Ground-based AERI Temperature Profile Retrievals Under Clouds: A Cold Pool Example

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Background

- AERI has demonstrated ability to:
  - Provide accurate LWP and Reff when LWP < 60 g/m^2
  - Provide profiles of temperature and humidity in clear skies
- New optimal-estimation based AERI retrieval (called *AERIoe*) developed to simultaneously retrieve profiles of temperature and water vapor together with cloud properties
  - Turner and Löhnert JTECH 2013 (in review)
- AERIs deployed at Lamont and Garber X-band radar sites around the CF for the MC3E field experiment
- Interesting outflow event occurred 25 May during MC3E
  - Mesonet data suggested only Lamont experienced cold pool, not Garber
  - AERI retrievals seem to support this view and demonstrate depth of cold pool

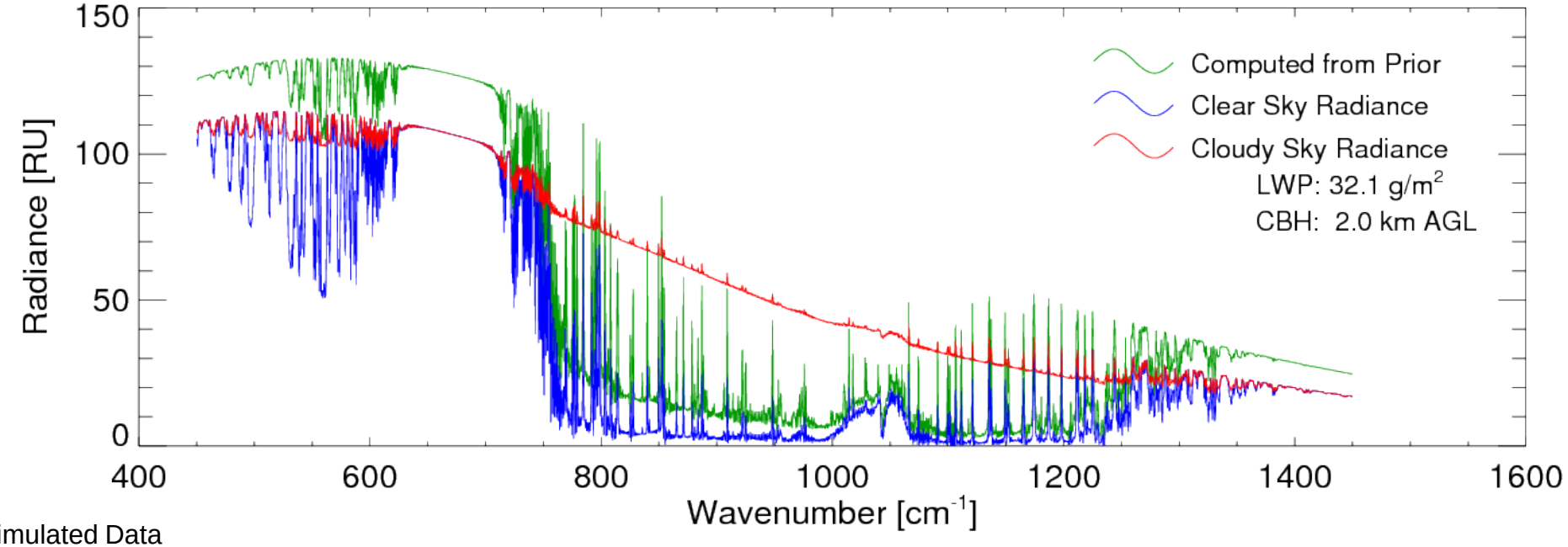
State Vector (What I am Retrieving)

$$\mathbf{X} = \begin{cases} \text{Temperature } (z_0) \text{ [C]} \\ \text{Temperature } (z_1) \text{ [C]} \\ \quad \ldots \\ \text{Temperature } (z_n) \text{ [C]} \\ \text{Water Vapor } (z_0) \text{ [g/kg]} \\ \text{Water Vapor } (z_1) \text{ [g/kg]} \\ \ldots \\ \text{Water Vapor } (z_n) \text{ [g/kg]} \\ \text{Methane (column) [ppm]} \\ \text{Nitrous Oxide (column) [ppm]} \\ \text{Carbon Dioxide (column) [ppm]} \\ \text{Cloud Liquid Water Path (column) [g/m}^2\text{]} \\ \text{Cloud Liquid Effective Radius (column) [µm]} \end{cases}$$

Future Additions

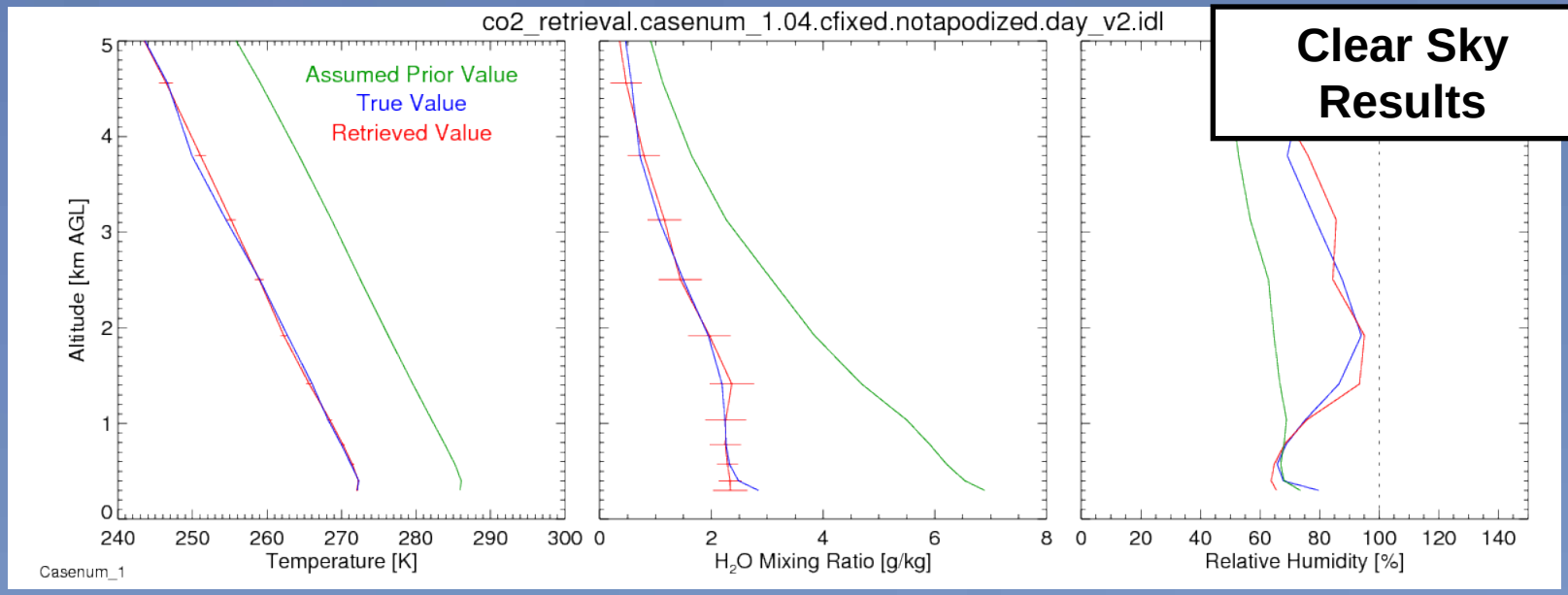
- Cloud Effective Height [km]
- Cloud Ice Water Path (column) [g/m^2]
- Cloud Ice Effective Radius (column) [µm]

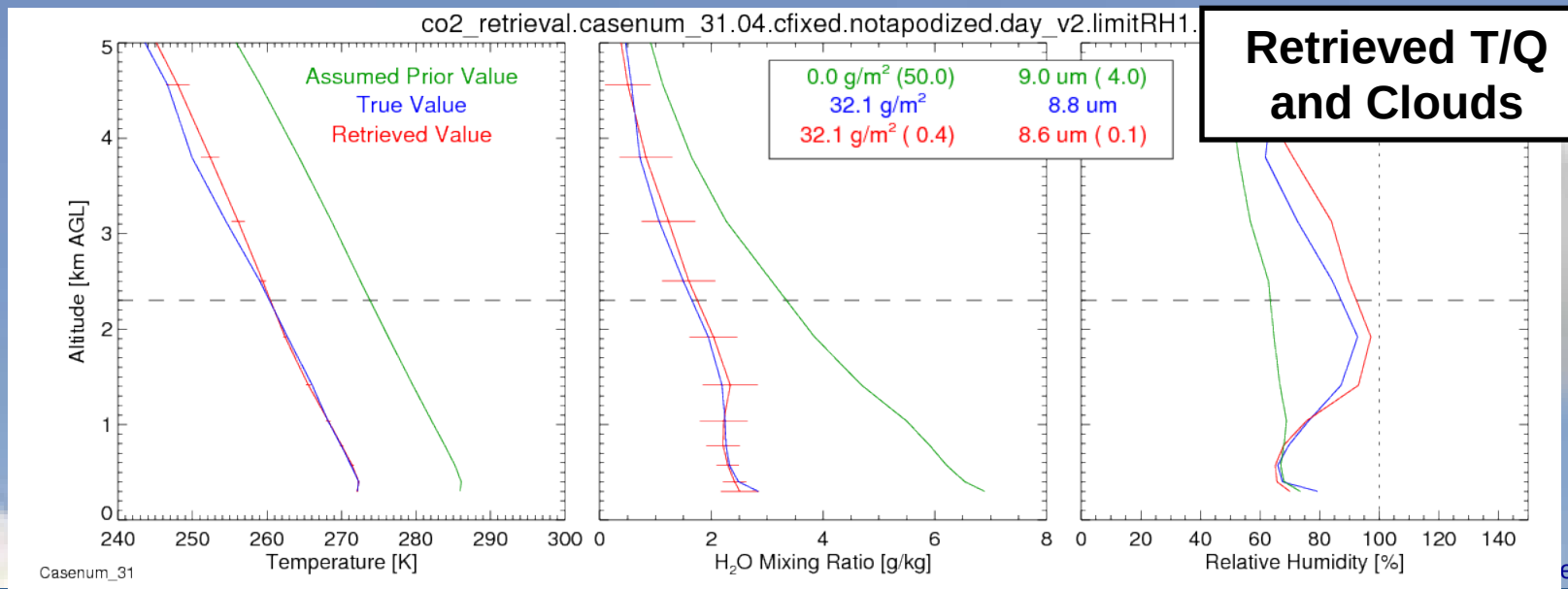
Cloudy Sky Retrieval Example (1)



Simulated Data

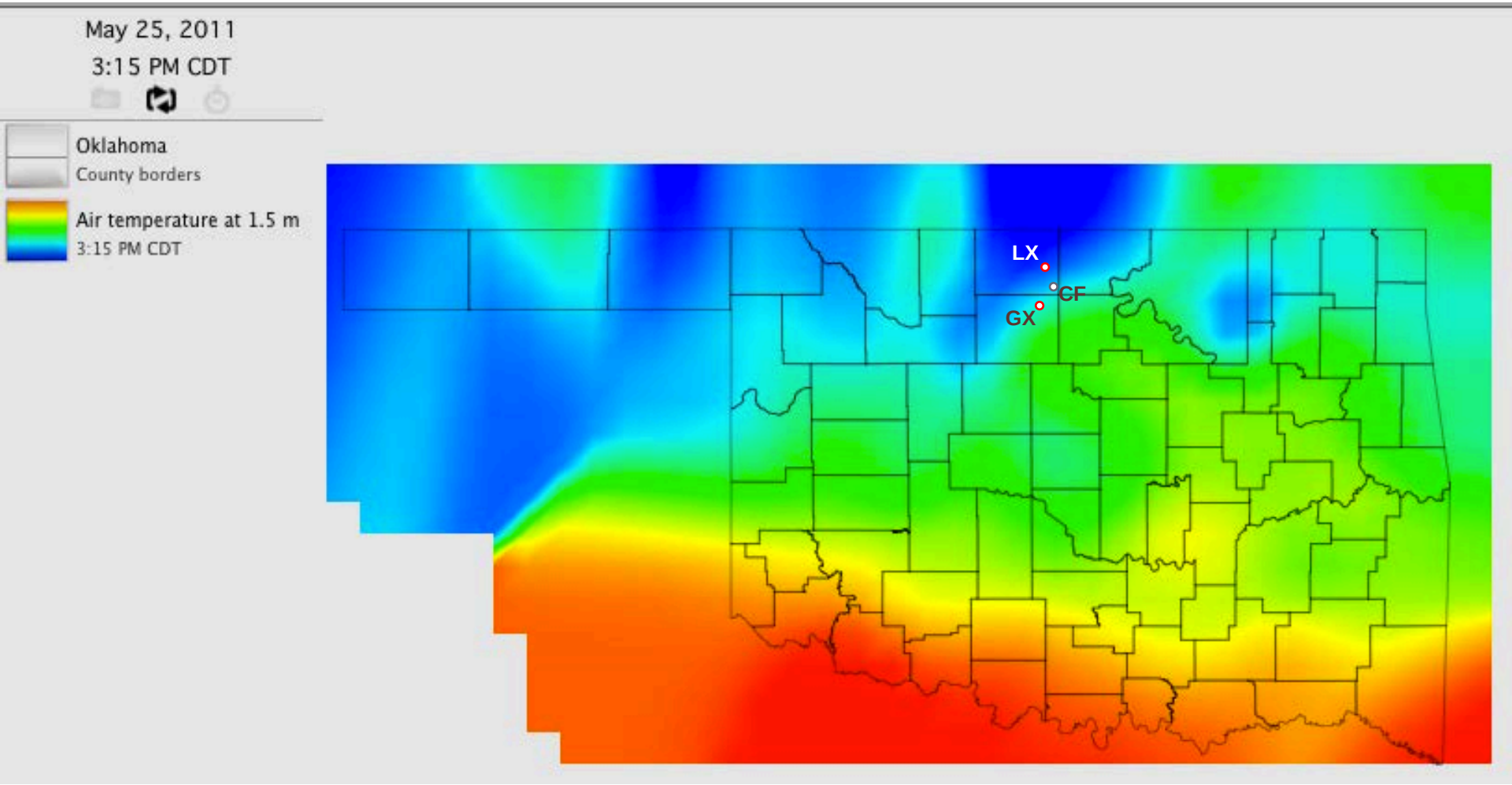
Cloudy Sky Retrieval Example (2)





Surface Conditions from OK Mesonet

Temperature at 20:15 UTC on 25 May 2009



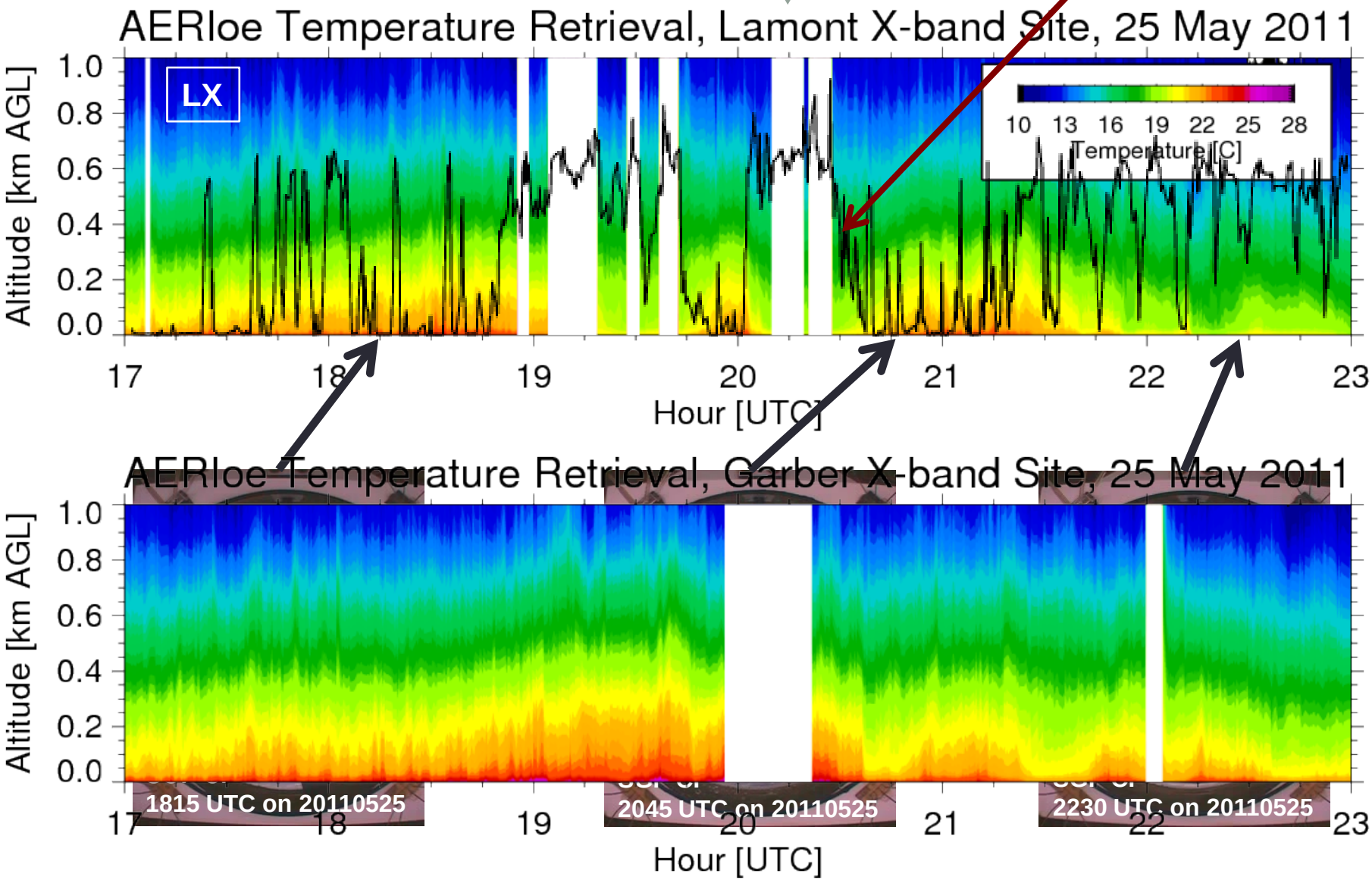
LX – Location of Lamont X-band Radar

GX – Location of Garber X-band Radar

Vertical white bars indicate times when the hatch was closed or retrieval did not converge

Time of Mesonet Image

Retrieved LWP



Summary

- A new algorithm has been developed to retrieve liquid water cloud properties and temperature/humidity profiles simultaneously from AERI observations
  - Will be extended to also retrieve ice cloud properties
- Iterative algorithm is ….slow….
  - Work in progress to speed it up
- Able to directly quantify retrieval uncertainty and information content of the observations
- Initial analysis suggests that temperature profiles in cloudy scenes very good
  - Water vapor profiles not quite as good, but ideas on how to improve
- MC3E case demonstrates AERI can capture rapid changes in the temperature profile during outflow events