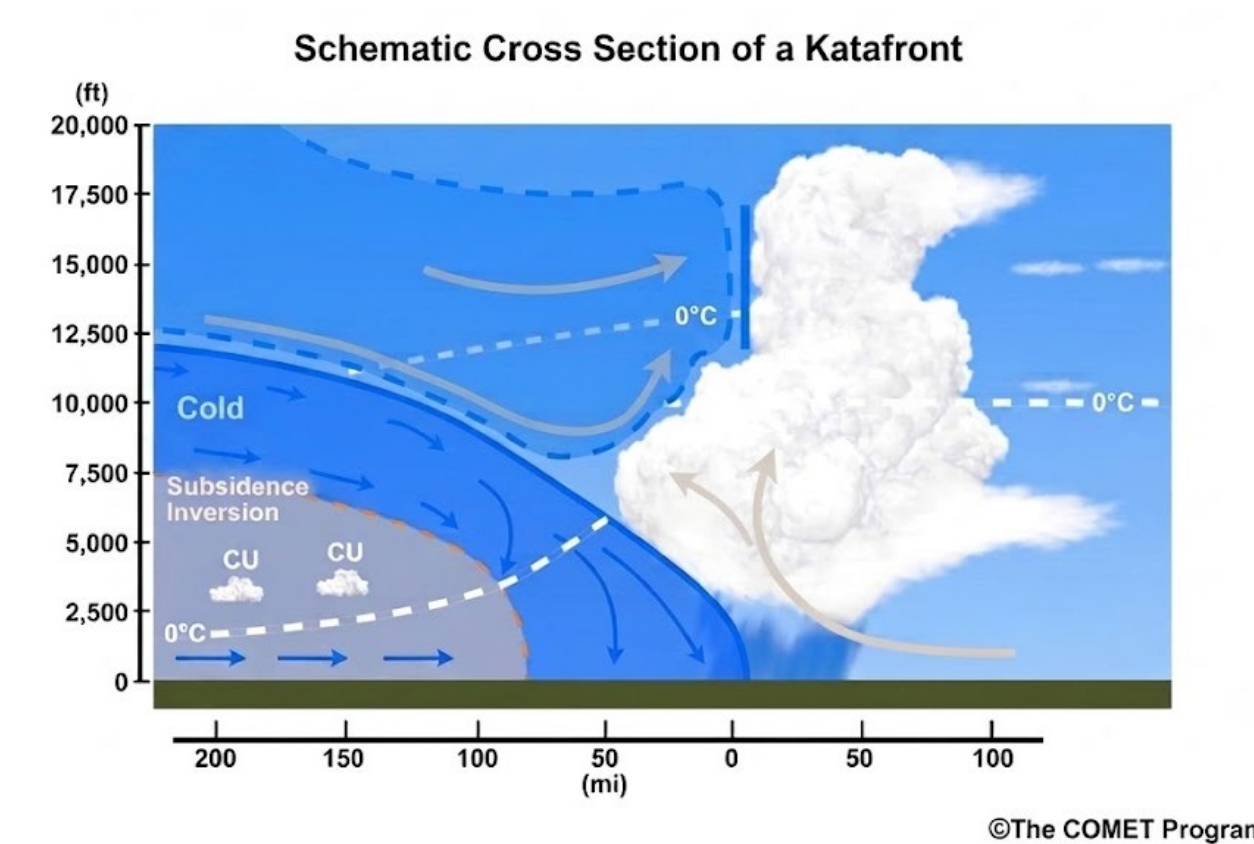


Motivation

Examination of real-world cases helps students bridge the gap between idealized examples in textbooks and practical applications of concepts. When looking at naturally-occurring cold-fronts, variables including wind direction, cloud and precipitation timing, and presence of clouds are not as consistent as introductory textbooks suggest.

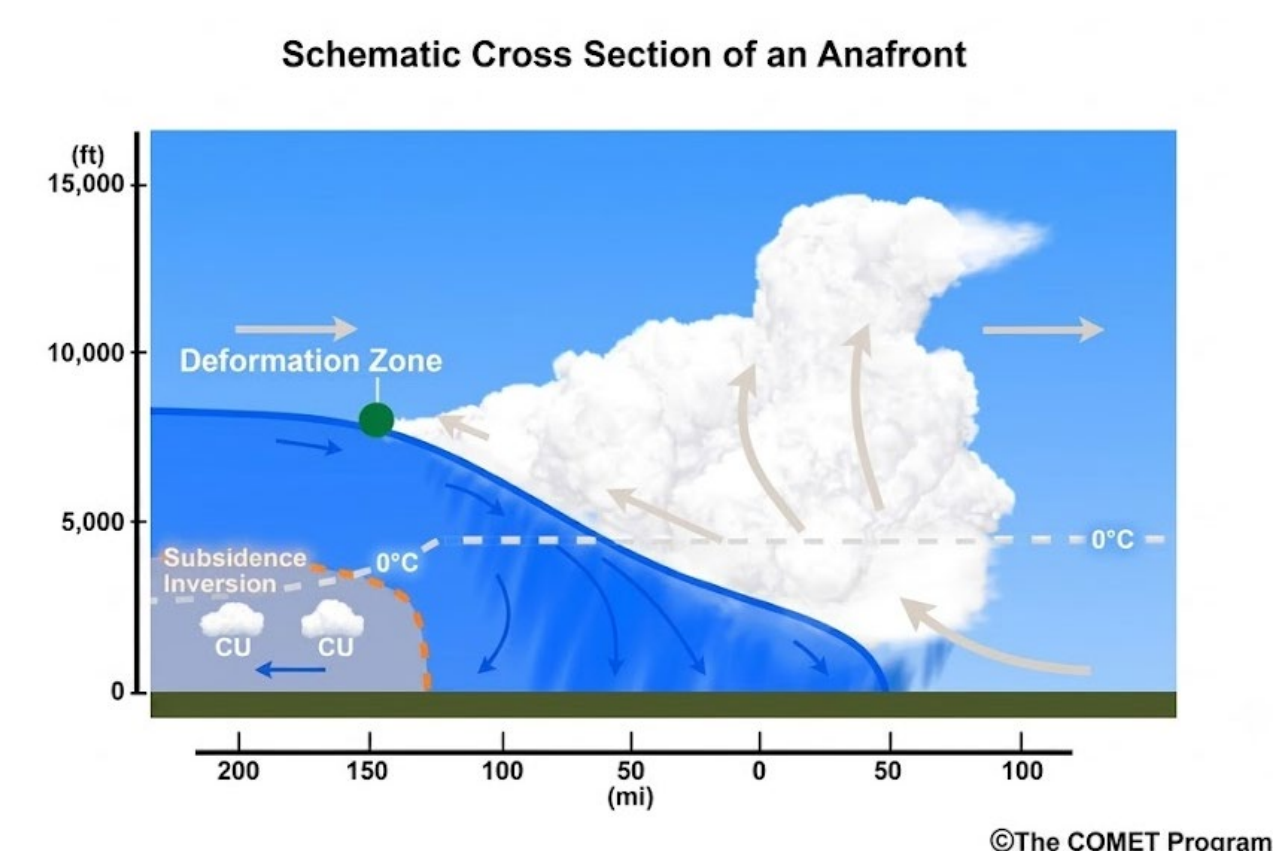
Katabatic Cold Fronts

- Dry air aloft
- Rain occurs before and/or during the frontal passage
- Period of rainfall is typically short
- Clear skies after the passage
- Stronger winds on the cold side



Anabatic Cold Fronts

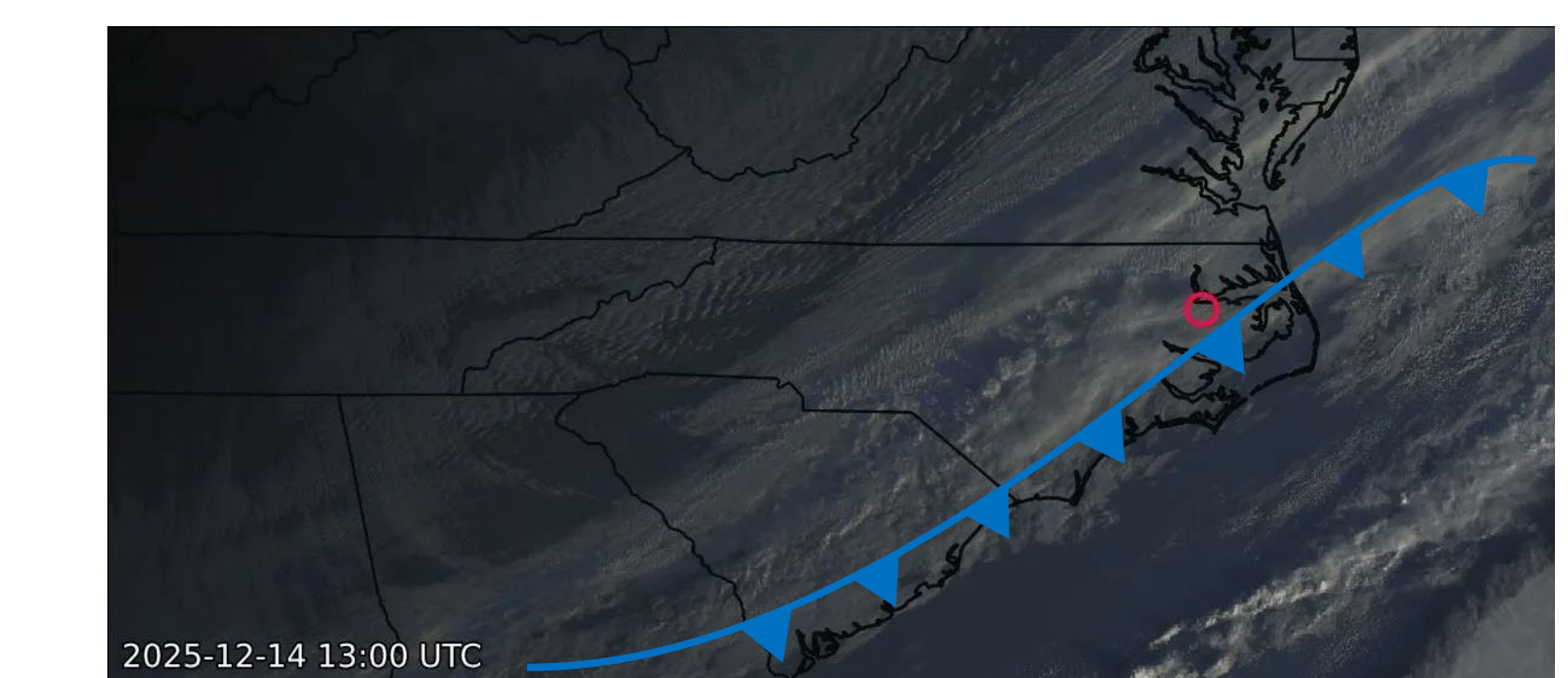
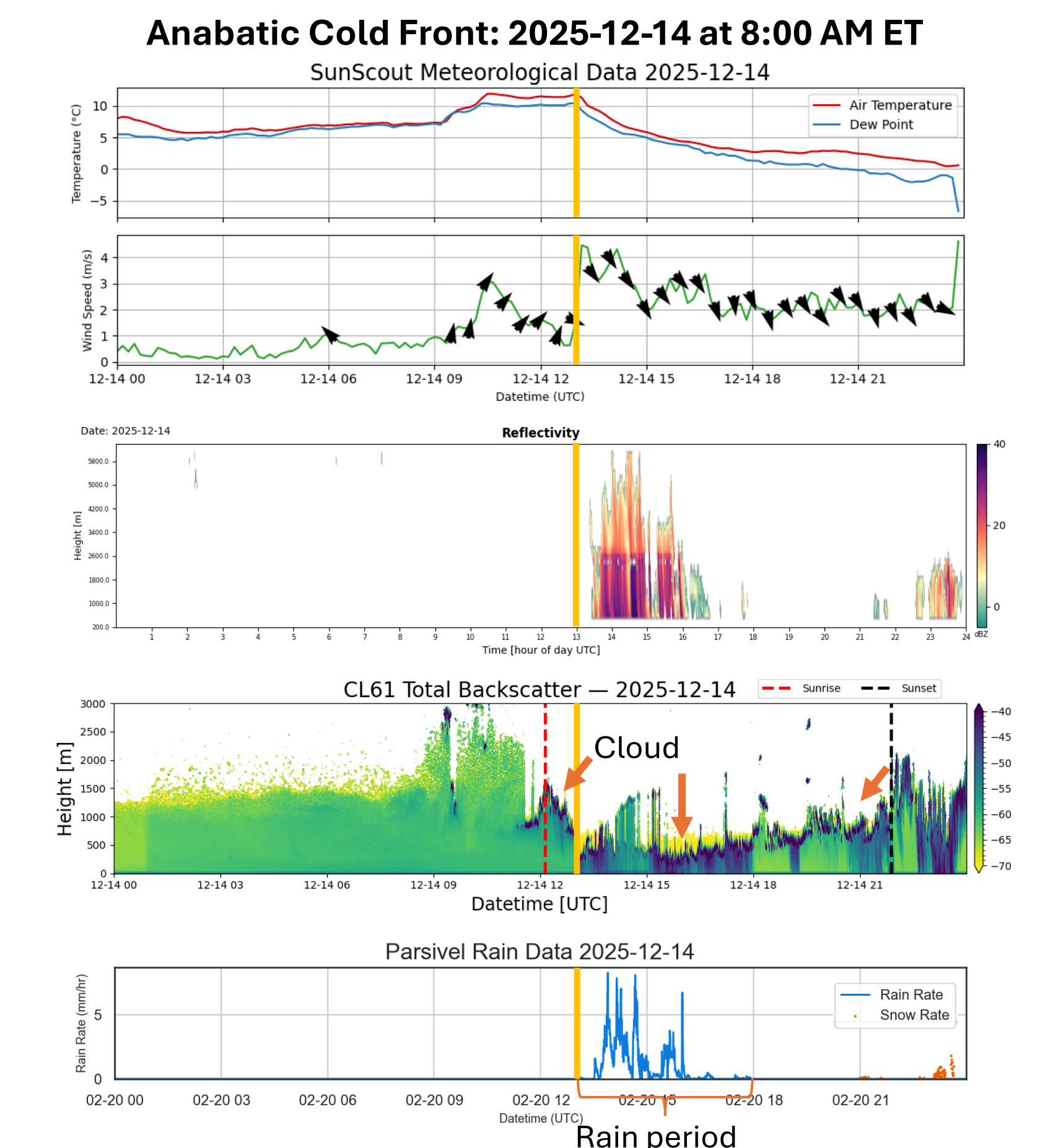
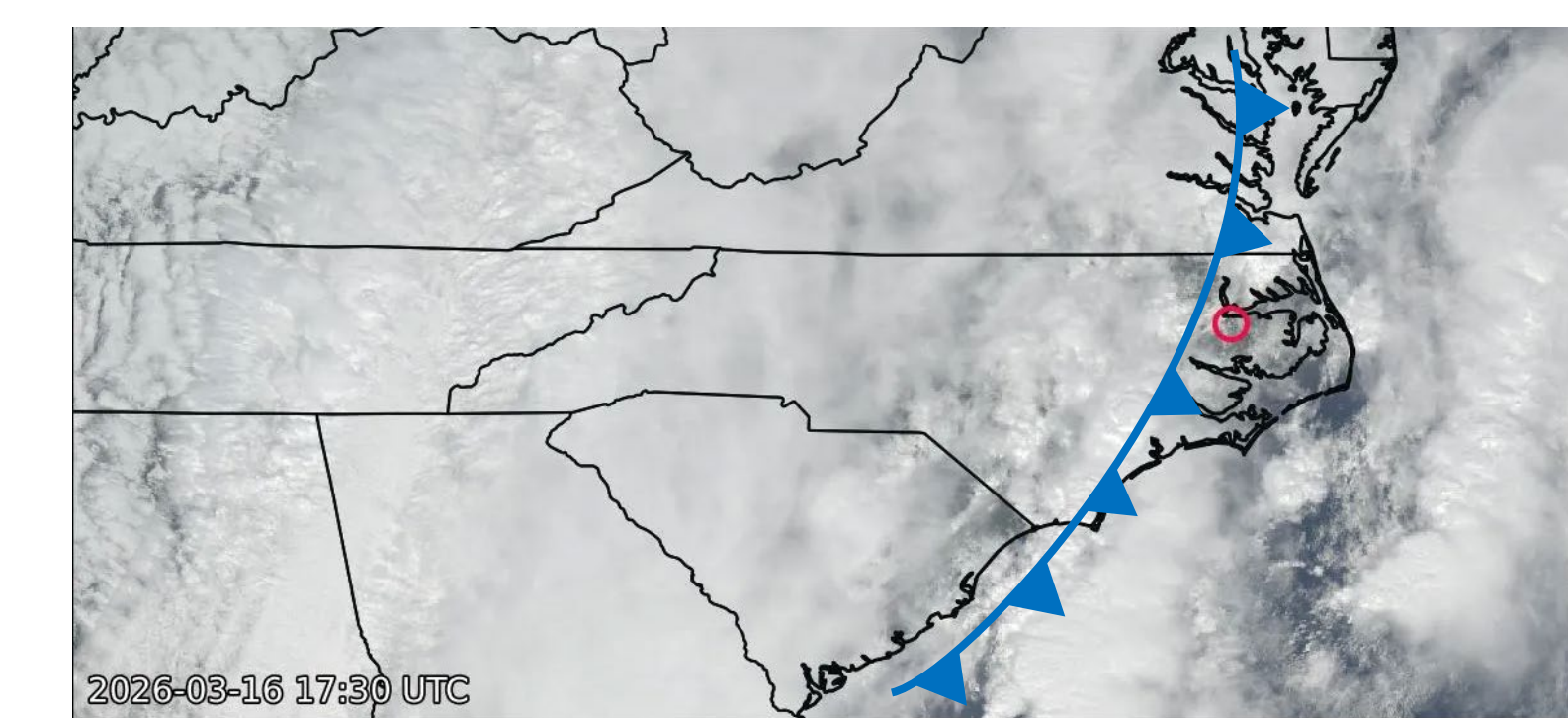
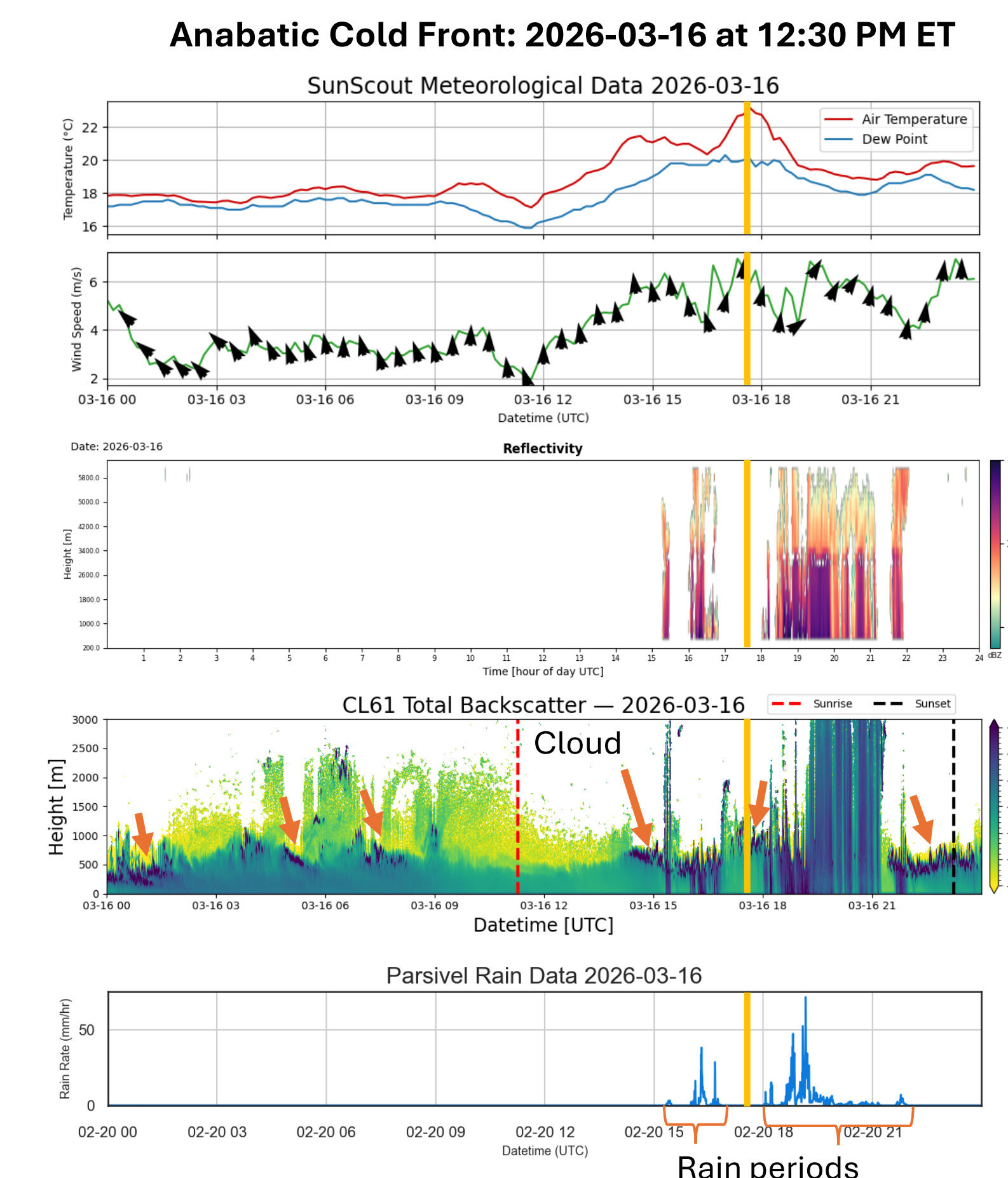
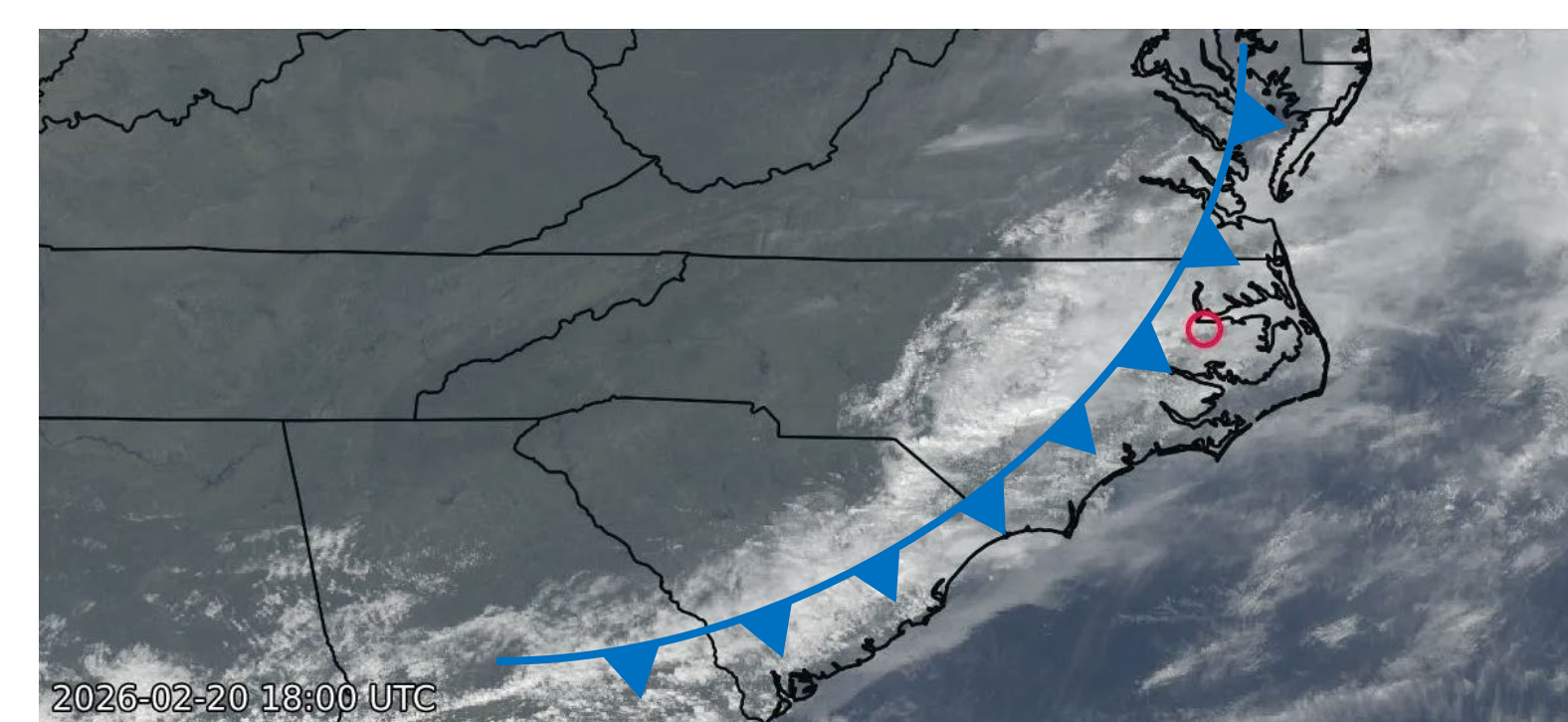
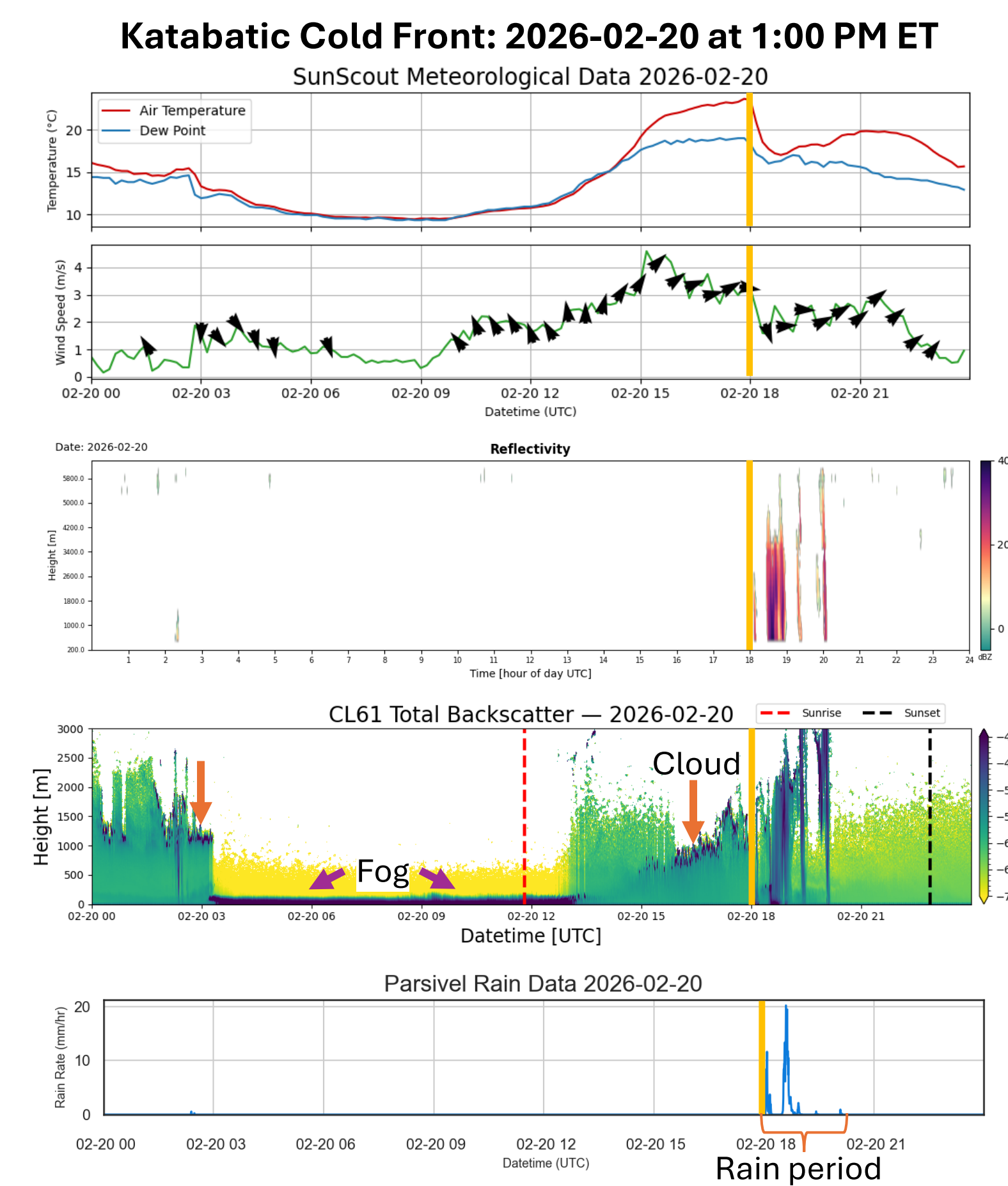
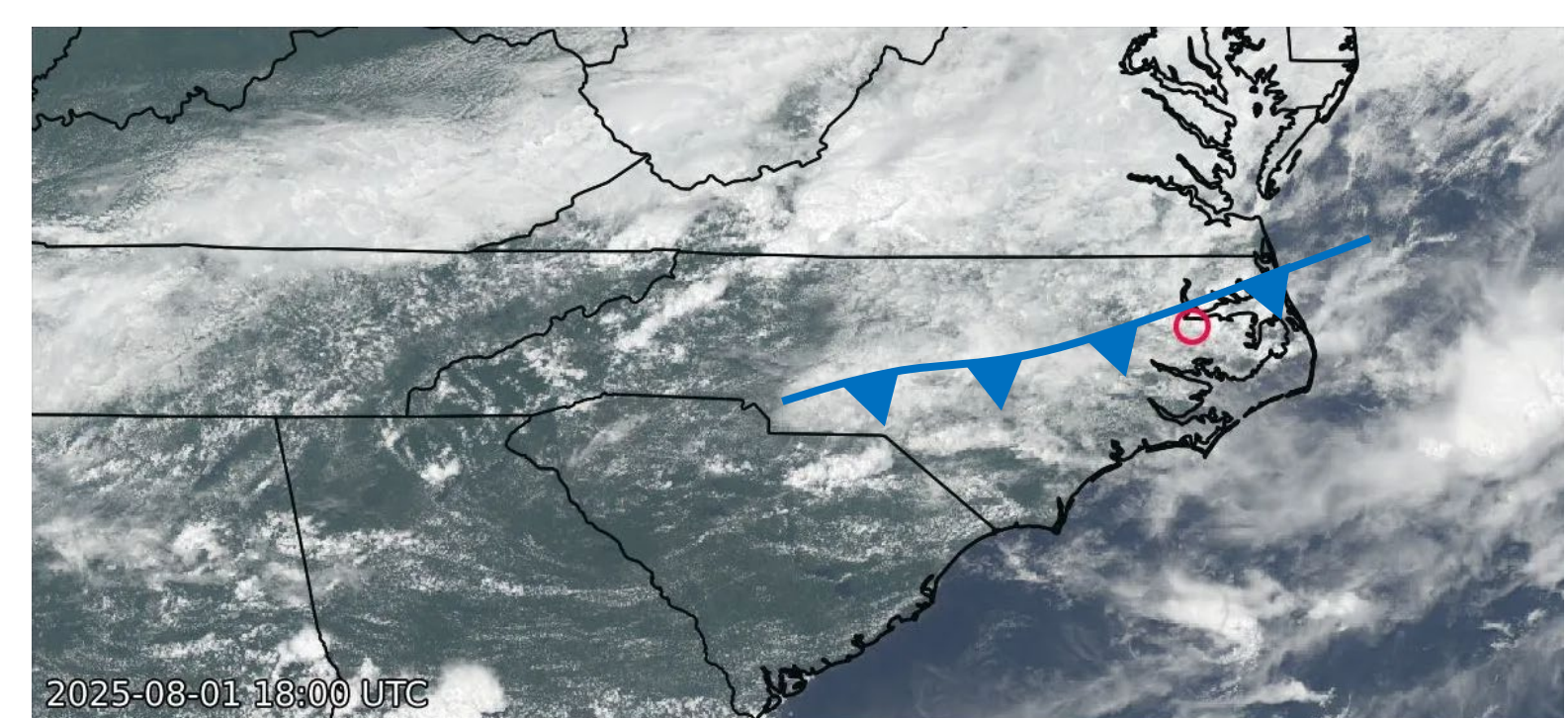
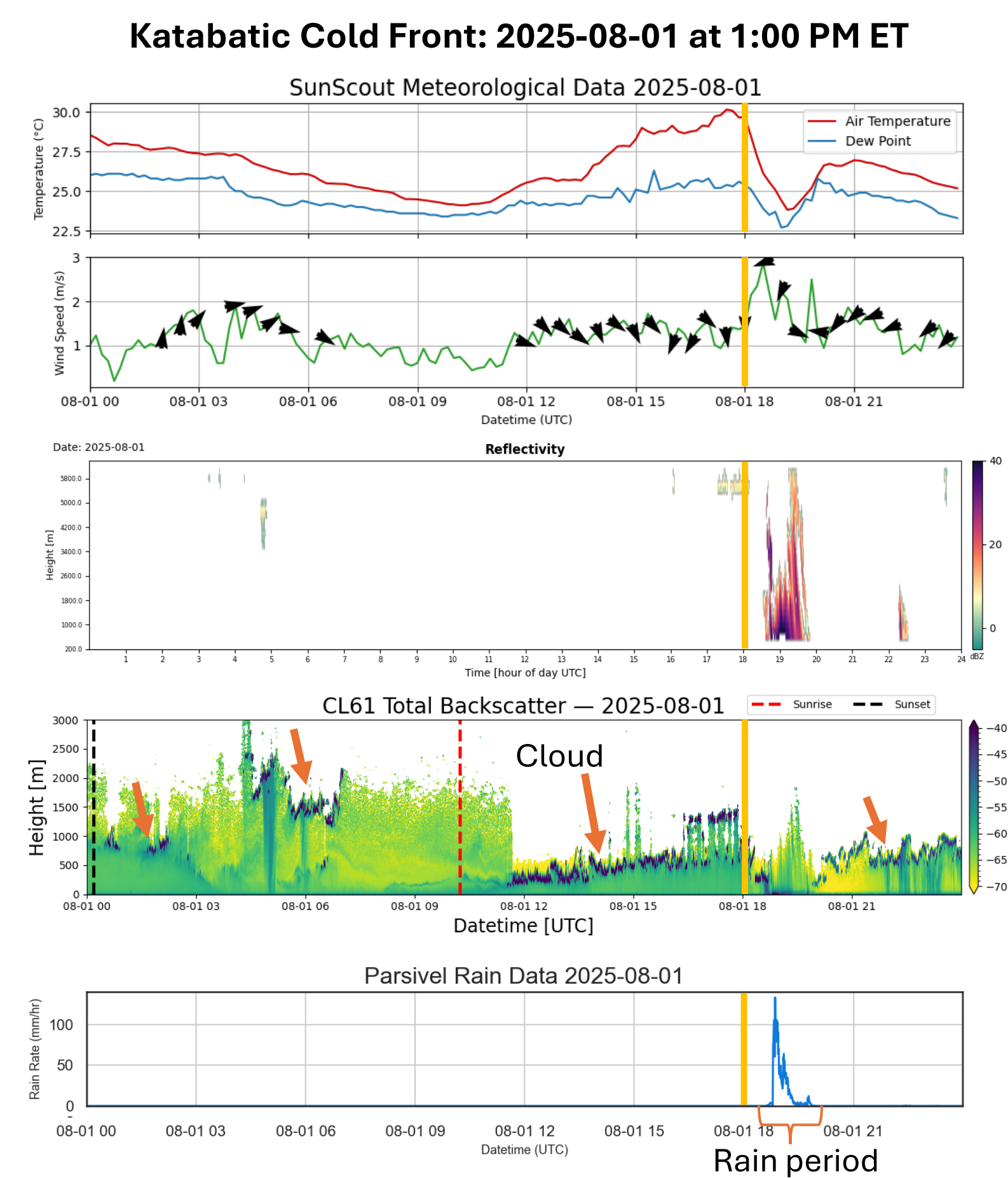
- Humid air aloft
- Rainfall occurs during and/or after the frontal passage
- Skies do not clear after the passage
- Rainfall lasts longer than a katabatic front
- Weak winds after the front



Methods

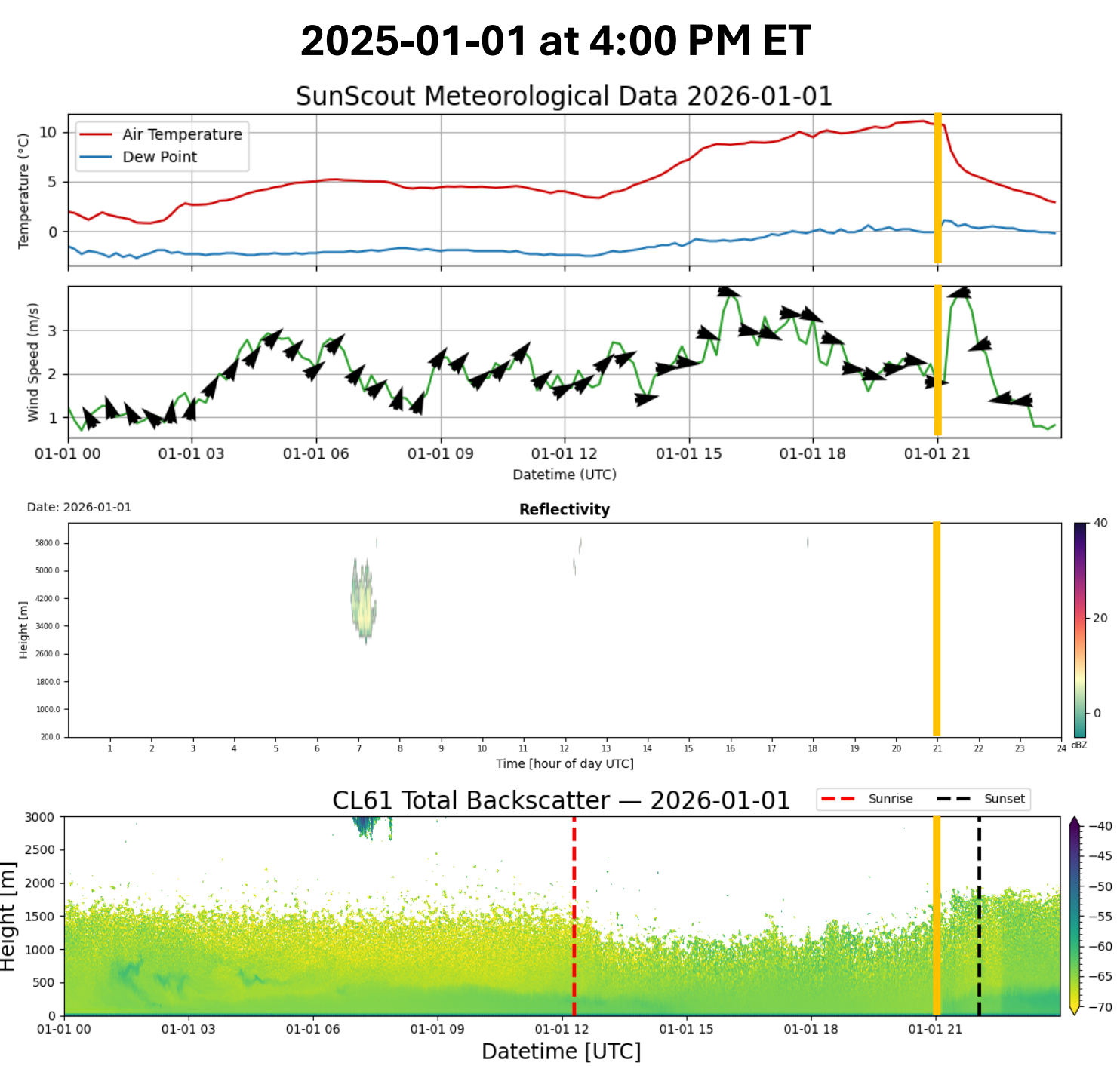
We examined data for 35 different cold fronts passing over the Eastern Carolina Atmospheric Observing Site in Plymouth NC. For temperature, dew point, and wind data, we used the Sunscout Meteorological data. For precipitation, we used profiles of radar reflectivity, profiles of LiDAR backscatter, and disdrometer rain rates. We took note of how far ahead of the front clouds and rain appeared, how long they lasted, and how winds and clouds changed with the frontal passage. To confirm if a front was katabatic or anabatic, we used sounding data from Newport, NC (~121 km from Plymouth) to determine how humid the air aloft was.

Real-world Cases



Cloudless Cold Front

One of 6 cold front cases in our sample of 35 that do not have pre-frontal clouds or precipitation. The temperature and wind direction signals of frontal passage are clear. The dewpoints are low (near 0 °C), consistent with dry air masses that do not have sufficient moisture to form clouds.



Summary of Findings and Future Work

- Real-world cold fronts can vary considerably from idealized examples found in textbooks
- Most fronts had pre-front clouds and some change in cloudiness after passage
- Timing of precipitation is the least consistent condition among front cases even within categories like anabatic and katabatic cold fronts

- 6 of 35 cases did not have any clouds associated with the frontal passage
- For future work, we will use these types of data to determine to what degree we can use pre-frontal conditions to forecast air mass driven changes in clouds

References

Katabatic and anabatic front diagrams source: COMET® Website <https://learn.meted.ucar.edu>. © 1997-2025 University Corporation for Atmospheric Research.

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