Another El Niño Surprise in the Pacific, But Was It Predicted?

El Niño has been playing hide-and-seek with the experts, but now it appears to be well under way; did a computer model know all along or were the forecasters just lucky?

More than a year ago a computer model called for an El Niño to strike the tropical Pacific this winter. Since then the experts have been arguing over whether such an ocean warming was on the way and, in recent months, over whether one had arrived. There is now growing agreement that it is here, along with its disruptive effects on the weather. It seems to be on the way out already, but that too is a matter of debate.

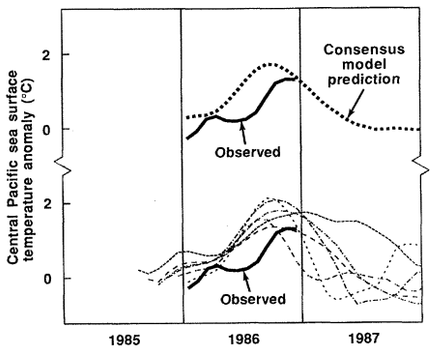
However, the biggest and most important debate promises to develop on the question of the success or failure of the December prediction and several, shorter term ones that followed. If that early prediction was well founded, El Niño is indeed a predictable phenomenon that reveals its imminent return in the condition of the tropical Pacific Ocean.

The existence of this El Niño has been much discussed because its strength is at best moderate and its behavior odd in the extreme. Last February and March the surface waters of the tropical Pacific became warmer than normal near the coast of South America. That is the classic opening to an El Niño. That behavior also generally fit the prediction of the computer model of the Pacific Ocean and atmosphere that was first presented the previous December by oceanographers Mark Cane and Stephen Zebiak of Lamont-Doherty Geological Observatory. If this El Niño developed true to form, sea surface temperatures along the coast would peak a few degrees above normal around April as the warmth spread westward into the central Pacific, where temperatures would peak around Christmas.

Just as attention was focused on the Pacific, and Cane and Zebiak were submitting their formal prediction for publication, the incipient warming faded away. No trace of it remained by May, but that did not stop more modelers from coming down on the side of a full-blown El Niño by the end of the year. Oceanographer James O'Brien of the University of Florida reported in June that four simpler models, including his own, were now calling for an El Niño.

Meteorologists on the whole were not impressed. They suspected that the models, several of which give the ocean the pivotal role in the timing of El Niños, had been fooled by a burst of winds that swept eastward across the Pacific in May. Both the ocean and atmosphere seemed to many of these observers to be too normal last summer to countenance an El Niño in 1986.

Then the central Pacific began warming. By the end of December everyone, including the staff of the National Weather Service's Climate Analysis Center in Camp Springs, Maryland, agreed that the warming of the central Pacific resembled the mature phase of an El Niño. And the accompanying changes in the atmosphere resembled those of the Southern Oscillation, the rearrangement of atmospheric structure that accompanies an El Niño. The Gulf coast of the United States was wetter than normal, the northern tier states, western Canada, and Alaska were warmer, northern Australia, southern Africa, and Indonesia were drier, and southern Brazil and equatorial East Africa were wetter. And it had begun to rain in usually dry regions of Peru. By January it therefore looked like a fairly typical El Niño–Southern Oscillation or ENSO event.



One and the same El Niño?
In the upper plot, the sea surface warming predicted by the model of Cane and Zebiak (dashed) is compared with the actual warming (bold). In the lower plot, the observed record is compared with the six individual model runs averaged to produce the model prediction. The observed and predicted curves are several tenths of a degree closer to each other here than presented elsewhere because of the use of a more appropriate climate record and a refined calibration of the model, according to the modelers.

Although all appears typical now, the absence of the classic early warming along the Pacific coast confounded analyses in 1986 that were based on the behavior of earlier ENSO events. Meteorologist Eugene Rasmusson of the University of Maryland, the cocreator in 1982 of a popular six-event composite ENSO usually taken as the canonical event, believes that the current event and the equally bizarre one in 1982–83 show that reliance on the detection of trends in winds or temperature, empirical models of events, and comparisons with a canonical event can easily lead forecasters astray. For lack of any better guidance, such practices have been common, especially among meteorologists. A more fundamental insight seemed to be needed.

Cane and Zebiak believe that their model's performance last year as well as earlier tests on events since 1970 suggest that their model can provide such insight. Of course, the model might simply have been lucky this time. ENSO events recur every 2 to 7 years, most typically every 3 to 4 years, and the previous event was 4 years ago. But Cane sees a reasonable resemblance between the model's prediction and the actual event.

In the published prediction based on observations through January 1986, the model predicted a moderate event for this winter in which the departure from the normal sea surface temperature in the tropical central Pacific would peak at 1.9°C in September. That is weaker than two of the three events of the past 15 years and several months earlier than the usual central Pacific peak in December.

So far, the sea surface temperature anomaly rose sharply and reached its highest level—1.1°C—in October, rather than in September, and has remained near that level through January at least, according to the Climate Analysis Center. The 0.8°C gap between predicted and observed temperatures narrows by 0.2°C if a more appropriate climate record is used to calculate the anomaly and by another 0.2°C when a more refined calibration of the model is used, says

Cane. If the warming now fades, the 1986–87 ENSO event will have been a relatively weak one that in the central Pacific peaked early, much like the predicted event. On the negative side, there was a considerable gap between predicted and observed temperatures last summer when the model called for a continuation of the early warming rather than the near normal conditions that prevailed.

Like most researchers in the ENSO community, Rasmusson will not say whether this is the event predicted by Cane and Zebiak, but "we did get a warming. It may not have developed as modeled, but we cannot shrug it off. They should feel pretty good about it. It's never been done before. At least this time we were highly suspicious; before we weren't even suspicious."

If the Cane and Zebiak prediction proves to have been well founded, meteorologists and oceanographers alike will know what part of the ocean-atmosphere system to monitor for signs that El Niño is ready to return. "We have a theory of how this works," says Cane, "that focuses very strongly on the amount of heat in the ocean." In their model, the accumulation of sufficient warm water in the tropical ocean is like the loading of a gun. Disturbances in the ocean-atmosphere system that could set the gun off occur frequently, Cane says, but it cannot go off unless it is loaded.

"Even after all those unfavorable conditions in the spring, it still happened," says Cane. "That suggests that this is a relatively robust phenomenon. If it's going to go, it's going to go."

Another new essential element of the model is a means for returning to anti-ENSO conditions. During an intensifying ENSO event warm water sloshes from the western into the eastern Pacific as the westward winds that had kept the warm water piled in the west weaken. Because those winds are driven by the temperature contrast that is rapidly being erased, a positive feedback between the wind and water temperature drives the ocean-atmosphere system faster and faster toward ENSO conditions.

In order to break out and return to anti-ENSO conditions, the model includes not only west-east winds and water flow along the equator but also poleward flow, a somewhat counterintuitive result of the disappearance of the Coriolis effect at the equator. This poleward flow drains the tropical reservoir of its excess warm water and then some, returning the system to the anti-ENSO state until enough warm water returns from higher latitudes to reload the gun. Westward winds may slacken in the meantime for any number of reasons, but without sufficient warm water the chain reaction of the positive feedback cannot take hold, according to the theory.

There remain plenty of loose ends. This event must still play itself out—a few researchers have suggested that this may be the beginning, not the end, of an event. If it soon fades, as most expect, the next chore will be to determine why not only the Cane and Zebiak model but also the short-term prediction models seemed to work. And then there is the even thornier problem of predicting the effects on weather around the globe. Even if a forecaster were certain of the timing and magnitude of a Pacific warming, the background variability of the atmosphere and the variability of its response to a warming would make useful forecasting difficult. As Cane notes, "The last thing I want to convey is that it's all solved." ■

RICHARD A. KERR

ADDITIONAL READING

M. A. Cane, S. E. Zebiak, S. C. Dolan, "Experimental forecasts of El Niño," *Nature (London)*, **321**, 827 (1986).
R. A. Kerr, "Another try at forecasting El Niño," *Science* **232**, 155 (1986); "Predicted El Niño failing to show," *ibid.*, p. 1604.

Wet-Nursing Boom in England Explored

From 1500 to 1700, wealthy English women did not nurse their babies—and had anywhere from a dozen to 20 or more children

For the past 5 years, Valerie Fildes of Edinburgh, Scotland, has been scouring historical records of infant feeding in England, asking what determined family size during the period 1500 to 1700 and why. Her results, says demographer Roger Schofield of Cambridge University, are "extraordinary."

Fildes' major observation is that well-to-do English women of that time "had anywhere from a dozen to 20 babies and even 30 babies was not unusual." They could become pregnant so often, Fildes writes, because they did not nurse their babies. As soon as a baby was born to a wealthy woman, she gave it to a wet nurse. She then became pregnant again almost immediately.

Breasts, Bottles and Babies, Fildes' recent book,* should be of particular interest to biologists and medical historians. Reproductive biologist Ann McLaren of the Medical Research Council in England says she was "fascinated by all the historical details," and impressed by the scholarship that went into the book. Schofield says what interests him is the information Fildes dug up on people's attitudes toward breast-feeding, the "Dr. Spock–type literature of the era," as he puts it.

The wet nurse boom began in England around 1500, according to Fildes, when it became the fashion for wives of the aristocracy, gentry, and other wealthy families to forgo nursing their own babies. By the early 18th century, even less wealthy women, such as the wives of shopkeepers, were hiring wet nurses.

The results were dramatic. Because lactation induces amenorrhea, nursing women are much less likely to become pregnant than women who do not nurse. Women who used wet nurses, and gave up the contraceptive effect of lactation, could then become pregnant almost immediately after giving birth and end up with a new baby virtually every year.

Women said they did not nurse because they felt it would make them look old before their time.

It was known at the time that lactation is a means of birth control, Fildes points out. For example, Hugh Downman, a Devon physician wrote in 1788 that "the nursing time was meant by wisest Nature, as a stay." And the Duchess of Devonshire wrote around the same time that her relatives did not want her to nurse her baby daughter because of their "impatience for my having a son and their fancying I shan't so soon if I suckle."

Parents saw very little of their young children. Nurses did not live with the families they worked for and, in fact, frequently lived miles away. Some London women, for example, sent their babies to nurses in Che-

*Edinburgh University Press, Edinburgh, 1986.