Understanding Tropical Cyclone Thermodynamics and Dynamics via Novel Observations and Model Comparisons

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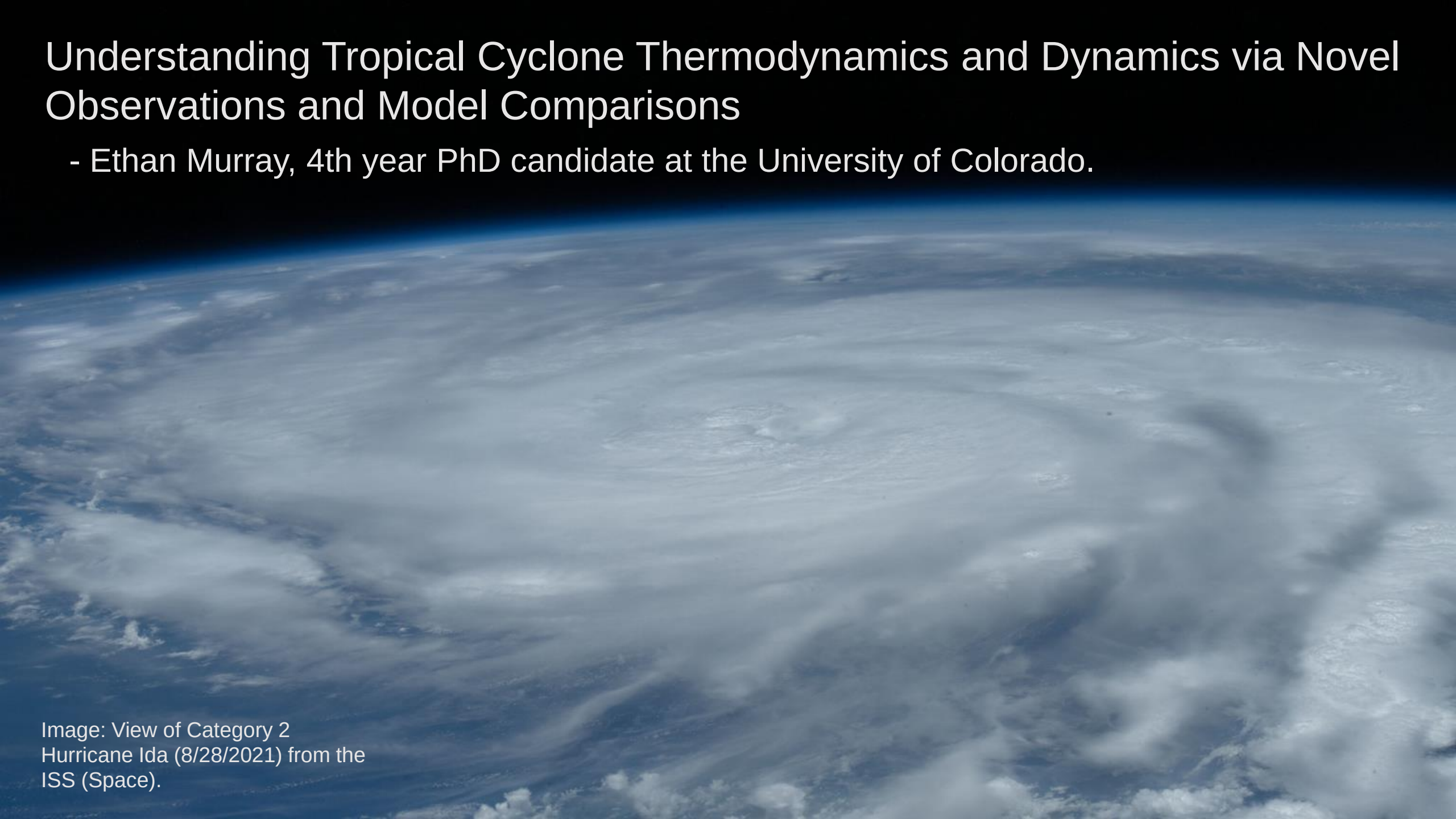
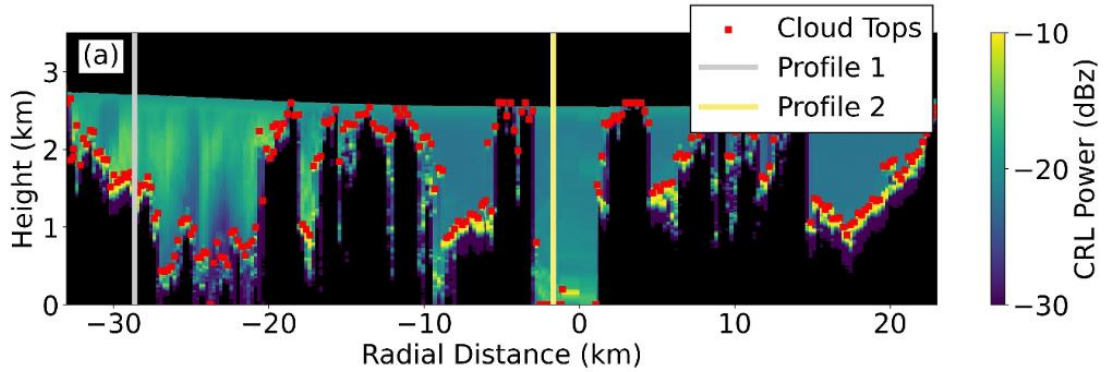
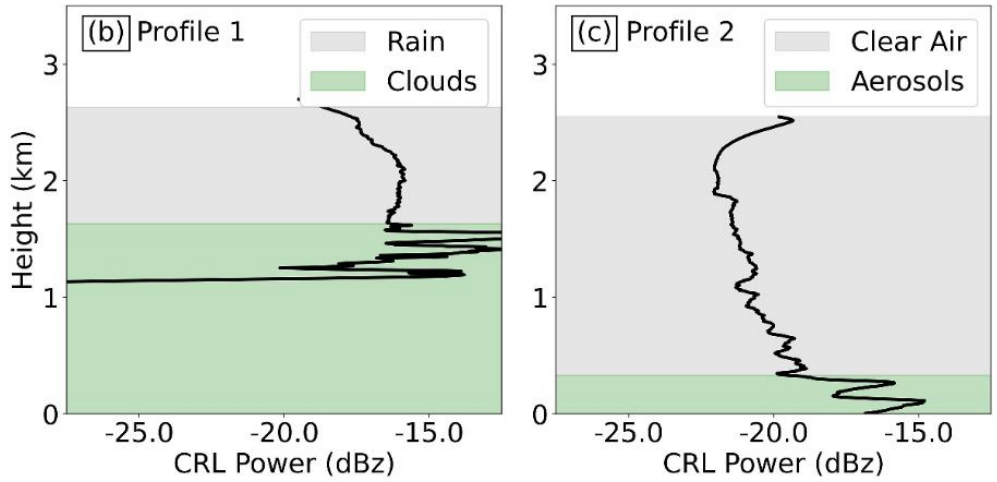


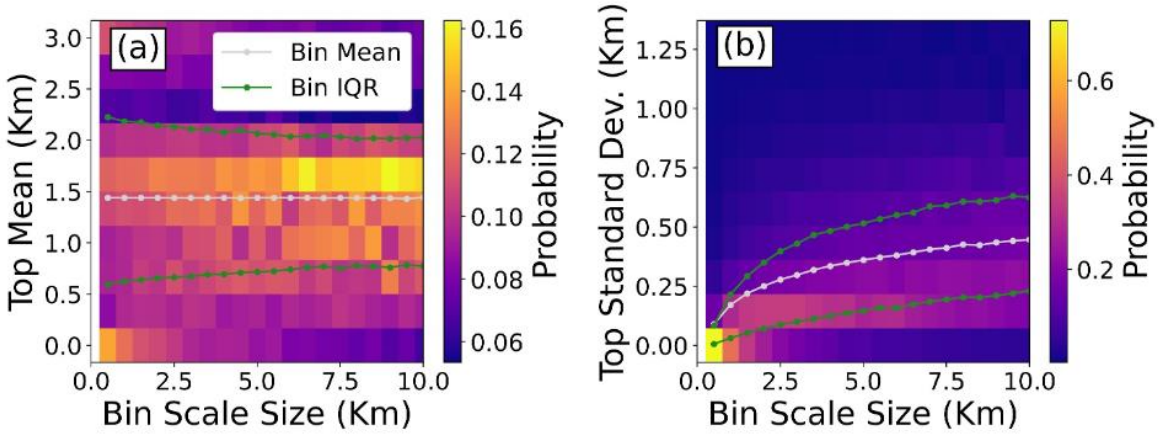
Image: View of Category 2 Hurricane Ida (8/28/2021) from the ISS (Space).

Project 1: New Observations of the TC Eye

- The eye, located at the center of a strong TC, is a region of calm winds, warm air and shallow clouds.
- Radar struggles to detect clouds in this region, as they are often non-precipitating.
- Here, we use the compact Raman lidar (CRL) to detect eye clouds with much higher spatial resolution (top).
- Statistics reveal that low level eye clouds are plentiful and have variable cloud top heights (bottom).
- Eye clouds are related to dynamic mixing processes and thermodynamic environments for a case study (TC Sam, 2021) and for all available profiles.
- Results published in *GRL* in June 2024. Link to article: https://doi.org/10.1029/2024GL108515

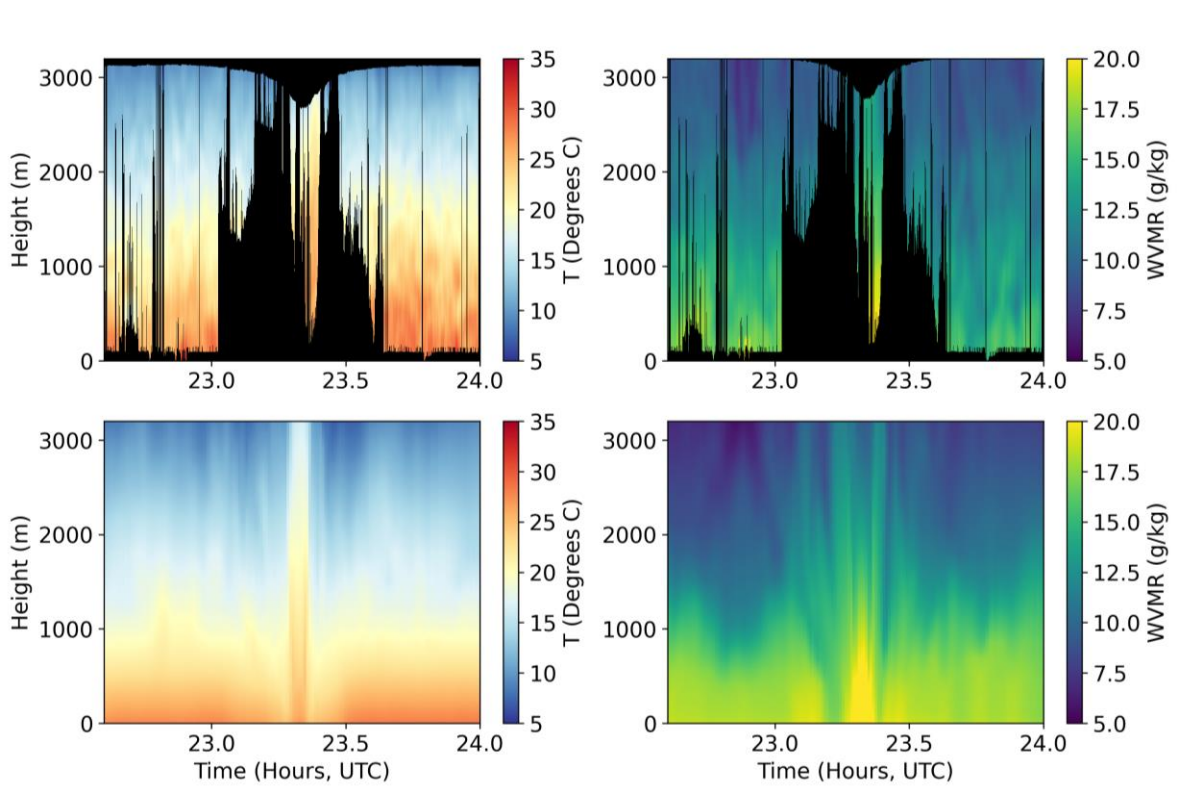


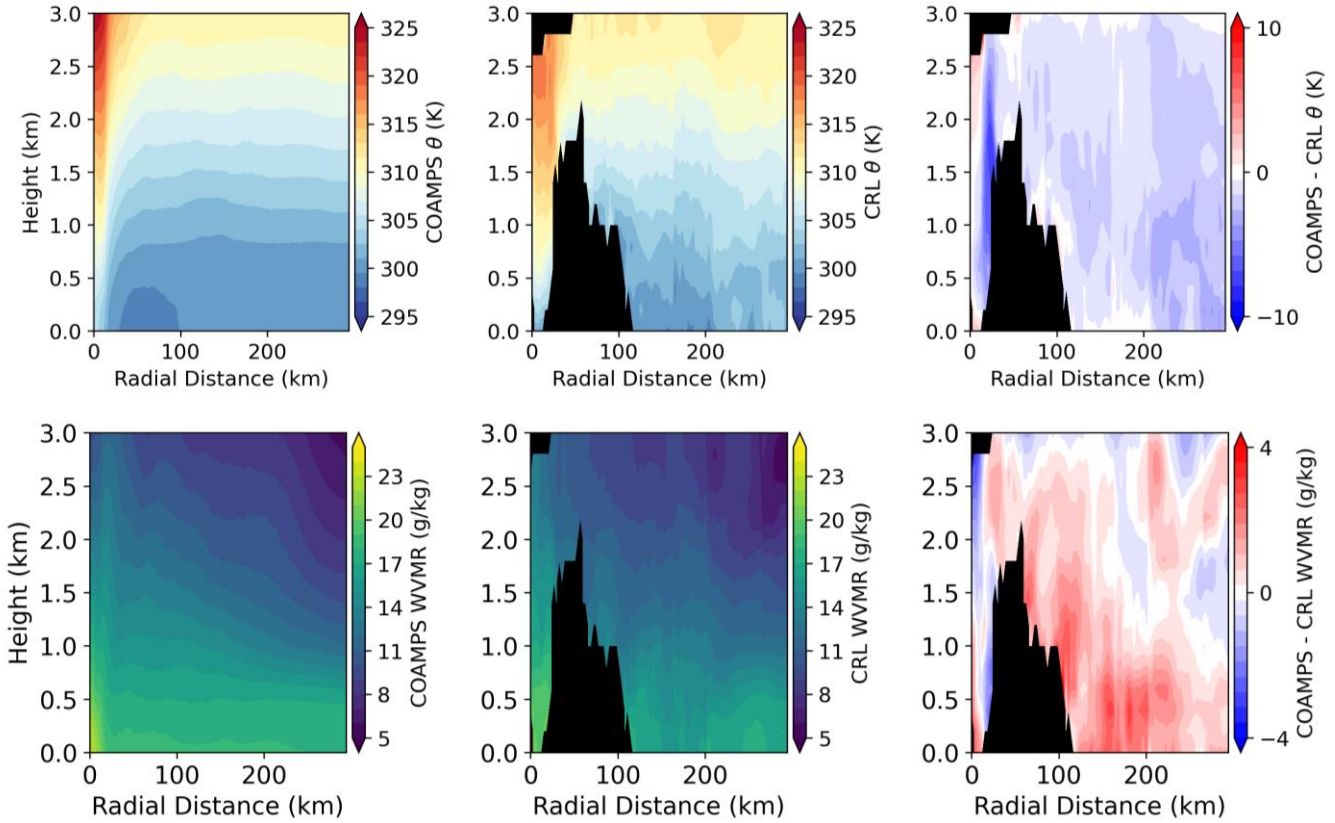




Project 2: Comparisons of COAMPS-TC Boundary Layer to Novel Observations

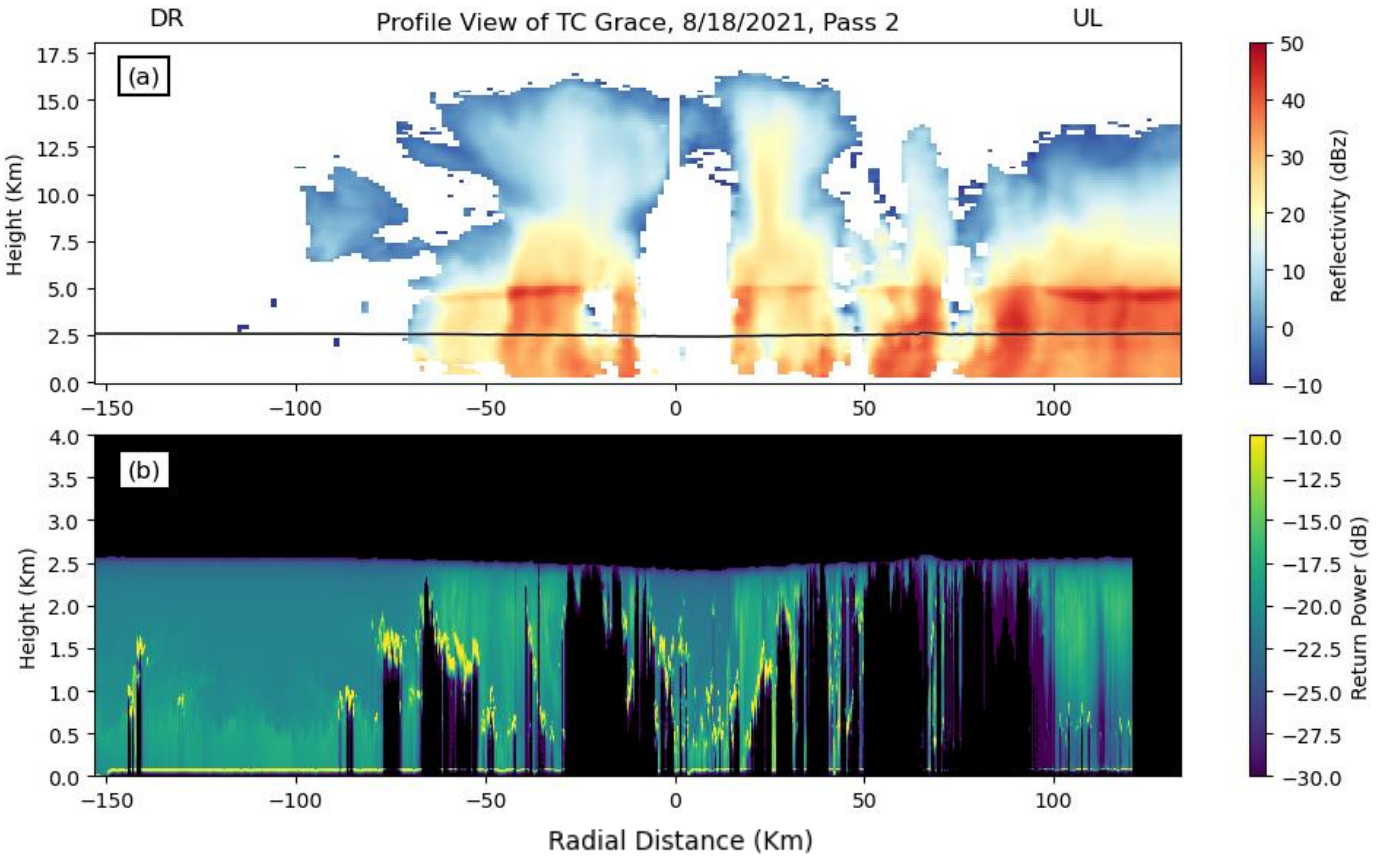
- Submitted to *MWR* in March 2025.
- Compared CRL temperature and moisture profiles to COAMPS-TC forecasts of TC Sam (left).
- After compositing the observations and model data, the low level TC eye is found to be too cold in COAMPS-TC, and the low level TC boundary layer is too moist (right).
- These thermodynamic differences impact TC Sam's intensity forecast in conflicting ways.

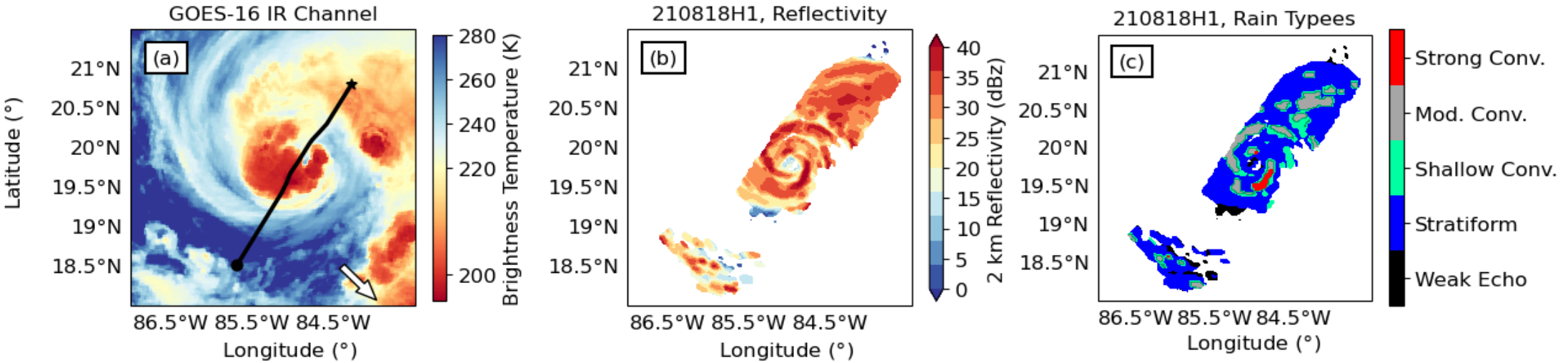




Project 3: New Observations of TC Rainband Clouds and Rainfall Patterns

- Satellites and aircraft radar currently provide estimates of cloud type (bottom).
- Yet, the CRL provides additional insight into low level cloud and rainfall structure (right).
- Algorithms are being developed to use CRL data to reclassify cloud types and improve existing identification methods.





Project 4: Building a Climatology of TC Structure using Dropsonde Observations

- Using the TC-DROPS dataset, the spatial and temporal coverage of dropsondes launched into TCs in the Atlantic Ocean is analyzed (left).
- By comparing first dropsonde locations to HURDAT2 genesis locations, regional sampling biases are identified.
- This method finds reconnaissance gaps in the South North Atlantic (or the Main Development Region), and the South Caribbean.
- First sampling intensities are also higher for these regions.
- TC inner core structural differences are compared across the four basins, searching for internal, rather than external (Majumdar et al. 2023), drivers of intensity change.