Our Changing Climate: the Impact on Horticulture

CANADA'S PREMIER GREEN INDUSTRY TRADE SHOW AND CONFERENCE

JANUARY 6-8, 2015
TORONTO CONGRESS CENTRE, TORONTO, ONTARIO

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:

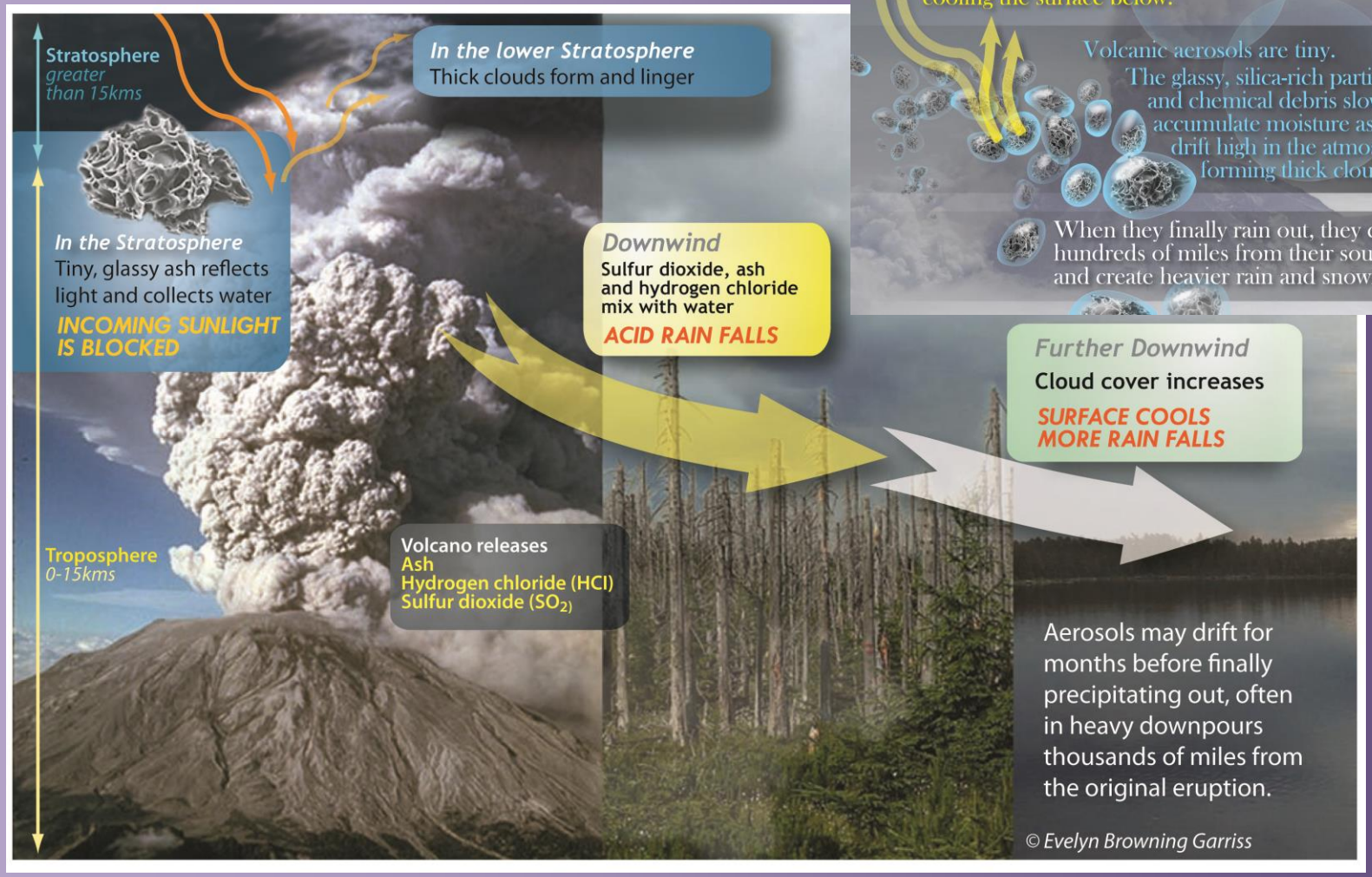
Historical records, coral and tree rings,
sediment layers, and glacial cores to learn how they
shaped the weather in the past.

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.

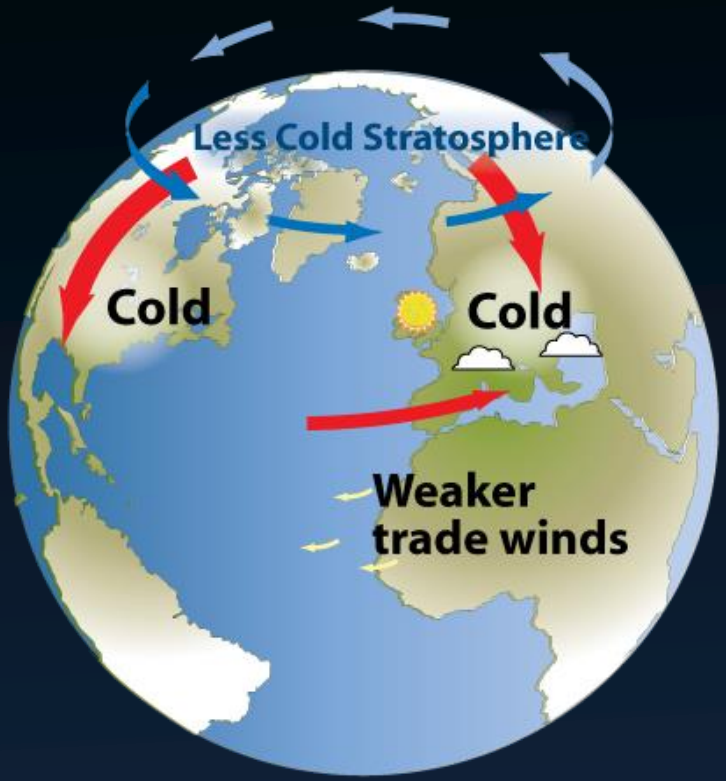
National Snow and Ice Data Center

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



Positive AO

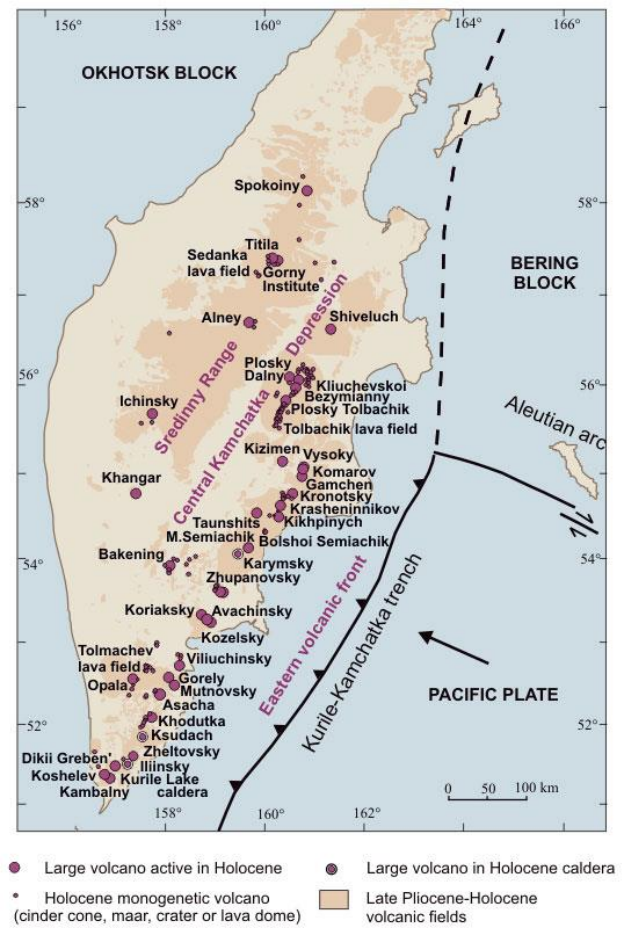
In 2012, the impact of northern Atlantic and Pacific volcanoes strengthened the circumpolar winds, making a strong positive Arctic Oscillation and trapping cold air north.



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



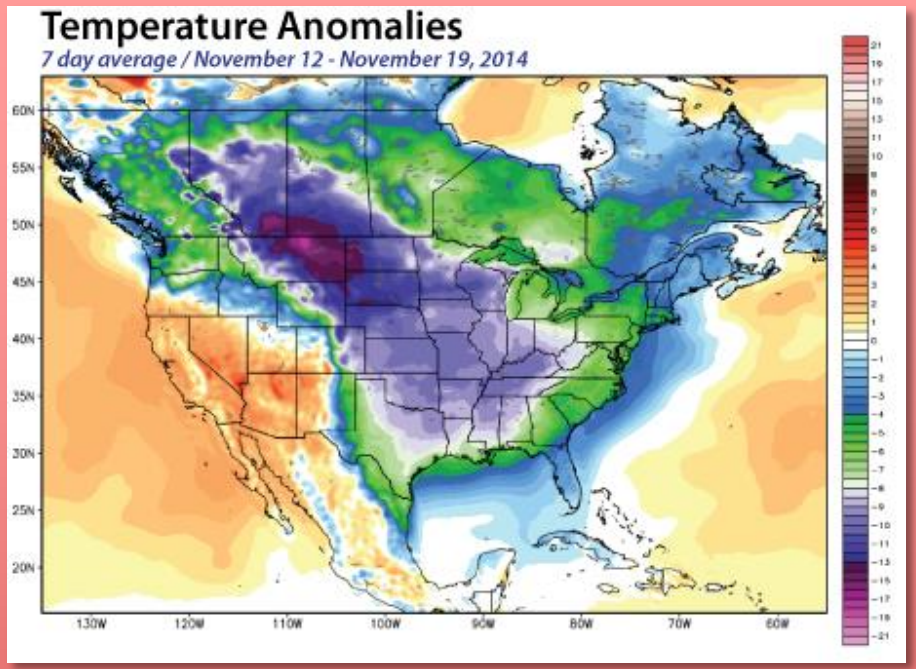
1 Volcanoes are the WILD CARDS of climate. They temporarily change long-term trends.

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




News Notes

If the chemical haze from the giant eruption in Iceland's Holuhraun lava field has its normal historical impact, it could create energy problems for Europe this heating season.

Not only does this type of eruption historically produce colder weather increasing demand, but it creates haze that affects generation of renewable energy. It produces heavy clouds, which interfere with solar energy and acidic moisture which can be damaging to the exposed elements of wind generators.

A recently released European Energy Markets Observatory report has warned that the risk of blackouts in Europe will grow in the coming winter as thermal power-generating capacity has been shuttered amid the region's economic slump and a greater reliance (23.5%) on renewables.

A cold winter would exacerbate the problem. The report noted growing share of renewable energy is pushing out conventional sources of power, reducing the "electricity system's margin to meet peak demand in specific conditions such as cold, dark and windless days".

In particular, the study noted that **3 nuclear reactors in Belgium have been halted because of damage and safety concerns. France usually relies on Belgian power imports on cold days because of the relatively large number of homes in the largest country that are equipped with electric heating.**

Add to this the growing difficulties with Russia over the Ukraine. Russia's Gazprom is a major provider of gas and has used gas supplies as a negotiation tool in the past.

Great Britain's National Grid has warned that its capacity to supply electricity this winter will be at a seven-year low due to generator closures and breakdowns. Its spare energy capacity is currently at 4%, compared to 17% three years ago. Since then, 15 power plants have been closed or partially closed, taking out a large chunk of the UK's energy-generating capacity.

The nation's Energy Minister Matt Hancock noted that the UK does not receive any gas directly from Russia, but if there are supply problems to other nations, gas flows to Europe could be affected, which will in turn affect supplies to the UK. Officials report that the nation will import more expensive liquefied natural gas.

Meanwhile authorities are reassuring people that they have made adequate contingencies plans. It should be noted the plans are 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 National Hurricane Center tracking maps, but remain dangerously strong, even deadly.

The Atlantic is so hot that we saw two "zombies" cross the ocean and hit Europe – the remnants of Bertha in August and Gonzalo earlier in October. However the warm El Niño has pushed so much warm water north that a rare Pacific event hit the West Coast. The Central Pacific Hurricane Area swept past Hawaii. Then the notorious Pineapple Express, the stream of moisture that occasionally brings tropical rain and weather from Hawaii to the Pacific Northwest, grabbed the remnants of Ana and took it for a ride.

The storm drenched the region but did little damage. Its last moisture reached as far inland as Montana. You know the weather is turning weird when Montana and Southern Alberta get rain from Hawaii!

Fig 14 **Rain from a "zombie" hurricane**

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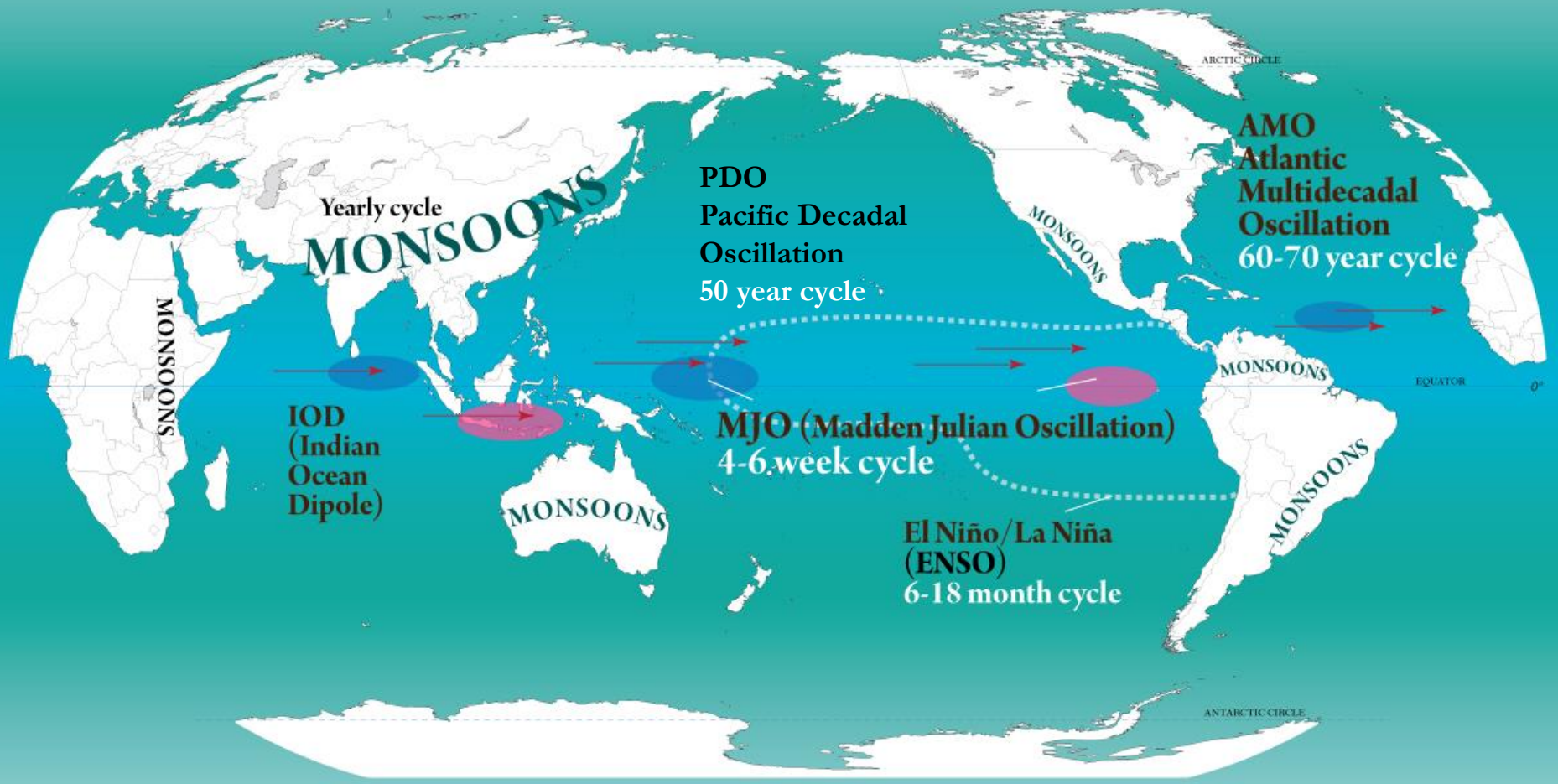
The November newsletter warned that a Russian volcano would trigger a cold spell in the 2nd week of November.

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

Oceans store and transport heat



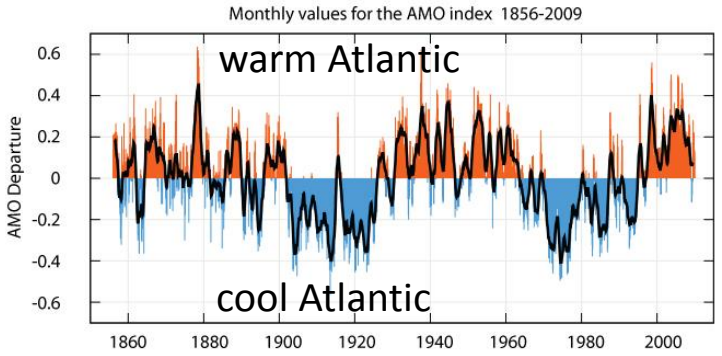
There are several oscillating patterns of ocean currents.

Oceans store and transport heat

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

The Gulf stream flows faster.

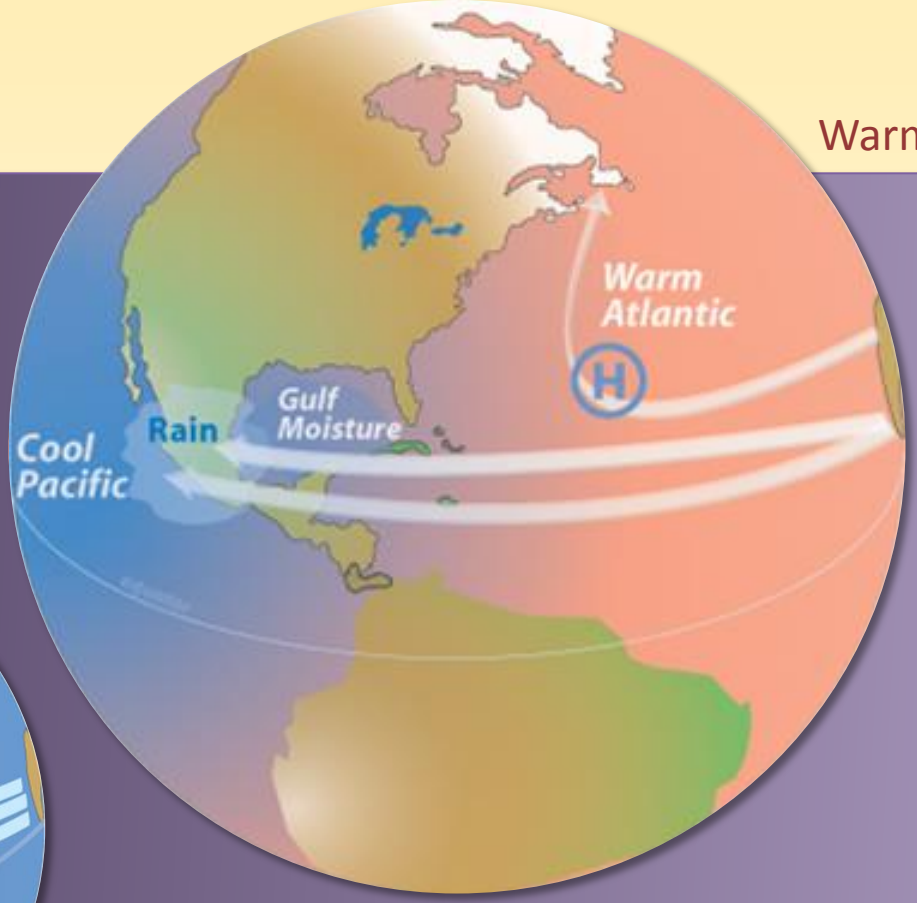
The North Atlantic warms.



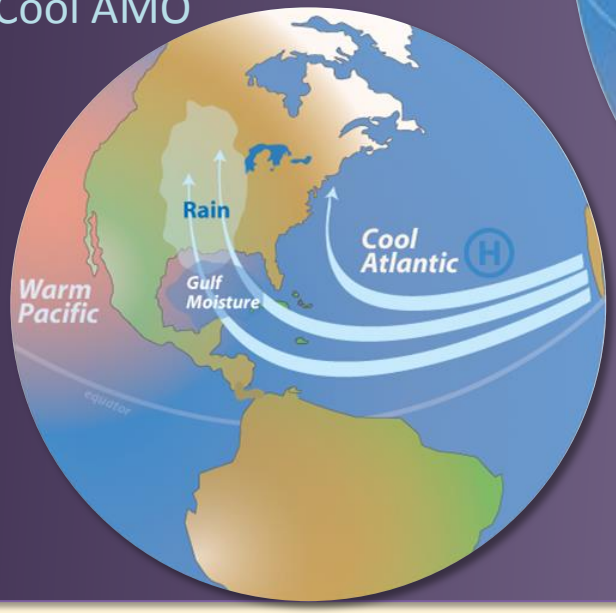
The Atlantic Multidecadal Oscillation (AMO) 1856-2009

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

Warm AMO



Cool AMO

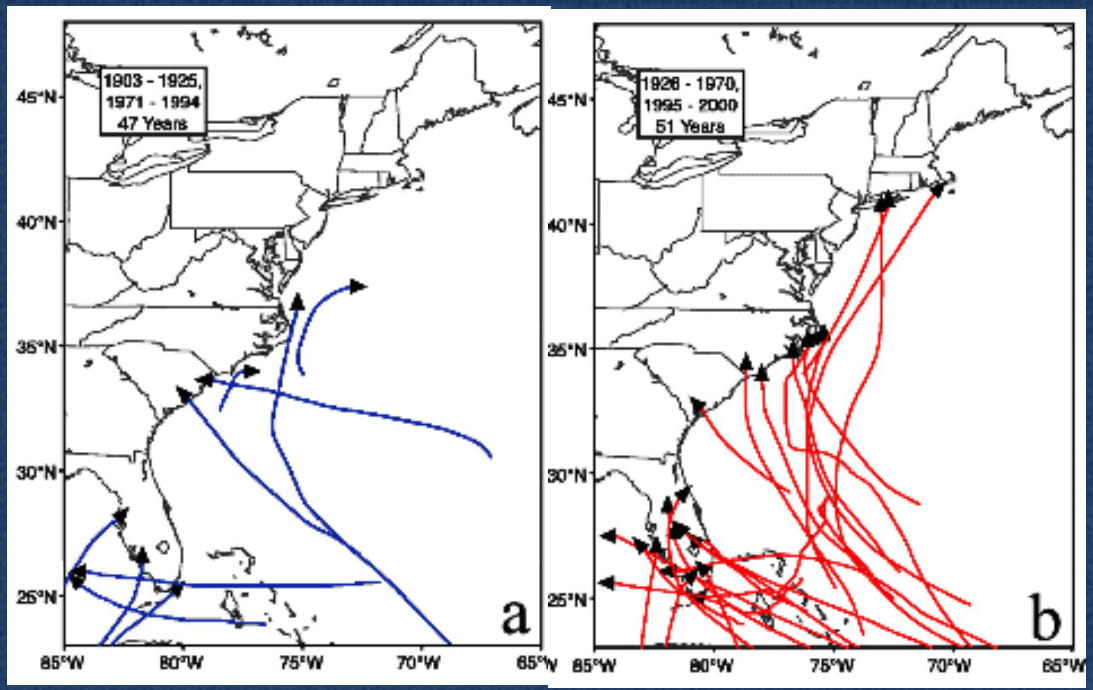


The warm phase of the AMO diverts precipitation from the Prairie Provinces,Gulf, and Great Plains.

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

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

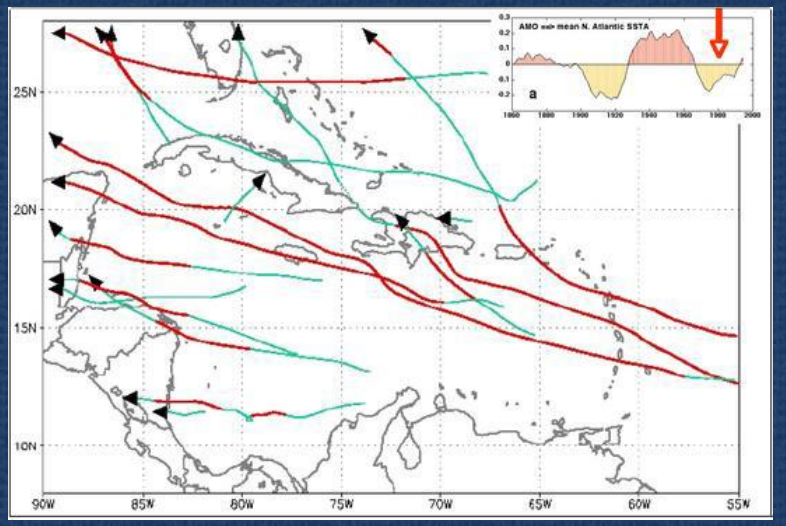
Atlantic hurricanes go farther north, including into Canada, double in number and, on average, carry more moisture.

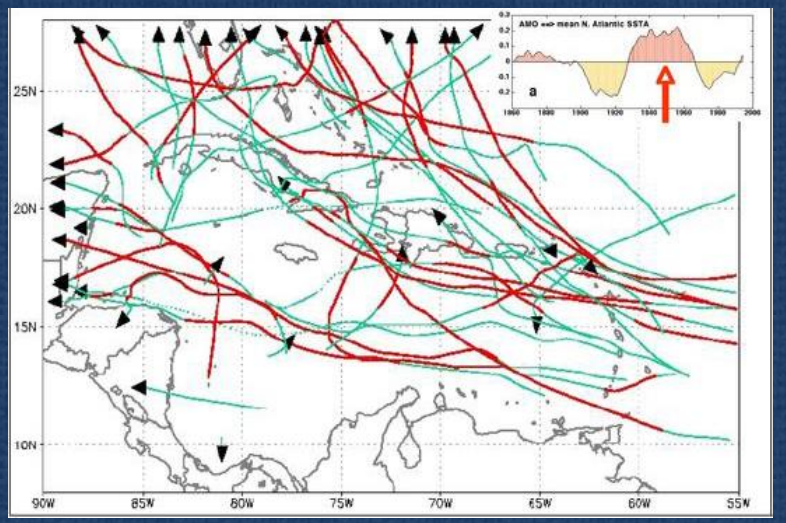


Cool Atlantic

Warm Atlantic

Cool Atlantic



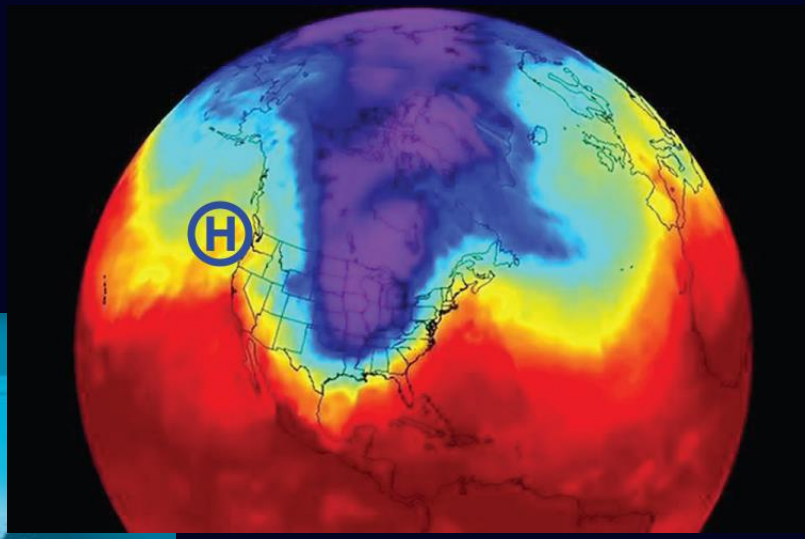


Warm Atlantic

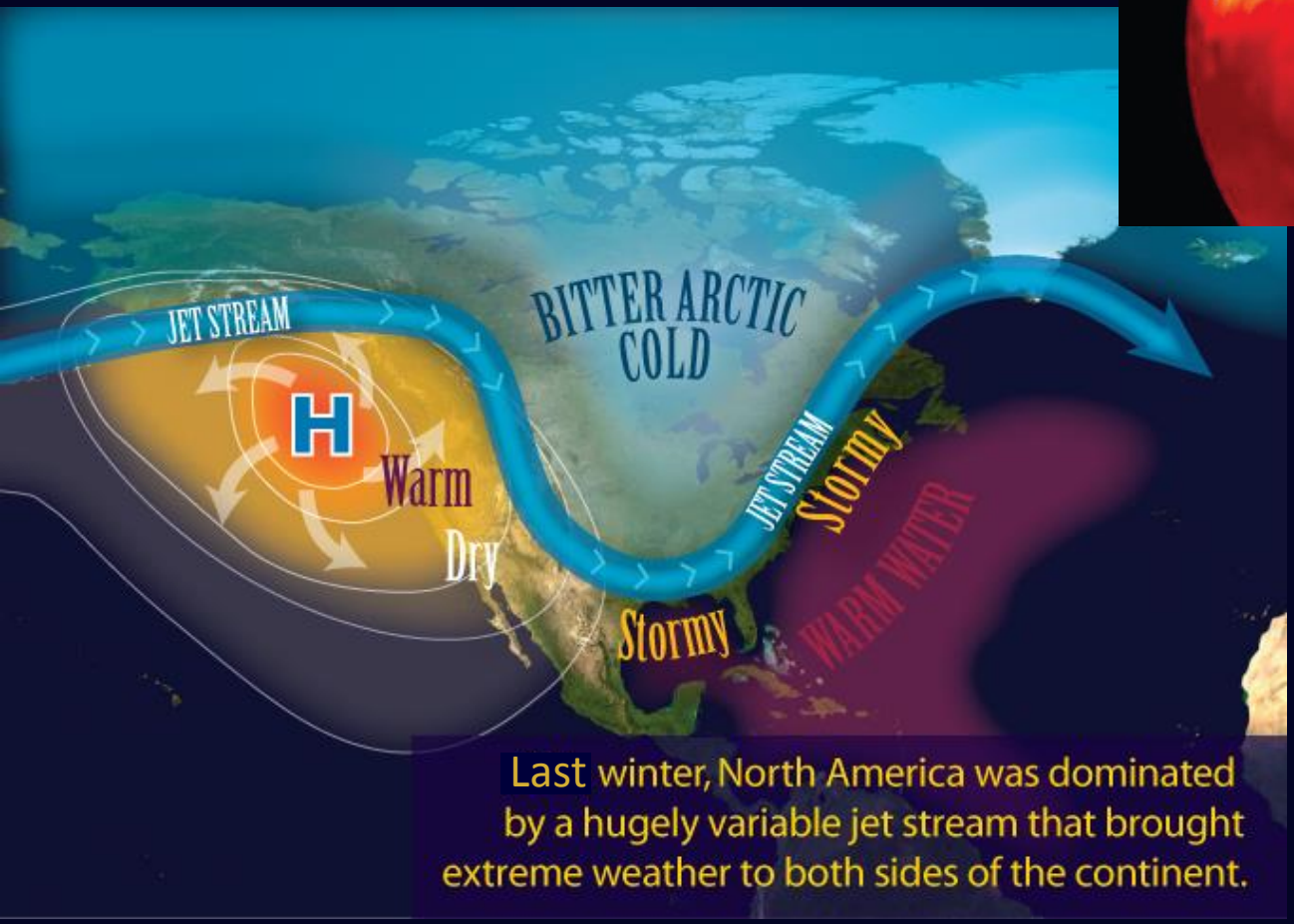
courtesy: NOAA/GOES

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

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



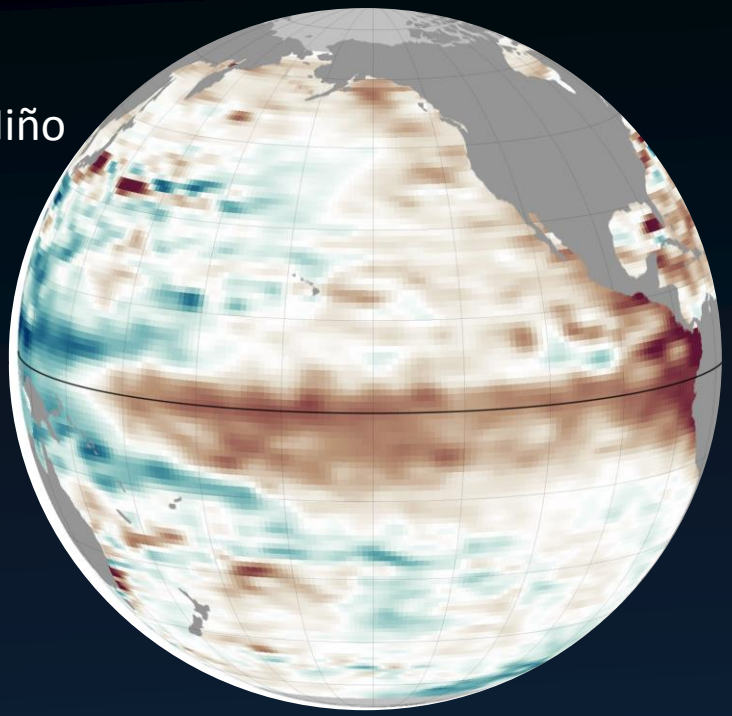
Winter's divided weather patterns will linger through spring.



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.

coutesy: NOAA

El Niño



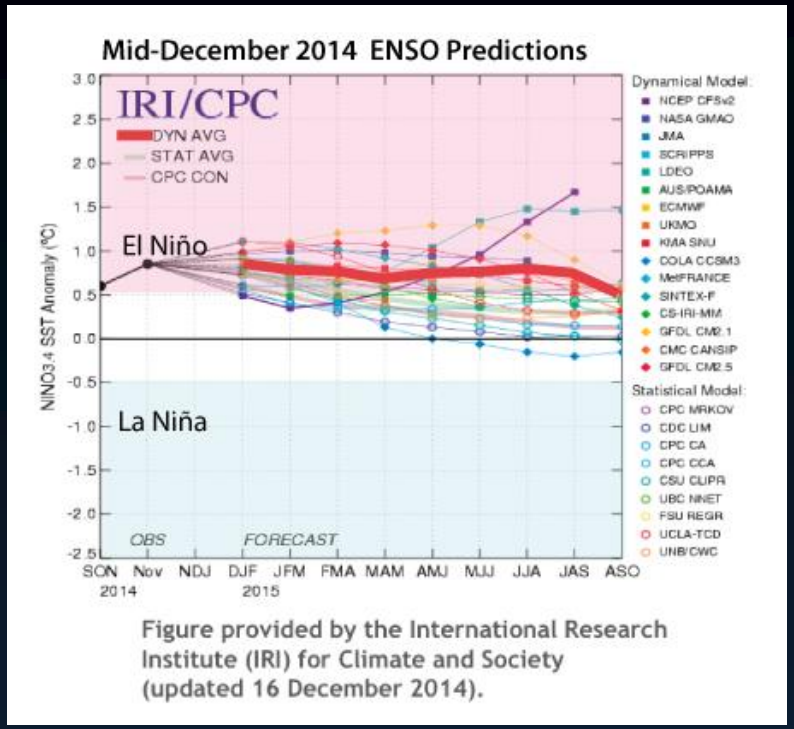


Figure provided by the International Research Institute (IRI) for Climate and Society (updated 16 December 2014).

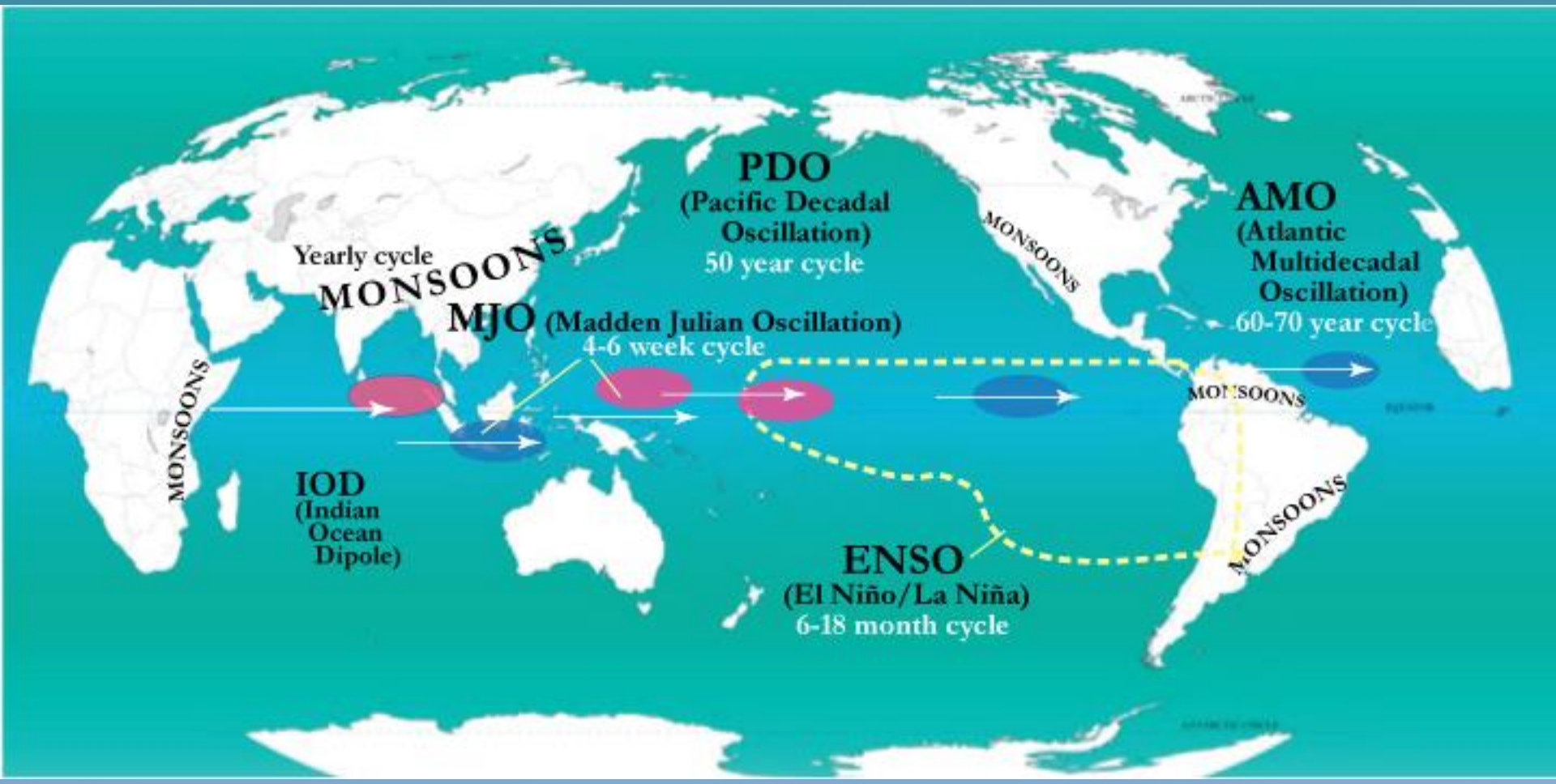
El Niño conditions developed in the Central and Eastern Tropical Pacific in Late May.

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

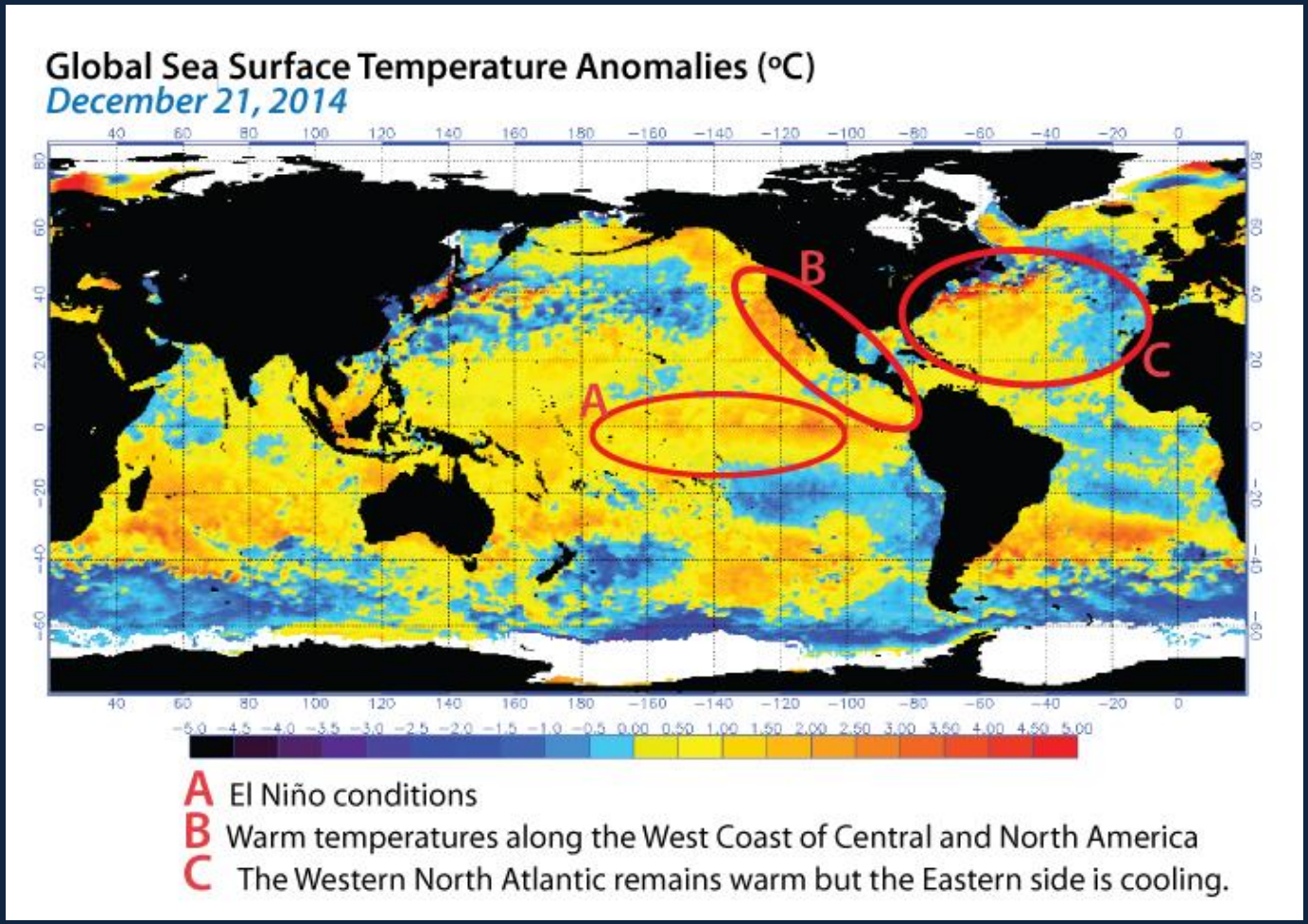
65%+ chance of an El Niño event returning.

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

Remember the hot and cool MJOs

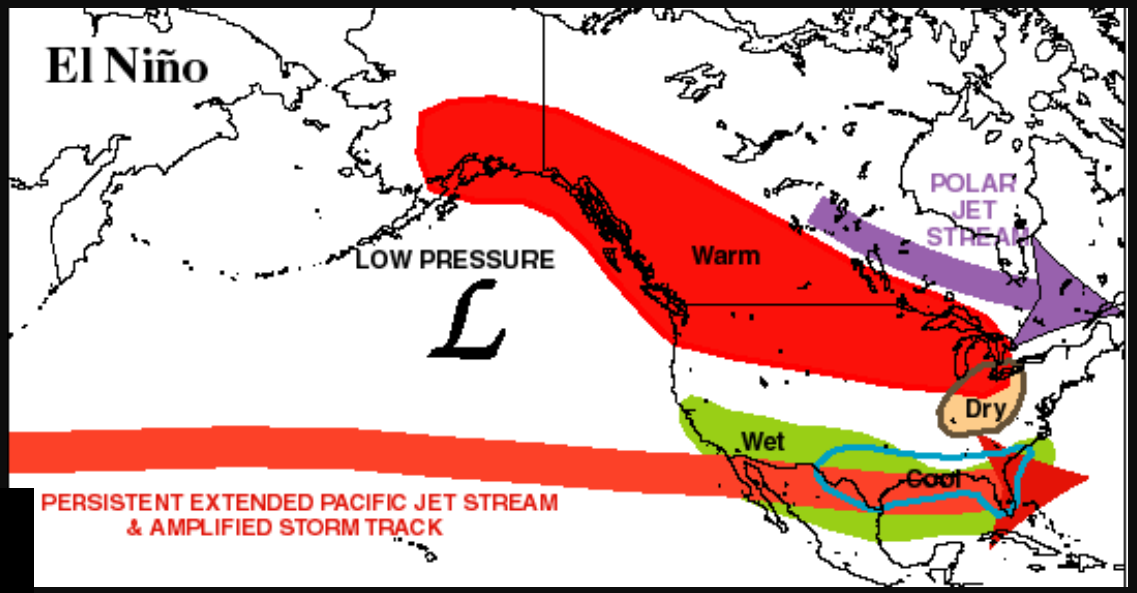


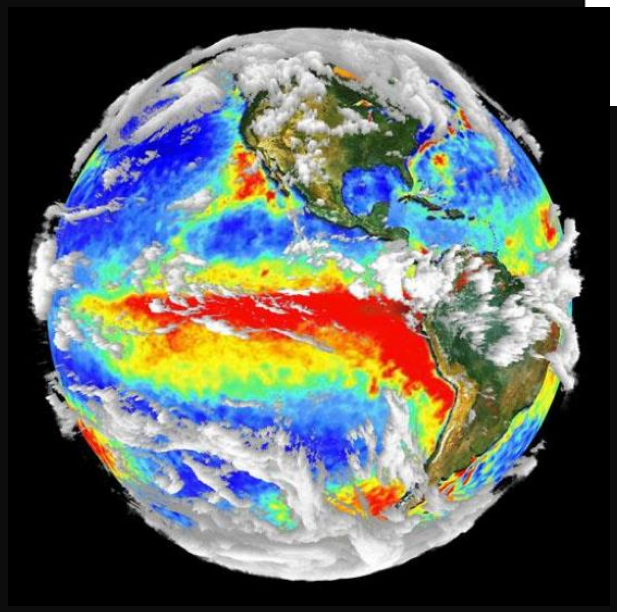
A cool MJO churned up the El Niño conditions starting in July and two warm MJOs are reheating it.



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

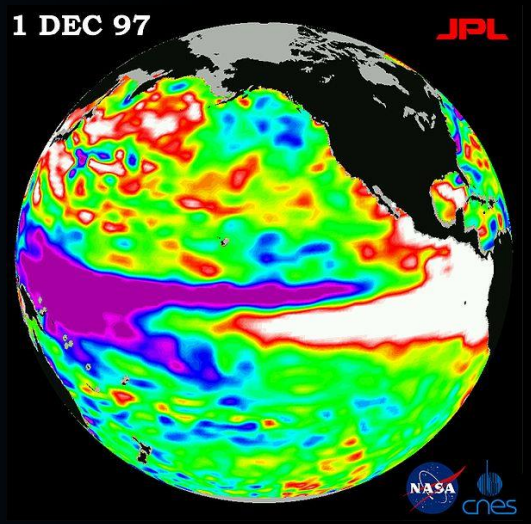
Typical Strong to Moderate El Nino winter weather
(during years without heavy polar volcano activity)





http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml; above, courtesy: NOAA

What to monitor as El Niño develops:



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

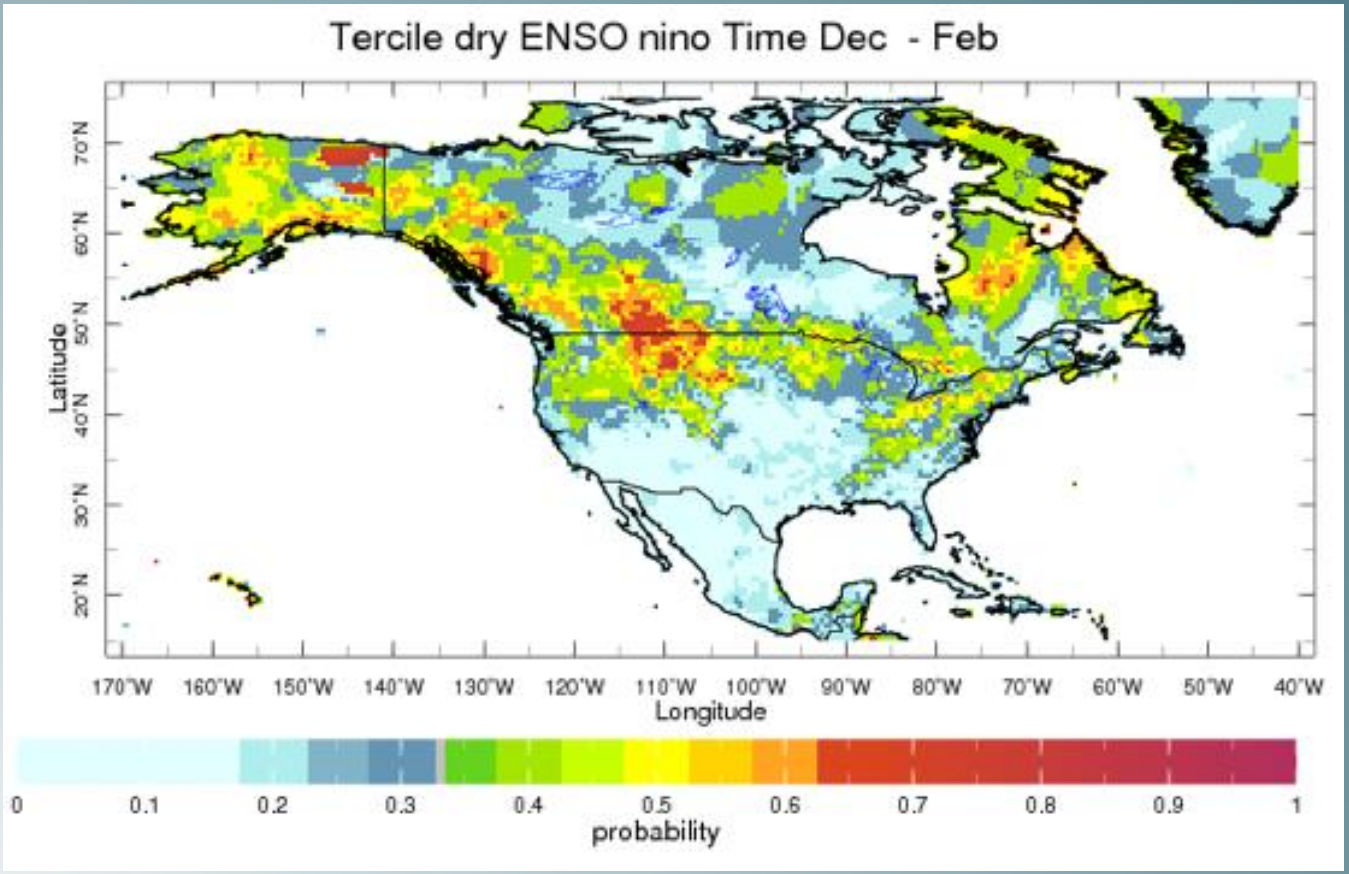
SIZE – The larger it is, the more like it is to warm Canada from the West Coast to the Great Lakes.

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

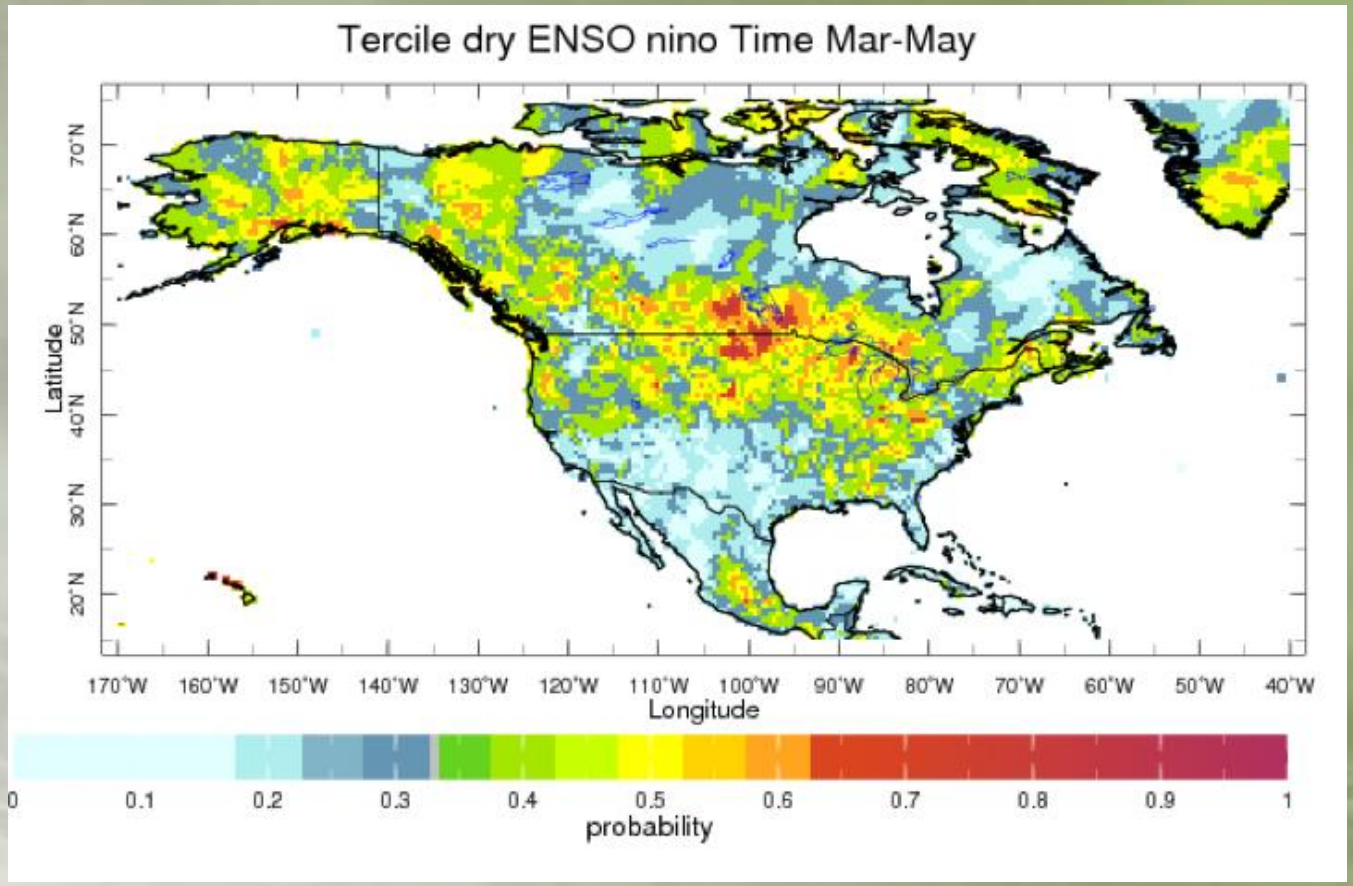
Winter and Spring will be shaped
by how big and long lasting the El Nino is.

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

Precipitation Anomalies



http://iridl.ldeo.columbia.edu/maproom/ENSO/Climate_Impacts/ENSO_PRCP_Prob_TS2p1.html?bbox=bb%3A-170%3A15%3A-40%3A75%3Abb&T=Mar-May&Tercile=dry



The impact of an El Niño on spring precipitation

http://iridl.ldeo.columbia.edu/maproom/ENSO/Climate_Impacts/ENSO_PRCP_Prob_TS2p1.html?bbox=bb%3A-170%3A15%3A-40%3A75%3Abb&T=Mar-May&Tercile=dry

Mid December – Mid January

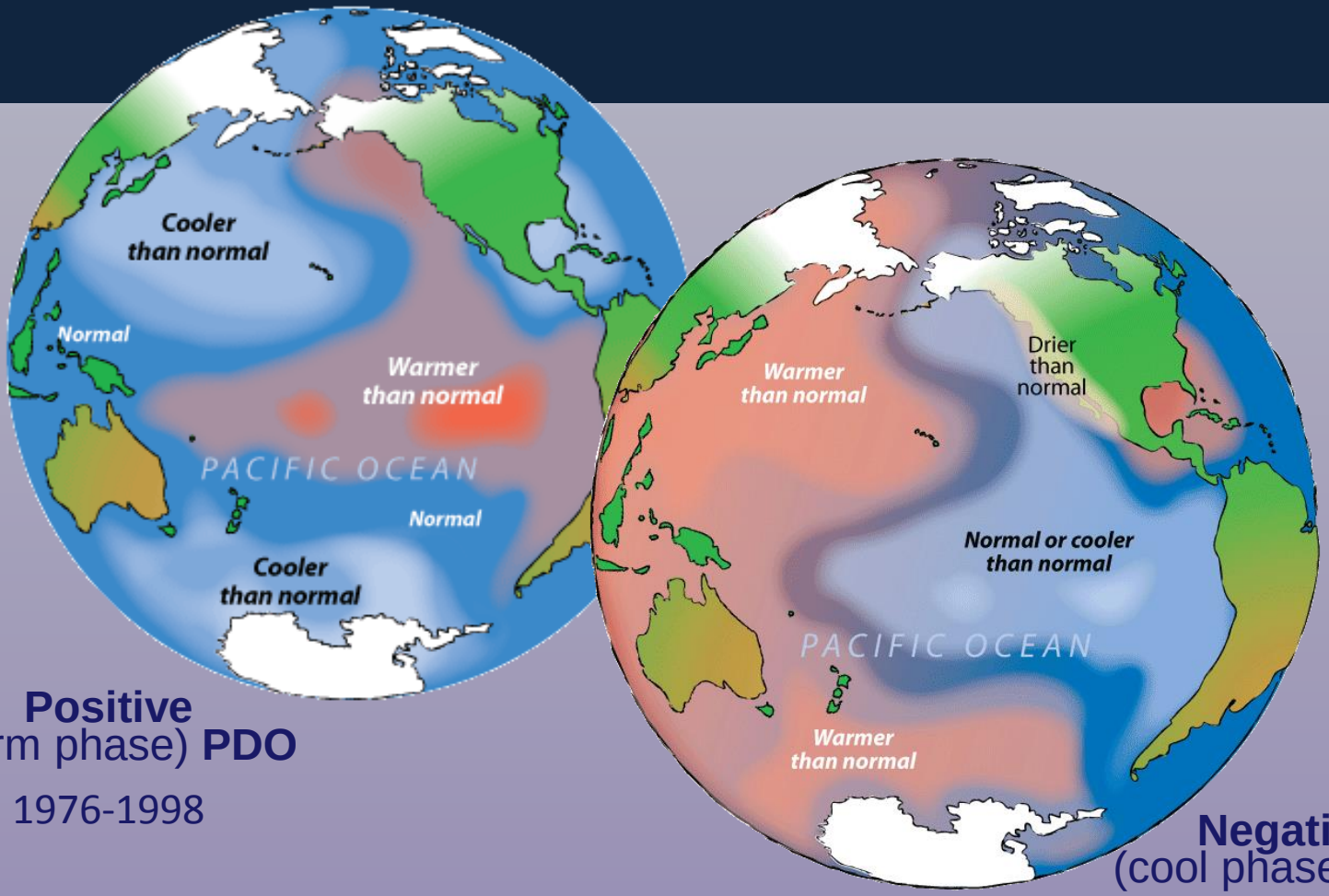
Mid February – Mid March

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.



Positive (warm phase) **PDO**

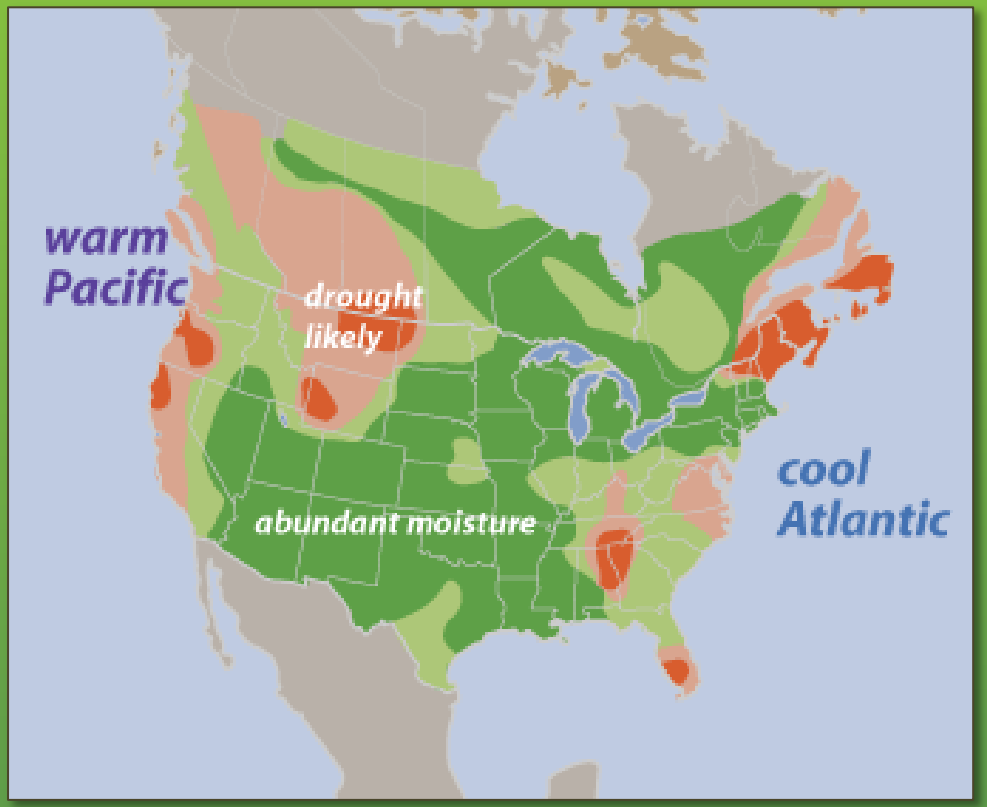
1976-1998

Negative (cool phase) **PDO**

2006-present

The Pacific Decadal Oscillation

Each phase lasts 20-30 years

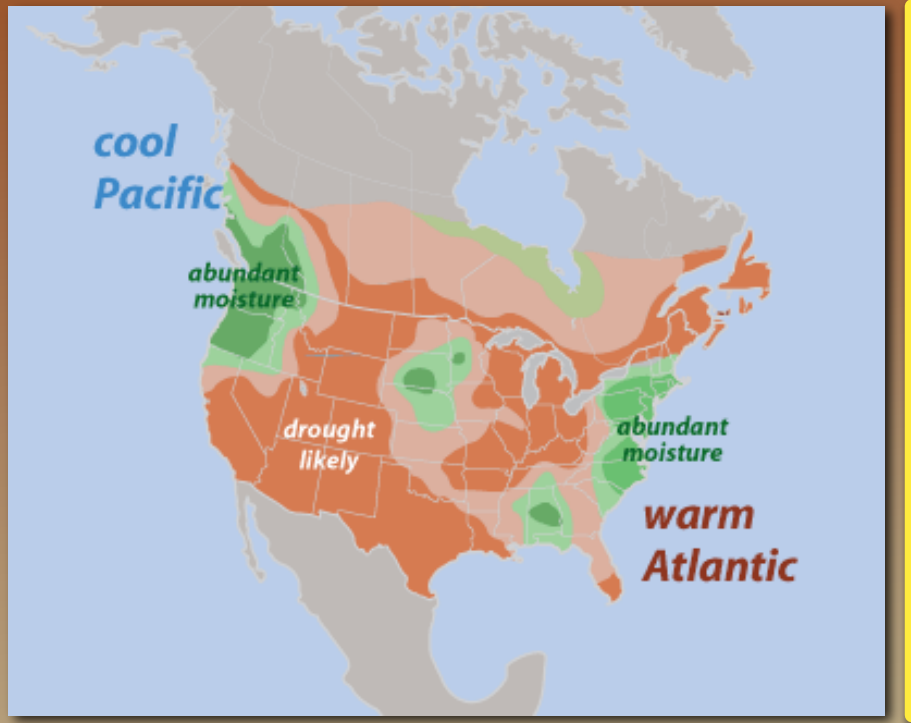


The Atlantic AMO changed in 1995.

The Pacific Dedacal 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.

data-US only: US Geological Survey

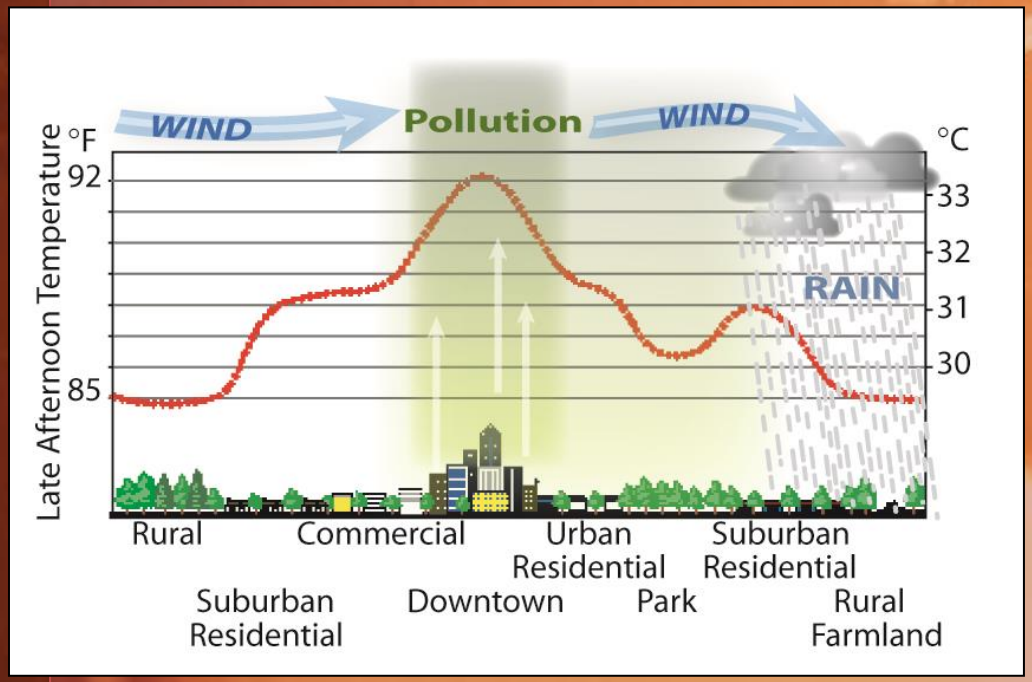
Since 2006, the two oceans have combined to create dry weather in the West and Great Plains.



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.

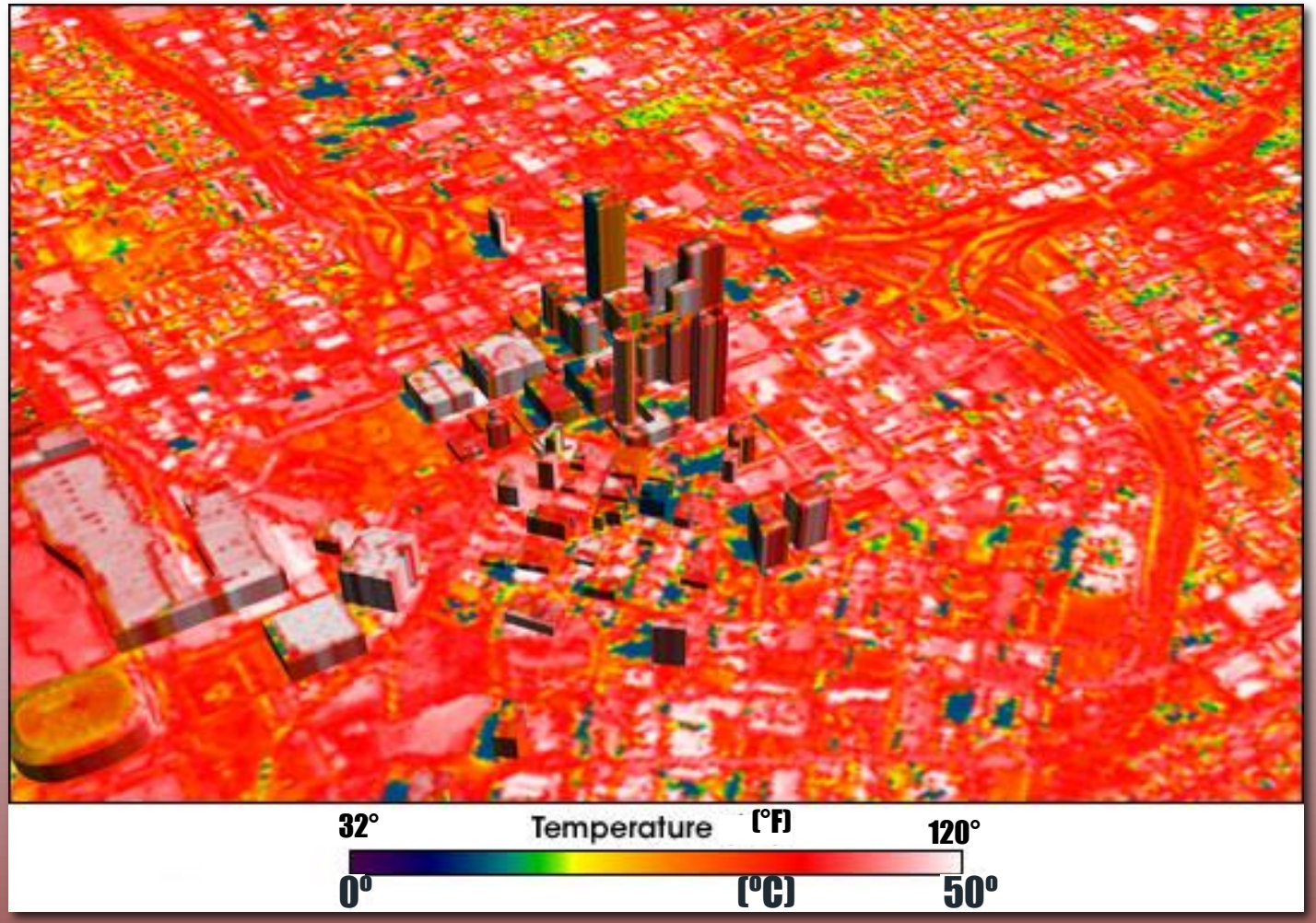
IMPACTS ON WILDLIFE

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



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

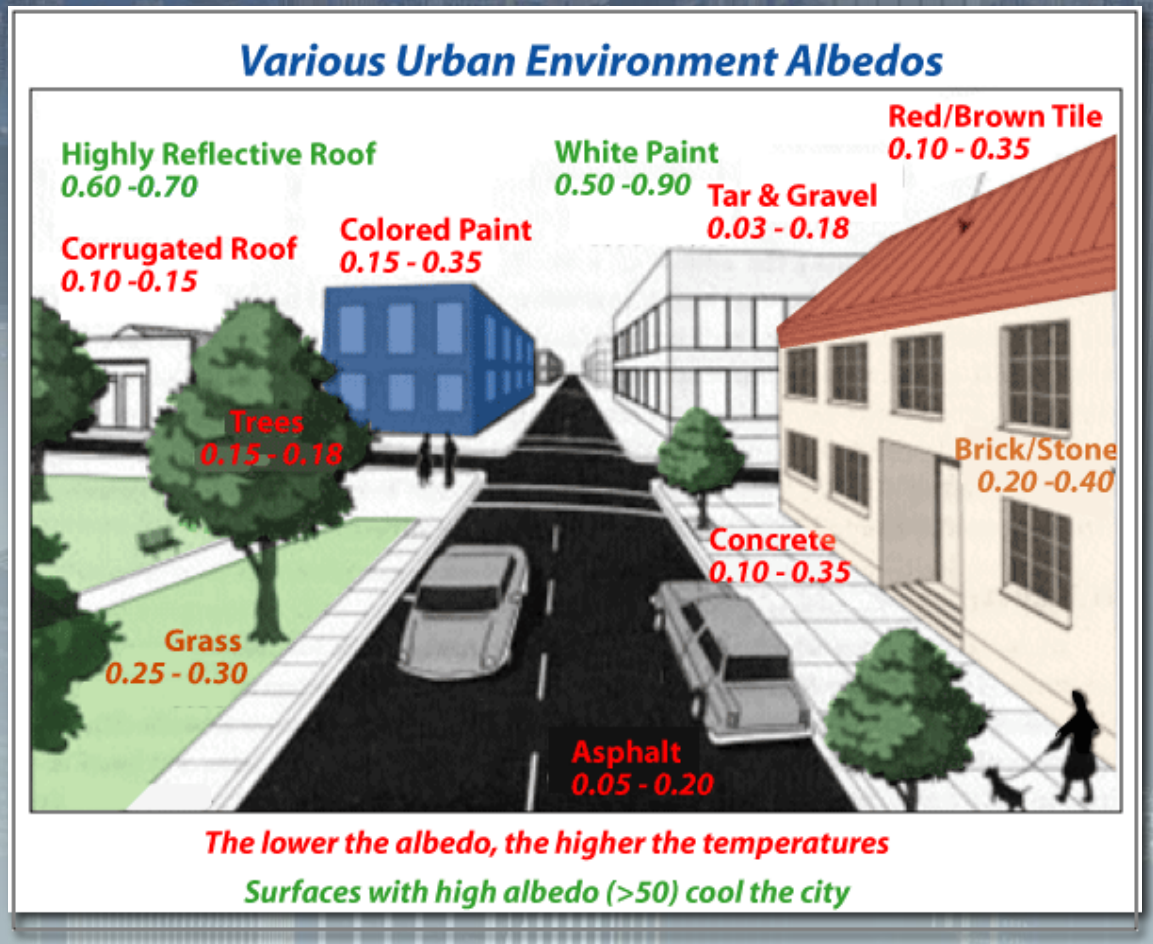
http://eetd.lbl.gov/HeatIsland/HighTemps



Atlanta's rooftops and highways bake

http://eobglossary.gsfc.nasa.gov/Study/GreenRoof/index.html

Different surfaces increase the amount of heat in the city



courtesy: NASA

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.

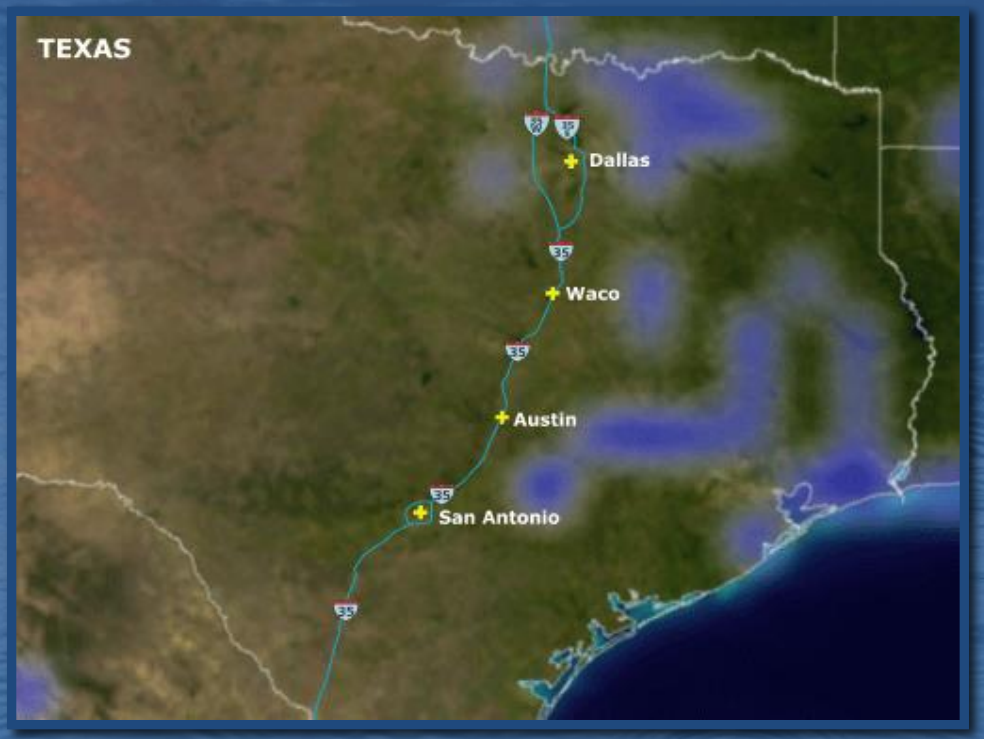
source: Dr. J. Marshall, et al.
http://www.gsfc.nasa.gov/topstory/20020613urbanrain.html

The urban heat and pollution delay the rain.

Prevailing winds blow the clouds away.

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

source: Dr. J. Marshall, et al.
http://www.gsfc.nasa.gov/topstory/20020613urbanrain.html



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.

source: Dr. J. Marshall, et al.
http://www.gsfc.nasa.gov/topstory/20020613urbanrain.html

Marine air & mountains
can trap pollution over seaside cities.

When the clouds finally rain out, they create superstorms.

The Positive AMO redistributes scarce water in the Middle East.

The Positive AMO redistributes scarce water in the Middle East.

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.**

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- **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.**


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