



In this write up we are going to discuss the top 6 weather events and three other (honorable mention) events that impacted the North Country during 2014. The year started off very cold with the coldest average March temperature on record for the State of Vermont, before warming up and drying out over the summer months. A wide range of weather events affected northern New York into Vermont over the past year, including winter storms to flash flooding to severe weather. The events we are going to discuss were decided upon by the staff at WFO (Weather Forecast Office) Burlington, VT based on impact and historic significance.

When compared to the spring of 2011 Lake Champlain flooding or Irene in August of 2011 or the December 2013 ice storm, 2014 was relatively quiet with only a couple large scale high impact weather events. The #1 weather event for the North Country in 2014 was the prolonged heavy wet snowstorm from December 9th through 11th, which left over 100,000 customers without power and up to 2 feet of snow in the mountains. The #2 weather event was the April 15th and 16th widespread river flooding from snowmelt and heavy rainfall. The 3rd most significant event was the record cold March. The next two spots are the significant snowstorm on March 12th and the damaging thunderstorm wind event on July 8th, followed by the pre-Thanksgiving snow storm on November 26th. The three honorable mentions are the supercell thunderstorm and associated large hail in Rutland and Addison Counties on May 27th, the July 28th flash flood event in Chester, VT, and finally the localized heavy lake effect snow event from November 18th through November 21st.



After a relatively quiet 2014 weather year, our most significant storm with greatest impact was a powerful prolonged heavy wet snow event from December 9th through December 11th. Snowfall ranged from only a couple inches across the Connecticut River Valley to almost two feet near Warren, Vt. [Click here](#) for a complete listing of storm total snowfall for the event. In addition, figure A below shows the North Country storm total snowfall ending at 5 PM on December 11th. This heavy wet snowfall contain plenty of water with total precipitation amounts ranging from 1 to 3 inches across the

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region, with a [COCORAHs](#) (Community Collaborative Rain, Hail, and Snow Network) observer reporting up to 3.61 inches at Lincoln, Vt. The snow to liquid ratios ranged from 5 to 7 inches of snow to 1 inch of rain, which lead to the snow sticking to trees and power lines. This storm produced over 100,000 people without power across the North Country and caused more damage to the power infrastructure than the January 1998 ice storm or hurricane Irene in August 2011. In addition to the heavy wet snowfall, significant ice accumulation up to 1 inch was observed near Barnard, VT, as well as the higher terrain of central and eastern Vermont during the event.

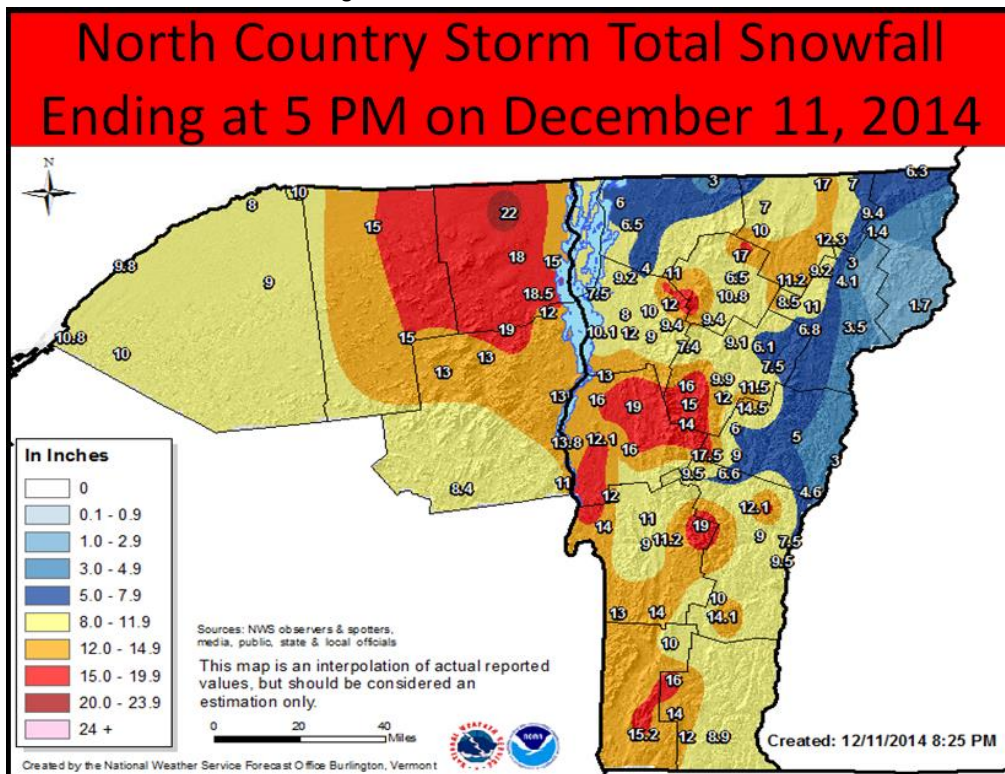


Figure A: North Country storm total snowfall from 9 December at 7:00 AM to 11 December 2014 ending at 5:00 PM.

Albany, NY Sounding on 9 December 2014 at 7 PM

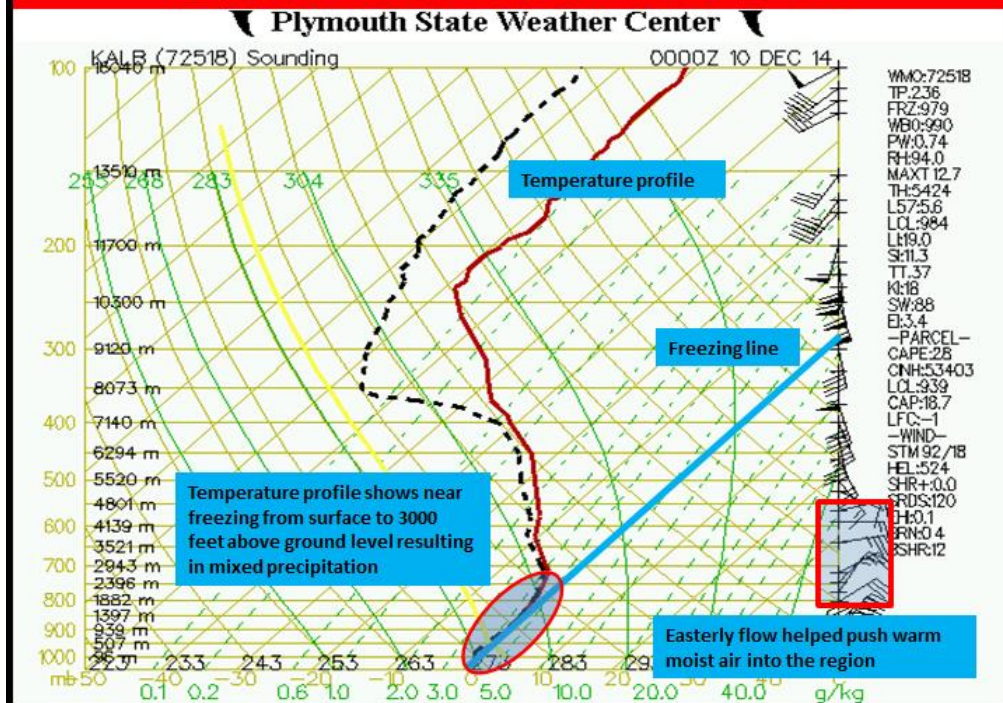


Figure B: Albany, New York sounding on 9 December 2014 at 7:00 PM.

The combination of a complex upper level pattern and associated surface low pressure track, along with very marginal temperatures profiles for frozen precipitation, made for an extremely difficult forecast. Figure B above shows the Albany, New York sounding on 9 December 2014 at 7:00 PM, which clearly shows a temperature profile from the surface to 3,000 feet AGL (above ground level) near freezing. This profile supports a very heavy wet snow event, especially as the heavier precipitation occurred with this storm and cooled the column just enough to support wet snow. Further north in Vermont, a cold layer of air was observed around 2,000 feet (AGL) supporting a mix of sleet and freezing rain. Also in Figure B you can see easterly winds between 4,000 feet and 8,000 feet (AGL) which helped pull deep Atlantic moisture into our region, along with a warm nose of air above 32°F. This warm nose of air impacted the Northeast Kingdom and Connecticut River Valley of Vermont, resulting in much less snowfall and more rain/mixed precipitation. Meanwhile, a much colder thermal profile was observed over northern New York, resulting in all snow with 1 to 2 feet accumulation over the Adirondack Mountains.

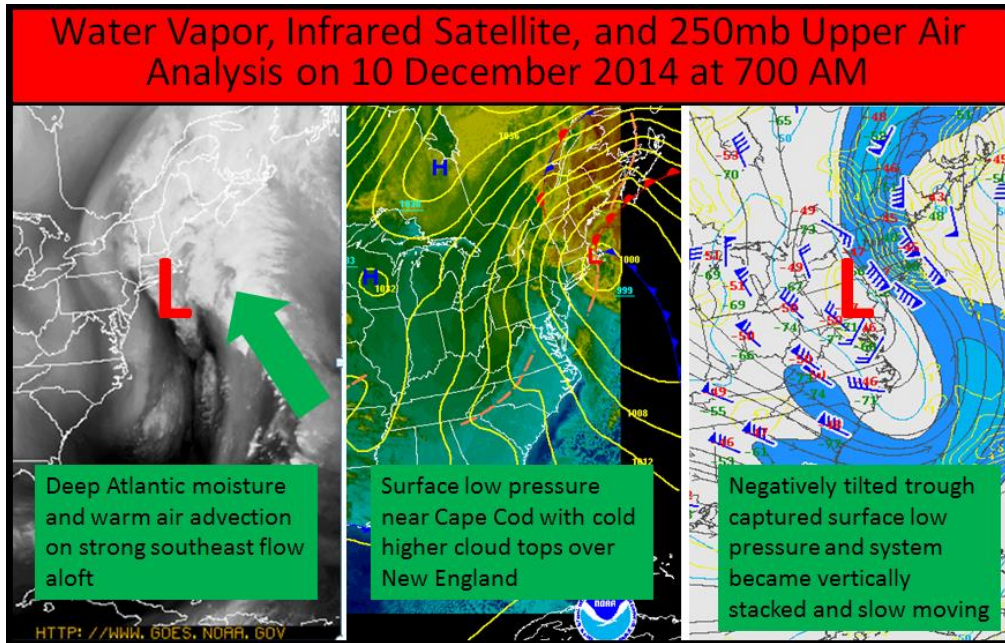


Figure C: Water vapor (left), Infrared Satellite (middle), and 250mb upper air analysis (right) on 10 December 2014 at 7:00 AM.

Not only did this powerful winter storm have a complicated thermal profile, but a very complex mid and upper level synoptic pattern developed along the northeast United States. This synoptic scale pattern featured a blocking high pressure over the Canadian Maritimes, while potent short wave energy enhanced a deep closed cyclonic circulation off the mid-Atlantic Coast, helping develop surface low pressure just east of Cape Hatteras, NC on the evening of December 8th. The system became vertically stacked from the surface through 250mb, and only moved slowly northeast toward the Gulf of Maine by December 11th, as a blocking high remained anchored over the north Atlantic. The counterclockwise circulation around low pressure pulled plenty of deep Atlantic moisture and warm air back into the North Country, resulting in several rounds of heavy precipitation, along with a prolonged period of backside upslope snowfall. Figure C above shows the water vapor (left), infrared satellite (middle), and 250mb upper air analysis on 10 December 2014 at 7:00 AM. The water vapor shows deep advection of Atlantic moisture across New England while the infrared satellite illustrates the colder higher cloud tops indicating the areas of heavy precipitation with surface low pressure near Cape Cod. The 250mb analysis displays a deep negatively tilted trough with favorable upper level divergence (yellow lines) from right rear jet quadrant impacting most of Vermont into the eastern Adirondacks Mountains. The combination of thermal profiles just cold enough to support wet snow in many locations and favorable track of the mid/upper level circulation lead to very heavy precipitation occurring across the North Country.

Radar and Surface Map Evolution on December 9th and 10th 2014

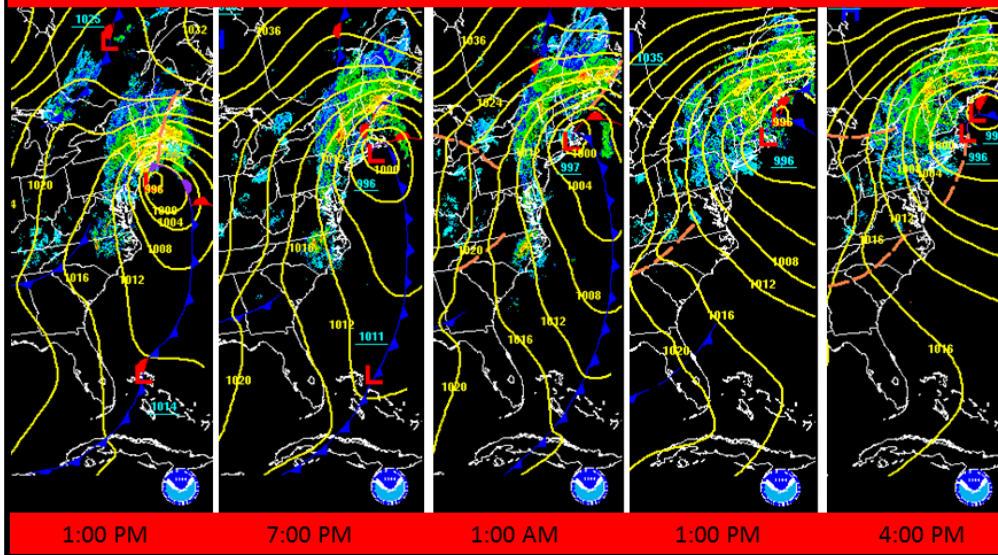


Figure D: Radar and surface map evolution on 9 December from 1:00 PM to 4:00 PM on 10 December 2014.

Figure D above shows the surface low pressure evolution along the northeast corridor, along with associated radar imagery from 1:00 PM on December 9th through 4:00 PM on December 10th. The slow movement of low pressure from coastal New Jersey on December 9th into the Gulf of Maine by the evening of December 10th, lead to several rounds of moderate to heavy precipitation across the North Country. The brighter yellow colors in the radar imagery above shows the areas of heavier precipitation associated with this system. The two day precipitation totals showed a widespread 1 to 3 inches occurred with localized mountain locations receiving up to 4 or 5 inches. The low snow-to-liquid ratios resulted in a heavy wet dense snow, while keeping snow accumulations much lower than if the storm had a snow to liquid ratio around 15 to 1.

Figure E below shows several storm related photos taken several days after the storm. The heavy wet pasty snow stuck to trees and power lines, and was extremely difficult to shovel and plow. In addition to the snow pictures, you can see some significant ice accumulated across the higher terrain near Barnard, Vermont during this event. The combination of heavy snow and ice caused significant power outages across northern New York into Vermont, which lasted for up to a week and produced more damage to the power grid than the January 1998 ice storm and hurricane Irene, making this snowstorm our # 1 weather related event in 2014.

Storm Photos



Figure E: Storm photos taken near Barnard, VT.



The #2 weather event across northern New York into Vermont was the widespread river flooding from snowmelt and heavy rainfall on April 15th and 16th 2014. The long winter of 2014, prolonged by cold temperatures in March, strongly contributed to the widespread spring river flooding. Typically the spring melt begins in March with a more gradual release of water held in the snowpack. In 2014 snowmelt was delayed, and more water was held in reserve later in the spring.

Heading into April, rivers retained most of their ice cover, and the region was blanketed in a deep, water laden snowpack (Figures 1 & 2), especially outside of the immediate Champlain Valley. After

a delayed start to the spring freshet, snowmelt and rainfall created flooding through mid-month across northern New York and Vermont.

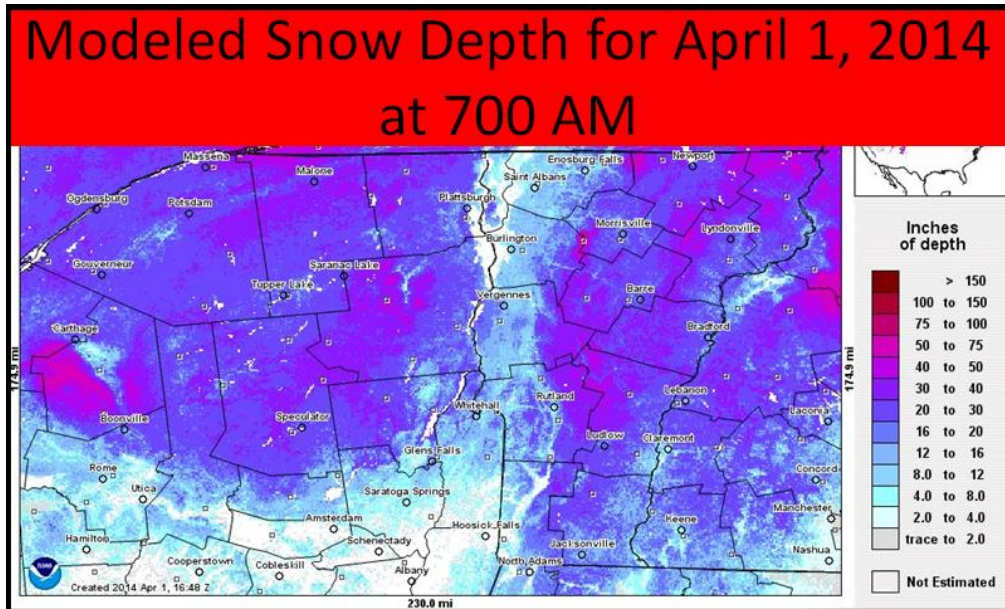


Figure 1: Snow Depth (in inches) April 1, 2014.

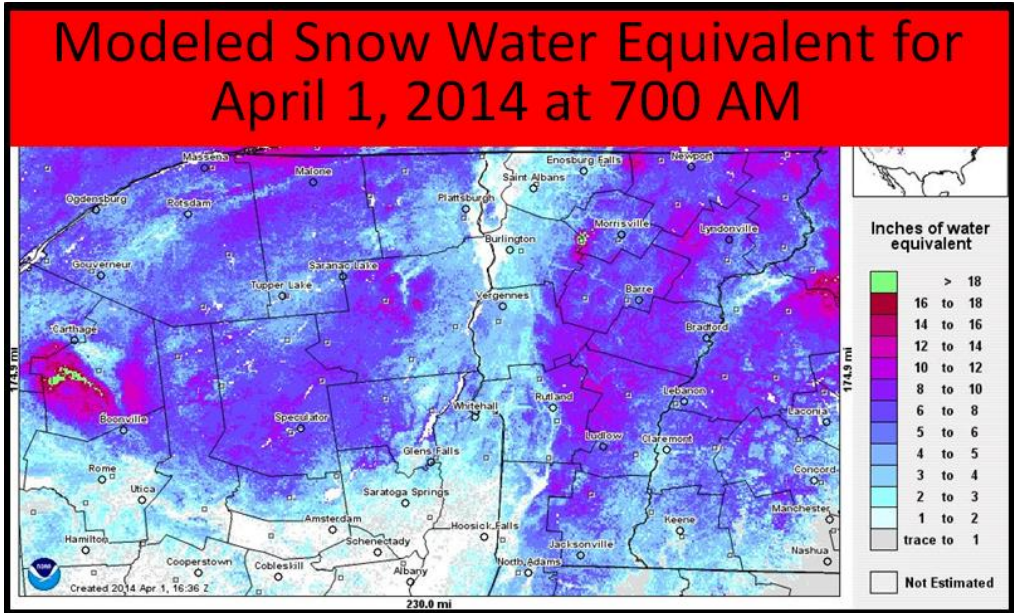


Figure 2: Snow Water Equivalent (in inches) April 1, 2014

The first week of April was characterized by moderating temperatures and light amounts of precipitation in the form of rain or a wintry mix. Runoff was limited, however, as the ripening snowpack absorbed the majority of the rainfall.

Rainfall on April 7th produced an inch of rain over Saint Lawrence County NY, and a quarter to half inch of rain elsewhere. Runoff from this rainfall along with temperatures in the 50s produced rises on rivers on April 8th and 9th that were sufficient to break up river ice. Ice movement was noted mainly on northern rivers including the Great Chazy in northern New York, and the Missisquoi and Lamoille in Vermont. The Great Chazy at Perry Mills went above flood stage due to an ice jam, with minor impacts to local roads and additional ice jam flooding downstream in Champlain Village. The Barton River at Coventry also went into flood due to runoff from snowmelt and rainfall.

On April 9th and 10th the rainfall and snowmelt runoff caught up with the slower responding rivers in St. Lawrence County NY, with reports of flooding mainly along the Oswegatchie, Grass, and St. Regis Rivers. On the 10th an ice jam on the Oswegatchie caused flooding near Heuvelton, and a portion of the Maple City recreation trail in Ogdensburg was inundated as well. Other parts of Saint Lawrence County began to flood during this time period as well, when small creeks and streams became overwhelmed by runoff from snowmelt and rainfall.

Very warm temperatures returned April 10th through the 15th, with highs in the 60s and 70s and overnight lows well above freezing. Snowmelt began in earnest through the weekend of April 12th and 13th, and runoff unabated by freezing temperatures pushed rivers to bank full or minor flood levels in the days before rain arrived. Figure 3 depicts the modeled loss of Snow Water Equivalent (SWE), which

indicates a majority of SWE released from the snowpack in a one week period. Rain moved in from west to east late Tuesday the 15th into Wednesday the 16th, with a swath of one to two inches from Essex County NY, and northern Vermont. Other areas received ½ inch or less (Figure 4). The rainfall coincided with peak discharge from melting snow, and forced many rivers into flood.

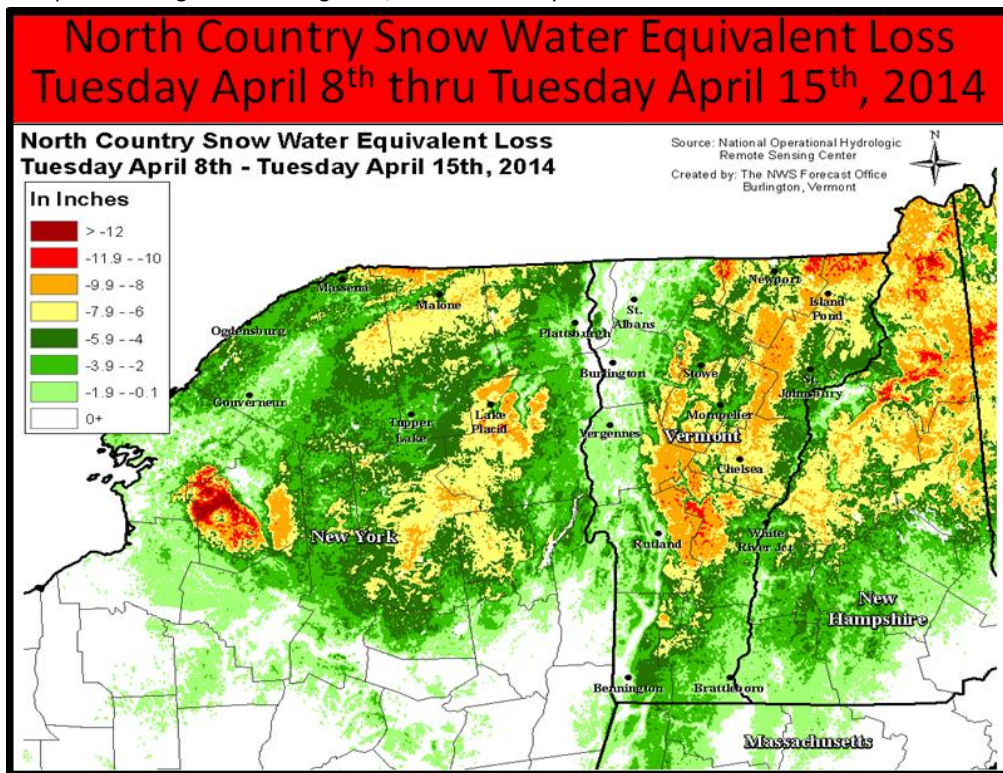


Figure 3: Snow Water Equivalent loss (in inches), April 8-15

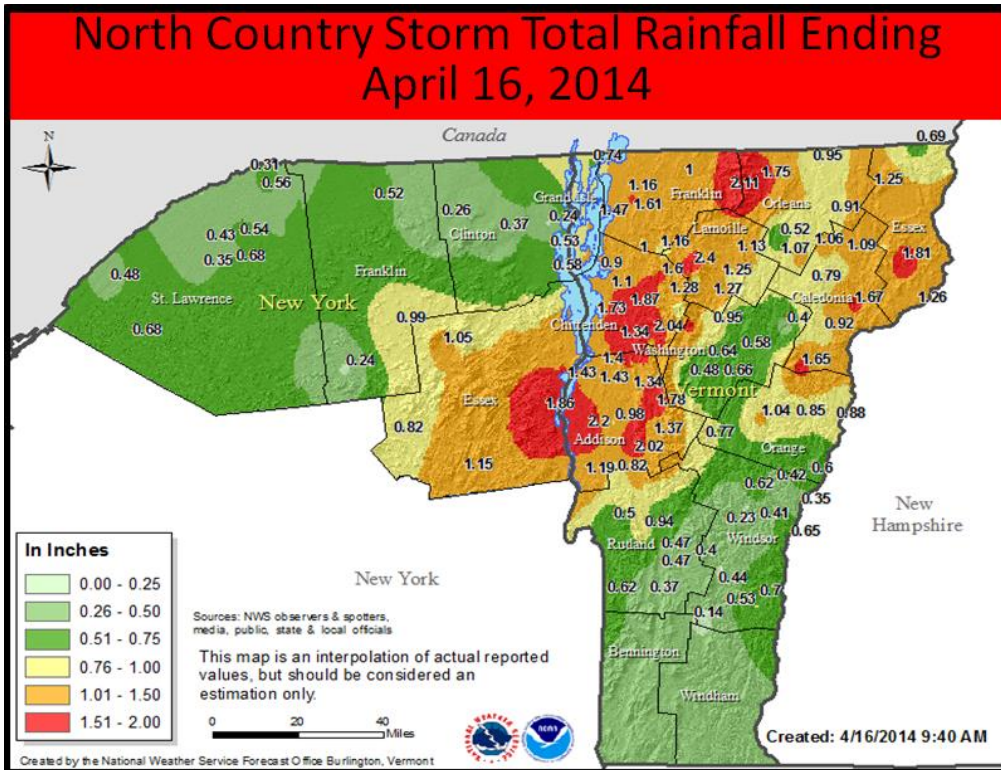


Figure 4: Storm Total Rainfall (in inches) ending April 16.

Widespread flooding resulted, mainly along the larger main stem gaged rivers. In Vermont the Missisquoi, Lamoille, Passumpsic, Winooski, and Otter Creek flooded, and in New York flooding continued along the Oswegatchie, St. Regis, Grass, and Salmon Rivers. In St. Lawrence and Franklin Counties in New York there were widespread road closures and field flooding, and some homes were evacuated along the St. Regis. The St. Regis at Brasher Center reached flood flows that had not been seen since 1937. Flooding along the Passumpsic River in Vermont from Lyndonville through Passumpsic rose to major levels, threatening homes and businesses as well as main thoroughfares in Lyndonville and St. Johnsbury. The river gage on the Passumpsic River near Passumpsic, Vermont witnessed its 5th highest observed peak since records began in 1928. The Lamoille at Jeffersonville, Vermont also rose to major levels, isolating some homes and cutting off highways.

It is interesting to note that in the Winooski basin, the upstream portion that drains through Montpelier and Waterbury VT received lesser amounts of rainfall. The majority of the rain fell in the lower portion of the basin that fed the Essex Junction gage. Although field flooding was noted throughout the drainage basin, the ½ inch of rainfall in the upper part of the basin likely spared Montpelier and Waterbury from flooding that could have been equal to that of April 2011.

Lake Champlain rose 5 feet in two weeks as a result of the snowmelt and rainfall, eventually going above the flood stage of 100 feet on April 17th. The lake crested at 100.54 feet on April 21st, and remained above flood stage for the remainder of the month (Figure 5). The lake eventually fell below flood stage on May 10th.

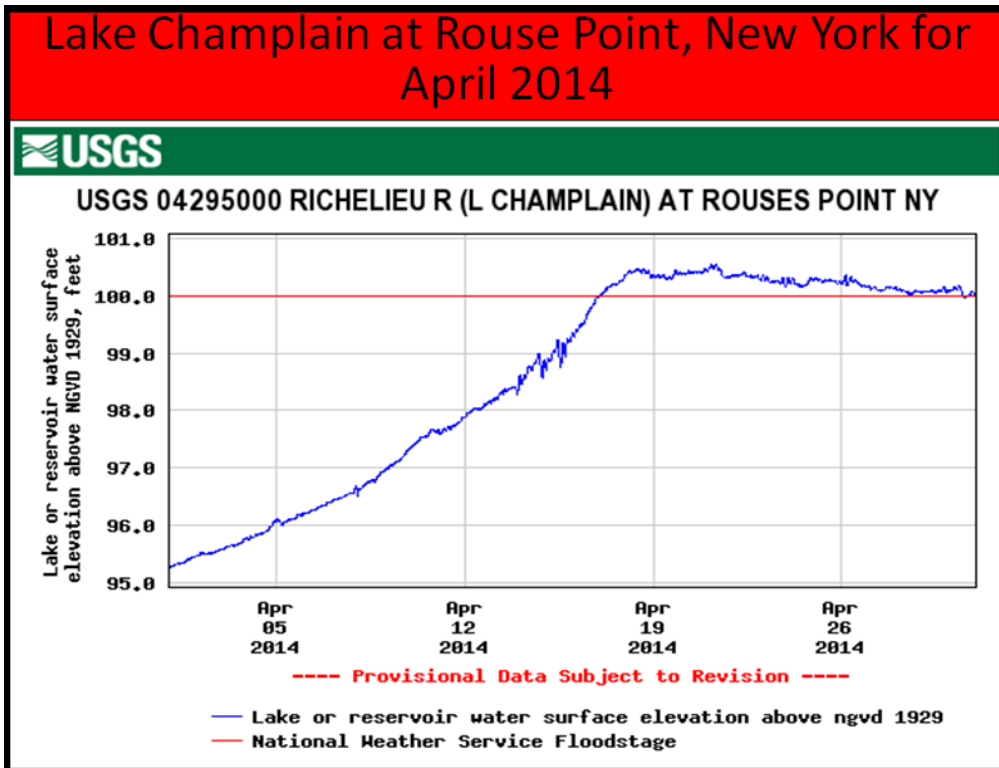


Figure 5: Lake Champlain at Rouse Point, New York.



The #3 greatest weather event across the North Country voted on by the NWS BTV staff during 2014 was the record cold March. Vermont had the coldest March on record with a temperature average of 8.9°F below normal, and nearly two thirds of the Great Lakes remained frozen until early April impacting

commercial shipping. This record cold was caused by a deep trough in the jet stream winds across the Eastern United States, which resulted in numerous arctic outbreaks. This cross polar flow in the winds aloft produced a direct feed of very cold air from the Arctic Circle, which is highlighted in Figure 6 below. This highly amplified pattern featured a strong ridge of high pressure across the Western United States, with a deep downstream trough over the eastern two-thirds of the nation. Note the jet stream is a fast ribbon of air between 25,000 and 35,000 feet above the surface and divides warm air to the south and cold air to the north, and typical helps in the development and track of surface cyclones. The counter clockwise circulation around the quasi-stationary area of low pressure over the Hudson Bay region, helped to advect numerous blasts of arctic air across our region during March of 2014.

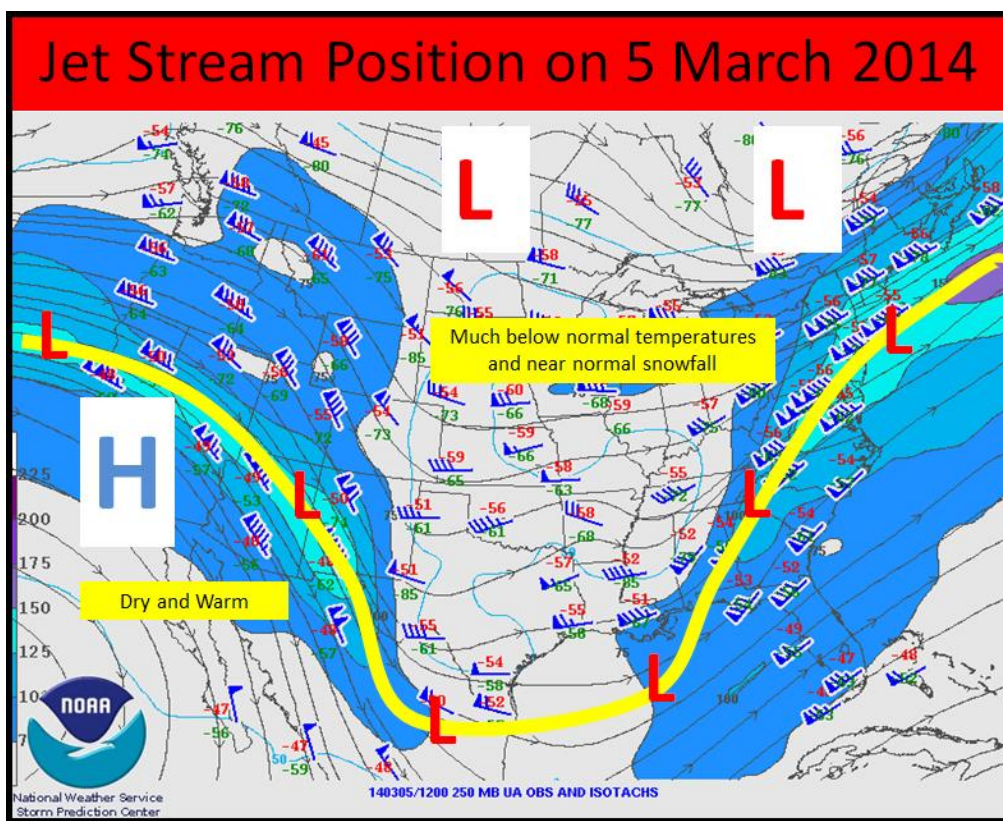


Figure 6: Jet stream position on 15 March 2014.

Figure 7 below shows the daily average temperature departures from March 1st through the March 31st across the entire United States. Noticed in the loop several extremely large departure below normal daily average temperatures (10 to 20°F below normal), highlighted by the darker blue color. These large temperature departures impacted most of the eastern two-thirds of the country, with above normal temperatures over the western United States.

Daily Average Temperature Departures March 1-31, 2014

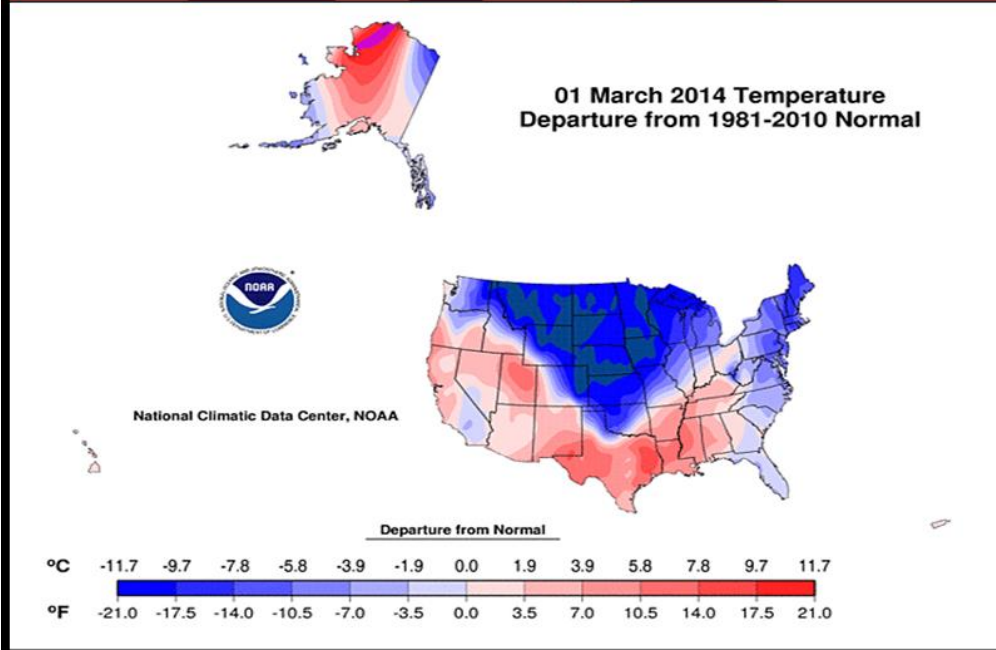


Figure 7: Daily Average Temperature Departures March 1st through March 31st, 2014.

Figure 8 shows the statewide temperature ranking for the month of March 2014. Note Vermont rank coldest on record for the 1895 to 2014 period with New Hampshire and Maine ranking #2.

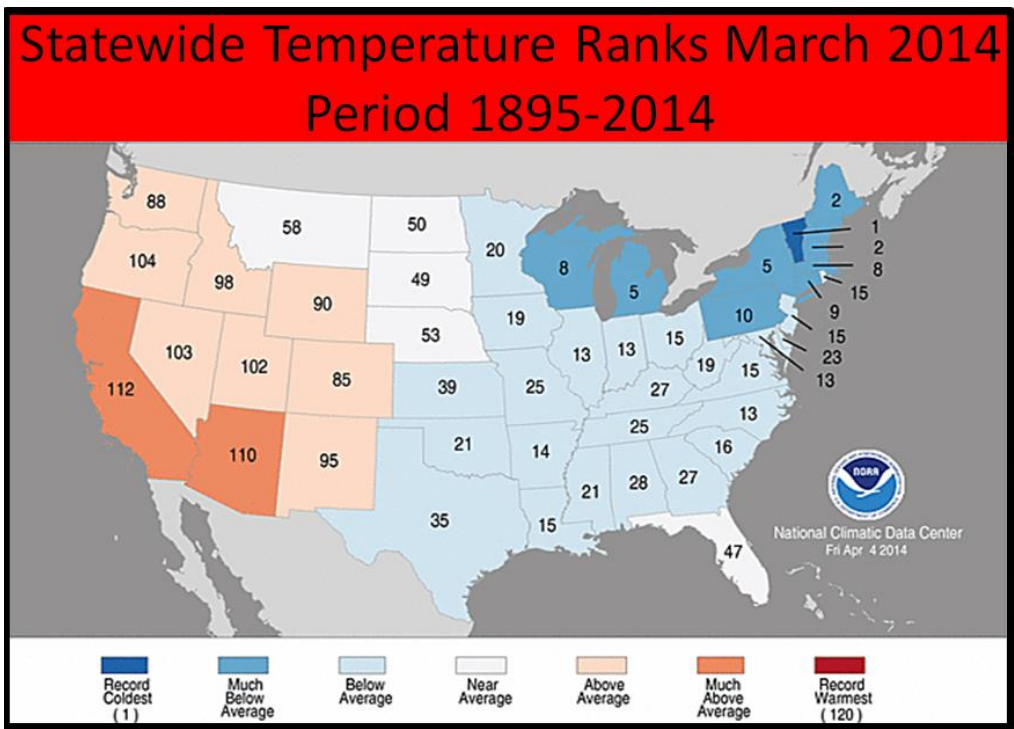


Figure 8: Statewide Temperature Ranks March 2014; Period 1895 to 2014.

Looking at individual sites across the North Country showed Burlington, VT had the 4th coldest March on record, with an average temperature of 22.1°F, which was -8.9°F below normal. Compare this to the average 2012 March temperature of 43.2°F, which was the warmest ever on record, shows the extreme between the two months. This is highlighted in figure 9 below.

March 2012 vs. March 2014 Burlington (Normal: 31.0°)

March 2012:

Average Temperature: 43.2° (+12.2)
(Warmest)

March 2014:

Average Temperature: 22.1° (-8.9)
(4th Coldest)

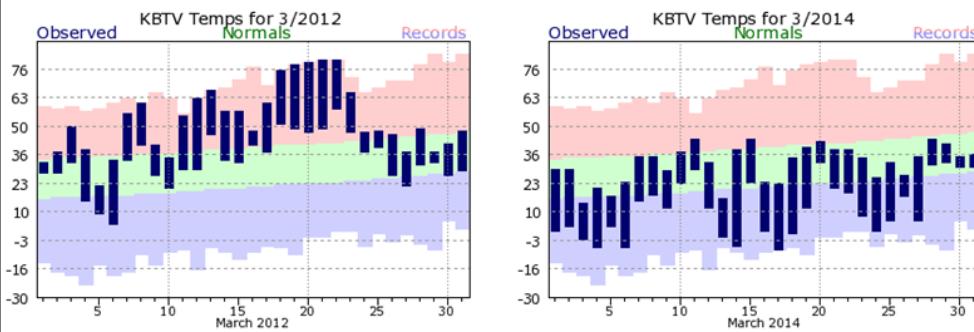


Figure 9: Burlington, VT March 2012 vs. March 2014 daily temperatures.

A similar temperature pattern was observed at Saint Johnsbury, VT with the 2012 average March temperature of 38.8°F or +8.5°F; while 2014 saw an average of 18.9°F or -11.4°F below on normal. Figure 10 shows the daily temperatures observed at Saint Johnsbury during March 2012 and 2014.

March 2012 vs. March 2014 St. Johnsbury (Normal: 30.3°)

March 2012:
Average Temperature: **38.8° (+8.5)**

March 2014:
Average Temperature: **18.9°(-11.4)**

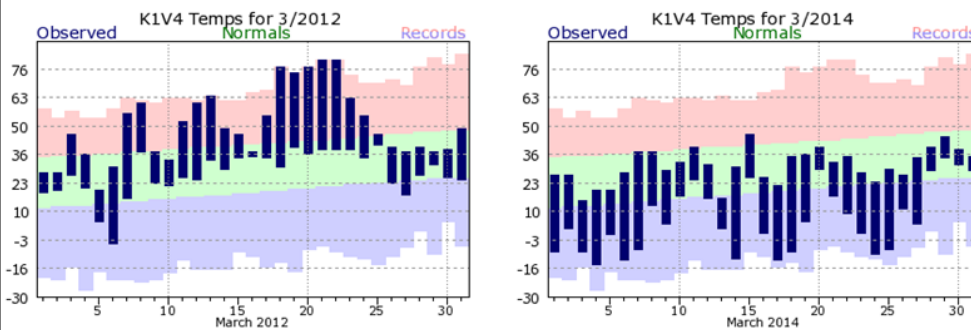


Figure 10: Saint Johnsbury, VT March 2012 vs. March 2014 daily temperatures.

Finally, a similar temperature profile was observed at Saranac Lake, but just colder per its high mountain valley location. From Figure 11, the average March 2014 temperature was 13.1°F or -11.4°F below normal. The warmest temperature observed was 42°F on March 28th, while the coldest was -29°F on March 17th. Saranac Lake experienced 18 days when the minimum temperature was 0°F or colder during the month of March 2014. March 2014 was an extremely cold month across our region and much of the nation, which will probably not occur again for many years.

Saranac Lake March 2014 Temperatures

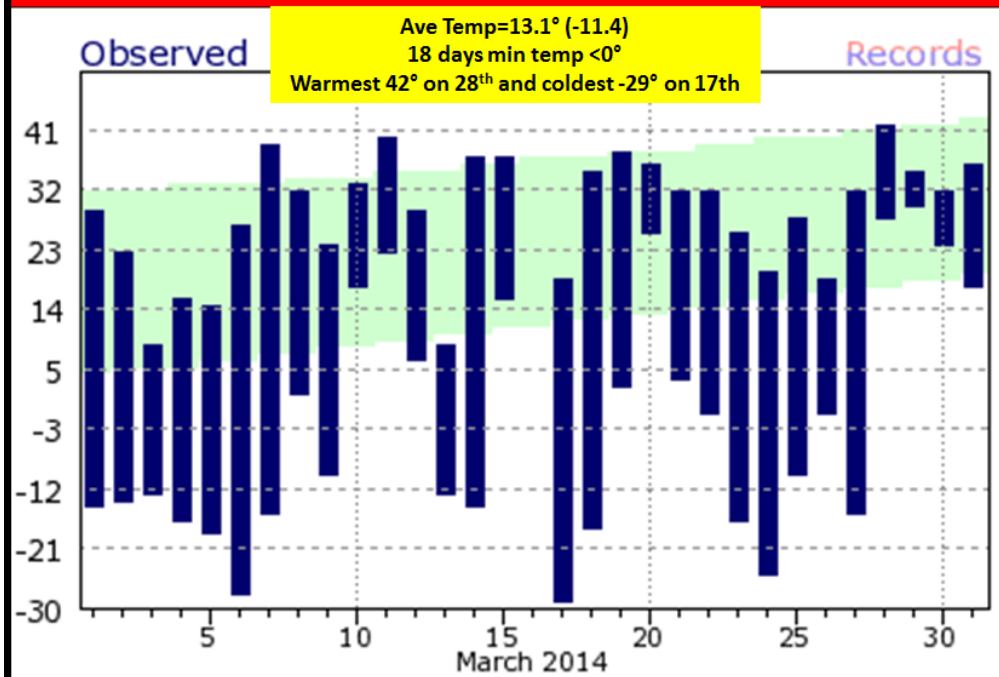


Figure 11: Saranac Lake, NY March 2014 daily temperatures.



The 4th most significant weather event across the North Country during 2014 was the March 12th snowstorm. This storm produced a widespread 10 to 20 inch snowfall across northern New York into Vermont, with some localized lighter and heavier amounts. The highest snowfall was observed at Bethel, VT with 25 inches, while 6 to 8 inches fell across Southern Saint Lawrence County and parts of the Northeast Kingdom of Vermont.

Figure 12 shows the surface analysis on 12 March 2014 at 10 PM, with a 981mb low pressure near Boston, MA and a building 1024mb high pressure near Hudson Bay. This created a very strong pressure

gradient across our county warning area (CWA) with surface wind gusts between 35 and 45 mph observed. A peak wind gust to 42 mph was measured at Burlington International Airport during the event and combined with temperatures only in the 10s and 20s, created near blizzard like conditions at times across the Champlain Valley and higher elevations. At the height of this storm visibilities were near zero with heavy snow and areas of blowing snow. Extremely hazardous driving conditions were observed during the evening hours on March 12th and for the following morning commute.

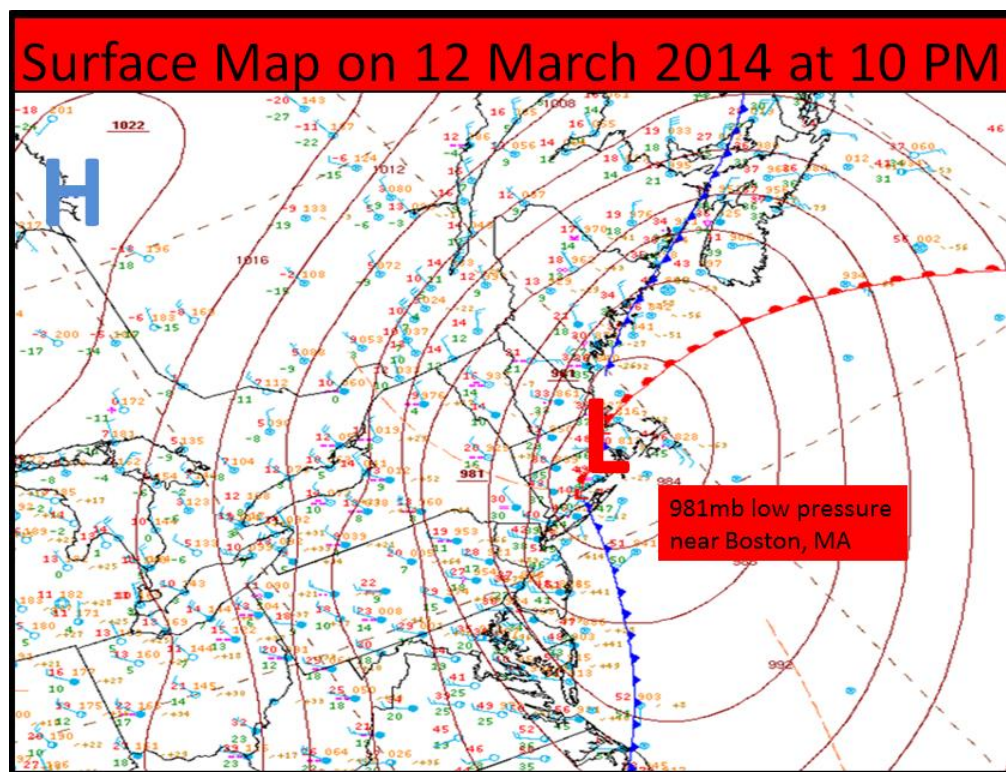


Figure 12: Surface map analysis on 12 March 2014 at 10 PM.

Figure 13 shows the radar and surface map evolution on 12 March 2014 from 1:00 PM to 10:00 PM. The initial surface low pressure tracked across the Ohio Valley into Southern Pennsylvania by late afternoon on March 12th, before making the turn and strengthening to 981mb near Boston MA by 10 PM. This track placed Vermont and northern New York on the cold side of the system and in a very favorable location for moderate to heavy snowfall to occur. The radar evolution shows multi bands of stronger reflectivity (darker green and yellow colors in Figure 13) impacting our CWA during the event, which resulted in snowfall rates of 1 to 2 inches per hour on the evening of March 12th.

Radar and Surface Map Evolution on 12 March 2014

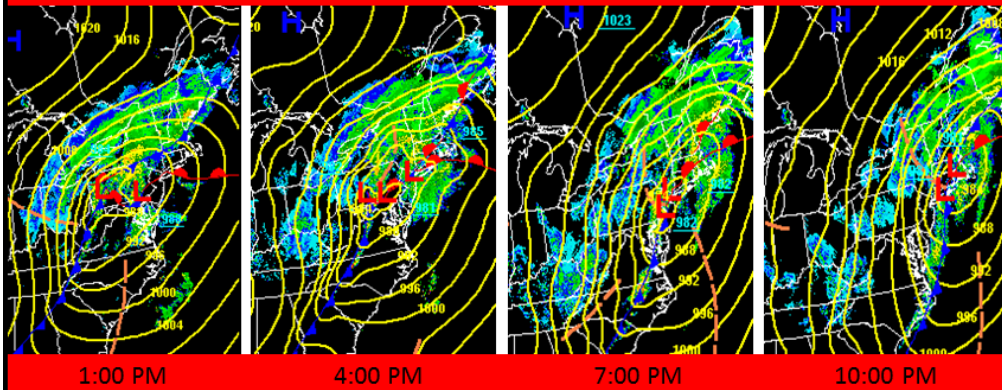


Figure 13: Radar and surface map evolution on 12 March 2014 from 1:00 PM to 10:00 PM.

Figure 14 shows the 24-hour snowfall map ending at 7 AM on 13 March 2014. Note the heavier band of snowfall across most of central and northern Vermont with amounts between 10 and 20 inches. The 24-hour snowfall at Burlington International Airport was 18.2 inches with Bethel, VT the big winner with 25 inches. We had lots of blowing and drifting of this light and fluffy snow, making measurements difficult. This storm increased snow depths across the North County between 20 and 40 inches with Mount Mansfield having a snow depth of 76 inches on March 14th. Figure 15 shows the snow depth across WFO BTV CWA on March 14th after this significant winter storm.

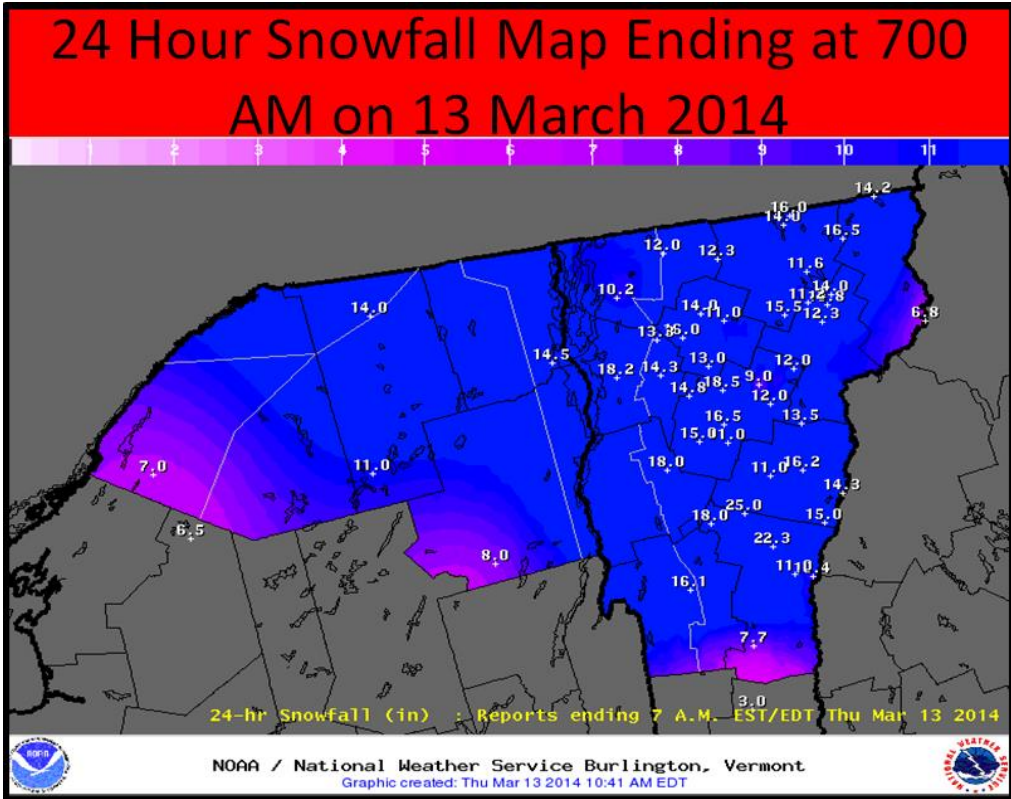


Figure 14: 24-hour snowfall map (in inches) ending at 700 AM on 13 March 2014.

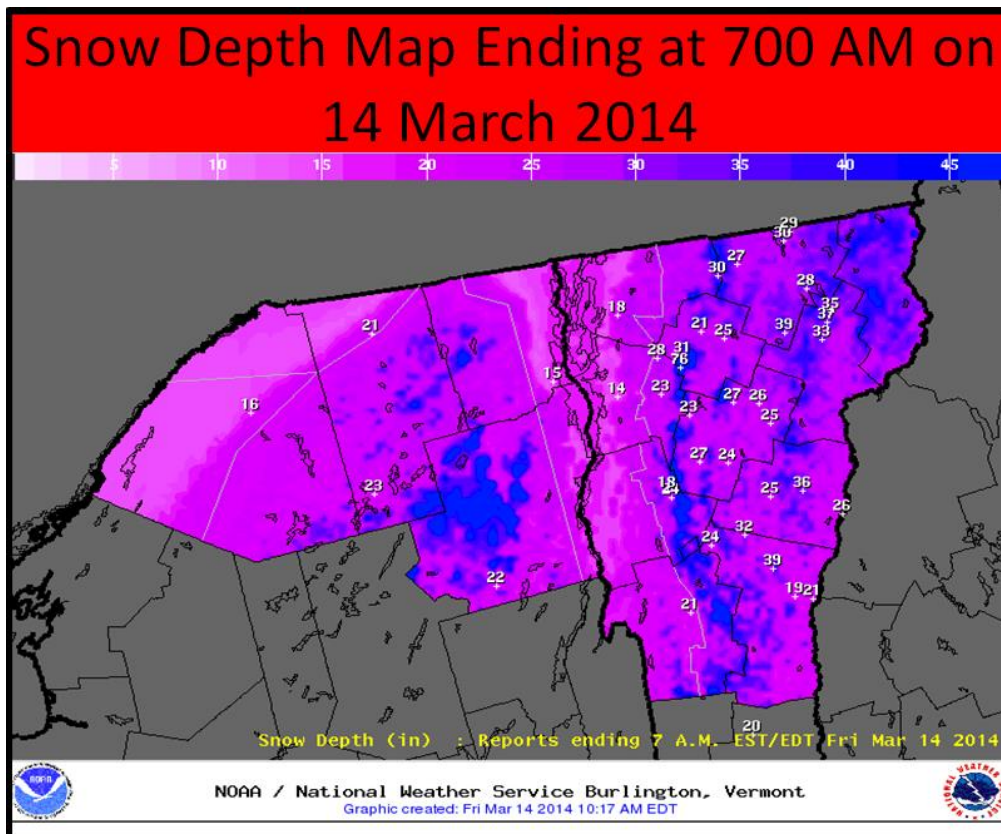


Figure 15: Snow depth map (in inches) ending at 700 AM on 14 March 2014.



On the evening of July 8th 2014 a line of fast moving severe thunderstorms impacted the North County with damaging winds and was the 5th most significant weather event for our region in 2014. This large convective complex contained numerous mini bow lines of storms, which formed along a cold front, which interacted with temperatures well into the 80s and dewpoint values near 70°F. The highest concentration of damaging winds occurred from the Saint Lawrence Valley in northern New York into parts of central and northern Vermont, including the Champlain Valley.

Figure 16 below shows a map of Local Storm Reports (LSRs) received by the National Weather Service (NWS) Burlington (BTV), Vermont Weather Forecast Office (WFO). The severe thunderstorm winds were estimated between 60 and 80 mph across many locations in the North Country during this event. The primary severe weather threat observed was damaging winds, which resulted in over 30,000 people losing power across Vermont and numerous trees down across the North Country from these bowing lines of storms.

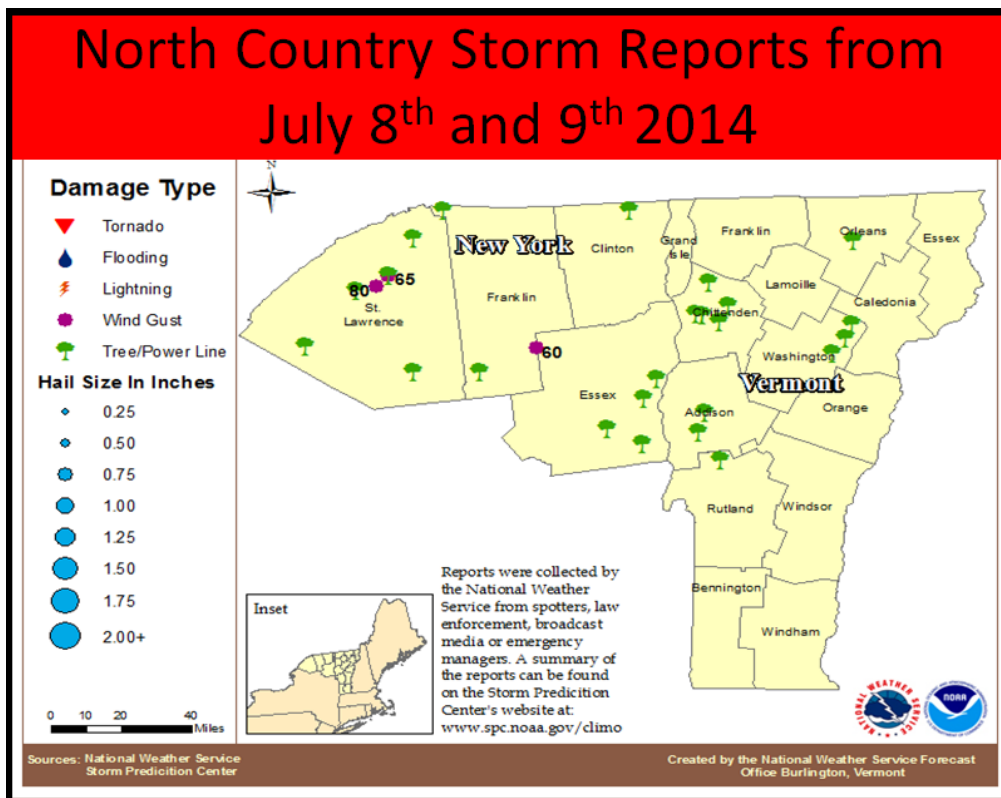


Figure 16: Map of Local Storm Reports on July 8th & 9th 2014. Green trees indicate trees or power lines down, light blue circles show location of large hail, and red dot is measured wind gust.

Figure 17 shows the 700 PM surface map and associated analysis on 8 July 2014. A well-defined cold front extended from a convectively induced meso surface low pressure across the Saint Lawrence Valley, while a weak warm front was lifting across northern New York and Vermont. This cold frontal boundary providing the necessary surface convergence and lift to produce multiple bowing line segments of severe thunderstorms across the North Country.

Surface Analysis at 700 PM on 8 July 2014

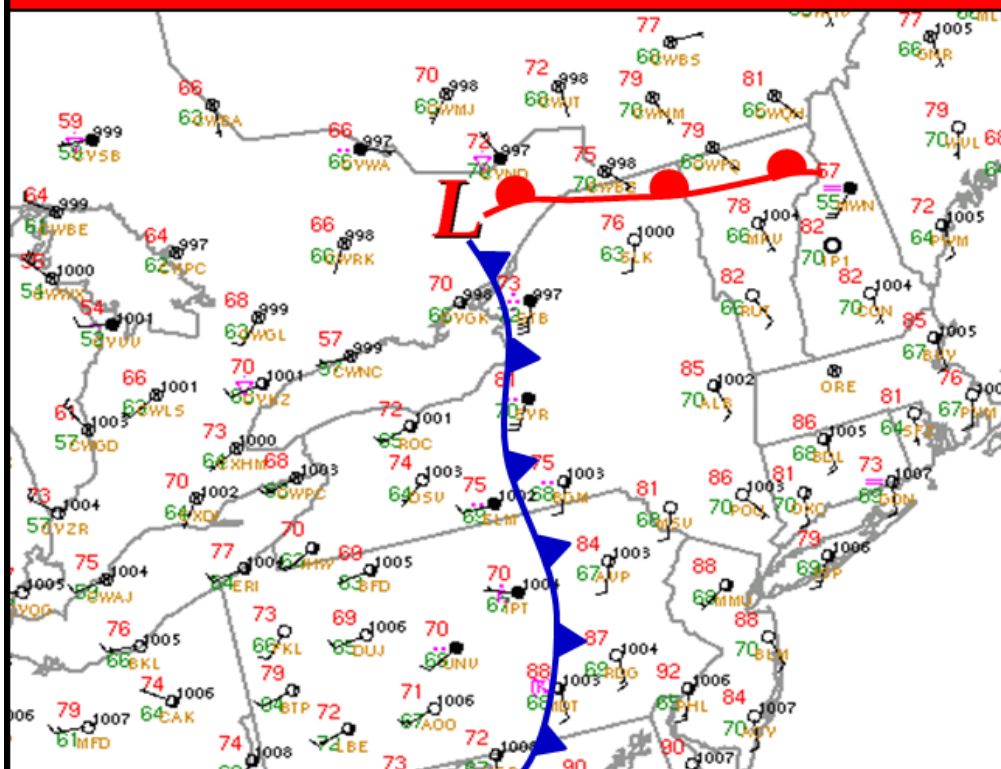


Figure 17: Surface map at 700 PM on 8 July 2014 with surface plots and cold front (blue line with triangles and warm front red line with half circles).

Figure 18 shows the evolution of multiple bow echoes within a large convective complex that impacts the region on July 8th. It should be noted ahead of the main line, several isolated supercells developed across parts of central New York and produced a deadly tornado near the Syracuse area. Given these are 1 hour snap shots of the line evolution and the associated comma head, the isolated supercells are hard to detect. In addition to favorable shear and instability parameters, the large-scale pattern included potent forcing for ascent, contributing to severe convective storms over a large area (Fig. 18).

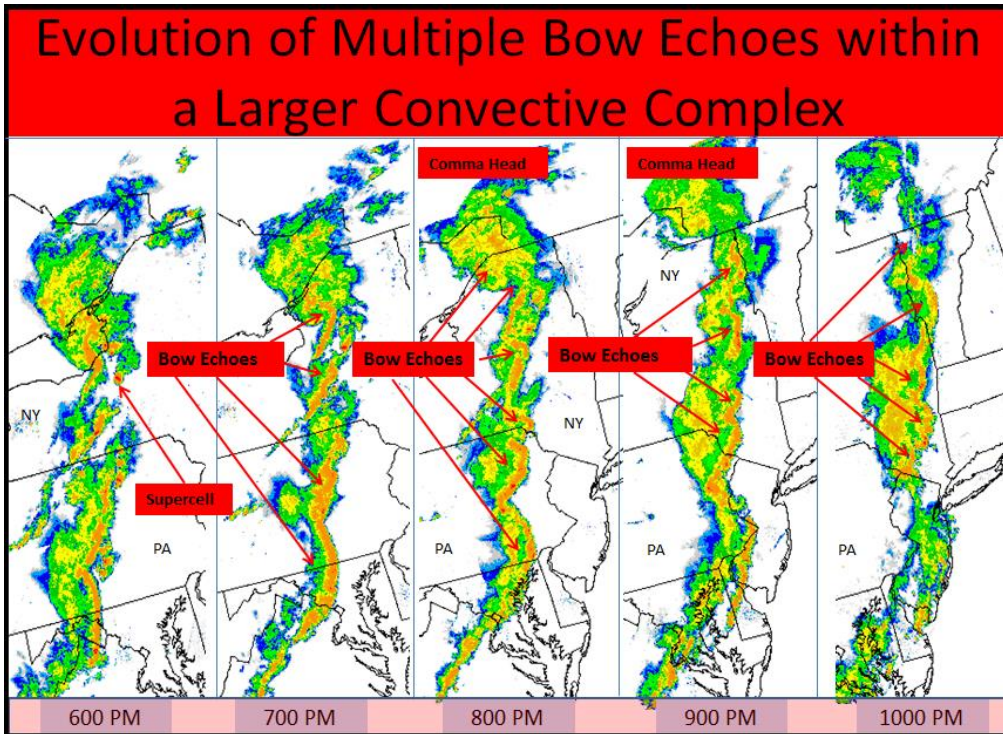


Figure 18: 0.5° Mosaic reflectivity across the Mid Atlantic to Northeast United States from 600 PM to 1000 PM on the evening of 08 July 2014.

Figure 19 below shows the KTYX 0.5° base reflectivity loop from 602 PM to 801 PM on 08 July 2014. This loop clearly shows a well-defined bow echo and associated comma head signature tracking northeast at 45 to 55 mph, from the Tug Hill Plateau to southern Saint Lawrence County. The decreasing reflectivity returns on the southwest flank of the storm, indicates an extremely strong rear inflow jet, which was verified by the KTYX VAD measuring 75 knots at 1000 feet above ground. As this broken line of storms moved quickly across northern New York and into Vermont, widespread damaging thunderstorm winds occurred.

KTYX 0.5° Reflectivity Loop From 602 PM to 801 PM on 08 July 2014

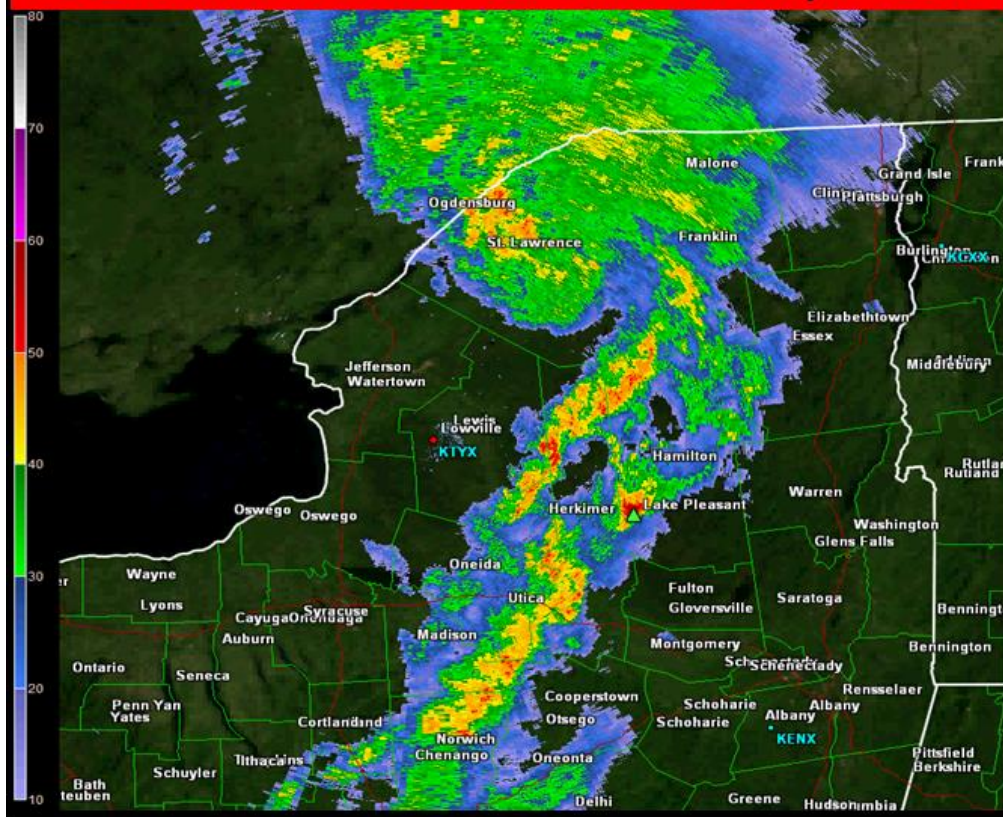


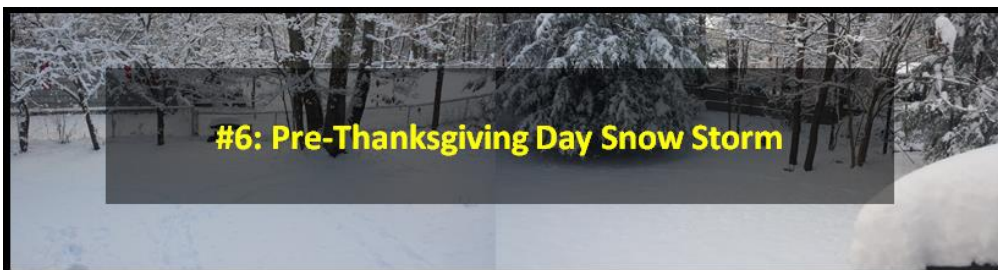
Figure 19: KTYX 0.5° base reflectivity loop from 602 PM to 801 PM on 08 July 2014.

This was the first widespread significant severe weather event of the 2014 season, which featured a long swath of damaging winds causing numerous communities across northern New York and Vermont to lose power. At the height of the storm, over 30,000 people were without power in Vermont and nearly 6,000 across extreme northern New York. This large, meso-convective system featured numerous embedded mini bow echoes. Figure 20 below show a mosaic of storm damage pictures across northern New York into Vermont.

Storm Damage Pictures



Figure 20: Storm Damage Pictures from 8 July 2014.



The 6th greatest impact storm of 2014 to impact the North Country was the pre-Thanksgiving Day snow storm on 26 November 2014. Surface low pressure developed during the late evening hours on November 25th across northern Florida and quickly raced along the eastern seaboard on the 26th. This tracked pushed enough Atlantic moisture back into our region, resulting in a tight northwest to southeast snowfall gradient. Figure 20a below shows the North Country storm total snowfall ending on November 27th, which ranged from a couple inches across the Saint Lawrence Valley and northern New York to over a foot in parts of central Vermont. As snow started to fall on November 26th, surface

temperatures were near freezing, resulting in a heavy wet snow, which produced scattered power outages across southern Vermont. At the peak, nearly 5,000 customers lost power in Vermont, with over 200,000 in New Hampshire and 100,000 Maine, which took nearly a week to restore. It was New Hampshire's 4th greatest power outage in state history.

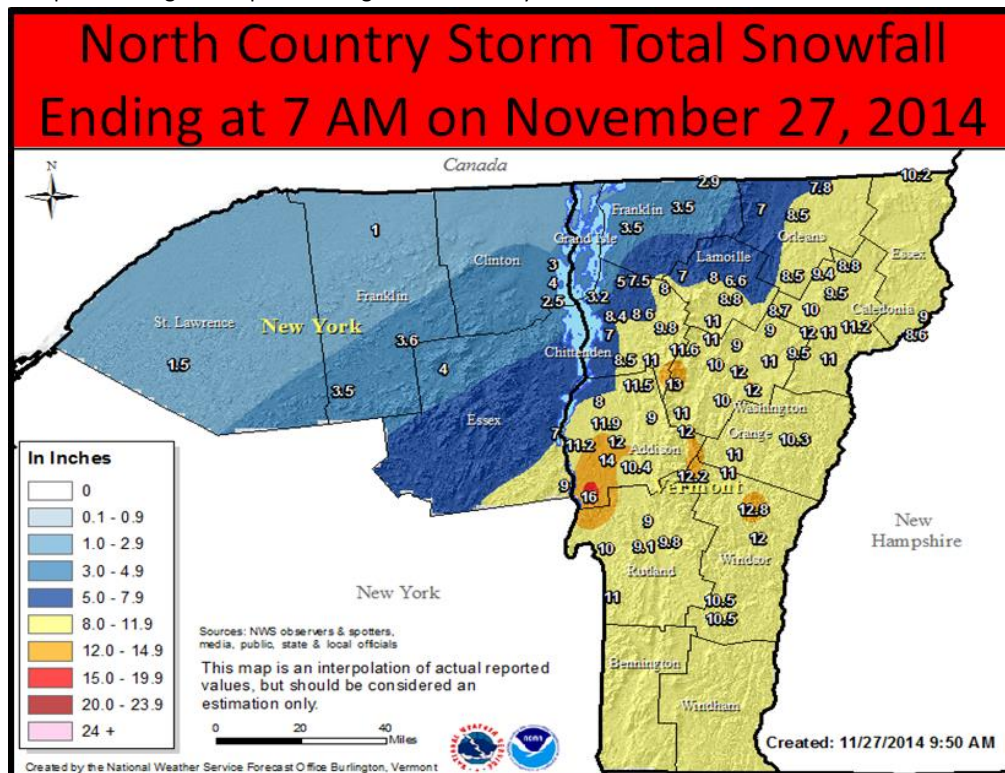


Figure 20a: North Country storm total snowfall ending 27 November 2014 at 7 AM.

Figure 20b shows the radar and surface evolution on 26 November 2014. At 700 AM on November 26th surface low pressure was developing near the North Carolina and South Carolina border area and quickly raced north and was located near Cape Cod by 1000 PM on the 26th. Surface analysis showed pressure values of 1008mb at 700 AM, but deepened to 988mb near Cape Cod by 1000 PM on 26 November 2014. This track is very favorable for producing a moderate snow event across central New England, with a sharp northwest to southeast gradient in precipitation across our region. The radar evolution during this event shows an intense snow band located across central Vermont between 100 PM and 700 PM on November 26th, which produce snowfall rates of 1 to 2 inches per hour and surface visibilities below one half of a mile.

Radar and Surface Map Evolution on 26 November 2014

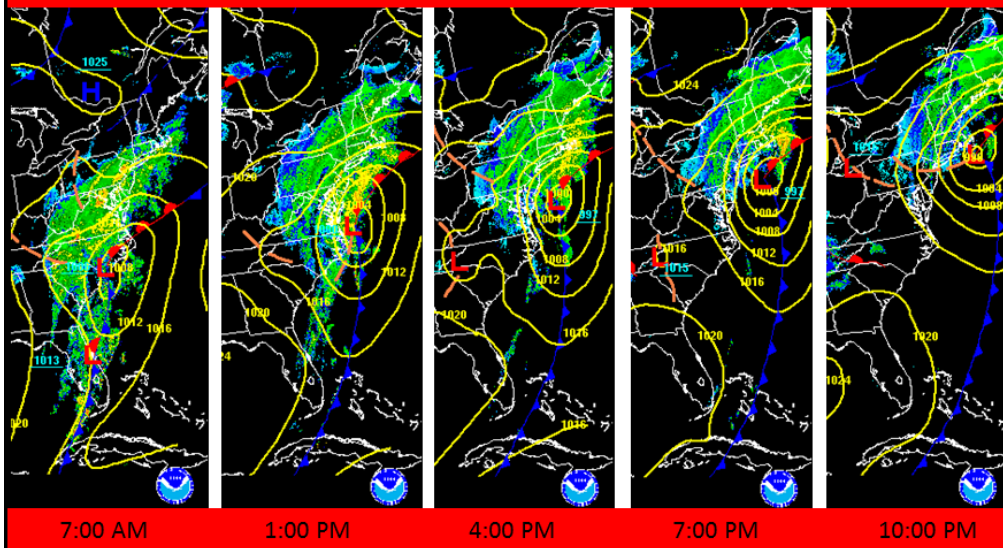


Figure 20b: Radar and surface map evolution on 26 November 2014 from 700 AM to 1000 PM.

Figure 20c shows a water vapor image at 715 AM on 26 November 2014, along with position of surface low pressure and track (Red). The combination of a digging mid/upper level trough and position of a strong jet across southern Canada helped pull deep sub-tropical moisture along the eastern seaboard. This is indicated by the brighter white color clouds in the image below, showing the areas of greater available moisture. The track of deepening surface low pressure helped advect low level Atlantic moisture back into central and southern New England during the event.

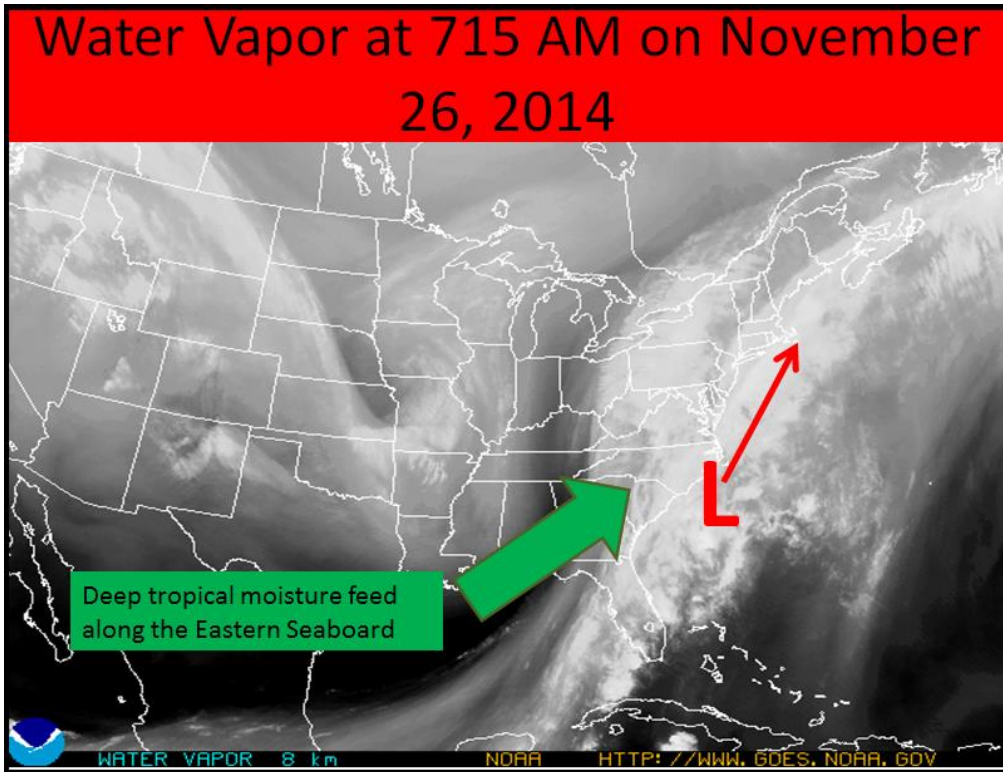


Figure 20c: Water vapor at 715 AM on 26 November 2014, with surface low and track (red).

Figure 20d below shows several storm related pictures in Essex, Vermont. Surface temperatures initially near freezing resulted in a heavy wet snow, which stuck to trees and power lines, especially across central and southern Vermont and most of southern New England. This produced up to 5,000 people losing power in Vermont and over a quarter million in Maine and New Hampshire. Also, the timing of this significant winter storm produced major delays at many airports along the east coast and disrupted travel on numerous roads. Snowfall across the WFO BTV CWA ranged from a couple inches across northern New York to over a foot in central Vermont, making this a moderate winter weather event for our region, especially with the timing a day before Thanksgiving.

Storm Photos

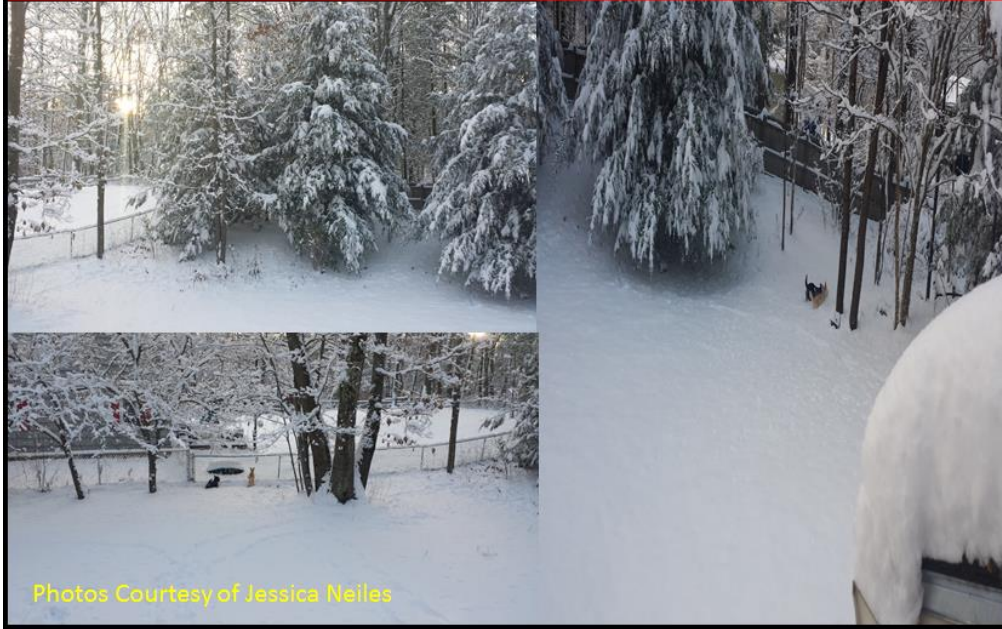


Figure 20d: Storm photos in Essex, Vermont. Photos courtesy of Jessica Neiles.



The 27 May 2014 Isolated Supercell across Addison and Rutland Counties of Vermont

Our first honorable mention occurred on 27 May 2014, as isolated supercell developed across the higher terrain of the eastern Adirondack Mountains in northern New York and tracked southeast across the central Champlain Valley, before dissipating over southern Vermont. This single storm tracked along a sharp backdoor cold front, which separated warm moist tropical air with temperatures in the 80s to the south from cool moist maritime air with temperatures in the 50s to the north and east. In addition to the contrasting air masses, this boundary helped create favorable turning of the low-level wind field, which enhanced organized supercell thunderstorm development and low-level rotation.

This monster supercell produced a long 40 to 50 mile swath of large hail from Bridport to Shrewsbury, VT, along with several localized areas of damaging thunderstorm winds. A National Weather Service (NWS) damage survey team determines the wind damage was caused by straight-line winds. [Click here](#) for a complete summary of the public information statement. Numerous reports of golf ball (1.75") size hail were reported, along with a measured 74 mph wind gust 2 miles Northwest of Bridport, VT, and several areas of downed trees and power lines. Figure 21 below shows a map of the local storm reports received by the NWS office in Burlington, VT (BTV) during the event. [Click here](#) for a complete listing of all severe weather report.

Field Code Changed

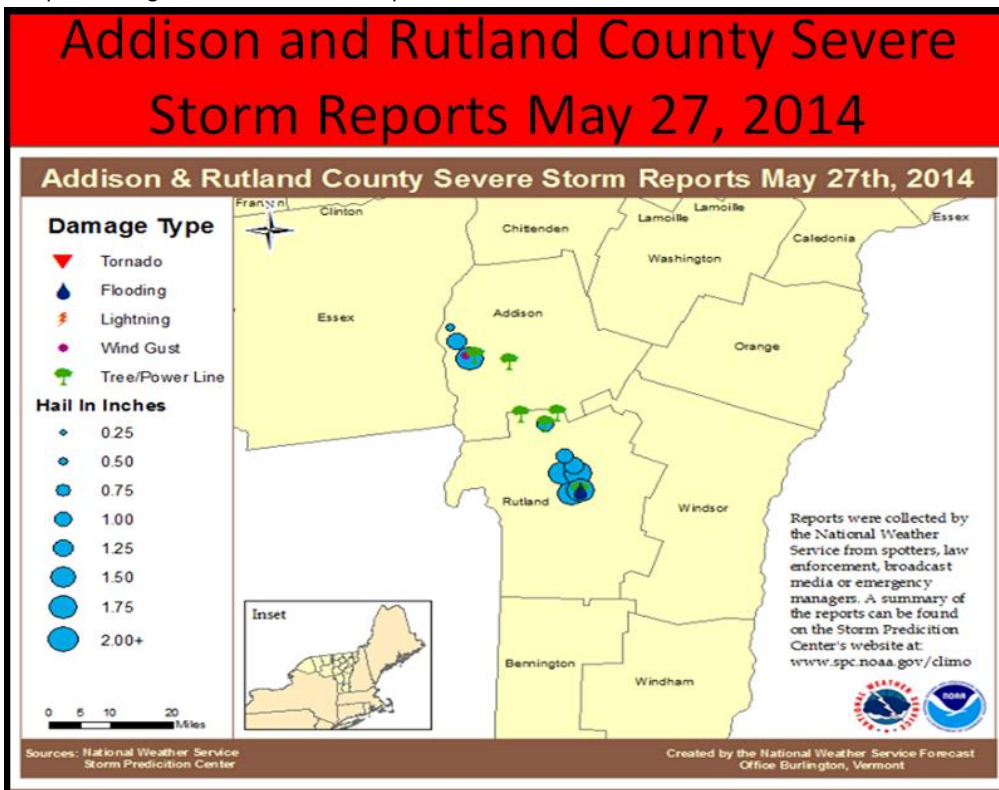


Figure 2122: Map of Local Storm Reports on 27 May 2014. Green trees indicate trees or power lines down, light blue circles show location of large hail, and red dot is measured wind gust.

Figure 22 below shows the 300 PM surface map and associated analysis on 27 May 2014. This shows a sharp cold front with a well-defined wind shift from the southern Saint Lawrence Valley across the Adirondack Mountains into southern Vermont. This front separated temperatures in the upper 70s to lower 80s across eastern New York from the upper 40s to middle 50s over most of central and eastern New England associated with the maritime air mass which had pushed inland from the Gulf of Maine and Gulf of St. Lawrence. Glen Falls, New York reported a high temperature of 85°F on May 27th, prior to the arrival of the backdoor cold front (not shown). Surface dewpoints on the warm side of the

boundary were in the upper 50s to lower 60s, before convection developed.

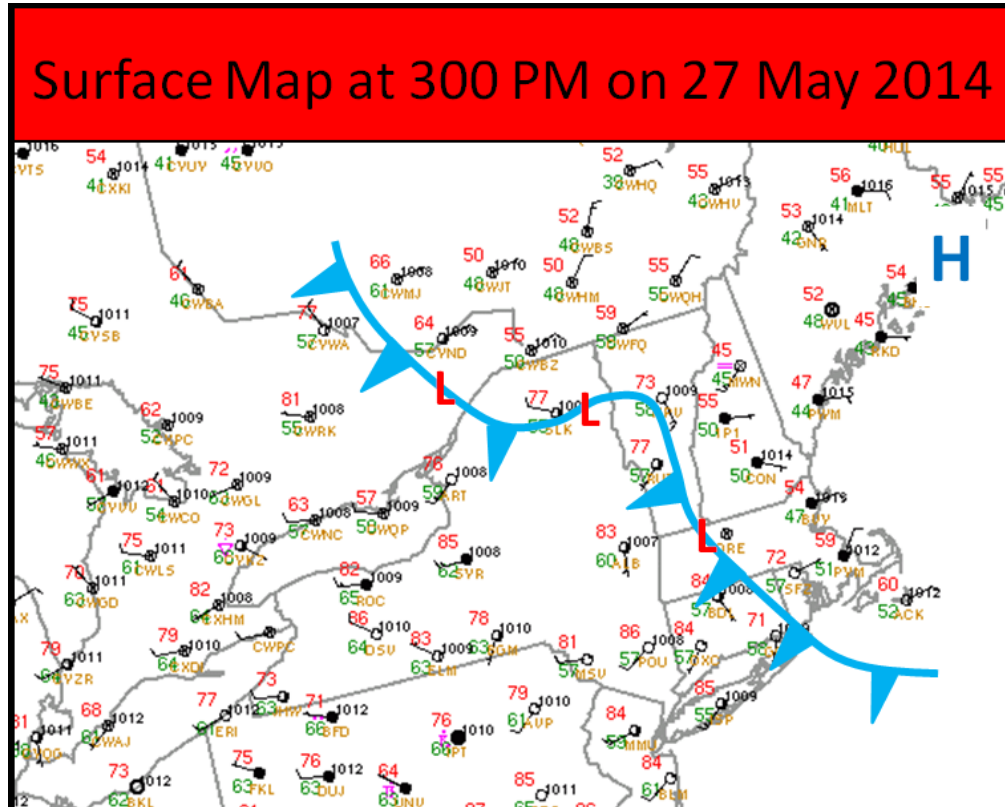


Figure 2223: Surface map at 300 PM on 27 May 2014 with surface plots and cold front (light blue line with triangles).

Figure 23 below shows the KCXX 0.5° base reflectivity loop from 324 to 504 PM on 27 May 2014. This loop clearly shows an isolated supercell tracking southeast at 25 to 30 mph with a well-defined reflectivity core and hook echo structure on the southwest flank of the storm. This indicates a well-organized rotating supercell with 60 to 70 dBZ reflectivity representing large hail and very heavy rainfall.

KCXX 0.5° Base Reflectivity from 324 to 504 PM on 27 May 2014

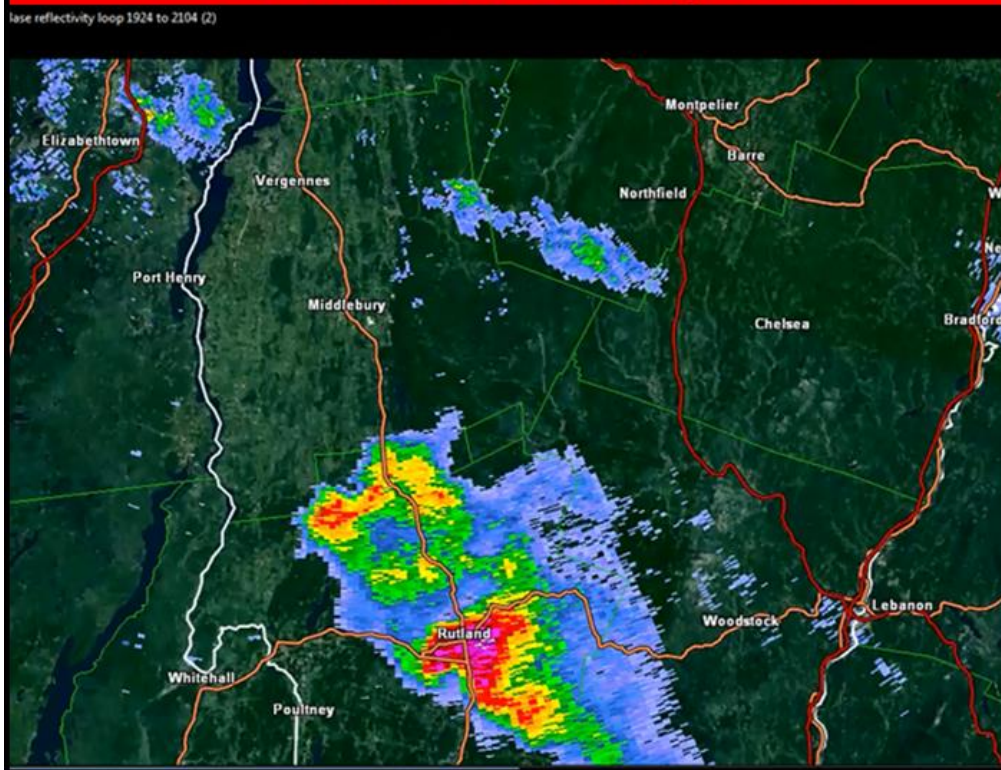


Figure 2324: KCXX 0.5° base reflectivity loop from 324 UTC to 504 PM on 27 May 2014.

Figure 24 below shows KCXX 0.5° velocity (left) and reflectivity (right) at 342 PM near Bridport, VT on 27 May 2014. The velocity data show outbound winds (blowing away from the radar located in Colchester, VT) of 50 to 60 knots (yellow circle in the left image), which is likely associated with a descending rear flank downdraft (RFD). At this time, the storm inflow winds (winds blowing toward the radar) were generally less than 10 knots. The reflectivity structure (right image) showed a well-defined hook echo, with the outflow velocity closely associated with the southwest flank of the reflectivity hook. These outbound winds produced localized wind damage mainly across the slightly elevated terrain of southern Addison County near Bridport, Vermont. In addition, localized wind damage and large hail was observed under the storm core from several miles northwest of Bridport to West Shoreham to Rutland. This is depicted with the yellow circle in image below (right) highlighting the 60 to 70 dBZ (pink/purple) reflectivity core. The silo damage occurred several miles southwest of Bridport, VT, associated with the descending RFD portion of the storm.

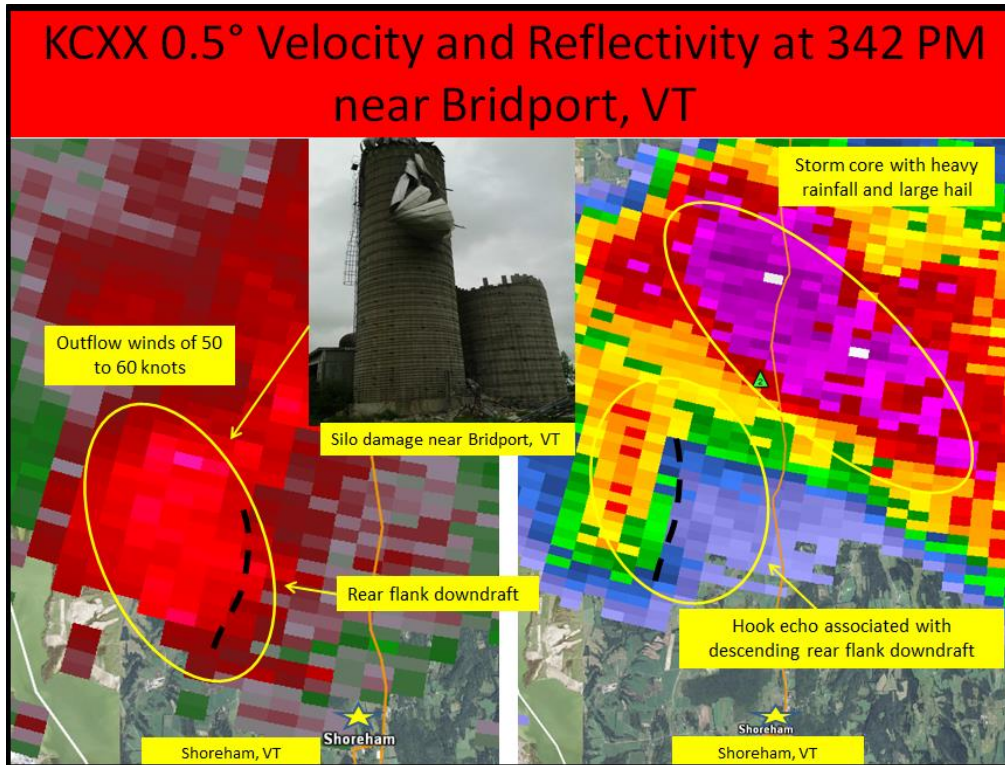


Figure 24: KCXX 0.5° velocity (left) and reflectivity (right) at 342 PM near Bridport, VT on 27 May 2014.

In the following image we associate reflectivity structure (left), with actual storm photograph (right) of supercell thunderstorm near West Shoreham, VT at 424 PM on 27 May 2014. In both the reflectivity cross section and storm photograph we are looking north into the storm with the east being to the right in the image below. The reflectivity cross section shows a well-defined storm reflectivity overhang and bounded weak echo region (BWER). Note how the strongest reflectivity core is elevated above an area where radar echoes are weak to non-existent. It is this region that is referred to as a BWER. Figure 25 shows a classic example of a BWER. Meteorologists can infer that the updraft is so strong that it is able to suspend rain and/or hail aloft, and not fall to the ground (hence, the lack of echo returns below the strong reflectivity core). Storms that have this particular signature are capable of producing severe weather.

Also, a strong southwest flank reflectivity core is present. This reflectivity core is associated with the descending RFD and is shown nicely with the lowering cloud structure photograph (lower right). Given the distance away and higher terrain, it looks like the cloud is touching the ground in the photograph below, but probably is several hundred feet above ground level. Also, note the cloud structure is not circular in shape, but instead has a boot like appearance on the east flank, indicating the

potential for gusty downburst winds. The translucent areas in the photo background indicate the storm's core with very heavy rainfall and large hail.

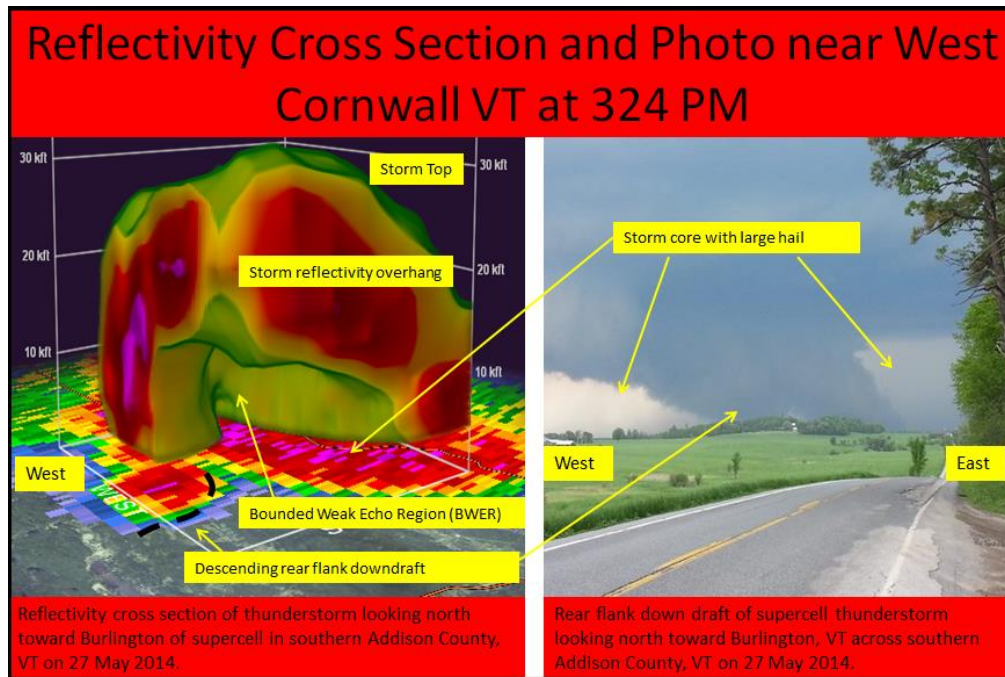


Figure 25: KCXX reflectivity cross section and storm photo near West Cornwall, VT at 2024 UTC on 27 May 2014.

This supercell thunderstorm was 9 miles tall with storm top reflectivity over 48,000 feet above ground level (AGL) as it approached Rutland, VT. In addition, a solid 60 to 70 dBZ reflectivity core was present to 30,000 feet AGL, indicating a very warm and unstable air mass was being lifted into the storm's updraft. Soundings showed a very unstable profile with tall equilibrium levels to 37,000 feet and favorable shear for organized and persistent convection capable of producing severe hail.

Figure 26 below shows Echo Top (lower left) and Vertical Integrated Liquid (VIL) (lower right) at 2040 UTC on 27 May 2014 near Rutland, VT. Echo top is a good indication of the storm top and the taller the storm the greater potential for severe winds or large hail. VIL is an estimate of the total mass of precipitation in the clouds. The measurement is obtained by observing the reflectivity of the vertical column as obtained by radar. This measurement is usually used in determining 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 downburst is occurring, a result of a weakening of the storm's updraft and the storm's inability to hold the copious amounts of moisture/hail within the storm's structure. This means greater potential for the storm to produce damaging winds as the downburst descends to the surface. Figure 26 shows VIL (gray and white

color) values $> 80 \text{ kg/m}^2$ several miles northwest of Rutland. This indicates a very well developed updraft, which produced 1.75" diameter hail in Proctor and Rutland. It was noted just prior to the storm, the Automated Weather Observation Station (AWOS) at Rutland Regional Airport had southeast storm relative inflow winds sustained at 30 mph with gusts to 37 mph. This supercell storm continued to track southeast before weakening near Shrewsbury, VT during the early evening hours of May 27th.

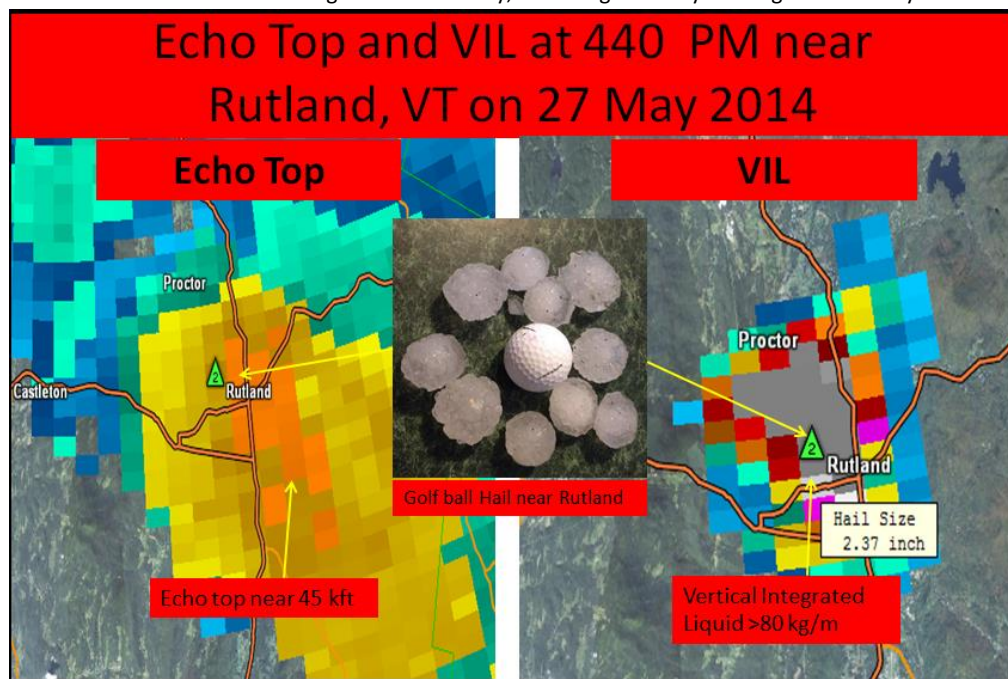


Figure 26: Echo Top (in feet, left) and Vertically Integrated Liquid (km/m^2 , right) at 440 PM on 27 May 2014 near Rutland, VT.

This was the first significant severe weather event of the 2014 season, which featured a long swath of large hail and localized wind damage associated with an isolated supercell thunderstorm. This was the only severe thunderstorm across the WFO BTV CWA on 27 May 2014. A 74 mph wind gust was measured northwest of Bridport, VT during the event, along with isolated areas of trees down and some structural damage to houses and farmsteads across southern Addison County. At the height of the storm, only 500 people were without power, indicating the main impact from the storm was very large hail. Many reports of hail up to golf ball size or 1.75" in diameter was observed. The image below shows areas of wind damage and the large swath of severe hail from near Bridport to Whiting to Proctor to Rutland. Finally, some brief heavy rainfall occurred with this supercell thunderstorm, with urban and poor drainage flooding being observed in the City of Rutland. Finally, Figure 27 shows some of the storm related structural and tree damage that occurred, along with several pictures of large hail. During the peak of the storm, hail was measured several inches deep in West Rutland.



Figure 27: Storm damage photos from 27 May 2014.

The Chester, Vermont Flash Flooding Event on 28 July

Our 2nd honorable mention was the devastating but very isolated flash flooding event that occurred on 28 July 2014, near Chester, VT. Stationary thunderstorms developed in the early evening of July 28 over south central Windsor County in Vermont in the headwaters of the Williams River. Rainfall totals were two to three inches in a little over an hour, and the one hour return interval was over a 50 year event (Figure 28).

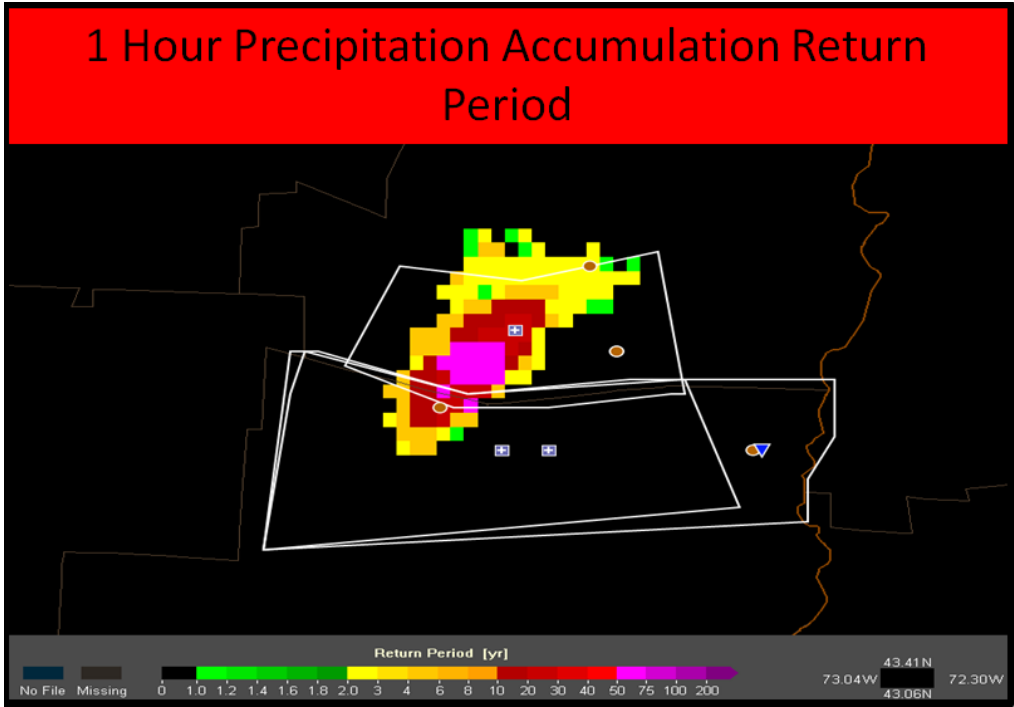


Figure 28: Precipitation accumulation return period.

At the surface, low pressure moved from southeast New York across southern New England during the day of the 28th. South winds ahead of the low brought warm moist air to southern Vermont, with afternoon high temperatures near 80 and surface dewpoint temperatures in the upper 60s (Figure 29).

Surface Plot on 28 July 2014 at 8 AM

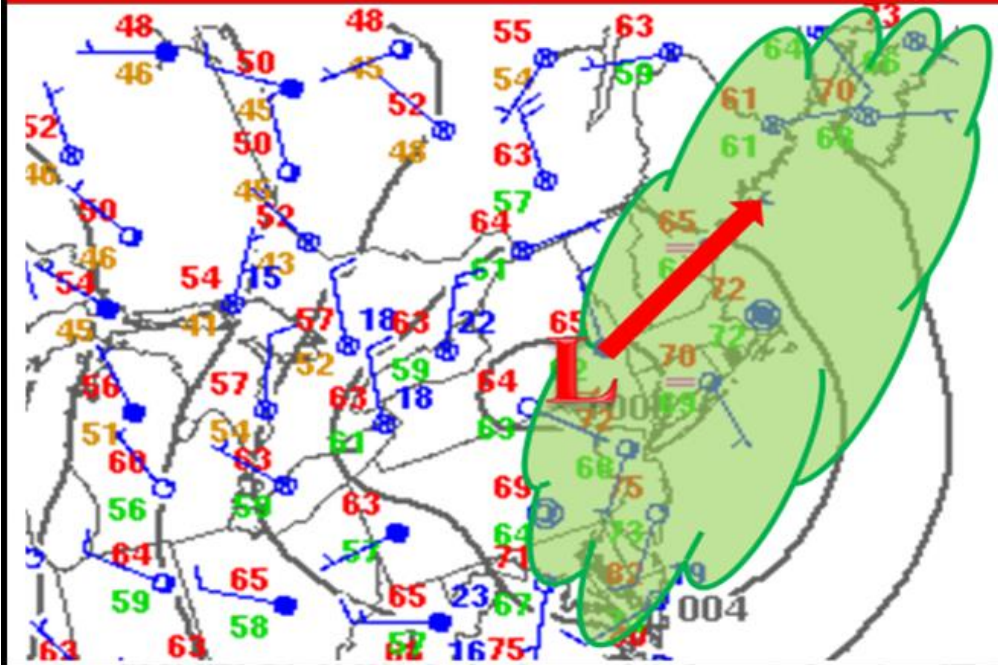


Figure 29: Surface plot valid 8 AM July 28, 2014. Surface low track (red arrow) and dewpoint >65°F (shaded green).

At 500 mb, a trough of low pressure extended south from a closed low over Quebec, while a shortwave trough lifted northeast through southern New England on a track similar to the surface low (Figure 30).

500 mb Map on 28 July 2014 at 8 AM

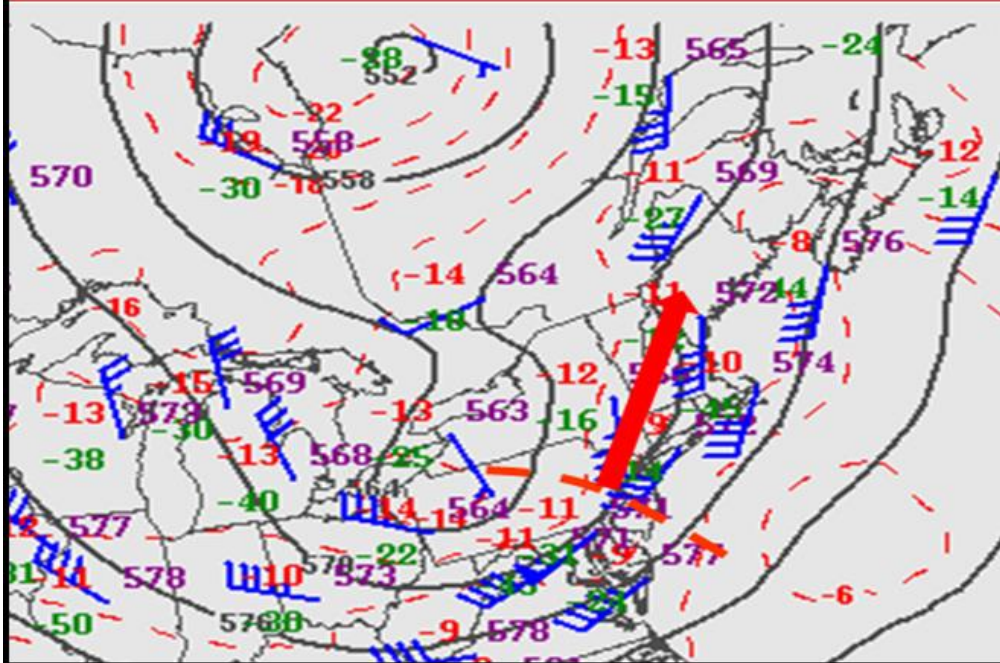


Figure 30: 500 mb height and wind analysis valid at 8 AM on 28 July 2014. Short wave trough (dash red line) and track (red arrow).

The model sounding (18 UTC NAM model sounding valid 19 UTC for Springfield VT, Figure 31) revealed mixed signals as to the potential for heavy rain production. The precipitable water value at 1.25 inches was near the 50th percentile (about normal) for late July. The warm cloud depth extended 2.7 km and was favorable for warm rain processes, but still short of the more ideal 3 km depth. Additionally the sounding did not exhibit a "tall skinny" profile, indicating saturation through the depth of the atmosphere. On the other hand MBE velocities were low, less than 10 knots through the afternoon, suggesting any storms that formed would remain stationary.

NAM Model Sounding for Springfield, VT at 4 PM on 28 July 2014

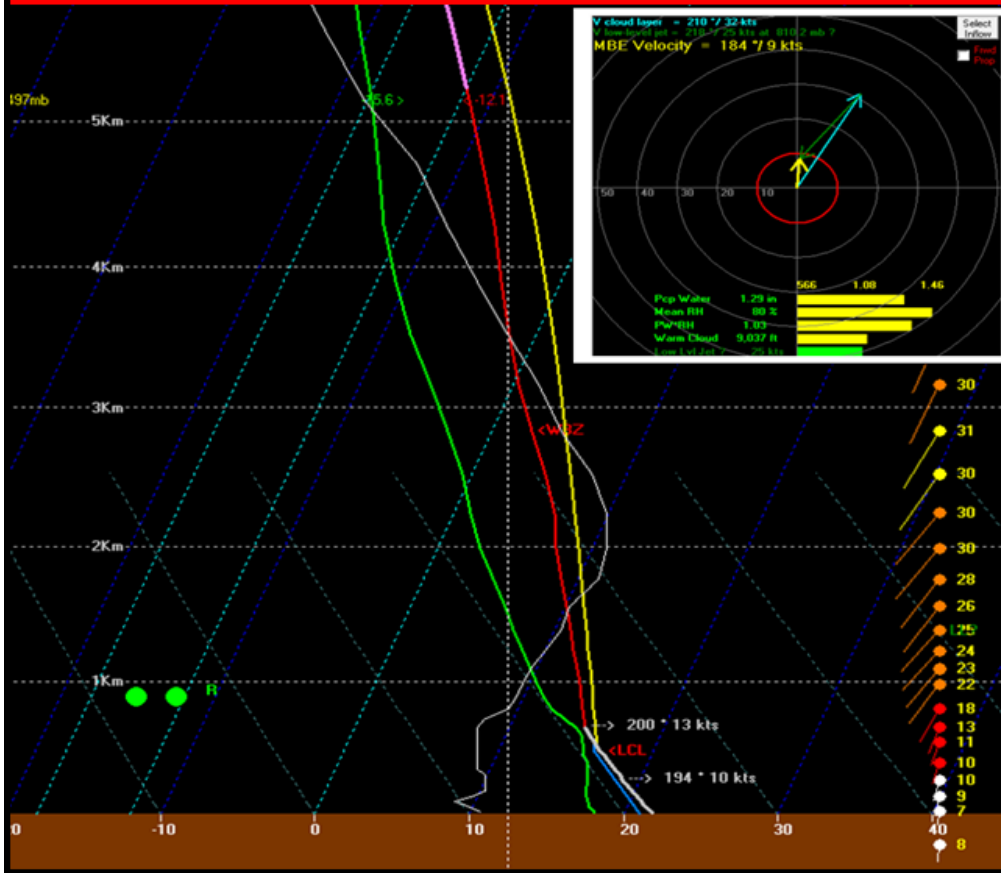


Figure 31: NAM model sounding for Springfield, VT valid 300 PM on 28 July 2014. The insert shows the mean cloud layer wind (cyan vector), the low-level jet (green vector), and the resultant slow storm propagation vector (toward the north at 9 knots, yellow vector).

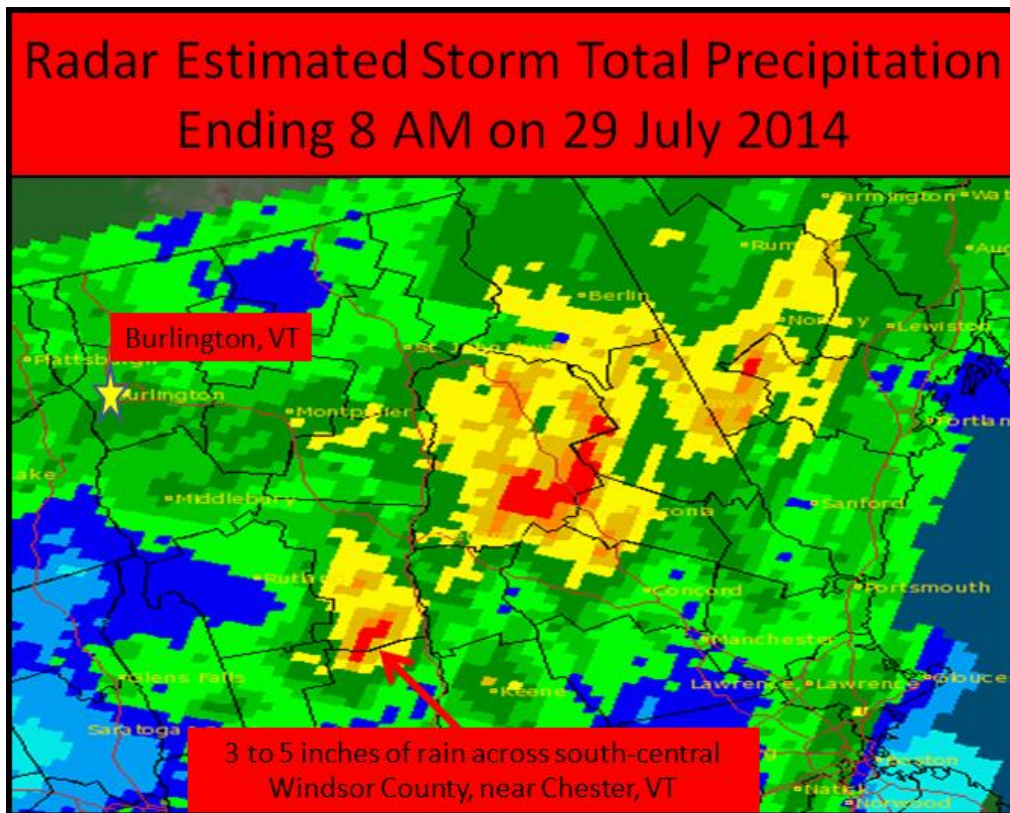


Figure 32: Radar estimated storm total precipitation ending at 8 AM on 29 July 2014.

Figure 32 above shows the radar estimated storm total precipitation ending at 8 AM on 29 July 2014. Note the very small, but intense rainfall foot-print across south central Windsor County, near Chester, VT. Radar and surface observations confirmed 3 hour rainfall amounts between 3 and 5 inches across this region of Windsor County.

State highways 11 and 103 and many local roads were washed out or closed due to flash flooding, and cars were washed away and houses damaged as well. There were many comparisons made to the flood damages from Tropical Cyclone Irene in 2011. Preliminary flood damage totals amounted to over \$1.5 million.

The November 18th through 21st Significant Lake Effect Snow Event

A strong arctic cold front quickly moved through western and central New York on the evening of November 17th and produced a prolonged and significant lake effect snow event for southern Saint Lawrence County and parts of the western Adirondack Mountains in northern New York from November 18th through early morning on November 21st. Temperatures quickly dropped into the upper teens and

lower 20s behind this arctic boundary with brisk west to southwest winds at 15 to 25 mph. These chilly winds blowing over Lake Ontario water temperatures near 50°F produced a significant lake effect band of heavy snow from eastern Lake Ontario into southern Saint Lawrence and Franklin Counties on November 18th and 19th. Snowfall rates of 2 to 4 inches per hour were observed in this band, along with near white conditions in areas of blowing and drifting snow. This very intense snow band drifted south of the region and impacted parts of the Tug Hill Plateau region late on November 19th, before moving back into the area on November 20th. Figure 35 below shows the North Country storm total snowfall from November 18th through 7 AM on November 21st. This multi day lake effect event included 42 inches at Fine, NY and 36 inches at Oswegatchie, NY, and over 2 feet in Gouverneur, NY. Meanwhile, from the figure below one can clearly see very light snowfall occurred outside the lake effect band with only a dusting in the Champlain Valley. This localized lake effect snow event closed several state and county highways, with surface visibilities near zero and blizzard like conditions. It's been many years since southern Saint Lawrence and Franklin Counties in northern New York have received this much snow from a lake effect snow event, make it into our honorable mention category for our top weather event in 2014 across the North Country.

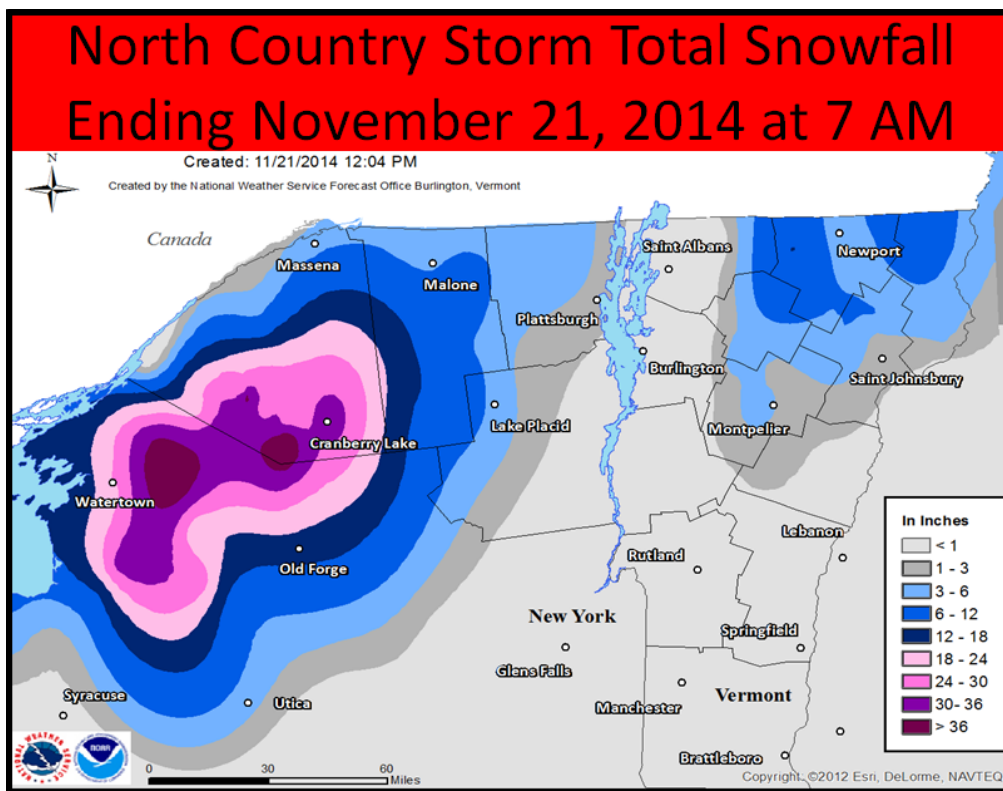


Figure 35: North Country storm total snowfall from November 18th through 7 AM November 21st, 2014.