
Marine Life


Drought

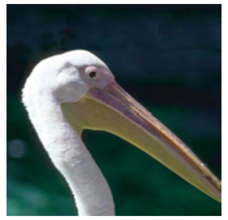

Flood


Coastal Erosion

El Niño

Yesterday...Today...Tomorrow


Coral Reefs


Bird Life


Forest Fires


Tropical Storms

What is El Niño?

The term El Niño (Spanish for "the Christ Child") was originally used by fishermen along the coasts of Ecuador and Peru to refer to a warm ocean current that typically appears around Christmas and lasts for several months. Fish are less abundant during these warm intervals, so fishermen often take a break to repair their equipment and spend time with there families.

In some years, however, the water is especially warm and the break in the fishing season persists into May or even June. Over the years, the term El Niño has come to be reserved for these exceptionally strong warm intervals that not only disrupt the normal lives of fisherman, but bring heavy rains.

Subtle changes in the interplay of wind and water in the tropical Pacific can affect local ecosystems and human lives in far flung regions of the globe. El Niño can be responsible for changes in bird and marine life, coral reefs, floods, coastal erosion, drought, forest fires, and tropical storms.

El Niño and Climate

The link between climatic effects in distant parts of the globe and El Niño is now well established. Yet it has taken decades for scientists to understand how the various pieces of the puzzle from ocean currents to winds and heavy rains all fit together. Decades ago, the British scientist Sir Gilbert Walker provided the first clue.

During the 1920s, while scientists in South America were documenting the local effects of El Niño, Walker was on assignment in India trying to find a way to predict the Asian monsoon. As he sorted through world weather records, he discovered a remarkable connection between barometer readings at stations on the eastern and western sides of the Pacific. He noticed that when pressures rises in the east, it usually falls in the west, and vice versa. Walker coined the term Southern Oscillation to dramatize the ups and downs in this east-west seesaw in the southern Pacific barometers. When the seesaw is in its "high-index" (strongly tilted) state, pressure is high on the eastern side of the Pacific and low on the western side.

Along the equator, the east-west pressure contrast drives easterly surface winds which extend from the Galapagos Islands nearly all the way to Indonesia. When the seesaw switches into a "low-index" (weakly tilted) state, the easterly surface winds weaken. The biggest changes in the slope of the seesaw and in the strength of the easterlies occur over the western Pacific. West of the dateline the easterlies usually disappear altogether during low-index years, whereas east of the dateline they usually weaken.

Walker noticed that monsoon seasons with low-index conditions are often marked by drought in Australia, Indonesia, India, and parts of Africa. He also claimed that low-index winters tend to be unusually mild in western Canada. One of his British colleagues chided him in print for suggesting that climatic conditions over such widely separated regions of the globe could be linked. In his reply Walker predicted, correctly, that an explanation would be forthcoming, but that it would require a knowledge of wind patterns above ground level, which were not routinely being observed at the time.

In the following decades, researchers added new pieces to the emerging picture of the Southern Oscillation. One such piece came from a remote part of the world for which Walker had no information: the desert islands of the central equatorial Pacific. According to standard climate statistics, these islands receive as much rainfall as many islands with much more luxuriant vegetation. One might wonder, then, "Why are they so barren?" The answer becomes apparent when one examines the rainfall records year by year.

Most years, in fact, the islands receive little or no rainfall. During "low-index" years, they experience torrential rains, day after day, month after month. Hence Walker's pressure seesaw is linked to dramatic chances in the distribution of rainfall in the tropics.

In the late 1960s, University of California professor Jacob Bjerknes gained fame by publishing the first clearly understandable description of the life cycle of storms in temperate latitudes. Now, years later, he was the first to see a connection between warm sea-surface temperatures and the weak easterlies and heavy rainfall that accompany low-index conditions. Ultimately, Bjerknes' discovery led to the recognition that the warm waters of El Niño and the pressure seesaw of Walker's Southern Oscillation are part and parcel of the same phenomenon—sometimes referred to by the acronym ENSO.


The NOAA ship Káiminoana supports oceanographic and climate research in the equatorial Pacific Ocean. The ship's primary mission is to deploy, recover, and service deep sea moorings that measure ocean currents, ocean temperatures, and atmospheric conditions throughout the equatorial regions of the Pacific Ocean.
The Káiminoana supports a series of 70 buoys known as the Tropical Atmosphere-Ocean (TAO) array, which were first deployed as part of an international oceanographic research program to learn how to predict the El Niño/Southern Oscillation phenomenon. The buoys measure wind direction and speed, air temperature and humidity, and temperature of the ocean at the sea surface and at various depths to 500 meters. A few buoys also measure currents, rainfall and solar radiation. These buoys help scientists learn more how warm water of the equatorial Pacific affects world-wide climate, and are providing critical data about the El Niño event.

Surface winds affect the temperature and chemical properties of the surface water along the coast of Peru and southern Ecuador. The southeasterly winds that blow along the coast tend to drag the surface water along with them. The earth's rotation deflects the water toward the left, away from the coast. Water "upwells" from below to replace it.

The temperature and chemical properties of the upwelled water depend upon the strength of the easterlies far to the west, in the central and western equatorial Pacific. With the absence of wind, the "thermocline" (the layer that divides the warm surface water from the colder water below) would be nearly flat.

When the easterlies are strong, they drag the surface water westward, raising the thermocline nearly all the way up to the surface along the South American coast and depressing it in the western Pacific. The cold water below the thermocline is rich in chemical nutrients.

Whenever the easterlies in the central Pacific are strong, the thermocline along the South American coast is so shallow that upwelling and stirring by the wind bring nutrient-rich water to the surface. In the presence of sunlight, tiny plant species called phytoplankton use the nutrients to produce a greenish plant called chlorophyll. The phytoplankton would soon use up all the nutrients were they not continually being replenished by upwelling.

During El Niño, the easterlies along the equator slacken and the thermocline along the South American coast plunges several hundred feet, preventing nutrient rich water from reaching the surface. Phytoplankton production declines, reducing the food supply for tiny sea animals, called zooplankton, which "graze" on them.

Ultimately, anchovies, sardines, sea birds, and many other animals at higher levels of the marine food web are adversely affected.

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Clouds and Winds

The easterly winds along the equator produce local upwelling, which brings cool water to the surface. When the easterlies are blowing at full strength, the band of cold water along the equator chills the air above it, making it too dense to rise high enough for water to condense to form clouds and raindrops.

As a result, the strip of ocean stays conspicuously free of clouds and the rain in the equatorial belt is largely confined to the extreme western Pacific near Indonesia. But when easterlies weaken during the early stages of an El Niño event, the upwelling slows and the ocean warms.

The moist air above the ocean also warms. It becomes buoyant enough to form deep clouds which produce heavy rain along the equator. The change in ocean temperatures thus cause the major rain zone over the western Pacific to shift eastward.

Related adjustments in the atmosphere cause a further weakening of the easterlies in the central Pacific. In this way, the dialogue between wind and sea in the Pacific can become more and more intense, as each partner sends back a stronger message. Small perturbations in the ocean and atmosphere can amplify one another until eventually a full-fledge El Niño is under way.

Just as it is often hard to say which partner was responsible for a change in the mood of a dialogue, or precisely what they said that set the conversation off in a new direction, it is often difficult to identify the subtle change in the ocean-atmosphere system that initiates a transition into or out of El Niño conditions.

El Niño Impacts

Australia, Brazil, Ethiopia, India and Peru are already successfully using predictions of El Niño in connection with agricultural planning. It is not a coincidence that all these countries lie at least partially within the tropics.

Tropical countries have the most to gain from successful prediction of El Niño because they experience a disproportionate share of the impacts and, coincidentally, they occupy the part of the world in which accuracy of climate prediction models are the greatest.

But for many countries outside the tropics, such as Japan and the United States, more accurate prediction of El Niño will also benefit strategic planning in areas such as agriculture, and the management of water resources and reserves of grain and fuel oil.

Encouraged by the progress of the past decade, scientists and governments in many countries are working together to design and build a global system for (1) observing the tropical oceans, (2) predicting El Niño and other climatic variations, and (3) making routine climatic predictions readily available to those who have need of them for planning purposes, much as weather forecasts are made available to the public today.

The ability to anticipate how climate will change from one year to the next will lead to better management of agriculture, water supplies, fisheries, and other resources. By incorporating climate predictions into management decisions, mankind is better becoming adapted to the rhythms of climate.

El Niño Predictions

The National Oceanic and Atmospheric Administration has the primary responsibility within the Federal Government to routinely provide climate forecasts and products to the Nation. Most parts of NOAA are in some way involved in El Niño research, monitoring and prediction. For example, NOAA monitors the developing and, in time, decreasing pool of warm waters in the tropical Pacific with state-of-the-art satellites and buoys; launches new research initiatives; improves future climate forecast; monitors the impact of the climate event on the fish population in U.S. coastal waters; operates research ships to study the world's vast oceans; and provides critical ocean data to users.

Scientists are now taking NOAA's understanding of El Niños a step further by incorporating the descriptions of these events into numerical models (computer programs designed to represent, in terms of equations, processes that occur in nature).

Such models are fed information, mostly in the form of sets of numbers, describing the present state of the atmosphere-ocean system (e.g., observations of wind speeds, ocean currents, sea level, and the depth of the thermocline along the equator). Updated sets of numbers generated by the models indicate how the atmosphere-ocean system might evolve over the next few seasons or years.