The Significant Severe Weather Outbreak on 2007 August 16th Across the North County

On 2007 August 16th a significant severe weather outbreak occurred across the Weather Forecast Office, Burlington, Vermont county warning area. The Weather Forecast Office in Burlingtonissued 26 severe weather warnings and 24 were verified with nearly 4 dozen reports of severe weather across the North Country. This particular event featured two large and long lived supercell thunderstorms, which produced large hail and widespread significant wind damage. A supercell thunderstorm is a long-lived violent thunderstorm, which contains large hail, high winds, and potential tornadoes, and is most common across the Central Plains. These violent thunderstorms produced a 91mph wind gust at Cumberland Bay near Plattsburgh, along with reports of golf ball size hail near Beekmantown, New York. The following Storm Prediction Center graphic shows the two distinct lines of severe weather reports across our region.

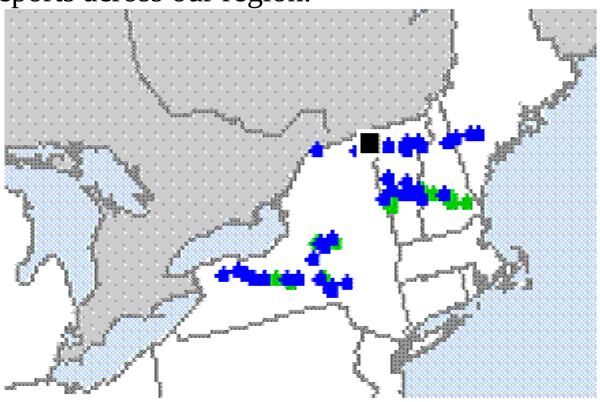

Figure 1 Storm Prediction Centers reports of severe wind (blue) and hail (green), significant wind (black)

Click the link below for a complete listing of all the storm reports
http://www.weather.gov/media/btv/events/16Aug2007/LSRBTV.pdf

The following link will provide you with a complete result of the storm surveys performed by the National Weather Service in Burlington, Vermont on August 16th.
http://www.weather.gov/media/btv/events/16Aug2007/PNSBTV.pdf

Pre-Storm Environment

Several meteorological ingredients came together to produce these supercells. First, we had a potent disturbance in a very strong middle to upper level wind flow across southern Canada into northern New York and Vermont. This disturbance in the winds aloft combined with a surface cold front interacting with low level instability, helped to fuel these two distinct complex areas of severe thunderstorms. The image below shows the water vapor along with lightning data, note the strong drying across the Saint Lawrence Valley and the tight gradient of height lines across the region, which indicates very strong winds aloft.

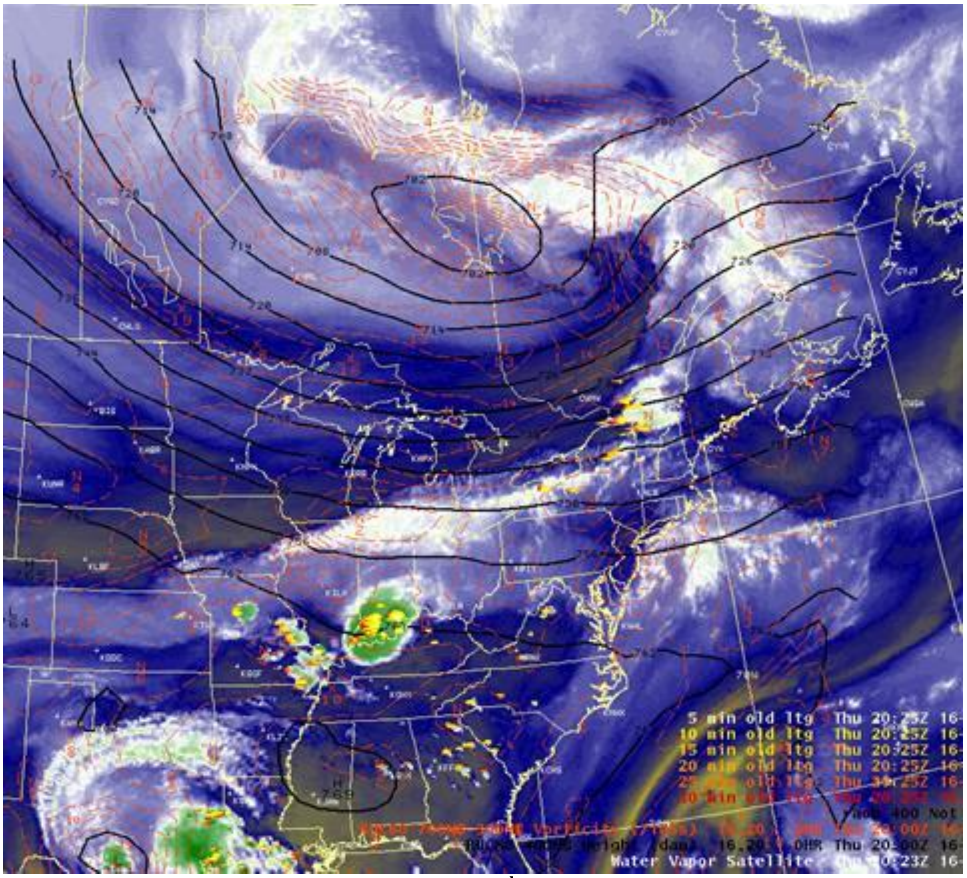

Figure 2 Water Vapor at 425 PM on Aug 16th

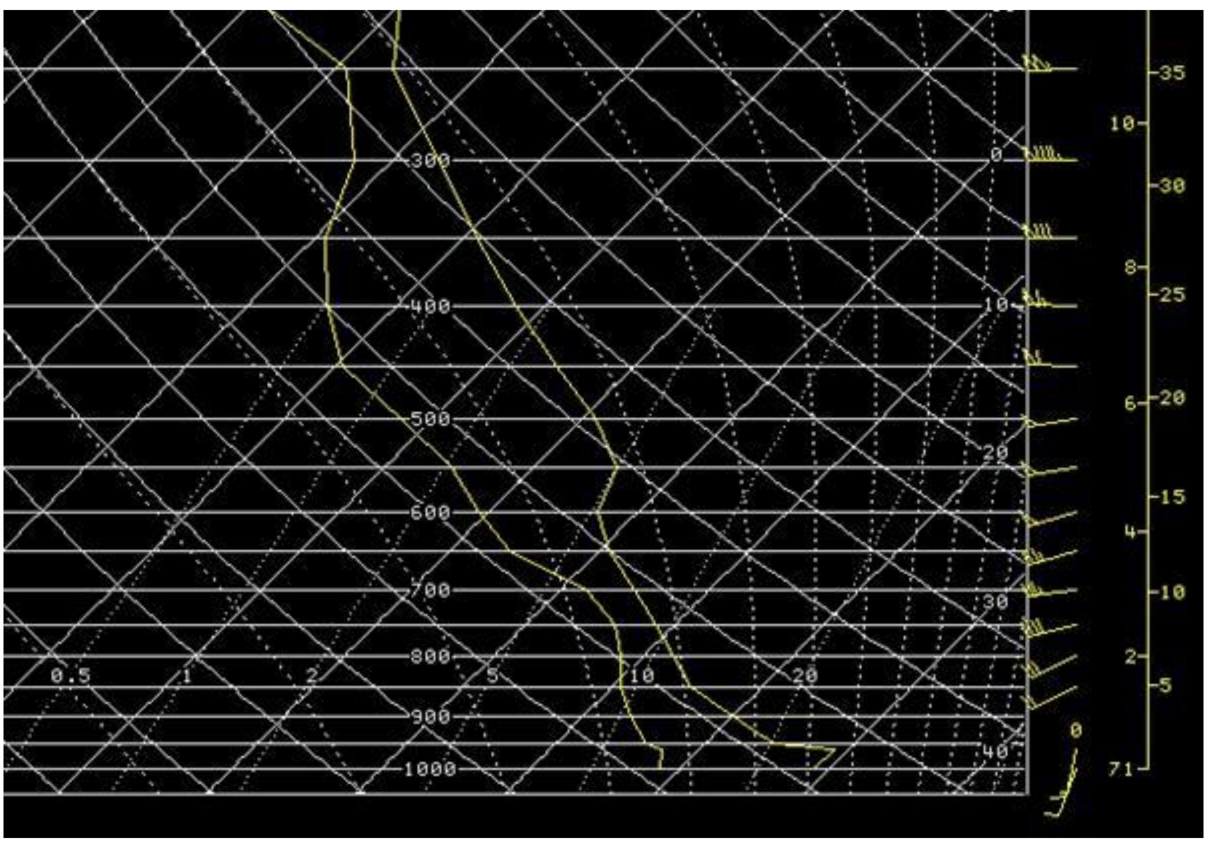

Figure 3 Laps 400 PM Sounding August 16, 2007

The 4 PM surface analysis (pictured below) showed a cold front approaching northern New Yorkand Vermont with scattered thunderstorms developing along and ahead of the front. The visible satellite picture below shows the over shooting thunderstorm cloud tops, along with 5 minute lightning strikes and surface observations. You can see the observation at Burlington, Vermont was 84 degrees with a southerly wind at 15 mph with gusts to 28 mph. Furthermore, note all the clearing ahead of the developing storms across central and southern Vermont, which helped to destabilize the atmosphere by aiding in daytime heating.

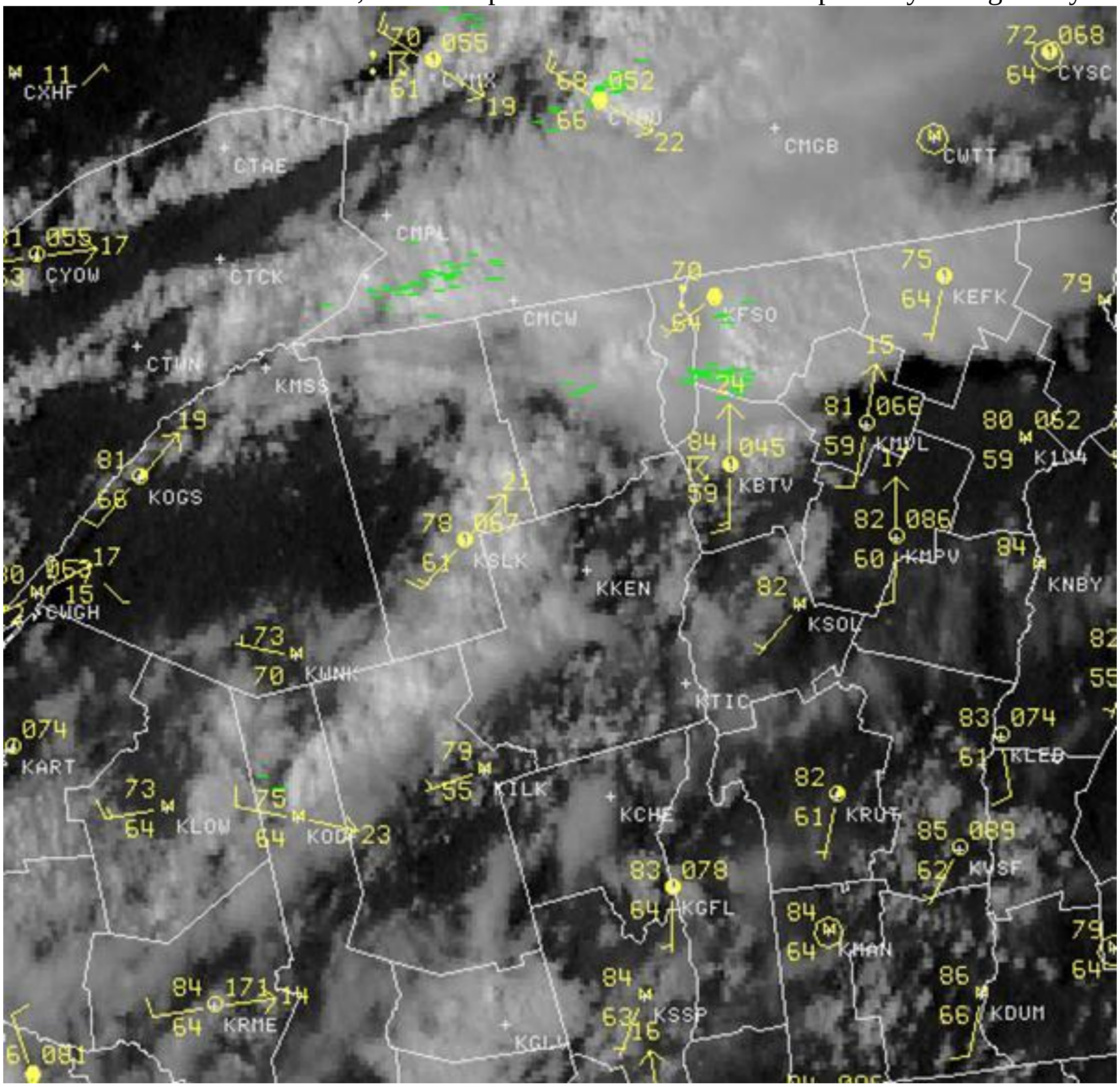

Figure 4 Satellite 400 PM with lightning (green), surface obs (yellow), frontal position (blue)

Storm Analysis (Supercell #1 Plattsburgh to Saint Johnsbury)

On 2007 August 16th two distinct supercells tracked across our county warning area. The first severe thunderstorm cell developed across southern Canada/Saint Lawrence River Valley, and tracked southeast into central Clinton County, then across southern Grand Isle County in theChamplain Valley, then followed the Lamoille River Valley from Georgia Center to Cambridge, through the Green Mountains to The Upper Connecticut River Valley near Saint Johnsbury. Numerous reports of widespread trees down and power lines were common along this track, along with several reports of large hail the size of golf balls. Storm surveys conducted by The National Weather Service showed the damage was a result of straight line thunderstorm winds of 70 to 90 mph from the Plattsburgh/Cumberland Head area in New York thru Grand Isle County into the Georgia /Fairfax areas of Vermont. The survey results showed most of the tree and structural damage to be in the same directions with the center of the maximum winds appearing to be about 4 miles wide across Grand Isle County.

The radar reflectivity picture below was taken at 3:47 PM on August 16th, when the storm was very close to the Cumberland Head/Plattsburgh area. The highlighted area shows a well defined hook-like reflectivity structure, which is very common to tornadic producing supercells. The light blue circle in the upper left image represents where the KCXX radar was indicating a mesocyclone/rotation in the storm. In addition, note the strong low level reflectivity gradient in the southwest part of the storm, also suggesting a well organized storm, capable of producing a tornado.

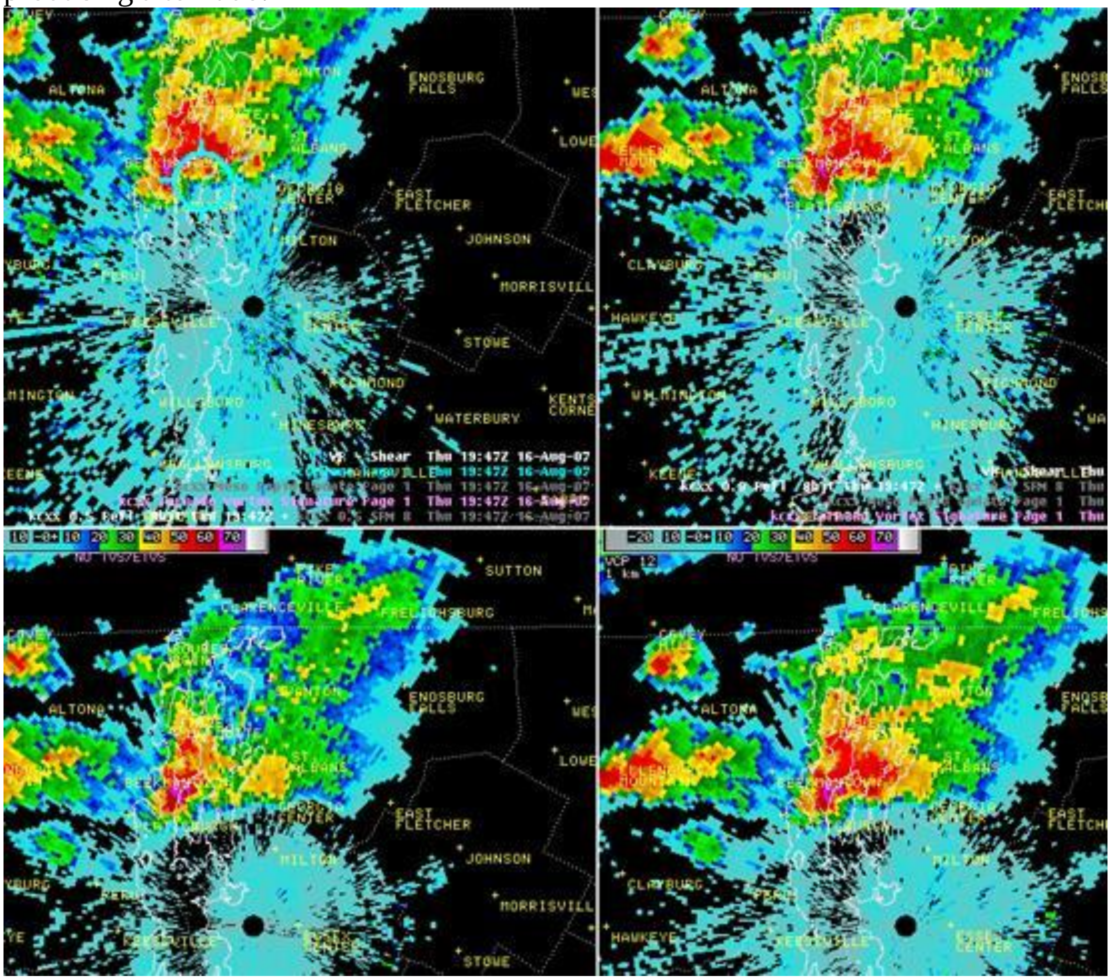

Figure 5 The Lowest 4 Base Reflectivity Elevation Scans of the KCXX Radar at 3:47 PM

As you can see from figure 6 pictures below, the radar structure of the storm near Plattsburgh exhibited classic supercell features, like the schematic diagram on the right. These characteristics included a sharp hook-like reflectivity gradient on the southwestern portion of the storm, which is the most likely place for a tornado. The storm also had a core of stronger radar returns, which is indicated in the brighter purples and pinks on the left hand image. Reflectivities of this nature are associated with strong winds, large hail and very heavy rain, which occurred with this storm.

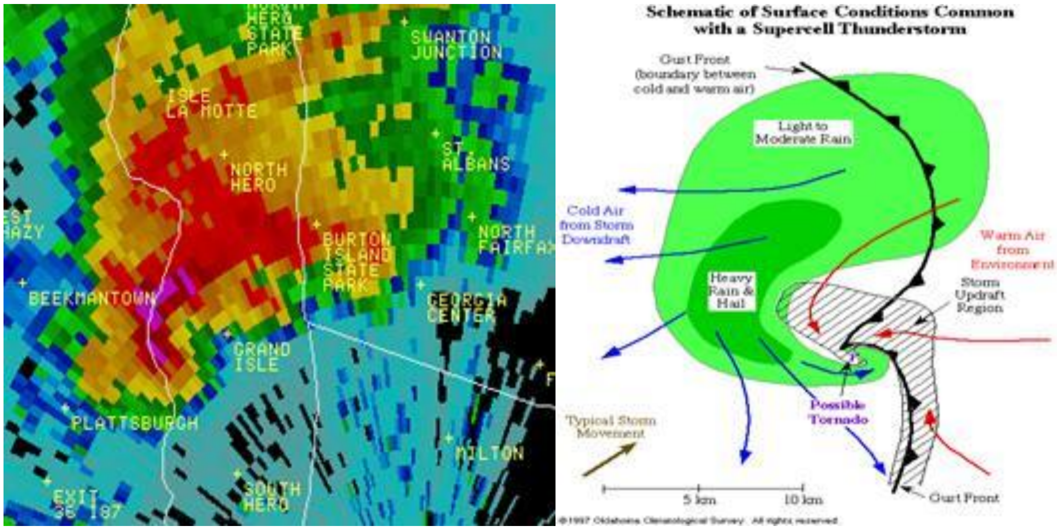

Figure 6 Supercell Near Plattsburgh at 3:47 PM Compared to Supercell Schematic From OCS

A reflectivity cross section (seen below in Figure 7) is a vertical look into the storms reflectivity structure. This radar data is used to determine the height of the strongest radar returns, along with the reflectivity gradient. Figure 7 shows a very strong storm near Plattsburgh, New York with a 50 dbZ return to 30,000 feet. The reflectivity tilt is caused by strong west to east winds displacing the radar returns downstream. Furthermore, the strong radar returns aloft are being held above the ground, by the storms strong updraft. The air associated with the storms updraft is warm and moist air and positively buoyant, which is being carried into the storm by southerly inflow winds. This strong reflectivity core aloft is called a Bounded Weak Echo Region (BEWR). The white returns are indicating dbZ of 70 or more, which indicates the presence of large hail. The dark red shows dbZ of 50 or higher shown below.

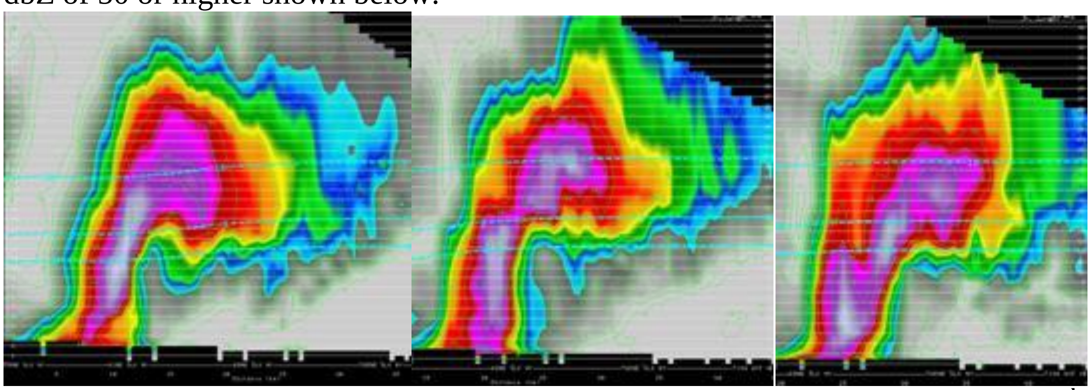
Figure 7 Cross Section Reflectivity Near Plattsburgh at 3:42, 3:47, and 3:52 PM on August 16th

The image below is the lowest elevation angle of velocity data off the KCXX radar taken at 3:47 PM. The light green shows velocities of 40 to 50 knots, the dark blue indicates wind speeds of 50 to 60 knots coming toward the radar, and the light blue color shows incoming winds of greater than 70 knots moving toward the radar, just above the ground. This image was taken very close to the time when all the damaging thunderstorm winds were occurring near Cumberland Head, New York. The warm colors or red/orange colors indicate air flowing away from the radar, which suggests southerly winds feeding into the storm.

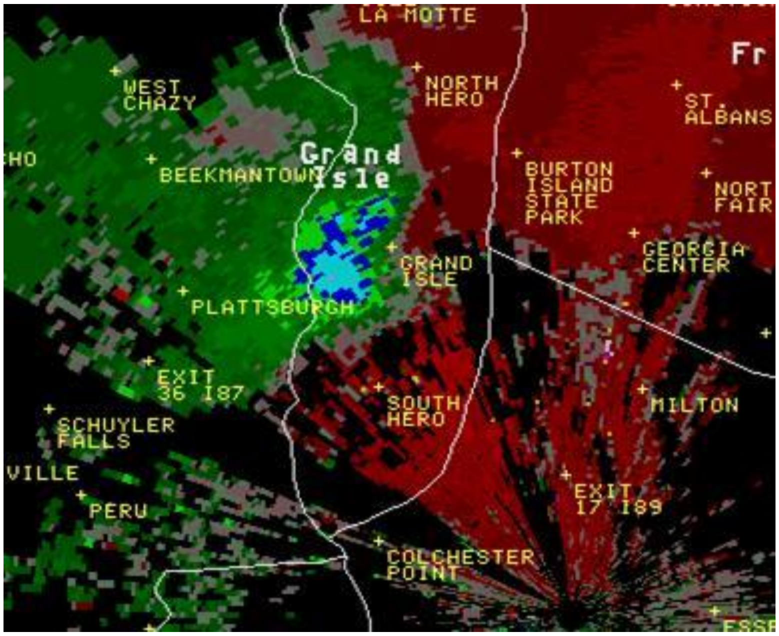

Figure 8 Low Level Velocity at 3:47 PM

Figure 9 below is a velocity cross section of the Champlain Valley Storm near Plattsburgh at 3:47 PM. The green colors are winds coming toward the radar, while the red colors are winds moving away from the radar or outbound winds. This cross section shows some very interesting features associated with the potential rotation in the low to middle part of the storm. Note the inbound (green color showing winds coming toward the radar) and outbound (red color indicating winds moving away from the radar) couplet circled in yellow. This suggests a cyclonic storm rotation between 2000 and 4000 feet above the surface. In addition, look how the strong updraft has tilted the low to mid level velocity signature from horizontal to vertical, which is outlined in the white circle. The storm had very good cyclonic or counter-clockwise rotation between 2000 and 4000 feet above the surface, but a cool outflow boundary cutoff the circulation and prevented the rotation from reaching the ground. The lightest color green in the picture below indicates inbound winds of greater than 50 knots or 58 mph. The darker red color is winds between 40 and 50 knots moving away from the radar.

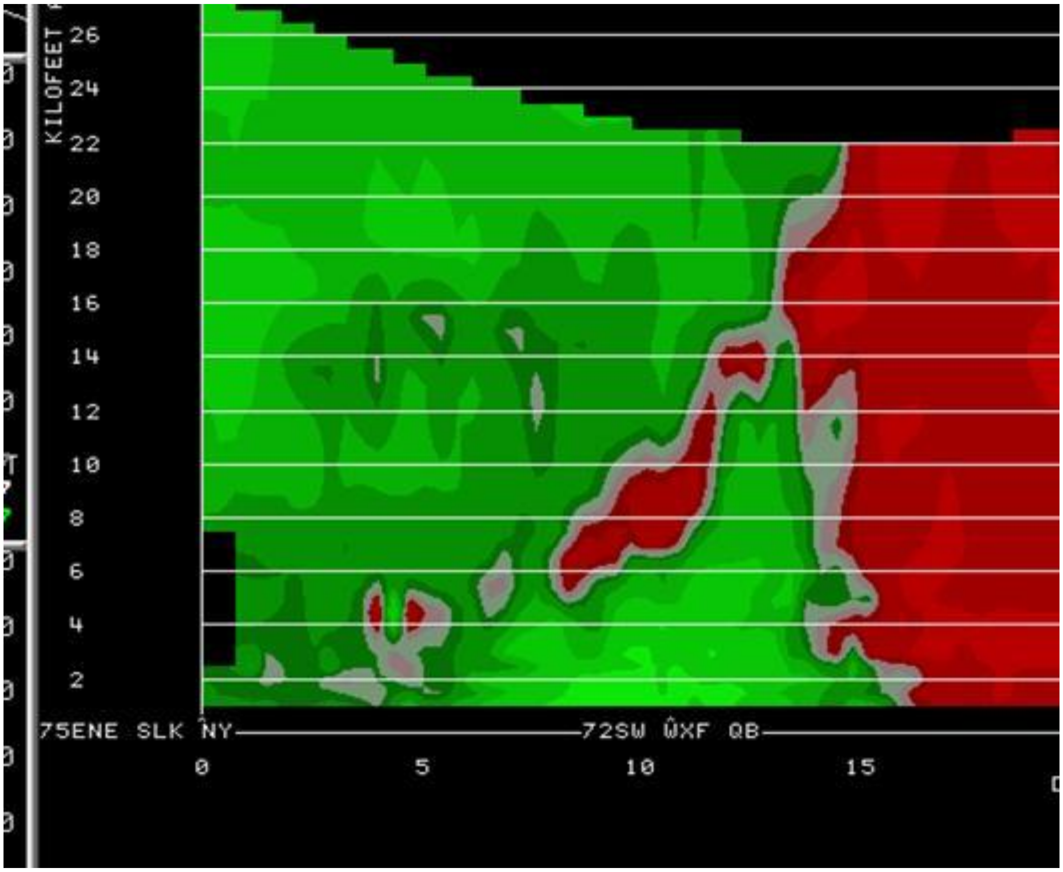

Figure 9 Vertical Velocity Cross Section Near Plattsburgh at 3:47 PM

Figure 10 below shows low level velocity data on the right and low level reflectivity data from the KCXX radar at 4 PM. The green and blue colors in the velocity data on the left display shows inbound winds of 40 to 70 knots. Note the very small outflow boundary, which cutoff the storms updraft and prevent the cyclonic rotation from reaching the ground. The image at the right shows the hook like reflectivity gradient, along with a core of very strong radar returns in the red/pink colors associated with the storms core.

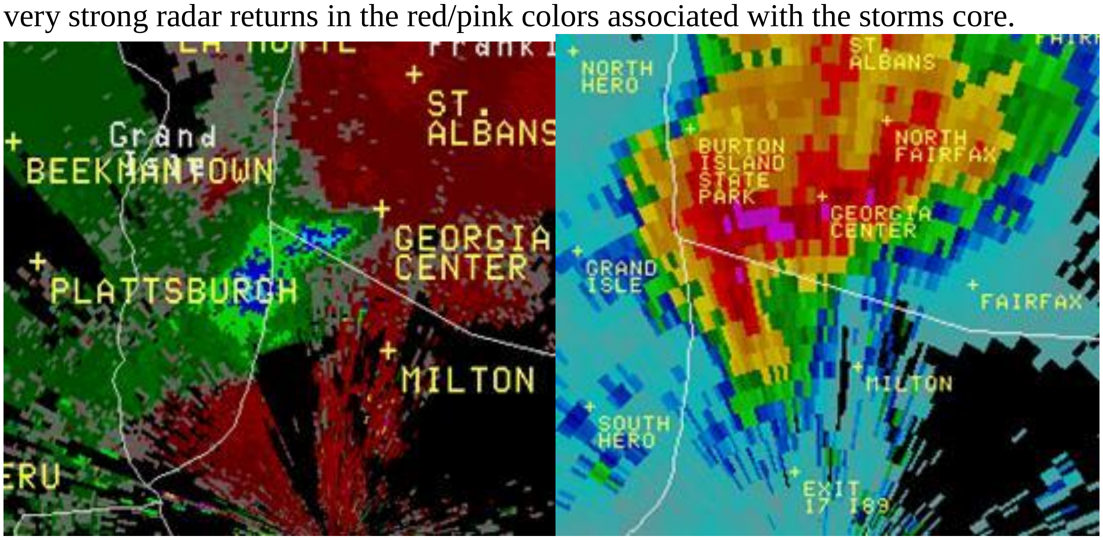

Figure 10 Velocity Data (left) and Reflectivity Data (right) at 4 PM

Supercell #2 (Rutland County from near Benson to just south of Killington)

A second supercell thunderstorm developed on August 16th, which tracked across northernRutland County into west-central Windsor County before weakening. The damage path started near Benson in northwest Rutland County and tracked east through Chittenden and toward the Hubbardton/Pittsford areas of northern Rutland County. A team of meteorologists from the National Weather Service in Burlington, Vermont surveyed the damage and determined the damage was caused by straight-line thunderstorm winds. The survey team estimated the winds ranged from 70 to 90 mph based on damage indicators and concluded the path was about 1/2mile wide and 2 to 3 miles long. They noted several hundred trees uprooted or snapped...but all blown down in the same direction, roughly northwest to southeast near Chittenden, Vermont. In addition, the team discovered the most significant and widespread damage to be near Chittenden Road, which was where the winds were funneled between two hills and accelerated in the valley. In the Hubbardton and Pittsford areas had only sporadic tree damage occurred and the team estimated the winds to be between 45 and 65 mph.

The storms environment was characterized by modest instability with CAPE values around 1500 J/kg, but very highly sheared. Shear means, there was plenty of turning and changing of wind speed and direction with height in the atmospheric profile. This shear helped to organize the supercell and caused the storm to exhibit strong rotation.

Figure 11 below shows the lowest level reflectivity display from the KCXX radar, along with the tornado vortex signature in the white triangle. The radar displayed a hook-like signature, very similar to the storms that impacted the northern Champlain Valley earlier in the day. The circled region on the figure below would be the area most favorable for tornadic development within this cell.

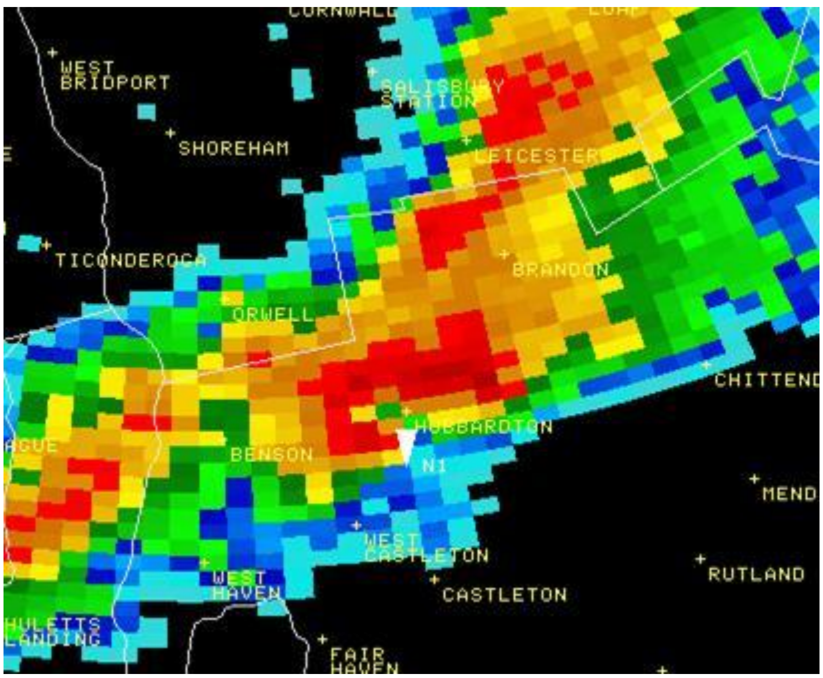

Figure 11 Reflectivity and Tornado Vortex Signature (White Triangle) on August 16th at 5:47 PM

Figure 12 below shows the storm relative motion data from the KCXX radar at 5:47 PM on August 16th, along with the digital mesocyclone detection display. This radar algorithm, which is highlighted in purple below will radar data to determine if the storm has circulation and the potential to produce a tornado. In addition, it will provide warning meteorologist a storm track of where the circulation is moving, which is shown in the purple line below in figure 12. Once again, the lighter green colors in the display show inbound winds or wind coming toward the radar of 40 to 50 knots, while the red colors are winds moving away from the radar. Note the strong gate to gate couplet shown in the storm relative motion display below, which is circled and indicating show low level rotation just north of West Castleton.

Figure 12 Storm Relative Motion and Digital Mesocylone Detection (purple) on August 16th at 5:47 PM

The following figure 13 below shows a 4 panel display of, composite radar reflectivity upper left panel, vertically integrated liquid upper right panel, one hour storm total precipitation lower left, and echo tops in the lower right display. The image was captured at 5:51 PM on August 16th, during the height of the damage produced by this storm across Northern Rutland County. The strongest part of this storm, that developed into a line of thunderstorms had vertical integrated liquid (VIL) values around 50 kg/m^2, along with 65 to 70 dbZ reflectivity returns, and storm echo tops of 50,000 to 55,000 feet tall. These values are very characteristic of s supercell thunderstorm, which would be found on the Central Plains of the United States. Furthermore, this storm produced one hour storm total precipitation amounts of around 1 inch.

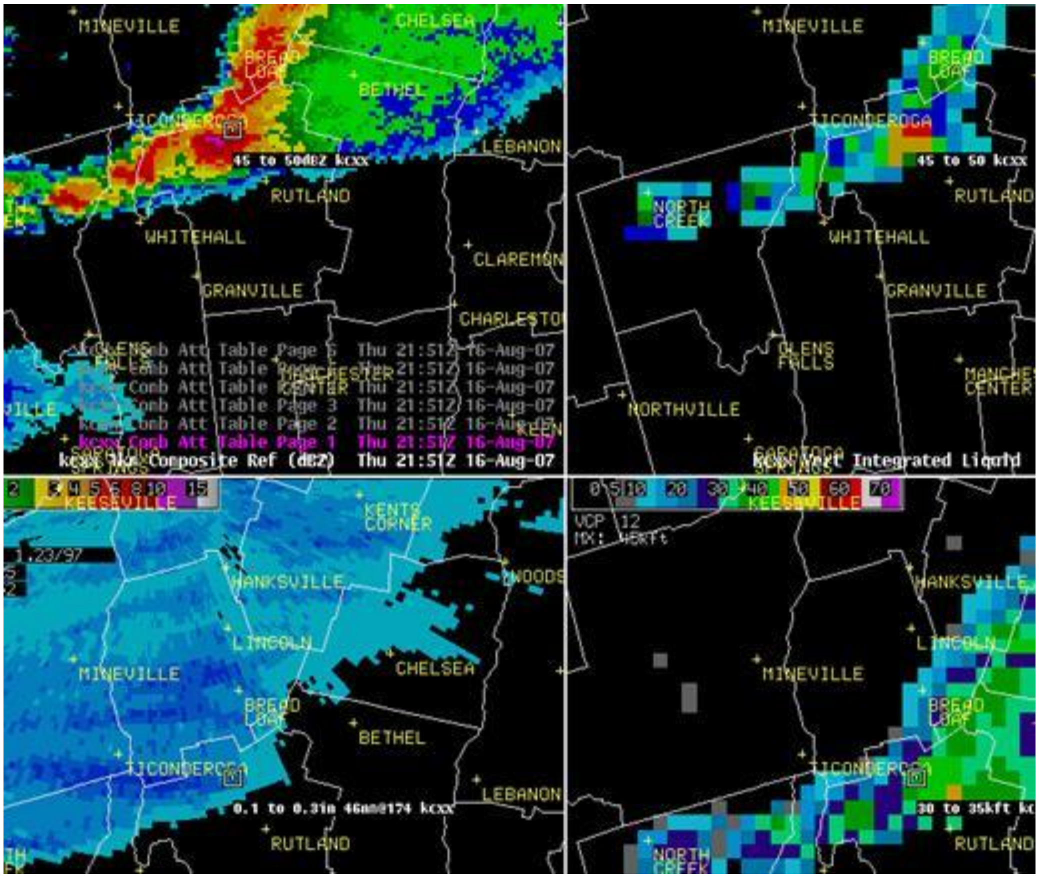

Figure 13 Radar 4 Panel of Composite Reflectivity (upper left), Vertical Integrated Liquid (upper right), One Hour Precipitation (lower left), and Echo Top (lower right) on August 16th at 5:47 PM

The figure below shows two reflectivity cross sections taking over northern Rutland County on August 16th at 5:42 PM and 5:47 PM. These cross sections are used to determine the height of the strongest radar return, along with a vertical examination of storm structure. The image at the lower left shows a weak bounded echo region (circled in yellow) between 4,000 and 8,000 feet above the ground, in the lowest elevation angles. This signature suggests a strong updraft holding the reflectivity core aloft. Furthermore, the first image shows a height of the 50 dbZ to 26,000 feet, which suggests the potential for strong winds and hail. The cross section on the right shows a very strong reflectivity core aloft (circled in yellow), which is being held aloft by the strong updraft. The reflectivity cross section on the right shows a 60 dbZ core to almost 26,000 ft. This is a very strong thunderstorm capable of producing widespread wind damage and large hail, which was the result, based on the storm reports we received from spotters and local law enforcement. Warning meteorologists look at vertical reflectivity cross sections to determine strength and height of the maximum radar reflectivity return, and the potential damage the storm can cause. Many times if we see a 50 dbZ return above the -20C isotherm or a 60 dbZ return above the 0C isotherm, the storm will be capable of producing severe hail penny size or large or damaging thunderstorm wind gusts.

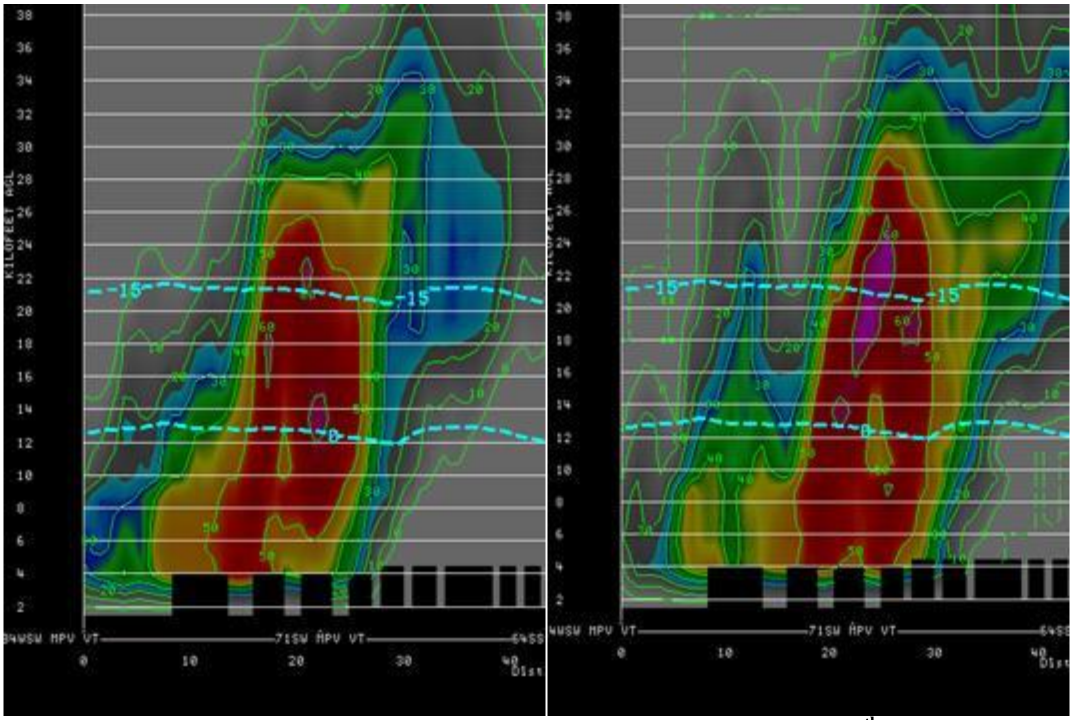

Figure 14 Reflectivity Cross Sections at 5:42 PM and 5:47 PM on August 16th

Storm Summary:

The 2007 severe weather season continues to be very active across northern New York as well as central and northern Vermont. The significant outbreak on August 16th featured two distinct supercells, which produced extensive damage. This on August 16th had numerous reports of large trees down and many people were left without power due to the strong winds knocking down trees and power lines. In addition, a tractor trailer was blown off Interstate 87 between exits 40 and 41 during the height of the storm, along with a measured wind gust to 91 mph at Cumberland Head near the Plattsburgh area. The following are several interesting storm structure pictures taken by National Weather Service Meteorologists from the South Burlington airport, along with a few damage survey pictures from Plattsburgh/Grand Isle area as well as a picture from northern Rutland County.