The Four Seasons

National Weather Service Burlington, VT

VOLUME VIII, ISSUE II

SUMMER 2022

Table of Contents

Letter from the Editors

Welcome to our summer newsletter. We've had some active weather so far this summer, and we'll be highlighting a few events in this edition of our newsletter. First, we'll look at the tornado that occurred in Addison, VT on July 18th. Next, we'll switch gears to look at the conditions that led to a record breaking cold day this last June. The third weather event that we'll dive into is the damaging severe thunderstorm wind event that occurred over northern New York in June.

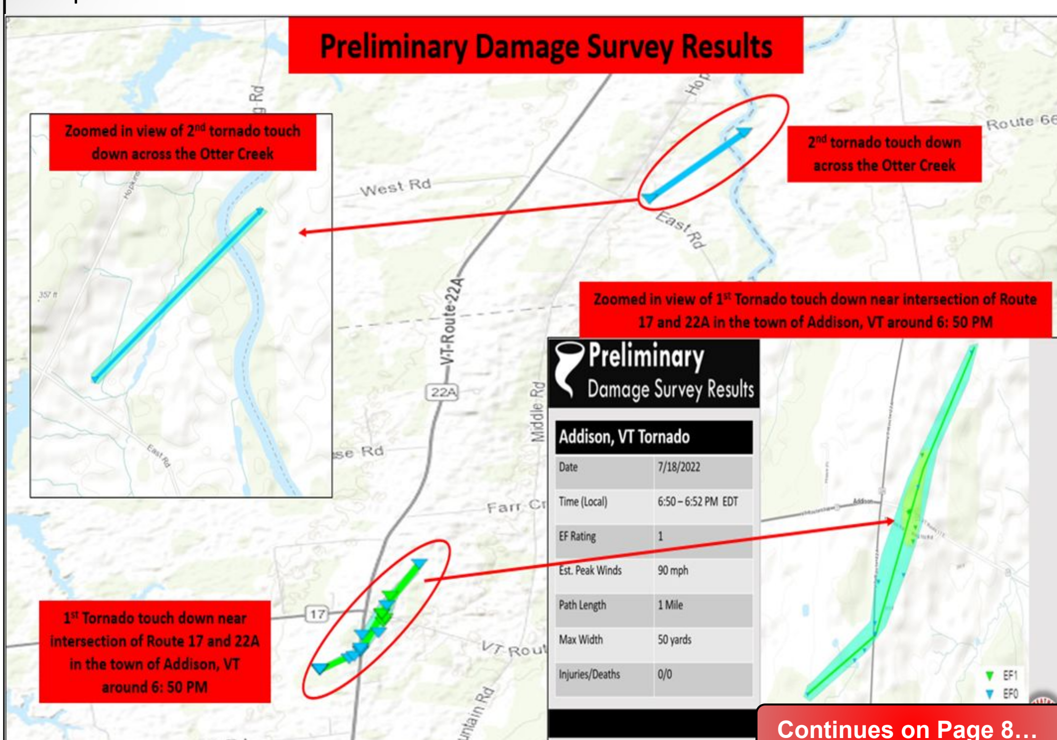
Based on feedback from our partners and you, we have reformatted our popular forecast product, the Lake Champlain Recreational Forecast, and we'll cover those changes here. Finally, we are excited to introduce our newest forecaster to the area!

Click here to provide feedback on the newsletter!

Review of Addison County, Vermont Tornado Event on July 18

by Brooke Taber

On July 18, a long track rotating low-topped shower produced two tornado touchdowns across Addison County, VT, which caused property damage and uprooted or snapped off multiple trees.



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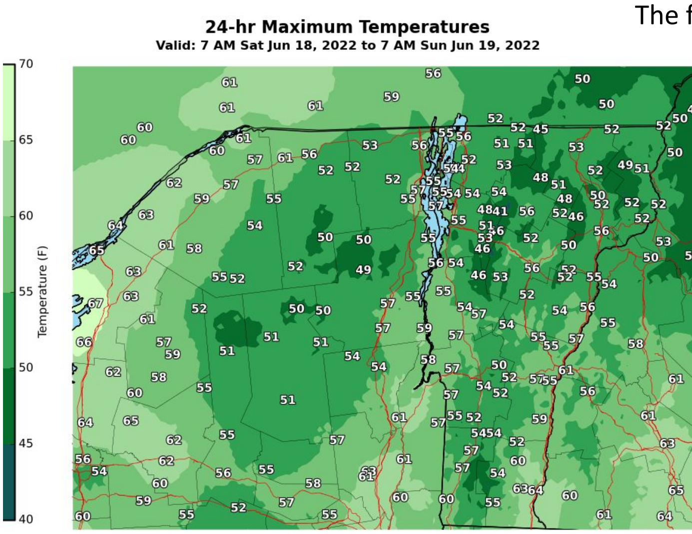
Record Cold Event on June 18th

by Seth Kutikoff

While we have seen occasional hot stretches, by and large seasonable and comfortable air has graced the North Country this summer. On the flip side, early in the summer we had one day that was remarkably cold, managing to set record low maximum temperatures. In our coldest spots, the temperature never made it out of the 40s on June 18th!

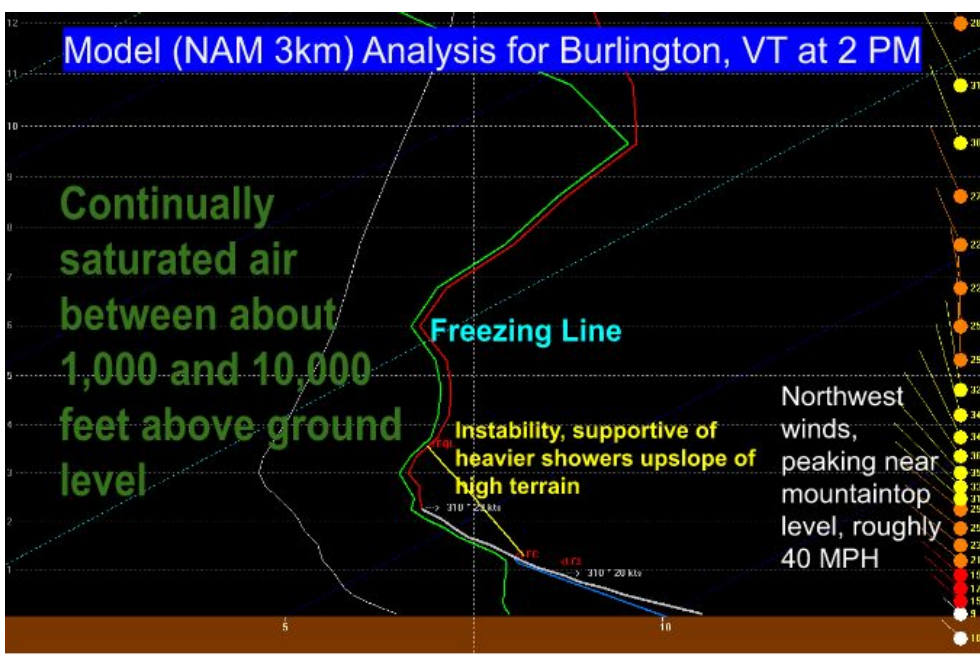


The following day, we shared this table of climate records:

Location	Saturday 6/18/22 Maximum Temperature	Previous Record Cold Maximum Temperature
Burlington, VT	55 (NEW)	56 in 1959
Plattsburgh, NY	57 (NEW)	60 in 2005
Saranac Lake, NY	50 (NEW)	55 in 2005
Massena, NY	61 (Tied)	61 in 2005

Note that the records broken at the first three locations are for sites that have records going back to 1884, 1945, and 1903. Perhaps most remarkable is that these temperatures were extreme for any day this late into June, not just for the date. In Burlington, there had only been one colder summer (June, July, and August) maximum temperature recorded beyond that date (June 19 - August 31), and that was June 23, 1918.

The only way to see such low maximum temperatures so near to the summer solstice when the days are long and the sun angle so high is to have a cold pool of air aloft accompanied by a deep and persistent layer of moisture near the ground. The air mass was reinforced with strong northwesterly flow such that winter-like wind chills were felt in our higher terrain. One public comment from Cyrus Hudak, "I had 44 midday at the base of Jay Peak. With crazy wind gusts, and sheet rain all day. Definitely one for the record books."



Really, it hardly could be worse for recreating in the mountains, between the wind, cold, and small droplets of rain that produced low visibility. Representing the worst of the conditions in our region, the Mount Mansfield COOP station at 3,950 feet elevation records wind and temperature data every 5 minutes.

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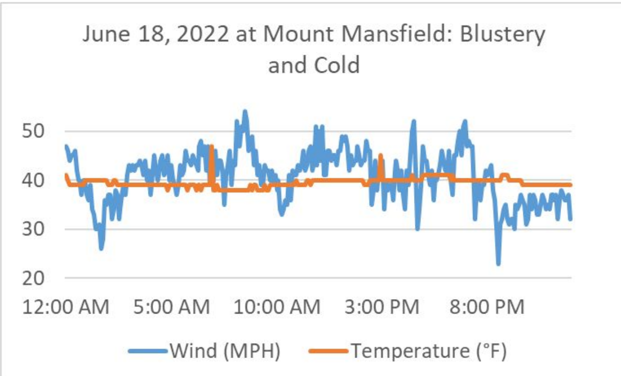
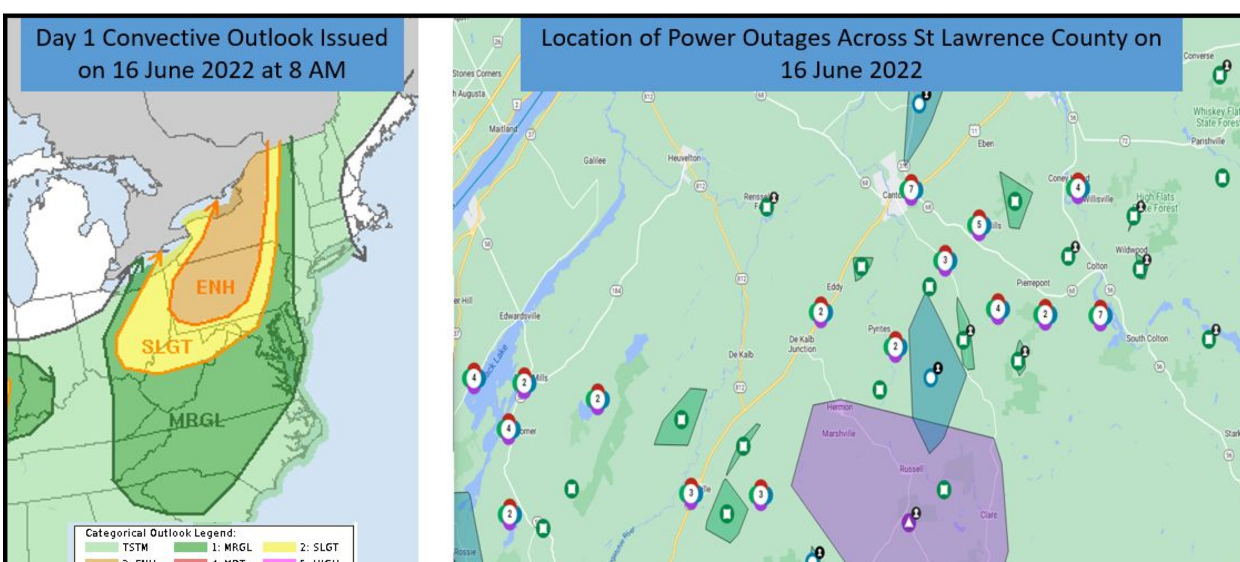


How brutal was the wind chill? Take noon as an example. With a temperature of 40 degrees and wind at 50 MPH, the wind chill was 26 degrees. Even at a more representative, off of the summit, 20 MPH, that wind chill would still be below 32 degrees. Given the wet conditions, hypothermia risk was rather high and unfortunately to our east a hiker reportedly succumbed in the White Mountains that day after becoming cold and wet.

Damaging Severe Thunderstorm Wind Event over Northern New York on June 16th

by Brooke Taber

On 16 June 2022 a very warm and unstable air mass combined with favorable wind profiles to produce widespread wind damage across the Saint Lawrence Valley into parts of the northern Adirondacks in New York. Over 180 reports of downed trees or power lines occurred from this event according to local media outlets, while over 10,000 people lost power across northern New York at the peak. The Storm Prediction Center (SPC) placed northern and western New York into an enhanced risk for severe thunderstorms, while only General Thunderstorm was predicted for most of Vermont, due to cool/stable maritime air mass. From SPC, enhanced risk means there is a high confidence that several storms will contain damaging winds, severe hail, and/or tornadoes, with scattered to numerous storms expected. In this event strong and damaging thunderstorm winds were the primary threat, while large hail was secondary concern. The figure below shows the Day 1 Convective Outlook from SPC issued on 16 June 2022 at 8 AM (left image) and the location of power outages (right image) across Saint Lawrence County during the evening of June 16th.



Storm Prediction Center (SPC) day 1 convective outlook (left image) and location of power outages across Saint Lawrence County on 16 June 2022 at 8 PM.

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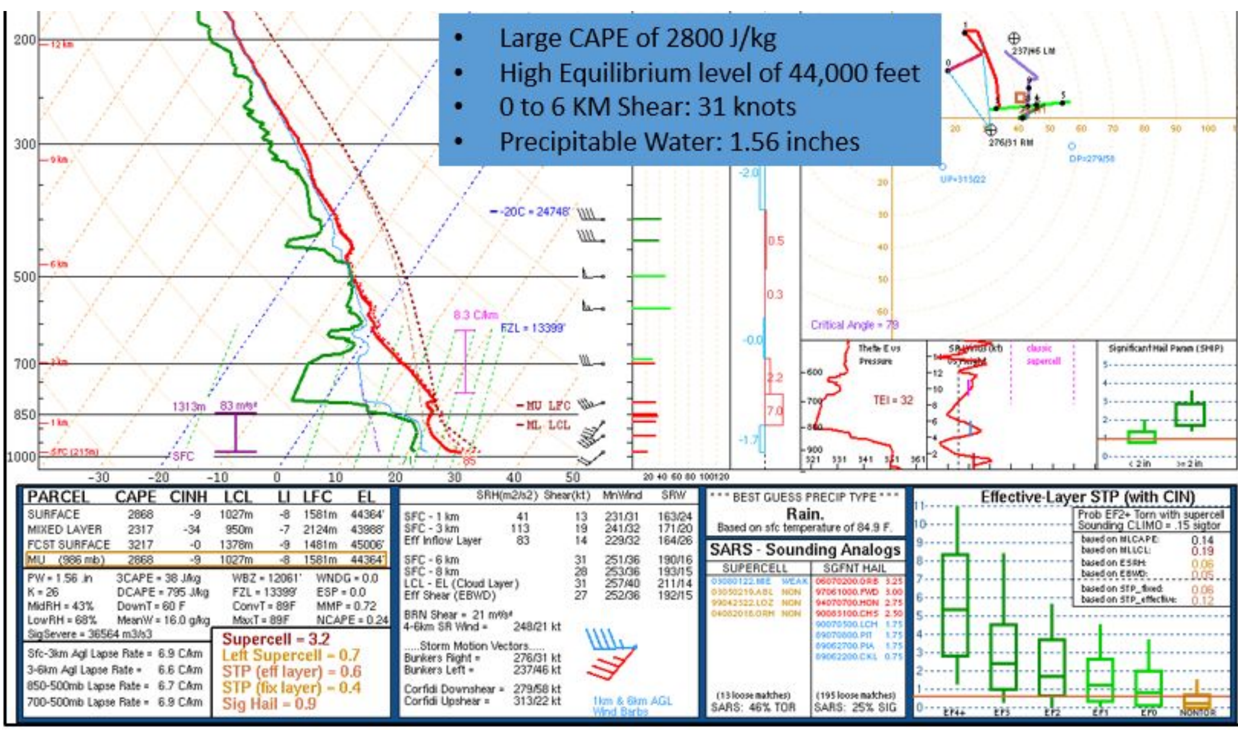
The pre-storm environment across northern and western New York featured large CAPE profiles and moderate deep layer shear, per upper air sounding at Buffalo on 16 June 2022 at 1 PM (See figure below). The combination of surface temperatures in the mid to upper 80s and dew points in the upper 60s to near 70°F, created surface-based convective available potential energy (CAPE) values of 2800 J/kg and a lifted index (LI) of -8C (Celsius) across the Saint Lawrence Valley. CAPE values greater than 1800 J/kg suggest a moderately unstable environment favorable for thunderstorm development. The large CAPE profile and very high equilibrium levels (44,000 feet) indicated thunderstorm tops would extend to 45,000 to 50,000 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 Buffalo sounding also showed surface to 6km shear of 31 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 sounding showed precipitable water value of 1.56 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 suggest a greater potential for heavy rainfall, especially during the summertime.



Upper air sounding from Buffalo, New York on 16 June 2022 at 1 PM.

This event primarily featured two distinct supercell thunderstorms, which persisted for several hours and tracked from the central Great Lakes into northern New York and Vermont.

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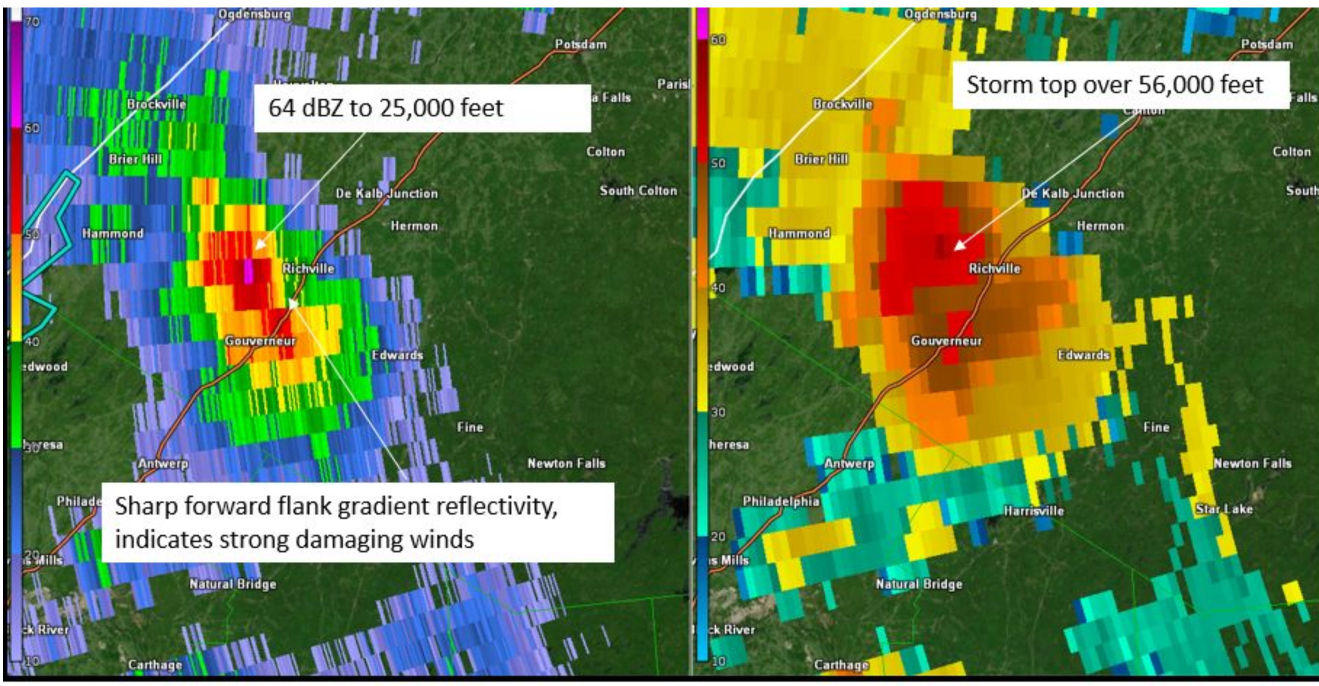
The first storm developed northwest of Lake Ontario and tracked eastward into western Saint Lawrence County around 5 PM, before finally weakening by 8 PM as it approached the Champlain Valley where the air mass was much more stable and not conducive for thunderstorms. The image below shows the first supercell near Gouverneur, New York at 4:54 PM with a solid 50 to 65 dBZ core from the surface to 25,000 feet above ground level (bottom left), and storm top echoes reaching over 56,000 feet (bottom right) or over 10 miles tall into the atmosphere. A thunderstorm this tall has the potential to transfer stronger winds aloft toward the surface, hail over 1 inch in diameter, torrential rainfall, and frequent cloud to ground lightning. Based on surface reports from emergency management and spotters winds of 60 to 70 mph were observed in western and central Saint Lawrence County, along with numerous reports of trees and power line damage.



KCXX reflectivity (left image) and echo top (right image) on 16 June 2022 at 4:54 PM over western Saint Lawrence County.

The next supercell tracked from near Ottawa, Ontario to Massena to Malone and weakened just east of Swanton, Vermont after 7 PM on 16 June 2022. The vertical structure of this supercell was similar with storm top echoes over 50,000 feet at times, low to mid level broad rotation, and persisted for several hours, as the storm tracked along a west-east oriented surface boundary. The reflectivity cross section (image next page), indicated a solid and deep 50 dBZ or greater reflectivity core up to 40,000 feet, with storm tops over 50, 000 feet just north of Malone at 5:36 on June 16th. This storm did produce wind damage across northern Franklin County, New York and 1 inch hail near Highgate Falls, Vermont. In addition, torrential rainfall and frequent lightning was observed from this severe thunderstorm, before weakening near Jay Peak, Vermont around 8 PM on June 16th.

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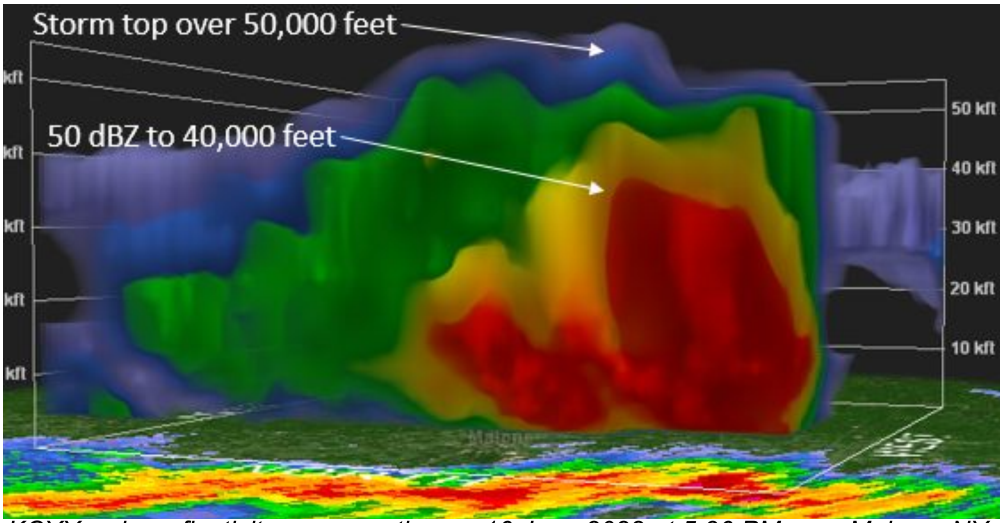
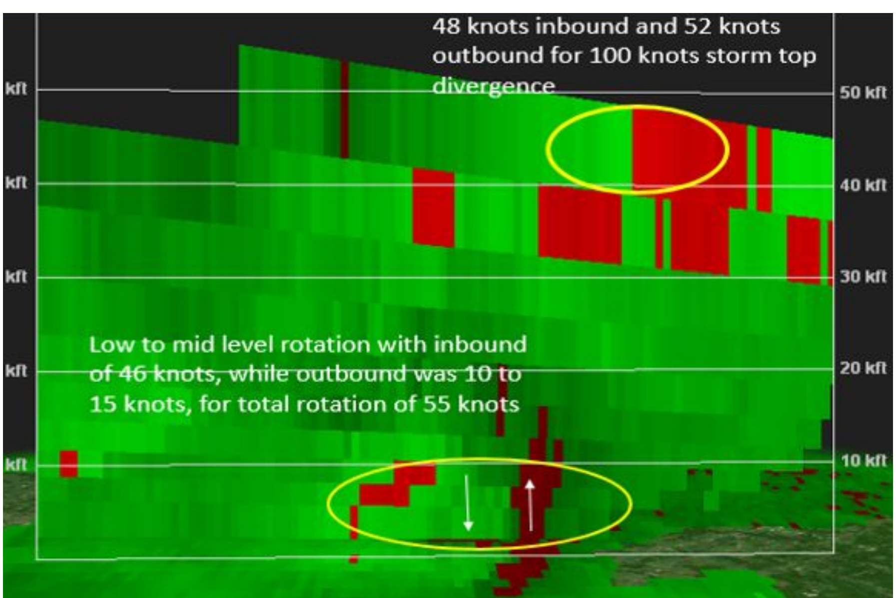


KCXX radar reflectivity cross section on 16 June 2022 at 5:36 PM near Malone, NY.

The final image (below) shows the KCXX radar velocity cross section near Malone, New York. The green color indicates wind moving toward the radar, while the red color identifies wind moving away from the radar. When inbound velocities (green color) and outbound (red color) are are close together with values of 30 to 40 knots within 25 to 30 miles from the radar, the potential for a tornado increases due to the rotation. In this image we saw inbound velocities (green color) of 46 knots, while outbound (red color) values were around 10 knots, creating a total rotation of 55 knots over a distance of 5 miles. We refer to this as broad rotation of moderate strength with a small chance of producing a tornado, but a high probability of large hail or damaging winds, given the reflectivity structure. For better tornado potential, we like to see tighter low level rotation and outbound winds to match inbound values. Otherwise, this storm had storm top divergence of 100 knots, helping to enhance a strong updraft and creating a deep vertical reflectivity structure. It's not too frequent we experience supercell thunderstorms across the North Country, but when instability and shear are favorable, Central Plains type of thunderstorms can impact the region.



KCXX radar velocity cross section on 16 June 2022 at 5:46 PM near Malone, NY.

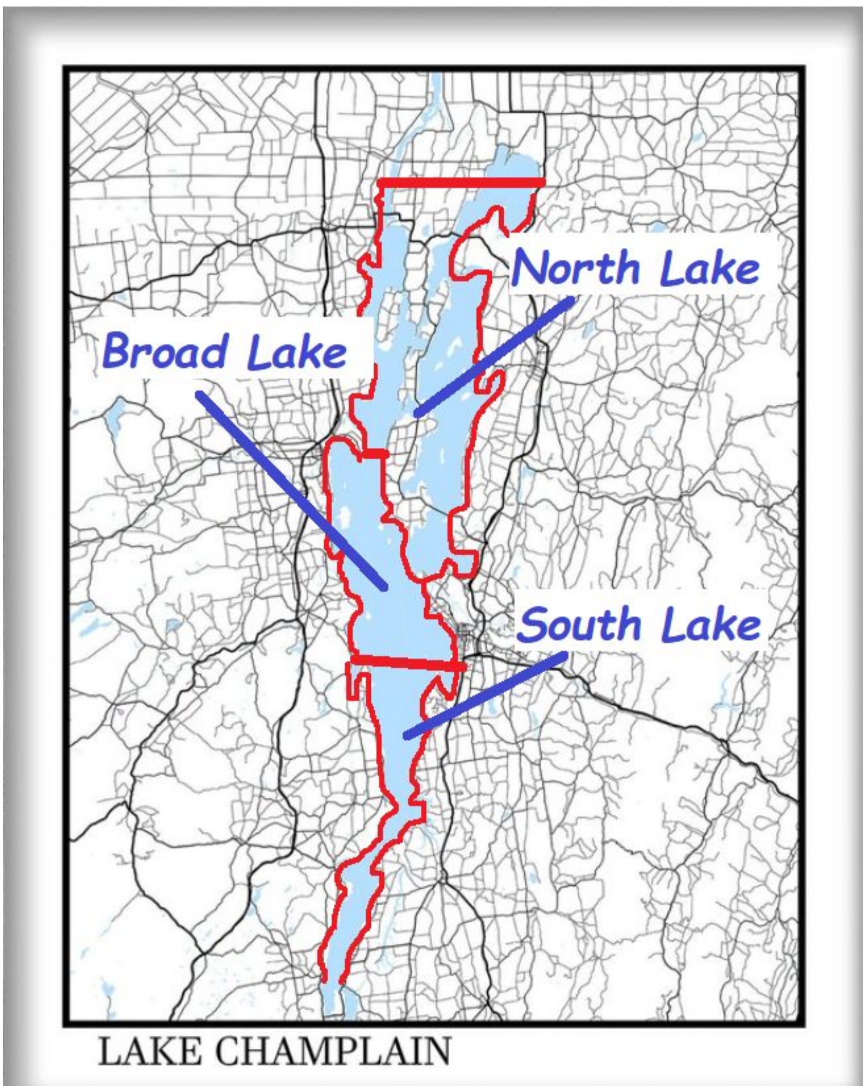
Summary

The primary impact from this severe weather episode was widespread power outages and tree damage across Saint Lawrence and Franklin Counties in New York, followed by one inch diameter hail in northern Vermont. As these storms traveled into the Champlain Valley and central Vermont, conditions were much less favorable and the convection quickly weakened. The thunderstorms definitely packed a punch across the Saint Lawrence Valley with up to 180 reports of trees and power lines down, from widespread damaging winds of 60 to 70 mph.

Lake Champlain Recreational Forecasts Expand to Include Three Zones

by John Goff

As a result of coordination between the National Weather Service in Burlington, U.S. Coast Guard Burlington, and feedback from the general public, the Lake Champlain Recreational Forecast expanded from two to three distinct zones on July 15 of this year. The zone changes reflect differences in wind and wave behavior during north and south wind regimes on the lake, and were designed to help both recreational and commercial users of the forecasts make more informed decisions before heading out on the water. The new forecast format can be accessed online at www.weather.gov/btv/recreation, and is divided into the following segments (see map):



1. **Northern Waters**, including Malletts Bay, the Inland Sea and Isle La Motte
2. **Broad Waters**, including Colchester Reef, Valcour Island and Cumberland Bay
3. **Southern Waters**, including Willsboro and Shelburne Bays, and Diamond Island

For NOAA Weather Radio, only the Broad Waters forecast will be broadcast to ensure broadcast cycle brevity. Forecast content and the valid forecast cycle (5 days) remains unchanged. For those needing catered, more specific graphical and point-based forecasts for the lake, those also remain unchanged at https://www.weather.gov/btv/lake_graphical and https://www.weather.gov/btv/lake_point.

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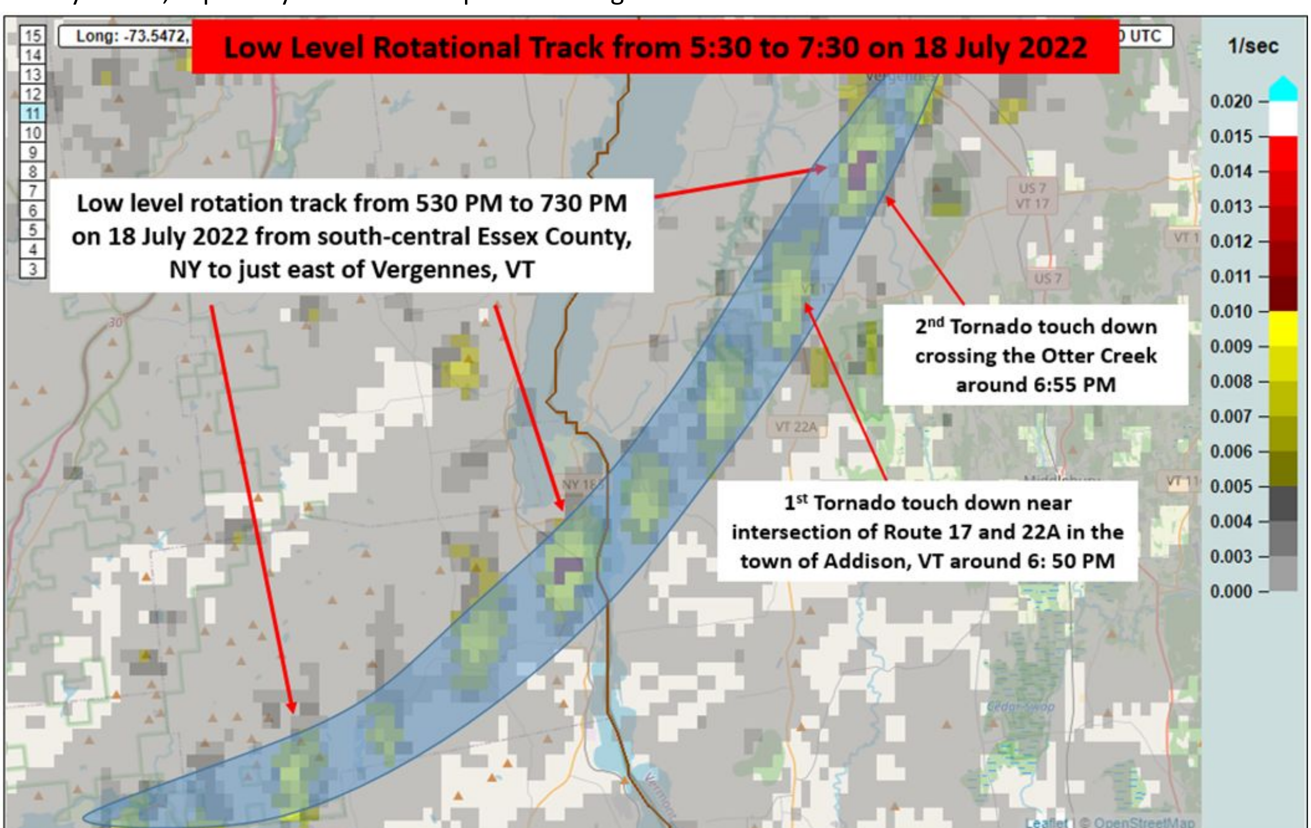
Based on damage and tornado videos, it was determined two touchdowns occurred. The first, an EF-1, occurred around 6:50 PM near the intersection of Route 17 and 22A in the town of Addison. Meanwhile, the second, a brief EF-0, touched down approximately 2 miles west-northwest (WNW) of Waltham, VT near the Otter Creek basin around 6:55 PM. The pre-storm environment featured a warm and very moist tropical air mass across the Champlain Valley, while a subtle warm front was lifting from south to north over the central Champlain Valley into parts of central VT. The atmosphere presented limited instability as temperatures were in the upper 60s to lower 70s, due to plenty of clouds and areas of showers, resulting in this low top tornadic shower having no lightning and a very weak reflectivity structure. The lack of significant vertical reflectivity and no lightning provided storm and associated tornadic identification challenges for NWS forecasters.

The rotating shower started near Schroon Lake, New York (NY) in south-central Essex County around 5:30 PM on July 18th and tracked northeast into central-northeastern Addison County, VT before weakening by 7:30 PM across southeast Chittenden County. Image 2 below shows the Multiple Sensor Multiple Radar (MRMS) 0 to 2 km maximum azimuthal shear (rotational track) from 5:30 to 7:30 PM on July 18th. The Warning Decision Training Division (WDTD) defines maximum azimuthal shear as rotation divided by diameter; s^{-1} in the low-level (0–2 km). This MRMS product provides a history of the intensity and spatial coverage of storm circulations that may be associated with mesocyclones or tornadoes and can be utilized to determine if a storm has intensified or dissipated over time. From the image below, the yellow and red colors within the low level rotational track indicate stronger rotation, with values in the 0.01 to 0.020 s^{-1} range. In addition, the azimuthal shear tracks have shown enormous effectiveness after events for guidance in directing damage survey teams, especially with well sampled and long tracked tornadic events.



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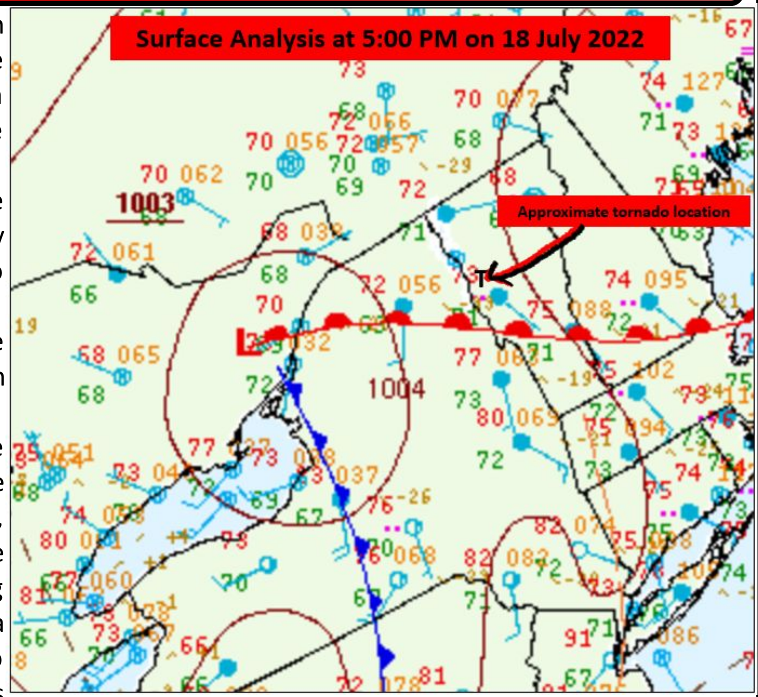
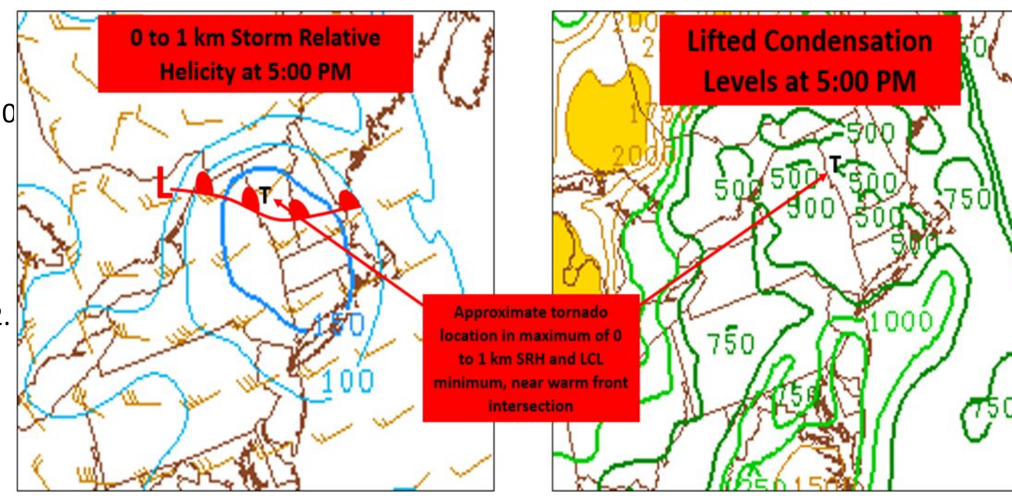


The surface analysis at 5 PM on July 18th indicated 1003 mb low pressure entering the southern Saint Lawrence Valley with a warm front extending from low pressure across the High Peaks into central- southern VT. The warm front was lifting from south to north across the region and was the leading edge of slightly better instability with CAPE values increasing to 500 J/kg over the southern Champlain Valley. In addition, this feature helped produce the necessary shear or turning of the winds with height to create conditions favorable for rotating showers and potential tornadoes. Surface winds ahead of this boundary were from the southeast with temperatures in the lower 70s, which behind this front winds shifted to the south-southwest with temperatures warming into the mid/upper 70s. It should be noted a very tropical-like air mass was advecting into the North Country with this warm front, as surface dewpoints were climbing into the lower 70s with precipitable water values exceeding 2.0 inches.

The Storm Prediction Center (SPC) Rapid Refresh (RAP) model of 0 to 1 km Storm Relative Helicity (SRH) (left) and Lifted Condensation Level (LCL) are shown at 5:00 PM on 18 July 2022. From SPC 0 to 1 km SRH is a measure of the potential for cyclonic updraft rotation in right-moving supercells, and is calculated for the lowest 1-km above ground level. Larger values of 0-1-km SRH (greater than 100 m²/s²), however, do suggest an increased threat of tornadoes with supercells.

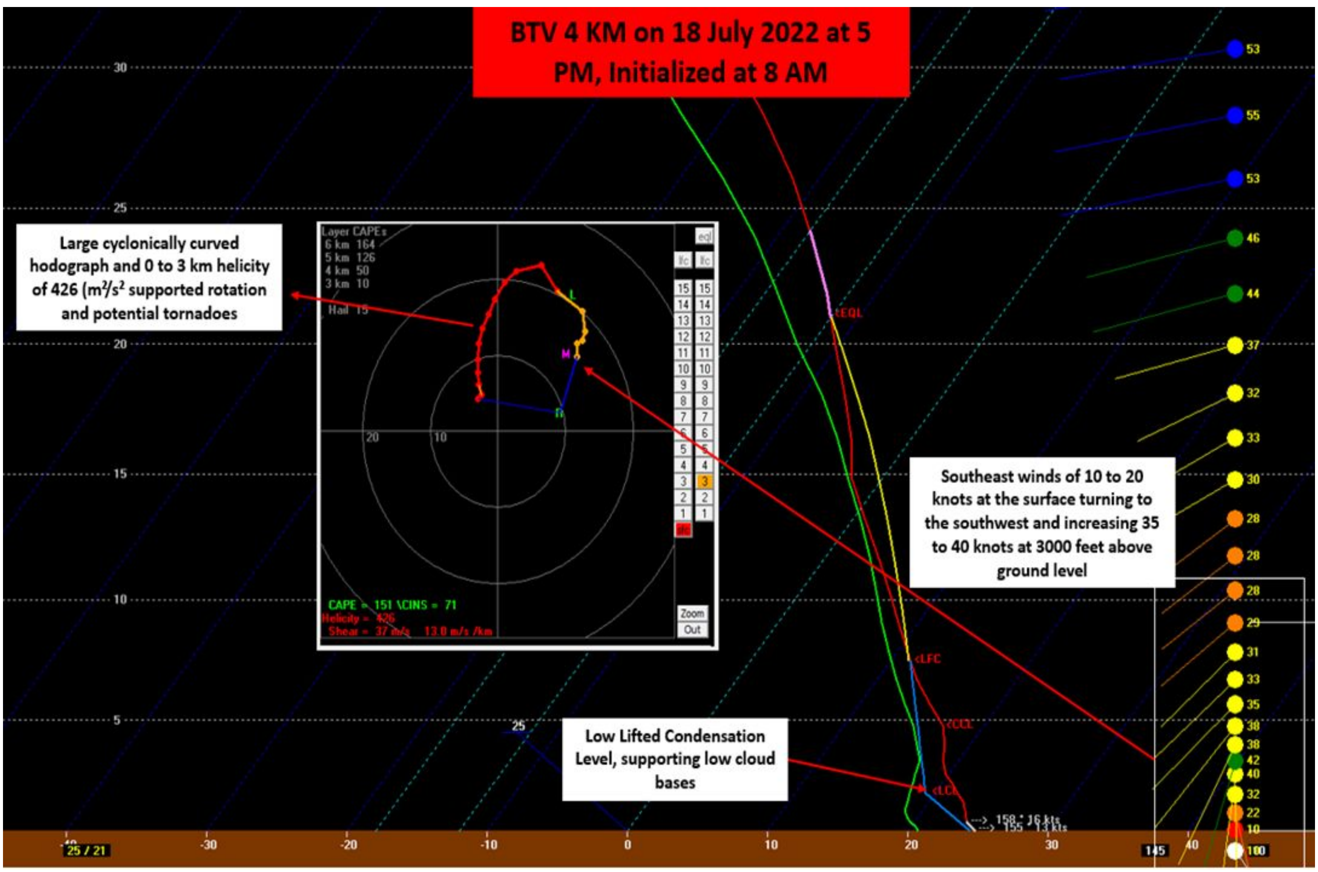


For SRH, larger values are generally better, but there are no clear thresholds between non-tornadic and significant tornadic supercells. In this event, 0 to 1 km SRH values were up to 150 m²/s² near the tornado locations in central Addison, County. The 0 to 1 km SRH is enhanced in the vicinity of the surface warm front and co-located within an axis of lower LCLs.

Meanwhile, from SPC the LCL (Lifting Condensation Level) is the level at which a parcel becomes saturated. It is a reasonable estimate of cloud base height when parcels experience forced ascent. The axis of lower LCL heights across the central Champlain Valley were a result of lift provided by the warm front and created lowering cloud bases favorable for potential tornadoes to occur. LCL heights were generally around 500 meters above ground level.

...Continued from Page 9

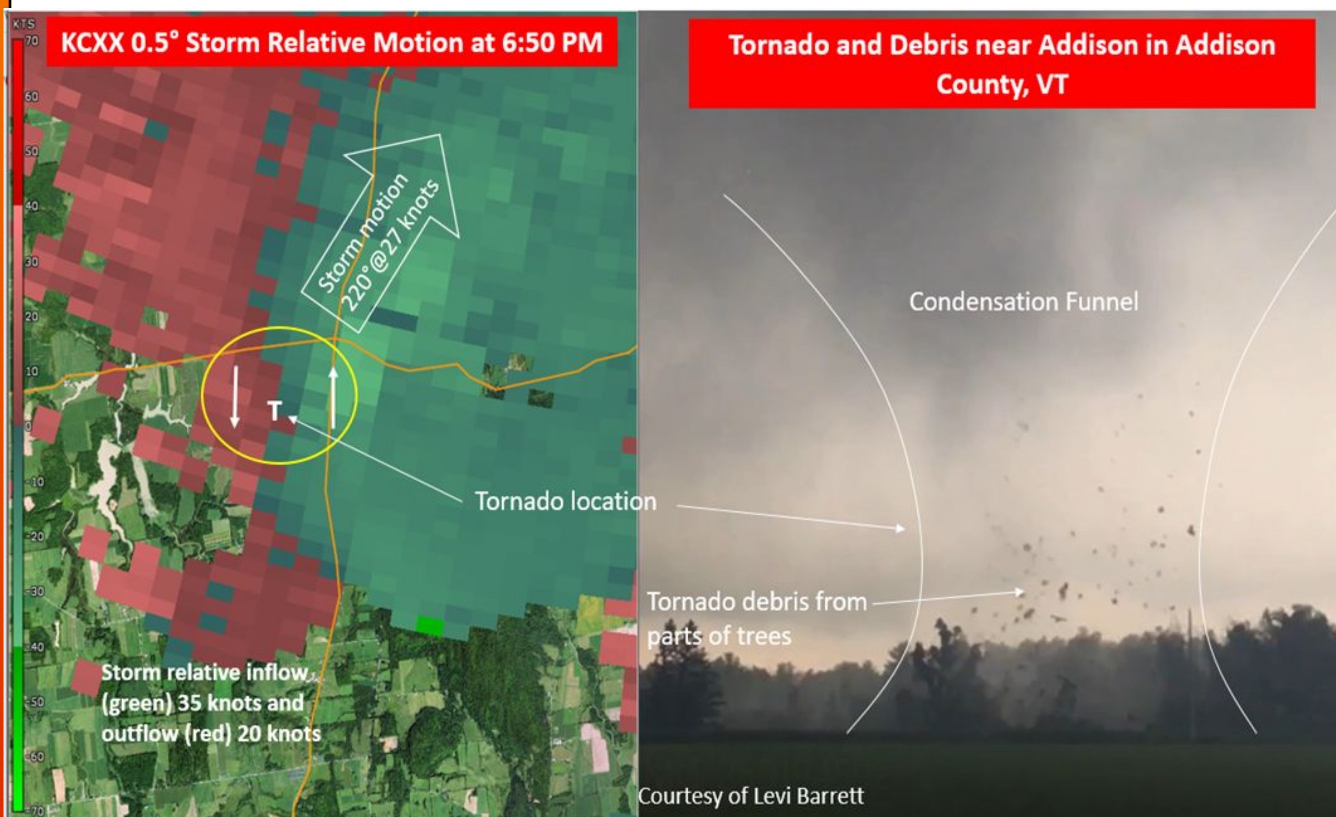
The next discussion item will be the pre-storm environmental conditions, to determine if thermodynamic and wind profiles were favorable for tornadoes. The model sounding at Burlington, VT, indicated very low LCL heights with potential cloud bases around 2,000 feet above ground level (AGL), especially as the warm front and associated precipitation developed, while wind profiles were veering from southeast at the surface to southwest between 2,500 and 3,000 feet (AGL). A veering wind profile (turning clockwise with height) indicates warm-air advection, which can destabilize the atmosphere. Furthermore, the 10 to 20 knots southeast winds in the boundary layer veering to the southwest at 35 to 40 knots at 4,000 feet (AGL) created large cyclonically curved hodograph, with 0 to 3 km helicity values > 400 m²/s², supporting rotating updrafts and potential tornadoes. Larger values of 0-3 km SRH (greater than 250 m²/s²), suggest an increased threat of tornadoes. Instability within the 0 to 3 km layer was very minimal with values of CAPE < 200 J/kg and explains why only showers occurred with no lightning.



The Storm Relative Motion (SRM) radar product is very useful for investigating small scale circulations "mesocyclones" in thunderstorms and sometimes these small scale circulations are areas where tornadoes form. What separates storm relative motion from base velocity is the motion of storms are "subtracted" from the overall flow of the wind. As storms move, their own motion can mask circulations within themselves. This motion is removed to make the view of the wind relative to the storm. In effect, what is seen is the wind's motion as if the storms were stationary.

...Continued from Page 10

The green inbound velocities indicate wind speeds of 35 to 40 knots, while red outbound winds are 20 to 25 knots, creating a favorable total rotation ($V_{in} + V_{out}$) of 55 to 65 knots and rotational velocity ($V_r = [V_{in} + V_{out}]/2$) of 30 knots at 6:50 PM near the 1st tornado touch down in Addison, VT. Typically gate to gate rotational velocity of 45 knots or greater within 30 nautical miles of the radar is considered favorable for tornadic formation. The image on the right below clearly shows a tornado and associated debris from trees being picked up by the EF-1 tornado near Addison, VT. The tornado picture was captured from video taken by Levi Barrett.



The next image on the following page shows the same SRM product as above, but next to the KCXX 0.5° base reflectivity at 6:50 PM on July 18th. The overall reflectivity structure of this shower is very weak, however there is a weak reflectivity appendage on the southern flank, with some enhanced returns of 40 to 45 dBZ. These enhanced reflectivity returns could be a result of debris, such as pieces of trees being lofted into the air by the tornado. The stronger 50 to 60 dBZ returns associated with localized heavy rainfall was displaced well north of the apparent tornadic circulation, creating a difficult detection for forecasters at WFO BTV.

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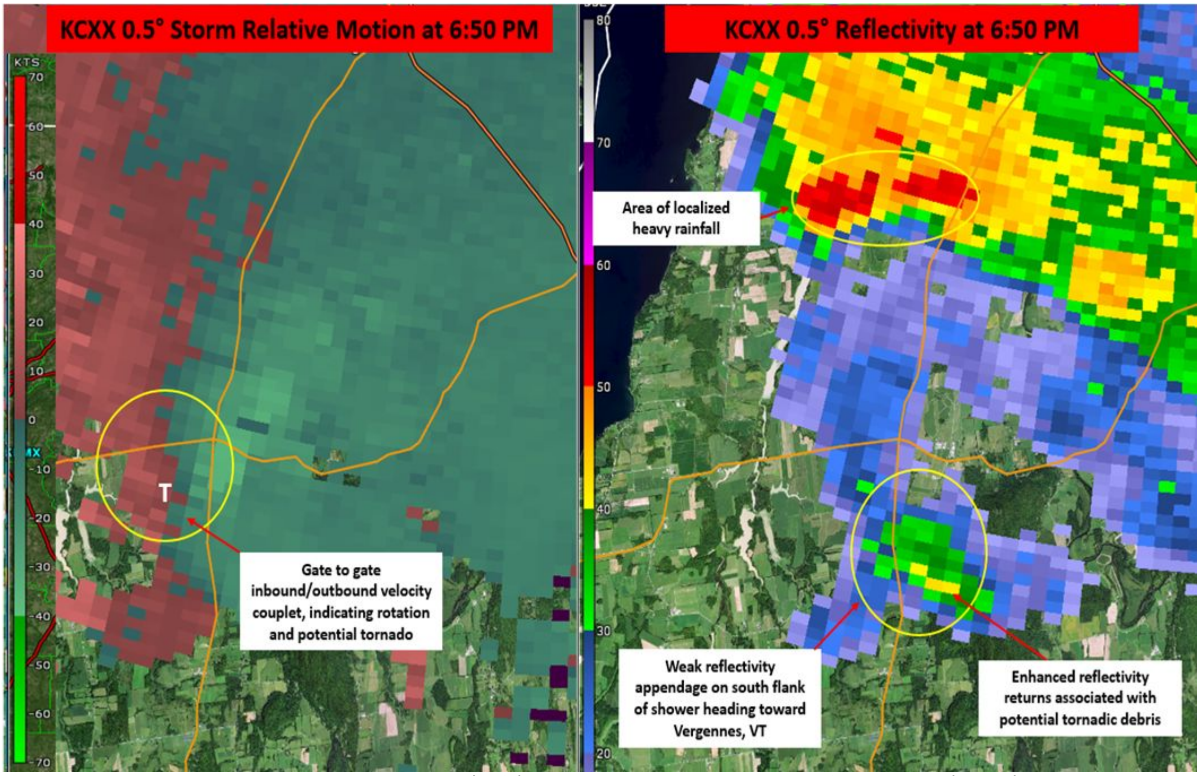
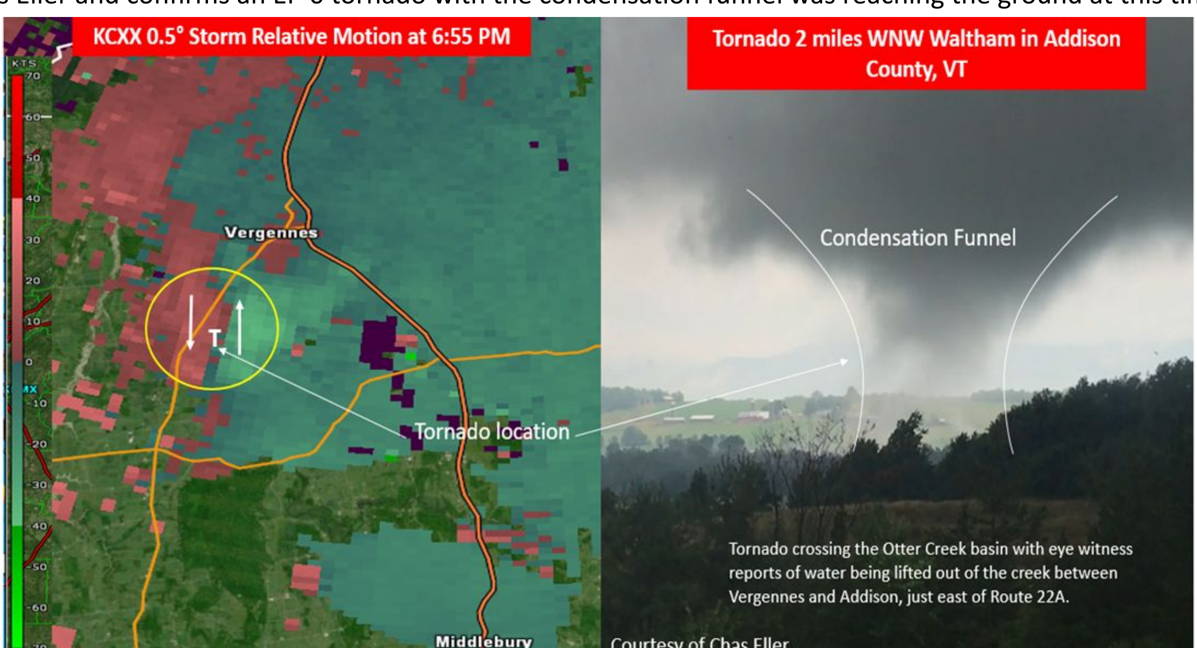


The final image shows the KCXX 0.5° SRM (left) at 6:55 PM and photo of tornado (right) by Chas Eller located approximately 2 miles WNW of Waltham, VT between Addison and Vergennes in Addison County, VT on 18 July 2022. The SRM continues to show gate to gate rotation with inbound (green color) winds of up to 40 knots, while outbound (red color) of 30 knots. Radar indicated the circulation had increased slightly prior to the last scan at 6:50 PM, while crossing the Otter Creek Basin. The tornado picture was captured from video taken by Chas Eller and confirms an EF-0 tornado with the condensation funnel was reaching the ground at this time.



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Summary

This event featured two tornado touchdowns from the same shower across Addison County, VT, on 18 July 2022. The first touchdown occurred around 6:50 PM near the town of Addison and was rated an EF-1 with peak winds of 90 mph, based on the NWS damage survey. The second touchdown occurred at 6:55 PM about 2 miles WNW of Waltham, VT with a rating of EF-0 and winds of 70 mph, based on video received by the NWS WFO in Burlington. The tornadoes caused property damage in the town of Addison, along with uprooting or snapping off several trees in its path. The path length of the Addison tornado was 1 mile long and up to 50 yards wide, while the 2nd tornado was 0.7 miles long and 25 yards wide. The pre-storm atmosphere indicated wind profiles were favorable for rotating updrafts and potential tornadoes, but the lack of instability limited the convective development and created a difficult environment for forecasters to identify showers that had the potential to produce a tornado.

Changes at BTV - Welcome Jessica!

Welcome Jessica Storm!

This summer, we welcomed our newest forecaster Jessica Storm. Yes, that really is her last name! Jessica originally hails from southern New Jersey and got her bachelor's degree in Meteorology from the University of Delaware.

After college, Jessica worked as a meteorologist for AccuWeather in State College, Pennsylvania for a year and a half before joining us at NWS BTV. In her free time, Jessica likes to knit, hike, and read. She is already thoroughly enjoying Vermont's Creemees and is looking forward to hiking the Green Mountains and hopefully seeing a moose in Vermont. She is nervously excited to experience her first New England winter this year.

The Four Seasons

Volume VIII, Issue II

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We Need Your Storm Reports!

Please report snowfall, flooding, damaging winds, hail, and tornadoes. When doing so, please try, to the best of your ability, to measure snowfall, estimate hail size, and be specific as to what damage occurred and when. We also love pictures!

For reports, please call:
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Or visit:
http://www.weather.gov/btv/stormreport

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