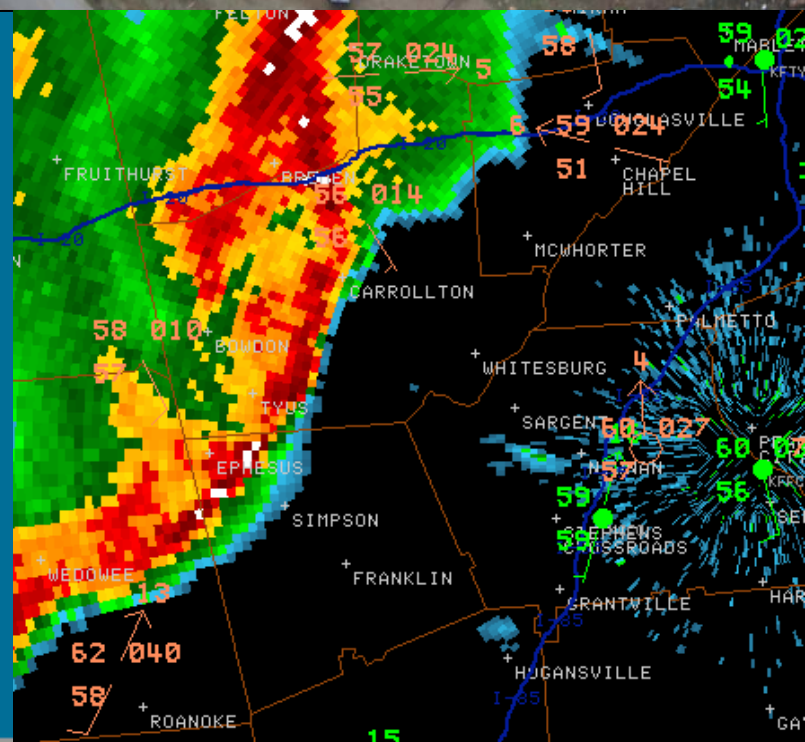


Characteristics and Estimated Warning Success Rates of QLCS and Supercell-Produced Significant Tornadoes in the Southeast U.S.

Garrett D. Combs – Lyndon State College*
Steven E. Nelson – WFO Peachtree City

* 2010 NOAA Hollings Scholar

March 3, 2011
National Severe Weather Workshop

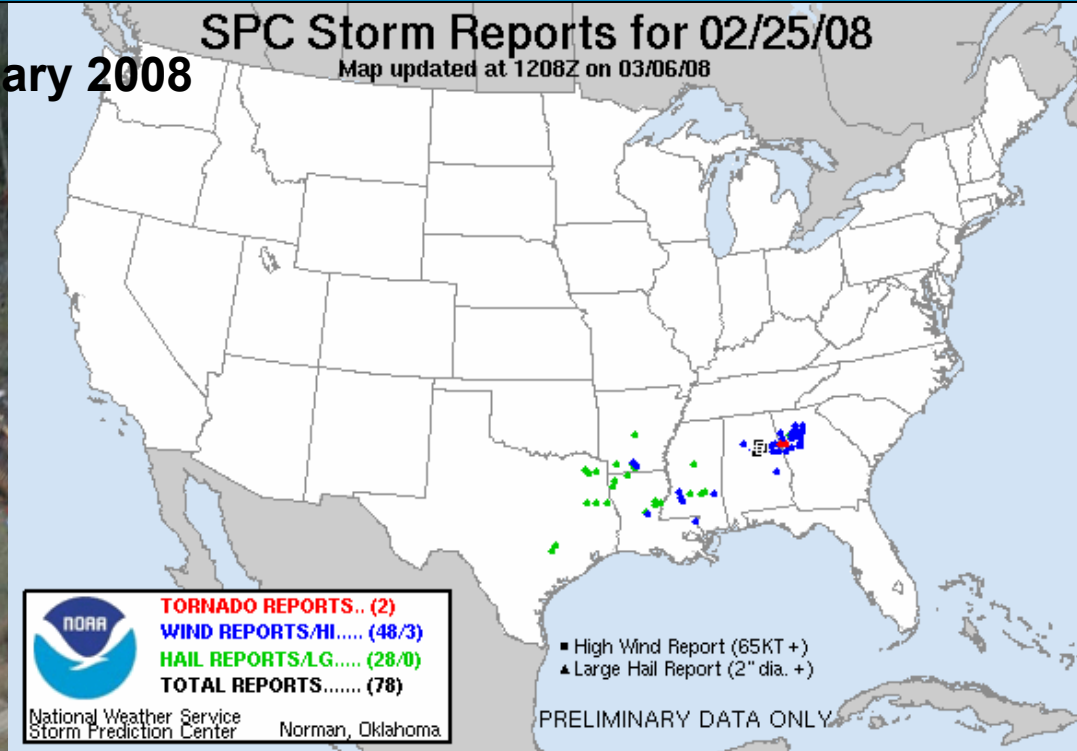
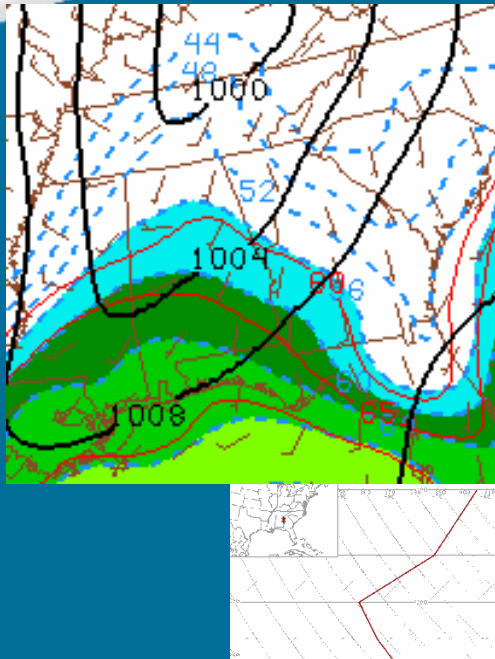


Outline

- **Motivation**
- **QLCS vs Supercell Tornadoes**
- **Data/Methodology**
- **Radar Results**
- **Warning Success Rates Results**
- **Environment – Preliminary Results**
- **Summary**

Motivation

1100UTC 26 February 2008



Carroll County, GA Tornado #1
26 February 2008 555 am EST

- EF0
- EF1
- EF2
- EF3



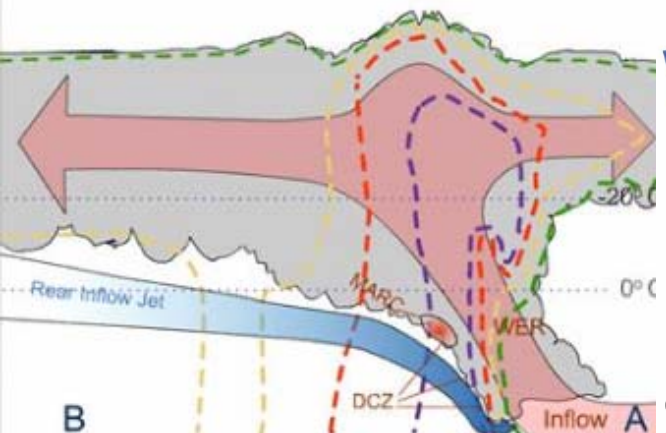
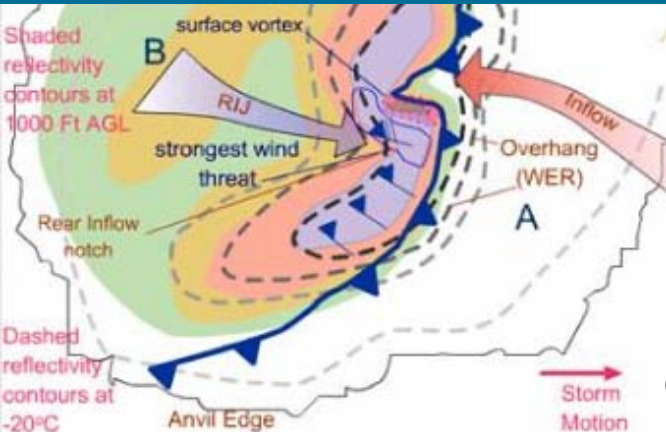
Tornadoes from QLCS

Shear parallel to orientation of cells, straight-line hodograph \rightarrow

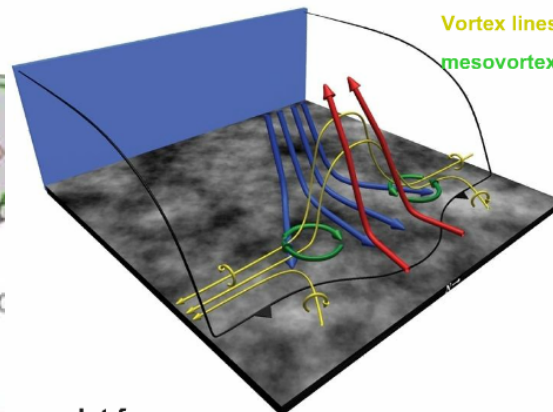
trailing-stratiform QLCS \rightarrow cold pool \rightarrow RIJ \rightarrow RIN

\rightarrow Streamwise vorticity along the QLCS boundary is tilted by a **downdraft** (Trapp and Weismann 2005) or an **updraft** (Atkins and St. Laurent 2009) from the RIJ

\rightarrow The cyclonic vortex (north of apex green circle) develops near the **ground**, spins **up** and **broadens** with time (5-30 minutes?)



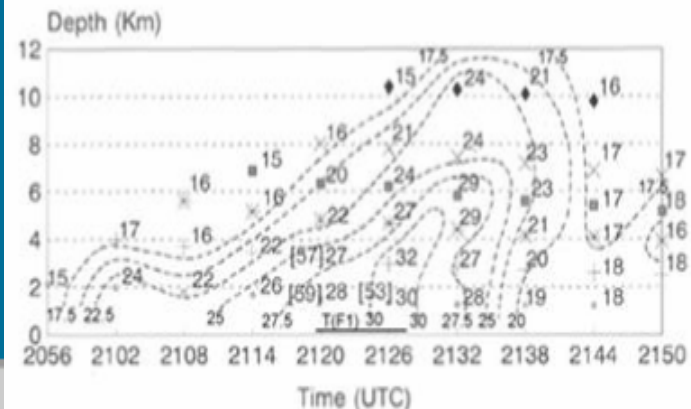
Cross-wise vorticity



couplet forms:
anticyclonic south (right)
of cyclonic couplet

From Atkins and St. Laurent 09b

Circulation #2 / 29 June 1998
Magnitudes of $V_r(m/s)/\Delta-V$ [] values (m/s)



QLCS Tornado Comparison

- Not as common as supercell tornadoes

Tornadoes	US	SE
Supercell	79%	69%
QLCS	18%	28%
“Other”	3%	3%

- Just as likely to produce significant tornadoes
- Higher relative frequency...
 - 11pm – 6am
 - Nov, Jan, and Feb (equally likely Mar, May, and June)

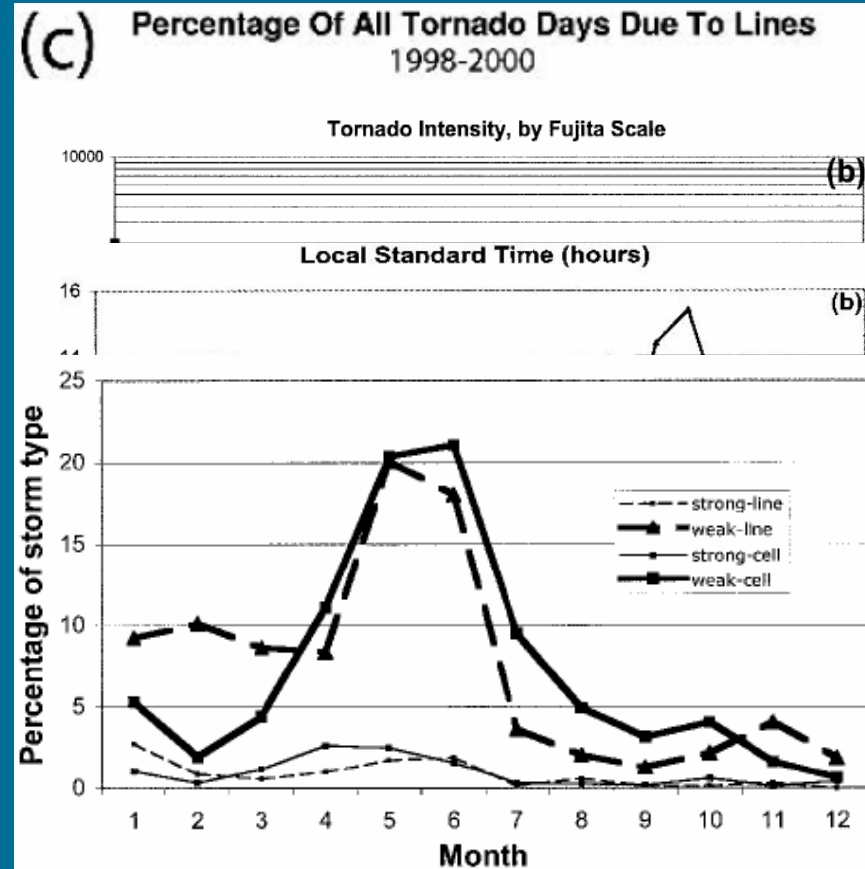
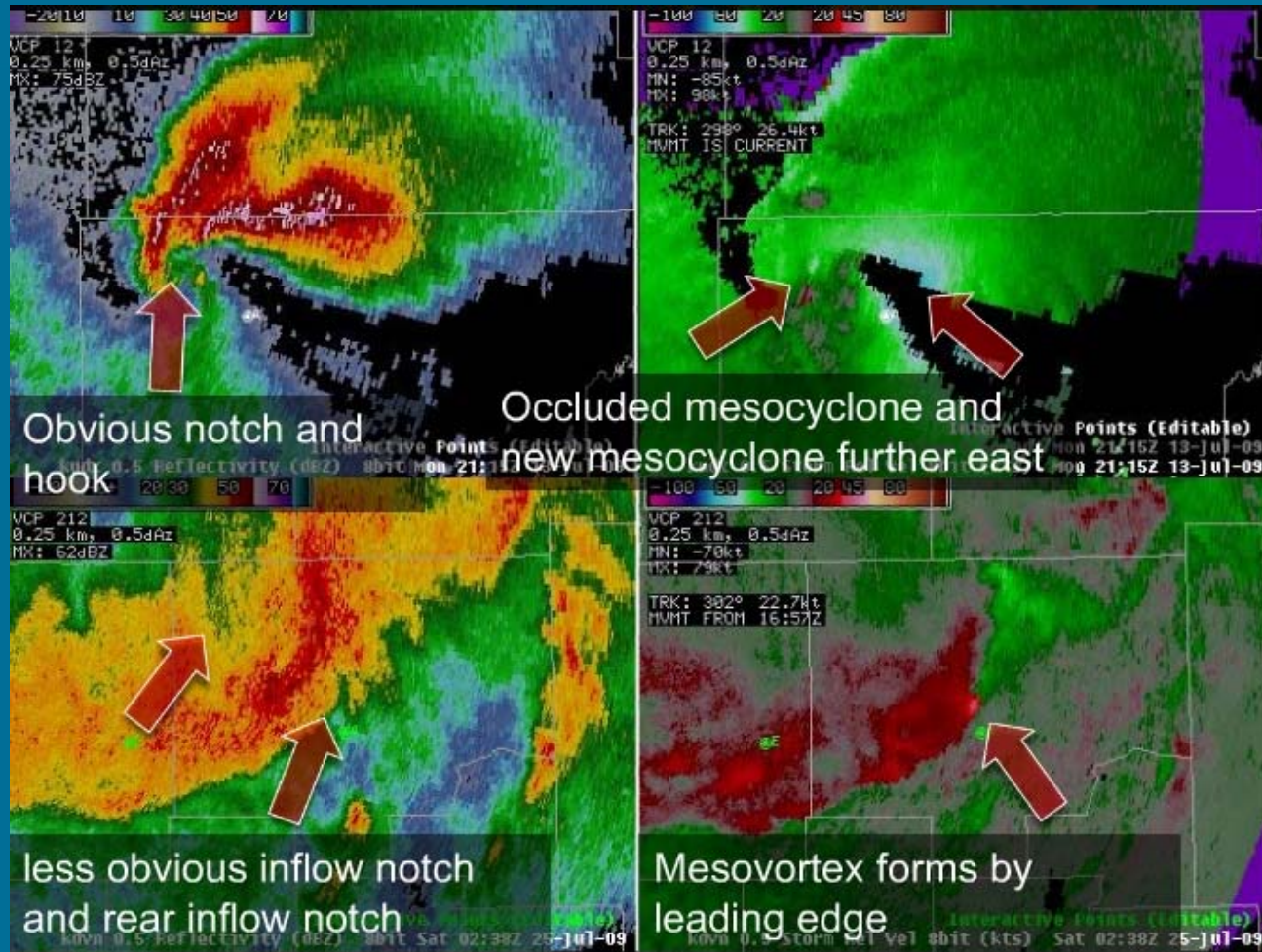


FIG. 5. 1998–2000 U.S. tornado distribution by month of occurrence and parent storm type (cell or QLCS). Percentage is based on total number of events per storm type. “Weak” denotes F0–F1 tornadoes, and “strong” denotes F2–F3 tornadoes.

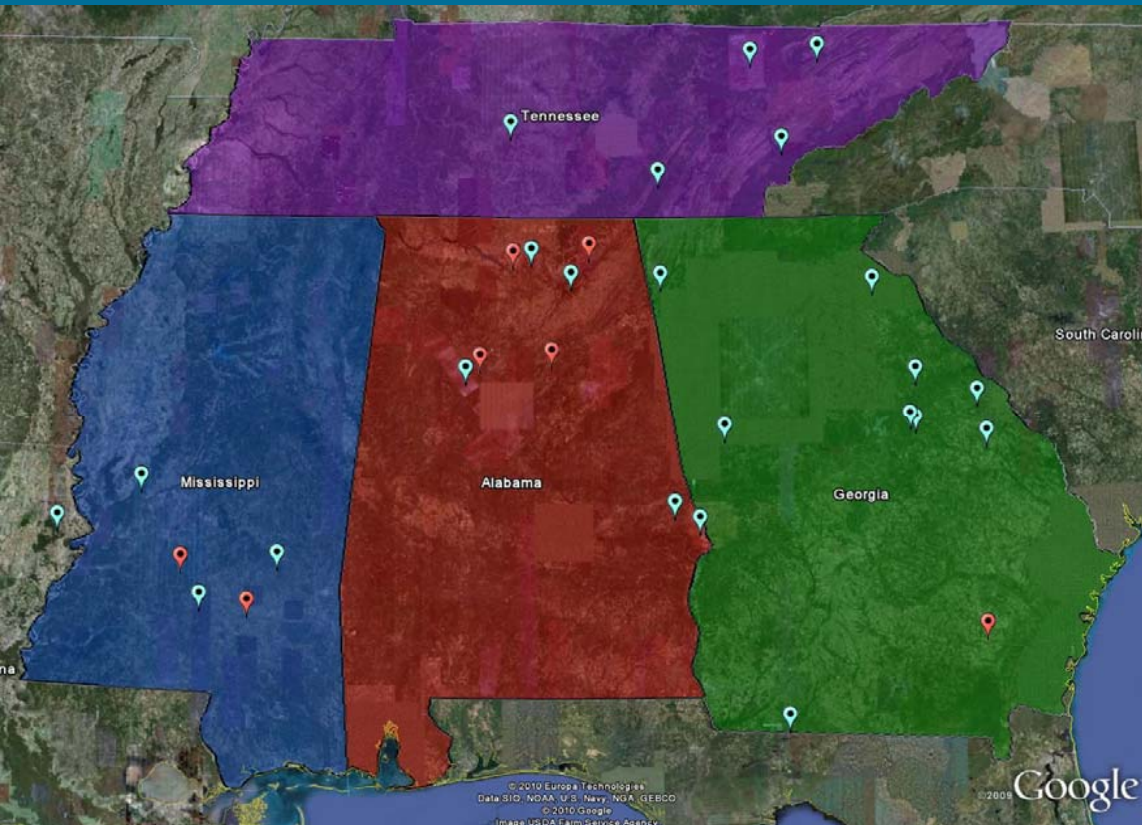
QLCS Tornado Comparison

- Similar but different
- Both have “notches” and WERs
- QLCS features more subtle
- Different vortex evolution and motion
- QLCS tornadoes shorter duration (< 30 minutes)



Data/Methodology

All significant tornado events (\geq EF2), as well as NWS outlook, watches, and warnings obtained for MS, AL, TN, GA for 11/1/08 – 5/31/09, 11/1/09 – 4/31/10.

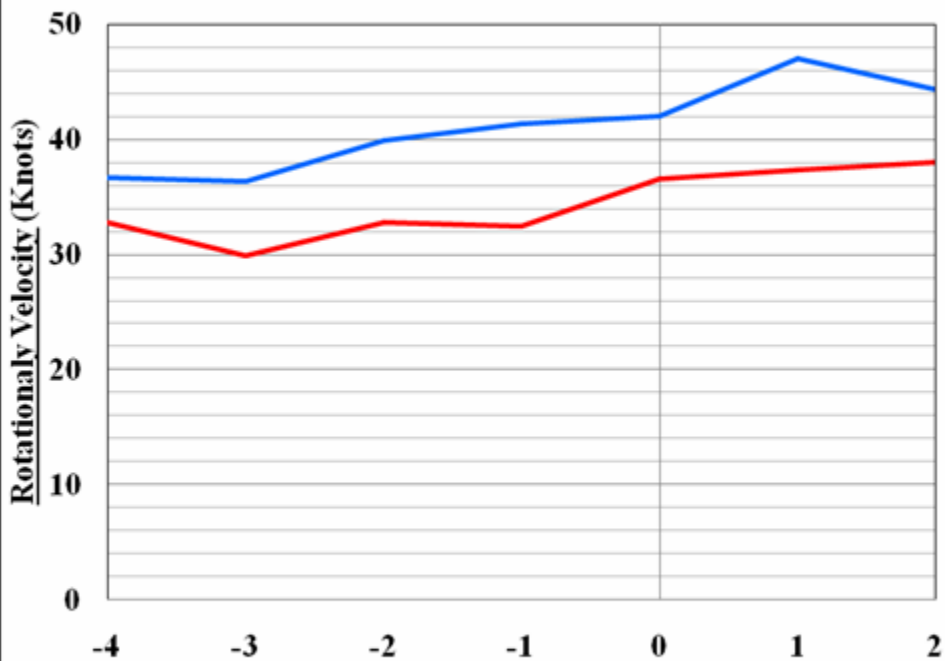


30 Cases

23 Supercell (77%)
7 QLCS (23%)

Radar Results

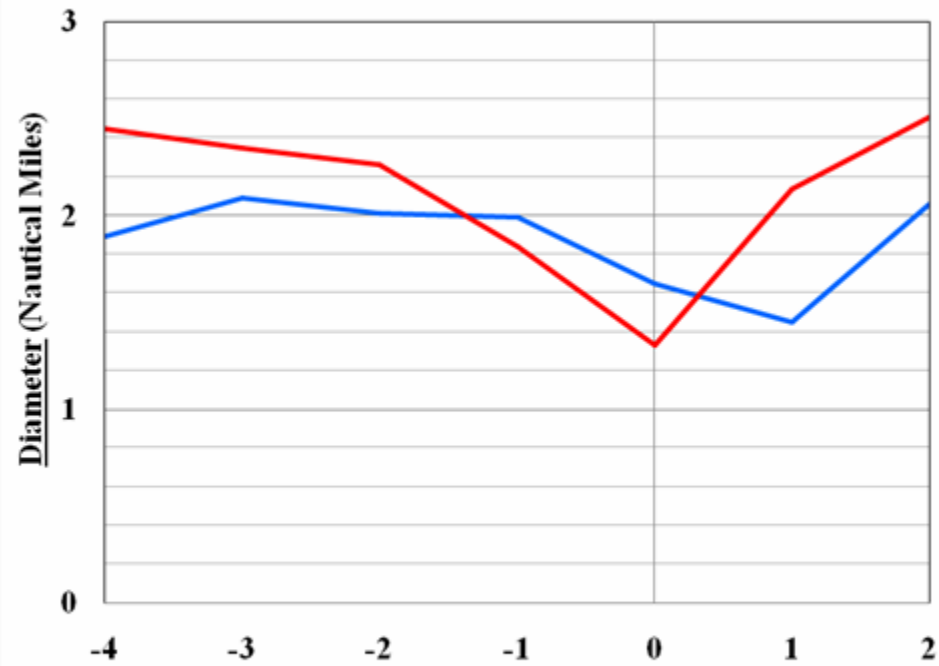
**Supercell vs. QLCS:
0.5-Degree Rotational Velocity Values**



Scan Time (0 = Tornado Touchdown)

— Supercel Rot. Vel — QLCS Rot. Vel.

**Supercell vs. QLCS:
0.5-Degree Diameter Values**

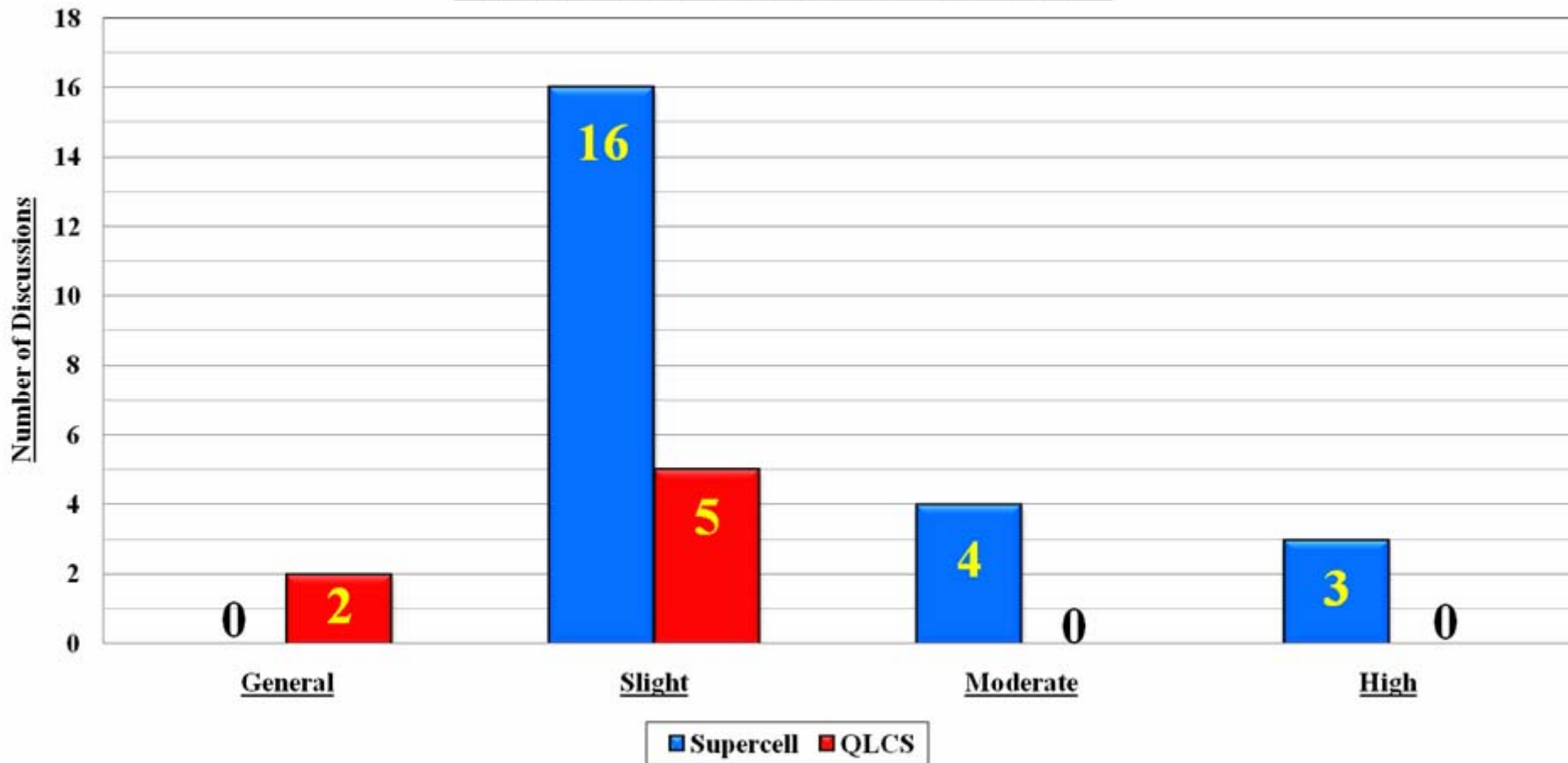


Scan Time (0 = Tornado Touchdown)

— Supercell Diam. — QLCS Diam.

SPC Outlooks

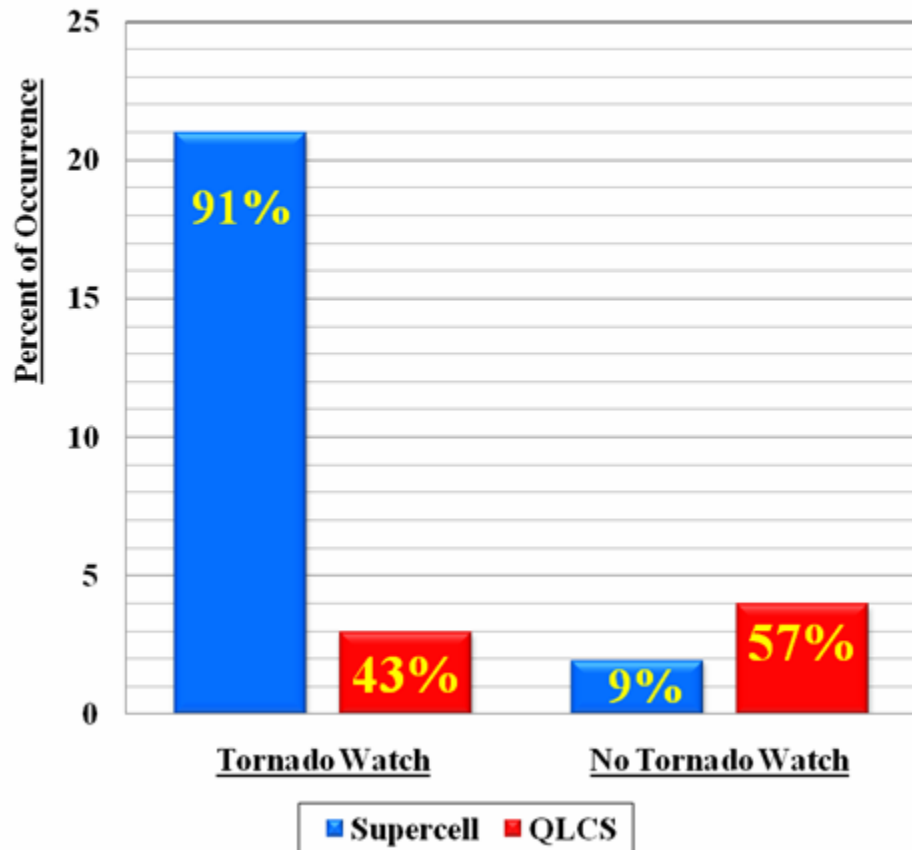
Supercell vs. QLCS: SPC Day 1 Outlook (1200Z)



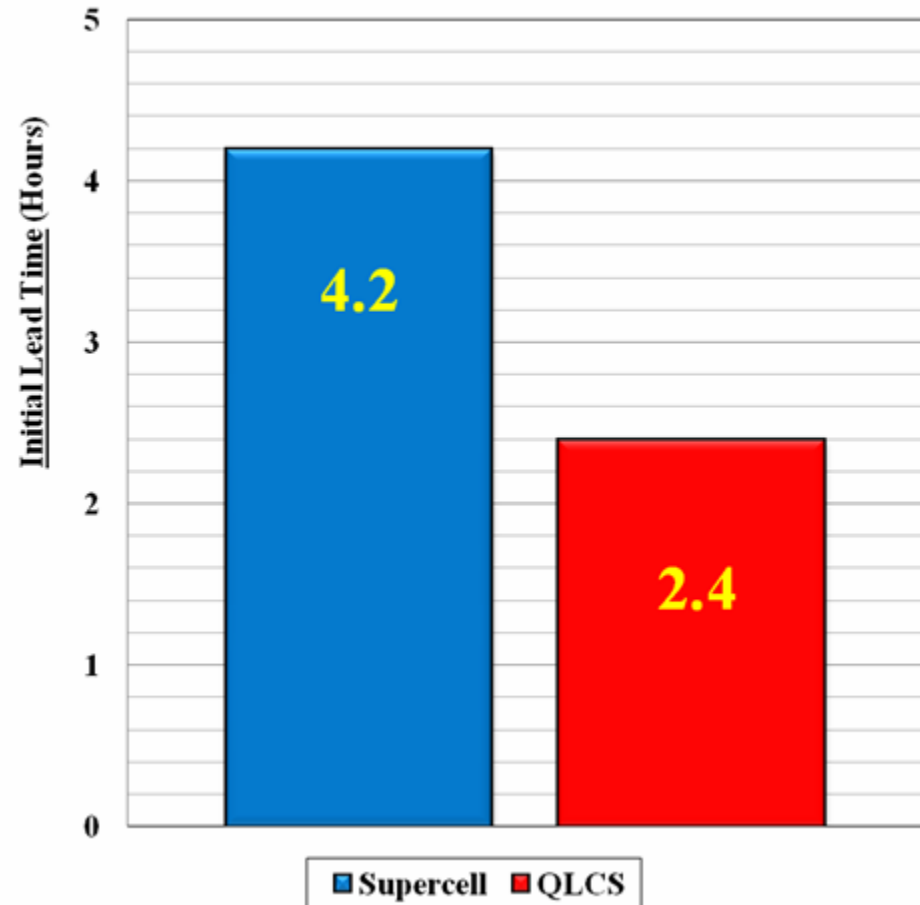
SPC Watches

- All severe thunderstorm watches placed into “No Watch” category for study.

Supercell vs. QLCS: Watch Frequency

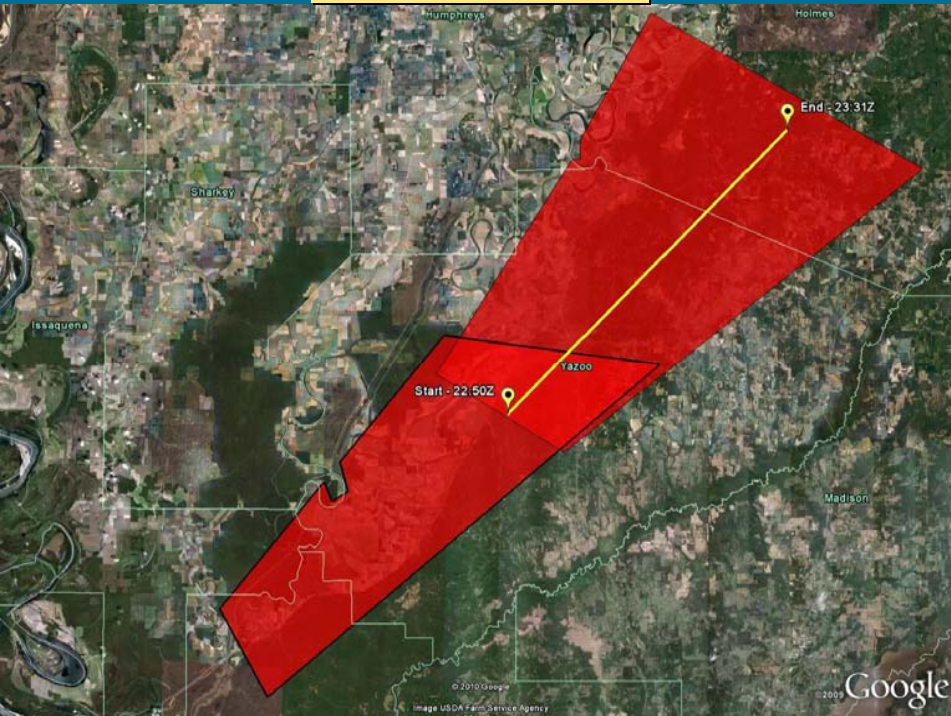


Supercell vs. QLCS: Watch Lead Time



Warning Accuracy Metric - PEW

Warned Case



Lead Time:

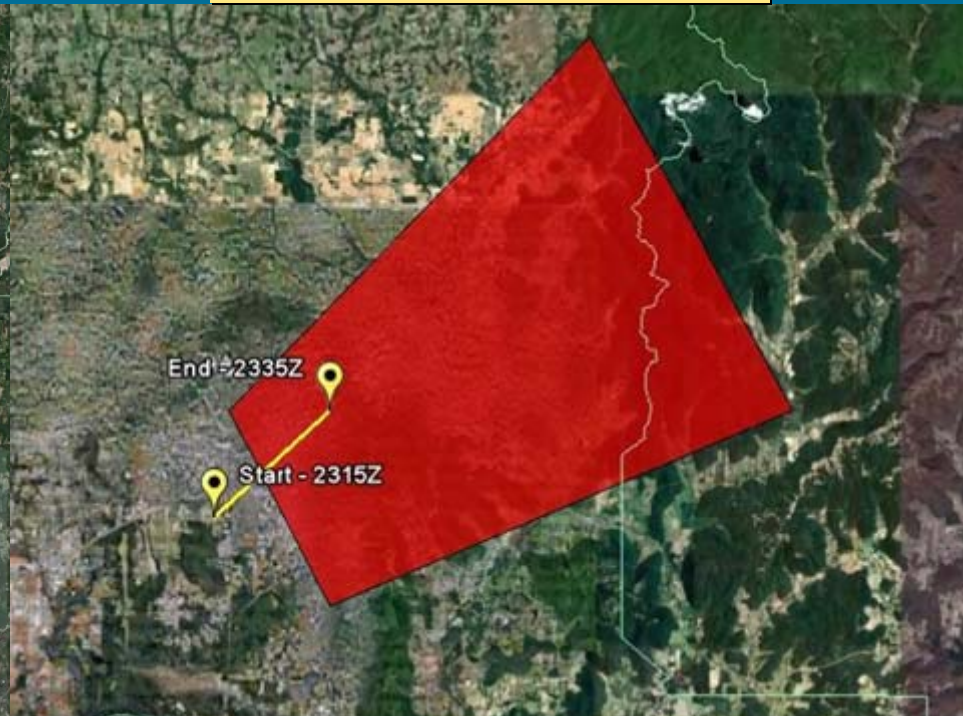
Time of Tornado Touchdown – Time Warning Issued

2250Z – 2216Z = +34 Minutes

(34 Minutes Before Touchdown)

Percent Event Warned (PEW) = 100%

Partially Warned Case



Lead Time:

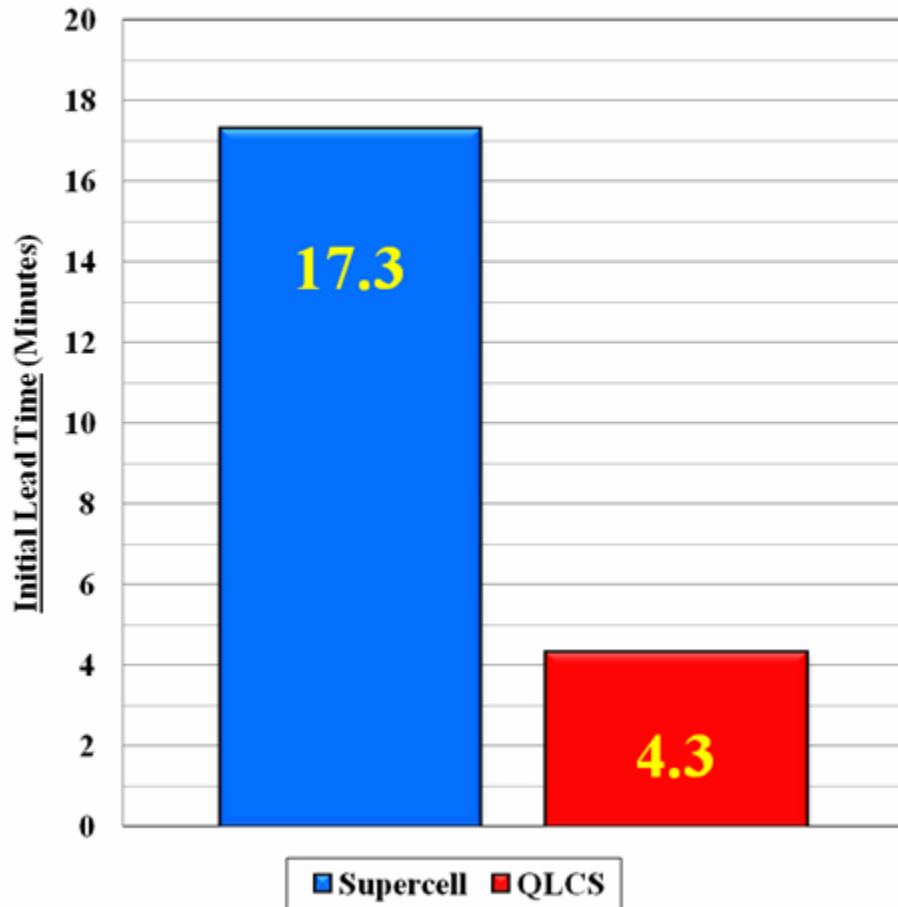
Time of Tornado Touchdown – Time Warning Issued 2315Z – 2323Z = -8 Minutes

(8 Minutes After Touchdown)

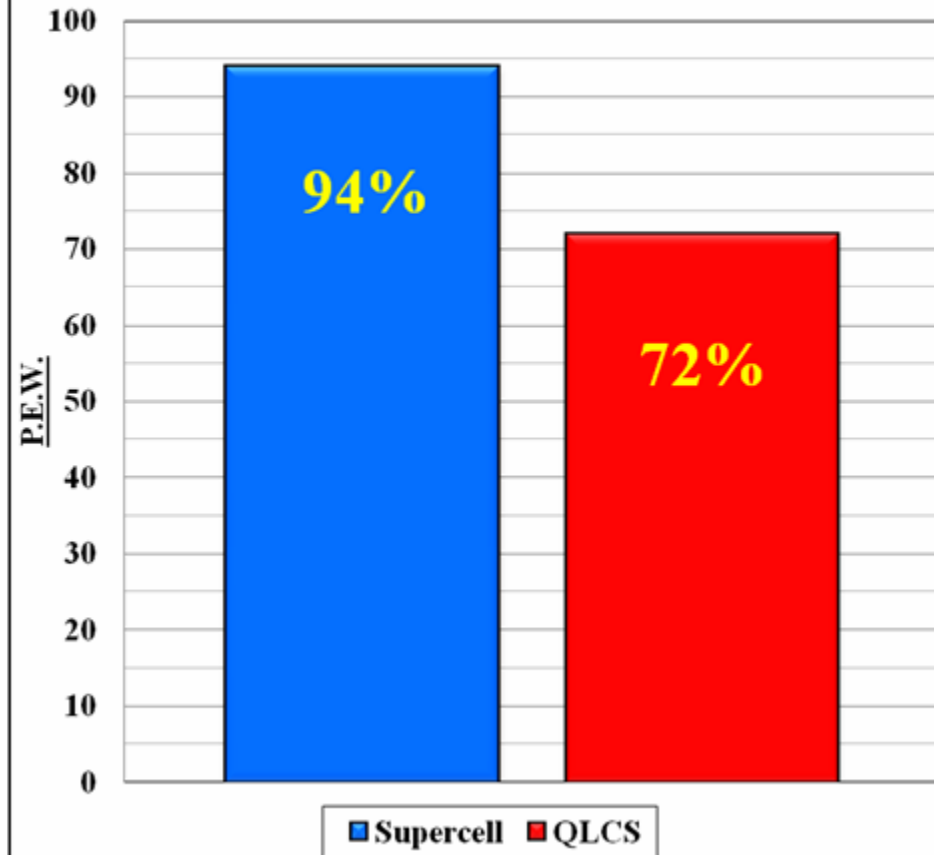
Percent Event Warned (PEW) = 62%

NWS Tornado Warnings

Supercell vs. QLCS: Initial Lead Time



Supercell vs. QLCS: Percent Event Warned



Environment – Preliminary Results

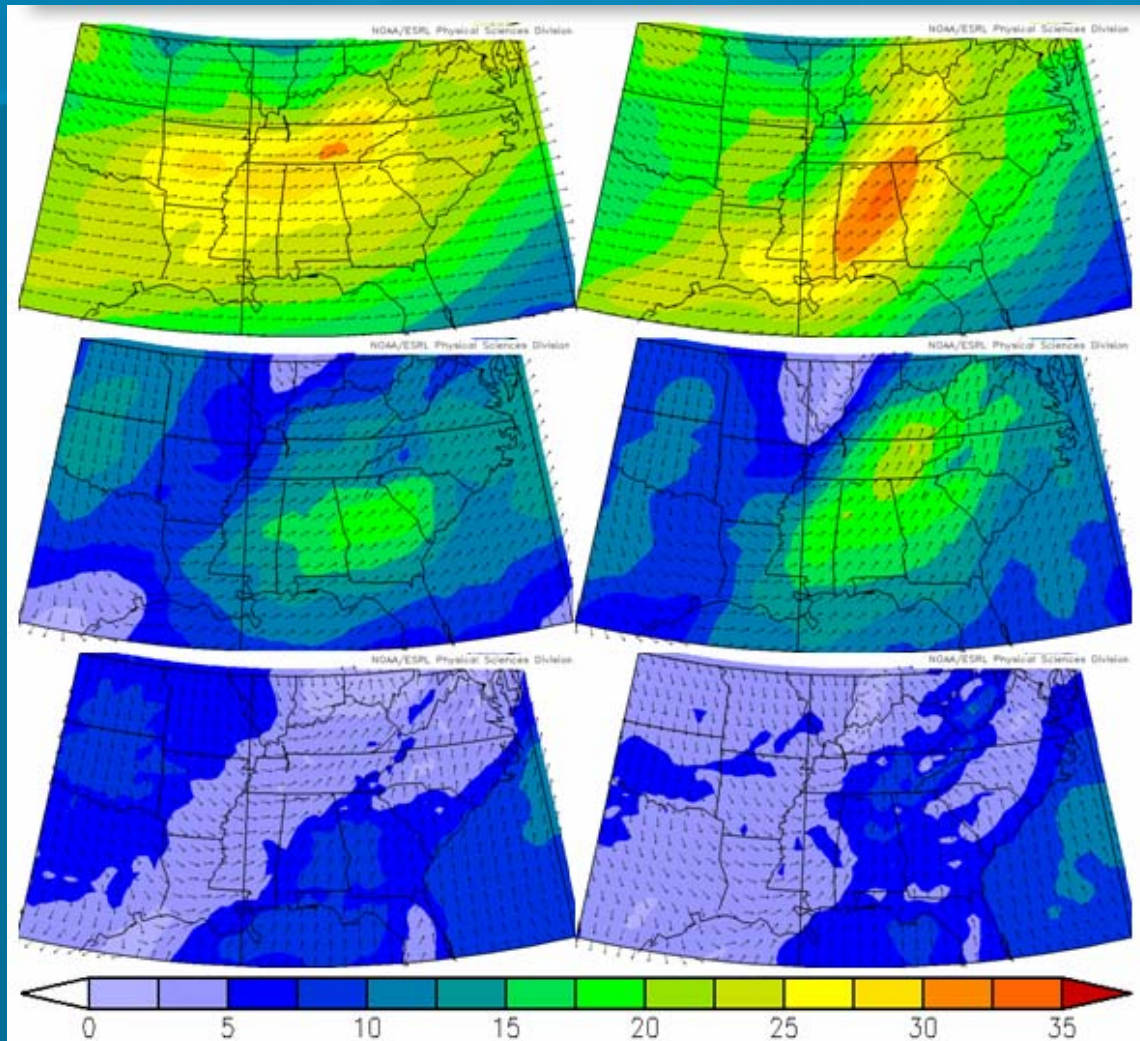


Figure 9: NARR 3 hr composite wind field at 500, 850, and 1000 hPa in m/s for supercell (left) and QLCS (right) tornado events.

Environment – Preliminary Results

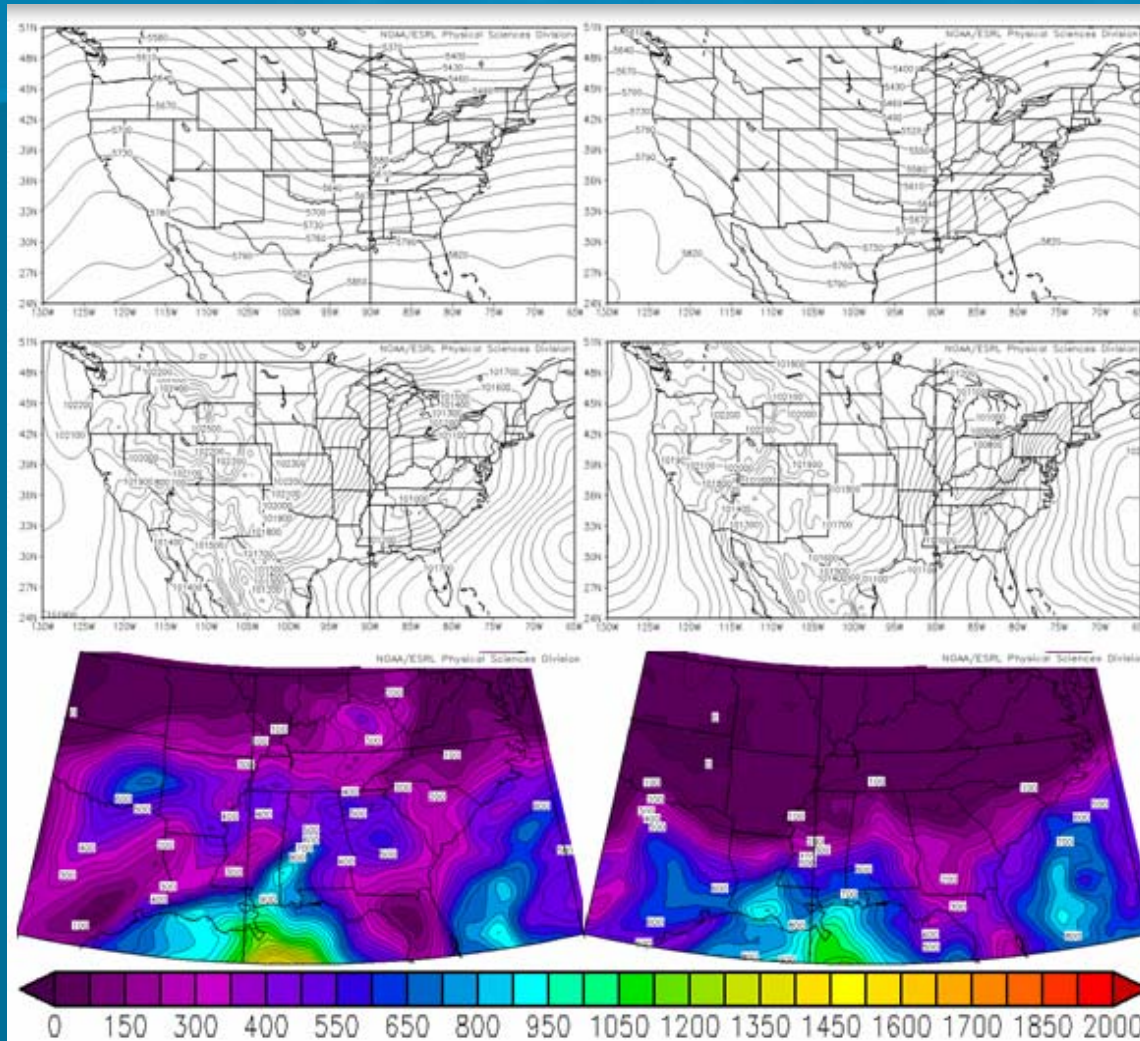


Figure 10: NARR 3 hr composite height at 500 hPa in m, MSL Pressure in Pa, and SBCAPE in J/kg for supercell (left) and QLCS (right) tornado events.

Summary

- Traditional tornado warning training and methodology has not accounted for QLCS tornadoes until recently
- Tornadoes from QLCS are dynamically and climatologically distinct from supercell-based tornadoes
- Out of 30 significant tornadoes in the Southeast from Nov 2008 – Apr 2010, 7 (22%) developed from QLCS
- Rotational velocity for QLCS vortices averaged 5-7kts lower than supercells, but diameters were about the same
- Tornado warning lead time for QLCS tornadoes averaged **4 minutes**, while supercell events averaged **17 minutes**
- Tornado warning PEW for QLCS tornadoes averaged **72%** compared with **94%** for supercell tornadoes

Future Research

- **Expand study (Thompson and**
- **Estimate warning thresholds for QLCS and supercell tornadoes from superres radar data**
- **Further investigate pre-storm environment (instability, CIN, vertical wind profile) of QLCS and supercell tornadoes**

Questions??



Contact: Garrett.Combs@lyndonstate.edu
Steven.Nelson@noaa.gov