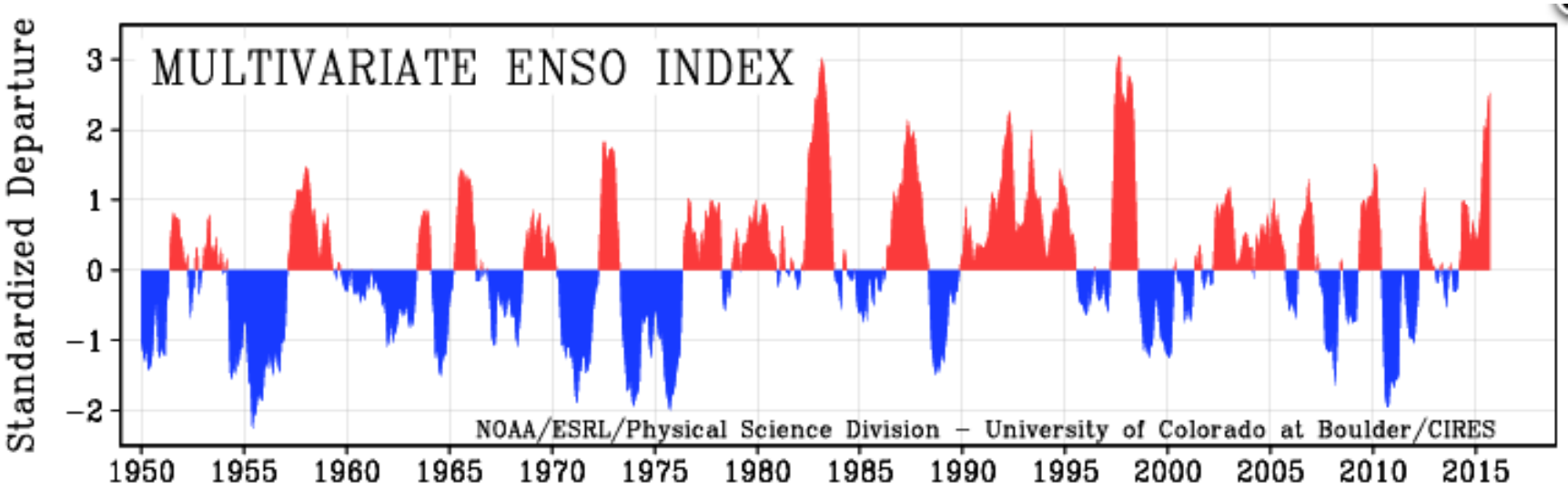
Climate Extremes Past and Present: A 40-Year Perspective

Henry F. Diaz, Martin P. Hoerling, Klaus Wolter

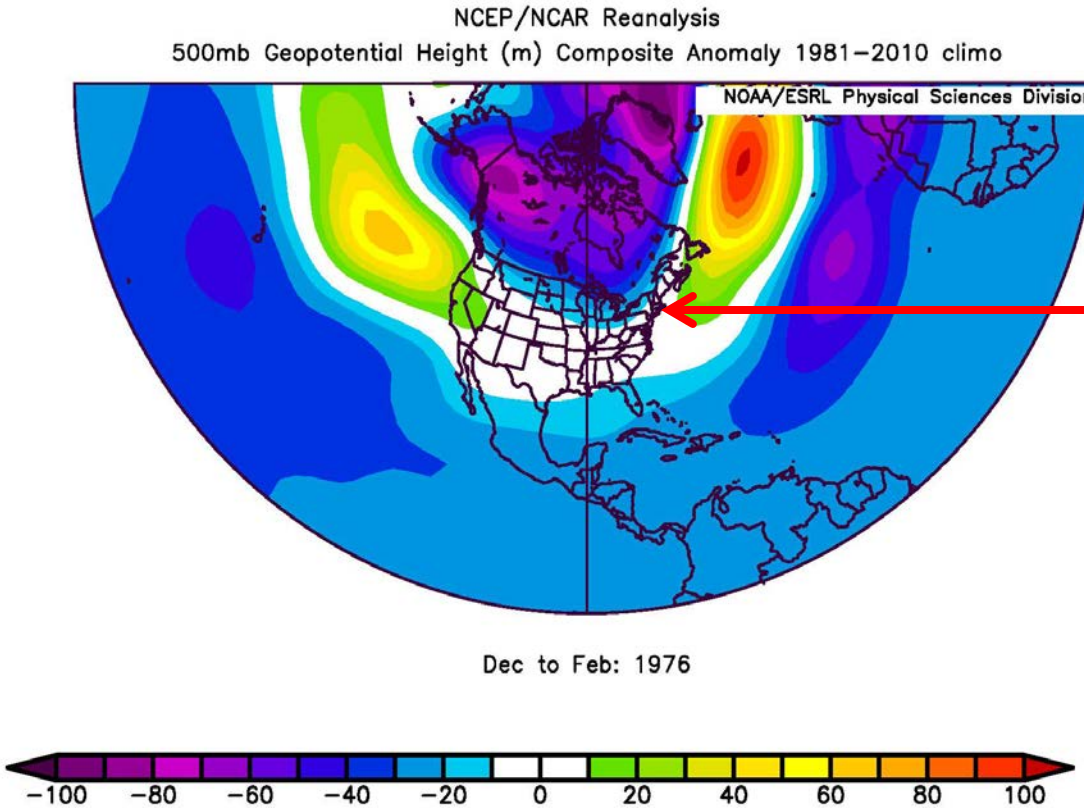
NOAA/ESRL and CIRES

Boulder, CO



CIRES

Cooperative Institute for Research in Environmental Sciences



Major Fish and Benthic Fauna Kill in NY Bight

Oxygen Depletion and Associated Benthic Mortalities in New York Bight, 1976

Chapter 3. Atmospheric Conditions and Comparison With Past Records

Henry F. Diaz[1]

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[1] National Climatic Center, Environmental Data and Information Service, NOAA, Federal Building, Asheville, NC 28801

INTRODUCTION

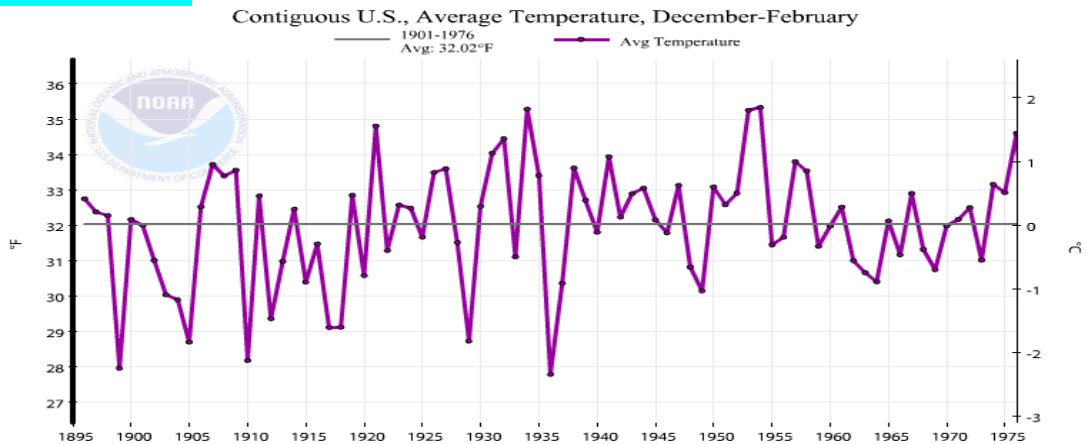
During the first half of 1976, atmospheric conditions along the Middle Atlantic coast departed substantially from the climatological norm. Following a cold January associated with a moderately amplified trough pattern in the westerlies over eastern North America (Wagner 1976a), the mean circulation at 700 millibars (mb) over the eastern United States reverted to a generally fast zonal flow in February (Dickson 1976a). This pattern prevailed through March (Taubensee 1976a). The pattern of 700-mb heights provides a measure of the air circulation at low levels. Negative height anomalies indicate relatively cold conditions prevailing whereas positive departures from the mean height indicate relatively warm conditions. At 40° N latitude the height anomaly of the mean 700-mb surface along the U.S. east coast changed from about −20 m in January to around +45 m in February and +50 m in March.

These departures in February and March were reflected in anomalous pressure and circulation patterns (more typical of spring conditions) that limited the transport of cold air from Canada to the United States. As a result, warm maritime air masses predominated over most of the country, causing extreme warm conditions over the eastern two-thirds of the United States during these months.

The April circulation pattern was close to normal, although mean temperatures in the eastern United States remained 1° to 2° C above the climatological mean (Wagner 1976b). The monthly mean pattern, however, masks the very large change that occurred between the first and second halves of the month. In the New England area mean 700-mb heights increased by more than 100 m and record cold weather during the first half of April was replaced by record warm weather in the second half.

Talk of the Town

Circa 1976



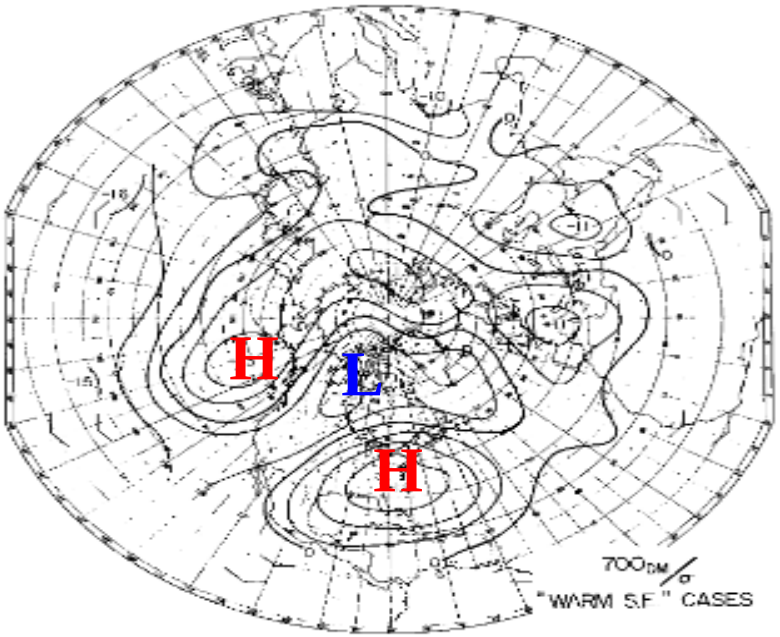


FIG. 2a. Mean distribution of standardized 700 mb height anomaly for the warm SE group of winter months. The terms "anomaly" or "DM" refer to the departure from the long term mean; σ is the standard deviation.

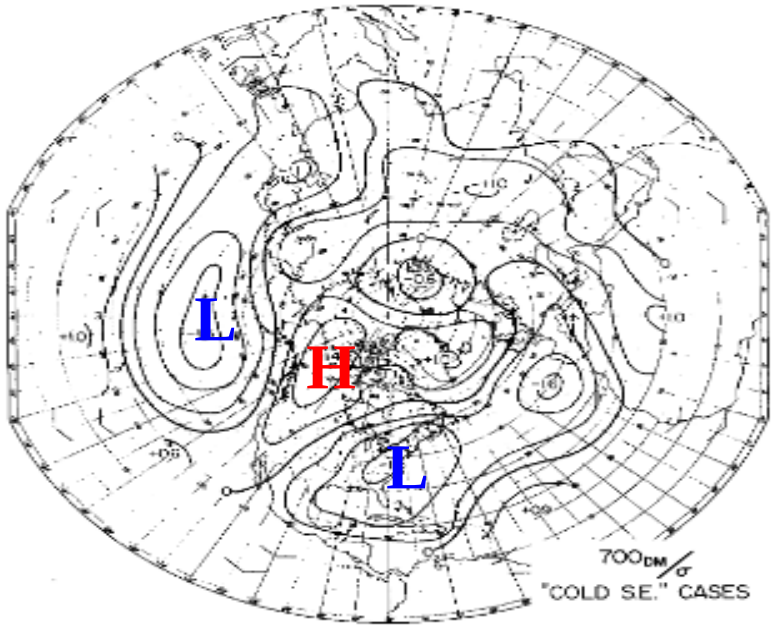


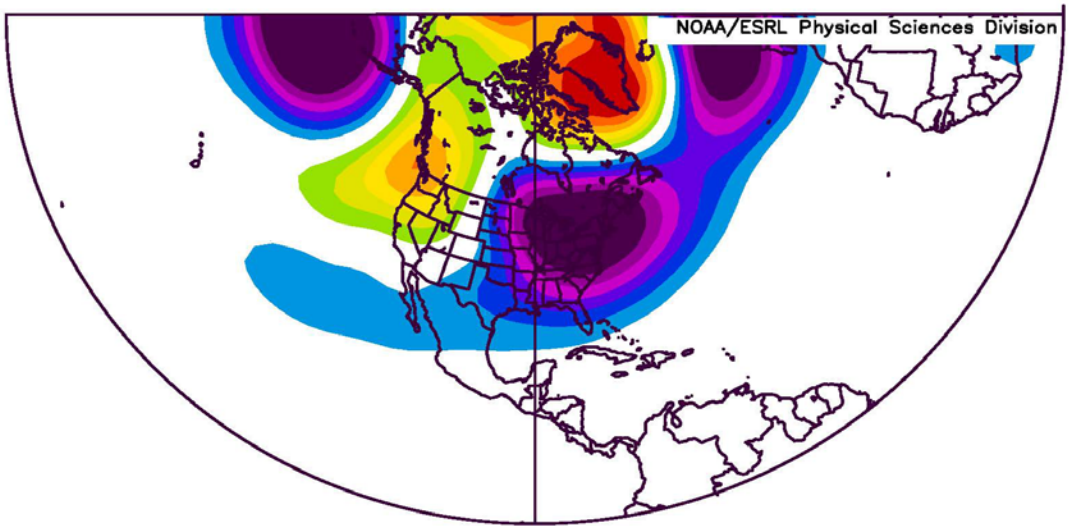
FIG. 2b. As in Fig. 2a except for the cold SE group of winter months.

From Dickson and Namias MWR 1976

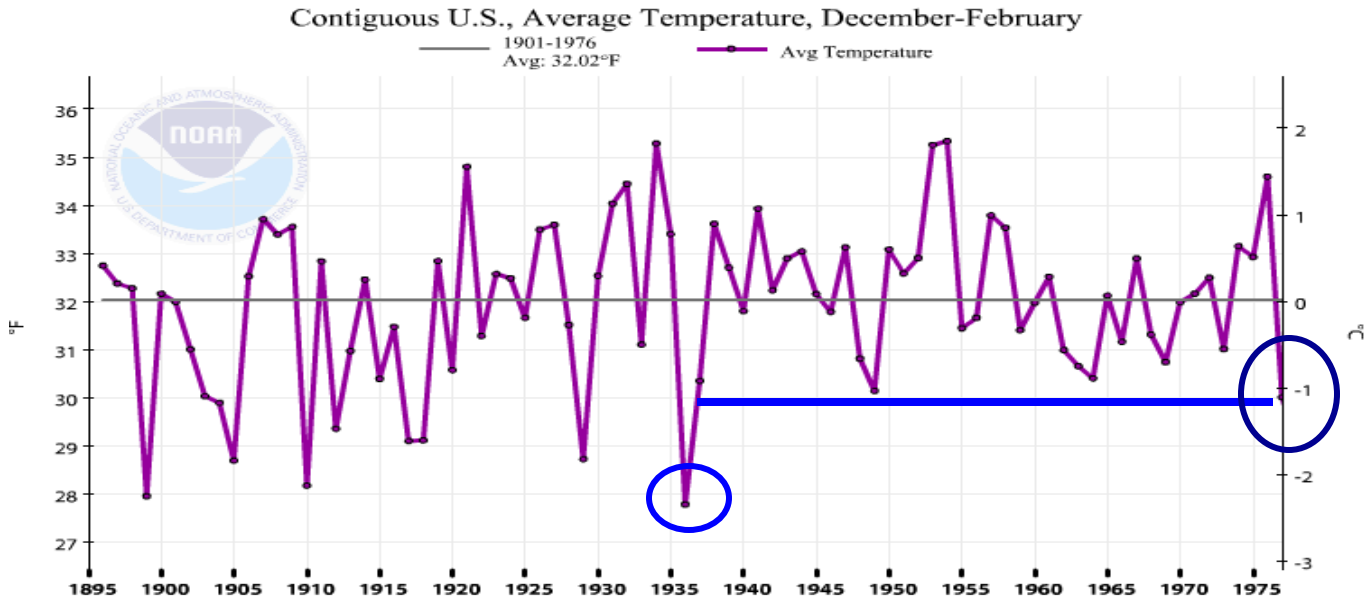
Precursor to PNA pattern formalism

NCEP/NCAR Reanalysis

500mb Geopotential Height (m) Composite Anomaly 1981–2010 climo



Dec to Feb: 1977



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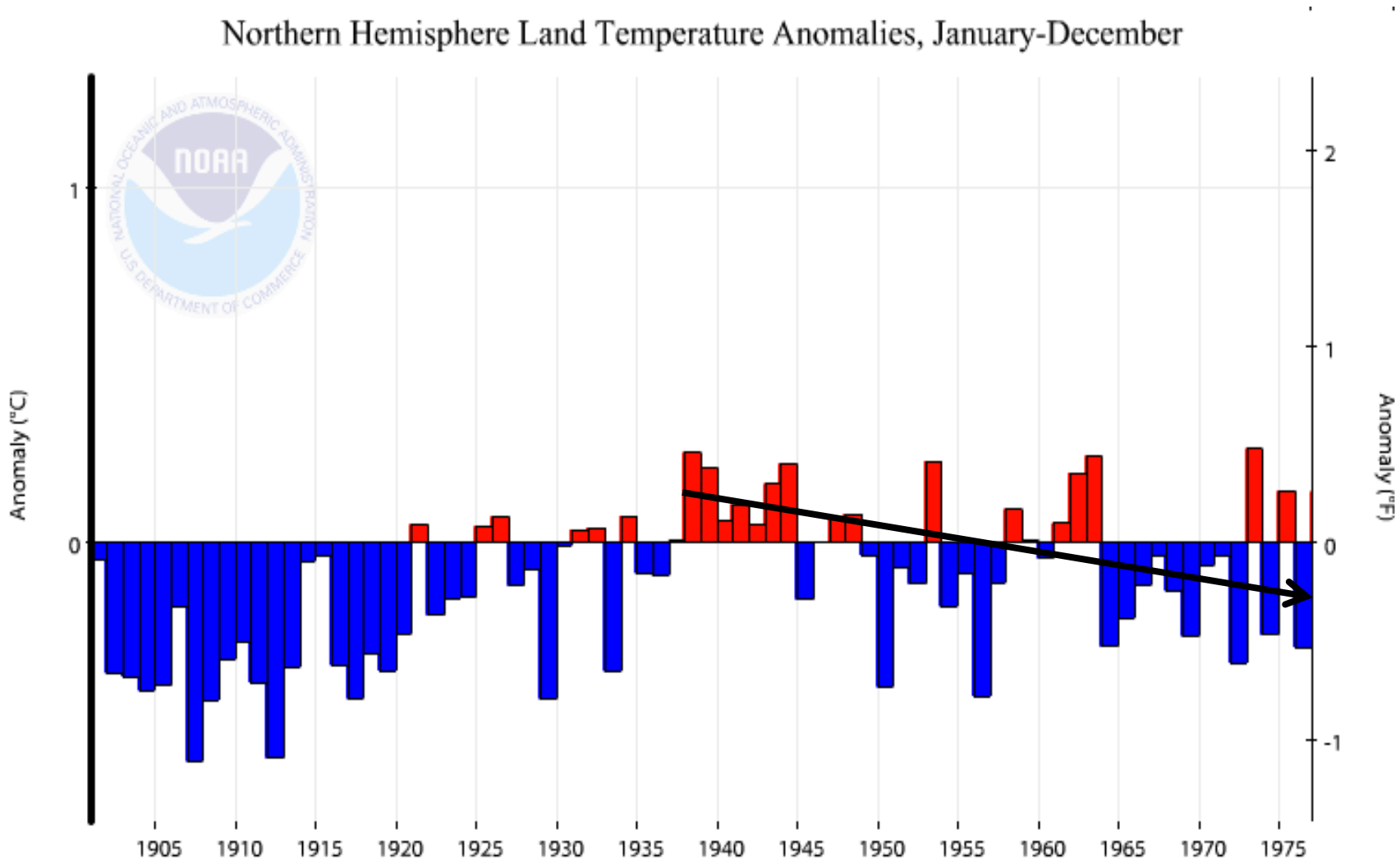
Concerns about possible descent into a new “little ice age”



NH annual temperature anomalies 1901-1976

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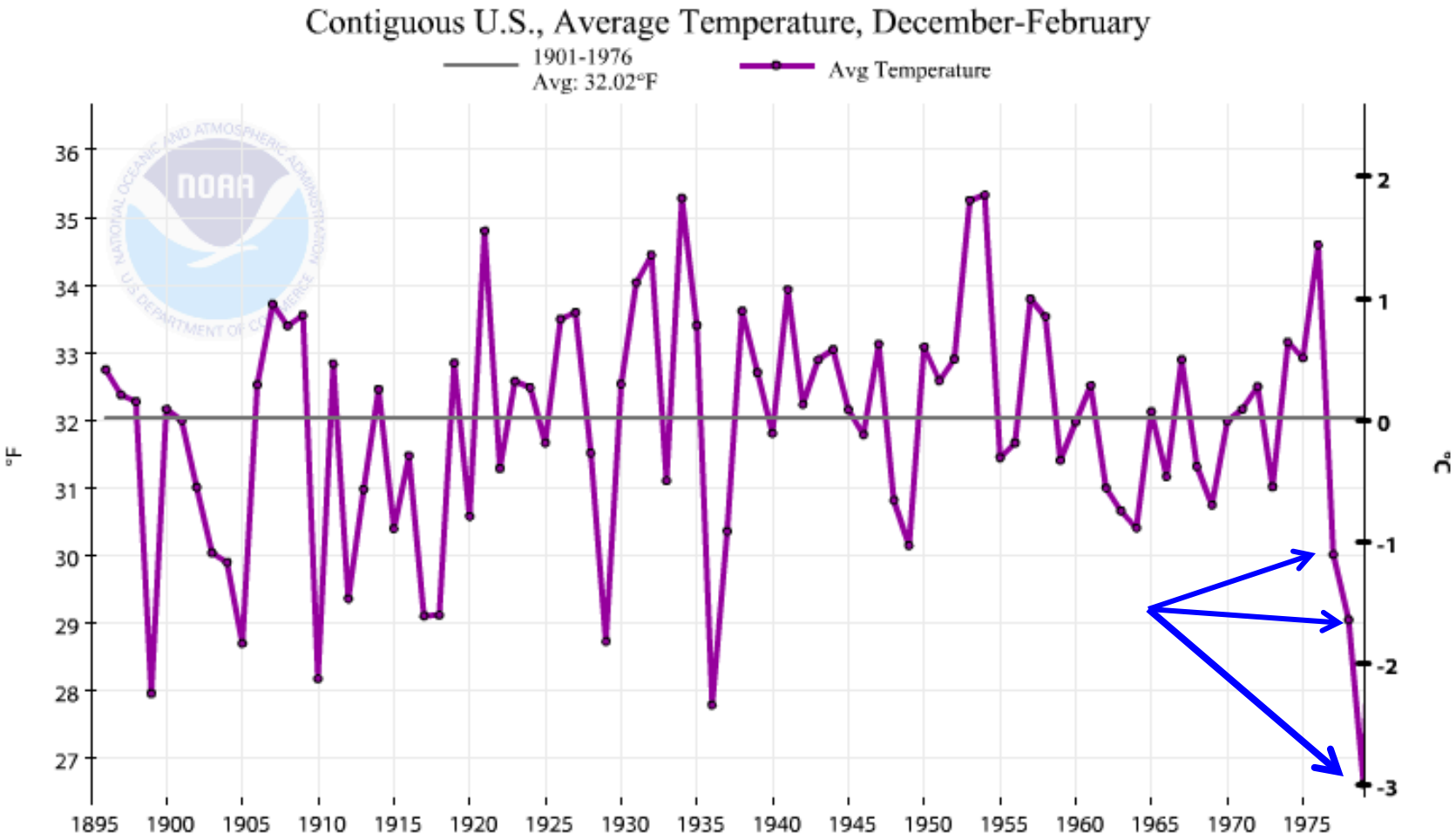
CONUS Mean Winter (DJF) Temperature



Climate Impacts Get (Some) People's Attention

National Climate Program Act

signed into law on September 17, 1978

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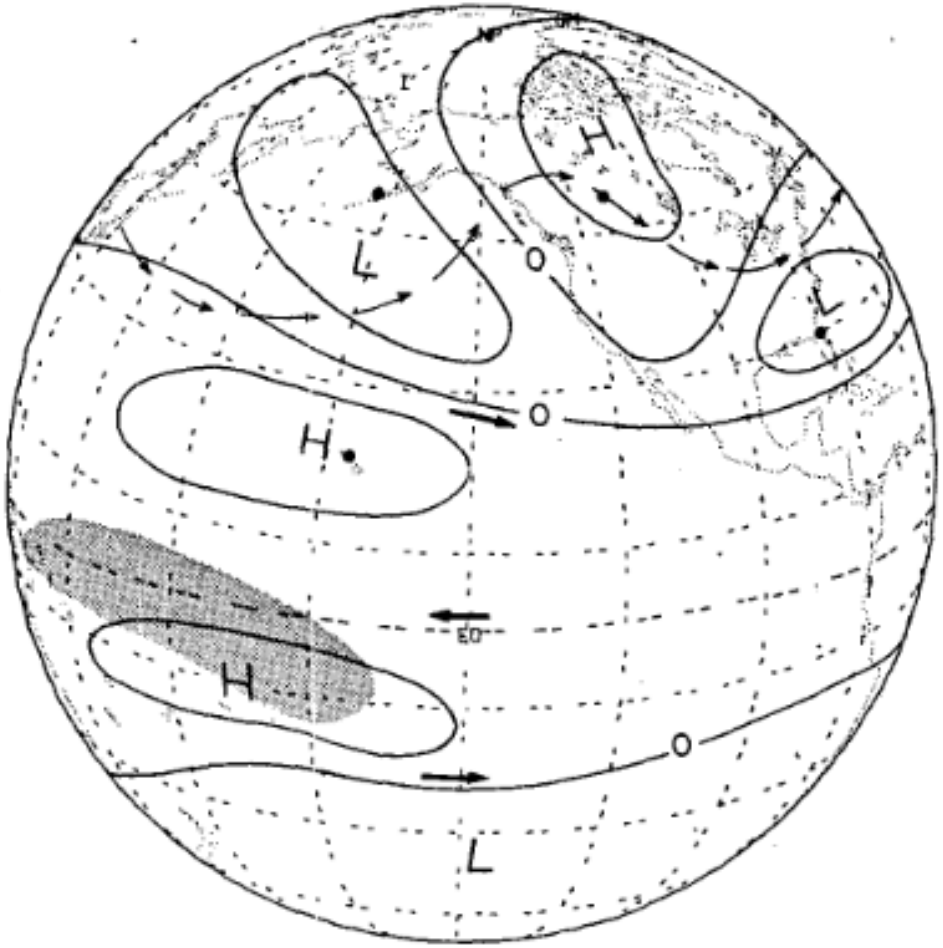

FIG. 11. Schematic illustration of the hypothesized global pattern of middle and upper tropospheric geopotential height anomalies (solid lines) during a Northern Hemisphere winter which falls within an episode of warm sea surface temperatures in the equatorial Pacific. The arrows in darker type re-

Horel & Wallace
MWR 1981
and
Wallace & Gutzler
MWR 1981

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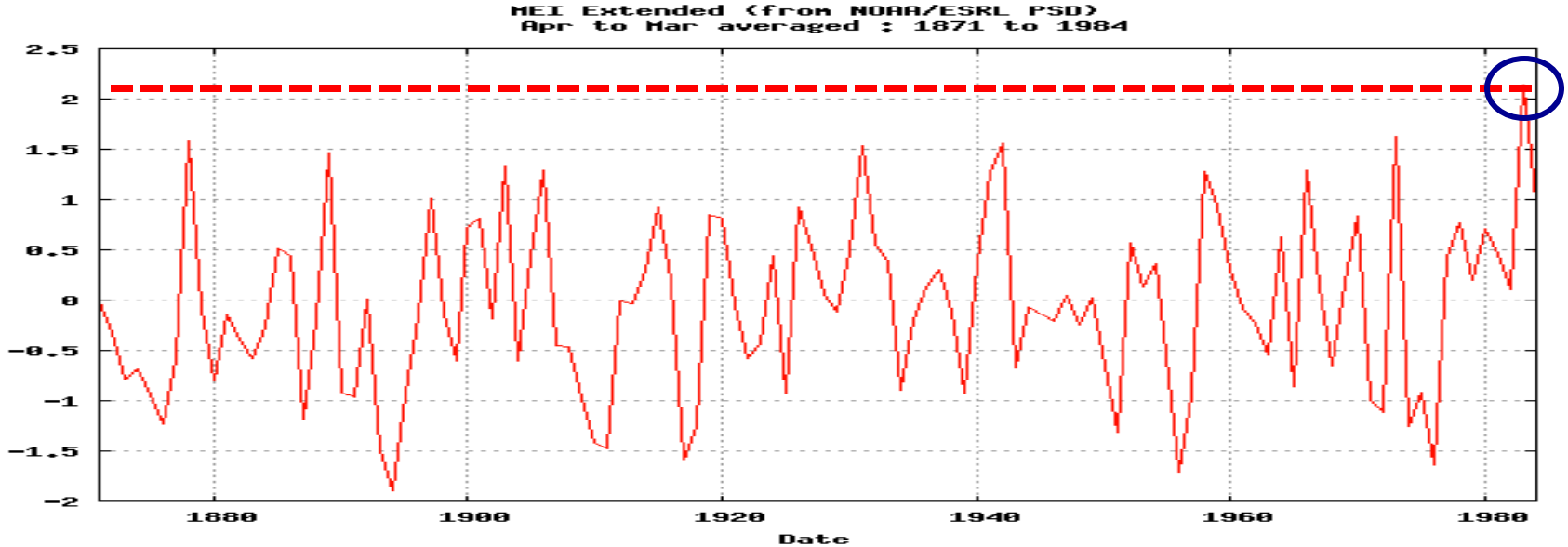
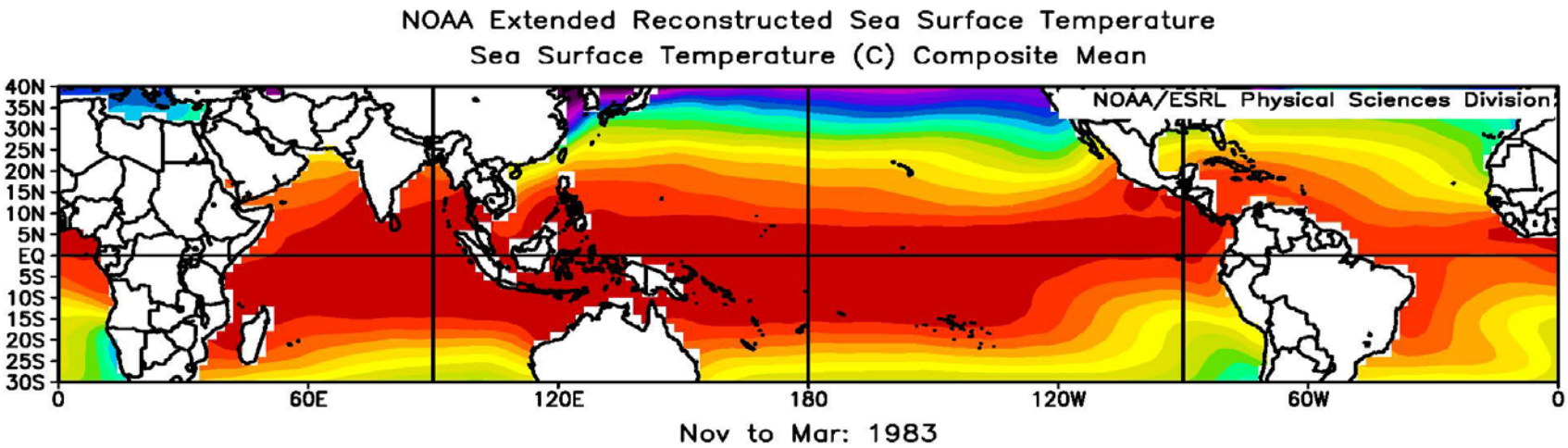
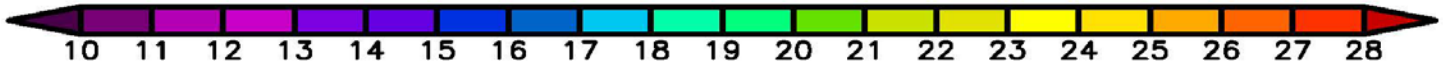
The (2nd) Age of El Niño

1982-83 “mega” El Niño

April-March MEI

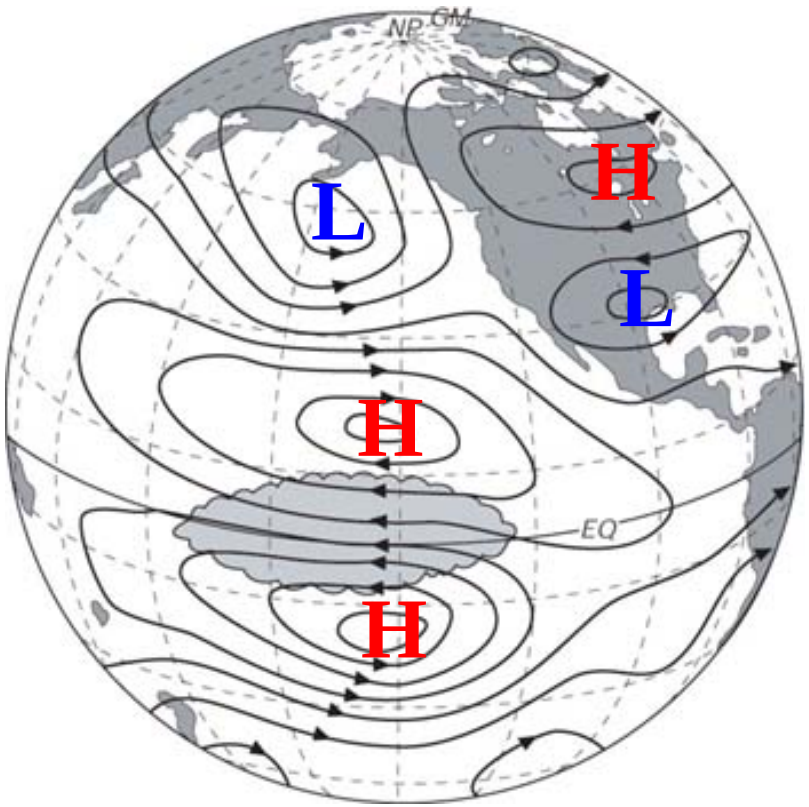




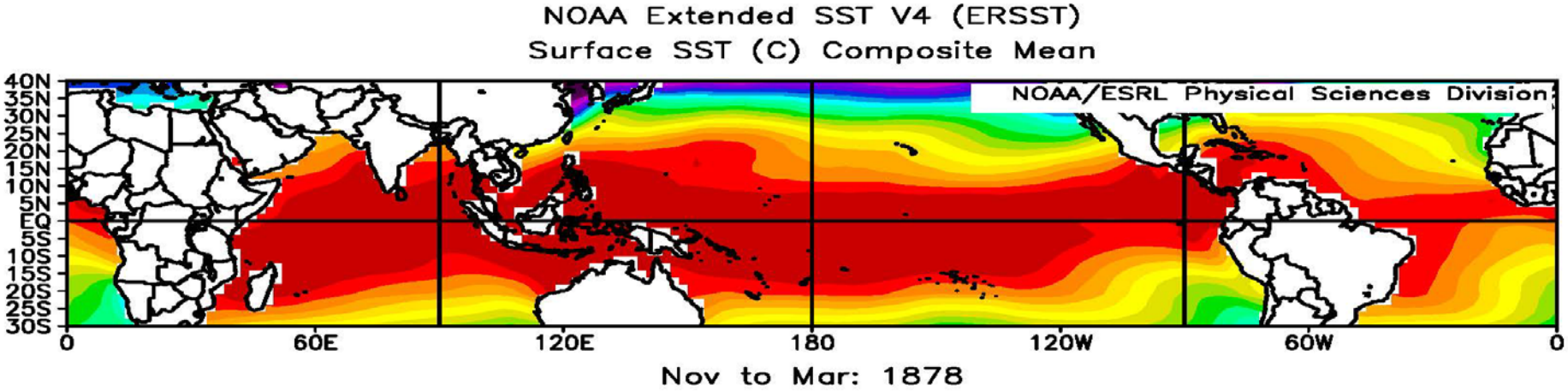


The 1982-83 El Niño was the strongest and most devastating of the century, perhaps the worst in recorded history. During that period, trade winds not only collapsed-they reversed direction. Its effects were long lasting as well. It caused weather-related disasters on almost every continent. Australia, Africa, and Indonesia suffered droughts, dust storms, and brush fires. Peru was hit with the heaviest rainfall in recorded history-11 feet in areas where 6 inches was the norm. California had very high rainfall and the year was characterized by extensive flooding and land sliding. The event was blamed for nearly 2,000 deaths and more than $13 billion in damage to property and livelihoods.

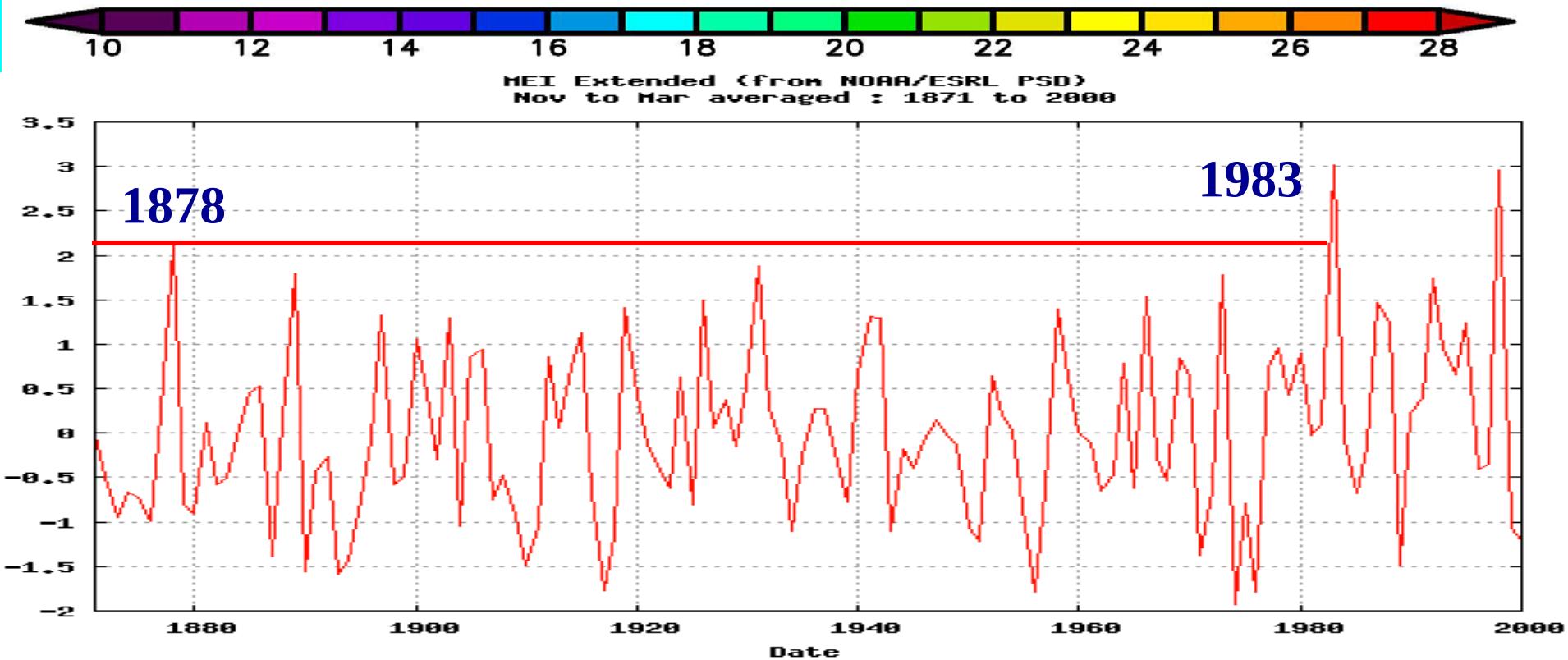
Source: John Monteverdi, San Francisco State Univ.



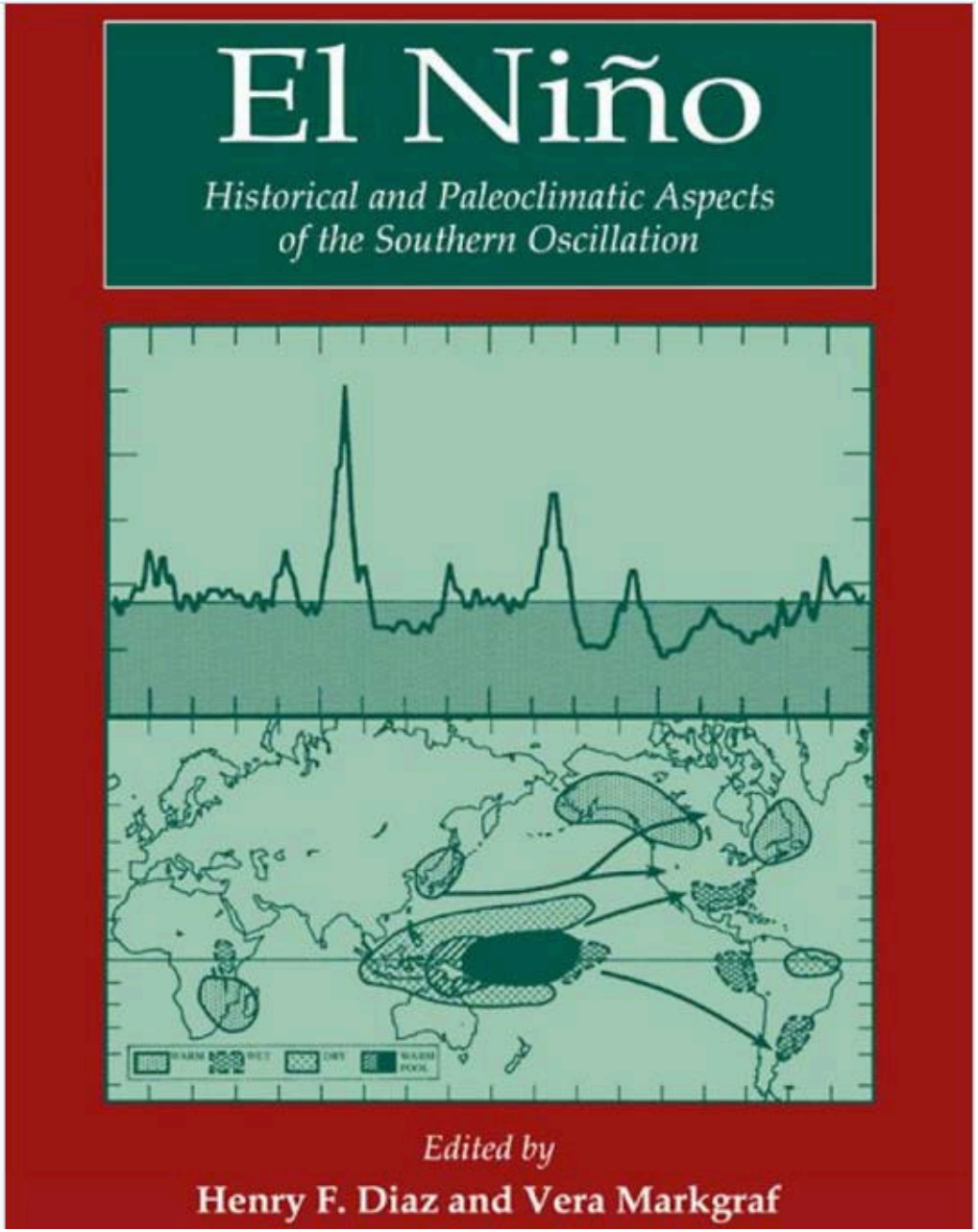
Rasmusson & Wallace 1983



Kiladis & Diaz MWR 1986

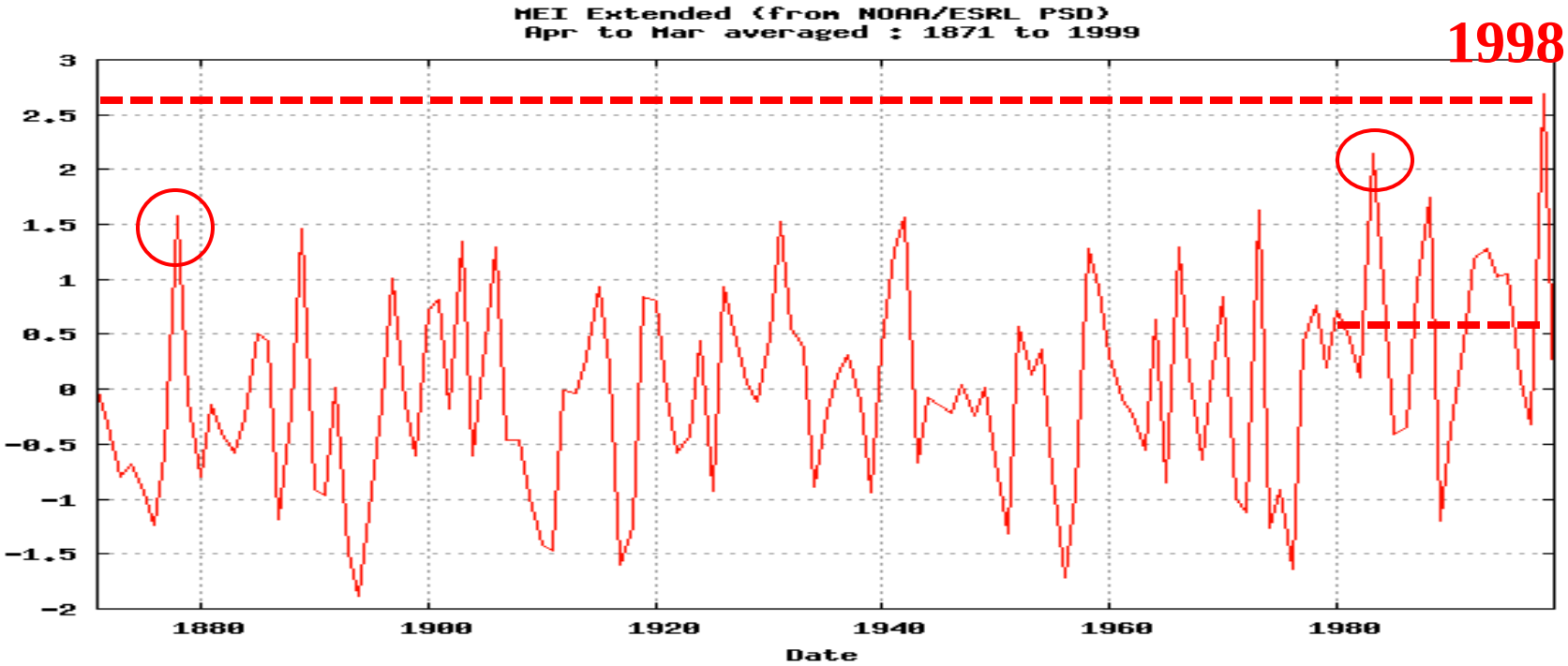


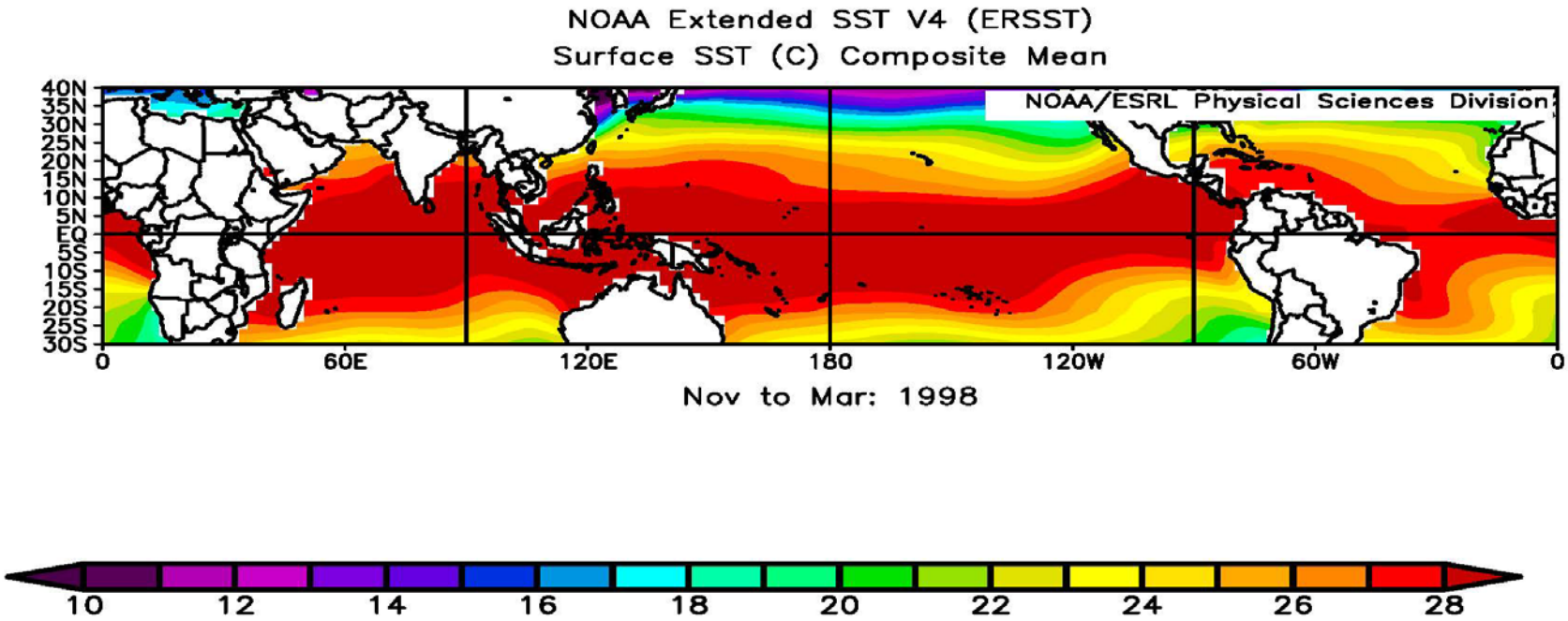
Increased attention regarding longer-term changes in ENSO



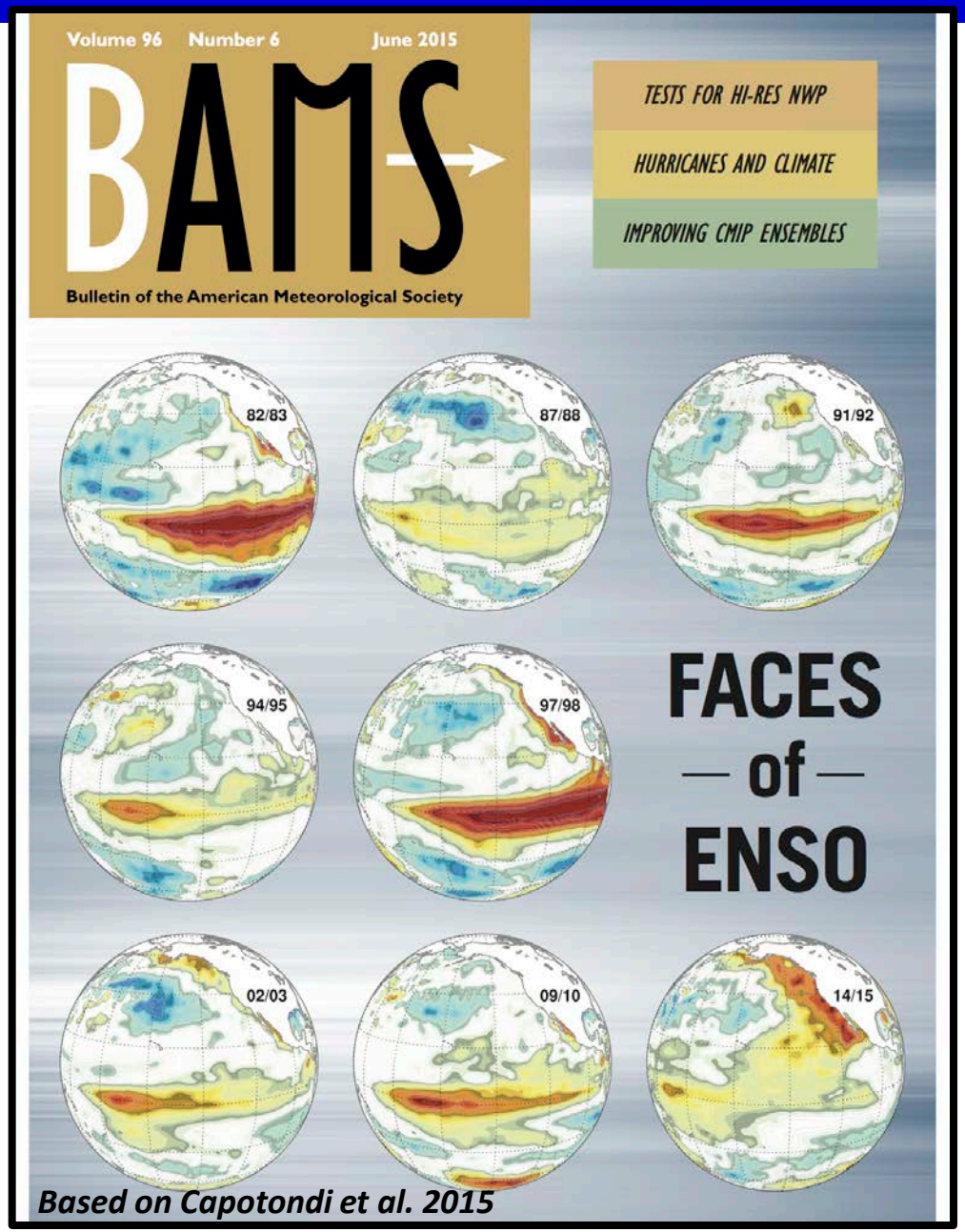
Cambridge University Press 1992

April-March MEI



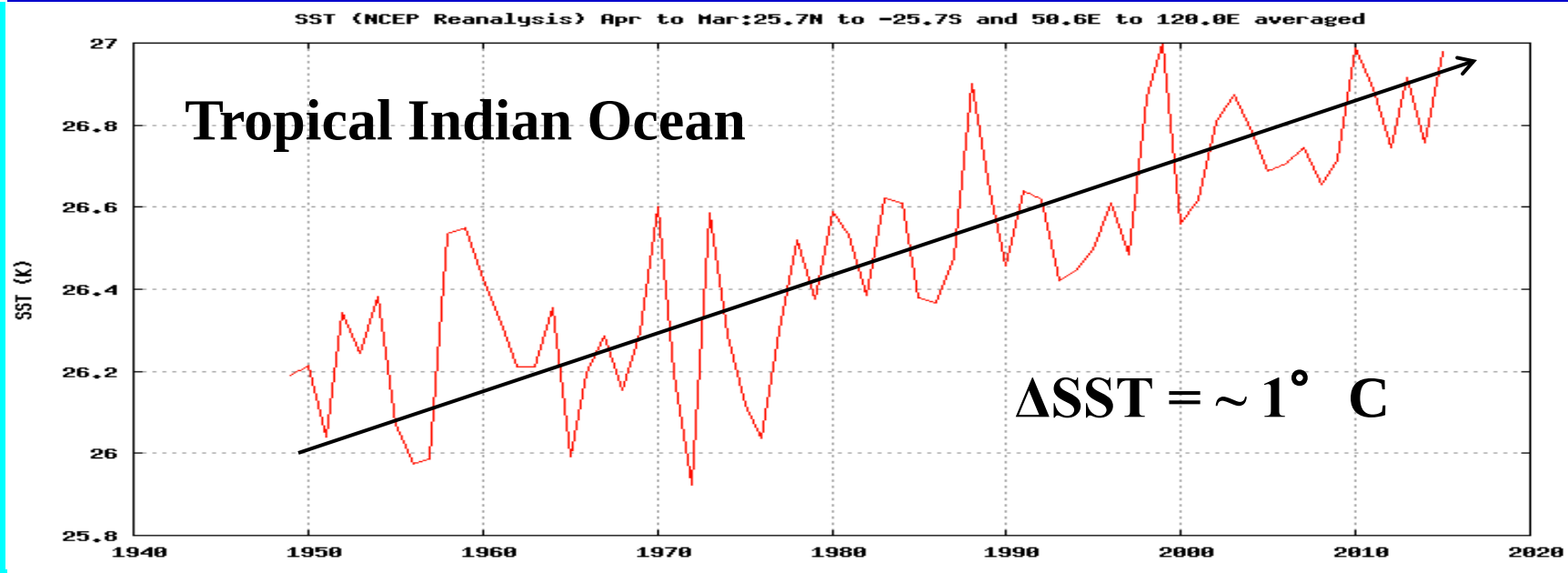


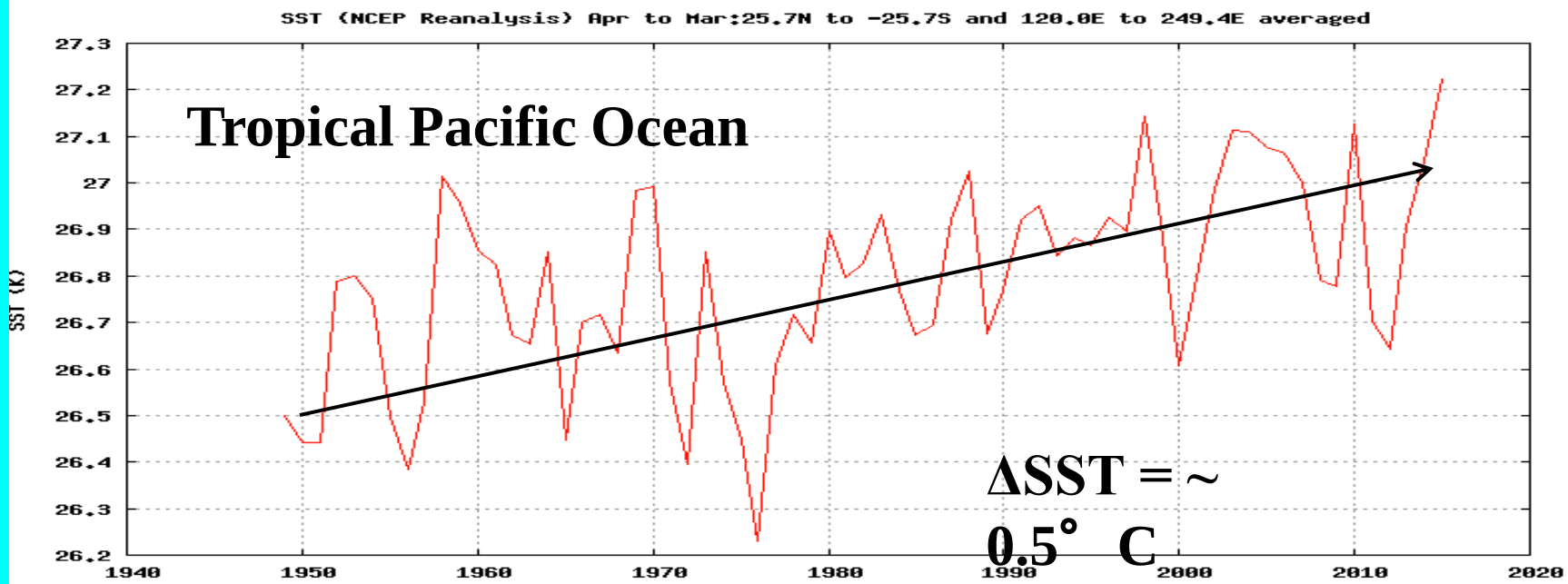
Types, Flavors and Faces of ENSO



Based on Capotondi et al. 2015

April Through March SST (1948-2015)





nature climate change

REVIEW ARTICLE

PUBLISHED ONLINE: 17 AUGUST 2015 | DOI: 10.1038/NCLIMATE2743

ENSO and greenhouse warming

Wenju Cai[1,2*], Agus Santoso[3], Guojian Wang[1], Sang-Wook Yeh[4], Soon-Il An[5], Kim M. Cobb[6], Mat Collins[7], Eric Guilyardi[8,9], Fei-Fei Jin[10], Jong-Seong Kug[11], Matthieu Lengaigne[8], Michael J. McPhaden[12], Ken Takahashi[13], Axel Timmermann[14], Gabriel Vecchi[15], Masahiro Watanabe[16] and Lixin Wu[2]

"The projected slow-down in Walker circulation is expected to weaken equatorial Pacific Ocean currents, boosting the occurrences of eastward-propagating warm surface anomalies that characterize observed extreme El Niño events. Accelerated equatorial Pacific warming, particularly in the east, is expected to induce extreme rainfall in the eastern equatorial Pacific and extreme equatorward swings of the Pacific convergence zones, both of which are features of extreme El Niño. The frequency of extreme La Niña is also expected to increase in response to more extreme El Niños, an accelerated maritime continent warming and surface-intensified ocean warming. ENSO-related catastrophic weather events are thus likely to occur more frequently with unabated greenhouse-gas emissions."

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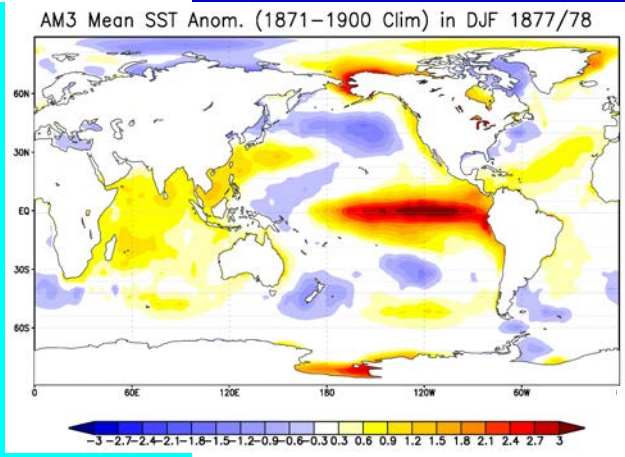
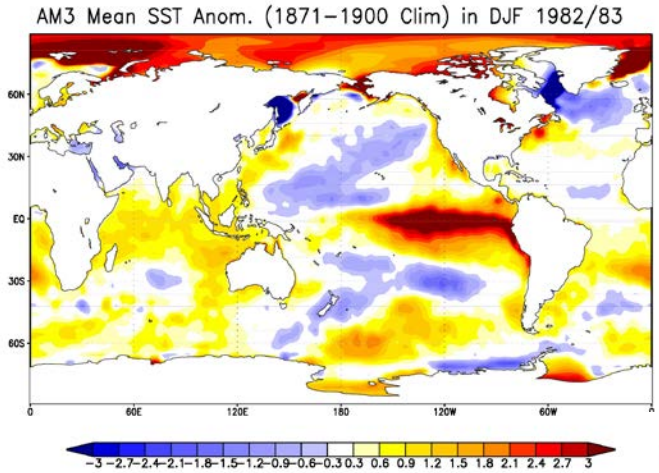
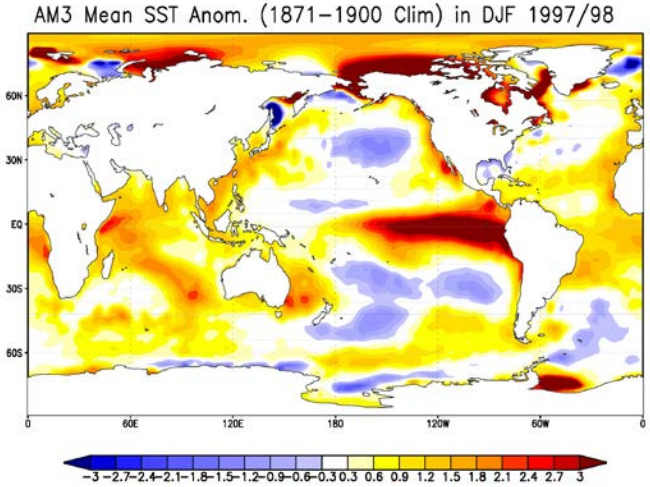
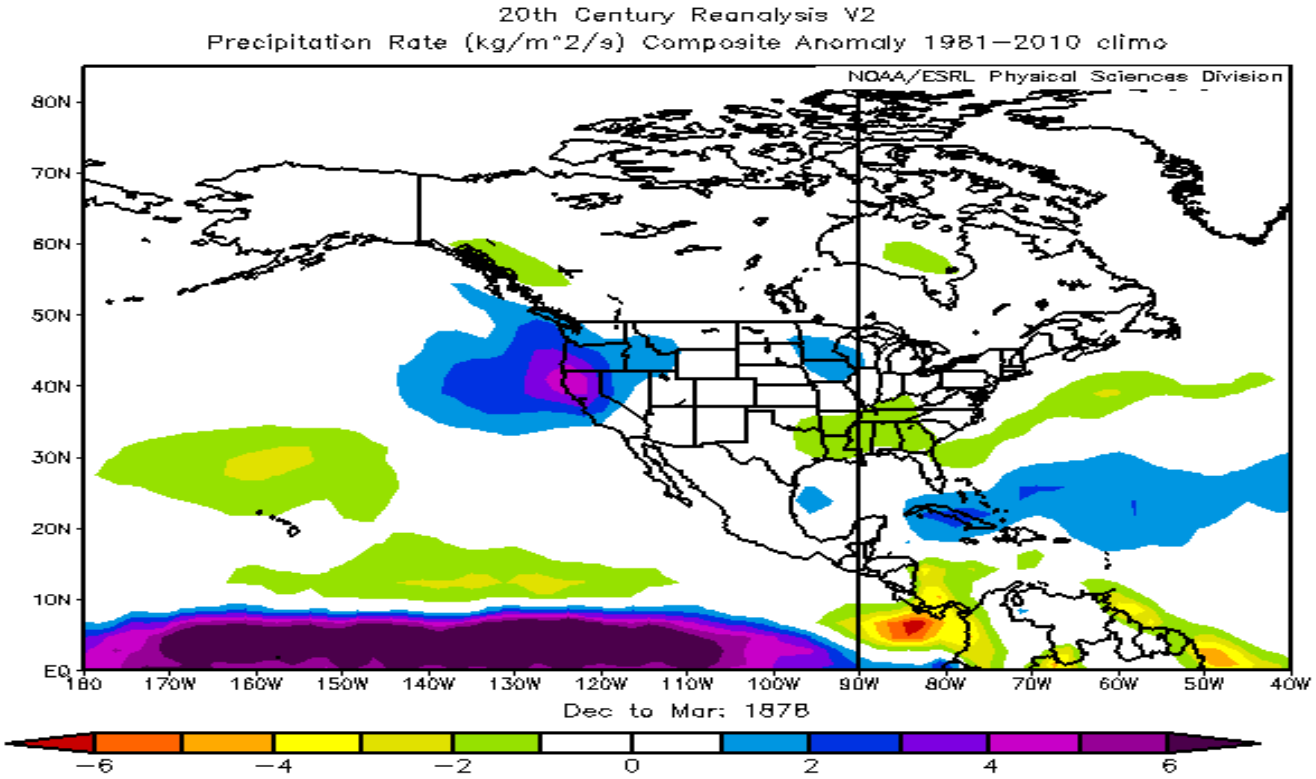
1877-1878 1982-1983 1997-1998



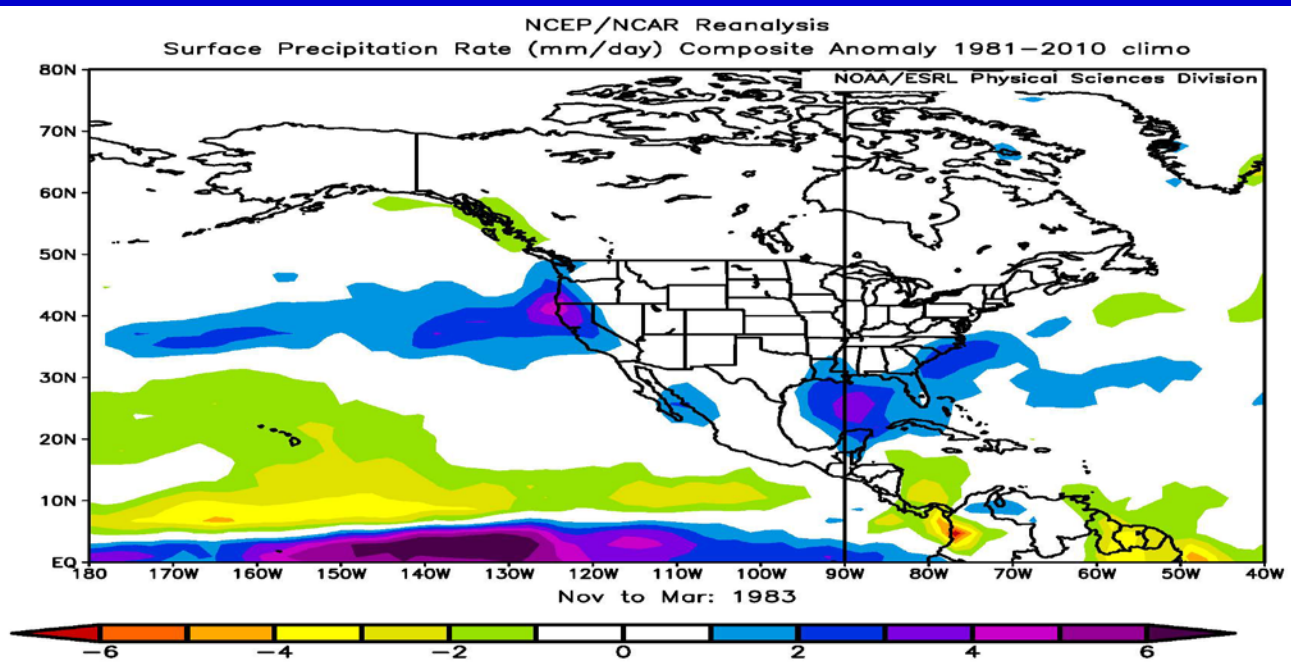
W.R.T. 1871-1900 Climo



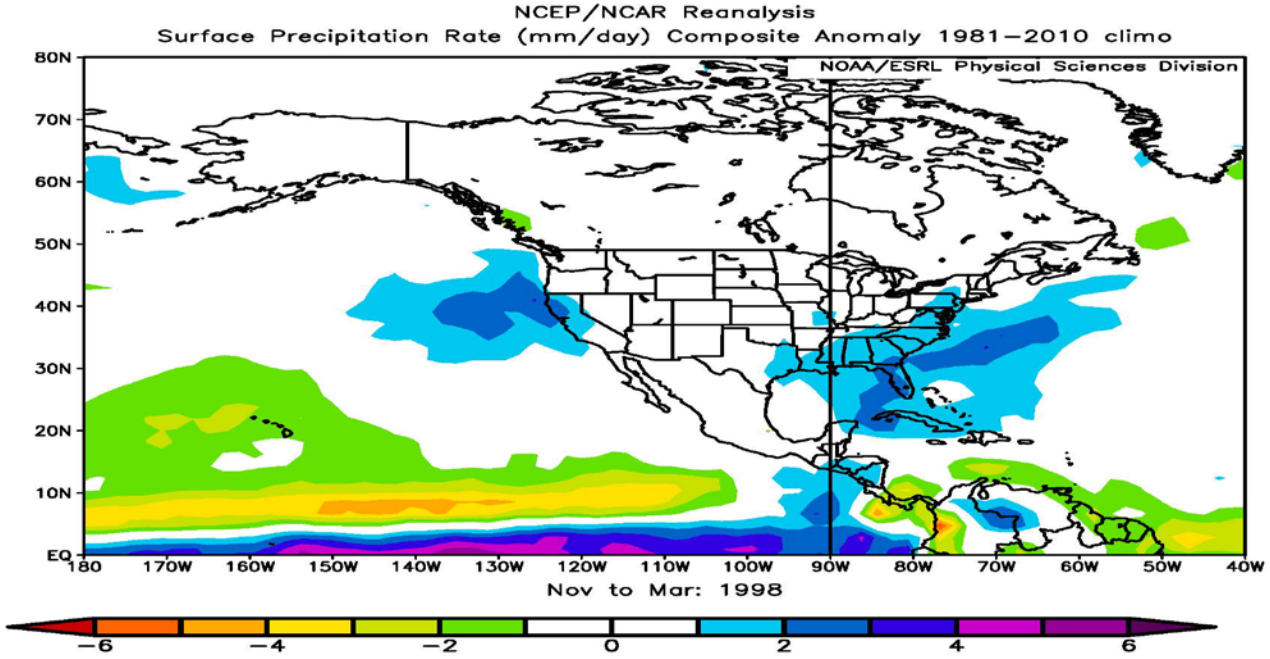




1877-78 (Dec-Mar) PRECIP-Anomaly

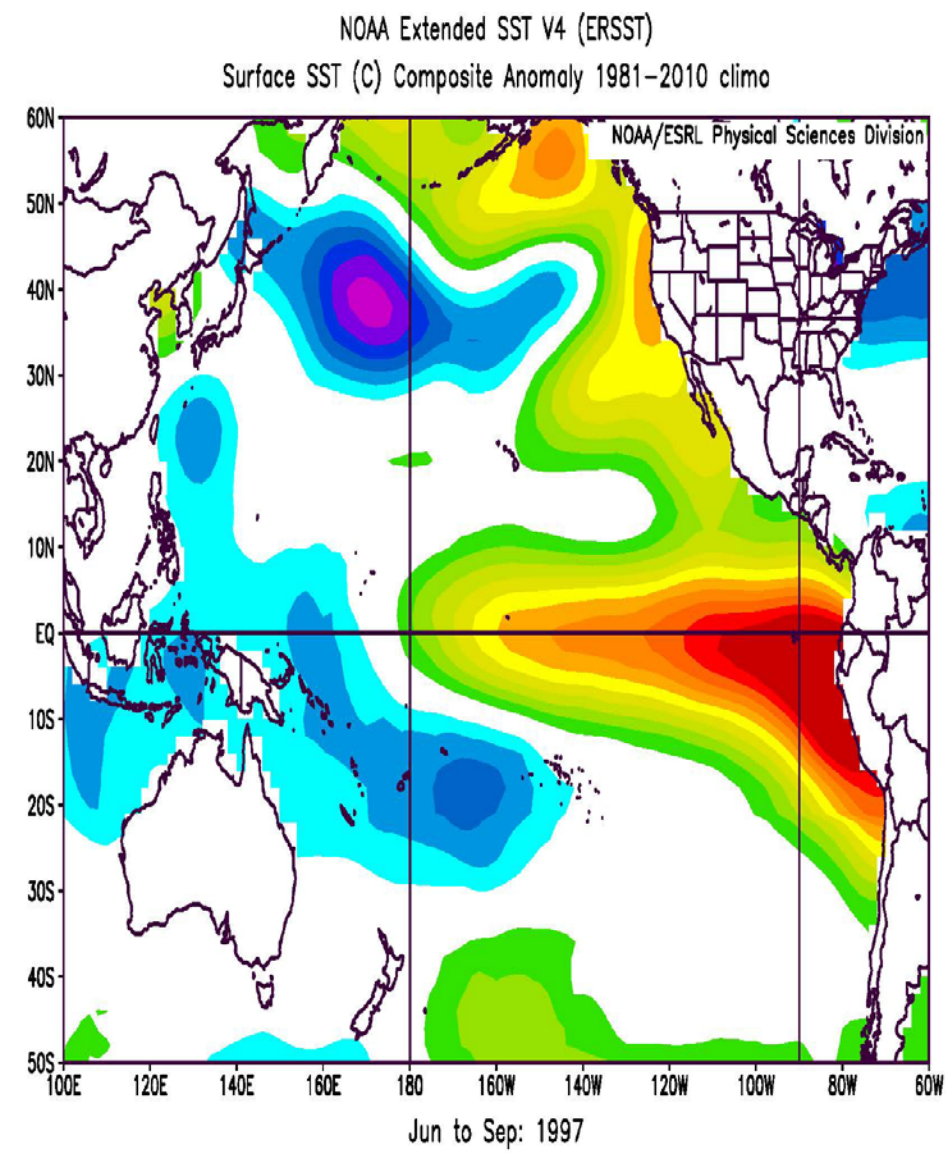


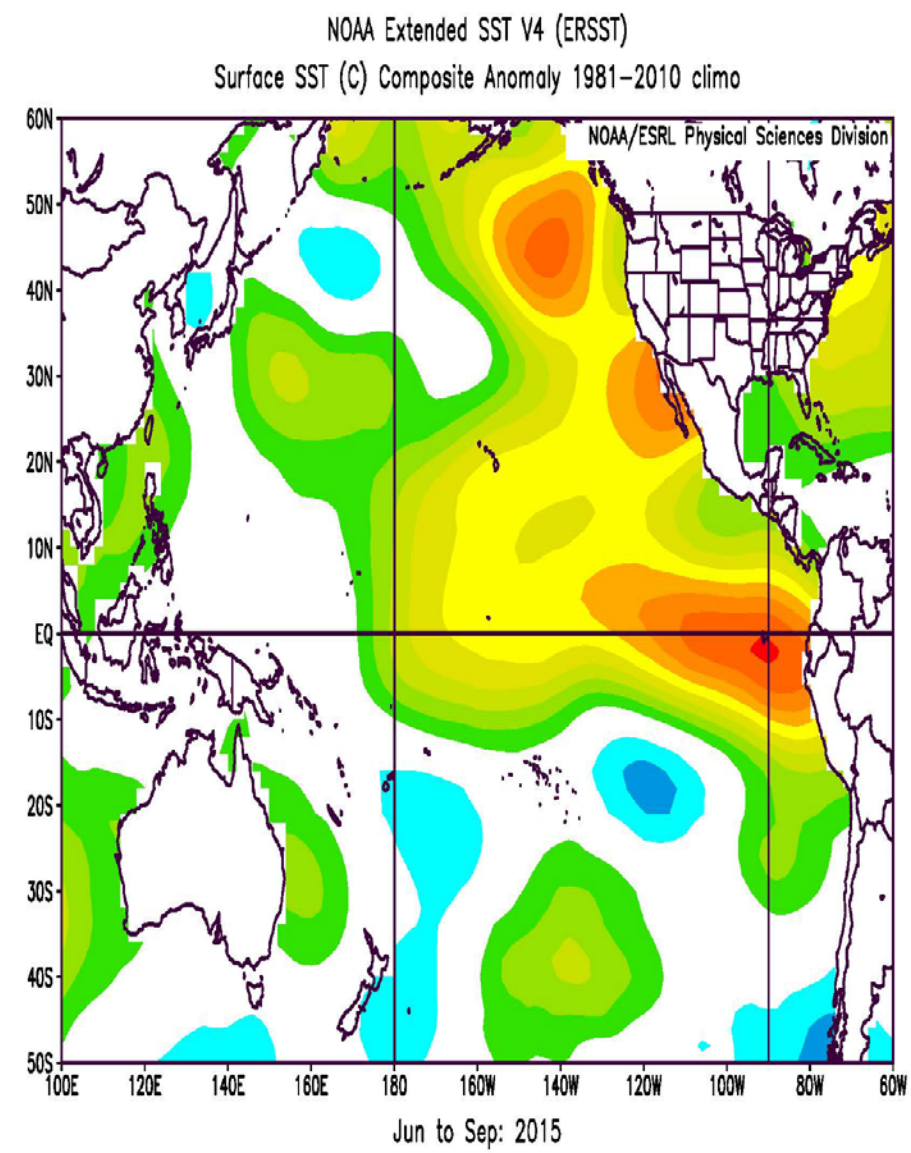
NDJFM 1982-83 Precip Anomaly



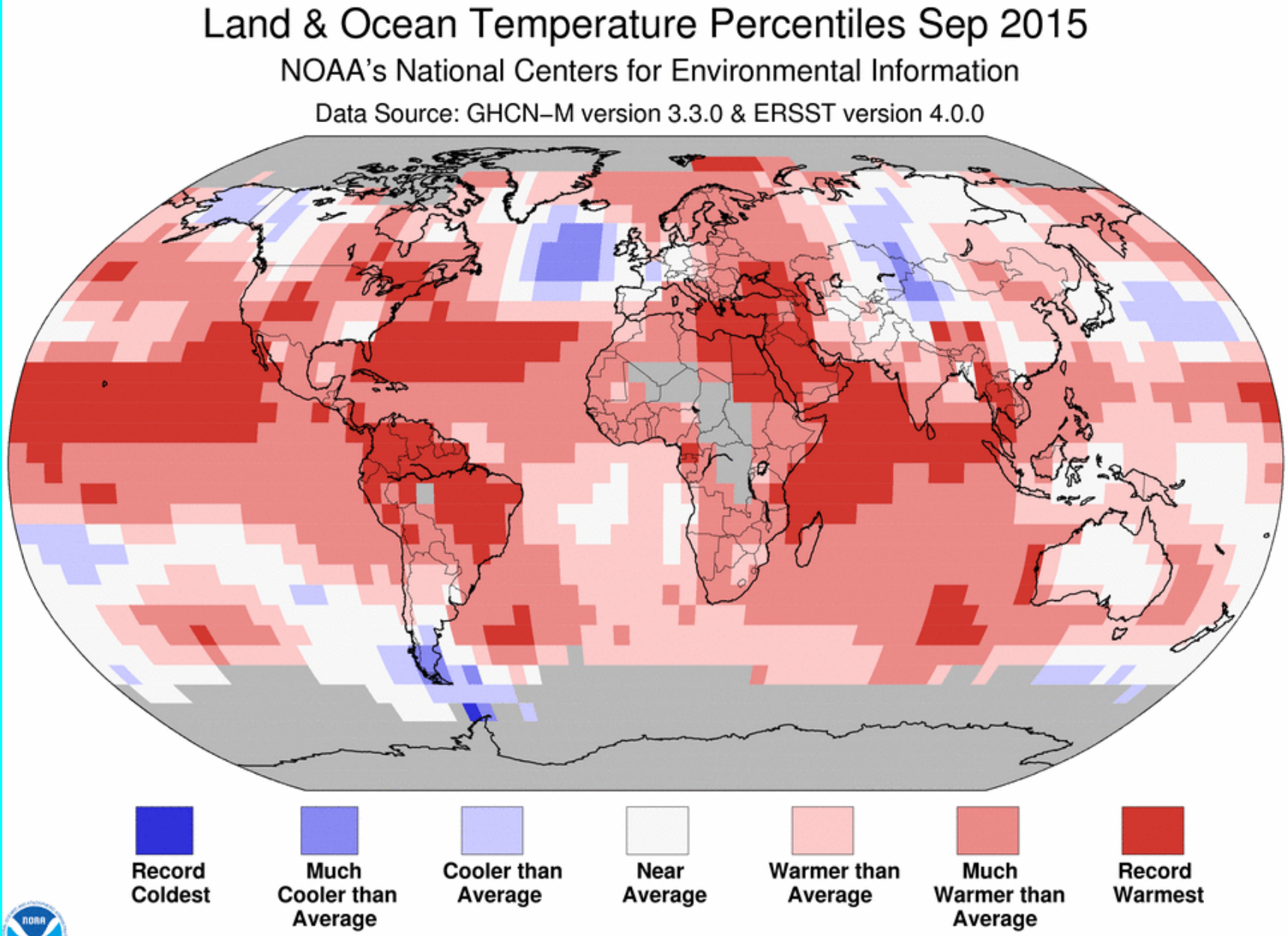
NDJFM 1997-98 Precip Anomaly

What about the 2015-16 El Niño of the (this?) Century?


NOAA Extended SST V4 (ERSST)
Surface SST (C) Composite Anomaly 1981–2010 climo
NOAA/ESRL Physical Sciences Division
60N
50N
40N
30N
20N
10N
EQ
10S
20S
30S
40S
50S
100E
120E
140E
160E
180
160W
140W
120W
100W
80W
60W
Jun to Sep: 1997
−2.5
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5


NOAA Extended SST V4 (ERSST)
Surface SST (C) Composite Anomaly 1981–2010 climo
NOAA/ESRL Physical Sciences Division
60N
50N
40N
30N
20N
10N
EQ
10S
20S
30S
40S
50S
100E
120E
140E
160E
180
160W
140W
120W
100W
80W
60W
Jun to Sep: 2015
−2.5
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5

Record Warm September Globally

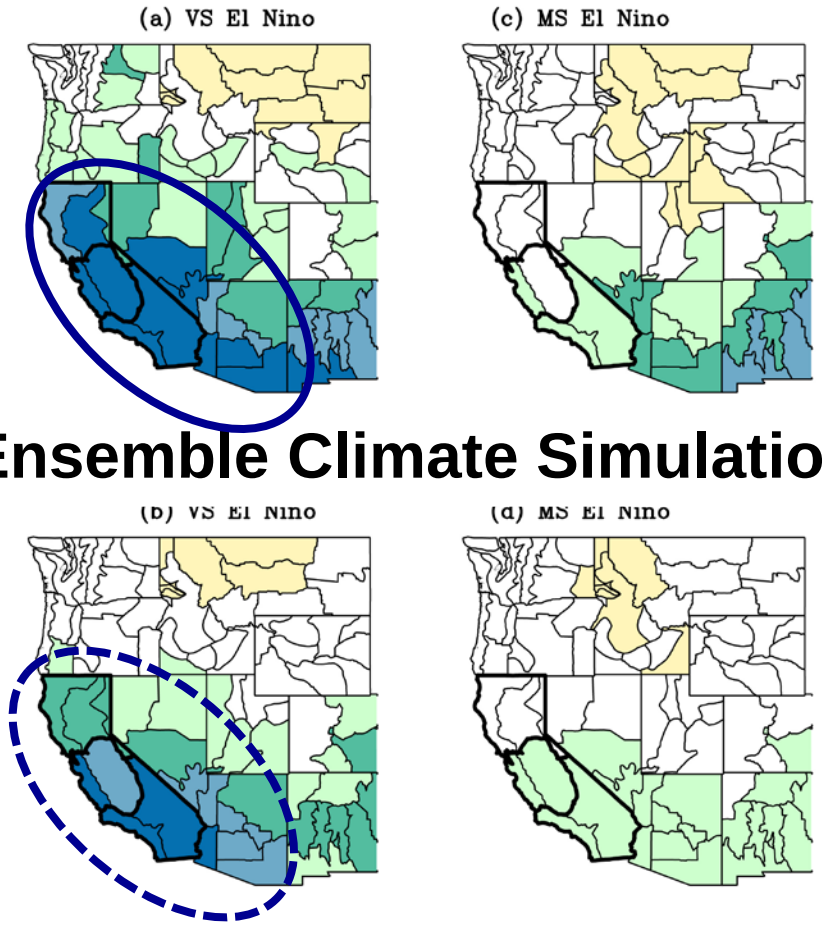


Does El Niño Intensity Matter for California Precipitation? *from Hoell et al. 2015*

Observations

Very Strong El Niño

Moderately Strong El Niño



Ensemble Climate Simulations

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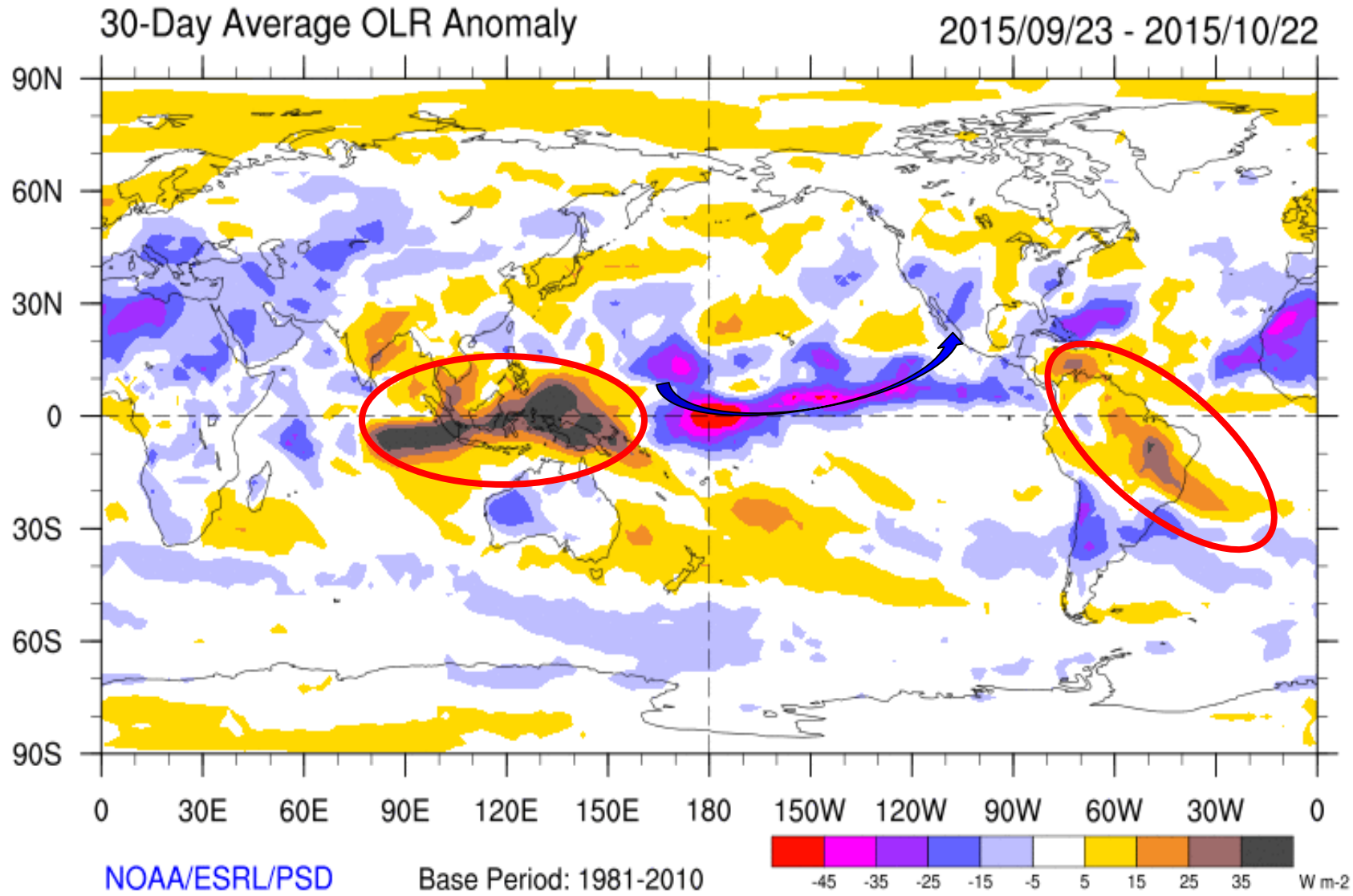

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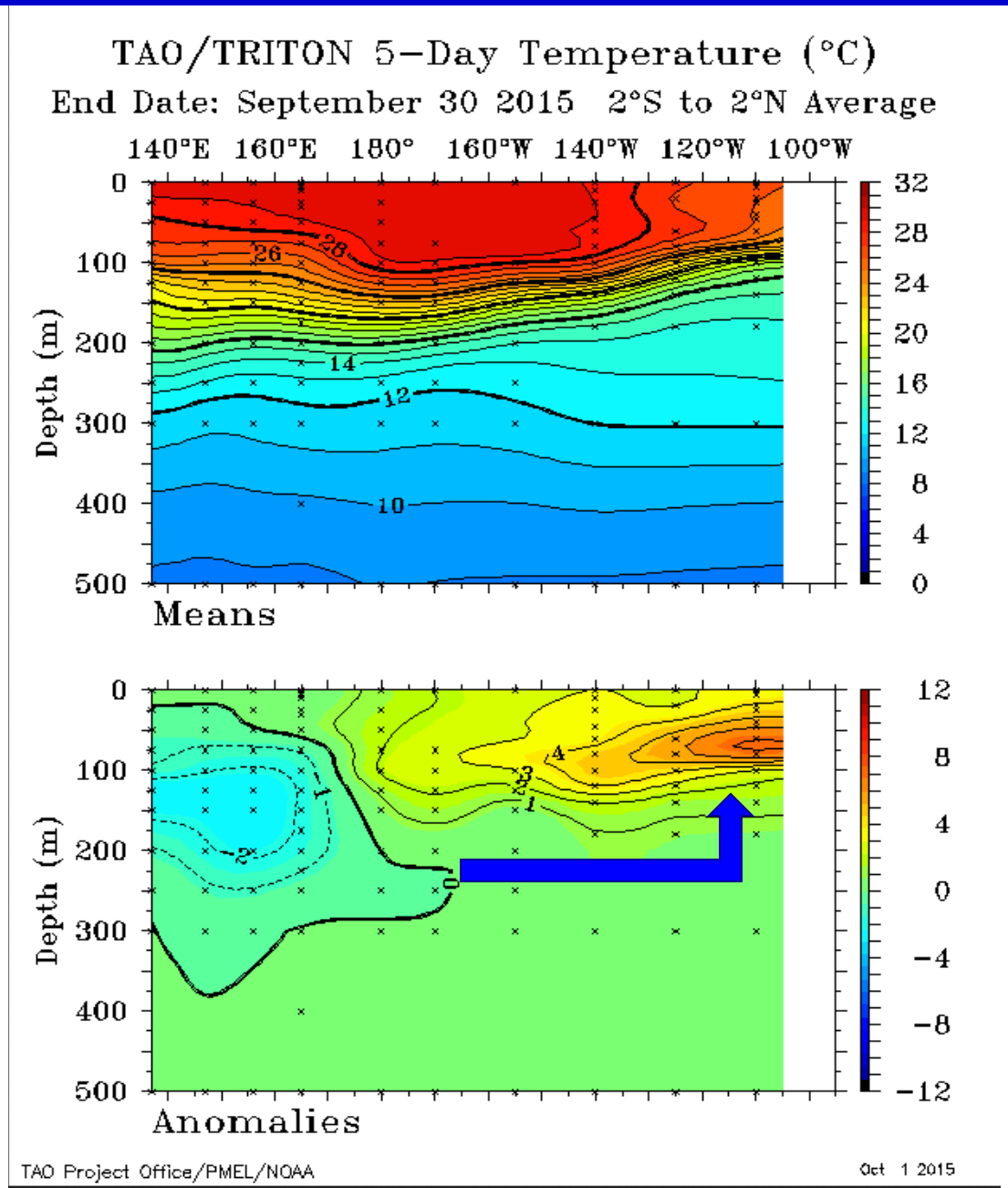
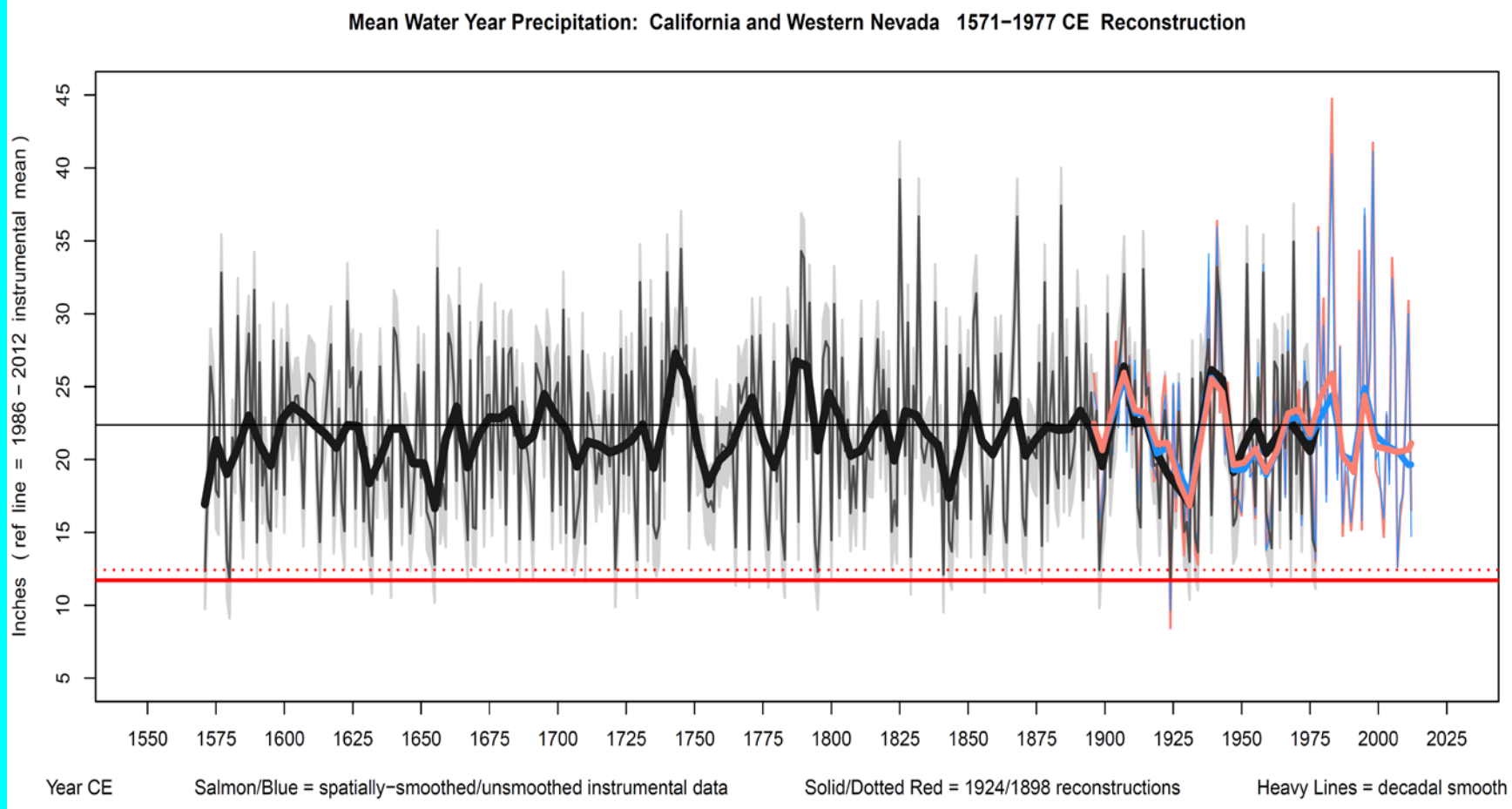
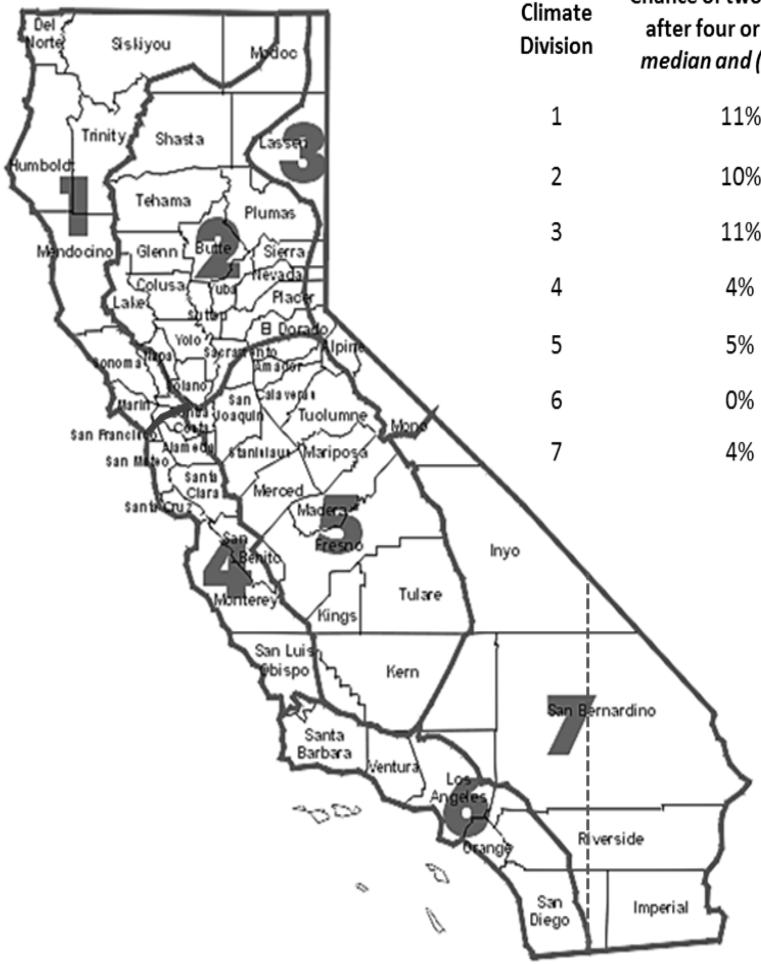
La Niña cometh?





Diaz and Wahl (J Climate 2015)



Climate Division	Chance of two strong wet years after four or more dry years *median and (95th percentile)*
1	11% (18%)
2	10% (18%)
3	11% (18%)
4	4% (12%)
5	5% (13%)
6	0% (11%)
7	4% (11%)

Map source: NOAA's Climate Prediction Center

Prob. of 2 wet WYs in a row following 4 consecutive dry WYs

Based on 408-year (1571–1977) WY precipitation reconstruction for western US

~ 4–10% versus unconditional ~ 6%

Internet Age Arrives

The Weather Channel

WEATHER UNDERGROUND | Maps & Radar | Severe Weather

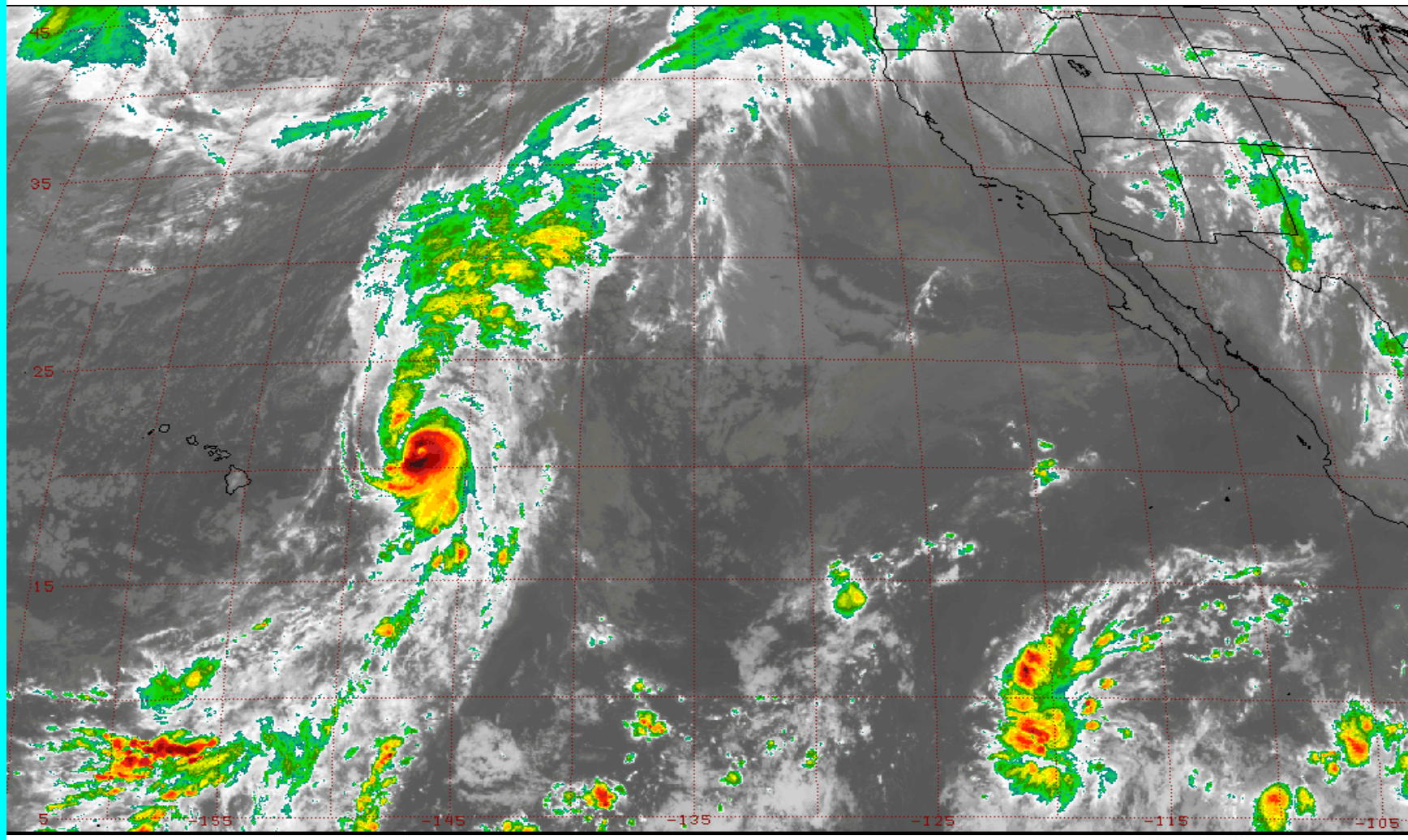
Google

intellicast The Authority in Expert Weather

PSD Interactive Climate Analysis and Plotting Web-Tools

Climate Diagnostics Center

Thank You!



Atmospheric River 10.7.15

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World Climate Community ca. 1975