ABSTRACT

School of Graduate Studies

The University of Alabama in Huntsville

Degree Doctor of Philosophy College/Dept. Science/Atmospheric Science

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Title Numerical Investigations into the Environmental Conditions that Affect Convective Storm Behavior

Knowledge of the environmental conditions that affect the behavior of deep, moist convection is critical to weather forecasters, researchers, and the public. In this research, output from a high resolution, cloud-resolving model is used to evaluate the contribution of various aspects of the environmental profile to storm behavior. Over 200 idealized simulations are analyzed, each with a unique starting profile of temperature, humidity, and wind that is constructed from seven basic environmental parameters. Each simulated storm is initiated using a warm bubble in an otherwise horizontally homogeneous environment and tracked for up to 2 h.

The simulations produce a variety of storm behaviors, ranging from weak and pulse-like storms to "supercell" convection with vigorous, rotating updrafts. It is found that bulk environmental characteristics, namely, convective available potential energy (CAPE) and deep-layer tropospheric shear, explain a substantial amount of the variability seen in storm behavior. However, other characteristics also play a role. For example, CAPE and shear together account for about 50 percent of the inter-experiment variance in mean updraft velocity, but the full seven-parameter environmental profile accounts for about 81 percent (with similar results for updraft area). The rotational characteristics of the updrafts are also explained reasonably well by the background environmental conditions, but are strongly influenced by the storm-relative winds. It is found that the strongest low level mesocyclones occur when storm-relative inflow trajectories are oriented roughly 180 degrees from storm-relative outflow at upper levels.

The influence of the environmental profile on storm morphology is sometimes a function of the environment itself. For example, updrafts in CAPE-starved regimes require large concentrations of buoyancy at low levels to persist. Interestingly, it is found that regardless of the ambient CAPE, persistent storms all produce roughly the same liquid precipitation rates at the surface. As well, the size and strength of storm-generated cold pools, while in general correlated positively with the depth of the subcloud evaporative layer, behave differently when CAPE becomes large. Additional thermodynamic parameters that can be derived from the starting environmental profiles are found to offer useful information in anticipating storm outflow characteristics, as well as other storm properties.

Abstract Approval: Committee Chair ________________________

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