Verification of RUC analyses using VORTEX2 soundings for non-tornadic and tornadic supercell environments

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Research Question

Can our best-available observational dataset reproduce the key, subtle differences between the environments of non-tornadic and tornadic supercells sampled during VORTEX2?

Motivation

The wind profile below 500 m was the main discriminating factor between non-tornadic and tornadic supercells in VORTEX2. However, observations near the surface are scarce, and boundary layer parameterizations can lead to errors.

Importance of low-level humidity and winds for tornadogenesis

- Low humidity in the boundary layer leads to colder outflow, which is detrimental to stretching needed for tornadoes.
- Strong near-surface shear promotes intense low-level mesocyclones.

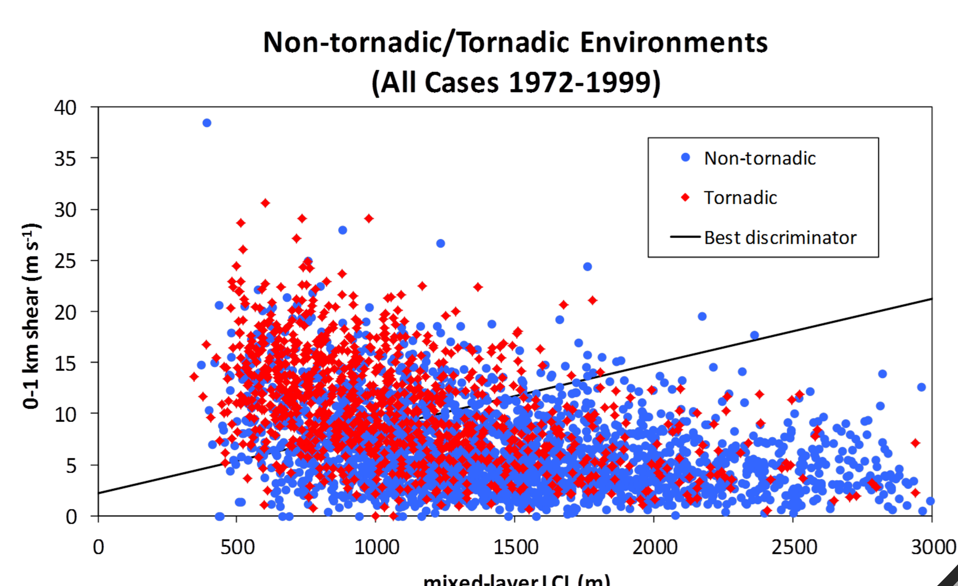

Figure 1: Scatter plot of non-tornadic versus tornadic supercells as a function of mixed-layer LCL and 0 – 1 km vertical wind shear. Figure from Craven and Brooks (2004) and adapted by Markowski and Richardson (2010).

VORTEX2 soundings & RUC pseudo-soundings

- Parker (2014) compiled soundings from the 12 best sampled VORTEX2 supercells (5 non-tornadic, 7 tornadic).
- In this study, only the 41 far-inflow soundings were analyzed.
- RUC pseudo-soundings were created by interpolating the gridded fields in space and time to the radiosonde path.

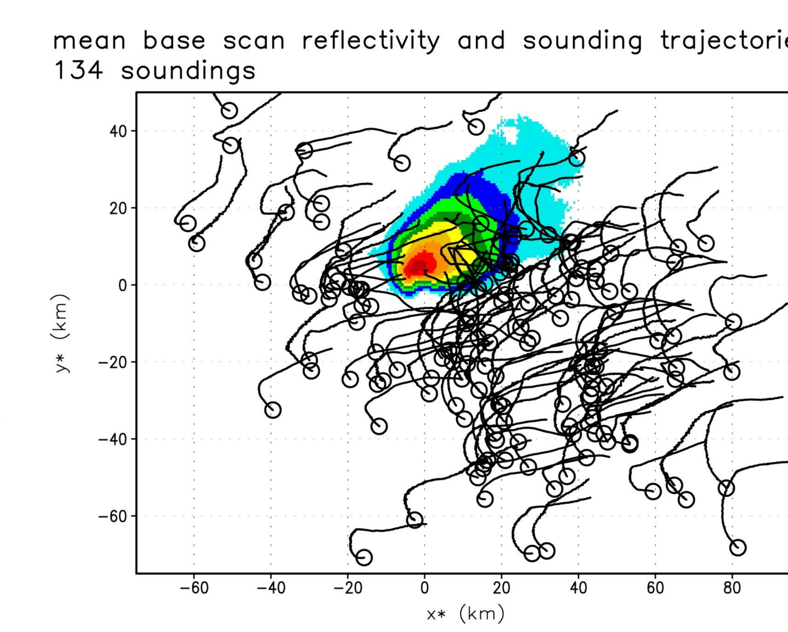

Figure 2: Trajectories for the VORTEX2 soundings analyzed by Parker (2014) in a x-y plan view plot. All sounding points are storm-relative (centered on the updraft position). The composite base scan radar reflectivity is shaded.

Composite soundings

- The RUC temperature profile exhibits minimal errors.
- RUC dry biases exist in the low- to mid-troposphere, while moist biases are found in the upper troposphere.
- Winds below 500 m are too fast in the RUC, however the hodograph shape is well-represented in both cases.

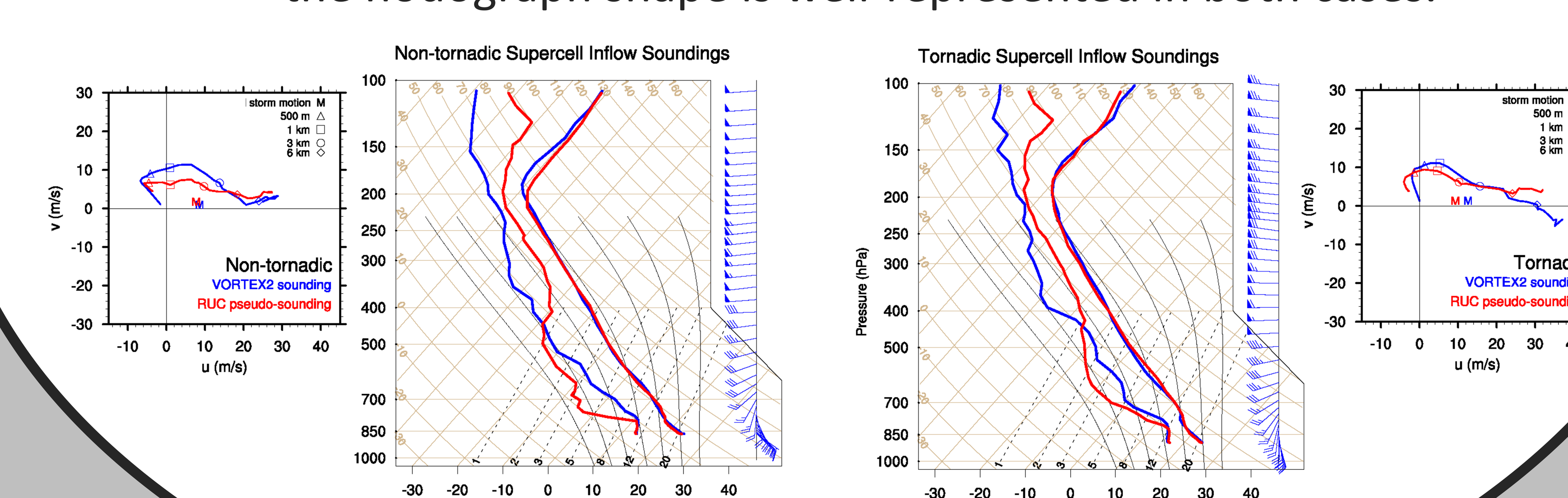

Figure 3: Skew *T*-log*p* diagram and hodograph showing the non-tornadic (left) and tornadic (right) for the observed VORTEX2 soundings (blue) and RUC pseudo-soundings (red).

LCL and SRH differences in composite soundings

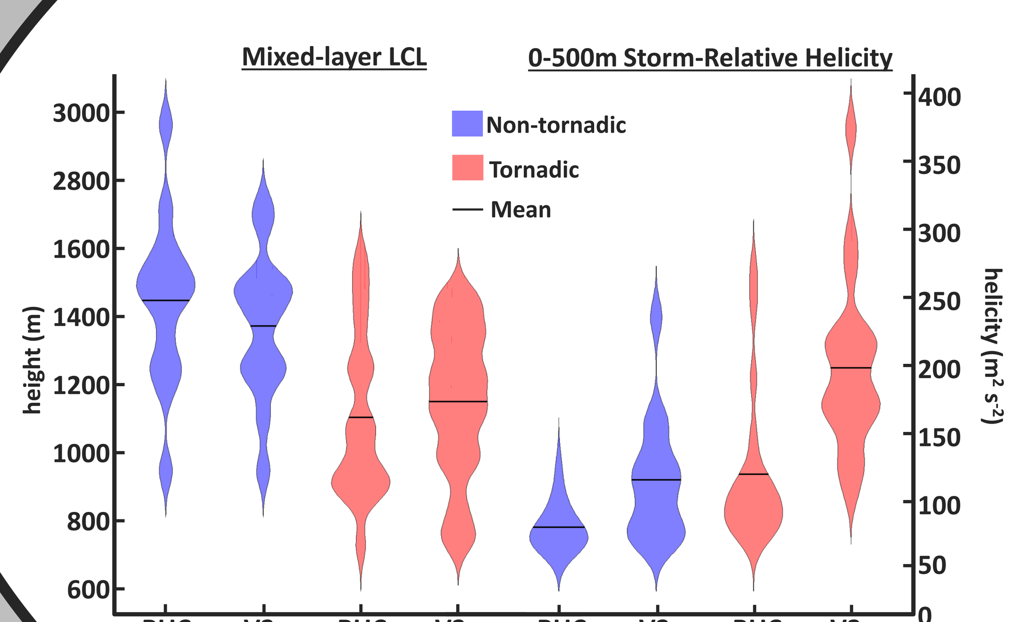

Figure 4: Smoothed kernel density estimation violin plot of mixed-layer LCL height (m; left y-axis) and 0 – 500 m storm-relative helicity ($m^2 s^{-2}$; right y-axis) for the non-tornadic (blue) and tornadic (pink) RUC pseudo-soundings and observed VORTEX2 soundings.

- Mixed-layer LCL height was well handled by the RUC analyses.
- Near-surface storm-relative helicity was underestimated by the RUC, especially in the tornadic supercellular environments.

Future Work

- Incorporate SPC mesoanalysis into near-surface RUC analyses.
- Use observed storms motions for SRH calculations.
- Spatially average RUC pseudo-soundings using a Barnes analysis technique.

Any questions?
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