A comprehensive climatology of Arctic aerosol properties on the North Slope of Alaska

Jessie M. Creamean, Gijs de Boer, Matt Shupe, Allison McComiskey
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17 – 19 Nov 2015
## Aerosol Measurements at Barrow

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Other measurements exist from field campaigns, these are continuous and long term. Data available through NOAA GMD and DOE ARM.
Background on Arctic Aerosols at Barrow

- Polissar et al.: **CN, scattering, AOD**
  - 1977-1994
- Quinn et al.: **chemical and optical properties**
  - 1997-1999
- Iziomon et al.: **size and absorption**
  - 1998-2003
- Quinn et al.: **chemistry**

• Pollution aerosols and submicron sea salt in winter/spring

• Supermicron sea salt, biogenic emissions, and CN high in summer, with some influence from midlatitude fires

• These studies used some combination of measurements, but not all that are currently available

• Aerosol climate impacts vary depending on properties, thus it is important to look at chemistry, size, number, mass and optical properties
Seasonal Trends: Mass vs. Number

- **Submicron mass** highest during haze
  - Pollutants, dust, biomass burning, SS

- **Submicron number** highest in spring into summer
  - Suggests the spring haze is worse than the winter (climate impacts in spring)
  - Due to small transported haze particles AND biogenic

- **Supermicron mass** highest in fall, secondary peak in spring
  - SS in fall, dust in spring

- **Supermicron number** highest in late summer and during haze
  - SS starts around here... why does not continue into fall?
  - Dust in spring

- **Number and mass follow very different seasonal trends.**
- **Mass:** important for deposition on sea ice.
- **Number:** important for clouds and radiation.
Seasonal Trends: “Haze” Aerosols

- **Pollutants** highest during haze, concurrent with $\sigma_a$ and $\sigma_s$.

- **Mineral dust** markers highest in spring, earlier than midlatitudes.

- **Biomass burning** markers highest depending on size:
  - Submicron peak in winter
  - Supermicron peak in late fall/winter

Pollution, mineral dust, and biomass burning contribute to haze aerosol extinction, number, and mass.
Seasonal Trends: Sea Salt Aerosols

- Submicron sea salt (SS) highest in winter, concurrent with largest submicron mean size.
  - Suggests LRT

- Supermicron sea salt (SS) highest in fall, when open water is exposed, concurrent with largest and most certain single-scattering albedo ($\omega_o$).

- Small sea salt indicate transport with pollutants.
- Larger sea salt generated mechanically during open ocean, contribute to high number and mass.
Seasonal Trends: Biogenic Aerosols

**Submicron MSA**
- Highest in summer, when the Ångström Exponent is highest (= smaller $D_p$).
- Chlorophyll production is highest.
- Sea ice is diminishing, exposing open water.
- Sunlight is available for biological production.
- Smallest mean sizes are observed.

Biogenic activity in summer with most sunlight, creating large number concentrations of small particles.
Conclusions

- Haze (winter + spring) = ↑ extinction, ↑ pollutants, dust, biomass burning, submicron sea salt, ↑ submicron number, ↑ submicron mass, ↑ submicron size

- Summer = ↑ bio emissions (chlorophyll and MSA), ↓ size, ↑ submicron number, ↑ Ångström Exponent

- Fall = ↑ supermicron SS, ↑ supermicron mass, ↑ supermicron number (late summer/early fall), ↑ single-scattering albedo, ↓ Ångström Exponent

- The different aerosol sources contribute to number and mass, which have disparate seasonality.

- It is important to look at multiple types of measurements to help constrain models.
Future Directions

Next steps:
- Relate seasonal trends to those in meteorology, dynamics, transport sources
- Look at increases or decreases over time, do we see any relationships with regulations?
- Quantitative comparison with previous work

- Oliktok Point, AK will soon have aerosol measurements, very interesting comparison for Barrow!
Acknowledgements

Data acquisition:
- Dr. Patricia Quinn and NOAA PMEL
- DOE ARM
- NOAA GMD

Oliktok Point Site Science Team

Funding: DOE ASR

References: