CNAP
California-Nevada Climate Applications Program

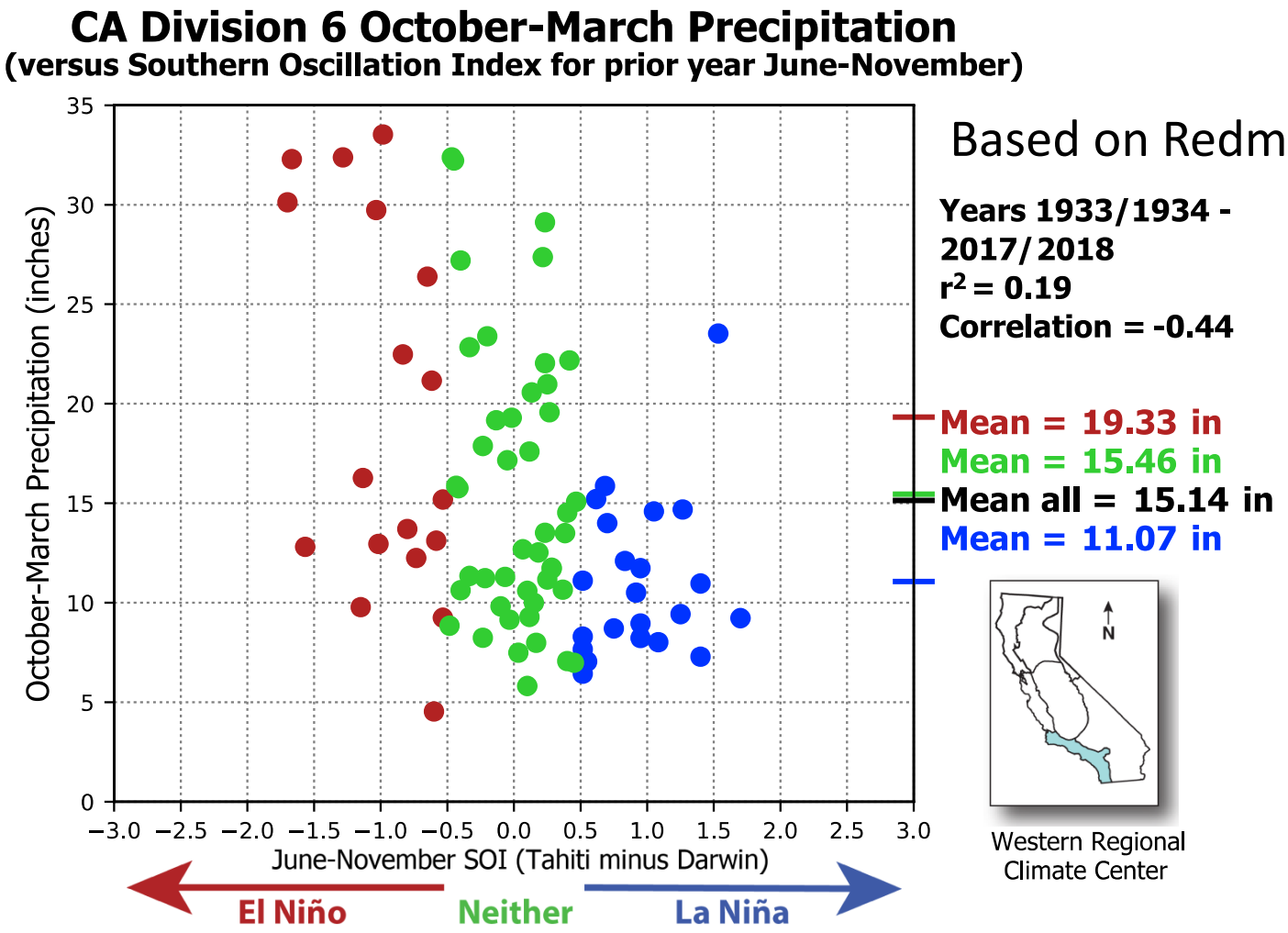
WESTERN REGIONAL CLIMATE CENTER

El Niño and El Niño Modoki: Communicating Precipitation Teleconnections in the Western US

Nina Oakley, WRCC

Winter Outlook Workshop: Oct 31 2018

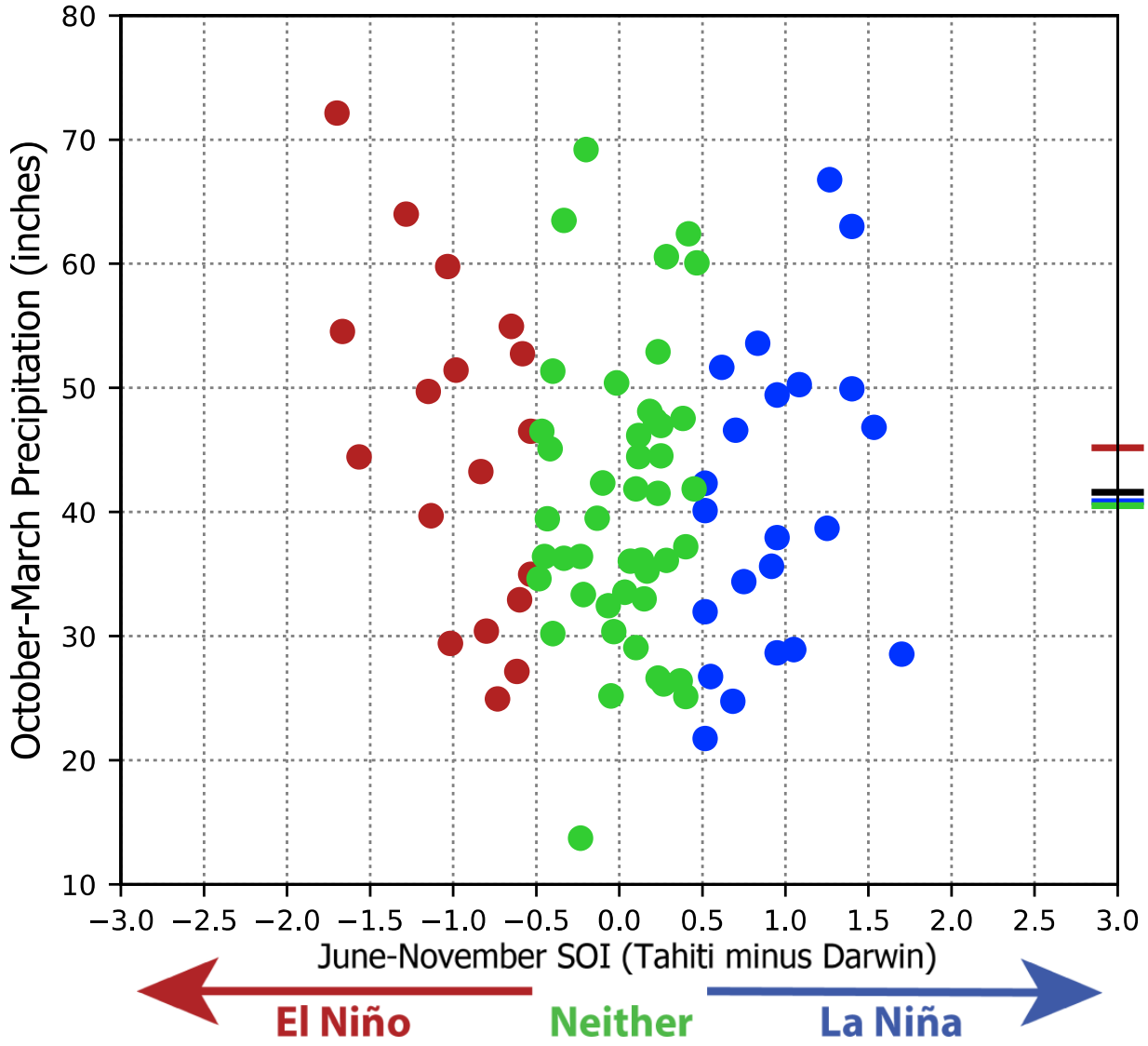
We have updated WRCC SOI-precipitation scatterplots for western NCEI Climate Divisions!



https://wrcc.dri.edu/Climate/soi_precip.php

CA Division 1 October-March Precipitation

(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018

r^2 = 0.01

Correlation = -0.11

Mean = 45.17 in

Mean all = 41.59 in

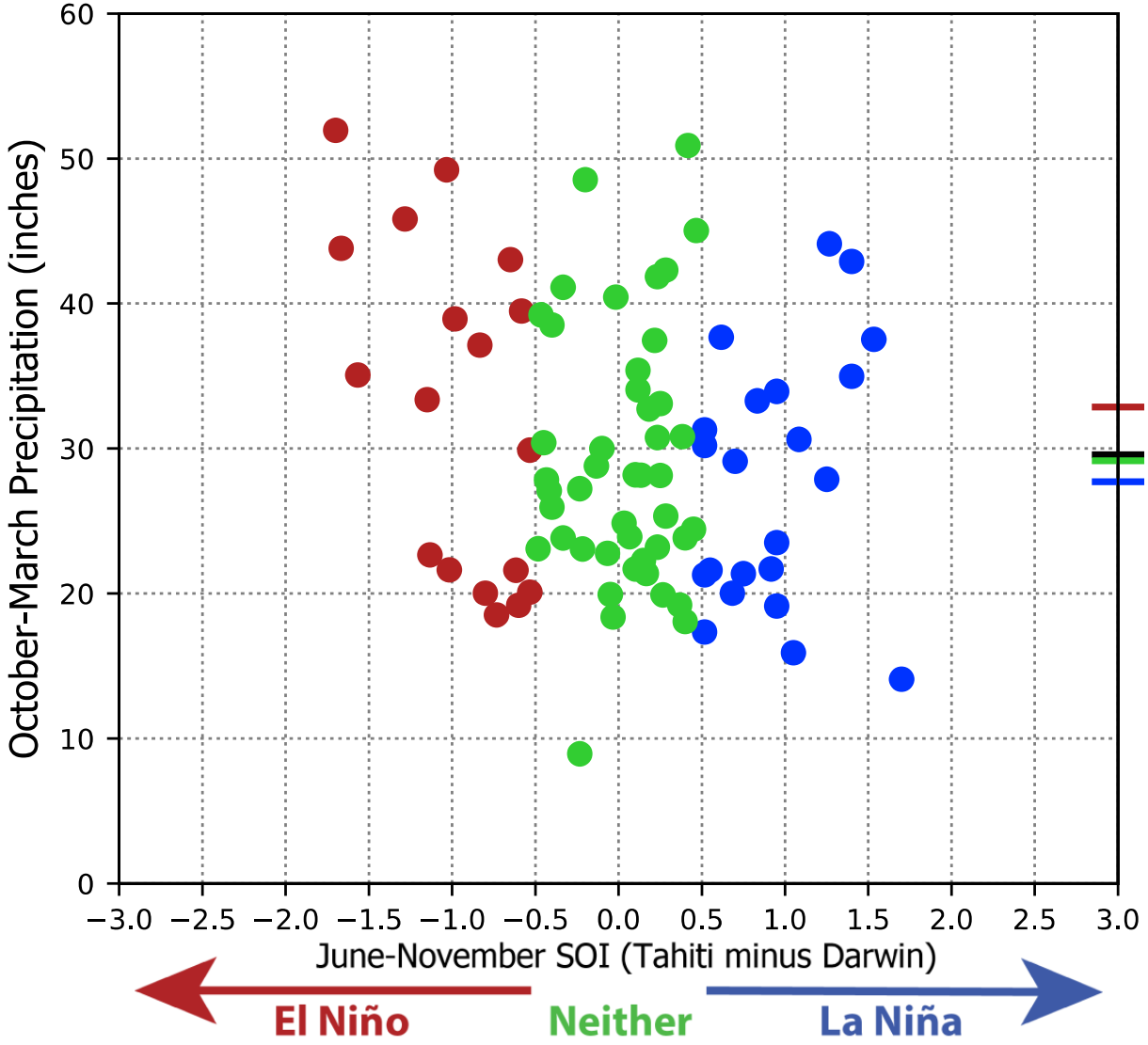
Mean = 40.84 in

Mean = 40.52 in

Western Regional Climate Center

CA Division 2 October-March Precipitation

(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018

r^2 = 0.04

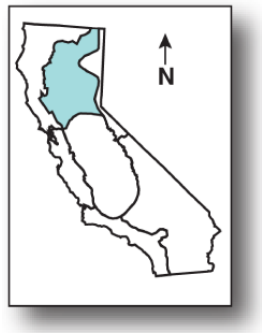
Correlation = -0.20

Mean = 32.86 in

Mean all = 29.57 in

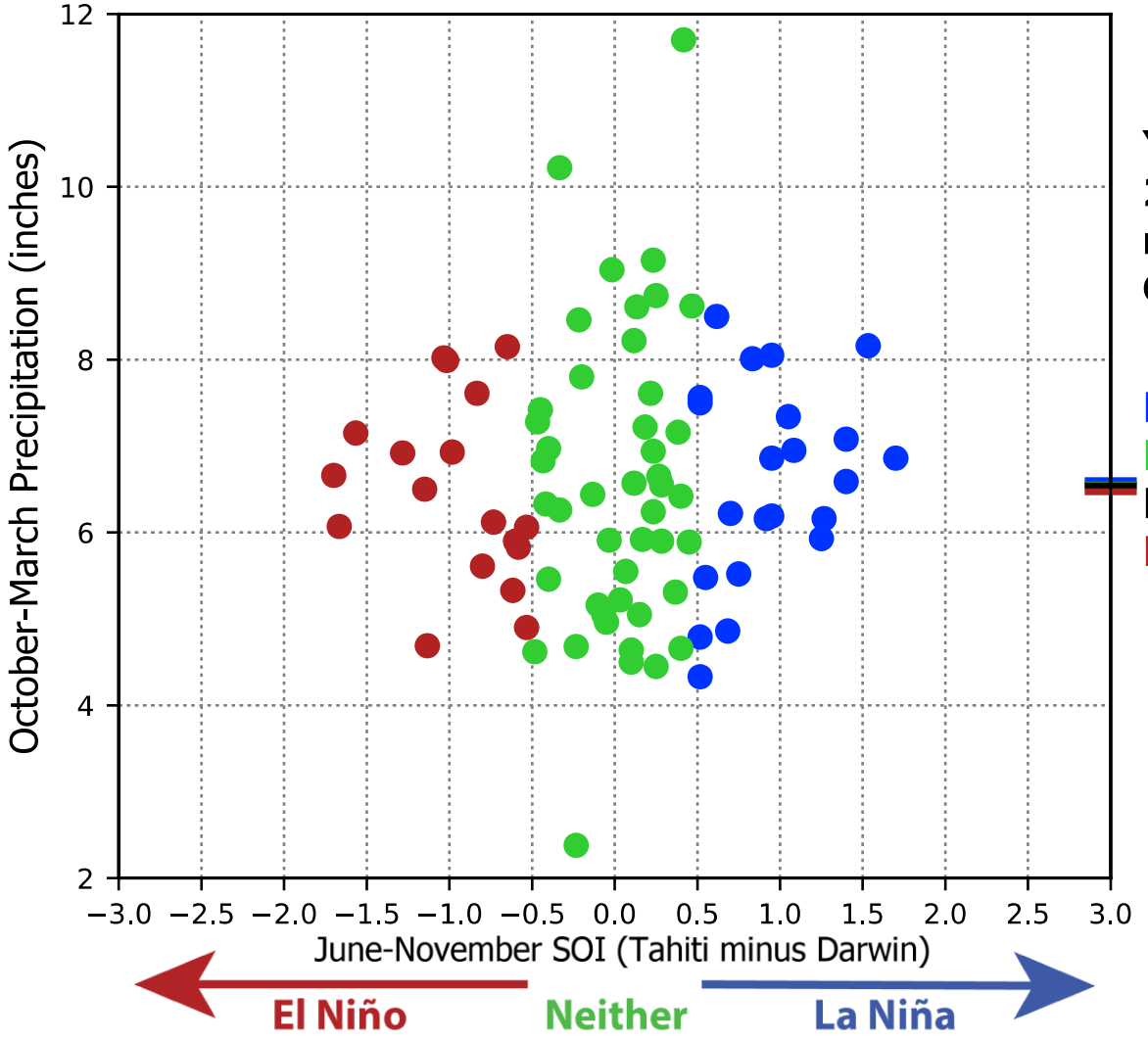
Mean = 29.16 in

Mean = 27.71 in



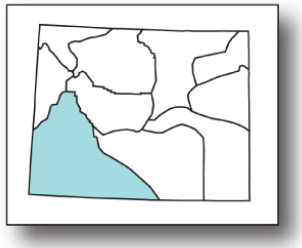
Western Regional Climate Center

WY Division 3 October-March Precipitation
(versus Southern Oscillation Index for prior year June-November)



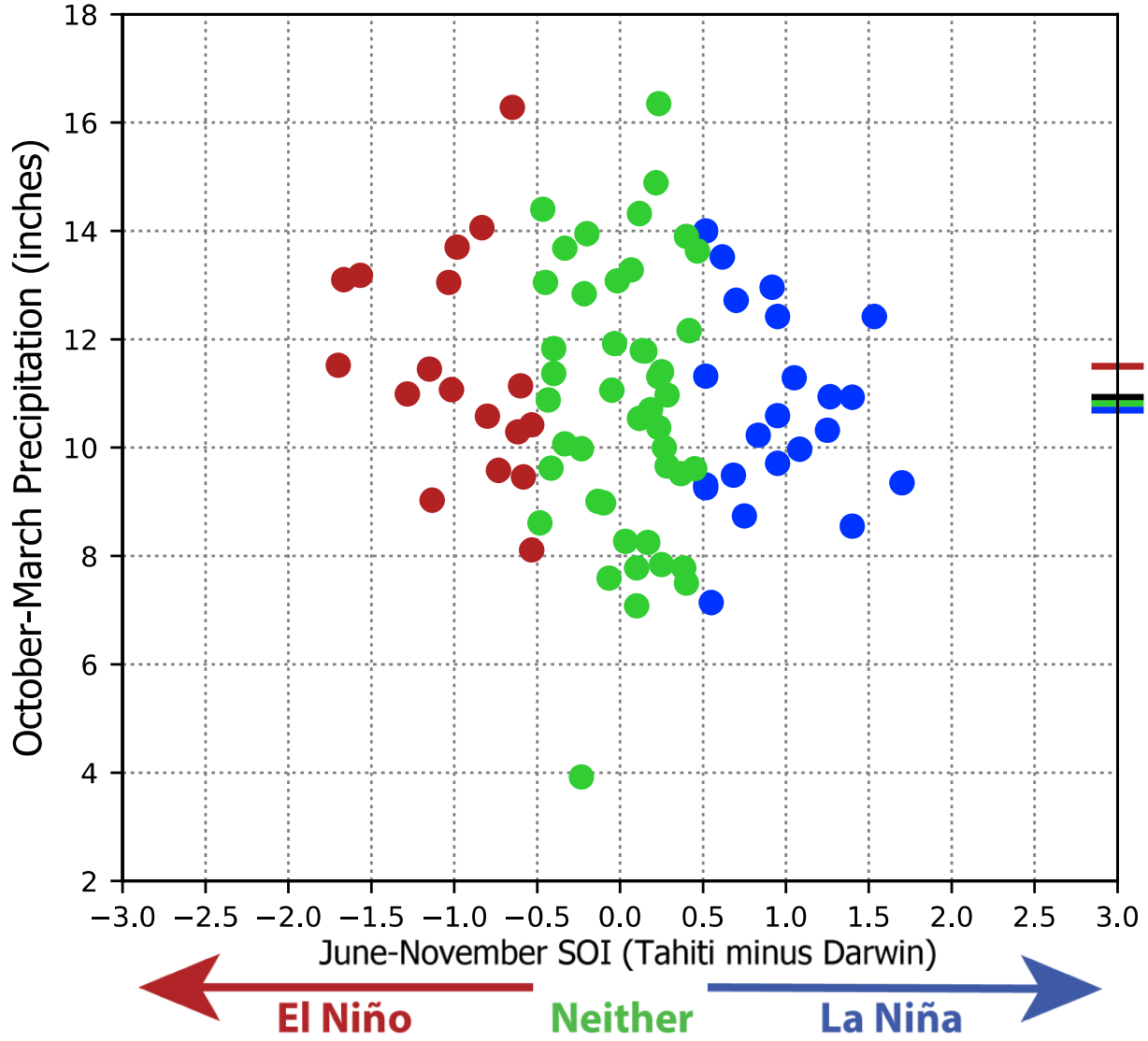
Years 1933/1934 - 2017/2018
r^2 = 0.0
Correlation = 0.07

Mean = 6.60 in
Mean = 6.55 in
Mean all = 6.54 in
Mean = 6.47 in



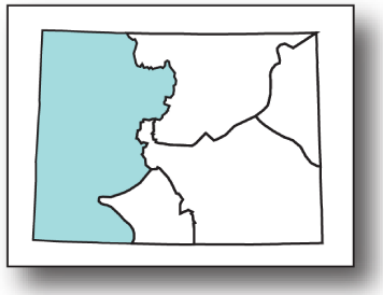
Western Regional Climate Center

CO Division 2 October-March Precipitation
(versus Southern Oscillation Index for prior year June-November)



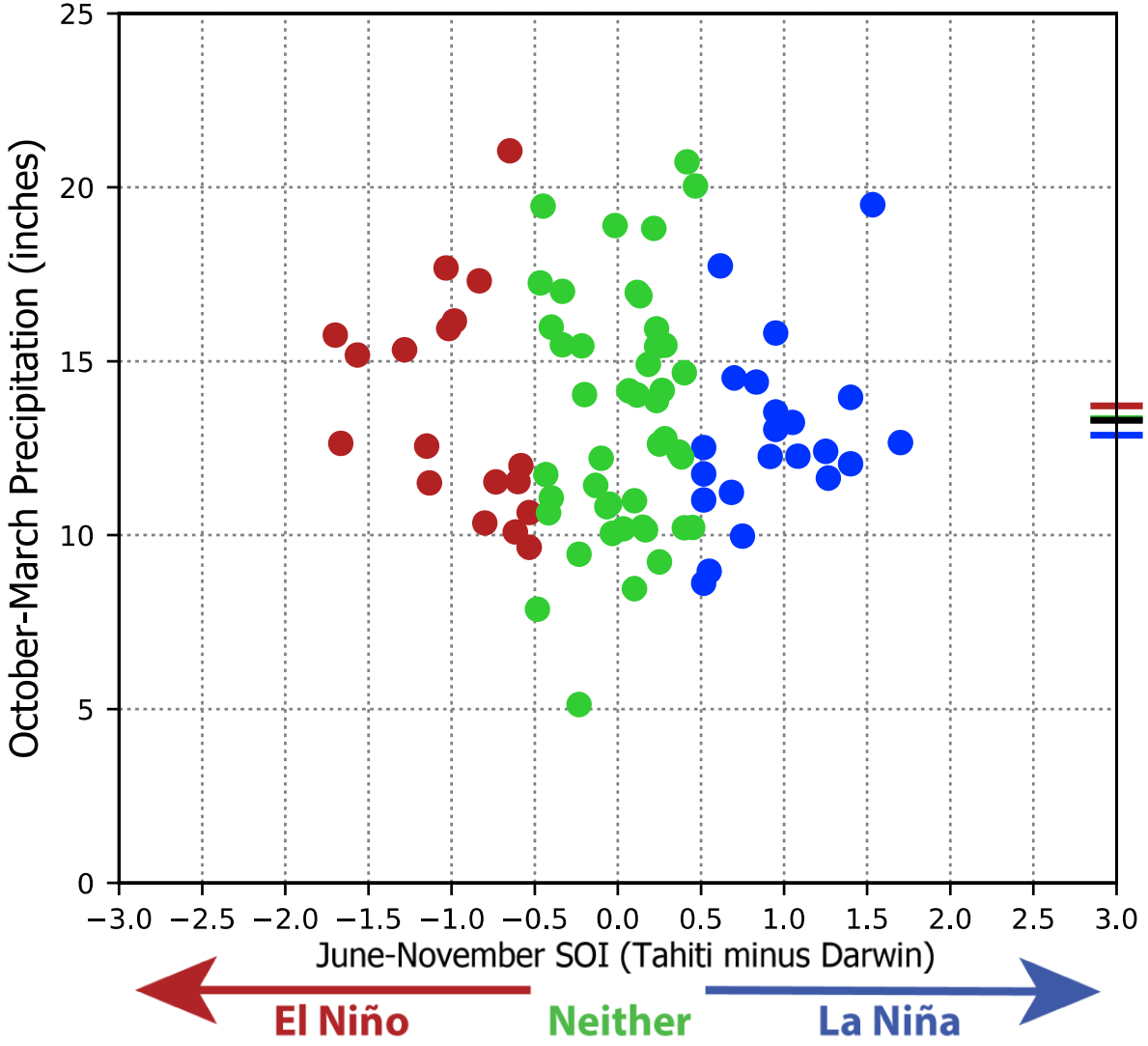
Years 1933/1934 - 2017/2018
r^2 = 0.02
Correlation = -0.15

Mean = 11.50 in
Mean all = 10.93 in
Mean = 10.81 in
Mean = 10.69 in



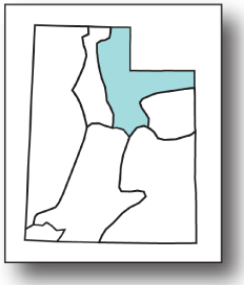
Western Regional Climate Center

UT Division 5 October-March Precipitation
(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018
r^2 = 0.0
Correlation = -0.05

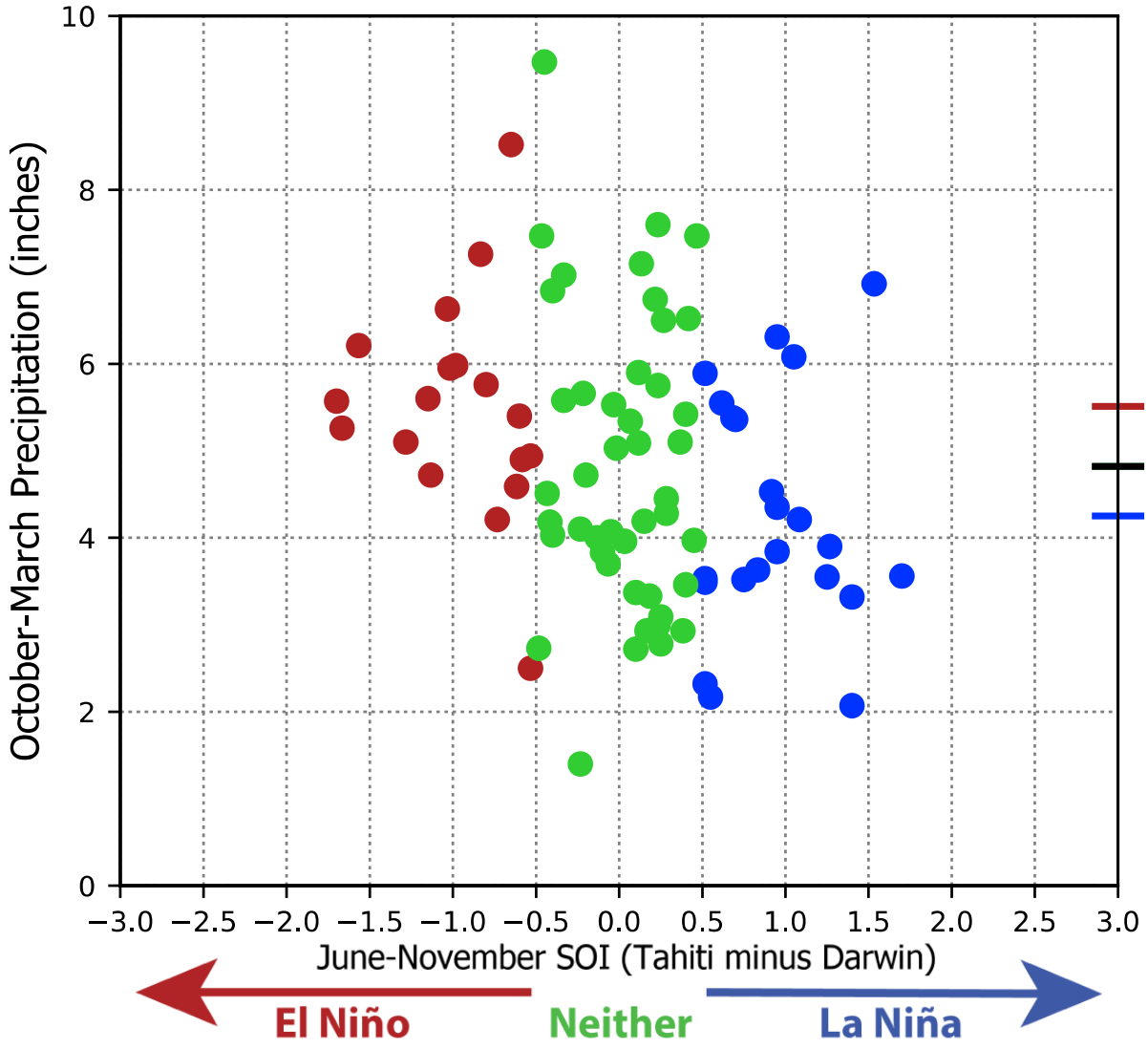
Mean = 13.72 in
Mean = 13.35 in
Mean all = 13.30 in
Mean = 12.87 in



Western Regional Climate Center

UT Division 6 October-March Precipitation

(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018

r^2 = 0.08

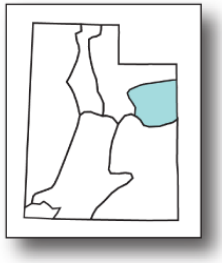
Correlation = -0.28

Mean = 5.51 in

Mean = 4.82 in

Mean all = 4.82 in

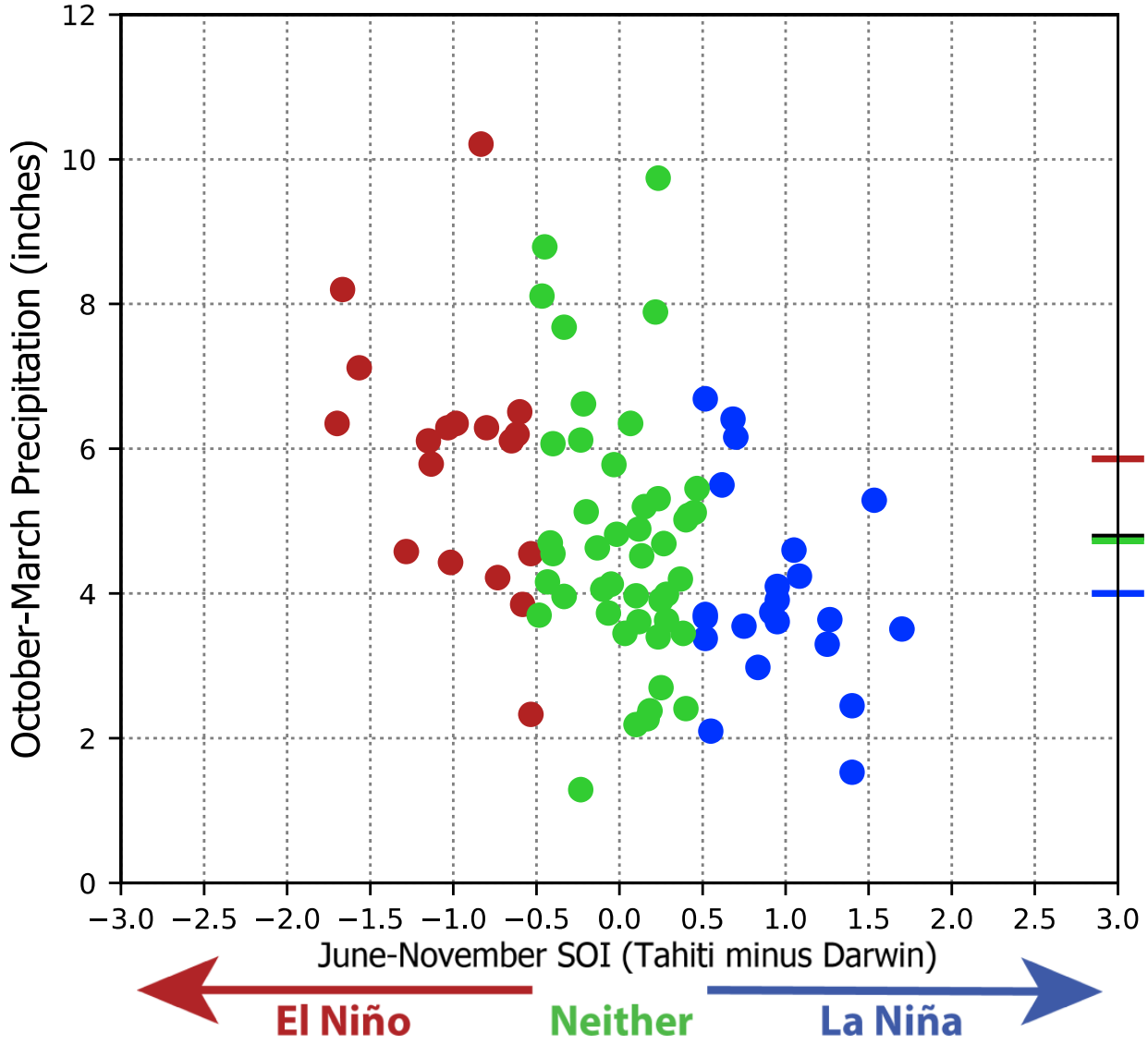
Mean = 4.25 in



Western Regional Climate Center

UT Division 7 October-March Precipitation

(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018

r^2 = 0.19

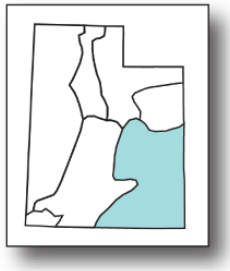
Correlation = -0.44

Mean = 5.86 in

Mean all = 4.78 in

Mean = 4.73 in

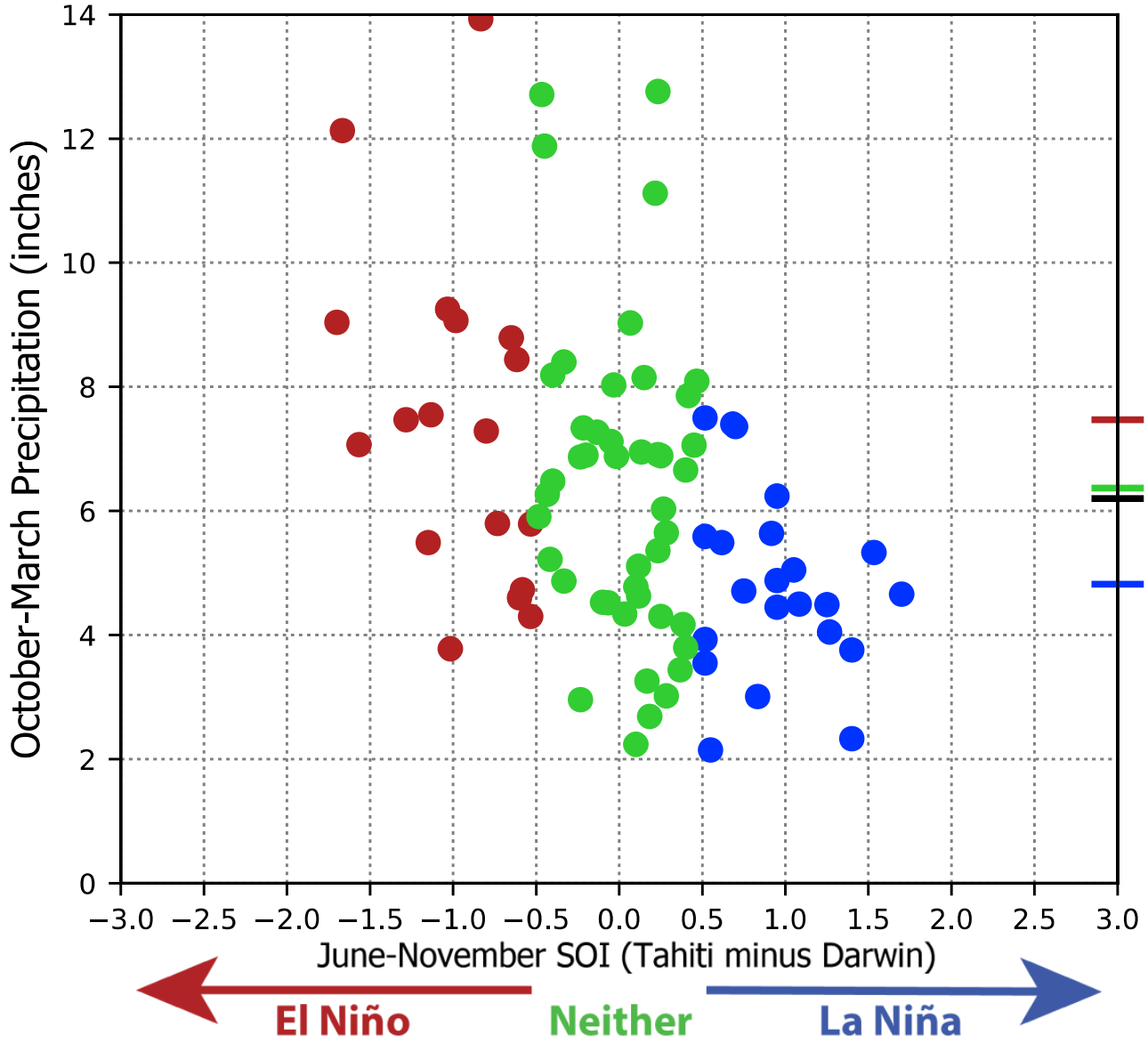
Mean = 4.00 in



Western Regional Climate Center

AZ Division 2 October-March Precipitation

(versus Southern Oscillation Index for prior year June-November)



Years 1933/1934 - 2017/2018

r^2 = 0.19

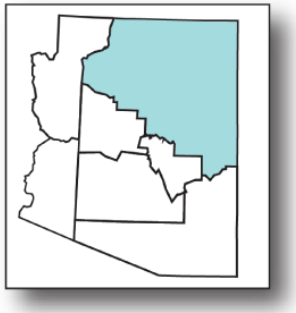
Correlation = -0.44

Mean = 7.47 in

Mean = 6.37 in

Mean all = 6.20 in

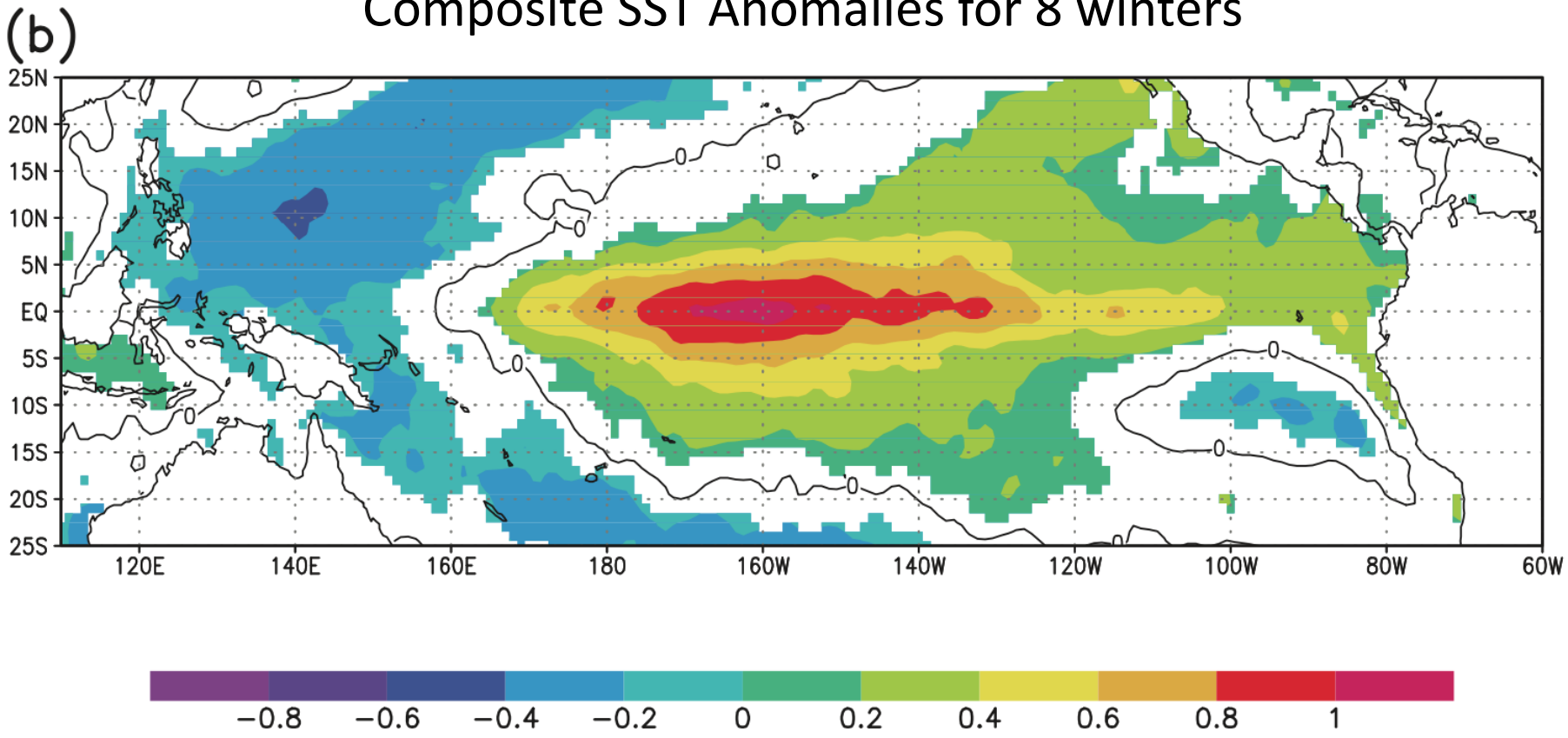
Mean = 4.82 in



Western Regional Climate Center

El Niño Modoki

Composite SST Anomalies for 8 winters



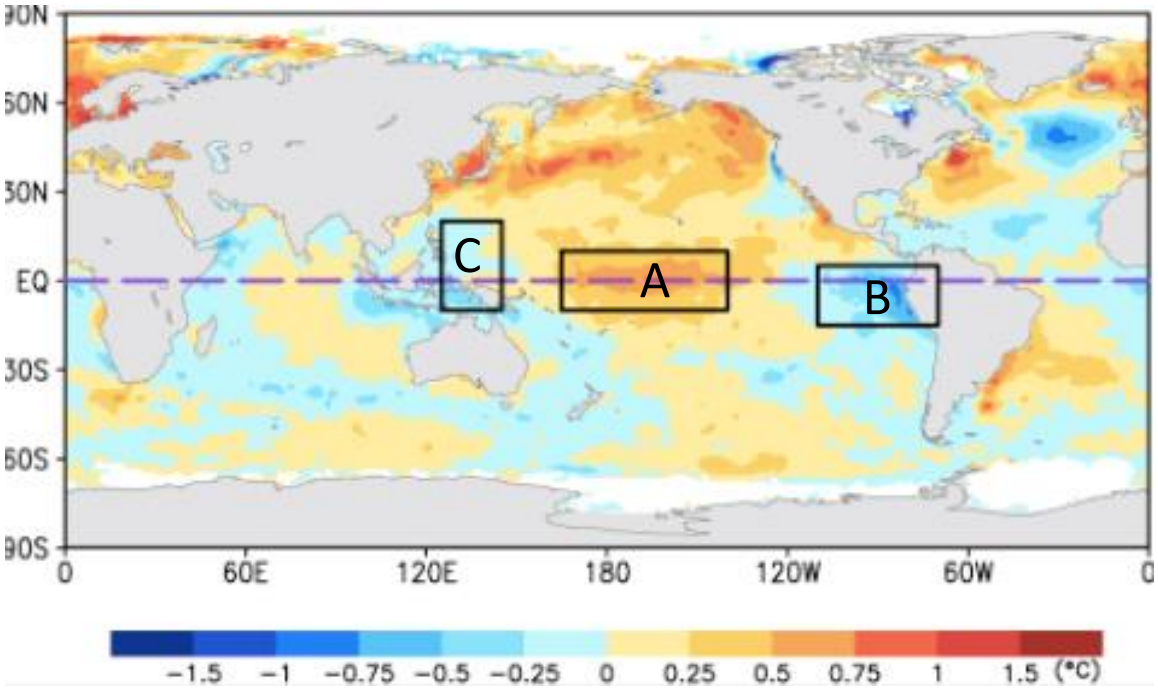
Composite SST anomalies for strong positive El Niño Modoki Events
For 8 boreal winters: DJF 1979/80, 1986/87, 1990/91, 1991/92, 1992/93, 1994/95, 2002/03, 2004/05

Ashok et al. 2007 *JGR*

El Niño Modoki Index

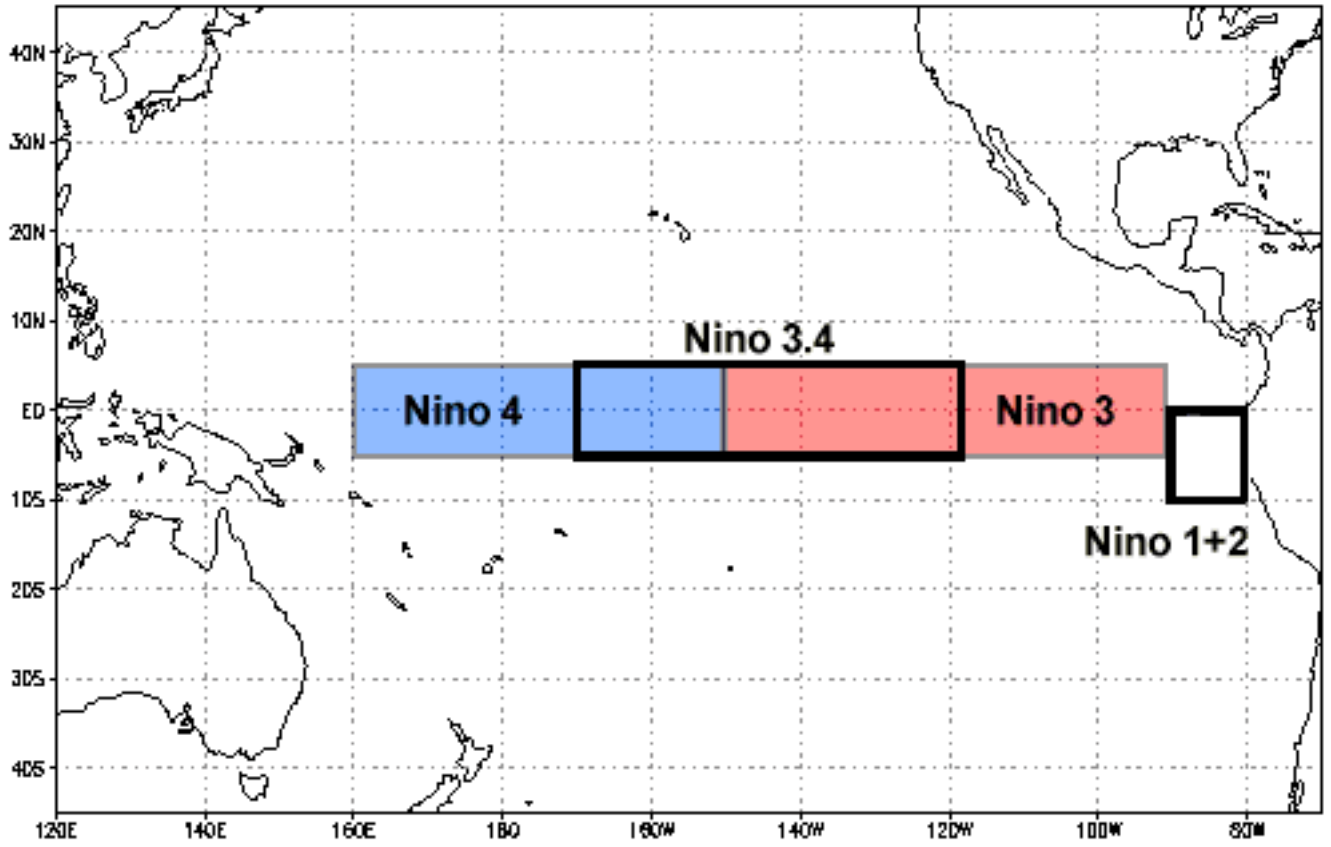
Due to unique tri-pole nature of SST anomalies, equation is:

$$EMI = [SSTA]_A - 0.5^* [SSTA]_B - 0.5^* [SSTA]_C$$



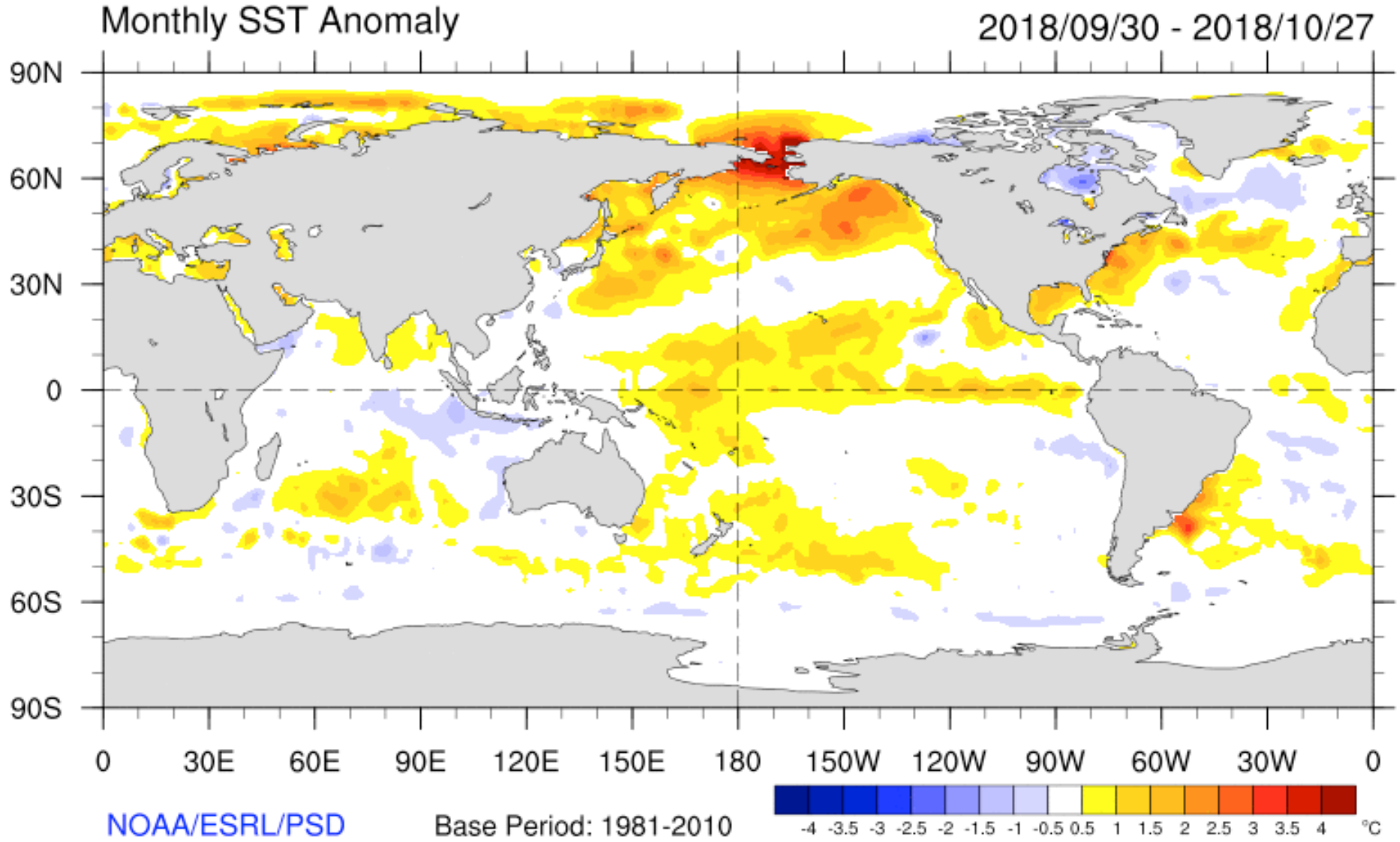
Ashok et al. 2007 *JGR;* EMI maintained by JAMSTEC

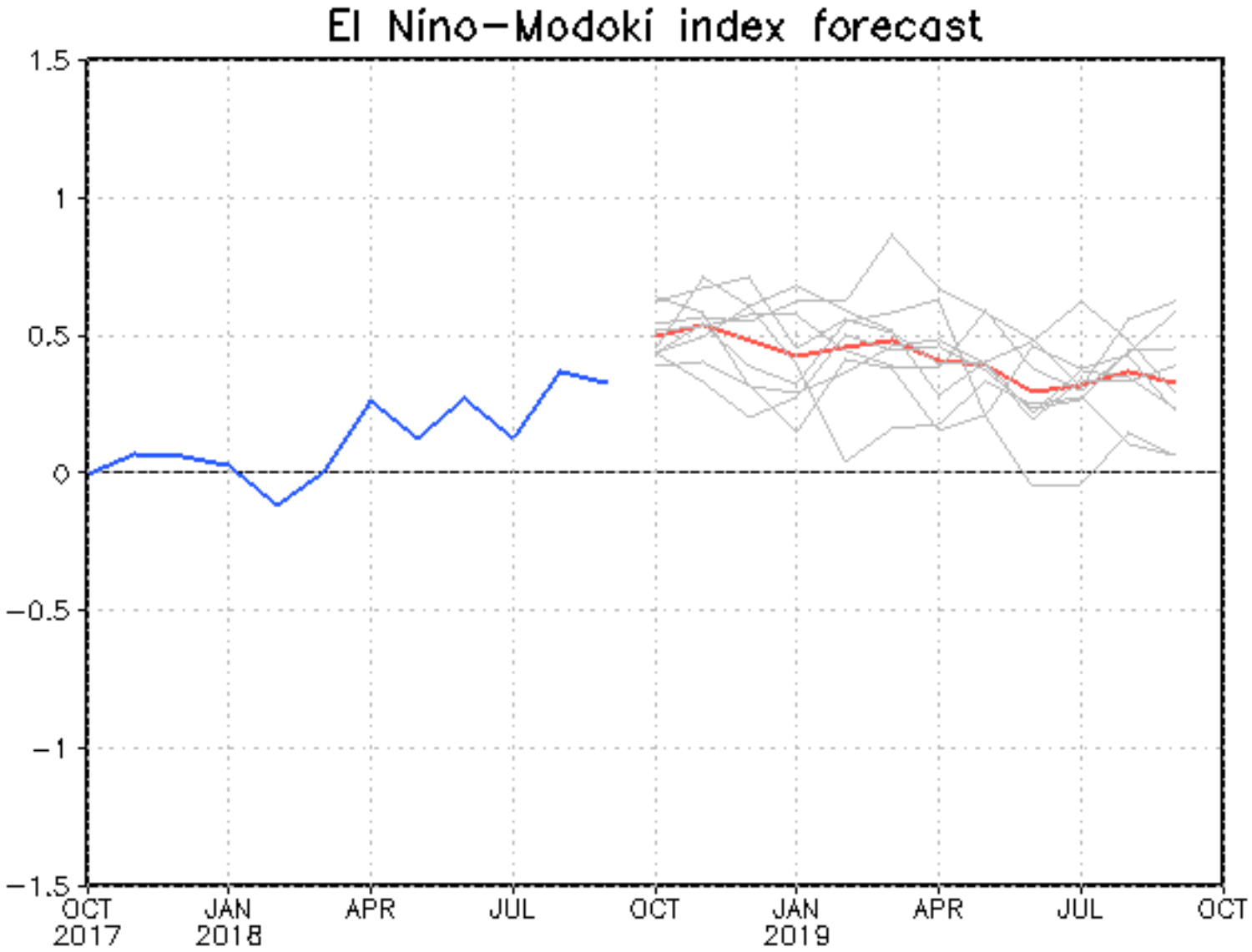
Oceanic Niño Index



3-month running mean of anomalies in the Niño 3.4 region
A year is considered an El/La Niño/a year if ONI anomaly exceeds threshold of 0.5 for five overlapping seasons

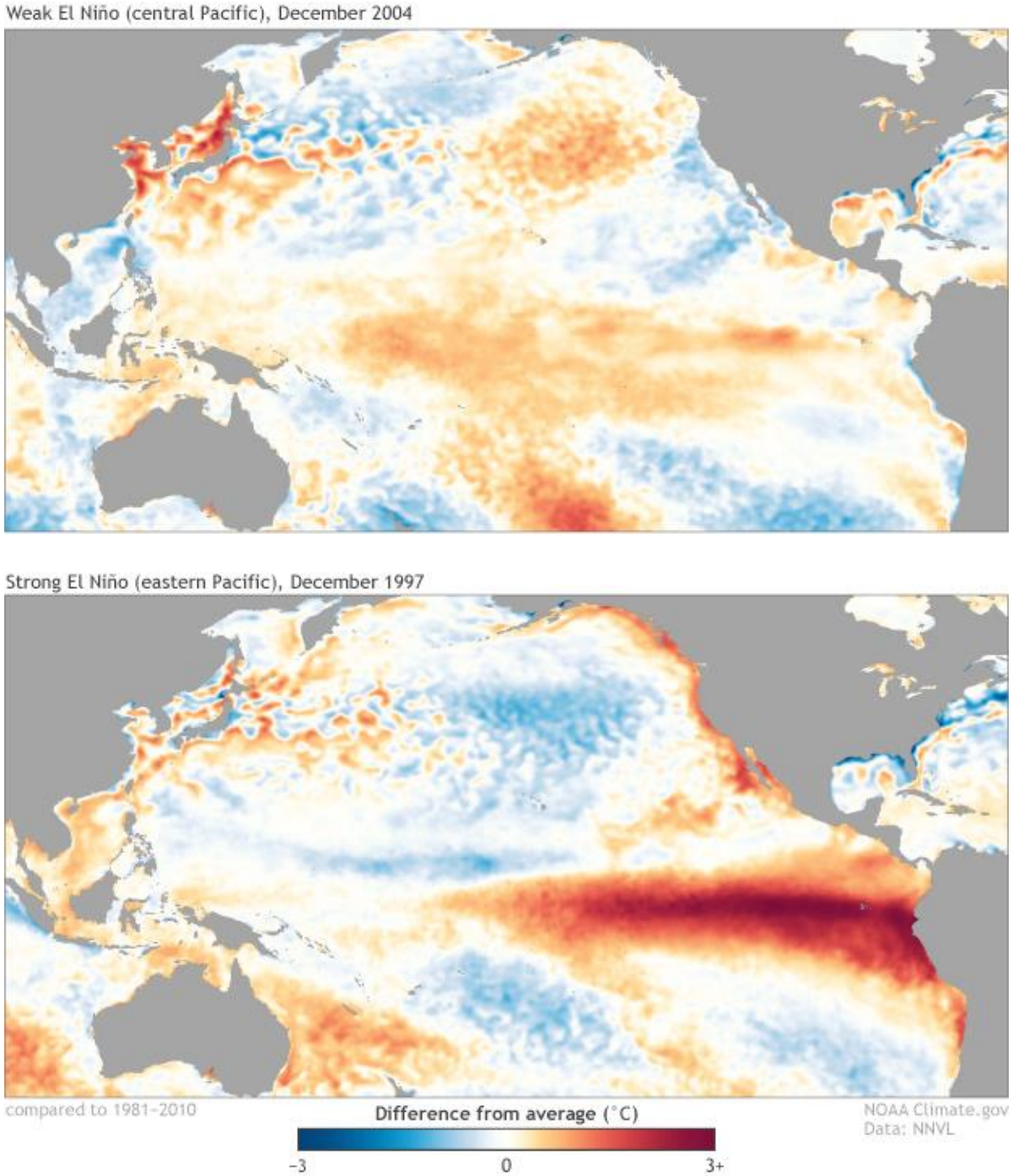
Current SST Anomaly





Source: JAMSTEC

Strong and weak El Niño sea surface temperature patterns



December 2004
Weak “Central Pacific” El Niño
El Niño Modoki year
Very wet year in southern 2/3 CA, above normal UCRB

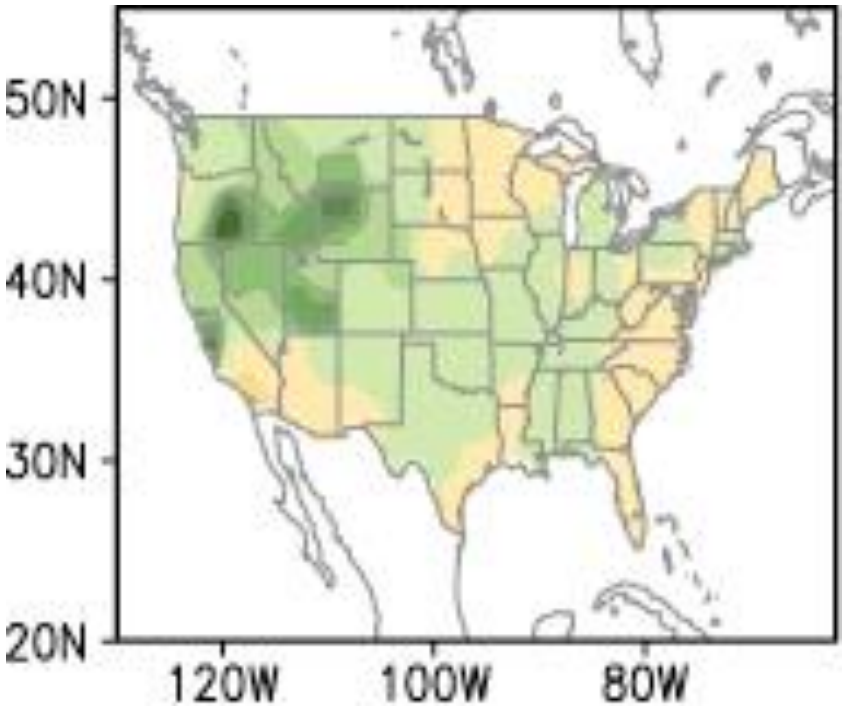
Weak El Niño events tend to have max SST anomalies in central Pacific

December 1997
Strong canonical El Niño
Not an El Niño Modoki
Very wet year in CA, near/slightly above normal UCRB

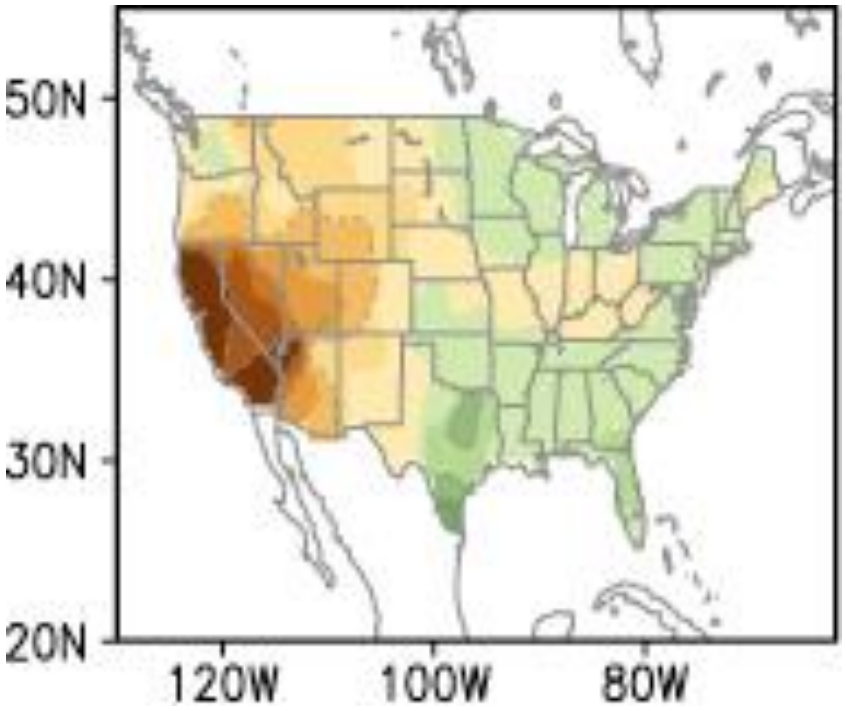
Strong El Niño events tend to have max SST anomalies in eastern Pacific

Modoki and Western precipitation

Canonical El Niño



El Niño Modoki



According to JAMSTEC, no units or reference given

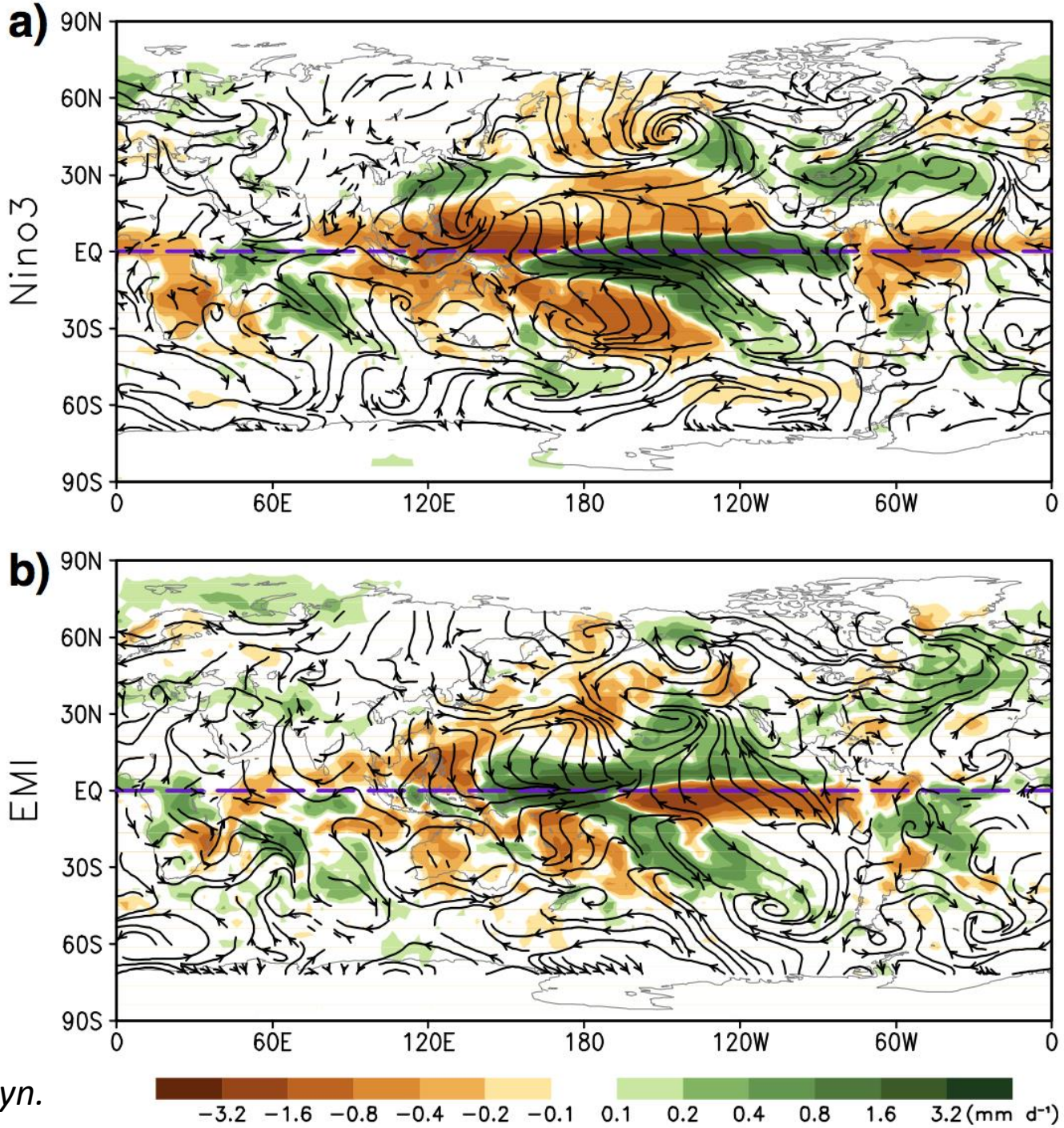
http://www.jamstec.go.jp/frcgc/research/d1/iod/enmodoki_home_s.html.en

“El Niño”
Partial correlations of NINO3 and GPCP rainfall rate anomalies and surface wind vectors

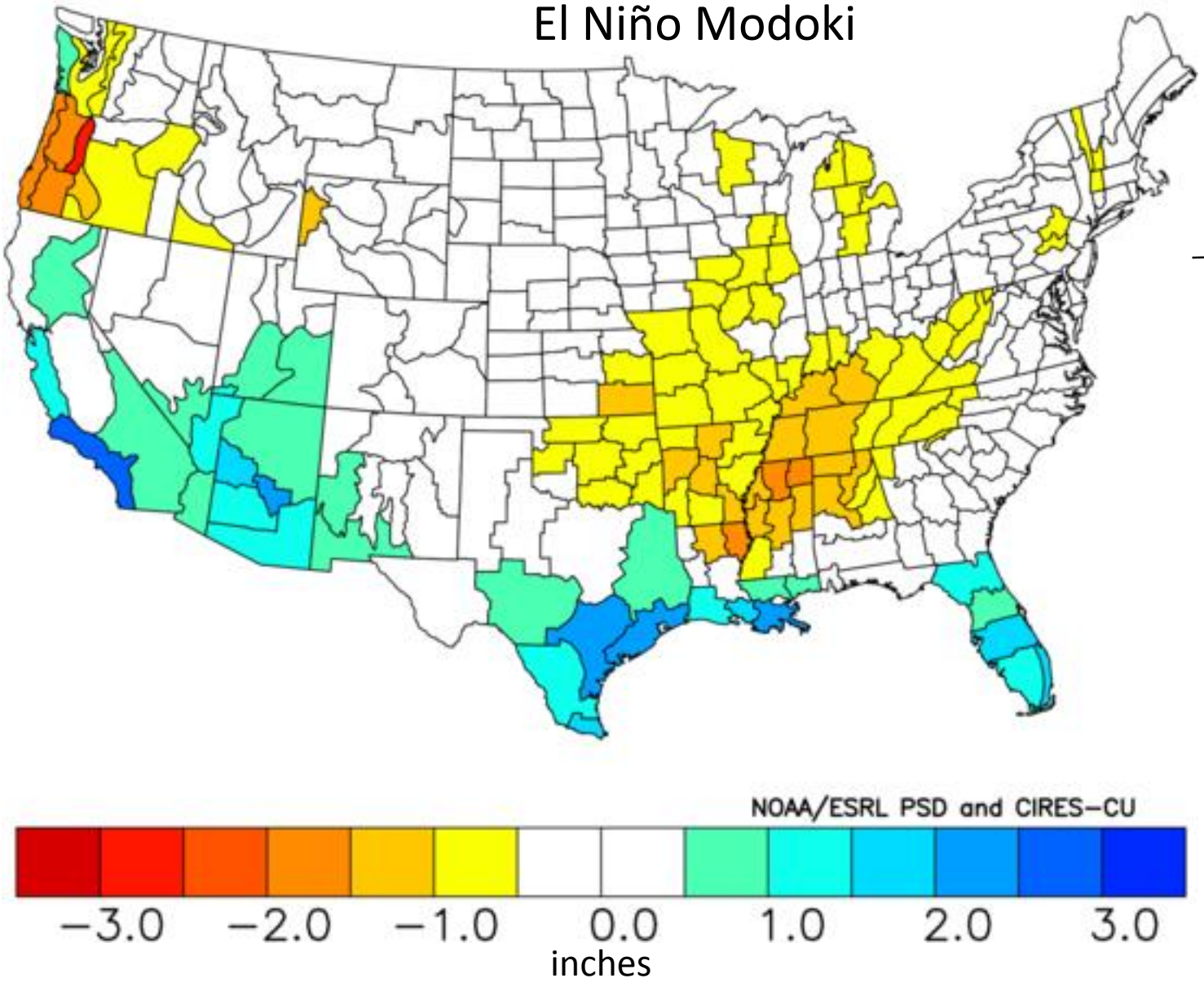
“El Niño Modoki”
Partial correlations of the EMI with GPCP rainfall rate anomalies and surface wind vectors

JFM period, 1979-2005

Weng et al. 2009 *Clim. Dyn.*



Composite DJF Precipitation Anomalies from 1981-2010 Mean



El Niño Modoki
DJF ending in:

1924
1930
1941
1947

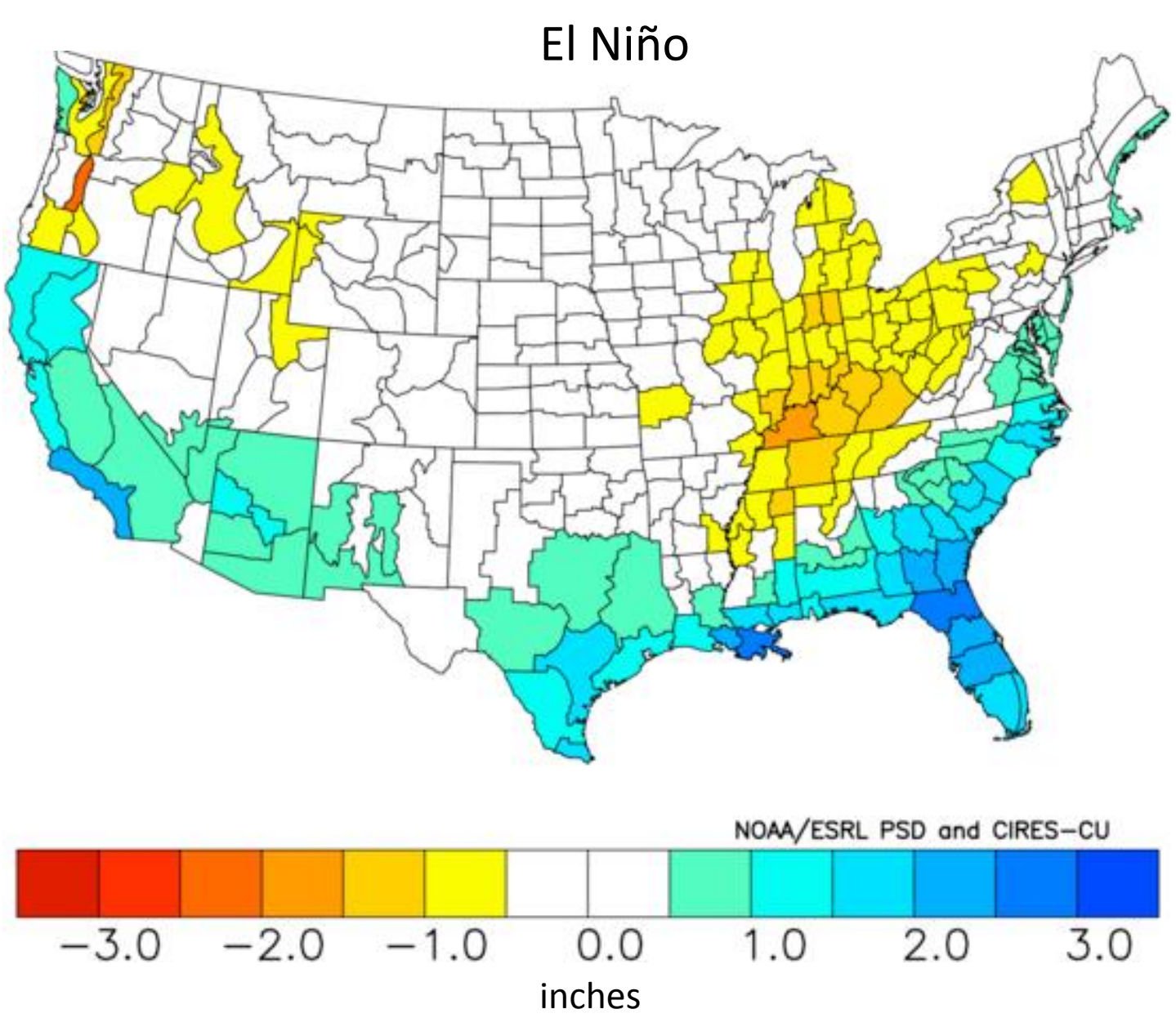
ONI begins

1958
1959
1964
1966
1968
1969
1978
1980
1991
1992
1993
1995
2003
2005
2010
2015

El Niño years based on ONI

https://www.esrl.noaa.gov/psd/data/usclimdivs/

Composite DJF Precipitation Anomalies from 1981-2010 Mean

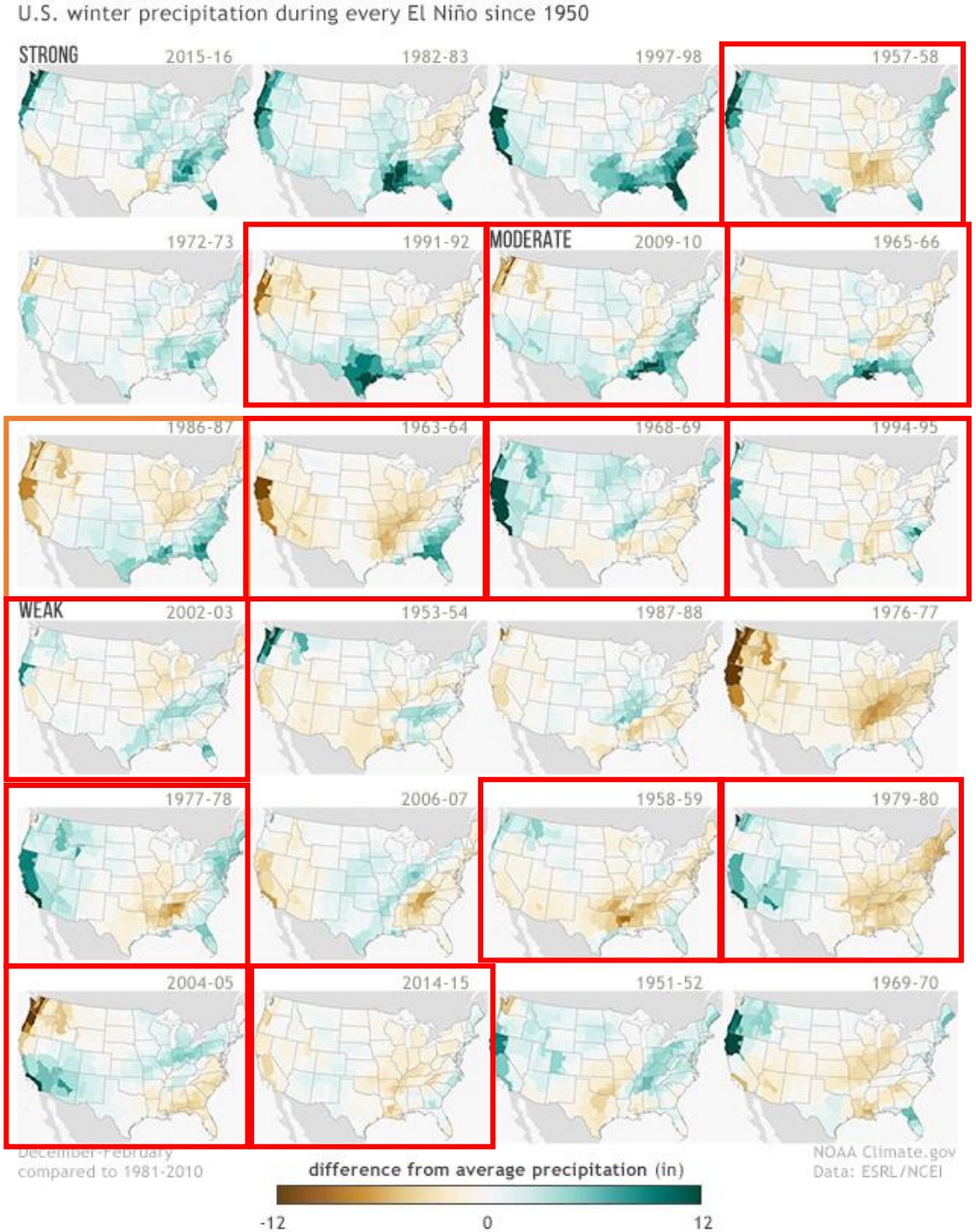


https://www.esrl.noaa.gov/psd/data/usclimdivs/

El Niño (ONI)
DJF ending in:

1964
1966
1969
1970
1973
1977
1978
1980
1983
1988
1987
1992
1995
1998
2003
2005
2007
2010
2015
2016

El Niño Modoki years based on EMI



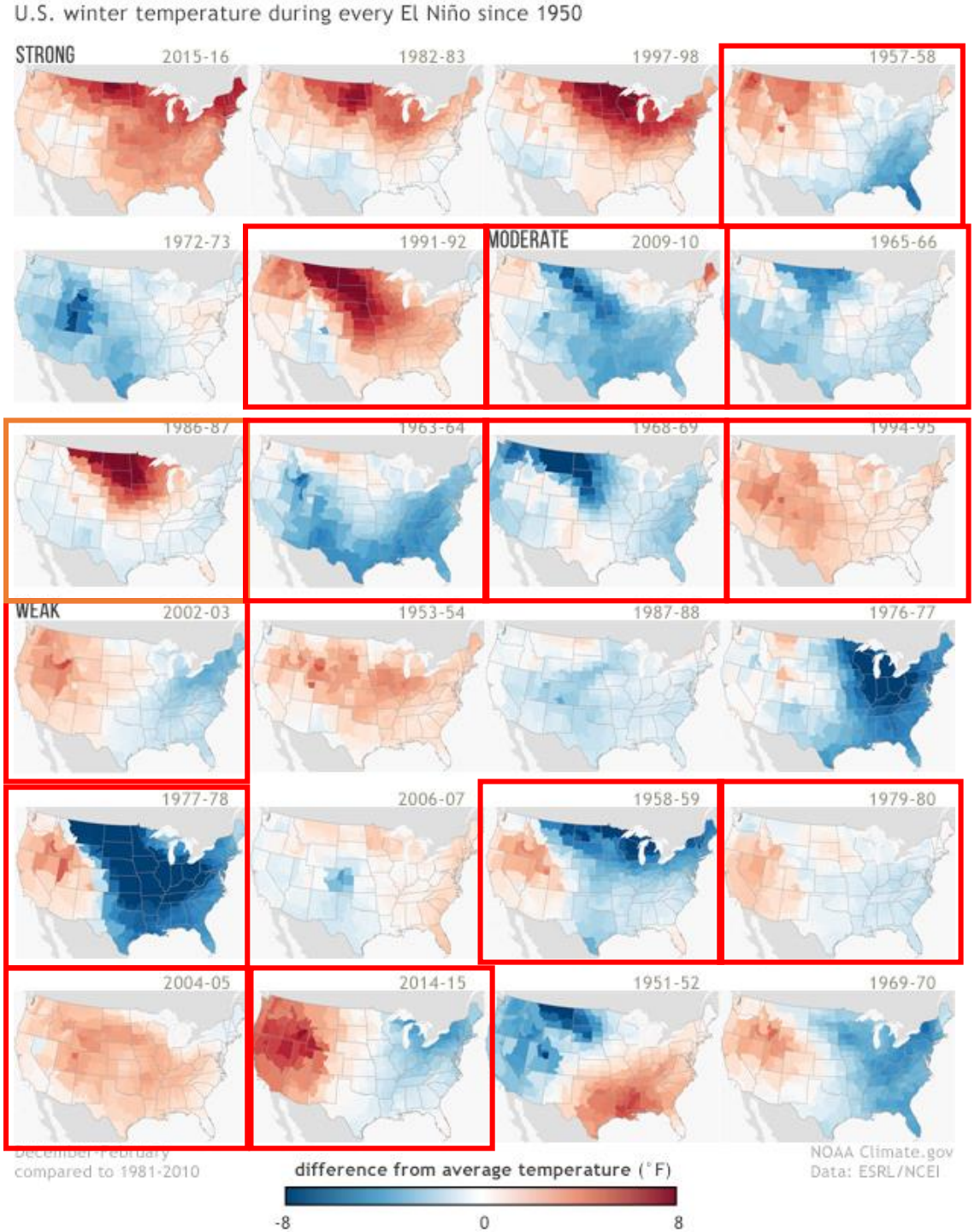
DJF precipitation during El Niño
1950-present
Based on ONI

El Niño Modoki years

Variable outcomes for CA and UCRB

El Niño Modoki years since 1950 that were not also considered El Niño:
1967-68, 1990-91, 1992-93, 1994-95

https://www.climate.gov/news-features/featured-images/us-winter-precipitation-during-every-el-ni%C3%B1o-1950



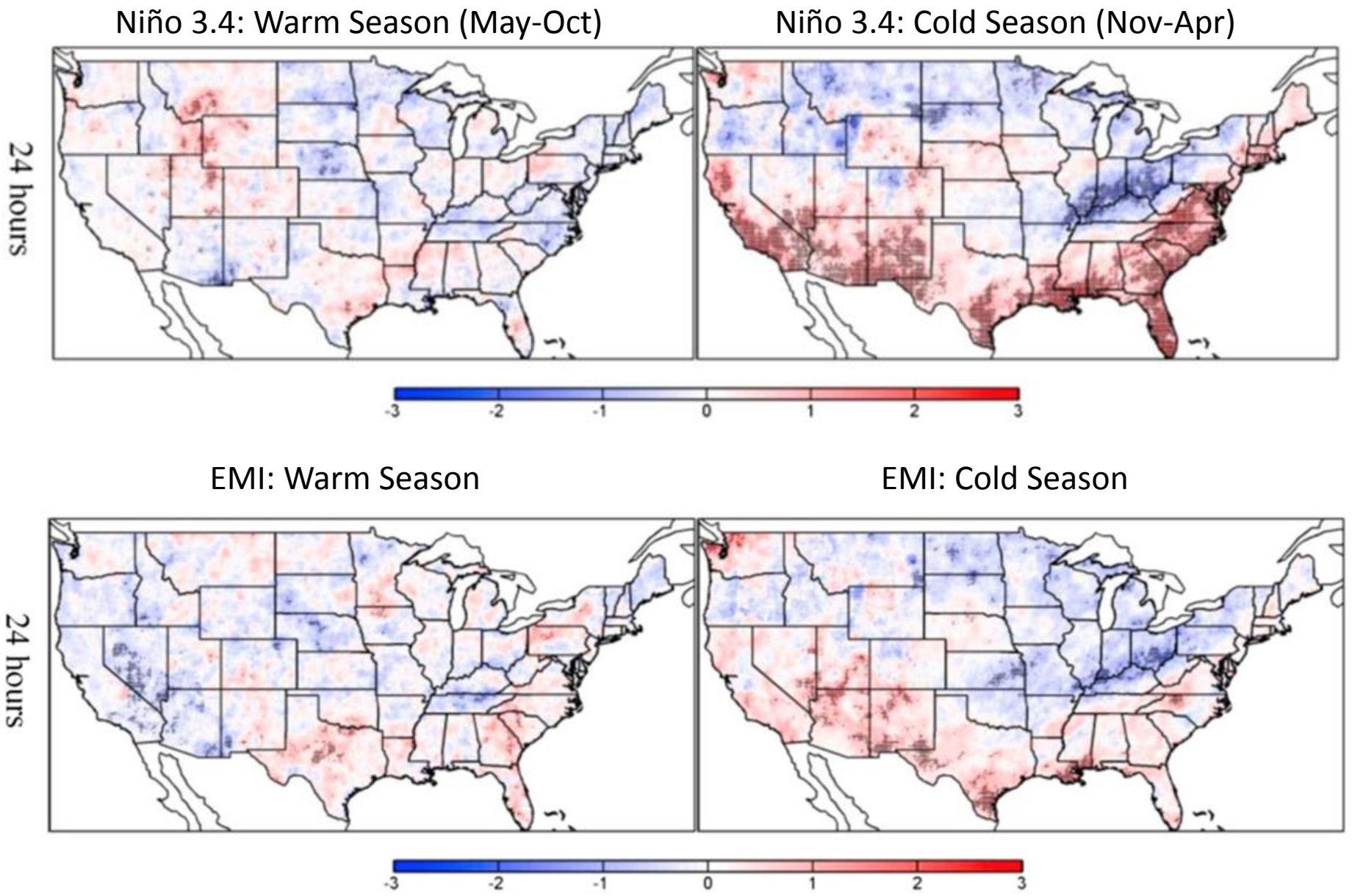
DJF temperature during El Niño
1950-present
Based on ONI

El Niño Modoki years

Tend to be warmer than average over CA/UCRB excepting 2009-10, 1965-66, 1963-64, 1968-69

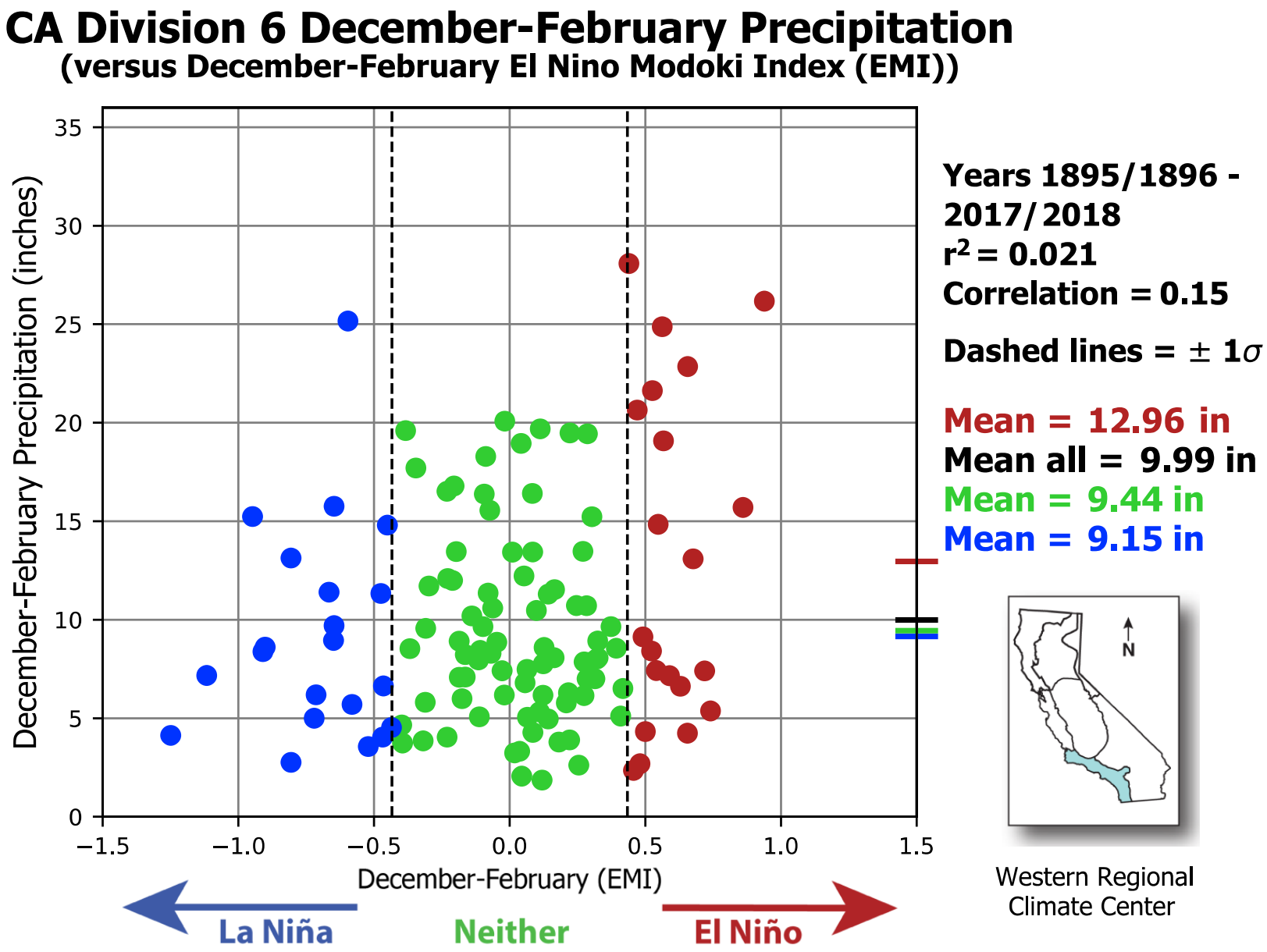
El Niño Modoki years since 1950 that were not also considered El Niño:
1967-68, 1990-91, 1992-93, 1994-95

Anomalous Number of 24h Precipitation Extremes (1979-2013) Regressed on Indices

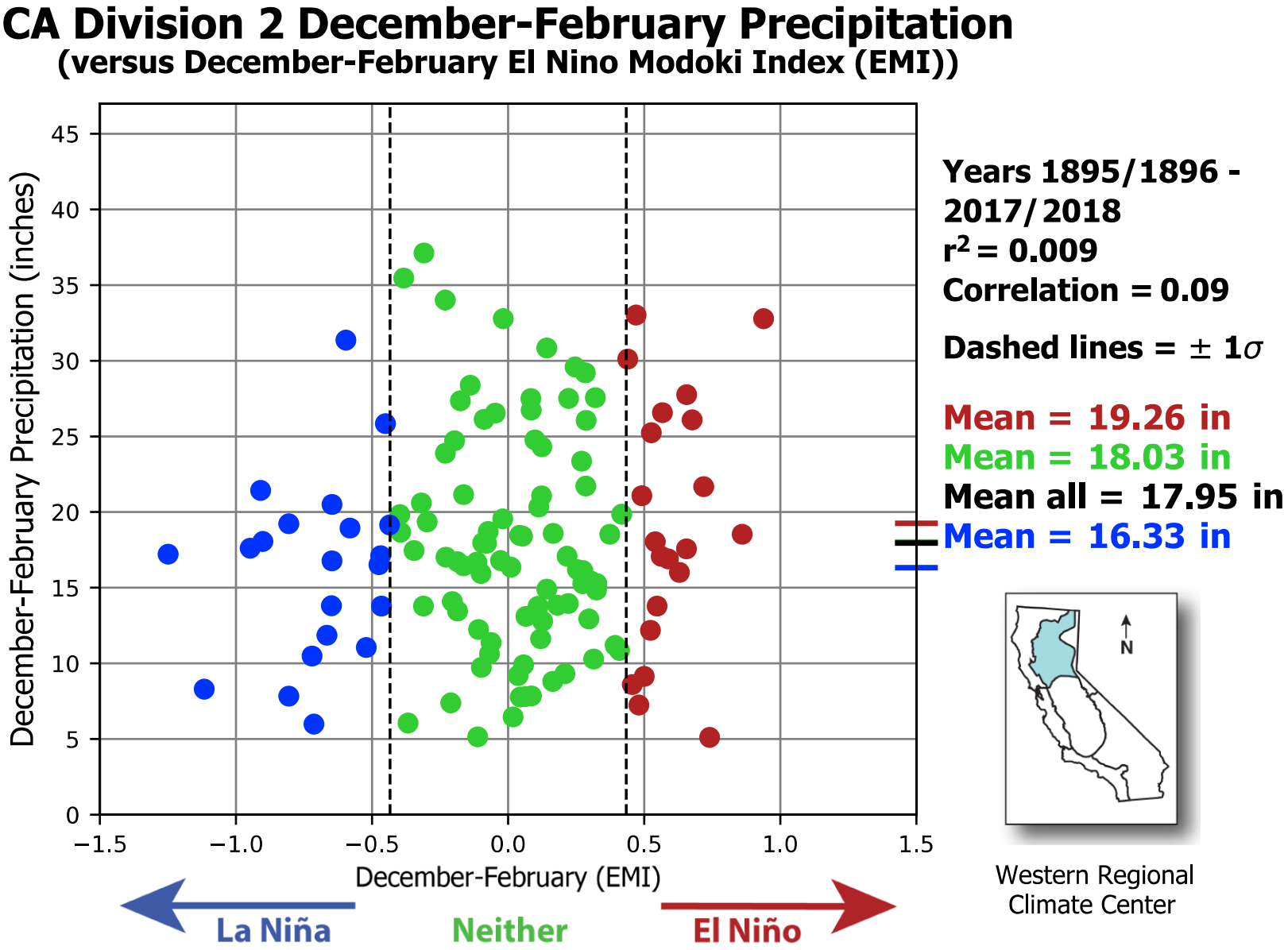


Yu et al. 2017, *JGR Atmospheres*

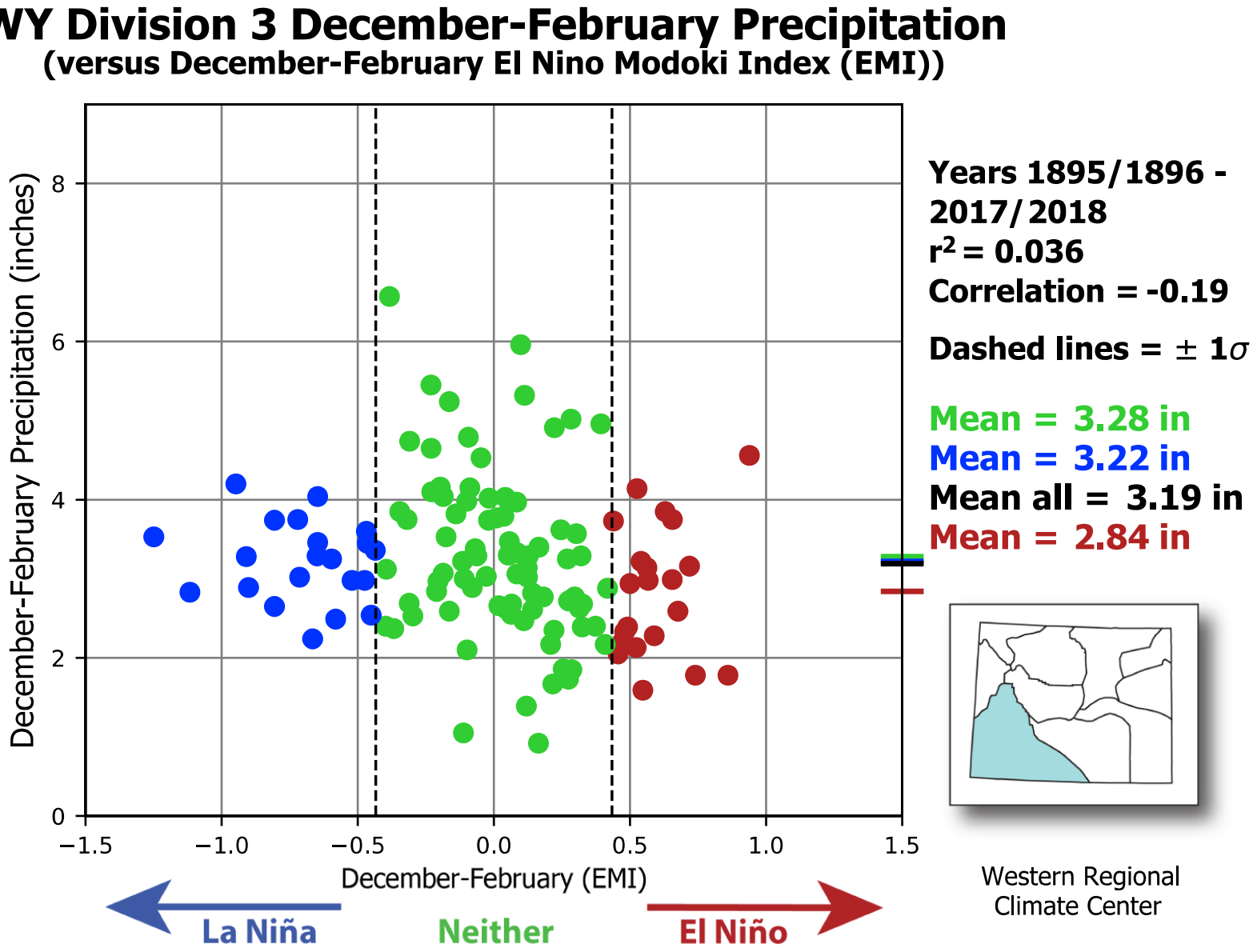
EMI scatterplots



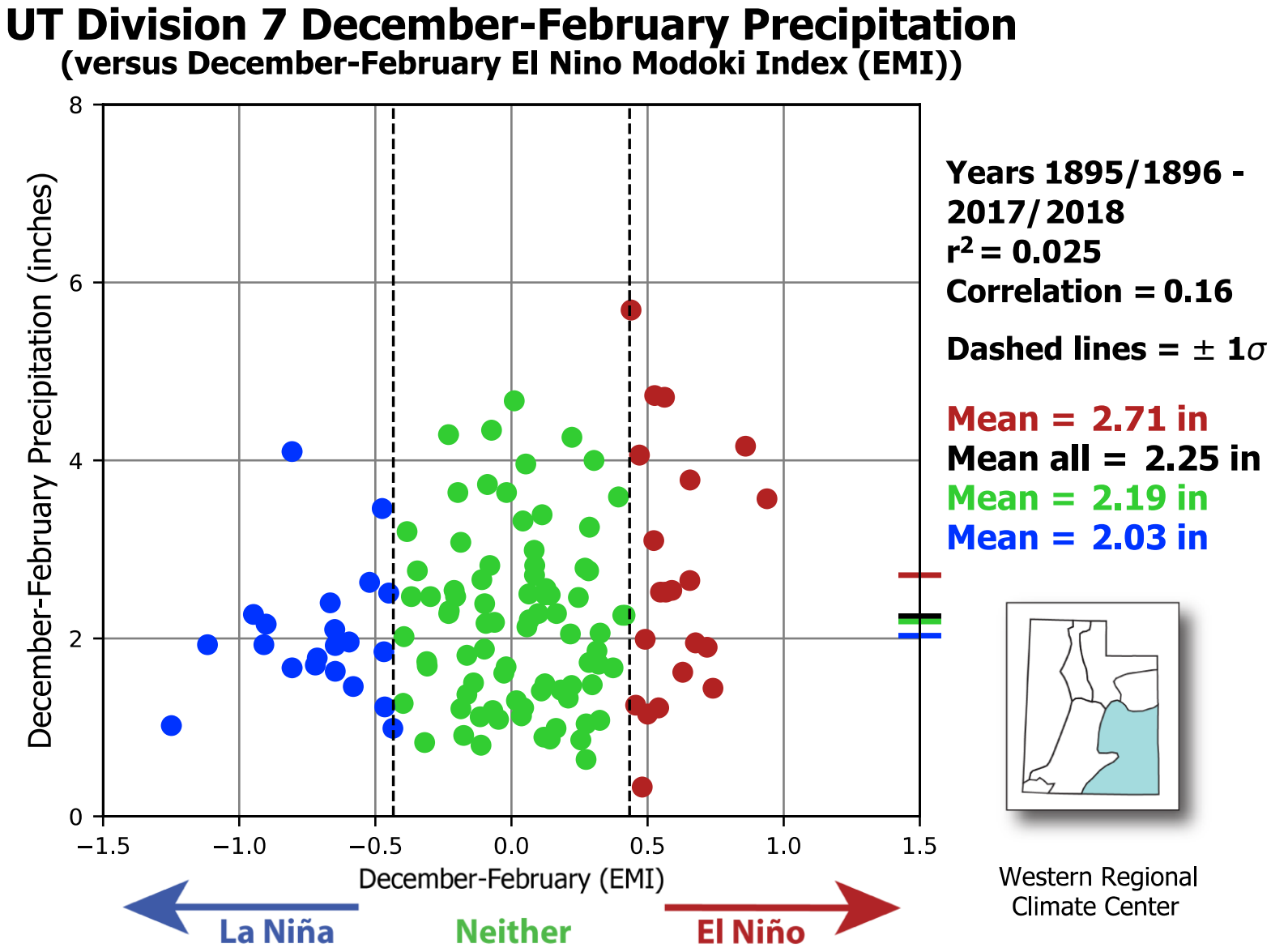
EMI scatterplots



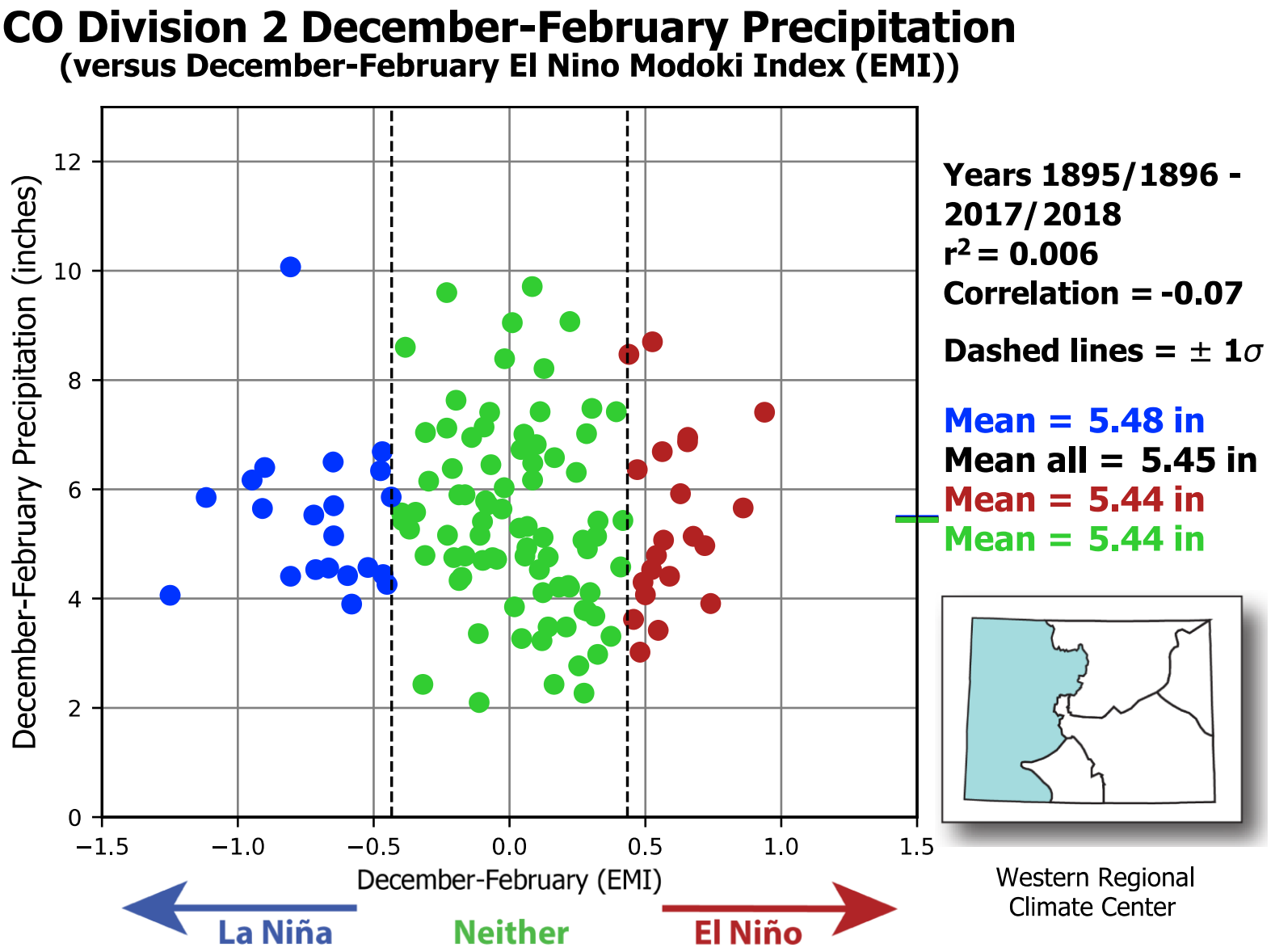
EMI scatterplots



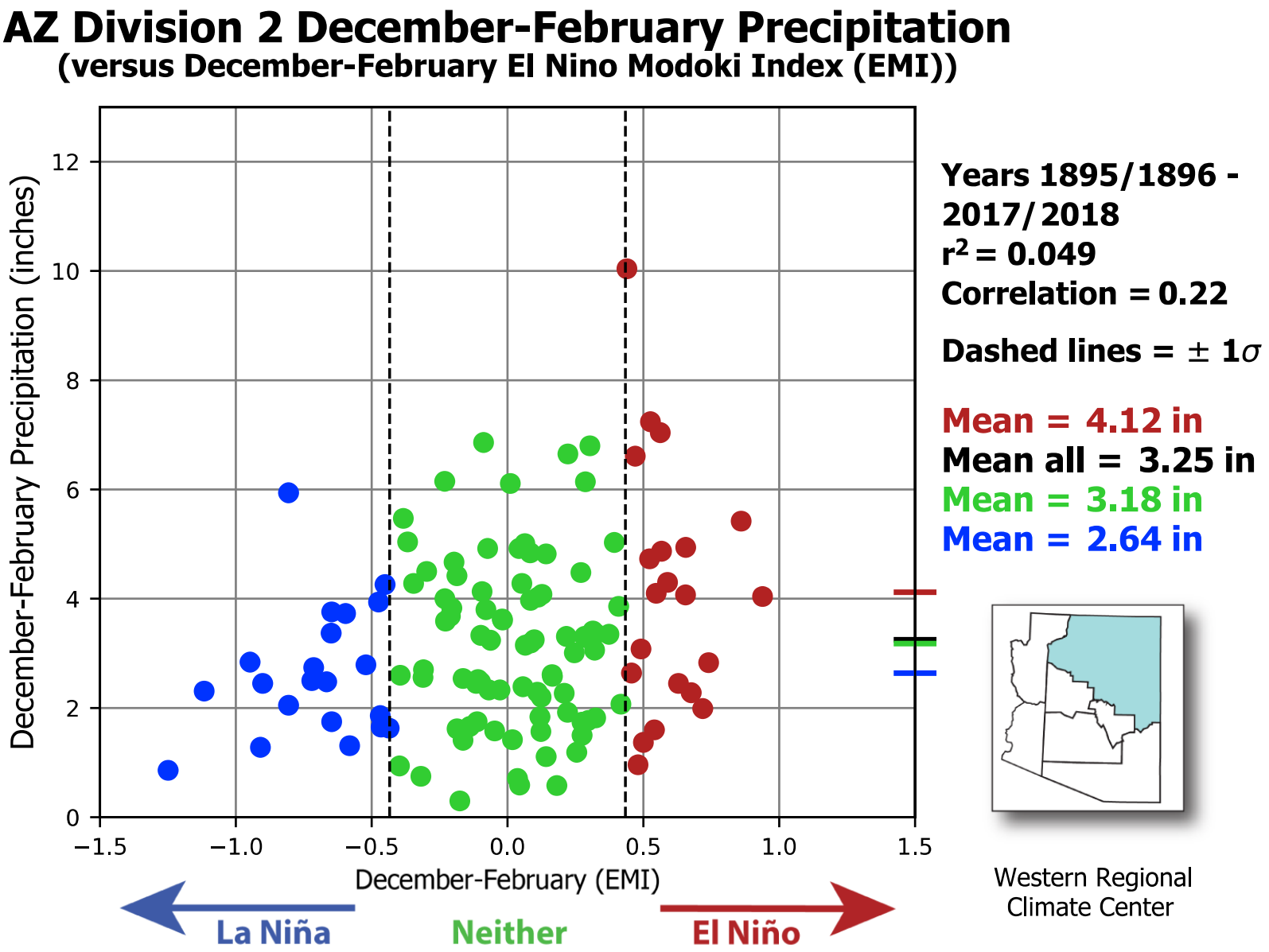
EMI scatterplots



EMI scatterplots



EMI scatterplots



Summary

- Scatterplots can be used as communication tool to show varying ENSO impacts
- It appears we are teetering on observing El Niño Modoki conditions this winter season
- Literature suggests El Niño Modoki has western US precipitation patterns distinct from El Niño, observations give mixed signal
- Perhaps more meaningful for southern CA, AZ than for water resource regions UCRB and northern CA

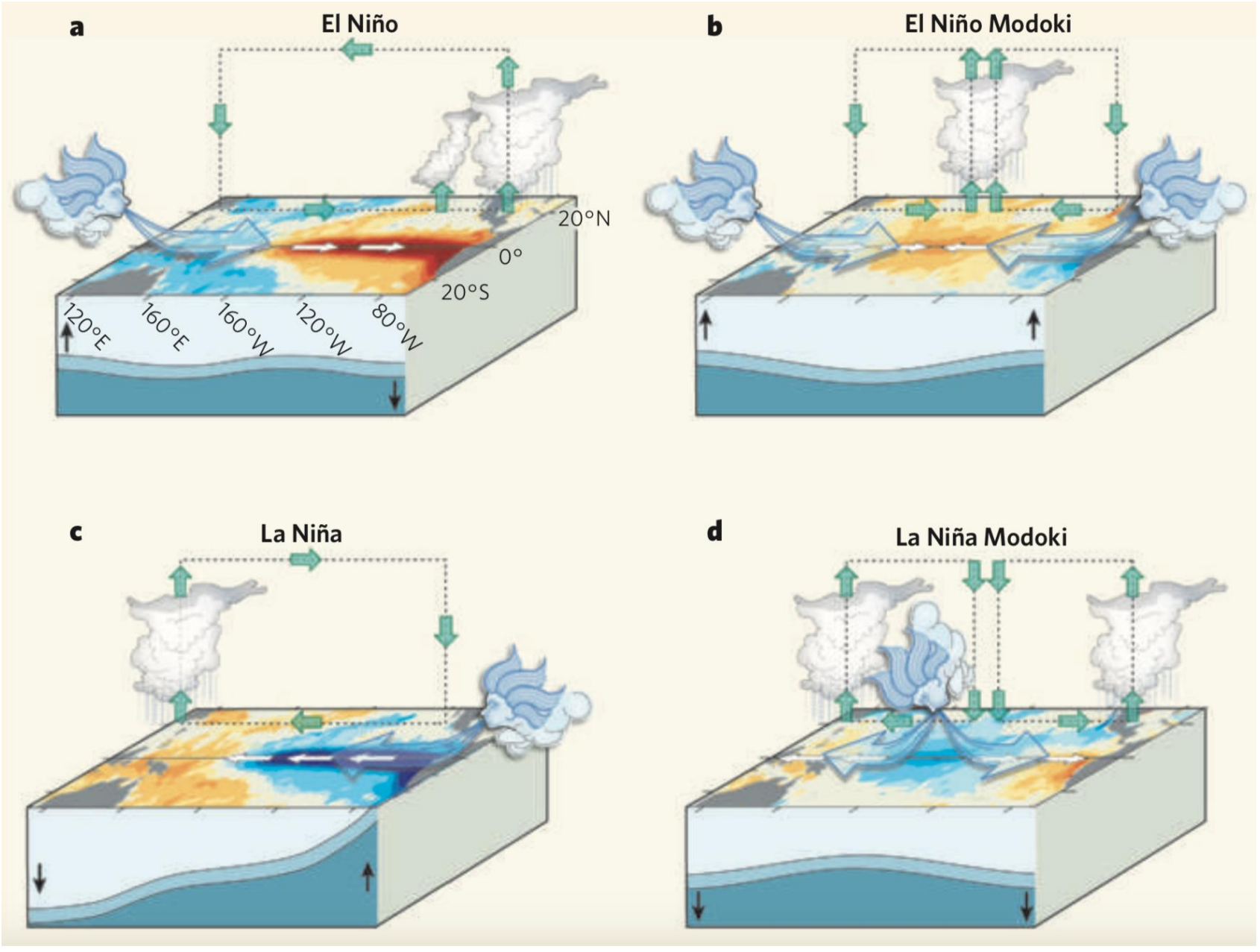
Discussion

- Should we create scatterplots for indices besides SOI such as ONI? Methods to address?
- Will exploring El Niño Modoki will give us additional usable insights to precipitation variability in CA and UCRB?
- Future activities with El Niño Modoki and the EMI?
- Other ideas for graphics and materials to communicate ENSO potential impacts to a water resource management or broad audience?
- Thoughts on ENSO in changing climate, how to communicate to public?

Extra Slides

El Niño Modoki

Ashok and Yamagata 2009, *Nature*



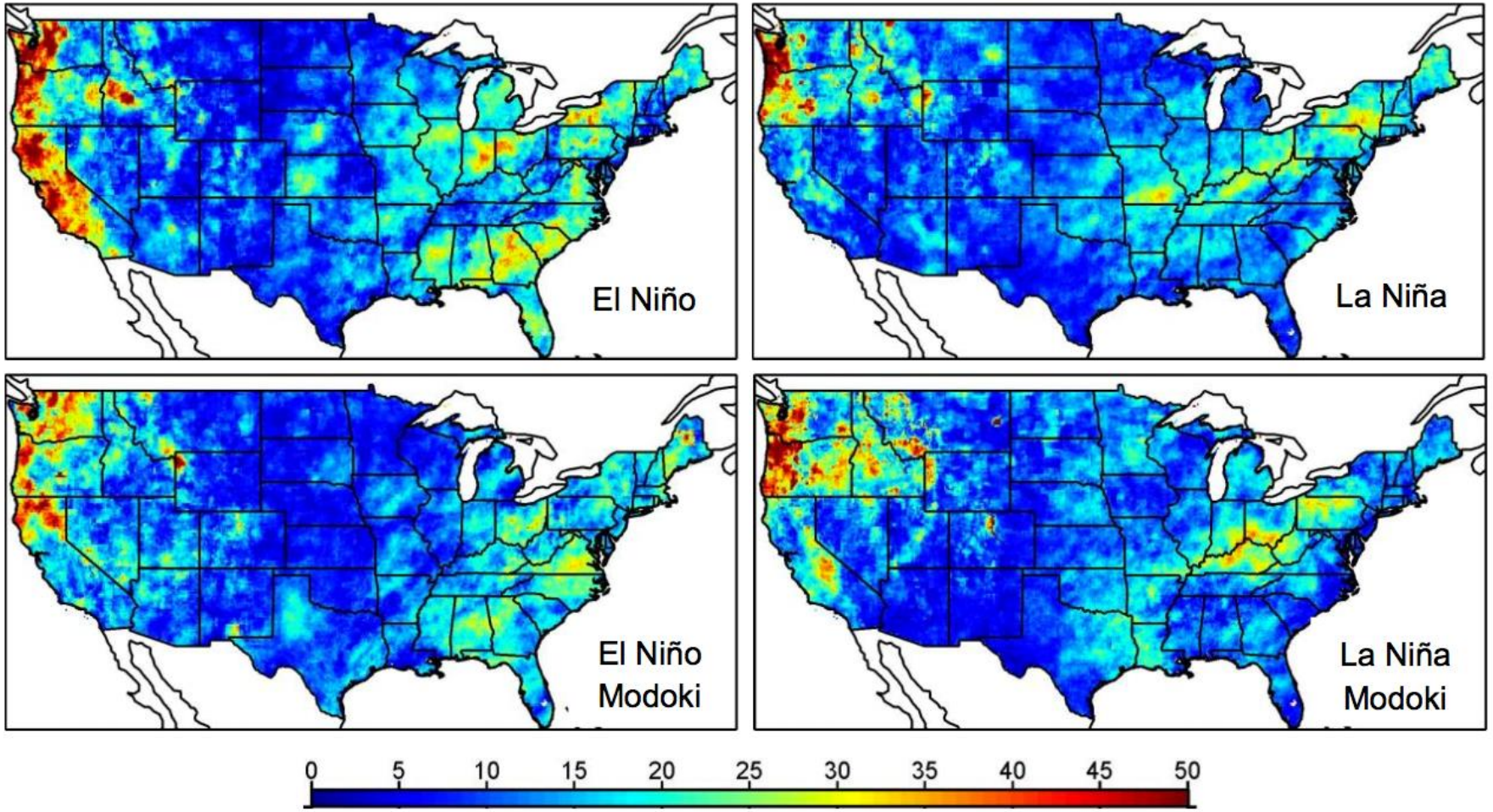


Figure S4. The standard deviations of the number of 1-hour extreme precipitation events that occurred during the cold-season El Niño, El Niño Modoki, La Niña, and La Niña Modoki episodes from 1979-2013.

Yu et al. 2017, *JGR Atmospheres*

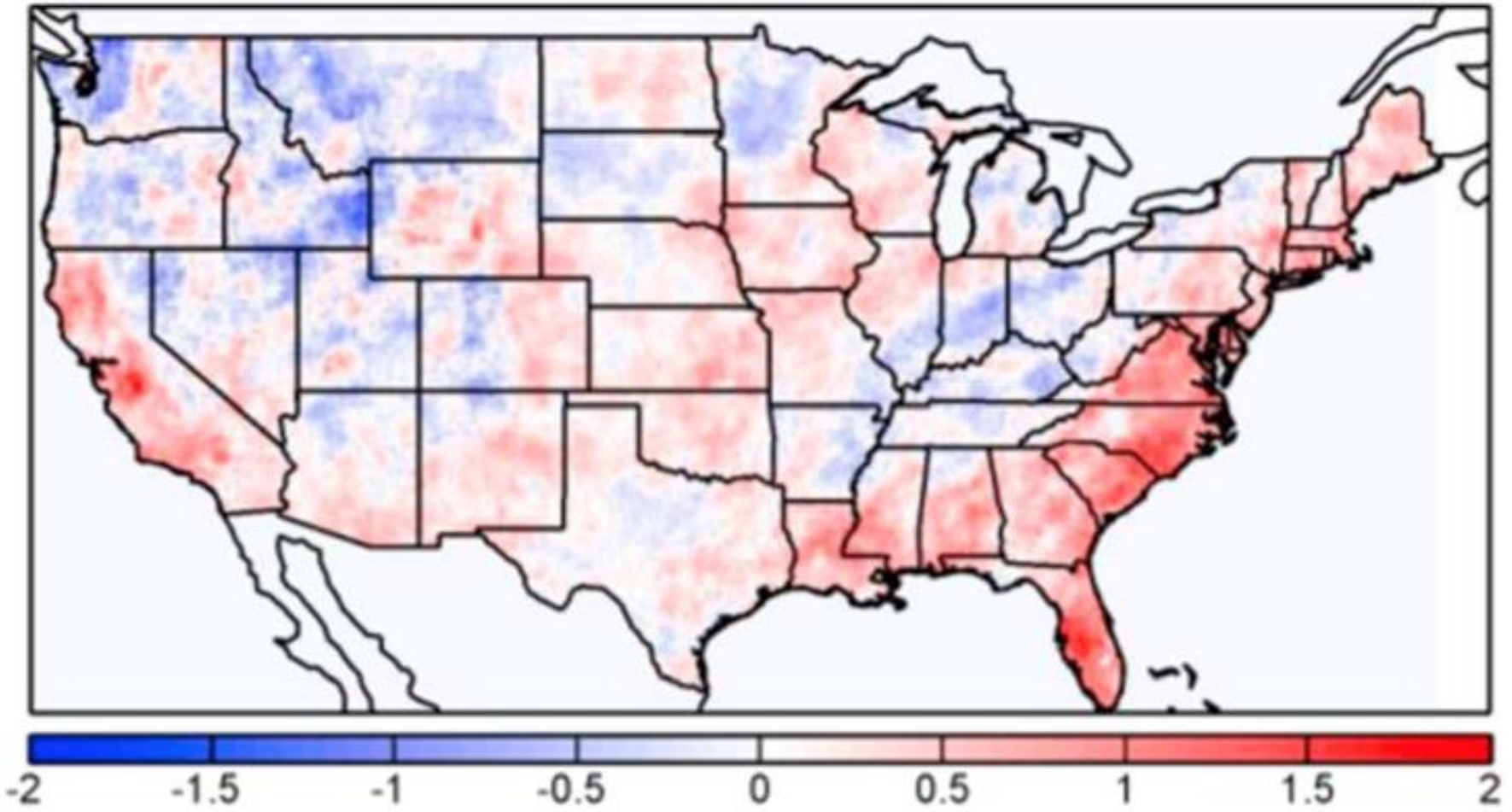
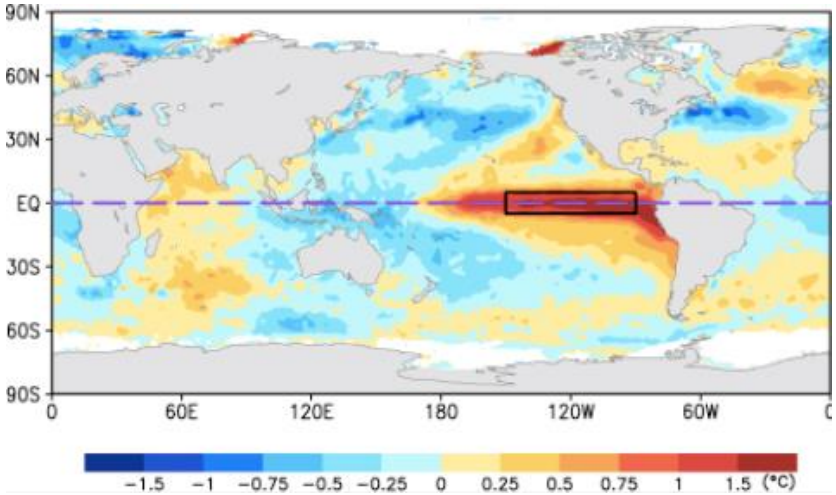
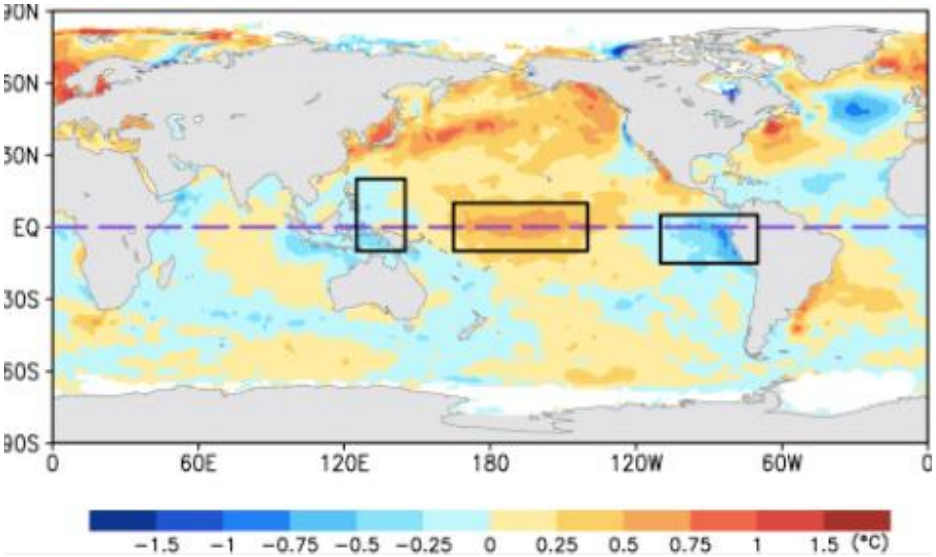


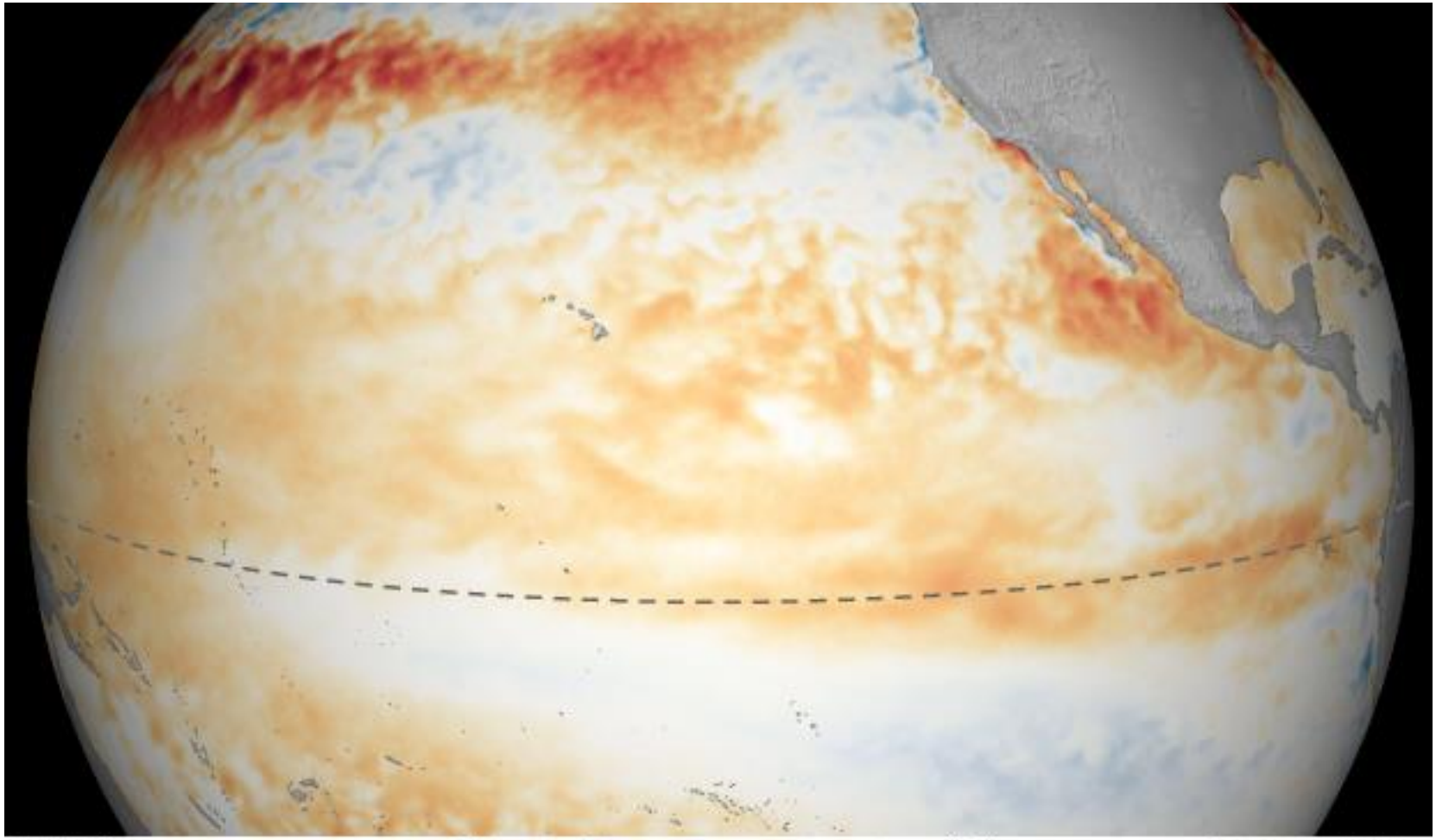
Figure 9. The differences of the anomalous number of cold-season daily extreme precipitation events regressed onto the normalized Niño 3.4 and El Niño Modoki indices.

Yu et al. 2017, *JGR Atmospheres*





Source: JAMSTEC



July 2018
compared to 1981–2010

Difference from average temperature (˚F)

−9 0 9

Climate.gov/NNVL
Data: Geo-polar SST

Cold season El Niño Modoki: 1990–1991; 1994–1995; 2002–2003; 2004–2005; 2009–2010

From Ashok 2007 DJF 1979/80, 1986/87, 1990/91, 1991/92, 1992/93, 1994/95, 2002/03, 2004/05

ENSO Modoki seems to be more likely/prevalent than ENSO in a warmer climate and since the “76 shift” –Ashok et al. 2007 GRL,
More frequent events with the cool anomalies on the side since
Ahok and Yamagata 2009 Nature

Predictability of ENSO modoki Index low compared to predictability of ENSO indices Ashok and Yamagata 2009 Nature

The seesaw with the dry north and the wet south in the western USA is more likely to occur during El Niñ̃o Modoki, while much of the western USA is wet during El Niñ̃o. The moisture to the southwestern USA is transported from the northward shifted ITCZ during El Niñ̃o Modoki, while it is carried by the storms traveling along the southerly shifted polar front. More tropical moisture into far Southwest as an “atmospheric river”.

Weng et al. 2008 *Climate Dynamics*