Observations of hail cores of tornadic thunderstorms with four polarimetric radars

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Series of severe tornadic thunderstorms that hit Oklahoma in May 2013 were observed with four polarimetric radars: three S-band WSR-88Ds (collocated KOUN and KCRI), KTLX located 20 km away from the first two, and a mobile X-band radar collocated with KOUN. The hail cores were observed with the radars simultaneously. The sizes of hailstones from these thunderstorms reached 7 cm. Such giant hailstones exhibit strong scattering resonances and produce different reflectivities even within the same frequency band. The WSR-88Ds operate at different frequencies and exhibit noticeable difference in reflectivities, differential reflectivities, and correlation coefficients in the hail cores. Observed radar variables are compared with the ones calculated by the T-matrix method. It is shown that the radar system differential phase upon transmission contributes to the observed differences.

Fields of two new dual polarization parameters are studied; these are the differential Doppler velocity (DDV) and Slant Differential Reflectivity (SDR). Fields of DDV show that this parameter can be used for identifying areas of inflows. The inflow areas can be identified even in cases where the main inflow is orthogonal to the radar beam and the Doppler velocity cannot be used for their identification. The data demonstrate that inflow areas can stretch to heights of 4 -5 km.

SDR is a proxy for circular differential reflectivity that can be used to obtain the axis ratios (width/length) of scatterers. Fields of SDR in tornado vortexes and hail cores are presented. SDR in tornado debris balls exhibit anomalously large SDR values. In hail cores, SDR is used to estimate the shape of hailstones. Impacts of the difference in radar frequencies within the S band and the differential phases between transmitted H and V waves on the polarimetric variables are quantified.