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Thematic Working Group Synthesis Documents**

Title of synthesis document and associated theme:

Arctic observations in the context of global observing initiatives

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Overview of theme and objectives:

The Arctic is an interconnected component of the global system. Changes in the Arctic, including to the physical environment, climate, ecosystems, or human activity, have implications at all latitudes, and vice versa. With this in mind, Arctic observation initiatives must be synchronized and integrated with existing and emerging global observing systems. The Arctic is not detached from the rest of the planet, and Arctic observations must not be either.

The 2016 Arctic Observing Summit Theme 5: Arctic observations in the context of global observing initiatives working group will include consideration and discussion of all aspects where Arctic and non-Arctic regions and observations are interlinked. It is to be noted that although very important, links between Arctic and global observations in the areas of sensor technologies, observing platforms, observation frequency and spatial resolution were not specifically addressed in the white papers and short statements submitted to this theme.

Brief summary of the papers reviewed

Seven white papers and nine short statements were submitted to Theme 5. These documents were well connected to the theme, approaching it from different perspectives. The documents focused on Arctic observation efforts at all scales, from local efforts addressing specific problems, to international efforts spanning the whole Arctic and beyond. Some of the initiatives presented discuss the global context

explicitly, while others clearly demonstrate the demand for global integration and synchronization of Arctic observations.

The objectives and implementation of the Year of Polar Prediction (YOPP), coordinated by the Polar Prediction Project (PPP), are outlined by Goessling *et al.* YOPP will be a period of concentrated observing, modeling, prediction, verification, user engagement and educational efforts in the Polar regions, which promises to make significant contributions to Arctic observations and observation systems.

Vihma *et al.* outline the work of the International Arctic System for Observing the Atmosphere (IASOA) and its efforts to facilitate international collaboration to ultimately improve Arctic atmospheric data products for different users. IASOA represents a good model for international Arctic observations collaboration, elements of which can be replicated in other fields to help identify and fill gaps in data.

The complementarity of, and existing connections between the Sustaining Arctic Observing Networks (SAON) process and the Group on Earth Observations` (GEO) effort to develop the Global Earth Observation System of Systems (GEOSS) is discussed by Druckenmiller *et al.* Community based monitoring (CBM) is highlighted as a key opportunity to engage stakeholders and community-members in the data collection process, and to establish collaborative Arctic observations at all levels. The GEO Cold Regions Initiative (GEOCRI), described by Qiu *et al.* (Theme 1), aims to coordinate observation efforts and facilitate international collaboration and synergies throughout the Arctic and beyond. GEOCRI works to expand the capacity of users to employ open earth observation data, using GEOSS as a platform to synchronize and integrate Arctic and global observations.

Arctic-wide observing systems, such as SAON and IASOA, and global initiatives, such as GEOSS, offer perhaps the most efficient opportunity to cement Arctic observations within global observing initiatives.

The Asian Forum for Polar Science (AFoPS) Secretariat presents the contributions of AFoPS to Arctic observations. This document describes the collaborative surveying activities, logistical coordination and international initiatives, such as the Arctic Challenge for Sustainability (ArCS) – an example of international cooperation to improve Arctic observations (Headquarter of ArCS Project). AFoPS demonstrates the global need for Arctic observations and the enthusiasm for Arctic observing initiatives from all regions.

Kodama *et al.* introduce a long-term plan for Arctic environmental research for the Japan Consortium for Arctic Environmental Research (JCAR). The plan aims to focus research efforts on global warming and biodiversity, engage the expertise of researchers working in other areas and offers guidelines to improve research infrastructure and capabilities. In a second short statement, Kodama *et al.* also discuss the need for sustainable seamless monitoring in the Arctic through international collaboration and synchronization of remote sensing and in situ observations across oceans, cryosphere, atmosphere and land.

Schöner *et al.* introduce CryoNet, a growing network of surface-based cryosphere observation stations developed by Global Cryosphere Watch (GCW), which includes 10 stations in the Arctic and highlights the ongoing expansion of CryoNet to include more stations and fill information gaps. Also described are GCW's efforts to improve interoperability between data management systems. CryoNet does not separate the Arctic from the global – Arctic observations are placed in a global context by default.

McCammon *et al.* discuss the monitoring activities of the Alaska Ocean Observing System (AOOS) and the importance of an Alaska-specific ocean observing network due to its unique challenges

and environmental issues. This document highlights the importance of developing regionally specific specialties that address local needs while also contributing to global observing initiatives.

Kim *et al.* provide an overview of Arctic observation initiatives by the Korean Polar Research Institute (KOPRI). The paper describes the KOPRI Arctic observation infrastructure and efforts to obtain past climate records, understand ocean biogeochemical cycles and collect cloud observation data in the Arctic.

McLennan *et al.* outline how a coordinated Arctic vegetation classification can be used to calibrate Canadian terrestrial ecosystem classification in both the Arctic and sub-Arctic and discuss how this can provide a template for ecosystem monitoring throughout the Arctic.

Matsuura *et al.* discuss Arctic forest ecosystem monitoring, and propose an international platform for further and ongoing forest ecosystem research within the context of changing climate.

Schuur *et al.* outline the Permafrost Action Team, which aims to improve observations and monitoring of Arctic permafrost and improve predictions of how permafrost change will influence landscapes, ecosystems and humans in the Arctic.

Bullard & Darlington discuss the need for a coordinated observation network to understand Arctic dust generation and emissions, and how these components may change in the face of ongoing environmental change. Initiatives such as this highlight the importance of observations not normally associated with the Arctic, and are an example of where Arctic observations could become better connected with global observations.

Lee introduces an innovative initiative for oceanographic data collection via animal-borne sensors, and emphasized oceanographic-biological linkages over broad scales.

Yabuki *et al.*, discuss how the ever-increasing interest in the Arctic drives an ongoing need for more Arctic observation data, and thus a comprehensive Arctic Data archive System (ADS) which is open to all in both Arctic and non-Arctic nations. The challenges of developing an ADS and how to overcome them are discussed. Related to the topic of data management, the white paper by Allison *et al.* describes the need for an e-infrastructure that supports data-intensive, multi-disciplinary research that addresses 21st century global change challenges. Developing these elements for Arctic observations will help ensure all users, working in all regions, are able to maximize their utilization of data to meet their specific needs.

Needs, priorities and challenges highlighted by contributions

The theme “Arctic observations in the context of global observing initiatives” encompasses broad and diverse areas of research, and as such, there are many priorities and challenges associated with Theme 5. High quality and long term Arctic observation data that connect globally are required for the benefit of a wide range of users.

The white papers and short statements submitted for this theme highlight many national Arctic observation efforts and examples of successful international coordination. Arctic observations have been improved by the work of IASOA, YOPP, and GCW, and coordination and data sharing enhanced by GEOCRI and GEOSS.

Nonetheless, the white papers and short statements also identify areas for improvement. Some of the challenges highlighted by Vihma *et al.* and IASO include standardizing measurements and observing products for atmospheric data, an important consideration for global initiatives. Schoner *et al.* also makes the recommendation for the development of best practices of cryospheric observations for all regions. Yabuki *et al.* and Allison *et al.* discuss some of the challenges of managing and distributing Arctic

observation data, a key area of work to fully integrate Arctic observations with global observing initiatives.

Several research and knowledge gaps with global implications were discussed which can be addressed through Arctic observations. These include carbon sequestration from permafrost due to climate warming (Schuur *et al.*), sampling stations for cryosphere observations (Schöner *et al.*), technology and observation platforms (Kodama *et al.*), and observational gaps in forecasting ability for the polar regions (Goessling *et al.*).

Moreover, a special focus should be given to the link between Arctic and global observations in the areas of sensor technologies, observing platforms, observation frequency and spatial resolution. Discussion of observing systems within and beyond the Arctic must include some tracking of ecosystem components, drivers and stressors related to the linkages between the region and lower latitudes.

Theme 5 Working Group discussions

The AOS theme 5 working group is articulated in four discussions:

1. Global coordination for Arctic observations: For who?
Keynote: an example of a user-driven project: YOPP
Discussion: Identification of users and users' needs, and the contribution of Arctic observations to global mechanisms
2. Global coordination for Arctic observations: Not just snow and ice
Keynote 1: Arctic Dust Observation
Keynote 2: The International Arctic Systems for Observing the Atmosphere (IASOA)
Discussion: Rising topics to be focused/ strengthened and parameters requiring global coordinations
3. Global coordination for Arctic observations: Contributors
Keynote 1: Global coordination mechanisms for the Arctic
Keynote 2: The Global Cryosphere Watch (GCW)
Discussion: Building an overall efficient coordination system: with organizations, which mechanisms?
4. Global coordination for Arctic observations: The way forward
Keynote 1: Long-term plan for Arctic environmental research
Keynote 2: Arctic observations for monitoring and understanding Arctic climate change
Discussion: How to build sustainable, efficient and user-driven observations networks for cross-cutting issues

Intended outcomes from the discussions

The following outcomes should help shape the next Arctic Observing Summit:

1. Identification of linkages among themes (commonalities, synergies, areas of future collaboration, etc.) and to other programs and initiatives.

- Forest, atmospheric dust, and permafrost are research areas connected to international coordinations for long-term observations focused in Theme 1.
 - Animal-borne sensors for marine observations and cryosphere monitoring systems are related to Theme 2 as technology available or to be improved.
 - Druckenmiller *et al.* (GEOSS) is linked to Theme 6 as a community-based observation network.
2. Examples of successful structures, tools, case studies, etc.:
 - GEOSS, GCW, CryoNet, IASOA, PPP, AOOS
 3. Recommendations, both specific and general, and timelines for implementation:
 - Dialogues among communities: GEOCRI as an emerging example, but other as well to define well-organized actions. The overview of different actions, project, area, temporal coverage should be easily accessible. This requests collaboration and resource sharing, and will help avoiding duplication.
 4. Implementation in the coming year:
 - Make success case of science coordination model ex. YOPP

Referenced white papers and short statements – full document available on the AOS website

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- Druckenmiller, M.L., Pulsifer, P., Alessa, L., Eerkes-Medrano, L. and Lee, O. 2016. Advancing Arctic observing within the Global Earth Observation System of Systems (GEOSS) through a focus on Community-Based Monitoring. Synthesis paper, Arctic Observing Summit 2016, Theme 5 (Arctic observations in the context of global observing initiatives). Fairbanks, AK.
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- Headquarter of ArCS Project. 2016. New Japanese Arctic Research Project “Arctic Challenge for Sustainability (ArCS)” and related activities. Synthesis paper, Arctic Observing Summit 2016, Theme 1 (International and national strategies for sustained support of long-term Arctic observing). Fairbanks, AK.
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- Matsuura, Y., Noguchi, K., Morishita, T., Toriyama, J., Fujii, K. *et al.* 2016. Comparative long-term forest ecosystem study in circumpolar region. Synthesis paper, Arctic Observing Summit 2016, Theme 5 (Arctic observations in the context of global observing initiatives). Fairbanks, AK.
- McCammon, M., Janzen, C., and Bochenek, R. 2016. A Brief Introduction to the Alaska Ocean Observing System: A Presence in the Arctic (AOOS). Synthesis paper, Arctic Observing Summit 2016, Theme 5 (Arctic observations in the context of global observing initiatives). Fairbanks, AK.
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- Schöner, W., Key, J., Fierz, C., Goodison, B., Godøy, Ø., Snorrason, and Á., Ondráš, M. 2016. The Global Cryosphere Watch Surface Network in the Arctic and Beyond. Synthesis paper, Arctic Observing Summit 2016, Theme 5 (Arctic observations in the context of global observing initiatives). Fairbanks, AK.
- Schuur, E.A.G., Schädel, C., and McGuire, A.D. 2016. Permafrost Action Team: Short statement for ASSW 2016. Synthesis paper, Arctic Observing Summit 2016, Theme 5 (Arctic observations in the context of global observing initiatives). Fairbanks, AK.

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