AGRICULTURAL OUTLOOK FORUM

Outlook for El Niño and its Impact on Global Crop Weather

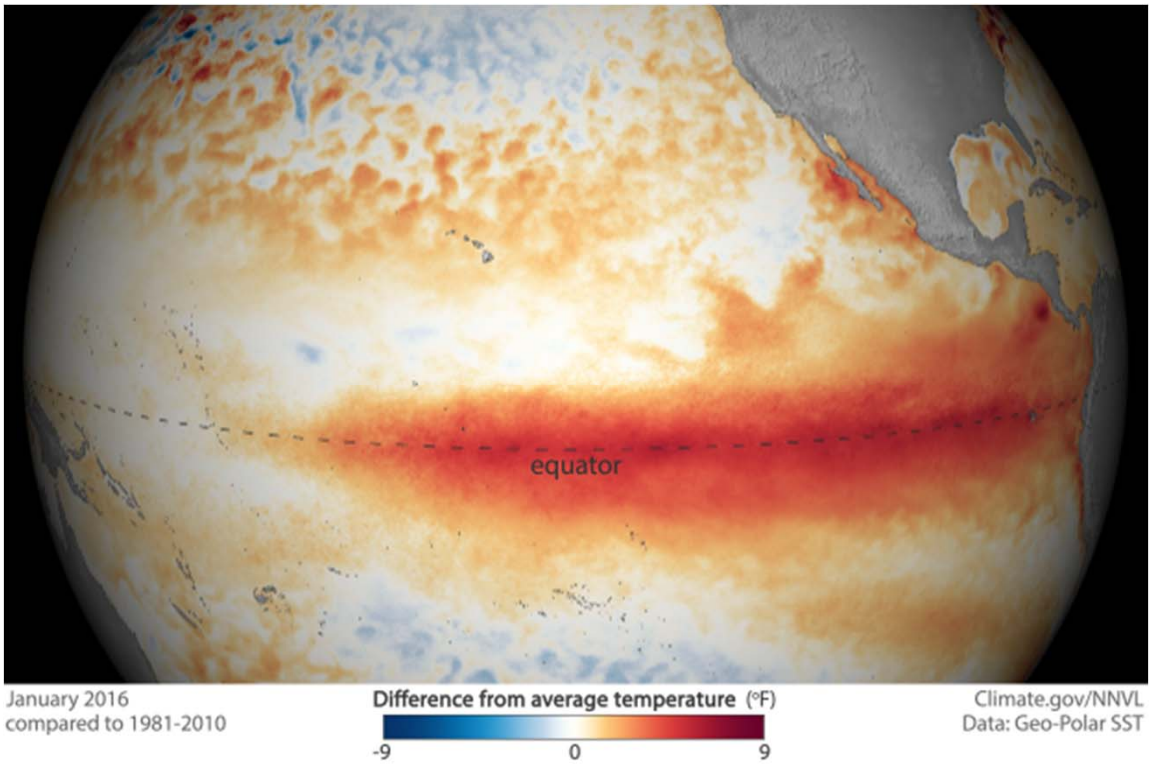


Image source – https://www.climate.gov/enso

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

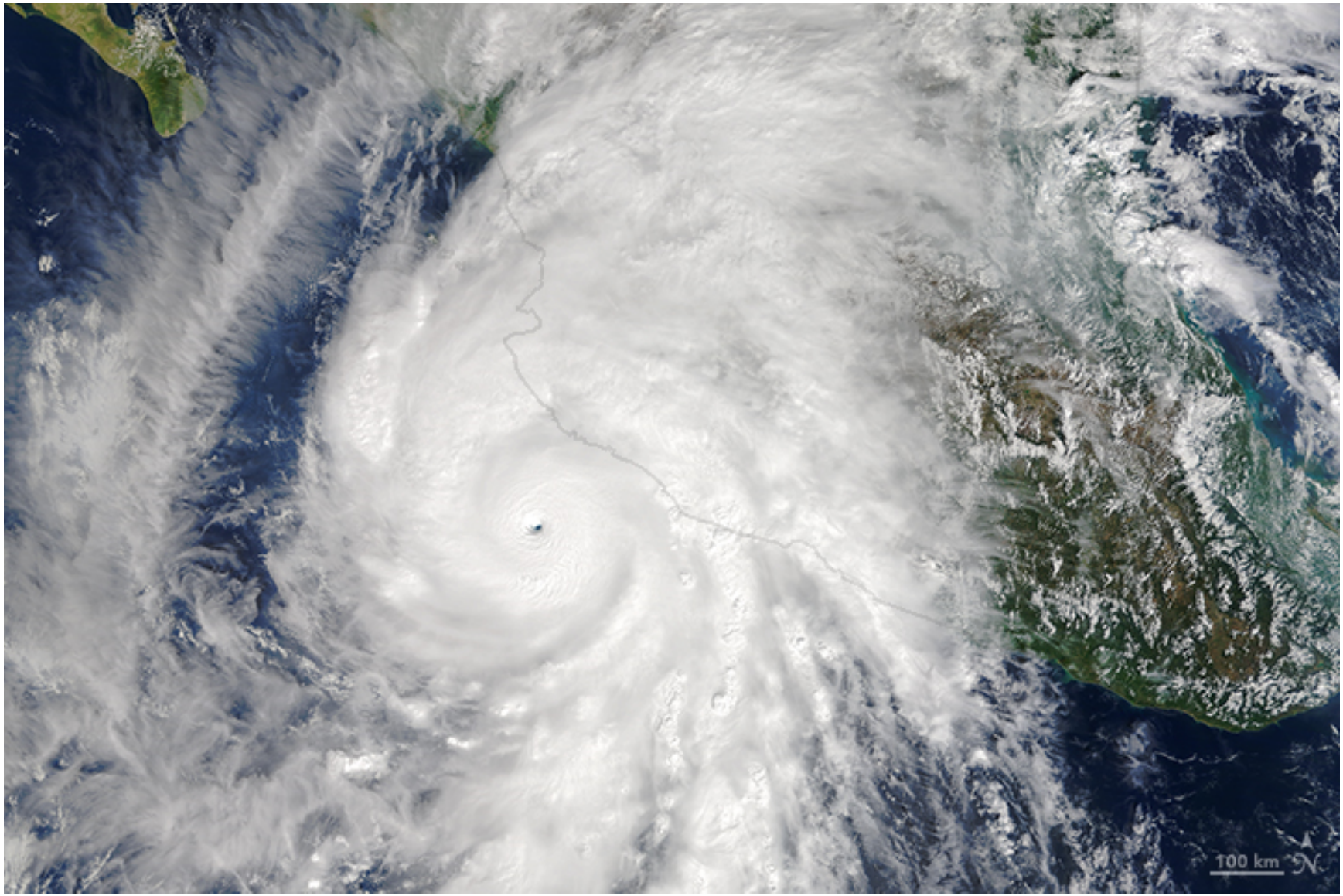
Drought in Papua New Guinea

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

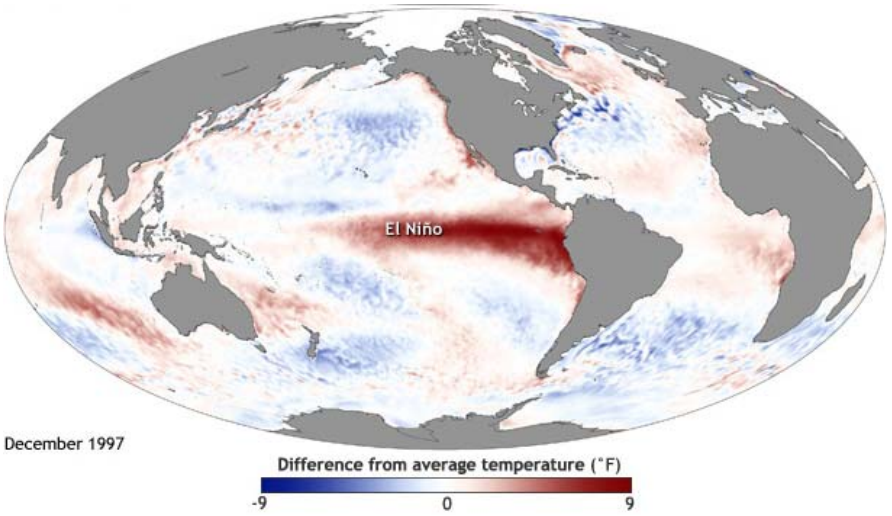
Welcome mountain snows

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.

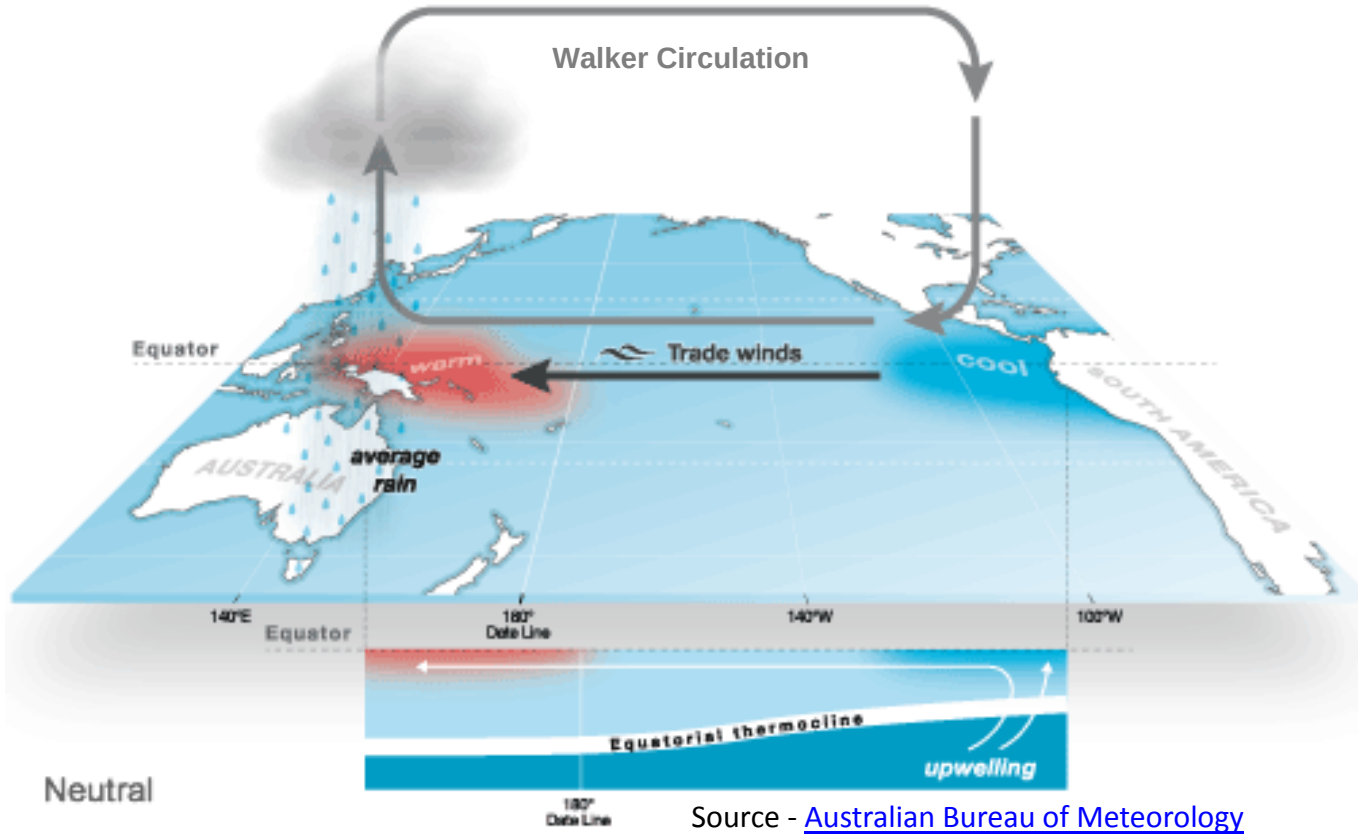


Source - NOAA Climate.gov

- 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.

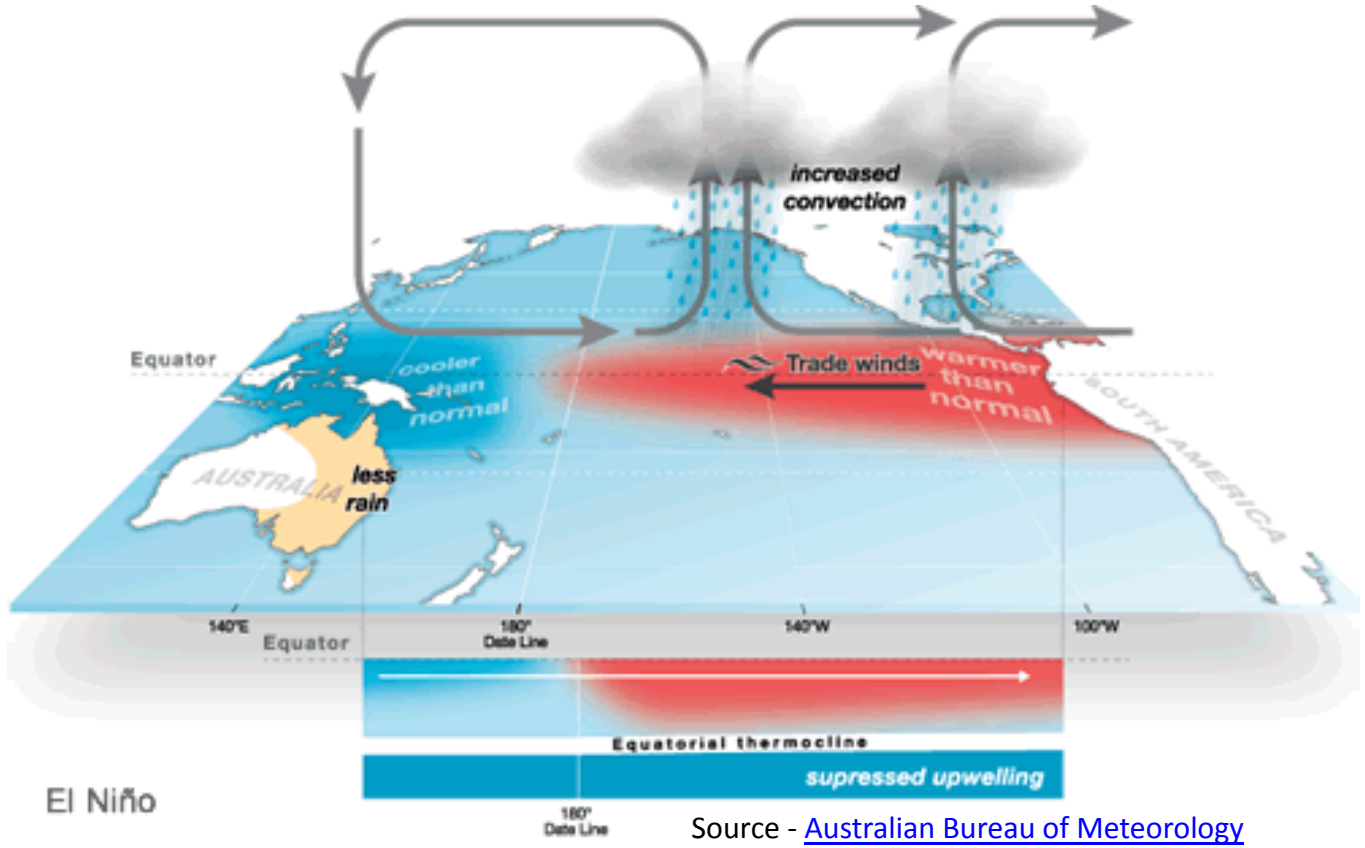
ENSO Neutral Phase



Source - [Australian Bureau of Meteorology]

- 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)



Source - Australian Bureau of Meteorology

- 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.

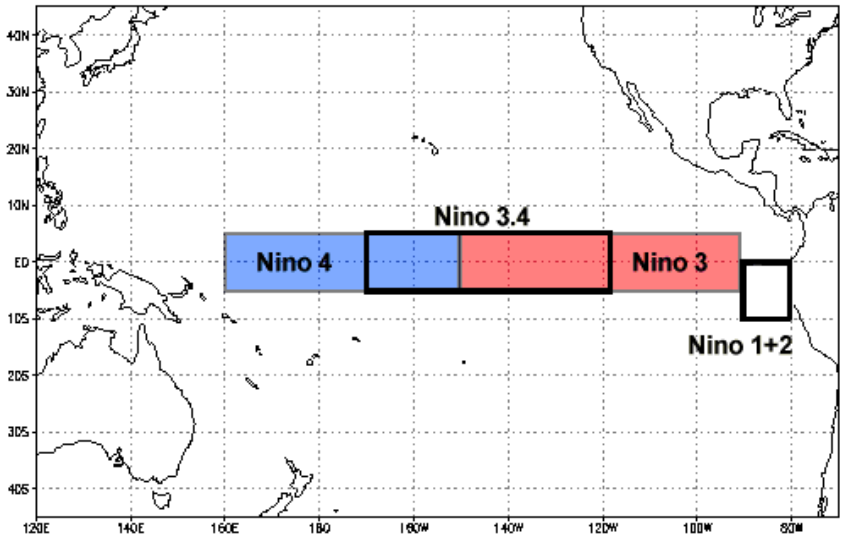
How is the strength of an El Niño measured?

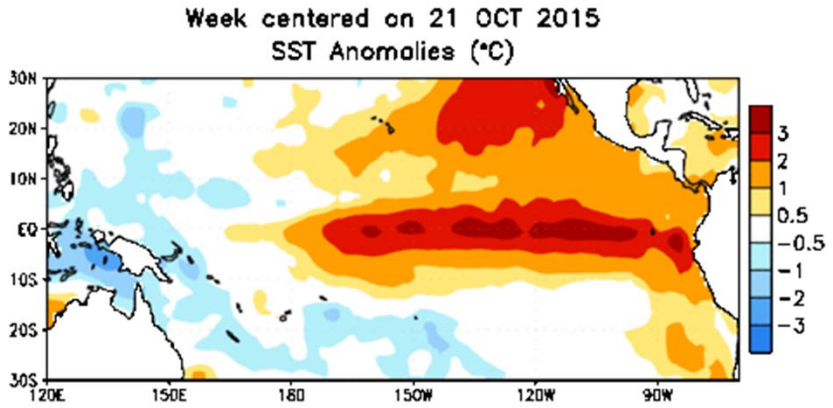
- The current state of the ENSO is often measured by sea surface temperature anomalies in parts of the equatorial Pacific Ocean.

- 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°C
Weak El Niño	+0.5°C to +0.9°C
Moderate El Niño	+1.0°C to +1.4°C
Strong El Niño	+1.5°C to +1.9°C
Very Strong El Niño	≥ +2.0°C





Source - NOAA/NWS/CPC

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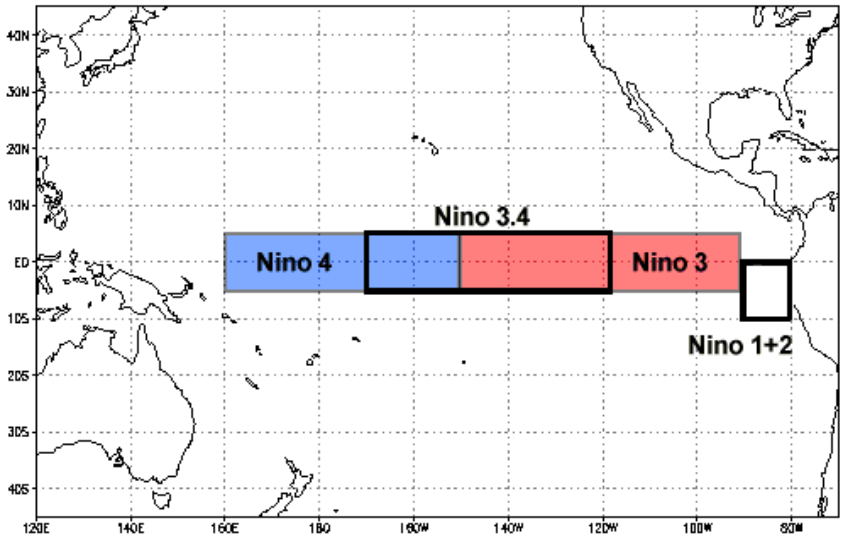

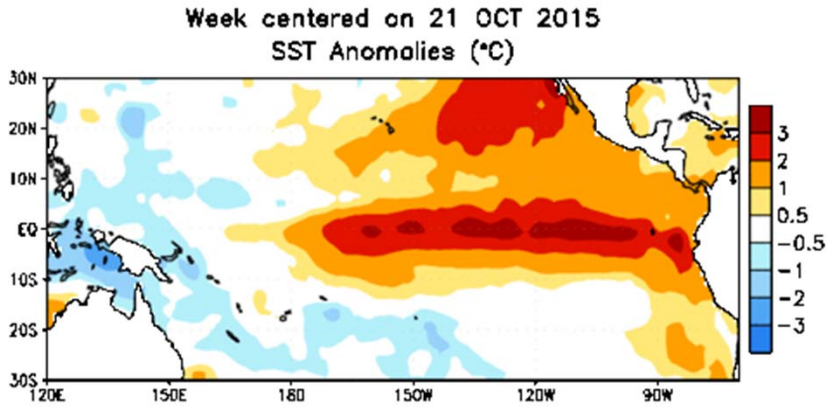

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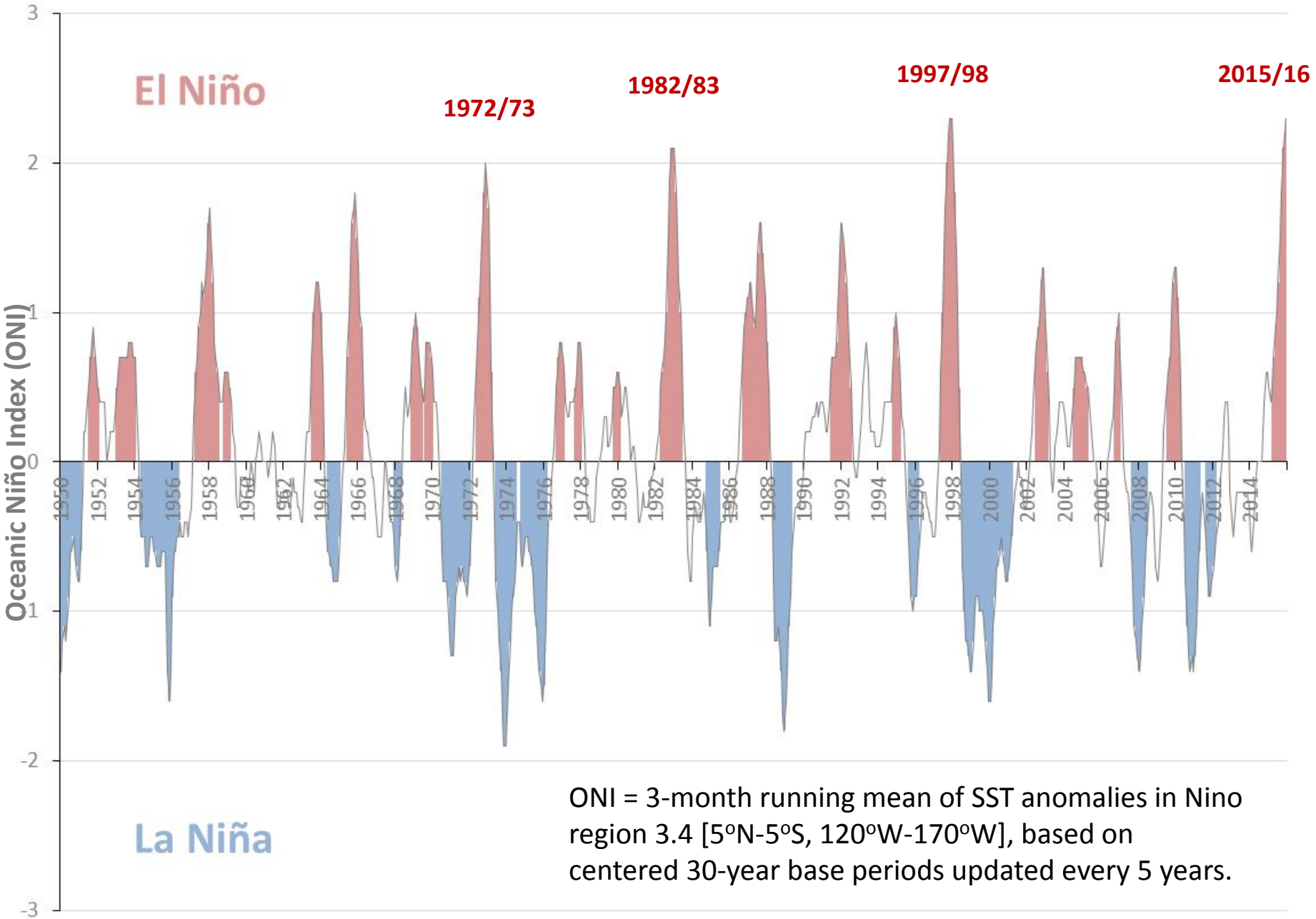
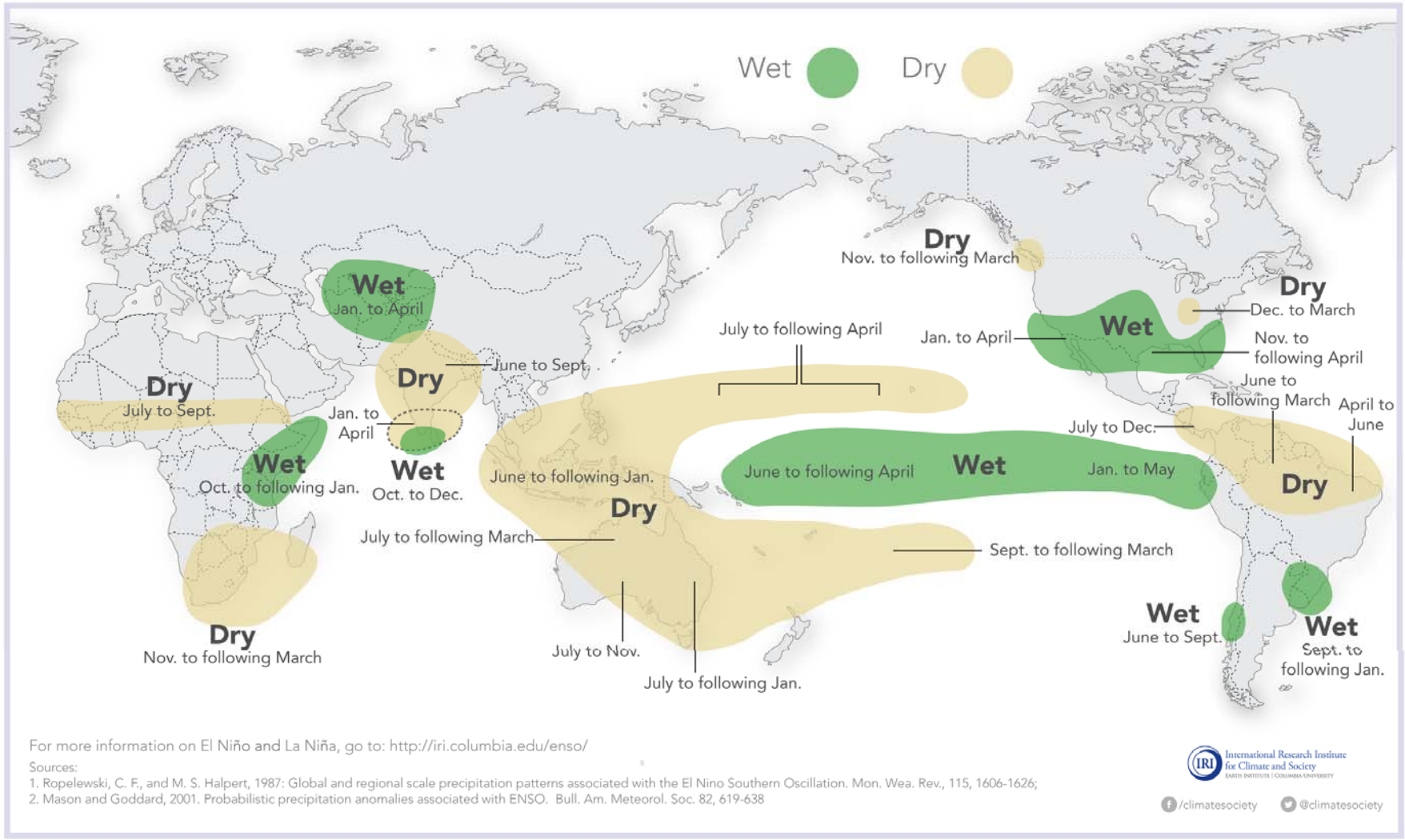


ONI = 3-month running mean of SST anomalies in Nino region 3.4 [5°N-5°S, 120°W-170°W], based on centered 30-year base periods updated every 5 years.

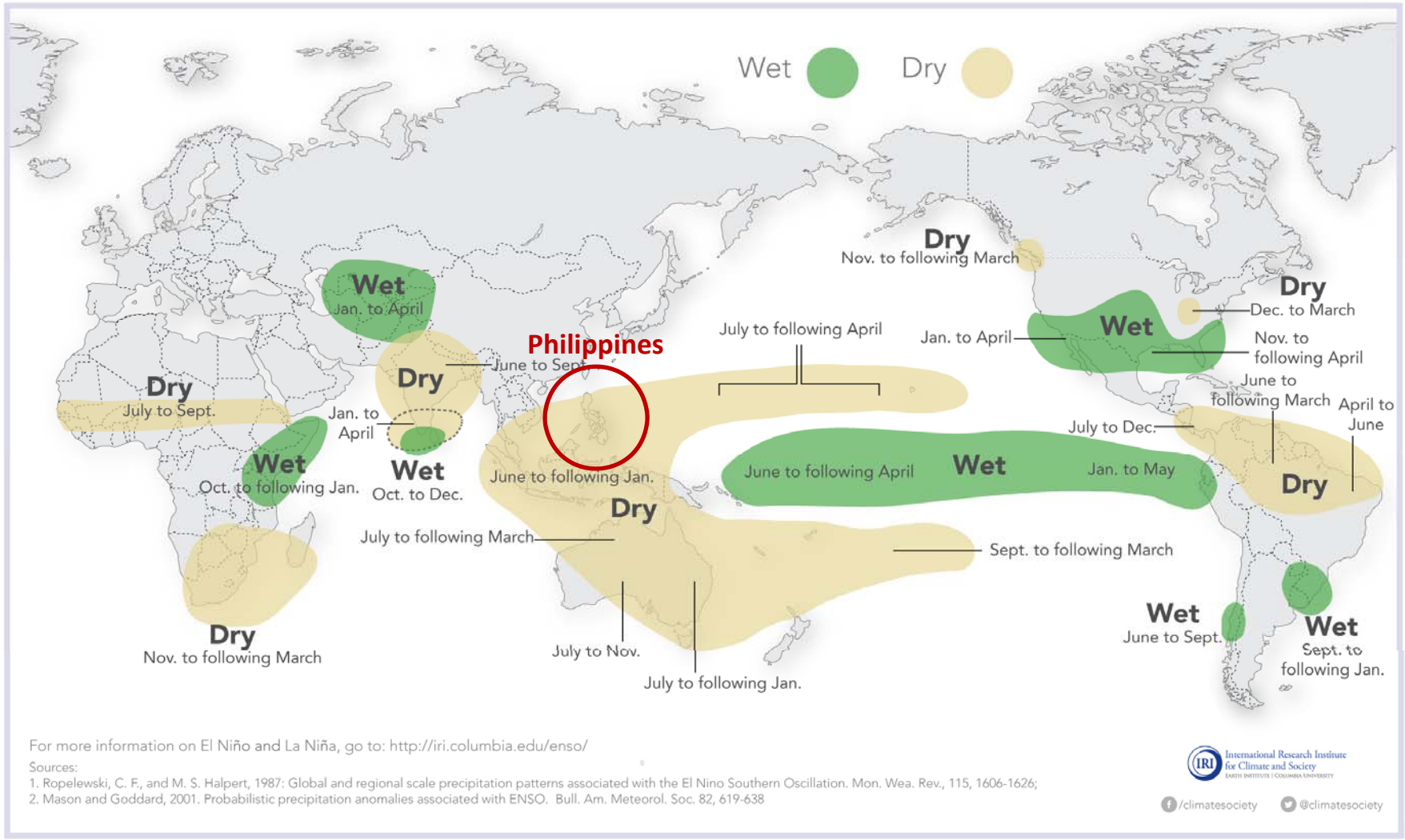
Source - [NOAA/NWS/CPC]

Typical Impacts



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

Typical Impacts



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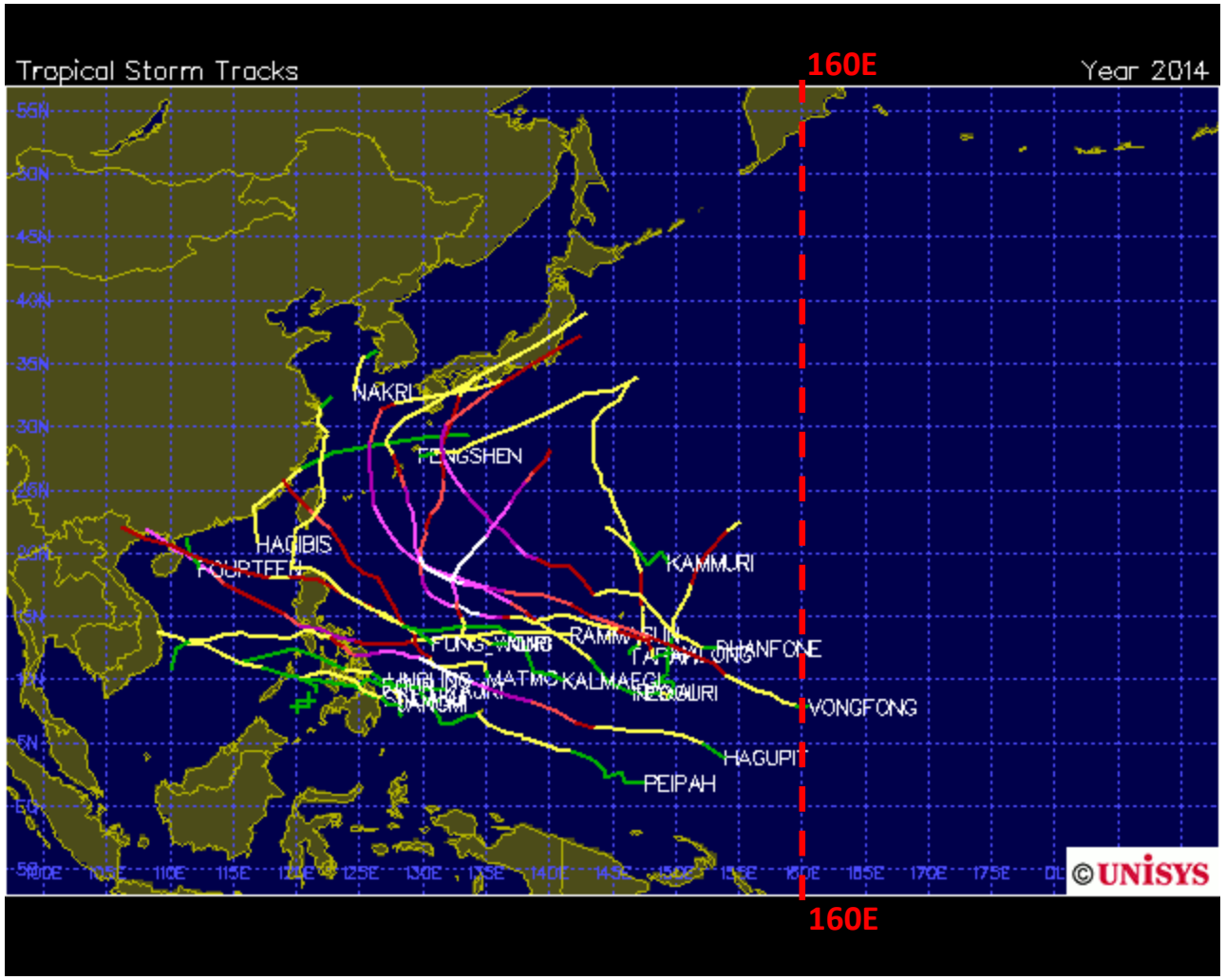
Western Pacific Tropical Cyclone Tracks - 2014



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

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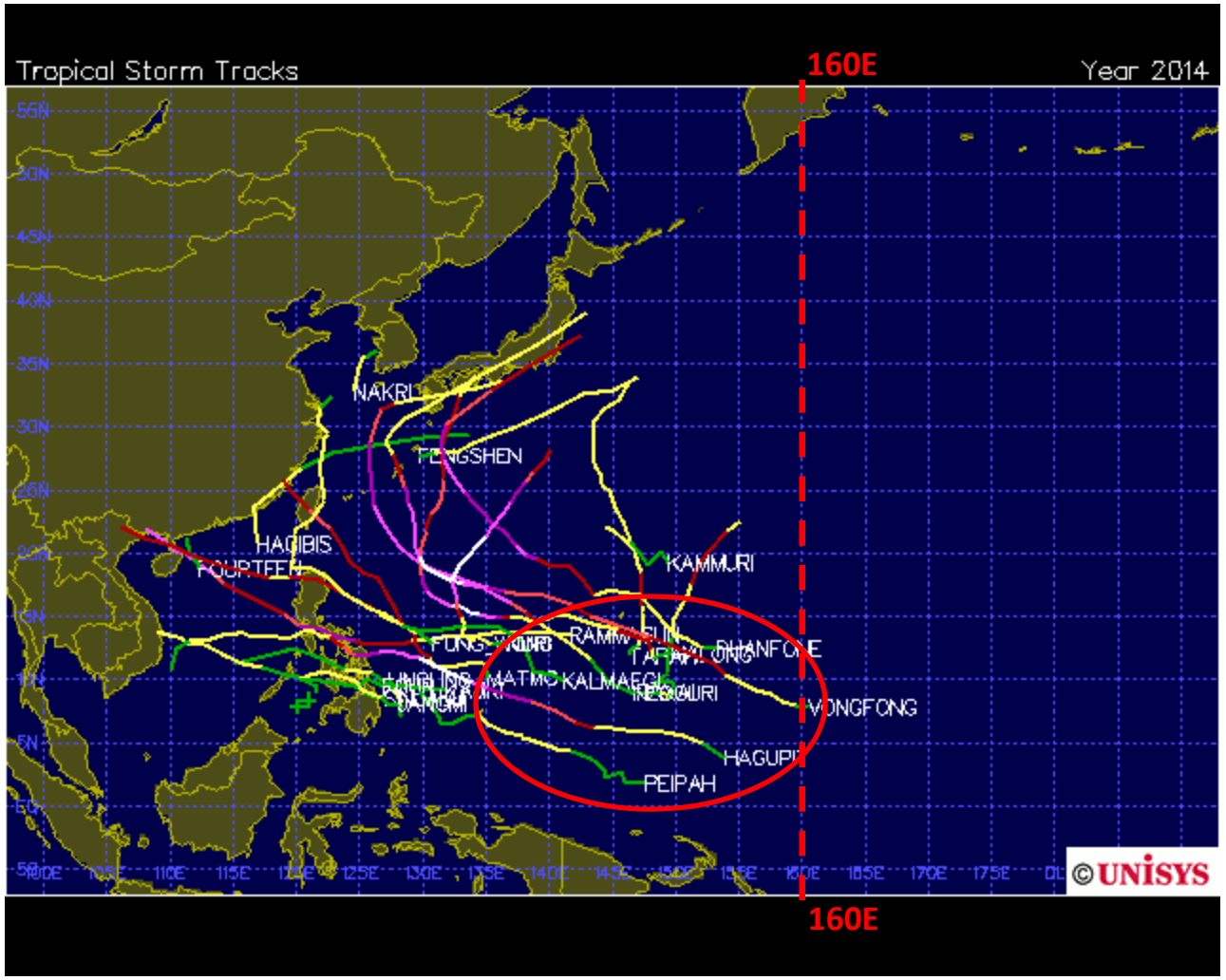
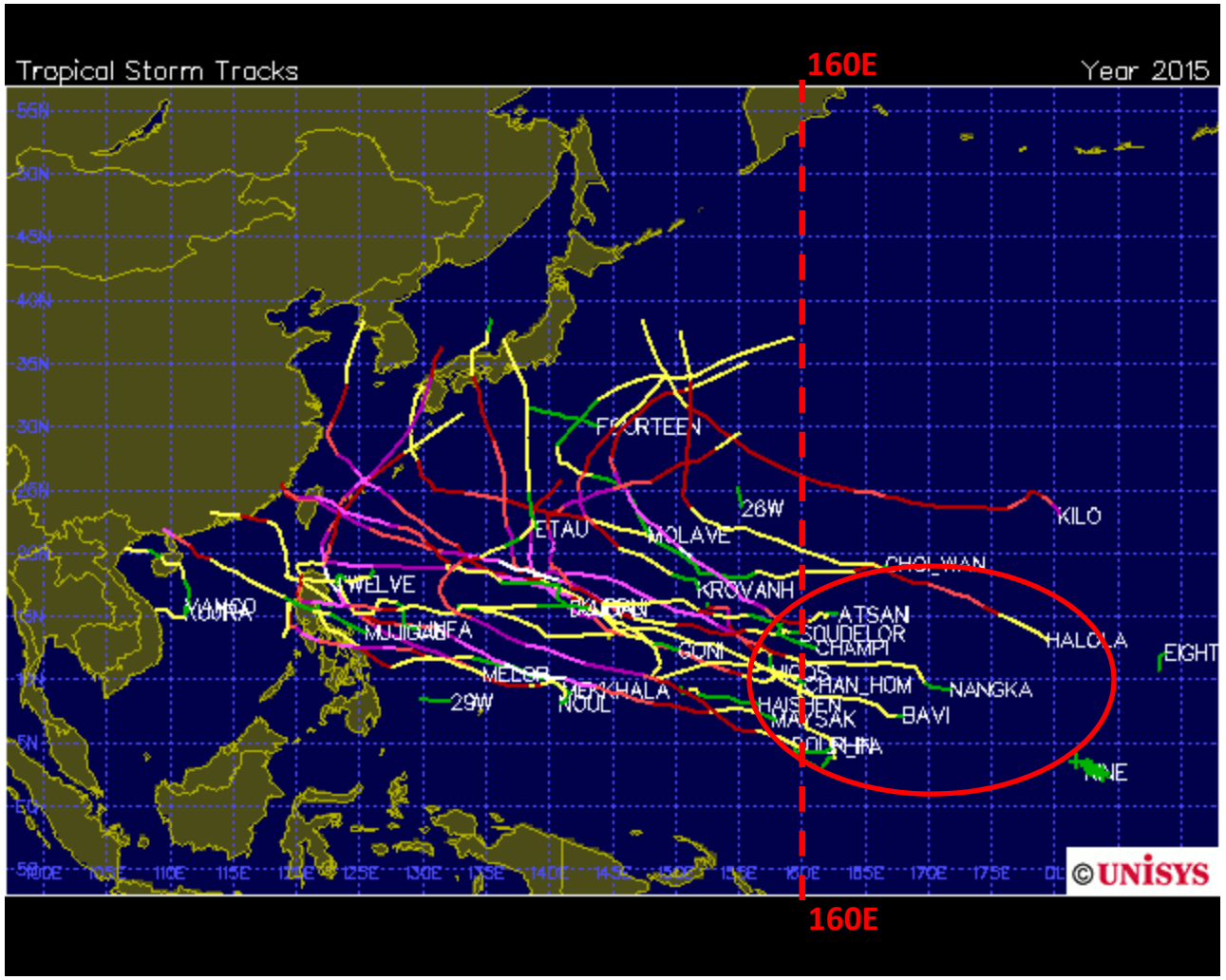


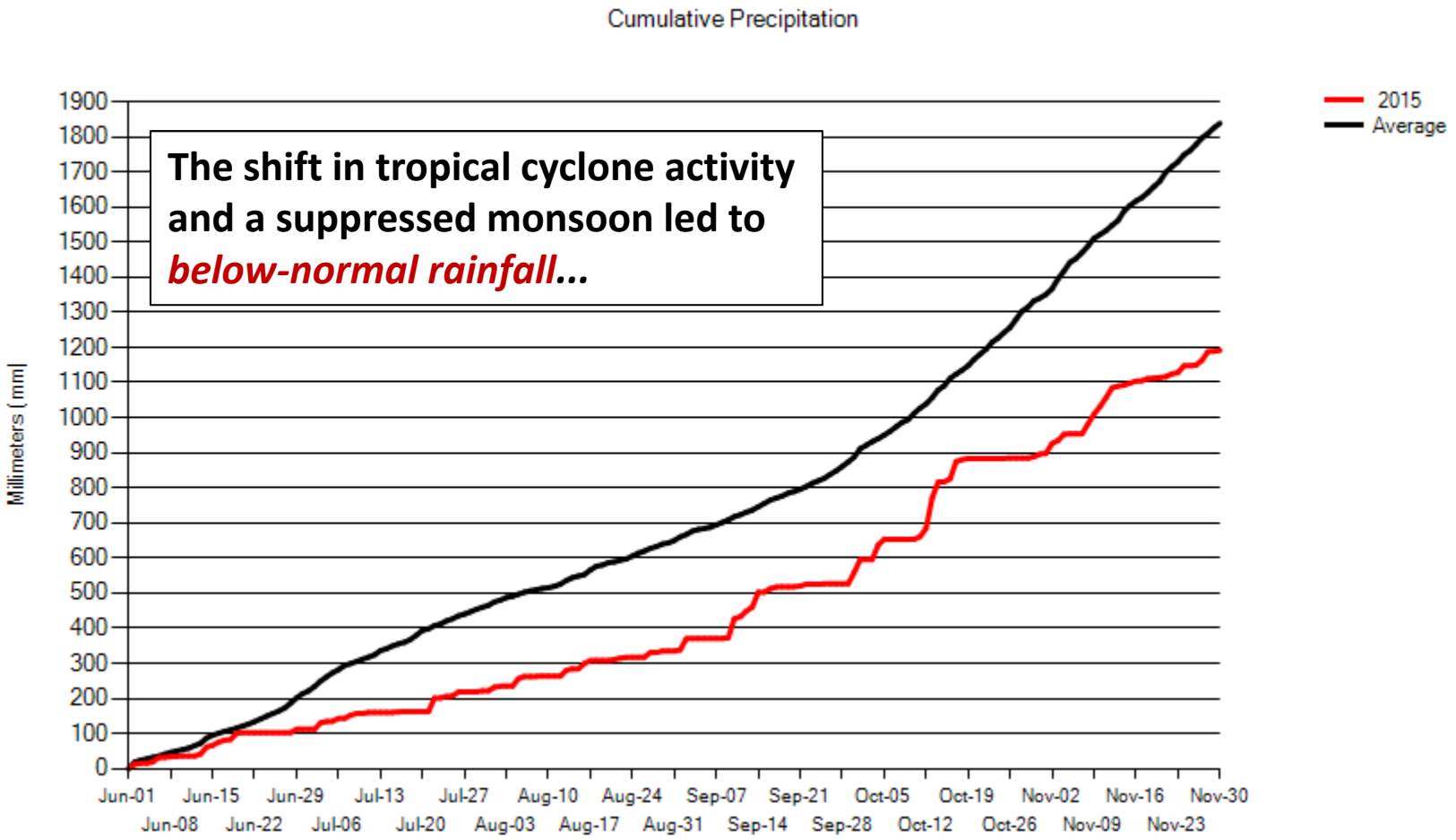
Source - http://weather.unisys.com/hurricane/w_pacific/2014/index.php

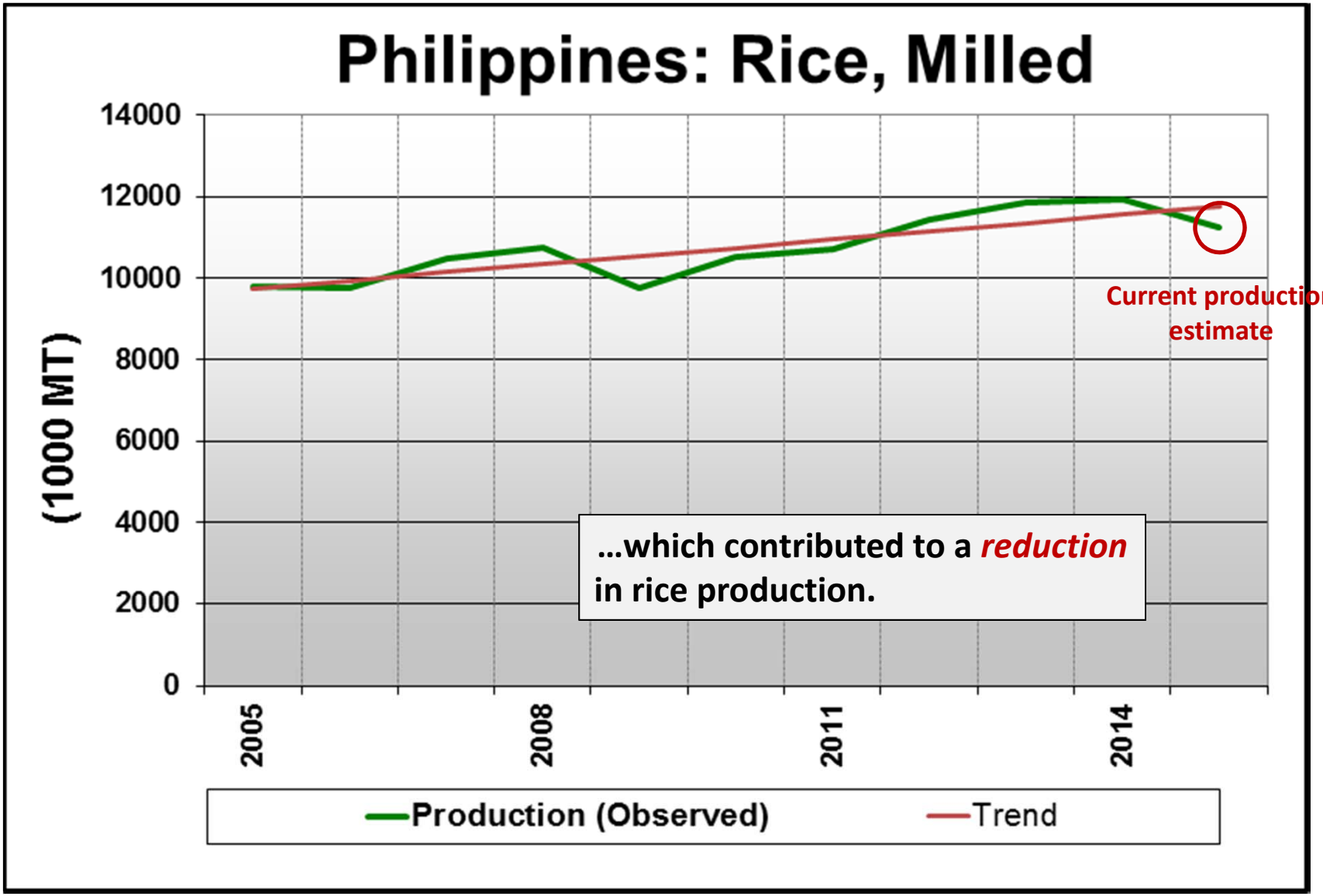
Western Pacific Tropical Cyclone Tracks - 2015

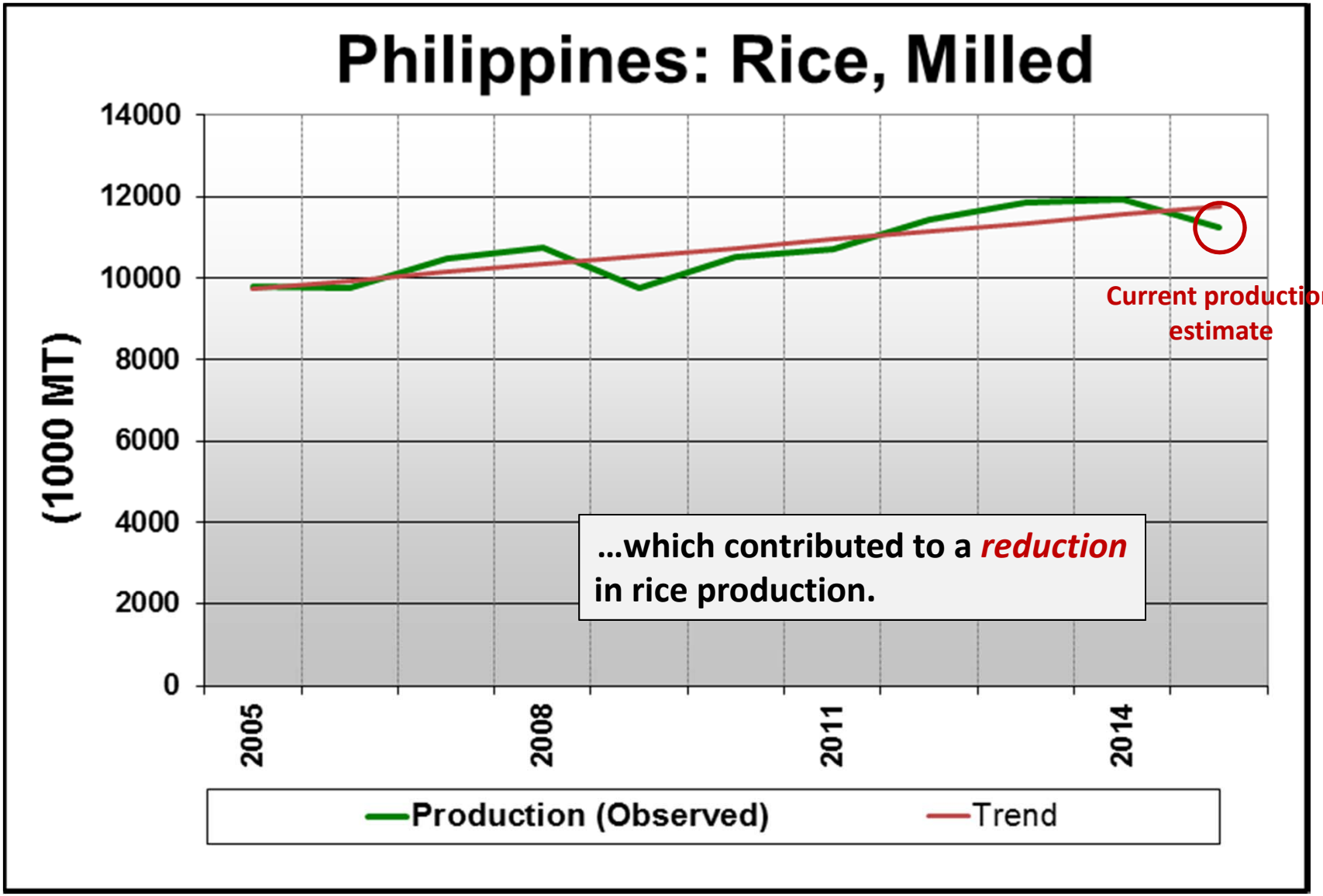


Source - http://weather.unisys.com/hurricane/w_pacific/2015/index.php

Philippines

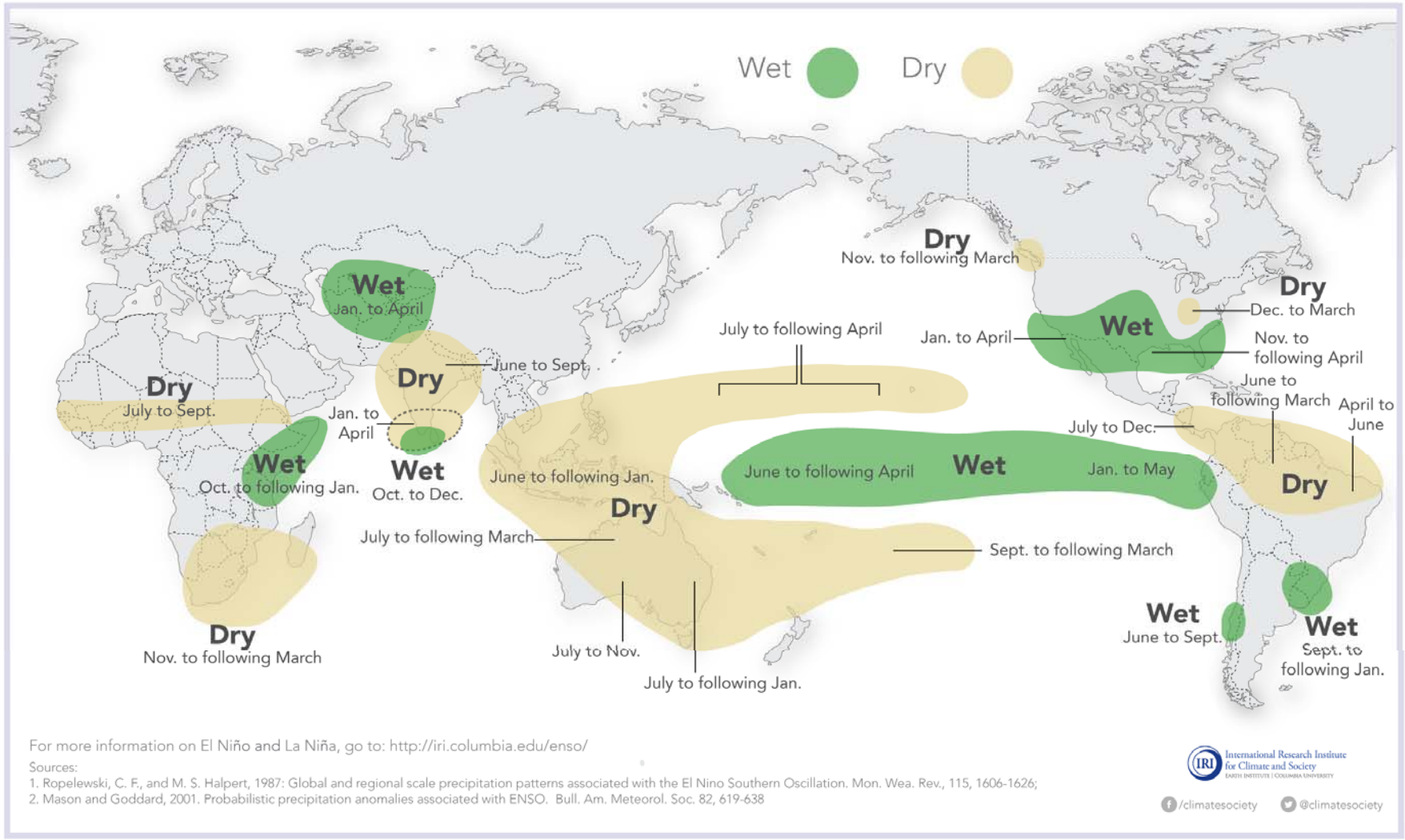



Philippines: Rice, Milled
(1000 MT)
14000
12000
10000
8000
6000
4000
2000
0
2005
2008
2011
2014
Current production estimate
…which contributed to a reduction in rice production.
Production (Observed)
Trend



Textbook example of El Niño dominating throughout growing season.

Typical Impacts



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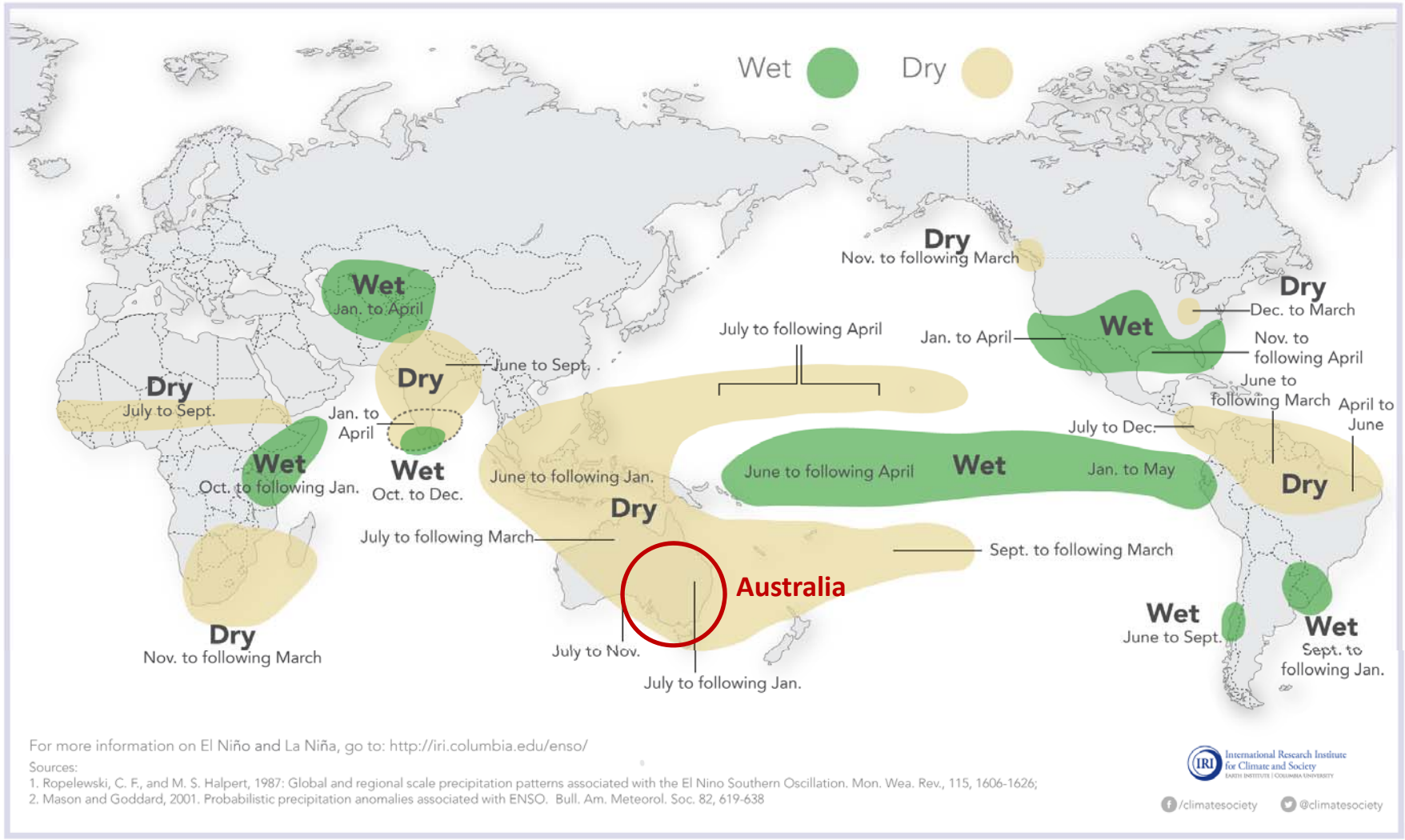

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EL NIÑO IN AUSTRALIA

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

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 *WAS IN* **2009–10**

TYPICAL IMPACTS ON OUR CLIMATE

RAINFALL **DECREASES** IN EASTERN AUSTRALIA

TEMPERATURE **INCREASES** IN SOUTHERN AUSTRALIA (DAYTIME TEMPERATURES)

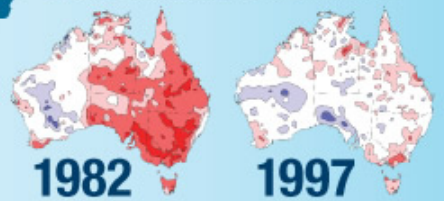
GLOBALLY, **7 OUT OF 10** OF THE HOTTEST YEARS ON RECORD WERE IN AN EL NIÑO YEAR OR THE YEAR FOLLOWING

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

EVERY EL NIÑO IS DIFFERENT

EL NIÑO WINTER AND SPRING RAINFALL



RED = *DRIER THAN NORMAL* **BLUE** = *WETTER THAN NORMAL*

THERE HAVE BEEN
26 EL NIÑO EVENTS SINCE 1900
17 HAVE BROUGHT WIDESPREAD DROUGHT

7 OF AUSTRALIA'S 10 DRIEST YEARS ON RECORD **WERE DURING EL NIÑO**

Australian Government
Bureau of Meteorology

www.bom.gov.au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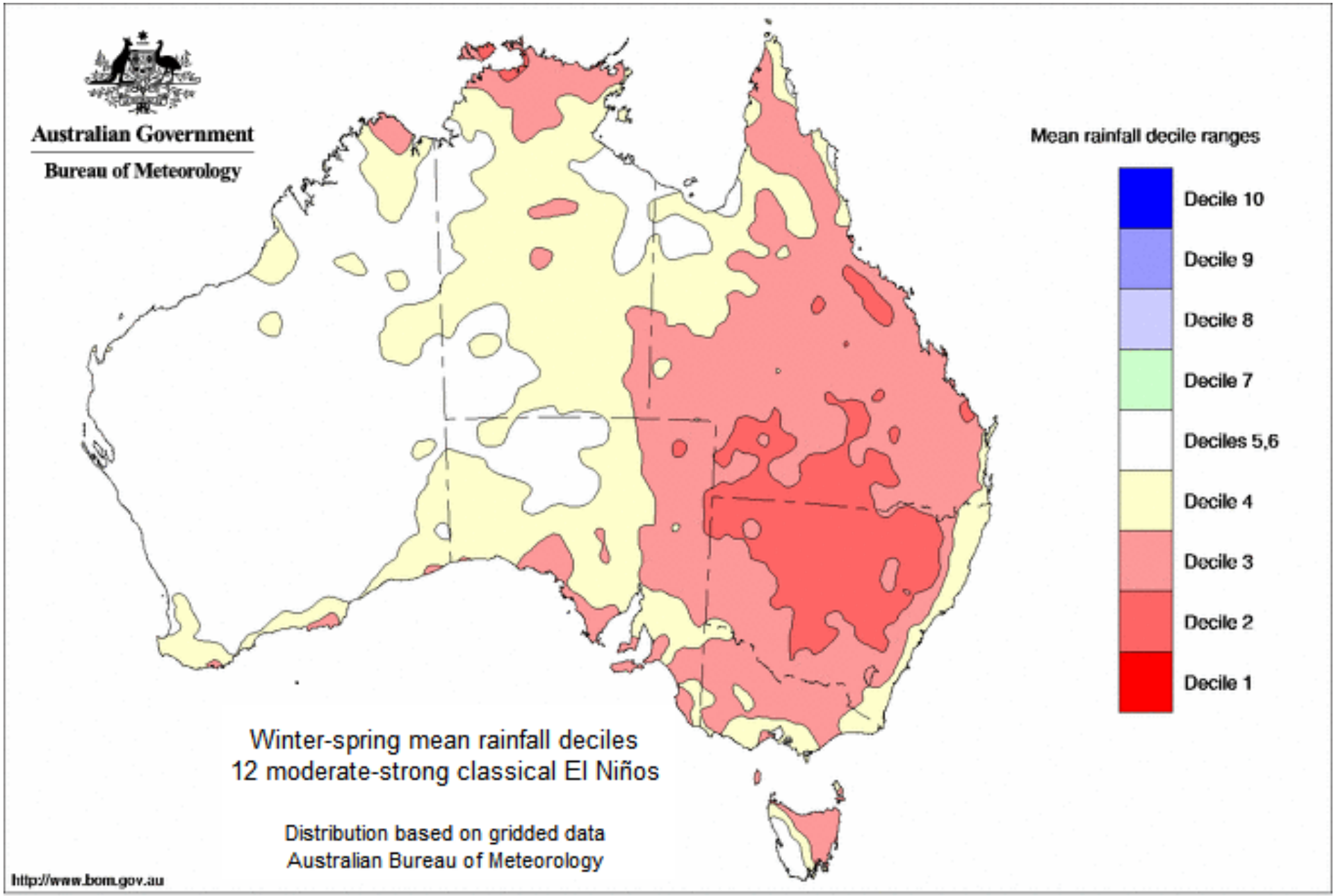
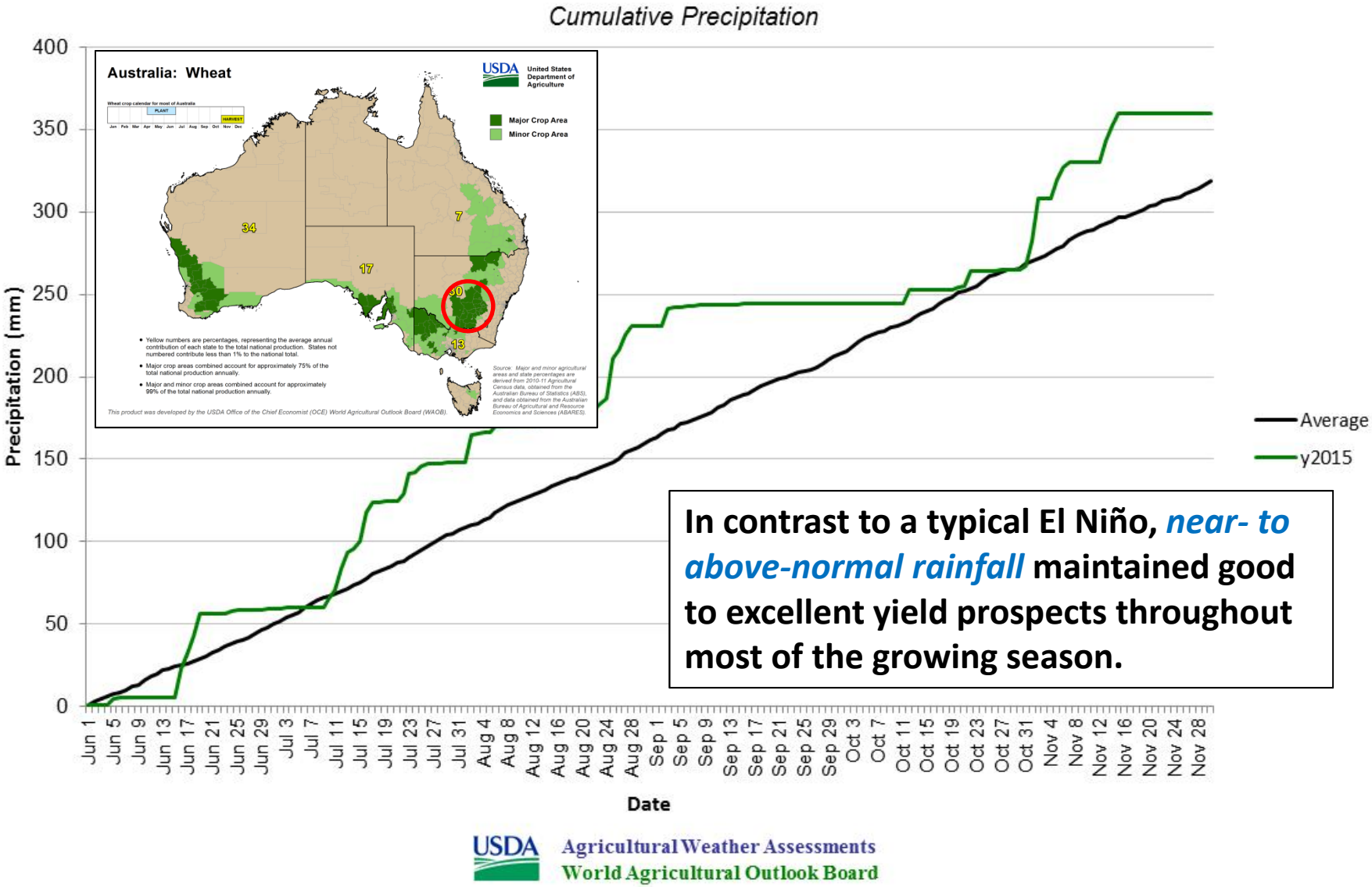


 ID code: Analyser

Issued: 25/05/2015

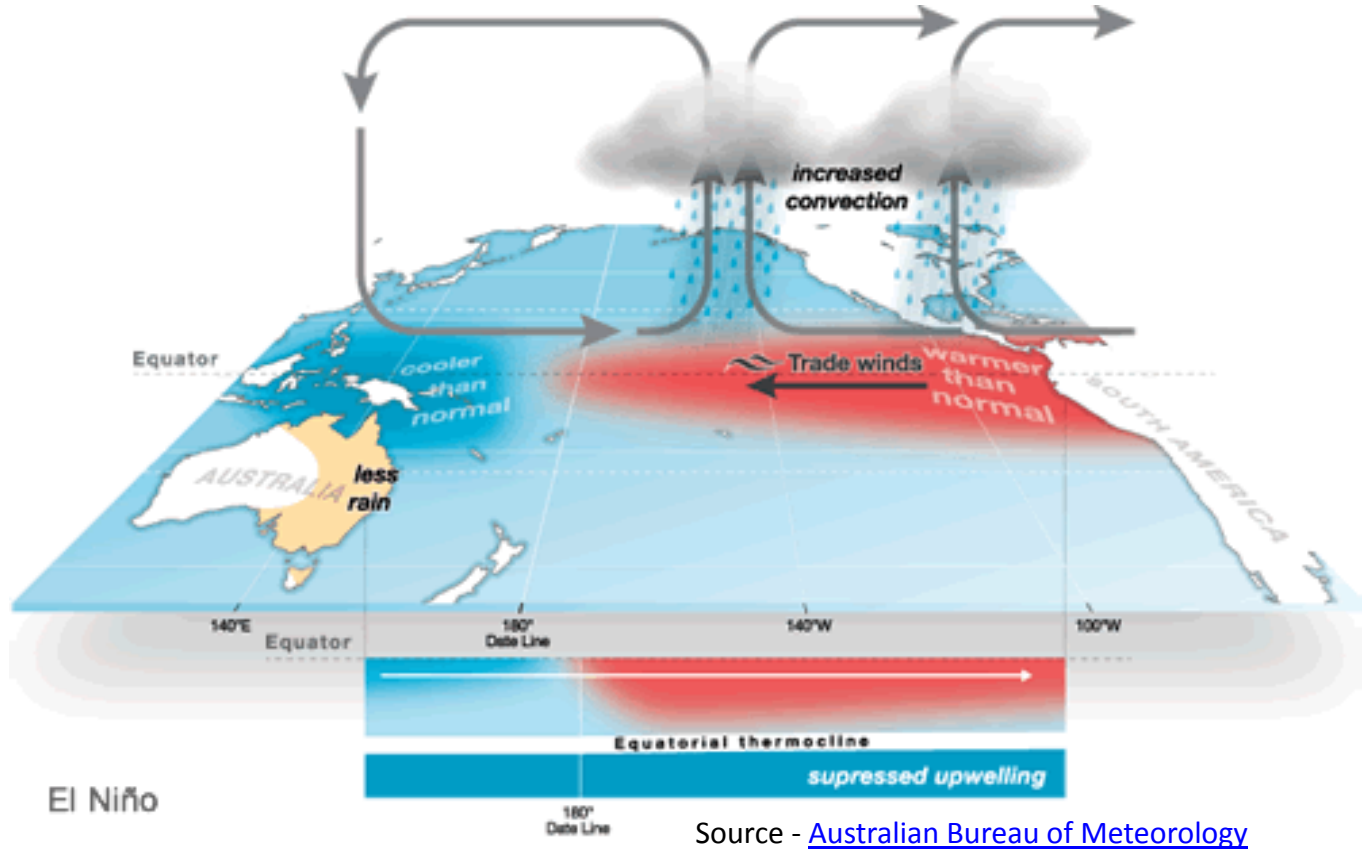
New South Wales



In contrast to a typical El Niño, *near- to above-normal rainfall* maintained good to excellent yield prospects throughout most of the growing season.

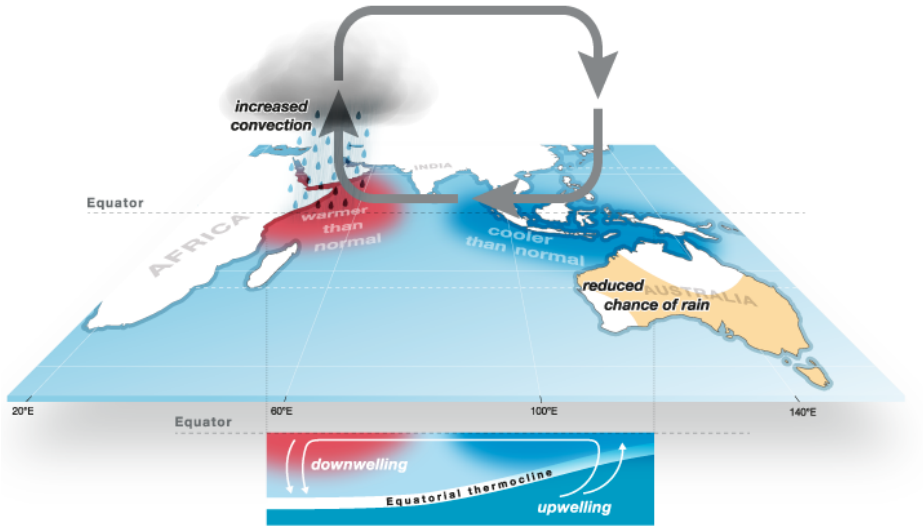
USDA Agricultural Weather Assessments
World Agricultural Outlook Board

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

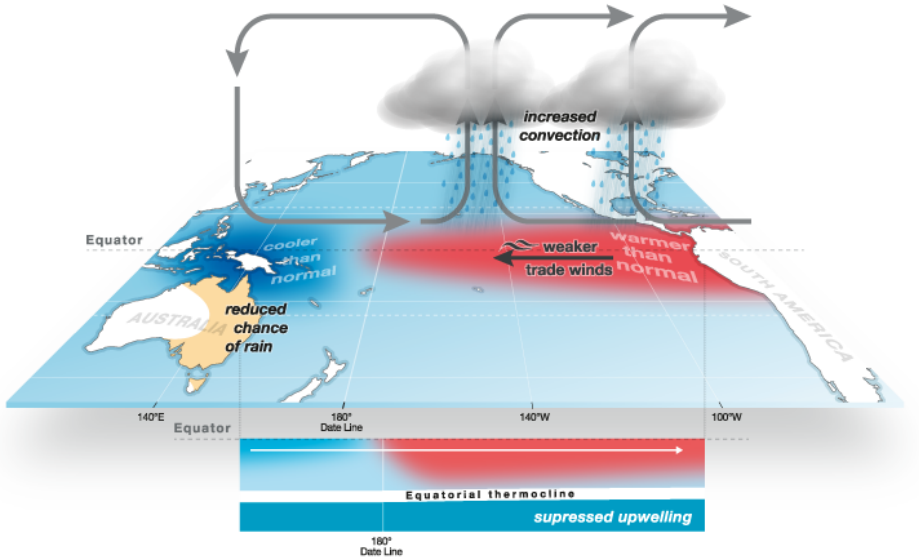


Source - [Australian Bureau of Meteorology]

Indian Ocean – Positive IOD

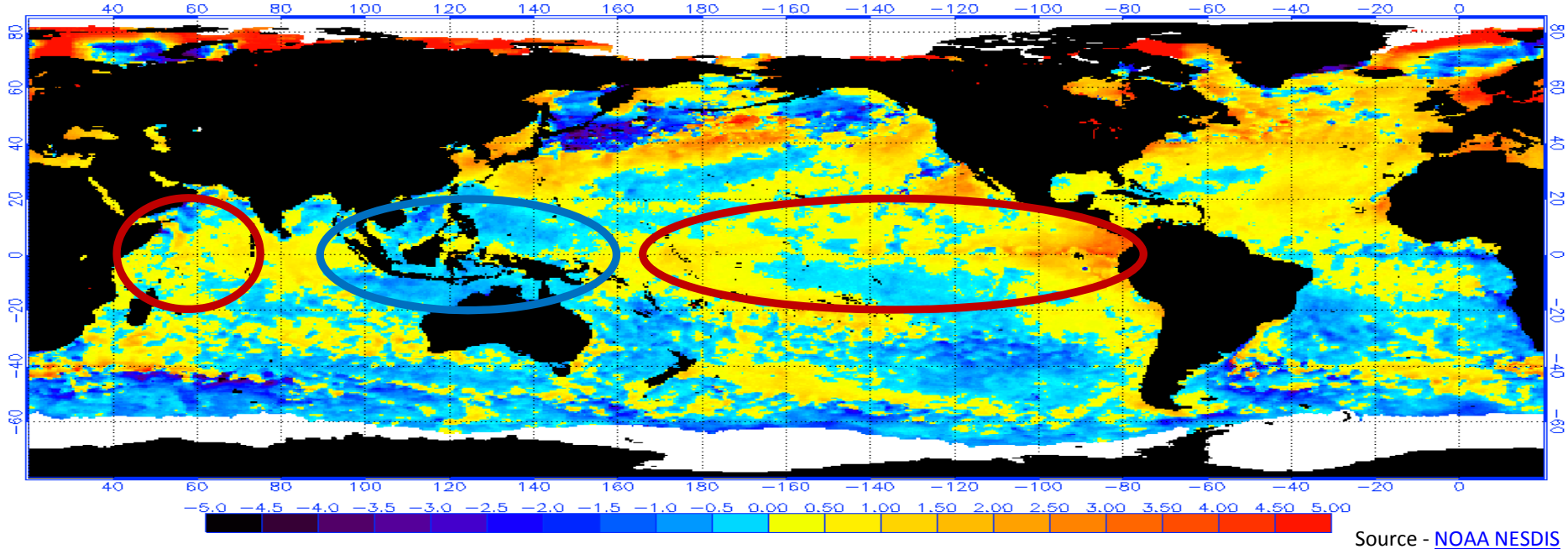


Pacific Ocean – El Niño



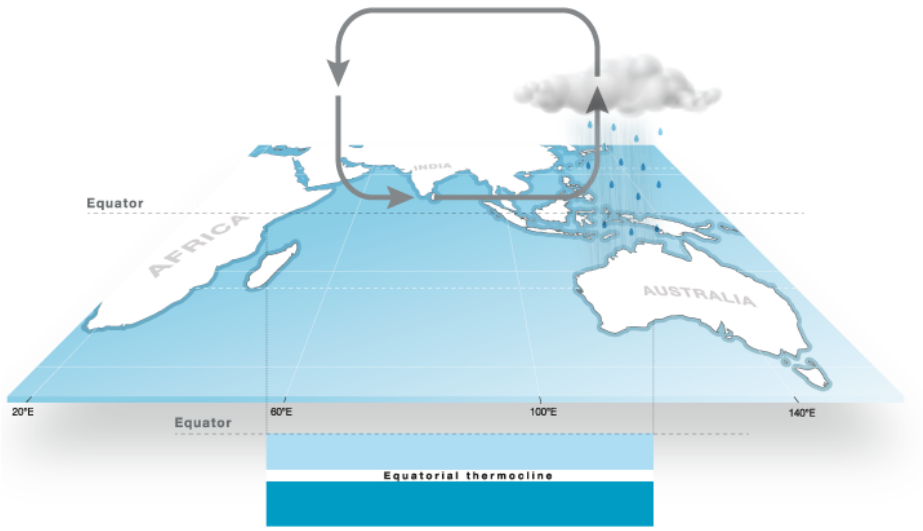
Source - Australian Bureau of Meteorology

Sea surface temperature anomalies – August 5, 2006

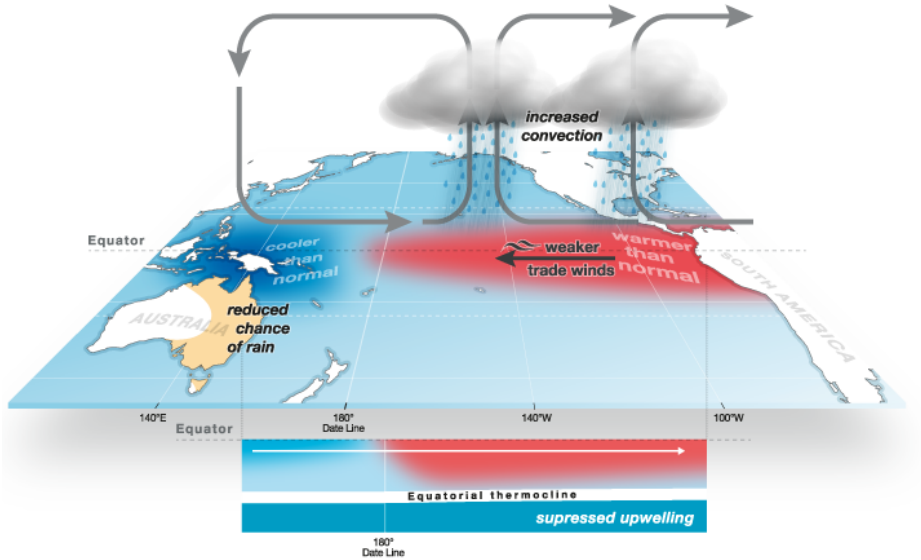


Source - NOAA NESDIS

Indian Ocean – Neutral IOD

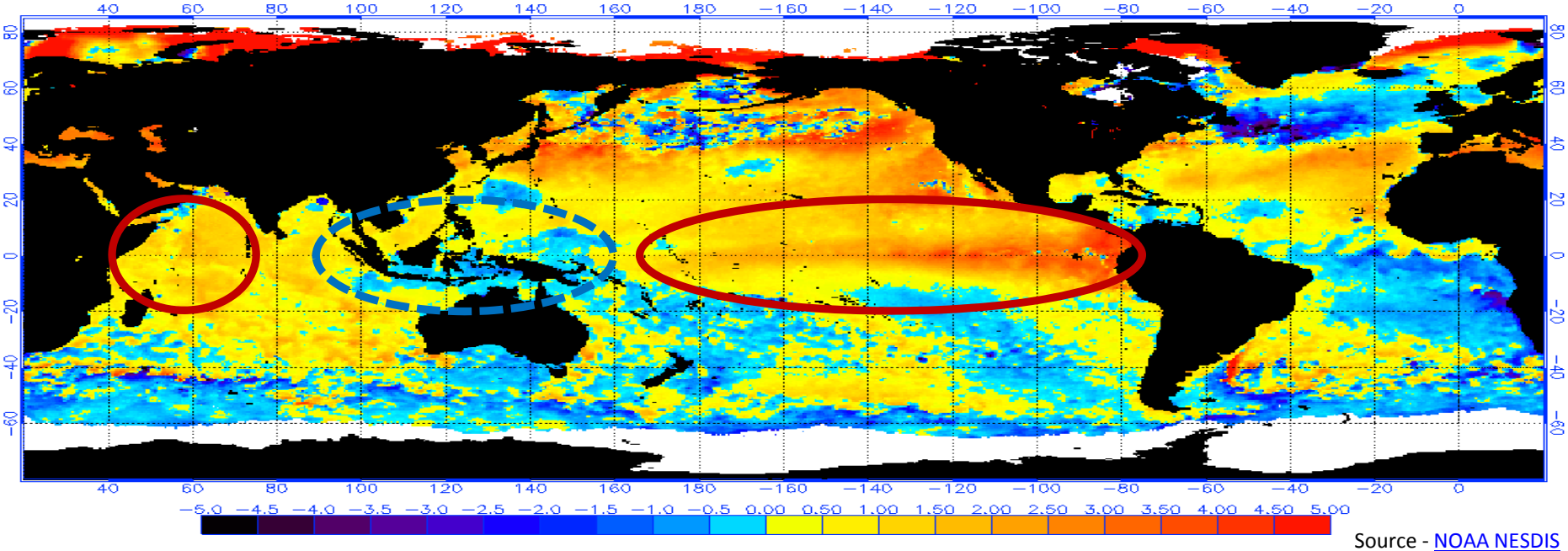


Pacific Ocean – El Niño



Source - Australian Bureau of Meteorology

Sea surface temperature anomalies – August 3, 2015



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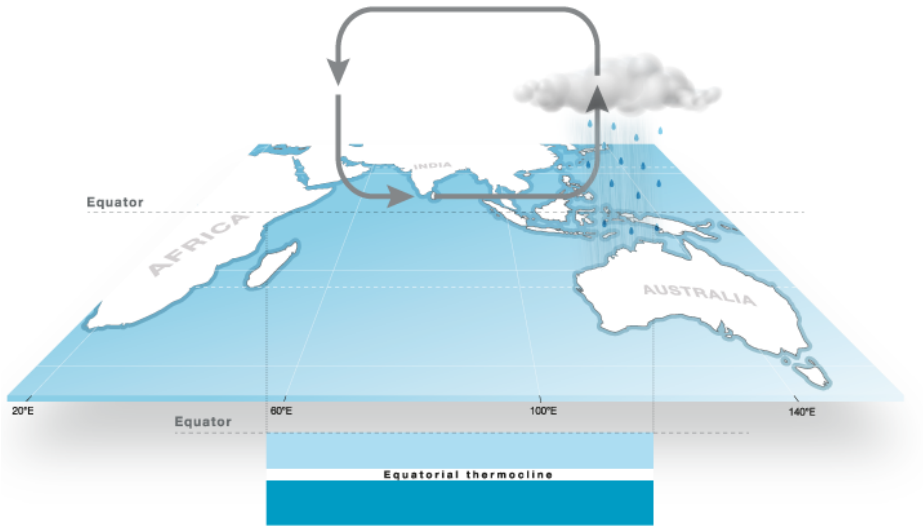
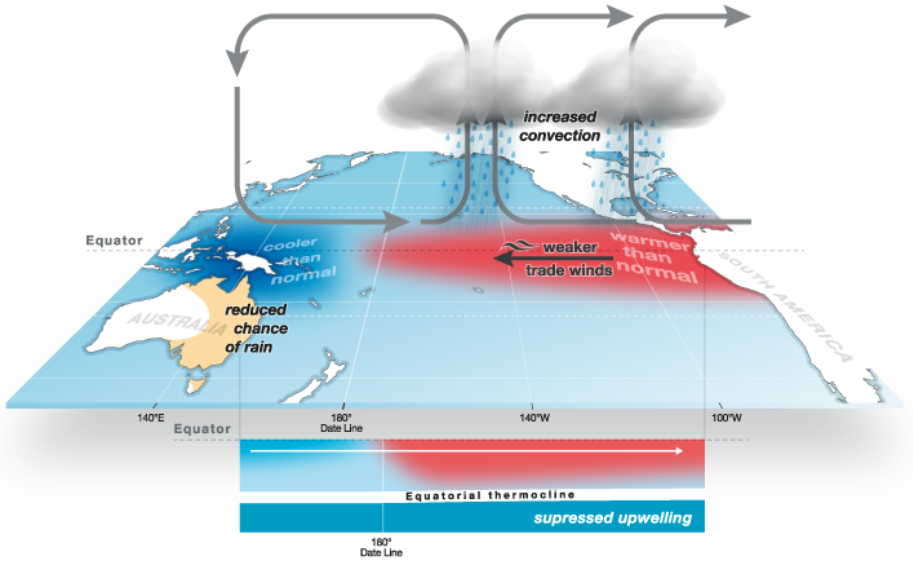
Why didn't El Niño have more of an impact?

Indian Ocean – Neutral IOD



Pacific Ocean – El Niño



Source - [Australian Bureau of Meteorology]

Competing climate patterns impacted the weather in Australia.

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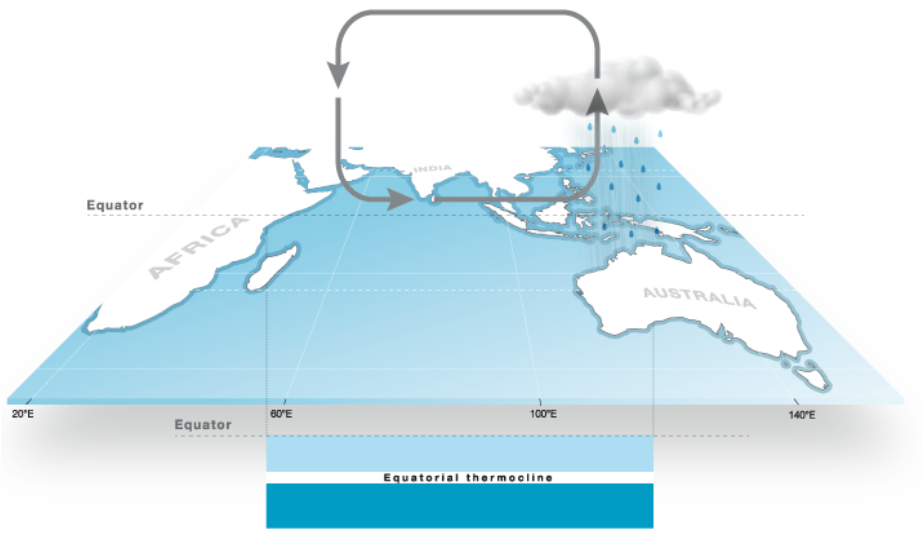

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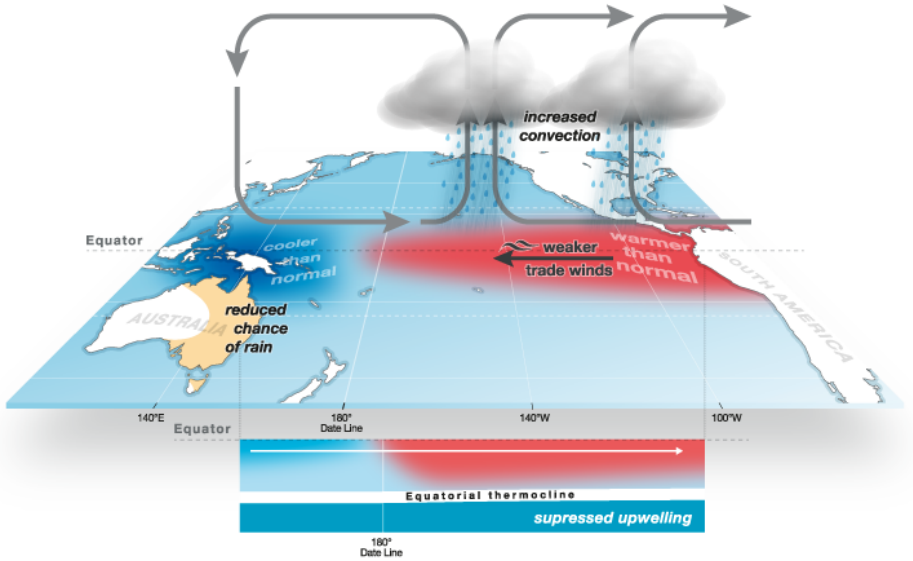
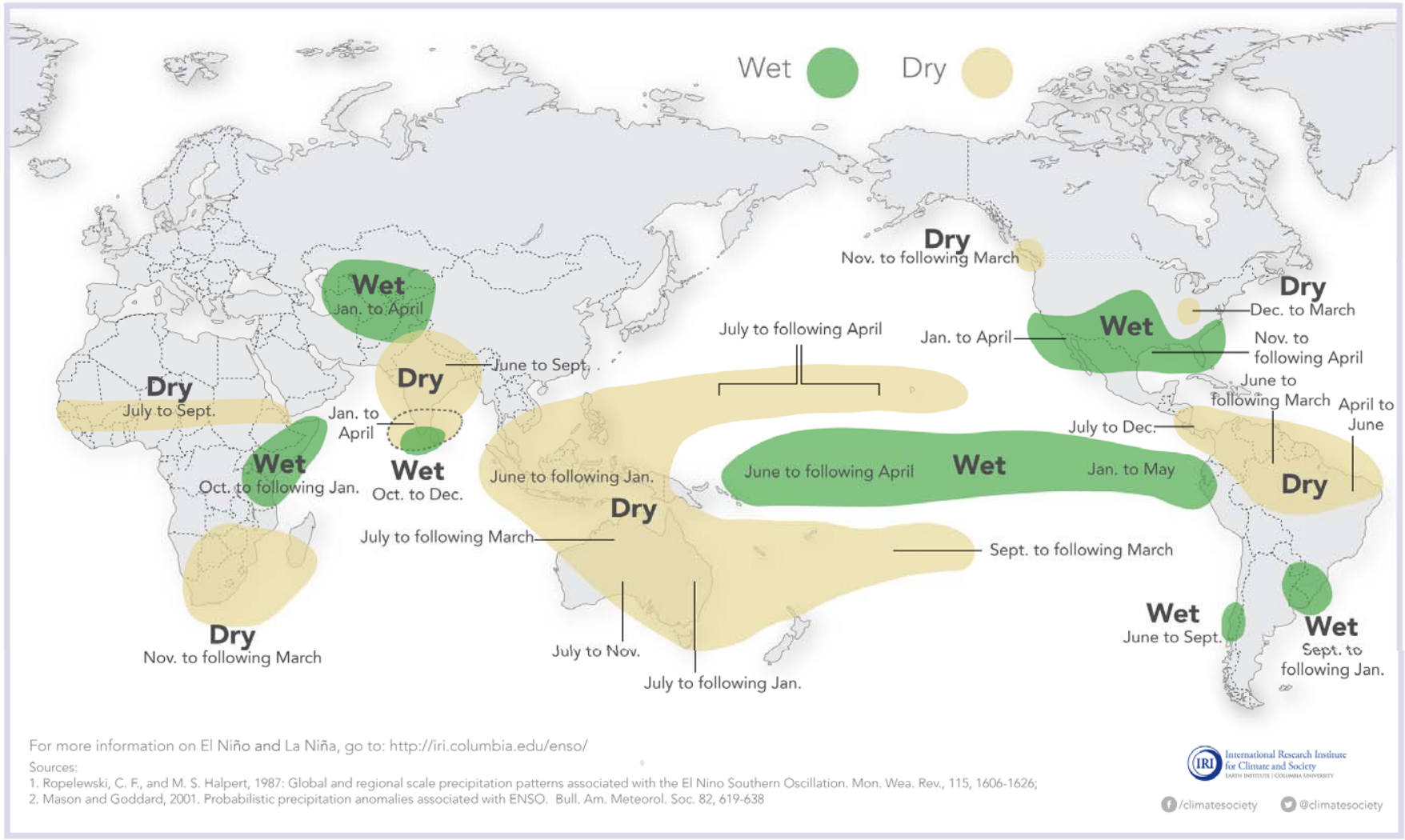


Source - Australian Bureau of Meteorology

Competing climate patterns impacted the weather in Australia.

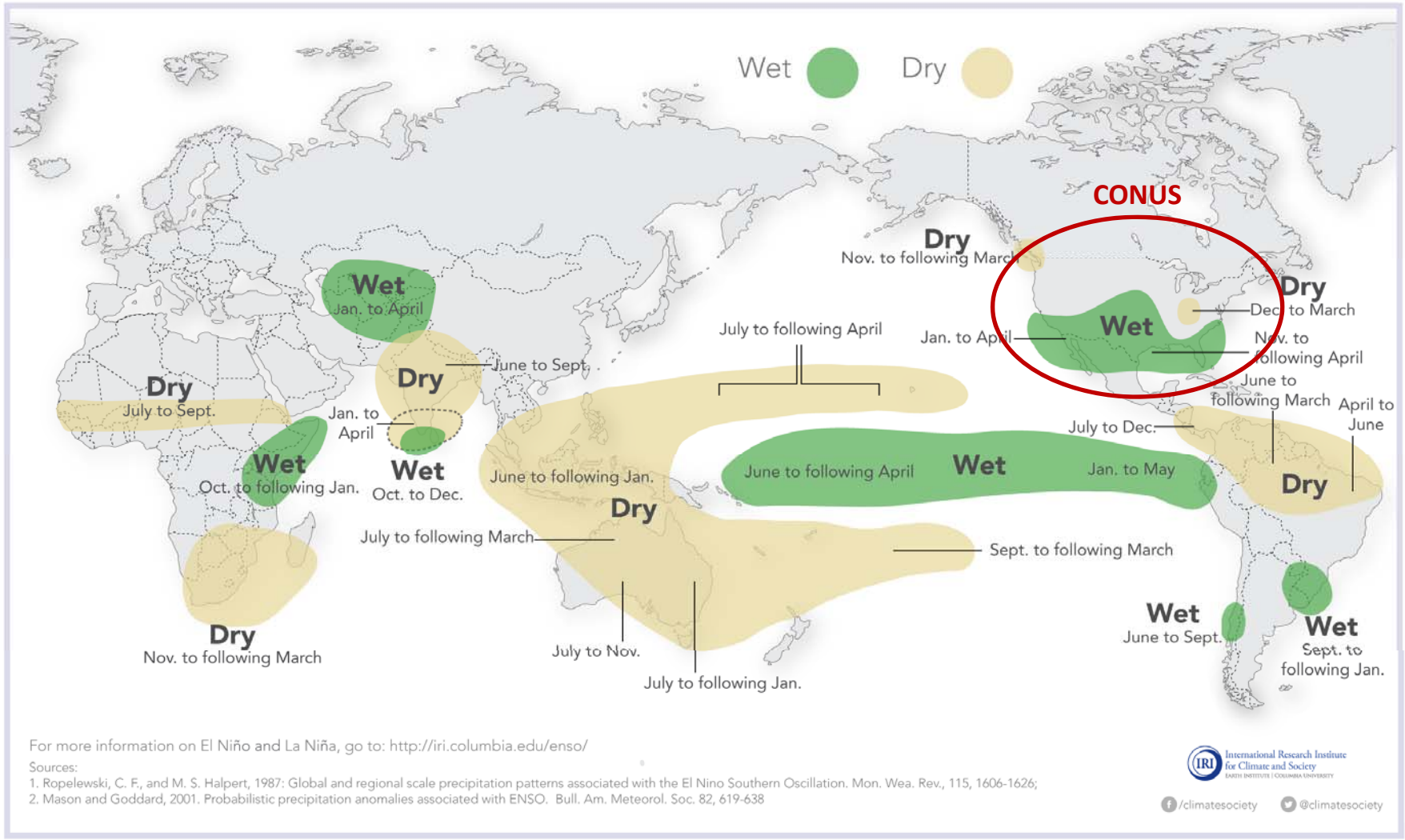
Warmer-than-normal Indian Ocean fueled rains, leading to better than expected crop production.

Typical Impacts



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

Typical Impacts

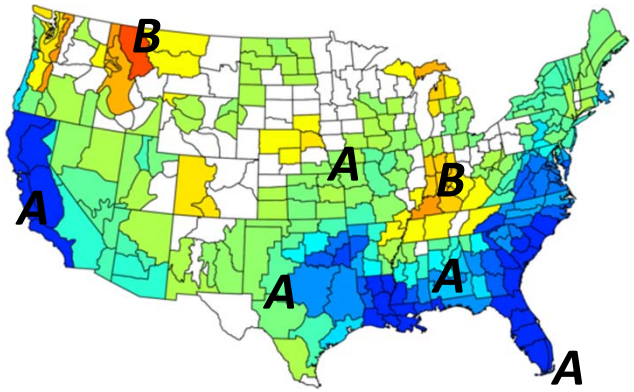


Source - http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/ElNinoandRainfall.png

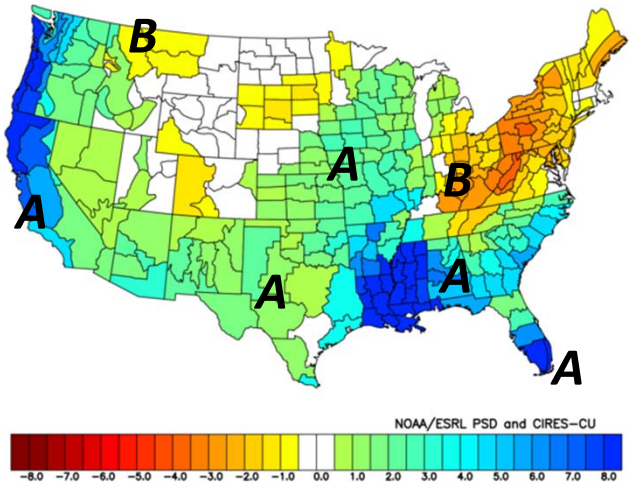
Winter Precipitation Anomalies (in)

December – January – February

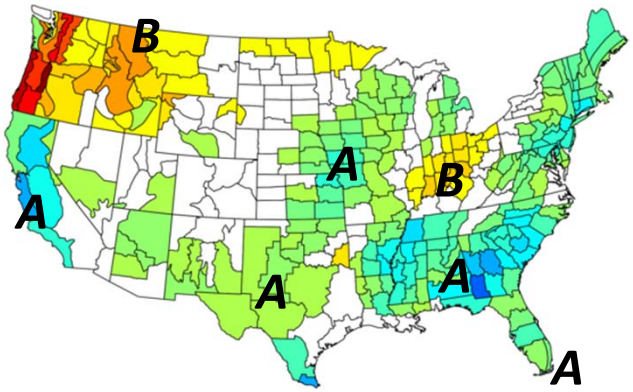
1997/98



1982/83

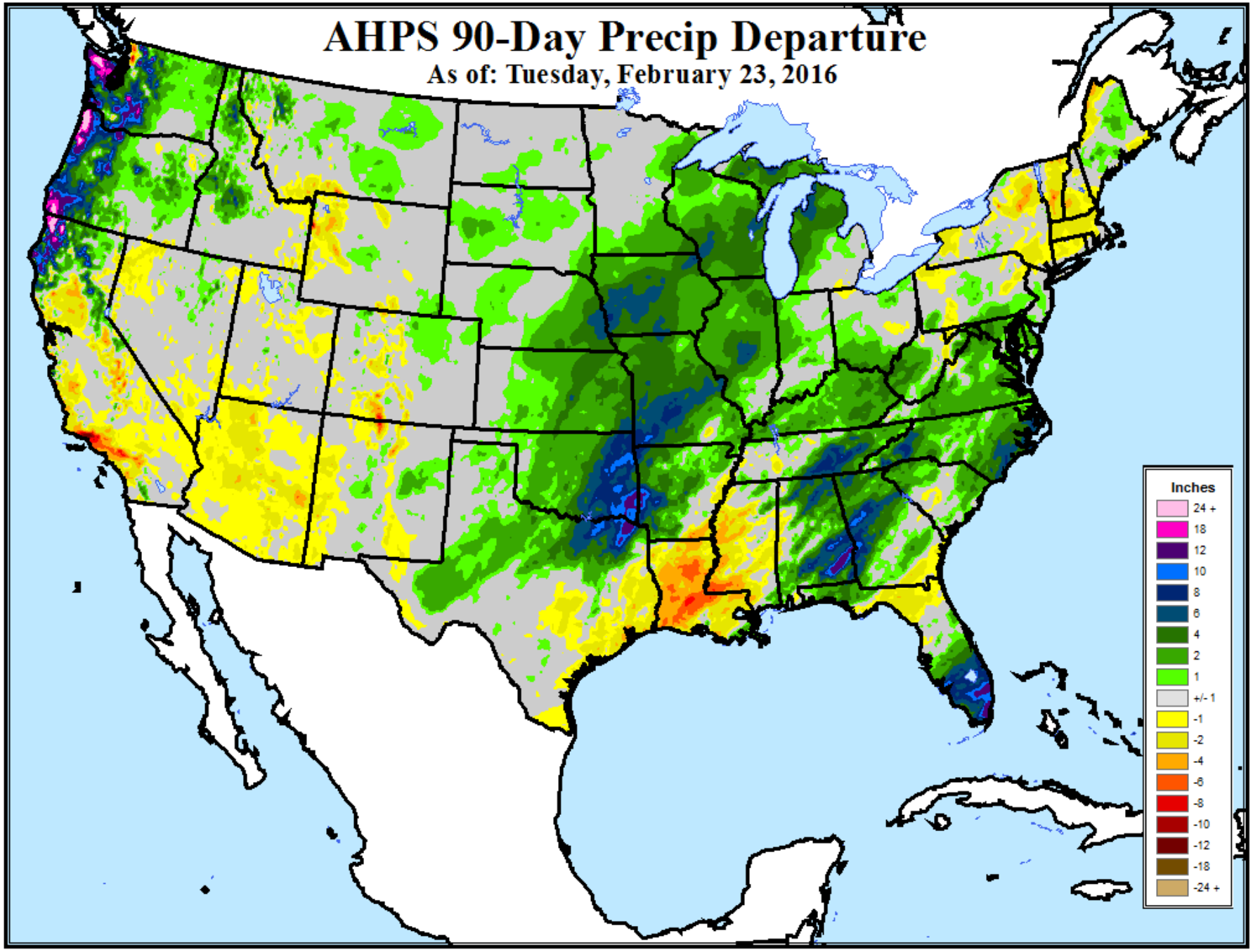


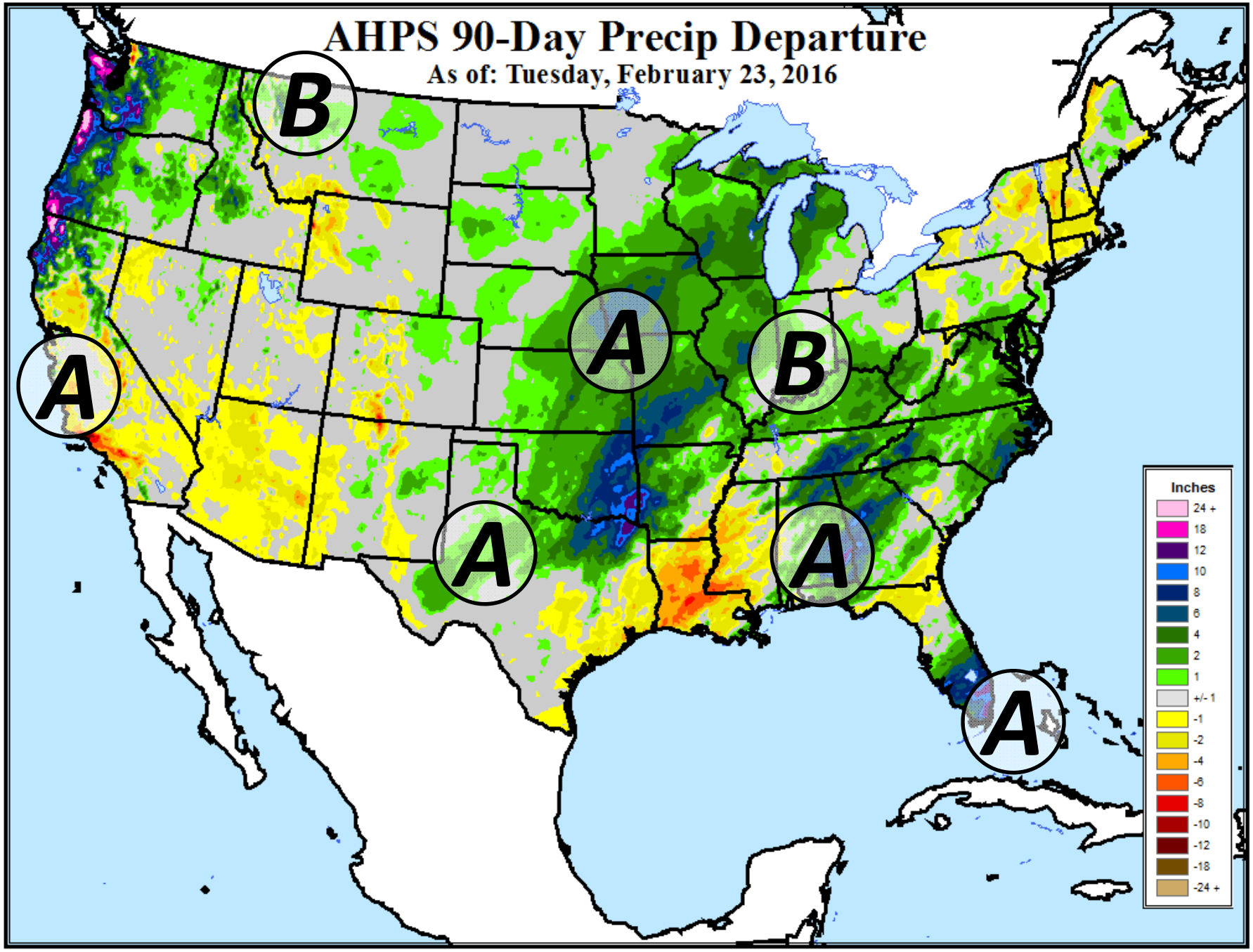
1972/73

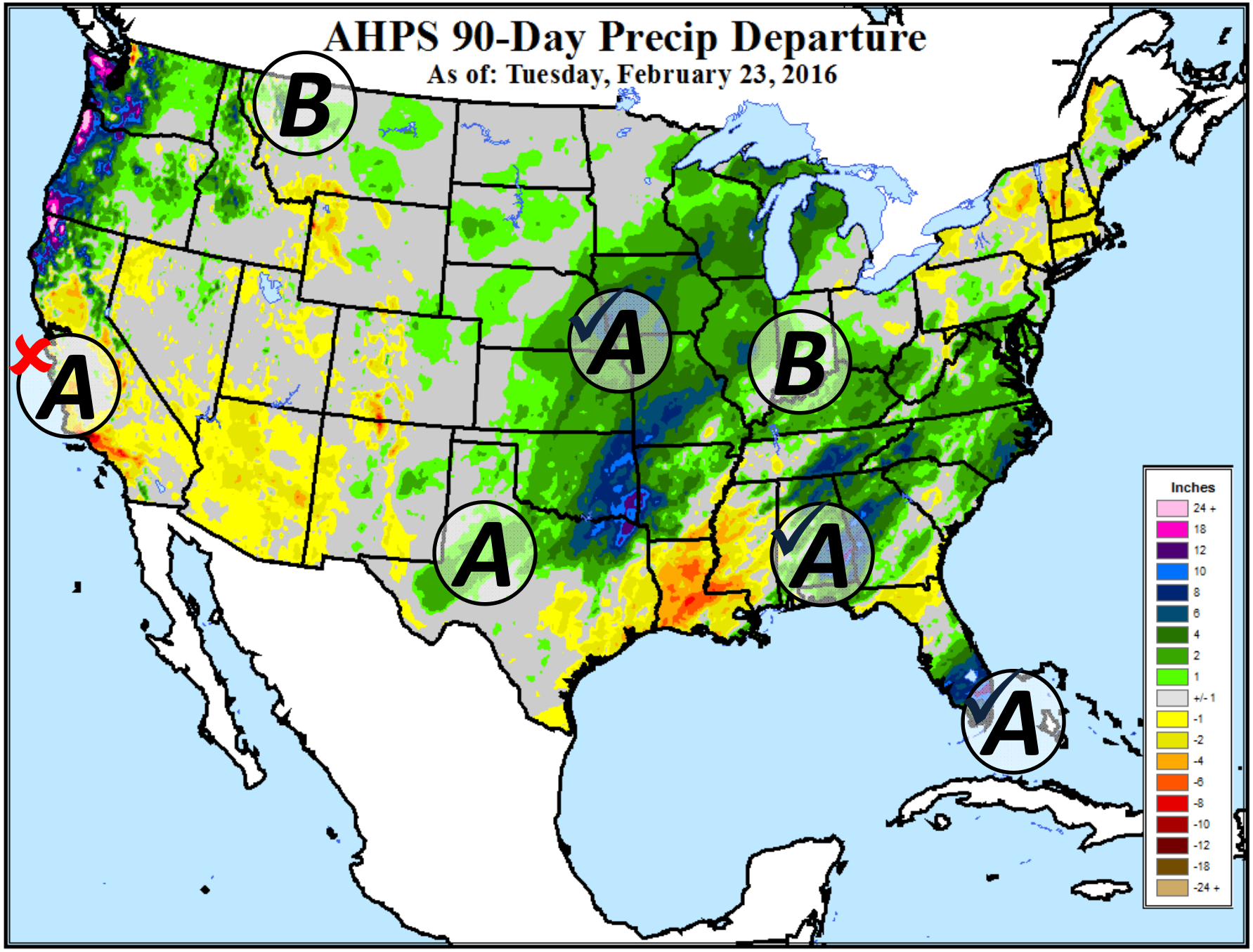


(A) = above normal
(B) = below normal

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


AHPS 90-Day Precip Departure
As of: Tuesday, February 23, 2016
Inches
24 +
18
12
10
8
6
4
2
1
+/- 1
-1
-2
-4
-6
-8
-10
-12
-18
-24 +


AHPS 90-Day Precip Departure
As of: Tuesday, February 23, 2016
B
A
A
B
A
A
A
Inches
24 +
18
12
10
8
6
4
2
1
+/- 1
-1
-2
-4
-6
-8
-10
-12
-18
-24 +

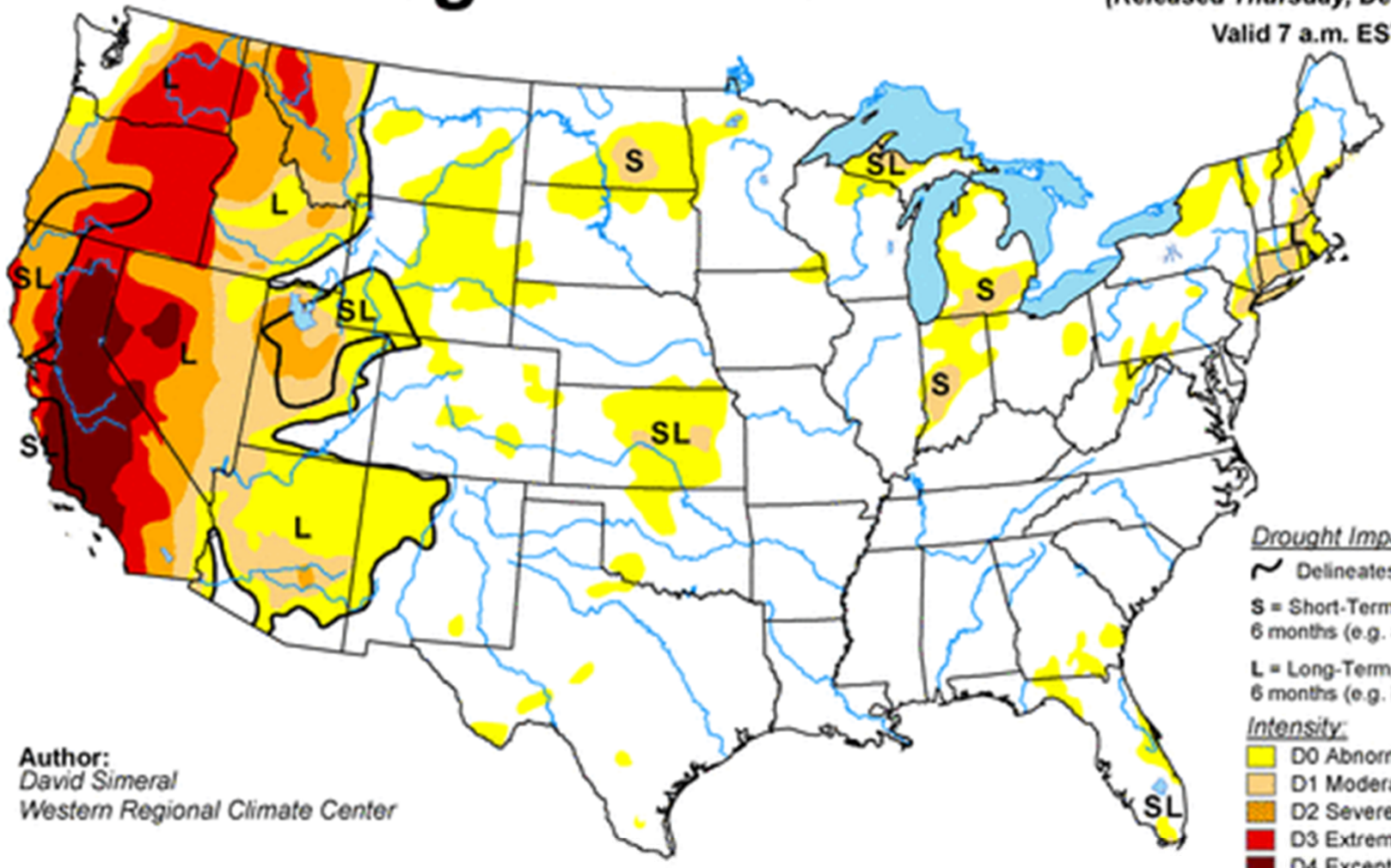

AHPS 90-Day Precip Departure
As of: Tuesday, February 23, 2016
B
A
A
B
A
A
A
Inches
24 +
18
12
10
8
6
4
2
1
+/- 1
-1
-2
-4
-6
-8
-10
-12
-18
-24 +

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

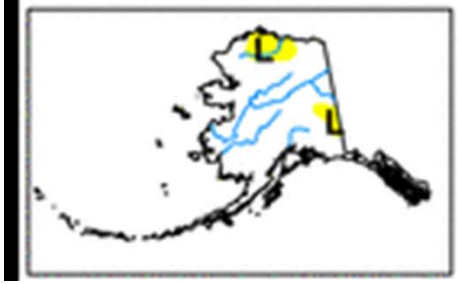
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

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.



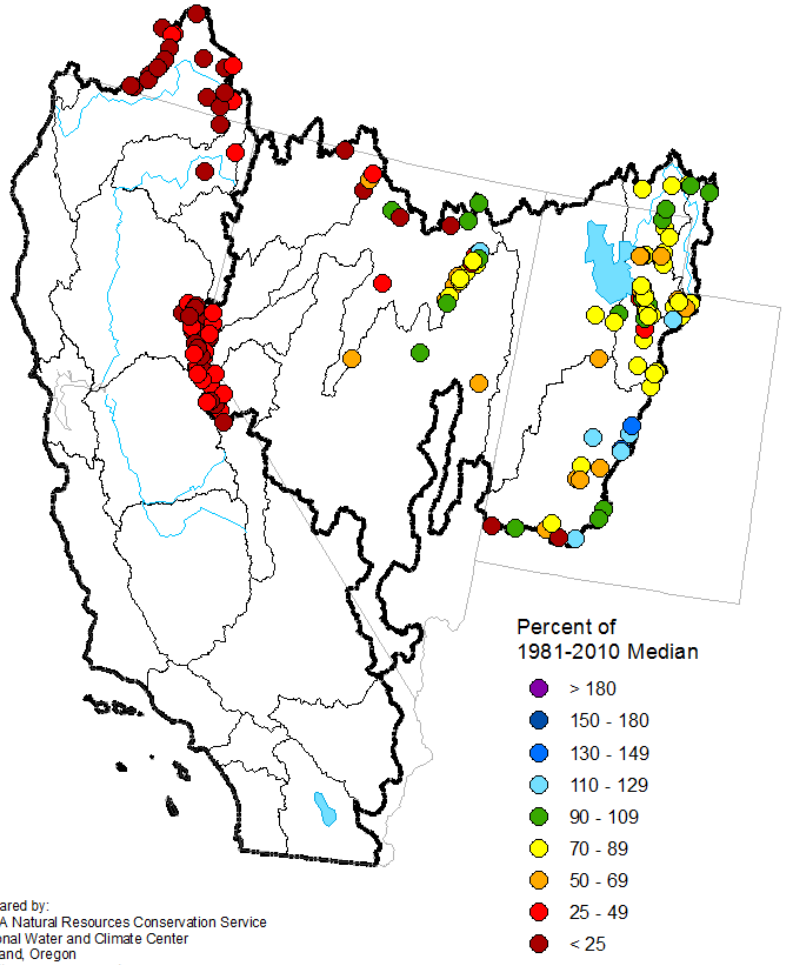
USDA

National Drought Mitigation Center

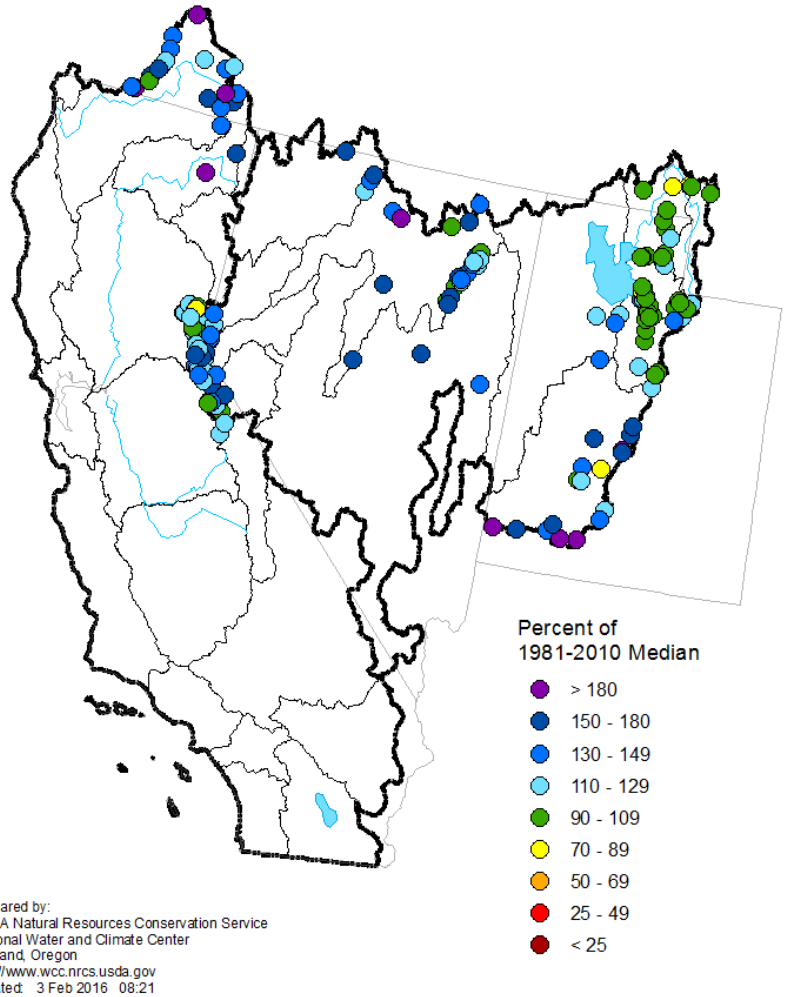
http://droughtmonitor.unl.edu/

Great Basin and California Mountain Snowpack

February 1, 2015



February 1, 2016



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

IRI/CPC Pacific Nino 3.4 SST Model Outlook

Updated – February 18, 2016

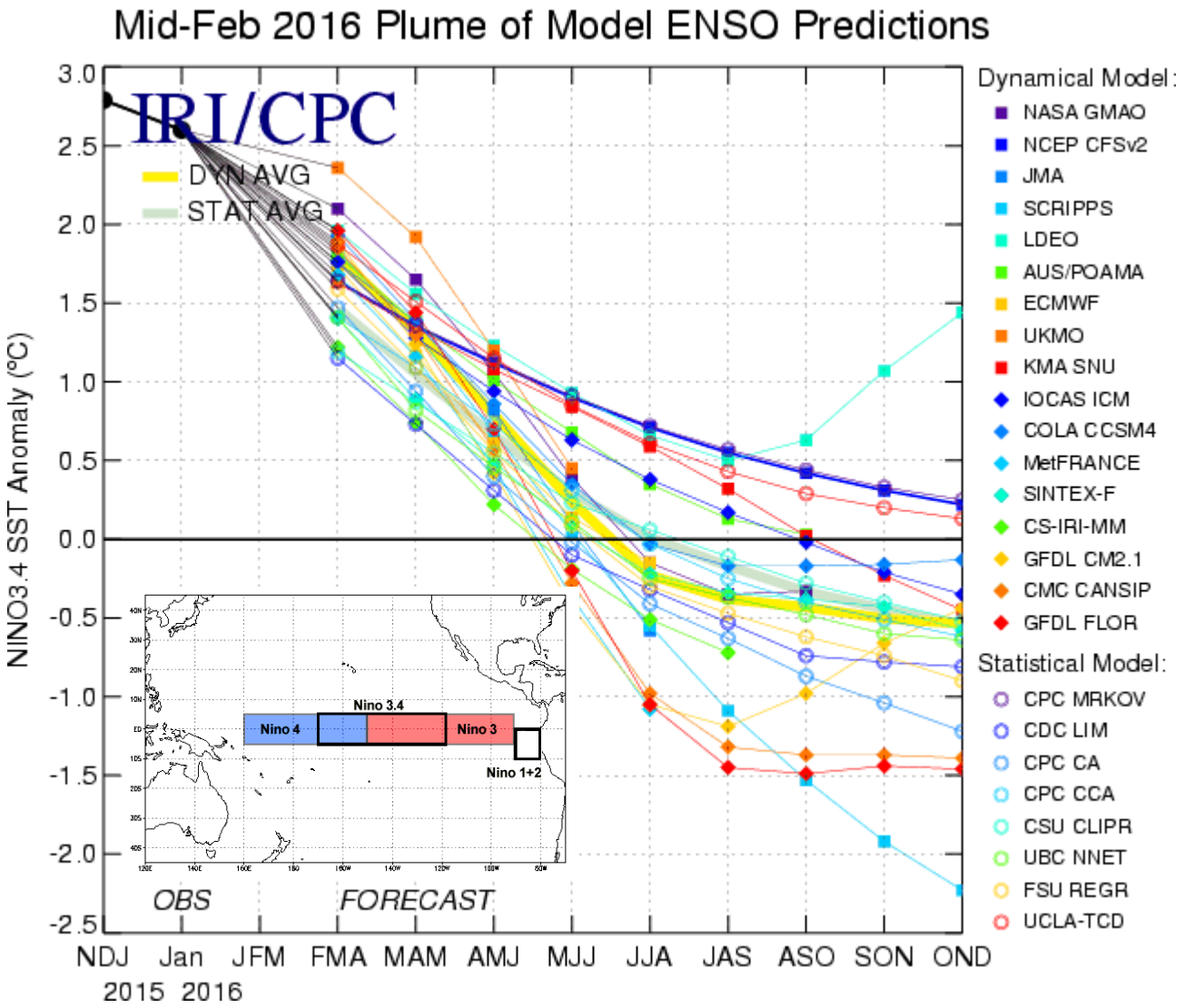
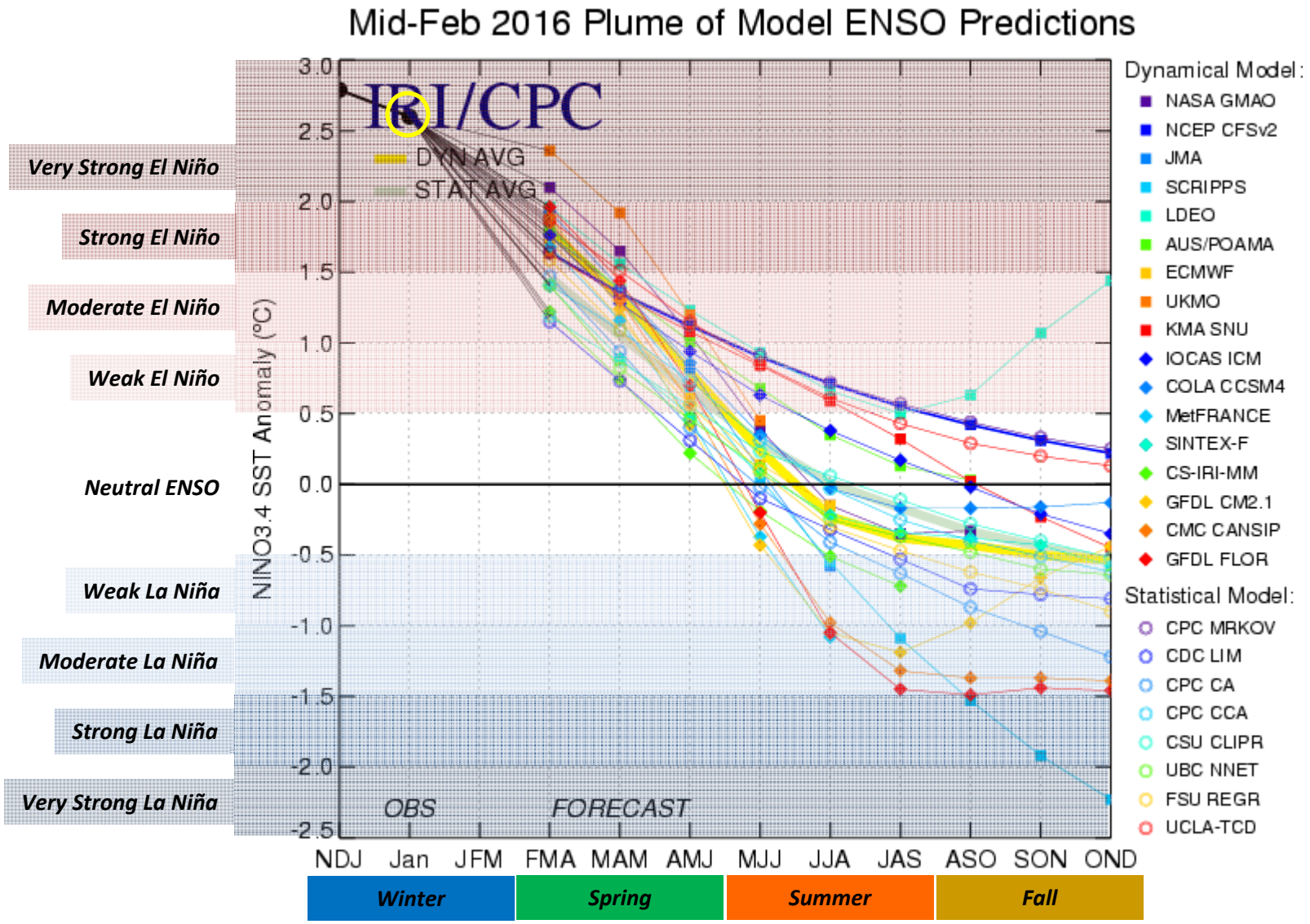


Image source – http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table

IRI/CPC Pacific Nino 3.4 SST Model Outlook

Updated – February 18, 2016



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IRI/CPC Pacific Nino 3.4 SST Model Outlook

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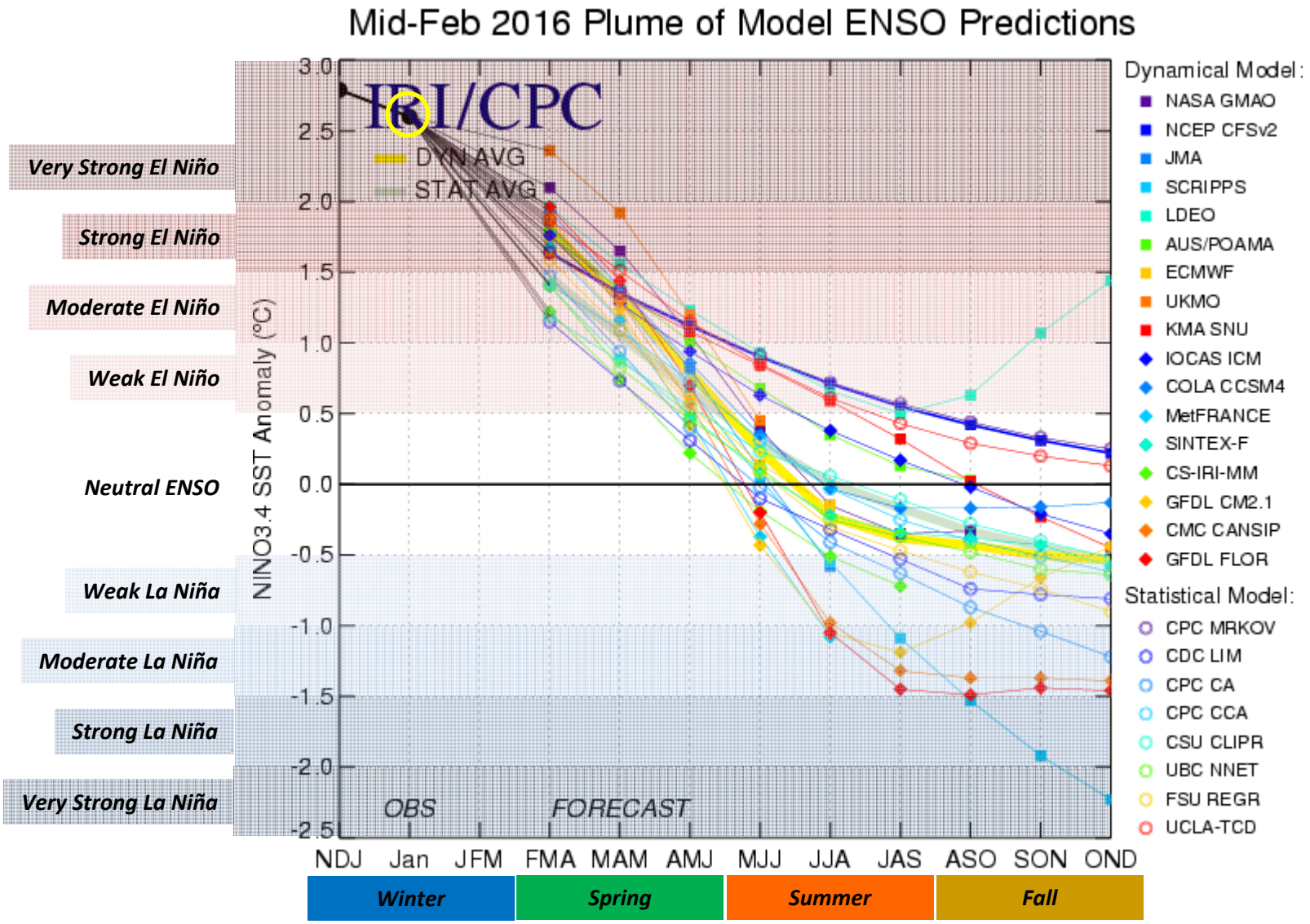


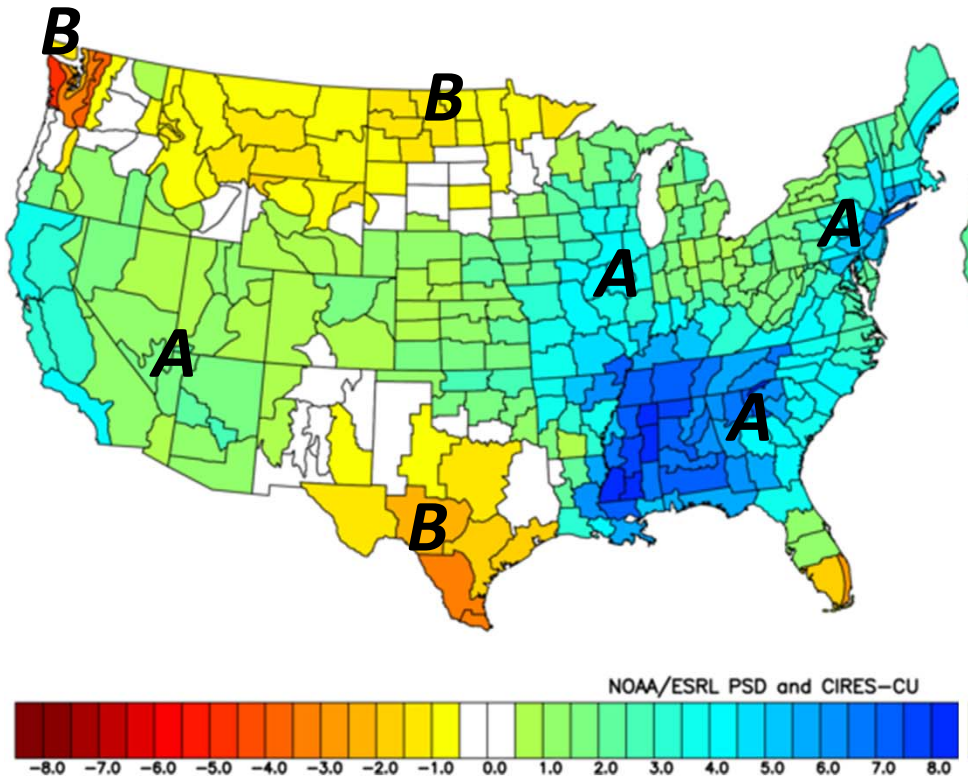
Autumn probabilities – 51% La Niña, 32% Neutral, 17% El Niño

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

Composites based on data from 1998, 1983, 1973

Precipitation Anomalies (in)

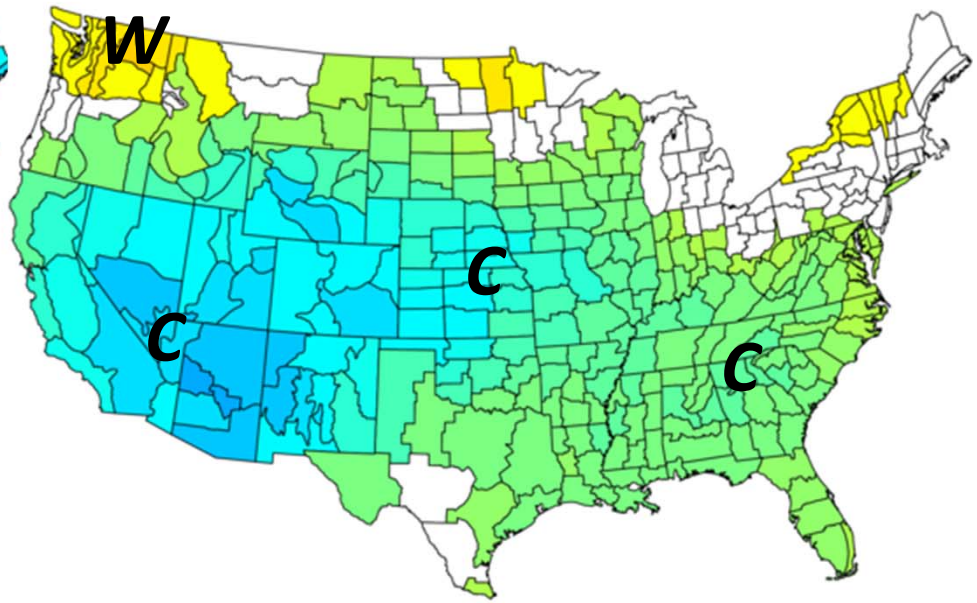
Mar – May

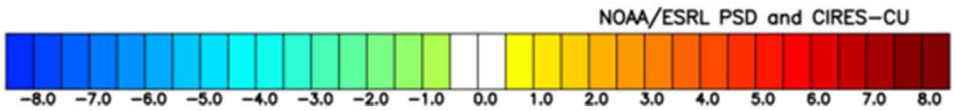


(A) = above normal
(B) = below normal

Maximum Temperature Anomalies (F)

Mar – May





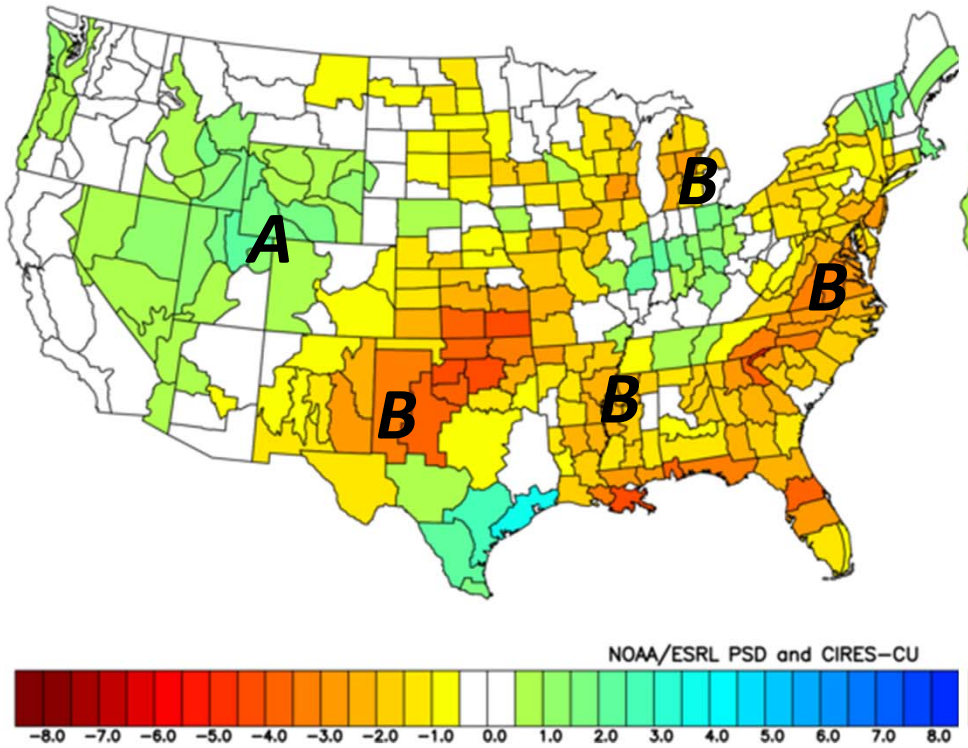
(W) = warmer than normal
(C) = cooler than normal

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

Composites based on data from 1998, 1983, 1973

Precipitation Anomalies (in)

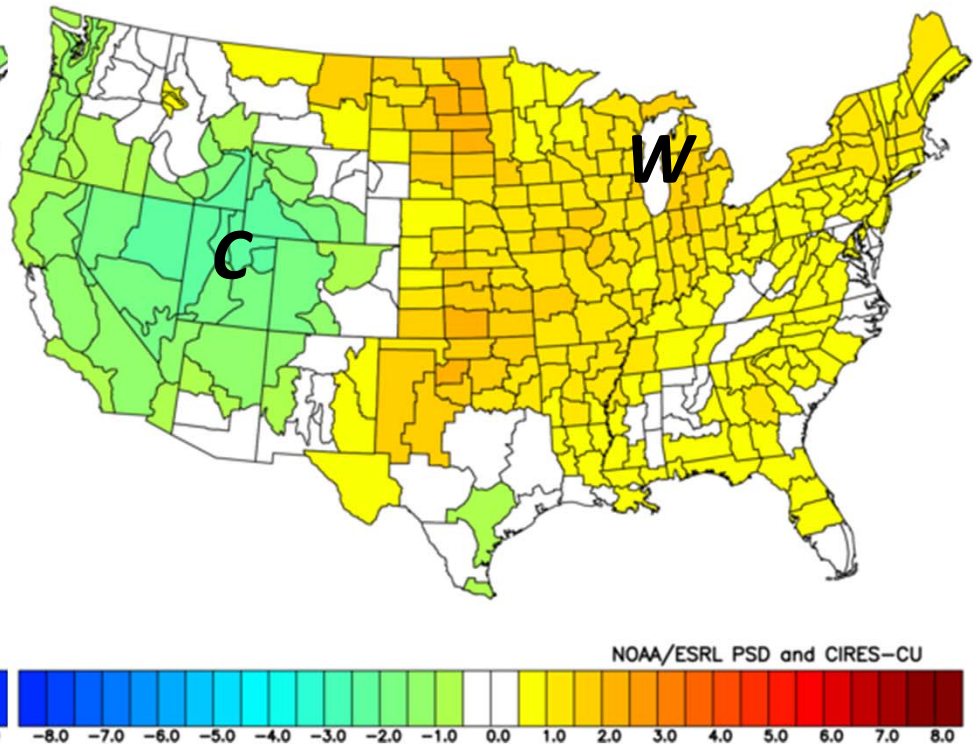
Jun – Aug



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

Maximum Temperature Anomalies (F)

Jun – Aug



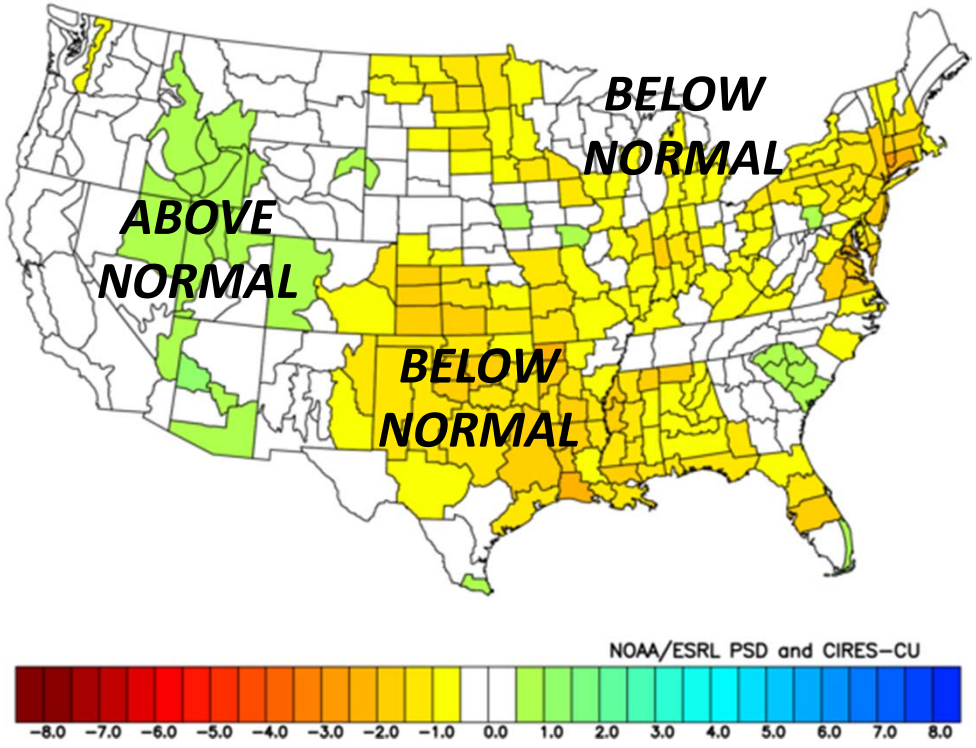
(W) = warmer than normal
(C) = cooler than normal

Climate patterns associated with developing La Niña – Summer

Composites based on 11 distinct events

Precipitation Anomalies (in)

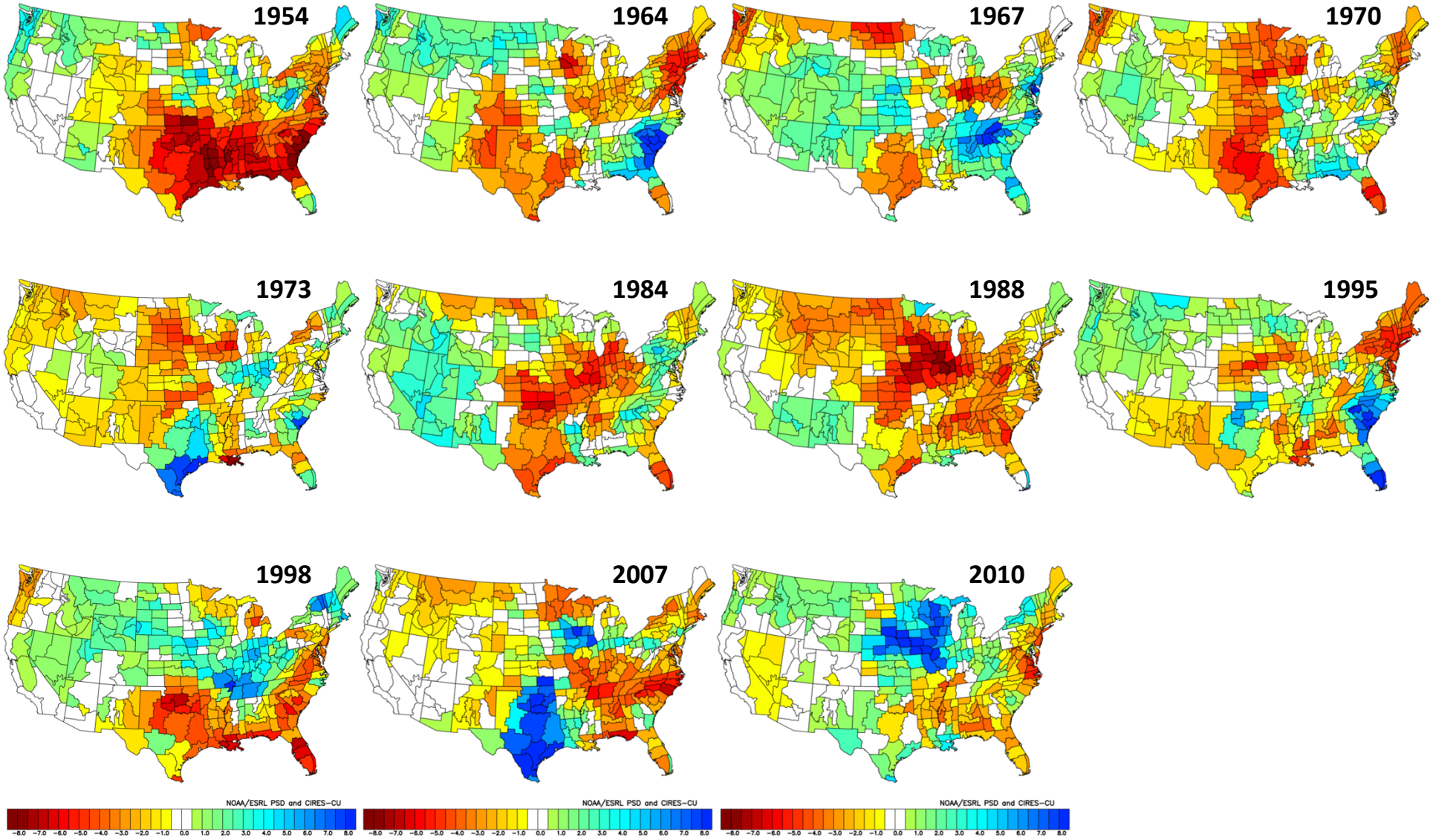
Jun – Aug



Climate patterns associated with developing La Niña – Summer

June – July – August

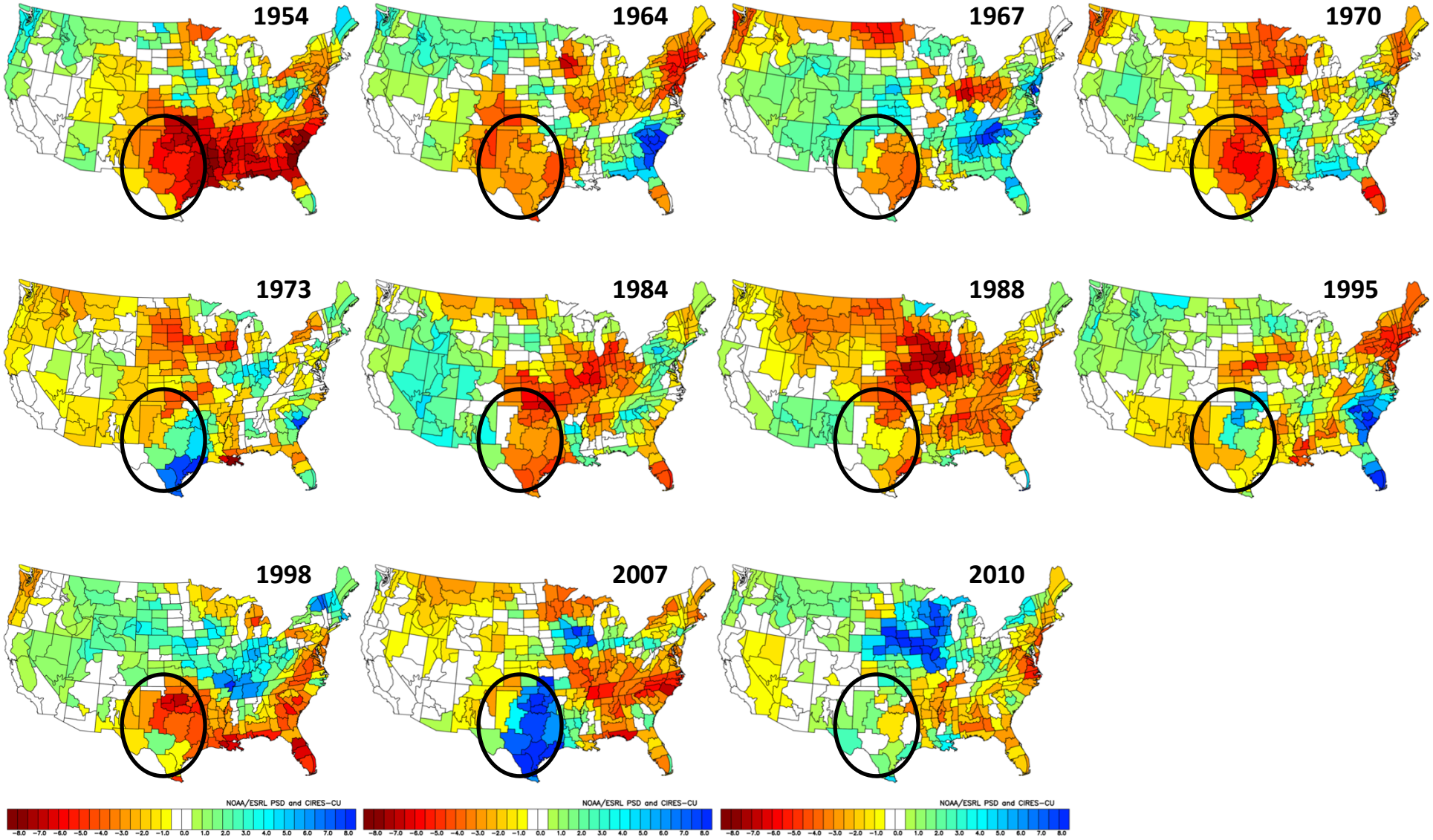
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

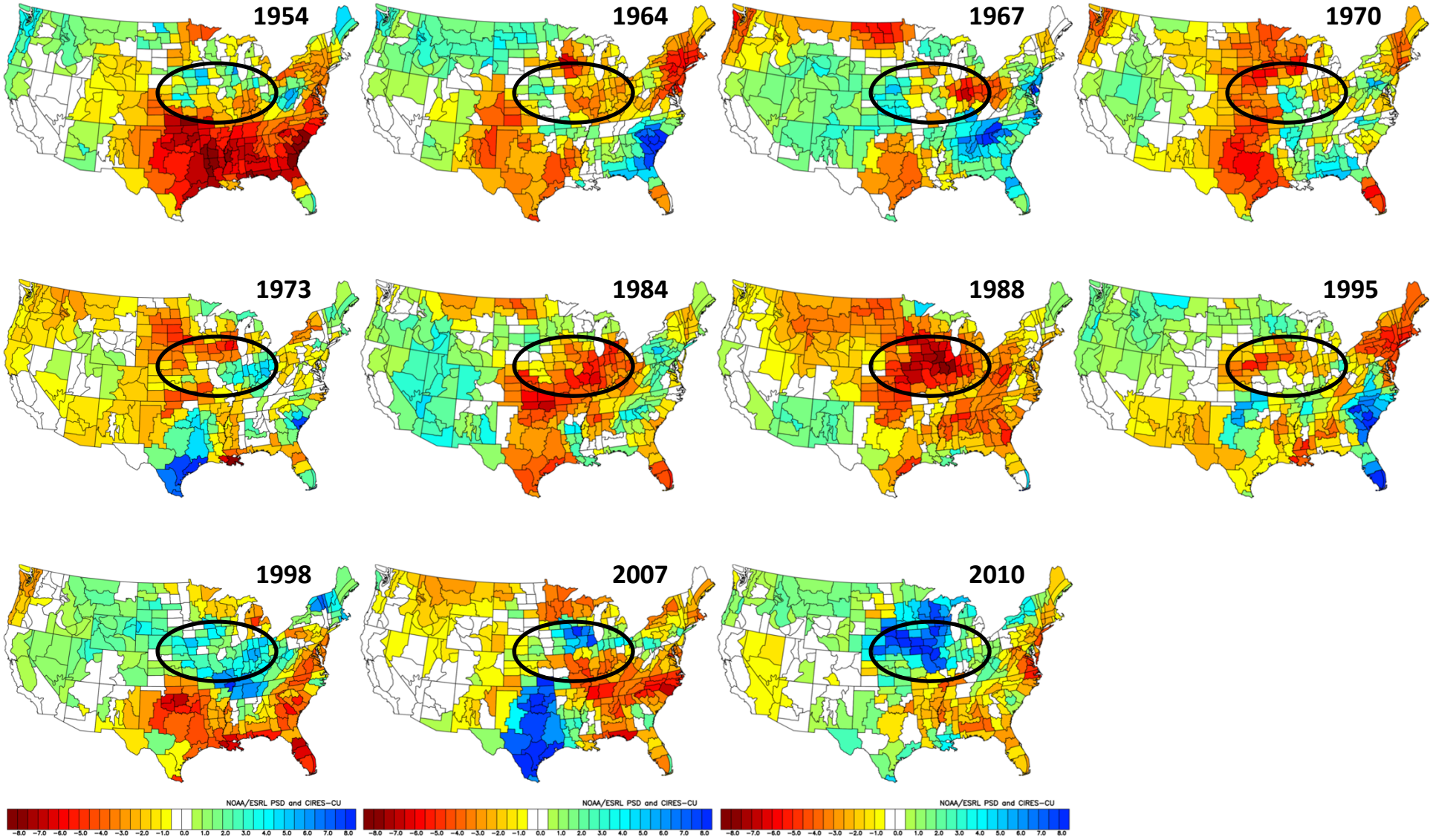
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

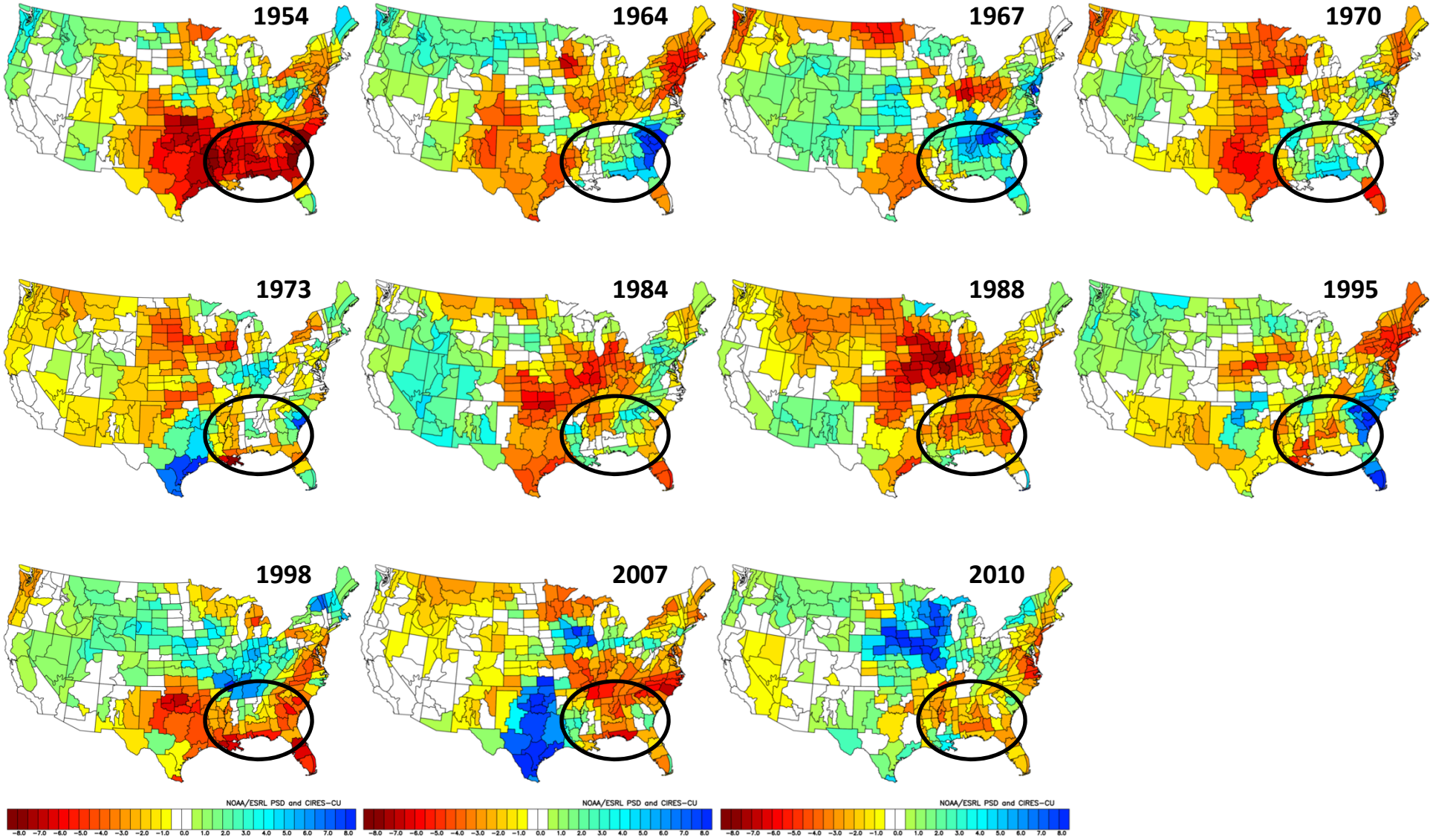
Precipitation Anomalies (in)



Climate patterns associated with developing La Niña – Summer

June – July – August

Precipitation Anomalies (in)

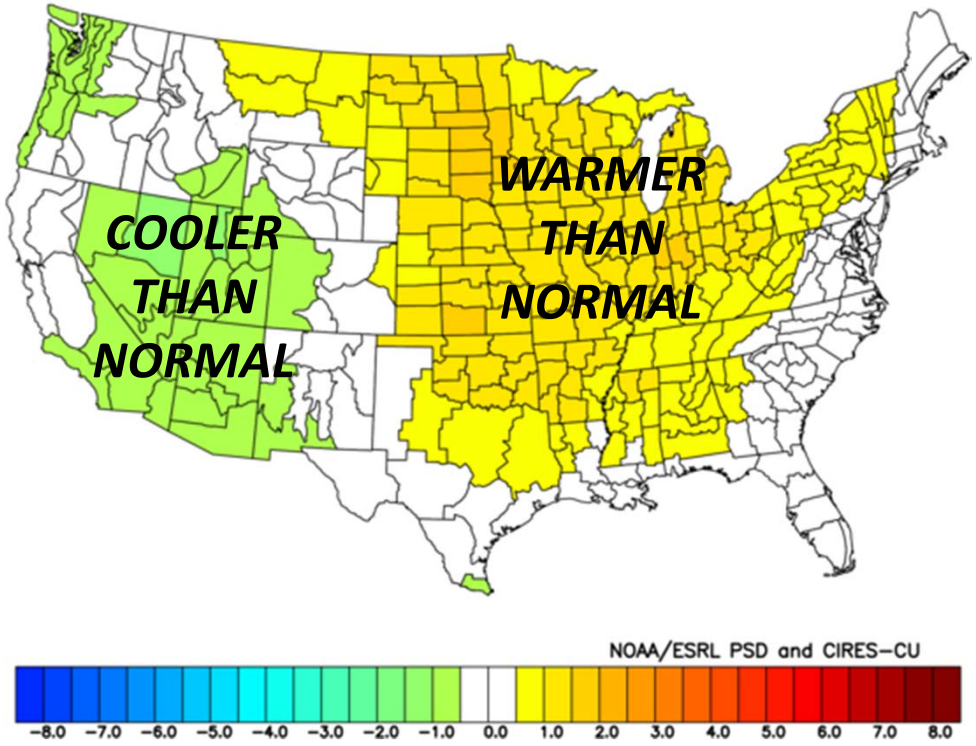


Climate patterns associated with developing La Niña – Summer

Composites based on 11 distinct events

Maximum Temperature Anomalies (F)

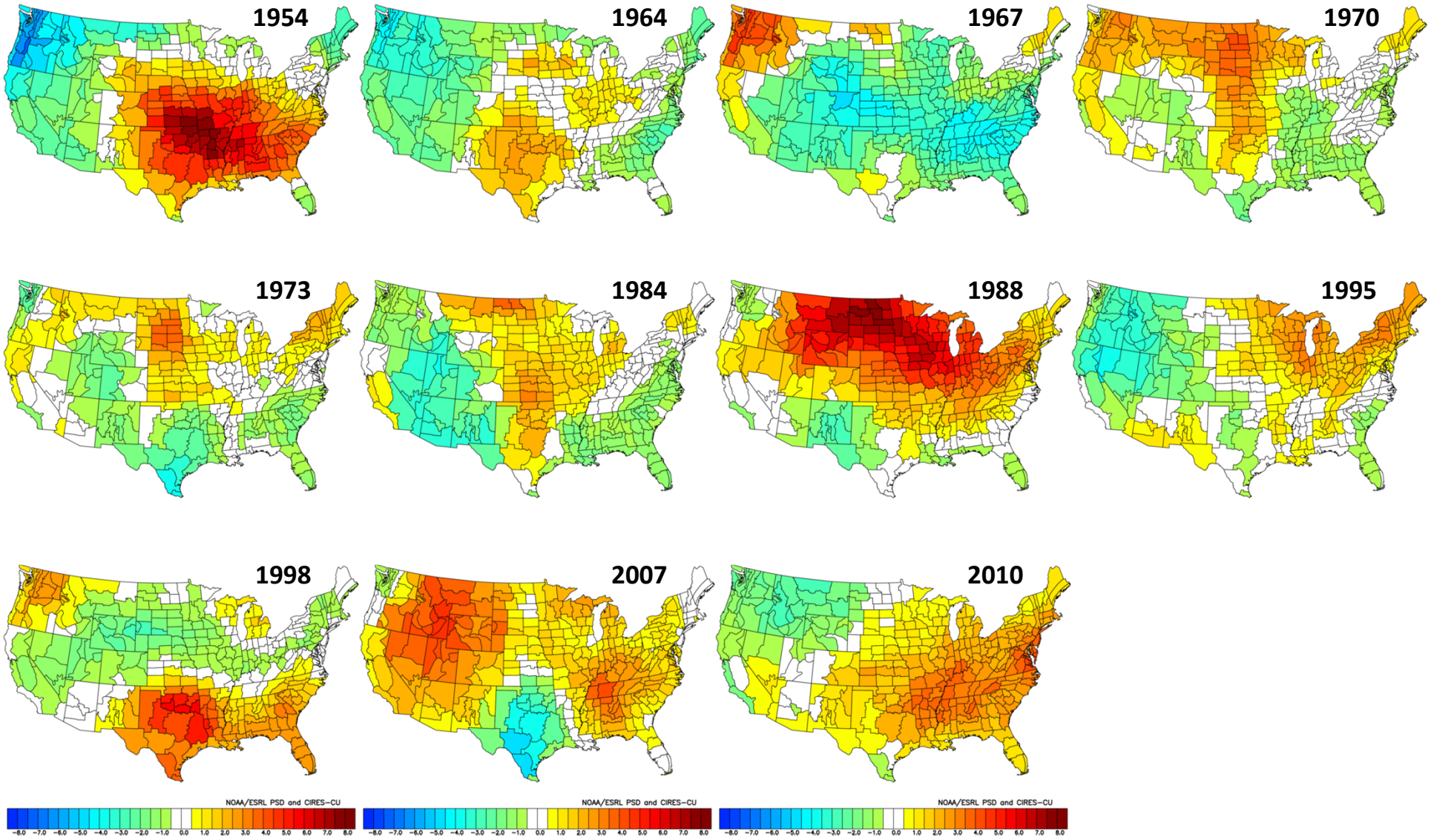
Jun – Aug



Climate patterns associated with developing La Niña – Summer

June – July – August

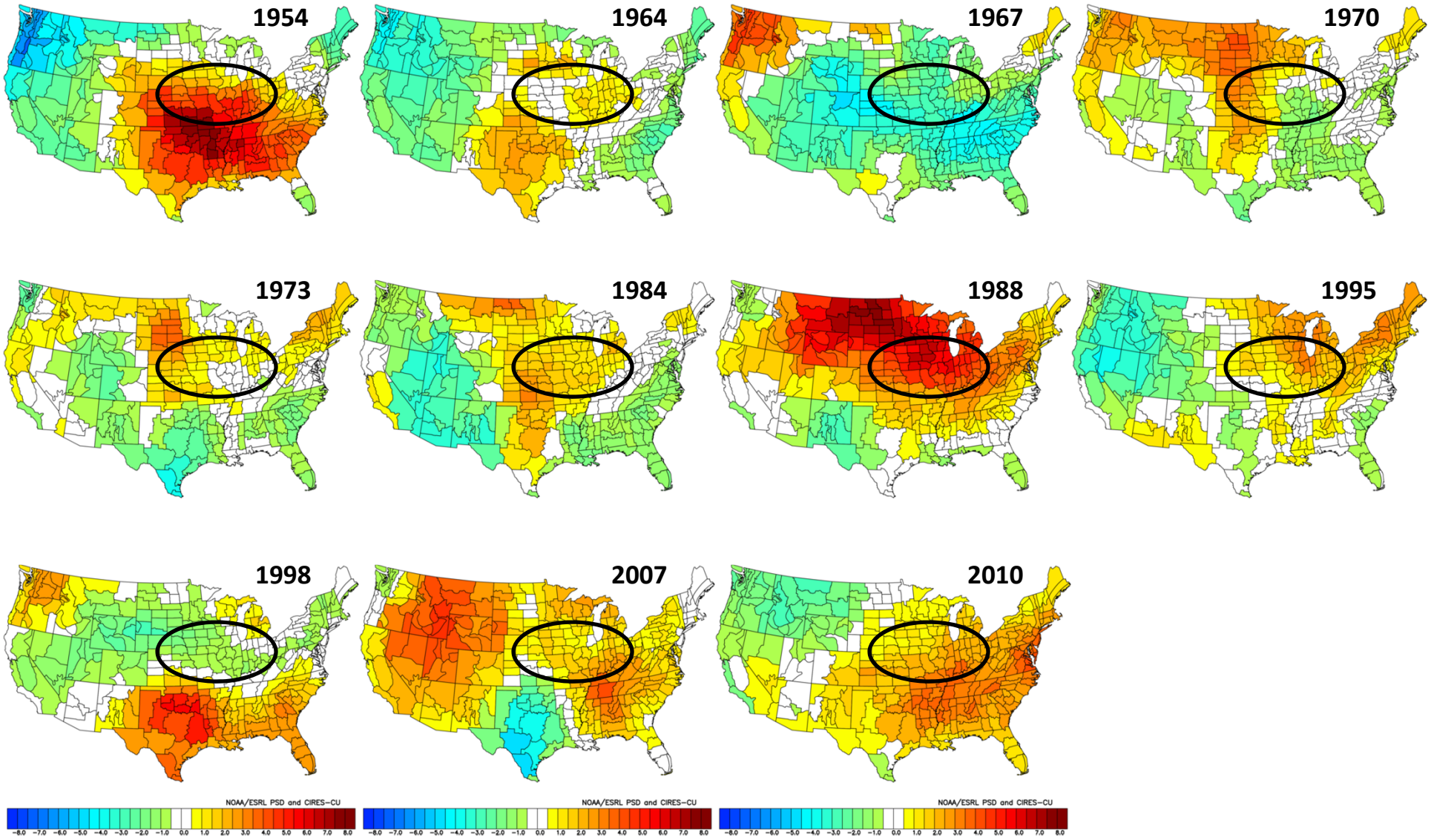
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

June – July – August

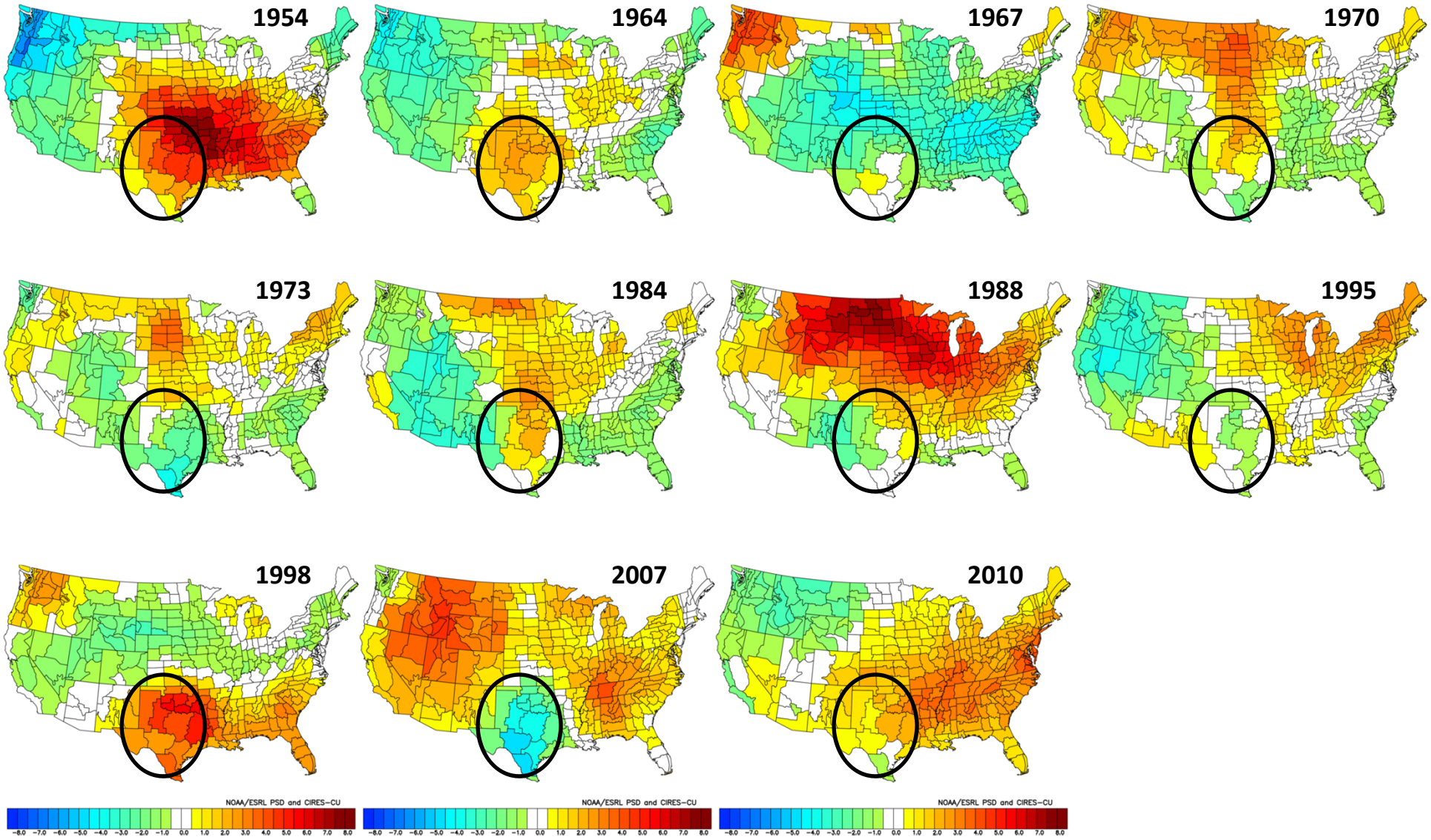
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

June – July – August

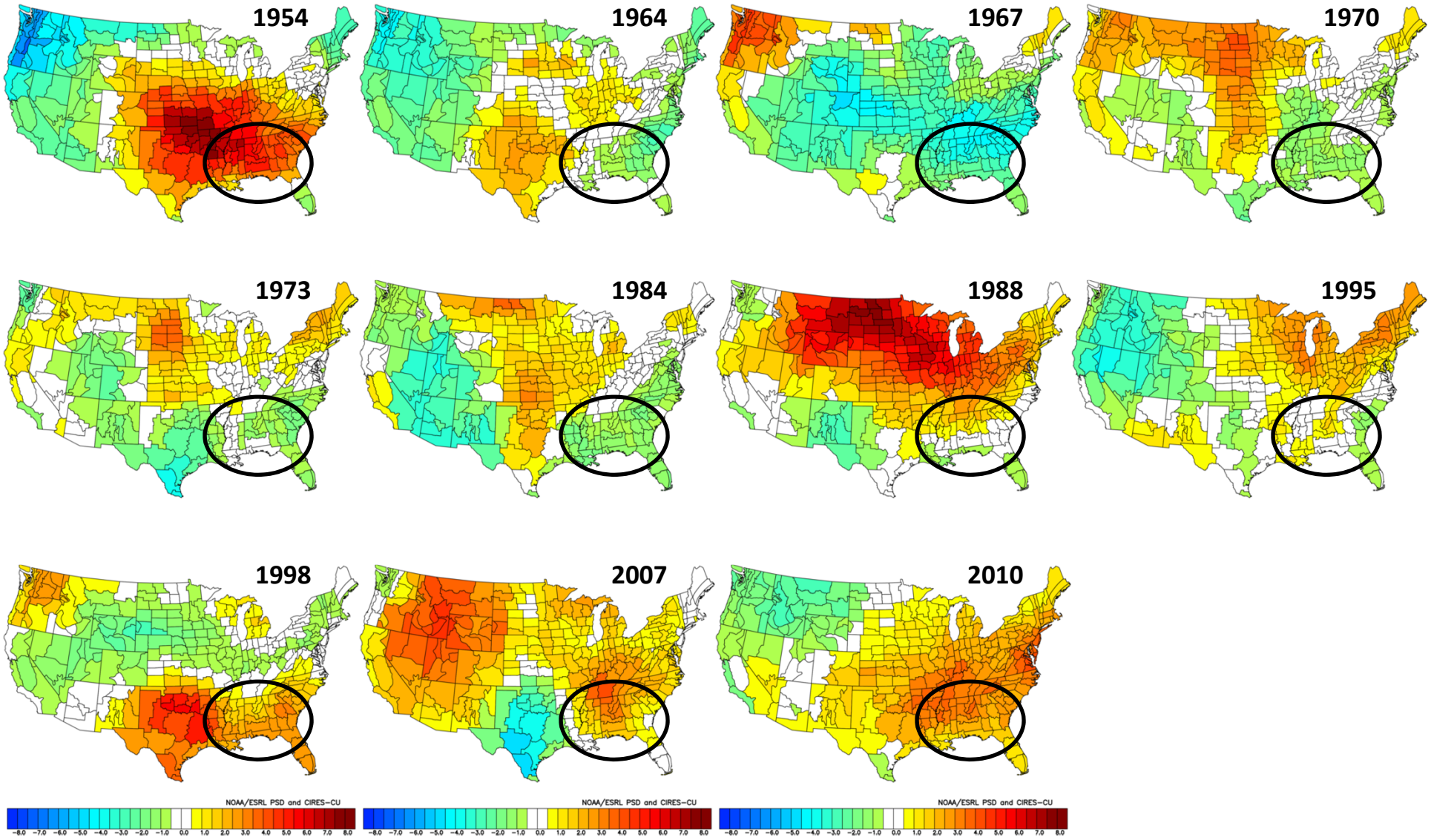
Temperature Anomalies (F)



Climate patterns associated with developing La Niña – Summer

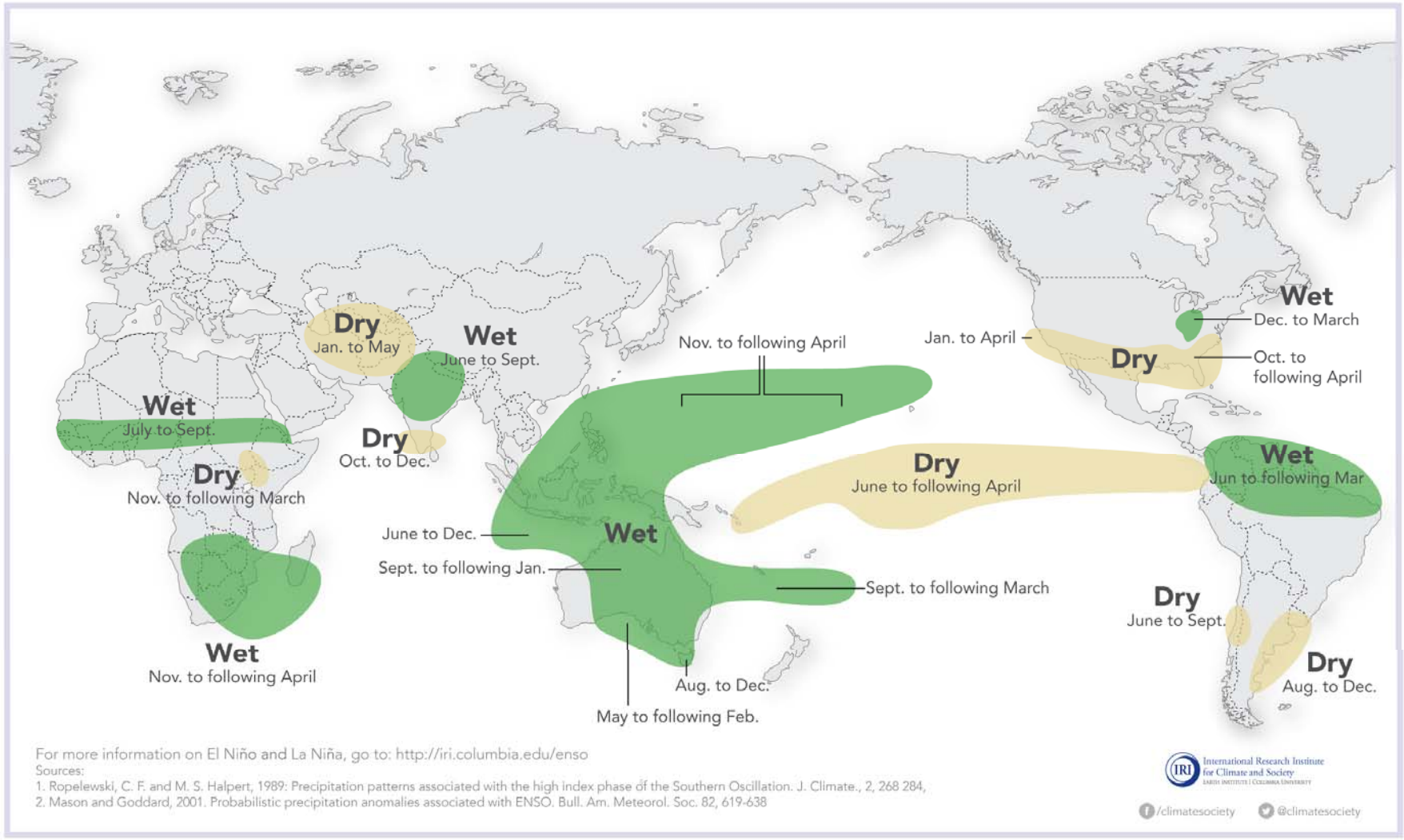
June – July – August

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.

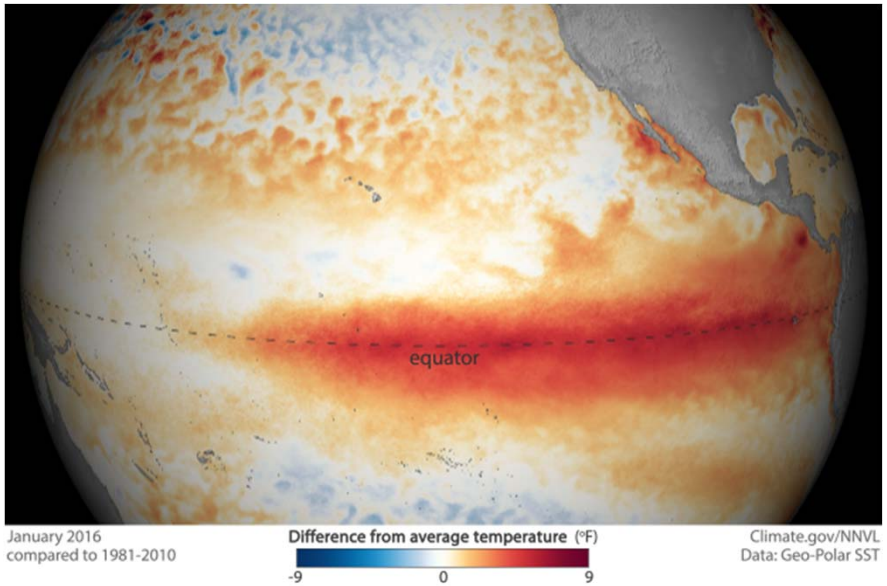
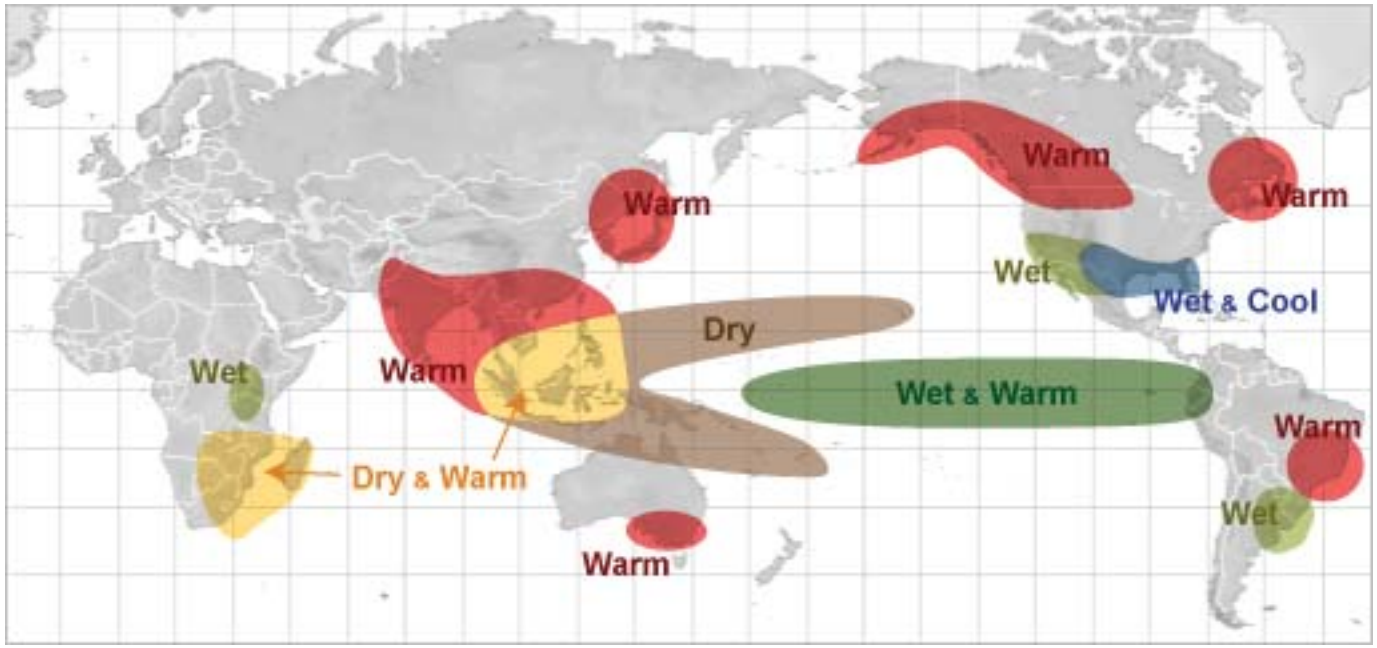


Image source – https://www.climate.gov/enso

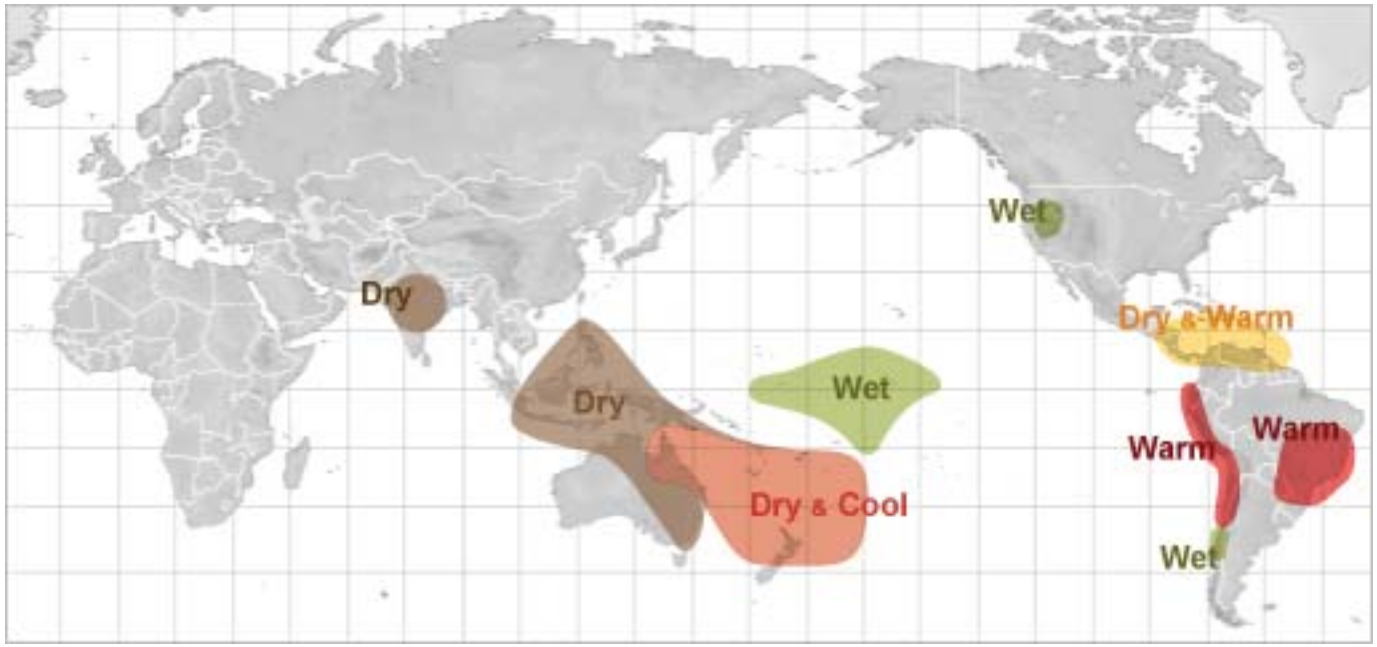
What is possible:

- 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.

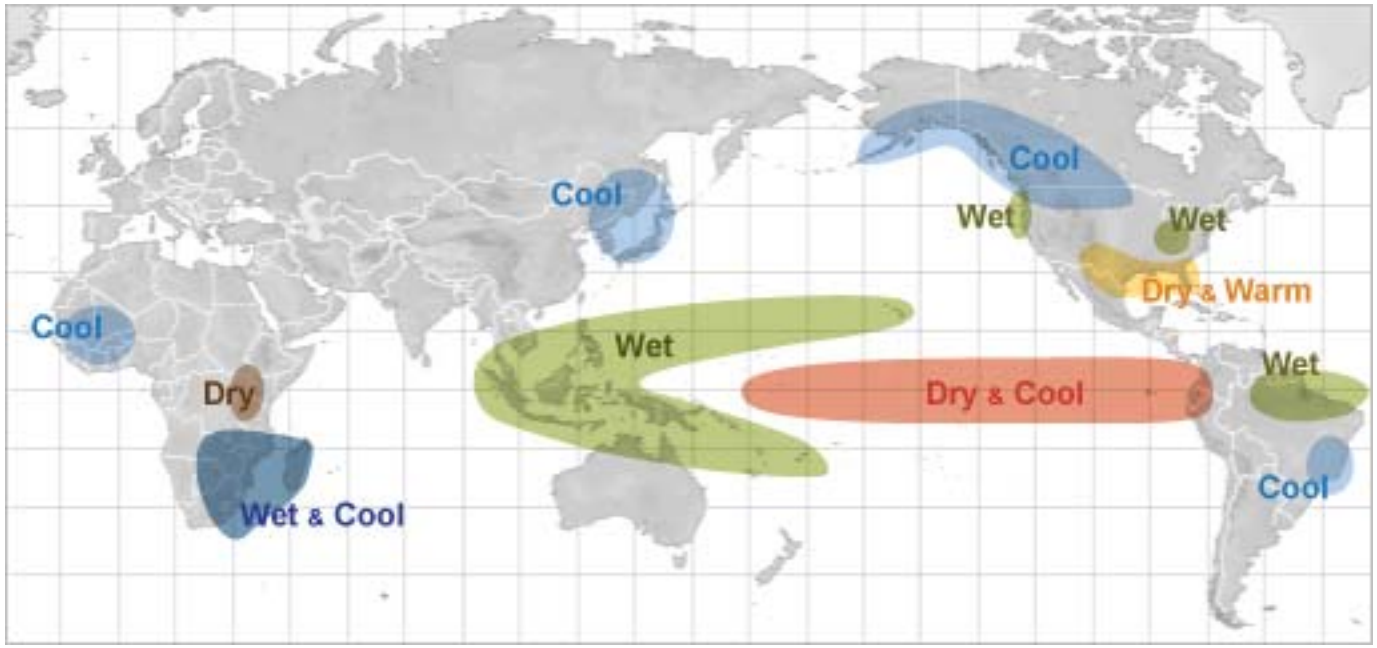
El Niño – Dec/Jan/Feb



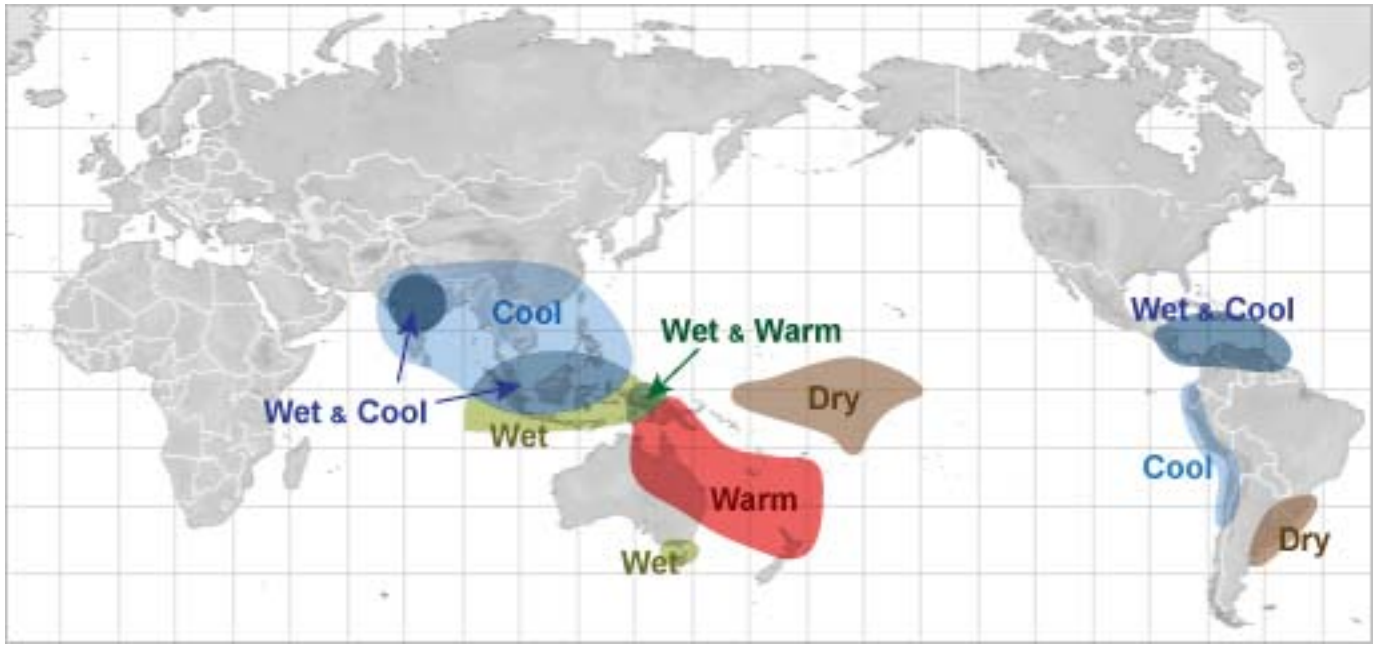
El Niño – Jun/Jul/Aug



La Niña – Dec/Jan/Feb



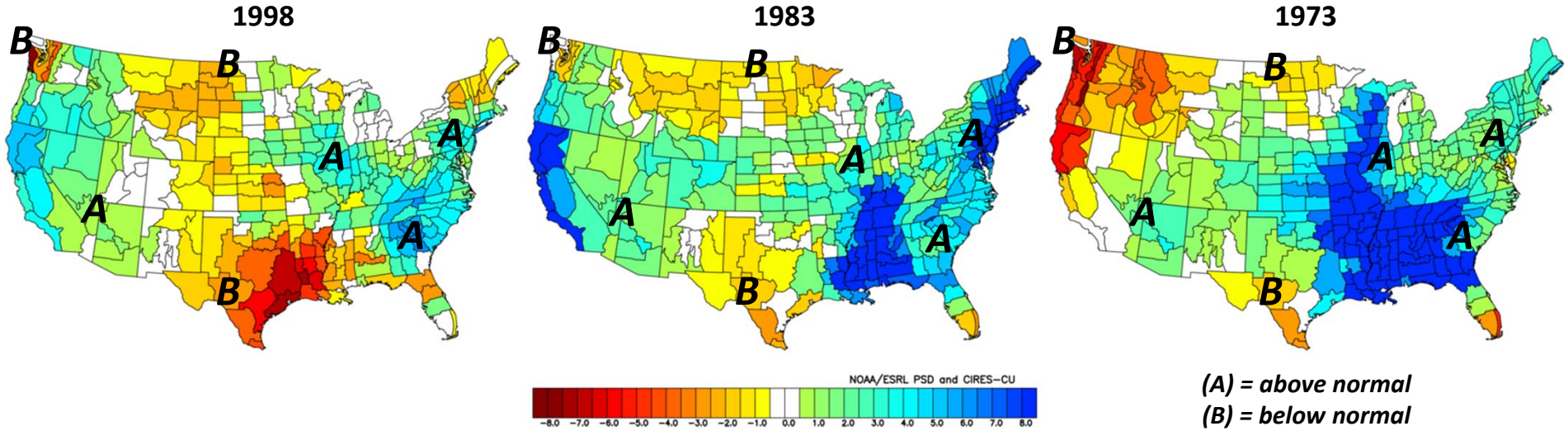
La Niña – Jun/Jul/Aug



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

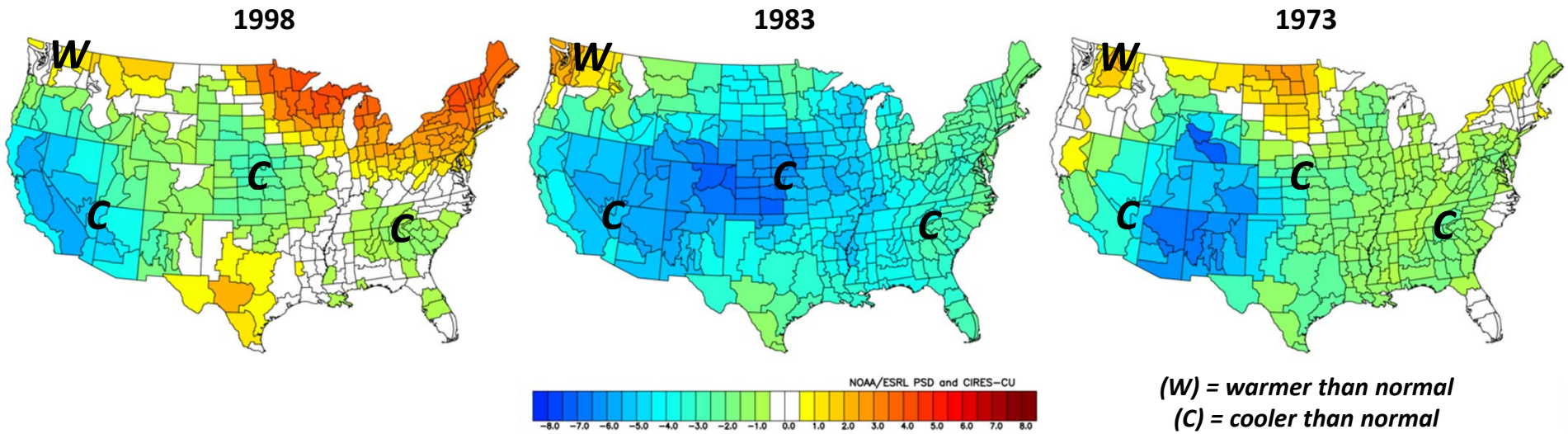
March – April – May

Precipitation Anomalies (in)



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

Maximum Temperature Anomalies (F)



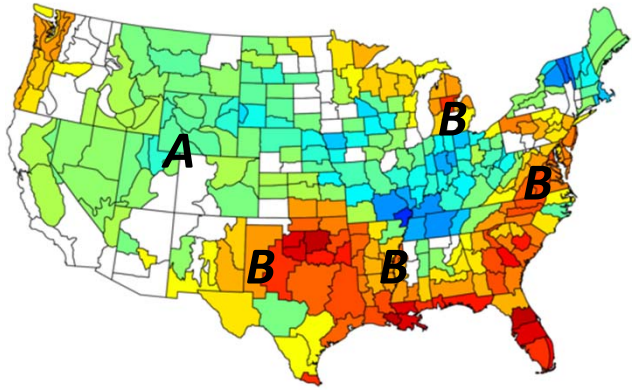
(W) = warmer than normal
(C) = cooler than normal

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

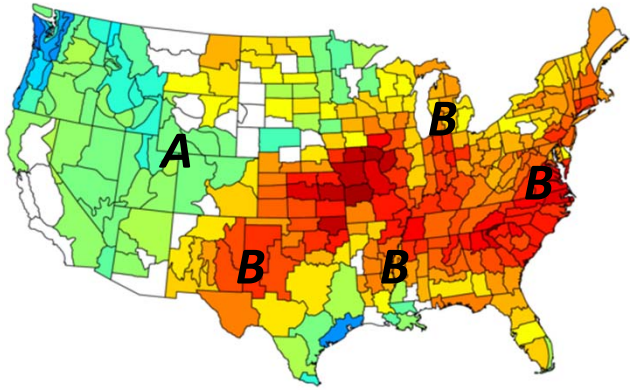
June – July – August

Precipitation Anomalies (in)

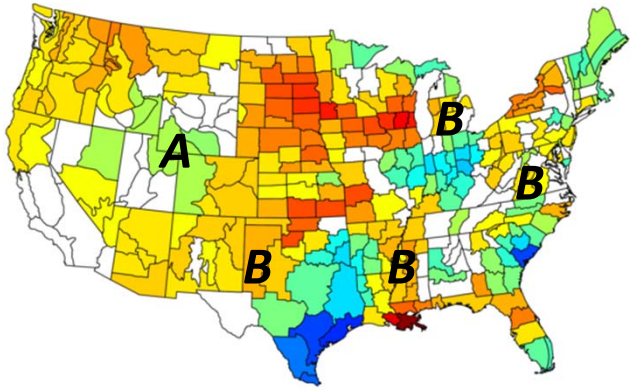
1998

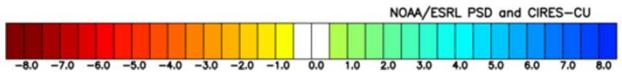


1983



1973





(A) = above normal
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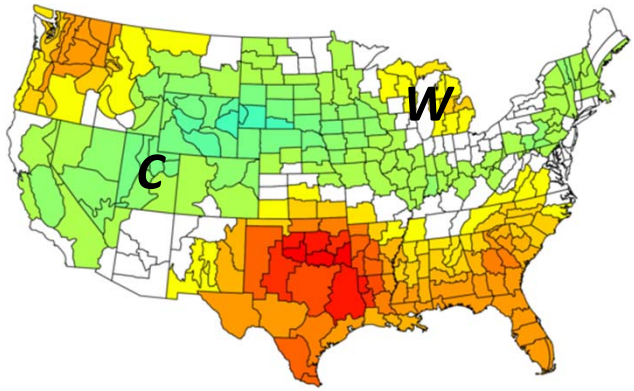
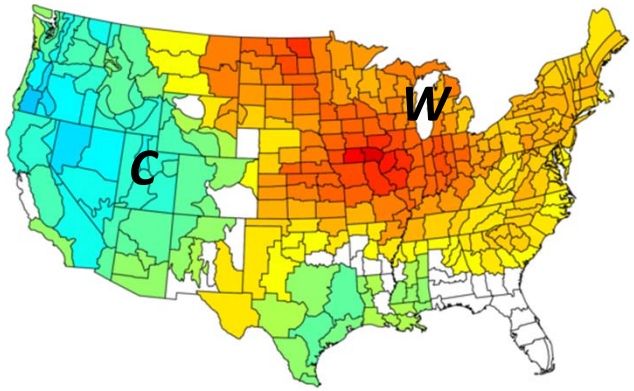
Maximum Temperature Anomalies (F)

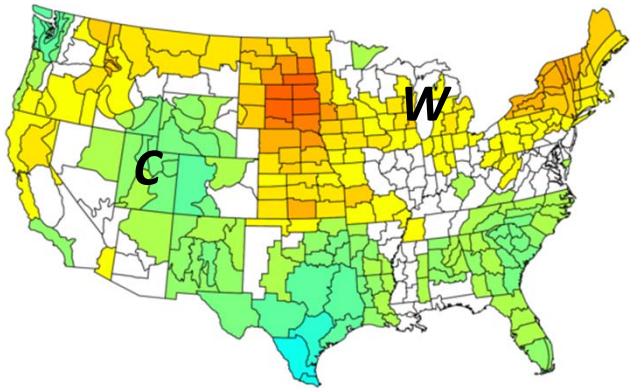
1998

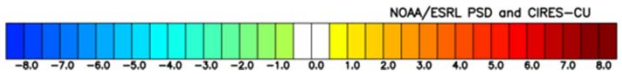


1983

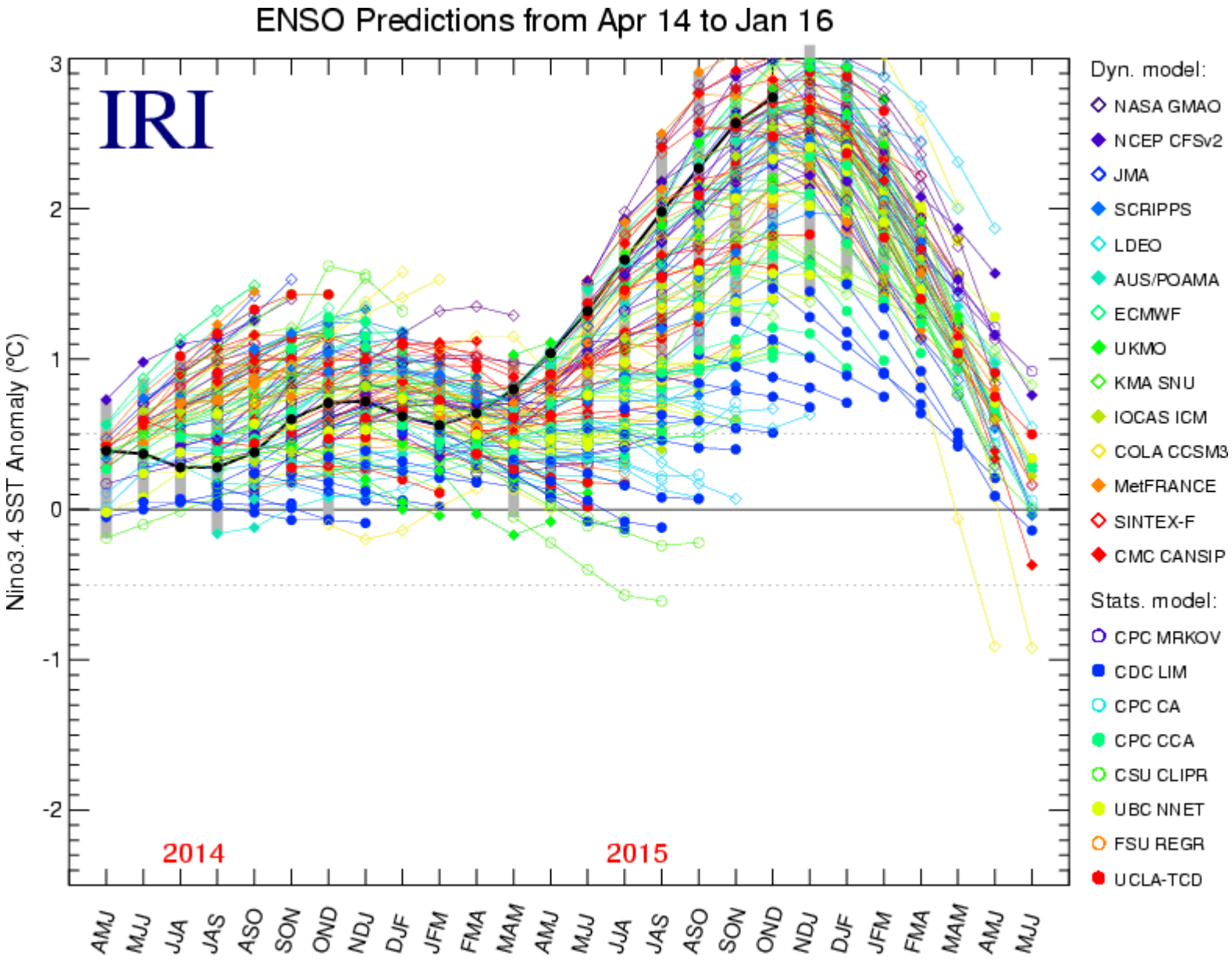


1973



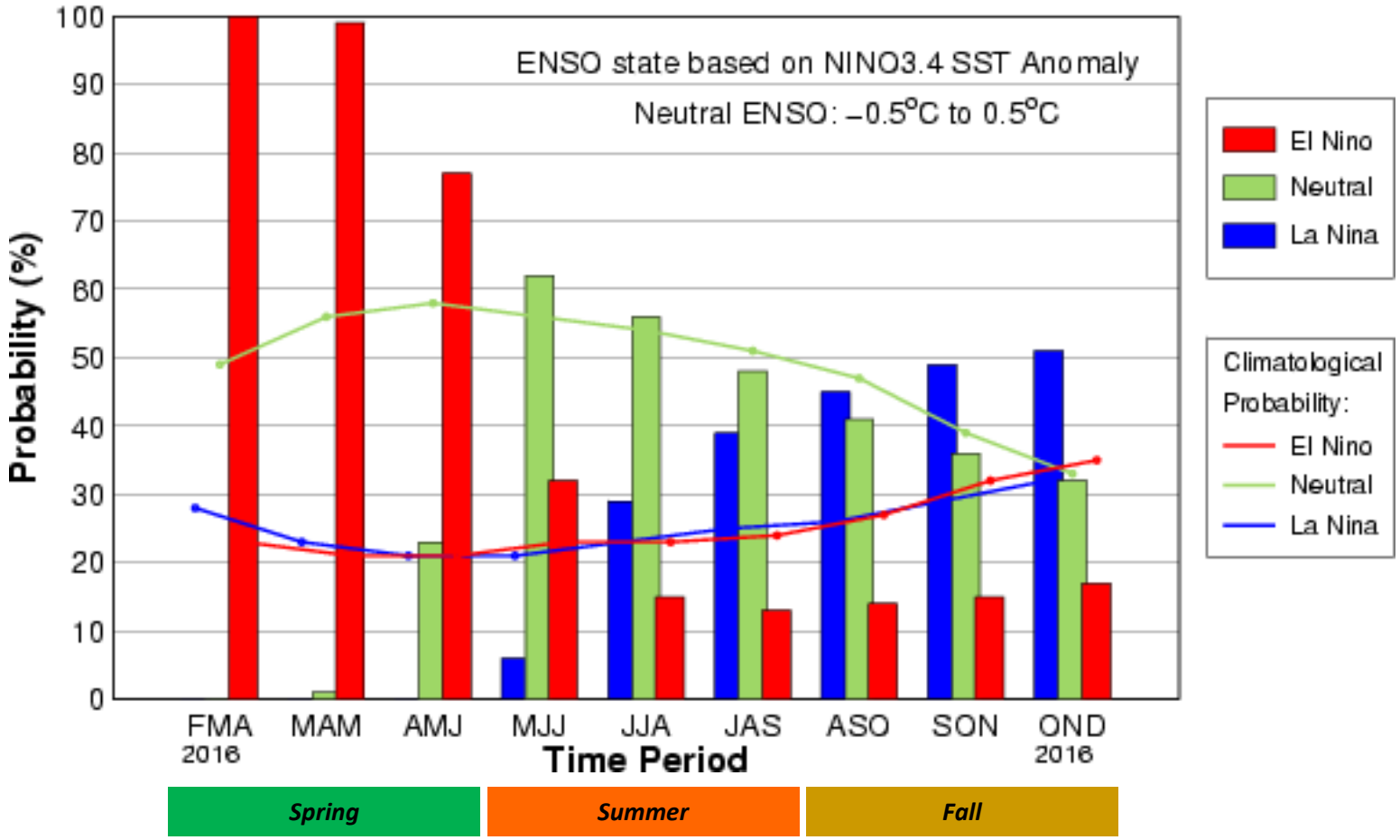


(W) = warmer than normal
(C) = cooler than normal


ENSO Predictions from Apr 14 to Jan 16
IRI
Nino3.4 SST Anomaly (°C)
3
2
1
0
-1
-2
2014
2015
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
Dyn. model:
NASA GMAO
NCEP CFSv2
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
IOCAS ICM
COLA CCSM3
MetFRANCE
SINTEX-F
CMC CANSIP
Stats. model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA-TCD

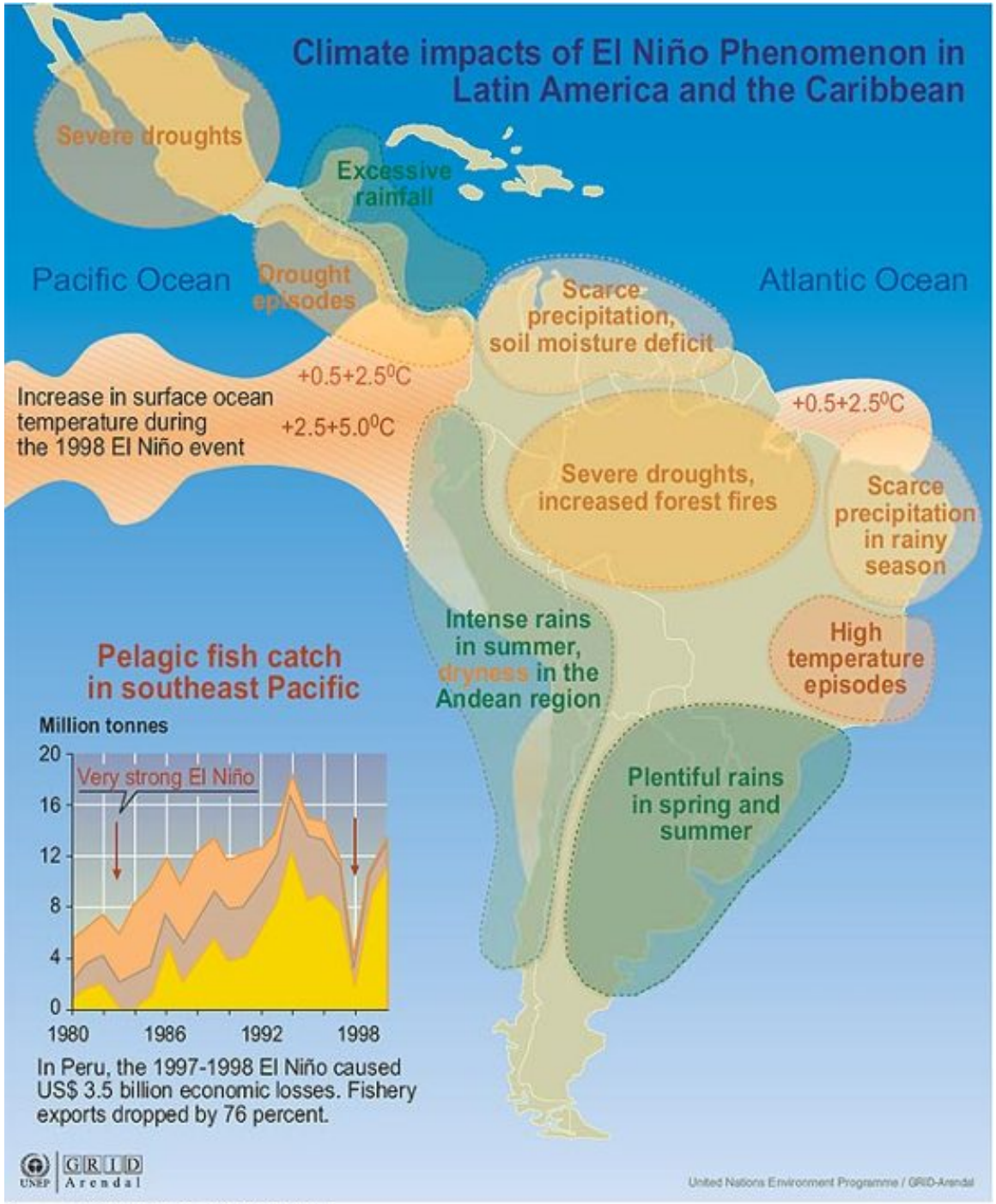
CPC/IRI Consensus Probabilistic ENSO Forecast

Updated – February 18, 2016



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

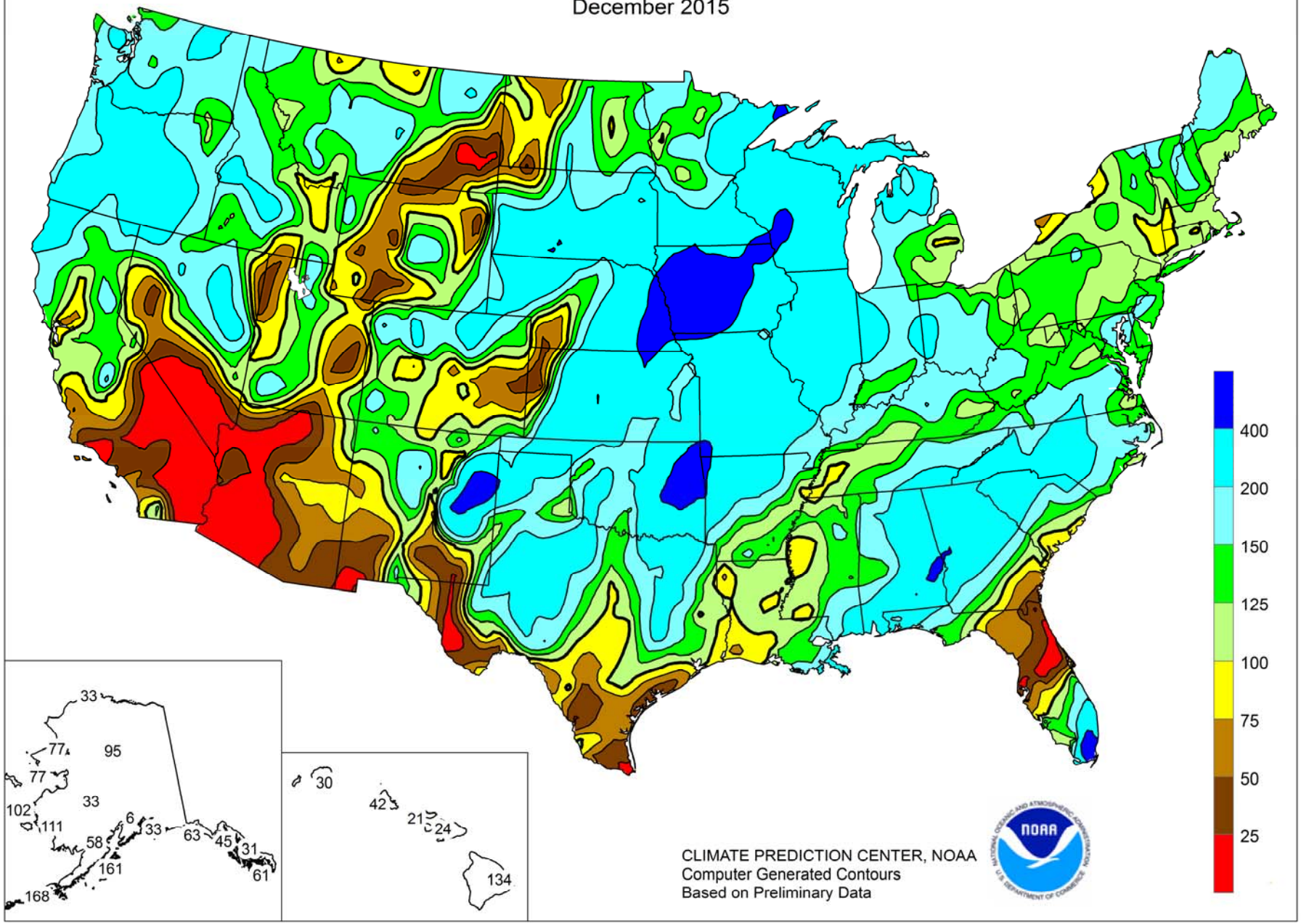
Image source – http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_plume

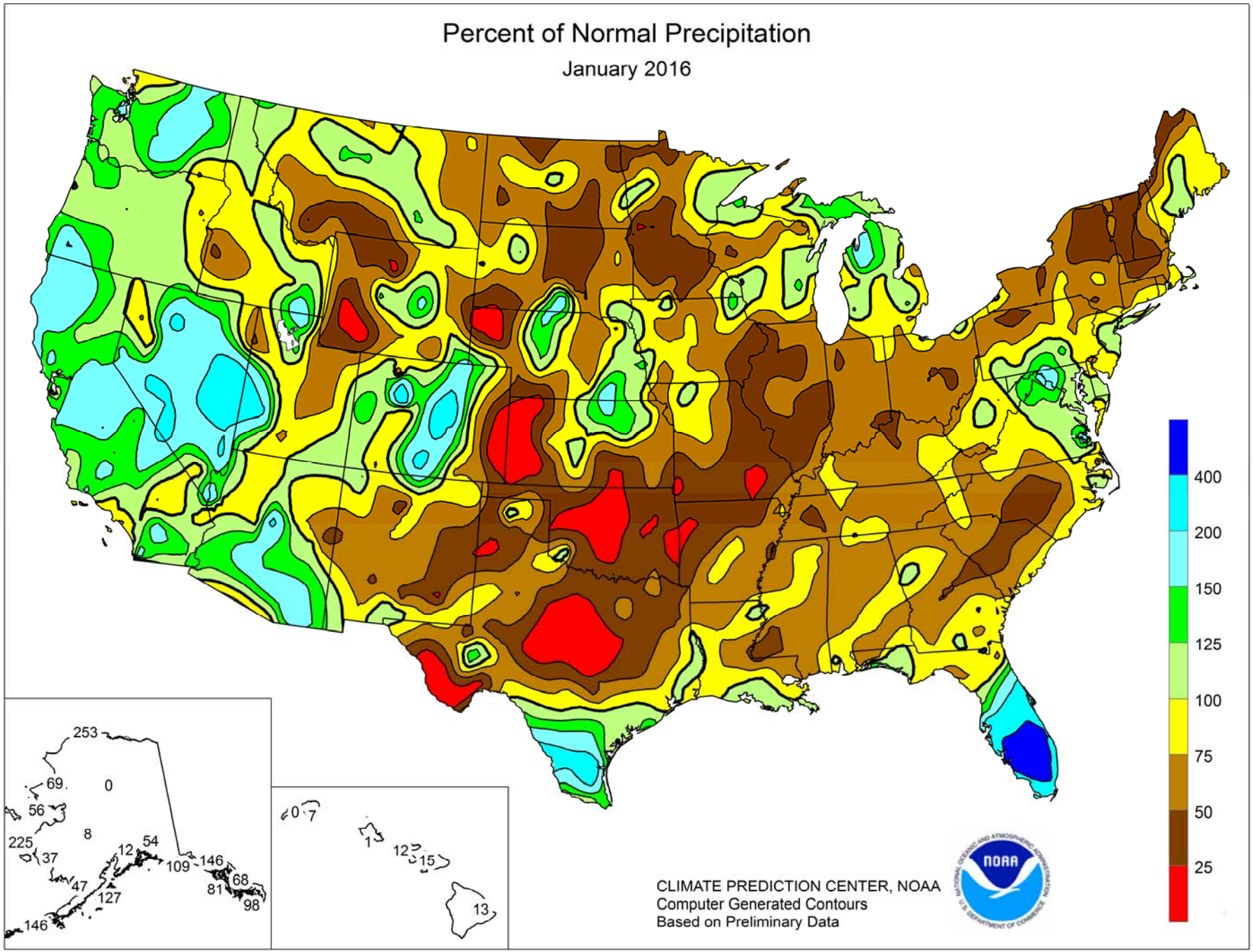


Sources: IPCC 2001, FAO 2002, UNEP 2003

Percent of Normal Precipitation

December 2015




Percent of Normal Precipitation
January 2016
400
200
150
125
100
75
50
25
253
69
0
56
8
225
37
12
54
109
146
68
81
98
47
127
146
0
7
1
12
15
13
CLIMATE PREDICTION CENTER, NOAA
Computer Generated Contours
Based on Preliminary Data
NOAA