Impact of Terrain on Supercells According to Idealized Simulations with Actual Terrain

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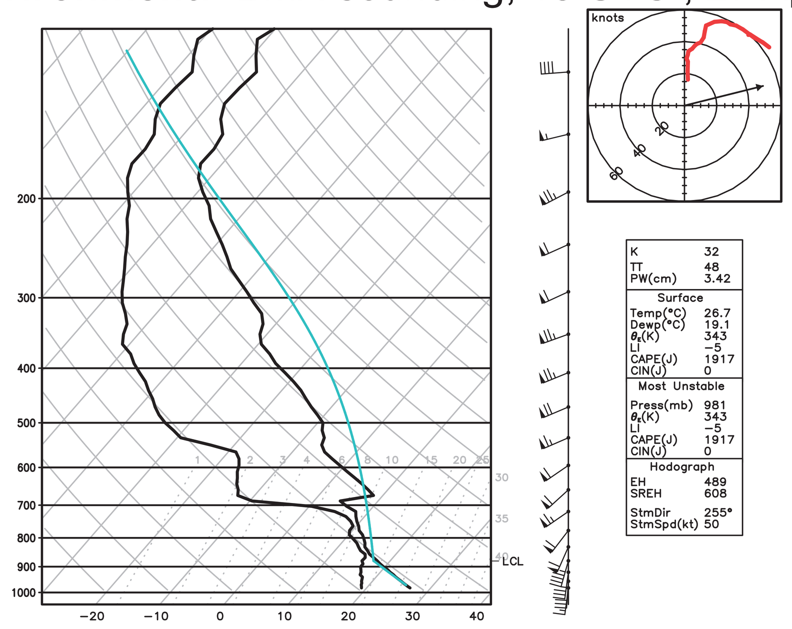
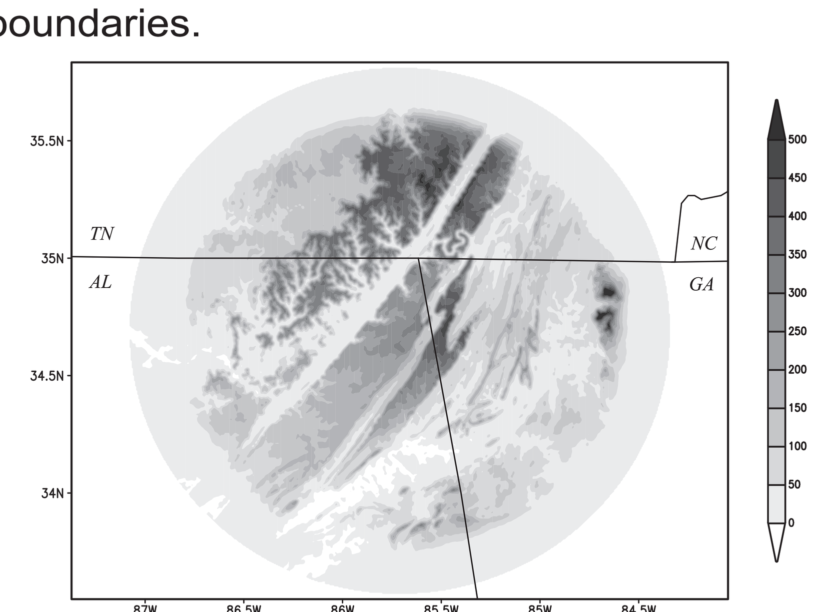
1) Motivation and Methodology

- Motivation: Use idealized modeling framework to better understand the interactions of supercells with topography.
- Methodology: Use topography and environment from an actual case.

Environment: BMX sounding, 18 UTC , 27 April 2011



Topography: Southeastern USA, tapered toward zero near the model boundaries.

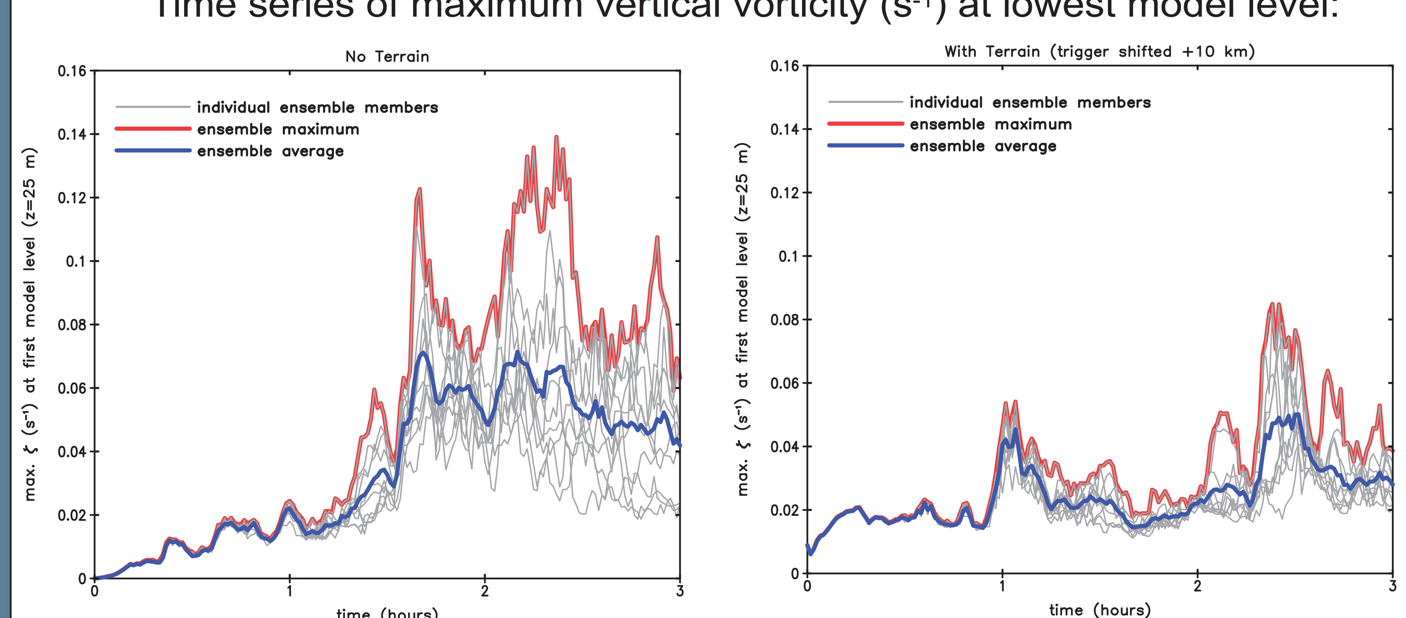


Model Setup:
- Use CM1, Δx = Δy = 500 m, 112 levels (Δz = 50 m near surface)
- Morrison microphysics (with reduced raindrop breakup)
- "Constant" environment (no surface drag, no radiation)
- Storms initiated with "updraft nudging" technique

2) An Ensemble Approach

- To address the influence of different topographic features, a "No Terrain" simulation is conducted, plus three different "With Terrain" simulations in which the updraft "trigger" is progressively shifted 10 km northward.
- To evaluate the robustness of each configuration, an ensemble of simulations is produced; each setup is conducted 10 times with a different set of initial moisture perturbations (±0.5 g/kg for z < 1 km).

Time series of maximum vertical vorticity (s^{-1}) at lowest model level:

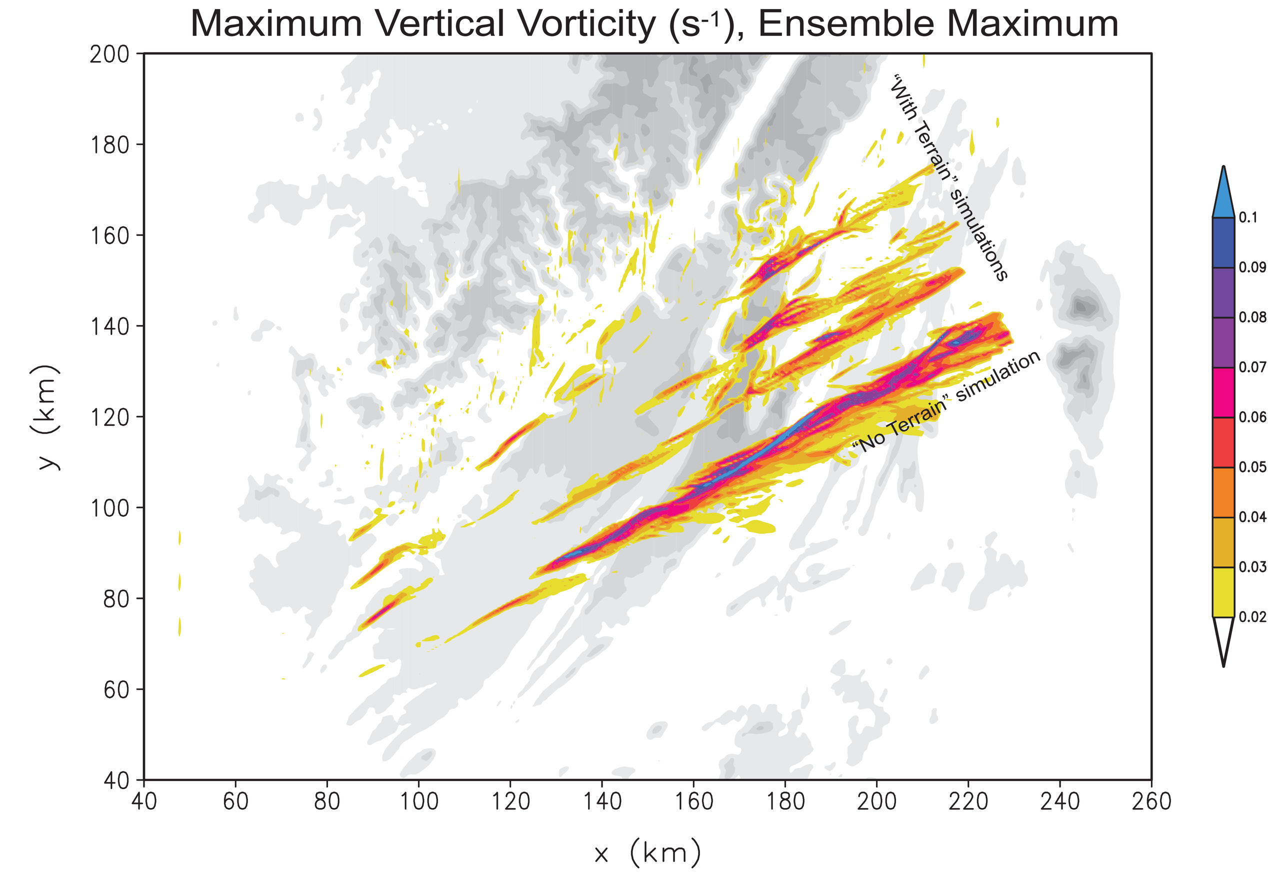


- Near-surface vertical vorticity tends to be larger when there is no terrain.

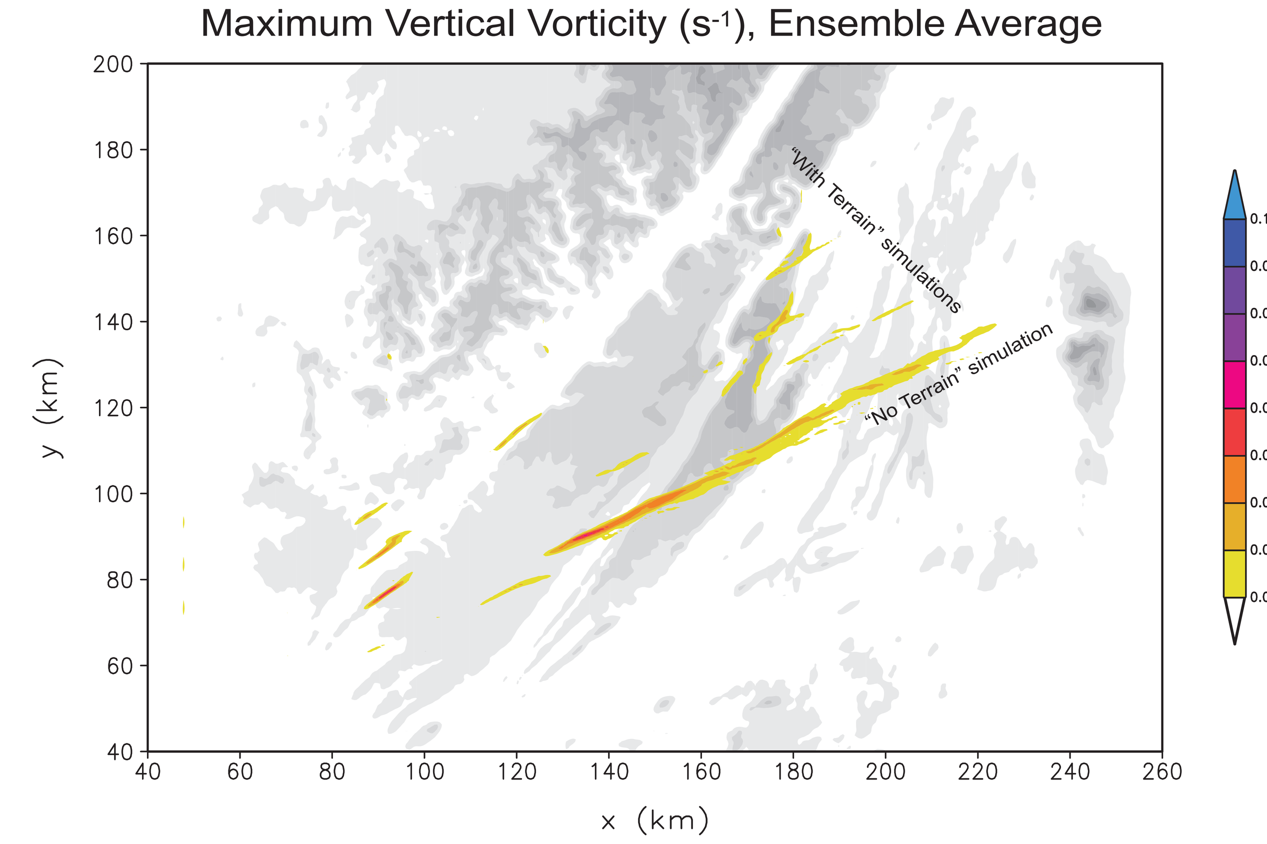
3) Near-Surface Rotation

- These figures show "swaths" of maximum vertical vorticity (ζ) at the lowest model level (z = 25 m AGL) from all simulations.

Maximum Vertical Vorticity (s^{-1}), Ensemble Maximum

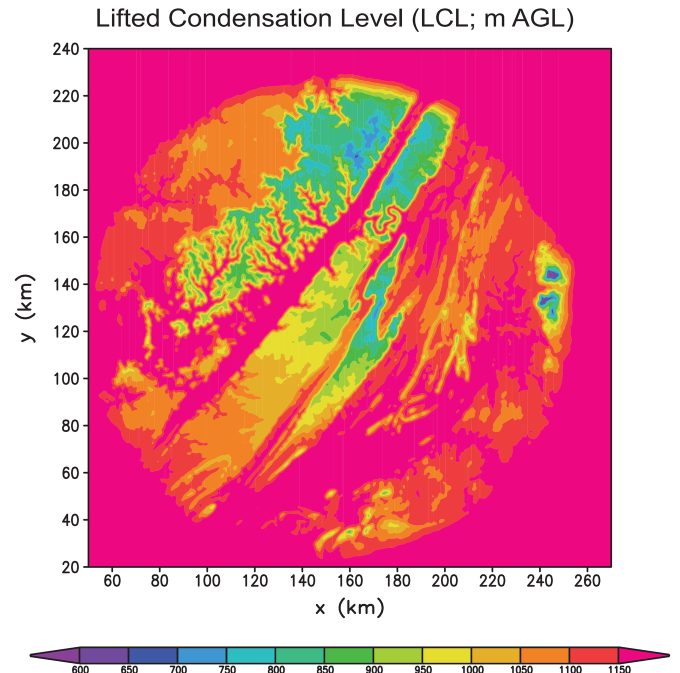


Maximum Vertical Vorticity (s^{-1}), Ensemble Average

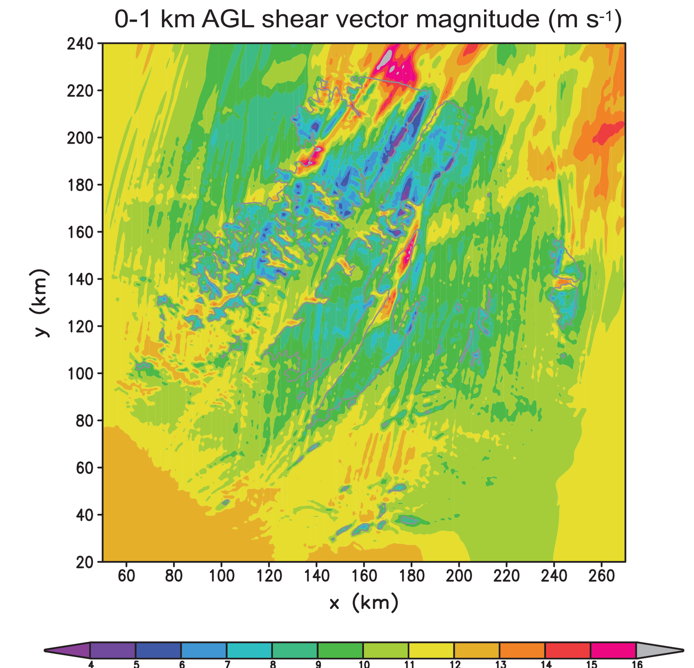


4) Environmental Conditions

- These figures illustrate how the topography modifies the thermodynamic and kinematic properties of the environment. These results are from a simulation without a supercell storm (i.e., no updraft nudging) at t = 4 h.



- LCL and cloud base are lower at higher altitudes.

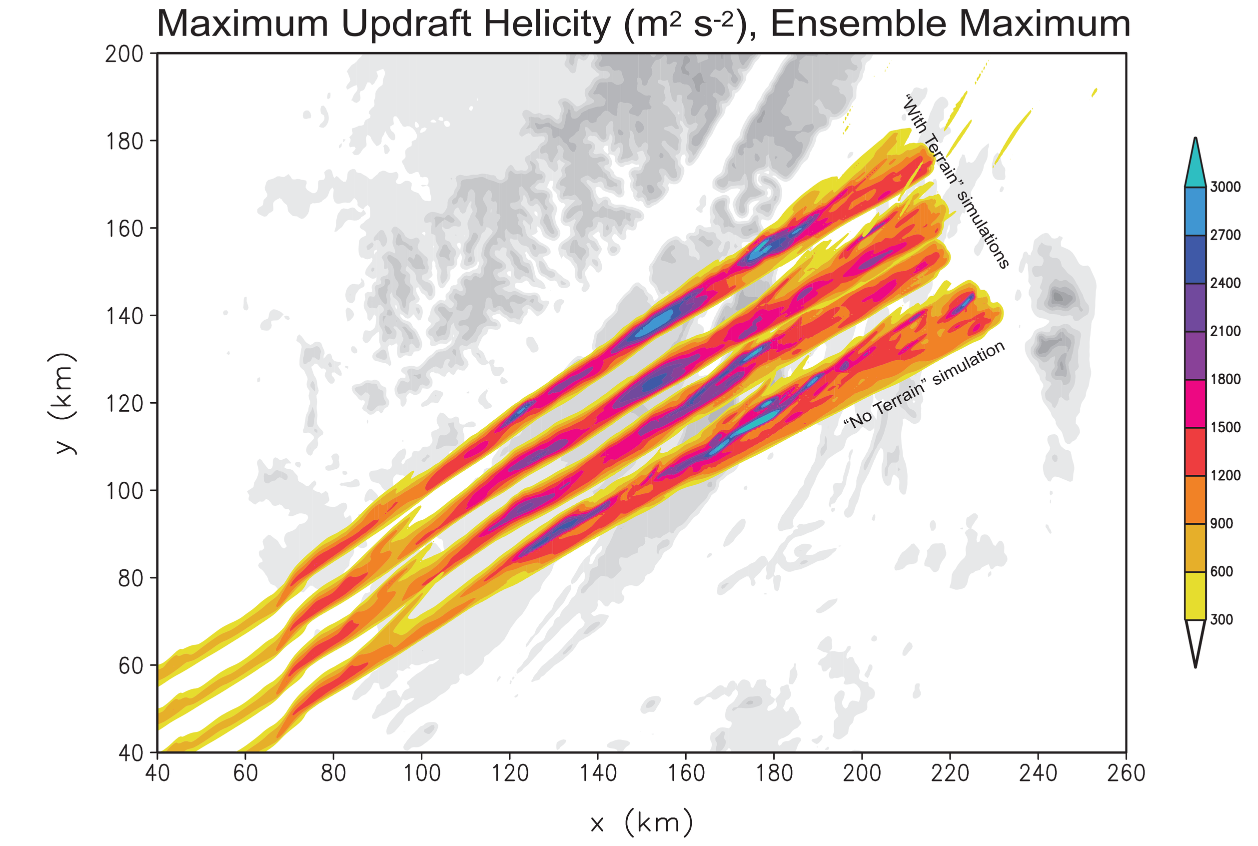


- Near-surface shear tends to be lower at higher altitudes, except on the downstream ends of ridges.

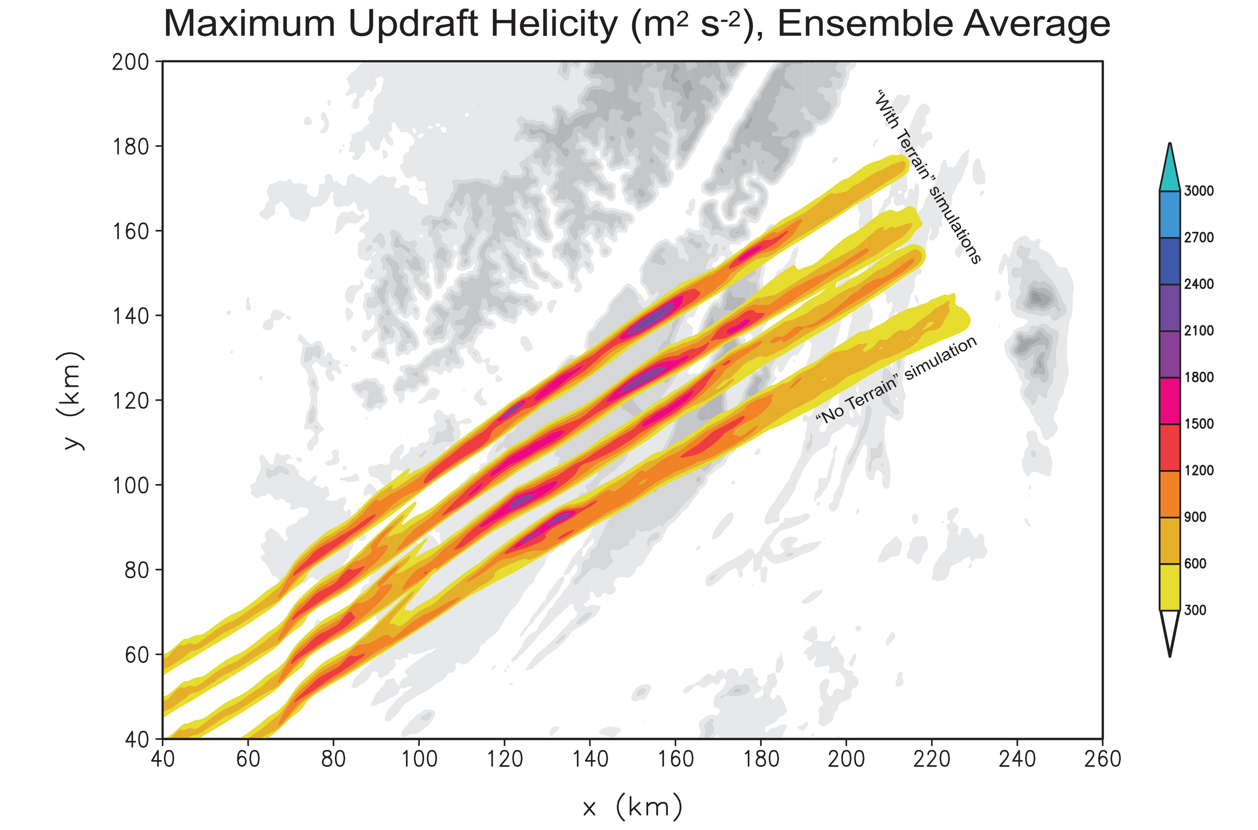
5) Updraft Rotation

- These figures show "swaths" of maximum 2-5 km AGL vertically integrated updraft helicity (UH).

Maximum Updraft Helicity ($m^2\ s^{-2}$), Ensemble Maximum

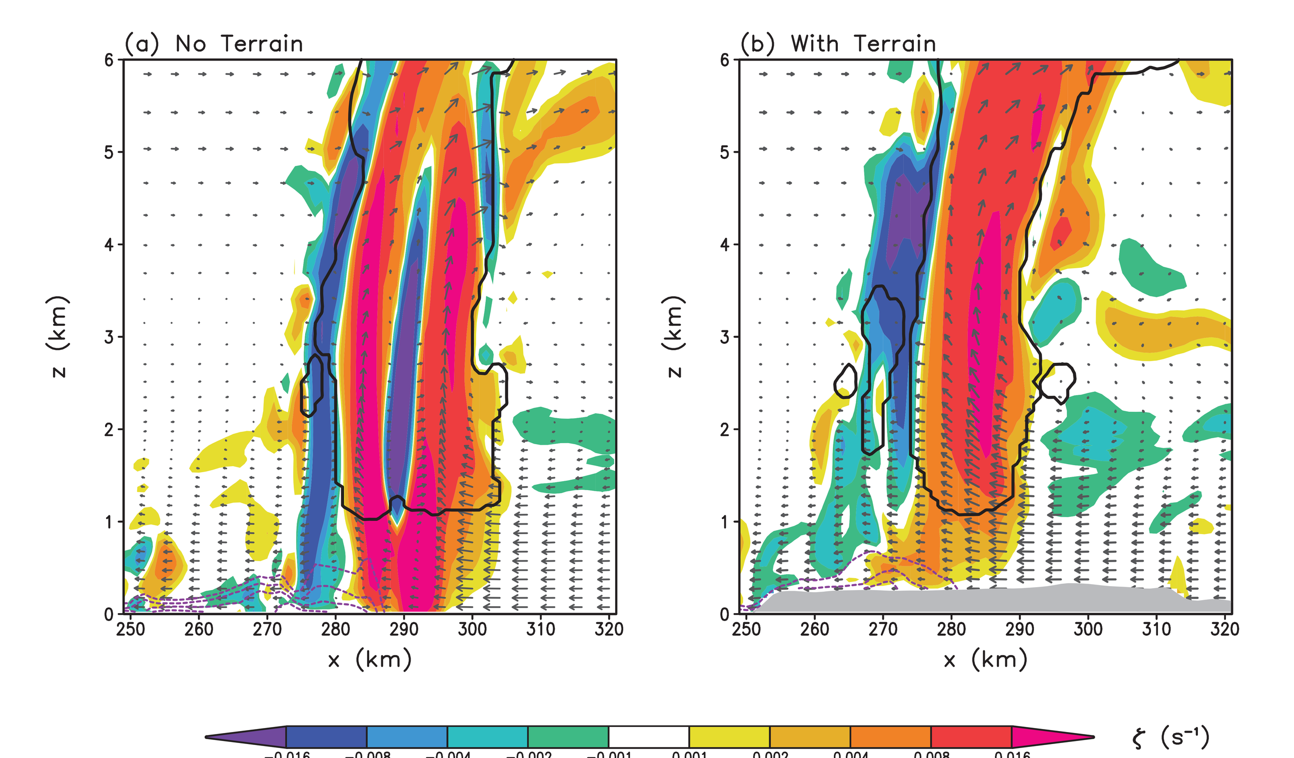


Maximum Updraft Helicity ($m^2\ s^{-2}$), Ensemble Average



6) Storm Structure

- Vertical cross sections: Vertical vorticity (shaded); cloud boundary (black contour); buoyancy (dashed purple contour).



- Differences in storm structure are subtle. The "With Terrain" simulations (right) tend to have lower cloud base, narrower updrafts, and shallower cold pools

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