Introduction

- Evaluating Arctic aerosol properties has implications for cloud formation, resulting in impacts on cloud lifetime, precipitation processes, and radiative forcing (Quinn et al., 2008; McFarquhar et al. 2011).
- Further, many remaining uncertainties exist regarding modeled and observed Arctic aerosol properties, thus, a better understanding of aerosol properties and sources in the Arctic is needed.
- Here, we present a comprehensive climatology of aerosol physical, chemical, and optical properties along the North Slope of Alaska at the joint NOAA and DOE ARM Barrow facility. We also investigate the potential for aerosol type (i.e., mineral dust) to influence cloud ice formation using in situ and remote sensing measurements (DeMott et al., 2003).

Aerosol Observations at Barrow

- Aerosol observations at Barrow extend back to 1976. See Table 1 for the complete list of aerosol measurements and where data were accessed.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Instrument/Method</th>
<th>λ (nm)</th>
<th>Size cut (nm)</th>
<th>Agency</th>
<th>Data source</th>
<th>Years available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle number concentrations</td>
<td>Smolow Mobility Particle Sizer (SMPS)</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2007 - 2009, 2012 pres.</td>
<td></td>
</tr>
<tr>
<td>Condensation particle Counter (PC)</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 1997 - pres.</td>
<td></td>
</tr>
<tr>
<td>Particle size distributions</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
<tr>
<td>Absorption coefficient (α)</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
<tr>
<td>Scattering coefficient (g)</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
<tr>
<td>Aerosol optical depth (AOCD)</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
<tr>
<td>Total mass concentrations</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
<tr>
<td>Soluble ion concentrations</td>
<td>GMD</td>
<td>1-10</td>
<td></td>
<td>GMD</td>
<td>GMD 2006 - pres.</td>
<td></td>
</tr>
</tbody>
</table>

*Some years do not have data from all months. Includes quality-controlled and validated data only.

Evaluating the Impact of Atmospheric Dust on Cloud Ice

- Here we combine information from NOAA filter samples with ARM remote sensors and NWS and ARM radiosondes to evaluate whether there is a noticeable increase in in-cloud ice amount for time periods with dust loading. Dust loading is based on the mass concentration of non-sea salt magnesium and non-sea salt calcium. Cloud top ice super saturation is determined using radiosonde data, and cloud top height and ice water content are derived from MCMR measurements. Cases are limited to those with cloud tops lower than 2 km and cloud top temperatures below 270 K. The distributions illustrate cases with no dust (lighter colors) and those with dust loading (darker colors), and are separated into times when the cloud top ice supersaturation was found to be lower than 1 and times when cloud top supersaturation exceeded 1. Next steps involve ensuring that all radiosonde measurements are dry bias corrected and including the maximum in-cloud ice supersaturation instead of only the cloud-top value.

Seasonal Disconnect between Surface and Column Aerosol Optical Depth

- In situ surface aerosol measurements can provide a continuous and detailed record of variability in physical, chemical, and optical properties and the relationships among them. However, in the stratified Arctic atmosphere, significant effects from aerosols aloft may be overlooked.

Summary

- The properties and sources of aerosols at the surface varied each month, indicating seasonally disparate aerosol impacts on surface radiation and cloud formation effects.
- Winter/spring: Long-range transported submicron sea salt, mineral dust, industrial metals, pollution, and biomass burning, concurrent with higher concentrations of total submicron mass, number, and enhanced extinction
- Summer: Relatively clean air, with influences from small, regionally-generated biogenic aerosols concurrent with availability of sunlight and open water.
- Fall: Relatively clean air persists, but now with influences from regionally-generated supermicron sea salt, supporting the highest single scattering albedos.
- However, the seasonality of aerosols above the boundary layer is shifted, indicating different sources aloft versus at the ground.
- Preliminary results suggest cloud ice amount is potentially correlated to mineral dust observed at the surface under similar atmospheric conditions, although more work is needed.
- Results such as these could be used to constrain models by providing detailed information on the types of aerosols present in the Arctic.

References


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