When Meteorologists See Red

Worldwide warming has tripped up U.S. forecasters

By RICHARD MONASTERSKY

From the sixth floor of the World Weather Building, just south of Washington, D.C., it's impossible to miss the signs of a cold front barreling toward the region. A wall of dark clouds blots out the western horizon while barren trees whip back and forth in gusts that herald the coming February storm. In a short time, the temperature outside will plummet from a record high of 74°F to near freezing, jumping from summer to winter all within the span of the evening rush hour.

The building's public address system crackles and a voice announces, "Attention. We have switched to backup power because of convection in the area." Down in the parking lot, a diesel generator kicks on to provide a steady source of electricity for the people who forecast the nation's weather.

The air outside is roiling like a pot of soup on a flame. A strong updraft plucks an empty grocery bag off the ground and hoists it more than 50 feet skyward, past the window of Robert E. Livezey, a meteorologist with the National Weather Service's Climate Prediction Center (CPC) in Camp Springs, Md. At the moment, Livezey is not paying attention to the shifting winds. He's trying to explain a much bigger change—one that's skewing the weather of the entire United States and screwing up seasonal forecasts.

"We are undergoing—for whatever you want to attribute it to—a change in climate. That's clear," says Livezey.

Climate researchers have long maintained that over the past century, the average global temperature has climbed markedly (see page 191). Scientists making predictions for the next century have been forced to consider this trend (SN: 2/27/99, p. 133), yet this slow rise has been of little concern to meteorologists who predict conditions for the next few weeks and months.

Forecasters are now starting to take notice of the long-term changes, however. Livezey and his colleagues recently recognized that the warming trend has interfered with their work, making it necessary to incorporate slow shifts in climate into their analyses. Last September, they quietly started altering their forecasts to correct for the global shift, which has taken some of the sting out of U.S. winters over the past 3 decades.

In its first real test, the new technique helped CPC meteorologists foresee the general pattern of warm weather that dominated the contiguous United States throughout much of January and February. "We are definitely on a very rapid learning curve here with respect to the [global warming] trend and its effect. This has been a revolution in this business," says Livezey.

At just about this time last year, some forecasters at CPC were not feeling so satisfied. All through the winter of 1997–1998, the United States and much of the rest of the world was reeling under the influence of the record-setting El Niño. This warming of the equatorial Pacific had developed early in 1997, giving meteorologists plenty of advance notice as they put together their wintertime forecasts.

El Niño should have made this an easy task. When the central Pacific goes warm, it has a standard modus operandi as a weather maker. In past episodes of El Niño, the Northwest and the Great Lakes region typically experienced warmer-than-normal winters, whereas unusually cool conditions predominated in the southern Southwest, Texas, the Gulf Coast, and the Southeast.

So, when it came time to forecast the first 3 months of 1998, CPC meteorologists bet on the Pacific influence. "We were leaning very heavily on the El Niño statistics, which implied strong things about precipitation and temperature in winter," recalls Livezey.

The CPC forecast for temperatures looked like the classic El Niño pattern but deviated slightly by making the northern warmth a little more pronounced.

"What in fact happened is that it was much, much warmer than we had anticipated," says Livezey. "No part of the U.S. was colder than normal, and something like two-thirds of it was in the warmer-than-normal [category]."

A trim man in his 50s, Livezey has graying hair and eyebrows that seem to leap off his face. He likes to plug away at long, tortuous problems, both in his corner office and outside. Last year, Livezey hiked a 140-mile segment of the Appalachian Trail, completing an 18-year effort to cover the entire 2,160-mile journey in segments.

When the winter of 1998 ended up warmer than expected, Livezey and his colleague Thomas M. Smith thought they knew why. They had just finished an analysis of U.S. temperatures since 1950, in which they had picked out different climate patterns at work.

Their analysis brings to mind the technique used to produce Technicolor movies during the 1940s. To make these early color films, directors employed a three-lensed camera containing separate strips of blue, red, and yellow film. Each color was captured on a different strip, and the films were then combined to produce the full range of hues to be seen in movies such as *Meet Me in St. Louis*.

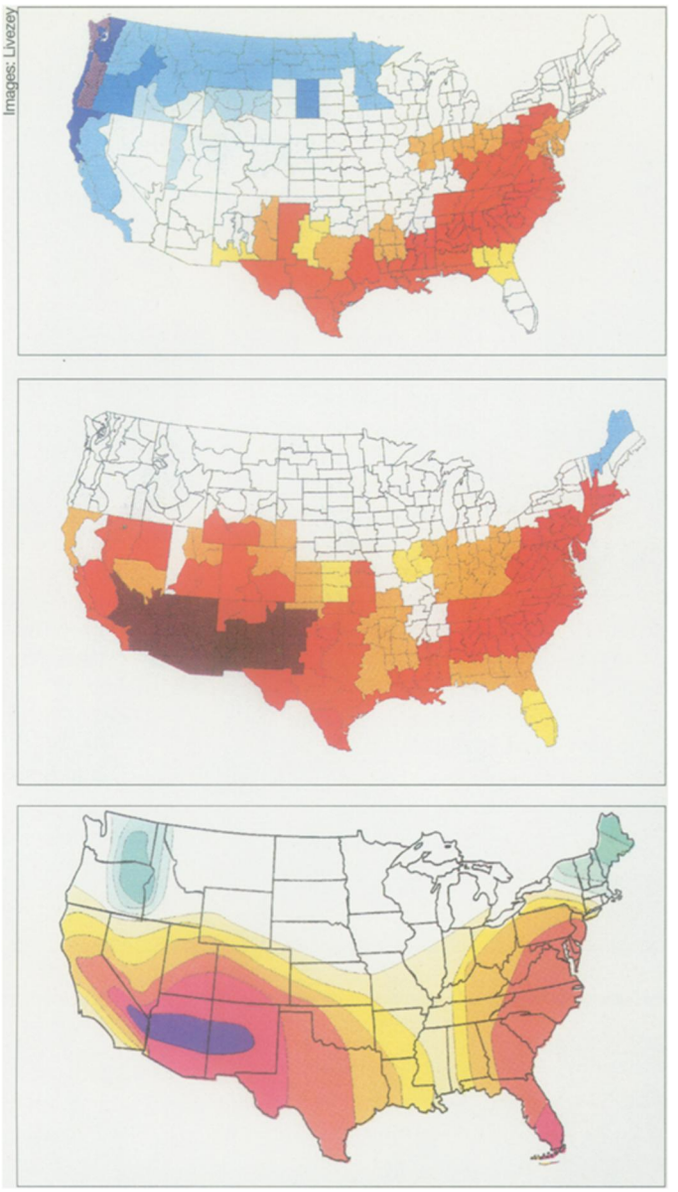
Livezey and Smith worked in the opposite direction, starting with the equivalent of a complete movie and splitting it up into its separate components. Much of the temperature variation in North America could be broken down into three distinct patterns, all operating at the same time. The scientists published their analysis in the January JOURNAL OF CLIMATE.

The first pattern in the record arises from the tropical Pacific Ocean, home to El Niño warmings and La Niña coolings. In roughly the reverse of El Niño, La Niña typically cools the Northwest and the northern states while warming the Southeast and southern states in winter.

The second fundamental pattern relates to cycles of ocean temperature in the northern Pacific and Atlantic Oceans. These regions have slow oscillations that tend—over decades—to warm the eastern states while cooling the western states or vice versa.

The third pattern, however, did not appear to be part of any cycle. This general warming started developing in the mid-1960s and has grown stronger over the past 30 years. In the oceans, it affects much of the Pacific, Indian, and Atlantic basins. In the United States, the pattern appears as wintertime warming across the country, with the strongest influence in the western and central states. During summer, the picture is more complex. The central states cool off, whereas warmer-than-normal weather occurs in the Southwest, West Coast, and northern states.

Livezey and Smith started calling this third pattern the global-change trend, and they propose it as an explanation for what went wrong with the winter forecast in early 1998. Forecasters hadn't before considered that the wintertime climate of the United States was actually growing milder to a degree that would affect their work.



Data culled from eight past episodes of La Niña show that the Pacific cooling typically exerts a strong influence on U.S. winter temperatures (top map). Blue signifies cooler-than-normal weather; other hues indicate warmth. When meteorologists combined the usual La Niña pattern with the long-term warming trend, a starkly different temperature projection emerged (middle), which was used to make the U.S. temperature forecast for January through March (bottom). So far this winter, higher-than-average temperatures have dominated much of the contiguous United States, except for California and southern Oregon.

Late in 1998, the global-change trend burned the CPC meteorologists a second time.

To put together precipitation forecasts for autumn, meteorologists again put their money on the power of the tropical Pacific, which was in the cold grip of a strengthening La Niña. In past episodes of La Niña, above-average precipitation has drenched the Northwest, while dry weather has parched the Southwest, Texas, Great Plains, Gulf Coast, and Southeast. Forecasters called for essentially the same pattern to recur, and they put unusually strong odds on dryness in Texas and the Southwest.

"We went whole hog on the forecast for Arizona to Texas, and we did very badly," says Livezey. Texas received above-average amounts of rainfall, and the Southwest was either wet or near-normal for October through December.

Although it wasn't clear at the time of the forecast, Livezey has since found that the global-change trend is increasing autumn precipitation across much of the country, especially the central states. "When you add the trend, it kills most of the higher probability for dryness" in the typical La Niña pattern, he says.

Following their missed opportunities last year, the CPC meteorologists are now trying to take the changing climate into account. This attempt appears most clearly in the temperature forecast for January through March.

Judging from La Niña episodes earlier this century, the Northwest and northern states should be cold in winter, yet the long-term warming trend counters that effect. When Livezey and his colleagues blended the two patterns, the cooling disappeared. So they called for only a small patch of lower-than-normal temperatures in eastern Washington and Oregon. The forecast map of the United States is mostly yellow and red, reflecting the expectation that the southern two-thirds will go warm under the influence of both La Niña and the long-term trend.

That approach seems to have saved CPC from making a major error. So far this winter, temperatures in the northern and northwestern states have remained mostly average or higher than normal. The South has been warmer than normal.

The recent warmth in these locations has surprised many weather researchers who track La Niña, including Kelly T. Redmond, a climatologist at the Western Regional Climate Center in Reno, Nev. "This isn't the pattern you would expect with La Niña. I've been kind of puzzled why that is the case."

Meteorologists at CPC think they have the solution. "The trend for warmer and wetter weather is overwhelming La Niña," says A. James Wagner, the senior forecaster at CPC. "Unless you consciously somehow take that trend into account, you end up with surprising errors."

CPC's new approach has won some fans among other climate scientists. "I think this work is very interesting and potentially very useful," says Chester F. Ropelewski, director of climate monitoring at the International Research Institute for Climate Prediction (IRI) in Palisades, N.Y.

The institute issues seasonal climate forecasts for the entire globe. Many countries are starting to use them for agricultural planning and other purposes. Like the U.S. Weather Service meteorologists, IRI forecasters will have to start taking account of the warming trend, says Ropelewski.

Forecasters in Europe, however, say they don't suffer from the same problems. Unlike CPC, which uses a combination of computer models and statistics on past weather patterns, meteorologists at the European Centre for Medium-Range Weather Forecasts in Reading, England, rely almost exclusively on computer climate models to produce their forecasts.

These tools start with up-to-date global measurements and then predict how the oceans and atmosphere will evolve over the next several months. Because they begin with current data, they implicitly take into account any warming that has happened in the past few decades, says Tim N. Palmer, head of seasonal predictions for the European center.

As forecasters wrestle with how best to deal with long-term climate change, many are wondering about the origin of these trends. The CPC staff has consciously stayed away from speculating, at least in its formal publications. "Personally, I think it's a no-brainer," says Livezey, who concludes that greenhouse gases generated by human activities are probably driving these changes in U.S. weather.

Wagner takes a more cautious line, saying that it's impossible to tell whether or not some as-yet-unidentified century-long cycle is currently warming the globe.

Other researchers at CPC are attempting to untangle the physics behind the U.S. changes. Some initial work indicates that warming waters in the region around Indonesia may have helped drive the climate shifts seen in North America, says Wayne Higgins, a senior meteorologist at CPC.

Whatever the cause, the new developments are lending support to suspicions that older generations have long harbored: The weather today just isn't what it used to be. □