**U.S. ARCTIC OBSERVING COORDINATION**

**WORKSHOP REPORT**

**INTERNAL DRAFT**

**DRAFT REPORT OUTLINE**

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**EXECUTIVE SUMMARY**

The Arctic is undergoing tremendous changes. Permafrost is thawing, ice sheets are melting, and sea ice is thinning and retreating. These changes are impacting ecosystems and human activities. Observing, understanding, and responding to these changes are the central themes of the U.S. Interagency Study of Environmental Arctic Change (SEARCH). SEARCH is a collaborative scientific program that brings together academic and government agency scientists as well as stakeholder representatives to prioritize, plan, conduct, and synthesize research focused on Arctic environmental change.

The Arctic Observing Network (AON) constitutes a key piece of the U.S. SEARCH effort. One of the defining aspects of the AON is the policy of rapid, free, and open access to all data and metadata. This open access approach has lead to broad and direct collaboration between scientists, agencies, and stakeholders. The Arctic Observing Network Coordination Workshop was designed to build on this collaboration by bringing together researchers, representatives from the relevant agencies, and stakeholders involved with long-term observations of Arctic change to work towards the following goals:

* Develop a shared vision of a successful AON;
* Identify steps needed to accomplish that vision;
* Identify specific tasks and timelines for activities associated with these steps;
* Identify "showcase" projects for observing activities, with recommendations for short-term implementation (5 years or less), including designated task leads.

The workshop focused on two key themes that are well suited for cross-disciplinary and cross-agency collaboration. They are (1) improving the understanding and prediction of sea ice changes and their consequences for ecosystems, human activities, and climate, and (2) understanding the consequences of the loss and warming of shallow permafrost on Arctic and global systems.

The workshop started with a plenary session with nine invited presentations. These presentations discussed the observational needs of stakeholders, agencies, decision makers, and modelers and SEARCH science goals. There was also an evening poster session covering a wide range of topics including Arctic observations and activities.

After the main plenary session, the workshop participants divided into four breakout groups, two focused on the ocean and two on land. The ocean groups addressed the SEARCH science goal of “Sea Ice/Consequences of an Ice-Diminished Arctic Ocean” and the land groups discussed the goal of “Permafrost/Land Surface Change/Hydrology.” Breakout groups were charged with developing “showcase projects” that could help identify and highlight effective approaches towards interagency collaboration in the context of the Arctic Observing Network while at the same time serving as nucleation sites for incremental consolidation of core network activities. There were three breakout sessions. In the first session, the theme was “Develop a vision of a successful Arctic Observing Network.” The second session focused on “Identify specific ways to achieve the vision.” The final session discussed “Details and showcase projects.” The third breakout session also included a special Data Issues group that considered such topics as inter-operability, proprietary data, data formats, common archive structure, and provision of data for showcase projects. After each breakout session, the workshop returned to plenary sessions for each breakout group to report on its deliberations.

The breakout groups developed eleven showcase projects that balanced the research interests of the scientific community and the information needs of different agencies and stakeholders. These projects will foster dual-use of resulting datasets and information products, both from a fundamental and an applied research perspective. The eleven showcase projects are:

* From Observations to Management: Providing Scientific Information to Inform Decisions Regarding Offshore Oil and Gas Activities in the Chukchi Sea
* A Distributed Biological Observatory
* Multidisciplinary Drifting Observatory for the Study of Arctic Climate
* Community-based observation network for Adaptation and Security
* Ocean Observations to Improve Sea Ice Forecasting
* Long-Term Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts
* Arctic Ocean Freshwater and heat observing system
* Distributed Environmental Observatory
* Utilizing the State of the Existing Knowledge to Guide Infrastructure Development
* What are the causes and consequences of the greening of the Arctic?
* Connecting Arctic Communities with One Another and with Scientists: Building a Community-Based Observation Network

For each project a lead contact was identified and information on the what, why, where, when, and who was presented. The lead contact for each showcase project will arrange follow-up activities for the showcase projects.

**I. INTRODUCTION**

The Arctic Observing Network (AON) constitutes a key piece of the U.S. Interagency Study of Environmental Arctic Change (SEARCH). SEARCH is a collaborative scientific program that brings together academic and government agency scientists as well as stakeholder representatives to prioritize, plan, conduct, and synthesize research focused on Arctic environmental change. It is guided by a Science Steering Committee (SSC) and several panels and working groups (details at the SEARCH website, [www.arcus.org/search](http://www.arcus.org/search)) with broad representation of the research community. At a time of rapid Arctic change, the SEARCH program is in itself a response by the Arctic research community to these major transformations underway in the North. The origins of SEARCH lie with the realization of key segments of the Arctic research community of the major changes underway in the Arctic ocean/ice/atmosphere system, leading to the development of a broadly interdisciplinary, cross-sector science plan published in 2001 (Morison et al., 2001). In 2005, a community workshop resulted in the formulation of an implementation document (SEARCH Implementation Workshop Report - SIW, 2005) which in turn informed the plans for ramping up a key component of the program during the International Polar Year (IPY) 2007-08.

SEARCH has been conceived as an interagency program, led by the SSC with an Interagency Program Management Committee (IPMC) focused on the technical details of supporting such interagency efforts. The program has taken a tri-partite approach to Arctic change, with activities grouped into Observing, Understanding and Responding to Change categories(Figure A). The activities associated with each of these are overseen by three topical panels and working groups addressing data-related issues or important topics deserving of attention. Of these three, Observing Change (OC) has made the greatest advances, with the US Arctic Observing Network (AON) and its more than 50 component projects constitute the core OC effort. An overview of activities related to the Understanding component of SEARCH is provided by a recent report by the Understanding Arctic Change Task Force (Walsh et al., 2012). While many SEARCH activities developed natural ties to the Responding to Change (RtoC) theme, an explicit implementation of RtoC has proven to be more challenging. However, in the very recent past, an international workshop organized by the International Study of Arctic Change (ISAC) with substantial contributions by SEARCH has outlined a way forward and provided a framework for planning and coordination RtoC activities (Murray et al., 2012). The AON Coordination Meeting was explicitly designed to help achieve progress in linking observations of Arctic change to improved understanding and effective responses, while at the same time developing and strengthening interagency (and stakeholder) ties for these activities.

The origins of the AON lie with the IPY when NSF, based on the recommendations of the SIW report, funded a broad portfolio of AON projects, integrating existing Long-term Observatory (LTO) projects that originated with the early phase of SEARCH. One of the defining aspects of the AON is the adherence to the SEARCH data policy, developed by the SEARCH Data Working Group (McGuire et al., 2007; <http://www.arcus.org/search/searchscience/data.php>), with two key tenets:

- AON data are considered SEARCH community data with fully, free and open access as quickly as possible after collection and quality control; timely data availability is part of the SEARCH proposal review criteria;

- SEARCH Data Management Plan guidelines with respect to preparation and submission of data, metadata, and documentation should be followed, with data submitted to an appropriate data archive.

These guidelines and recognition by lead investigators and NSF of the value of this open access approach for AON datasets have opened a door to much broader and more direct collaboration with agencies and stakeholders, preparing the ground for meetings such as the AON Coordination Workshop. At the same time, by the (Advanced) Cooperative Arctic Data and Information Service (A-CADIS; [www.aoncadis.org](http://www.aoncadis.org)) provides a mechanism and platform for archival and access of AON datasets.

An overview of the status of the AON and its development and future directions at the end of the IPY is summarized in a State of the AON report based on a workshop held in December of 2009 with leadership by the Observing Change Panel (AON, 2010). From the workshop, a number of recommendations emerged that are relevant in the context of the workshop reported on here:

- Optimization of an AON capable of sustained, decadal-scale observing will require improved coordination between the agencies that support Arctic observations

- AON must develop effective approaches for partnering with industry and a broad range of federal, state and local agencies to sustain long-term observing activities

- Standardization and coordination of measurements need to be advanced and improved

- An international collaborative framework for long-term Arctic observations needs to be created.

At the present time, an AON Design and Implementation Task Force (ADI; [www.arcus.org/search/aon/adi](http://www.arcus.org/search/aon/adi)) is meant to provide guidance on how to achieve a well-designed, effective, and robust Arctic Observing System. The ADI effort will culminate in a final report with recommendations for the next steps in optimizing, coordinating, and enhancing the existing components of an international arctic environmental observing system, with emphasis on the U.S. AON. The final report is expected to be completed summer 2012 and will integrate findings from the present meeting.

Building on the activities outlined above, the AON Coordination Workshop was aiming to bring together researchers, representatives from the relevant agencies, and stakeholders involved with long-term observations of Arctic change to work towards the following goals:

- Develop shared visions of a successful AON;

- Identify steps needed to accomplish that vision;

- Identify specific tasks and timelines for activities associated with these steps;

- Identify "showcase" projects for observing activities, with recommendations for short-term implementation (5 years or less), including designated task leads.

In order to keep the scope of the meeting manageable and achieve progress, the organizing committee, broadly representative of the workshop participants and interests, decided to focus on the most urgent, relevant and mature themes as identified in a range of agency documents and the SEARCH 5-year goals and strategy document. Specifically, the focus was on improved understanding and prediction of (1) sea ice changes and their consequences for ecosystems, human activities, and climate, and (2) the consequences of the loss and warming of shallow permafrost on Arctic and global systems (see meeting background materials for more details with a compilation of published agency Arctic research priorities and the SEARCH goals document; <http://www.arcus.org/search/meetings/2012/coordination-workshop/>). These two research areas lend themselves most readily to cross-sector, cross-agency collaboration.

In a nutshell, the purpose of the AON Coordination Workshop builds on the premise that the momentum generated by the ramping-up of NSF-supported AON projects during IPY now allows the broader research community, agencies and stakeholders to identify specific, incremental steps of how to best achieve the original vision of an Interagency AON (IAON), as laid out by the Interagency Arctic Research Policy Committee (IARPC, 2007). Progress towards more coordinated networked efforts can occur along several different pathways. During the workshop, three themes or topical areas were of particular interest: (1) Balance and prioritization, in particular with respect to scientific research interests and societal, agency or stakeholder information needs; (2) Integration, e.g., through ingestion of AON data into models, partnering between community-based observations and academia, or through merging of in situ and remote sensing data; (3) Coordination, such as through focusing on specific topics (e.g., ice-diminished Arctic Ocean, warming and thawing permafrost), methods-based prioritization (e.g., observations needed to improve climate models, community-based observations etc.), local-national/regional-international scaling of activities, or information and data product-based coordination (e.g., through focused data portals).

Examples of how a focus on these three themes can help advance an improved, better coordinated network include the role of large-scale model improvements in driving observational programs, such as the Next Generation Ecosystem Experiments (NGEE) project or the priorities developed by the climate modeling community with respect to improved representation of sea ice (e.g., Perovich et al., 2012). Such activities can also help with the prioritization of observations from a systems perspective. Along the same lines, SEARCH’s Arctic Sea Ice Outlook (Calder et al., 2011), an international synthesis effort focusing on improved seasonal prediction of the Arctic ice cover has helped constrain observing activities and was discussed in more depth in the relevant break-out groups. Finally, with respect to regional, national and international coordination the workshop provided a forum for location-specific discussions (such as the Barrow-region break-out group) that cut across disciplines and domains and can then lead to further integration at the international level. With respect to the latter, the AON Coordination Workshop also served as an important forum to discuss recommendations and plan for an international Arctic Observing Summit under the auspices of ISAC and the Arctic Council’s Sustaining Arctic Observing Networks initiative.

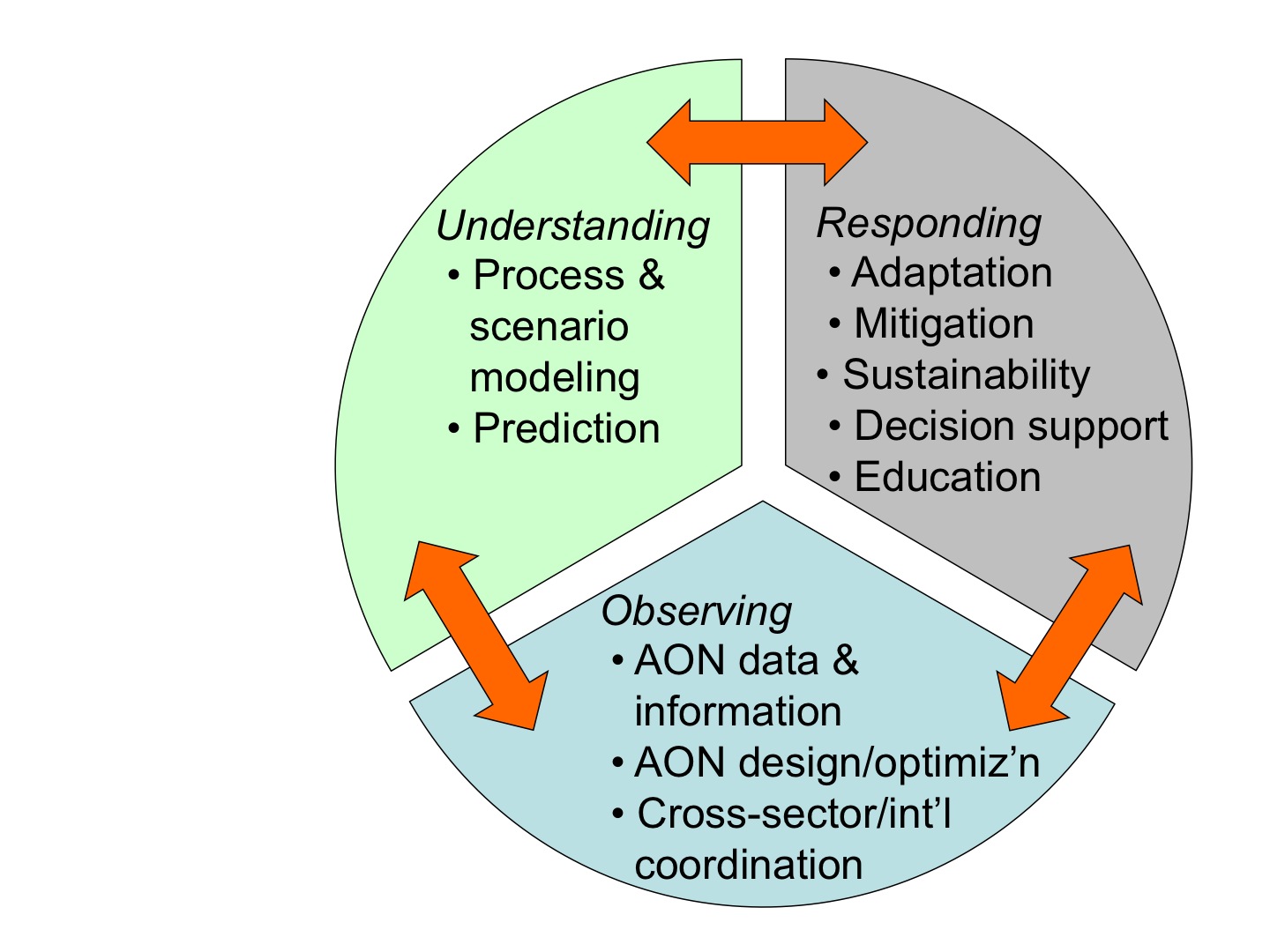


Figure A: Schematic depiction of SEARCH tri-partite approach and associated activities.

**II. WORKSHOP STRUCTURE AND ORGANIZATION**

The workshop was organized by plenary session and break-out group. The meeting agenda is presented in Appendix III. The main plenary session, on Tuesday morning, was divided into two parts. The co-chairs of the organizing committee, John Payne and Don Perovich, began Part 1 with an introduction and welcome followed by a description of workshop goals & expected outcomes. They were followed by talks by five speakers, who were asked to address broad, high level topics to set the stage for the workshop. Part 2 had talks by four speakers who were asked to be more specific and address the following question as it relates to the four SEARCH Science Goals: “With the resources we have now, what are the greatest advances that could be made in observational data/products for use by scientists and stakeholders?”

The Plenary Session 1 talks were:

1. Observations on the Observations: Where We Might Go From Here

Fran Ulmer (Chair, U.S. Arctic Research Commission)

John Farrell (Executive Director, U.S. Arctic Research Commission)

1. Overview of the Study of Environmental Arctic Change (SEARCH) and the Arctic Observing Network (AON)

Hajo Eicken (University of Alaska Fairbanks & Chair, SEARCH Science Steering Committee)

1. Data and Observational Needs from Agencies, Stakeholders, and Decision-Makers

Larry Hartig (Commisioner, Alaska Department of Environmental Conservation)

1. Arctic Observational Needs For Modeling and Prediction

John Walsh (International Arctic Research Center, University of Alaska Fairbanks)

1. Back to the Future: A Conceptual Framework for Advancing AON

Martin Jeffries (Office of Naval Research)

The Plenary Session 2 talks were:

1. SEARCH Science Goal #1: Sea Ice/Consequences of an Ice-Diminished Arctic Ocean Julienne Stroeve (National Snow and Ice Data Center, University of Colorado Boulder)
2. SEARCH Science Goal #2: Permafrost/Land Surface Change/Hydrology

Larry Hinzman (International Arctic Research Center, University of Alaska Fairbanks)

1. SEARCH Science Goal #3: Land Ice Loss Tad Pfeffer (Institute of Arctic and Alpine Research, University of Colorado Boulder)
2. SEARCH Science Goal #4: Society/Policy - Links Between Observational Data/Information and Public Understanding Henry Huntington (PEW Environment Group, Arctic Program Science Director)

After the main plenary session, the workshop participants divided into four break-out groups (Ocean 1, Ocean 2, Land 1, Land 2) to address SEARCH science goals 1 and 2: (1) Sea Ice/Consequences of an Ice-Diminished Arctic Ocean, and (2) Permafrost/Land Surface Change/Hydrology. After each break-out session, the workshop returned to brief plenary sessions for each break-out group to report on its deliberations.

During Break-out Session 1, each group was asked to Develop a Vision of a Successful Arctic Observing Network by addressing these questions:

1. Which audiences would an ideal AON serve?

2. Given these audiences, in an ideal world what would an AON look like in

5 years? What would the 'value added' be, beyond the current way of business?

3. What products and services would be created?

During Break-out Session 2, each group was asked to identify Specific Ways to Achieve the Vision by addressing these questions:

1. What activities are needed?

2. Can significant progress be made by combining existing resources or infrastructure, or by implementing targeted activities?

3. Are there cross-cutting activities or showcase projects, e.g., data-focused, place-based/regional, etc., that could be implemented?

During Break-out Session 3, each group was asked to discuss Details and Showcase Projects. Specifically, the charge was to develop showcase project descriptions organized into five categories: Why? What? How? Where? When? Break-out Session 3 included a special Data Issues group tasked to consider topics such as inter-operability, proprietary data, data formats, common archive structure, provision of data for showcase projects, etc.

The first day of the workshop concluded with a poster session. The posters covered a wide range of topics that included SEARCH, Arctic observing activities and Arctic science.

**III. SUMMARY OF SHOWCASE PROJECTS**

Due to the breadth and diversity of Arctic (long-term) observation programs supported or carried out by different agencies, academia and various stakeholder groups, the workshop organizers focused on incremental, bottom-up approaches towards improved coordination and integration of these activities. Break-out groups were thus charged with identifying “showcase projects” that could help identify and highlight effective approaches towards interagency collaboration in the context of the AON while at the same time serving as nucleation sites for incremental consolidation of core network activities.

Attributes of promising, viable showcase projects include the following sets of criteria and break-out groups were asked to indicate how specific showcase project proposals would encompass these:

An advanced level of readiness, as expressed, e.g., in the number of datasets available for synthesis, known plans for recurring field programs that would help sustain coordinated efforts, or existing databases accessible for observation planning, data discovery or dissemination

A high potential for cross-agency collaboration and support, including specific information on relevant funding opportunities, existence of interagency working groups or informal communities of practice that could help advance coordination and collaboration

In addition, break-out groups were asked to identify ways in which the respective showcase projects could help balance the research interests of the scientific community and the information needs of different agencies and stakeholders. Ideally, showcase projects would foster dual-use of resulting datasets and information products, both from a fundamental and an applied research perspective. Finally, leads for these different showcase activities were to be identified or recruited by the break-out groups.

**SHORT ABSTRACT OF EACH OF THE SHOWCASE PROPOSALS (SEE FULL LISTING OF SHOWCASE PROJECTS IN APPENDIX SECTION)**

**1. From Observations to Management: Providing Scientific Information to Inform Decisions Regarding Offshore Oil and Gas Activities in the Chukchi Sea (Molly McCammon)**

The goal of this project is to develop linkages among changes in the large-scale pan-Arctic ice pack and regional scale sea ice dynamics and ocean conditions, and their impacts on living resources in the Chukchi Sea. This would information would be used to support policy decisions concerning whether, where, when, and how to explore for and produce oil and gas and prepare for potential impacts and responses to those impacts in the Chukchi Sea Outer Continental Shelf, especially in light of documented climate change. Although regulating offshore oil and gas activity is a policy matter, scientific observations and research results can provide relevant information to inform policy decisions and adaptive management of those activities. However, the needs of decision-makers may not be fully apparent to scientists, and the results of scientific studies and observations may not be presented in ways that meet the needs of decision-makers. In addition, the connection between large-scale Arctic observations and regional- and local-scale science and management needs is typically not made. This showcase project would address these challenges.

In particular, this project, which requires interagency support, would develop: coupled pan-Arctic and regional sea ice models and forecasts of presence and characteristics on seasonal and annual time scales; annual/seasonal forecasts of freeze up and break up in the Chukchi lease sale area; risk and vulnerability assessments and likely sensitivities of key marine species to disturbances from sea ice and storm hazards and human activities; projections of likely trajectories of spilled oil due to potential sea ice hazards; and transparent steps for use of the above information in decision-support materials and processes for policy and regulatory issues pertaining to potential oil and gas activities in the Chukchi lease sale region.

**2. The Distributed Biological Observatory (DBO) (Jackie Grebmeier)**

The Pacific Arctic region is experiencing rapid sea ice retreat and seawater warming that can have cascading impacts on many components of the marine ecosystem. Recent observations of altered pelagic and benthic prey bases for marine mammals and seabirds coincident with varying predator foraging areas and habitat use highlight changes in the region. It is essential to track biological response to changing environmental forcing to provide information to multiple end-users, including government agencies responsible for evaluating marine ecosystem health as well as societally-relevant concerns, about the impact of multiple stressors to the ecosystem. The Distributed Biological Observatory (DBO) is being developed by an international consortium of scientists in the Pacific Arctic as a change detection array to systematically track the broad biological response to sea ice retreat and associated environmental change. The DBO is tracking select biological measurements at multiple trophic levels, coincident with physical and chemical data, in a latitudinal array of transect lines and stations in the northern Bering and Chukchi seas. Coordinated ship-based observations on a regular basis, together with satellite and mooring observations at the designated sites, can provide an early detection system for biological and ecosystem response to climate warming. The current 2010-2012 pilot program focuses on two areas in the Chukchi Sea where the highest number of ships from six Pacific countries agreed to participate and share data sets, both real-time and post-cruise, through the Pacific Arctic Group (PAG; <http://pag.arcticportal.org/>). Successful implementation of the biological change detection array as envisioned by the DBO effort will provide for a national and international network of coordinated sampling. This network will provide up-to-date information of one of the most productive regions of the Arctic. The DBO efforts will facilitate data collection, sharing and archiving through the US ACADIS (Advanced Cooperative Arctic Data and Information Service) data program and associated international data agreements. Further information on the DBO can be found at <http://www.arctic.noaa.gov/dbo/>.

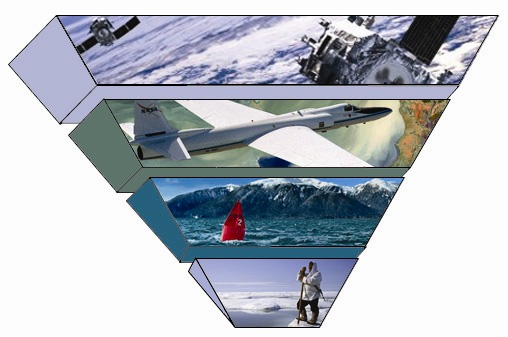
**3. Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC)** **(Matthew Shupe)**

Multi-year, detailed, and comprehensive measurements extending from the atmosphere through the sea-ice and into the ocean of the central Arctic Basin are needed to improve our understanding and modeling of Arctic climate and weather, and to enhance Arctic sea-ice predictive capabilities.   These observations will be designed to provide a process-level understanding of the new central Arctic climate system, consisting of dramatically less and thinner sea-ice than in the recent past, as well as a more detailed understanding of the processes leading to these sea-ice changes.  Scientific emphasis will be placed on processes that transfer heat, moisture, density, and momentum through the system.  To obtain the needed measurements, a manned, transpolar drifting observatory is proposed, wherein an ice-hardened ship serves as a central hub for intensive observations of atmospheric, oceanic, and sea-ice properties.  The comprehensive information from this central facility will be expanded to larger spatial scales using a coordinated network of distributed measurements made using buoys, unmanned aerial systems, autonomous underwater vehicles, additional ships, aircraft, and satellites.  A broad consortium of nations and funding agencies is needed to facilitate, coordinate, and support such a constellation of central Arctic observations.

**4. Community-Based Observation Network for Adaptation and Security (CONAS) (Lilian Na’ia Alessa, Andrew Kliskey)**

A pan-arctic community-based observation network for adaptation and security (CONAS) will a) monitor and understand environmental change, b) evaluate points of resilience and risk and c) ensure that undesired changes are met and managed before they become catastrophic. CONAS relies on data that are collected by local residents year-round on environmental variables and resources of importance such as water, weather, plants and animals as well as the social and economic contexts in which they exist. The current phase exists as the Bering Sea Sub Network (BSSN [www.bssn.net](http://www.bssn.net)). Planned expansion would extend CONAS north of Bering Strait to the U.S and Russian Far East peripheries of the Chukchi Sea.

CONAS will establish consensus on critical variables to be observed, the co-production of science, shared interpretation of data, and co-management of applications as appropriate. The tools to accomplish these goals involves a) structured survey forms and semi-structured narratives, b) architecture for information fusion (AIDA), c) hand-held data capture devices for image, voice and environment, d) distributed micro sensor arrays and data from IUAVs, gridded at appropriate spatial geometries, e) computer programming, hardware and other and cyber infrastructure for discovery, f) social processes of discourse for knowledge sharing face-to-face and face-to-place to achieve a better understanding of arctic environmental variability and resilience.



*Nested scales of observation in AON from remote satellite observing at global scales, airborne observing at regional scales and buoy/instrument-based marine terrestrial networks. BSSN/CONAS adds a scale of resolution that works synergistically with these networks to better resolve the heterogeneity of change.*

**5. Ocean Observations to Improve Sea Ice Forecasting (Julienne Stroeve)**

The showcase project for ocean observations is aimed at improving sea ice forecasting on several time-scales: seasonal, interannual and decadal. These time-scales are important to a variety of stakeholders, including operational users (safety of life and property), crisis responders, resource managers, weather and climate forecasters, climate change detection researchers, politicians and coastal communities. The initial target areas include the Beaufort, Chukchi and northern reaches of the Bering Sea and implementation of the project will be under guidance from the US-AON steering committee and a relevant international group (e.g. SAON), possibly forming a new program office for overall guidance. Collaborations with key stakeholders are important to ensure observational planning meets forecasting needs on various time-scales.

Initial development of the project will build upon existing observational platforms (e.g. ships, aircraft, fixed offshore platforms, coastal stations, satellites) and will foster partnerships with national, international and private industry. Consultation with modeling centers will help define data needs, identify platforms of opportunity and define high priority products. Successful implementation of this project will provide continued and enhanced observations directly supporting various user needs; improved coordination among agencies and countries, improved model-based forecasts with error estimates and extended data records to support climate science.

**6. Long-Term Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts (Steve Okkonen)**

Sea level is arguably the most basic of oceanographic measurements. Coastal peoples have historically recognized that travel, commerce, and the harvesting of marine resources are influenced by changes in sea level and that the ability to predict these changes greatly improves efficiency and safety in pursuit of these activities.

Benefits of long-term sea level measurements along the Alaskan Chukchi and Beaufort coasts include:

1) Coastal sea level is a suitable proxy for near-shore, sub-tidal current velocities. A network of stations reporting in near real-time allows circulation along the Alaskan arctic coast to be described in a systematic sense.

2) Sea level measurements are used to both assess and validate numerical storm surge and circulation models. The ability of a numerical model to reproduce observed sea level is a fundamental measure of a model’s skill. A skillful storm surge model is an emergency preparedness and response decision support tool for coastal Alaskan villages.

3) Sea level measurements that have been acquired along Alaska’s arctic coast have generally been of too short duration to resolve seasonal and long-period (e.g. associated with the Arctic Oscillation) changes in sea level.

4) Sea level measurements along the arctic coast of Alaska would provide a unique set of observations to validate sea height estimates derived from satellite remote sensing. Additionally validated remote sensing sea level estimates obtained from radar altimetry or SAR could be used to fill the gaps in the proposed tide station location in the Beaufort Sea. Satellite images of actual storm surge events can also be better interpreted using the coincident tide gauge observations.

**7. Arctic Ocean Freshwater and heat observing system (Peter Schlosser)**

Freshwater and heat content determine the stratification and circulation patterns in the Arctic Ocean including its shelf seas. These fundamental features of the Arctic Ocean impact sea ice formation/melting, sea ice extent, meltwater distribution, biological activity, runoff from land (rivers and glacial melt water) and navigation in the Arctic Ocean, among others. We propose to implement a system for systematic, pan-Arctic, multi-platform, long-term observations to determine the freshwater and heat contents of the Arctic Ocean, as well as their variability and trends. The system would cover observations of the central basins of the Arctic Ocean and its shelves and would allow us to narrow the errors in our estimates of freshwater and heat inventories and fluxes. Parts of the system are in place through national (mainly NSF AON, NOAA, ONR, NASA) and international efforts. The proposed system can be completed in a 5-year time frame. As laid out below the Freshwater and Heat Observing System serves many purposes within the science and stakeholder communities.

**8. A Distributed Environmental Observatory for Terrestrial Change Detection (Philip Martin)**

This project establishes a network to rescue, standardize, collect, distribute and synthesize long-term observational data pertaining to the effects of permafrost degradation and changing hydroclimate regime on *ecosystem services*, including *wildlife, habitat, and human infrastructure* in northern Alaska. The Environmental Observatory will focus work in specific watersheds that collectively represent the diversity of landscape settings and dominant ecological processes within the region, take advantage of existing science/logistics capacity for the sake of efficiency, and provide opportunities to build on existing long-term data sets. Our intent is to measure key system drivers and processes in a standardized fashion across sites. For example, we will measure climate, snow cover, soil moisture, water balance components (e.g., precipitation, surface storage, runoff, evapotranspiration), active layer depth, soil temperature profile, vegetation composition and seasonality, disturbance (fire, thermokarst, human activity). Candidate sites include those with active science programs (e.g., Barrow/Meade River, Kuparuk River, Fish Creek, Jago/Okpilak/Hulahula rivers) supported by both NSF and federal resource agencies. We intend to institutionalize and strengthen the independent observation activities at each of these locations by providing support for central network functions and filling data gaps. Network planning and design is currently underway under the auspices of the Arctic Landscape Conservation Cooperative (ALCC), with support from the US Geological Survey. Operational funding, particularly for centralized network functions such as data management, synthesis, and outreach will likely be available from the Arctic Landscape Conservation Cooperative and USGS Alaska Climate Science Center. This project is motivated by the identification of overlapping priorities expressed by the scientific community and management agencies. For this network to be sustainable, it will be important to maintain relevance to applied problems of interest to the resource management community to ensure relevance to applied problems, as well as provide a suite of “open-source” environmental time-series for use by the research community.

**9. Utilizing the State of the Existing Knowledge to Guide Infrastructure Development (Larry Hinzman)**

To date, infrastructure development, construction and placement has not adequately considered future environmental conditions. Understanding generated by AON and other climate scientists and ecologists could inform design and location of such structures in a way that would minimize disturbance and ensure long-term functional stability. Using research efforts to guide responsible development and using development projections to guide investment of scientific resources will ensure that research activities provide a useful product back to local communities, and tribal, state and federal governments. Any land or resource management agency, every community that anticipates growth and development, and every company that contemplates industrial developments in the Arctic must think strategically on at least a 30 year planning horizon, including consideration of how the changing climate will impact local environmental conditions. Civil projects that could benefit from consideration of climate and ecosystem analyses should interface with the AON program to enable most efficient analyses and optimum design incorporating the state of the science. Civil projects offer the opportunity to collect unique datasets and an opportunity to collect pre-disturbance data and monitor impacts and recovery. To ensure successful execution and maximum value of such a program, it should include early involvement of industry and agencies/governments, synthesis and incorporation of existing data, development of best management/design practices, incorporation of permit conditions that facilitate optimum data collection and sharing, and integration of best management/design practices with geographic data layers to develop ecologically and economically viable alternatives.

**10. Showcase Project: What are the causes and consequences of the greening of the Arctic?** **(Eric Kasischke and Craig Tweedie)**

Analyses of satellite remote sensing data shows there has been a pronounced increase in greenness of vegetation in the pan-Arctic over the past three decades. A number of changes to Arctic vegetation have also been observed through a number of landscape to regional scale studies, and their consequences are important to subsistence users, land managers, and policy makers. This showcase project would address three questions: ***What actual changes to vegetation are occurring?*** In particular, in different Arctic ecosystems, what changes are occurring to community composition, vegetation growth, and vegetation phenology? ***What are the causes of vegetation change?*** In particular, how do changes in climate (temperature, precipitation, snow cover, etc), disturbance (fire, insects,thermokarst, etc), permafrost warming and thawing, herbivory, and changes to nutrient availability interact to control changes to vegetation? ***What are the consequences of vegetation change?*** In particular, how do changes in vegetation influence wildlife habitat and migratory bird and mammals, permafrost dynamics, subsistence, and key feedbacks between the land surface and atmosphere (albedo, latent heat exchange, surface energy exchange)?

**11. Connecting Arctic Communities with One Another and with Scientists: Building a Community-Based Observation Network (Henry Huntington)**

Many Arctic residents spend considerable time on the land and sea throughout the year, but their observations are rarely documented. Some community-based projects are underway, but there are few connections among them. A community-based observation network can provide mutual support for technical and other challenges, generate more interest among community members, and strengthen connections with scientists. The Showcase Project will start with an evaluation of current efforts, to identify the factors that determine the success of community-based observation programs in terms of observer participation, quality of data, sustainability, and other parameters that matter to long-term observational efforts. On the basis of this analysis, the Showcase Project will design a network-support system to foster greater community involvement, more interactions among communities, and better integration with other monitoring work. Once this system is in place, it can be evaluated and modified based on experience.

**IV. SUMMARY OF DATA MANAGEMENT BREAKOUT SESSION**

A dozen workshop participants including data managers, scientists, and agency program managers attended the breakout session. The objective of the discussion was to focus on Arctic Observing data issues (e.g. interoperability, sharing of proprietary data, data formatting common archive structures, provision of data for showcase projects) and how one might set priorities for activities that would improve the discovery and access to the rich AON datasets that are held in dozens of archives across the region.

What does the community need? They need to be able to find and share the data, and be able to browse an inventory of available data to streamline the discovery and access process. There is certainly a need for special products for decision makers, politicians and the public (by species, discipline, parameter, etc). It is an ongoing discussion topic to determine who is responsible for preparing these ‘value-added’ products.

The group discussed a variety of issues with a focus on what is needed to promote Arctic observing data (here defined as the union of Arctic Observing Network (AON) project data holdings plus state, federal and local community operational and research data) to be shared by all groups. The fundamental question is how can the these data be collected, archived and distributed to maximize their utility by the decision makers, the research community and local communities to help with analysis assessment and recommendations needed for improved product and services to describe the changes underway in the Arctic region.

There is a wide ranging audience for this diverse dataset and the products produced from it including the research community (e.g. synthesis products), commercial fisheries, the energy industry, general public (e.g. weather ice and sea state forecasts), indigenous population (e.g. whalers, hunters) regulators, resource managers, emergency services, military (e.g. U.S. Coast Guard) and politicians.

An initial step was made in preparation for this workshop with the preparation of an inventory of web sites that include data archives, real time and near real time products, federal state and local agency web sites and also specialized sites for Geographic Information System(GIS) formatted products and other information. This list is included in Appendix 1I.

There are several high priority responsibilities and activities that can be considered for implementation by those responsible for the archival and dissemination of Arctic data. AON data must be accessible freely, opening and quickly. The multi-agency nature of AON requires collaboration among the various data archives to maximize this sharing—these helps support and highlight the interagency aspect of AON. There should be consideration an AON Data Policy that emphasizes open access and reflects multi-agency buy in to the process. Distributed archives are the norm today but they must be interoperable. This is most effectively done by considering consistent discovery-level metadata, formats standards, common collection practices, conforming units and taxonomy. It is also vital that the international links be opened to permit sharing of regional and pan-Arctic data and information.

The development, acceptance and implementation of an Arctic Observations Data Policy that facilitates the exchange of data among all providers are important first steps. Key attributes are to encourage the unrestricted access to some or all of the Arctic data in the US. Second it is vital that the policy respect restrictions on data access but require open access of clearly specified embargo periods. The policy should emphasize the need for a common metadata schema to enhance exchange. The policy must emphasize the need for dataset attribution to make sure the data providers are given proper credit and citation for the data provided.

- “Buy in” by agencies to build an inventory on how the data are discoverable

- Propose a project to demonstrate metadata connectivity

- Expose data and metadata through open web services (API)

- Provide tools for the researchers to help them meet their data management requirements

- AON Project Portal and/or Data Portal

The group considered some concrete next steps that could be taken to foster the discovery and access to this rich dataset. (1) It would be valuable to provide an inventory of data archive and access points (the edited list from Appendix 1) as well as the responsible person/agency (GIS layers). (2) It would be wise to activate an interagency data collaboration team or forum to discuss key components of an improved process for sharing Arctic data.

This group would consist of working level data managers and curators that could comment and implement metadata standards and best practices. A primary task of the group would be to develop and implement procedures to overcome impediments to interagency exchange of existing data. The group could approach the very challenging aspects of international data exchange. This group would be responsible for completing and updating the inventory (Appendix 1). (3) A key component of achieving improved data discovery and sharing is the implementation of metadata exchange standards and protocols across the various archives. One valuable statistic that may help prioritize our efforts would be to identify the most used/highest priority AON datasets and the key questions being answered with those data. (4) Finally, it would be highly desirable to use other showcase projects under consideration from this meeting as a demonstration of improved data/metadata collection, archival and sharing from all groups.

**V. KEY ISSUES AND CHALLENGES**

**Issues and Challenges of Integrating AON Activities/AON Programmatic Issues**

Workshop participants identified a number of issues and challenges relevant to achieving one of the major goals of the workshop: to better integrate AON activities with the needs of a broader group of stakeholders, and in particular, federal and state agencies. These challenges are listed in no particular order.

1. Participants discussed at length how to make scientific observations, in particular the long-term observations supported by the AON, more responsive to stakeholder information needs and agency management goals, also as pertaining to scientific guidance on policy development. It was noted that managers tend to need more highly integrated and interpreted data and information products that distill data from multiple sources for use in decision support tools. At present no clear pathway has been identified on how to generate such products based on AON data streams.
2. The time scale for management policy decisions is often shorter, yet many of AON observation goals are long term owing to the nature and long-term drivers of Arctic environmental change. Arctic policy decisions are typically Alaska-focused, yet AON is a pan-Arctic program. While this present challenges with respect to funding support under shrinking federal budgets, many of the changes observed in recent years are driving by hemispheric-scale processes and have pan-Arctic dimensions, such that a program such as AON can provide a framework in understanding events and processes at the local scale. Stronger pathways need to be developed to link the pan-Arctic observations to the regional (Alaska) management needs.
3. The academic science community, largely funded by NSF, often does not have forums for networking and collaborating with managers to assess and understand their observation needs, not only for current uses, but also to meet future needs. At the same time, there is still a reluctance by some academic researchers to engage in such collaboration because of perceived or real threats to researchers’ fundamental science research portfolio.
4. While it is relatively straightforward to identify who is accessing web-based AON observational data, it is very difficult to assess if and how it is being used. While the theme of responding to Arctic change is driving part of the observing network, to date AON has not identified operational users as a key audience. Here, rigorous assessments of how the observatory is meeting user needs would be of value. Moreover, exploring how gap analyses and conceptual models can be used to optimize the program in terms of site location, parameter observation, data collection, and analysis would also be of value.
5. While some progress has been made, integration of social science data, community-based observations, traditional and local knowledge, and industry-collected data into the AON remains a challenge. Because of different levels of readiness with respect to well-designed long-term observing programs, AON is perceived by some as focusing largely on physical parameters, and not the biological species and other parameters that agencies are responsible for managing.
6. Most agencies have little funding for long-term observations and monitoring activities, which makes it difficult for them to participate in a collaborative project. In addition, because of their annual funding cycle, agencies are usually reluctant to (or prohibited from) committing to the long-term support needed for an AON-type project. This also limits the way in which agency personnel can engage with the academic research community or partnerships such as AON.
7. Federal agencies often find it difficult to co-mingle funds to support integrated projects, although established interagency programs, such as the National Ocean Partnership Program, may serve as models for new approaches to integrated funding. Here, guidance from the Arctic Research Commission and the Interagency Arctic Research Policy Committee may help raise awareness and identify solutions.
8. AON is now focused on serving up observing data, but some participants suggest that it be expanded to include developing synthesized products and services. The SEARCH goals of observing change, understanding change and responding to change are useful for planning, but provide an artificial barrier to synthesize and integration. Here, topical, cross-sector working groups may help advance more integrated approaches.
9. While AON operates under the open-access SEARCH data policy, data access and integration remain challenging and were a topic of discussion by the data breakout group.
10. As a program, AON needs to be better marketed and branded, beginning with an inventory of existing projects, datasets and findings.

**VI. FUTURE DIRECTIONS AND OPPORTUNITIES**

One of the main goals of the AON Coordination Workshop was to provide a forum for information exchange that could also help set the stage for improved coordination between agencies, academia and key stakeholders. This goal has largely been met by the workshop. The roughly equal mix of university researchers, many affiliated with ongoing AON projects, and agency representatives helped ensure that conversations explored approaches and topics not covered in previous meetings with more imbalanced attendance. The format of the meeting was also conducive to delve into more detailed planning discussions and helped identify potential challenges, such as those outlined in the previous section of the report.

The biggest challenge remains to achieve a productive balance between the fundamental research questions driving much of the NSF-supported AON researcher (as discussed in relevant SEARCH documents such as the State of the AON report in 2009 or the SEARCH Implementation Workshop Report from 2005) and the information needs of agency managers. The 2012 AON Coordination Workshop is thus only the first step towards a more coordinated approach that will require additional resources and efforts to work towards the goals outlined above and in the introduction to this report. Specific steps that help in achieving these near- and mid-term objectives include the following:

(i) Showcase projects: The showcase project outlines developed by the different break-out groups demonstrate the breadth of information needs and potential for collaboration and synergy, but they also highlight several areas where substantial benefits could be derived from improved planning and coordination which in turn would substantially increase the scope and value of information obtained from long-term observations while increasing efficiency in the data collection effort. One example are the observations related to offshore oil and gas development in the Beaufort and Chukchi Seas. Here, next steps would include efforts to bring together agency scientists and managers with university researchers to explore how the observing activities can best be integrated across the relevant scales, from the pan-Arctic to the local. At the same time, some showcase project outlines are at a level of maturity where they are ready for funding support, either through responses to appropriate solicitations or through direct support.

(ii) Topical working groups: To make progress towards improved coordination, topical working groups composed of a broader spectrum of experts involved or interested in long-term observations in the context of responses to Arctic change may be most effective. The SEARCH 5-year goals and objectives documents outline themes or topic areas that have matured to the point that they may serve as the starting point for such topical working groups that bring together researchers, managers, funders and stakeholders.

(iii) Funders circle: Along the same lines, suggestions to create an informal working group that meets regularly to explore viable ways forward towards joint support of high-priority activities appears promising.

(iv) Data management working group: Access to and management of data and data products is a common denominator among all AON projects and similar efforts by other agencies. Harmonizing the various approaches and working towards best practices and improved intercompatibility are key issues that require a forum among data managers and representatives from the different data use communities. Such a group would also benefit from links to the SEARCH Data Advisory Group which grew out of the SEARCH data policy committee that helped define some of the key guidelines (such as open, unembargoed access to AON data) for AON data management.

(v) Flagship sites and regional foci: Many of the issues that need to be resolved for improved coordination across agencies, stakeholders and academia can best be addressed at specific sites where a high density of observation infrastructure, a history of collaboration between different entities, clearly articulated common data and information needs and a more manageable spectrum of research projects have come together. At the AON Coordination Meeting, several such locations presented themselves as potential sites to explore and foster different approaches towards improved coordination. An evening meeting by researchers active in the Barrow, Alaska region attracted over 30 participants and highlighted the potential for flagship observatories located at Barrow in both the marine and terrestrial realm to serve as one of several focal points for improved coordination.

An important next step will be to distill and discuss the conclusions from the AON Coordination Workshop in a broader international context as planning for the Arctic Observing Summit, to be held in spring of 2013 in Canada gets underway. The workshop served as an important contribution to the planning of this event; in particular, issues of importance identified at the meeting, as well as showcase project outlines, may serve as starting points for community white papers that will be solicited in the coming months to obtain and synthesize input from the broader international community towards improved coordination of long-term Arctic observations.

Finally, the AON Coordination Workshop clearly highlighted two important aspects central to effective studies of and responses to Arctic change. First, the meeting’s discussions focused on the integration of Observing, Understanding and Responding to Arctic Change science, demonstrating that only a comprehensive, fully tri-partite approach to long-term observations addresses the key challenges and scientific questions in a viable and effective manner. Second, the breadth of information reviewed with respect to observing activities by different agencies, academia, stakeholders and other entities demonstrated that the AON is in fact an Interagency AON, or IAON, that already contains many pieces or nuclei for cross-agency collaboration. While this is in part an issue of properly “branding” the IAON, it does present the broader Arctic research community and stakeholders with an excellent foundation for more effective, cutting-edge approaches to societally relevant Arctic research.

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**VIII. APPENDICES**

**Appendix I. Showcase projects**

1. From Observations to Management: Providing Scientific Information to Inform Decisions Regarding Offshore Oil and Gas Activities in the Chukchi Sea: A Showcase Project for the Arctic Observing Network and Agency, Industry and Community Collaborations

Lead Contact: Molly McCammon

Goals

Develop linkages between changes in the large-scale pan-Arctic ice pack and regional scale sea ice dynamics and ocean conditions, and their impacts on living resources in the Chukchi Sea, Determine how well current observational data can be used to support policy decisions concerning whether, where, when, and how to explore for and produce oil and gas and prepare for potential impacts in the Chukchi Sea Outer Continental Shelf, especially in light of documented climate change.

Challenges

Regulating offshore oil and gas activity is a policy matter. However, scientific observations and research results can provide relevant information to inform policy decisions. While management agencies such as BOEM and oil and gas industries seeking permits to explore and develop in the outer continental shelf waters off Alaska have invested extensively in projects and activities designed to address scientific information needs, the connection between scientific input and specific policy decisions may not be as strong as it could, in part because the needs of decision-makers may not be apparent to scientists and the results of scientific studies and observations may not be presented in ways designed to meet the needs of decision-makers. In addition, the connection between large-scale Arctic observations and regional and local scale science and management needs is typically not made. This showcase project would address these challenges.

Objectives

1. Predict the survivability of different ice types in the Chukchi region between breakup and freeze up on seasonal and annual time scales and identify their potential to create hazards to exploration activities;
2. Assess current observing resources and their ability to identify and predict break up and freeze up timing on a seasonal basis;
3. Assess the impacts of changes in sea ice and ocean conditions on living resources that are of biological or cultural significance in the region and evaluate the likely sensitivities of these species to disturbance from sea ice and storm hazards, as well as human activities of various kinds; and
4. Determine likely trajectories of spilled oil based on hazards that could be created by sea ice under varying conditions.

Deliverables and anticipated outcomes

1. Coupled pan-Arctic and regional sea ice models and forecasts of presence and characteristics on seasonal and annual time scales;
2. Annual/seasonal forecasts of freeze up and break up in the Chukchi lease sale area;
3. Risk and vulnerability assessments of likely sensitivities of key biological species to disturbances from sea ice and storm hazards and human activities;
4. Projection of likely trajectories of spilled oil due to potential sea ice hazards; and
5. Development of transparent steps for use of the above information in decision-support materials for policy and regulatory issues pertaining to potential oil and gas activities in the Chukchi lease sale region.

Collaborative activities

1. Convene a small team of agency officials and scientists from appropriate disciplines to work iteratively to identify key policy questions regarding OCS activities and the scientific information needed to support decisions; assess existing information; evaluate the showcase project and its potential usefulness for future decision-support; and develop recommendations for improvements.
2. Iterate as needed to create suitable approaches for future decision-support.
3. Share the experiences and results with others to foster better use of scientific information in policy decisions in DOI and other agencies.

Readiness

OCS decisions are being made now. There are also many observational data sets and results from many research projects in the Chukchi. One goal of this project is to determine how to use the information that IS available (not the information that one would like to have available) in the time frame of decision-making. Thus, “readiness” is not really a consideration in the sense that delaying this project in the expectation of new data in the future would ignore the fact that decisions will be made soon with or without optimal scientific support.

For sea ice, existing data include satellite data, ice-based buoys, and ongoing local aerial surveys for ice thickness. Continued gaps are validation of remotely sensed ice data, accurate ice edge data, increased temporal and spatial coverage, and improved models that couple pan-Arctic basin data with weather and ocean condition data to product regional/local scale forecasts. For living resources, significant data exists from work done by BOEM and industry in the lease area region and efforts are underway to integrate these data and develop synthesis products. All the datasets have spatial and temporal gaps, with a need for more sustained observations of the pelagic and benthic systems over annual cycles and the long term.

Balancing Scientific, Management, and Community Interests

This project looks squarely at the intersection of management/policy and scientific interests. It does not focus specifically on communities, although community concerns and cultural significance of certain areas are among the considerations of policy makers. That said, Arctic communities will be keenly interested in the results of an exercise of this kind, and should be involved in a substantive way to ensure that (a) traditional knowledge is incorporated both from previous research and from engagement of knowledgeable individuals, and (b) the results and the process for achieving them are transparent and not seen as yet another imposition of knowledge or decisions from outside the region.

Agency Support & Funding

The project should be of interest to DOI, NOAA, and other departments (including state, tribal, and local governments and other institutions). Funding opportunities could be available through BOEM, the US Fish and Wildlife Service’s Arctic Landscape Conservation Cooperative, the North Slope Science Initiative, North Pacific Research Board, and the Alaska Ocean Observing System.

**2.** **Distributed** Biological Observatory (DBO)

Lead Contact: JM Grebmeier, [jgrebmei@umces.edu](mailto:jgrebmei@umces.edu); http://www.arctic.noaa.gov/dbo/

What: The Distributed Biological Observatory (DBO) is being developed by an international consortium of scientists in the Pacific Arctic as a change detection array to systematically track the broad biological response to sea ice retreat and associated environmental change. The DBO is tracking select biological measurements at multiple trophic levels, coincident with physical and chemical data, in a latitudinal array of transect lines and stations in the northern Bering and Chukchi seas. Coordinated ship-based observations on a regular basis, together with satellite and moorings at the designated sites, can provide an early detection system for biological and ecosystem response to climate warming. The purpose of designating the DBO as a “Showcase Project” is to transition it to a full-scale implementation effort from current pilot-scale efforts.

Where: The core study region is the northern Bering Sea to the Chukchi Sea/Barrow sea ice arc in the Pacific Arctic region, with sampling focused at 5 biological “hot spot” sites on a latitudinal S-to-N array where some times-series data already exists. The 2010-2011 pilot program focused on two areas in the Chukchi Sea where the highest number of ships from the six Pacific countries agreed to participate and share data sets, both real-time and post-cruise, through the Pacific Arctic Group (PAG; http:// pag.arcticportal.org). In addition, the PAG is expanding the DBO concept to both a pan-Arctic sand Antarctic scale for time-series transects and sites through cooperation within the IASC marine working group and Arctic-Antarctic “bipolar” action working group (see <http://iasc.info/index.php/home/groups>).

When:The DBO project will continue to ramp up in 2012 to a full implementation phase starting in 2013 as a “Showcase” AON project for a 5 year period through 2017, and with appropriate adjustments to be continued in some longer term form beyond. The time-series transect and station occupations will occur from spring to fall (and opportunistically in winter), depending on national and international collaborations to collect biological, chemical and physical oceanographic samples from ships transiting north, using both varying temporal and spatial sampling to evaluate biological and ecosystem response to environmental change. The expectation is that this biological change detection array will be the basis of a long-term (decadal-scale) ecosystem-monitoring program.

Who: Implementation is occurring through both national and international community collaborations, with coordination by the international Pacific Arctic Group. Interaction with a proposed US-AON steering committee and other international groups, such as SAON, would occur in the 5-year implementation phase.

How: Implementation will expand upon the successful 2010-2012 DBO international pilot program by providing incremental funding for ongoing national and international cruises in order to sample the full 5 time series transect array in the Bering and Chukchi Seas. The project will support coordinated efforts for opportunistic, international sampling by ships transiting to the US northern Chukchi Sea to develop seasonal time slices of physical, hydrographic, and sentinel plankton, benthos, and higher trophic level measurements.

Why: It is essential to track biological response to changing environmental forcing to provide information to multiple end-users, including local, state and national agencies responsible for evaluating marine ecosystem health as well as societally-relevant concerns about the impact of multiple stressors to the ecosystem (e.g, climate change impacts, renewable and nonrenewable resource extractions, increased shipping). Scientific surveys have shown changes in benthic biological hotspots supporting marine mammals and seabirds, including several that are listed as threatened species under the US Endangered Species Act. We are observing changes in the prey base for benthic- and water column-feeding marine animals, and the northward expansion of Pacific species of zooplankton and benthic invertebrates. New fish species are being reported in the Beaufort Sea, and changes have also been observed in marine mammal ands seabird foraging areas and habitat use.

Partners: The DBO is supported by sampling contributions funded by NSF, BOEM NOAA, NASA and facilitated by International collaborators from Canada, China, Japan, Korea, and Russia through the Pacific Arctic Group. Collaborative sampling within the DBO network includes:

* funded US AON investigators participating in the DBO
* NOAA: Oceanographic and biological sampling as part of the RUSALCA (Russian-American Long-term Census of the Arctic) annual sampling in the Bering Strait region; also RV Fairweather hydrographic sampling
* Ongoing collaboration through the C3O (Canada’s Three Oceans) annual July sampling on the CCGS Sir Wilfrid Laurier
* BOEM CHAOZ project and COMIDA Hanna Shoal research program (2012-2014)
* NASA ICESCAPE program
* New Japanese 4 year science program in the Chukchi Sea including biophysical moorings and sampling program around two of the Chukchi DBO sites (2012-2016)
* planned industry occupation of the northern DBO line through their Chukchi Sea Environmental Assessment Program (CSEAP)

Anticipated five-year accomplishments:Successful implementation of the biological change detection array as envisioned by the DBO will provide for a national and international network of coordinated sampling. This network will provide up-to-date information to local, state and federal agencies responsible for maintaining a standard of ecosystem health of one of the most productive regions of the Arctic. The DBO efforts will facilitate data collection, sharing and archiving through the US ACADIS data program and associated international data agreements.

Additional development:There is a need to expand and integrate existing local community research partnerships, currently in the developmental stage, thus extending the DBO transect lines to the coast and engaging local community users of the living resources.In addition, consideration of dedicated US cruises for the full implementation of the DBO in coordination with opportunistic national and international cruises, should be considered in future planning efforts to ensure that seasonal, annual and decadal ecosystem responses to change will be detected. Finally, it is important to point out the need to expand the DBO to include process studies to understand the mechanisms responsible for change and to enable the forecast of future ecosystem states.

Cross-linkage with other showcase projects: We anticipate that data needs for the DBO effort are cross-linked with the sea-ice forecast project, Arctic ocean freshwater and heat observations, and coastal zone observation infrastructure, including both the local community observatory and sea level observatory efforts. Incorporation of satellite products through involvement of NASA would add value. Inventories of higher trophic organisms through NOAA, USGS and USFWS efforts will also be necessary within a fully operational DBO.

3. Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC)

Lead Contact: Matthew Shupe

Basic concept: Drifting, multidisciplinary, manned observatory (ocean-ice-atmosphere) in coordination with a network of distributed observations and coastal land-based multidisciplinary observatories, for developing a process-level understanding of the central Arctic climate system. The intention is for the central drifting observatory to be an icebreaker-supported ice station, with intensive local supporting measurements, installed in the ice for a multi-year drift through the Arctic Basin.

What is the question/challenge? Developing detailed understanding of process interactions, feedbacks, and linkages within the atmosphere-ocean-sea-ice system in the “new” Arctic. One guiding science theme is developing a better understanding of processes leading to disappearing sea-ice coverage. Model difficulties and shortcomings: insufficient process parameterizations, lack of Arctic process-level evaluation data, difficulties with sea-ice and land surface prediction

Who are the players? Multidisciplinary researchers (atmosphere, ocean, sea-ice, biology); AON investigators; International research community NSF; DOE (ARM); NOAA; NASA; ONR; Opportunity to strongly engage other agencies into US-AON. Modeling groups: global, regional, process, climate and weather; forecasting for weather and sea-ice. Resource management: exploration, development, transportation, ecosystems

Where does previous information exist on such a problem? Key issues/requirements are outlined in SEARCH Implementation Report (2005) Heritage: Russian drifting stations, SHEBA, LeadEx, other ice stations, land-based observatories Regional model simulations Isolated measurements in a variety of environments

Perceived challenges and potential programmatic barriers that could influence success? Major logistical challenges: Implementation in harsh environment; Difficult access; Identifying infrastructure (platforms, UAV, aircraft, transportation); Logistical support International coordination of activities/support among agencies and countries

What is the roadmap for implementation? Ongoing: Interface with existing process observing networks (ocean- and land-based). In next 2 years: Science planning; Implementation planning; International coordination. Beyond 2 years: Securing funding; Securing infrastructure; Logistical planning; Drifting ice station component (2016-2017?); Real-time coupling between observations and modeling activities

Contacts / Organizers Ola Persson and Matthew Shupe (Univ. of Colorado), Klaus Dethloff (Alfred Wegener Institute), Michael Tjernstrom (Stockholm Univ.), IASC-Atmosphere WG (with support from Cryosphere & Marine WGs), Liaisons from CliC (Don Perovich, Alexander Makshtas)

4. Community-based observation network for Adaptation and (CONAS) (currently: The Bering Sea Sub Network BSSN)

Lead Contact: Lilian Na’ia Alessa, Ph.D., P.Reg.Biol: Director, Resilience and Adaptive Management Group, UAA, Faculty, Institute for Northern Engineering, UAF; [lalessa@alaska.edu](mailto:lalessa@alaska.edu)

What: Evolving the Bering Sea Sub Network (BSSN) to a pan-arctic community-based observation network for adaptation and security (CONAS) using multiple methods and technologies (See “**How**” below). Key components include local observations of environmental variables and resources of importance to local communities such as water, weather, plants and animals. These data are collected by residents year-round and in situ and provide socioeconomic and cultural contexts. Such observations will provide linkages between biophysical change, social adaptation and resource security.

Where: Study region is the U.S. and Russian Far East peripheries of the Bering and Chukchi Seas including coastal land, nearshore and marine environments. For more information, see below and [www.bssn.net](http://www.bssn.net)

When:In its current rendition BSSN will continue to operate through 2014 with data inflows occurring every month. Data acquisition occurs via several hundred observers across all locations who report to Community Coordinators in each village. In addition, data obtained from biophysical observing networks are integrated with resident observations to derive products such as maps reflecting hotspots of specific types of change.

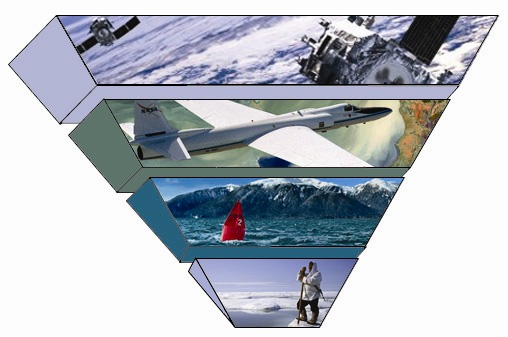
Who: Implementation is occurring through partnerships and agreements with local community and regional governments. Oversight is provided by the Science Oversight Committee, comprised of the Community Coordinators and the project principal investigators. Interactions with other AON efforts should increase as BSSN/CONAS is an excellent means to acquire fine resolution, societally-relevant data across seasons.

How: The foundation of the proposed approach involves consensus on critical variables to be observed, the co-production of science, shared interpretation of data, and co-management of applications as appropriate. Needed tools are as follows: (a) structured survey forms and semi-structured narratives obtained through high-trust community coordinators for information capture, (b) architecture for information fusion (i.e., AIDA), (c) hand-held data capture devices for image, voice and environment, (d) distributed microsensor array, gridded at appropriate spatial geometries, (e) computer programming, hardware and other and cyberinfrastructure for discovery, and (f) social processes of discourse for knowledge sharing face-to-face and face-to-place.

The application involves simultaneous data acquisition through instrumentation, surveys, narratives, information fusion and image capture and can be phased over time to add different variables at various temporal and spatial scales. Synthesis of data coupled context as defined by community observers will allow rule-based algorithms to be developed for the purpose of targeted forecasting. Such an effort will not only yield high quality, socially-relevant information but will advance education (of both western and indigenous scientists), diversity (of personnel and ontologies) and workforce development to increase under-represented minorities in STEM related fields.

Why: One of the goals of observing networks is to enhance place-based resilience under changing environmental conditions through ‘early warnings­’ of specific types of change. The rapid proliferation of new technologies and the growing amount of data being generated begs an organizing framework that has utility to local adaptation and policy settings.

Indigenous, place-based science is spatially localized and place-based, temporally spans immediate short-term periods to extended periods and includes systematic and integrative understanding of natural and human processes as cause and effect. Additionally, the application of indigenous science to sustain observing networks will assist in a better understanding of uncertainty and variability within arctic ecosystems. *It is important to note that an indigenous place-based science is not just Indigenous or Traditional Knowledge but rather a process that allows the co-production of science which is (a) culturally and spatially appropriate (and hence more likely to inform decision making) and (b) inter-operable with other data derived through experimentation, instrumentation or other means of acquisition.*



*Nested scales of observation in AON from remote satellite observing at global scales, airborne observing at regional scales and buoy/instrument-based marine terrestrial networks. BSSN/CONAS adds a scale of resolution that works synergistically with these networks to better resolve the heterogeneity of change. It also behaves as a local scale human sensor array capable of detecting change at the scale of daily human lives.*

A pan-arctic. community-operated, place-based (bottom-up) observing system will help address the need to link biophysical science-driven efforts to coordinate and synthesize multiple sources of data (a top-down approach). A community-based network, in order to be successful, should be developed at the community level first, and then be expanded to the regional and pan-arctic scale. Two of the major challenges in achieving this include (a) establishing systematic observing networks whose data are interoperable and t­­imely and (b) formalizing place-based observations through structured instruments. The utility of integrating local and indigenous knowledge with western science, ideally from first processes, lies in placing data in societally-relevant contexts. Many practitioners are reluctant to entertain circumstances which would enable this, in part because of poor returns on funded projects which have included ‘traditional ecological knowledge, traditional local knowledge’, etc. as well as the perception that this knowledge cannot be structured for interoperability with other, quantitative data. However, there are ways to integrate community-based observing and knowledge systems within the existing structures of AON. In this way we believe that we will be better able to inform the Arctic’s mounting sustainability challenges.

Partners: BSSN is facilitated by International collaborators from the U.S. and Russia. Collaborative sampling within BSSN currently includes:

* Funded US AON investigators and data sites: CADIS, NCDIS, ELOKA.
* Alaskan and Russian communities (see map above).
* Sustaining Arctic Observing Network (SAON), an initiative of IASC and Arctic Council.
* Arctic and Antarctic Research Institute (AARI).
* ECORA, a Russia-based project of UNEP-GRID Arendal [www.grida.no/ecora/](http://www.grida.no/ecora/)
* Beringovsky District of Chukotka, Ministry of Natural Resources.
* Norwegian Polar Institute
* CAFF (Conservation of Arctic Flora and Fauna working group of AC), BSSN reports are published by CAFF in the Monitoring series. [www.caff.is](http://www.caff.is).

Expansion to communities in the Chukchi region is planned and currently includes: Lorino and Meinypylgino in Russia, and Wales, Kivalina, Wainwright and Point Hope in Alaska, U.S.A.

Anticipated five-year accomplishments:Acquisition of observations on several key species of fish, marine mammals, sea state, weather, temperature, precipitation, resource use patterns and linkages of various environmental changes to social impacts. Observations include historic patterns over multiple generations with low resolution and over a person’s lifetime with more specificity.

Additional development:Build linkages to the Distributed Biological Observatory (DBO) that has an interest in expansion to include local community research partnerships. Such a linkage could enhance our understanding of teleconnectivities with the nearshore, if any. Utilization of community-obtained data for decision support and forecast tools such as in agent-based models (e.g., Forecasting Environmental Resilience in Arctic Communities, FERAL). Acquisition of new, micronized technologies to enable simultaneous spatio-temporally correlated data collection of basic variables (e.g., air and water temperature, image capture of biota, etc.)

Cross-linkage with other showcase projects: Linkages are implicit and easily made with each of the other showcase projects, particularly those involving biota and sea ice. BSSN-CONAS is a dynamic, adaptive network able to collect diverse environmental variables at multiple time scales and locations. Its strengths lie in (a) the resolution (local), (b) the approaches, data streams and synthesis methods, and (c) its ability to collect data that allow relationships between environmental change and social dynamics to be better understood for forecasting and decision support.

5. Ocean Observations to Improve Sea Ice Forecasting

Lead Contact: Julienne Stroeve

What: This showcase project is designed to provide the necessary ocean observations to improve sea ice forecasting on daily, seasonal, inter-annual and decadal time-scales. These time-scales are needed for safe marine operations, infrastructure/community planning, and ecosystem stewardship in the Arctic.

Where: The initial target areas are the Chukchi Sea, Beaufort Sea, and northern reaches of the Bering Sea. This regional study will allow researchers and forecasters to work together to test different models, different model parameterizations, data assimilation, observational error impacts, etc. It will also allow for process studies on how sea ice changes in the Beaufort/Chukchi Sea are impacting the evolution of the Arctic-wide sea ice cover. While initially regionally focused, a pan-Arctic perspective is needed to provide upstream information for the target areas, support international goals and provide the basis for longer-term projections of sea ice.

When: The project could begin in 2013 and extend for 5 years, through 2017, for its initial phase. Observations will be required year around to enable the desired forecast products.

Who: Implementation will draw from the broad national and international community, under guidance from the US-AON steering committee and a relevant international group (e.g., SAON), with implementation (possibly) guided by a (new) Program Office. Collaboration with weather forecasters will be critical for increasing accuracy of sea ice forecasts at the shorter-time scales. The existing International Arctic Buoy Programme will be a key partner in this project, and its leadership will be invited to participate in planning of this project. Remote sensing will be a key component as it can provide near real-time pan-Arctic maps of ice motion, ice edge location, ice thickness, ice concentration, melt pond fraction, timing of melt onset/freeze-up, SSTs (at the ice edge), surface albedo, surface temperature, leads/polynyas. Some effort needs to be expended to turn some of these remote sensing data sets into operational products.

How: Implementation will be based on existing activities and is likely to include most of the following:

* Planning for observations must include input from modeling centers to ensure that modelers will have access to and use the data they require for initialization, validation and assimilation of various forecast models. Key modeling centers include NOAA/NCEP, NRL/Stennis, Canadian Ice Service. For pan-Arctic and longer-term time scales, the climate modeling centers must be consulted as well;
* Both in situ and remotely sensed observations will be needed, taking full advantage of international remote sensing assets. In situ observations are key for better understanding of the processes impacting ice melt/growth, predicting storm surges and coastal impacts, for ecosystem assessment and habitat management, whereas remote sensing provides pan-Arctic sea ice state variables needed for data assimilation and model initialization;
* Key data needs include: temperature and salinity profiles; ocean heat content; sea ice thickness and snow cover; web cams for land fast ice, near-shore leads, and melt ponds; sea ice extent on the pan-Arctic scale and in the focus areas.
* In situ platforms that directly measure snow depth, sea ice thickness, bottom and top ablation, surface air temperature, mixed layer ocean temperature, tides, bathymetry and circulation are needed. Floe size and shape are also important for ecosystem studies.
* Remote sensing provides large-scale characteristics of sea ice, such as ice concentration, ice thickness, ice type (first-year vs. perennial), ice motion, leads/polynyas, melt pond fraction, surface albedo and temperature. Snow depth over sea ice remains a critical remote sensing gap, and efforts are needed to develop snow depth estimates over large spatial-scales.
* Continuous or frequently repeated data collection will be needed, including surveys in at least spring and fall, to allow forecasts of ice loss and regrowth;
* International collaboration will be a necessary component of this project, not only because Canada and Russia share the target region with the U.S., but also because international collaboration is needed for data sharing (e.g. ESA CryoSat-2 for ice thickness);
* To meet the observational requirements in a cost-effective way, it will be necessary to take full advantage of all available observing platforms (e.g., ships, aircraft, fixed offshore platforms, coastal locations) on an opportunistic basis. Partnerships with national, international and private industry are needed so that platforms could be equipped with instrumentation for many of the needed observations on a mutually beneficial basis;
* For the shorter-term forecast needs, real-time access to data will be essential, requiring most data transmitted in near-real time to data centers and modeling centers. Whenever technically possible, data should be placed on the GTS for use by modeling centers.
* For seasonal forecast needs, improved access to sea ice buoy data, satellite data products, aircraft and ship observations are needed, particularly during late spring (initialization), late summer (ocean) and early autumn (verification);
* Model output should include a measure of uncertainty or probability so that different stakeholders can perform their own risks analysis. Deterministic output is required for accurate marine and coastal storm surge forecasts;
* The Sea Ice Outlook (SIO) activity should continue as a means to synthesize and disseminate seasonal sea ice forecasts, with efforts to become a more formal program that includes cooperation with SEARCH and international participation.

To initiate the project, several near-term actions have been identified, including:

* Consult with modeling centers to agree on data needs;
* Identify platforms of opportunity and arrange for relevant observations from them;
* Strengthen the ongoing Sea Ice Outlook effort, and take advantage of that experience to guide enhanced observing and forecast efforts;
* Identify a subset of potential users and consult with them to define high priority products and establish a process for producing the products;
* Consult with selected living marine resource managers (species specific and ecosystem-based), harvesters (commercial and subsistence), and researchers to define data and product requirements to support their objectives and build these requirements into the observing strategy to the extent possible;
* Evaluate need for a Program Office or some structure to facilitate coordination and implementation and then establish the desired structure;
* Evaluate the potential of the National Ocean Partnership Program as a means of implementing interagency support for this project.

Why: Sea ice forecasts have value to a broad range of stakeholders, including operational users (safety of life and property), crisis responders, resource managers, weather and climate forecasters and their users, climate change detection researchers, politicians, coastal communities, etc.

Anticipated Five-Year Accomplishments: Successful implementation of this project will provide continued and enhanced observations directly supporting various user needs; improved coordination among agencies and countries to enhance quality, efficiency, and coverage; improved model-based forecasts with error estimates; and extended data records to support climate science.

Cross-Linking with Other Showcase Projects: This project shares observational needs with the “heat and freshwater” project and also links closely with the DBO project and the coastal projects (sea level and place-based community observations). Should all projects go forward, a means of sharing data between projects will be essential, with real-time exchange important for many variables.

6. Long-Term Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts

Lead Contact: Steve Okkonen

What: A network of long-term stations to monitor coastal sea level along the Alaskan arctic coast and report those measurements in near real-time.

Where: The sea level recording stations would be sited at Little Diomede, Wales, Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Long-term stations presently exist at Red Dog (seasonal) and Prudhoe Bay.

Why: Sea level is arguably the most basic of oceanographic measurements. Historically, coastal residents have recognized that travel, commerce, and the harvesting of marine resources are influenced by changes in sea level and that the ability to predict these changes greatly improves efficiency and safety in pursuit of these activities.

Coastal sea level is a suitable proxy for near-shore, sub-tidal current velocities. A network of stations reporting in near real-time allows circulation along the Alaskan arctic coast to be described in a systematic sense.

Sea level measurements are used to both assess and validate numerical storm surge and circulation models. The ability of a numerical model to reproduce observed sea level is a fundamental measure of a model’s skill. A skilful storm surge model is an emergency preparedness and response decision support tool for coastal Alaskan villages.

Although the tidal variations in sea level have been identified at many locations along Alaska’s arctic coast, the measurements have generally been of too short duration to resolve seasonal and long-period (e.g. associated with the Arctic Oscillation) changes in sea level. Long-term (decadal) measurements are needed to investigate these long-period signals.

Sea level measurements along the arctic coast of Alaska would provide a unique set of observations to validate sea height estimates derived from satellite remote sensing. Additionally validated remote sensing sea level estimates obtained from radar altimetry or SAR could be used to fill the gaps in the proposed tide station network in the Beaufort Sea. Satellite images of actual storm surge events can also be better interpreted using the coincident tide gauge observations.

How: It is NOAA’s mission to provide water level information. Responsibility for the installation, operation, and maintenance of water level stations lies with the National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS). Logistics associated with recent two-year (2008-2010) deployments of water level gauges near Barrow are described in NOAA Technical Report NOS CO-OPS 062 and serve as a model for deployment of similar gauges at other locations. Value is added if these water level recorders are able to report in near real-time.

When: As soon as is practical, with a goal to have the entire proposed suite operational within two years,

7. Arctic Ocean Freshwater and heat observing system

Lead Contact: Peter Schlosser

What: We propose to implement a system for systematic, pan-Arctic, long-term observations to determine the freshwater and heat contents of the Arctic Ocean, as well as their variability and trends. The system would cover observations of the central basins of the Arctic Ocean and its shelves and would allow us to narrow the errors in our estimates of freshwater and heat inventories and fluxes. Parts of the system are in place through national (mainly NSF AON, NOAA, ONR, NASA) and international efforts (e.g., IAOOS). The proposed system can be completed in a 5-year time frame. As laid out below the Freshwater and Heat Observing System serves many purposes within the science and stakeholder communities.

Why: Freshwater and heat content determine the stratification and circulation patterns in the Arctic Ocean including its shelf seas. These fundamental features of the Arctic Ocean impact sea ice formation/melting, sea ice extent, meltwater distribution, biological activity, runoff from land (rivers and glacial melt water) and navigation in the Arctic Ocean, among others.

As many of these Arctic ocean components and processes are undergoing rapid change it is important to obtain a more complete picture of the freshwater and heat budget (FHB) of the Arctic Ocean both from a point of understanding present and future changes and for producing information of immediate relevance for stakeholders (e.g., sea ice trends, ecosystem dynamics, navigation).

The freshwater export from the Arctic is a major link to low latitudes and influences stratification in areas of deep convection such as the Greenland/Iceland/Norwegian seas or the Irminger and Labrador seas, i.e., major components of the global ocean circulation system.

The need for this information is urgent as demonstrated by the abrupt decline in sea ice extent in 2007. Similar events could be in a preconditioning phase and only a complete set of observations would allow us to identify them before we are faced with further surprises.

Where: The system should cover the main basins of the Arctic Ocean, its shelves, and the main gateways (Bering Strait, Fram Strait, Canadian Archipelago).

When: The first U.S. components of the system were put in place during the Fresh Water Initiative. Major additions were completed during the IPY period by U.S. and international groups. The highest priority is to finish implementation of the original design of the system as laid out in plans such as the report from the SEARCH Implementation Workshop (2005) and the DAMOCLES science plan. Coordination with other international groups such as ArcticNet will be enhanced during the Arctic Observing Summit. It seems to be a realistic goal to complete the initial plan for the system in a 5 year time frame (depending on availability of resources).

Components: The Freshwater and Heat Observing System consists of Eulerian (e.g., Moorings, Bottom Pressure Gauges) and Lagrangian (e.g., Ice Tethered Platforms, gliders, AUVs) instruments, hydrographic/tracer sections (e.g., Icebreakers, Airborne Surveys, Submarines), and satellites. This mix of platforms has the demonstrated potential to resolve the major features of the freshwater and heat distribution and their fluxes through gateways. Development of new technology is an important priority but the system can be implemented with existing technology and components can be substituted by new technology as it becomes available (e.g., gliders, ARGO-type array).

Some of the platforms can be shared to carry additional sensors such as those needed by the Distributed Biological Observatory.

Who: There is an international core community that has tested and deployed essential components of the system including moorings, ITP’s airborne survey methods, icebreaker sections, or sampling from submarines (e.g., SCICEX missions). Other groups are actively working on adjustment of new technology such as gliders or PALACE floats to deployment in (partially) ice-covered regions.

Specific Needs:

* Complete the system by filling gaps in coverage
* Add more autonomous sensor to the array
* Achieve seasonal resolution on a pan-Arctic scale
* Include model simulations into the design and further development of the system
* Work on access to EEZs, especially the Russian EEZ

Synergies: Scientifically, the Freshwater and Heat Observing System would contribute to the data flow needed for understanding sea ice dynamics and change, ecosystem changes and evolution, navigability of the Arctic and its shelf seas through its impact on sea ice, interaction of terrestrial and oceanic freshwater cycles, and fluxes of freshwater to the global ocean. Logistically, there will be synergies through sharing of platforms for sensors and joint use of platforms such as icebreakers, aircraft, or submarines.

**8.** **Distributed Environmental Observatory**

Lead contact: Philip Martin – needs to be reformatted

Introduction – Change is occurring in the Arctic, but detecting its rate and character is impossible without a continuous, long-duration time series of basic variables. With fewer and fewer monitoring sites maintained in the Arctic, we are losing our ability to quantify change. This project establishes a network to rescue, standardize, collect, distribute and synthesize long-term observational data aimed at the SEARCH goal to, “understand the consequences of the loss of shallow permafrost on arctic systems.” As a collaborative venture that extends beyond researchers to serve the needs of management agencies and local communities, the focus is on providing a framework for interdisciplinary study of the effects of permafrost degradation and changing hydroclimate regime on ecosystem services, including wildlife, habitat, and human infrastructure in northern Alaska.

The Environmental Observatory will focus work in specific watersheds that collectively represent the diversity of landscape settings and dominant ecological processes within the region, take advantage of existing science/logistics capacity for the sake of efficiency, and provide opportunities to build on existing long-term data sets. Our intent is to measure key system drivers and processes in a standardized fashion across sites. For example, we will measure climate, snow cover, soil moisture, water balance components (e.g., precipitation, surface storage, runoff, evapotranspiration), active layer depth, soil temperature profile, vegetation composition and seasonality, disturbance (fire, thermokarst, human activity). High resolution topographic surveys and ecological mapping of vegetation and soil characteristics (texture, ice content) will provide the basis for scaling up results of in situ measurements to a landscape level. Data products and services will include raw data in standardized formats for use by researchers, as well as interpreted synthesis (e.g, annual summary statistics, trend analysis, “Report Card” publications) in a variety of formats intended for researchers, resource managers, and the general public.

**Potential For Cross-Agency Collaboration And Support** – Candidate sites include: Barrow/Meade River, Fish Creek (northeast NPR-A), Kuparuk River, and the combined areas of the Jago, Okpilak, and Hulahula river basins. Depending on additional funding, a Noatak River site and a river basin draining into the Kasegaluk Lagoon (Chukchi Sea coast) are also under consideration. Sites such as Barrow and Kuparuk, with strong past and current investments by NSF and other federal research programs are included. Other candidate sites are of particular interest to the land management agencies within Department of Interior. We intend to institutionalize and strengthen the independent observation activities at each of these locations by providing support for central network functions and filling data gaps. Funding sources for monitoring by individual researchers and agencies are unstable, but when multiple stakeholders (Federal, State, Local, Private, Academic) agree to the collective value of a fixed network necessary for change detection, funding is better justified and thus more sustainable.

Network planning and design is currently underway under the auspices of the Arctic Landscape Conservation Cooperative (ALCC), with support from the US Geological Survey. Operational funding, particularly for centralized network functions such as data management, synthesis, and outreach will likely be available from the Arctic Landscape Conservation Cooperative and USGS Alaska Climate Science Center. Contributory funds are anticipated to come from the Bureau of Land Management, US Fish and Wildlife Service, and Toolik Field Station for individual sites within their respective management responsibilities. Operational funding for some aspects of data collection is available from current AON projects (CALM and TSP permafrost monitoring projects, CALON lake monitoring project), and a currently proposed AON project (“Arctic FLOW: Flagship Observational Watersheds of the Arctic,” submitted by UAF). Future AON calls are expected to provide further opportunities for funding, particularly for the sites that already support a broad spectrum of NSF-funded research. Synergies with the DOE NGEE project activities in Barrow are likely. A mutually beneficial relationship with the NASA ABoVE project is anticipated, particularly in the arena of local-to-regional scaling via remote sensing techniques. Observations associated with NEON sites at Toolik Lake (Kuparuk) and Barrow will also contribute to our proposed network.

**Level of Readiness** – Project design explicitly takes advantage of existing long-term data sets, while also identifying and filling data gaps (Table 1). Many physical-process monitoring activities are already underway; filling gaps and coordination of activities at multiple sites could be accomplished incrementally, and is anticipated to take 3- 5 years. Vegetation and other biotic monitoring activities of various types occur at these sites, but methods and targeted taxa vary by site and over time; further coordination and organization will be required.

**Balancing the Interests of the Scientific Community & Agency/Stakeholder Interests** – This project is motivated by the identification of overlapping priorities expressed by the scientific community and management agencies. The academic hydrology community has proposed variations on the concept in documents such as Vorsomarty et al. (2001), pp. 18-19, and Arctic Observing Network (2010) p. 17. Resource management agency interest in this work was expressed in Martin et al. 2009, p. 114, and subsequent planning activities of the ALCC Hydrology Working Group, with support from the ALCC Steering Committee. For this network to be sustainable, it will be important to continue to communicate with the resource management community to ensure relevance to applied problems; this may be accomplished via the ALCC, the North Slope Science Initiative, and top-level managers within the Alaska Climate Change Executive Roundtable. The involvement of independent groups, such as the American Water Resources Association and the Interagency Hydrology Committee for Alaska, will help to maintain relevance to the scientific community and to build support for the program.

The interests of diverse audiences must be addressed by providing a diverse portfolio of products. We anticipate that the scientific community, including climate and ecosystem modelers, will be served by providing consistently formatted and accessible raw data sets, as well as summary statistics and periodic synthesis. We further expect that the availability of reliable and comparable long-term data sets from a variety of arctic landscape settings will stimulate and provide a foundation for complementary and independently funded process-based studies; it is anticipated that results will be communicated to the scientific community via peer-reviewed publications. Resource management agencies will best be served by synthesis products that interpret observed trends and forecast future ecological conditions, and by the development of decision-support tools. Local communities will benefit from similar products, particularly for topics most closely related to the availability of, and access to, subsistence resources.

**Leads for Proposed Activities** – Arctic LCC, AON TSP and CALM

**Barriers and Challenges** – The main barrier to initial implementation is that a framework for cost-sharing among resource management agencies and research programs is not in place. Providing meaningful feedback to the community-at-large and to stakeholders will be an on-going challenge requiring dedicated resources for synthesis and interpretation of data, and for outreach.

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**Table 1**. Existing datasets for each of five candidate focal watersheds, and enumeration of the number of sites at which each parameter is measured.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Hulahula/Jago Rivers Area** | **Kuparuk River Area** | **Fish Creek Area** | **Barrow/Meade River Area** | **Kasegaluk Lagoon Area** |
| Meterology - Logger, Power, Comm. | 1 | 4 | 2 | 2 | 0 |
| Meterology - Profile of Air Temp | 1 | 4 | 2 | 2 | 0 |
| Meterology - Wind Speed/Direction | 1 | 4 | 2 | 2 | 0 |
| Meterology - Radiation | 0 | 4 | 2 | 2 | 0 |
| Meterology - Precipitation (liq/solid) | 1 | 4 | 2 | 2 | 0 |
| Meterology - Pressure/Rel Humdity | 0 | 4 | 0 | 2 | 0 |
| Hydrology - River Stage | 2 | 3 | 3 | 2 | 0 |
| Hydrology - River Discharge | 1 | 3 | 3 | 2 | 0 |
| Hydrology - Wetland/Lake Stage | 0 | 2 | 7 | 8 | 0 |
| Water Quality - Temperature | 0 | 2 | 0 | 0 | 0 |
| Water Quality - Coductivity | 0 | 2 | 0 | 0 | 0 |
| Water Quality - Turbidity | 0 | 2 | 0 | 0 | 0 |
| Water Quality - Dissolved Oxygen | 0 | 2 | 0 | 0 | 0 |
| Water Quality - pH | 0 | 2 | 0 | 0 | 0 |
| Water Chemistry - various | Yes | Yes | No | Yes | No |
| Soils/PF - Temperature Profile | 0 | 7 | 2 | 3 | 0 |
| Soils/PF - Active Layer Depth | 0 | 2 | 0 | 1 | 0 |
| Soils/PF - Soil Moisture | 0 | 5 | 0 | 5 | 0 |
| Soils/PF - Texture/Character | No | Yes | No | Yes | No |
| Soils/PF - Carbon and Ice Content | No | Yes | No | Yes | No |
| Soils/PF - Gas Fluxes | No | Yes | No | Yes | No |
| Soils/PF - Vegetation Cover | No | Yes | No | Yes | No |
| Topo - River Geometry | No | Yes | Yes | No | No |
| Topo - Wetland/Lake Geometry | No | Yes | Yes | Yes | No |
| Interval Camera | 0 | 1 | 3 | 3 | 0 |

9. Utilizing the State of the Existing Knowledge to Guide Infrastructure Development

Lead Contact: Larry Hinzman – needs to be reformatted

Using the science to guide responsible development and use development projections to guide scientific efforts.

To date persistent infrastructure placement has not adequately considered future environmental conditions. Science generated by AON and other climate scientists and ecologists could inform design and placement of such structures in a way that would minimize disturbance.

Players

Land management agencies

Industry

Climate Modelers

Economists

Local Residents

Scientists (Ecosystems, Biologists, Hydrologists, Geophysicists, Remote Sensors, Climatologists, Engineers)

Existing Information

Digital Terrain Data

Dynamic vegetation data (Alaska Integrated Ecosystem Model\*)

TransAlaska Pipeline Design and Construction info

Ecological effects

NEPA documents

Russian experiences

Down-scaled climatologies and scenarios

Legacy data

Existing ecological, hydrological and geophysical data

Perceived Challenges and Programmatic Barriers

Proprietary data

Uncertainty surrounding climate projections

Economic barriers to implementing optimum solutions

Permitting barriers (e.g. Endangered Species Act)

Land ownership patterns

Social/cultural Impacts

Project Considerations

Sensitive Ecosystem/Species Assemblages

Rare landforms

Keystone waterways

Essential habitats

Probability of lake/landscape evolution

Construction material source locations

Roadmap for Implementation

Civil projects that could benefit from consideration of climate and ecosystem analyses should interface with the AON program to enable most efficient analyses and optimum design incorporating the state of the science. Civil projects offer both the opportunity to collect unique datasets. An opportunity to peer into the system, collect pre-disturbance data and monitor impacts and recovery.

Early involvement of industry and agencies

Synthesis and incorporation of existing data

Development of best management/design practices

Incorporation of permit conditions that facilitate optimum data collection

Integration of best management/design practices with geographic data layers to develop ecologically and economically viable alternatives

Readiness: data sets, field programs, data bases to disseminate,

Data sets:

Digital Terrain Data

Dynamic vegetation data (Alaska Integrated Ecosystem Model\*)

TransAlaska Pipeline Design and Construction info

Ecological effects

NEPA documents

Russian experiences

Down-scaled climatologies and scenarios

Legacy data

Surface Geology Maps

Hydrography

Land cover

Existing ecological, hydrological and geophysical data

Environmental Atlas of Alaska\*\*

Animal Tracking

Other AON data

Tools:

Lake Fate Model

Alaska Integrated Ecosystem Model

SNAP Down-scaling model/climate forecasts

Dynamic Vegetation Modeling

Permafrost Model

Hydrologic Models

Field Programs

USGS Changing Arctic Ecosystem

NSSI Landcover

BLM AIM – Assessment Inventory and Monitoring in NPRA

NPS Arctic Network Vital Signs

Identify ways to balance interests of scientific community and agencies/stakeholders

Proponents pushing infrastructure construction

Natural Resource agencies – preserving migratory corridors and preserving integrity of natural systems and connectivity

Using the science to guide responsible development and use development projections to guide scientific efforts.

Potential for inter-agency support and cross-agency collaboration

Clear interest from agencies with resource management responsibilities

Clear opportunity for funding agencies seeking broader implications of their science

Leads for proposed Activities

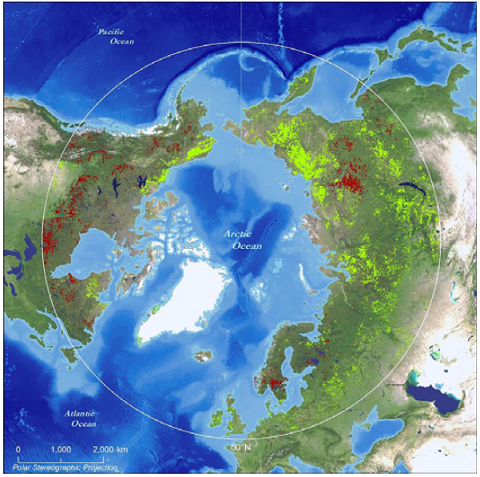
NSSI

Arctic LCC for climate related issues

Any number of university programs

10. What are the causes and consequences of the greening of the Arctic?

Lead Contact: Eric Kasischke and Craig Tweedie – needs to be reformatted



Analyses of satellite remote sensing data shows there has been a pronounced increase in greenness of vegetation in the pan-Arctic over the past three decades. A number of changes to Arctic vegetation have also been observed through a number of landscape to regional scale studies, and their consequences are important to subsistence users, land managers, and policy makers. This showcase project would address three questions:

* What actual changes to vegetation are occurring?

In particular, in different Arctic ecosystems, what changes are occurring to community composition, vegetation growth, and vegetation phenology?

* What are the causes of vegetation change?

In particular, how do changes in climate (temperature, precipitation, snow cover, etc), disturbance (fire, insects, thermokarst, etc), permafrost warming and thawing, herbivory, and changes to nutrient availability interact to control changes to vegetation?

* What are the consequences of vegetation change?

In particular, how do changes in vegetation influence wildlife habitat and migratory bird and mammals, permafrost dynamics, subsistence, and key feedbacks between the land surface and atmosphere (albedo, latent heat exchange, surface energy exchange)?

A number of organizations (NSF, NASA, DOE, BLM, USFWS, NPS, DNR, NSB, USGS) are sponsoring and developing projects and programs focused on monitoring and understanding the causes and consequences of Arctic vegetation change (CALM, NEON, ITEX, BTF, LCC, Arctic LTER, NGEE, Biocomplexity, TSP, ARM, ABoVE) and data from these organizations/projects are available through a number of established archives (CADIS, BEO, ITEX, GINA, CARMA, Arctic LTER, NSIDC, NASA DAACS, etc.) and data not currently available through an archive (e.g., BLM and USFWS).

While the agencies and programs involved in this monitoring and research have all acknowledged the need for cooperative efforts, a number of challenges exist, including developing an effective mechanism for programmatic coordination, establishment of monitoring and research priorities, establishing and maintaining long-term monitoring of key variables, and the synthesis and integrations of results from individual researchers as well as coordinated groups of scientists working on large projects.

Implementing this showcase project would first require agreement amongst the agencies and organizations sponsoring monitoring and research activities on Arctic vegetation change. A mechanism to bring about this agreement could involve forwarding the recommendations of showcase projects from this to the Arctic Research Commission, who could then forward these recommendations to the Subcommittee on Global Change Research. Upon the agreement by the various organizations to develop a coordinated research and monitoring effort, a science and monitoring definition team would be established to develop the plan required for each showcase project.

**11. Connecting Arctic Communities with One Another and with Scientists: Building a Community-Based Observation Network**

Lead Contact: Henry Huntington

Goal

Creating a functioning network connecting community-based observation efforts with one another and with the wider Arctic observation network.

Challenge

There are several community-based observation projects in operation in Alaska, but there are few connections among them. Furthermore, the connections between community observers/observations and scientists/scientific data are typically sparse and serendipitous rather than robust and planned. We are thereby missing opportunities to identify broader patterns by recognizing similar observations in different communities, to connect community concerns and scientific understanding, to link local observations with gaps and questions in current science, to support and encourage the collaboration of community members and scientists, and other ways of fostering greater overall engagement in observing, understanding, and responding to Arctic change.

Objectives

(a) Identify several community-based observations efforts that are willing to take part in the showcase project, and   
(b) Determine, for each effort, the parameters observed, the degree of engagement with scientists within and outside the project, the data management approach, observing protocols adhered to, duration, time/work required to become operational, time/work devoted to connecting among communities or with scientists, etc.

(a) Identify several community observers who are willing to take part in the showcase project, and  
(b) Evaluate their experiences to determine what factors foster satisfactory interactions with other communities or scientists outside the project and provide information of relevance with regards to community concerns, and what factors impede success.

(a) Identify several scientists, not affiliated with community-based projects, who have interacted with these efforts and are willing to take part in the showcase project, and  
(b) Evaluate their experiences to determine what factors foster satisfactory interactions with community observers and result in observations of interest to the scientific community, and what factors impede success.

Analyze the results of 1-3 to identify promising ways to foster networking among communities and between communities and scientists.

Design a network-support system (e.g., social networking, data portal, communication platform, etc.) to support the Goal; Implement; Evaluate; Modify; Continue.

Readiness

Several projects are underway, such as SIZONet, the Bering Sea Sub-Network, the Exchange for Local Observations and Knowledge in the Arctic (ELOKA), the Nelson Island Project, the Local Environmental Observers (LEO) project, and others. Collectively, these efforts have accumulated a great deal of experience, but have had few opportunities to share the lessons learned.

Balancing Scientific, Management, and Community Interests

This project looks squarely at the intersection of community and scientific interests. It does not focus specifically on management, except to the extent that some community concerns will be related to practical applications or issues such as coastal erosion, sanitation, subsistence, etc.

Agency Support & Funding

The project should be of interest to several agencies already engaged in or providing funding for community-based efforts. These include NSF, the NPRB, and others. Other than annual calls for proposals, we are not aware of specific funding opportunities, but note that NSF and others have small grant programs that can provide modest funding under the right circumstances. Management agencies may have an interest in the results, to the extent that they are interested in community-based observations. Whether they would be willing to support this showcase project is not known.

**Appendix II. Federal, State, and Local Government Programs and**

**Partnerships Pertinent to U.S. Arctic Observing Programs**

US Government Programs

Department of Agriculture

US Forest Service: Comprised in Alaska by the Chugach and Tongass National Forests as well

as the State and Private Forestry program.

Climate Change Assessment for Alaska Region: <http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_038171.pdf>

Forest Inventory & Analysis: The Nation's continuous forest census projects how forests are likely to appear 10 to 50 years from now. <http://www.fia.fs.fed.us>/

Forest Service Research & Development: Conducts biological, physical, and social science to promote sustainable management of Nation's diverse forests and rangelands <http://www.fs.fed.us/research/>

Natural Resources Conservation Service: Works with landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems. <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/about>

Major Land Resource Areas of Alaska (MLRA): NRCS coordinates the collection of soils and related natural resource data for the state of Alaska. <http://www.ak.nrcs.usda.gov/soils/index.html>

NRCS Snow Survey Program: Provides mountain snowpack data and streamflow forecasts for the western United States. <http://www.ak.nrcs.usda.gov/Snow/index.html>

Department of the Interior

Alaska Climate Science Center (CSC): Provides scientific information, tools, and techniques to anticipate, monitor, and adapt to climate change. <http://www.doi.gov/csc/alaska/index.cfm>

Landscape Conservation Cooperatives (LCC): The Arctic Landscape Conservation Cooperative (ALCC) supports conservation in the arctic by providing applied science and tools to land managers and policy makers. <http://www.fws.gov/science/shc/lccinfocontacts.html>

Bureau of Land Management (BLM): Administers approximately 75 million surface acres of federal public land in Alaska. <http://www.blm.gov/ak/st/en.html>

Rapid Ecoregional Assessment (REA): Establish landscape-scale baseline ecological data to gauge the effect and effectiveness of future management actions. <http://www.blm.gov/wo/st/en/prog/more/climatechange/reas/seward.html>

Bureau of Ocean Energy Management (BOEM): Oversees more than one billion acres on the Outer Continental Shelf and more than 6,000 miles of coastline in Alaska -- more coastline than in the rest of the United States combined. The Alaska region encompasses the Arctic ocean, the Bering Sea and the northern Pacific Ocean. <http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Index.aspx>

BOEM Alaska Environmental Studies Program: Conducts environmental studies to obtain information pertinent to sound leasing decisions as well as to monitor the human, marine and coastal environments. <http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Environment/Environmental-Studies/Index.aspx>

National Park Service (NPS): Manages over 54 million acres of national parks in Alaska and some of the most spectacular and remote natural places in the country. <http://www.nps.gov/akso/nature/science/index.cfm>

NPS Inventory and Monitoring Program (I&M): Develops scientifically sound information on the current condition and long-term trends in park ecosystems to determine how well current management practices are sustaining those ecosystems. <http://science.nature.nps.gov/im/units/AKRO/>

Murie Science and Learning Center (MSLC): Supports scientific research fellowships that assist park managers in making informed decisions about the protection of natural and cultural resources and visitor experiences in arctic and subarctic parks. <http://www.nps.gov/dena/naturescience/upload/2012-MSLCFellowship.pdf>

Ocean Alaska Science and Learning Center (OASLC): Supports marine and coastal research that addresses high priority resource management concerns for Alaska's coastal national parks. <http://www.oceanalaska.org/>

Shared Beringian Heritage Program: Supports projects of scientific and local importance in western Alaska and eastern Chukotka, in partnership with community organizations and academic institutions. <http://www.nps.gov/akso/beringia/projects/index.cfm>

U.S. Fish and Wildlife Service (FWS):

National Wildlife Refuge Inventory and Monitoring Program: Developing a nationally-coordinated program of inventory and monitoring (I&M program) on FWS lands

<http://www.fws.gov/filedownloads/ftp_region6_upload/Brian_C_Sanchez/IMDocs/National/046159_StrategicPlan_FINAL_for_DTS_and_DIRCTOR_MEMO.pdf>

U.S. Geological Survey (USGS):

Alaska Science Center: Provides timely, relevant, and impartial study of the landscape, natural resources, and natural hazards for Alaska and the nation. <http://alaska.usgs.gov/>

Department of Commerce

National Oceanic and Atmospheric Administration (NOAA), Alaska: Conducts a wide range of programs focused on the condition of the oceans, marine resources, the atmosphere, climate and weather. <http://www.legislative.noaa.gov/NIYS/NIYSAK.docx>

National Marine Fisheries Service (NMFS), Alaska: Oversees sustainable fisheries that produce about half the fish caught in US waters, and works to ensure the viability of protected species, principally marine mammals. <http://www.alaskafisheries.noaa.gov/>

National Weather Service (NWS), Alaska: Provides weather, hydrologic, climate forecasts and volcanic ash and tsunami warnings for the state of Alaska and its surrounding waters. <http://www.arh.noaa.gov/>

Department of Defense:

US Army Corps of Engineers. Cold Regions Research and Engineering Laboratory (CRREL): Applies science and engineering to complex environments, materials, and processes in all seasons and climates, with unique core competencies related to the Earth's cold regions. <http://www.crrel.usace.army.mil/>

Office of Naval Research (ONR): Supports innovative scientific and technological solutions to address current and future Navy and Marine Corps requirements. <http://www.onr.navy.mil/en.aspx>

Department of Homeland Security:

US Coast Guard (USCG): Safeguards our Nation's maritime interests and environment around the world. USCG icebreakers serve in Arctic/Antarctic serving science and research as well as providing supplies to remote stations. <http://www.uscg.mil/datasheet/icepolr.asp>

Department of Energy:

Argonne National Lab: Energy research and regionally-focused ecological and climate interactions and their impact on local economy and policy decisions. <https://blogs.anl.gov/major_initiatives/>

Sandia National Laboratory: Enhancing the nation’s security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems. <http://www.sandia.gov/mission/index.html>

National Aeronautics and Space Administration (NASA):

NASA’s Earth Observing System (EOS) is a coordinated series of polar-orbiting and low inclination satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. <http://eospso.gsfc.nasa.gov/>

National Science Foundation (NSF):

National Ecological Research Observatory Network (NEON): A continental-scale observatory designed to gather and provide 30 years of ecological data on the impacts of climate change, land use change and invasive species on natural resources and biodiversity. <http://www.neoninc.org>/

Office of Polar Programs (OPP): Manages and initiates National Science Foundation funding for basic research and its operational support in the Arctic and the Antarctic. <http://www.nsf.gov/dir/index.jsp?org=OPP>

State of Alaska Programs

Alaska Department of Environmental Conservation: Conserves, improves and protects Alaska's natural resources and environment (e.g., air, water, environmental health) to enhance the health, safety, economic and social well-being of Alaskans. <http://dec.alaska.gov/>

Alaska Department of Fish and Game: Protects, maintains, and improves fish, game, and aquatic plant resources of the state, and manages their use and development. <http://www.adfg.alaska.gov/index.cfm?adfg=about.divisions>

Alaska Department of Natural Resources: Manages all state-owned land, water and natural resources, except for fish and game, on behalf of the people of Alaska. <http://dnr.alaska.gov/commis/pic/about.htm>

Governor’s Subcabinet on Climate Change: Advises the Office of the Governor on the preparation and implementation of the Alaska climate change strategy. <http://www.climatechange.alaska.gov/>

Local Government

North Slope Borough

Department of Wildlife Management: Facilitates sustainable harvests and monitors populations of fish and wildlife species through research, leadership, and advocacy from local to international levels. <http://www.north-slope.org/departments/wildlife/>

Multipartner Programs

Alaska Climate Change Coordinating Committee (C4): The bridging group for the ACCER, LCCs, DOI CSC, and NOAA. <https://nccwsc.usgs.gov/?q=ACCER_AND_C4>

Alaska Climate Change Executive Roundtable (ACCER): Comprised of senior level executive both federal and non-federal agencies from throughout Alaska, the Climate Change Executive Roundtable meets regularly to share information and facilitate cooperation among agencies. <http://www.aoos.org/adiwg/accer/>

Alaska Committee for Noxious and Invasive Plants Management (CNIPM): Interagency collaboration for management of invasive plants. <http://www.uaf.edu/ces/cnipm/>

Alaska Data Integration Working Group (ADIWG): Initiated by ACCER, this group was created to promote policies and procedures to help streamline data sharing in Alaska. The primary effort of the technical subgroup thus far has been to improve data integration and project tracking among federal and state agencies in Alaska. <http://www.aoos.org/adiwg/>

Alaska Geographic Data Committee (AGDC): Statewide group organized in 1990 to promote data sharing among federal, state, native, local, commercial and NGO member agencies. The USGS hosts the Alaska Geospatial Data Clearinghouse for the AGDC. <http://agdc.usgs.gov/contact/>

Alaska Invasive Species Working Group (AISWG): Interagency collaboration for management of all invasive species (including marine invasives) across Alaska. <http://www.uaf.edu/ces/aiswg/>

Alaska Marine Ecosystem Forum: Organized by North Pacific Fishery Management Council to improve coordination and cooperative understanding between Federal agencies on issues of shared responsibilities related to the marine ecosystems off Alaska’s coast, other than fisheries. The initial focus of the AMEF has been on the Aleutian Islands marine ecosystem. <http://www.fakr.noaa.gov/npfmc/conservation-issues/amef.html>

Alaska Nanuuk Commission: Represents villages in North and Northwest Alaska on matters concerning the conservation and sustainable subsistence use of polar bear. <http://www.nanuuq.info/>

Alaska Ocean Observing System (AOOS): Working to develop a unified, comprehensive, cost-effective approach to providing ocean observations (biological, chemical and physical) from a permanent monitoring system and developing the information products based on those observations to meet the needs of users of coastal ecosystems. <http://www.aoos.org/about-aoos/>

Alaska Shorezone: A Coastal America project for coastline mapping and classification that specializes in the collection and interpretation of low-altitude aerial imagery of the coastal environment. <http://alaskafisheries.noaa.gov/shorezone/>

Arctic Observing Network (AON): AON was initiated by the NSF during International Polar Year (IPY). AON is integral to the Study of Environmental Arctic Change (SEARCH). <http://www.arcus.org/search/aon>

Arctic Research Consortium of the United States (ARCUS): A nonprofit member consortium of educational and scientific institutions that have a substantial commitment to arctic research. <http://www.arcus.org/>

Bering Sea Project (BEST-BSIERP): A six-year partnership project between the North Pacific Research Board and the National Science Foundation, that seeks to understand the impacts of climate change and dynamic sea ice cover on the eastern Bering Sea ecosystem, from the benthos and the atmosphere to human communities, and everything in between. <http://bsierp.nprb.org/index.html>

Centers for Ocean Science Excellence (COSEE Alaska): Strives to spark and nurture collaborations among research scientists and educators to advance ocean discovery and make known the vital role of the ocean in our lives. <http://www.coseealaska.net/>

Circumarctic Environmental Observatories Network (CEON): CEON is a network of terrestrial and freshwater observation platforms, science experts and network partners promoting the collection and dissemination of environmental data from the Arctic. <http://www.ceon.utep.edu/>

Coastal America: An action-oriented, results-driven collaboration process dedicated to restoring and preserving coastal ecosystems and addressing critical environmental issues. <http://www.coastalamerica.gov/index.php?option=com_content&view=article&id=1550&Itemid=81>

Coastal and Marine Spatial Planning for Western US (CMSP): To promote better understanding of current and future science needs in the realm of Coastal and Marine Spatial Planning (CMSP). <http://pubs.usgs.gov/of/2011/1152/>

Cooperative Ecosystems Studies Network (CESU): A network of federal agencies, universities, and other organizations striving to facilitate research in local and regional ecosystems. The University of Alaska hosts the North and West Alaska CESU. <http://www.uaf.edu/snras/cesu/>

Eskimo Walrus Commission: Works on walrus and related resource co-management issues, on behalf of Alaska Natives as an essential cultural, natural, and subsistence resource to the Alaskan coastal Yupik and Inupiaq communities. <http://www.kawerak.org/servicedivisions/nrd/ewc/>

Exxon Valdez Oil Spill Trustee Council: A State and federal partnership formed to oversee restoration of the injured ecosystem through the use of EVOS civil settlement. <http://www.evostc.state.ak.us/>

Federal Subsistence Management Program: A multi-agency effort to provide opportunities for a subsistence way of life by rural Alaskans on federal public lands and waters while maintaining healthy populations of fish and wildlife. The Federal Subsistence Board is the decision-making body that oversees the Federal Subsistence Management Program. <http://alaska.fws.gov/asm/board.cfml>

Geographic Information Network of Alaska (GINA): Works with agencies, NGOs, and private sector organizations, to serve the geospatial data covering Alaska. <http://www.gina.alaska.edu/information>

Incorporated Research Institutions for Seismology (IRIS): An NSF-supported consortium of over 100 US universities dedicated to the operation of science facilities for the acquisition, management, and distribution of seismological data. <http://www.iris.edu/hq/about_iris>

Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska: This group was established by an Executive Order and works to coordinate the efforts of Federal agencies responsible for overseeing the safe and responsible development of onshore and offshore energy in Alaska. <http://www.doi.gov/alaskaenergy/index.cfm>

Interagency Arctic Research Policy Committee (IARPC): IARPC was established by Congress through the Arctic Research and Policy Act, is chaired by the National Science Foundation, and provides cross-agency coordination regarding Federal arctic research. <http://www.nsf.gov/od/opp/arctic/iarpc/start.jsp>

Interagency Hydrology Committee for Alaska (IHCA): An organization of technical specialists working at the Federal, State, and local levels, who coordinate the collection and implementation of water resources related data throughout the State of Alaska. <http://ak.water.usgs.gov/ihca/>

International Study of Arctic Change (ISAC): ISAC was initiated in 2003 by the International Arctic Science Committee (IASC) and the Arctic Ocean Sciences Board (AOSB) following the SEARCH Open Science Meeting in Seattle in October 2003. <http://www.arcticchange.org/>

Inuit Circumpolar Council Alaska: Represents and advocates for the Iñupiat of the Arctic Slope, Northwest, and Bering Straits; St. Lawrence Island (Siberian) Yupik; and Central Yup’ik and Cup’ik of the Yukon-Kuskokwim Delta in Southwest Alaska. <http://www.iccalaska.org/servlet/content/home.html>

North Pacific Fisheries Management Council (NPFMC): One of eight regional councils established by the Magnuson Fishery Conservation and Management Act in 1976 (which has been renamed the Magnuson-Stevens Fishery Conservation and Management Act) to oversee management of the nation's fisheries. <http://www.fakr.noaa.gov/npfmc/>

North Pacific Research Board (NPRB): Congress created the North Pacific Research Board in 1997 to recommend marine research initiatives to the US Secretary of Commerce, who makes final funding decisions. <http://www.nprb.org/>

North Slope Science Initiative (NSSI): The NSSI is an intergovernmental effort to increase collaboration at the local, state, and federal levels to address the research, inventory, and monitoring needs as they relate to development activities on the North Slope of Alaska. <http://www.northslope.org/>

Porcupine Caribou Herd Management Board: The Porcupine Caribou Management Board works to manage the Porcupine Caribou Herd, one of the largest herds of migratory caribou on the continent, and to protect and maintain its habitat in Canada. <http://www.taiga.net/pcmb/>

Study of Environmental Arctic Change (SEARCH): SEARCH is an interagency effort to understand the nature, extent, and future development of the system-scale change presently seen in the Arctic, in terrestrial, oceanic, atmospheric, and human systems, including: air temperatures, ocean circulation and sea level, sea ice cover, and permafrost. Nine U.S. agencies, including DOI, collaborated to begin this program starting in 2001. <http://www.arcus.org/search/index.php>

Sustaining Arctic Observing System (SAON): Continues International Polar Year efforts to research, monitor, preserve and share information about Arctic environments. <http://www.arcticobserving.org/>

US Arctic Research Commission (USARC): USARC Commissioners facilitate cooperation among the federal government, state and local governments, and other nations with respect to basic and applied Arctic research. <http://www.arctic.gov/>

U.S.-Canada Northern Oil and Gas Research Forum: DOI bureaus and Canadian agencies formed The U.S.-Canada Northern Oil and Gas Research Forum looking at research and opportunities related to oil and gas activities on the North Slope, Mackenzie Delta, and Beaufort Sea. <http://www.arcus.org/meetings/2010/northern-oil-and-gas-research-forum>

US-Russia Polar Bear Commission: Works to ensure that polar bear populations in Alaska remain a healthy, functioning component of the Bering, Chukchi, and Beaufort seas ecosystems. Management responsibilities are described in the Conservation Plan for Polar Bears in Alaska. <http://alaska.fws.gov/fisheries/mmm/polarbear/bilateral.htm>

Western Arctic Caribou Herd Working Group (WACH WG): Established by an interagency agreement to provide interagency support for the cooperative management of the Western Arctic Caribou Herd. <http://westernarcticcaribou.org/>

Western Regional Air Partnership (WRAP): The purpose of the WRAP is to develop data, tools, and policies needed by states and tribes to improve visibility in parks and wilderness areas across the West. <http://www.wrapair.org/>

Yukon River Inter-Tribal Watershed Council: An Indigenous grassroots organization, consisting of 70 First Nations and Tribes, dedicated to the protection and preservation of the Yukon River Watershed. <http://www.yritwc.org/About_Us/About_Us.aspx>

**Appendix III. Workshop Agenda**

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| Tuesday, 20 March 2012 | |
| Day 1 Objectives: Set the stage and develop a vision of a successful arctic observing network. | |
| 8:00 a.m. | Check-in and Continental Breakfast |
| Overview and Setting the Stage [All Plenary Sessions in Fore Deck, Lobby Level] | |
| 8:30 a.m. | Welcome, Introductions, Meeting Goals & Expected Outcomes   1. John Payne (North Slope Science Initiative) and Don Perovich (U.S. Army Cold Regions Research and Engineering Laboratory); Workshop co-Chairs |
| 9:00 a.m. | Observations on the Observations: Where We Might Go From Here   1. Fran Ulmer, U.S. Arctic Research Commission Chair 2. John Farrell, U.S. Arctic Research Commission |
| 9:30 a.m. | Overview of Study of Environmental Arctic Change (SEARCH) and the Arctic Observing Network (AON)   1. Hajo Eicken (Univ. Alaska Fairbanks/SEARCH Science Steering Committee Chair) |
| 9:50 a.m. | Data and Observational Needs from Agencies, Stakeholders, and Decision-Makers   1. Michelle Bonnet (Director, Alaska Department of Environmental Conservation Division of Water) |
| 10:10 a.m. | Arctic Observational Needs For Modeling and Prediction   1. John Walsh (International Arctic Research Center, Univ. Alaska Fairbanks) |
| 10:30 a.m. | Morning Break |
| 10:45 a.m. | Back to the Future: A Conceptual Framework for Advancing AON   1. Martin Jeffries (Office of Naval Research) |
| Advances in Observing Activities By SEARCH Science ThemesGuiding Question: With the resources we have now, what are the greatest advances that could be made in observational data/products for use by scientists and stakeholders? | |
| 11:05 a.m. | SEARCH Science Goal #1: Sea Ice/Consequences of Ice-Diminished Arctic Ocean   1. Julienne Stroeve (National Snow and Ice Data Center) |
| 11:20 a.m. | SEARCH Science Goal #2: Permafrost/Land Surface Change/Hydrology   1. Larry Hinzman (International Arctic Research Center, Univ. Alaska Fairbanks) |
| 11:40 a.m. | SEARCH Science Goal #3: Land Ice Loss   1. Tad Pfeffer (Institute of Arctic and Alpine Research, University of Colorado) |
| 12:00 p.m. | SEARCH Science Goal #4: Society/Policy - Links Between Observational Data/Information and Public Understanding   1. Henry Huntington (PEW Environment Group, Arctic Program Science Director) |
| 12:20 p.m. | Lunch (On your own) |
| Breakout Session 1: Develop a Vision of a Successful Arctic Observing Network (break as needed) | |
| 1:45 p.m. - 3:45 p.m. | 1. Break-out groups would be split into two thematic areas: ice-diminished arctic ocean, and warming permafrost/land surface linkages; with 2 groups for each theme (4 groups total) 2. Participants will be assigned to each group to encourage cross-disciplinary discussion and interaction.   To develop a shared vision of a successful arctic observing network, breakout groups will address the following guiding questions:   1. Which audiences would an ideal AON serve? 2. Given these audiences, in an ideal world what would an AON look like in5 years? What would the 'value added' be, beyond the current way ofbusiness? 3. What products and Services would be created? |
| 3:45 p.m. | Reports from Breakout Groups and Goals for Day 2 |
| Poster Session and Reception [Aft Deck, Lobby Level] | |
| 5:00 p.m. - 7:30 p.m. | Opportunity for participants to present specific projects or activities related to SEARCH, Observing Activities, or arctic science. Poster boards will be provided, and the maximum size allowed for posters will be 4’ x 4’. Participants will be able to put up their posters anytime during the first day, and pins will be provided. Posters may remain up until ~5pm on Wednesday. Reception will include appetizers and a cash bar. |

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| Wednesday, 21 March 2012 | |
| Day 2 Objectives: With the vision discussed in Day 1, identify specific ways to achieve the vision. The exact structure of the day will be adaptive to the groups' progress, so break-out times and structure can change, if needed. | |
| 9:00 a.m. | Quick review of yesterday's progress, today's goals, charge to break-outs.   1. John Payne and Don Perovich |
| Breakout Session 2: Specific Ways to Achieve the Vision (break as needed) | |
| 9:30 a.m. – 12:00 p.m. | 1. Breakout groups will be tasked with outlining specific recommendations for how to achieve the vision for each science theme? 2. What activities are needed? 3. What can be done from combining existing resources or infrastructure? (Or where can targeted activities make great progress?) 4. Also start thinking about cross-cutting activities or showcase projects– data-focused, place-based/regional, etc. |
| 12:00 p.m. | Lunch (On your own) |
| 1:15 p.m. | Brief Break-out Group Reports to PlenaryDiscussion of common themes emerging |
| Breakout Session 3: Details and Showcase Projects | |
| 2:30 p.m. – 4:30 p.m. | 1. Continuing from the morning, flesh out the activities needed – discuss specific tasks, next steps, timelines, and possible mechanisms, and possible 'showcase' projects 2. Be prepared to report to plenary in the morning 3. One breakout group focused on data issues (e.g., interoperability, proprietary data, data formatting, common archive structures, provision of data for showcase projects) |
| 4:30 p.m. | Adjourn for Day |
| Evening – groups could meet informally to further ideas, areas of collaboration, etc.Possible side meetings focusing on Bering Sea, Barrow region, Toolik Lake & Kuparuk watershed, data issues, etc. | |

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| Thursday, 22 March 2012 | |
| Day's objective(s): Identifying "showcase" projects for observing activities, with recommendations for short-term implementation (5 years or less), with identified task leads | |
| Plenary Review and Discussion | |
| 9:00 a.m. | 1. Goals for the day 2. Breakout group reports from yesterday afternoon 3. Plenary Discussion: How are the ideas resonating with the group? What priorities might be emerging? 4. Charge to Final break-out groups |
| More Details, Showcase Projects, and Next Steps | |
| 9:30 a.m. – 10:45 a.m. | Breakout groups focus on showcase projects that could be launched in the near-term –theme-based, regional-focused, and/or data-focused   1. Discuss details of showcase project – scope, specific next steps, identify key participants 2. Identify key lead(s) that could convene an ad-hoc task group after the workshop |
| 10:45 a.m. | Morning Break |
| 11:00 a.m. | Final Plenary Discussion   1. What are the key recommendations for a successful observing network? 2. Showcase projects – what and how they can be accomplished 3. Specific next steps/recommendations |
| 12:00 p.m. | Workshop Wrap-up and Next Steps |
| 12:15 p.m. | Adjourn |
| 1:00 p.m. | Small writing group meet in afternoon to begin workshop report |

**Appendix IV. Workshop participants**

Lilian Alessa

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