Operational Application from the 23 Nov. 2014 QLCS Tornadic Event: Persistent Regeneration of Weak Tornadoes with Pronounced Tornado Debris Signatures

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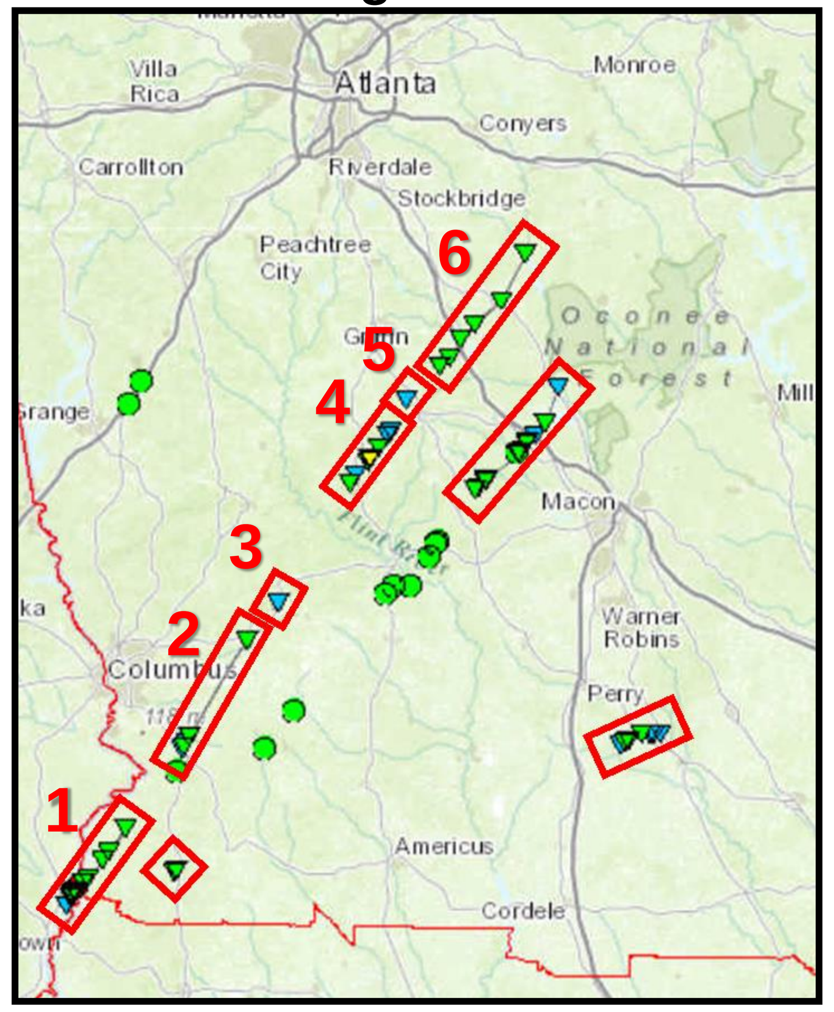
Introduction

The tornadic development across central Georgia on the afternoon of 23 Nov. 2014 was not the typical case one would expect in the Southeast U.S. for two reasons:

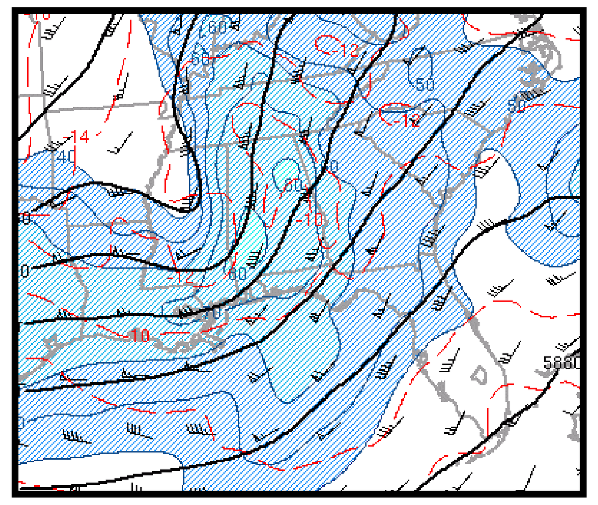
1. A persistent northern bowing segment or "broken-S" QLCS convective mode resulting six separate tornadoes
2. Pronounced tornadic debris signatures (TDS) seen with five of the six tornadoes, some of which lofted debris to a significant height above the ground more than previously documented with weak tornadoes (Banghoff and Nelson, 2014)

The near storm environment and trends in cell intensity and evolution were analyzed to distill possible operational utility for improving enhanced wording in future warning scenarios.

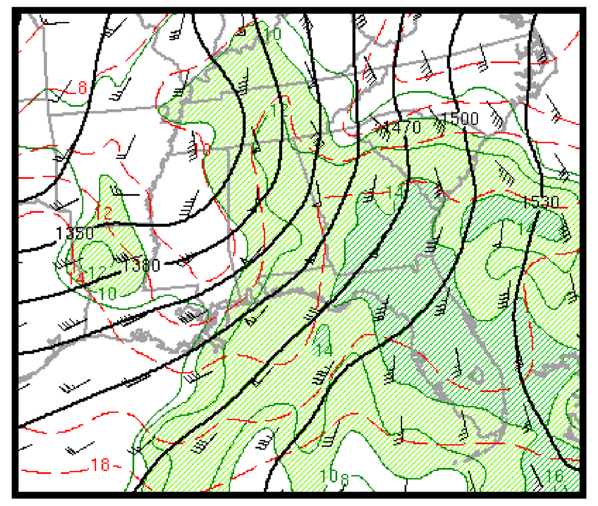
Surveyed Tornadoes & Damage Points



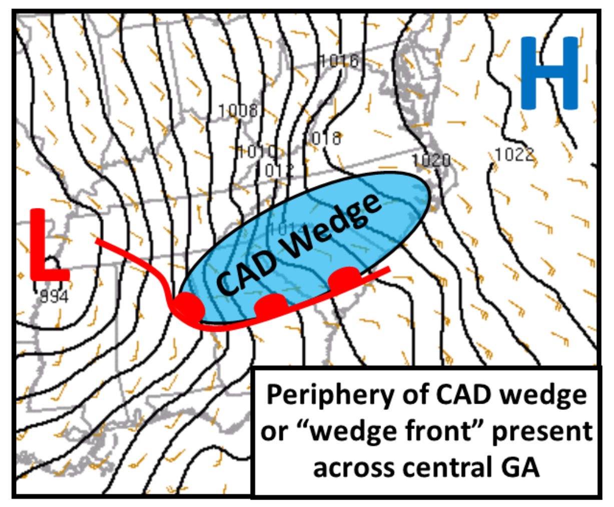
Synoptic Setup and Storm Environment



Negatively titled upper shortwave trough tracked NE across the Southeast



Attendant low pressure system advected moisture off northern Gulf of Mexico

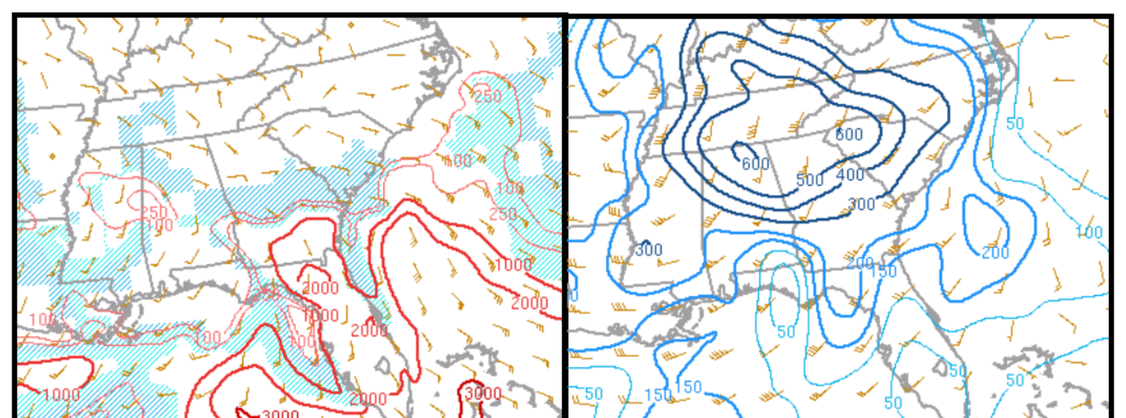


Parent high set up hybrid cold-air damming (CAD) along eastern slopes of Appalachians

Combination of wedge and approaching system provided high shear low CAPE (HSLC) environment for convective development

Special 18z TLH Sounding

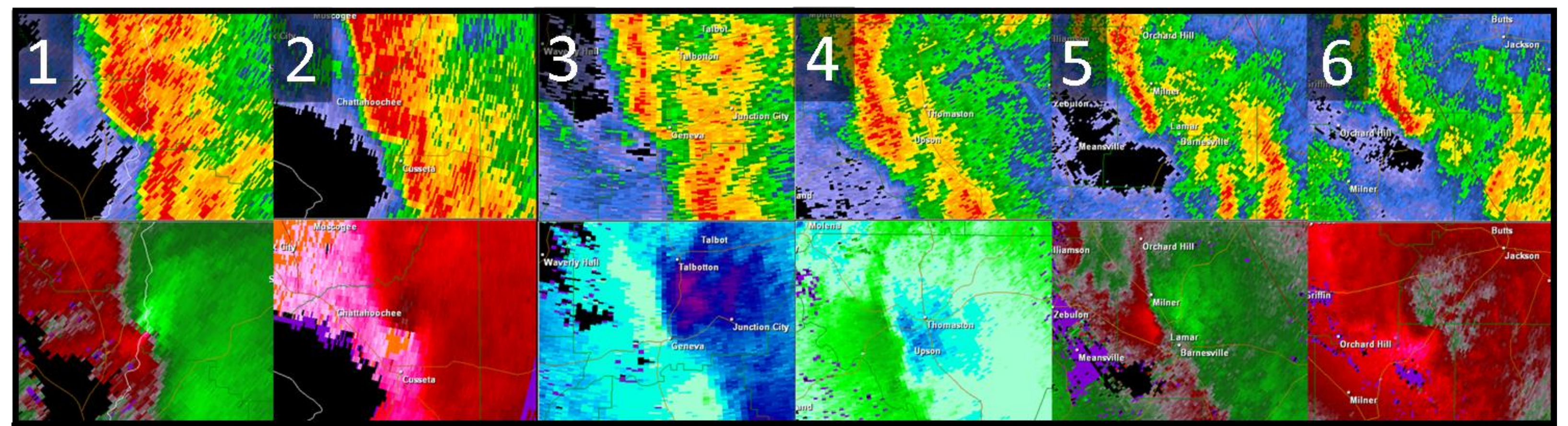
SBCAPE	377 J/Kg	0-1 km SRH	211 m2/s2
SBCIN	-49 J/kg	0-6 km Bulk	47 kts
MLLCL	596m	SCP	4.6
MLLFC	1166m	STP (eff layer)	0.7



SBCAPE (J/Kg contour), SBCIN (shaded) | 0-1 km SRH (m2/s2), Storm motion (kts)

Trends in Tornadic Cell Intensity and Evolution

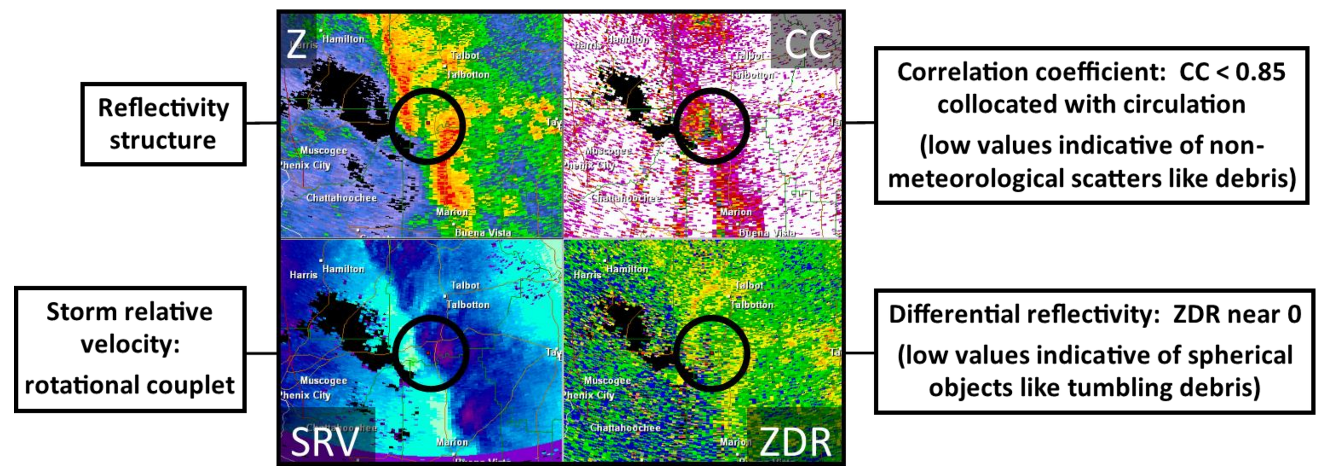
Persistent regeneration of six tornadoes below was observed to consistently occur along wedge front as it rapidly retreated NEWD across central Georgia.

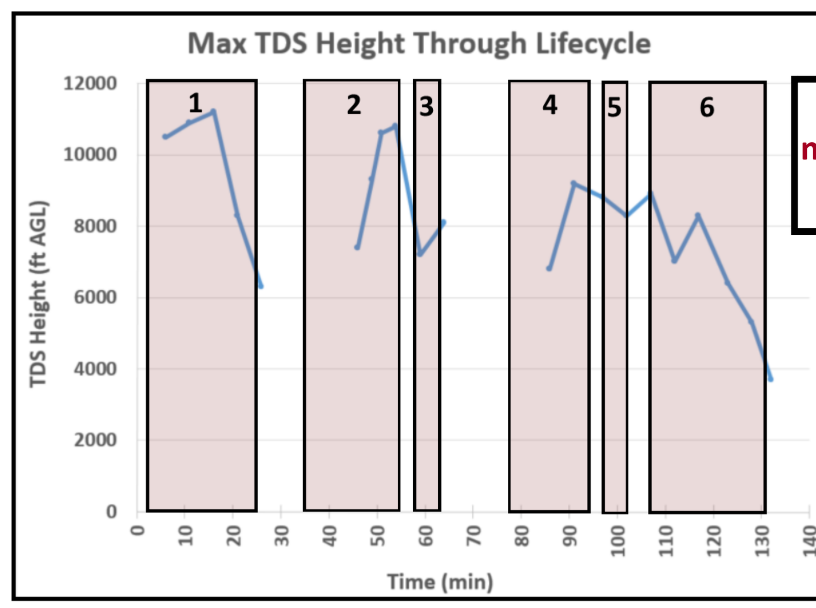


1	2	3	4	5	6
EF1 - 110 mph	EF1 - 107 mph	EF0 - 80 mph	EF2 - 130 mph	EF0 - 82 mph	EF1 - 100 mph
16.7 miles long	18.1 miles long	3.2 miles long	11.0 miles long	1.4 miles long	21.6 miles long
400 yd wide	75 yd wide	50 yd wide	200 yd wide	70 yd wide	100 yd wide
24 min	20 min	4 min	16 min	4 min	25 min

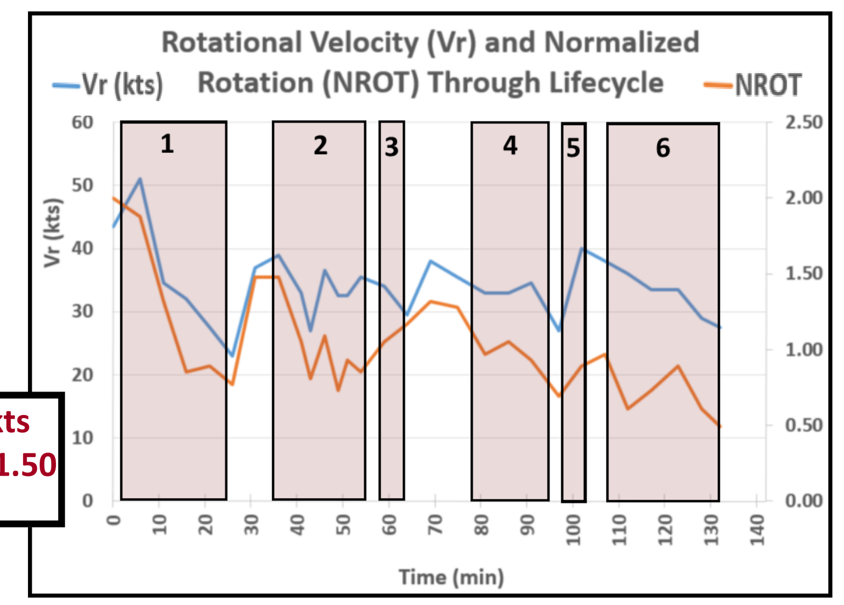
Avg. Duration: **15.5 min**, Avg. Between: **7.6 min**

Dual-polarization radar data were analyzed for each of the tornadic cells to assess cell strength and max TDS heights (used GR2Analyst).





TDS Height mainly in 6-11 kft range



Vr: 30-40 kts NROT: 0.80-1.50

Much of this data were also analyzed during the event in real-time to assist in enhanced wording of the tornado warnings (prior to implementation of Impact-Based Warning (IBW) wording.

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AT 310 PM EST...NATIONAL WEATHER SERVICE METEOROLOGISTS CONFIRMED A
TORNADO BEING TRACKED ON RADAR. EXTREMELY STRONG ROTATION WAS SEEN WITH
THIS STORM AND MAY BE A SIGNIFICANT AND OR STRONG TORNADO. THIS TORNADO LOCATED
NEAR LAKEPOINT RESORT STATE PARK...OR 11 MILES NORTH OF GEORGETOWN...
MOVING NORTHEAST AT 45 MPH.
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AT 411 PM EST...NATIONAL WEATHER SERVICE DOPPLER METEOROLOGISTS CONTINUE
TO DETECT A TORNADO THAT HAS LOFTED DEBRIS FROM CAUSING PREVIOUS DAMAGE.
THIS DANGEROUS TORNADO WAS LOCATED OVER TALBOTTON...MOVING NORTHEAST AT 50 MPH.
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Discussion

It is proposed that the wedge front provided a nearly steady source of low level streamwise vorticity available for tilting into the vertical within the convective updraft as subsequent downdrafts instigated persistent tornadogenesis by bringing vorticity to the surface. Presence of the front thus compensated for the lack of surface based instability in the HSLC environment and helped focus tornadic development. This serves as an extension to previous research on wedge front influence in conversely *low* shear *high* CAPE environments (portrayed in this adapted figure from Baker and Lackmann, 2009).

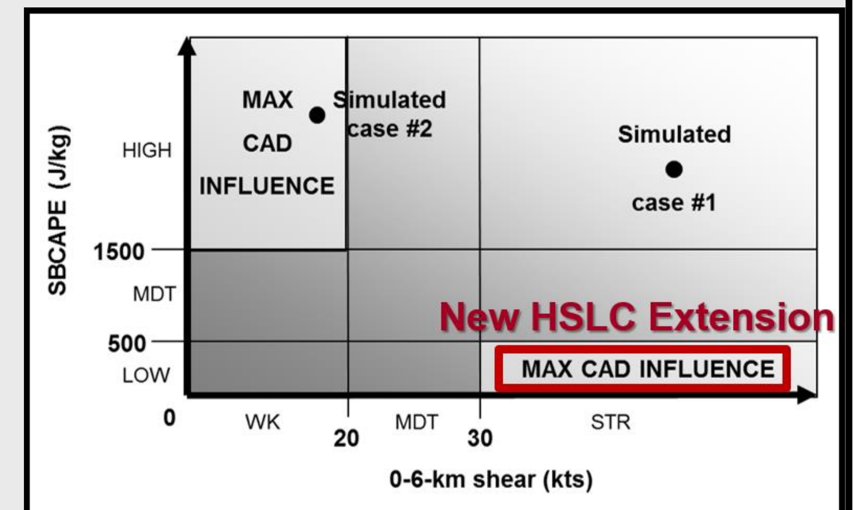
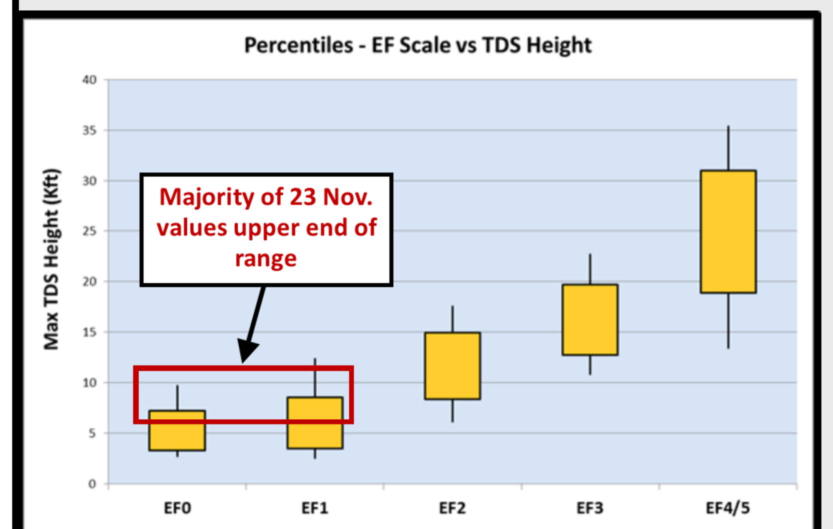


Figure 16. Proposed conceptual scenario of upstream atmosphere for wedge front to be more significant with triggering strong rotating convection (situations either with (1) high SBCAPE or MUCAPE and weak 0-6-km shear or with (2) high shear and low CAPE). Black circles represent the stratification of the CAPE and shear environments associated with the cases simulated in this study relative to the speculated favorable situation. Black arrows show increasing amounts of SBCAPE including low, moderate (MDT), and high, and increasing amounts of deep-layer shear including weak (WK), moderate (MDT), and strong (STR).



The analyzed TDS heights primarily stayed in a 6-11 kft range, which is more common to the significant EF2 category observed with previous research (Entremont and Lamb, 2013). While the surveyed tornadoes in this event mainly fit in the weak EF0-EF1 categories, it is proposed that such anomalously high TDS heights were due to the presence of abundant fall foliage and lofted leaf debris combined with subsequent tornadic updraft regeneration.

Conclusion

Trends in observed radar data and associated near-storm environment from this particular case provide unique utility in operations. The findings not only extend the proposed effect of wedge front influence on convection in HSLC environments, but also present an upper bound of TDS height correlation to tornado strength during the fall season. This provides aid to awareness and enhanced wording in warning decisions. Warning operators could justify a seasonal adjustment to the threshold for tornado damage threat tags with the newly implemented IBW structure.

NWS Atlanta IBW Decision Aid for Tornado Threat Tags

EF Scale	Vrot (kts) Rotational Velocity	NROT	TDS Height (ft AGL)	Tornado Damage Threat Tag (Intensity)
EF0-EF1	30 - 44	0.9 - 1.5	< 10,000	NONE (weak)
EF2-EF3	>45	>1.5	10,000 to 18,000	Considerable (strong)
EF4-EF5	>75	>2.2	> 18,000	Catastrophic (violent)

* Could be raised for fall season

References

Baker and Lackmann, 2009: Convection and Appalachian Cold-Air Damming. Masters Thesis, North Carolina State University.

Banghoff and Nelson, 2014: Analysis of Polarimetric Tornado Debris Signatures Observed by WSR-88D Associated with Significant Tornadoes. NWA 39th Annual Meeting, Salt Lake City, UT.

Entremont, C. and Lamb, 2013: Relationship Between Tornado Debris Signature (TDS) Height and Tornado Intensity. Southeast Severe Storms Symposium, Mississippi State University.