

Our Changing Climate: the Impact on Horticulture



**CANADA'S PREMIER GREEN INDUSTRY
TRADE SHOW AND CONFERENCE**

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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.
- 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 in the Eastern provinces. They usually allow hurricanes to travel further north, including into Canada, and double their numbers. **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, it warmer, drier conditions through Southern Canada, except the Rockies.
- **We have reached a tipping point. The PDO has changed and is creating more extreme weather and drier conditions in the Western Provinces for the next 15 – 20 years. It may also have changed the impact of El Niños.**

Basically the climate is determined by:

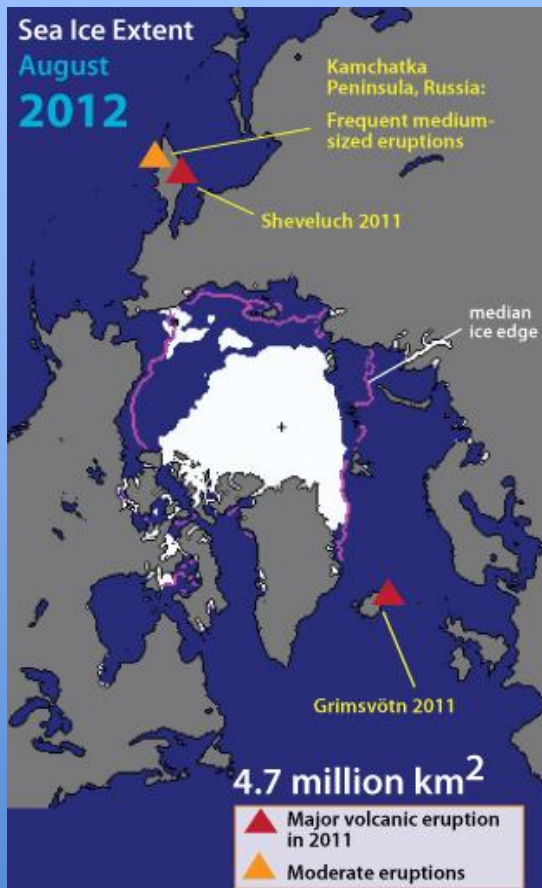
- © How much solar radiation the Earth receives (the Sun)
- © The patterns of where the solar radiation falls or is reflected (Clouds/Volcanoes)
- © Where the heat from the solar radiation is stored (Oceans/Urban Heat Islands)

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.

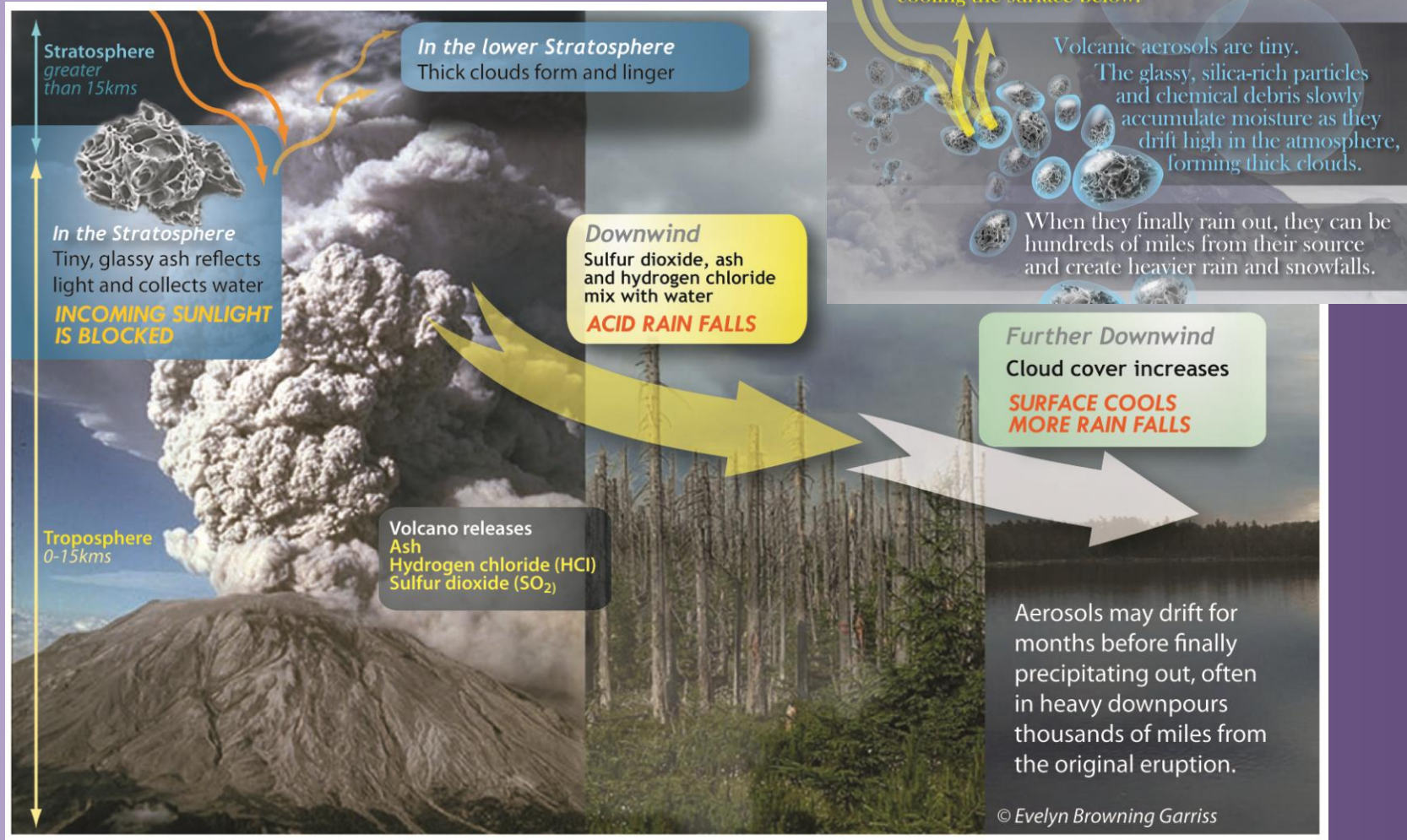
In 2011, large volcanoes erupted in both the North Atlantic and Pacific.

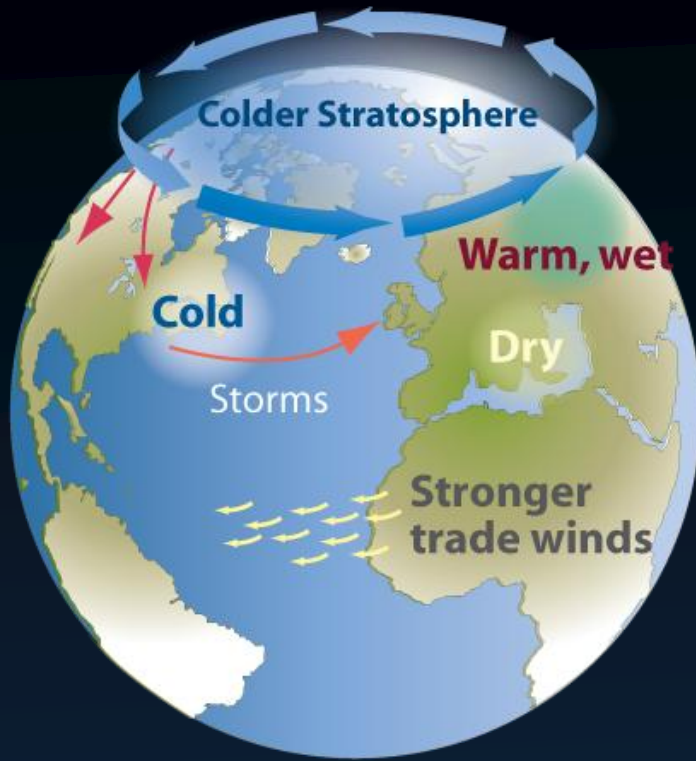


The cool Arctic summers have reduced the amount of summer melt for three years in a row.



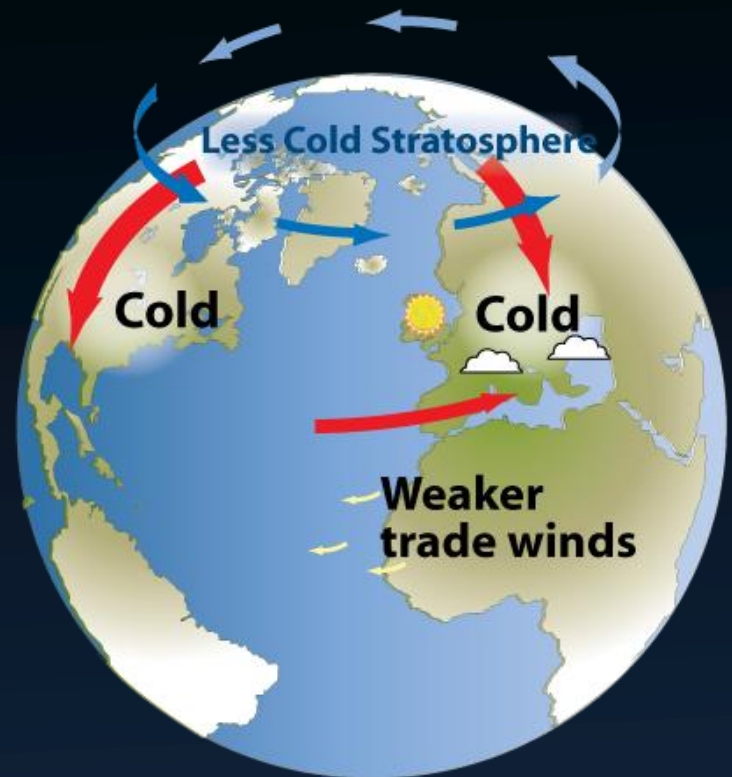
Clouds, the debris from large volcanoes, and man-made aerosols can reflect back sunlight and change rainfall patterns.





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

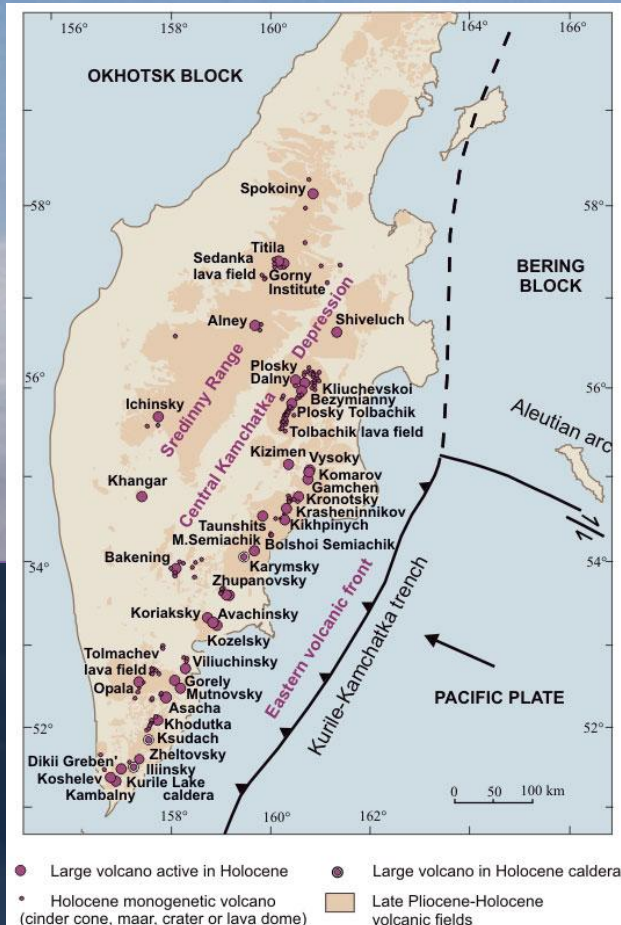
1 Volcanoes are the **WILD CARDS** of climate. They **temporarily** change long-term trends.

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>





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



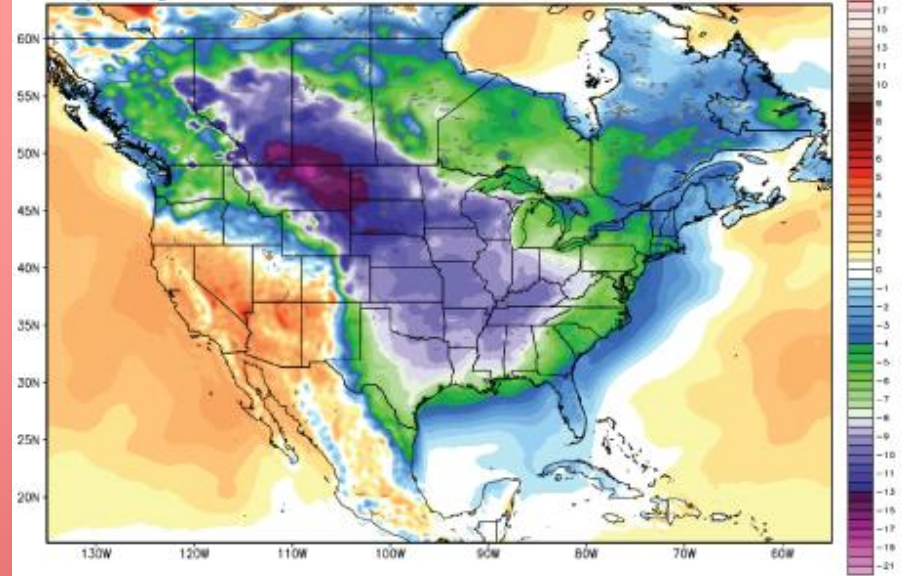
Mount Sheveluch in Russia remains restless. On October 28 and 30 the volcano erupted, with the ash plumes rising 11 km (6.8 miles) high. This is not large enough to affect climate, but it is large enough to enter the next passing cold front and bring a freeze around the second week of November.



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

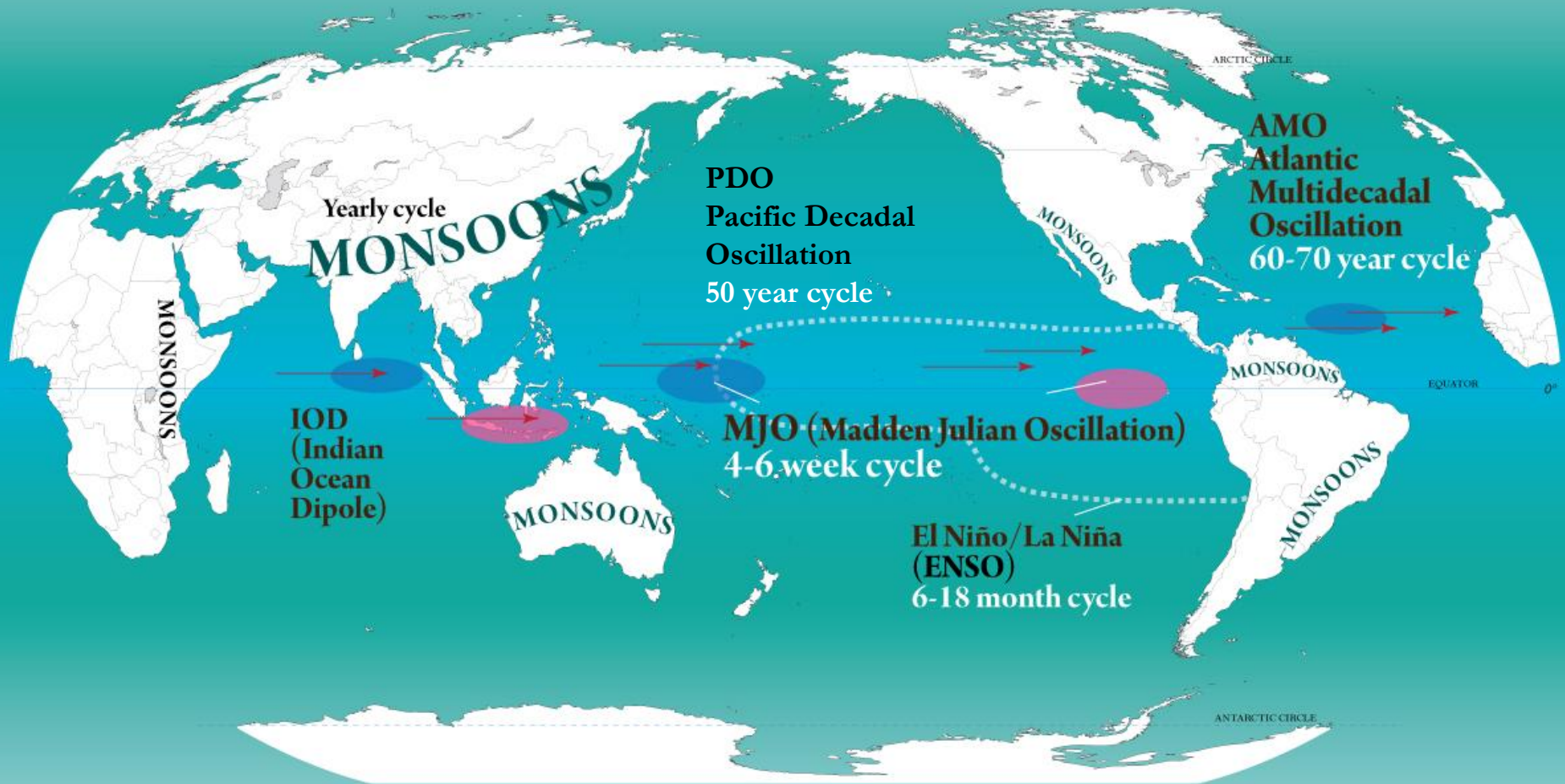


The November newsletter warned that a Russian volcano would trigger a cold spell in the 2nd week of November.

courtesy: NOAA/NCEP

<http://graphical.weather.gov/sectors/conusWeek.php#tab>

Oceans store and transport heat



There are several oscillating patterns of ocean currents.

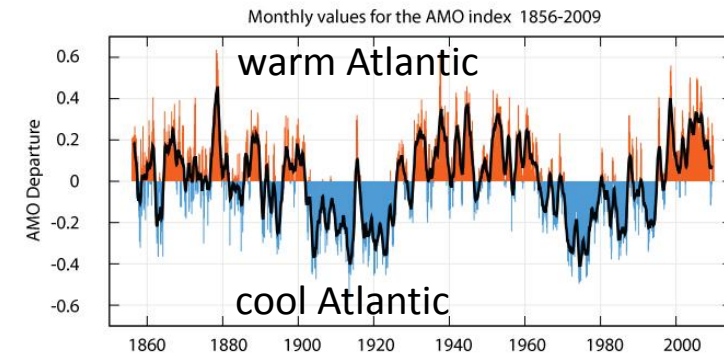
Oceans store and transport heat



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

The Gulf stream flows faster.

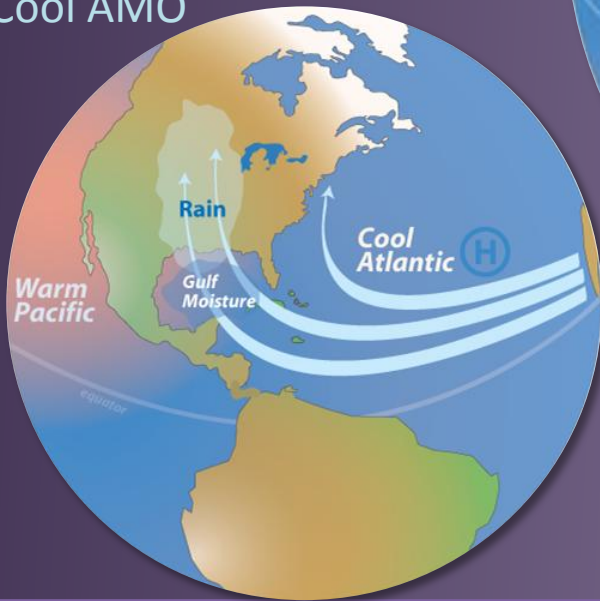
The North Atlantic warms.



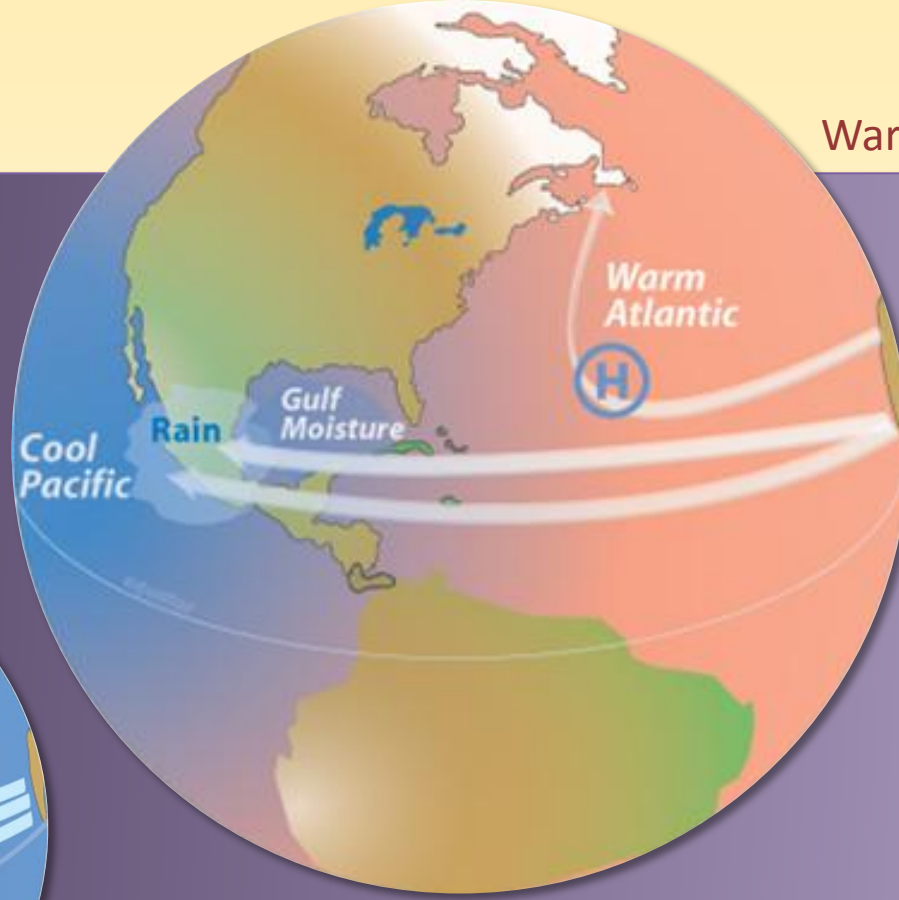
The Atlantic Multidecadal Oscillation (AMO) 1856-2009

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

Cool AMO



Warm AMO

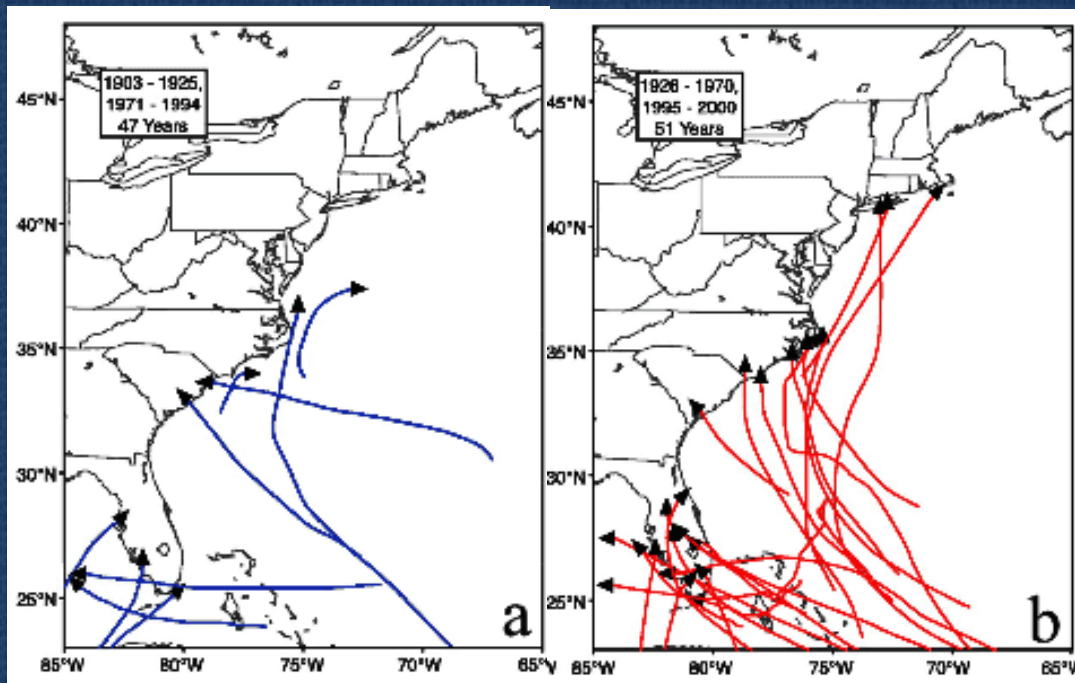


The warm phase of the AMO diverts precipitation from the Prairie Provinces, Gulf, and Great Plains.

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

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

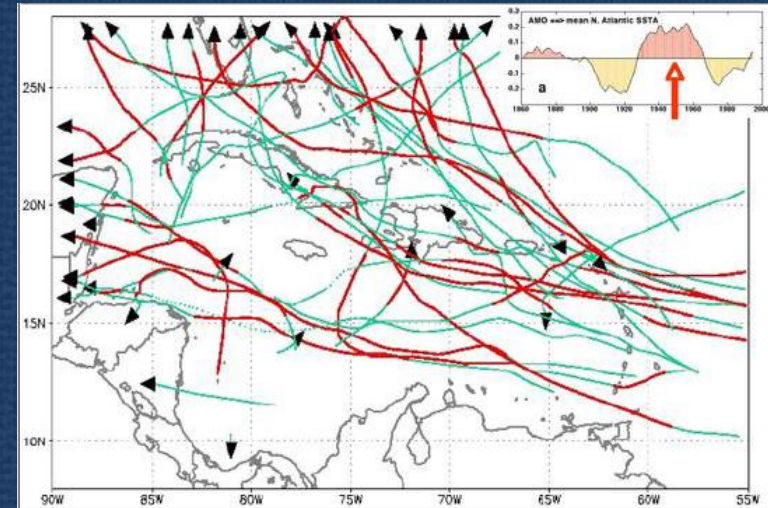
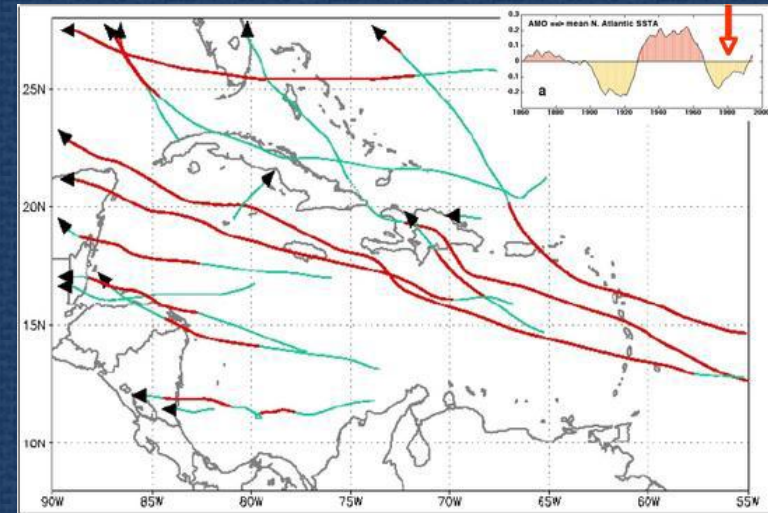
Atlantic hurricanes go farther north, including into Canada, double in number and, on average, carry more moisture.



Cool Atlantic

Warm Atlantic

Cool Atlantic



Warm Atlantic

courtesy: NOAA/GOES



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

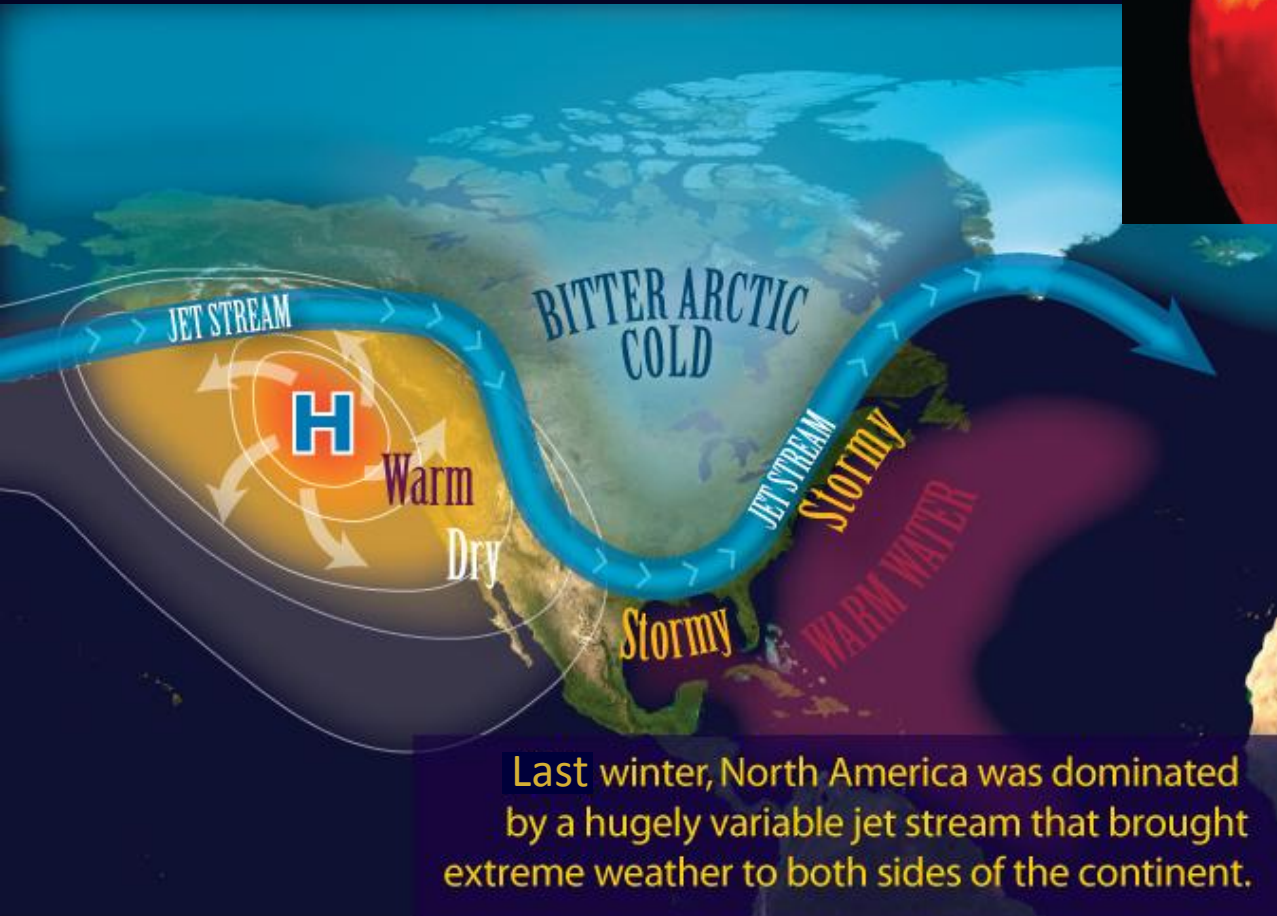


The Positive AMO redistributes scarce water in the Middle East.

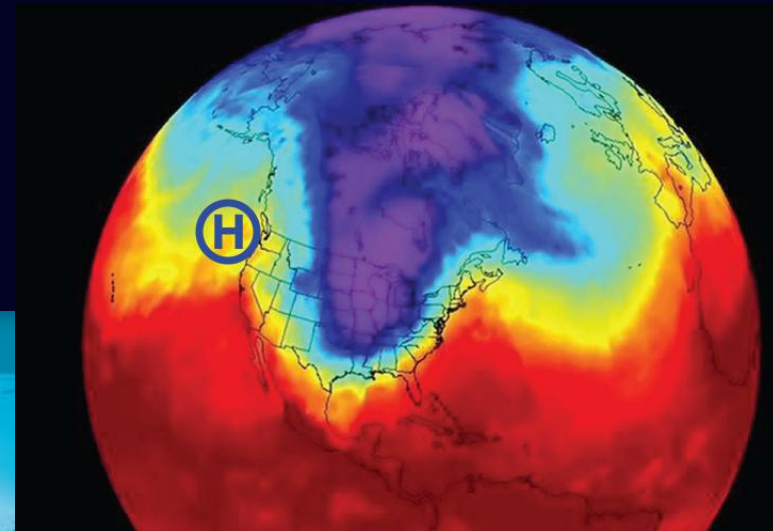


The Positive AMO redistributes scarce water in the Middle East.

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



Last winter, North America was dominated by a hugely variable jet stream that brought extreme weather to both sides of the continent.



Winter's divided weather patterns will linger through spring.



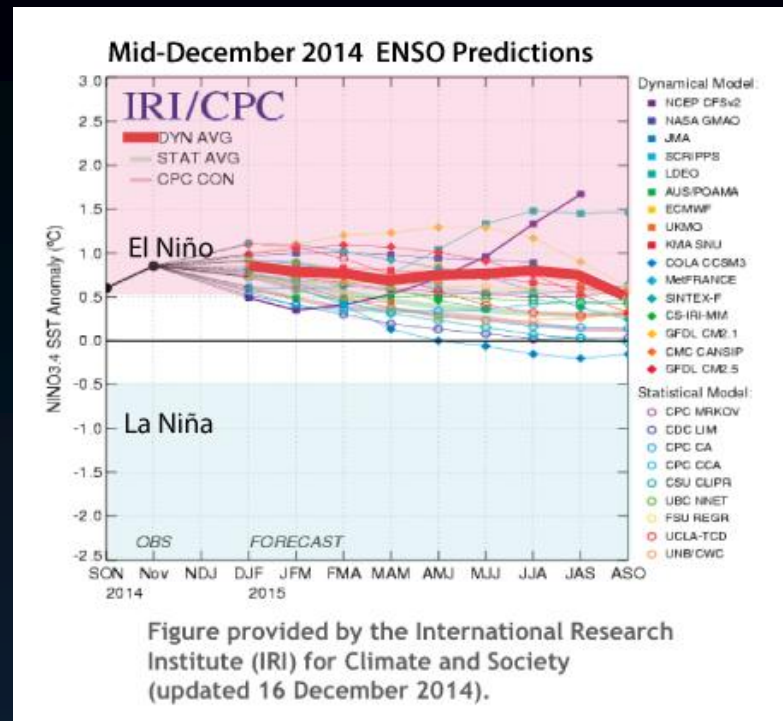
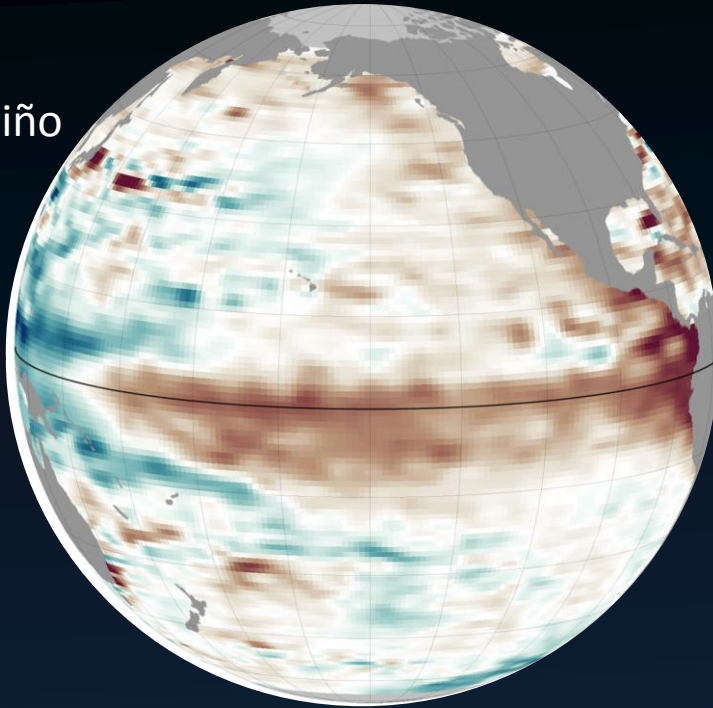
Last winter 92% of the Great Lakes froze over
and they didn't become ice free until June.

This helped cool spring and summer temperatures.

This year the ice cover began in late November, the earliest in 40 years.

Most experts expect only average coverage this year.

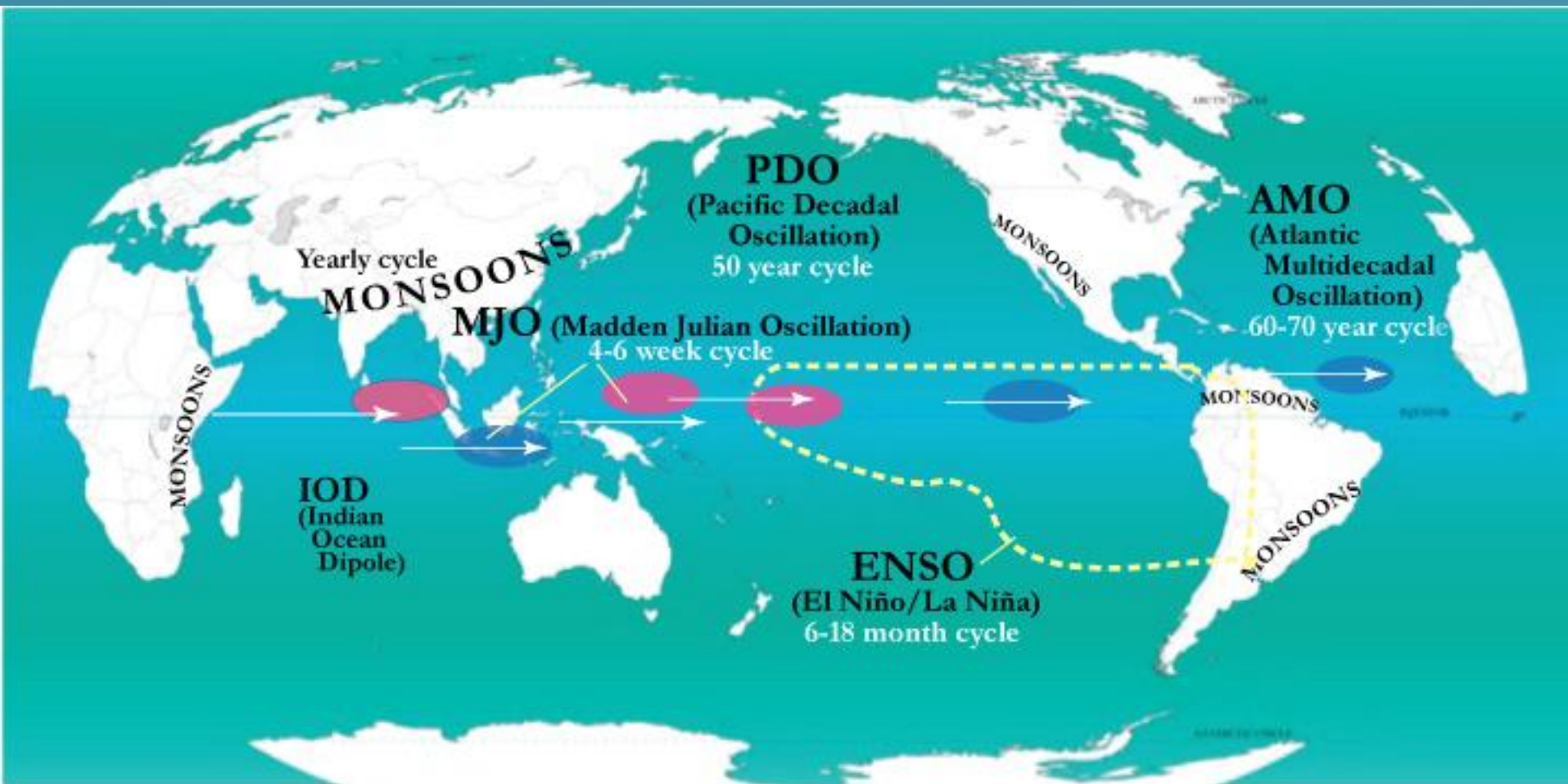
El Niño



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

These conditions faded but **experts say there is a 65%+ chance of an El Niño event returning.**

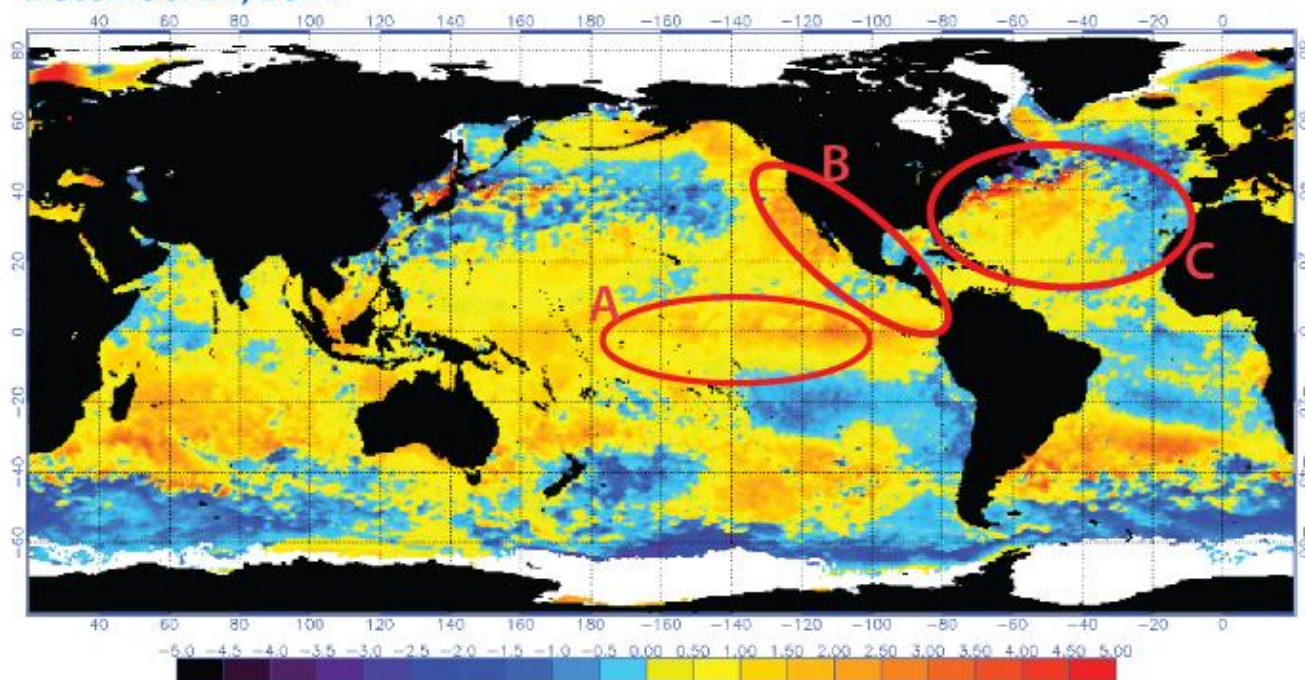
Remember the hot and cool MJOs



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)

December 21, 2014



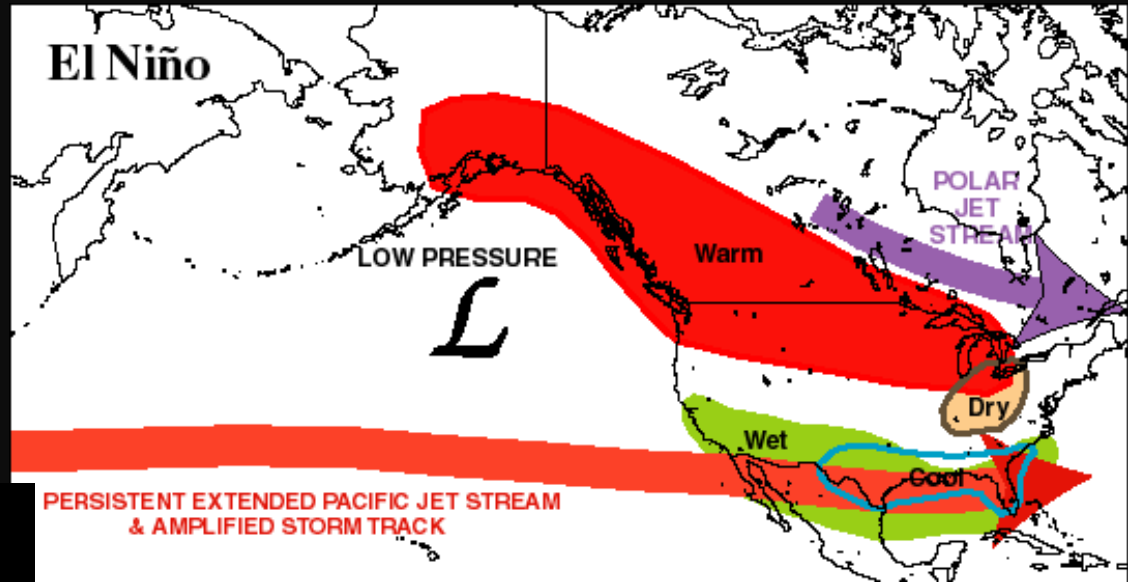
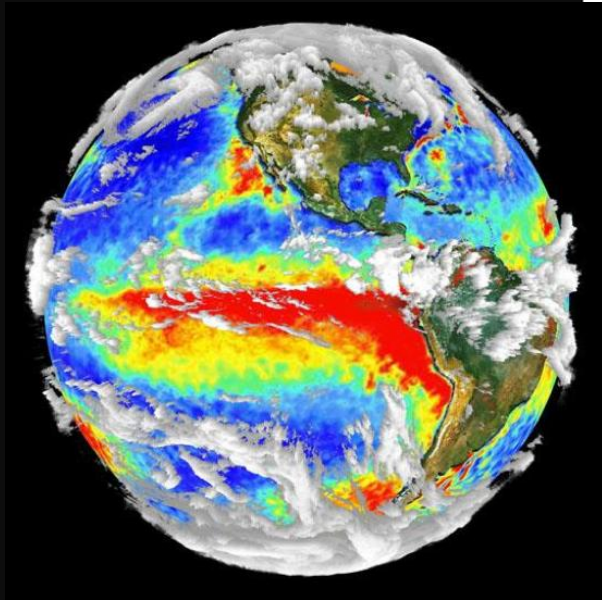
A El Niño conditions

B Warm temperatures along the West Coast of Central and North America

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

<http://www.ospo.noaa.gov/data/sst/anomaly/2014/anomnight.12.1.2014.gif>

Typical Strong to
Moderate El Niño
winter weather
(during years without heavy
polar volcano activity)

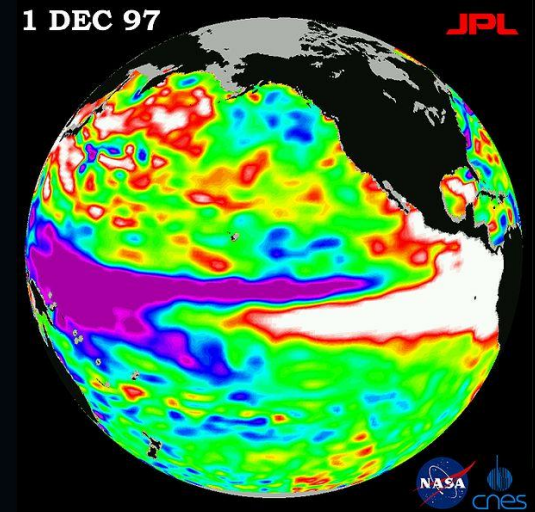


What to monitor as El Niño develops:

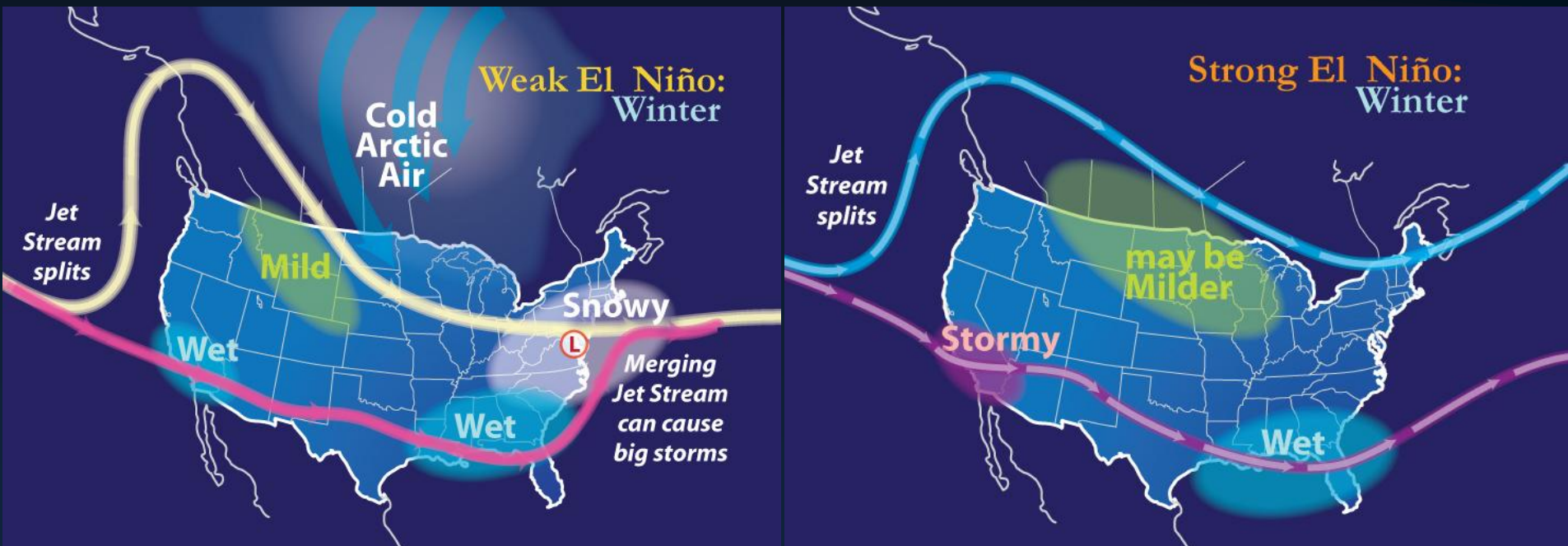
LENGTH – If it lasts into winter and spring, it creates warmer weather and severe Nor'easters

SIZE – The larger it is, the more like it is to warm Canada from the West Coast to the Great Lakes.

INTENSITY – A hot El Niño creates a warm Canadian winter. Cooler events can have cold winters.

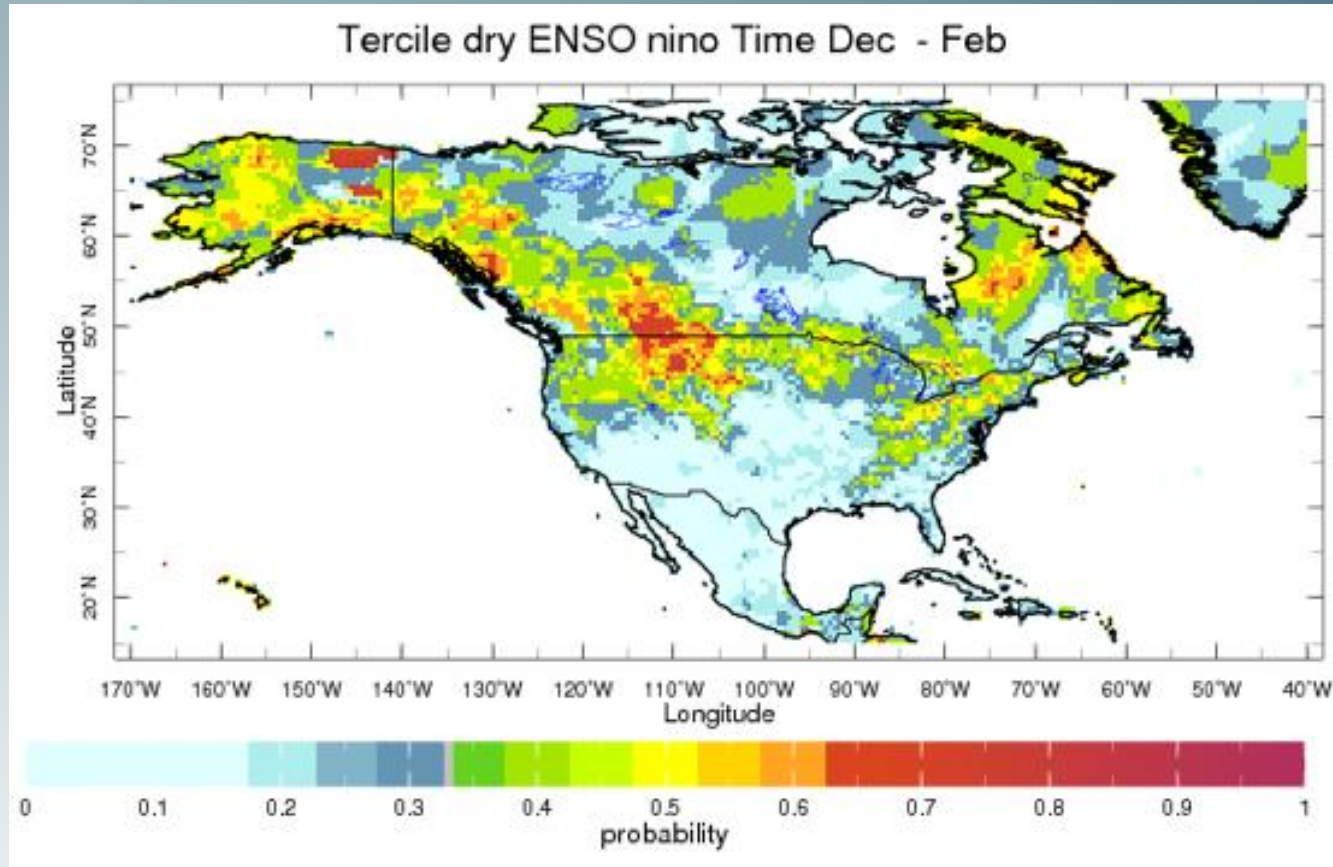


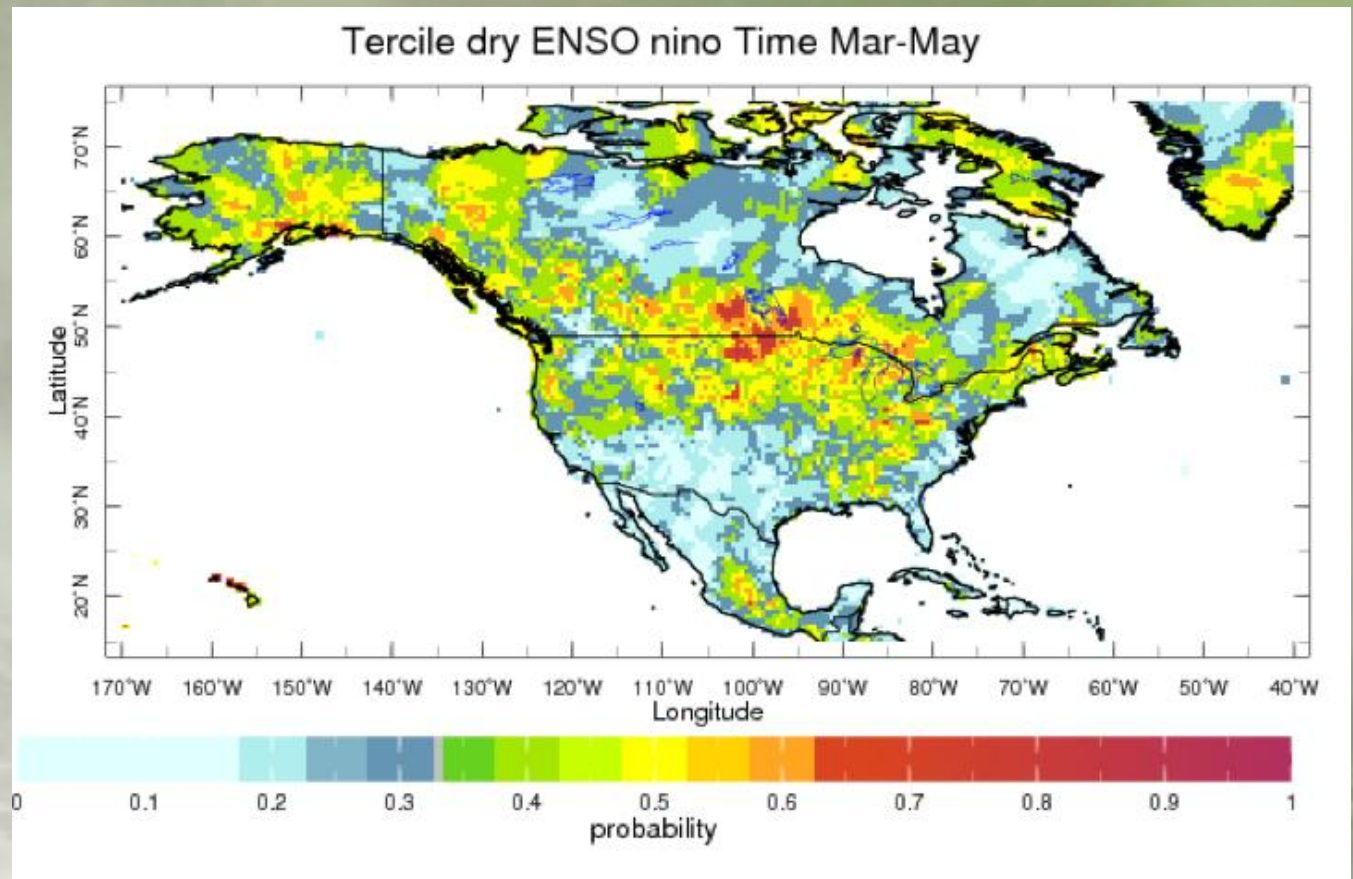
Winter and Spring will be shaped
by how big and long lasting the El Nino is.



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

Precipitation Anomalies





The impact of an El Niño on spring precipitation



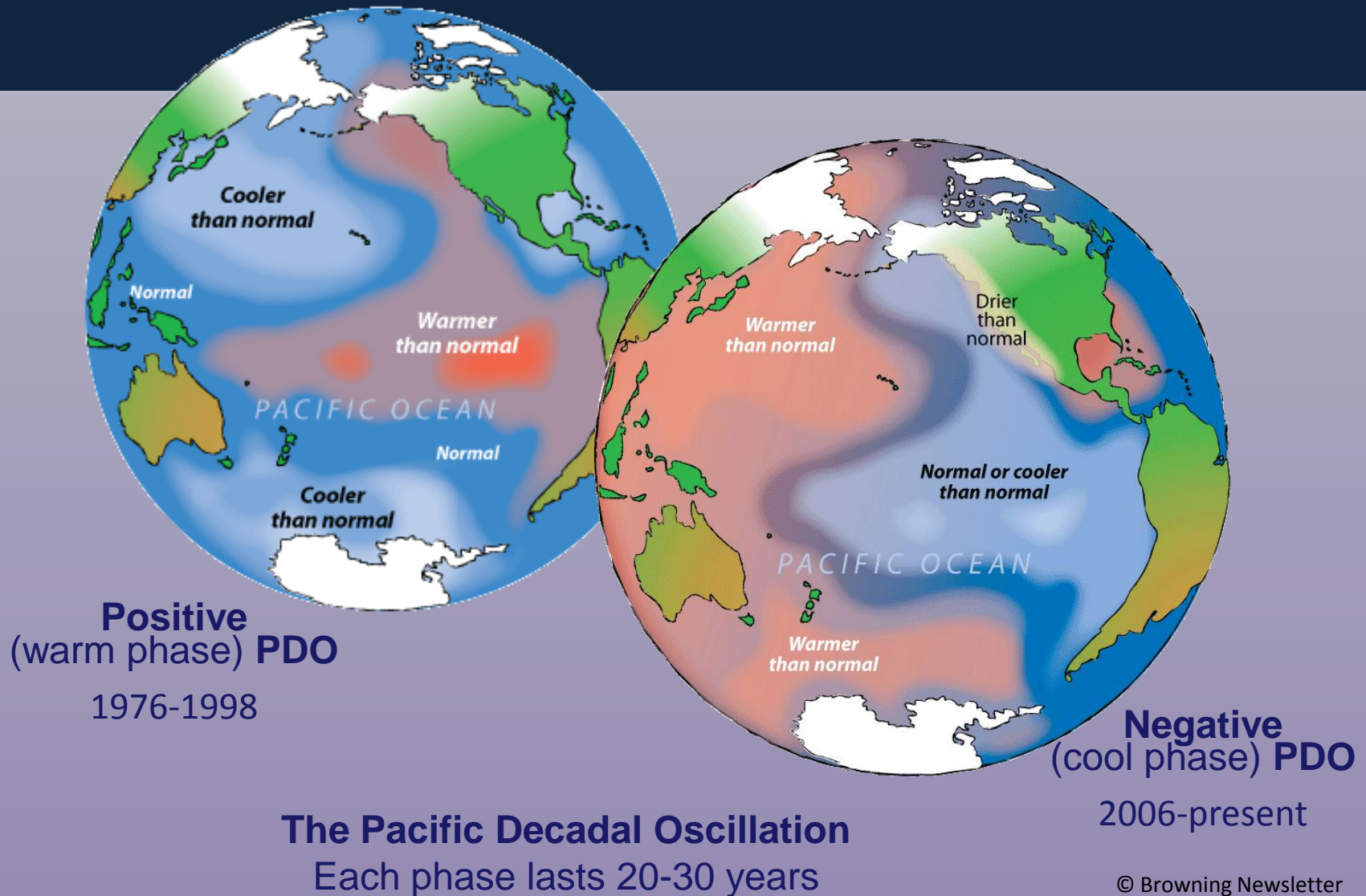
Mid February – Mid March

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

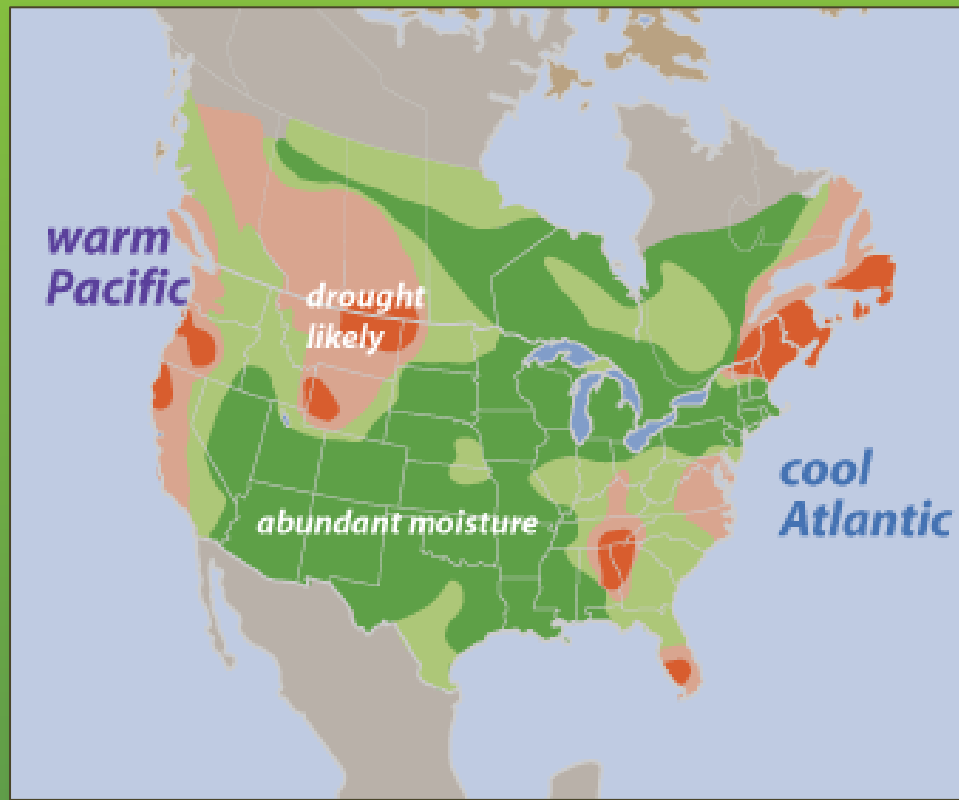
⊕ A moderate Russian volcanic eruption will make this region colder.

* If El Niño conditions continue.

Like the Atlantic, the Pacific has a long-term cycle,
the Pacific Decadal Oscillation.



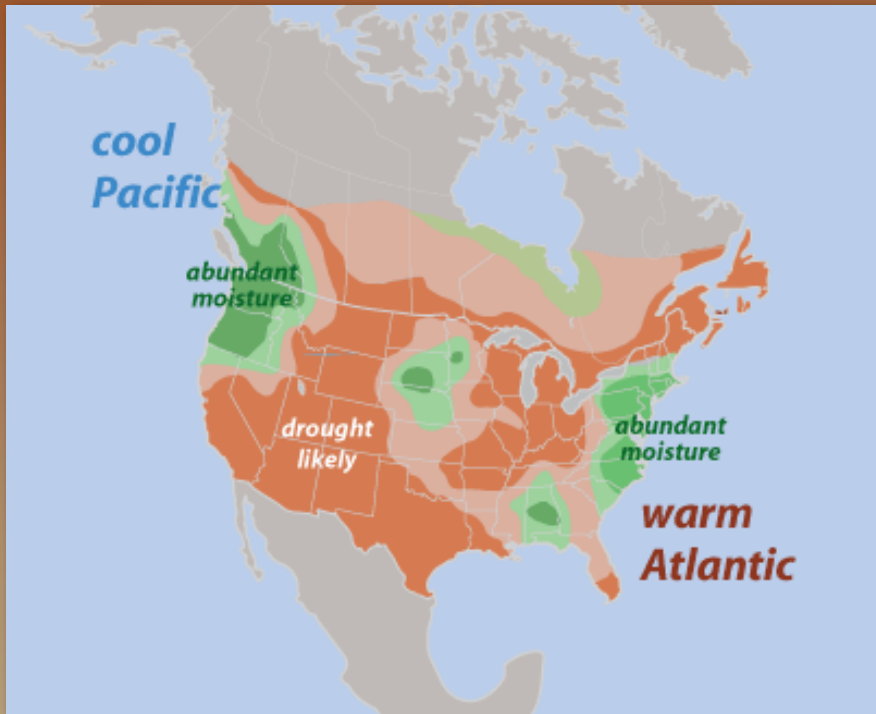
© Browning Newsletter



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.

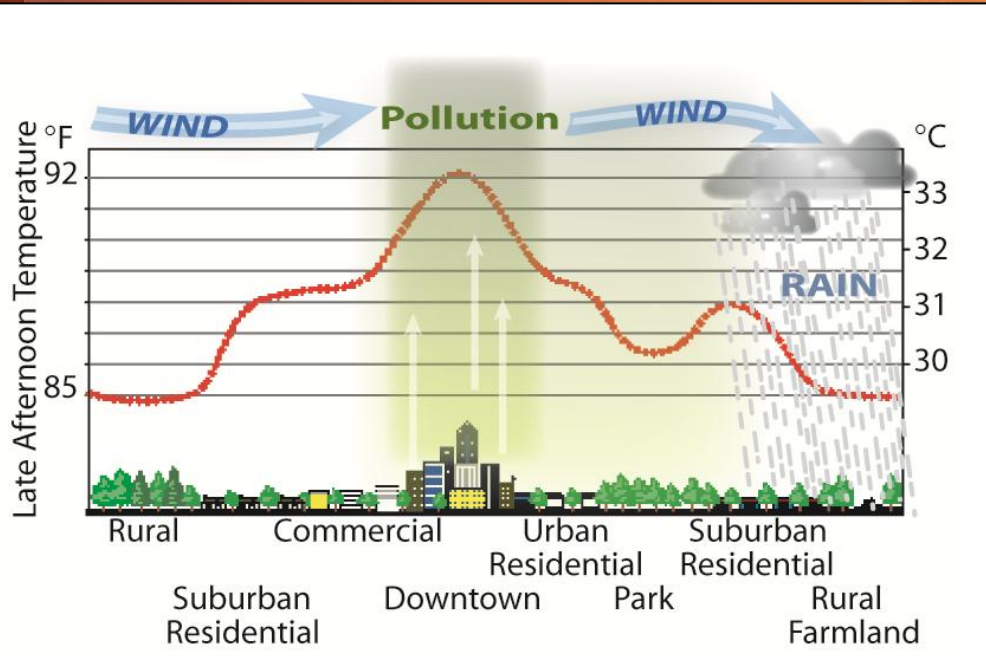


IMPACTS ON WILDLIFE

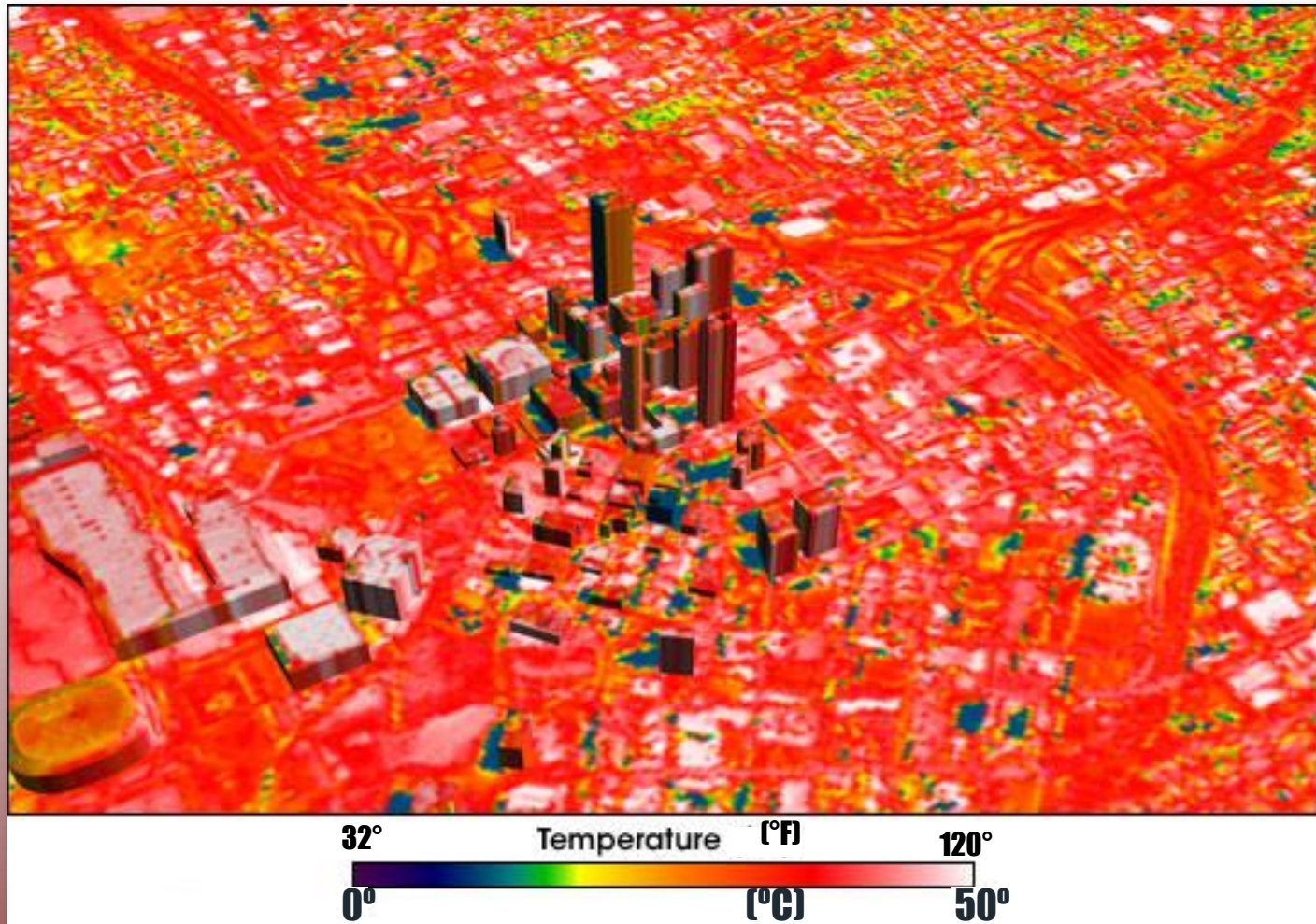
With the Western Provinces turning drier, forests are stressed, leaving woodland environments more susceptible to disease, insect infestations and wildfires.



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



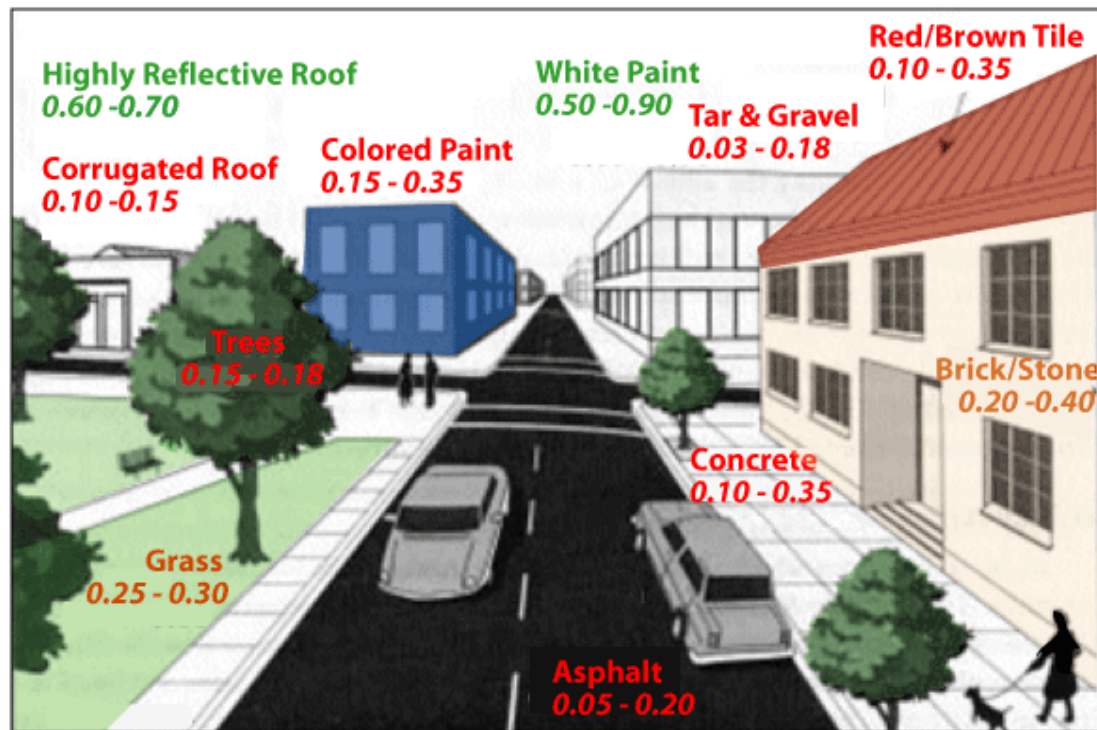
Human construction, pollution, and energy use makes the climate change even more extreme.



Atlanta's rooftops and highways bake

Different surfaces increase
the amount of heat in the city

Various Urban Environment Albedos



The lower the albedo, the higher the temperatures

Surfaces with high albedo (>50) cool the city



Cities tend to be .56 to 5.6°C (1-10°F) warmer than surrounding areas.

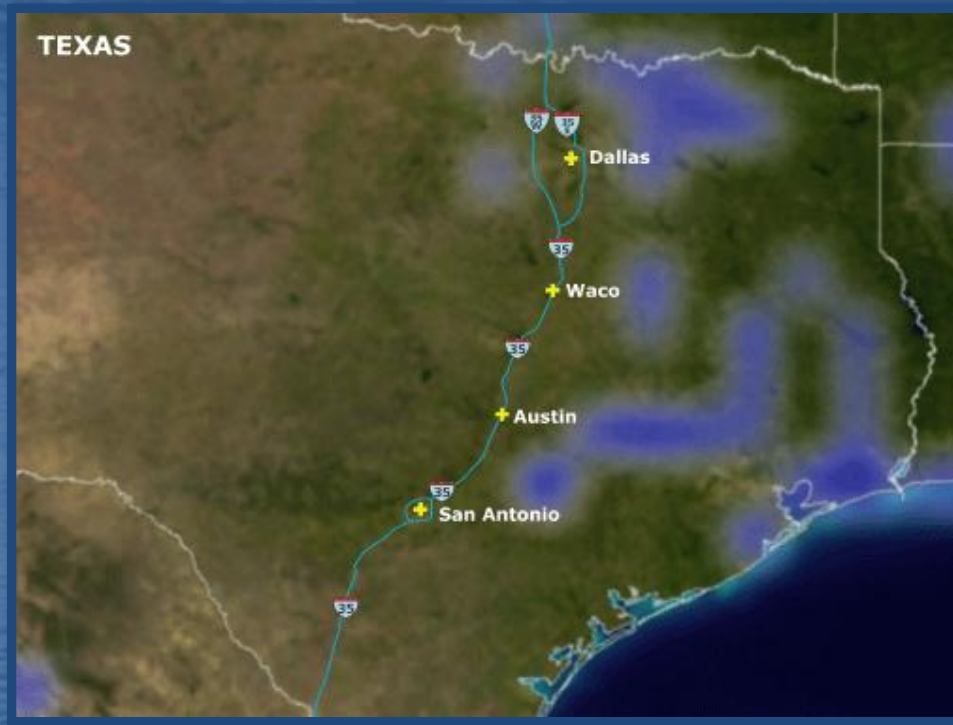
Hot air and pollution rise above the cities and can form rain clouds filled with micro-droplets.



The urban heat and pollution delay the rain.

Prevailing winds blow the clouds away.

When they finally rain out, it is frequently very stormy.



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.

Marine air & mountains
can trap pollution over seaside cities.



When the clouds finally rain out, they create superstorms.

CONCLUSIONS

- **Climate change is not linear. It ebbs and flows.**
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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 in the Eastern provinces. They usually allow hurricanes to travel further north, including into Canada, and double their numbers. **The effect should last another 15 – 20 years.**
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