PACES
air Pollution in the Arctic:
Climate Environment and Societies

2nd PACES Science Workshop

27-29 June 2017

Coast Victoria Hotel, Victoria, Canada

Workshop Summary

The 2nd PACES (air Pollution in the Arctic: Climate, Environment and Societies) Open Science Workshop was held in Victoria, British Columbia, Canada on 27-29 June 2017. More than fifty scientists representing 13 countries with interests in the Arctic Earth system gathered at the Victoria Coast Hotel to discuss the latest science and societal issues regarding sources, processing and impacts of trace gas and aerosol pollution in the Arctic. As a recently launched international activity, PACES aims to review existing knowledge and foster new research on the sources and fate of Arctic air pollution, its impacts on climate, health, and ecosystems, on the feedbacks between pollution and natural sources, on climate responses, and on societal perspectives, including sustainability, adaptation and economic feedbacks. The role of PACES is to coordinate international research efforts on these topics in collaboration with existing and planned initiatives, and to motivate trans-disciplinary research efforts related to Arctic air pollution. PACES is co-sponsored by IASC (Atmosphere WG) and IGAC (International Global Atmospheric Chemistry) project. See http://pacesproject.org/.

The Workshop included oral and poster presentations as well as guided open discussion across 7 session themes: Long Range Transport of pollution to the Arctic, Feedbacks between Anthropogenic Pollution and Natural Cycles, Local Processes and Societal Interactions, Improved Predictive Capability, and a discussion of a potential new field/modeling study. In addition to around 50 scientists attending in person, another 10 joined the workshop oral sessions remotely. A poster session on day 2, featured around 15 posters across the range of workshop themes, and facilitated informal discussion between workshop participants. On the afternoon of the third day, an open, joint session was held between PACES participants and scientists attending the meeting of the AMAP Expert Group (EG) on Short-lived Climate Forcers, which immediately followed the Workshop. This final day concluded with an open discussion of linkages between the PACES and AMAP EG goals and interests.

While many scientific topics were discussed in detail, several broader themes dominated throughout the workshop. Key scientific highlights of the workshop included:

- Long-range transport of pollution to the Arctic is intimately linked to Arctic climate change and changes in large-scale circulation patterns but such linkages require improved quantification.

- Natural sources of trace constituents in the Arctic such as dust aerosols or biogenic hydrocarbons, and their potential evolution as a result of climate change, are poorly constrained.
- Large uncertainties surround the formation and processing of local air pollution under very cold, dry, stable conditions in the Arctic.
- Model treatments of wet deposition and chemical/aerosol processing are still significant and are motivating the planning of a new field experiment (IMPAACT) designed to sample air masses in a quasi-Lagrangian fashion during transport of pollution from Asia to the Arctic

Jim Overland (NOAA Pacific Marine Environmental Laboratory) opened the Workshop with an invited talk that highlighted the immediacy, rapid pace, and astonishing magnitude of Arctic climate change. The uncertainty in the rate and magnitude of this change was a recurring topic throughout the Workshop. Arctic climate change affects the magnitude of local sources of pollution due to increased economic activity, the amount and type of natural emissions of gas-phase species and aerosols from more-open Arctic waters, the production of dust from newly exposed soils, changes in the deposition of pollutants, and changes in Arctic clouds and precipitation. A new theme considered by PACES is the apparent linkage between Arctic climate change, sea ice loss and mid-latitude circulation, which may affect mid-latitude air quality, but also pathways transporting air pollution from mid-latitudes to the Arctic. This latter link was highlighted in an invited presentation by Luca Pozzoli (JRC, Italy). A lack of understanding of drivers of Arctic climate amplification presents a challenge for predicting changes in the composition of the Arctic troposphere. More work needs to be done on these topics, and more coordination with climate scientists is required to better understand feedbacks between Arctic climate change and chemistry should be a priority moving forward.

Several presentations demonstrated that significant gaps remain between model simulations of the abundance and distribution of gas-phase and aerosol species and observations, despite improvements in both models and measurements. Key remaining issues include a lack of observational constraints on the vertical distribution of pollutants throughout the troposphere, a paucity of measurements in the Russian Arctic, and uncertainties in the sensitivity of soluble and aerosol species to wet removal, which is very poorly constrained in models. Russell Schnell (NOAA, USA) gave an overview of historic measurements of Arctic air pollution from Barrow and also past aircraft missions, which have the potential to provide an extensive synthesized dataset for model evaluation. The Pan Eurasian Experiment (PEEX) aims to develop a network of research sites across the boreal and sub-Arctic regions of Eurasia to better understand atmospheric chemistry and transport of pollutants, potentially addressing the large gaps in data coverage in this region. PEEX provides an opportunity for expanding measurement quality and coverage within the Russian Arctic, and for developing collaborations between Russian, Asian, European and North American Researchers.

Interactions between Arctic societies and air pollution, and improving knowledge of local pollution sources and interactions with the local environment, were major themes of the workshop. Economic activity in both the Eurasian and North American Arctic is increasing,

leading to more pollution from shipping, resource extraction and processing, and residential emissions. Nazar Kholod (PNNL, USA) presented new findings on sources of black carbon in Russia, demonstrating an important contribution from the mining industry to transport sector emissions in Murmansk region. The impact of local emissions can be hyper-local, with very strong local concentrations in the stratified Arctic troposphere. Community-based monitoring is an approach that may improve understanding of local air quality and its impact on Arctic populations, but Stanley Edwin of the Council of Athabascan Tribal Governments emphasized that local people must be deeply involved in planning and designing measurement programs, and must participate in analysis and interpretation as well. Susan Anenberg (Environmental Health Analytics) discussed methodologies for estimating the health impacts of air pollution on local Arctic populations, and some of the challenges associated with producing such estimates, which at present do not exist specifically for the Arctic region. A lively open discussion explored the possibility of establishing new measurements in an Arctic urban environment to better understand some of the unique processes that may control the formation and processing of air pollution under heavily polluted, cold, dry conditions.

A number of presentations explored response of natural sources of trace gases and aerosol to Arctic change, with relevance for climate feedbacks in the Arctic. Andreas Stohl (NILU, Norway) presented new modeling of Arctic dust, highlighting important sources in Eastern Canada and Kamchatka as well as Iceland. Jinqui Mao (U Fairbanks, Alaska) presented work using satellite observations and modeling to examine recent changes in biogenic volatile organic compound emissions from high latitude vegetation, and discussed possible climate drivers for these changes.

The final theme of the Workshop was planning for and discussion of a nascent field and modeling experiment, IMPAACT, to examine pollutant transport from East Asia to the North American Arctic. This project, planned for spring 2021, would involve airborne, ground-based and ship-borne measurements across the Pacific Ocean from the South China Sea to Alaska and western Canada. A focus of the project is the effect of wet removal during transport on pollutant concentrations and speciation as well as aerosol-cloud interactions. Modeling on a range of scales is essential to guide the project design, provide in-field forecasting, and to analyze and interpret the observations. There was keen interest in this project from a number of Workshop participants from Asia, Europe and North America. The IMPAACT Steering Committee will maintain close communication with the PACES community as planning for this project develops.