



AGRICULTURAL OUTLOOK FORUM

*Outlook for **El Niño** and its Impact on Global Crop Weather*

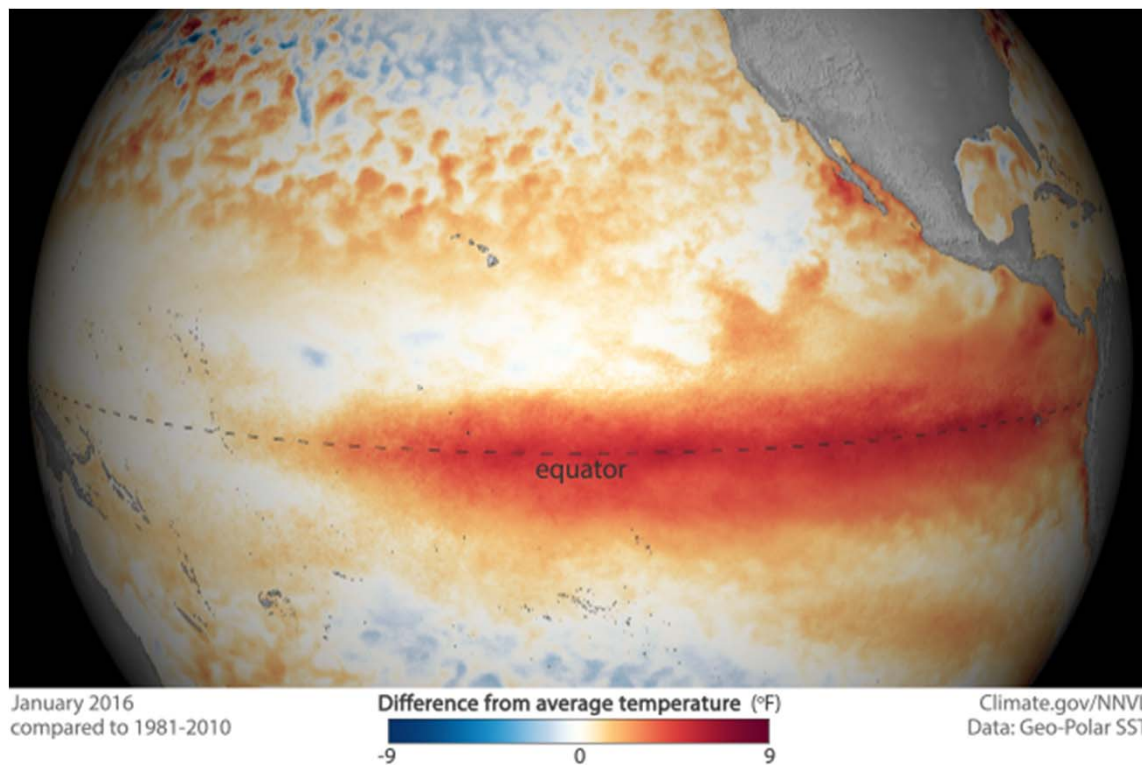


Image source – <https://www.climate.gov/enso>

Harlan D. Shannon
Meteorologist
U.S. Department of Agriculture
Office of the Chief Economist
World Agricultural Outlook Board
Washington D.C., U.S.A.

Godzilla El Niño



Source - <http://www.latimes.com/local/lanow/la-me-ln-godzilla-el-nino-winter-california-20150821-htmlstory.html>

Water shortages in South Africa



Source - <http://phys.org/news/2016-01-south-africa-drought-crops-shortages.html>

Drought in Papua New Guinea



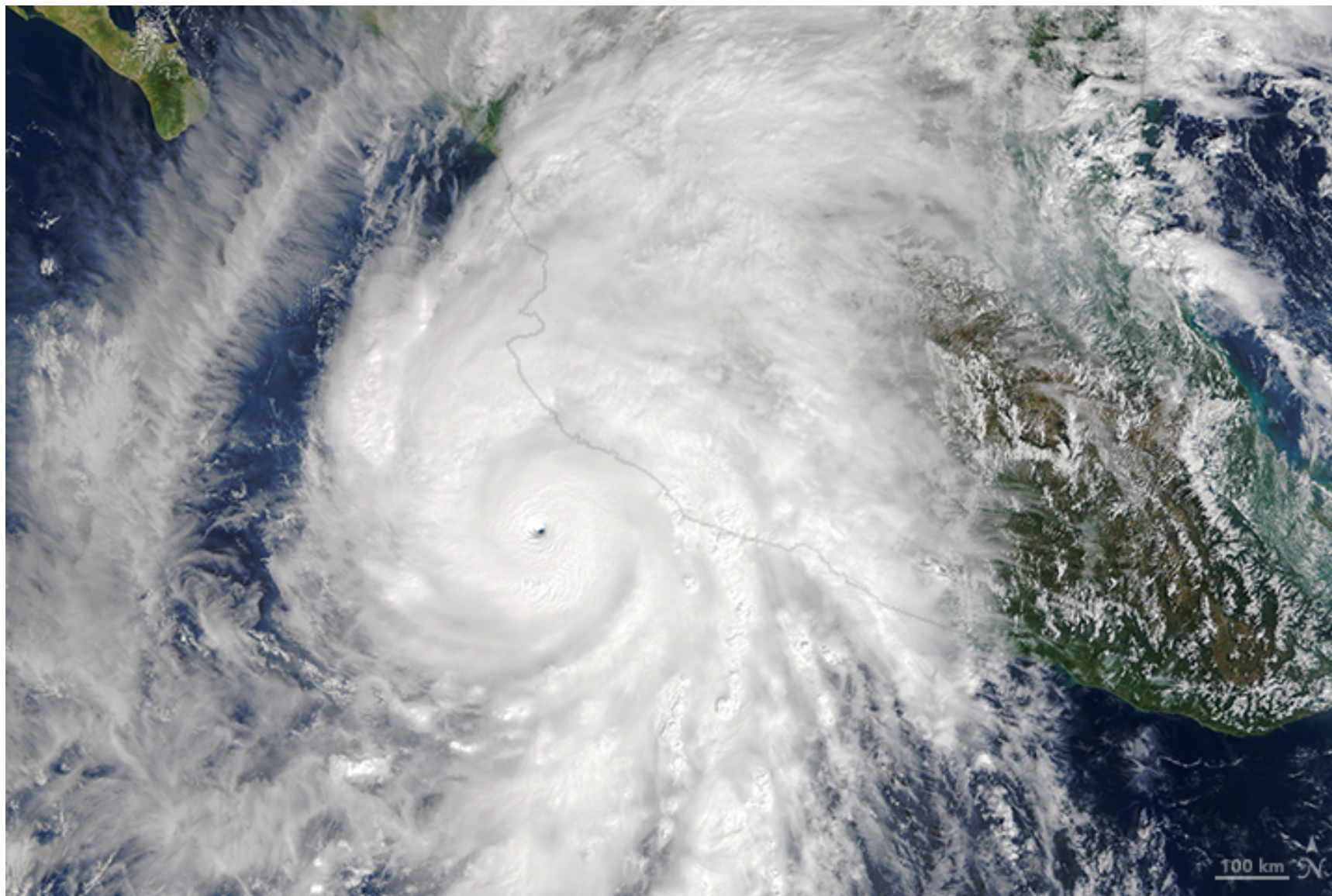
Source - <http://www.theguardian.com/environment/2015/oct/12/el-nino-could-leave-4-million-people-in-pacific-without-food-or-drinking-water>

Flooding in Paraguay



Source - <http://www.ibtimes.co.uk/el-nino-photos-show-widespread-flooding-worse-weather-come-1536302>

Hurricane Patricia – 200 mph sustained winds



Source - <http://earthobservatory.nasa.gov/IOTD/view.php?id=86882>

Deadly December tornadoes



Source - <http://www.usatoday.com/story/weather/2015/12/27/deadly-december-tornadoes/77947472/>

Excessive rains



Source - <http://abc7.com/weather/photos-best-images-from-socal-el-nino-storms/1148740/#gallery-4>

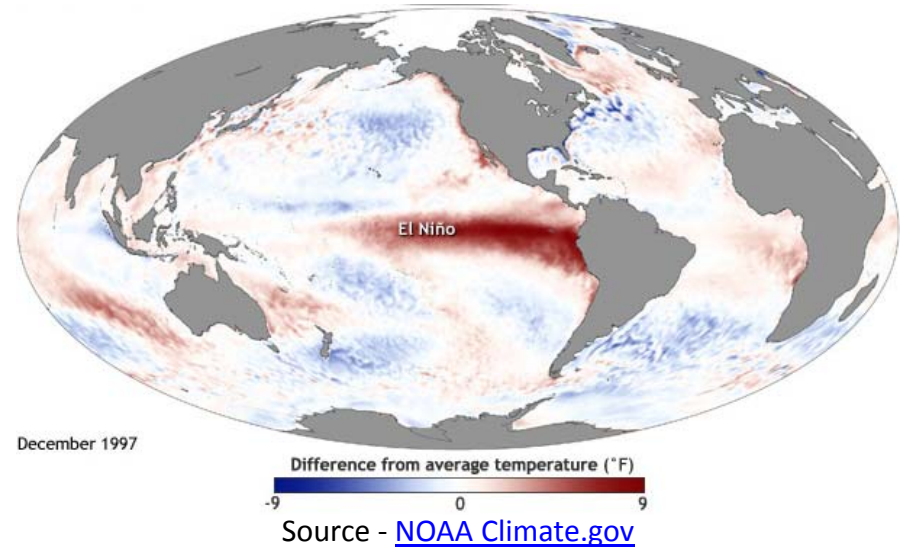
Welcome mountain snows



Source - <http://abc7.com/weather/el-nino-dumps-snow-across-california-mountain-areas/1147492/>

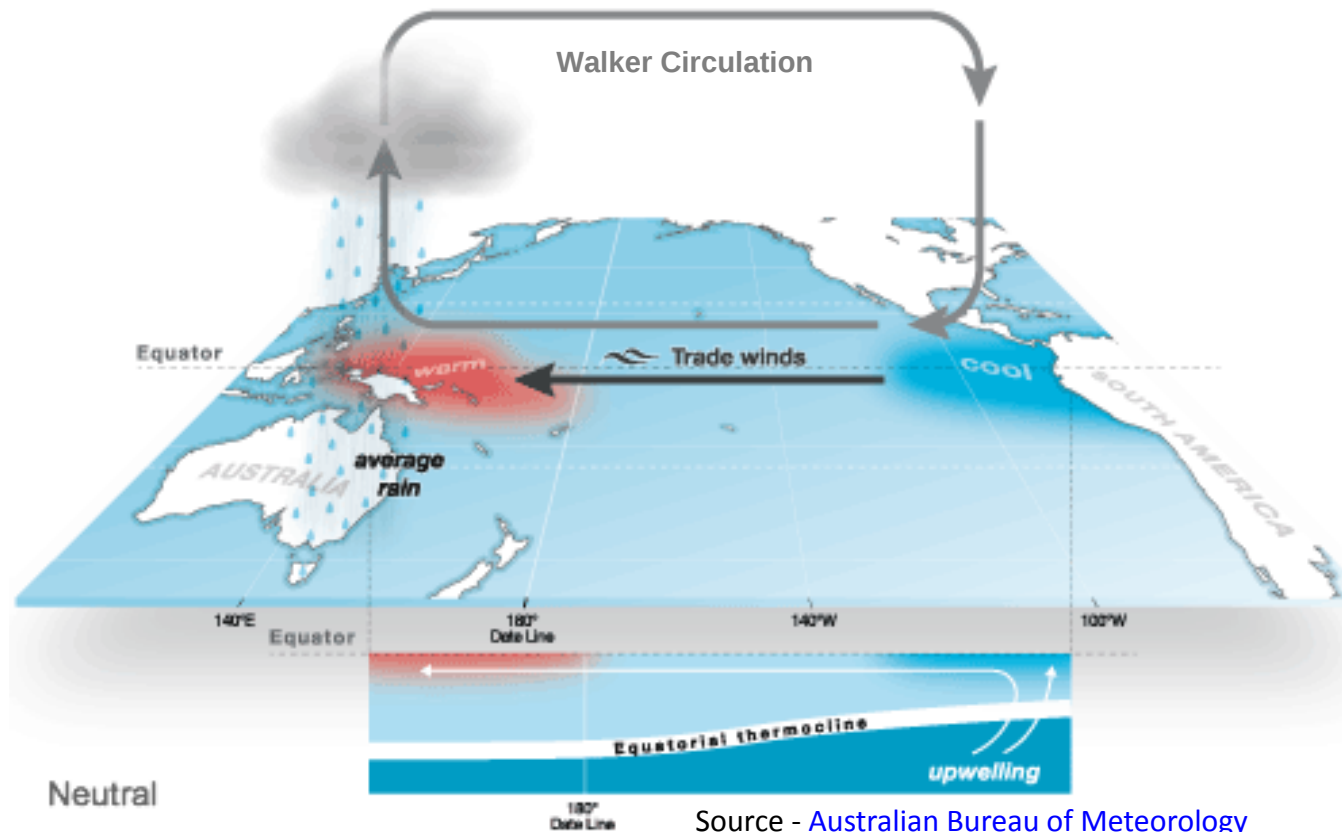
What is El Niño?

- El Niño was first recognized by fishermen off the coast of South America in the 1600's, with the appearance of unusually warm waters in the Pacific Ocean.
- This phenomenon was referred to as El Niño (i.e., *Little Boy* or *Christ Child* in Spanish) because of the tendency for the warm waters to arrive around Christmas.



- In the mid 1900's, scientists discovered that the anomalous warming in the central & eastern Pacific Ocean was linked to periodic variability (i.e., oscillations) in regional atmospheric patterns.
- The phenomenon is now referred to as ENSO (El Niño / Southern Oscillation), in an acknowledgement that there are both ocean and atmospheric components.

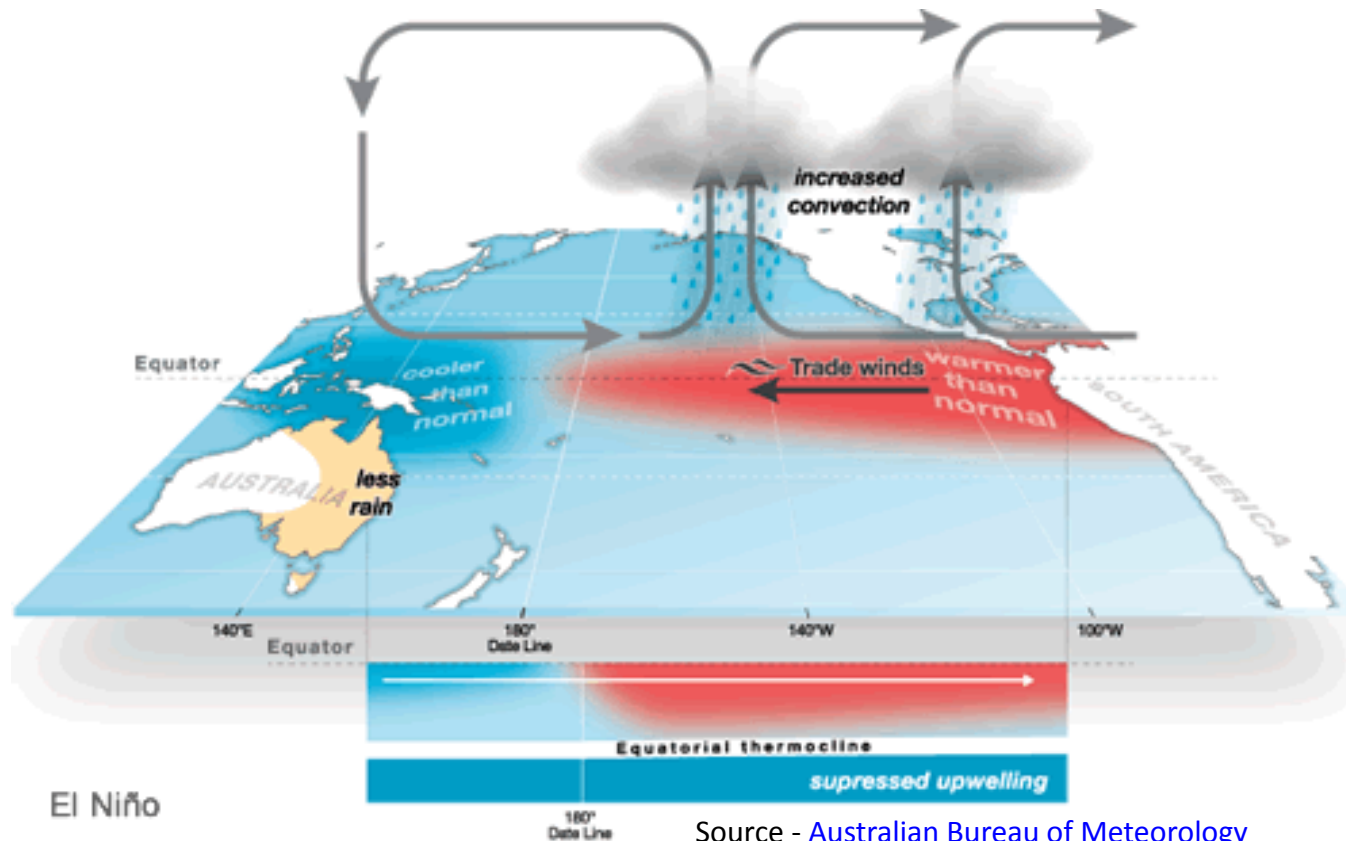
ENSO Neutral Phase



Source - [Australian Bureau of Meteorology](http://www.bom.gov.au/enso/)

- At the surface, trade winds blow from east to west across the Pacific Ocean.
- The winds blow water westward, helping pool the warmest water in the west Pacific.
- The warmer waters in the west promote convection, which drives the Walker Circulation.

ENSO Warm Phase (**El Niño**)



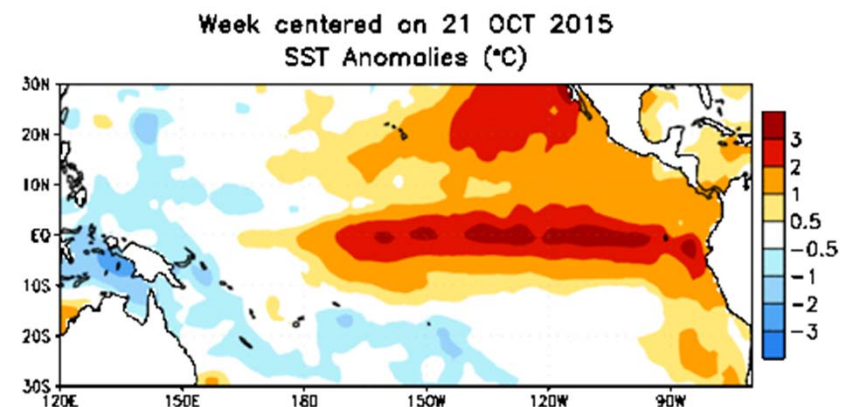
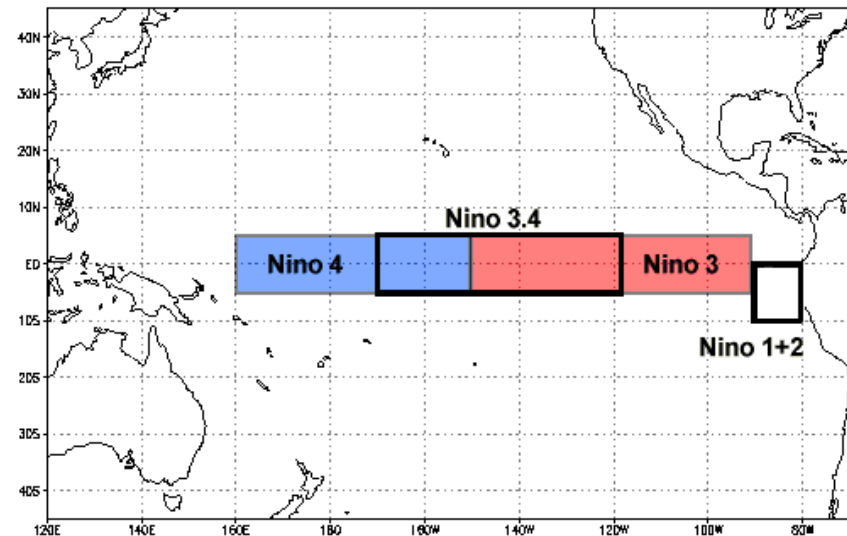
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- About every 2-7 years, the easterly trade winds weaken (or become westerly).
- SST rise above normal in the central & eastern Pacific; convection shifts eastward.
- This displacement in convective activity disrupts the Walker Circulation, leading to anomalous temperature & precipitation patterns on local & regional levels.

How is the strength of an **El Niño** measured?

- The current state of the ENSO is often measured by sea surface temperature anomalies in parts of the equatorial Pacific Ocean.
- NOAA/NWS/CPC declares the onset of an **El Niño** when 3-month average SST departures exceed 0.5°C in Nino region 3.4 [5°N - 5°S , 120°W - 170°W]
- El Niño** intensity classifications:

Classification	SST anomalies
Neutral ENSO	$< 0.5^{\circ}\text{C}$
Weak El Niño	$+0.5^{\circ}\text{C}$ to $+0.9^{\circ}\text{C}$
Moderate El Niño	$+1.0^{\circ}\text{C}$ to $+1.4^{\circ}\text{C}$
Strong El Niño	$+1.5^{\circ}\text{C}$ to $+1.9^{\circ}\text{C}$
Very Strong El Niño	$\geq +2.0^{\circ}\text{C}$

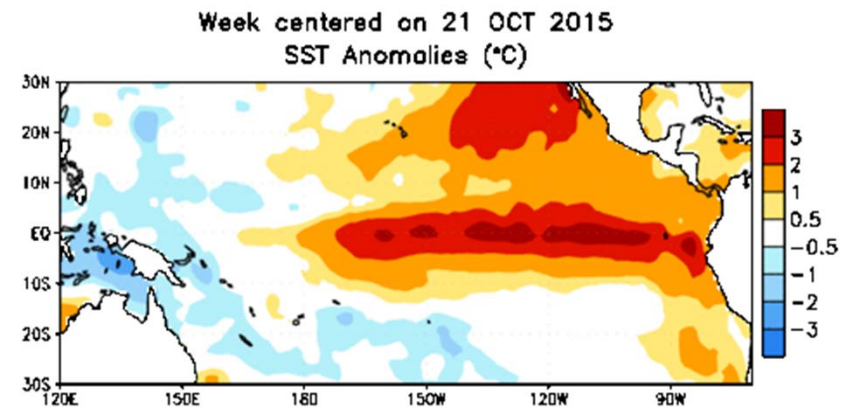
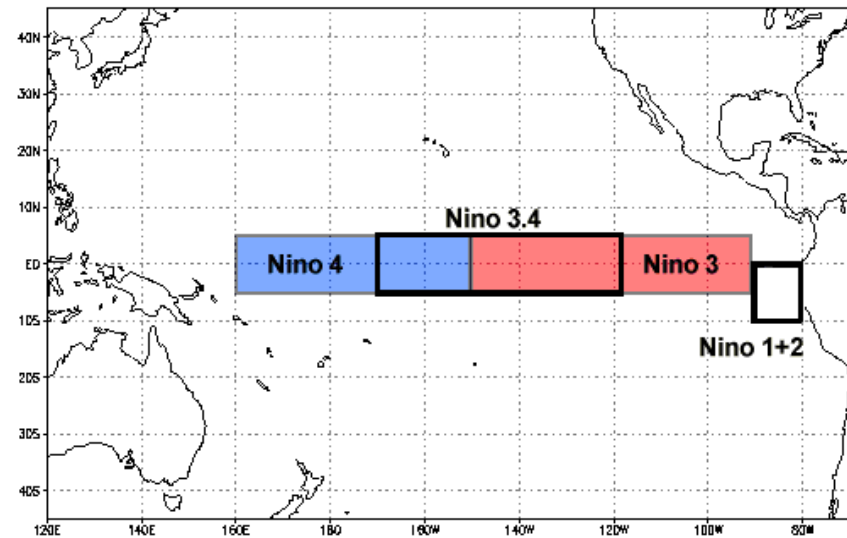


Source - [NOAA/NWS/CPC](https://www.noaa.gov/data/monitoring-assessments/monitoring-el-nino/)

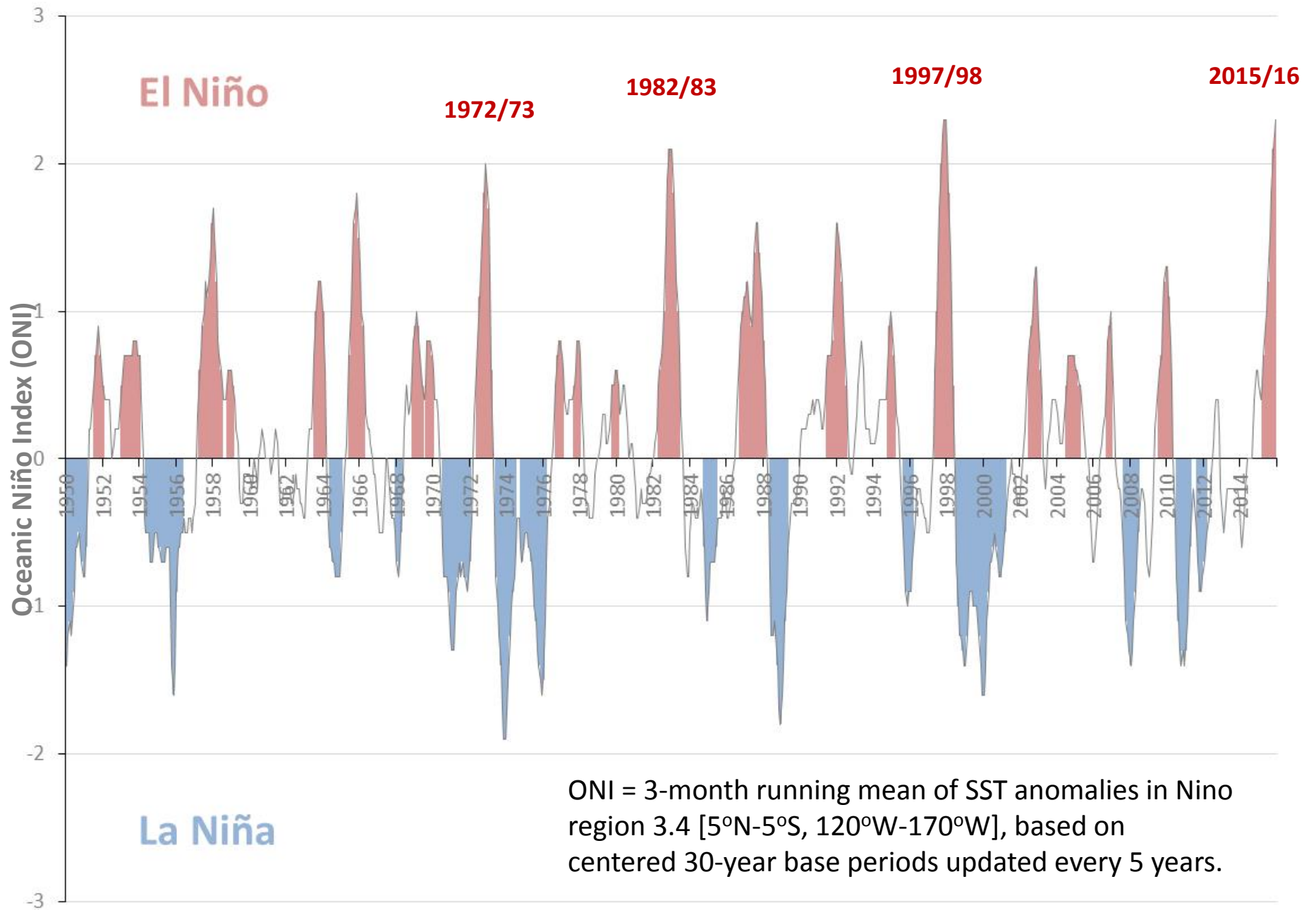
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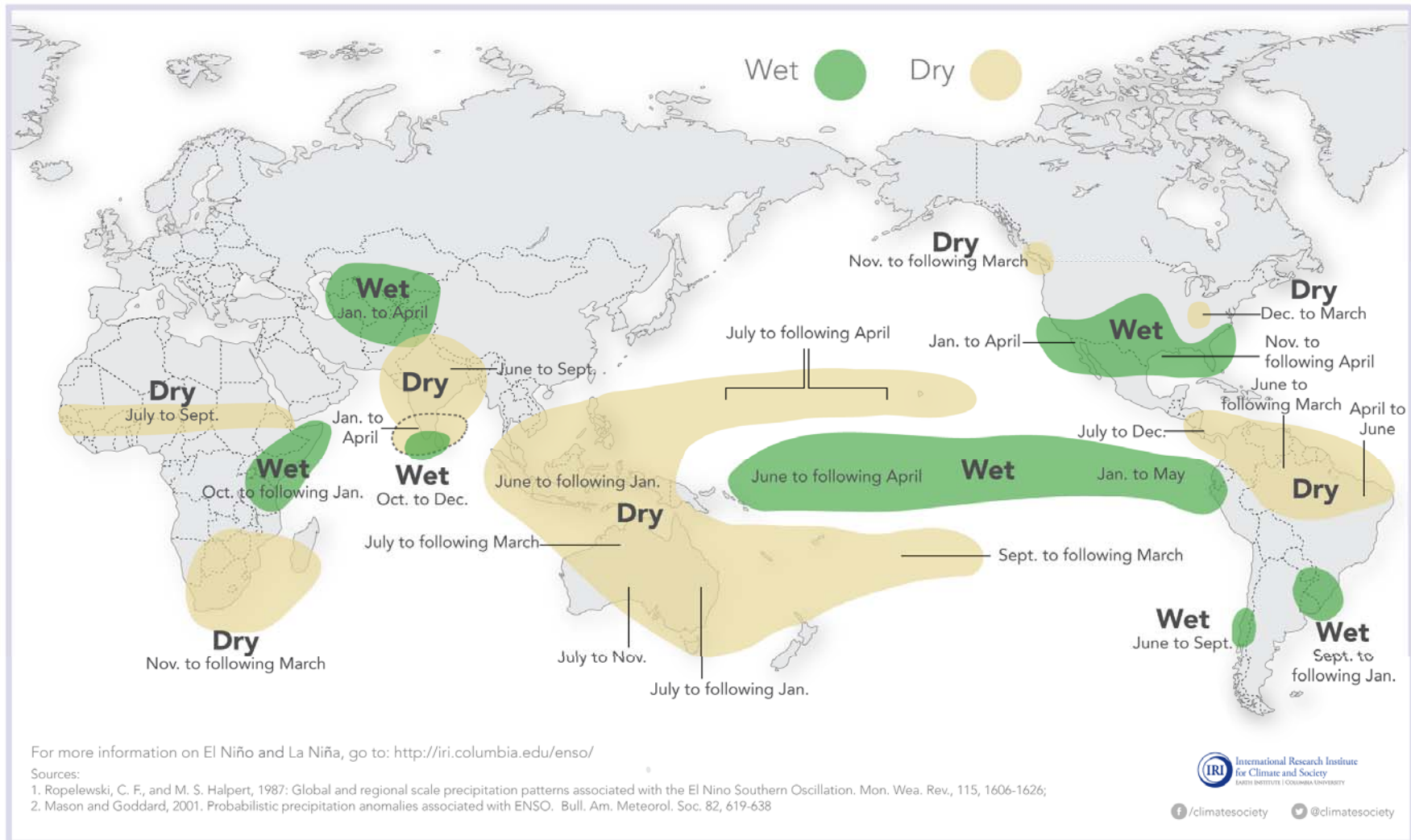


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Typical Impacts

El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.

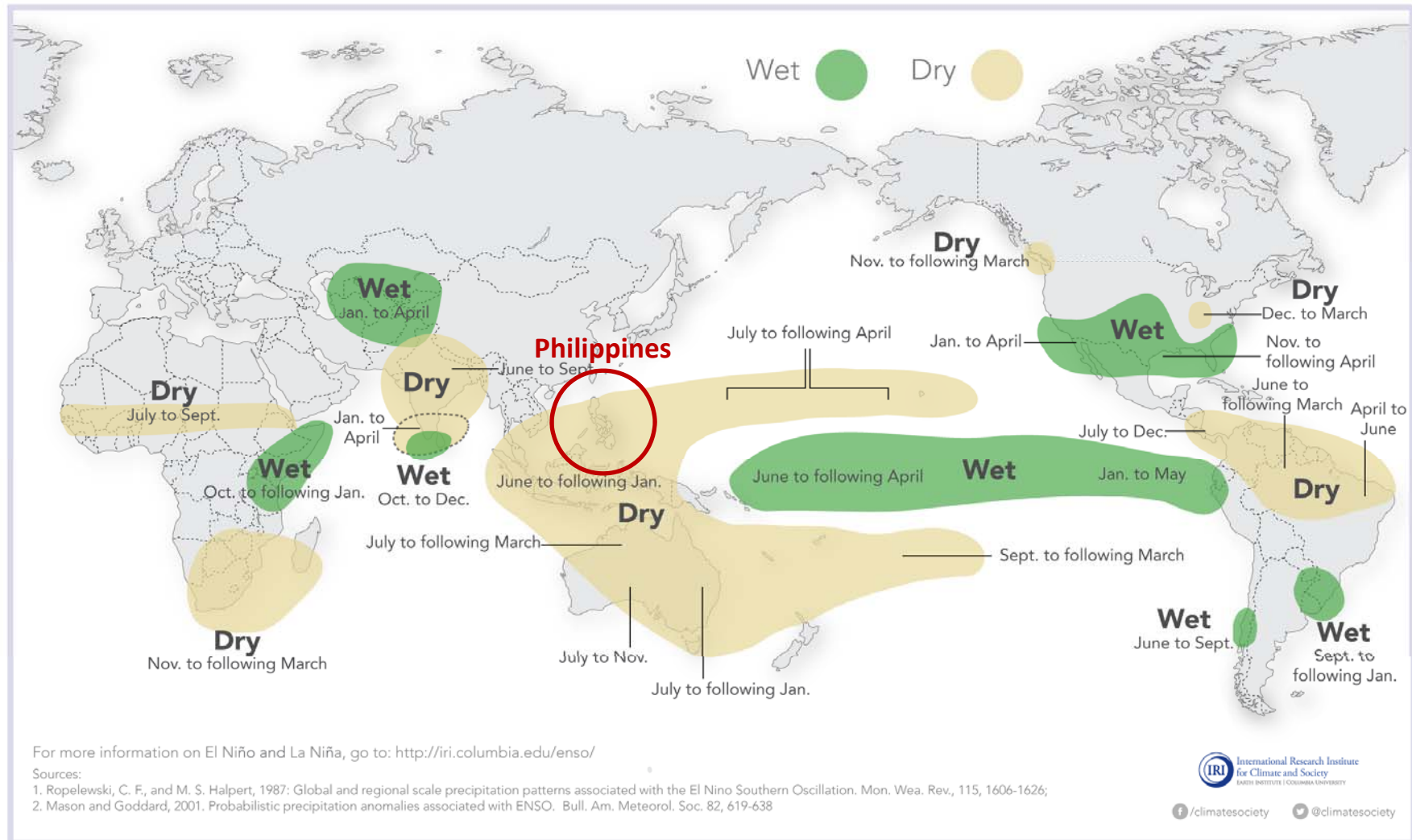


Source - <http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/ElNinoandRainfall.png>

Typical Impacts

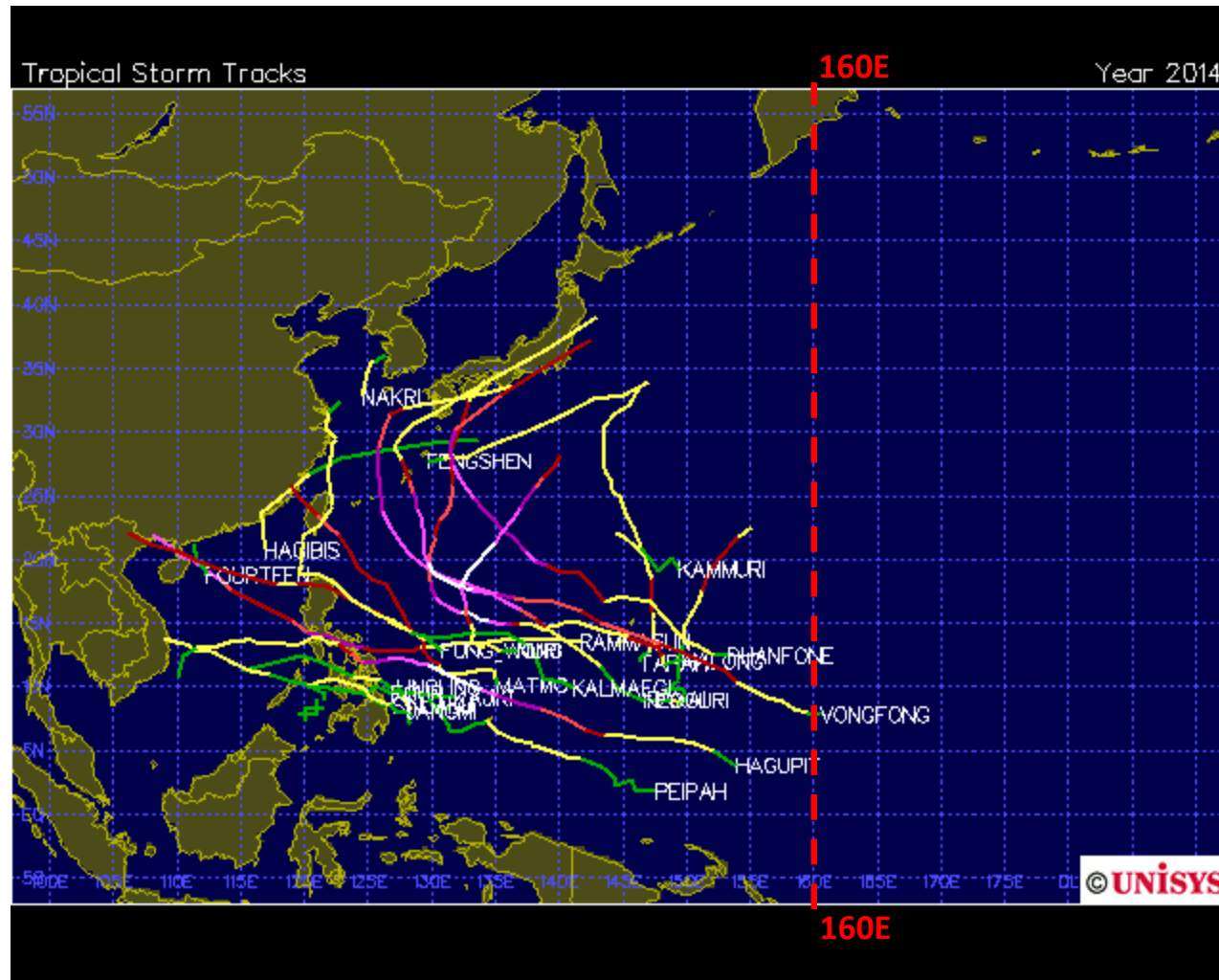
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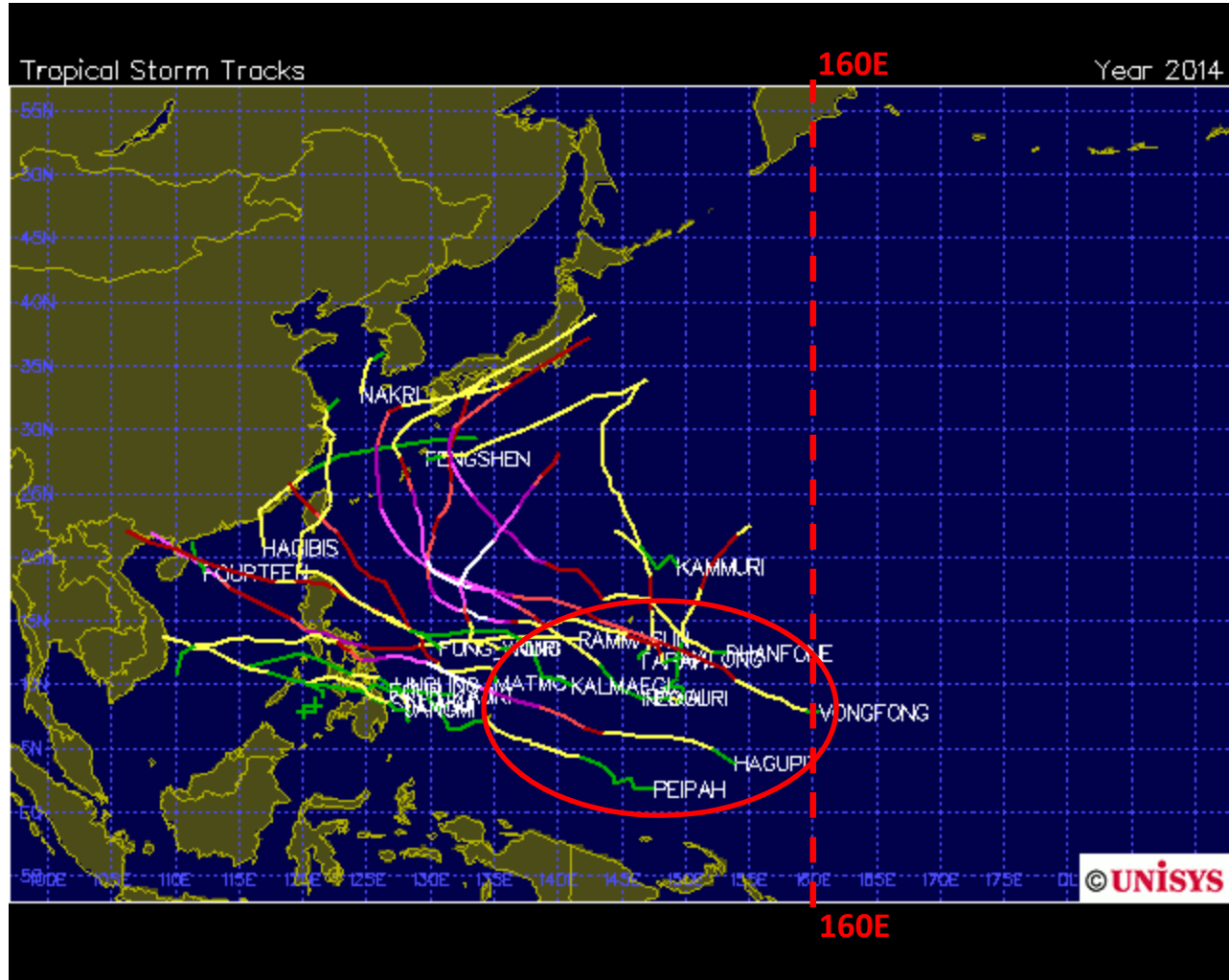
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Western Pacific Tropical Cyclone Tracks - 2014



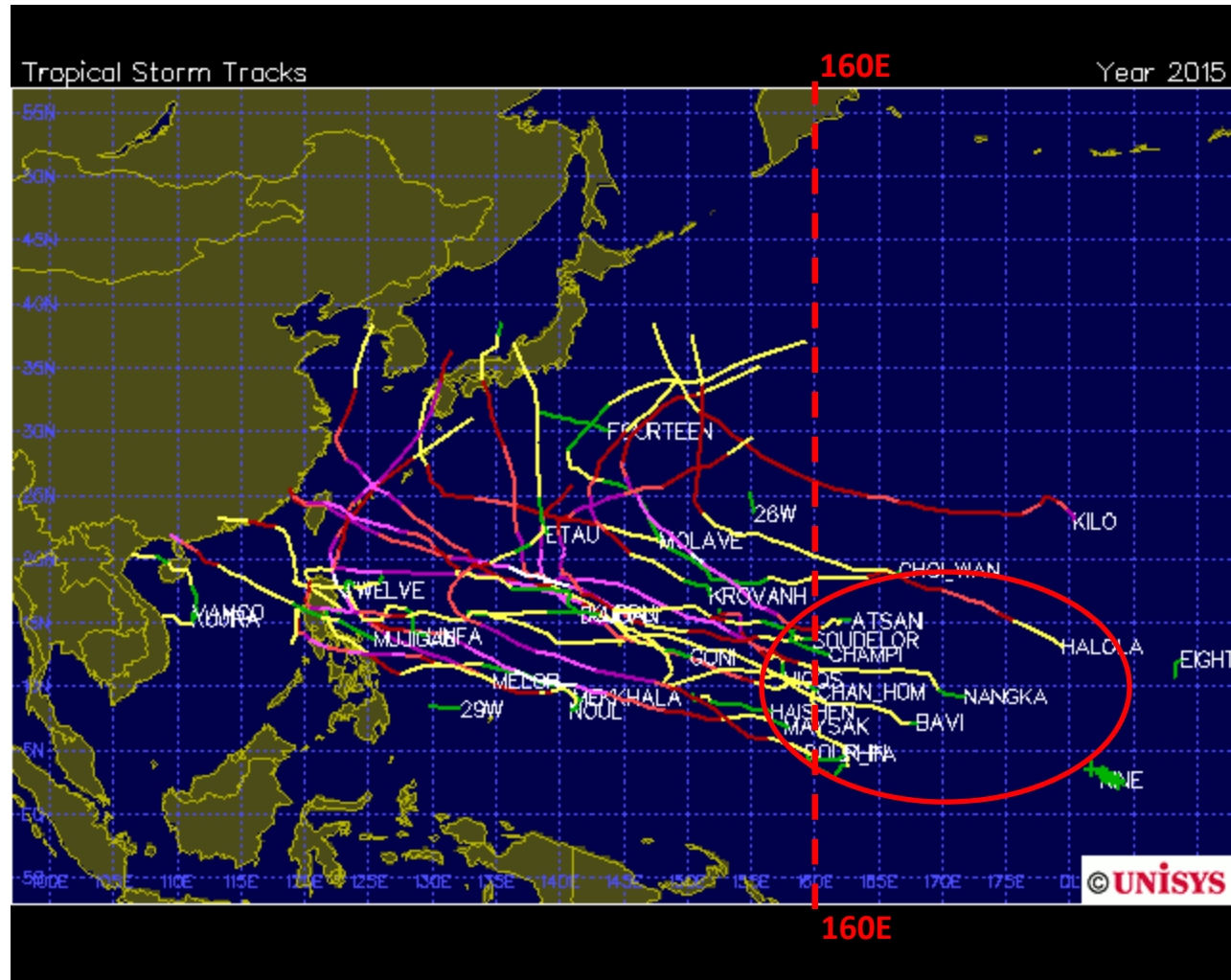
Source - http://weather.unisys.com/hurricane/w_pacific/2014/index.php

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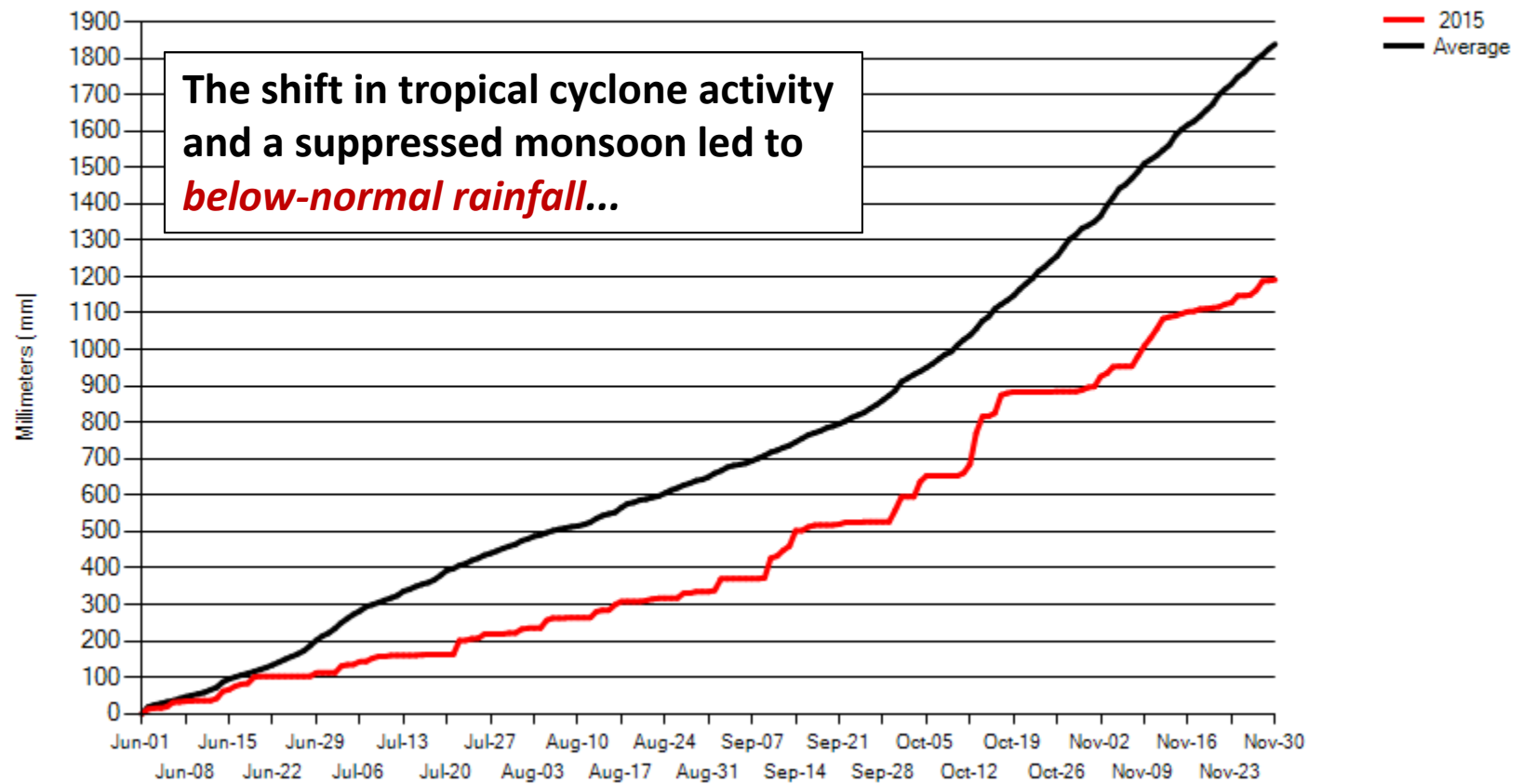
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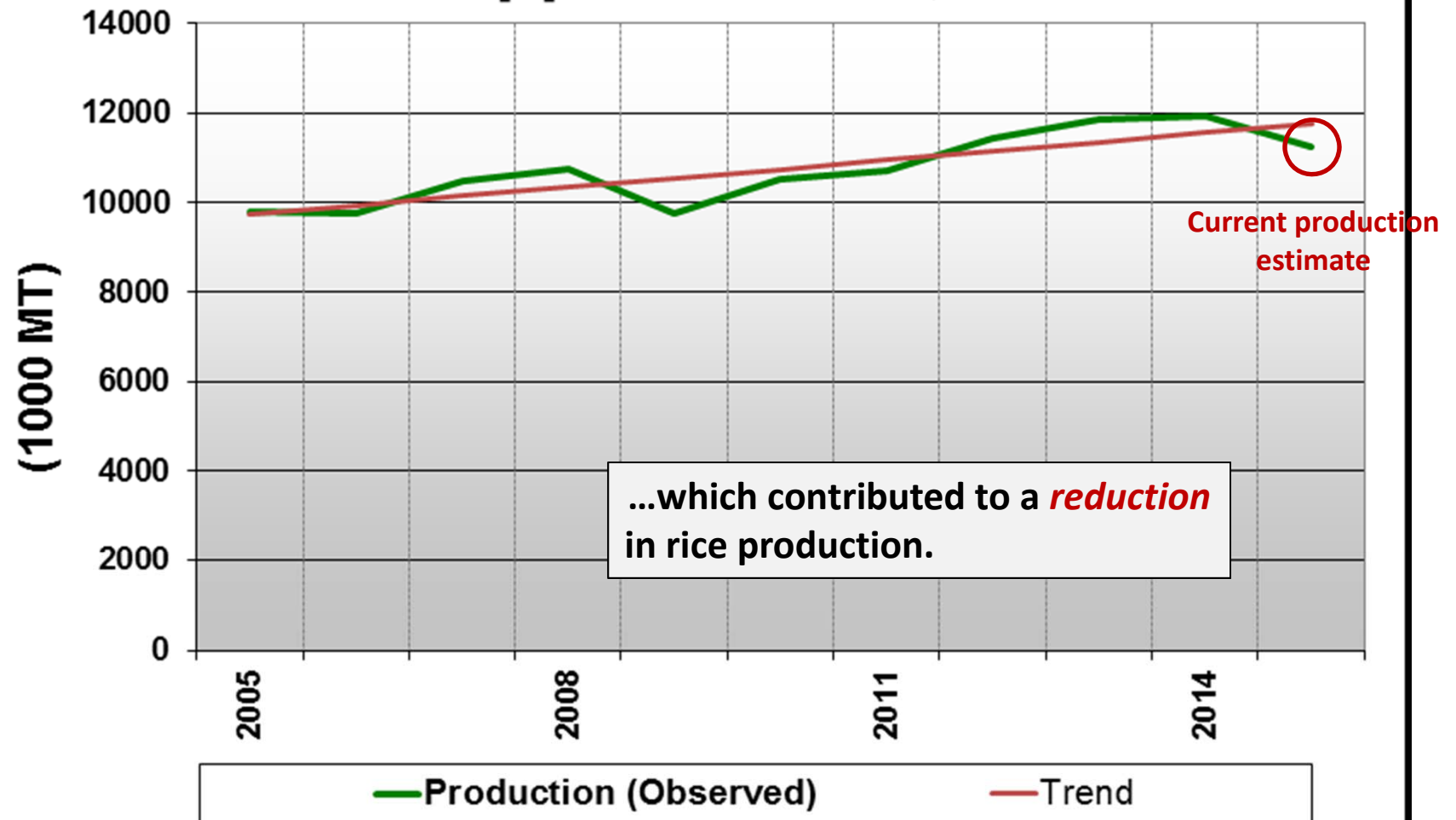
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Philippines

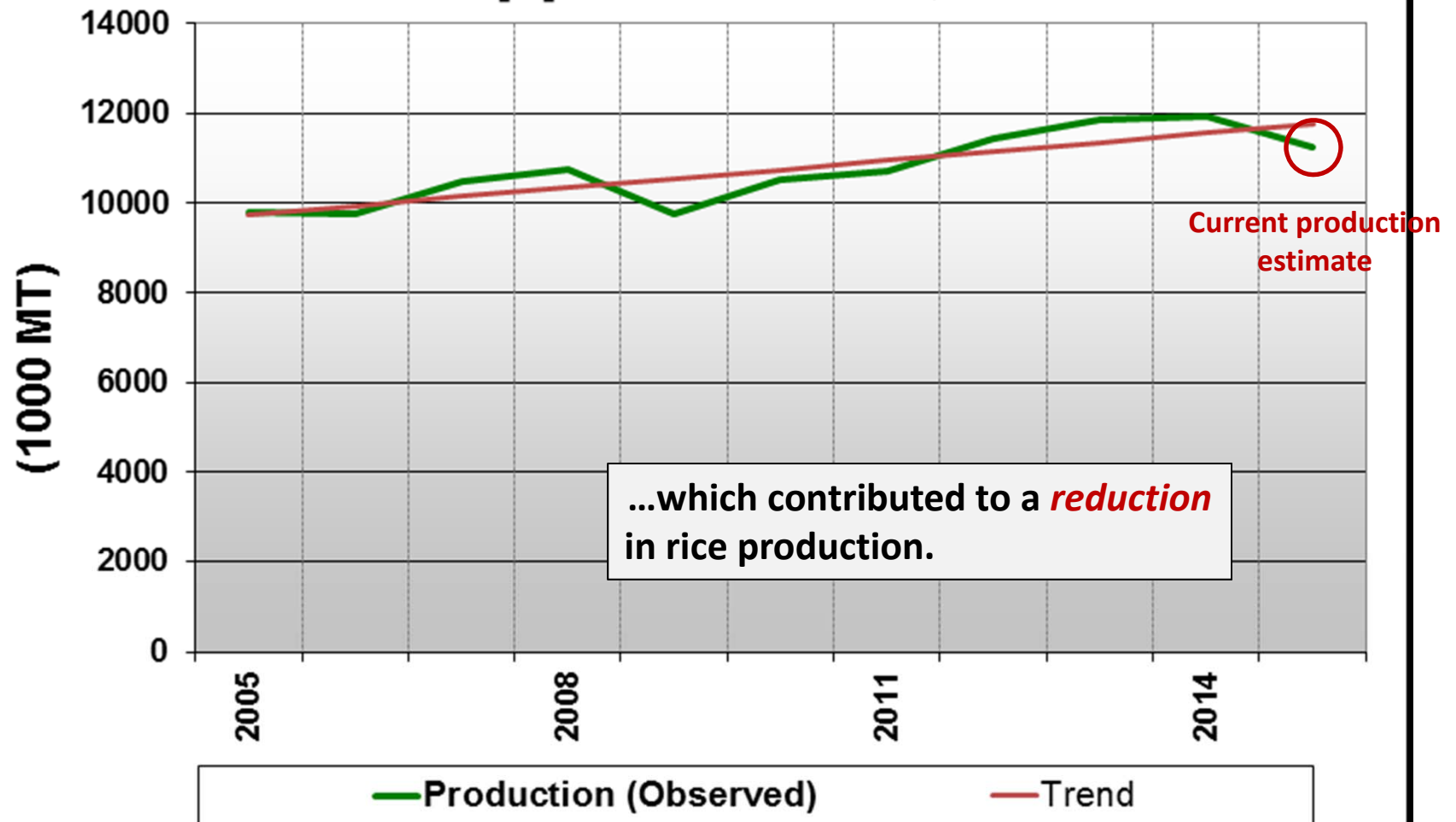
Cumulative Precipitation



Philippines: Rice, Milled



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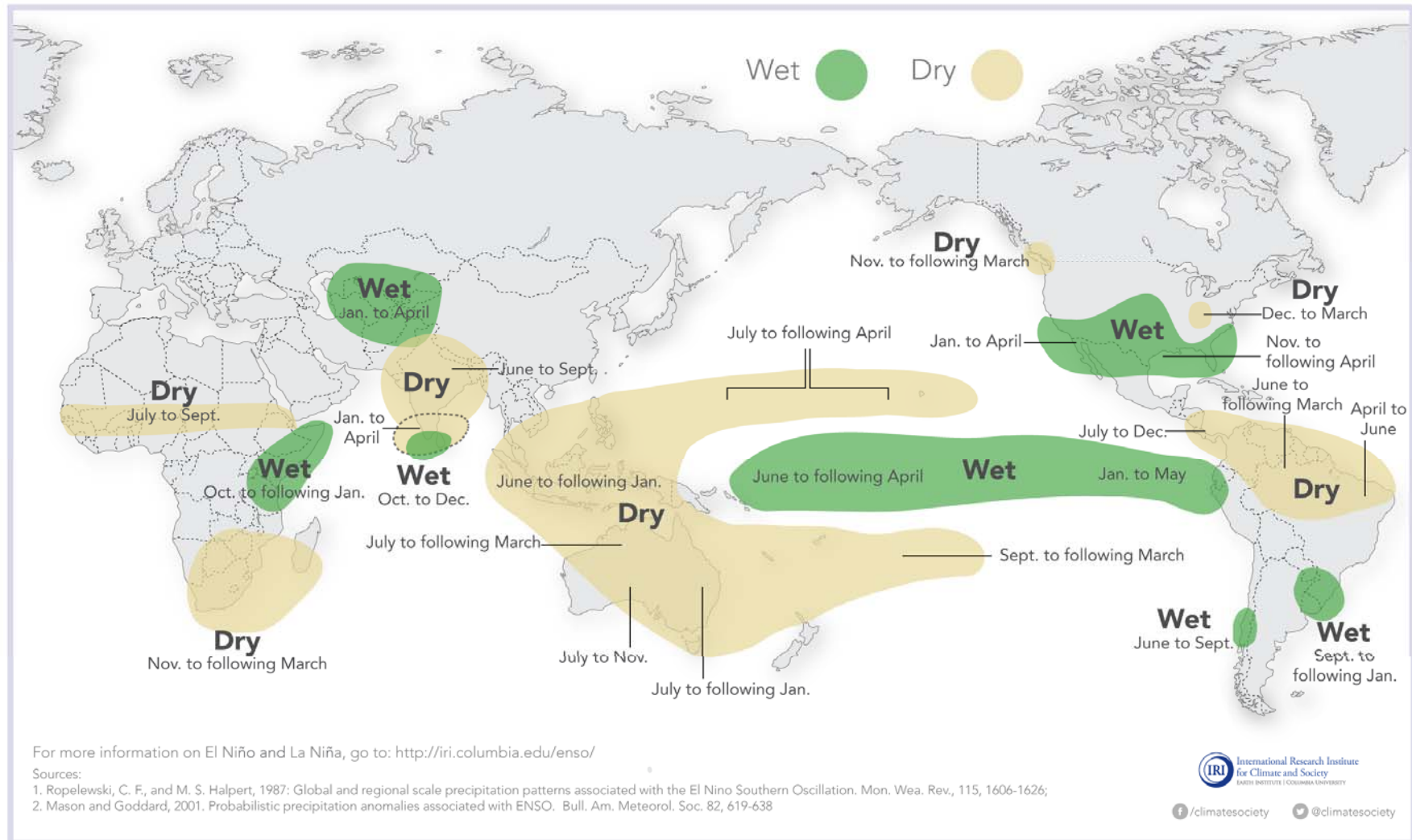


Textbook example of El Niño dominating throughout growing season.

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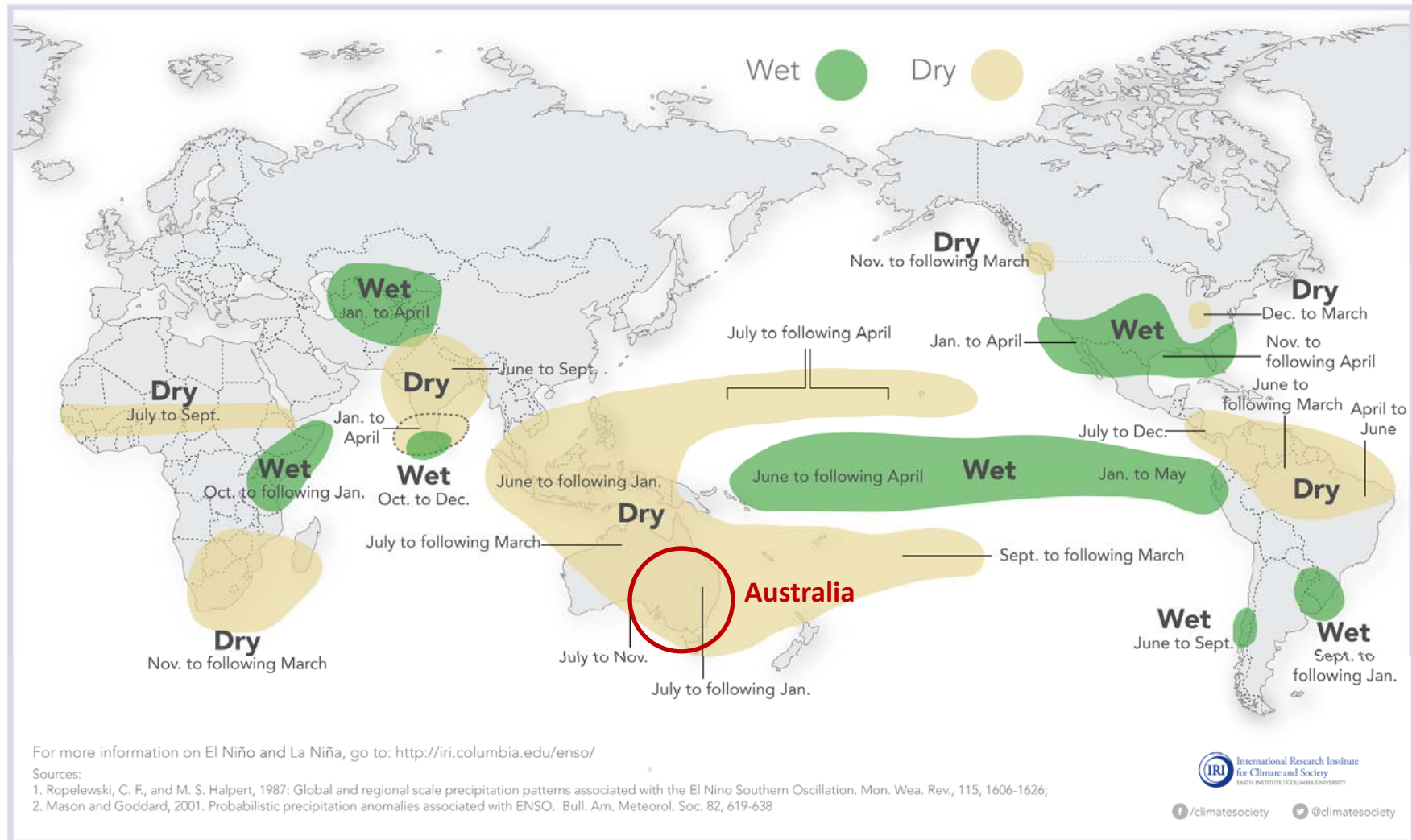


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SPOTTING AN EL NIÑO



TEMPERATURES

in the tropical Pacific Ocean warm, both at the surface and below



SURFACE PRESSURE

changes across the Pacific; higher in the west, lower in the east



TRADE WINDS

weaken, and sometimes reverse



CLOUD

increases near the Date Line

TYPICAL IMPACTS ON OUR CLIMATE



RAINFALL DECREASES
IN EASTERN AUSTRALIA



TEMPERATURE
INCREASES IN SOUTHERN AUSTRALIA
(DAYTIME TEMPERATURES)



7 OUT OF **10**

OF THE HOTTEST YEARS ON
RECORD WERE IN AN EL NIÑO
YEAR OR THE YEAR FOLLOWING

OTHER IMPACTS

INCREASED BUSHFIRE RISK



FEWER TROPICAL CYCLONES



LATER START TO NORTHERN WET SEASON



MORE HEATWAVES



LONGER FROST RISK SEASON



REDUCED CHANCE OF WIDESPREAD FLOODS



LESS CHANCE OF INDIAN OCEAN HEATWAVES



STRONGER SEABREEZES



WHEN DO THEY OCCUR?

USUALLY EL NIÑO DEVELOPS IN
AUTUMN TO WINTER
AND STARTS TO DECAY IN SUMMER



EL NIÑO EVENTS CAN
LAST FOR AS LITTLE AS

6 MONTHS
OR AS LONG AS

2 YEARS

ON AVERAGE
THEY OCCUR EVERY

3 TO **5** YEARS

THE LAST

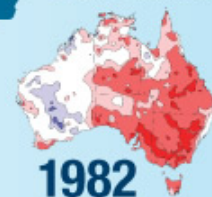
EL NIÑO

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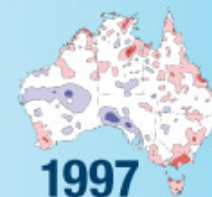
2009–10

EVERY EL NIÑO IS DIFFERENT

EL NIÑO WINTER AND SPRING RAINFALL



1982



1997

RED = DRIER THAN NORMAL BLUE = WETTER THAN NORMAL

THERE HAVE BEEN

26 EL NIÑO EVENTS
SINCE 1900

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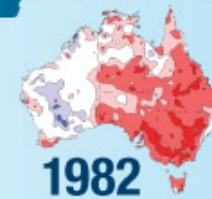
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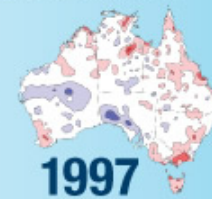
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Australian Government
Bureau of Meteorology

www.bom.gov.au

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7 OUT OF 10

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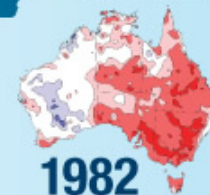
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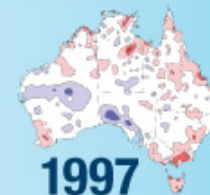
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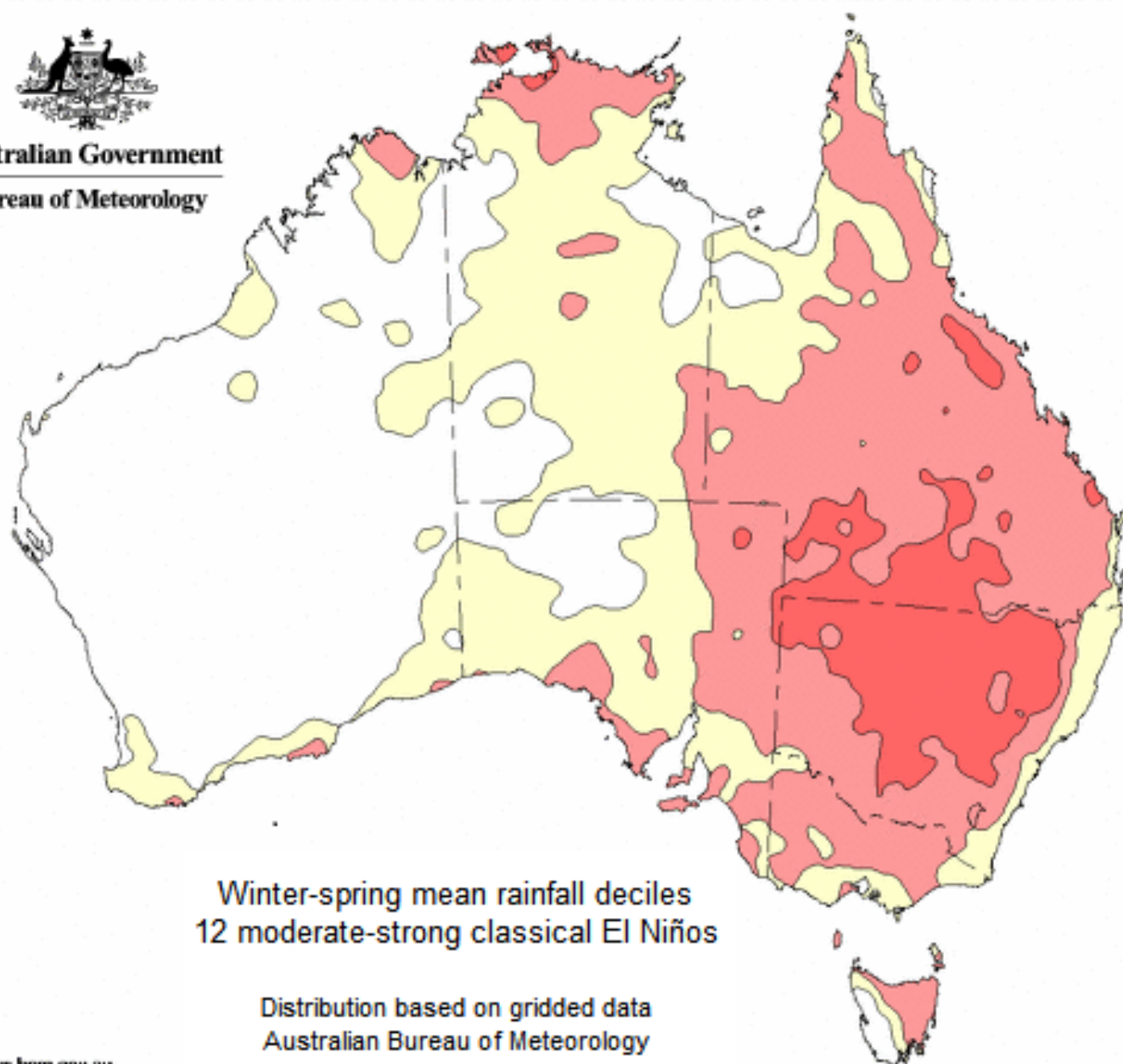


Australian Government
Bureau of Meteorology

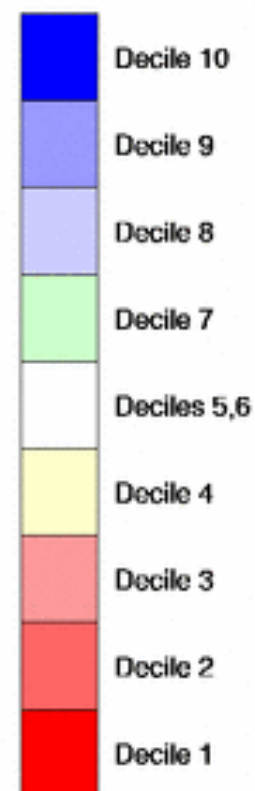
www.bom.gov.au



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Mean rainfall decile ranges



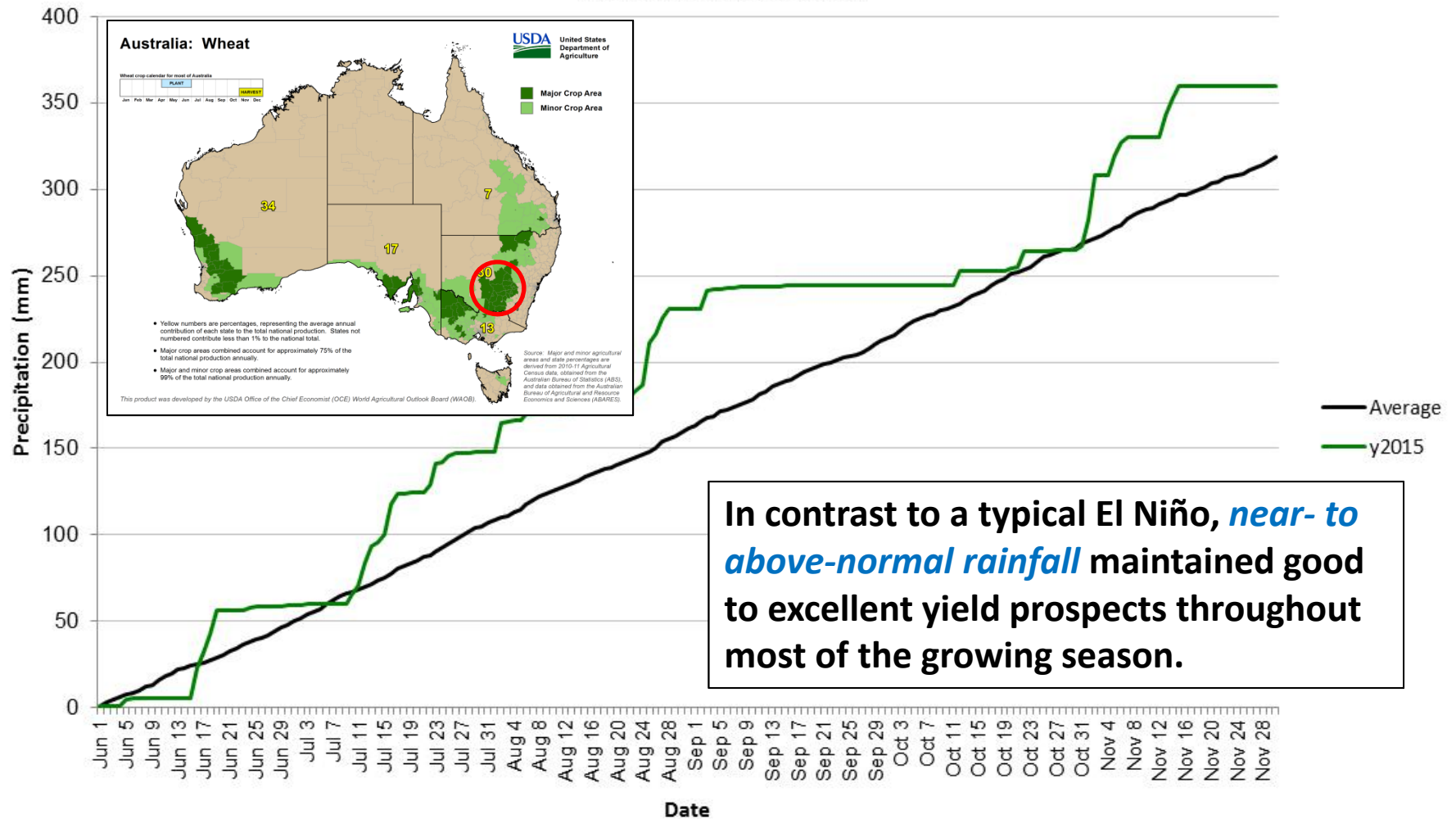
Winter-spring mean rainfall deciles
12 moderate-strong classical El Niños

Distribution based on gridded data
Australian Bureau of Meteorology

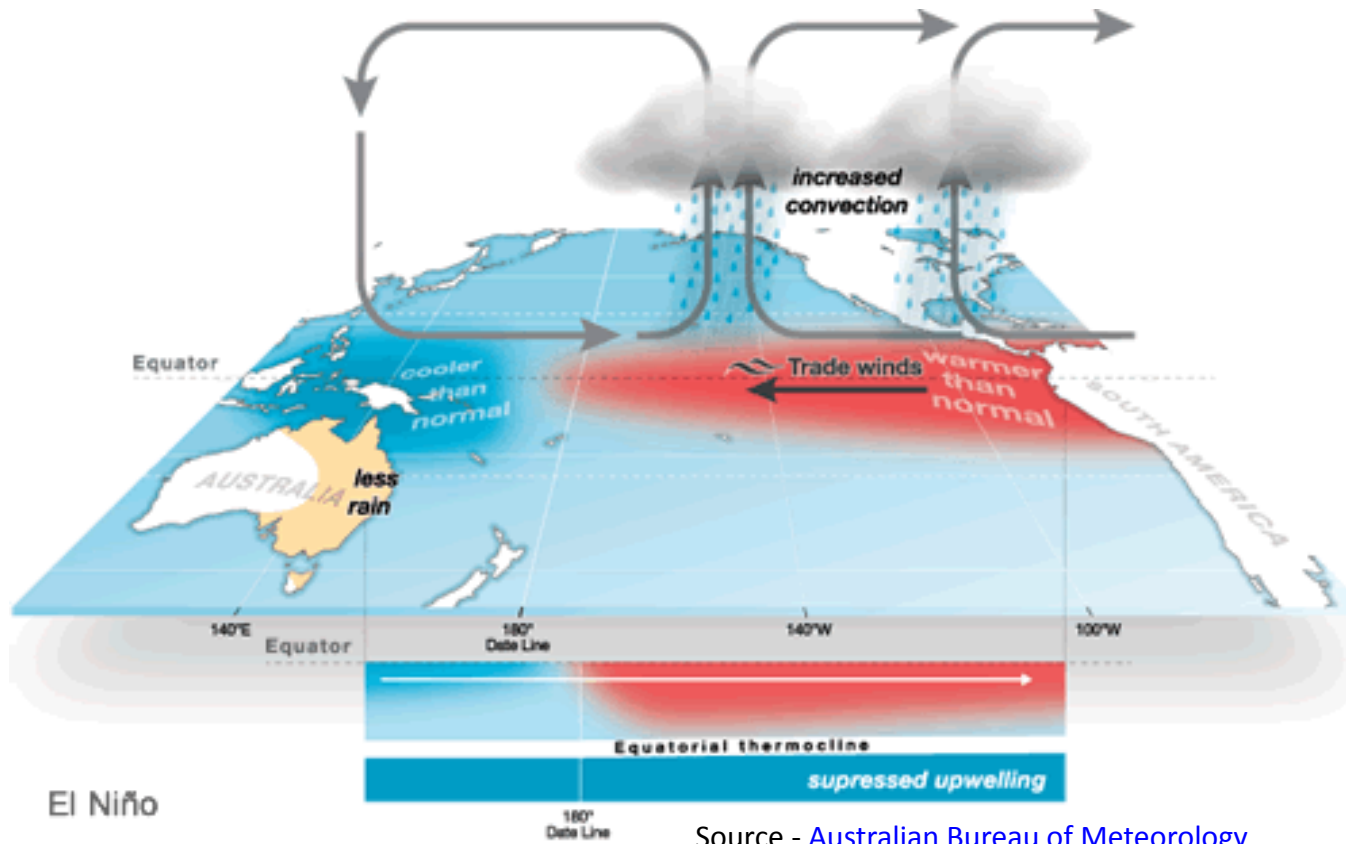
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New South Wales

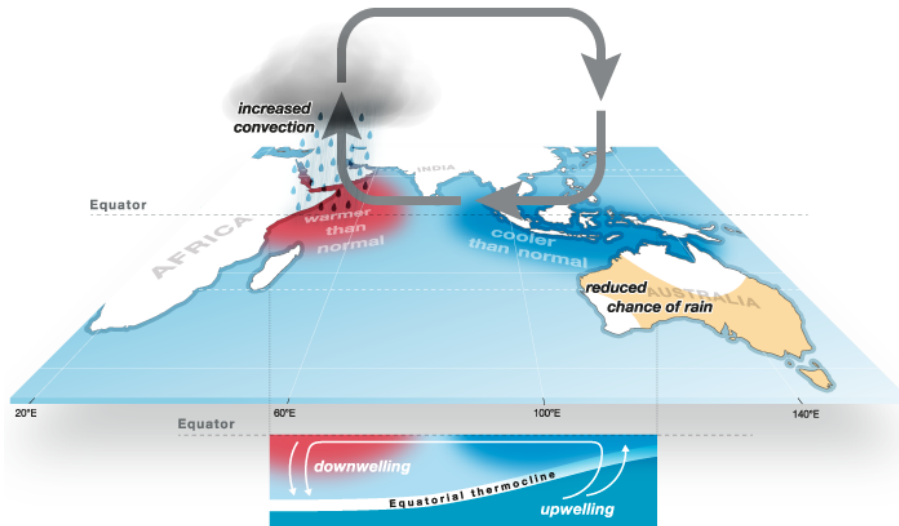
Cumulative Precipitation



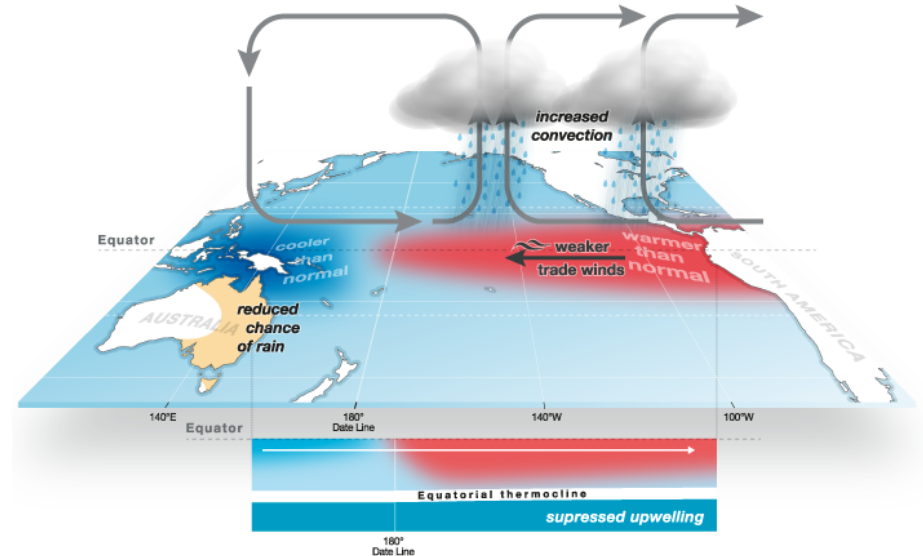
Why didn't El Niño have more of an impact?



Indian Ocean – Positive IOD

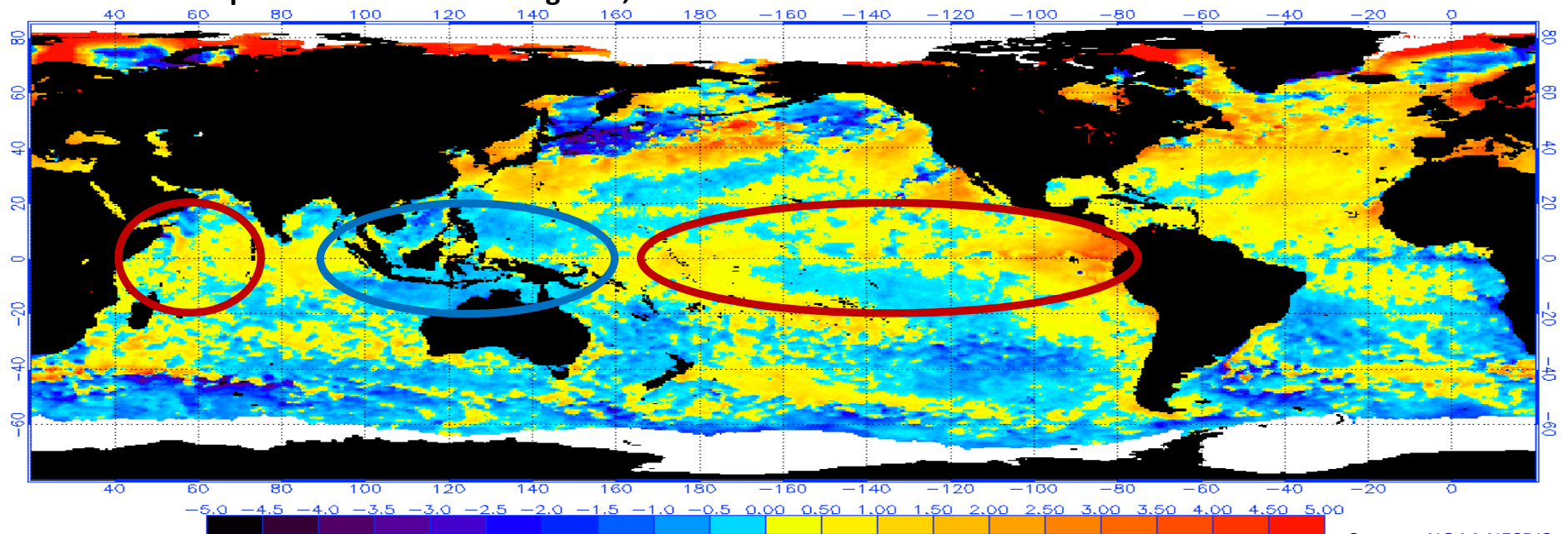


Pacific Ocean – El Niño



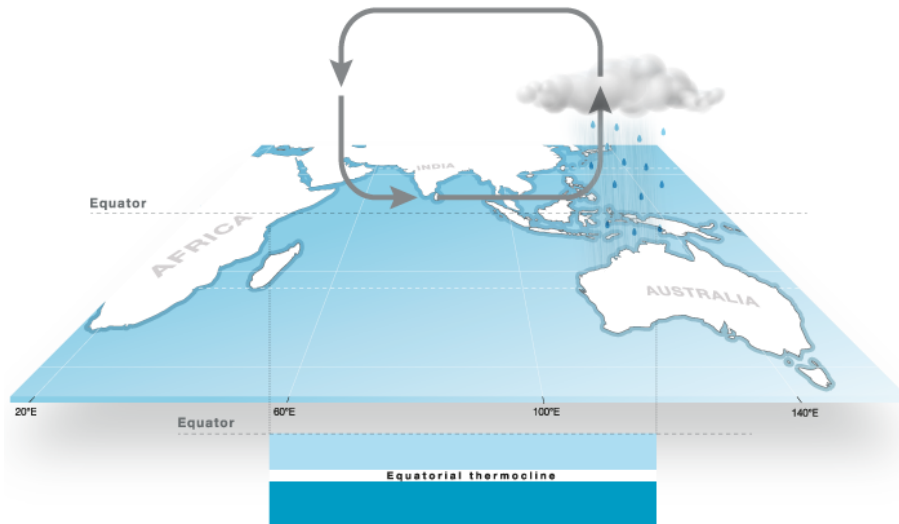
Source - [Australian Bureau of Meteorology](#)

Sea surface temperature anomalies – August 5, 2006

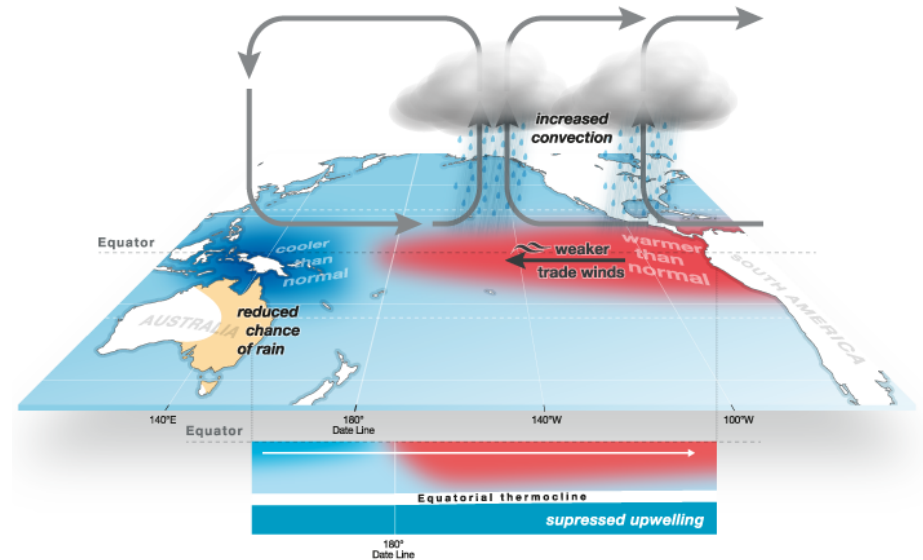


Source - [NOAA NESDIS](#)

Indian Ocean – Neutral IOD

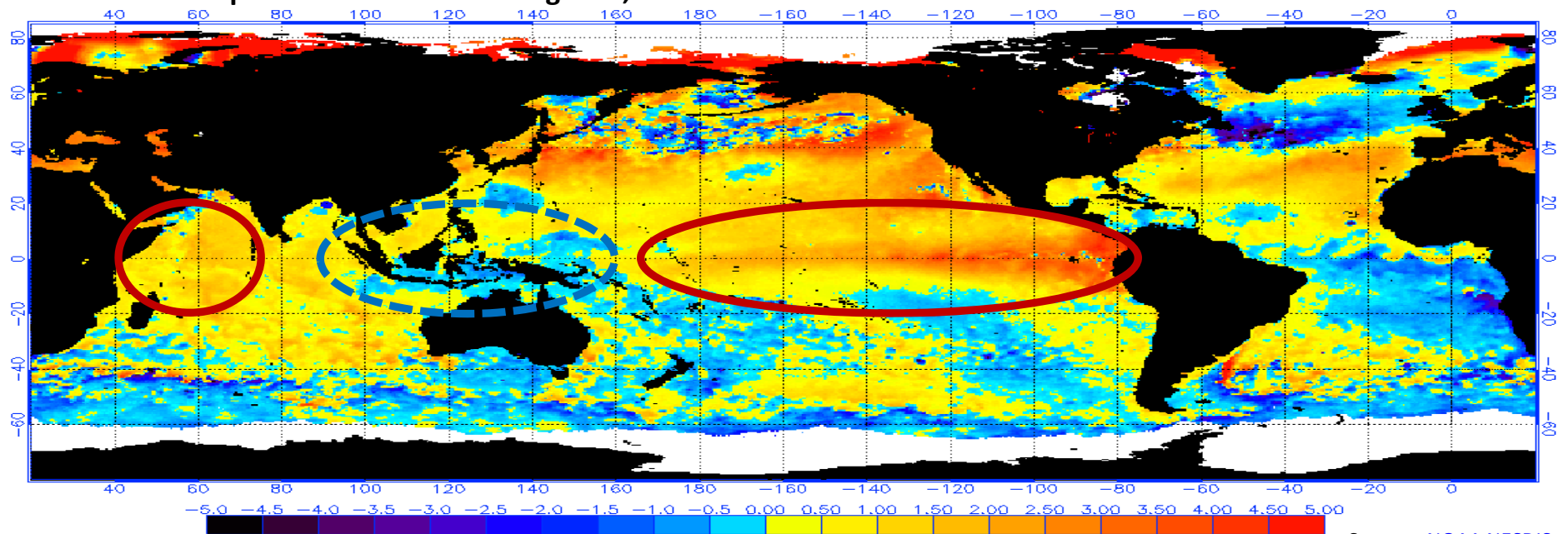


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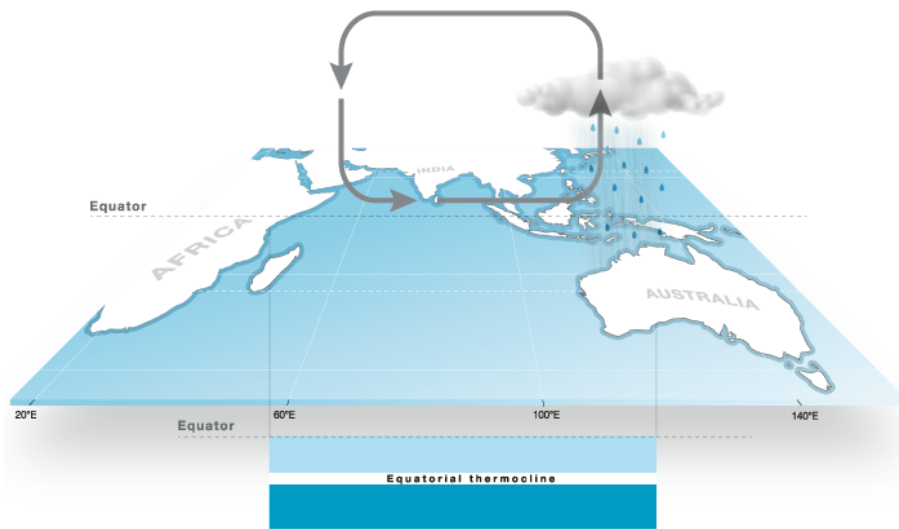
Sea surface temperature anomalies – August 3, 2015



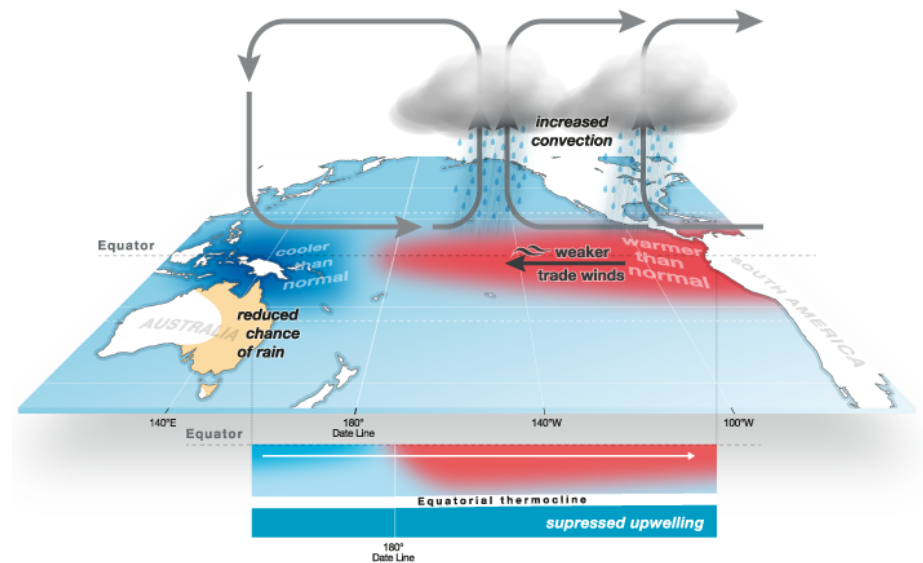
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Why didn't El Niño have more of an impact?

Indian Ocean – Neutral IOD



Pacific Ocean – El Niño

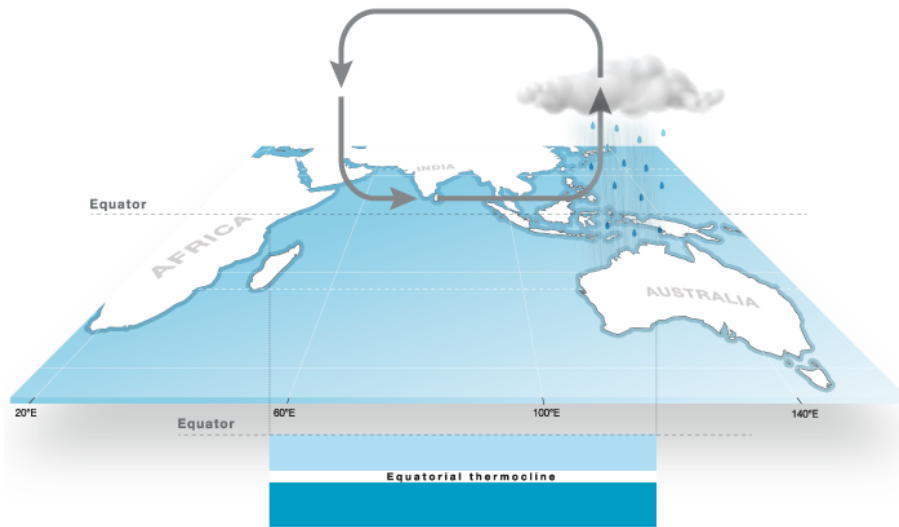


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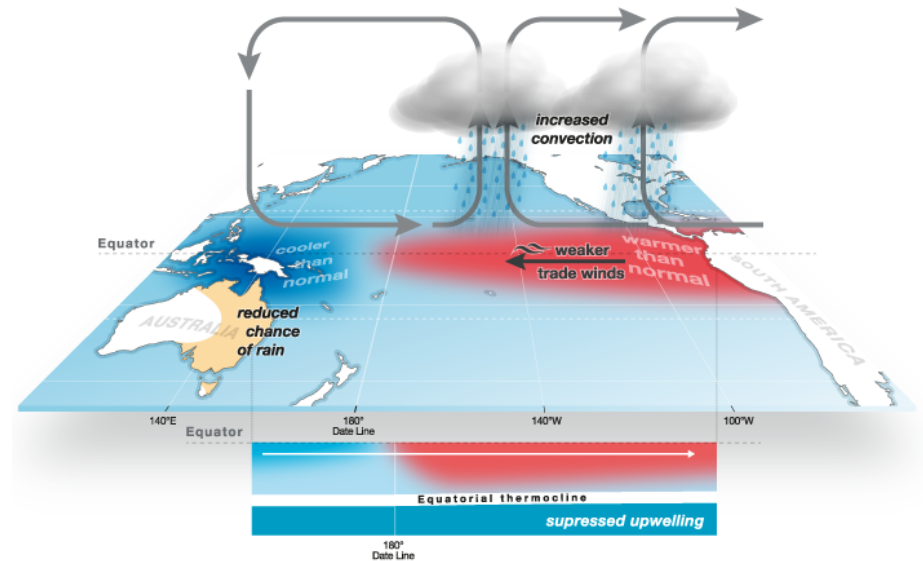
Competing climate patterns impacted the weather in Australia.

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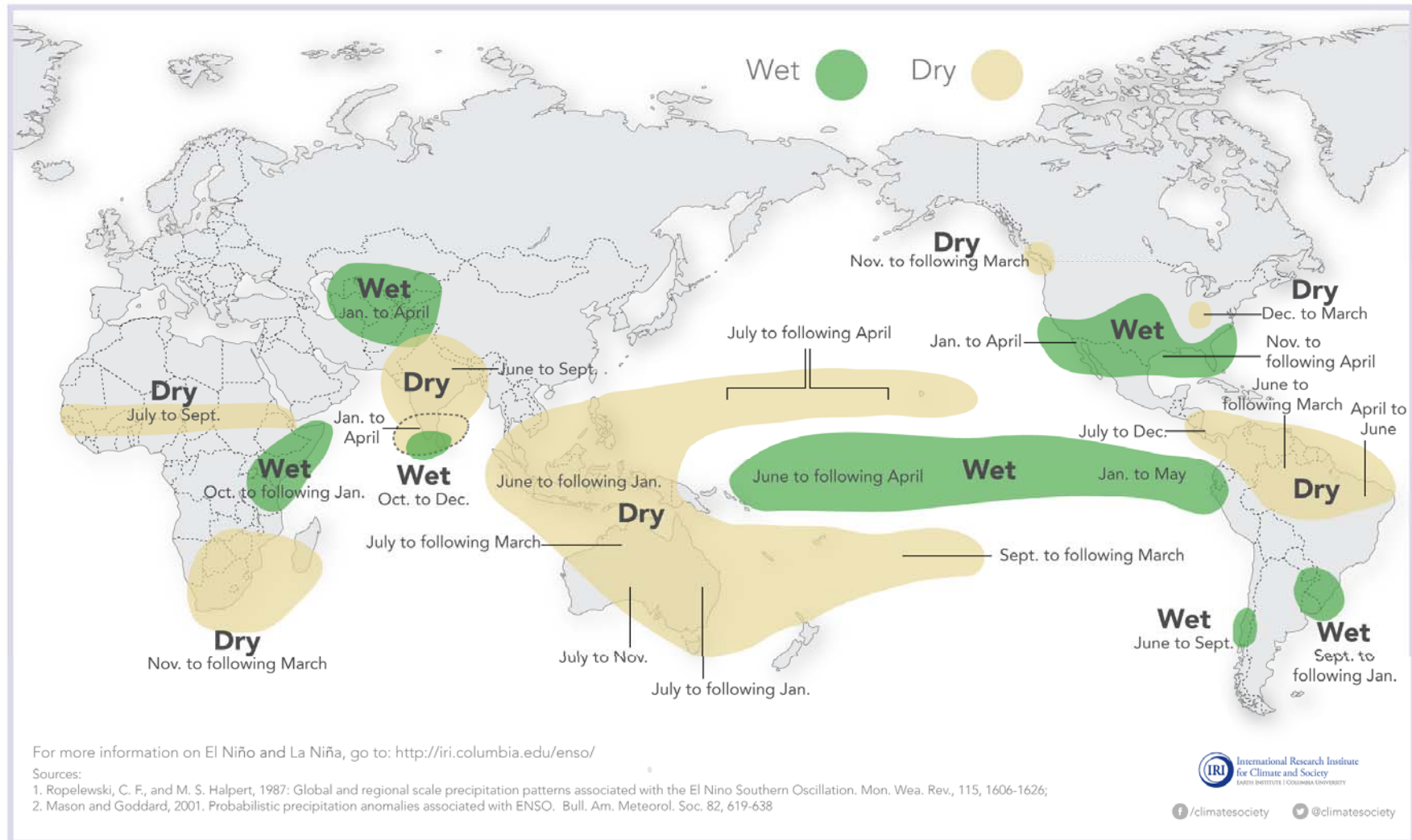
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Warmer-than-normal Indian Ocean fueled rains, leading to better than expected crop production.

Typical Impacts

El Niño and Rainfall

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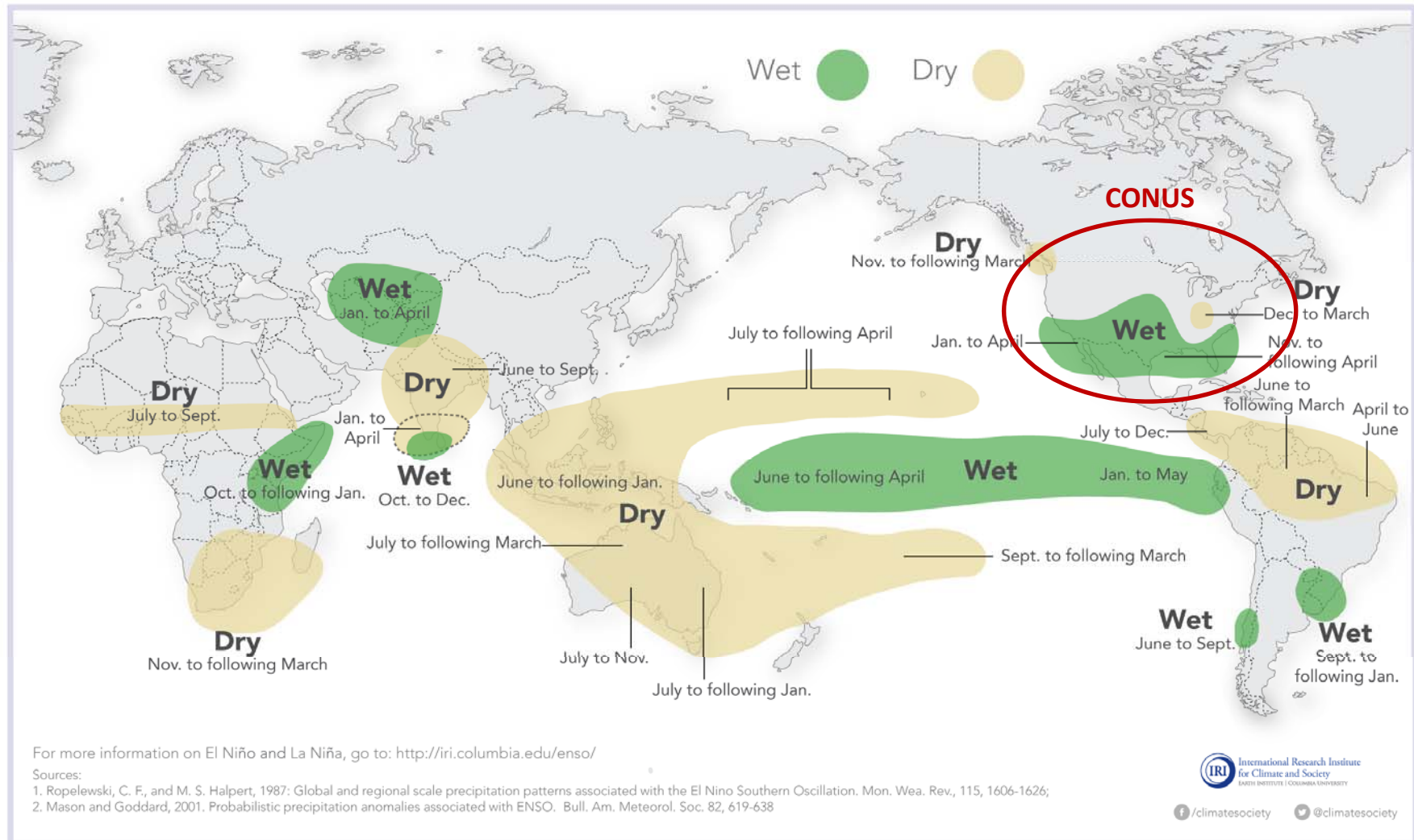


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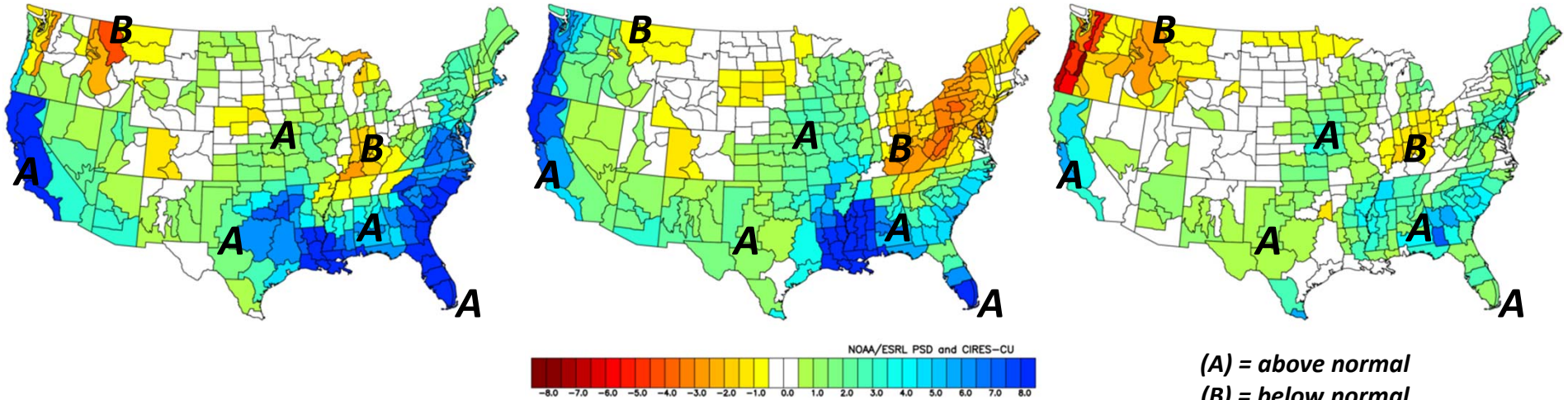
Winter Precipitation Anomalies (in)

December – January – February

1997/98

1982/83

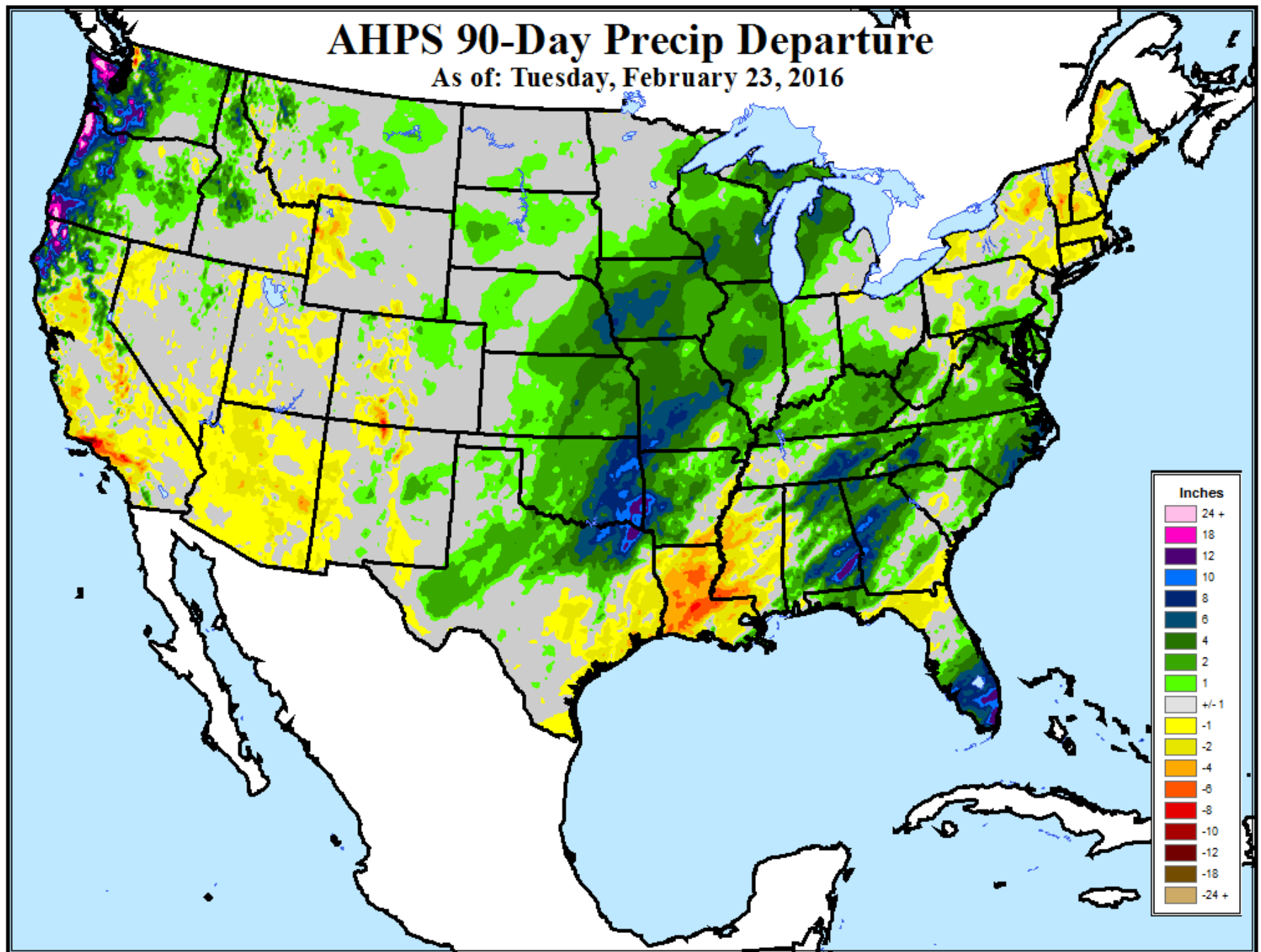
1972/73



Analyses illustrate typical precipitation patterns, but also local variability among El Niño events.

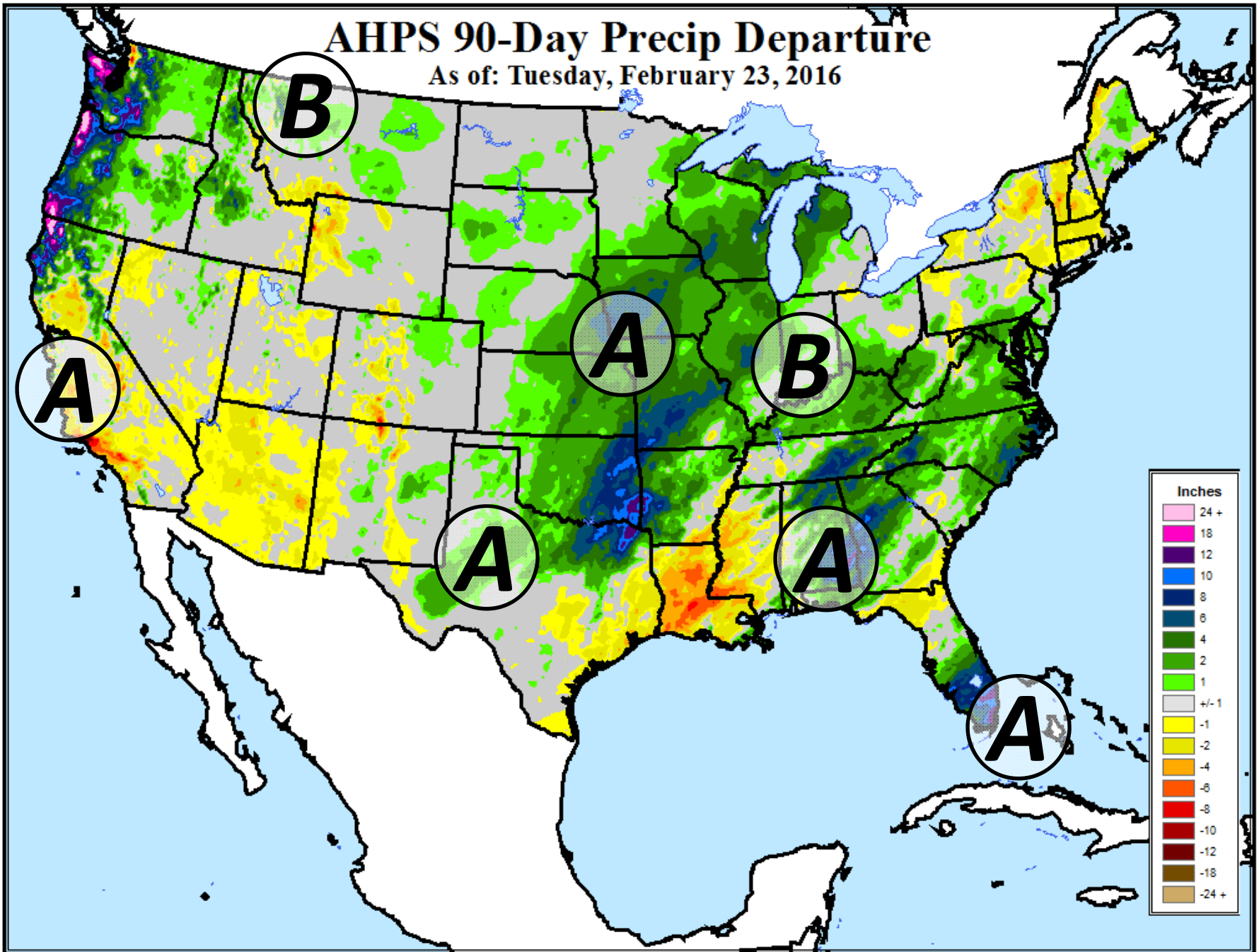
AHPS 90-Day Precip Departure

As of: Tuesday, February 23, 2016



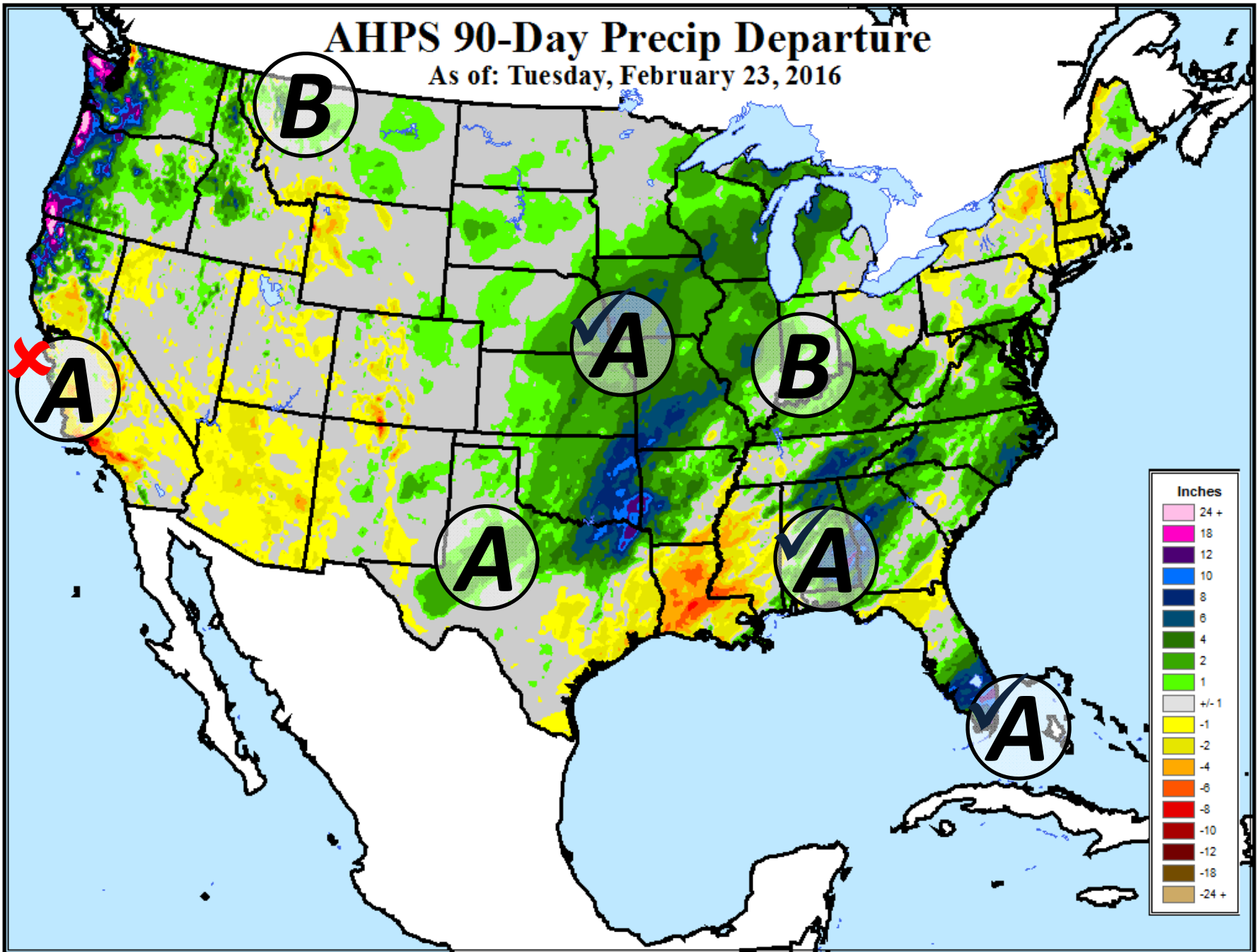
AHPS 90-Day Precip Departure

As of: Tuesday, February 23, 2016



AHPS 90-Day Precip Departure

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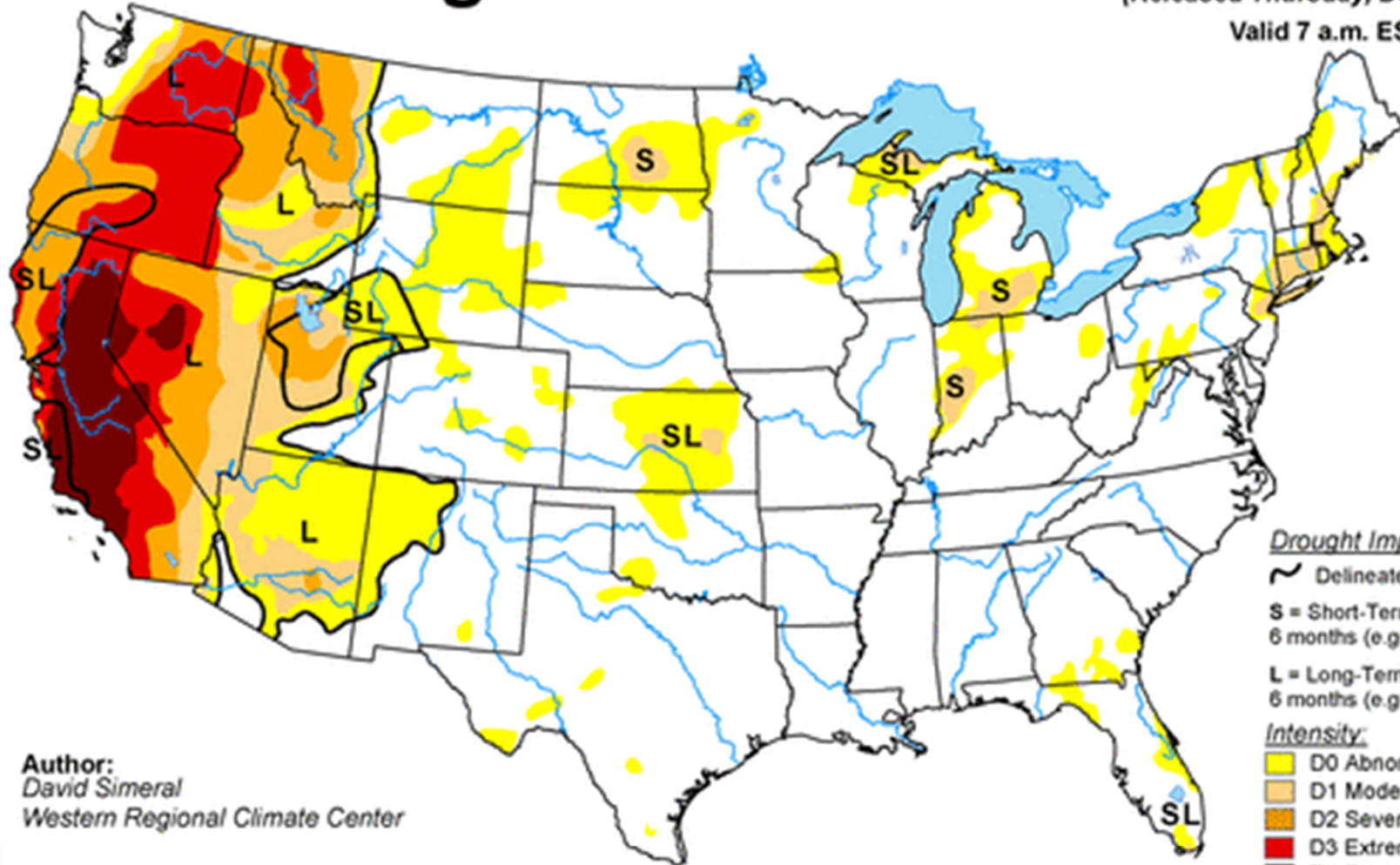


U.S. Drought Monitor

December 1, 2015

(Released Thursday, Dec. 3, 2015)

Valid 7 a.m. EST



Author:
David Simeral
Western Regional Climate Center

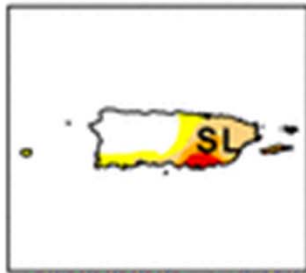
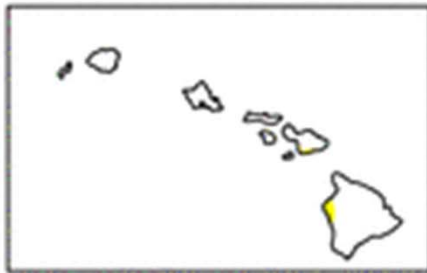
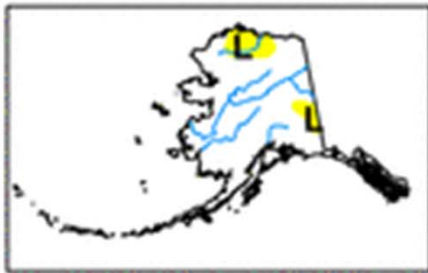
Drought Impact Types:

- ~ 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:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

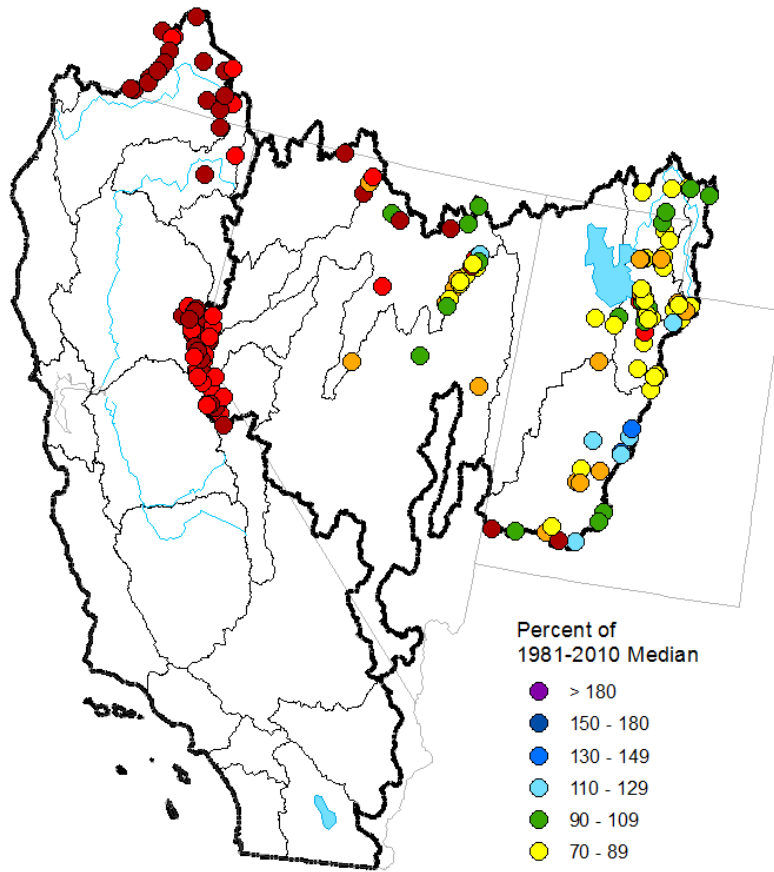
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



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

Great Basin and California Mountain Snowpack

February 1, 2015

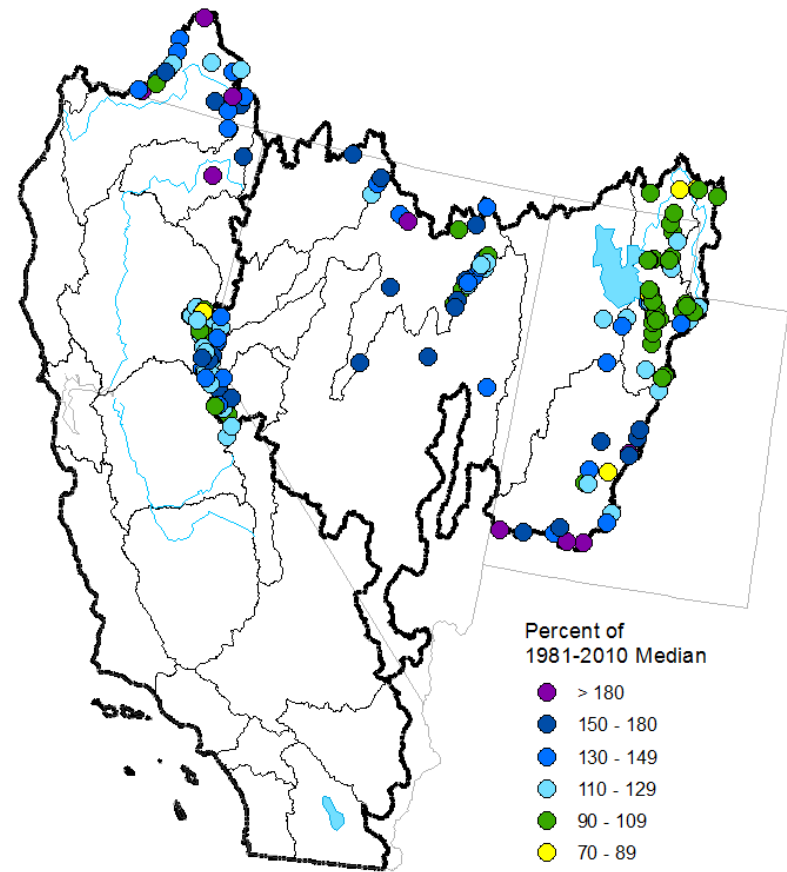


Percent of
1981-2010 Median

- > 180
- 150 - 180
- 130 - 149
- 110 - 129
- 90 - 109
- 70 - 89
- 50 - 69
- 25 - 49
- < 25

Prepared by:
USDA Natural Resources Conservation Service
National Water and Climate Center
Portland, Oregon
<http://www.wcc.nrcs.usda.gov>
Created: 4 Feb 2015 11:06

February 1, 2016



Percent of
1981-2010 Median

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Prepared by:
USDA Natural Resources Conservation Service
National Water and Climate Center
Portland, Oregon
<http://www.wcc.nrcs.usda.gov>
Created: 3 Feb 2016 08:21

Source - <http://www.wcc.nrcs.usda.gov/gis/snow.html>

IRI/CPC Pacific Nino 3.4 SST Model Outlook

Updated – February 18, 2016

Mid-Feb 2016 Plume of Model ENSO Predictions

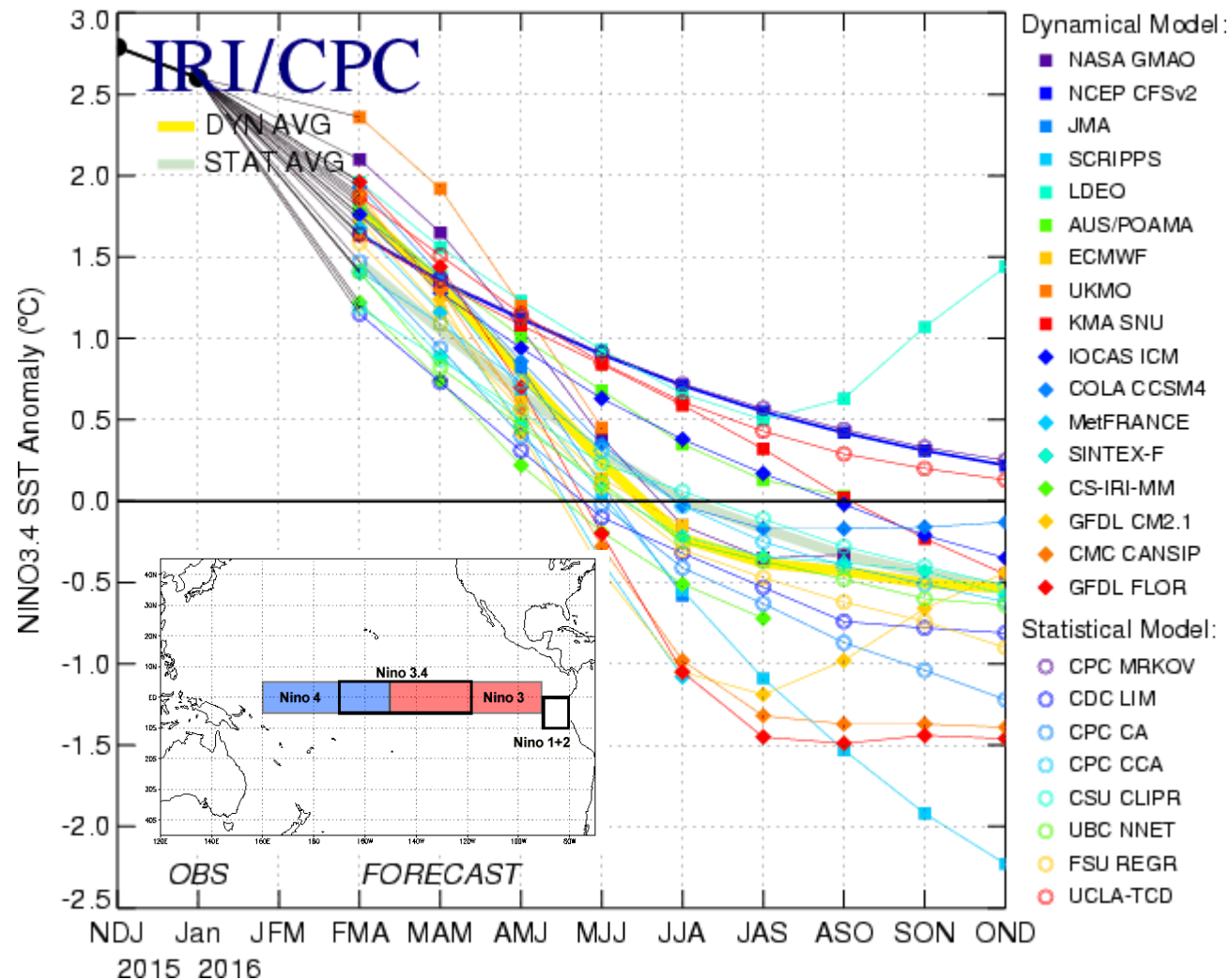


Image source – http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table

IRI/CPC Pacific Nino 3.4 SST Model Outlook

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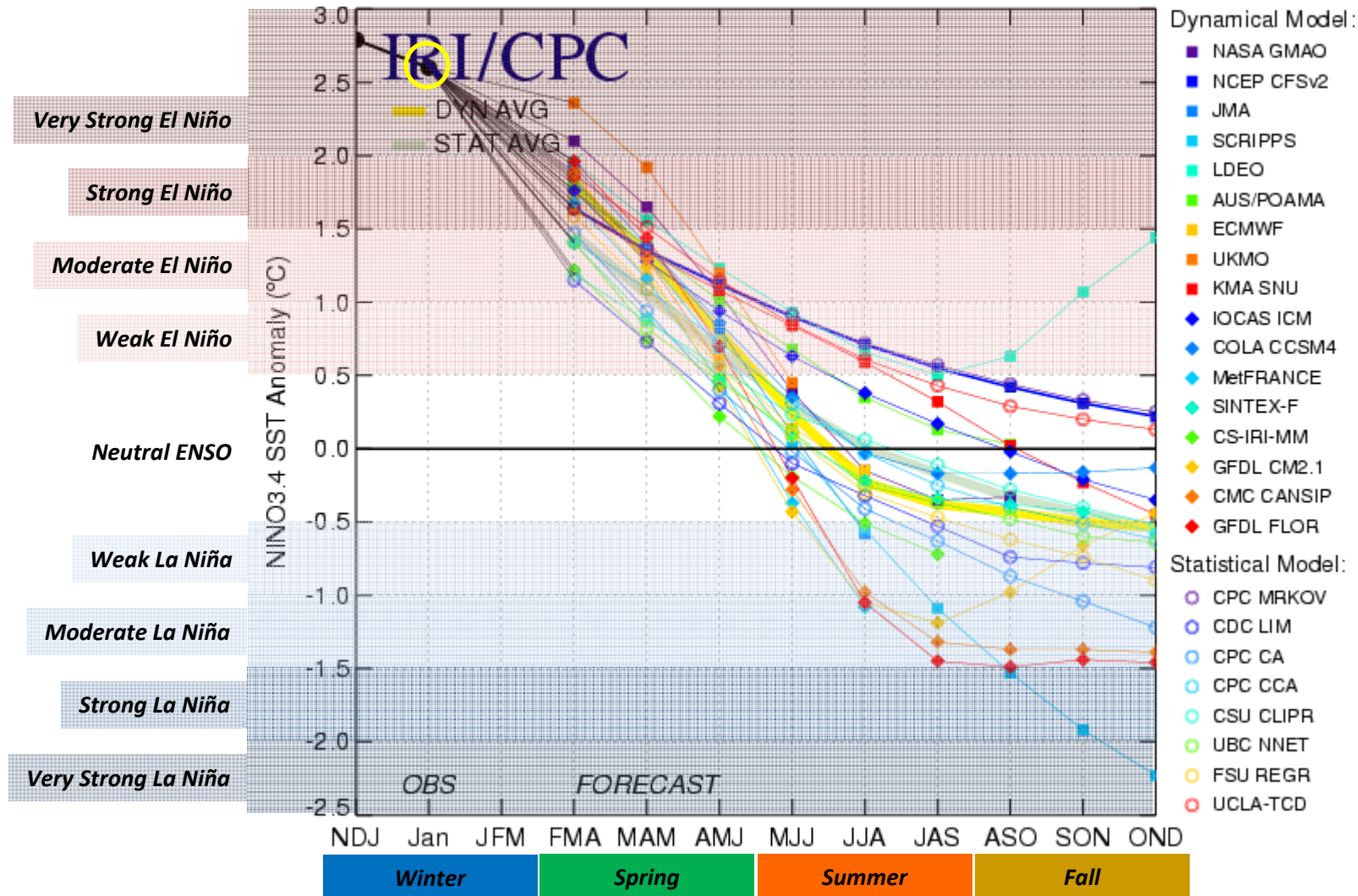
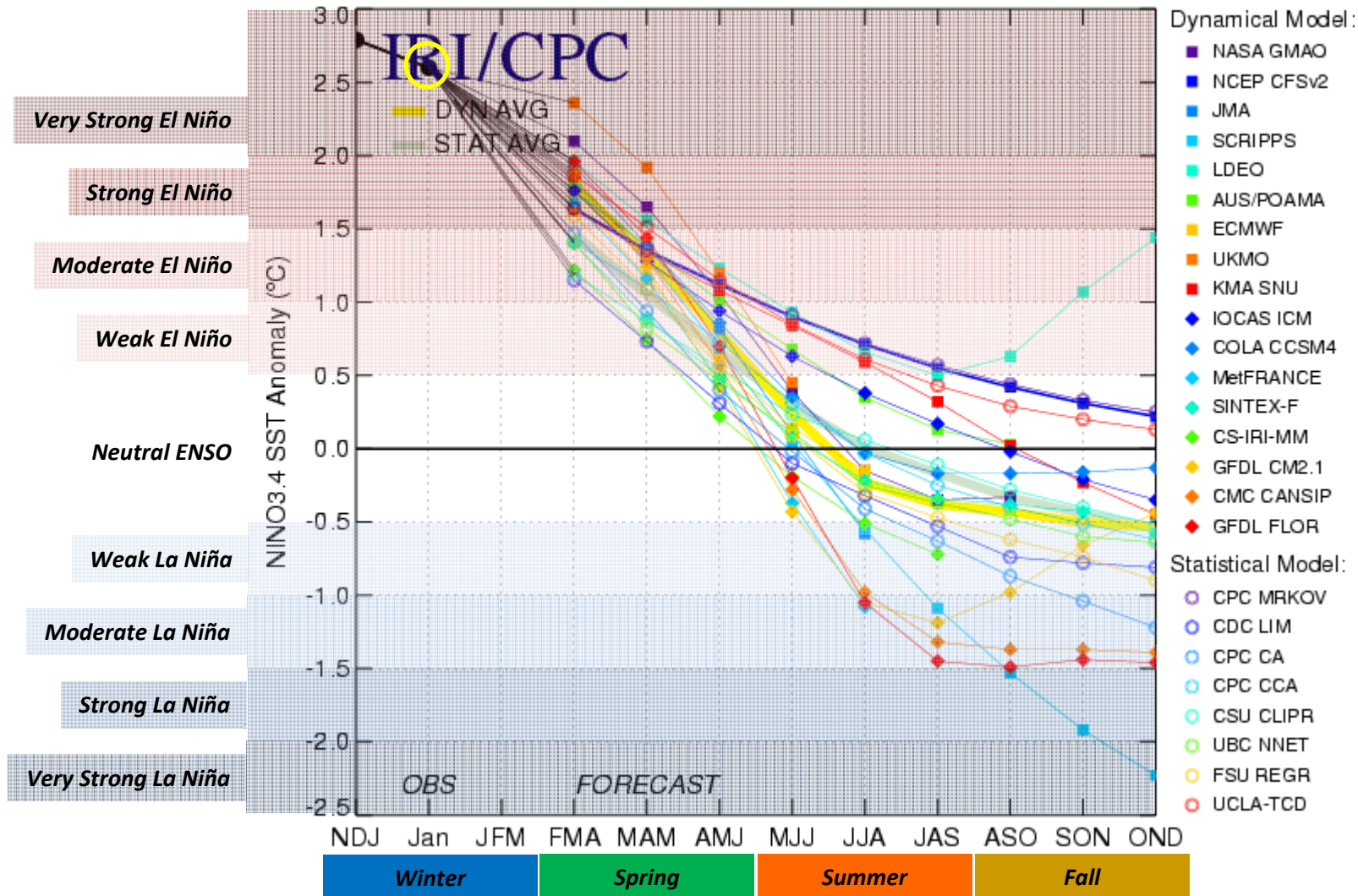


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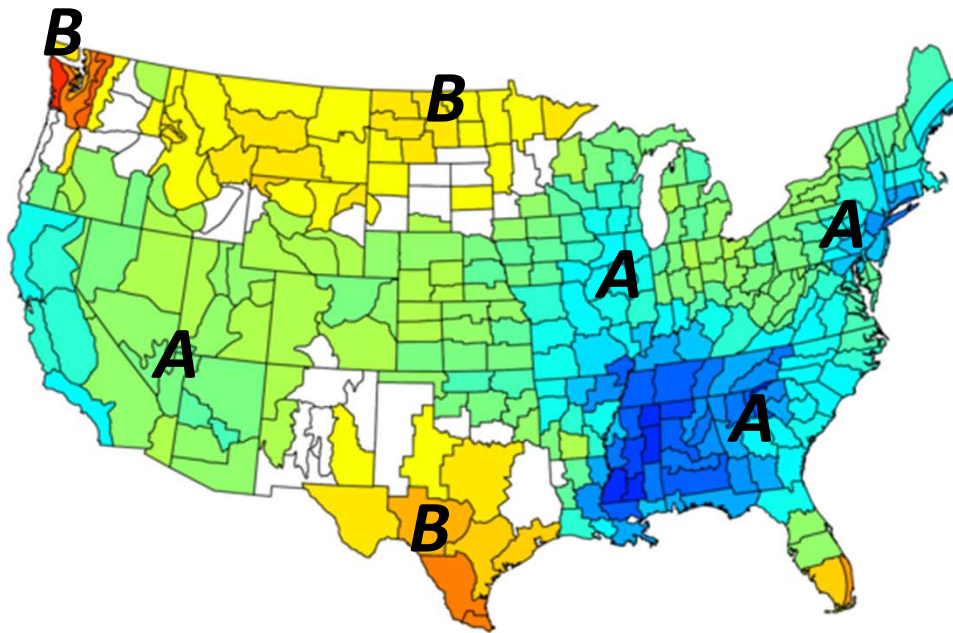
Autumn probabilities – **51% La Niña**, **32% Neutral**, **17% El Niño**

Climate patterns associated with El Niño – Spring (following peak)

Composites based on data from 1998, 1983, 1973

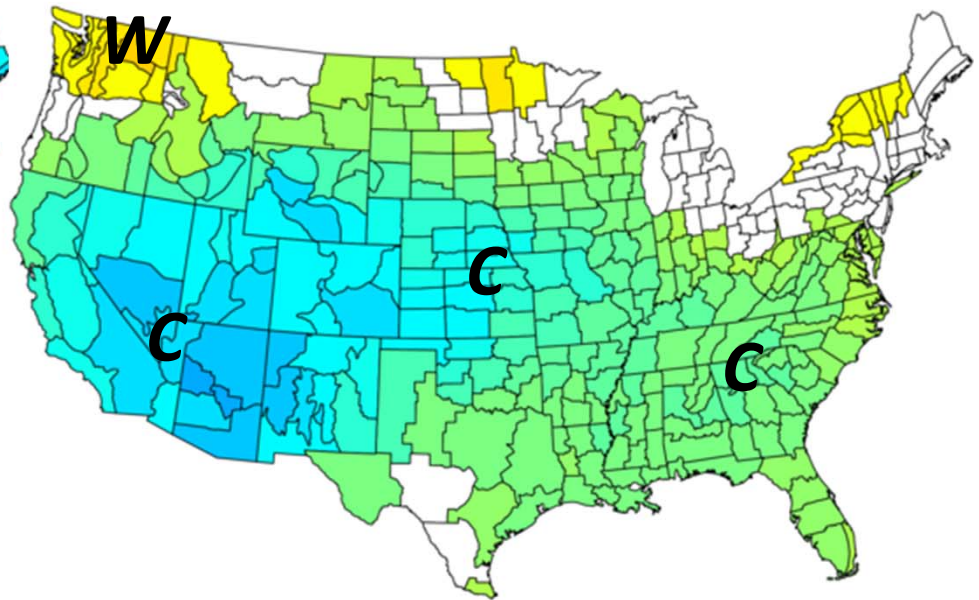
Precipitation Anomalies (in)

Mar – May

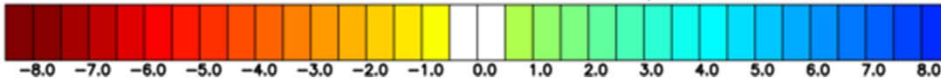


Maximum Temperature Anomalies (F)

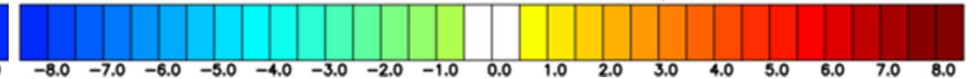
Mar – May



NOAA/ESRL PSD and CIRES-CU



NOAA/ESRL PSD and CIRES-CU



(A) = above normal
(B) = below normal

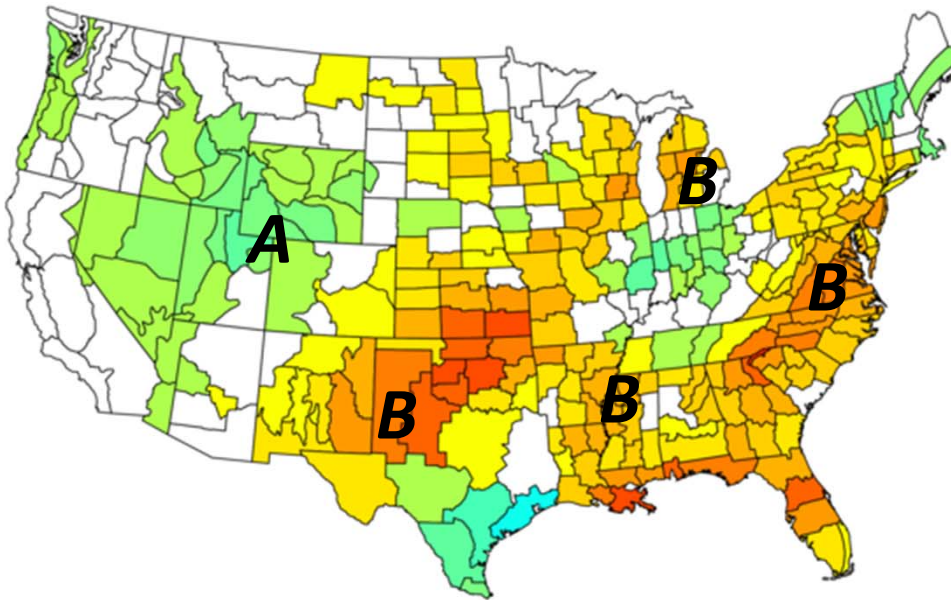
(W) = warmer than normal
(C) = cooler than normal

Climate patterns associated with El Niño – Summer (following peak)

Composites based on data from 1998, 1983, 1973

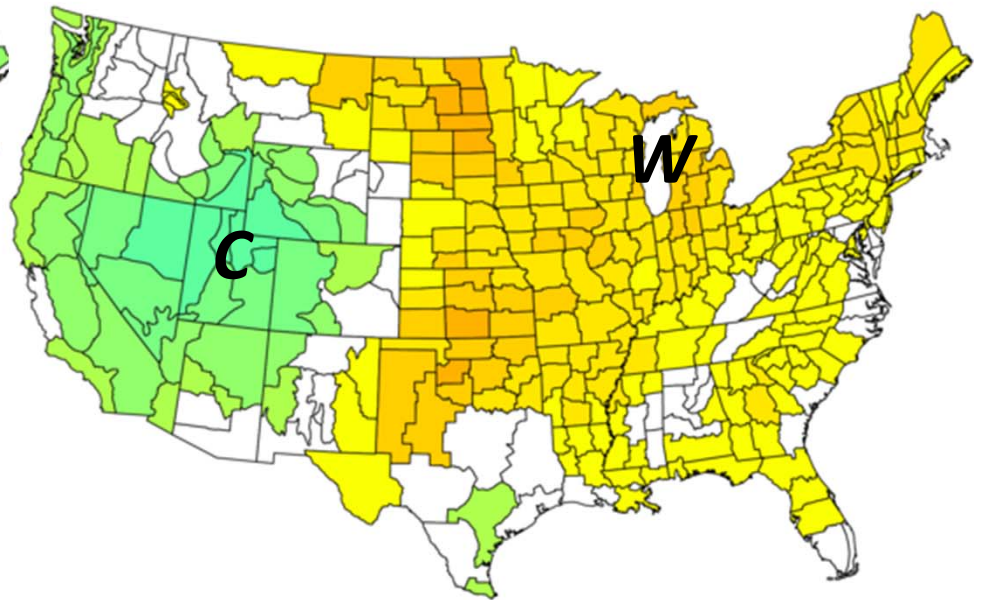
Precipitation Anomalies (in)

Jun – Aug

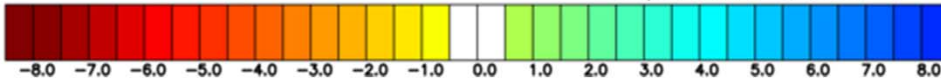


Maximum Temperature Anomalies (F)

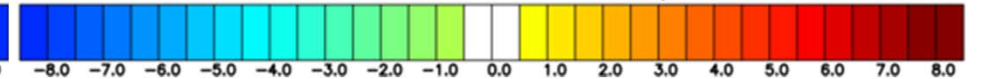
Jun – Aug



NOAA/ESRL PSD and CIRES-CU



NOAA/ESRL PSD and CIRES-CU



(A) = above normal
(B) = below normal

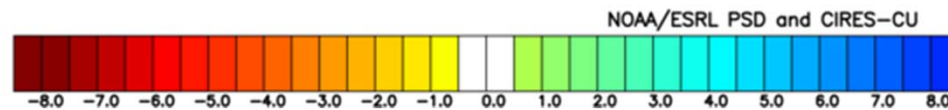
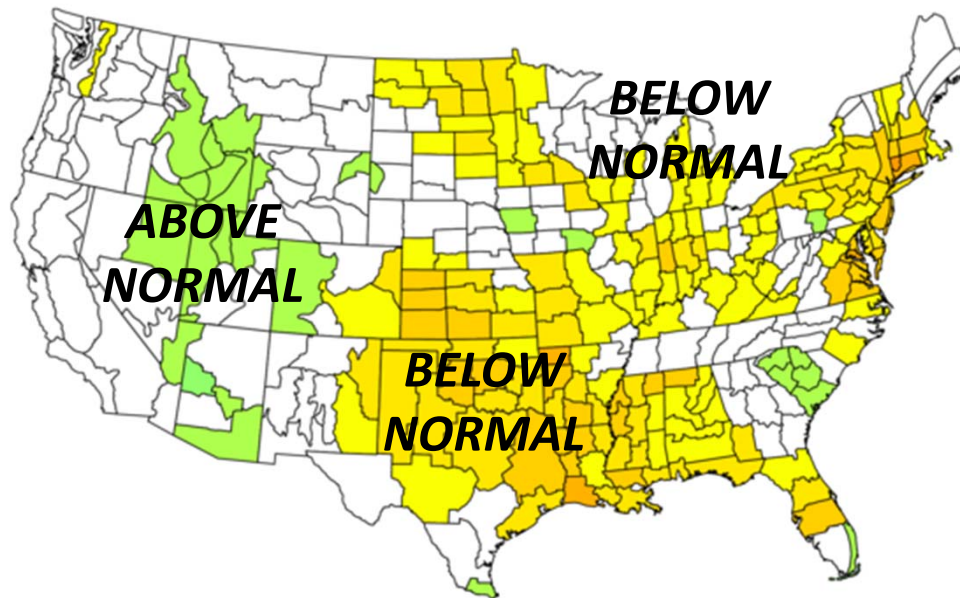
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Climate patterns associated with developing La Niña – Summer

Composites based on 11 distinct events

Precipitation Anomalies (in)

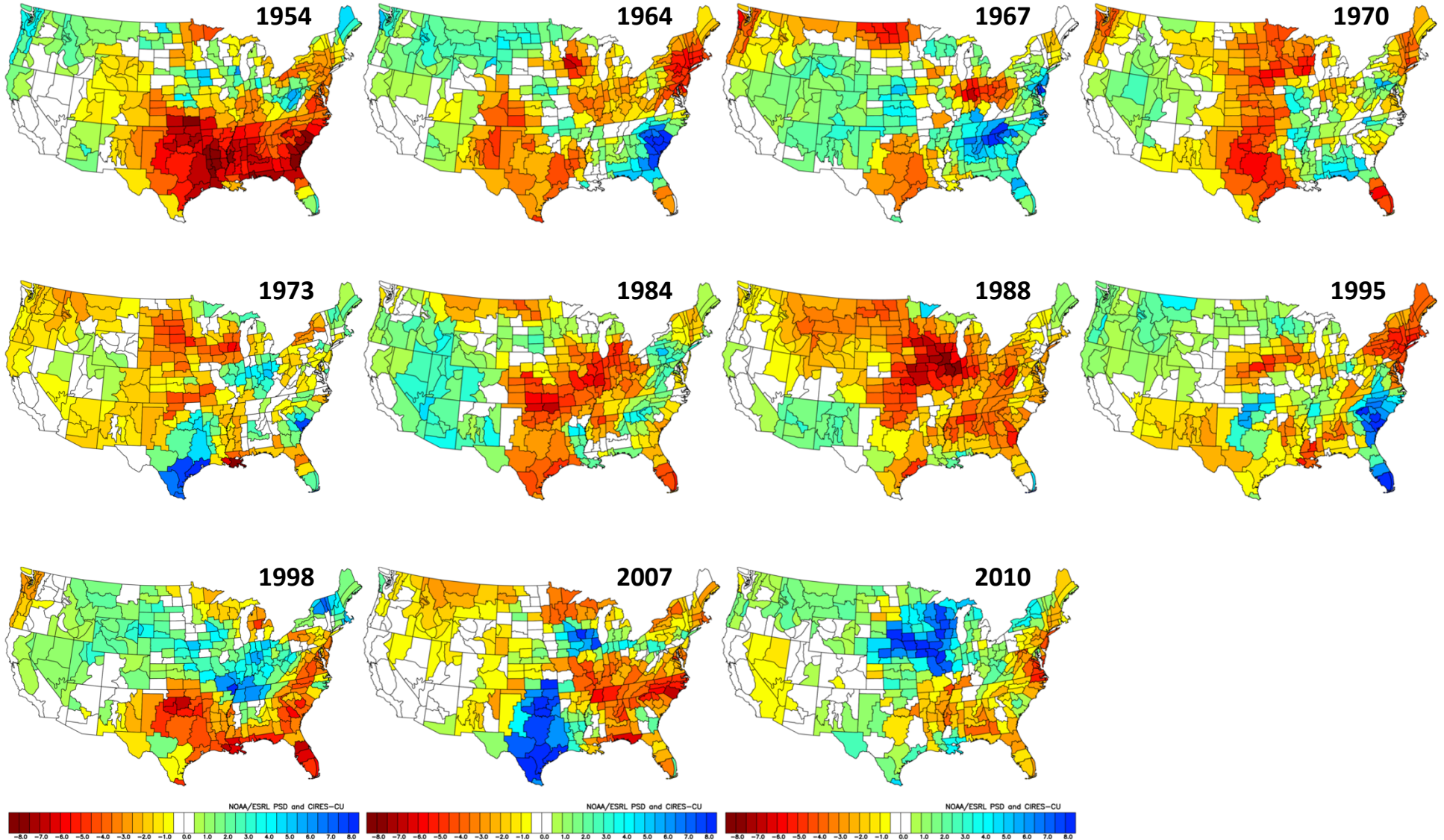
Jun – Aug



Climate patterns associated with developing La Niña – Summer

June – July – August

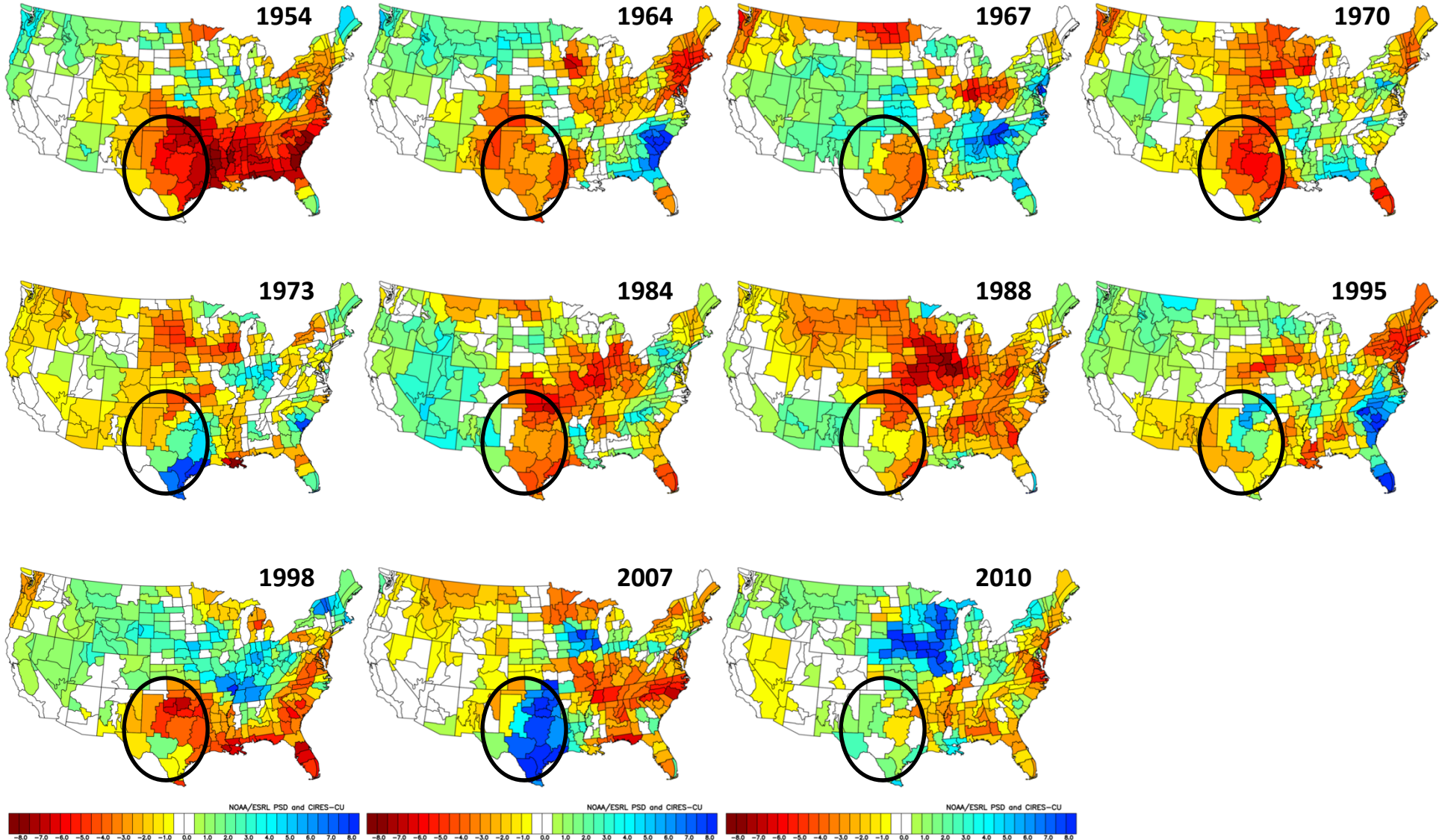
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

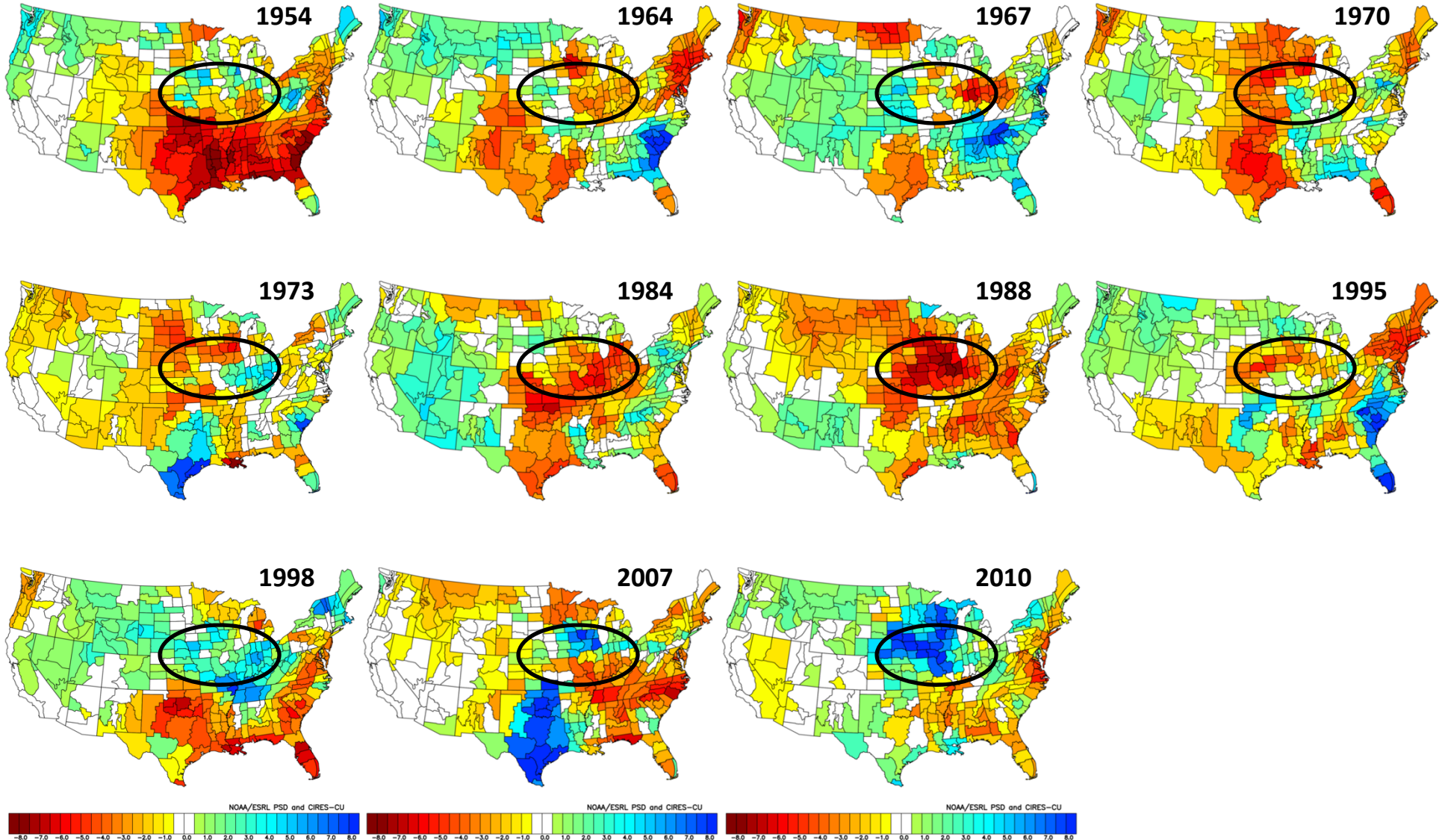
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

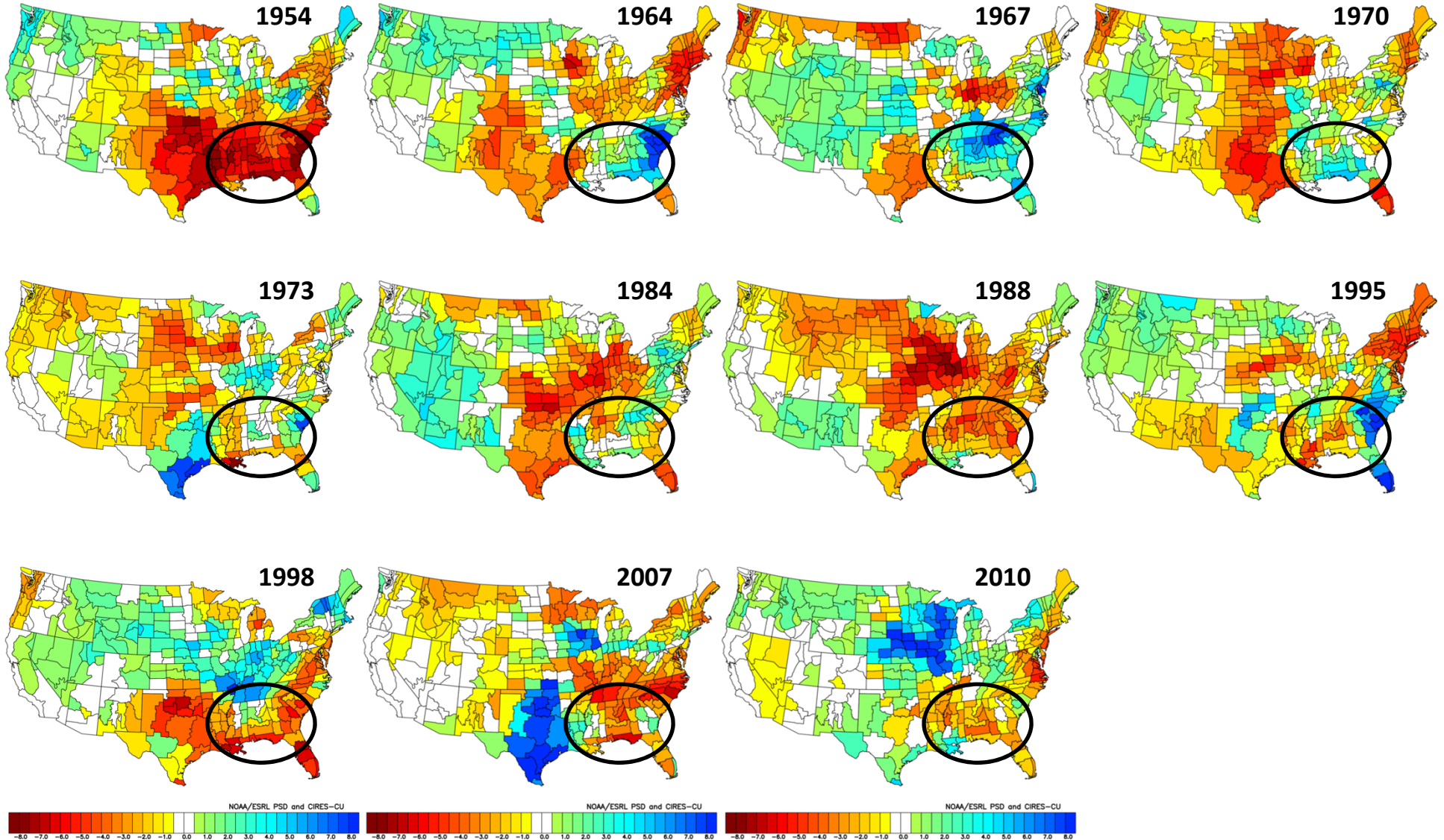
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

Precipitation Anomalies (in)

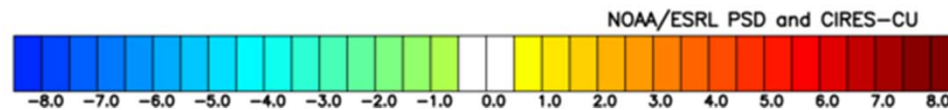
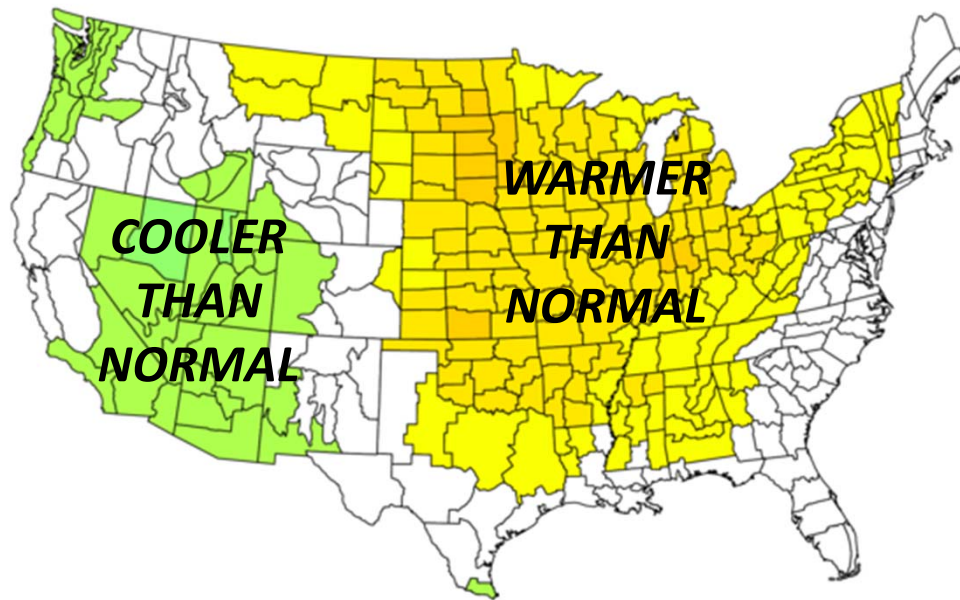


Climate patterns associated with developing La Niña – Summer

Composites based on 11 distinct events

Maximum Temperature Anomalies (F)

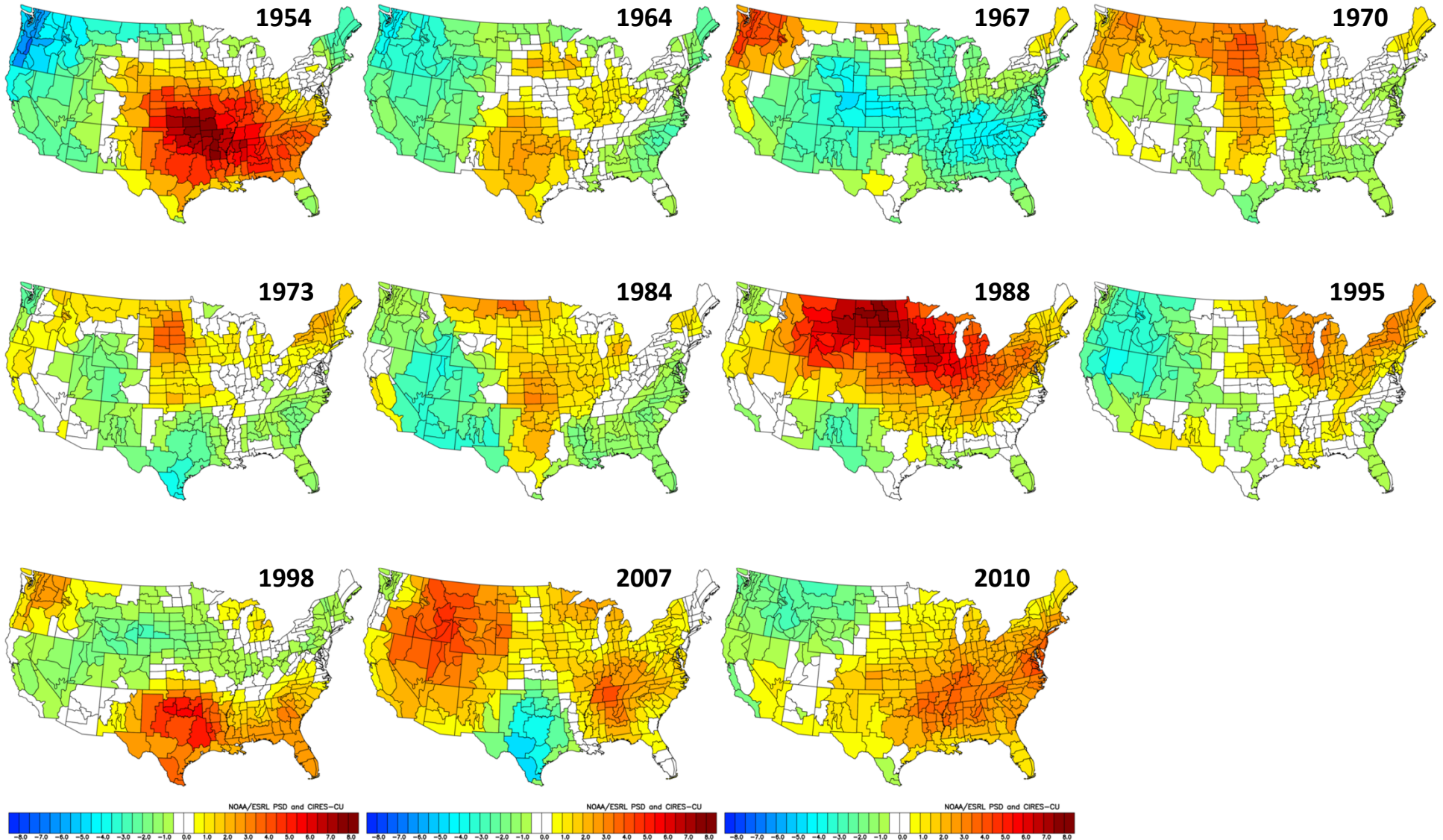
Jun – Aug



Climate patterns associated with developing La Niña – Summer

June – July – August

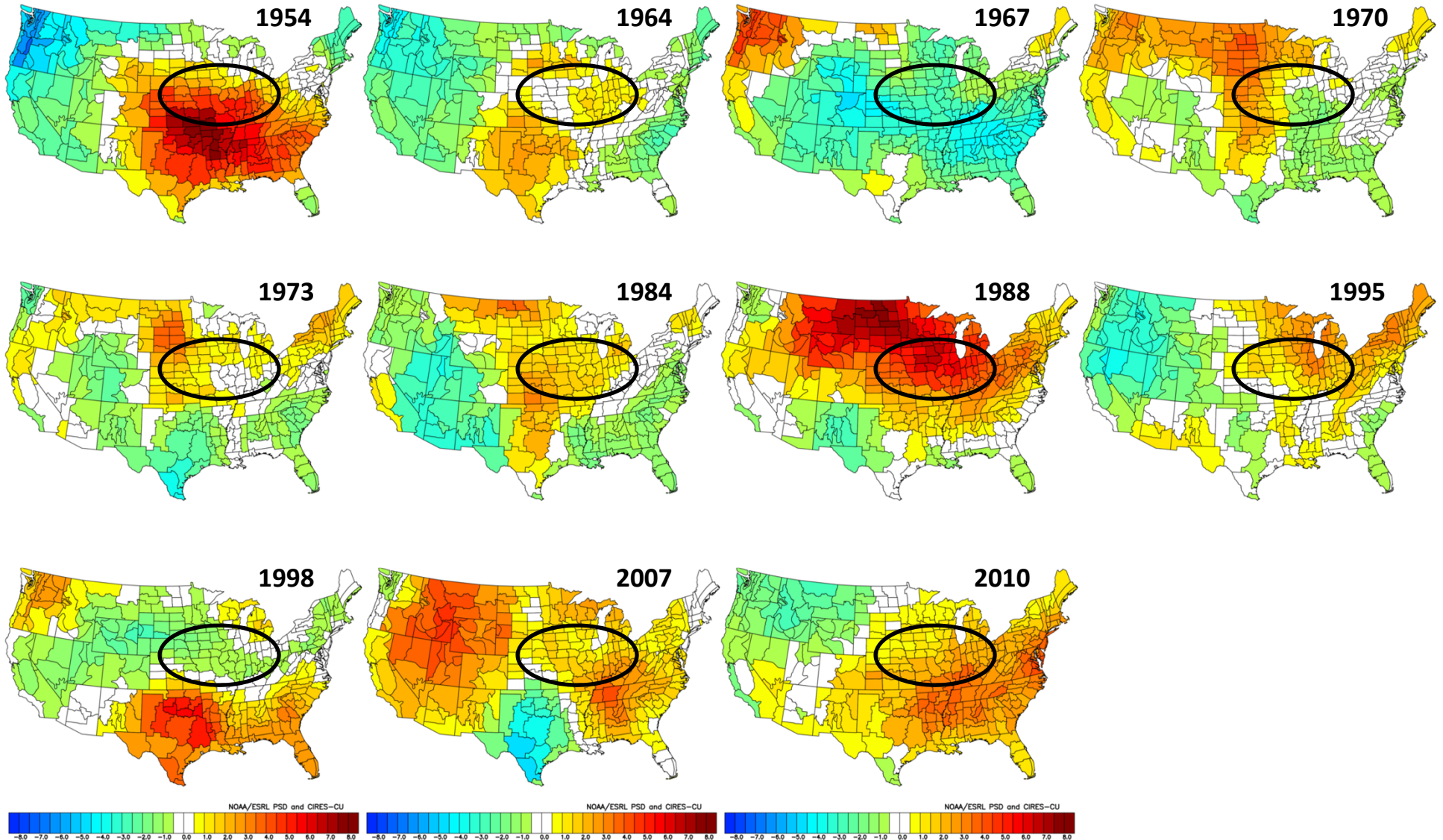
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

June – July – August

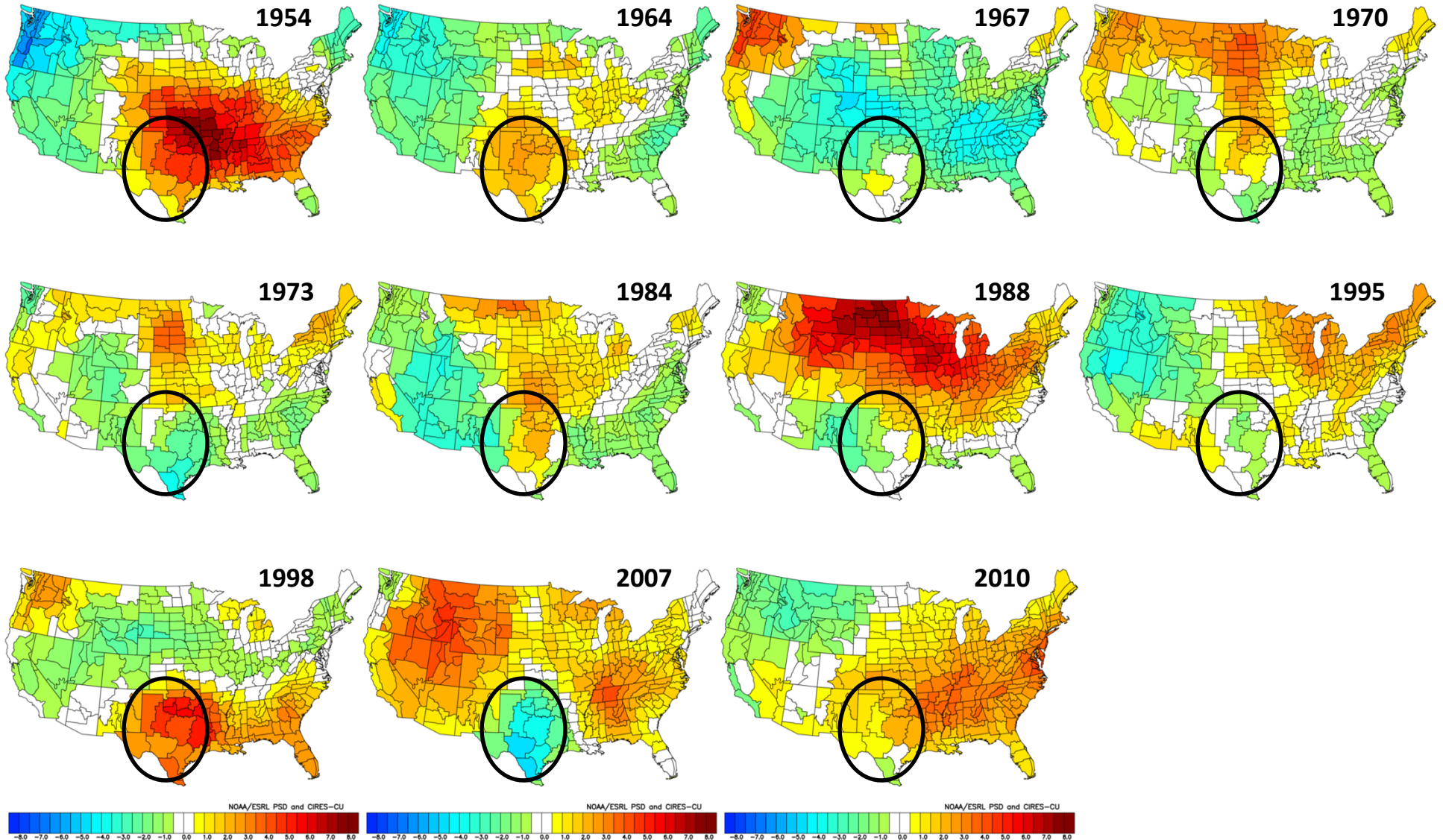
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

June – July – August

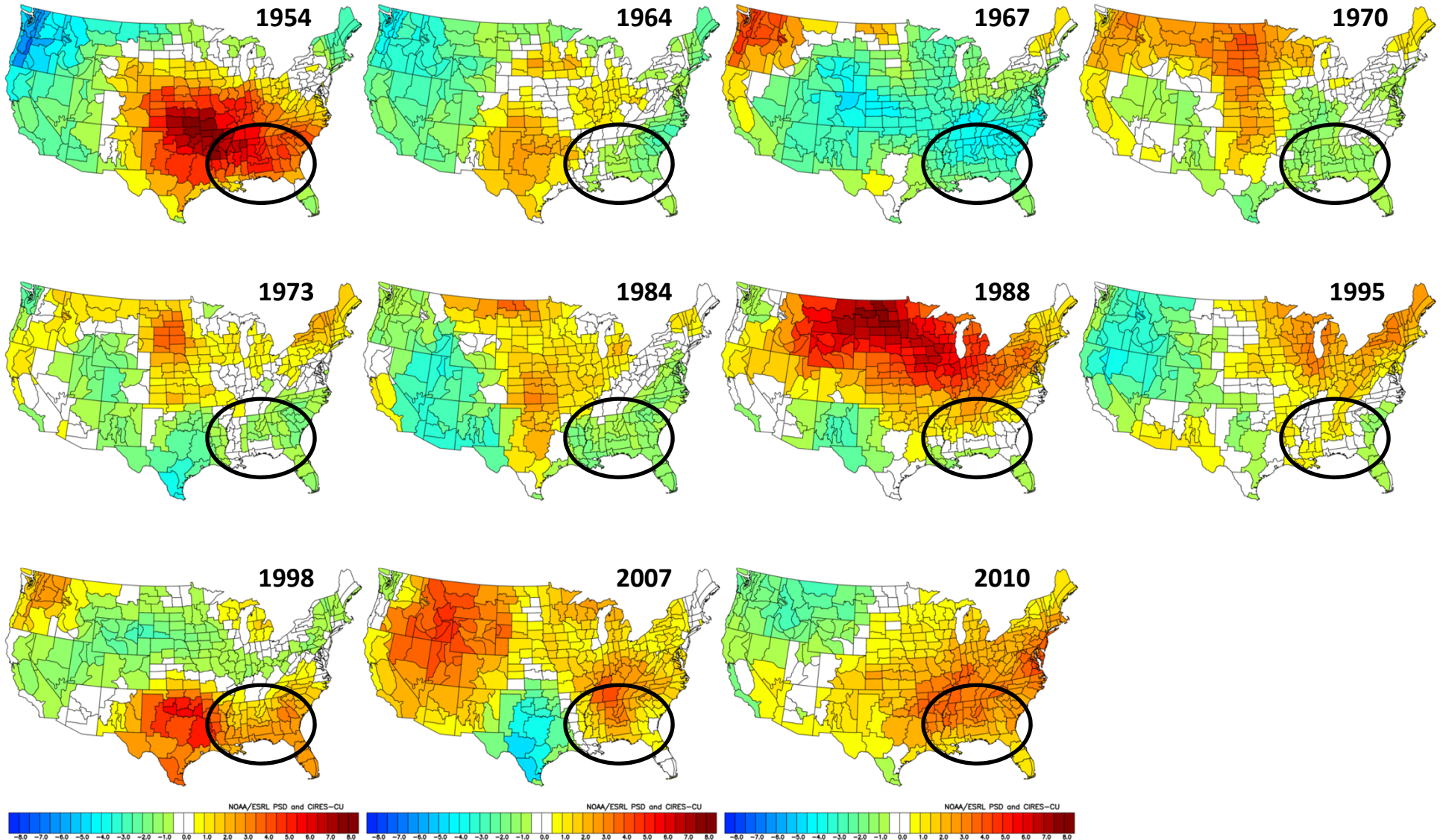
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

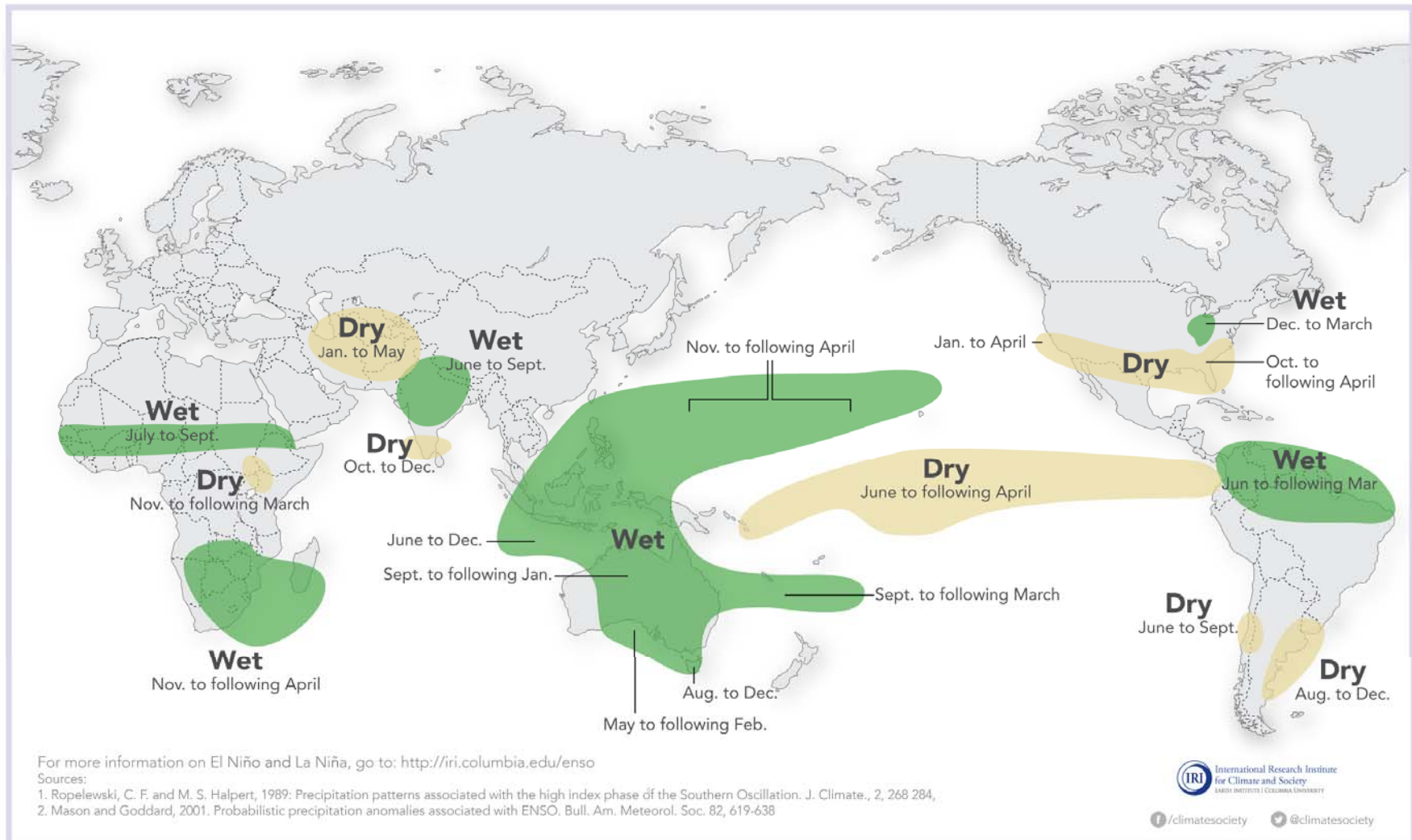
June – July – August

Temperature Anomalies (F)



La Niña and Rainfall

La Niña conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one La Niña to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



Source - <http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/LaNinaandRainfall.png>

Outlook for **El Niño** and its Impact on Global Crop Weather

Summary

What we know:

- The 2015/16 **El Niño** is still going strong, but it appears to have peaked in intensity.

What is likely:

- The **El Niño** is forecast to weaken through the spring, with a return to neutral ENSO conditions likely by this summer.

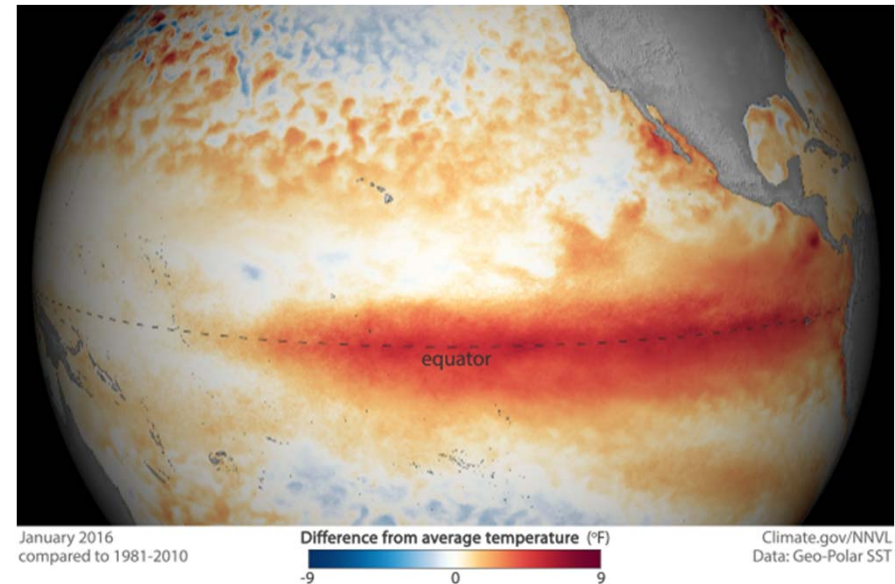
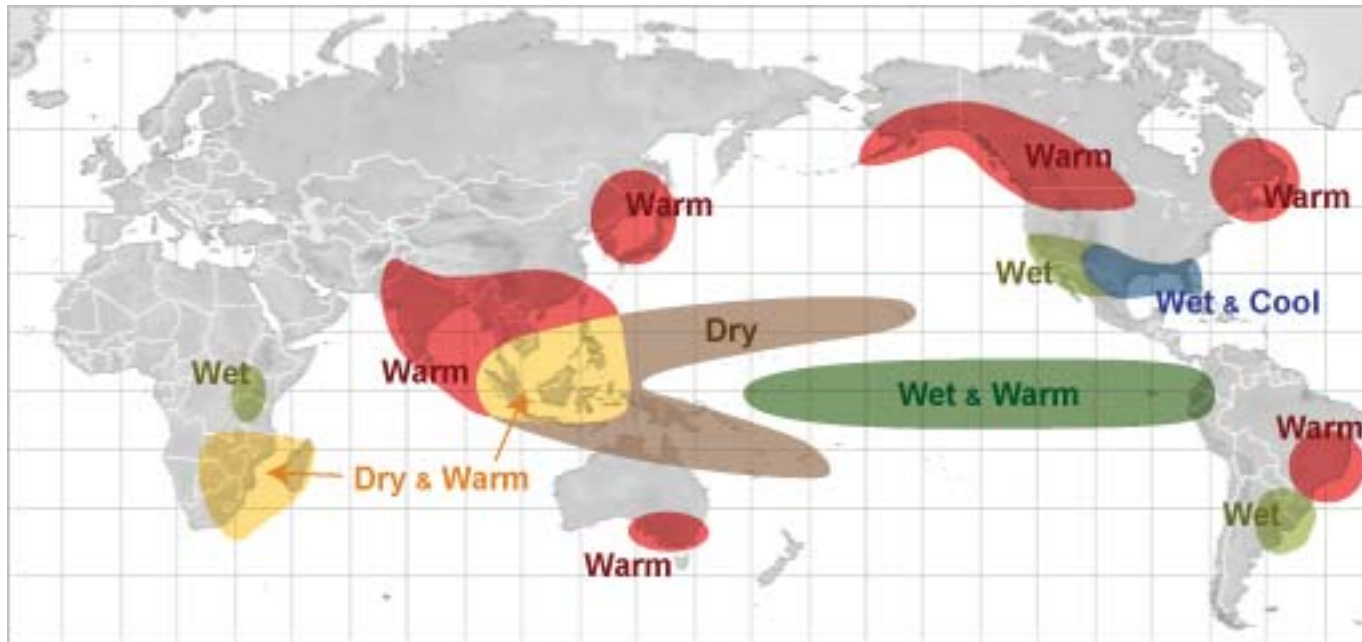


Image source – <https://www.climate.gov/enso>

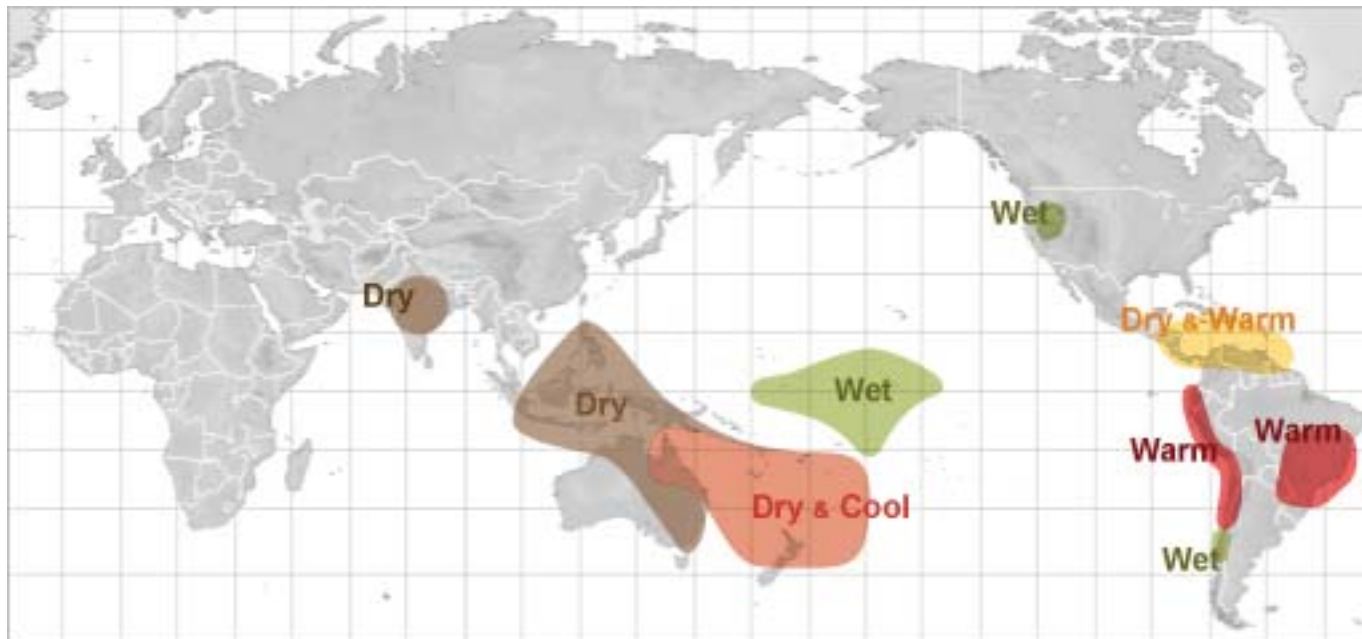
What is possible:

- About 50% of the time, a weakening moderate to strong **El Niño** is followed by **La Niña** development by the end of the calendar year (*i.e.*, 2016).
- About 70-80% of the time, **La Niña** development occurs by the end of the **NEXT** calendar year (*i.e.*, 2017).
- Should a **La Niña** develop, the impact on crops is often opposite that typically observed during **El Niño** events.

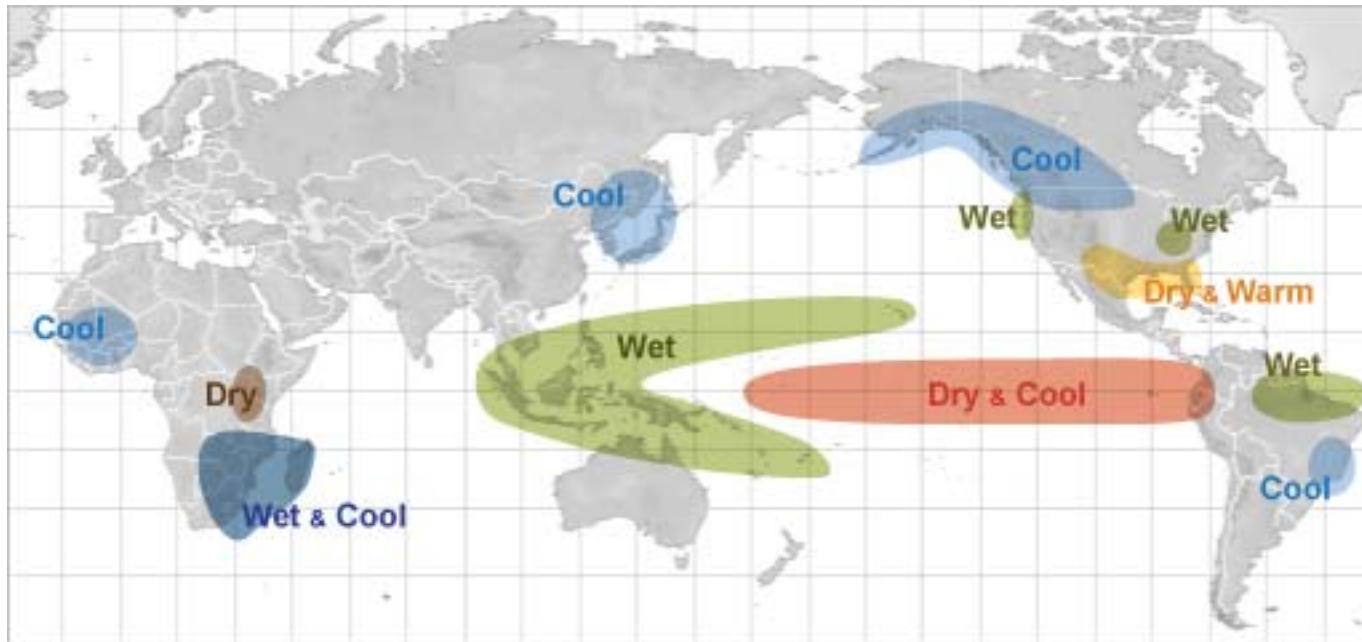
El Niño – Dec/Jan/Feb



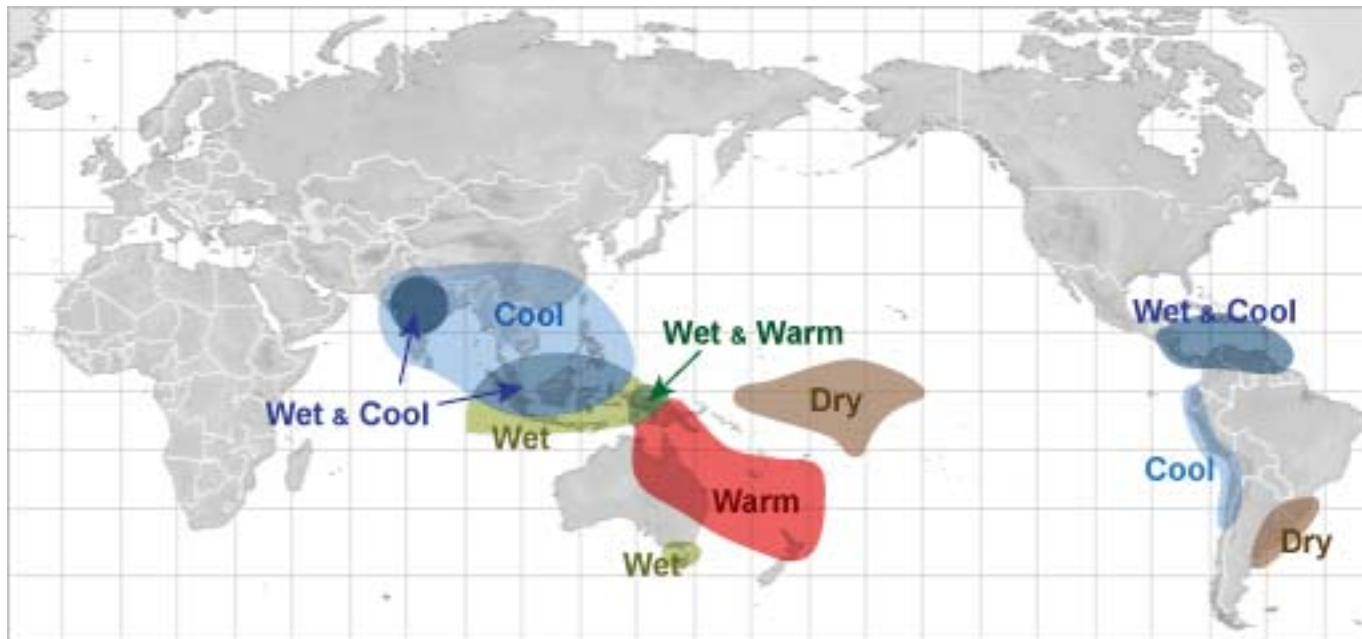
El Niño – Jun/Jul/Aug



La Niña – Dec/Jan/Feb



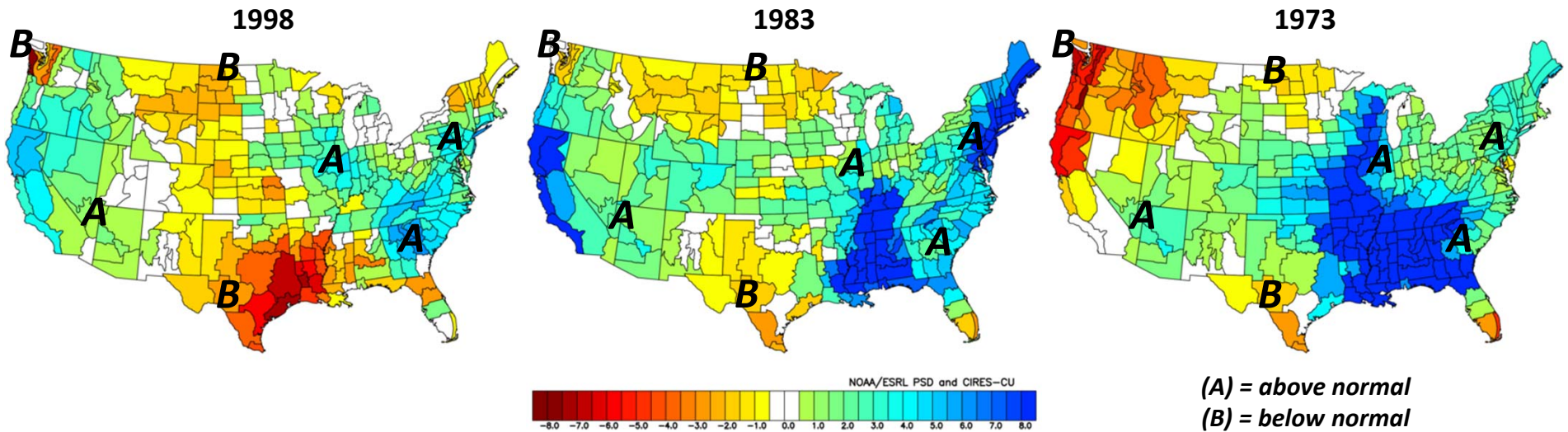
La Niña – Jun/Jul/Aug



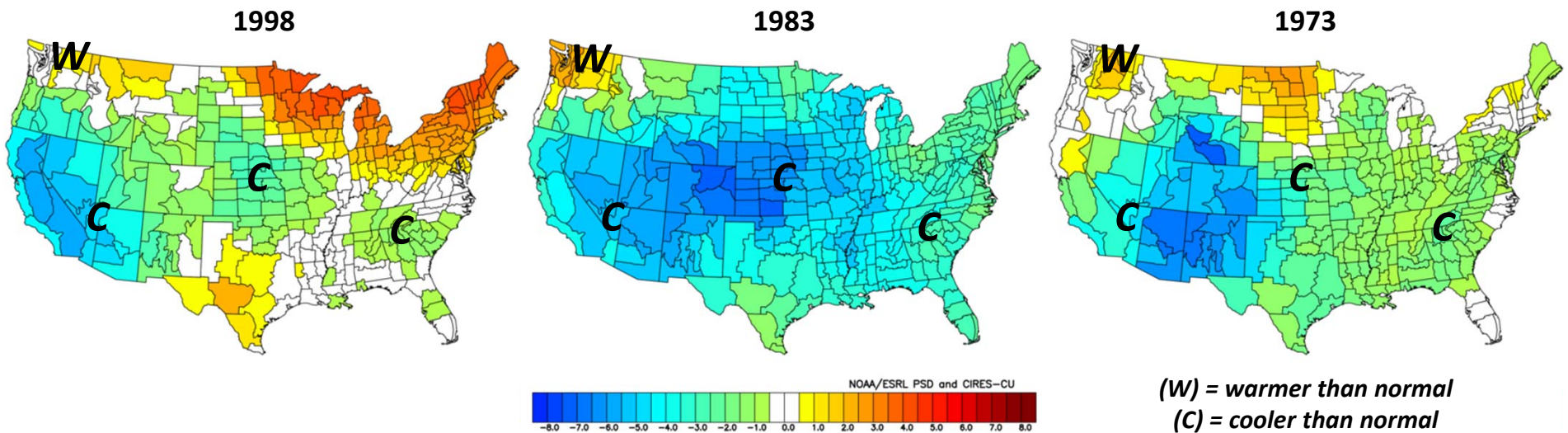
Climate patterns associated with El Niño – Spring (following peak)

March – April – May

Precipitation Anomalies (in)



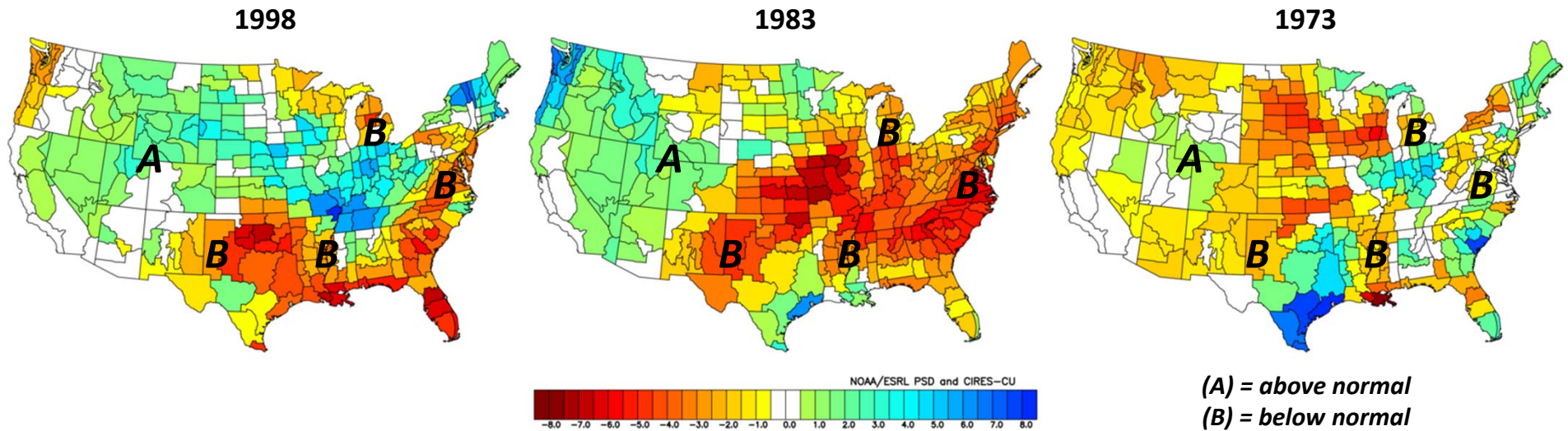
Maximum Temperature Anomalies (F)



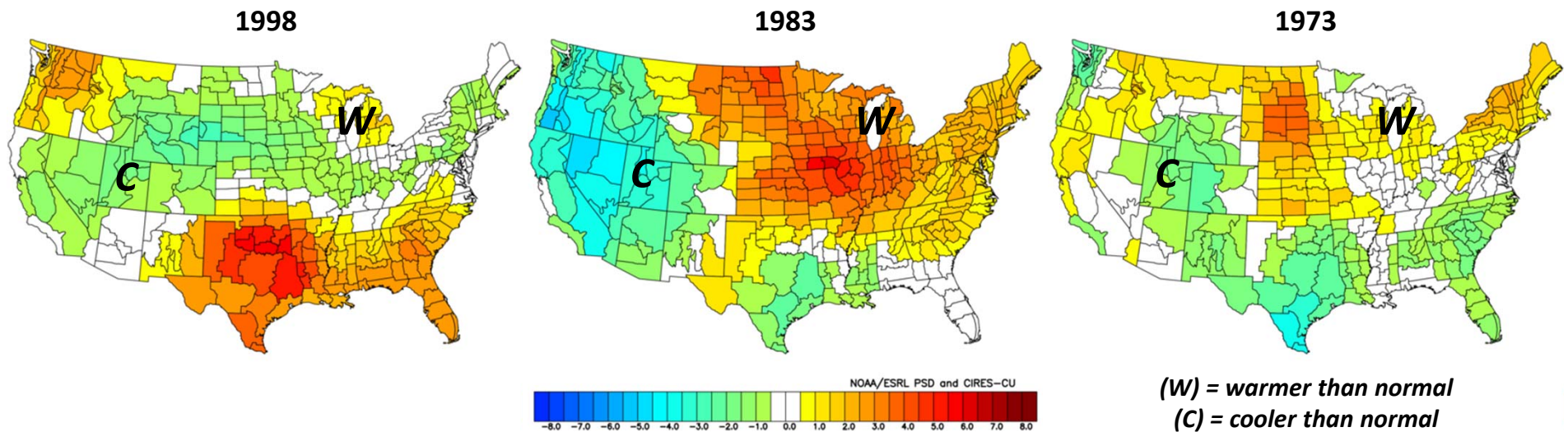
Climate patterns associated with El Niño – Summer (following peak)

June – July – August

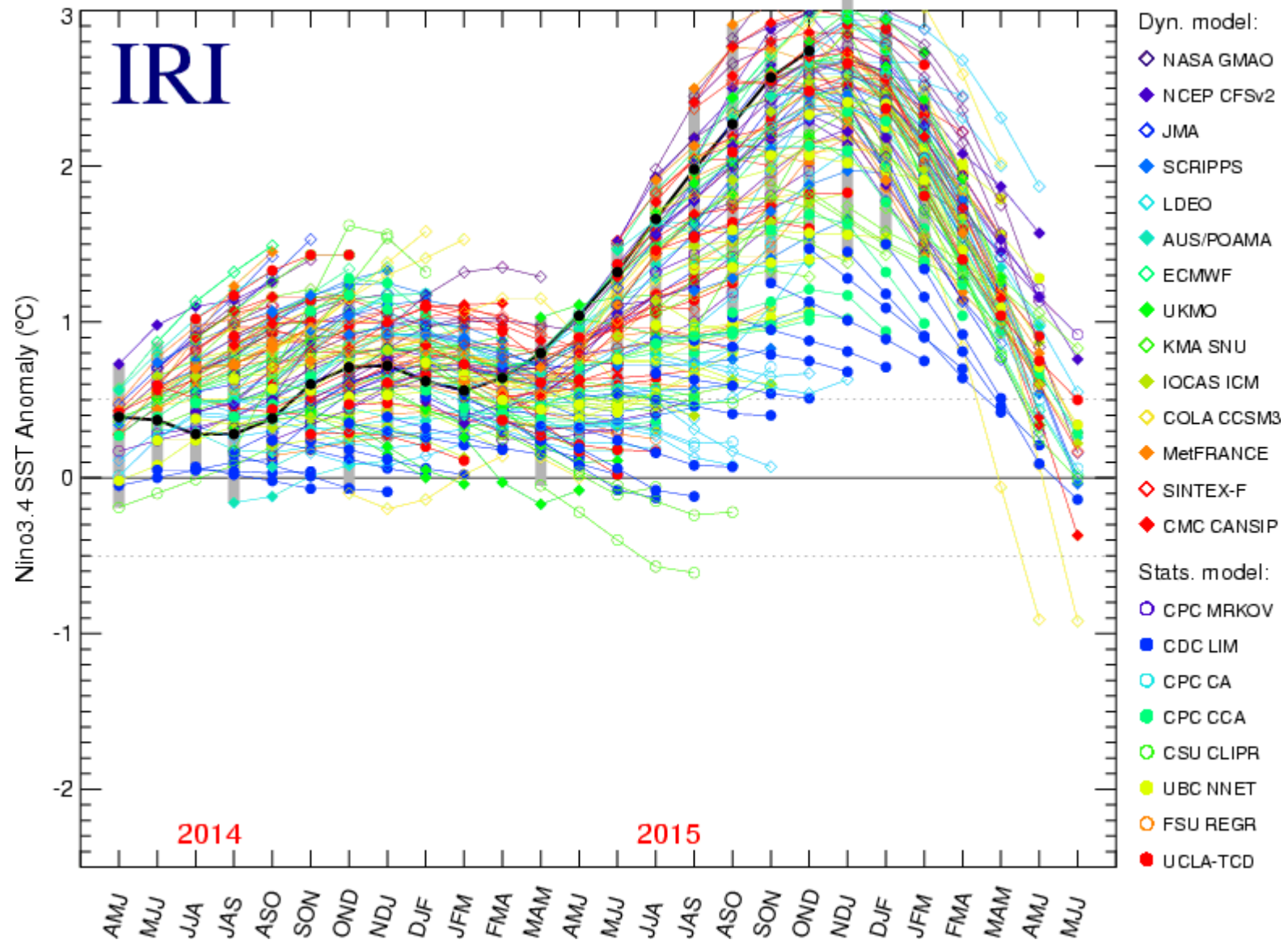
Precipitation Anomalies (in)



Maximum Temperature Anomalies (F)

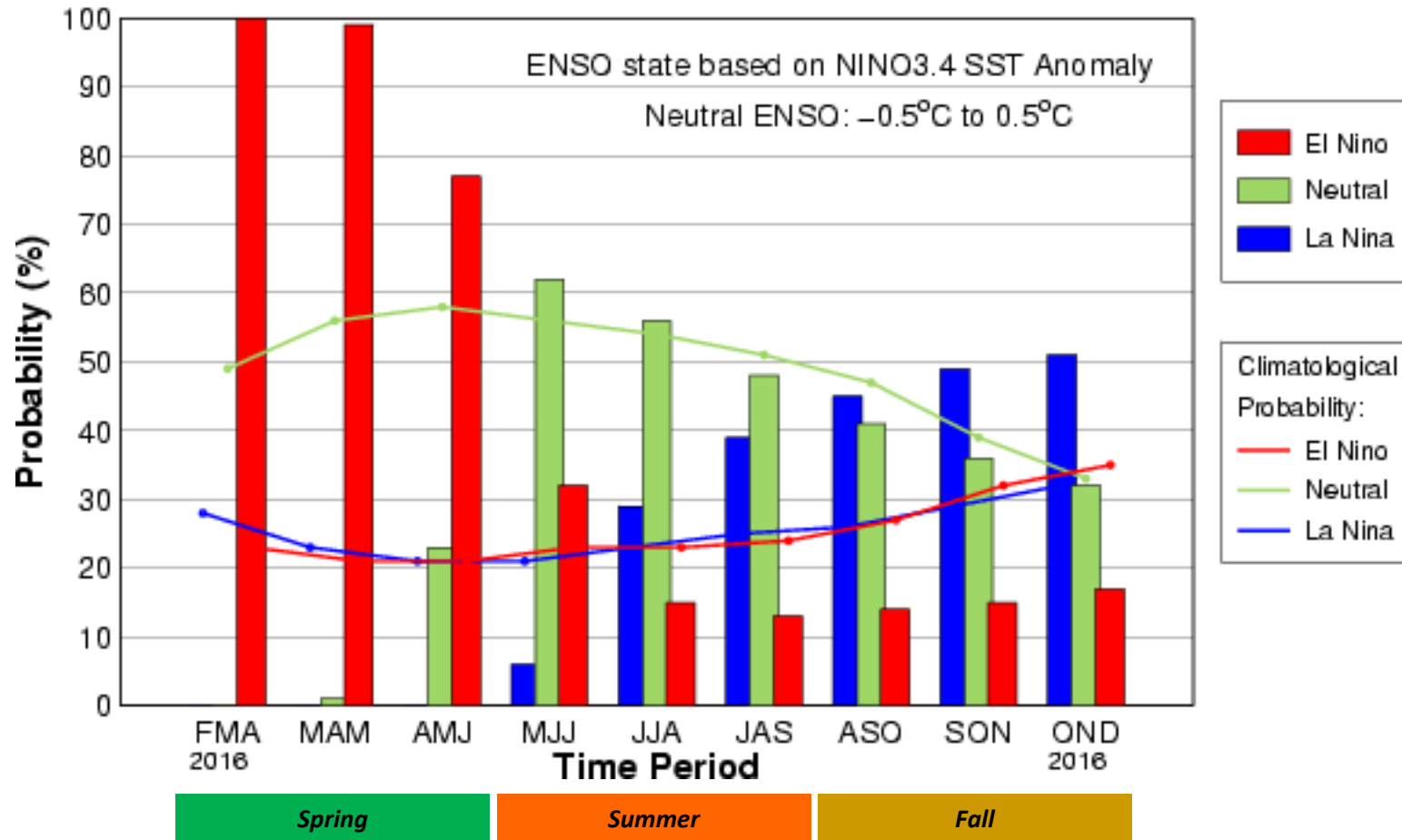


ENSO Predictions from Apr 14 to Jan 16



CPC/IRI Consensus Probabilistic ENSO Forecast

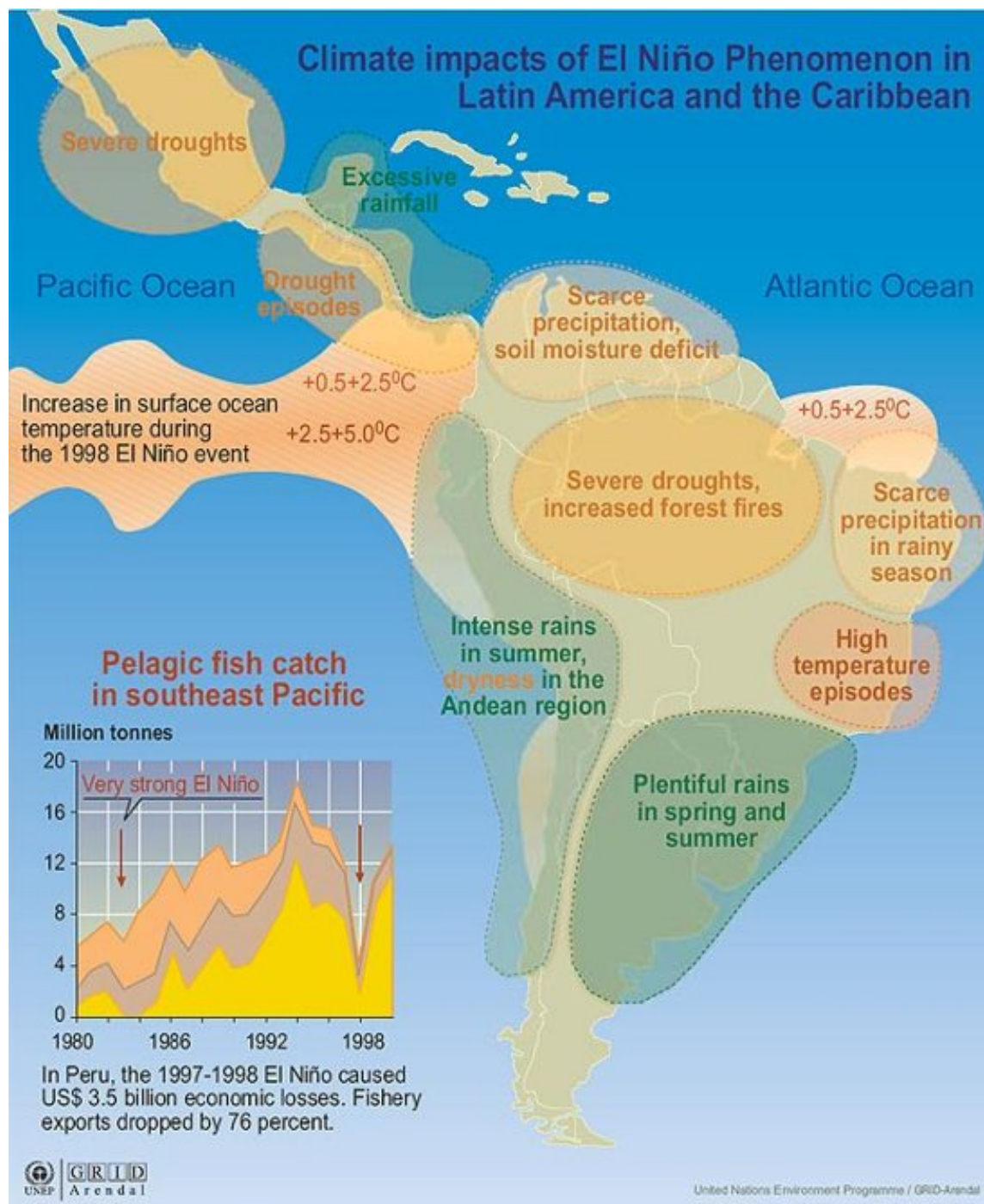
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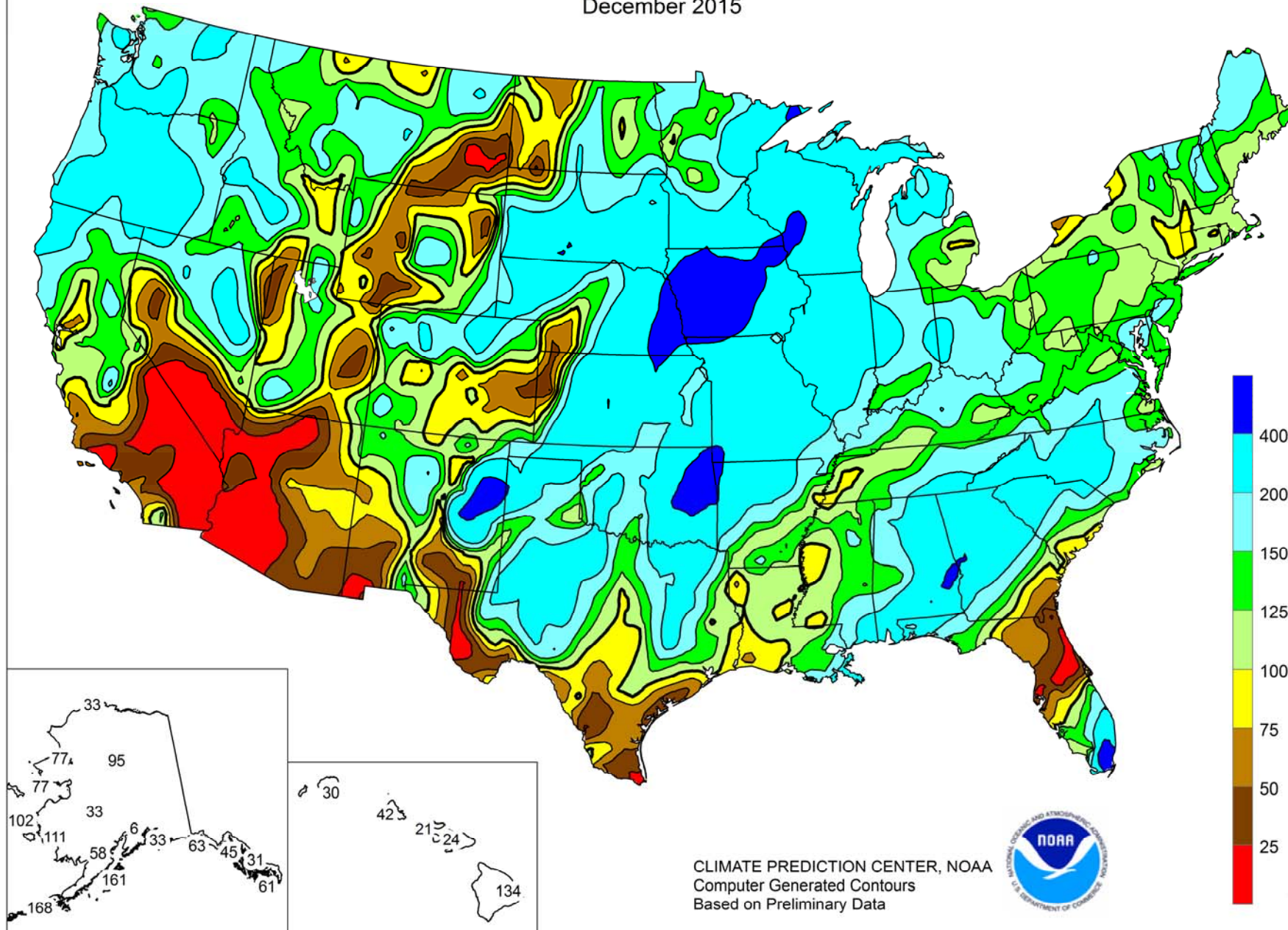
Image source – http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_plume

Climate impacts of El Niño Phenomenon in Latin America and the Caribbean



Percent of Normal Precipitation

December 2015



CLIMATE PREDICTION CENTER, NOAA
Computer Generated Contours
Based on Preliminary Data



Percent of Normal Precipitation

January 2016

