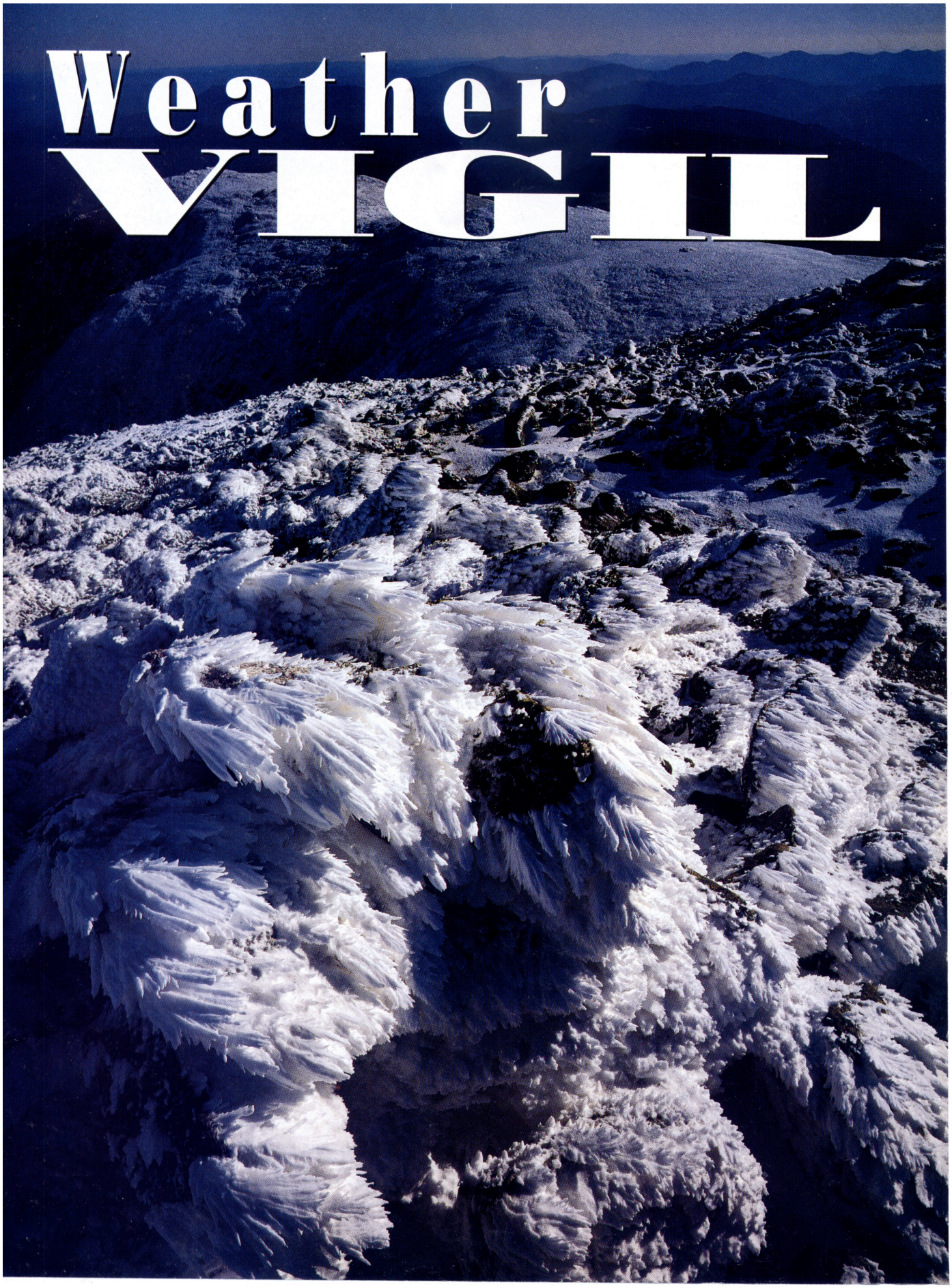
Weather
VIGIL

Meteorologists atop Mount Washington observe the worst conditions the skies dish up. And yet they love their work.

by Daniel Grossman

Daniel Grossman

The weather station staff uses snowcats to travel between the mountaintop and civilization below. Frequent snows mean frequent plowing on the mountain's auto road.

All in all, the most horrific in the world. That is the title Peter Crane claimed for the weather at the place where he earns his daily bread, the Mt. Washington Observatory in New Hampshire. I had called Crane to set up a winter visit to the only mountaintop weather station operated year-round in North America and asked him just what distinction had earned the mountain its reputation for extremity. Although Mt. Washington is 6,228 feet tall (1,898 m) — the tallest peak for nearly 1,000 miles in any direction — it is not a high mountain by the standards of the Alps, Rockies or Himalayas. A broad, bald dome dominating a rugged chain known as the Presidential Range, it is not an obvious contender for global supremacy.

In many individual weather categories, Crane replied, the mountain does not rank worst. The South Pole, for example, has registered 117 degrees below zero Fahrenheit (-82.8 C), making Washington's low point of 47 below (-44 C) seem like a spring afternoon. But the South Pole gets little snow and rarely experiences high winds. Mt. Washington, by comparison, often has low temperatures, extreme winds and dense fogs all at once. "When it comes to pure misery," Crane told me, "we take the cake."

Now it is three weeks later and I find myself sitting in the back of a snowcat making its way toward the summit from Pinkham Notch. The climatic signals I see are mixed. Most everywhere I look, I see clear skies, but Mt. Washington's summit is shrouded in ominous fog. This is not an unusual state of affairs: The mountain is clouded 60 percent of the time. Still it leaves me a little apprehensive about what to expect when we reach the top.

Jammed into the snowcat with me are six passengers, a driver and a week's worth of groceries. Our journey is short in distance, barely eight miles. But the snowstorm that blasted the mountain the previous day has left drifts eight feet deep, making the trip both slow and treacherous. We skirt the rim of a broad, deep basin known as the Great Gulf Wilderness. Then, halfway to the top, our rig rounds Cragway Corner and faces the full force of the elements. A fierce wind rattles the snowcat's windows, but our bodies and a powerful heater keep the cabin warm.

Although our rugged vehicle with its steel tank treads is deftly operated by Ken Rancourt, the observatory's staff meteorologist, I can't help thinking of the scores of lives lost to the unexpected on these wind-blasted slopes. Wind and temperature combinations often reach beyond the limits of wind chill charts, and fogs regularly obscure hikers' views of their own feet.

Since 1849, the peak has claimed the lives of 113 individuals, most of whom died of hypothermia. Last winter was the most tragic season in recent years, as one camper and two ice climbers froze to death within the space of six weeks. All had been drawn to the mountain by the possibility of adventure in its wildness, and the weather that killed them was part of that. Two more people died during the mountain's spring skiing season, another product of Mt. Washington's unique weather. Tuckerman's Ravine, a huge glacial hollow on the mountain's east flank, holds skiable snow until late June most years. Glaciologists say that it would take only a slight climatic cooling to bring glaciers back to the ravine.

But the story of Mt. Washington isn't all tragedy. Its commanding height and severe weather have also attracted the attention and admiration of scientists and explorers for more than 350 years. An Irishman named Darby Field ascended the summit in 1642 with two American Indians from coastal New Hampshire. His tales of finding rich mineral deposits (which turned out to be quartz) attracted prospectors, but the first scientific expedition didn't reach the peak until 1784.

That party included two members of the American Academy of Arts and Sciences and Reverend Manasseh Cutler of Ipswich, Massachusetts. The team's attempt to calculate the summit's altitude using surveying instruments was frustrated by a

Crystals of rime ice form when supercooled water vapor strikes a solid object and converts directly into ice. On Mt. Washington, several inches of rime ice may form in a single hour.

Tom Till

Daniel Grossman

Mt. Washington Observatory is located in the building that also serves as a visitor center during the summer.

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Norman Michaels enters weather data to send by fax and modem to the National Weather Service and other users.

heavy cloud cover, so Cutler turned to measurements of barometric pressure and concluded that Washington's elevation surpassed 10,000 feet, thus exceeding the currently accepted figure by about 4,000 feet. The team also made observations of the summit's flora and noted for the first time that plants there grow in distinct elevation zones.

Scientific studies of Mt. Washington continued throughout the 19th century, but inhospitable winter weather (which generally lasts half the year) precluded four-season observations until 1870. In that year, New Hampshire's state geologist, Charles Hitchcock, outfitted a vacant building on the summit to serve as a winter meteorological observatory. As he noted in a detailed account of the research conducted there, a scientist could, in a single day's journey to the New Hampshire summit, reach and study a climate identical to that of Greenland, 2,000 miles to the north. "It is an arctic island," he explained, "in the temperate zone."

Hitchcock's colleague, Joshua Huntington, foresaw more practical benefits for the observatory. "Knowledge of the climatology of a country is intimately connected with the welfare of its people," he wrote. Huntington hoped that observations such as those conducted on the mountain would help transform meteorology from the untutored conjecture of folk wisdom into a bona fide science governed by immutable laws. "If we are able to understand these laws, we ought just as surely to be able to give forecasts of the weather, as to foretell the changes of the planets," he wrote.

The same year that Hitchcock and Huntington began making winter observations on Mt. Washington, the U.S. Congress created a federal service under the Army Signal Corps for forecasting weather. Hitchcock's post was one of the first stations in a network of weather stations to telegraph synchronized observations to Washington, D.C.

The Mt. Washington Observatory today is located not far from the site of Hitchcock's studies. The station is operated by a private organization dedicated to recording and studying the weather of Mt. Washington. Observers there provide 10 weather reports every day to local radio stations and take readings every three hours for the National Weather Service, a demilitarized descendent of the Signal Corps's forecasting branch.

We reach the observatory at the end of a four-hour climb. (In summer, we might have made as good time on foot.) By now, the clouds have dispersed, permitting a rare view from New England's highest lookout. The light is intense — the more so because a dazzling white coat of ice and snow is plastered onto everything. But we don't admire the light for long; a biting wind drives us quickly indoors.

The observatory is located in the northwest wing of a large concrete building where summer tourists get refreshments and consult state rangers. Today, the inhospitable peak is empty save the observatory crew and the staff operating a summit radio transmitter. A curved bank of windows on one side of the sturdy building is reminiscent of a ship's bridge. The "weather room" inside, where most of the instruments are read, is indeed the observatory's scientific helm. Its windows are well fortified against the elements: two heavy sheets of plate glass capped with a bullet-proof pane to protect against windblown ice missiles. The assorted readouts, which cover an entire wall, are partly obscured by numerous explanatory notes and admonishments. One advises against removing ice from station radio antennae by hammering on them. Another explains how to protect electronic equipment during a thunderstorm.

Norman Michaels, one of the passengers on our unusual commute, is already beginning his shift in the weather room. The staff here works round the clock in eight-hour shifts. Michaels is a stocky man with furrowed brow, heavy gray beard and thinning

black hair. He says he likes the camaraderie of the observatory — and the isolation. Although the summit is packed with visitors in the summer, during the winter an entire week might pass without a single person coming or going.

Michaels begins work by recording the weather conditions. The basics of meteorology have not changed since Hitchcock's days: temperature, barometric pressure, atmospheric moisture and wind speed and direction. But the tools used to analyze these measurements have changed enormously. The National Weather Service now uses a Cray supercomputer in Suitland, Maryland, to analyze data from hundreds of observatories, weather balloons, satellites, aircraft and ships and produce two national forecasts every day. Virtually every TV, radio and newspaper weather forecast in the country is based on the detailed reports produced by the weather service.

EARTH: Steve Davis

Mt. Washington stands in White Mountain National Forest in New Hampshire. The Appalachian Trail passes over the summit, which is also reachable by road and by the coal-burning Cog Railway.

At present, observers at 1,200 stations supply the National Weather Service with tens of thousands of observations every day. In the next five years, nearly all of these stations will be replaced by automated equipment. But Rancourt says that the work on Mt. Washington is unlikely to be done by remote controlled machines anytime soon. "I would be very happy to see our equipment automated," he says cheerfully. But he says the summit's furious weather precludes gathering data there with unattended instruments. At least for the time being.

Crystalline tendrils of rime ice, deposits formed when supercooled clouds strike solid objects, form sculptures of great beauty on rocks, signposts and, unfortunately, meteorological instruments. Rancourt says winter gales sometimes deposit several inches of rime ice per hour. Some instruments are heated to avoid such build-ups, but if left unattended they can still develop heavy coatings that deflect wind or even snap measuring devices from their supports. Perhaps with improvements in equipment, the Mt. Washington Observatory will someday lose its human observers (as Coast Guard lighthouses have

The Appalachian Trail runs south from Mt. Washington along the ridge of the Presidential Range. The next peak is asymmetric Mt. Monroe.

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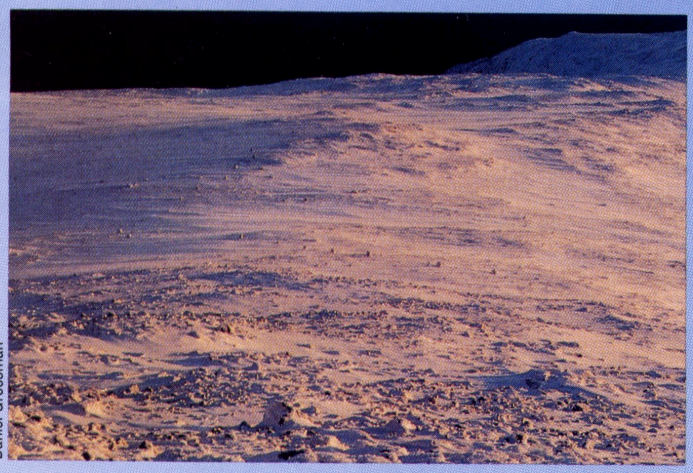
already done). But for now it is still a bastion of meteorological foot soldiers in the service of weather forecasting.

Michaels carries a steel bar up the frigid stairs of the observation tower, a turret that juts 25 feet above the building. He is now the highest person in the entire Northeast. Behind him the snow-capped Presidential Range glows in the day's last light, forming an irregular orange band that stretches four miles to the northeast and six miles to the southwest. With a visibility of 50 miles, Michaels can see trackless forests, distant towns and frozen lakes. But he has no time to appreciate his exalted position. In a period of only 20 minutes, he must take one dozen readings for the 6:00 p.m. National Weather Service observation. And first he must remove rime ice that formed earlier in the day. Thus the bar, which he raps firmly against the brittle deposits.



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The many hiking trails and bridle paths on the mountain's treeless upper slopes are marked by large cairns, closely spaced and built to be seen even when visibility is measured in feet.

There is no cloud cover to observe this evening, so Michaels moves to the next measurement: dew point. This, he explains, is the temperature at which water vapor condenses to liquid water. Meteorologists consider it an important parameter because it indicates the amount of moisture in the atmosphere, and airborne moisture is the atmosphere's most significant mechanism for absorbing incoming radiation from the sun. When water condenses from damp air, it releases large amounts of energy, which help drive the movement of air in the atmosphere.

Michaels calculates a dew point of 19 degrees F (-7 C). A dew point so close to the actual temperature (24 F or -4.5 C) means that even a slight cooling could cause vapor in the air to condense and a cloud to form. Such conditions are common here because air rising up from the valleys cools dramatically, decreasing its ability to hold water. Michaels says the altitude at which air becomes saturated in this area is generally about 5,000 feet (1.5 km). That puts the summit smack in the heart of the region's low-level cloud cover. The peak is hidden in clouds almost two-thirds of the time. On the summit they appear as a dense, drenching fog.

Michaels notes the other observations in rapid succession. The wind speed and direction and the barometric pressure are all read from gauges in the weather room. The wind has been rising all afternoon. By now it has reached a respectable 57 miles per hour (92 km/h) with gusts into the 70s, although it is well below the early morning peak of 93 miles per hour (150 km/h).

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Snow and whipping winds often come together on Mt. Washington, where they can make the mountain's boulder-strewn upper slopes look like a stormy sea.

Wind speed is perhaps the observatory's greatest pride. The highest wind speed ever recorded on the face of the planet, after all, was measured on Mt. Washington. On April 12, 1934, a crew of three huddled inside a rustic cabin lashed by gusts three times stronger than a Force 12 Hurricane gale, then the most powerful category of wind ranked in the Beaufort scale of winds. In the early afternoon, the big gust came. It was clocked at 231 miles per hour (371.75 km/h), a record still intact after 60 years. Salvatore Pagliuca, the project's chief observer knew right away a record had been broken. "Will they believe it?" he wrote in the station's log.

The staff today remains preoccupied by wind. Michaels points out that the wind speed averaged over the entire year tops 35 miles per hour (22 km/h). Last year, he says, hurricane force winds occurred on one out of three days. In the weather room no fewer than

Bob Grant/Comstock, Inc.

Seen from a smaller mountain to its southeast, Mt. Washington rises from the long ridge of the Presidential Range. On its right flank is Tuckerman's Ravine, a rugged glacial hollow that holds New Hampshire's last snows into late June.

four gauges display wind speed simultaneously and two display direction. Even in the living quarters, where staff members can retire to a lounge and bunk rooms, two computer monitors silently display wind speed in amber type 24 hours a day. Michaels tells how once, wearing steel crampons on his boots and carrying an ice axe, he retrieved a rain and snow gauge in 133-mile-per-hour winds (214 km/h). "The rougher it is," he says, "the better we like it."

Observatory meteorologist Rancourt says that wind speed and direction are the two most important measurements made on the summit. He says two factors explain why a pint-sized peak (by world standards) has earned a place in the *Guinness Book of World Records*: unique location and continuous observation. There is no question that very high winds do occur on Washington, he says. They occur because prevailing winds reach the Presidential Range unimpeded by obstacles and because a fortuitous alignment of the range intensifies their velocity. Prevailing winds from the west and northwest encounter the Presidential Range, which runs north to south, as a formidable barrier. These currents cannot circumvent the long, rocky spine, so they must climb sharply. But the tropopause, a disjuncture in the atmosphere at about 30,000 feet (9 km), forms an impassable ceiling. The flow is squeezed and, as a consequence, speeds up. "It's just like water passing through a garden hose nozzle," Rancourt says.

But why the world's highest wind? Rancourt suspects that other parts of the globe might occasionally be subject to even higher winds, but so far nobody has been there to record them. No other mountaintop observatory anywhere else on this continent operates year round, through the seasons' worst weather. The Mt. Washington Observatory, however, has an unbroken meteorological record stretching back to 1932. Observatory director Guy Gosselin worries that the summit's preeminence could someday be lost to another location. "Every time a major hurricane whips through the Caribbean, we keep a close eye on the wind velocity," he joked to a reporter on the record gust's 60th anniversary last April. "We don't want to be put out of business."

Rancourt suggests that I spend the night on the summit. It takes time, he says, to become acquainted with the observatory's activities. Besides, he's not driving down until the following day and the only other way out is on foot.

Despite raging winds and plummeting temperatures outside, the evening passes uneventfully; the building's fortress walls shield the bunk room from even a trace of the elements. Morning brings clear skies, moderate temperatures and a light breeze. Michaels, already at work in the weather room, says it will be raining or snowing by afternoon. But Rancourt is anxious to leave right away — just in case the storm comes sooner. His anxiety is a reminder that despite a worldwide network of satellites, weather observers and state of the art computers, weather forecasting is still fraught with uncertainty.

Meteorologists have made great strides in the last twenty years. Ken Comba of the National Weather Service says that forecasts made five days in advance today are just as accurate as three-day forecasts were when he began his career 22 years ago. But still he doubts the old dream that weather forecasting will approach the certainty of planetary motions. There are too many variables interacting in too-complicated ways. Besides, he says, "life might become boring if we knew everything." ⊕

Daniel Grossman is a Boston-based science writer and radio producer. He and Seth Shulman wrote about nuclear waste disposal in Earth, March 1994.