Air Quality Before and After Different Types of Rain Events

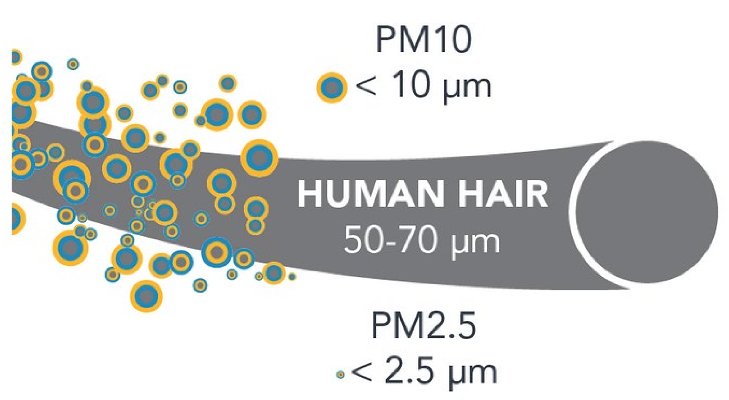
Lily Price[1], Sandra E. Yuter[1,2], and Matthew A. Miller[1]
[1]Department of Marine, Earth, and Atmospheric Sciences, and the [2]Center for Geospatial Analytics
North Carolina State University, Raleigh, NC

NC STATE

ENVIRONMENT ANALYTICS
environmentanalytics.com

Motivation

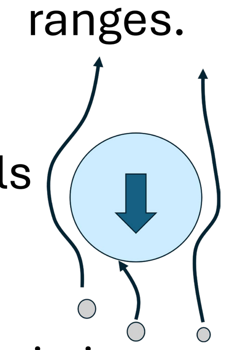
Atmospheric aerosols are a mixture of combustion products, industrial emissions, smoke, dust, and pollen and have negative impacts on human health. Different types of aerosols have different chemical compositions and sizes.



Air quality monitoring subsets particles by size ranges.

https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health

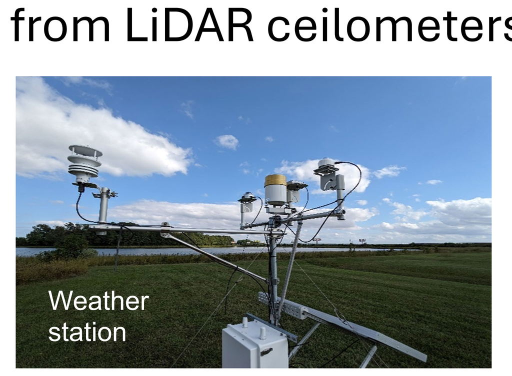
Rain removes a portion of aerosols when particles get swept up into falling rain drops.



Aerosol scavenging (removal) by rain is currently oversimplified in most weather models. Information on observed variations in aerosol as a function of weather conditions, particularly rainfall intensity and duration will aid in improving understanding of this process.

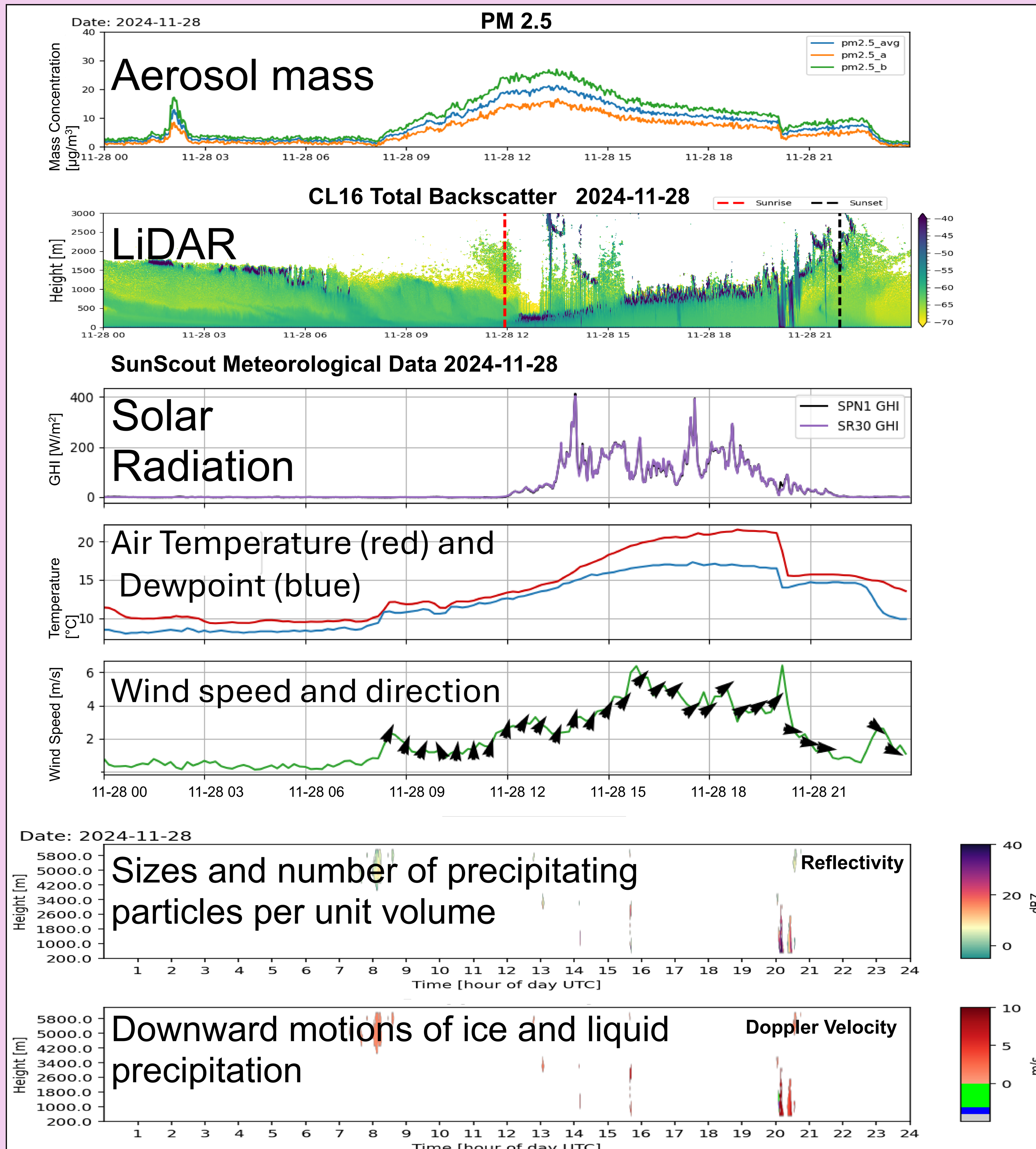
Methods

We use data from the Eastern Carolina Atmospheric Observing Site in Plymouth, NC. Observations include near surface aerosol mass from a PurpleAir air quality sensor, meteorological variables from a weather station, vertical profiles of precipitation occurrence and intensity from a Micro Rain Radar (MRR), and vertical profiles of aerosol backscatter and shapes from LiDAR ceilometers.

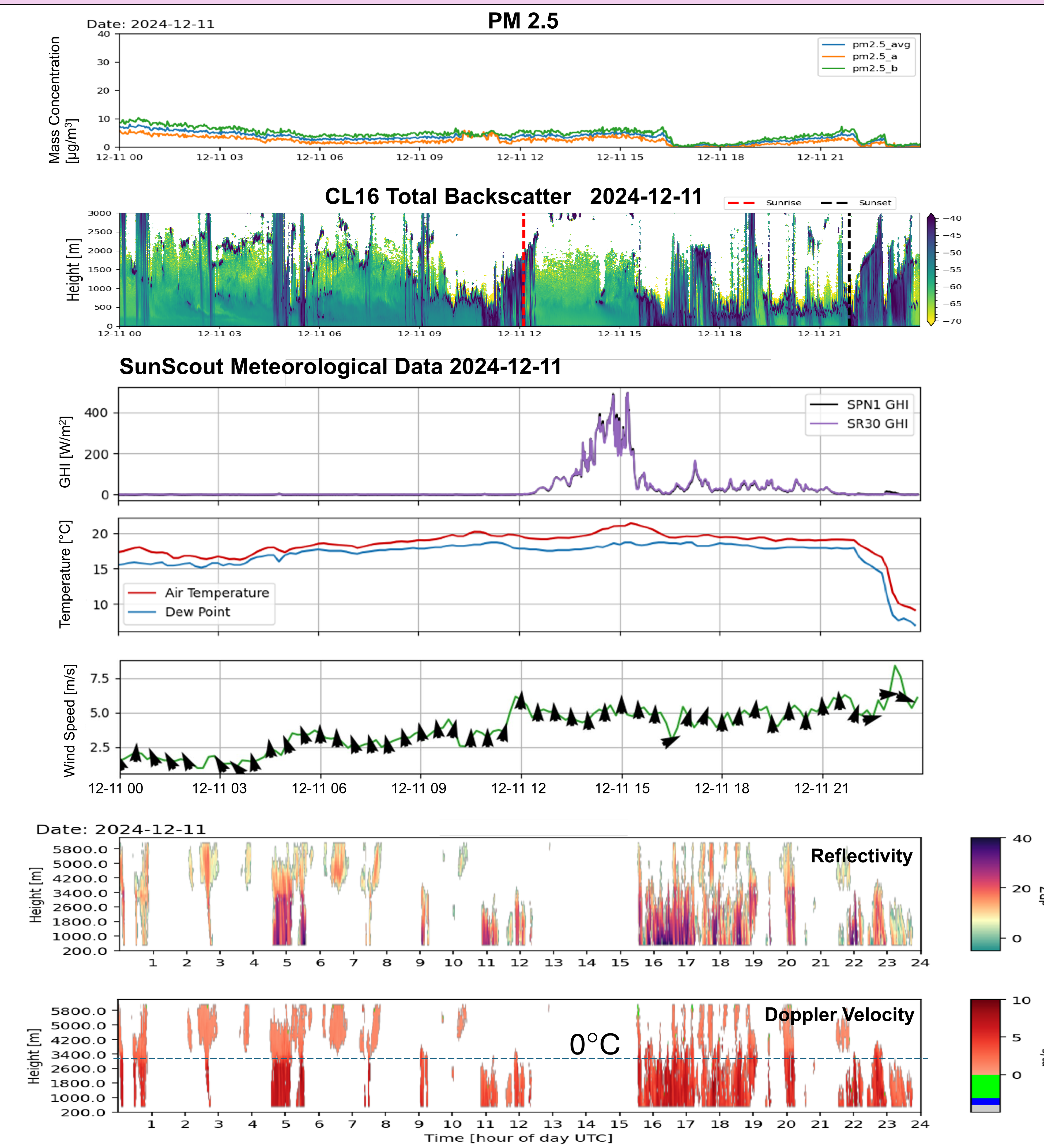


Acknowledgements

Seasonal PM2.5 maps from Josey et al., 2023: *BMJ Open,* doi.org/10.1136/bmjopen-2023-072810. Thank you to Wayne Johnson, Warren Lewis, Rebecca Moore, and Philip Zimmer for their feedback. Funded the Office of Naval Research grant N000142412216 and Robinson Brown donation in support of undergraduate research.

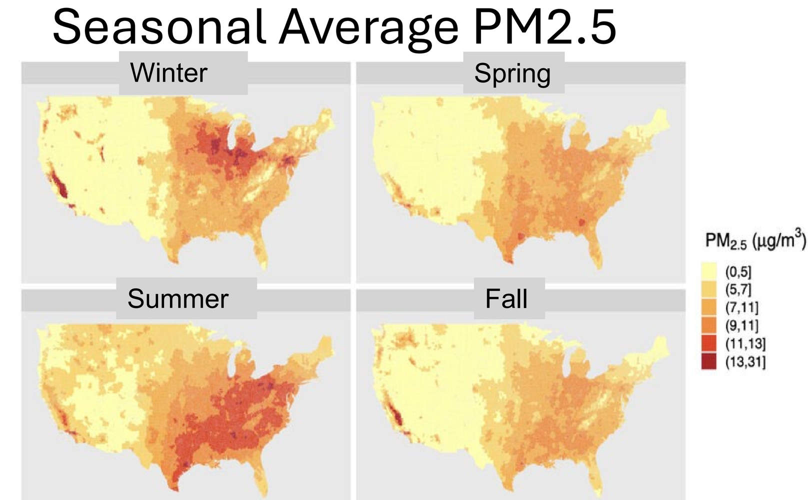


On 28 Nov 2024 aerosol mass peaked a few hours after sunrise and then gradually declined as low-level mixing and turbulence increased during the day spreading the near surface aerosol across a thicker layer of air. There was a short rain event between 20 and 21 UTC that yielded a steep drop in PM 2.5 mass from about 10 to 5 µg/m³.



On 11 Dec 2024 there are rain showers throughout the day. Compared to 28 Nov 2024, this day had a lower baseline of aerosol mass. The longer rain event between 1540 and 19 UTC included a notable drop in PM 2.5 mass from about 7 to 1 µg/m³ and the rain event near sunset at 22 UTC had a drop in PM 2.5 mass from about 5 to 1 µg/m³.

Seasonal Average PM2.5



Summary and Future Work

- The observations shown above illustrate two examples from a preliminary analysis which indicates a wide range of changes in aerosol mass within different rainfall events and atmospheric boundary layer structures.
- The factors controlling near surface quality are complex and often involve a superposition of factors including the degree of mixing of the lower atmosphere, transitions between air masses with different baseline aerosol loads, pulses of air pollution, as well as scavenging.
- Next steps will involve looking at a lot more examples to examine the joint variability of aerosol characteristics and different weather conditions. As part of the analysis, we will need to identify events when there is a superposition of factors that can modify aerosol mass.