The Four Seasons

National Weather Service Burlington, VT

VOLUME IV, ISSUE III

FALL 2017

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Letter from the Editors

Welcome to The Four Seasons, a quarterly newsletter issued by the National Weather Service in Burlington, VT. In this edition we review the severe wx that occurred during the summer, as well as look at severe wx climatology for the North Country. We take a look at 2 historic wx events, the Great Flood of 1927 and this past March's Pi Day Storm. We also see BTV in action here and afar in leadership training and supporting the Oregon wildfires. Fimally, we bid farewell to a long time NWS Burlington employee as he starts a new adventure in his NWS career.

2017 North Country Severe Weather Review

By Brooke Taber

The 2017 severe weather season of May, June, July, and August across the North Country was very similar to 2016 and close to normal in terms of warnings issued and severe weather reports. The Weather Forecast Office (WFO) in Burlington (BTV), Vermont 64 severe thunderstorm warnings and received 117 severe weather reports. A severe weather report is defined by damaging thunderstorm winds and/or any measured thunderstorm wind gust of 58 mph or stronger and/or hail 1 inch in diameter or larger. Many of our severe weather events in 2017 were pulse storms, which is a single thunderstorm, which produces severe weather for a short period of time. A pulse storm environment typical consists of moderate instability and weak shear.

Figure 1 shows the number of warnings issued by WFO BTV from 2010 to 2017, along with the number of severe weather reports received during the months of May, June, July, and August. As you can see by the chart 2011 and 2012 severe weather seasons were very active with 90 and 84 warnings issued respectively and over 200 reports.

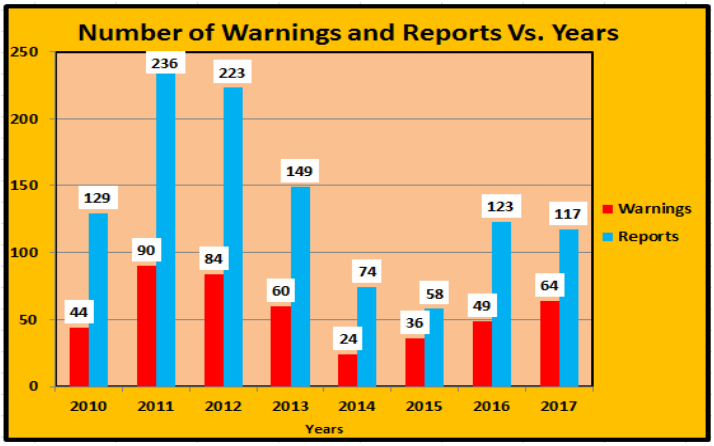

Figure 1: Graph showing the number of warnings and reports versus years.

Figure 2, on the next page, shows the number of wind and hail reports from 2010 to 2017 across WFO BTV county warning area, which extends from Northern

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New York into most of Central and Northern Vermont. As you can see the primary severe weather threat across the North Country is strong and damaging thunderstorm winds, that typical cause power outages or tree damage. In 2017 of our 117 severe weather reports, 98 were damaging winds with only 19 reports of hail 1 inch or greater.

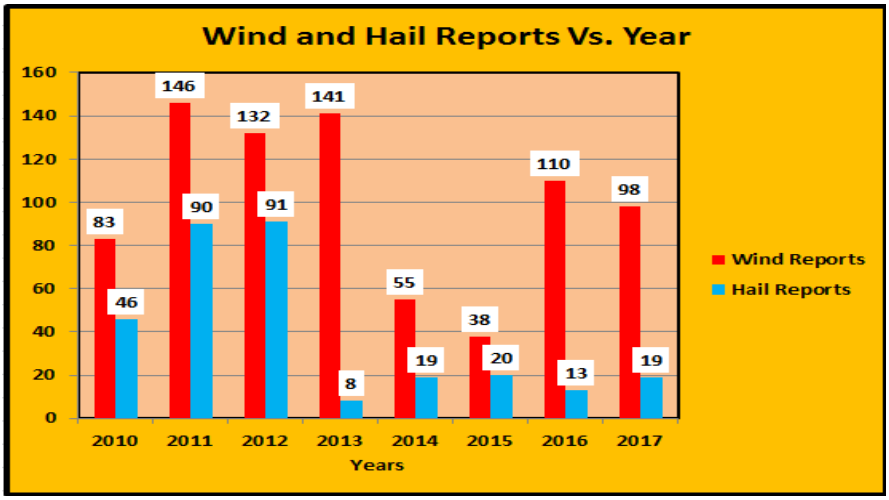

Figure 2: Chart showing wind and hail reports vs year.

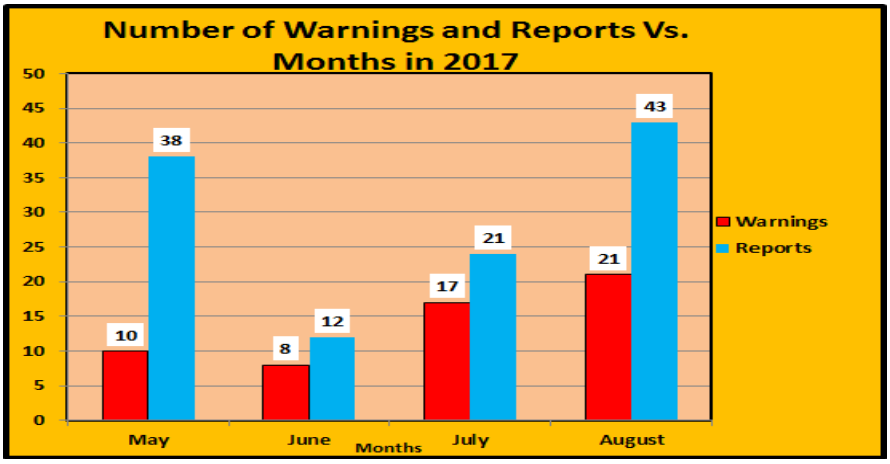

Figure 3: Chart showing warnings and severe weather reports vs. months in 2017.

Figure 3 breaks down the number of severe weather warnings and reports by month in 2017 across our county warning area. The most active month during the 2017 severe weather season was August with 21 warnings issued and a combined 43 hail and wind reports received by our office. Severe weather climatology indicates June and July are typically our most active months, with a majority of our events occurring during the afternoon hours associated with peak heating.

Our data shows two of the more active severe weather days this season were May 18th and August 22nd with 7 and 9 warnings issued respectively. On the 18th we received 18 reports of severe weather with from severe thunderstorm winds and 13 reports on August 22nd. Figure 4, on the next page, shows the 0.5° KCXX velocity data (left) and KTYX vertical reflectivity cross section (right) at 5:20 p.m. on 18 May 2017. Given the closeness to the KCXX radar in Colchester, VT this storm was very poorly sampled aloft, but captured the low level velocity downburst signature very well. Meanwhile, the KTYX radar in Montague NY was too many miles away for good data sampling in the low levels, but displayed the reflectivity structure aloft well. The 0.5° velocity data clearly showed a divergence signature with 60 knots (green) moving toward the radar and 40 to 45 knots (red) moving away from the KCXX radar associated with a downburst of wind within a severe microburst thunderstorm. The reflectivity cross section from the KTYX radar indicated a storm top of 40,000 feet or over 7 miles tall, and 50 dBZ reflectivity core to 25,000 feet. This strong reflectivity core aloft and favorable mid-level wind fields with good mixing in the low levels created an environment conducive for damaging microburst winds.

Figure 5, on the next page, shows the KCXX reflectivity cross section at 620 p.m. on the evening of May 18th near Potash Bay Road in the town of Addison, VT, where a severe microburst occurred with estimated winds of 80 to 100 mph. These winds blew a camp along Lake Champlain off its foundation and caused trees and power lines to come down across western Addison County. The storm structure clearly shows an

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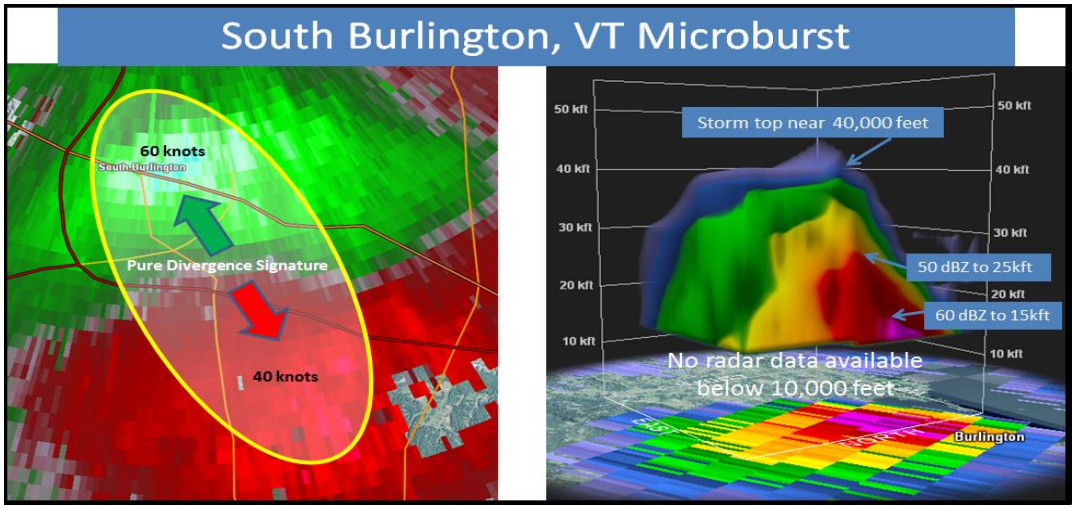

Figure 4: The KCXX 0.5° velocity (left) and KTYX reflectivity cross section (right) at 5:20 p.m. on 18 May 2017.

and power lines to come down across western Addison County. The storm structure clearly shows an overshooting top with reflectivity values greater than 40,000 feet above ground level, along with a forward and back sheared anvil. This well organized storm also exhibited a very deep/strong reflectivity core with 70 dBZ to 10,000 feet and 60 dBZ to 20,000 feet, along with a tilted west to east core, indicating very strong mid-level winds.

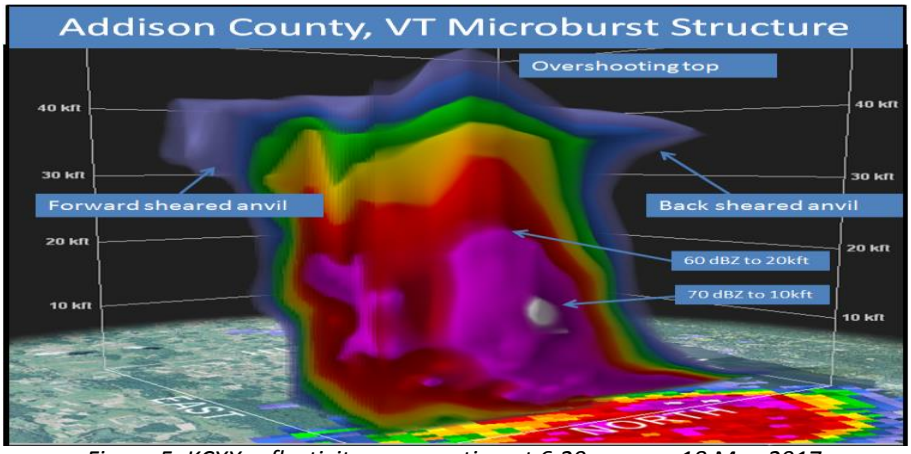

Figure 5: KCXX reflectivity cross section at 6:20 p.m. on 18 May 2017.

Figure 6, below, shows pictures taken by the NWS BTV survey team during their investigation of damage in western Addison County, which includes holes in vinyl siding of several homes from large hail, structural damage to a summer camp on Potash Bay Road, and pine trees uprooted or damaged. Similar damage was observed from a microburst with multiple reports of trees down in the South Burlington and Williston areas on 18 May 2017.

Figure 6: Storm survey photos taken by NWS BTV on Potash Bay Road in Western Addison County.

Meanwhile, on August 22nd, a line of severe thunderstorms rapidly developed across portions of the Champlain Valley and quickly moved into parts of central and

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northern Vermont. The primary threat was damaging wind gusts, which caused property damage near Vergennes, Vermont and areas of trees and powerlines down. Figure 7 shows the KCXX 0.5° reflectivity and velocity data at 5:56 PM on 22 August 2017. The image indicates a sharp bowing reflectivity gradient with enhanced inbound winds of 50 to 60 knots, just a few hundred feet above ground level. This matches very well the structural and tree damage the NWS surveyed near Vergennes associated with this storm. A large barn was destroyed with tin and wood support blown from southwest to northeast up to 100 yards away, along with isolated tree damage.

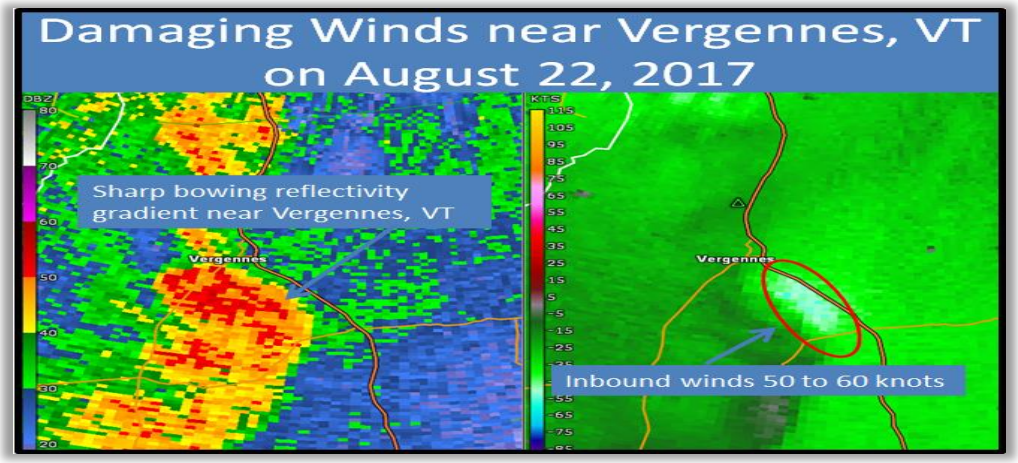
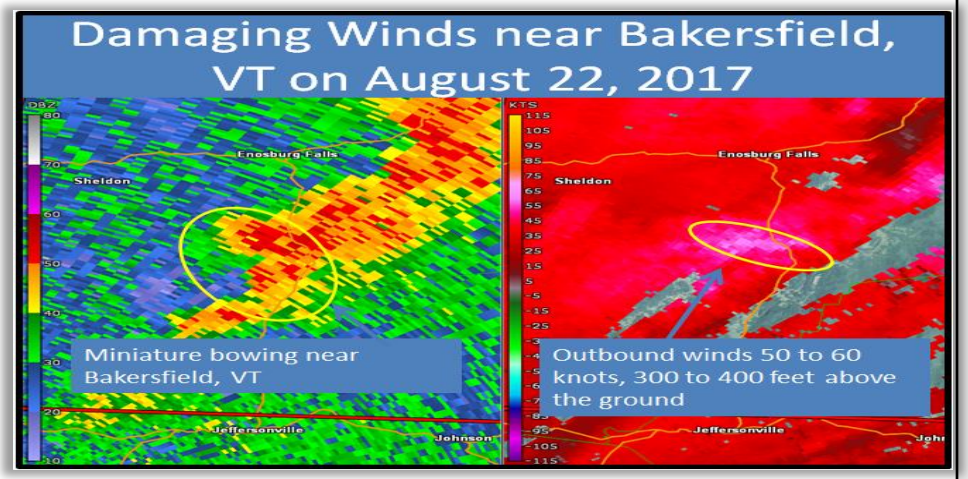


Figure 7: The KCXX 0.5° reflectivity (right) and velocity (left) at 5:56 p.m. on 22 August 2017.

Figure 8: The KCXX 1.8° reflectivity (right) and 0.5° velocity (left) at 5:51 p.m. on 22 August 2017.

Figure 8 shows another weak miniature bow echo reflectivity structure with an enhanced outbound wind speeds of 50 to 60 knots about 500 feet above ground level. This bow like structure created trees and powerlines down in Bakersfield and south Enosburg Falls area. In addition, to severe winds, frequent lightning and brief heavy downpours occurred with both thunderstorms during the late afternoon hours on 22 August 2017.



In summary the severe weather season across the North County was near average in terms of number of warnings issued by our office (64) and reports of severe weather (117) received from May through August. The ratio of wind (98) versus hail (19) was caused by the very warm thermal profiles in the atmosphere. The favorable position of stronger winds at mid and upper levels associated with troughs and cold fronts, resulted in damaging winds being the primary threat from thunderstorms in 2017 across Northern New York into Central and Northern Vermont. As we approach the fall months our threat for severe weather decreases from the lack of surface heating and instability, but every couple years we can experience a few stronger storms with damaging winds and hail. ♦

Severe Weather Climatology For The North Country

-Andrea LaRocca

At some point or another, whether here in New England or elsewhere in the United States, you have most likely received warning of an approaching severe thunderstorm. You may be aware that these warnings mean you should seek shelter until the nasty storm has blown over, but do you know exactly what designates a storm a severe thunderstorm? According to the National Weather Service (NWS), a severe thunderstorm is defined as: "A thunderstorm that produces a tornado, winds of at least 50 kt (58 mph), and/or hail at least 1 inch in diameter."

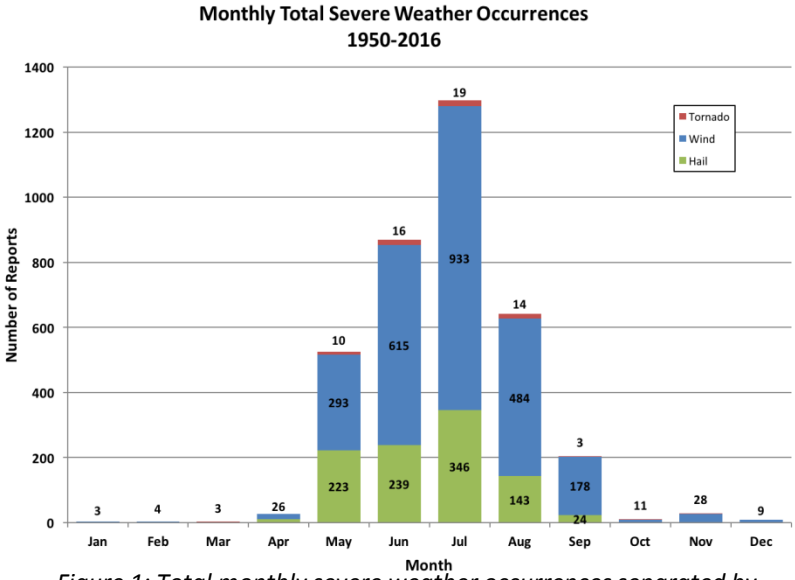


Figure 1: Total monthly severe weather occurrences separated by category. Data labels for months outside May- September are not separated categorically and therefore represent the total number of reports for that month.

Severe weather is not a very common occurrence here in New England, but nevertheless it does happen. This summer, as a student volunteer for NWS Burlington, I was tasked with updating the climatology of severe weather for the state of Vermont and northern New York through 2016. These climatology records date as far back 1950 for tornado reports and hail and wind reports from 1955. These records are largely made-up of reports from community members, emergency personnel and HAM radio operators via our spotter network. These severe weather reports are not only important in maintaining a complete weather record, but they also serve to verify warnings issued by the NWS. The verification of these warnings aim to protect members of the community through future warnings and warning improvement.

Most commonly, severe weather occurs across northern New York and Vermont from May to September, with the peak of the "severe season" being July. Figure 1 shows the primary threat as wind (blue), followed by hail (green), and lastly tornadoes (red). The topography of the region plays a large role in the limited number of tornado occurrences, with the highest frequency of reports in flat, valley locations such as St. Lawrence County, NY and Franklin County, VT (Figure 2).

Looking spatially at the distribution of hail and wind reports, populated areas such as Burlington, Montpelier, and Rutland appear to

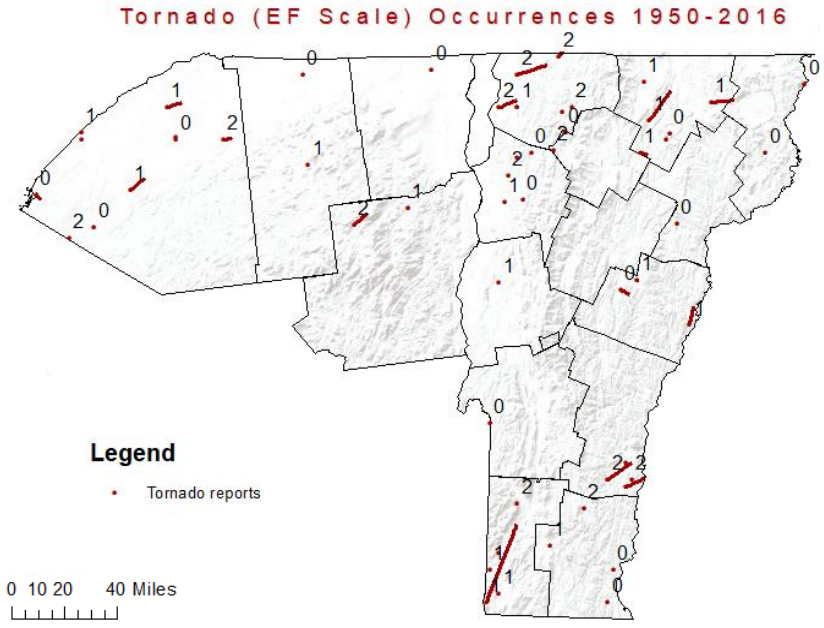


Figure 2: Spatial distribution of tornado reports from 1950-2016 including EF scale ranking.

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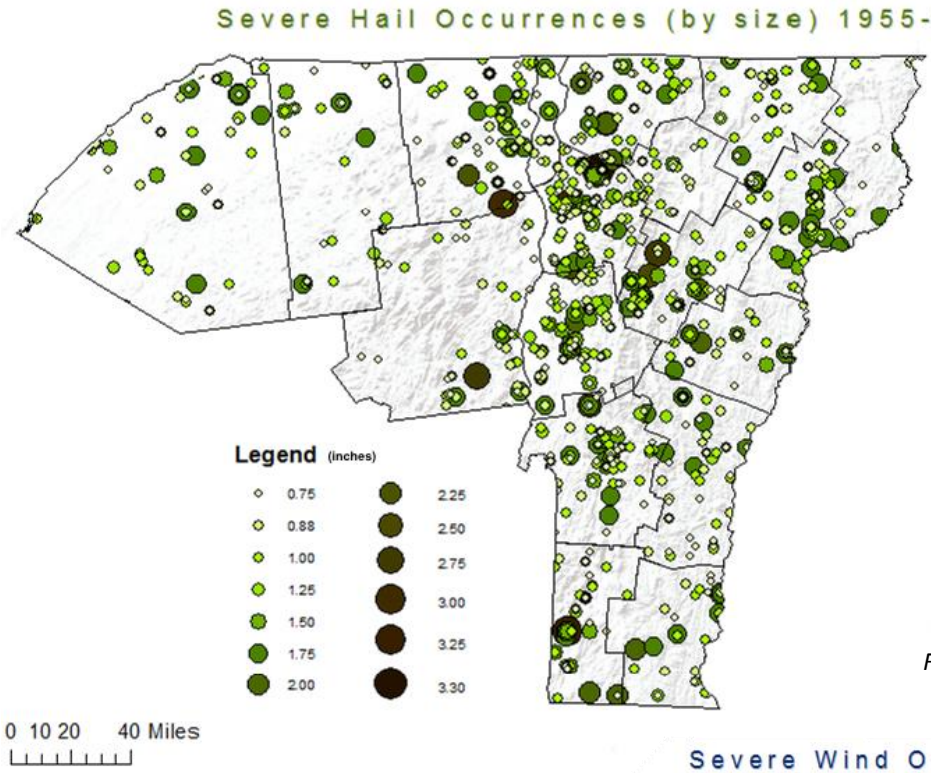
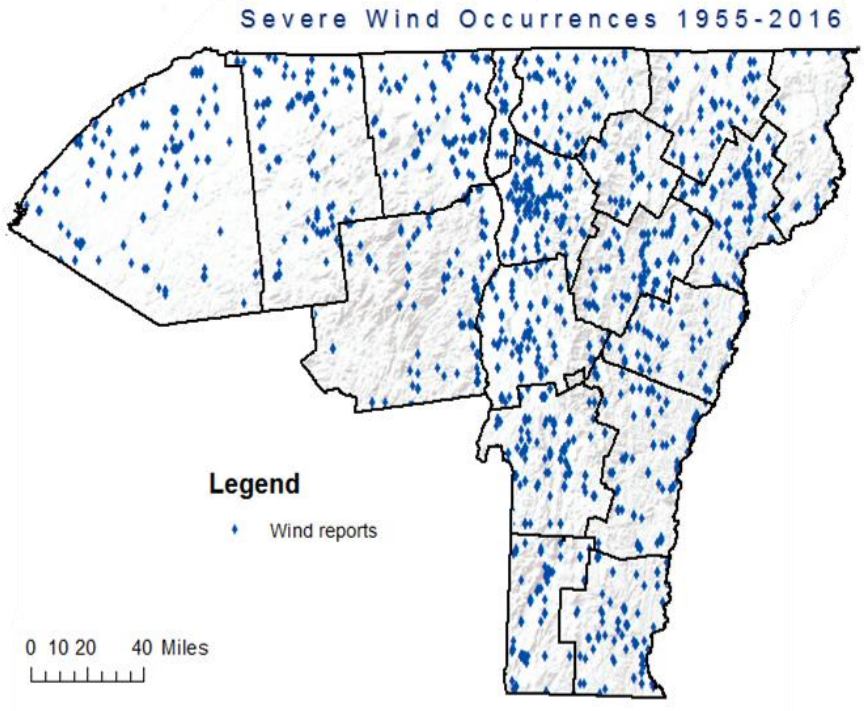


Figure 3: Spatial distribution of hail reports. Colored circles indicate reported size of hail stone.

Figure 4: Spatial distribution of wind reports. Note cluster of reports around Burlington.



receive more severe weather events than more rural locations (Figures 3 and 4). This pseudo-surge of severe weather is closely related to the density of people in these areas, resulting in an increased number of reports for any given weather event.

When looking at the data it is important to remember, if a tree falls in the forest and no one is around to hear or see it, did the tree really fall? With the use of social media, reports from both rural and urban locations have increased, but obtaining reports in very isolated locations such as the Adirondacks is still a challenge. If you ever have a storm report you would like to submit, we ask that you please do so when it is safe and include estimated or actual measurements (for hail, coins are suggested for size comparison), as well as time and location of the event. ◆

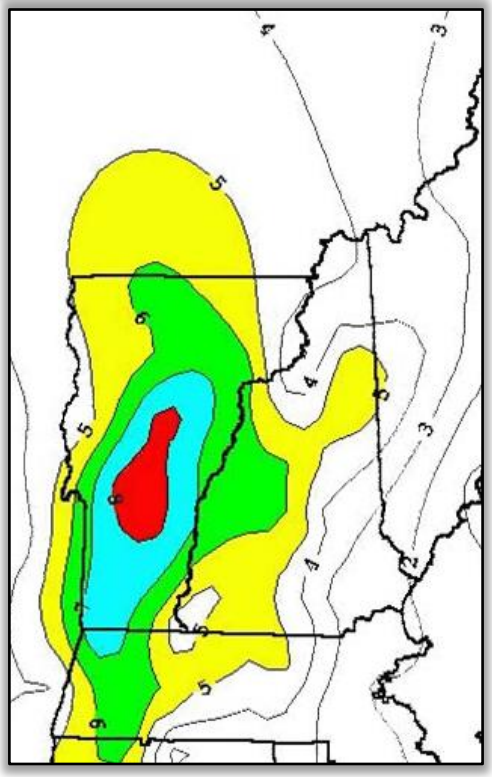
90th Anniversary of the Great Vermont Flood of 1927

-John Goff

The flood of November 3-4, 1927, stands as the greatest natural disaster in Vermont history. Devastation occurred throughout the state with 1,285 bridges lost, countless numbers of homes and buildings destroyed, and damage to hundreds of miles of roads and railroad tracks. The flood waters claimed 84 lives, including that of the Vermont Lieutenant Governor at the time, S. Hollister Jackson. An account of the flooding across the state, written by Luther B. Johnson, editor of the *Randolph Herald*, was published in 1928. His account was republished in 1996 by Greenhills Books. The following information is from the above book and The Vermont Weather Book, by David Ludlum.

Soils were heavily saturated from an abnormally wet October, where rainfall during the month averaged about 150 percent of normal across the state. In northern and central Vermont, some stations received 200-300 percent of normal. Heavy rainfall periods during the month were separated enough that flooding did not occur in October. The saturated soil conditions combined with the lateness of the year and the fact that most vegetation was either in, or near, seasonal dormancy, meant any further rainfall would runoff directly into the rivers. This is exactly the scenario that led to Vermont's greatest disaster.

Rain began on the evening of November 2, as a cold front moved into the area from the west. Rainfall continued through the night with light amounts being recorded by the morning of the third. Rainfall intensity increased during the morning of November 3 as a low pressure center moved up along the Northeast coast. This low had copious moisture associated with the remnants of a former tropical storm. As the low moved up the coast, a strong southeast flow developed, furthering increasing the influx of moisture. This moisture-laden air was forced to rise as it encountered the Green Mountains, resulting in torrential downpours along and east of the Green Mountains. Rainfall amounts at the Weather Bureau station in Northfield totaled 1.65 inches from 4 am to 11 am on the 3rd, with 4.24 inches falling from 11 am to 8 pm. The total from late evening of November 2 to late morning on November 4 was 8.71 inches.



The United States Geological Survey estimated that 5,530 square miles (53%) of the state received over 6 inches of rain, 3,320 square miles over 7 inches, 1,660 square miles over 8 inches, and 457 square miles over 9 inches. The graphic above illustrates the rainfall distribution.

Richford, VT 1927, Figure 4. Courtesy of Special Collections, University of Vermont

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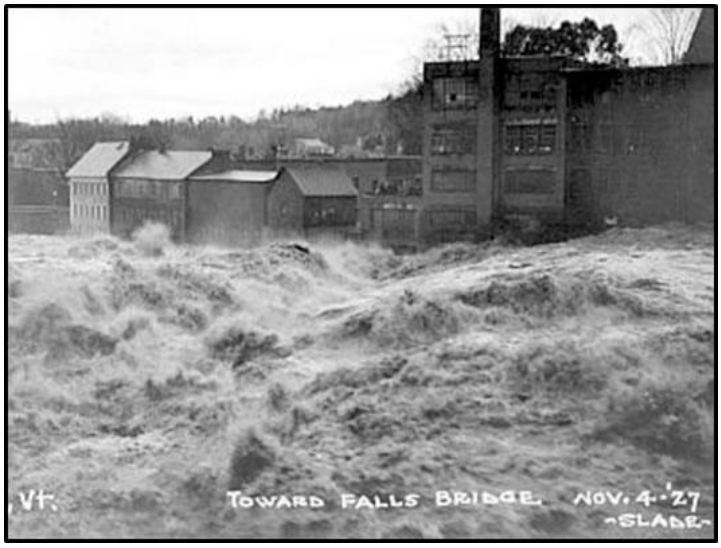
Devastation was distributed across the state, but the hardest hit area was most likely the Winooski Valley, where the majority of the population lived. As a result of the statewide devastation caused by the flood, the U.S. Army Corps of Engineers built three flood retention reservoirs and accompanying dams in the Winooski River basin at East Barre, Wrightsville, and Waterbury to try to mitigate the effects of further flooding. In 1949, the Union Village Reservoir and dam on the Ompompanoosuc River was completed. By the early 1960s, four other reservoirs/dams were completed in the Connecticut River basin. These were built on the Ottaquechee River at North Hartland, the Black River at North Springfield, and the West River at Ball Mountain (Jamaica) and Townshend. The historic flooding of Tropical Storm Irene brought additional devastation to the state in August 2011, but given the massive extent of damage, the flood of 1927 still stands as the worst natural disaster in Vermont history.♦



Black River in Springfield, VT, AP Photo/Vermont Historical Society

The 14-15 March 2017 "Pi Day" Snowstorm Across Vermont & Northern New York

-Peter C. Banacos & Robert Deal

This widespread late winter storm across the northeastern U.S. (Fig. 1) produced record snow for a single March storm in Burlington, Vermont (30.4") along with localized blizzard conditions across portions of the Champlain Valley of Vermont and New York during Tuesday afternoon, March 14th, 2017. Total snow accumulations generally ranged from 12- 18" across far eastern portions of Vermont, and 18-36" elsewhere across Vermont and northern New York (Fig. 2). The axis of highest snowfall totals affected northern New York and northwestern Vermont, where localized snowfall totals in excess of 3 feet were observed (Fig. 2).

The storm total snowfall of 30.4" is the second highest on record for Burlington, where records date back to 1883 (Table 1). Snowfall rates peaked at 3-5"/hr during the afternoon hours on March 14th, and nearly a foot of snow fell during just a 4 hour period during the height of the storm. Storm impacts included difficult travel conditions and widespread school closures on both Tuesday (March 14th) and Wednesday (March 15th). The storm was well-advertised; lead times on National Weather Service (NWS) Winter Storm Watches issued Saturday (March 11th) approached 72 hrs. As a result of good planning, the overall societal impacts were mitigated for a snowstorm of this magnitude.

While not widespread, blizzard conditions were recorded at Plattsburgh, New York (PBG) and several mesonet stations in the vicinity of Lake Champlain, where northerly gusts were locally enhanced owing to

Notable numbers from the storm:

- **1**: Biggest March snowstorm on record at Burlington, VT (BTV)
- **10**: Number of years between Blizzard Warnings in Vermont and northern New York (2/14/2007 to 3/14/2017)
- **22**: Maximum snow depth achieved during the event (2pm Wednesday, 3/15) at BTV
- **30.4**": Storm total snowfall, the 2nd greatest snowstorm on record at BTV.

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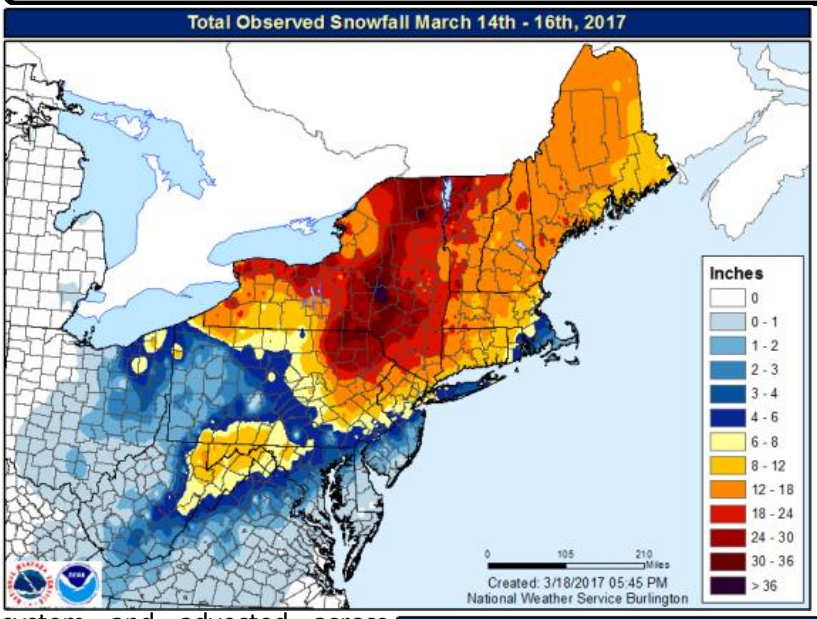
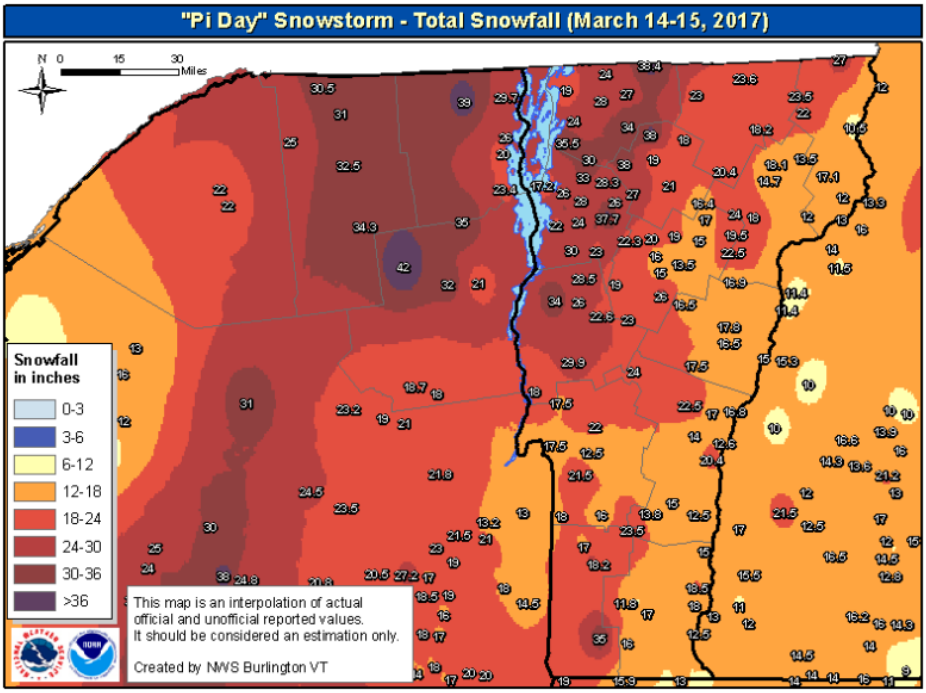


orographic channeling effects. At PBG, wind gusts in excess of 35 mph occurred between 3:42pm EDT and 10:53pm EDT. Visibility was consistently one-quarter mile or less in heavy snow during the first 3 hours of that stretch (meeting blizzard criteria), and generally one-half mile in moderate snow later in the evening.

The 14-15 March 2017 was a "textbook" Nor'easter with an intense surface low track over southeastern New England spreading heavy snowfall and strong winds inland across Vermont and northern New York. Rich moisture from the Gulf of Mexico and sub-tropical Atlantic was entrained into the system and advected across interior New England and New York as a closed low developed to our south. Combined with frontogenetic forcing mesoscale banding, the result was extremely heavy snowfall with hourly rates exceeding 3- 5"per hour in many areas during the afternoon hours on Tuesday, March 14th. The slow departure of the system across northern Maine on March 15th resulted in considerable wraparound snowfall, and low-level convergence in the Champlain Valley with northerly deep-layer winds extended accumulating snowfall through much of Wednesday. Good dendritic Snow growth resulted in snow-to-liquid ratios around 12:1 during the early part of the storm, before increasing to 15:1 or greater during the latter stages of the event. The end result was a storm at #2 (Table 1) on the all-time list for Burlington, and localized totals in excess of 3 feet in the Adirondacks of New York and in northwestern Vermont. ♦



Date	Storm Total Snowfall
Jan 2-3, 2010	33.1"
March 14-15, 2017	30.4"
Dec 25-28, 1969	29.8"
March 6-7, 2011	25.8"
Feb 14-15, 2007	25.7"

http://www.weather.gov/media/btv/events/14March2017/14March2017_Review.pdf (for the full write-up)

Table 1 (left): top 5 snowstorms for BTV. Fig 1 (top left) regional storm total snowfall map. Fig 2 (above) storm total snowfall map for northern New York and Vermont.

NWS Burlington Meteorologist Supports Fire Fighters in Oregon

-Eric Evenson & Kimberly McMahon

One of our Lead Forecasters is on assignment in Brookings, Oregon to help with the Chetco Bar Fire, which is just under 185,000 acres. Eric Evenson is what we call an *Incident Meteorologist* – traveling to wild fires to support the fire fighters working to put out these fires. This position is very important to let all the emergency personnel working the fire know what to expect with regard to weather and how that will affect the fire behavior, such as the ability and likelihood of the wildfire quickly spreading and which direction. Another concern is the location and movement of the smoke plume(s), which can be a hazard in itself.

The following is an account from Eric, while he is still in Oregon assisting the fire community:

"The Chetco Bar Fire is only 8% contained as its a large fire in difficult terrain. Northeast winds over the fire brought smoke down into Brookings, but it has not been too bad. On the warmest and driest day of the time I have been here, the fire did get active. The northeast winds are good because it keeps the marine layer away from the fire and our camp. It was very foggy at a couple morning briefings I when I first got here.

The incident command post is in an old strip mall, but our camp and where we brief is 5 miles away with a nice ocean view when there is no fog. I am working 4am to 9am. I do a daily Emergency Operations Center brief in Brookings. One of the briefings I conducted, the Governor of Oregon, a state Senator, a state Representative, and the new Chief of the Forest Service were there to listen in. The town has signs everywhere thanking the fire fighters and last weekend about 50 people lined up along the street waving big thank you signs and cheering as the crews and team drove to the fire.

Plenty of terrain to deal with along with marine layer, depth of the inversion, smoke dispersion, air operations as terrain is difficult to get people on the ground, and the locals worried about a Chetco wind event, which is a dry northeast wind that funnels down through the Chetco River at night and can cause issues. Burned the town down twice many years ago, which is why they rebuilt it north of the river."

We're proud to have one of our own supporting such important efforts, such as combatting the wildfires out west. We wish Eric a safe deployment and look forward to his safe return. ♦

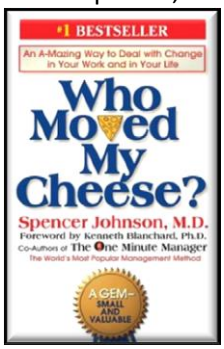
NWS Burlington Leadership Activities

-Kimberly McMahon

On April 13, 2017, WFO Burlington held our third annual Spring Leadership Workshop. This year's theme focus on living through one's values. To kick off the workshop, Lead Forecaster Brooke Taber facilitated an exercise on effective listening. Attendees paired off with their backs to each other and had to describe an image for the other to draw. During the first round, drawers were not allowed to speak - only listen to their partner giving directions. There were many laughs as the importance of communication became clear when comparing what was drawn and the original. Pairs were then given a different image to draw, but this time the drawer could ask questions in addition to listening. The crowd became animated in the freedom of being able to ensure clarification and have greater communication. This fun interactive exercise raised awareness as well as had those in attendance energized to learn more.

We then jumped into an exercise to reflect upon each of our core values as individuals and as an office. This activity was based on the concept that in order to truly lead authentically, it is necessary to know what you value such as honesty, integrity, strong work ethic, openness, innovation, etc. It was fun to take the time to reflect, compare, and discuss what each value means to us as individuals and as an office that works together at all hours of the day and night towards a common goal.

We rounded out our workshop with a remote guest speaker, the Chief of Staff of the NWS, George Jungbluth. The Chief of Staff and his team provide direct support to the NWS Director and Deputy Director on the development, integration and implementation of policies, strategies, planning communications, public affairs, programs, and procedures. George spoke about his career and what principles he lives by that keep him grounded and have lead him to be the NWS Chief of Staff. There were two concepts that resonated with NWS BTV staff:



1. Knowing when to find a new challenge: when you are comfortable in your current position and feel settled, that's when it's time to make sure you are being challenged in new ways to better yourself and grow professionally

2. We are all Olympians: As Olympians we need to train hard, work hard or perform our best, and we also need to recover from big weather events.

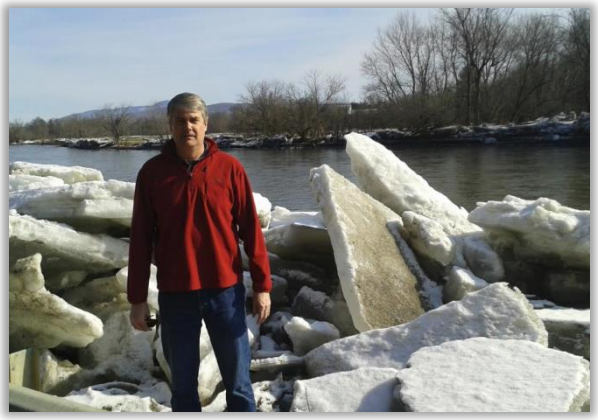
These lessons are something to keep in mind as we strive to make a difference in our agency, our community and our nation.

NWS Burlington also conducted a book discussion this past August on "Who Moved My Cheese" by Spencer Johnson. Several staff members joined in this discussion on how we can better handle change individually and as an agency. The book is an easy to read story of four different kinds of characters and how they handled a change in their situation. There were several lessons laid out, asking the read to reflect - such as "what would you do if you weren't afraid?" The group agreed, that as an office and agency, we are all there to help each other through change, especially with regard to professional changes. We enjoyed the book and the questions it raised, and will try to keep it in mind as we all go through changes and challenges in the future.

Exit Interview with NWS Burlington's Senior Service Hydrologist

-Kimberly McMahon & Jessica Neiles

Greg Hanson started his career back in 1988, just after graduating college with a Bachelor's in Meteorology. He worked at the NWS Athens, Georgia office for six months before moving to the Atlanta office. After three years, Greg received a promotion to General Forecaster and moved to Dodge City, Kansas. He spent only two years in Dodge City before becoming a Hydrology Instructor at the NWS's Operations Training Branch, which is the equivalent of the current Warning Decision Training Division of the NWS. In 1998, Greg made his way to the NWS Burlington Weather Forecast Office as the Senior Service Hydrologist. But after almost two decades in Burlington, it's time for Greg to take on a new adventure. He will become the Warning Coordination Meteorologist at NWS Weather Forecast Office in Boulder, Colorado. He will be sorely missed. But before he left us for good, I sat down with him to talk about his experiences at Burlington and what's waiting for him in Boulder.



What has been your favorite part of working here?

"Without a doubt, my co-workers. The people in this office have been great to work with. Everyone knows their stuff and has always been professional and pleasant to work with. It's been fun working with this good group of people, especially when working odd shifts.

It's also been a pleasure getting to know and work with our external partners and customers. Everyone is very friendly - you get to know them on a first name basis. It makes for a great environment to work in."

Outside of work, what has been your favorite part of living in Vermont and the North Country?

"Growing up in the Plains, we didn't really have real maple syrup available, so it's been fun and interesting becoming a maple syrup aficionado. In my time here, I was able to tap the trees on my property and make some of my own maple syrup. It's also been great to get out and see the country. There's a wealth of outdoor activities here."

What place or activity will you miss most?

"Lake Champlain! There's nothing quite like it anywhere else - a big lake, but you can still see across to the other side."

What are you looking forward to most on your new adventure?

"A number of things. I'm looking forward to getting to know the new customers and partners of the WFO in Boulder. As well as the collaboration that occurs between the NWS, University Corporation for Atmospheric Research (UCAR), National Center for Atmospheric Research (NCAR), the Community Collaborative Rain, Hail, & Snow Network(CoCoRaHS), and Colorado State meteorology program.

I'm also looking forward to the challenges of working in an area with large population centers combined with low population, rural areas in one County Warning Area."

We thank you for your service, Greg, and wish you the best of luck!

The Four Seasons

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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:
(802) 863-4279
Or visit:
http://www.weather.gov/btv/stormreport

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