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ASR Atmospheric System Research

ARM

EMSL Environmental Molecular Sciences Laboratory
A DOE OFFICE OF SCIENCE USER FACILITY

Aerosol Influences on Ice Nucleating Particles (INPs) in SAIL

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U.S. DEPARTMENT OF ENERGY

2023 ASR/ARM PI Meeting SAIL breakout

Introduction, Background, and Motivation

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- Using measurements of ice nucleating particles (INPs) and other aerosols conducted during the ARM Surface Atmosphere Integrated Field Laboratory (SAIL) campaign, we seek to understand seasonal INP influences on cloud and precipitation properties within the SAIL mountain watershed. Through extension, we will seek numerical representations applicable for use in aerosol-cloud interaction studies for other western U.S. mountain regions that are so critical for water supplies.

ASR Goals and Objectives

Atmospheric System Research

ARM

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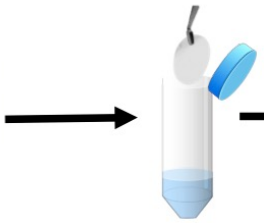
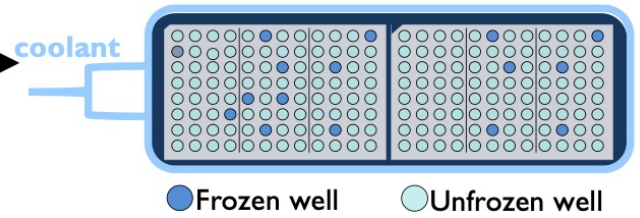
- Connect a comprehensive investigation of ice nucleating particle (INP) concentrations, compositions and inferred sources measured during the Atmospheric Radiation Measurement (ARM) program's Surface Atmosphere Integrated field Laboratory (SAIL) campaign (18 months) with size-resolved aerosol collections to be analyzed on a single particle basis at EMSL.
- **DOE relevance**: How do aerosol properties influence glaciation processes active in clouds, with links to climate and hydrology?
- **Anticipated outcomes:** Synthesized descriptions of INP populations and their relationships to ambient aerosols, and their use for collaborative numerical modeling studies of aerosol-cloud-precipitation interactions

Approach, Method, or Experiment Plan

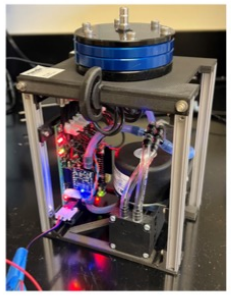
Open-faced filter (AOS)



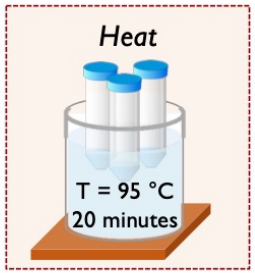
Samples cooled at 0.33 degrees per minute and frozen wells recorded until ~-28 °C



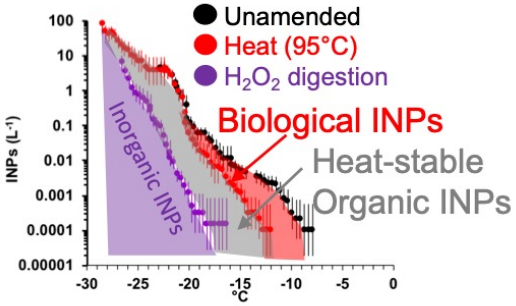
IcePuck (TBS)



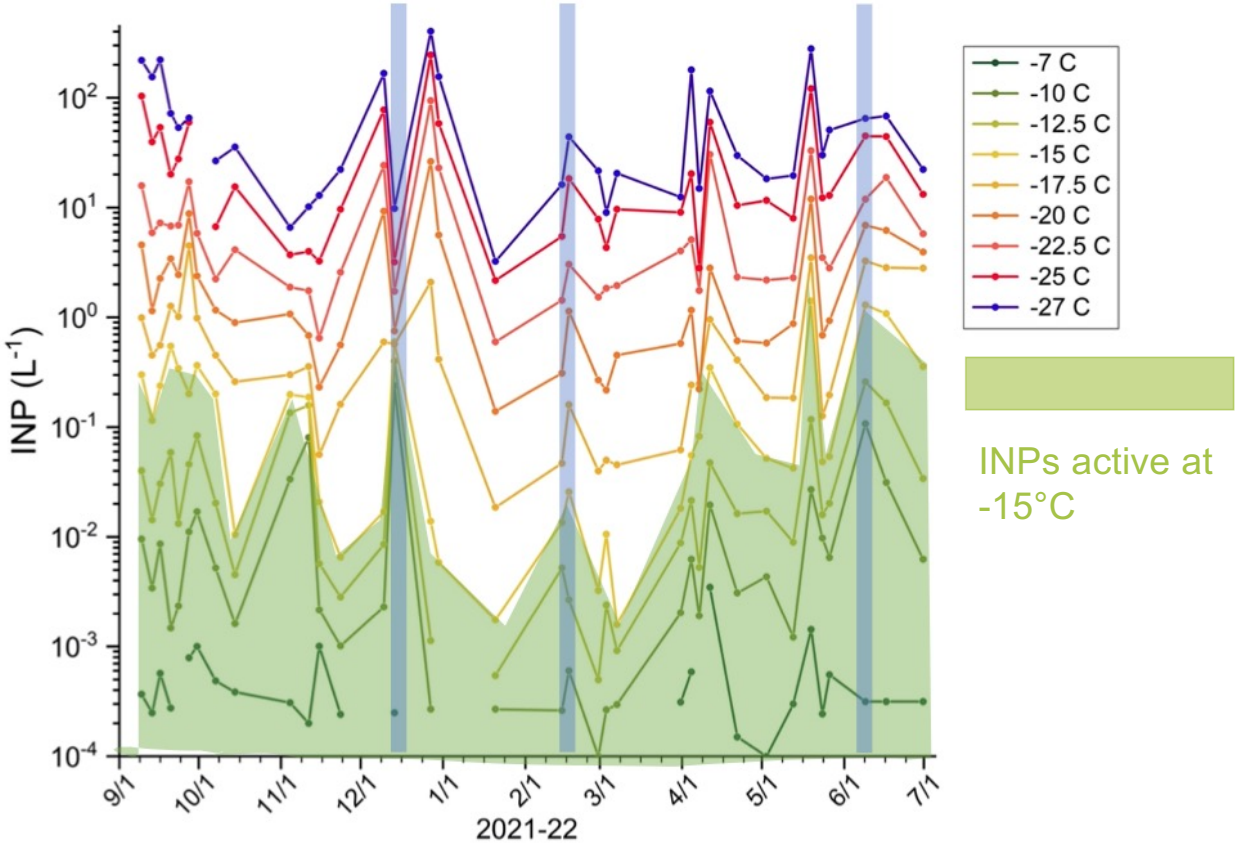
Offline treatments:



+Catalase after

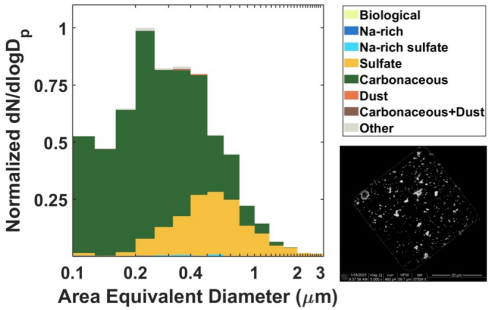


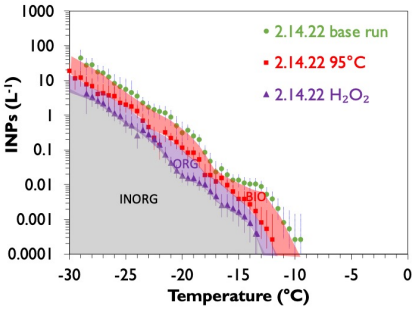
Results and Discussion: annual INP cycle



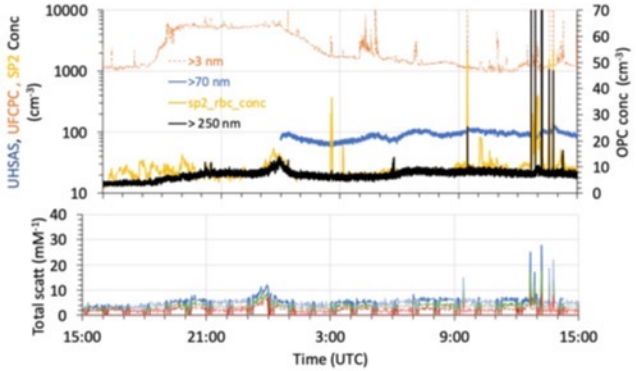
Diverse annual cycle present in processed AOS data from 2021-2022. Apparent active biological INPs present in warm season (Spring to Fall) but mostly absent in Winter. Greater than 1 order of magnitude variability in INPs at any temperature over the year.

Results and Discussion: Assembling case studies (mid-Winter and late Spring here)

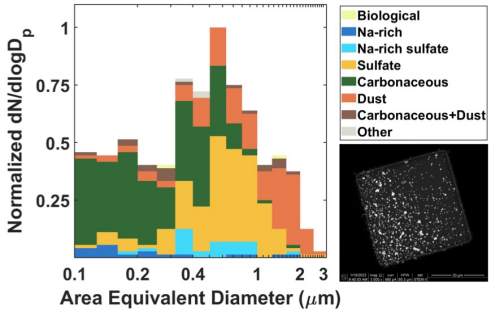


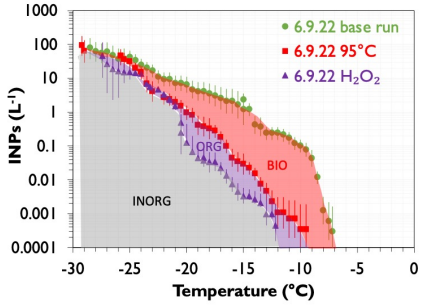


Typical winter was low dust and INPs from some type of other mostly organic particle type (biomass burning?).

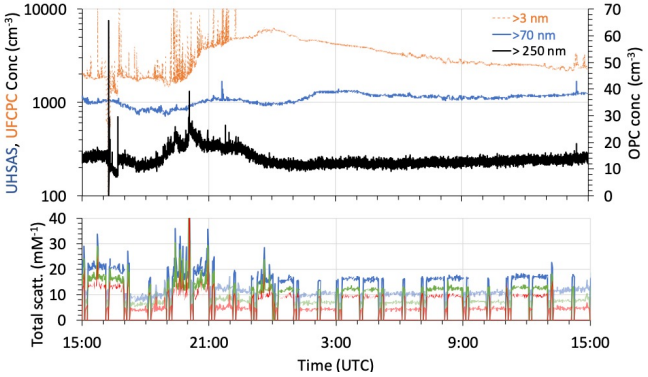


Dark traces are PM10 (light is PM1) for 700, 550, and 450 nm)

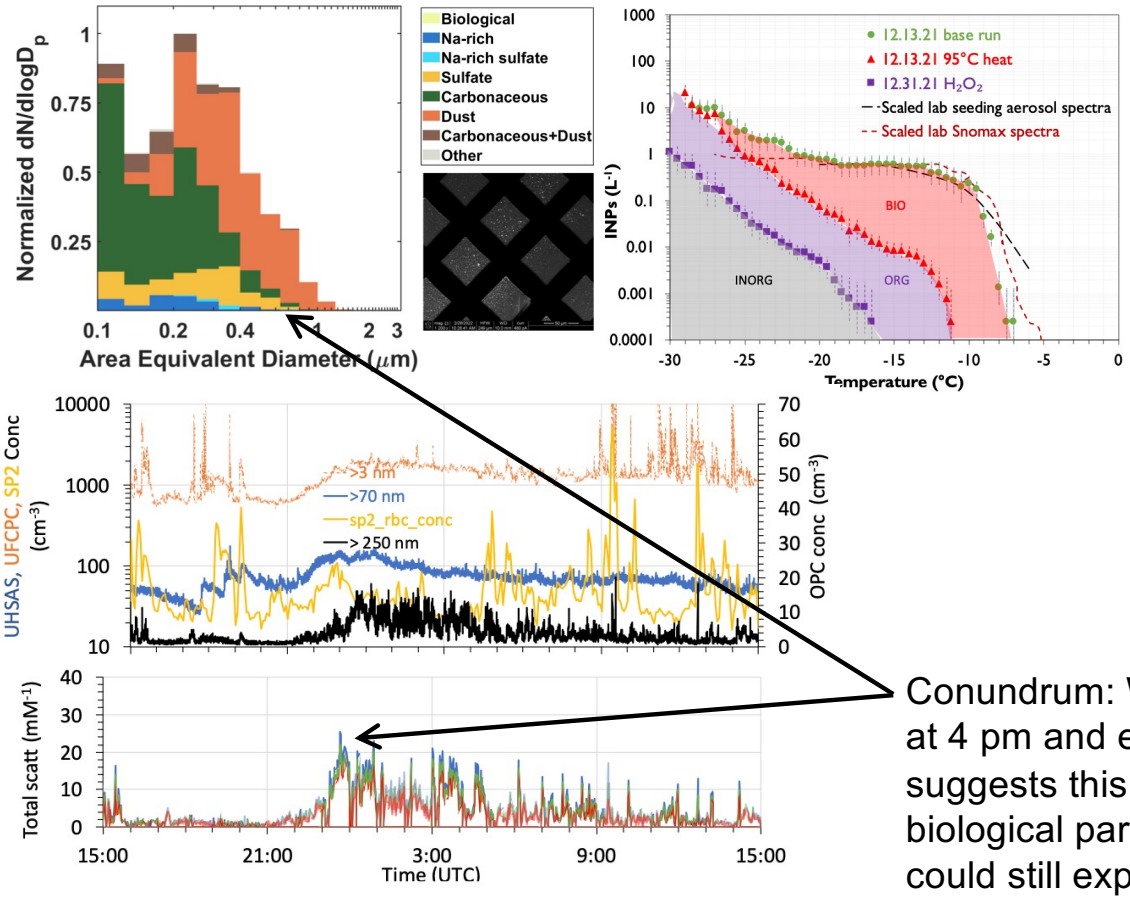




Typical warm season had apparent arable dust influences and biological INPs during plant growth.



Will the local influences of cloud seeding and snowmaking be detectable? Challenging.



Look for winter periods with unexpected INP spectral signatures. This one could be explained by a regional dust incursion, or snowmaking adding bio-INPs via Snomax used in snowmaking machine water. The spectra also looks like that expected from the regional cloud seeding network, but **seeding generators were not operating on this day**.

Conundrum: Would snowmaking have commenced at 4 pm and ended by 8pm? Dust in STAC analysis suggests this was a short transport event, although 1 biological particle in 1000 overall particles analyzed could still explain 1 per liter INPs acting like Snomax.

Acknowledgements

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