

Multimodal Chemical Characterization of the Light-Absorbing Atmospheric Aerosols and Their Deposits in the Colorado Rockies Snowpack

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Dust on Snow Events at Gothic, CO

CHEMICAL CHARACTERIZATION OF TWO DUST ON SNOW EVENTS: FEB 22, 2022, AND APRIL 4, 2023. Aeolian dust from Arizona is regularly deposited at Gothic during haze events and snowstorms. These dust layers have dramatic impacts on surface albedo and accelerate snowpack depletion.

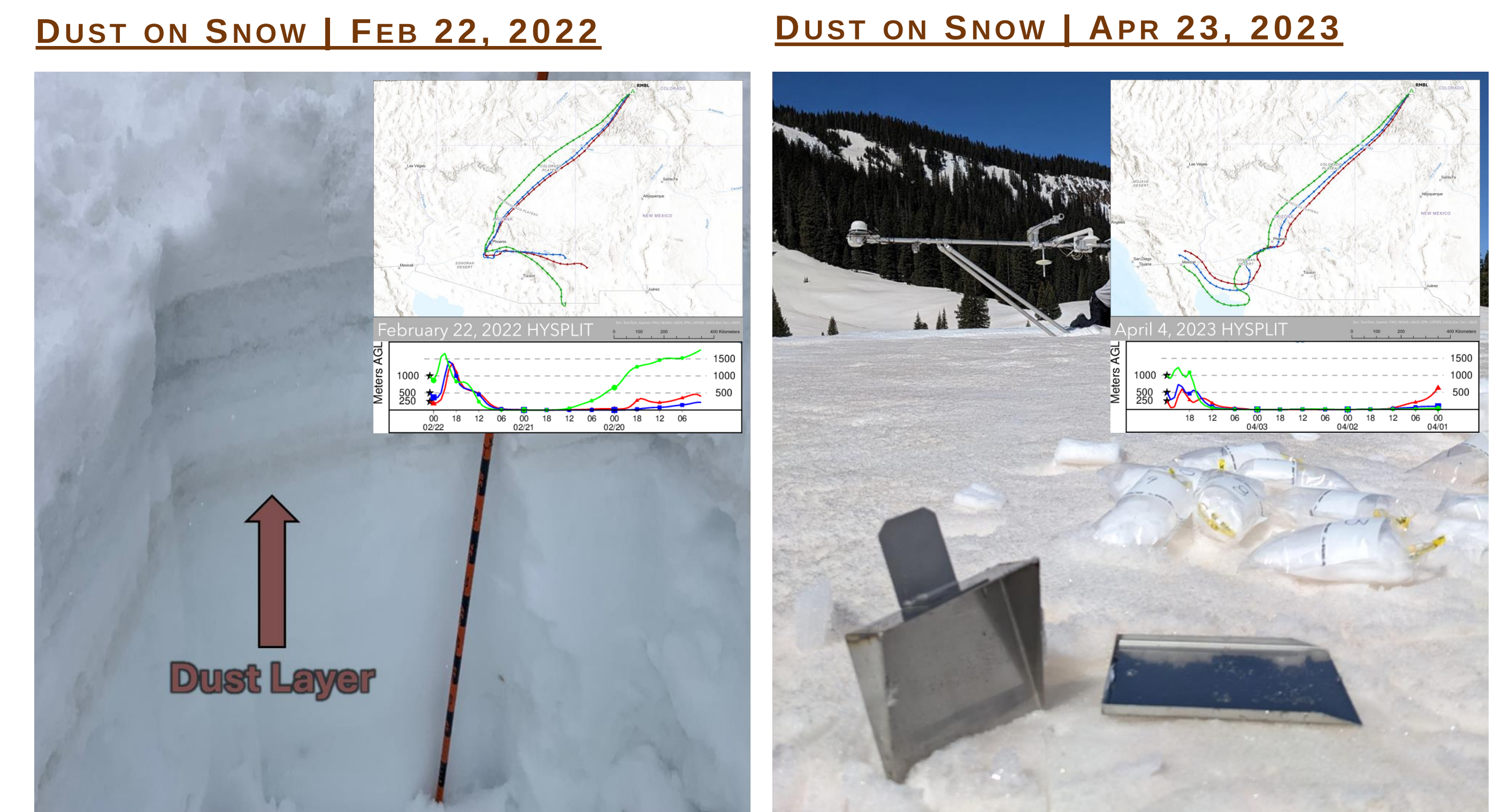


FIGURE 1: The two dust events sampled from Gothic, CO. Left: Snow pit with the February 22, 2022, dust layer sampled on April 5th, 2023. Right: April 4, 2023, dust event on top of snow at Gothic. Insets: HYSPLIT backwards trajectories of dust events. Red: 250 m agl, Blue: 500 m agl, Green: 1,000 m agl.

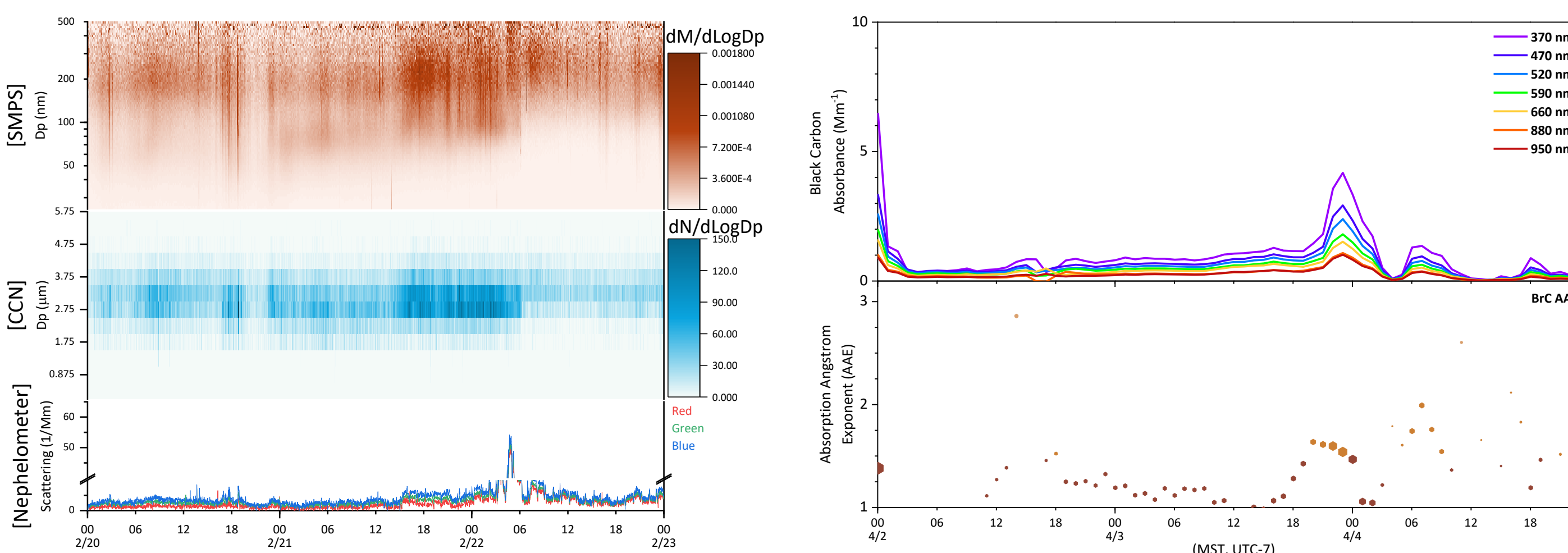


FIGURE 2: Dust events spotted on real-time instruments deployed at the SAIL AMF2 and AOS sites. Left: SMPS, CCN, and Nephelometer (AOS) peaks during the Feb 22 event. Right: AE33 absorbance and calculated AAE during the Apr 4 event.

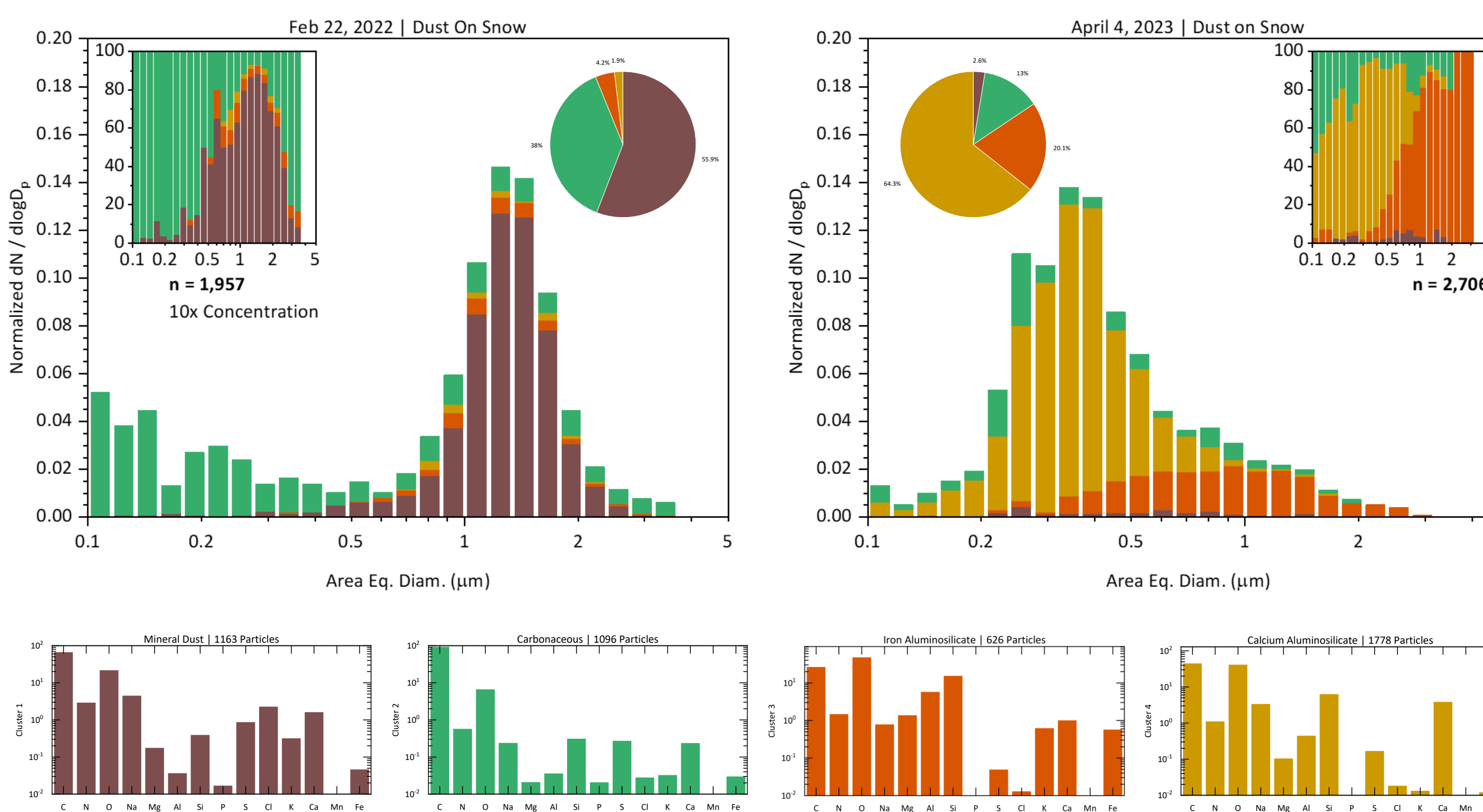


FIGURE 3: Elemental composition of dust particles sampled from each event. Clusters were assigned with a K-means algorithm. Feb 22nd dust is dominated by salty mineral dust and organic material. Apr 4th dust is dominated by Calcium-rich and Iron-rich aluminosilicates. Note that Feb 22nd dust is 10x more dilute than Apr 4th dust.

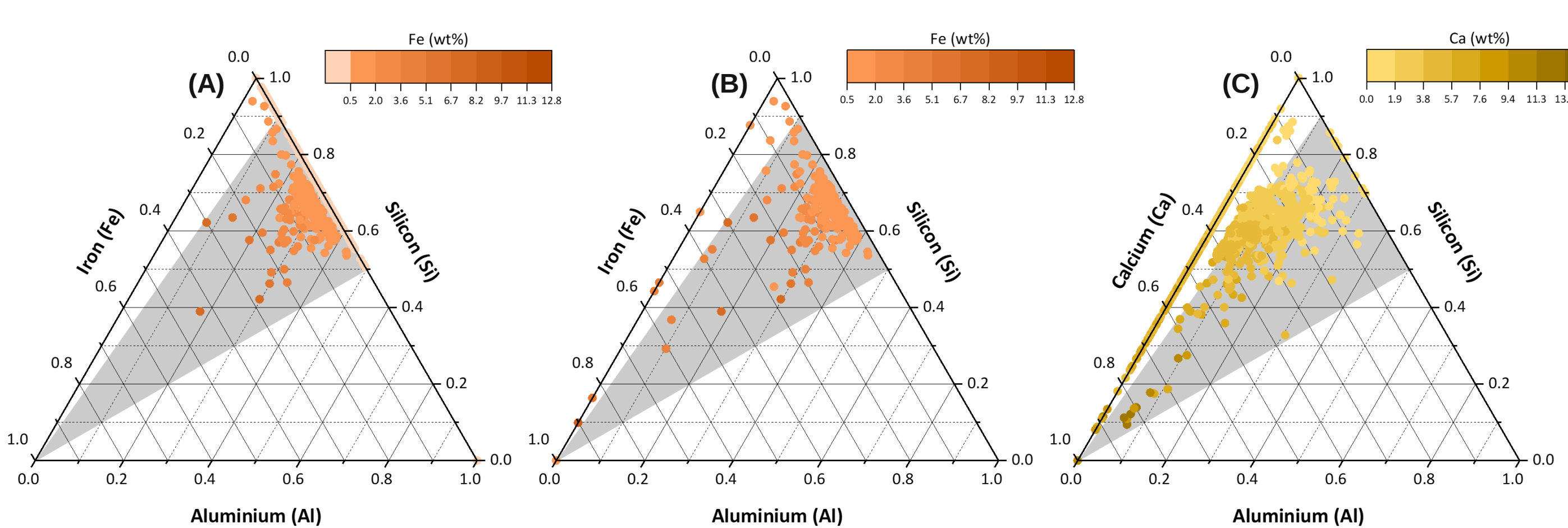
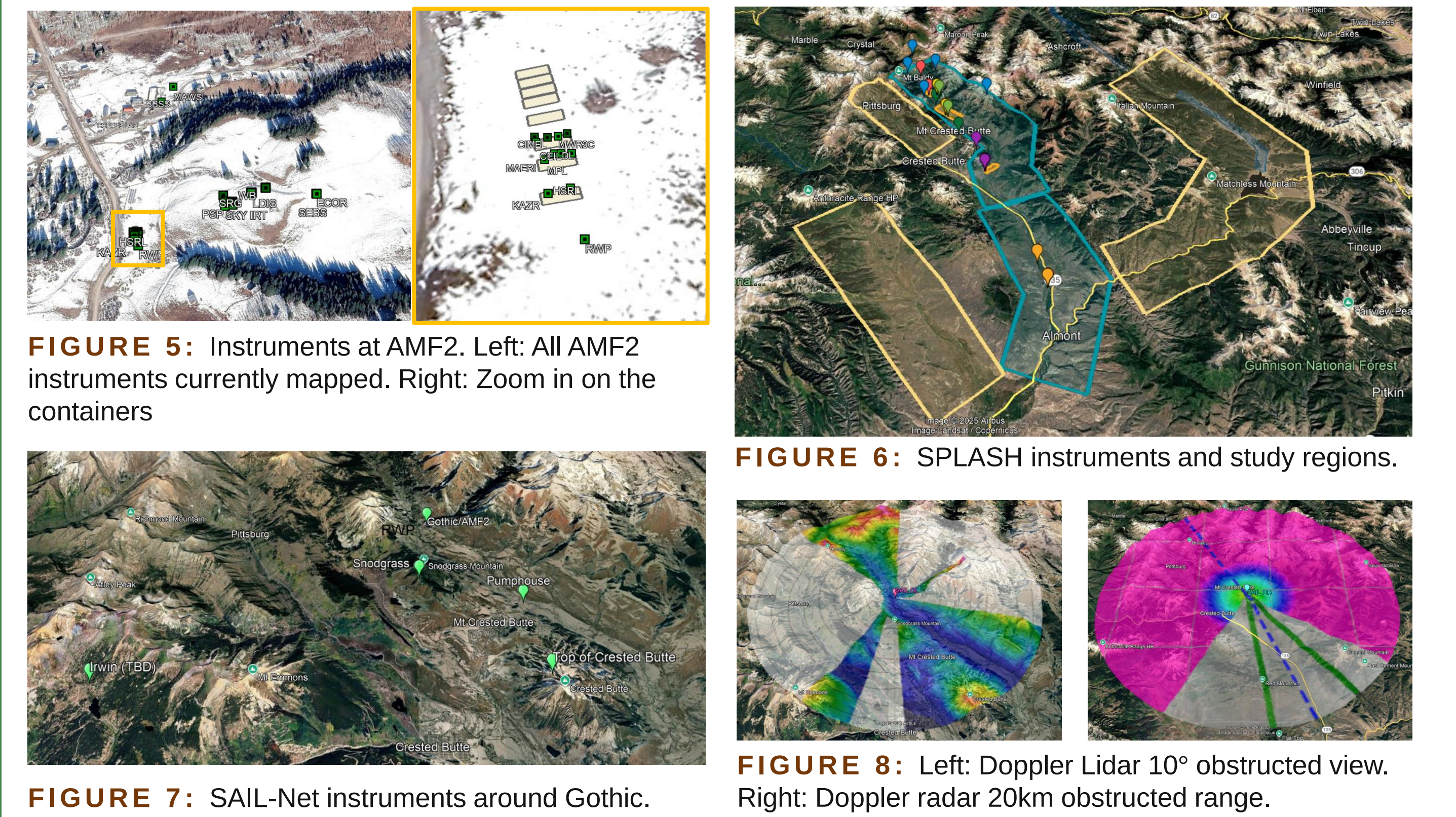


FIGURE 4: Ternary plots for the aluminosilicate clusters. Shaded regions represent the range of Si/Al ratios expected for aluminosilicate minerals. (A) Fe-aluminosilicates from all particles in Cluster 3; (B) Fe-aluminosilicates from all Fe-containing particles analyzed with CCSEM/EDX; (C) Ca-aluminosilicates from all particles in Cluster 4.

Instrument Asset Google Earth

SAIL/SPLASH/SOS INSTRUMENT MAP TO PROVIDE CONTEXT FOR CURRENT AND FUTURE RESEARCHERS Reference map helps provide context to where different measurements were taken. Started with AMF2. AOS is next.



Aerosol Diurnal Variation

AVERAGE MONTHLY DIURNAL VARIATION OF BRC AND MET VALUES AT GOTHIC, CO. What does an average day look like at Gothic?

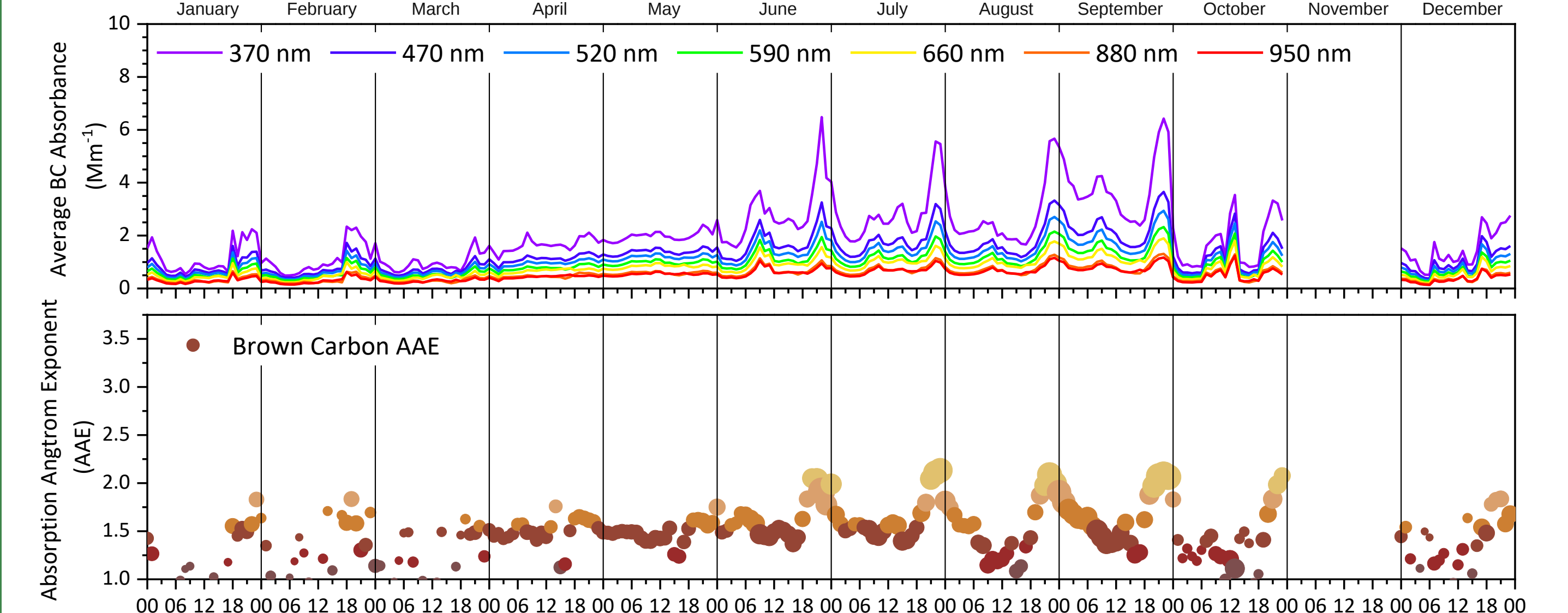


FIGURE 9: Diurnal variation recorded on the AE33 from the 18-month period of operation. Top: Aerosol absorbance recorded at seven wavelengths. Bottom: AAE calculated from absorbances at 370, 420, and 520 nm. There is limited data for October (11 days) and no data from November. All times are local (UTC-7).

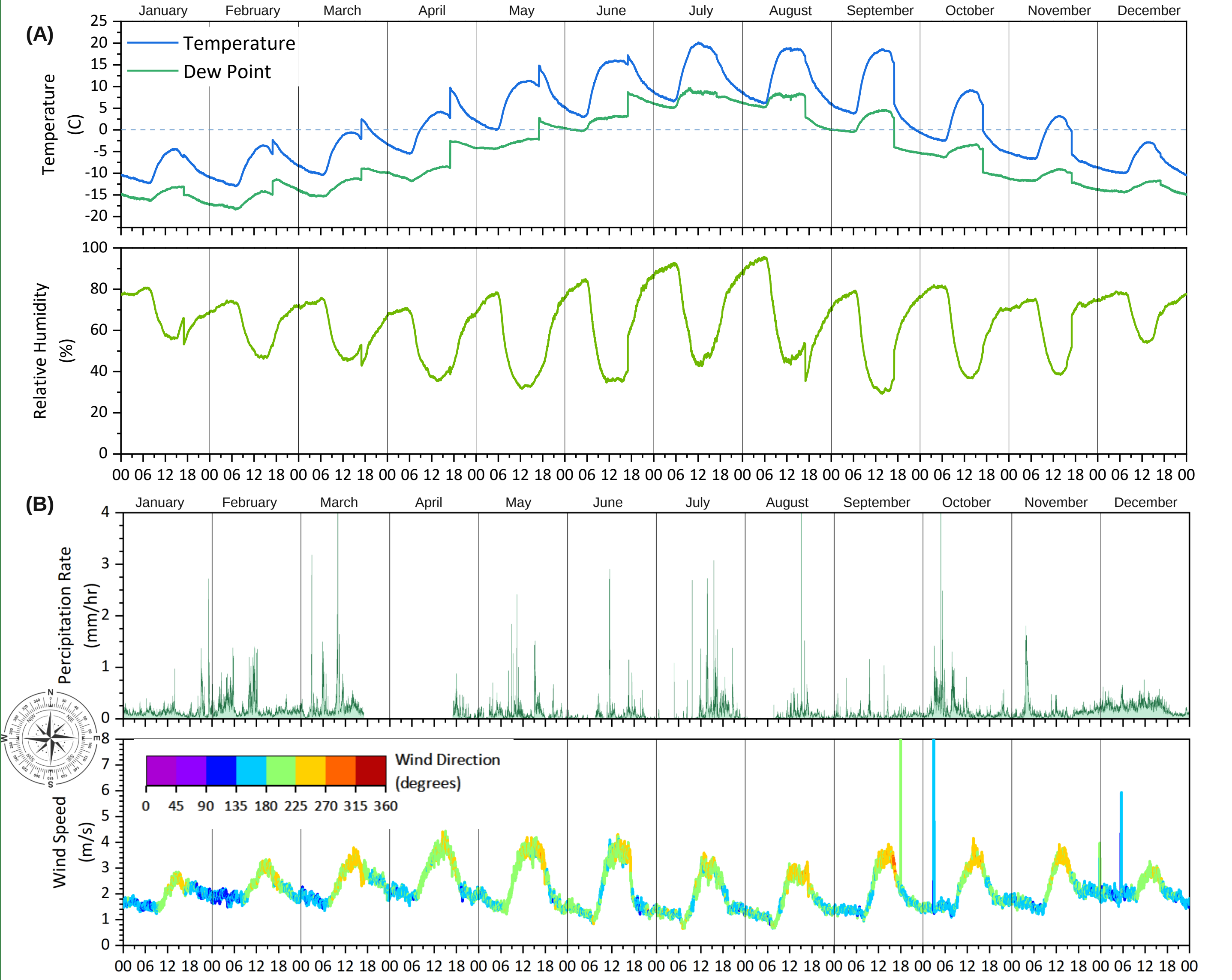


FIGURE 10: Diurnal variation recorded on the SAIL MET instrument during its operation (Sep 2021 – June 2023). (A) Top: Temperature (blue) & Dew point (green). Bottom: Relative humidity. (B) Top: average precipitation rate. Bottom: average vector wind speed and direction. All times are local (UTC-7).

Chemical Imaging of Ambient Particles

STXM/NEXAFS ANALYSIS OF SAMPLES OF LOCAL AEROSOL Samples were collected on a Time Resolved Aerosol Collector (TRAC) and imaged at PNNL and ALS at LBNL.

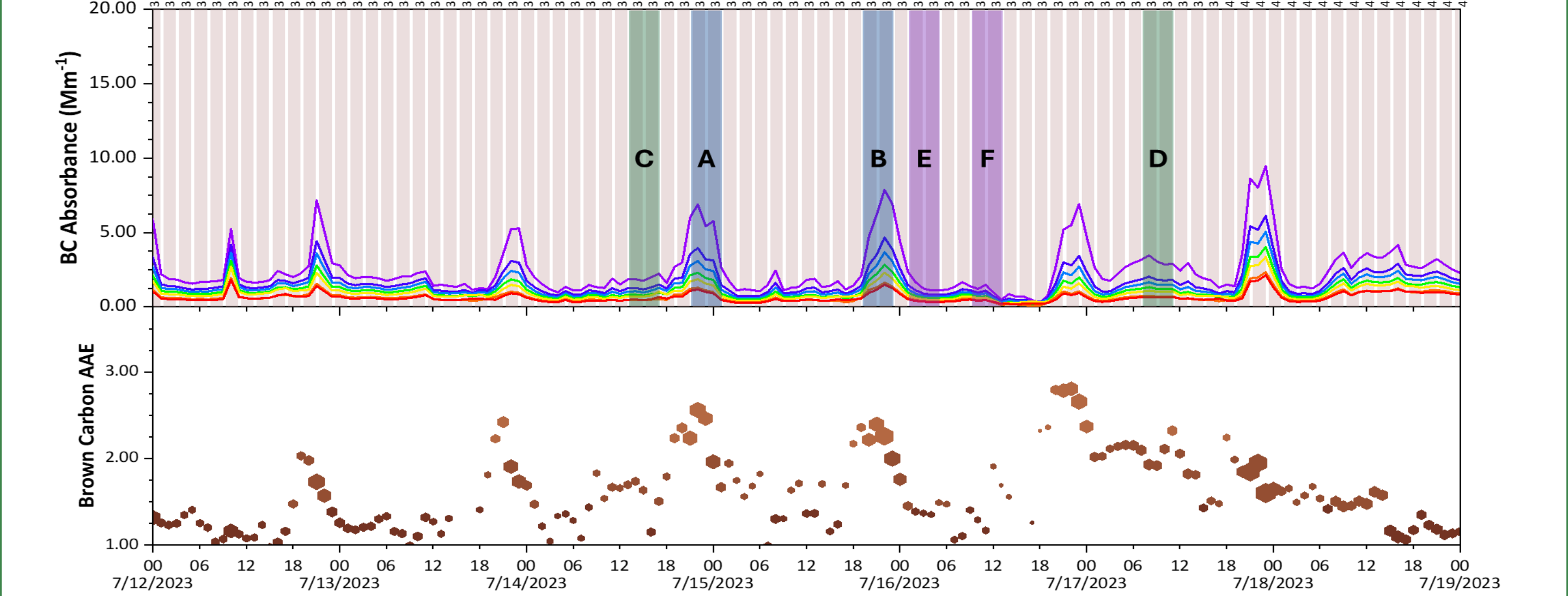


FIGURE 11: Selected samples collected by the TRAC based on their absorbance and AAE observed by the AE33. Aerosols observed during were primarily from local sources. Samples A & B are evening NPF, C & D are regional aged BBOA, and E & F are nighttime and daytime background, respectively. All times are local (UTC-7).

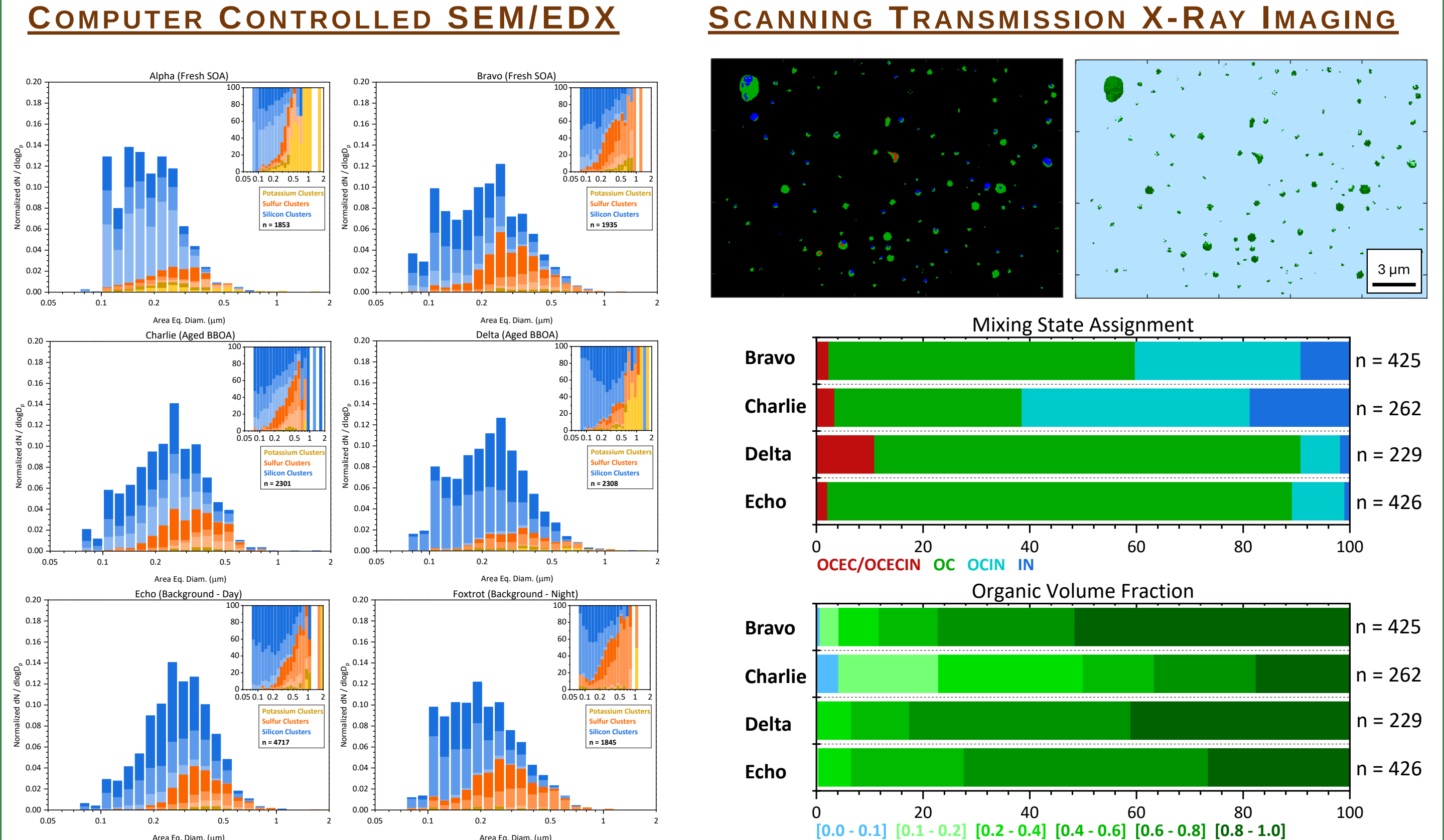


FIGURE 12: Elemental composition of aerosols from each event. Clusters were assigned with a K-means clustering algorithm. There is not much variation in the inorganic composition between samples. **FIGURE 13:** Top: representative Carbon map and OVF map of imaged samples. The lack of soot in nightly peaks suggests that SOA with BrC spectral characteristics is forming as temperature drops and RH increases.

Molecular Composition of Bulk OA

TPD-DART-HRMS / HPLC-ESI-HRMS ANALYSIS Particles impacted on AE33 tape were used as bulk samples.

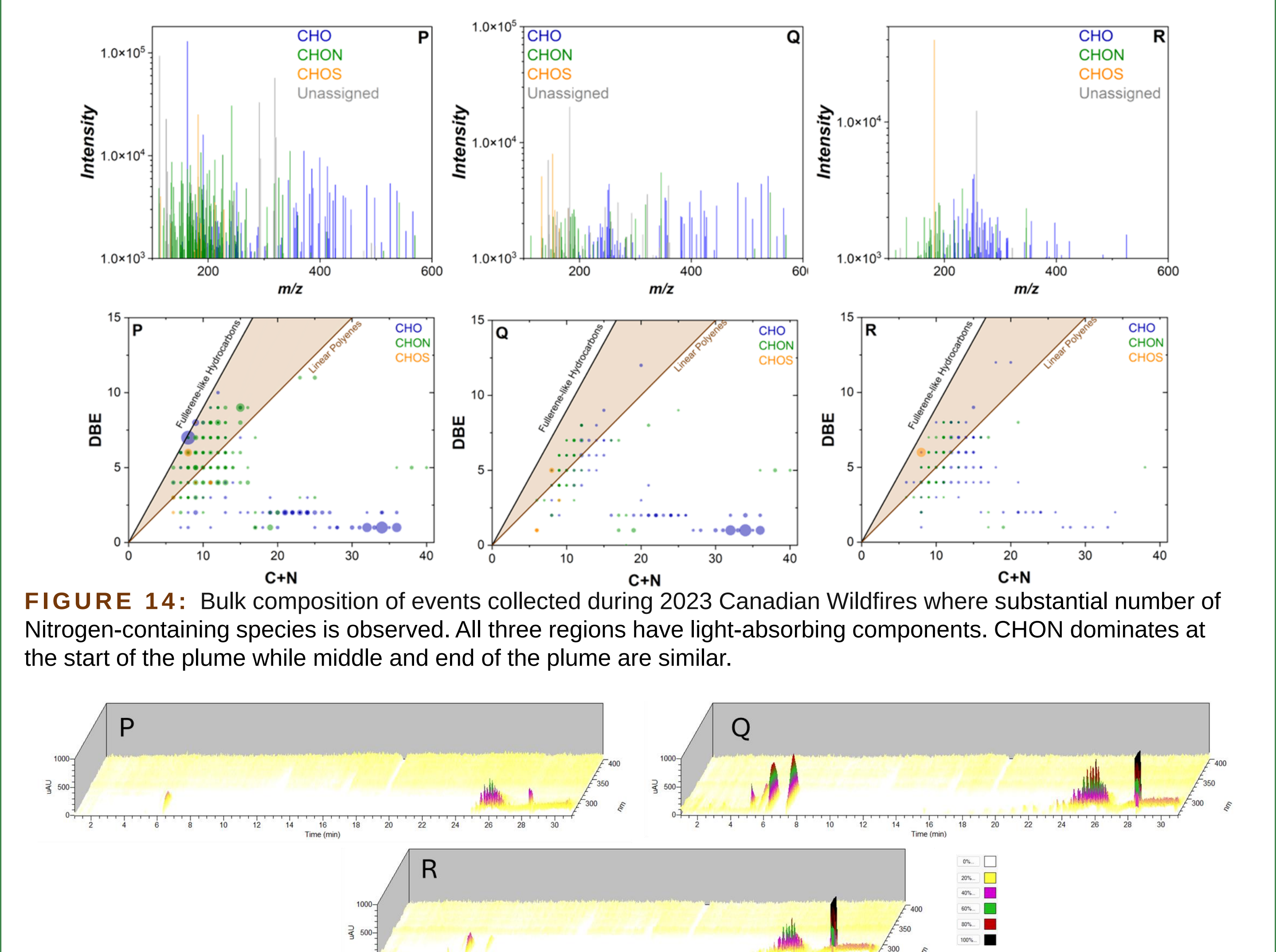
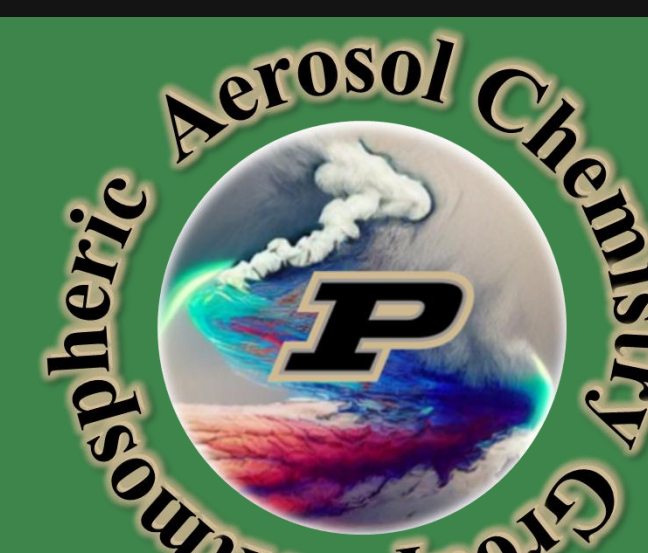


FIGURE 14: Bulk composition of events collected during 2023 Canadian Wildfires where substantial number of Nitrogen-containing species is observed. All three regions have light-absorbing components. CHON dominates at the start of the plume while middle and end of the plume are similar. **FIGURE 15:** 3D UV-vis absorption overlay maps from HPLC-PDA as a function of retention time (x-axis) and wavelength (z-axis). The corresponding identification of the light absorbing species is underway.



Acknowledgments

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