The Arctic is rapidly changing due to rising temperatures and sea ice loss. Changes in the Arctic are inducing large feedback effects on the atmosphere and ecosystem, dramatically increasing the effects of climate change. The Arctic environment gathers much of the pollution emitted from the mid-latitudes, particularly in the wintertime when air pollution is transported to the Arctic. Pollution is transported to the Arctic, increasing the effects of climate change.

Aerosols are small particles (typically 0.005 – 10 microns in diameter) of liquid or solid matter suspended in the atmosphere. These can be composed of many things including sea salt, soot, sulfuric acid, and/or oxidized organic compounds. These particles play important roles in atmospheric chemistry by providing reactive surfaces for heterogeneous reactions with trace gas species in the air. They also contribute to radiative forcing by absorbing or scattering radiation and serving as nuclei for the formation of cloud droplets and ice crystals. In the springtime, haze layers formed by transport and photochemistry of anthropogenic pollution are visible in the Arctic. The aerosol particles of this haze are not well characterized, making modeling their impact more uncertain. Determining the source(s) of the aerosol particles and their size distribution will improve our understanding of the complex chemistry of the Arctic environment and allow us to better predict future changes.

Materials and Methods

- The Purdue Univ. Airborne Laboratory for Atmospheric Research (ALAR) flew vertical profiles over the tundra and sea ice as a part of the BROMEX field campaign.
- A GRIMM Portable Aerosol Spectrometer (Model # 1.109) measured particle size and concentration through an inlet in the front of the plane using 21 divisions in diameter from 0.25μm to 6.5μm. In order to correct for possible inlet loss, size-resolved transmission was modeled, and concentrations were corrected accordingly.
- NOAA HYSPLIT backward air mass trajectory modeling used meteorological data to determine the most probable path a trajectory modeled, and transmission was modeled, and enhancements near 300m were mostly seen above 300m. The layers ranged from 20 – 200m in depth and normally contained near 1000 particles/cm3, but enhancements near 10000 particles/cm3 were observed.
- The mean particle diameter mode for both enhanced and background particle concentrations was near 250nm. The aerosol particles of this haze are not well characterized, making modeling their impact more uncertain. Determining the source(s) of the aerosol particles and their size distribution will improve our understanding of the complex chemistry of the Arctic environment and allow us to better predict future changes.

Introduction

The Arctic is rapidly changing due to rising temperatures and sea ice loss. Changes in the Arctic are inducing large feedback effects on the atmosphere and ecosystem, dramatically increasing the effects of climate change. The Arctic environment gathers much of the pollution emitted from the mid-latitudes, particularly in the wintertime when air pollution is transported to the Arctic. Pollution is transported to the Arctic, increasing the effects of climate change.

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Results and Discussion

Background Aerosol

- The background air near Barrow, Alaska was characterized by low (~100 particles/cm3) particle concentrations and long transport over the Arctic sea ice, which is consistent with previous observations of Staebler et. al. at Alert, Canada.

Enhanced Aerosol

- Several instances of enhanced layers of aerosol were observed during BROMEX. These enhanced layers had up to 10 times the concentration of background and were mostly seen above 300m. The layers ranged from 20 – 200m in depth and normally contained near 1000 particles/cm3, but enhancements near 10000 particles/cm3 were observed.
- The mean particle diameter mode was similar to background profiles, with the majority of the particles having a diameter near the instrument detection limit of 250nm.
- The air masses were characterized by faster transport, with no more than 5 days over sea ice, from anthropogenic sources in Russia. Specific sources where the particles may have originated are still being investigated. This is consistent with previous springtime observations by Staebler et. al. in Alert, Canada.

Conclusions and Future Work

- Aerosol around Barrow was primarily composed of submicron Arctic haze aerosols, likely sulfate mixtures, rather than supermicron sea salt particles. Future comparisons with filter measurements of particle chemistry will investigate this hypothesis. The mean particle diameter of all measurements was near 250nm.
- The background aerosol concentration is about 100 particles/cm3 with enhancements (1000-10,000 particles/cm3) present aloft, consistent with Arctic haze layers. Further work characterizing the chemical and physical properties of the haze aerosols are needed to better understand atmospheric processes.
- To better understand aerosol-halogen interactions, aerosol size distributions will be compared with BrO measurements by the University of Heidelberg on ALAR using DOAS (Differential Optical Absorption Spectroscopy). Possible shifts in particle diameter mode with BrO enhancements will be investigated.

General Observations

- The mean particle diameter mode for both enhanced and background measurements was ~250nm indicating an aerosol mostly comprised of species accumulated in the atmosphere with a large sulfate component rather than sea salt from ocean spray.
- The majority of the air masses associated with the measured aerosols originated from northeastern Russia, moving along a circular air current just north of Barrow consistent with normal pollution at Alert, Canada.
- No biomass burning events have been identified thus far.
- Ozone was not found to correlate with aerosol particle concentration.

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References