4–8 November 2019, Kraków, Poland
ECSS2019-193

Impact of terrain on supercells according to idealized simulations with actual terrain

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This study examines the impacts of terrain on supercell thunderstorms in a hybrid real-data/idealized approach. The actual terrain from the Southeastern United States is used for the lower boundary in a series of simulations using the CM1 numerical model. An observed sounding from a tornadic outbreak day in Alabama is used to define a horizontally homogeneous initial state. Thunderstorms are then initialized with an updraft nudging technique, which is placed in different locations relative to the terrain in an ensemble of simulations. Radiative processes and boundary-layer evolution are neglected so that the atmospheric conditions remain nearly steady and can be controlled via changes to the initial sounding. This methodology was designed to isolate the effects of the actual topography in a controlled manner, and to evaluate the relative effects of terrain as compared to changes in atmospheric conditions (e.g., shear and instability). Results show that supercell thunderstorms are usually narrower, have lower cloud bases, and have shallower cold pools when interacting with terrain, as compared to “control” simulations that have no terrain. Low-level rotation is usually (but not always) weaker when the simulated supercells interact with terrain in these simulations. Additional sensitivity experiments that vary the low-level wind profile suggest that variations in environmental conditions have a larger impact on supercell intensity and structure than terrain variations.