June 9th, 2004 Severe Weather

On June 9th 2004 a significant severe weather outbreak occurred across northern New York as well as central and northern Vermont. The event featured numerous lines of thunderstorms with embedded supercells, which started in the morning hours across northern New York and continue through the day. This severe weather outbreak included tornadoes, large hail, and damaging winds. Figure 1 below from the Storm Prediction Center (SPC) shows the location and type of severe weather that was reported across our county warning area during the event. (Not all reports are plotted)

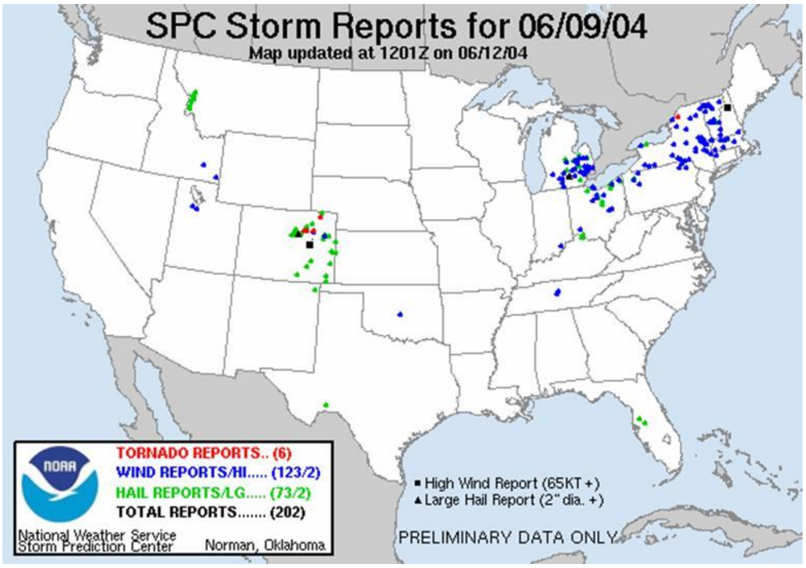

Figure 1 Shows Severe Weather Reports

A National Weather Service team conducted an aerial and ground survey of the damage across Saint Lawrence County in northern New York and concluded that two F0 tornadoes occurred. The first tornado occurred in western Saint Lawrence County near Chippewa Bay, while the other tornado touched down 3 miles southeast of Gouverneur. The tornadoes were part of a supercell thunderstorm that tracked southeast from southern Canada into Saint Lawrence County. The following link is a public information statement about the intensity, location, and details of the damage from the two tornadoes.

Click here for the Public Information Statement

In addition, numerous locations across northern New York as well as central and northern Vermont sustained wind damage with many reports of trees and power lines down. This event included over 20 reports of severe weather, with our office issuing numerous severe thunderstorm warnings and a tornado warning, along with many other severe weather statements and nowcasts.

Click here for the Local Storm Report Summary

Research shows the last tornado to occur in Saint Lawrence County was in 1989 before the event on June 9th. Since 1950 only 7 tornadoes have been reported in Saint Lawrence County, with the highest being rated an F2, which occurred twice, once on Sept 19, 1954 and again on August 15, 1986. Tornadoes across our northern New York zones are very rare with only 11 being reported since 1950. However, so far this year 3 tornadoes have been reported in this region, which includes: Saint Lawrence, Essex, Franklin, and Clinton Counties in northern New York. Below you will find the history of tornadoes across Saint Lawrence County since 1950.

	County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1	ESSEX	05/06/1952	1300	Tornado	F2	0	0	25K	0
2	ST. LAWRENCE	09/19/1954	1730	Tornado	F2	0	0	25K	0
3	ESSEX	10/16/1958	1530	Tornado	F1	0	0	25K	0
4	ST. LAWRENCE	08/07/1972	1200	Tornado	F1	0	0	25K	0
5	ESSEX	05/09/1978	1730	Tornado	F	0	0	0K	0
6	ST. LAWRENCE	05/31/1985	2030	Tornado	F1	0	0	250K	0
7	FRANKLIN	07/26/1986	0950	Tornado	F1	0	0	250K	0

8	ST. LAWRENCE	08/15/1986	1630	Tornado	F2	1	3	250K	0
9	ST. LAWRENCE	07/24/1987	1435	Tornado	F0	0	0	250K	0
10	ST. LAWRENCE	08/09/1988	2130	Tornado	F0	0	0	3K	0
11	ST. LAWRENCE	07/10/1989	0420	Tornado	F1	0	1	25K	0

This case study will include an in-depth analysis of radar data and the signatures associated with the tornadoes, along with velocity displays that produced significant wind damage across the North Country. In addition, satellite and surface observation data will be used to show low-level boundaries and the air mass across the forecast area before and during the event. Also, water vapor will be used to show upper level energy, along with areas of moisture. Finally, LAPS data will be used to assess low level instability and shear during the event, along with some interpretation of model data.

Synoptic Overview:

The upper level pattern on June 9th showed a mid/upper level ridge across the southeast United States, with a fast west to east flow over our forecast area. Embedded within the fast flow aloft were several jet couplets and vorticity maximums. The closeness of the height contours, along with the 250mb upper air analysis showed a strong 130 knot jet across southern Canada. This upper level jet helped to enhance divergence aloft across our region. Figure 2 below shows the 250mb upper air analysis on June 9th at 12z.

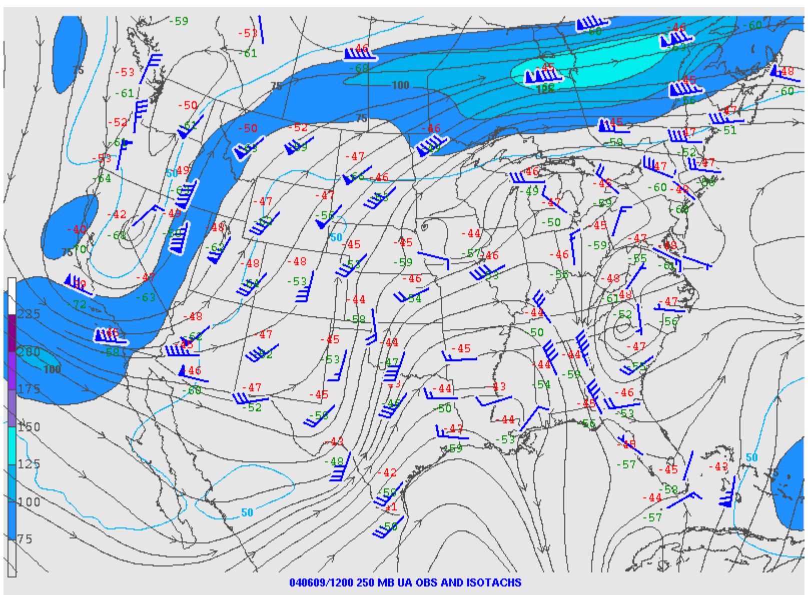

Figure 2: 250mb Analysis

The 500mb and 700mb analysis also showed a couplet of stronger winds across southern Canada at 12z. The 40 knot winds at 700mb, along with the 50 knot plus winds at 500mb helped enhance the shear and lift across the region. Also, note the tongue of 700mb moisture over southern Canada and the central Great Lakes advecting into our northern county warning area associated with the board southwest flow aloft. Figure 3 shows the 700mb upper air analysis on June 9th.

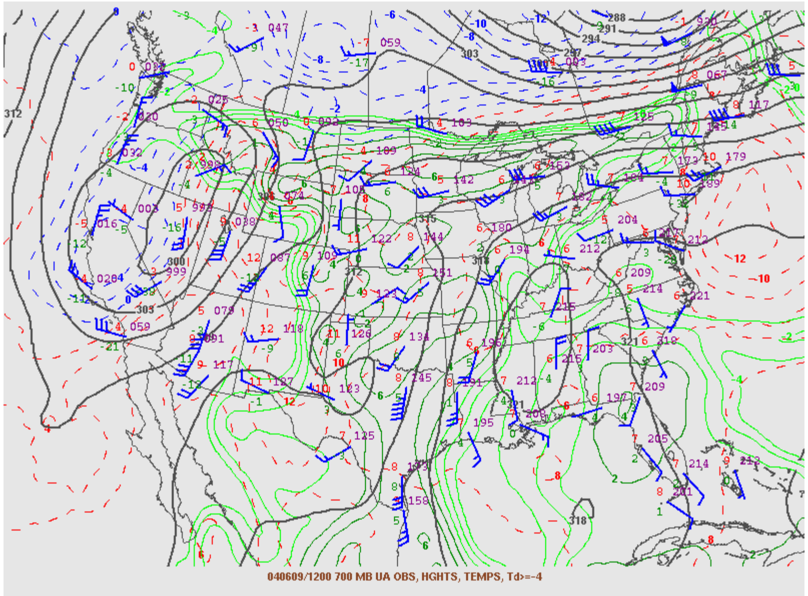

Figure 3: 700mb Analysis

The following link shows a water vapor loop from around 12z on the 9th through 23z. Also, displayed is lightning data, along with the 20km ETA height and Vorticity analysis. This shows the fast flow aloft with several embedded vorts traveling across our northern zones.

Click here for a Water Vapor Loop

Model Data:

Overall the GFS and ETA both handled the synoptic features associated with this event very well. They had the timing of the surface cold front approaching the Saint Lawrence Valley around 18z and pushing across our forecast area by 00z. Also, the models handled the initial 500mb vorticity maximum well by tracking it from Canada across our northern zones. Both models showed plenty of mid level moisture and lift across our region, along with favorable thermal profile for surface heating. 850mb temperatures near 14C supported highs well into the upper 70s to mid 80s across the region with surface dewpoints in the 60s and lower 70s. The four-panel display below shows the 18z GFS progged frontal position, along with the 700mb and 500mb height fields. In addition, the models predicted precipitation is displayed and the progged 850mb temperatures.

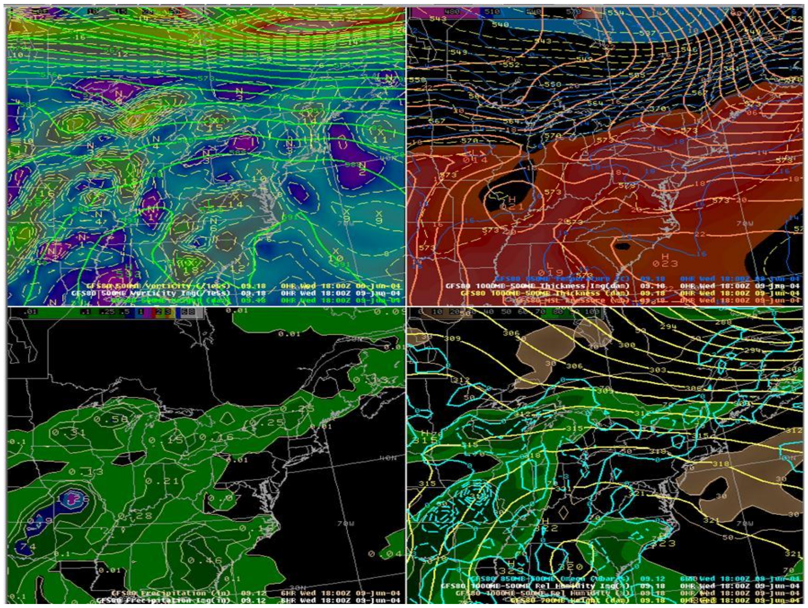

Figure 4: 18z GFS

Model Analysis of Shear and Instability Parameters:

The 20km ETA was used to determine the low-level shear and instability parameters for this event. This model seemed a few degrees too high on progged surface dewpoint across the Saint Lawrence and Champlain Valleys. However, with surface temperatures in the 70s and 80s and dewpoints well into the 60s, this created a very unstable air mass across the region. The 20km ETA did a very good job capturing the low level advection of high-octane air in the southern Champlain Valley and parts of northern New York.This helped to create CAPE values greater than 2000 J/KG and Lifted Index values greater than -4 across our southern forecast area.

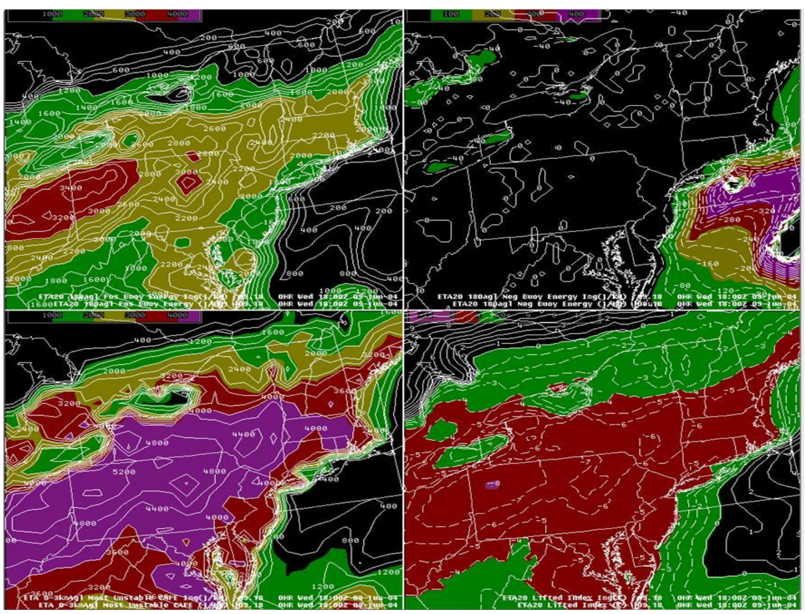

Figure 5: Low-Level Instability Parameters

The combination of instability and shear parameters, such as VGP and EHI showed an axis from the Hudson Valley into the southern Champlain Valley of favorable conditions for thunderstorms development.The VGP values were greater than 0.30 with EHI around 1.5. These numbers along with BRN Shear numbers near 80 support development of supercell thunderstorms. The best shear parameters for this event were located across our northern zones associated with the strong low/mid level winds.

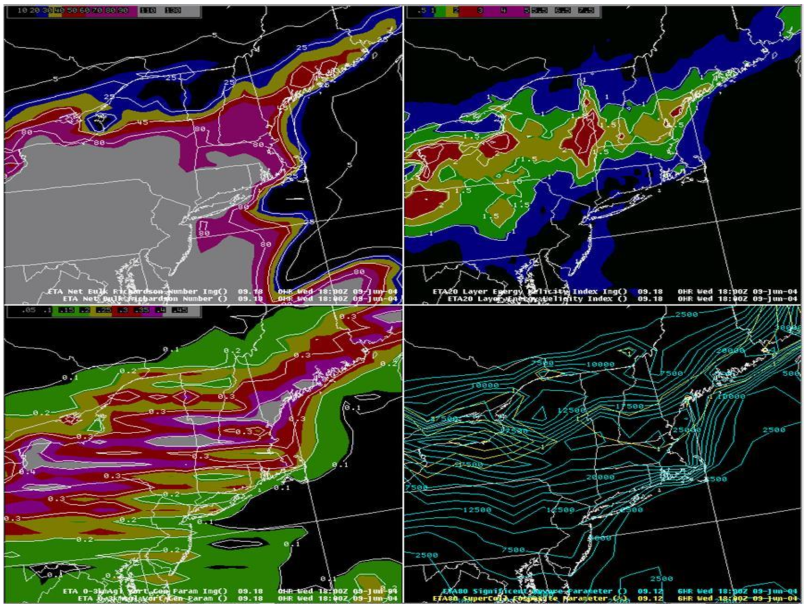

Figure 6: Combination of Shear and Instability Parameters

<u>Pre-Storm Conditions</u>

The pre-storm conditions included plenty of sunshine across the region, which helped to warm surface temperatures into the 70s and 80s. The surface cold front at 16z was located across southern Canada based on the observation and visible satellite trends. The link below shows a visible satellite loops with surface observations and lightning data starting at 15z and ending at 22z on June 9th. This loop shows the development of the first line of storms around 15z across the Saint Lawrence Valley and the quick movement across our region. The high winds were associated with the first line of storms. Meanwhile, another complex of severe thunderstorms developed over the northern Adirondack Mountains around 19z and the final cluster of storms moved into our western zones by 20z. Each area of storms contained severe weather, along with plenty of lightning and setup numerous outflow boundaries.

Click here for a Visible Satellite Loop

The following links contain the Storm Prediction Center Day 1 outlooks for severe thunderstorms, in addition to their chances for severe hail and winds. Also, there′s a link to the 12z Day 1 severe weather outlook discussion.

Click here for the SPC Day 1 Outlook Discussion

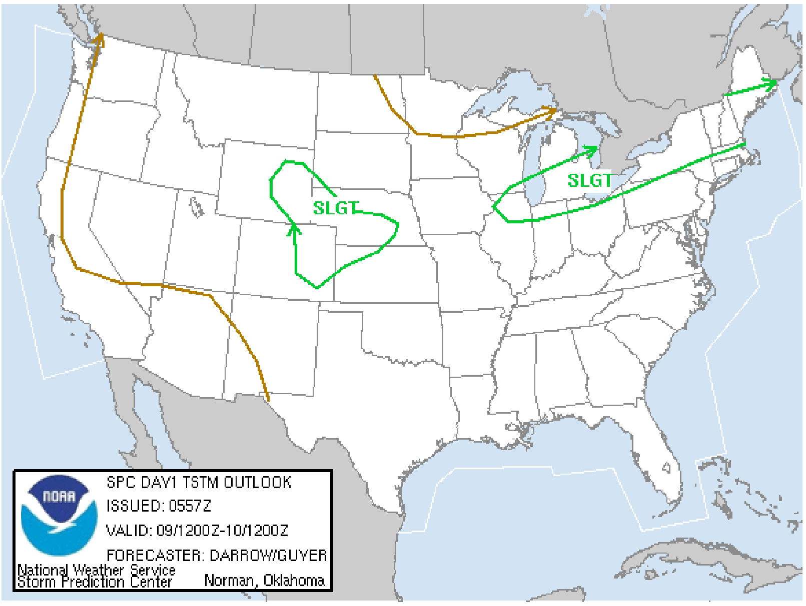

Figure 7: Storm Prediction Center Day 1 Severe Weather Outlook

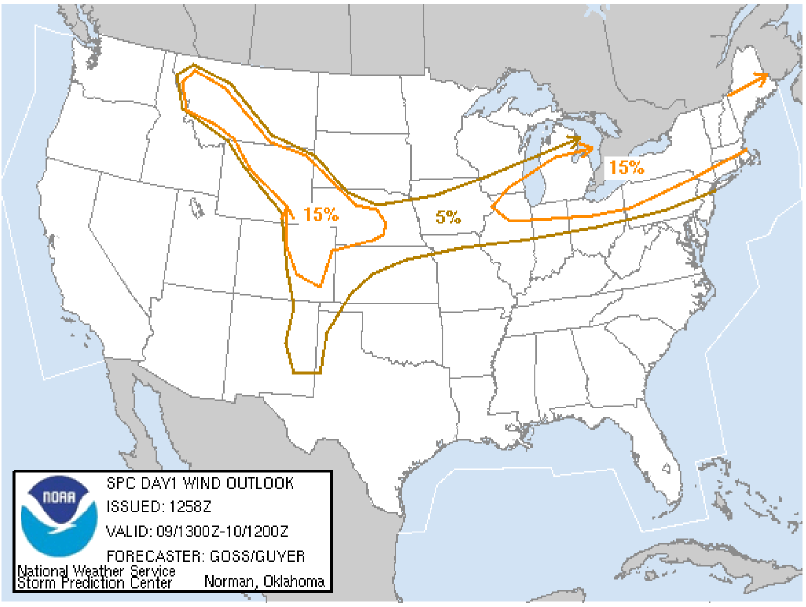

Figure 8: Wind Outlook

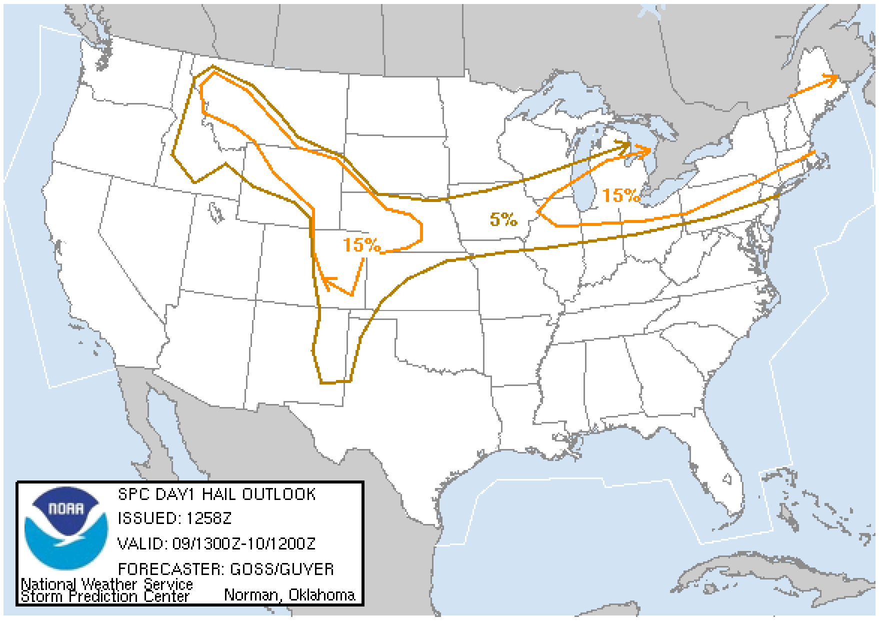

Figure 9: Hail Outlook

The visible satellite picture below is at 1932z and shows several low level boundaries across the region. The first significant boundary is approaching the Saint Lawrence Valley associated with the cold front. The next boundary is leftover outflow from the first line of convection. Also, note the differential heating boundaries and structure of the cumulus clouds across northern New York.

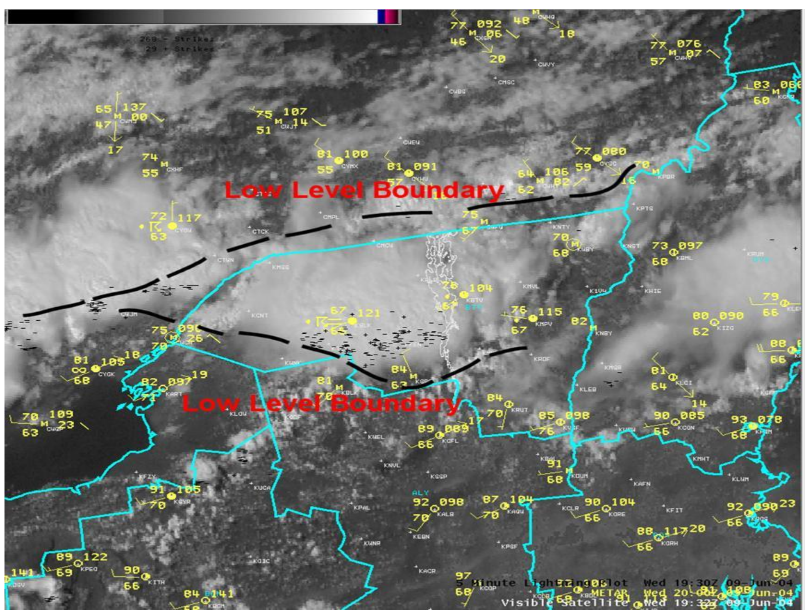

Figure 10: Visible Satellite at 1932z

The 19z LAPS analysis showed an axis of very unstable air from southern Saint Lawrence County into Rutland County, which was along a low level boundary. Also, noted was strong low-level moisture convergence along the east-west boundary across northern New York. CAPE values ahead of this boundary were between 2000-3000 J/KG with VGP axis of greater than 0.30.The figure below shows the LAPS analysis at 19z.

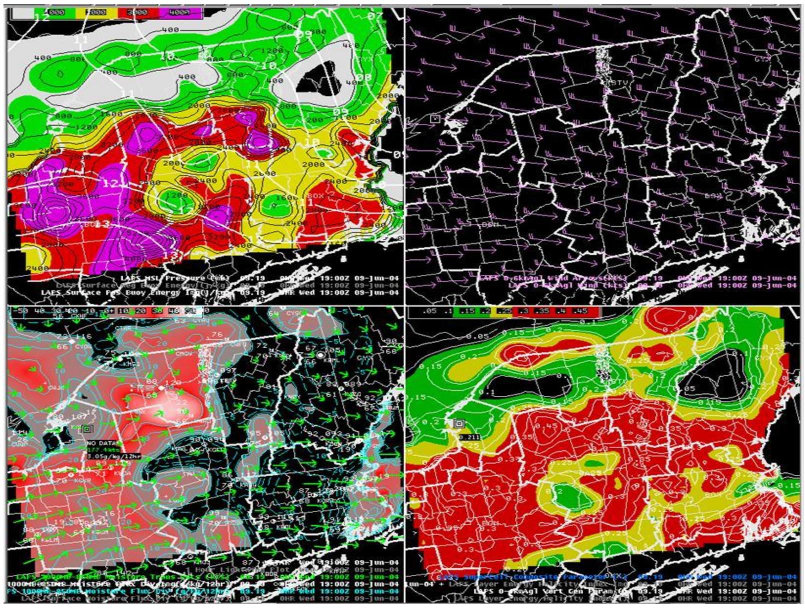

Figure 11: 19Z LAPS Analysis

Radar Analysis:

The radar analysis showed numerous lines and clusters of thunderstorms moving across our forecast on June 9th. The first composite reflectivity loops shows the line of severe thunderstorms that produced significant wind damage across the Champlain Valley and eastern Adirondack Mountains. In the loop notice the quick movement of the cells to the east. In addition, note the development of new cells across the Saint Lawrence valley.

This data shows several bow like line segments structures with DBZ returns greater than 60, especially across the Champlain Valley and western slopes of the Green Mountains. The link below shows a mosaic composite reflectivity loop from 16z to 17z on June 9th.

Click here for the Composite Reflectivity Loop from 16-17z

The next composite reflectivity loop is from 20z to 22z. This loop shows numerous clusters of thunderstorms across the region with a few embedded supercells. One especially strong cell is located across southern Saint Lawrence County and produced several TVS alerts between 2006-2042z. This cell will be examined closer with storm relative motion products and up-close radar displays. However, the link below shows a mosaic composite reflectivity loop from 20z to 22z.

Click here for the Composite Reflectivity Loop from 20-22z

Storm Relative Motion Products:

The Storm Relative Motion product from the TYX radar in Montague showed several gate-to-gate cyclonic circulation couplets in the cell that tracked from Chippewa Bay and through southern Saint Lawrence County. The TVS signature showed low-level delta velocity of 70-knots in Chippewa Bay with circulation depth from 3,300 to 28,000 feet. In addition, the low-level shear from Vr shear was 0.02/s suggesting potential for tornadoes. This couplet and TVS persisted for several scans as the cell tracked from Chippewa Bay to just southeast of Gouverneur. The following radar displays are the lowest elevation scans of the SRM product from the Montague radar.

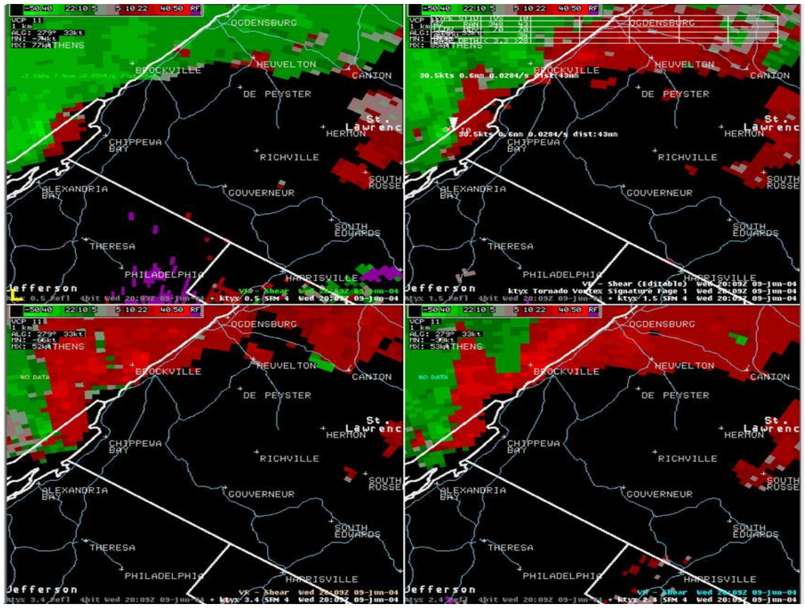

Figure 12: Storm Relative Motion 2009Z

The next SRM product was taken at 2019z on June 9th.This continues to show a TVS near Chippewa Bay and very close to Route 37. At this time the low-level delta velocity was 46 knots, while the mid- level delta velocity was 56 knots. The inbound/outbound couplet near Chippewa Bay still showed pure cyclonic circulation and gate-to-gate. This cell was traveling along a dual boundary; one boundary was an east-west boundary across southern Saint Lawrence County with another one approaching the region from southern Canada.

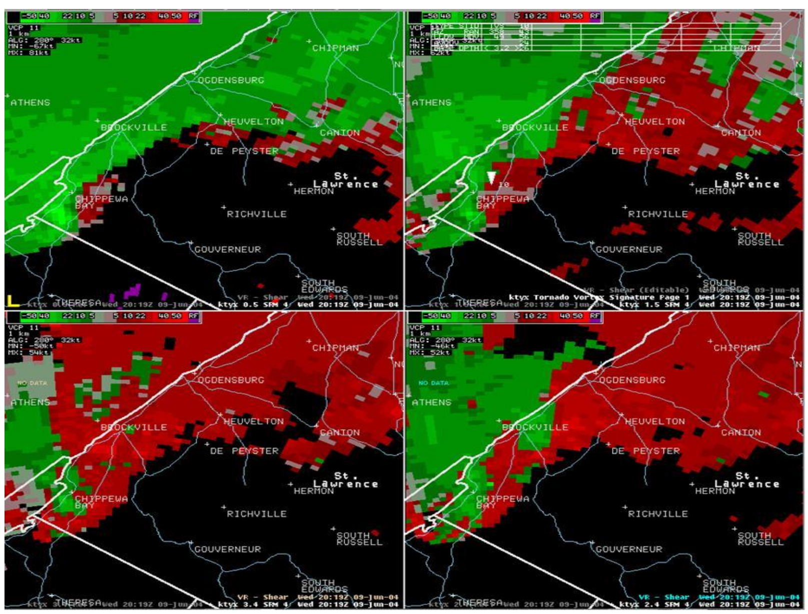

Figure 13: Storm Relative Motion 2019Z

The next SRM display below shows the tornado producing thunderstorm cell just southeast of Gouverneur at 2039z. This continued to have a TVS with both low-level and mid level delta velocity of 51 knots. Also, the base depth was only 2,700 feet high was top elevation around 15,000 feet.

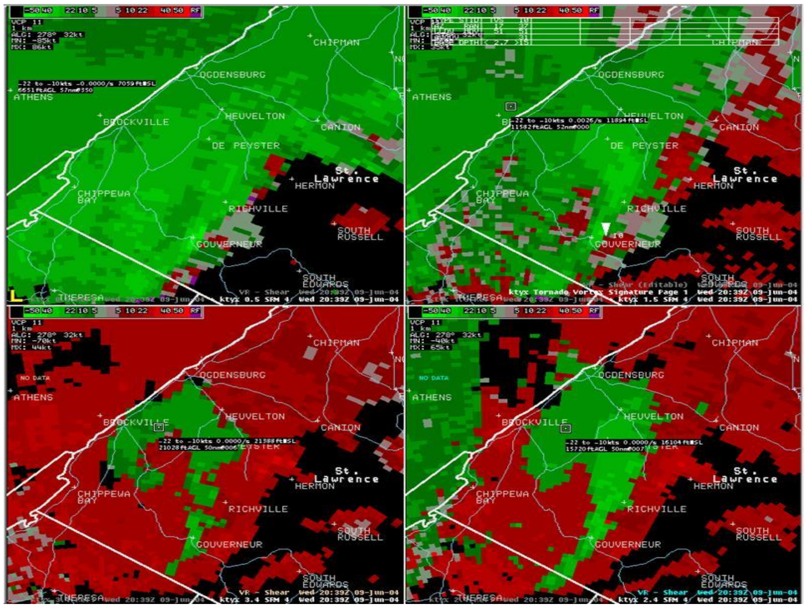

Figure 14: Storm Relative Motion 2039Z

The following four panel is reflectivity in the lowest four elevation scans from the Montague radar. This display shows a well, developed hook echo structure entering Chippewa Bay, along with a strong reflectivity gradient on the southwest side of the storm. Also, noted was a BWER (Bound Weak Echo Region) suggesting strong updraft and core aloft.

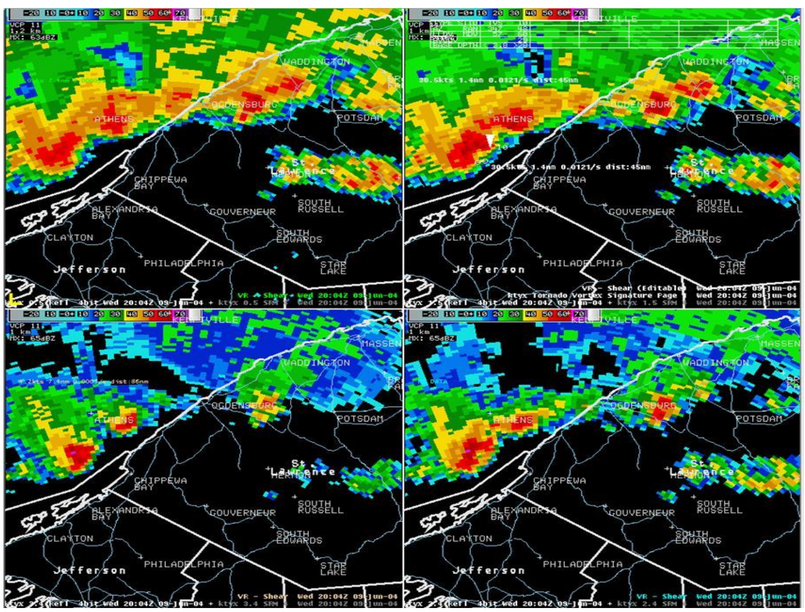

Figure 15: TYX Reflectivity 2004Z

The tornadic cell continues to show well-defined hook echo with a strong low level reflectivity gradient on the southwest flank. This signature is evident over the Chippewa Bay area.

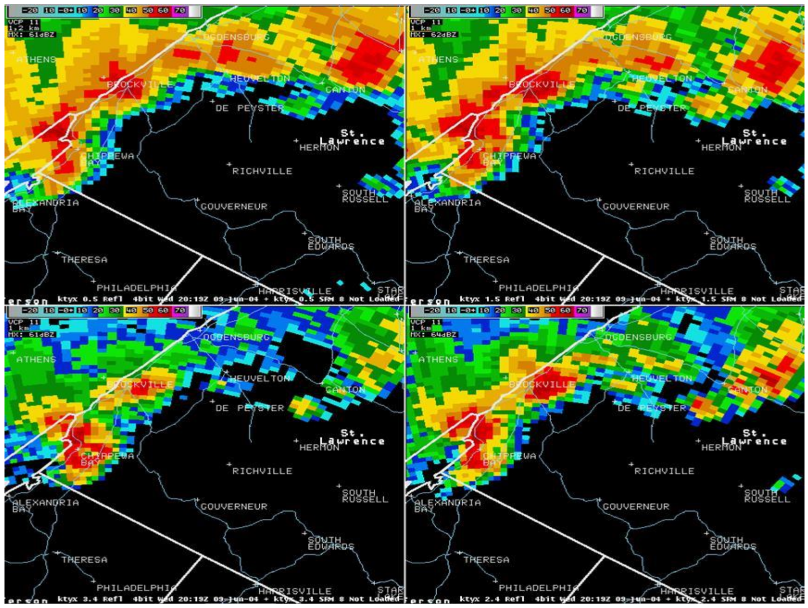

Figure 16: Reflectivity at 2019Z

Click here for a loop of the TYX Base Reflectivity from 20-21z

This display shows echo tops up to 50,000 feet near Gouverneur with VIL values near 60. Also, the composite reflectivity shows hook-echo structure with strong reflectivity gradient.

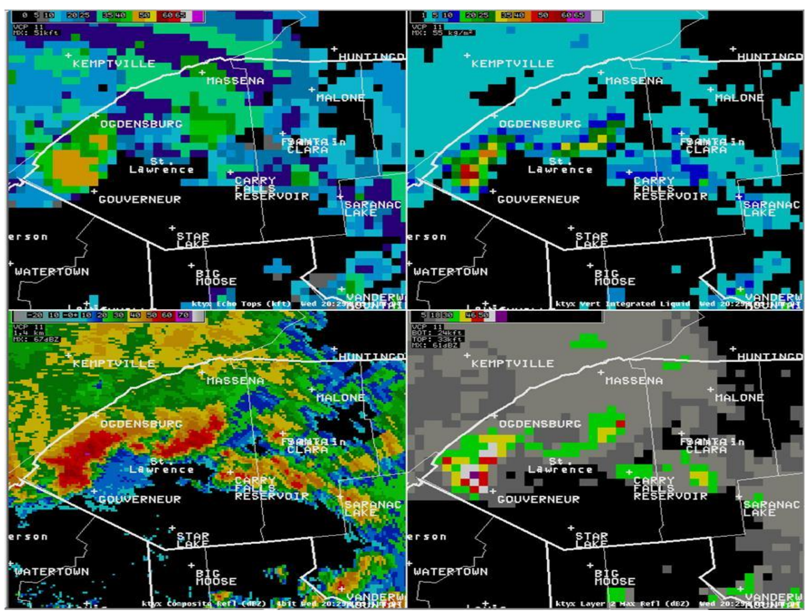

Figure 17: Echo Top, VIL, Composite Reflectivity, and Layer 2 Max Refl 2023Z

The display below shows a velocity cross-section from the CXX radar in Burlington. This was taken along the radial of the radar beam, as a line of severe thunderstorms approached the Champlain Valley and Burlington Vermont area. You can see the descending rear inflow jet associated with the line of storms. The enhanced velocities of 50 knots start around 20,000 feet across northern New York and descend to near the surface over the Champlain Valley. This signature translated into some straight-line wind damage across the Champlain Valley and western slopes of The Green Mountains.

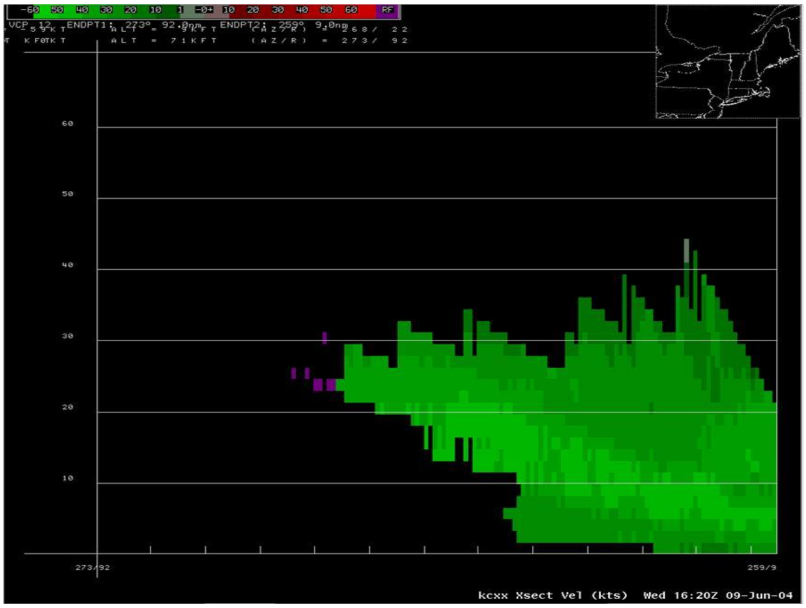

Figure 18: Velocity Cross-Section

This display shows the new products available on the CXX radar. These products include the Enhanced Echo Top and Digital VIL, both have better resolution and detail. In addition, the bottom right display shows one-hour storm total precipitation for the line of thunderstorms. The Digital VIL in this display shows a value of 80 kg/m^2 with an echo top near 50,000 feet. We did receive several severe weather reports associated with this cell across Addison County.

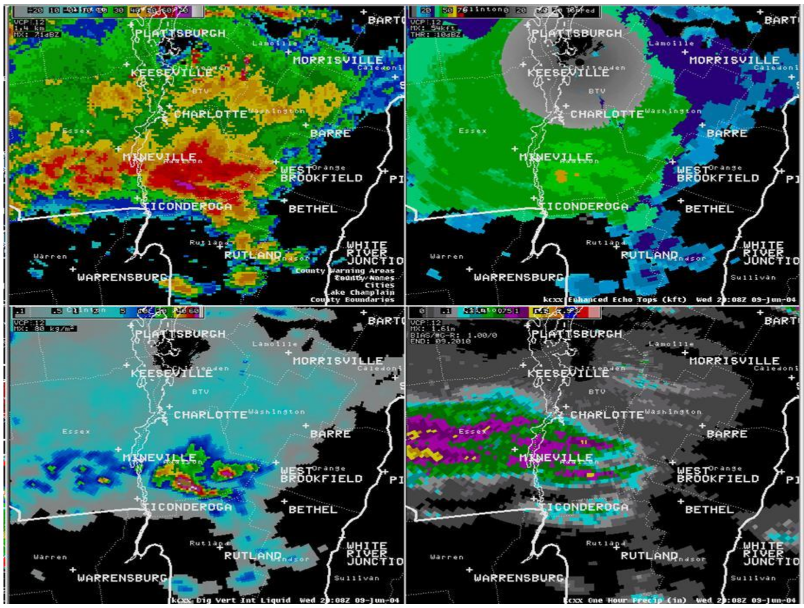

Figure 19: Comp Refl, Enhanced Echo Top, Digital VIL, and One Hour Precip

Damage Analysis:

The picture below shows the track of the F0 tornado across Chippewa Bay into Saint Lawrence County. An aerial survey confined the track to be around 3 miles long and approximately a quarter mile wide. Also, note several other areas of less concentrated damage north and south of the track. Several structures were damaged and the roof of one building was dropped into the Saint Lawrence River. 40 to 60 trees were blown down across the Chippewa Bay area.

Numbers on the map along the tornado path coincide with storm survey photos below.

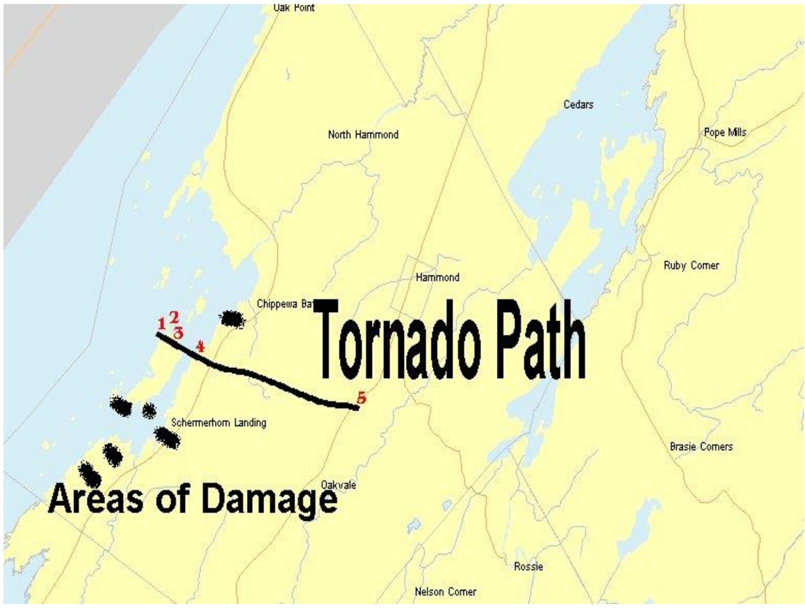

Figure 20: Tornado Path near Chippewa Bay

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

The picture below shows the track of the F0 tornado near the town of Gouverneur. An aerial survey confined the track to be around 900 feet long and approximately 300 feet wide. Also, note several other areas of less concentrated damage northwest and southeast of the track. Several structures were damaged and several large trees were blown down.

Numbers on the map along the damage path coincide with storm survey photos below.

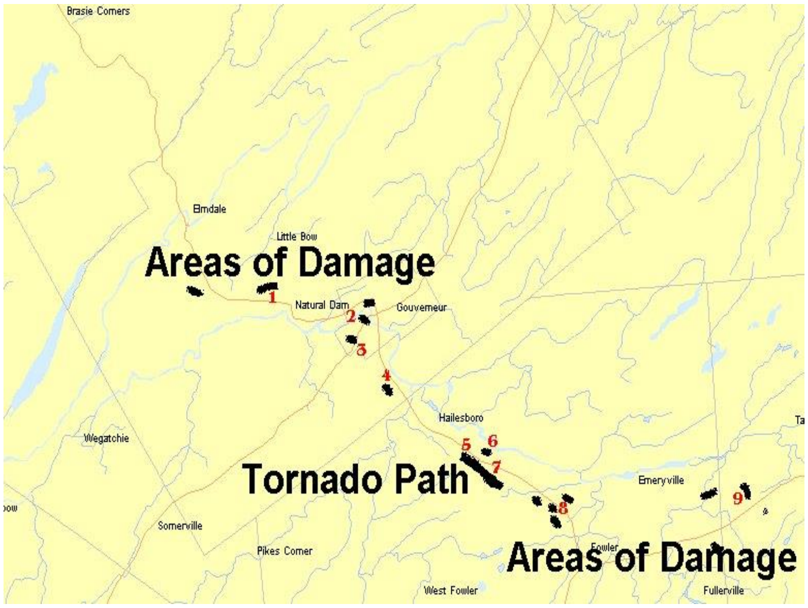

Figure 21: Tornado Path near Gouverneur Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Picture 7

Picture 8

Picture 9