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Operational benefits to correcting S-Band differential reflectivity for hail detection

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Differential reflectivity (Z_{DR}) is a radar moment defined as the logarithmic ratio of the reflectivity factors at horizontal and vertical polarization. This field provides meteorologists with information about the size and shape of scatterers, among other characteristics, and is an input to downstream products such as the Hydrometeor Classification Algorithm (HCA). However, hardware component variations and diurnal factors can introduce biases in the Z_{DR} field, affecting analyses of severe convective hazards, such as the estimation of hail size and extent. To address these uncorrected biases, several methods examining the returns from external targets were developed. These include the comparison of measured Z_{DR} to the intrinsic values of light rain, dry snow, and clear-air bragg scatter with volume-by-volume statistics provided by the United States Weather Service Radar 1988 Doppler (WSR-88D) network. This study quantifies the benefits of applying a weighted mean of these bias metrics to produce a “corrected” Z_{DR} and new HCA fields for the identification of hail.

The ten largest hail reports within 60 km of a polarimetric WSR-88D each year from 2013 to 2016 were identified. For each case, a 2 hour window of archived data was processed for the main radar and all surrounding radars within 350 km. This domain of overlapping radar coverage was used to generate the Maximum Expected Size of Hail (MESH) product using the multi-radar/multi-sensor processing system. To estimate the Z_{DR} bias, the main radar had 96 total hours (+/- 2 days) of data surrounding each case processed through the WSR-88D software. The weighted mean bias correction was applied to the original Z_{DR} field on the main radar, the HCA was rerun, and the differences in hail/no hail classification between the two HCA fields were compared to the MESH product. Correcting this bias generally improved the quality of the hail detections from the HCA. For example, during the 20 May 2013 severe weather event in central Oklahoma, the estimated Z_{DR} bias from KTLX was -0.44. Correcting this bias resulted in an 18% (N=1,300) increase in the number of HCA hail classifications collocated with 1 inch (25.4 millimeter) hail estimates from MESH while only $\sim$4% (N=317) of bins became misclassified as no hail. These benefits warrant an accelerated analysis of implementing an external target correction technique for real-time Z_{DR} bias mitigation.