Preliminary Analysis of Environments Associated with Slow-Moving Supercells: Tornadic and Non Tornadic

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Introduction

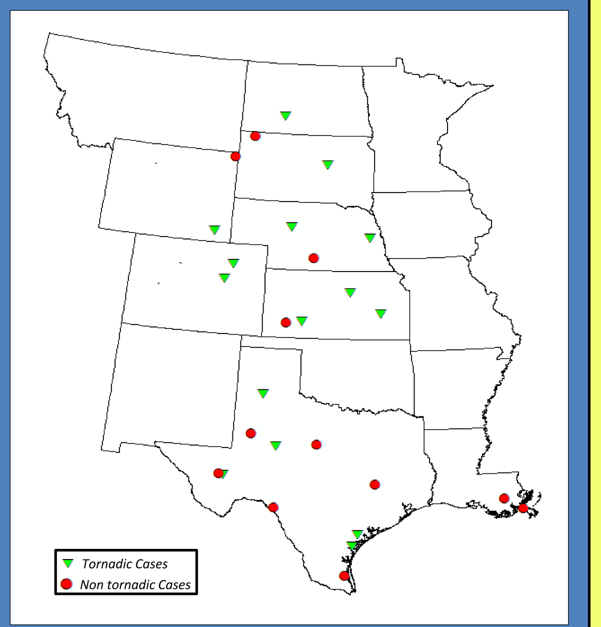
27 supercells were chosen for their tornadic environment and motion of 5 knots or slower, spanning across the central United States, occurring 2009-2013.

Supercell definitions taken from Moller et al. (1994); Lemon (1980)

- Low and mid level reflectivity structures, such as Hook echo and/or weak echo region (WER)
- Persistent mesocyclone for ≥ 20 minutes with vertical vorticity ≥ .01 s^{-1} through a substantial portion of the column (~1/3 depth)

Cases were split into tornadic and non tornadic storms.

- 15 tornadic (green)
- 12 non tornadic (red)



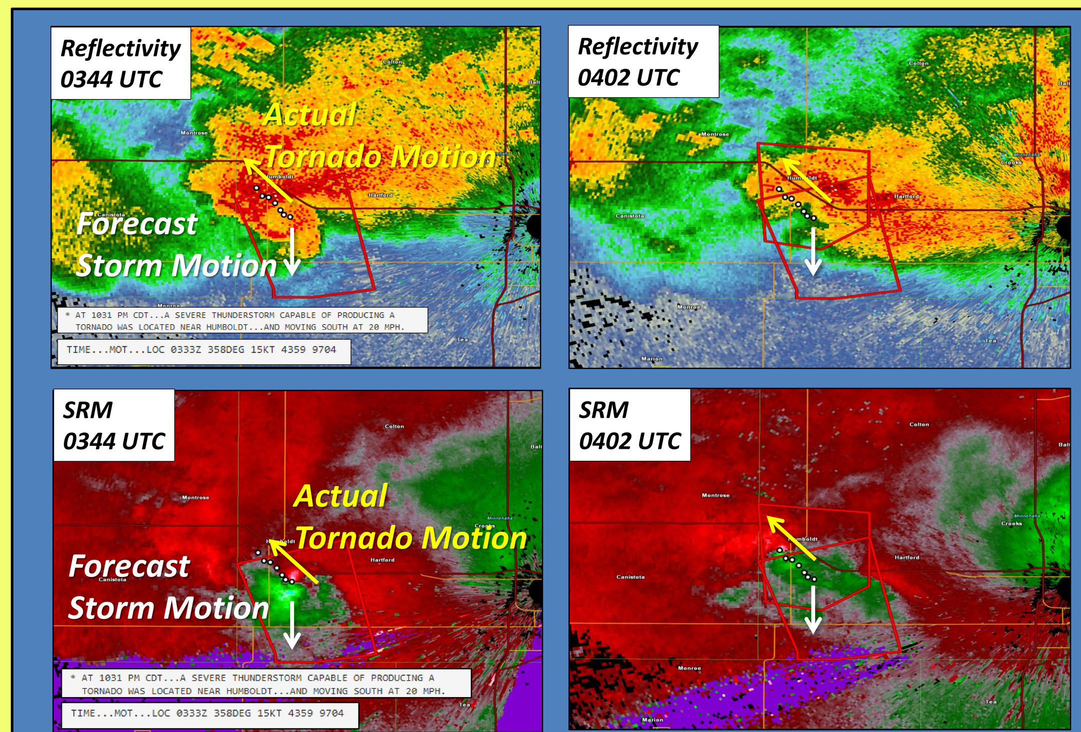
Map of the tornadic (green) and non tornadic (red) cases across the domain

The mesoscale environment as well as the cell classification were examined for each case in order to explore the predictability and behavior of slow-moving supercells.

Flash flooding statistics among the 27 cells were calculated to determine a relationship between these slow-moving, prolific rain-producing storms and flash flooding.

A connection to operational implications and a layout of future efforts relating to this study are later discussed.

Warning Challenges



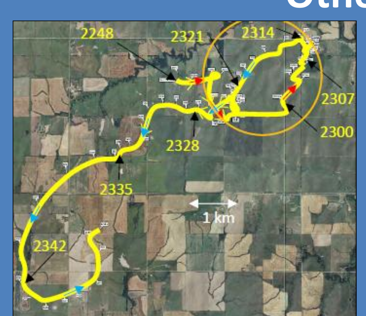
June 17, 2014
Humboldt, South Dakota

A slow-moving supercell formed near Sioux Falls, SD with a forecast storm-motion toward the south.

The tornado moved northwest toward the northern edge of the warning polygon, toward Humboldt, SD.

These examples illustrate the importance of using a higher uncertainty of tornado motion when slow-motion supercells become tornadic.

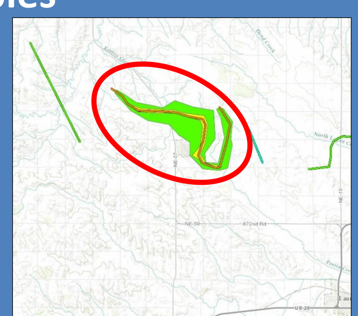
Other Examples



Ottawa County Kansas (Bennington) Tornado
May 28, 2013

Storm Motion: East at 5 knots

EF-3 tornado formed west of Bennington, Kansas, and became nearly stationary for 5 minutes. The tornado stayed within the 2.5 km diameter orange circle for nearly 35 minutes (Wurman et al. 2014).

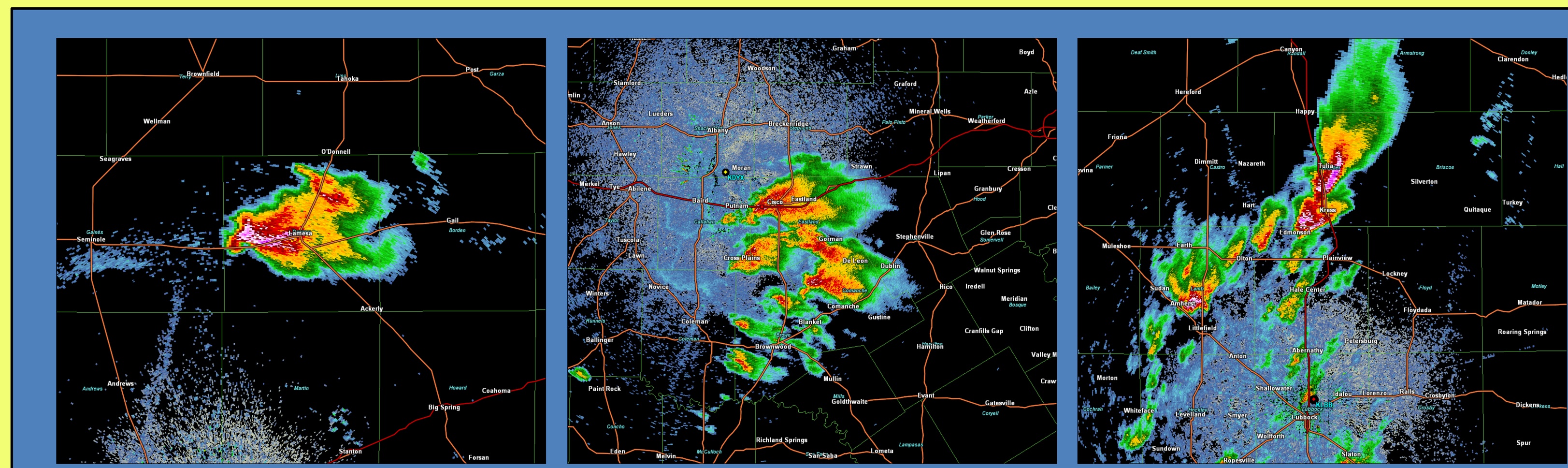


Cedar County Nebraska (Coleridge) Tornado
June 17, 2014

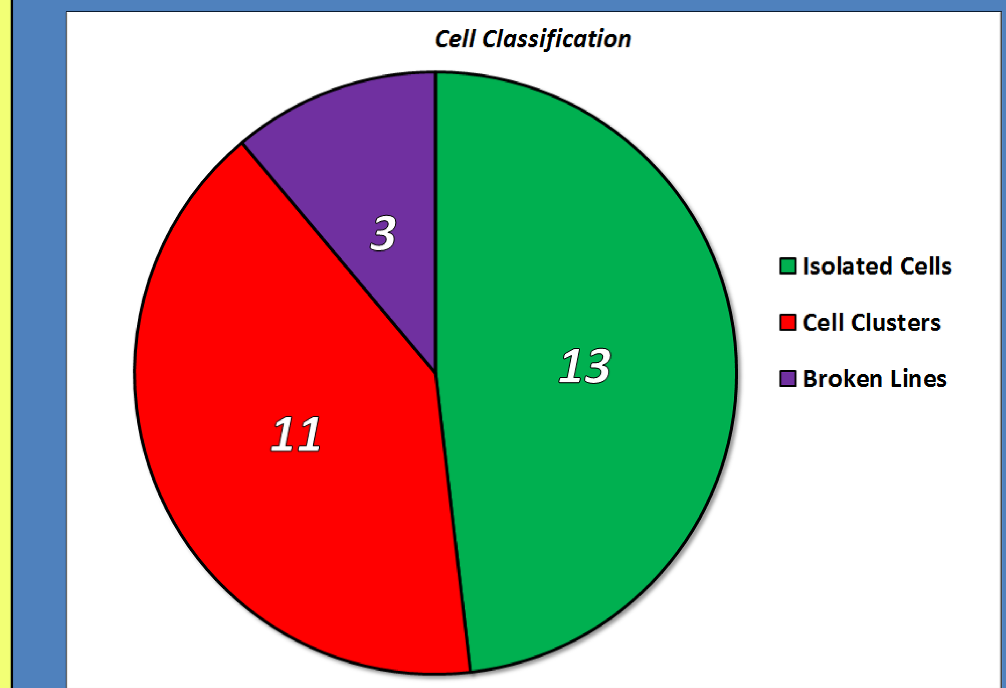
Storm Motion: East at 8 knots

EF-3 tornado formed northwest of Coleridge and deviated strongly to the south as it entered Coleridge. After a brief turn to the east it moved north before dissipating.

Cell Identification



Isolated Cell — *Cell Cluster* — *Broken Line*

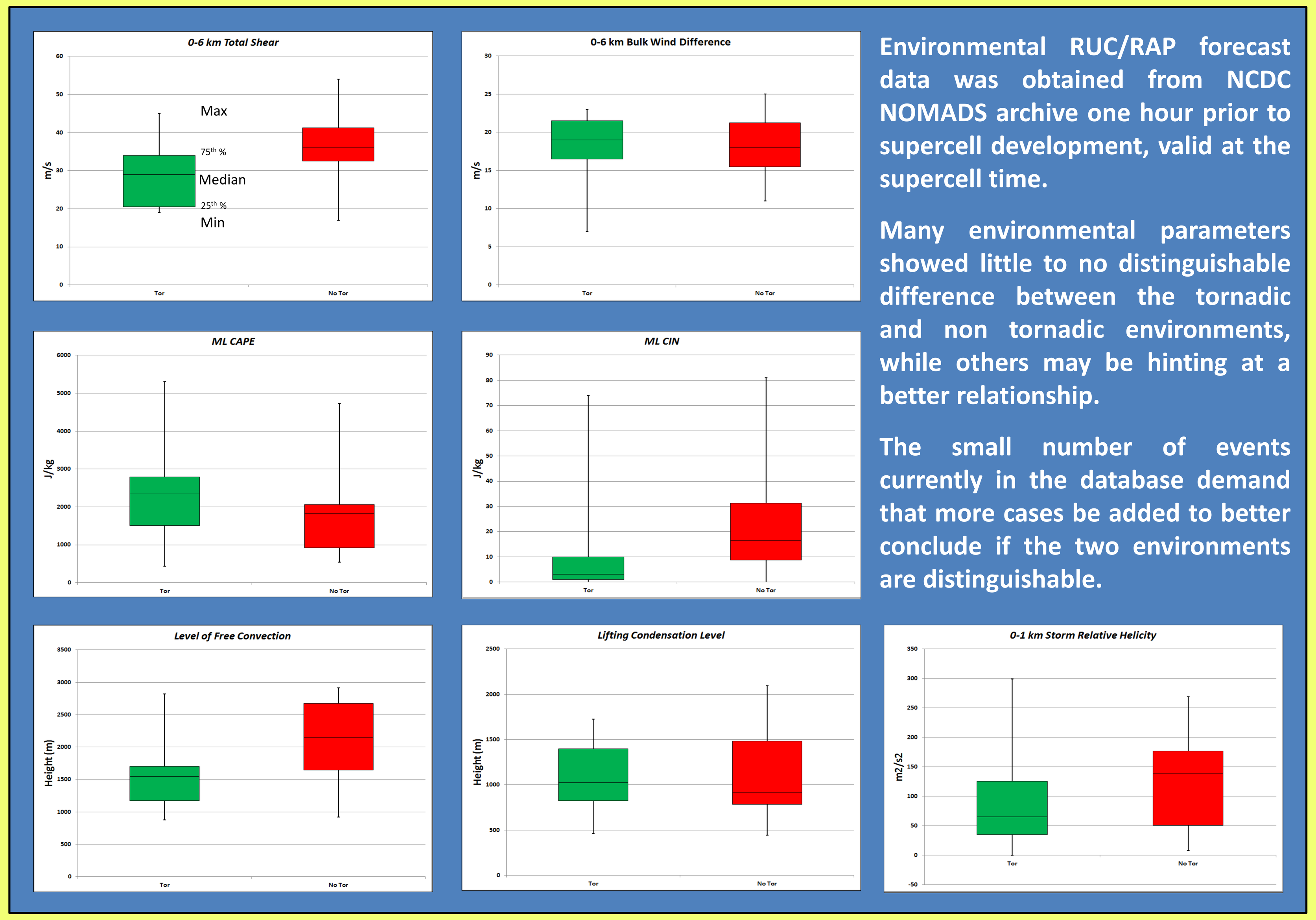


The radar-based storm classification for all 27 cases followed similar methods used by Duda and Gallus Jr. (2010).

- 13 - Isolated Cells (48%)
- 11 - Cell Clusters (41%)
- 3 - Broken Line (11%)

53% of the isolated cells in the study contained robust upstream updraft development that merged into the parent storm, aiding in its slow movement.

Environmental

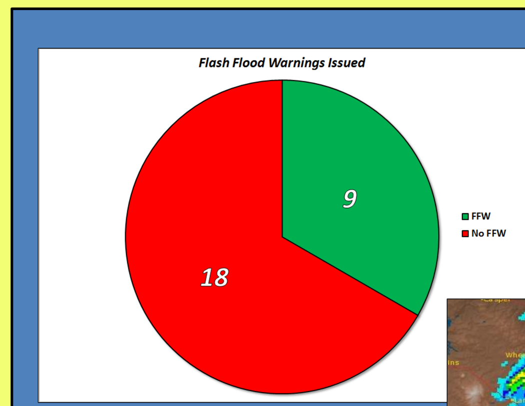


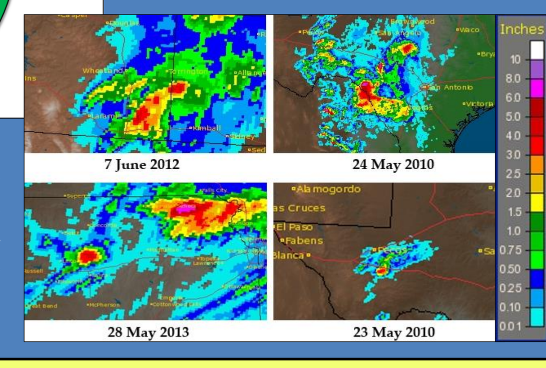
Environmental RUC/RAP forecast data was obtained from NCDC NOMADS every one hour prior to supercell development, valid at the supercell time.

Many environmental parameters showed little to no distinguishable difference between the tornadic and non tornadic environments, while others may be hinting at a better relationship.

The small number of events currently in the database demand that more cases be added to better conclude if the two environments are distinguishable.

Flash Flooding





Radar estimated rainfall amounts associated with four of the supercells in the study. These radar estimates would suggest 6 to 8 inches of rain with some of these storms.

Of the 27 cases, nine had flash flood warnings (33%) and six had confirmed flash flooding (22%).

Of the nine cases with reported rain amounts, five of those cases had over five inches of rain associated with them, including two storms that produced 11 inches and 15 inches.

Attention in real-time is traditionally focused on tornado and other severe hazards, which potentially limits obtaining rainfall/flooding reports.

Discussion and Future Work

Tornadoes oftentimes do not follow a perfectly linear path; rather, at times these tornadoes deviate – subtly or dramatically – from a straight-line path.

When the storm motion slows down to a near-halt, the tornado may demonstrate erratic behavior, which would bring much complication to NWS warning polygons, Impact-Based Warning tags, and communication with media and emergency personnel.

Aside from difficulties with predicting and communicating tornado direction and speed, the slow movement of these prolific, rain-producing storms can bring high-impact flash flooding, which could complicate the process of seeking shelter from the tornado at the lowest possible level.

Due to the limited number of cases that fulfilled the initial criteria, potential expansion of the domain, years included, and/or storm speed will be explored.

Subjective surface analysis will be performed to investigate any potential relationship between these nearly stationary storms and their location relative to an observable surface boundary.

The environments associated with slow-moving supercells and their respective tornado behavior will be compared to traditional environments conducive for supercellular tornadoes to determine whether these rare conditions are present. Additionally, observed storm motions will be compared to the forecast storm motions derived from hodographs to determine their predictability.

References

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