Time Evolution of Radar-Derived Rotational Velocity in Supercells: Implications for Impact-Based Warnings

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A recent study by Smith et al. (2014) established a relational climatology for tornadoes that compared the peak magnitudes of damage on the EF scale and rotational velocity (Vrot) on the WSR-88D 0.5° elevation scan. The results were used to establish Vrot magnitude thresholds for determining the optimal use of Impact-Based Warning (IBW) tags. Our work builds on Smith et al. (2014) by examining the time evolution of Vrot at the four lowest-elevation scans during several supercell tornadoes that caused damage of at least EF2 magnitude. In addition, we examine the time evolution of Vrot during several supercell null cases (i.e., persistent mesocyclones in supercells that did not produce a tornado) that occurred during the same day as, and in a similar synoptic environment to, the tornado cases.

Of the 18 tornadoes examined, 16 had peak 0.5° Vrot greater than 45 kt, a threshold at which warning decision forecasters should consider using an IBW "Considerable Damage Threat" tag (Smith et al. 2014, Wagenmaker and Mann 2014). In addition, 15 of those 16 tornadoes crossed this threshold at least one volume scan before causing EF2 damage, with an average lead time of 13 min from crossing the threshold to the beginning of EF2 damage. In contrast, just two of the eight null cases examined crossed this Vrot threshold. These results solidify 45 kt as a threshold Vrot value at which an IBW "Considerable Damage Threat" tag should be considered, and suggest that lead time in issuing the tag can be attained prior to the occurrence of EF2 damage. We also found that Vrot values peaked at the 1.3° and/or 1.8° elevation scans at least one volume scan before the 0.5° elevation scan in 76% of the tornado cases examined. This result fits the physical model of a downward-building mesocyclone.