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World Meteorological Organization

El Niño Update

INTRODUCTION

WMO has produced this ***El Niño Update*** in order to ensure that the most effective and accurate information is made available, and to provide other UN agencies and organizations with materials and information they may use in their programmes and distribute as they deem appropriate. It is a summary of: (i) our knowledge of the El Niño phenomenon, (ii) its associated impacts on a global scale, and (iii) forecast information for the coming months. This ***Update*** is compiled from a variety of scientific sources including several major global climate prediction centres, and is intended to address the questions and concerns of an audience that ranges from the general public to the policy maker. The background information (part 1 of the ***Update***) is covered in somewhat greater detail in this issue. Future updates will focus primarily on climate monitoring and forecast information (part 2 of this ***Update***) which will be updated each month.

Summary: Intense warming of the ocean waters across the eastern and central tropical Pacific Ocean, due to the phenomenon known as the El Niño/Southern Oscillation (ENSO), has developed since March 1997. The El Niño developed very rapidly during April-May, and reached high intensity by June. This event is comparable in magnitude and extent to the 1982/83 episode, which was one of the strongest El Niño of the century. Prediction products from several prediction centres around the world indicate these conditions will probably persist during the northern hemispheric spring season of 1998. Based on past warm episodes and on current long-range forecasts, the El Niño is expected to weaken during the late spring and early summer of 1998.

Features accompanying the current El Niño include: abnormal patterns of raiufall and cloudiness over most of the global tropics, a nearly complete shut-down of the normal easterly winds across the entire tropical Pacific, and abnormal air pressure patterns throughout the global tropics. Thus far, the primary El Niño impacts have been in the tropics and subtropics, and across the eastern South Pacific and central South America. There has also been a dramatic decrease in tropical storm and hurricane activity across the subtropical North Atlantic and an expanded area of favorable conditions for tropical cyclone activity over the eastern North Pacific.

PART 1: BACKGROUND INFORMATION ABOUT EL NIÑO

(1) What are El Niño, ENSO, and La Niña?

"El Niño" is the term that is used for an oceanographic phenomenon: an extensive warming of the upper ocean in the tropical eastern Pacific lasting three or more seasons. The negative, or cooling phase of El Niño is called La Niña. El Niño events are linked with a change in atmospheric pressure known as the Southern Oscillation (SO). This is characterized by a see-saw in the atmospheric pressure between the western and central regions of the Pacific ocean, with one centre of action located in the vicinity of Indonesia and the other centre located over the central Pacific ocean. The index that measures the magnitude of the SO is known as the Southern Oscillation Index (SOI) and it is obtained by calculating the difference in atmospheric surface pressure between Tahiti and Darwin, Australia. Because the SO and El Niño are so closely linked with each other, they are collectively knowu as El Niño-Southern Oscillation, or "ENSO".

"La Niña" is characterized by unusually cold ocean temperatures in the central and eastern equatorial Pacific, as compared to El Niño, which is characterized by unusually warm ocean temperatures in the same region. Global climate abnormalities associated with La Niña are less pronounced, and in some areas tend to be opposite those that are associated with El Niño.

(2) Why is it called El Niño?

El Niño was originally recognized by fishermen off the coast of South America as the appearance of unusually warm water in the Pacific Ocean, occurring near the beginning of the year. El Niño means "The boy Child" in Spanish. This name was used to reflect the tendency of the phenomenon to arrive around Christmas.

There have been several uses for the terms El Niño, La Niña and ENSO by both the scientific community and the general public. Originally, the term El Niño denoted a warm southward flowing ocean current that occurred every year around Christmas time off the west coast of Peru and Ecuador. The term was later restricted to unusually strong warmings that disrupted local fish and bird populations every few years. The tendency in the scientific community though is to refer interchangeably to El Niño, ENSO warm event, or the warm phase of ENSO. Conversely, the terms La Niña, ENSO cold event, or cold phase of ENSO are used interchangeably to describe the opposite phase. The term "El Viejo" (The Old One) has also been applied to the cold phase of ENSO. However, this term is used less frequently, as the term La Niña is more commonly applied.

The ***El Niño Update*** refers to the coupled climate-ocean phenomenon as "El Niño," as the public has adopted that broader definition.

(3) Why does El Niño occur?

El Niño results from interaction between the surface layers of the ocean and the overlying atmosphere in the tropical Pacific. It is the very complex interaction between the ocean and the atmosphere that determines the onset and termination of El Niño events. The system oscillates between warm (El Niño) to neutral (or cold) conditions with a natural periodicity of roughly 3-4 years between El Niño events. External influence (also known as "forcing") from volcanic eruptions (submarine or terrestrial) and sunspots have not conclusively been shown to have an influence on El Niño events. In addition, a connection between the occurrence of El Niño events and possible global warming has not been confirmed by research.

(4) Is El Niño a new phenomenon?

El Niño is not a new phenomenon. Evidence suggests that El Niño events have existed for thousands of years in the past. However, it is only in the last decade that satisfactory understanding of how they form and are maintained has been gained.

Sir Gilbert Walker, during the 1920s, made the seminal connection between barometer readings of air pressure at sea level at stations on the eastern and western sides of the Pacific Ocean (Tahiti and Darwin, Australia). He observed that when pressure rises in the east, it usually falls in the west, and vice versa. He is responsible for the term Southern Oscillation, which, as noted earlier, refers to the ups and downs in this east-west seesaw effect. It was not until another 40 years later, in the 1960s when Jacob Bjerknes confirmed the connection between the unusually warm sea-surface temperatures and the weak easterlies and heavy rainfall that accompany low values of the Southern Oscillation Index ("low-index" conditions). Bjerknes' discovery helped to clarify that the warm waters of El Niño and the pressure seesaw of Walker's Southern Oscillation are part of the phenomenon now known as ENSO.

During the last three decades there has been a great deal of investment in monitoring and research to enhance the capacity to predict El Niño. It wasn't until the advent of high speed computers, though, that the complex interactions and massive amounts of data could be put together to provide a relatively clear picture of the phenomenon.

Even so, the 1982-83 El Niño, widely recognized as perhaps the most severe of the 20th century, caught scientists by surprise. Unlike the El Niño events of the previous three decades, it was not preceded by a period of stronger than normal easterlies on the Equator, and it took place later in the calendar year than usual. Even though it wasn't recognized as an El Niño until it was half over, it was responsible for extreme impacts on the global climate. North America experienced highly unusual weather throughout 1983; Australia experienced massive drought and devastating bushfires; it was one of the worst periods for drought in the sub-Sahelian countries; and the monsoons failed in the Indian Ocean. Total damages were estimated at somewhere between $8 billion and $13 billion (US dollars), and approximately 2,000 lives were lost.

(5) How are El Niño events detected?

Coherent research efforts on El Niño developed during the 1970s, motivated in part by the disruptive effects in the Americas from climate variations thought to be associated with El Niño. The intense El Niño of 1982-1983 served as an impetus for the organized international monitoring and research programme that resulted in the development of the Tropical Ocean Global Atmosphere (TOGA) programme (1985-1994), under the World Climate Research Programme (WCRP). Mainly as a result of TOGA, El Niño events in the tropical Pacific Ocean can now be detected by many methods, including satellites, moored buoys, drifting buoys, sea-level analysis, and expendable bathythermographs (XBTs). This research observing system is now evolving into an operational climate observing system. Large computer models of the global ocean and atmosphere use data from this observing system as input to predict El Niño. Other models are used for El Niño research to further the understanding of the phenomenon.

(6) Are all El Niño events the same?

Although El Niño events share many general characteristics, every one is somewhat different in magnitude, duration and the resulting global climatic impacts. Magnitude can be determined in different ways, such as variations in the Southern Oscillation Index (SOI). Another measure of the magnitude of El Niño events is sea surface temperature averaged over specific regions of the Pacific Ocean, such as the Niño 3 region in the Eastern Equatorial Pacific Ocean, which extends from 150%W to 90%W and 5%N to 5%S. The El Niño in 1982-1983 and the current El Niño are associated with far greater abnormalities in the sea surface temperatures in the Niño 3 region than those in 1976, 1987, and 1991.

(7) Why do the tropical Pacific Ocean temperatures affect global weather patterns?

During El Niño, the tremendous concentration of excess heat in the eastern tropical Pacific Ocean modifies the atmosphere immediately above it, and the effects are carried around the globe by the modified circulations in the atmosphere, resulting in changes in the normal weather patterns in many regions. The sea surface temperatures in the Indian and Atlantic Oceans are also modified, which in turn affects the climate over them and in adjacent continental regions. The atmospheres over these oceans cooperate with the corresponding water masses beneath them to magnify the initial sea surface temperature deviations even further. The result is climatic response that is truly global. At higher latitudes the effects are more variable from one El Niño to another and the long-range climate forecasts are generally not as reliable as in the tropics.

(8) Do El Niño events occur only in the Pacific Ocean?

The great width of the Pacific Ocean is the main reason we see El Niño/Southern Oscillation (ENSO) events in that ocean rather than in the Atlantic and Indian Oceans. Most current theories of ENSO development involve the movement of very long ocean wave-like phenomena (so-called planetary-scale equatorial waves). To a large extent the Pacific Ocean's width dictates the time it takes for these waves and their reflections from the continental boundaries to cross the ocean and promote positive re-enforcement and subsequent amplification of relatively small initial disturbances. The narrower width of the Atlantic and Indian Oceans precludes the alignment of the necessary ingredients that are needed for the reinforcement to materialize into mature Pacific El Niño-like phenomena.

(9) What is the relationship between tropical cyclones and El Niño?

It is believed that El Niño conditions suppress the development of tropical storms and hurricanes in the Atlantic; and that La Niña (cold conditions in the equatorial Pacific) favonr hurricane formation. Over the eastern and central Pacific Ocean, El Niño tends to increase the numbers of tropical storms.

(10) Considering many El Niño events, what are their typical global impacts?

During warm (El Niño) and cold episodes the normal pattern of tropical precipitation becomes disrupted. This affects tropical atmospheric circulation features, such as the jet streams in the subtropics and in the temperate latitudes of the winter hemisphere. The jet streams over the Pacific Ocean are stronger than normal during a warm episode and weaker than normal during a cold episode. Also, during warm and cold episodes extra tropical storms and frontal systems follow paths that are significantly different from normal, resulting in persistent temperature and precipitation anomalies (abnormal conditions) in many regions.

By studying past warm and cold episodes, scientists have discovered precipitation and temperature anomaly patterns that are highly consistent from one episode to another. Within the tropics, the eastward shift of thunderstorm activity from Indonesia into the central Pacific during warm episodes usually results in abnormally dry conditions over northern Australia, Indonesia and the Philippines in both seasons. Drier than normal conditions are also usually observed over southeastern Africa and northern Brazil. During the northern summer season, the Indian monsoon rainfall tends to be less than normal, especially in the northwest. Wetter than normal conditions during warm episodes are usually observed along the west coast of tropical South America, and at subtropical latitudes of North America (Gulf Coast) and South America (southern Brazil to central Argentina).

PART 2: INFORMATION ABOUT PRESENT EL NIÑO

(11) How strong is tbis El Niño?

Strong warm episode (El Niño) conditions have persisted in the tropical Pacific since July 1997. Sea surface temperatures throughout the equatorial east-central Pacific increased during April and May, when temperatures normally decrease in this region. During August and September ocean surface temperatures reached near-record levels in many sections of the equatorial Pacific. Departures from normal exceeded +4°C along the Equator east of 120°W, and were greater than+5°C near the Galapagos Islands and along the coast of northern Peru.

(12) What is the current forecast of the El Niño of 1997-1998?

Recent model forecasts indicate that strong warm episode oceanic conditions, comparable to those observed during 1982-83, will continue throughout the remainder of 1997 and into early 1998. Over the past few seasons several of the statistical and coupled model predictions have consistently indicated the development and persistence of a strong warm episode. These forecasts indicate that strong warm episode conditions will continue into the March-May 1998 season. Thereafter, several coupled model forecasts iudicate the reestablishment of the normal conditions which are characterized by a cold tongue of water in the eastern equatorial Pacific.

(13) What are the regional impacts of the 1997-1998 El Niño?

The most pronounced impacts have been observed in the tropics and subtropics, and across the eastern Sonth Pacific and central South America. Dramatic changes in rainfall are evident over much of the global tropics, with significantly increased rainfall across the eastern Pacific and well below-normal rainfall throughont Indonesia and the western tropical Pacific. In Indonesia, many areas have experienced rainfall deficits of more than 400-500 mm (16-20 inches) during the past several months, with area-averaged totals of only 60 mm (2.25 inches) compared to the normal of 180-200 mm (7-8 inches) recorded during August and September. This dryness has contributed to large-scale burning of wildfires in Sumatra and Borneo.

Elsewhere, El Niño-related dryness during June-October included virtually all of Central America and northern South America, and an area extending eastward across the tropical South Atlantic. Farther east, the southern part of western Africa has experienced substantially below-normal rainfall during July-September. Other El Niño impacts during the period include 1) a dramatic decrease in tropical storm and hurricane activity across the subtropical North Atlantic, 2) an expanded area of favourable conditions for tropical cyclone activity over the eastern North Pacific and an extension of that activity well into November, and 3) an overall weaker than normal monsoonal circulation in the npper atmosphere across the Indian subcontinent, despite generally near-normal rainfall across India this summer.

A summary of some of the regional impacts is provided below.

Australasia Region: The region has been very dry since June, with large-scale wildfires and drought. Many areas have already experienced rainfall deficits of 400-500 mm (16-20 inches) in the last several months.

Southern Part of West Africa: The region has also received abnormally low rainfall since July. The region also received an extended period of suppressed rainfall during the 1982-83 El Niño.

Southern Africa: The onset of the rainy season has not begun for most of the region.

Eastern Africa: As of the first part of November, the region had experienced abnormally intense rainfall along the coast, and generally higher than normal precipitation.

Central Europe: Experts do not claim with confidence that impacts of El Niño reach the European continent, and there is no evidence at this time that the heavy rain and catastrophic floods that occurred in July are related to El Niño.

Tropical Storm and Hurricane activity: There was a nearly complete shut-down of Atlantic tropical storm and hurricane activity after July, and an expanded area of favorable conditions for hurricane activity over the eastern North Pacific. This is due in part to an El Niño-related pattern of abnormally strong upper-level westerly winds extending from the eastern North Pacific to the southwestern Sahel area of Africa.

Central America: Abnormally dry conditions covered the region during June-October.

Northern South America: Abnormally dry conditions developed across the region, with dryness extending northeastward to western Africa.

Southern South America: Much of central and southern South America was wetter than normal during June-October, with most of the central portion of the continent also warmer than normal. Some locations in central Chile received their normal annual rainfall total in a single day. These conditions have resulted from an El Niño-related increase in jet stream winds and storminess across the central and eastern South Pacific, and a pronounced eastward extension of this storminess into the continent.

North America: North America typically receives its strongest El Niño impacts during the winter and early spring. However, the current episode started earlier than normal, and has already affected the continent in several ways. The persistence of abnormally warm ocean waters off the west coast has resulted in the appearance of unusual marine species from the Baja Peninsula to the Pacific Northwest. Another impact has been reduced tropical storm and hurricane activity across the eastern and Gulf coasts of the USA, with only one system (Danny) entering the country this year. At the same time, the expanded area of favourable conditions has led to several eastern Pacific hurricanes that turned north and went into Mexico with disastrous results.

Western Canada and Pacific Northwestern USA: The region has been experiencing abnormally wet conditions due to increased storminess and enhanced onshore flow. However, it is not clear if these conditions are related to El Niño.

Southern Alaska: This area has been experiencing abnormally warm and dry conditions due to the same southward shift in storminess and westerly winds that has brought increased rainfall to western Canada and the northwestern USA. Also, very warm ocean waters are present along the entire southern coast of Alaska. Again, it is not clear if these conditions are related to El Niño.

(14) Where can I Learn More about El Niño?

The WMO Home Page has an "El Niño Information" button, which provides links to a number of the major climate prediction centres and to the WMO Members with Web and Gopher servers that have notified us of the existence of their Home Pages. These sites give information about the climatological characteristics of El Niño, including the corresponding rainfall and temperature patterns; observed evolution of the sea-surface temperatures over the Pacific Ocean; the outlook for the Pacific Ocean sea surface temperatures (SSTs), rainfall and temperature during the coming months, and other related information. The WMO site is found at the following location: http://www.wmo.ch/

More scientific information on the global patterns of abnormal precipitation and temperature related to warm and cold episodes in the tropical Pacific can be found in Ropelewski and Halpert (1987, Mon. Wea. Rev., 115, 1606-1626); 1989, J. Climate, 2, 268-284), and Halpert and Ropelewski (1992, J. Climate, 5, 577-593). A general description of a warm (El Niño) episode and its composite evolution can be found in Rasmusson and Carpenter (1982, Mon. Wea. Rev., 110, 517-528). Upper-tropospheric circulation features that accompany extreme phases of the Southern Oscillation are discussed in a paper by Arkin (1982, Mon. Wea. Rev., 110, 1393-1404). A comprehensive discussion of the objectives and lessons that resulted from the international Tropical Oceans and Global Atmosphere (TOGA) research programme, and citations of recent El Niño research, are contained in Learning to Predict Climate Variations Associated with El Niño and the Southern Oscillation (1996, National Academy Press).

For further Information about WMO, please contact:

Information and Public Affairs Office
World Meteorological Organization
41, avenue Giuseppe-Motta
P.O. Box 2300
1211 Geneva 2
Switzerland
Tel. (+41 22)730 83 15; Fax (+41 22)733 28 29
E-mail: ipa@www.wmo.ch
http://www.wmo.ch
or your national Meteorological or Hydrometeorological Service