Atmospheric Radiation Measurement Program
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Developing El Niño

The National Oceanic and Atmospheric Administration (NOAA) recently announced the development of El Niño conditions in the tropical Pacific Ocean near the South American coastline. Scientists detected a 4ºF increase in the sea-surface temperatures during February. Conrad C. Lautenbacher, NOAA administrator and Under Secretary of Commerce for Oceans and Atmosphere, indicated that this warming is a sign that the Pacific Ocean is heading toward an El Niño condition. Although it is too early to predict how strong the El Niño will become or the conditions it will bring to the United States, Lautenbacher said that the country is likely to feel the effects as soon as midsummer (Figure 1).

During the last El Niño in 1997-1998, the United States experienced strong weather impacts. Even though researchers don't understand what causes the onset of El Niño , they do recognize what to expect once development has begun. Scientists can monitor the development of El Niño through NOAA's advanced global climate monitoring system of polar-orbiting satellites and 72 ocean buoys moored across the equator in the Pacific Ocean. The resulting measurements of surface meteorological parameters and upper ocean temperatures are made available to scientists on a real-time basis, allowing for timely monitoring and predictions. This complex monitoring array enabled NOAA to predict the 1997-1998 El Niño six months in advance.

El Niño is a result of events in the tropical Pacific. Earth's weather engine is located along the equator, where the sun heats the land and water strongly. One result of this equatorial heating is the development of trade winds. As warm air rises from the surface along the equator, air from the north and south flows toward the equator to fill the void. This flow, known as the trade winds, moves generally from east to west and pushes the warmer surface water westward toward Indonesia and Southeast Asia.

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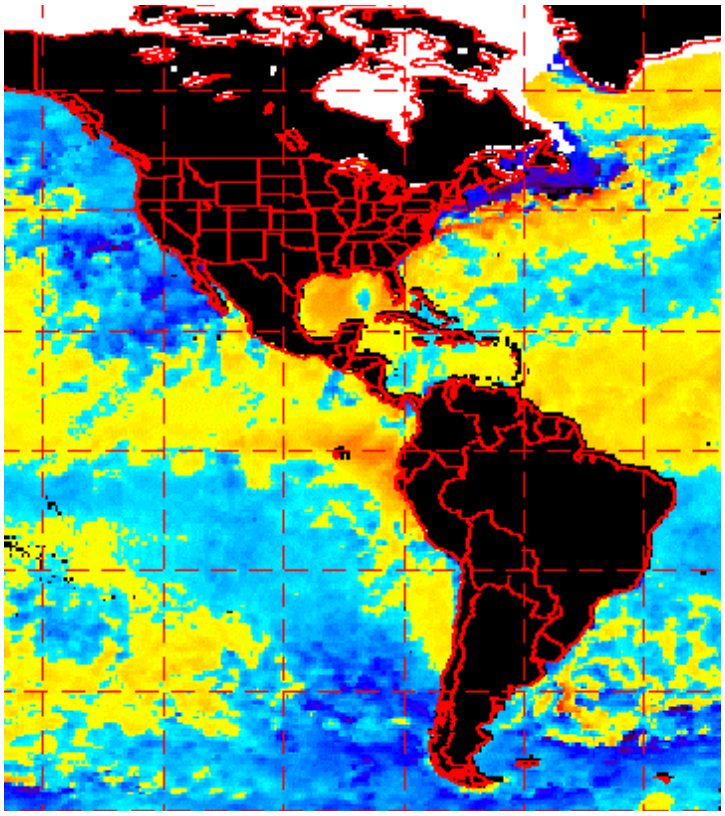

Figure 1. Sea surface temperatures on April 15, 2002. Notice the warmer temperatures extending westward from the coast of Ecuador, South America, along the equator. This is a classic indicator of an developing El Niño event. (Source: NOAA)

As the warm water moves westward, cooler water from deeper in the ocean is drawn up to the surface in the eastern equatorial Pacific, making the surface water about 10ºF cooler in this region than in the west, where the West Pacific warm pool is building. The warm pool is a major driving force of world climate. The warm water evaporates into the air, producing clouds and precipitation, and it also helps to define the paths of the jet stream and weather patterns.

In El Niño conditions, the normal patterns change (Figure 2). The trade winds weaken, allowing the warm pool to drift eastward, toward the western coast of Ecuador and Peru. The region of warm, humid, rising air moves eastward with the warm pool, carrying with it the effects on the jet stream and air circulation. This event changes weather patterns around the globe.

As warmer water moves closer to the South American coast, it

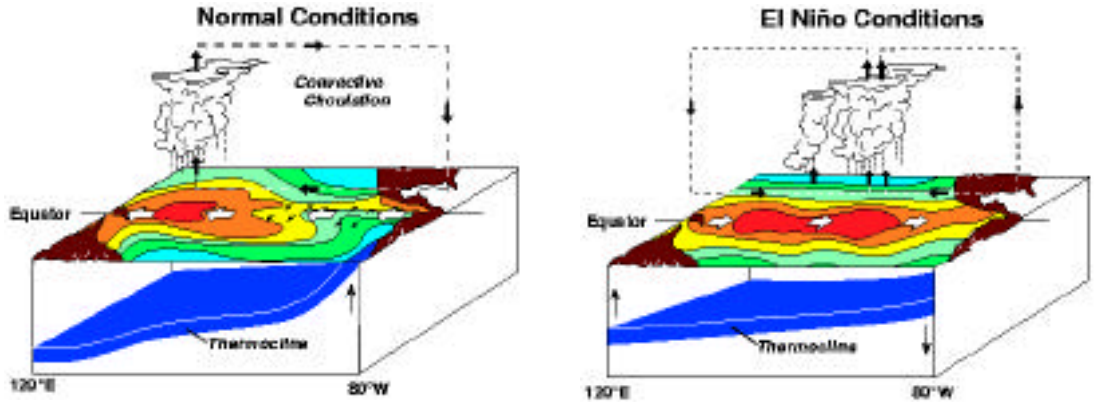

Figure 2. Ocean temperature and air flow patterns for normal conditions and for an El Niño event. (Source: NOAA)

prevents the upwelling of cold, nutrient-rich water that holds plankton, a source of food for fish. The fish eventually die, disrupting the food chain in the area and the local fishing economy. The warm pool brings with it heavy rainfall and flooding, which spawn epidemics of cholera and other disease in South America. As the water near South America warms, it reduces the east-west temperature gradient, further decreasing the trade winds.

El Niño events occur approximately every 4-5 years and can have a duration up to 12-18 months. Typical impacts to the United States as a result of an El Niño event include these:

Figure 3. The ARM site on Manus Island, Papua New Guinea.

- Fewer hurricanes in the Atlantic Ocean
- More Nor'easters along the East Coast during the winter
- Southwestern states monsoon season drier than normal
- Pacific Northwest fall and winter seasons drier than normal
- Northern Great Plains and Upper Midwest fall and winter seasons wetter than normal
- Gulf Coast states wetter than normal during the winter

NOAA will continue to monitor the conditions pointing to the return of El Niño. Information regarding El Niño conditions and forecasts made by NOAA's Climate Prediction Center are online at this address: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina

The Department of Energy's ARM Program has established measurement facilities in the tropical Western Pacific to investigate the regional atmospheric and ocean processes that have such a strong influence on Earth's climate. The site at Manus Island (Figure 3), Papua New Guinea, is always in the "warm pool," whereas the site on the island of Nauru (Figure 4), approximately 1200 miles to the east, is in the warm pool only during El Niño events. These sites are equipped with instrumentation similar to that at the Southern Great Plains site. The data collected at these sites will enable ARM scientists to develop improved models for more accurate prediction of the El Niño phenomenon.

Figure 4. The ARM site on Nauru.