Los Alamos NATIONAL LABORATORY

Allison C. Aiken
and many others!

Supermicron and Bioaerosol Events and Impacts

AOS

PM Sensor

Bioaerosol

TBS

SAIL Science Summit
Boulder, CO
November 2, 2023

ASR Atmospheric System Research

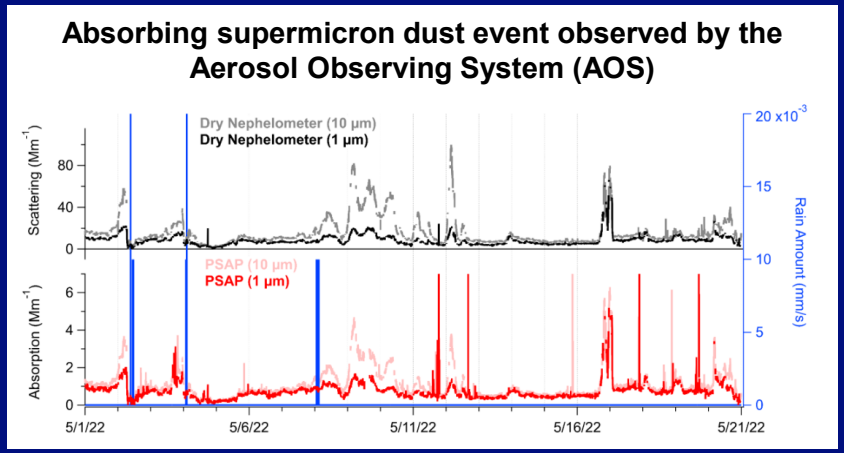
LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

ARM

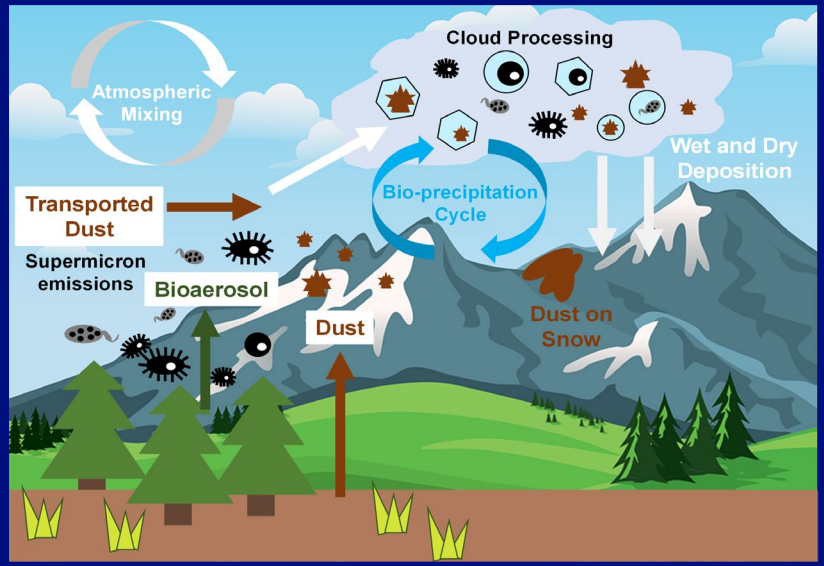
LA-UR-23-28300

Motivation: Supermicron and Bioaerosol Impacts within Complex Mountainous Terrain

- Lack of observations
- Known interactions with surface and atmospheric radiation, the water cycle and hydrology
- Goal: seasonal and diurnal cycles, sources and sinks, variability within the region



Feldman, Aiken et al., BAMS, 2023.



Supermicron and bioaerosol cycles and impacts to the atmosphere (e.g., interact with clouds and the water cycle) and the surface in mountainous terrain.

Los Alamos NATIONAL LABORATORY

Absorbing Dust → Snowmelt → Hydrological Impact

Dan Feldman (LBNL), Leah Gibson (Handix), Adeyemi Adebiyi (UC-Merced), Laura Riihimaki (NOAA), Erica Woodburn (LBNL)

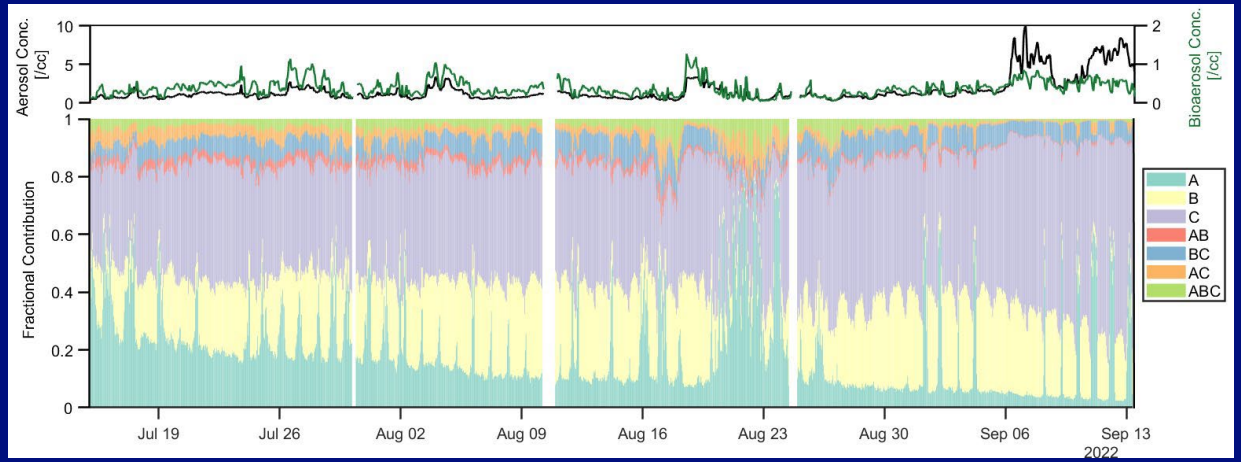
- Interdisciplinary project tracing dust transport in the atmosphere to deposition on snow using changes in surface radiation
- Predictive modeling to understand how impacts on albedo at the surface impacts the timing of snowmelt and overall hydrologic output of water within the region

Interested in joining our new aerosol discussion series? →

https://docs.google.com/forms/d/1MwdZHk4hasERzO56l3FsyoXNSrAiU1s_6oSOIo7e-yI/

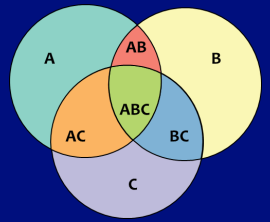
Real-Time Single-Particle Bioaerosol Data

- Two deployments in 2022 and 2023
- Seasonal and diurnal trends observed for fluorescent particle types
- Size and shape information (asymmetry factor) also collected (not shown)



Shawon et al., in prep, 2023.

Bioaerosol: directly emitted particles from plants and the microbiome that contain biological material.



Fluorescent particle types by Perring et al. 2015.

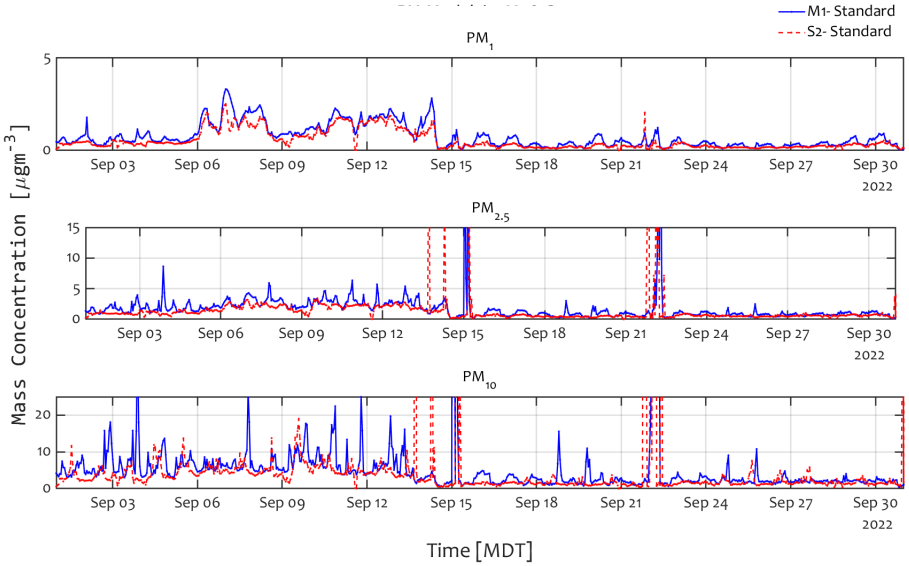
Bacteria, pollen and fungi detected by the fluorescence of biological material due to the presence of tryptophan and NADH in the particles.

LANL Colleagues:
Katherine Benedict
Abu Sayeed Md Shawon

Los Alamos NATIONAL LABORATORY

Particulate Mass (PM) Timeseries at 2 Sites (AMF2 and AOS)

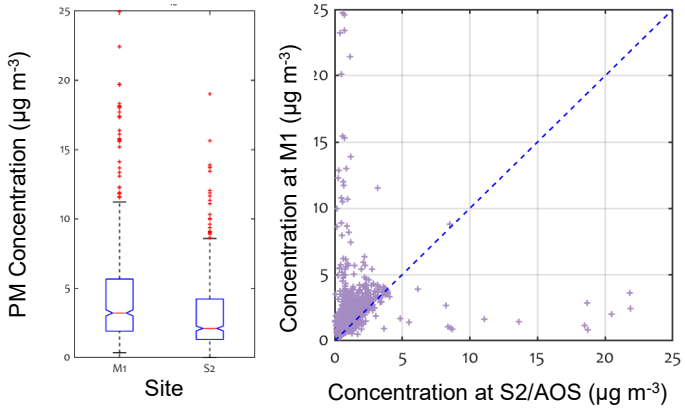
High-time resolution PM data



M1 in Gothic, CO at 9500 feet a.s.l.

S2 with the AOS on Crested Butte Mountain at 10,300 ft.

Year-round comparison of PM10



Los Alamos NATIONAL LABORATORY

SAIL Aerosol Vertical Profiles (SAIL-AVP)

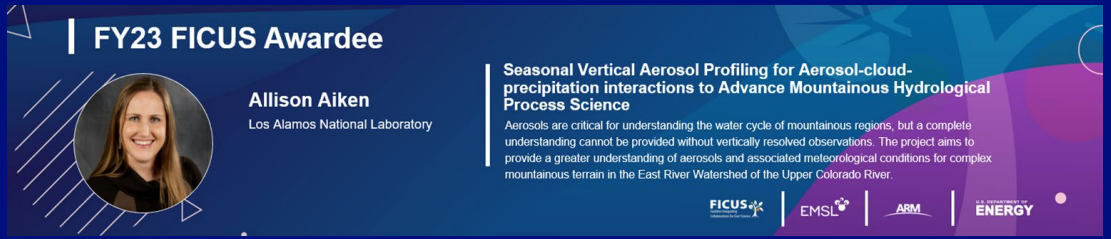
- **Funded by FICUS (ARM and EMSL)**
  - Title: “Seasonal vertical aerosol profiling for aerosol-cloud-precipitation interactions to advance mountainous hydrological process science”

PI Team: Aiken (LANL), Feldman (LBNL), Paul DeMott (CSU), Nick Bouskill and John Christensen (LBNL), Jessie Creamean (CSU), Wenming Dong (LBNL), Jiwen Fan (ANL), Jim Smith (UCI)

- **Four TBS deployments in 2023**
  - Winter Storm – January
  - Spring Melt – April and May
  - Summer Monsoon – June

TBS at SAIL in June. Photo by Aiken.

Feldman, Aiken and Dexheimer at the TBS during SAIL. Photo by N. Bilow



Los Alamos NATIONAL LABORATORY

SAIL Aerosol Vertical Profiles (SAIL-AVP)

Instrument	Property Measured	Type
Printed Optical Particle Spectrometer (POPS) (6 units)	Aerosol size distribution from 140 nm to 3 μm	Baseline
Condensation Particle Counter (CPC) Model 3007 (4 units)	Total aerosol concentration from 0.01 μm to 1 μm	Baseline
Size- and Time-Resolved Aerosol Collector (STAC)	Size- and time-resolved chemical composition from 0.1 μm to 5.0 μm	Baseline
Cascade impactors (6 units)	Size-resolved chemical composition at four cut-off sizes (0.25, 0.5, 1.0, 2.5 μm)	Available upon request
MicroAeth AE-51	Black carbon concentration measured at 880 nm	Available upon request

Example Aerosol Payload for the Tethered Balloon System (TBS).

Instrument Payload

- **Aerosol Flights: (~1-4 per day)**
  - Filter collection for metal analysis (LBNL)
  - IcePuck (Ice Nuclei)

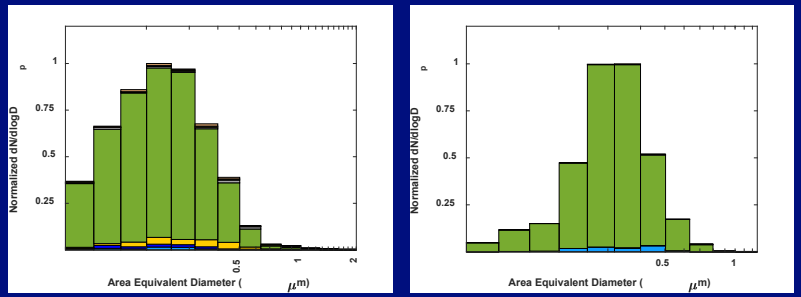
Los Alamos NATIONAL LABORATORY

SNL Colleagues: Dari Dexheimer, Andrew Glen Whitson, Casey Longbottom

SAIL Aerosol Vertical Profiles (SAIL-AVP)

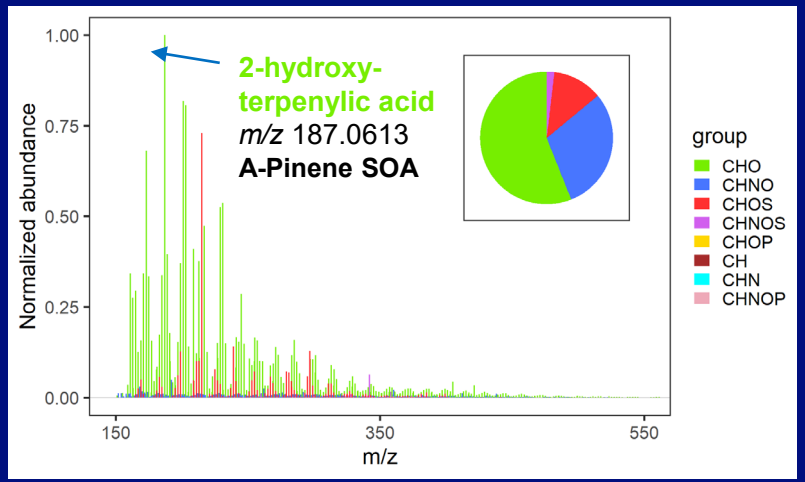
- **EMSL Imaging and Chemical Analysis**
  - Chemical composition and organic molecular composition, examples shown below
  - Coating analysis and heterogenous ice nucleation
- **Ice Nuclei analysis TBD (led by CSU)**

Elemental Composition



Size-selected elemental analysis using Scanning Electron Microscopy (SEM) from a Spring SAIL TBS Flight in 2023 by Zezhen (Jay) Cheng at EMSL.

Molecular Characterization of Organics



Bulk chemical analysis using mass spectrometry from a Summer SAIL TBS Flight in 2023 by Gregory Vandergrift at EMSL.

Los Alamos NATIONAL LABORATORY

PNNL/EMSL Colleagues: Swarup China, Zenzhen Cheng, Gregory Vandergrift

Summary

- **Interdisciplinary project integrating ARM atmospheric observations with surface radiation measurements to understand dust on snow events**
- **Observed changes in different bioaerosols based on fluorescence patterns and physical properties (size and shape) throughout the sampling periods and in the monthly diurnal profiles. Manuscript in prep.**
- **Supermicron data collected at two locations to determine regional variability.**
- **Collected vertical profile aerosol physical and chemical information using the TBS during 4 deployments. Analysis is underway and in collaboration with EMSL, LBNL/metal analysis and CSU/ice nuclei.**

Acknowledgements

- LANL/ARM Site Operations Staff for AMF2 (SAIL): Heath Powers, John Bilberry, Juarez Viegas
- Dan Feldman, SAIL PI, and the SAIL Science Team
- SAIL TBS/EMSL FICUS Science Team
- Paul DeMott and Jesse Creamean, CSU, Ice Nuclei analysis
- Dari Dexheimer, SNL, SAIL TBS deployments
- Swarup China and the EMSL analysis and coordination team, PNNL

- **Sponsors →**

ASR Atmospheric System Research

EMSL

ARM

LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

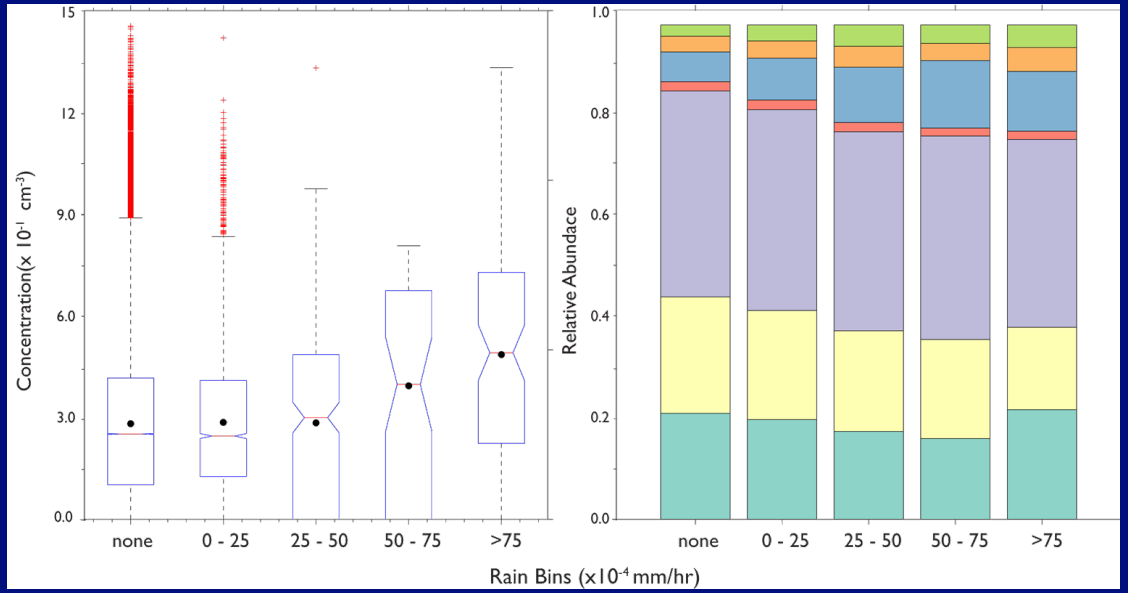
- **Thank you for your attention!**

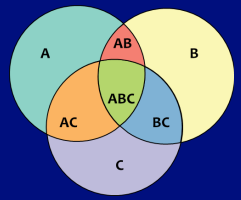
Los Alamos NATIONAL LABORATORY

Backup

Bioaerosol Trends with Meteorology

- 45 Precipitation events in 2022 categorized by rain rate
  - Increasing trend in bioaerosol number concentration with rain
  - More spherical particles during rain
- Also analyzed by wind direction, speed, etc.



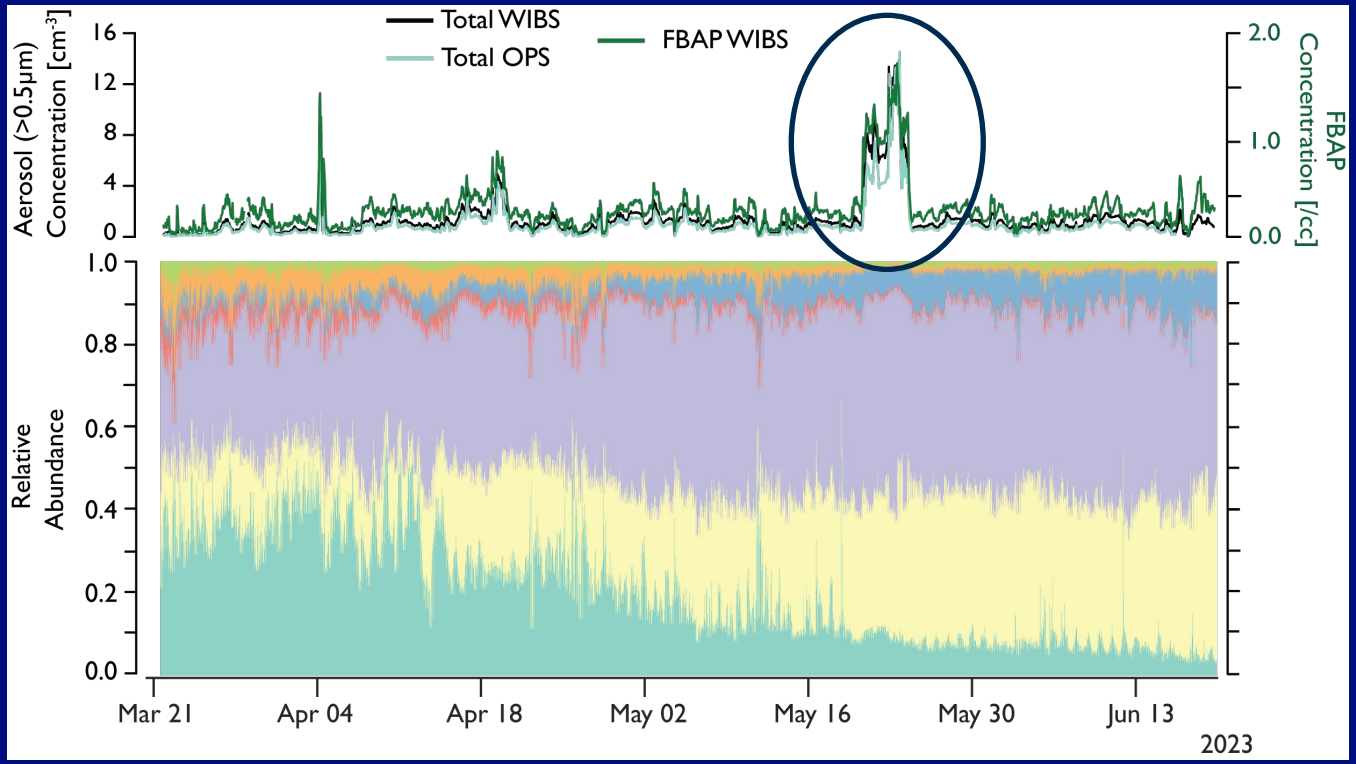


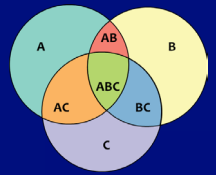
Fluorescent particle types by Perring et al.

Los Alamos NATIONAL LABORATORY

Real-time Bioaerosols – Spring 2023

- ***Preliminary Analysis – multiday event likely biomass burning***





Los Alamos NATIONAL LABORATORY