Spring 2023 Vol. 64 No. 1

WINDswept

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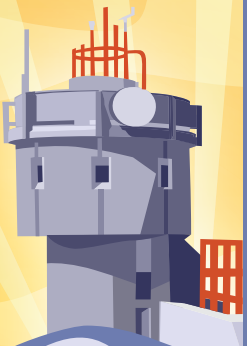

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Mount Washington Observatory™ is a private, nonprofit, member-supported institution with a mission to advance understanding of the natural systems that create Earth's weather and climate. It serves this mission by maintaining a weather station on the summit of Mount Washington, performing weather and climate research, conducting innovative science education programs, and interpreting the heritage of the Mount Washington region.

Membership in the Observatory is open to all. Members who donate at least $60/year or $5/month receive: Tours of our famous mountaintop weather station (generally mid-May through mid-October); a one-year subscription to *Windswept™: The Bulletin of the Mount Washington Observatory*; meteorology and climate research news from the summit of Mount Washington, straight to your inbox; free admission to *Extreme Mount Washington™* museum; advanced notice of special events; a 15% discount on all purchases in our museum and online shop; and free admission to more than 300 science centers through the ASTC Passport Program (restrictions apply, please see the ASTC website for details).

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Extreme Weather Makes Our Purpose Crystal Clear

Charlie Buterbaugh

BY **CHARLIE BUTERBAUGH**, EDITOR

Extreme weather events have a way of distilling the Observatory's purpose into its purest form.

During the span of two days in early February, when our summit team worked continuously through the worst-of-the-worst weather known to descend on Mount Washington, the meaning behind our mission was made unforgettably clear.

This is a place dedicated to the long-term study of our atmosphere at a location that is often incredibly inhospitable. Consistency rules. Every hourly observation matters. Continuous data are vital to our research of extreme weather and the bigger picture of Earth's climate.

For students of meteorology, the summit of Mount Washington is about as close as one can get to the research subject. Observers forecast the weather, record it real-time, and study it in hindsight while living among the clouds, perched on the 50-yard line of the atmosphere's playing field.

For those working on Feb. 3-4, as the summit temperature stayed below -45 °F for 13 straight hours and wind chill values approached -110 °F, this was a coveted opportunity. It's considered good luck for such a great storm to occur during your shift.

This is the kind of experience many of our observers seek when they apply for a role at the summit, even if it means working inconceivably hard to ensure continuous observations during "once in a generation cold wind chills," words the National Weather Service in Gray, ME used to describe the early February Arctic blast.

As Observer Karl Philippoff writes in his weather story recounting the Feb. 3-4 event, "Experiencing weather at its worst has always fascinated me, and was certainly part of what made me want to work on Mount Washington." See p. 15.

Many who know the Observatory's history wondered if the station's record low temperature of -47 °F would be broken. Some of us surely felt a heightened connection with our organization's past, thinking of the bond that extreme weather experiences can solidify over the chasm of time between present and past observers. I certainly felt this.

It was in January 1934 when an air temperature as low as -47 °F was last recorded by observers working on

Continued on page 6

Building On Our Collective Strengths

Drew Bush

BY **DREW BUSH,**
EXECUTIVE DIRECTOR

As I write these words, we are still in the depths of January's wintertime snow. We have just had one snow day for local schools in the Mount Washington Valley region of New Hampshire, with two more expected this coming week.

Despite the dramatic storms of this winter, researchers with whom we work at the University of New Hampshire, Appalachian Mountain Club, Hubbard Brook Ecosystem Study, and beyond will be continuing efforts to understand how this winter may have differed from those back when Mount Washington Observatory's data record began in 1932.

You may have noticed more times in the winter when rain falls on snow, sometimes only to be followed by a dramatic drop to freezing temperatures. As you can read about in this issue, the idea of "winter weather whiplash" may soon shape how crisis managers think about winters, transportation, and human safety across the United States and Canada. Here in the early days of the New Year, this represents only one project we have begun discussing how to help facilitate.

Observatory staff, trustees, and volunteers have been busy discussing how to strengthen all of our partnerships to sustain our research on topics like winter weather for the next 90 years. By the time you read these words, we hope you will be seeing changes in how we work with our Mount Washington summit partners and the Mount Washington Commission to better care for this internationally unique place.

Our corporate sponsorship campaign will also have already launched (only a few short days from now) with a renewed focus on aligning our authentic brand with sponsors who will sustain our work. We will also be rethinking our approach to major donations and planned giving in 2023, so that we can identify real needs in our community that we, as an organization, can help to address.

Our work does not end there. We are talking to researchers around the world to develop new research projects and products to test at our home atop the Northeast's highest peak. We have also been participating in grant writing to support the development of the next generation of automated weather station technology for use in places such as Mount Everest as well as at home, right here, in our own Mount Washington Regional Mesonet. Here too we are working with partners at other regional mesonets through the Northeast Moun-

tain Observatory's network to expand the value of this work.

Our educational programs will be refocused to emphasize how we can support teaching and learning in weather and climate science for schools in our region and, as we gain steam, beyond. Already, we are having discussions with funders and partners on how to make Mount Washington's summit and our weather station more accessible to middle school students.

After you have read these words, we expect to launch a brand new website that makes our work more easily accessible and user-friendly. Soon thereafter, as we do each year, we will be helping to open the Mount Washington summit to children, adults, families, and others from all over the world for another season up among the clouds. We hope you will join us for a tour of our weather station or to visit our Extreme Mount Washington Museum, in New Hampshire's Mount Washington State Park.

I have no doubt 2023 will be a busy and productive year for the Observatory. Now, while it is still getting dark each day quite early, I hope we can take time to reflect. We have accomplished so much together in 2022. We owe a great debt of thanks to all of you.

Our supporters, donors, and partners have helped us get this far. Many of you have been on this journey for far longer than me — I only joined this wonderful organization this past year. Already, however, I feel fully immersed in its amazing history, layered relationships, and years of sound scientific practice.

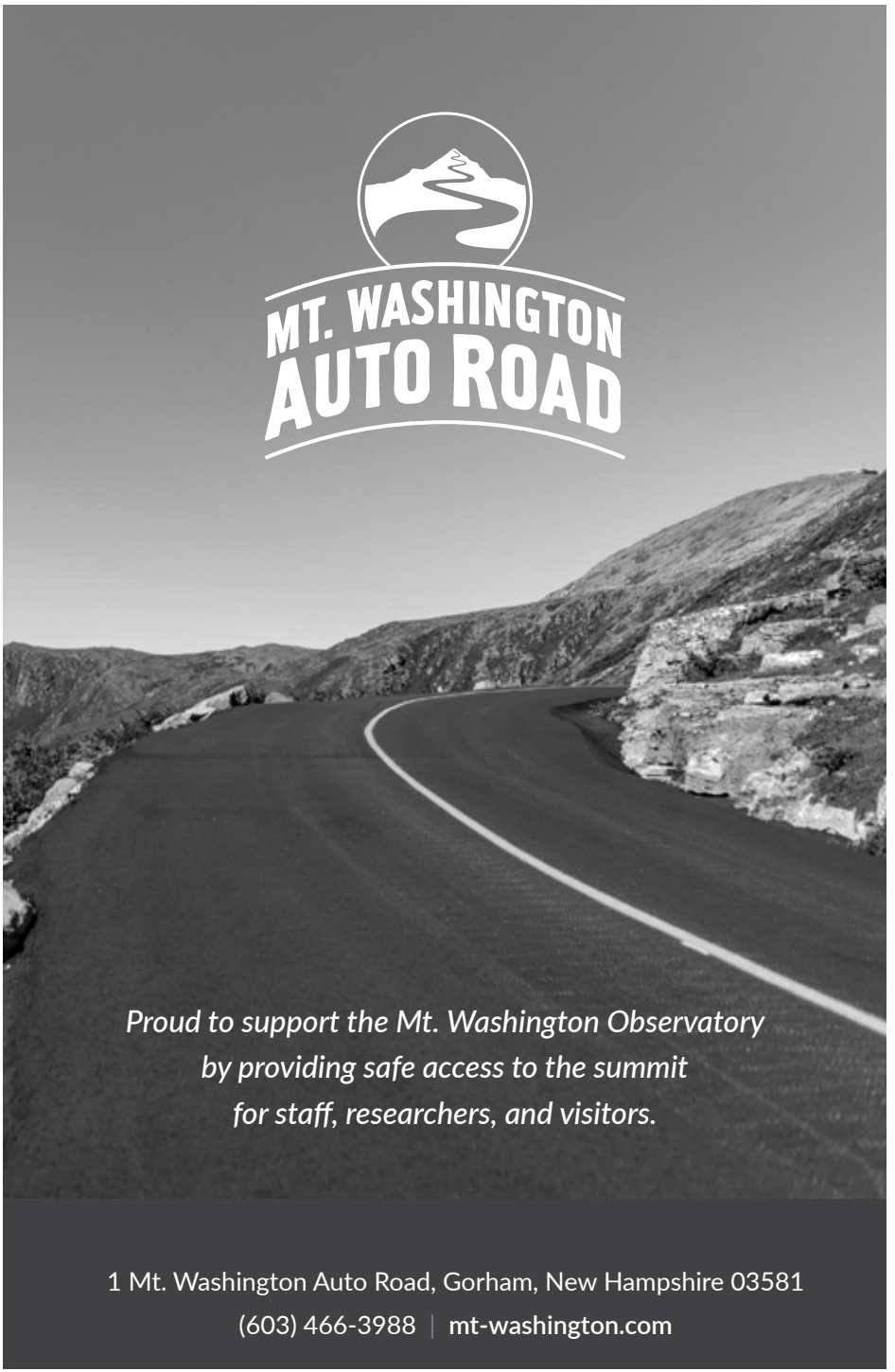
Help me as we embark on this journey together. We are striving to better serve the audiences that rely upon us for their safety while recreating in this region. We are also working to create educational programs to help students, adults, and families learn about the processes that shape Earth's climate and weather. Our research has already helped lead to new technologies and understandings of our natural world, with yet more topics under discussion.

Get involved with our work. If you are able, consider supporting all that we have planned. All that we are able to offer as an organization results directly from donor contributions like those that helped to mark the beginning of our New Year. Thank you for helping us to reach our 2022 Year-End Campaign goal.

In My View continued from page 4

Mount Washington. And while this record was not broken on Feb. 3-4, it was matched. Doing so took 89 years and a tremendous amount of grit as observers Karl, Alexis George, and Francis Tarasiewicz worked around the clock to take continuous measurements.

Extreme weather events help to remind us of our purpose, and it is our purpose that carries our summit team through the physical challenges of extreme weather.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Record Low Matched During February Arctic Front

During the powerful Arctic front that moved through New England in early February, Mount Washington Observatory measured the coldest air experienced at the summit weather station since 1934.

Through the night of Feb. 3-4, weather observers suited up frequently to protect themselves against unprecedented wind chill values while taking air temperature measurements with the sling psychrometer. They knew the storm, unique even for Mount Washington's standards, carried the power to push the temperature below the Observatory's all-time record low of -47 °F.

Factors causing the mountain's notoriety as the Home of the World's Worst Weather were in full effect. Storm tracts merged, topography intensified the system, and cold air normally contained in the upper atmosphere descended, situating the summit in the Polar Vortex.

The coldest air temperature of the event, -46.7 °F, was recorded around 4:00 a.m. on Feb. 4, matching the Observatory's all-time record low temperature that was measured 89 years ago on Jan. 28, 1934. In precise units (not rounded), the new measurement eclipsed the -46.5 °F air temperature measured in 1934.

Taking a look back at the weather system's setup, near the end of January – the warmest January in the Observatory's 90-year climate dataset – weather models indicating the potential for severely cold temperatures caught the attention of Observatory staff. Despite a warmer-than-average January, a drastic swing came into clear view as the Feb. 1 Higher Summits Forecast issued a wind chill warning, predicting air temperatures approaching -40 °F, wind gusts in the triple digits, and wind chills plummeting to -100 °F.

As the strengthening area of low pressure passed to the north of the region late on Thursday, Feb. 2, temperatures began to fall from 5 °F into the -20s by early Friday. Strong cold air advection continued behind the front through Friday night and early Saturday, pushing air temperatures into the -30s and eventually -40s. During this time, as the core of the cold air mass arrived at Mount Washington, a lobe of the Polar Vortex rotated over southeastern Canada and northern New England.

Observatory staff ensured continuous weather observations throughout the storm. Knowing there was a chance of surpassing the weather station's record low temperature, observers increased their measurements to 15-minute intervals during the height of the storm, even as wind chills reached -109 °F.

The -109 °F wind chill reported on the Observatory's Current Summit Conditions page – on at least three occasions during the storm – is arguably the lowest wind chill ever reported in U.S. history.

It should be noted that wind chill, while a helpful frost bite risk factor that allows people to know how cold temperatures will feel on exposed skin, is a calculated value based on temperature, wind speed, and humidity, representing the amount of energy lost due to these factors. Unlike air temperature, wind chill is not a measurable or recordable meteorological parameter.

The Feb. 3-4 storm made headlines across the world as the Observatory measured temperatures below -45 °F for 13 straight hours, sustained wind speeds above 82 mph for 28 straight hours, and a top wind gust of 127 mph. Observatory staff continued a legacy of outreach and education as media outlets called to report on the powerful arctic front and learn about the weather observers who continued taking measurements in unprecedented wind chills.

NEWS

Andrea Masters joins Observatory as Director of Development

Andrea Masters has joined the Observatory as the new Director of Development, following more than 20 years as the Pope Memorial Library executive director.

One of the highlights of her career at the library, other than daily interactions with patrons, was overseeing the library's building expansion and renovation in 2019-20 from its conceptual stage through completion.

Masters' background is in healthcare; she has an M.D. and practiced medicine for eight years as a board-certified physician (internal medicine) at a teaching hospital in Hanau, Germany. Her scientific research lead to a Ph.D. in clinical pharmacology.

Masters went on a sabbatical in 1999 when she met her now wife on Cape Cod who prompted her to move to the Mount Washington Valley with her and start a new career.

Andrea Masters

Her hobbies include reading, photography, current affairs, spending time with her two dogs, and lots of outdoor activities: running, biking (MTB & road), triathlons, hiking, skiing (downhill, XC, BC), and much more. In her youth, she played volleyball and was offered to play in the second-highest league in Germany.

Masters succeeds Stephanie Fitzgerald, who joined the Observatory in 2016 and concluded her successful tenure in February to continue raising her family.

Meow from the Meowtin

TRANSLATED BY **AMY MULLER**

It's been purrrfect up here! You are not ready for the tails I am about to share. No cat napping, I worked too hard during my nap time.

During one of my visits to the weather room, to my su-purr-ise, I was already up there. "Paw-don me," I sad, "who are you?" No reply from this furry guy with the uncatty resemblance.

I looked at the observer and was like, "Are you kitten me? Get him out of here." When they did not, I took matters into my own paws.

Nimbus wasn't quite sure what to make of his new doppelgänger.

As the weather got colder this winter, my moussing duties picked up, as the little fugitives were all trying to find a place to get warm (in the humans' space of course). When you love your work, you never work a day in your life.

One day, I heard whiskers that I was going on a car ride down to the valley. I was unsure and feline nervous. Paws, I heard I was going to the vet, and the vet is not my idea of a fun trip. But my day off the meowtain was purrty good. I was given a clean bill of health and enjoyed the ride.

There was a big storm as February began. All of my fans were concerned about me. They hoped the Chief Mouser wouldn't get blown off the meowtin or encatsulated in rime. I was OK, with many warm cushions to snuggle. My adventures to the weather room are not at the top of my list of things to do. But when I do go visit, I steal warm human chairs. Litter-aly the best seat in this place.

It is pawsome to see their faces when they come in from an observation to find me in their chair (I open my eyes just long enough to see). Yawwnn, my apaw-logies.

All of this writing has made me tired. I have official business of catnapping to attend to, so meow for now!

Winter Whiplash: A Closer Look at Rain on Snow Events

BY **FRANCIS TARASIEWICZ**

The culture of New England depends to a large degree on its cold and snowy winters. Everything from skiing to ice fishing to fruit picking in the summertime depends on an extended period of cold and snowy conditions.

What many know as a "good old-fashioned New England winter" is becoming less and less reliable. Up on Mount Washington, 90 years of hourly weather observations are beginning to paint a changing picture for winter. On New England's highest peak, the mid-winter thaw, which used to be a relatively rare occasion, is increasingly taking a toll on the snowpack, winter sports, and the very identity of New England.

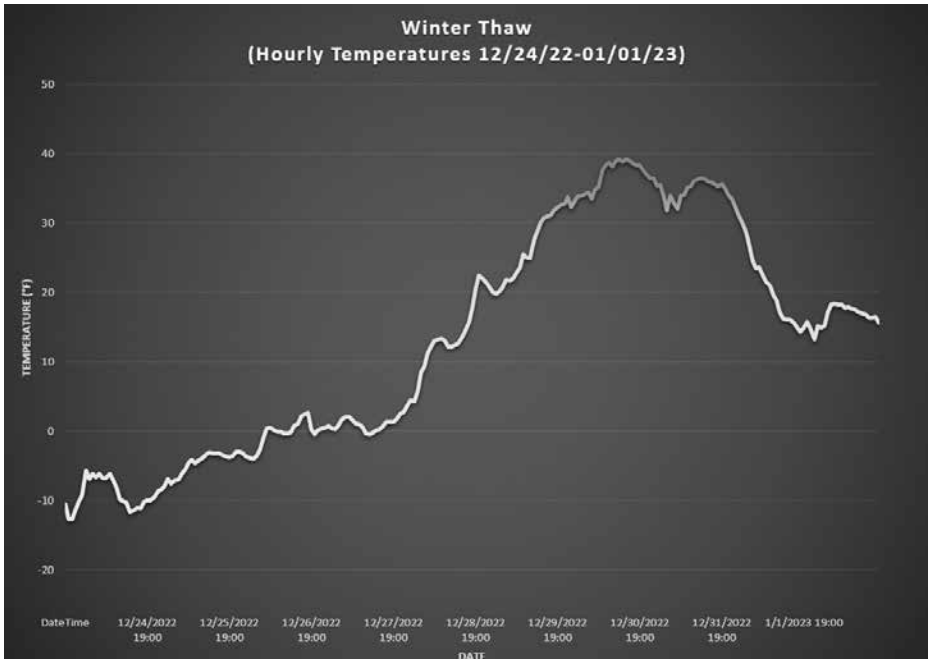
Recent studies conducted on Mount Washington have shown that winter thaw events are increasing by every metric. They are becoming longer, more frequent, and creating larger holes in our once pristine winters.

To understand mid-winter thaws, it is necessary to answer a few questions. First, what is a winter thaw event? What kinds of weather patterns drive these snow destroyers? And perhaps most importantly, how are they changing over time?

We do not need to look very far back in our dataset to answer the first question. In fact, shortly after the country experienced a December chill in late 2022 that broke records for many, the higher summits and the eastern seaboard experienced a dramatic warming event. By taking a closer look at this, the hope is to give a better sense of what goes into creating a mid-winter thaw.

To set the stage, we need to first look at some of the features that combined to create this event. Winter thaw events in the Northeast are typically the result of being in the right (or wrong) place at the right time. In this case, the place to be is a warm sector which is quite simply the "warm" part of a storm. Storms are our planet's attempt at distributing heat evenly at each latitude. The warm sector is where warmer air travels up from the equator towards the poles. To find yourself in a storm's warm sector, you'll need to be generally south and east of the storm's center where southerly winds push warmer air northward.

During this last season's event, a storm system passed hundreds of miles to the northwest of the summit. At the same time, an area of high pressure developed off of the Mid-Atlantic coastline. The high pressure was just as, if not more, important than the storm to the west. Clockwise flow of air around the high pressure transported warmer air from



Summit temperatures between Dec. 24 and Jan. 3.

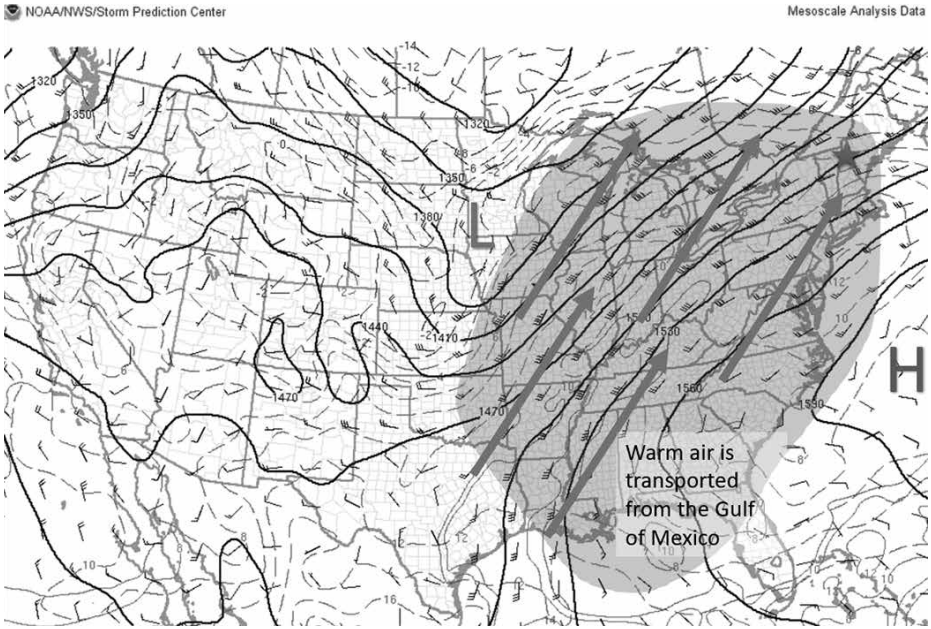
the Atlantic and Gulf of Mexico into New England.

If the warm sector of the storm acted like a road for warm air to advance northward, the offshore high pressure acted more like a super highway. In short, the warm spell had its roots in the tropics.

Now that we have the larger picture of this event in mind, let's take a look at how things played out on the summit. To tell the full story, the clock is set back to Dec. 24. The summit was just recovering from a powerful storm system that brought seven inches of snow, a deluge of rain, and wind gusts that reached 150 mph. Behind it, the Arctic floodgates were unleashed with temperatures falling to the negative teens on the summit. It took nearly two days for summit temperatures to even approach zero. When they finally surpassed zero, they didn't do so by much, at least initially.

Temperatures hovered within a few degrees of zero for another day, then began their climb in earnest later on Dec. 27. Temperatures soared above 20 degrees around shift change and continued to warm through the overnight. The combined influence of the low pressure to the west and high pressure to the southeast pushed temperatures to their highest level early on Dec. 30. While not quite a record (42 °F), the mercury topped out at 40 °F.

The impressive part of this mid-winter warmth was its persistence. Temperatures remained well above freezing for over a day, allowing for snow to quickly melt. The snow depth on the summit decreased from 19



This image illustrates the "why" behind the late-December 2022 winter whiplash event, with the storm to the west and the high pressure to the southeast. 850mb temperature (dashed lines C) heights (thick contours m) and wind (wind barbs kts) on January 1st.

inches on Dec. 24 to around nine inches on Jan. 1.

Occasional winter warmth is nothing new in New England, but events like these are microcosms of a much warmer, broader picture. To further illuminate trends in rain-on-snow events on Mount Washington, Dr. Eric Kelsey of Plymouth State University has dissected wintertime thaw events since 1932. The findings were striking and somewhat frightening.

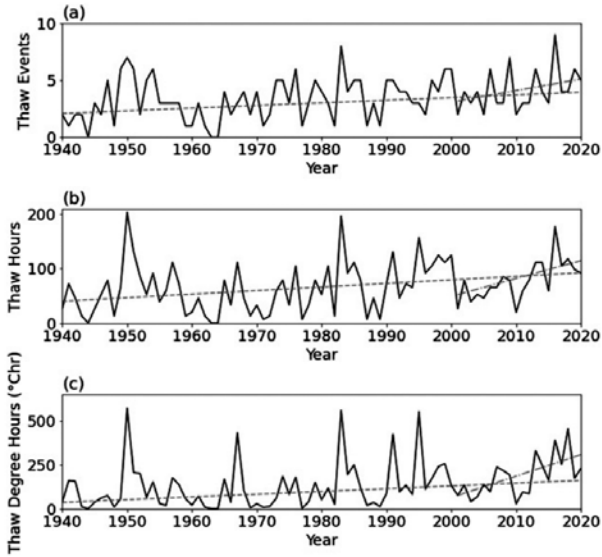
Kelsey and his team found that wintertime thaw events are growing at a statistically significant rate on Mount Washington's summit. More significantly, the number of thaw events are increasing at an exponential rate, especially since the year 2000. Not only have the number of specific events increased, but so have the hours of winter spent above 32 °F.

The average rate of increase between 1939 and 2000 was 17.70 hours more above freezing per decade. The study found that after 2000, that number has soared to over 82 hours per decade. This means that we are adding roughly three days of above-freezing air to our winters on Mount Washington each decade. The results of this warming are beginning to be felt in the overall health of the summit snowpack.

Kelsey's work indicated that there has been a loss of 1.2 snow-covered days per decade. While this hasn't statistically changed the end date of continuous snowpack, the study suggests this metric is likely to shift earlier. This means earlier snowless days on the

summit, which will have ripple effects beyond wintertime.

The impacts of a less reliable snowpack are far-reaching and impact not only summit life, but the lives of those in the valleys and the surrounding region as a whole. Wintertime recreation in the White Mountains has experienced some of the first and most dramatic impacts from warming winters. Not only is the ski and ride season shortening, but the snowpack that is still intact is becoming increasingly dangerous.



From Kelsey and Cinquino's 2020 long-term study of thaw trends, annual number of thaw events (top), cumulative thaw hours (middle), and thaw degree hours (bottom) are shown.

With increased freeze-thaw cycles, and an uptick in sleet/freezing rain events, ice layers are beginning to find their way into previously untouched snow. These layers act as surfaces for new snow to freely slide around, which increases the risk of avalanches triggered by people exploring the backcountry.

Below tree line, increased melt incidences and intensity have translated into more frequent and impactful flooding. Significant impacts from streams and rivers are no longer confined to the spring. In fact, recent years have begun to feature a different cause of flooding: ice jams, which result from rivers freezing (as they typically do) and then thawing with periods of rapid and intense warming. Melt and rainwater rushes off of the surrounding snowpack, breaking up any ice. The ice then floats downstream and can get caught up, thereby blocking the flow of water, causing rapid rises in water levels. When the ice jam finally breaks loose, continued flooding can make its way downstream. Ice jams are particularly dangerous due to their quick and unpredictable nature.

Now more than ever, observations are helping to lead the way in understanding our changing planet. Mount Washington Observatory continues to provide insights into how climate change is impacting alpine environments, not just in New England, but around the world. This scientific work will continue to prove necessary in understanding how snow and weather are evolving, and how public policy will need to respond in support of significant economic drivers like outdoor recreation.

Brutal cold on Mount Washington: A Weather Story

BY **KARL PHILIPPOFF**

As our newest weather observer, in my brief time on the summit I have already experienced a slew of firsts, including using a mallet as part of a job (to de-ice the wind instruments), being encased in rime ice while de-icing said instruments, experiencing wind gusts over 100mph, commuting to work via snow tractor, and being an active part in one of the biggest weather stories in America on Feb. 3 and 4.

I have been fascinated with the weather since I was young, with some of my formative weather experiences including waking up the morning after the Blizzard of '96 with snow drifting nearly over my dad's car (which he had parked out near the edge of the driveway in the hopes of getting to work that day. He did not.) and watching then-tropical storm Floyd completely transform the lake in which I enjoyed swimming into a wave pool and flow over the dam, creating a raging torrent of water.

Experiencing weather at its worst has always fascinated me, and was certainly part of what made me want to work on Mount Washington.

My other principal passion is being in the mountains. I love their uniqueness and the awe and wonder the peaks inspire. I love the physical effort required to experience them and the sense of accomplishment you feel afterwards, a 'mountain high' if you will. They require you to push yourself, but the views at the end make it all worth it (usually).

Let's take a closer look at what transpired on what was a truly memorable and historic extreme week at the summit for weather observers Alexis George, Francis Tarasiewicz, and myself, our two summit volunteers Pat Luddy and Steve Moore, and Mount Washington State Park employees Christopher Lavigne and Nate Camille.

Francis and I were looking at weather models in late January, and it was apparent we might get some very cold weather on the summit during the first weekend of February. This was after January had been snowy but the warmest on record for the summit, with only three days below normal, and a monthly average temperature of 10.3 °F above normal.

By the time of our shift change meeting on Wednesday, Feb. 1, the predicted cold was well within the time frame that model forecasts are fairly accurate, and we were predicting winds over hurricane-force to coincide with potentially record-breaking cold temperatures, producing nearly unfathomably cold wind chills.

Karl Philippoff holds the mallet used for de-icing wind instruments.

This was also when I was told that it was likely that I would need to assist our night observer, Alexis, during the coldest time period Friday night, possibly into early Saturday morning, in anticipation of breaking not only the all-time Mount Washington Observatory station record low of -47 °F, set on January 29, 1934, but possibly surpassing the coldest temperature ever observed in New Hampshire in modern history, the -50 °F observed on January 22, 1885 by the Army Signal Corps on Mount Washington. (And yes, our station record is not -50 °F because of the nuances involved in instrument siting and the lack of continuity between when the Signal Corps stopped recording weather information in the 1890s and when Mount Washington Observatory was established in 1932.)

I knew already that if we were to get near that cold, I would probably not be sleeping through Friday night anyway, but would be refreshing the current conditions page on my phone through the night. All-time records at stations which have existed for 90+ years are hard to come by, and I was ready for it.

There was also the possibility that a tropopause fold could move directly over Mount Washington. This was important, because the tropopause is an inversion above which temperatures are typically steady or increase with altitude. Such layers are what meteorologists term "stable," meaning they resist vertical motions and can act as a lid over the atmosphere below. Having this layer come down to summit level would have the ability to accelerate the anticipated hurricane-force winds even further, similar to how when you put your thumb on a garden hose, the portion of the water stream which is not blocked by your thumb is accelerated substantially compared to its unimpeded flow. In this analogy, the 'thumb' was a combination of the strength of the inversion layer and the sheer height of Mount Washington

serving as an obstacle to the onrushing arctic air, and the 'water' was some of the coldest deep-level air in the world at the time, and that I had ever seen.

In addition, since the summit was supposed to be above the tropopause boundary, we might be expected to smell ozone – a pungent odor similar to chlorine bleach – during our observations, as ozone, usually firmly ensconced in the stratosphere, could be paying us a visit all the way down at 6,288 feet above sea level.

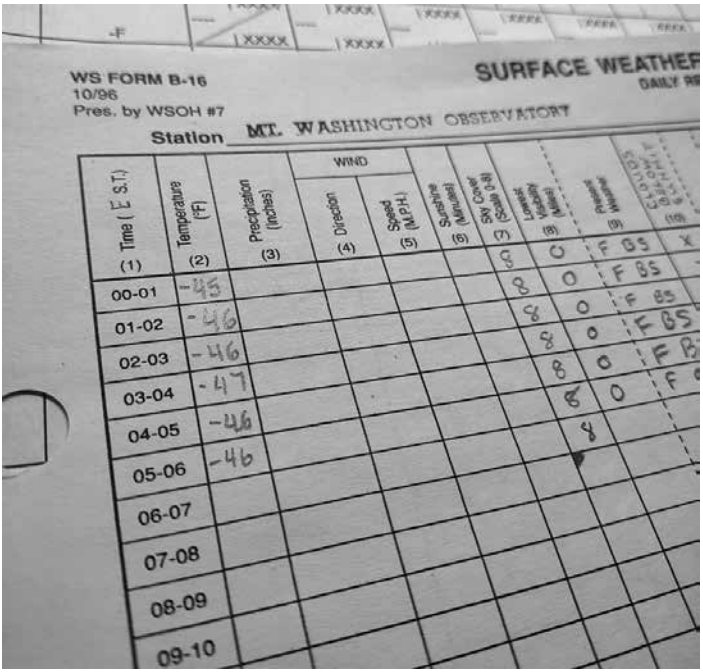
This was all leading up to a memorable Higher Summits Forecast that I issued on Wednesday afternoon, where I had to explicitly caution outdoor recreationists about the increased risks for hypothermia and frostbite, and that camp stoves may not work because the fuel used to power them may gel or freeze solid in such cold conditions. I forecasted temperatures to slide to 40 degrees below zero by Friday afternoon on the summit, with winds increasing to well above hurricane force, producing wind chills of nearly 100 degrees below zero. Let me say that again. 100. Degrees. Below. Zero. In other words, it would *feel* colder than any temperature ever measured outside of Antarctica in the dead of winter. Yes, yes, wind chills are apparent or 'feels-like' temperatures, but it would not change the fact that we were about to experience "wicked cold" conditions in the words of one reporter who talked with Francis on Thursday. And it was all going to happen in my third week at the summit.

The weather fanboy in me was certainly getting excited by Thursday when the area forecast discussion for Gray, ME blared out "*****ONCE IN A GENERATION COLD WIND CHILLS POSSIBLE FRIDAY NIGHT INTO SATURDAY*****." I had memorized notable weather statistics since elementary school, but this was the first time that I would be responsible for actually measuring them.

The model output statistics for the two models we use as guidance for issuing our Higher Summits Forecasts were calling for temperatures down to -50 °F, well under our station record. The first indications that Mount Washington would soon be front-page news started on Thursday with Francis fielding interview requests from The Boston Globe, CBS, CNN, NPR, and Reuters, sometimes even having the phone ringing in another room while he was already on a call.

Our Director of Weather Operations Jay Broccolo had been called to a press conference with the governor of New Hampshire, Chris Sununu, to caution the public about the weather conditions expected in the mountains Friday into Saturday. This, of course, in a state whose famous motto is "Live Free or Die."

This reached a head for me, personally, when, while browsing on my phone before going to bed Thursday night, I saw an article in The New York Times mention our -100 °F wind chill forecast for Friday night. I tried and was ultimately successful in getting some sleep Thursday night before getting up bright and early at 2:30 a.m. Friday to assist Alexis when the weather started to deteriorate. It would be quite the memorable next day and a half for us at the summit.



WS FORM B-16
10/96
Pres. by WSOH #7

SURFACE WEATHER

Station MT. WASHINGTON OBSERVATORY

Time (E S T) (1)	Temperature (°F) (2)	Precipitation (inches) (3)	WIND Direction (4)	WIND Speed (M.P.H.) (5)	Sunshine (Minutes) (6)	Sky Cover (Code 0-9) (7)	Lowest Visibility (Miles) (8)	Present Weather (9)
00-01	-45					9	0	F BS
01-02	-46					8	0	F BS
02-03	-46					8	0	F BS
03-04	-47					8	0	F BS
04-05	-46					8	0	F
05-06	-46					8		
06-07								
07-08								
08-09								
09-10								

Our B-16 daily weather form, with our station's record low being matched around 4:00 a.m. on Feb. 4.

Mind you, I did not think that I was volunteering for a well-over 24-hour shift, starting when I woke up on Friday. According to most models we had been looking at, the window during which we would experience the absolute minimum temperature was supposed to be fairly narrow between about 10:00 p.m. and 1:00 a.m. Friday night into early Saturday morning. Instead, we dropped to -45 °F by the 6:00 p.m. observation on Friday, and did not rise above -45 °F until the 7:00 a.m. observation on Saturday morning, 13 hours later.

Since we were so close to the all-time record low for much of this time, beginning around 10:00 p.m. on Friday, we began taking measurements every half-hour, and by 12:15 a.m., we started to take them every 15-20 minutes until 5:15 a.m., ultimately totaling 22 measurements during these seven hours. This entailed basically non-stop work with very little downtime since it took 3-4 minutes to get dressed to go out in the extreme conditions, about 4-5 minutes to take the observation, and then about 1-2 minutes to remove gear and breathe before attempting to do it all again.

Why would I remove gear? Because sweating underneath all those clothes, especially going outside as frequently as I did, would have been a recipe for disaster. And on top of that, it was very hard to move my head freely and breathe with a facemask, sweatshirt hood, hat, puffy hood, shell hood, goggles, and a headlight (for the night shift) all on at the same time.

I was so muffled up that when I returned to the weather room to give Alexis the temperature readings, I had to make her wait in suspense while I freed my voice from underneath all the layers.

Towards morning, during the brief interludes between gearing

up, removing gear, and taking measurements, I looked at the temperatures at some of the stations upwind of Mount Washington to the north and west and noticed that after similarly long periods of stasis, their temperatures had started dropping ever so slightly by early Saturday morning. Shortly thereafter, the Foxboro digital thermometer — located on the observation deck — and our sling psychrometer measurements also seemed to show a small, but at this point record-tying dip. After having held steady between -45 °F to -46 °F for six hours, we were consistently getting measurements below -46 °F. At 3:40 a.m., we measured a -46.6 °F reading, and the Foxboro was indicating that temperatures were still dropping. I slung again at 4:10 a.m., and Alexis came out to assist me in reading while I slung. I stepped out from the sheltered location in the lee of the tower into the brute force of the 90+ mph winds to get the best exposure to the coldest air flow. One of the reasons that I had asked Alexis to assist me in reading the thermometer was that, due to how I was bundled up against the cold, my breath would become trapped within my layers and freeze on the inside of my goggles, making it near impossible to read the temperature through them. In order to read the thermometer accurately, I had to take my goggles off in the lee of the building. In this instance, I dashed over to Alexis so she could read the alcohol at its lowest point and confirm my previous reading. It read -46.7 °F!

We had done it! We had tied the all-time record low temperature at Mount Washington Observatory, equaling a record that had been set 89 years ago.

I think I can anticipate some of the questions that will typically be asked about weather conditions like this:

What did the weather conditions feel like?

Properly suited up underneath six layers on the top, three layers on the bottom, incredibly thick boots, and a combination of three hoods, a balaclava, a hat, a neck gaiter, and goggles, it was not all that bad. You immediately noticed any exposed skin, which felt like a pretty severe sunburn. Even unexposed skin that was near creases or cracks of clothing felt like a low-degree burn, which for me was the gap between the top of my goggles and all of my hoods. As long as you were only out for a few minutes at a time in the lee of the tower it was almost comfortable. With more exposure to the wind, however, it cut right through to my legs, like they had been dunked in cold water, especially when I went out for two short stints on the parapet. Holding anything metallic, like a phone (more on this in a bit) or the sling psychrometer, almost immediately made those fingers cold, with a slight numbness noticeable after a few minutes. On top of the cold was of course the wind, which as soon as you stepped out onto the observation deck sounded like the constant roar of jet engines at some remove on a plane that refused to take off.

How did we take observations in such conditions?

For the most part, we let nature do the work, especially during the worst of the conditions. Since we were experiencing such cold temperatures with considerable winds, we mostly sheltered

ourselves behind a windscreen in the lee of the tower while sticking one arm holding the sling psychrometer (for non-meteorologists: a thermometer) through the windscreen slats into the wind. Since the summit was in the fog for most of the arctic blast, we were most interested in the dry bulb reading, especially for the sub-hourly observations Friday night into Saturday morning. After holding it steady for a few minutes in order for the temperature to stabilize to near the ambient air temperature, we would quickly read it at its lowest point, or move several yards downwind of the tower, sling for 20-30 additional seconds, and read it then. Later on, thinking that we had been too close to the building, I went to a slightly more exposed location for about 30 seconds before dashing back into the lee of the building to take measurements as quickly as possible, as it was impossible to hold the thermometer still enough to take measurements in the blustery winds. Quick measurements were necessary because the temperature would often rise a few tenths of a degree the longer we held the thermometer steady in the lee of the building, presumably due to the combination of the building, mittened hands, and faces all becoming significant heat sources at such low temperatures.

What did I wear?

The short answer is everything. The long answer is my moon boots, so-named because they lift me about two inches off the ground and look like something an astronaut would wear on the moon, and heavy wool socks on my feet. A very heavy and a lighter pair of long johns and insulated snow pants on the bottom. And a skin-tight polyester layer, a medium weight wool top, one medium weight fleece with a hood, one heavy weight fleece, a down jacket and a shell jacket on top, with a balaclava, hat, neck gaiter, and goggles to top it off. I got pretty good at dressing and undressing quickly as the day wore on.

Were we scared/frightened/terrified?

There was only one time when I think Francis and I were concerned for our safety. This occurred Friday afternoon during what turned out to be the highest wind gust we experienced during the event. While heading out for one of our hourly observations, the door to the observation deck slammed shut without warning, hitting Francis in his heel. It took us about 20-30 seconds to pry the door open again. As this happened, we both think the latch on the door to the catwalk (one floor below) broke in half, which we noticed heading down the stairs from the observation deck. Francis, initially on his own, then with help from me and one of the volunteers, managed to pin the door mostly shut. Francis found a Mount Washington State Park employee, who managed to install a new latch, and later, a 2x4" to ensure the door would not open again. Needing to limbo under and over this new obstacle, which was at about waist high for me, made subsequent observations even more of an adventure.

The only other time when I was more than a little concerned was when I fell down briefly in the more exposed location, while slinging, just before taking a measurement. Due to how the westerly to northwesterly winds flow around the structures on the summit, I was temporarily caught in the worst of it for a short time. I could not stand

up without fear of being blown farther down the deck. I managed to get myself back to where I had been standing previously by sitting on my butt and inching myself backwards, taking advantage of the slower winds near ground level. Forty-five seconds later, I was back to slinging again.

It was all-hands-on-deck for weather observers Alexis George, left, Francis Tarasiewicz, and Karl Philippoff during the Feb. 3-4 storm.

Any other memorable moments?

As we got closer to our all-time record low, we thought it would be a good idea to obtain some photographic evidence of our lowest measured temperature. We did go to some lengths to get this information, but we were not entirely successful. In such cold weather, working a camera using glove liners was not going to be possible, but after some trial and error, we thought using the video function might work. By hitting the record button before going outside, it would be possible to take a still out of the footage for record-setting purposes. The problem was that at night, it was very hard to shoot the thermometers without glare and keep it steady with mittened hands in strong winds. This combined with the fact that holding the thermometer steady for too long caused the temperature to start to rise and made it nearly impossible to collect the required footage. We ultimately decided it was more important to make the necessary measurements by eye than record each of them with a phone. On a related note, I have to say I was very impressed by my phone's ability to function in such temperatures and not die after freezing and thawing multiple times throughout the event. I can only hope that it remains working for a long time to come.

Our windows in the weather room were not the most weather-tight, with frost forming on the inside of the window jambs right next to the heaters. We usually use the heaters next to the windows to heat up and dry out our outerwear after each observation, but the extreme cold made this less useful. Instead, we had to pile our clothes on the table several feet away from the windows to at least keep them

near room temperature. One of the volunteers had left a glass of water on top of the heater in the corner of the room Friday night, and by Saturday morning, it had frozen solid.

The extreme temperatures also made the building creak, sounding like muffled gunshots as the steel and concrete contracted at different rates in the extremely cold temperatures. This, on top of the fact that the heater near my desk startles me nearly every time it turns on, kept me on edge for most of Friday evening and Saturday morning.

The constant winds sustained near 90-100 mph for most of the event whistled around the building. As the winds turned slightly more northwesterly Saturday, they sounded like a high pitch shrieking through the door that opens from the outside to the weather room. This prompted one reporter to ask Francis whether he could turn that sound off, to which Francis replied that it would be hard to turn off the wind. Shoving some folded-up paper into the slits around the door did help to reduce the whistling somewhat and kept us slightly more sane.

Some statistics from the event:

- Temperatures at or below -45 °F for 13 straight hours
- The -47 °F reading (rounded) is the coldest in 89 years, tying our record low. Our lowest recorded slung temperature of -46.7 °F may be the lowest temperature ever measured in Mount Washington Observatory records, to the tenth of a degree, as the lowest temperature slung by the weather observers in January 1934 was -46.5 °F as reported in their journals and a brief article published in the Monthly Weather Review in February 1934.
- Wind chills below -100 °F for 15.5 straight hours
- -109 °F was the lowest wind chill reported on our current conditions page on at least three separate occasions
- Sustained winds greater than 82 mph for 28 straight hours, with a top gust of 127 mph
- Zero hours of sleep while recording all of this extreme weather

I would like to thank all the people who were at the summit during this cold wave. The two volunteers, Pat and Steve, kept us sane under insane conditions and calmed us down when things were getting intense. We greatly appreciated their joviality and cooking(!) under trying circumstances. Mount Washington State Park employees Chris and Nate kept the building and Curly, Larry, and Moe (our heaters) running smoothly throughout the event and allowed us to concentrate on the weather observations. They also stepped up when the door blew in and kept the weather we were observing outside the building. And I would like to thank Francis and Alexis for their friendship, tenacity, and professionalism throughout the event. We were tested, but were not found wanting.

The Role of Elevation-Based Forecasts in Backcountry Safety

BY **CHARLIE BUTERBAUGH**

The Southern Presidential Range summits with snow at sunrise on Oct. 11.

Spreading the word about harsh weather in the White Mountains has become an increasingly high priority for groups aiming to improve hiker decision-making.

Even as rescue incidents continue at a steady pace, work on the prevention side of search and rescue is producing measurable results in the region's growing backcountry community.

In 2022, one group of volunteers spoke with over 27,000 hikers at popular trailheads leading to the mountain range's unique alpine tundra, which produces extreme cold, wind, and precipitation.

Their advice to hikers at the Appalachia, Ammonusuc, Champney Falls, Old Bridle Path, and Welch-Dickey trail heads resulted in more than 3,400 people modifying their plans during the past year, from mid-May through the end of October.

John Marunowski, who started the Trailhead Steward Program eight years ago with some maps and a pickup truck, described these locations as "great bottlenecks." At the time, he noted an increase in both rescues and natural resource damage while working as a U.S. Forest Service ranger in the Pemigewasset Wilderness.

The group now includes 200 volunteers and hosts a training every spring. Marunowski, the White Mountain National Forest's (WMNF) partnership and volunteer coordinator, thinks of the program as "hikeSafe on the road," referring to New Hampshire's mountain safety program.

A Trailhead Steward Program volunteer reviews trail routes with hikers. White Mountain National Forest image.

Taking a hospitality approach, the volunteers field questions about trail routes and ask hikers about the gear they've brought. But their main focus is to inform visitors about weather above treeline, which is often wildly different than at trailheads.

Marunowski described Mount Washington Observatory's Higher Summits Forecast as a "a critical component of our program," adding that "there is a bit of shock and awe that we are giving to the public."

On June 18-19, which Marunowski called "the big weekend," about 70% of hikers, or 250 people, who talked with program volunteers at the Old Bridle Path trailhead in Franconia Notch changed their plans after being armed with the Observatory's elevation-based forecast, which called for temperatures falling into the 20s and winds increasing to 60-80 mph, with a chance of rain and snow showers.

Marunowski also leads the Backcountry Steward Program, which involves

John Marunowski leads a Trailhead Steward Program training session. White Mountain National Forest image.

New signs at trail heads leading to upper elevations in the White Mountains warn of potentially dangerous weather.

volunteers hiking trails and talking with the public. In 2022, program volunteers covered over 1,000 miles and made contact with more than 2,500 backcountry hikers, resulting in 162 people modifying their plans.

The twice-daily Mount Washington and Higher Summits forecasts, created by Observatory meteorologists with expertise in analyzing weather across complex terrain, are read by 20,000 unique visitors per week, on average, at mountwashington.org. An automated text service launched last year increased access to this information in the backcountry. Sending a text to 603-356-2137 triggers a response with the Current Summit Conditions and forecast summary.

In a recent effort to continue building weather safety awareness at trailheads, the WMNF, New Hampshire State Parks, Appalachian Mountain Club (AMC), and Randolph Mountain Club partnered with the Observatory to install over 100 new warning signs at locations leading to summits in the Presidential Range and Franconia Notch. The bright yellow signs, printed on 1/8" sturdy metal, warn of potentially dangerous weather up high while promoting the text service, which has responded to over 32,000 requests for weather updates since it was launched in December 2021.

The AMC's Joe Dodge Lodge at Pinkham Notch Visitor Center serves as another hub for hiker activity in the Northern Presidentials. Hikers, climbers, and backcountry skiers often congregate in the pack room before accessing numerous trails in the Great Gulf Wilderness and others leading to the summit. A front-country base camp for Mount Washington, the lodge offers overnight stays, refuge for hikers, and a base for search and rescue missions.

The Higher Summits Forecast is reported every evening at dinner to lodge guests, helping them plan according to the next day's weather.

Higher up in the White Mountains at AMC's eight huts, the forecast is read aloud to guests at breakfast every morning.

"It's a captive audience. Everyone staying at the hut is there," said James Wrigley, AMC's director of White Mountain lodging operations.

He described the Observatory's forecast as "my go-to when heading out for field visits" at AMC huts, adding that it's tailored to complex weather systems

moving through the White Mountains, in contrast with standard smart phone forecasts that simply average out data from computer models.

"For the huts and our lodges, the forecast is pretty invaluable to be able to share with folks what they're going to be getting into in the next 48 hours," Wrigley said.

When the huts are full in the summer and fall, that means a few hundred people will be heading onto hiking trails, with a significant amount planning to get above tree line, all of them informed about what to expect as well as the uncertainties inherent in mountain weather.

"We would always rather prevent a search and rescue than respond to one," Wrigley said. "Weather is a huge part of that in the Northern Presidentials, where conditions are so dynamic. It can snow in June and July. We have that reality to help people make the right decisions."

Hikers are often surprised that it's 30 °F on the summit of Mount Washington, and realizing they are undertaking something serious, they enhance their preparation.

"The opportunity to frontload that information with folks when they're getting out on the trails, that is huge," Wrigley said.

From June to September, the huts not only offer lodging for well-prepared hikers but also for the injured or under-prepared in need of refuge.

"People come in drenched to the bone, and we give them soup and hot water as they're getting themselves back together to get down the mountain," Wrigley said. About 400 people needed to take refuge last summer, and another 370 needed to stay overnight because they were injured or couldn't continue with their planned hike.

Skiers prepare their gear in the pack room at AMC's Pinkham Notch Visitor Center before heading out to Hermit Lake Shelters. AMC image.

When search and rescue incidents happen, AMC hut crews and caretakers are often closest in proximity. They're on call 365 days a year, 24/7, and in 2022 they responded to over 50 incidents, spending 450-500 hours on response

Snow and ice coat the summit cone of Mount Washington in the foreground as the morning sun illuminates the northern Presidential Range on Sept. 25.

time. Before they head out on a rescue, it's a protocol to check the Higher Summits Forecast.

Many other organizations have expert mountaineers on call 24 hours a day for search and rescue in the White Mountains, including New Hampshire Fish and Game, which oversees activity at most times, and the U.S. Forest Service, which oversees activity on the eastern side of Mount Washington in winter and spring. Others include Mountain Rescue Service, Androscoggin Valley Search and Rescue, the Pemigewasset Valley Search and Rescue Team, New Hampshire State Parks, and Lakes Region Search and Rescue.

Jeff Fongemie is acting director and lead snow ranger at the Mount Washington Avalanche Center (MWAC), which has a two-part mission of prevention and search and rescue. In winter and spring, the MWAC, part of the Forest Service, leads search and rescue for Tuckerman Ravine and the Cutler River drainage.

Once the snow fields fill in, an avalanche specialist on Fongemie's team heads out each day on Mount Washington to assess hazards and publish a safety advisory about elevation-based avalanche risk across an area of 106 square miles. They also issue an avalanche-related weather forecast, including details such as snowfall and wind speeds.

If he's forecasting for the next day, Fongemie heads into the field, conducts stability tests to make an assessment, then checks the Observatory's Higher Summits Forecast before going to bed, "thinking about what's going to change overnight," he said.

Jeff Fongemie leads search and rescue and avalanche safety messaging training at Pinkham Notch Visitor Center in early December. MWAC image.

He factors in historical weather data from mountwashington.org, and in the morning, "the Higher Summits Forecast is key for us," Fongemie said.

When he's running dispatch for a search and rescue mission, the forecast serves as a decision-making tool, helping him decide whether it seems like a night when he can send people above treeline.

"We do our best to push the limits as much as we can, and the forecast is part of that," Fongemie said.

From trailheads to front-country lodges, backcountry huts, and even on the steep, rocky paths above treeline, many people participate in communicating the mountain weather forecasts that are created each day at the summit of Mount Washington, aiming to educate and inform visitors about decision-making in the face of risk in the White Mountains.

New Hampshire Fish and Game Lieutenant James Kneeland said the total number of search and rescue missions conducted annually during the past three decades has remained steady, ranging from 180 to 200 missions per year.

"What has changed is we have far more people going into the mountains than we ever did. With more people out there, you would think more rescues would be needed. But numbers are staying steady," Kneeland said, adding that communication efforts focused on weather safety and responsible outdoor recreation seem to be making a difference.

Kneeland has been coordinating missions for the past 10 years, and previous to that spent 20 years as a first responder with Fish and Game.

Summer/Fall 2022 Weather Data

	AUG	SEPT	OCT	NOV
Temperature (°F)				
Average	51.7	42.8	37.7	23.9
Departure	+3.0	-0.3	+6.4	+3.1
Maximum	65	60	57	52**
Date(s)	4th, 6th	10th/11th	5th	12th
Minimum	36	21	19	-10
Date(s)	12th	24th	19th, 20th, 21st	21st
Precipitation (inches)				
Monthly	11.45	11.45	9.33	9.57
Departure	+3.73	+3.79	-0.66	+1.48
24-hour Maximum	3.19	3.21	5.74	2.75
Date(s)	18th	19th/20th	13th/14th	11th/12th
Snowfall (inches)				
Monthly	0.0	1.1	2.1	23.9
Departure	-0.1	-0.1	-16.9	-11.7
24-hour Maximum	0.0	1.1*	1.5	4.4
Date(s)	N/A	22nd/23rd	9th	16th
Season Total	0.0	1.1	3.2	27.1
Departure	-0.1	-0.2	-17.1	-28.8
Wind (mph)				
Average	24.2	28.0	27.0	46.2
Departure	-0.3	+0.4	-8.5	+6.8
Peak Gust/Direction	80 W	116 NW	89 S	112 NW
Date(s)	9th	23rd	14th	25th
Days 73+	4	8	4	22
Days 100+	0	2	0	6
Other				
% Sunshine	31	33	61	37
Clear Days	0	1	1	1
Partly Cloudy Days	2	7	10	5
Cloudy Days	29	22	20	24
Days with Fog	31	29	19	25
Days with Rain	22	14	9	9
Days with Snow	0	4	6	17

*Some fell as hail

**NOV MAXIMUM TEMPERATURE - MONTHLY RECORD HIGH OF 52°F EQUALED; RECORD ORIGINALLY SET ON NOV. 4TH, 1982 AND EQUALED ON NOV. 1ST, 2019

Ample Precipitation, with Lower Snow Totals as Winter Began

BY **RYAN KNAPP**

This period saw temperatures remaining above normal with ample amounts of precipitation. However, snow for the season has been off to a rough start as October and November saw snowfall totals well below normal.

August 2022

High pressure at the start of the month weakened as low pressure passed to our south. A cold front provided drizzle/rain on the 2nd then a persistent northwesterly flow provided continued drizzle for the 3rd before clearing as high pressure crested overhead. A return flow on the 4th pumped warm air into the region as cold air aloft moved in resulting in instability that lead to convective rain showers and thunderstorms that lingered into the 5th. Rain tapered on the 6th and summits cleared as high pressure crested over the region. A cold front moved in on the 7th and then remained quasi-stationary through the 9th provided fog and daily rain showers. The 10th saw cooler conditions in the wake of the front as fog and drizzle lingered. Another cold front passed on the 11th and then stalled along the coast on the 12th with rain showers lingering both days. Cold air followed late overnight and into the 13th despite high pressure allowing for a bit of sunshine during the day. Temperatures rebounded on the 14th as high pressure provided fair weather conditions that remained until the midday hours of the 16th.

Late on the 16th, low pressure along the coast would spread rain showers over the summits with rain lingering through the 19th. Clearing would set up late on the 19th with fair weather continuing into the 20th as high pressure built over the region. Fair skies would give way to clouds on the 21st as low pressure approached from the west. A warm front on the 22nd provided light rain and as the front stalled along the international border, rain showers lingered into the 23rd. The low lifted NE on the 23rd and dragged a cold front through on the 24th with continued drizzle and rain showers. Intermittent clearing briefly returned on the 25th. A cold front on the 26th returned clouds and provided thunderstorms and scattered rain showers. Rain and drizzle tapered early on the 27th and clearing returned as high pressure built. Fair weather conditions continued for the 28th/29th as the ridge crested and then slid east. A warm front on the 30th returned fog and light rain showers then a cold front provided rain on the 31st.

September 2022

A trailing upper level trough provided light rain showers on the 1st prior to tapering. Temperatures plunged on the 1st leading to the first icing of the season. But, high pressure built on the 2nd allowing for clearing and milder conditions to return and then linger into the 3rd. The ridge slid east on the 4th as a cold front approached with passage on the 5th providing fog and rain through the day. A trough passed on the 6th providing additional drizzle and rain. High pressure on the 7th allowed for undercast conditions to form below as clear skies set up overhead. The ridge would remain in control through the 10th providing fair weather conditions with some low-level cumulus dotting the skies most days. Clouds moved back in on the 11th as low pressure approached and provided scattered rain showers that lingered into the 12th. A secondary low on the 13th provided widespread rain that would linger into the 14th. Canadian high pressure build down on the 15th/16th keeping summits cold and in the fog leading to rime ice formations.

Clearing finally set up late on the 16th allowing for fair skies on and milder conditions on the 17th. Low pressure tracked along a stalled front on the 18th providing drizzle and rain through the 20th. High pressure briefly provided clearing for the 21st as the remnants of Hurricane Fiona tracked towards the Gulf of Maine for the 22nd/23rd. Rain transitioned to a wintry mix and eventually snow and a tight pressure gradient provided a gusts of 116mph, the first triple digit winds since May 2022. Fog and icing continued into the 24th. A warm front lifted and stalled along the international border on the 25th providing drizzle/rain. Then the front sagged south as a weak cold front provided another round of rain showers for the 26th/27th. Another cold front passed on the 28th providing rain that tapered to a wintry mix. High pressure then build on the 29th eventually leading to clearing skies for the 30th.

October 2022

High pressure remained on the 1st as some high clouds passed from the remnants of Hurricane Ian passing to our south. A weak cold front passed early on the 2nd then high pressure built over the region through the evening on the 7th. The ridge provided fair weather skis and temperatures remained well above normal for early Oct. A cold front passed late on the 7th and into the 8th providing rain that tapered to snow as temperatures dropped to below freezing. Another cold front on the 9th reinforced the cold temperatures and provided sleet and snow. Clearing early on the 10th gave way to fog and snow/sleet as an upper level trough passed. High pressure built over the region on the 11th and this slid offshore on the 12th providing clear skies both days. A cutoff low moved in on the 13th providing heavy rain that would linger into the 14th. High pressure rebuilt over the region on the 15th but fog lingered through most of the day despite clearing overhead.

Clearing arrived on the 16th ahead of a strengthening low over the Great

Lakes that would move in for the 17th. A warm front provided a wintry mix on the 17th then a trailing cold front on the 18th passed providing additional mixed precipitation. Intermittent fog lingered through the 19th then a weak disturbance on the 20th returned fog and snow for the morning. High pressure then allowed for clearing late on the 20th with fair weather conditions lingering through the 23rd. A broad coastal low passed on the 24th providing rain and warm temperatures. Another low moved in form the Midwest on the 25th providing drizzle and rain overnight and then through the 27th. High pressure then rebuilt over the region providing fair weather conditions and unseasonably warm temperatures through the end of the month.

November 2022

A cold front started the month with fog and drizzle and allowed for some light glaze ice. High pressure then built back on the 2nd and provided fair skies that lingered into the 3rd. As the ridge slid east, clouds spread back in on the 4th and eventually thickened and lowered back to fog on the 5th. Low pressure passed to our north on the 6th with a passing warm front providing light rain. A trailing cold front on the 7th provided moderate rainfall as well as significantly colder air in its wake. Upslope flow on the 8th provided a few light snow showers prior to tapering. Canadian High Pressure built down on the 9th allowing for clearing and temperatures started to rebound. The ridge departed on the 10th and the remnants of tropical cyclone Nicole moved north. A warm, moist flow provided summit fog, moderate to heavy rain, and record warmth as a daily record high was met on the 11th and the monthly record high of 52F was tied on the 12th. A trailing cold from the 13th dropped temperatures to single digits and transitioned precipitation back to snow. A coastal low passed on the 14th providing light snow prior to high pressure providing clearing on the 15th.

A strong coastal low on the 16th/17th provided the first significant snowfall of the season. A low from the Great Lakes on the 18th/19th provided additional light snowfall. A cold front provided snowfall on the 20th then the low tracked along the international border providing additional light snowfall and gusts up to 108 mph the 21st/22nd. Another cold front on the 23rd provided additional light snow. High pressure provided fair skies on Thanksgiving then another low passed on the 25th providing snow and gusts up to 112 mph with winds/snow lingering on the 26th. A coastal low on the 27th provided a wintry mix that lingered into the 28th. High pressure provided fair skies on the 29th then a low from the west closed the month with a wintry mix.

COMPILED BY **HAYDEN PEARSON**

4:27 p.m., Wed., Sept. 28

"Returning to Mount Washington Observatory" Hello! My name is Alex Branton and I am a new Weather Observer & Education Specialist at Mount Washington Observatory. Although I am far from my home in Pensacola, FL, this is not my first time on the summit. Last summer, I was an intern here, and I fell in love with the job and the White Mountains. I am so excited to return and experience all the extreme weather Mount Washington has to offer. During September, I have experienced many "firsts" on the summit. One morning while driving up the mountain for shift change, I got my first taste of Fall with leaves starting to change color. This is something that does not really happen in Florida, and I am so excited to see the foliage continue to change. Last weekend, Sept. 23-25, Mount Washington received its first inch of snow and coating of rime/glaze ice of the season. Wintry conditions are another thing that I am not used to, and this was my first time seeing snow fall from the sky. Waking up to the summit being coated with ice and physically being outside in those conditions was such a surreal experience, and I look forward to the next one. During the same event, we recorded 100 mph winds for the first time this season. The peak gust was 116 mph on Sept. 23 followed by 108 mph on Sept. 24, both surpassing my previous wind record of 107 mph during Hurricane Ivan. Mount Washington weather is so powerful and beautiful, and I feel incredibly lucky to be a meteorologist at The Home of the World's Worst Weather. Having a career as a meteorologist has been a dream of mine since I was young. Some of my earliest memories include hunkering down in a hotel during Hurricane Ivan in 2004 and riding out Hurricane Katrina at home in 2005. Each of these storms were devastating to everyone impacted by them, but they inspired my passion for the weather. I remember watching meteorologists on television as they reported from the middle of the worst weather across the country and thinking, "wow, I want to do that when I grow up," (not necessarily the TV reporting part, but the being outdoors in extreme weather part). In addition to meteorology, another passion of mine is being in the mountains. I enjoy the physical challenge and the emotions that recreating in the mountains can inspire. Combining these two things, I can think of no place more fitting to me than Mount Washington Observatory. In the time between the conclusion of my internship and moving back to New Hampshire, I graduated from the Florida Institute of Technology where I was a member of the Women's Cross Country team and received degrees in Aviation

Meteorology and Air Traffic Control. Through college, I spent my summers zip line and via ferrata guiding, thru hiking the John Muir Trail, and interning at MWOBS. After graduation, I spent the majority of the summer travelling in the United States and in Spain before beginning my new position at the Obs. In the U.S., I drove across the country in a campervan so that I could hike, rock climb, and visit as many national parks as I could. In Spain, I cycled around the entire island of Mallorca over the course of five days. I have had some incredible adventures, but I am excited for the adventures ahead at the summit, writing mountain forecasts and helping aviation and outdoor communities understand the unique relationship between weather and high terrain in the White Mountains.

–Alex Branton

11:02 a.m., Tues., Oct. 18

"Leaving the Mountaintop I Call Home. Where Do I Even Start?" From the very beginning of working at Mount Washington Observatory, I knew this week would never come at the "perfect" time, would never be easy, and would certainly not feel right. In a perfect world, I would probably never leave this mountaintop that I have come to call home. It is true that all of us weather observers are drawn to the Home of the World's Worst Weather for just that; the extreme weather. But after just over two years here, I can humbly say that I now prefer high pressure and the nice weather conditions that usually accompany it. I have definitely been enjoying my last few shifts on the summit, and was lucky enough to get an entire week of high pressure last shift, which has come to be my favorite. Along with the fair weather came many beautiful sunsets followed by just-as-beautiful sunrises. I will still cherish all of the cold, wind, and storminess that I was able to experience, but after two winters on the summit, let's just say I have now come to appreciate fair weather much more! My time on the summit has come to an end not for any one reason. I just feel the time has come. After all, I am a mechanical engineer by trade, and I was lucky enough to land this dream position straight out of college. I feel the need to continue on an engineering-focused path since I spent four years of my life studying it, and it is a passion of mine equal to weather. I specifically wanted to mention this fact because more than anything, it takes passion to follow your dreams. I entered this job with very little atmospheric/meteorological knowledge, and now I have gotten to the point where I have been training meteorologists to be weather observers. If anyone reading this has the dream to work up on the summit of Mount Washington, for any of the entities that call the summit home, I cannot recommend it enough. With all of this being said, I have no doubt I will continue to stare up at clouds and estimate their heights for the rest of my life. This is only a goodbye for now, and I already look forward to visiting this magical place in the future.

–Sam Robinson

10:50 a.m., Thurs., Nov. 17

"New Trail Signs Meant to Improve Weather Safety in the White Mountains." New signs at trail heads leading to upper elevations in the White Mountains state the following, WARNING: Weather Conditions At High Elevations May Be

Dangerous. For information from the Mount Washington Observatory about weather conditions & high elevation forecasts, text "weather forecast" to 603-356-2137. A project led by Observatory Life Trustee Jack Middleton to design and print over 100 warning signs for display at White Mountain trailheads was recently completed. The bright yellow signs, printed on 1/8" sturdy metal, warn of potentially dangerous weather at higher elevations while informing hikers that a quick text to 603-356-2137 will generate an automated reply with the current summit conditions and Observatory forecast. With a QR code that generates an automated text when scanned, the signs are meant to increase awareness and access in the backcountry, where WiFi signals are often not available. "What inspired this are the news reports on a frequent basis of people being injured on mountains at higher elevations, often with injuries that can be life-threatening," said Middleton. He also credited author Ty Gagne's books about decision-making and risk in mountaineering as inspiration. White Mountain National Forest, New Hampshire State Parks, Appalachian Mountain Club, and Randolph Mountain Club have all assisted with hanging the signs at trail heads leading to higher elevations in the Presidential Range and Franconia Notch.

–MWOBS Staff

11:21 a.m., Tues., Dec. 27

"Christmas Bomb Cyclone Sweeps through the Northeast." Strong winds and heavy snow came to Mount Washington just in time for Christmas thanks to a nasty bomb cyclone sweeping through the Northeast. I wrote this comment Christmas morning at our summit weather station, where sustained winds exceeded 100 mph. What is a bomb cyclone and how does it form? A bomb cyclone forms when two very different air masses interact. Commonly, a cold, arctic mass shifts down from the north and a warm airmass is drawn into the storm. This type of system is defined by how rapidly it intensifies, with pressure at the center of the storm dropping at least 24 millibars over a 24-hour period. The rapid decrease in pressure produces a sharp pressure gradient between the two airmasses, which leads to strong winds. Arctic air masses regularly shift down to the United States, but this strong system was unusual in that it affected states farther south with the potential for places like Florida to have one of its coldest Christmas holidays since 1983! This massive low-pressure system brought a perfect mess of hazardous weather conditions to Mount Washington, especially on Dec. 23. The most noticeable hazards were the strong winds. Weather conditions really started to deteriorate right around 1:00 a.m. on Dec. 23, with winds quickly ramping up and sustaining at 100+ mph. The storm also produced substantial snowfall across the higher summits. At the end of the day, this strong low-pressure system dumped close to 9 inches of snow at the summit. In addition to heavy snowfall, the system produced particularly strong winds. Winds were so strong by the morning of Dec. 23 that the day observer was unable to collect the precipitation can for the synoptic observation due to how dangerously high the winds were. Winds peaked at 150 mph early during the morning on Dec. 23.

–Alexis George

Tropical Cyclones: The Most Efficient 'Engines' on Earth

BY **ALEXANDRA BRANTON**

On the summit of Mount Washington, we feel the blunt force of nature on a regular basis. Whether it is high winds on Mount Washington, a tornado in the Midwestern United States, or a hurricane in Florida, weather uses energy supplied by the sun (directly and indirectly) to create some of the most powerful forces on Earth.

Tropical cyclones, for example, use heat from the ocean, transforming it into wind. This might sound very similar to the definition of an engine, a machine that converts any of various forms of energy into mechanical force and/or motion. Even more relevant is the definition of a heat engine, which converts heat energy into mechanical force and/or motion.

First, let us talk about heat engines before connecting them to tropical cyclones.

For a heat engine to create usable energy, heat is supplied to a gas in a closed cylinder. Adding heat causes the gas to expand, which then pushes a piston forward. This results in work being done by the engine.

Work is done when there is a force being applied to an object or substance and there is a reaction by the object or substance in the direction of the force. For example, if one were to push a door open, the arm used to move the door forward does work on the door.

After the piston is moved forward, the issue then becomes: how do we move the piston back to where it started to get another iteration of the process, and how do we do it using as little energy as possible? This is called efficiency, something most engines lack. This is not the case, however, for Carnot Heat Engines, which achieve maximum efficiency allowed by the laws of physics.

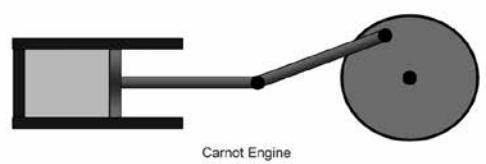


Figure 1: In a Carnot Heat Engine, gas in a cylinder expands and contracts, like a spring, to move a piston back and forth. The movement of the piston turns the wheel in the process (Virginia.edu).

This is achieved by taking advantage of the Carnot Cycle, a procedure consisting of two isothermal processes and two adiabatic processes. An isothermal process is one in which, although there might be heat exchange, a substance does not change temperature. Some variables that can change during this process are pressure and volume.

In contrast, an adiabatic process is one in which a substance does not exchange heat with the environment around it, although it might change temperature. Other variables that can change during this process are pressure and volume.

Throughout the Carnot Cycle, energy is transferred from a warm pool to a cold pool in order to transform heat into

mechanical work. Reversible processes allow the gas in the cylinder to expand and contract (in other words, acting as a spring), pushing and pulling the piston back and forth. Since the air inside the system is much colder after expanding, it takes less energy for the gas to compress back to its original state.

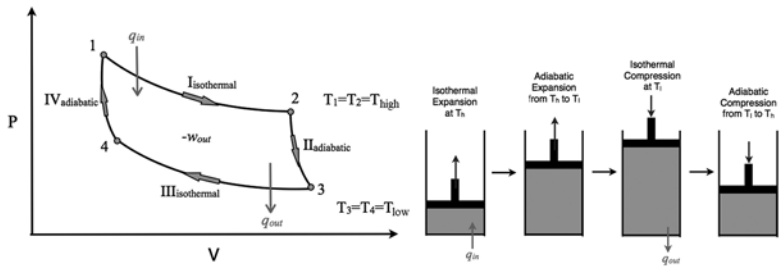


Figure 2: The Carnot Cycle on a pressure-volume diagram and as an ideal gas-piston model (CC BY 4.0; XiSen Hou via Hope College, libretexts.org)

The Carnot Cycle is depicted in Figure 2 and proceeds as follows:

1. Heat is introduced to the system (q_{in}) by a heat source at a high temperature and the gas expands isothermally. Although heat is added, the temperature (T_h) of the gas remains constant due to expansion and loss of energy as the gas does work on the environment.
2. No heat is removed, but the gas expands adiabatically and cools to a low temperature (T_l). The gas is cooling due to expansion and the loss of energy as it does work on the environment.
3. The environment does work on the gas and it compresses isothermally. Heat is lost to the environment (q_{out}) although the temperature of the gas in the system remains constant due to compression. Air molecules in the environment lose energy to the molecules in the gas in our system, therefore causing the temperature to increase.
4. Finally, the gas compresses adiabatically. Although no heat is added to the system, the environment does work on the gas and it warms back to its initial state.

As mentioned previously, this process has the maximum efficiency possible for an engine, meaning it creates a high net amount of mechanical energy. In more technical terms, efficiency is the ratio of the net work done by the heat engine to the heat absorbed by the heat engine. After considering the laws of thermodynamics, the definition of work, and doing some math, we get that the efficiency of the Carnot heat engine is just the ratio of the difference between the maximum and minimum temperature to the maximum temperature of the system.

$$efficiency = \frac{T_h - T_l}{T_h}$$

While the Carnot Cycle theoretically achieves maximum efficiency possible, it is not possible in a Carnot Heat Engine. This is due to other variables such as friction of the gas on the cylinder. This type of engine is also not ideal for practical use because the processes involved are very slow; however, if we consider the Carnot Cycle in a tropical cyclone, these types of engines can create massive amounts of

force on very large scales.

The term "tropical cyclone" is an all-encompassing term for storms such as tropical depressions, tropical storms, hurricanes, typhoons, and similar storms. A tropical cyclone is an organized storm system that rotates about a low-pressure center. The center of the cyclone is called an eye and it is usually the calmest, most clear of clouds location within the storm. The eye is surrounded by the strongest part of the storm, the eyewall. This is made up of large cumulo-nimbus, or storm clouds. There is a secondary circulation in the vertical concentrated near the eyewall. This is where the Carnot Cycle will take place. Much like a heat engine, heat energy is supplied to the tropical cyclone by the ocean. Air rises near the eyewall, then subsides, or sinks, as it moves away from the storm center. Heat energy is transformed into wind in this process. The Carnot Cycle in a tropical cyclone is depicted in Figure 3 and proceeds as follows:

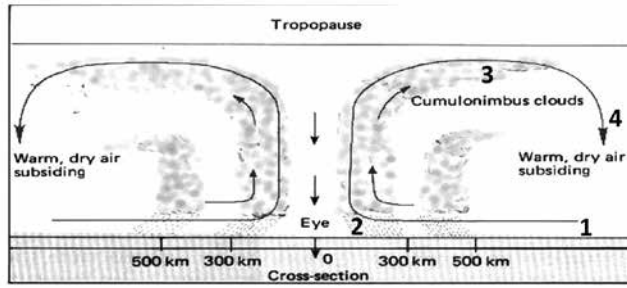


Figure 3: The Carnot Cycle in Tropical Cyclone (University of Nebraska-Lincoln).

1. Air expands isothermally as it moves towards an area of lower pressure in the center of the cyclone while receiving heat (q_{in}) from the ocean surface.
2. Air expands adiabatically as it ascends through a cumulonimbus cloud and its anvil top. Although no heat is being taken out, the air is doing work on the environment as it expands, therefore causing it to cool.
3. The air undergoes isothermal compression as the environment does work on the air. Heat is lost (q_{in}), though the temperature remains constant.
4. The air compresses adiabatically as it sinks back to its initial state.

This is a very simplified, theoretical model of a tropical cyclone and there are many variables that are not considered. First, the assumption we have made here is that a tropical cyclone is a closed system. In reality, this is not the case. These very dynamic storms are influenced by many other variables relating to complex fluid dynamics and microphysics. That being said, this model does produce realistic estimates of the three-dimensional wind fields of tropical cyclones that align with observations. It is truly amazing that tropical cyclones can generate so much power just by using heat.

References:

- *Georgia State University Department of Physics and Astronomy*
- *LibreTexts Chemistry*
- *University of Virginia Department of Physics*
- *The COMET Program*
- *University of Nebraska-Lincoln*

Learning Continues Across Age Spectrum, with New K-12 Programs Taking Shape

BY **BRIAN FITZGERALD**

After two relatively quiet winters on top of the Rockpile, the return of the Overnight Edutrip program has been a welcome shift toward "normalcy," hosting eager visitors at the weather station.

This winter's program saw the return of several favorites from years past, including the "Science of Winter Storms" led by Observatory staff and "Mountaineering Essentials" with longtime instructor/guide Joe Lentini. Newer programs featured knowledgeable instructors like broadcast meteorologist Sarah Long and professor of geography and mountain meteorology expert Dr. Baker Perry.

An Edutrip provides one of the single most impactful ways for people to truly understand and appreciate the work that goes into maintaining summit operations in the name of science. For many Edutrip participants, the program serves as a springboard for long-term Observatory involvement through summit volunteer stints, membership, Seek the Peak participation, and beyond.

Winter 2022-23 also saw the return of Arctic Wednesdays, our professional development program for teachers. Nearly 20 teachers applied for the dozen available seats in the program, in which a pair of teachers joins summit staff for Wednesday shift change days throughout the winter months.

When applying, teachers share plans for integrating the opportunity into their classroom teaching, including the use of Observatory resources with their students. This winter saw teachers from across the K-12 span from New Hampshire and Massachusetts participate, with many teachers taking the opportunity to connect live with their students from the summit during their visits to build excitement around learning weather and climate topics.

Teachers shadowed the weather observation process, toured the facility, and even sat in on shift change meetings to receive weather briefings and updates on research projects and instrumentation. If you know a teacher that might benefit from the Arctic Wednesdays program, encourage them to check out the opportunity and apply for next winter!

Science in the Mountains continued in earnest through the winter months, with the Observatory hosting monthly presentations from speakers covering weather and climate-related topics. Participation in the program remains strong, with programs averaging 130 attendees each Zoom webinar, with many more through Facebook Live and YouTube.

New Hampshire weather emergencies, aviation weather operations at the Center Weather Service Unit, and Dr. Peter Crane's Observatory history program

WMTW News 8 Meteorologist Sarah Long, right, coaches EduTrip participant Cristen Carpentier through a weather report from the observation tower during February's Behind the Scenes and Science of Broadcast Meteorology Edutrip program, with WMTW photojournalist Ryan Haskell on camera.

celebrating our 90th anniversary all proved to be standouts. Looking ahead to the spring, Science in the Mountains continues with MWOBS staff and other experts sharing about winter weather "whiplash" in the Northeast and the aurora borealis. If you missed a program, or want to register for an upcoming one, visit mountwashington.org/sitm.

Last but certainly not least, Observatory staff are excited for the strategic initiative to expand K-12 offerings for students and teachers around the region. Recent conversations with area K-12 teachers and administrators have confirmed not only the demand for greater Observatory involvement, but shed light on the approach and types of programming that meet a variety of needs. Staff will look to build upon successful distance learning programs, with newer initiatives such as school-day and after school programs, field trips, and the development of more centralized Observatory learning resources.

Following the multi-year WeatherX curriculum development project, we now possess a number of valuable assets for the classroom, such as lesson plans and curriculum, data resources, and an extensive collection of video, photo, and historical materials.

As the Observatory undertakes this significant investment in school-based programs, we are extremely appreciative of our members, corporate sponsors, and granting partners who make this work possible. Stay tuned for more updates, and as always, you can reach us at education@mountwashington.org for your weather and climate-related education needs.

A Storm for the Record Books

BY **JAY BROCCOLO**

Shown the evening of Feb. 4, after weather observers measured an air temperature matching the station's all-time record low, are Mt. Washington State Park employee Nate Camille, left, Observatory volunteers Steve Moore and Patrick Luddy, Weather Observers Alexis George, Karl Philippoff, and Francis Tarasiewicz, and state park employee Christopher Lavigne.

The beginning of February was one for the record books, literally. On Feb. 4, the Observatory tied the station's all-time low temperature of -47° F.

There was a lot of anticipation a week ahead of the event, which made for an exciting transition from a warm January winter month into the beginning of one of the statistically coldest and snowiest months of the year for the White Mountains.

Several days out, there were signals of a very deep upper level low, which usually brings high winds and cold temperatures along with it. This system seemed to have an unusually large depth to it, and our forecast held true right through the event. Winds were forecasted to be gusting well over 100 mph, with air temperatures expected to near 50° F below. The summit team was in for one doozy of a storm, and it delivered.

Temperatures and snowfall decreased throughout Friday as the cold front passed through. By mid-afternoon, temperatures had fallen 50° from the 5° above that was recorded at our 0100

am synoptic, putting the ambient air temperature at -45° F with wind gusts upwards of 110 mph.

Heeding their own and others' warnings, the summit crew performed admirably with tenacity and dedication to the history and continuation of our 90-year dataset. The teamwork involved through the struggles and exhaustion brought on by this substantial weather event is a proud moment for all at the Observatory.

The care and determination to keep each other safe while maintaining our dataset is immensely valued. It's these types of moments that commemorate the comradery and re-invigorate the purpose of our summit team and support.

Every observation, whether it's a calm, sunny day with temperatures in the upper 60s, or approaching 50° below with winds howling at 110+ mph and blowing snow pelting one's body, is important.

These events are what make up our 90-year dataset. The dedication and belonging that our summit team demonstrated in observing and recording every interval during this wild and gnarly event occurred while maintaining operations, the onslaught of media outreach, operationally significant happenings, and lastly but arguably the most intrusive, our own self-doubt brought on by ourselves and others.

Congratulations and job well done from a past Observer and currently proud Director!

Boots muddied. Souls, cleansed.

Every pair of Oboz footwear is crafted to comfortably take you as far as you need to go. The way we see it, anything less just wouldn't be true to the trail.

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Observatory Shares Research at AMS

BY **MWOBS STAFF**

Observatory staff and interns presented two posters at the American Meteorological Society's (AMS) Annual Meeting in January, sharing the results of their recent research.

The first project entailed an investigation of the seasonal near-surface lapse rate (NSLR) in the White Mountains – work begun by intern Henry Moskovitz, continued by intern Jackson Hawkins, and now being advanced by Weather Observer & Research Specialist Karl Philippoff.

Simply put, the NSLR is the rate at which air temperature at the ground (as opposed to, say, 1000 feet in the air) changes with elevation. Accurately understanding how the temperature changes with elevation is valuable for a variety of applications, from the Observatory's forecasting to academic studies in the region.

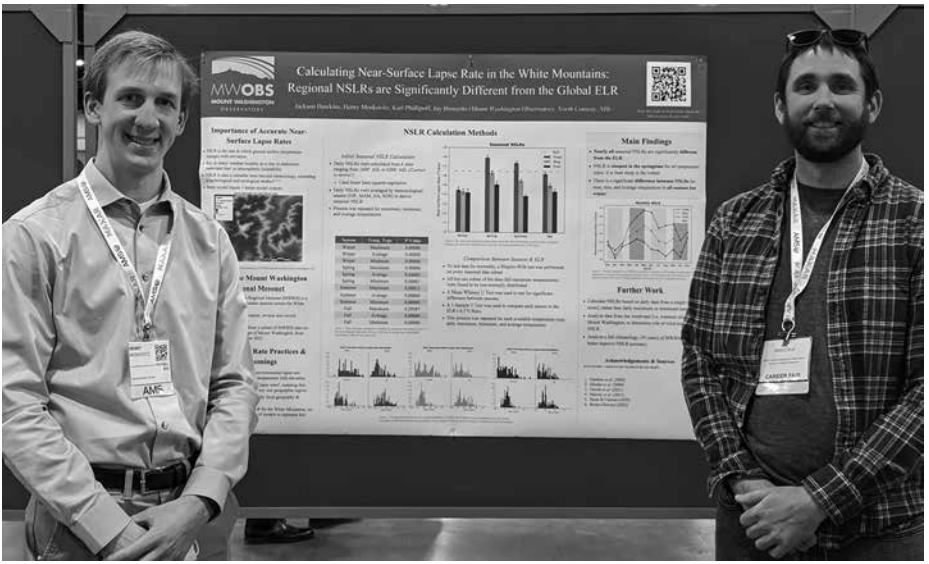
For example, a more rapid change in temperature may lead to more thunderstorms forming, and the NSLR can also play a big role in forecasting where the transition may be between rain and snow during precipitation events. From a broader perspective, having an accurate NSLR can help researchers better understand processes such as snowmelt or shifting habitat ranges in the White Mountains.

Currently, there is no NSLR known specifically for the Whites. Instead, weather models and scientists use the environmental lapse rate (ELR). This value, -6.5 °C/km or -3.5 °F/1,000 feet (meaning temperature decreases on average 3.5 °F per 1,000 feet in altitude gain) is an average of lapse rates across the globe, and thus not necessarily representative of any one mountain range or climate.

While using the ELR is better than nothing, knowing what the specific NSLR is for the White Mountains will help improve answers to questions like those mentioned above. Subsequently breaking the NSLR down by season can further improve the accuracy of forecasts, since seasonality is so influential in White Mountain weather.

Key findings shared at AMS include the following:

- Nearly all seasonal NSLRs are significantly different from the ELR.
- NSLR is steepest in the springtime for all temperature types. It is least steep in the winter.
- There is a significant difference between NSLRs for maximum, minimum, and average temperature in all seasons but winter.



Director of Weather Operations Jay Broccolo, right, and recent summit intern Henry Moskovitz presented "Establishing Near-Surface Lapse Rates along Mount Washington, NH" at the American Meteorological Society's Annual Meeting in January.

Further work to advance what is known about NSLRs in the White Mountains is recommended to:

- Calculate NSLRs based on daily data from a single time (e.g. noon), rather than daily maximum or minimum temperature.
- Analyze data from the windward (i.e. western) slope of Mount Washington, to determine role of wind exposure in NSLR.
- Analyze a full climatology (30 years) of Mount Washington Regional Mesonet data to better improve NSLR accuracy.

The second project presented at AMS addressed the question, "Are Winter Wind, Relative Humidity, and Damaging Events Changing on Mt. Washington, NH?" The Observatory collaborated with the Appalachian Mountain Club on this research.

The summit of Mount Washington experiences some of the harshest weather in the world. This includes extreme wind speeds, year-round foggy conditions, and sub-zero temperatures. The winter months are especially brutal, and the extreme conditions cause enough damage to trees to suppress their growth.

As a result, the treeline is largely defined by this extreme weather, and trees tend not to grow above a couple meters tall beyond 4,400 feet in elevation. With a myriad of climate change impacts accelerating globally, and recent evidence that the annual average temperature at the summit is warming (Murray et al, 2021), we wanted to update wind and RH trend analyses from the Observatory's data set. This work expanded a study from

Seidel et al (2007) on relative humidity and one from Cronin (2015) on wind speeds. We also combined variables to examine extreme or "damaging" events.

Conclusions of this study include the following:

- The summit has seen subtle changes in climatic conditions over the last 80 years
- Since 1941, we are seeing a downward trend in damaging events, i.e. when it is foggy, windy, and freezing
- The ecological impact of the shift in climate and extreme conditions may both result in the upward shift of the tree line and the endangerment of endemic alpine species

Though we are not seeing a large shift in relative humidity, fog frequency, or wind speeds individually, we are seeing a downward trend in the number of damaging events in winter occurring each year.

Extreme conditions, because of their ability to cause mechanical damage to trees, have an impact on the elevational status of the tree line in the White Mountains. A reduction in the number of damaging events each year may allow the tree line to slowly shift up as more trees are able to grow taller.

Warming temperatures are also expected to favor tree line expansion. Ecologically speaking, this would shrink the alpine zone, and the habitat of many rare and endemic species. The conservation of the area thus relies not only on the protection of the area from trampling by humans, but also on greater regulations to slow the changing of the earth's climate.

Past summit interns Henry Moskovitz, Jackson Hawkins, Naomi Lubkin, and Appalachian Mountain Club intern Larz von Huene, contributed reporting for this column.

The March 10 sunrise illuminates the snow above treeline on the Northern Presidentials.

Volunteers Cover Key Needs, with More Opportunities Available

BY **LINDA & HANK DRESCH**

Volunteers preparing December's membership mailing include Karen Franke, left, Marie Kaspar, Bill Housum, Sandy Kurtz, Drew Bush, Joan Kurtz, Linda Denis, Kim Henry, and Linda Dresch. Not pictured: Hank Dresch and Karen & Gary MacDonald.

We are pleased that new Executive Director Drew Bush is already supporting our efforts to grow volunteer participation beyond mailings and gardening.

There are opportunities to help with reorganizing the storage and workshop areas of the basement, assisting retail operations to prepare for re-opening the summit museum and gift shop, plus library cataloging and archiving, and possibly special projects at the summit.

When we hear of special onetime projects, we will notify volunteers on the email list. The date(s) will be determined by the staff we will be assisting. Most likely, there will be a couple of day options.

Cleanup of the Observatory administrative office grounds in North Conway was held on a glorious day in early November. Leaves were collected, mulched, and spread on all the plant beds in preparation for the arrival of spring.

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Our membership mailings are held on the second Thursday of the month, at 9:00 a.m., in the administrative offices, located at 2779 White Mountain Highway, second floor. Anyone visiting the area on mailing day is more than welcome to join us, while always practicing current safety practices to protect our community from COVID-19.

Sadly, we bid a very fond farewell to Stephanie Fitzgerald, with whom we have worked closely over the last six years. With her maternity leave beginning Feb. 3, Stephanie decided to leave her post as director of development to take additional time to raise her growing family. We will miss Stephanie's always pleasant disposition and helpful demeanor, no matter what was asked of her. We wish her all the best! Since Stephanie lives in North Conway, she'll be able to join us occasionally on mailing days.

Carrie Slife, who assisted Stephanie last year, will now be working more closely with us. We are looking forward to seeing her on a regular basis.

As any member supported nonprofit organization realizes, volunteers are a vital part of its success. Those volunteers who have helped over the past few months include:

Barbara Althen
Floyd Corson
Peter Crane
Marietta Deegan
Linda Denis
Linda & Hank Dresch
Peter Fisk
Karen Franke
Donna Gray
Kim Henry
Ava Honan
Bill Housum
Marie Kaspar
Joan & Sandy Kurtz
Karen & Gary MacDonald
Judy Meagher
Bill Ofsiany
Jane & Ken Rancourt
Mary Anne Sledzinsky
Jean Sweeney

UPCOMING EVENTS

ANNUAL MEETING

The Mount Washington Observatory Annual Meeting is a recap of the prior year. It also gives a chance for Observatory members and the public to meet the staff and trustees. This year, the meeting will be held on Saturday, June 24 at 9:30 a.m. Stay tuned for additional details.

SEEK THE PEAK

Seek the Peak, Mount Washington Observatory's largest annual fundraiser, will take place Sat., July 15. All outdoor enthusiasts are invited to raise funds, set goals, and earn gear – all in support of the Observatory's work. This year, we're going back to our "Hike-a-Thon" roots. And we're excited to introduce our "Hike and Make Friends" initiative, which pairs up solo hikers with others in our awesome Obs community! For the first time, our registration fee includes a food voucher, so anyone who registers to hike gets to refuel at our Aprés Hike Party! Anyone can buy a ticket for the party. But if you register for the hike, your food is included!

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...Thank you

25 Years

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Dennis & Johanna Vienneau

Rob Weeks

Howie and Sue Wemyss

John Wiley

Ms. Gretchen S. Yealy

William and Sarah Young

...Thanks for your continued support

Tributes & Memory Gifts

Jean Humphreys ..... In Memory of Charlie Humphreys
Joan Lowery ..... In Memory of Charlie Humphreys
Philip Everhart ..... In Memory of Gordon Thompson
Jennifer Kirkland ..... In Memory of Gordon Thompson
Deborah Weiss ..... In Memory of Gordon Thompson
Stacy Dutch ..... In Memory of Jim Hoburg
James Eagleton ..... In Memory of John W. Stewart
Tor Clark ..... In Memory of Victor F. Clark
Elizabeth Seabury ..... In Memory of Victor F. Clark

In Memory of Josh Gillenson

Janice Axelrod
Suzanne Berman
Peter Gardner
Elizabeth Gardner
Linda Gershman
Katharine Gillenson
Sally Gillenson
Jim Fornari & Amy Gillenson
Andrew Greenhouse
Maxine Harelick
Susan Klebanoff
Christine Lott
Karen Nagel
Lori Najdzin
Jean Stevens

In Memory of Samuel Gawel

Susie Aisner
Joanne Aronovitz
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Peter & Judy Aydelott
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Berkley High School Science Dept.
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Stacy Doctoroff
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Henrike Frowein
Susan Gartenberg
Leah Gawel
Leah Gawel
Jessica Gawel and Ramon Perez
Rose Genstein
Paula and Lou Glazier
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Norman Silverman
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Megan Terpstra
Kelly Victor
Tracy Weeks
Jodi Weinfeld
Eric Weissman
Wendy Wilder
Deborah Wolney
Jeremy Yoskowitz
Laurie Zeidman

In Honor of ...

William R. Ofsiany ..... In Honor of Aaron Ofsiany & Sarah King
Susan Tewksbury ..... In Honor of David Tewksbury
Victor Kordish ..... In Honor of Dennis E. Kordish, Esq
William D. DeCamp Jr. ..... In Honor of Edwin O'Malley
Megan Hinckley ..... In Honor of Karen S. Franke
Drew Schaffran ..... In Honor of Michael Lombardi
Deb Martin ..... In Honor of Ray (Fred) Martin
Mark Warren ..... In Honor of Robert Tucker

GREEN FLASH

Weather Observer Alexis George catching some air while sledding down a snowdrift on Feb. 28.

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