VORTEX-SE (VSE):

Characterization of storm structure and storm environments through the integration, improvement, and analysis of multi-platform radar data

Center for Severe Weather Research

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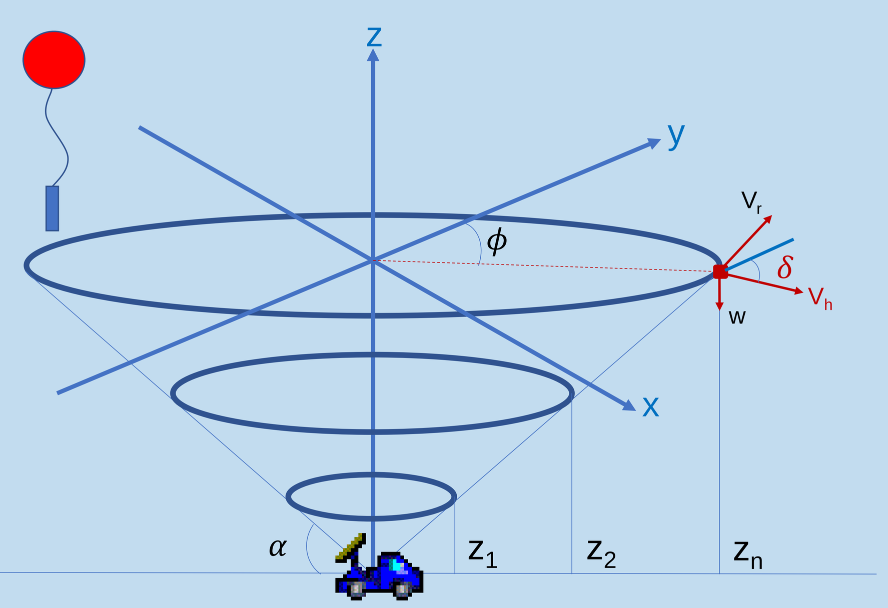
GOALS:

1. **Produce VAD wind profiles using mobile, fixed, and airborne VSE radars in regions of complex terrain and varied land use. Improve low-level VAD retrievals by constraining with empirical estimates based on nearby dual-Doppler, and in situ observations.**

2. Integrate NOAA P3 aircraft radar observations with ground-based radars to optimize syntheses of storm structure.

3. Use the findings from (1) and (2), combined with radiosonde and other wind profiling data collected during the 2016-2018 VSE field phases, to map the heterogeneity in the upstream near-storm environment of quasi-linear convective systems (QLCSs) or lines of closely-spaced independent cells/supercells that may transition into them. Relate this variability to terrain and land use features unique to the VSE observing area and determine if local mesoscale variabilities correspond to structure and intensity of storm-scale features related to QLCS severity and/or tornadoes.

VAD TECHNIQUE: $V_r = \mathbf{V_h}\cos(\alpha)\cos(\boldsymbol{\delta} - \phi) + w\sin(\alpha)$

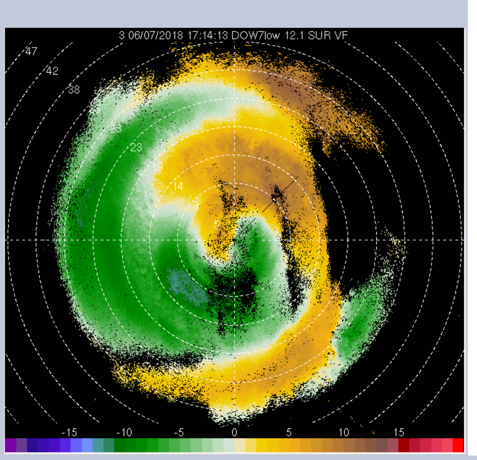


- Using RADAR collected along a ring at a constant height (z)
- Can get a vertical profile of horizontal wind ($\mathbf{V_h}$) and direction ($\boldsymbol{\delta}$) similar to a sounding
- Higher temporal frequency than soundings (i.e., coincident with radar update)
- Radar return is limiting

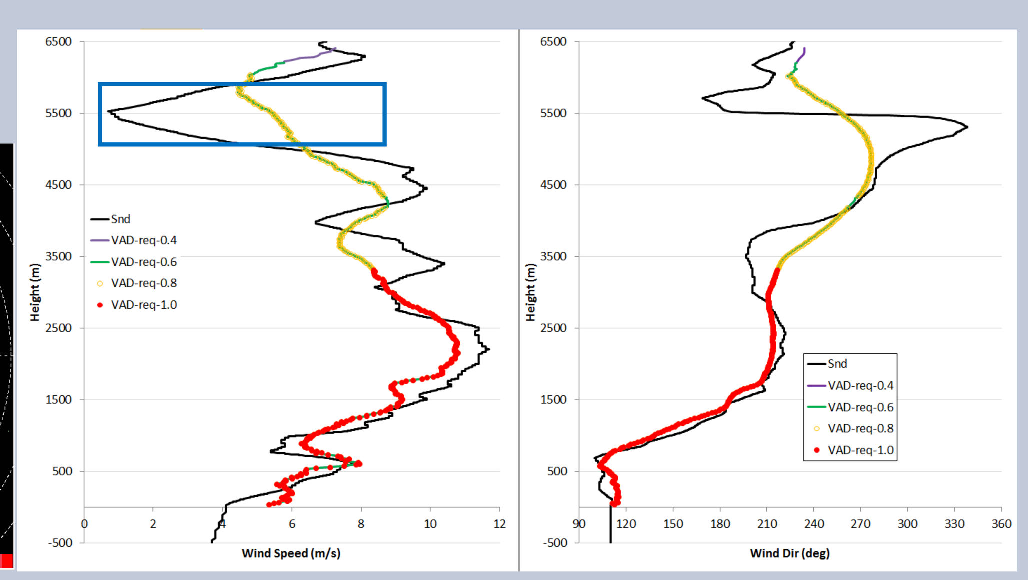
COMPARISONS & SENSITIVITY TESTS:

- Incomplete 360 scans (due to blockage, lack of scatterers, etc.) characterize many VSE mobile radar observations
- Want to check the robustness of VAD winds when sectors are missing by comparing to proximal soundings
- Initially used DOW (Doppler on Wheels) data and sounding data from the 2018 GRAINEX project, which focused on clear air observations

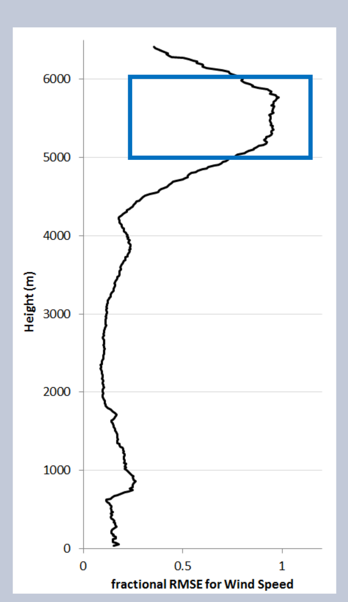
Mobile Radar Data Vs. Sounding Data



DOW data used for VAD analysis.

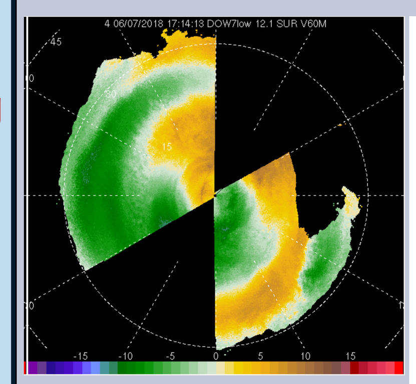


Comparison of VAD-derived winds (colored lines/dots) to sounding-measured winds (black line). The left panel is wind speed in m/s and the right panel is wind direction. The different colors in the profiles indicate VADs calculated with differing minimum fractions of data around the ring at a constant range that is tolerated to perform the sine fit, ranging from 0.4 (purple line) to 1.0 (red dots).

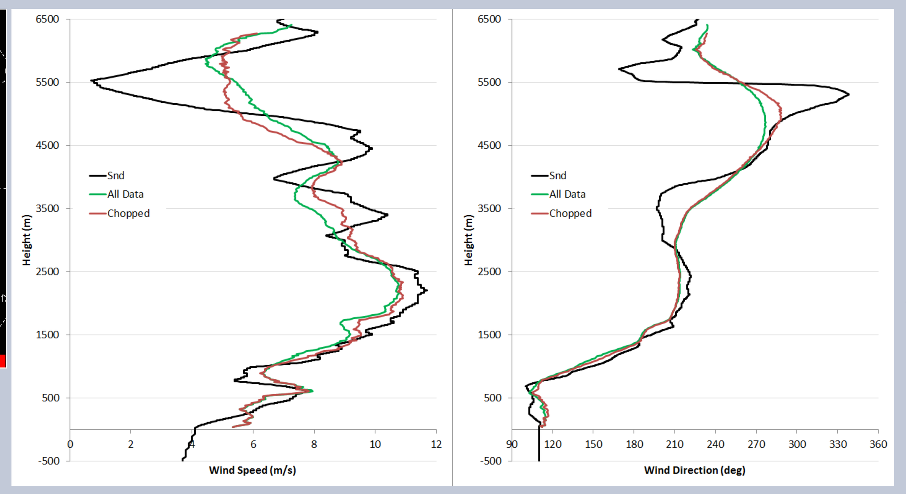


Root mean square error for VAD analysis. VAD wind speeds are in general agreement with radiosonde data.

Mobile Radar Data with a 60-Deg Sector Missing Vs. Sounding Data



DOW winds with 60-degree sectors removed.



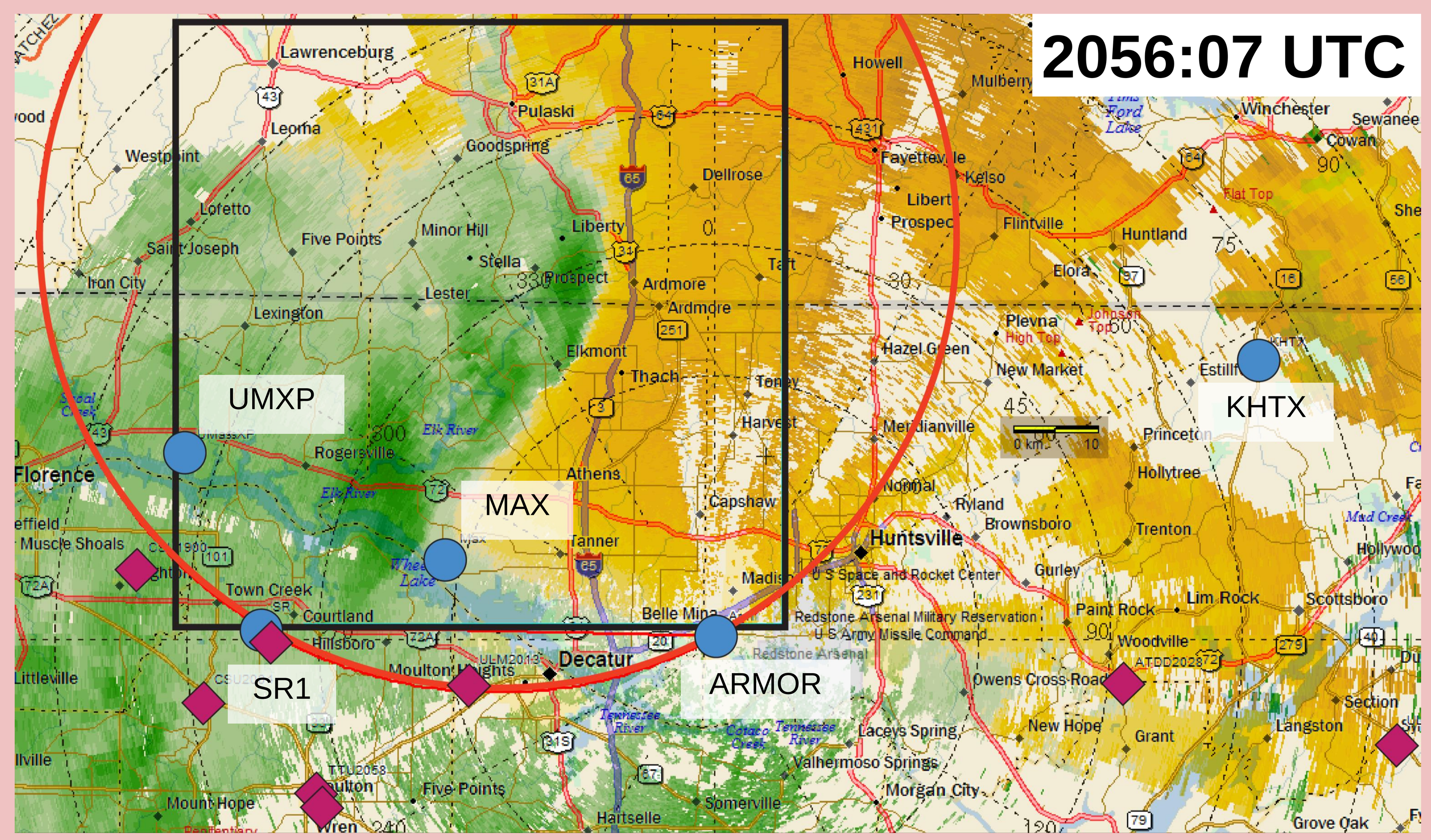
Comparison of VAD-derived winds (colored lines) with and without 60-degree sectors removed to sounding-measured winds (black line). Left panel is wind speed in and the right panel is direction. The green line is the VAD winds with no data removed and the brown line is the VAD winds with the 60-degree sectors removed.

Relatively robust to missing sectors – even when missing sector is coincident with the 0 Doppler line or encompasses the strongest Doppler winds.

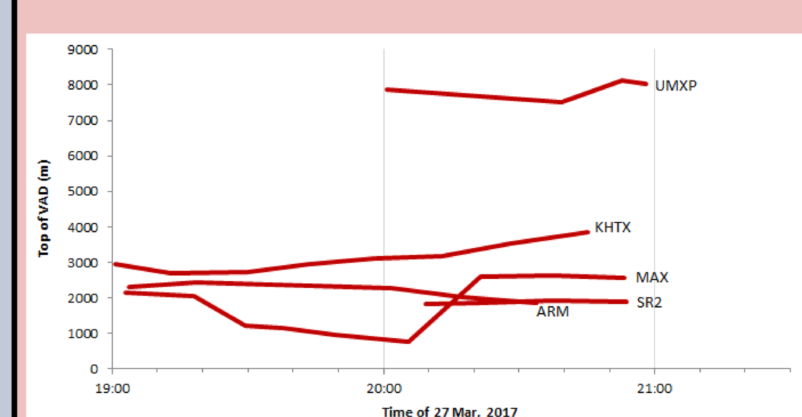
APPLICATION TO 2017 VSE DATA:

Can use VAD analyses to characterize mesoscale environment heterogeneities in the SE. Only wind data. May be able to infer possible thermodynamic heterogeneities.

27 March 2017



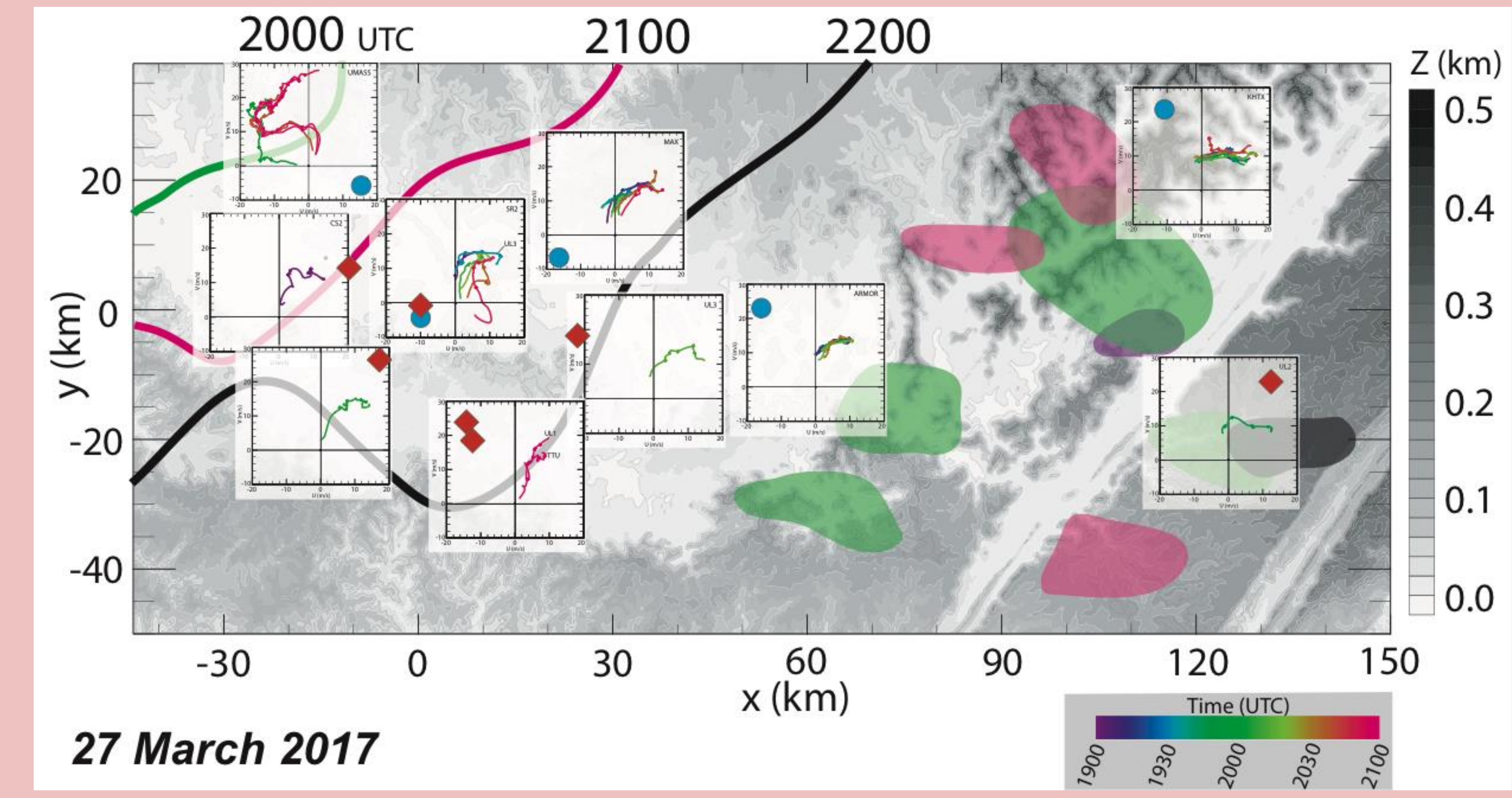
Overview of radar and radiosonde locations during the 27 March 2017 VSE observation period. Radars shown with blue circles and radiosonde launches shown with red diamonds. Dual-Doppler lobe between SMART radar (SR1) and ARMOR radar shown in red and the black rectangle depicts the dual-Doppler analysis domain. Doppler velocity data from ARMOR is shown at 2056:07 UTC, when the QLCS is central within the dual-Doppler domain.



Highest height available for VAD-derived winds as a function of time and radar for 27 March 2017. Data were available for UMXP at 8 km due to the presence of a stratus cloud layer, while the data for other radars is more representative of the depth of boundary layer returns. Encouraging for "early season" experiments.

Time (UTC)	Speed (m/s)	Direction (degrees)
MAX RADAR		
1903	9.7	215.8
1918	10.4	200.9
2021	8.1	219.0
2037	8.5	225.0
2053	8.9	214.0
SMART RADAR		
1902	6.4	209
2009	11.1	201
2021	9.6	213.5
2037	9.8	209.2
2053	13.7	178.3
CSU Sounding		
1900	8.6	192
2004	11.1	214
ULM Sounding		
1933	3.6	215
2100	7	195
TTU Sounding		
2058	9.3	193

Radiosonde-measured and VAD-derived 0-1 km shear values for 27 March 2017. Evolving shear important for QLCSs.



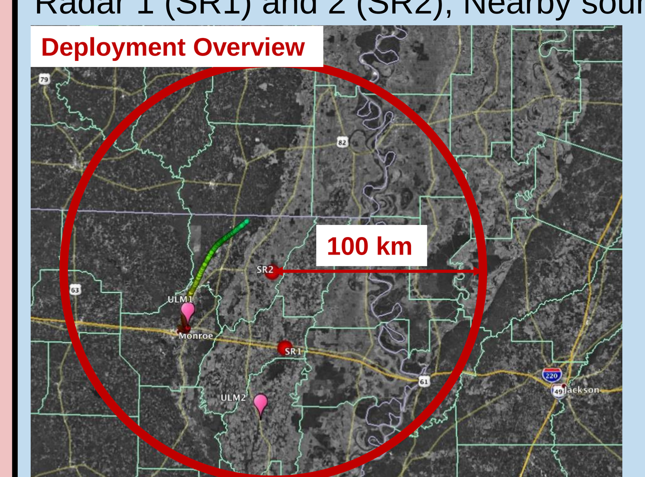
VAD and sounding hodographs for vertical wind profiles between 0-2.5 km (as vertical data availability permits) from VSE instruments deployed on 27 March 2017. Profiles are overlaid on a local USGS terrain map (height above the lowest terrain level - gray shading). Position of the QLCS (trace of the highest KHTX reflectivity at the leading edge of the convective line - thick lines) and isolated storms leading the QLCS (black, green, red shaded polygons) are illustrated at regular time intervals. Storm traces and hodographs are colorized according to their time after 1900 UTC. Blue circles and red diamonds indicate the location of the radar and radiosonde sites, respectively, on the terrain map.

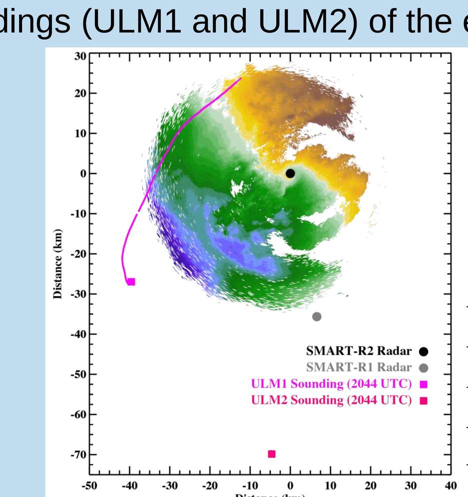
APPLICATION TO 2018 VSE DATA:

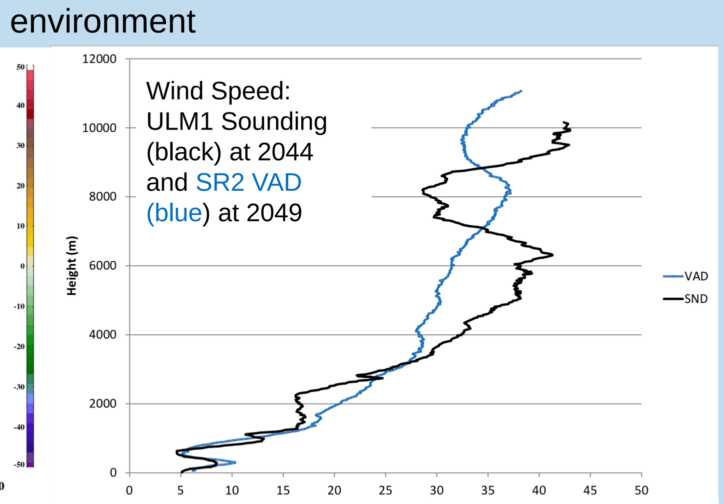
Mobile radar data from Spring 2018 became available August 2019, so still evaluating cases.

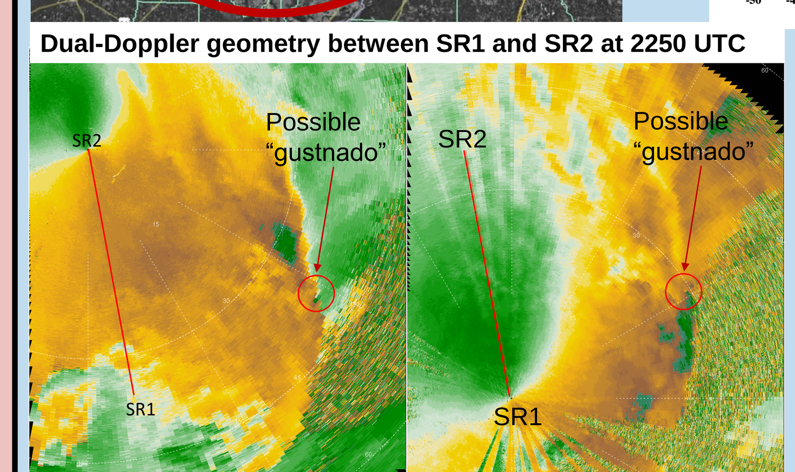
IOP 2A: 28 March 2018

Deployment near Jackson, MS; Possible "gustnado" along the gust front; Good dual-Doppler potential between SMART Radar 1 (SR1) and 2 (SR2); Nearby soundings (ULM1 and ULM2) of the environment

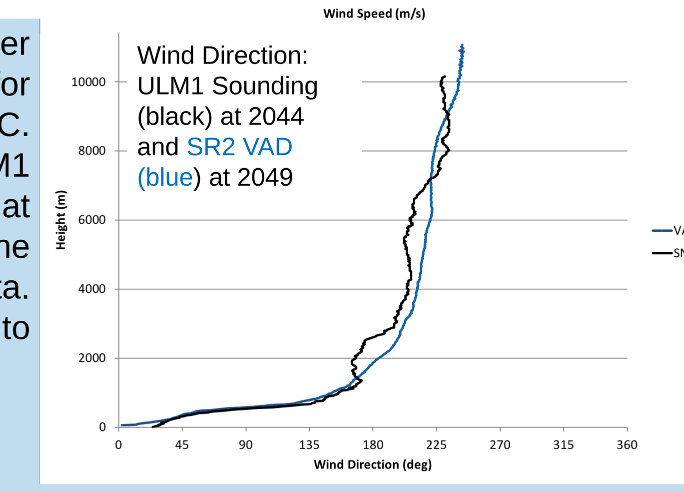






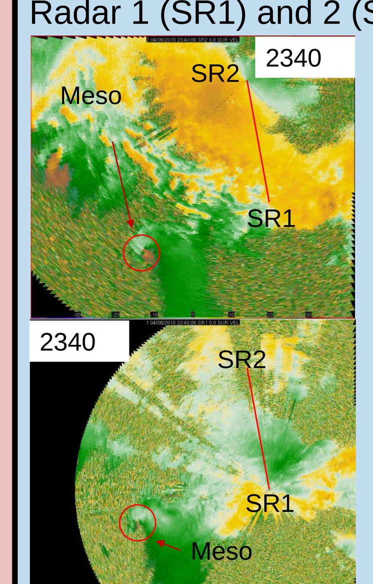


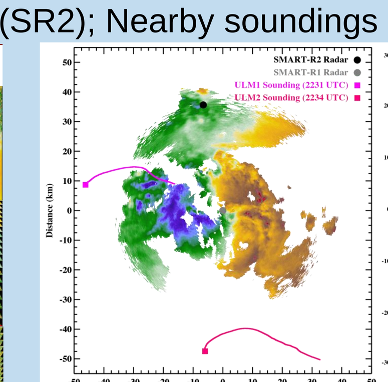
Above. SR2 Doppler velocity data used for the VAD at 2049 UTC. Location of ULM1 sounding launched at 2044 relative to the SR2 VAD data. Comparison shown to the **Right**.



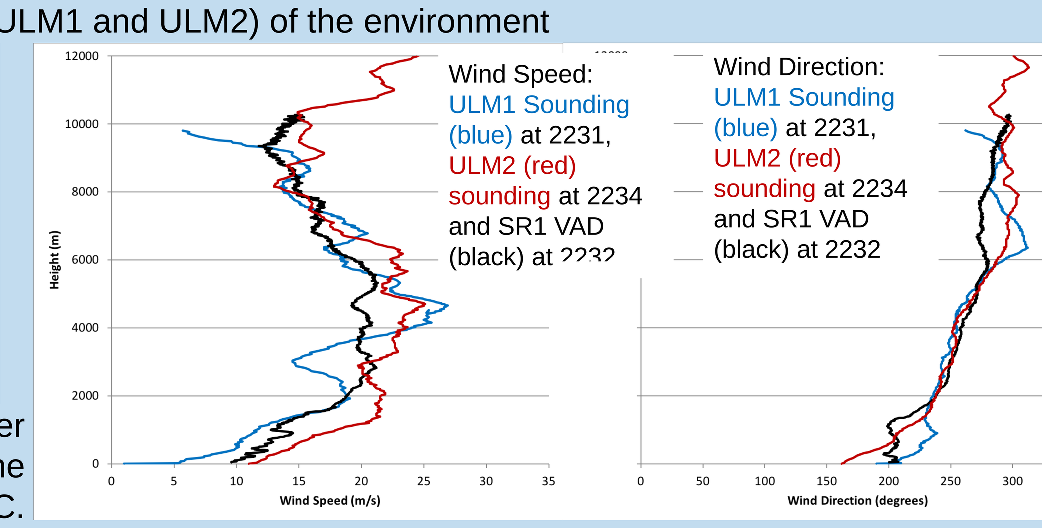
IOP 4: 6 April 2018

Same deployment sites as IOP2A; Supercell with possible tornado; Mediocre dual-Doppler potential between SMART Radar 1 (SR1) and 2 (SR2); Nearby soundings (ULM1 and ULM2) of the environment





Above. SR1 Doppler velocity data used for the VAD at 2232 UTC. Location of soundings relative to VAD data.



Above. Comparison of VAD and sounding data.