Single-particle Source and Chemical Mixing State on the North Slope of Alaska

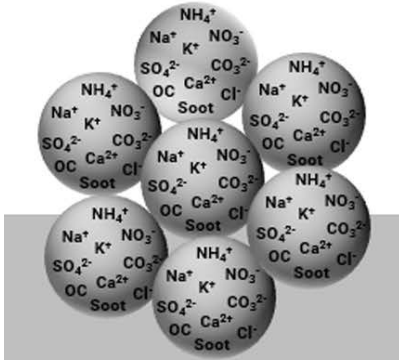
Kerri A. Pratt

University of Michigan

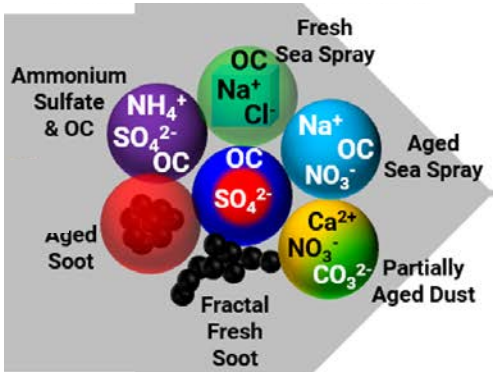
Aerosol Mixing States Define Absorption & Cloud Activation Properties

- Individual particle chemical composition is defined by the particle source and aging processes.
- Mixing state = Distribution of chemical species within an aerosol population.
- Mixing state controls cloud activation properties (CCN and INP efficiencies) and absorption properties. *Highlighted by Jessie Creamean (INP) and Laura Fierce (soot-sulfate absorption) this morning!*

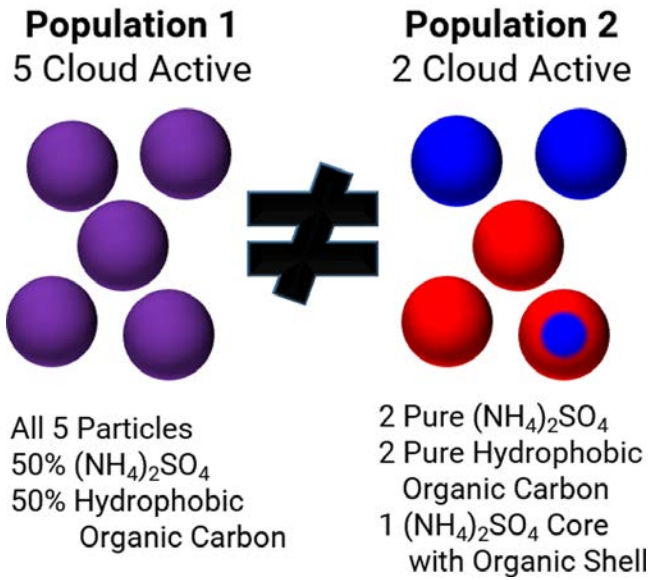
Bulk Composition Measurements



Single-Particle Measurements



Ault & Axson 2017, *Analytical Chem.*



- **Few Arctic aerosol mixing state measurements exist (especially outside of spring-summer), limiting knowledge of aerosol processes.**

Pratt Lab Aerosol Mixing State Field Campaigns on the NSA

Real-time Aerosol Time-of-Flight Mass Spectrometry (ATOFMS):

- **Utqiaġvik:** Sep. 2015
- **Oliktok Point:** Aug. – Sep. 2016

Particle Sampling for Off-line Computer-controlled Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (CCSEM-EDX):

- **Utqiaġvik:** Jan. – Feb. 2014, Aug. – Sep. 2015, Mar. – May 2016,
- **Oliktok Point:** Aug. – Sep. 2016, Mar. – May 2017

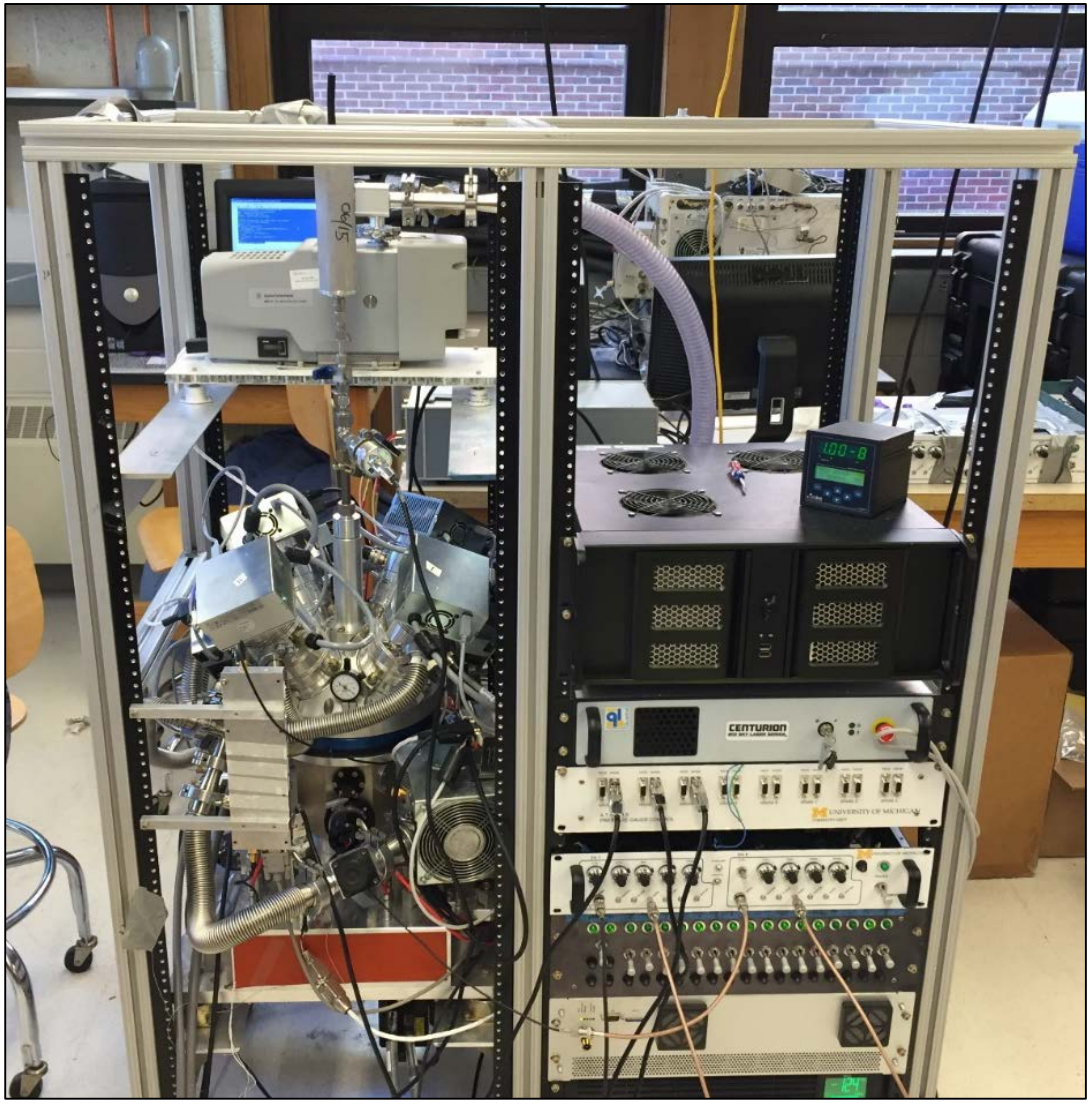
*Collaboration with Andrew Ault (Univ. of Michigan)

ARM NSA Barrow

UIC-Science Barrow

AMF3 Oliktok Point

Single-Particle Mass Spectrometry



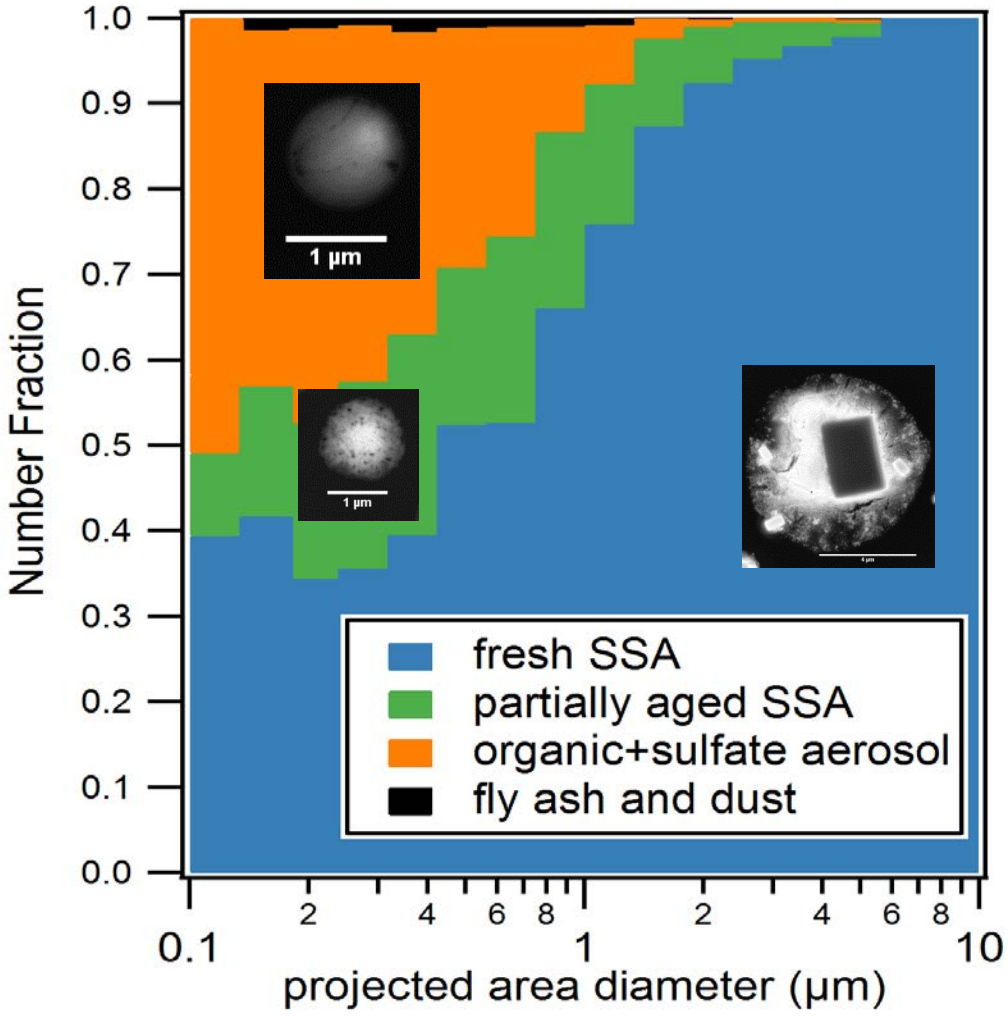
- Real-time measurement of the size and chemistry of individual particles (0.07-1.6 µm, >10 Hz chemical analysis)
- Home-built aircraft aerosol time-of-flight mass spectrometer (A-ATOFMS)

- Both ATOFMS & CCSEM-EDX data can be used to define particle diversity/mixing state parameters for particle-resolved modeling (Riemer, Fierce)

Pratt et al. 2009, *Analytical Chem.*

Utqiagvik, Jan. – Feb.

- **Significant sea spray aerosol contribution in winter**



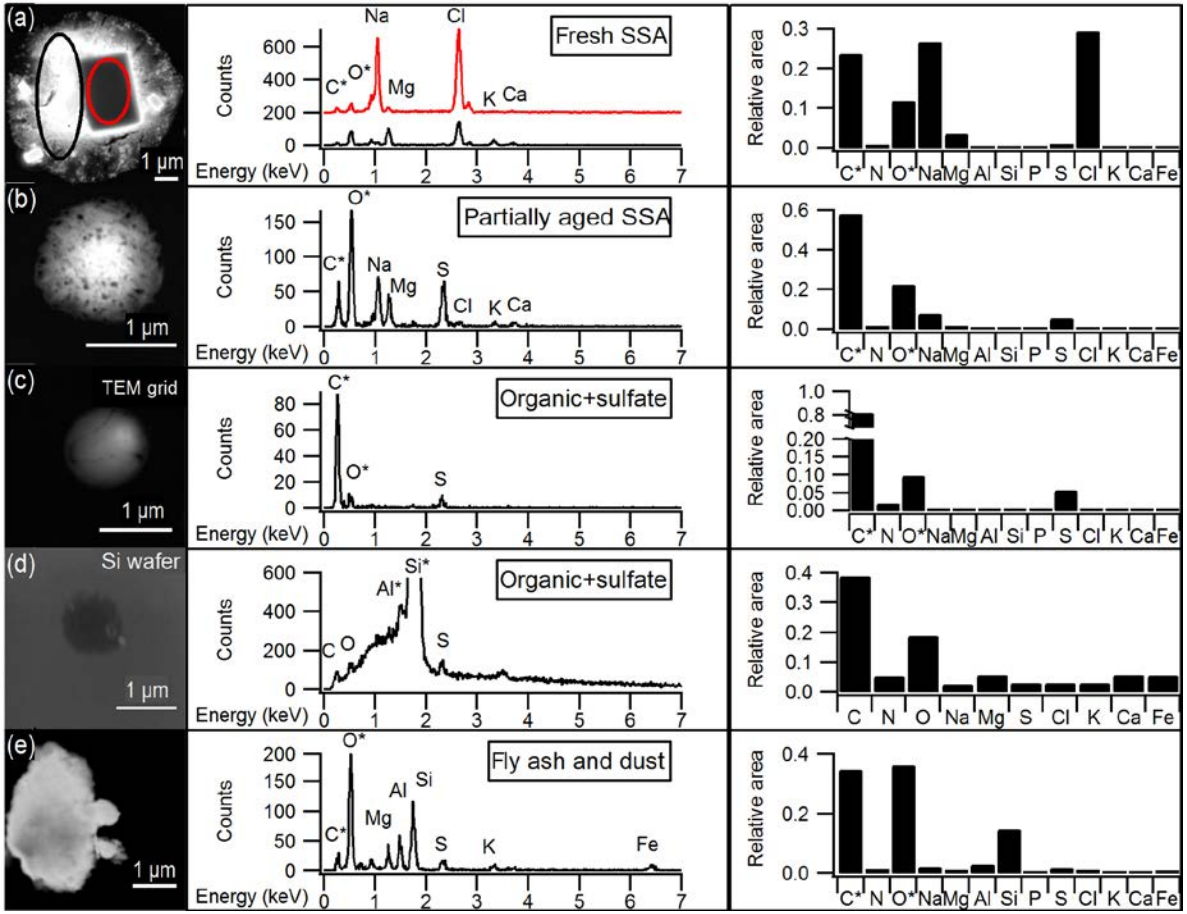
Hajo Eicken, UAF

Sea ice lead emissions of supermicron sea spray aerosol (May et al. 2016, *Atmos. Environ.*)

Kirpes, Bondy, Bonanno, Moffet, Wang, Laskin, Ault, & Pratt. 2018, *Atmos. Chem. Phys.*

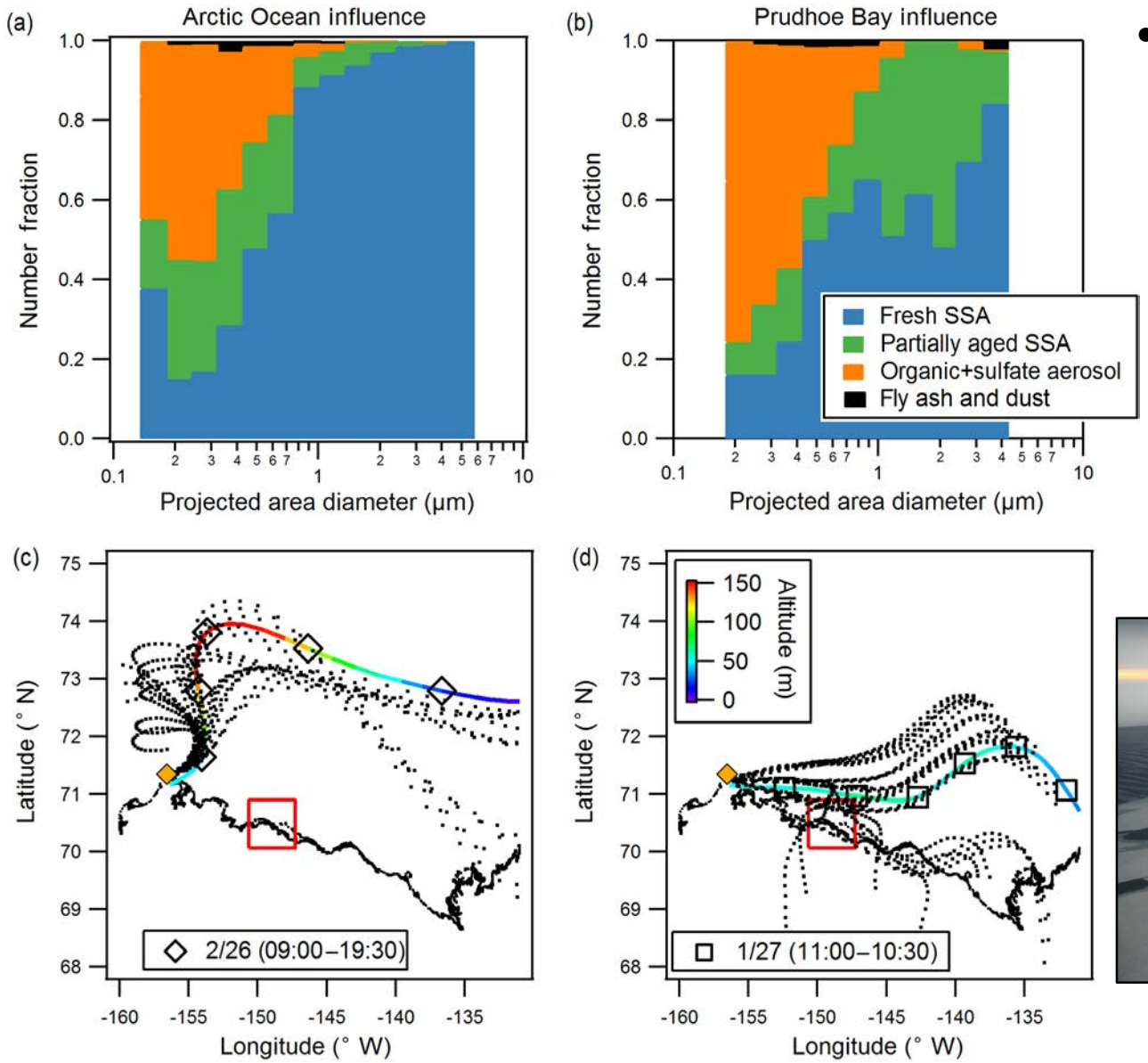
Utqiagvik, Jan. – Feb.

- **Secondary sulfate is internally mixed with sea spray aerosol (SSA) and organic aerosol**
  - No externally mixed sulfate (sulfate-only) particles observed
  - No externally mixed soot particles observed



Kirpes, Bondy, Bonanno, Moffet, Wang, Laskin, Ault, & Pratt. 2018, *Atmos. Chem. Phys.*

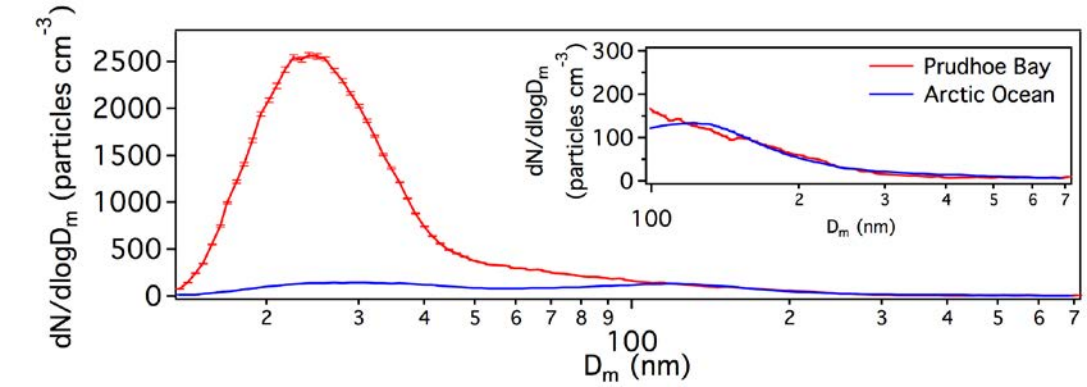
Utqiagvik, Jan. – Feb.

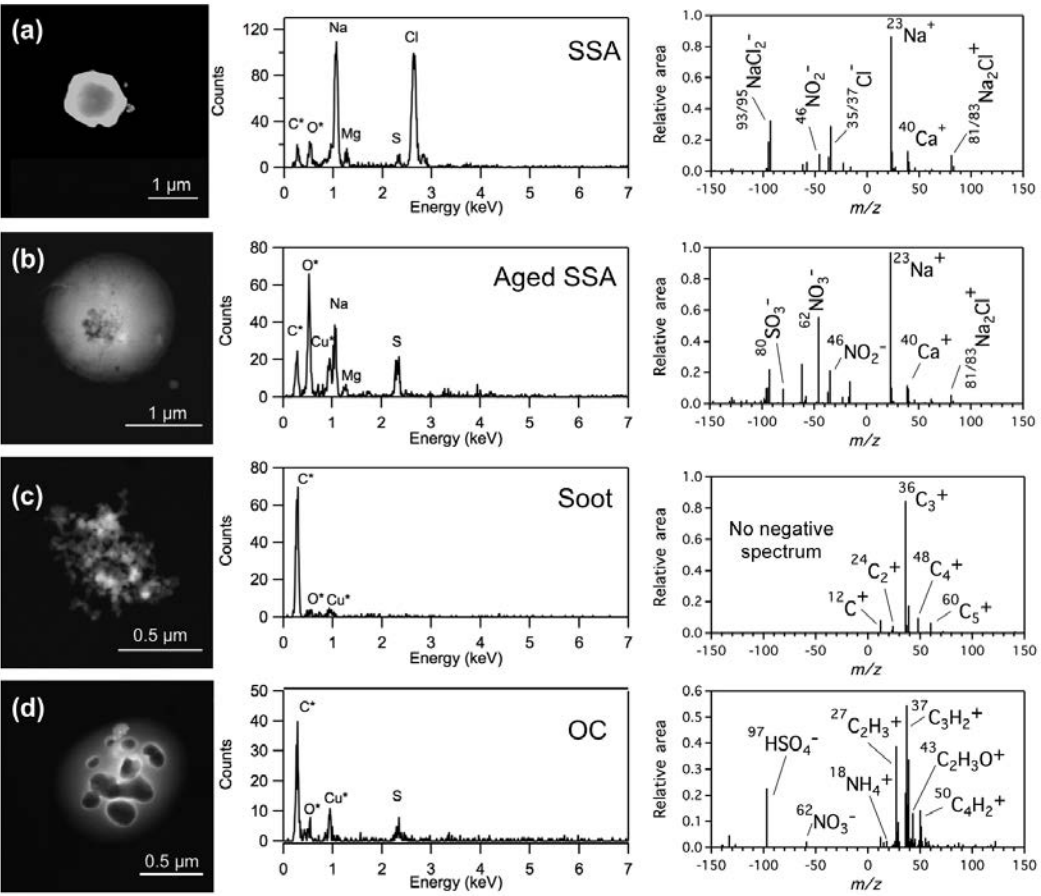


- **Aerosol mixing state changes with air mass influence from the Prudhoe Bay oil fields**
  - Increased sea spray aerosol
  - Increased organic+sulfate particles

Kirpes, Bondy, Bonanno, Moffet, Wang, Laskin, Ault, & Pratt. 2018, *Atmos. Chem. Phys.*

Utqiagvik, Sep.



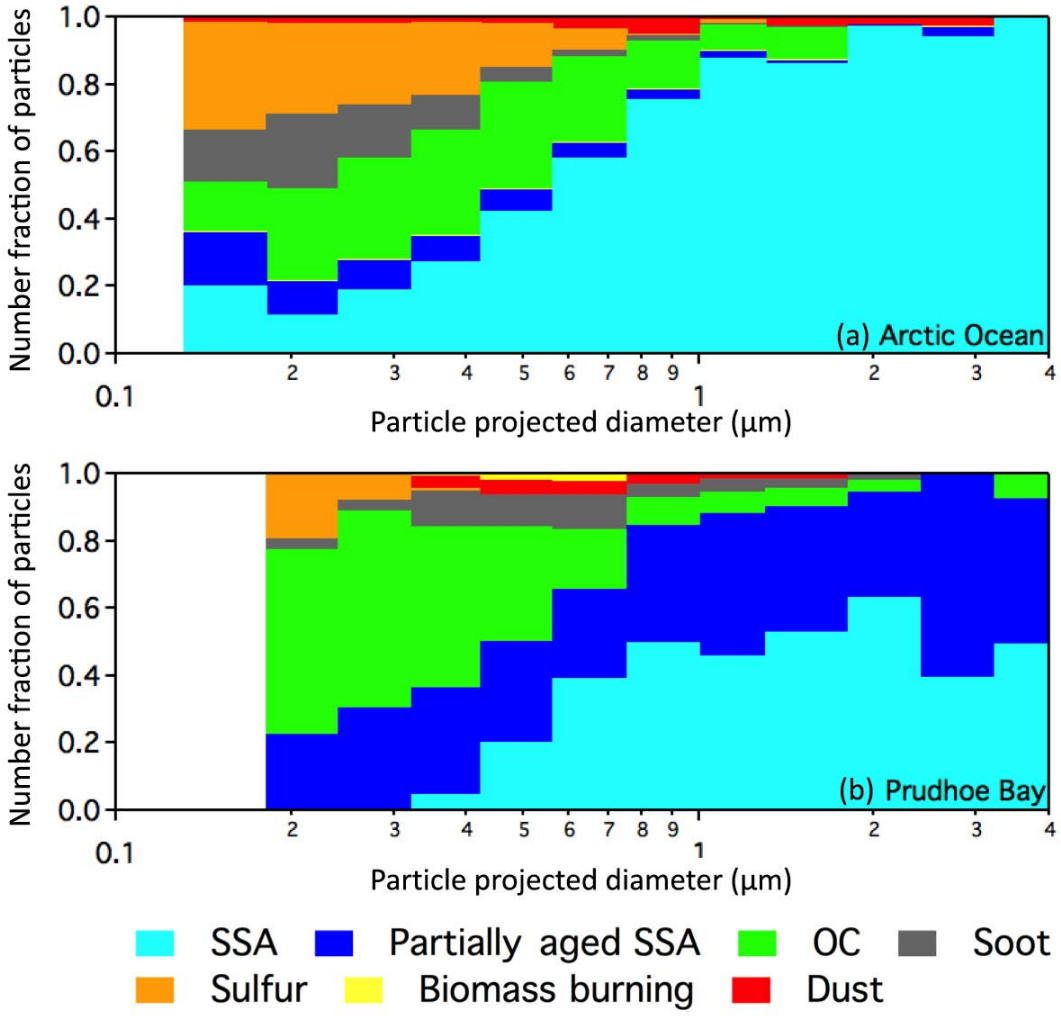


- Increased (ultrafine) particle concentrations with Prudhoe Bay air mass influence
- More frequent aerosol growth events for Prudhoe Bay air masses (Kolesar et al. 2017, *Atmos. Environ.*)

- Coupled CCSEM-EDX with aerosol time-of-flight mass spectrometry for improved source characterization

Gunsch, Kirpes, Kolesar, Barrett, China, Sheesley, Laskin, Wiedensohler, Tuch, Pratt, 2017. *Atmos. Chem. Phys.*

Utqiagvik, Sep.



- Similar to Jan. – Feb. measurements, **increased organic carbon and aged sea spray aerosol observed during Prudhoe Bay oil field air mass influence**
- Note: Externally mixed soot and sulfur particles were observed, unlike in the winter

Gunsch, Kirpes, Kolesar, Barrett, China, Sheesley, Laskin, Wiedensohler, Tuch, Pratt, 2017. *Atmos. Chem. Phys.*

Very Significant Knowledge Gaps

- Very few Arctic aerosol mixing state measurements (most observations in Svalbard and still few)
- NSA aerosol mixing state measurements *extremely* limited outside of spring-summer (only Jan.-Feb. for NSA ground-based measurements)
- Quantitation of aerosol sources during periods of increased INP (very limited INP measurements on the NSA)

Sea ice freeze-up is already extremely delayed in the Chukchi Sea (no knowledge of aerosol mixing state)