Abstract

Turbulent Generation of Horizontal Streamwise Vorticity in a Simulated Supercell Thunderstorm During the Tornado Maintenance Phase

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Recent cloud model simulations of a supercell containing a long-track, EF-5 tornado at high temporal and spatial resolutions (isotropic 30 meter grid spacing; data saved every model time step of 1/6s) have provided an opportunity to investigate the processes that lead to the development and maintenance of a violent tornado that persists for nearly 2 hours within the simulation. Initial analysis of Lagrangian parcel trajectories during both tornadogenesis and maintenance suggest that horizontal streamwise vorticity in the cold pool is an important source of rotation for the tornado. Additionally, a feature that has been identified and named the Streamwise Vorticity Current (SVC) appears to be influential in lowering the pressure within the low-level updraft of the supercell and maintaining mesocyclone strength. Parcel trajectories for both the SVC and the tornado during the maintenance phase originate from the cold pool within the lowest 200 meters of the simulation, indicating that the interaction between the lower free-slip boundary and the storm relative flow may be responsible for this source of vorticity. Using the sub-grid turbulence closure scheme within the model, this study closes the vorticity budget to address how and where this horizontal vorticity generated, and evaluates the impact it has on maintaining tornado and mesocyclone strength by looking at cases with different lower boundary conditions and turbulence closure schemes that result in weaker or shorter-lived tornadoes.