
The New Normal:
The Impact of Climate Change
on the East Coast and Europe.
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Conclusions -**The New Normal**

For the next 15 – 20 years, the Atlantic will trend warmer and the Northern Pacific will trend cooler.

In North America, the warmer Atlantic trend causes hotter summers, more active hurricane seasons and stormier winters in the Northeast, Midwest and Mid-Atlantic states. It also raises the risk of Gulf hurricanes and droughts in Georgia, Texas and the Southern and Central Plains.

In Europe, the warmer Atlantic trend causes hotter, drier summers in Southern Europe and wetter summers in the UK and Central Europe. Northern and Eastern Europe tend to have colder, drier winters.

The changed phase of the Pacific PDO is strengthening La Niñas and weakening El Niños which creates stormier East Coast hurricane seasons and winters.

Man-made warming and pollution is adding to the impact of the warming phase of the AMO. The pollution from the Eastern megalopolis adds to the intensity of coastal storms.

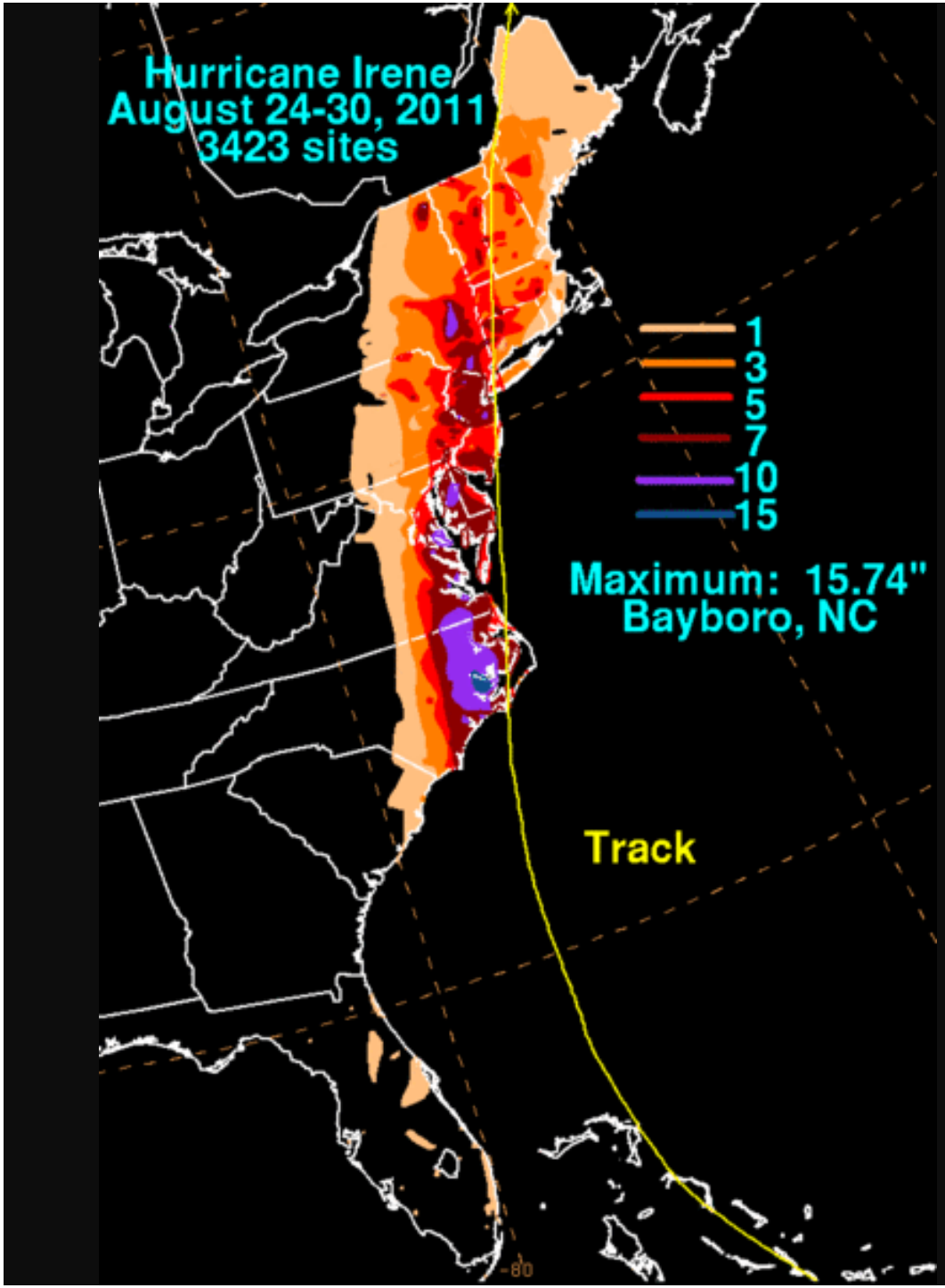
Irene
August 27, 2011

Two hurricanes in two years have inflicted tremendous damage on the East Coast. People are beginning to question,

"Are we finally seeing the impact of man-made global warming?"

Sandy
October 28, 2012

images courtesy NASA



In August 2011, Hurricane Irene raged from the Caribbean to Canada.

A Category 3 storm, it inflicted $16.6 billion in damages ($15.6 billion in the US), killed 49 people and left 7.4 million homes and businesses without power.

New York and the Northeast experienced 500 and 100 year floods.

In October, this year,
Hurricane Sandy also raged from the Caribbean to Canada.

The biggest Atlantic hurricane on record with a diameter of 1,100 miles (1800 km), it combined with a cold front to affect 24 states, **cause an estimated $52.4 billion in damage ($50 billion in the US), killed 199 people and left 8.2 million homes and businesses without power.** It created a powerful storm surge that flooded New York City and its subways.

Many are speculating that the recent surge of destructive hurricanes is due to man-made climate change.

The IPCC stated,
"Based on a range of models, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical SSTs." but gave no specific estimates.

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)

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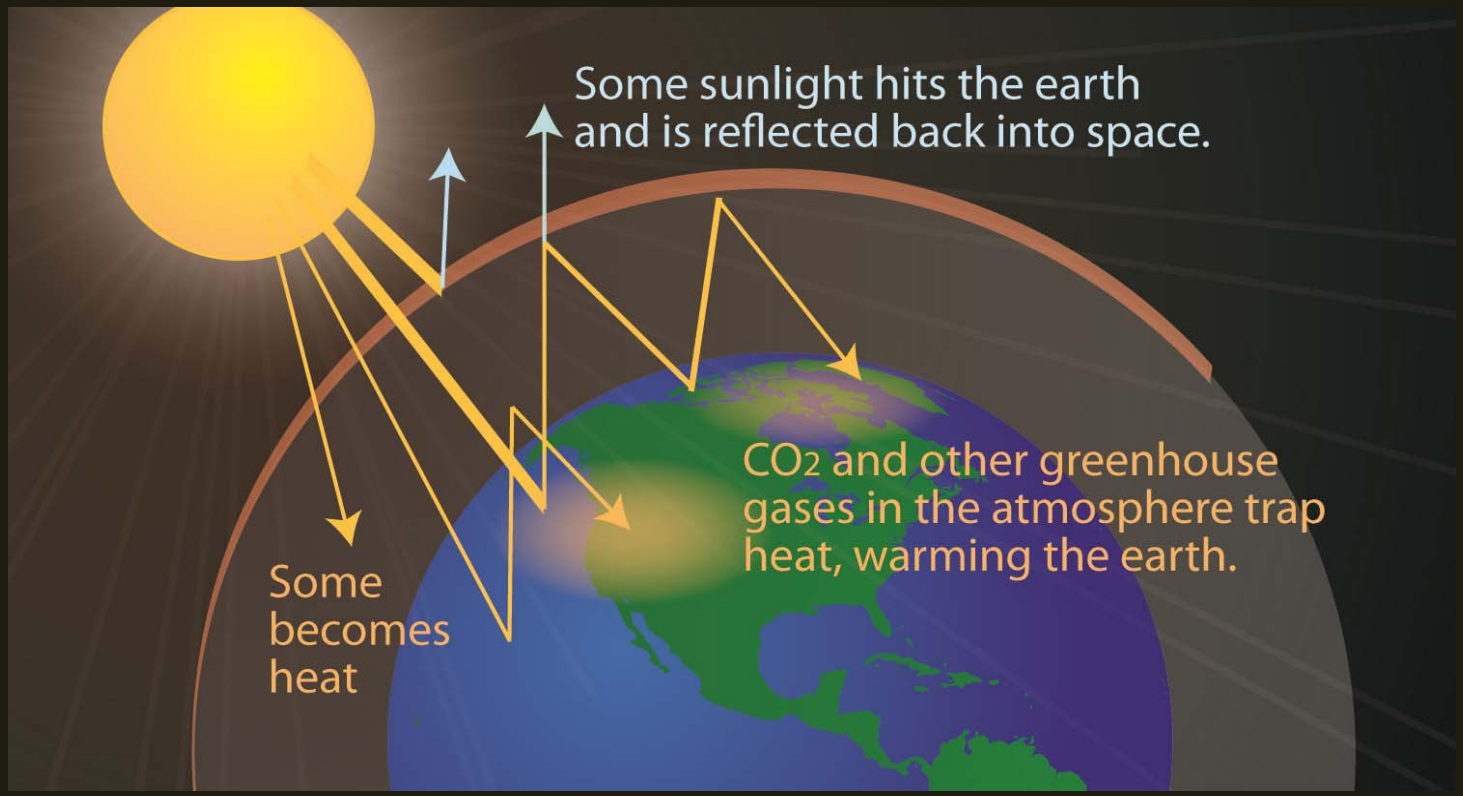
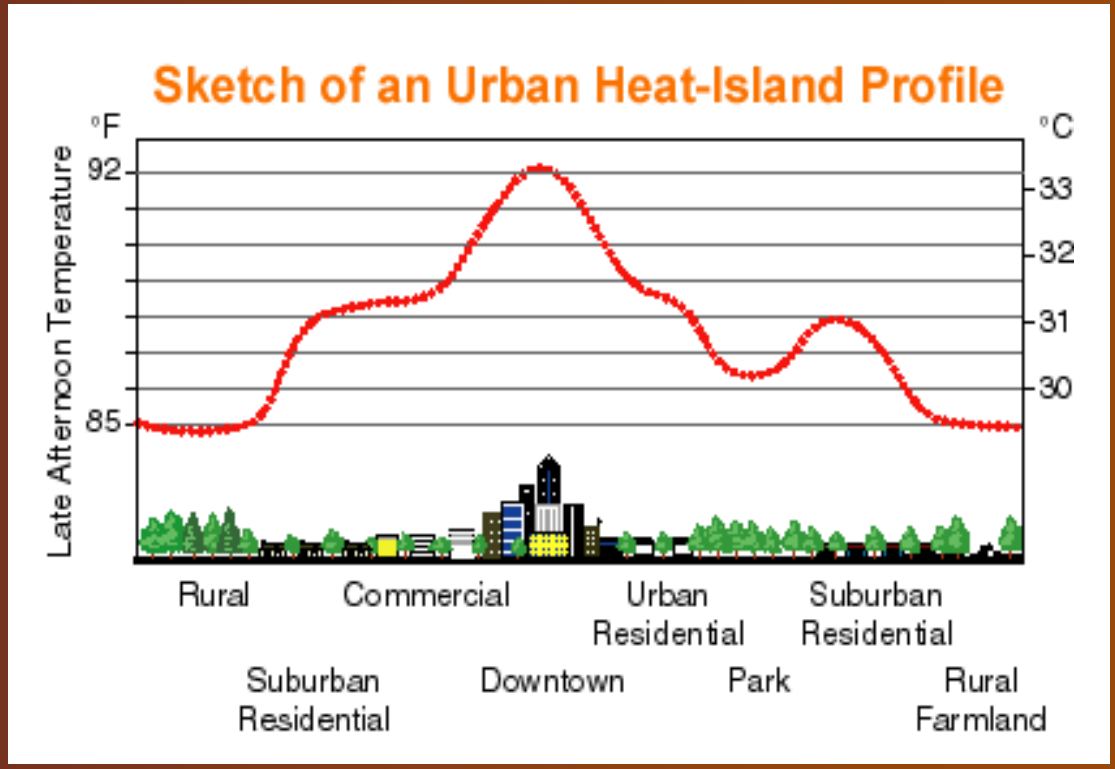
- Where the heat from the solar radiation is stored (Oceans/Urban Heat Islands)

The Greenhouse Effect



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



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

Cities tend to be .56º to 5.6ºC (1-10ºF) 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.

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.

We are seeing this phenomenon throughout Europe and North America.

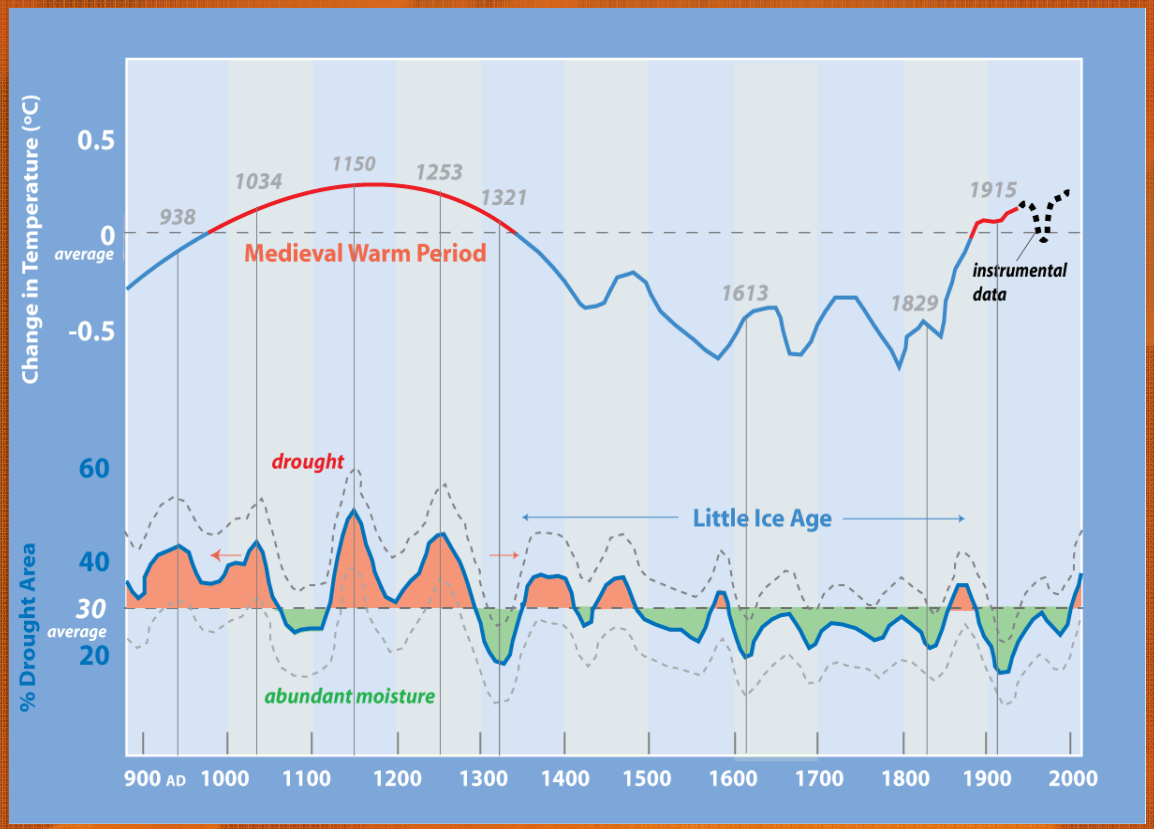
source: Dr. J. Marshall, et al. http://www.gsfc.nasa.gov/topstory/20020613urbanrain.html

Marine air & mountains
can trap pollution over seaside cities.

When the clouds finally rain out,
they create superstorms.

Historical records show that a change of 1˚ F changes the freeze zone 300 miles.

(1˚C changes the freeze zone 1000 km)



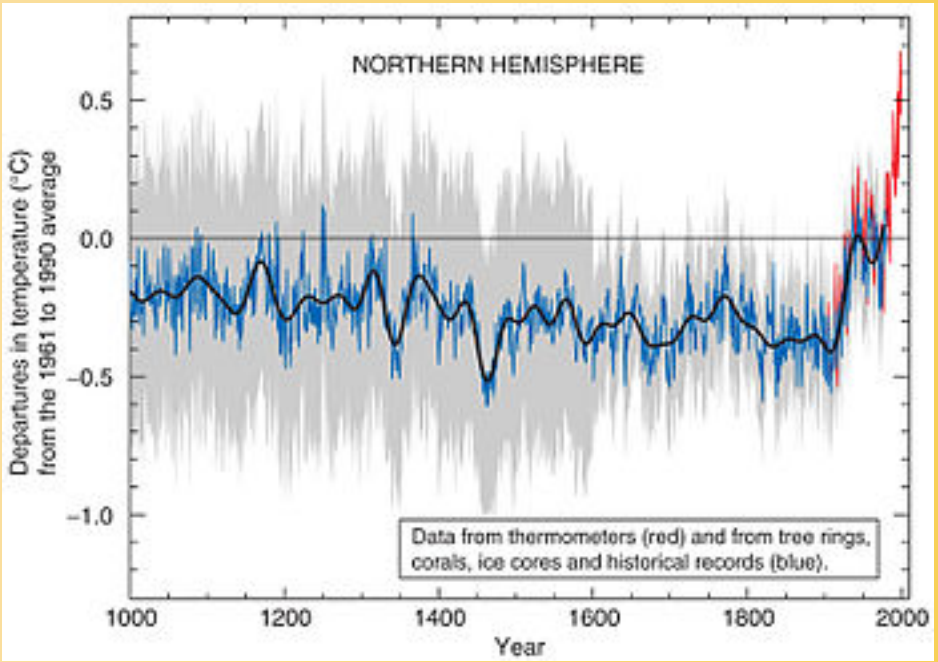
data sources: top: http://www.ldeo.columbia.edu/res/div/ocp/drought/medieval.shtml

bottom: RS Bradley & JA Eddy, based on JT Houton, et al Climate Change Assessment, Cambridge University Press, Cambridge, 1990 and IPCC 1990 and Mann 1999 and Moburg 2005

Tree rings in North America show that small changes in temperatures result in major changes in precipitation.

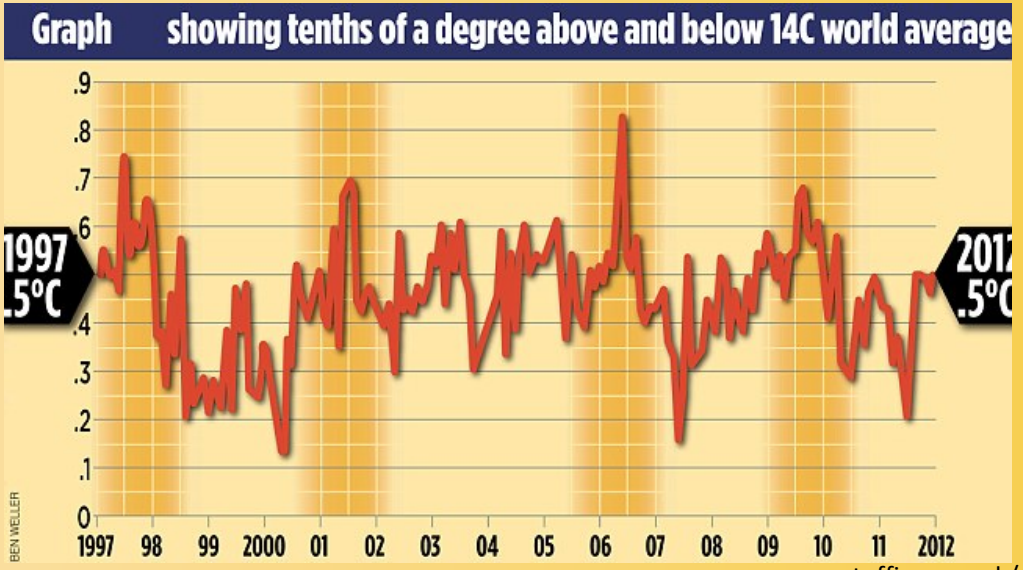
Climate change reports have been conflicting.

The 2001 "Hockey Stick" graph became controversial and helped spark the "Climategate" e-mail controversy.



IPCC, Michael E. Mann, Raymond S. Bradley, Malcom K. Hughes, *et al*

A 2012 UK Met office graph reported that global warming stopped 16 years ago.



www.metoffice.gov.uk/

Human Impacts on Climate Change

1 The Earth began to warm up naturally from the "Little Ice Age" changing temperatures and precipitation patterns.

2. Human carbon emissions and pollution have added to climate change.

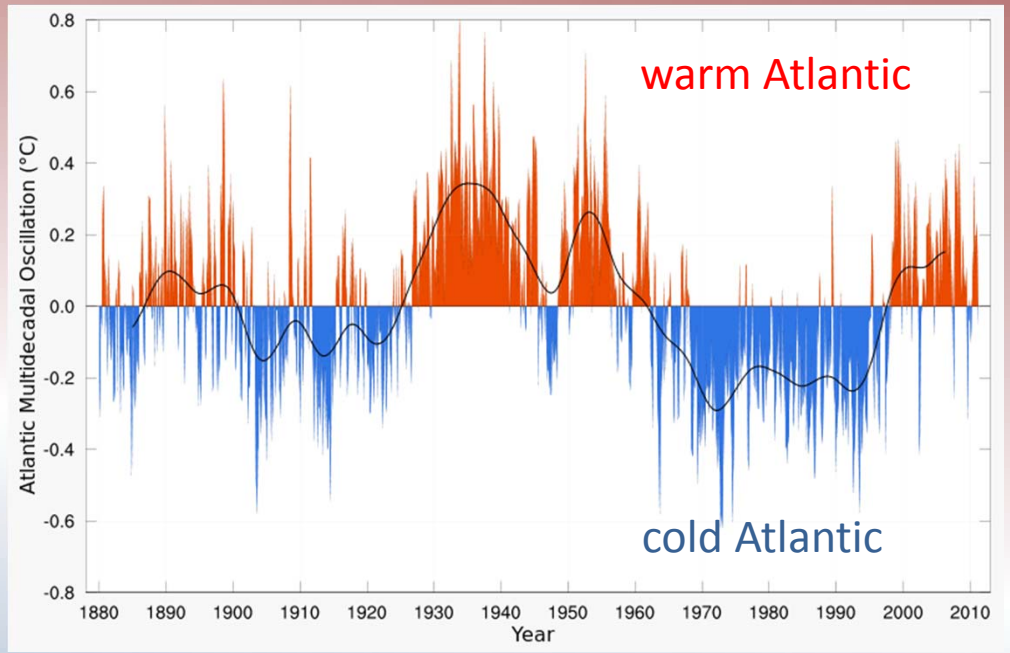
3. Warming has become more extreme particularly in urban heat islands.

4. Precipitation patterns have changed and urban pollution has made some events more extreme.

The long term Atlantic Multidecadal Oscillation **(AMO)**, a 60 – 70 year cycle, turned positive in 1995

The Gulf stream flows faster.

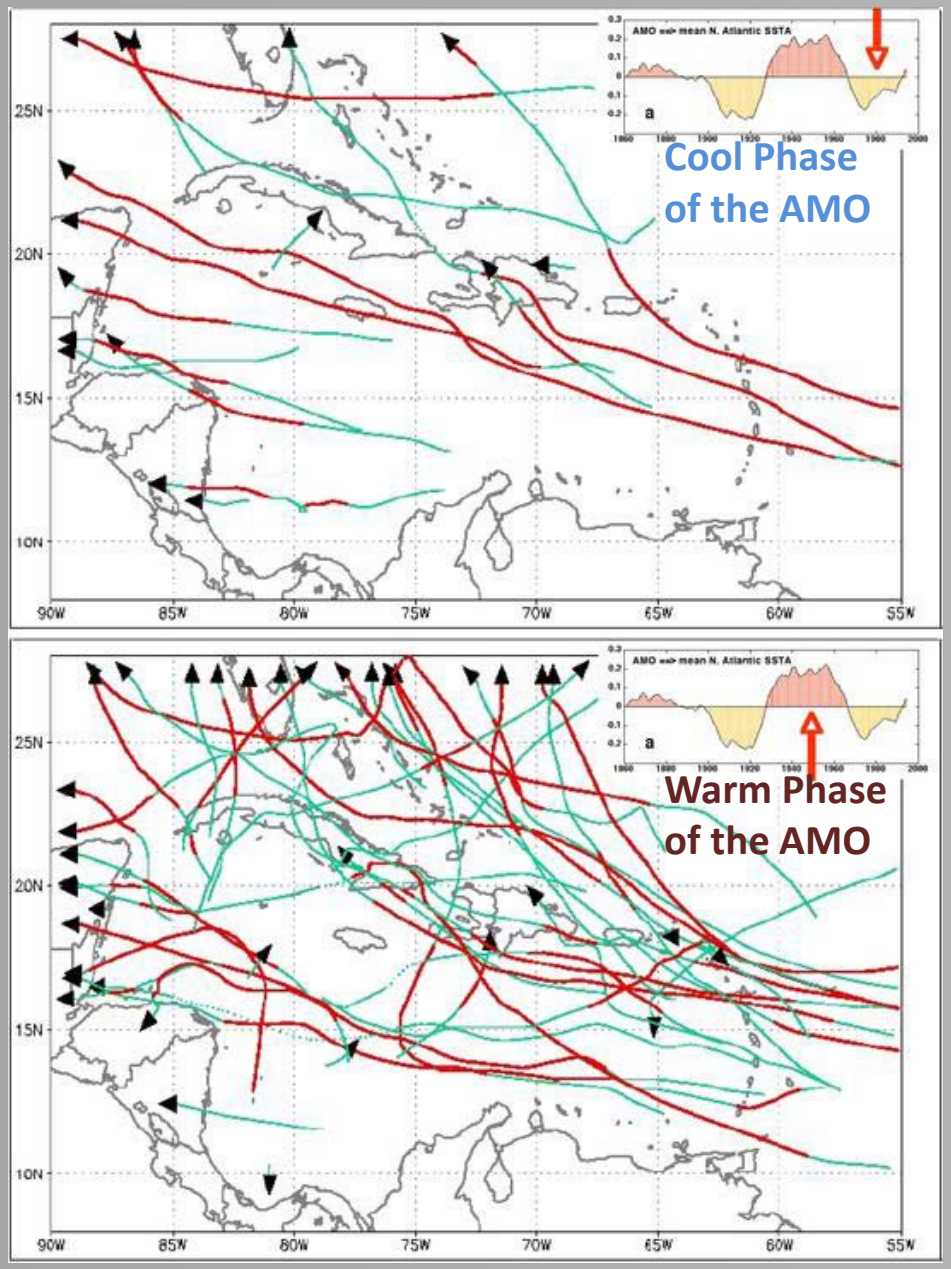
The North Atlantic gets warmer.



The Atlantic Multidecadal Oscillation **(AMO) 1880-2011**

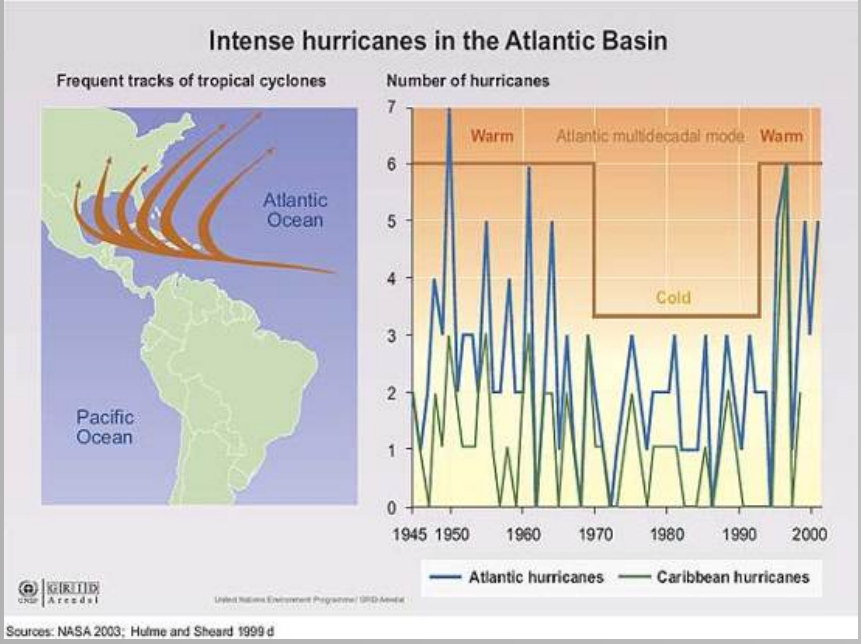
The warm phase should last at least 20 more years.
It may be at its peak warmth this year.

http://en.wikipedia.org/wiki/File:Atlantic_Multidecadal_Oscillation.svg



courtesy: NOAA Atlantic Oceanographic and Meteorological Laboratory

The warm phase *(below, left)* **of the AMO doubles the number of hurricanes.**

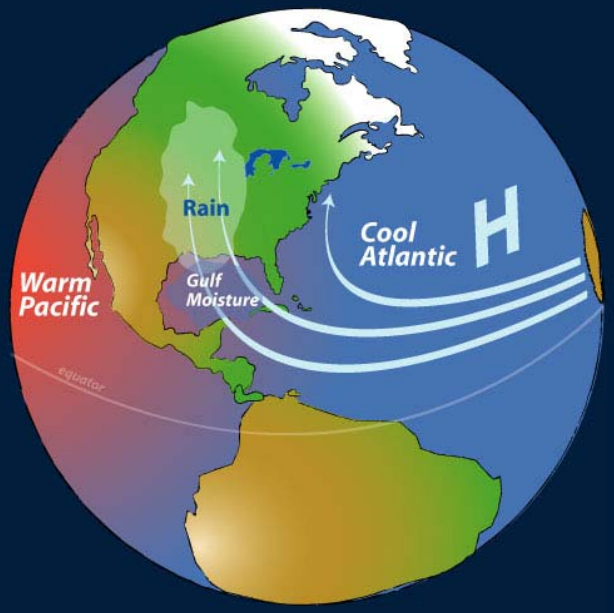


http://www.grida.no/graphicslib/detail/intense-hurricanes-in-the-atlantic-basin_3743

Changes in Atlantic temperatures increase the risk of coastal and riverside property damage, especially in areas settled in the 1970s, 1980s and 1990s, when the Atlantic was cool.

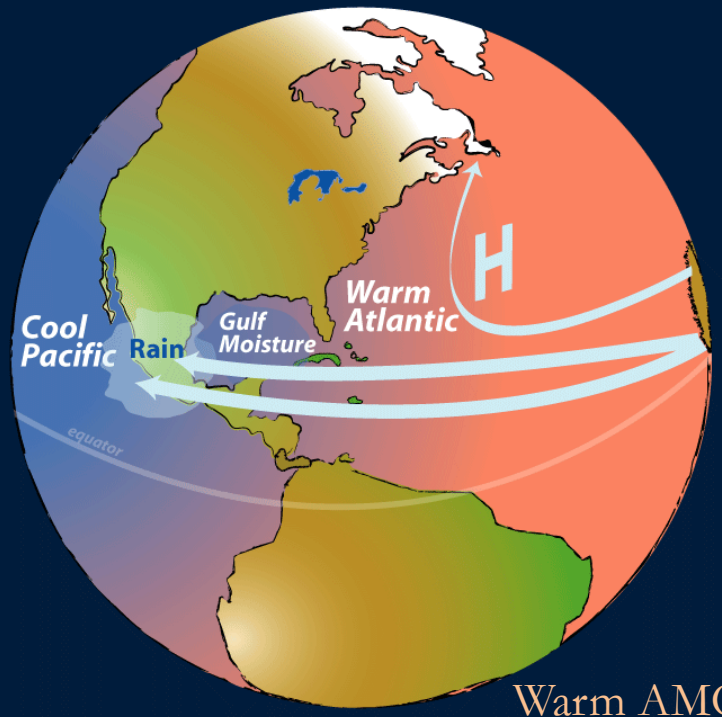
More than half of the US population lives within 50 miles of a shoreline.

image: courtesy FEMA



Cool AMO
(prior to 1995)

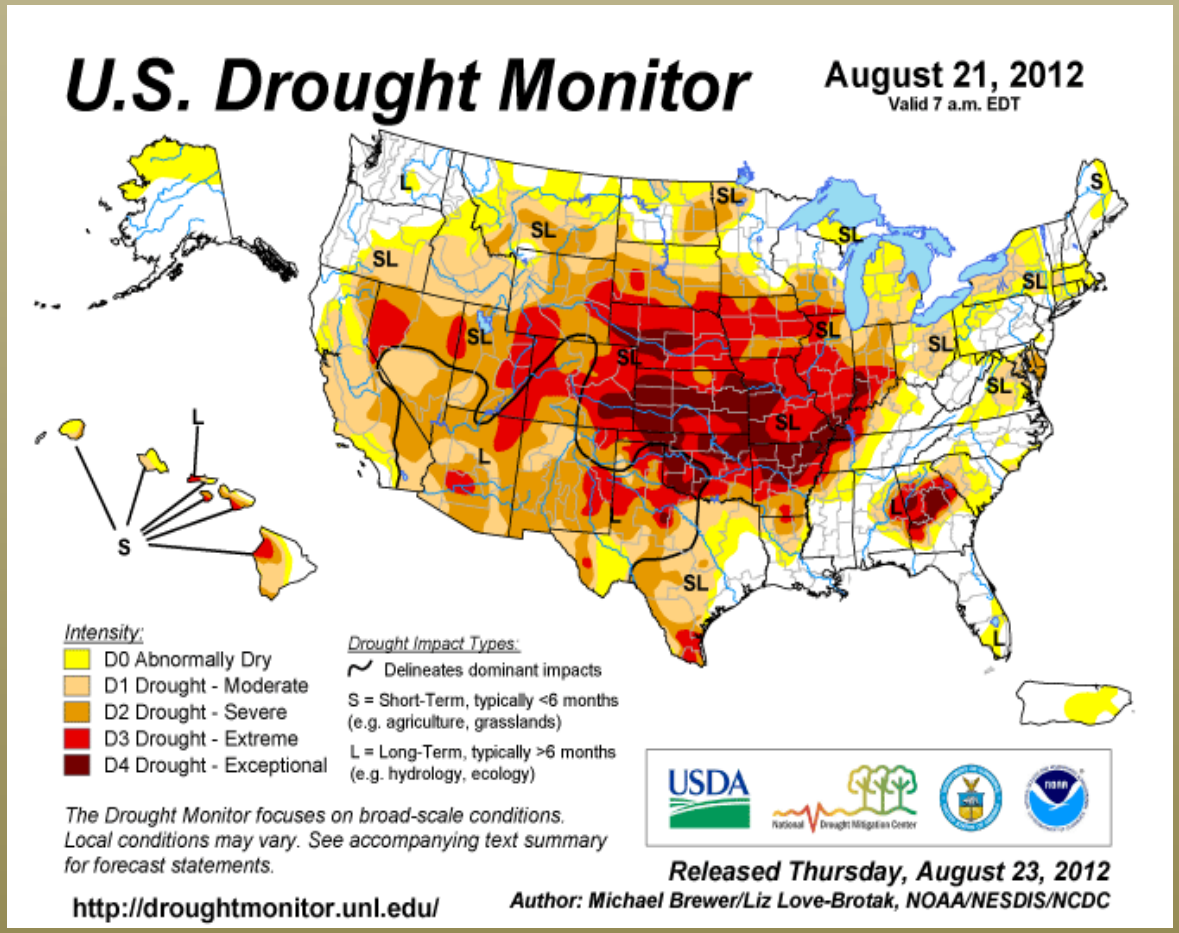
The warmer AMO creates stronger trade winds which allow less tropical moisture to flow into the Great Plains and Midwest.



Warm AMO
(after 1995)

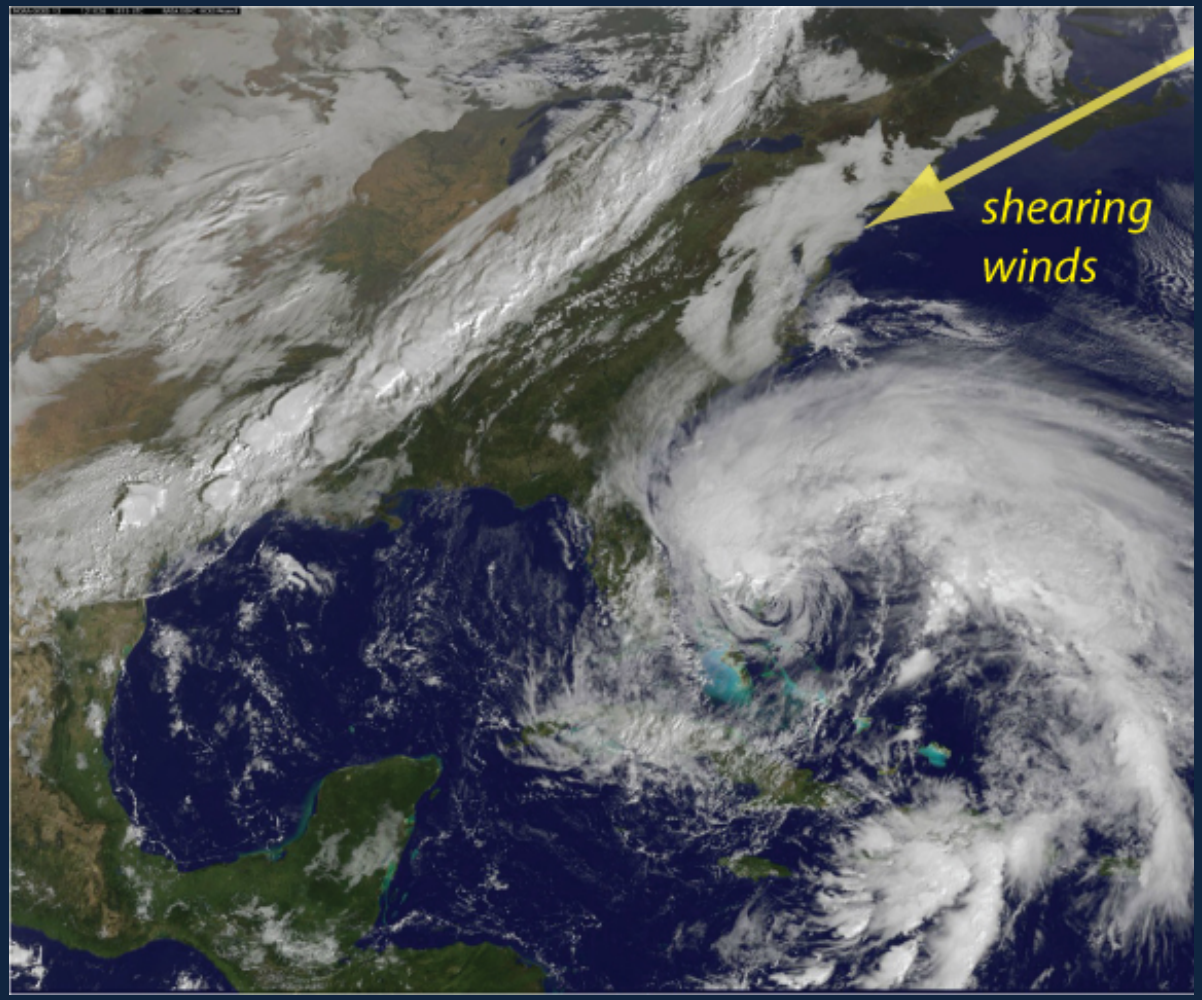
Atlantic Multi-Decadal Oscillation **(AMO)**

The fast flow of the Atlantic this summer produced a major heat wave. This in turn produced a "flash drought," drought due to high evaporation rates.



This left more than 77% of the continental US dry or in drought.

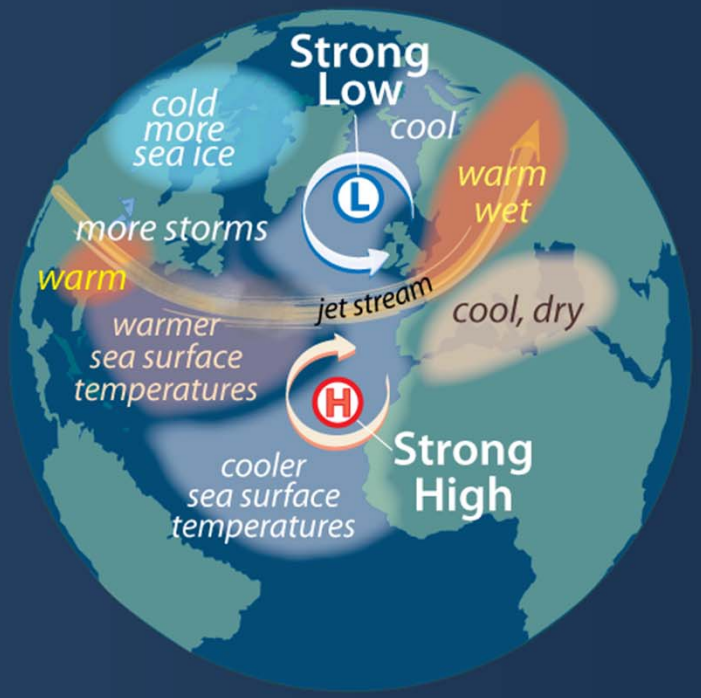
Hurricane Sandy was hit by shearing winds from the "Greenland High", an atmosphere pressure typical of negative NAOs.



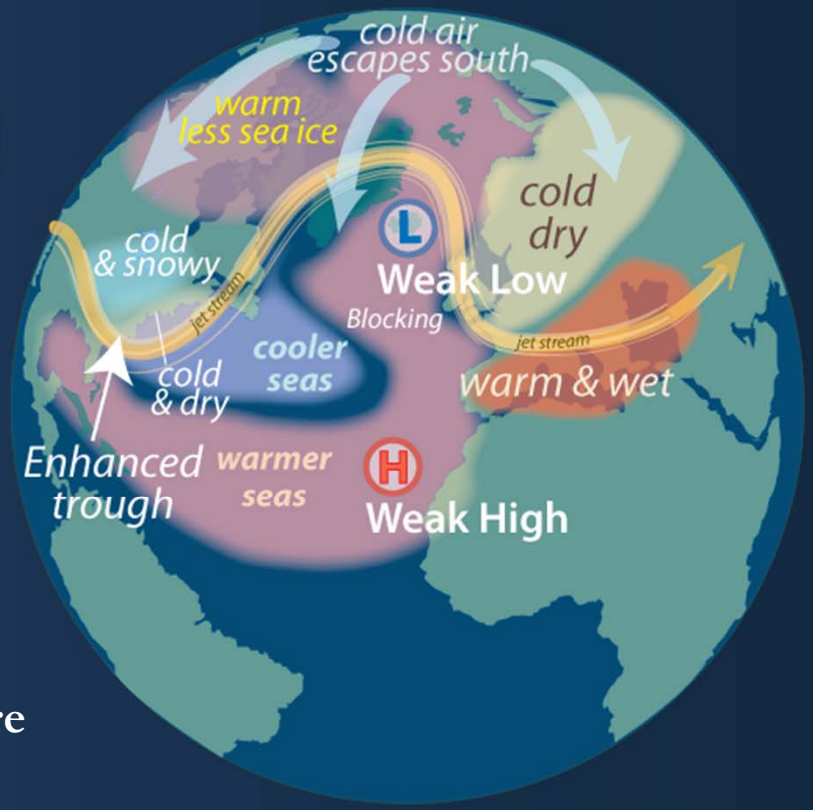
However, the Atlantic's hot waters kept the storm expanding in size even as the shearing winds kept it from growing in strength.
It is now the largest Atlantic hurricane on record.

courtesy: NASA

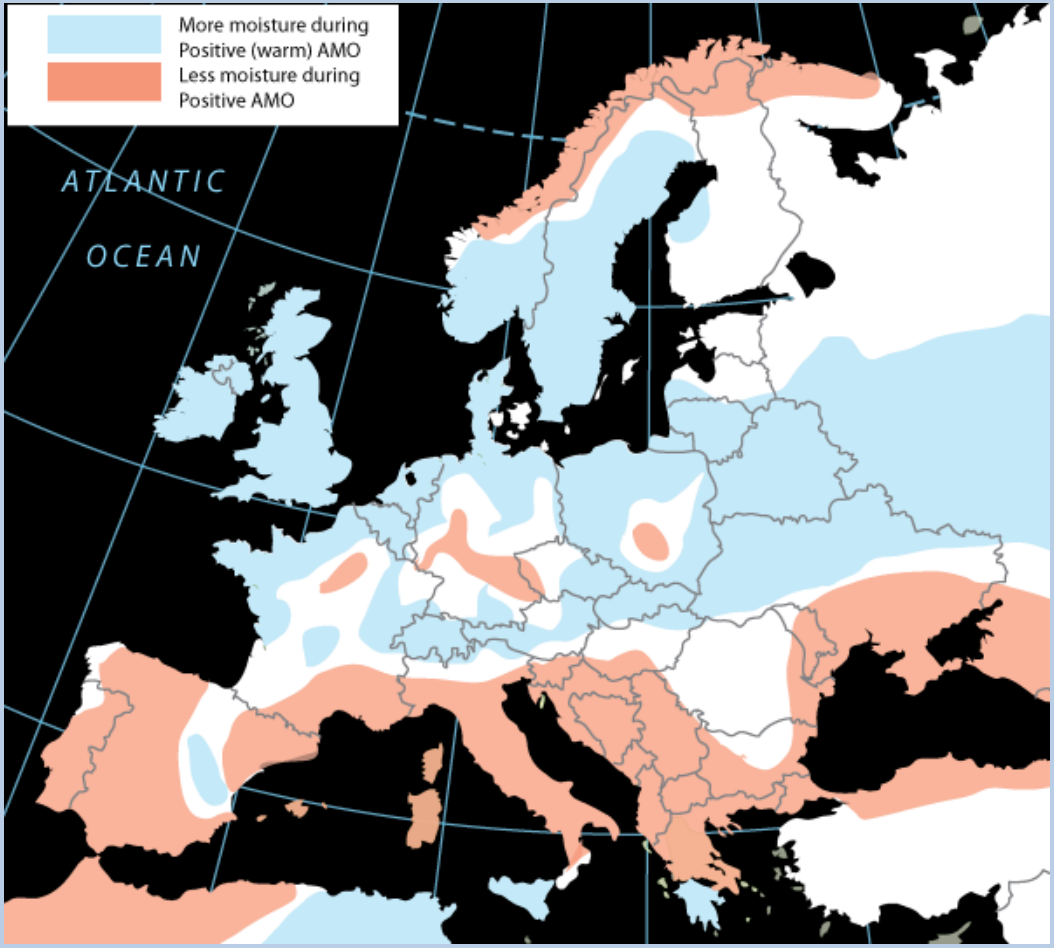
Positive North Atlantic Oscillation



Negative North Atlantic Oscillation



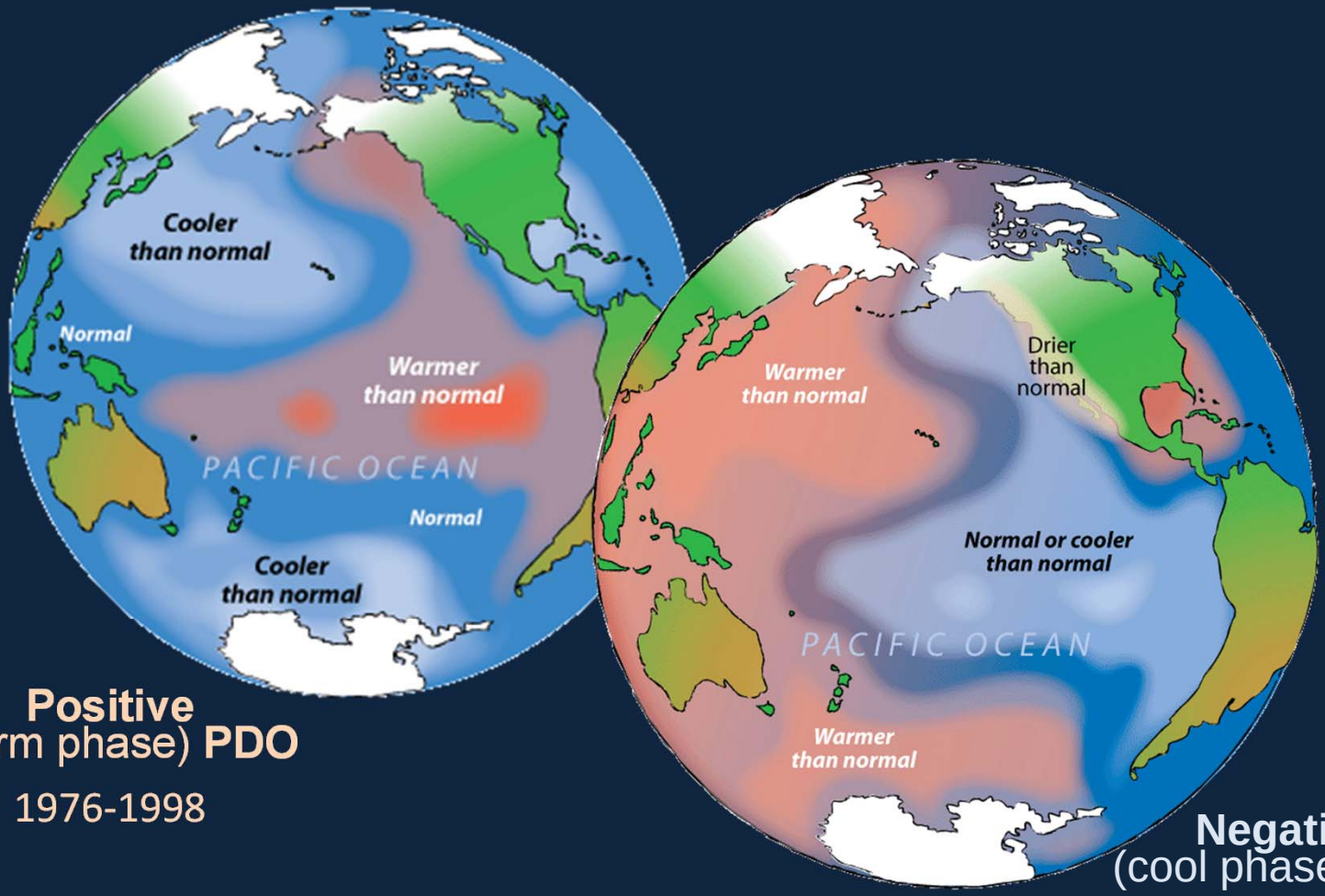
The hot Atlantic changes atmosphere pressure which frequently creates a weather pattern called a Negative North Atlantic Oscillation. Negative NAOs create stormier winters in the East.



based on: "Atlantic Ocean Influence on a Shift in European Climate in the 1990s", by Rowan T. Sutton & Buweng Dong, Nature Geoscience-Letter *October 7, 2012*

When the North Atlantic is warm, rains shift throughout Europe.

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

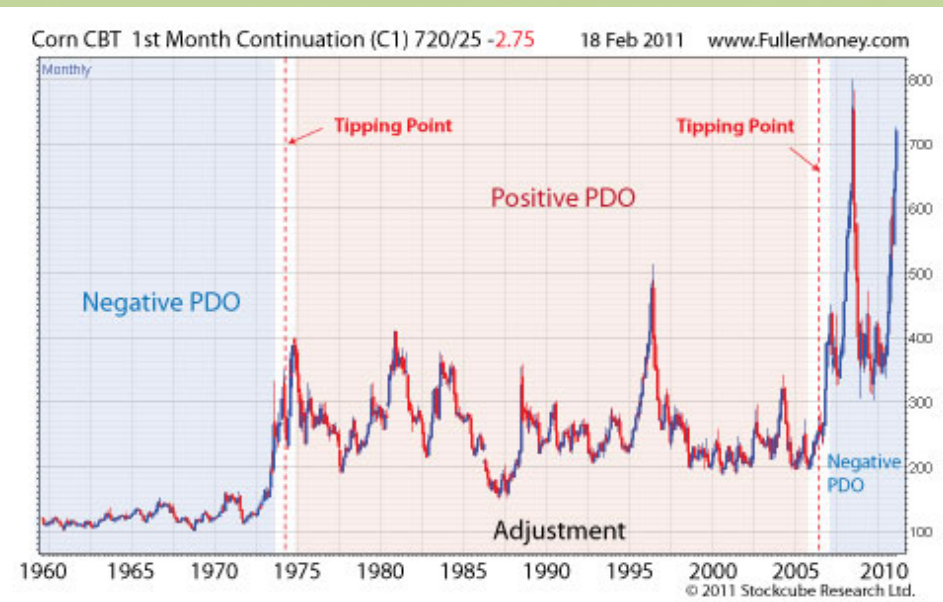
The Pacific Decadal Oscillation
Each phase lasts 20-30 years

Long Term Climate Impacts

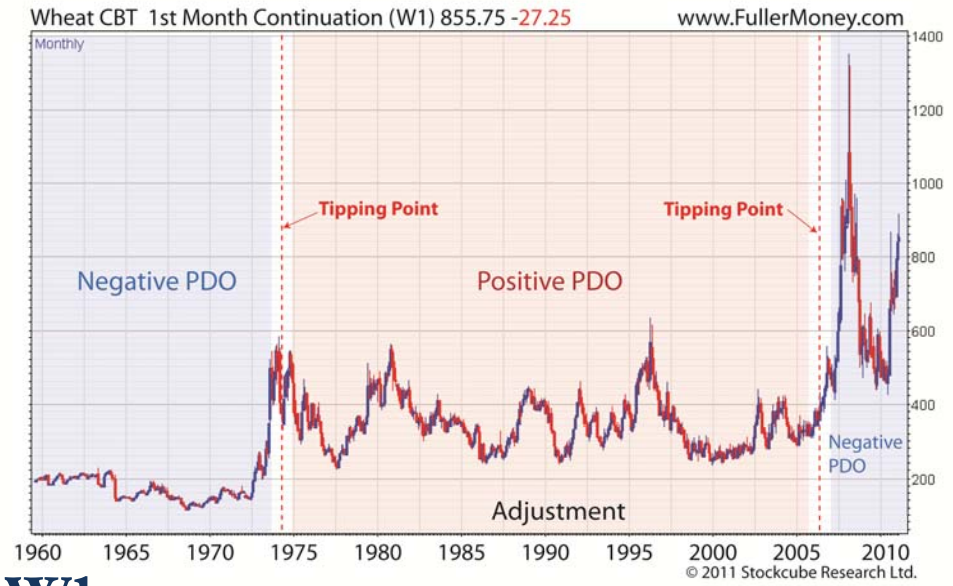
The PDO's impact on precipitation

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

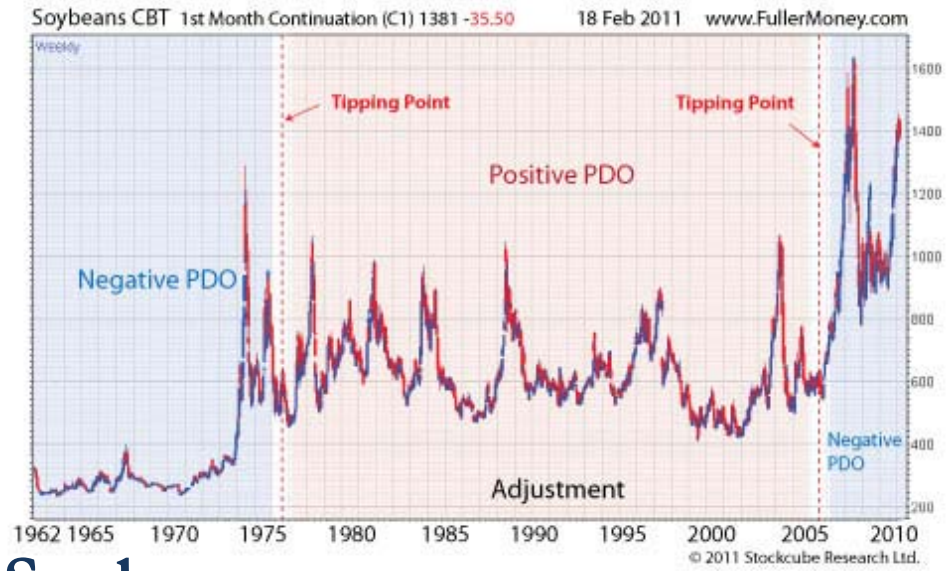
The Impact on Agriculture



Corn 1960-2011

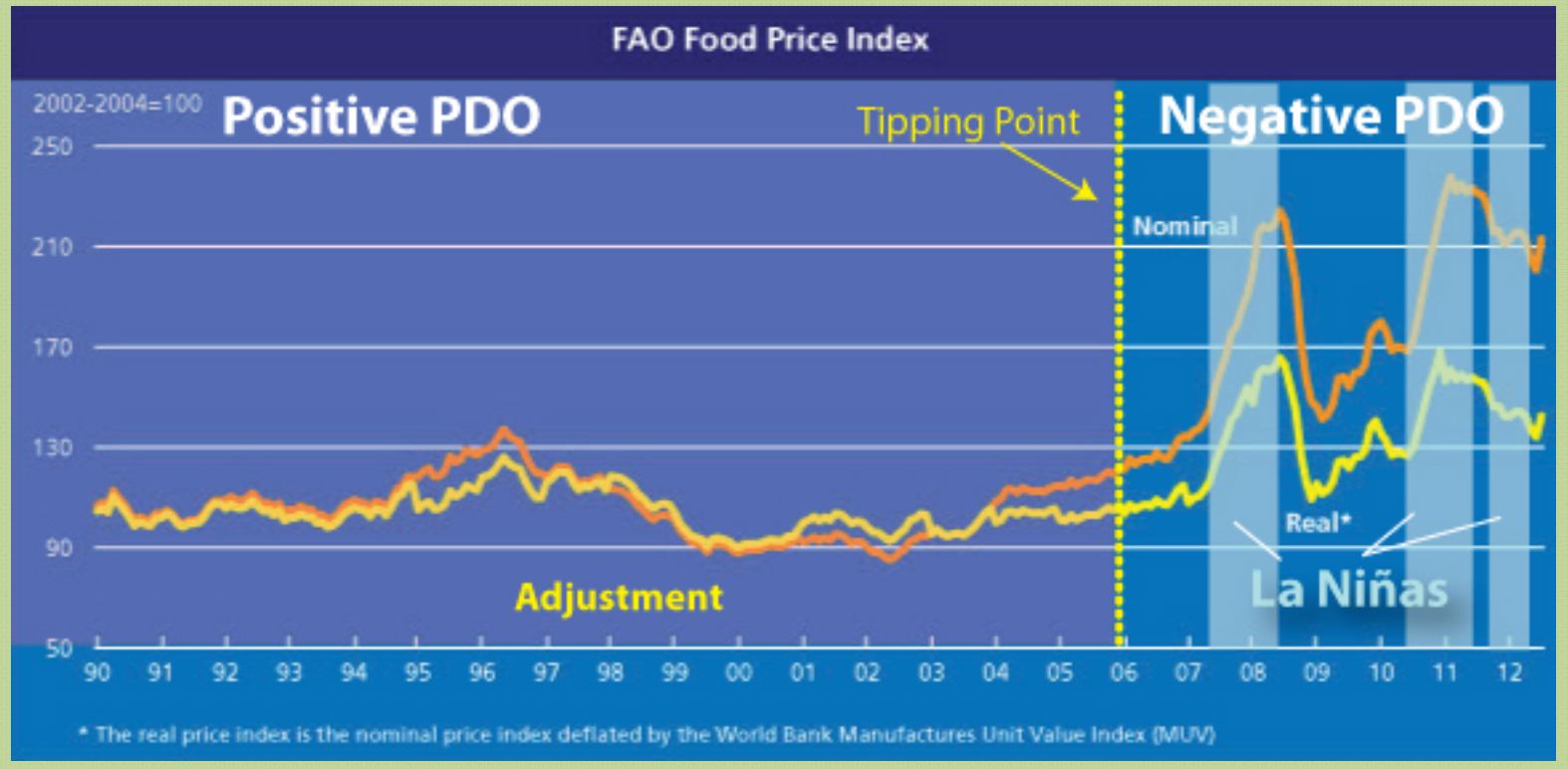


Wheat 1960-2011



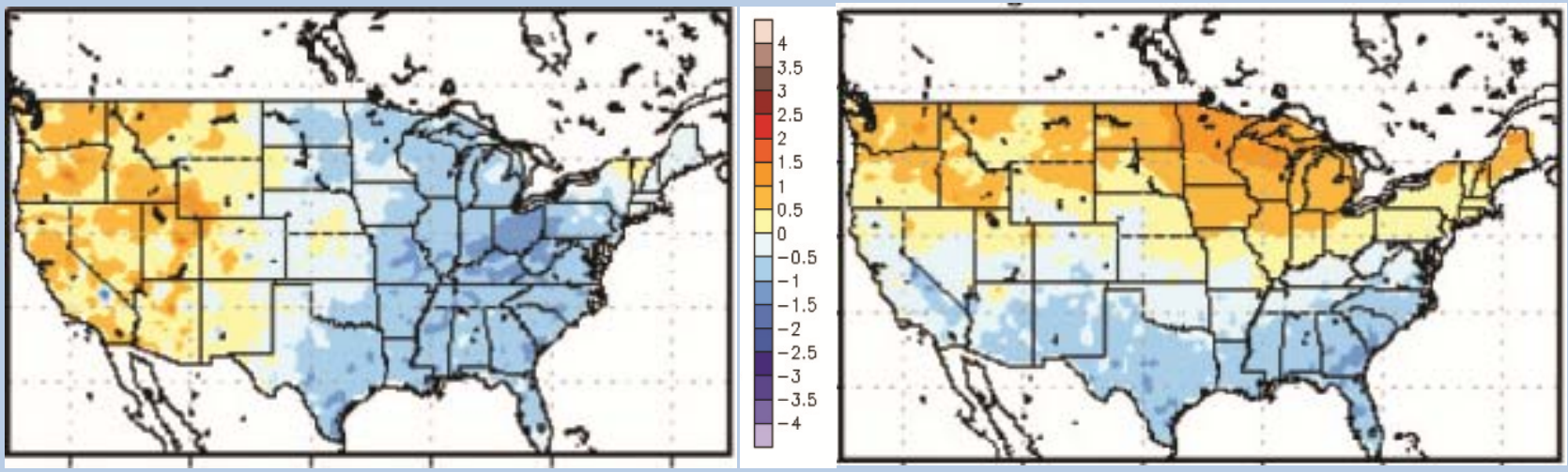
Soybeans 1962-2011

A La Niña magnifies the impact of a cold PDO.



Until global agriculture adjusts to the changed PDO, agricultural production will be vulnerable to La Niñas.
It usually takes 7 – 10 years.

PREMIER LEVEL

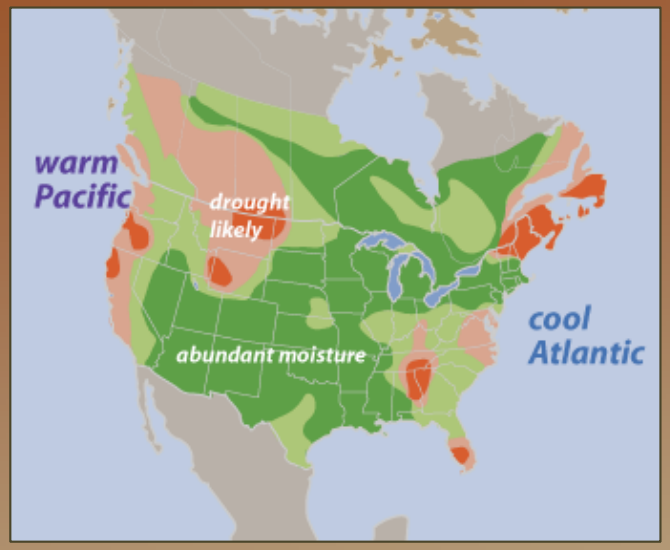


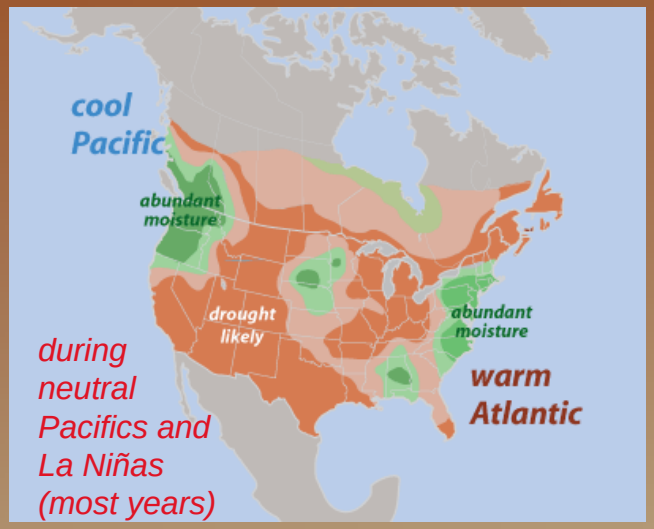
Most likely weather pattern in early and late winter.

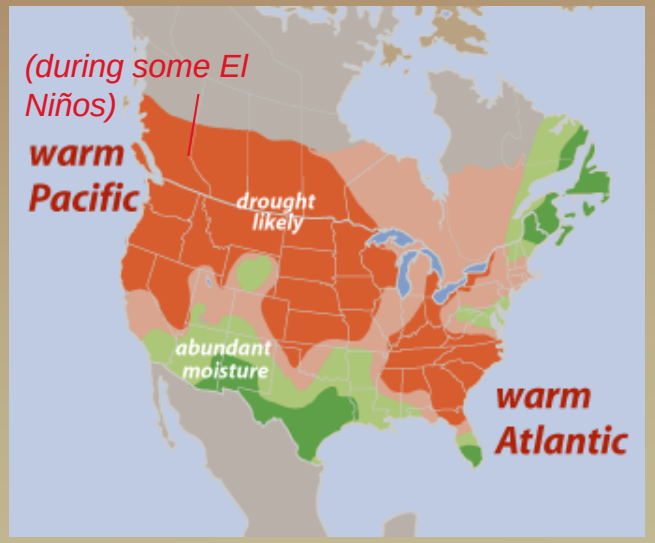
Most likely weather pattern in mid winter.

Since the 2006 PDO turning point, the El Niños have been atypical, shorter, more interrupted and weaker. This makes a difference in warming patterns in the Eastern US

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







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.

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.

data-US only: US Geological Survey ©Browning Newsletter

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