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NEWS AND INFORMATION ABOUT CLIMATE CHANGE STUDIES FOR TEACHERS AND STUDENTS

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A Meteorologist from the National Weather Service in Papua New Guinea Explains El Niño and La Niña

Hands On: A Lesson in Geography

Meet an NWS Meteorologist

The Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility supports education and outreach efforts for communities and schools located near its sites. The mission of the Education and Outreach program is to promote basic science education and community awareness of climate change research by focusing on three goals: student enrichment, teacher support, and community outreach.

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El Niño and La Niña: famous kids of the Tropical Western Pacific

by Kasis Inape, PNG National Weather Service

If you live in the Tropical Western Pacific region of the world, chances are you and your students know a lot about El Niño and La Niña. In fact, anybody who studies weather and climate is likely to know something about the weather phenomenon known as El Niño because, although it originates in the TWP region, its impacts are far reaching and influence weather and climate worldwide.

The name El Niño is Spanish for "the little boy," and refers to the Christ child. This name was chosen because the phenomenon is usually noticed around Christmas time in the Pacific Ocean off the west coast of South America. Similarly, La Niña means "the little girl."

So why are El Niño and La Niña so popular? In the following pages, Kasis Inape, a meteorologist at the Papua New Guinea National Weather Service, explains why the two weather phenomena occur and why they are so important to people who live in the TWP and beyond. The PNG NWS plays an important role in operating the ARM climate research facility on Los Negros Island in Manus, PNG. (Read more about Kasis Inape on page 6.)

What is El Niño?

The term El Niño refers to the situation when sea surface temperatures (SST's) in the central eastern Pacific Ocean are significantly warmer than normal. This event has a return period of 3 to 8 years and is generally associated with a strong negative phase of the Southern Oscillation Index (SOI). The SOI is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. Sustained

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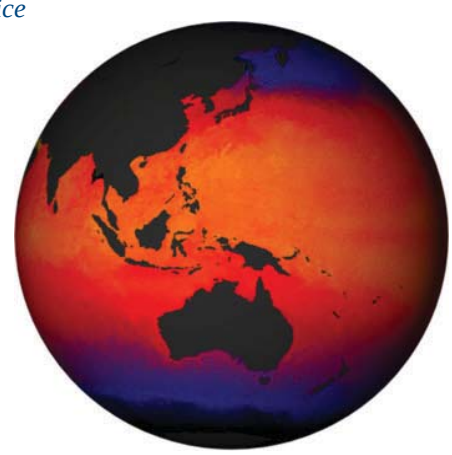

The West Pacific Warm Pool is a large area of ocean centered in the seas around Indonesia. This region contains the warmest ocean water in the world, and slowly fluctuates in size. The extent of the West Pacific Warm Pool affects the size and frequency of El Niño. In the image at left, cold waters are blue, purple, red, and orange waters are warmer, and yellow indicates sea surface temperatures up to 35°C. (Graphic and caption courtesy of NASA's Earth Observatory website http://earthobservatory.nasa.gov/Study/Oscillations/.)

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negative values of the SOI often indicate El Niño episodes. These negative values are usually accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds, and a reduction in rainfall over eastern and northern Australia. Read on for more information about the SOI.

The Walker Circulation

The Walker Circulation refers to an east-west circulation of the atmosphere in the vertical plane above the tropical Pacific, with air rising above warmer ocean regions (normally in the west), and descending over the cooler ocean areas (normally in the east). Its strength fluctuates with the Southern Oscillation.

The easterly trade winds (blowing from the east) are the low-level component of the Walker Circulation. Typically, the trade winds bring warm moist air towards the Indonesian region. Here, over the normally warm seas, moist air rises to high levels in the atmosphere causing abundant rainfall over the maritime continent and providing a source of moisture for rainfall over Australia, Indonesia, and Papua New Guinea.

The air then travels eastward before sinking over the much colder eastern Pacific Ocean (see Figure 1a on page 3). The rising air in the west is associated with a region of low surface air pressure, towering cumulonimbus clouds and heavy rainfall. In the east, high pressure and dry conditions accompany the sinking air.

During El Niño events the Walker Circulation weakens and may even reverse in the more intense episodes. In this instance westerly winds (blowing from the west) are observed (see Figure 1b on page 3) over parts of the equatorial western and central Pacific where normally easterly trade winds would be expected. Oceans around Australia and Papua New Guinea cool, and less moisture is fed into the region, resulting in below-average rainfall.

The Southern Oscillation Index

The SOI provides a simple measure of the strength and phase of the Southern Oscillation and Walker Circulation. The SOI is calculated from the monthly mean air pressure difference between Tahiti and Darwin. The 'typical' Walker Circulation pattern shown in Figure 1a has an SOI close to zero (Southern Oscillation close to the long-term average state).

During an El Niño episode, the SOI becomes persistently negative (for example -7) for at least 5 months or more. There is a shift in the Walker Circulation; air pressure is higher over Australia and lower over the central Pacific.

El Niño events usually emerge in the March to June period. It is at this time of the year that we can first expect to see falling SOI values and a weakening of the Walker Circulation, heralding the onset of an El Niño event. It usually reaches its peak late in the year before ending early the following year.

El Niño's Impacts on PNG Weather and Climate

Not all El Niño events are the same, but a strong El Niño event is typically associated with an increased risk of dry conditions across large areas of Papua New Guinea. The period of strongest influence is the six months of winter and spring. [In the Southern Hemisphere, it is spring December-May, and winter June-November.]

El Niño events are sometimes referred to as "weak" or "strong" depending on the extent to which ocean temperatures in the tropical

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Crop failure in the Highlands of Papua New Guinea due to the drought of the 1997-98 El Niño. (Picture courtesy of **The National** *Library Archives)*

Figures and Activities

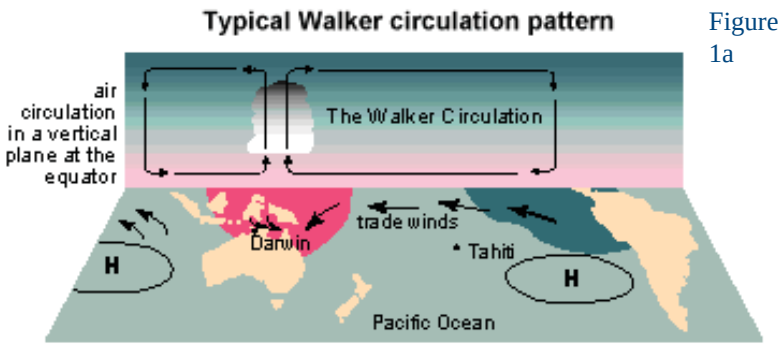


Figure 1a

The easterly trade winds are the low-level component of the Walker Circulation. Typically, (trade) winds bring warm moist air towards the Indonesian region. Here, over the normally warm seas, moist air rises to high levels in the atmosphere causing abundant rainfall over the maritime continent and providing a source of moisture for rainfall over Australia, Indonesia, and Papua New Guinea.

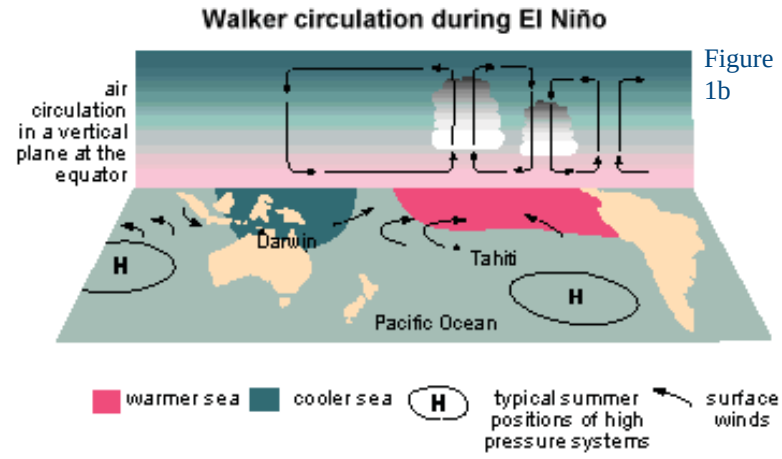


Figure 1b

During El Niño events the Walker Circulation weakens and may even reverse in the more intense episodes. In this instance westerly winds are observed over parts of the equatorial western and central Pacific where normally easterly (trade) winds would be expected. Oceans around Australia and Papua New Guinea cool, and less moisture is fed into the region, resulting in below-average rainfall.

Figure 1 courtesy of the Australian Bureau of Meteorology

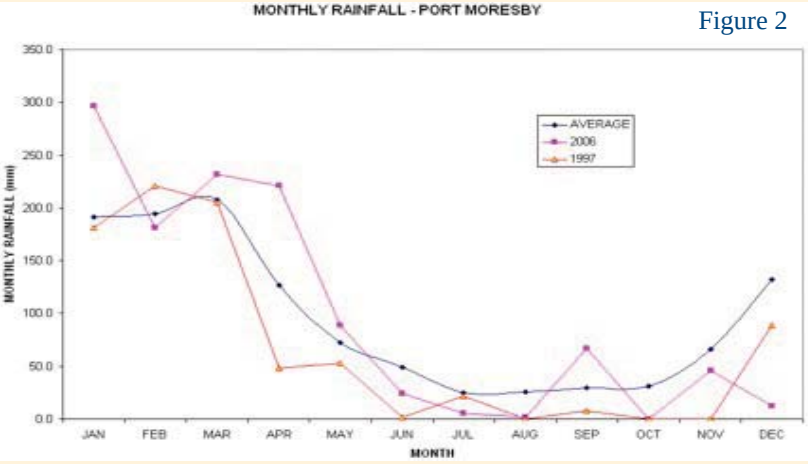


Figure 2

This figure shows the monthly rainfall impact for Port Moresby during the 1997-98 and 2006-07 El Niño events compared with the average or normal conditions. It clearly shows that during strong El Niño events such as 1997-98, the rainfall pattern for Port Moresby is seriously reduced.

Figure 2 courtesy of the Australian Bureau of Meteorology

Geography

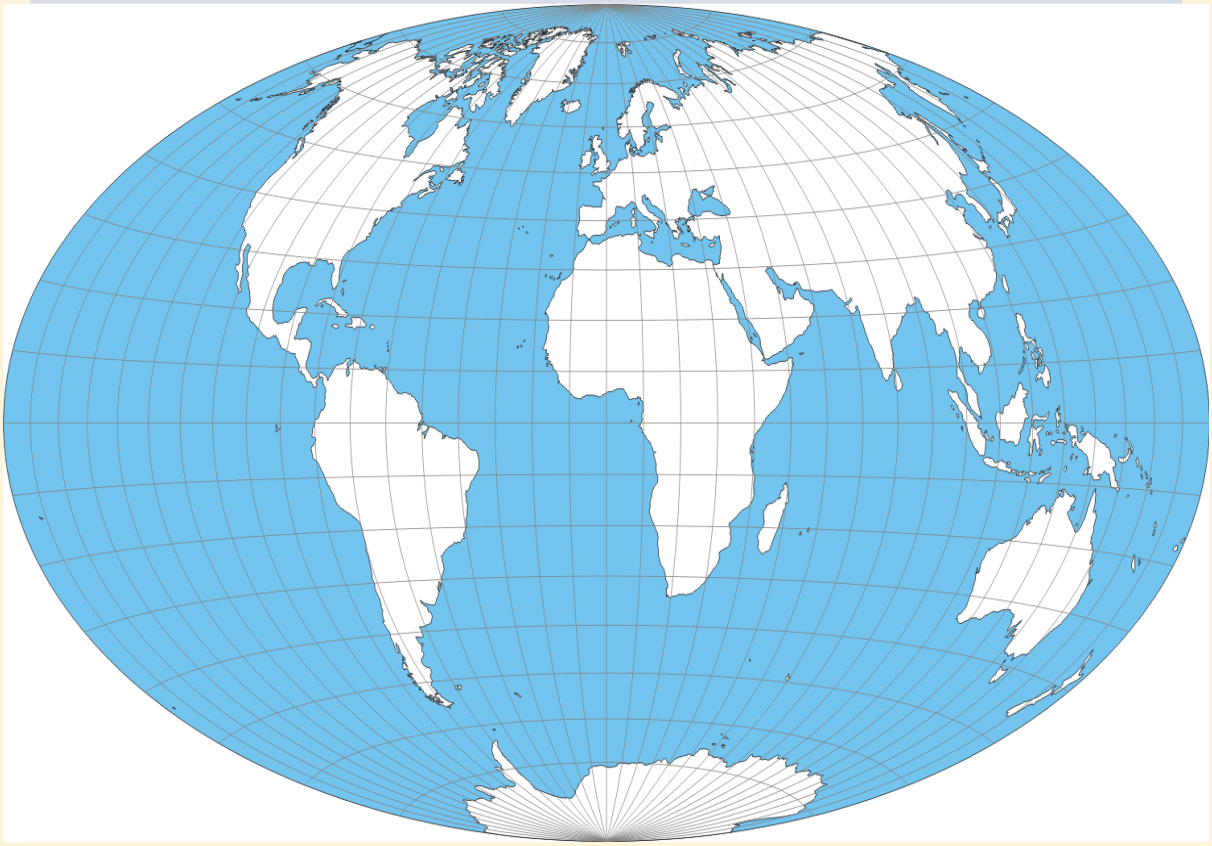
Ask students to label the continents and oceans of the world and draw a compass on the map below and answer the following questions:

1) On which continent did the term El Nino originate?

2) Where is the “warm pool” located?

3) In which direction(s) do the pacific trade winds blow under normal conditions? Draw arrows on the map.

4) In which direction(s) do the pacific trade winds blow under El Nino conditions? Draw arrows on the map.



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eastern Pacific increase above their normal levels. In that sense, 1982-83 and 1997-98 were very strong events, while 1991-92, 1993-94, 2002-03, and 2006-07 were weaker events.

Figure 2 shows the monthly rainfall impact for Port Moresby, the capital of PNG, during the 1997-98 and 2006-07 El Niño events compared with the average or normal conditions. It clearly shows that during strong El Niño events such as 1997-98, the rainfall pattern for Port Moresby is seriously reduced.

In addition to its effect on rainfall, the El Niño phenomenon also has some influence on temperatures over Papua New Guinea. During winter/spring, El Niño events tend to be associated with warmer than normal daytime temperatures, which serve to worsen the effect of below normal rainfall by increasing evaporation. Conversely, reduced cloudiness and rainfall means that temperatures tend to cool very rapidly at night, often leading to widespread and severe frosts. During the 1997-98 El Niño event, many food gardens in the Highlands were destroyed as a result of frost.

El Niño's Opposite Phase: La Niña

When the eastern Pacific Ocean is much cooler than normal, the SOI is usually persistently positive (say about +7) and the Walker Circulation (Figure 1a) is stronger than average. These changes often bring widespread rain and flooding to Papua New Guinea - this phase is called La Niña.

Papuan villages flooded as a result of a La Niña event. (Picture courtesy of **The National** *Library Archives)*

The effect of La Niña on Papua New Guinea rainfall pattern is more widespread than that of El Niño. Nearly the whole country tends to experience the impacts of La Niña; for example, wetter than normal conditions (See photo above).

Forecasting El Niño and La Niña

Scientists have made important advances in understanding the El Niño/La Niña phenomenon in recent decades. This has led to the development of computer models, which can be used to forecast the behavior of El Niño and La Niña some months in advance.

Using this knowledge, the PNG National Weather Service has been producing seasonal climate outlooks for Papua New Guinea since 2002. The service offers three monthly outlooks of rainfall for the country using its rainfall monitoring stations located around the country, together with longer-term projections of the behavior of the El Niño-Southern Oscillation.

ARM Research in the TWP Region

The Tropical Western Pacific (TWP) locale was established in 1996 as the second ARM Climate Research Facility site. Operated by the Tropical Western Pacific Office (TWPO) at Los Alamos National Laboratory, the TWP site consists of three climate research facilities: the Manus facility on Los Negros Island in Manus, Papua New Guinea (established in 1996); the Nauru facility on Nauru Island, Republic of Nauru (1998); and the Darwin facility in Darwin, Northern Territory, Australia (2002). The operations are supported by local government agencies in each host country.

Kasis Inape: A meteorologist at work

Kasis Inape is the Acting Director of the Papua New Guinea National Weather Service in Port Moresby, PNG.

Kasis Inape is a meteorologist at the Papua New Guinea National Weather Service. He holds a Master of Science degree in Applied Agriculture and Meteorology from the University of Reading in the UK, as well as a Bachelor of Science degree in mathematics from the University of Papua New Guinea. Furthermore, Inape has received training and earned certificates in climate studies from universities in various countries around the world, including Australia, Israel, China, Malaysia, and the United States.

Inape was born in the village of Monibi in 1970; two years later, he migrated with is family to Goroka, where he has lived most of his life. He started primary school at North Goroka Community school in 1977, where he completed with a Grade 6 certificate in 1982. Inape was then selected to proceed with his education at Goroka Demonstration High School. After four years, he completed high school with a Grade 10 Certificate in 1986 and was further selected to complete years 11 and 12 at Aiyura National High School, which is approximately three hours from Goroka Town. Inape graduated from high school with a year 12 certificate and was accepted to the University of Port Moresby.

Over a period of several years, Inape has served the PNG NWS as a research meteorologist, senior climatologist, and as Assistant Director of Research and Climatology, and Assistant Director of Climate and Special Services. He is now Acting Director of the PNG NWS.

In his spare time, Inape enjoys travelling, playing sports, and looking after his children.

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