Port Settlement Fog and Air Quality Study in Iqaluit

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Background and Motivation

Coastal communities experience unique atmospheric chemistry due to the interactions of human emissions and natural marine sources such as marine biological activity and sea spray. This is particularly true of northern ports such as Iqaluit where the background atmosphere is very clean, possibly allowing even small emissions to dominate the atmospheric chemistry. Coastal communities are also often frequently influenced by low visibility due to fog advected from nearby bodies of water, affecting marine and air transportation. The formation, visibility and dissipation of this fog can be influenced by the properties of the aerosol particles suspended in the atmosphere such as number, size and chemical composition.

This project aims to study the unique chemistry of the atmosphere in Iqaluit, especially the interactions between ocean and human emissions in a clean background, as well as the properties of any fog events that occur and their relationship to the aerosol particles. These observations can be used to constrain air quality models, such as GEM-MACH operated by Environment and Climate Change Canada (ECCC), and will also be relevant for human exposure and climate studies.

Methods

Measurements will be conducted for approximately 30 days in the window of July to September 2021 at the existing Iqaluit meteorological supersite that is part of the Canadian Arctic Weather Science project conducted by Environment and Climate Change Canada at the Iqaluit Airport southwest of the runway. Most equipment will be housed inside a temporary 10' x 6' trailer that will be installed near the existing meteorological equipment on the site for the duration of the study. Two additional instruments will be operating outside of the trailer. Their exact locations are to be determined but will be within 100 m of the trailer. The exact dates of the study are yet to be determined and will depend on whether it is possible and safe to travel.

Instruments deployed will measure criteria pollutants (O3, NO, NO2), and other gases relevant for climate and air quality, like CO2, CH4 and HCl, as well as properties of the particulate matter (concentration, size, chemical composition and hygroscopicity). A complete list of the proposed instruments is listed in the table below.

Instrument	Property
Fourier Transform Infrared Spectrometer	CO2, CH4, CO, volatile organic compounds and other trace gases

Medium Volume Sampler	Aerosol chemical composition
Scanning Mobility Particle Sizer	Aerosol size distribution
Aerodynamic Particle Sizer	Aerosol size distribution
Aerosol Chemical Speciation Monitor	Non-refractory aerosol chemical composition
Cloud Condensation Nuclei Counter	Cloud condensation nuclei
Gas phase instruments	O3, NO, NO2, HCl

Expected Results

Our observations will provide extensive information about the chemical and physical properties of the gases and particles in the surface atmosphere. These results will be not only useful for determining the air quality of Iqaluit but also in improving our understanding of the type of chemical reactions that occur in northern settlements. Although rare, the visibility of any fog events that occur during the study will also be studied in relation to the background particles. These latter results may also be studied further through modelling to better understand summer fog formation and the controls on visibility.

While routine measurements have been made in the past at Iqaluit, this would be the first time that the atmospheric chemistry will be characterized in such detail, especially for the aerosol particles. Although previous measurements suggest that the air quality in Iqaluit does not present a health concern, we expect to learn whether improvements can be made and better understand the interactions between urban and marine settings in the North. This would allow models to determine how changes in the future due to human activities and/or climate will impact the air in Iqaluit. Our measurements will also complement the existing ECCC meteorological observations that currently measure the vertical structure of temperature, wind and water vapour above Iqaluit.