Table of Contents

Letter from the Editors

Welcome to the Winter 2021 edition of The Four Seasons, a quarterly newsletter issued by the National Weather Service in Burlington, VT. This winter has been off to a busy start with a damaging wind event in early December, multiple mixed precipitation events in mid to late December, and then several Arctic Outbreaks in January. We've included some write-ups on several of these events in this edition. The Arctic Outbreaks that have occurred this January provide favorable conditions for steam devils on Lake Champlain, and several of you have reported seeing them and we've loved seeing your pictures. We included an article in this edition that goes over the science behind these steam devils. We also present a quick review on how to measure and report ice for all of our storm spotters out there. Finally, but certainly not least, we bid a happy retirement to our Meteorologist-In-Charge Paul Sisson who has been with us for 28 years here at NWS Burlington. He will be sorely missed at work, but we know he's having a great time on the slopes! Thanks for reading, and stay warm!!!

The Christmas Day Freezing Rain Event

-Rebecca Duell

While we all hoped for a White Christmas, Christmas Day 2021 didn't exactly deliver the type of precipitation we may have hoped for. A messy mixed precipitation event unfolded that made for difficult travel throughout the holiday weekend. I personally will never forget seeing my family slide sideways in their car all the way down the hill on our street going home from Christmas Dinner! The setup leading up to the event was a favorable setup for freezing rain for our forecast area, with strong high pressure parked over Quebec just to our north that filtered cold air southward into our forecast counties. This set the stage for mixed precipitation by ensuring plenty of sub-freezing air was at the surface ahead of a warm front. As the warm front moved over on Christmas Day, a warm nose resulted that favored a period of freezing rain. Areas east of the Green Mountains stayed below freezing for much of the day on Christmas while temperatures around 850 mb rose to between 0 and 2 degrees C for portions of southern Vermont and northern New York.

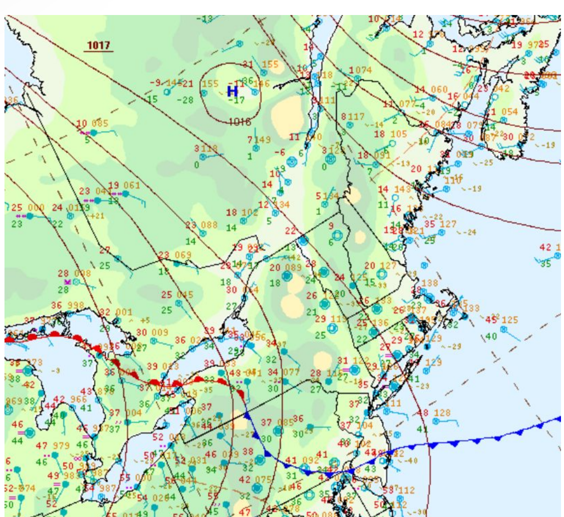
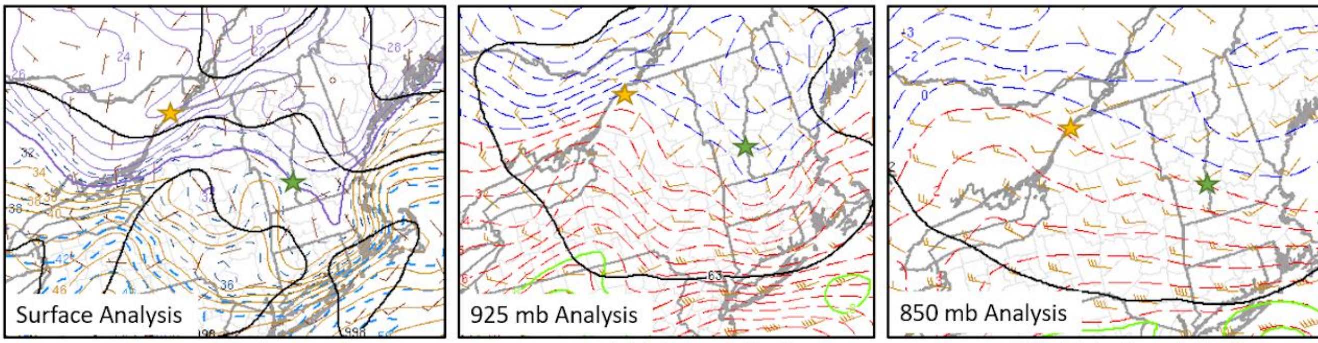


Figure 1. Weather Prediction Center (WPC) surface analysis from 0600 UTC 25 December 2021.

…Continued from Page 1

After the freezing rain ended, a period of freezing drizzle started during the evening on Christmas Day and lasted into the night. The freezing drizzle occurred throughout the area, and created slick conditions that resulted in dangerous travel conditions as many headed home from Christmas Day/Evening festivities.

SPC Mesoanalysis from 1900 UTC 25 December, 2021



Surface temp (thick line is 32F)
pmsl (black)
dewpoint (blue)

925 mb height (m msl, black)
925 mb temp (C, red (above 0), blue (below 0))
925 mb wind (kt)

850 mb height (m msl, black)
850 mb temp (C, red (above 0), blue (below 0))
850 mb wind (kt)

The above images show the SPC Mesoanalyses for the lower levels from 1900 UTC 25 December, 2021. Both Massena NY (yellow star on mesoanalyses) and Springfield VT (green star on mesoanalyses) reported freezing rain throughout the morning and into the early afternoon on December 25. Note the sub-freezing surface northeasterly flow in Massena directly below the near freezing southwesterly flow analyzed on the 925 and 850 mb analyses. Meanwhile, in eastern Vermont, surface sub-freezing air was slow to scour out east of the Green Mountains in Springfield VT, but warm air was moving in just above the surface. This setup favorable conditions for freezing rain that eventually transitioned to plain rain as the surface temperatures finally rose to above freezing.

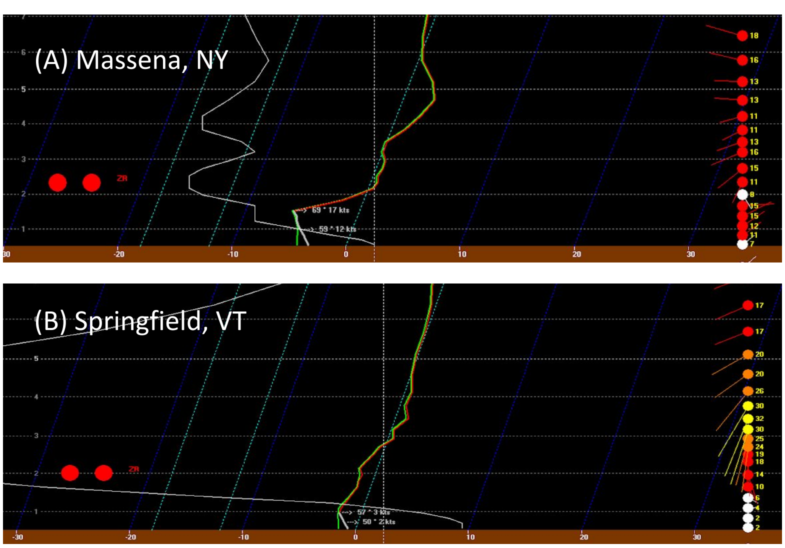


Figure 2 (above). NAM 3 km forecast soundings valid for (A) Massena, NY, 1700 UTC 25 December 2021, (B) Springfield, VT, 1600 UTC 25 December 2021.

The forecast soundings for Massena and Springfield (above) both supported a period of freezing rain. The warm nose was most pronounced in the Saint Lawrence Valley, as evident on the KMSS sounding, where low level warm air quickly noses up the Saint Lawrence Valley on southwesterly flow. Thermal profiles were more isothermal in eastern Vermont (see Springfield sounding), which made the forecast tricky. A one or two degree difference in temperatures in the low-levels could really change the outcome.

...Continued from Page 2

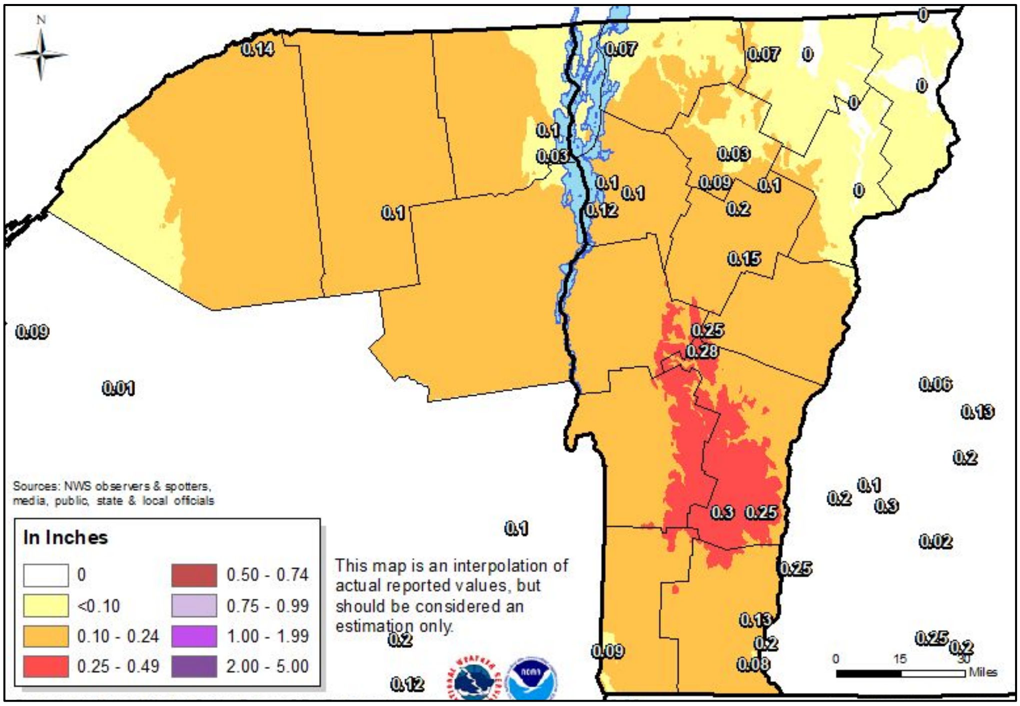


Figure 3: North Country Storm Total Ice Accumulation Ending December 26, 2021.

Once the freezing rain ended, the remainder of the day and into the night saw an extended period of freezing drizzle. The combination of the freezing rain earlier in the day with the freezing drizzle later into overnight made for hazardous travel conditions over the holiday. All said and done, by the morning of December 26th, storm total ice reports (Fig. 3) ranged from a light glaze over portions of northern Vermont, around a tenth of an inch in the Saint Lawrence Valley, northern Adirondacks, and central Vermont, and up to three tenths of an inch in southern Windsor County.

Review of Two Arctic Outbreaks and Bitterly Cold Wind Chills in January 2022

-Brooke Taber

A significant pattern change occurred in January 2022, as the deep trough which brought copious amounts of moisture and feet of snow to the western United States was replaced with a building ridge of high pressure, while a deep mid-upper level trough developed over the eastern United States. Prior to the trough development, the North Country experienced temperatures 2 to 6 degrees above normal temperatures for December 2021, with several mixed precipitation events, but overall below normal snowfall.

This pattern of a general mid-upper level trough across the eastern United States and ridge of high pressure across the Rocky Mountains has prevailed through most of January into early February, resulting in several more arctic outbreaks of below normal temperatures. As always we will be monitoring for coastal systems for heavy snowfall, as the large-scale pattern supports this potential.

…Continued from Page 3

During the month of January we observed several arctic outbreaks with dangerously cold wind chill values. Our first polar express of very cold air, with wind chill values of -15°F to -35°F, occurred on 11 January. The synoptic scale setup featured a weak clipper system racing off the New England Coast, while a 1034 mb high pressure over the northern Great Lakes built into the region. Figure 1 shows the surface analysis on 11 January 2022 at 10 PM EST. The circulation between these two systems produced breezy north winds and cold temperatures.

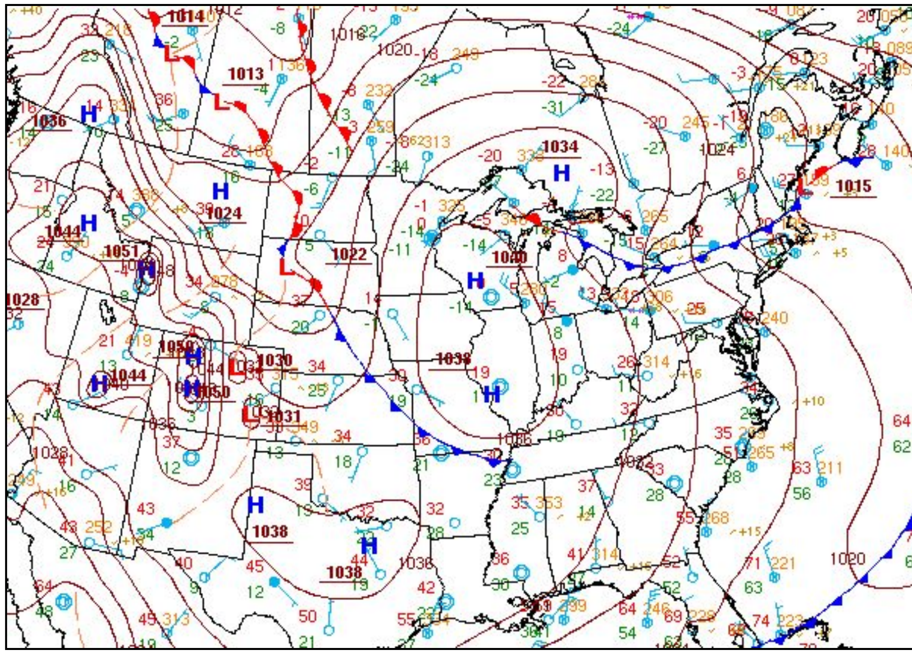
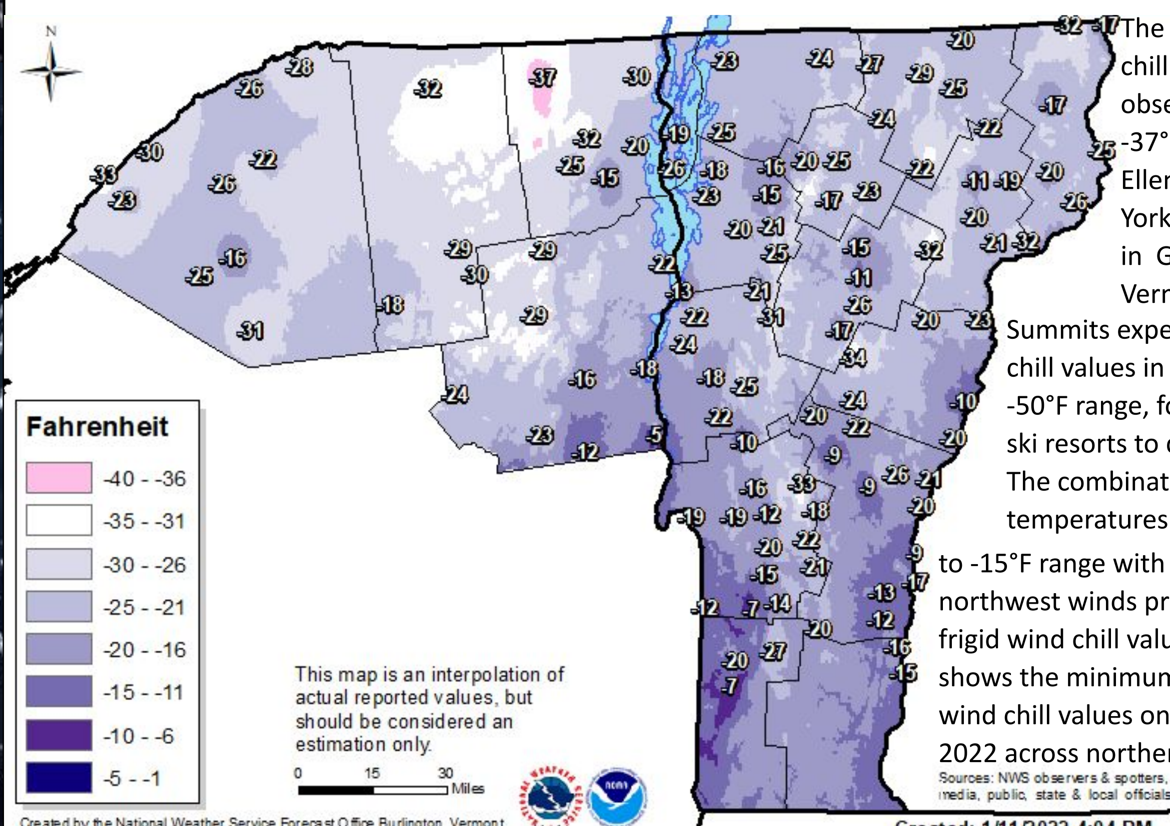


Figure 1: Surface analysis from Weather Prediction Center on 11 January 2022 at 10 PM EST.



The coldest wind chill values observed were -37°F in Ellenburg, New York, and -35 °F in Greensboro, Vermont. Summits experienced wind chill values in the -35°F to -50°F range, forcing many ski resorts to delay opening. The combination of temperatures in the -5°F to -15°F range with west to northwest winds produced these frigid wind chill values. Figure 2 shows the minimum observed wind chill values on 11 January 2022 across northern New York into Vermont.

Figure 2: Observed North Country minimum wind chills on 11 January 2022.

...Continued from Page 4

The next arctic blast with the combination of very gusty north winds 15 to 30 mph and temperatures plummeting between -5°F and -15°F occurred on 14-16 January 2022. The coldest wind chill values between -25°F and -40°F occurred early morning on January 16th. The weather map showed a deep surface cyclone (972 mb) over the western Atlantic Ocean, while strong 1043 mb arctic high pressure was building southeast from central Canada. See figure 3 for a surface analysis on 14 January 2022 at 7 PM EST. The pressure gradient between these two systems produced very gusty north winds and dangerously cold wind chills, as our air mass came directly from the arctic.

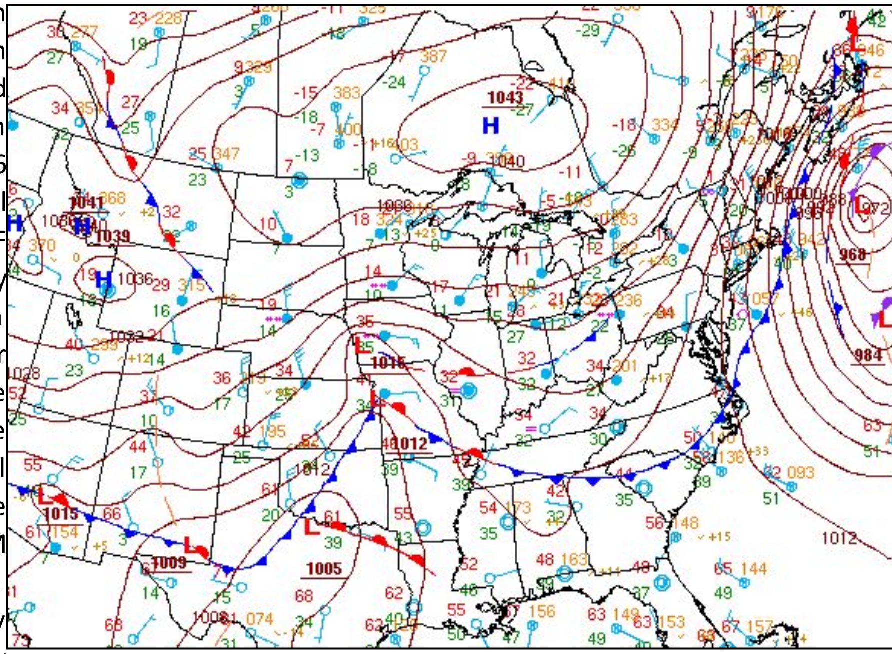


Figure 3: Surface analysis from the Weather Prediction Center on 14 January 2022 at 7 PM EST.

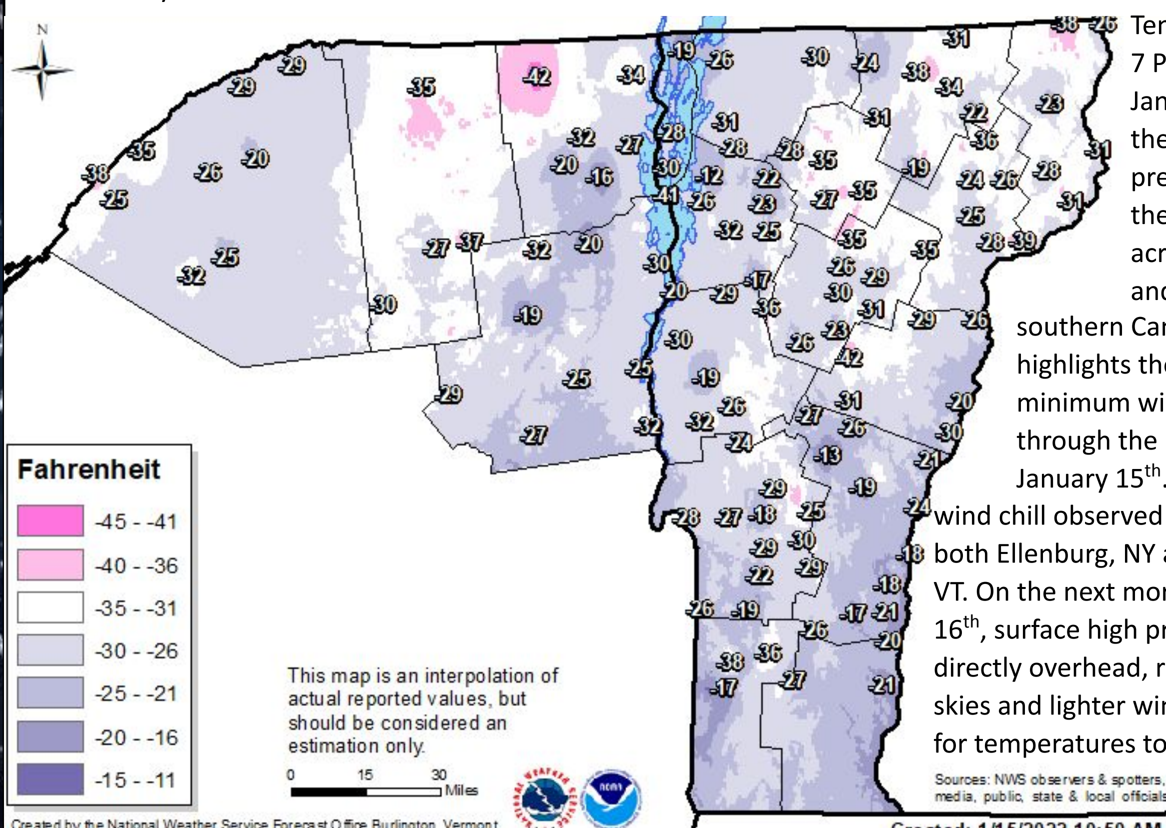


Figure 4: Observed North Country minimum wind chills on 15 January 2022.

Temperatures at 7 PM on 14 January under the arctic high pressure were in the -10°F to -20°F across central and southern Canada. Figure 4 highlights the observed minimum wind chill values through the morning of January 15th. The coldest wind chill observed was -42°F at both Ellenburg, NY and Brookfield, VT. On the next morning of January 16th, surface high pressure was directly overhead, resulting in clear skies and lighter winds, allowing for temperatures to drop between -10°F and -30°F for lows.

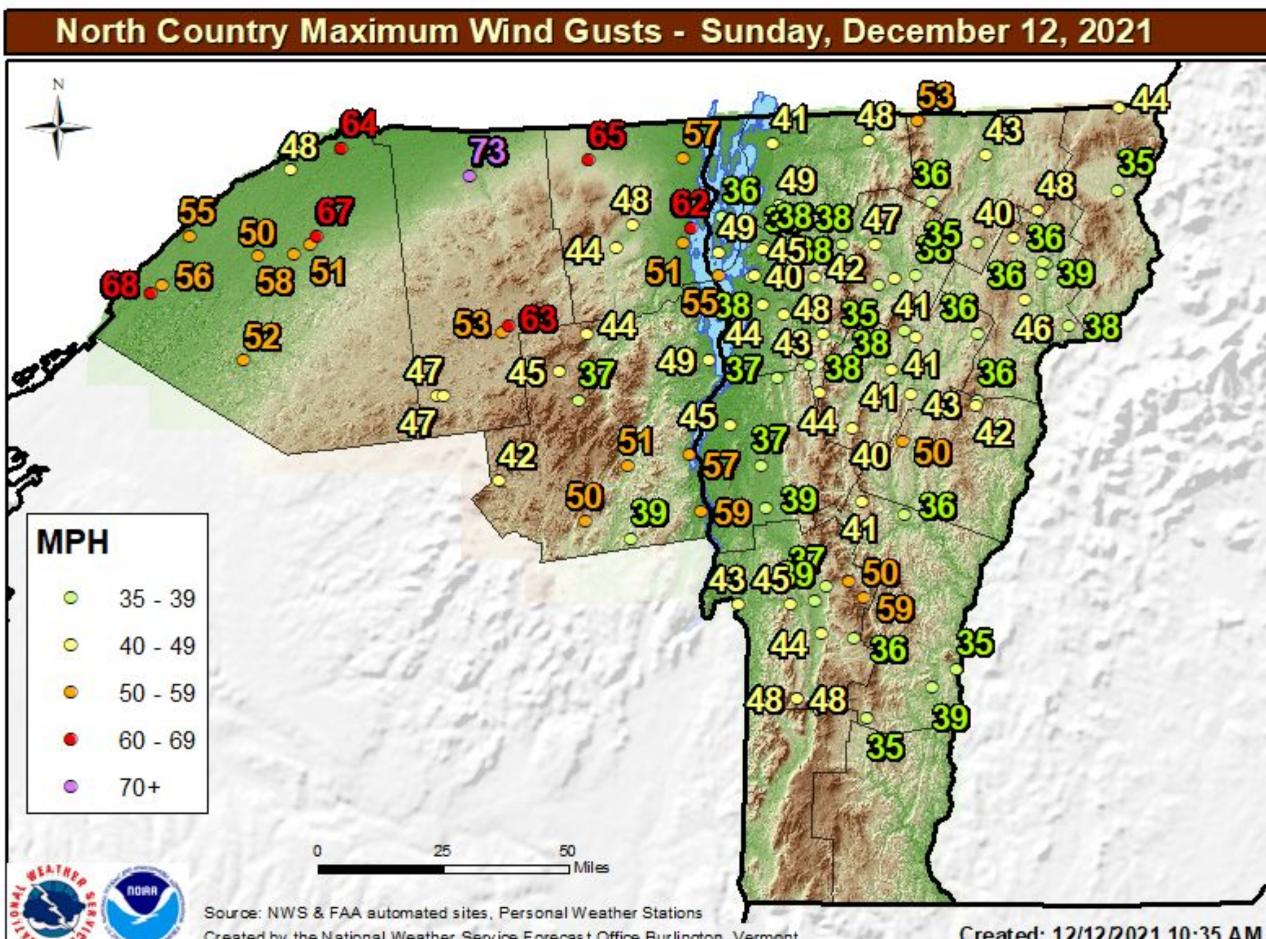
Early December Damaging Winds

-Nichole Hammond

On Saturday, December 11th, an anomalous low pressure system brought damaging wind gusts of 50-70 mph to the North Country. Strong winds battered portions of northern New York and Vermont late Saturday night through Sunday morning, resulting in thousands of power outages, and unfortunately, one fatality near Mooers, New York.

Windy weather is fairly common through the autumn months and into early winter. However, this event was unique because of the strength and depth of the low pressure system, combined with its track very near to the North Country. In fact, model guidance was showing the potential for uncommonly strong winds several days in advance.

At first, this system delivered a period of mixed precipitation early Saturday morning with the arrival of a warm front. But by mid-morning, strong wind gusts of 30-50 mph were beginning to develop ahead of the approaching cold front.This was merely a preview of what was to come later that night. As the cold front passed, a low-level jet of 60-80 knots moved overhead, roughly 3,000 feet above ground level. Cooling temperatures aloft provided deep-layer mixing, allowing these strong winds aloft to come crashing down to the surface. As a result, southwesterly wind gusts were observed up to 50-70 mph across much of northern New York and Vermont late Saturday night.



…Continued from Page 6

Areas across downslope regions of the Adirondacks, namely the northern slopes, experienced the strongest wind gusts in excess of 60 mph. For example, the highest reported wind gust was 73 mph at Malone, New York which occurred at 7:15 PM on Saturday, December 11th. Ultimately, many trees and powerlines were downed and thousands of power outages ensued. There were even a few instances of property damage, and sadly, one fatality occurred. When winds of this magnitude occur, it is important to take protective action such as seeking shelter in an interior room, staying away from trees and powerlines, and exercising caution when driving.

Steam Devils on Lake Champlain

-Matthew Clay

With several arctic cold fronts ushering in the coldest air since January of 2018, we thought it would be fun to talk about steam fog which is commonly referred to as sea smoke. In order to get this sea smoke to form, we need a very cold (arctic) air mass to move across a relatively warm body of water. In the case of the North Country, this warm body of water would be Lake Champlain where water temperatures through January typically range from 35° to 40° F. When you have this sharp division between a warm body of water and a very cold air mass overhead, we see a transfer of heat at the surface of the water which results in water vapor quickly condensing as it mixes with colder air. A good way to picture this is when you are out for a walk on a chilly morning and can see your breath as the warm air you exhale quickly condenses into a cloud that you can see.

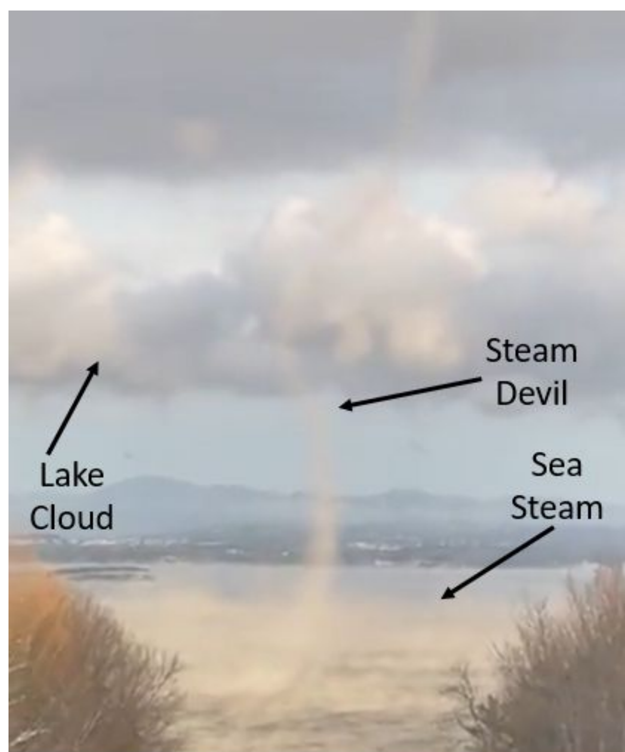
Steam fog itself is very interesting but did you know that under unique circumstances you can get another phenomenon called a steam devil? A steam devil forms when steep lapse rates (rapid cooling of temperatures through the atmosphere) coincide with steam fog. You need an unstable air mass in place at the surface and the best way forecasters can analyze the instability is by looking at lake induced CAPE. This is calculated similar to normal CAPE but uses the temperature of the lake surface rather than the surrounding land. Evaporation along the surface of the water causes moistening within the lowest levels of the atmosphere and can create significant instability. Occasionally, all parameters come together perfectly and you can get sea smoke to rise and rotate. These steam devils resemble a dust devil which many people have seen during warm summer days.

…Continued from Page 7

You may be wondering, if a steam devil can rise and have rotation, how this compares to a waterspout. Well, a waterspout has deeper convection associated with it and will be attached to a cloud base while steam devils will not be attached to any cloud base as they typically extend upwards to 10 meters into the air. Compare the photos on the next page to see the difference between the two phenomena.

Steam devils (left) on Lake Champlain on January 15th 2009. Waterspout (right) on Lake Champlain on January 15th 2009. Photos courtesy of Andy MacDougal.

Let's dive in and look at an event that occurred on January 3rd of this year. A video shared by Chief Meteorologist Tyler Jankoski at NBC5 from Sophie Clark shows some sea steam and an impressive steam devil of Willsboro Point on Lake Champlain. The water temperature on Lake Champlain was warm at the beginning of January following the warm December and preceding the very cold air seen during much of the month of January. Based on observations at the USGS gauge in Burlington, Vermont, the lake temperature was 39 degrees F on January 3rd. Using a combination of reanalysis data and interpolating between the Maniwaki, Quebec and Albany, NY, our temperature at 950 mb (around 1500 ft) was around 2 degrees F. That's a change of 37 degrees over just 1500 feet! We refer to these types of temperature changes (lapse rates) as super adiabatic. This sharp temperature change over such a short distance allowed for the lake steam on Lake Champlain to rise and form the impressive steam devil. Remember how we mentioned instability earlier? When you look at the model data for the day, we only had around 100 J/kg of CAPE over land but close to 500 J/kg of CAPE over the water. In general, 500 J/kg of CAPE is close to the bottom end of the amount of instability needed in order for steam devils and water spouts to form.



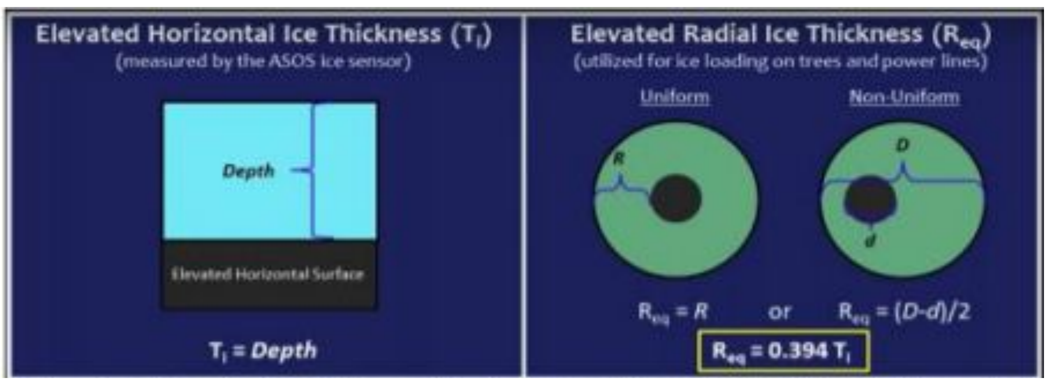
A screen capture from a video taken by Sophie Clarke on January 3rd, 2022 at Willsboro Point on Lake Champlain. In the photo, multiple phenomena along Lake Champlain can be seen including a lake cloud, sea steam, and a steam devil.

How to Measure and Report Ice

-Rebecca Duell

We love to get your ice reports during mixed precipitation events! Measuring ice thickness can be tricky because there are numerous ways to measure it. As we are still in the heart of winter, we thought now would be a good time to go over how to measure and report ice thickness to the NWS. ***First and foremost, only report ice thickness when it's safe to do so!*** Ice can be hard to measure because when trekking outside during or after an ice storm, surfaces can be slick. No ice measurement is worth your safety! Only go out to measure ice if you have the appropriate gear or you're able to do so from a treated surface that is not slippery.

Assuming you're in a safe place to do so, here's the basics of taking ice measurements. There are different methods of measuring ice accretion on surfaces, the two most common being a **Flat Ice Measurement** (or Elevated Horizontal Ice Thickness) and a **Radial Ice Measurement** (or elevated Radial Ice Thickness).



Flat Ice Thickness is a direct measurement of the depth of ice on top of a flat object above the surface. The official NWS ice accretion forecast is for flat ice thickness. An example of a flat ice thickness measurement is below.

Radial Ice Thickness is the measurement of ice thickness around a circular branch or wire. The image below shows how you would take this measurement. In this example, you would take the total diameter of ice, then subtract the branch diameter, then divide by 2.

Once you have your ice measurement, you can report it either by calling it into the office at (802) 862-2475 and pressing * to speak with a forecaster, or by submitting it online at www.weather.gov/btv/stormreport You can enter in the ice measurement in the Additional Details section and please remember to specify whether it is a flat ice thickness measurement or a radial ice thickness measurement. Thank you in advance for your reports, and remember to stay safe when getting measurements!

Congratulations Paul Sisson!

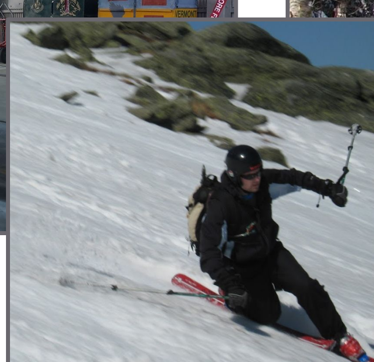
After more than 39 years of federal service and more than 28 at the National Weather Service Office in Burlington, VT, Paul Sisson, Meteorologist-in-Charge retired on January 1st, 2022.

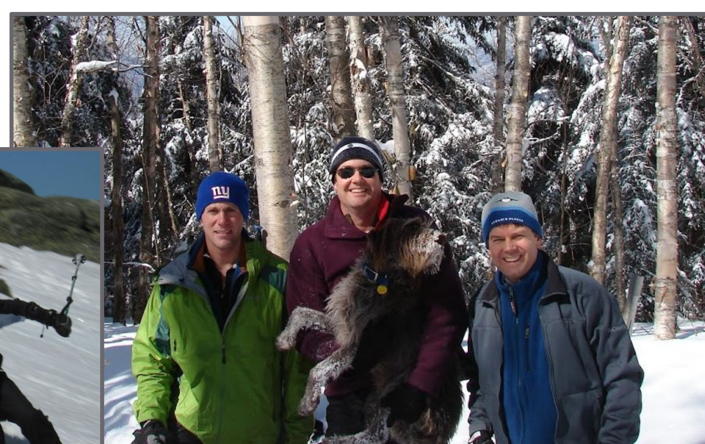
Paul grew up in East Greenwich, RI with a love of the outdoors instilled upon him by his parents. Paul developed a fascination with the weather stemming from experiencing hurricanes, giant hail storms, and the blizzard of 1978. Paul attended Lyndon State College to study meteorology (and almost as importantly, to ski at Burke Mountain). He earned a B.S. in Meteorology and B.S. in Mathematics in 1982.

Paul began his federal career in 1982 as a Operations Research Analyst at Aberdeen Proving Ground (APG) in Maryland working for the Army on the weather effects on the M1 tank. Paul's NWS career began in 1989 as MIC of the NWS Office in Providence, RI just a few miles from where he grew up. Even before he started he had to give media interviews as hurricane Hugo threatened the east coast. Paul worked closely with Rhode Island Emergency Management and provided decision support services (before it was called that) for significant weather events including a rare tornado, "The Perfect Storm", and Hurricane Bob.

In 1993, Paul moved to Burlington, VT as the first Science and Operations Officer (SOO) where he helped the office through many technological and operational changes. One of the highlights of his time as SOO position was working with various universities and McGill University studying heavy precipitation and extreme weather events. Paul concluded his NWS career just as he started -- as MIC. For Paul, it has always been about developing relationships with all the people he worked with and doing so as MIC was the most rewarding part of all.

Paul's expertise and dedication to the National Weather Service, its people and its mission, inspired many. His leadership skills - particularly his calm, lead-by-example approach - will be greatly missed. Paul plans to stay in Vermont, spending time with family and friends, traveling a bit, skiing, snowshoeing, mountain biking, running, and fishing.





ALL OF US AT NWS BURLINGTON WISH PAUL THE VERY BEST ON HIS WELL-DESERVED RETIREMENT! SEE YOU ON THE SLOPES, PAUL!

The Four Seasons

Volume VI, Issue III

Contributors:
Matthew Clay, Meteorologist
Rebecca Duell, Meteorologist
Nichole Hammond, Meteorologist
Brooke Taber, Lead Meteorologist

Editors:
Rebecca Duell, Meteorologist
Seth Kutikoff , Meteorologist
Marlon Verasamy, Observing Program Leader

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

National Weather Service Burlington, VT
Burlington International Airport
1200 Airport Drive
South Burlington, VT 05403
Phone: (802) 862 2475
www.weather.gov/btv
Email: btv.webmaster@noaa.gov

Follow us on Facebook and Twitter!
Check out our YouTube Channel!

US National Weather Service Burlington, VT

@NWSBurlington

ww.youtube.com/user/NWSBurlington