In-Situ Thermodynamic and Doppler Radar Observations of a Circulation within the Rear-Flank Downdraft of a Tornadic Supercell during VORTEX2 on 19 May 2010

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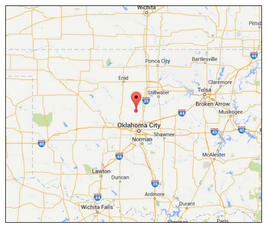
Introduction

On 19 May 2010, during the Verification of the Origins of Rotation in Tornadoes Experiment 2 (VORTEX2), high-resolution single-Doppler radar observations were obtained of a circulation within the rear-flank downdraft of a tornadic supercell near Kingfisher, OK. Additionally, mobile mesonet observations of the near-surface thermodynamic environment and of wind speed and direction have been analyzed and are presented.

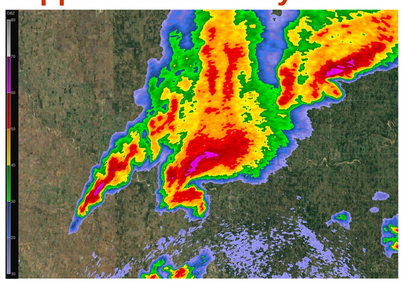
Data and Analysis Methods

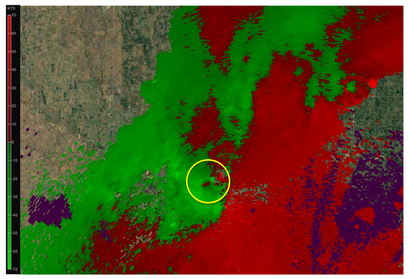
At 2345 UTC on 19 May 2010, a Doppler on Wheels (DOW) radar deployed at 35.85002° N 97.58508° W within the hook echo of a tornadic supercell. Three full volumetric scans were taken along with an incomplete fourth volume scan. All four volumes have been edited with SOLO3 software to remove regions of poor-quality data (noise) and ground clutter as well as to dealias velocities. These data were then objectively analyzed to a Cartesian grid using OPAWS to determine the characteristics of the vortex.

The DOW is an X band radar with wavelength of 3 cm and a beamwidth of 0.95 degrees. The grid resolutions for the objective analysis domains are 200 m for the domain including the entire storm, and 100 m for the domain focusing on the hook echo. The radii of influence are 0.419 km^2 and 0.0464 km^2 respectively. Data were collected from 23:45:14 – 23:50:45 UTC. Below is a map of the deployment location.

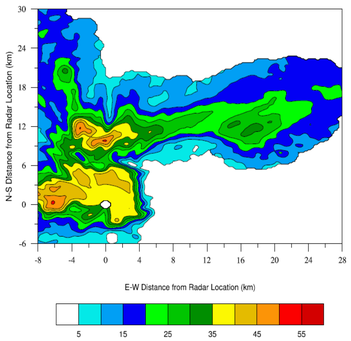


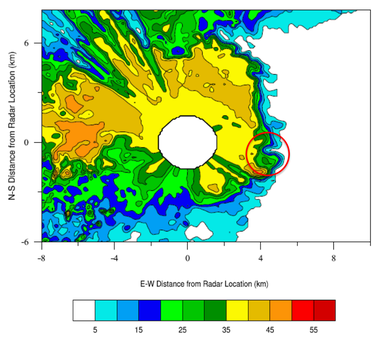
Doppler Radar Analyses



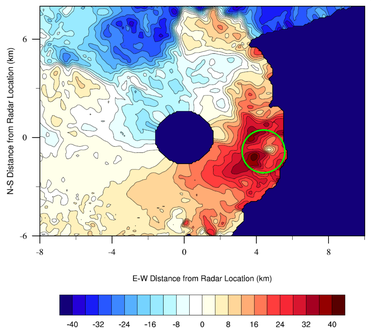


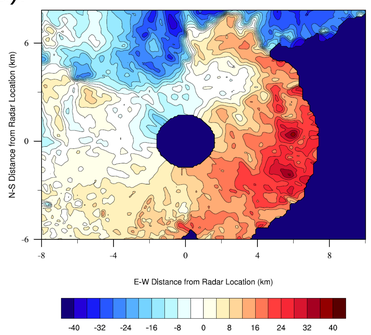
KTLX WSR-88D reflectivity (dBZ) and radial velocity (knots) at 23:48:13 UTC. These data are too coarse temporally and spatially to display the vortex, which was located along eastern edge of the hook echo. The mesocyclone, however, is clearly evident within the inflow notch and is circled.





Objectively-analyzed DOW radar reflectivity fields at 100 m above ground level (AGL) over the entire storm (left) and hook echo (right) at 2345:14 UTC. Attenuation owing to heavy rain and hail within the forward-flank of the storm prevent radar returns from most of this region of the storm in the left image. There is a reflectivity appendage along the eastern edge of the hook echo (right) about 4 km ESE of the radar location (circled).

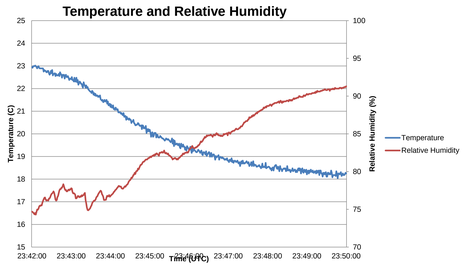


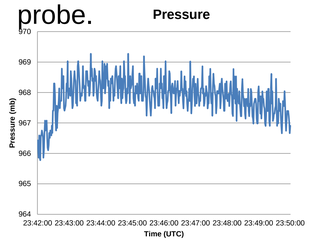


Objectively-analyzed radial velocity fields at 100 m AGL from 2345:14 UTC (left) and 2347:43 UTC (right). At 2345 UTC, the vortex is approximately 4 km ESE of the radar location. The velocity differential is 40 m s^{-1} over a distance of 1 km. By the time of the second image (150 s later), the vortex has dissipated.

Thermodynamic Analyses

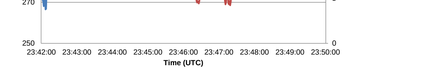
The mobile mesonet was stationary and colocated with the DOW during data collection. The graph to the right depicts a 4 C drop in temperature and a corresponding increase in relative humidity as the rear-flank gust front passed the probe.





The graph to the left shows an increase in pressure of over 2 mb in 60 s as the vortex moved away from the probe. Some of this increase is also likely attributable to the buoyancy-driven pressure perturbations within the rear-flank outflow.

Westerly winds greater than 20 m s^{-1} at the beginning of the observation period are consistent with the vortex passing north of the probe and the pressure rise across the gust front. The winds became more northerly later owing to the parent circulation.



Conclusions

- A short-lived vortex, with a velocity differential of 40 m s^{-1} was observed by a high-resolution mobile Doppler radar.
- This vortex was likely within 1 km of the mobile mesonet and radar at 2342 UTC, but this was prior to the beginning of radar data collection at 2345 UTC.
- A pressure rise of over 2 mb in 60 s was observed as the vortex moved away from and as the rear-flank gust front passed over the mobile mesonet.

Acknowledgments

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