

Pacific Region ENSO UPDATE AND SEASONAL OUTLOOK

May 9 2016

PREPARED BY THE PEAC CENTER

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University of
Hawai'i
M Ā N O A
UH/SOEST

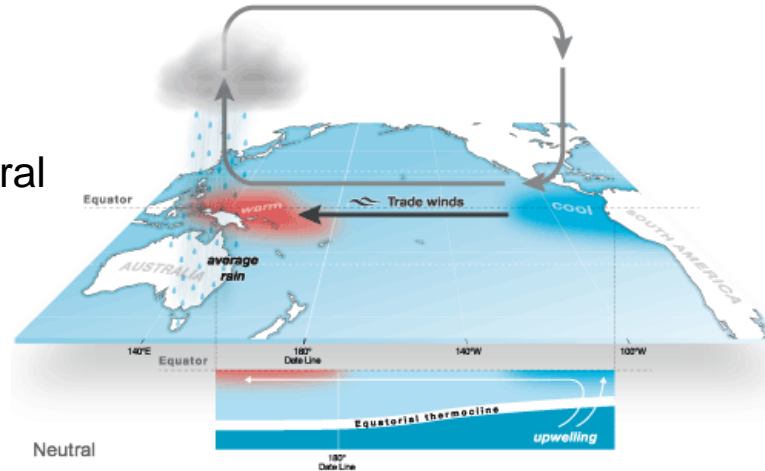


What Is El Niño

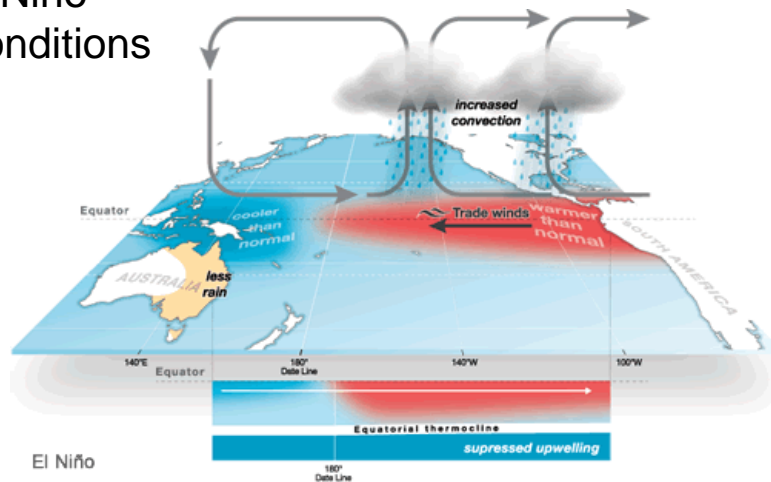
A general description of its global impacts

El Niño-Southern Oscillation (ENSO)

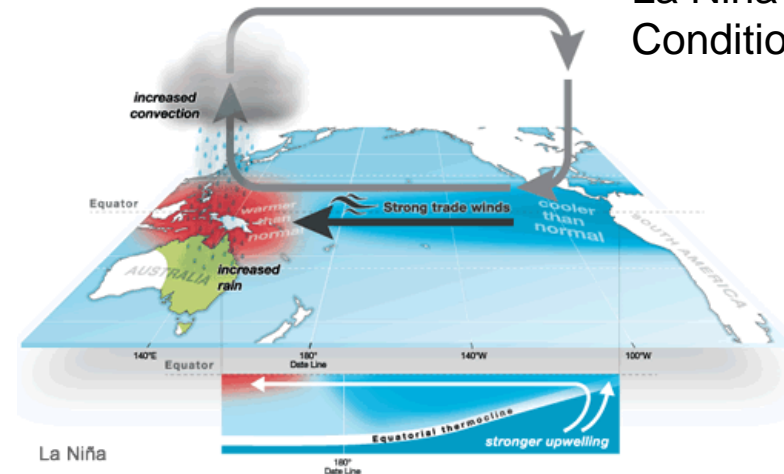
ENSO Neutral Conditions



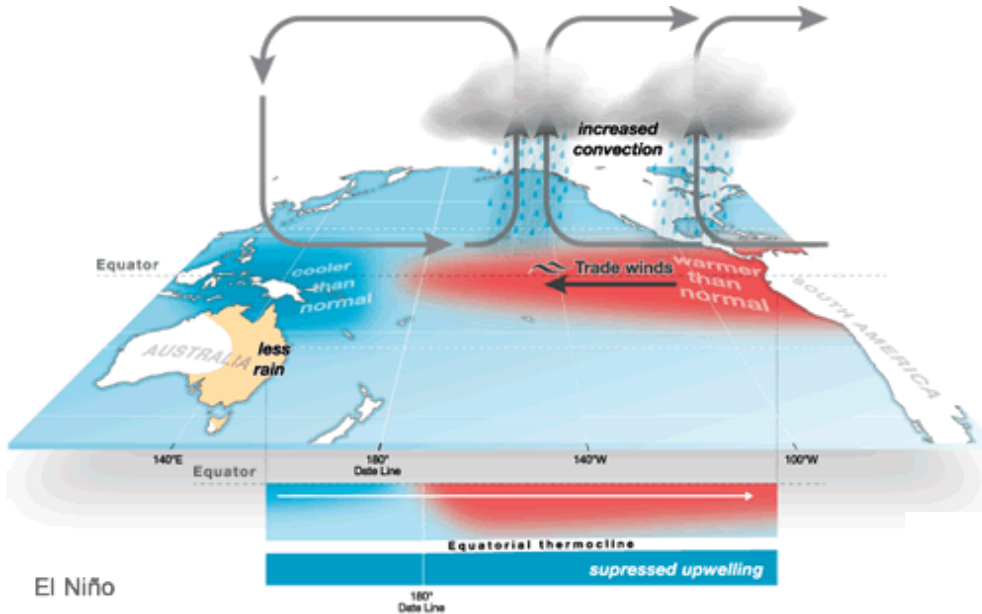
El Niño Conditions



La Niña Conditions



El Niño in a nutshell

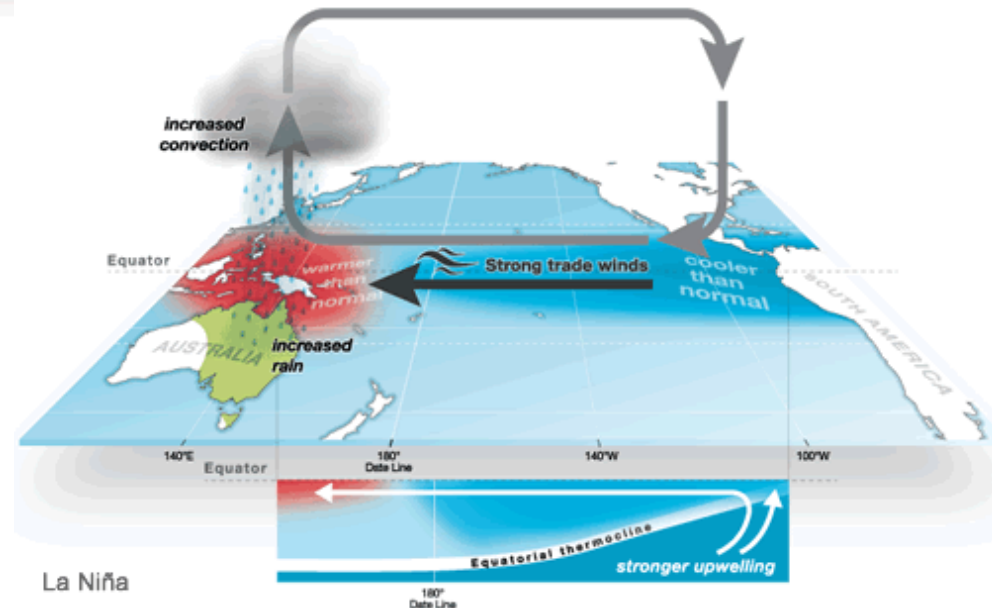


El Niño Conditions:

- 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:

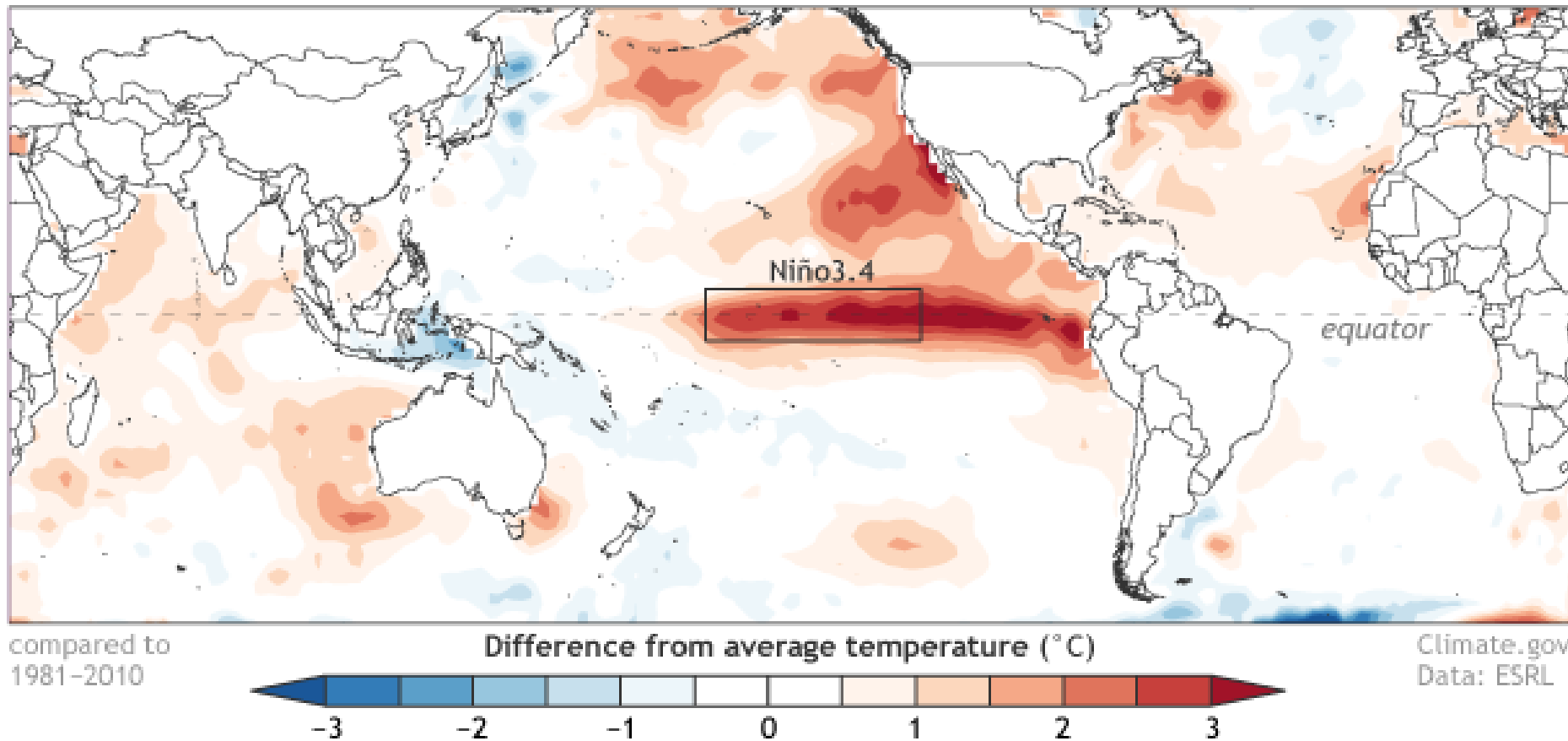
- Cooler than normal sea surface temperatures to the east and warmer to the west
- Stronger trade winds
- Enhanced rainfall over the Western Pacific
- Higher than normal sea levels over the Western Pacific



El Niño development, peak and decay

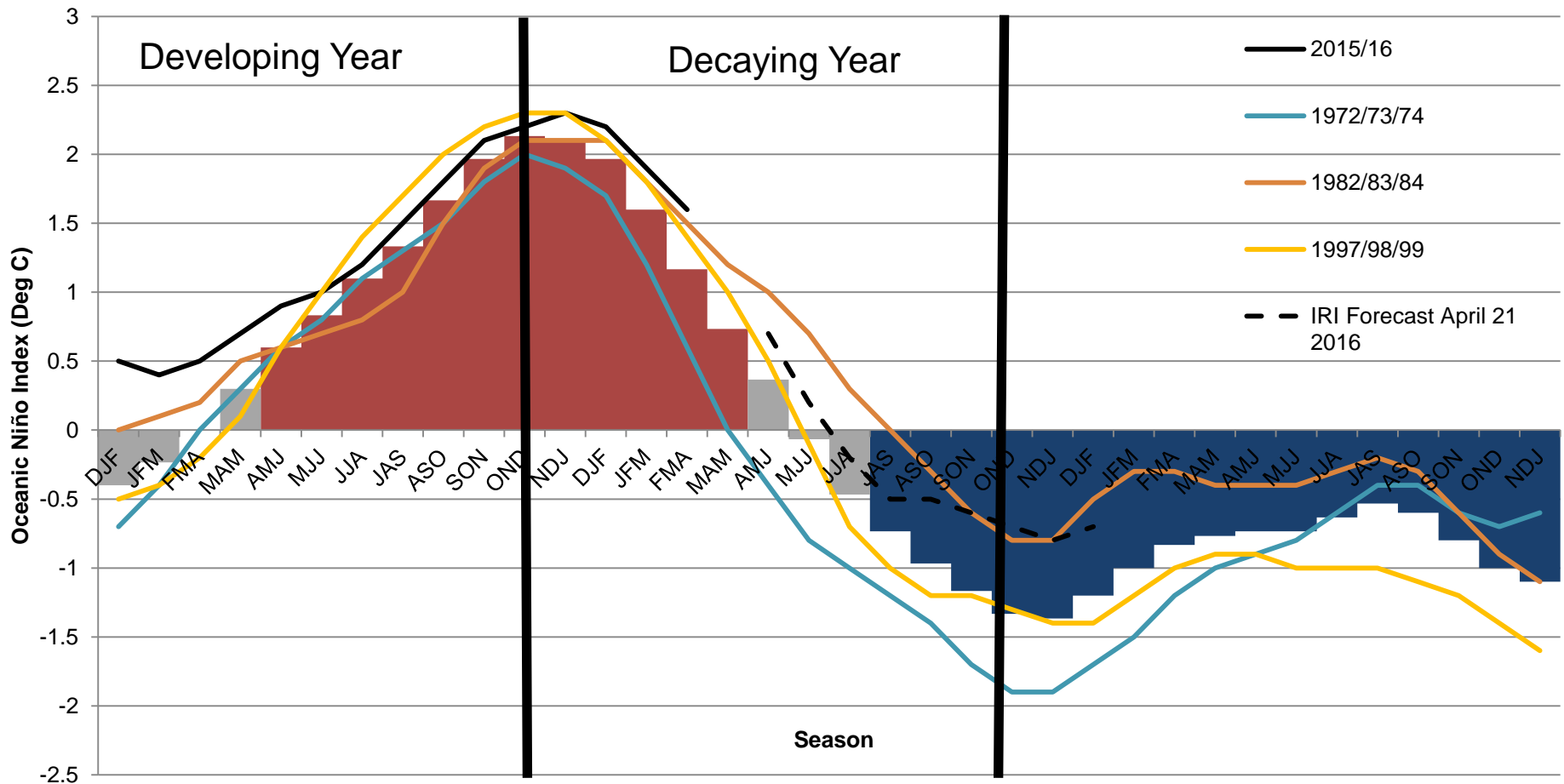
- Oceanic Niño index averaged for 5 recent El Niño events
 - 1963/64, 1972/73, 1982/83, 1997/98, 2009/2010

Sea surface temperature anomaly, Oct 11–Nov 7, 2015

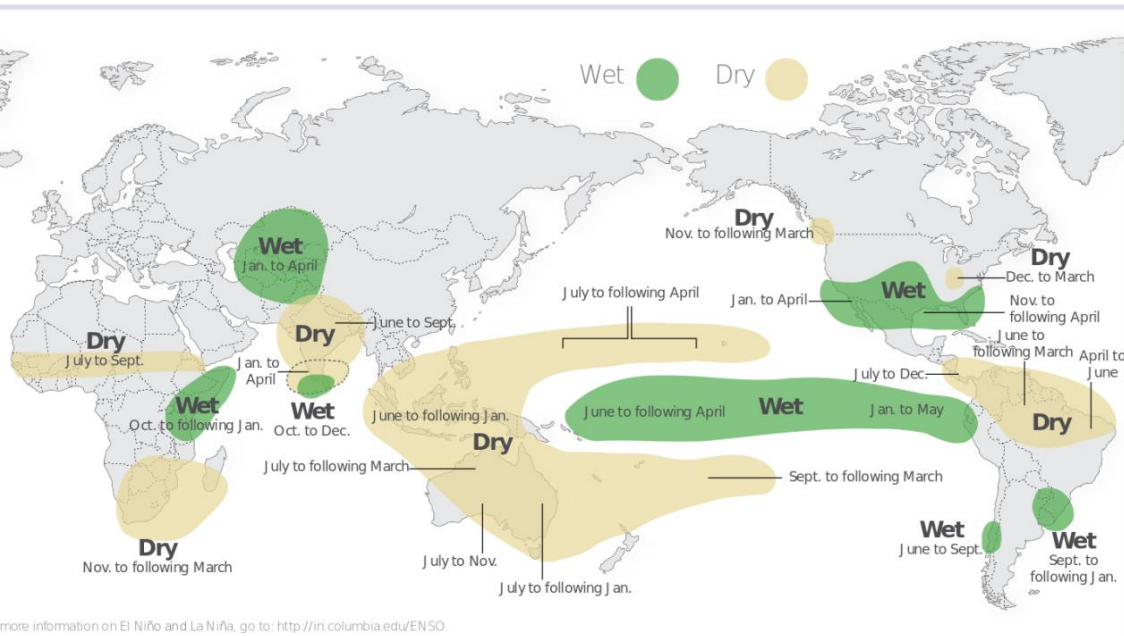


El Niño development, peak and decay

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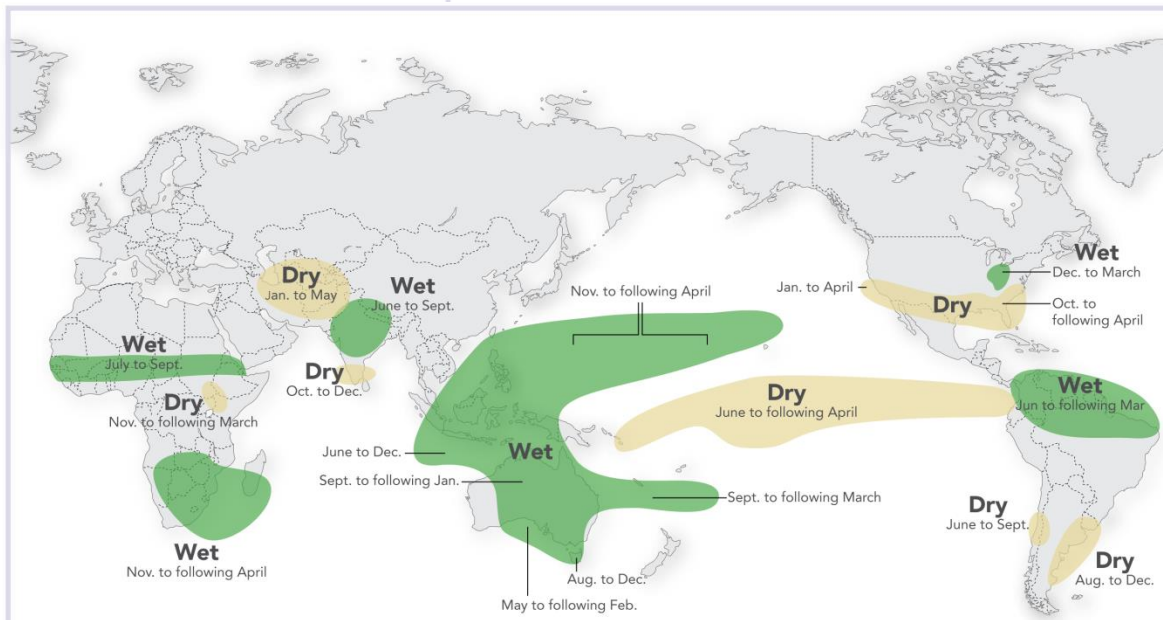
El Niño and Rainfall



For more information on El Niño and La Niña, go to: <http://iri.columbia.edu/ENSO>

Sources: Ropelewski, C. F. and M. S. Halpert, 1989: Precipitation patterns associated with the high index phase of the Southern Oscillation. J. Clm Mason and Goddard, 2001: Probabilistic precipitation anomalies associated with ENSO. Bull. Am. Meteorol. Soc. 82, 619-638

La Niña and Rainfall



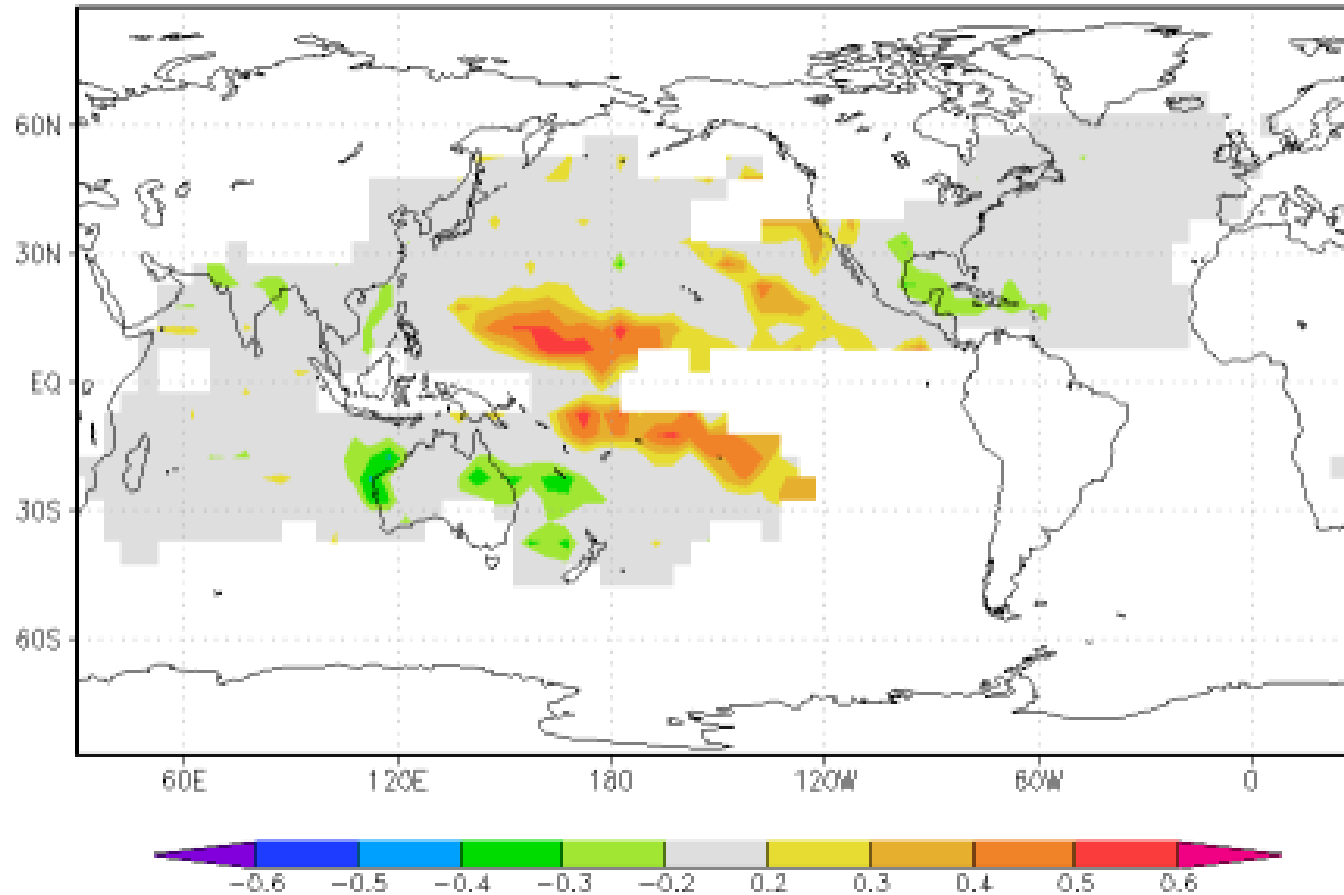
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Sources:
 1. Ropelewski, C. F. and M. S. Halpert, 1989: Precipitation patterns associated with the high index phase of the Southern Oscillation. J. Climate., 2, 268-284,
 2. Mason and Goddard, 2001: Probabilistic precipitation anomalies associated with ENSO. Bull. Am. Meteorol. Soc. 82, 619-638

<http://www.climate.gov/news-features/department/8443/all>

ENSO and Tropical Cyclones

corr Jul–Jun averaged NINO3.4 index
with Jul–Jun averaged MIT #TS tracks 1856:2004



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

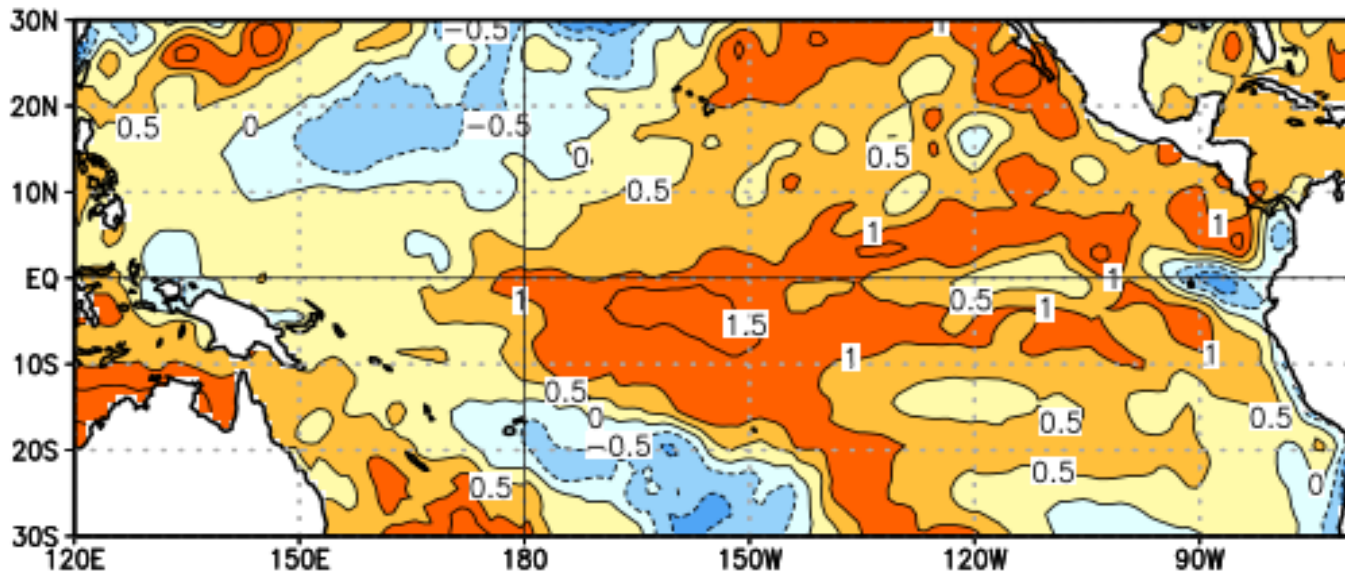
- ENSO expected to transition to Neutral conditions during spring or early summer 2016
- Increasing chance of **La Niña** during the second half of the year

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 SST Anomalies
3 APR 2016 – 30 APR 2016

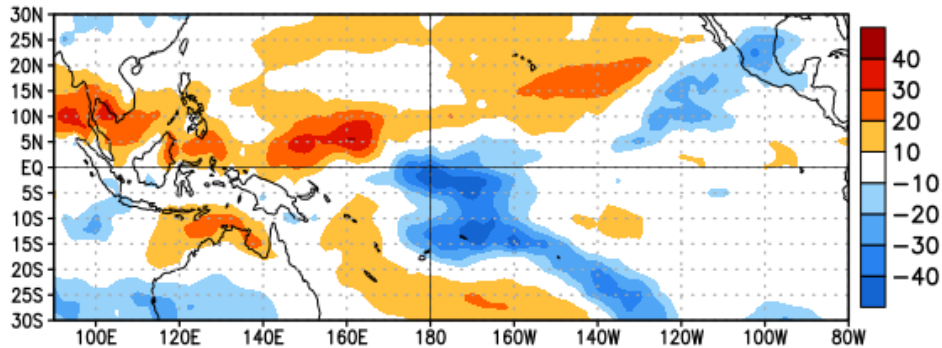


Average sea surface temperature (SST) anomalies ($^{\circ}$ C).

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

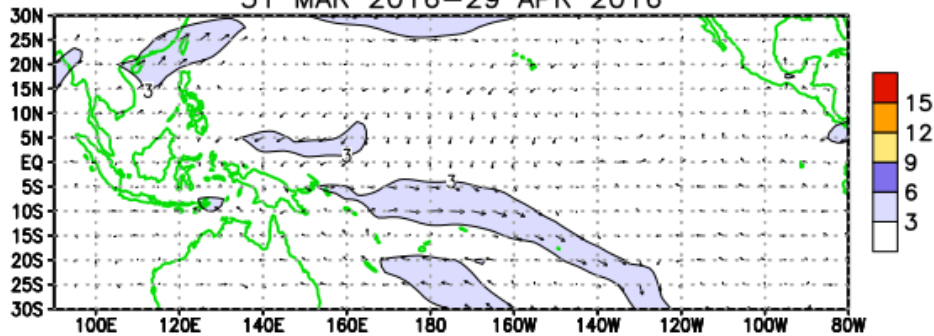
OLR and Wind Anomalies for Past 30 Days

OLR Anomalies
03 APR 2016 to 28 APR 2016



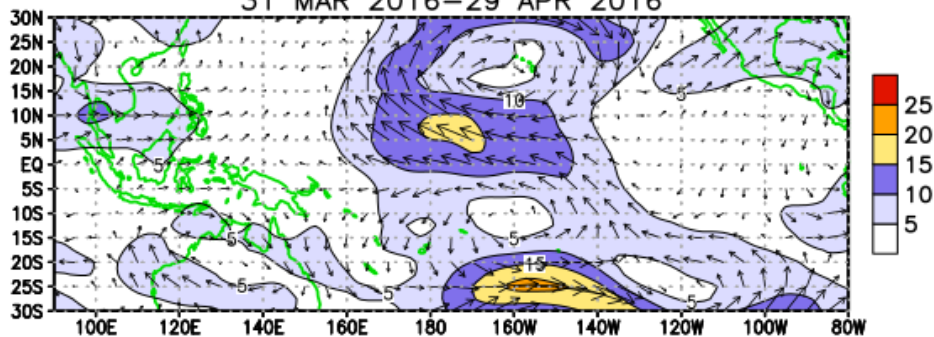
- Above average deep convection (- OLR anomalies)
- East of the dateline
- Not extending as far east as during the past three months
- Below average precipitation (+ OLR anomalies)
- Western Pacific

CDAS 850-hPa Wind Anoms
31 MAR 2016-29 APR 2016



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

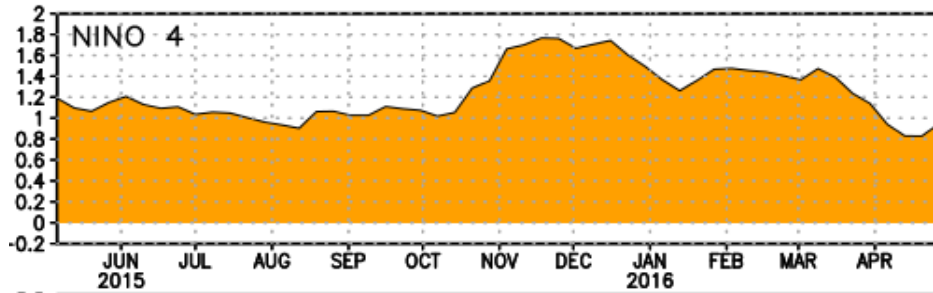
CDAS 200-hPa Wind Anoms
31 MAR 2016-29 APR 2016



Upper level winds show predominant easterly winds

SST DEPARTURES AND UPPER OCEAN (0 - 300m) HEAT CONTENT ANOMOLY

SST Anomalies



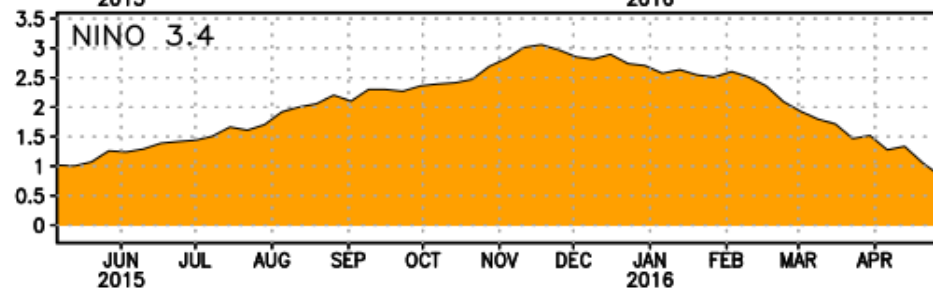
The latest weekly SST departures are:

Niño 4 0.9°C

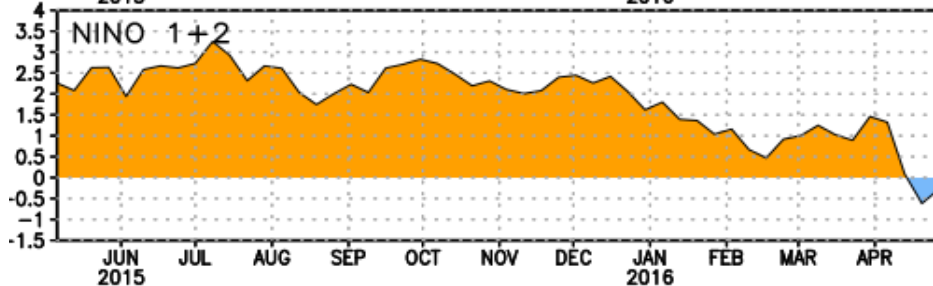
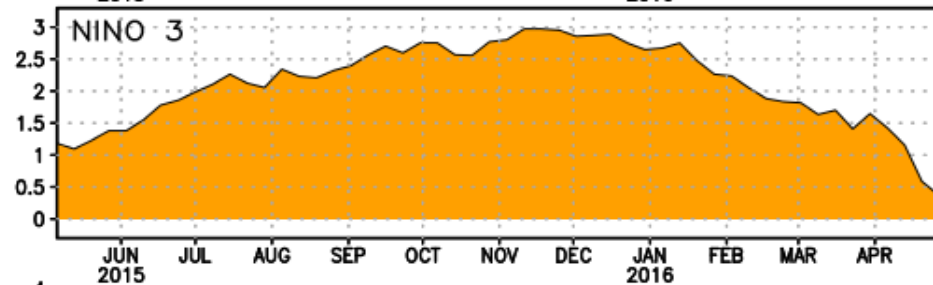
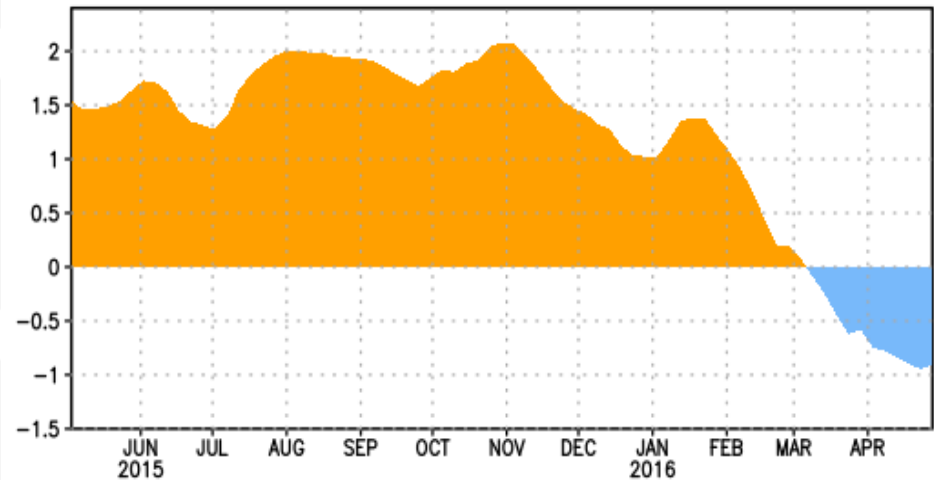
Niño 3.4 0.8°C

Niño 3 0.4°C

Niño 1+2 -0.3°C



EQ. Upper-Ocean Heat Anoms. (deg C) for 180-100W



EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

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

Synopsis:

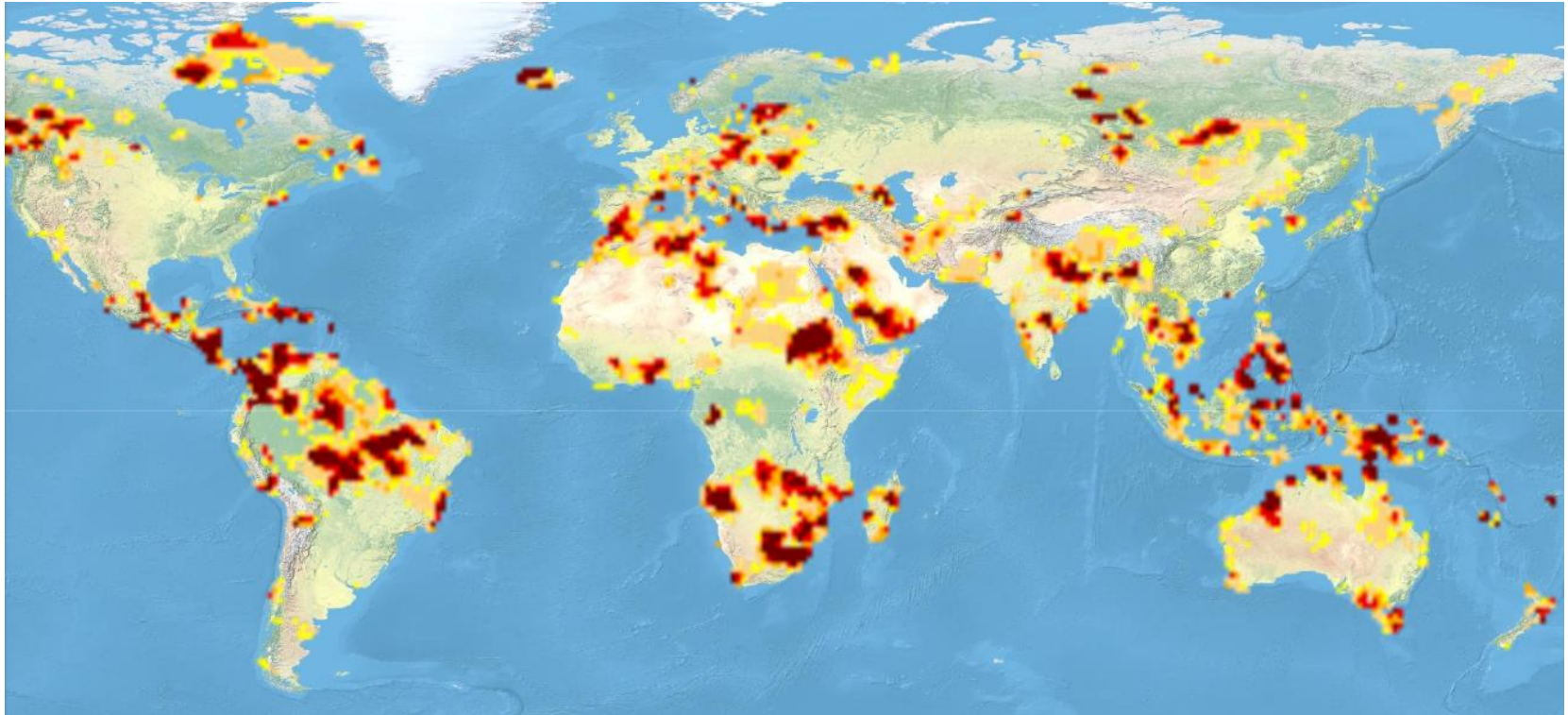
- Sea surface temperature anomalies were between 1.0° and 1.5° C across most of the central and eastern equatorial Pacific Ocean during early April, having weakened appreciably over the last month.
- The latest weekly values for all of the Niño indices dropped to below 1.5° C.
- The subsurface temperature 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 GPCP satellite derived Standardized Precipitation Index
- Represents the 12 month accumulated rainfall deficit
- Darker colors represent larger rainfall deficits

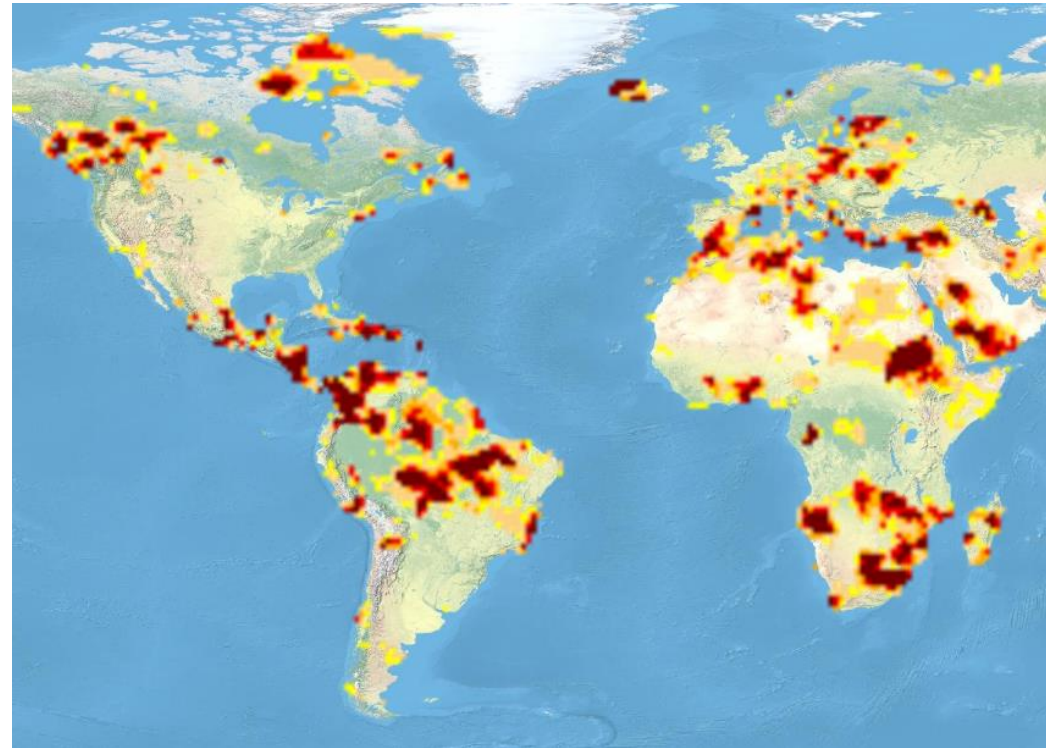
At the end of April 2016, El Niño continues to exert its influence with severe droughts across the globe

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

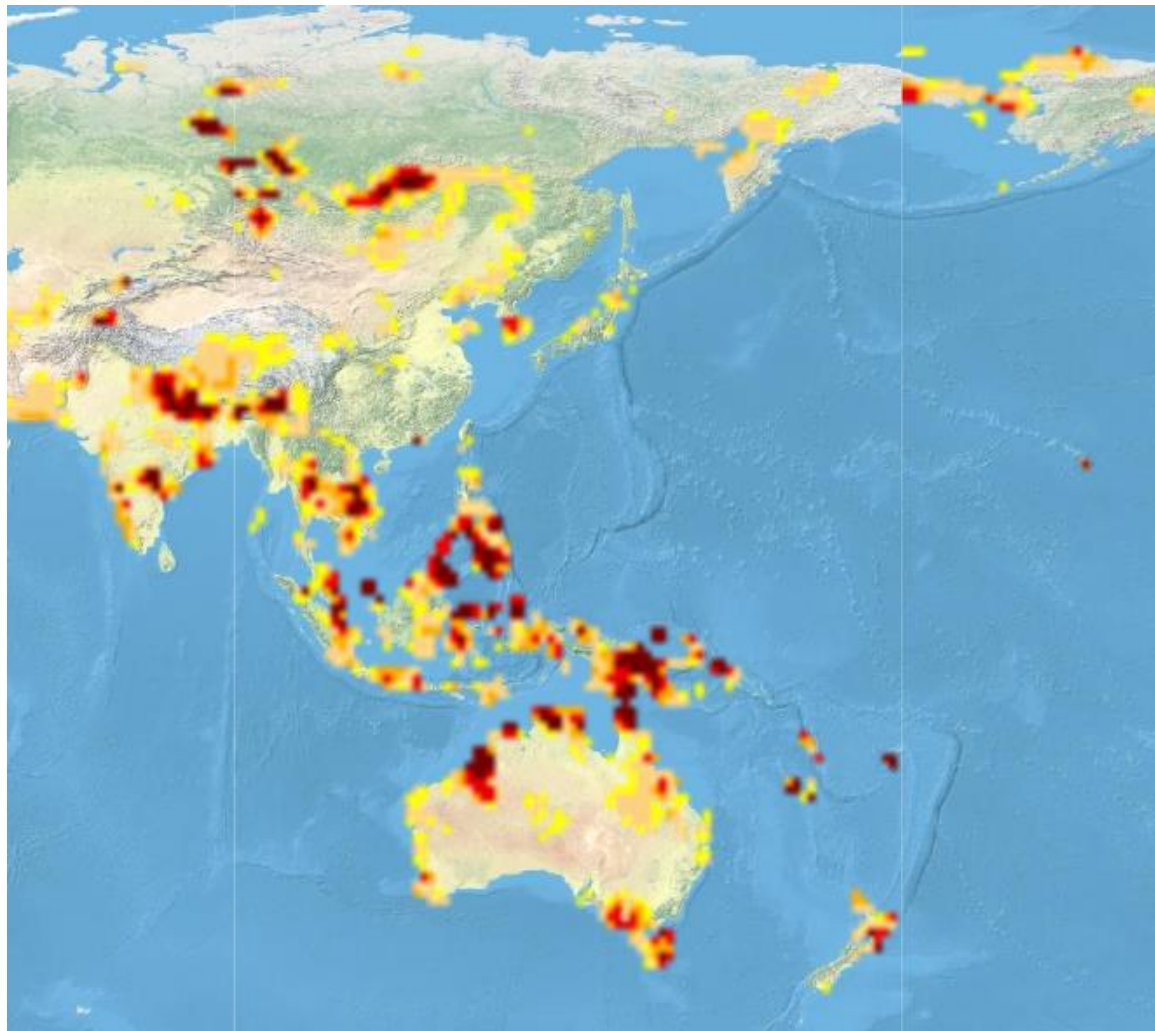


<https://www.drought.gov/gdm/current-conditions>

Rainfall impacts:

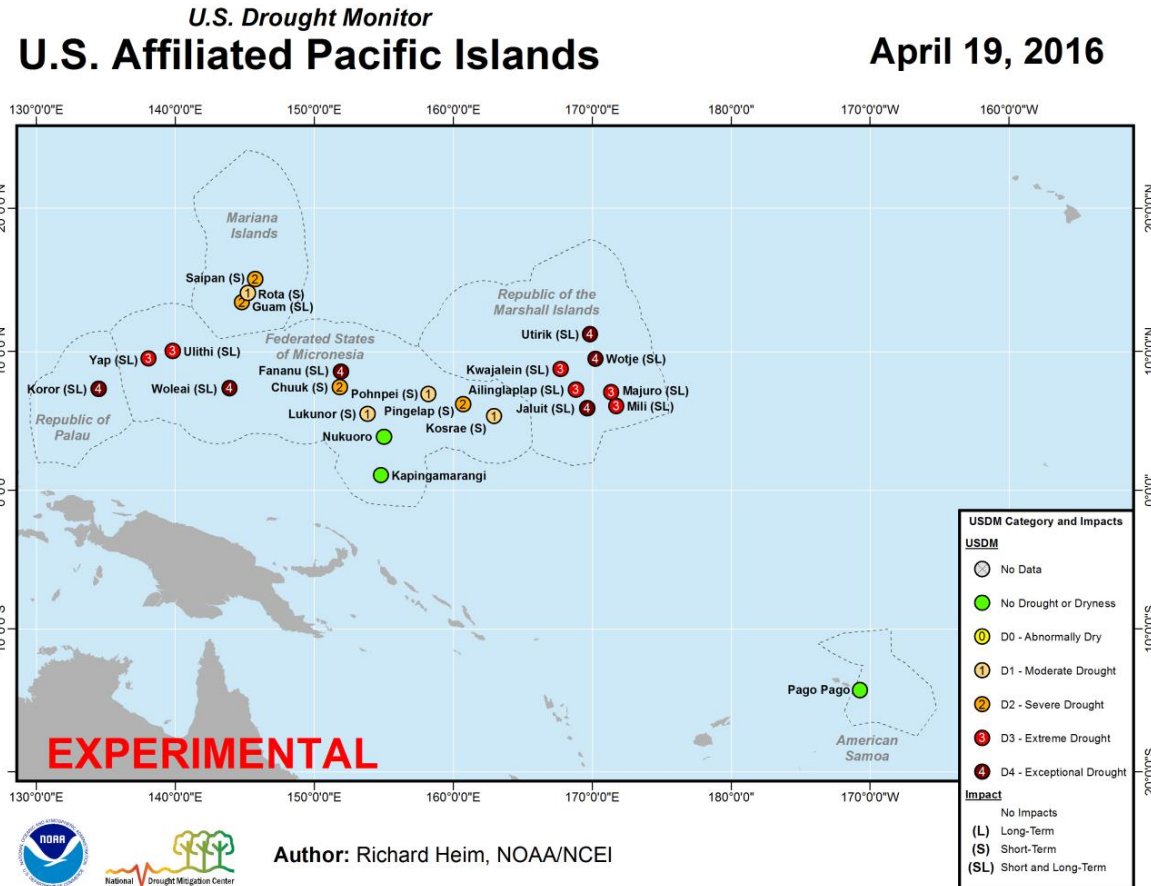
Drought in Asia and the Pacific

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



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 issues for smaller islands
- Damage to food crops likely for smaller islands
- Lack of fresh water may lead to deterioration in health.

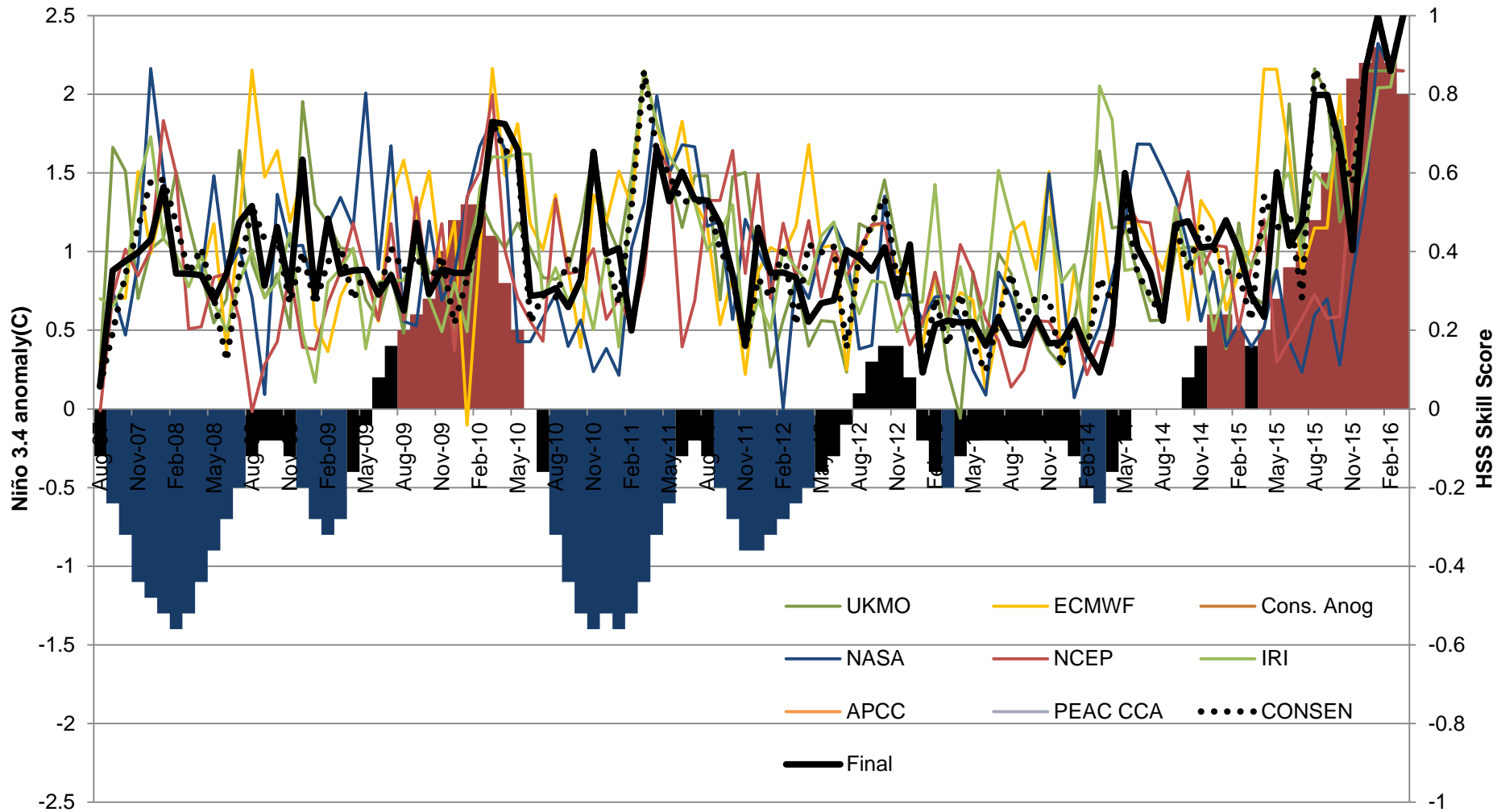


Special acknowledgement to

Richard Heim NOAA/NCEI
Chip Guard NWS WFO Guam
WSO personnel throughout the USAPI

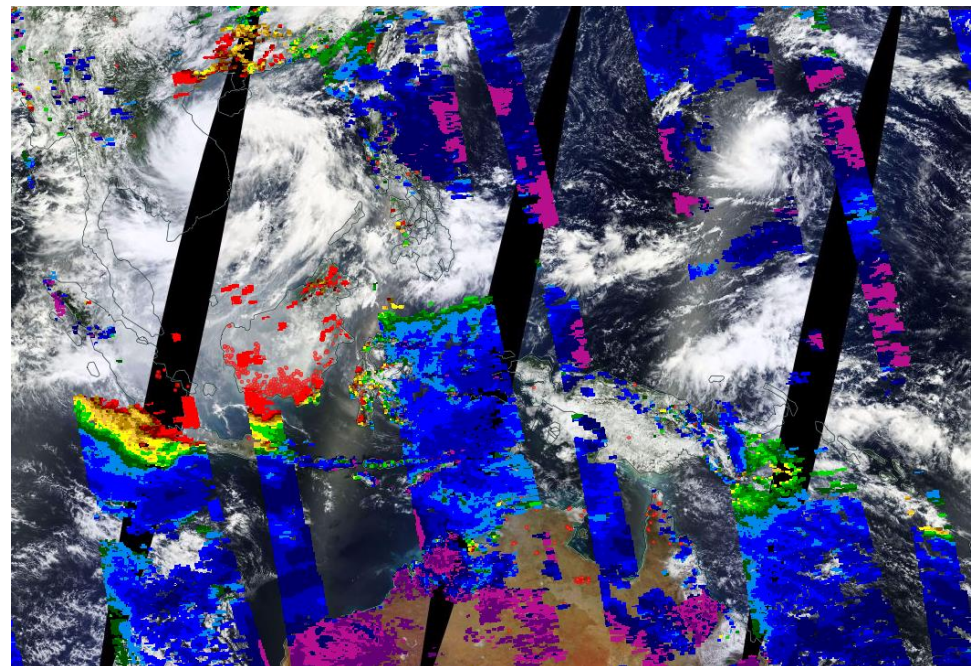
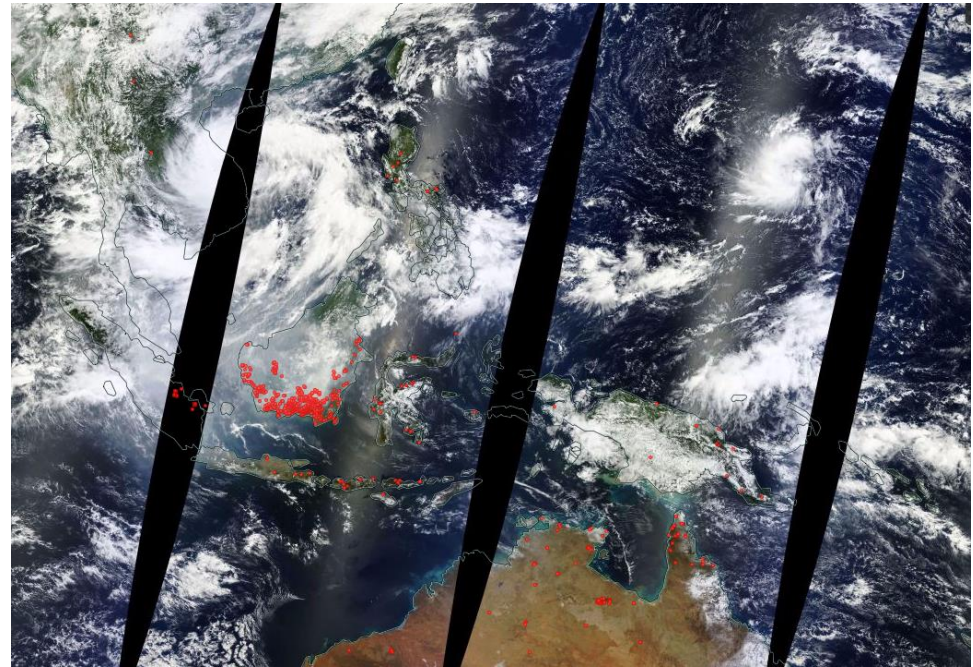
US Affiliated Pacific Islands

PEAC Center Rainfall forecast performance



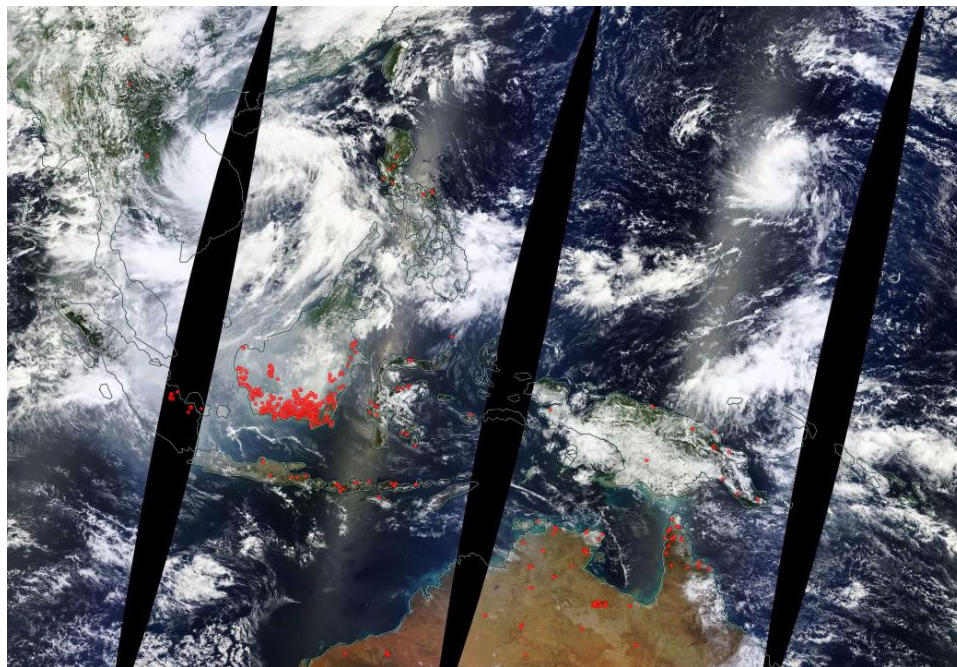
Borneo fires

- 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



Global Economic Losses

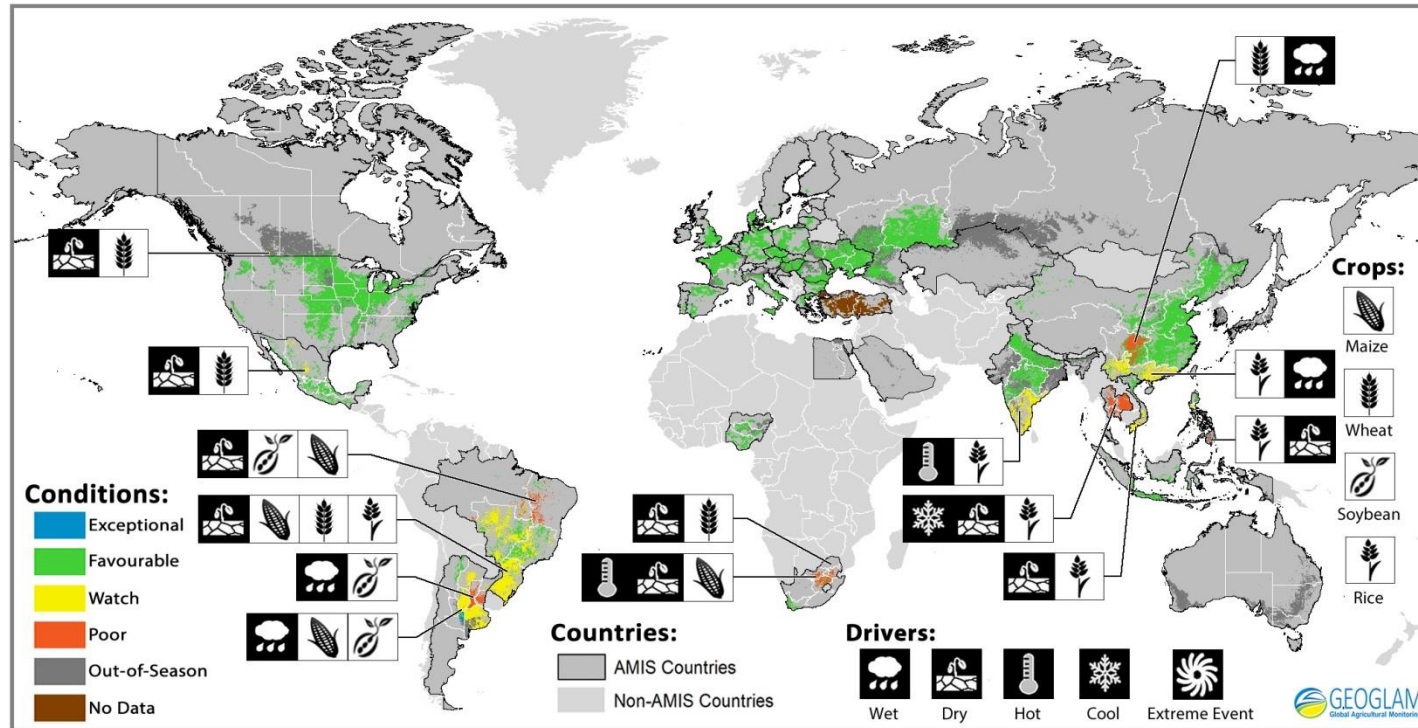
Exhibit 1: Top 10 Global Economic Loss Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
Yearlong	Forest Fire	Indonesia	19	16.1 billion	250 million
April 25 & May 12	Earthquake(s)	Nepal	9,120	8.0 billion	200 million
October 1 – 11	Flooding	United States	21	5.0 billion	700 million
October 2 – 4	Tropical Cyclone	China, Philippines	22	4.2 billion	100 million
Nov. – Dec.	Flooding	India, Sri Lanka	386	4.0 billion	650 million
May 23 – 28	Severe Weather	United States	32	3.8 billion	1.4 billion
February 16 – 22	Winter Weather	United States	30	3.3 billion	2.1 billion
August 2 – 9	Tropical Cyclone	China, Taiwan	34	3.2 billion	100 million
December 26 – 30	Severe Weather	United States	46	3.0 billion	1.4 billion
December 22 – 31	Flooding	United Kingdom	N/A	2.5 billion	1.3 billion
		All Other Events		70 billion	27 billion
		Totals		123 billion¹	35 billion^{1,2}

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.



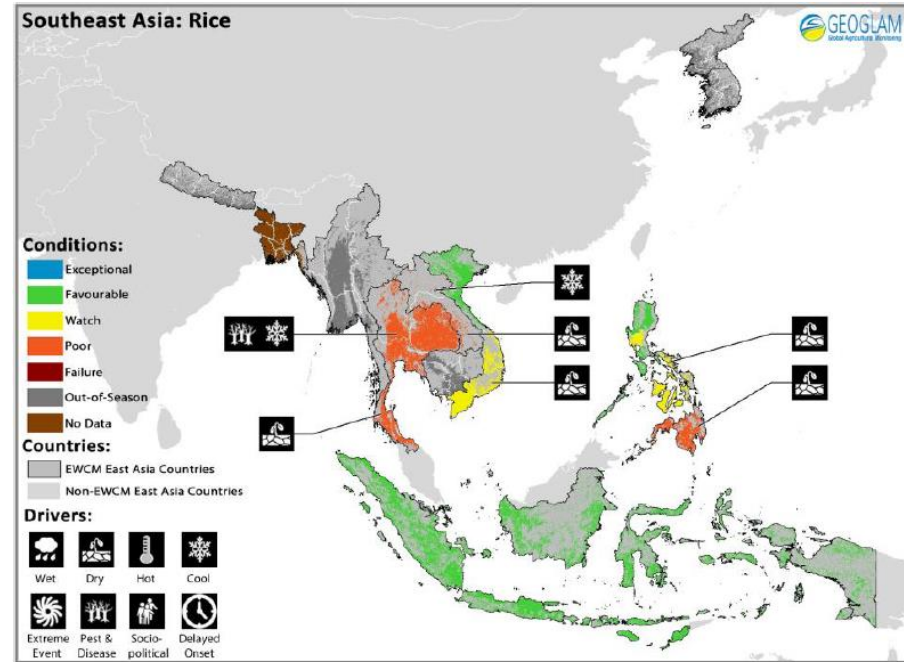
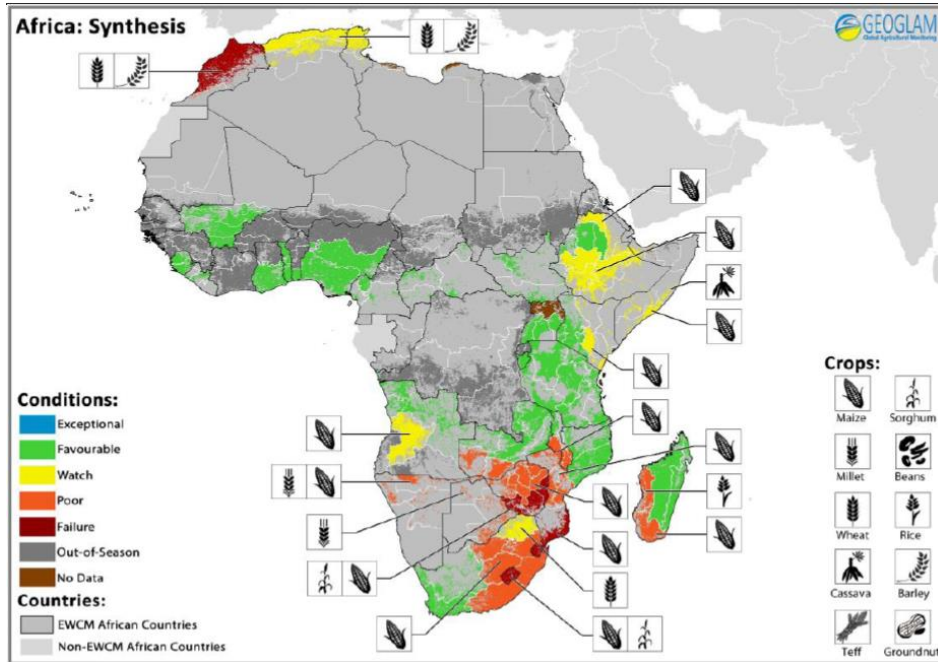
- China
 - Good conditions over the eastern portion
 - Southern regions seeing watch and poor conditions for wheat and rice
- India
 - Watch conditions over the south for rice crops

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

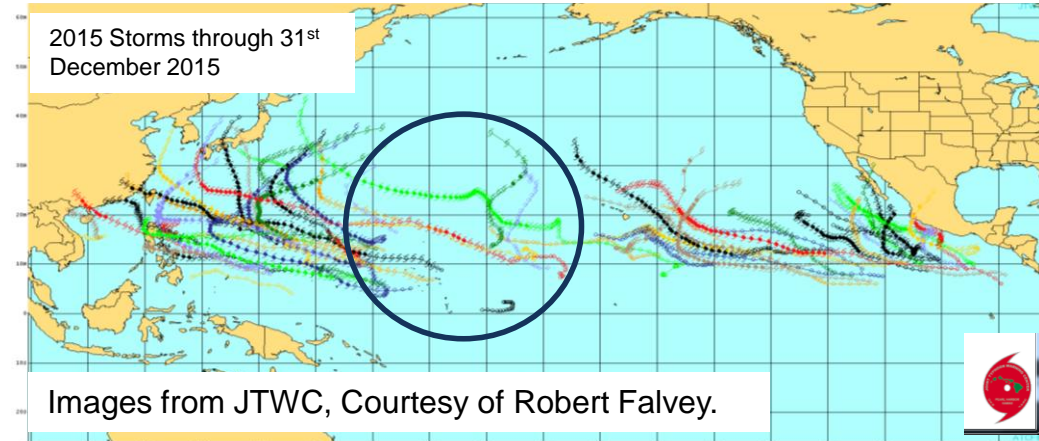
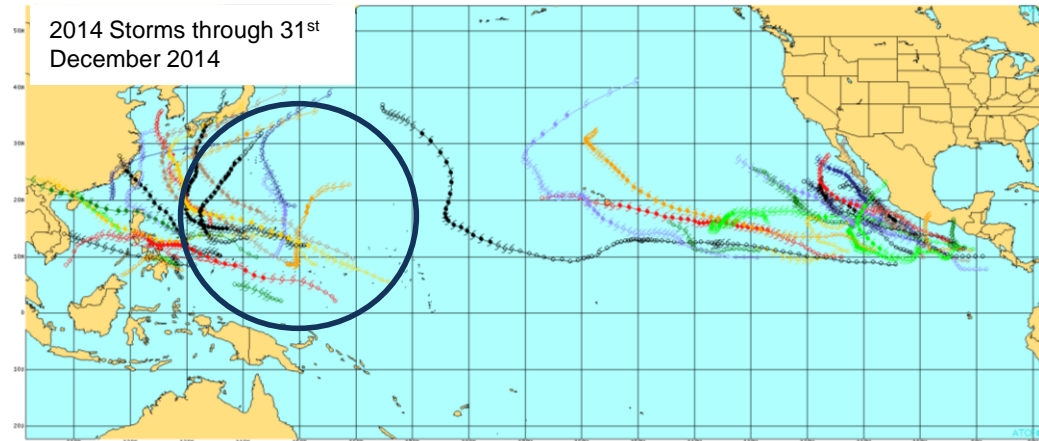
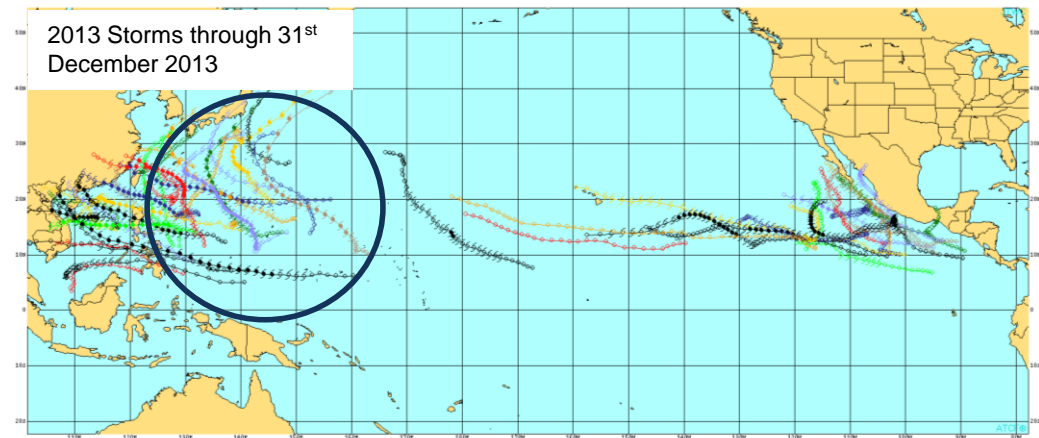
- Severe drought over the southern portion of the continent producing poor conditions for most crops

- 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

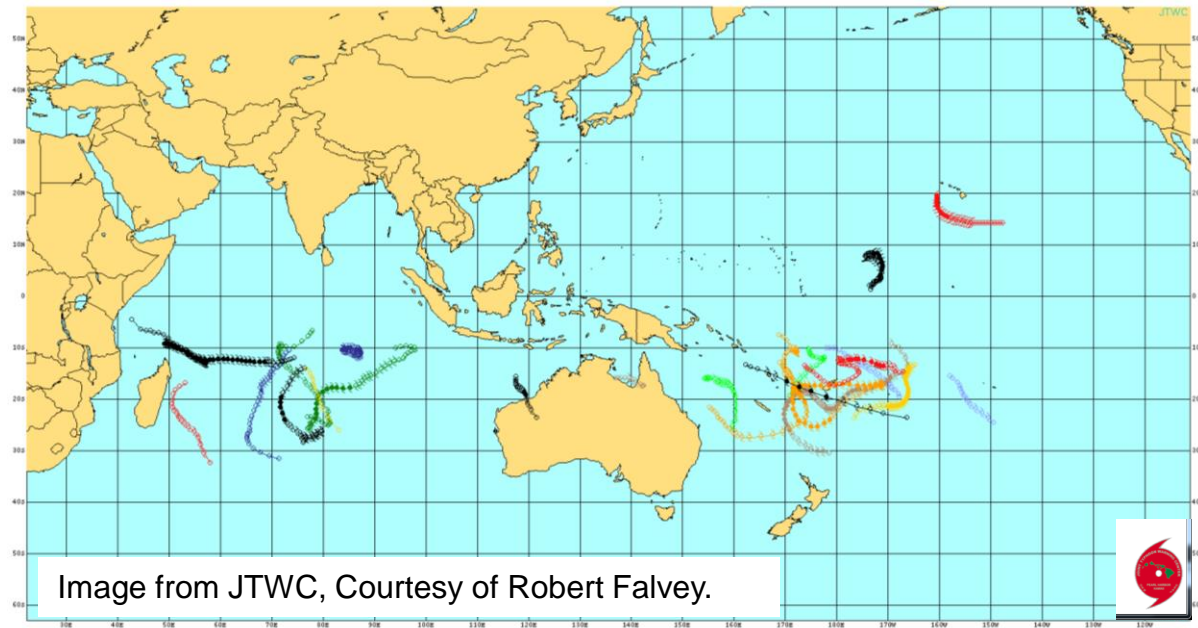


Images from JTWC, Courtesy of Robert Falvey.



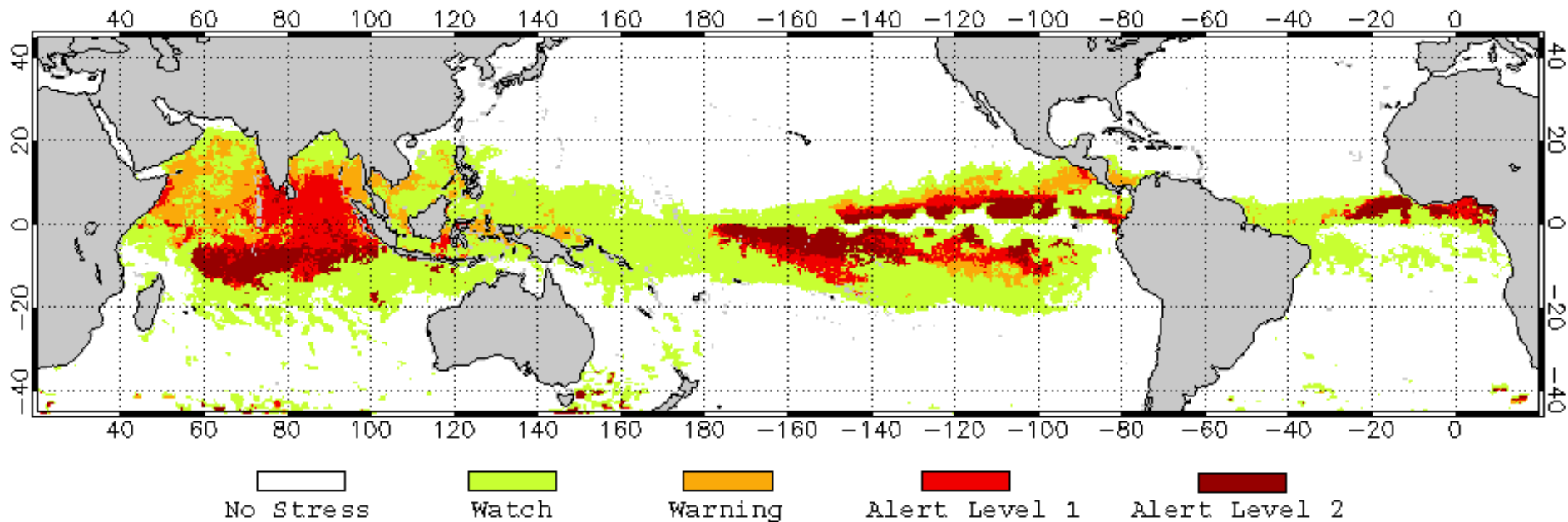
Southern Hemisphere Tropical cyclones

- 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



Coral Bleaching Alert Areas

NOAA/NESDIS Bleaching Alert Area, 5/5/2016 From Coral Reef Watch
<http://coralreefwatch.noaa.gov/satellite/baa.php>



- 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

How ENSO affects global health

THE LANCET • Published online May 20, 2003 • <http://image.thelancet.com/extras/02art5336web.pdf>

REVIEW

Review

W El Niño and health

R Sari Kovats, Menno J Bouma, Shakoor Hajat, 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

THE LANCET • Published online May 20, 2003 • <http://image.thelancet.com/extras/02art5336web.pdf>

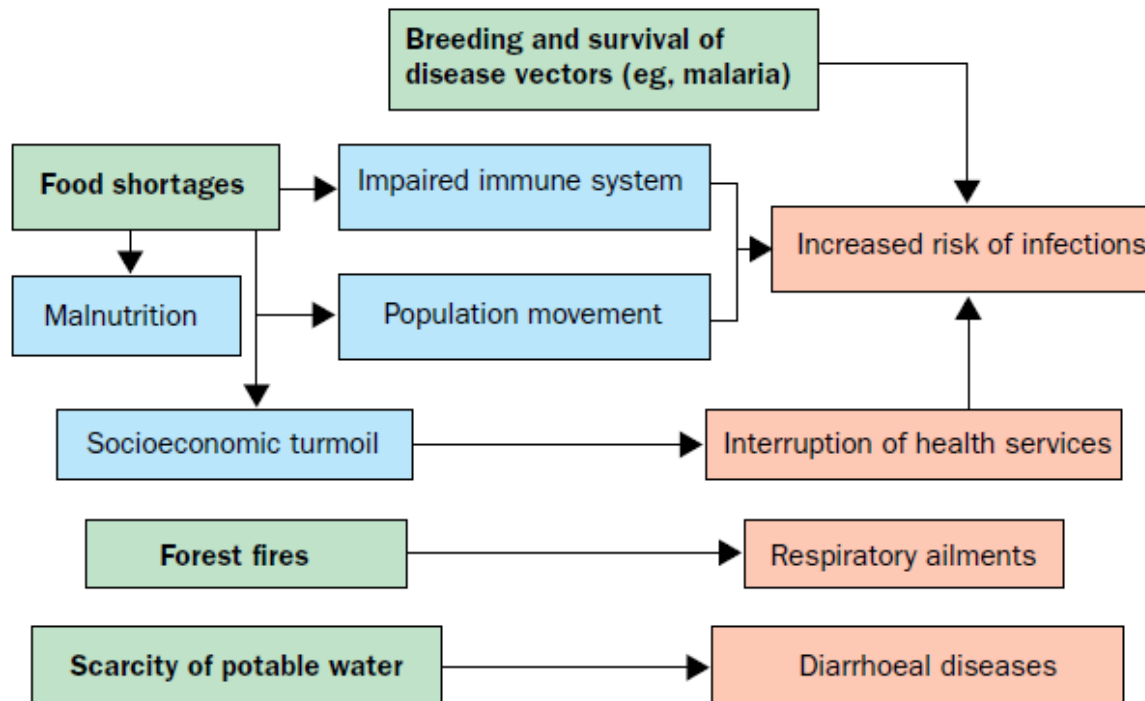
REVIEW

Review

El Niño and health

R Sari Kovats, M

El Niño Southern
consequences of
occurrence of El
disasters increas
South Asia and
disease is provid
on other mosqui
to dealing with
climate forecast



wide-ranging
The irregular
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and seasonal
paredness.

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

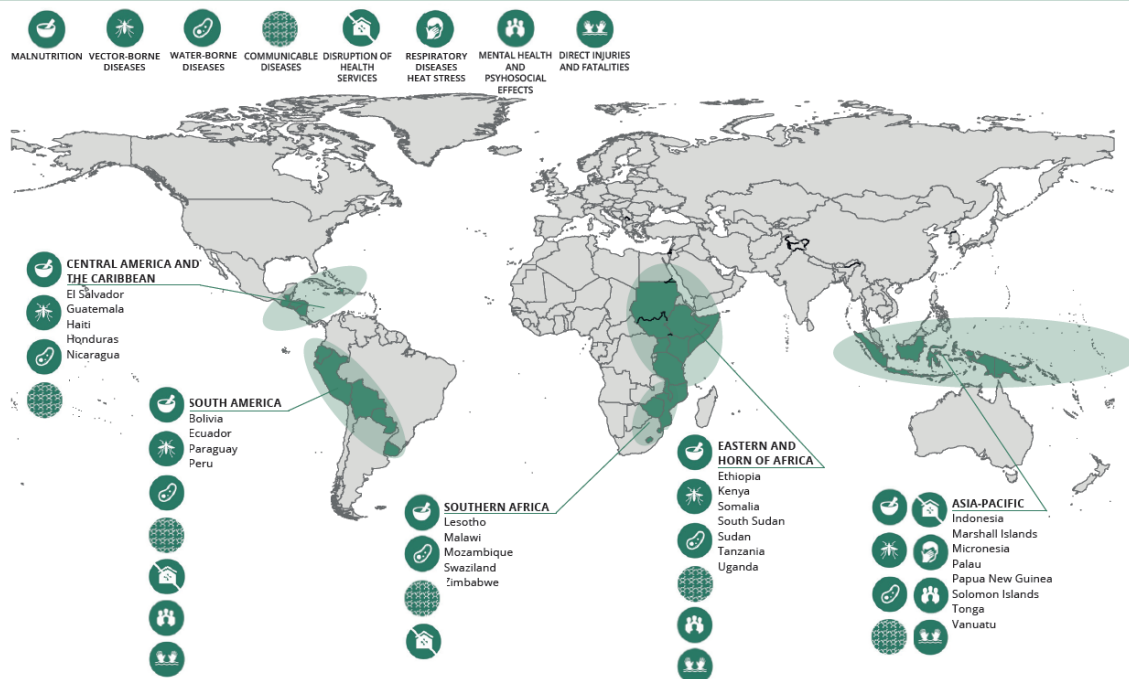
- Increasing malnutrition and disease risks
- Growing concerns about the interruption to anti-retroviral therapy

• 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



http://www.who.int/hac/crises/el-nino/who_el_nino_and_health_global_report_21jan2016.pdf

• 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



USAID
FROM THE AMERICAN PEOPLE

EL NIÑO-RELATED DISASTERS

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

WHERE WE'RE WORKING



A GLOBAL CALL FOR SUPPORT & ACTION: RESPONDING TO EL NIÑO



- 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>

El Niño – Current Funding Status¹ (in million US\$)

Government Plans

	Requirements \$ M	% Funding needs met	Funding available	Funding Gap
Lesotho	36	28	10	26
Malawi	146	49	71	75
Marshall Islands	8.9	50	4.5 ²	4.4
Mozambique	265	7	18.1	246.9
Palau	3.2	0	0	3.2
Swaziland ³	45	21	9.7	35.3
Zimbabwe ⁴	600	33	200	400
	1104.1		313.3	790.8

Joint Government and HCT Plans

	Requirements \$ M	% Funding needs met	Funding available	Funding Gap
El Salvador	44.6	9	4.2	40.4
Ethiopia ⁵	1400	54	798	602
Sudan	82	0	25.3	56.7
Timor Leste	25	0	0	25
Madagascar ⁶	69.9	12.5	8.8	61
Vietnam	48.5	16	7.8	40.7
	1670		844.1	825.8

HCT Plans

	Requirements \$ M	% Funding needs met	Funding available	Funding Gap
Guatemala	57	23	13.2	43.8
Haiti	105.5	10	10.1	95.4
Honduras	44.2	25	10.9	33.3
Lesotho	59	20	11.8	47.2
Papua New Guinea	37.57	23	8.75	28.81
Mongolia	14.3	43	6.36	7.94
Mozambique	60	0	0	60
Somalia	127	29	23	104
Zimbabwe	359	33.4	120	239
	863.6		204.2	659.4
GLOBAL TOTAL	\$ 3638 M		\$ 1362 M	\$ 2276 M

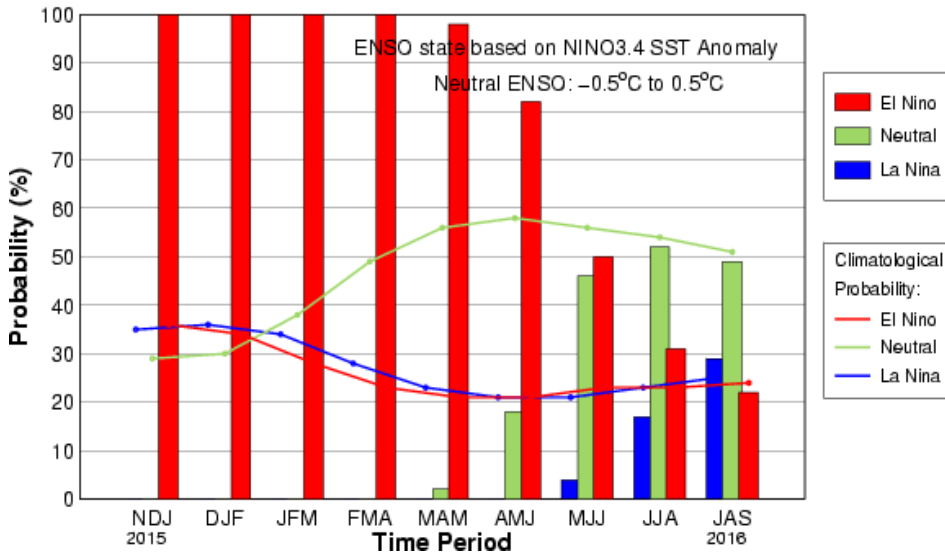
Forecast

ENSO forecasts

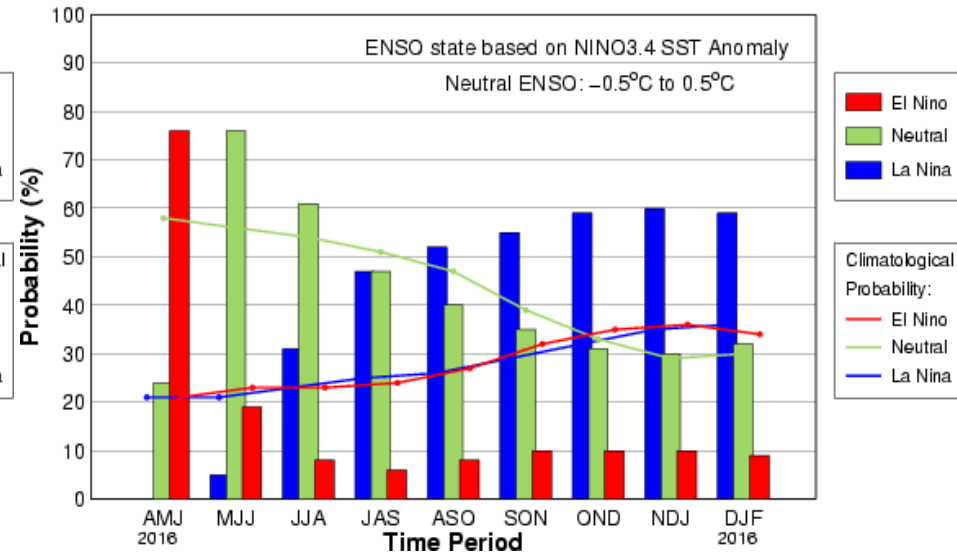
Rainfall, Sea level, Tropical Cyclones and
Coral Bleaching

CPC/IRI ENSO Forecast

Mid-Nov IRI/CPC Plume-Based Probabilistic ENSO Forecast



Mid-Apr IRI/CPC Model-Based Probabilistic ENSO Forecast



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

Expected Conditions

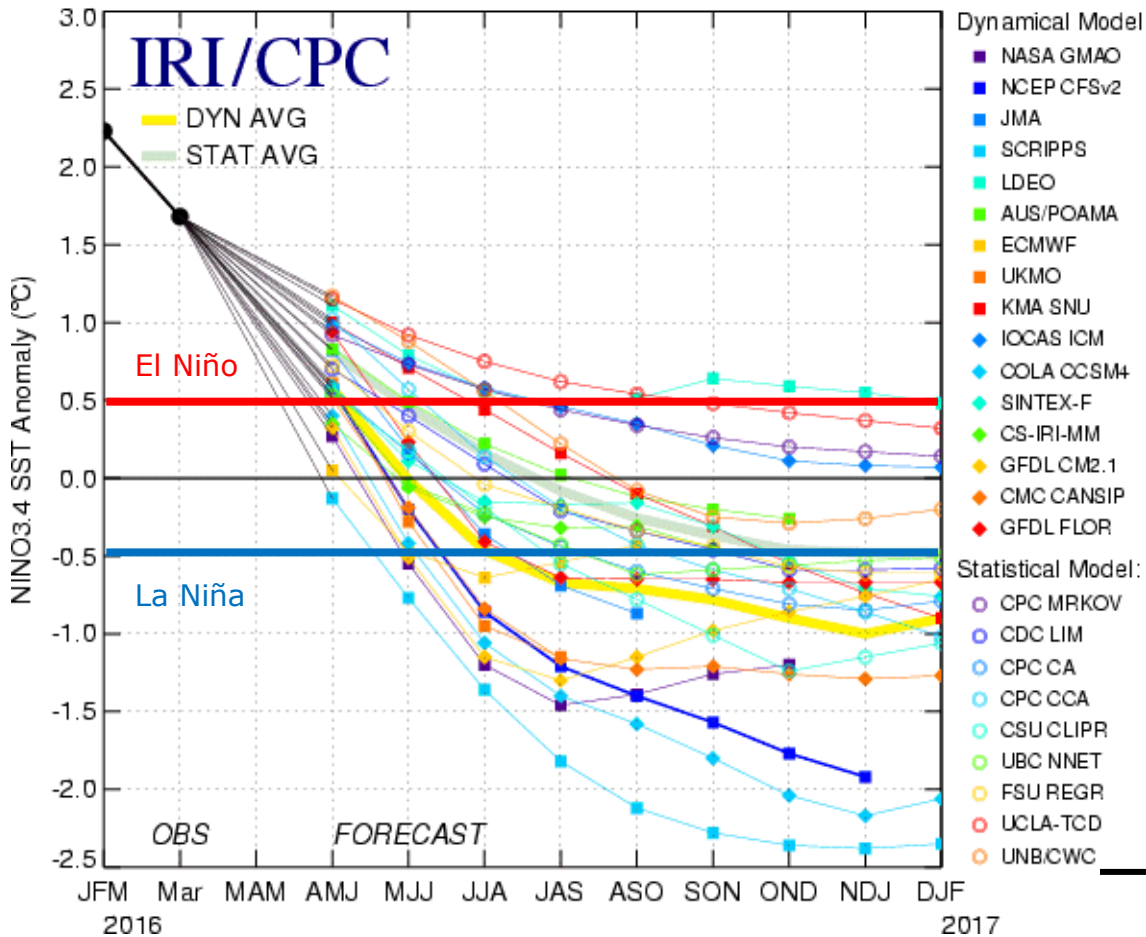
- Strong El Niño to continue weakening, and return to neutral by late spring or early summer 2016
- 60% possibility for La Niña development by fall

Season	La Niña	Neutral	El Niño
AMJ 2016	~0%	24%	76%
MJJ 2016	5%	76%	19%
JJA 2016	31%	61%	8%
JAS 2016	47%	47%	6%
ASO 2016	52%	40%	8%
SON 2016	55%	35%	10%
OND 2016	59%	31%	10%
NDJ 2016	60%	30%	10%
DJF 2016	59%	32%	9%

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

CPC/IRI ENSO Forecast

Mid-Apr 2016 Plume of Model ENSO Predictions



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

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.

Climate Prediction Center
National Centers for Environmental Prediction
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College Park, MD 20740

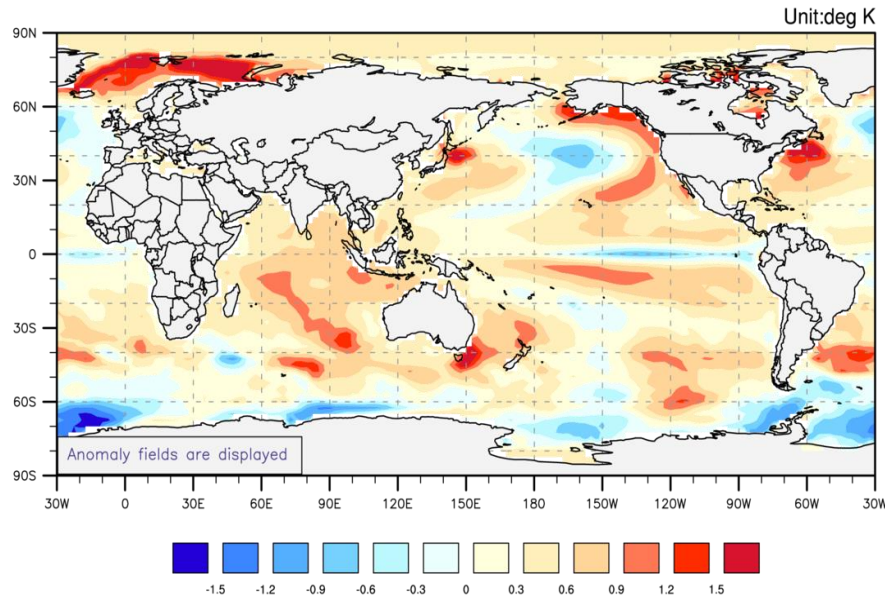
Average Niño 3.4 SST Anomaly Forecast

	AMJ	MJJ	JJA
Dynamical	0.6	0	-0.5
Statistical	0.8	0.5	0.2
All Models	0.7	0.2	-0.2

http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_update
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-iri_update
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table

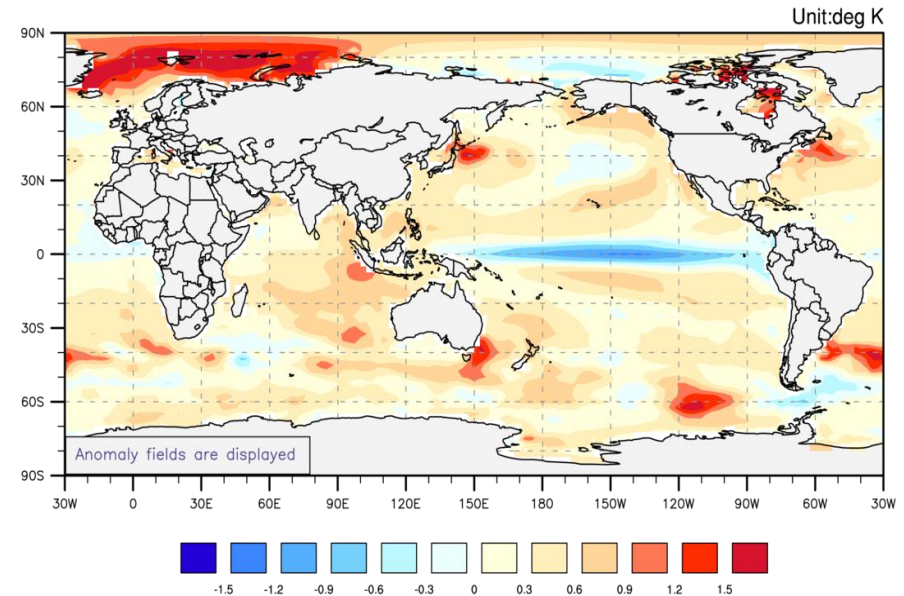
Tropical SST Forecasts (May 2016-Oct 2016)

Sea Surface temperature for May-July 2016



© APEC Climate Center

Sea Surface temperature for August-October 2016



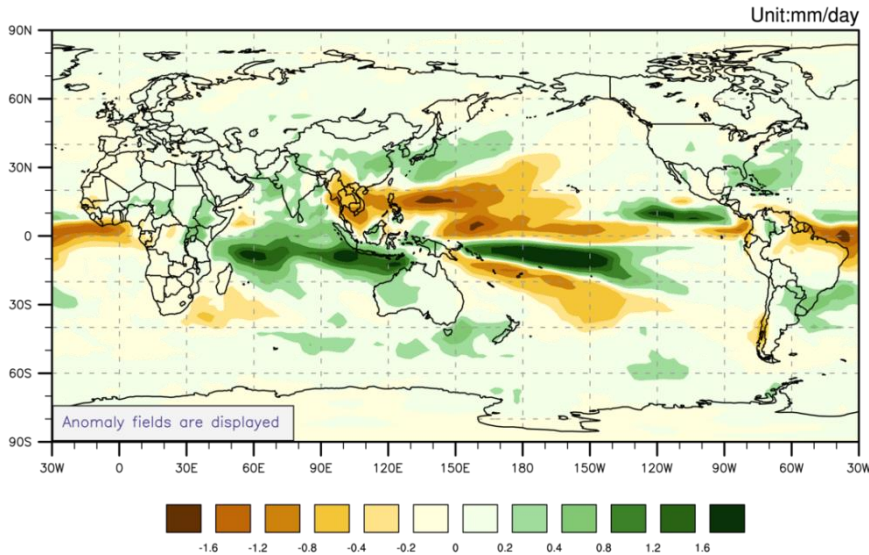
© APEC Climate Center

From: <http://www.apcc21.org/ser/outlook.do?lang=en>

- 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 -0.8C (moderate La Niña)

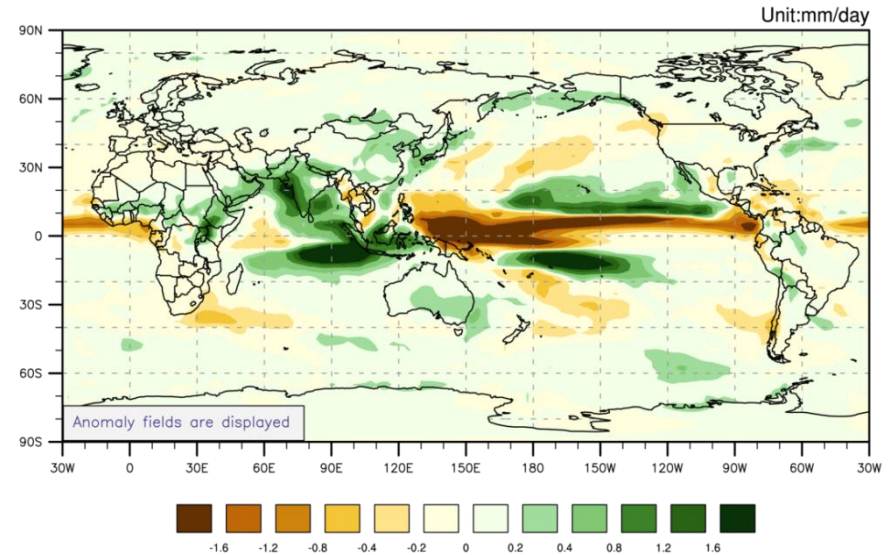
Tropical Rainfall Forecasts (May 2016-Oct 2016)

Precipitation for May-July 2016



© APEC Climate Center

Precipitation for August-October 2016



© APEC Climate Center

• 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

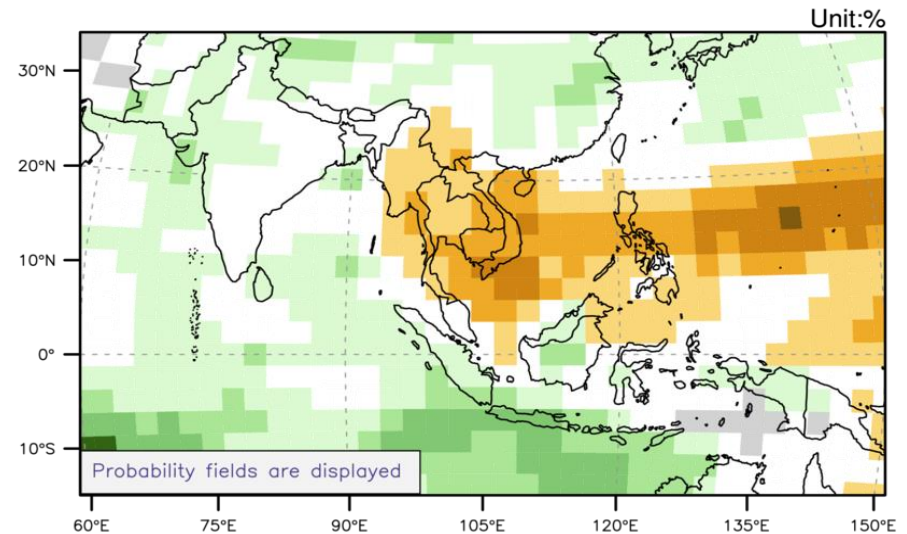
- Wet conditions over the Indian Ocean intensify
- Dry conditions over the equatorial tropical Pacific extend to far along equator
- Dry conditions over South America persist

From: <http://www.apcc21.org/ser/outlook.do?lang=en>

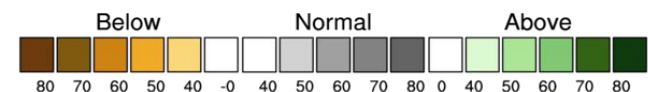
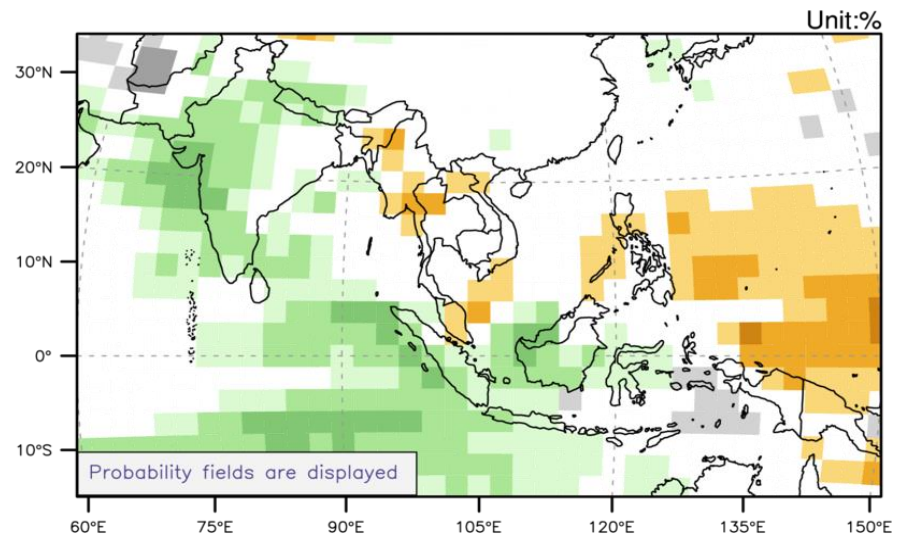
Asia Pacific

- 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

Precipitation for May-July 2016



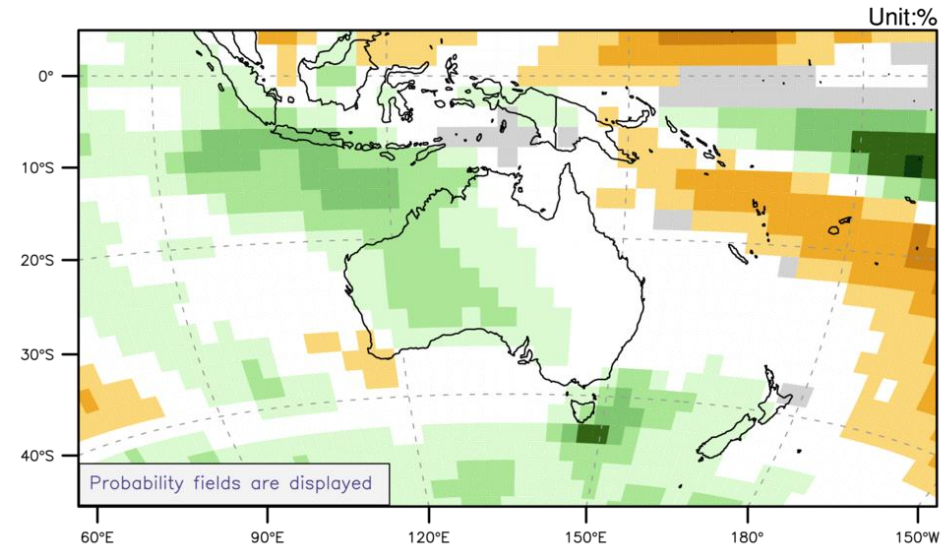
Precipitation for August-October 2016



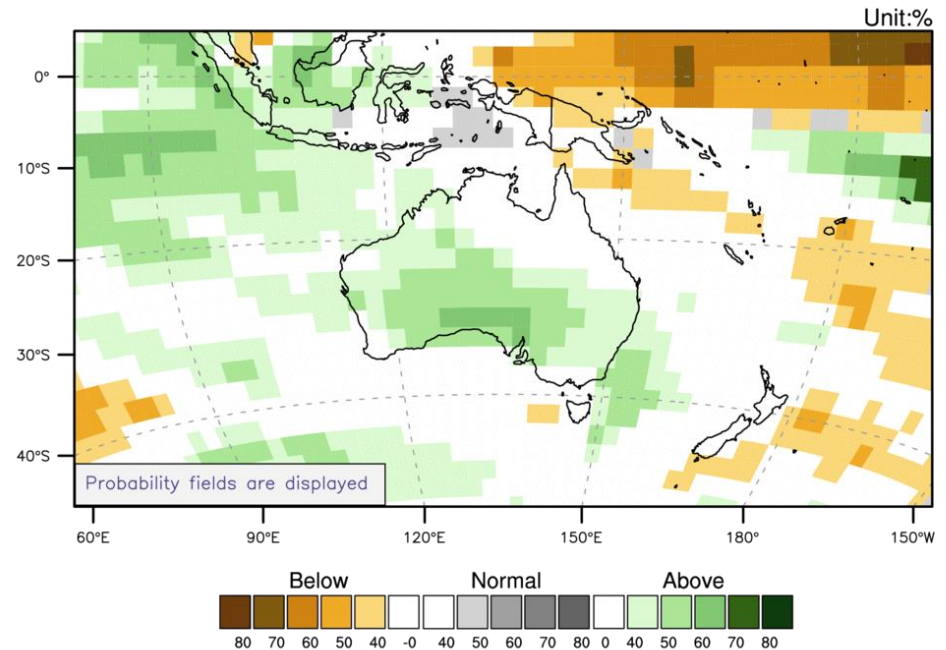
Australia - Pacific

- 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

Precipitation for May-July 2016



Precipitation for August-October 2016



US Affiliated Pacific Islands Rainfall

April - May - June (AMJ) 2016

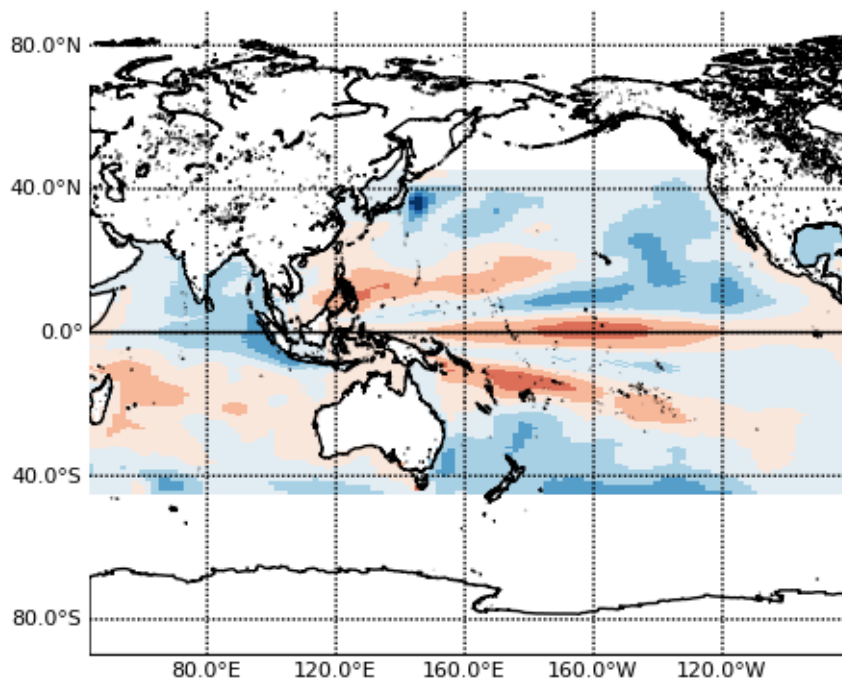
Model:	UKMO	ECMWF	NCEP_CA	NASA GMAO	NCEP Coupled	IRI	APCC	PEAC CCA	Final Outlook	Final Probabilities	
Republic of Palau											
Koror	L 7 ° 22' N, λ 134° 32' E	Below	Avg	Above	Avg-Above	Avg	Below	Below	Avg	Below	45:30:25
Federated States of Micronesia											
Yap	L 9° 29' N, λ 138° 05' E	Below	Below	Avg	Avg	Avg-Below	Below	Below	Avg-Below	Below	45:30:25
Chuuk	L 7° 28' N, λ 151° 51' E	Below	Avg-Below	Above	Avg-Above	Avg-Below	Below	Below	Below	Below	40:35:25
Pohnpei	L 6° 59' N, λ 158° 12' E	Below	Below	Avg-Above	Avg-Below	Below	Below	Below	Below	Below	45:30:25
Kosrae	L 5° 21' N, λ 162° 57' E	Below	Avg	Avg	Avg-Below	Below	Below	Below	Below	Below	45:30:25
Republic of the Marshall Islands											
Kwajalein	L 8° 43' N, λ 167° 44' E	Below	Below	Avg-Below	Avg-Below	Below	Below	Below	Below	Below	50:35:15
Majuro	L 7° 04' N, λ 171° 17' E	Below	Below	Avg	Avg	Below	Below	Below	Below	Below	45:35:20
Guam and CNMI											
Guam	L 13° 29' N, λ 144° 48' E	Below	Below	Below	Below	Below	Below	Below	Below	Below	50:30:20
Saipan	L 15° 06' N, λ 145° 48' E	Below	Below	Below	Below	Below	Below	Below	Clim	Below	50:30:20
American Samoa											
Pago Pago	L 14° 20' S, λ 170° 43' E	Below	Below	Avg-Below	Above	Above	Below	Below	Clim	Avg-Below	35:35:30
State of Hawaii											
Lihue	L 21° 59' N, λ 159° 20' E	Below	Below	Below	Avg	Avg	Below	Below	Below	Below	40:35:25
Honolulu	L 21° 19' N, λ 157° 56' W	Below	Below	Below	Avg	Avg	Below	Below	Clim	Below	40:35:25
Kahului	L 20° 54' N, λ 156° 26' E	Below	Below	Below	Avg	Avg	Below	Below	Below	Below	40:35:25
Hilo	L 19° 43' N, λ 155° 03' E	Below	Below	Below	Avg	Avg	Below	Below	Below	Below	40:35:25



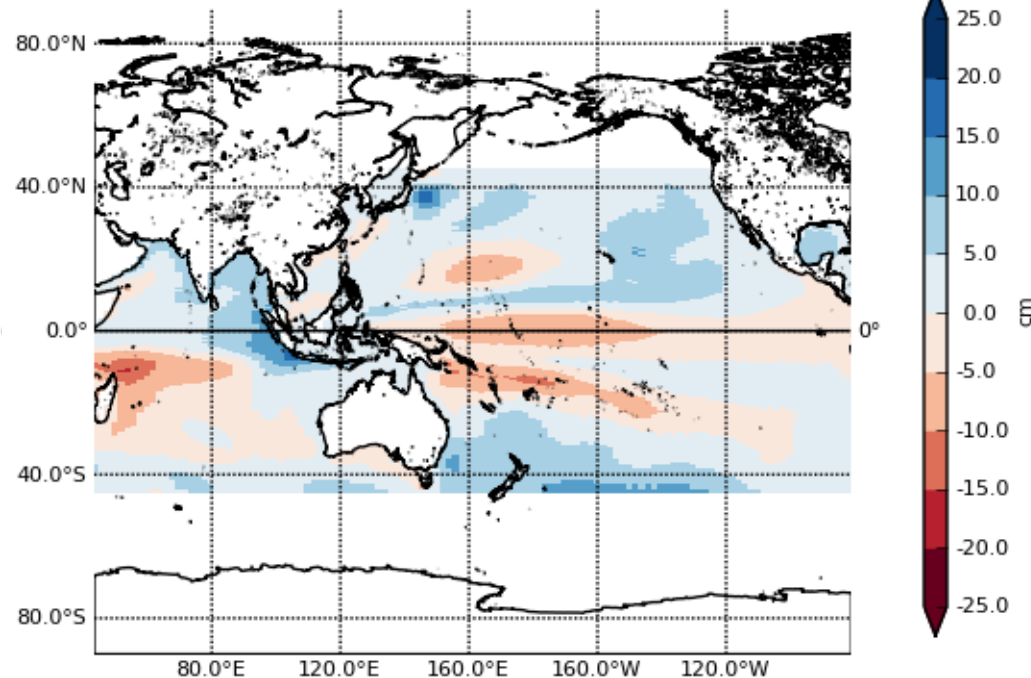
People line up for water in the Marshall Islands in early 1998 to receive a ration once every 14 days. (Photo courtesy of Federal Emergency Management Agency)

Sea Level Forecasts

Forecast period: Jun - Aug, 2016, Lead time: 1 month



Forecast period: Sep - Nov, 2016, Lead time: 4 months



- 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

Tide Gauge Station	Forecast Anomaly for MAM 2016 (in inches)			
	MEAN Deviation(1)	Standard Deviation MAM season	MAX Deviation (2)	Standard Deviation of MAM season
Marianas, Guam	+2	3.9	+16	3.8
Malakal, Palau	-2	4.4	+37	4.9
Yap, FSM1	-1	4.8	+30	5.2
Chuuk, FSM**	-2	*	*	*
Pohnpei, FSM	+2	2.5	+28	2.9
Kapingamarangi, FSM	*	*	*	*
Majuro, RMI	+3	1.9	+41	2.7
Kwajalein, RMI	+3	2.7	+40	3.1
Pago Pago, American Samoa	0	4.4	+25	4.9
Honolulu, Hawaii	+2	1.7	+19	1.9
Hilo, Hawaii	+2	1.9	+23	2.4

(*) 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 withing 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)

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

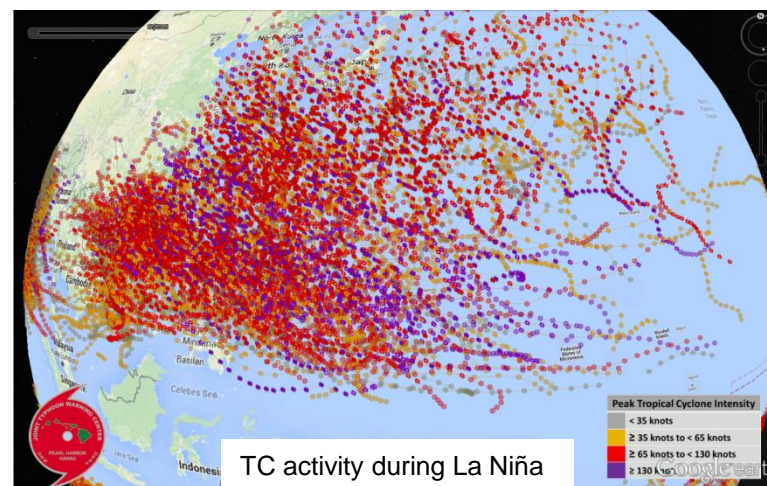
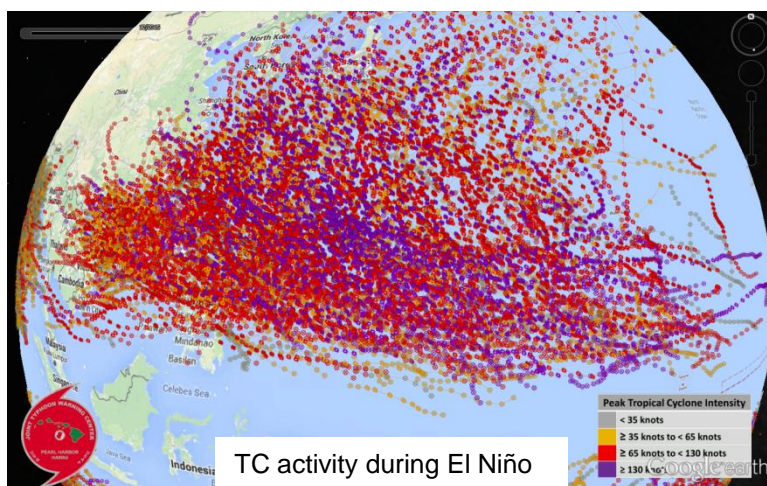
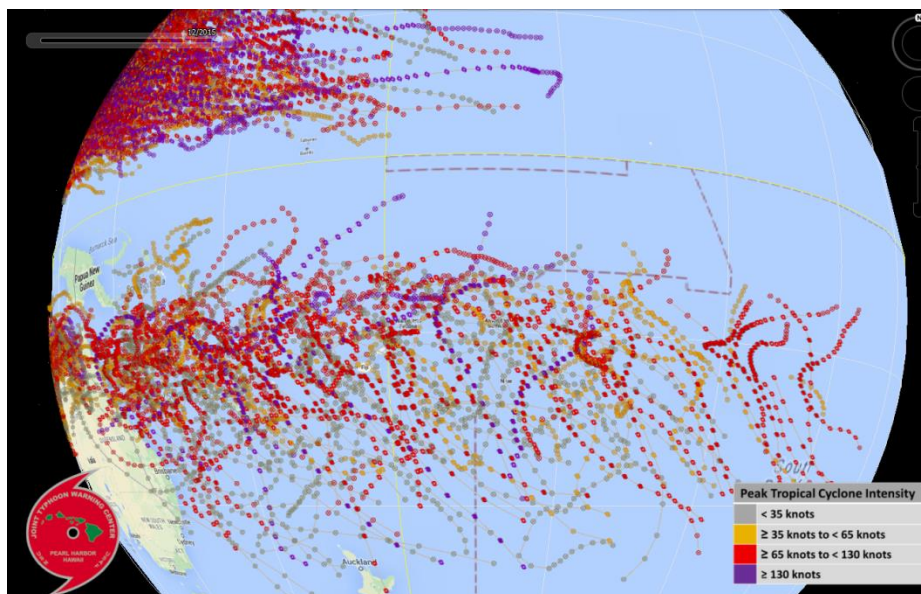


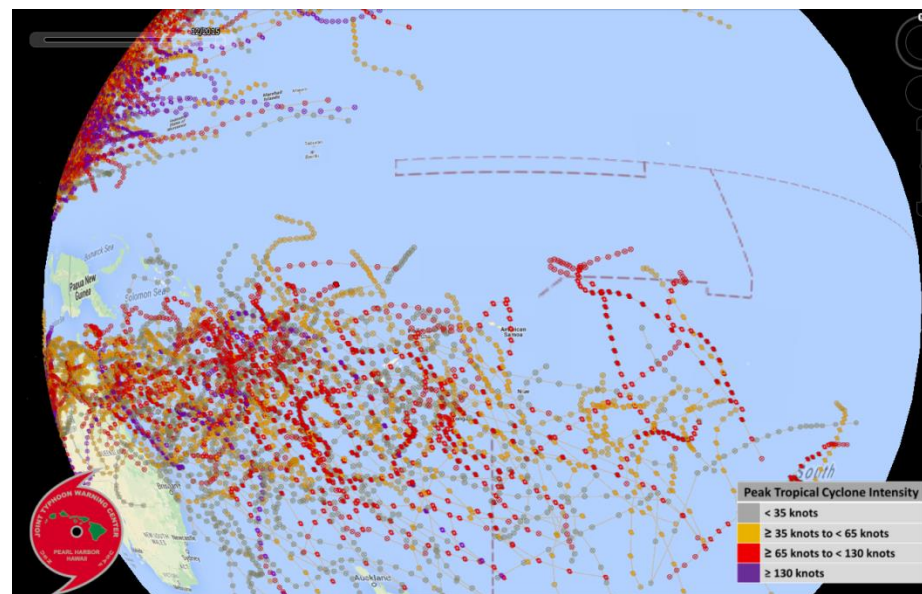
Image from JTWC, Courtesy of Mr. Brian Strahl.

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



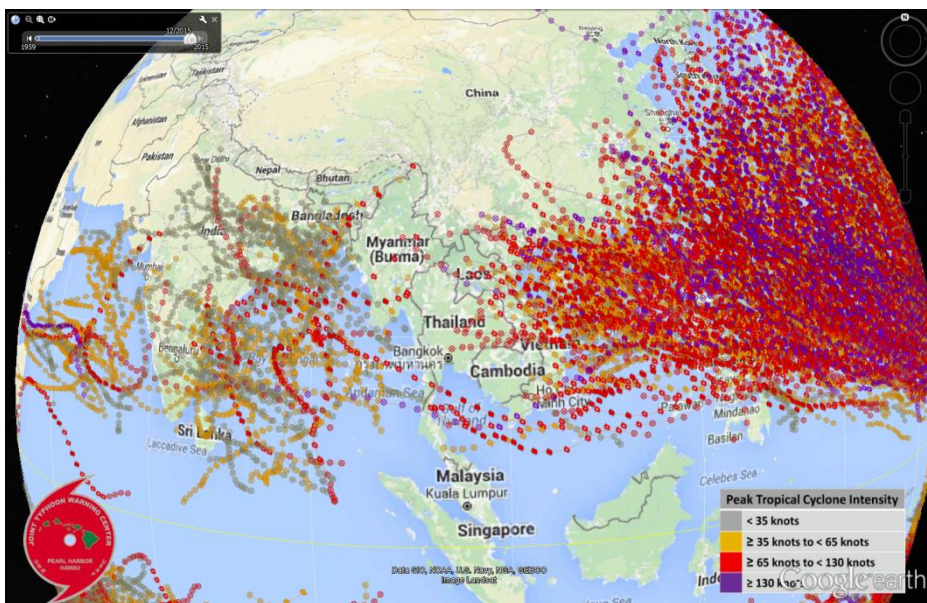
TC activity during El Niño



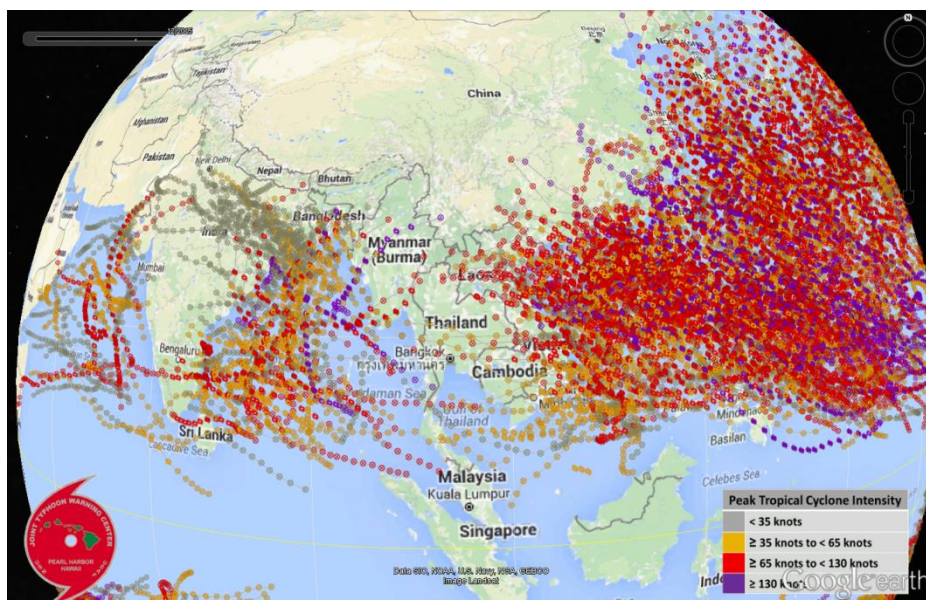
TC activity during La Niña

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



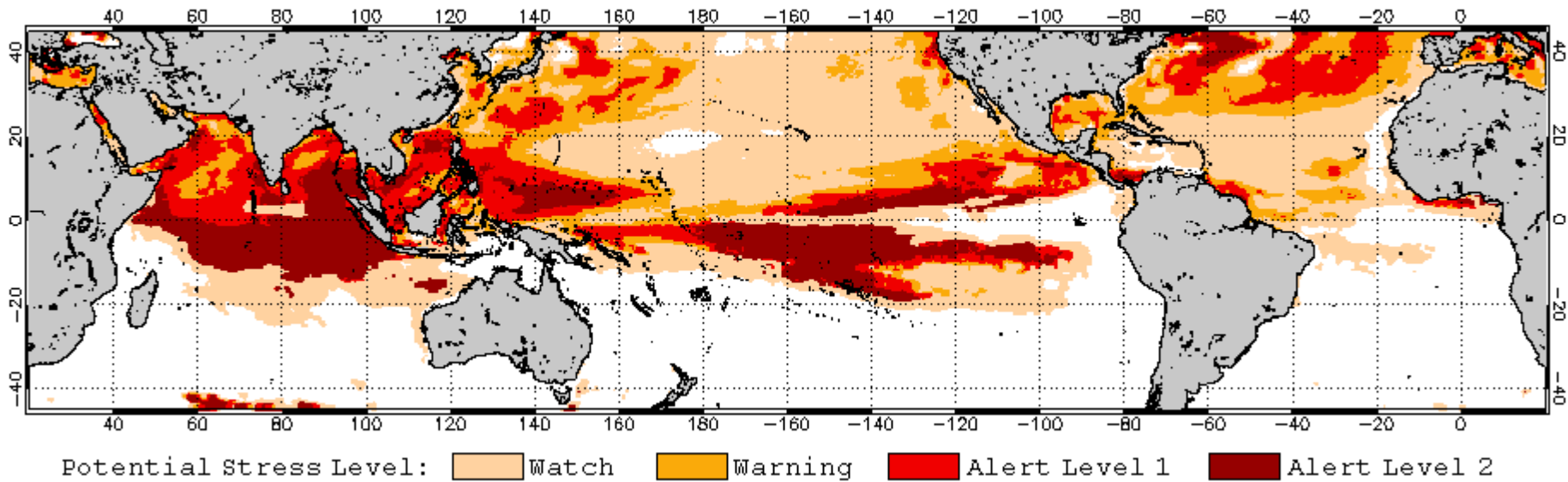
TC activity during El Niño



TC activity during La Niña

Coral Bleaching Outlook

2016 May 3 NOAA Coral Reef Watch 60% Probability Coral Bleaching Thermal Stress for May–Aug 2016
Experimental, v3.0, CFSv2-based, 28-member Ensemble Forecast



- 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

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

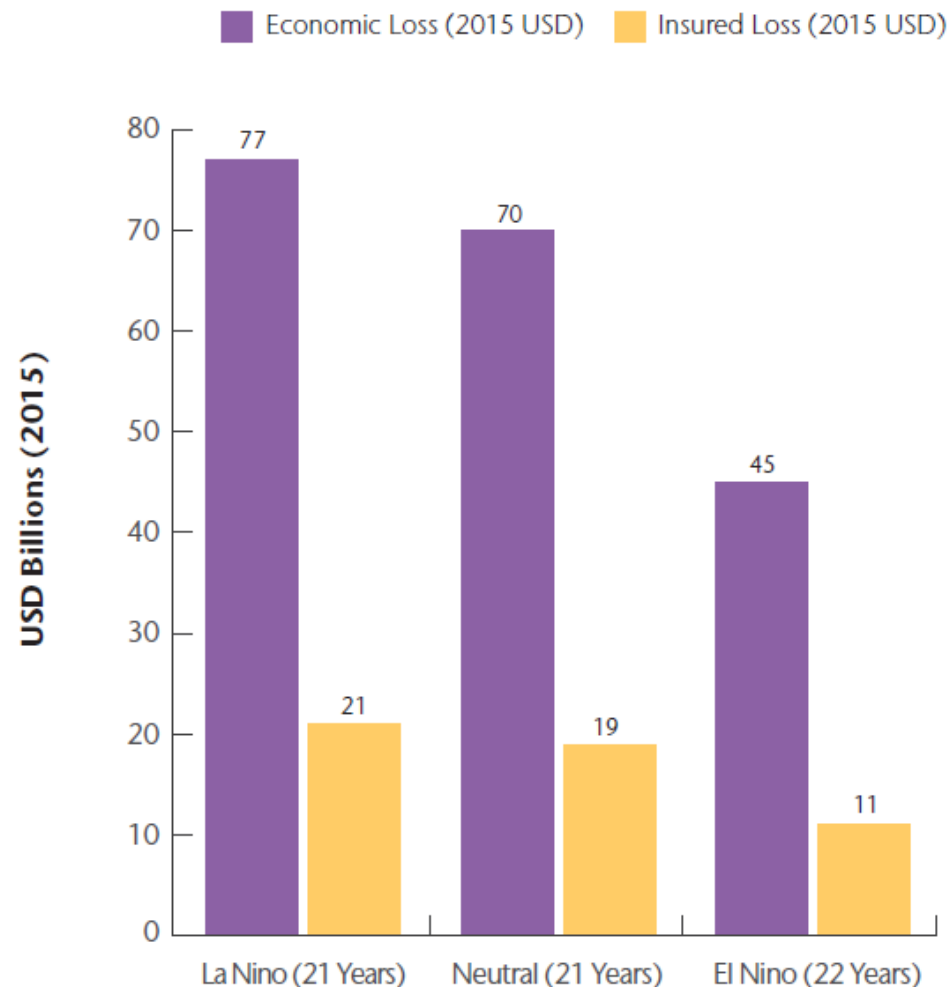
La Niña years have clearly shown greater average annual losses in comparison to El Niño and Neutral phases.

- 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

Exhibit 13: Global Weather Catastrophe Losses (Annual Average)



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
 - 1969/1970 El Niño followed by La Niña conditions from JJA1970 through DJF 1972
 - 1972/1973 El Niño followed by La Niña conditions from MJJ1973 through FMA 1976
 - 1997/1998 El Niño followed by La Niña conditions from JJA1998 through FMA 2001
- This makes it so that La Niña type impacts can be present for many years.



The PEAC Center

The Pacific ENSO Applications Climate
Center



Photo courtesy of
Lt. Charlene Felkley