# The Sensitivity of Supercell Thunderstorm Behavior Near Complex Terrain

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## MOTIVATION

The goal is to **determine the sensitivity of supercell behavior following terrain interactions** to its **approach angle** and **level of maturity**.

- Enhancing our understanding is necessary to improve short-term forecasts and storm warnings.

## METHODS

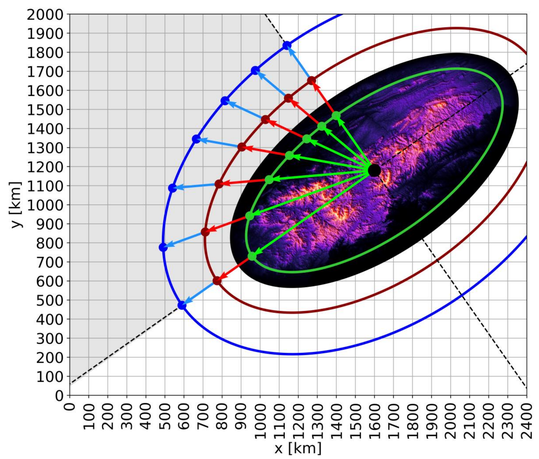
- Supercell-terrain interactions are systematically tested in a set of experiments with Cloud Model 1 (CM1).

**CM1 Configuration**

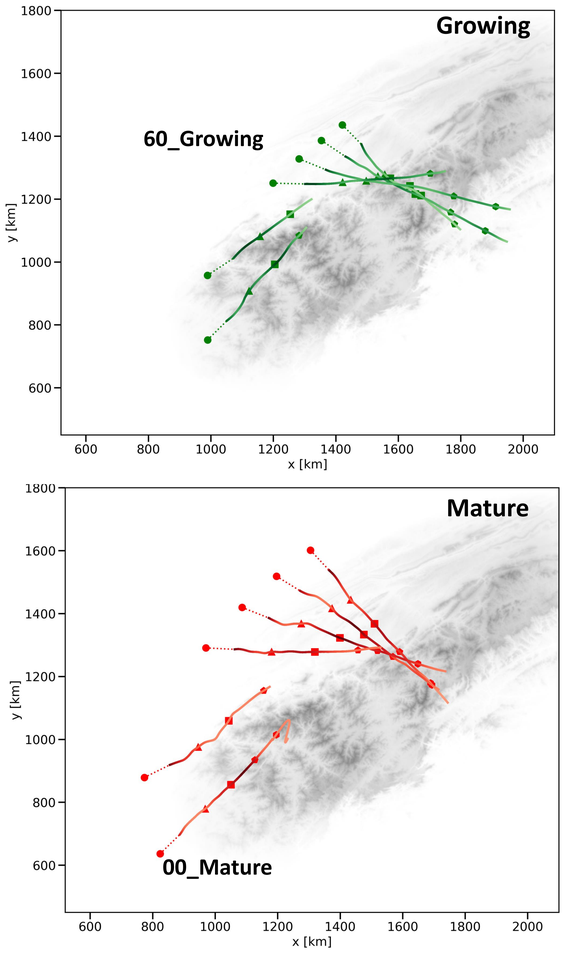
| Parameter | Setting |
|---|---|
| dx, dy | 250 m |
| dz | 100-500 m |
| Time Step | 1 s |
| Integration Time | 28800 s (Terrain) |
| Microphysics | NSSL 2-Moment |
| Initialization | Updraft Nudging |

## EXPERIMENTS

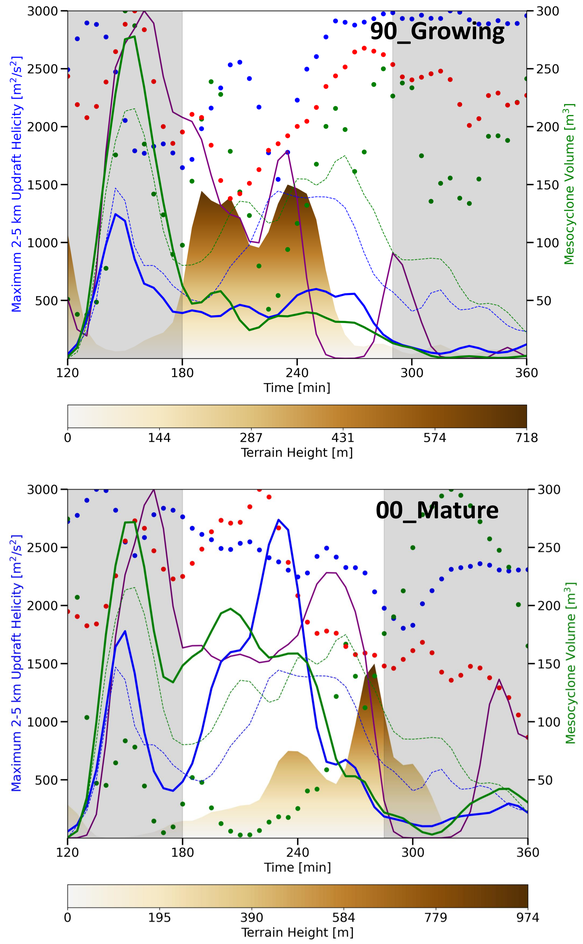
- 21 total experiments
- 7 approach angles
  - Parallel to perpendicular at 15° intervals
- 3 maturity levels
  - Growing, mature, decaying




*Schematic showing the setup of experiments and a hillshade of the realistic terrain profile from the southern and central Appalachian Mountains. The dots represent convection initiation (updraft nudging) location with arrows displaying the approach angles and colors showing the three maturity levels (growing, green; mature, red; decaying; blue).*



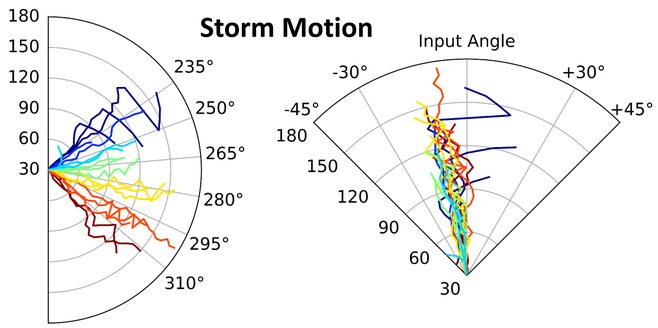

*Maps showing storm track and intensity in growing (top), mature (middle), and decaying (bottom) experiments for all approach angles. Intensity is based on updraft helicity where higher intensity is shown in darker colors (note: intensity is normalized from 0 to 1 for each experiment, individually). Shapes laid under storm track are at 30 min intervals starting 60 min after convection initiation. Labeled storm tracks are shown in time series.*



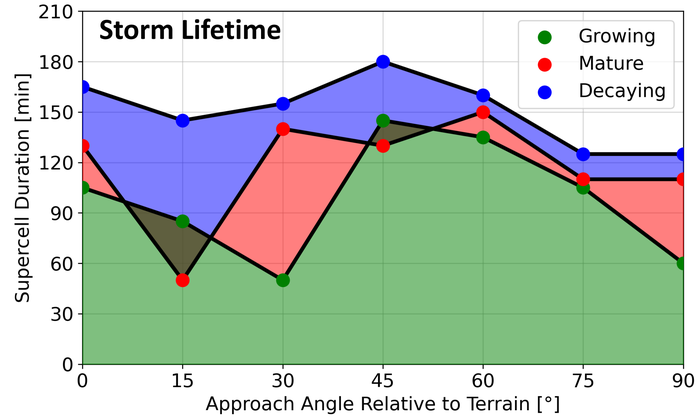

*Time series depicting the terrain profile (shaded) and supercell intensity based on updraft helicity (blue; UH) and mesocyclone volume (green; MCV). The environment is shown by scattered dots for convective available potential energy (CAPE; blue), convective inhibition (CIN; green), and 0-500 m storm relative helicity (SRH; red). UH and MCV from a flat terrain, control simulation are shown in the dashed lines. The highlighted period of time is from 60 min (supercell organization) to decay (updraft helicity below 200 m²/s²).*

## KEY RESULTS

- Terrain shortens supercell lifespan relative to flat, control simulation
- Decaying storms least impacted by terrain and have greatest overall longevity
- Growing storms have greatest variability in storm track length and tend to be weaker
- Perpendicular storms cross mountain range and growing storms maintain intensity leeside
- Storms tend to intensify ahead of terrain peak, less common for decaying storms
  - Increase in updraft helicity and mesocyclone volume
  - Stronger surface to low-level vorticity
- Terrain causes counterclockwise deviation from input sounding Bunkers storm motion




*Storm tracks colored based on approach angle relative to convection initiation location (left) and Bunkers estimate motion based on the input sounding (right). The radial distance depicts time in minutes following convection initiation.*




*Storm lifetime based on supercell status duration (updraft helicity above 200 m²/s²).*

## FUTURE WORK

Future work is focused on finding the causes of changes in storm intensity including terrain-induced environmental perturbations and terrain flow patterns (i.e., channeling, downslope, upslope, and blocking).