July 18th, 2008 Severe Weather Event across the North Country

On July 18th, 2008, several meteorological ingredients came together to produce a significant severe weather outbreak across northern New York and central and northern Vermont. The highest concentration of damage occurred from the Saint Lawrence Valley in northern New York into the northern Champlain Valley, then into central and northern Vermont. This particular severe weather outbreak produced over two dozen severe weather reports, with the primary damage being caused by strong and damaging straight line wind gusts. However, a damage survey and video obtained by the National Weather Service in Burlington, confirmed a brief EF1 tornado touched down several times in the North Cambridge, Vermont area. It was determined by the survey and the damage; winds approached 100 mph by this tornado. In addition, several nickel to quarter size hail reports occurred during this event. The widespread severe thunderstorms resulted in over 20,000 customers losing power across northern New York and Vermont during the event.

In this post storm write up, we will investigate one distinct area of damage, from a thunderstorm which develop across the northern Adirondack Mountains, then traveled east into Chazy, New York, through Grand Isle County, Vermont, then down the Lamoille River Valley to the Waterville, Vermont. A second storm which will not be investigated was an isolated supercell, which developed across southern Ontario, Canada and tracked into western and central Saint Lawrence County, New York on 18 July 2008. It should be noted other areas of damage occurred in Addison County, Vermont and across portions of eastern Vermont during this event, but will not be discussed in detail during this post event summary write up.

The maps below show the Storm Prediction Center (SPC) outlook for severe weather, along with the highlighted potential for damaging winds. SPC placed the WFO BTV forecast area in slight risk for severe thunderstorms, which indicated the potential for a significant severe weather outbreak. Click here for SPC's severe weather outlook day 1 text product. Click here for the text Mesoscale Discussion from SPC at 2 PM and click here for the graphic outline of the discussion.

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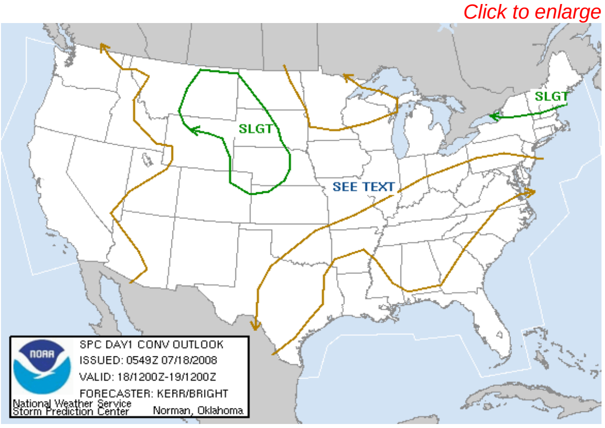

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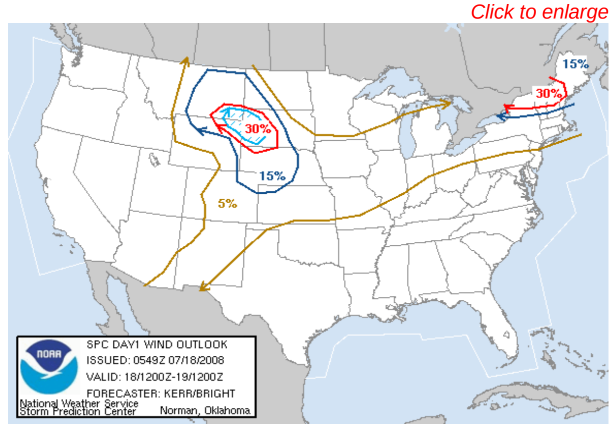

The image to the right (Figure 2) shows a Google Map plot of all the severe weather reports which occurred on July 18, 2008 across northern New York and parts of New England.

Click here to view the local storm report of all the severe weather reports, which occurred in the National Weather Service Office Burlington, Vermont forecast area.

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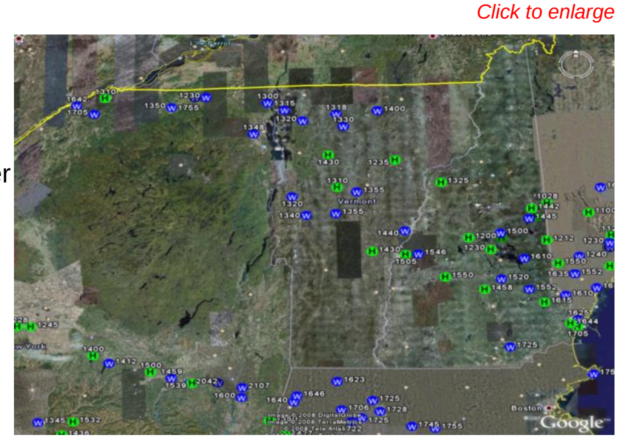

The first complex of storms produced widespread wind damage in a line from near Chazy, New York to Waterville, Vermont. A damage survey performed by The National Weather Service in Burlington, Vermont, estimated the winds to be between 70 and 90 mph, with near 100 mph associated with the localized tornado damage near North

Cambridge Road and Route 108. These winds resulted in widespread trees and power lines down across the region. We will closely examine low level radar data, including velocity and reflectivity displays to provide details of the storm in northwestern Lamoille County, near North Cambridge Road. However, first we will examine the pre storm environment and the ingredients which came together to produce this significant severe weather outbreak across the North Country on 18 July 2008.

Pre Storm Upper Air Environment

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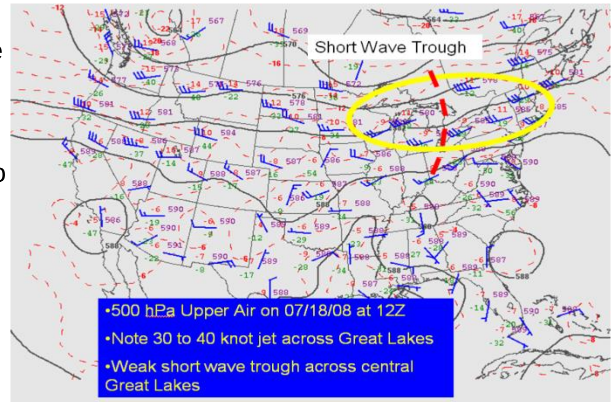

Figure 4 shows the upper air analysis at 500hPa (near 20,000 feet) on July 18th at 8 AM. Note the trough and weak short wave energy across the central and eastern Great Lakes, along with several embedded jet couplets of 35 to 45 knots.

As the trough moved into our region, these jet couplets helped to enhance lift for thunderstorms and created an environment favorable for severe thunderstorm winds.

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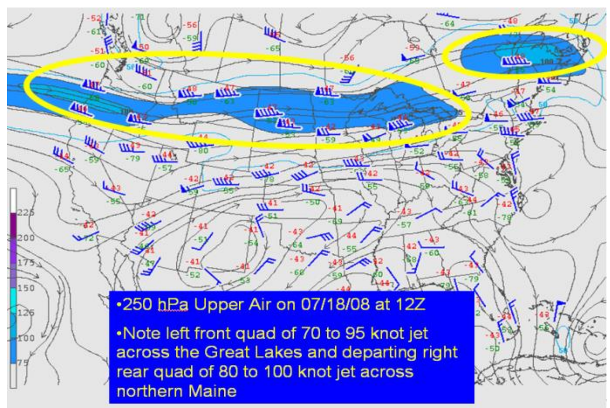

Figure 5 shows the upper air analysis at 250hPa (near 40,000 feet) on July 18th at 8 AM. Note the left front quadrant of 70 to 90 knot jet across The Great Lakes approaching our western New York.

In addition, the region was under a right rear quadrant of an 80 to 100 knot jet across northern Maine. These two jets helped to enhance upper level divergence (evacuation of air aloft) and upward motions associated with the developing thunderstorms.

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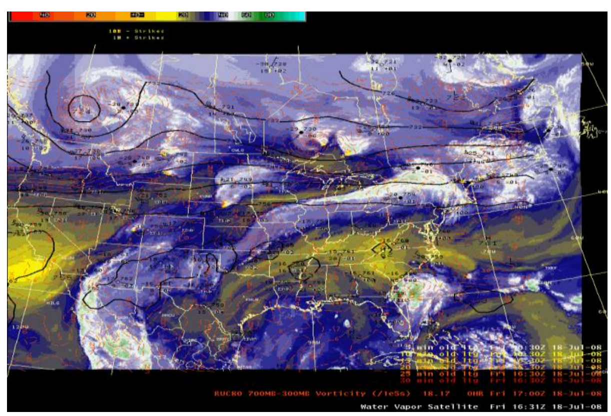

Figure 6 shows a water vapor loop from 1231 PM to 710 PM on July 18th. First note the quick movement of the clouds across the central Great Lakes into New England. This movement, along with the tight packing of the height contours (black lines) suggests very strong mid to upper level winds across our region. Furthermore, note the potent short wave energy digging across the central Great Lakes (denoted by red X) and the rapid development of lightning activity over central and northern New England after 4 PM on July 18th. Finally, as more short wave energy located north of Lake Superior, rotated toward the Saint Lawrence Valley after 6 PM on July 18th, more storms developed across southern Ontario, and track along a low level boundary into western and central Saint Lawrence County, New York. The mid and upper level pattern on July 18th featured a well established ridge across the southern United States with a developing mid/upper level trough across the central and northern Great Lakes. The gradient between these two systems helped to enhance favorable mid/upper level wind fields across the area.

Pre Storm Surface and Thermodynamic Environment

The pre storm thermodynamic environment featured a strong low level boundary/thermal gradient in place with surface temperatures well into the 80s across southern Vermont and only in the upper 60s across northern Vermont. In addition, to the warm surface temperatures, plenty of low level moisture was available with dewpoints in the 60s, along this east to west boundary. These temperatures and surface boundary combined with plenty of moisture contributed to a very unstable atmosphere, which produced robust updrafts and towering cumulus clouds, and eventually very strong thunderstorms. The combination of a surface cold front approaching the Saint Lawrence Valley and a strong west to east instability axis across central Saint Lawrence County, helped to enhance a second round of storms after 6 PM on July 18th.

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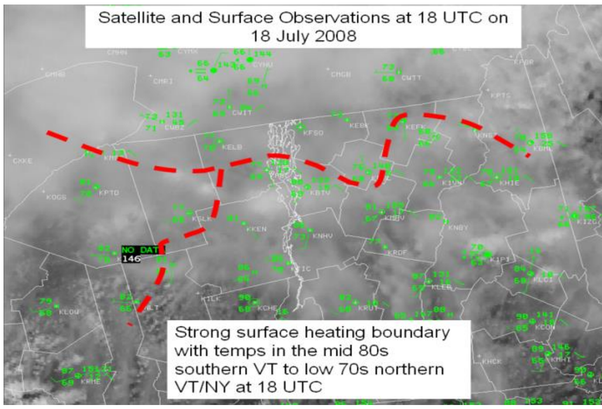

Figure 7 shows the surface analysis at 2 PM on July 18th. Note the west to east boundary across northern New York into northern Vermont, separating the low to mid 80s from the 70s.

Also, note the weak outflow boundary left behind from convection earlier in the morning, which has help in the development of more thunderstorms during the afternoon hours on July 18th.

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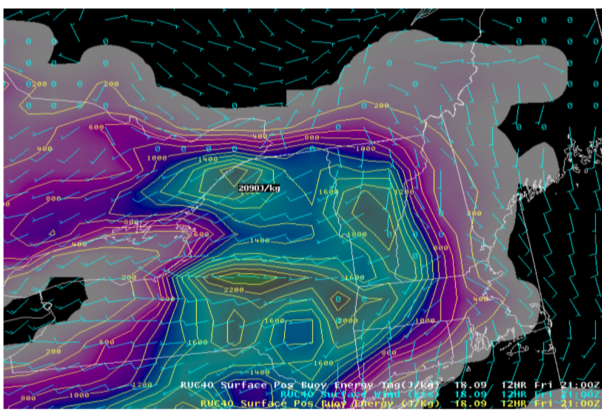

Figure 8 shows surface based CAPE and wind analysis across northern New York and Vermont. Simply put, CAPE (Cape Available Potential Energy) is an indication of atmospheric instability and potential upward motion within the atmosphere.

Note the surface based CAPE axis of 1500 to 2000 j/kg across the central and southern Vermont, along with another axis across the Saint Lawrence Valley. This diagnostic helps forecasters identify areas of maximum instability and the potential for severe thunderstorms, if vertical wind shear and a lifting mechanism are also present.

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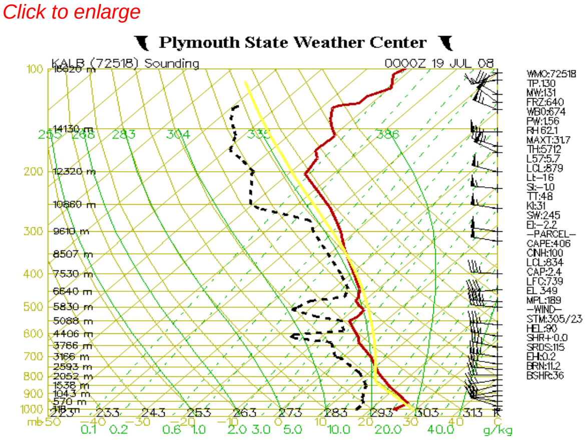

Figure 9 shows the 8 PM Albany sounding on July 18th. A sounding is a vertical profile (from the surface to 50,000 feet above the surface) of the temperature and dewpoint, and the winds. This helps forecasters determine the winds aloft, amount of vertical instability, and available moisture in the column of air. The Albany sounding showed very steep 950 hPa to 700 hPa lapse rates from strong low level heating and developing cold pool aloft. In addition, this sounding below showed strong 500 hPa winds of 40 knots with 700 hPa winds of 35 knots. The parcel instability parameters were limited do to the loss of surface heating and mixing out of low level boundary layer moisture. Furthermore, the very moist column produced plenty of clouds, which limited the amount of surface instability in the Albany area. The Maniwaki sounding (not shown) did have stronger 700 hPa and 500 hPa winds, which helped to enhance the deep layer shear across our central and northern forecast area. These strong winds and the amount of available CAPE in the atmosphere were excellent indicators for thunderstorm development, with the primary threat being severe winds. Also, note the precipitable water value near 1.50 inches. These values suggested the potential for strong to severe thunderstorms capable of producing damaging winds and very heavy rainfall. However, with the freezing level around 13,500 feet, the potential of severe hail would be limited to occur only in the strongest storms that had the greatest vertical development.

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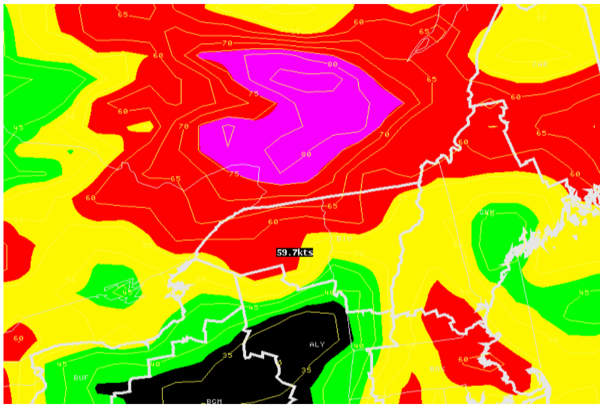

Figure 10 shows the RUC 2 PM 0-6 KM shear analysis. Note the 60 to 80 (outlined in red) knot shear values across northern New York into Vermont, associated with a strong mid to upper level wind field over the region.

This shear helped in the development and organization of thunderstorms, and provided an environment favorable for super cell development, especially across northern New York and Vermont.

Radar Analysis

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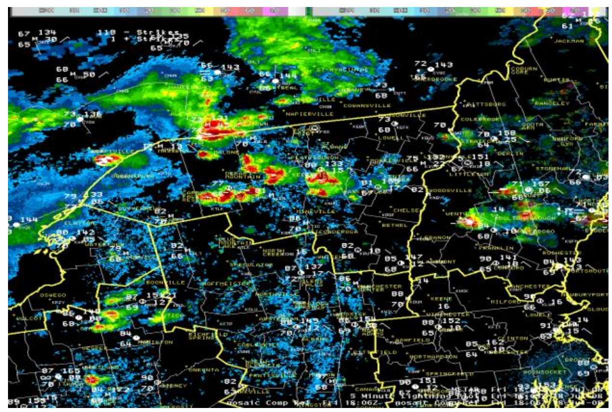

In the radar analysis we will closely examine two storms which produced widespread wind damage across northern New York and Central Vermont. The radar display below shows a mosaic composite reflectivity loop with lightning data starting at 206 PM and ending at 754 PM on July 18th. In this loop notice the numerous thunderstorms developing along and just north of the surface boundary across northern New York into central Vermont. The bright purple and red dBZ returns, indicate very strong thunderstorms, capable of producing severe winds or large hail. Also, note the very quick movement of the individual thunderstorm clusters, which suggests very strong steering winds aloft.

Chazy, New York to Isle La Motte to North Cambridge to Waterville, Vermont Storm Analysis

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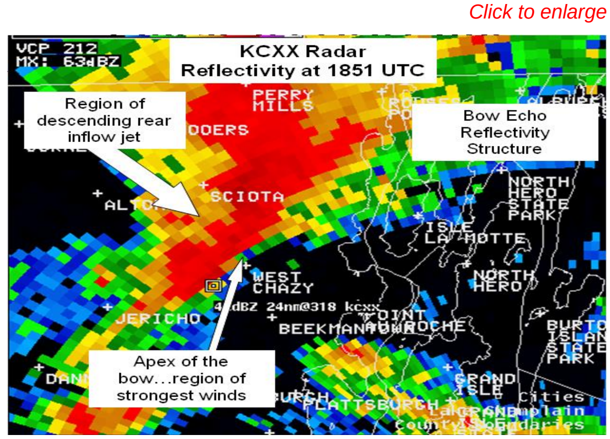

Figure 12 shows the KCXX radar reflectivity across the northern Champlain Valley at 251 PM on July 18th. The reflectivity structure represents a bow-echo pattern, which is associated with producing strong and damaging thunderstorm winds. A bow echo is a mesoscale convective system, which is shaped like an archers' bow and can produce severe straight-line winds and occasionally a tornado. These systems range in size from 20 to 200 km and have a life span of 3 to 6 hours. The bow shaped echo is a result of focusing of the strong flow at the rear of the system, which is noted in figure 11 below by the decreasing reflectivity gradient in the rear part of the storm. The strongest concentration of wind is found around the apex of the bow echo, which is near Chazy, New York in the image below.

Click to enlarge

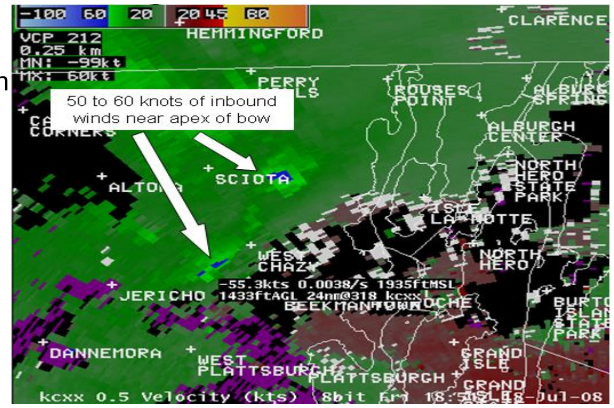

Figure 13 shows KCXX velocity display at 251 PM on July 18th. The green and blue colors highlighted near Chazy, New York in the image above, shows winds coming toward the KCXX radar in Colchester, Vermont of 50 to 60 knots. These winds are associated within the apex of the reflectivity bow echo, which is displayed in figure 11. As the storm continued to track across extreme eastern Clinton County, New York into Grand Isle County, Vermont, the velocity signature became stronger and closer to the ground. This was caused by the radar sampling the storm better and the closer proximity to the radar.

North Cambridge to Waterville, Vermont Tornadic Storm

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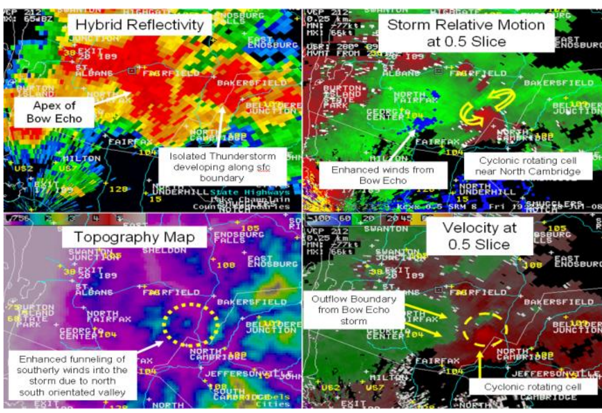

The bow echo continued to track southeast, along a west to east surface boundary, which was draped from near Chazy, New York to Waterville, Vermont. Meanwhile, several isolated storms developed ahead of the bow echo, along the boundary near Bakerfield, Vermont around 320 PM. Figure 14 is a four panel display from the KCXX radar in Colchester, Vermont at 323 PM on July 18th. The first panel in the upper left is a hybrid reflectivity scan, which shows the apex of the bow echo interacting with an isolated thunderstorm near Bakerfield, Vermont. The storm relative motion (SRM) display, which is located in the upper right panel, clearly shows a broad rotating storm near North Cambridge, Vermont, with strong outflow winds from the bow echo storm approaching the area of rotation. In the SRM product, the average storm motion is subtracted out to better examine rotation within a storm, which provides for better detection of storm circulations, especially in fast moving storms.

In the lower left corner of figure 14 above is topography map of the terrain near North Cambridge, Vermont. It should be noted, the rotating storm was located within a south to north orientated valley, which helped to enhance the low level storm circulation. Southerly winds are funneled into these valleys and help to organize the turning of the low level winds, especially if a west to east orientated boundary is present. The 0.5 degree velocity product is displayed in the lower right corner of figure 13 above. This shows the outflow boundary approaching the isolated rotating thunderstorm near North Cambridge. The velocity values are much weaker (10 to 20 knots) at this time, because the storm is moving perpendicular to the radar, which is located to the southwest in figure 14. Storms which move down the radial beam or directly toward or away from the radar are sampled much better by the doppler radar.

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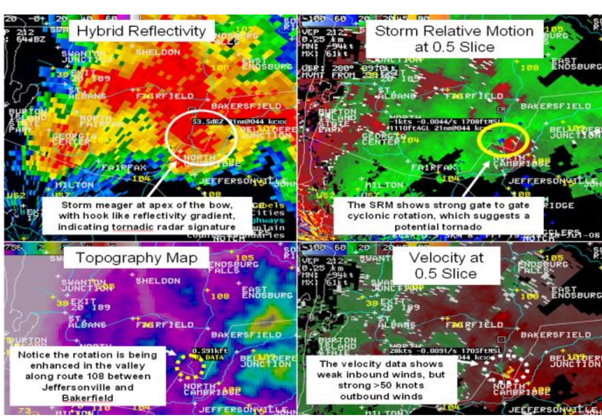

Figure 15 shows a four panel of hybrid reflectivity scan, storm relative motion, topography map, and velocity display at 323 PM on July 18th. Note in the hybrid reflectivity scan in the upper left corner the apex of the bow echo storm has merged with the isolated thunderstorm just south of Bakersfield, Vermont. The wind energy associated with the bow echo, along with strong southerly inflow from valley orientation, has resulted in a tight gate to gate cyclonic rotating thunderstorm. The reflectivity gradient shows weak hook like structure, which combined with the rotation observed in the SRM product in the upper right, supports the formation of a tornado. The SRM showed 30 to 40 knots outbound (upper right red color) with 40 to 50 knots inbound (upper right blue color) with total rotation of 70 to 80 knots. Based on the storm survey damage, radar data, and talking with eyewitnesses on the ground, the tornado touched down several times from near North Cambridge Road to Route 108. The initial touch was rated an EF0, but the damage on route 108 near a farmstead was consistent with damage found associated with an EF1. A complete post storm survey with pictures will be included in the next section.

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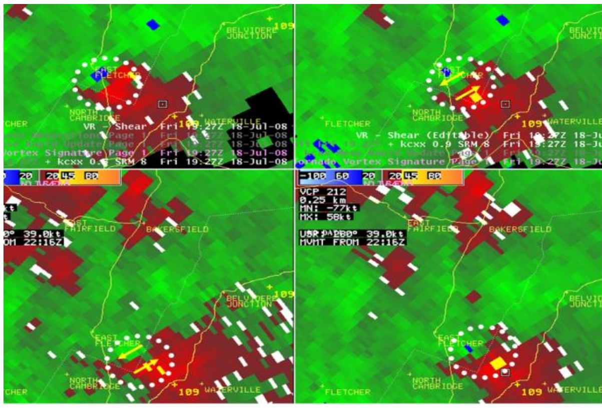

Figure 16 shows the lowest four elevation scans of the storm relative motion product from the KCXX radar at 327 PM on July 18th. Note the strong gate to gate cyclonic circulation in the SRM. The blue colors in the SRM product above indicate inbound winds of 40 to 50 knots, while the yellow colors represent outbound winds of 40 to 50 knots. The closer the color couplet is together, the stronger and tighter the low to mid level circulation is. This was the time and location of the tornado, which touched down several times between North Cambridge Road and Route 108 between East Fletcher and North Cambridge.

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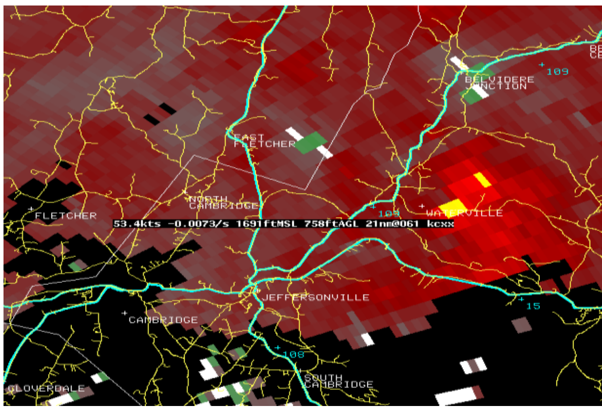

Figure 17 shows the KCXX velocity at 332 PM on July 18th. This radar display shows the storm has become outflow dominated with radar velocities approaching 50 knots near Waterville, Vermont.

The yellow color in the image above shows outbound winds, moving away from the KCXX radar. The damage survey performed by the NWS supports straight line wind damage occurred south and east of Waterville, Vermont along Plot Road.

Damage Path and Survey Pictures

The image below shows a Google Map outline of the damage, which occurred in the Cambridge to Waterville, Vermont area. From the map and the survey The National Weather Service determined the damage started on Pond Road in North Cambridge, then continued eastward across Kinsley Road, North Cambridge Road, Route 108, then Route 109 about 1 mile south of Waterville, and finally ended on Plot Road several miles southeast of Waterville. We determined the damage from Pond Road to Kinsley Road was caused by straight-line winds between 70 and 90 mph from the bow echo which also impacted the Grand Isle County area. Meanwhile, as the bow echo interacted with strong southerly winds moving up the North Cambridge Road Valley, and Route 108 Valley, two brief EF0 and EF1 tornadoes touched down. The first touch down on North Cambridge Road, is labeled with a "T" in the image below and produced winds up to 80 mph. Meanwhile, the next touch down occurred near a farmstead located on Route 108 and produced winds up to 100 mph according to the amount of damage and is also labeled with a "T" on the image below. The lighter white areas represent winds of 50 to 60 mph with isolated to scattered trees down and minor damage was observed. Meanwhile, the brighter white color in figure 17 below indicates winds between 70 and 90 mph with isolated areas of winds approaching 100 mph based on the damage. The damage path was about 6 to 7 miles long and one third to one half mile wide. According to eyewitnesses the storm occurred between 3:27 PM and 3:35 PM on July 18th. The worst of the damage occurred near North Cambridge Road and Route 108, where 80 to 90 percent of the trees, mostly softwood, were blown over or snapped midway up. There was also significant structural damage which occurred to a farmstead along Route 108.

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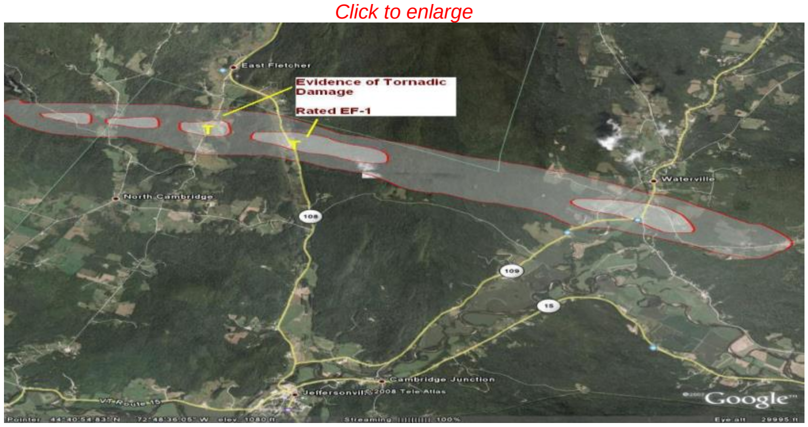

Click here to view video taken by Nancy Lepsiz along North Cambridge Road. Note in the video, the rapid changing of wind direction from south at the start of the video to northwest toward the end of the video, along with several trees going down. The convergence of two different wind directions and the valley orientation helped to produce two brief tornado spin ups. The pictures taken below were taken during the NWS damage survey from Pond Road to Route 108.

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The Chazy, New York to Isle La Motte, Vermont damage was due to straight line thunderstorm winds of approximately 70 to 80 mph, based upon analysis of damage pictures and video, as well as radar analysis. The damage path was about 10 to 15 miles long. The damage started around 300 PM along Miner Farm Road (Route 191) between Olena and Ridge Roads and Continued east-southeast through Chazy, New York then moved over Lake Champlain, impacting some of the island communities before reaching the eastern shore of the lake and finally affecting the residents between Saint Albans and Georgia between 320 and 325 PM. The hardest hit areas were around Chazy and the town of Isle La Motte, especially along portions of West Shore Road. The open waters of Lake Champlain allowed the winds to accelerate before coming ashore in Isle La Motte and caused damage to dozens of homes and downed hundreds of trees.