4–8 November 2019, Kraków, Poland
ECSS2019-175

The Effects of Idealized Topography Shape and Location on the Generation of Intense Near-Surface Vertical Vorticity in Supercells

Branden Katona and Paul Markowski
Pennsylvania State University, Meteorology and Atmospheric Sciences, United States (katona@psu.edu)

Recent studies indicate that complex topography may play a role in both the distributions of observed convective storm hazards and convective storm environments as portrayed by operational convective-scale models. Observations of hazards and environments, however, say little about changes to severe storm dynamics and the ability of a storm to undergo tornadogenesis. Complex topography is sometimes proposed as a mechanism for observed storms producing tornadoes in regions where they normally do not. However, it is impossible to know how this particular storm would evolve in the absence of complex topography. An idealized cloud model is used to investigate the role of topography shape and location on the generation of intense vertical vorticity near the surface in simulated supercell storms. A large ensemble of simulations with the same idealized topography shape placed at varying locations in the model domain is generated and compared to a control run with a flat lower boundary. The simulations are objectively classified into groups that contain similar evolutions of vertical vorticity near the surface. Representative simulations from each group are further analyzed using material circuits and trajectory analysis in order to assess how topography affects the baroclinic generation of vorticity of parcels that contribute to the development of intense near-surface vorticity within the storm. Despite using an initial environment used by others to simulate supercells that produce long-lived, violent tornadoes, the control run fails to do so. Some of the runs with topography are able to generate intense vertical vorticity near the surface, indicating that topography, in this particular case, may aid in the tornadogenesis process. The mechanisms by which this happens are currently under investigation. Several plausible hypotheses include: modification cold pool buoyancy by flow over terrain, generation of ambient vertical vorticity by tilting of sheared flow over the terrain, and favorable changes to parcel trajectories as they approach the low-level mesocyclone induced by the terrain. In addition to cases in which terrain aids in generating intense vertical vorticity near the surface, the possibility terrain-induced tornadogenesis failure will be investigated by using a different environment in which the control run produces a tornado.