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Teleconnections

How Patterns Far Away Can Influence Our Weather

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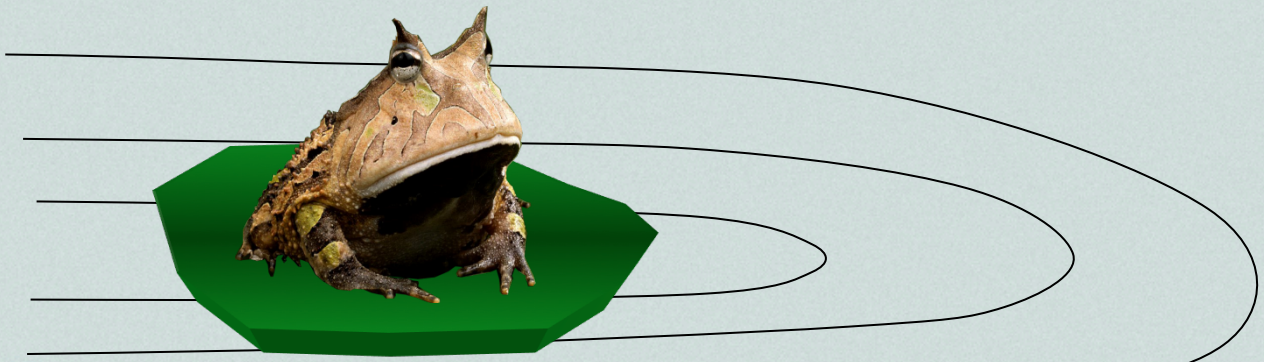
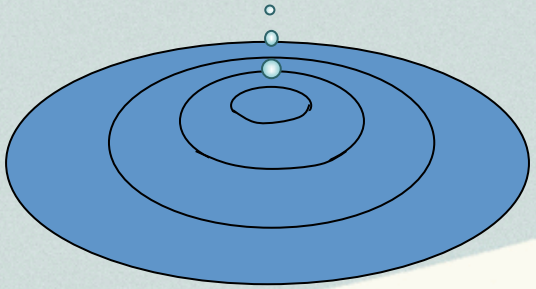
Teleconnections

Connectedness of large-scale weather patterns across the world

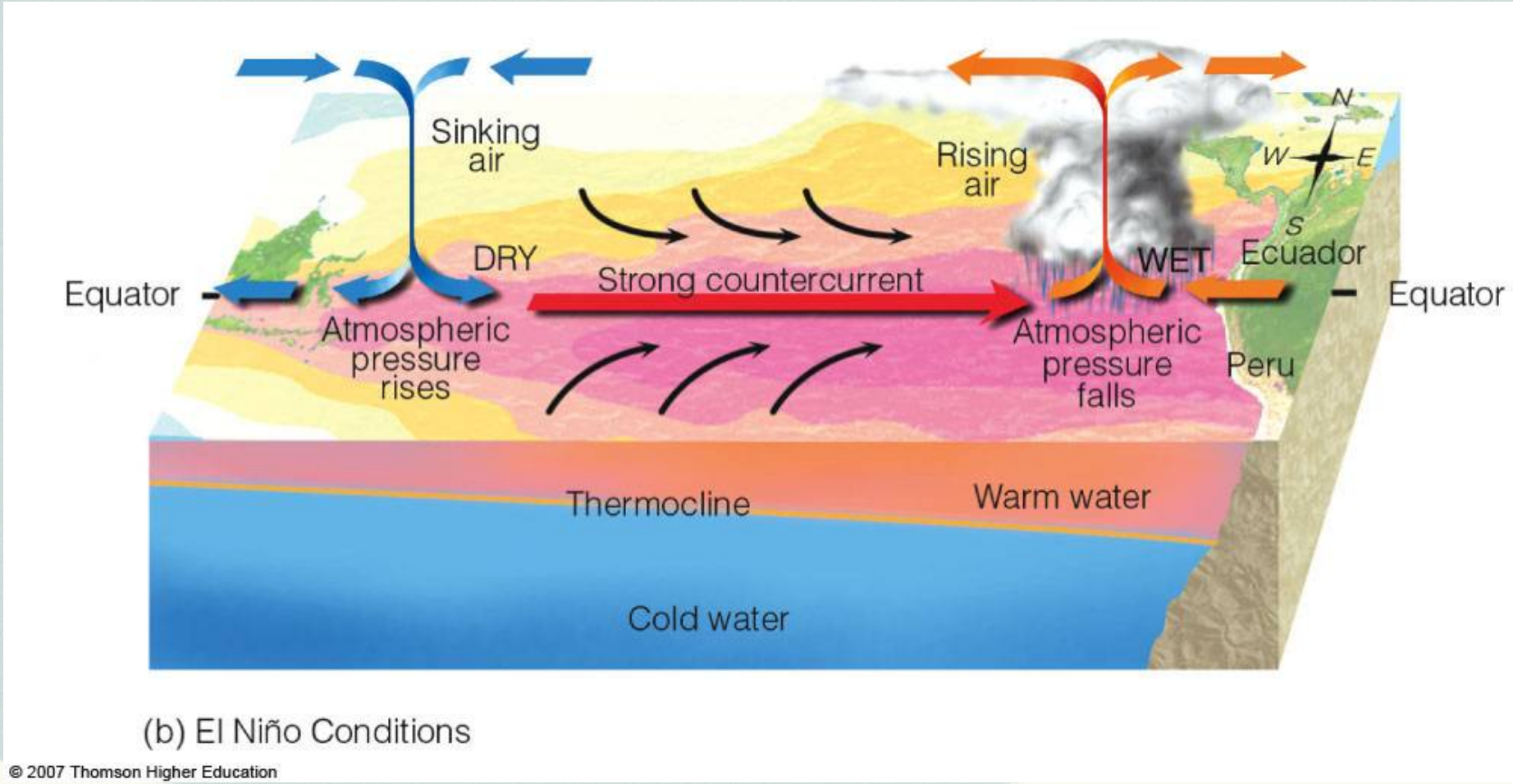
If you poke one area, another area is affected as well

Like dropping a pebble in a pond – ripples interact to make some waves bigger





El Niño Conditions



(b) El Niño Conditions

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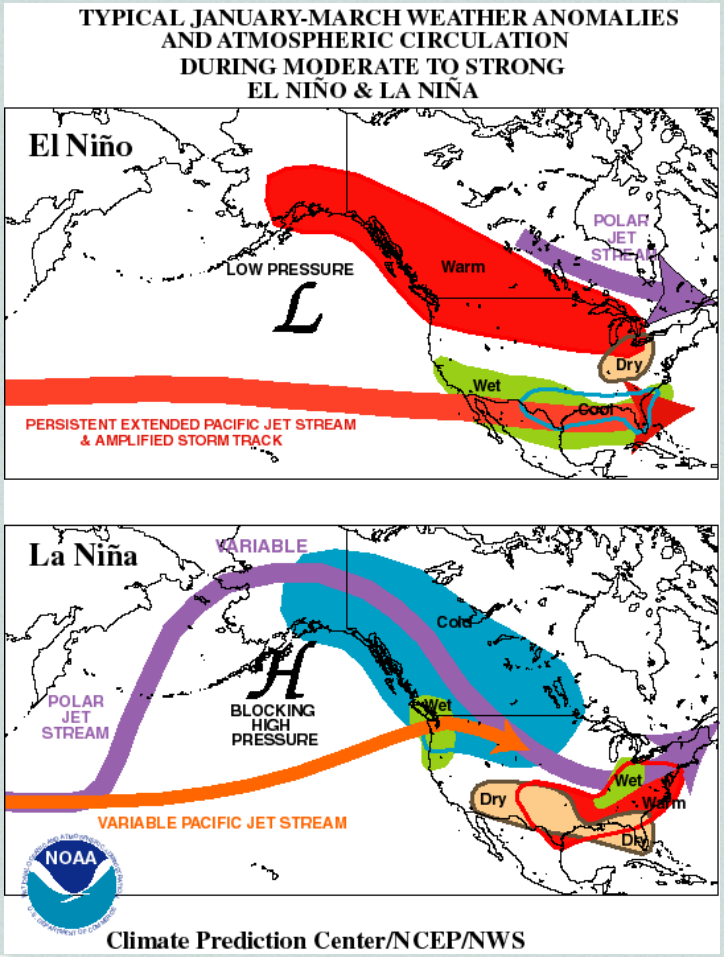
Typical ENSO Winter Effects



- **El Niño:**
  - Lots of [non-Arctic] storms tracking rapidly from west-to-east across southern half of U.S.
  - Very wet across Southern states; very warm across Northern states
- **La Niña:**
  - Storm track often stays north of us
    - OK warm & dry for extended periods.
  - When it jumps south (quickly) we get weather systems, but they often lack sufficient moisture
    - We go from warm, dry and windy to cold, dry and windy
  - The storm system finally explodes with precipitation somewhere around Memphis

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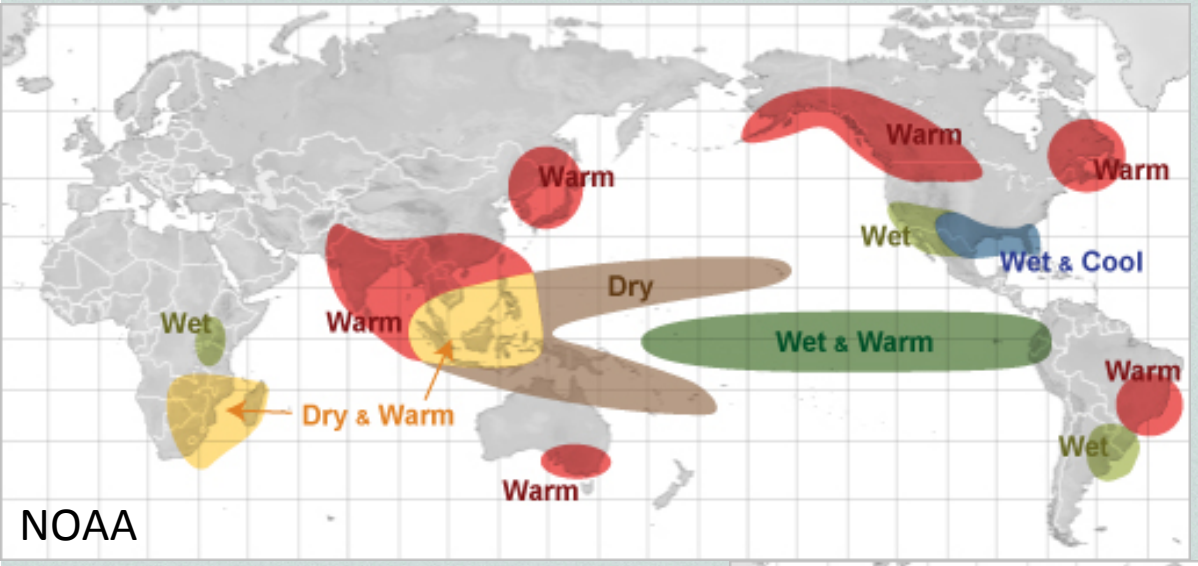
Typical El Niño Impacts



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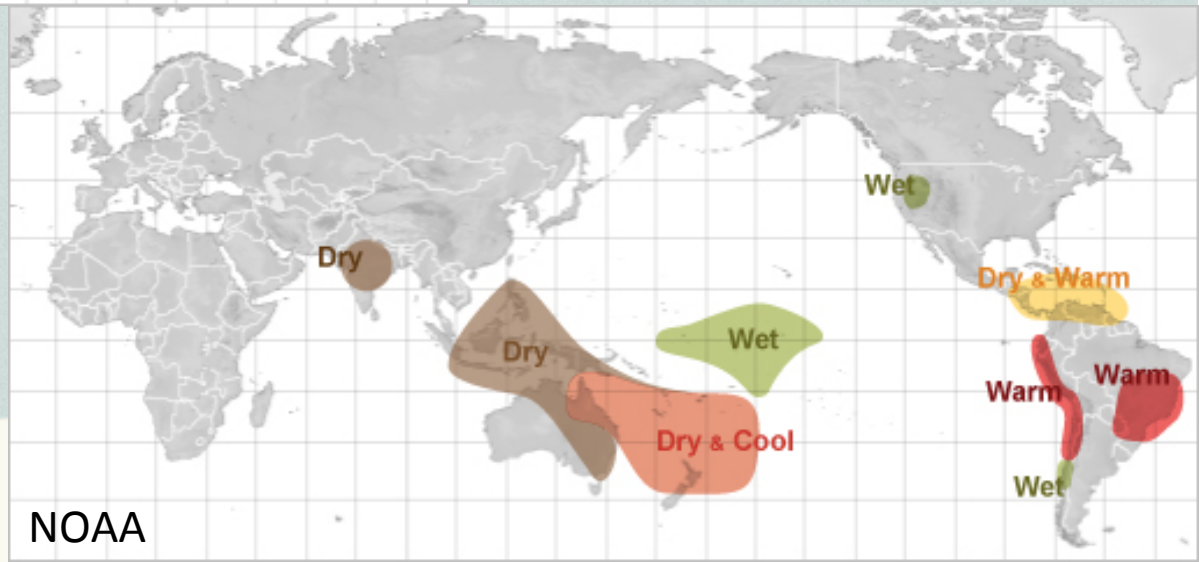
Winter

Summer



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A note about El Niño / La Niña

Effects most pronounced in the winter

- Jet stream is shifted northward in summer; no connection between tropical Pacific and Southern Plains

A dry winter and spring can get the dry soil feedback process going in summer (like 2011)

Moderate relationship in Oklahoma; stronger in Texas and Southwest

In Oklahoma in the Fall, actually reversed relationship

- El Niño = dry, La Niña =wet

Most predictable of the seasonal / inter-annual factors, but only partially explains seasonal rainfall and temperature patterns

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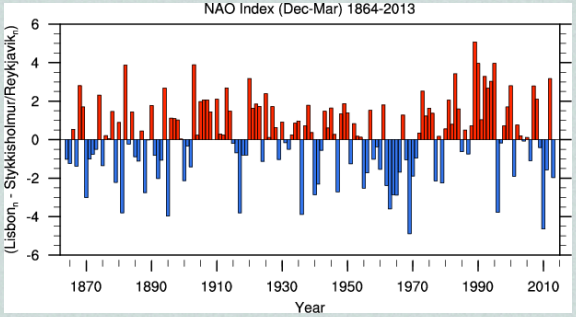
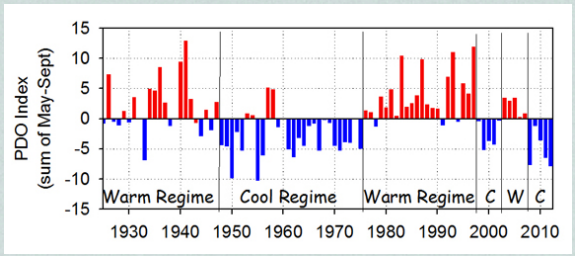
But Wait, There's More…

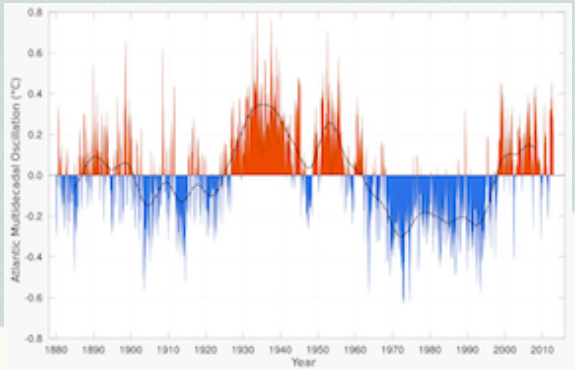
- North Atlantic Oscillation (NAO)
  - High-frequency oscillation
  - Stronger impact on N. American east coast & Europe
  - Negative tends toward dry southern plains



- Pacific Decadal Oscillation (PDO)
  - "Sloshing" between northern and central Pacific, typically 20-30 year period.
  - May be a major contributor to extended drought patterns (negative phase)
  - Cool phase favors development of La Nina



- Atlantic Multidecadal Oscillation (AMO)
  - Also long pattern (20-30 years)
  - Warm phase usually dry southern plains
  - More active hurricane seasons as convection shifts eastward



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CAUSES AND IMPACTS OF DROUGHT

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Large-Scale, Stationary High Pressure

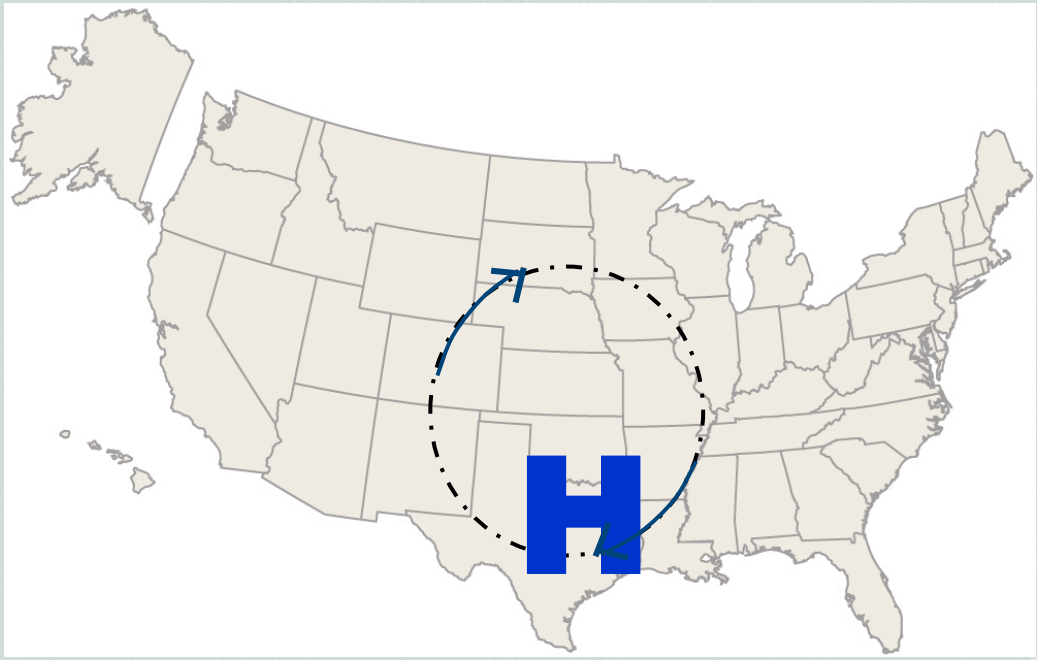
Air rotates clockwise around high pressure

"steers" storms away

Air descends = no clouds

As long as it sits in place, lots of sunshine, no rain

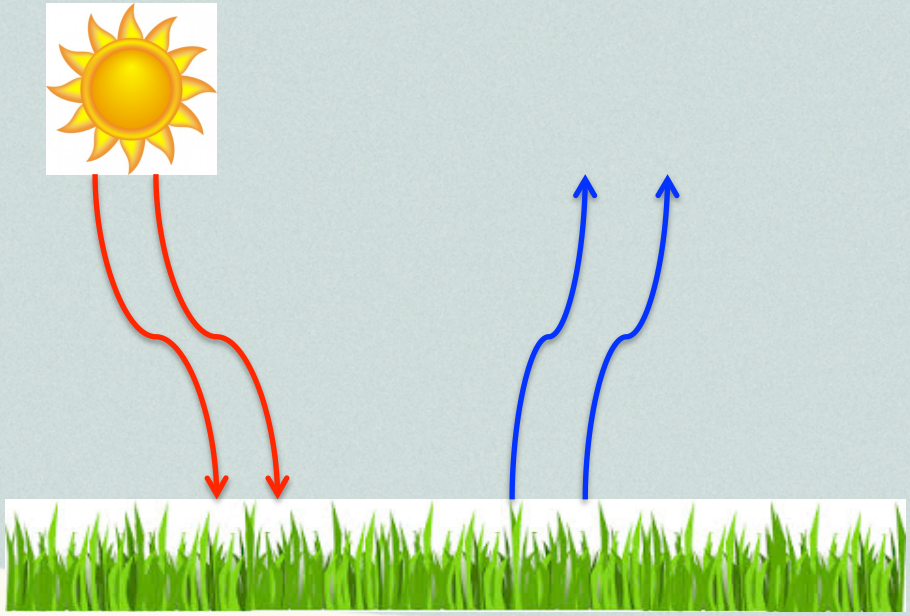
Occurs, to some extent, every summer

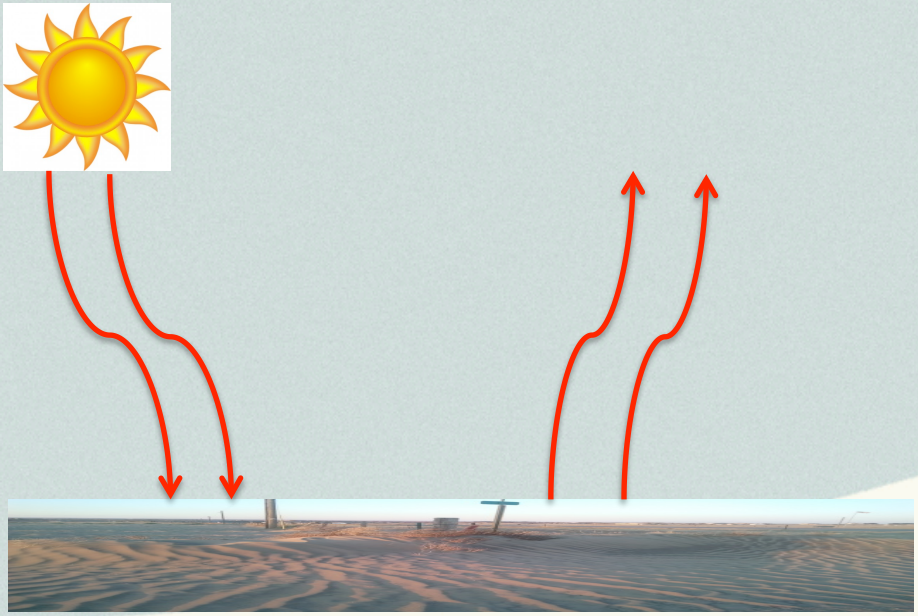


Feedback from Dry Soils

Normally, vegetation and water bodies evaporate water, which cools the air near the ground

If there isn't enough water to evaporate, sun's energy heats soil instead





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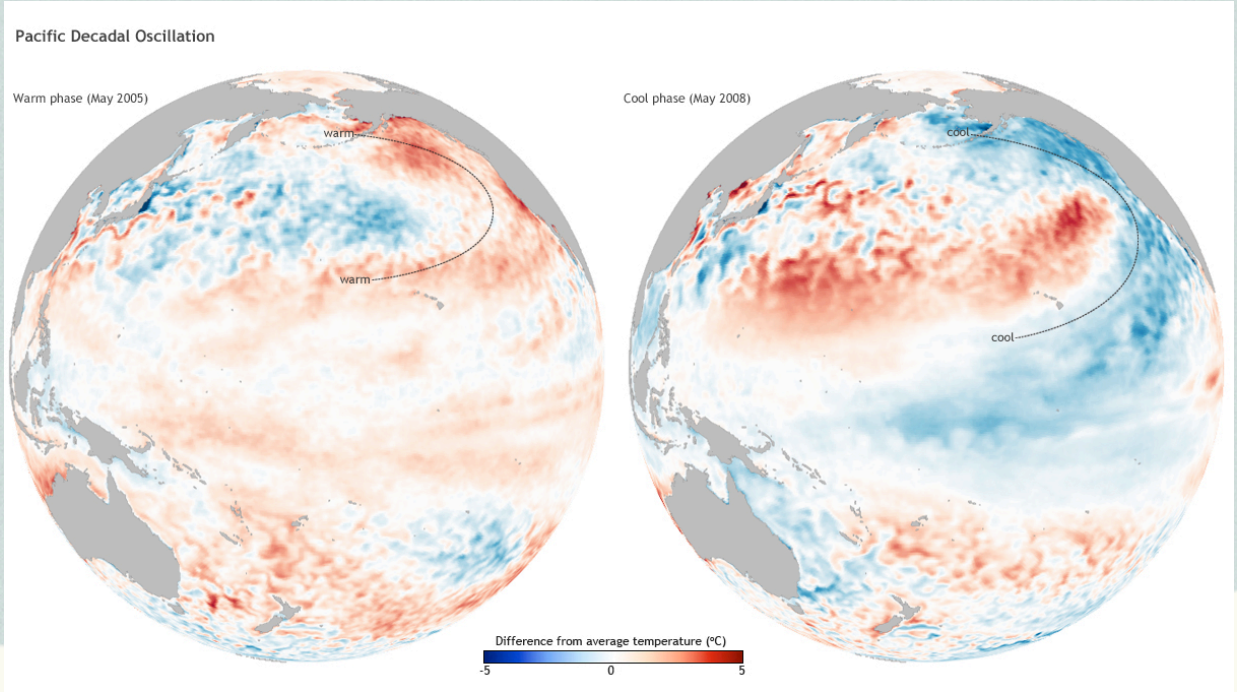
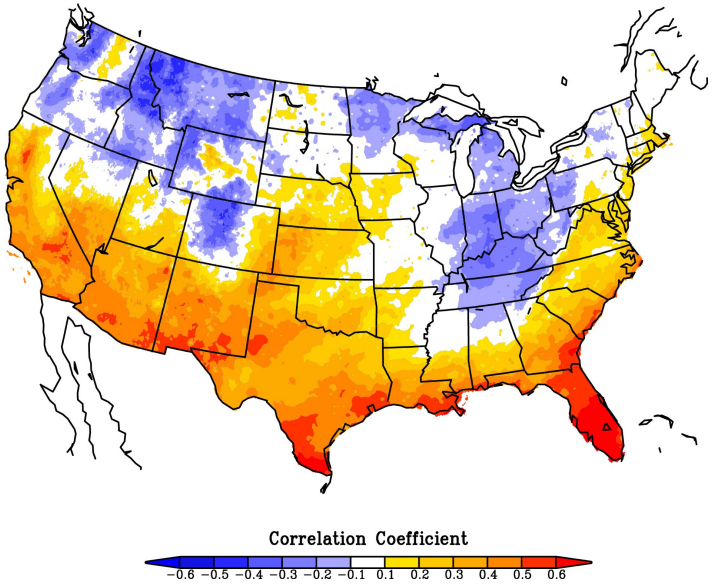
Ocean Circulations

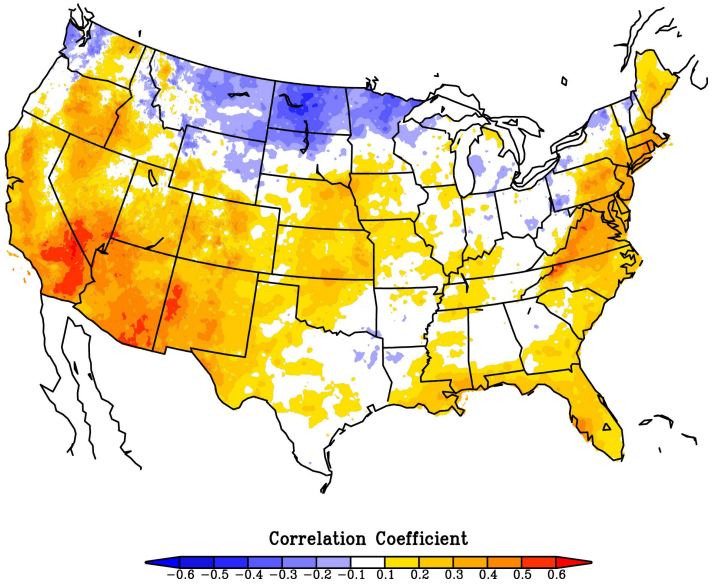
- Oceans flip between “warm phases” and “cool phases”
- Pacific, Atlantic oscillations about every 20-30 years
- Tropical Pacific every few years (El Niño / La Niña)
- Affects jet stream patterns



DJF Precipitation versus MEI (1956–2005)



MAM Precipitation versus MEI (1956–2005)



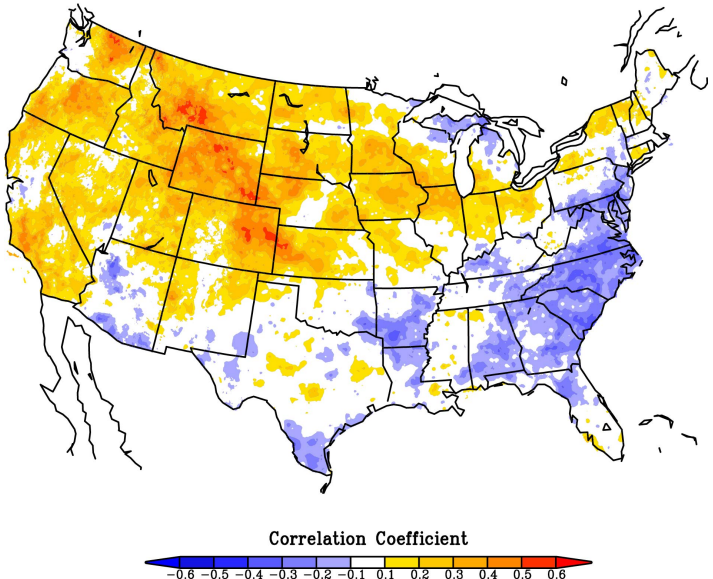
Seasonal cycle of ENSO impacts

New Mexico has positive correlations year-round, especially in winter and spring (top panels).

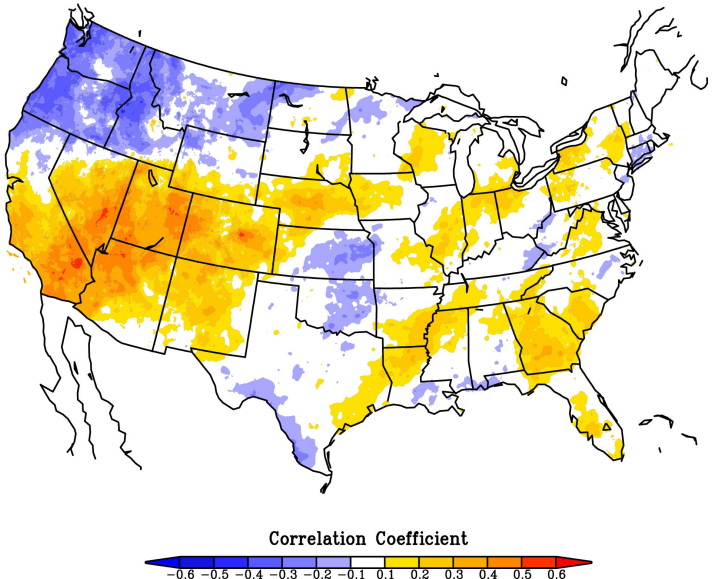
Texas correlates highest in winter. Summer and fall are barely constrained by phase of ENSO.

Oklahoma shows negative correlations in fall (lower right), while the other three seasons favor positive correlations, especially in winter.

JJA Precipitation versus MEI (1956–2005)

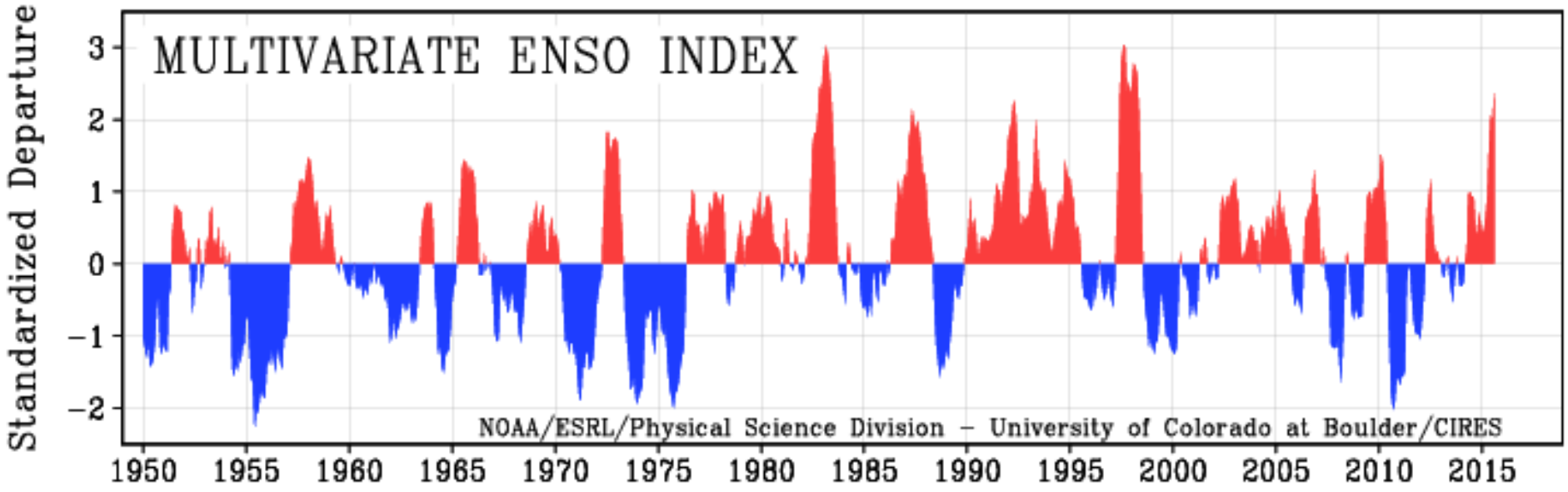


SON Precipitation versus MEI (1956–2005)



“Phases” of ENSO

Preference for El Niños



Preference for La Niñas

Unsettled, but often weak

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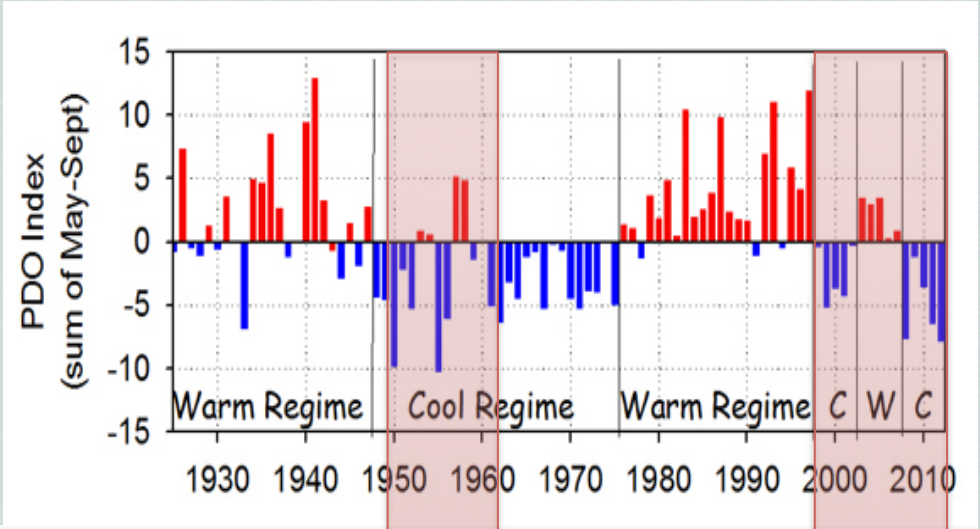
Source: NCA

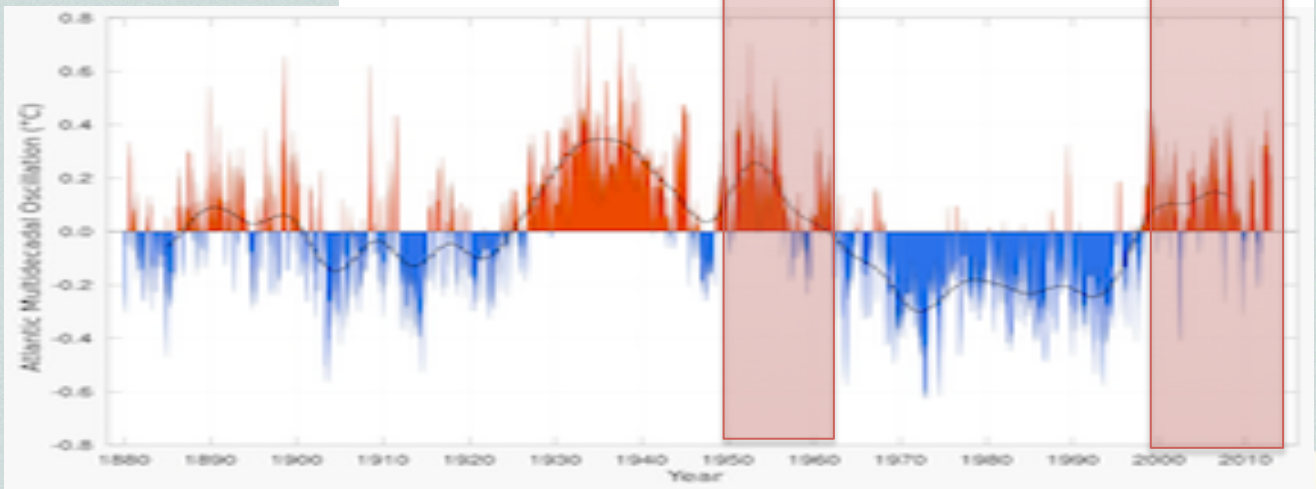
National Drought Mitigation Center · TAMU · LSU · OU

When These Align, It Can Be Bad News

PDO



AMO



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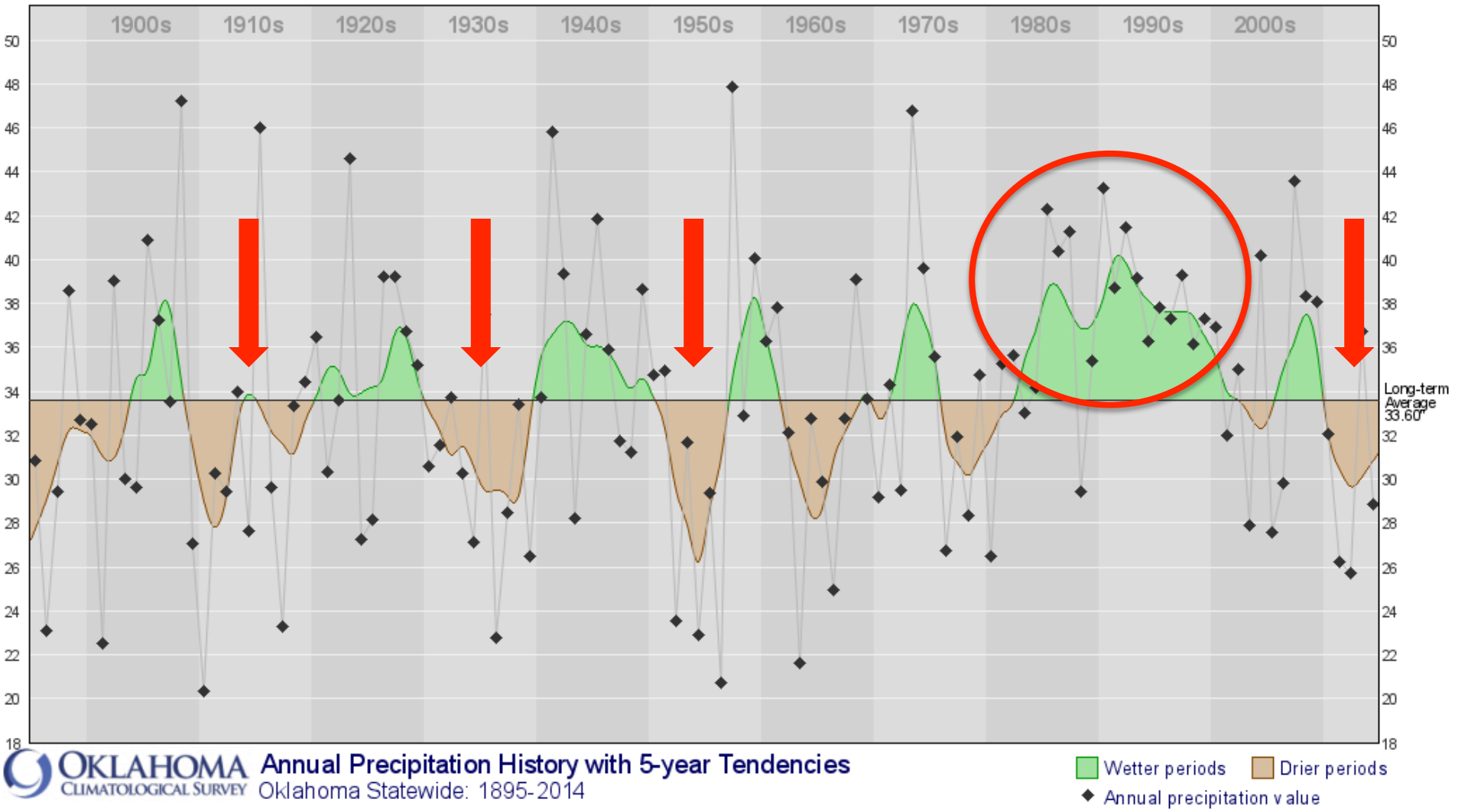
Historical Droughts in Oklahoma



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Projections for the Future

Higher air temperatures will cause increases in surface evaporation

Drier soils will absorb a larger proportion of the incoming heat from the sun

Hotter soils and adjacent air results in hotter summers

- Even areas where precipitation does not decrease will be susceptible to drought from higher temperatures

Under higher emissions scenarios, widespread drought is projected to become more common over most of the central and southern U.S.

By mid-century, the *average* annual temperature in most locations will exceed the current *hottest* year on record

- For most states, the hottest year on record is less than 3 degrees above the long-term mean

Energy, Water, and Land Use

Rising temperatures are leading to increased demand for water and energy. In parts of the region, this will constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs.

National Climate Assessment, 2014

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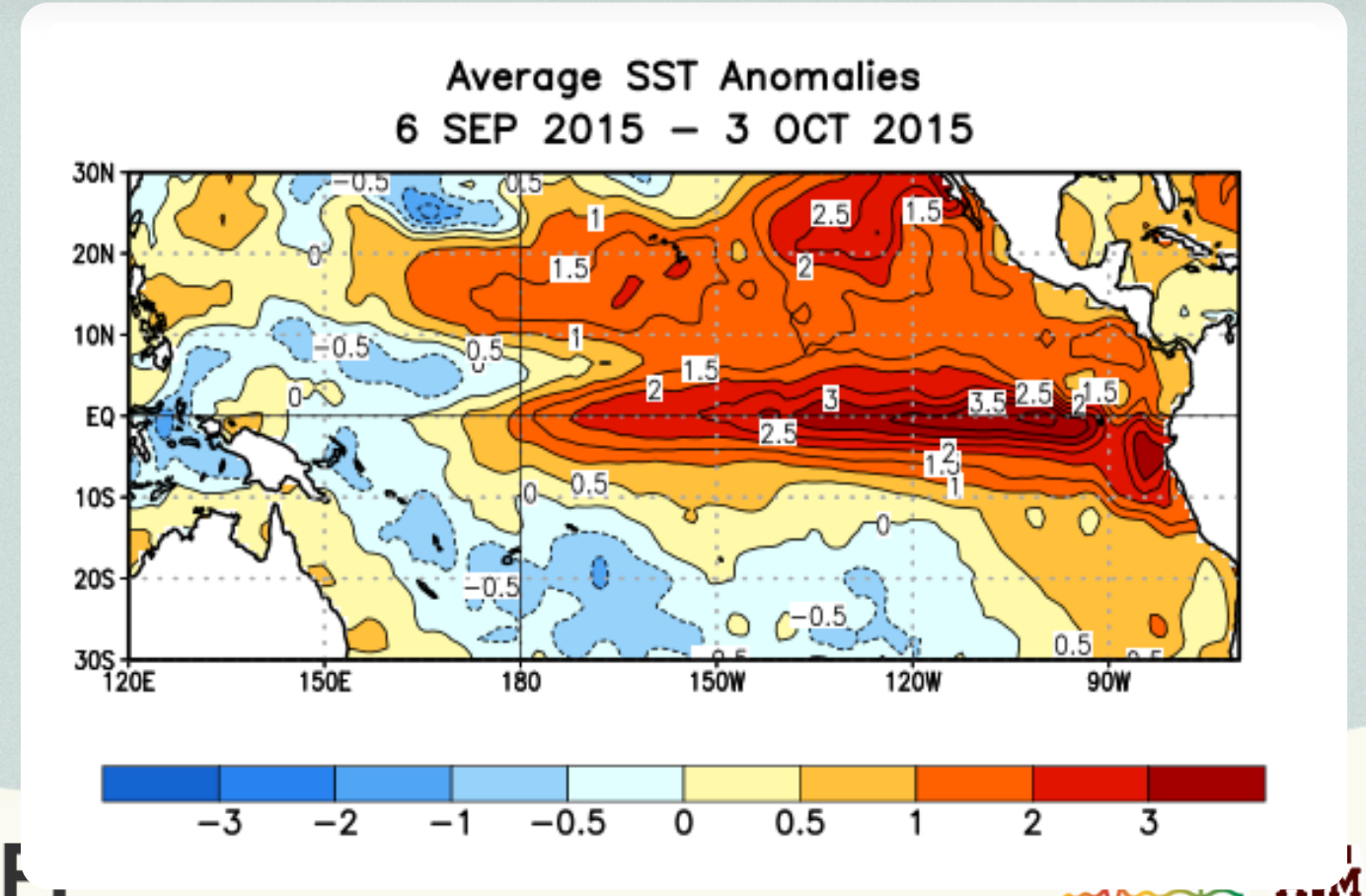
CURRENT TELECONNECTIONS STATUS

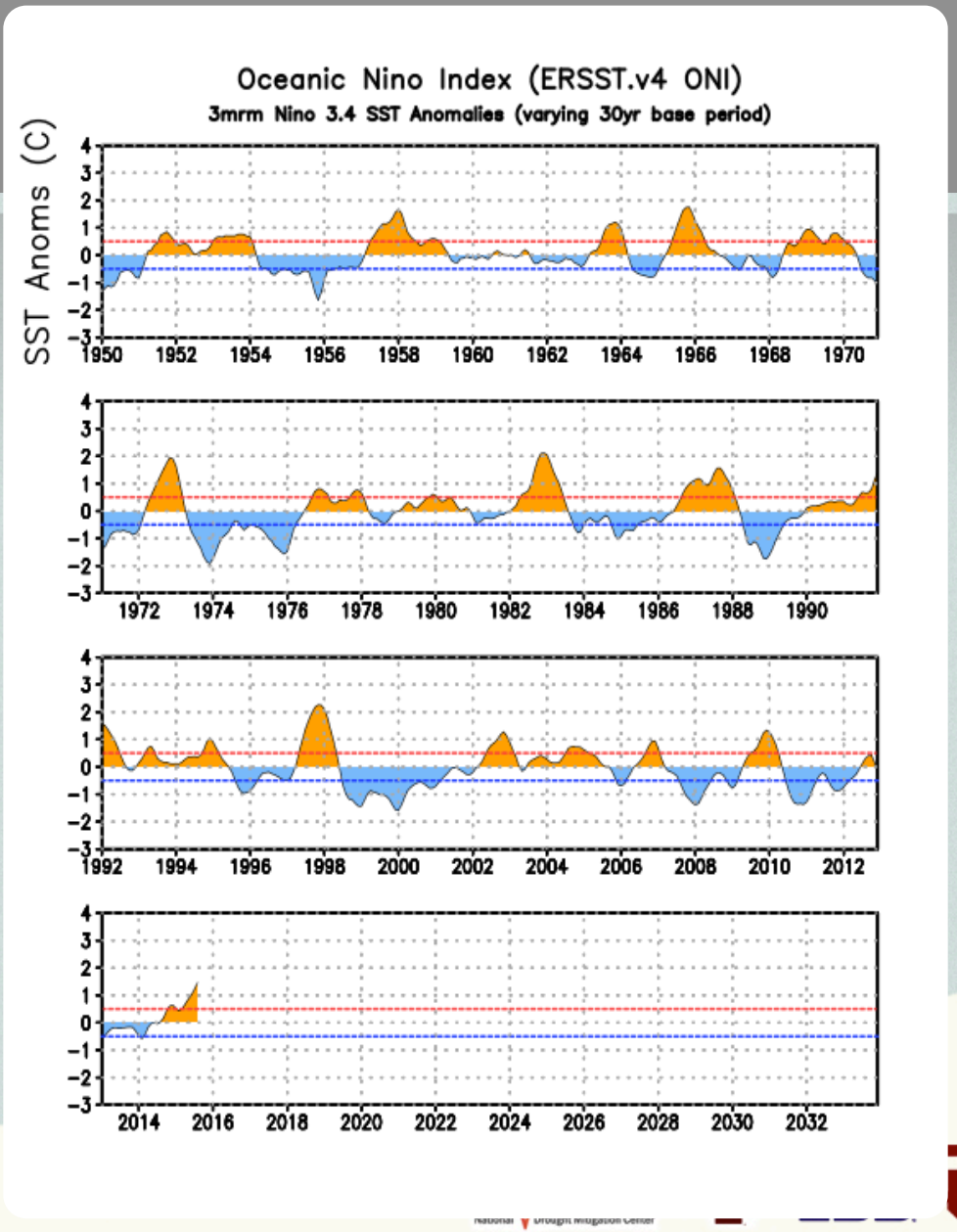
SST Departures (°C) in the Tropical Pacific During the Last Four Weeks

During the last four weeks, tropical SSTs were above average across the central and eastern Pacific, with the largest anomalies in the eastern Pacific.



ONI (°C): Evolution since 1950

The most recent ONI value (July - September 2015) is 1.5°C.



El Niño

Neutral

La Niña

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Historical El Niño and La Niña Episodes Based on the ONI computed using ERSST.v4

Recent Pacific warm (red) and cold (blue) periods based on a threshold of +/- 0.5 °C for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v4 SST anomalies in the Nino 3.4 region (5N-5S, 120-170W)]. For historical purposes, periods of below and above normal SSTs are colored in blue and red when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

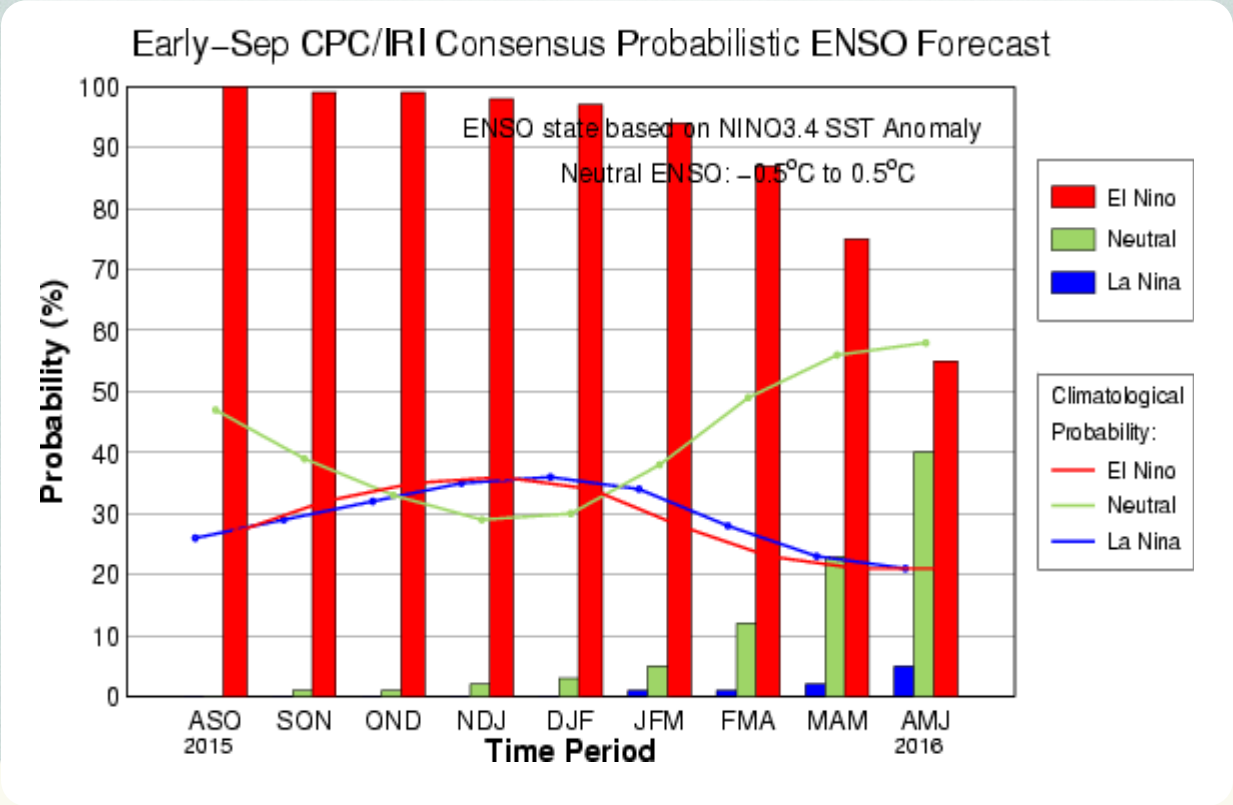
The ONI is one measure of the El Niño-Southern Oscillation, and other indices can confirm whether features consistent with a coupled ocean-atmosphere phenomenon accompanied these periods. The complete table going back to DJF 1950 can be found here.

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2003	0.9	0.6	0.4	0.0	-0.2	-0.1	0.1	0.2	0.3	0.4	0.4	0.4
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.5	0.5	0.4	0.2	0.1	0.0	0.0	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.2	0.0	0.1	0.2	0.3	0.5	0.8	0.9	1.0
2007	0.7	0.3	0.0	-0.1	-0.2	-0.2	-0.3	-0.6	-0.8	-1.1	-1.2	-1.3
2008	-1.4	-1.3	-1.1	-0.9	-0.7	-0.5	-0.3	-0.2	-0.2	-0.3	-0.5	-0.7
2009	-0.8	-0.7	-0.4	-0.1	0.2	0.4	0.5	0.6	0.7	1.0	1.2	1.3
2010	1.3	1.1	0.8	0.5	0.0	-0.4	-0.8	-1.1	-1.3	-1.4	-1.3	-1.4
2011	-1.3	-1.1	-0.8	-0.6	-0.3	-0.2	-0.3	-0.5	-0.7	-0.9	-0.9	-0.8
2012	-0.7	-0.6	-0.5	-0.4	-0.3	-0.1	0.1	0.3	0.4	0.4	0.2	-0.2
2013	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
2014	-0.5	-0.6	-0.4	-0.2	0.0	0.0	0.0	0.0	0.2	0.4	0.6	0.6
2015	0.5	0.4	0.5	0.7	0.9	1.0	1.2	1.5				

CPC/IRI Probabilistic ENSO Outlook

Updated: 10 September 2015

The chance of El Niño is approximately 95% through Northern Hemisphere winter and is near 55% by the late spring (AMJ) 2016.



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IRI/CPC Pacific Niño 3.4 SST Model Outlook

Most models indicate that Niño 3.4 will be above +1.5°C (a "strong" El Niño) during late 2015 into early 2016.

Positive anomalies are predicted to weaken through the Northern Hemisphere Spring 2016.

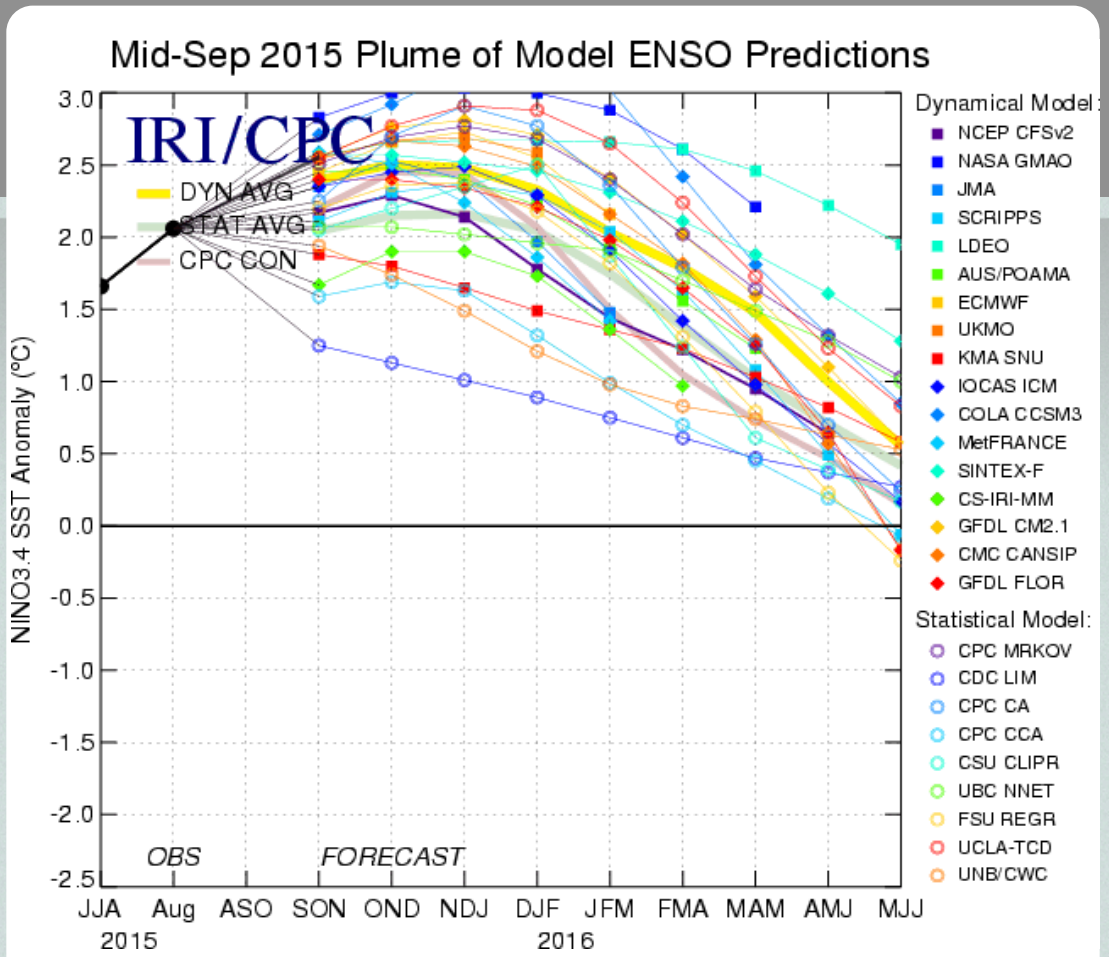

Figure provided by the International Research Institute (IRI) for Climate and Society (updated 15 September 2015).

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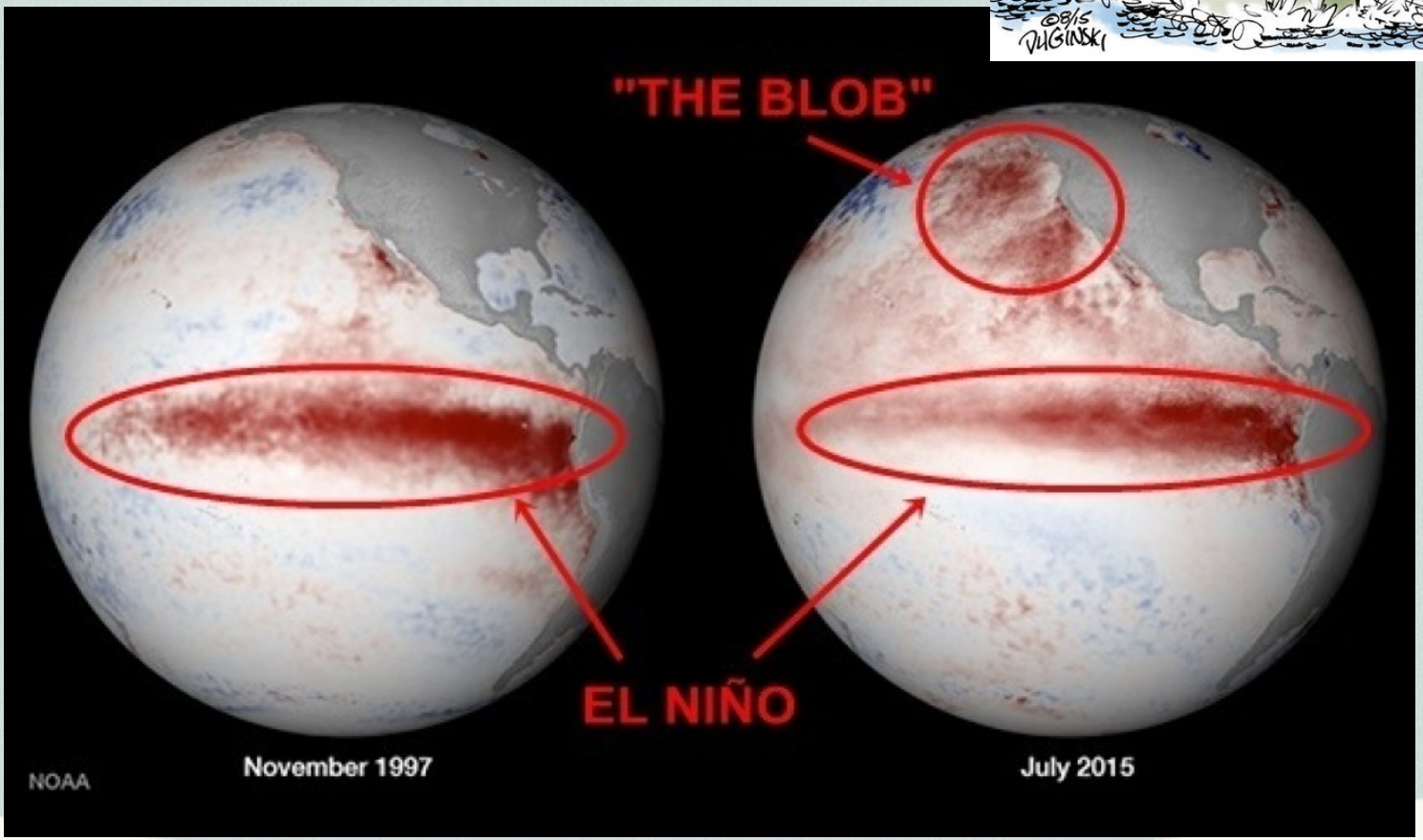
“Godzilla” El Nino versus The Blob



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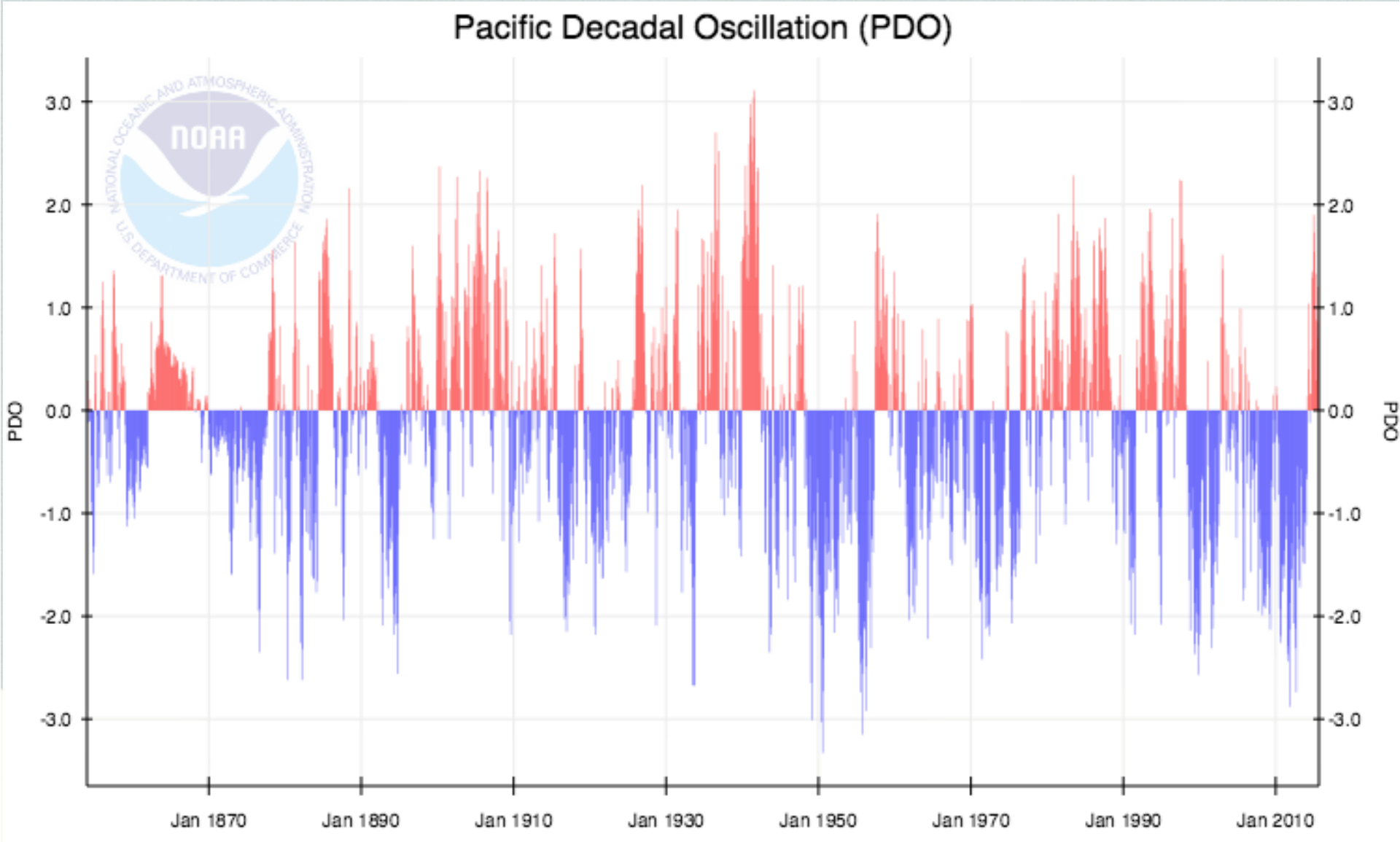
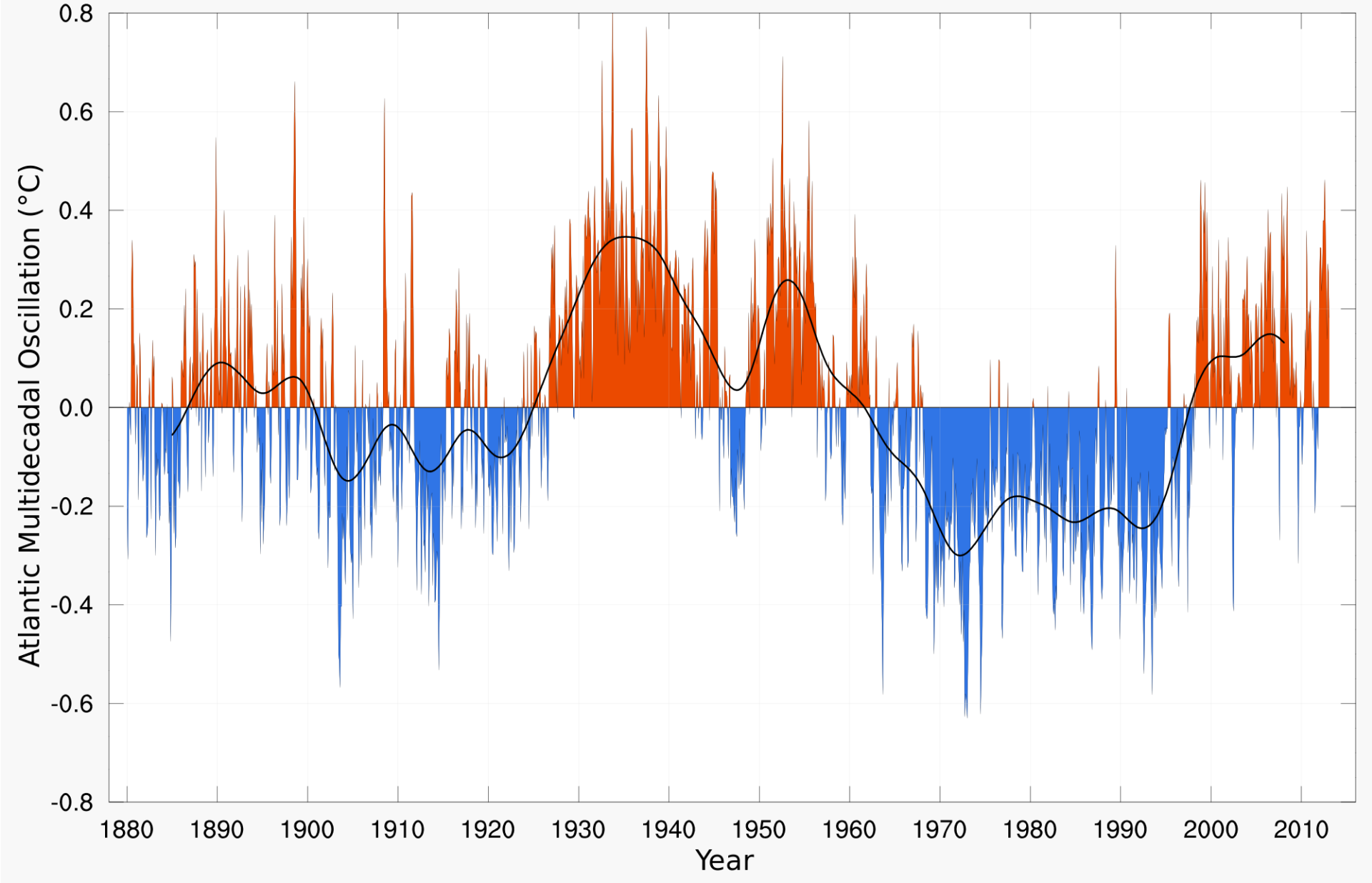
Current Status of the Pacific Decadal Oscillation



Atlantic Multidecadal Oscillation still running warm



Thank You!

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NOAA Sectoral Applications Research Program (SARP)
NIDIS / Coping With Drought