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Letter from the Editors

Welcome to our winter newsletter! One thing unique about this season relates to the solar calendar, in that it overlaps two years. So while it is now 2021 it's a good time to look back at the previous year, as we have done with a look at the top weather events of 2020. Complementing that list is a behind the scenes walkthrough of how we issued a rare tornado warning, a scientific explanation of a special and beautiful optical phenomenon, an in depth look at what our incident meteorologists do to support wildfire suppression efforts, and explanation of the Weather Story on our website. As always, thank-you for reading! We hope you find this newsletter informative and entertaining. If you haven't done so before, check out the last page for the many ways you can stay connected, send us storm reports, and let us know how we can better serve you.

First Tornado Warning in 6 Years - Robert Haynes

Tornadoes are uncommon across our forecast area. On average, one occurs every other year in our forecast area. We tend to lack the instability necessary for strong, persistent updrafts. Variable terrain also makes it difficult for these violent circulations to develop. Aside from environmental inhibitors, high terrain also blocks our radar signal, making it difficult to assess near surface rotation. Lower population density across our region also means they are less likely to be observed if they do occur. As a result, our forecast area had not issued a tornado warning since 2014. So for the remainder of this article, we look at some reasons why the first tornado warning in 6 years was issued August 2nd, 2020 (Figure 1).

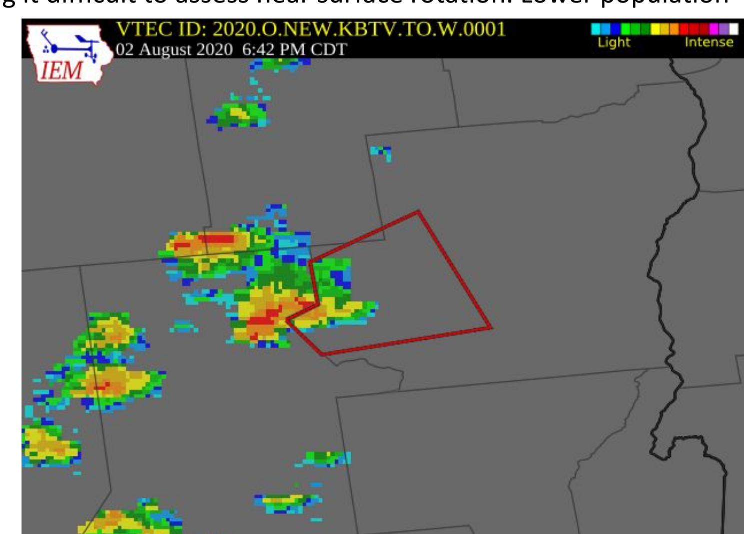

Figure 1: Polygon for the tornado warning in southwestern Essex County, New York at 2342 UTC 2 August 2020.

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STORM ENVIRONMENT

Before we think about issuing warnings, we carefully consider whether atmospheric conditions are favorable for thunderstorms. From there, we ask whether we think storms will organize and develop strong convective patterns or will remain disorganized and cycle up and down. High resolution models can help us envision how storms develop and evolve through the course of the day, and we can use their output to consolidate different measurements for whether the atmosphere can support events like tornadoes. Use of simple tools like checklists help us to keep track of this information and leverage model data to characterize potential threats. We use this checklist internally to help guide our forecasting and messaging. Below is a "behind the curtain" look at what we saw after running it August 2nd (Figure 2). It is not so much to tell us what will happen, but what could happen, and we can click each section of pros and cons for potential threats.

Occasionally, we post model depictions of showers and storms through a .gif on social media. Often, we include a reminder that the model is not showing what will happen, but show how precipitation is expected to evolve. One forecast model is not going to tell the whole story because our atmosphere is a fluid system and we cannot perfectly measure it all the time. We launch balloons equipped with instruments that help, but they measure the atmosphere at one point in time and are carried downwind from a point. They cannot perfectly encapsulate the atmosphere therefore every forecast model will err. Ensemble forecast systems help to make up for these challenges by making adjustments for errors/biases or differences in how we fill in gaps of data. These have many useful applications, like detecting probabilities for the development of a favorable tornado environment across several model runs as opposed to relying on a single model depiction. The High Resolution Ensemble Forecast (HREF) system is one that we use often for severe weather forecasting. On August 2nd, 2020, looking at updraft helicity, which tells us the likelihood of rotating updrafts (favorable for tornadoes), we saw values between 10 and 40 percent across much of Northern New York (Figure 3, next page).

Severe Weather Checklist - Results

August 2nd, 2020
Sunday

Sounding Analysis | Checklist Questions | Results | Svr Parm Help

Display results by section: | Display results by time:

- Dynamic Bow Echoes: Increased threat **this evening**
- Tornadogenesis: Increased threat **this evening**
- SHARS: Increased threat **this afternoon, this evening**

Tornadogenesis - *12z-17z*

Pro	*Con*
• Surface-based Cin is 0 J/kg • 0-3km low level CAPE is 51 J/kg • The greatest hodograph turning is in low-levels (0-1km SRH is 44 m^2/s^2; 0-3km SRH is -60 m^2/s^2)	• 0-1km storm relative helicity is 44 m^2/s^2 • 0-3km storm relative helicity is -60 m^2/s^2 • The LFC height is 5018 feet • The LCL height is 4255 feet • The Energy-Helicity Index (EHI) is -0 J/kg

Figure 2: Sample of NWS Burlington's Severe Weather Checklist run on 2020 August 2. A snippet of the pros and cons table is using data from forecast soundings and based on questions answered (i.e. "Is the region in the favorable front right or left exit region of an upper jet?")

STORM TIME

As the day unfolds, we watch for the forecast to come together. We closely monitor observations to see whether our forecast is verifying or to detect important changes. Low-level boundaries are important to watch. One of the three ingredients for convection is convergence of winds. This can occur with frontal

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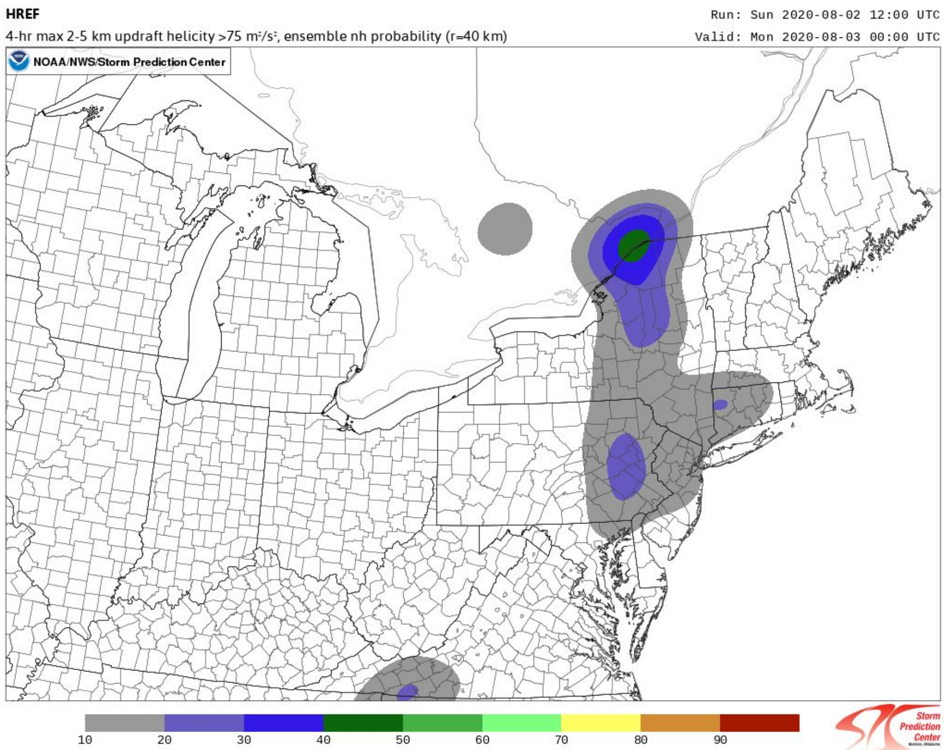

Figure 3: HREF neighborhood probability of 2-5 km updraft helicity at 00Z 3 August 2020, which was about the time the supercell developed in northern Hamilton County, NY.

STORM TIME

boundaries or with troughs that develop ahead of them. During the summer months, we frequently see prefrontal troughs develop due to terrain features across the Champlain Valley. Here is a look at a surface analysis at 8 PM on August 2nd, around the time the supercell developed (Figure 4). We also keep an eye on other parameters, like the supercell composite parameter, which is a combination of information related to shear and instability. Keeping track of changes is important, because based on the supercell composite, the most favorable conditions for supercells developed a bit further east than the HREF forecast we showed earlier.

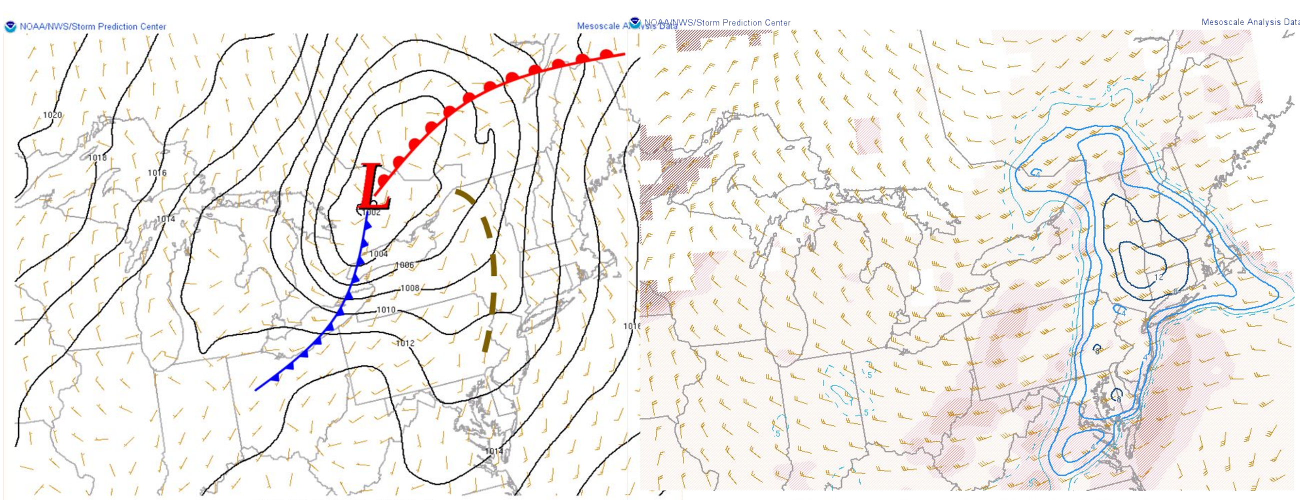

Figure 4: Left) Surface analysis at 00Z 3 August 2020. Right) Supercell Composite Parameter at 00Z 3 August 2020. Darker and increasingly solid contours indicate favorable parameters.

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On this day, it took some time for convection to develop as mid-level dry air limited convective initiation. But around 8 PM, a supercell developed over northern Hamilton County, New York, and tracked into southwestern Essex County, New York, just north of Newcomb. When making the warning decision, we look for radar indicated rotation, or velocity couplets. Ideally they are persistent and don't fade in and out. We also want to see a hook echo with a weak echo region (WER) and turbulent motion noted in spectrum width (SW). The issue in this area is that Mount Van Hoevenberg partially blocks the radar beam and Newcomb is several miles away from the radar. As a result, the radar beam intercepts the storm 4000 feet above ground level at the lowest radar scan available. A tornado occurs on the ground, though, which is why we want to look out for lofted debris (and rely heavily on storm spotters). Nevertheless, strong rotational velocity up to 45 knots is suitably strong at such a distance from the radar (Figure 5). The signals were not perfect, but based on our understanding of the environmental conditions and forecasts, the first tornado warning in 6 years was issued.

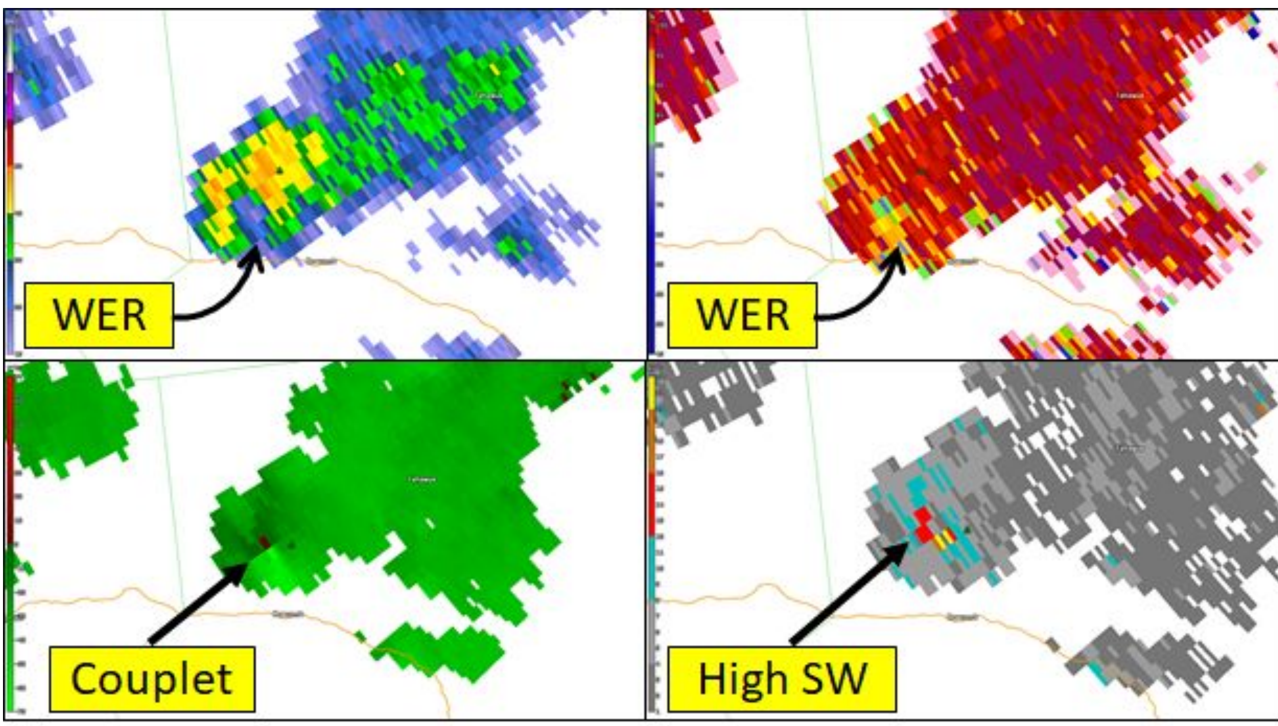

Figure 5: Top Left) Base reflectivity at 0004Z 3 August 2020. The weak echo region is a common characteristic of a super cell. Top Right) Correlation Coefficient for the same time. Bottom Left) Base Velocity at 0008Z 3 August 2020 with radar detected 2 knot outbounds and 90 knot inbounds right next to each other. Together, this makes about 45 knots of rotational velocity. Bottom Right) Spectrum Width. Higher values can show where turbulent flow is occurring.

Fortunately, the supercell was strongest over an area with few people. By 8:45 PM, the population within the warning was only 92 people, and the actual area of rotation within with warning polygon is much smaller. This supercell tracked over an area of wilderness. As a result, no tornado was observed, nor any damage reported. In the instance damage is reported, we will go out and perform a storm survey. Although we had wanted to go and see if we could find any damage, incoming Tropical Storm Isaias and health concerns during the COVID-19 pandemic kept us from performing the survey. With that, thanks for reading this window into severe weather forecasting. Any time you see severe weather, let us know, because every little bit helps develop our understanding further.

Stunning Light Pillars in Arctic Air

By Peter Banacos

Fig. 1. "Light pillars" over the Burlington International Airport during the early morning hours on 15 January 2015. (NOAA/NWS Burlington photo).

While most of us don't look forward to frigid winter nights, occasionally there are atmospheric optical phenomena that can provide luminous delight within arctic air masses. One such example was on prominent display during the pre-dawn hours on 15 January 2015. Distinct vertical beams of light - known as "light pillars" - appeared over the Burlington International Airport (Fig. 1). Some of the light pillars extended skyward from terrestrial sources, while others appeared to float like candles in the night sky. How does this optical phenomena occur?

At the time the light pillar photograph was taken, temperatures at the airport hovered near -3F (-19C). At these temperatures, tiny ice crystals - sometimes referred to as "diamond dust" - can form and hover in calm and stable conditions beneath clear skies. These ice crystals can take the form of needles, columns, or hexagonal plates. Typically the plate-like crystals have the best ability to reflect light off their facets. When millions of plate-like crystals become oriented horizontally, the combination of reflection and refraction can result in light bouncing back to the observer in a vertical alignment (Fig. 2.). Because light diverges from its source, the reflected light beams travel different distances before reaching the observer. The different distances traveled allows the optical effect to extend dramatically in the vertical.

Light pillars are usually only observable a few times per year across Vermont and northern New York, typically on subzero nights and near bright terrestrial light sources. If you observe light pillars this winter, feel free to share your photos with us on our Facebook and Twitter accounts.

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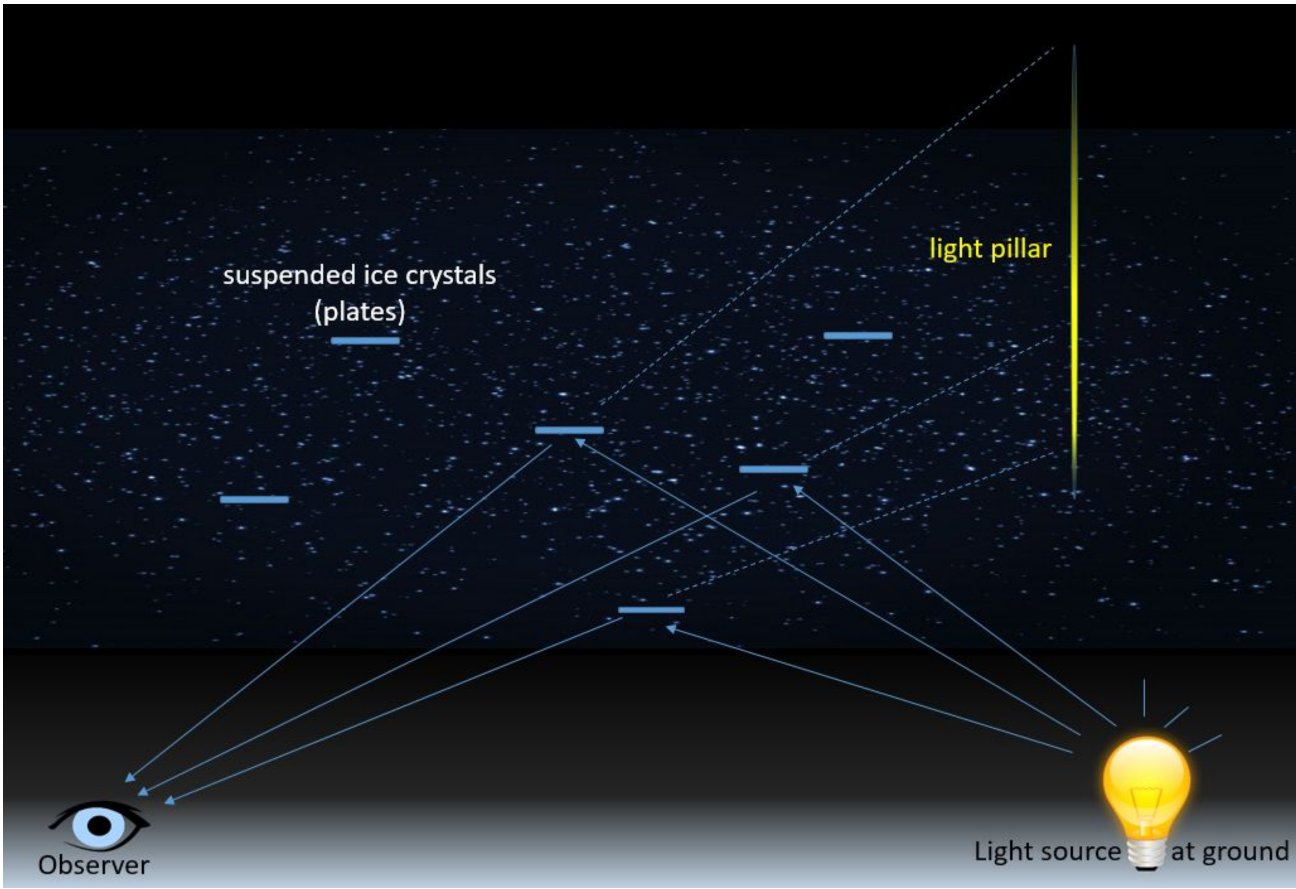

Figure 2: Schematic diagram showing artificial light reflecting off horizontal facets of tiny suspended ice crystals (plates) and being refracted back to an observer (or camera) at the ground. This set of conditions creates the "light pillar" optical phenomena.

Figure 3: "Light pillars" over Fairbanks, Alaska during the early morning hours on 03 November 2020. (NOAA/NWS Fairbanks photo).

Top 3 Weather Events for the Burlington County Warning Area (CWA)

By Brooke Taber

The following is a brief review of the top 3 weather events in 2020 across the North Country as voted on by the staff at the National Weather Service (NWS) Burlington, Vermont. Overall, it was a relatively quiet year for weather, in terms of large scale significant impacts or memorable events. However, we did experience a few good winter storms, some flooding, several days of severe thunderstorms, a tropical system, and drought conditions. Based on staff ranking the winter storm that brought 10 to 20 inches of snowfall to most of the region on 7 February 2020 was ranked first. The 2nd most impactful event was the Summer Drought, followed by a tie for third place with Tropical Storm Isaias and 8 July 2020 Severe Weather episode. A late honorable mention is the south-central Vermont Epic Winter Storm on 17 December.

Honorable Mention: The Epic Central-Southern Vermont 17 Dec 2020 Snowstorm:

A late entry for honorable mention is the record breaking snow storm that produced a narrow axis of 20 to 40 inches of snow from northern Pennsylvania and parts of New York into southern VT and NH on 17 December 2020. Snowfall rates were 3 to 6 inches per hour with surface visibilities below 1/4 mile in heavy snow. The heaviest snowfall in our forecast area of responsibility occurred across Rutland and Windsor counties, where 30 to 40 inches of snow was observed, with most of the accumulation occurring within 24 hours. A few of the higher totals in Vermont included 41 inches at Ludlow and Springfield, 40 inches at Mt Holly and West Windsor, and 39 inches at Windsor. Meanwhile, at the NWS office, located at the Burlington International Airport, we only measured 2.5 inches with only a dusting of snow near the International Border. Figure 1 below highlights the sharp north to south snowfall gradient across the North Country. The good news about this significant winter storm was that with a very cold air mass locked in place, no mixed precipitation occurred and the snow was light and fluffy with ratios in the 20 to 25 to 1 range. Meaning 1 inch of precipitation resulted in at least 20 to 25 inches of snowfall. However, the ratios quickly dropped off away from the heaviest axis of snowfall, as the flake size was much smaller. The coldest airmass of the season followed, with many locations with fresh/deep snowpack dropping below zero on December 18th and 19th.

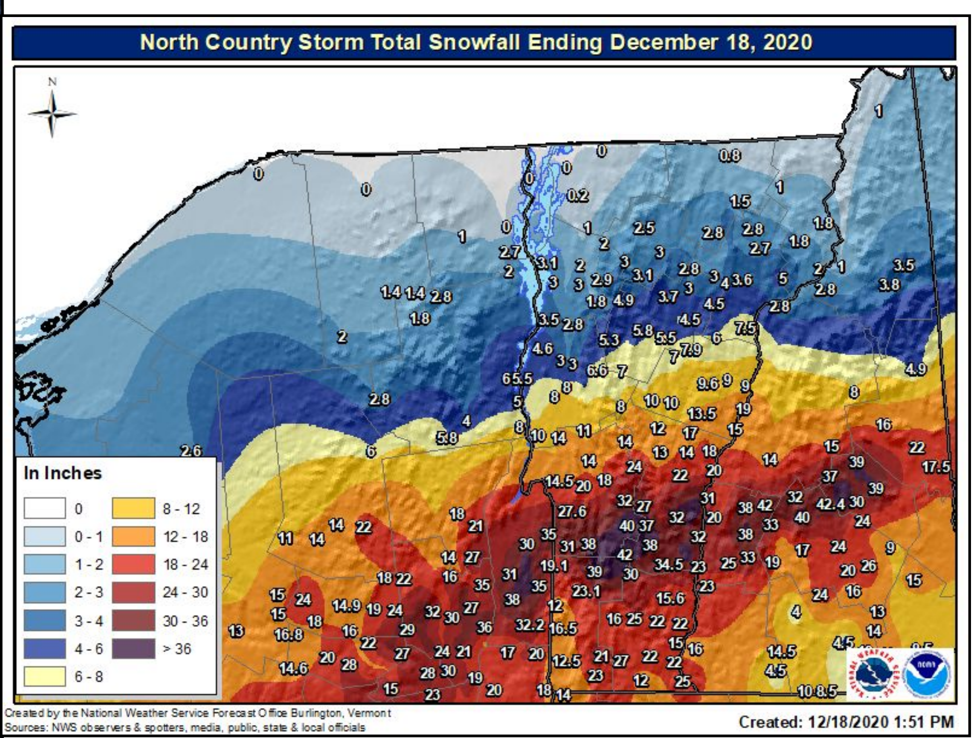

Figure 1: North Country storm total snowfall ending on 18 December 2020.

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#3: Tropical Storm Isaias/8 July 2020 Severe Weather Episode (Tie):

For third place we had a tie between tropical storm Iasias and the 8 July 2020 severe weather episode for most impactful weather events. Isaias developed in the Western Atlantic, tracked across the eastern Caribbean and made landfall as a weak category 1 hurricane over the eastern Carolinas, before racing northward toward central Vermont. Isaias produced heavy rainfall across the North Country, with amounts ranging from 0.75 inches to 3 inches, along with some localized very high rainfall rates. However, given the very dry conditions prior to the storm, only minor flooding was observed across our forecast area. Figure 2 shows the 24 hour precipitation totals associated with tropical system Iasias. In addition to heavy rainfall, isolated gusty winds of 40 to 50 mph occurred, which caused some localized power outages and a few small trees to fall, because of saturated ground conditions. Overall, the large scale impacts from tropical storm Isaias were minimal across northern New York and Vermont.

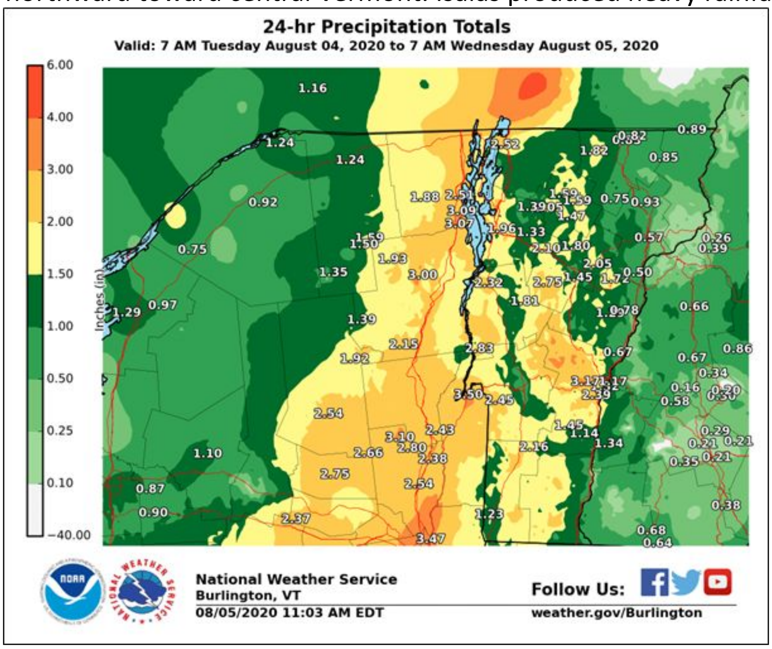

Figure 2: 24-hour precipitation totals associated with tropical system Isaias.

A warm and humid air mass with temperatures well into the 80s, combined with energy aloft and strong wind profiles to provide environmental conditions favorable for strong to severe thunderstorms on 8 July 2020. Widespread wind damage was observed across the northern Champlain Valley associated with a bowing line segment, while a long track supercell thunderstorm produced large hail and downed trees across parts of Rutland County. The combination of lightning and damaging winds did produce some scattered power outages across the areas hardest hit by these severe thunderstorms. Figure 3 shows the North Country storm reports from the event.

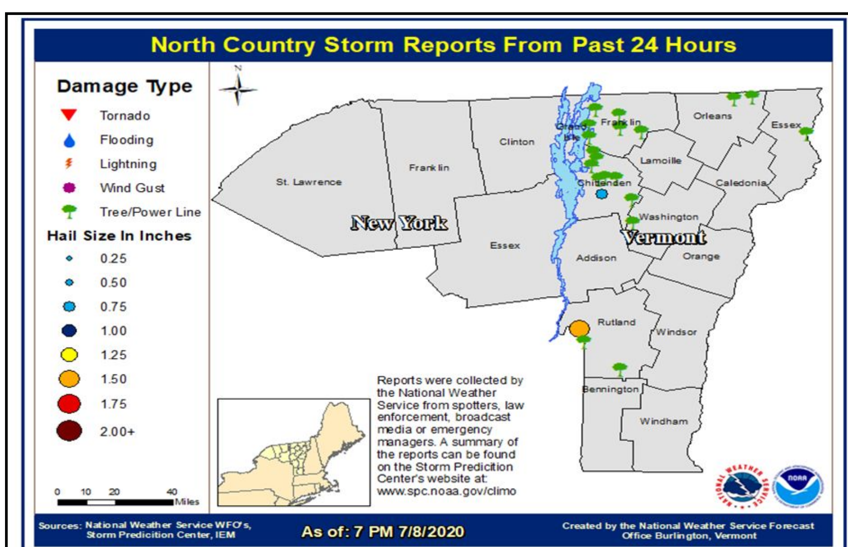

Figure 3: North Country storm reports as of 7 PM on 8 July 2020.

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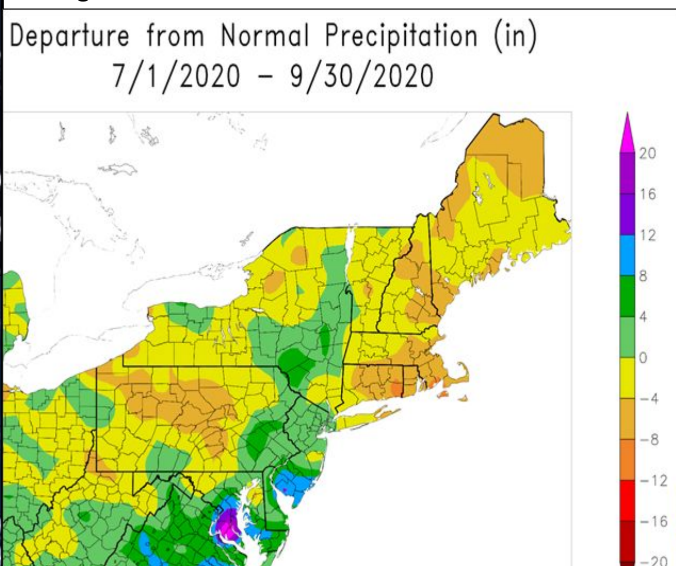
#2: Summer Drought:

The Summer 2020 drought makes our 2nd most impactful weather event across the Burlington, VT forecast area. Figure 4 below shows departure from normal precipitation (left image) and United States Drought Monitor for 29 September 2020 (right image). Rainfall during this 3 month period ranged from near normal across Essex County, New York to 4 to 8 inches below normal for parts of Saint Lawrence County and lower Connecticut River Valley. The United State Drought Monitor had our entire area at least abnormally dry with areas of moderate to severe drought across parts of central and eastern Vermont and portions of the Saint Lawrence Valley as of 29 September 2020. The three month stretch of July, August, and September witnessed the 10th driest on record at St Johnsbury COOP with only 7.47 inches of rainfall, where records date back to 1894. In addition, Massena, NY experienced their driest April through June period of record, with only 3.09 inches of precipitation. The good news is our weather pattern became more active in the fall months, with greater frequency of precipitation events, which has allowed the area to recover from the drought conditions.



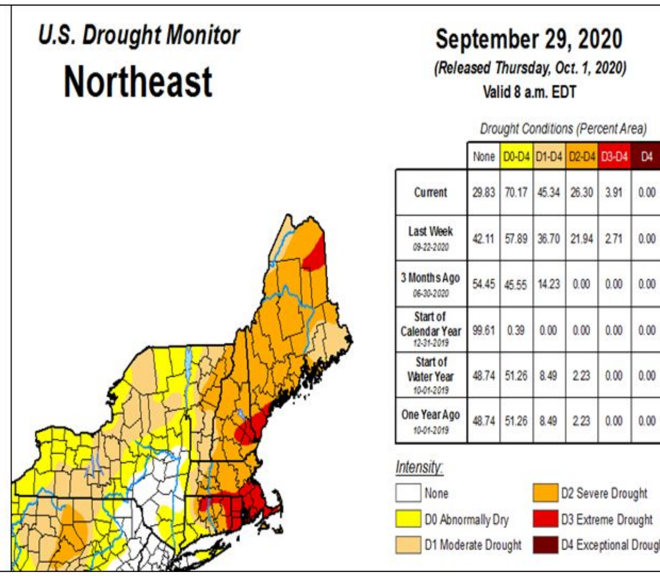


Figure 4: Departure from normal precipitation (left image) and United States Drought Monitor on 29 September 2020 (right image).

#1: 7 February 2020 Snow Storm:

Strong low pressure tracked from the Ohio Valley into Southern New England on 7 February 2020 and produced a widespread 10 to 20 inches of snowfall across most of the North Country. Initially, an icy wintry mix occurred, with Burlington International Airport receiving 0.35 of ice accumulation, before changing to snow. This ice accumulation caused a ground stoppage at the airport, while hazardous driving conditions with multiple vehicle accidents occurred across the region. Meanwhile, rain changed to a wintry mix across Rutland and Windsor Counties later in the event, which resulted in less snowfall. Snowfall rates of 1 to 2 inches per hour were observed across northern New York into Vermont, with surface visibility below ½ mile at times in periods of heavy snowfall. These dangerous conditions caused many schools and businesses to close, while road crews worked hard to clear area roadways. Fig. 5 shows the storm total snowfall across the North Country ending on 8 February 2020 and Fig. 6 shows pictures from area roadways during the snowstorm.

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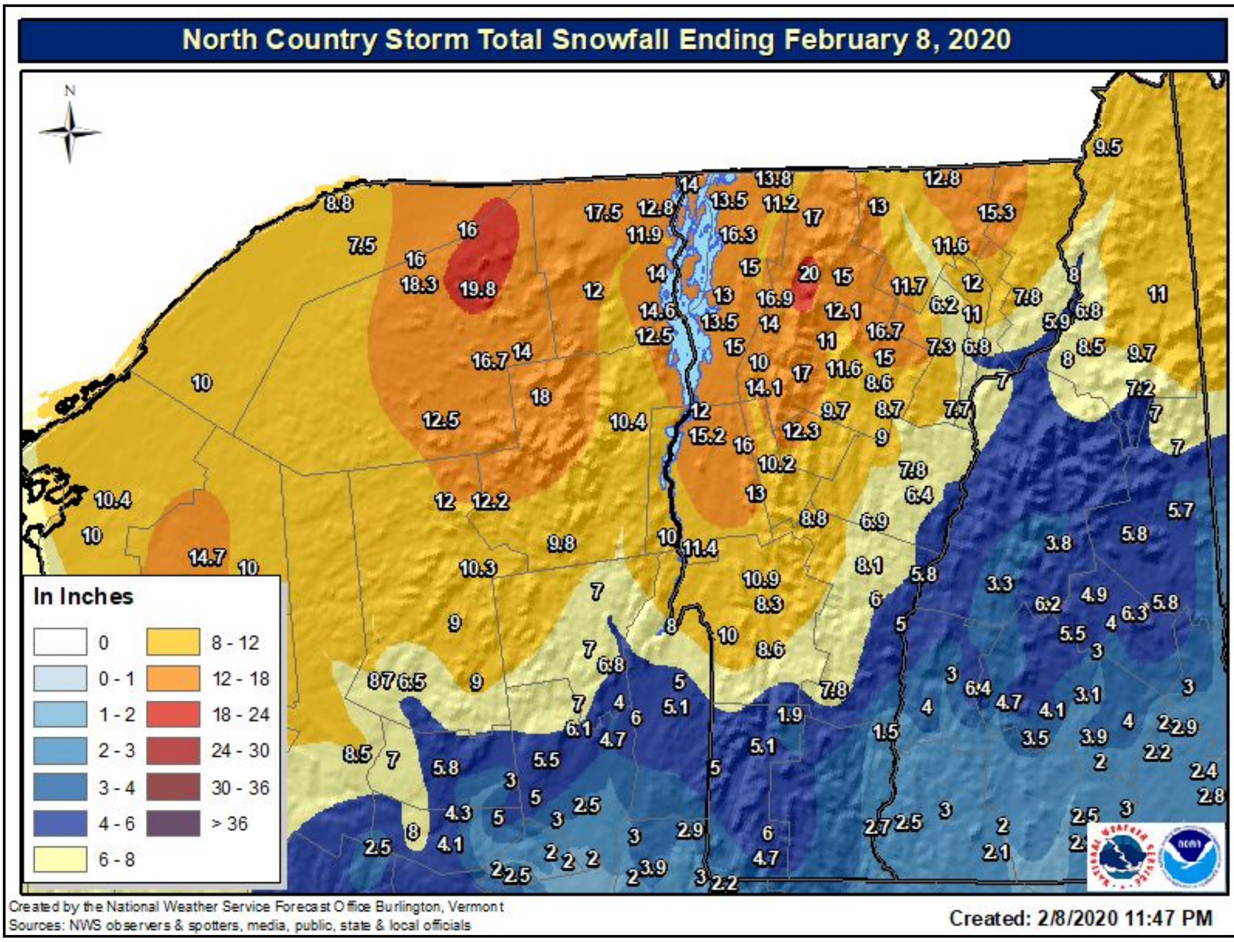

Figure 5: North Country storm total snowfall ending 8 February 2020.

Figure 6: Route 2A near Essex (left) and exit ramp in St Albans (right) on 7 February 2020.

Two NWS Burlington Incident Meteorologists Deployed to August Complex in Northern California

By Brooke Taber

Brooke Taber and Eric Evenson, Incident Meteorologists from the National Weather Service Office in Burlington, Vermont, were deployed to the August Complex in northern California to provide weather support to wildland firefighters. The August Complex started on 22 July 2020 as a series of lightning strikes ignited several fires across Northern California. This area of California has been experiencing severe to extreme drought conditions, with year to date rainfall 10 to 20 inches below normal. The exceptionally dry fuels, combined with several Red Flag events for extreme fire weather conditions, including gusty offshore winds, very low relative humidity values and much above normal temperatures, provided containment challenges to fire crews. As a result, the August Complex grew to be the largest wildfire in California history at over 1 million acres. As of mid-October, the August Complex was only 67% contained and unfortunately destroyed almost 1000 structures despite the efforts of nearly 4800 personnel, including 100 fire crews and 40 aircraft. The red outline in the image above indicates the acreage burned by the August Complex.

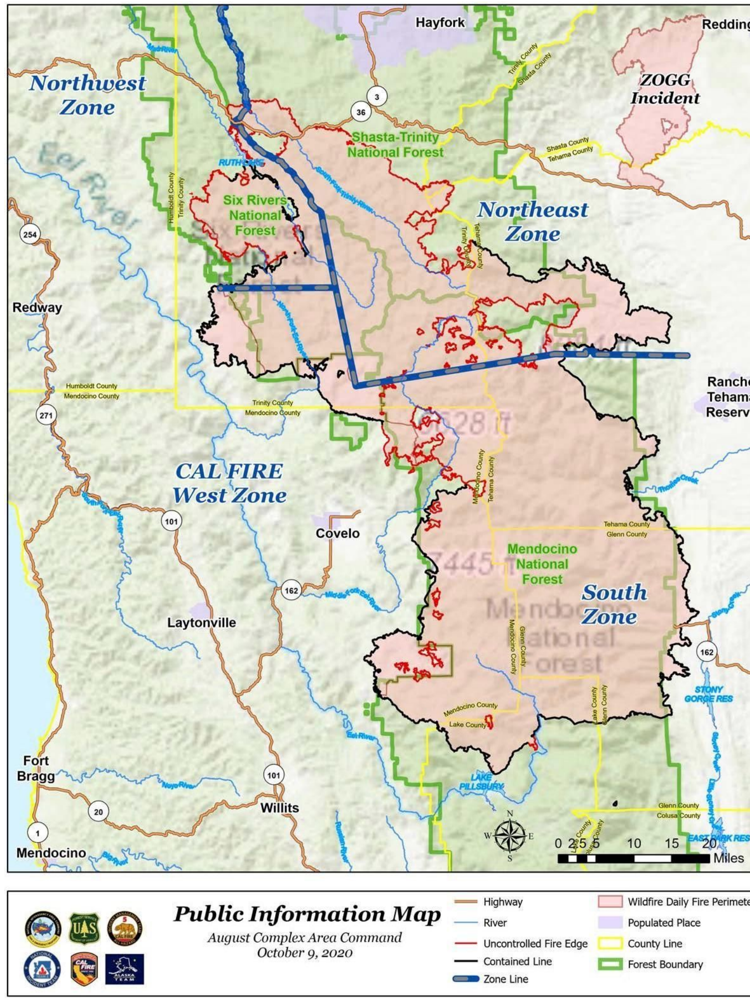

Figure 1: Public Information Map of the August Complex Area Command and associated burn footprint as of 9 October 2020.

As certified incident meteorologist (IMETs) with the National Weather Service, Brooke and Eric provide detailed and continuous weather information to fire crews and aviation resources in an effort to help contain large wildfires and provide for firefighter safety. These include interpreting weather information and providing daily weather briefings, extended weather outlooks, significant weather updates, along with site specific spot forecasts for strategic burnout operations. We utilize specialized weather software to view important meteorological data, such as weather models, radar, satellite and other critical fire weather parameters in our effort to provide the best onsite decision support services as possible.

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In addition, we participate in long term strategic planning meetings, while partaking in frequent community meetings and providing updated weather information to community members via videos on social media. We typically embed with an Incident Management Team (IMT) and work out of an Incident Command Post (ICP), which can sometimes be some distance from the actual fire.

Figure 2: Brooke Taber (left) and Eric Evenson (right) at ICP in Redding, California on 3 October 2020.

Some of the most beneficial data we can examine is the GOES-17 satellite. This information helps us understand fire development and spread by the amount and structure of the smoke, along with potential impacts to the aviation community. As the fire grows and burns very dry timber, large vertical columns of smoke develop, which can cause gusty and erratic outflow winds, similar to a severe thunderstorm if a column collapse occurs. As IMETs we must constantly monitor radar and satellite data for this potential and provide radio updates if a column collapse is possible for firefighter and aviation safety. Figure 3 shows the GOES-17 Band 2: 0.64 (red visible satellite) on 3 October 2020 at 6 PM EDT, along with several vertical smoke columns. Furthermore, you can see how thick smoke is moving downwind of the August Complex. The right side of the image is a smoke column of the August Complex from Redding, California on 27 September 2020.

Another very important piece of equipment for IMETs is an Incident Remote Automated Weather Station (IRAWS). These IRAWS transmit critical weather information every 15 minutes and are strategically placed at different locations across the fire to capture ridgetop winds, midslope conditions, or potential gap winds in a steep canyon. This specialized weather equipment provides IMETs with temperature, wind direction and speed, relative humidity, precipitation, and solar radiation, along with daily maximum and minimum values for a particular location. Figure 4 below shows a picture of IRAWS 26 on the South Fork Mountain Ridge at 5351 feet, as it helps IMETs on the August Complex capture ridgetop weather conditions.

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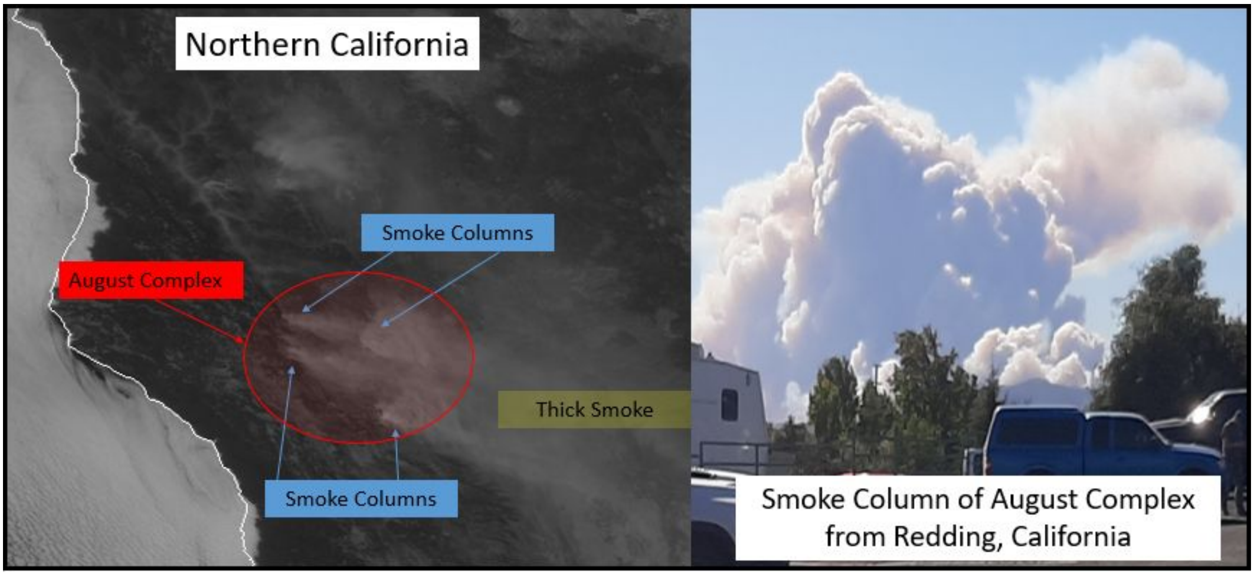


Figure 3: GOES 17 Band 2: 0.64 (red visible satellite) on 3 October 2020 at 6 PM EDT (left) and Smoke Column of August Complex from Redding, California.

Figure 4: Incident Remote Automated Weather Station 26 (IRAWS 26) on South Fork Mountain Ridge as part of the August Complex observational network. Photo by Eric Evenson.

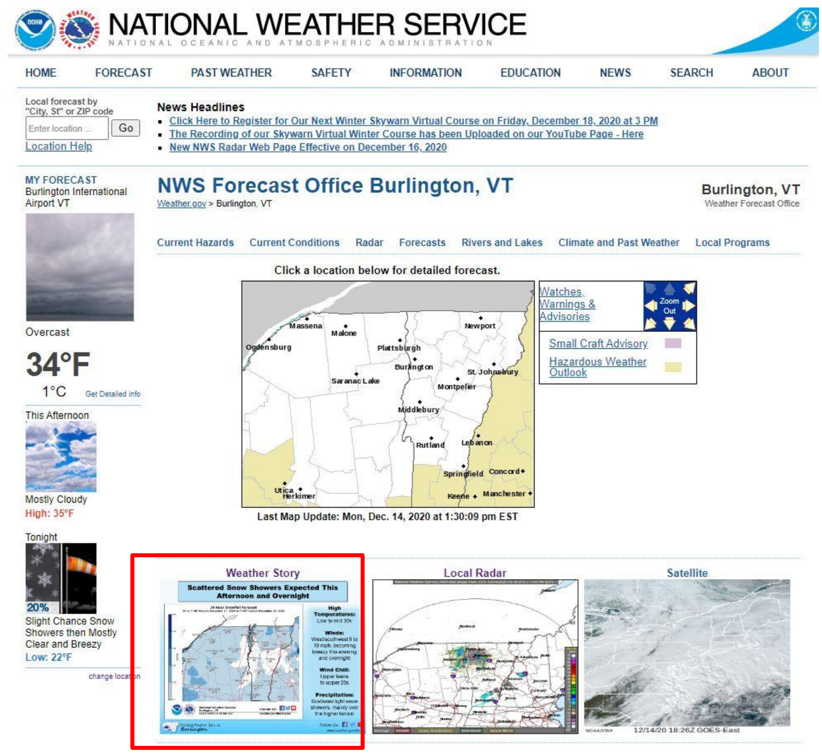
As IMETs, we work closely with local, state, and federal fire agencies by interpreting weather information, assessing its impact on the fire, and helping develop strategies to best fight the fires, while keeping both firefighters and the general public safe. Communicating accurate and timely weather information to decision makers and the public is all part of the incident decision support services provided by IMETs, during deployments.

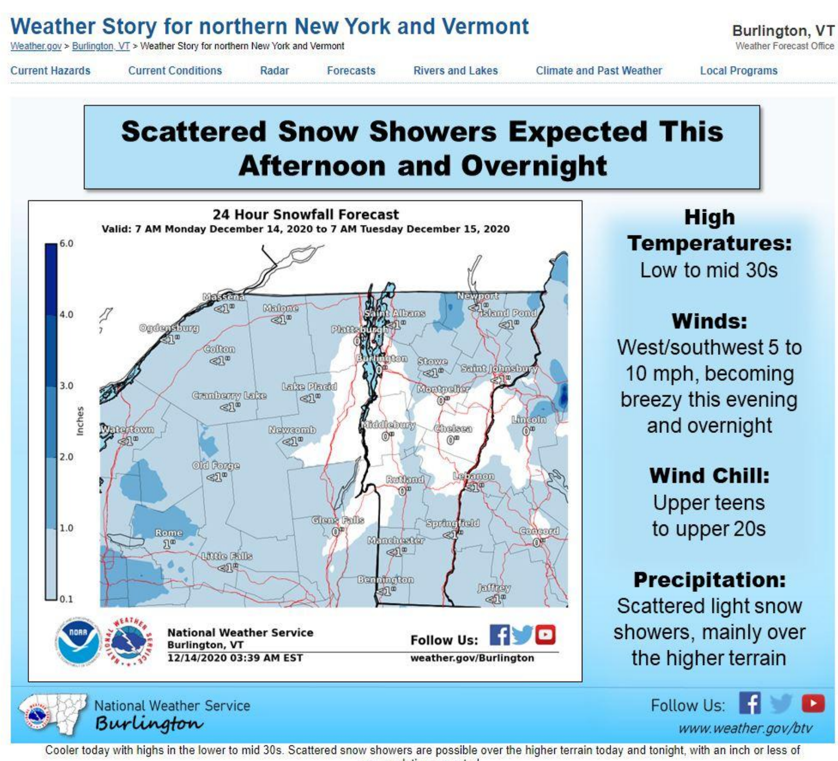
Additional Information on the August Complex:
Incident Information System: August Complex
Facebook Shasta-Trinity National Forest
IRAWS data ZOGG Fire

Weather Story: New Addition To Our Website

- Eric Evenson

On December 1st, 2020 the National Weather Service added a new feature to our website, the Weather Story. The Weather Story highlights the most relevant weather information, current or upcoming, that is expected for our area (northern New York and much of Vermont). This may include a daily weather forecast, an upcoming weather outlook, or details related to significant weather conditions that require a watch, warning, or advisory. This information may be ideal for those of you that might not follow us on social media as this type of data typically is posted on our Twitter and Facebook pages. You will now have that same direct "what you need to know" information regarding the upcoming weather. The Weather Story will generally be issued once per day (early morning hours) and can be found on the main page of our website (weather.gov/btv) just below our detailed forecast map. You can click on the Weather Story image and get a larger version for easier viewing.





The Four Seasons

Volume VI, Issue III

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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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