Environmental Characteristics of Recent Tornadic Versus Non-Tornadic Events

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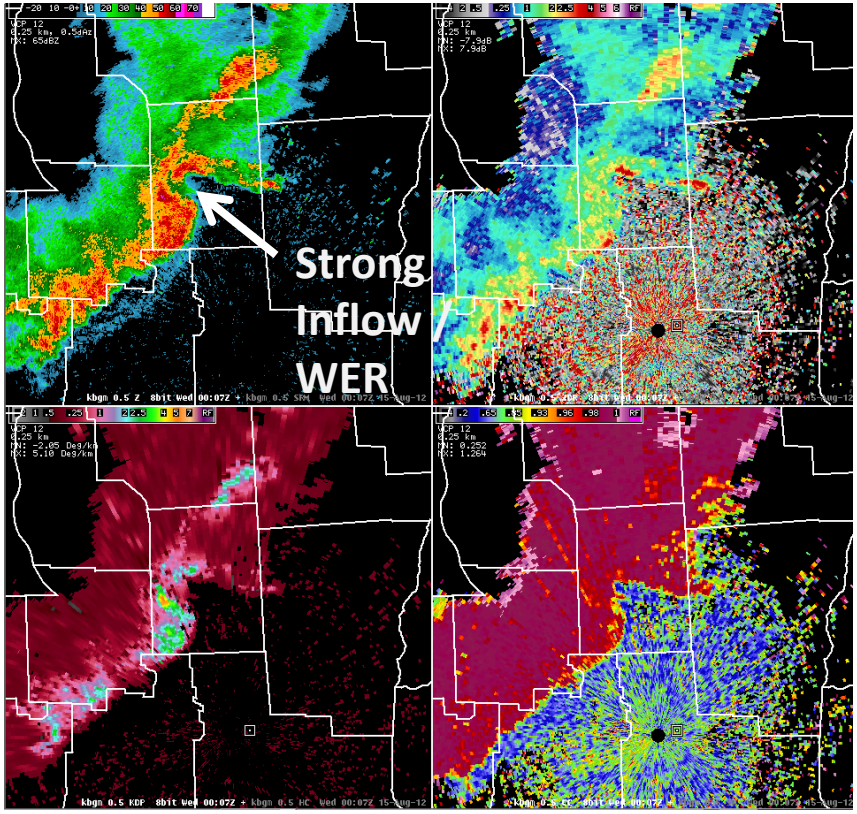
Outline

- Direct comparisons (7/26/12 vs. 8/14/12)
  - Four-panel radar imagery
    - Recent Dual-pol study (ZDR and KDP signatures)
  - Synoptic settings
  - Convective parameters
- Relevance to past studies of tornadic vs. non-tornadic supercell environments
- Conclusions

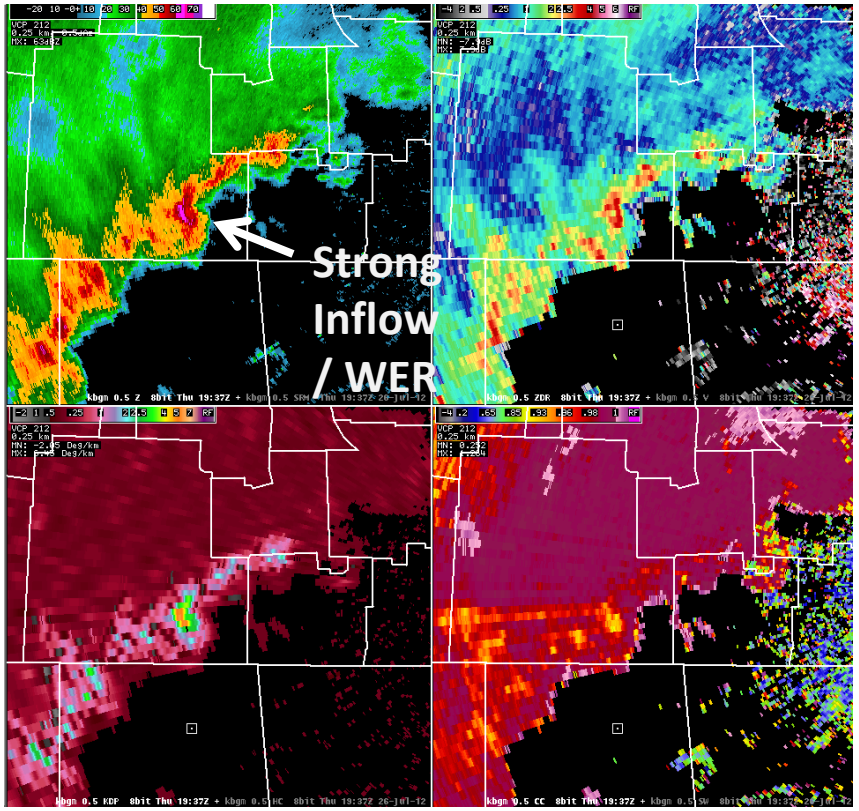
Radar Imagery

Reflectivity + Dual-Pol Variables

Z/ZDR/KDP/CC @ 0007z, 8/15

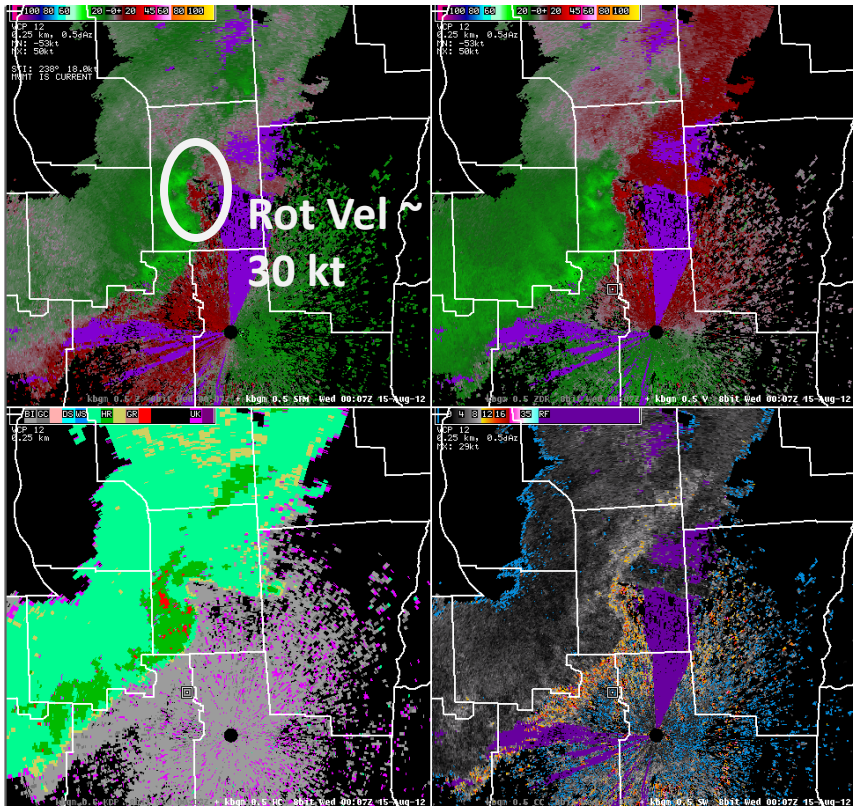


Z/ZDR/KDP/CC @ 1937z, 7/26

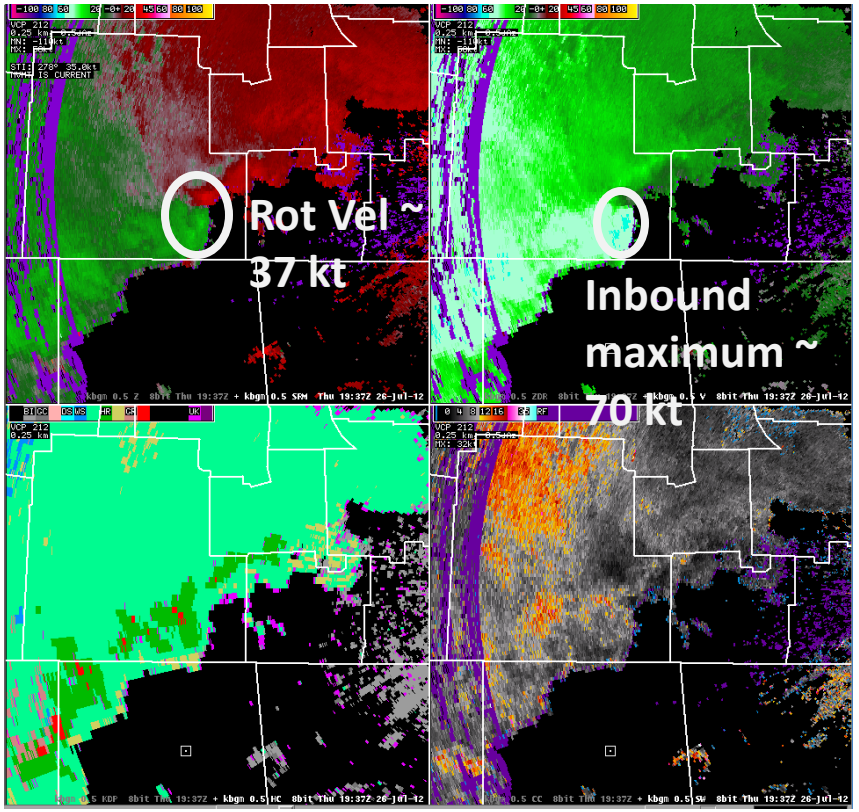


Velocity Products

SRM/V/HC/SW @ 0007z, 8/15

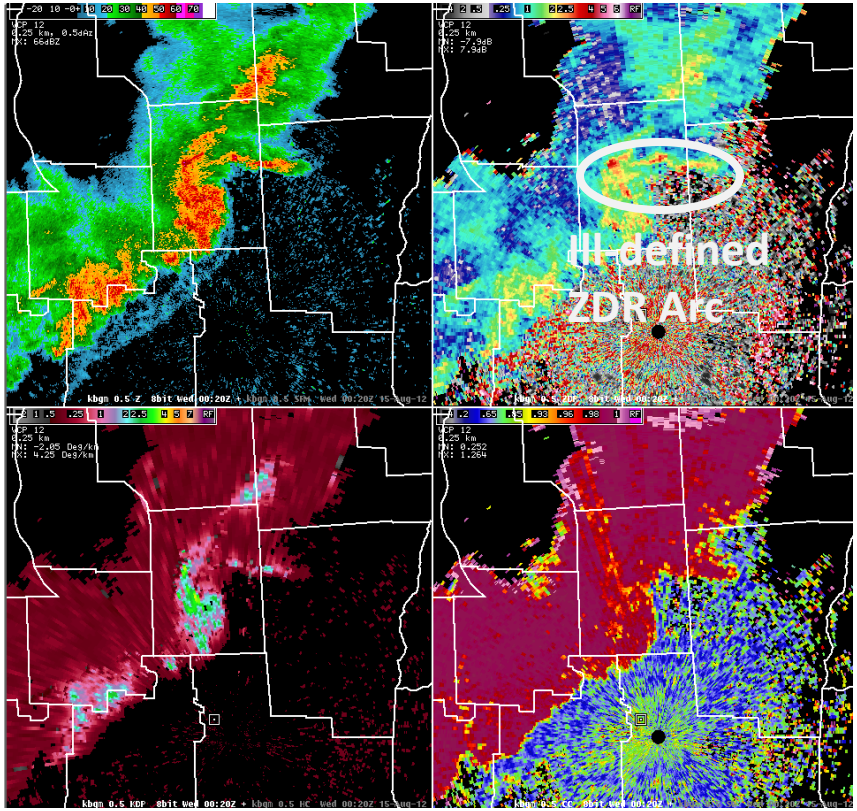


SRM/V/HC/SW @ 1937z, 7/26

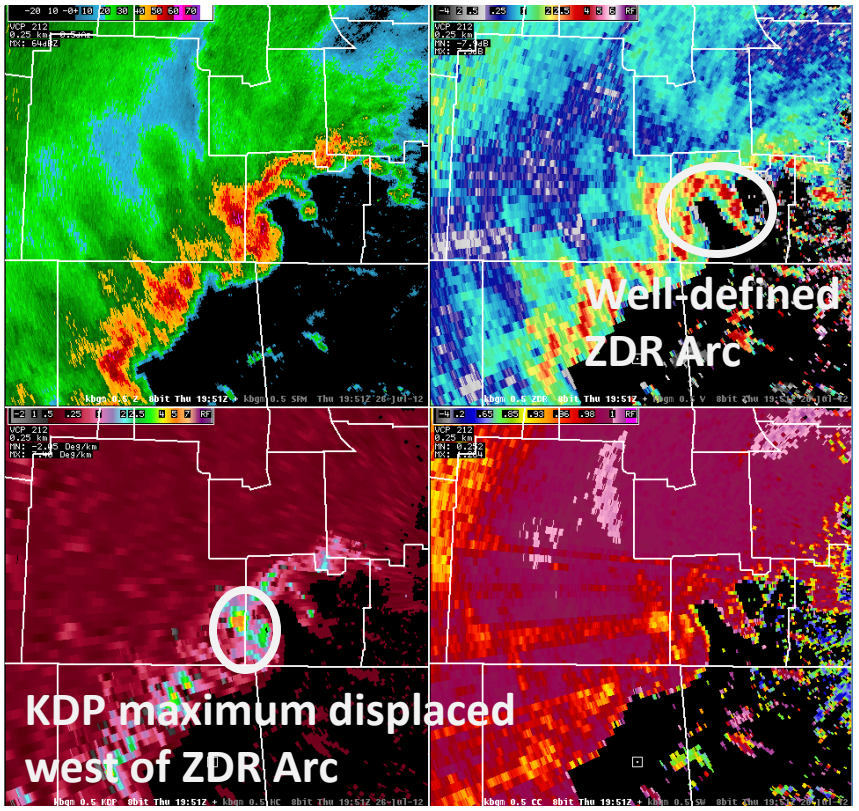


Reflectivity + Dual-Pol Variables

Z/ZDR/KDP/CC @ 0020z, 8/15

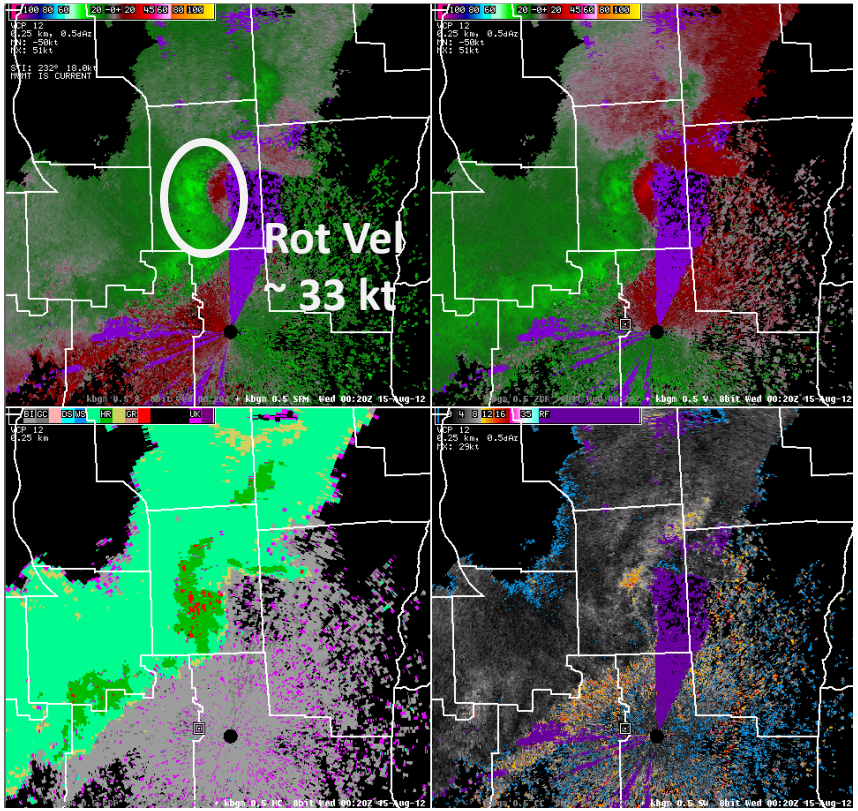


Z/ZDR/KDP/CC @ 1951z, 7/26

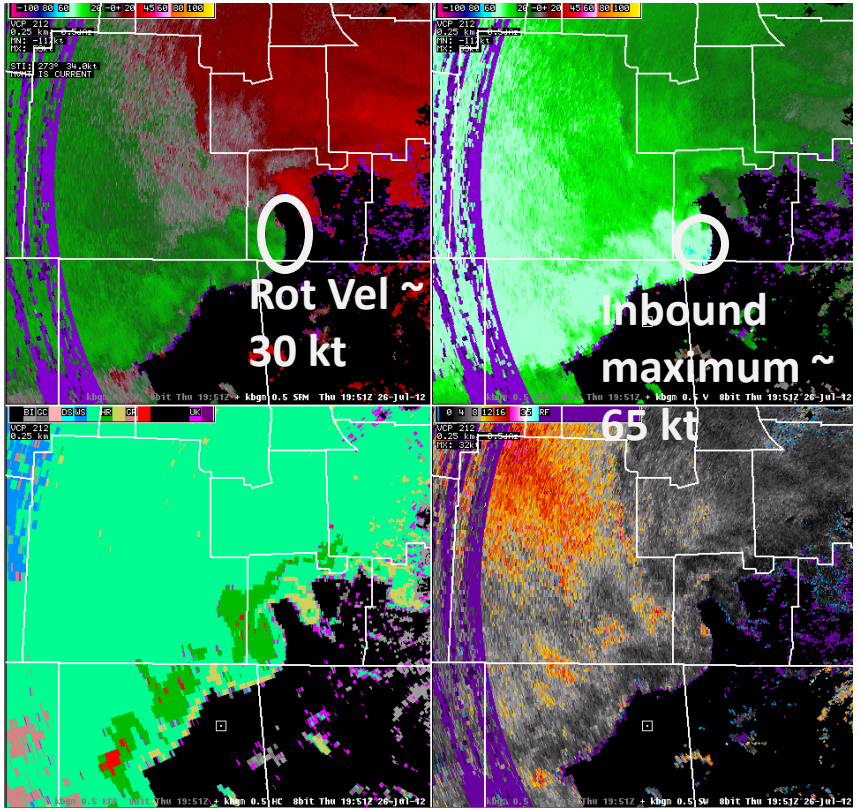


Velocity Products

SRM/V/HC/SW @ 0020z, 8/15

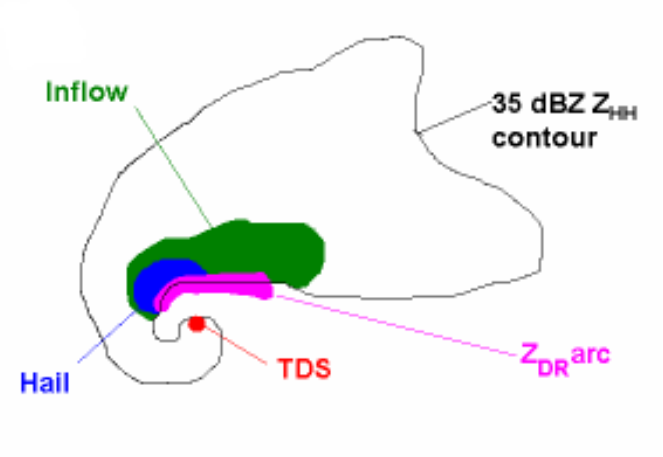


SRM/V/HC/SW @ 1951z, 7/26

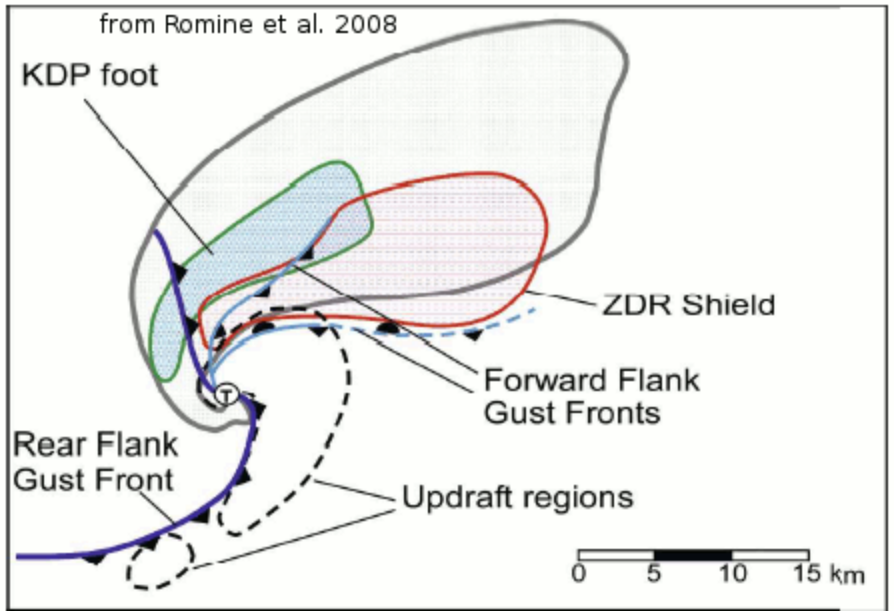


Potential Dual-Pol tornadic signatures

from Kumjian et al. 2008



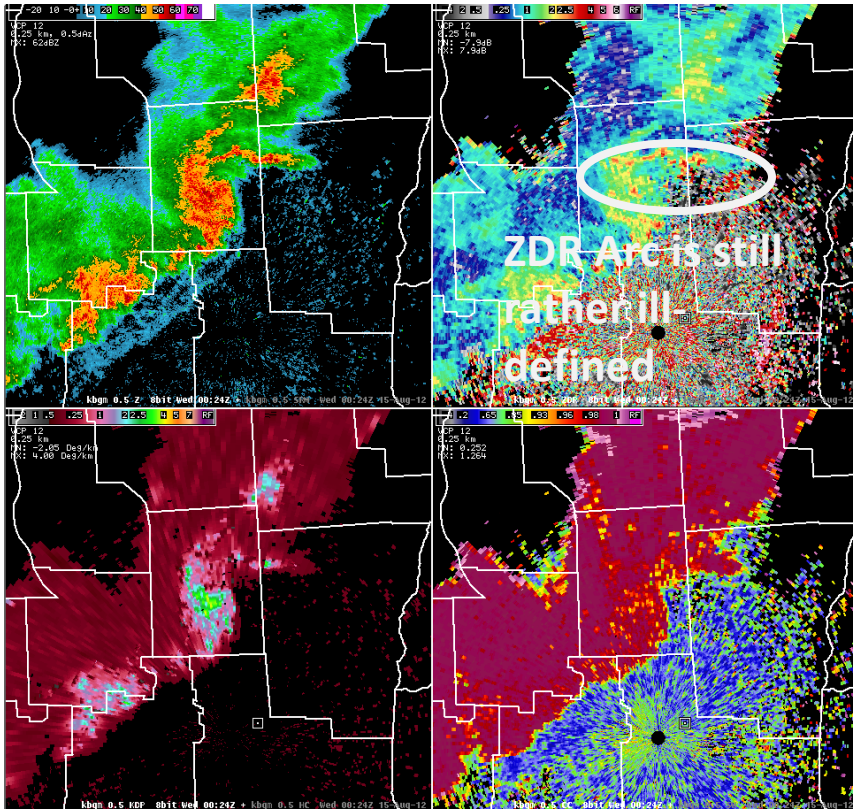
Modeling studies indicate that ZDR arcs on the southern edge of the forward flank precipitation shield, are associated with enhanced storm relative helicity.



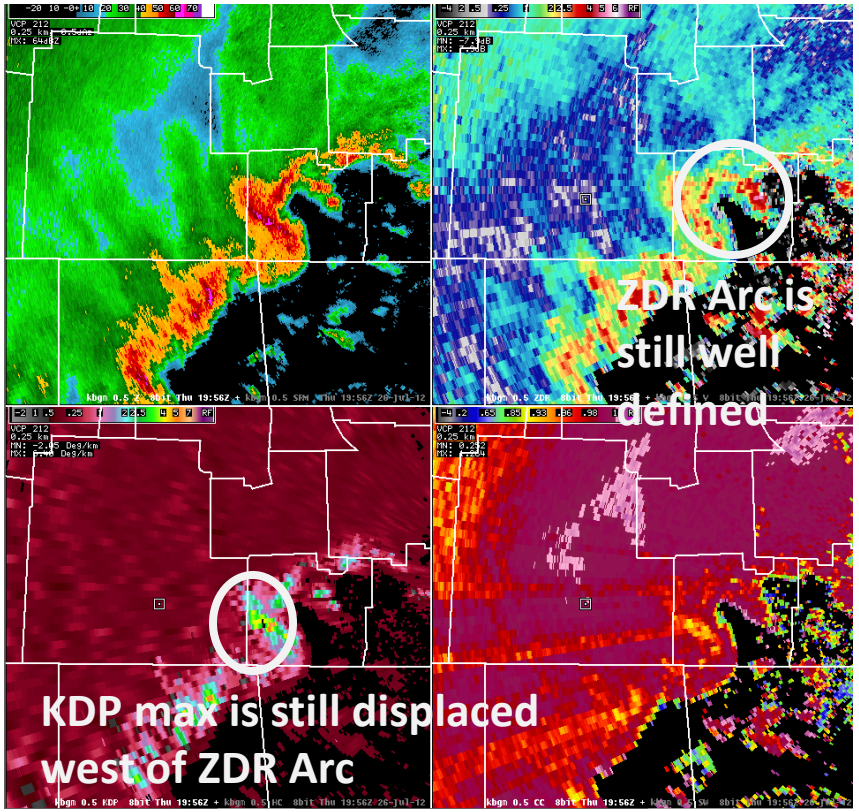
Enhanced shear is also indicated by separation between maxima of ZDR (large drops) and KDP (maxima of liquid water).

Reflectivity + Dual-Pol Variables

Z/ZDR/KDP/CC @ 0024z, 8/15

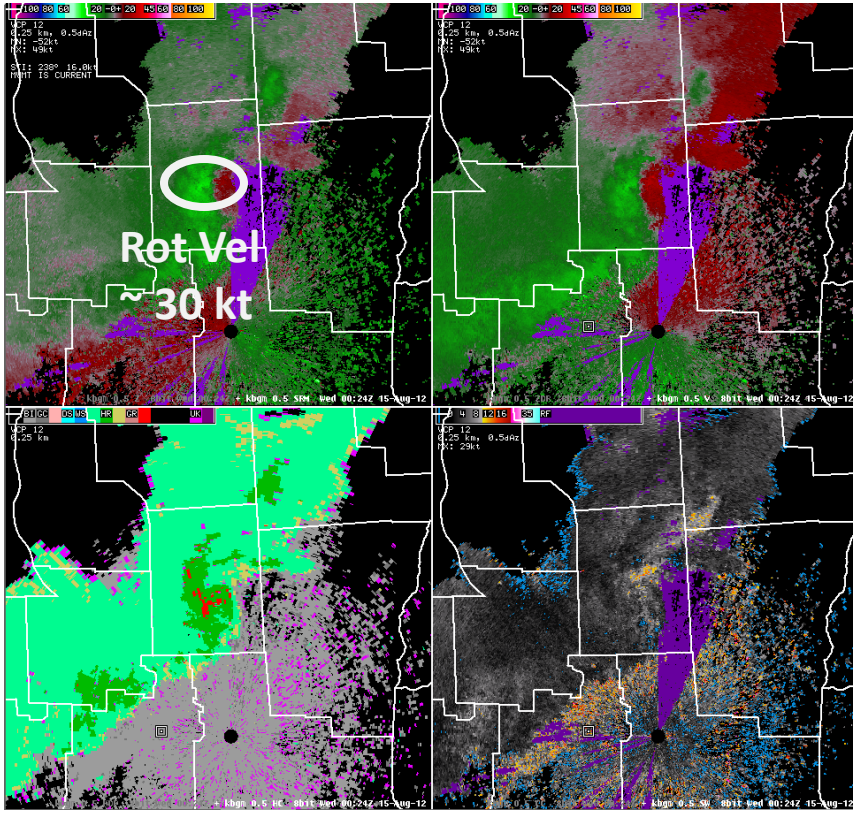


Z/ZDR/KDP/CC @ 1956z, 7/26

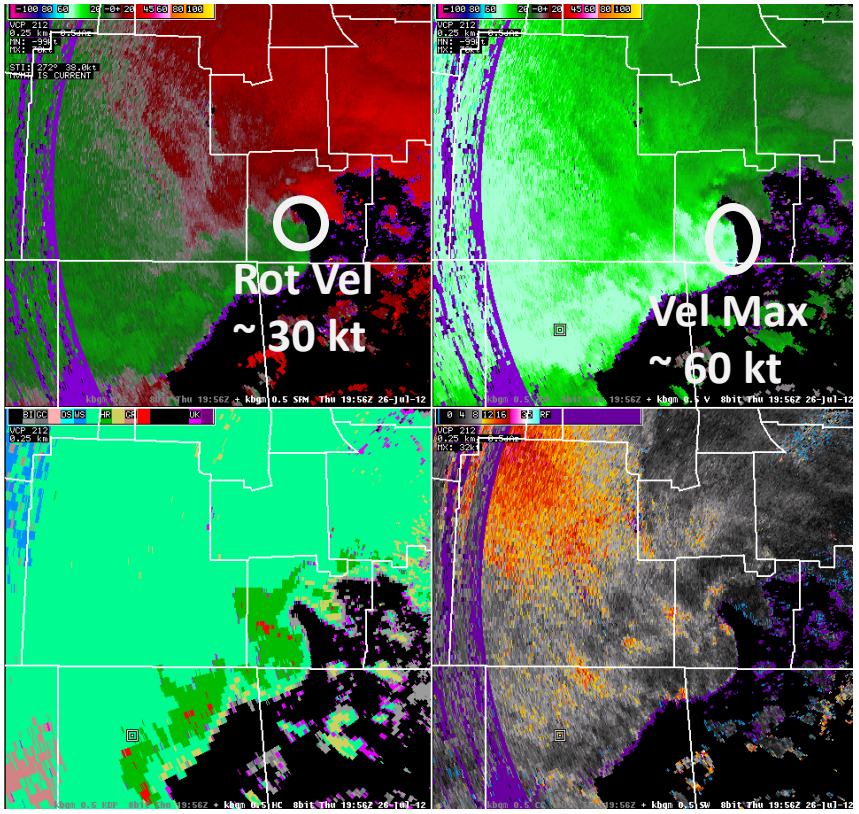


Velocity Products

SRM/V/HC/SW @ 0024z, 8/15



SRM/V/HC/SW @ 1956z, 7/26



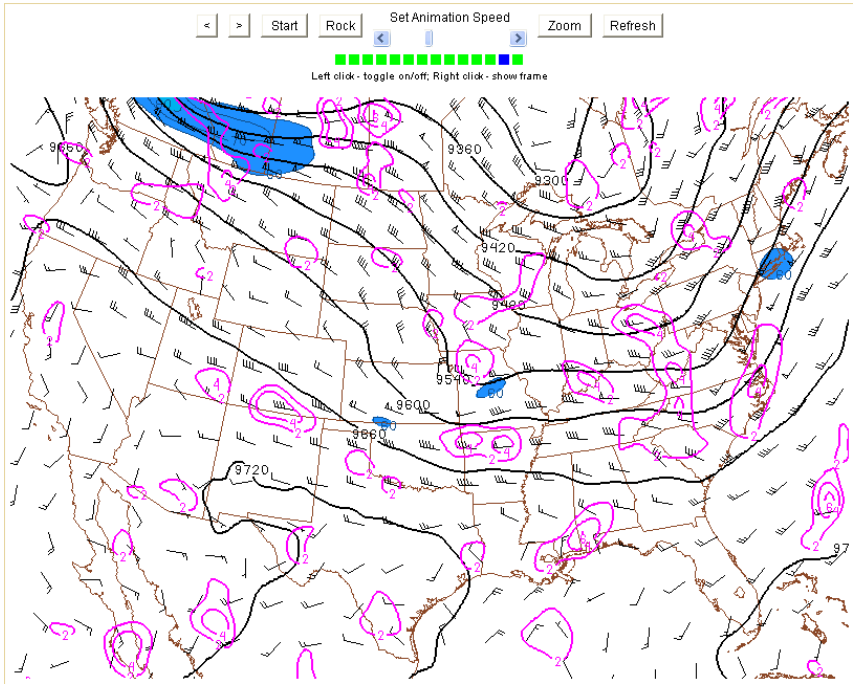
Radar Summary

- Overall, each sampled storm exhibited similar traits
  - Well defined inflow / weak echo regions
  - Vr maxima of 30-40 kt at a range of 30-40 nm
    - Moderate mesocyclones
- Newly proposed ZDR / KDP signatures showed promise in this particular comparison
  - More pronounced ZDR arc and KDP separation on 7/26, versus 8/14

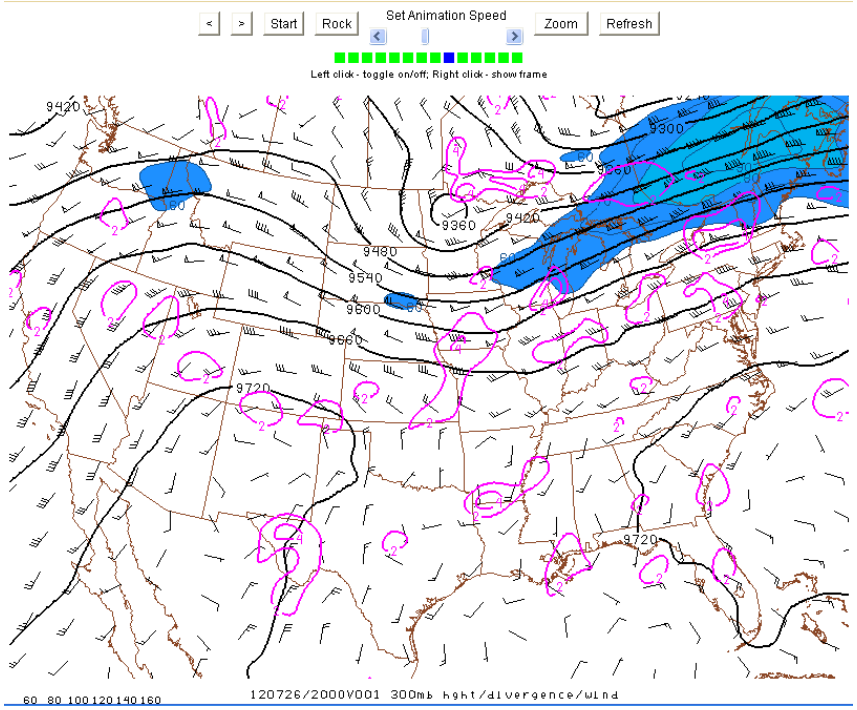
Synoptic Setting

Upper-Level (300 mb) Analyses

August 14, 2012 @ 23z

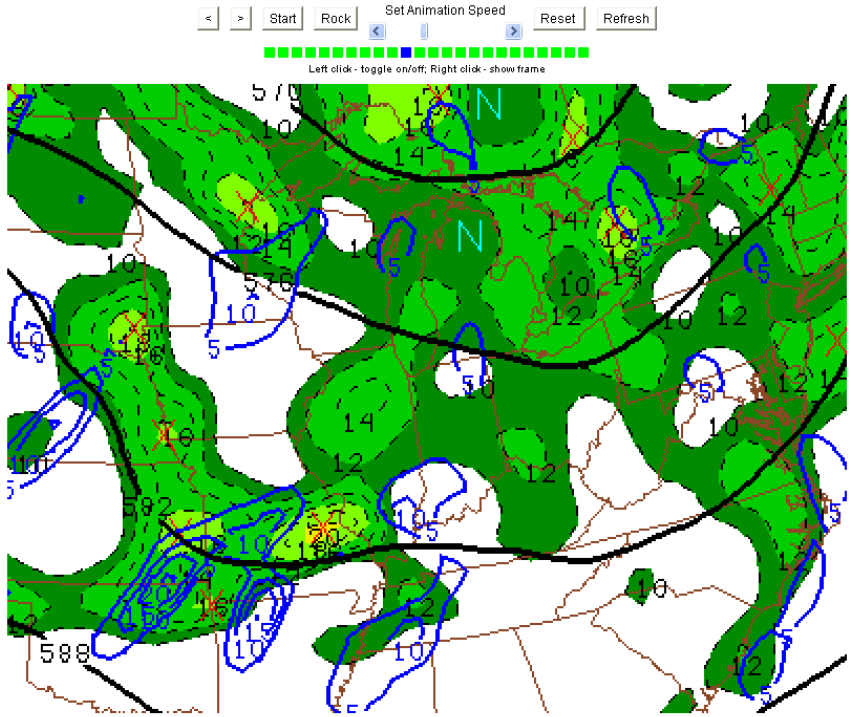


July 26, 2012 @ 20z

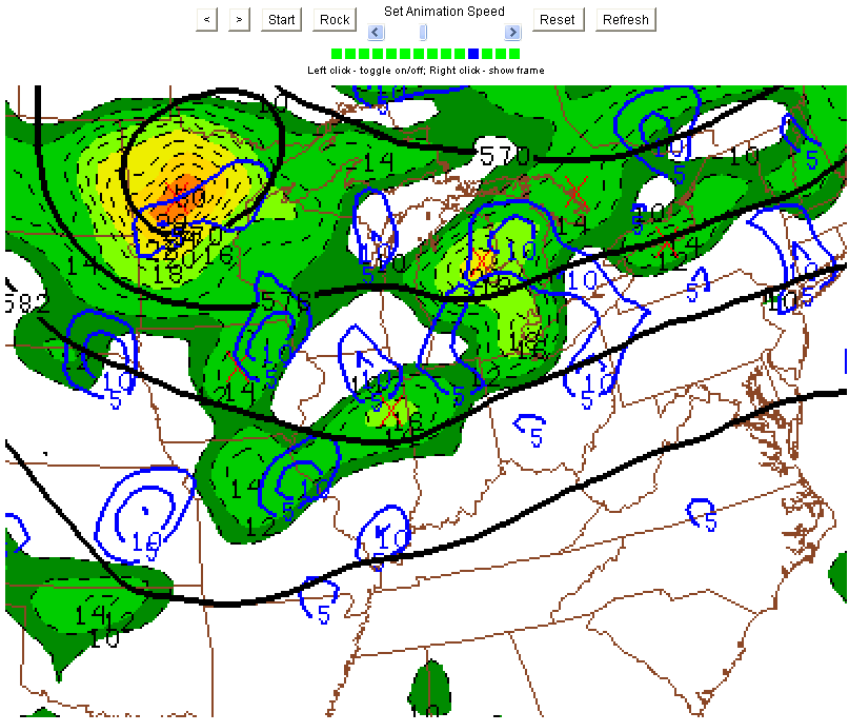


Mid-Level (700-400 mb) Analyses

August 14, 2012 @ 23z

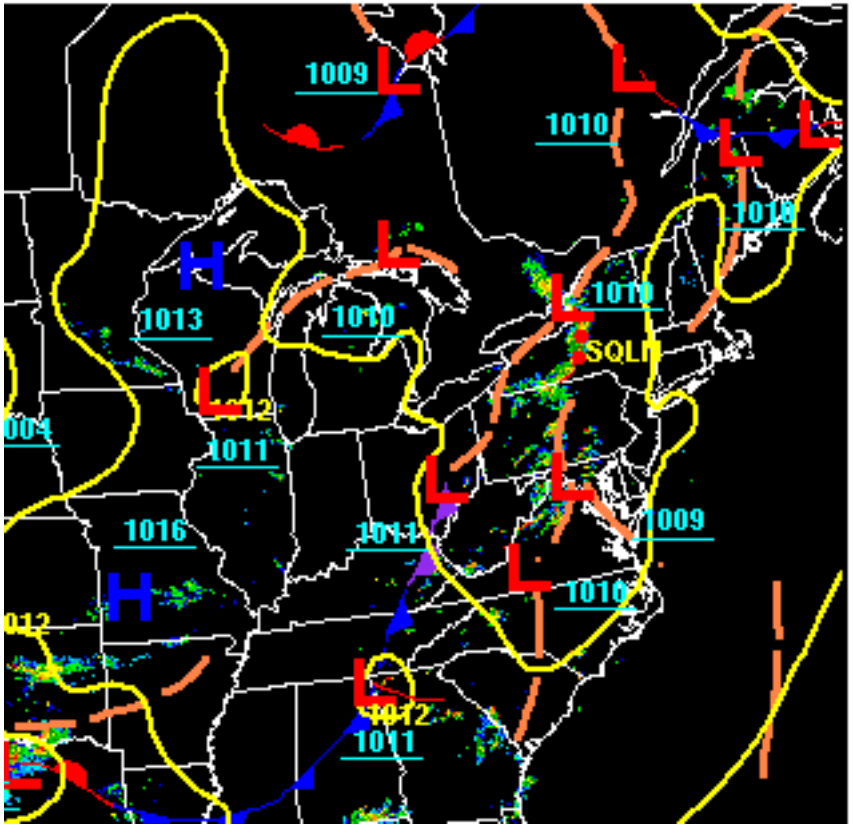


July 26, 2012 @ 20z

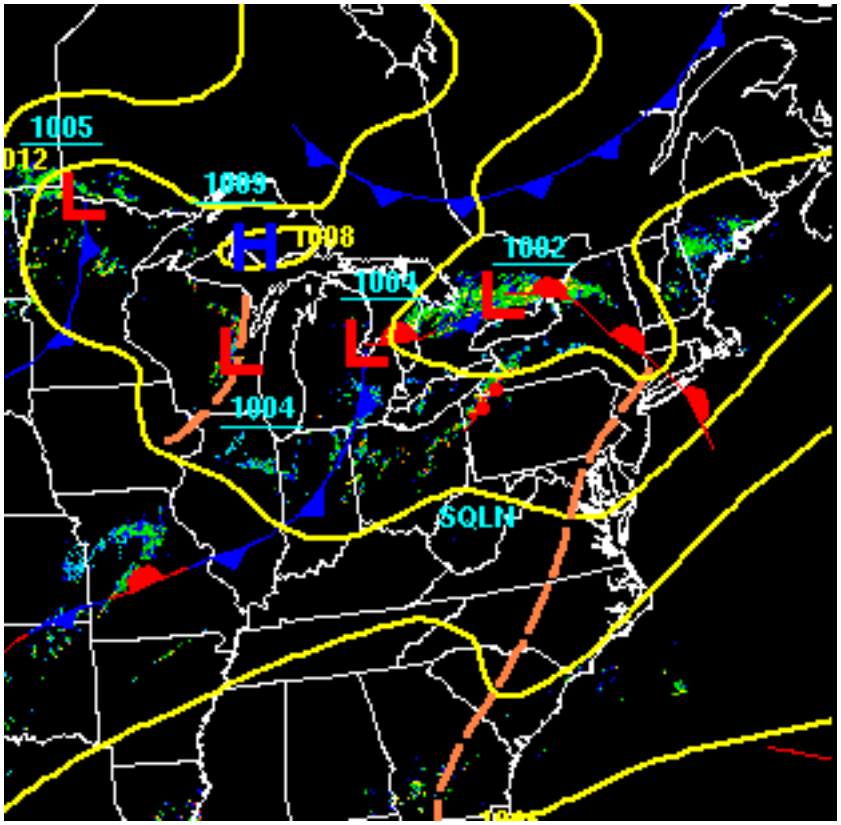


MSLP Analyses

August 15, 2012 @ 00z



July 26, 2012 @ 18z



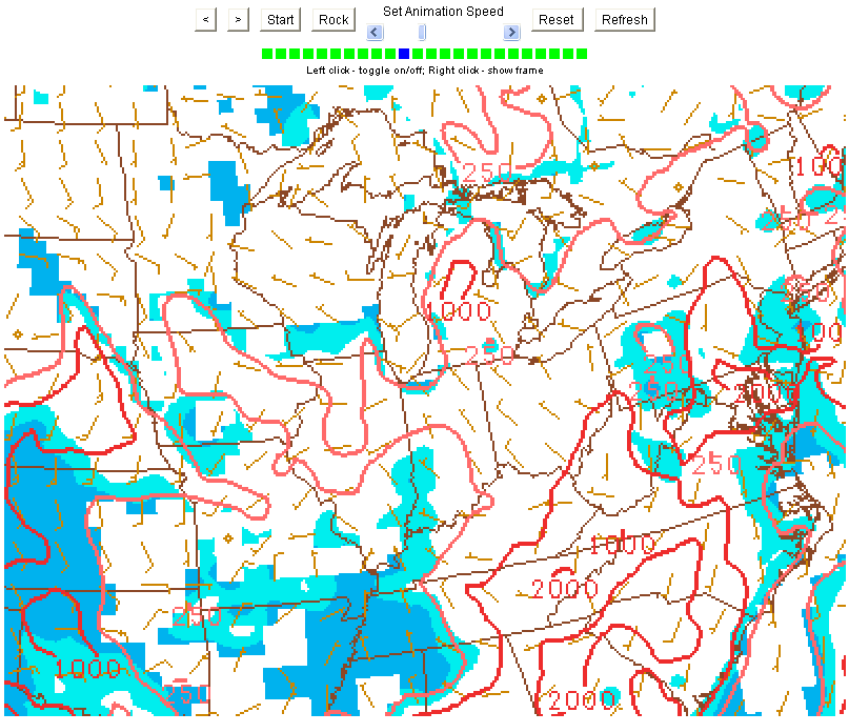
Synoptic Summary

- Stronger upper-level jet dynamics on 7/26, versus 8/14
- Both events featured flat progressive short-waves, at the southern edge of the westerlies
- In both cases, convective lines raced well ahead of weak surface fronts/troughs

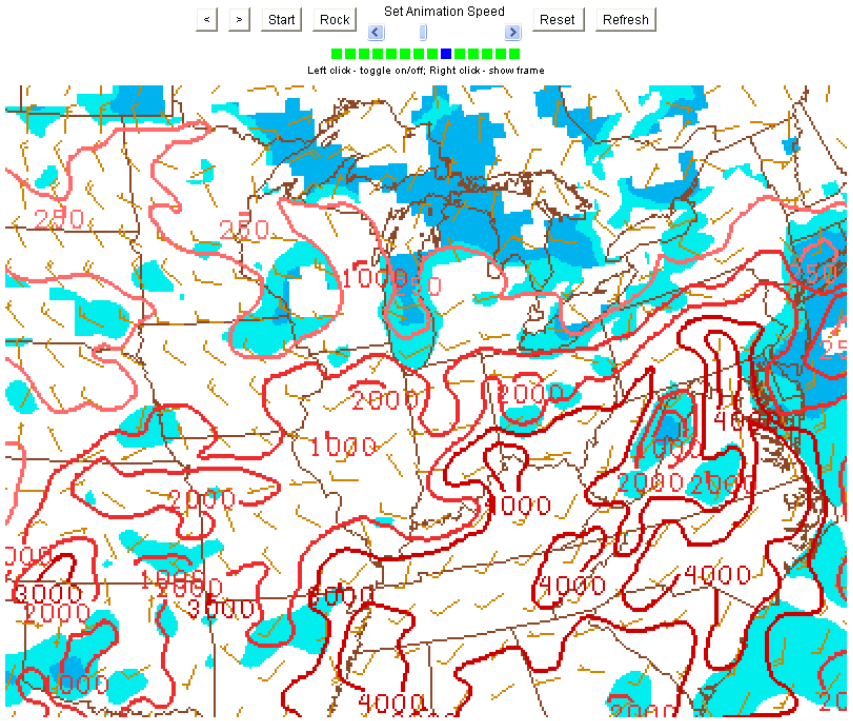
Convective Parameters

Mixed Layer CAPE

August 14, 2012 @ 23z

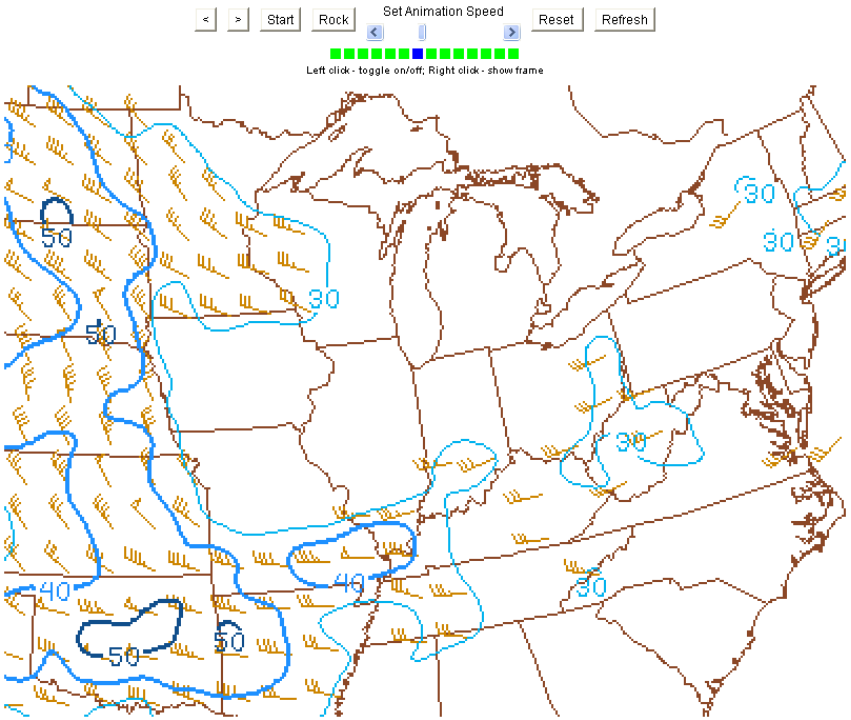


July 26, 2012 @ 19z

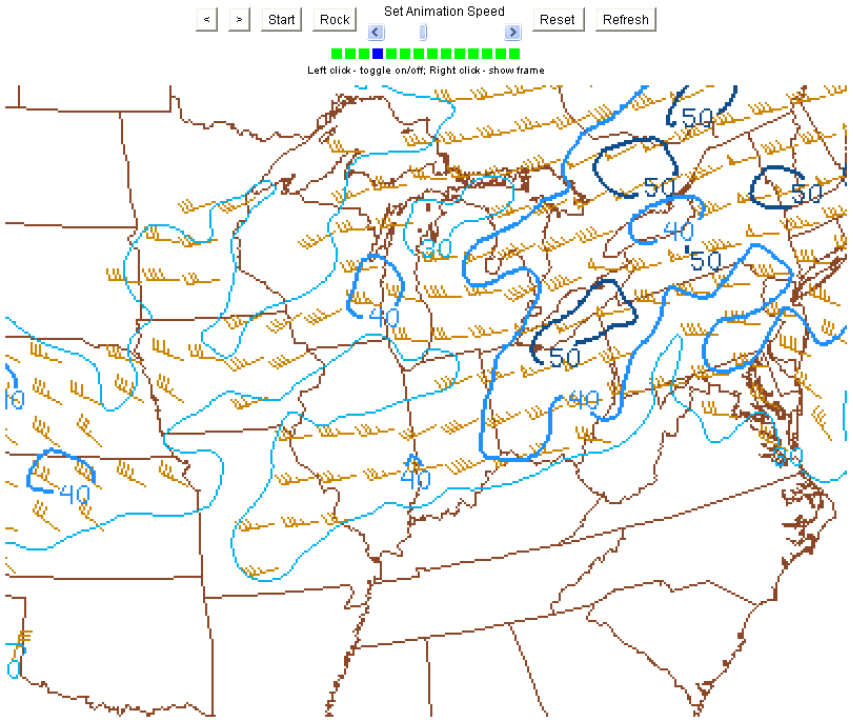


Deep-Layered Shear (0-6 km)

August 14, 2012 @ 23z

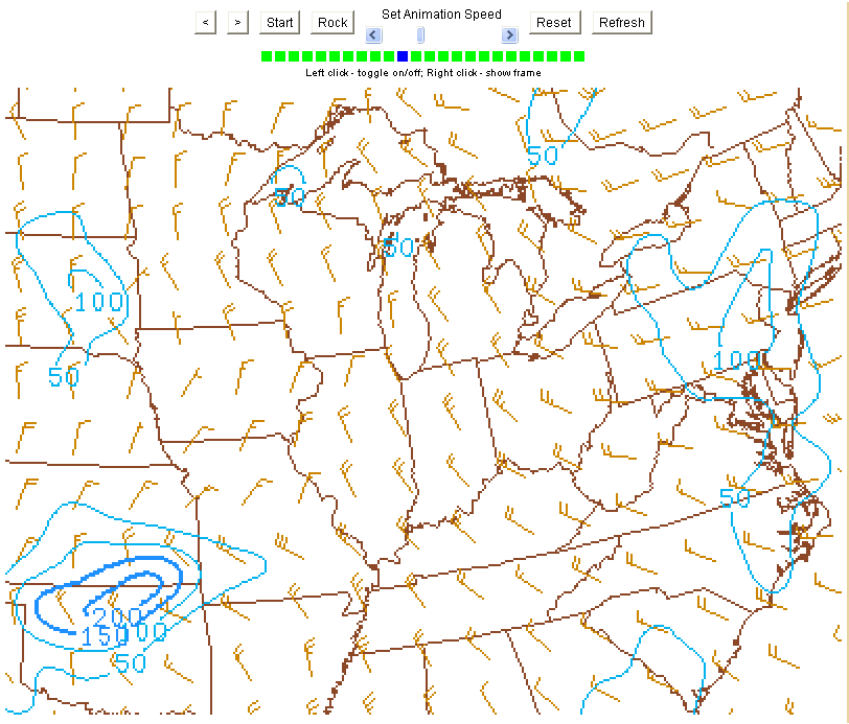


July 26, 2012 @ 19z

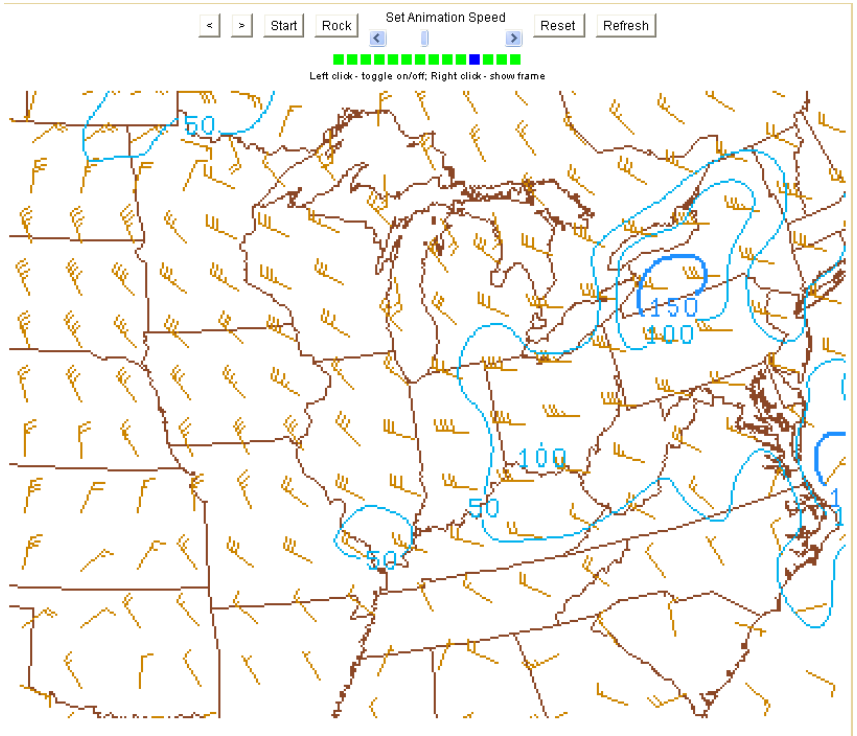


Low-Level SR Helicity (0-1 km)

August 14, 2012 @ 23z

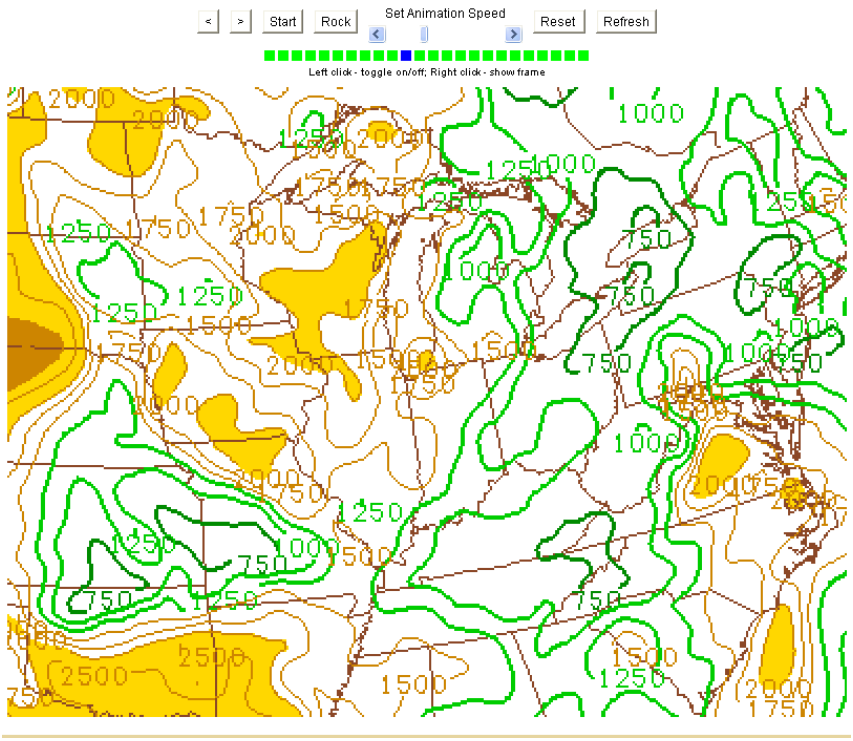


July 26, 2012 @ 19z

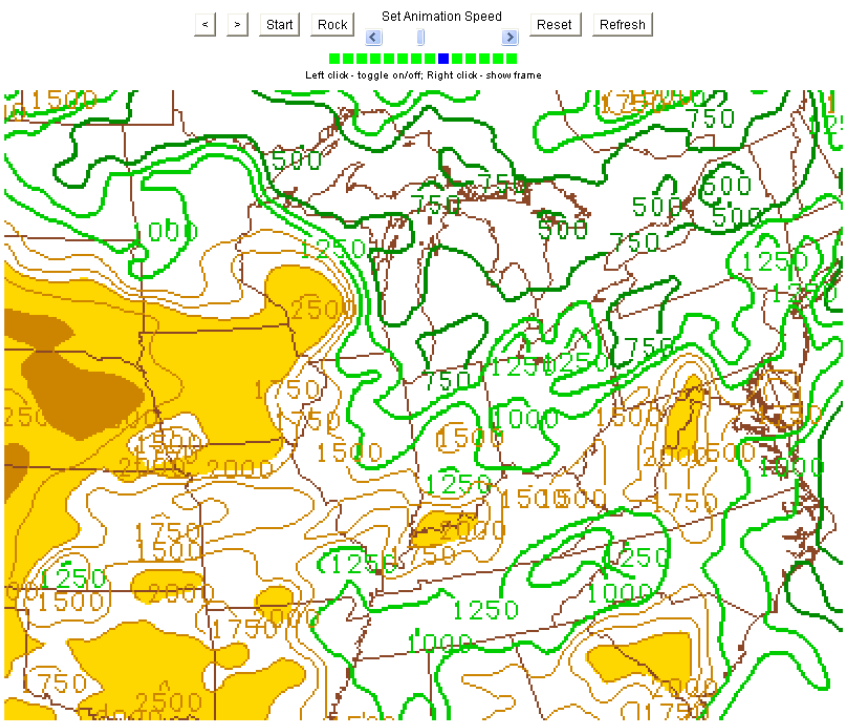


LCL Heights

August 14, 2012 @ 23z



July 26, 2012 @ 19z



Convective Environment Summary

- With regards to stability (ML CAPE) and low-level moisture (LCL Heights), each case had a very similar back-drop
- However, fairly large differences were noted in the shear profiles
  - 40 to 50 kt of shear in the lowest 6 km on 7/26, versus only around 20 kt on 8/14
  - SRH in the lowest km of about 150 m2/s2 on 7/26, versus less than 50 m2/s2 on 8/14

Past Studies of Tornadic vs. Non-Tornadic Events

SPC Study (Thompson, et al., 2003)

Percentage of Missing Ingredients

	SRH	SHR	CAPE	LCL	ND	M2	M3+
ST	.08	.03	.06	.31	.11	.14	.00
T	.18	.22	.36	.73	.22	.20	.13
SH	.25	.23	.18	.46	.26	.30	.17
H	.36	.36	.24	.48	.36	.32	.32
SW	.37	.41	.29	.45	.86	.35	.41
W	.57	.71	.14	.71	.86	.43	.57

Table 5: Percentage of missing significant tornado ingredients for each event class (sample size): ST (≥ F2 tornado, 36), T (F0-F1 tornado, 45), SH (≥ 2 inch hail, 142), H (1.75 inch hail, 25), SW (≥ 65 kt wind, 49), W (53-64 kt wind, 7). ND=non-discrete storms, M2 = missing two ingredients, and M3+ = missing ≥ three ingredients.

10^{th} and 90^{th} Percentile Threshold Values

10^{th} SRH1	10^{th} SHR6	10^{th} MLCAPE	90^{th} MLLCL
75 $m^2\ s^{-2}$	**18** $m\ s^{-1}$	**1000** $J\ kg^{-1}$	**1300** m AGL

Table 1: Significant tornado threshold percentile values for the four sounding-derived ingredients, based on T03. SRH1 = 0-1 km SRH, and SHR6 = 0-6 km bulk shear.

SPC Study (Thompson, et al., 2003)

Percentage of Missing Ingredients

Historically, *0-1 km SRH* and *0-6 km Shear* have been the *Most Reliable Indicators*

	SRH	SHR	CAPE	LCL	ND	M2	M3+
ST	.08	.03	.06	.31	.11	.14	.00
T	.18	.22	.36	.73	.22	.20	.13
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10th and 90th Percentile Threshold Values

*** For these two cases (7/26/12 and 8/14/12), *0-1 km SRH* and *0-6 km Shear* were the *Best Discriminators***

10^{th} SRH1	10^{th} SHR6	10^{th} MLCAPE	90^{th} MLLCL
75 $m^2 s^{-2}$	**18** $m s^{-1}$	**1000** $J kg^{-1}$	**1300** m AGL

Table 1: Significant tornado threshold percentile values for the four sounding-derived ingredients, based on T03. SRH1 = 0-1 km SRH, and SHR6 = 0-6 km bulk shear.

***For 0-6 km Shear*:**

- **July 26 – 40 to 50 kt**
- **August 14 – 20 kt**

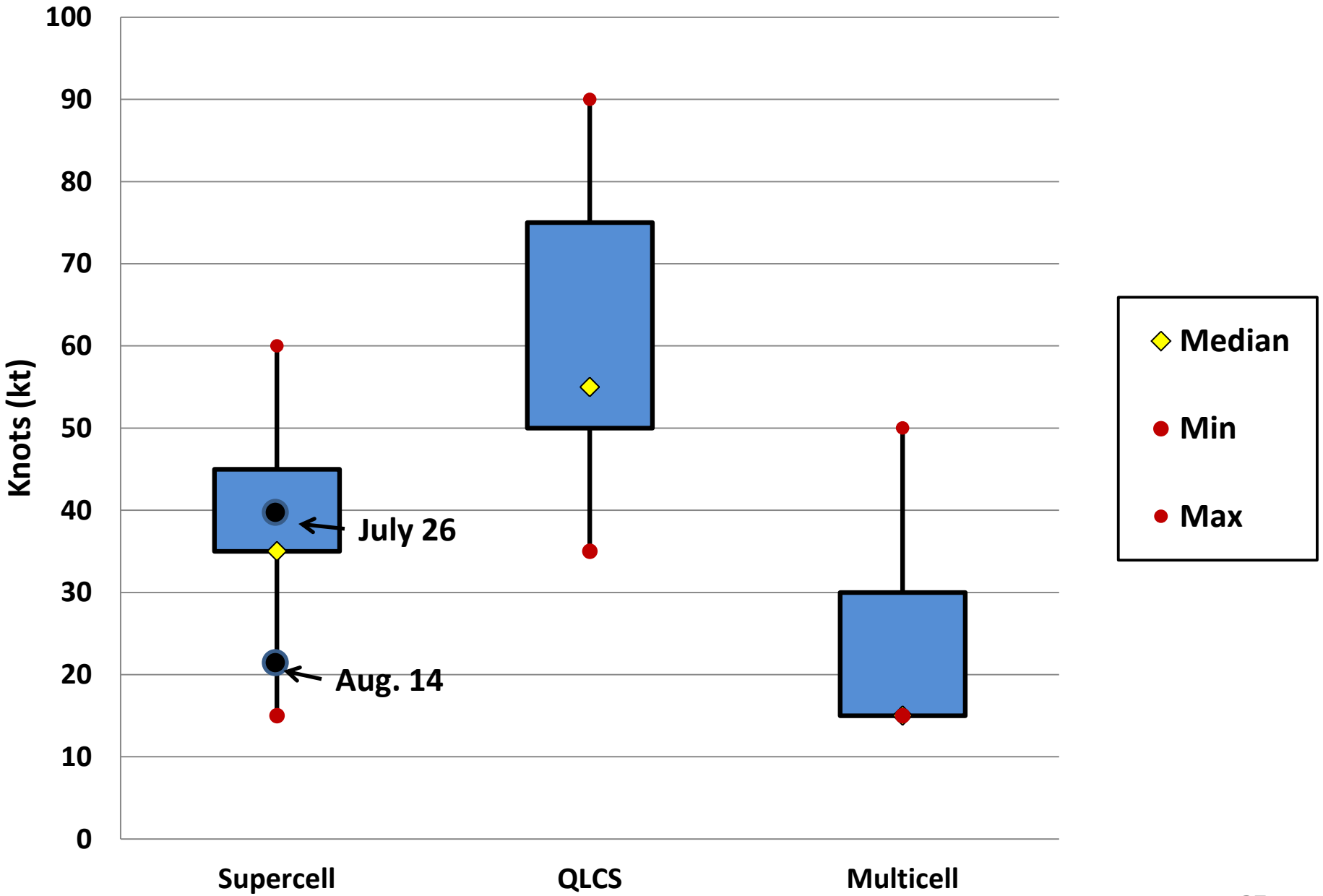
***For 0-1 km SRH*:**

- **July 26 – 150 m2/s2**
- **August 14 - <50 m2/s2**

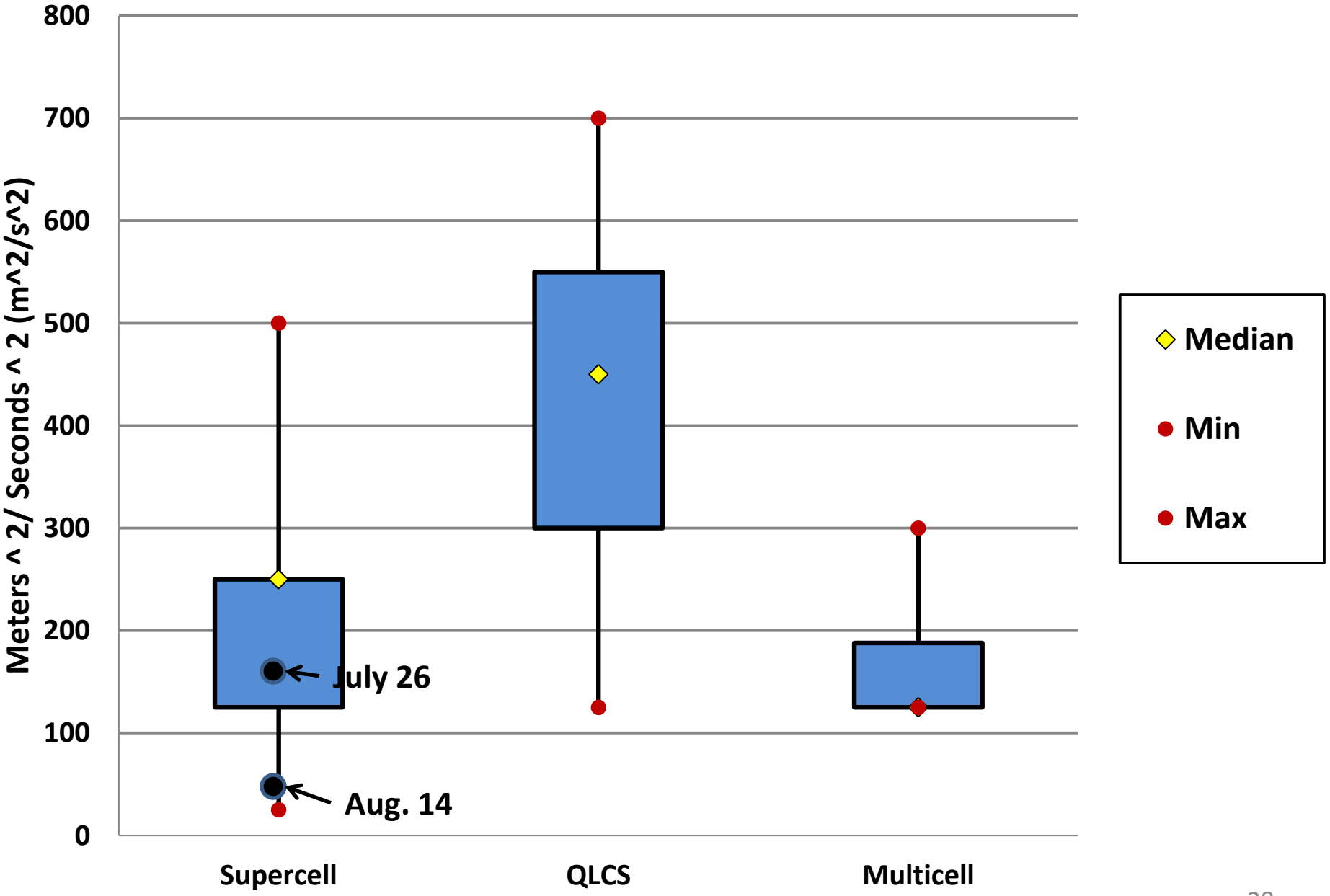
Study by Tim Humphries (Past Hollings Scholar)

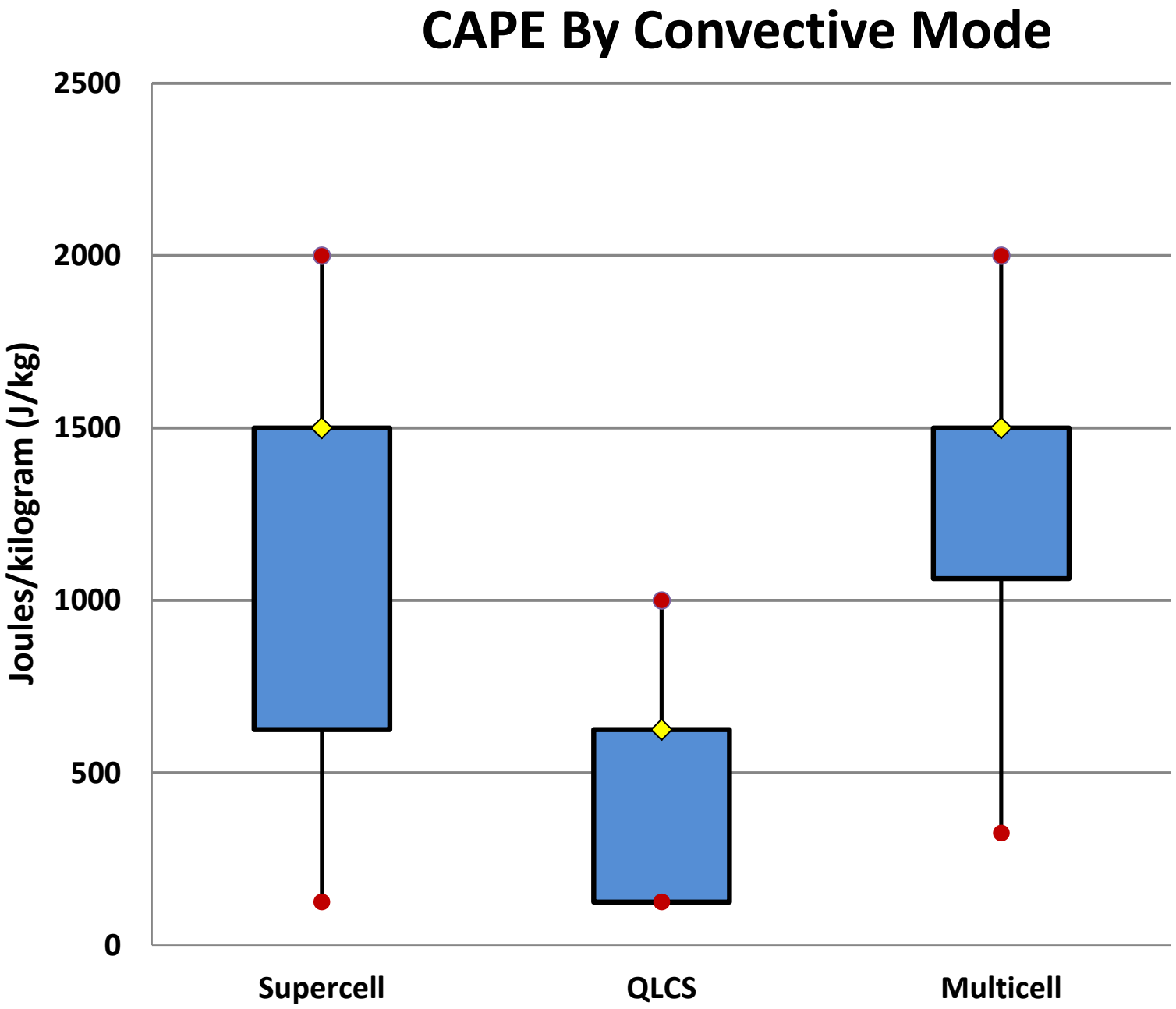
- Environments of tornadic vs. non-tornadic cases in the WFO BGM CWA
  - Low-level shear parameters were the most reliable discriminators
  - CAPE and LCL heights were less so

0 – 6 km Bulk Shear

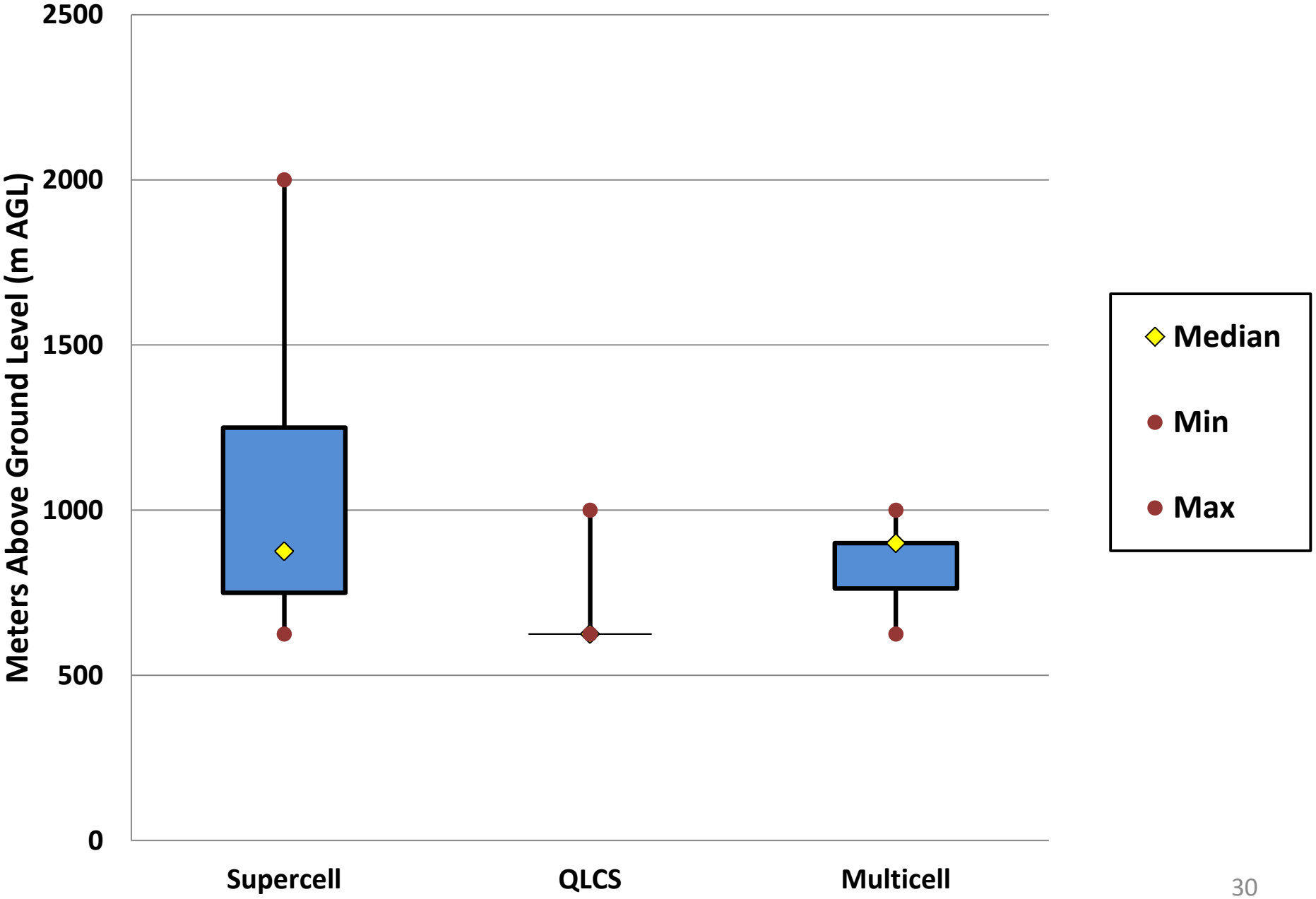


0 – 1 km Storm Relative Helicity (SRH)

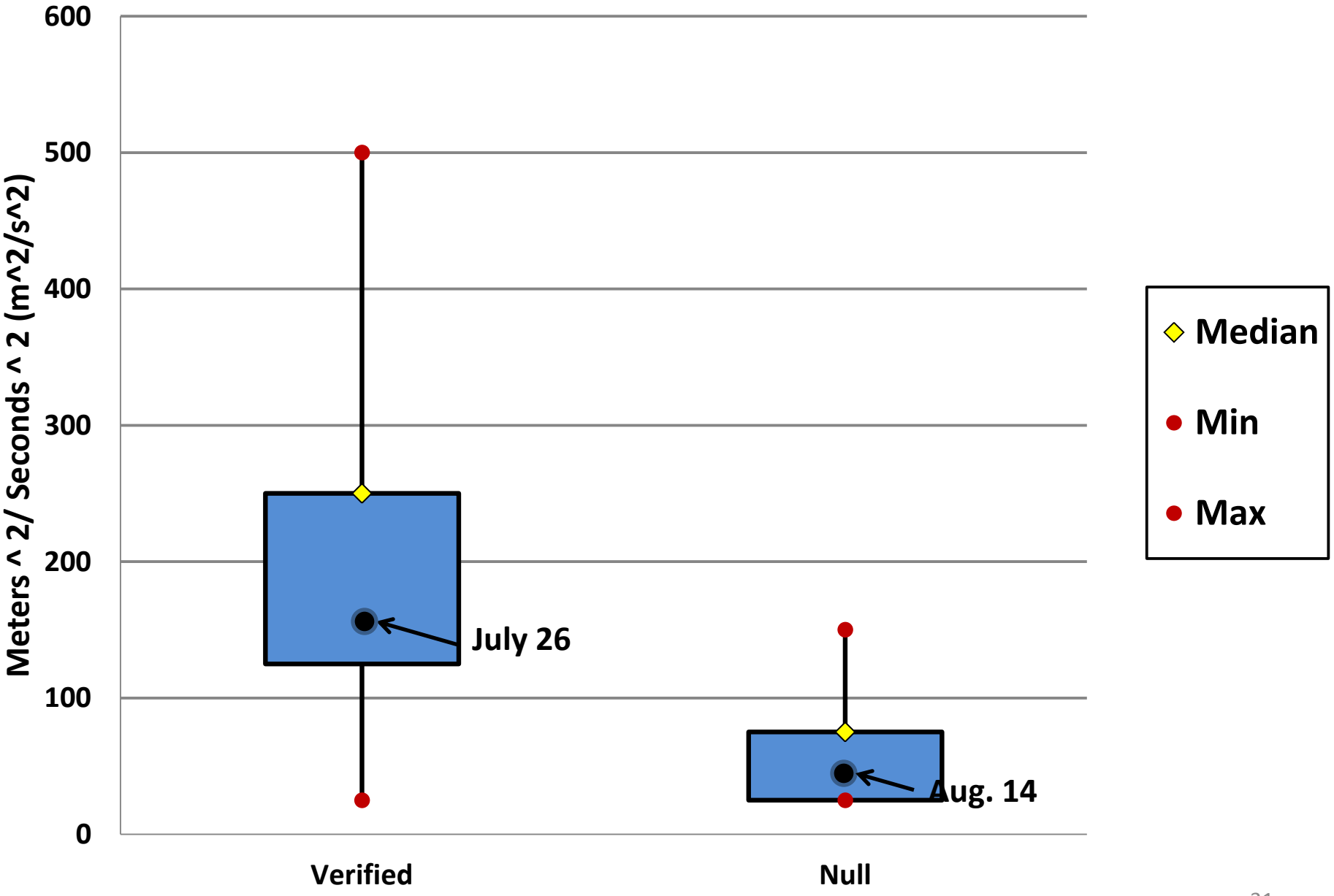



CAPE By Convective Mode
2500
2000
1500
1000
500
0
Joules/kilogram (J/kg)
Supercell
QLCS
Multicell

LCL Height


2500
2000
1500
1000
500
0
Meters Above Ground Level (m AGL)
Supercell
QLCS
Multicell
Median
Min
Max

Supercell 0 – 1 km SRH



Overall Conclusions

- The two sampled storms in this study had a very similar radar presentation
  - Strong low-level shear and WER's
  - Tornado warnings were issued for each based on WSR-88D signatures
- However, the results were vastly different
  - July 26 storm turned to be a long-lived supercell, with a number of associated tornadoes
  - August 14 storm had only sporadic wind damage, with no tornadoes

A Few Last Conclusions

- Some similarities, but also important differences noted with the synoptic setting/convective parameters
  - Jet dynamics better on 7/26, versus 8/14
  - ML CAPE (~1000) and LCL heights (< 1 km) nearly the same
  - Much stronger shear on 7/26 (0-6 km shear and 0-1 km SRH), versus 8/14
- Prior work on tornadic vs. non-tornadic settings did indeed show 0-6 km shear, and especially 0-1 km SRH to be good discriminators

The End

Questions ??