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High-Altitude Quest For Data

Information from Colorado's Mountain Research Station puts the global environment into sharper focus

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On Tuesdays—going back to 1980—Mark Losleben jogs, hikes, or skis his way to the high alpine tundra of Niwot Ridge on the eastern side of the Colorado Rocky Mountains just short of the Continental Divide.

There, he collects air samples and oversees instruments that report a wealth of data on climate, snow depth and content, wind, the makeup of ambient air, and other information that has served as the foundation for many an atmospheric chemist's and other scientist's research paper, dissertation, or book.


Courtesy of William Bowman
Thin Air Losleben stands outside the tundra lab.

Besides gathering samples and making measurements, Losleben maintains the 11,500-foot-high tundra lab of the University of Colorado's Mountain Research Station (MRS), as well as several other remote instruments spread throughout the high mountain ridge. He also conducts his own research based on the information he collects and shares with other researchers.

Scientists like Losleben have been gathering climate and other data at Niwot Ridge since the 1950s, when monitoring equipment was first installed there. The facility's data are woven into a web of information from other institutions around the world to paint a clearer picture of the global environment.

The station provides the longest running, single-mountain climate data set in the U.S., says Mark W. Williams, a geology professor at the University of Colorado at Boulder, which owns the facility. Williams is also a fellow at the Institute of Arctic & Alpine Research, a part of the university that oversees the station, and is a principal investigator with the National Science Foundation's Long Term Ecological Research (LTER) network, which helps fund the site.

Niwot Ridge is one of 26 U.S. LTER sites and was among the first 12 that were selected in 1980 for the program. Each site was chosen for its diverse ecology and for what each offers as a location for long-term study of ecological systems. The research station includes 50 structures on some 192 acres, from base labs at 9,500 feet to climate-monitoring instrument stations at 12,500 feet on the Continental Divide.

"In the simplest sense, we think of MRS as a tool for scientists to use to collect data on environmental phenomena," says William D. Bowman, director of the research station and a professor in the university's department of ecology and evolutionary biology. Along with providing climate data, MRS is open to biologists, atmospheric scientists, ecologists, and others who have conducted decades of research there.

Bowman estimates that 40 to 50 full-time senior researchers come to the mountain each year to use MRS's facilities, which include wet labs, lecture halls, and cabins. Classes are also held during summer months. Many more use the climate and other data generated by Losleben and other researchers. Most of it is public information, posted to the Internet.

MRS's history stretches back to 1920, when it was founded by a group of hikers and geologists and called "University Camp." It is funded by an alphabet soup of government agencies—NSF, the National Oceanic & Atmospheric Administration (NOAA), and the National Center for Atmospheric Research—as well as the University of Colorado. All have operations 40 miles down the mountain in Boulder.

With its mountain location and its isolation from anthropogenic influences, MRS is a little like a mountain island. It is located on Roosevelt National Forest land, sandwiched between the Indian Peaks Wilderness Area, Rocky Mountain National Park, and the City of Boulder Watershed, a protected area that supplies drinking water to Boulder.

In the late 1970s, scientists fought to end mining claims to Niwot Ridge and to limit access by hunters, hikers, and campers. It was set aside as a U.S. Biosphere Reserve, and no vehicular traffic is allowed except for an occasional watershed inspection by a City of Boulder snowmobile.

"People have a tremendous impact, even if they are nice and don't destroy or steal your equipment," says Losleben, the station's climatologist. "They alter the environment. They tramp all over the place. They kill plants; they alter air quality, water quality, and water-flow paths.

"The station gives us an idea of the natural conditions, and because it has been so well-studied, there is a good basis of background to put its current conditions into perspective," he continues. "The climate program has a half-century of data. If you go to a new area, you have no idea if it is an anomalous year, an average year, or whatever."

Losleben uses his feet and skis to collect data, as he has done for 26 years. On Tuesdays, Losleben climbs or skis to the 11,500-foot saddle of the ridge and along the way collects snow and precipitation samples that he sends to the National Atmospheric Deposition Program to be analyzed and added to its national database. At the saddle's lab, he fills four to six flasks with ambient air samples. These, he sends to NOAA's office in Boulder, where they are measured for some dozen compounds and added to its national database. He also records data and monitors equipment at other installations along the way.

At the ridge top, he loads the flasks, tubs, and recorded information into an unwieldy 2- × 3-foot backpack and then heads down the mountain. On other days, he travels to other sites on the well-characterized ridge, collecting data and fixing equipment.

NOAA combines data from Losleben's air samples with information it receives from some 70 other U.S. sites, says Pieter Tans, an atmospheric scientist with the Earth Systems Research Laboratory. NOAA began taking carbon dioxide measurements at Niwot Ridge in 1968, Tans says, and now, along with CO_2, NOAA monitors methane, carbon monoxide, hydrogen, nitrous oxide, sulfur hexafluoride, and isotopic ratios in several of those species. He estimates another 20 labs around the world have similar collection and monitoring programs, providing a global database for these compounds.

Over the past 20 years, more automatic equipment has been added to the station, such as continuous gas chromatographs. The equipment measures a host of variables—from the atmosphere above the forest to the interface of soil and snowpack.

Hidden in the forest are two 85-foot towers, twice the height of the forest canopy, that measure CO_2 fluxes between the forest and the atmosphere. The towers are part of the Ameriflux network, a global system of some 200 measurement devices primarily examining CO_2 changes in the environment.

"We are figuring out how much carbon dioxide is sequestered by the forest and how it is responding to climate change," says Russ Monson, the principal investigator for the Ameriflux site project and a professor at the department of ecology and evolutionary biology at the University of Colorado. His project's data are then tied into the MRS's basic climate and snowpack data to get a clearer sense of the mountain ecology.

Monson, Williams, Tans, and others are also studying what happens under the snowpack and the relationship of snow depth, soil temperature, and air temperature to the creation of CO_2 and other compounds. Overall, they've seen spring arrive earlier—by several weeks—and fall come later.

"We found that in years with a thinner snowpack, we got colder soils and less carbon dioxide entering the atmosphere from the ecosystem," Monson says. "And since the snowpack has been decreasing over the past couple of decades, it means that forests at higher elevations are losing less carbon to the atmosphere."

With some irony, he calls this phenomenon the "silver lining" of global climate change.

"We thought there wasn't much going on under the snow during winter. But when we looked at CO_2 and N_2O emissions from soil to snowpack, we found a huge amount of biological activity," Williams adds. "We found that you get a new type of microbe that has adapted to the environment and likes the temperature, which is always about 0 ^{o}C under a meter or more of snow. The temperature is relatively warm and stable. The microbes have plenty of water, and they really crank up biomass, much more than they do during the dry summers."

The snow season began earlier this year, about two weeks ago at Niwot Ridge when a foot of snow fell on the research station. It was a Wednesday, Losleben notes, with some satisfaction. "I got a chance to get my skis and other stuff out and have a little shakedown." A day earlier would have been a lot tougher.

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