Characteristics of QLCS Downdrafts and Environments Observed during the VORTEX-Southeast Project

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Project Goal: Dual-Doppler, surface (sticknet or “stesonet”), and sounding observations collected in multiple 2017 storms targeted by VORTEX-SE are examined to determine environmental sensitivities of downdraft properties in severe convective storms in the Southeast United States. Two QLCS storms, a storm type commonly associated with tornadoes in the SE U.S., were analyzed, 27 March and 30 April 2017. The 27 March case is the focus of this poster because of the superior observation density ahead of and within the storm. Current focus is to relate surface outflow temperature, downdraft strength, and hydrometeor types in downdrafts to environmental profiles and heterogeneity in the SE U.S.

Wind and thermodynamic observations from the “stesonet” are shown (time-space corrected, using a negative vertical vorticity are relatively weak, but these are likely underestimates of the true value owing to objective analysis owing to the range from each radar, or 2) from much shallower depths, z < 1 km. Peaks departing from the northern half of the dual-Doppler coverage region. The best dual-Doppler coverage of this storm utilized the SMART-R and ARMOR radars, with a large baseline of approximately 50 km. Mobile soundings were launched in an E-W-oriented line near the SMART-R/ARMOR baseline, roughly 45-60 min prior the gust front passing through the dual-Doppler region.

A combination of 3 proximity soundings in the near-storm inflow and 3 stesonet surface observations of outflow thermodynamics are used to constrain and pinpoint possible downdraft origin heights in the QLCS, and to address the sensitivity of these estimations to different environmental base states. Wet-bulb potential temperature is calculated for a variety of heights on each sounding and parcels brought down to the surface data from the “stesonet” are used to validate and calibrate this method. Typical parcel theory assumptions (e.g., neglects mixing of environmental/dry air, pressure gradient forces) to estimate downdraft/outflow thermodynamics, constrained by surface observations. A variety of possible downdraft origin heights are identified using this method. In general, downdrafts initiated from two main regions have thermodynamic properties that are consistent with surface observations: 1) from certain heights within the boundary layer (approximately 400-1800 m AGL), or 2) from various layers at upper levels (6.5-10 km AGL). Saturated air from mid-levels (~2.0 km - 6.0 km) is much colder at the ground than the surface observations. Air originating from the uppermost of the identified layers (z ~ 6.5-10 km) are positively buoyant for a deep layer aloft, suggesting that this air does not reach the surface as a downdraft without significant downward-oriented pressure gradient forces present. Downdraft air with thermodynamics consistent with surface data from the “Mid” and “North” stesonet stations have similar origin altitudes; thus, there is only subtle outflow heterogeneity on the northern half of the dual-Doppler coverage region. However, parcel-theory-determined altitudes generally are lower for the “South” stesonet station.

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