



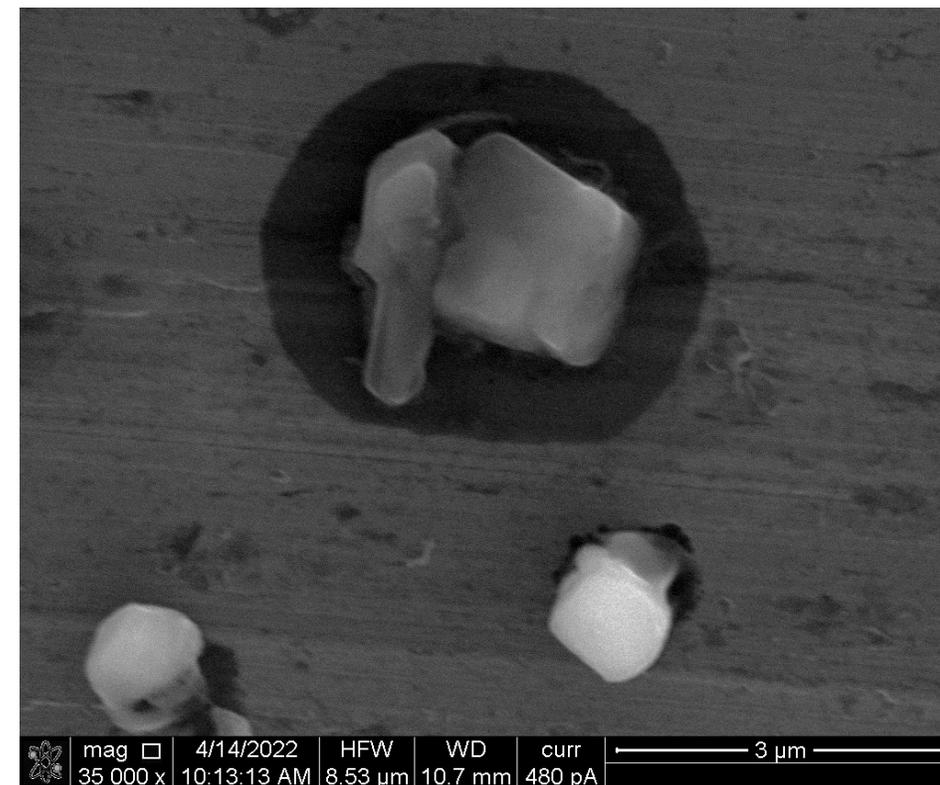
# Individual Atmospheric Particle Sources & Composition during MOSAIC

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<sup>3</sup>Department of Atmospheric Science, Colorado State University



Note: These are initial SEM-EDX analyses following re-opening of microscopy facilities in 2022 (previous restricted access due to COVID).



# Aerosol Sampling during MOSAiC

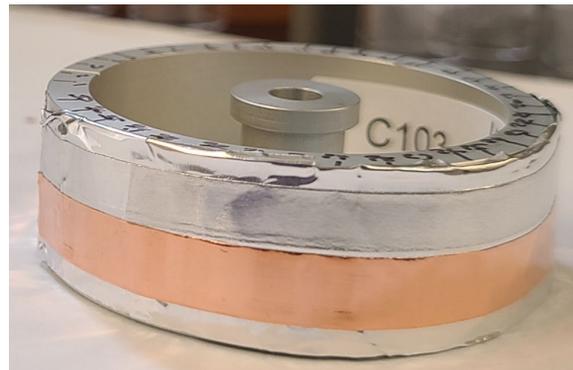


- MOSAiC sampling from Oct. 2019 – Oct. 2020
- Rotating DRUM impactor deployed with daily particle samples in three size ranges:

Stage	Particle aerodynamic diameter ( $\mu\text{m}$ )
A	> 1.15
B	0.34 - 1.15
C	0.10 – 0.34



A single DRUM stage with two different substrates:



Particles collected simultaneously on Al tape for carbon quantitation and Ni/Cu tape for dust identification

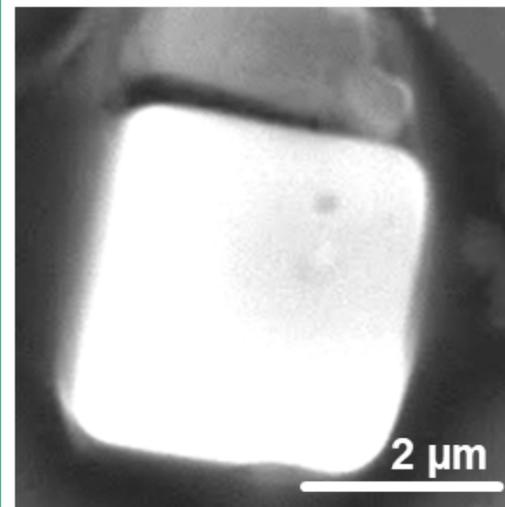
CSU & Michigan DRUM impactors deployed in the ARM container

# Offline Individual Particle Morphology & Elemental Composition via SEM-EDX

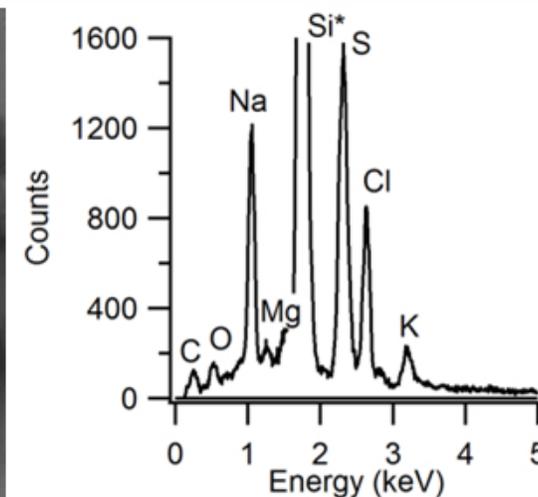


- Scanning electron microscopy (SEM): high resolution single-particle imaging
  - Individual particle size & morphology
- Energy dispersive X-ray spectroscopy (EDX): elemental composition of individual particles
  - Individual particle chemical composition (source identification)
- Computer-controlled (CC)SEM-EDX provides analysis of 100's-1000's of individual particles per sample
  - Provides sufficient statistics for an understanding of the atmospheric particle population

size, morphology



elemental composition



Scanning electron microscopy with energy-dispersive X-ray spectroscopy (**SEM-EDX**)

Check out our (Pratt Lab) previous Arctic aerosol papers using this approach!

Kirpes et al. 2018, *ACP*

Gunsch et al. 2017, *ACP*

Kirpes et al. 2019, *ACS Central Sci.*

Kirpes et al. 2020, *Environ. Sci.: Process. Impacts* Kirpes et al. 2022, *PNAS*

# Preliminary Analyses

## SEM-EDX data for samples collected on:

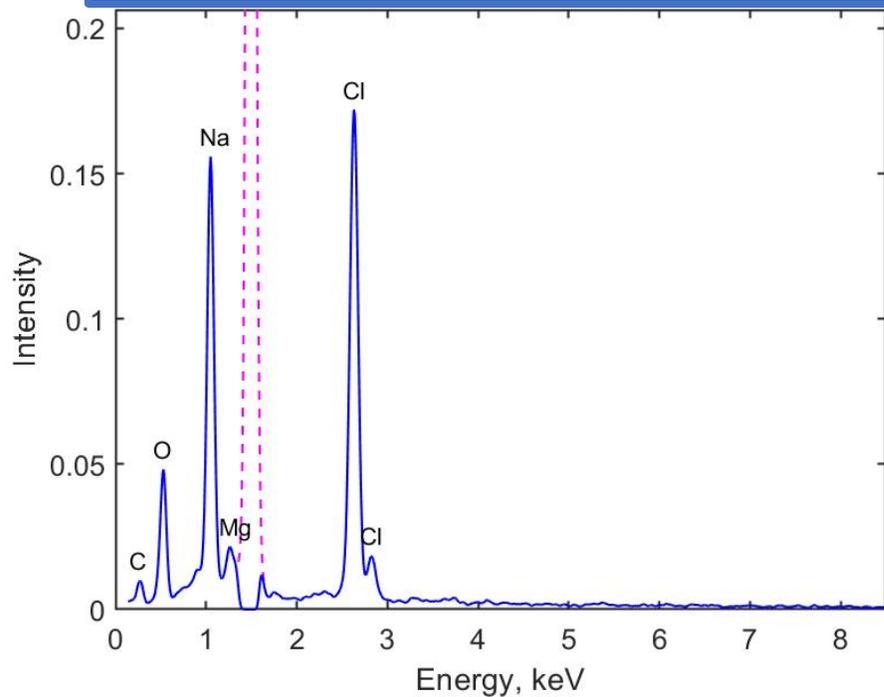
- November 11, 12, 16 (2019)
- December 7,8 (2019)
- March 19 (2020)
- April 15 (2020)
- May 1 (2020)
- June 20, 21, 25 (2020)

## Particle types observed during MOSAiC

- Sea salt/spray aerosol (main focus)
- Organic-rich
- Mineral dust
- Fly ash
- Soot
- Primary biological particles

# Sea Spray Aerosol

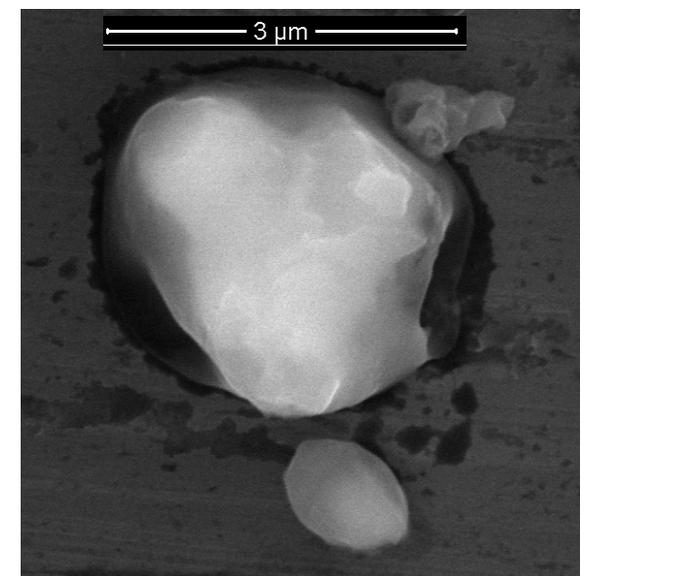
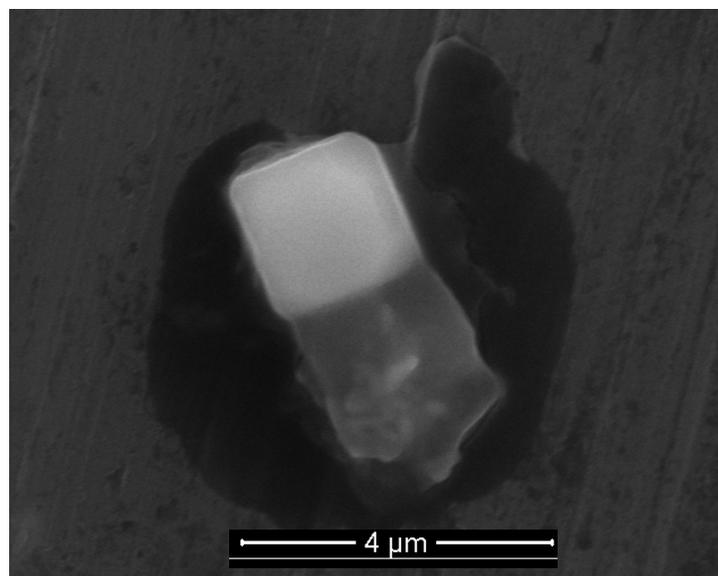
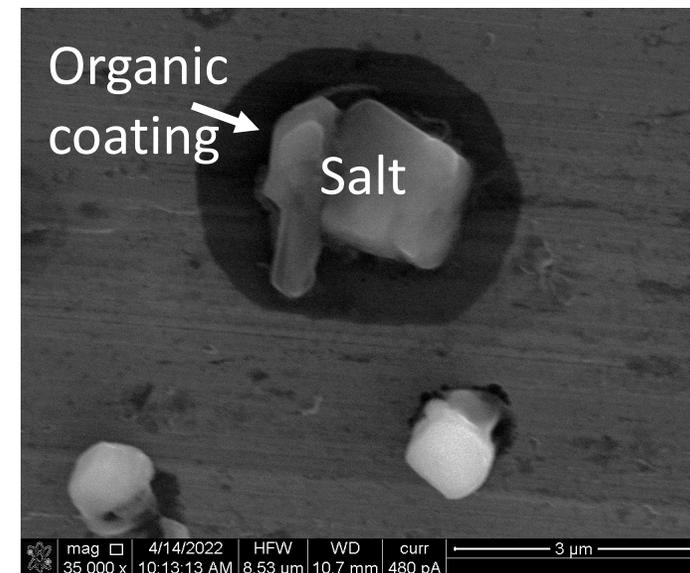
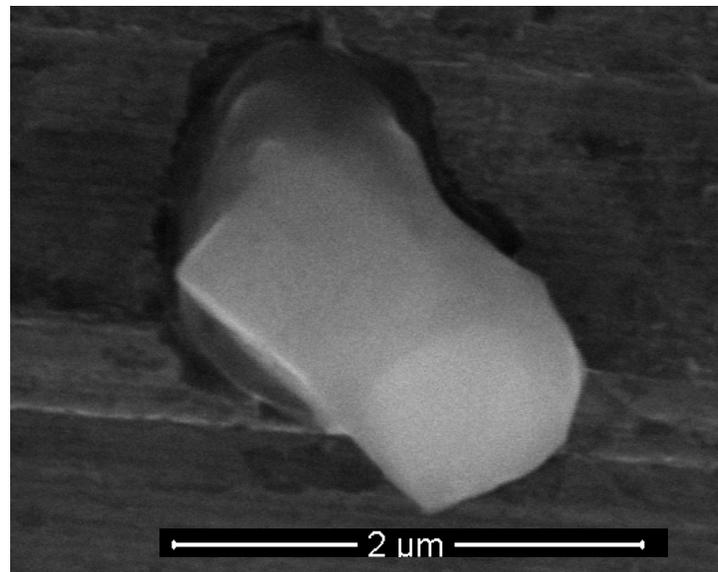
Representative EDX spectrum



## Major elements

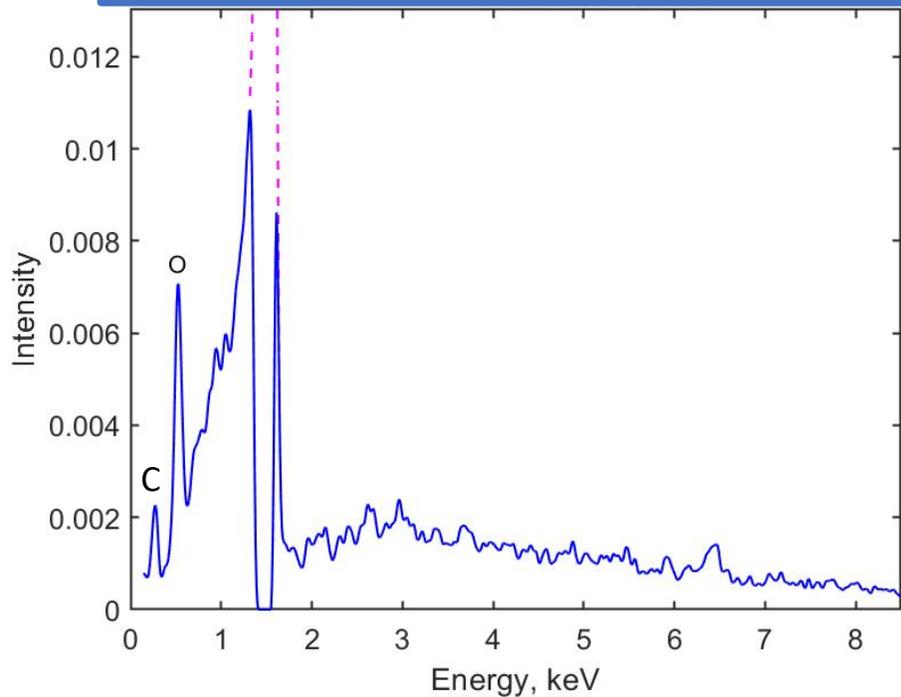
Na, Cl, Mg, O, C, S, K

Similar to Kirpes et al. 2019, *ACS Central Sci.*



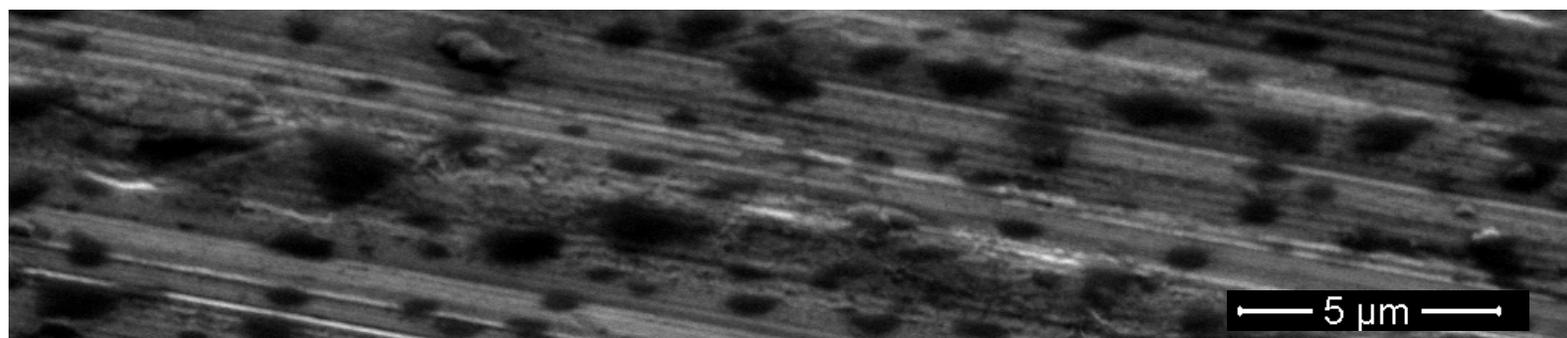
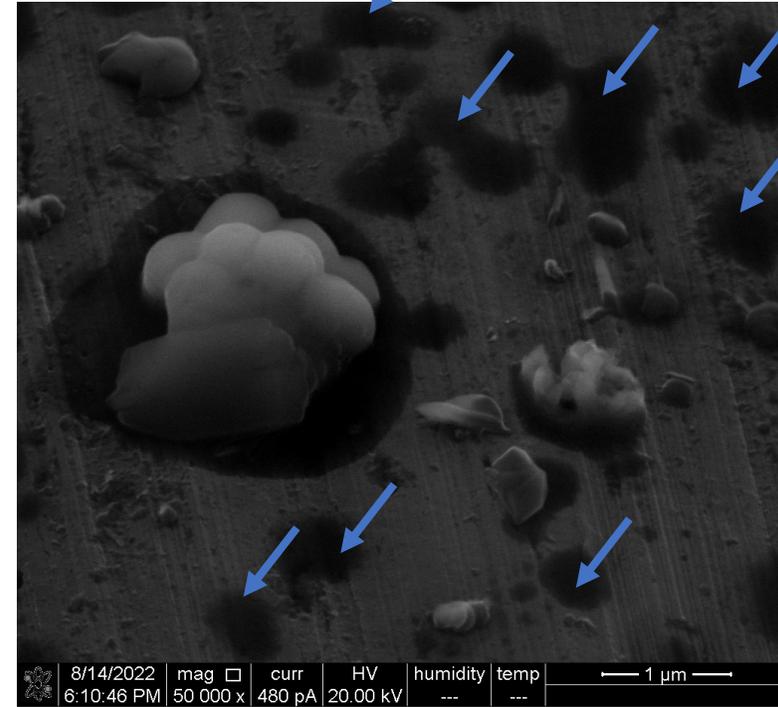
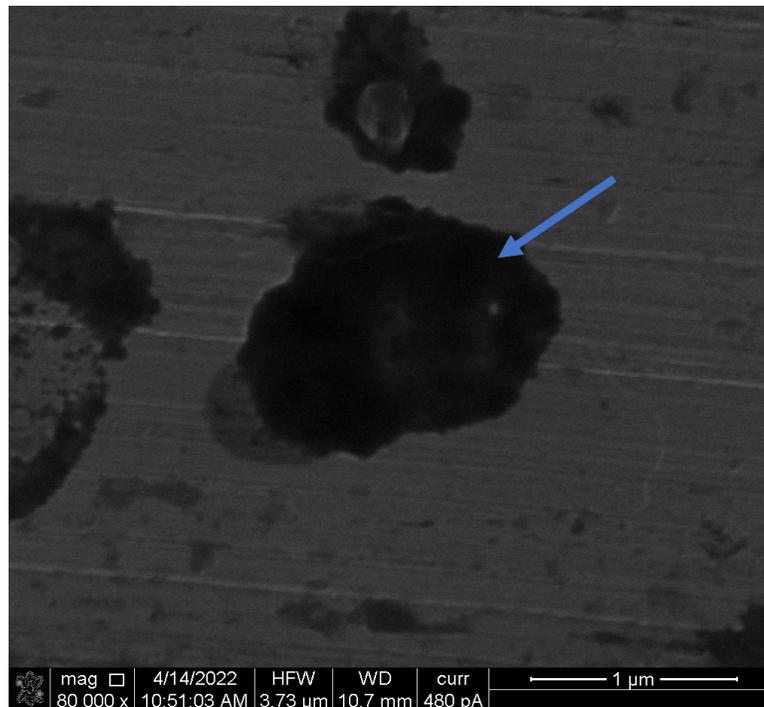
# Organic Aerosol

Representative EDX spectrum



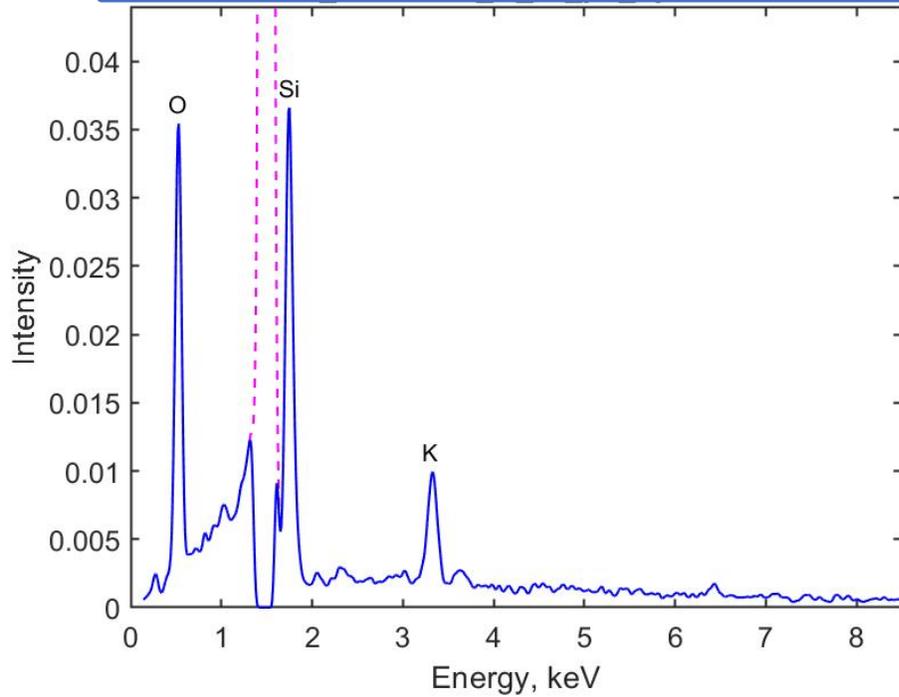
## Major elements

C, O, (S)



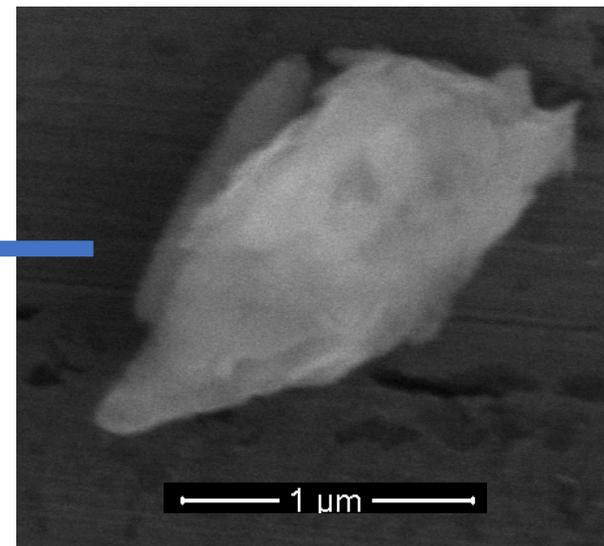
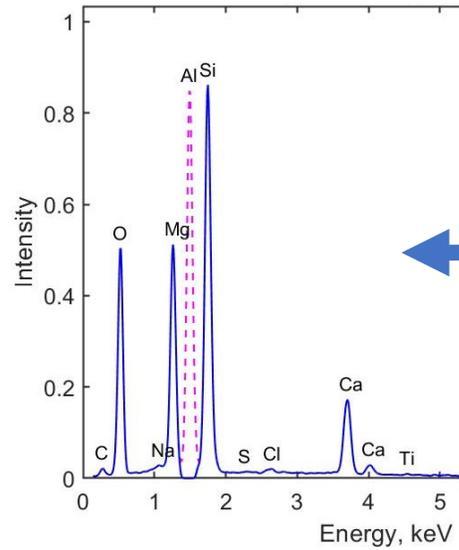
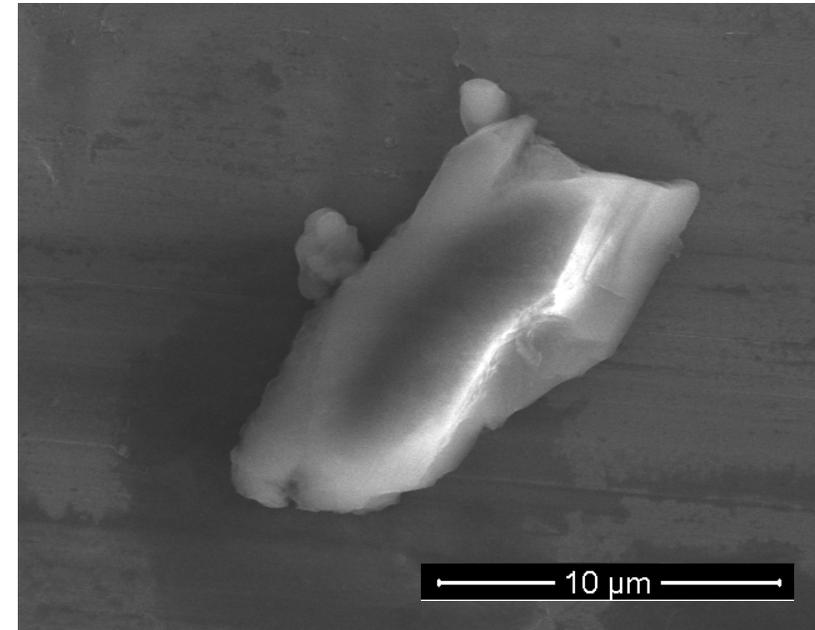
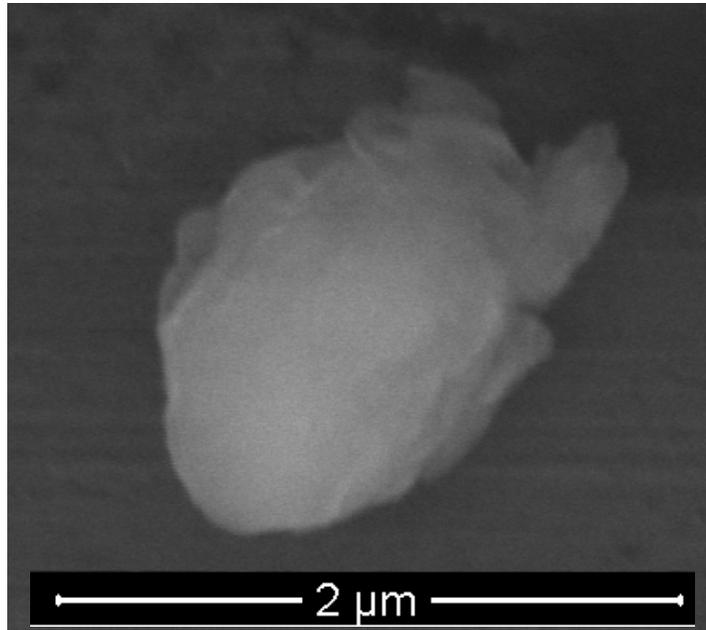
# Mineral Dust

Representative EDX spectrum



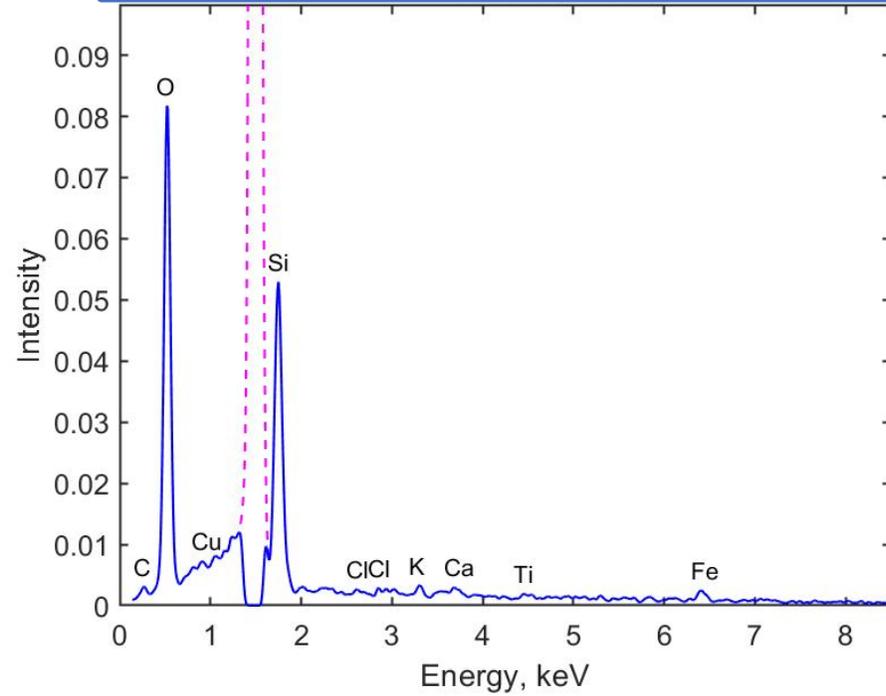
## Major elements

Si, O, Mg, Ca, Fe, K



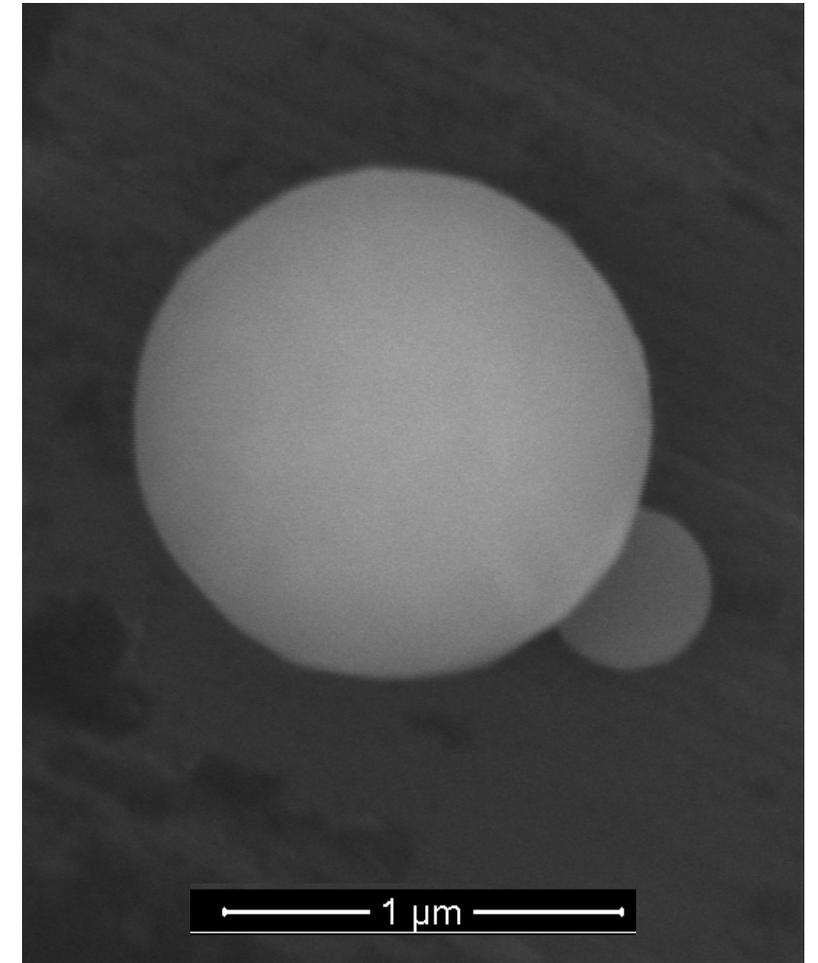
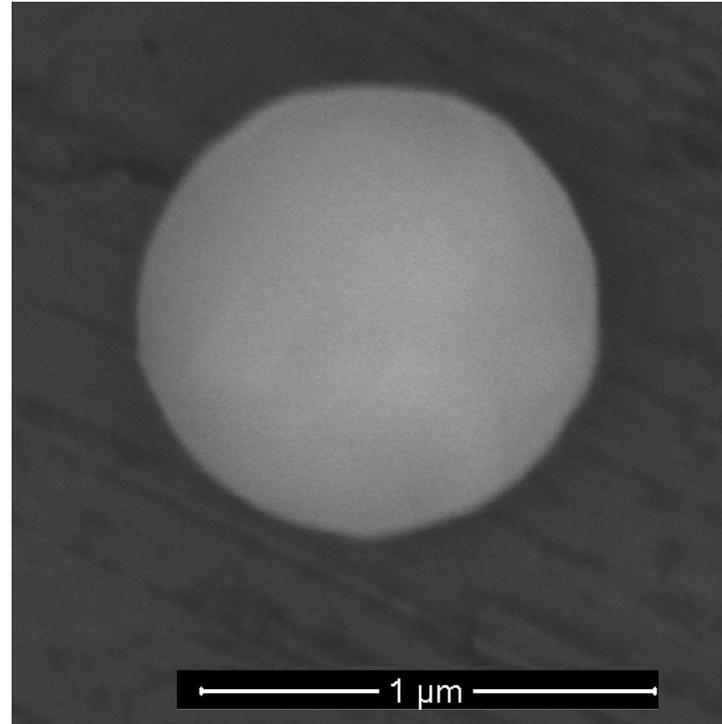
# Fly Ash

Representative EDX spectrum



## Major elements

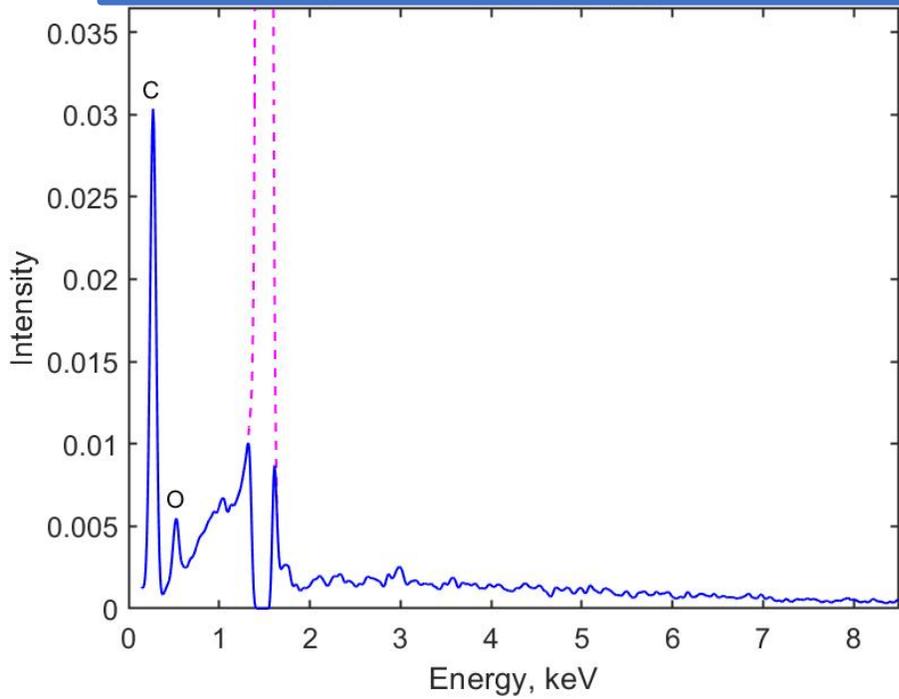
O, Si, Fe



Spherical morphology

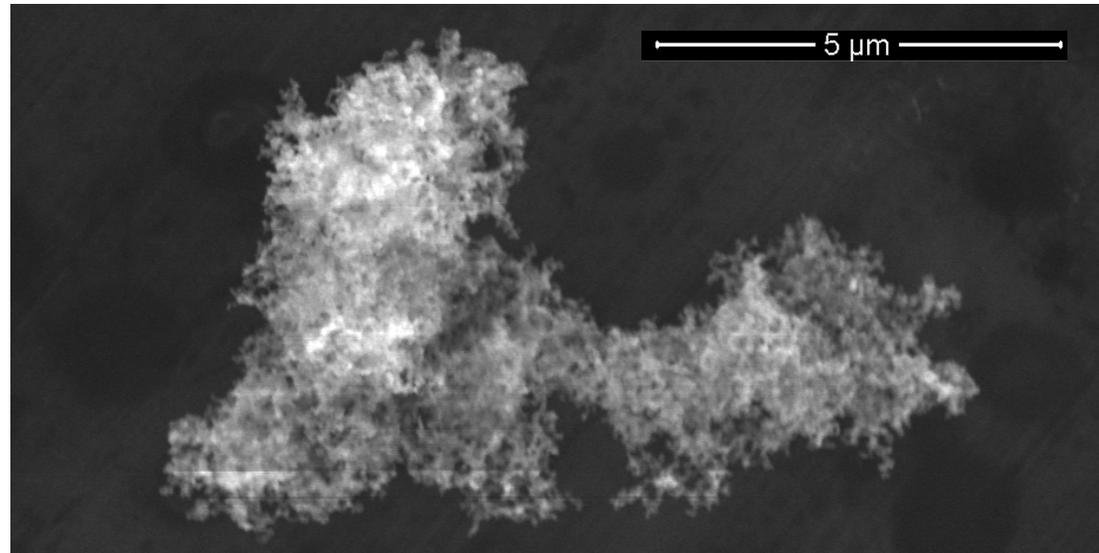
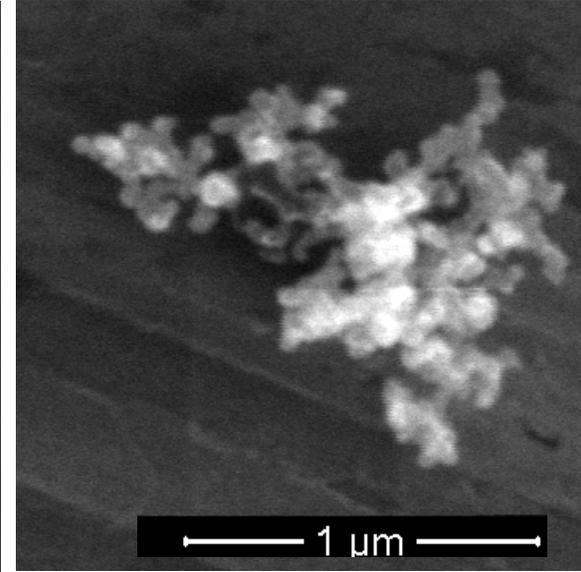
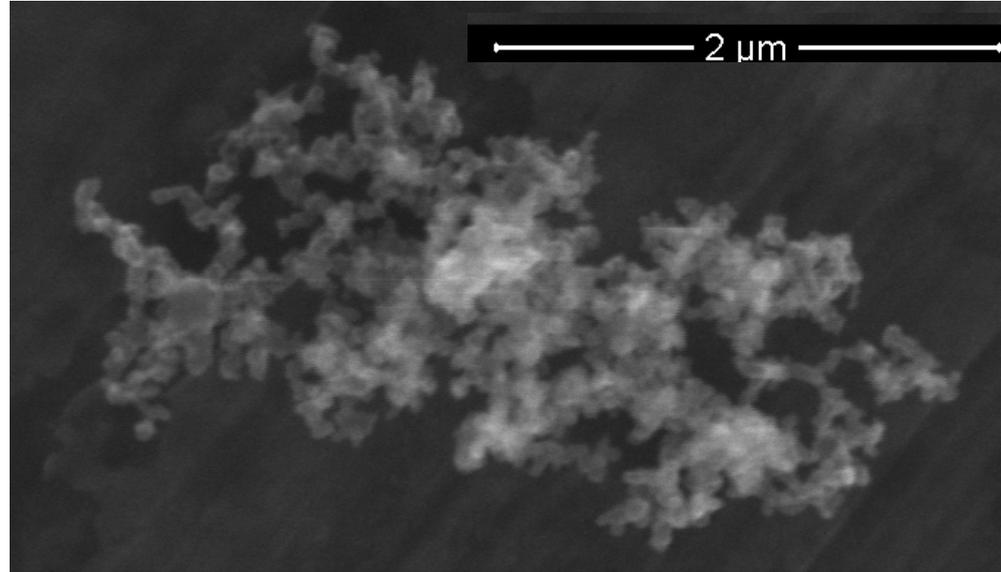
# Fresh (Local) Soot

Representative EDX spectrum



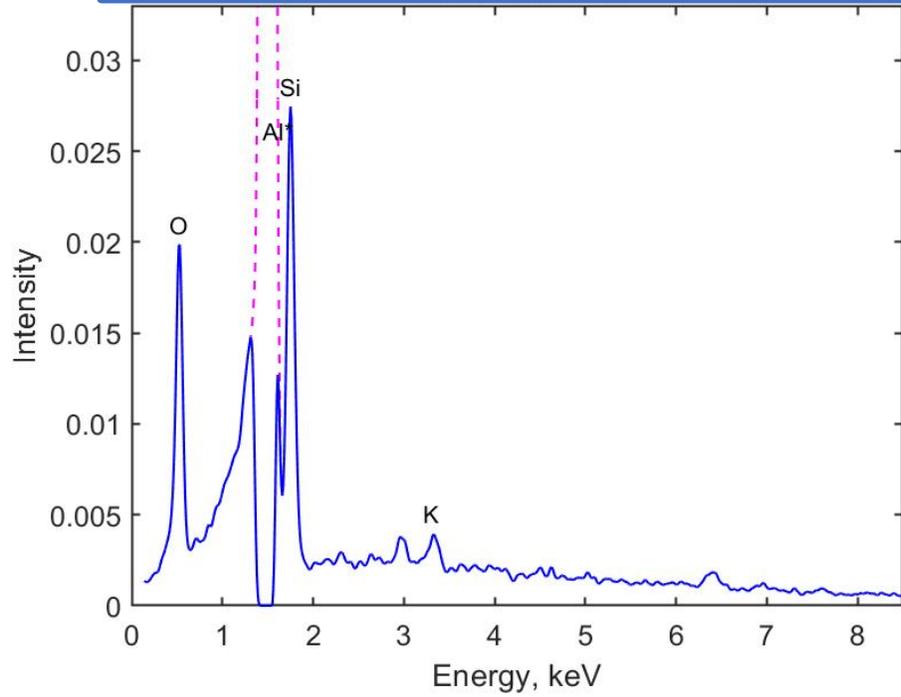
## Major elements

C, O, (S)



# Primary Biological Aerosol Particles

EDX spectrum



## Major elements

Si, O; C, N, P, K, S



	HV	curr	det	mode	WD	mag	HFV	tilt	5 µm	
	20.00 kV	0.40 nA	ETD	SE	4.1 mm	8 000 x	25.9 µm	0 °	MC2 FEI Helios 650 Nanolab	

# Summary (*Just the Start!*)

- Preliminary SEM-EDX analysis: major atmospheric particle types during MOSAiC were **sea spray aerosol** and **organic-rich aerosol**
- Mineral dust, fly ash, soot, and primary biological particles have also been observed
- Future work
  - Continue data collection of additional samples
  - Determine size-resolved individual particle type contributions during each sampling period



DOE Early Career grant (PI: Pratt)  
DOE ASR grant (PI: Creamean)  
ARM field campaign (PI: Pratt)



Thank you to MOSAiC scientists, ARM technicians, and the crew of the Polarstern!