A Polarimetric Radar Climatology of Supercell Thunderstorms in the United States

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Supercell thunderstorms in the United States (U.S.) are well known to produce several different types of severe weather hazards (e.g., tornadoes, hail > 2.5 cm diameter) that have devastating negative impact on people and property. Unfortunately, the evolution of supercells are known to be tied to complex internal processes and are sensitive to small changes in the near-storm environment (NSE), which complicate efforts to fully understand them. These shortcomings are exacerbated by the lack of real-time, finescale observational data of supercells that may otherwise help enhance their study and improve skill in their nowcasting. However, periodically, the introduction of a new observing or analysis system has supported the creation of a supercell or tornado climatology that has spurned advances in understanding and motivated important subsequent observational or modeling work; past examples include the DOW mobile radar tornado climatology (Alexander 2010) and supercell NSE climatologies (Rasmussen and Blanchard 1998; Thompson et al. 2003).

The upgrade of the Weather Surveillance Radar-1988 Doppler (WSR-88D) network in the U.S. to dual-polarization capabilities was completed in May 2013, and the hundreds of supercells that have been sampled in the past 5+ years afford an opportunity for a new supercell climatology. We detail an ongoing effort to leverage polarimetric radar data in hundreds of supercells to better understand (i) approximate microphysical differences between tornadic and non-tornadic supercells, (ii) the relationship between observed polarimetric radar signatures and the NSE, and (iii) how polarimetric signatures and bulk drop-size distributions (DSDs) change during important supercell processes, including tornadogenesis. The focus of this talk will be on the methodology behind supercell case selection and radar data quality control, and efforts to test a recent theory that hook echo drop sizes decrease (increase) in the minutes leading up to tornado formation (dissipation) based on the thermodynamic impacts of decreasing (increasing) evaporation at storm low-levels and the attendant reduction (increase) in negative buoyancy; the relationship between hook echo drop sizes and the NSE, namely lifting condensation level, also will be explored. Preliminary results of efforts to understand DSD differences between tornadic and non-tornadic supercells, and polarimetric signature evolution prior to tornado dissipation, also may be discussed.

Keywords: Tornadoes, Tornadogenesis, Supercells, Radar observations, Dual-polarization radar