

Pacific Region ENSO UPDATE AND SEASONAL OUTLOOK

January 18 2018

PREPARED BY THE PEAC CENTER

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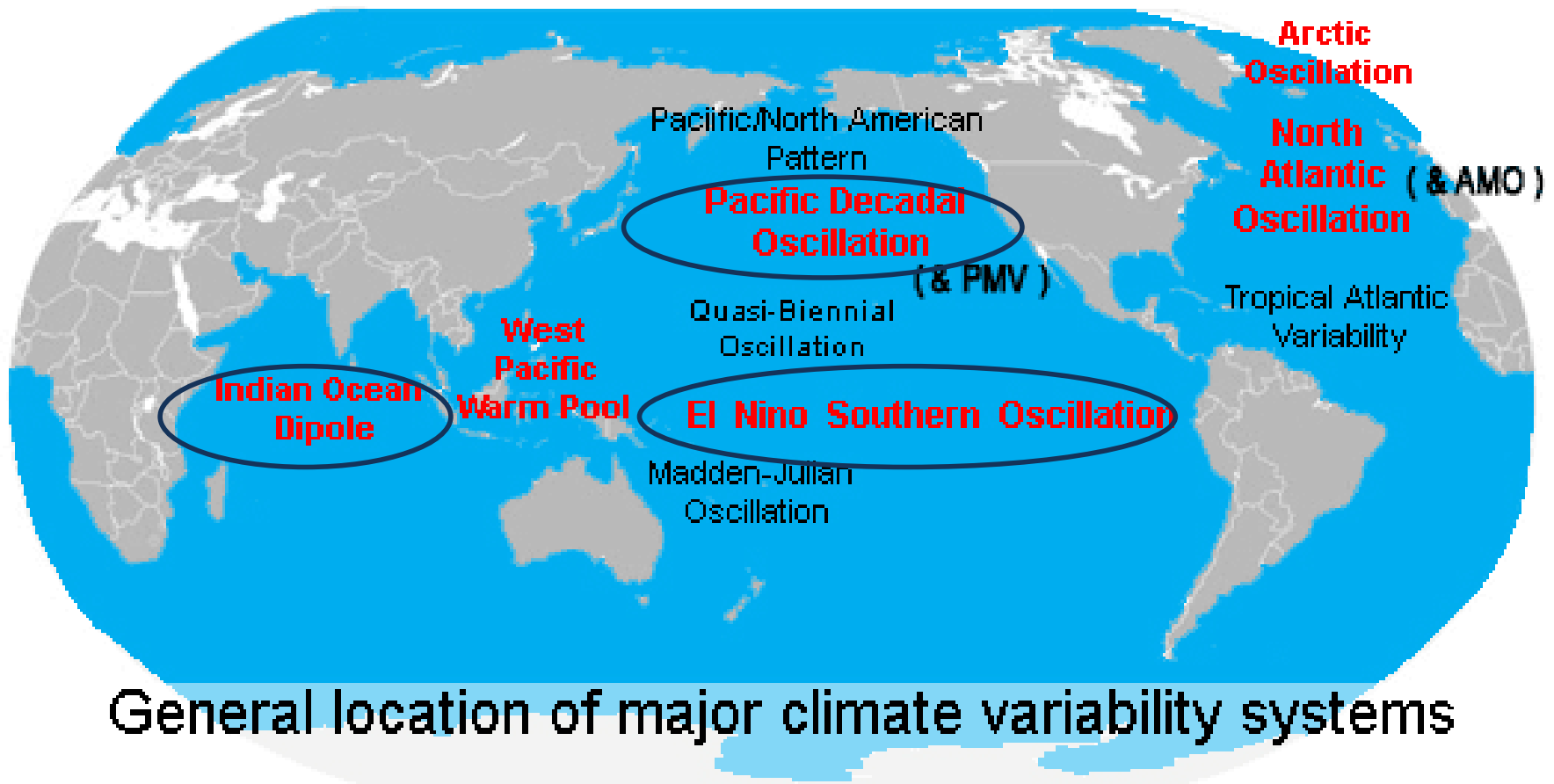


What Is El Niño and La Niña

A general description of ENSO and their global impacts

General Location of Major Climate Variability System

PDO: 210712: -0.18, 199710: +1.63, 199810: -1.4



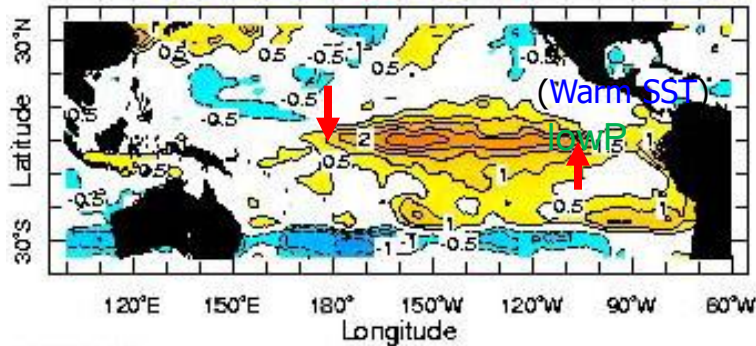
General location of major climate variability systems

Map adapted from Wikimedia Commons

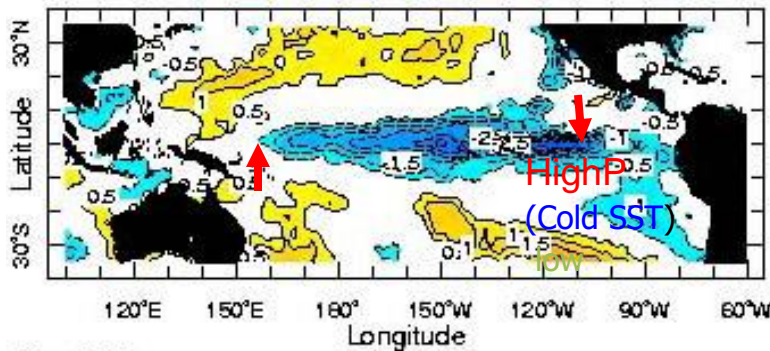
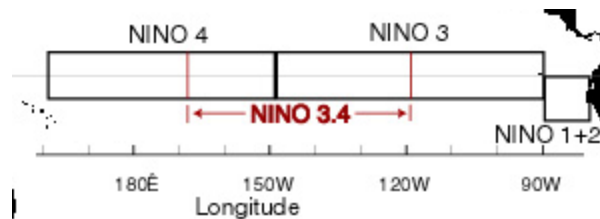
IOD: 201712: neutral, 1997: +ve, 1998: -ve

El Niño/La Niña -Southern Oscillation (ENSO)

(Develops in JAS, strengthen through OND, and weakens in JFM)



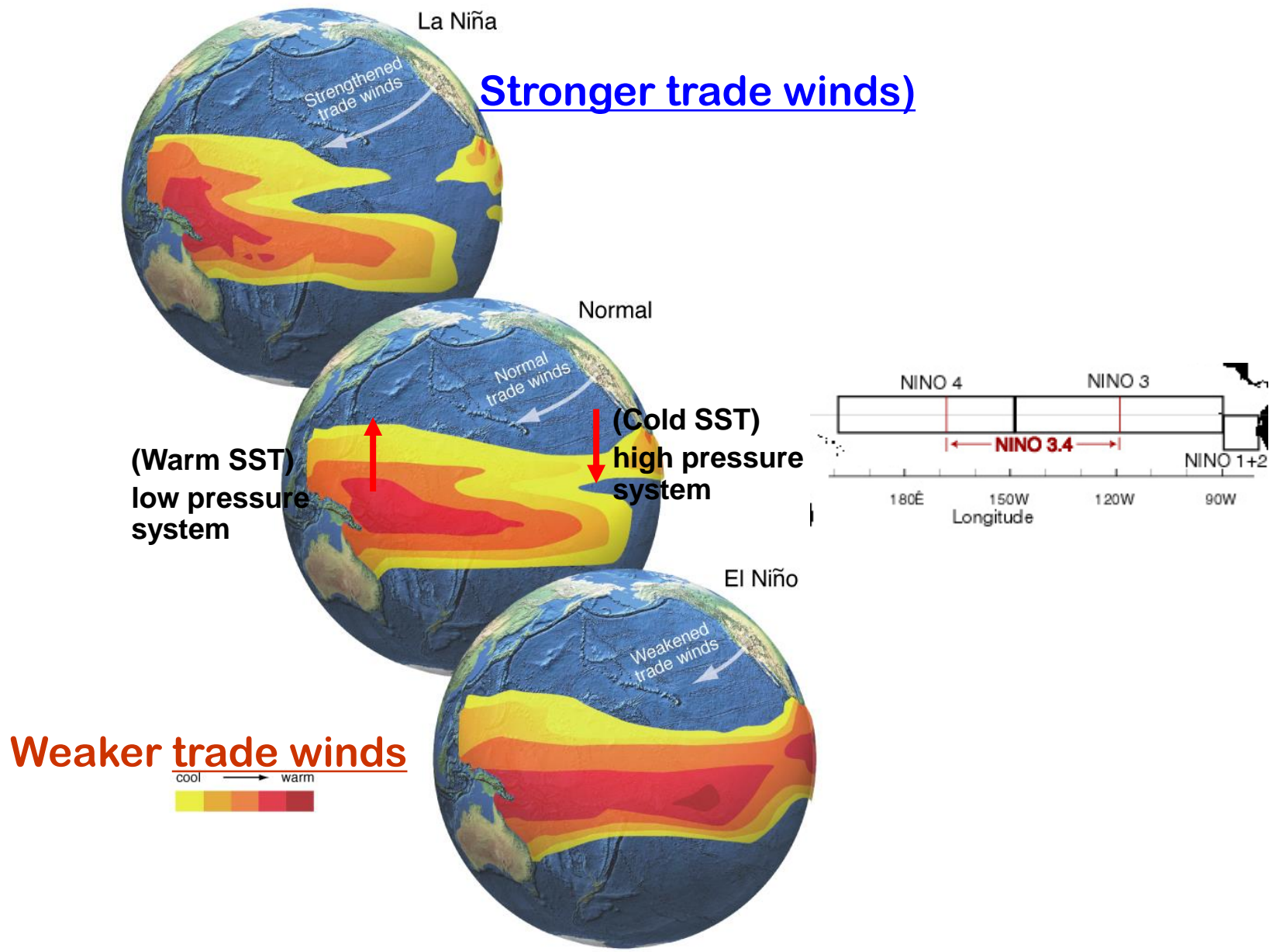
Dec 1991



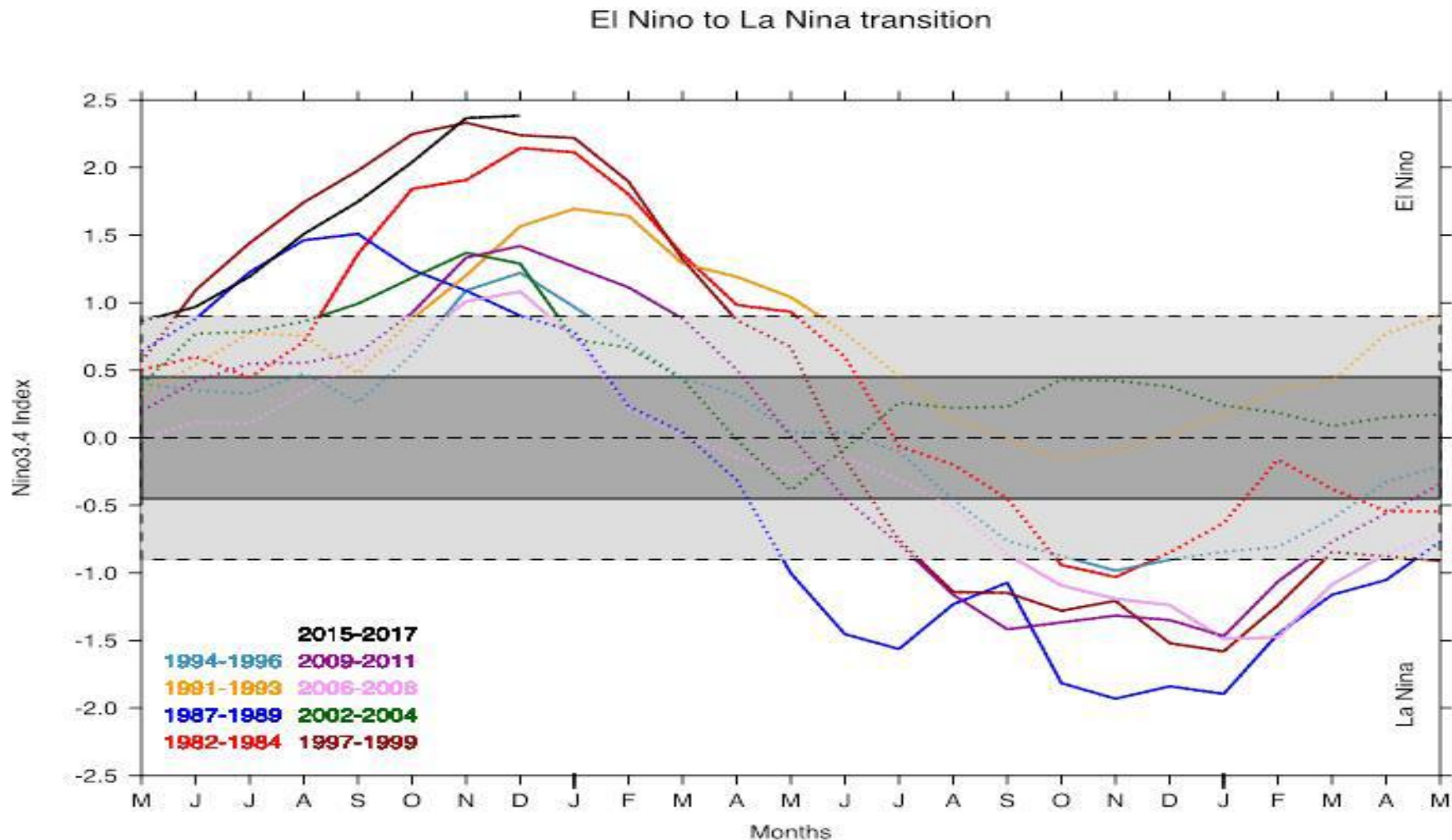
Dec 1988

- El Niño—**major warming** of the equatorial waters in the Pacific Ocean
 - **The anomaly of the SST in the tropical Pacific increases (+0.5 to +1.5 deg. C in NINO 3.4 area) from its long-term average;**
 - **A high pressure region is formed in the western Pacific and low-pressure region is formed in the eastern Pacific—this produces a negative ENSO index (SOI negative).**
- La Niña—**major cooling** of the equatorial waters in the Pacific Ocean
 - **The anomaly of the SST in the tropical Pacific decreases (-0.5 to -1.5 deg. C in NINO 3.4 area) from its long-term average;**
 - **A high pressure region is formed in the eastern Pacific and low-pressure region is formed in the western Pacific—this produces a positive ENSO index (SOI positive).**

El Niño and La Niña



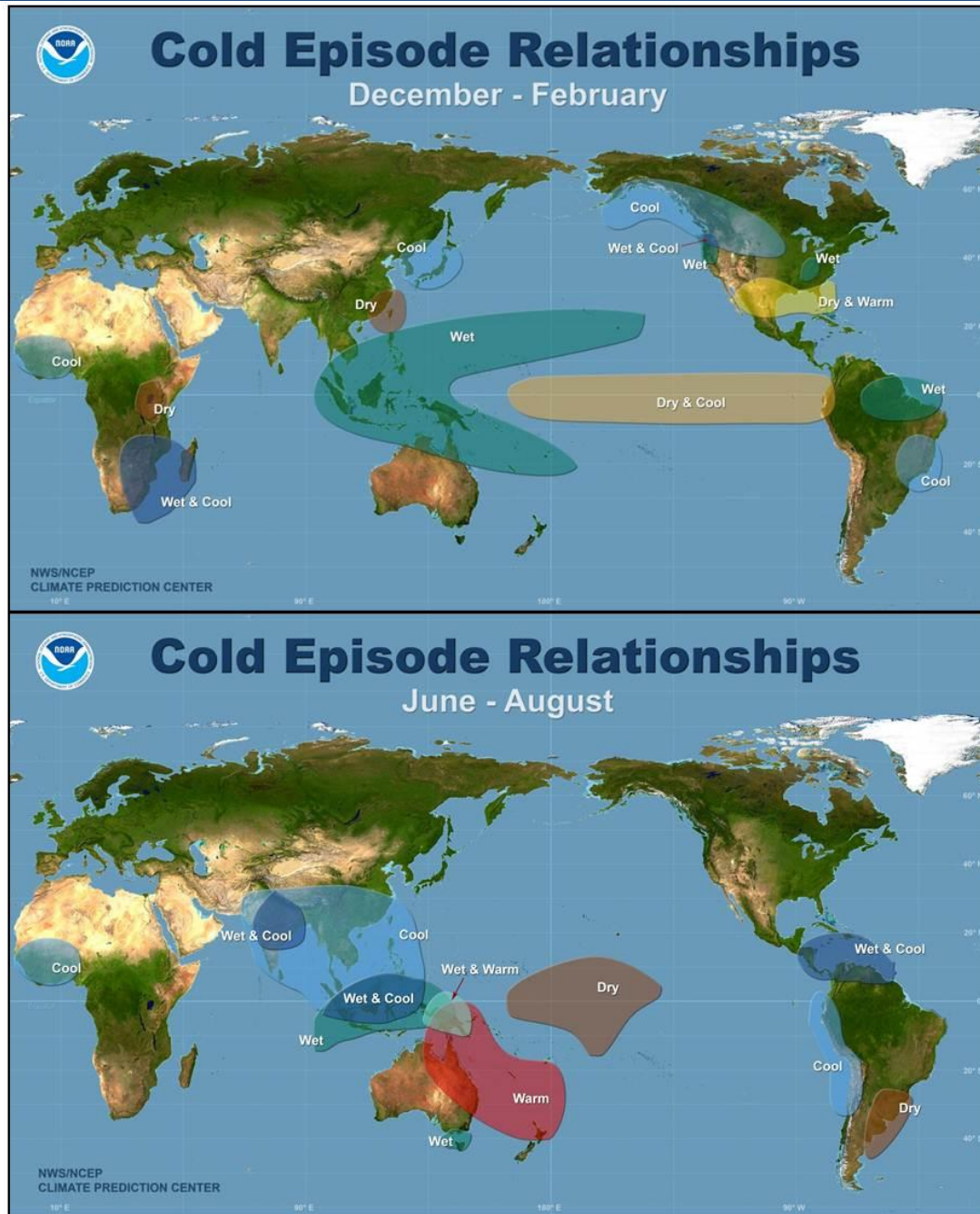
6 out of the 8 El Niño events since 1979 have transitioned to La Niña conditions.



La Niña-Rainfall

DJF: Wet over northern South America and Southern Africa/ and **Dry along coastal Ecuador, northwestern Peru and equatorial eastern Africa**

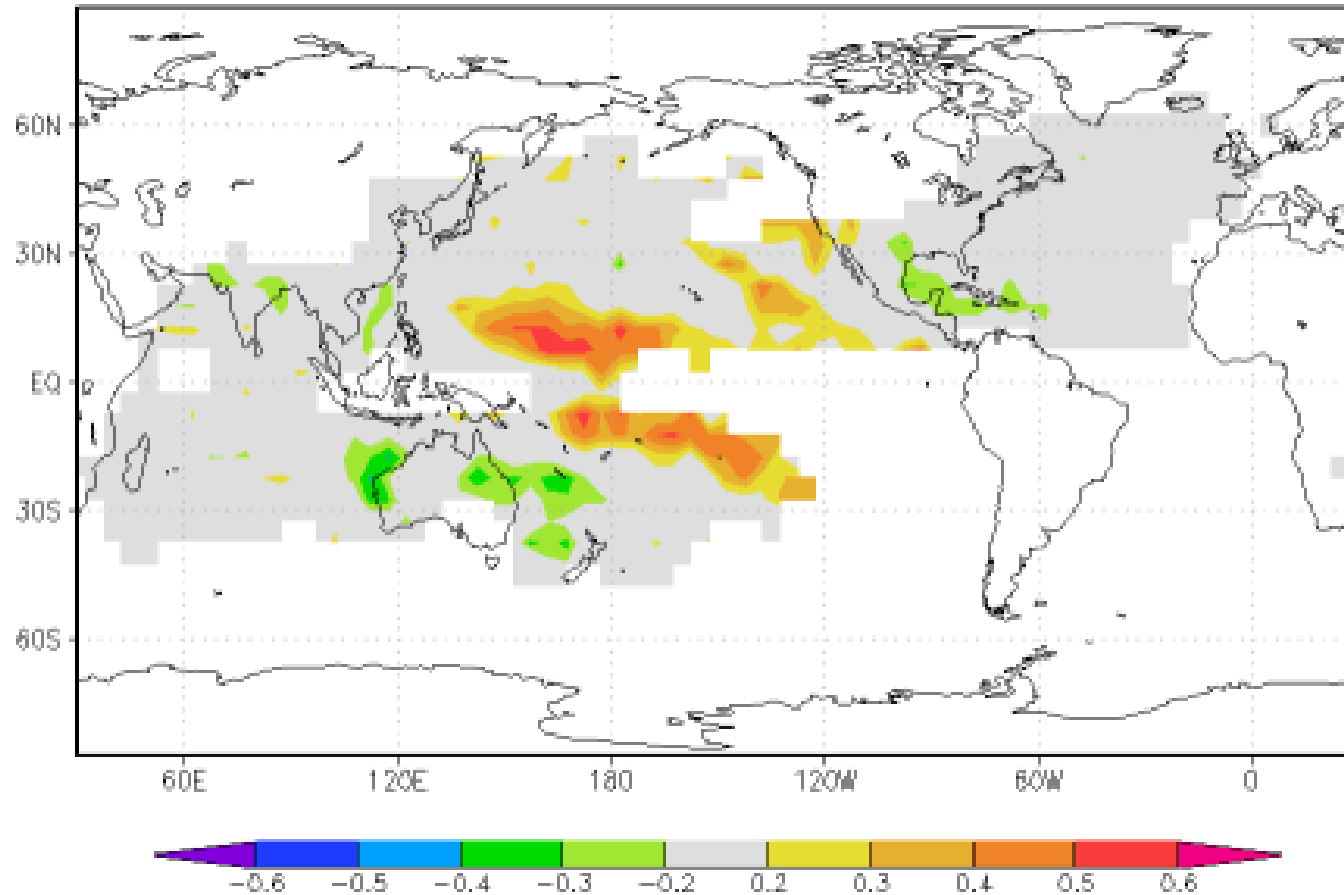
JJA: Wet over south-eastern Australia /**Dry over southern Brazil and central Argentina.**



Rainfall is enhanced across the western equatorial Pacific—Indonesia and the Philippines

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

Summary of historical global impact of La Niña and El Niño

Summary of Historical Impacts					
		La Niña		El Niño	
		Jun-Aug	Dec-Feb	Jun-Aug	Dec-Feb
Wetter		India, Malaysia, Indonesia, Central America, Sahel, southern Australia	Indonesia, Malaysia, Australia, northern South America, southern Africa	central Pacific, central Chile, western United States (US)	South America (Ecuador, northwestern Peru, southern Brazil, central Argentina, Uruguay), equatorial East Africa, northern Mexico/southern
Drier		central Pacific, Uruguay, eastern Argentina, central Chile	central Pacific, Ecuador, East Africa, southern India	India, Indonesia, Malaysia, eastern Australia, Sahel, southern Africa, northern South America	Australia, Indonesia, the Philippines, northern South America, southern Africa
Warmer		Papua New Guinea, eastern Indonesia	southern US	west coast of South America, southern Brazil, Central America	South East Asia, southern Africa, Japan, southern Alaska and western/central Canada, southeastern Brazil and southeastern Australia
Colder		West Africa, southeast Asia, western South America	West Africa, Japan, eastern Brazil, southern Alaska and western/central Canada	southern Pacific, New Zealand	Gulf coast of US

CURRENT CONDITIONS

General State of the Ocean and Atmosphere

Recent



Weak La Niña conditions are present in the tropical Pacific.

Sea Surface Temperatures are below average in the central and eastern equatorial Pacific.

Atmospheric La Niña signals have weakened in December 2017, and the Southern Oscillation Index (SOI) is slightly negative with -0.2 for December 2017.

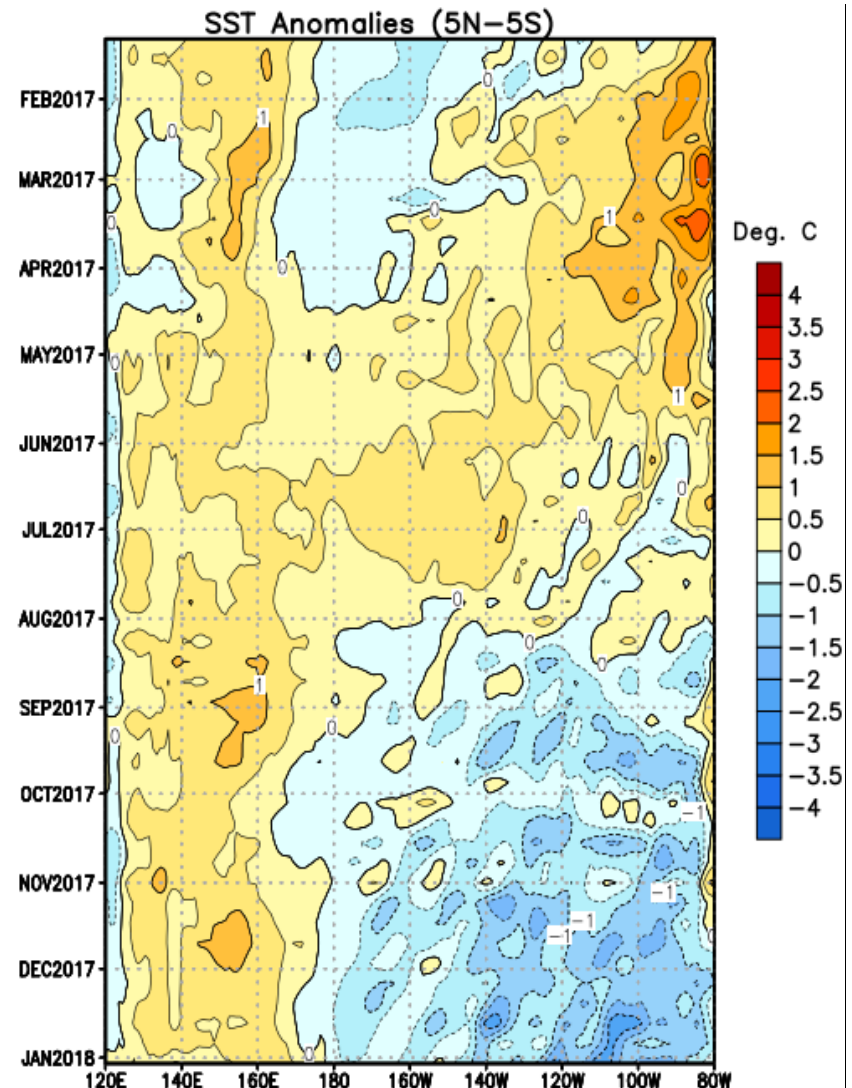
Recent Evolution of Equatorial Pacific SST Departures (°C)

During January and February 2017, above-average SSTs expanded in the eastern Pacific Ocean.

From mid April to July 2017, near-to-above average SSTs spanned most of the equatorial Pacific.

During August 2017, above-average SSTs dissipated east of the date line.

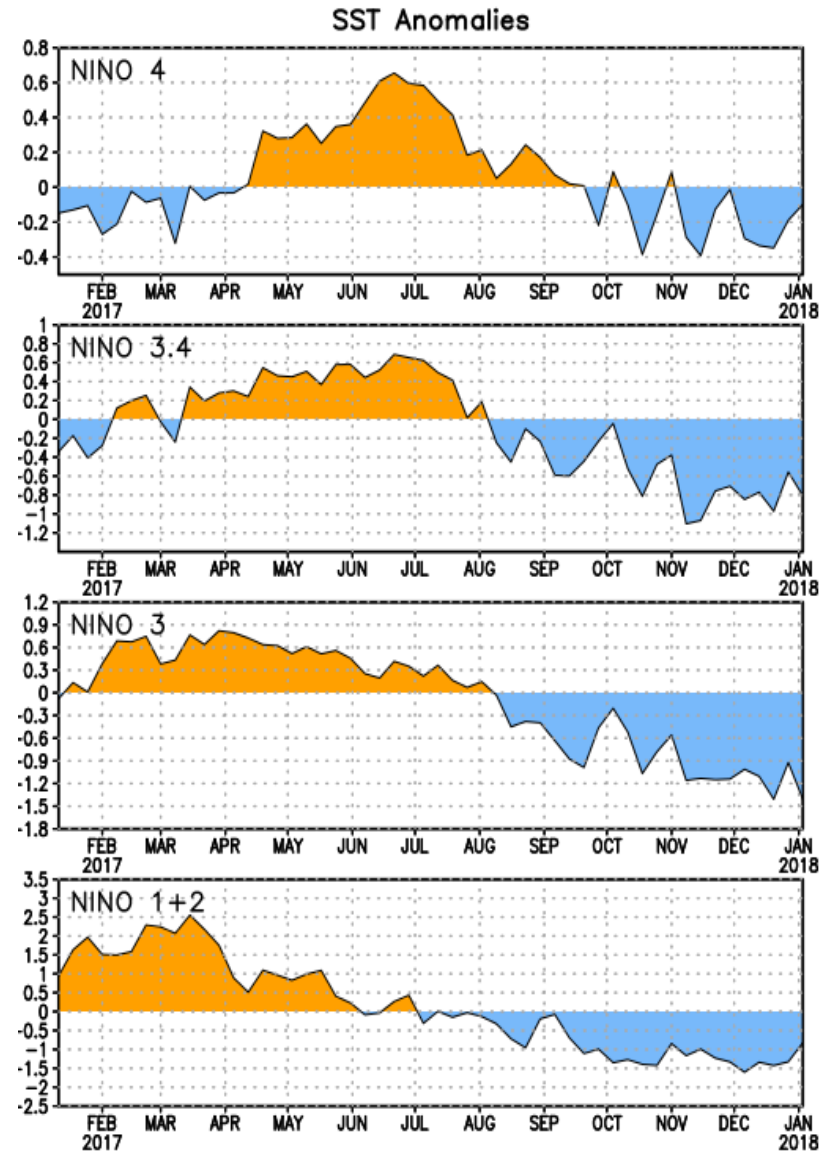
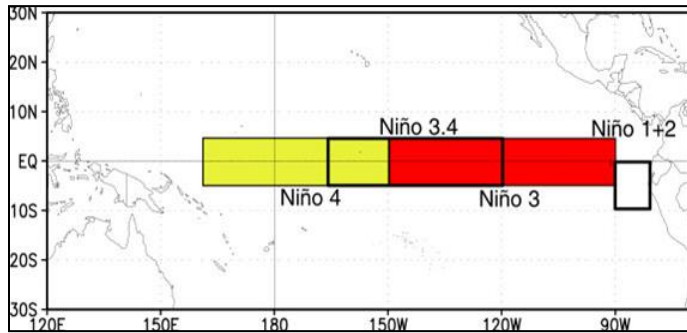
Since September 2017, negative SST anomalies have generally persisted in the central and eastern equatorial Pacific.



Niño Region SST Departures (°C) Recent Evolution

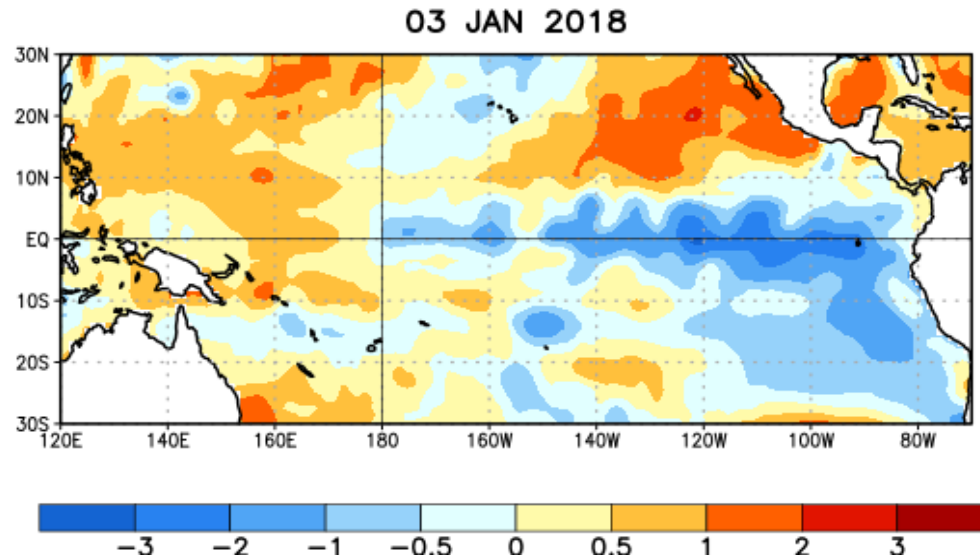
The latest weekly SST departures are:

Niño 4	-0.1°C
Niño 3.4	-0.8°C
Niño 3	-1.4°C
Niño 1+2	-0.8°C



Current State of ENSO (SST)

ENSO Alert System Status: **La Niña Advisory**



- **A weak La Niña event continues, along with its climate impacts around the world. SST at NINO3.4 region is -0.8°C**
- La Niña is likely (**$\sim 85-95\%$ by CPC-IRI**) (**72% by NIWA**) through Northern Hemisphere winter, with a transition to ENSO-neutral expected during the spring.

CPC/IRI ENSO Forecast

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

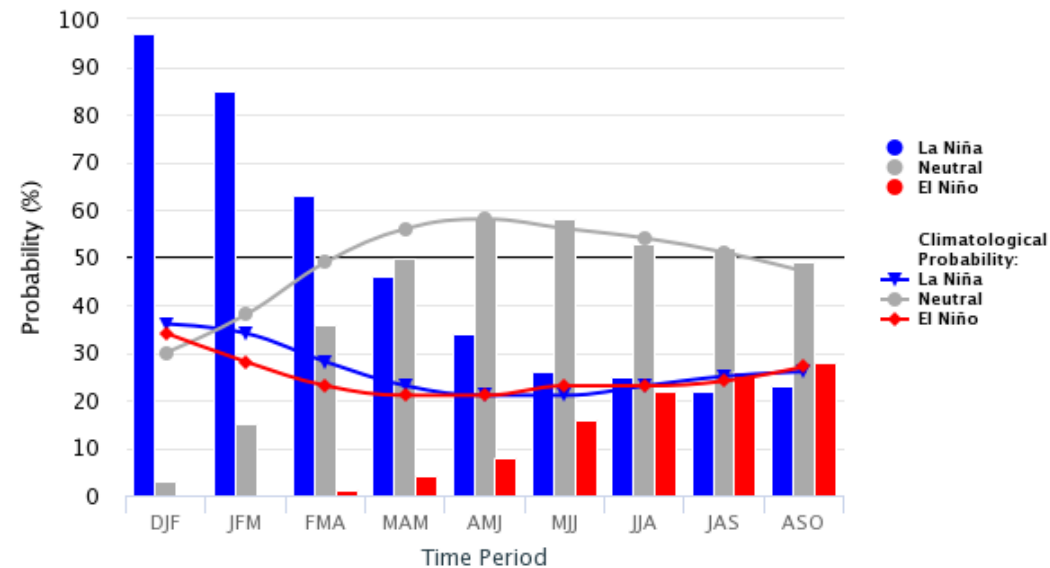
Expected Conditions

- The forecaster consensus favors La Niña continuing through the December-February season
- Rapidly returning to neutral

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

Early-Jan CPC/IRI Official Probabilistic ENSO Forecasts

ENSO state based on NINO3.4 SST Anomaly
Neutral ENSO: $-0.5\text{ }^{\circ}\text{C}$ to $0.5\text{ }^{\circ}\text{C}$



CPC/IRI Early-Month Official ENSO Forecast Probabilities

Season	La Niña	Neutral	El Niño
DJF 2018	97%	3%	0%
JFM 2018	85%	15%	0%
FMA 2018	63%	36%	1%
MAM 2018	46%	50%	4%
AMJ 2018	34%	58%	8%
MJJ 2018	26%	58%	16%
JJA 2018	25%	53%	22%
JAS 2018	22%	52%	26%
ASO 2018	23%	49%	28%

CPC/IRI ENSO Forecast

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

Expected Conditions

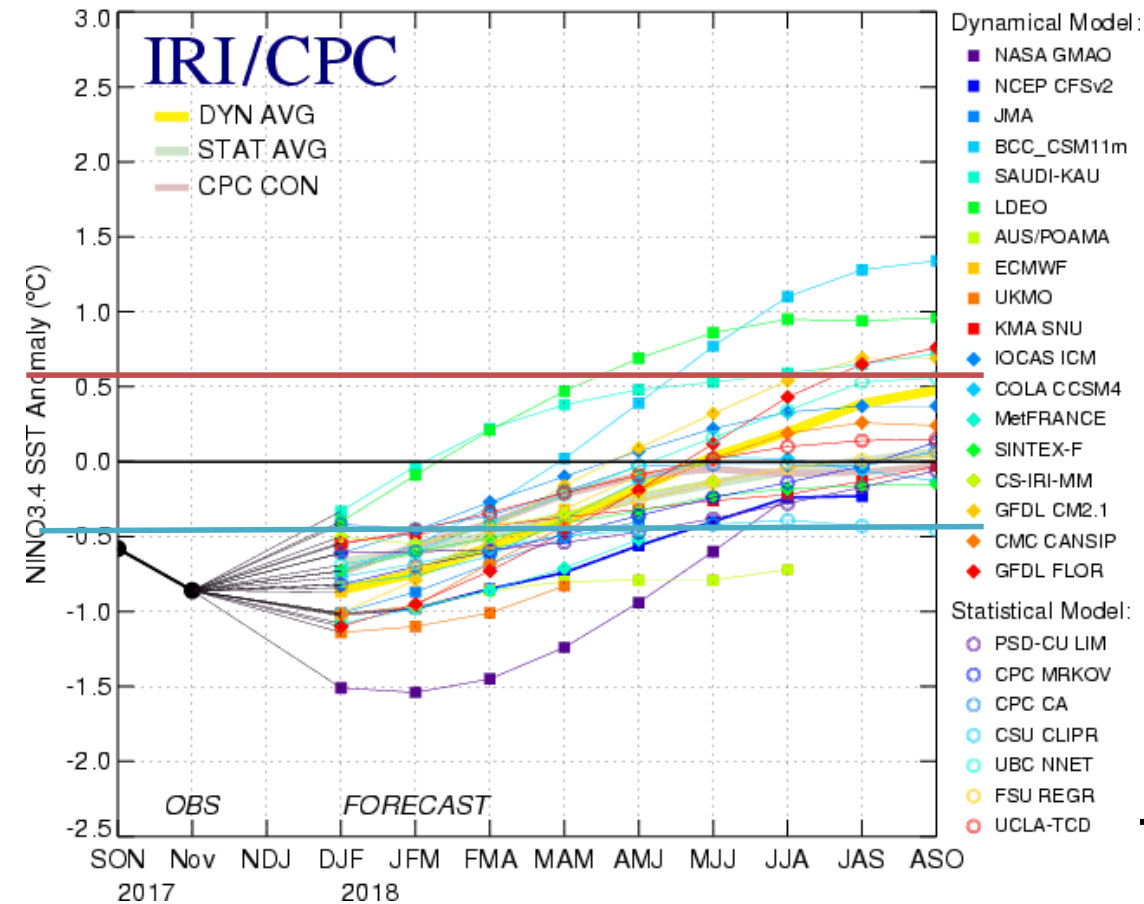
- Models favor weak La Niña conditions continuing through winter 2017-2018
- Quickly returning to neutral
- Predictions are for a **weak event** throughout

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

Average Niño 3.4 SST Anomaly Forecast

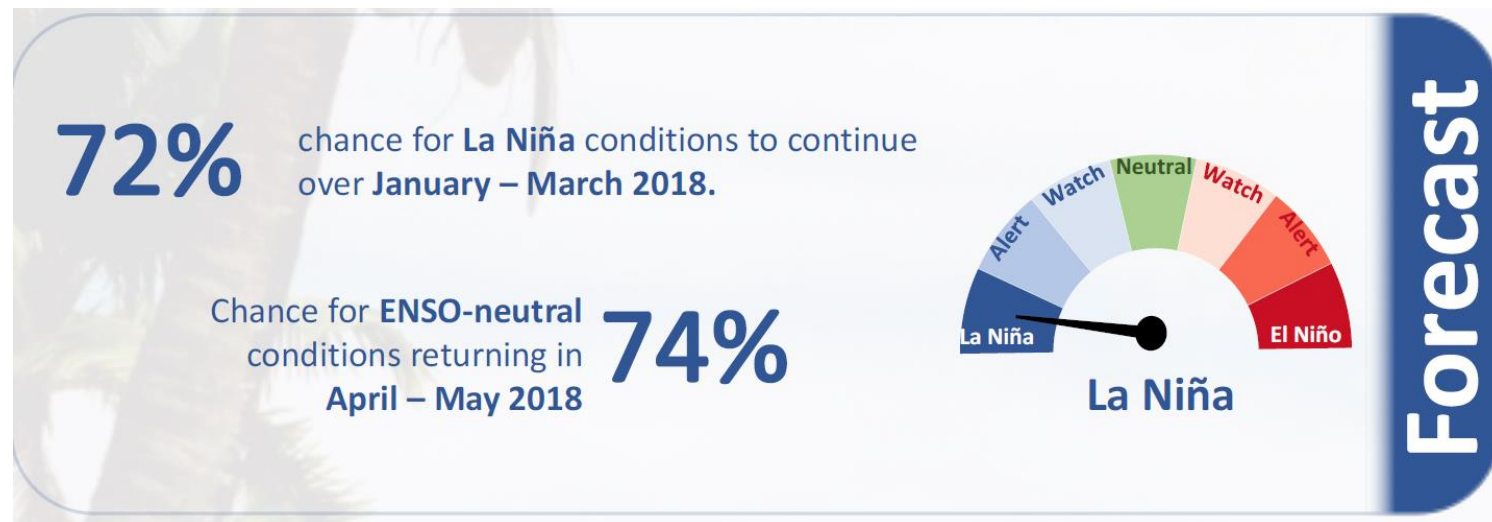
	JFM	FMA	MAM
Dynamical	-0.7	-0.6	-0.4
Statistical	-0.6	-0.5	-0.4
All Models	-0.7	-0.5	-0.4

Mid-Dec 2017 Plume of Model ENSO Predictions



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

ENSO Situation Summary



- **Atmospheric La Niña signals** have weakened in December 2017, and SOI is slightly negative with -0.2 for December 2017;
- **La Niña conditions are likely (72% chance) to persist over JFM of 2018;**
- **La Niña is likely to decay rapidly during AMJ of 2018;**
- **ENSO-neutral conditions is most likely (74% chance) over AMJ of 2018 period.**

<https://iri.columbia.edu/news/november-climate-briefing-la-nina-makes-it-official/>

<https://www.facebook.com/climatesociety/videos/1098793830256505/>

Dec 27: <https://iri.columbia.edu/news/december-climate-briefing-new-year-same-la-nina/>

Impacts

- Quick recap of the 2017/2018 La Niña
- Current conditions for
 - Rainfall
 - Sea Level
 - Tropical Cyclones
 - Societal Impacts

Global impacts of La Niña

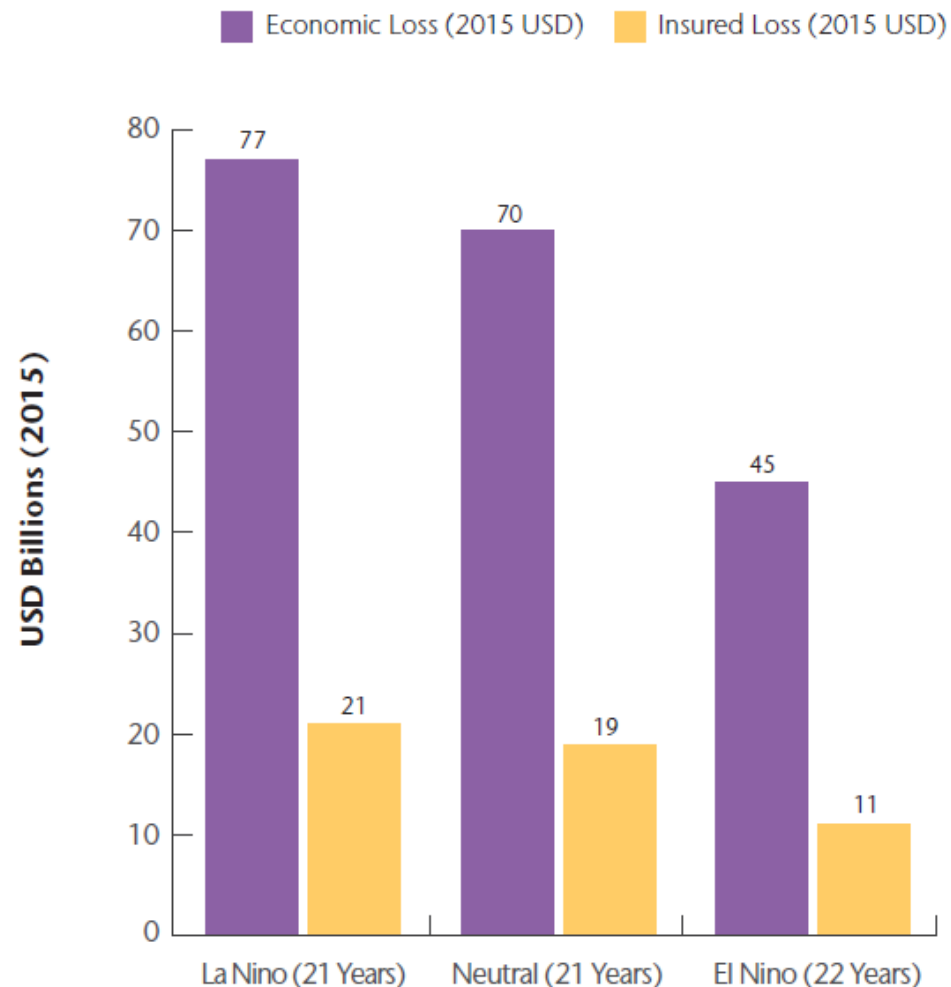
La Niña years have clearly shown greater average annual losses in comparison to El Niño and Neutral phases.

- 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

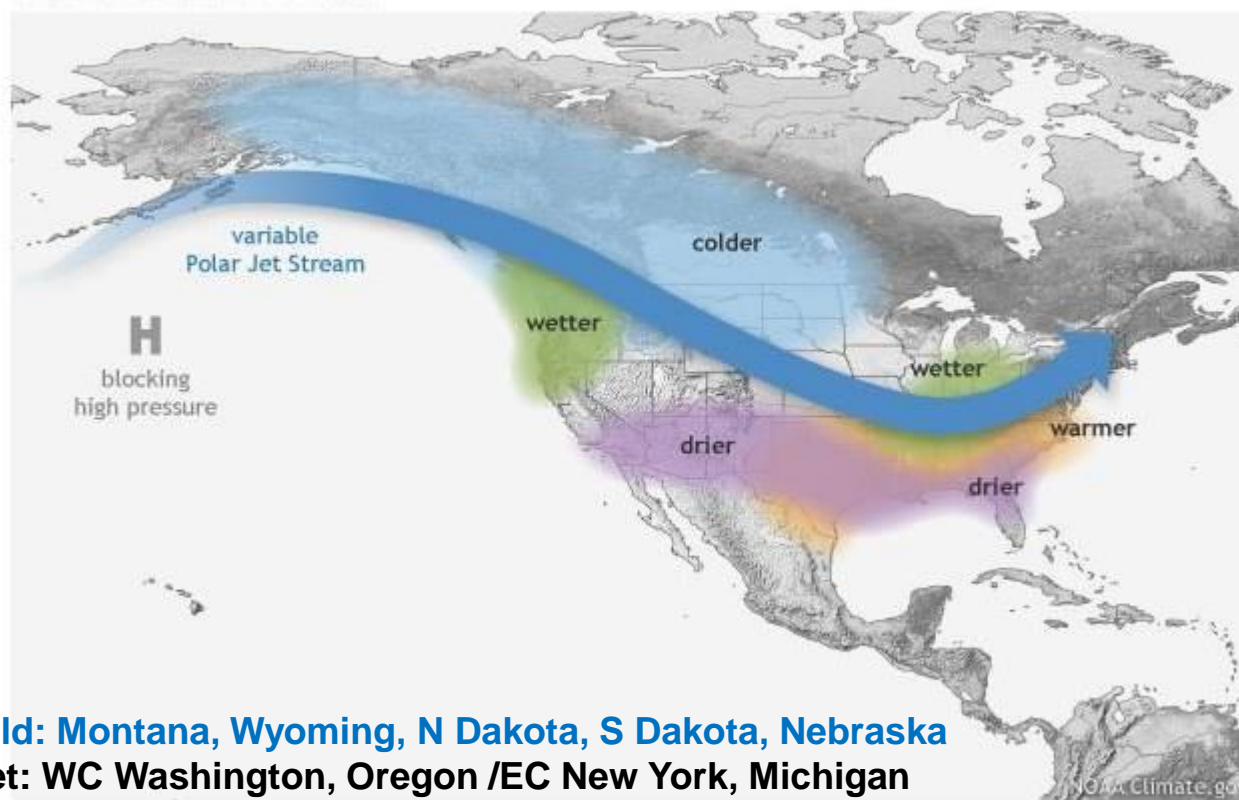
Exhibit 13: Global Weather Catastrophe Losses (Annual Average)



Source: Aon Benfield 2015 Annual Climate and Catastrophe report.

La Niña and Winter

WINTER LA NIÑA PATTERN



Because of La Niña, 2017 fall and winter weather pattern may turn out to be ***“drier fall and snowier winter across the NORTH, and drier winter across the SOUTH”***.

Cold: Montana, Wyoming, N Dakota, S Dakota, Nebraska
Wet: WC Washington, Oregon /EC New York, Michigan
Drier: California, Nevada, Texas, Louisiana, Mississippi, Florida

America battles EXTREME cold and ice in January 2018:

Bomb cyclone then bitter cold

- La Niña and shift of Arctic Circulation are the reason for this freezing weather.

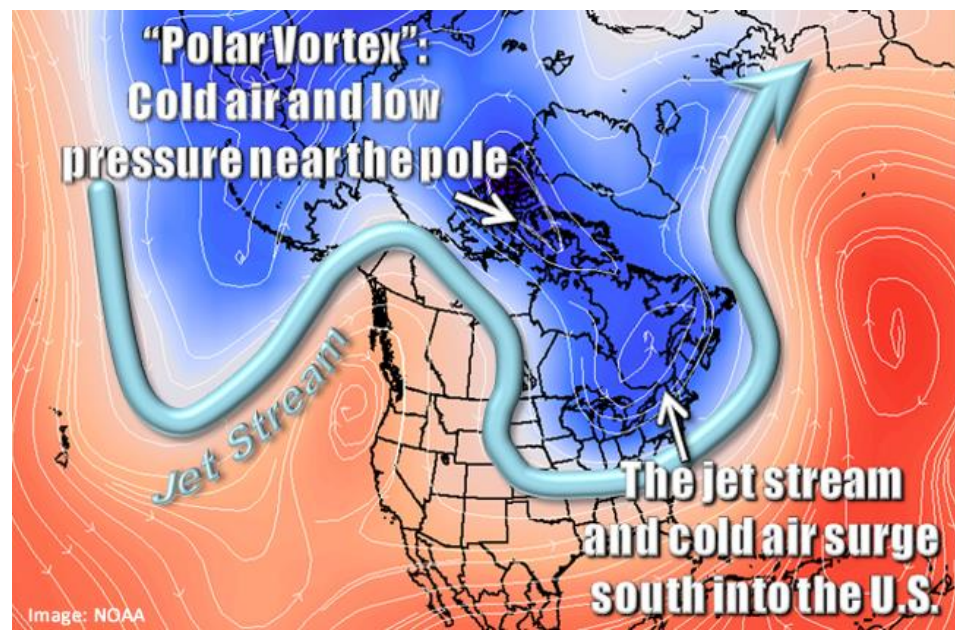
Bomb cyclone is beginning of a 100 year GLOBAL COOLING period???



What is the Polar Vortex?

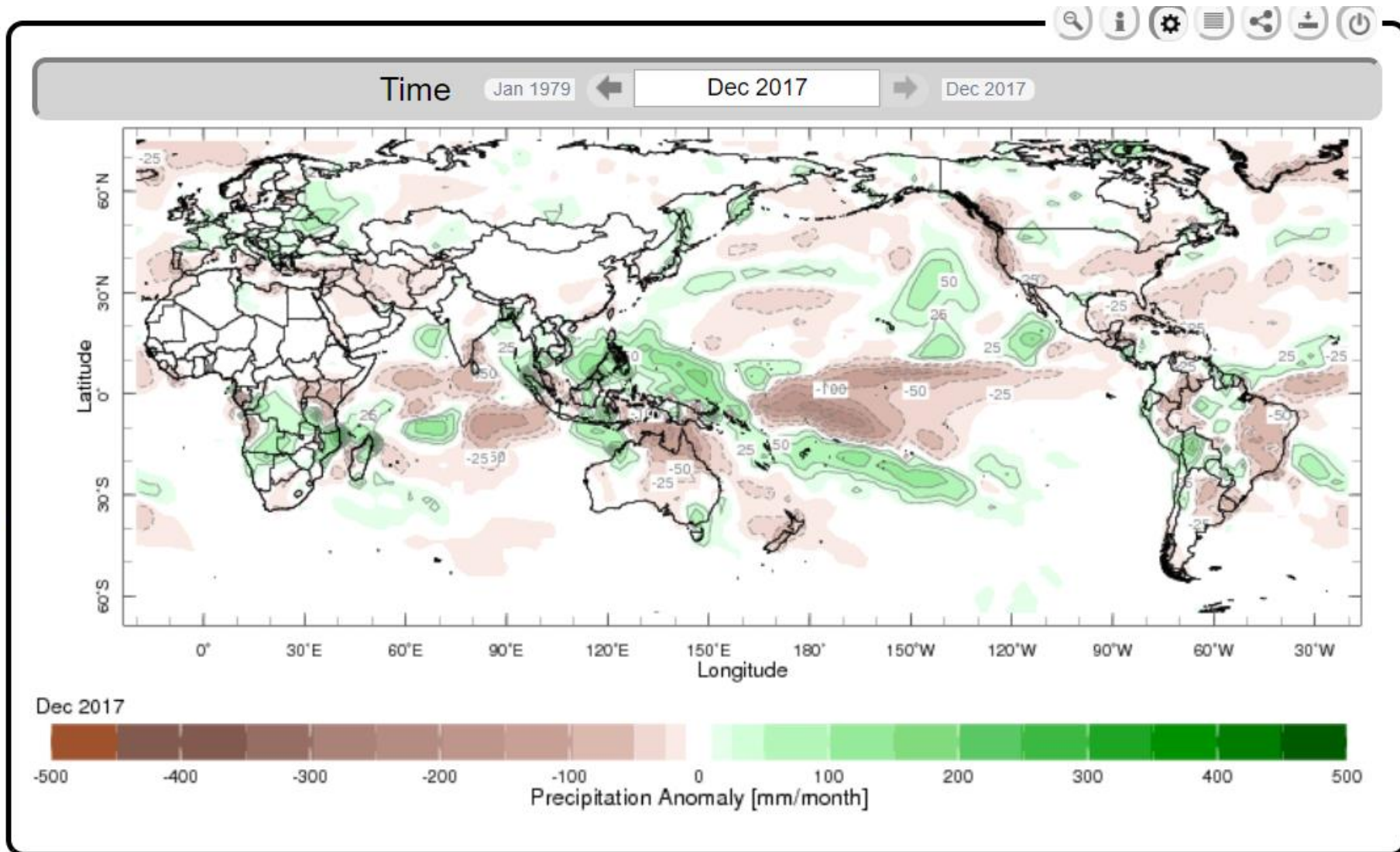
- Large area of low pressure and cold air near the poles—weakens in summer and **strengthen and expands** in winter sending cold air southward with the jet stream;
- "vortex" refers to the counter-clockwise flow of air that helps keep the colder air near the Poles;

- Since 2000, the Jet stream is **WEAKENING/began slowing down**—its waves meandering more;
- When this happens, Arctic air drops south, and sometimes very far south.



Colder outbreaks in 1977, 1982, 1985 and 1989 and January 2014

Global Monthly Precipitation Anomaly

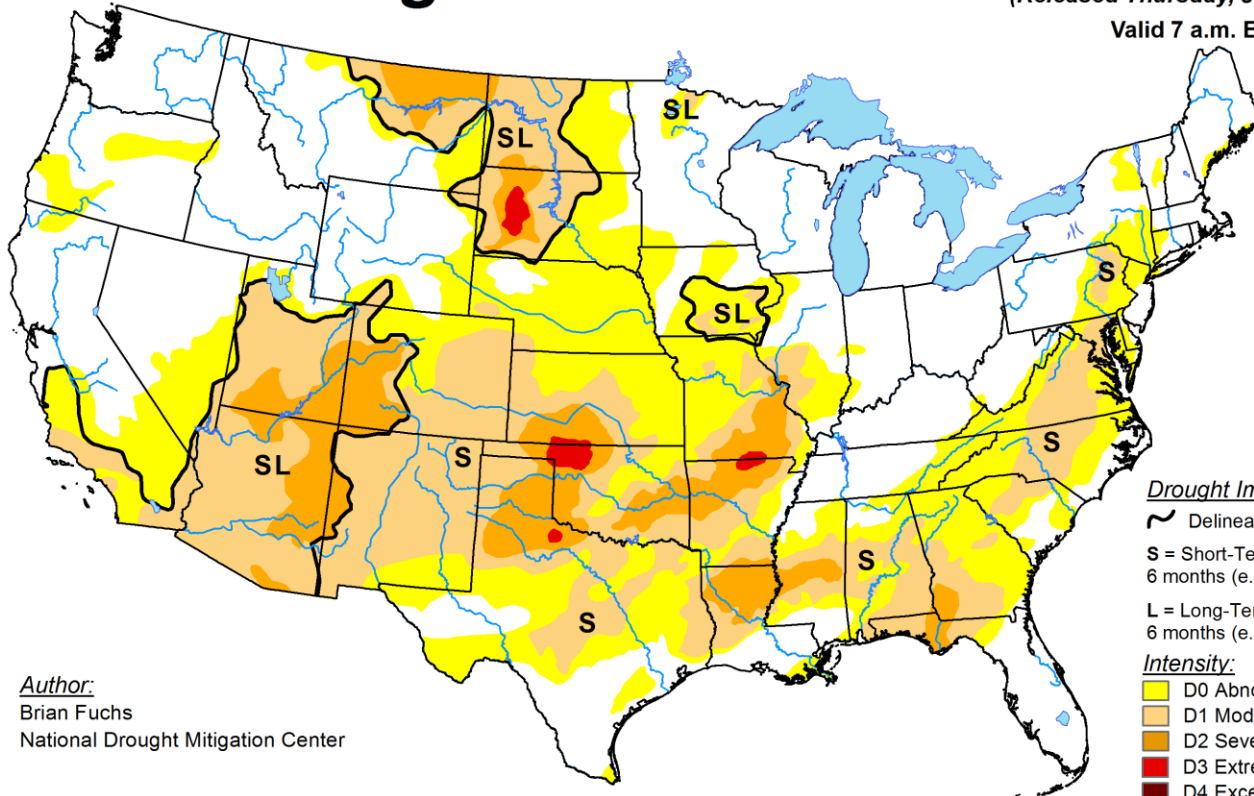


Drought Condition

U.S. Drought Monitor

January 9, 2018
 (Released Thursday, Jan. 11, 2018)
 Valid 7 a.m. EST

Drought now covers 26% of 48 contiguous states, easing in Arkansas but expanding in Texas Panhandle, Southwestern states and Illinois.

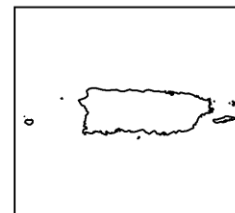
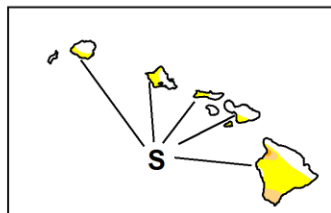
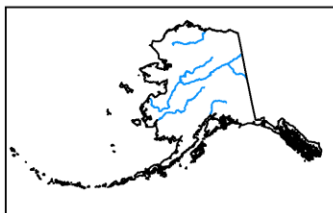


Author:
 Brian Fuchs
 National Drought Mitigation Center

- Drought Impact Types:**
- ~ Delineates dominant impacts
 - S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
 - L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)
- Intensity:**
- Yellow: D0 Abnormally Dry
 - Light Orange: D1 Moderate Drought
 - Orange: D2 Severe Drought
 - Dark Orange: D3 Extreme Drought
 - Dark Red: D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Dec 20-21: very heavy rains (4-10 inches) in western Maui, Lihue, eastern Molokai)

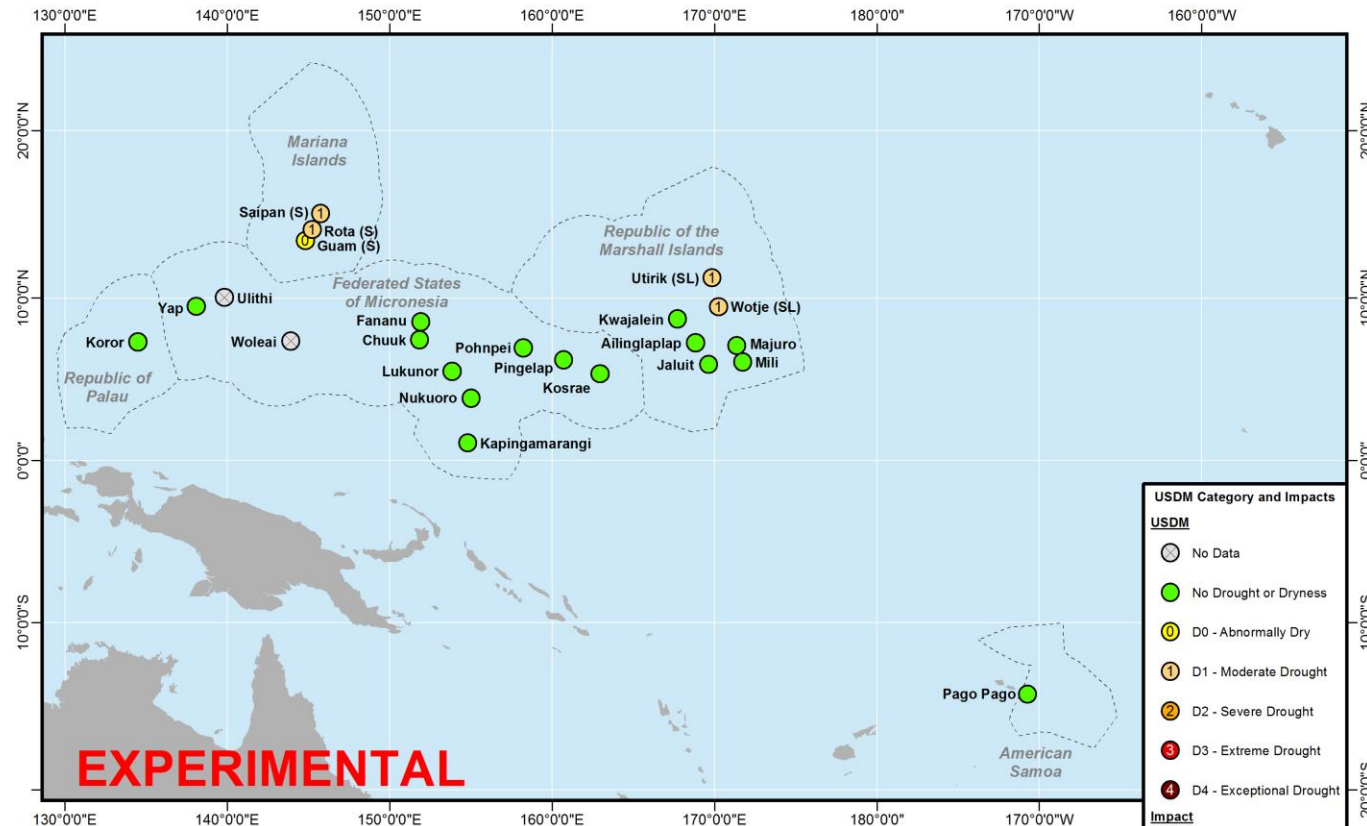


<http://droughtmonitor.unl.edu/>

Drought impacts to the USAPIs

U.S. Drought Monitor U.S. Affiliated Pacific Islands

January 16, 2018



Author: Richard Heim, NOAA/NCEI

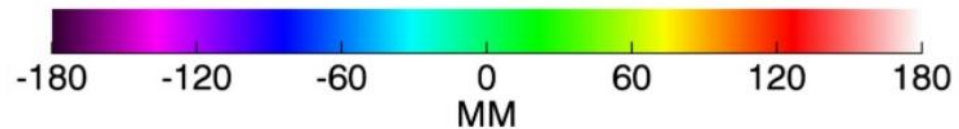
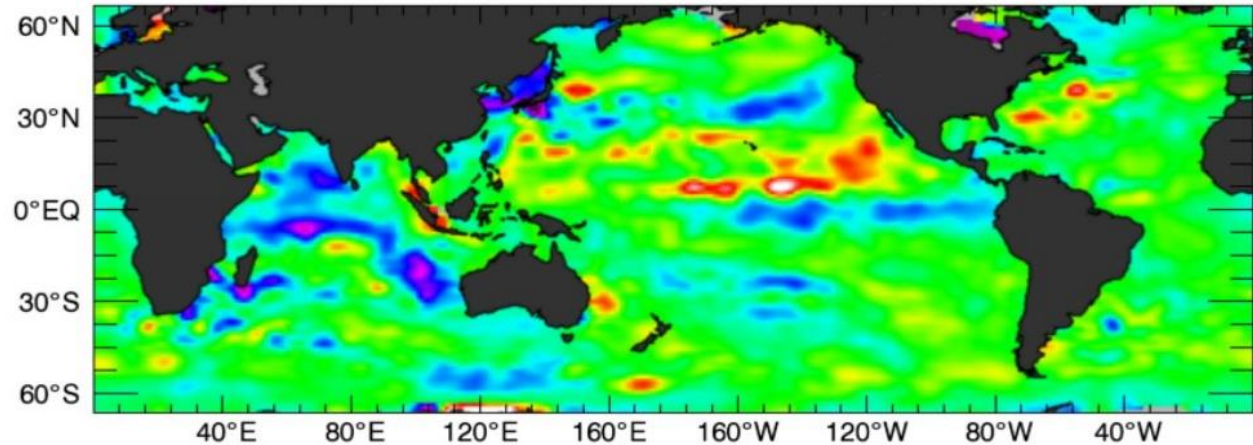
- Hydrological drought conditions have ended in the last couple of months

- Water supply no longer a concern
- Food security will take more time to recuperate

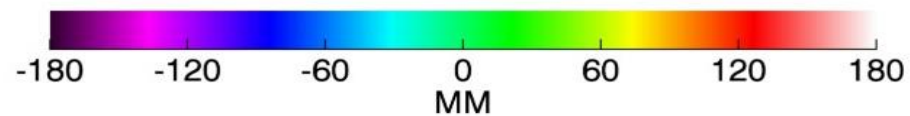
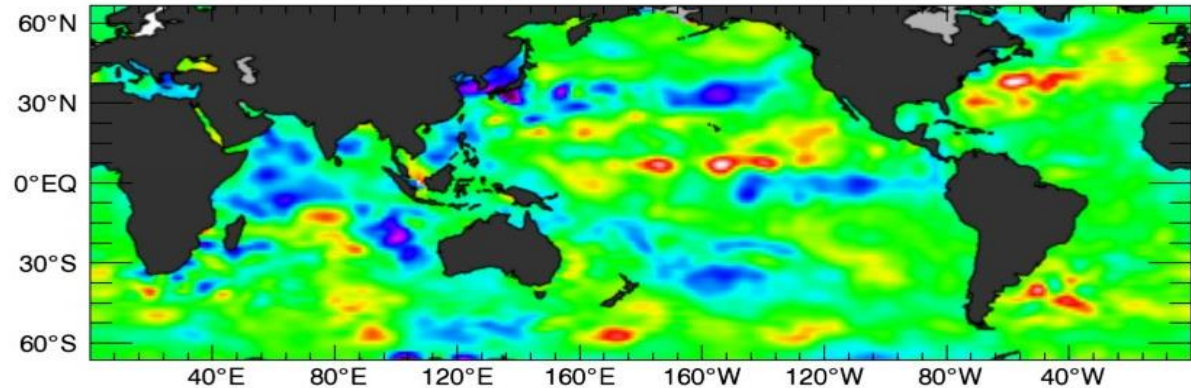
Sea Level Observation

- **Sea Levels have been Above average over Western Pacific Basin since March 2017**

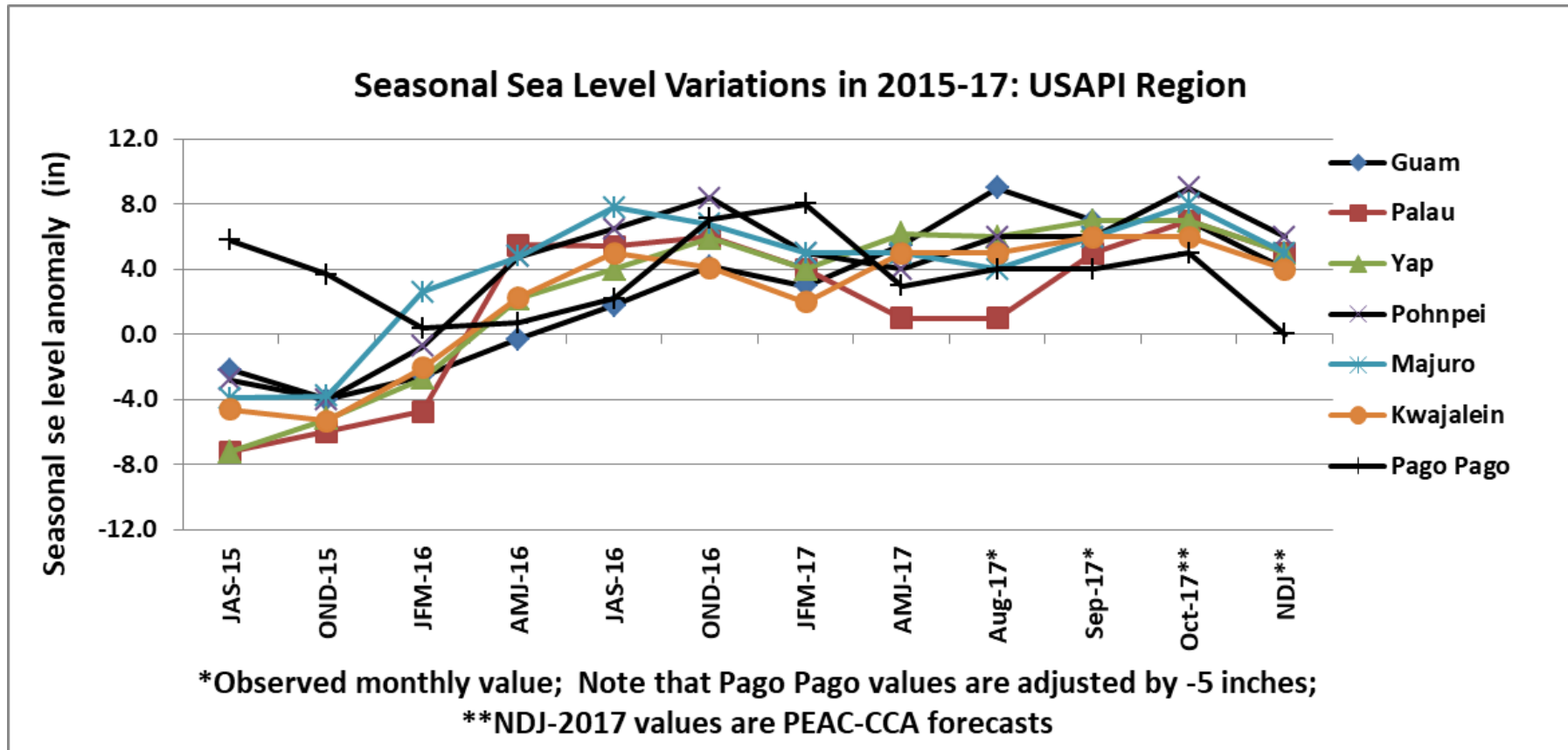
Jason-3 Sea Level Residuals DEC 7 2017



Jason-3 Sea Level Residuals DEC 22 2017



Synopsis of 2-years of SLV and Forecasts



- Rise from JAS-2015 and continued up to JAS 2016
- **Fall from OND-2016 and stayed marginally below average in JFM-2017**
- Rise again from June-2017 and currently staying above average
- **Likely to stay 5-8 inches above normal up to JFM of 2018**

High-Tides and Inundation pictures in Pohnpei & Kosrae on December 4 -5 (PC: Wallace Jacob, WSO-Pohnpei)



Damaged roads in Kosrae



2017 Northern Hemisphere Tropical Cyclone Activity (through October), by basin and with hemisphere totals

Basin	Named Storms	Days	Hurri/ Typh	Days	Major Hurri	Days	ACE**
Natl	16 (11)	89 (55)	10 (6)	51 (22)	6 (3)	19 (6)	224 (99)
ENP	18 (16)	66 (72)	9 (8)	20 (29)	4 (4)	5 (9)	98 (130)
WNP	22 (23)	85 (119)	11 (15)	36 (58)	4 (8)	6 (20)	144 (259)
NIO	2 (3)	4 (8)	1 (1)	0.3 (2)	0 (0.5)	0 (0.7)	4 (11)
NHem	58 (54)	244 (255)	31(31)	107(112)	14 (15)	30 (35)	469 (500)

**ACE is proportional to the square of the wind speed.

- Throughout 2017, there was a westward & northward displacement of the TC activity, *which is consistent with the development of La Niña*

2017 Atlantic hurricane season

(Preliminary damage is over \$369.86 billion)

- The 2017 Atlantic hurricane season was a hyperactive, deadly, and extremely destructive season, featuring 16/17 named storms, ranking alongside 1936 as the fifth-most active season since records began in 1851.
-
- The season also featured both the highest total accumulated cyclone energy (ACE) and the highest number of major hurricanes since 2005 with major hurricanes — Harvey, Irma, and Maria.
-
- This season is also one of only six years on record to feature multiple Category 5 hurricanes, and only the second after 2007 to feature two hurricanes making landfall at that intensity.
-
- This season is the only season on record in which three hurricanes each had an ACE of over 40: Irma, Jose, and Maria.

Hurricane Harvey

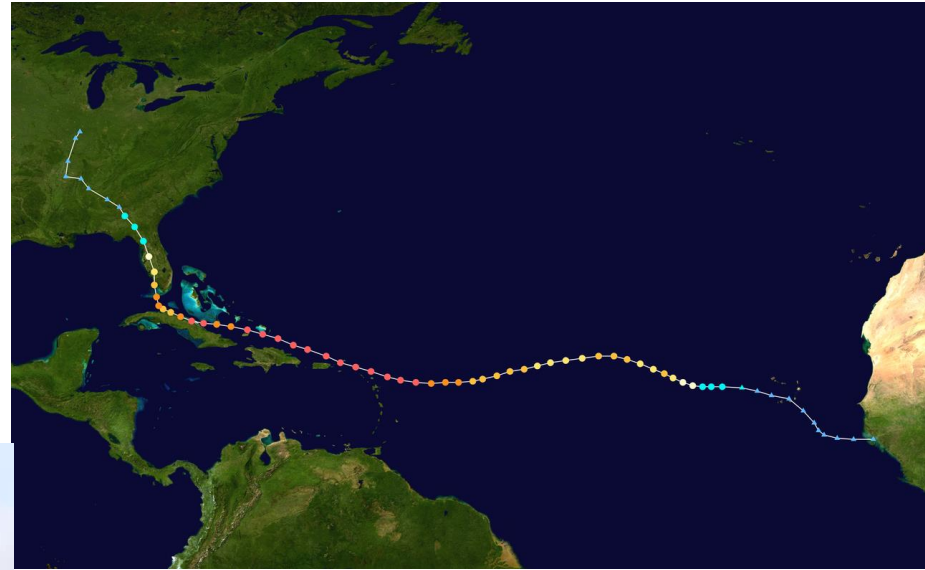
- Harvey was the first major hurricane (Cat 4: 134 mph) to make landfall in Texas on Aug 29-30 since Wilma ('05)



- Harvey was the costliest tropical cyclone on record, inflicting nearly \$200 billion (2017 USD) in damage;
- As of September 14, 2017, at least 82 people have died.

Hurricane Irma

- Irma was another major hurricane (Cat 5: 185 mph) to make landfall in Florida on Sep 10-11.



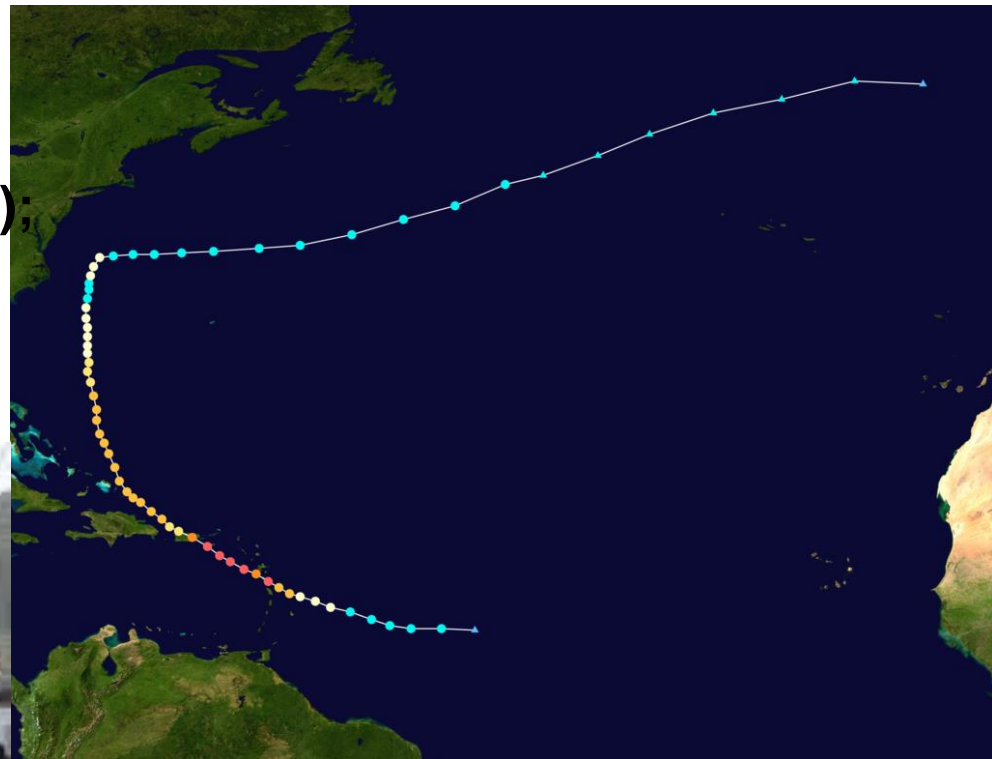
Hurricane Irma is the strongest Atlantic basin hurricane ever recorded outside the Gulf of Mexico and the Caribbean Sea. **Damage: US \$ 67 Billion**



Hurricane Maria

Hurricane Maria (Cat 5: 175 mph) was regarded as the worst natural disaster on record in [Dominica](#) and [Puerto Rico](#). It made landfall in Dominica on Sep 18.

Damage: \$103.45 billion (2017 USD)
Fatalities: 547



- **Hurricane Jose:** was a powerful longest-lived [Atlantic hurricane](#)
- **Hurricane Katia** struck the east coast of Mexico as a Category 1 storm

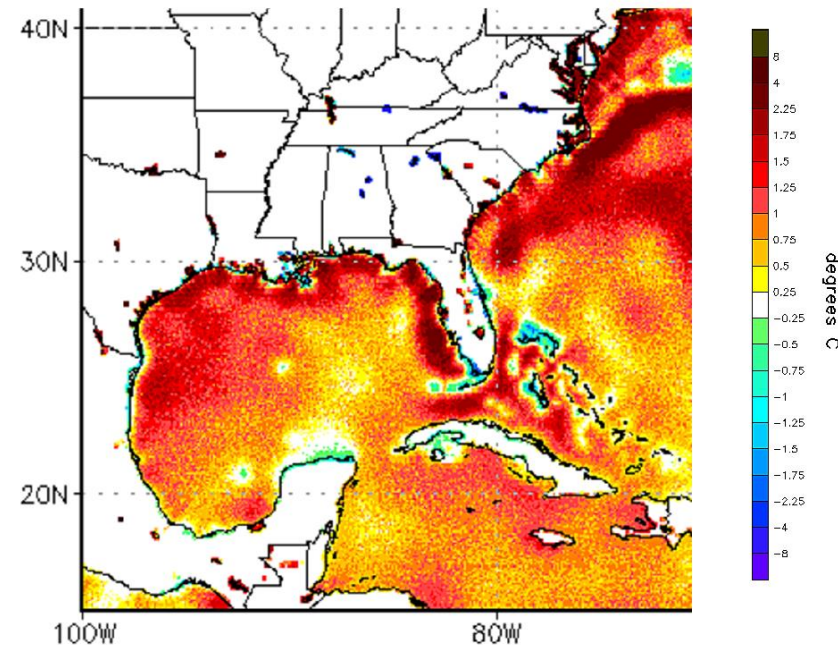
Why Hurricane Season was so Intense?

- Atmosphere was Hurricane friendly
- ENSO neutral—improving Atlantic Hurricane prospects
- Tropical Atlantic was exhibiting high “thermal potential”—meaning water can rapidly evaporate to atmosphere
- SST was warmer than average
- *As the world warms, evaporation speeds up. So on average there's more water vapor for a storm to sweep up and dump now, compared to 70 years ago*
- —global warming is making a bad situation worse???

Global warming is making a bad situation worse

- ❖ Harvey benefited from unusually toasty waters in the Gulf of Mexico
- ❖ As the storm roared toward Houston, sea-surface waters near Texas rose to between 2.7 -7.2 °F above average.
- ❖ The tropical storm, feeding off this unusual warmth, was able to progress from a tropical depression to a category-four hurricane in roughly 48 hours.

Atlantic Sea Surface Temperature Anomaly, August 23, 2017



RTG_SST_HR Anomaly (0.083 deg X 0.083 deg) for 23 Aug 2017
NOAA/NWS/NCEP/EMC Marine Modeling and Analysis Branch Oper H.R.

Harvey intensified rapidly amid sea surface temperatures in the Gulf of Mexico up to 2.7 - 7.2°F (1.5 - 4°C) above average, relative to a 1961-1990 baseline.

2017: The year of hurricanes, wildfires and floods

<http://www.thedailystar.net/onlinespecial/2017-the-year-hurricanes-wildfires-and-floods-1514830.html>

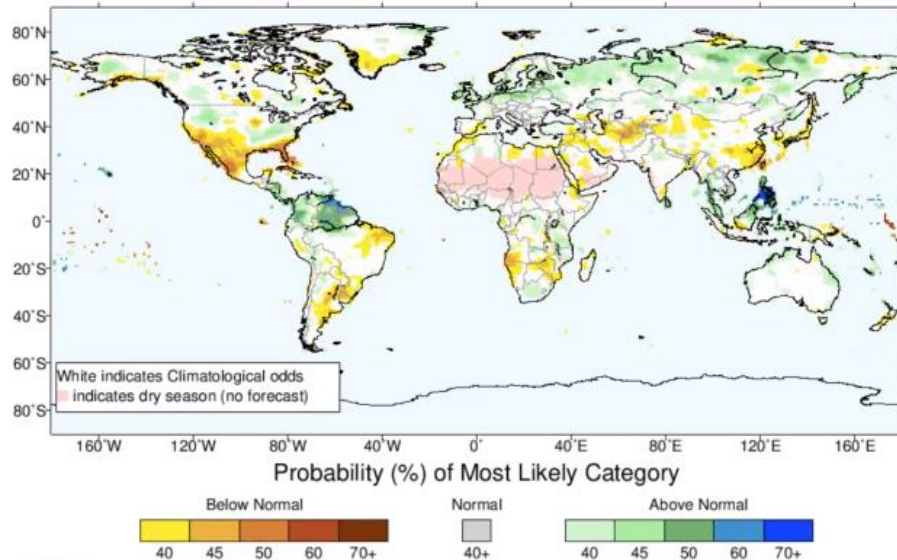
Forecast

ENSO forecasts

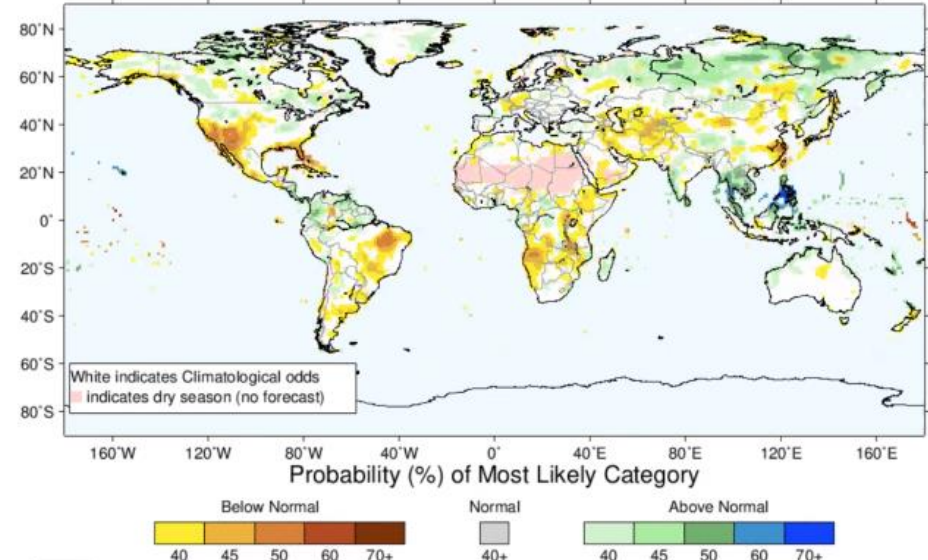
Rainfall, Sea level, Tropical Cyclones and
Coral Bleaching

Rainfall Forecasts (Typical effects of La Niña)

IRI Multi-Model Probability Forecast for Precipitation for January–February–March 2018, Issued December 2017



IRI Multi-Model Probability Forecast for Precipitation for February–March–April 2018, Issued December 2017



- Above-avg rains in Philippines, Indonesia and in southern America
- **Below-avg rains in Greater Horn due to weak response of IOD (+ more rains)**
- Above-avg rains in northern Europe, Asia, parts of the interior U.S. and Alaska
- **Strong drier-than-normal in the southern U.S and central to northern Mexico**
- Drier-than-normal in parts of South America, south Africa, central and eastern Asia, as well as smaller, scattered areas around the world....

**USAPI:
Rainfall
forecast
by
PEAC**

		Rasinfal forecasts for JFM 2018									
Location		UKMO	ECMWF	CA	NASA	NCEP	IRI	APCC	PEAC CCA	Rainfall Outlook	Final Probs
Palau											
Koror	7°	Above	Above	Avg-above	Avg.	Avg-above	Above	Above	Above	Avg-Abv	30:35:35
FSM											
Yap	9° 2'	Above	Above	Above	Avg.	Above	Above	Above	Above	Average	30:40:30
Chuuk	7°	Above	Above	Above	Avg-below	Above	Avg.	Avg.	Above	Avg-Abv	30:35:35
Pohnpei		Avg-above	Above	Above	Below	Above	Avg.	Avg.	Above	Avg-Abv	30:35:35
Kosrae	5°	Avg.	Above	Above	Below	Above	Avg.	Avg.	Clim.	Avg-above	30:35:35
RMI											
Kwajalein		Avg.	Above	Above	Below	Above	Avg.	Below	Above	Average	30:40:30
Majuro	7°	Avg-above	Above	Avg-above	Below	Avg-above	Below	Below	Above	Avg-above	30:35:35
Guam and CNMI											
Guam	13°	Above	Above	Avg-above	Avg-above	Avg-above	Above	Above	Above	Average	30:40:30
Saipan	1°	Above	Above	Avg-above	Avg-above	Avg-above	Avg-above	Above	Above	Average	30:40:30
American Samoa											
Pago Pago		Avg-above	Above	Avg-above	Avg.	Avg-above	Avg.	Avg.	Avg-above	Avg-above	30:35:35
State of Hawaii											
19.7° - 21.0' N, 155.0° - 159.5' W											
Lihue		Avg.	Above	Avg-above	Avg.	Avg-above	Above	Avg.	Above	Avg-above	30:35:35
Honolulu		Avg.	Above	Avg-above	Avg.	Avg-above	Above	Avg.	Above	Average	30:40:30
Kahului		Avg.	Above	Avg-above	Avg.	Avg-above	Above	Below	Above	Avg-above	30:35:35
Hilo		Avg.	Above	Avg-above	Avg.	Avg-above	Above	Below	Avg-above	Avg-above	30:35:35

Seasonal Sea level forecasts: USAPI

Observed and Forecasts of MEAN anomaly for JFM/2018 Season (in INCHES)

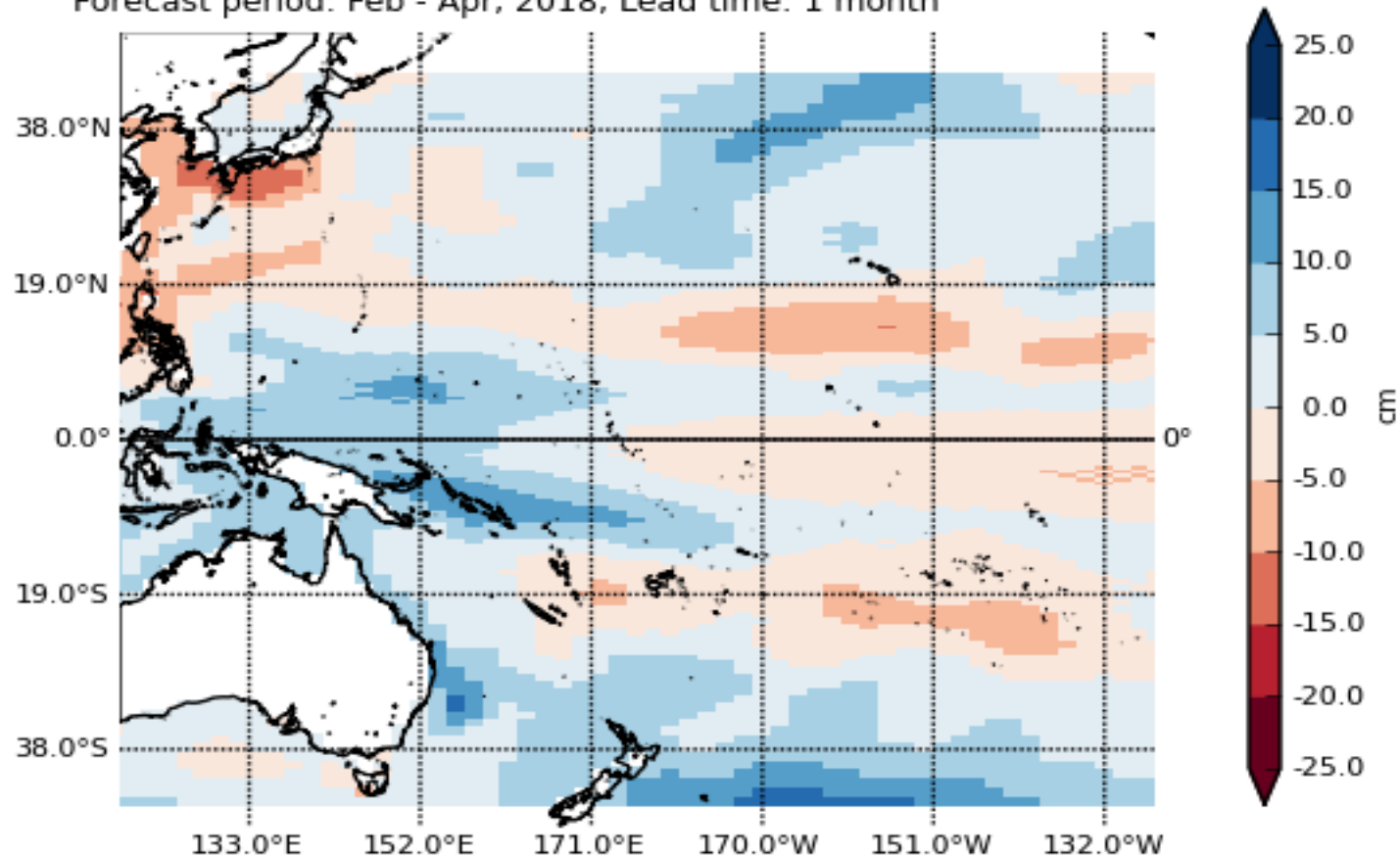
Tide-gauge	Observed Dec-17	JFM-18 Mean Forecasts	JFM-18 Std_Dev	JFM-18 Outlook
Guam,	+7	+5	+4.1	Above-Stable
Malakal, Palau	+4	+5	+4.3	Above-Stable
Yap, FSM	+9	+6	+4.6	Above-Stable
Chuuk	+9	+6	+4.4	Above-Stable
Pohnpei	+9	+7	+4.7	Above-Stable
Kapingamarangi	+7	+6	+4.5	Above-Stable
Majuro, RMI	+8	+7	+3.5	Above-Stable
Kwajalein	+6	+6	+3.6	Above-Stable
Pago Pago, AS	+7	+6	+3.1	Above-Stable
Honolulu	+5	+4	+1.7	Above-Falling
Hilo	+6	+5	+1.8	Above-Stable

MEAN is the difference between the mean sea level for the given month and the 1983 through 2001 monthly mean sea level value at each station (seasonal cycle removed);

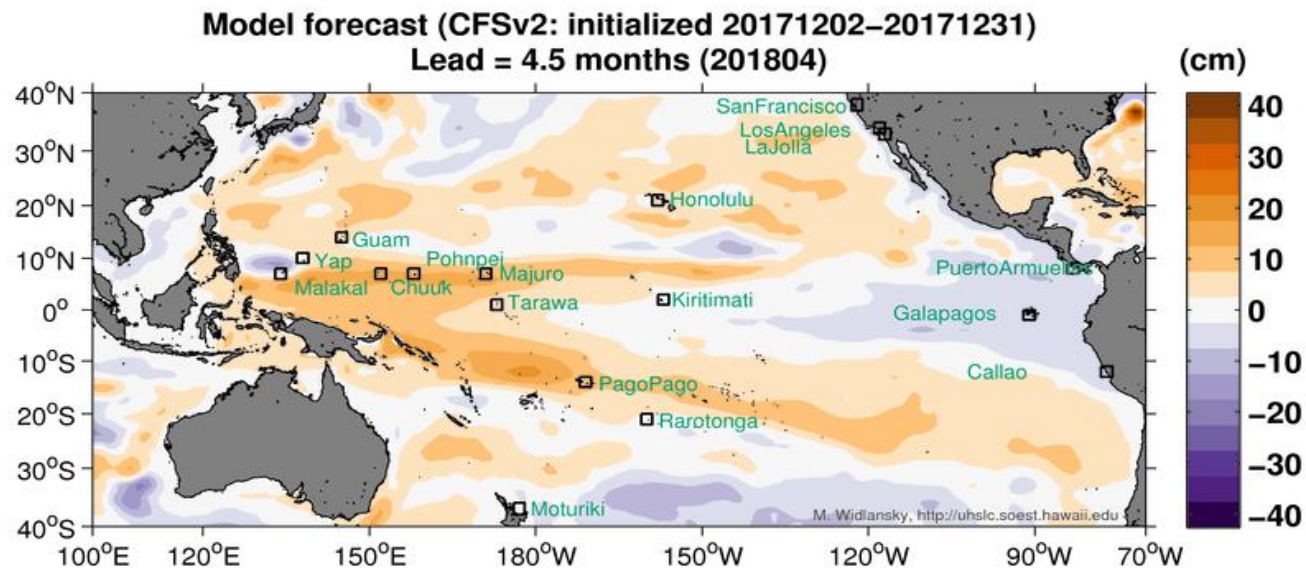
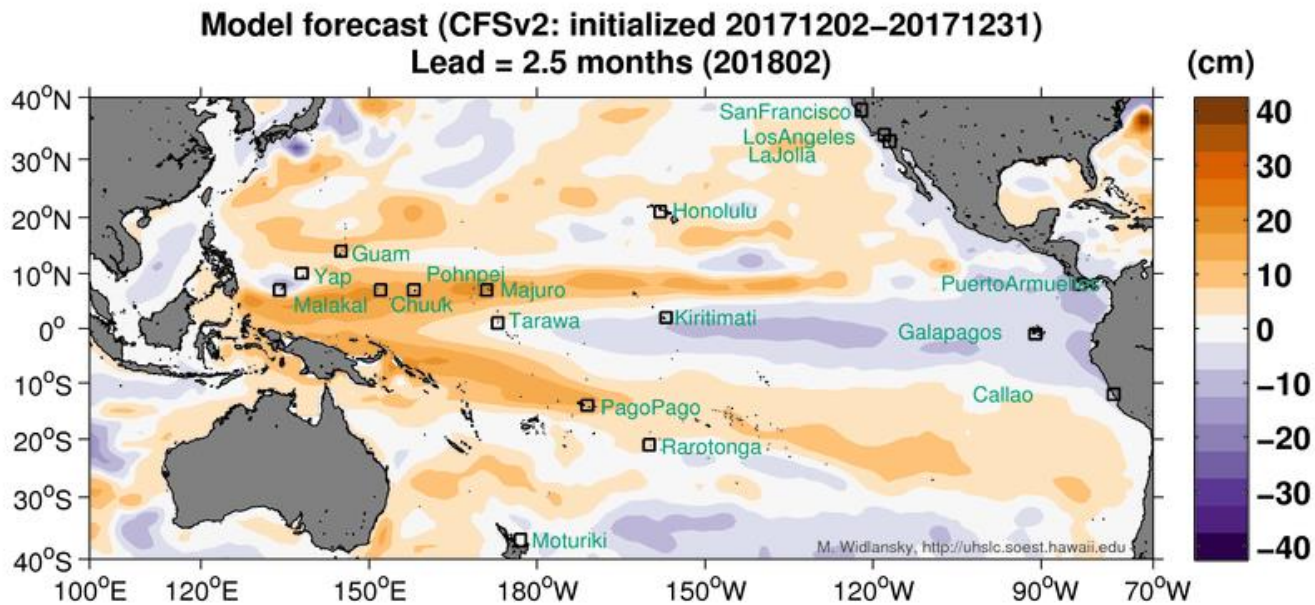
Seasonal SL Forecasts in the Western Pacific (Feb-Apr 2018)

PACCSAP: Dynamical Seasonal Outlooks for the Pacific.
Outlook based on POAMA 2 CGCM adjusted for historical skill.
Experimental outlook for demonstration and research only.
Variable: HEIGHT(cm)
Model initialised: 20180111
Forecast period: Feb - Apr, 2018, Lead time: 1 month

- **Sea Level across the Western Pacific Basin will be above average during FMA 2018**

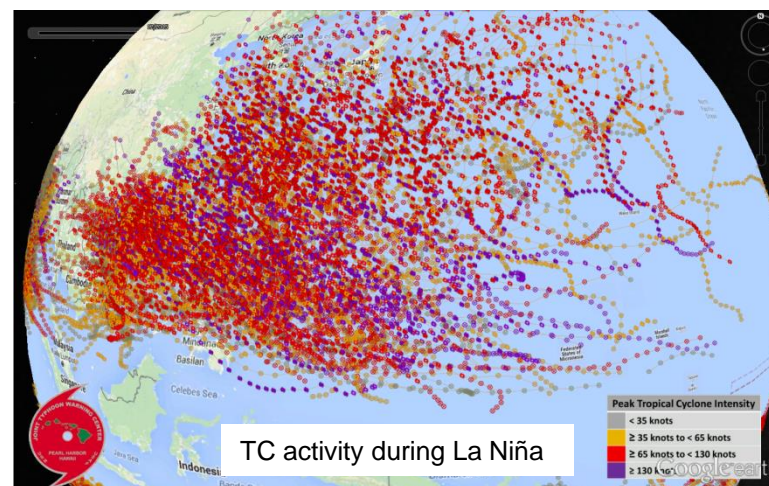
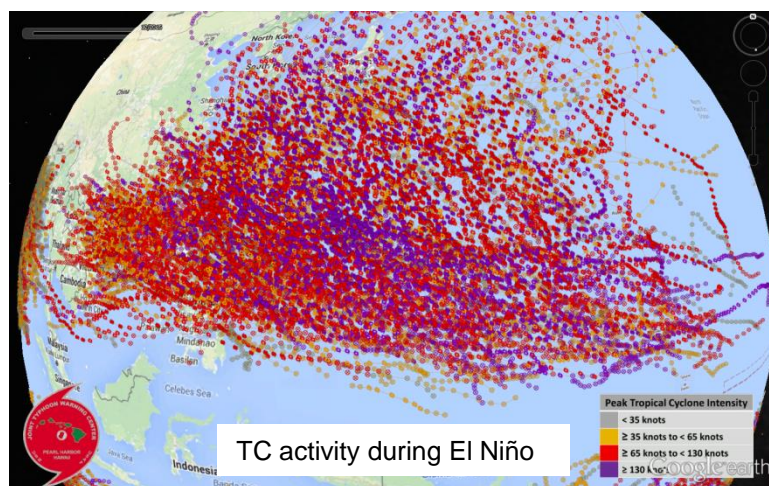


Sea Level Forecasts



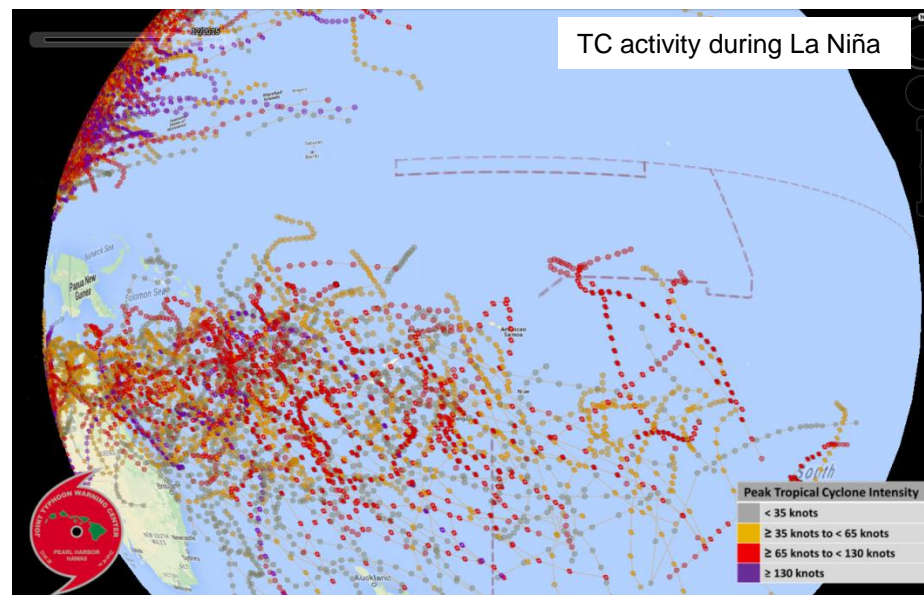
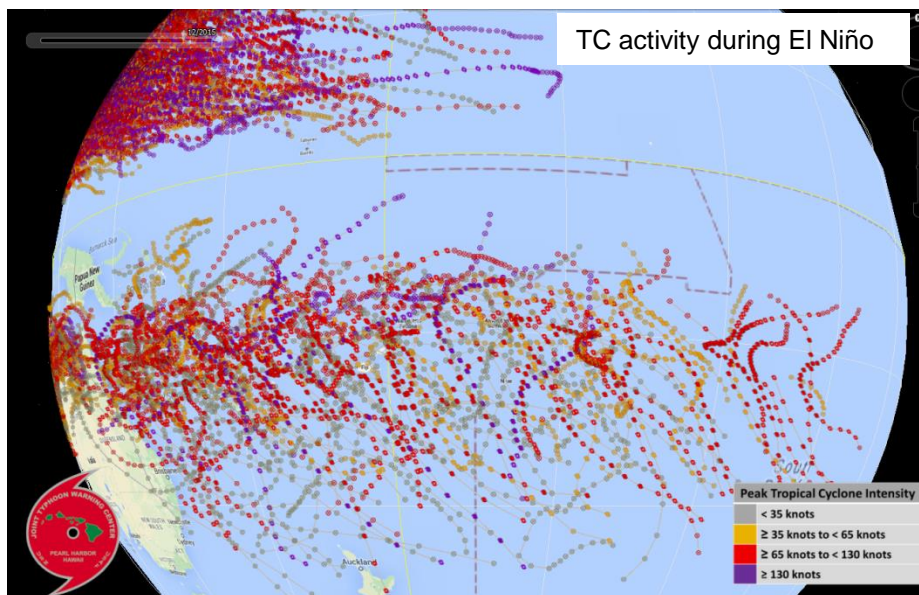
Tropical Cyclone Forecast

- US Affiliated Pacific Islands ()
 - Tropical cyclone activity will be near average with a westward displacement (Philippine Sea and South China Sea to remain the focus)
 - Below average in the western North Pacific basin
- From climatology, enhanced activity in the Bay of Bengal during La Niña



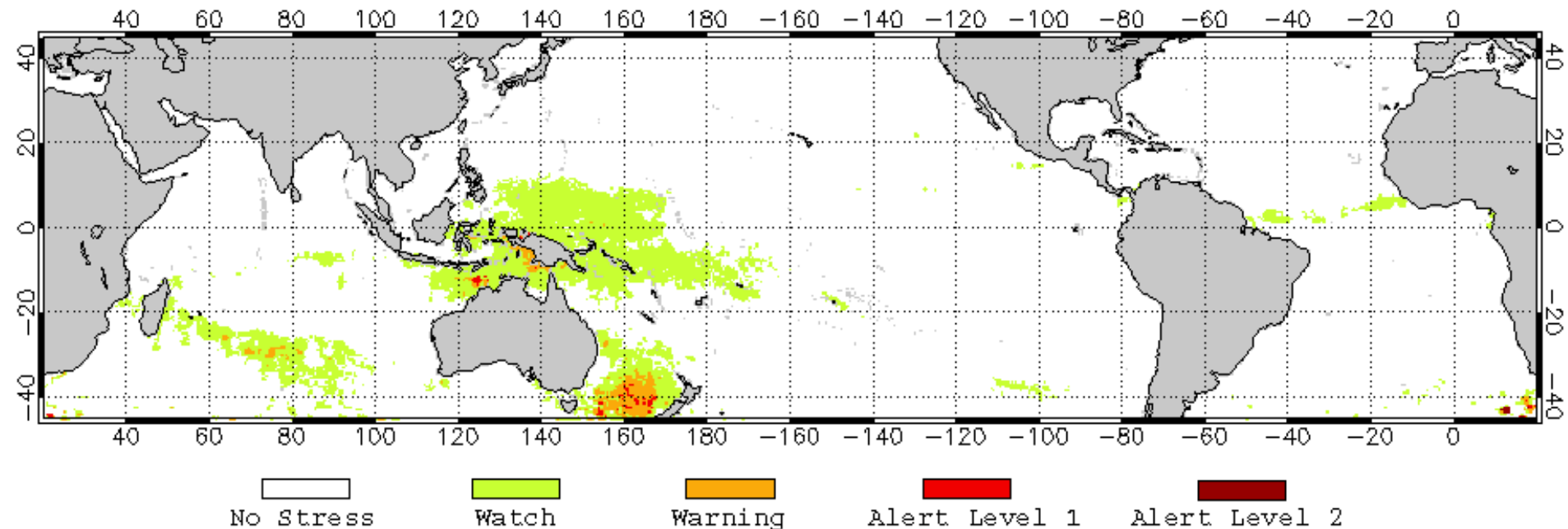
Tropical Cyclone Forecast

- American Samoa TC (PEAC Center Issued November 28th)
 - November to April TC season
 - American Samoa will be near average to slightly below average
- Australia (Australian BOM Forecast issued October 10th)
 - BoM is calling for near-average to slightly above average
 - NIWA is calling for a slightly above average
 - higher around the Coral Sea and west of the DL, and lower further east



Coral Bleaching Outlook

NOAA/NESDIS Bleaching Alert Area, 12/28/2017



- High probability of Coral Bleaching across the Pacific Islands
- Western South Pacific Islands may see bleaching in the coming months
- Australia at risk of bleaching events

La Niña and Flu Pandemics



- **Worldwide pandemics of influenza caused widespread death and illness in 1918, 1957, 1968 and 2009.**
- **A new study examining weather patterns around the time of these pandemics finds that each of them was preceded by La Niña conditions in the equatorial Pacific.**
- **La Niña alters the stopover time, fitness and interspecies mixing of migratory birds, which are thought to be a primary reservoir of human influenza.**
- **The scientists theorize that altered migration patterns promote the development of influenza.**

Summary

- **A weak La Niña event continues up to JFM of 2018, and then likely to decay rapidly in AMJ of 2018;**
- **Above-average rain in USAPIs and Philippines, Indonesia and in southern America, and parts of the interior U.S. and Alaska;**
- **Below-average rain in Greater Horn, South America, and eastern Asia;**
- **High sea Level across the Western Pacific FMA 2018;**
- **TC activity will be near average over the WNP;**
- **Flu Pandemics in next 3-6 months.**



The PEAC Center

The Pacific ENSO Applications Climate
Center

Mahalo
Mahalo

Photo courtesy of
Lt. Charlene Felkley