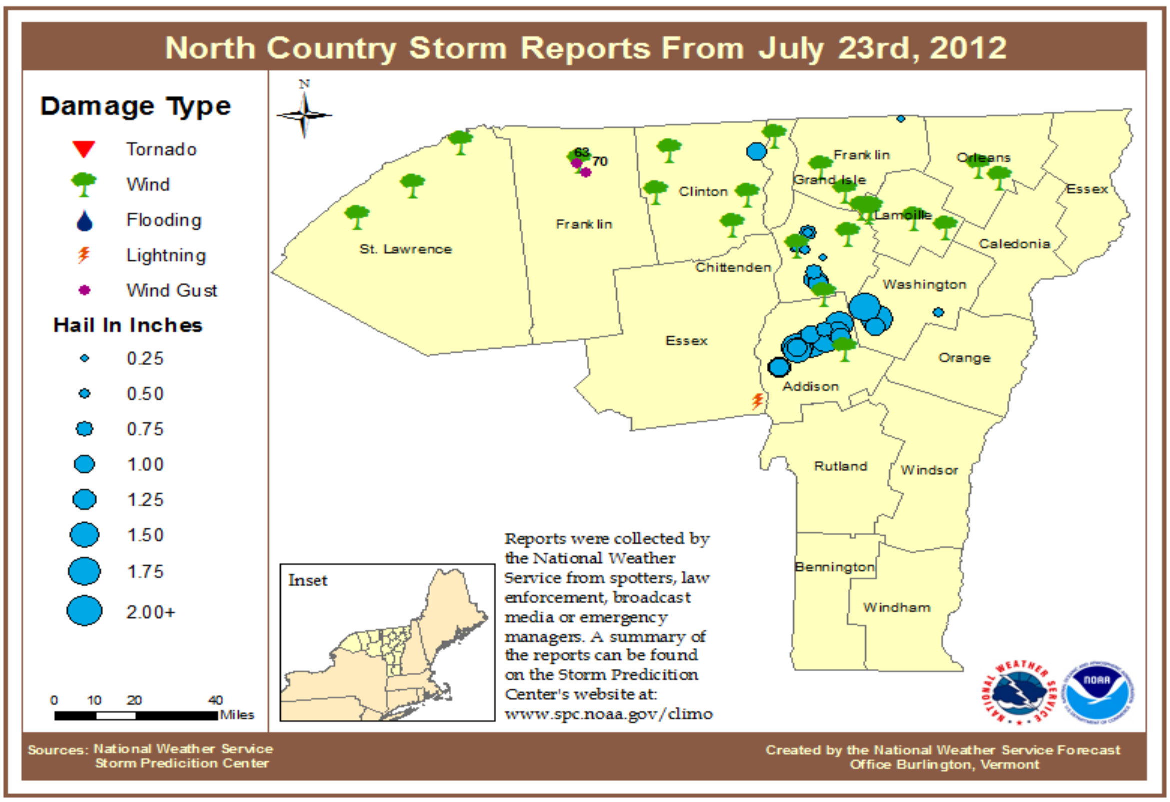
The Large Hail and Damaging Wind Event of 23 July 2012

1.) Overview/Summary

A significant severe weather outbreak took place on July 23rd, 2012. Figure 1 shows a map of Local Storm Reports (LSRs) that were received by the NWS Burlington, Vermont Weather Forecast Office (WFO). Severe weather was primarily from damaging winds, produced by a large mesoscale convective system (MCS) that moved out of eastern Ontario then across northern New York and northern Vermont. (Note: Click here for more information on MCSs.) Several reports of tree damage were observed with the MCS, with wind gusts estimated to be as high as 70 mph in Malone, NY. Several significant hailstorms associated with isolated supercell thunderstorms developed later in the afternoon across central and eastern Addison and western Washington counties of Vermont. The largest hail reported was 2 inches in diameter at 2 West of New Haven Mills in Addison County, Vermont at 2220 UTC. Another hailstorm developed near Hinesburg, VT in southern Chittenden County and produced quarter-size hail. Click here for a listing of storm reports used to make the below map.



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2.) Storm Prediction Center Outlook Information

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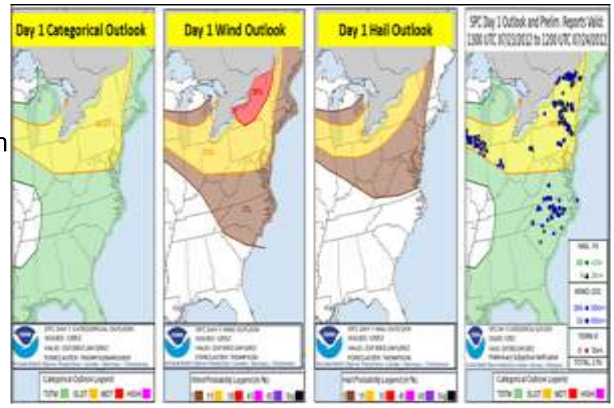

Figure 2 shows the Storm Prediction Center (SPC) day 1 categorical outlook (bottom left image), day 1 wind/hail probabilistic outlooks (middle two images), SPC day 1 outlook, and preliminary verification reports from 1300 UTC on 23 July to 1200 UTC on 24 July 2012. Click here for the 1300 UTC convective outlook text product. From the image you can see our entire county warning area was in slight risk for severe thunderstorms, with the greatest threat being damaging winds. From SPC, a slight risk implies well-organized severe thunderstorms are expected, but in small numbers and/or low coverage. Depending on the size of the area, approximately 5-25 reports of 1 inch or larger hail, and/or 5-25 wind events, and/or 1-5 tornadoes would be possible. The probabilistic wind forecast from SPC, showed a 30% chance of severe thunderstorm winds within 25 miles of a given point during the outlook period across portions of western New York and northwestern Vermont. The slight risk area verified very well across the Mid-Atlantic States into the Northeast, given the severe weather reports plotted in figure 2(lower right).

3.) Pre-storm Environment

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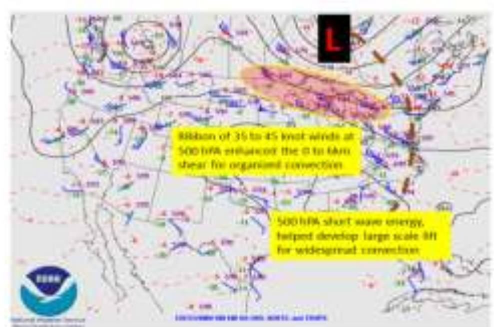

Figure 3 shows the 500 hPa (20,000 feet above the ground level) upper air analysis on 23 July 2012 at 00 UTC. A potent short wave trough was moving across the forecast area, along with a ribbon of enhanced wind speeds. This short wave helped to produce large scale lift for thunderstorm development, while the stronger winds aloft helped in the organization of storms and provided the severe weather wind threat across the forecast area.

The 500 hPA winds across the Ohio Valley into central New York were between 35 and 45 knots and with a good upper level divergent pattern in the height fields promoted deep vertical lift for thunderstorm development.

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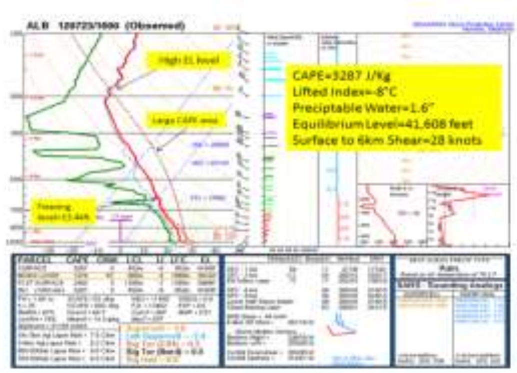

The 1600 UTC July 23rd rawinsonde observation at Albany, NY (Figure 4) shows high instability, and moderate deep-layer shear, due to the development of a strong mid-level jet from central New York into the Great Lakes (as shown in the previous section). The combination of surface temperatures in the lower 80s and dewpoints in the upper 60s to near 70°F, created surface-based convective available potential energy (CAPE) values of 3287 J/kg and a lifted index (LI) of -8C (Celsius). CAPE values greater than 1500 J/kg, suggest a moderately unstable environment, favorable for thunderstorm development. The large CAPE profile and very high equilibrium levels (41,000 feet) indicated thunderstorm tops would extend to 40,000 to 45,000 feet into the atmosphere, and be capable of producing severe winds or large hail, along with very heavy rainfall. The equilibrium level is the level at which the rising parcel equals the actual air temperature at that given height, and results in the rising parcel now becoming stable; it no longer accelerates upward.

The Albany sounding also showed surface to 6-km shear of 28 knots. This shear increased through the day, as the embedded mid-level jet approached the forecast area. Thunderstorms tend to become more organized and persistent as vertical shear increases. Supercells and organized convection, such as squall lines and derechos are commonly associated with vertical shear values of 30 to 40 knots and greater through this depth, which developed across our region as jet stream winds aloft increased.

Finally, the 1600 UTC Albany sounding showed precipitable water value of 1.60 inches, which suggests the potential for thunderstorms to produce very heavy rainfall. Precipitable water is the depth of the amount of water in a column of the atmosphere if all the water in that column were precipitated as rain. Values greater than 1.2 inches, suggests a greater potential for heavy rainfall, especially during the summertime.

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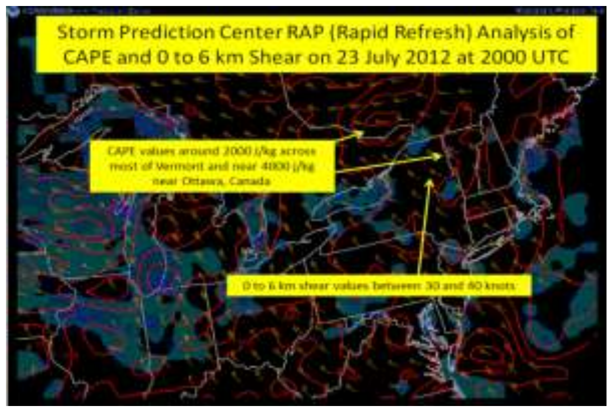

Figure 5 shows Rapid Refresh (RAP) analysis of CAPE and 0 to 6 km shear from SPC on 23 July 2012 at 2000 UTC. As the mid-level jet approached the region the deep layer shear increased between 30 and 40 knots, while CAPE values ranged between 1800 and 2500 J/kg across most of northern New York and Vermont.

This pre-storm environment was conducive for well-organized and persistent convection to develop, capable of producing damaging winds and large hail. Also, from figure 5, you can see the Convective Inhibition (blue shaded areas) decreased significantly as surface temperatures warmed into the 80s.

4.) Storm Prediction Center Mesoscale Graphic and Watch Box Information

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Figure 6 shows the SPC mesoscale graphic, highlighting the region for a potential severe thunderstorms (bottom left) and the actual severe thunderstorm watch box (bottom right). Click here for the mesoscale text discussion.

From the bottom left image at 1600 UTC, you can see how the instability and shear parameters were increasing to create an environment favorable for severe thunderstorms capable of damaging wind and large hail. The severe thunderstorm watch box extended from northeast Pennsylvania through most of eastern/northern New York, and included all of Vermont and was valid from 1725 UTC on July 23rd to 0300 UTC on July 24th.

5.) Radar Summary

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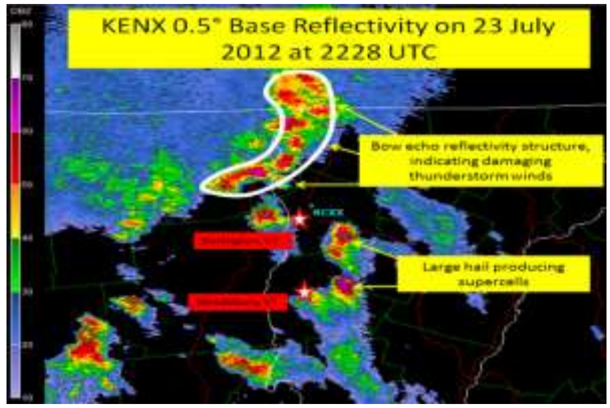

Figure 7 shows the 0.5° base reflectivity from the Albany, NY WSR-88D Doppler Radar (KENX) at 2228 UTC on July 23rd, 2012. It should be noted both KTYX and KCXX radars were unavailable during this event. KTYX had a communication problem, while KCXX was being upgraded to dual polarization technology. The three storms of interest, which produced the most significant severe weather, are highlighted in the figure 7. At this time, the mesoscale convective system known as a bow echo is shown moving across Grand Isle County in Vermont and extreme eastern Clinton County in New York. Click here for more information on a bow echo. Several intense reflectivity cores were embedded within the bow echo complex. Immediately behind the apex of the bow, low reflectivity values were evident, which suggests the presence of a strong descending rear-inflow jet. This jet helped produce the numerous reports of tree damage and estimated wind gusts approaching 70 mph across Franklin County in New York. The two storms that will be looked at more closely are the two isolated supercells across southeastern Chittenden County and in eastern Addison County. Both supercells produced large hail of at least quarter size, though the southern supercell in Addison County produced up to 2" hail in the New Haven Mills, VT area, with multiple reports of ping-pong ball or larger size hailstones as it continued across eastern Addison and into western Washington County.

a. Addison County (Bridport, Vermont):

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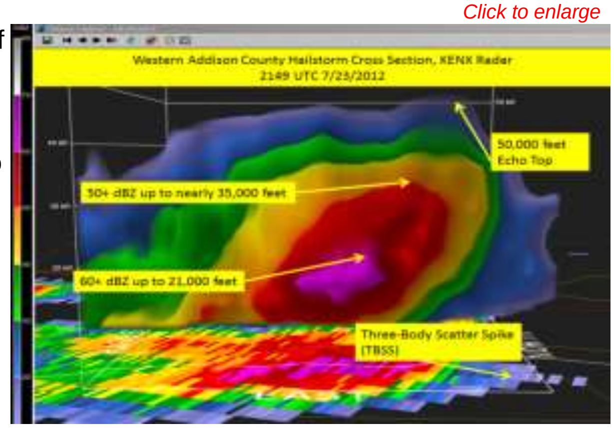

Figure 8 shows KENX reflectivity cross section of a supercell thunderstorm across Western Addison County near Bridport, Vermont on 23 July 2012 at 2149 UTC. This supercell thunderstorm had a 50 dBZ reflectivity core up to 35,000 feet above ground and a 60 dBZ reflectivity return to 21,000 feet above ground level.

These strong reflectivity returns above the freezing level and -20°C isotherm, along with a three body scatter spike (TBSS), suggested the potential for large hail. At 2154 UTC on 23 July 2012, 1.25" diameter hail was observed in Bridport, Vermont. With a storm top to 50,000 feet or over 9 miles tall in the atmosphere, very heavy rainfall was possible with this storm. A storm spotter in Bridport, Vermont reported 1.10" in less than one hour.

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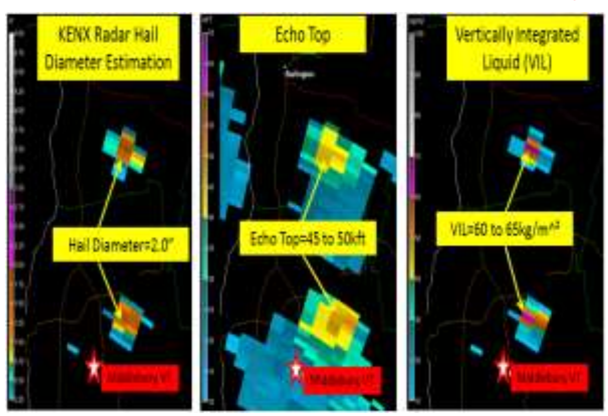

Figure 9 shows the KENX radar hail estimation product (lower left), echo top (middle), and Vertically Integrated Liquid (VIL) (lower right) at 2223 UTC on 23 July 2012. The KENX radar located near Albany, New York suggested maximum hail size of 2.0"was possible with echo tops around 50,000 feet above the ground. This showed the supercell thunderstorms extended almost 10 miles into the atmosphere and were capable of large hail and very heavy rainfall. Figure 9 shows the KENX Vertical Integrated Liquid (VIL) at 2224 UTC on 23 July 2012 to be between 60 and 65 kg/m2 near Hinesburg and Bristol, Vermont. VIL is an estimate of the total mass of precipitation in the clouds. The measurement is obtained by observing the reflectivity of the air as obtained by radar. This measurement is usually used to determine the size of hail, the potential amount of rain under a thunderstorm, and the potential downdraft strength when combined with the height of the echo tops. When VIL values quickly fall, it may mean that a damaging downburst wind is imminent, resulting in the weakening of the storm's updraft and the storms inability to hold the copious amounts of moisture/hail within the storm's structure. These VIL (pink/purple color) values between 60 and 65 kg/m2 near Hinesburg and Bristol, indicates a very well developed updraft, capable of producing large hail and damaging winds. When the storm collapsed and weakened near Fayston and Waitsfield Vermont, 1.75" diameter hail reported at 2246 UTC on 23 July 2012. These two supercells continued to produce severe weather reports across central Vermont, before slowly weakening across the Connecticut River Valley.

b. Hinesburg, Vermont Storm

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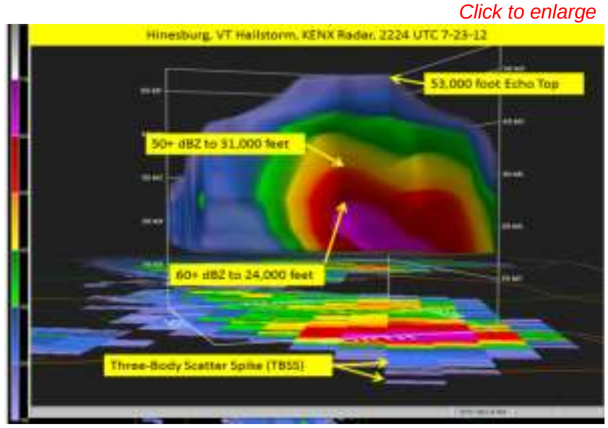

Figure 10 below shows KENX reflectivity cross section of a supercell near Hinesburg, Vermont on 23 July 2012 at 2224 UTC. This supercell thunderstorm had a 50 dBZ reflectivity core up to 31,000 feet above ground and a 60 dBZ reflectivity return to 24,000 feet above ground level. These strong reflectivity returns above the freezing level and -20°C isotherm, suggested the potential for large hail.

At 2227 UTC on 23 July 2012, 1.00" diameter hail was observed near Hinesburg and 1.50" diameter hail occurred in South Starksboro, Vermont at 2235 UTC. With a storm top to 53,000 feet, very heavy rainfall up to 3.0" occurred in Huntington and 2.57" in Waitsfield, Vermont. Click here for a complete listing of 24 hour rainfall totals across the North Country.

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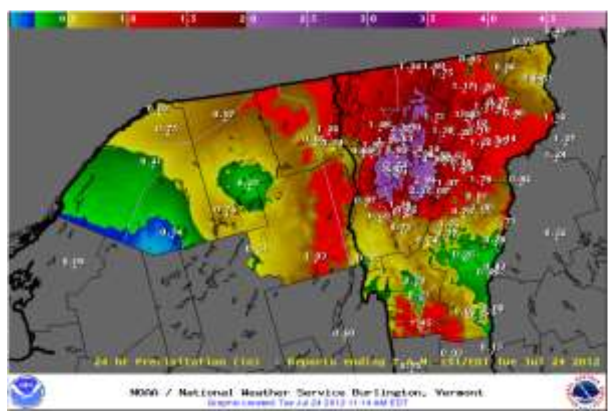

Figure 11 below shows the 24 hour accumulated rainfall across northern New York and Vermont from 1100 UTC on 23 July to 1100 UTC on 24 July 2012. This clearly highlights the track of the the supercell thunderstorms and the associated significant rainfall. Given the recent dry spell, no flash flooding was observed with event.

6.) Conclusion/Storm Pictures

The severe weather event on July 23rd, 2012 was significant, producing a variety of storm modes. The storm modes included a bow echo MCS associated with numerous reports of damaging wind gusts in excess of 60 mph across northern New York and northern Vermont and two isolated supercells which produced large hailstones across southern Chittenden, Addison, and western Washington counties. In addition, rainfall amounts of up 3.0 inches occurred with these supercell thunderstorms across central Vermont during this event, but no flash flooding was observed.

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7.) References

- Wikipedia for supercell and bow echo information
- Storm Prediction Center for slight risk definition and mesoscale discussion/watch box information and graphics
- GR2 Analyst software for radar products and reflectivity cross sections