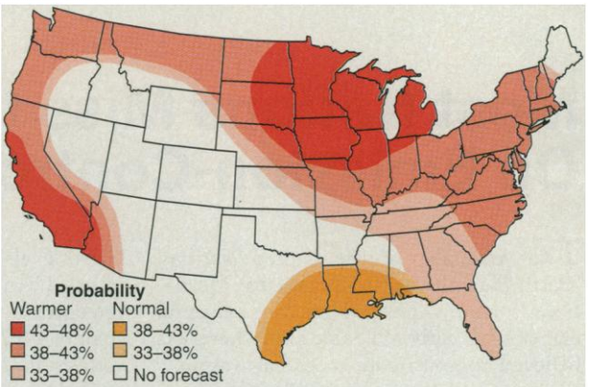
CLIMATE

Official Forecasts Pushed Out to a Year Ahead



Warmth is in store. New objective forecasting methods call for a warmer-than-normal January through March.

Those stodgy forecasters at the National Weather Service (NWS) have finally risen to the challenge. For almost two centuries, feisty prognosticators like the *Hagers-Town Town and Country Almanack* and the *Old Farmer's Almanac* have been boldly forecasting where no self-respecting meteorologist had dared to go: more than a year ahead. Drawing on everything from the phase of the moon to the number of sunspots, the almanacs would warn of an East Coast snowstorm months away or a Midwest drought the next summer. Now the official forecasters are jumping into the fray—in their own fashion.

"We're not forecasting the weather; we're forecasting the climate," says Edward O'Lenic, head of long-range forecasting operations at the NWS in Camp Springs, Maryland, about the 15-month forecasts that will be unveiled next month. That means the NWS won't be predicting individual storms, just large regions of above-, below-, or near-normal temperature and precipitation—not much help in planning, say, the family trip to the beach next June. Nor is the NWS making pie-in-the-sky promises about the reliability of its forecasts. "If you cannot accept forecasts [that are right only] five-and-a-half to seven times out of ten, then you shouldn't be using these forecasts," warns O'Lenic.

But O'Lenic thinks that industrial and government planners deciding how much natural gas or road salt to stockpile for the winter, for example, and farmers planning their spring planting will welcome these cautious forecasts. If so, they will be indirect beneficiaries of the latest understanding of El Niño, the huge pool of warm water that usually appears in the equatorial Pacific every 2 to 7 years and disrupts global weather. NWS forecasters finally have the confidence to compete with less scientific prognosticators, thanks to researchers' newfound ability to predict El Niño, albeit not perfectly, up to a year in advance and correlate it with climate patterns.

Forecasters have actually been taking El Niño's effect on climate patterns into account for several years, at least informally. In making 3-month seasonal forecasts—the longest range predictions the NWS now issues—they often take their cue from the state of the tropical Pacific because the warmth of an El Niño can displace the tracks of the jet streams that cross North America. The resulting shift in the subtropical jet stream can steer rain-laden storms to the Gulf Coast and the southeast, while the shift in the midlatitude jet stream pumps unusual warmth and dryness along much of the U.S.–Canada border. But the tropical Pacific was only one element in these forecasts, which also included other techniques and a lot of subjective judgment.

Now, NWS meteorologists are adopting three standard techniques for long-range forecasting, two of them based on objective methods for forecasting El Niño and its

Taking the Long View of Weather

The climate forecasters who are extending their long-range predictions out beyond a year (see main text) aren't the only ones raising their sights at the National Weather Service. The people who predict the daily weather are pushing the envelope too. Within the next year the NWS will be stretching its official 3- to 5-day forecast out to 7 days, and it will be on the lookout for rare but disruptive weather events as far as 2 weeks in advance.

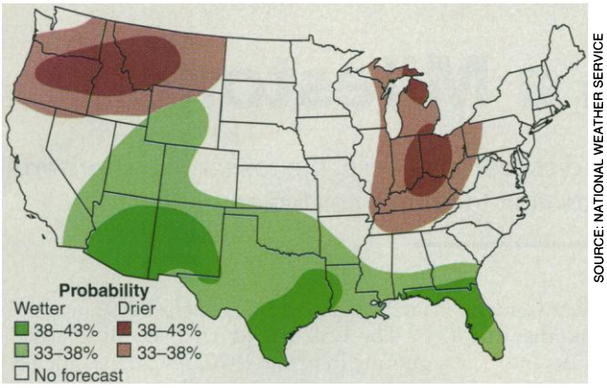
But unlike climate forecasters, who are taking advantage of new knowledge that makes global climate more predictable, the weather forecasters expect to do better because they have developed a new way of dealing with what they can't precisely predict: the chaotic behavior of the atmosphere, in which small changes can eventually lead to big changes in the weather. They are no longer trying to wring the perfect medium-range forecast out of ever-more-complex computer models, whose forecasts may run up to 12 days but tend to be swamped by chaos beyond 6 days or so. Instead, they have adopted an approach called ensemble forecasting: polling dozens of forecasts from somewhat less capable models to identify weather that is unlikely to disappear in a chaotic shift. "Years of futzing around with the models won't get you the improvements that this approach will," says Steven Tracton of the NWS in Camp Springs, Maryland.

This kind of polling is something human forecasters have been doing informally for years, Tracton explains. When Monday's new computer forecast comes in, they compare it with Sunday's and Saturday's. If all three of them call for an intense snowstorm to run up the east coast at the end of the week, the forecaster can be more confident that the storm is part of a more stable and therefore more predictable part of the atmosphere. Likewise, the forecaster may look at a half-dozen different global forecasts from the computer models that the NWS and other national centers exchange electronically. If most of them call for the same storm, the forecast looks even better. In ensemble prediction, says Tracton, "we're just doing [that] more systematically, more efficiently, and sampling the possibilities more adequately."

Sampling more possibilities, in the case of the NWS, means combining 46 different forecasts, made at different times or with slightly different starting conditions. The average of such an ensemble is a better estimate of the weather in 5 to 7 days than a single computer forecast can give. And it adds almost a whole day to the useful length of medium-range forecasts, says Tracton.

Beyond 7 days, even ensemble forecasts can't give consistently reliable weather forecasts, but they may still be able to pick up some extreme weather events 8 to 14 days in advance—severe snow storms, for example, or persistent rains like those that hit the Midwest last year. Last winter, ensemble forecasts made 1 to 2 weeks ahead hinted at the outbreak of severe cold that struck the East Coast last January, notes researcher Randall Dole of the National Oceanic and Atmospheric Administration in Boulder, Colorado. "Even if we can't get the timing and details correct," says Tracton, alerting the public weeks ahead half-a-dozen times a year "will have achieved our purpose." And it would be another strike for predictability over chaos.

–R.A.K.



SOURCE: NATIONAL WEATHER SERVICE

Chances of precipitation. El Niño may bring extra rain to the Gulf Coast and less moisture than normal to the north.

long-term influence on weather (*Science*, 24 January 1992, p. 402). One tool, canonical correlation analysis (CCA), is an effort to systematize what forecasters have already been doing: looking for hints of an impending El Niño and other signs of imminent climate change. This statistical method considers three kinds of observations—including changes in the temperature of the global sea surface over the past year—to pick up the signs of an approaching El Niño months before it arrives and predict the global weather patterns it tends to produce.

A second forecasting tool predicts El Niño not by extrapolating from past trends but by simulating what will happen in the future. This computer model, developed by Ants Leetmaa and his colleagues at the NWS, has two components linked together. One simulates the future evolution of the tropical Pacific given current surface and subsurface temperatures there; the other represents the atmosphere. Because the models are coupled, any ocean warming can drive the appropriate changes in the weather patterns around the globe.

Only the optimal climate normals (OCN) method, the third ingredient in the new extended-range forecasts, is independent of El Niño, says Anthony Barnston of the NWS. Simply put, OCN assumes that an existing climate pattern is likely to persist. Forecasters have long tempered their predictions with this kind of conservatism, but OCN makes it quantitative and draws on longer term trends. Given a 10-year series of wet winters, for example, OCN will predict that the next winter will be wet as well. And although the method may sound simplistic, Barnston says, "it really seems to do well."

Every month starting this January, the NWS will weigh the results of these three techniques (in a somewhat subjective manner) to issue 13 forecasts of temperature and precipitation for the United States. Each will cover a 3-month period, the first of them beginning 2 weeks from the forecast date and each of the next 12 overlapping the previous forecast by 2 months. All told, the forecasts issued each month will cover a total of 15 months.

The strategy's debut came last week, when NWS forecasters came out with the first official predictions—in this case limited to 3 months—based on this trio of techniques. If the new forecasting tools work as well as hoped, the coming January-February-March period should bring above average precipitation along the Gulf Coast and unusual warmth to the northern part of the lower 48 states and along coastal Alaska—a fairly typical El Niño winter. That may be a safe bet, because an El Niño is already developing in the Pacific. Next month, when the NWS issues a full set of forecasts out to 15 months in the future, it will be sticking its neck out a lot farther.

For one thing, notes Barnston, some seasons and some climate patterns are a lot harder to forecast than others. April-May-June is "a pretty dismal situation," says Barnston, and October-November-December is "another dud. We don't expect to put out much of benefit in the fall." Spring and fall are unstable seasons during which climate patterns are often muddled or shifting from one mode to another. As a result, some parts of the forecast map, possibly quite large areas, will be labeled "CL" for "climatological probability," or as Barnston translates it, "we don't know."

What's more, researchers' understanding of El Niño still has some worrisome holes. The El Niño now developing came as something of a surprise, notes Barnston. It is the third in 4 years, and El Niño forecasts, including that of the NWS's coupled model, didn't see it coming until late summer. With El Niño so central to extended-range forecasting, that's unsettling some people. "I think highly of what they're doing" at the NWS, says long-range forecaster Arthur Douglas of Creighton University in Omaha, Nebraska, but "you look at the [El Niño] forecasts, and I don't think they're very encouraging, at least over the past 2 years."

But the NWS forecasters aren't too rattled by El Niño's odd behavior of late. "We just have to be on our toes," observes O'Lenic. As the coupled model improves, he says, "we expect things will improve gradually with time." The almanacs needn't worry, though. Forecasting daily weather a year ahead is not in the Weather Service's plans.

–Richard A. Kerr

INDUSTRIAL ESPIONAGE

FBI Says Sting Nabs Biotech Spies

Two men were arrested in Worcester, Massachusetts, last week and charged with trying to pull off an illegal drug sale with a bizarre twist. The product wasn't cocaine or heroin, but a purloined biotechnology protein worth billions of dollars.

According to an affidavit filed in federal court by the Federal Bureau of Investigation (FBI), Vemuri Bhaskar Reddy, a Boston University Medical Center biochemist, handed over a brown attaché case to Subrahmanyan Kota in the parking lot of a Dunkin' Donuts in Westborough, Massachusetts, on 10 December. In the case was a genetically engineered cell line apparently capable of producing the human hormone erythropoietin (EPO), an anti-anemia drug with worldwide annual sales of more than $1 billion. The FBI alleges that Reddy, a former employee of Integrated Genetics (IG) in nearby Framingham, had taken the cells from the biotech company years earlier. Kota had bragged of past dealings with the KGB, the secret police of the former Soviet Union, the FBI says, and he intended to broker a sale to a KGB agent for $300,000, ostensibly so people in Russia could manufacture EPO and sell it on the black market.

Kota's KGB contact, however, was actually an undercover FBI agent, and the day after Kota received the goods from Reddy, the bureau pounced. Kota and Reddy have been charged with "conspiring to transfer and transport stolen property with a value of $5000 or more in foreign commerce," according to a statement from U.S. Attorney Donald Stern. As *Science* went to press, Kota and Reddy were still being held without bail and have not filed any pleas.

EPO has been one of the biggest success stories of the troubled biotech industry. The hormone stimulates the production of red blood cells, and the recombinant form is used to combat anemia, especially in patients undergoing kidney dialysis or multiple blood transfusions or those afflicted with certain AIDS-related illnesses. The U.S. and most worldwide patent rights to sell recombinant EPO are held by Amgen, a California biotech firm; IG had been developing the drug years ago, but stopped the work and put the cell lines in storage when Amgen filed its patent.

According to the FBI's affidavit, the bureau had been following Kota for years, suspecting him of having KGB contacts. The FBI initiated the sting operation in 1992, when one of its agents posed as a Russian and met with Kota, who offered to sell the agent secrets, says the affidavit. Would the outlandish scheme to make black-market EPO have worked? "It's very easy to produce as recombinant drugs go," notes Mark Hofer, a vice president at Genzyme, IG's majority owner.

–John Travis