Lesson VI. El Niño

The goal of this unit is to explain the weather phenomenon El Niño, its causes and effects.

Keywords: ***El Niño, trade winds, Global Positioning System***

Satellites: El Niño Watched from Space

TOPEX/Poseidon Initial Science Results

Source:http://www.csr.utexas.edu/tsgc/topex/results.html

NASA's space-borne sensors help to monitor global climate changes. In the context of climate and weather, the name El Niño originally referred to the warm ocean current that appears along the Pacific coast of South America every year around Christmas. In Spanish, "El Niño" means "the boy," a reference to the Christ child, since historically the phenomenon has been observed around Christmas. Recently, however, the term has been applied to those years when there is a change in this annual pattern.

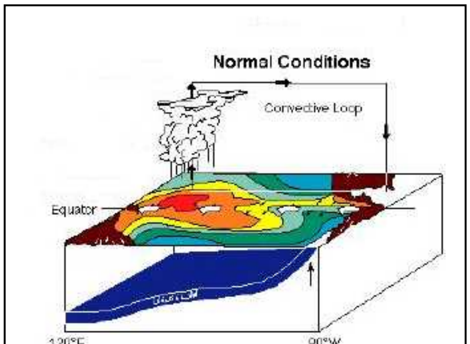

Figure courtesy of NOAA PMEL

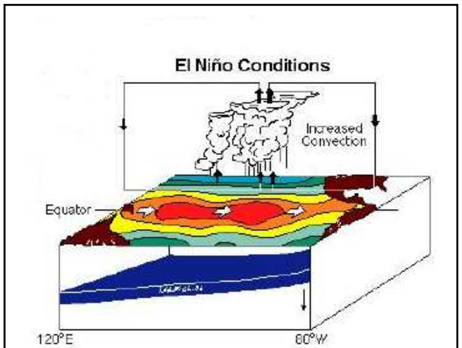

Figure courtesy of NOAA PMEL

In the equatorial Pacific Ocean, the wind usually blows from east to west, dragging the surface water along. Because of Earth's rotation, the eastward-flowing water is deflected to the north in the Northern Hemisphere and to the south in the Southern Hemisphere. This creates a surface divergence along the equator that is filled by cold, nutrient-rich water moving up from below (upwelling), forming a cold tongue in the eastern Pacific. As the warmer surface water is moved westward by wind, the **thermocline** (a zone in the water column that shows a sudden change in temperature with depth) separating the surface water from the colder water is raised in the east and depressed in the west. The easterly wind converges over the resulting warm water in the western Pacific, picks up large amounts of moisture and ascends through the atmosphere by a process known as deep convection.

Dry air subsides above the cold tongue and forms the Walker Circulation along the equator. The easterly wind retreats and the westerly wind pushes the convection process to the east of the International Date Line (a jagged arbitrary line where a date change occurs).

A ground-based beacon called "DORIS" sends radio signals to a satellite receiver that measures the "Doppler effect." The Doppler effect is an apparent change in the frequency of a wave, such as sound or light, when the source of the wave and the observer are in motion relative to one another. The frequency increases when the source and observer are approaching each other, and decreases when they are moving away from each other. The Doppler effect is named for the Austrian scientist Christian Doppler (1803-1853).

An example of the Doppler effect is the change in pitch of a train whistle as it passes an observer. As the train approaches, the pitch of the whistle is increased, and after the train passes, the pitch is decreased

Light from ground-based lasers is reflected off mirrors on the TOPEX/Poseidon satellite, and the Global Positioning System (GPS) network is used. At times, a TOPEX/Poseidon receiver tracks several GPS satellites simultaneously and, because the position of GPS satellites is well known, TOPEX/Poseidon's position can be calculated. This was originally only an experiment but is now a very reliable data source.

Satellite altimetry data that spans over a decade will be obtained by TOPEX/Poseidon and its follow-on mission, Jason-1. These data will provide the key to unraveling how El Niño events form, what their long-term impact on the climate might be, and possibly predict future El Niño events

Discussion Questions:

1. What is El Niño?
2. What might cause El Niño?
3. What are the physical consequences of El Niño?
4. Are there any economic consequences?
5. How does this phenomenon get its name?
6. NASA Goddard Space Flight Center says that the day was increased by 800 microseconds (less than 1/1000th of a second) during the strong 1982-83 El Niño episode, how did that happen?

Student Information Sheet
Lesson VI. El Niño

El Niño, the "mysterious force of nature," is actually a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe. Among these consequences are increased rainfall across the southern tier of the US and in Peru, which has caused destructive flooding, and drought in the west Pacific, sometimes associated with devastating brush fires in Australia.

Observations of conditions in the tropical Pacific are considered essential for the prediction of short-term (a few months to one year) climate variations. To provide necessary data, the National Oceanic and Atmospheric Administration (NOAA) operates a network of buoys which measure temperature, currents and winds in the equatorial band. These buoys daily transmit data which are available to researchers and forecasters around the world in real time.

For decades, climatologists have assembled data from around the globe in order to detect links to severe El Niño conditions. Pieces of the El Niño puzzle include dramatic shifts in normal conditions such as: drought in Australia, New Guinea, India, and Africa; mild winters in Canada and severe winters in California, Christmas Island (central Pacific) and Peru. Other, more subtle, evidence tied to severe El Niño conditions includes high pressure records in Australia, fishery production, patterns of marine life, changes in coral reefs, and few-degree increases in sea-surface temperature in the Pacific Ocean. Scientists have concluded that all of these conditions are tied to weakened **tradewinds** that allow warm ocean surface water to travel eastward. This warm water brings heavy rains that disrupt normal atmospheric conditions. All of this is signaled by a rise in sea surface height of only 18 cm (7 inches)!

Most people have heard of "El Niño" but few realize that it is caused by the interaction between the tradewinds and the ocean. A "minor" difference in sea surface height means a big difference in the where ocean heat is stored and where heavy rains and severe drought occur. The TOPEX/Poseidon satellite is a good way to monitor this relatively small change in the sea level that has such a huge impact.

Cool web sites

http://www.cais.net/publish/stories/0996cli9.htm

Monitoring El Niño with Satellite Altimetry:
http:/www.tsgc.utexas.edu/tsgc/topex/activities/elNiño/

Timeline

1957 First Artificial satellite, *Sputnik*, is launched by the Soviet Union.

1958 First US satellite, *Explorer*, is launched.

1960 First passive communication satellite, *EchoI*, is launched from Cape Canaveral, Florida. NASA deploys first Television Infrared Observation Satellite (TIROS) to observe weather.

1965 *Early Bird*, the first geostationary communication satellite, is launched.

1972 First Landsat Earth mapping satellite is launched.

1982 Space Shuttle *Columbia*, launches a pair of commercial satellites.

1984 Astronaut Bruce McCandless becomes the first human satellite as he tests the powered Manned Maneuvering Unit, moving independently in space without being tethered to the space shuttle.

1986 Space station *Mir*, comes into operation.

1990 Hubble Space Telescope is placed in orbit.

1994 NASA launches *Wind* satellite to study solar wind

1995 AT&T receives authorization to launch the high-powered satellites for U.S. commercial service to revolutionize transmission quality and capacity to handle future increased demands on communication service.