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

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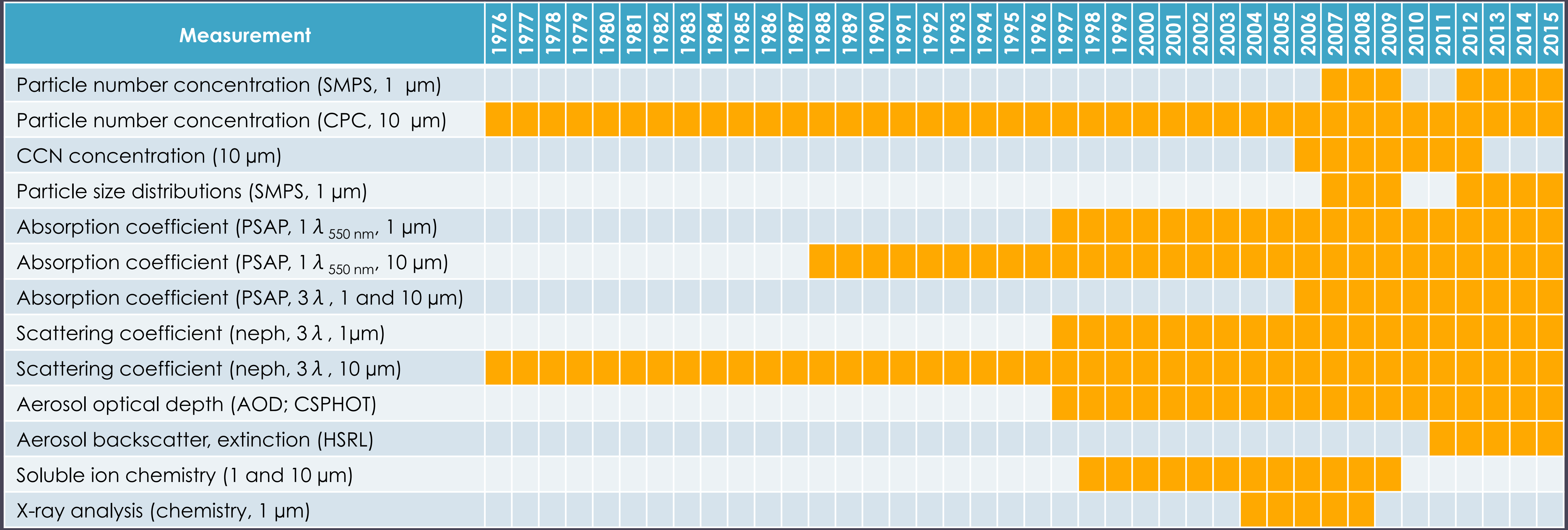
Aerosol Measurements at Barrow



Other measurements exist from field campaigns, these are continuous and long term. Data available through NOAA GMD and DOE ARM.

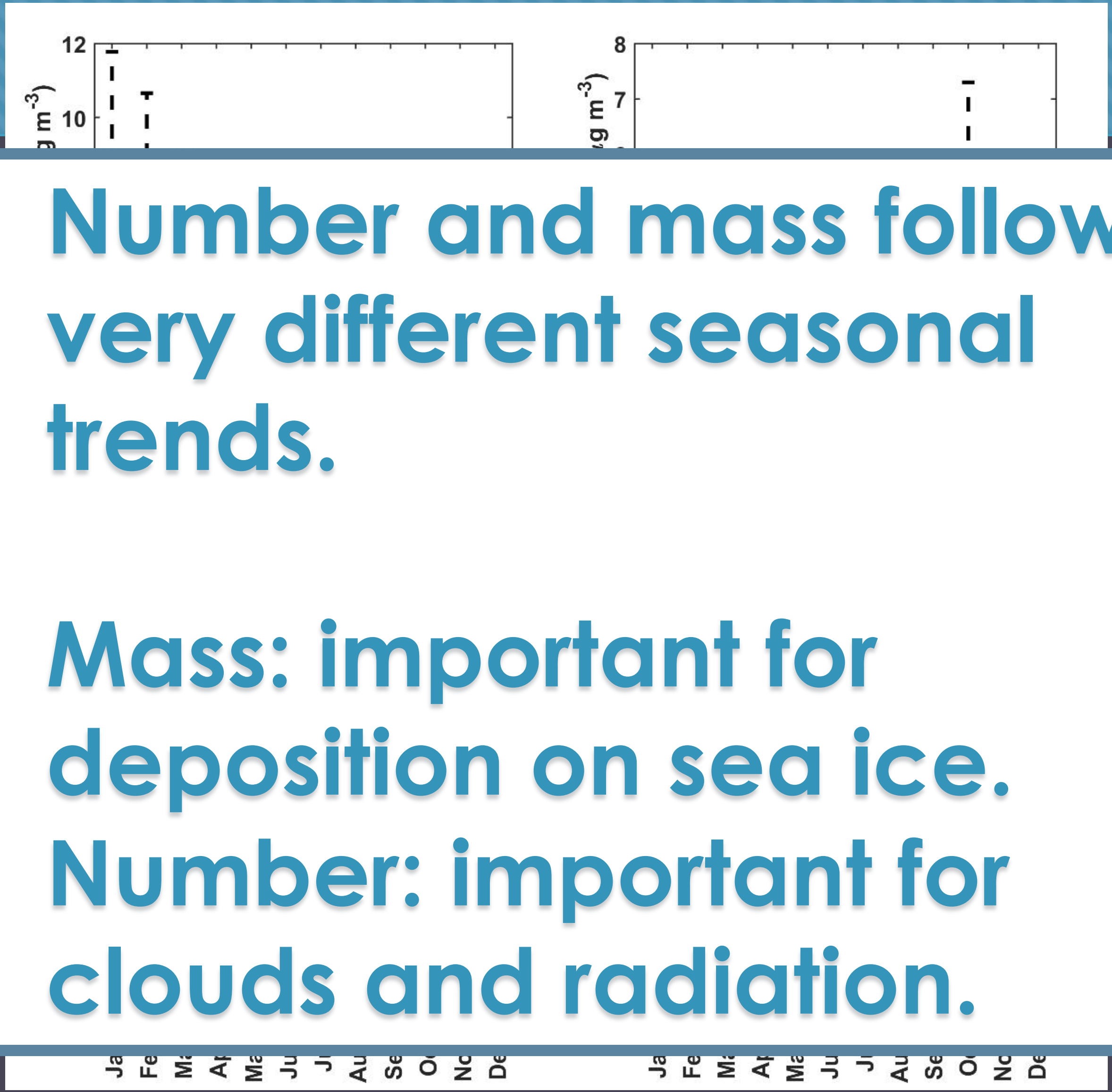
Background on Arctic Aerosols at Barrow

- 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**
  - 1976-1977; 1997-2008

- **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

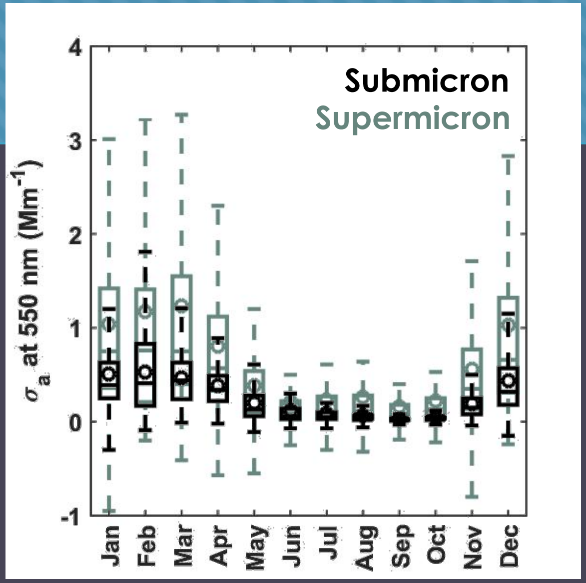
- **Submicron mass** high during haze
  - **Pollutants, dust, biomass burning, SS**
- **Submicron number** highest in spring into summer
  - Suggests the spring haze is worse than th winter (climate impo in spring)
  - **Due to small transported haze particles *AND* biogenic**

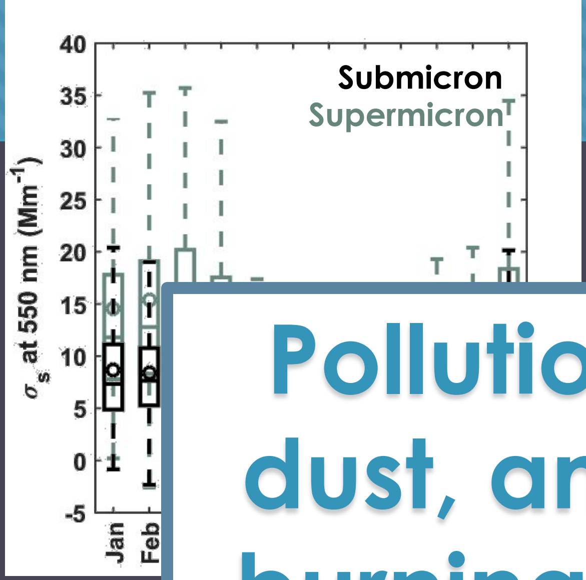


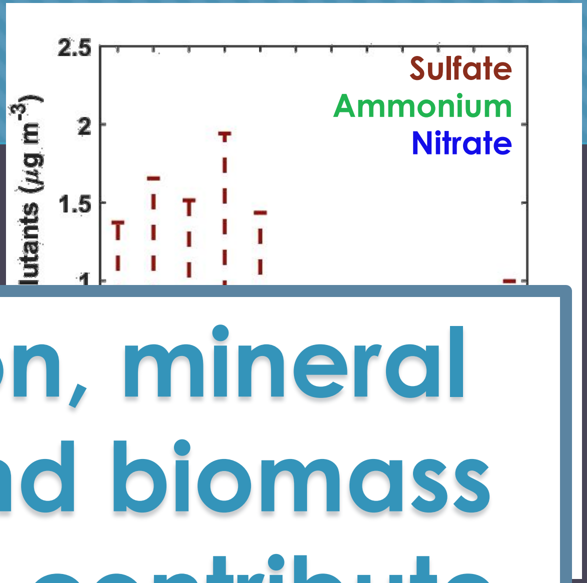
- **Number and mass follow very different seasonal trends.**
- **Mass: important for deposition on sea ice.**
- **Number: important for clouds and radiation.**

- **upermicron mass** ighest in fall, secondary eak in spring
  - **SS in fall, dust in spring**
- **upermicron number** ighest in late summer nd during haze
  - **SS starts around here… why does not continue into fall?**
  - **Dust in spring**

Seasonal Trends: "Haze" Aerosols

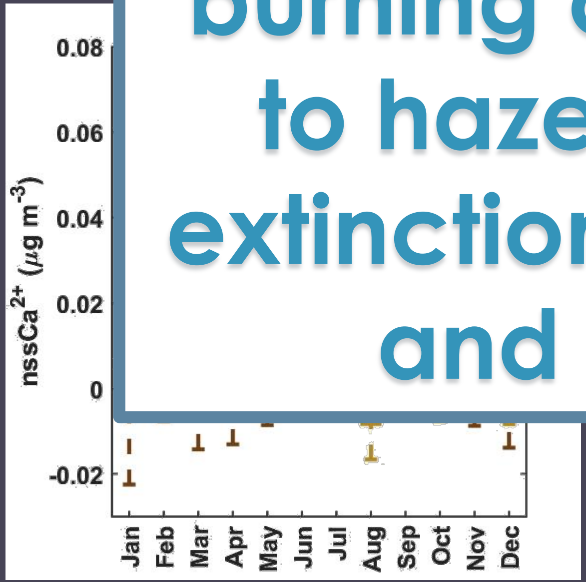


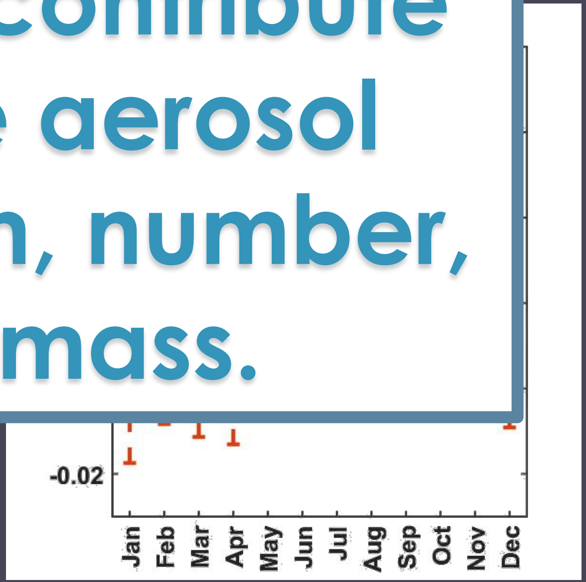




Pollution, mineral dust, and biomass burning contribute to haze aerosol extinction, number, and mass.

- **Pollutants** highest during haze, concurrent with σ_a and σ_s



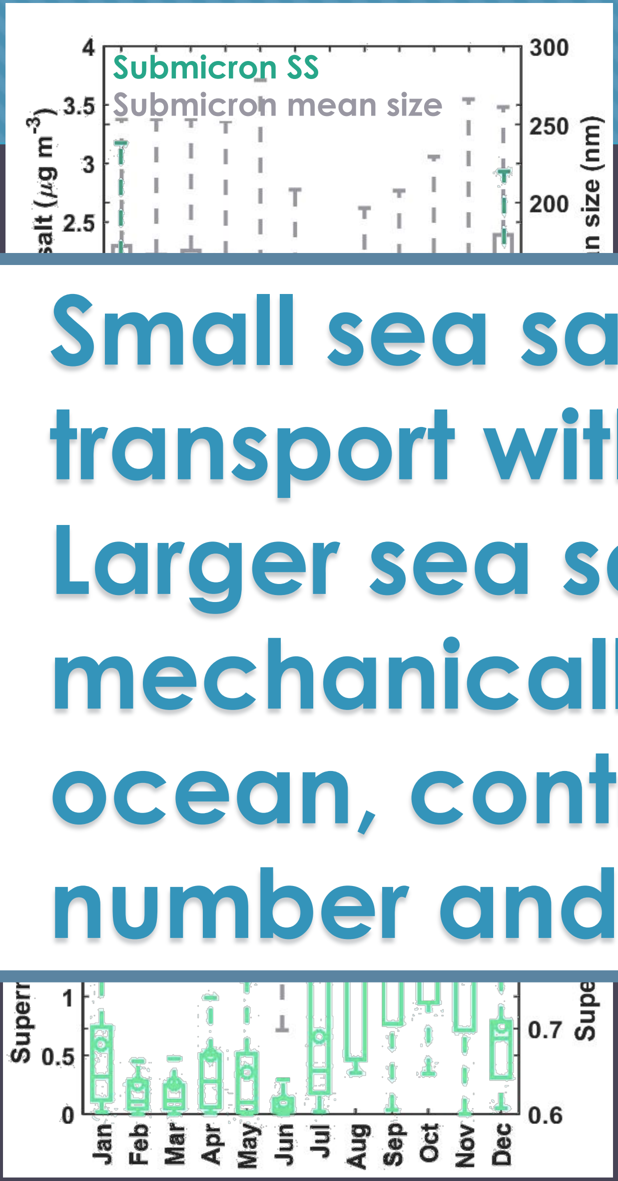


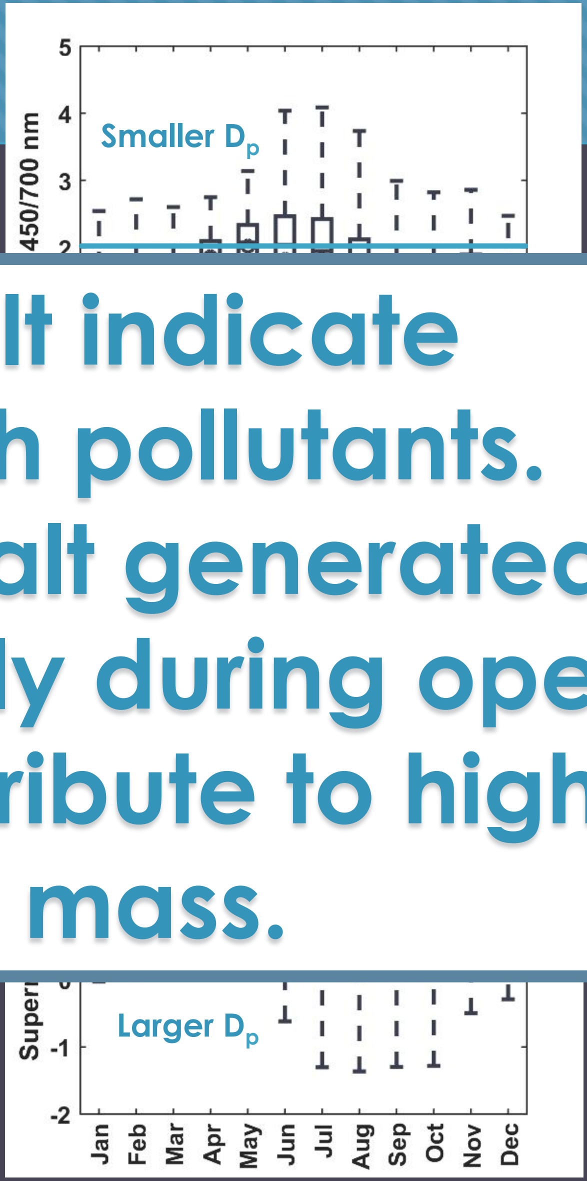
- **Mineral dust** markers highest in spring, earlier than midlatitudes

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

Seasonal Trends: Sea Salt Aerosols

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





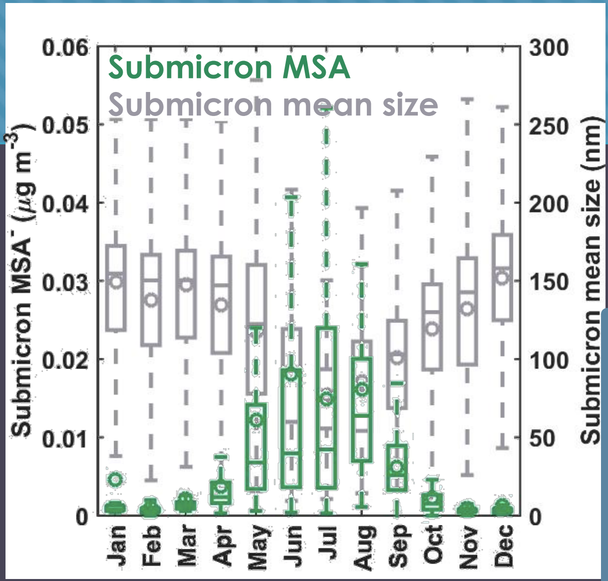
- Also concurrent with lowest submicron **Ångström Exponent (a)** = larger D_p

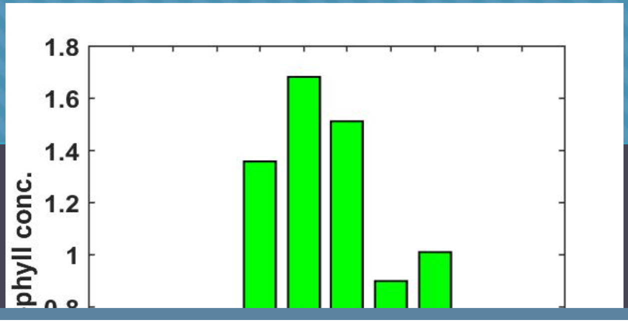
- **Small sea salt indicate transport with pollutants.**
- **Larger sea salt generated mechanically during open ocean, contribute to high number and mass.**

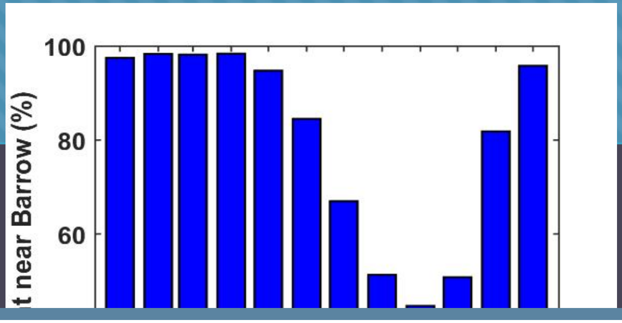
- **Supermicron sea salt (SS)** highest in fall, wh… open water is expose… concurrent with large… and most certain **single-scattering albedo (ω_o)**

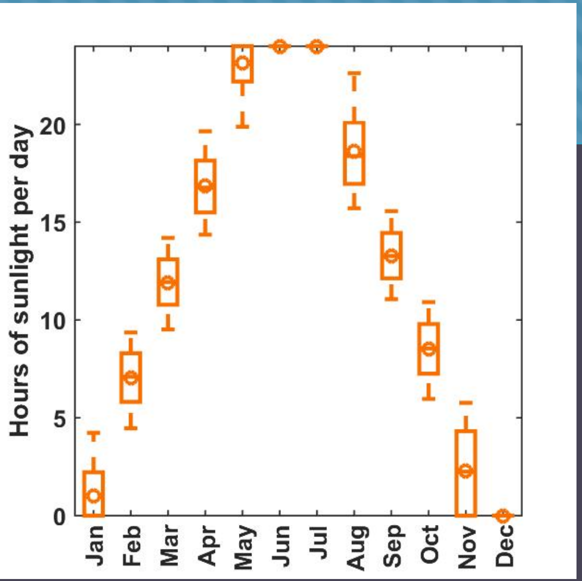
- Also concurrent with lowest supermicron **Ångström Exponent** = larger D_p

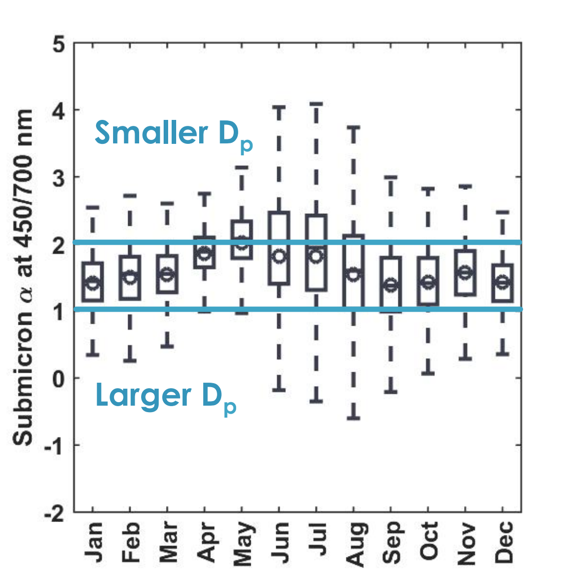
Seasonal Trends: Biogenic Aerosols











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

er D_p)

- **Sea ice** is diminishing, exposing open water
- **Sunlight** is available for biological production
- Smallest **mean sizes** are observed

Conclusions

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

  = LRT influence

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

  = local secondary emissions once sea surface and sunlight are available

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

  = local mechanical emissions from open ocean surface

- 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

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  - Dr. Patricia Quinn and NOAA PMEL
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