

# What to Expect from a Changing Climate

**CIRB**

Crop Insurance and Reinsurance Bureau, Inc.



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# Conclusions

- **Climate change is not linear. It ebbs and flows.**
- Because of the recent Polar eruptions, late winter and early springtime should be cold in the Midwest with Nor'easters along the East Coast. There is a high risk of a stormy spring. The impact of the polar volcanoes is fading.
- The warm phase of the AMO usually creates hotter summers (except during summers with major volcanic cooling), colder Eastern winters, drier weather in the Great Plains, and stormier springs around the Great Lakes and Corn Belt.  
**The effect should last another 15 – 20 years.**
- The Tropical Pacific is officially neutral with a 50 – 60 % of the current tropical warmth becoming an “official” El Niño, giving the West more heavy rain and snowfall. The Japanese expect the event to evolve into a Central Pacific El Niño which would give California a dry late winter, spring and summer.
- 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:**

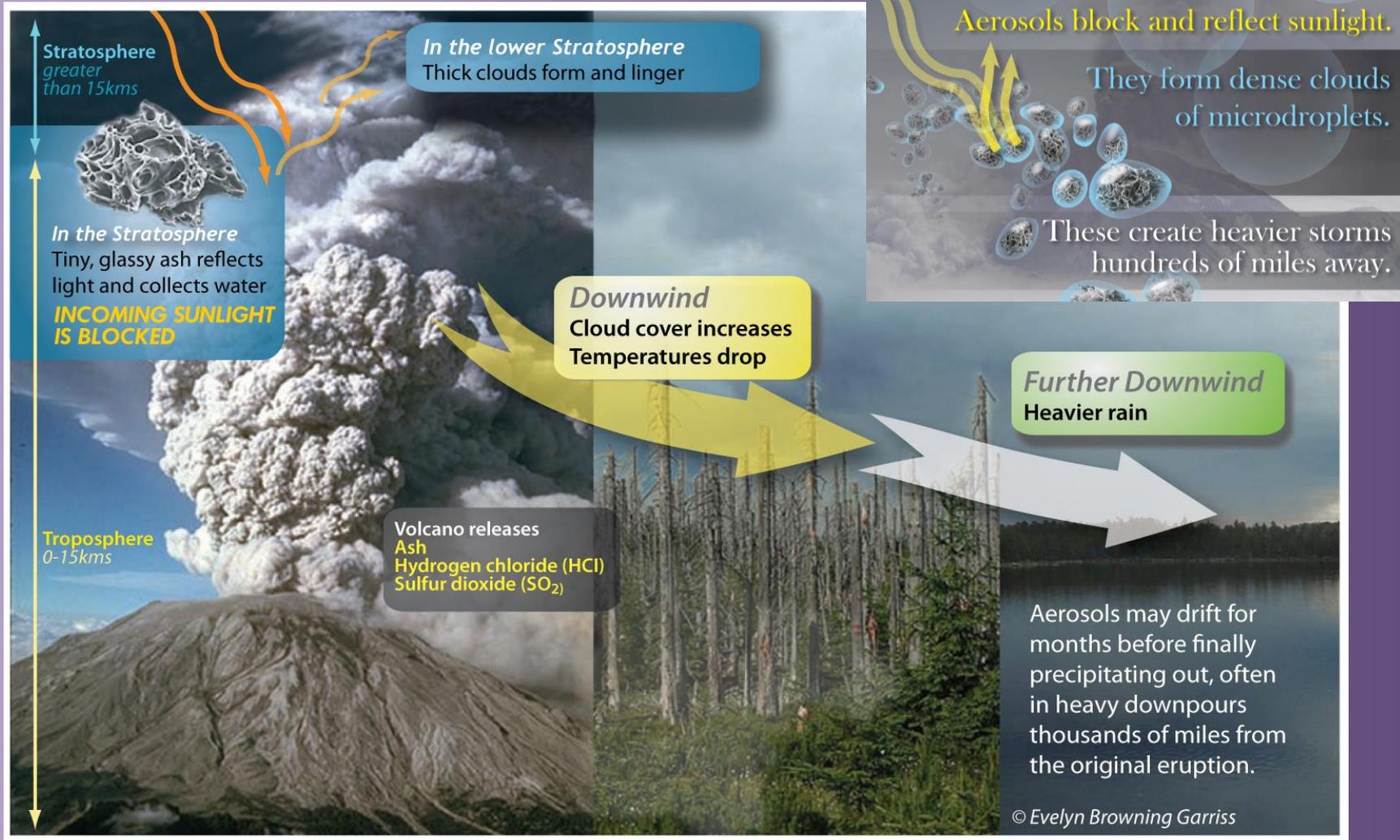
- ◎ **How much solar radiation the Earth receives (the Sun)**
- ◎ **The patterns of where the solar radiation falls or is reflected (Clouds/Volcanoes)**
- ◎ **Where the heat from the solar radiation is stored (Oceans/Urban Heat Islands)**

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

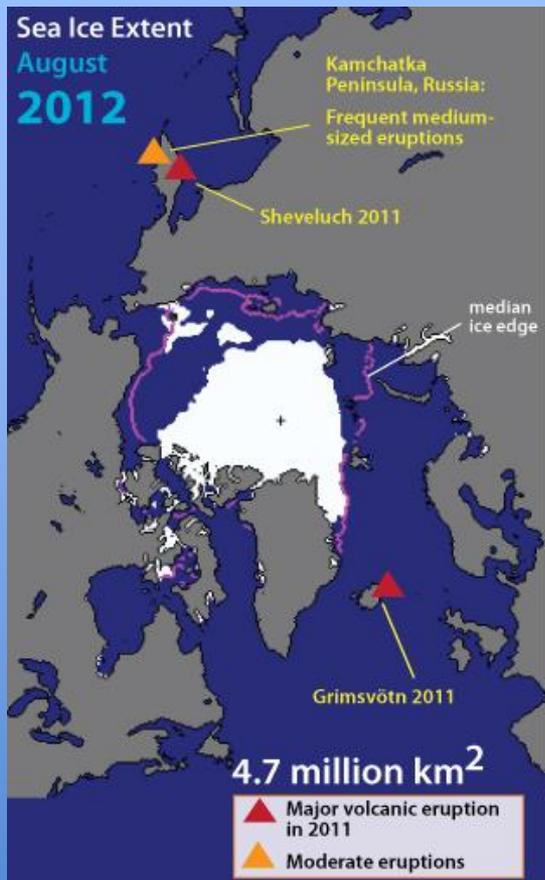


Historical records, coral and tree rings,  
sediment layers, and glacial cores to learn how they  
shaped the weather in the past.

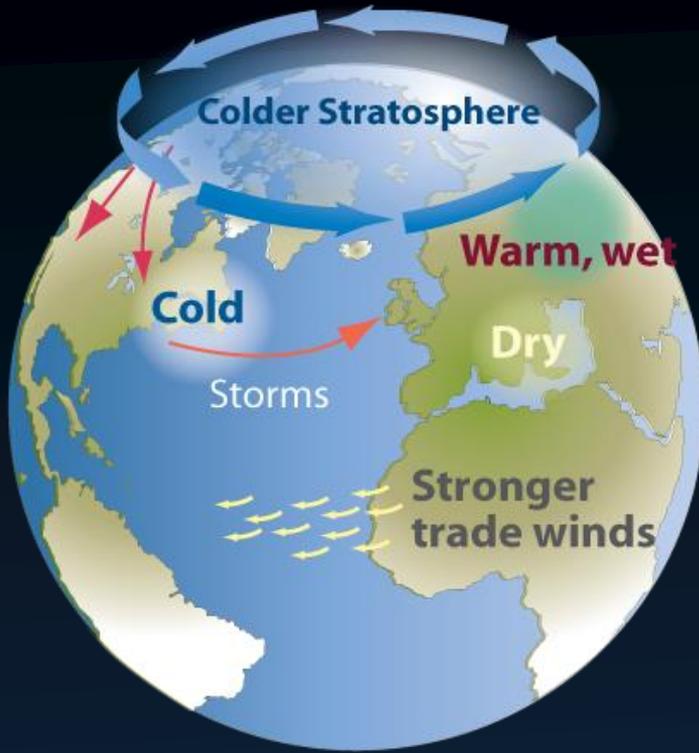
Clouds, the debris from large volcanoes, and man-made aerosols can reflect back sunlight and change rainfall patterns.



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

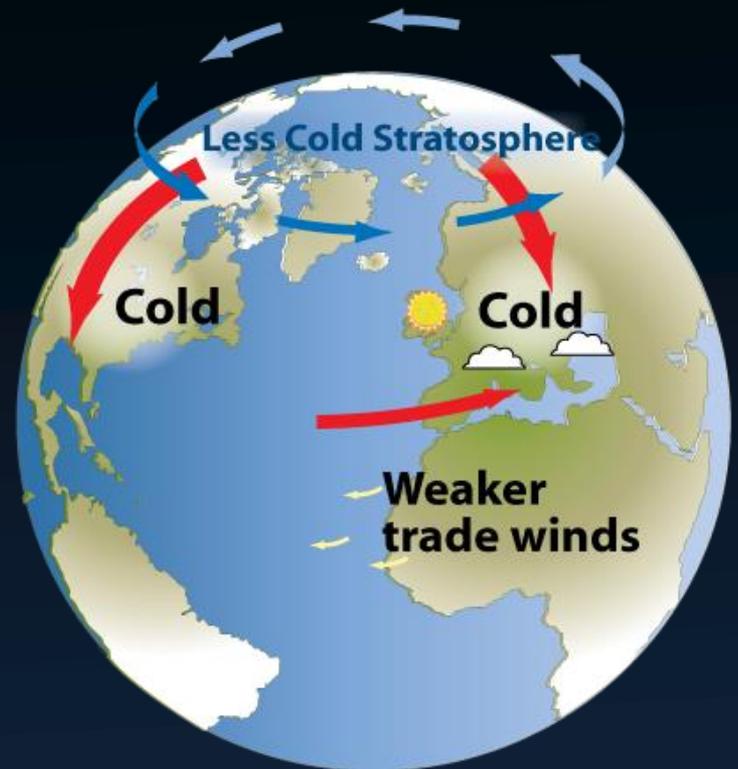


The cool Arctic summers have reduced the amount of summer melt for three years in a row.



## 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.



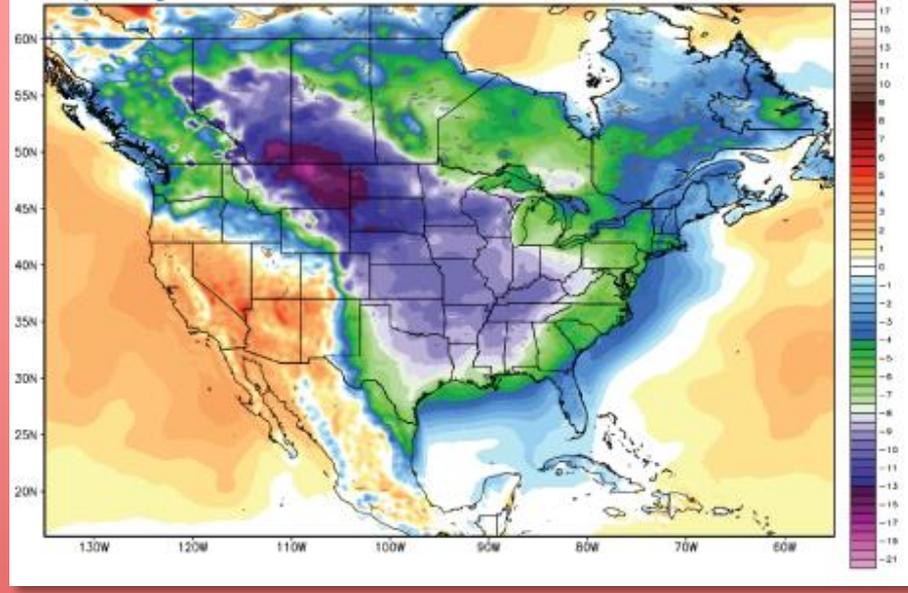
**News Notes**

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

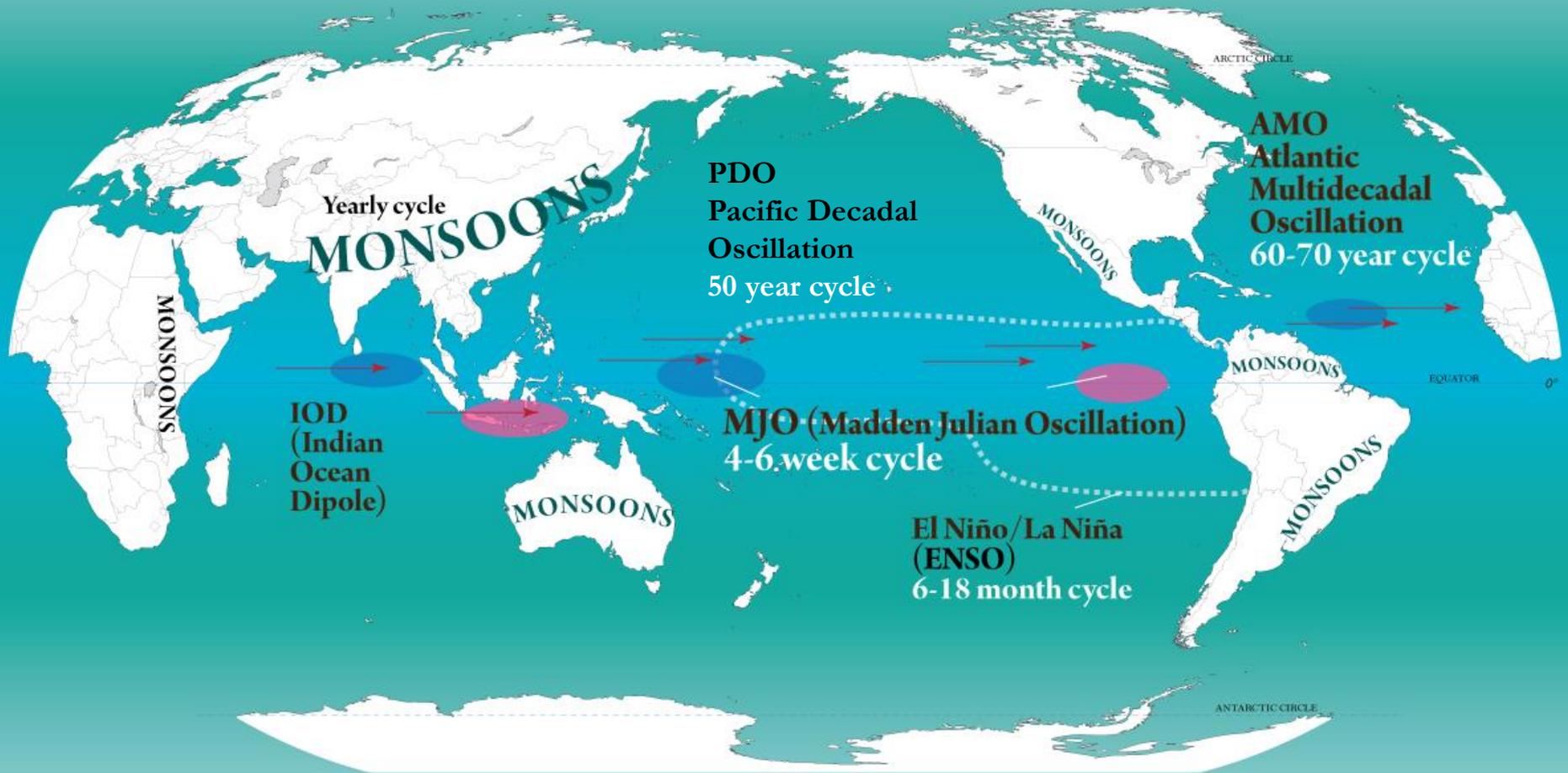
**Temperature Anomalies**  
7 day average / November 12 - November 19, 2014



**The November newsletter warned that a Russian volcano would trigger a cold spell in the 2<sup>nd</sup> week of November.**

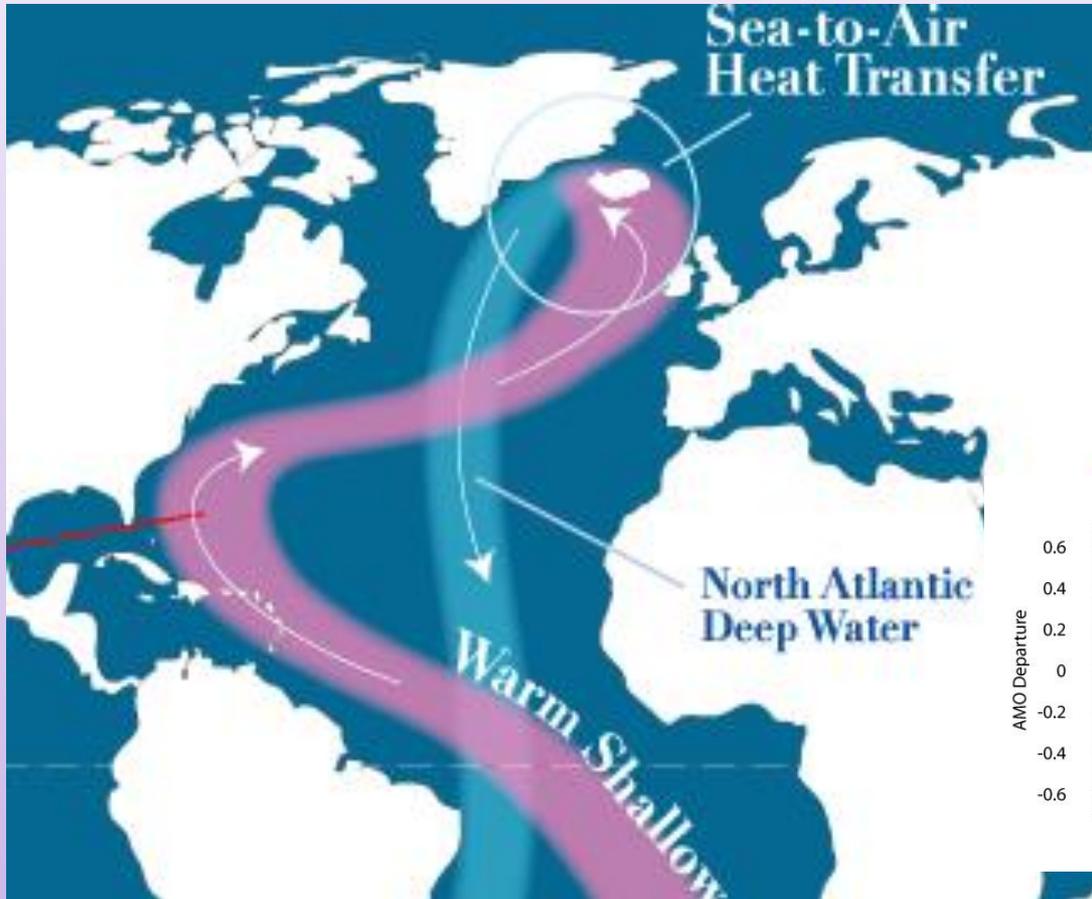
courtesy: NOAA/NCEP  
<http://graphical.weather.gov/sectors/conusWeek.php#abs>

# Oceans store and transport heat



There are several oscillating patterns of ocean currents.

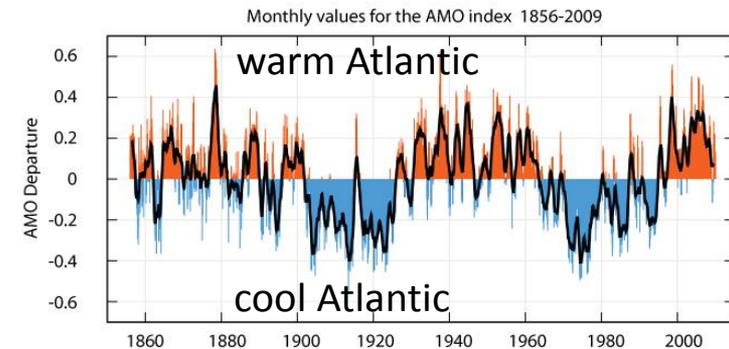
# Oceans store and transport heat



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

The Gulf stream flows faster.

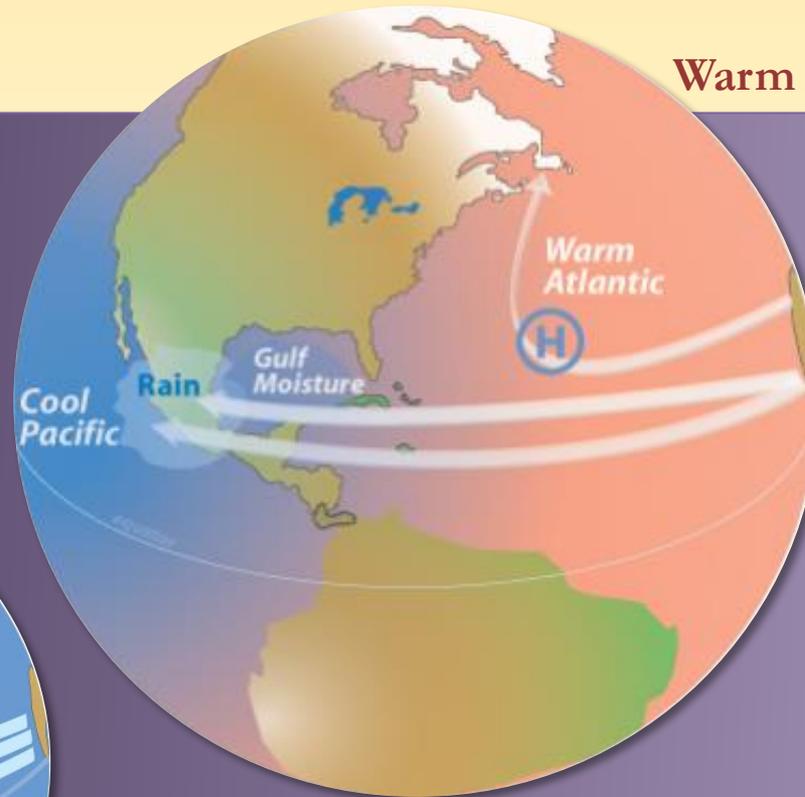
The North Atlantic warms.



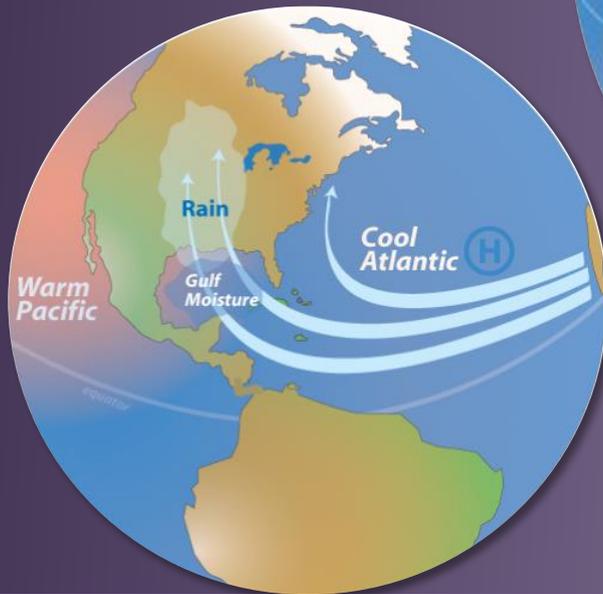
The Atlantic Multidecadal Oscillation (AMO) 1856-2009

[http://en.wikipedia.org/wiki/File:Amo\\_timeseries\\_1856-present.s](http://en.wikipedia.org/wiki/File:Amo_timeseries_1856-present.s)

## Warm AMO



## Cool AMO

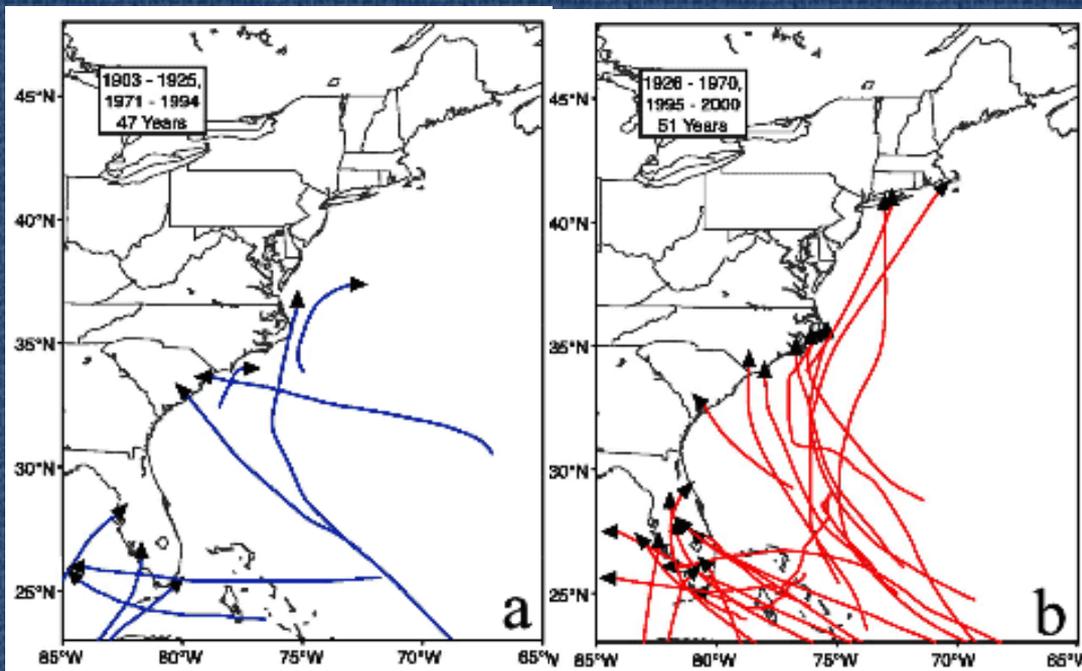


The warm phase of the AMO diverts precipitation from the Prairie Provinces, Gulf, and Great Plains.

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

When the Atlantic Multidecadal Oscillation turned positive in 1995, the North Atlantic became warmer.

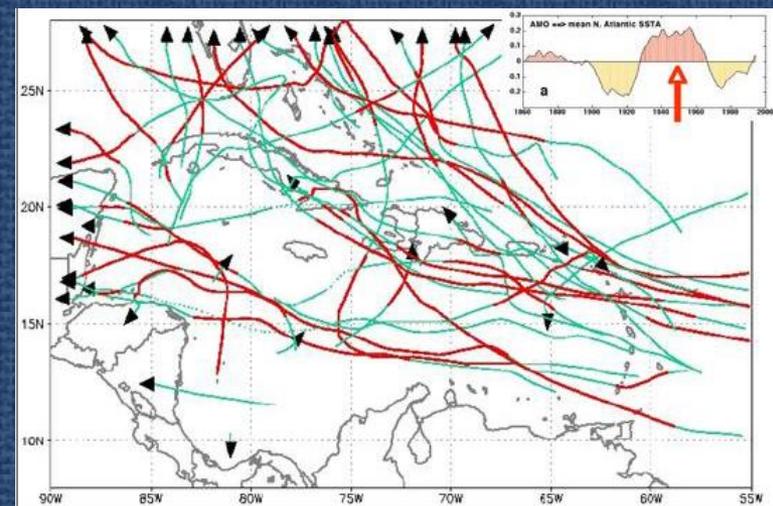
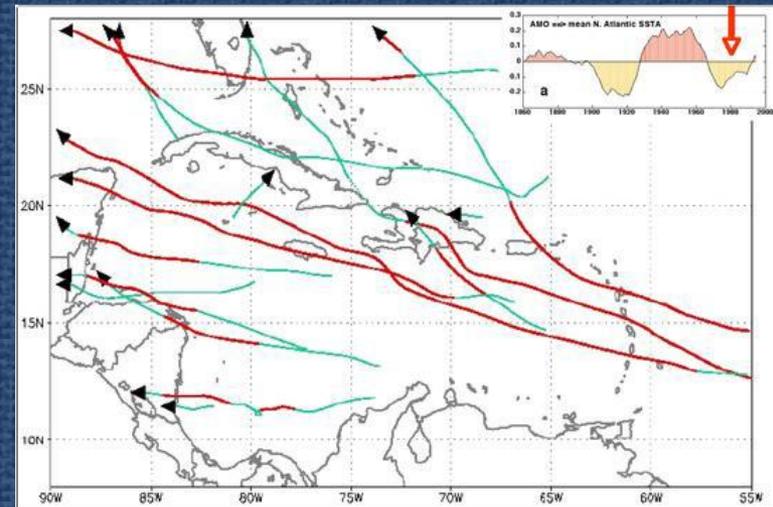
Atlantic hurricanes doubled in number, go farther north and, on average, carry more moisture.



Cool Atlantic

Warm Atlantic

### Cool Atlantic



### Warm Atlantic

courtesy: NOAA/GOES

During the cool Atlantic years (1968-1994)  
50% of the US population moved  
within 50 miles of the coast.



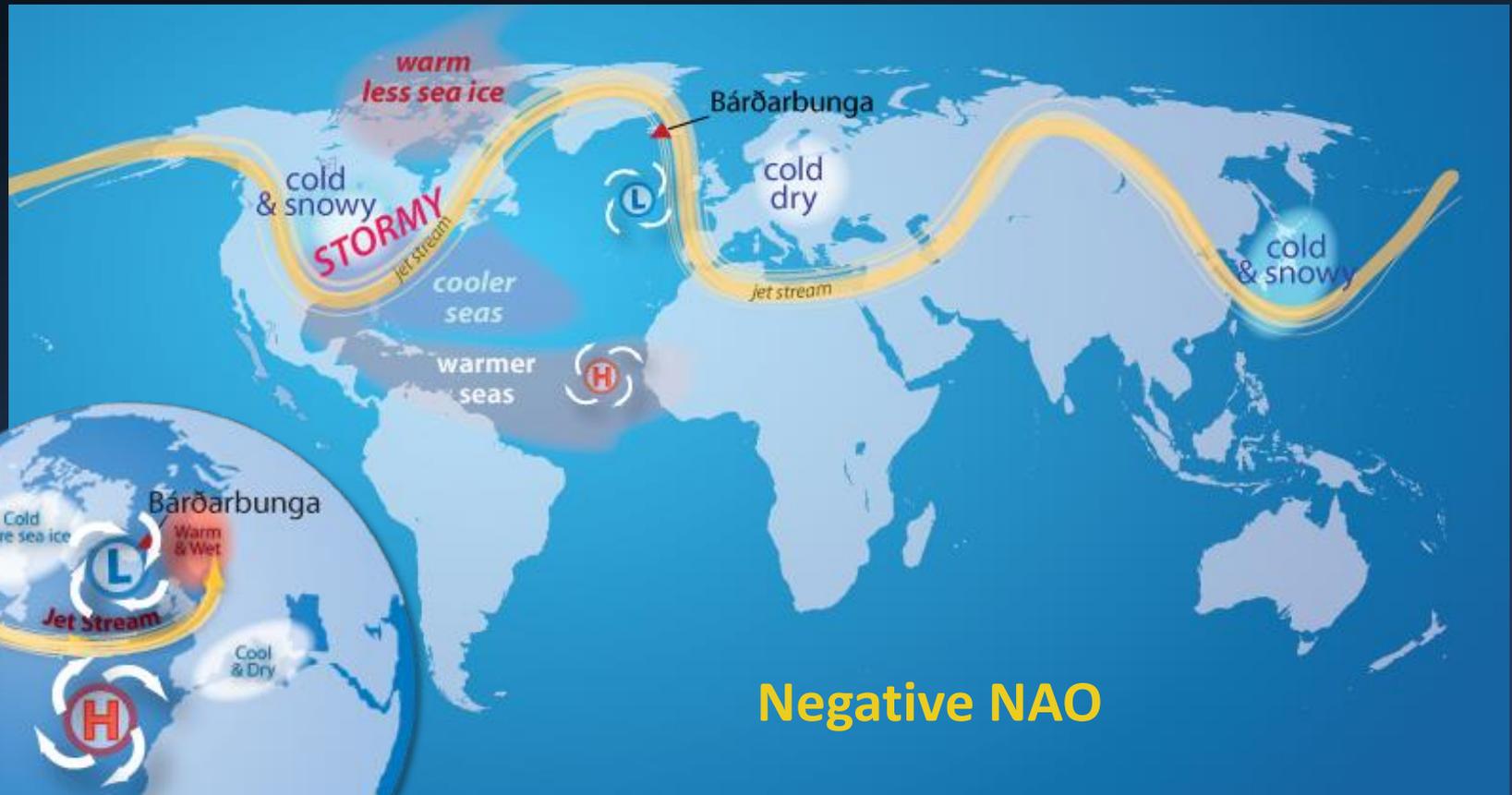
**As Hurricane Sandy showed,  
the warm Atlantic has put  
coastal property at greater risk.**

Sometimes exact scientific definitions and procedures designed in one climate paradigm don't work when the paradigm changes.



*courtesy: NOAA/GOES*

The Super Storm Sandy disaster forced the National Hurricane Center to restructure its entire warning system.



## Negative NAO

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

Positive NAO

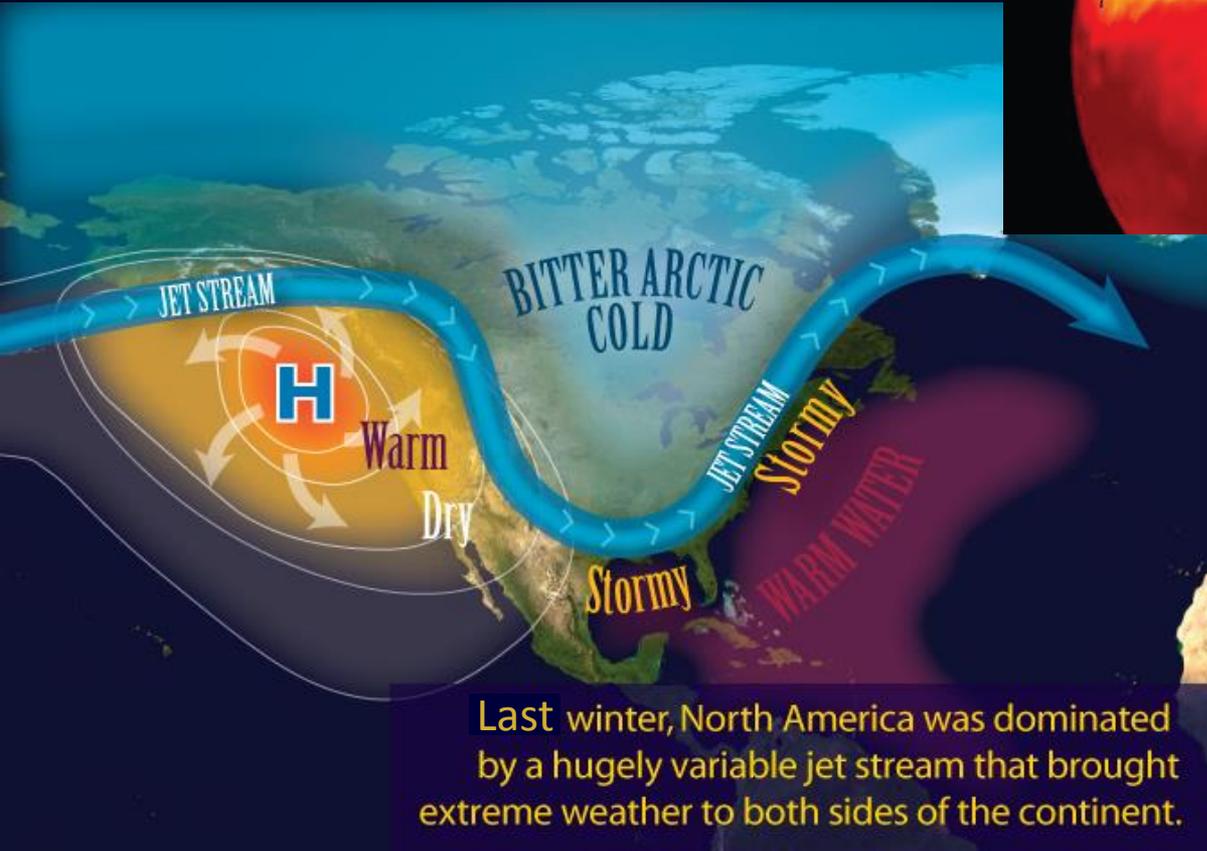
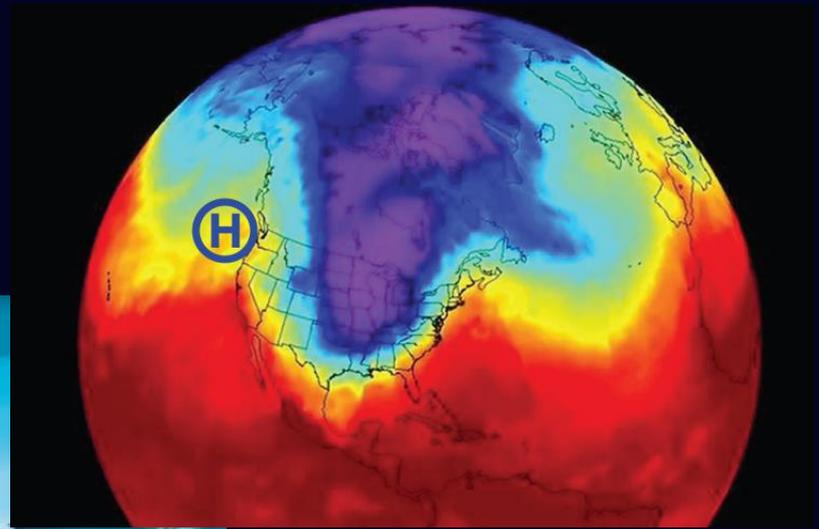


The Positive AMO redistributes scarce water in the Middle East.



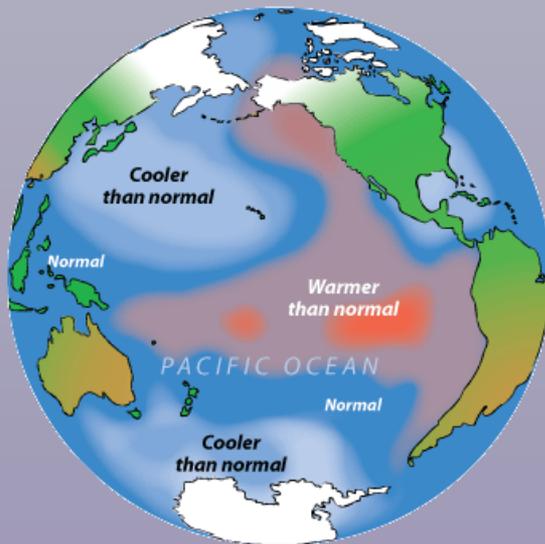
The Positive AMO redistributes scarce water in the Middle East.

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

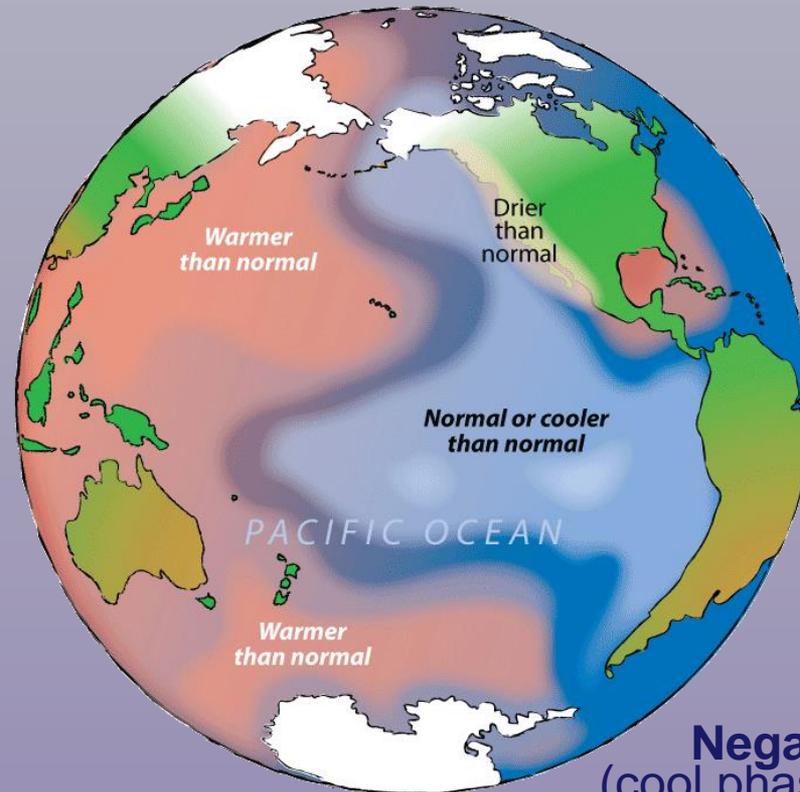


This winter's divided weather patterns will linger through spring.

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

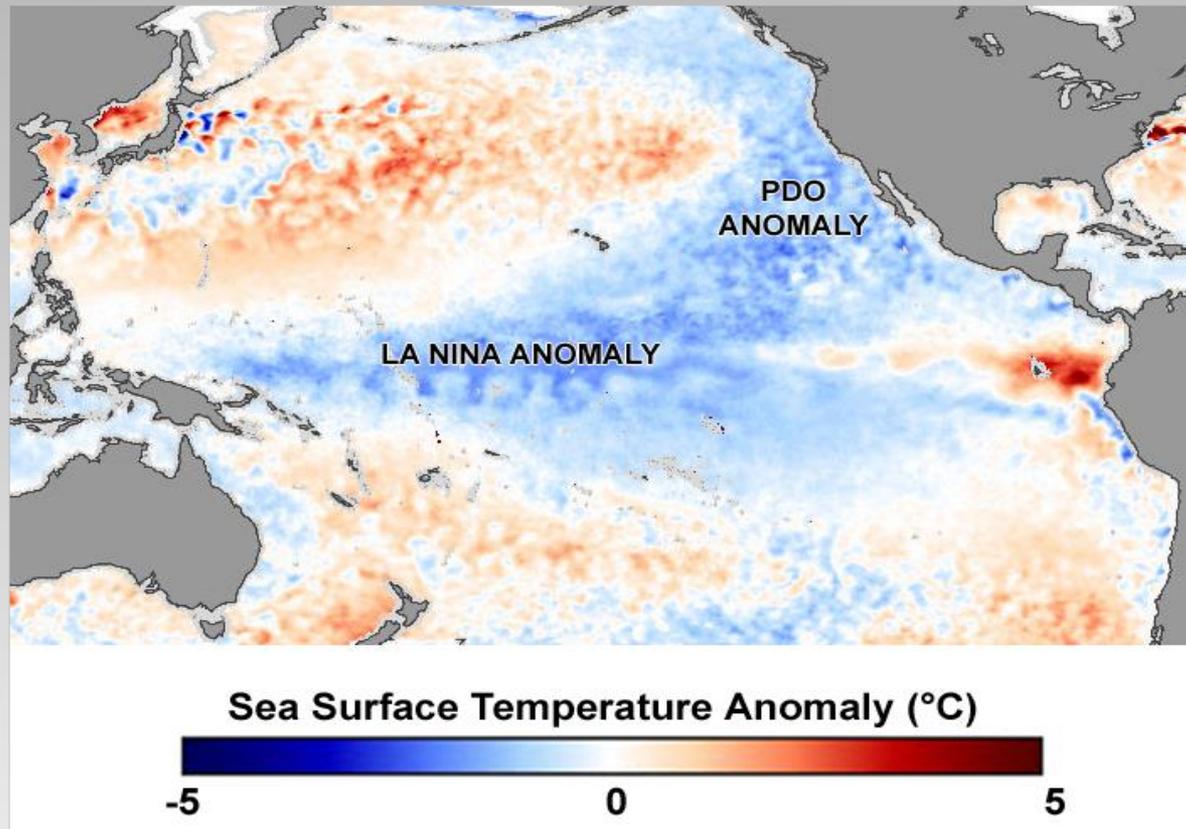
## Winners

- Midwest US
- *STRONGER MONSOON*:  
Northern & Central China
- *STRONGER MONSOON*: India
- *STRONGER MONSOON*: Japan
- Brazil
- Southern Africa
- *STRONGER MONSOON*:  
Eastern Australia

## Losers

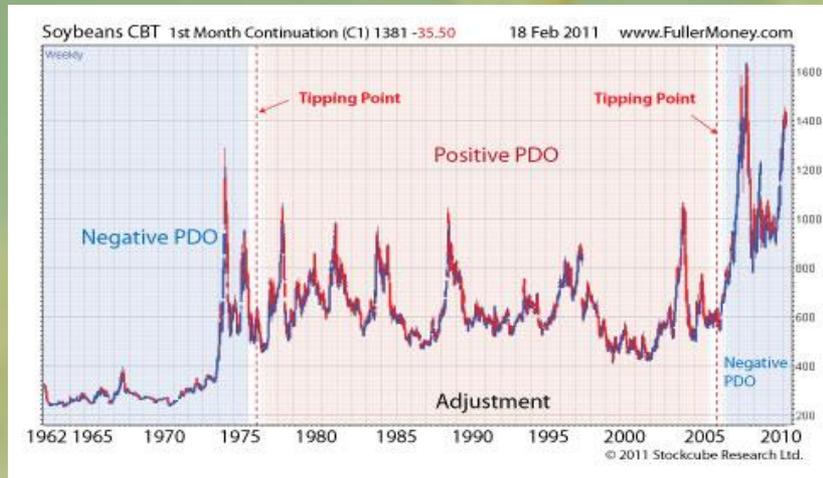
- California/Southwest US
- *WEAKER MONSOON*:  
Southern China
- *WEAKER MONSOON*: Pakistan
- *WEAKER MONSOON*: North Korea
- Andes Republics/  
Southern Argentina
- East Africa
- *WEAKER MONSOON*:  
Western Australia

**A La Niña magnifies the impact of a cold PDO.**

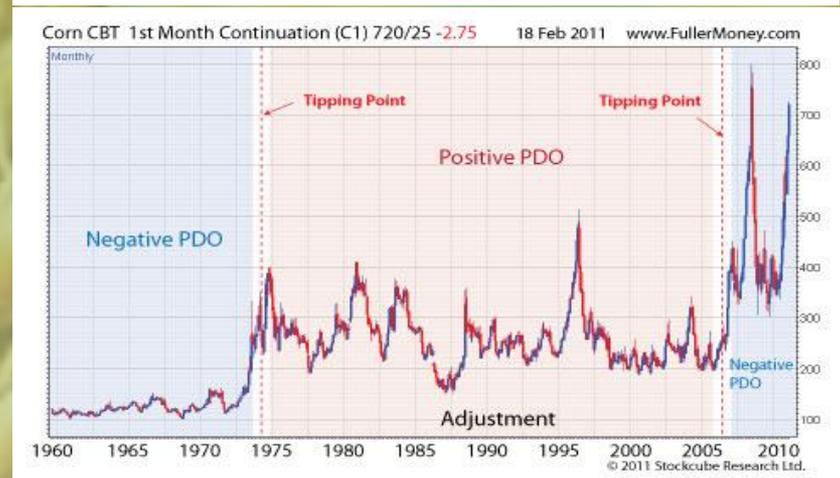


# The impact on agriculture

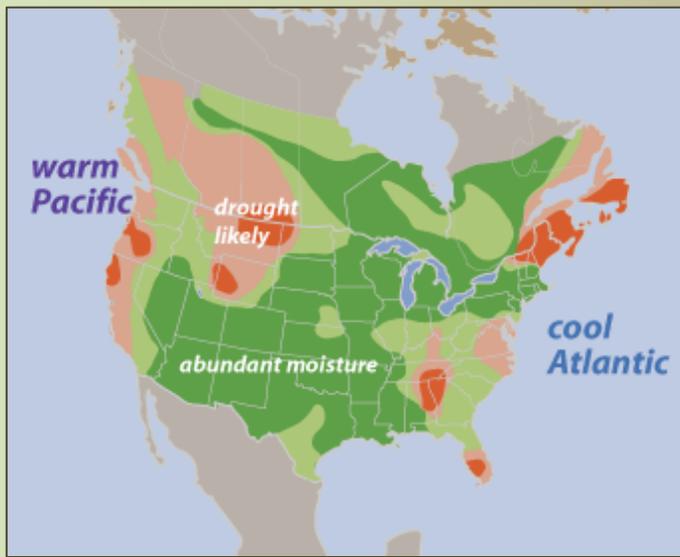
## Soybeans 1962-2011



## Wheat 1960-2011

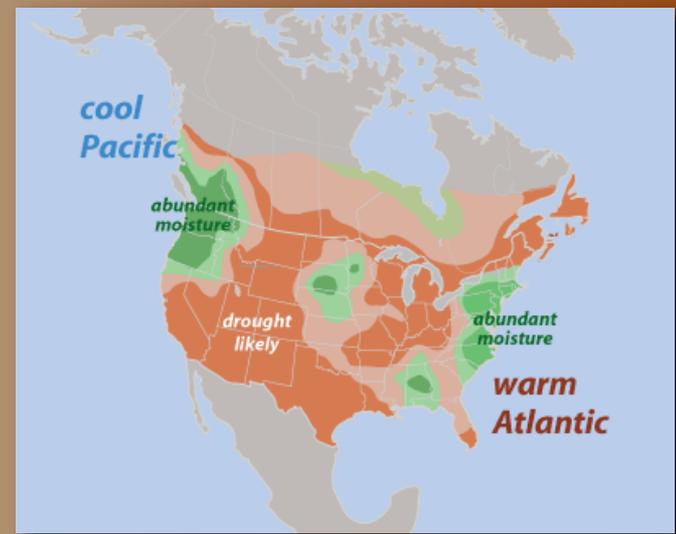


## Corn 1960-2011



**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 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.

Bitterroot National Forest  
1909

1948

1989



**Between fire suppression policies  
and decades of warm  
PDO precipitation,  
Western forests have become  
too dense for today's  
drier conditions.**

[http://upload.wikimedia.org/wikipedia/commons/e/ea/Forest\\_Development\\_in\\_Bitterroot.jpg](http://upload.wikimedia.org/wikipedia/commons/e/ea/Forest_Development_in_Bitterroot.jpg)

Drier conditions are stressing forests, leaving trees more susceptible to disease, insect infestations and wildfires.



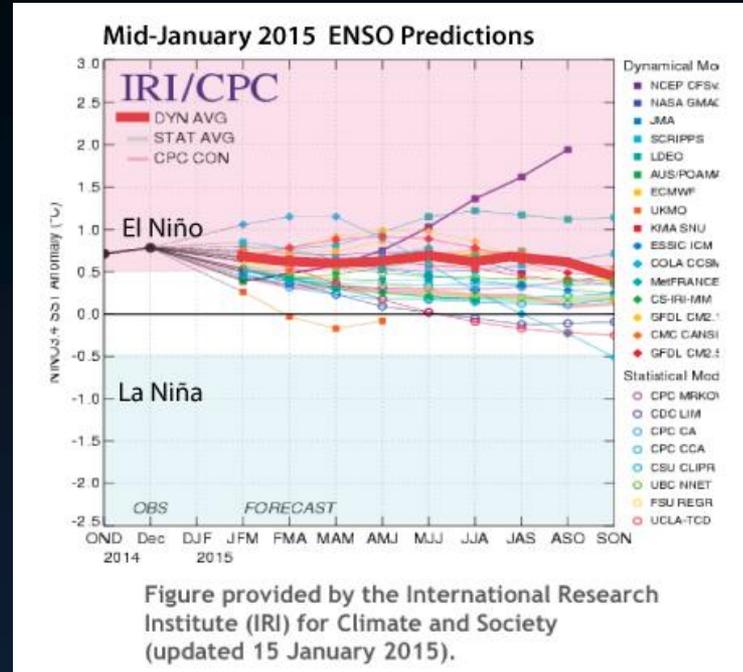
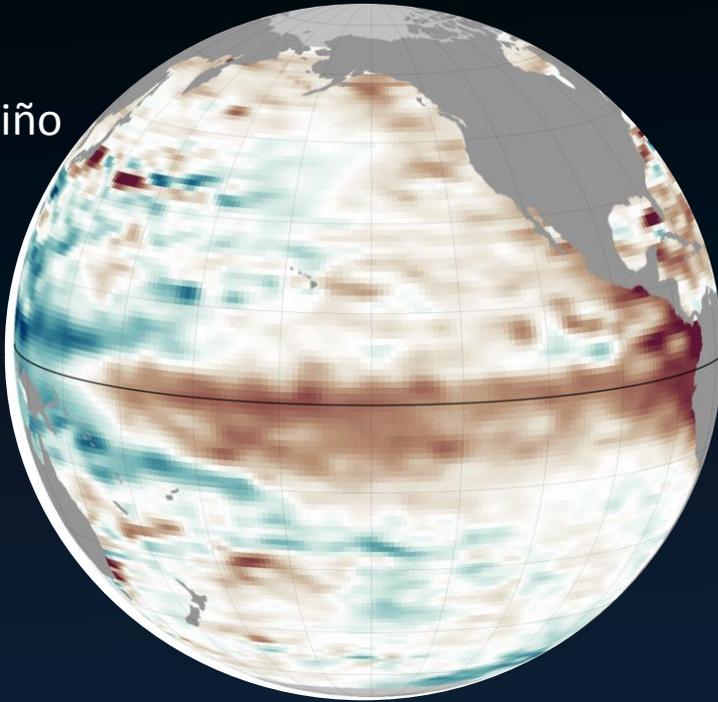
Photo Credit: Natural Resources Canada - Canadian Forest Service  
Crédit : Ressources naturelles Canada - Service canadien des forêts



The US Forest Service reports that some 32% of US housing units and 10% of all land with housing are situated in the Wildland/Urban Interface.

- Since 2010 it has been developing a new national Cohesive Wildland Fire Management Strategy which may force insurers to pay more of the firefighting costs.
- Fire fighters are increasingly declaring fire-vulnerable houses (isolated or surrounded by brush) indefensible and refusing to commit crews to some high-risk firescapes.

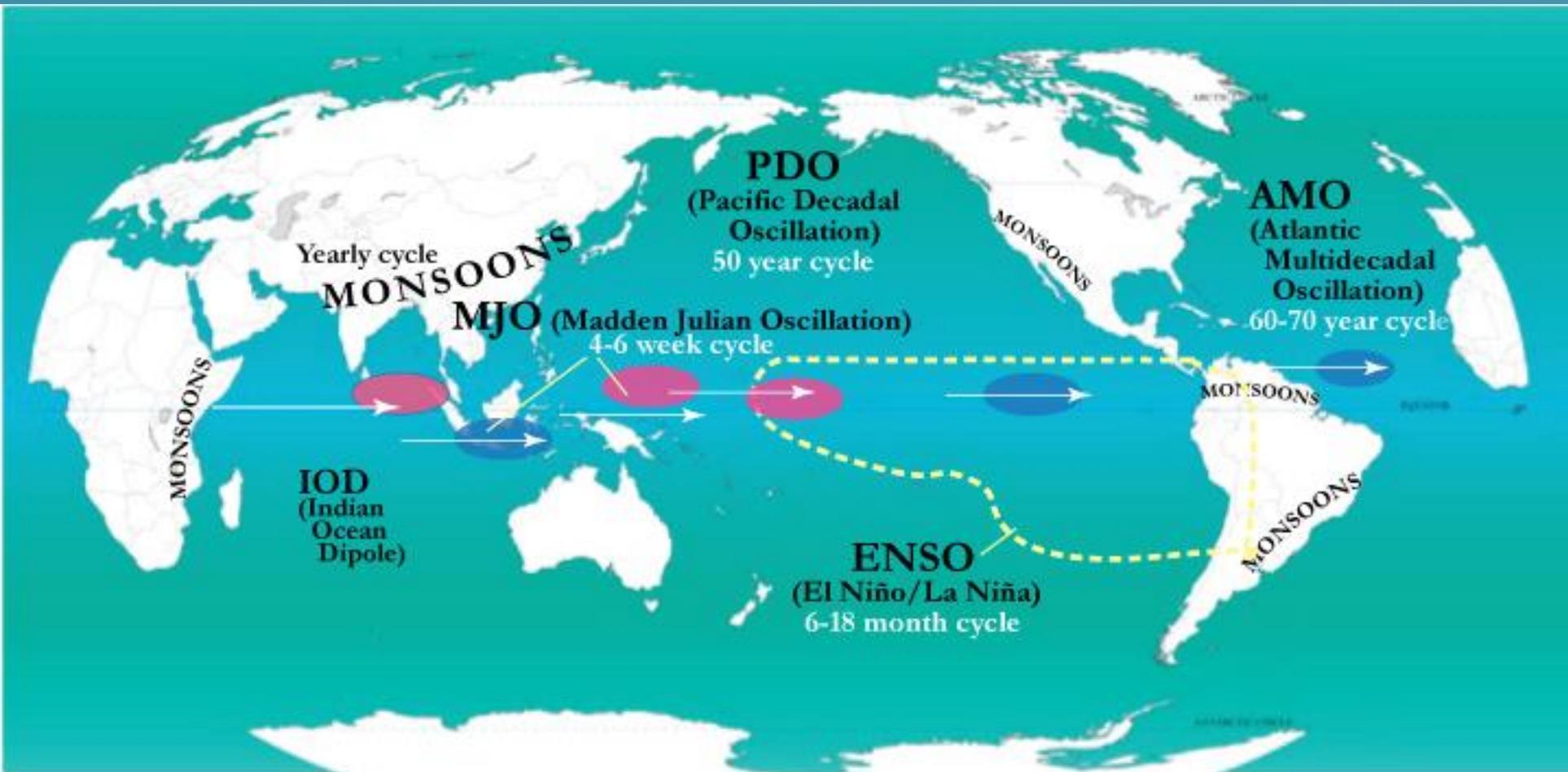
El Niño



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

These conditions faded but **experts say there is a  
50-60% chance of an El Niño event returning.**

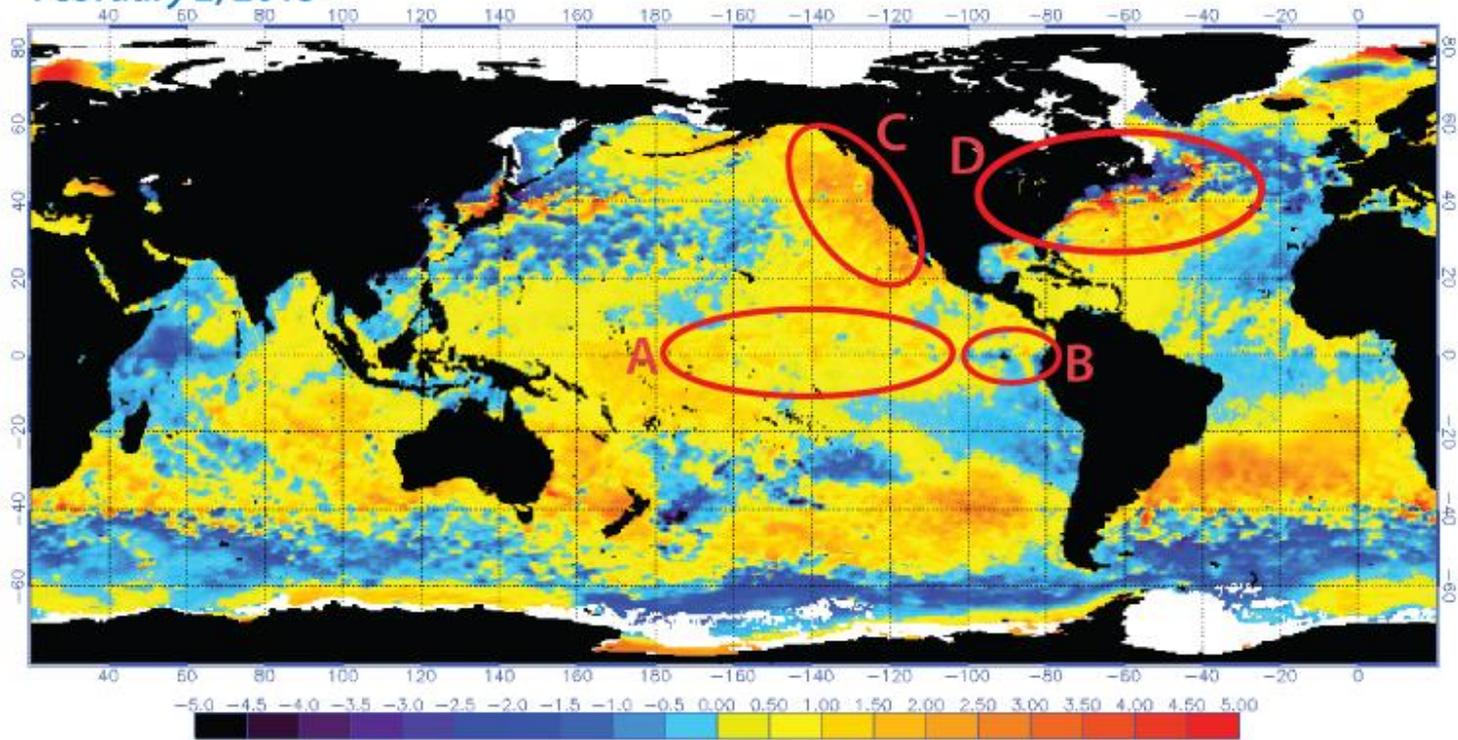
## Remember the hot and cool MJOs



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)

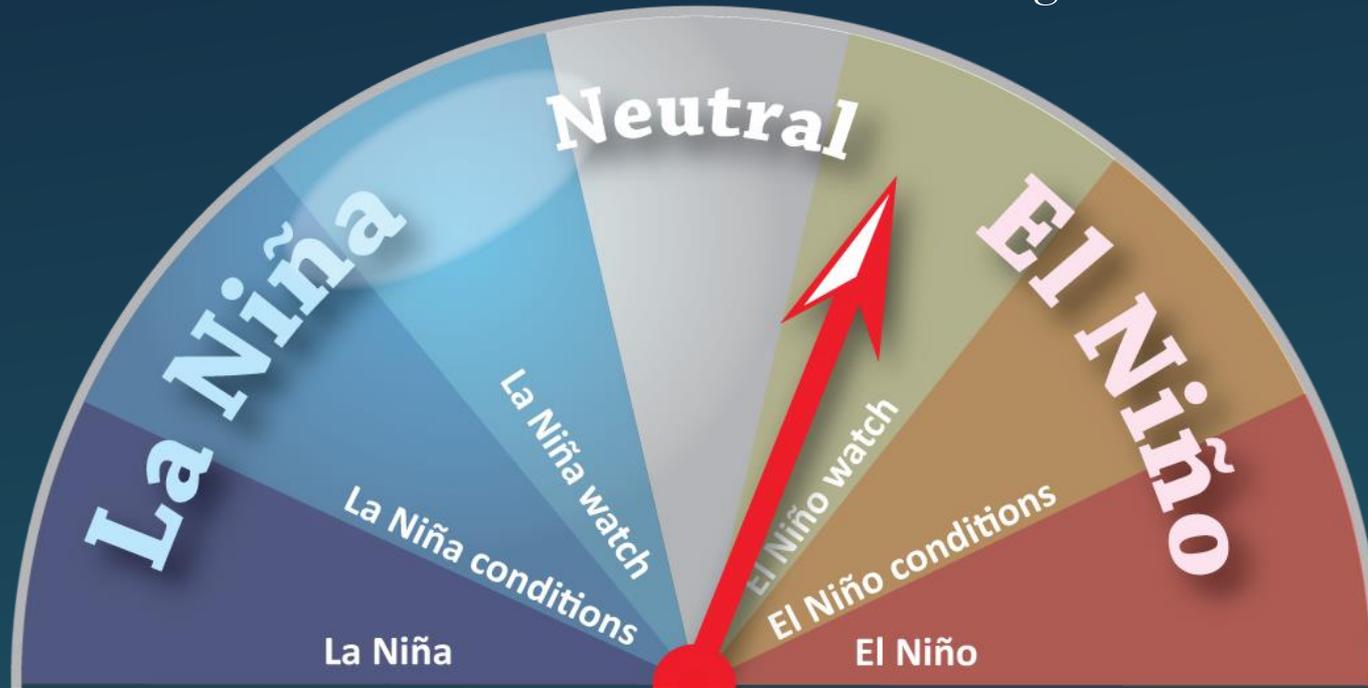
February 2, 2015



- A** El Niño conditions
- B** An MJO is cooling the eastern part of El Niño.
- C** Warm temperatures along the West Coast of North America
- D** 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 Niño watch, it is creating El Niño weather patterns that flicker in strength.



mid-January to mid-February



mid-February to mid-March

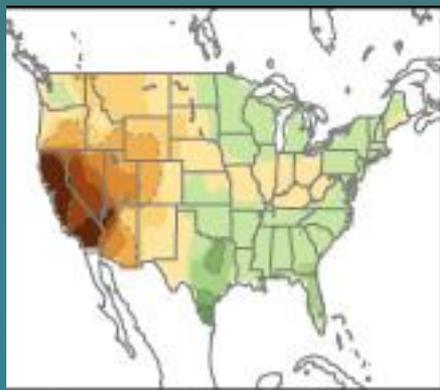
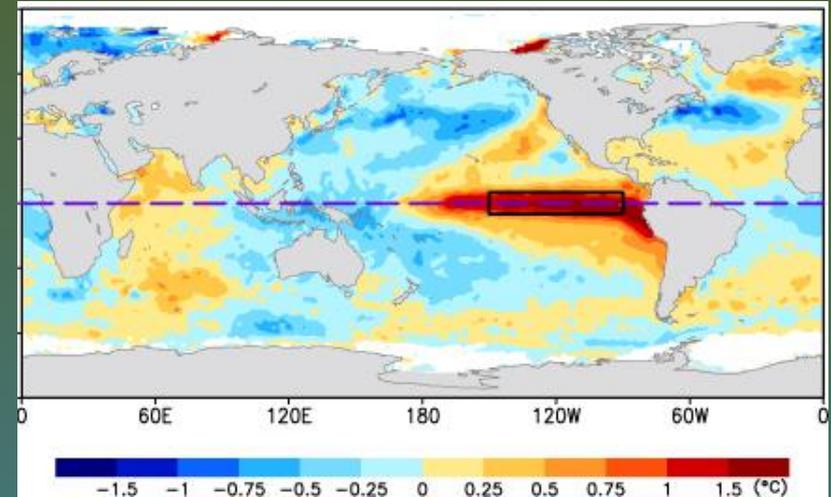
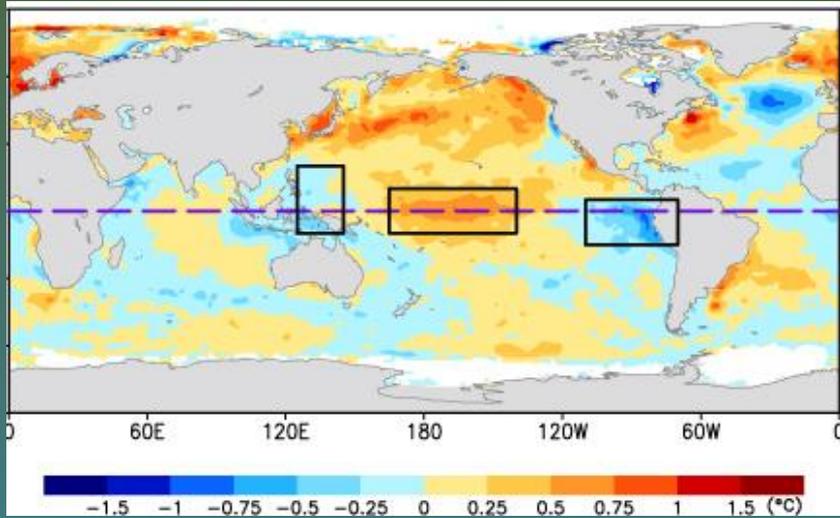


Hot	Warm	Cold
2-4°C or more higher than normal temps.	2-4°C or more higher than normal temps.	5°C or more lower than normal temps.

Cool	Dry	Wet
2-4°C or more lower than normal temps.	75% or less of normal moisture	125% or more of normal moisture

\* If El Niño conditions continue

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

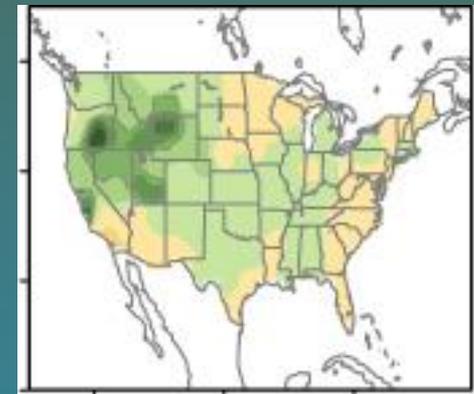


**El Niño Modoki**

**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.

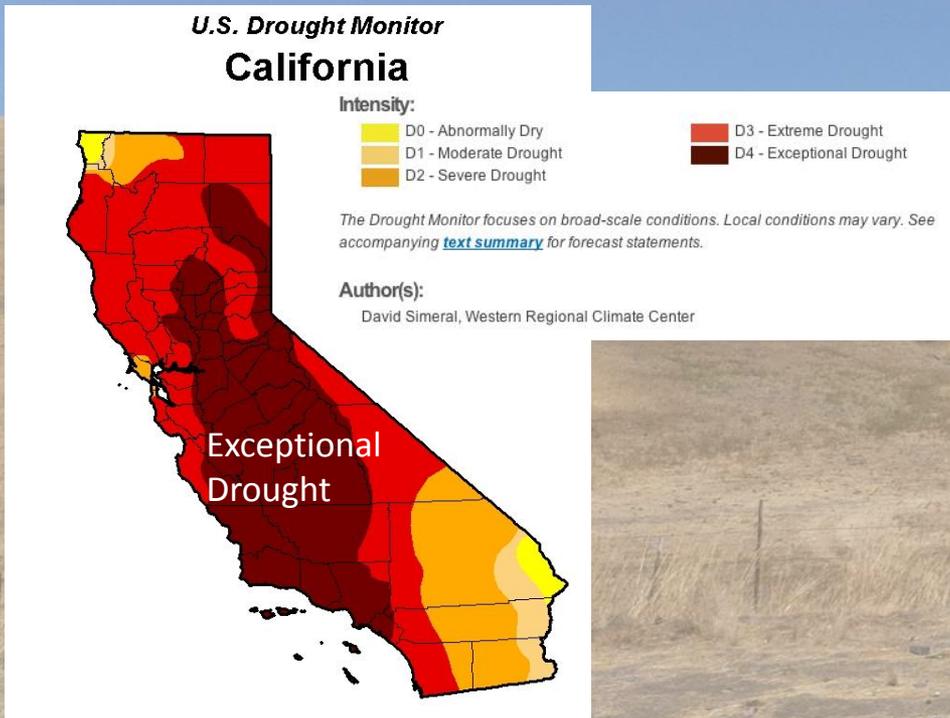


**El Niño**

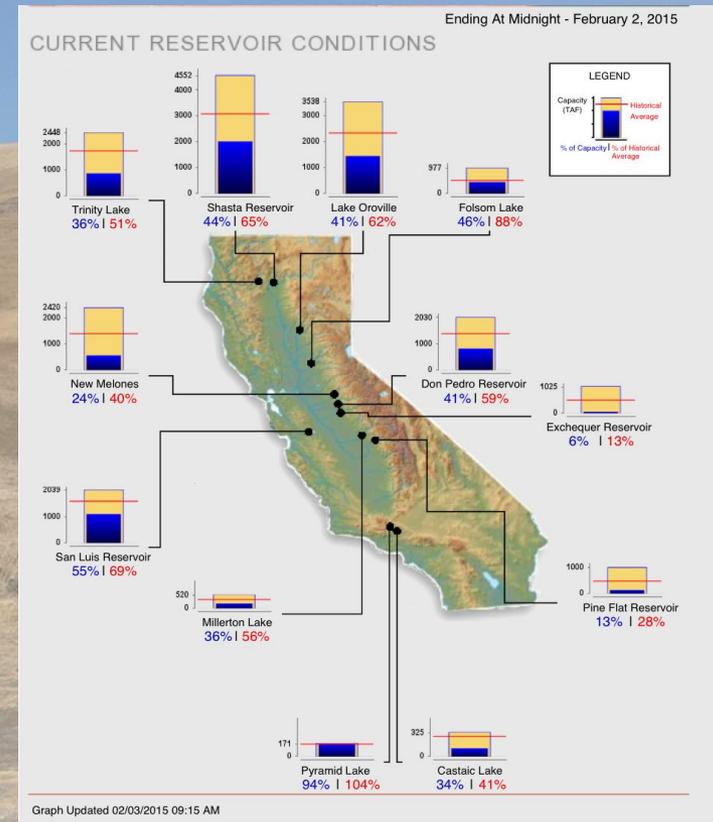
The California drought is affecting 37.2 million people.  
**100% of the state is in drought** and 40% is in the most severe state of drought. Currently the state reservoirs stand at 67% of average.

January 27, 2015

February 2, 2015

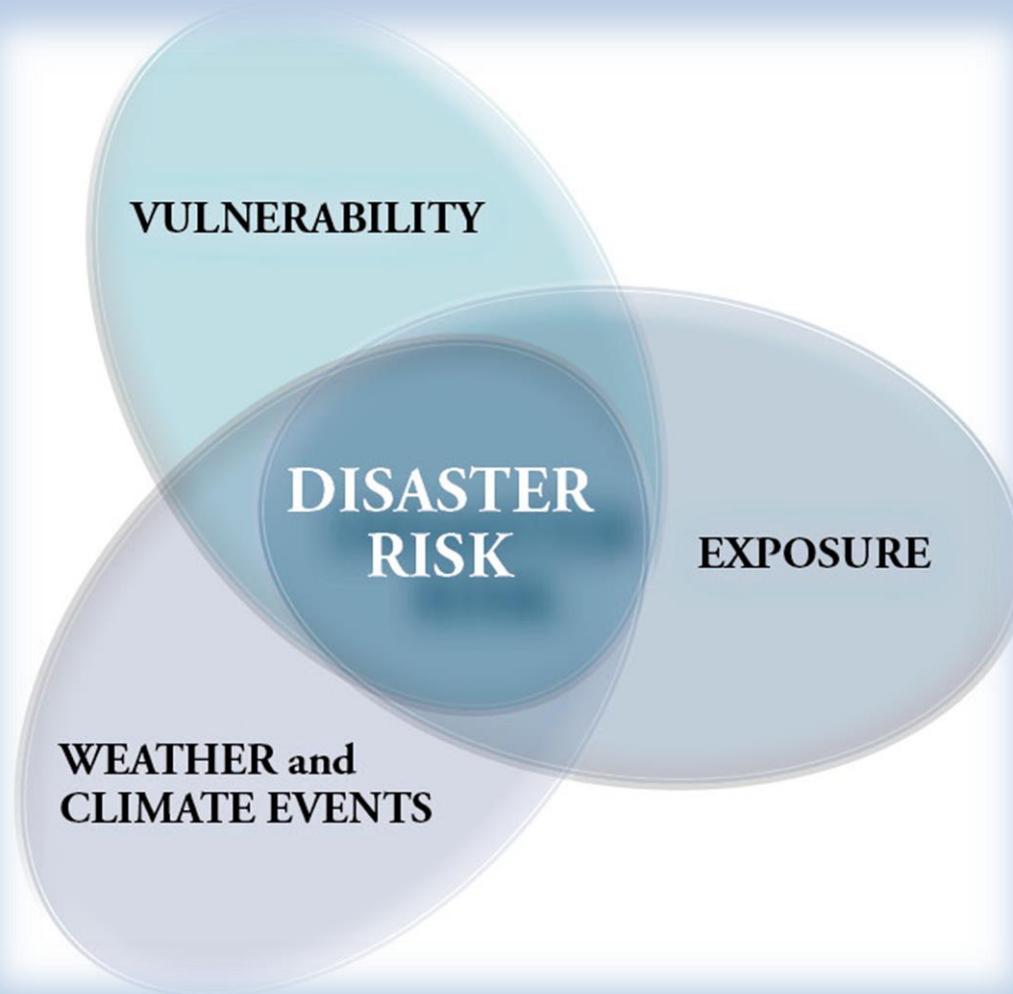


<http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA>



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

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



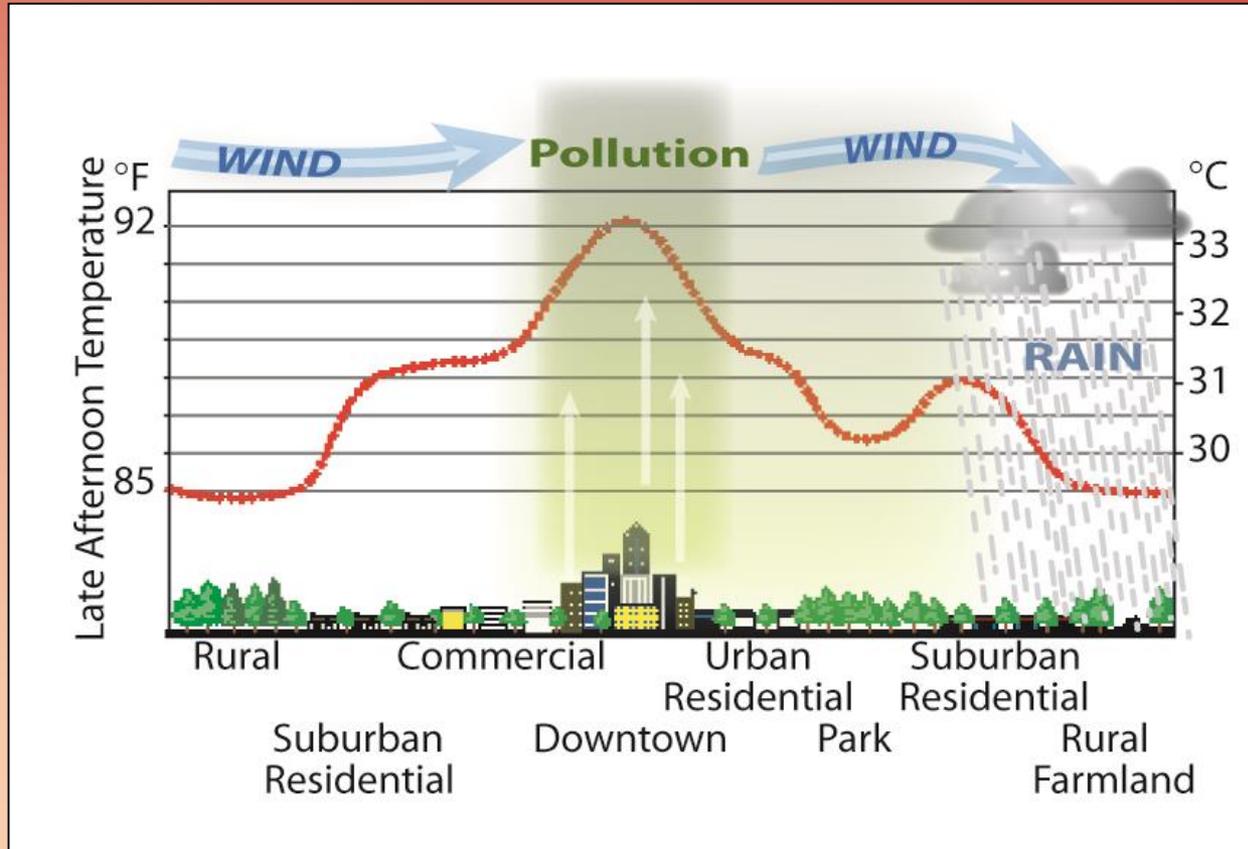
Shifts in global weather patterns connected to the AMO and PDO have increased humanity's vulnerability and exposure.

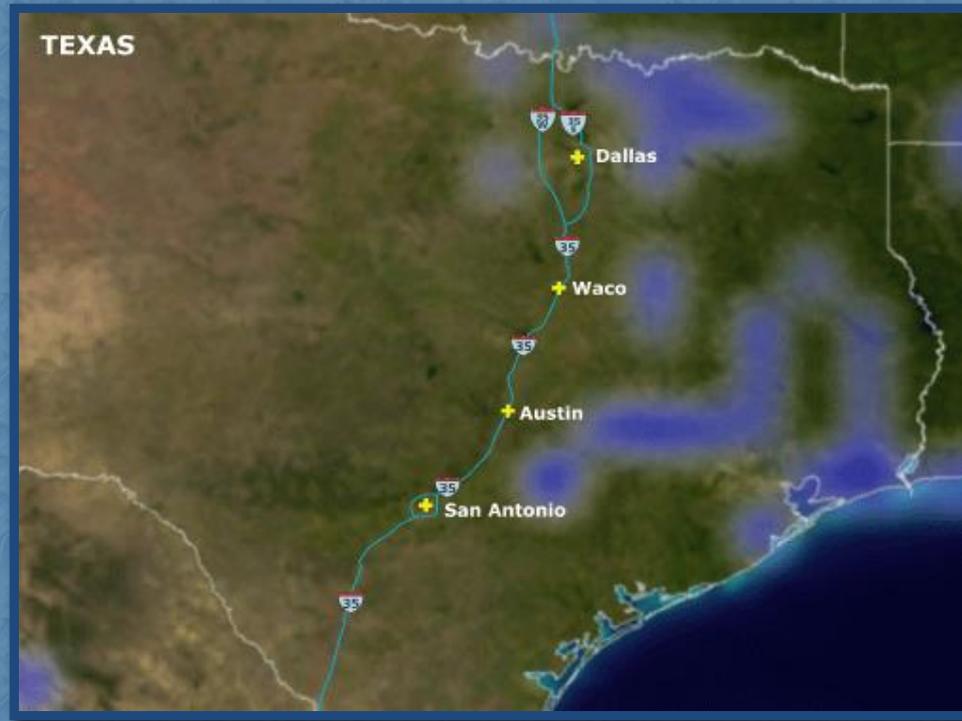
source: [http://ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure\\_FINAL.pdf](http://ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf)

## Areas Facing Increased Exposure to Weather-Related Risk

<b>DROUGHT</b> including flash droughts	<b>FLOODING &amp; SEVERE STORMS</b> including both winter and tropical storms
The US Southwest including Southern California	Western portions of the US Midwest
The US Southern Plains from Western Kansas to Texas	The Mid-Atlantic US states
Georgia and Northern Florida	Southern Mexico
Northern Mexico	The Caribbean
Southern Argentina	Southeastern Brazil
The Southern Andes Mountains	Africa's Eastern Sahel
Northern Africa	India
West Africa	Bangladesh
Mediterranean Europe	Central Coastal China
The Ukraine	Eastern Australia
Iran	
Pakistan	
The Southern Himalayas	
Southwest China	
North Korea	

Human construction, pollution, and energy use makes the climate change even more extreme.





The mean monthly rainfall rates within 30-60 km (*18-36 miles*)  
downwind of the cities averaged  
28% greater than the upwind region.  
**In some cities, the downwind rainfall  
was as high as 51% greater.**

**Long-term planning, using 20+ years  
of data, is biased towards climate conditions  
that no longer exist.**

**If long-term planners would look at 60 – 80 year climate data,  
they should make different and better decisions.**

# Conclusions

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

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