The Four Seasons

National Weather Service Burlington, VT

VOLUME VI, ISSUE IV — WINTER 2019-2020

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Letter from the Editors

Welcome to the Winter 2019-2020 Edition of The Four Seasons, a quarterly newsletter issued by the National Weather Service in Burlington, VT. We decided to ring in the new decade with a special jam-packed edition starting with a look back at the top 5 weather events of the 2010s for the North Country. We'll then take a look at some changes to our flash flood warnings and examine one of the reasons why this winter has been warmer than normal. Finally, we'll take a look at the history and future direction of the National Weather Service as the agency celebrated it's 150th anniversary this February. Thanks for reading and we hope you enjoy the newsletter.

Top 5 Weather Events of the 2010s for the North County

By Robert Haynes

Now that our calendars have turned to 2020, the 2010s are behind us, along with all the weather contained within. Here are the Top 5 Weather Events of the "Twenty-Tens" as decided by the staff at the National Weather Service in Burlington. Before we begin, this is a subjective list with each staff member giving different weight to different types of weather. For example, some gave preference to events associated with federal disaster declarations or based it on a high number of power outages, while others gave preference for events that broke longstanding or notable records. Some focused on weather events with far-reaching impacts throughout the North Country as opposed to weather events that impacted a local area (like a rare tornado or strong lake effect snow band). Many of these include excerpts from previous write-ups completed by our staff when available, which can be found in the "Past Wx Events" in the Research tab at the bottom of weather.gov/btv. With that said, we hope you enjoy this trip through some of the major events of the last decade..

Number 5: January 2018 Ice Jam Flooding

Excerpt from Event Review from NWS Burlington:

Indications that substantial snow and rain would arrive into New York and New England were evident several days prior as computer models suggested a storm system would track through the Great Lakes into the St. Lawrence Valley, tapping copious amounts of moisture from the Gulf of Mexico. Initially the focus was

...Continued from Page 1

on the winter threat of snow and mixed precipitation. However, as the storm neared it became evident that temperatures would be very mild, and for a long enough period of time so as to melt a considerable percentage of the existing snowpack. This would in turn lead to sharp river rises, potential ice breakup and flooding.

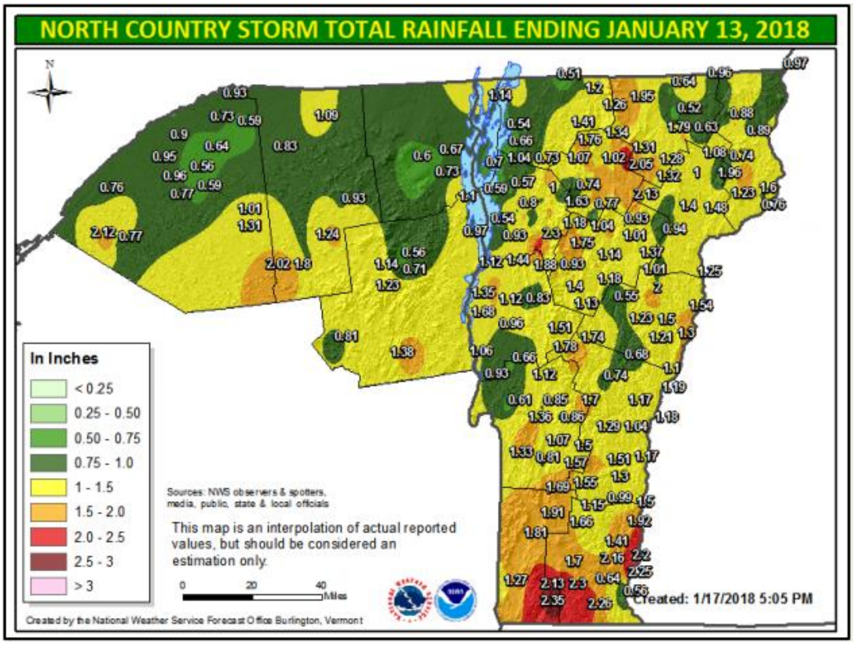

Figure 1.Storm total rainfall for the event. Many areas received over an inch of precipitation.

The phenomenon of ice jams and resultant flooding from impounded water blocked by ice is a common occurrence on portions of many rivers and streams across Canada and the northern portions of the United States. Typically they occur during late winter and early spring when persistent warmth and a higher sun angle act to melt snow and rot, or weaken the ice. However, they can occur at any time when conditions are right.

Of the many locations that reported flooding, perhaps the most severe occurred in Swanton, VT and Plattsburgh, NY. In Swanton, an unusually large ice jam on the Missisquoi River became lodged in town and upstream several miles from the Depot Street Bridge, affecting approximately 1.5 miles of State Route 78 and flooding several homes. A number of people were evacuated due to the high water. Eventually, receding water levels allowed some people to return to their homes the following week to assess damages. In the City of Plattsburgh, a large ice jam formed on the Saranac River near the SUNY Plattsburgh campus. High water impounded by the jam led to severe flooding of the Underwood Estates Mobile Home Park affecting approximately 50 homes, several of which were severely damaged. Fortunately, timely evacuations prevented any casualties.

Figure 2: Upper left: Flooding in Johnson Village along the Lamoille R. (photo credit Matt Sutkoski); Upper right: High water in Massena, NY from an ice jam on the Grasse R. (photo credit Massena Volunteer Fire Dept.); Lower left: First responders aiding in rescue efforts along the Salmon R. in Fort Covington, NY (photo credit Franklin County Sheriff); Lower right: High water along the Lamoille River in Cambridge, VT (photo credit NWS Burlington).

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Number 4: October 30th, 2017 Wind Storm

A strong extratropical low pressure system developed near the east coast of Florida in response to an anomalous mid-latitude trough and enhanced with moisture from Tropical Storm Philippe. This system quickly lifted northwards into New York state. This powerful system in combination with other synoptic and mesoscale factors produced a significant downslope winds that resulted in an estimated 125,000 without power.

Key to generating these damaging winds is a strong pressure gradient. Close proximity between an area of high pressure and an area of low pressure will lead to faster flow, especially if the low pressure system is rapidly deepening. In this instance here, Figure 3 shows the area of low pressure over New York and the area of high pressure. Wind flags can be seen showing the easterly winds. Topography plays a significant role in how these winds travel. As these winds move upslope, they decelerate. In an environment characterized by weak instability below the ridge tops (about 3500-4000 ft in our region), these winds will then accelerate as they head downslope. This process is most efficient when the winds approach perpendicular to the mountain ranges. Much like the recent Halloween Storm in 2019, rain prior to strong wind gusts on October 30th, 2017 resulted in widespread downed trees.

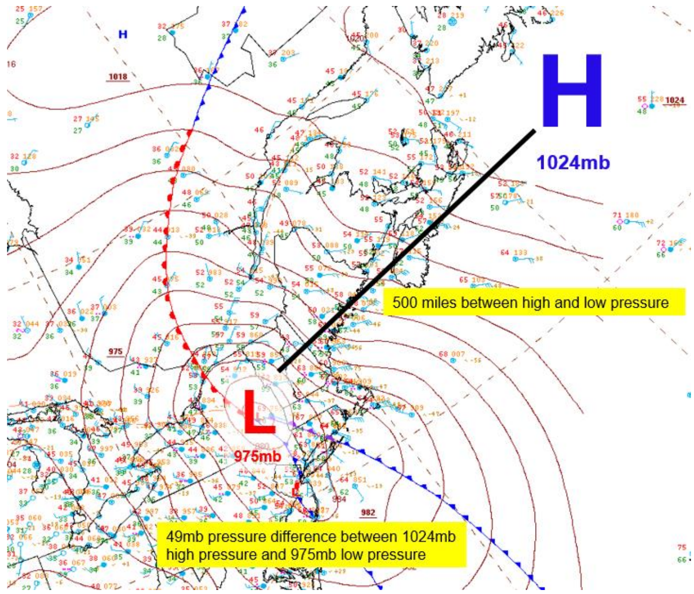

Figure 3: Schematic showing the the close proximity of high and low pressure yielding the strong pressure differential.

This event in particular was notable for how extensive the downslope winds were in this case. Strong downslope winds continued 15 to 25 miles west of the Green Mountain and into the more highly populated areas of Chittenden County. Mount Mansfield gusted to 115 mph during this wind storm.

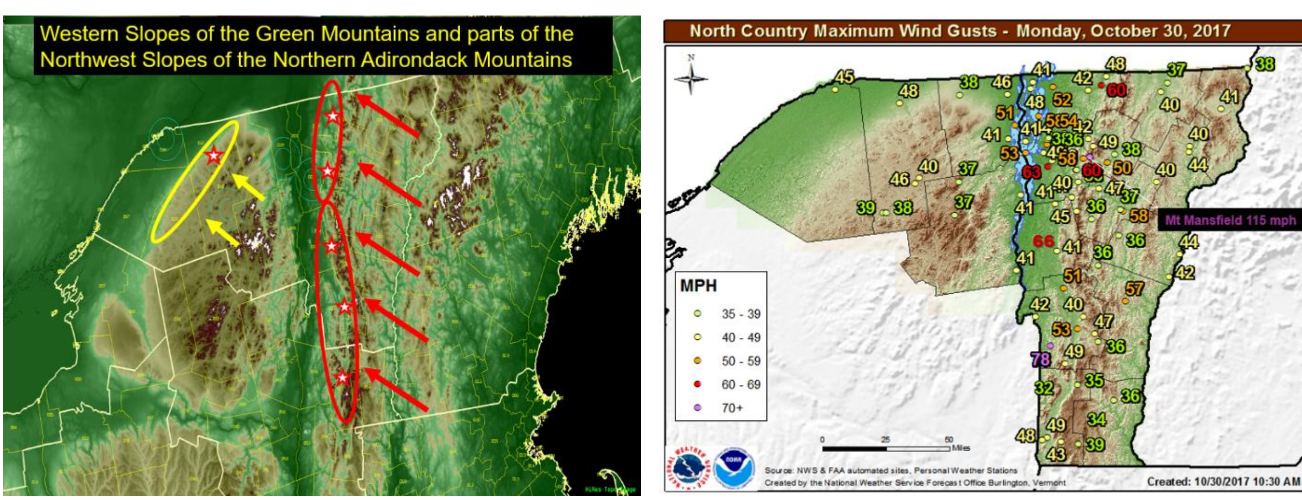

Figure 4: Left) Schematic showing regions prone to downslope winds from the southeast. Right) Max wind gusts experienced Monday, October 30th across the North Country.

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Number 3: Pi Day Storm - March 14, 2017

Excerpt from the Event Review written by Peter Banacos and Robert Deal:

"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"/hr in many areas during the afternoon hours on Tuesday, March 14th."

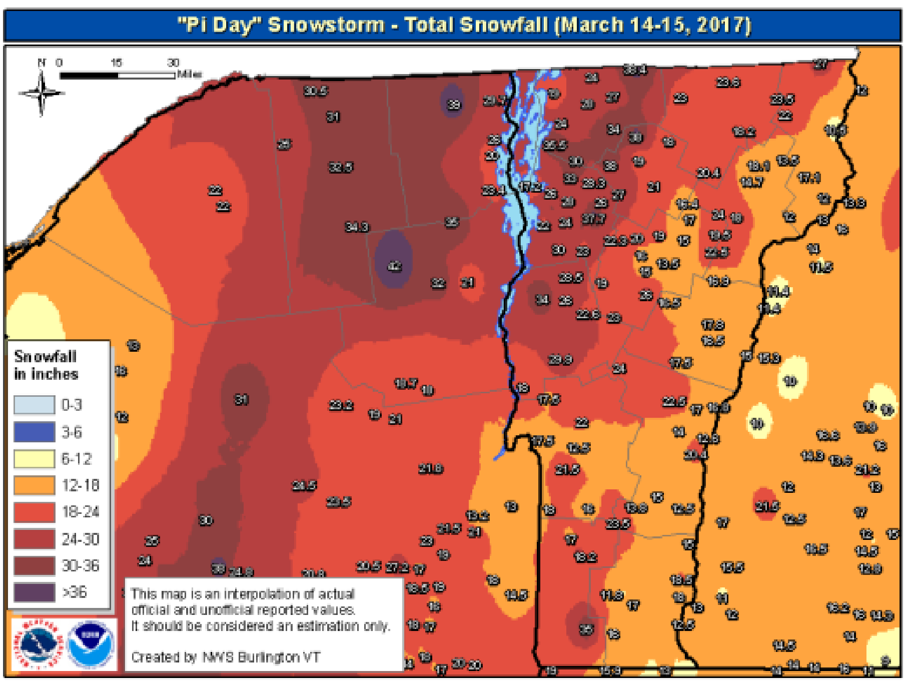

Figure 5: Storm Total Snowfall over the course of the Pi Day Storm

"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 the day 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 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."

Notable numbers from the storm:

- **1**: Biggest March snowstorm on record at Burlington, Vermont (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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Number 2: 2011 Spring Flooding, Record Lake Champlain Level

Due to a late season snow pack and several moisture-rich systems that came through the region, widespread flooding occurred multiple times in the Spring of 2011. Flash flooding occurred April 26th and 27th of 2011 from a combination of snowmelt from much above normal temperatures and several rounds of heavy precipitation. A strip of 2 to 4 inch rainfall totals extended from the Adirondacks northeast into the Northeast Kingdom. This pushed several rivers into flood, and put the river gage of the Lamoille Gage at Johnson into major flood.

Just one month later, May 26th and 27th featured another period with training thunderstorms with portions of eastern Vermont receiving 4 to 5 inches of rain. This event also produced multiple damaging thunderstorms with supercell characteristics. Reports of damaging wind gusts up to 70 mph and several reports of large hail occurred over the afternoon. With so much rain in a short window produced significant flash flooding again Spring 2011. Many residents and businesses were flooded out. Culverts were washed out, and many rivers were sent into moderate flood stage.

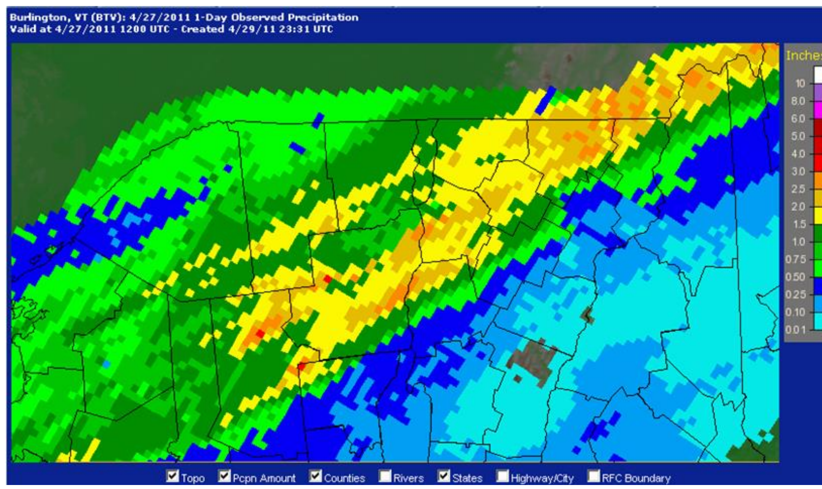

Figure 6 (above): 24-hr radar from April 27th-April 28th of estimated precipitation with a swatch of 1”-3” over much of the Adirondacks and Northern New York.

Between these two events, snow was continuing to melt after an above average snow season across the North Country. Additions to the late season snow pack offered by the March 2011 snow storm and continued spring rains pushed Lake Champlain to the highest level it has reached in our period of record. Flooding began in April and peaked at the current record level of 103.27 ft. on May 6th, 2011. Lake Champlain did not fall below flood until mid-June. This record level severely impacted the Champlain Valley, such as Route 2 and Route 78 with many beaches and marinas closed off during the early months of summer.

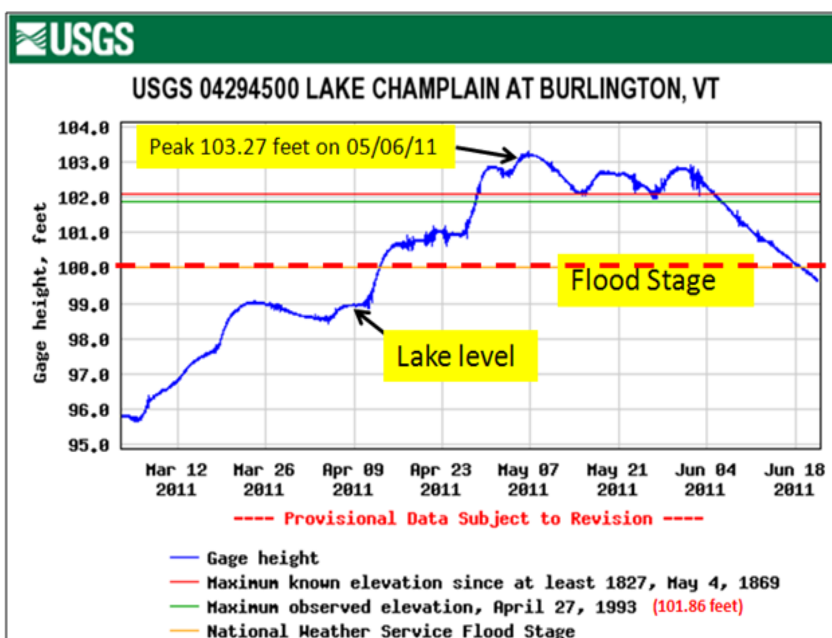

Figure 7: USGS graphic of Lake Champlain water levels showing ascent into flood stage and peak on May 6th, 2011.

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Number 1: Tropical Storm Irene - August 28th, 2011

Excerpt from the Top 5 Weather Events of 2011 across the North Country:

Figure 8: MODIS imagery of Tropical Storm Irene over Vermont.

"Tropical Storm Irene produced catastrophic river and flash flooding across Vermont and portions of northern New York on Sunday, 28 August 2011. The flood waters resulted in 3 fatalities in Vermont and 2 others in Clinton County, New York, and a scale of devastation not seen across the region since the epic floods of November 1927. Nearly a dozen Vermont communities were isolated for days due to the loss of numerous roads and bridges. Nearly 2000 road segments were damaged, with 118 sections of state roads and 175 local roads completely washed out. Among nearly 300 damaged bridges, several iconic covered bridges were heavily damaged or completely destroyed in Vermont, including the antique 160-foot Bartonsville Bridge which spanned the Williams River in southern Vermont since 1870 before being swept downstream in the storm. Over 800 homes and businesses, and several rail and major telecommunication lines were damaged or destroyed by fast-moving flood waters. Damage from Irene resulted in a Major Federal Disaster declaration for all of Vermont except Essex and Grand Isle counties, and much of eastern New York, including Clinton and Essex counties served by WFO Burlington, Vermont. The hardest hit areas were Essex County in New York, and central and southern sections of Vermont. Monetary damages at the time were estimated between $175 and $250 million in insured losses and needed repairs to public infrastructure."

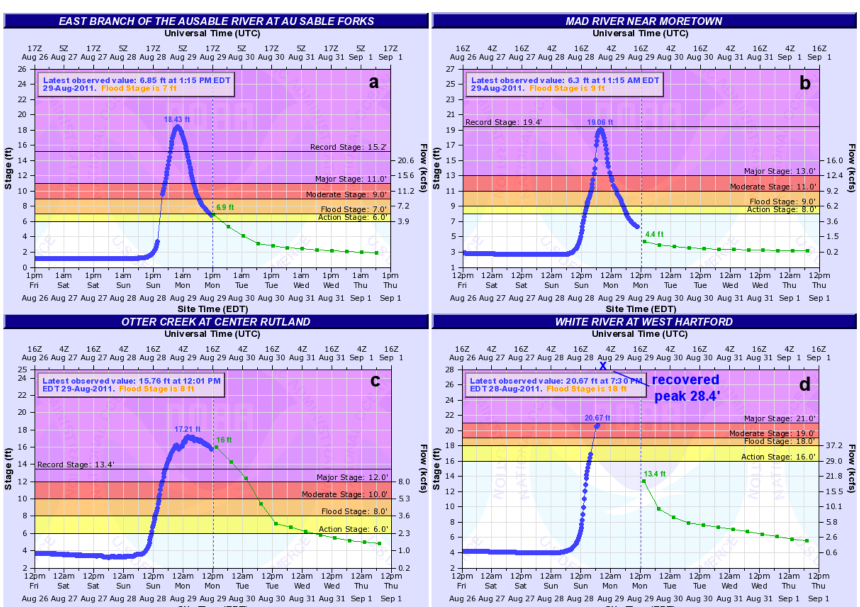


Figure 9: Hydrographs of river stage a) at the Ausable River in Ausable Forks, b) at the Mad River in Moretown, c) at Otter Creek at Center Rutland, and d) at the White River at West Hartford with the recovered value superimposed.

"A selection of hydrographs is shown in Figure 9. River gages show steep rises of 14-24 feet over a period of just 6 -12 hours from base levels to historically near -record and record crests. Record crests were recorded at the East Branch of the Ausable River at Ausable, NY (Fig. 9a), the Dog River at Northfield Falls, VT, the Otter Creek at Center Rutland, VT (Fig. 9c), and the Bouquet River at Willsboro, VT. A near - record crest was observed along the Mad River at Moretown, VT (Fig. 9b). Power was lost to gage houses in some cases due to the flood waters. However, via high -water marks and other post -event analysis methods, the recovered crest of 28.4 feet at West Hartford (per USGS) (Fig. 9d) is just below the all -time record crest of 29.3 feet set on 4 November 1927."

National Weather Service Adopts IMPACT-BASED Flash Flood Warnings

-John Goff

Impact-Based Warnings (IBWs) are designed to improve communication

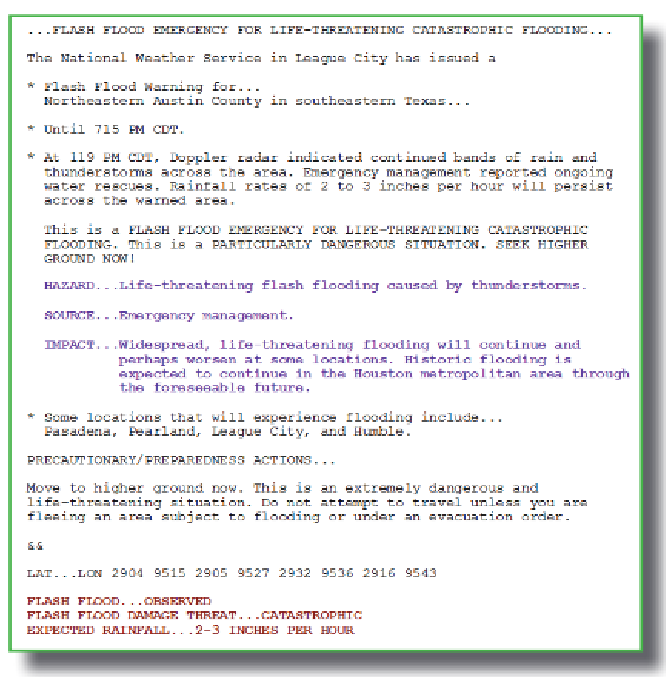
In an effort to simplify warning messaging and improve communication the National Weather Service has adopted a new methodology in how it issues Flash Flood Warnings (FFWs). These new ***IMPACT-BASED Flash Flood Warnings*** will contain a bulleted format of easily readable information describing the flash flood, the source of the information and a brief characterization of the event. It will also contain machine readable tags describing the flash flood damage threat, source information and causative event.

Only high-level flash flooding will trigger Wireless Emergency Alerts (WEAs)

With the new impact-based format, Wireless Emergency Alerts (WEAs, i.e. on your cell phone) will be limited to only flash flood warnings with damage threat tags of “Considerable” or “Catastrophic”. Third party vendors will be able will also be able to identify and extract the “emergency” language in the warnings.

Reasons for the change

The National Weather Service issues more than 4,000 flash flood warnings across our nation each year, with a range of impacts on lives and livelihoods. Public perception is that the NWS over-alerts FFWs, and the Federal Emergency Management Agency (FEMA) has noted a large number of complaints about overnight WEAs for FFWs with perceived little impact. With this change to impact-based FFWs, the NWS is aiming to improve the public response to Flash Flood Warnings by providing easily readable information and issuing WEA alerts only for flash flood events that require immediate life-saving action.



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...FLASH FLOOD EMERGENCY FOR LIFE-THREATENING CATASTROPHIC FLOODING...

The National Weather Service in League City has issued a

* Flash Flood Warning for...
  Northeastern Austin County in southeastern Texas...

* Until 715 PM CDT.

* At 119 PM CDT, Doppler radar indicated continued bands of rain and
  thunderstorms across the area. Emergency management reported ongoing
  water rescues. Rainfall rates of 2 to 3 inches per hour will persist
  across the warned area.

  This is a FLASH FLOOD EMERGENCY FOR LIFE-THREATENING CATASTROPHIC
  FLOODING. This is a PARTICULARLY DANGEROUS SITUATION. SEEK HIGHER
  GROUND NOW!

  HAZARD...Life-threatening flash flooding caused by thunderstorms.

  SOURCE...Emergency management.

  IMPACT...Widespread, life-threatening flooding will continue and
           perhaps worsen at some locations. Historic flooding is
           expected to continue in the Houston metropolitan area through
           the foreseeable future.

* Some locations that will experience flooding include...
  Pasadena, Pearland, League City, and Humble.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Move to higher ground now. This is an extremely dangerous and
life-threatening situation. Do not attempt to travel unless you are
fleeing an area subject to flooding or under an evacuation order.

&&

LAT...LON 2904 9515 2905 9527 2932 9536 2916 9543

FLASH FLOOD...OBSERVED
FLASH FLOOD DAMAGE THREAT...CATASTROPHIC
EXPECTED RAINFALL...2-3 INCHES PER HOUR
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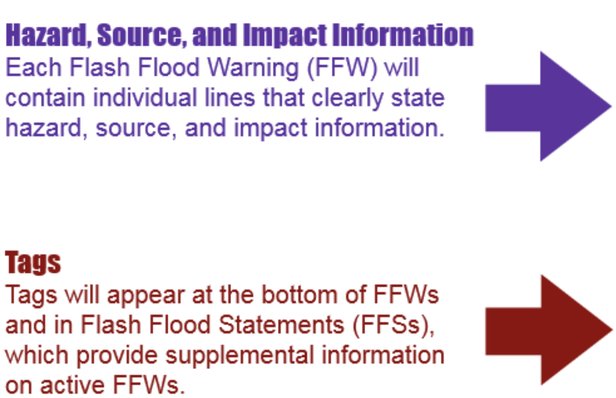


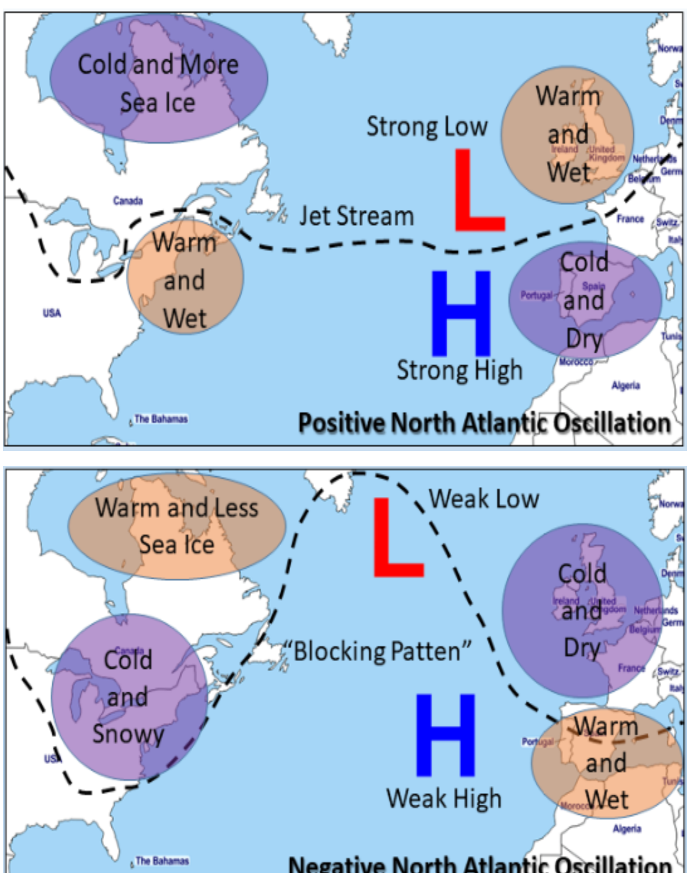
For more information, please see the NOAA/NWS press release highlighting these and other key points addressing this new change at the following link: https://www.weather.gov/media/wrn/FFW-IBW-factsheet.pdf.

A Look Into the Patterns That Have Led to a Warm Start to the Winter

- Matthew Clay

If you've been paying attention to the weather across the North Country this winter, you'll likely have noticed it has been quite mild with a lot of mixed precipitation events. A lot of you have reached out to us on social media and via the phone wondering why this has been the case. The quickest and easiest explanation is that the lack of a blocking pattern over the Atlantic has allowed for a strong jet stream to push all storm systems out to sea or west of the St. Lawrence River while keeping the arctic air locked up in the arctic. Without blocking over the Atlantic Ocean, it's difficult to get storms to curl up the east coast and give us our traditional Nor'easters. In addition, any arctic cold air intrusions that do occur end up pushing through our area within 36-48 hours as a strong jet streams quickly displaces the colder air. Looking at December and January, the first two months of meteorological winter, we recorded the 14th warmest period on record with our average temperature at 26.7 degrees.

One way forecasters can track weather patterns is through the use of climate anomalies related to one another at large distance known as teleconnections. These distances typically range around several thousand kilometers in order to understand the "big picture". For the northeastern US, there have been two teleconnections that have proven useful for forecasting climate patterns out past seven days and do a good job analyzing current conditions. These two teleconnections are known as the Arctic Oscillation and the North Atlantic Oscillation.



The North Atlantic Oscillation (NAO), which is the most commonly looked at teleconnection, looks at the anomalies over Greenland and over the North Atlantic between 35°N and 40°N. The positive phase of the NAO reflects below-normal heights and pressure across the high latitudes of the North Atlantic and above-normal heights and pressure over the central North Atlantic, the eastern United States and western Europe. The negative phase reflects an opposite pattern of height and pressure anomalies over these regions. Strong positive phases of the NAO tend to be associated with above-average temperatures in the eastern United States and across northern Europe and below-average temperatures in Greenland and oftentimes across southern Europe and the Middle East. They are also associated with above-average precipitation over northern Europe and

Figure 1. The positive and negative phases of the NAO. Positive phases trend warmer and wetter for New England while negative phases trend colder and near normal precipitation.

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Scandinavia in winter, and below-average precipitation over southern and central Europe. Opposite patterns of temperature and precipitation anomalies are typically observed during strong negative phases of the NAO.

The Arctic Oscillation (AO) is constructed by analyzing the 1000 mb height anomalies poleward of 20°N. This allows forecasters to discern atmospheric circulation over the mid-to-high latitudes of the Northern Hemisphere. The AO has an impact on the steering of storms and the mid-latitude jet streams. The positive phase of the AO is characterized by lower than average air pressure over the arctic paired with higher than average pressure over the northern Pacific and Atlantic Oceans. The jet stream is further north and storms can be shifted northward of usual tracks. The negative phase of the AO has higher than average air pressure over the arctic and lower than average pressure over the northern Pacific and Atlantic Oceans. The jet stream shifts toward the equator under these conditions which can conversely push storm systems further south. This allows cold air outbreaks (like the polar vortex) to impact the mid-latitudes. For New England in particular, higher frequencies of Nor'easters are seen in the negative phase of the AO.

This winter, there has been a strong correlation between the positive phases of the NAO and AO working together to produce above average temperatures for the month of January. In January alone, our average temperature ended up being 7.4° above normal with just a handful of days with below normal temperatures. Until we begin to see either the NAO or AO switch to their negative phase(s), we will continue to see more mild weather with only brief shots of cold arctic air. Additional research into these teleconnections have made the mid-range to long-range temperature forecast trends increasingly better.

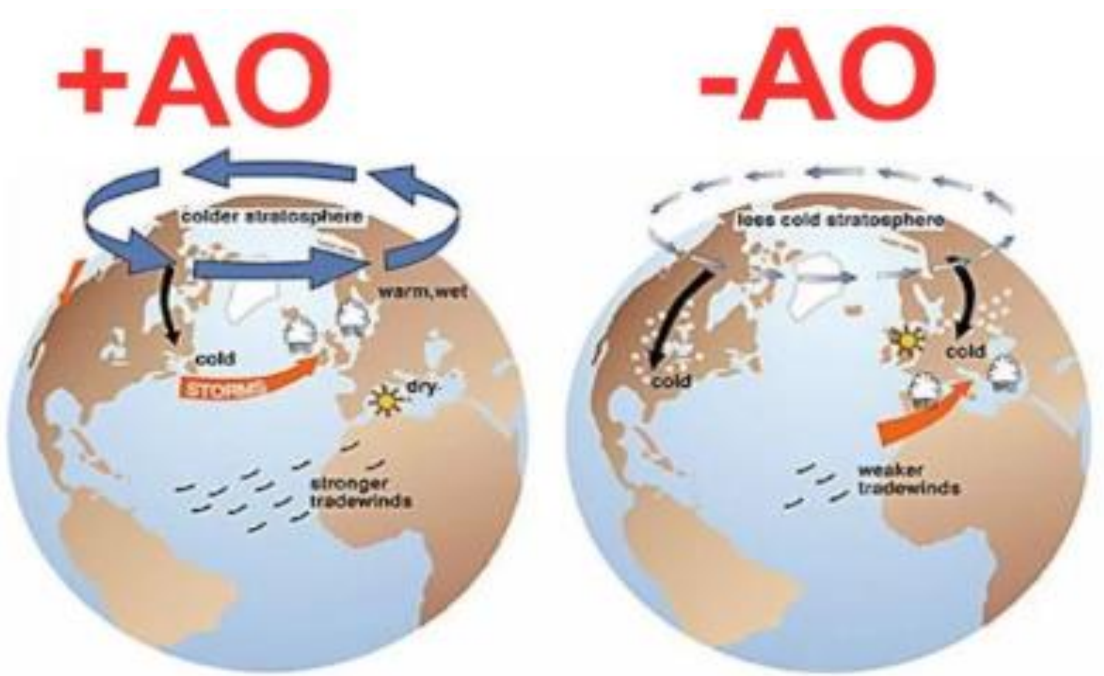

Figure 2. The positive and negative phases of the AO are shown here. Positive AO corresponds to warmer weather and storms being deflected away from the Northeast. Negative AO corresponds to more pronounced cold air outbreaks and favors the development of Nor'easters.

Happy 150th Birthday, NWS!

Celebrating Our Past, Defining Our Future

The year 2020 marks two monumental anniversaries within the weather, water, and climate community:

NOAA celebrates 50 years since its founding, as the National Weather Service celebrates 150 years saving lives, protecting property, and enhancing the nation's economy!

In observation of these milestones, NWS is recognizing the events, advances in science and technology, and most importantly, the stories of the people that shaped the agency over the last 150 years, making it what it is today.

> *"As we look back, we also look forward. Our heritage provides the context and inspiration for sustaining the NWS well into the future."*
>
> **– Louis W. Uccellini, Ph.D.,** Director, National Weather Service

Everything Has Changed But The Mission

The NWS of today and tomorrow was built on a 150-year-old foundation of science and service. Over time, advances in science, technology, and engineering have accelerated our understanding of the natural world, continually allowing us to better predict weather, water, and climate events.

As the needs of society have changed, so has the NWS. However, the fundamental mission has not: save lives, protect property, and enhance the nation's economy. From the very beginning, this has been the agency's fundamental focus.

Furthermore, while the NWS jobs of today are vastly changed from those 150 years ago and in-between, our staff's **dedication** to meet the mission continues to be one of our biggest strengths.

weather.gov/heritage

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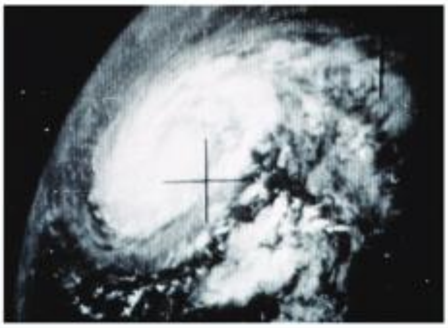

Drivers Of Change

Throughout its history, the NWS has continually evolved, driven by:

- **Advances** in science, technology, and engineering that have accelerated our understanding of the natural world, leading to better predictions of weather, water, and climate events.
- National and Global **Economic Transitions**, including the shift from agrarian to industrial economies, the growth of aviation, World Wars, internationalization, and the continual push-pull between serving public vs. commercial needs.
- Catalyzing **Events**, e.g., 1888 Blizzards, 1900 Galveston Hurricane, 1938 Long Island Express Hurricane, 1974 Super Outbreak of Tornadoes, and the 2011 Super Outbreak of Tornadoes in the Southeast that led to today's overarching goal to Build a Weather-Ready Nation and focus on providing Impact-based Decision Support Services.

> ***"Not only does the interest of commerce and navigation, but also that of humanity itself, demand that something should be done, if possible, to prevent the fearful loss of life and property on our great lakes."***
> **– Increase A. Lapham,** in a Memorial to Congress, December 1869

Recognizing Our Heritage, Now And For Future Generations

The NWS is recognizing the events, advances in science and technology, and the **people** that shaped the agency over the last 150 years, working to preserving this heritage for future generations. NWS is developing new tools and systems to better collect, catalog, and **share** the documents, research, and personal stories that comprise our agency's history.

This information is being compiled in a new website – **weather.gov/heritage** – that brings the story of the organization to life. The website is a public portal to the agency's rich history that also features links to and from other NOAA Heritage sites. New information is being added weekly with the goal of creating a true compendium of information about the agency's heritage and a jumping-off point for those who wish to dig deeper into NWS heritage topics. Feedback and contributions to the site are welcomed.

In addition, in the 150 days preceding its 150th Anniversary and throughout 2020, NWS is sharing a daily dose of historical information via its social media channels. These items showcase the science and technology, events, and people that made history and formed its 150-year-old foundation.

weather.gov/heritage

Changes at BTV – Congratulations Paul and Welcome Casey!

Congratulations Paul Sisson!

Paul Sisson has become the new Meteorologist in Charge (MIC) of the National Weather Service in Burlington. He has served as acting MIC since October 2018 and has been the Science and Operations Officer in Burlington since 1993. Paul began his NWS career as Meteorologist in Charge of the National Weather Service office in Providence, RI from 1989 to 1993. He was the primary staff meteorologist for US Army Test and Evaluation Command at Aberdeen Proving Ground, MD from 1982 to 1989. Paul earned a B.S. in Meteorology and B.S. in Mathematics from Lyndon State College in Lyndonville, VT and is originally from Rhode Island. Outside of the office, Paul enjoys the outdoors and can usually be found skiing the Green Mountains in winter and running or biking in summer.

Welcome Casey Thoenen!

We welcome Casey Thoenen, our newest Electronics Technician, to the NWS BTV family! Casey comes to us from the National Weather Service in Hawaii. Casey is looking forward to exploring the Burlington area and we are excited to welcome him.

The Four Seasons
VOLUME VI, ISSUE III

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