# Fading El Niño Broadening Scientists' View

## *El Niño and its attendant climatic extremes are weakening, leaving specialists looking even farther afield for ultimate causes*

It looks as though they won't have this El Niño to kick around anymore. It can no longer be blamed for everything from Australian droughts to the death of coral reefs. The El Niño of 1982–1983—the strongest warming of the equatorial Pacific in this century—seems to be leaving. It could conceivably return in full force this fall, or it may have some lingering effects on next winter's weather. But most signs point to its imminent, if somewhat delayed, departure. The weather seems to be less extreme too. This summer's Indian monsoon is reasonably normal, the Australian drought has broken, and the rains along the South American coast are abating. Such global effects on the weather have long been associated with El Niño. The peculiar behavior of the latest El Niño has reemphasized that its causes are equally global.

Researchers were guardedly optimistic in mid-August about El Niño's departure because both the ocean and the atmosphere seem to be returning to normal. By the end of July, the tongue of unseasonably warm water that had stretched 13,000 kilometers along the equator from the South American coast to the archipelagoes of the western Pacific had shrunk 5000 kilometers back toward the coast. The maximum warming above normal sea-surface temperatures had dropped from about 5° to 1°C in the central Pacific; near the coast, the maximum anomaly had fallen from 7° to 5°C. Typical coastal anomalies during major El Niños of the past 35 years have been about 2.5°C, so in June Ecuador was still taking a beating—the warm water brought 583 millimeters of rain to Quito during a "dry season" month whose normal precipitation is 13 millimeters.

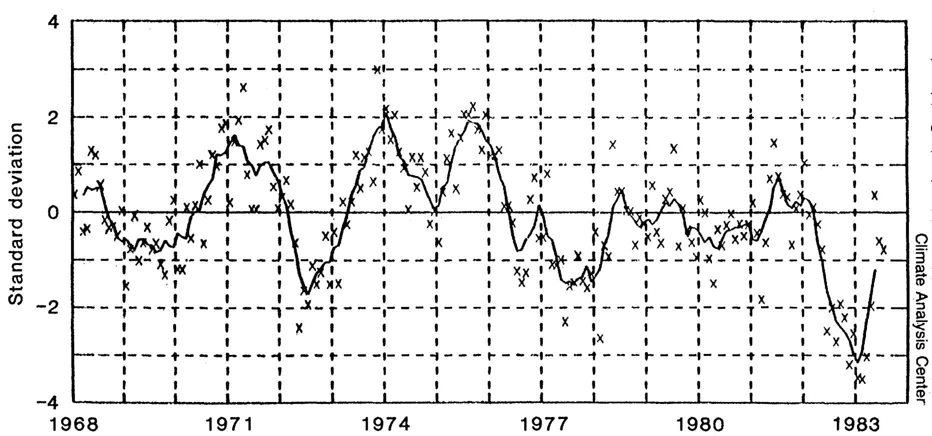
The ocean is retreating toward normalcy, but the best news is that the atmosphere had returned to near-normal conditions by May. Normal atmospheric conditions over the equatorial Pacific include an area of high pressure to the southeast where air descends and blows to the west along the equator as the trade winds. The trades blow into a low center or convergence zone near Indonesia, where the air rises and its water vapor condenses as rain. During an El Niño, the pressure imbalance that drives air into the Indonesian low decreases so that the trades weaken. As the winds abate, the ocean warms. This atmospheric seesawing, called the Southern Oscillation, is an inseparable part of the warmings that sweep the Pacific every 3 to 10 years, and so researchers refer to the coupled ocean-atmosphere changes as an El Niño–Southern Oscillation (ENSO) event.

The Southern Oscillation reached a record extreme at the end of 1982 as the trades actually reversed direction in some areas, but by May the pressure balance had swung back in the other direction and the trades were blowing normally, according to reports from the Climate Analysis Center of the National Meteorological Center (NMC) in Washington, D.C. Eugene Rasmusson of the NMC notes that no ENSO event on record has recovered its strength once the Southern Oscillation has returned to normal. Still, this has been a powerful and seemingly unpredictable event. Rasmusson will be watching the Pacific closely this fall when the first signs of an impending El Niño usually first appear.

From the beginning, this ENSO event misbehaved badly, boldly disregarding scientists' expectations. First, the trade winds failed to blow stronger than normal before the event began. Such intensification had seemed to be a necessary preparatory step of typical events. The stronger winds would pile even more water in the western Pacific and bring cold water even closer to the surface in the eastern Pacific. When the trades did ease from above to below normal speeds, the mound of water in the west would relax, raising sea level to the east and warming surface waters there. Some oceanographers have thought of this sea-level adjustment as an actual sloshing that carried warm water eastward. A more useful description, many now believe, is that a group of propagating, subsurface waves both move water eastward and thicken the surface layer of warm water, thus decreasing its mixing with deep, cold water.

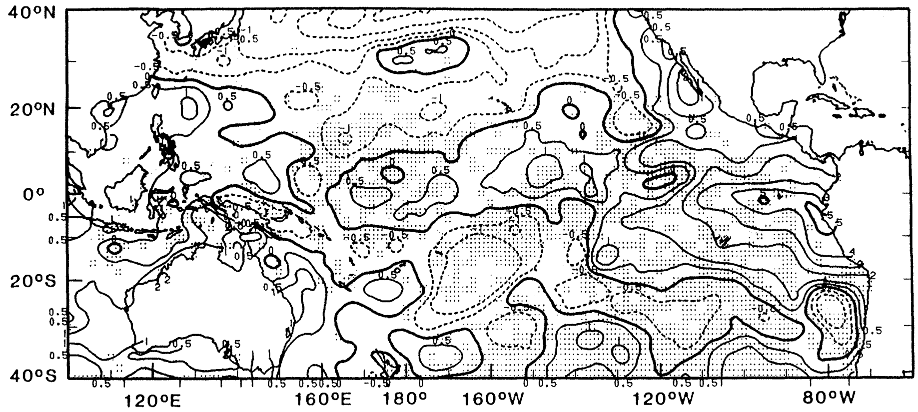
Either way, the buildup of the trades appeared to be a typical, even a required step. Numerical models of ENSO events did not require it, though, and neither did the 1982–1983 event. It came out of nowhere when perfectly normal trade winds collapsed. According to Klaus Wyrtki of the University of Hawaii, who first pointed out the buildups preceding other events, the 1982–1983 event shows that it is not how strong the trades are at the beginning of an event that counts; rather, it is the magnitude of the change.

The 1982–1983 event also confounded researchers by beginning in the spring of 1982. That broke another rule of the six major ENSO events since 1951. Warm water normally begins to appear off the coast around Christmas (between November and January), hence, the name El Niño or The Child. In fact, water of above-average temperature appears off the coast every December. That led some researchers to suggest that El Niño is a mild phenomenon of the fall season that gets out of hand, intensifies near the




***A return to normal?***

*The difference between the atmospheric pressure at Darwin and Tahiti, plotted here in terms of standard deviation, is often used as a measure of the overall state of the atmosphere in the tropical Pacific. Monthly values of this Southern Oscillation index (x) are plotted and a curve of the 5-month running mean is drawn through them. When the index falls sharply, as it did in 1969, 1972, 1976–1977, and 1982, the trade winds weaken and an El Niño warming begins.*




***The lingering El Niño***

*In July 1983, a pool of water that was as much as 4° to 5°C above normal for that time of year still lay off the South American coast. The maximum warming of a more typical El Niño event is only 2° to 3°C and so coastal warming is usually falling past 2°C by July.*

coast, and then spreads westward into the central Pacific. The 1982 warming not only began in May instead of December but it also first appeared in the central Pacific and spread eastward to the South American coast. By fall, the warming in the central Pacific seemed to be back in step with the typical development of an El Niño as temperatures peaked at 4.5°C in December. Usually that would be the end of an event, but then coastal waters soared to more than 6°C above normal by April.

The 1982–1983 ENSO event broke all the rules for typical events, but it seems to have a precedent, according to Rasmusson. He and Thomas Carpenter of NMC had inferred typical behavior from the well-observed events since World War II. Of the earlier events, the 1940–1941 El Niño bears the strongest resemblance to the most recent event, Rasmusson says. In both, warm water first appeared on the Peruvian coast in September rather than January and stayed at least through May. The 1941 temperatures peaked during January to March at less than 2°C above normal while the 1983 coastal temperatures went on to peak at a whopping 7°C in June. The similar timing of the two events argues strongly against the suggestion (*Science*, 14 January, p. 157) that the eruption of El Chichón in April 1982 triggered the 1982–1983 event, says John Wallace of the University of Washington. The 1940–1941 event also began at the "wrong" time of year, he notes, but no large eruption preceded it.

Early speculation about the odd timing of the 1982–1983 event centers around two opposing views. In one view, the mid-year initiation of this event and its west-to-east propagation show that ENSO events need not be locked to the seasonal cycle of the eastern Pacific; they can be triggered at any time. The other view holds that even this odd behavior suggests a link to the changing seasons, although a geographically broader perspective is required. Rasmusson notes that the recent event looks like a typical one whose two components, the winter-to-spring coastal warming and the spring-to-fall central ocean warming, appeared in reverse order. Rasmusson and Wallace are suggesting that what has been considered a single event may be two separate, seasonal responses to the Southern Oscillation, the eastern warming usually but not always preceding the western warming.

An El Niño warming that first appeared in the western Pacific in the spring came as a bit of a relief to Mark Cane of the Massachusetts Institute of Technology. He had wondered why it did not happen more often. Conditions in the western Pacific during the Northern Hemisphere spring seemed to favor an El Niño as much as those in the eastern Pacific during the fall. It is during the spring that the Indonesian low migrates northeast to the equator. Another, weaker system of converging winds, called the intertropical convergence zone (ITCZ), moves toward the equator in the eastern Pacific in the fall.

If a convergence zone moves over a pool of warmer water, they can interact and intensify each other. The warm, moist air carried upward by the converging winds can supply heat energy to accelerate the winds, which in turn can alter the surrounding circulation of the atmosphere. That alteration could drag distant warm water toward the convergence or set off the propagating waves that can precipitate sea-surface warming at a distance from the wind change.

Cane suggests that it was the Indonesian low that started things off in the spring of 1982, a season when this convergence zone is more free than usual to move eastward over the Pacific. When the ITCZ shifted toward the equator in the fall, the already warm water produced during the summer pulled it over the equator and allowed the record-breaking warming of early 1983 near the coast. George Philander of the Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, argues that the typical order of eastern and then western warming occurs most often because it is easier for the coastal warming to spread westward than for the western Pacific warming to spread eastward. One reason is that warmer water lies closer at hand in the eastern than in the western Pacific.

This ENSO event had yet another peculiarity, one that seems to have made a major difference in the weather over North America. In addition to the direct effects of a warming of the Pacific, such as the droughts and deluges, an equatorial warming can also send signals through the upper atmosphere that affect the weather in mid-latitudes, as one apparently did during the winter of 1976–1977 (*Science*, 7 May 1982, p. 608). That winter was brutally cold in the eastern United States and unusually warm and dry in the west, unlike the 1982–1983 El Niño winter which was characterized by heavy precipitation in the west and Gulf Coast and unusual warmth across the northern-tier states.

This difference could be just another example of the unpredictable effects of atmospheric teleconnections between the equator and mid-latitudes. But some meteorologists suspect that the apparent effects of the latest event depended on the position of the warming along the equator. Wallace points out that this event's warming moved far to the east, its attendant wind anomalies even reaching the coast, whereas the 1976–1977 anomalies were at the other extreme, having never moved much beyond the date line in the western Pacific. It may be that from there the weaker warming was able to send a stronger signal to mid-latitudes that brought about colder weather over the United States.

One point of the intensive monitoring of the most recent event and a 10-year program now being planned is to make ENSO events more predictable. Encouragingly, even the tropical Pacific's odd behavior of the past year may be beginning to make sense. And investigators agree that the Pacific is now moving, however slowly, back toward normal. But they are crossing their fingers and hoping that the unparalleled strength of this event does not allow it to rise Phoenix-like from its lingering warmth this fall.—RICHARD A. KERR