HIGH-RESOLUTION PHASED ARRAY RADAR OBSERVATIONS OF AN OKLAHOMA HAILSTORM PRODUCING EXTREMELY-LARGE HAIL

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Introduction

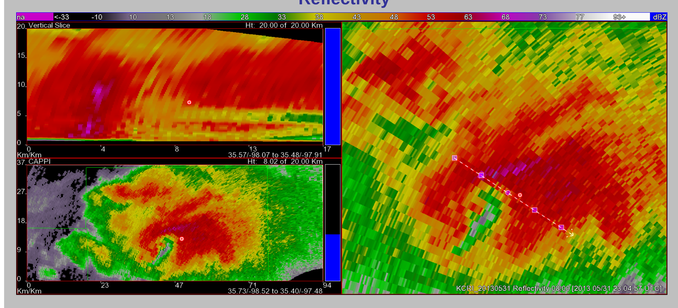
- Severe storms in central OK on 31 May 2013 produced hail up to 160 mm in diameter
- The Phased Array Radar (PAR) in Norman, OK collected data on these storms
- The 160 mm hailstone is a new record-large size for OK and the fifth largest in the U.S.; it fell on the west side of El Reno, OK at ~2305 UTC (106 min after first echo)
- This study presents high-resolution PAR observations of the storm that produced the 160 mm hailstone

Radar parameters examined

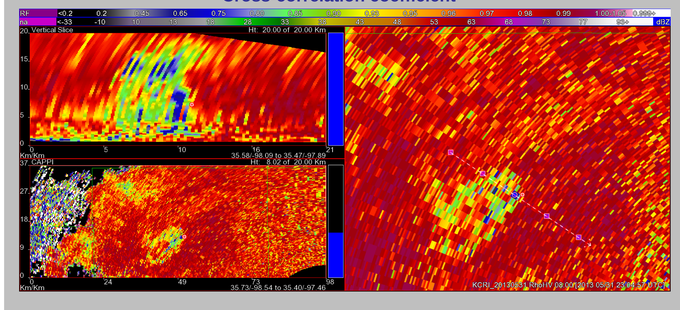
- Maximum reflectivity at the −20°C height (Z_{253K})
- Vertically integrated liquid (VIL)
- Maximum expected size of hail (MESH)
- Storm-top divergence (STD)
- Mid-altitude rotational velocity (MRV)

Dual-polarization data from KCRI

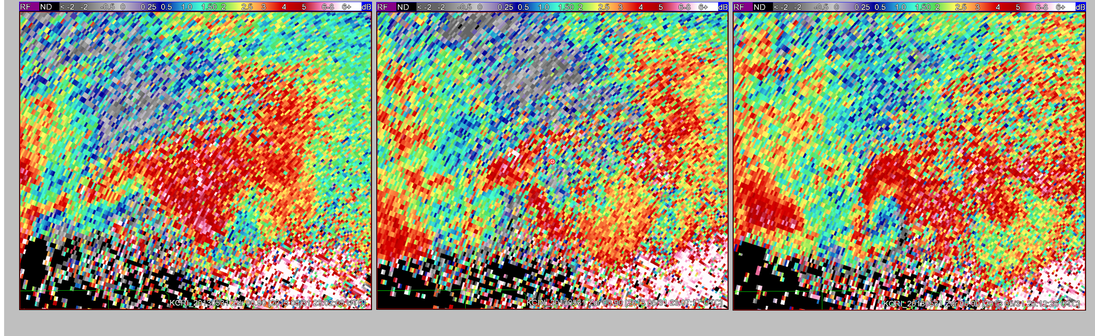
Reflectivity



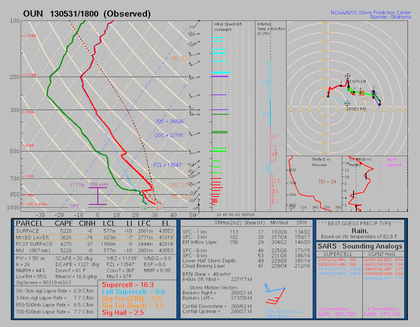
Cross-correlation coefficient

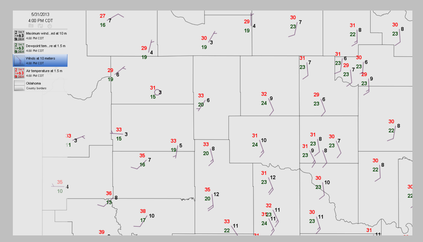


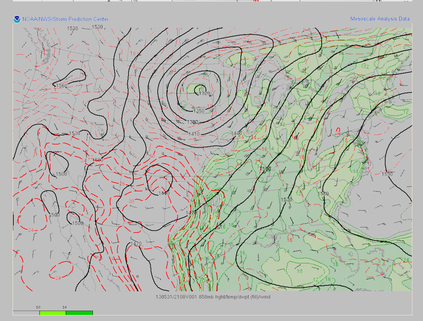
Differential reflectivity

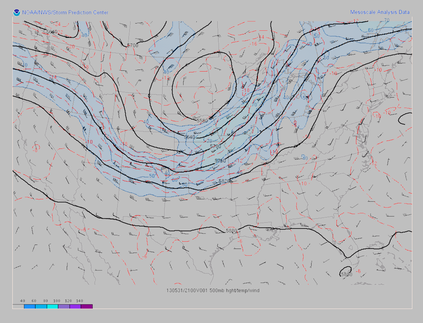


Storm environment



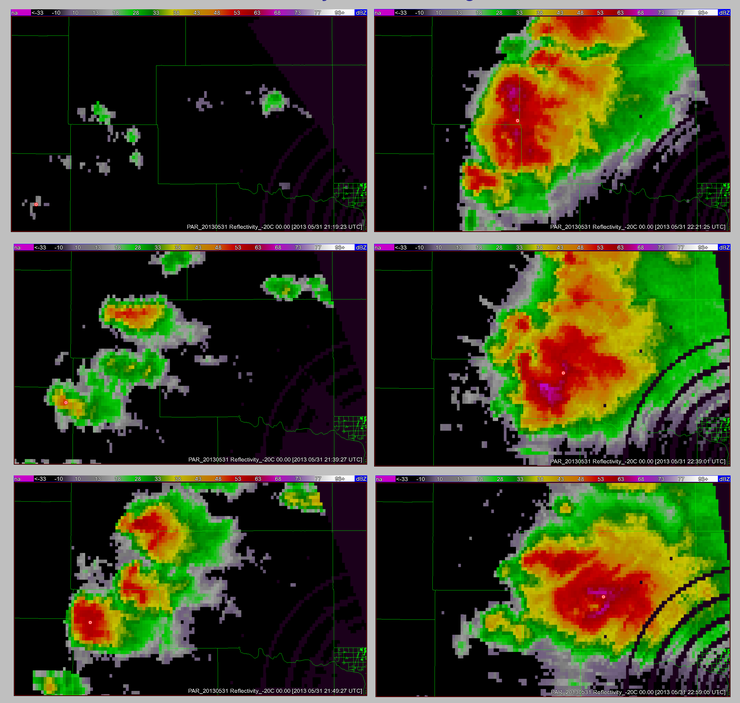




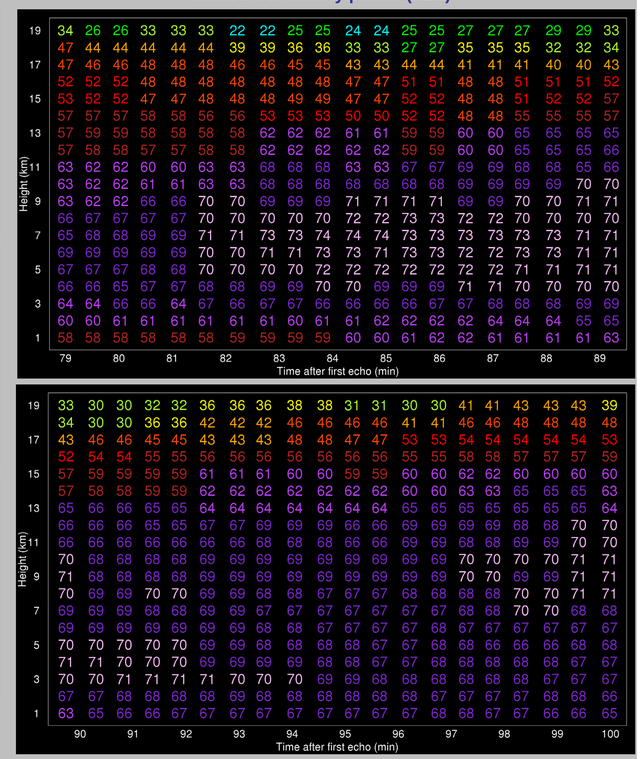


Radar observations

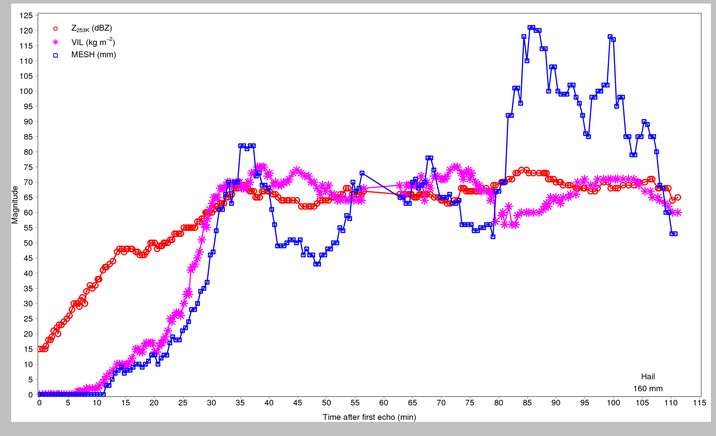
Reflectivity at the −20°C height



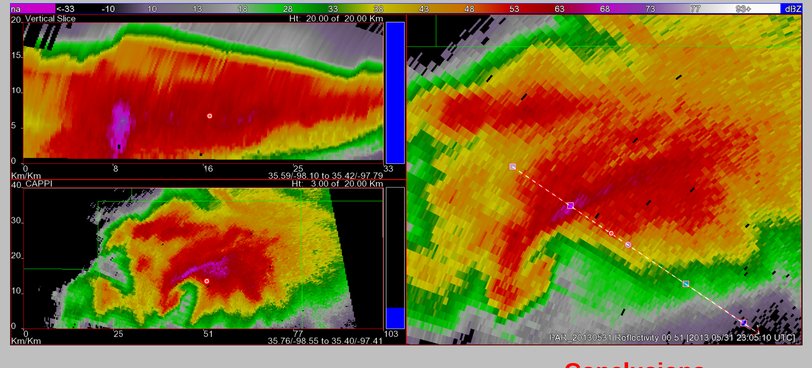
Vertical reflectivity profile (dBZ)



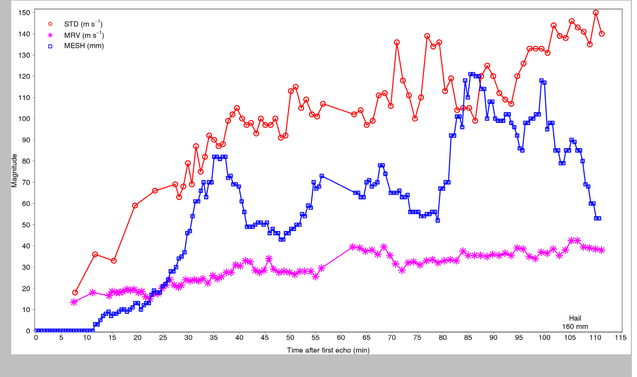
Time series of Z_{253K} , VIL and MESH



Reflectivity structure at 2305 UTC



Time series of STD, MRV and MESH



Conclusions

- Given the damage potential and threat to life and property from extreme severe weather events, adequate warning is vital
- The PAR's ability to rapidly scan a storm's full 3-D volume allows for additional warning lead-time
- During the 20-30 min prior to occurrence of the 160 mm hailstone, the storm exhibited exceptional supercell features and radar-measured intensities
- The maximum STD of 150 m s^{-1} is the second largest documented, and had an inbound velocity of 104 m s^{-1}
- The STD of 150 m s^{-1} is more than double the 72 m s^{-1} median STD for storms producing hail ≥ 102 mm in Blair et al. (2011), with the MRV of 42.5 m s^{-1} nearly double the median MRV of 24 m s^{-1} in Blair's study
- Although the maximum MESH of 121 mm was less than the observed size, such a high MESH gives adequate indication of the extreme threat
- The higher time resolution data from the PAR is most evident in the MESH and STD time-series, with some periods of rapid increase and decrease in magnitude
- More frequent observations of STD and MRV signatures provide greater confidence in the accuracy of their measured strength, especially when extremely high velocities and extensive aliasing are involved