Tropical Pacific Time Series

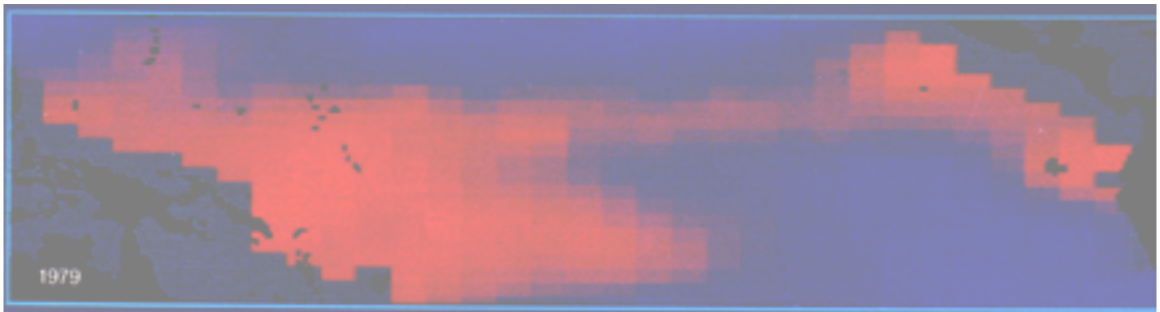

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

The weather—sunshine, fog, rain, and snow—is a very familiar aspect of our daily lives. Weather can change over short periods of time, from hours to days. But how does the general pattern of these conditions vary from season to season? An even more difficult question to answer is: How do the processes that influence weather behave over many years, giving rise to changing climate patterns? To help find the answers, scientists are studying a fundamental physical process: the movement of heat by winds and ocean currents over the globe. Covering three-quarters of our planet, the oceans act as a huge heat reservoir, first storing solar energy and then slowly releasing it to the atmosphere, thus moderating global temperature extremes. Over the past eight years satellite sensors have been used to obtain a global picture of sea-surface temperature (SST) and how it changes seasonally and annually. These and other critical studies are laying the basis for better understanding the variability of both short-term weather events and long-term climate patterns.

On a global scale, the oceans and atmosphere play an important role in the Earth's heat budget, each transporting an equivalent amount of heat from equatorial to higher-latitude regions. On ocean-basin scales, small variations in the SST pattern can influence the circulation of the atmosphere which, in turn, can amplify the SST pattern. The best known example of such a "feedback" phenomenon is the El Niño, one of whose characteristics is the modification of the equatorial Pacific SST pattern. El Niños occur every few years and are associated with devastating alterations in normal weather events ranging from flooding along the west coast of South America to drought in Australia. (See: 1982-83 El Niño.)

These images show the tropical Pacific SST pattern averaged over each January for five consecutive years beginning in 1979. Temperature ranges are color coded; warm water is shown in shades of red (28 to 34° C or 83 to 94° F), while cool water is purple and blue (16 to 24° C or 64 to 76° F). The data processing and image production were performed by Robert Bernstein at Sea Space in La Jolla, California.

The images have been derived from observations made by the Scanning Multi-frequency Microwave Radiometer (SMMR) carried aboard the Nimbus-7 satellite, which was launched in October 1978. The SMMR observes microwave radiation emitted from the ocean in five frequency bands, and the resulting observations are used to determine surface-wind speed, total water vapor in the atmosphere, local rainfall rate, and SST. Because microwave radiation can propagate through clouds and infrared cannot, microwave radiometers such as the SMMR can be used to observe the sea surface in the presence of clouds in order to determine SST.

The remarkably similar pattern for the first four years (figures 1-4) is characterized by a tongue of cooler water (1) which extends westward from South America along the Equator. Beginning in the summer of 1982, however, the strongest El Niño of this century was initiated, ultimately lasting a full year. The bottom map (figure 5) shows the SST expression of the El Niño near the time of its maximal development. The most striking feature is the absence

(2) of the cool tongue of water normally found along the equator. In addition, there is a general eastward displacement of warm water, resulting in SST's 3 to 5° C (6 to 9° F) above normal in the central and eastern Pacific. This displacement is associated with a weakening and ultimate reversal of the normally easterly Trade Winds.

Why would these events bring about disastrous weather conditions such as flooding along the west coast of South America? The key is the alteration in the normal large-scale patterns of the movement of moist air. As the reversed-direction Trade Winds blew across the abnormally warm water near the coast of South America, they picked up a great deal of moisture. When this warm, moist air hit the towering Andes mountains, it rose, cooled, and released its moisture; torrential downpours resulted. Rainfall in Peru during the 1982-83 El Niño was up to 300 times above normal.

Because so few ships normally transit the equatorial region, this major El Niño was not detected until it was well under way. Now, satellite sensors—such as the Low-Frequency Microwave Radiometer flying aboard the US Navy Remote Ocean Sensing System satellite and the continuing series of Advanced Very High Resolution Radiometers carried aboard the NOAA satellites—provide a capability to collect relevant SST observations. In addition to making available long-term data sets which can be used to understand the development of such large-scale phenomena, these satellite sensors also have the potential to serve as an early warning system for El Niños.

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