Dual-Doppler and Polarimetric Observations of Two Tornadic Supercells in Central Oklahoma on 19 May 2013

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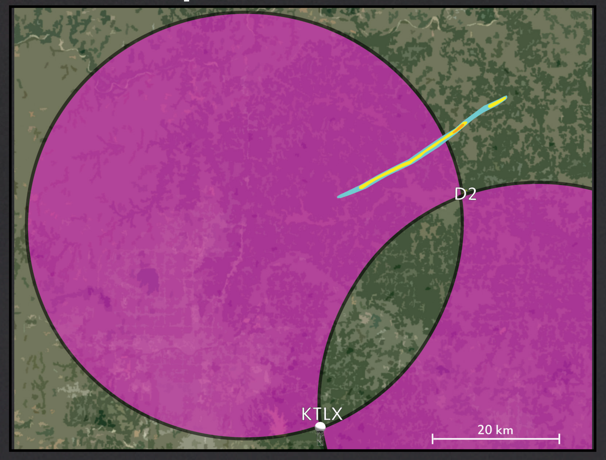
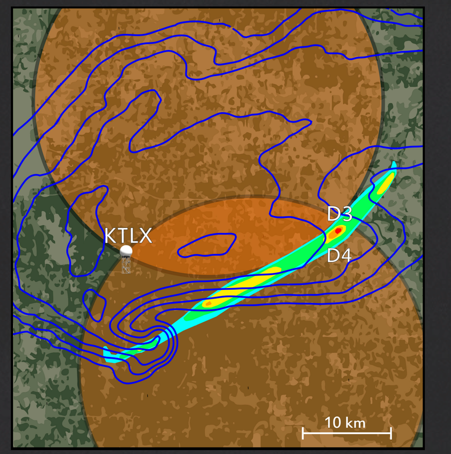
1. Introduction

On 19 May 2013, two supercells moved through central Oklahoma and produced seven tornadoes, including one of EF-3 and one of EF-4 intensity. High temporal and spatial resolution observations were collected in both strong tornadoes by a mobile, rapid-scan, X-band, polarimetric radar (RaXPol). In conjunction with the nearby WSR-88D Twin Lakes radar, dual-Doppler analyses were synthesized to produce the three-dimensional wind field and analyses of vertical vorticity throughout the tornadoes' lifecycles. Presented herein is a vertical vorticity analysis of the Norman-Shawnee supercell, which includes data from three separate RaXPol deployments (left). Analysis of the dual-Doppler windfield with respect to differential reflectivity (Z_{DR}) columns are also examined for the Edmond-Carney supercell (top right).

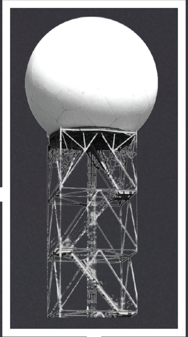




2. Methods and Radar Characteristics

Characteristics of the radars used to collect data on 19 May 2013, as well as the methods used to process and create the dual-Doppler wind syntheses, are described below:

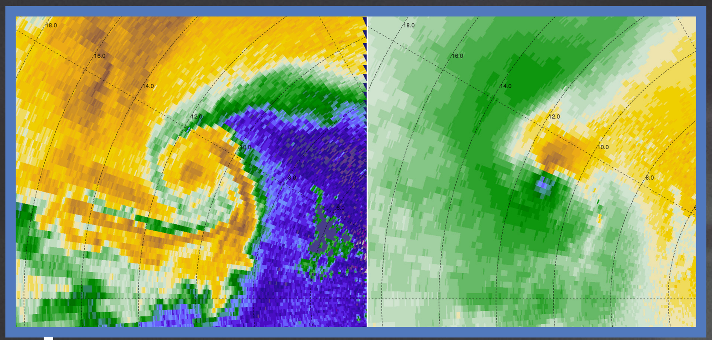
RaXPol	RADAR	KTLX
20 kW	Peak Transmit Power	475 kW
9.73 GHz	Operating Frequency	2.91 GHz
1.0°	Beamwidth (one-way, 3 dB)	0.91°
75 m	Range Resolution	250 m
180° s^{-1}	Antenna Rotation Rate	30°s^{-1}



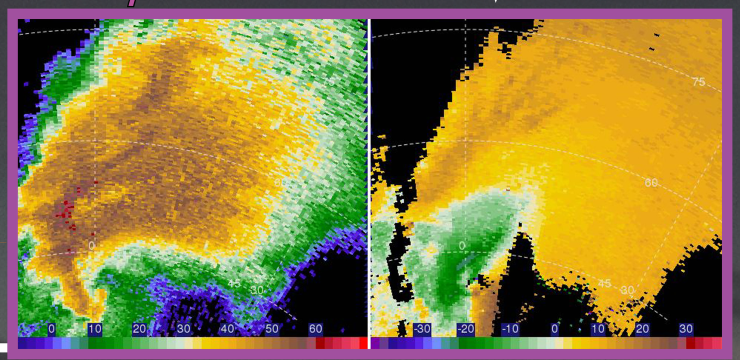
High-temporal resolution -- radar scans every 2 seconds

Much lower temporal resolution -- volumes collected approximately every 255 seconds

Raw RaXPol Data



Is it possible to combine these data sets to make them compatable given much different sampling rates?

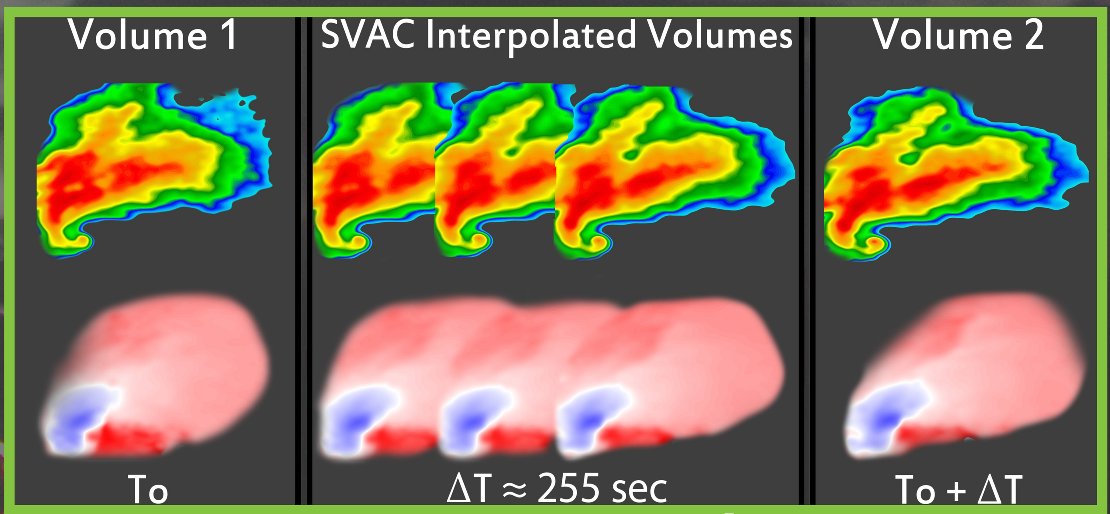


Raw KTLX Data

Objective Analysis

Observation Processing and Wind Syntheses (OPAWS) (e.g., Kosiba et al. 2013) was used to map the data to a Cartesian grid using a two-pass Barnes analysis, and a grid spacing of 250 m.

KTLX Analyses



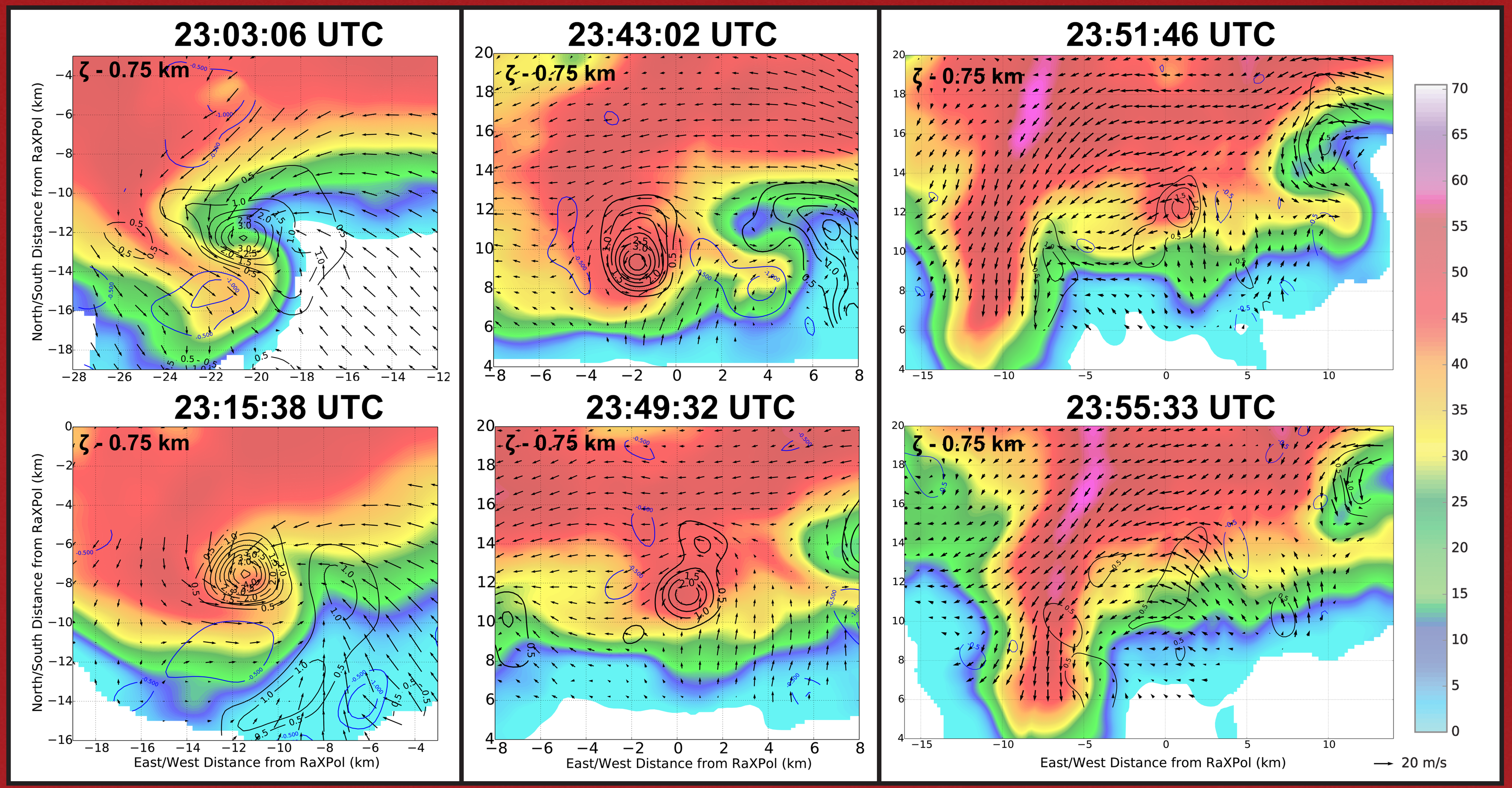
- Spatially variable advection correction technique employed to interpolate KTLX data linearly, in a Lagrangian sense, to the RaXPol analysis times (Shapiro et al. 2010a, b).
- Interpolated KTLX volumes are paired with RaXPol volumes at each corresponding time to create a dual-Doppler synthesis valid at each RaXPol volume.

RaXPol Analyses

Dual-Doppler Wind Synthesis

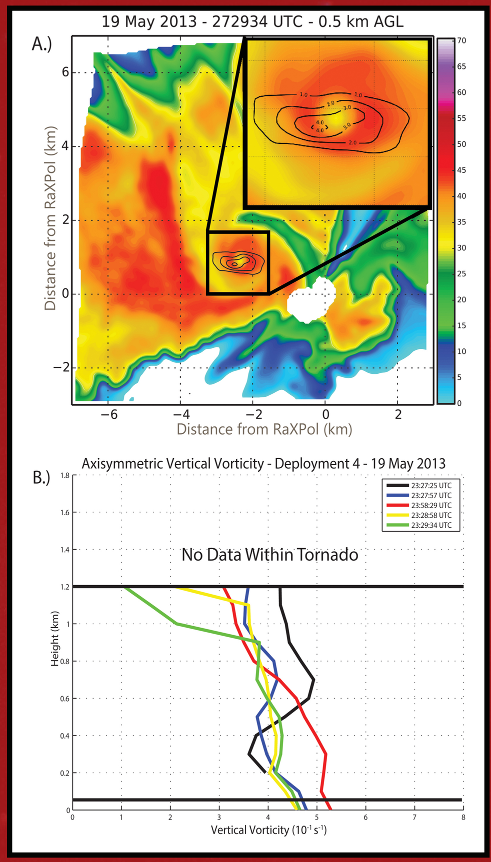
Z_{DR} Column Analysis

3. Dual-Doppler Analysis - Norman-Shawnee Supercell

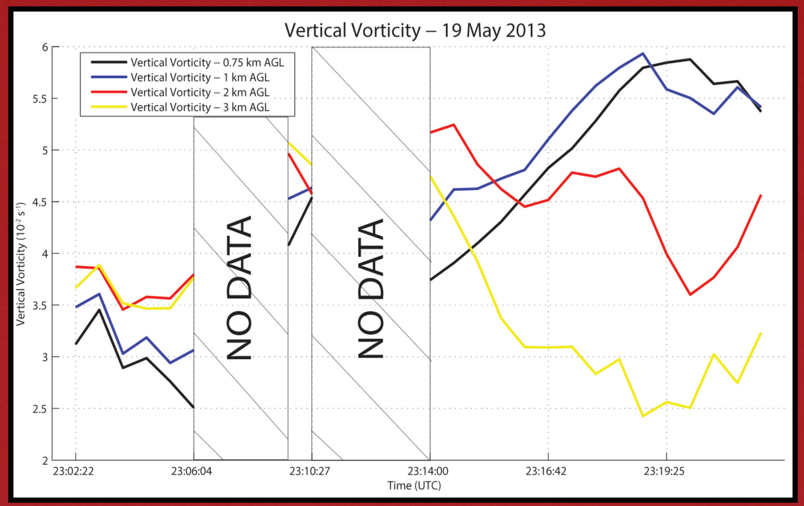


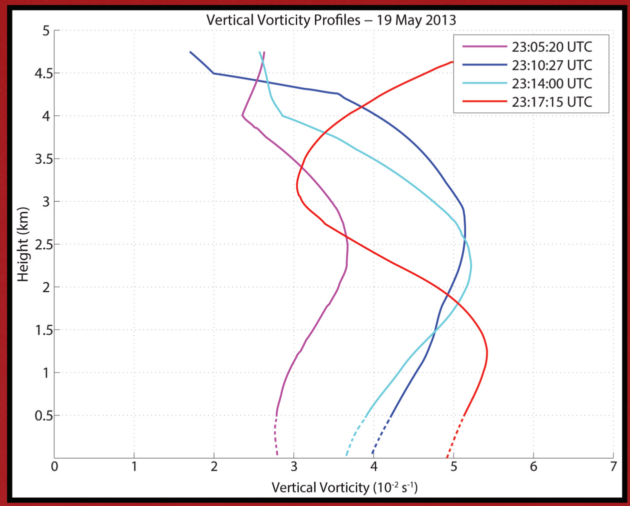
ABOVE: Evolution of the low-level vertical vorticity (ζ) at six selected times (labeled above). Contours of ζ are in increments of 0.5x10^{-2}s^{-1}. Black contours represent cyclonic vorticity (ζ > 0), and blue contours represent anticyclonic vorticity (ζ < 0). Horizontal wind vectors are storm relative.

RIGHT: Axisymmetric vertical vorticity analysis (top), and vertical profiles of ζ (bottom) at five selected times during RaXPol deployment 4. At 22:29:34 UTC, RaXPol was 2.5 km from the tornado. Black coutours represent ζ > 0, and are plotted every 0.5x10^{-1} s^{-1}.

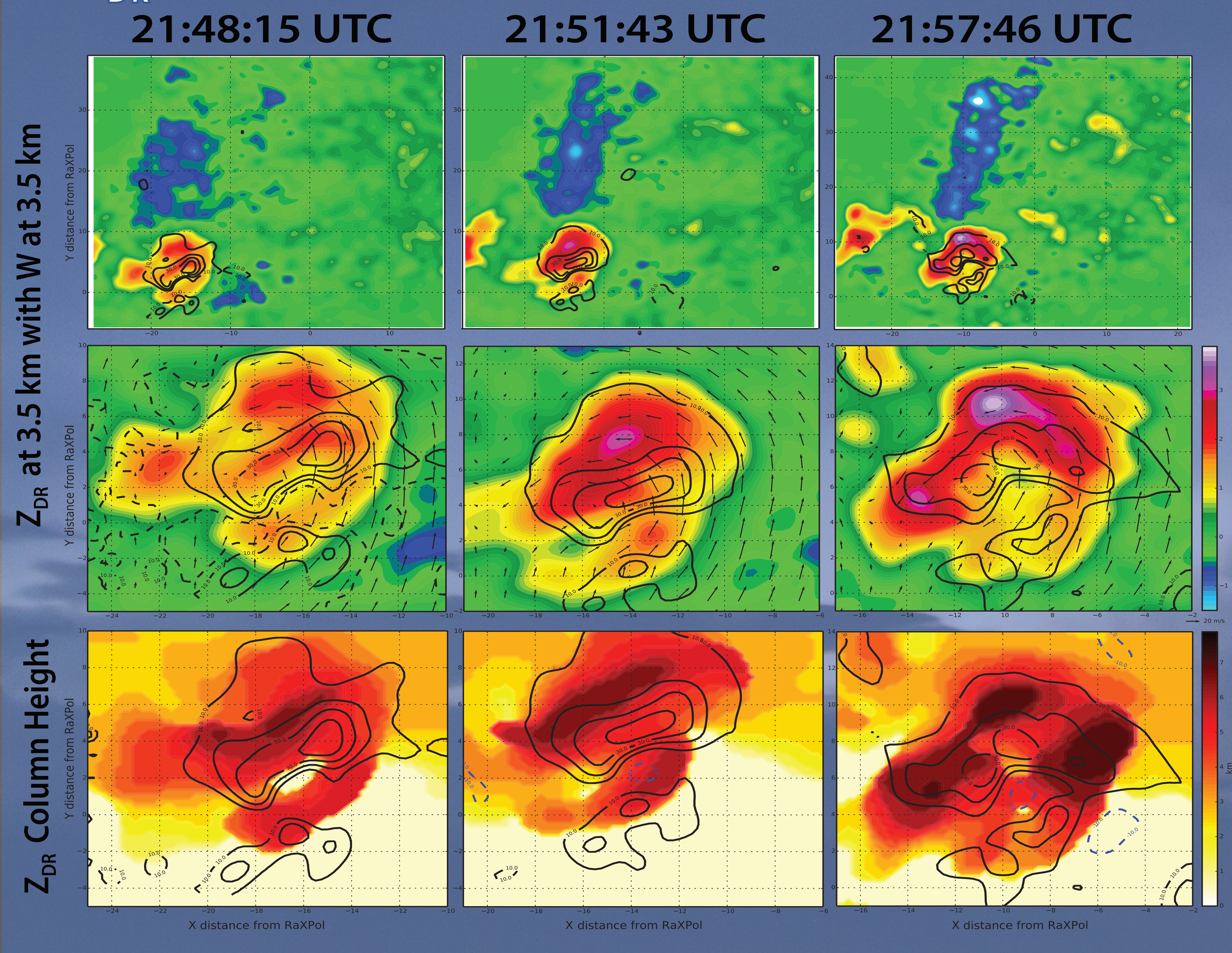


BELOW: Time series plots of ζ (left) at 0.75 km, 1 km, 2 km, and 3 km, and vertical profiles of ζ (right) at four selected times during the dual-Doppler analysis.



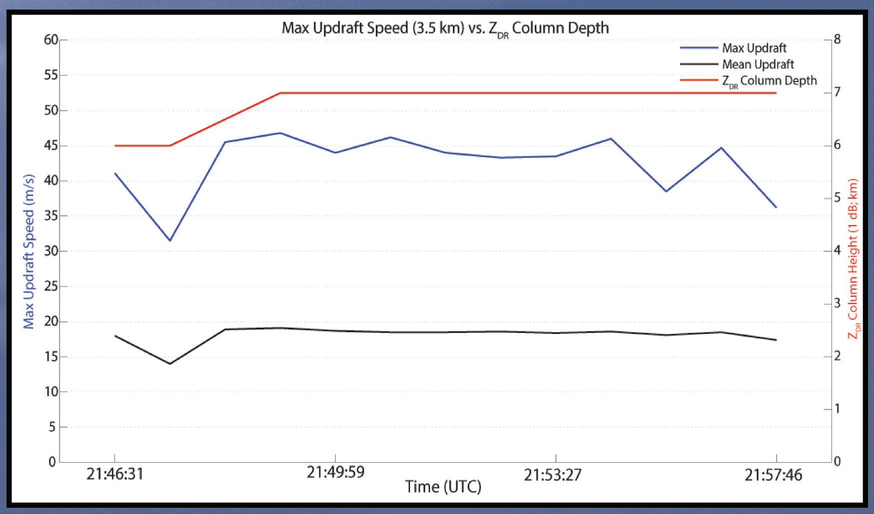


4. Z_{DR} Column Analysis - Carney-Edmond Supercell



LEFT: Analysis of Z_{DR} with respect to dual-Doppler derived wind field. Positive (negative) vertical velocity (w) is plotted every 10 m s^{-1} in black (blue). Dashed contours represent w of 5 m s^{-1}. Z_{DR} column height (km; a Z_{DR} column designated as Z_{DR} > 1) is also presented (bottom row).

BELOW: Time series of the maximum Z_{DR} column depth (red line), and mean (black) and maximum (blue) updraft intensity.



5. Conclusions

This study demonstrates that it is possible to use time interpolated radar data to supplement rapid-scan radar data where a second radar can be used to provide additional insight on the physical processes within a convective storm. Qualitatively, this technique yielded reasonable results. However, additional studies are needed to better understand the quantitative results (e.g., how well are the updraft strengths represented) and identify areas where this technique may exacerbate dual-Doppler errors.

Acknowledgments

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