affect the Earth's temperature patterns will also affect jet streams, and because jet streams create and steer weather patterns, those changes will also affect mid-latitude weather. The dramatic Arctic warming during recent decades is reducing this temperature difference, which is weakening the jet stream's west-to-east winds.<sup>1</sup> Instead of a coherent river of strong winds, a weaker jet tends to waver, split, and wander north and southward on its path around the northern hemisphere.<sup>2,3</sup> These wavier jet streams are responsible for a variety of extreme weather events, which have become more frequent in the U.S., Canada, Europe, and Asia.<sup>4,5</sup>

The linkage between amplified Arctic warming and mid-latitude weather is a rapidly evolving field of research. New evidence suggests that diminished sea ice in particular regions and seasons has distinct effects on weather extremes.<sup>6</sup> Ice loss and warming north of Alaska, for example, allows extra summer sunshine to warm those waters. Come autumn, that heat is released back into the atmosphere, which intensifies northward swings in the jet stream – known as ridges – in the area of ice loss. The “Ridiculously Resilient Ridge” largely responsible for California's ongoing extreme drought was likely strengthened by the warm Arctic.<sup>7</sup> Like a whipped jump rope, the effect downstream was a more southerly jet excursion – or trough – which allowed cold air to plunge into eastern states during winters of 2013/14 and 2014/15. Larger jet waves tend to linger in one place, favoring persistent weather patterns: relatively warm and dry under the ridge, cold and stormy in the trough. Prolonged summer heat waves and flooding caused by slow-moving storms may also get a boost from the Arctic meltdown.<sup>2</sup>



**Wandering jet stream from May 14, 2014.** Colors represent wind at 250 millibar from the GFS Model. (Credit: Climate Change Institute, University of Maine)

**WHERE THE SCIENCE IS HEADED.** While some mechanisms linking the rapidly warming Arctic and changes in mid-latitude weather are becoming clear, others are more difficult to identify because the atmosphere is such a chaotic beast. Challenges arise because the era of rapid Arctic warming began only a decade or two ago, other changes in the climate system are happening simultaneously, and natural fluctuations (such as El Niños/La Niñas) obscure signals.<sup>8</sup> Standard analysis methods that average over large areas or time periods may smear unusual jet features that don't appear in the same location each year. Computer models of the climate system struggle to realistically simulate very wavy jet features and complex Arctic processes, thus their utility for studying mechanisms of Arctic/mid-latitude linkages is imperfect. Much is left to unravel, but research is progressing quickly.



**January to May air temperature anomalies.** These anomalies, which are deviations from average temperature, are relative to the 1981-2010 average. (Data from NOAA/NCEP/ESRL)

## KEY REFERENCES

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