The Calm Before the Storm

Comparing the Initial Stages of Tornadic vs. Nontornadic Supercells

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Introduction

- Oklahoma is well known for its constantly changing and sometimes violent weather.
- One of the most dramatic displays of this weather are supercells: thunderstorms with a single rotating updraft.
- Many of these supercells develop tornados but many do not.
- It is still uncertain what causes some supercells to develop tornados and others to not develop tornados.

Events

- **May 31, 2013** in El Reno: supercell storm, multiple tornados, large amounts of property damage, deaths.

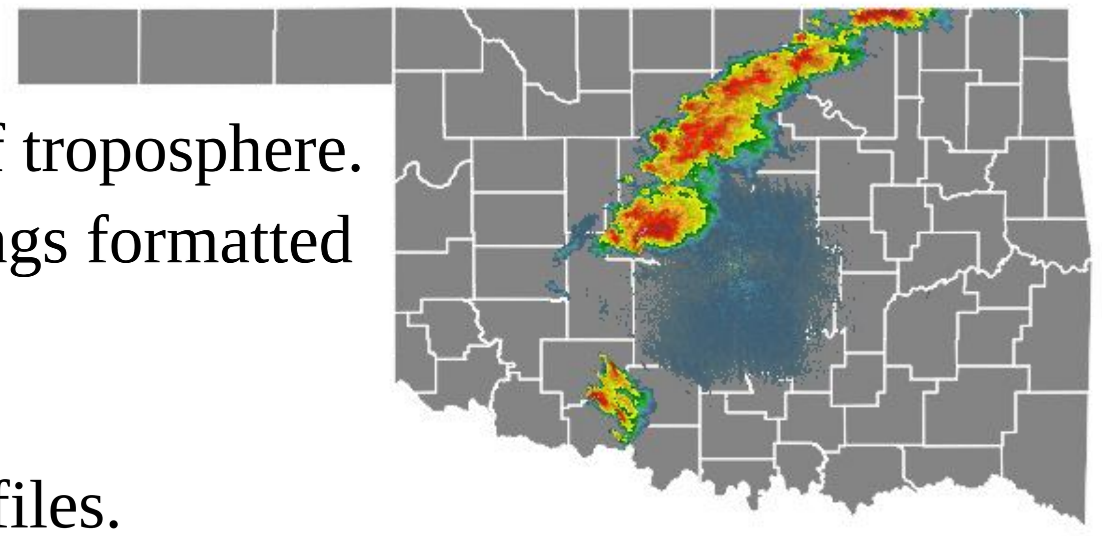
The El Reno, OK tornado. Credit Jeff Snyder.

- **April 14, 1998** in Duncan: supercell storm with brief lowering rotation but no tornado formed.

The Duncan, OK supercell, April 14, 1998.

Methodology

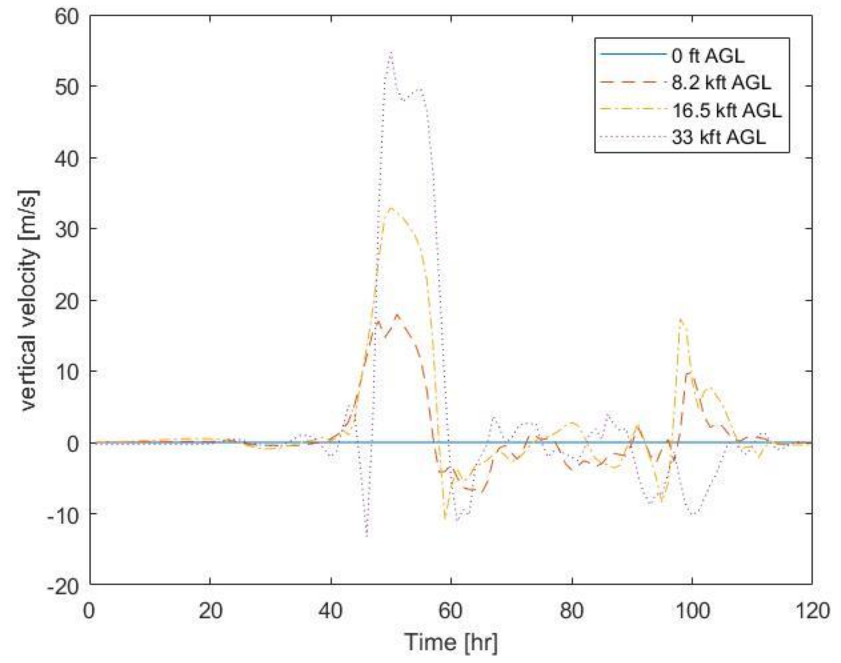
- Cloud Model 1 used to simulate supercell thunderstorms.
- Nontornadic simulated from preconfigured input file.
- Tornadic simulated from soundings: vertical profile of troposphere.
  - 00z (7:00am CDT) and 12z (7:00pm CDT) soundings formatted for input to Cloud Model 1 software.
  - Ran model in high performance computing system.
- Matlab used to generate output graphs from modeled files.
- Oklahoma Mesonet used to visualize surface conditions:
  - Atmospheric pressure and wind speeds at 10m from 2:00pm 6:00pm.
- Compared pressure and wind speed outputs for tornadic and nontornadic.



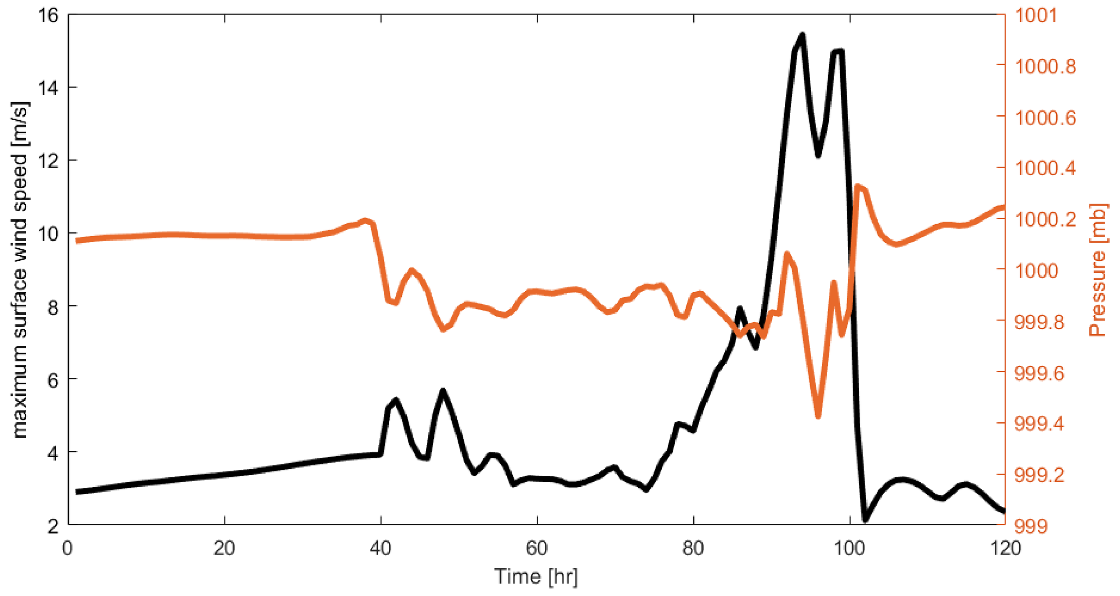
Radar of the May 31, 2013 supercell in El Reno, Oklahoma

Results

Simulation Data – modeled



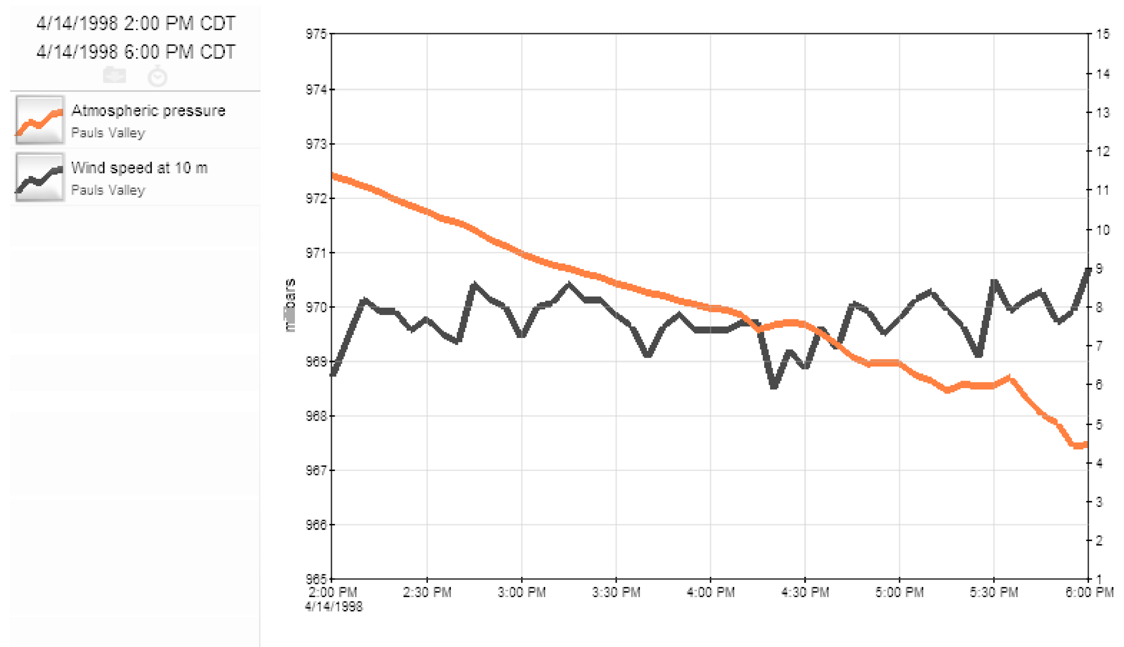
Nontornadic vertical velocity



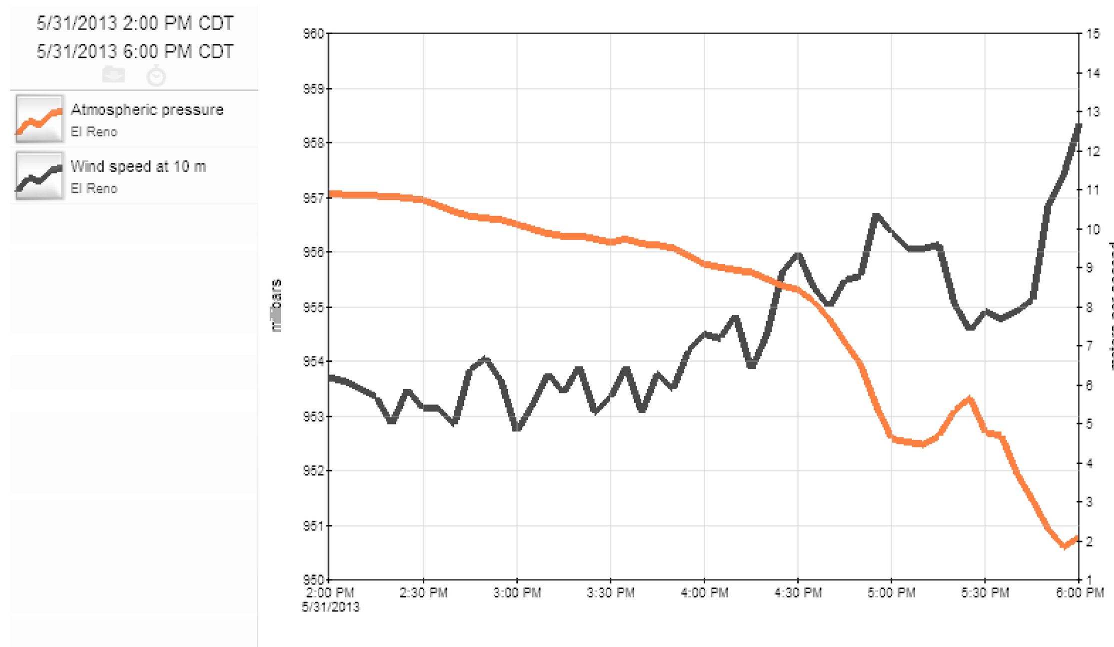
Nontornadic atmospheric pressure and maximum wind speed

Mesonet station in Butler, Oklahoma. credit Jim Foster (Oklahoma Mesonet)

Mesonet Data - actual



Nontornadic supercell from 2:00pm to 6:00pm



Tornadic supercell from 2:00pm to 6:00pm

Discussion

Mesonet

- The atmospheric pressure dropped in both supercells, but the overall pressure was higher for the nontornadic supercell.
- Both supercells had fluctuations in wind speed but the winds in the tornadic supercell increased more rapidly.

Simulation

- The atmospheric pressure for the nontornadic supercell dropped when the storm began, but the pressure overall was fairly high.
- The maximum wind speeds in the simulated nontornadic supercell increased slowly as in the Mesonet but more dramatically than the Mesonet.

Conclusions

- Lower pressure at the surface prior to supercell development and rapidly increasing surface wind speeds may indicate tornados are more likely.

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Primary References

- Markowski, P., & Richardson, Y. (2009). Tornadogenesis: Our current understanding, forecasting considerations, and questions to guide future research. *Atmospheric Research*, *93*(1-3), 3-10
- Markowski, P., Straka, J., & Rasmussen, E. (2002). Direct Surface Thermodynamic Observations within the Rear-Flank Downdrafts of Nontornadic and Tornadic Supercells. *Monthly Weather Review*, *130*(7), 1692-1721