Winter 2023-24 Vol. 64 No. 3

WINDswept

The Bulletin of the Non-Profit Mount Washington Observatory


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WINDswept

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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).

Members will receive the three issues of *Windswept* for the year following the quarter in which they join. Please make checks payable to the Mount Washington Observatory and send to Mount Washington Observatory, PO Box 2310, North Conway, NH 03860-2310, or join at mountwashington.org.

Windswept: The Bulletin of the Mount Washington Observatory (ISSN 1098-7215, USPS 330-710) is published three times a year (spring, summer, fall/winter) by the Mount Washington Observatory. Periodical postage paid at North Conway, NH, and additional mailing offices. Editorial office to which all correspondence and address changes should be mailed is PO Box 2310, North Conway, NH 03860-2310 or submit via email to cbuterbaugh@mountwashington.org

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A Year of Exceptional Weather and Meaningful Work

Charlie Buterbaugh

BY **CHARLIE BUTERBAUGH**,
DIRECTOR OR EXTERNAL AFFAIRS

It would be difficult to overstate how busy of a year we have had at the Observatory. The flurry of activity brought with it meaningful work as we built on established foundations and hustled to accomplish new feats.

Following are some notable 2023 highlights.

The year began with our staff and interns attending the American Meteorological Society's Annual Meeting in Denver, where they presented two research posters about near-surface lapse rates and wind and humidity trends. Our staff also gave a presentation at the conference summarizing our development of anemometers for measuring wind on the world's tallest peak, Mount Everest.

January kicked of a busy year in the media as the UK network Channel 4 News visited our weather station as part of reporting Earth's 2022 average surface temperature, released by NASA. Our team was excited to show how our continuous weather observations advance understanding of climate trends in the White Mountains and as part of broader studies.

It was Mount Washington's warmest January on record, with only three days below normal, and a monthly average temperature of 10.3 °F above normal. However, the warm-up quickly transitioned to predictions by our weather observers of potentially record-breaking cold in early February.

The -109 °F wind chill reported on the Observatory's Current Summit Conditions page – on at least three occasions during the February Arctic blast – is arguably the lowest wind chill ever reported in U.S. history. The event attracted media attention from around the world, resulting in stories by Anderson Cooper 360, The New York Times, CNN, the BBC and many other outlets.

Later in February, we hosted Nancy Chen of CBS Mornings, who produced an excellent story about the Observatory's work.

With spring came the publication of our technical overview of the Mount Washington Regional Mesonet in the American Meteorological Society's (AMS) 'Journal of Atmospheric and Oceanic Technology,' Volume 40: Issue 4, written by Brian Fitzgerald, Jay Broccolo, and Keith Garrett.

In July, hikers and sponsors participating in the 23rd annual Seek the Peak raised over $195,000 to propel the Observatory's commitment to real-

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A Look Back at My First Year: Big Plans Ahead

Drew Bush

BY **DREW BUSH,**
EXECUTIVE DIRECTOR

I am writing these words to you as I prepare for the first day of my second year at the Mount Washington Observatory. As you read them at the conclusion of 2023, I hope you will join me in marking a year of progress for our organization as we work to sustain our next 90 years.

Financially, my time here started with a strong endorsement from the Board of Trustees in October 2022 when they met and exceeded their Year-End Campaign challenge gift of $25,000. Our overall campaign exceeded its goal by $10,000. Seek the Peak followed in July 2023, with 120 new hikers present and our goal again far exceeded, this time by $25,000. Finally, our educational programs received a boost that will enable us to work with thousands of kindergarten-through-twelfth-grade students thanks to a generous bequest from the Sheldon Family Estate in June 2023.

We are incredibly grateful to each of you for helping the Observatory to make these strides toward long-term sustainability. Our donors and members make our work possible, more so than at many nonprofit organizations because so many resources go to supporting our 365-days-a-year weather station atop New England's highest peak. Your support ensures we can continue to deliver daily forecasts that keep recreators safe, provide hourly data for the National Oceanic and Atmospheric Administration (NOAA) and university partners, and develop innovative science and research programs for all.

Our donors and members make our work possible, more so than at many nonprofit organizations because so many resources go to supporting our 365-days-a-year weather station atop New England's highest peak.

This year marks great progress, but much more remains to ensure we can sustain this unique organization for many years to come. We have big plans for our research and educational programs, and intend to make our weather services more readily available to media partners in television, print, and radio.

And we'll continue to work to secure support that enables our staff to try new ideas.

To match your commitment to us, we have doubled-down on the research expertise and technology that will improve our core weather services to sustain our legacy of world class science. We've received two federal grants for the next three years—one from the Northern Border Regional Commission and the other from the Environmental Protection Agency—that will modernize our Mount Washington Regional Mesonet and double its size. We'll also be working with a network of groups in the Northeast United States (including University of Vermont and the Appalachian Mountain Club) to use these solar-powered, remote stations to monitor weather across the region.

By taking these steps, we aim to help businesses, communities, governments, and others to plan for extreme weather and changes to our country's climate. We are grateful to US Senator Jeanne Shaheen, and US Representatives Chris Pappas and Ann McLane Kuster for their incredible support of these efforts. They will be integral to improving our forecasts, data quality, and research potential.

Finally, this past year, we have gained new corporate support for our educational programs (from Cormack Construction Management, McLane Middleton Law Firm, and Northway Bank), summit crew's gear and food needs (from Eastern Mountain Sports {EMS}, Minus33, Cabot Creamery Co-Operative, Righteous Vices Coffee Roasters, Peter Limmer and Son), summit internship program (Eversource), unpredictable lodging needs for staff and guests (Cranmore Mountain Lodge), and more. We are grateful to our corporate partners for their willingness to collaborate and drive excellence. Each of these partnerships brings benefits for members as well, which you have begun to see this holiday season.

As I look back on this year, perhaps some of the most memorable first steps we have taken involved middle school students visiting our weather station and Mount Washington State Park to learn with our scientists and educators. I had the honor of helping with logistics for our first pilot educational field trips in May and June of 2023, made possible thanks to the New Hampshire Charitable Foundation's Neil and Louise Tillotson Fund. Showing our summit home to so many young minds I am sure helped make science, technology, engineering, and math (STEM) skills cool, even if just for this once, at the home of the world's worst weather.

Reflecting on the past year, I leave you with a list of a few of my favorite monthly highlights in reverse order from today:

September: Backpack giveaways (which include at-home weather stations, NOAA cloud guides, coupons from EMS, and more) have commenced across our region, and we've handed out more than 800 to students in the North Country of New Hampshire, Vermont, and Maine. Members of our new programs rolled out this Fall will also receive weather stations for their school.

August: We planned a visit from a peer reviewer at the American Museum of Alliance's Museum Assessment Program, who will provide a roadmap report for improving conservation of our archival materials at the Gladys Brook Memorial Library and displays at our summit museum.

July: The weather held for Seek the Peak 2023 and our participants enjoyed Tuckerman Brewing Company's kick-off party before hiking Mount Washington the next day and joining our summit volunteers for tours of our weather station and an Après Party with vendors, food, and live music hosted by our partners at the Mt. Washington Auto Road and Great Glen Trails.

June: We honored Life Trustees Jack Middleton and Guy Gosselin with the first Founders Awards given in our organization's history and celebrated during our Annual Meeting at the McAuliffe-Shepard Discovery Center in Concord, NH.

May: Our summit team completed shift change for the first time via the Mount Washington "Cog" Railway Company (along with partners at New Hampshire State Parks) when the Mt. Washington Auto Road suffered a wash out which was quickly repaired in time for the next week.

April: We hosted senior leadership from Mt. Washington Auto Road and Mount Washington "Cog" Railway Company and their families for an overnight at our summit weather station, along with the New Hampshire State Parks Supervisor. Together we celebrated more than 90 years of partnership.

March: We brought the leaders of EMS to Mount Washington's summit via snow cat to discuss our partnership, and reinvigorate a decades old relationship with new ideas such as a Higher Summits gear line available for public purchase.

February: We tied our record cold temperature on Mount Washington at -47°F with windchills approaching -108°F, garnering international media attention and rallying supporters worldwide.

January: We marked the passing of intern Samuel Gawel with his family at the summit, commemorating his dedication to our organization with a plaque in our living quarters.

December: I attempted to ride our snow cat to the summit, to deliver Christmas treats and other well wishes, but instead spent a memorable time with Observer and Education Specialist Francis Tarasiewicz and Night Observer Alexis George before turning around at Winter Cutoff.

November: Our Board of Trustees held the first retreat of my tenure as Executive Director with Trustee Lourdes B. Aviles (Associate Provost at Plymouth State University) giving a talk on the Great New England Hurricane.

October: We began work to cement a partnership to bring Howard University and Jackson State University students north to join our internship program in meteorology.

Bequest to Fund New Weather and Climate School Programs across New Hampshire

New Hampshire's school children will be the beneficiaries of a generous $4 million bequest from the Sheldon Family Estate to Mount Washington Observatory.

The funds, received in 2023, are being used to offer school educators enhanced support in the teaching of weather and climate science that meets the Next Generation Science Standards.

Remaining monies from the bequest will be used to pay down a portion of the substantial debt held by the Observatory's administrative office building in North Conway, as well as invested in the organization's endowment in anticipation of future expenses.

Eversource Energy Support to Expand Workforce and Diversity Internship Programs

New funding from the Eversource Energy Foundation will increase access for undergraduate and graduate students to participate in Mount Washington Observatory's (MWOBS) weather and climate internship. Eversource support will provide interns with a stipend to cover their time and travel while working on New England's highest peak.

University interns serve as integral members of MWOBS' weather observation team, living and working with trained meteorological staff on weekly shifts at the summit of Mount Washington. Each intern learns technical skills in meteorology, data science, and weather and climate research. Interns also undertake a unique semester-long research project and participate in science communications opportunities.

Funding from the Eversource Energy Foundation will expand MWOBS' longstanding Workforce Training Internship and new Diversity Internship Program, formed in fall 2022 with Howard University and Jackson State University to recruit from these two nationally premier meteorological programs. The Diversity Internship Program is part of MWOBS' larger effort to advocate for diversity, equity, and inclusion and make the summit of Mount Washington more accessible to university students.

New Trustees Appointed

At Mount Washington Observatory's Annual Meeting, held June 24 at McAuliffe-Shepard Discovery Center in Concord, Lesley-Ann Dupigny-Giroux and Hayley LaPoint were appointed new trustees.

Dr. Lesley-Ann Dupigny-Giroux

Hayley LaPoint

Dr. Dupigny-Giroux has served as the Vermont State Climatologist since 1997 and is the immediate Past President of the American Association of State Climatologists.

WMUR Meteorologist Hayley LaPoint grew up in Topsfield, MA and attended Lyndon State College in the Green Mountains of Vermont.

Learn more about our trustees at mountwashington.org.

Mount Washington Regional Mesonet Will Be Modernized and Expanded

Funding announced by the Northern Border Regional Commission in early September will allow the Observatory to upgrade 11 Mount Washington Regional Mesonet stations and add 18 new stations over the next three years.

This will advance our forecasting, provide rich data across mountainous terrain, facilitate research with partners, and help our region's businesses plan for economic development.

The Observatory was also awarded funding as part of a network of groups working on an Environmental Information Exchange Network Grant from the Environmental Protection Agency, which will establish high-elevation observation of weather across the Northeast. This network will be integral to data needed for our region to prepare for extreme weather and changes to climate.

Continued from page 4

time weather data and forecasting in the White Mountains. More than 290 participants raised funds in the lead-up to completing their hikes and gathering for the Après Hike Party on July 15. Thirty sponsors provided support for the event, with 22 organizations exhibiting in the vendor village and many contributing gear and outdoor experiences to the event raffle.

Summer 2023 proved to be a season of weather extremes. June surpassed the Observatory's snowfall record for that month, and July experienced record rainfall. As of Aug. 9, last summer had become the wettest on record, with the summit receiving more rain than any other summer since our data set began in 1932. The extreme weather was joined by numerous air quality warnings resulting from wildfires in Canada.

In September, our Education Team launched a full suite of school day, afterschool, virtual, and field trip programs, which kicked off with a backpack giveaway, providing free Cotopaxi backpacks with home weather stations, NWS cloud charts, and weather safety materials to hundreds of middle school students across northern New Hampshire and western Maine.

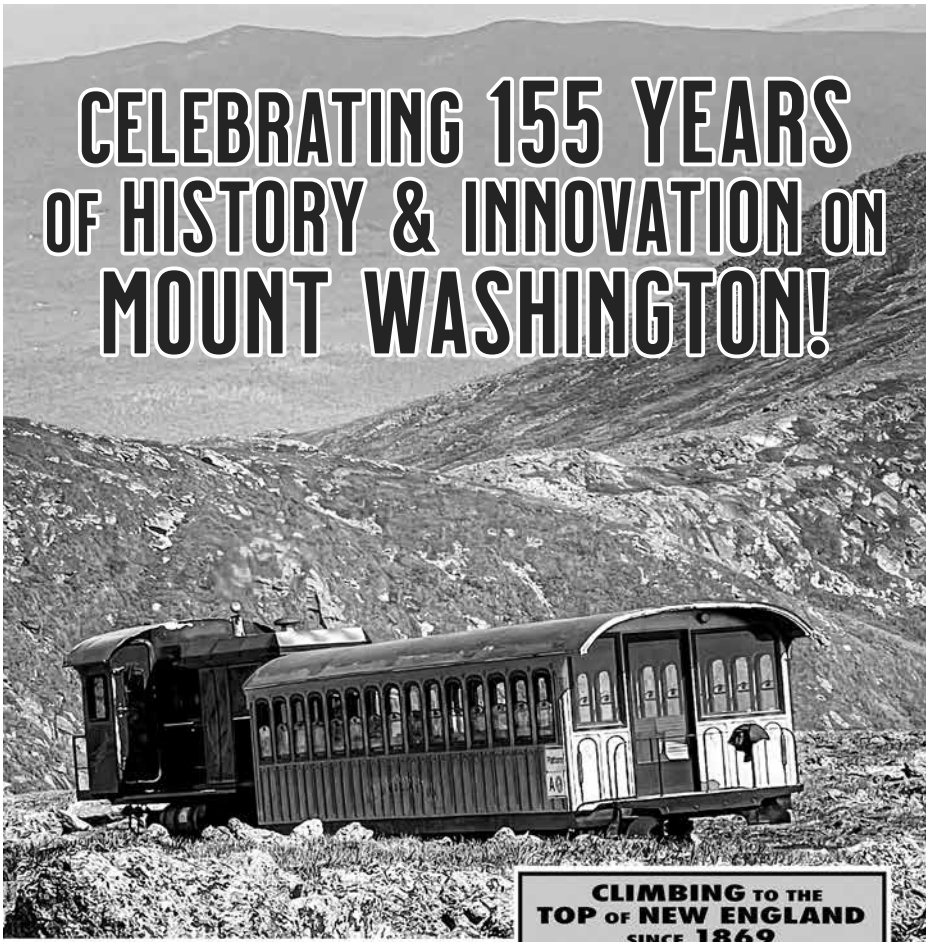
In October, the Observatory launched a new website at mountwashington.org. Our Fall Gathering was held at the end of October, including a hybrid in-person and virtual Science in the Mountains, featuring the 2024 Solar Eclipse presented by John Gianforte, Director of the University of New Hampshire Observatory. The event took place at Tin Mountain Conservation Center, where the Board of Trustees held their annual retreat the following morning.

In November, we announced a first-of-its-kind, 16-week immersive internship in collaboration with the Mount Washington Avalanche Center (MWAC). Select undergraduate and graduate students will get hands-on experience at the MWAC and Observatory's summit weather station, allowing meteorology students to apply their knowledge in challenging real-world scenarios.

The Observatory's annual Year-End Campaign also began in November, with the goal of raising $270,000 by Dec. 31 to sustain the nonprofit organization's work in three impact areas: Scientific Research & Technology, Education & Outreach, and Recreation & Safety.

As December began, two of our generous volunteers, Mike and Sue Zlogar, helped us bring a Christmas tree to the summit, an annual tradition that helps our summit staff celebrate the season as they carry out the responsibility of continuous weather observation in Mount Washington's extreme environment. They support each other to accomplish this, alongside their forecasting, research, and educational work.

2023 was an exceptional year for the Observatory. We could not have accomplished any of the above, and so much more that took place during the course of the year, without your generous support. Thank you for all that you do.



The Mount Washington Cog Railway is one of the world's great rail adventures, and an exhilarating journey through history, technology and nature. Throughout the year, we'll be celebrating the men and women who imagined, built, maintain and continue to grow this remarkable example of American ingenuity.

For year-round schedule, tickets, special anniversary events and much more, please visit **thecog.com**

We're proud to support our summit partners at the Mount Washington Observatory in their mission to perform vital climate and weather research in one of the fiercest environments on the planet. You can help– learn more at **mountwashington.org/donate**

Briggs Bunker

BY **PETER CRANE**

The White Mountain community of weather enthusiasts lost a cherished member on September 9, when Briggs Bunker, 92, of North Conway succumbed to a long illness.

A North Conway native who served in the U.S. Air Force and worked as a U.S.A.F. Air Traffic Controller, Briggs for many years was the National Oceanic and Atmospheric Administration/ National Weather Service cooperative weather observer for the Conway/ North Conway area. He served in that position starting just after the death of Joe Dodge, a founder of the Observatory, who was the local co-op observer from 1959 until his death in 1973. Briggs retired from that position in 2006, passing the baton to Ed Bergeron, a Trustee of the Observatory, who transferred that responsibility to the Observatory in 2015. In his career as a co-op observer, Briggs made about 12,000 weather observations.

Briggs was well known as a key part of "The Morning Weather Show" on local radio station WMWV. Following a tradition established by Joe Dodge, each morning he would share with the listening audience his weather observations and the National Weather Service forecast for the area, and would offer a "rating for the day," ranging from a mere nickel for a miserable day to fifty cents for a day with blue skies and sunshine. Voices were hushed around kitchen tables each morning on the Eastern Slope as listeners awaited Briggs' judgement on the worth of the day's weather.

Briggs was a plumber by profession, and

Mount Washington Observatory Executive Director Drew Bush, left, Roy Prescott of 93.5 WMWV, Briggs Bunker, Observatory Trustee Ed Bergeron, and Observatory Director of Education Brian Fitzgerald attended a ceremony in April to recognize Briggs' service to the community.

once used his skills to help the Observatory at a particularly awkward moment. Briggs was a participant in an Observatory winter EduTrip in January of 1994. Very cold and windy weather forced the trip to remain on the summit for two additional nights, and the surge of use troubled the Observatory's sanitary arrangements. No worries, as Briggs was more than willing to use his professional experience to solve the problem.

A number of Observatory staff members were honored to participate in a ceremony at Briggs' home in April of 2023 to recognize his service to meteorology in the community, and to accept his gift of a thermometer shelter, which he had used in the course of his daily observations for many years. The shelter has been refurbished and put into service atop Mount Washington, a fitting place for such a suitable memorial for a fellow weather professional. Briggs received an added and well-deserved honor of being named a "White Mountains Treasure" by the Mount Washington Valley Chamber of Commerce, with that designation being awarded posthumously in October 2023.

In addition to his weather service, Briggs also was active in the community, volunteering for several non-profit organizations and serving in town government as well.

Briggs and his wife Bobbi also served for many years as volunteers helping out at the Observatory's valley office; his son Mark has also volunteered at the Observatory's North Conway weather station. Briggs was a good man who is greatly missed, and the Observatory sends our heartfelt condolences to all his family and friends.

Director of Weather Operations Jay Broccolo and Weather Observer Charlie Peachey help Facilities Manager Greg Fitch install the thermometer shelter that was donated to the Observatory by Briggs Bunker.

My 9 to 5

TRANSLATED BY
CHARLIE PEACHEY

My humans on the summit have told me many of our visitors are worried I am trapped in the observatory all day. They want to know my daily schedule to ensure I am not confined 24/7. I figured this would be the purrfect time to tell everyone about my daily routine and clear up any confusion.

My daily routine

4:30 am: Wake up and wait in the food pantry's corner until the night observer visits. Once they are nearby, I cry until I am fed my first breakfast.

If they don't hear me cry, I shout louder and louder until I get my Purina Cat Chow food. If they feed me Meow Mix cat food, I will refuse to eat it

5:00 am: Begin my early-morning self-cleaning.

5:30 am: Curl up on the couch and wait for the morning observers to wake up. As soon as they wake up, I start crying again until they feed me my second breakfast.

If they fail to cooperate, I show them my angry face to convey my dissatisfaction.

8:00 am: Check if the door to the State Park's living quarters is open. If it is, I search for one of their humans and cry until they feed me brunch.

If the door isn't open, I climb into the cabinets to try and find my own food.

10:00 am: Early afternoon self-cleaning.

11:00 am: Sit at the bottom of the weather tower and scream loud enough for everyone in the observatory to hear until someone responds. I want to go outside and find a mouse for a mid-afternoon snack.

If the weather isn't perfect, I make the observers wait several minutes while I stare into the distance before running back inside.

3:00 pm: Visit the weather observers in their office towards the end of their shift and pester them until they feed me my lunch or play with me.

If they don't give me what I want, I sit directly on top of whatever they're working on as a sign of protest.

If they give me what I want, I curl up into their lap to show them my devotion.

5:00 pm: Begin my early evening cleaning.

6:30 pm: Sit by my food bowl while the humans have family dinner and show them my angry face because they are rude for eating without me. If that continues, I begin eating their fallen food scraps.

When they feed me, I ignore them until I'm done eating since food is more important.

8:00 pm: Begin my bedtime self-cleaning and find a comfy couch to sleep on for the night.

FEATURE

Hurricanes and Mount Washington

BY **KARL PHILIPPOFF AND FRANCIS TARASIEWICZ**

September 21st was the 85th anniversary of the most devastating tropical cyclone to ever hit New England during the modern era. While officially unnamed, this hurricane goes by various names in New England weather lore, most famously as "The Long Island Express" due to its astonishing forward speed of 47 mph at landfall. This furious northward movement allowed the hurricane to maintain much of its strength when it struck near Bellport, NY, sometime between 2:00 and 2:40pm. It hit as a Category 3 hurricane with sustained winds of 120 mph and a minimum pressure of 941mb, and was the strongest hurricane to make landfall in New England since the 1800s. Rhode Island experienced the highest storm surge as it struck, with water levels rising over 17 feet in just a few hours, devastating homes and claiming lives. The force of water and high waves crashing against the southern New England coastline were so powerful that seismographs in Alaska recorded them.

The hurricane's powerful winds carved a destructive path from Long Island to the White Mountains, demolishing homes, forests, and even damaging a section of Jacob's Ladder on the Cog Railway. Blue Hill Observatory recorded a peak gust of 186 mph, ranking second only to Mount Washington's 231 mph gust at the time. This gust remains one of the strongest ever directly measured in a hurricane. Mt. Washington itself recorded a peak wind gust of 160 mph, as well as several hours of sustained hurricane-force winds.

Renowned for its sub-arctic climate and extreme cold, Mount Washington might be one of the last places you associate with hurricanes. However, the summit's location makes it more susceptible to tropical system impacts than you might imagine. Nestled in the mid-latitudes, the White Mountains are affected by weather phenomena that originate in both the Arctic and the Tropics. While snow and rime ice typically bring extreme weather to the mountain, our extensive dataset reveals that Mount Washington has weathered impacts from more than 70 tropical systems since 1935, and more than 140 since 1850. In this article, we will summarize some of the weather experienced by the summit and statistically describe these tropical systems as they tracked close to Mount Washington, with a particular emphasis on those that have passed since 1935.

Hurricane Lee, as it tracked toward the summit in mid-September this year, sparked an investigation into all the tropical systems, and tropical systems that had transitioned into extratropical cyclones, that had moved near Mount Washington and what effects those systems had on weather at the summit. We

used the HURDAT2 database, which contains the tracks of all the tropical systems which have formed over the North Atlantic Ocean since 1851 (Website: coast.noaa.gov/hurricanes), high-resolution surface analyses dating back to January 1st, 1985, and our own daily weather forms, specifically B-16's, which are easily interpretable back to 1935, for this analysis.

We accessed the HURDAT2 database and searched for all tropical systems, and tropical systems that had transitioned into extratropical storms, that had tracked within a 100 and 200 nautical mile radius of Mount Washington. The HURDAT2 database extends back until 1851 for the entire North Atlantic Basin, and typically includes track information (e.g. position and maximum wind speed) which is updated every 6 hours over the life of the system from its birth as a tropical depression until it dissipates, either as a tropical system, or after it transitions into an extratropical storm. The 200 nautical mile limit was thought to be sufficient to capture the tropical systems that had the greatest impact on weather on Mount Washington. This was supported by the fact that, in general, the systems that tracked within 100 nautical miles had a much greater impact on summit weather than those that passed between 100 and 200 nautical miles from the summit, especially in terms of peak wind speeds and duration. For example, 13 of the 28 systems that tracked within 100 nautical miles had peak wind gusts equal to or exceeding 100 mph, while only 3 out of 42 systems that tracked between 100 and 200 nautical miles from the summit had peak wind gusts of the same magnitude. There were two exceptions to this criteria that were included in the records tables, but not in the storm track data: Hurricane Lee (2023) and Hurricane Sandy (2012). The center of Hurricane Sandy only passed within approximately 320 nautical miles at its closest approach, while Hurricane Lee passed just outside the 200-mile limit at 213 nautical miles. Both systems were noted to have extremely large wind fields, however, so while the list is not exhaustive, it likely contains the vast majority of systems that have had the greatest impacts on weather on Mount Washington, without extending the radius out too far to track systems that had only minor influences on summit weather.

After finding the dates of the systems that had tracked within the given radius, we then proceeded to estimate the time horizon over which the system influenced the weather on Mount Washington. This was first done by using the HURDAT2 data to determine when the systems were within approximately 200 nautical miles of the summit. This was then further refined by the use of high-resolution surface analyses (updated every 3 hours). We did this primarily by looking at isobars (lines of equal surface pressure), and how they seemed to shift in response to the oncoming system (beginning time) and when the system had moved far enough away that it was no longer affecting weather at the summit (ending time). Then the weather records on the summit were examined to look for wind shifts and/or winds ramping up or down in response to the influence of the system. Usually the estimates based on the different methods were fairly close, with the summit weather records acting as the tiebreaker, as they were updated hourly and were the most highly resolved of the three methods. Sometimes the

shifts were subtle, with the transition between the influence of the tropical system and other systems indistinct, leading to somewhat subjective beginning and ending times. However, for the most part, these times only changed the duration of tropical storm-force winds and the amount of rainfall attributed to the tropical system, not the peak winds associated with the system. Before 1985, we were only working with summit weather records and the track information derived from the HURDAT2 database, which made these estimates slightly less accurate and precise. And before the advent of easily decipherable summit data in 1935, only the track information from the HURDAT2 dataset was available. Therefore, only the track statistics from 1851-1934 are included, without any estimates of what summit wind speeds or precipitation would have been had the Observatory been in operation.

Once the duration of the influence of the system on the summit had been determined, several items of interest about the weather experienced on the summit were noted, including how much precipitation occurred, the peak wind gust on the summit, its direction, the highest hourly average sustained wind and its direction, and the total number of hours the summit experienced winds at or above tropical storm-force (>=39mph) and hurricane-force (>=74mph).

Without further ado, here is a brief write-up of the results and several tables that may be of interest; as to our knowledge, this kind of statistical deep dive into summit weather records has not been done before.

Mount Washington is usually most noted for its high wind speeds, but out of the 70 tropical systems to have tracked within 200 nautical miles of the summit since 1935, only 17 produced wind gusts >= 100 mph, or about 1 every 5 years. This is quite a small number considering that the summit averages wind gusts >=100 mph every 4th day during the winter season. Table 1 provides a summary of the peak wind gusts measured on Mount Washington associated with tropical systems. While the strength of the systems within 200 miles of the summit, as determined by their Saffir-Simpson category, did not seem to have an overwhelming influence on the wind speeds experienced on the summit, nearly all the systems had been category 3, or 'major,' hurricanes at some point in their development. One potential reason for this is the highest hurricane category attained may have indicated the overall strength of the system. This strength, at least for these systems, was retained even as the systems began to undergo extratropical transitions which expanded their surface wind fields, and decreased their maximum surface winds, which is commonly the case when tropical systems reach the latitude of Mount Washington. In addition, some of the systems might have had winds directed in ways that were substantially topographically enhanced, as may have been the case with Isaias's SE winds in 2020. These systems also tended to have long tracks and begin in the southern North Atlantic heading gradually west to northwest before accelerating northward up the Atlantic Seaboard toward New England, with few of the storms tracking through the Gulf of Mexico or the Caribbean Sea (See Figure 1). One additional piece of information is that the peak gusts associated with Isaias and David represent the

highest wind speeds ever recorded on Mount Washington during the months of August and September, respectively.

Similarly, only 13 tropical systems have produced hourly average sustained winds greater than hurricane force (>=74 mph) (Table 2), with very few producing these winds for longer than a handful of hours (Table 3). This is mostly due to the forward speed of the systems after they reached the latitude of Mount Washington. By this point, most systems are being caught by the jet stream and accelerated northward and/or eastward, leaving them in the vicinity of Mount Washington for only a few hours near peak intensity. Several systems have been associated with long durations of tropical storm-force winds (>= 39 mph) at the summit (Table 3), though this may be due to the fact that the average wind speed at the summit over the entire year is 35 mph and averages 28 mph during September, only slightly below the tropical storm-force threshold. Thus, these systems sometimes only have to have a marginal influence on summit weather to exceed this threshold.

At least 140 tropical systems have passed within 200 nautical miles of Mount Washington and affected its weather in some way since 1851 (Table 5), with the breakdown being 59 extratropical storms, 6 tropical depressions, 43 tropical storms, and 26 hurricanes. In general, the hurricanes that have tracked within 200 nautical miles move similarly to those that produced the highest wind gusts, with most of them originating in the southern North Atlantic, areas north and east of the Greater Antilles, and off the Southeastern US coast, with nearly all the hurricanes paralleling the Eastern Seaboard on their journey toward southern New England (Figure 2). The overall number of systems affecting the summit per year is actually quite similar over the full record (since 1851) versus since we have accurate summit records (since 1935) at about 4 systems every 5 years. There have been 82 years without any tropical activity, and 90 years with at least one system tracking within 200 nautical miles (Table 6). The greatest number of tropical systems in a single year is 5, which has occurred twice in 2021 and 1888. The most consecutive years that tropical systems have affected the summit is 9, which occurred between 1874 and 1882, whereas the greatest break between tropical systems has been slightly less than 7 years between October 1851 and September 1858, with 2 breaks of slightly over 6 years (Sept. 1979→Sept. 1985 and Aug. 1917→Oct. 1923). The strongest hurricane by category to track within 200 nautical miles of the summit is a category 3, which has occurred 6 times since 1851, and 2 times within 100 nautical miles since 1935, with one of those being the 1938 hurricane.

The median date for tropical systems to track within 200 nautical miles of the summit over the entire record is September 11th (Table 7). This is nearly the exact date of the climatological peak of tropical cyclone activity in the North Atlantic Basin, which is September 10th. Hurricane activity since 1851 peaks on the exact same date (9/11), whereas tropical storm activity peaks a bit earlier (9/6), while extratropical cyclone activity peaks a bit later (9/14). What is a bit surprising is that across all categories of systems, the median date of influence has shifted a bit earlier since 1935, with a

drastic decline in the number of systems in October being the primary culprit.

And finally, the greatest amount of precipitation to fall in a tropical system is 9.54" associated with tropical storm Floyd in 1999 (Table 8). Since many of the tropical systems have picked up some momentum by the time they reach the latitude of Mount Washington, relatively little precipitation has been associated these systems as a whole, especially when considering the average amount of precipitation that falls on Mount Washington in August (7.72"), September (7.66"), and October (9.99").

Table 1: Top 10 Peak Wind Gusts (since 1935)

Number	Name	Year	Peak Gust (mph)	Top Category attained	Top Category within 200 n. mi. of Mt. Washington	Wind Direction
1	David	1979	174	5	Tropical Storm	SE
2	Unnamed	1938	160	5	Category 3	SE
3	Isaias	2020	147	1	Tropical Storm	SE
4	Carol	1954	142	3	Category 3	ENE
5	Sandy*	2012	140	3	n/a	E
6	Floyd	1999	128	4	Tropical Storm	NW
7	Gloria	1985	127	4	Category 1	SE
8	Irene	2011	120	3	Tropical Storm	W
9	Frederic	1979	119	4	Extratropical Storm	SW
10	Bob	1991	115	3	Category 2	N

*Peak wind gusts on Mount Washington associated with tropical systems since 1935. Peak wind gusts are measured in miles per hour (mph). The 'Top Category Attained' column refers to the peak strength of the system as determined by its peak sustained surface wind speed in terms of the Saffir-Simpson categorical ranking system at any time of the system's development. The 'Top Category within 200 n. mi. of Mt. Washington' refers to the highest Saffir-Simpson category the tropical system had at any point within a 200 nautical mile radius of the summit. *'s indicate systems that never tracked within 200 nautical miles of Mount Washington.*

Table 2: Top 10 highest sustained winds (1-hour average)

Number	Name	Year	Highest hourly avg. wind speed (mph)
1	Unnamed	1938	118
2	Sandy*	2012	104
3	Irene	2011	96
4	David	1979	94
5	Floyd	1999	93
5	Carol	1954	93
7	Doria	1971	87
8	Donna	1960	82
9	Ike	2008	81
10	Hugo	1989	80

*Top hourly average winds associated with tropical systems since 1935. Hourly average wind speed is in miles per hour (mph). *'s denote systems that did not track within 200 nautical miles of Mount Washington.*

Figure 1:

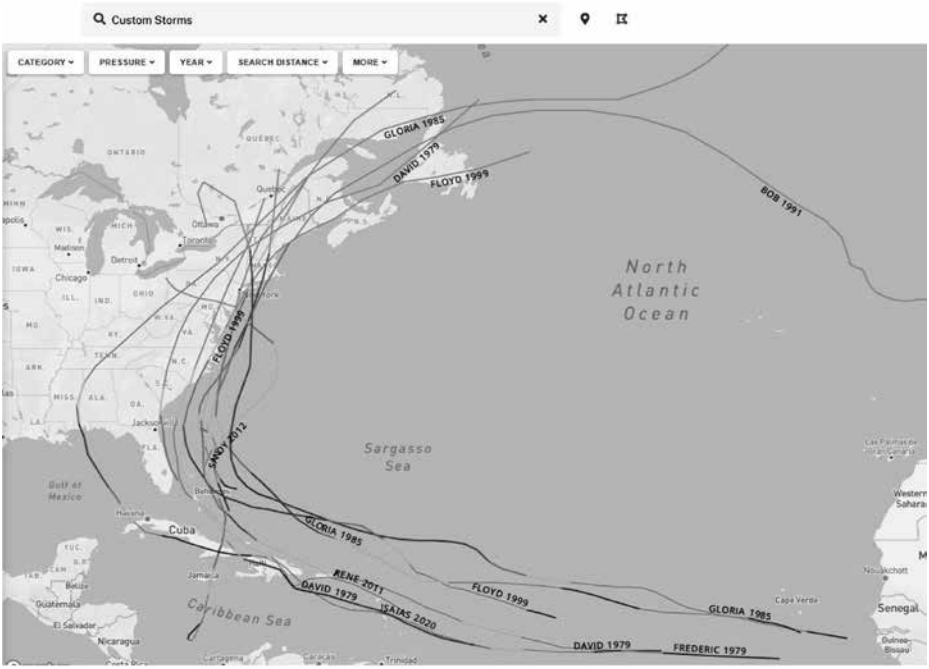


Figure showing the tracks of the 10 tropical systems which have produced the highest wind gusts recorded on Mount Washington since 1935. Note their origination locations and their long westerly tracks before accelerating up along or just off the Eastern Seaboard, with the exceptions of Hurricane Sandy (2012) which made a substantial westerly turn and made landfall in southern New Jersey, and Hurricane David, which made landfall along the Gulf Coast before tracking toward New England. The colors denote the strength of the system. Portions of the tropical cyclone track in which the tropical cyclone was a tropical depression are colored blue, with tropical storms in green, category 1, 2, 3, 4, and 5 hurricanes in yellow, orange, red, magenta, and purple, respectively, and extratropical storms in gray.

Table 3: Top 10 longest duration hurricane force wind speeds (hourly average winds>=74 mph)

Number	Name	Year	# of hours
1	Unnamed	1938	13
2	Sandy*	2012	12
3	Floyd	1999	9
4	Irene	2011	7
5	Gloria	1985	6
5	Carol	1954	6
5	Hugo	1989	6
8	David	1979	5
9	Doria	1971	4
9	Unnamed	1968	4

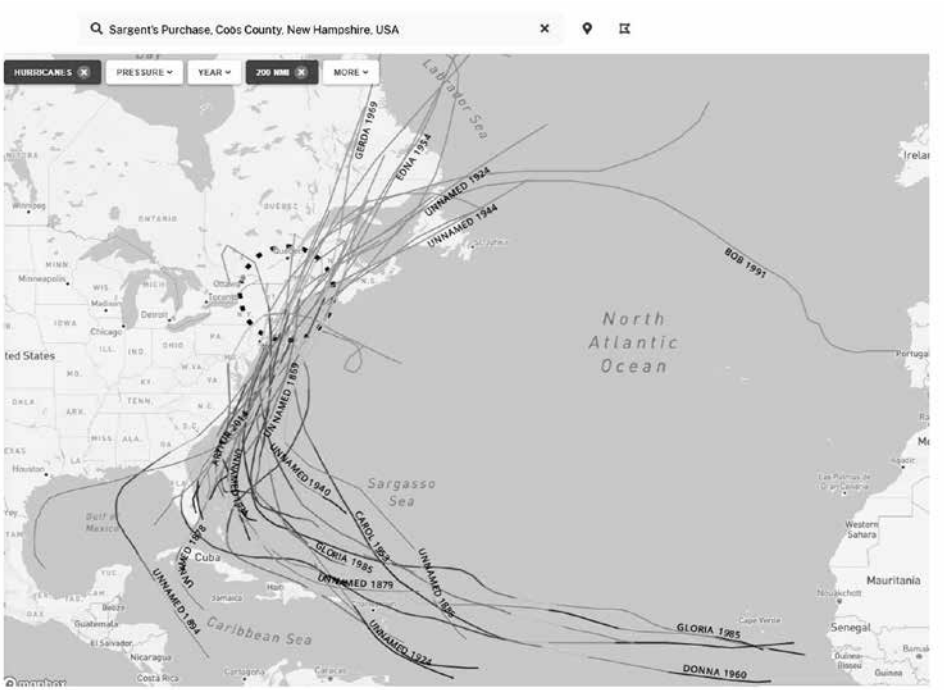
*The longest durations of hurricane force winds (>=74 mph) recorded at the summit associated with tropical systems since 1935. The number of hours is the summation over the duration of the influence of the tropical system as defined within the text, and need not be consecutive. *'s denote systems that did not track within 200 nautical miles of Mount Washington.*

Table 4: Top 10 longest duration tropical storm force wind speeds (hourly average >= 39 mph)

Number	Name	Year	# of hours
1	Sandy*	2012	75
2	Gloria	1985	47
2	Hugo	1989	47
4	Floyd	1999	44
5	Isaias	2020	42
6	Doria	1971	41
6	Wanda	2021	41
8	Arthur	2014	40
9	Lee*	2023	39
10	Carol	1954	37

*The longest duration of tropical storm force winds (>=39 mph) recorded at the summit associated with tropical systems since 1935. The number of hours is the summation of over the duration of the tropical system as defined within the text, and need not be consecutive. *'s denote systems that did not track within 200 nautical miles of Mount Washington.*

Figure 2:



Map of all 26 hurricanes that were still classified as at least a category 1 hurricane within 200 nautical miles of Mount Washington since 1851. The colors on the track follow the same color scheme as that on Figure 1. The dotted circle represents a circle with a 200 nautical mile radius centered around Mount Washington. Note the track of nearly all tropical systems offshore and parallel to the Eastern Seaboard before impacting southern New England. Also note the scarcity of tracks in the Caribbean Sea and the Gulf of Mexico.

Table 5: Number of storms tracking within a given radius of the summit within a given time interval of a given type or Saffir-Simpson category.

	Within 200 n. miles		Within 100 n. miles	
Saffir-Simpson Category	**Since 1851**	**Since 1935**	**Since 1851**	**Since 1935**
Extratropical Storm	59	30	18	10
Tropical Depression (<39 mph)	6	4	1	0
Tropical Storm (39 mph→73 mph)	49	24	22	12
Category 1(74 mph → 95 mph)	17	7	5	3
Category 2(96 mph→110 mph)	3	1	2	1
Category 3(111 mph → 129 mph)	6	4	4	2
Totals:	140	70	52	28
Tropical systems/year	0.81	0.80	0.30	0.32
Hurricanes/year	0.15	0.14	0.06	0.07
Tropical Storms/year	0.28	0.27	0.13	0.14
Extratropical Storms+TD's/year	0.38	0.39	0.11	0.11

Number of tropical systems of a given Saffir-Simpson category that have tracked within 200 nautical miles (first 2 columns) and within 100 nautical miles (second 2 columns) of Mount Washington since 1851 (first of the 2 columns) or since 1935 (second of the two columns). The wind speed cutoffs for the different Saffir-Simpson categories have been provided in parentheses in the leftmost column. No systems of greater than category 3 strength have been recorded since 1851. The last four rows describe the number of a given type of system that would be expected to occur during a typical year, with 'tropical system' referring the summation of hurricanes, tropical storms, depressions, and tropical systems that have transitioned into extratropical systems.

Table 6: Years with a given number of tropical-derived systems tracking within 200 nautical miles of Mount Washington.

# of tropical systems	# of years
0	82
1	55
2	26
3	5
4	2
5	2

The number of tropical systems that have tracked within 200 nautical miles of the summit in terms of systems per year. Slightly more than half (90/172) of all the years since 1851 have had at least one tropical-derived system that met this criteria.

Table 7: Summary of the dates of influence of tropical-derived systems that have tracked within 200 nautical miles of Mount Washington.

	All tropical systems		Hurricanes (1->3)		Tropical Storms		Extratropical Storms + Tropical Depressions	
Month	Since 1851	Since 1935	Since 1851	Since 1935	Since 1851	Since 1935	Since 1851	Since 1935
May	4	1			1		3	1
June	9	5					9	5
July	10	8	2	1	6	5	2	2
August	29	17	6	3	15	9	8	5
September	56	33	16	10	20	10	20	13
October	30	7	3		6		21	7
November	4		1		1		2	
February	1	1					1	1
Totals:	143	72	28	14	49	24	66	34
Median date	9/11	9/4	9/11	9/9	9/6	8/30	9/14	9/8
25th percentile	8/20	8/9	8/30	8/31	8/20	8/8	8/5	7/17
75th percentile	9/30	9/16	9/25	9/14	9/24	9/9	10/6	9/21
PERCENTAGES								
May	2.8	1.4			2.0		4.5	2.9
June	6.3	6.9					13.6	14.7
July	7.0	11.1	7.1	7.1	12.2	20.8	3.0	5.9
August	20.3	23.6	21.4	21.4	30.6	37.5	12.1	14.7
September	39.2	45.8	57.1	71.4	40.8	41.7	30.3	38.2
October	21.0	9.7	10.7		12.2		31.8	20.6
November	2.8		3.6		2.0		3.0	
February	0.7	1.4					1.5	2.9

Summary of the dates of influence for tropical-derived systems on Mount Washington. Dates were determined using only the HURDAT2 dataset before 1935, and with a combination of the HURDAT2 dataset, summit weather records (since 1935), and high-resolution surface analyses (since 1985) from 1935 to 2022. The top half of the table represents the number of systems that tracked within 200 nautical miles of Mount Washington during each month. If the system's influence began during August and extended into September, for the purposes of this table, it was counted as part of August and September. This only occurred 3 times since 1851. Tropical systems were divided into hurricanes, tropical storms, and extratropical storms and depressions. The median date of influence is shown below the totals, with 50% of the systems influencing the summit between the dates represented by the 25th and 75th percentiles. The percentage makeup of the numbers of tropical systems is displayed in the bottom half of the table.

Table 8: Top 10 highest Precipitation events associated with a tropical system tracking within 200 nautical miles of Mount Washington since 1935.

Number	Name	Year	Precipitation total (in.)
1	Floyd	1999	9.54
2	Irene	2011	6.78
3	Bob	1991	6.63
4	Gloria	1985	6.03
5	Sandy*	2012	5.79
6	Donna	1960	4.94
7	Bertha	1996	4.75
8	Frances	2004	4.52
9	Belle	1976	4.43
10	Edna	1954	4.42

*The greatest precipitation totals recorded at the summit associated with tropical systems since 1935. The totals represent a summation of hourly precipitation totals recorded over the duration of the tropical system as defined within the text. *'s denote systems that did not track within 200 nautical miles of Mount Washington.*

Jo-Ann Driscoll Helps Observatory Prioritize Safe Access to Summit

BY **CHARLIE BUTERBAUGH**

In the White Mountains, where weather creates the unique combination of stunning beauty, exhilarating recreation, and risk for the unwary, Jo-Ann Driscoll feels at home helping others.

She has led many kids on hikes and ski-camping trips in the Northern Presidential Range and volunteered with the White Mountain National Forest's Trailhead Steward Program since its inception almost 10 years ago.

On weekend mornings, Driscoll can often be found at the Appalachian Trailhead, where she generously shares her time greeting hikers, talking about their planned routes, and highlighting the day's Higher Summits Forecast from Mount Washington Observatory.

Driscoll volunteers her time with the Trailhead Steward Program, fielding hikers' questions about trail routes and informing visitors about weather above treeline, which is often wildly different than at trailheads.

"I try to get them to the point where they're willing to think about turning around once they stick their head above tree line," Driscoll said. "The mountains will be here. Next time, we want you to be." – is a punchy phrase lined with the concern of a seasoned hiker, meant to make others think about the risk-reward balance on the White Mountains' higher summits.

A long-time Observatory supporter, Driscoll came forward with a major gift three years ago to meet a critical transportation need. The organization's 4x4 pickup truck was aging and in disrepair, and she felt compelled to step in and ensure safe passage for weather observers to and from the summit.

"We can push this. We can make it happen," she recalls thinking.

The truck plays a vital role, particularly during the shoulder seasons of spring and fall when snow and ice conditions change from day to day on

Jo-Ann Driscoll helped the Observatory purchase this new 4x4 Chevrolet Silverado with V-plow in 2021.

the Mount Washington Auto Road. The Observatory's snow tractor is parked at higher elevations to prevent it from damaging bare sections of the road where snow has melted or not accumulated yet.

The truck does well navigating patches of ice and plowing a path to the snow cat, which is used to traverse the upper reaches of the auto road during shift change, when observers relieve their teammates who have worked all week at the summit weather station.

This mix of transportation modes can get complicated as weather varies drastically with elevation gain and the snow cat needs to be maintained, and started, in a remote location. The team relies heavily on the versatility of a 4x4 truck, in addition to collaboration with the Mount Washington Auto Road and Mount Washington State Park.

Changing climatic patterns being studied by the Observatory include precipitation trends and extreme weather events during shoulder seasons and other times of the year. Better understanding of these trends will help communities, businesses, and organizations like the Observatory plan for evolving seasonal conditions.

The Observatory and its focus on studying mountain weather have been close to Driscoll's heart since she started hiking in the White Mountains in the 1970s. She and her husband David loved ski camping, and they covered most of the mountain range

during their winter adventures.

They spent as many weekends as possible in the mountains, and their "amorphous plan" to eventually retire in the area took shape when they purchased a 350-square-foot A-frame. They built a substantial part of their life here, moving their home base several times, always with an eye toward spending more of their lives in the mountains.

Driscoll is shown hiking in England.

Their 15 nieces and nephews – David was the oldest of seven siblings – grew up learning to hike and ski in the northern Presidentials and other parts of the White Mountain wilderness. Jo-Ann and David frequently took three to four kids ski-camping to Zealand Hut and other remote locations.

The kids have grown up and are now passing the outdoor traditions they learned from their Aunt Jo-Ann and Uncle David to the next generation. David passed away in 2012, and his ashes are on Mount Washington. Every summer, family members gather for a hike to Appalachian Mountain Club huts, in memory of David.

Driscoll now lives in Jackson with a beautiful view of the tallest peak in New England.

"David can keep an eye on me, and I can keep an eye on him," she said.

Their shared love of volunteering led them on many trips to places like Indonesia, the Philippines, Japan, Bangladesh, and Haiti where they helped communities recover from disasters like hurricanes, typhoons, earth quakes, and volcanoes.

Driscoll has made it a priority of her life to help others find their way safely through mountains. It made perfect sense that she would feel compelled to ensure the Observatory had a reliable vehicle to withstand harsh conditions during shoulder seasons – and to prevent any interruptions in the Observatory's daily mountain forecasting and continuous collection of data for weather models, meteorologists, and climate researchers.

Many things are riding, quite literally, on the vehicles that carry Observatory staff to and from the summit. Driscoll's gift, combined with additional generous support from the Vela Foundation and Berlin City Auto Group, allowed the Observatory to purchase a 4x4 Chevrolet Silverado with V-plow in 2021, replacing a 20-year old truck.

We're incredibly grateful for Jo-Ann Driscoll's generosity.

For the Love of a Mountain: In Memory of Aurelie Druckenmiller

BY **ELLEN ESTABROOK**

"This is our mountain."

After hiking up Tuckerman Ravine Trail, a 14-year-old girl named Aurelie turns to her younger brother on the summit of Mount Washington in 1949, offering assurance and a lifelong promise.

In this feature, with the aid of her oldest daughter, Kathleen, and younger brother, Jack Heffernan, we shine a light on Aurelie Druckenmiller, whose love of mountains and all of nature would lead to a life of adventure and an affinity for a mountain she would introduce to so many. This grace and guidance has touched generations and is rooted in both a love for the outdoors and formative New England childhood experiences; though there is one mountain in particular with which she had a special connection, and that was Mount Washington.

Aurelie's outgoing disposition traces back to her early childhood years when she was known to go knocking on neighbor's doors looking for friends or sneaking into The Explorer's Club to hear the historic 1953 lecture by Everest expeditioners Tenzing Norgay and Ed Hilary. As a young adult, Aurelie was undoubtedly a people person with a penchant for following her own compass.

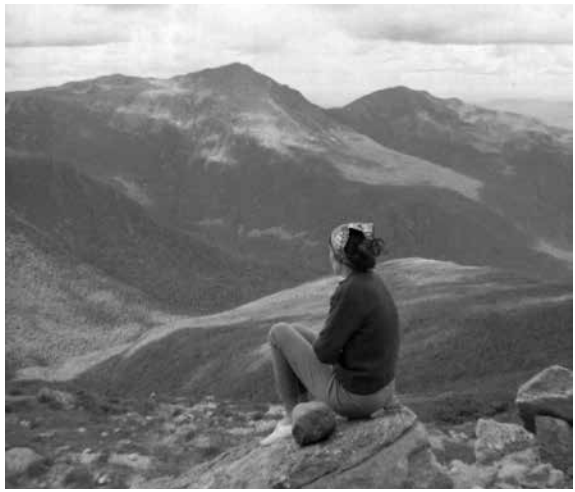
It was one of those neighbors who happened to own summer sleepaway camps in Maine, which is how she was invited to the camps she (and her brother) would go back to summer after summer. Aurelie's affinity for the outdoors was realized at these Maine summer camps in her youth; first Camp Bendito and then Tawasi, both all-girls sleepaway camps (which as her daughter Kathleen describes, were a big deal at the time). She was first introduced to the highest peak in the northeast on group hikes here, and with each passing summer she climbed the ranks from camper to counselor to guide, ultimately leading campers, and many others, up that very mountain every summer for years to come. Her brother, who had also grown to lead trips for the affiliated nearby boy's camp, remembers with a smile: "We were like western Maine mountain guides."

As a youth leader, Aurelie instilled an appreciation for the outdoors in younger generations while fostering adventurous spirits and sparking curiosity for the White Mountain region, New England, and beyond. She not only introduced young people to hiking, but taught archery, swimming, cycling, canoeing and much more— a testament not only to her teaching but also her athleticism.

Jack recalls Aurelie's first summit of

Mount Washington with him in 1949. "As an 11-year old on Tuck's, there was a bit of exposure at certain spots," Jack remembers. "I was frightened, and kind of froze." Aurelie held out her hand, offering words of encouragement that he has never forgotten to this day.

"She was and continues to be our virtual belay. Aurelie and her introduction to Mount Washington is something that sustains my life every day— A communion with greater nature," Jack explained.



Aurelie enjoying the view while hiking Mount Washington, circa 1955

Jack would also go on to form a mountaineering club for teenagers, leading both summer and winter hikes to the summit, which he did for forty years. He led many other mountain expeditions around the world over the years; accomplishments he attributes to "his inspiration," his older sister.

After one year at a women's college near her hometown, Aurelie transferred to Tufts University in Massachusetts, where her love of nature was paired with an active lifestyle. She could most often be found cycling long distances, cross-country skiing, hiking, and playing tennis, to name a few. She studied physical therapy in school, which would become her career, another highlight of her personable and caring demeanor. It was at Tufts where she met her future husband, Gary Druckenmiller.

"When my dad proposed to her in 1954," Kathleen explains, "my mother was swift to say, 'Yes, but I won't marry you until you climb Mount Washington with me!' Dad made it to the summit and he too fell in love with the mountains and Maine's natural beauty." Just as she spent summers in Maine growing up, Aurelie and her husband Gary would also bring their children to Maine over many summers to experience nature and explore. The family enjoyed many activities, including swimming, tennis, hiking, boating and trips up the famous Mount Washington Auto Road.

As world travelers, Aurelie and Gary explored mountain ranges across the country and in Europe, from the Alps to the Grand Tetons and Alaska. But her lifelong love was for Mount Washington, which can be best described by her daughter Kathleen as "a connection that endures all space and time— a connection that was also a prerequisite for my father."

Aurelie's leadership skills from youth extended to her role as a mother of five children. "She was one of those rare

Aurelie, circa 1998

mothers who knew just how much rope to give you as a young person," Kathleen shared as she recalled a harrowing drive home as a teenager from upstate New York in a snow squall after a day of skiing with her siblings. "My Mom always knew when to extend trust to us and she always challenged us to try things that might be hard."

"Together, my parents made sure we were exposed to the great outdoors as kids, and not everyone gets that experience," Kathleen continued. "All of us kids now live near mountains, lakes, and oceans because of our mom's passion for all this when she was young. Those experiences were gifts we all cherish."

In speaking with those near and dear to her, it is an unmistakable joie de vivre that Aurelie possessed, and exudes still, through the adventures she encouraged during her lifetime and the adventures that her legacy continues to inspire. Here we find the spirit of a mountain personified, and through her legacy a love for the mountain lives on: A reminder that in the preservation and protection of this mountaintop we are also celebrating the legacies of the individuals who left their imprints indelibly upon it.

It is an honor to highlight advocates of Mount Washington and the Observatory in these pages, and we thank supporters Kathleen and Jack for introducing us to Aurelie and sharing their story as we continue to share the summit with her memory and celebrate a special steward of the White Mountains.

"Boldness has genius, power and magic in it. Begin it now."

– Johann Wolfgang von Goeth

Spring/Summer 2023 Weather Data

	APRIL	MAY	JUNE	JULY
Temperature (°F)				
Average	28.0	34.3	44.7	52.7
Departure	+4.3	-2.0	-0.8	+2.8
Maximum	54	62	65	66
Date(s)	15th	31st	1st	6th
Minimum	-1	11	26	35
Date(s)	2nd	18th	4th	30th
Precipitation (inches)				
Monthly	5.50	8.07	17.30	17.08**
Departure	-1.81	+0.39	+8.71	+8.15
24-hour Maximum	1.38	2.96	2.95	4.03
Date(s)	23rd/24th	2nd/3rd	16th/17th	10th
Snowfall (inches)				
Monthly	21.4	23.0	8.4*	0.0
Departure	-11.7	+10.1	+7.1	± 0.0
24-hour Maximum	5.7	14.3	4.4	0.0
Date(s)	25th	2nd/3rd	6th/7th	N/A
Season Total	224.6	247.6	256.0	0.0
Departure	-43.0	-32.9	-25.8	± 0.0
Wind (mph)				
Average	38.3	35.4	19.3	22.1
Departure	+2.7	+5.8	-7.5	-3.4
Peak Gust/Direction	119 E	121 E	82 NW	80 W
Date(s)	30th	1st	6th	27th
Days 73+	13	15	2	1
Days 100+	6	1	0	0
Other				
% Sunshine	42	59	23	25
Clear Days	1	1	0	0
Partly Cloudy Days	7	13	3	2
Cloudy Days	22	17	27	29
Days with Fog	23	19	27	31
Days with Rain	10	4	24	22
Days with Snow	18	9	9	0

* JUNE MONTHLY SNOWFALL: NEW MONTHLY RECORD FOR SNOWFALL OF 8.4"; PREVIOUS RECORD OF 8.1" SET IN 1959
** JULY MONTHLY PRECIPITATION: NEW MONTHLY RECORD FOR PRECIPITATION OF 17.08"; PREVIOUS JULY RECORD OF 16.85" ORIGINALLY SET IN 1996

Spring/Summer '23 Totals, with Wettest July on Record

BY **RYAN KNAPP**

Late-season snowfall lingered for late May and into early June, setting a new June snowfall record. Then, a wet pattern developed for the summer, delivering our 2nd wettest June and wettest July in our dataset. The few days it wasn't raining, wildfire smoke provided hazy conditions, and several poor air quality days.

April 2023

A passing low provided a wintry mix on the 1st that transitioned to upslope snow showers by the 2nd. Snow showers tapered on the 3rd, and a clearing pattern returned with high pressure. The ridge lingered early on the 4th, and then a warm front returned fog and light snow. As temperatures warmed on the 5th, snow transitioned to rain, which lingered into the 6th as temperatures remained in the mid-40s (F). A cold front approached during the afternoon, with freezing conditions returning overnight. A secondary cold front on the 7th provided additional cold air and light snow. High pressure allowed for clearing to return overnight into the 8th. Fair weather conditions lingered for the 9th through the 11th, and a gradual warming pattern developed as the ridge slid east. A weak cold front resulted in light sleet and cooler conditions on the 12th. A Bermuda High built behind the front on the 13th and remained through the 15th, providing temperatures in the 50s (F) while providing hazy but fair weather conditions.

Clouds returned on the 15th, and a moist flow on the 16th produced fog and drizzle. A cold front on the 17th provided rain that tapered to light snow. A broad upper-level low on the 18th/19th provided continued summit fog and light snow. Snow tapered early on the 20th, and a drying pattern started to return with high pressure. The ridge would settle over the region on the 21st, providing fair weather skies that lingered until the morning of the 22nd. A weak warm front late on the 22nd returned clouds and summit fog. Low pressure tracked towards Hudson By on the 23rd, dragging a cold front through, allowing for a quick transition from rain to snow. A broad upper-level low rotated several shortwaves through the region from the 24th through the 27th, resulting in continued summit fog and snowfall. Late on the 27th, a weak ridge provided partial clearing, which lingered into the 28th. A low from the west provided a wintry mix on the 29th/30th. A secondary coastal allowed the wintry mix to continue into the overnight.

May 2023

A coastal low started the month with high winds, a wintry mix, and isolated thunderstorms. As this low exited, a broad upper-level low settled over the region from the 2nd through the 5th, providing continued snowfall that amounted close to 2 feet by the time precipitation tapered. High pressure built behind the low late on the 5th, allowing for fair weather skies to return on the 6th and lingering into the 7th. A cold front on the 8th dropped temperatures and provided a brief period of fog around sunrise. High pressure returned and kept fair weather skies in place later on the 8th and through the 10th. A weak disturbance on the 11th provided a few clouds overhead as summits remained fog-free. A weak shortwave on the 12th provided summit fog and rain showers. A cold front provided colder temperatures and allowed fog to linger into the morning of the 13th, then high pressure allowed for a clearing pattern. The 14th saw some brief fog early, then fair weather conditions returned during the day, with fog-free conditions lingering into the 15th.

Clouds thickened and lowered on the 16th as a cold front allowed fog and snow to return overnight. An upper-level low on the 17th continued fog, cold, and snow. High pressure provided clear skies on the 18th, with fog-free conditions lingering through the day on the 19th. Late on the 19th, a trough shifted east, allowing clouds and fog to return overnight. Early on the 20th, brief clearing gave way to rain as a southerly flow set up ahead of a cold front. The cold front swept through on the 21st, providing continued rainfall. High pressure returned on the 22nd/23rd, and fair weather conditions persisted apart from some brief patches of fog. A cold front on the 24th allowed rain to transition to snow as temperatures dropped. Cold and foggy conditions lingered on the 25th. High pressure provided clearing late on the 25th, then fog-free, warm, and hazy (smoke from Canadian wildfires) conditions remained through the end of the month.

June 2023

High pressure kept things hot and hazy as a new daily record high of 65F was set on the 1st. A cold front on the 2nd provided rain, hail, and numerous thunderstorms. Low pressure in the Gulf of Maine provided continued rainfall on the 3rd. The low remained over the region through the 10th. A persistent wintry mix delivered 8.4" of snow/sleet as cold air moved in, setting a new June Monthly Snowfall record (previously 8.1" set in 1959). High pressure on the 10th provided a brief break in wet weather. Summits cleared from fog; however, smoke/haze from Canadian wildfires returned and lingered into the 12th. A cold front provided rain showers overnight and into the 13th. A warm front on the 14th provided rain, drizzle, and thunderstorms. The 15th saw a moist flow, resulting in fog, drizzle, rain showers, and thunderstorms.

A cold front on the 16th provided rain

and thunderstorms, with rain continuing for the 17th/18th. An upper-level trough followed, providing continued rain, drizzle, fog, and cool temperatures for the 19th/20th. The 21st had fair weather cumulus during the day, then clearing overnight as high pressure built. High pressure continued fair weather conditions for the 22nd/23rd. Fog returned on the 24th as a low to the SW provided another round of rain. A trough on the 25th/26th provided moderate to heavy rain and numerous thunderstorms. Another broad low on the 27th/28th provided moderate rainfall and thunderstorms. Rain showers tapered on the 29th, but summits remained in the clouds. High pressure provided partial clearing on the 30th. When all was said and done, June 2023 was the second wettest June in our dataset, with 17.30" of precipitation.

July 2022

High pressure on the 1st provided intermittent fog and dense haze/Canadian wildfire smoke. A stalled front to the south allowed for a series of lows to pass on the 2nd/3rd/4th, providing periods of moderate to heavy rainfall and isolated thunderstorms. High pressure provided clearing for the 5th/6th while wildfire smoke/haze from Canada returned. A cold front approached on the 7th, then stalled over VT on the 8th, and remained through the 11th, providing numerous rain showers and thunderstorms. Several inches of rainfall led to flooding around the Northeast, especially in VT, which experienced severe flooding in multiple areas. High pressure early on the 12th provided some clearing before another trough provided scattered afternoon showers and thunderstorms. A cold front on the 13th provided fog, rain showers, and thunderstorms. Instability on the 14th provided rain showers and isolated thunderstorms. The 15th saw partial clearing early but led to afternoon/evening showers/thunderstorms.

A low tracked north along a stalled cold front bringing 3.30" of rainfall and numerous thunderstorms on the 16th. Stratus and light rain lingered on the 17th before a weak ridge provided clearing but hazy conditions, resulting in air quality issues. Rain and thunderstorms returned with a cold front on the 18th. High pressure and haze returned on the 19th/20th. A surface low passed on the 21st and stalled to the north on the 22nd, resulting in summit fog and light rain showers. High pressure on the 23rd provided clearing and excellent views for the day. A cold front on the 24th provided thunderstorms and rain showers. A secondary cold front on the 25th provided rain showers and thunderstorms. The 26th saw brief clearing with high pressure. A strong low on the 27th provided moderate to heavy rainfall and gusty conditions. Intermittent fog persisted on the 28th, and then a cold front stalled over the region on the 29th, providing another round of rain showers. Despite high pressure on the 30th, summit fog persisted ahead of a cold front on the 31st. When all was said and done, July saw 17.08" of precipitation, making it the wettest July in our dataset (the previous record was 16.85" in July 1996).

COMPILED BY **ALEX BRANTON**

9:38 p.m., Fri., May 5

Have you ever noticed that when a full moon is rising is appears huge when compared to the foreground? Then, once the Moon is higher, it no longer appears as large? What you are experiencing is in fact called the Moon Illusion. Why does the Moon appear bigger? Our brains interpret the size of the Moon based on how near or far it is from the horizon and how big we expect an object to be when we see it. The human brain has trouble understanding that the Moon's distance doesn't change that much no matter where in the sky it is located. Thus, when it is closer to the horizon, we expect it to be close, and when it is high in the sky, we expect it to be far away. Additionally, having objects in the foreground like trees, houses, or mountains tricks our brains into thinking the Moon is closer.

– Hayden Pearson, Weather Observer & Research Specialist

10:53 p.m., Sat., May 6

The much-anticipated gathering of New Hampshire's outdoor community, Seek the Peak, was announced in May. New this year, the Hike and Make Friends option was extended to hikers of all ability levels, pairing hikers with similar goals for a trek on or around Mount Washington. The goal for our largest fundraiser of the year was to raise $170,000 to sustain the weather station and services like our Higher Summits Forecast.

–MWOBS Staff

7:48 p.m., Sat., May 27

April ended with flooding rains and damaging winds. May then began with heavy snow, graupel, and hail on the summit. Flooding resulted in significant damage on a quarter mile stretch of the Mt. Washington Auto Road. After the rain stopped, snow began. 20.2" of snowfall was measured over the course of a couple of days, far above the average 12.9" that falls during the month of May. The timing of the snow presented a pretty large operational hassle for our shift change. Recall that at the time, a sizeable portion of the Auto Road was washed out. After some planning and discussion, the Cog offered to provide transportation to the observers. The journey, however, was anything but easy. With an easterly wind, snow was able to more readily pile onto their tracks. This meant a slow journey led by a gargantuan snow blower. Thank you again to the hardworking team at the Cog for getting the summit teams up and down the mountain safely.

–Francis Tarasiewicz, Weather Observer & Education Specialist

4:50 p.m., Mon., June 19

Hello, my name is Myah Rather, and I am super excited to be a summit intern with the Observatory this summer! I recently graduated from Pennsylvania State University in May with a bachelor's degree in Meteorology and Atmospheric Science. In the fall, I will be heading to Howard University to pursue their graduate school program. The exceptional opportunity to engage in research, forecasting, and weather communications all in one internship is what drew me to the summit. In my second week on the summit, I participated in the Mt. Washington Auto Road Foot Race! The adventure was truly one-of-a-kind and left me feeling fulfilled.

– Myah Rather, Summit Intern

7:10 p.m., Tue., June 27

When large portions of Quebec's boreal forests began to burn, millions across the eastern seaboard became shrouded in smoke. Exceptionally warm and dry conditions in Canada in the spring quickly melted snow and dried the forests' underbrush. Ignition sources came from lightning and humans burning seasonal brush. Smoke from these fires impacted many beyond the reaches of Canada, including New England. Areas of the Northeast experienced a significant wildfire smoke event that darkened the skies and sent air-quality into hazardous levels. This smoke plume originated in Quebec and a complex weather pattern guided it southward.

– Francis Tarasiewicz, Weather Observer & Education Specialist

7:34 p.m., Mon., July 24

While Mt. Washington and the White Mountains might be better known for cold weather risks, the summer comes with its own risks related to heat illness. It is essential to recognize the signs of heat illnesses and take precautionary steps to have be safe. Three heat related illnesses to lookout for are heat cramps, heat exhaustion, and heat stroke. These preparation tips can help reduce the risk: Stay hydrated. Wear loose-fitting, lightweight, light-color, moisture-wicking clothing. Shade your head and neck with a hat. Start outdoor activities early. Take frequent breaks. Go at a slower pace. Wear sunscreen.

– Ryan Knapp, Weather Observer/ Staff Meteorologist

5:15 p.m., Fri., August 4

This summer, Mount Washington Observatory welcomed Jackie Bellefontaine and Emily Veh to the education team. Bellefontaine is the Observatory's School Programs Coordinator, and Veh joins the organization through AmeriCorps as the School Programs Educator. Bellefontaine, a former MWOBS weather observer, is excited to be part of the team once again. She is a Boston native with a B.S. in Earth Sciences from the University of Maine. Veh, originally from California, relocated to New Hampshire to pursue her interest in environmental education and interpretation. Expect to see these educators leading field trips to the summit, making in-classrooms visits, and educating learners of all ages on the forces that drive Earth's weather and climate.

– MWOBS Staff, Education

5:58 p.m., Fri., August 4

The recipients of the organization's first-ever Founders Award are Jack Middleton of Freedom, NH and Guy Gosselin of Gorham, NH. Middleton and Gosselin both have long histories with MWOBS, and each has been integral to Observatory operations throughout their lives. Middleton worked at MWOBS from 1952 to 1953, served as Secretary from 1956 until 2019, then as a trustee from 1957 to 2022, and now as a life trustee. Gosselin is one of the North Country's most respected modern pioneers and regional historians, but he says the "high point" of his career began February 15, 1961, when he became a MWOBS weather observer. Gosselin became chief observer in 1963 and was appointed to the director's post in 1971. He joined the Board of Trustees in 1978. Both Middleton and Gosselin have made MWOBS what it is today. We hope you will join us in celebrating their accomplishments.

– Drew Bush, Executive Director

4:35 p.m., Sun., August 6

Among the more remarkable weather events to occur in New England is the July 2023 flooding in Vermont. Saturated ground conditions combined with excessive rainfall resulted in flooding which exceeded that of which occurred during Hurricane Irene in 2011. This extraordinary rainfall event in Vermont occurred after the state had already received roughly 150-250% of their average rainfall over the previous two weeks. Warm, humid air was being drawn into the region and a low pressure system slowly moved eastward in early July. The amount of moisture involved and the minimal movement of the system would act to keep a relatively narrow corridor under near continuous heavy rainfall for an extended period of time. The result was a historic flooding event with over 9" of rain falling in some locations from July 9 through July 11.

– Karl Philippoff, Weather Observer – Research and IT

3:36 p.m., Mon., August 7

August marks the last month of meteorological summer (Jun, Jul, Aug) – a season that was full of thunderstorms, flooding, wildfire smoke, and overall poor weather conditions in 2023. To begin meteorological summer, a quasi-stationary low sat over New England for much of June, delivering cold temperatures and 8.4 inches of snow. This made June 2023 the snowiest June on record at Mount Washington Observatory. Later in the month, Mount Washington received 17.30 inches of liquid equivalent precipitation, which is 8.71 inches higher than normal and makes June 2023 the second wettest June on record. July followed suit with high precipitation totals, high humidity, and dense cloud coverage. In total, 17.08 inches of rain was measured, which is 8.15 inches higher than normal and makes July 2023 the wettest July in Observatory history. The Climate Prediction Center is projecting normal precipitation for the rest of this calendar year and temperatures that are warmer than normal.

– Alexandra Branton, Weather Observer & Education Specialist

5:59 p.m., Fri., Sept. 8

This summer, I had an incredible opportunity to intern at Mount Washington Observatory. I took many walks and cloud gazed during my time on the summit. I gave radio calls and weather station tours which helped me to effectively communicate science. I was able to stand outside in 60-70 mph winds. I also had the incredible opportunity to meet Willem Lange, a distinguished host of "Windows to the Wild" and an outdoor adventurer. The experience of being interviewed by his team was truly enjoyable. Another highlight of my summer internship was conducting research for a Rain on Snow project and presenting data for the August edition of Science in the Mountains. After this summer, I feel a lot better with presenting science analysis, weather forecasting, and educating people about science.

– Myah Rather, Summit Intern

7:08 p.m., Fri., Sept. 8

The El Niño Southern Oscillation (ENSO) can be summarized as a regular cycle of sea surface temperature changes across the equatorial Pacific, occurring every two to seven years. These temperature changes are driven by shifts in sea-level air pressure over the tropical Pacific. There are two phases, El Niño and La Niña. ENSO greatly impacts convection, or thunderstorm activity. Changes in the concentration of convection can significantly alter the jet stream's configuration, affecting precipitation patterns and drought development globally. The Climate Prediction Center (CPC) predicts at least an 80% chance of El Niño through next spring. The crucial point in both forecasts is the expectation of El Niño conditions throughout the winter.

– Francis Tarasiewicz, Weather Observer and Education Specialist

4:43 p.m., Tue., Sept. 19

Summer 2023 was rainy, snowy, foggy/cloudy, and "calm". In August 2023, the summit of Mt. Washington received 48.39 inches of rain, which was 23.15 inches above normal. This makes summer 2023 the second wettest season in our dataset behind the winter of 1969 with 50.26 inches. The summit received 8.4 inches of snow this summer, which was 7.0 inches above normal. While a trace of snow fell in August 2023, the rest fell in June, making it the snowiest June in our dataset. Our average summer temperature for 2023 was 47.8°F, which is 0.2°F below normal. Ironically, July was 2.8°F above normal, making it the 7th warmest July in our dataset and the 8th warmest month in our dataset. Average wind this summer was 23.5 mph, which is 2.1 mph below normal. June 2023 was our 3rd least windy June and was the 11th least windy month in our dataset. The highest gust for summer 2023 was 94 mph, which occurred on August 19th. No gusts over 100 mph occurred this summer. We averaged 24% of the possible sunshine. The summit had 0 days (sunrise to sunset) that were noted as clear or mostly clear and we had 80 days were precipitation was recorded.

– Ryan Knapp, Weather Observer/ Staff Meteorologist

Meteorological Summer 2023 By The Numbers

BY **RYAN KNAPP**

Meteorological seasons typically occur three weeks earlier than astronomical seasons. Meteorological seasons are based on the annual temperature cycle – winter is cold, summer is warm, and fall/spring are the transition between the warmth and cold. So using the annual temperature cycles, meteorological autumn would be Sept, Oct, and Nov (winter – Dec, Jan, Feb; spring – March, April, May; and summer – June, July, August). Meteorological autumn therefore occurred 1 September 2023 and will run until 30 November 2023. Why do meteorologists and climatologists do this? This is done for consistency – by dividing up the seasons by calendar dates they are nearly even varying between 90 to 92 days. And the other reason is for less variation between seasonal and monthly statistics from year to year.

No matter which fall you choose to recognize and/or celebrate, the key thing to remember is that September is the start of our transition season from summer into winter which means that our warmest weather is generally behind us, more icy/snowy weather lies ahead (we received our first few flakes of the season in late August), and winds start to roar back to life as stronger pressure gradients develop (by October, statistically speaking, 1 out of every 2 days will see hurricane force winds and 1 out of every 4 will see gusts of 100 mph higher). So, make sure to check out the Higher Summits Forecast so that you are prepared for whatever the mountain might throw your way.

While meteorological fall has arrived, I figured it might be worthwhile reflecting back on meteorological summer 2023. Looking back at weather stats, if I had to summarize summer 2023 weather conditions on the summit, they would be – rainy, snowy, foggy/cloudy, and "calm". To find out why these words were chosen, let's look back at some of the stats from last year:

In terms of total liquid precipitation, from 1 June to 31 August 2023, the summit of Mt. Washington received 48.39 inches, which was 23.15 inches above the 1991-2020 30-year normal for our location. This makes summer 2023 our second wettest season in our dataset (1932-present) behind the wettest season which is winter (Dec-Jan-Feb) 1969 when 50.26 inches of precipitation was collected. June 2023 was the 2nd wettest June in our dataset with 17.30 inches falling. July 2023 was our wettest July in our dataset with 17.08 inches falling. And August 2023 was our 2nd wettest August in our dataset with 14.01 inches falling.

From 1 June to 31 August of 2023, the summit received 8.4 inches of snow, which was 7.0 inches above the 1991-2020 30-year normal for our location. While a trace of snow fell in August 2023, the rest fell in June with that 8.4 inches in June making it the snowiest June ever in our dataset.

Our average summer temperature for 2023 was 47.8°F (8.8°C), which is 0.2°F below the 1991-2020 30-year normal for our station. When broken down by months, June was a cool month as it was 0.8°F below the 1991-2020 30-year normal for our station. July was a hot month as it was 2.8°F above the 1991-2020 30-year normal for our station. As such, July 2023 wound up being our 7th warmest July in our dataset and the 8th warmest month ever in our dataset. August on the other hand was 2.6°F below the 1991-2020 30-year normal for our station. As such, August 2023 wound up tying for the 14th coolest August in our dataset. Our warmest temperature recorded in summer 2023 was 66°F (18.9°C), which occurred on July 6th. Our coldest temperature recorded in summer 2023 was 26°F (-3.3°C), which occurred on June 4th.

In terms of winds, for summer 2023 our average was 23.5 mph, which was 2.1 mph below the 1991-2020 30-year normal average for our location. Of note was June 2023 which was our 3rd least windy (or "calmest") June in our dataset and was the 11th least windy (or "calmest") month ever in our dataset. Our highest gust recorded for summer 2023 was 94 mph, which occurred on August 19th. From 1 June to 31 August 2023, we had 10 days which had gusts of 73 mph or greater and of those days, 0 days had gusts that were 100 mph or greater.

Alex Measuring Summer Precip Record.

As for our weather during 1 June to 31 August 2023, we averaged 24% of the possible sunshine. The summit had 0 days (sunrise to sunset) that were noted as clear or mostly clear, and there were 8 partly sunny days, with the remaining 84 days being filed under mostly cloudy, cloudy, or obscured (fog). We had 88 days with at least some amount of fog recorded during a 24-hour period. We had 70 days with rain and 10 days with snow.

If interested in additional weather data, please check out our F-6 page (updated nightly), our Normals, Means, and Extremes page, our Current Conditions Page, our 48-Hour Higher Summits Forecast, and our Annual Temperature Graph.

From Schools to Summit, Edu-Programs are in Full-Swing

BY **BRIAN FITZGERALD**

And just like that, another summer has passed, and school is back in session with our eyes on this fall and winter. It's been a tremendously busy summer preparing for the launch of Mount Washington Observatory's (MWOBS) expanded menu of school-based programs that include school day, after school, field trip and virtual programs (in addition to an array of free educational resources). To kick off this exciting time and share our enthusiasm for building weather and climate knowledge, Observatory educators (with help from our valley volunteers) have put together 800 backpacks to give away to middle schoolers across Northern New Hampshire and Western Maine. As I write this, the Observatory education team has our extended passenger van filled to the brim with Cotopaxi backpacks stuffed with home weather stations, winter storm science and safety activity books, cloud identification posters, and many other goodies. Don't be surprised if you see MWOBS parked outside a school near you!

Naturally, one of the most exciting school-based opportunities that MWOBS is proud to offer is a field trip program to the summit of Mount Washington. In partnership with the Mount Washington Cog Railway and Mt. Washington Auto Road, MWOBS educators have been working with educators to offer field trips that connect weather and climate topics being taught into the classroom with Next Generation Science Standards (NGSS) and the "real-world" science taking place right in students' backyard. Thus far, we've had schools from both northern and southern extremes of New Hampshire and beyond to take advantage of the program with our educators this year exploring concepts like weather observation, mountain ecozones and the human history on Mount Washington. One notable program brought New Hampshire's 2023 Teacher of the Year, Christian Cheetham, from Alvirne High School in Hudson, New Hampshire along with 25 of his JROTC cadets. New Hampshire Department of Education Commissioner Frank Edelblut and Deputy Commissioner Christine Brennan joined the program to help honor Christian's outstanding contribution to education in New Hampshire and see first-hand how Observatory field trips literally bring learning to another level.

In addition to students visiting the summit, a dozen teachers will once again travel to the highest peak in the Northeast via the Arctic Wednesdays professional development program.

New Hampshire Teacher of the Year Christian Cheetham, left, and Department of Education Commissioner Frank Edelblut visited the summit in September with Cheetham's students from Alvirne High School.

This program is now entering its eighth winter welcoming K-12 educators from across the region to learn first-hand about the nature of weather and climate. Teachers that apply and are accepted to the program bring specific intentions behind their visit, with many teachers choosing to connect virtually on the summit with their students in their classroom to share the wintertime expedition experience. Others might opt to get their students involved by doing engineering design challenges with student projects getting tested at the "Home of the World's Worst Weather" or connect literary goals to the heritage of the region through notable books like Cat in the Clouds by Eric Pinder. If you know a K-12 teacher who might benefit from the Arctic Wednesdays program, be sure to have them apply!

This past fall saw a continuation of our Science in the Mountains lecture series that took advantage of MWOBS' dynamic staff to share out programs on the Observatory's Regional Mesonet and current research projects examining rain-on-snow events and

establishing mountain lapse rates. University of Utah Professor Dr. Jim Steenburgh joined our September program to share "The Secrets Behind 'The Greatest Snow on Earth'". For the skiers who attended, many likely sought airfare for Salt Lake City this winter. Be sure to join us for an upcoming Science in the Mountains program if you like learning about current topics in weather and climate.

Last but not least, winter overnight Edutrips return for this winter season with another slate of summit learning experiences. MWOBS weather observers will once again serve as the primary instructors for the "The Science of Winter Storms" theme, while "Weather Basics", and "Behind the Scenes & Science of Broadcast Meteorology" help round out the atmospheric science-related topics. And because weather and climate connect to and impact so many disciplines, we're always happy to build on those connections through programs such as "Winter Ecology" and "Mountaineering Essentials".

With so much happening in the educational program space at MWOBS (including undergraduate and graduate programs offered through MWOBS research team), we invite you to participate in whatever way serves you best. Whether it's through a member tour of the summit weather station, a virtual Science in the Mountains program, a program at your child's school, or a winter trip of a lifetime, we're grateful to offer these services with your support. See you at a program soon!

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.

Revitalizing Key Areas, Instrument Funding & Exciting Internship News

BY **JAY BROCCOLO**

This past summer was full of progress around the summit for operations, myself, and our fine weather observers and meteorologists. We brought the shift leader positions back, completed (and continue to work on) some long needed summit and snow tractor maintenance, fundraised for new summit instrumentation, brought on and are establishing product testing contracts, and have worked to build out our internship program further. Most importantly though, after a year of organizing and revitalizing our organizational processes while building up our experience as a cohesive team, we're now able to focus on the future and improve upon our offerings. I am ecstatic and proud of the work we have put into this past year and the results are showing both in our work and where we are now looking (you will have to wait until the next Windswept update to hear more about that though). Let's dig into some of what we have accomplished this past summer and autumn.

In August, Alexandra Branton and Karl Philippoff were promoted to Shift Leaders for each of their respective shifts. The summit has not had shift leaders since before the COVID era which put a lot of pressure on the Summit Manager position. After restructuring the Summit Manager position into a Director of Weather Operations (DWO) role, which focuses more on the weather operations of the weather station and the weather and science, a shuffling of summit staff, and the end of the pandemic, it was absolutely necessary to bring these positions back. Shift Leaders are such an important part of operations for numerous reasons. Organizationally, they help funnel and filter information and are the point person of each shift. Communication between shifts and the DWO are vital and having Alex and Karl at the helm each week has really strengthened valley and summit communications. They run our shift changes and both attend our weekly Directors meetings amongst all the other responsibilities they have. Congratulations and thank you to you both!

We have also established a Summit Task Force responsible for the upkeep of the weather station and its future needs. We have identified and prioritized the maintenance needs of the weather station and living quarters. Since then, we have re-welded the tower parapet ladder which was in need of repair, repainted our tower stairs with safety red and yellow, re-painted the A-Frame and the precipitation can and we are currently in the process of

replacing our summit thermoshack with one donated to us by the late Briggs Bunker, which is only fitting considering his contribution to the organization and weather community! In the near future, we will be working to replace our thermostats for heating, lighting fixtures, and windows in the living quarters before tackling some of the broader items on our agenda. I would like to thank our Summit Task Force for their work and dedication to the summit space as it is our home for half the year and they certainly understand that!

Over the past summer and fall, we also began a fundraising campaign put on by our communications and development department in coordination with weather operations to help update our some of our summit instrumentation not associated with any other funding sources. Through many of wonderful members and supporters we were able to update one of our older temperature instruments, the earlier version of the HMP-155. The HMP-155a temp probe will help the observatory continue its long climate record by replacing an out of date and difficult to calibrate temperature probe. The new HMP-155a will allow for easier calibration, low power consumption, and accurate readings with an aspirated heat shield, which is not currently in use at the summit of MWO. This sensor also has a wider range which will incorporate any potential new low records! Our generous supporters also allowed us to purchase about 3 years' worth of alcohol thermometers to continue the 90+ year old temperature record. Lastly, one generous donor supported our summit and IT team with a new communications antenna that is much shorter and will accumulate less ice, so it'll be way easier and safer to de-ice. It also has a higher wind load and will ensure top quality communications throughout the complex terrain.

Our Transportation Coordinator, Jon Powers— and his mustache along with Piston Bully— did a complete assessment of the snow tractor over the summer and completed any necessary work that needed to be done for a clean bill of health and safe mountain passage. They raised the suspension that had sagged after decades of use, cycled out the old fluids in with the new, replaced bearings, and tightened the trusty machine up with a new radio and a clean touch. Our snow tractor is truly a sight when in its elements and with our tremendous operators behind the helm. Without the snow tractor, our operations would come to quick halt and it is great to see the effort and care that goes into our fleet of vehicles. Along with our collaboration with partners at NH State Parks, the MW Auto Road, and MW Cog Railroad, we ensure safe passage up and down the Mountain to support all of our operations.

The last update I have from the summit is some positive changes to our internship program. We have dedicated funds to pay our interns and have actively sought out other ways to fund the program as well. Eversource became a sponsor of our internship program and we are actively working on ways to collaborate inside and outside of the internship program.

Storm Window Installation, October.

This winter will also be the first joint Mount Washington Observatory and United States Forest Service internship with the Mount Washington Avalanche Center (MWAC). This joint MWAC/MWObs internship will be an immersive 16-week internship split between each site on the summit and at their Hermit Lake Hut in the bowl of Tuckerman Ravine! We are also working towards completing the same type of internship with the Appalachian Mountain Club (AMC). Having these collaborations with our partners in the White Mountains will allow our interns much more opportunities in understanding the interconnectedness and dynamics of the Earth's processes, which is a key goal of our mission.

With Partner Support, Mesonet, Research, & Internships Expand

BY **JAY BROCCOLO**

Not only has the organization helped support the foundation of summit activities and the weather station, but we have also put in a massive effort to better support the mesonet system, comprised of 18 automatic weather stations throughout the White Mountains. A grant through the Northern Borders Regional Commission has enabled us to update and expand our mesonet system. We will be able to add stations along the Mount Washington Cog Railway and throughout the north country of New Hampshire. Having data along the west side ahead of the weather station is such a monumental addition to the overall system. Any station to the north and west of the summit is integral to our operations as winds are predominately from the west and northwest. Through another grant in collaboration with University of Vermont and the Atmospheric Sciences Research Center at Whiteface Mountain Field Station under SUNY at Albany, we have secured partial funding for staff support to initially hire a new Mesonet Technician position as well as develop a web-based location where our three organizations can visualize our data and bring attention to our respective organizations.

Our physical mesonet work ties in nicely with our work with the University of Delaware (UDel). Our contract with UDel is quite involved but at its core is a working group to build out a new meta-data database that follows the structure other types of large mesonet systems share. Establishing this dataset will also allow us to fill past meta-data and strengthen our research potential. This process will develop working internships and publications with graduate and doctoral students and effectively expand MWOBS research credibility.

Our current research is also helping to build towards our success. Synoptic Data funded our "Characterizing Near Surface Lapse Rates in the White Mountains Region Using High-Resolution Mesonet Data" project which is now in the writing phase. Once completed, we will launch our findings and presentations in our current research section of our website. With the lapse rate project coming to a close, the next round of funding has begun and with it a new project investigating and characterizing liquid rain events that fall on a measurable snow depth at Mount Washington. From this research, one of our interns, Amy Cotter, is working on a case study investigating runoff into local watersheds using stream data and our precipitation and snow depth data. Our other intern, Jordan, is working to

Mesonet station at 5300' on Mount Washington Auto Road.

track the last 40 years of storm tracks and will start working backwards to examine if there has been any change in their position relative to Mount Washington through climatologies.

Jointly, the Appalachian Mountain Club (AMC) and MWOBS are collaborating on a project funded by the Waterman Fund evaluating MWOBS' wind and relative humidity trends and digging deeper into the mixing ratio and dew point climate trends. All of these research projects will start to roll out on our new website through the winter and spring season, so be sure to check them out there.

Concluding our update on research from the summit, we are organically launching new offerings under a program called "Undergraduate Adventures in Meteorology" (UAM). The UAM program will offer undergraduate and some graduate students the opportunity for field trips to the summit weather station, in-school lectures, capstone research projects, labs working on data acquisition, instrumentation, and forecasting and field camps. Currently we are working with Plymouth State University and Vermont State University to support their weather programs and we are looking forward to working with regional universities and elsewhere as we explore this space.

The Everest Pitot: A Follow-up

BY **KEITH GARRETT**

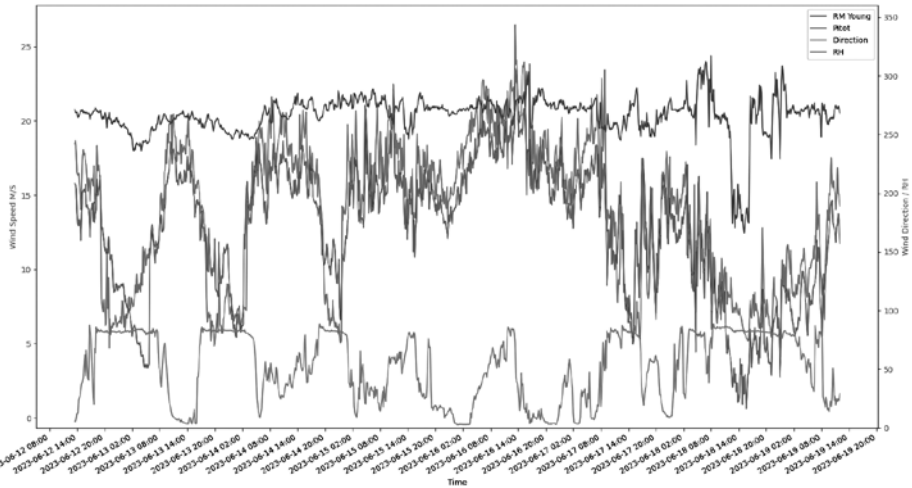
The monsoon season of the Himalayans is drawing to a close, and with it so does the heavy snow and ice precipitation that began in June.

In April, another National Geographic and Rolex Perpetual Planet team led by Dr. Baker Perry of Appalachian State University, and supported by Tenzing Gyalzen Sherpa of Nepal, began the arduous task of repairing and upgrading the remote automated weather stations on Mount Everest. A few of the many tasks included replacing data loggers and control systems as well as wiring harnesses, batteries, and weather instrumentation from Base Camp all the way to Bishop Rock, just below the summit of Everest.

Among these tasks, a third pitot built by Mount Washington Observatory for the 2022 expedition made its trip to Camp IV (South Col), along with a new data/control system, and battery bank. Earlier in the winter, this 3rd unit was sent to Appalachian State for full integration and testing into this new control system. The same team also replaced cables, connectors, and broken instrumentation at Bishop Rock, in the hopes of bringing both of these stations fully online.

Shortly after the work was completed on each of these stations, data began arriving via satellite. It was good data! Wind speed and direction were coming from the RM Young 05108 at Bishop rock, and wind speeds from the Pitot! Other sensors looked good, and no hints of wiring issues that had occurred on the previous trips. The Camp IV data looked interesting– only wind speeds from the pitot, and nothing from the other wind instruments.

Now for a little technical information on these particular pitot anemometers. First, they are fixed direction. The tube only points west, and should be accurate to about + or – 15 degrees of the direction it is facing. For this reason, wind direction is extremely helpful to determine the operational status of the instrument. Second, calibration! The pressure transducers in these devices have an oil filled diaphragm. The difference in pressure between the force of the wind and the flow over holes perpendicular to the flow is measured in units of inches of water column. At zero winds, you would expect the value of the output of the sensor to be zero, but its not! It is zero when the sensor is in a perfectly vertical orientation; any tilt in any direction changes this output at what should be zero. This is important, and we call this its offset. Each sensor is a bit different, and the stations are not perfectly mounted.



The RM Young reads 10 meters per second, but the pitot reads 4, or the RM Young reads 4 meters per second but the pitot reads -1! These are examples of pre-calibrated data that come from the units, particularly Bishop Rock. Using calibration data from bench tests before sending the units to Nepal, offsets were calculated for each instrument (they are applied after data retrieval so that we know actual readings). Special software was written to plot the raw data from each unit, and compare it to any working wind instrument at that same location. The offset can be adjusted in software for testing purposes to see how each instrument performs.

So how did they work? GREAT is my answer. Contact us if you wish to see an example plot (they are in color, so the black and white of this print edition will be difficult to interpret). Most of the time during non-icing conditions, the pitot and RM Young at Bishop Rock were with about half a meter per second of each other. The effect of directional shifts can be seen clearly in the data, as well as some of the effects of icing on both units, however it is difficult to quantify icing. The propeller on the RM Young slows, at the same time that the ports on the pitot begin to be covered with ice. As time allows, we will hopefully be writing a paper about the performance of the unit at the summit of Everest.

During June, icing began in earnest, slowly affecting power availability of the stations. Bishop Rock ceased communication in July, but South Col station held on until September. The end of the monsoon season has brought about clear, cold, and sunny skies. The hope and expectations are that either one, or both, of these stations will wake up from their icy slumber as the ice sublimates.

(A note on reading the chart: The period is 5 days, at ten-minute resolution. The top line is wind direction. The bottom line is relative humidity, and the mix of the two in the middle are the RM Young and pitot overlaid. Look for the online color version).

Backpacks Inspire Future Weather Scientists

Valley Volunteers gather at the Observatory's office in North Conway, NH on Sept. 7 to help assemble backpacks with weather education materials. In total, volunteers helped assemble 800 backpacks with weather kits.

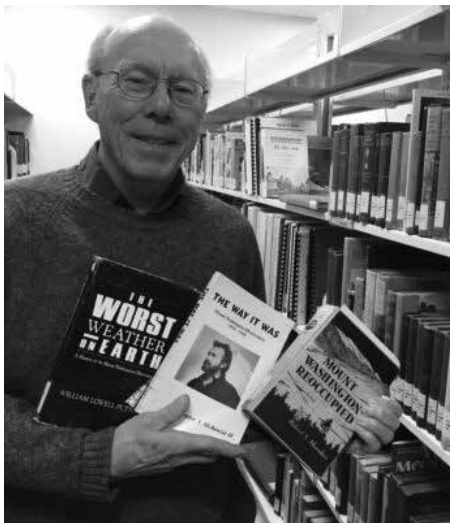
Our volunteers helped our education team assemble backpacks with home weather stations, NWS cloud charts, and weather safety materials for hundreds of middle school students across northern New Hampshire and western Maine.

Thanks to our volunteers' support, Observatory educators journeyed to 22 middle schools to deliver backpacks, meet the students, and inspire them to pursue careers in science, technology, engineering, and math (STEM).

Some classrooms immediately began to incorporate the wireless temperature stations into their curriculum. For example, teachers had their students record the temperature outside of their homes and the temperature at the summit of Mount Washington every morning to create a temperature comparison graph.

A huge thanks to our volunteers for their support, which made this initiative possible.

Peter Crane, a Dedicated Member for 50 Years



Peter Crane

In this edition we acknowledge our members who have supported the Observatory for the last half century. Without their longstanding commitment to our organization, our work would not be possible. The history and legacy of their dedication is a testament to them as individuals and to the work the Observatory began in 1932.

One person celebrating their 50th year of membership at the Observatory is Peter Crane. He began his Observatory career in 1988 as a weather observer, museum manager, and Summit Shift Leader. After three years of summit duty, he served for several years as Director of Programs before transitioning to his current position. Peter is the Curator of The Gladys Brooks Memorial Library, which features an extensive collection of ephemera pertaining to the Observatory, White Mountains, Arctic, and Antarctic. Peter is a wealth of knowledge, always willing to share with everyone, and always has the question "Did you know?" at the ready.

Peter has lived in the White Mountains for more than thirty years, and has worked for the U.S. Forest Service and Appalachian Mountain Club in resource management, public information, and educational roles. He is an ardent year-round hiker, with significant ties to the White Mountain Outdoor Community, from his volunteer work for Appalachian Mountain Club, to being a member of Androscoggin Valley Search and Rescue (AVSAR). Peter also serves on the board of the New Hampshire Outdoor Council.

As the Observatory continues its work in the future, we thank Peter for protecting the past and sharing it. He is a true steward.

If not for these individuals, and their foresight 50 years ago, we would not be what it is today. Our gratitude is immeasurable. Thank you.

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Peter J. Crane

Michael J. Cohen
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...Thank you

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CORPORATE SUPPORT

The summit team in front of the thermometer shelter donated to the Observatory by Briggs Bunker, a fitting gift memorializing his passion for meteorology.

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