1982-83 El Niño

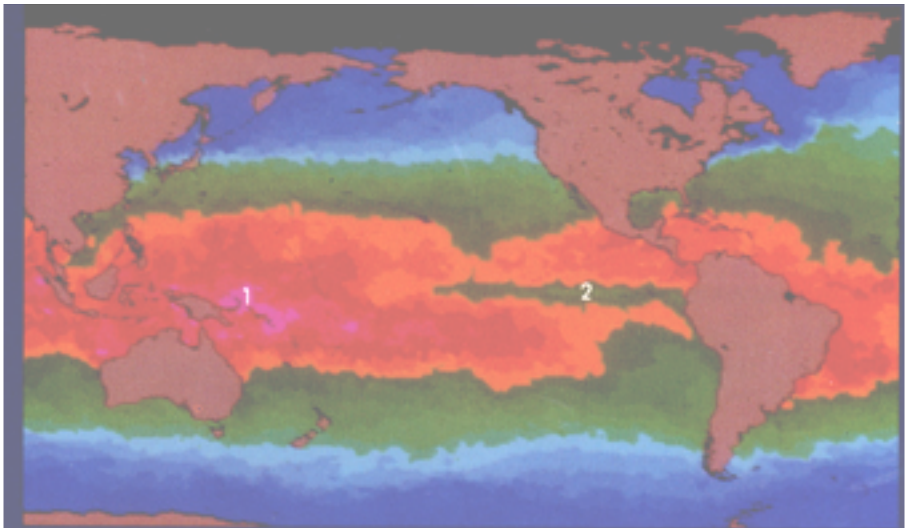

Figure 1

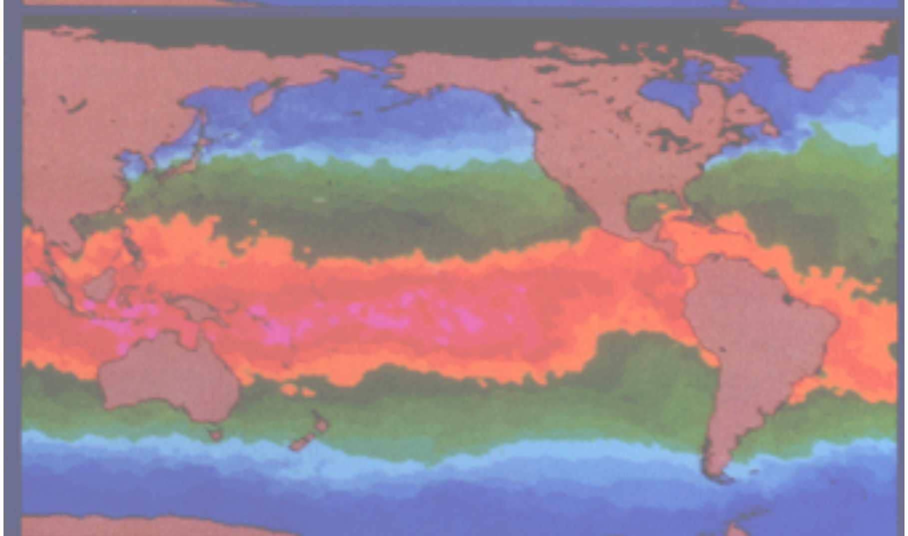

Figure 2

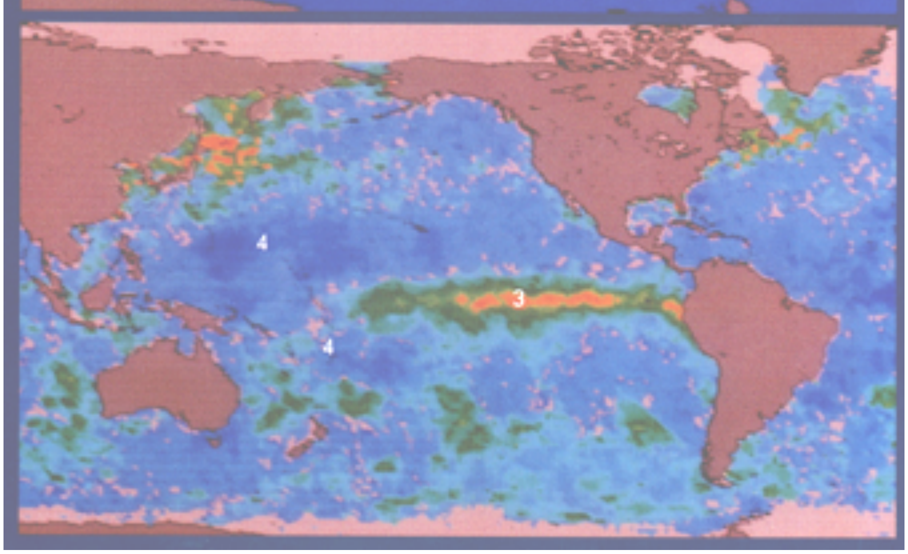

Figure 3

The anchovy fishery off the Peruvian coast has long been one of the major fisheries of the world. It depends on the upwelling of cool nutrient-rich water, which in turn stimulates the abundant growth of phytoplankton and zooplankton which are food for the anchovies. Every few years, usually around Christmas time, the upwelling of cool water stops and the phytoplankton and anchovies disappear. This is just one manifestation of what we now recognize as an interrelated set of changes in the global atmospheric and oceanic circulation known as an El Niño.

During the winter of 1982-83 the biggest El Niño of the century was under way. In Australia, the country struggled with the worst drought in 200 years; immense dust storms and fires resulted in over two billion dollars in losses. On the other side of the Pacific along the west coast of South America, the situation was reversed: heavy rains, up to 300 times above normal, virtually inundated the region. The resulting loss of crops, fisheries, and other businesses amounted to one billion dollars in Peru and Ecuador.

Residents of North America witnessed record snow accumulation in the Rockies with subsequent heavy spring flooding, as well as devastation of the California coast by high tides and waves the likes of which had rarely been seen before.

To help understand such El Niño events, these three sea-surface temperature (SST) maps were produced by Richard Legeckis of the National Oceanic and Atmospheric Administration's Environmental Satellite Data and Information Service using data collected by the Advanced Very High Resolution Radiometer carried aboard the NOAA-7 polar-orbiting meteorological satellite. They were prepared with a spatial resolution of 100 km using computer routines developed at the University of Miami. In the color scale used, blues indicate cool (0° to 12° C or 32 to 54° F) waters, greens intermediate temperatures (13 to 24° C or 56 to 76° F), and yellow-red-magenta warm (25 to 30° C or 78 to 87° F) waters.

During most years the distribution of SST in the Pacific is as shown on January 20, 1984, (top, figure 1) with the warmest water found in the western equatorial Pacific (1) and a tongue of relatively cold water extending along the Equator westward (2) from South America. The source of the tongue of relatively cold water is twofold. Southeasterly winds along the Peruvian and Chilean coast cause coastal upwelling. The Peru Current carries this cooler water northward along and then westward from the western coast of South America. In addition, the strong easterly Trade Winds cause a local transport of water away from the Equator toward both poles, which in turn induces an upwelling of cooler subsurface water along the Equator.

The middle image (figure 2) on January 20, 1983, shows the "anomalous" SST pattern associated with the 1982-83 El Niño. Comparison with the upper image (corresponding to the following year) shows that the cooler waters associated with the Peru Current and equatorial upwelling were absent during the El Niño. Satellite monitoring of SST throughout these two years revealed that a rapid warming of the surface waters in the eastern equatorial Pacific began during August 1982, with elevated SST's persisting until June 1983. During that period the easterly Trade Winds weakened and actually reversed direction for a few months. During this time the upwelling along the equator ceased, and the warm surface waters normally pushed to the western side of the equatorial Pacific by the Trade Winds "sloshed" back to the east.

In the lower figure (figure 3), the difference in SST between 1983 and 1984 shows the extent of the anomalies during the 1982-83 El Niño. In particular note that along the Equator in the Eastern Pacific (3) upwelling had ceased and temperatures were 2 to 6° C (4 to 11° F; green, yellow, red) warmer than in 1984. Also, large regions of the Western Tropical Pacific (4) were 1 to 3° C (2 to 6° F; darker blues) cooler than normal. This general pattern persisted for ten months.

In normal years (upper image, figure 1), the warm western tropical ocean waters supply much of the energy that drives the circulation of the atmosphere. The climate system is "conditioned" to expect this warm water in the western Pacific, producing "normal" weather. During El Niño (middle image, figure 2) the atmosphere responded dramatically to these large-scale changes in the temperature patterns. Unusually high pressure over the Indian Ocean gave rise to very sparse monsoon rainfall. In the North Pacific, the Aleutian Low was exceptionally strong and displaced eastward.

A major international program called Tropical Ocean and Global Atmosphere (TOGA) is now under way to improve our understanding of El Niño events and to develop a basis for predicting their occurrence. Satellites will continue to play an indispensable role in these studies by providing SST observations.

Satellite missions from the NASA Scatterometer (NSCAT) on the US Navy Remote Ocean Sensing System satellite and from the Ocean Topography Experiment (TOPEX/POSEIDON), combined with continuing SST observations, are providing scientists with the global measurements of surface winds over the oceans and of ocean surface currents necessary to better understand the interrelations involved with events such as El Niño.

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