A Chance to Predict Next Month's Weather?

A successful computer simulation of 1977's brutal January weather strengthens the hope that such 30-day forecasts are possible

Knowing nothing more than the weather around the globe on 1 January 1977, a computer model has successfully generated a reasonably good facsimile of the general weather pattern that persisted through the rest of that month. Impressed with this achievement and with recent theoretical progress, researchers are beginning to see some prospects for bringing the computer to the aid of beleaguered long-range forecasters, in much the way that it aided short-range forecasters 30 years ago. The optimism is guarded, however. The January 1977 simulation is only one case and an extreme case at that. This model must succeed in many more trials before it will prove itself useful and not simply lucky.

The successful computer model was one of several used by Kikuro Miyakoda and his group at the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey. It was not the first one they tried. Other GFDL models, less sophisticated and less demanding of expensive computer time, had repeatedly failed to predict the strong ridge of high pressure over Alaska and Canada that blocked the normal air flow and steered frigid air into eastern North America in January 1977. All of their attempts at simulating this blocking pattern involved general circulation models (GCM's) of the type used by medium-range forecasters to make predictions out to 7 days or so (*Science*, 1 April, p. 39). As described in a forthcoming paper,* the GFDL group constructed various GCM's from two basic elements. One is a computational scheme for predicting the flow of an ideal atmosphere, called by itself a dynamical model. The other is a set of mathematical descriptions of the processes that cause the atmosphere to depart from the behavior of an isolated, ideal gas, such as precipitation, evaporation, and cloudiness. These are called physical parameterizations or simply the physics.

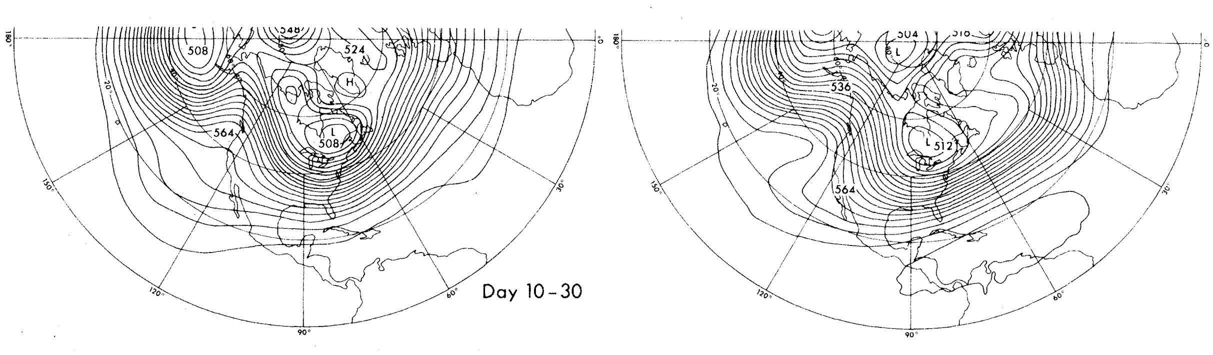
Both elements of the most successful GCM were the most sophisticated of their kind available to the group. The dynamical model has a finer spatial resolution than its closest competitor, a known advantage in medium-range forecasting in that the sharper the picture of the weather the more accurate the forecast. The model has a loftier gap in its Rocky Mountains, which might help deflect westerly winds into the meandering of the January 1977 blocking pattern. And Pacific storms in the model dissipate more readily, perhaps preventing them from disrupting the blocking ridge to the east. The physics package also paints a more realistic picture of the world, especially where the atmosphere interacts with land and water.

The success of the GCM was measured by correlating 10-day means of the anomalies in the forecast Northern Hemisphere pressure pattern with the actual pressure anomalies of January 1977. When the model started with 1 January weather as analyzed by a GFDL computer program, the correlation coefficient after 25 days was 0.60. By any standards of the long-range forecasting business, that is a spectacular score. If 2 January or even the National Meteorological Center's rendition of 1 January was used as the starting point, the correlation coefficient dropped to about 0.38. Presumably, small differences between the 2 days or the way the same day's observations were prepared for the model degraded the forecast. Substitution of a less sophisticated physics package in the GCM lowered the single-run correlation coefficient from 0.60 to 0.25. Three runs of the least sophisticated combination of GCM elements gave an overall correlation of just 0.04—no correlation at all.

The model's best performance in this one case was impressive, but there are things that it did not or cannot do. No long-range forecasting method will ever be able to describe the weather 30 days hence in the detail of a daily forecast. The long-term, detailed behavior of the atmosphere is inherently unpredictable, forcing the long-range forecaster to talk about average conditions over large regions. The GFDL model did not even do that perfectly. Its best forecast anticipated the severe cold in eastern North America but made it colder by 2.5°C than it actually was. It also failed to forecast the unusual warmth along the west coasts of the United States and Mexico.

None of the models tested was asked to predict the appearance or disappearance of the blocking ridge and the resulting cold, only its maintenance through the month. That a model achieved even that is a bit surprising, since it did not contain what may have been the ultimate cause of the January 1977 cold. The winter of 1977 seems to have been a classic case of a warming of tropical Pacific waters, called an El Niño, affecting weather patterns in the mid-latitudes

*K. Miyakoda, T. Gordon, R. Caverly, W. Stern, J. Sirutis, W. Bourke, *Mon. Weather Rev.* 111 (No. 4) (1983).



Observed (left) and computer simulated (right) weather of January 1977

In both, a blocking ridge juts into Alaska, as shown in the height of the 500-millibar level. [Source: Monthly Weather Review] of the Northern Hemisphere (*Science*, 7 May 1982, p. 608). But the successful GCM only had normal sea surface temperatures. The use of actual boundary conditions, such as sea surface temperatures and the extent of snow cover, that tend to persist for months at a time is one reason to expect that long-range forecasting models would be practical. Miyakoda's group suggests that the atmospheric conditions alone during blocking may be sufficient to maintain that blocking, at least for a few weeks.

While lauding the GFDL work as important and a cause for hope, researchers have two major reservations. One is that the modelers cannot show exactly why their forecast worked. No one can yet explain blocking. The strikingly accurate forecast does make some physical sense, Miyakoda and his group argue, at least in terms of the local resonant interaction theory, one of many theories proposed to explain blocking. The behavior of the model, they believe, suggests that there can be a special relation between the long-period atmospheric waves created by the Himalayas and the westerly winds blowing off the Pacific and across the Rocky Mountains. If the westerlies at those latitudes blow at the proper speed, they say, constructive interference of the waves amplifies the deflection of winds by the Rockies and the block appears. The successful model reproduced the weakened westerlies that might have been crucial to the blocking, the group notes, but the other models did not or did so poorly.

The other major reservation is that January 1977 is only one case. There is no guarantee that all the fussing with the models has not produced one tuned to forecasting the weather of January 1977 and no other month. The best, most sophisticated model did make the best forecast; that is reassuring, observers note, but not convincing. Many researchers are particularly concerned about the large sensitivity of the model's forecast to the initial conditions, as evidenced in the correlation coefficient's drop from 0.60 to 0.38 when the starting point was shifted from 1 to 2 January. Many more simulations of the same and other months must be performed in order to demonstrate the general usefulness of the model, they say. Miyakoda agrees but adds that his group has also applied the forecasting model to two other months having strong blocking patterns, January 1979 and March 1965. Using a new, even more sophisticated physics package, they found that the matches between forecast and observation are not as good as for January 1977, but correlation coefficients are still between 0.4 and 0.5, Miyakoda says.

This particular GCM is not the only reason for guarded optimism in long-range forecasting. There are other indications that more reliable forecasts out to 30 days may be practical. For one, long-range forecasters relying on various empirical aids have shown marginal but significant skill. If people can do it, perhaps machines will help to do it better.

By comparing 60-day simulations starting with the first day of three different Januaries, with and without added random errors, J. Shukla of the Goddard Space Flight Center in Greenbelt, Maryland, has shown that, even after 30 days, inevitable errors in the initial weather picture that cascade through the model's atmosphere had not totally destroyed predictability. Because the boundary conditions of his model were held fixed, Shukla suspects that predictability may be even higher. And theorists are increasingly confident that within a few years they will be able to explain the blocking phenomenon, a prime target of forecasters.—**Richard A. Kerr**

Incidence of Strokes Declines

In the past decade, the incidence of death from stroke has declined precipitously, down 42 percent since 1972. Although no one knows exactly why, a number of researchers attribute it to gains made in treating high blood pressure. At the National Conference on High Blood Pressure Control, held late last month in Washington, D.C., medical researchers applauded the success of recent campaigns to convince Americans and their physicians that high blood pressure should be treated. Now they are talking about increasing efforts to identify and treat people with mild hypertension.

In the early 1970's, almost half of those with high blood pressure were unaware of it. In 1980, only one-quarter of those who have high blood pressure did not know it. Ten years ago, only 16.5 percent of persons with hypertension (defined as diastolic blood pressure of at least 115) had it controlled. Now 34.1 percent do. These correlations are suggestive, but, says Claude Lenfant, director of the National Heart, Lung, and Blood Institute (NHLBI), "we are not ready to make any cause and effect claims."

William Friedewald, an NHLBI epidemiologist, says, "In my judgment, the largest portion of stroke decline is due to blood pressure control." But he cautions that many other changes occurred in the 1970's that could have lowered the death rate from strokes. "There were changes in life-style, in drugs, and in coronary care units. There were changes in diet and in the number of men who smoke. Any of these changes singly or in combination may have had an effect," Friedewald says.

Although they are elated by the reduction in deaths from strokes and cardiovascular disease, many of the conference speakers noted that they have a new challenge ahead: to make the public more aware of the need to treat mild hypertension. Thirty-five million Americans have diastolic blood pressure ranging from 90 to 114 mmHg, which puts them in the "mild hypertension" category.

Some physicians have questioned whether mild hypertensives should be treated, but conference speakers, such as Robert Levy, former director of the NHLBI and now vice president for health sciences at Tufts University, Marvin Moser of New York Medical College in Valhalla, and James Taylor of the Brigham and Women's Hospital in Boston, argued that recent clinical trial results point conclusively to the value of treating these people. By treatment, they mean to try nondrug treatment first, such as weight reduction, and drug treatment only if all else fails.

Moser, who is an enthusiast for treatment of mild hypertension, nonetheless stresses that there is a danger of overkill and that he and his colleagues must be cautious in their recommendations. "Perhaps in our enthusiasm to conquer high blood pressure we have become alarmists" he says.

The real challenge in the decades to come may be to get the message to doctors and patients that mild hypertension should only be treated if it is clearly present. Many who seem to have mild hypertension on one visit will have normal blood pressure in subsequent visits. Otherwise, the treatment may do more harm than good.—**Gina Kolata**