The August 2, 2020 tornadic supercell in Connecticut

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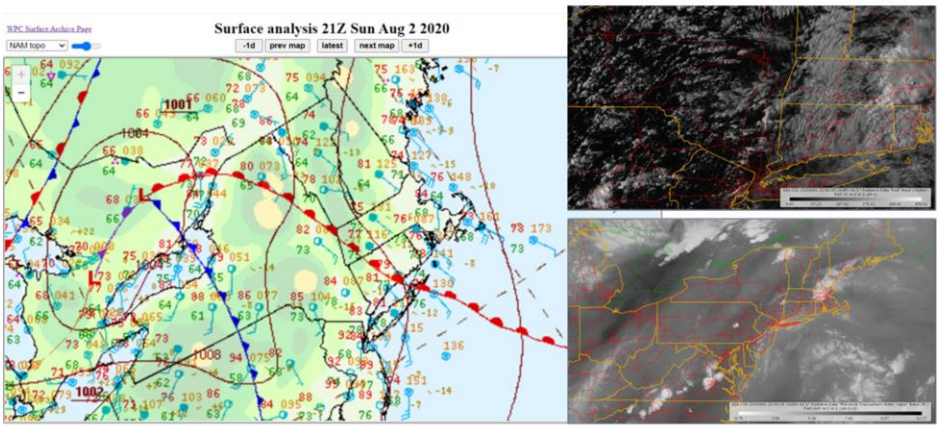
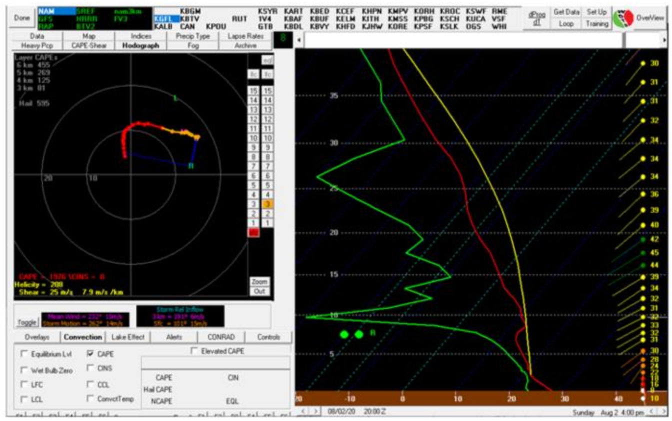
Surface plot and satellite images



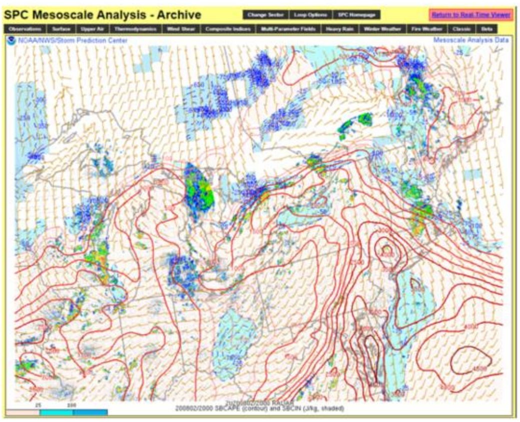
This slide shows a surface analysis at 21 UTC, just prior to the occurrence of 4 tornadoes in western New England. A surface warm front was analyzed from northern New York south-southeast to southern Connecticut, and a cold front was analyzed over central New York. Temperatures southwest of the warm front were in the mid 80s, with dew points in the 70s. East of the warm front, temperatures were in the 70s, with dew points also in the 70s. The visible satellite image on the right shows that the warm front was associated with a cloud boundary, with clouds east of the front covering much of New England, while mainly clear skies can be seen farther west over eastern and central New York. The water vapor imagery in the lower right shows a significant short wave, associated with darker region, approaching New York from the west, however no significant short-wave energy can be seen to east across eastern New York or New England.

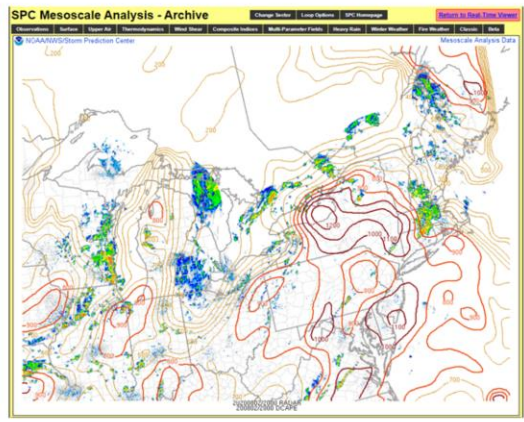
NAM forecast sounding at POU valid 20z



The NAM forecast sounding valid at Poughkeepsie, NY at 20z shows a moderately strong, veering wind profile with a long, anticyclonically curved hodograph. A weak cap can be seen around 10000 feet, with moderately steep lapse rates above and below the cap.

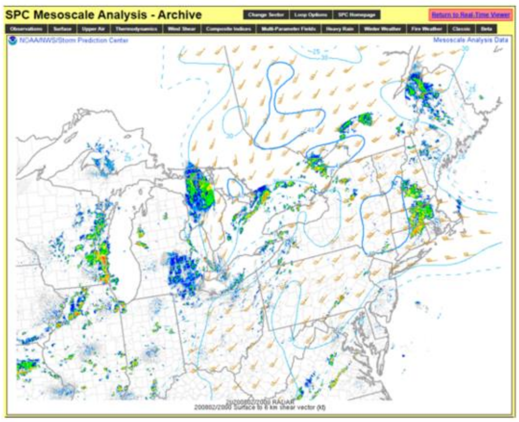
SPC meso-analysis – SBCAPE and DCAPE – 20z

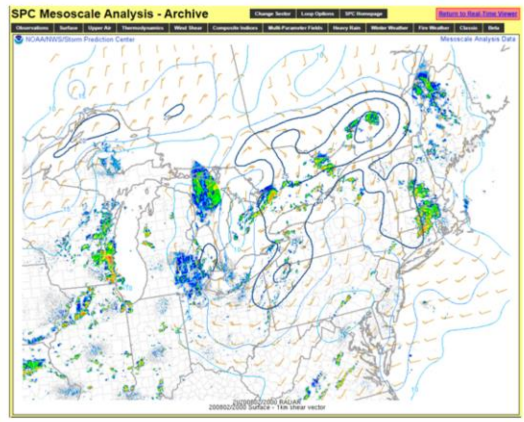




SPC meso-analysis at 20z showed surface-based CAPE values as high as 4000 J/kg over the lower and mid-Hudson valley southwest of the warm front. Downdraft CAPE values were near to just above 1000 J/kg. These CAPE values indicated a moderately unstable atmosphere in the warm sector west of the warm front. CAPE values rapidly diminished east of the warm front, however some modest instability can be seen as far east as eastern Massachusetts.

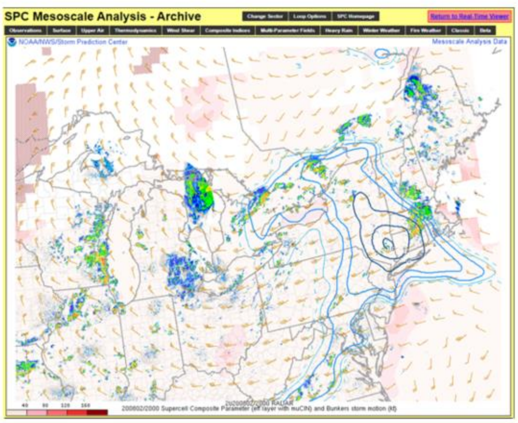
SPC meso-analysis – shear – 20z

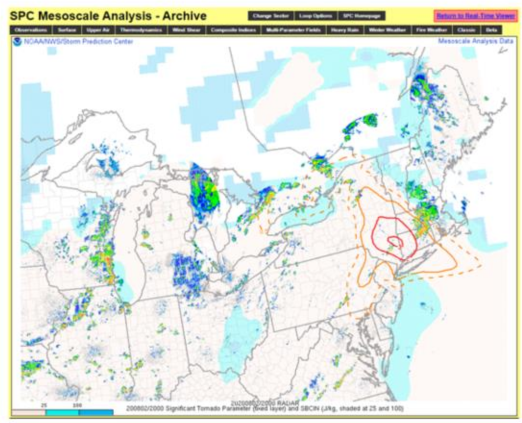




Deep layer wind shear values were around 40-45 kts over southeast NY and southwest New England, with 0-1 km shear values around 25 kts.

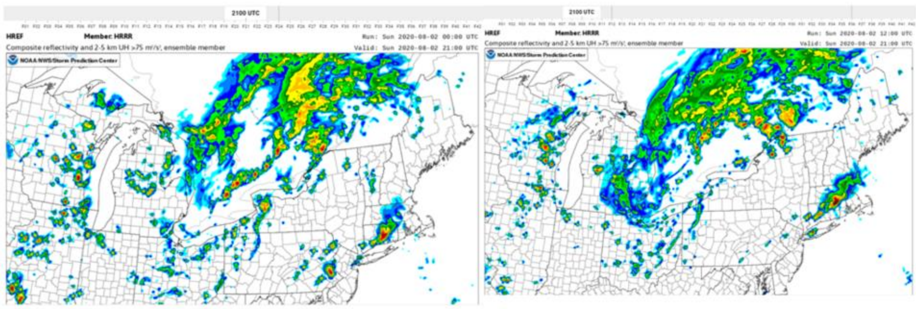
SPC – meso-analysis – Supercell and sig tor composites – 20z





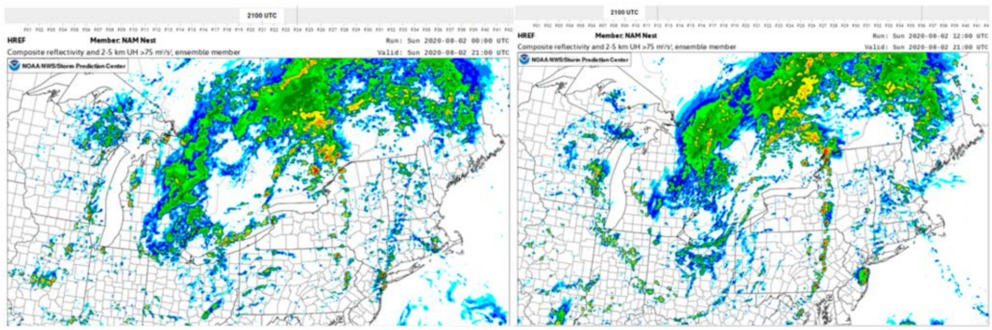
Composite indices indicated an enhanced potential for supercell development and significant tornadoes over the area from the mid-Hudson Valley into southwest New England.

00z and 12z HRRR reflectivity valid 21z



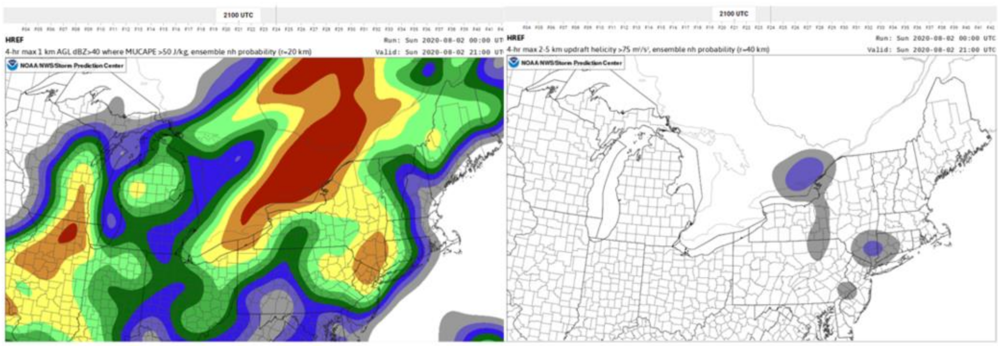
HRRR runs indicated the potential for a discrete cell over southern New England during the afternoon on the 21st. Overall coverage across the region was forecast to be low.

00z and 12z NAM nest reflectivity valid 21z



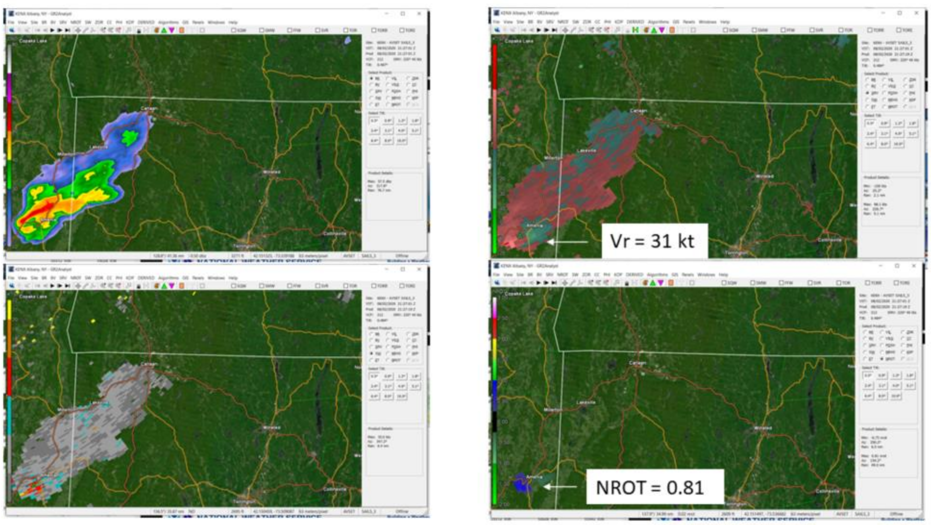
The NAM nest was only forecasting the development of weak cellular convection across New England.

00z HREF probability of 50 dbz reflectivity and 2-5 km helicity > 75 m2/s2 valid at 21z



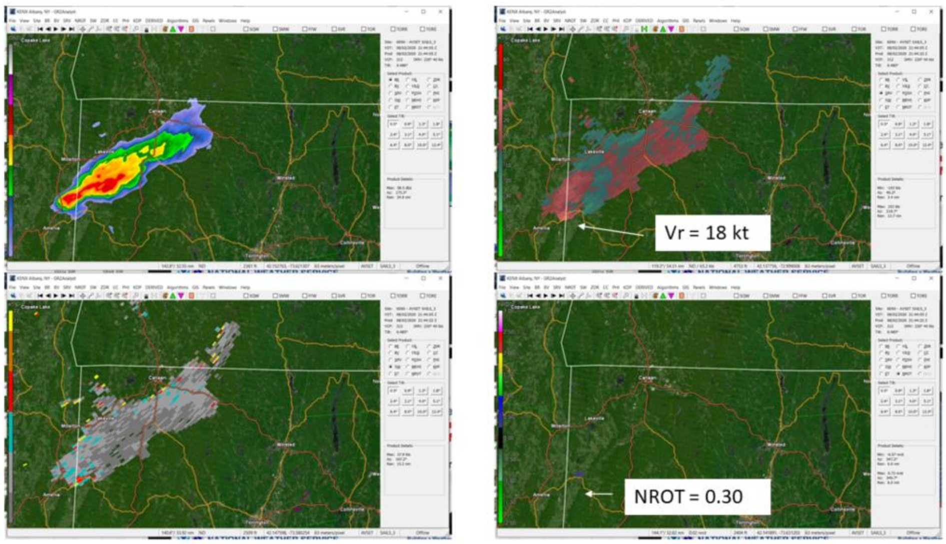
The HREF, composed of several high resolution model forecasts, indicated an enhanced chance of rotating convection over southeast NY and southwestern New England at 21z (based on enhanced probabilities for 50 dbz reflectivity, and 2-5 km helicity > 75 m2/s2.

2127 UTC - 10 minutes before the first tornado



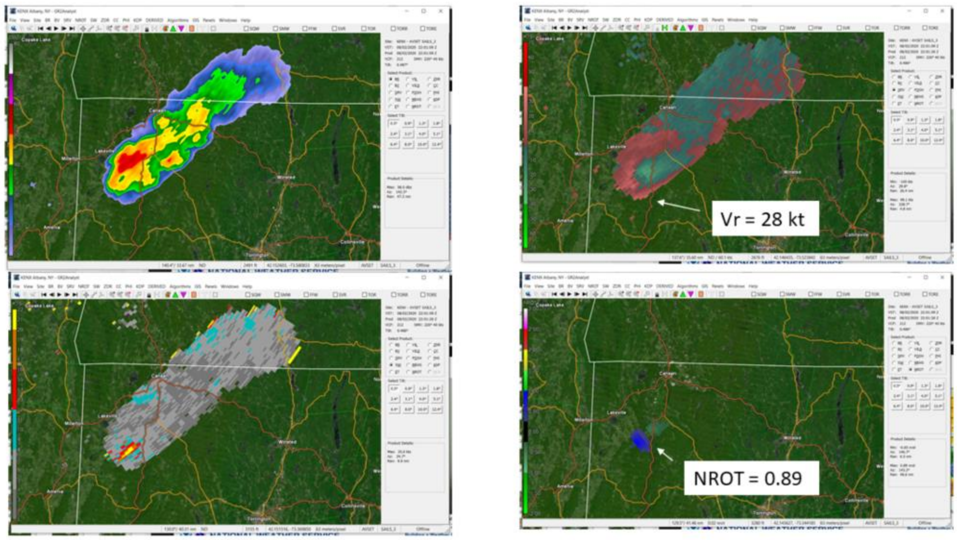
The next several slides show the evolution of a small supercell storm that developed over the mid-Hudson Valley and tracked northeast across northwest Connecticut between 2100 UTC and 2300 UTC. The variables plotted on the next several slides are 0.5 degree reflectivity (upper left), 0.5 degree storm relative velocity (upper right), 0.5 degree spectrum width (lower left), and 0.5 degree normalized rotation calculated by the GR2 Analyst software (lower right). At 2127 UTC, this storm was already exhibiting moderately strong rotation at around 4000 feet AGL, which was the lowest scan for which data was available.

2144 UTC First tornado is on the ground



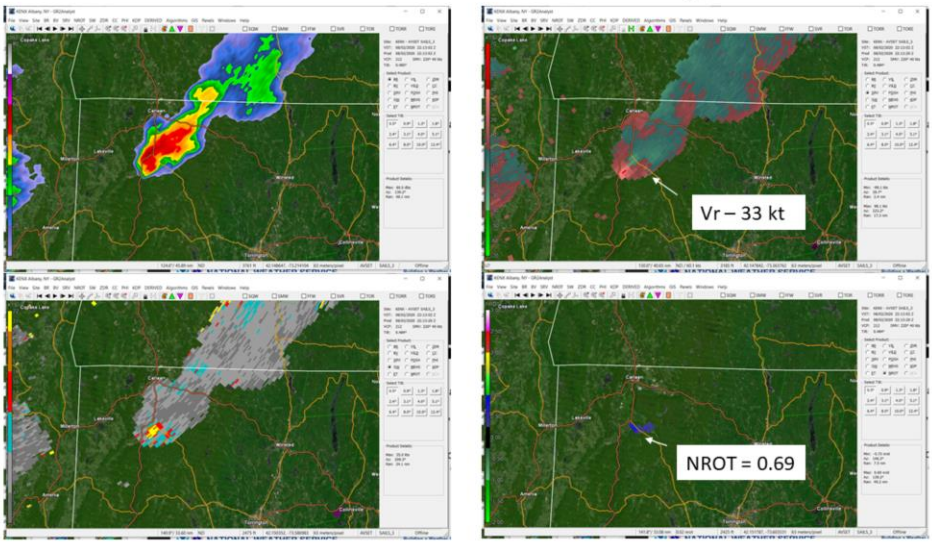
At 2144 UTC, the first in a series of weak tornadoes with this storm was on the ground over northwest Connecticut. Radar-sampled rotation had weakened considerably at that time, implying that the most significant rotation was well below the height of the radar beam at this time.

2201 UTC - 8 minutes before the 2nd tornado



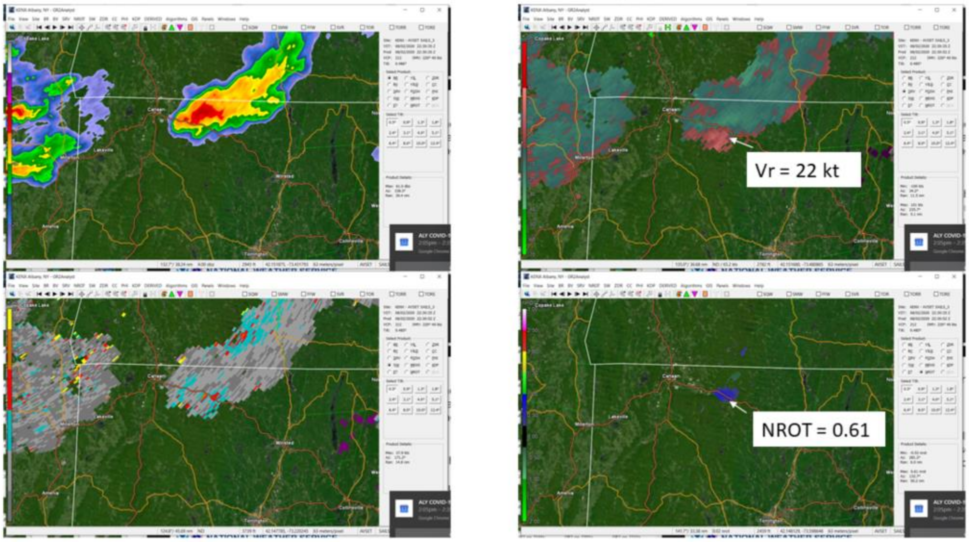
By 2201 UTC, the first tornado had ended. Radar-sampled rotation was beginning to increase. In addition, a significant maximum in spectrum width can be seen in the lower left at this time. A bounded weak echo region can be seen in the reflectivity image in the upper left, associated with the strongest rotation.

2213 UTC – 2nd tornado on the ground



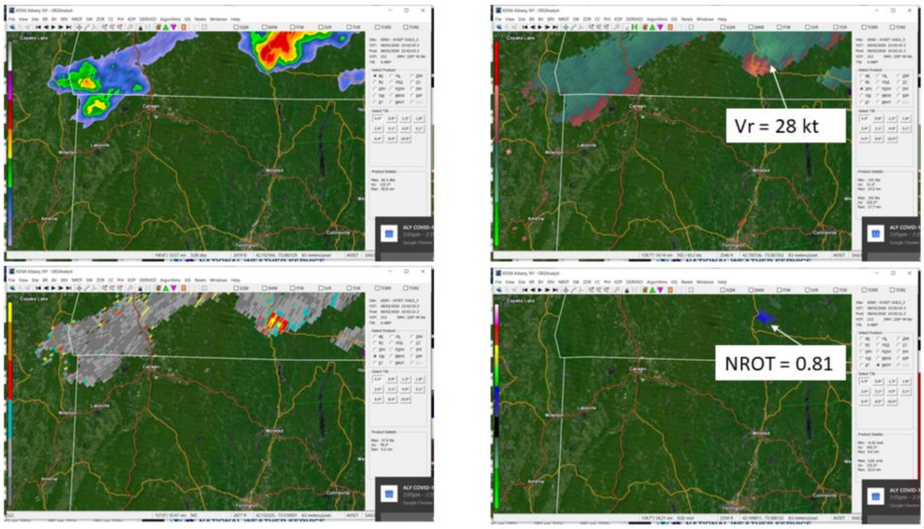
At 2213, the second tornado was on the ground near Falls Village. This was the strongest tornado of the day, rated as EF-1. Rotation had increased and a pronounced maximum spectrum width can be seen at the location of the tornado.

2230 UTC – 3rd tornado on the ground



At 2230 UTC, a third, short-lived tornado developed over Norfolk, Connecticut. Rotation at 4000 feet was weakening at this time, and the spectrum width maximum had also decreased, indicating that the best signals for a tornado at this time were below the level of the radar beam.

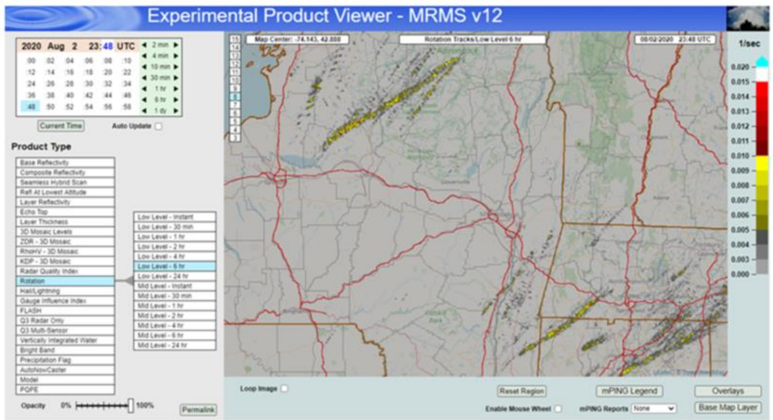
2302 UTC – 4th tornado on the ground



A fourth tornado developed over southwest Massachusetts around 2300 UTC and was on the ground at the time of the images shown on this slide. Rotation and spectrum width values were all shown to be increasing again at this time.

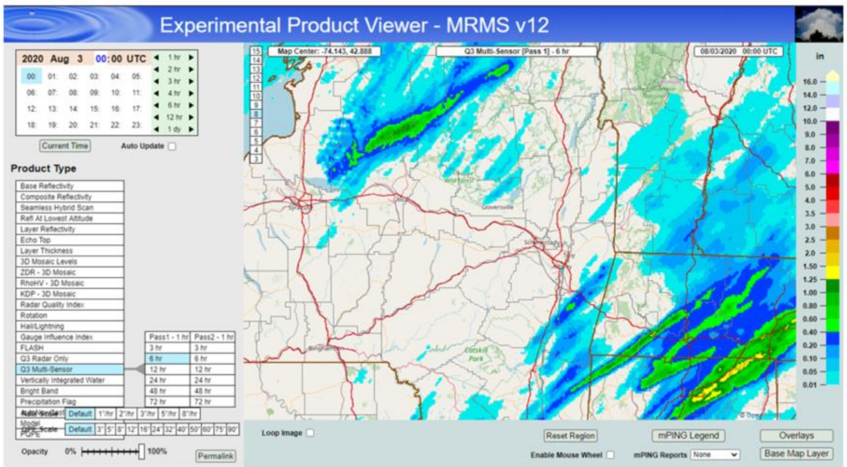
MRMS 6-hr Total Rotational Tracks

- https://mrms.nssl.noaa.gov/qvs/mrms_v12/



There was two distinctive rotational tracks, in the vicinity of Litchfield County, CT and northern Herkimer-Hamilton Counties.

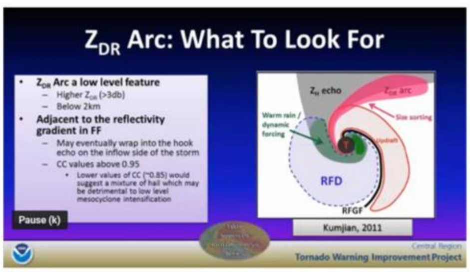
MRMS 6-hour QPE (18Z-00Z)

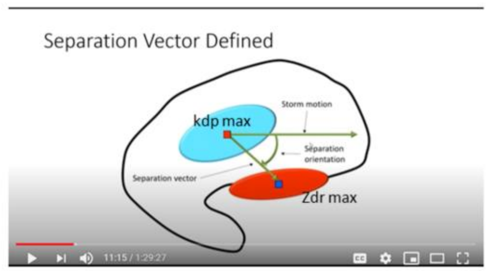


Quantitative precipitation estimates from the multi-radar-multisensor application highlights a few streaks of heavy rainfall associated with southwest to northeast tracking convective storms on this day, and also highlight the lack of rainfall coverage. For example, no rain at all fell in the Capital District on this day.

Examining the angle between the size-sorting vector and the storm motion vector

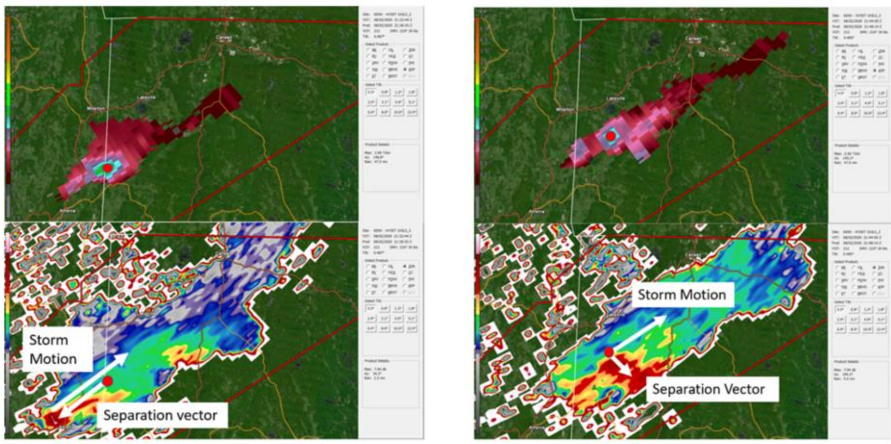
- From Loeffler, S. D., Kumjian, M. R., Jurewicz, M., & French, M. M. Differentiating between tornadic and nontornadic supercells using polarimetric radar signatures of hydrometeor size sorting. Geophysical Research Letters, e2020GL088242.
- Note – This was work performed on storms at sampling heights below 1 km. The August 2nd storm was far enough from the radar so that lowest elevations were sampled at 1.2 km (4000 ft).





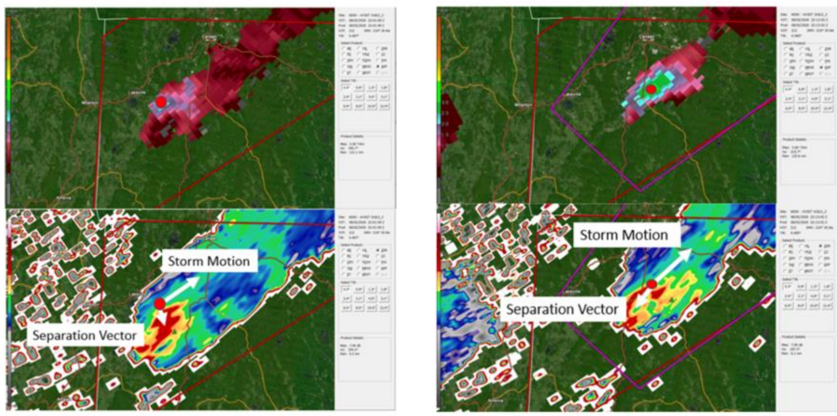
This slide briefly summarizes work done by Loeffler et al on a technique to evaluate the tornado potential within a supercell by evaluating the angle between the vector oriented from the maxima of specific differential phase (kdp) and the differential reflectivity (Zdr) within a Zdr arc, and the vector representing the storm motion. An angle near 90 degrees between these two vectors indicates the development of storm-scale storm-relative helicity, which is favorable for tornado occurrence. Since a well-defined Zdr arc was evident with the supercell on August 2nd, the next several slides show the application of this technique on this storm. It should be noted that the research done by Loeffler et al was based on storms close enough to the radar location so that the elevation of the data was 1 km AGL or less. In this case, the storm was farther from the radar, and the elevation of the data shown on the next several slides was approximately 4000 feet AGL.

Zdr, Kdp, Separation vector and storm motion – 2132 and 2144 UTC (1st tornado touches down at 2136 UTC)



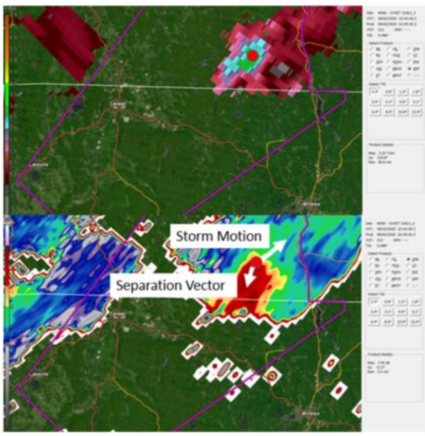
The slide on the upper left shows the 0.5 degree Kdp maximum associated the supercell as it was tracking northeast from New York into Connecticut (2132 UTC). The red dot shows the centroid of the maximum in Kdp. This was approximately 5 minutes before the touchdown of the first tornado in western Connecticut. The slide on the lower left shows the 0.5 degree Zdr at 2132 UTC, and the separation vector between the kdp maximum (red dot) and the maximum of Zdr within the Zdr arc. This vector is oriented from northeast to southwest. The storm motion vector is also shown on this plot, oriented from southwest to northeast. The angle between these two vectors is approximately 180 degrees, which is unfavorable for development of storm-scale storm-relative helicity. The same variables are shown on the right, except for 2144 UTC, when the first tornado was on the ground. Note that the orientation between the separation vector and storm motion vector is now approximately 90 degrees, which is favorable for the development of storm relative helicity. So in this case, it appears that the technique did not provide much lead time for the development of a tornado, although it did indicate favorable conditions for development of storm-scale storm relative helicity when the tornado was on the ground.

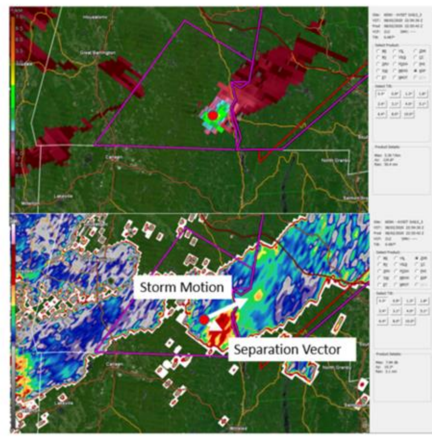
Zdr, Kdp, Separation Vector and storm motion vector at 2201 UTC, 2213 UTC (2nd tornado touchdown at 2209 UTC)



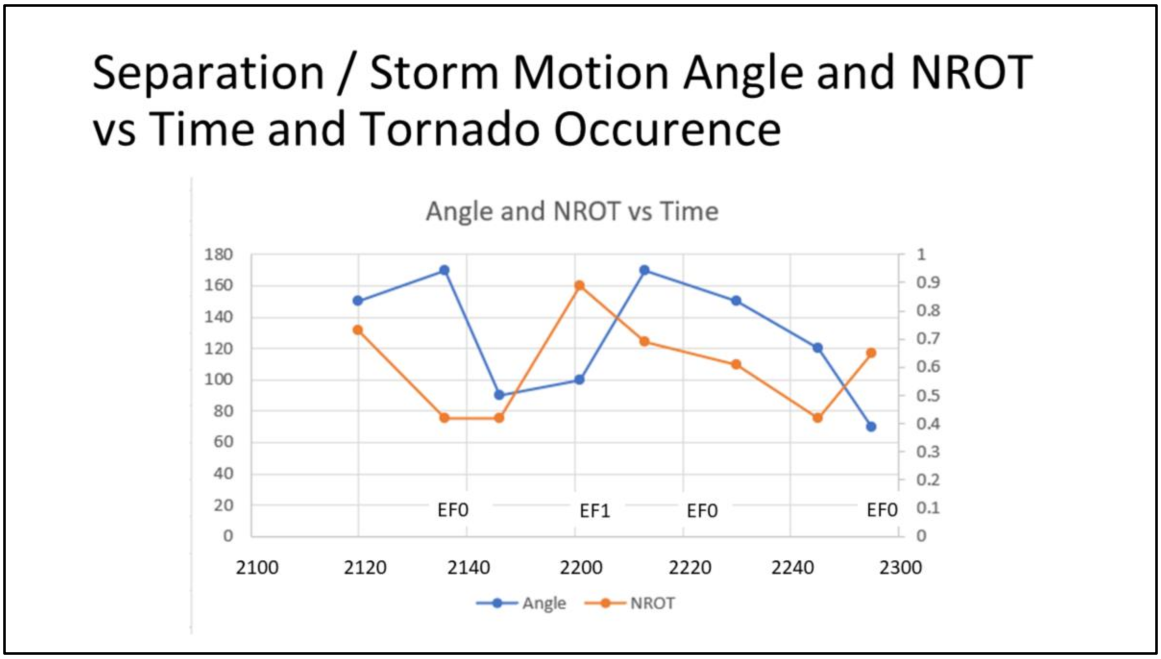
At 2201, the angle between the separation vector and storm motion remained near 90 degrees. An EF-1 tornado touched down at 2209 UTC. Shortly after touchdown, the angle increased to about 180 degrees as the Kdp maximum again moved to a position northeast of the Zdr maximum.

Zdr, Kdp, Separation Vector, Storm Motion vector at 2244 UTC, 2255 UTC (tornado touchdown at 2258 UTC)





The Kdp maximum remained in a position to the northeast of the Zdr maximum while a 3rd small tornado touched down near Norfolk Connecticut. At 2255 UTC, the Zdr maximum once again became re-positioned to the south of the Kdp maximum, resulting in a near 90 degree angle between the storm motion and separation vector. Another weak tornado touched down shortly after this re-configuration.



The graph on this slide summarizes the radar-indicated rotation trends and the separation vector / storm motion angle trends for the supercell. Looking first at 0.5 degree normalized rotation (NROT, the orange line), rotational values fell prior to the first tornado touchdown, then increased prior to the 2nd, strongest (EF-1 tornado touchdown). Rotation gradually decreased through the occurrence of the 3rd tornado, then spiked back upward prior to the 4th tornado.

The angle between the separation vector and storm motion (the blue line) followed a similar trend to the NROT. The angle was initially unfavorable for storm-scale storm-relative helicity development through the occurrence of the first tornado. The angle became favorable, around 90 degrees, approximately 20 minutes prior to the development of the second, strongest (EF-1) tornado. After the touchdown of the second tornado, the angle became unfavorable again, and remained unfavorable through the occurrence of the third tornado, before decreasing to around 90 degrees once again approximately 10 minutes prior to the occurrence of the fourth tornado.

Summary of rotation (NROT) and size-sorting methodology

- First tornado (EF0) – NROT decreased and vector angle increased to nearly 180 degrees prior to tornado touchdown.
- Second tornado (EF1) – NROT increased and vector angle decreased to optimal values near 90 degrees for 10-20 minutes prior to tornado touchdown. The vector angle signal appeared prior to the increase in NROT.
- Third tornado (EF0) – NROT gradually decreased and the vector angle was greater than optimal prior to and during tornado touchdown.
- Fourth tornado (EF0) – NROT increased and vector angle trended toward an optimal 90 degrees approximately 10 minutes prior to tornado touchdown.

Additional Comments

- This tornadic supercell was sampled at heights near 4000 feet AGL, which is slightly higher than what has been done in previous research.
- The vector angle methodology worked best for the strongest (EF-1) tornado. In that case, the angle became optimal at least 20 minutes prior to tornado occurrence, earlier than the increase in NROT.
- In 2 of 3 EF0 tornadoes, neither the NROT or vector angle technique provided good guidance for tornado occurrence.
- In 1 of the EF0 tornadoes, the NROT and vector angle technique both indicated increasing probabilities for a tornado, with approximately equal lead time implied.

Summary of IDSS

- Our IDSS emails combined both hazards of severe convection and TS Isaias (minus the tropical briefing we conducted via telephone briefings).
- Communication challenges with respect to forecast coverage of convection and the impending future impacts from TS Isaias.
- We did an outstanding job with highlighting the initial hazard and kept our IDSS emails short and concise.
- We conveyed via AFD and Social Media that severe potential was rather elevated, however, coverage was in question which was suggested in the model guidance and SPC discussions
- Tornado Watch was issued, and 4 tornadoes occurred in our county warning area. However, only ~2-3 distinctive storms developed per radar coverage. This made messaging the threat a challenge, with many locations not even seeing any rain.