The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England

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1. Introduction

Severe thunderstorms across the northeastern United States are very uncommon in the late fall and winter. For example, Albany, New York (NY), only averages about 3 thunderstorm days every decade in the month of November (Fig. 1). Albany typically averages two dozen thunderstorm days a year. One exception was the pair of severe weather events in November 1989 that produced extensive wind damage and numerous tornadoes (LaPenta and Barton, 1993; Nemeth and Farina, 1994).

Severe thunderstorms producing damaging winds in excess of 50 knots (58 mph) and large hail (greater than 1.9 cm) occurred Thanksgiving morning over much of eastern NY and Western New England. An anomalously strong low pressure system and its associated cold front focused an area of thunderstorms that developed between 1000 UTC and 1200 UTC 25 November 2004 from central NY southward into Pennsylvania (PA) and Maryland. There were nearly two dozen wind damage reports over New York and New England from this severe weather event.

Forecasting these events more than a day in advance is a challenge to forecasters. This poster presentation will take a multi-scale approach analyzing the event from the synoptic-scale to the storm-scale, in order to understand the environment that caused the anomalous severe weather over the Northeast.

2. Data

Data analyzed include 40-km and 80-km North American (NAM) model grids, surface observations (will be shown in poster), upper air data, satellite imagery (will be shown in poster), and Weather Surveillance Radar – 1988 Doppler (WSR-88D) radar data. The WSR-88D data is high resolution 8bit data from KENX. SPC upper air charts and soundings will also be used (www.spc.noaa.gov) from the severe weather thunderstorm archive.

3. Synoptic Overview

The 25 November 2004 case was an anomalous late November case where fairly widespread severe weather occurred over New York and portions of western New England. A total of 21 severe weather reports occurred mainly in the mid to late morning. The majority of the reports were wind damage (19) and two large hail reports. The Albany forecast area was hit the hardest with 11 severe thunderstorm events (NCDC).

A warm and humid air mass for very late autumn was in place over the Northeast. In the warm sector of the air mass, surface temperatures were $> 15^{\circ}C$ and dewpoints between 10-15°C over much of eastern NY and western New England Thanksgiving morning. A strong cold front with a potent wave of low pressure was approaching from the Midwest and eastern Great Lakes region 0000 UTC to 1200 UTC 25 November. This storm system had a history of producing numerous cool season tornadoes over the Southeast and southern Plains the preceding couple of days. At 500 hPa, the cold core (-38°C) of a strong upper level trough was pushing equatorward from central Ontario (Fig. 2). The trough began to develop a neutral-weakly negative tilt over the Ohio Valley and central Great Lakes region. An impressive 500 hPa jet developed along the East Coast of 65-95 knots. The 500 hPa jet streak was the most intense near the Delmarva Peninsula at 1200 UTC with a value of 95 kts (Fig. 2). A plume of upper level divergence was moving over the forecast area between 1200-1600 UTC on the left front quadrant/cyclonic exit region of the upper level jet streak (not shown). A 850 hPa southwesterly lowlevel jet was intensifying to 35-50 kts over the Mid Atlantic region northeastward into NY (not shown). A strong baroclinic zone was in place at 1200 UTC with 850 hPa temps of around +12°C over southwestern New England upstream to -2°C near Niagara Falls, NY. This thermal gradient is evident by the strong 850 hPa cold air advection moving across western and central NY at 1200 UTC(Fig 3a). The 1000-500 hPa layer showed relative humidity values less than 80% over portions of eastern PA and NY, and western New England (Fig. 3b).

The region broke out into a warm sector with sunny conditions after sunrise. Consistent with the

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analyzed 1200 UTC relative humidity field, the water vapor and infrared satellite picture showed this clearing between 0900 UTC and 1200 UTC. An active line of showers and developing thunderstorms with several cloud to ground lightning strikes quickly developed ahead of the cold front over central NY and PA in this region of surface heating. This convective line was moving into a convectively unstable environment

4. Sounding and Radar Analysis

The upper air analysis showed good support for convective activity 25 November 2004. Upstream over Buffalo at 1200 UTC the cold front had blasted through where the winds below 850 hPa had turned northwesterly and the air temperatures dropped close to freezing. The rainfall had transitioned to wet snow there at 1200 UTC. A steep frontal inversion was in place at 925 hPa to about 800 hPa (not shown). At Albany (ALY) 500 km downstream, the 1200 UTC sounding was dramatically different. The surface based convective available energy (CAPE) value was 358 J kg⁻¹. The mixed layer CAPE was even higher at 637 J kg⁻¹ (Fig. 4). The downdraft CAPE (DCAPE) was also very high at 629 J kg⁻¹, which indicates the potential strength of the rain-cooled downdrafts in thunderstorms. Large DCAPE values are associated with stronger downdrafts.

The supercell composite parameter (SCP; Thompson et al., 2003) is calculated as the product of the most unstable CAPE in the lower 300 hPa, the 0-3 km storm relative helicity (SRH) and the Bulk Richardson Shear, which are all divided by a scaling factor. SCPs greater than 1 indicate the increased potential for supercells and tornadoes. This current value was marginal, but peaked forecaster awareness. The 0-6 km shear value was 67 kt. This increased forecaster awareness that organized convection with the potential for supercells was likely. Veering wind flow was evident in the surface to 800 hPa layer, while from the 800 hPa to 250 hPa layer it was nearly unidirectional. 0-1 and 0-3 km SRH values were 187 and 188 $(m/s)^2$. The NAM also forecasted the helicity and shear values to intensify by 1500 UTC over eastern NY (not shown). The ALY sounding also depicted a low Lifted Index of -1 and most importantly a fairly steep lapse for late November of 6.6°C/km in the 700 hPa to 500 hPa layer with low wet bulb zero height and freezing level at 7 kft. These parameters highlighted the potential for large hail, damaging winds and isolated tornadoes.

The 1200 UTC ALY sounding and the developing convection between 0900 UTC-1200 UTC coupled with the 0600 UTC and 1200 UTC NAM guidance prompted the Storm Prediction Center (SPC) to put out a slight risk over eastern NY

and western New England with the early morning update at 1300 UTC. A watch box shortly followed, as cross sections from the NAM of omega, winds and equivalent potential temperature (theta-e) showed an area of convective instability developing near the Hudson River Valley by 1500 UTC (not shown).

Rapid destabilization occurred over eastern NY between 13-1500 UTC with a possible narrow coldfrontal rain band of intense convection sweeping across upstate NY. A line of intense low-topped (radar derived echo tops product showed tops at 20-30 kft) convection with a tight reflectivity gradient reached the Hudson River Valley. Numerous bowing convective elements occurred along the line with shallow mesocyclone at 1529 UTC. A bow echo south of ALY produced a microburst uprooting 80-90 trees in eastern Ulster county (Fig. 5). Some elevated reflectivity cores of 55 dBz to almost 20 kft generated hail the size of pennies. At 1539 UTC, a break occurred in the line southeast of the KENX radar site, where a supercell developed. The line took on a broken-S configuration (Fig. 6). The supercell moved eastward into Rensselaer county. At about 1 nm (gate-to-gate) across the mesocyclonic couplet the rotational velocity value was 33 kt with a shear value of 0.17 s^{-1} (Fig. 7). The circulation never tightened up in diameter further and the mesocyclone did not meet local warning criteria thresholds for a tornado warning. The operational forecasters continued with severe thunderstorm warnings. No tornadoes were reported with this event, but several microbursts occurred. The severe weather was over prior to noontime Thanksgiving morning.

5. Summary

A significant low-topped severe weather outbreak occurred with eastern NY and western New England in a high shear, low CAPE environment. The region was in the left front quadrant/cvclonic exit region of a vigorous mid- and upper-level jet streak with strong divergence aloft. A strong baroclinic zone existed ahead of the deep trough and its associated cold front. The convective environment was conducive for bow echoes and isolated supercells with the high DCAPE values and This severe environment marginal SCP values. became more apparent less than 5 hours before the event.

Anticipation of this case was a challenge for operational forecasters days in advance due to the seasonality and time of the day for the severe convection. SPC issued a timely severe thunderstorm box in the mid morning based on the developing strongly forced low-instability convective line and its associated lightning production (Van Den Broeke et al., 2005). Despite the difficulty of the early awareness of the event, the ALY forecast office was able to yield timely severe thunderstorm warnings (18.9 min lead time average) with an excellent probability of detection (0.818) and a low false-alarm ratio (0.333). Cool season severe events will always be a challenge in the Northeast. Future work, should focus on a climatology and case study analysis of such events across NY and New England to understand the synoptic and convective parameters that produce them to enhance forecaster awareness.

6. Acknowledgements

Thanks to Dave Novak from Eastern Region Scientific Services Division, and Alicia C. Wasula, and Neil Stuart for reviewing and assisting with this preprint. Thanks also to Kenneth LaPenta, a retired WFO Albany Senior Forecaster, for help with the graphics with some of the presentations to this research.

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Fig. 1: Climatology of thunderstorm days at Albany. The x-axis is the calendar month and the y-axis is the mean thunderstorm days.



Fig. 2: 500 hPa height (dam, solid), temperatures (°C, dashed red), winds (knots) and dewpoint depression from RAOB (green), valid 1200 UTC 25 November 2004.



Fig. 3: a) 1200 UTC 25 November 2004 Eta 850 hPa thermal advection (°C/100 km/3 hr, shaded) and height (dam, solid). b) Mean sea level pressure (hPa, solid), 1000-500 hPa thickness (dam, dashed) and 700 hPa RH (%, shaded).



Fig 4: 1200 UTC 25 November 2004 Albany Sounding (http://www.spc.noaa.gov).



Fig. 5: 1529 UTC 25 November 2004 KENX 0.5° base reflectivity (dBz) and radar indicated mesocyclones. Magenta arrow indicates developing supercell along line.



Fig 6: 1539 UTC 25 November 2004 0.5° KENX base reflectivity (dBz) and lightning (1545 UTC). White box indicates area shown in Fig. 7.



Fig 7: 1539 UTC 25 November 2004 KENX 0.5° SRM and radar indicated mesocyclone plot overlayed. Note a rotational velocity of 33 kt and a shear value of 0.017 s⁻¹ over a 1.1 nm gate to gate coupler located 16 nm from the RDA.