Title: Arctic Air Pollution and Society

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Rapid changes to and complex interactions within the Arctic environment due to global warming and socio-economic drivers mean that there is an urgent requirement to improve understanding about sources of Arctic air pollutants, which contribute both to, and are driven by, Arctic environmental and climate change. Air pollutants include aerosol particulate matter, such as black carbon, and trace gases such as tropospheric ozone. These have deleterious effects on regional air quality (human health) and ecosystems. These pollutants are emitted as a result of anthropogenic activities and from natural sources, such as boreal vegetation fires. Local sources of Arctic air pollution from activities like oil/gas extraction and shipping are already affecting atmospheric composition and wintertime air pollution from increased combustion for heat and power is affecting Arctic communities, particularly in urban areas. Local anthropogenic emissions may increase in the future due to increasing opportunities for development in a warming Arctic, while natural emissions such as fires may increase as a result of changes in climatic conditions or human activity. Improved quantification of the relative contributions of different pollutant sources is needed to

provide a sound scientific basis for sustainable solutions and adaptive strategies. Despite these issues, severe deficiencies exist in our understanding of local pollution sources, and how these may respond to future climate and socioeconomic change (*Schmale et al., 2018*). A lack of observations at high latitudes presents a major challenge to advancing our understanding and hinders our ability to make credible near- and long-term projections of future Arctic environmental impacts. This Short Statement describes activities being spun up as part of the international initiative - air Pollution in the Arctic: Climate Environment and Societies (PACES) (see www.igacprojects.org/PACES, *Arnold et al., (2016)*), endorsed by the International Global Atmospheric Chemistry project (under Future Earth) and the International Arctic Science Committee (IASC/Atmosphere WG). PACES has the overall goal to promote and establish new observational efforts to reduce uncertainties in process-level understanding and improve predictive capability of impacts related to Arctic air pollution. This Statement issues relevant to sub-themes 1: Observing System Design, 2: Observing in Support of Adaptation and Mitigation) and 5: Arctic Observations in the context of Global observing initiatives. PACES focuses on both wintertime and summertime local air pollution with an emphasis on better quantifying sources and processes responsible for enhanced levels of air pollutants which affect human health and ecosystems.

A particular area of focus is urban air pollution in wintertime. Previous studies of urban sensitivity to climate change have mostly focused on lower and mid-latitude cities, and rarely consider northern/Arctic cities. Important issues that require in-depth study include the effects of urban meteorology, such as heat islands, and the interactions of stably stratified boundary layers with wintertime urban air pollution episodes in a changing climate. In addition, as urbanization progresses and life styles

globalize, the need for agricultural and industrial products increases. This poses environmental challenges in terms of local food production (unique ecosystems) and transportation to the Arctic (infrastructure development). Due to cold weather conditions in Arctic settlements, high-energy consumption is typical, particularly in winter. With limited potential for renewable energy generation, adopting sustainable lifestyles is a particular challenge. Changes in the high latitude terrestrial environment include observed increases in temperature extremes and precipitation patterns, which are leading to increasing trends in summertime boreal wildfires. Recent years (including 2019) have seen unprecedented fire activity at Arctic latitudes, leading to unhealthy air quality in high latitude communities, including smaller settlements and cities. The scale of such impacts and how these may change in future decades under a warming climate are poorly understood at present.

In order to understand the social-environmental effects of urbanization and changes in natural emissions such as fires under rapid climate change, a multi-scale approach, encompassing both natural and social science is necessary. An approach under active development is the so-called “Twin City" approach which is used already in the mid-latitudes and more recently in the tropics. As part of a joint effort involving the Pan Eurasian Experiment (PEEX), World Meteorological Organization’s Global Atmospheric Watch Urban Research Meteorology and Environment project (WMO-GURME) and PACES, pilot studies are being proposed in several Arctic cities. Building on existing initiatives, a trans-disciplinary approach is being developed as a partnership between northern communities and natural/social scientists with the aim to expand and exchange knowledge about Arctic air pollution, through, for example, community-based observations, making use of recent technical developments and also

benefiting from local community knowledge to improve assessment of air pollution risks and explore sustainable solutions in northern communities.

References

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