



The Four Seasons



National Weather Service Burlington, VT

VOLUME XI, ISSUE II

SUMMER 2023

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Letter from the Editors

Welcome to our summer newsletter. We've got a special flooding section for you in this edition, as it was the main story of the season and arguably the decade. So many events occurred that there isn't space to include them all, but we've included a few stories aside from the larger scale Vermont river flood event. As the stormy weather occurred, we brought aboard a new forecaster who you can learn more about. We also have a story on the first smoke out event early in the summer and a rundown of aviation forecasting that we do on a routine basis.

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The Great Vermont Flood of 10-11 July 2023

- Peter Banacos

Catastrophic flash flooding and river flooding occurred across much of Vermont in early to mid-July 2023. Extensive flooding to communities, washouts of numerous roads and bridges, and even the occurrence of land and mudslides resulted in significant property losses (monetary values are still

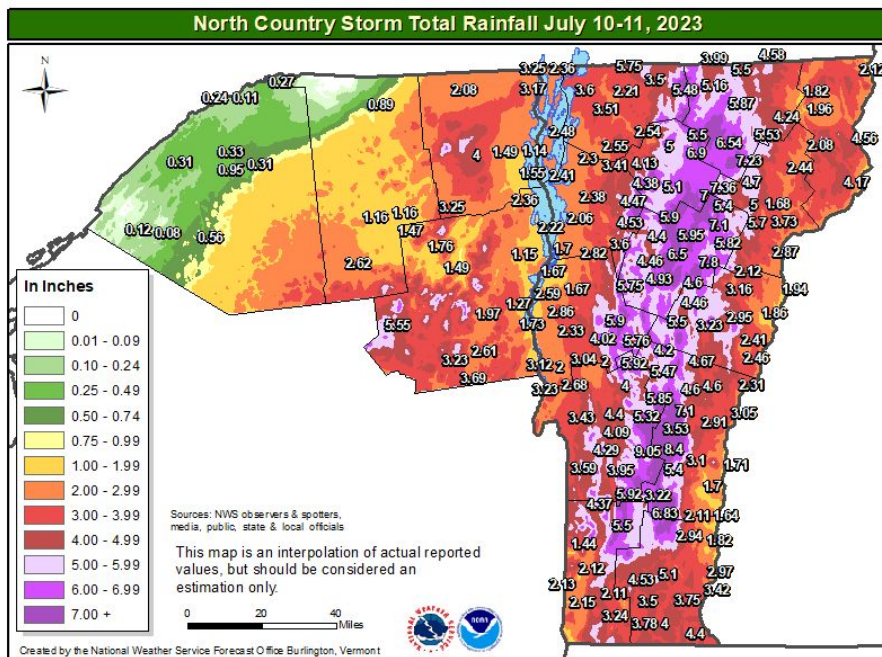


Figure 1. Observed 48-hour rainfall amounts (inches) for the period 8 am EDT Sunday (7/9/2023) through 8 am EDT Tuesday (7/11/2023). Analysis by NWS Burlington

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being tallied). The most widespread and significant flood damage occurred as a result of prolonged heavy rainfall during the 10-11 July 2023 period, when rainfall amounts of 3 to 9 inches were observed across the state over 48 hours (Fig. 1). The highest 48-hour rainfall total was 9.20" in Calais, Vermont and rainfall reports of 4 to 8 inches were commonplace along the spine of the Green Mountains and adjacent communities.

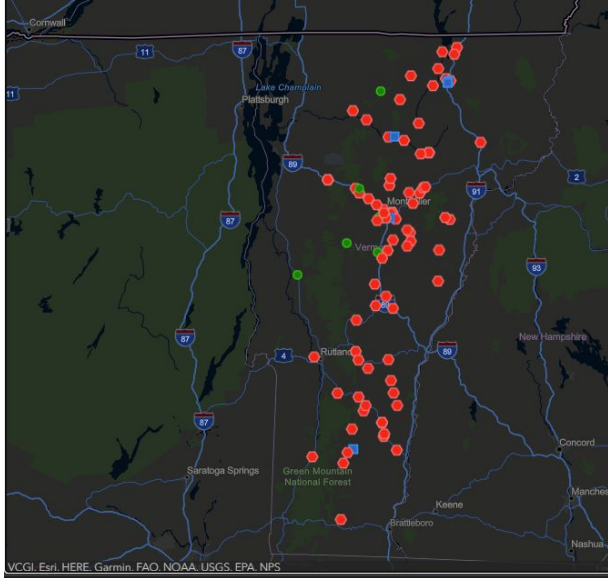


Figure 2. Status of state and U.S. highway total road closures (both lanes, red dots) at 230am EDT on Tuesday, July 11th. Blue squares denote partial road closures (e.g., one-lane open) and green dots indicate where previously closed roads had reopened. At its peak, state and U.S. highway road closures exceeded 100 instances across Vermont.

forecasts allowed a State of Emergency Declaration by Vermont Governor Phil Scott on Sunday afternoon, 9 July 2023, for the "imminent likelihood of excessive rain" and associated threat to property and public safety. The State of Emergency declaration facilitated mobilization of Type 1 swift water teams and other resources from nearby states, and activation of the state Emergency Operating Plan to mitigate storm impacts to the maximum extent possible. These were crucial steps in the protection of life and property during the flood events that followed. By the pre-dawn morning hours on July 11th, nearly 100 State and U.S. Highways were closed (Fig. 2). By July 14th, at least 212 urban and swift water rescues had been performed across Vermont. In anticipation of potentially historic flooding, on Sunday morning, July 9th, forecasters on duty worked to coordinate a "HIGH-risk" Weather Prediction Center (WPC) Day 2 Excessive Rainfall Outlook (ERO). This was the first HIGH-risk Day 2 ERO ever issued for the Burlington forecast area.

The 5.28" rainfall at the airport in Montpelier was the greatest calendar day rainfall at the site since records began in 1948, beating the previous record of 5.27" set with Tropical Storm Irene on 28 August 2011. July rainfall at Montpelier set an all-time monthly record of 12.06", beating the previous monthly record set in August 1989 (10.69").

Damage from the Great Vermont Flood of July 2023 rivaled - and in some areas exceeded - Tropical Storm Irene in 2011. Only the Great Flood of 3-4 November 1927, an event that preceded modern flood control in the state, exceeded the impact of the 2011 and 2023 events in the past century.

While two fatalities tragically occurred in connection with the flooding, the National Weather Service (NWS) Burlington forecast office worked in partnership with state agencies in advance of the storm to raise awareness of its severity. Confidence in the weather and water

This is an excerpt from the full event write-up. For a deeper dive into some of the meteorological factors that led to this event, see the [full event summary here](#). We also have a recording of a public webinar on the event [linked here](#).

NWS Burlington Support of the Vermont State Emergency Operations Center (SEOC)

- Maureen Hastings

When catastrophic flooding hit the state of Vermont, NWS Burlington staff were not only tasked with providing flood warning and safety services to the public. As part of the Stafford Act (1988) and the Weather and Research and Forecasting Innovation Act (2017), the NWS has the authority to support the emergency management community in a public safety role by providing Impact Decision Support Services (IDSS). These are services that give emergency managers what they need, when they need it, and in plain language, so they can understand and act. IDSS is vital to helping these high-end, core partners fulfill their mission to the best of their ability.

These IDSS services are usually done remotely, consisting of emailed and televideo briefings and conferences. However, during high impact weather events, IDSS is often provided by deployed meteorologists on-site. Once the truly catastrophic and widespread nature of the flooding became clear, it was quickly decided that remote IDSS would not do. In all, six NWS forecasters provided on-site support to Vermont Emergency Management's State Emergency Operation Center (SEOC). The SEOC serves as a joint command center, a meeting point for state public safety officials, during high impact events. NWS offices often send a meteorologist to these centers, especially during high impact weather events, to enhance coordination and to help the public safety officials fulfill their mission.

At first, the SEOC was sited at VEM's main offices in Waterbury, Vermont, but when flood waters threatened, it was relocated to Berlin, Vermont. The forecasters moved right along with their federal, state, and local partners, working 12-14 hour shifts. On-site meteorologists provided several briefings each day, including directly to Governor Phil Scott and his staff. They served as subject matter experts, giving public safety officials, swift water rescuers, AOT personnel, and first responders radar updates for severe storms and flash flooding, potential dam break scenarios, and river crest forecasts and information.

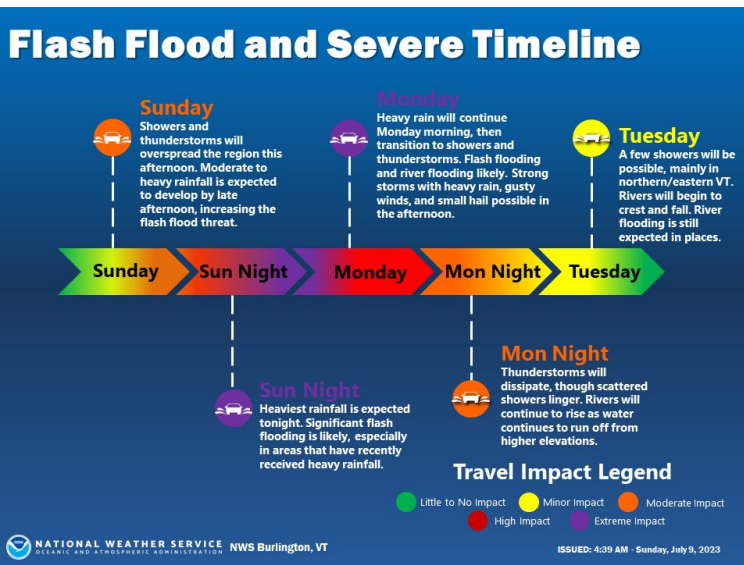
As the state's response started to stand down in late July, the NWS' role turned from on-site to remote. From our office located in Burlington International Airport, we continued to provide daily briefings and weather coordination for nearly two months after the initial flooding, ceasing only when the SEOC in Berlin finally closed. NWS Burlington staff worked tirelessly to keep our core partners informed on expected weather hazards, working hours of overtime and giving up planned vacations.

NWS Burlington remains dedicated to providing the best possible support services to emergency management personnel, and to our general public. Doing so helps to fulfill our mission to "provide weather, water and climate data, forecasts, warnings, and impact-decision support services for the protection of life and property..."

Communication and Social Science Best Practices for the Great Flood of July 2023

- Rodney Chai

As confidence grew in the days leading up to the historic flooding of 10-11 July 2023, it became pivotal for NWS Burlington to effectively convey the gravity of what was about to unfold. Consistent with the increased emphasis of social science in the NWS, NWS Burlington has developed effective ways of communicating and creating actionable information for the public. The use of a graphical timeline (Figure 1) using colors recommended by social science best practices helped both the public and emergency managers to easily visualize what was a multi-faceted and highly complex weather event.

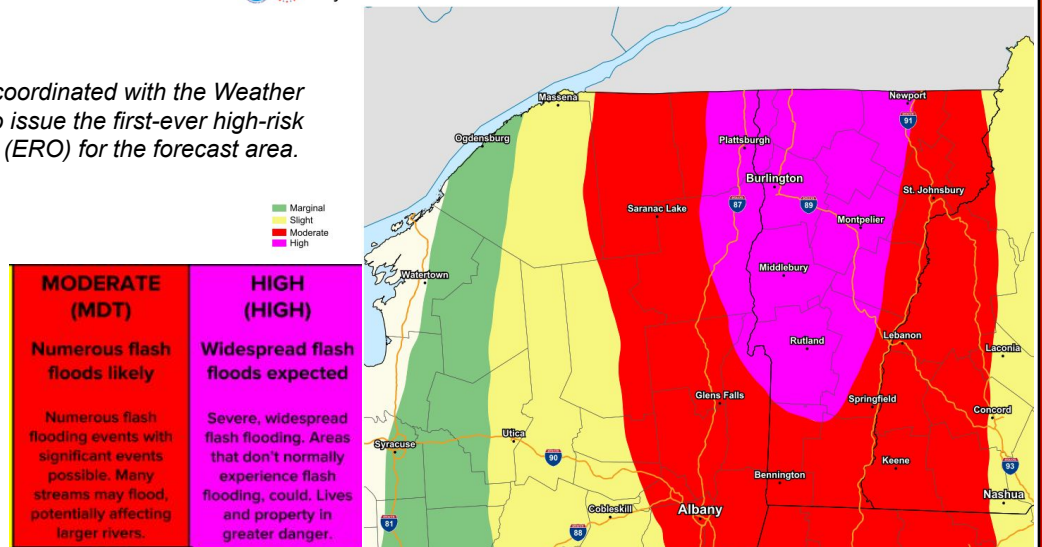


On Sunday morning, July 9th, forecasters worked with the Weather Prediction Center (WPC) to coordinate a “high-risk” Day 2 Excessive Rainfall Outlook (ERO) (Figure 2). It was the first High-Risk ERO ever issued for the NWS Burlington forecast area, which consists of most of Vermont and northern New York. In addition, while high risk EROs are only issued by WPC on 4% of days, they account for 40% of all flood-related fatalities and 90% of all flood-related damages.

Figure 1: A graphical timeline produced by NWS Burlington forecasters to help both the public and emergency managers visualize a multi-faceted and highly complex weather event.

Day Two Excessive Rainfall Outlook

Figure 2: NWS Burlington coordinated with the Weather Prediction Center (WPC) to issue the first-ever high-risk Excessive Rainfall Outlook (ERO) for the forecast area.



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Coordination and communication with our partners, including Emergency Managers (EMs), TV meteorologists and the public on social media platforms (Figure 3) helped to greatly mitigate the impacts of this historic event. Despite damage rivaling other benchmark storms in the state - Tropical Storm Irene in 2011 and the Great Flood of 1927 - only one direct flood-related fatality was reported. On July 9th during a conference call with the Vermont Emergency Management (VEM), forecasters

used the words “historic” and “catastrophic” to describe the flooding that was about to unfold. In particular, forecasters stated that impacts would be the worst seen since Irene. Confidence in the forecast led to the Vermont Governor Phil Scott to declare a State of Emergency that afternoon (Figure 4). The State of Emergency declaration facilitated mobilization of swift water teams and other resources from nearby states to mitigate storm impacts.

Figure 3: A social media post by NWS Burlington on the morning of July 10, 2023 emphasizing the life-threatening and catastrophic nature of the flooding.

Figure 4: A screen capture from X (formerly Twitter) showing Governor Phil Scott declaring a state of emergency for the state of Vermont in advance of the catastrophic flooding.

Smoky Start to June as Canadian Wildfires Burn

- Matthew Clay

Many will forget that an unusually dry period of weather was observed through the months of May and June given how wet July and the beginning of August were. Taking a look at **Figure 1**, we see a map created by Agriculture and Agri-Food Canada in Collaboration with Environment Canada that shows just how dry it was over a 30 day period ending on June 6th, 2023. Places near Montreal, Ottawa, and as far west as Windsor were “exceptionally low” with 25 out of 30 days reporting no measurable rainfall. A combination of dry weather, near record temperatures, and high evapotranspiration rates quickly dried out dead leaf litter and dead trees from the previous fall.

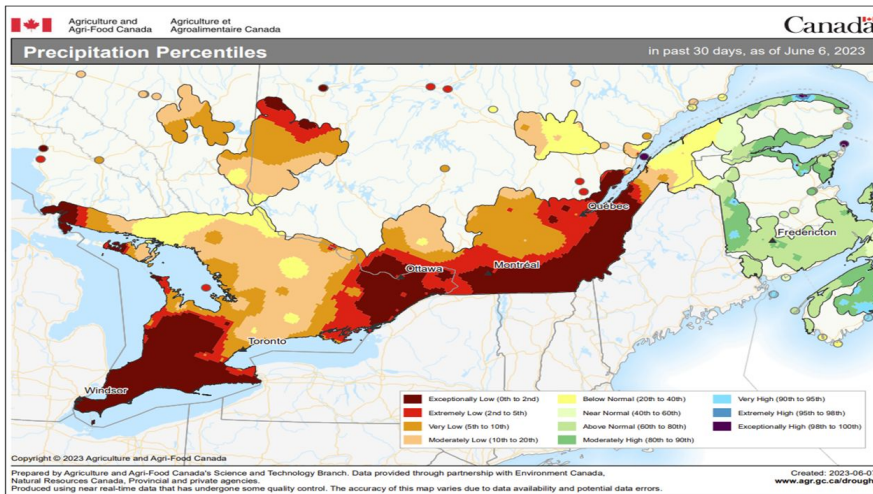
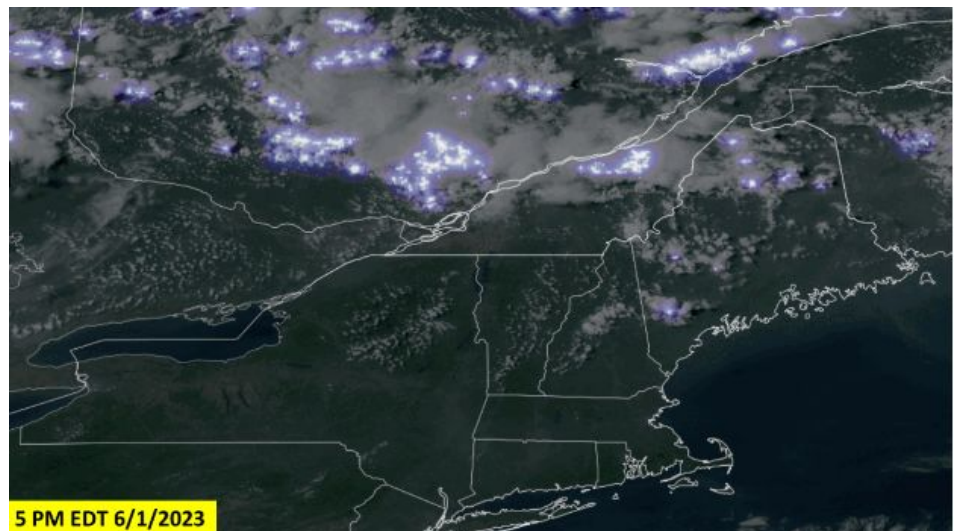


Figure 1. A map created by Agriculture and Agri-Food Canada in coordination with Environment Canada showing the precipitation percentiles. Much of southern Quebec and Ontario has some of the lowest precipitation during this 30 day period on record (red and deep red colors).

A cluster of thunderstorms developed the afternoon of June 1st across southern Quebec and southern Ontario in response to a cold front heading south toward the International Border. The air mass was typical of early June with modest instability and weak low to mid-level shear but the thunderstorms this day produced copious amounts of lightning as seen in **Figure 2**. In addition to all

Figure 2. A map showing thunderstorm activity at 5 PM on June 1st, 2023 using the CIRA Group Energy Density to highlight where thunderstorms were occurring.



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of this thunderstorm activity, conditions at the surface approached “red flag” conditions which are denoted by strong winds and very low relative humidity (RH) values. Observations at both the Val-d’Or Airport and Chibougamau-Chapais showed RH values below 20% and winds in excess of 20 mph. Given the dry antecedent conditions, widespread thunderstorms, and continued dryness the day of the thunderstorms, it’s no surprise that wildfires developed in response. **Figure 3** shows a map of wildfires depicted by the MODIS constellation on June 6th, 2023.

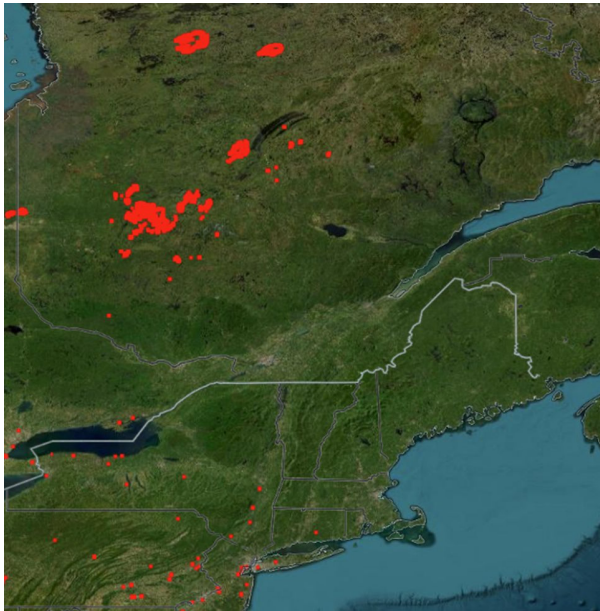


Figure 3. This image, created jointly by NASA and the US Forest Service, shows the hot spots associated with the forest fire. Each pixel is not an individual fire but represents where the MODIS constellation detects ongoing fire activity.

There were several episodes through the month of June that poor air quality was observed in the North Country from the Canadian wildfires. We are going to take a look at an event that occurred on June 6th through June 8th at several sites across the region. For starters, the air quality index (AQI) is the way that both the Environmental Protection Agency (EPA) and state environmental agencies measure air pollution. The AQI is an index that tells people how good or bad the air quality is for their location. The AQI ranges from “good” where no impacts are expected all the way to “hazardous” where all groups of people are impacted and encouraged to avoid all physical activity outdoors.

Wildfire smoke contains fine particles that the EPA calls PM (particulate matter) 2.5. The 2.5 stands for the size of the particulates as wildfire smoke tends to fall in the 2.5 micrometer range. These particles are very tiny and reduce visibility and cause the air to be hazy when levels are

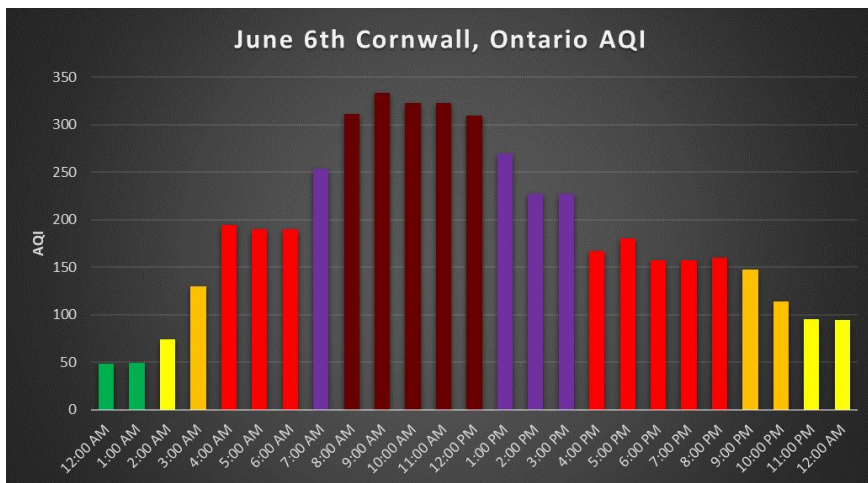


Figure 4. The observed Air Quality Index (AQI) at Cornwall, Ontario (just across the St. Lawrence River by Massena, NY) on June 6th.

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elevated. Fine particles, like PM 2.5, can get deep into lungs and some may even get into the bloodstream, according to the EPA, which can affect a person's lungs and/or heart. State environmental agencies coordinated closely with the National Weather Service following the wildfire outbreak to issue Air Quality Alerts for much of New England and the Northeast on June 6th, 7th, and 8th as wildfire smoke moved across the region. Northerly surface winds coupled with a stable layer near the surface allowed for the wildfire smoke across Ontario and Quebec to steam into the North Country and lead to hazardous air quality values. Take a look at **Figures 4 and 5** to see how air quality deteriorated across the North Country. Higher AQI values denote worsening air quality with anything above 150 being hazardous to all demographics.

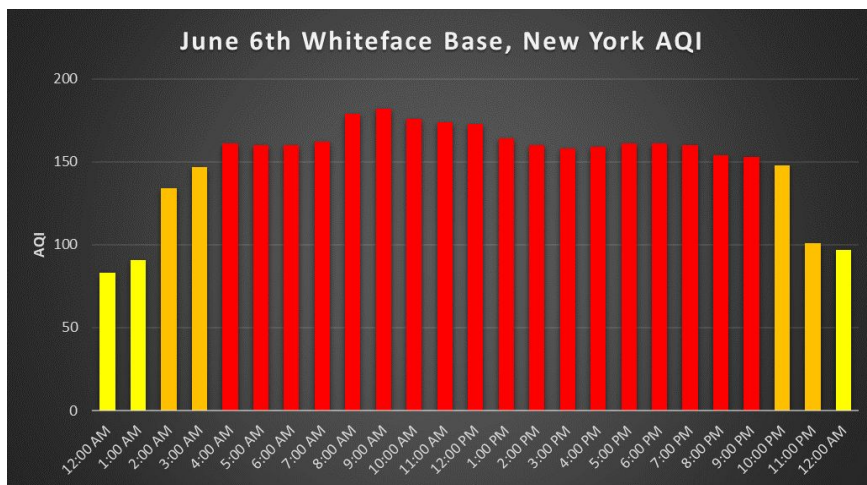


Figure 5. The observed Air Quality Index (AQI) at Whiteface Mountain Base, NY on June 6th.

Multiple Landslides Across the State of Vermont This Summer

- Rebecca Duell

Dozens of landslides and mudslides occurred throughout Vermont this summer as a result of saturated soils from July's heavy rainfall event. One of the bigger mudslides that was reported this summer occurred on July 7th in Killington, Vermont, where up to 20 feet of debris washed across U.S. Route 4 after heavy rain, causing a multi-day road closure. Several area roads around Killington were also closed due to road washouts after the flooding, including East Mountain Road, which connects Route 4 to Bear Mountain.

In Ripton, an impactful landslide occurred in the overnight hours of July 14th - 15th after strong thunderstorms brought between 3 and 3.5 inches of rainfall to the area. The landslide occurred along Route 125 and destroyed one home while multiple other homes had to be evacuated. Town emergency managers were evacuating residents overnight because of river rises on the Middlebury River when the landslide occurred at 2 AM. Luckily, there were no reports of injuries resulting from this landslide.



Image 1. Mudslide in Killington across Route 4 - courtesy of the Killington Police Department social media.

In addition to the two landslides mentioned above, numerous other landslides were reported throughout the state in July and August. The town of Barre was particularly hard hit as a result of the interaction between the heavy rainfall and the local geology. Over 40 landslides were reported in Barre, destroying at least one home, trapping cars, and stopping traffic on multiple roads. The numerous landslides and mudslides that occurred this summer resulted after soils became saturated after the multiple heavy rainfall events throughout the month of July. According to the U.S. Geological Survey, intense, short bursts of rain may be particularly dangerous for landslides, especially after longer periods of heavy rainfall and damp weather. Areas with steep terrain are more susceptible to landslides after soils become saturated. While the NWS relays reports of landslides and mudslides, our meteorologists do not predict or forecast them. However, if you live in a landslide prone area, stay alert to local Flood Warnings and rainfall forecasts and review landslide preparedness information that is available online from the U.S. Geological Survey at the following website: <https://www.usgs.gov/programs/landslide-hazards/landslide-preparedness>.

Geologists who work for the Vermont Geological Survey within the state's Department of Environmental Conservation are the local experts on landslides and mudslides, and respond to and monitor landslide events across the state of Vermont. For more information on landslides in Vermont, see this webpage <https://dec.vermont.gov/geological-survey/hazards/landslides>

Ellenburg NY Flash Flood of July 2, 2023

- Matthew Clay

Several rounds of convection affected the west central portions of Clinton County, NY during the morning and afternoon hours of July 2nd, 2023. The bulk of the rainfall occurred in two distinct rounds with the first occurring between 7 PM on Saturday July 1st and 1 AM on Sunday July 2nd with the second affecting the area between noon and 5 PM on Sunday the 2nd. Total rainfall estimates in the Ellenburg and Lyon Mountain area ranged from 4 to 7 inches with localized totals of 8 to 9 inches which can be seen in **Figure 1**. Numerous roads were flooded and impassable, numerous culverts were washed out, and several homes affected by flood waters. In addition, the Blue Haven Campground began evacuating campers between 2 AM and 5:30 AM on the 2nd of July.

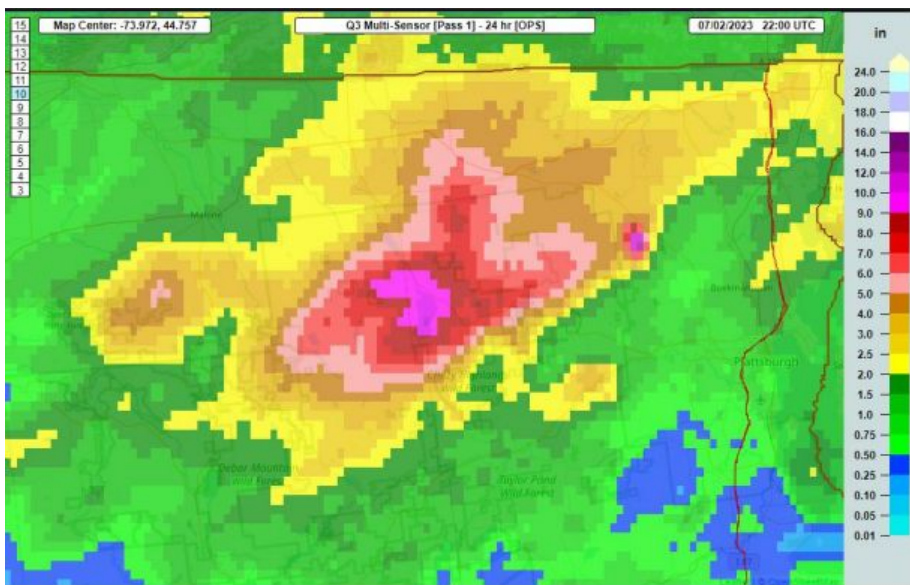


Figure 1. Multi-Radar Multi-Sensor (MRMS) storm total precipitation estimates on July 2, 2023 in the Ellenburg, NY area. Reliable estimates of 4 to 7 inches fell with localized amounts of 8 to 9 inches.

The hardest hit area by the flash flooding was the Blue Haven Campground which is located along the Great Chazy River. From first hand accounts and high water marks observed during a flood survey, the Great Chazy River rose around 5 feet within a 3 hour period. This prompted one official at the campground to go “door-to-door” urging people to seek higher ground due to the rapid response of the river. The evacuation began around 2 AM and continued for the next 3 hours with campers helping to wake other campers and spread the word to evacuate the campground. The actions of these people, especially the staff at the campground, likely prevented any fatalities from a nocturnal flooding event. See **Figure 2** to see what the center of the Blue Haven Campground looked like at first light on July 2nd.

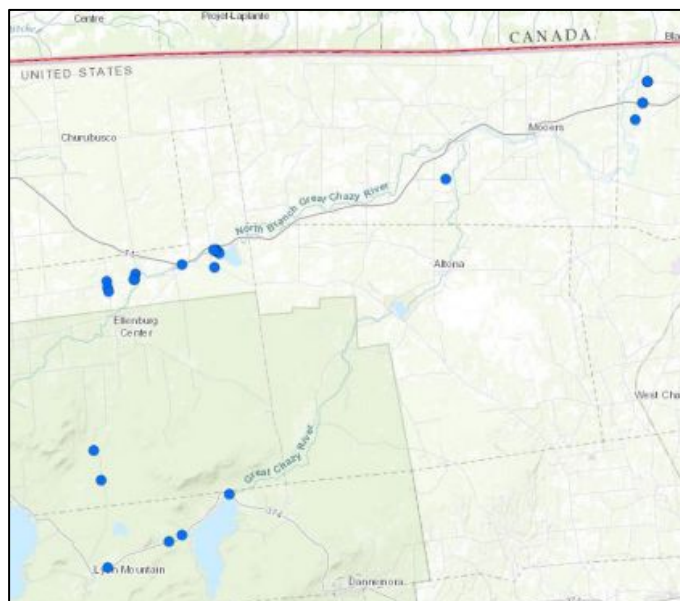
Interestingly enough, after a brief reprieve in the rainfall during the morning hours, another batch of showers and thunderstorms developed over the same area. Looking back at meteorological data, it seems an area of convergence between the northern slopes of the Adirondacks and Lake Champlain was responsible for the re-development of the storms in the afternoon hours.

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Figure 2 (above): Flood waters from the North Branch of the Great Chazy River swept through the Blue Haven Campground in Ellenburg, NY in the early morning hours of July 2, 2023.

Figure 3 (below): Locations of observed flood damage noted on a storm assessment survey by NWS Burlington on July 3, 2023. Each blue dot denotes observed flood damage.



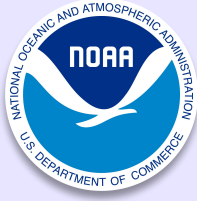
Our meteorologists were on top of the rapidly evolving situation and worked closely with Clinton County Emergency Management and issued flash flood warnings during the afternoon hours to highlight the flooding threat. Before long, we received word of swift water rescues due to people having re-entered several campgrounds along the Great Chazy River during the morning hours to assess flooding damage. Again, first hand reports noted the Great Chazy River rising close to 5 ft in a short period of time which led to extensive flooding in the Ellenburg and Lyon Mountain area. If you take a look at **Figure 3**, you'll see the area that the survey team found flood damage. Please note, given the extensive amount of flood damage, not every report was documented.

Changes at BTV - Eric Myskowski joins NWS BTV

Welcome Eric!

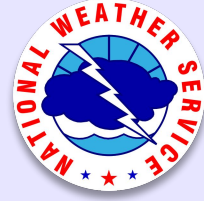
Eric grew up in Connecticut and earned a bachelor's degree of meteorology with honors from Penn State. During his time in college, he was a Pathways Intern at the National Water Center and the Mid Atlantic River Forecast Center where he worked with flood inundation mapping. Previously, he was a student volunteer for the National Weather Service in Caribou. He was also a member of the Penn State marching band and the travel curling club. His other interests include hiking, birding, and watching college hockey, and he is looking forward to hiking in the Green Mountains and the Adirondacks. As a snow lover, he is excited to experience his first "real" winter in years. In the summer, he wants to find creemees that can satisfy his ice cream withdrawals from a lack of Penn State Creamery ice cream.





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