An Overview of Purdue's Mobile Disdrometer Operations in PERiLS 2023

Team Members:

Purdue:

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OU/NSSL:

Michael Biggerstaff (OU): ongoing PIPS support
Sean Waugh (NSSL): ongoing PIPS development and support

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- Chris Weiss and the rest of the TTU team
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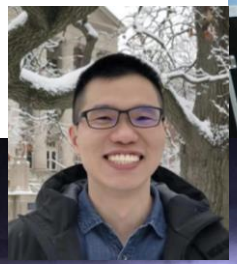
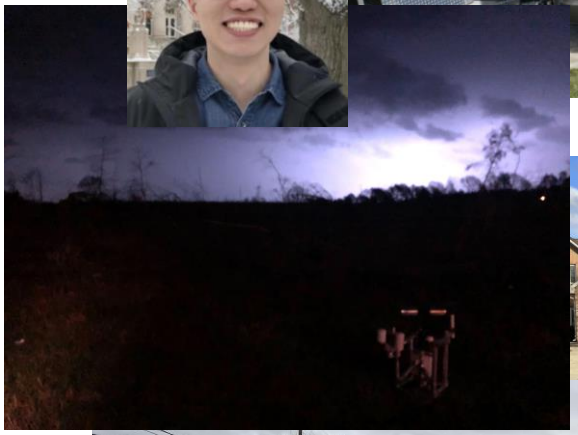





Our Research Goal in PERiLS is…

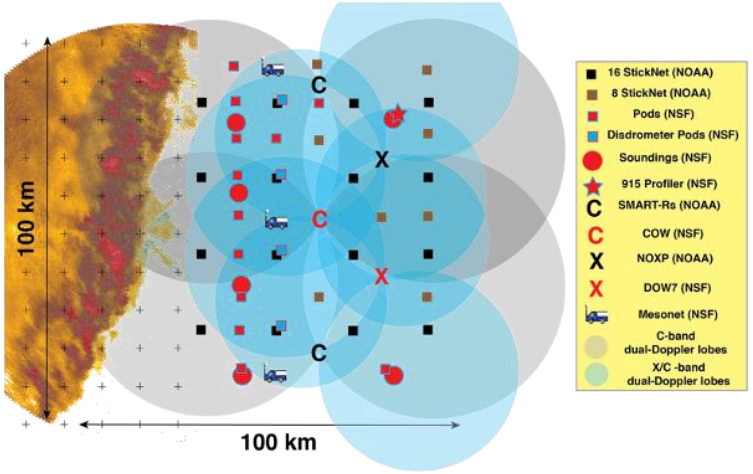
to uncover links between QLCS microphysics, cold pool strength, gust front structure, and tornado potential on time horizons of minutes to hours.

We will accomplish this goal by characterizing the variability of rain drop size distributions (DSDs) in QLCS's using in situ observations from portable disdrometer-equipped platforms (the PIPS).

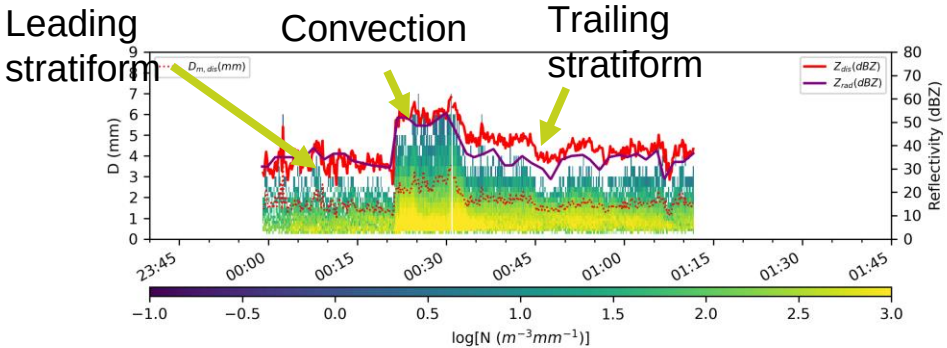
Microphysical processes that are potentially linked to tornadogenesis potential include

1. Cooling from rain evaporation and hail melting that modulates cold pool strength and associated gust front dynamics

2. Size sorting of hydrometeors by low-level storm-relative inflow winds that may relate to low-level updraft strength and rotation



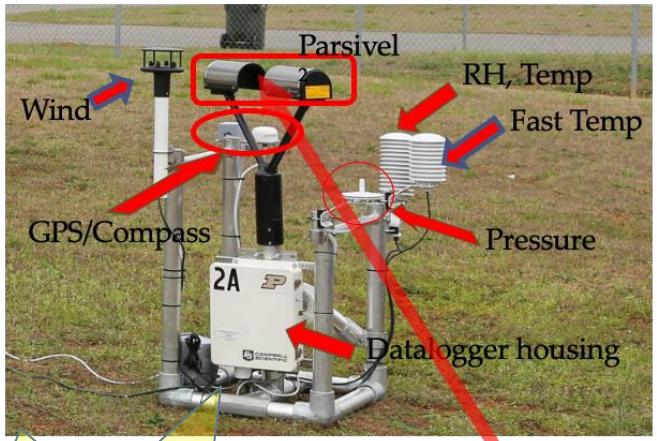
Example from IOP #2 in 2022
(see Hamid Syed's talk tomorrow!)



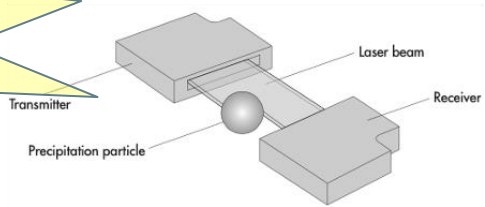
The Portable In-Situ* Precipitation Stations (PIPS)

The PIPS each contain…

- An OTT Hydrometeor Parsivel[2]** laser disdrometer (Loeffler-Mang and Joss 2000; Tokay et al. 2014)
- Multiple instruments for recording wind speed, direction, RH, temperature, pressure, location, and heading
- The original 4 (1A, 1B, 2A, 2B) were built in 2015 and have been deployed in numerous convective storms and tropical cyclones
- 2 new PIPS (3A and 3B) built in 2021 and deployed during the PERiLS field program



NEW in 2023! Real-time monitoring in the field with cellular data connections!



*"Integrated" works too… **PARticle SIze and VELocity

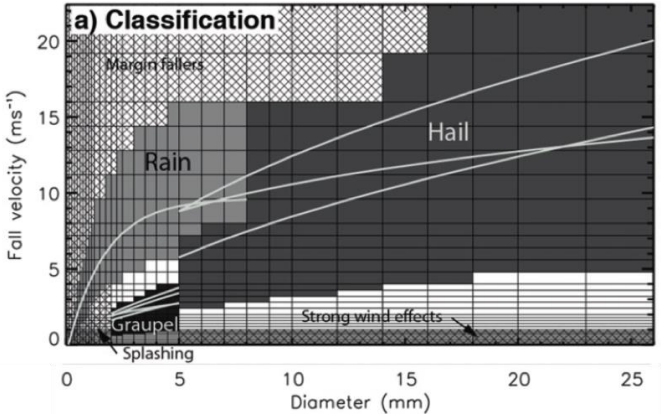
Data Analysis and Quality Control

- Original Campbell Scientific binary format converted to CSV and then converted to netCDF

- Two netCDF files per PIPS per deployment
  - ”Conventional” files: all instrument output/derived quantities **except for Parsivel data** at 1-s intervals.
  - “Combined” files: 10-s Parsivel data and derived DSD moments (both QC’ed and raw) **and** conventional data averaged to 10-s intervals

- Conventional data QC (ongoing):
  - Correcting biases using mass tests
  - Cleaning up data dropouts in compass readings (mainly an issue for 3A and 3B) which affects wind direction
  - General clean-up

- Parsivel data QC (nearly complete):
  - V-D matrix filtered to remove suspicious particles (margin fallers/splashing drops, etc.)
  - Additional step to remove particles that are likely not rain drops



Parsivel Fallspeed-Diameter bins, typical fall speed curves for various hydrometeor categories and overlaid QC/hydrometeor category filtering regions. From Friedrich et al. (2014)

Data Availability:

2022 data available in netCDF format on EOL catalog: https://data.eol.ucar.edu/dataset/610.027 (will be updated soon with new conventional data QC pass)

2023 data available on request and preliminary version will be uploaded to EOL soon

Summary of PERiLS 2023 field operations

IOP and Date	Subdomain	Description	PIPS Deployments
IOP #1 (02/16/23) 	Brooksville, MS	Mostly weak, disorganized convection	None 
IOP #2 (03/03/23) 	Clarksdale, MS	Tornadic QLCS	PIPS1A/2B PIPS2A/1B PIPS3A/3B
IOP #3 (03/24/23) 	Lake Providence, LA	QLCS with embedded supercells	PIPS2A PIPS3A
IOP #4 (03/31/23) 	Tennessee Valley	QLCS with embedded circulations	PIPS1A/2A PIPS1B/2B PIPS3A PIPS3B
IOP #5 (04/05/23) 	Kennett, MO	QLCS with embedded circulations and strong gust front	PIPS1A PIPS1B PIPS2A PIPS2B PIPS3A PIPS3B

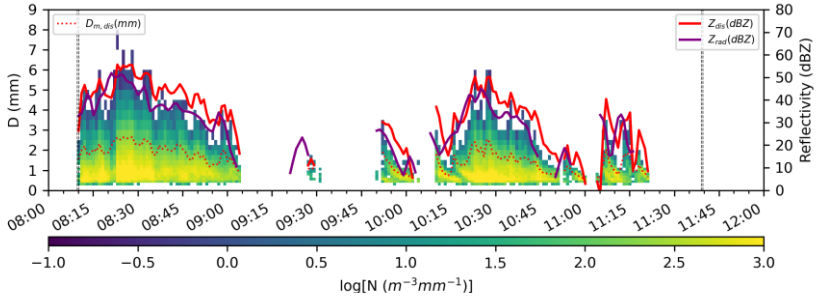
IOP #2

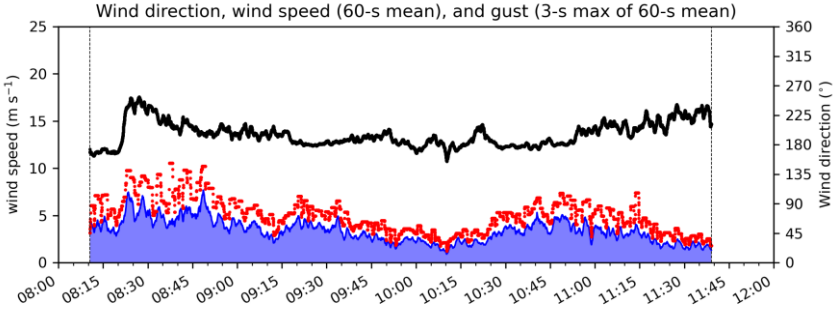
Nocturnal, briefly tornadic QLCS

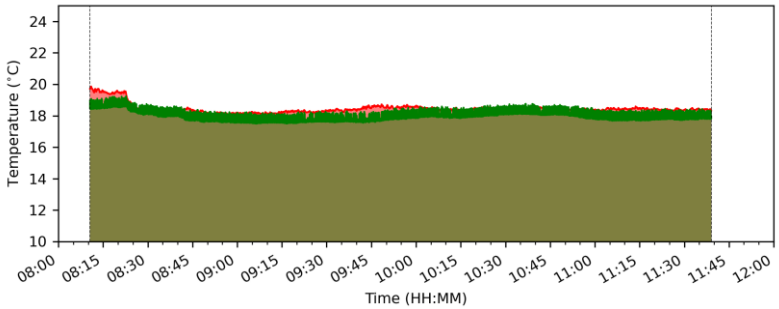
We deployed all six PIPS in collocated pairs in an “L-shape” (dictated by road geometry) south of Stuttgart, AR

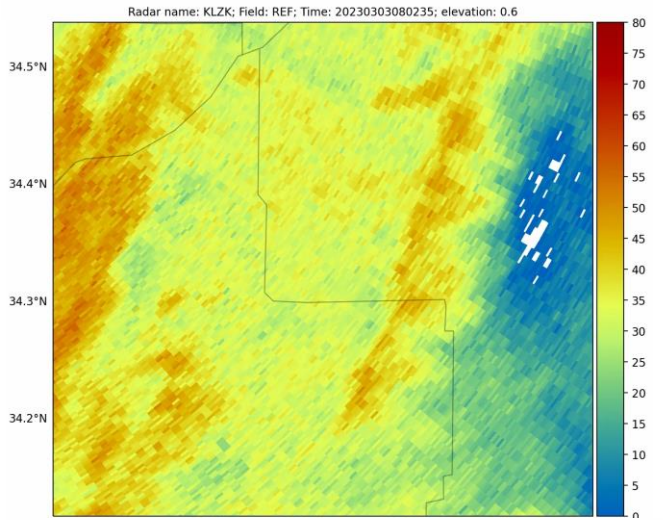
We got them down just in the nick of time!

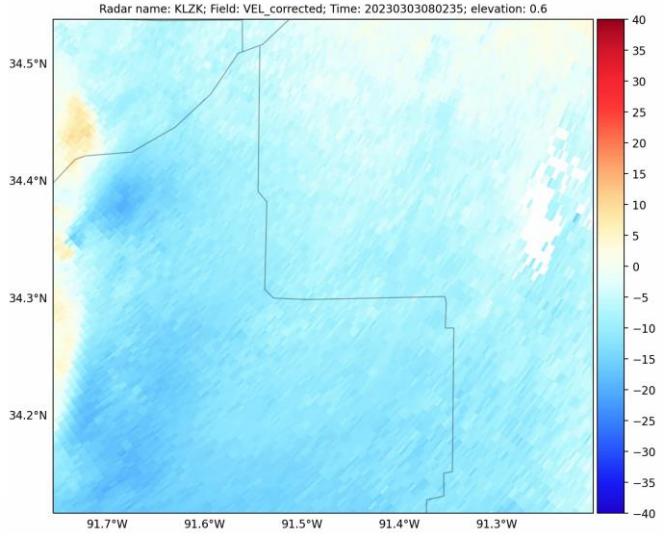
Obs show relatively weak cold pools (~ 2 K temp drop)











IOP #3

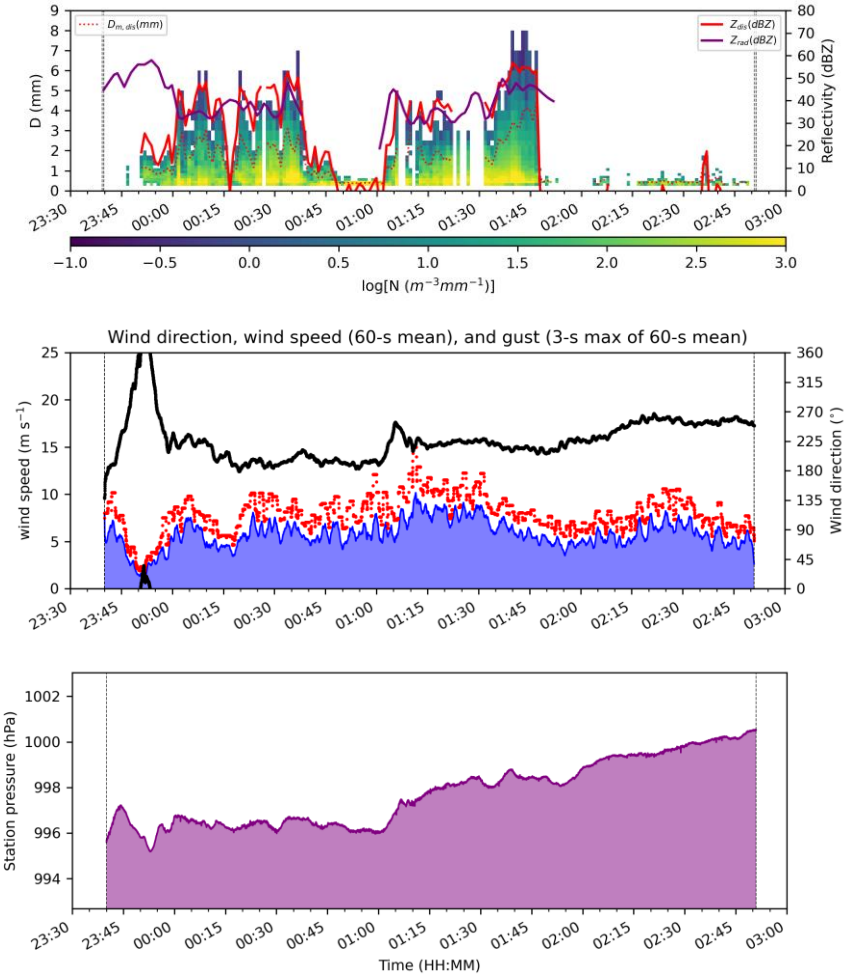
Supercell embedded in a band of relatively weak convection followed by a weaker (but windier) QLCS ~90 min later

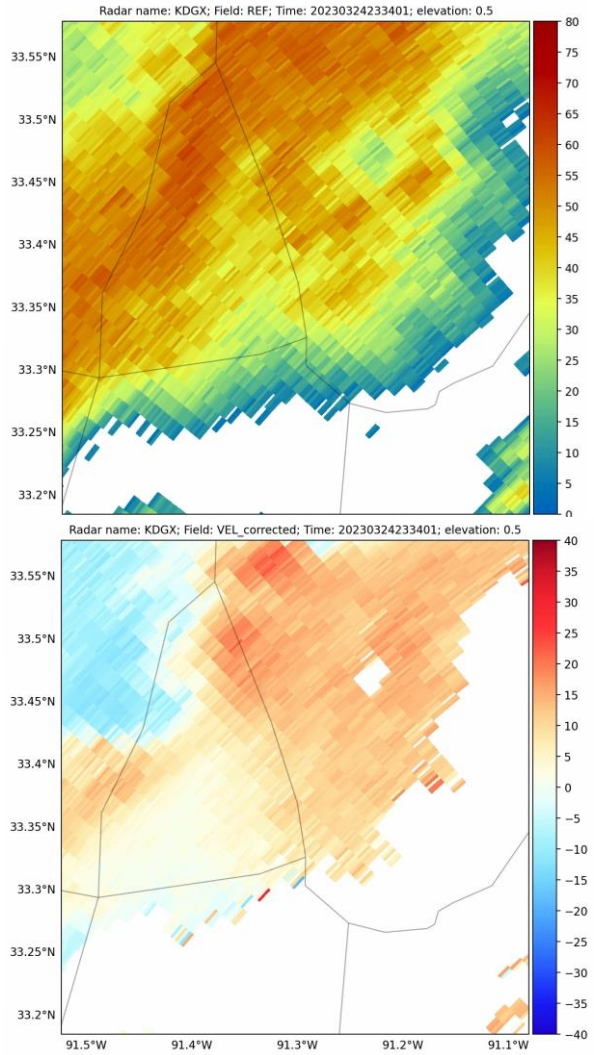
Only 2 PIPS deployed, collocated with TTU StickNets north of Lake Village, AR

Main circulation passed north of PIPS

Difficult deployment owing to poor road options and ambiguous mode

Winds occasionally affected DSD measurements



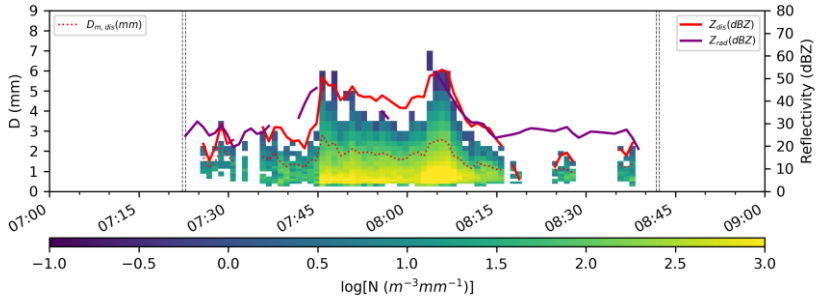


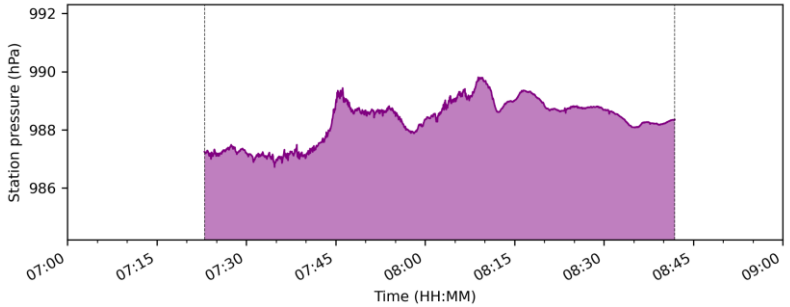
IOP #4

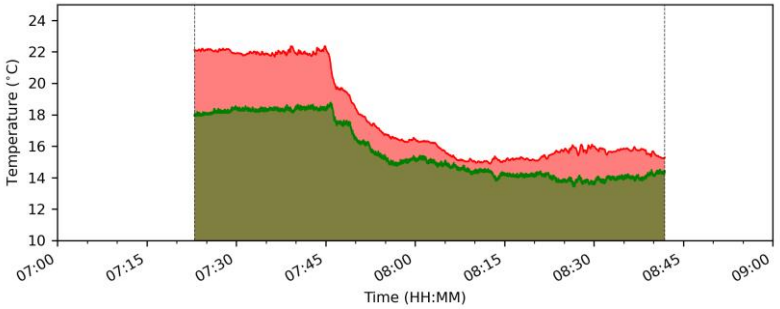
QLCS with embedded mesovortices finally developed from scattered, occasionally tornadic supercells over northern AL well after midnight

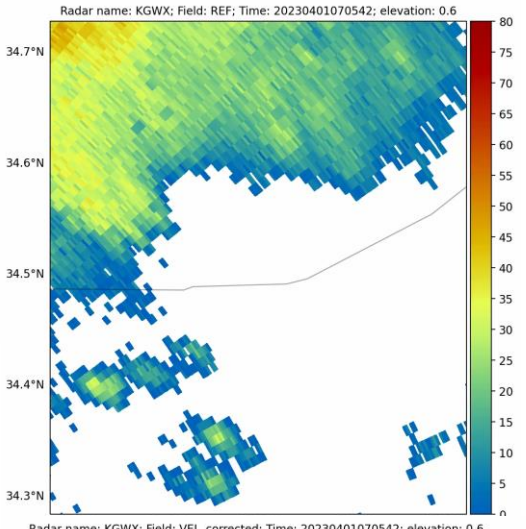
Deployed in N-S array centered near Moulton, AL, interleaved with TTU StickNets

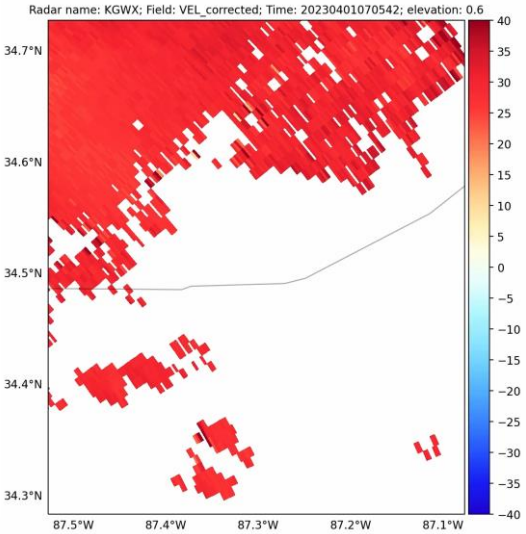
PIPS3A captured some interesting pressure oscillations after the passage of the southern portion of the line (which had a tornado warning south of the array)











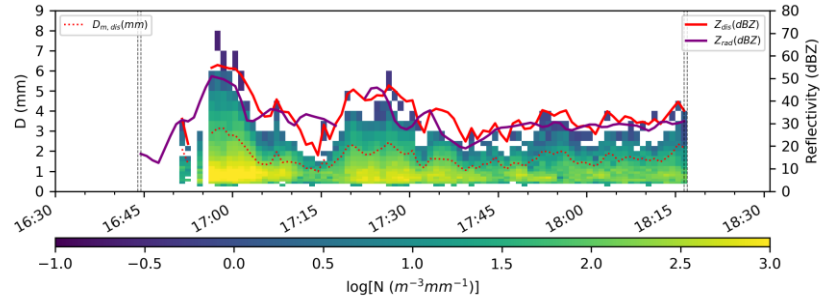
IOP #5

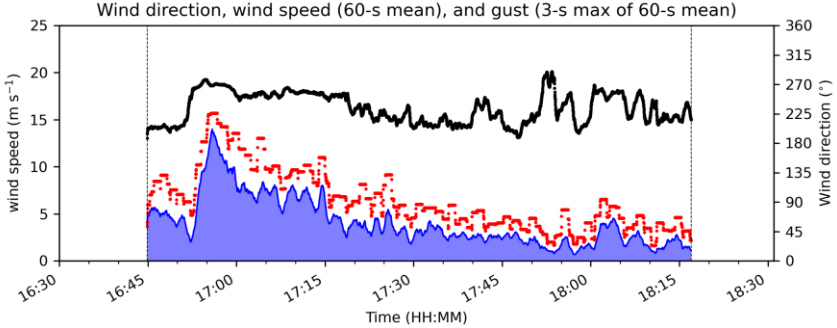
Deployed in N-S array centered near Harrisburg, AR, interleaved with TTU StickNets

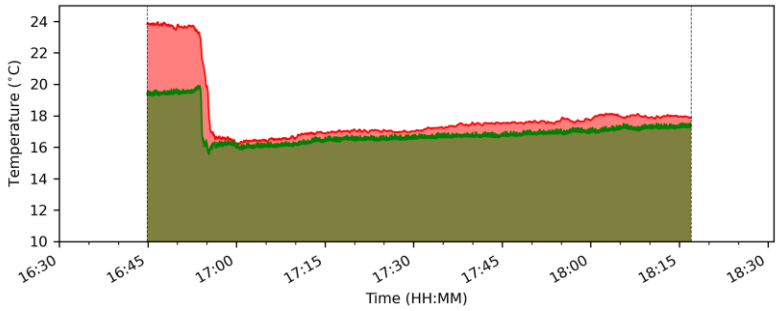
Two lines of convection, with northern line overtaking array around 1700 UTC

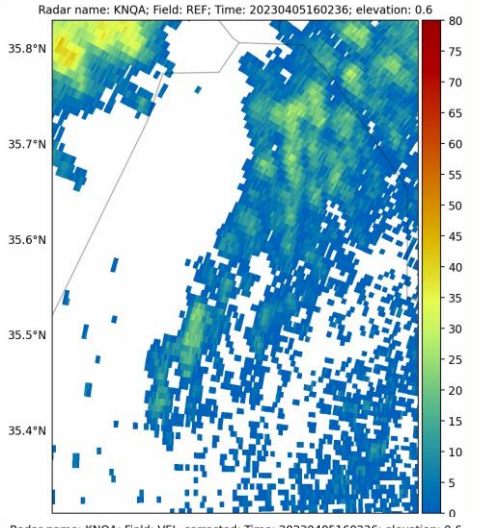
Strong gust front, with 3-s gusts over 15 m/s

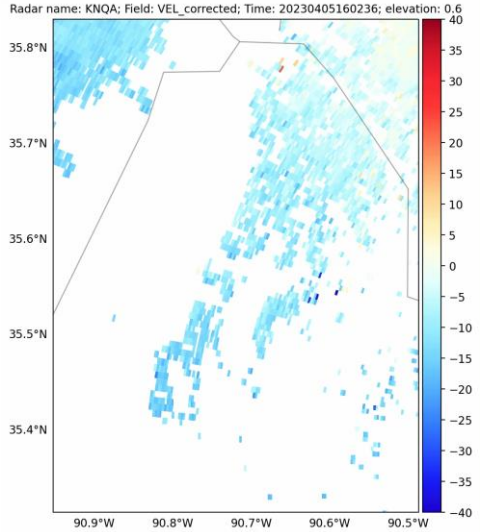
Sharp temperature drop with gust front arrival (~7-8 K)











Summary and Ongoing/Future Work

- Completed: Collected disdrometer and meteorological data in several convective systems across 4 IOPs during the PERiLS 2023 season
- Completed: First QC/radar comparison pass, nearly ready for EOL upload of preliminary dataset
- Ongoing: QC'ing, analyzing, analyzing…
- Future: synthesis with other PERiLS assets, particularly StickNet obs and mobile radars
    - Characterization of DSD evolution from aloft to surface using combination of Eulerian and Lagrangian techniques
    - Need 4D winds (dual/multi-Doppler across time) and polarimetric observations
- Ultimate goal: to get a deeper understanding of the complex links between microphysical, dynamical, and thermodynamical processes associated with QLCS tornadogenesis