What Is El Niño

A general description of its global impacts
El Niño-Southern Oscillation (ENSO)

El Niño in a nutshell

El Niño Conditions:
• Warm sea surface temperatures to the east and cold to the west
• Weakened trade winds, westerly winds over east Pacific
• Rainfall over the Central and East Pacific
• Lower than normal sea levels over the western Pacific

La Niña Conditions:
• Cooler than normal sea surface temperatures to the east and warmer to the west
• Stronger trade winds
• Enhanced rainfall over the Western Pacific
• Higher than normal sea levels over the Western Pacific

El Niño
development, peak and decay

- Oceanic Niño index averaged for 5 recent El Niño events
El Niño
development, peak and decay

- Oceanic Niño index averaged for 5 recent El Niño events
El Niño and Rainfall

La Niña and Rainfall

http://www.climate.gov/news-features/department/8443/all
ENSO and Tropical Cyclones

El Niño shifts TC genesis Eastward over the North and South Western Pacific

- Less TC activity
  - Australia
  - Philippines
- More TC activity
  - Tropical Pacific
  - Hawaii
  - American Samoa

From the Royal Netherlands Meteorological Institute
http://www.knmi.nl/research/global_climate/enso/effects/
GENERAL SYNOPSIS

This section will give a quick overview of the coming topics
**Synopsis**

**ENSO Alert System Status:** El Niño Advisory/ La Niña Watch

**Current Conditions**

- Current ENSO status is **El Niño**
- Sea Surface Temperature warmer than normal over the Eastern Pacific
- Atmospheric conditions consistent with weakening El Niño

**Observed Impacts**

- Severe dry conditions over the Western Pacific
- Tropical cyclone activity shifted
- Below average sea levels over the Western Pacific

**General ENSO Forecast**

- ENSO expected to transition to Neutral conditions during spring or early summer 2016
- Increasing chance of **La Niña** during the second half of the year
Current Conditions

General State of the Ocean and Atmosphere
During the last 4 months, equatorial SSTs were well above average across the Eastern Pacific Ocean.

Average sea surface temperature (SST) anomalies (°C).

Over the past month, Warm SST anomalies were still present over the Equatorial Pacific but weakened strongly over the past month.

http://www.cpc.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.ppt#356,6,SST Departures (°C) in the Tropical Pacific During the Last 4 Weeks
OLR and Wind Anomalies for Past 30 Days

- Above average deep convection (\(\sim\) OLR anomalies)
- East of the dateline
- Not extending as far east as during the past three months

- Below average precipitation (\(\sim\) OLR anomalies)
- Western Pacific

Low level winds over the Equatorial Central Pacific are close to normal

Upper level winds show predominant easterly winds

http://www.cpc.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.ppt
The latest weekly SST departures are:

Niño 4 0.9°C  
Niño 3.4 0.8°C  
Niño 3 0.4°C  
Niño 1+2 -0.3°C
EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

ENSO Alert System Status: El Niño Advisory/ La Niña Watch

Synopsis:

• Sea surface temperature anomalies were between 1.0° and 1.5° C across most of the central and eastern equatorial Pacific Ocean during early April, having weakened appreciably over the last month.

• The latest weekly values for all of the Niño indices dropped to below 1.5° C.

• The subsurface temperature anomaly in the central and eastern Pacific decreased to negative values.

• Low-level westerly wind anomalies and upper-level easterly wind anomalies weakened compared to February.

• The equatorial Southern Oscillation Index (SOI) remained negative but weakened, while the traditional SOI was near zero.

• Enhanced convection continued over the central tropical Pacific but weakened east of the Date Line, and was suppressed over northern Indonesia and the Philippines.

• Collectively, these anomalies reflect a weakening El Niño.
Impacts

Rainfall, Sea Level, Tropical Cyclones and Societal Impacts
Rainfall impacts:
Drought

- Global Precipitation Climatology Center GPCC satellite derived Standardized Precipitation Index
- Represents the 12 month accumulated rainfall deficit
- Darker colors represent larger rainfall deficits

At the end of April 2016, El Nino continues to exert its influence with severe droughts across the globe

From the Global Drought Information System (http://www.drought.gov/gdm/content/welcome)
Rainfall impacts:
Drought

- In Europe:
  - Drought conditions intensified around the Mediterranean Sea
- In Africa
  - Drought intensified in the northern portions of the continent
  - Remains intense in the south
  - Zambezi River flowing at a 30-year low. Hydroelectric power is expected to be reduced or stopped in the next six months
- In Morocco, drought has reduced the wheat harvest by half
- In South America
  - strong drought continues to impact the northern part of the continent
  - Venezuela facing severe power shortages
  - Drought in Cuba is being characterized as their worst in 115 years

https://www.drought.gov/gdm/current-conditions
Rainfall impacts:
Drought in Asia and the Pacific

- In Asia
  - drought remains entrenched across the Indian sub-continent, around Mongolia, and in the West.
  - In Vietnam, the Mekong River is at its lowest level since 1926.
  - Reduced water supplies and water-borne disease has led to the death of 16 children in the Thar district of Pakistan

- In Oceana
  - drought continues in Southern Australia and Papua New Guinea.
  - Intensified over New Zealand

https://www.drought.gov/gdm/current-conditions
Drought impacts to the USAPIs

- State of Emergency due to drought declared for
  - Republic of Palau
  - Federated States of Micronesia
  - Federal and State levels
  - Republic of the Marshall Islands

- Water Rationing Implemented on bigger islands
- Drinking water likely to become a serious issue for smaller islands
- Damage to food crops likely for smaller islands
- Lack of fresh water may lead to deterioration in health.

Special acknowledgement to

Richard Heim NOAA/NCEI
Chip Guard NWS WFO Guam
WSO personnel throughout the USAPI
US Affiliated Pacific Islands

PEAC Center Rainfall forecast performance

Niño 3.4 anomaly (C) vs. HSS Skill Score
Borneo fires

- Sep 14 2015
- Top MODIS Terra true color and thermal anomalies
- Bottom MODIS Terra Aerosol Optical Depth
- This type of widespread fires was also seen during 1997
Borneo fires

• Costliest singular event of 2015
  • Estimated 16 billion in economic cost
  • 1.9% of Indonesia’s GDP

Source: AON Benfield
2015 Annual Global Climate and Catastrophe Report
Global crops

From GEOGLAM Early Warning Crop Monitor Mat 2016
http://www.geoglam-crop-monitor.org/
Latest information up to April 28th 2016.

- China
  - Good conditions over the eastern portion
  - Southern regions seeing watch and poor conditions for wheat and rice
- India
  - Watch conditions over the south for rice crops
Crops in Africa and South East Asia

From GEOGLAM Early Warning Crop Monitor Mat 2016
http://www.geoglam-crop-monitor.org/
Latest information up to April 28th 2016.

- Africa
  - Severe drought over the southern portion of the continent producing poor conditions for most crops

- South East Asia
  - Large portions of continental South East Asia and the Philippines seeing poor crop conditions due to drought
Tropical Cyclones

- **West Pacific**
  - 2013, 33 TCs, 5 Super Typhoons
  - 2014, 23 TCs, 8 Super Typhoons
  - 2015, 29 Cyclones, including 8 Super Typhoons
  - Tropical Cyclone genesis region has shifted eastward well to the east of Guam
- **East/Central Pac.**
  - 2013, 6 TCs form or move over the Central Pac, none of hurricane intensity
  - 2014, 6 TCs form or move over the Central Pac., 5 of which attain Hurricane intensity
  - 2015, 9 Cyclones form in the Central Pacific basin and 8 more moved into the basin from the east, 8 attained or maintained Hurricane intensity in the Central Pacific basin

Images from JTWC, Courtesy of Robert Falvey.
Southern Hemisphere Tropical cyclones

- Central Pacific
  - 2 early season Central Pacific cyclones…possible extension of the 2015 season
- Increased activity in the Southern Pacific basin
- No winter/spring cyclones in the western North Pacific
- Very little activity near Australia

Image from JTWC, Courtesy of Robert Falvey.
Coral Bleaching

Alert Areas

- The Central and Eastern Pacific show large areas of Level 2 alert (mortality likely)
- Indian Ocean under severe stress
- Alert level areas collocated with warmest SST anomalies
- Low sea levels may also be playing a role over the southwest Pacific
- Great Barrier Reef area which saw widespread bleaching in early 2016 may be seeing some relief

From Coral Reef Watch
http://coralreefwatch.noaa.gov/satellite/baa.php
How ENSO affects global health

El Niño and health

R Sari Kovats, Menno J Bouma, Shakoor Hajar, Eve Worrall, Andy Haines

El Niño Southern Oscillation (ENSO) is a climate event that originates in the Pacific Ocean but has wide-ranging consequences for weather around the world, and is especially associated with droughts and floods. The irregular occurrence of El Niño and La Niña events has implications for public health. On a global scale, the human effect of natural disasters increases during El Niño. The effect of ENSO on cholera risk in Bangladesh, and malaria epidemics in parts of South Asia and South America has been well established. The strongest evidence for an association between ENSO and disease is provided by time-series analysis with data series that include more than one event. Evidence for ENSO's effect on other mosquito-borne and rodent-borne diseases is weaker than that for malaria and cholera. Health planners are used to dealing with spatial risk concepts but have little experience with temporal risk management. ENSO and seasonal climate forecasts might offer the opportunity to target scarce resources for epidemic control and disaster preparedness.
How ENSO affects global health

El Niño and health

Breeding and survival of disease vectors (e.g., malaria)

- Food shortages
- Impaired immune system
- Malnutrition
- Population movement

Increased risk of infections

- Socioeconomic turmoil
- Interruption of health services

- Forest fires
- Respiratory ailments

- Scarcity of potable water
- Diarrheal diseases

Figure 2: Potential health effects of drought in developing countries
Observed Health impacts during 2015-16

- **Tanzania**
  - Cholera epidemic of more than 12,000 reported is likely to spread to other countries
  - This Tanzanian cholera outbreak is the largest since 1997-1998, which had over 40,000 reported cases

- **In Ethiopia**
  - Number of people in need of emergency health interventions nearly doubled in three months

- **In southern Africa**
  - Increasing malnutrition and disease risks
  - Growing concerns about the interruption to anti-retroviral therapy

- **South America**
  - Above-average rainfall
  - Floods and increased diseases spread by mosquitoes

- **In Guatemala and Honduras,**
  - 2 years of drought and El Niño
  - 2.8 million people in need of humanitarian assistance
  - 1-5 households will face critical food consumption gaps and acute malnutrition

- **Papua New Guinea**
  - Drought
  - Major immediate public health threats include the interruption of critical infrastructure

- **Vanuatu, Fiji, Solomon Islands**
  - Water shortages
  - Increased incidence of diarrhoeal diseases

- **Indonesia**
  - Fires
  - Likely cause respiratory disease, food insecurity
EL NIÑO-RELATED DISASTERS

How USAID’s Office of U.S. Foreign Disaster Assistance is Preparing and Responding

WHERE WE’RE WORKING

- Guatemala
- Colombia
- Paraguay
- Uruguay
- Ethiopia
- Somalia
- Indonesia
- Papua New Guinea
It is expected that there will be
- 52 million food-insecure people in Southern and Eastern Africa
- 4.7 million people at risk from adverse weather in the South Pacific
- 4.2 million people affected by drought in Central America and
- Millions affected by drought and extreme weather conditions across Asia

Governments and the international community did prepare for this El Niño event and employed preparedness and response actions, but funding has been limited.

Islands across the Pacific have been coping with the impacts of changed El Niño weather patterns. Many countries were able to mitigate the most serious impacts before most situations reached crisis point.

The current funding gap stands at over $2.2 billion, of which approximately one third is for Ethiopia.

From the United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
http://www.unocha.org/el-nino
Forecast

ENSO forecasts
Rainfall, Sea level, Tropical Cyclones and Coral Bleaching
CPC/IRI ENSO Forecast

CPC/IRI EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

Expected Conditions

- Strong El Niño to continue weakening, and return to neutral by late spring or early summer 2016
- 60% possibility for La Niña development by fall

Climate Prediction Center
National Centers for Environmental Prediction
NOAA/National Weather Service
College Park, MD 20740
### Expected Conditions

- Most models indicate that a strong El Niño will weaken with a transition to ENSO-neutral during the late spring or early summer.
  - The chance of La Niña increases during the late summer or early fall.
- The official forecast is consistent with the model forecasts.
- This transition to La Niña is also supported by a historical tendency for La Niña to follow strong El Niño events.

### Average Niño 3.4 SST Anomaly Forecast

<table>
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<tr>
<th></th>
<th>AMJ</th>
<th>MJJ</th>
<th>JJA</th>
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<tr>
<td>All Models</td>
<td>0.7</td>
<td>0.2</td>
<td>-0.2</td>
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</table>
Tropical SST Forecasts (May 2016-Oct 2016)

- This particular model ensemble
  - Produces a reasonable La Niña “horse shoe” spatial pattern
  - Develops La Niña conditions by July 2016
  - Ensemble predictions for NINO3.4 index are around -0.8°C (moderate La Niña)
Tropical Rainfall Forecasts (May 2016-Oct 2016)

- May-July
  - Current dry conditions over the Western Pacific start to extend east past the dateline
  - Dry conditions subsist over South America
  - Strong wet conditions over the Indian Ocean

- August-October
  - Wet conditions over the Indian Ocean intensify
  - Dry conditions over the equatorial tropical Pacific extend to far along equator
  - Dry conditions over South America persist

Asia Pacific

• Eastern China and the Korean Peninsula likely to receive above average rainfall for the next 3 months
• Dry conditions likely to continue over the tropical Western North Pacific
  • Western Pacific Islands will likely see continuing severe drought
• India
  • Above average rainfall in the Brahmaputra-Meghna area
  • May-July wet conditions over the entire subcontinent
• Philippines projected to receive below average rainfall
• Mainland Southeast Asia likely to see dry conditions slightly improve over the next 6 months

Australia - Pacific

- Maritime Southeast Asia will start getting more rain and relief from severe drought

- South Pacific Islands likely to see continuing dry conditions

- Australia
  - Likely above average rainfall for the next 6 months
  - Could make for severe floods
  - 2010-2011 Queensland floods
    - TC + Enhanced wet conditions
    - Produced ~2.4 Billion in damages

US Affiliated Pacific Islands Rainfall

<table>
<thead>
<tr>
<th>Model:</th>
<th>UKMO</th>
<th>ECMWF</th>
<th>NCEP CA</th>
<th>NASA Godao</th>
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People line up for water in the Marshall Islands in early 1998 to receive a ration once every 14 days. (Photo courtesy of Federal Emergency Management Agency)

Forecasts for the AMJ season issued on April 18 2016 available at http://www.weather.gov/peac/
Sea Level Forecasts

- Sea Level across the Western Pacific Basin has been well below average since early 2015 and is expected to
  - Start returning to normal over the next few months
  - Be above average starting September 2016

## US Affiliated Pacific Islands

### Sea level forecast

#### Table 1: Forecasts of MEAN and MAX sea level anomaly in inches for MAM 2016

<table>
<thead>
<tr>
<th>Tide Gauge Station</th>
<th>MEAN Deviation(1)</th>
<th>Standard Deviation MAM season</th>
<th>MAX Deviation (2)</th>
<th>Standard Deviation of MAM season</th>
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</table>

(*) Data Unavailable  
Values for Chuuk (**) are guesstimated based on estimates from neighboring tide stations and observations from WSO Chuuk.  
Deviations between 0±1 inch are considered to be negligible and are denoted by ***(+-)**.  
Deviations within the range of (+/-) 2 inches are unlikely to cause any adverse climatic impact.

1: Difference between the mean sea level for the given month and the 1983 through 2001 mean sea level value at each station (seasonal cycle removed);  
2: Difference between the maximum sea level for the given month and the 1983 through 2001 average maximum sea level value at each station (seasonal cycle removed)

Forecasts for the MAM season issued on March 12 available at http://www.weather.gov/peac/
Tropical Cyclone Forecast

- West North Pacific Basin
- Can have TCs year round, but has a minimum of activity in February and March
- TC activity tends to shift eastward during El Niño and westward during La Niña

- US Affiliated Pacific Islands (PEAC Center Forecast)
  - As TC activity shifts west during La Niña events, most USAPI will see below normal TC activity

- Central Pacific Basin
  - TC season June 1 to November 30. Forecast issued May 26 by CPHC
  - Based on climatology, Average to Below Average activity is expected

Image from JTWC, Courtesy of Mr. Brian Strahl.
Tropical Cyclone Forecast

- American Samoa TC season just ended (November to April)
  - PEAC Center forecasts are for an average to below average 2016-2017 season
- Australia (Australian BOM Forecast)
  - Below Average Cyclone season, Nov 1, 2015 – Apr 30, 2016
  - Based on the BOM 2010-2011 forecast
    - Australian region likely to get above average TC activity during the 2016-2017 season

Image from JTWC, Courtesy of Mr. Brian Strahl.
Tropical Cyclone Forecast

• South China Sea (City University of Hong Kong)
  • Forecast issued in April and July for June 1 to November 30
  • Based on the forecasts for 2007/2008 & 2010/2011 La Niña suggest TC activity shifted westward
  • Likely to see greater number of landfalling storms

• Indian Ocean
  • Enhanced activity in the Bay of Bengal during La Niña

Image from JTWC, Courtesy of Mr. Brian Strahl.
Coral Bleaching
Outlook

- High probability of Coral Bleaching across the Indian Ocean
- Western Pacific Islands may see bleaching in the coming months
- Great Barrier Reef may see some improvement

From Coral Reef Watch
http://coralreefwatch.noaa.gov/satellite/baa.php


Synopsis

ENSO Alert System Status: El Niño Advisory/ La Niña Watch

Current Conditions

- Current ENSO status is **El Niño**
- Sea Surface Temperature warmer than normal over the Eastern Pacific
- Atmospheric conditions consistent with weakening El Niño

Observed Impacts

- Severe dry conditions over the Western Pacific
- Tropical cyclone activity shifted east over the Western Pacific and enhanced over the Central and Eastern Pacific Basin
- Below average sea levels over the Western Pacific

General ENSO Forecast

- ENSO expected to transition to Neutral conditions during spring or early summer 2016
- Increasing chance of **La Niña** during the second half of the year
Forecast Summary

- Rainfall
  - Dry conditions likely to continue over the tropical Western North Pacific
    - Western Pacific Islands will likely see severe drought
  - Eastern China likely to receive above average rainfall for the next 3 months
  - India, increasingly wet conditions
  - Philippines projected to receive below average rainfall
  - Mainland Southeast Asia likely to see dry conditions slightly improve over the next 6 months
  - Maritime Southeast Asia will start getting more rain and relief from severe drought

- Sea Level
  - Likely return to normal in the coming months and continue to increase

- TCs
  - Western Pacific
    - US Affiliated Pacific Islands likely below normal activity
    - South China Sea likely to see increased activity
  - Central Pacific Basin
    - Near normal possibly below
  - Philippines
    - 1-3 tropical cyclones in the April to June 2016 period (PAGASA)
  - Australia
    - Likely above average cyclone season, Nov 1 2016 – Apr 30 2017
  - Indian Ocean
    - Above average activity in the Bay of Bengal
Global impacts of La Niña

La Niña years have clearly shown greater average annual losses in comparison to El Niño and Neutral phases.

- La Niña USD77 billion
- El Niño USD45 billion

Much of the increase in losses during a La Niña year surrounds

- Increased frequency of costly landfalling tropical cyclone events in the Atlantic Ocean basin
- Increased flooding events across Asia Pacific

Source: Aon Benfield 2015 Annual Climate and Catastrophe report.
La Niña can linger on…

- While El Niño conditions rarely persist more than one year, La Niña conditions can persist many years:
  - 1953/1954 El Niño followed by La Niña conditions from AMJ1954 through AMJ 1956

- This makes it so that La Niña type impacts can be present for many years.
The PEAC Center

The Pacific ENSO Applications Climate Center