

State of the Arctic Conference 2010: International Perspectives on Progress of Research Responsive to Decision-Makers' Information Needs

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A CONFERENCE TO EVALUATE THE STATE OF THE ARCTIC SYSTEM

In 2003, the U.S. Study of Environmental Arctic Change (SEARCH) hosted an international meeting to review evidence of system-wide Arctic environmental change. Since then, rate and extent of such change have increased and are impacting Arctic communities, ecosystems, and society at large. The State of the Arctic (SoA) Conference, held in spring of 2010, brought together over 400 participants from 16 countries, including representatives of indigenous organizations, to exchange new findings from research in a changing Arctic. Reflecting the close coupling between different components of the Arctic system, the international conference organizing committee grouped contributions into four themes: (1) Advances in Understanding the Arctic System, Including Human Dimensions, (2), Arctic Change—Rapid, System-Scale Changes and the Capability to Project Future States of the Arctic System Under Various Scenarios, (3) Linkages to the Earth System—Linkages and Feedbacks Between the Arctic System and the Earth System, and (4) Human Dimensions of Arctic Change—Translating Research into Solutions. Here, we review highlights and key outcomes of the meeting. SoA contributions and products are available online at <http://soa.arcus.org>

THE ARCTIC SYSTEM: CHANGES AND INTERACTIONS

The SoA Conference surveyed changes underway in various sub-regions and sub-systems of the Arctic, confirming

and extending previous findings. However, in their entirety, the contributions also provided novel insights into the interplay between different processes and components of the Arctic system that are transforming the system as a whole through interactions and feedbacks not observed in the past. Examples and highlights reported on below are meant to illustrate such intertwined transformations.

Reverberations of a Changing Sea-Ice Cover

The overarching importance of the changing sea-ice cover, as a result of long-term decline in thickness and summer minimum extent, as well as through punctuated events such as the 2007 record minimum, was reflected in the contributions to the meeting. Out of a total of 378 talks or poster presentations, 41 focused on changing sea ice, and an additional 75 addressed some aspect of it. Overview presentations by Walsh and Overland highlighted how a combination of factors (a long-term thinning trend; enhanced melt promoted by advection of ocean heat from lower latitudes and amplified by solar heating of exposed open water; a polar dipole pressure pattern enhancing export of ice) have resulted in a thinner, less extensive, and more mobile ice pack. Several contributions indicated that these changes are now affecting the atmosphere with higher fall and winter surface air temperatures throughout the Arctic, delayed onset of freeze-up and ensuing changes in atmospheric pressure patterns (Overland and Wang 2010). Intriguing links between these changes and the Arctic Oscillation (which may contribute to a weakening of the Beaufort Gyre) were hinted at, but require further study (see also Stroeve et al. 2011). It is unclear to which extent this system-wide response may aid in allowing the ice pack to recover from extreme years such as 2007, and to which extent these changes in the Arctic, including those over

land such as changes in snow cover (Cohen et al. 2010), are shaping weather patterns such as colder winters observed just prior to the SoA meeting and this past season (Overland and Wang 2010).

The conference showed that while impacts on Arctic marine and terrestrial ecosystems as a result of such sea-ice change are undisputed, we lack a solid grasp on the nature of these impacts and the ensuing quantitative changes in, e.g., gross primary production. Discussions at the conference, e.g., by the panel on strengthening governance and management of the Arctic, recognized this lack of understanding. SoA presenters pointed to the North Pacific Fishery Management Council's recommendation to prohibit commercial fishing activities in U.S. waters north of Bering Strait as one approach to allow the science to catch up with a rapidly changing Arctic.

Reindeer herding, Socio-Economic Change and Resilience of Communities

The conference reviewed evidence from diverse sources around the circumpolar Arctic for successful adaptation to global change. The case of indigenous Nenets reindeer herders in Northwest Siberia illustrates some of the complexities that researchers must grapple with in understanding how societies respond to multiple stresses. Despite anthropogenic fragmentation and transformation of a large proportion of the environment, recent socio-economic upheaval, and pronounced climate warming, the Yamal-Nenets social-ecological system has proven highly resilient over the past several decades (Forbes et al. 2009). The persistence of long-distance tundra nomadism in the face of rapid and extensive change offers positive lessons for other regions experiencing or anticipating comparable scenarios of massive hydrocarbon development and climate warming. Institutional constraints and drivers were as important as the documented ecological changes, indicating that it is not sufficient to separate the biophysical from socio-economic components for analysis. Such cases call for science that: (i) is truly interdisciplinary in nature; (ii) involves the direct participation of local actors; (iii) may take several years to plan and implement, and (iv) is geared to inform policy through science-based recommendations. Policy-relevant research encompassing northern residents of even sparsely populated areas necessitates a delicate blending of bottom-up and top-down approaches to address simultaneously the various concerns of local people, scientists with relevant expertise, governance bodies (e.g. Arctic Council) and actual policy makers.

Related issues raised in the sessions include the following:

- Concerns about invasions by non-indigenous species introduced via, e.g., increased ship traffic;
- Importance of identifying important ecological areas, and implications for oil and gas exploration and development, Arctic shipping, port sites, sub-sea pipelines;
- Local and traditional knowledge (LTK) is valuable—maps and data developed that include LTK would be co-owned;
- How to foster resilience—positive examples of successful adaptation, e.g., Yamal Nenets;
- Rapid declines in arctic sea ice cover, especially summer ice cover, will alter competitive and predator–prey relationships as sub-arctic marine mammals colonize the Arctic. Advances in radio telemetry and in remote sensing have highlighted the seasonal importance to marine mammals of specific habitat features including sea ice, snow cover, bathymetry, and biological productivity;
- Arctic Observing Network-Social Indicators (AON-SI) and Humans and Hydrology at High Latitudes (H3L) projects have published a framework for time series of human-dimensions data.

A CHANGING ROLE FOR ARCTIC SCIENCE?

The conference provided a comprehensive picture of the changes affecting Arctic marine and terrestrial environments. While a number of presentations explored the role of anthropogenic greenhouse gas forcing and natural variability in driving such change, the meeting—arguably for the first time from such a broad vantage point—also highlighted the role of feedbacks and system responses, including socio-economic factors, in transforming the Arctic beyond its twentieth century state. The conference offered valuable perspectives on how repercussions of such pan-Arctic transformations are not necessarily gradual and may be associated with abrupt, disruptive change at the local and regional level.

The range of contributions to the SoA themes suggests that research continues to focus on how individual components of the Arctic system drive and respond to change. Presentations and panel discussions also reflected a growing recognition that society's need for projections of plausible Arctic future states requires research that is both interdisciplinary and cognizant of stakeholder requirements. Several presentations and panels argued for new partnerships between the scientific community, state, and regional agencies, Arctic communities, and industry. Andreeva and Kryukov highlighted the degree to which scientists in Russia have been involved in drafting new federal

laws that respond to policies recognizing the Arctic as the main resource base in the 21st century. The Chief Oceanographer of the U.S. Navy, Admiral Titley, identified adaptation as a top priority at a time where important infrastructure is threatened by increasing sea level, coastal retreat and changing weather and ice regimes. These examples illustrate a broader challenge to the scientific community discussed in a companion paper by Murray et al. (submitted). At present, the rapid rate of change may outpace the ability of researchers to provide the desired scientific information underpinning answers to these questions through traditional means of communication and outreach. The conference presented several approaches of how this challenge can be met. Examples include direct involvement of those experiencing change in the research design as practiced, e.g., by ArcticNet in Canada or the US-Russian Bering Sea Sub-network program, a focus on climate change adaptation as in the Community Adaptation and Vulnerability in Arctic Regions project (CAVIAR), or novel ways of synthesizing and communicating insights into seasonal predictability (e.g., through the Arctic Sea Ice Outlook; www.arcus.org/search/seaiceoutlook). Closer engagement with stakeholders requires platforms where such exchange can occur naturally and the SoA Conference itself was designed to meet this challenge.

OBSERVING SYSTEMS AND DECISION-MAKERS' INFORMATION NEEDS

The need for better coordination of long-term observations meant to address key scientific questions and serve decision-makers was a recurring theme that emerged from the meeting. It was universally recognized by participants that the momentum built during the IPY needs to be preserved. Equally important is the broad support received from all Arctic nations in providing access for scientific research and encouraging rapid release of resulting data (as embedded in the conditions for financial support of US National Science Foundation Arctic Observing Network projects). The International Polar Decade may emerge as a means to achieve these goals, but participants also recognized the need for shorter, coordinated intensive observation periods. The conference supported the idea of an Arctic Observing Summit, currently in its early planning stages to create a forum for such international coordination and collaboration.

It was noted that in contrast with terrestrial observing systems, which often centered on ecological questions, the marine observatories were mostly concentrating efforts on the physical components of the system. As a result, important opportunities to connect with key stakeholders,

in particular Arctic residents, may be missed. At the same time, a biological project, the Circumpolar Biodiversity Monitoring Programme (organized under the Arctic Council's Conservation of Arctic Flora and Fauna Working Group), was highlighted as an example of how long-term observations of Arctic change can be anchored through existing programs with fairly modest additional support.

RESPONDING TO ARCTIC CHANGE

While the rapidity and extent of Arctic environmental and socio-economic change does present significant challenges, the SoA Conference demonstrated that significant progress has been made over the past decade in designing research projects that address effective responses to such change (Murray et al., submitted). Presentations summarizing research done as part of the Canadian ArcticNet program highlighted the potential of meta-analyses of local adaptation to climate change to inform efforts in other regions and to aid development of best practices and effective management approaches (Ford 2010). Presentations by Young, Gulledge, and others argued that existing frameworks at the policy level provide multiple pathways towards potential responses to change, but that adaptation or strengthening of key institutions appears to be a prerequisite for these to be effective. Evidence from Alaska suggests that new partnerships and bottom-up approaches towards building Communities of Practice may contribute towards this goal (Lovecraft and Eicken 2011).

SUMMARY

The SoA conference emphasized that urgent questions posed by society and decision-makers in response to rapid Arctic change require that Arctic research address the broader concepts of sustainability as well as adaptation to and mitigation of interrelated environmental and socio-economic change. Murray et al. (submitted) explore progress made in this context. The SoA meeting demonstrated significant progress by the Arctic community of scientists and stakeholders in meeting this challenge, as well as the need to better engage the private sector and find more effective ways to partner with relevant research activities outside of the polar regions.

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REFERENCES

- Cohen, J., J. Foster, M. Barlow, K. Saito, and J. Jones. 2010. Winter 2009–2010: A case study of an extreme Arctic Oscillation event. *Geophysical Research Letters* 37: L17707. doi:[10.1029/2010GL044256](https://doi.org/10.1029/2010GL044256).
- Forbes, B.C., F. Stammer, T. Kumpula, N. Meschtyb, A. Pajunen, and E. Kaarlejärvi. 2009. High resilience in the Yamal-Nenets social-ecological system, West Siberian Arctic, Russia. *Proceedings of the National Academy of Sciences* 106: 22041–22048.
- Ford, J. 2010. Dangerous climate change and the importance of adaptation for the Arctic's Inuit population. *Environmental Research Letters* 4: 1–9.
- Lovecraft, A.L., and H. Eicken 2011. in press. *North by 2020: Perspectives on Alaska's changing social-ecological systems*. Fairbanks: University of Alaska Press.
- Murray, M.S., P. Schlosser, and J. Fahnestock. submitted. Increasing demand for and implementation of solution-oriented science: A transformation of Arctic research. AMBIO.
- Overland, J.E., and M.Y. Wang. 2010. Large-scale atmospheric circulation changes are associated with the recent loss of Arctic sea ice. *Tellus Series A-Dynamic Meteorology and Oceanography* 62: 1–9.
- Stroeve, J.C., J. Maslanik, M.C. Serreze, I. Rigor, W. Meier, and C. Fowler. 2011. Sea ice response to an extreme negative phase of the Arctic Oscillation during winter 2009/2010. *Geophysical Research Letters* 38: L02502. doi:[10.1029/2010GL045662](https://doi.org/10.1029/2010GL045662).

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