71

EnKF and Polarimetric Analyses of the 31 May 2013 El Reno, Oklahoma Supercell during Tornadogenesis

Patrick S. Skinner[1,2], Jeffrey C. Snyder[1,2], Louis J. Wicker[2], Howard B. Bluestein[3], and Kyle J. Thiem[3]

[1] - Cooperative Institute for Mesoscale Meteorological Studies/University of Oklahoma; [2] - NOAA/National Severe Storms Laboratory;

[3] - University of Oklahoma

Pre-Tornadogenesis (2255 - 2300 UTC)

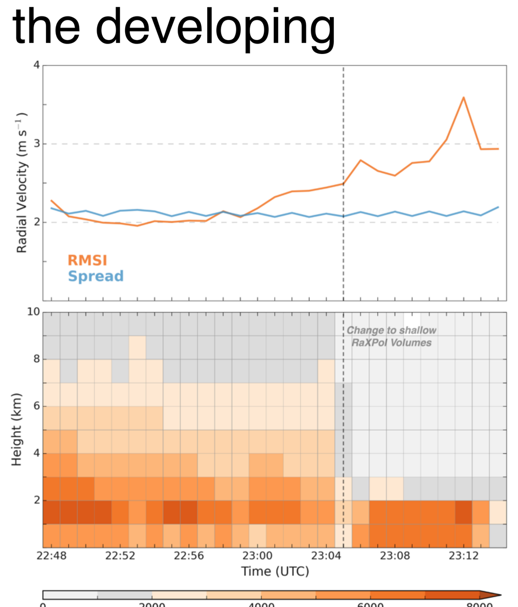
Tornadogenesis (2300 - 2305 UTC)

Tornado Intensification (2305+ UTC)

- Cyclic mesocyclogenesis occurs between 2255 and 2300 as an occluded, weak tornado moves rearward with respect to the RFD gust front and a new mesocyclone develops underneath the storm updraft
- An intense downdraft develops northwest of the developing mesocyclone by 2258

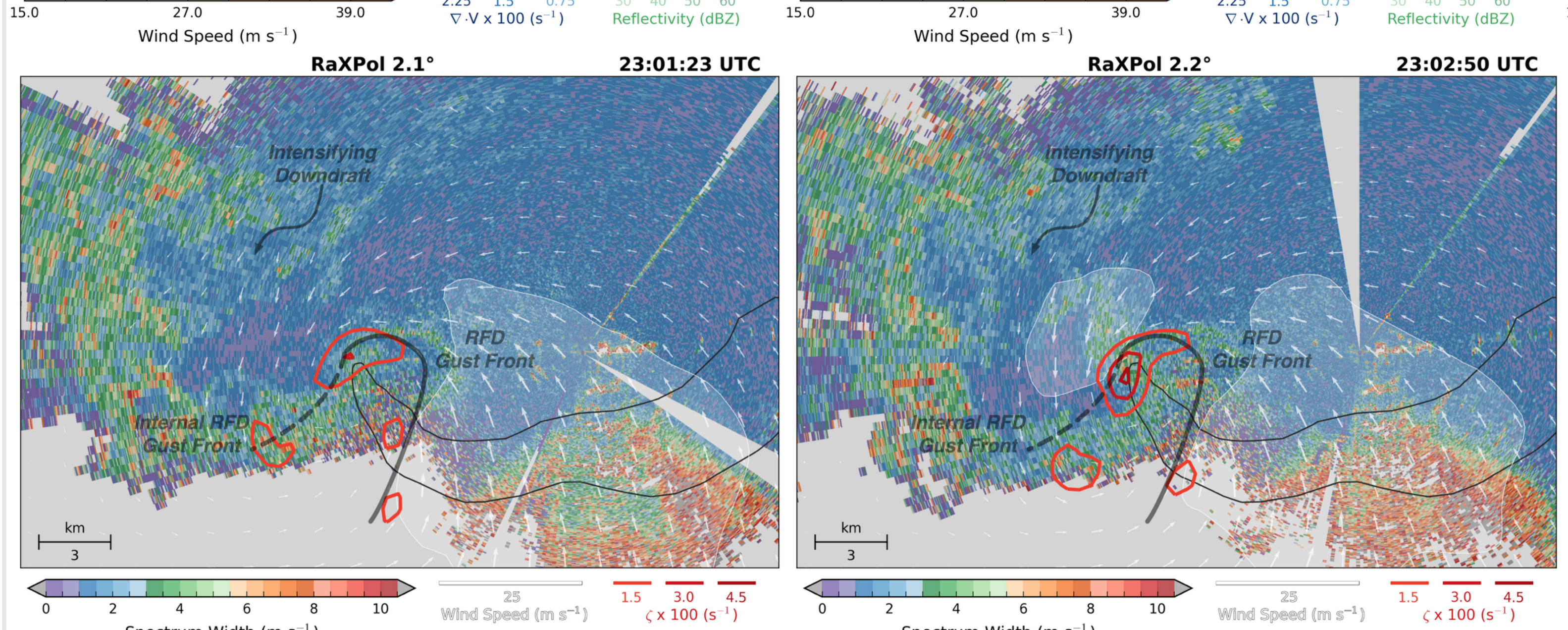
Methodology

- 54-member ensemble of NCOMMAS simulations with 2-moment ZVD microphysics similar to Skinner et. al. 2015
- Multifunction Phased Array Radar and RaXPol data are assimilated using a LETKF filter
- 500 m analyses at 1-min from 2247 - 2312



Time series of (top) posterior radial velocity RMSI and spread (m s^{-1}) and (bottom) number of obs. per 500 m vertical bin for each cycle.

*Corresponding Author Address: Patrick Skinner CIMMS/NSSL
120 David L. Boren Blvd., Suite 4380 Norman, OK 72072
patrick.skinner@noaa.gov



- An RFD surge and associated gust front develop immediately southeast of the downdraft, resulting in a rapid increase in convergence surrounding the developing mesocyclone
- The RFD surge gust front is roughly coincident with the leading edge of higher Z_{DR} wrapping around the meso from the forward flank
- Z_{DR} values decrease ahead of the RFD surge gust front, consistent with findings of Kumjian (2011) and French et al. (2015)
- Highest wind speeds in RFD surge are co-located with a minimum in spectrum width, suggesting a weak turbulent component to the flow

Figure Descriptions

EnKF ensemble mean analyses are overlain on low-level RaXPol scans to compare storm-scale kinematic features with radar signatures. Attenuation-corrected radar reflectivity (top row), differential reflectivity (middle row) and select spectrum width, correlation coefficient, and specific differential phase RaXPol scans are provided. EnKF divergence (middle row) at the lowest model level or vertical vorticity (top row) at ~450 m are contoured. Wind vectors are overlain and wind speeds >25 m s^{-1} are shaded white. The El Reno tornado damage track is contoured in thin black and annotations are placed in identical positions for each plot to facilitate intercomparison. The bottom row provides a broader view of ensemble mean wind speed, divergence, and simulated reflectivity.

- Rapid intensification of the tornado coincides with development of an organized near-surface wind field consisting of a broad, arcing downdraft bounding strong winds wrapping from the storm inflow to the rear of the tornado
- The downdraft is co-located with X-band polarimetric signatures indicative of hail; including attenuation in Z_H and Z_{DR}, CC values below 0.9, and very large K_{dp} values that are normally associated with a large amount of melting hail (Kumjian 2013)

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