Changing Climate: Impacts on Agriculture

Great Lakes Crop Summit 2015

Conclusions

- **Climate change is not linear. It ebbs and flows.**

- Recent polar volcano eruptions created a cool autumn and will create a cold winter and cooler early spring. The impact of the volcanoes should fade during springtime and should have limited impact on the growing season.

- The warm phase of the AMO usually creates hotter summers (except during summers with major volcanic cooling) and stormier spring and summers around the Great Lakes and Corn Belt.
  The effect should last another 15 – 20 years.

- There were early summertime El Niño conditions and the conditions should affect this winter as well. Historically this means slightly cooler and wetter conditions in winter and, if it lasts until spring, creates a warm spring planting season with good rainfall in the Western Corn Belt.

- We have reached a tipping point. The PDO has changed and is creating more extreme weather and an increased risk of dry weather around the Great Lakes and Eastern Corn Belt for the next 15 – 20 years. It may also have changed the impact of El Niños.

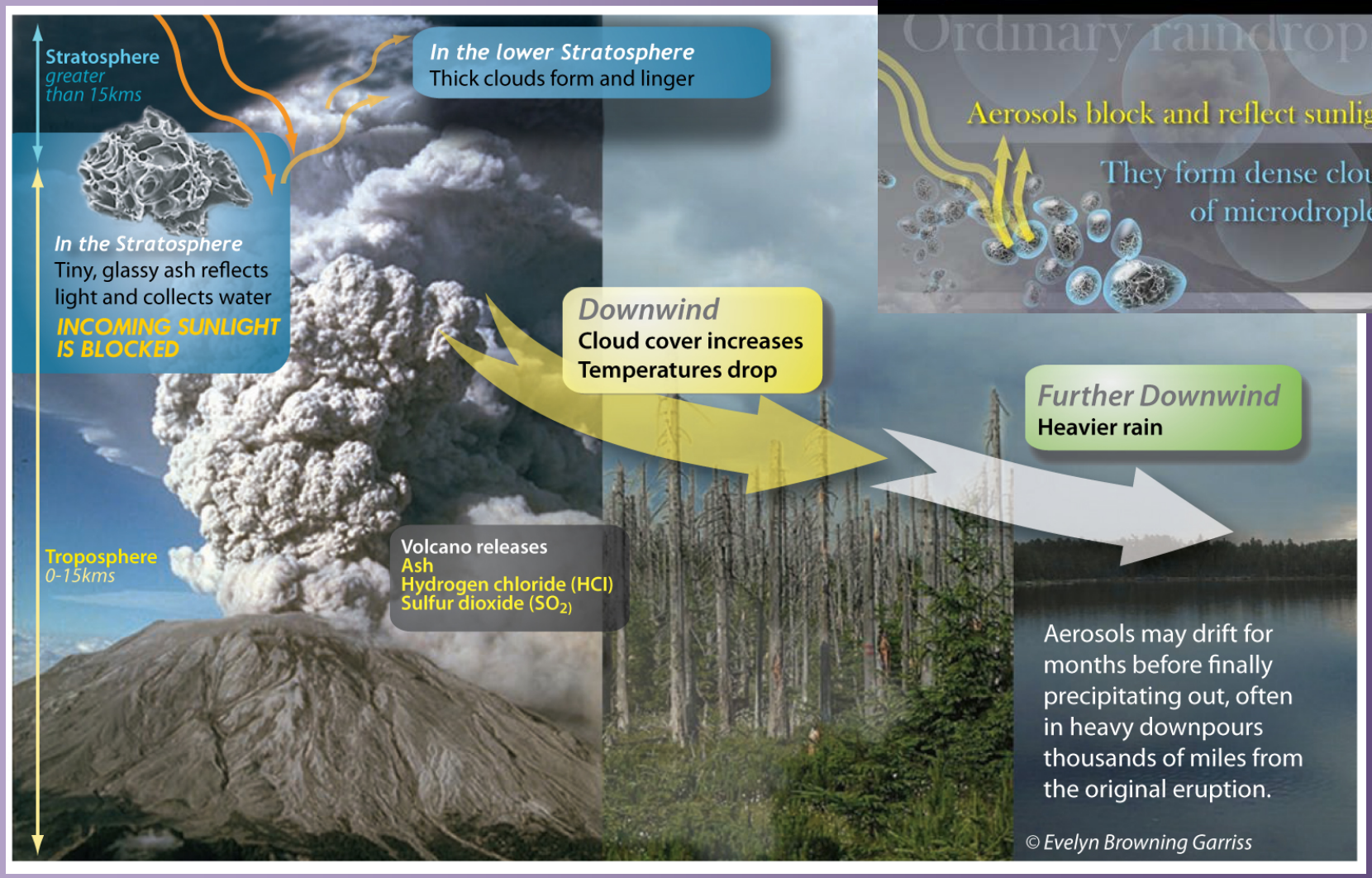
Basically the climate is determined by:

- How much solar radiation the Earth receives (the Sun)
- The patterns of where the solar radiation falls or is reflected (Clouds/Volcanoes)
- Where the heat from the solar radiation is stored (Oceans/Urban Heat Islands)

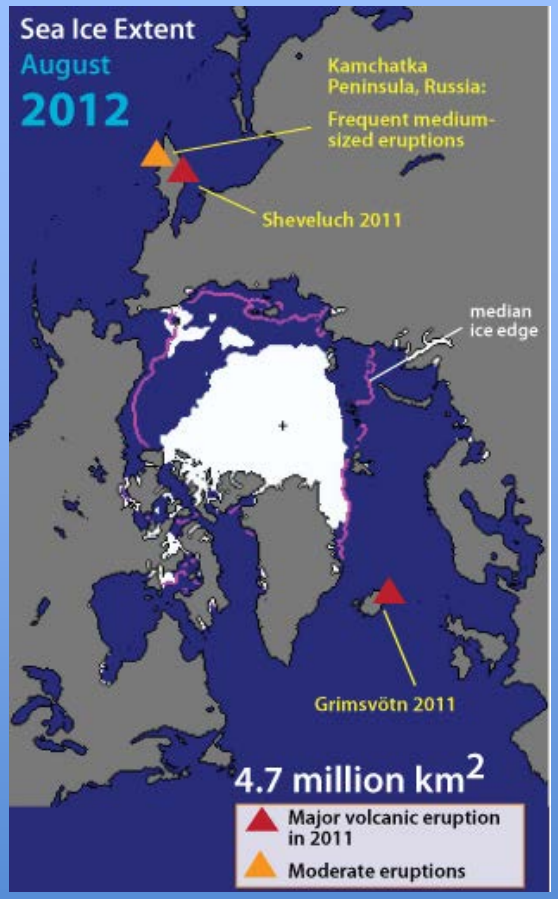
As an historical climatologist,
I look at what factors are shaping the weather and use:

Historical records, coral and tree rings,
sediment layers, and glacial cores to learn how they
shaped the weather in the past.

Clouds, the debris from large volcanoes, and man-made aerosols can reflect back sunlight and change rainfall patterns.



In 2011, large volcanoes erupted in both the North Atlantic and Pacific.

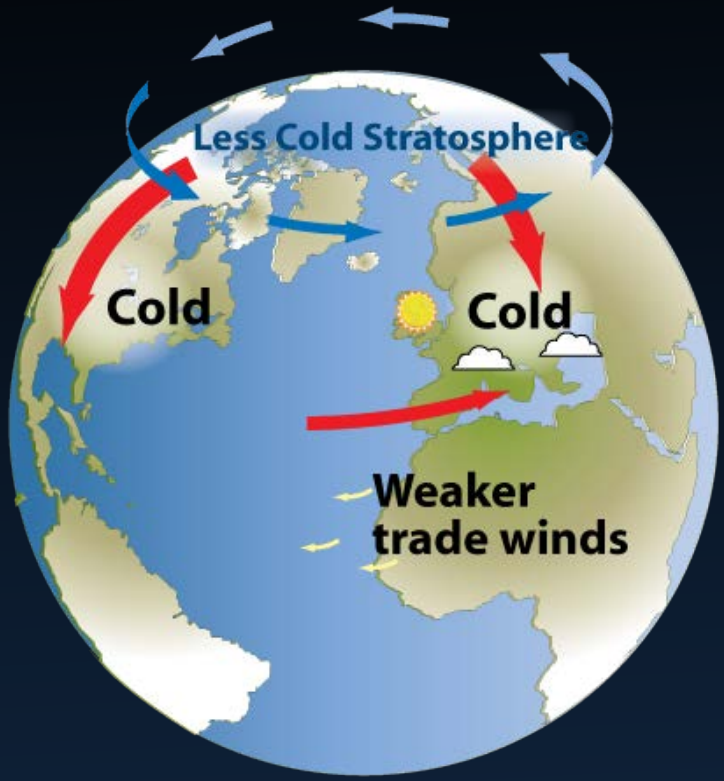


The cool Arctic summers have reduced the amount of summer melt for three years in a row.

National Snow and Ice Data Center

Positive AO

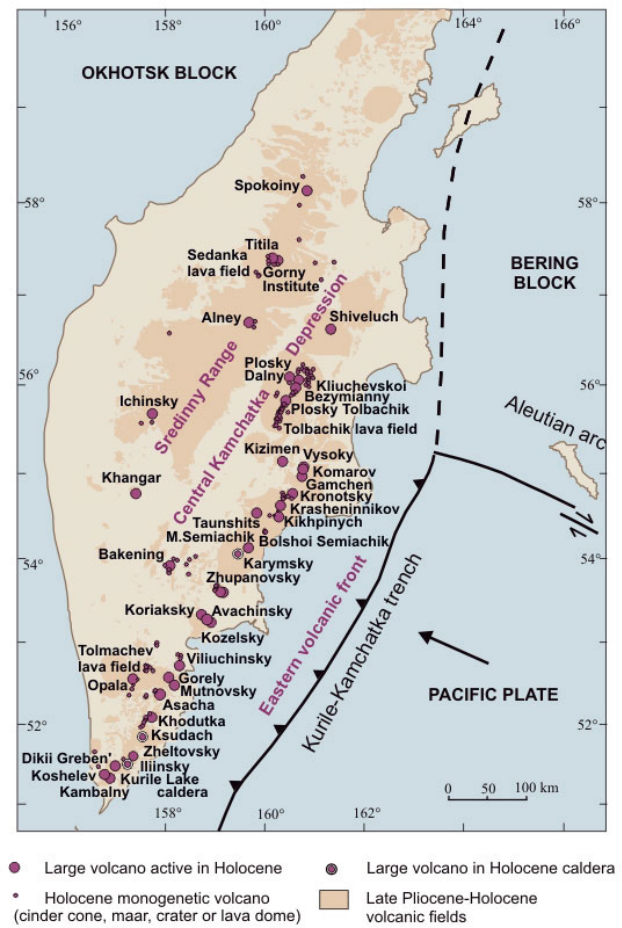
In 2012, the impact of northern Atlantic and Pacific volcanoes strengthened the circumpolar winds, making a strong positive Arctic Oscillation and trapping cold air north.



Negative AO

This year the circumpolar winds are weaker and are letting the unusually cold air flow south.

Facts to Remember about Volcanoes and Climate



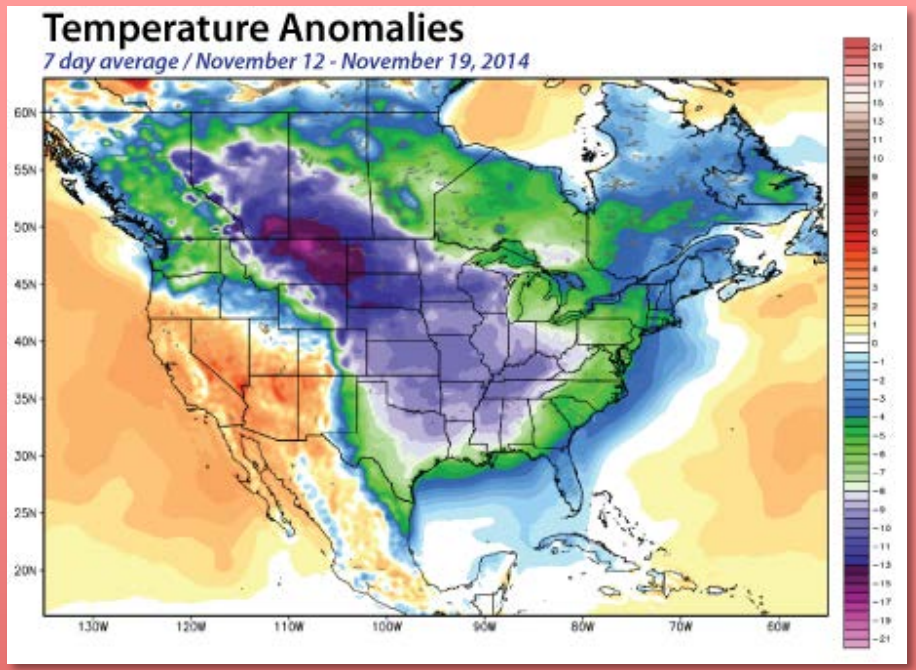
1 Volcanoes are the WILD CARDS of climate. They temporarily change long-term trends.

2 The key to an explosion's impact is LOCATION, LOCATION, LOCATION! Explosions in different areas change wind patterns differently.

The Russian volcanoes are restless and even moderate eruptions encourage the eastward – flowing polar jetstream to dive furthest south in North America.

Expect this to happen several times this winter.

http://www.kscnet.ru/ivs/volcanoes/holocene/main/main.htm




News Notes

based on assumptions that this winter will have the same demand (and similar temperatures) as last year.

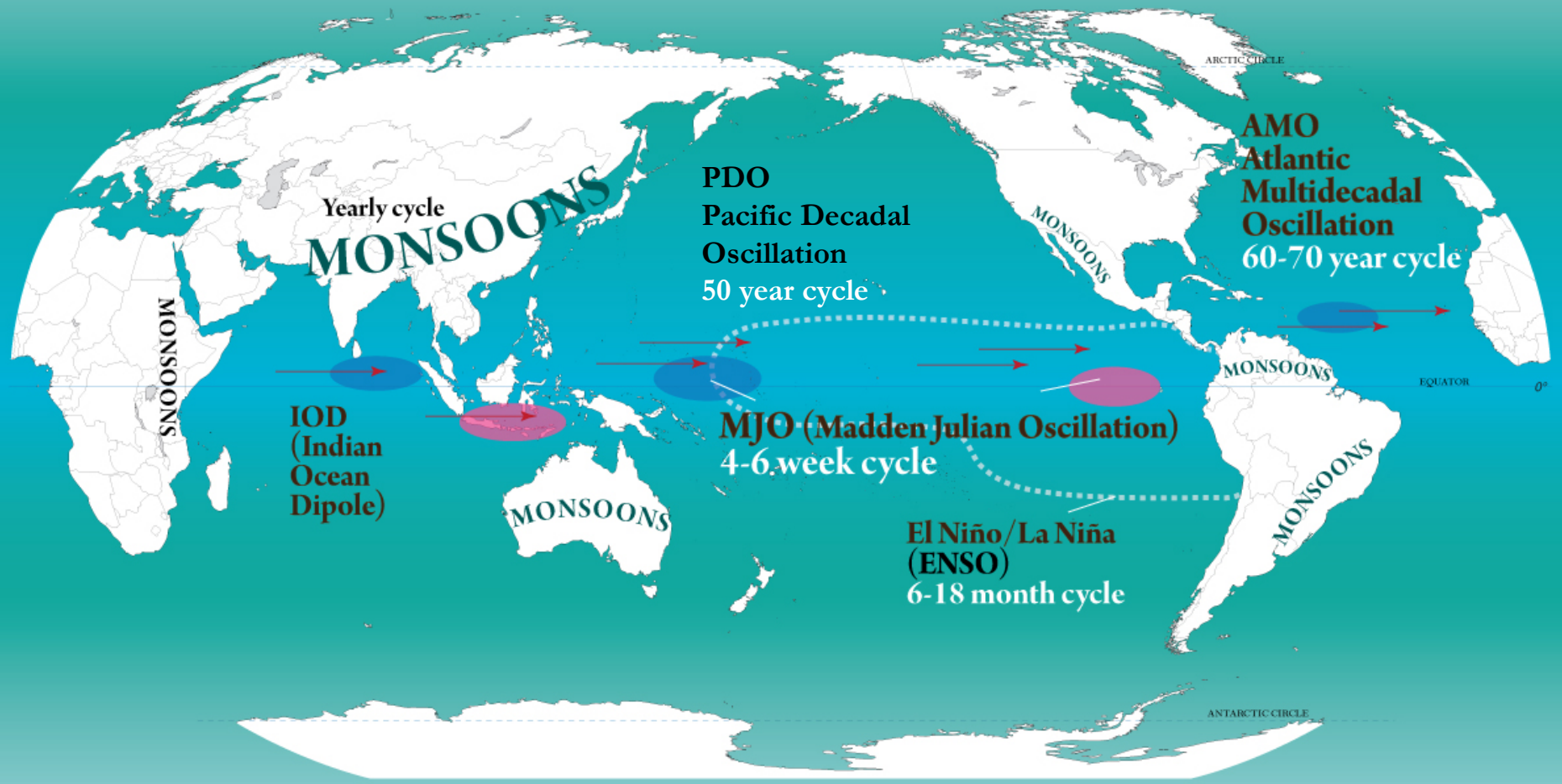
Mount Sheveluch in Russia remains restless. On October 28 and 30 the volcano erupted, with the ash plumes rising 11 km (6.8 miles) high. This is not large enough to affect climate, but it is large enough to enter the next passing cold front and bring a freeze around the second week of November.

Did you see the zombie hurricane that attacked Washington and British Columbia? This is the Halloween appropriate nickname some weather watchers are giving the still dangerous remnants of hurricane Ana. The problem is that a hurricane may lose its name, its structure and even its place on

The November newsletter warned that a Russian volcano would trigger a cold spell in the 2nd week of November.

courtesy: NOAA/NCEP
http://graphical.weather.gov/sectors/conusWeek.php#tabs

Oceans store and transport heat



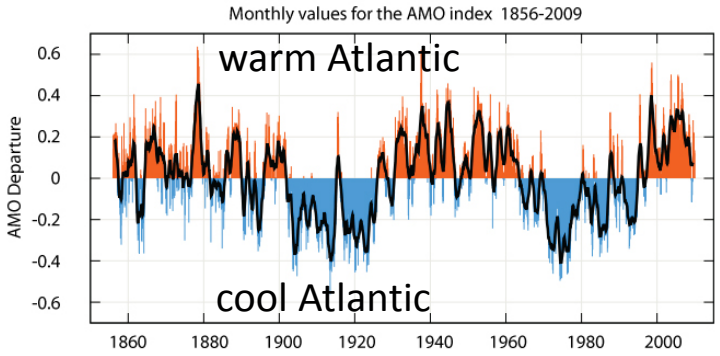
There are several oscillating patterns of ocean currents.

Oceans store and transport heat

The long-term Atlantic Multidecadal Oscillation **(AMO)** turned positive in 1995.

The Gulf stream flows faster.

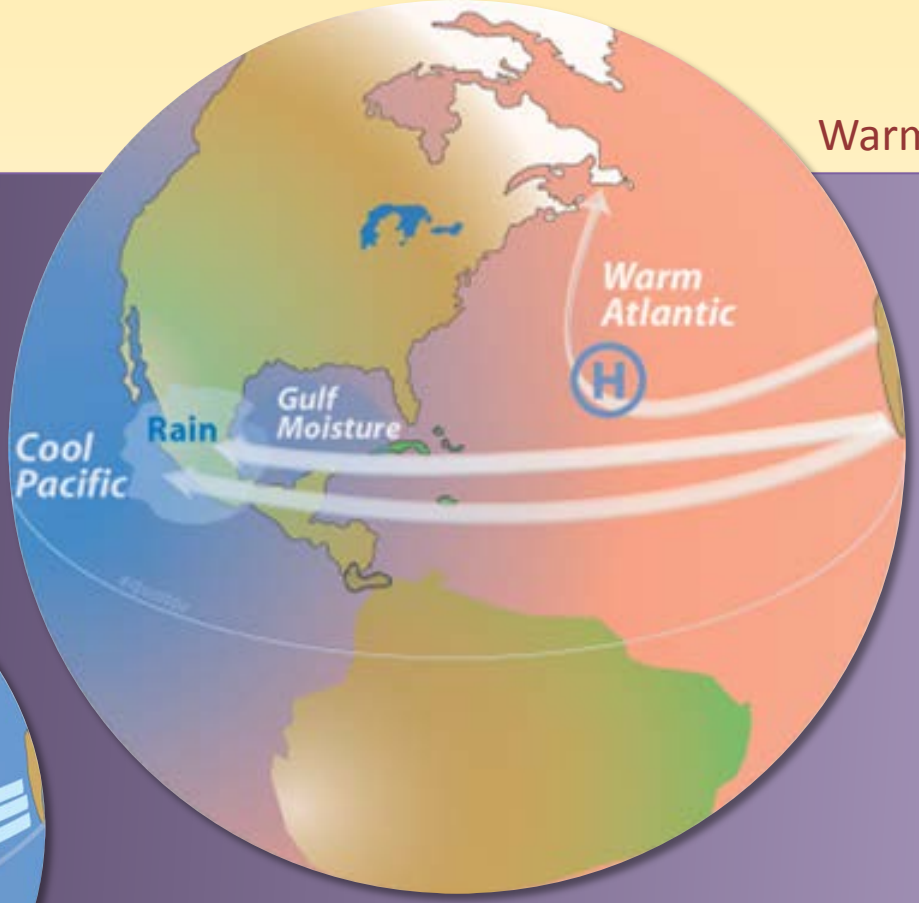
The North Atlantic warms.



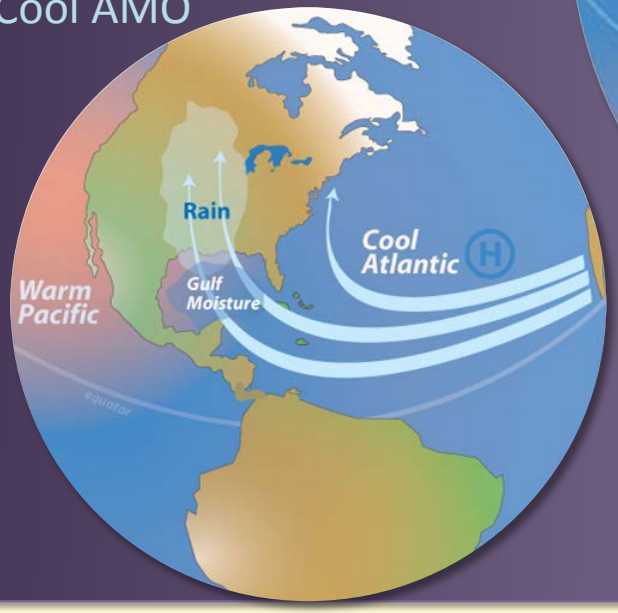
The Atlantic Multidecadal Oscillation (AMO) 1856-2009

http://en.wikipedia.org/wiki/File:Amo_timeseries_1856-present.s

Warm AMO



Cool AMO

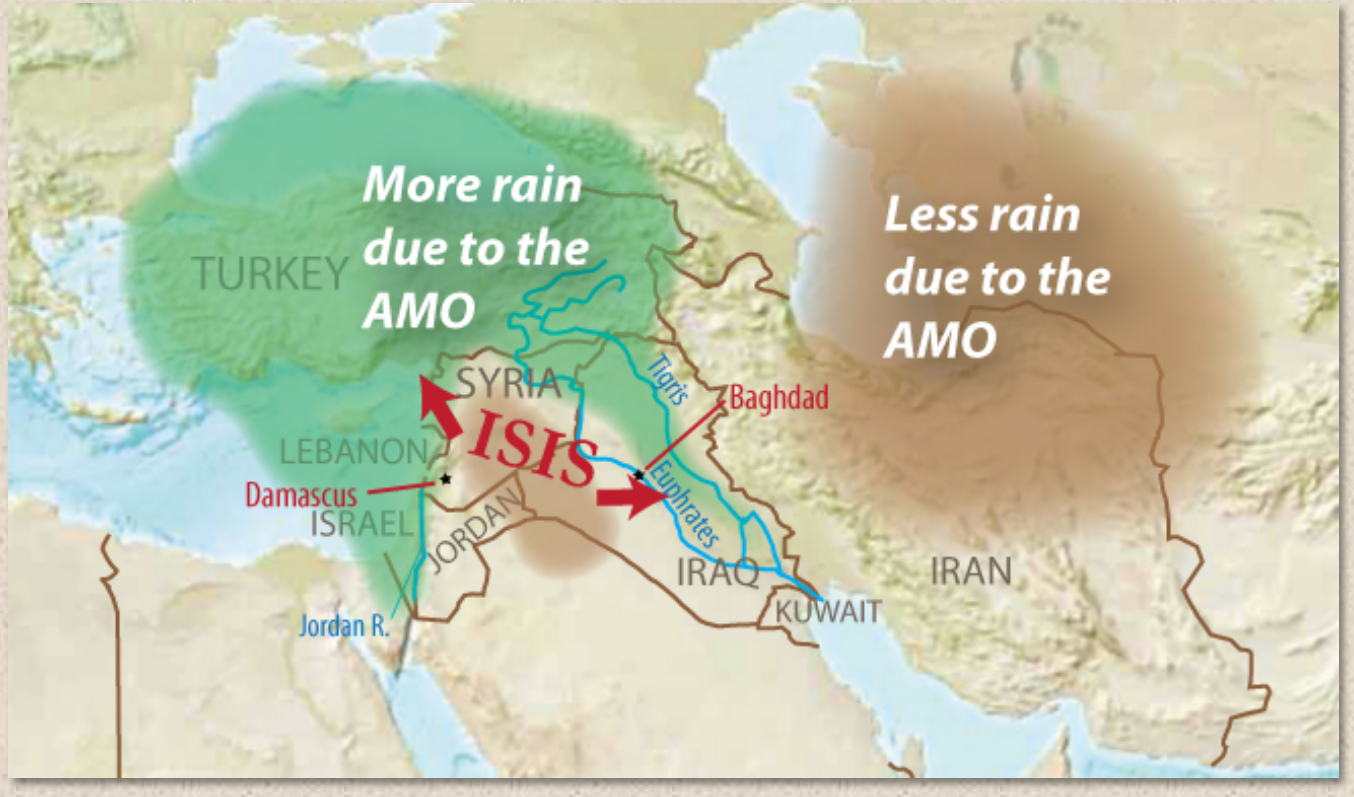


The warm phase of the AMO diverts precipitation from the Prairie Provinces,Gulf, and Great Plains.

This increases the risk of heat waves, droughts and wildfires.

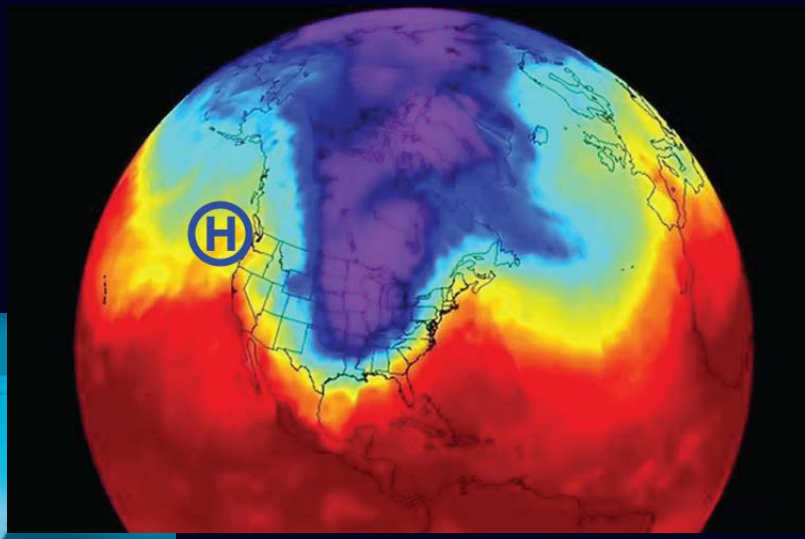
When the Atlantic is warm,
winter negative North Atlantic Oscillations
become more frequent.

The Positive AMO redistributes scarce water in the Middle East.

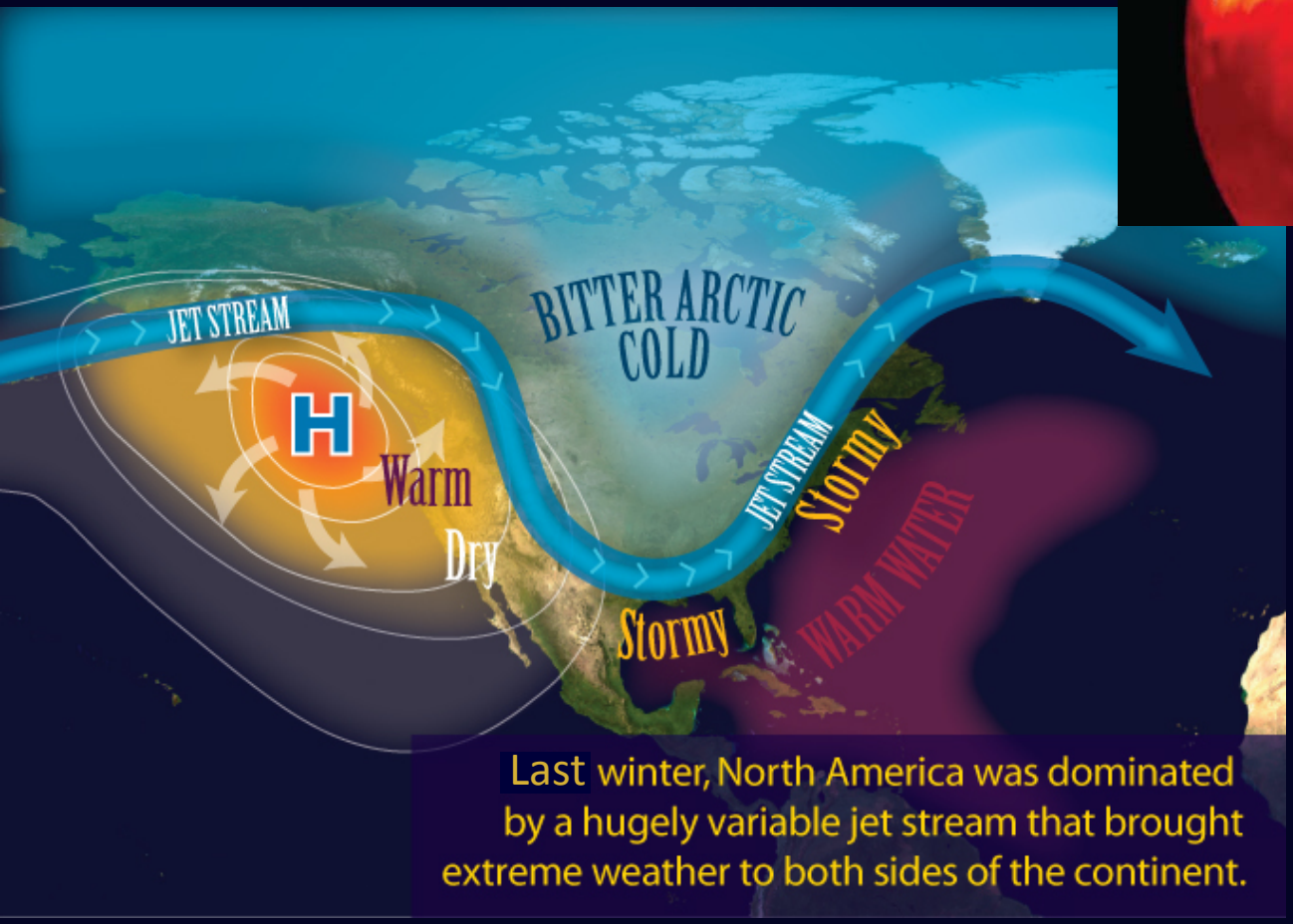


The Positive AMO redistributes scarce water in the Middle East.

These were the conditions that shaped last winter's notorious Polar Vortex weather.



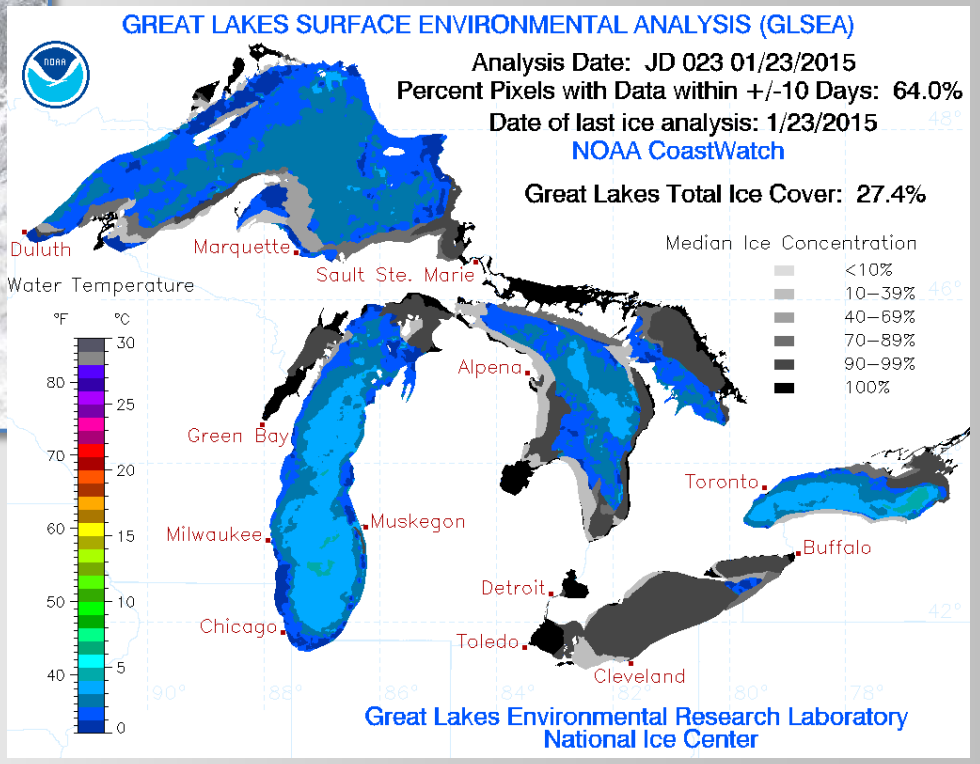
Winter's divided weather patterns will linger through spring.



2014

Last winter 92% of the Great Lakes were covered with ice and the ice lingered until June, cooling spring.

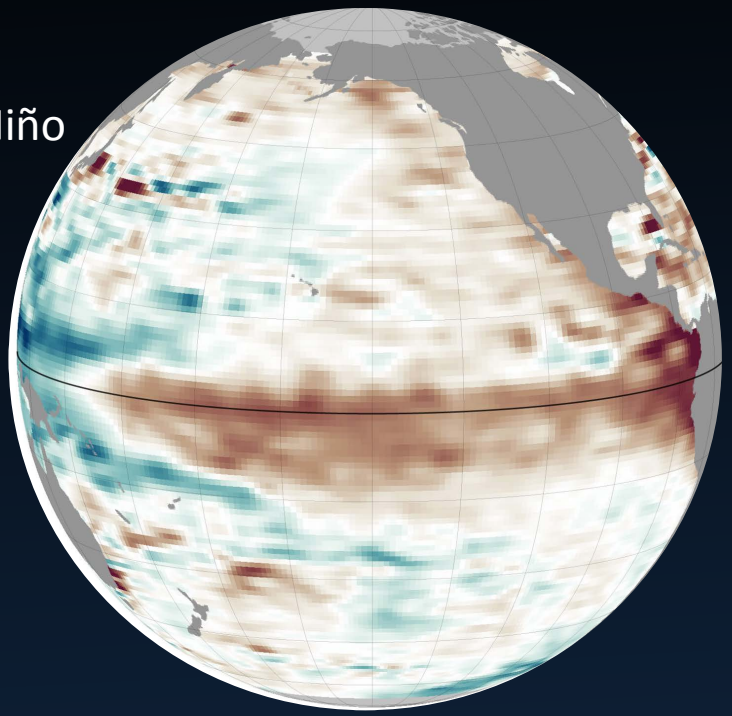
2015



So far, this year is matching last year, but experts expect only average cover.

coutesy: NOAA
http://coastwatch.glerl.noaa.gov/glsea/cur/glsea_cur.png

El Niño



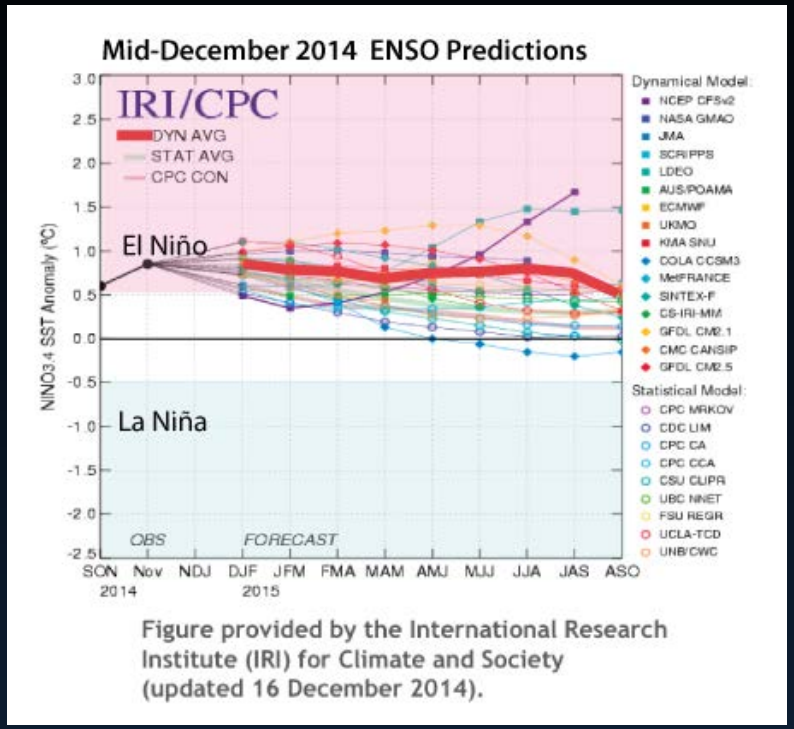


Figure provided by the International Research Institute (IRI) for Climate and Society (updated 16 December 2014).

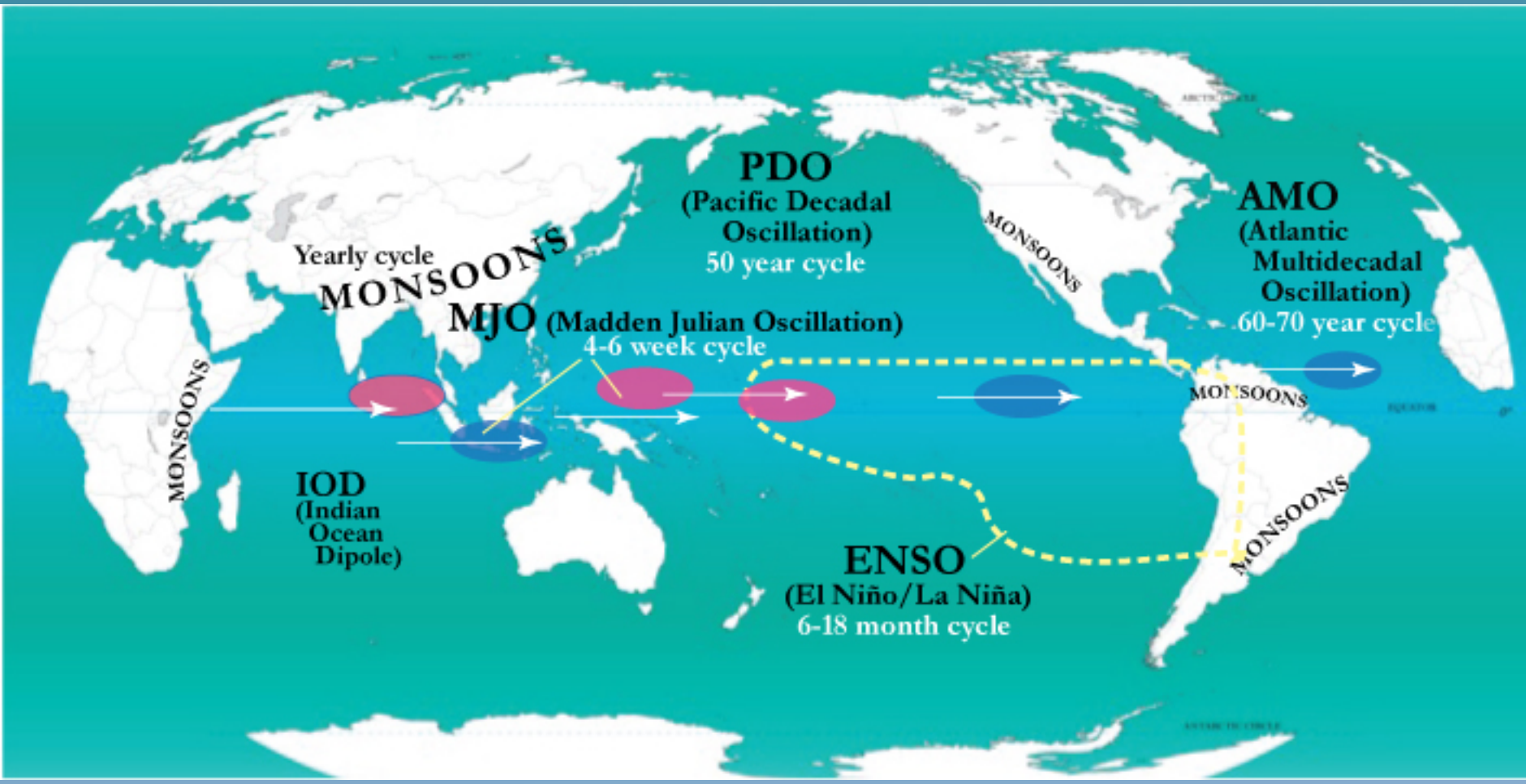
El Niño conditions developed in the Central and Eastern Tropical Pacific in Late May.

These conditions faded but **experts say there is a**

60%+ chance of an El Niño event returning.

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

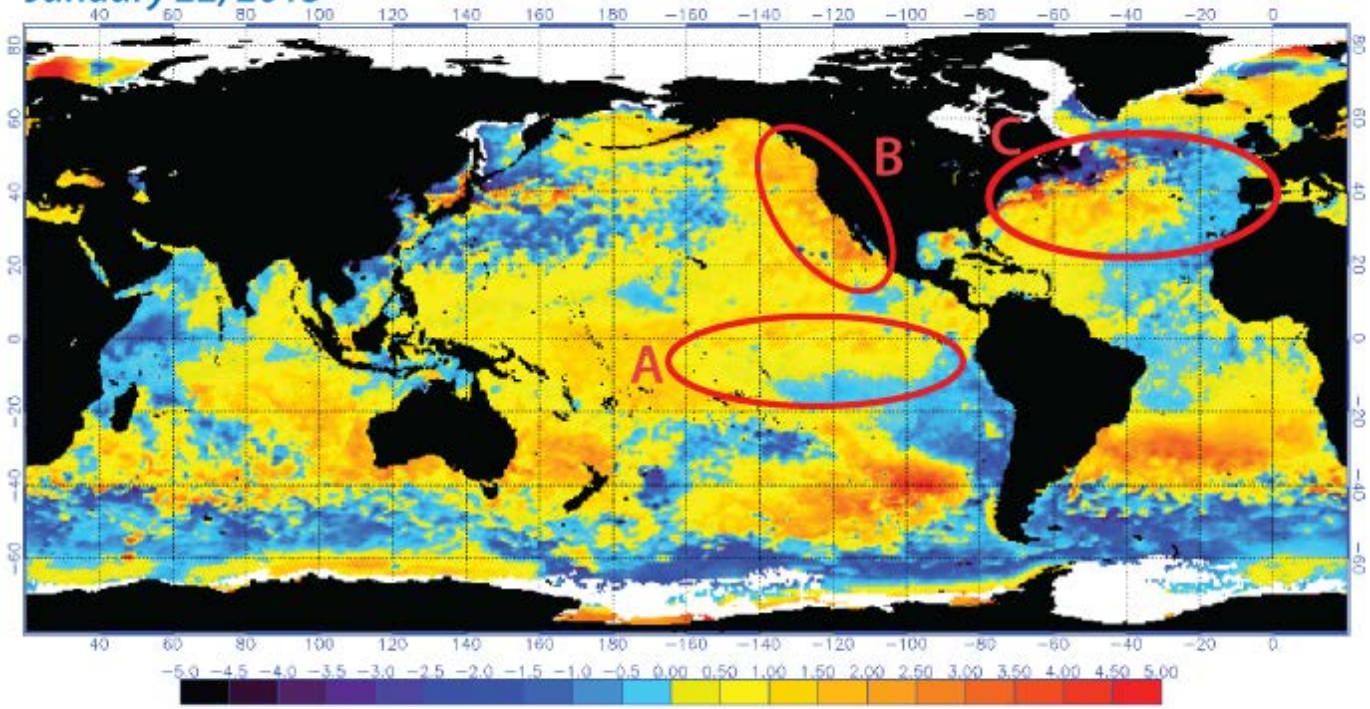
Remember the hot and cool MJOs



A cool MJO churned up the El Niño conditions starting in July and two warm MJOs are reheating it.

Global Sea Surface Temperature Anomalies (°C)

January 22, 2015



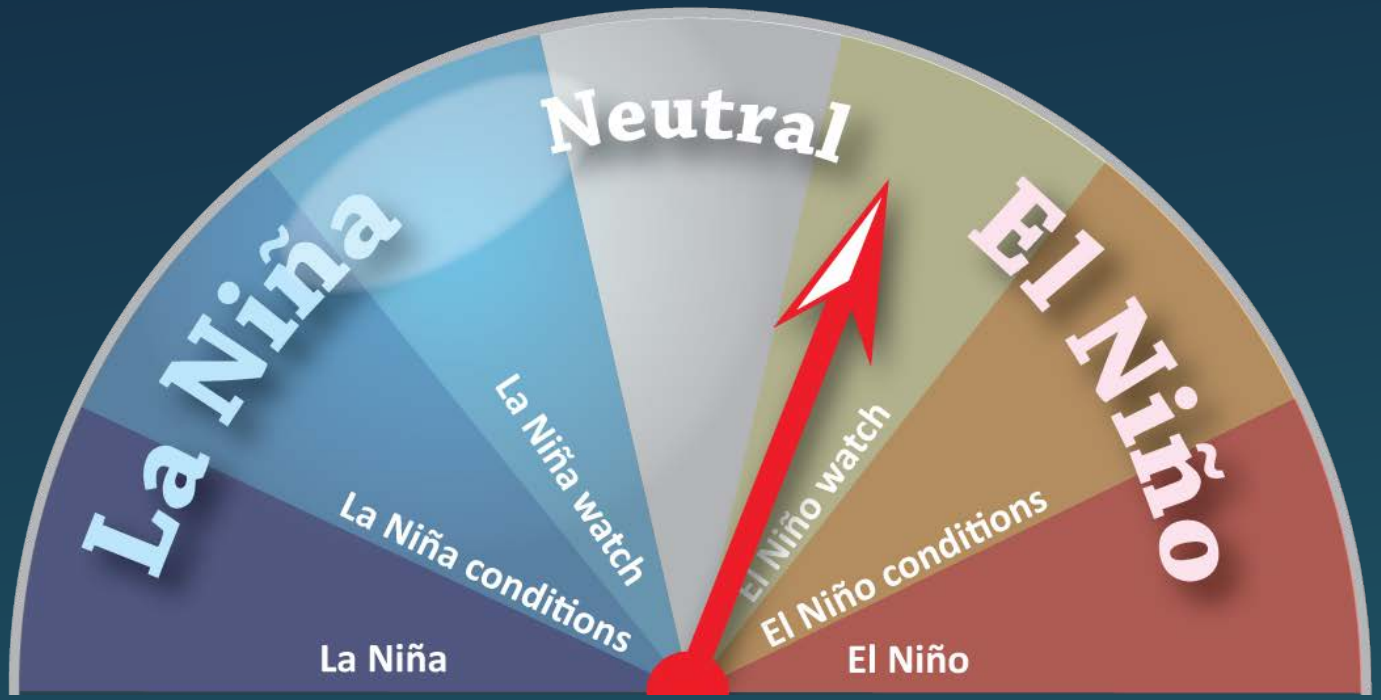
A El Niño conditions

B Warm temperatures along the West Coast of North America

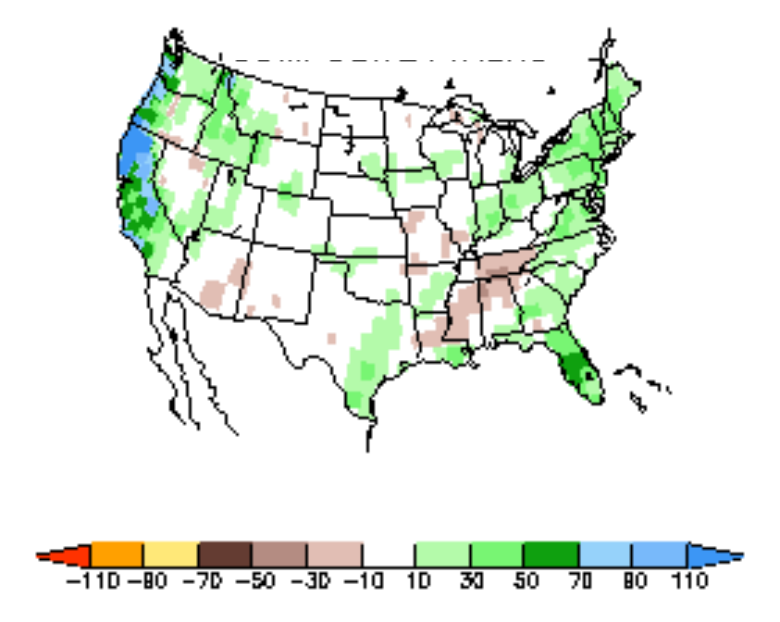
C The Western North Atlantic remains warm but the Eastern side is cooling.

http://www.ospo.noaa.gov/data/sst/anomaly/2015/anomnight.1.22.2015.gif

Even though there is only an official El Nino watch, it is creating El Nino weather patterns.



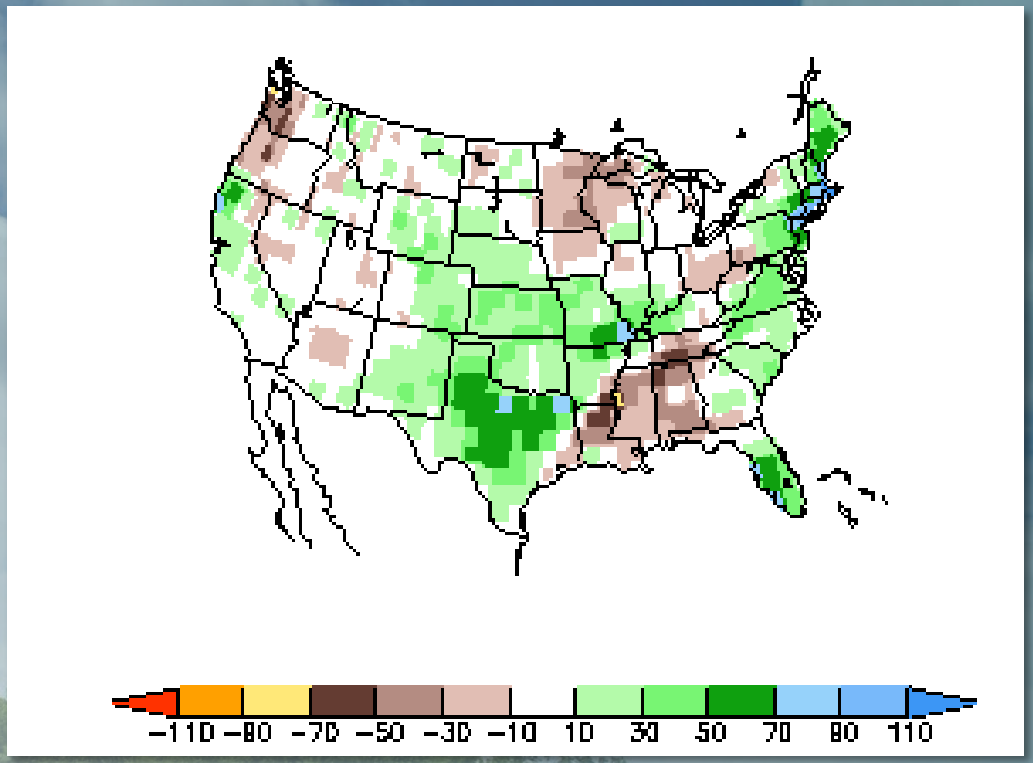
Winter and Spring will be shaped
by how big and long lasting the El Nino is.



December/ January/February
Precipitation Anomalies during El Niño

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/elnino.djf.precip.gif

Precipitation Anomalies



March/April/May

If the El Niño conditions become an El Niño, this is the most likely conditions in spring:

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/elnino.fma.precip.gif

mid-January to mid-February

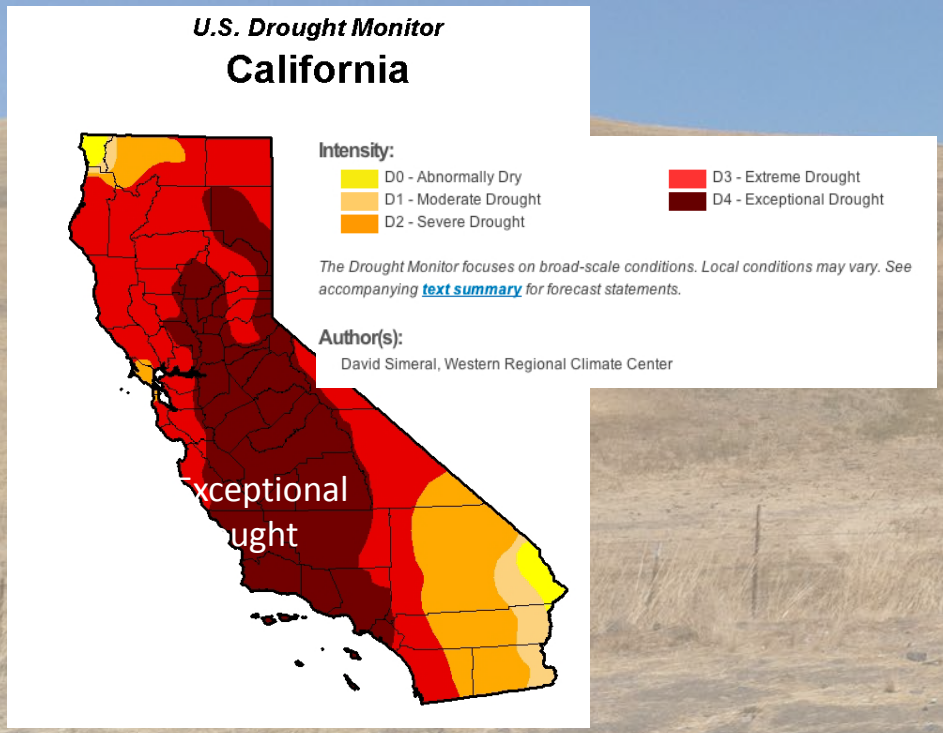
mid-February to mid-March

*If El Niño conditions continue

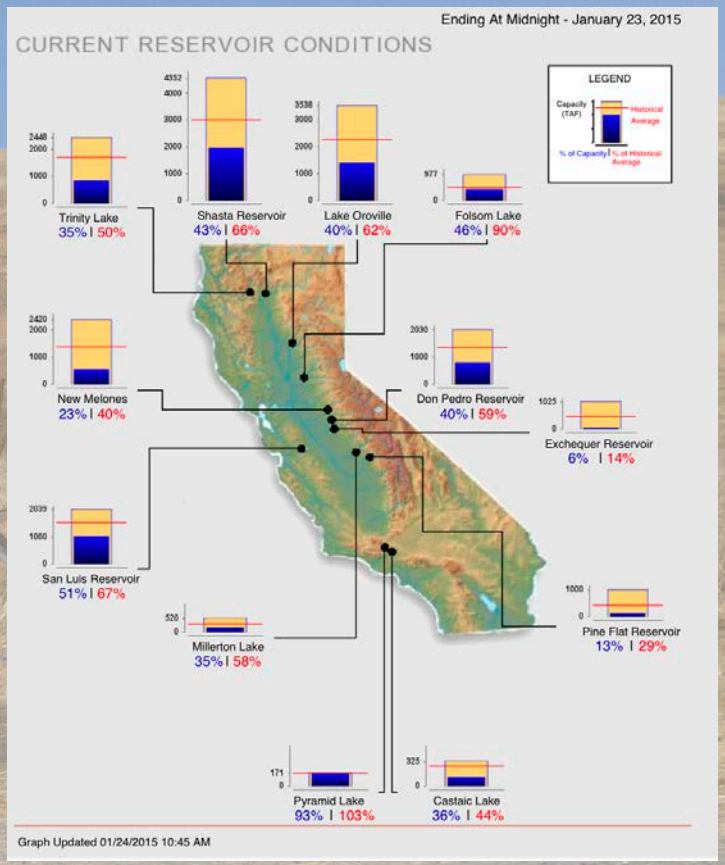
‡ A moderate Russian volcanic eruption will make this region colder.

Hot	Warm	Cold	Cool	Dry	Wet
2-4˚C or more higher than normal temps.	2-4˚C or more higher than normal temps.	5˚C or more lower than normal temps.	2-4˚C or more lower than normal temps.	75% or less of normal moisture	125% or more of normal moisture

The California drought is affecting 37.2 million people. **100% of the state is in drought** and 39% is in the most severe state of drought. Currently the state reservoirs stand at 61% of average.

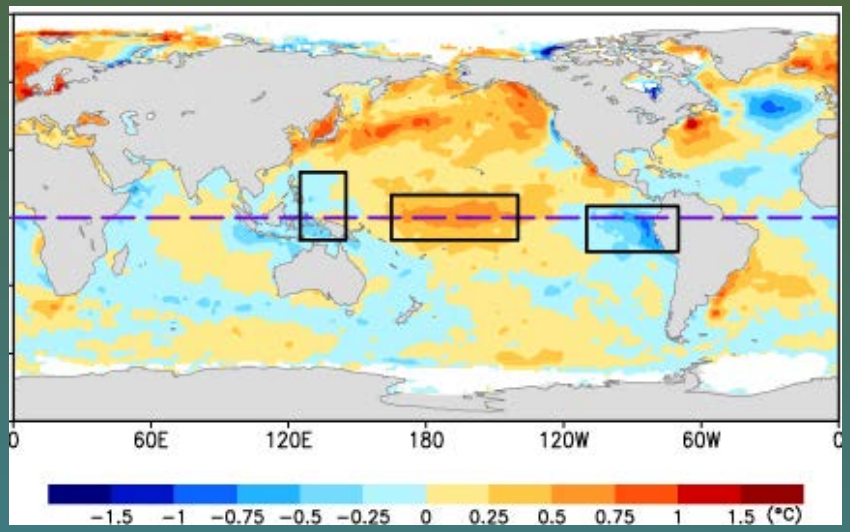


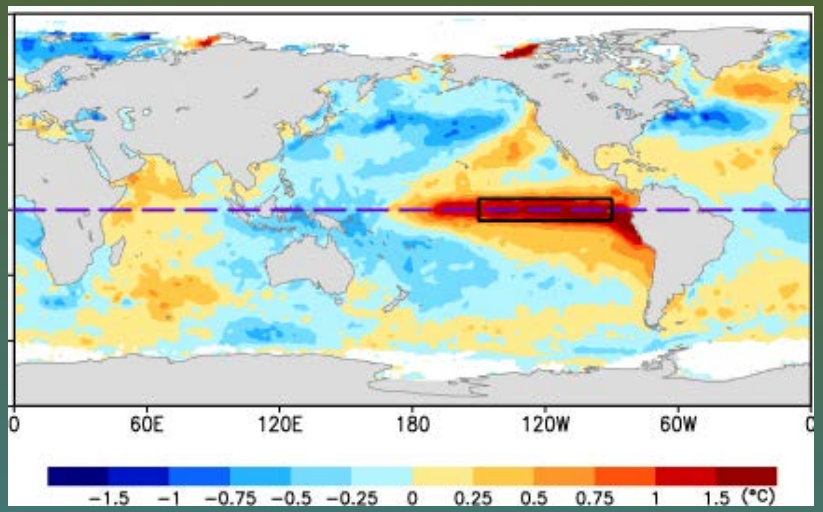
http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA

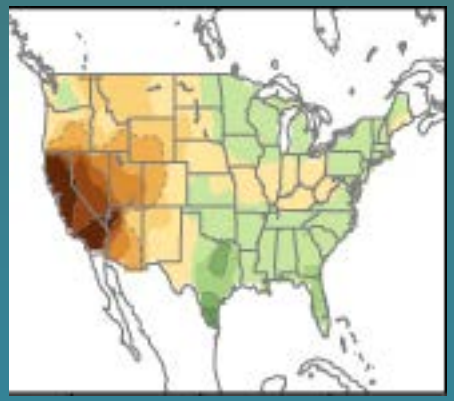


http://cdec.water.ca.gov/cgi-progs/products/rescond.pdf

Even heavy rainfall will not end California's long-term drought.





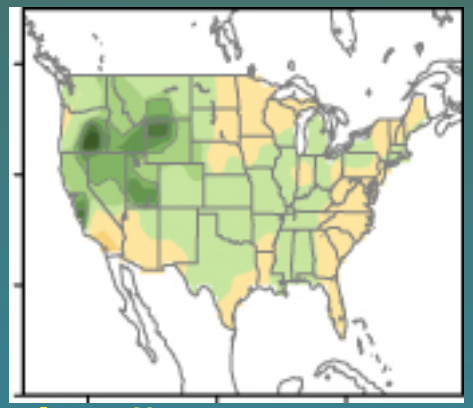


El Niño Modoki

One thing to look out for

– the Japanese are warning that they see a strong possibility of the El Niño conditions shrinking to a Central Pacific El Niño, an **El Niño Modoki**.

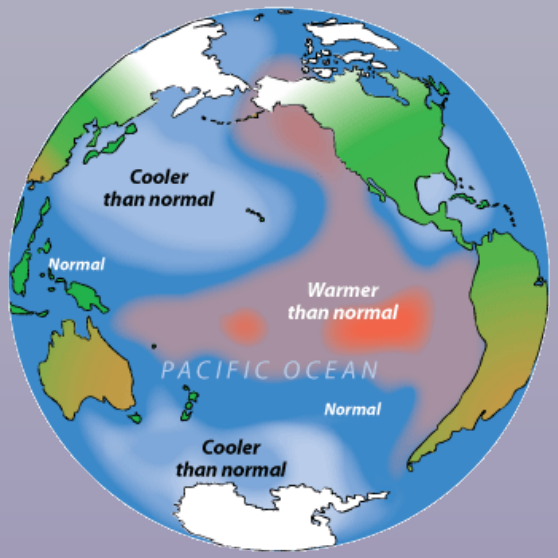
If that happened, it would cut off most of the springtime rain to California.



El Niño

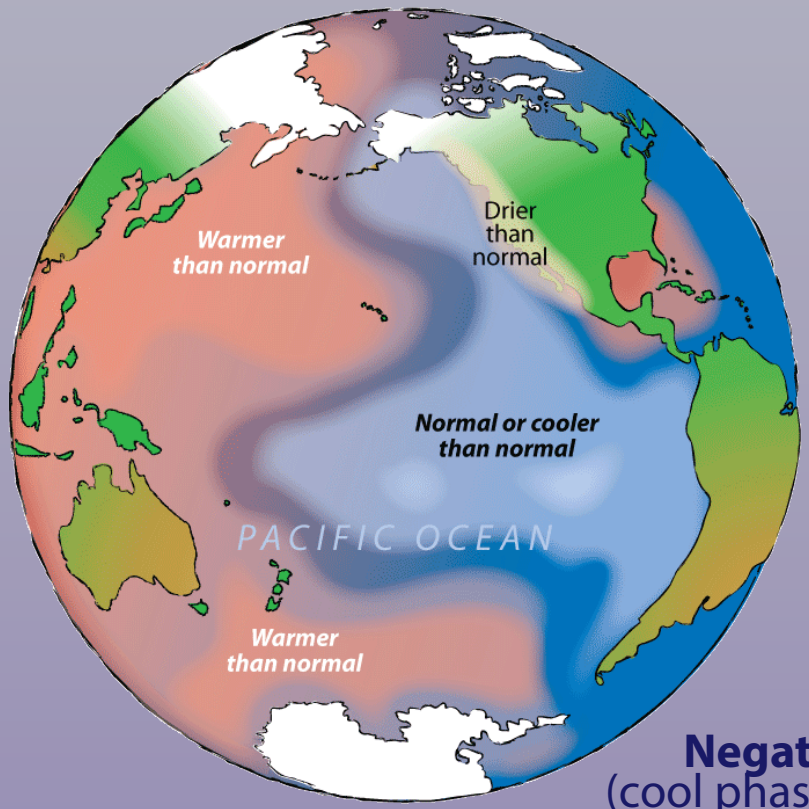
www.pecad.fas.usda.gov

There is a new paradigm in the Pacific –
The **Pacific Decadal Oscillation** tipped from a positive to a negative trend in 2006.



Positive
(warm phase) **PDO**

1976-1998



Negative
(cool phase) **PDO**

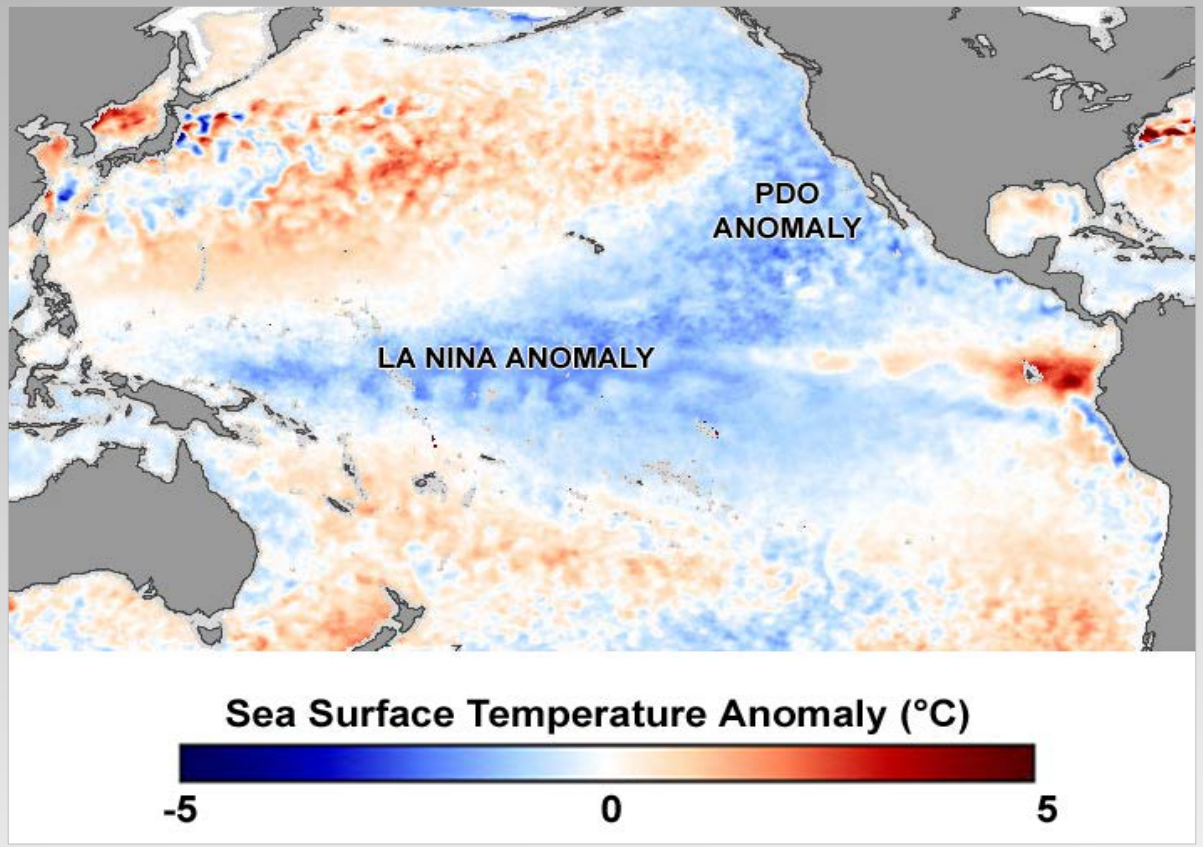
2006-present

The Pacific Decadal Oscillation
Each phase lasts 20-30 years

The PDO's impact on precipitation

Winners	Losers
• Midwest US	• California/Southwest US
• *STRONGER MONSOON:* Northern & Central China	• *WEAKER MONSOON:* Southern China
• *STRONGER MONSOON:* India	• *WEAKER MONSOON:* Pakistan
• *STRONGER MONSOON:* Japan	• *WEAKER MONSOON:* North Korea
• Brazil	• Andes Republics/ Southern Argentina
• Southern Africa	• East Africa
• *STRONGER MONSOON:* Eastern Australia	• *WEAKER MONSOON:* Western Australia

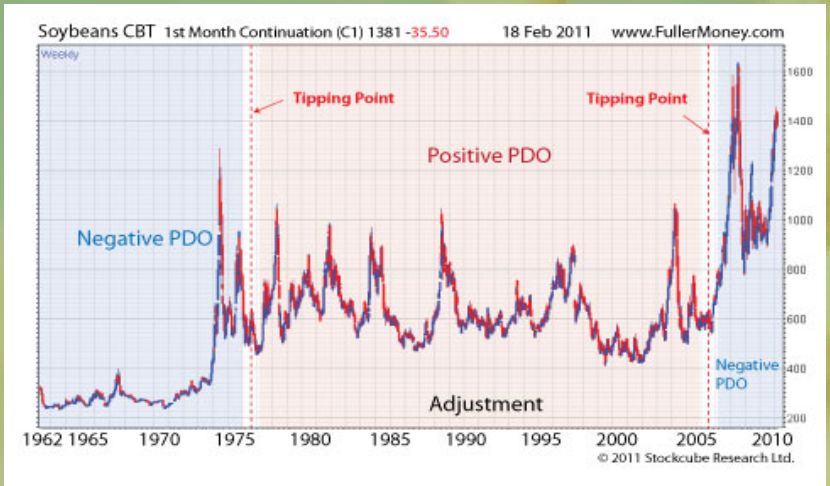
A La Niña magnifies the impact of a cold PDO.



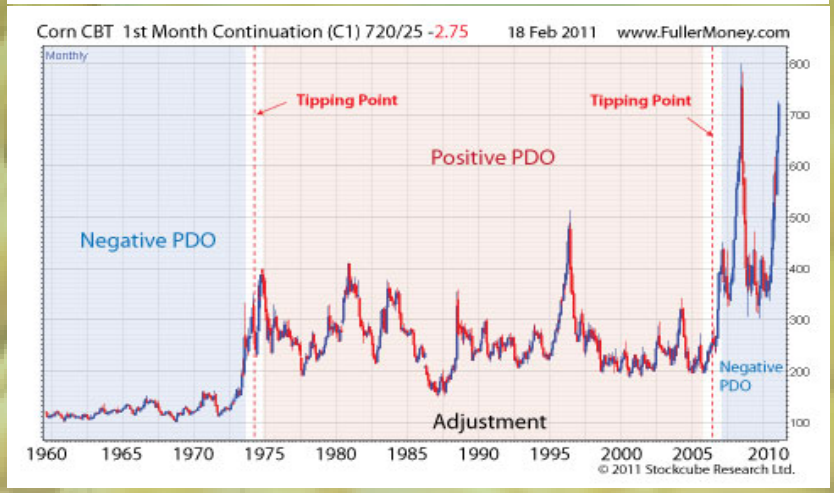
http://en.wikipedia.org/wiki/File:La_Nina_and_Pacific_Decadal_Anomalies_-_April_2008.png

The impact on agriculture

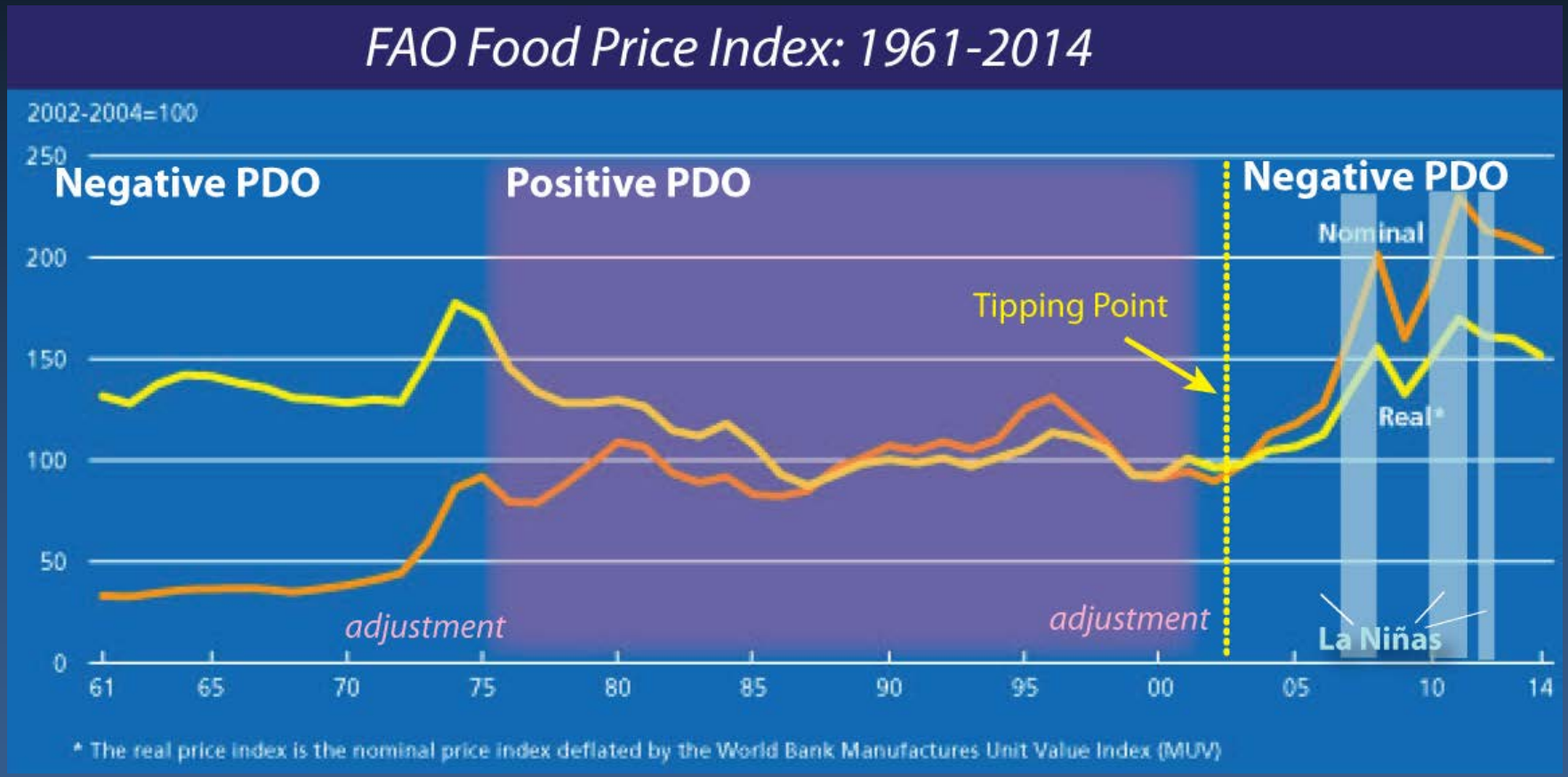
Soybeans 1962-2011



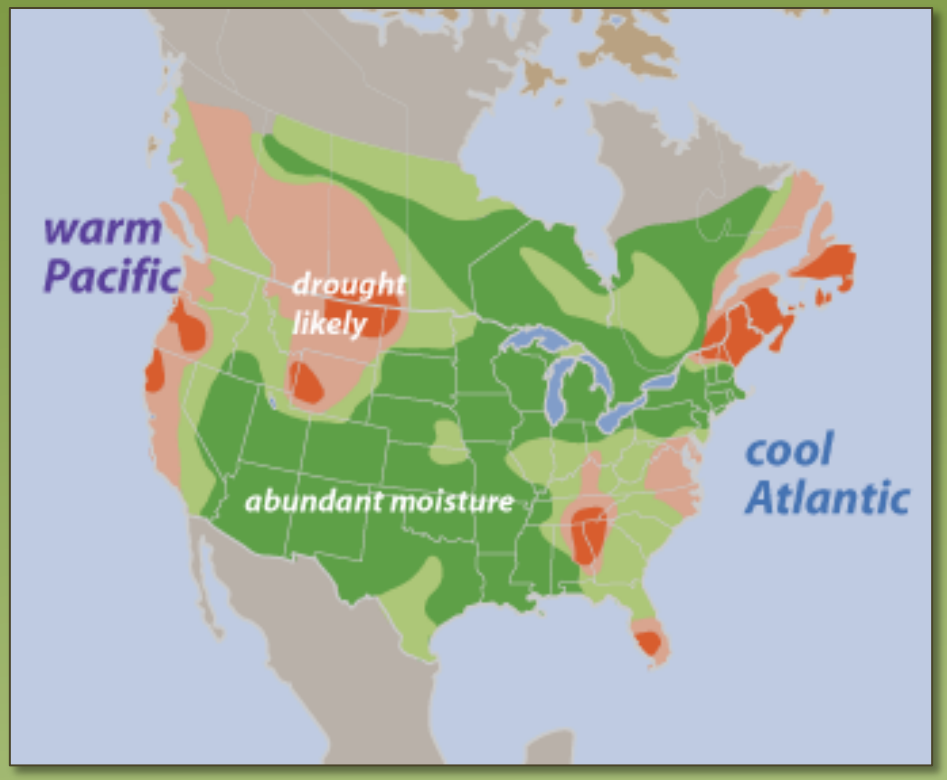
Wheat 1960-2011



Corn 1960-2011



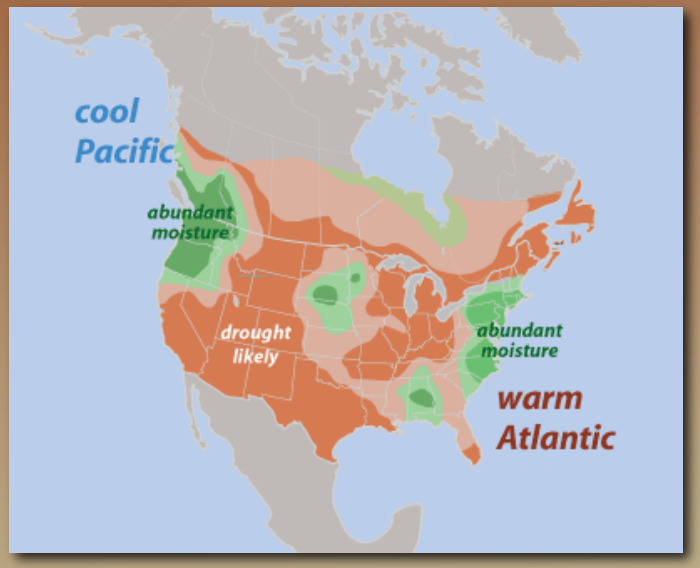
courtesy: FAO



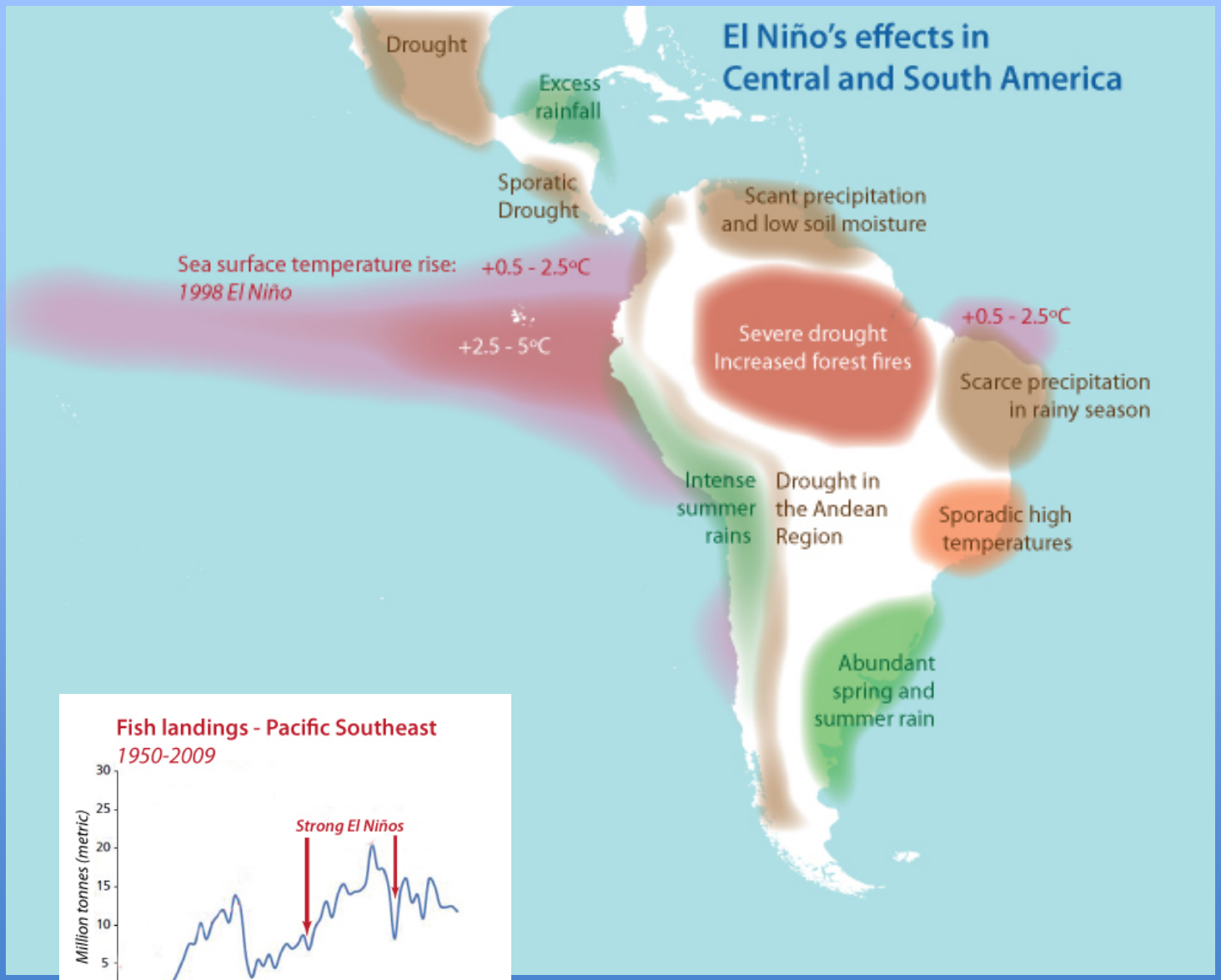
The Atlantic AMO changed in 1995.

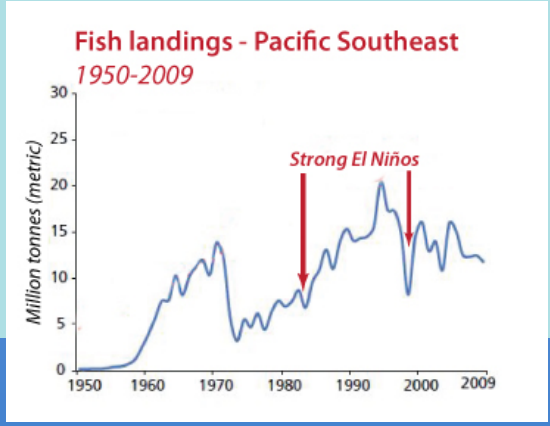
The Pacific Decadal Oscillation is less stable but from the mid 1970s to the late 1990s the US & Canada enjoyed the most benign combination of the PDO and AMO.

Since 2006, the two oceans have combined to create dry weather in the West, Midwest, and Great Plains.



As the east Pacific changes from cool to warm and back again, drought hits much of the nation for months, even years at a time.





El Niño and South America

Outlook for SOUTH AMERICA over the next 10 years.

Conclusions

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- The warm phase of the AMO usually creates hotter summers (except during summers with major volcanic cooling) and stormier spring and summers around the Great Lakes and Corn Belt.
  The effect should last another 15 – 20 years.

- There were early summertime El Niño conditions and the conditions should affect this winter as well. Historically this means slightly cooler and wetter conditions in winter and, if it lasts until spring, creates a warm spring planting season with good rainfall in the Western Corn Belt.

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