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DSD Characteristics and Evolution of the Leading Stratiform Region of a Tornadic QLCS during PERiLS-2022 IOP#2 (30 March 2022).

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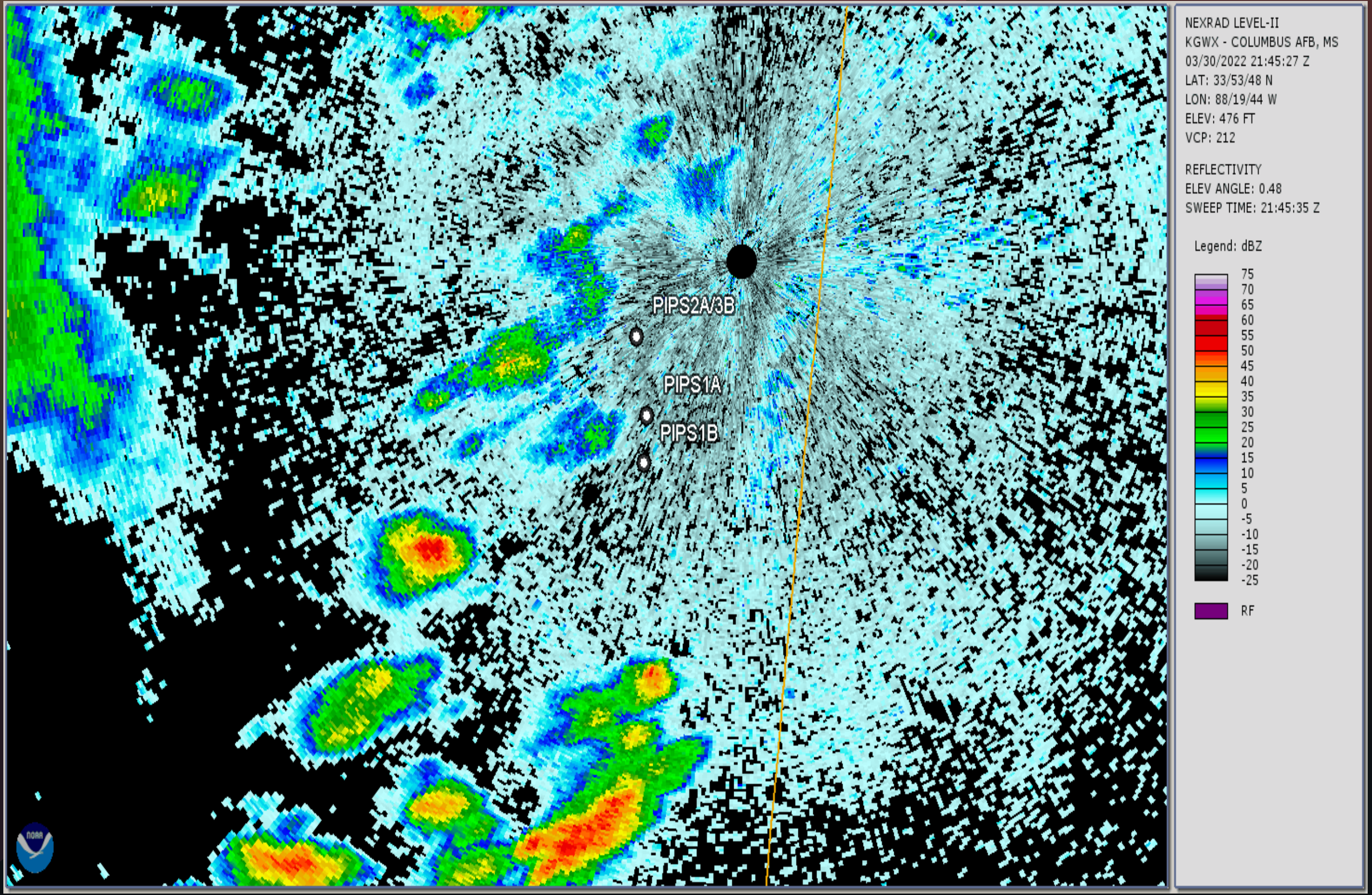
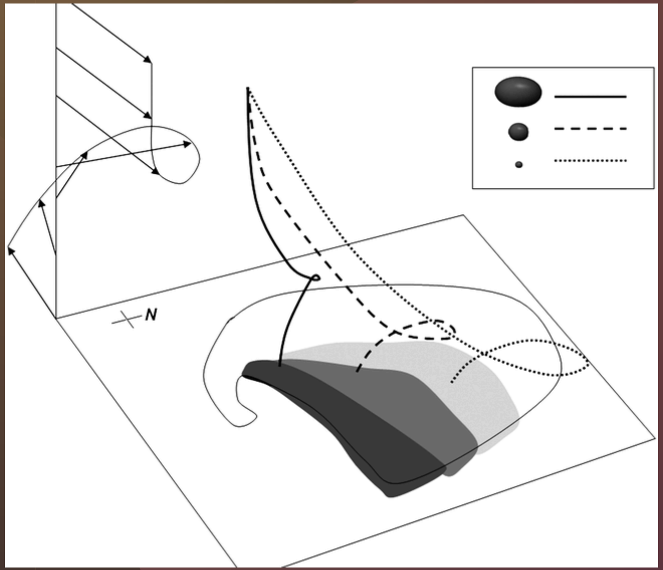
Event Overview

- We investigate a tornado-producing quasi-linear convective system (QLCS) that occurred during the PERILS IOP2 event. This event crossed the PERiLS domain from 30th March 2022, 22 Z, to 31st March 02 Z.
- 4 PIPS were deployed during this time on highways 45 and 8 near and north of Hamilton,
- PIPS 2A and 3B were collocated at the northern end of the array

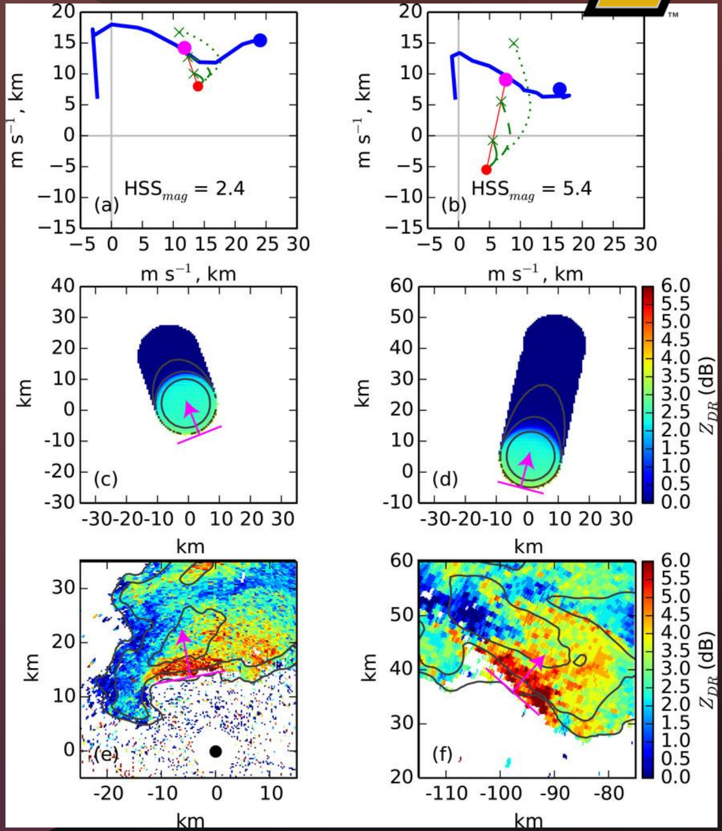


Motivation & Objectives

- To understand the potential impacts on tornadogenesis within the line of near-surface thermodynamic changes in the inflow region of the QLCS associated with Leading Stratiform precipitation
- To investigate the influence of size sorting from the storm-relative winds on DSD evolution between the radar level and the surface.



Kumjian and Ryzkhov, 2009.



Dawson et. al., 2015.

What is size sorting, and why is it important?

- Hydrometeor size sorting results from varying fall speeds of different-sized particles, and it is a dominant process that contributes to DSD evolution.
- Sedimentation rate differences can narrow particle size distribution by favoring specific sizes.
- Size sorting tell us about the wind profile at lower levels and specifically information about the mean storm-relative winds and their direction. (Dawson et al., 2015; Kumjian & Ryzhkov, 2012).

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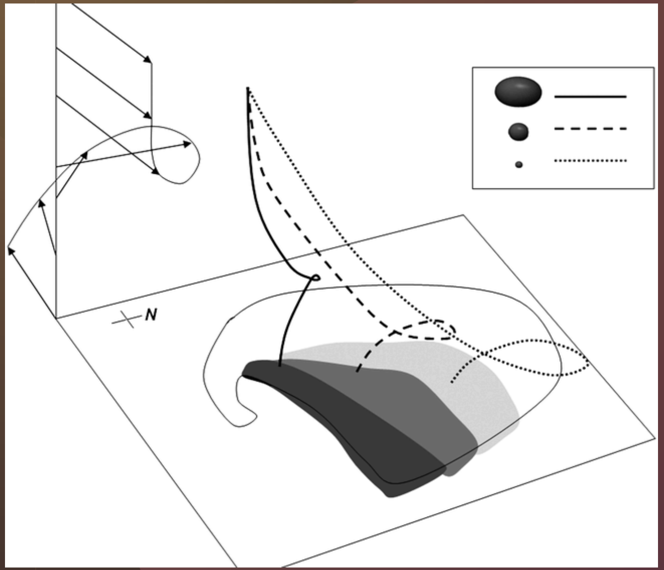

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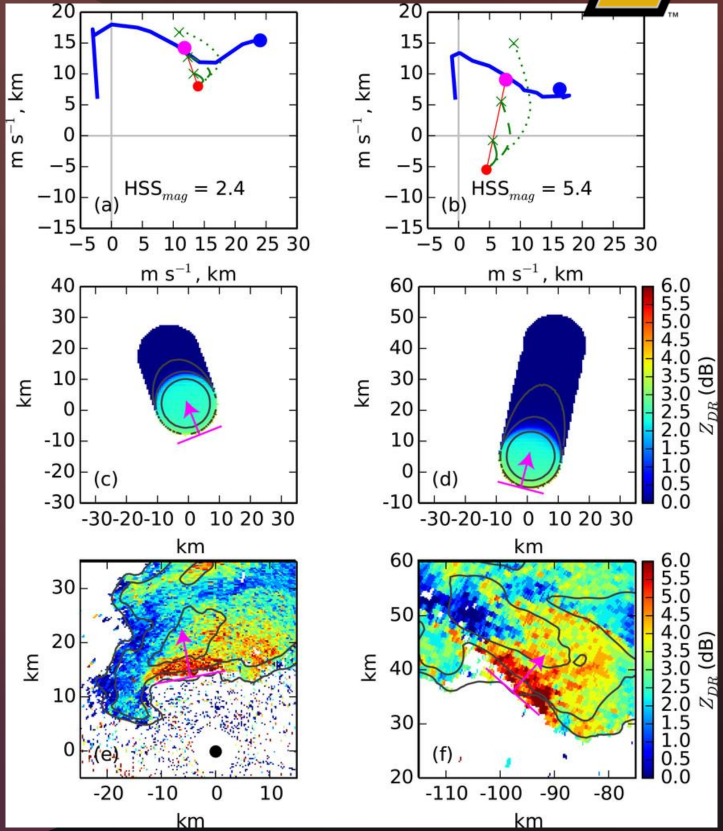

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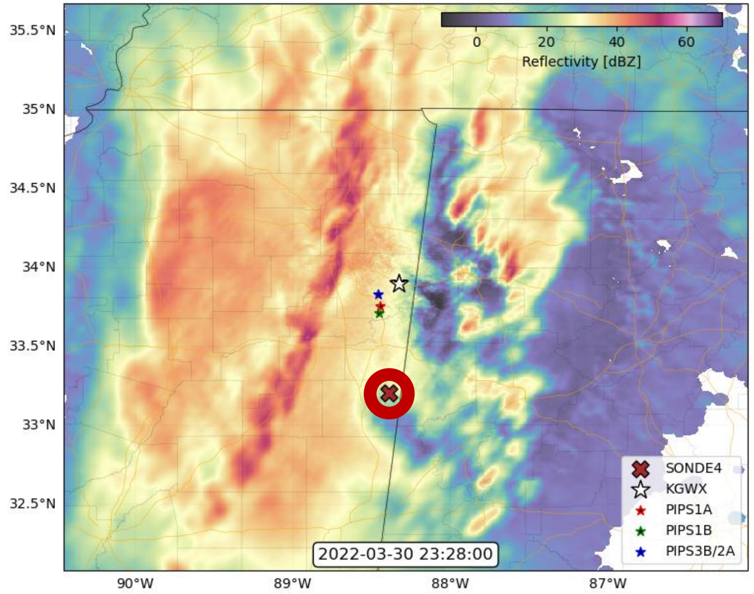
Data

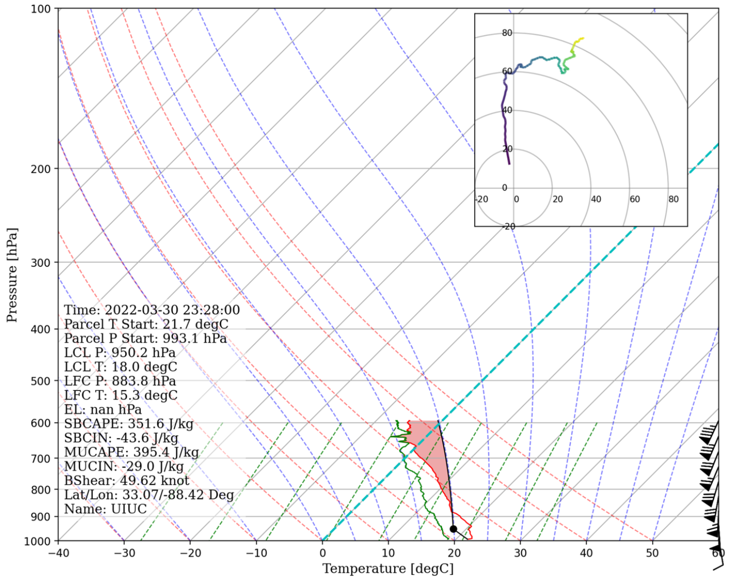
23:28

- ➔ Radar: KGWX
- ➔ Purdue Portable In-situ precipitation stations (PIPS) (Dawson D., 2022)
- ➔ Special nearby soundings launched by UIUC (Wurman, J., Kosiba, K. 2022)



Methodology

- ➔ Investigated size sorting's impact on DSD evolution using raindrop trajectory model (Dawson et. al., 2015).
- ➔ Used moments & constrained-gamma DSD model to initialize DSDs from lowest radar sweeps of Z and ZDR, see Zhang et al. (2001).
- ➔ Utilized nearby PERiLS sounding for low-level wind profiles for initializing multiple trajectories for discrete drop-size bins.
- ➔ Analytically solved trajectory surface endpoints to compare model DSDs with PIPS observations and quantify size sorting effect.



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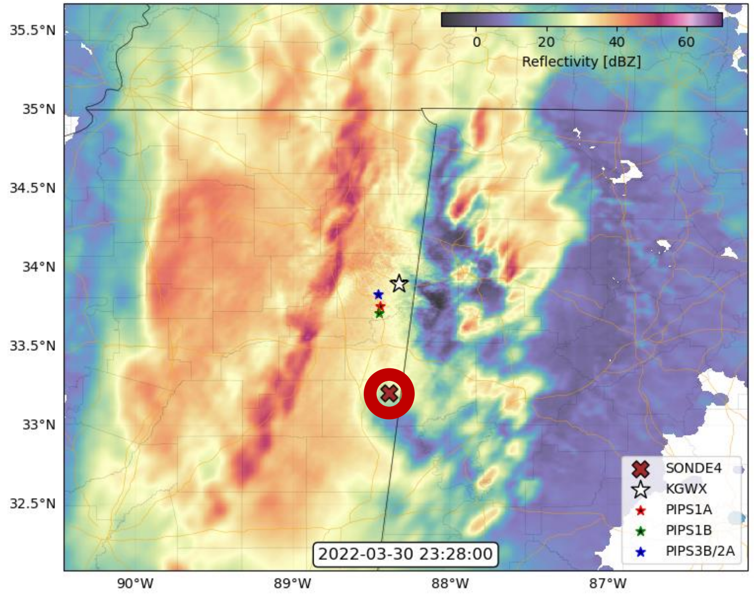
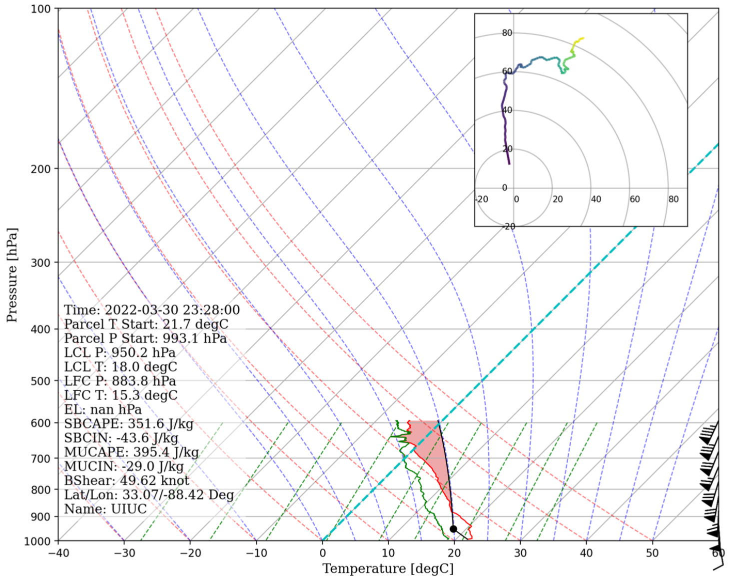
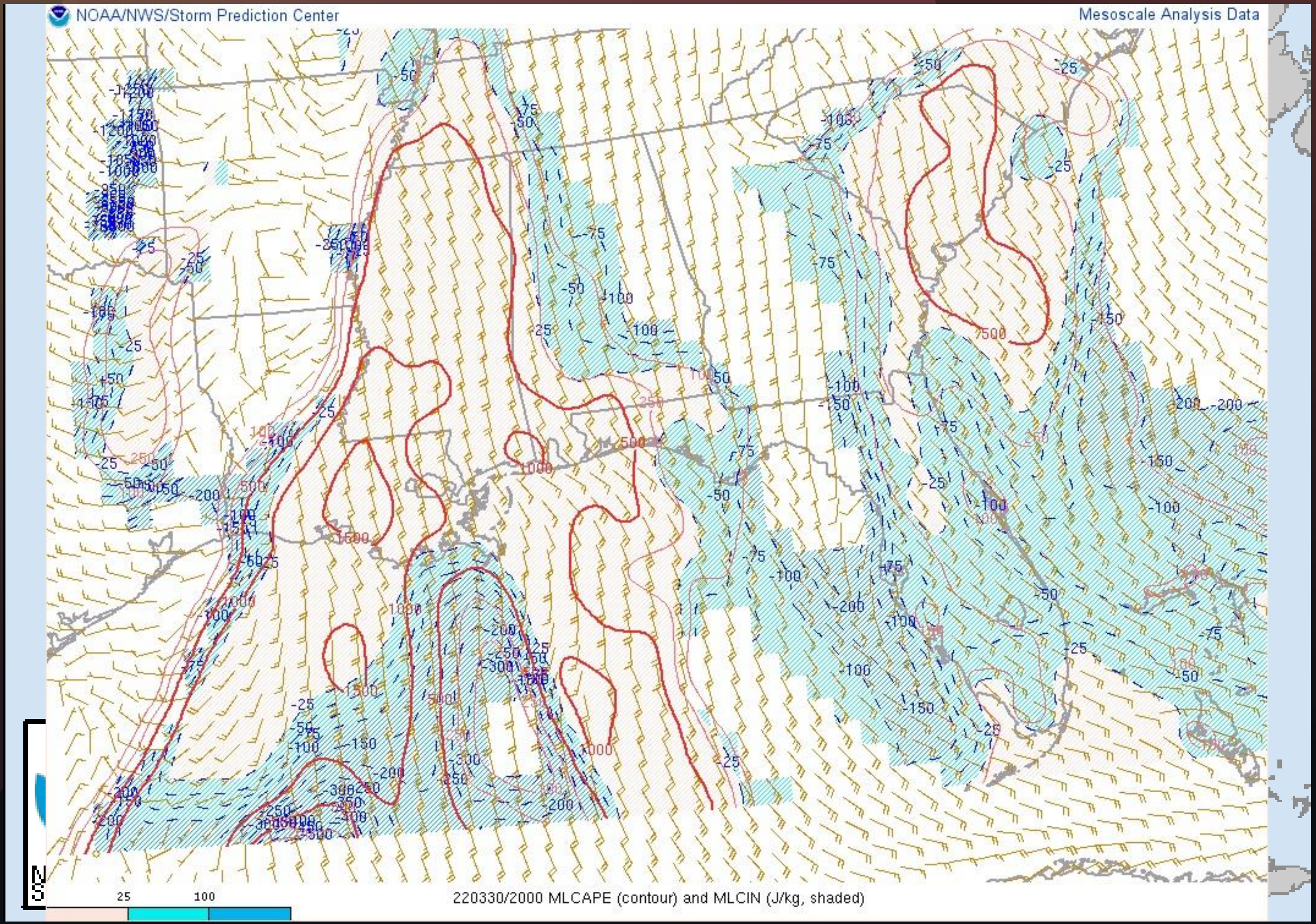




Environmental Conditions

- ➔ 114 Tornado reports with some EF0 to EF2.
- ➔ High shear low cape. (Sherburn and Parker, 2014)
- ➔ The shear vector in the (0-1) km layer varied from 20 to 60 knots.
- ➔ 100 mb MLCAPE figure suggests the presence of instability in the mixed layer.



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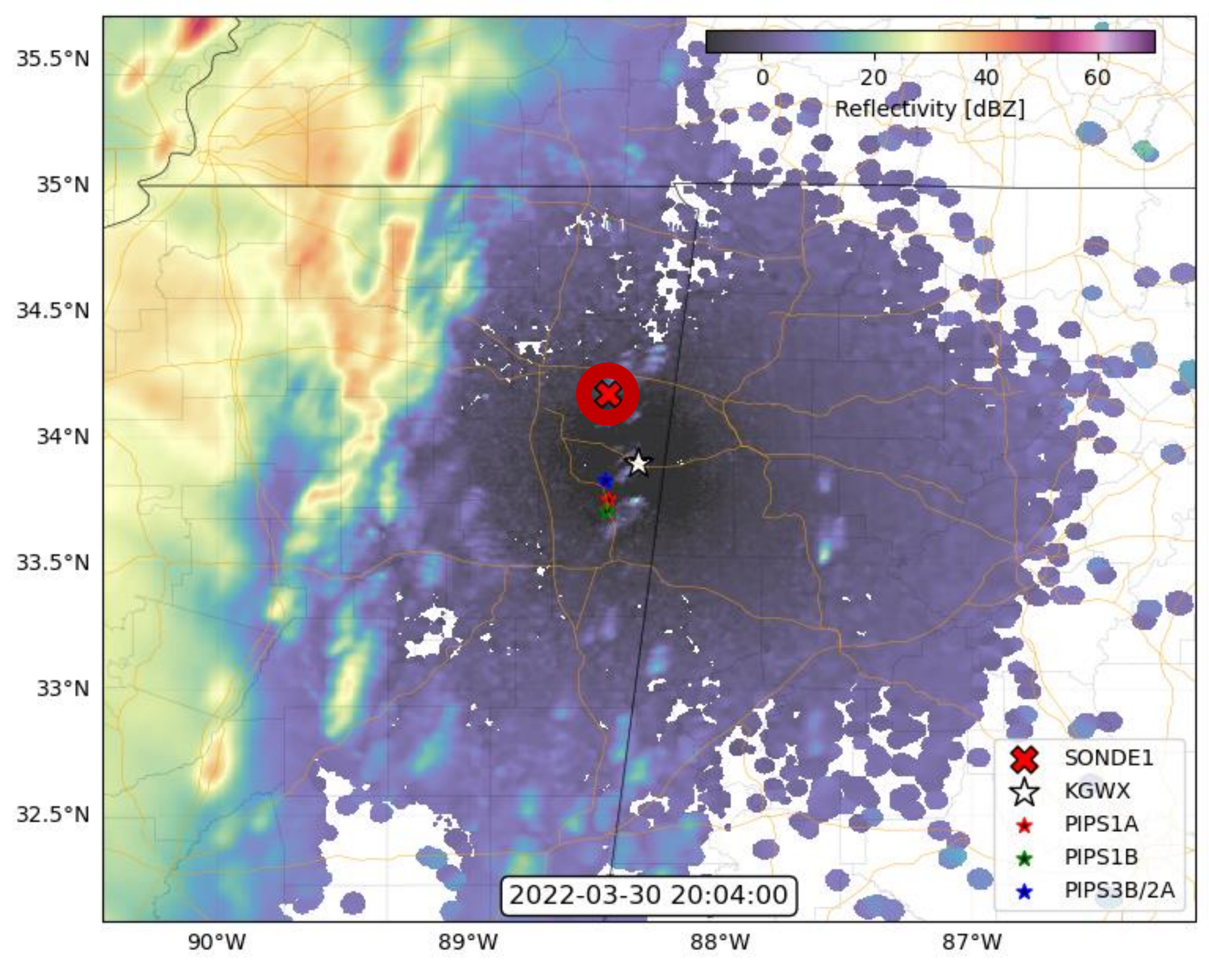

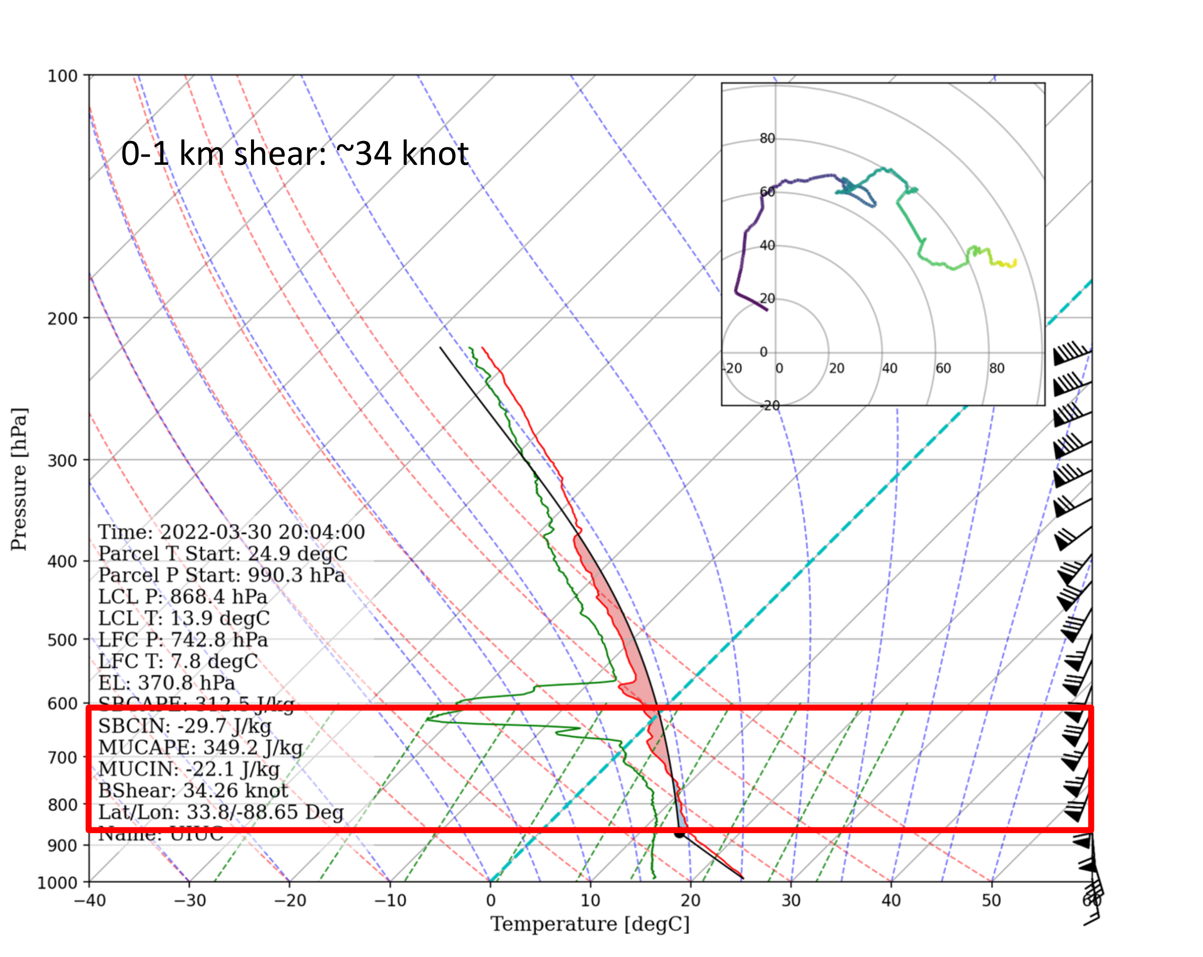

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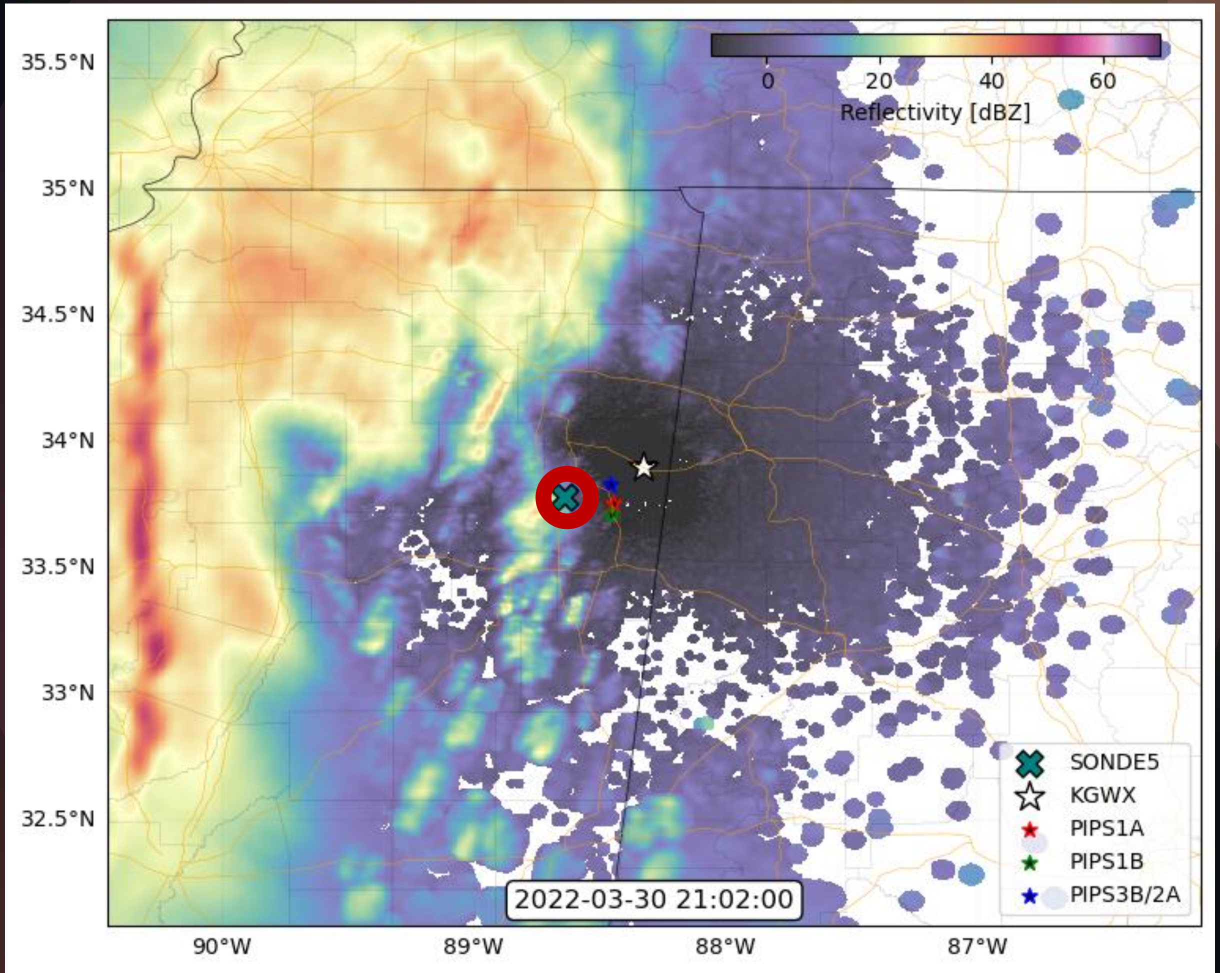

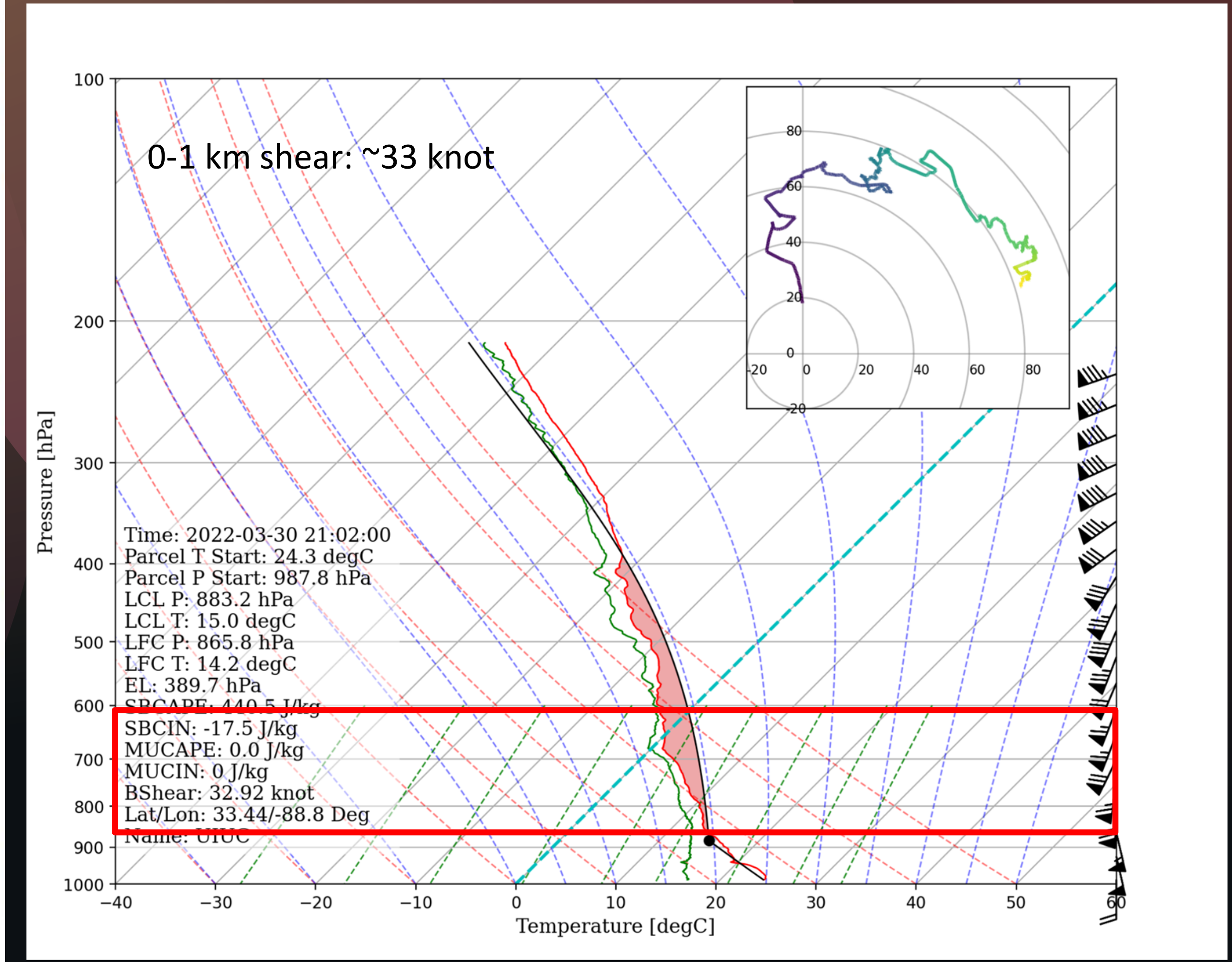

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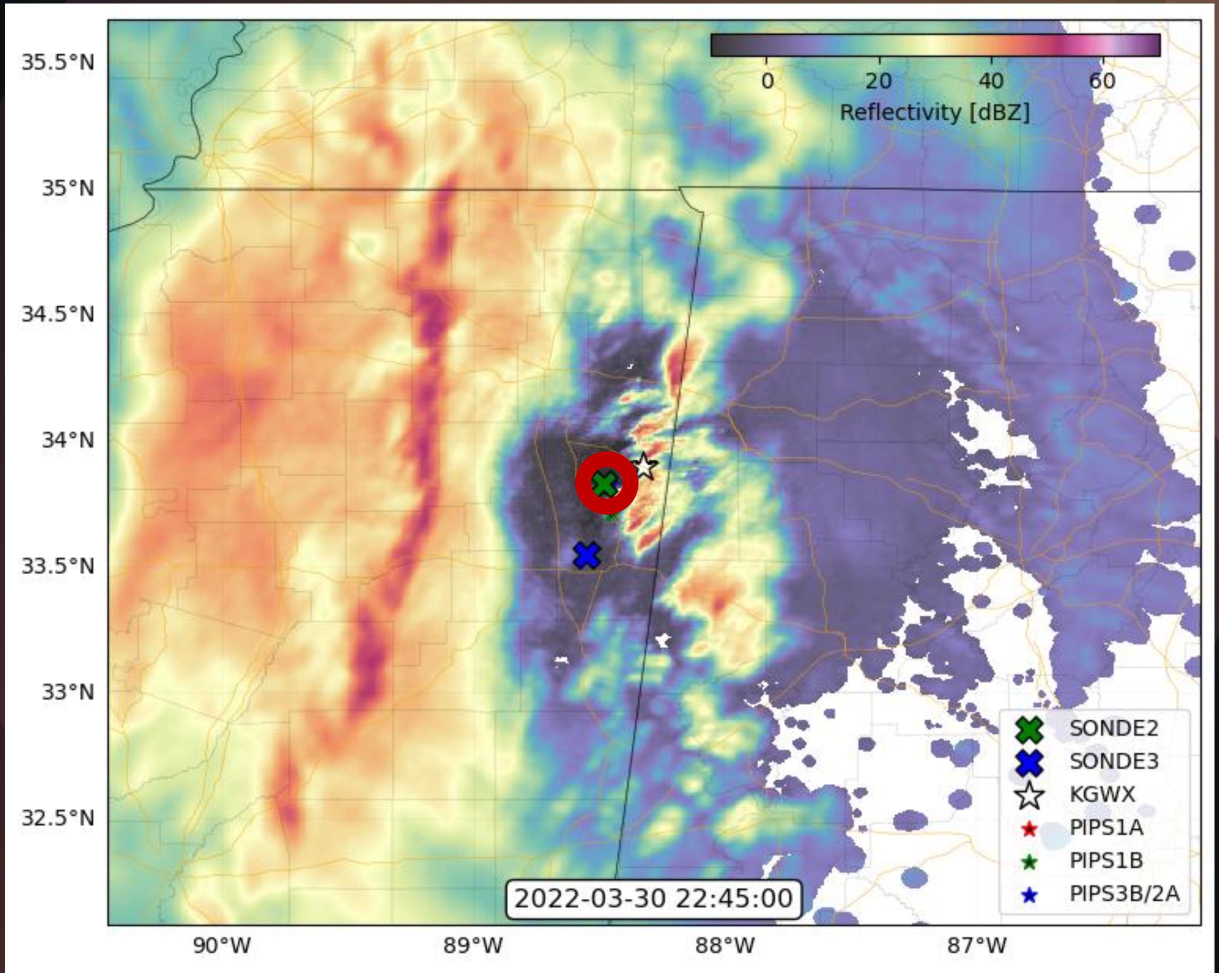

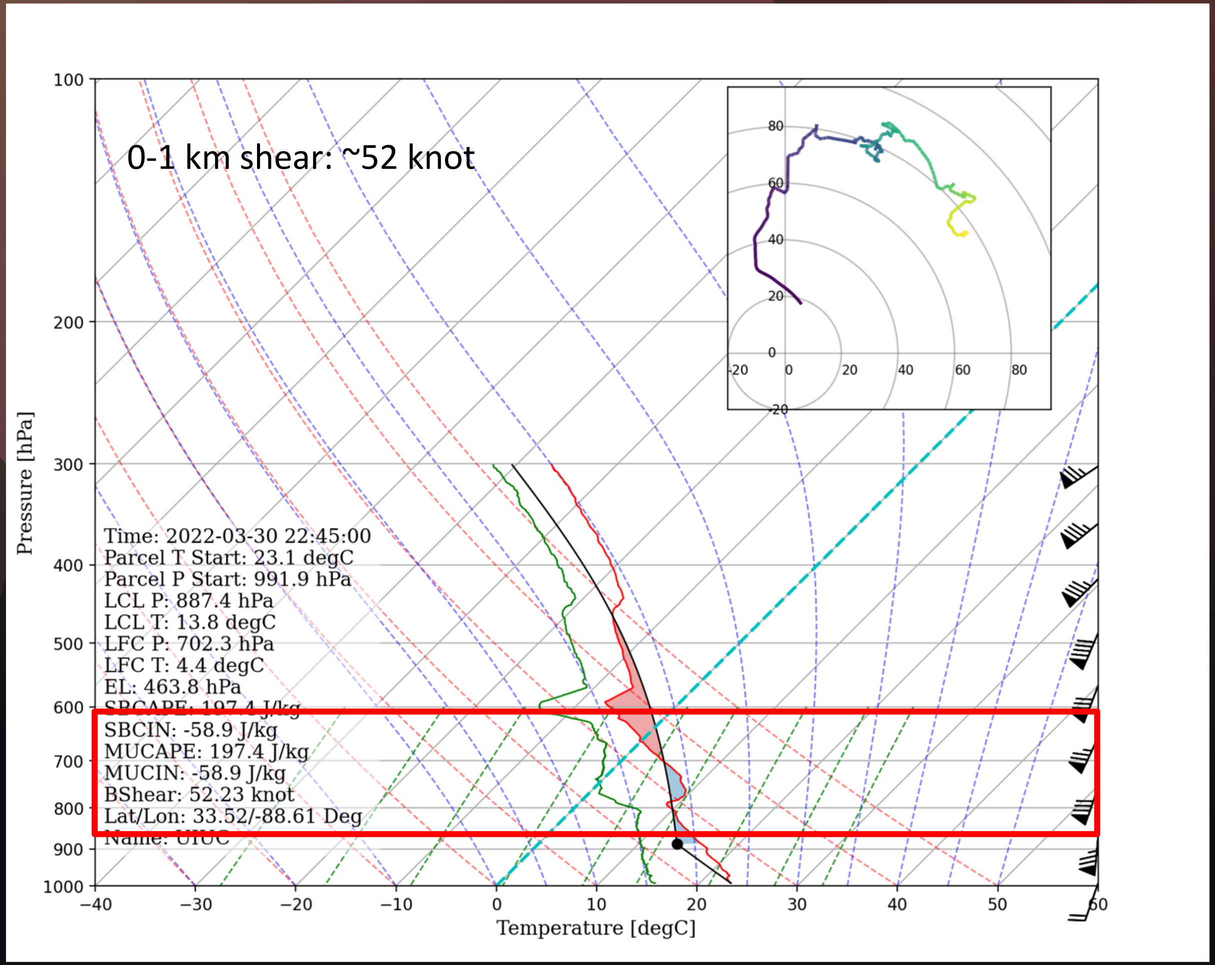

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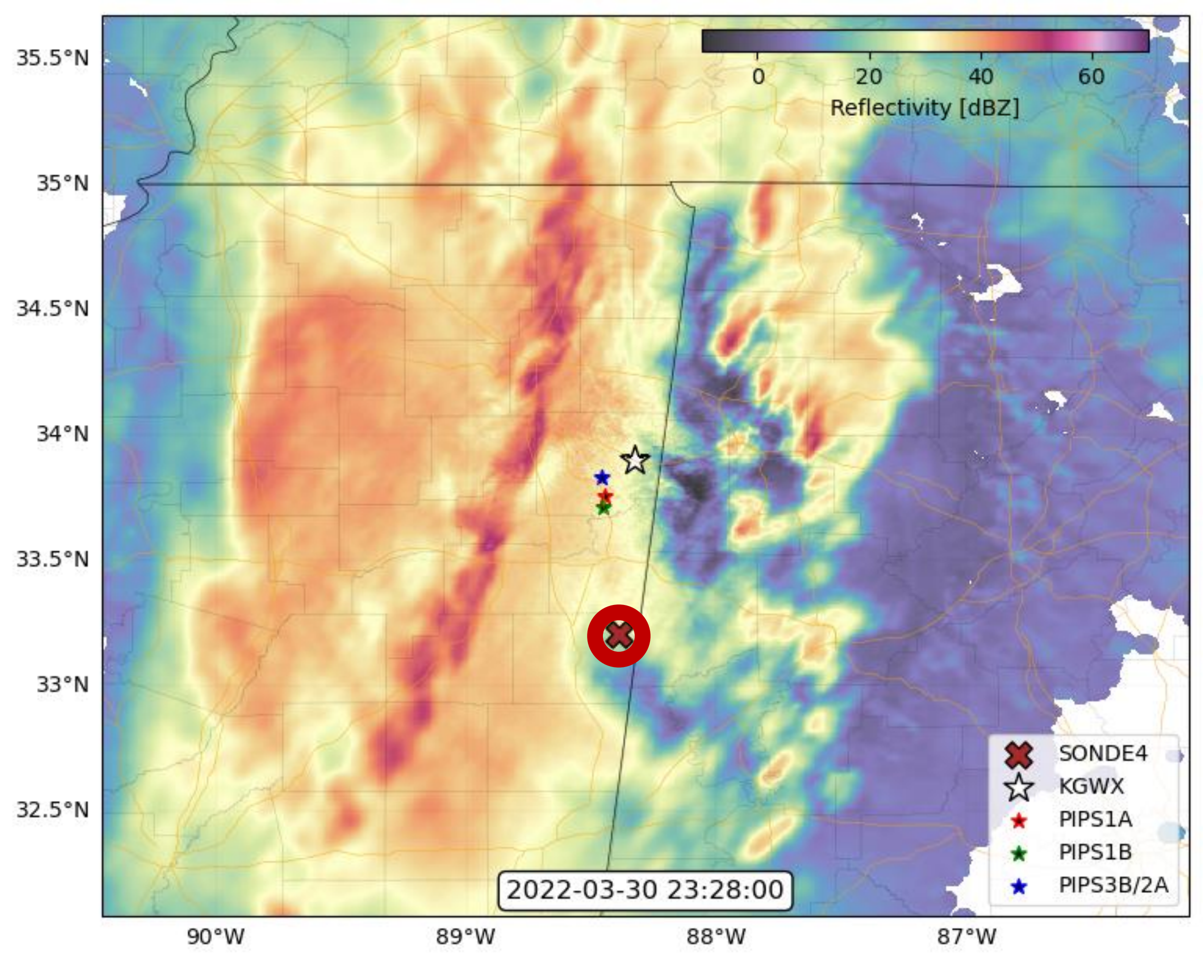
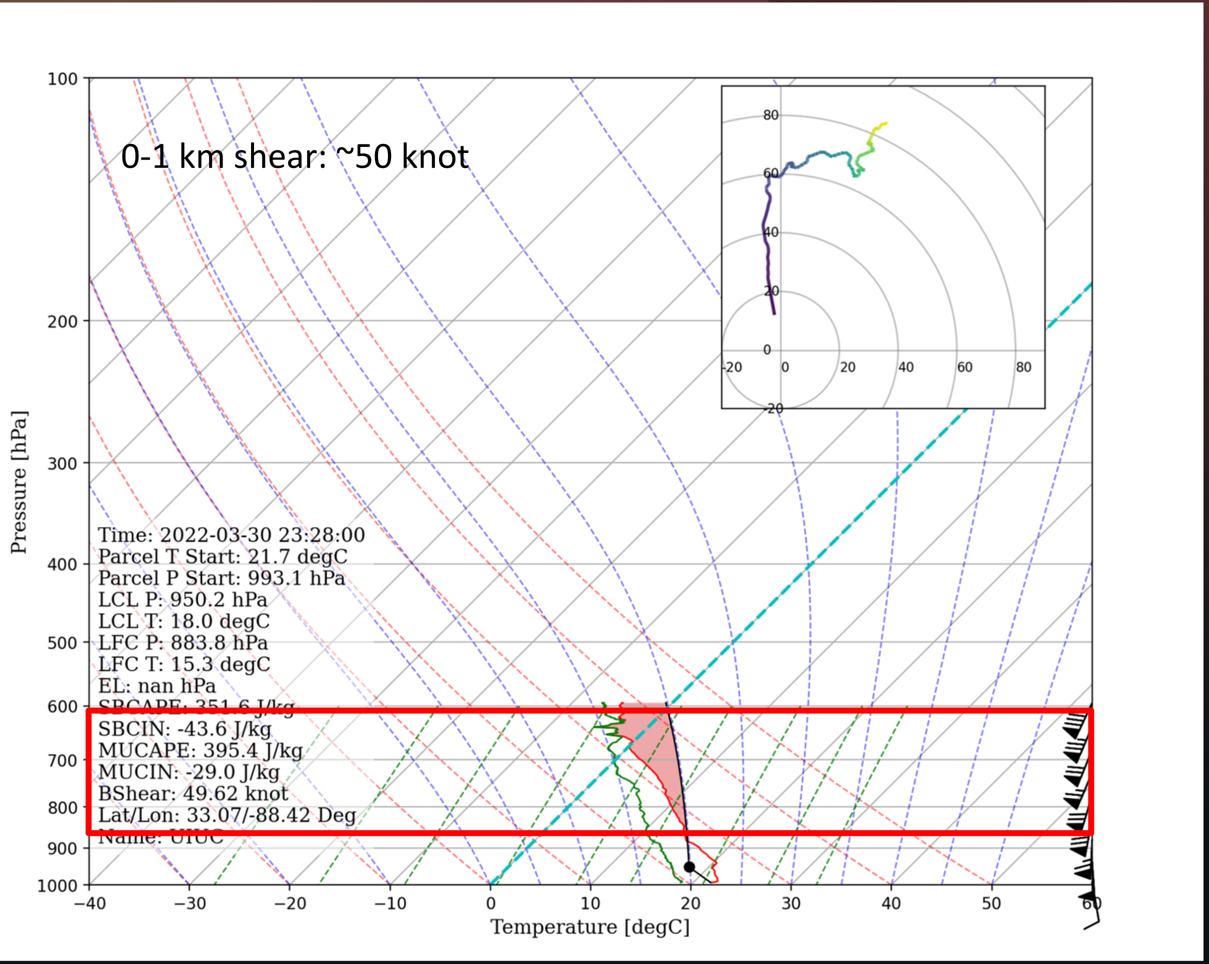




Meteograms

Reflectivity

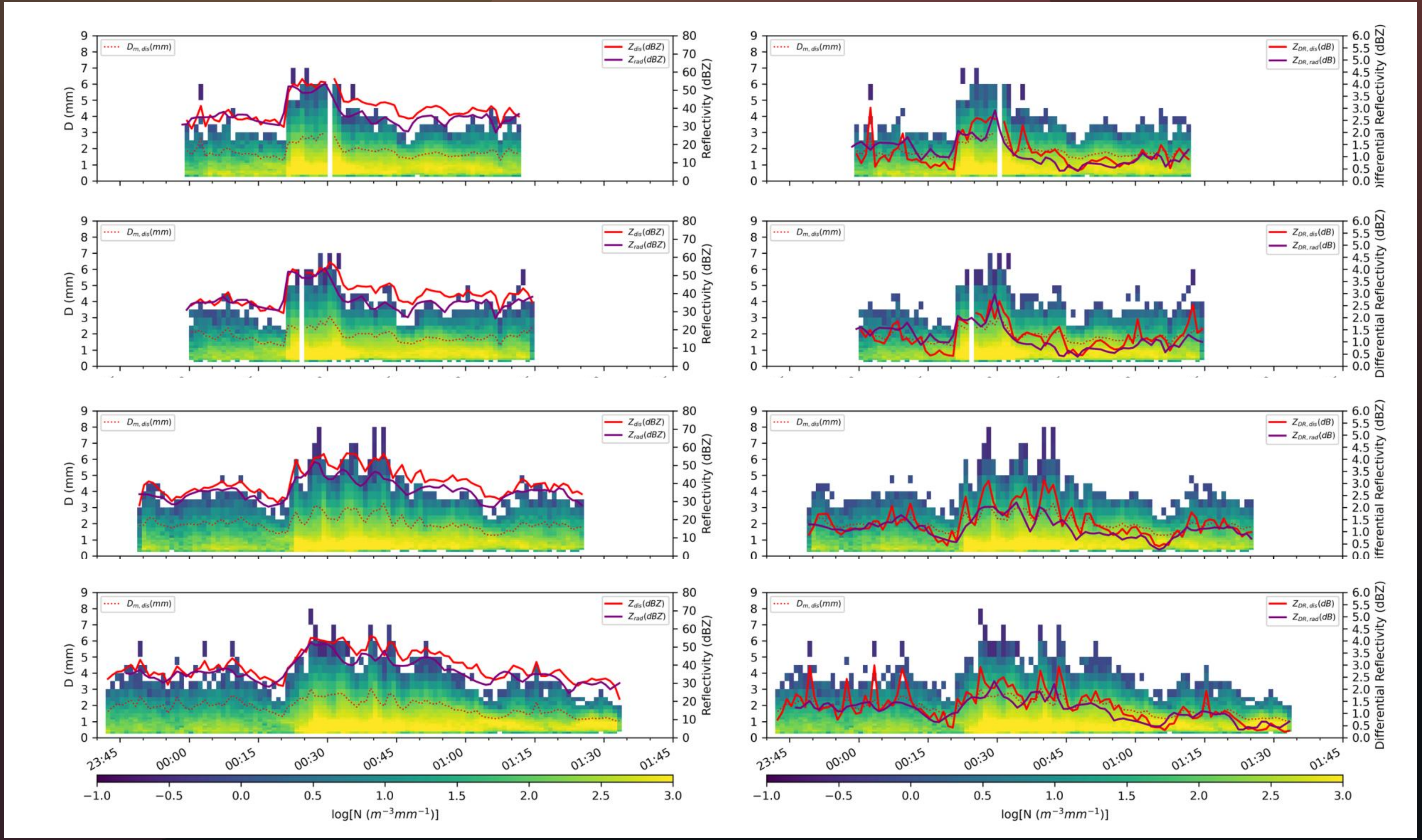
Differential Reflectivity

PIPS#2A

PIPS#3B

PIPS#1A

PIPS#1B



Meteograms

Reflectivity

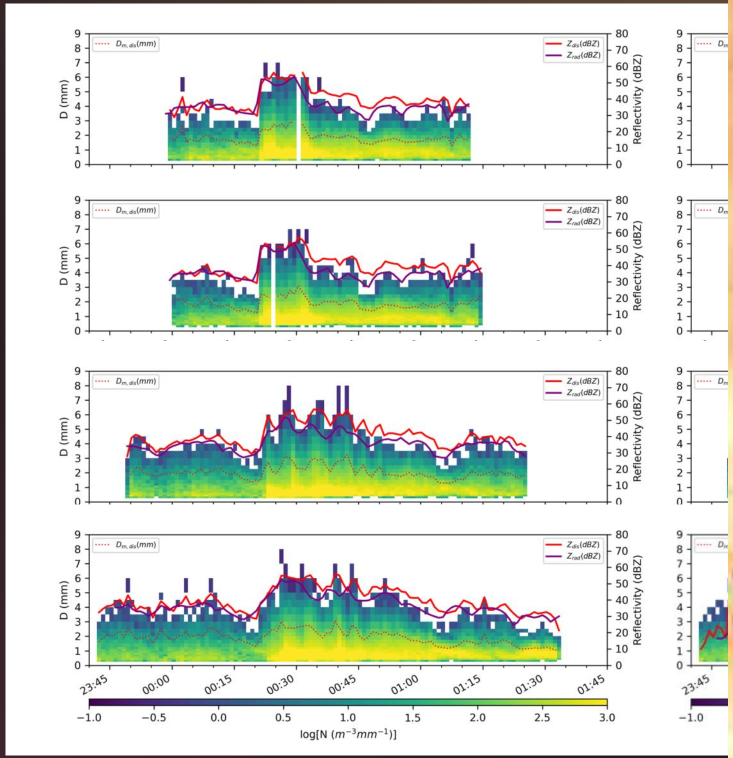
D

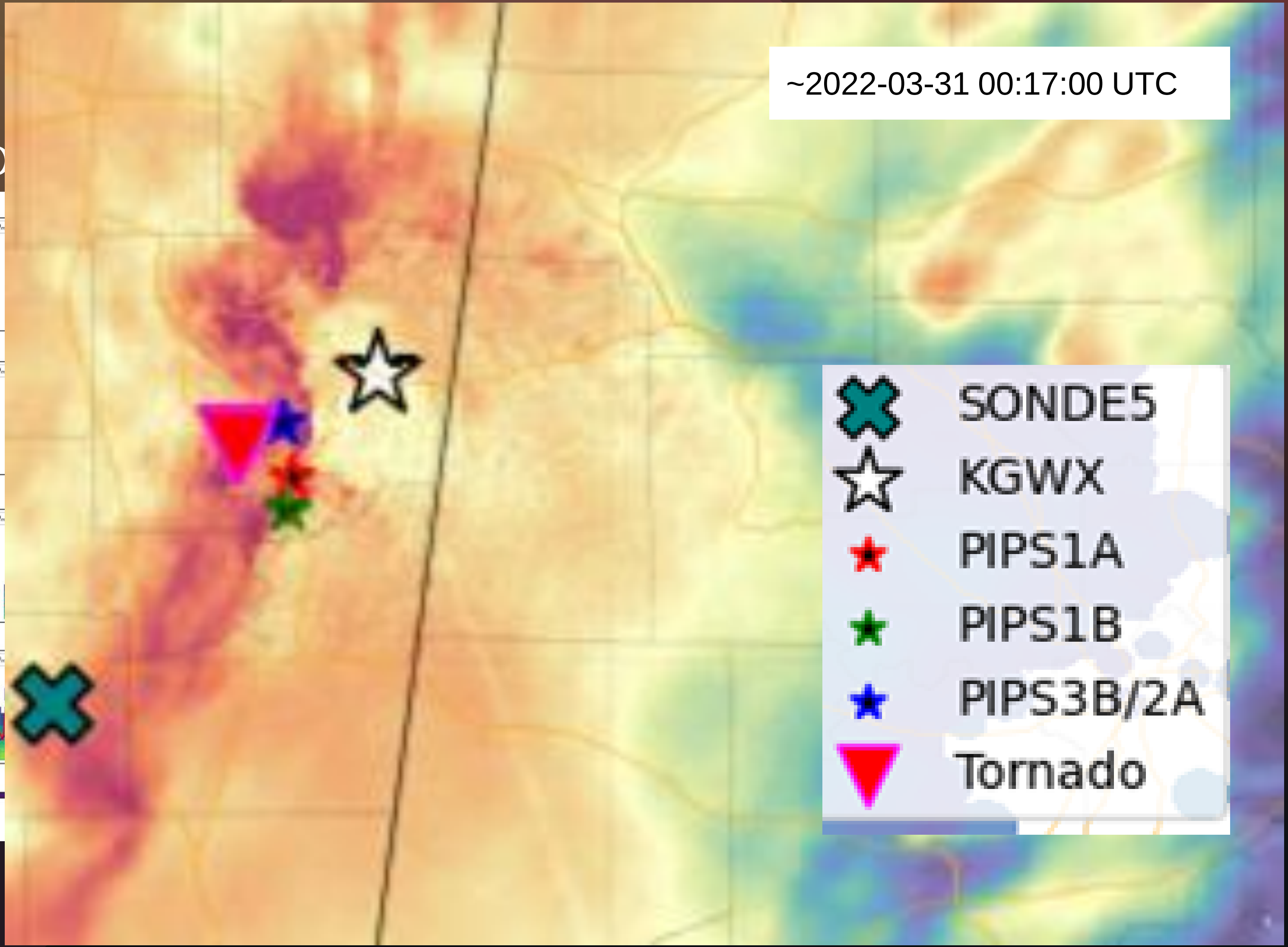
PIPS2A

PIPS3B

PIPS1A

PIPS1B





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D

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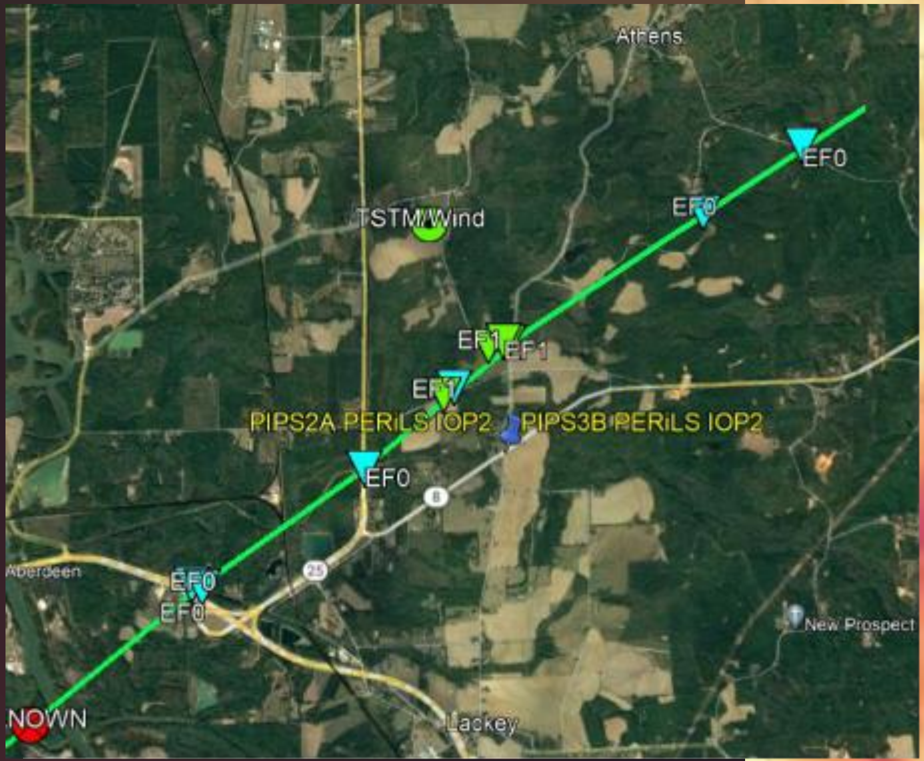

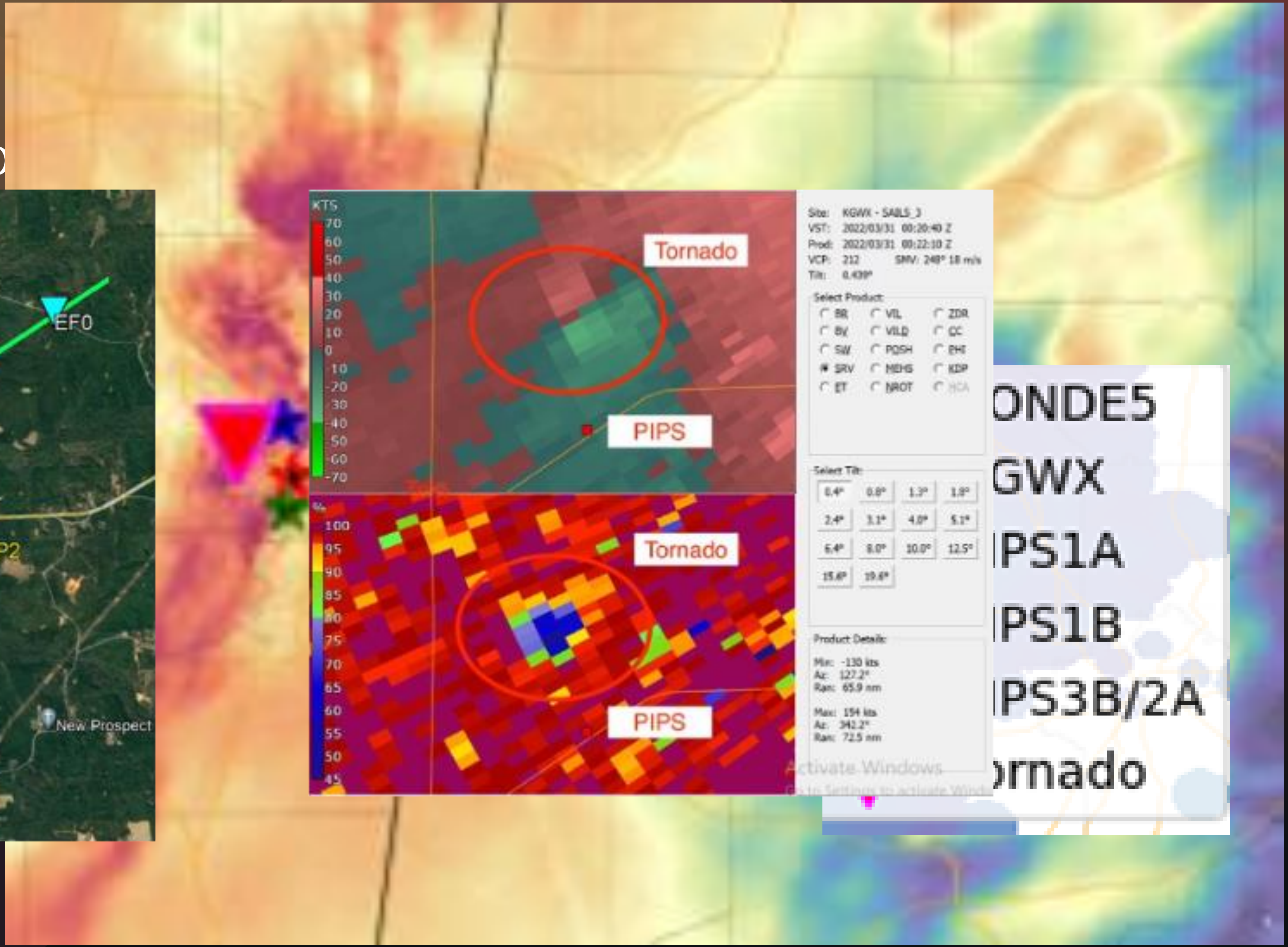

Meteograms

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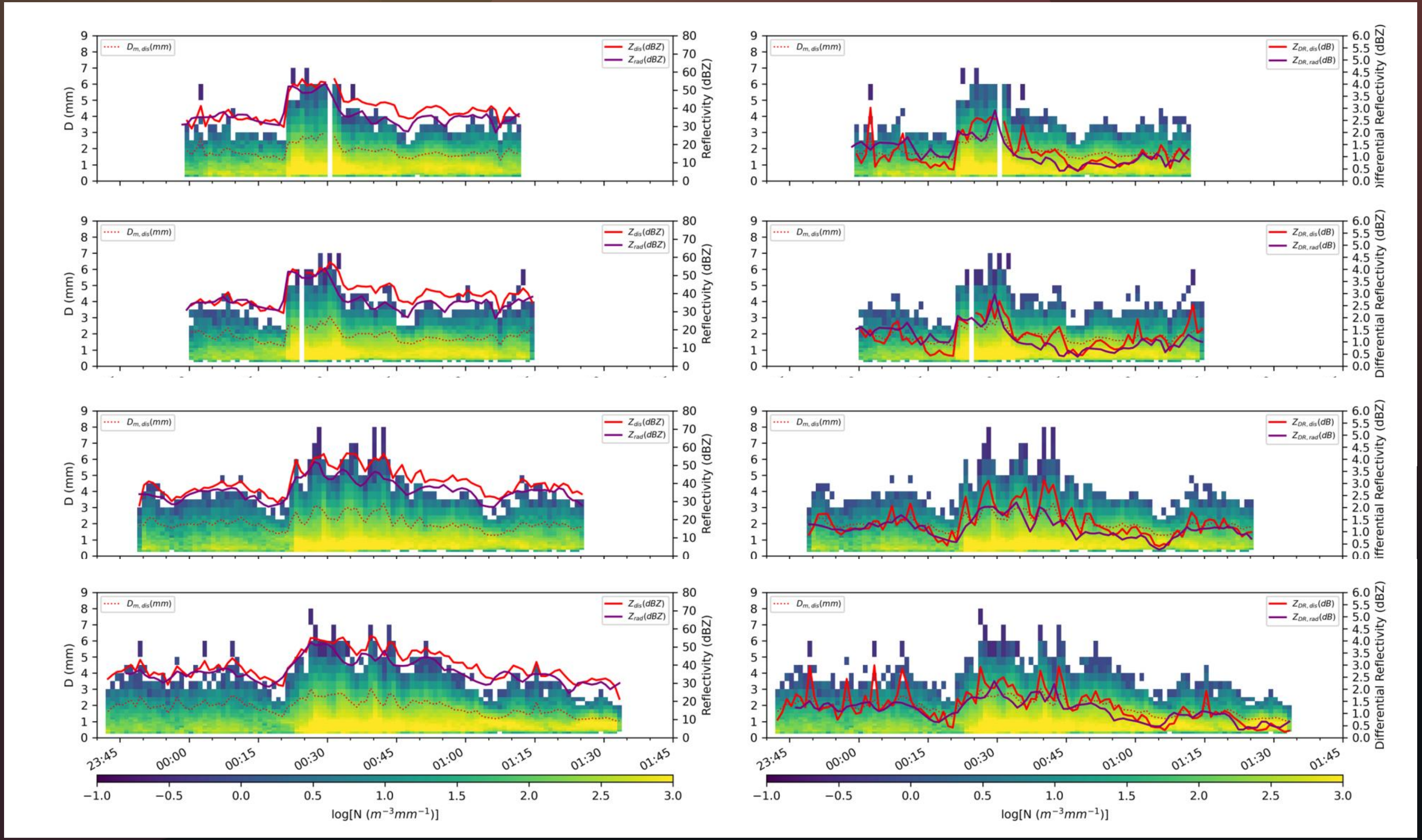
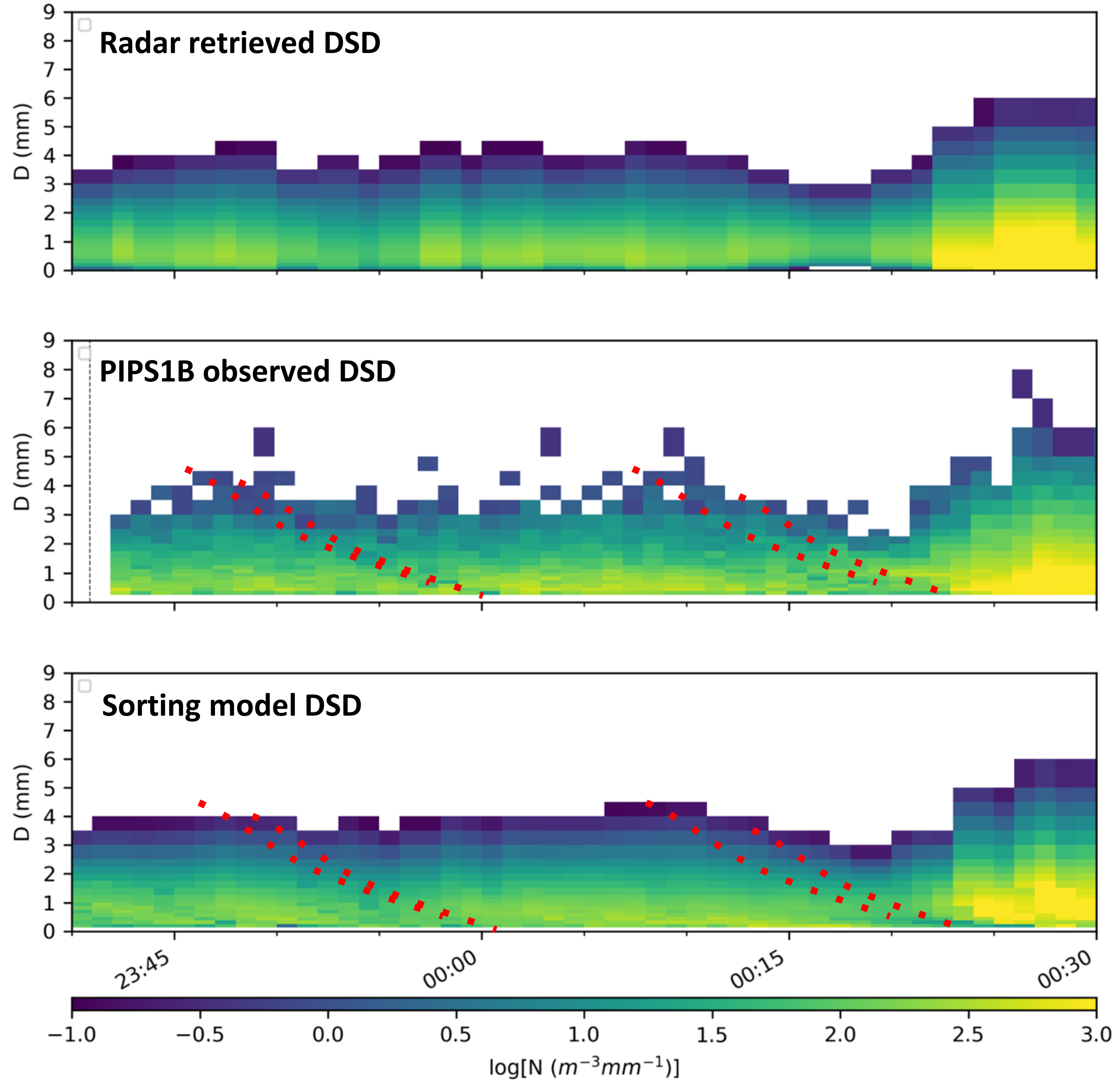
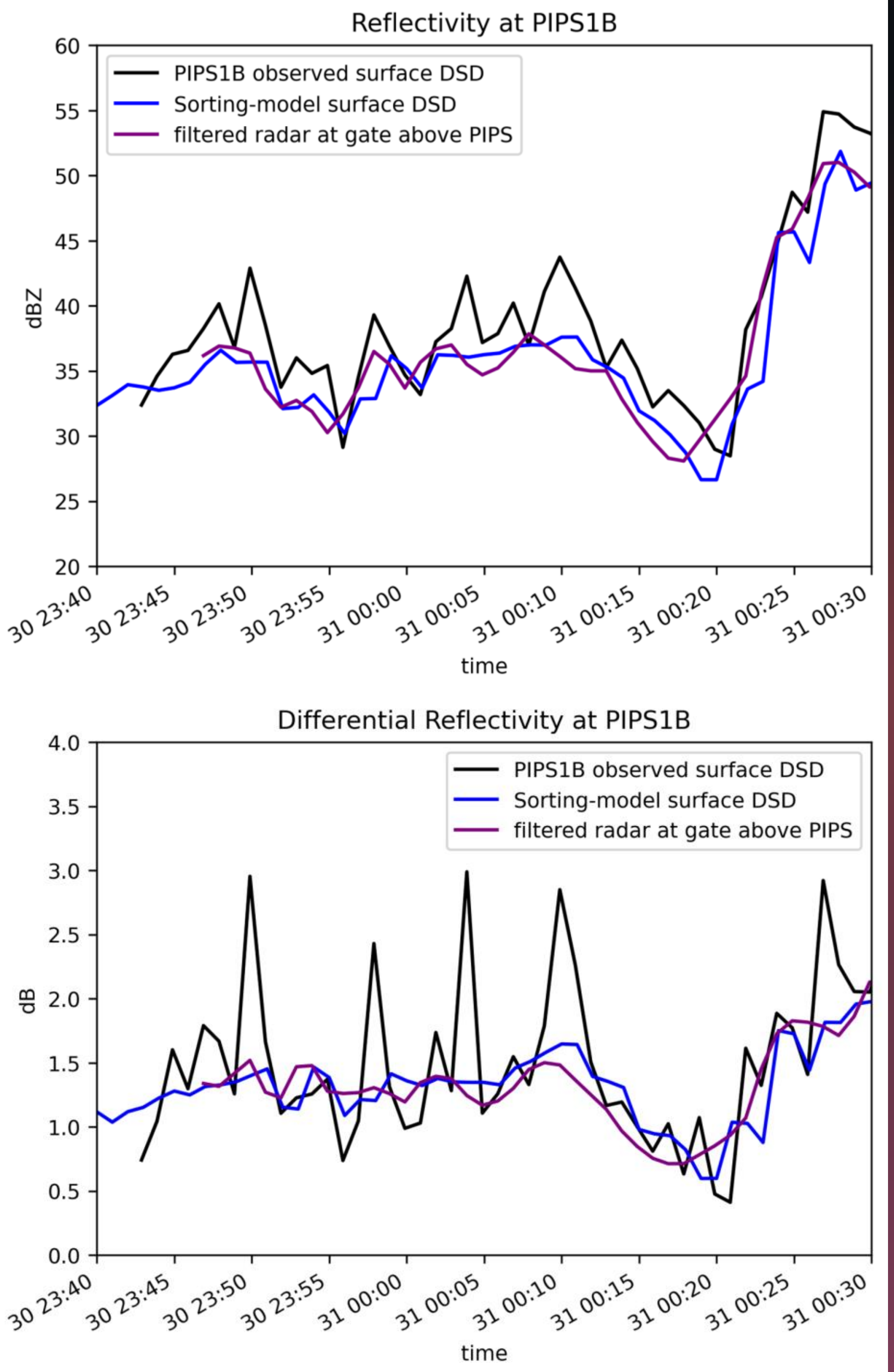
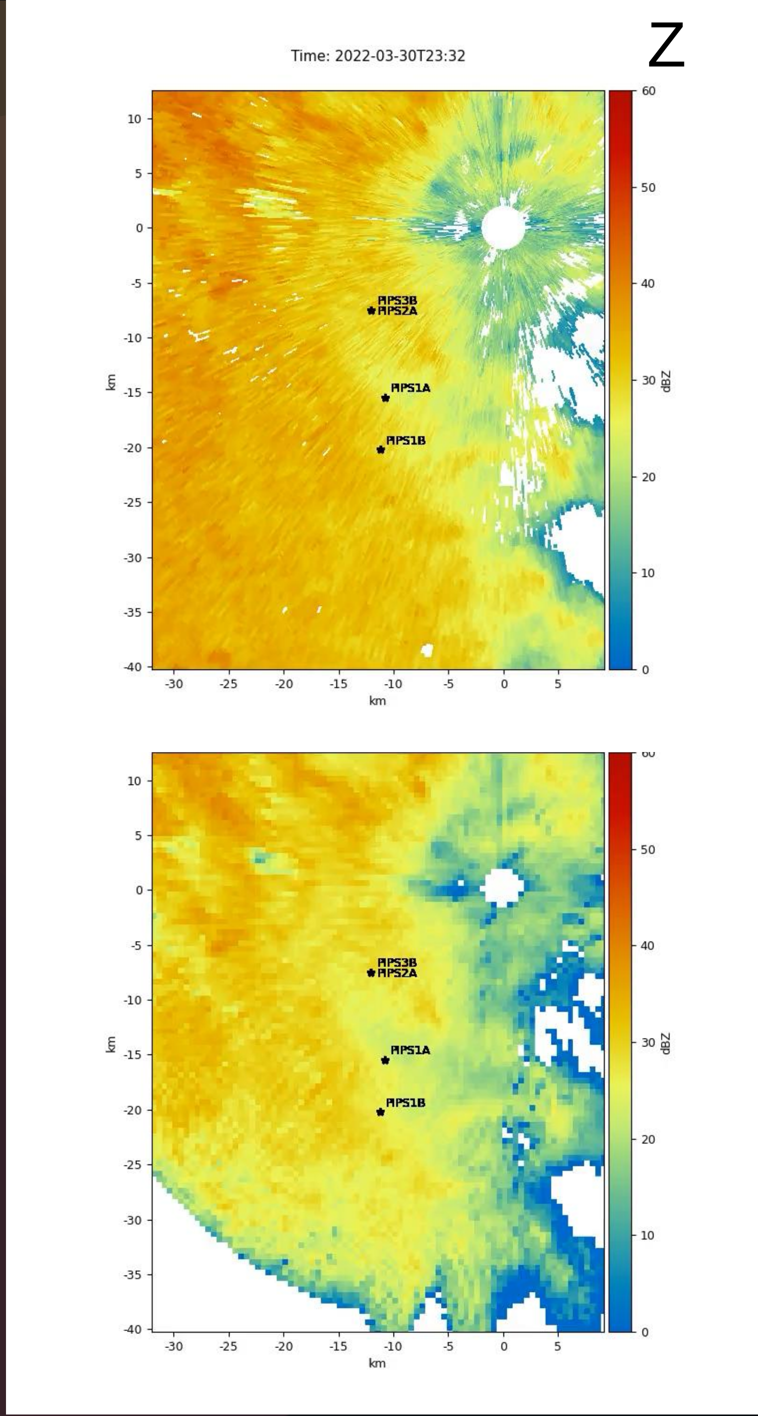
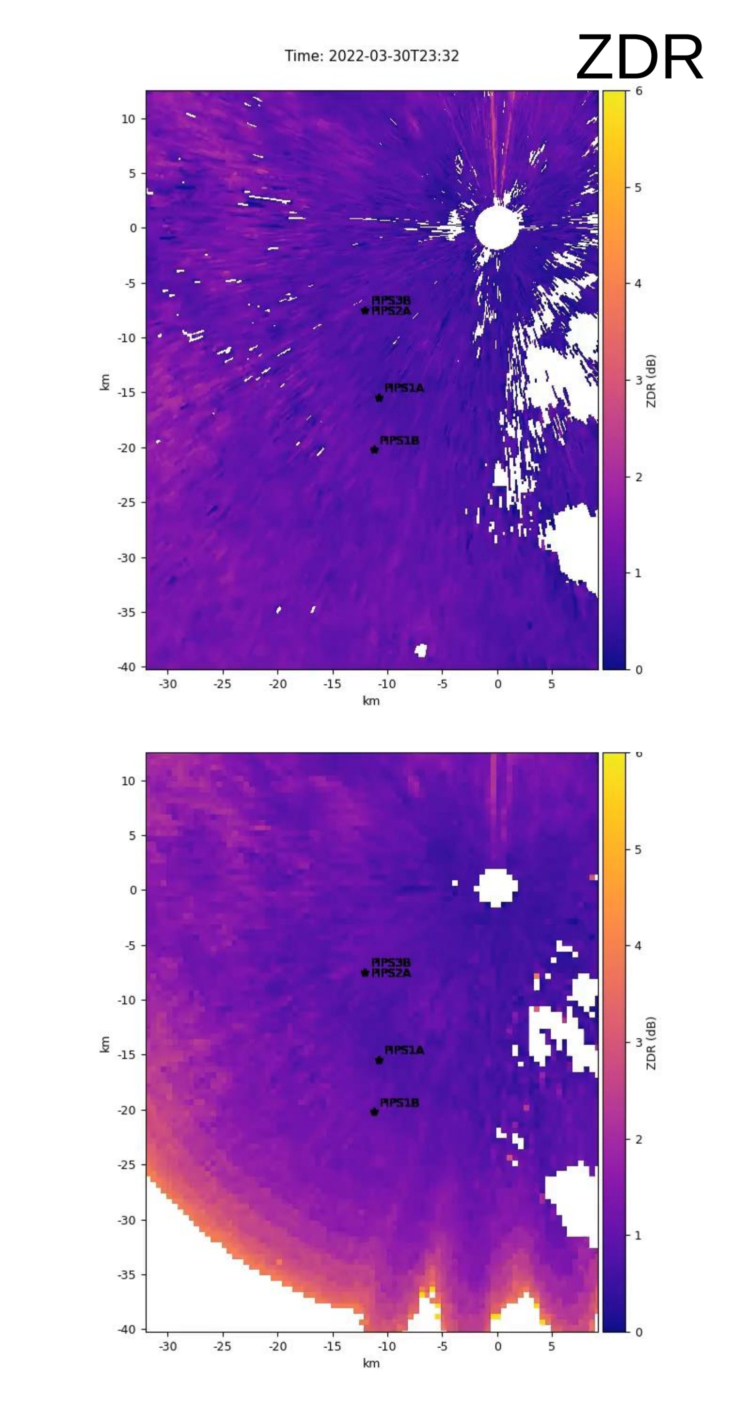



Radar retrieved DSD
PIPS1B observed DSD
Sorting model DSD
D (mm)
23:45
00:00
00:15
00:30
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
log[N ($m^{-3}mm^{-1}$)]


Reflectivity at PIPS1B
PIPS1B observed surface DSD
Sorting-model surface DSD
filtered radar at gate above PIPS
dBZ
time
30 23:40
30 23:45
30 23:50
30 23:55
31 00:00
31 00:05
31 00:10
31 00:15
31 00:20
31 00:25
31 00:30
Differential Reflectivity at PIPS1B
PIPS1B observed surface DSD
Sorting-model surface DSD
filtered radar at gate above PIPS
dB
time

- **Radar Level**: Filtered lowest elevation





- **Surface**)
- Retrieved using sorting model

Summary & Future Scope

- Takeaways
  - Described the evolution of leading stratiform DSDs in the 30 March 2022 tornadic QLCS during PERiLS
  - Applied a simple drop trajectory model to investigate impact of size sorting below the radar level
  - Modeled surface DSDs agree reasonably well with disdrometer observations
  - Some evidence of size sorting in detailed evolution of small drop portion of the DSD (more work required)
- Future work
  - Quality control methods for disdrometer data needs to be improved.
  - Improvement in retrieval techniques e.g., constrained gamma model
  - Improving the capabilities of the trajectory model (e.g. add evaporation)
  - Ultimate goal is to better understand the microphysical evolution and relation to low level thermodynamics and stability, and how does it affect tornadogenesis in QLCSs.

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