Arctic Observing Summit (AOS) 2016

Thematic Working Group 2 - Technology and innovation for sustained Arctic observations

Co-authors: Cliff Sweatte (International Civil Aviation Organization [ICAO], USA); Dr. Rune Storvold (Norut, Norway); Alice Bradley (University of Colorado Boulder, USA)

Introduction

A modern pan-Arctic Observing System relies on technical innovation to achieve the appropriate spatial and temporal resolution. Key needs include improved interoperability and sensor development and the ability to generate accurate and continuous data records. During the AOS 2016, topics for discussion include the utility of drones (UAVs, Unmanned Aircraft Systems or Remotely Piloted Aircraft Systems) and their role in remotely sensing the atmosphere, sea or ice conditions and marine mammals including operation across national borders, and exploration of the use of modern technology for community-based observations. Advances in other technologies that may support sustained Arctic observations (such as unmanned underwater vehicles, AUVs and unmanned surface vehicles, USVs) will also be discussed.

Summary of submitted papers

Papers submitted to the Technology and Innovation theme of the Arctic Observing Summit (*Appendix 1*; reviewed below) focused around two major areas with a recurring thread of successful studies using new technologies for Arctic observations:

1) Autonomous sensing technology, a rapid growth area in the field. Each new sensing capability and development opens additional opportunities for research and innovation.
2) Data collection and integration. Data collected through new technologies must be integrated with existing data sets and shared, while existing data services and systems provide platforms to be improved upon.

The submitted papers focus on developments related to in-situ technologies as well as automatic and autonomous sensor platforms. Satellite remote sensing platforms are only briefly discussed in the submitted white papers, though they certainly represent a large fraction of the longer time-series records of Arctic observations and are an area of ongoing innovation and development. Coupling of the in-situ and autonomous sensor platforms and the satellite remote sensing operations has potential to improving the data quality and scientific benefit of both systems.

- **Autonomous sensing technologies**

White papers submitted to the Technology and Innovation theme covered a variety of types of platforms, including unmanned aircraft, autonomous underwater vehicles, drifting buoys, and large observational stations.

Micro Buoys for low-cost observations of the upper Arctic Ocean

This white paper addresses the potential of micro buoys as a cost efficient tool in the future ocean observing system. Initial tests are presented, and even though this technology is in early stages, it has shown great potential. The basic technology and deployment system can be used to collect data in a variety of scientific disciplines, especially sea-ice. The technology and their small set of sensors can be coupled to the use of other automatic or autonomous technologies such as unmanned aircraft or surface vessels and provides an inexpensive method to access measurements in otherwise difficult areas to monitor.

Micro-UAS as a tool for observing the Arctic environment

This short statement addresses the opportunities and potential, as well as challenges, of using micro UAS as a low cost measurement platform in the Arctic. The statement addresses the use of the technology in atmospheric boundary layer data collection. Challenges range from cold weather adaption, and sensor inter-calibration needs to airspace access. The technology is currently mature enough for deployment and could be a valuable and inexpensive complement to radio soundings providing previously unattainable measurements of the Arctic environment.

The WCRP-FPA2 Polar Challenge: Expanding the capabilities of current Autonomous Underwater Vehicles.

The World Climate Research Programme (WCRP) and the Prince Albert II of Monaco Foundation (FPA2) are sponsoring a Polar Challenge (www.wcrp-climate.org/polarchallenge) that will reward the first team to complete a 2,000 km mission with an Autonomous Underwater Vehicle (AUV) under the Arctic or Antarctic sea-ice.

Michael Rixen will present the Polar Challenge during the AOS Theme 2 breakout session 2 (http://www.arcticobservingsummit.org/general-schedule#breakout2).

Permafrost Active Layer Seismic Interferometry Experiment (PALSIE) and Satellite Observations

The whitepaper presents results from the PALSIE experiment which shows promising results in coupling horizontal to vertical spectral ratio and ambient noise seismic interferometry from buried seismometers to active layer thickness. The potential for use of satellite optical and SAR sensors for monitoring permafrost are also described.

Opportunities for sustained Arctic observations and scientific collaborations at the US Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Facilities on the North Slope of Alaska.

The U.S. Department of Energy ARM program has maintained observational facilities on the North Slope of Alaska since 1997. The facilities provide measurements and resources to support research and field campaigns for a wide spectrum of users and partners. Observations include terrestrial, ocean and atmospheric systems using land based, remote and aerial equipment. These provide opportunities to solve problems and serve the growing community of researchers and stakeholders working in the Arctic. An ARM site at Oliktok Point has recently launched UAS with access to international airspace from its gravel runway and special use airspace including the newly created Warning Area that extends

approximately 1300 km (700 nautical miles) north into Arctic airspace offering opportunities for research with tethered balloons, unmanned aircraft systems, and modified manned aircraft.

Dr. Mark Ivey of Sandia National Laboratories will present on behalf of DOE during the Theme 2 breakout session 2 (http://www.arcticobservingsummit.org/general-schedule#breakout2).

- **Data Collection and Integration**

The optimal future observing system should exploit and leverage the potential of new technologies. Faster computers and better models to feed back into the measurement system in near real time would allow autonomous platforms to be steered to create maximum impact with regard to improving model performance and upscaling satellite data.

The need for data and technology integration to observe tundra wildfires at multiple scales

This short statement highlights the need for multiscale monitoring of Arctic wildfires. The current capacity includes satellite measurements and global datasets. There is a need for a coordinated effort to collect tundra wildfire knowledge and create regional data with both airborne (UAS) and ground-based observation systems to understand the relationship between the tundra's in-situ bio-geo-physical characteristics, and remotely sensed data with an ultimate goal of providing information to be integrated into a circumpolar observation network.

Arctic Biodiversity Data Service (ABDS)

The statement from The Conservation of Arctic Flora and Fauna (CAFF) explains their charter and mandate to address the conservation of Arctic biodiversity in an effort to promote practices which ensure the sustainability of the Arctic's living resources. CAFF has established the Arctic Biodiversity Data Service (ABDS www.abds.is), a publicly accessible, online, interoperable data management system for information generated by projects and programs of CAFF that serves as a focal point and common platform for all CAFF programs and projects. ABDS also provides a dynamic source for up-to-date circumpolar Arctic biodiversity information.

Exploring the Arctic: Integrating earth observations on the WorldView Discrete global Grid System

This short statement introduces the Open Geospatial Consortium (OGC) and explains a new earth reference standard called a Discrete Global Grid System (DGGS) that is analogous to any discrete "Digital" data structure - as opposed to the continuous "Analog" model of the Earth represented by geographic coordinates. WorldView DGGS permits easy repeatable manipulation, visualization and analysis of measurements from any location at any scale, and facilitates the integration of Arctic data sources.

A Pan-Arctic Airborne sea ice observation system

This white paper presents an Arctic sea-ice observation system that focuses on unique direct observations of sea ice plus snow thickness using a network of research institutions who maintain an observation system that is utilized in international projects supported by research partners. Activities in

the field use research aircraft, helicopter operations from research icebreakers and bases on land. The paper discusses a plan to augment the observation system by simultaneous measurements of snow depth and to investigate opportunities for technological advances, such as the utilization of unmanned aircraft systems.

Adjoint Sensitivity Analysis (ASA) and Observing System Simulation Experiments (OSSE) as a tool to analyze and optimize observations in the Arctic Ocean

Panteleev et al. offer ASA and OSSE as tools for understanding of the environmental changes in the Arctic where data acquisition is extremely complicated and expensive. The paper provides two examples in the Arctic where ASA and OSSE can be used for optimizing the locations of the High Frequency Radars (HFRs) and passive tracer survey. They describe the basic ideas behind the ASA and OSSEs techniques, and show how application of these tools may help to optimize the location of the HFRs, identify the gaps in existing observational programs, and increase the information content of the various passive-tracer observations collected during ship surveys.

The Arctic Adaptation Exchange Portal: An Arctic Council tool to build a knowledge system for resilient Arctic communities

This short statement details the Arctic Adaptation Exchange Portal (AAEP), a project of the Arctic Council's Sustainable Development Working Group (SDWG) and The University of Alaska. The AAEP is an open and web-based platform that supports the flow of knowledge between Arctic communities and other users, including researchers and policymakers. A unique and distinguishing feature of the AAEP is that it is not geared primarily for scientists to use, recognizing the overwhelming number of databases and other technical sites that currently exist. Instead, the AAEP fills a current unmet niche: that of building a knowledge base at ground level, where day to day adaptation actions are occurring right now, in real life and not in theory.

Acknowledgements

The co-leads of Thematic Group 2 would like to acknowledge the Arctic Monitoring and Assessment Programme (AMAP), an Arctic Council working group, and the AMAP UAS Expert Group for their institutional support and the University of Alaska, Fairbanks for their support in funding travel to AOS 2016.

We invite you to attend our breakout sessions to hear speakers bring to life the themes and latest technologies presented in the white papers and short statements and to participate in the ensuing discussions. The AOS Theme 2 breakout sessions are described in more detail in *Appendix 2*.

APPENDIX 1 - List of Submitted White Papers and Short Statements

Author(s)	Title	Type of Paper
Meir, W., Rixen, M.	The WCRP-FPA2 Polar Challenge: Expanding the capabilities of current Autonomous Underwater Vehicles	Short Statement
Cassano, D., de Boer, G., Lawrence, D.	Micro-UAS as a tool for observing the Arctic Environment	Short Statement
Francis, P., Herbert, D., Panteleev, G. Posey, P., Stroh, J.	Adjoint Sensitivity Analysis and Observing System Simulation Experiments as a tool to analyze and optimize observations in the Arctic Ocean	White Paper
de Boer, G. Dexheimer, D., Hardesty, J., Helsel, F., Ivey, M., Lucero, D.	Opportunities for Sustained Arctic Observations and Scientific Collaborations at the US Department of Energy Atmospheric Radiation Measurement (ARM) Facilities on the North Slope of Alaska	White Paper
Masrur, A., Petrov, A.	The Need for Data and Technology Integration to Observe Tundra Wildfires at Multiple Scales	White Paper
Abbott, R., Cole, C., James, S., Knox, H. Lee, R.	Permafrost Active Layer Seismic Interferometry Experiment (PALSIE) and Satellite Observations	White Paper
Bradley, A.; Lawrence, D., LoDolce, G., Maslanik, J., Palo, S., Weibel, D., Zappa, C.	Microbuoys for low-cost observation of the upper Arctic Ocean	White Paper
Barry, T.; Lárusson, K.	Arctic Biodiversity Data Service (ABDS)	Short Statement
Abdelrahim, S., Alessa, L., Beaujean, G., Cox, S., Gamble, J., Linklater, J. Meceda, A., Raymond, V. Roddick, S.	The Arctic Adaptation Exchange Portal: An Arctic Council Tool to Build a Knowledge System for Resilient Arctic Communities	Short Statement
Eicken, H., Gerdes, R., Gerland, S., Haas, C., Hendricks, S., Herber, A., Krumpen, Thomas; Mahoney, A. Gerdes, R.	A Pan-Arctic Airborne Sea Ice Observation System	White Paper
Jones, J., Peterson, P.	Exploring the Arctic: Integrating Earth Observations on the WorldView Discrete Global Grid System	Short Statement

Appendix 2. Thematic Working Group 2 Breakout Sessions and Presentations

Discussion during each session will revolve around the submitted white papers, short statements and presentations.

- Session 1: Autonomous Sensing Technologies

  Speakers: Dr. Phillip McGillivary, Science Liaison for US Coast Guard (USCG) PACAREA. Dr. McGillivary coordinates science issues for the USCG for the Pacific Ocean in conjunction with USCG Headquarters and their Research & Development Center

  Prof. Torbjørn Eltoft, UiT Arctic University of Norway. Prof. Eltoft is the PI of CIRFA (Centre for Integrated Remote Sensing and Forecasting for Arctic Operations)

- Session 2: International and National Strategies for Sustained Support of Long-Term Arctic Observing.

  Speaker: Dr. Mark Ivey, Sandia National Laboratories. Dr. Ivey is the manager for the DOE's ARM climate research facilities in Alaska and is also a distinguished member of the technical staff at Sandia where he has worked since the early 1980's.

  Presentation: Polar Challenge, Dr. Michel Rixen, World Climate Research Programme

- Session 3: Intelligent Integrated Observing Systems

  Speaker: Dr. Cathy Cahill, Director, Alaska Center for Unmanned Integration Systems Integration (ACUASI).

- Session 4: Towards a Pan Arctic Observing Network

  Speaker: Morten Rasch, Senior Executive Consultant, Department of Geosciences and Natural Resource Management, University of Copenhagen. Dr. Rasch was one of the key scientists involved in the establishment of the Villum Research Station Greenland and has worked in the Arctic since the early 1990's.