

# Climate Change, Water and Agriculture



Dick McNider

Department of Atmospheric Science

University of Alabama in Huntsville

[mcnider@nsstc.uah.edu](mailto:mcnider@nsstc.uah.edu)



Agriculture

Southeastern Irrigation

Water 



**Climate Change and EPA's New Proposed Carbon Rules** – this will hit your bottom line in energy and costs of irrigation

**Water and Climate** – why the Southeast should expand its irrigated agriculture



Agriculture

Southeastern Irrigation



PRESIDENT OBAMA MEETS WITH CLIMATE TASK FORCE  
JULY 16, 2014

## May 2, White House Released National Climate Assessment

## June 2, President Obama Announced Executive Order on Carbon Reductions

**UNDERSTAND**  
Climate Change

Climate change is happening now. The U.S. and the world are warming, global sea level is rising, and some types of extreme weather events are becoming more frequent and more severe. These changes have already resulted in a wide range of impacts across every region of the Nation and many sectors of the economy. Today, America needs reliable scientific information about current and future changes, impacts, and effective response options. The U.S. Global Change Research Program—which released the Third National Climate Assessment in May 2014—is at the center of fulfilling this critical need.

[NATIONAL CLIMATE ASSESSMENT](#)

What's Happening & Why   Impacts on Society   Response Options   USGCRP's Role   Learn More

**What's Happening & Why**

Evidence from the top of the atmosphere to the depths of the oceans, collected by scientists and engineers from around the world, tells an unambiguous story: the planet is warming, and over the last half century, this warming has been driven primarily by human activity—predominantly the burning of fossil fuels.

[LEARN MORE](#)

**EPA** United States Environmental Protection Agency

Español | 中文: 繁體

[Learn the Issues](#)   [Science & Technology](#)   [Laws & Regulations](#)   [About EPA](#)

**Carbon Pollution Standards**  
**Health effects of carbon pollution**

Unchecked carbon pollution leads to long-lasting changes in our climate, such as:

- Rising global temperatures
- Rising sea level
- Changes in weather and precipitation patterns
- Changes in ecosystems, habitats and species diversity

These changes threaten America's health and welfare for current and future generations. Public health risks include:

- More heat waves and drought
- Worsening smog (also called ground-level ozone pollution)
- Increasing the intensity of extreme events, like hurricanes, extreme precipitation and flooding
- Increasing the range of ticks and mosquitoes, which can spread disease such as Lyme disease and West Nile virus

Our most vulnerable citizens, including children, older adults, people with heart or lung disease and people living in poverty may be most at risk from the health impacts of climate change.

**Learn More**

- [Climate change impacts and adaptation](#)
- [Health, environmental and economic impacts of climate change](#)

# Failures of Consensus Science and Suppression of Contrary Information



The theme behind both the National Climate assessment and the EPA Carbon Rules is that the Science of climate change is settled and it is time to take action.

Our skeptical position is based on observations and the uncertainty in models of climate change.

Agriculture

Southeastern Irrigation

# THE WALL STREET JOURNAL.

## Opinion

### **McNider and Christy: Why Kerry Is Flat Wrong on Climate Change**

**It was the scientific skeptics who bucked the 'consensus' and said the Earth was round.**

By  
Richard McNider And  
John Christy  
Updated Feb. 19, 2014 7:31 p.m. ET

In a Feb. 16 speech in Indonesia, Secretary of State John [Kerry](#) assailed climate-change skeptics as members of the "Flat Earth Society" for doubting the reality of catastrophic climate change. He said, "We should not allow a tiny minority of shoddy scientists" and "extreme ideologues to compete with scientific facts."

## Is the majority right?

There are numerous examples where the scientific consensus has been proven wrong –

- Copernicus and Galileo challenging the Earth as the center of the solar system
- Einstein challenging Newtonian dynamics
- English Sea Captains challenging the Sick and Hurt Board on the cause of scurvy

The scientific establishment in 19<sup>th</sup> Century dismissed sea captains use of fresh vegetables and fruits “ as mere empiriks without proper theory”.

Thousands of English sailors died needlessly.

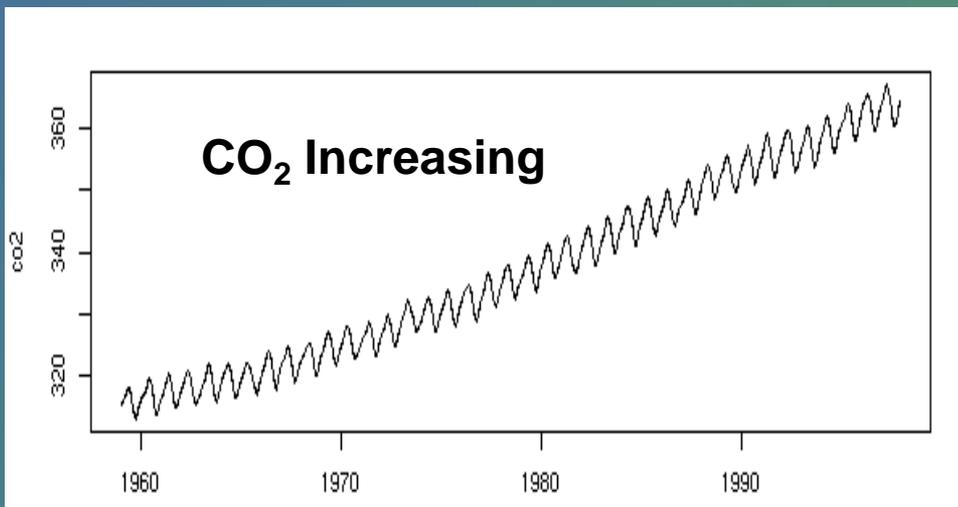
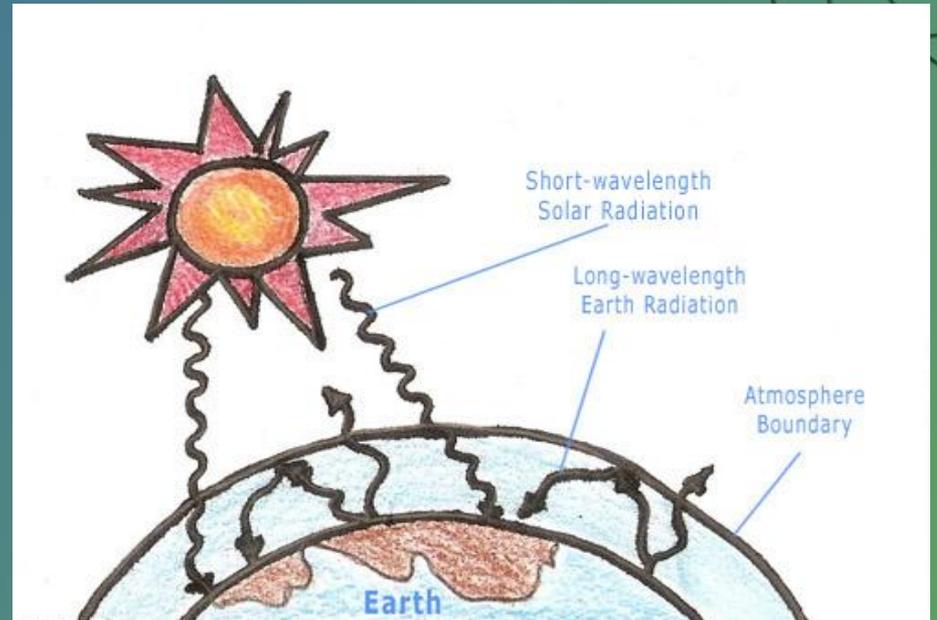


Agriculture

Southeastern Irrigation

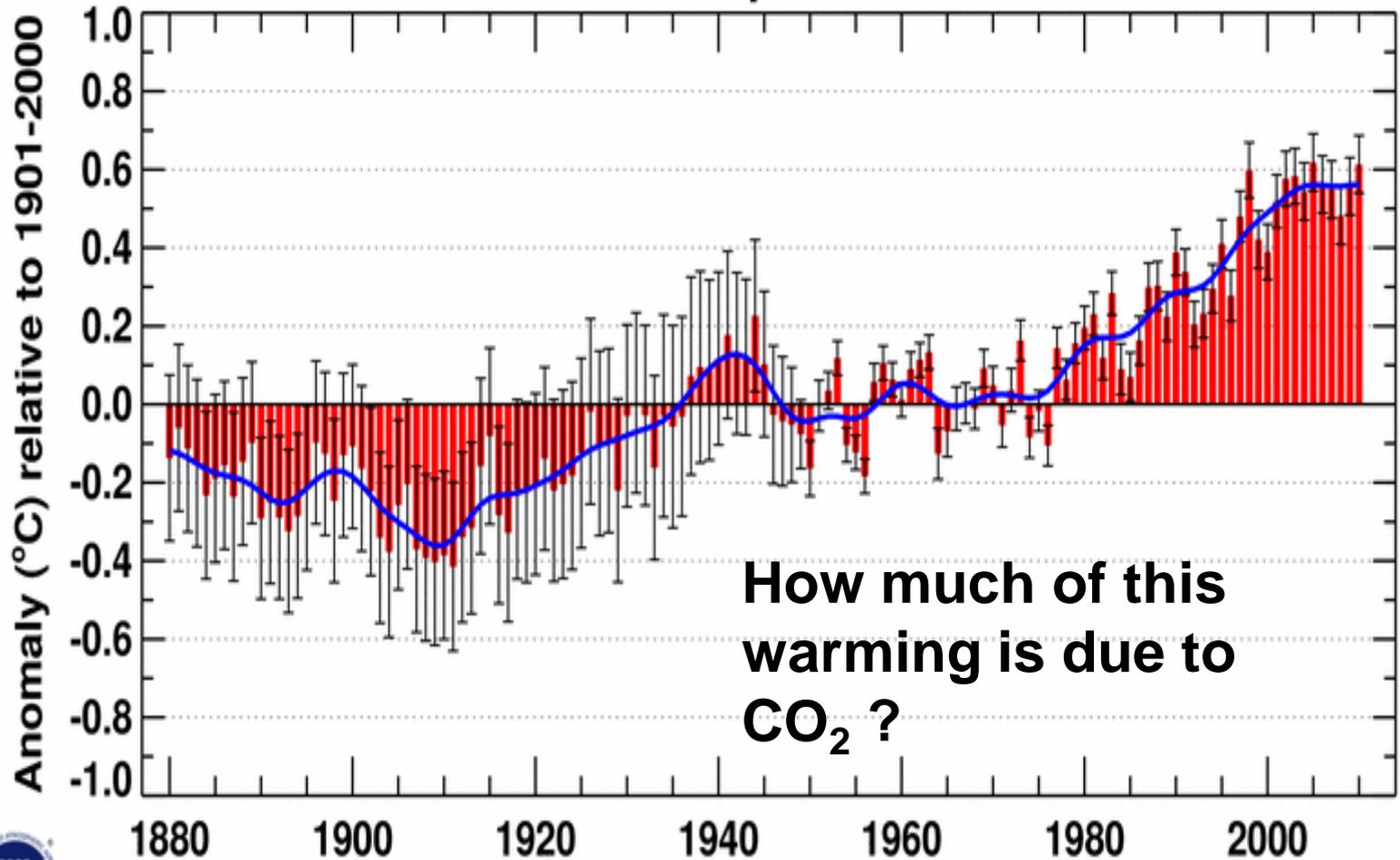
# CO<sub>2</sub> Climate Change

**Added CO<sub>2</sub>  
Increases the  
Natural  
Greenhouse  
Effect**



**No disagreement on this fact. But, the open question is how much will the Earth warm and will it be significant compared to the natural variability in the climate system.**

# Jan-Dec Global Mean Temperature over Land & Ocean

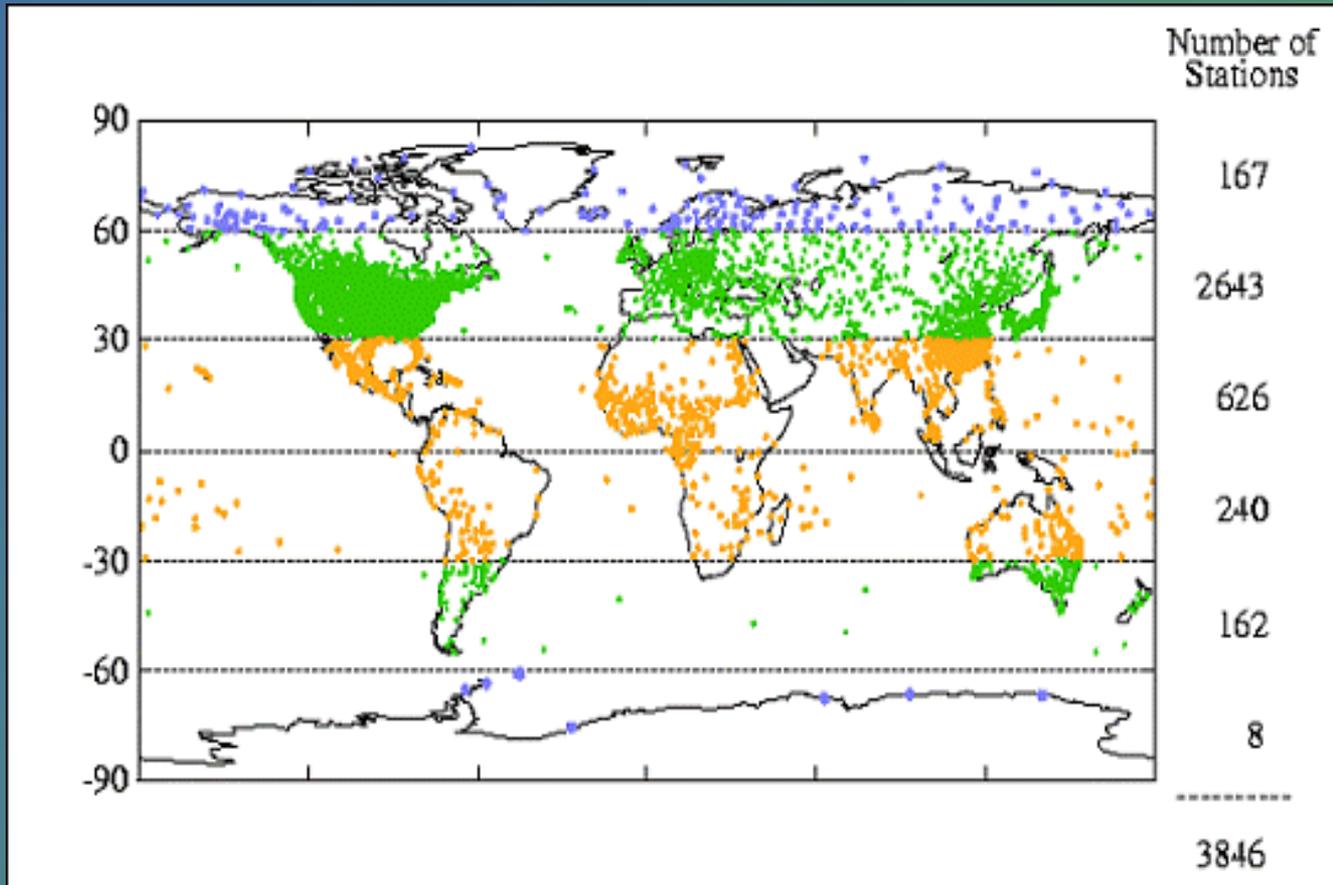


**How much of this  
warming is due to  
CO<sub>2</sub> ?**



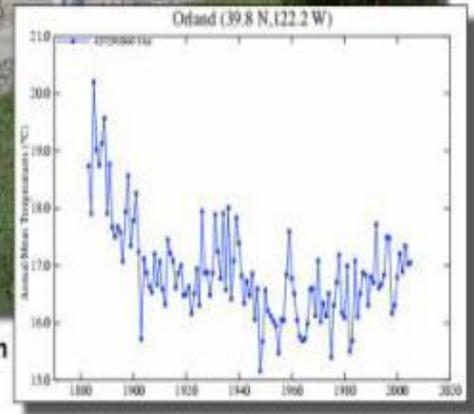
NCDC/NESDIS/NOAA

# Thermometer locations used to track the Earth's temperature

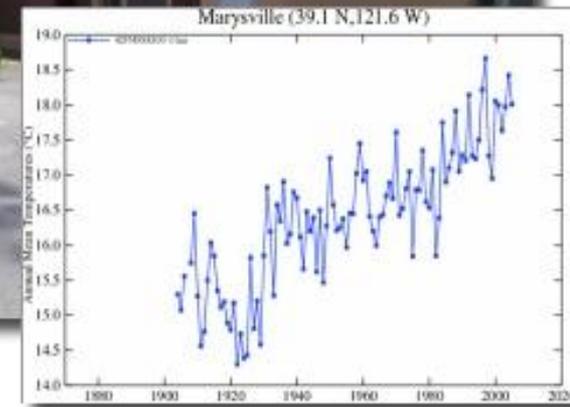
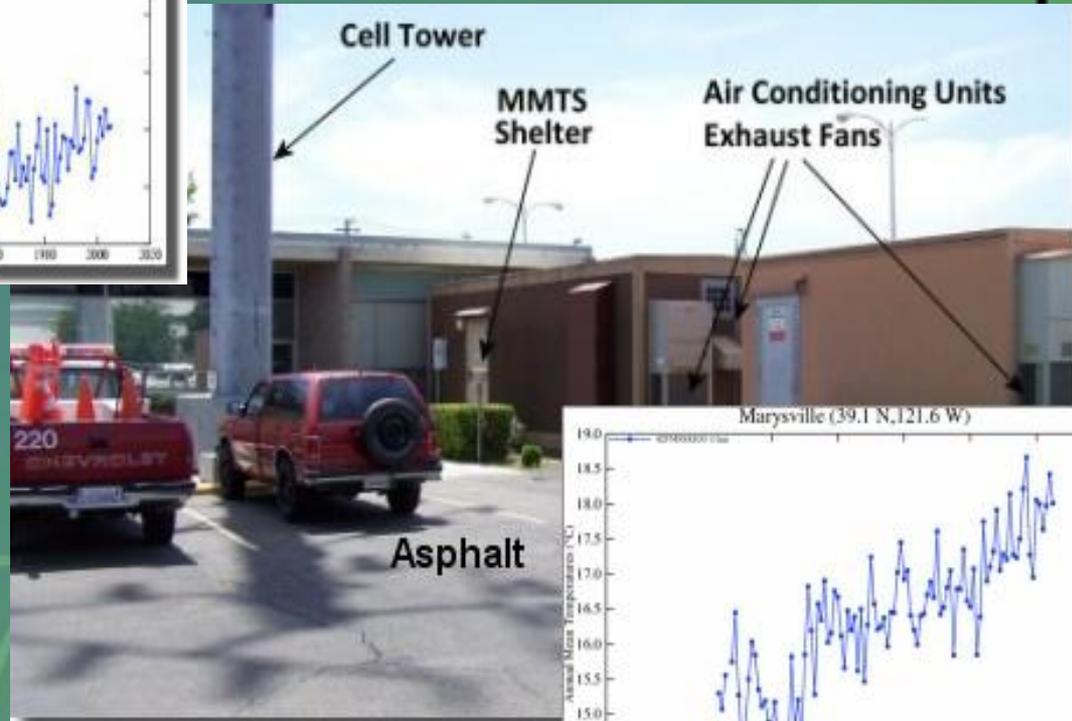




# Exposure of thermometers and land use change can cause changes in temperature



This USHCN Station in Orland, CA has been in the same location for over 100 years



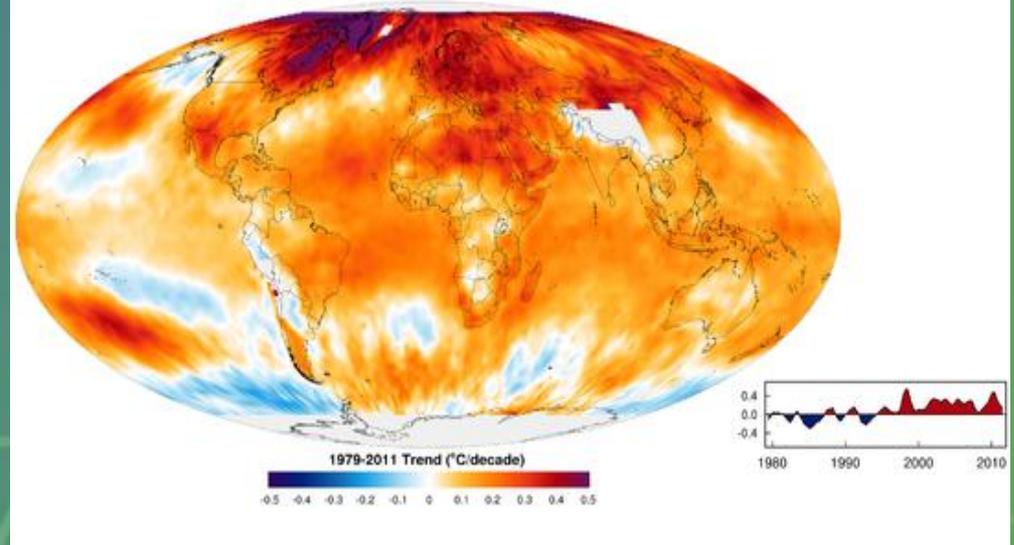


## Microwave Sounding Unit (MSU) on NOAA Polar Orbiting Satellites

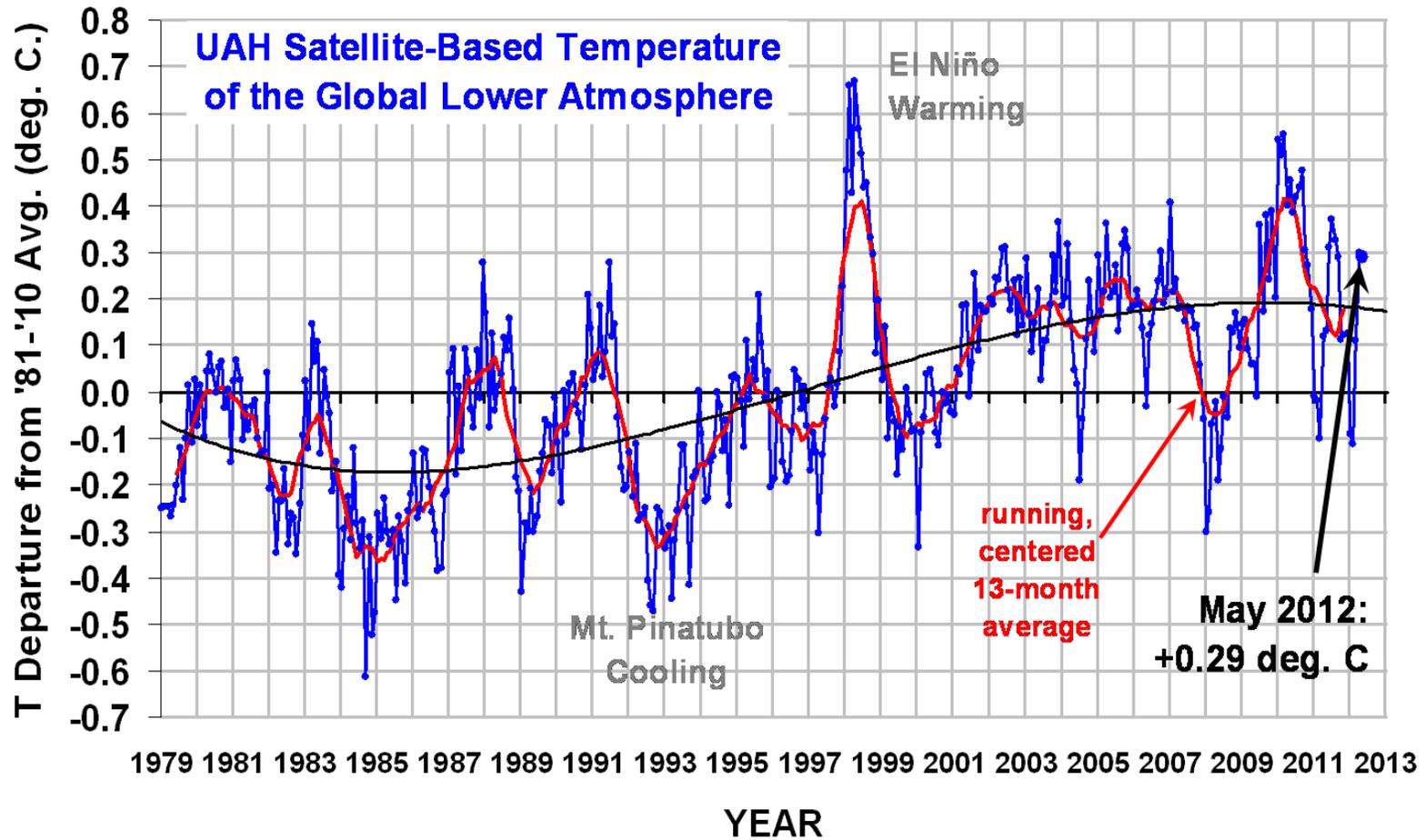


Provides true global coverage of the temperature of a deep layer of the Earth's atmosphere

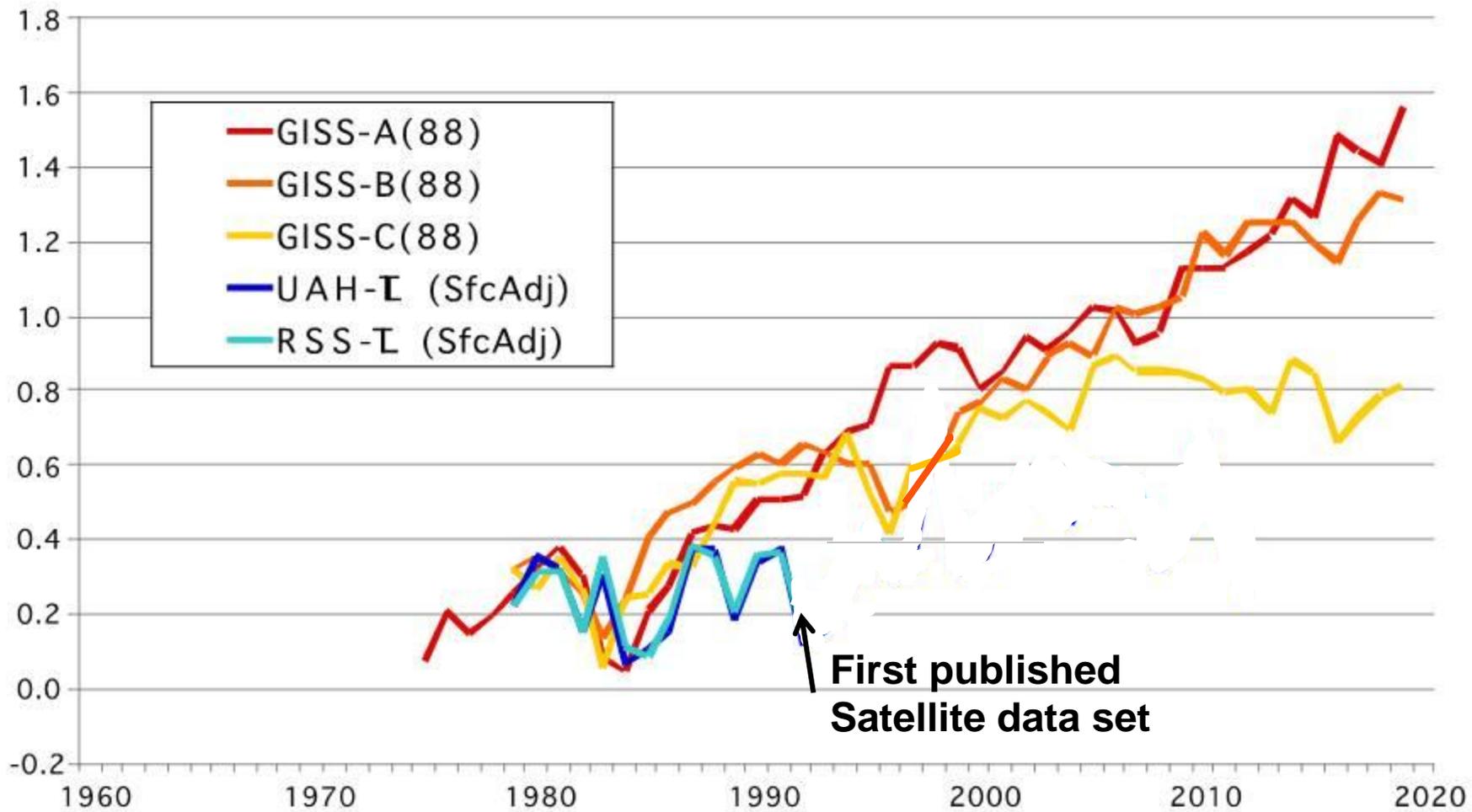
Lower Troposphere



# Roy Spencer and John Christy pieced together several satellites to make a long period record

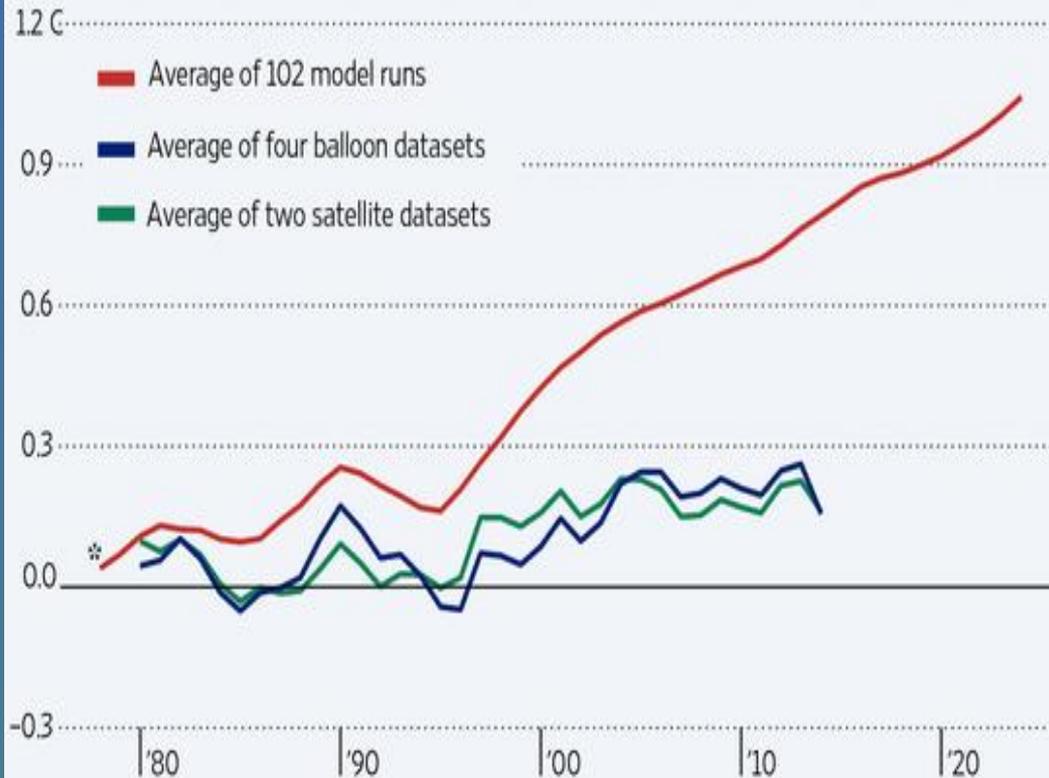


# History Lesson 1988



## Warming Predictions vs. the Real World

Global mid-tropospheric temperature 5-year averages, in degrees Celsius



\* The linear trend of all three curves intersects at zero in 1979, with the values shown as departures from that trend line.

Sources: Various, as described in the "State of the Climate in 2012" in the Bulletin of the American Meteorological Society, August 2013

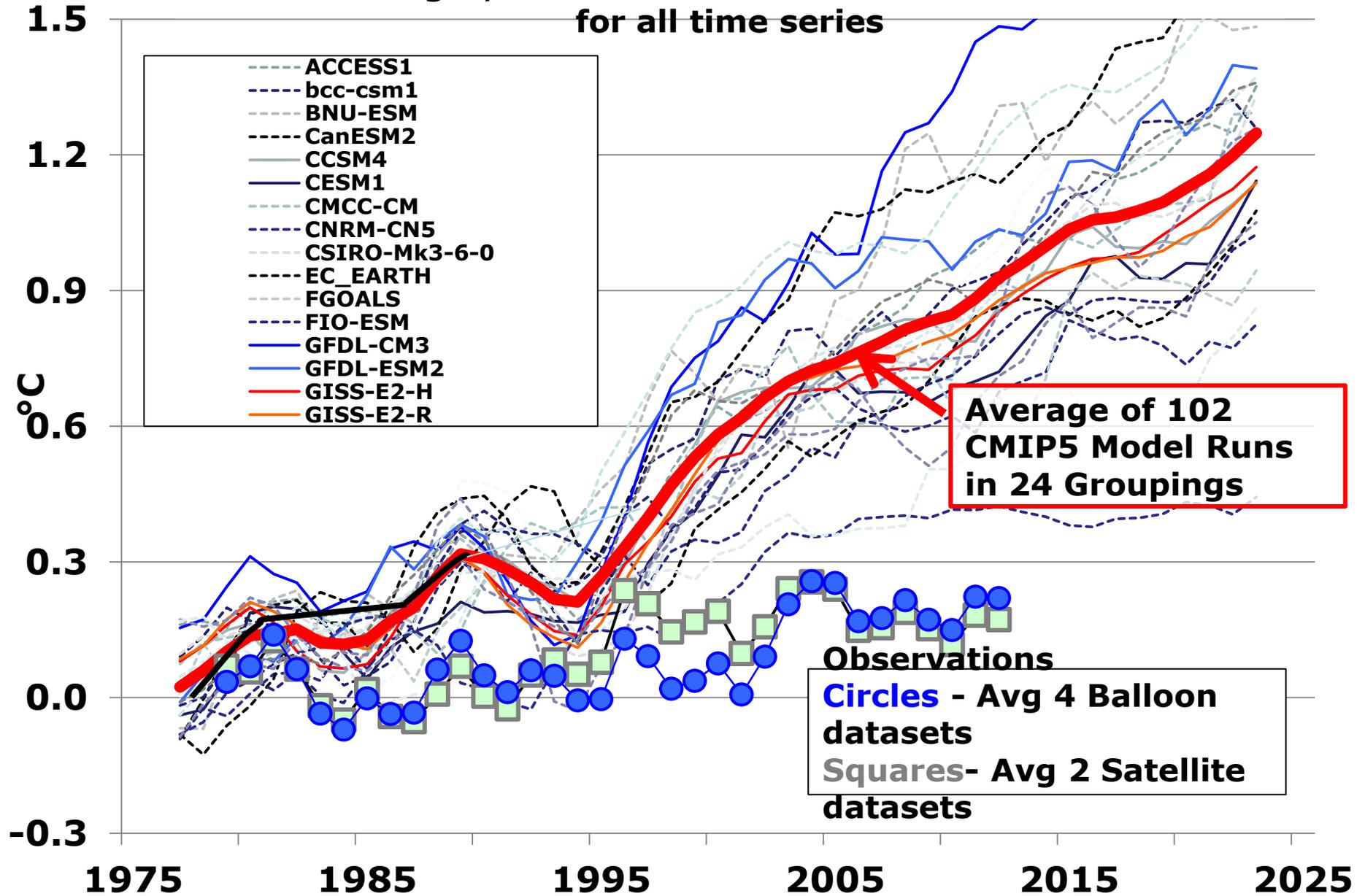


**In science, a fundamental principle is that when you understand a system, you can predict its behavior**

# 102 CMIP-5 rcp4.5 Model runs in 24 Groups

## Tropical Mid-Tropospheric Temperature

5-Year Averages, 1979-2013 Trend line crosses zero at 1979 for all time series



Water



**Well what about all the things we hear on television and from the Obama administration about hurricanes increasing, drought and floods increasing, glaciers melting, sea level rising?**



Agriculture

Southeastern Irrigation

Water 

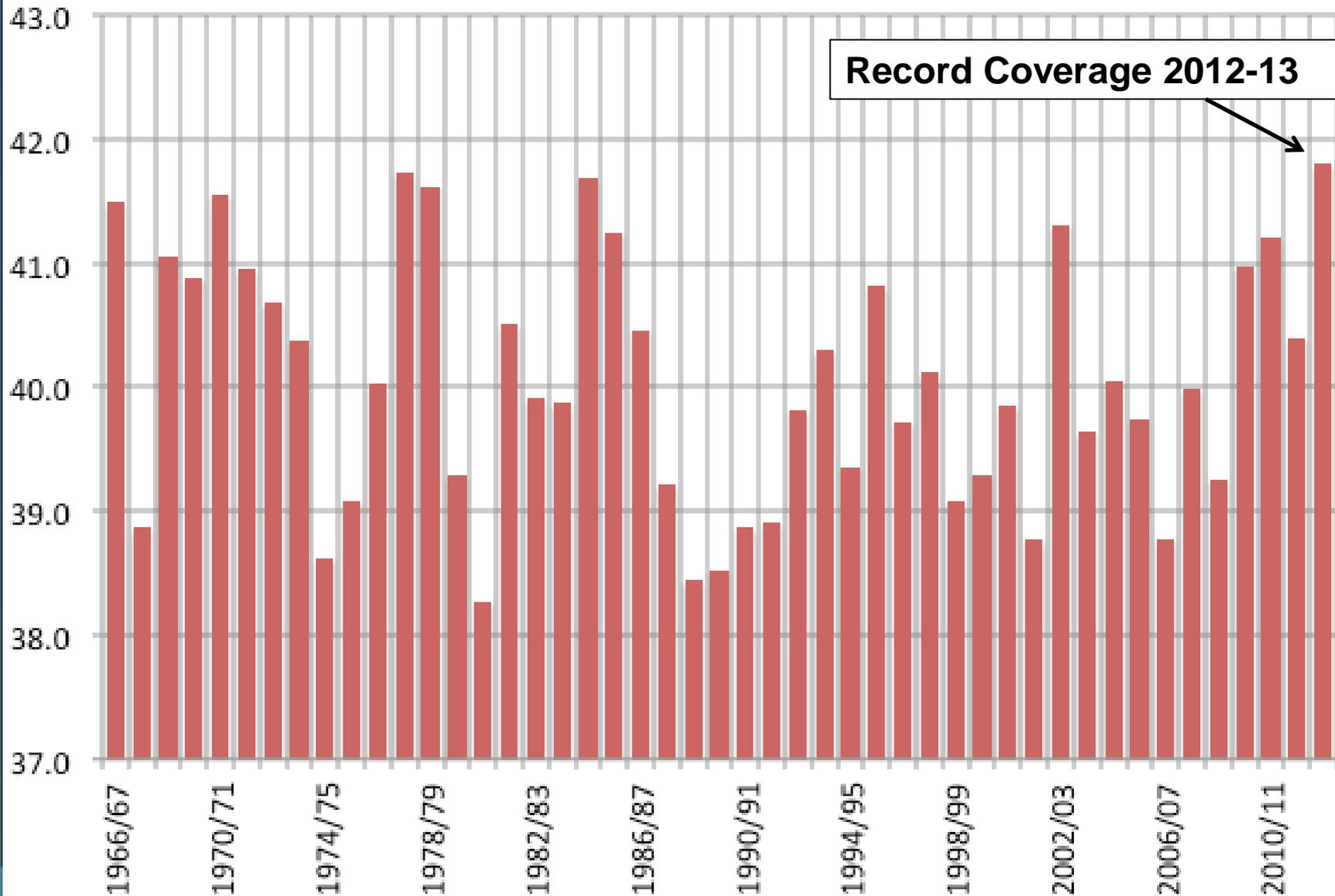


# Disappearing Snow and Sea Ice?



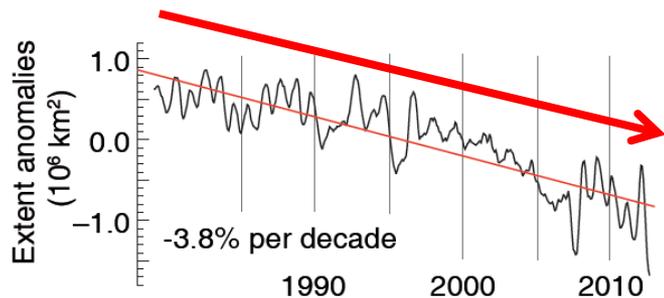
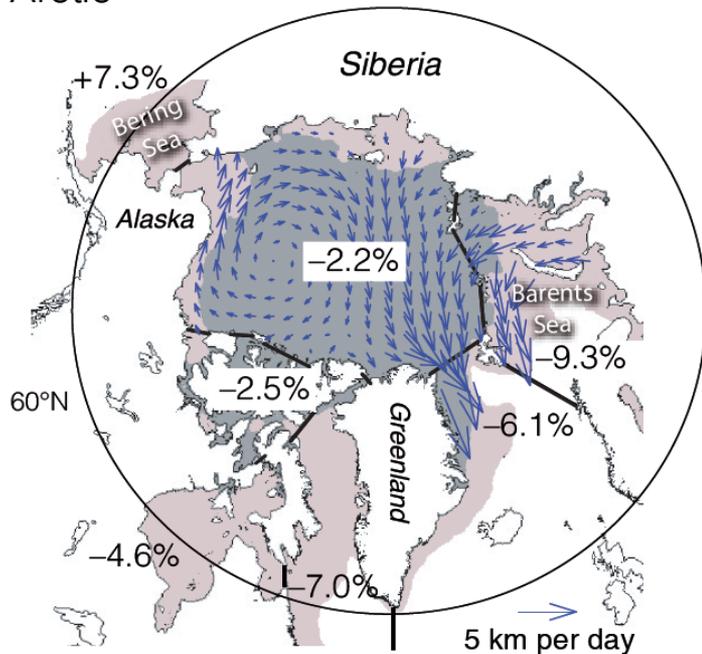
Agriculture  
Southeastern Irrigation

# Northern Hemisphere Snow Extent November to April

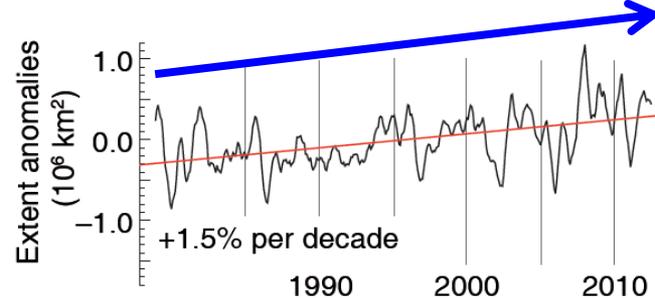
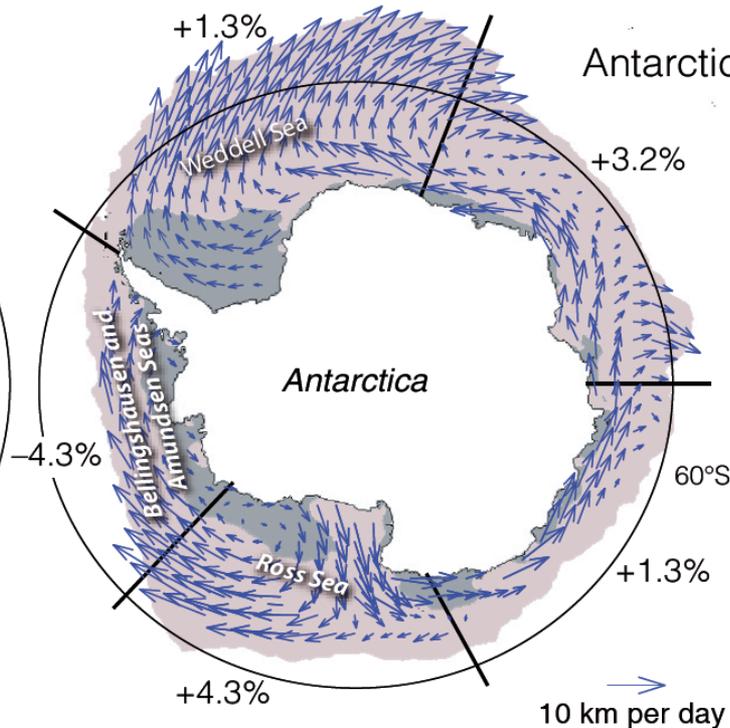


# IPCC AR5 Chapter 4

Arctic



Antarctic



**FAQ 4.1, Figure 1** | The mean circulation pattern of sea ice and the decadal trends (%) in annual anomalies in ice extent (i.e., after removal of the seasonal cycle), in different sectors of the Arctic and Antarctic. Arrows show the average direction and magnitude of ice drift. The average sea ice cover for the period 1979 through 2012, from satellite observations, at maximum (minimum) extent is shown as orange (grey) shading.

**Arctic Downward**

**Antarctic Upward**

**Sea Ice Changes 1979-2012**

Western Irrigation

Water 



# Ice Caps and Sea Level

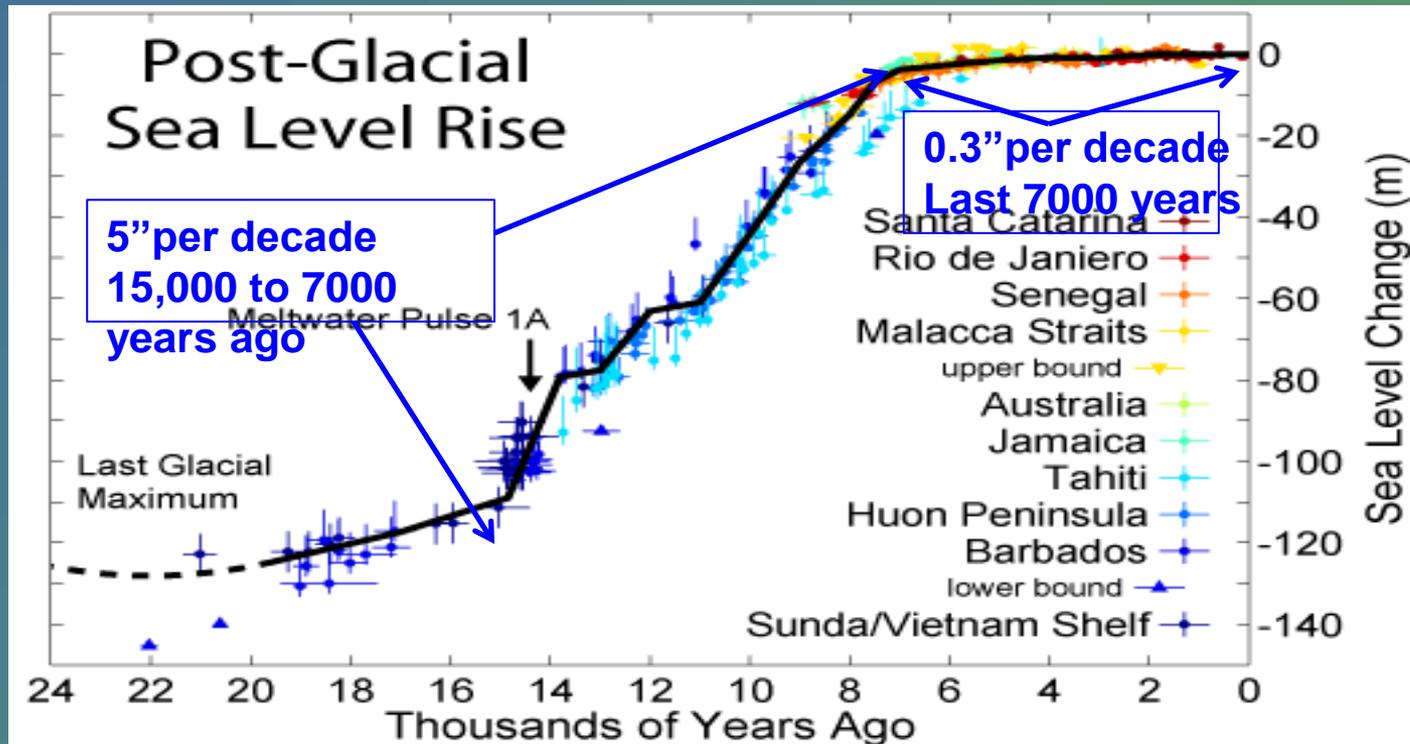


Agriculture  
Southeastern Irrigation

## Sea Level Rises as Land-ice melts.

The major low-latitude ice-age ice sheets finished melting about 8,000 years ago (i.e. Illinois, New York, etc.) and since then the remnant mountain glaciers and parts of Greenland and Antarctica are still adding some melt-water. [The warm period 130,000 years ago saw sea levels 20 ft higher than today, i.e. naturally.]

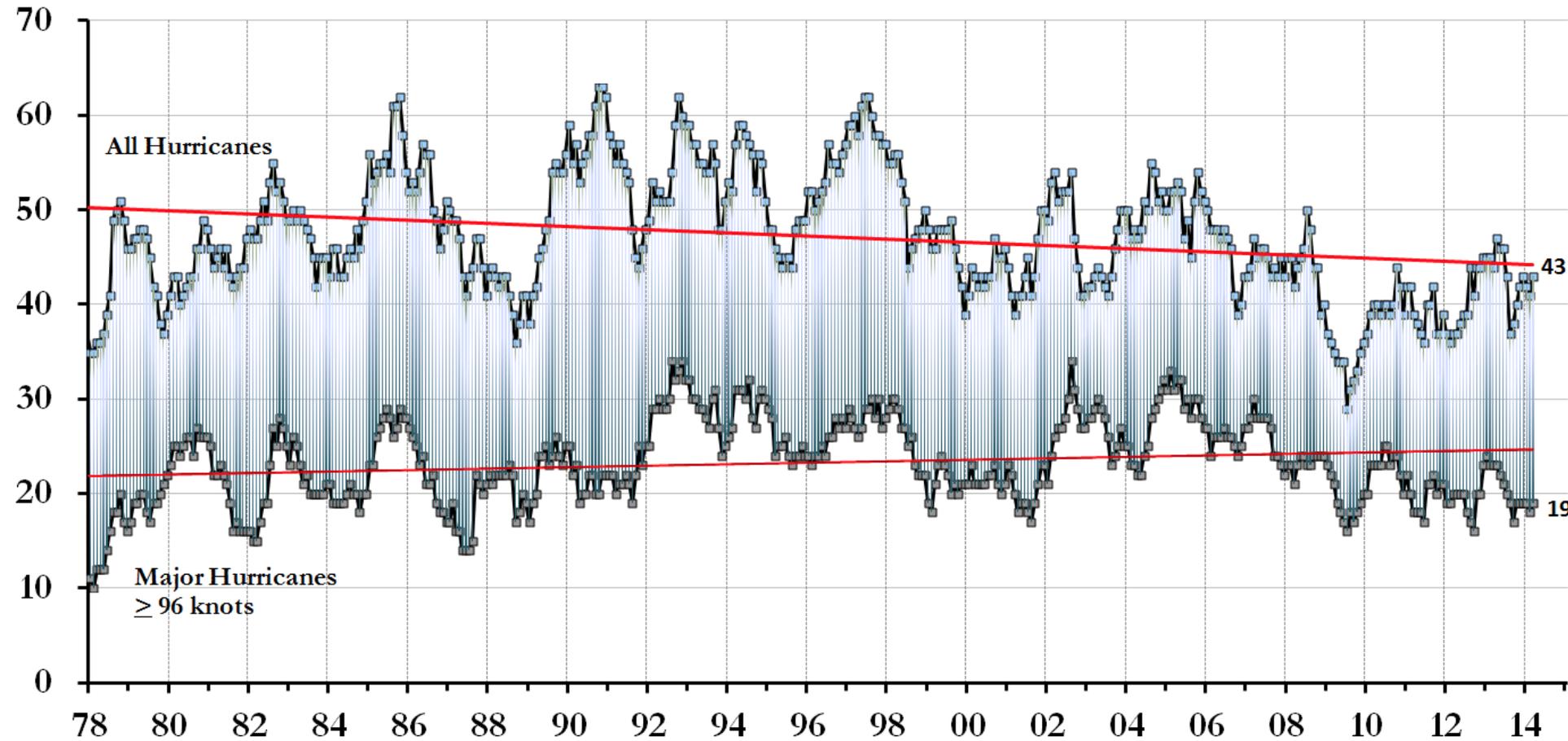
Sea level also rises for other reasons such as increases in eroded soil material flowing into the ocean and thermal expansion of the water itself.



# Global Hurricanes (1971 to Mar 2014)

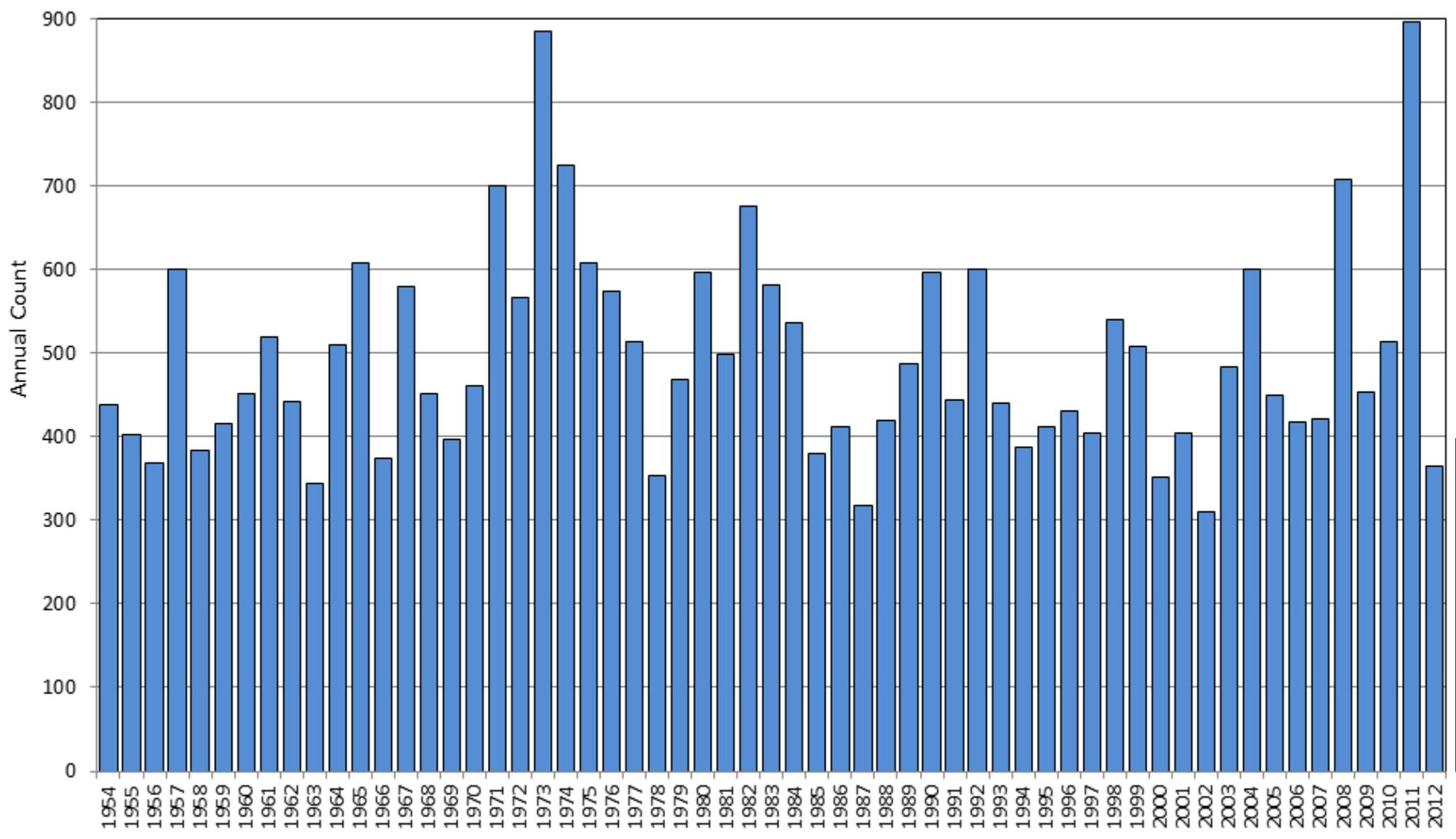


Global Hurricane Frequency -- Dr. Ryan N. Maue -- Updated March 31, 2014 -- 12 month running sums





## U.S. Annual Count of EF-1+ Tornadoes, 1954 through 2012

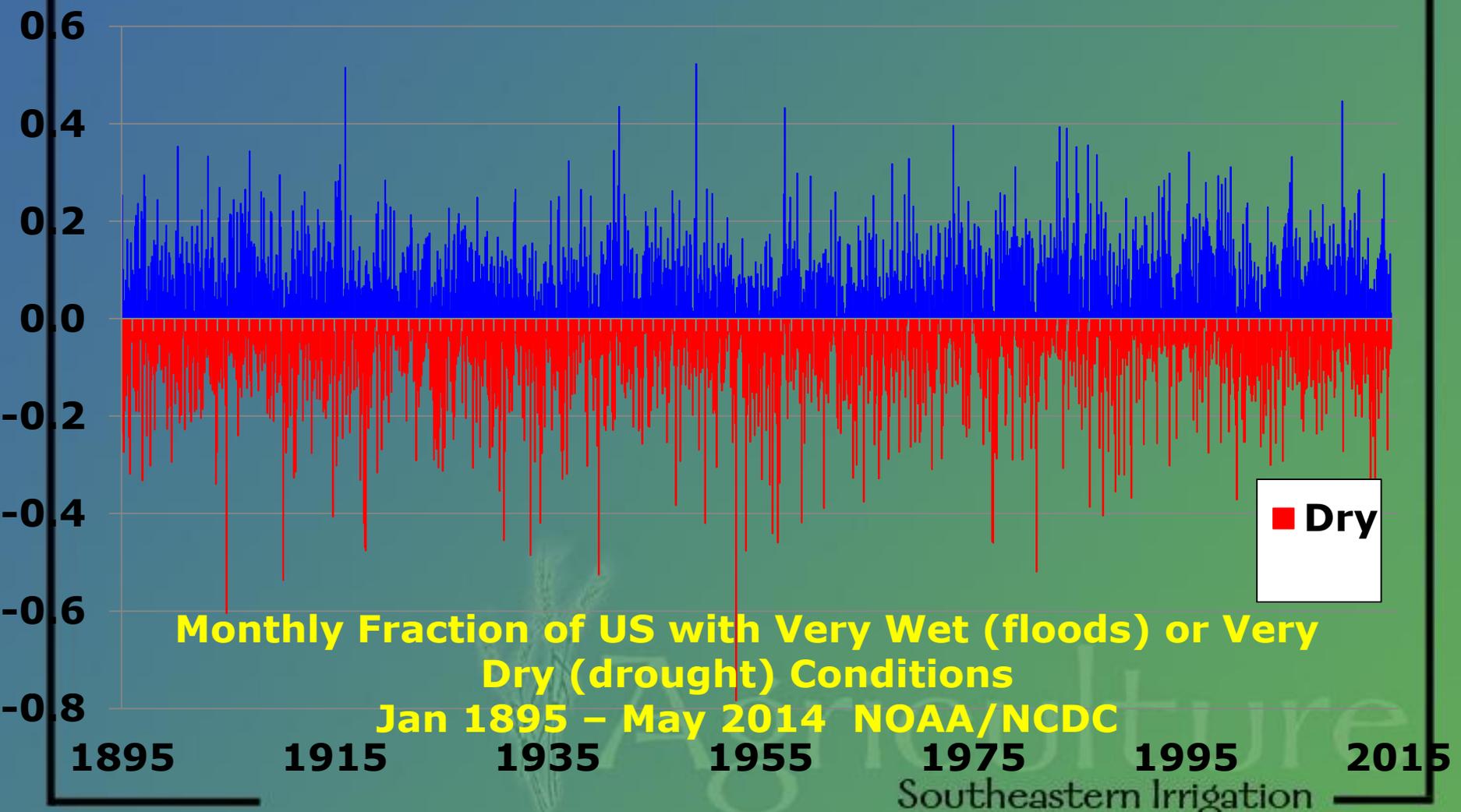


Data Source: NOAA/ NWS Storm Prediction Center

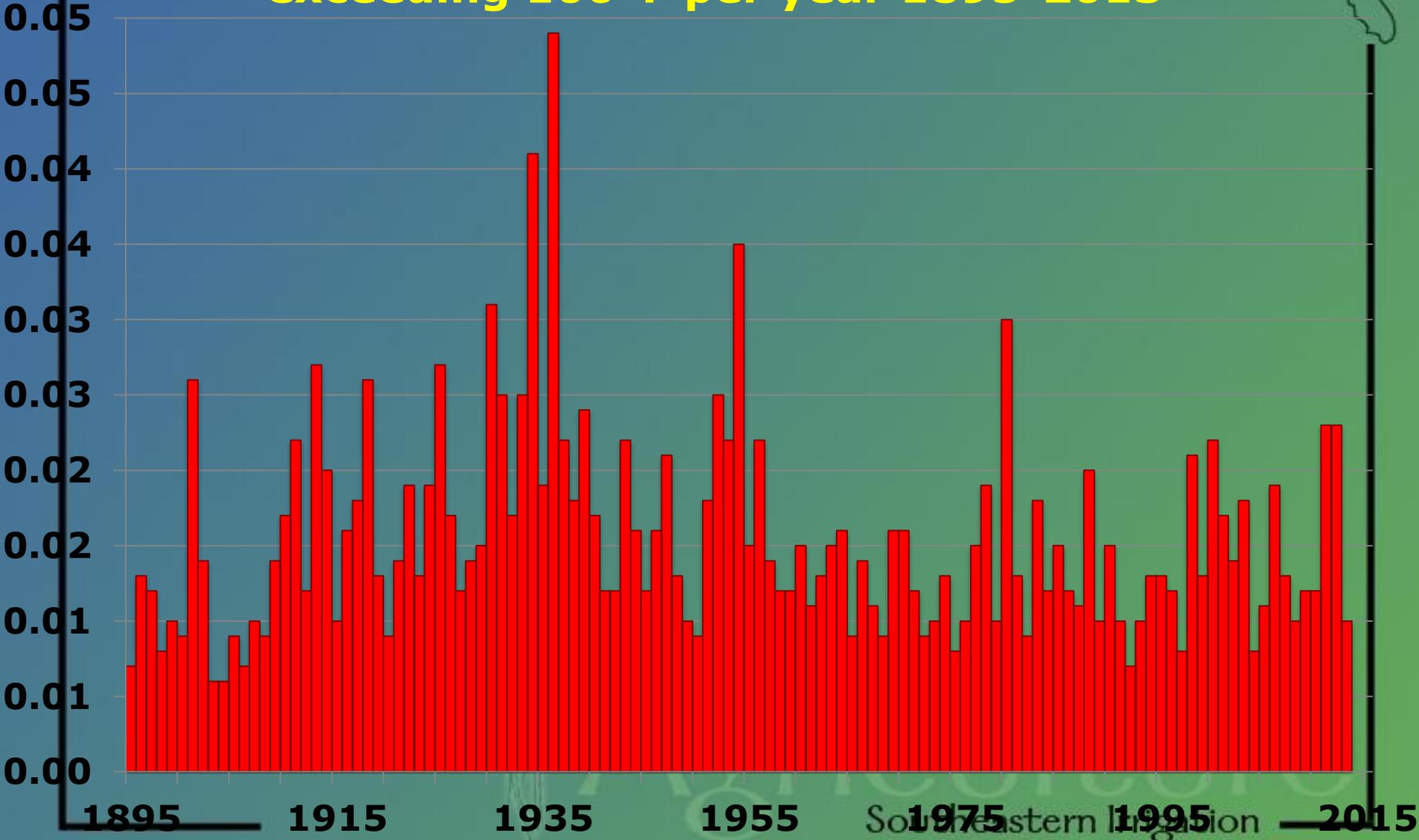
**(2013 Preliminary, will decline as duplicates removed)**

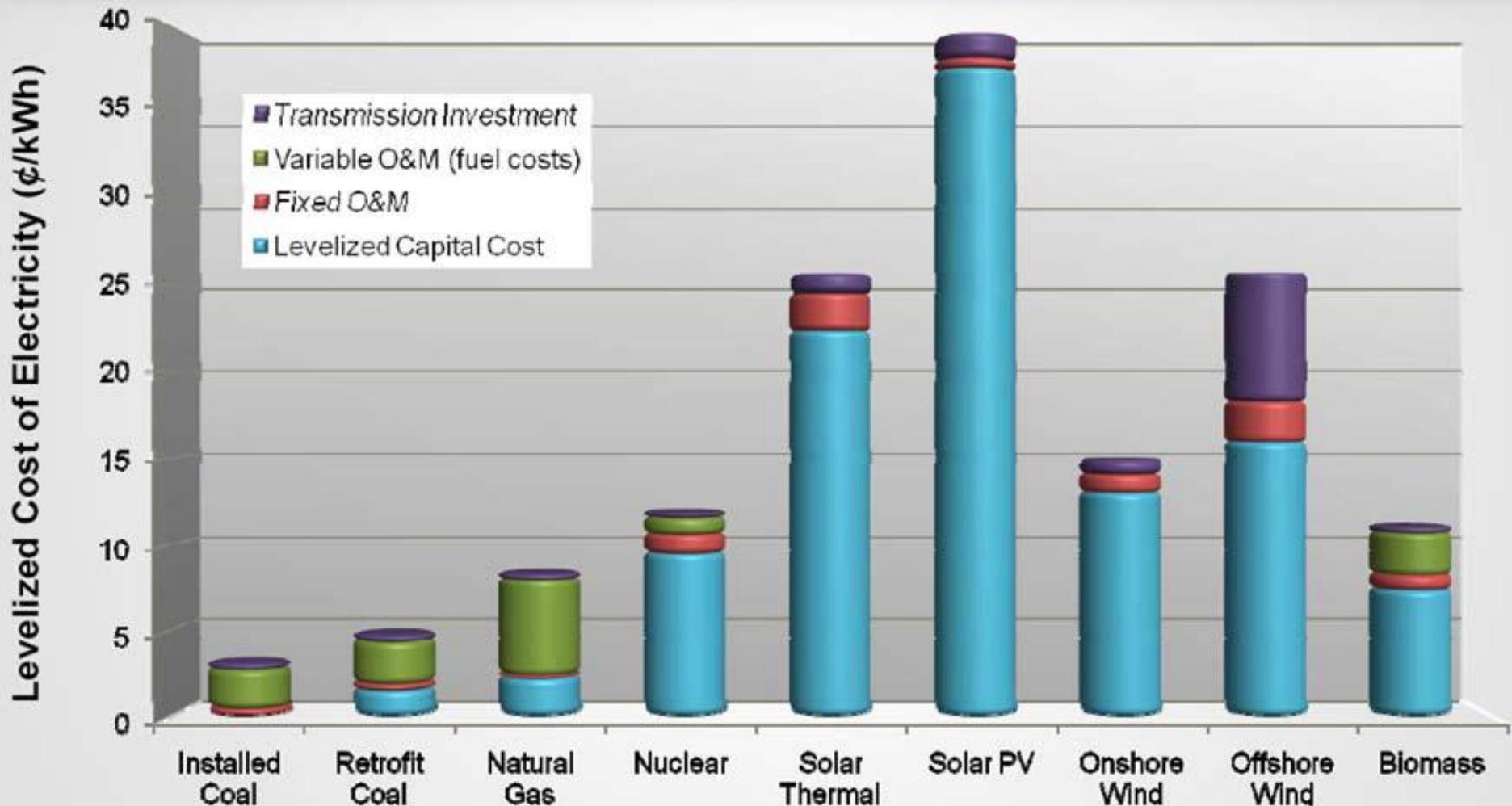
Water

# Floods and Droughts



# Fraction of Daily High Temperatures at 982 USHCN Stations exceeding 100°F per year 1895-2013

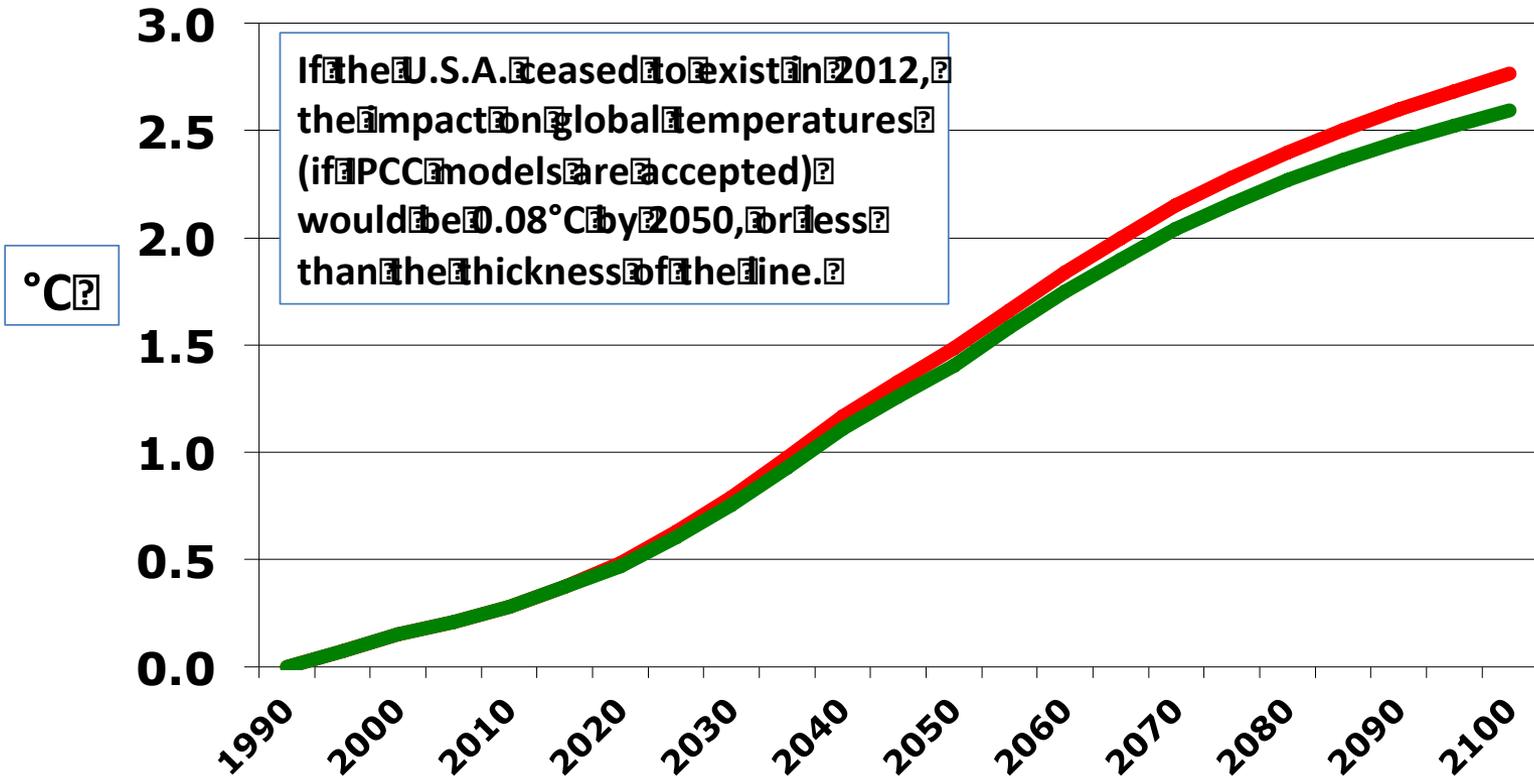




1. All cost data from EIA 2010
2. Installed coal costs estimated from EIA projections for new generation less capital costs
3. Retrofit coal capital costs derived from Burns & McDonnell analysis December 2010

Source: Van Ness Feldman and Burns & McDonnell, 2011.

**Red - Temperature PCC A1B Emissions**  
**Green - U.S. stops all emissions 2012**



Data from SPPI, Paul Knappenberger

# Energy Poverty



Alabama (4.8 million people) produces more electricity than all of sub-Saharan Africa (with 910 million people).

Carbon based energy in the last 100 years has done more to lengthen lives , reduce poverty, produce food and improve the quality of life than any future harmful effects of climate change.



Southeastern Irrigation



**In summary I don't believe we have enough confidence in our predictions or understanding of the Earth's Climate System to risk our economic system by reducing CO2 emissions at great cost.**

**The costs of reducing CO2 emissions are more certain than the risk of catastrophic climate change.**

**The poor would be disproportionately hurt by high energy prices.**

**We should be investing in research in sustainable non-fossil energy so that in the end they can compete without subsidies.**

**Agriculture**  
Southeastern Irrigation

Water 



# Climate and Agriculture



Agriculture

Southeastern Irrigation



**While almost everyone in the climate change community has expressed concern about the impact of climate change on agriculture, less has been discussed about agricultural change in the last century in the U.S. which makes agriculture more vulnerable to climate.**

**The drought of 2012 in the Midwest and the current Western drought expose this vulnerability**

**Agriculture**

**Southeastern Irrigation**

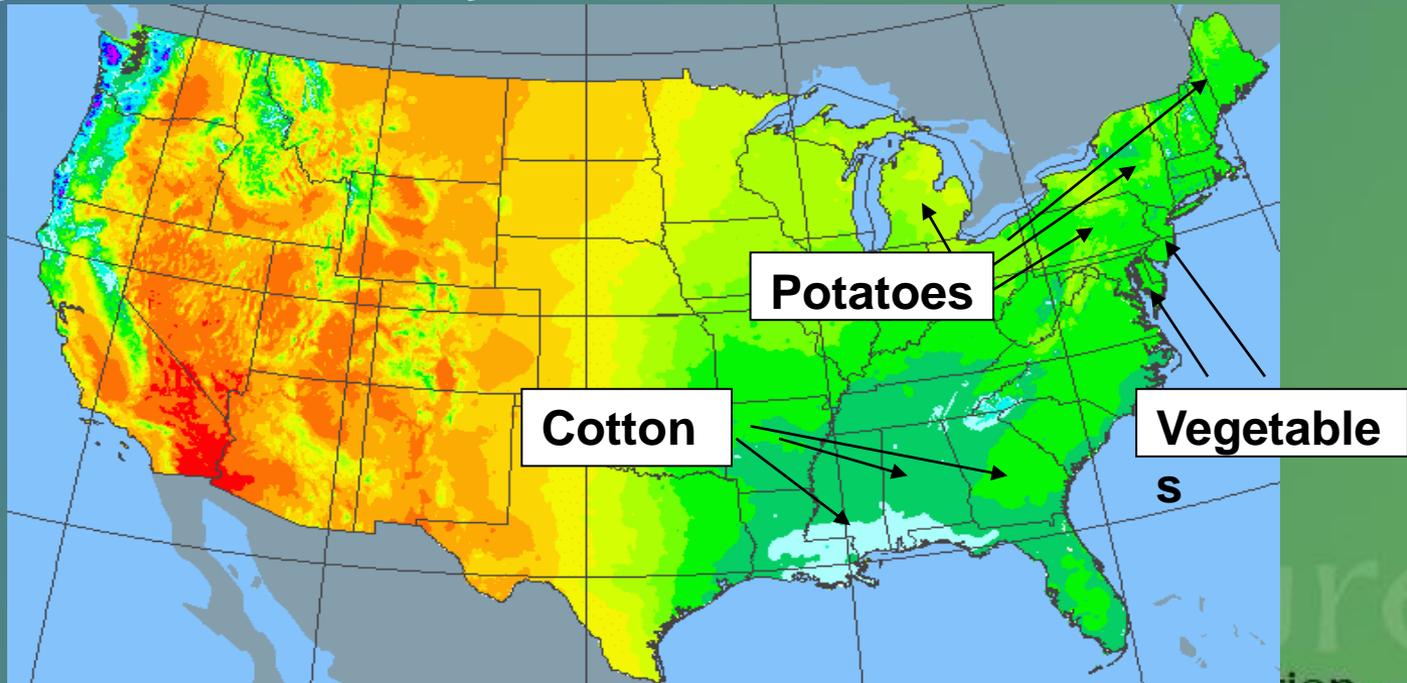
Since 1940 there has been a major migration of agricultural production in this country driven by water. Makes agriculture more vulnerable to climate.

Prior to 1940 Maine ,Pennsylvania and New York led the nation in potato production

Cotton was King in the Southeast

New Jersey/Del Marva Peninsula provided vegetables for urban areas

Corn was grown in almost every State for local use

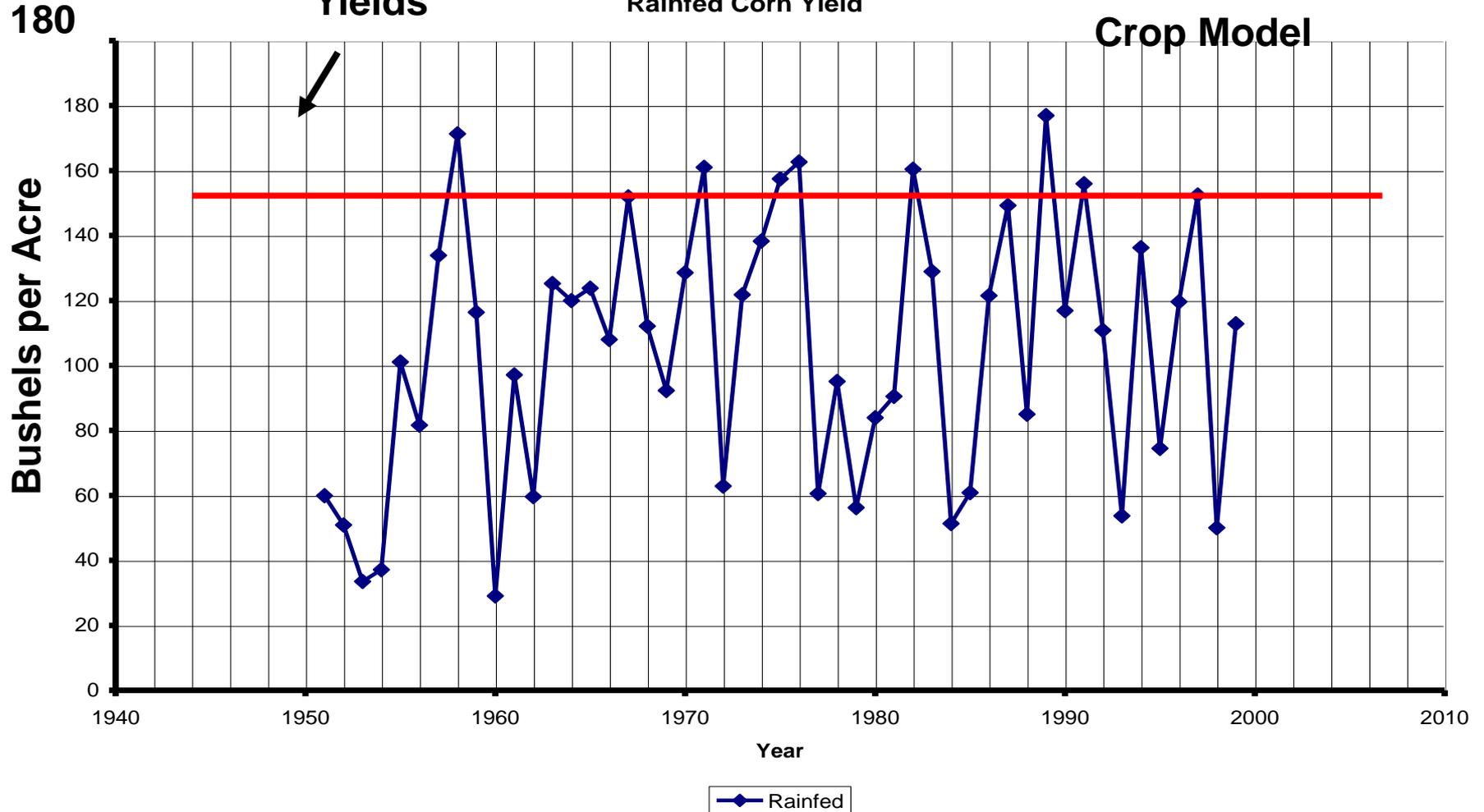


# Deep water holding soils in the Midwest largely insulated farmers from short-term losses that plagued the Southeast

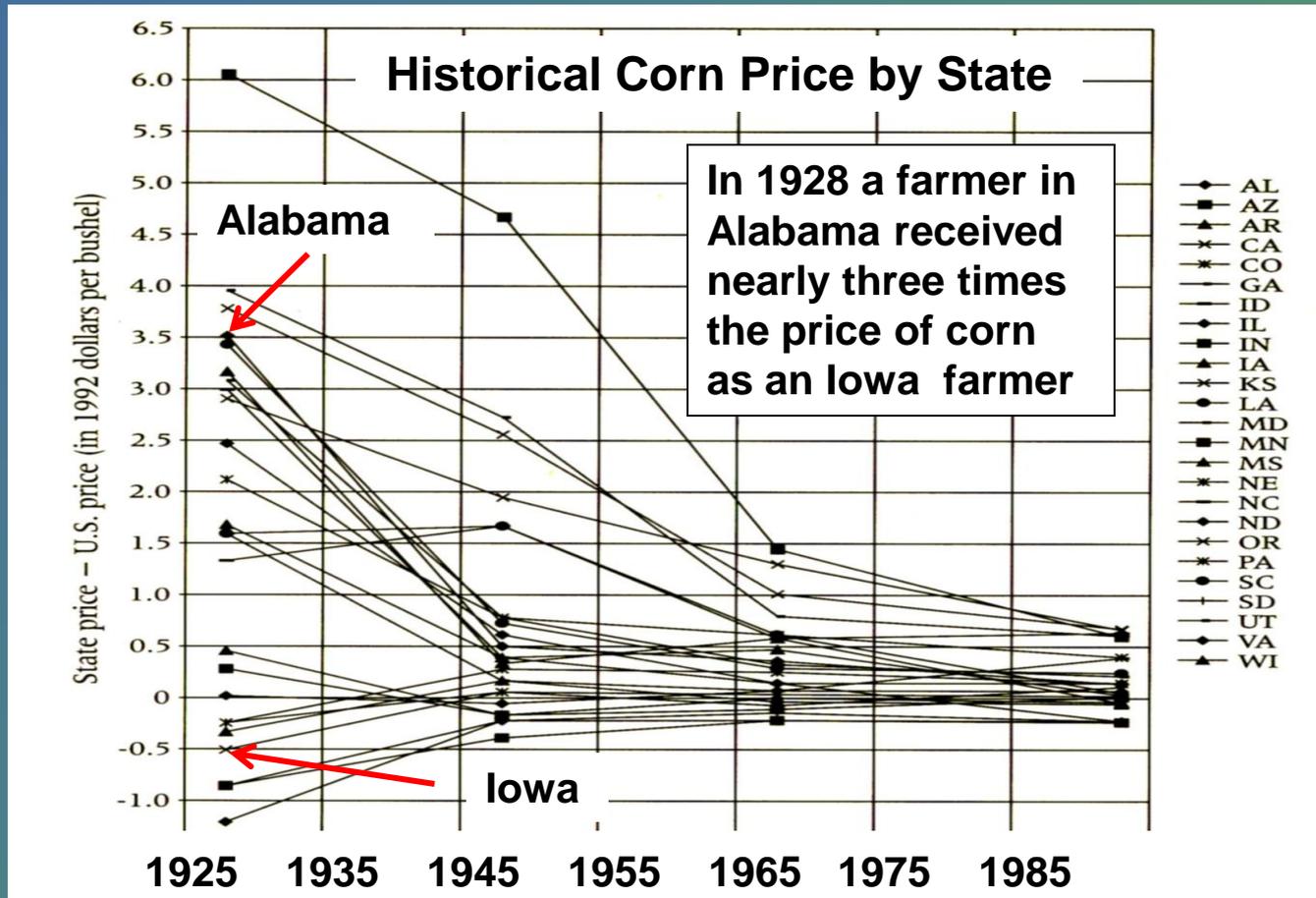
Average Mid-west  
Yields

Headland, AL  
Rainfed Corn Yield

Crop Model



# Transportation Improvements Intruded into Regional Markets that had Functioned for Generations

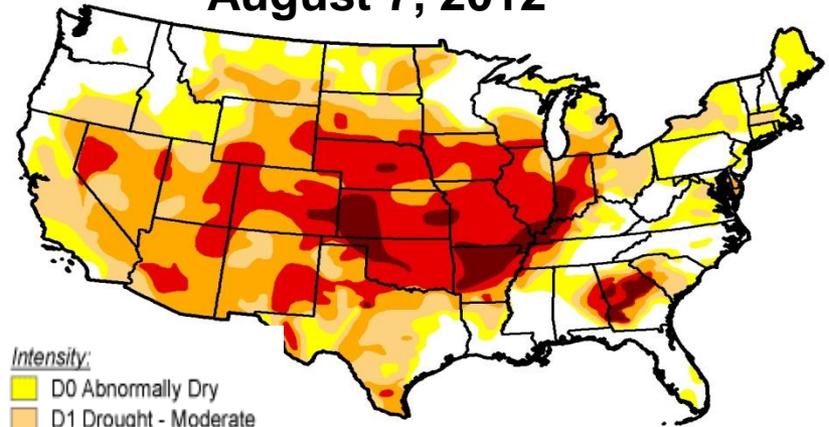


Corn prices by state from 1928 to 1988. From Gardner 2002.

Midwest Drought of 2012 shows the danger of concentration too much of the Nation's agricultural production in one region

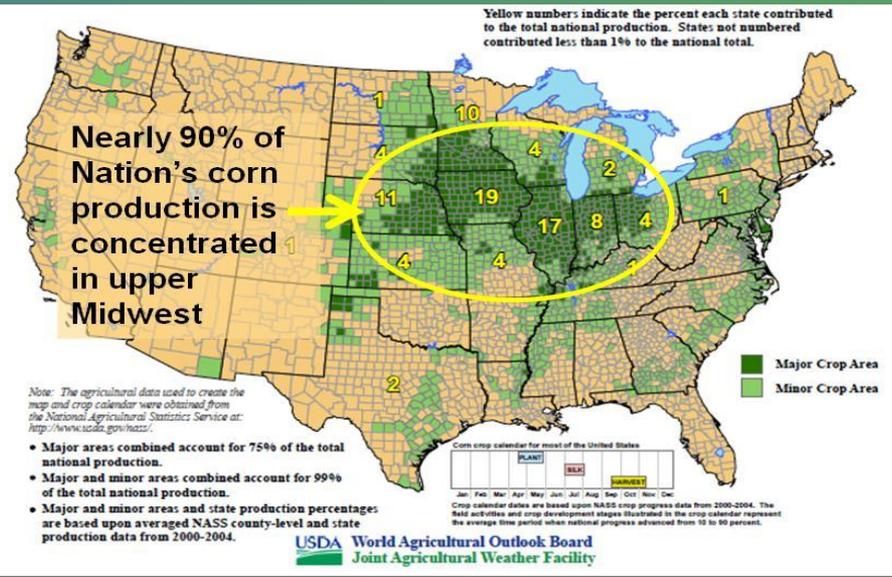
The impact could have been much worse because this drought was short-lived and was not centered on the corn production region

## Drought Monitor August 7, 2012



### Intensity:

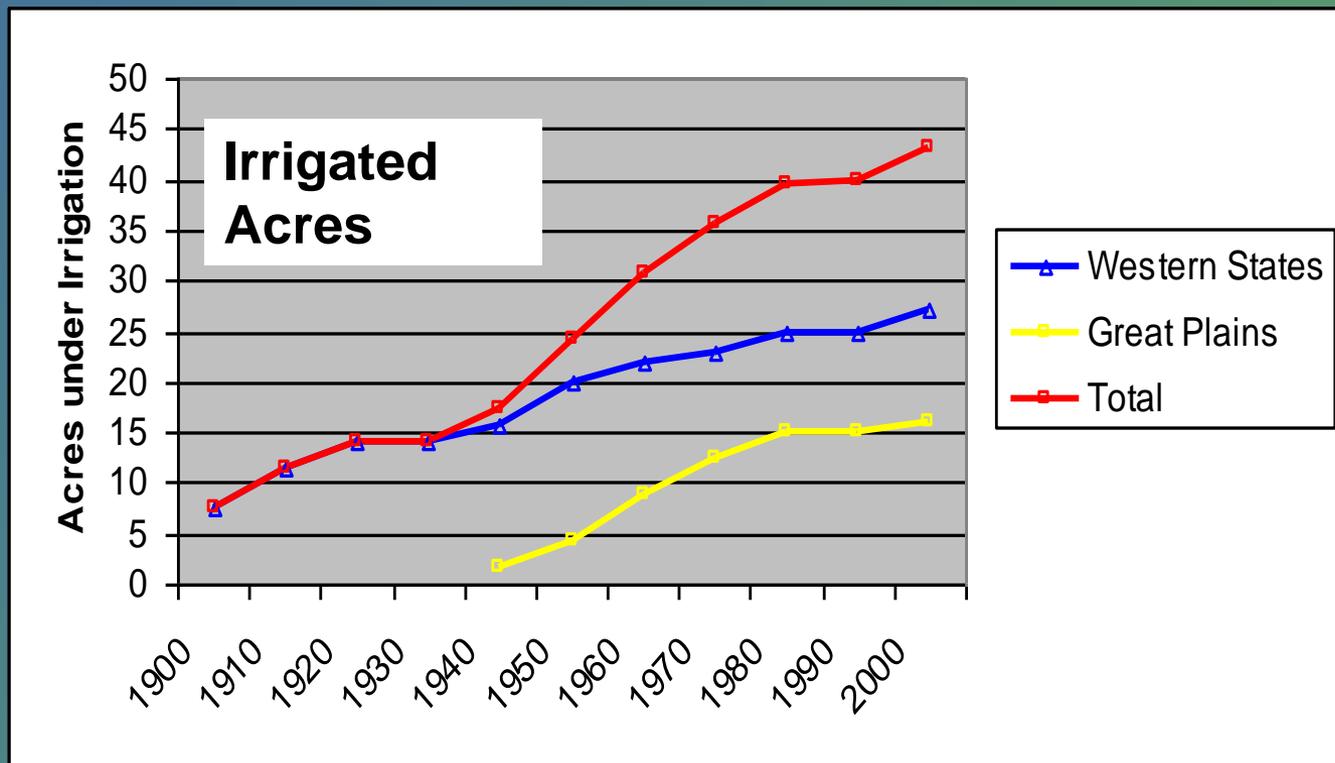
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional



## Irrigation also drove the migration of agriculture

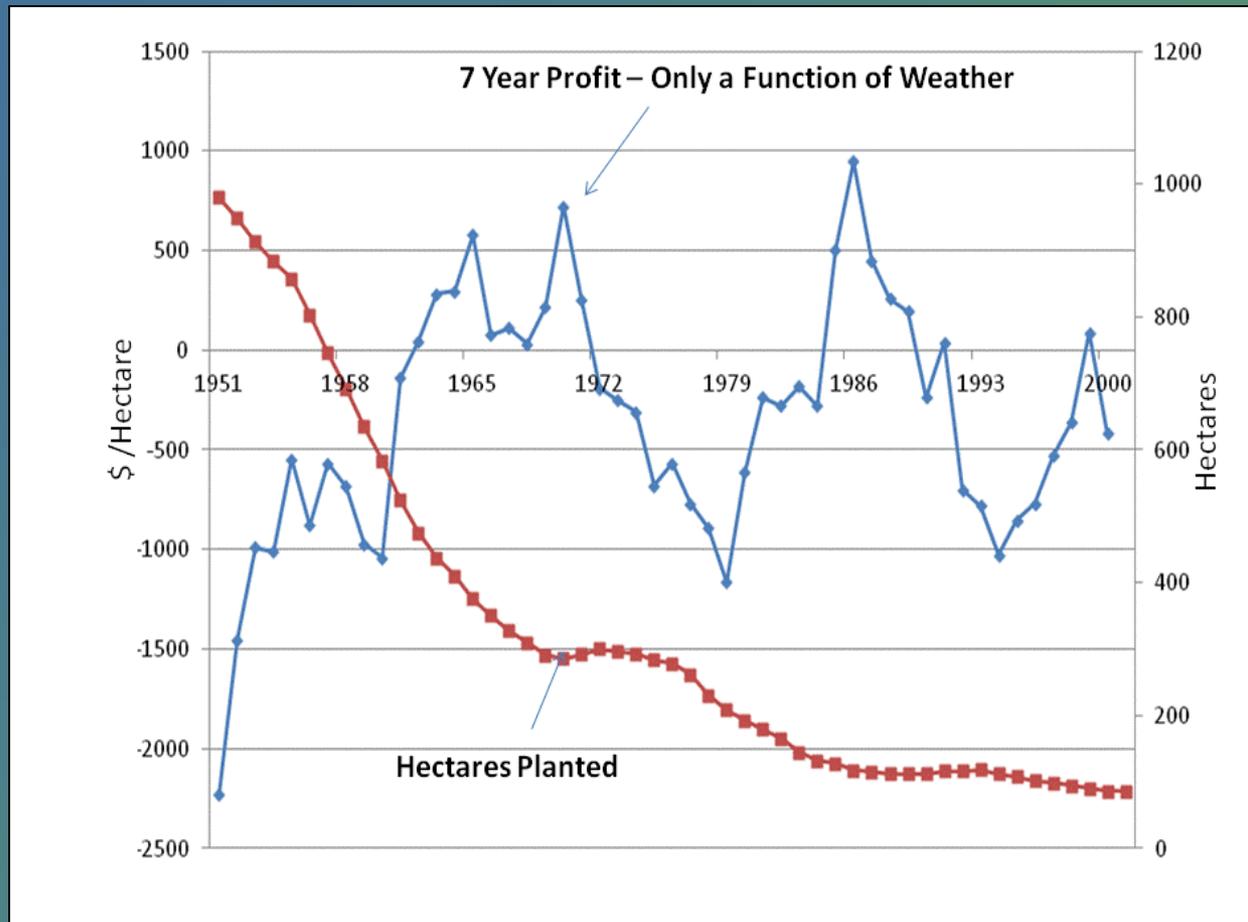
Potato production became concentrated in the Snake River Valley so that Maine, New York and Pennsylvania lost their production.

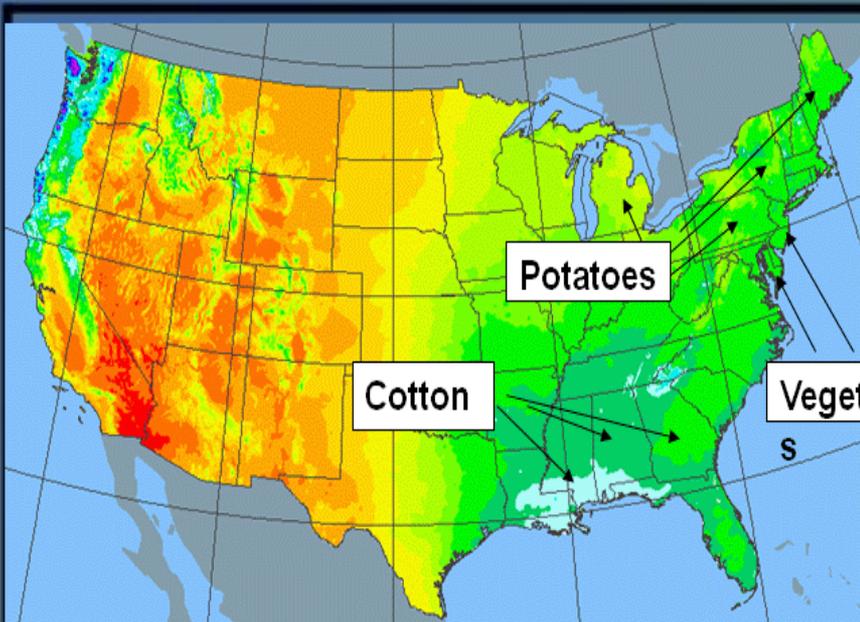
Irrigated cotton in California, New Mexico and Arizona drove Southern Cotton farmers out of business.



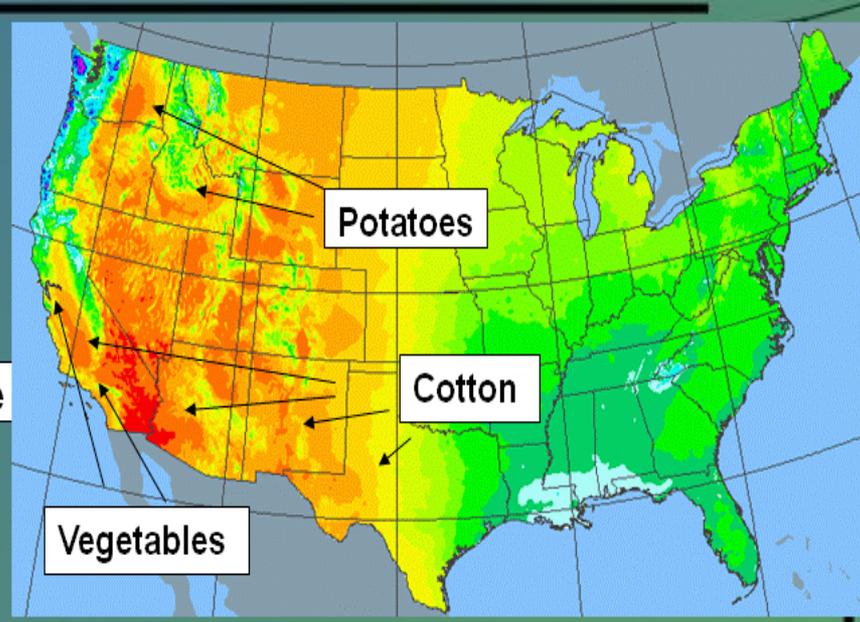


## Climate can totally change agriculture and society





**1930**



**2013**

The underlying map shows precipitation.

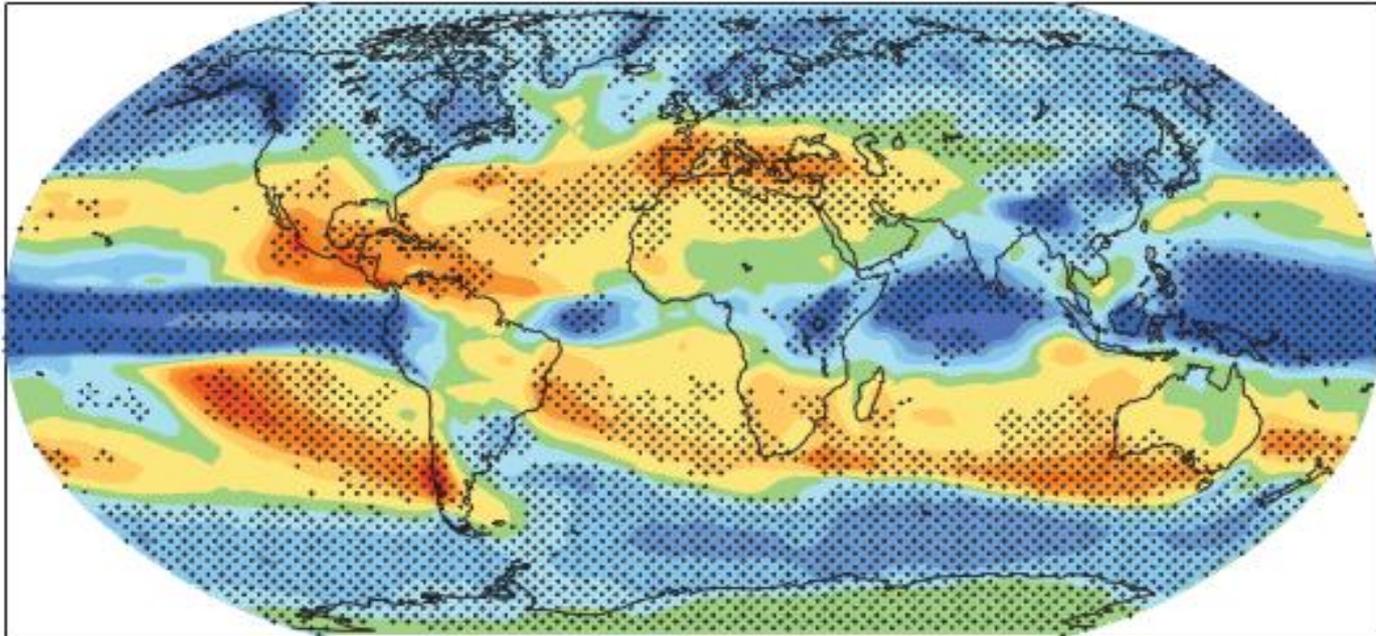
We have moved production away from the Nation's water



Agriculture  
Southeastern Irrigation

Aggregate of climate models predict drying in the Southern High Plains and Southwest but no change or an increase in precipitation in the SE.

a) Precipitation



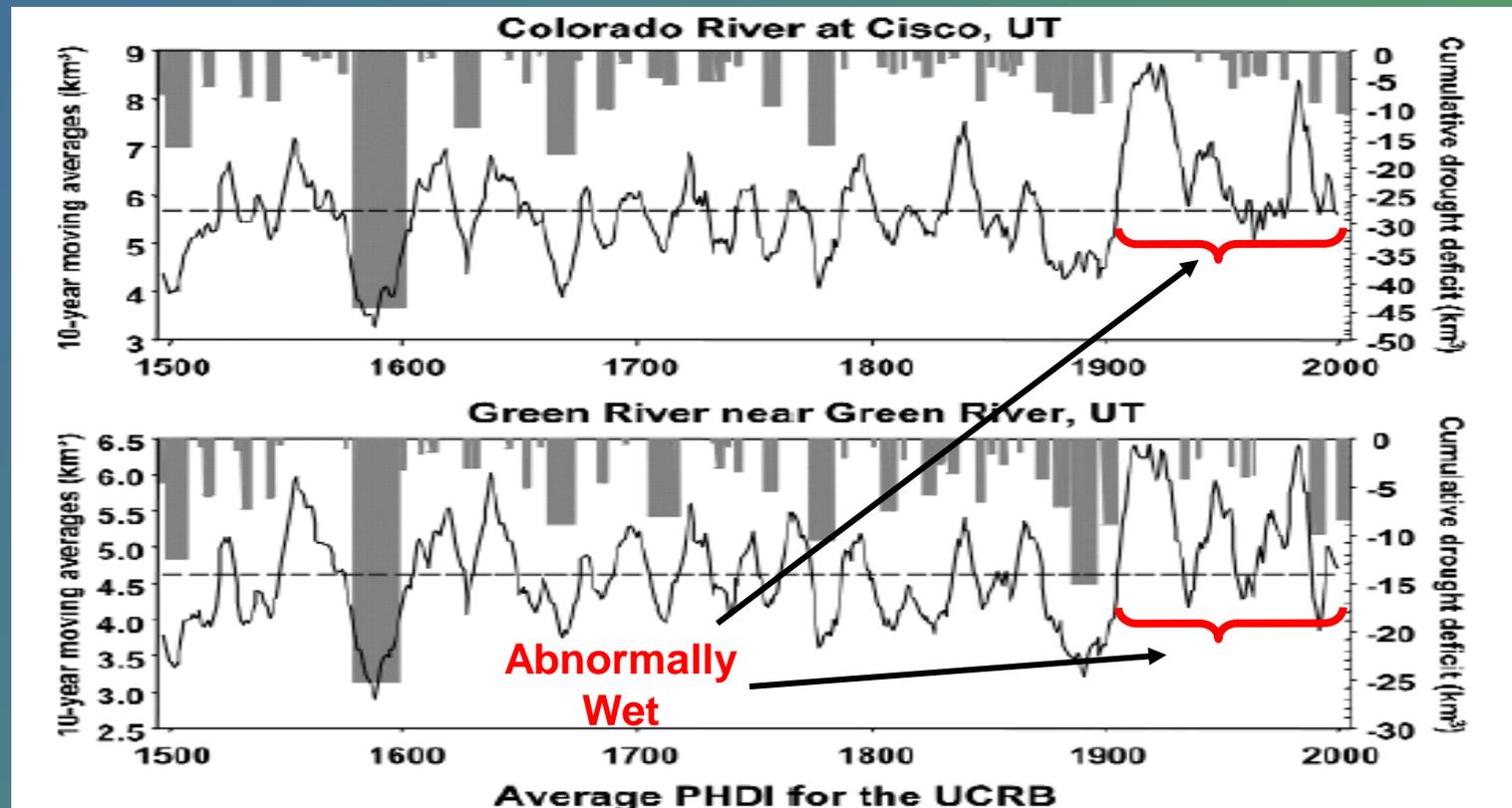
From IPCC 2007



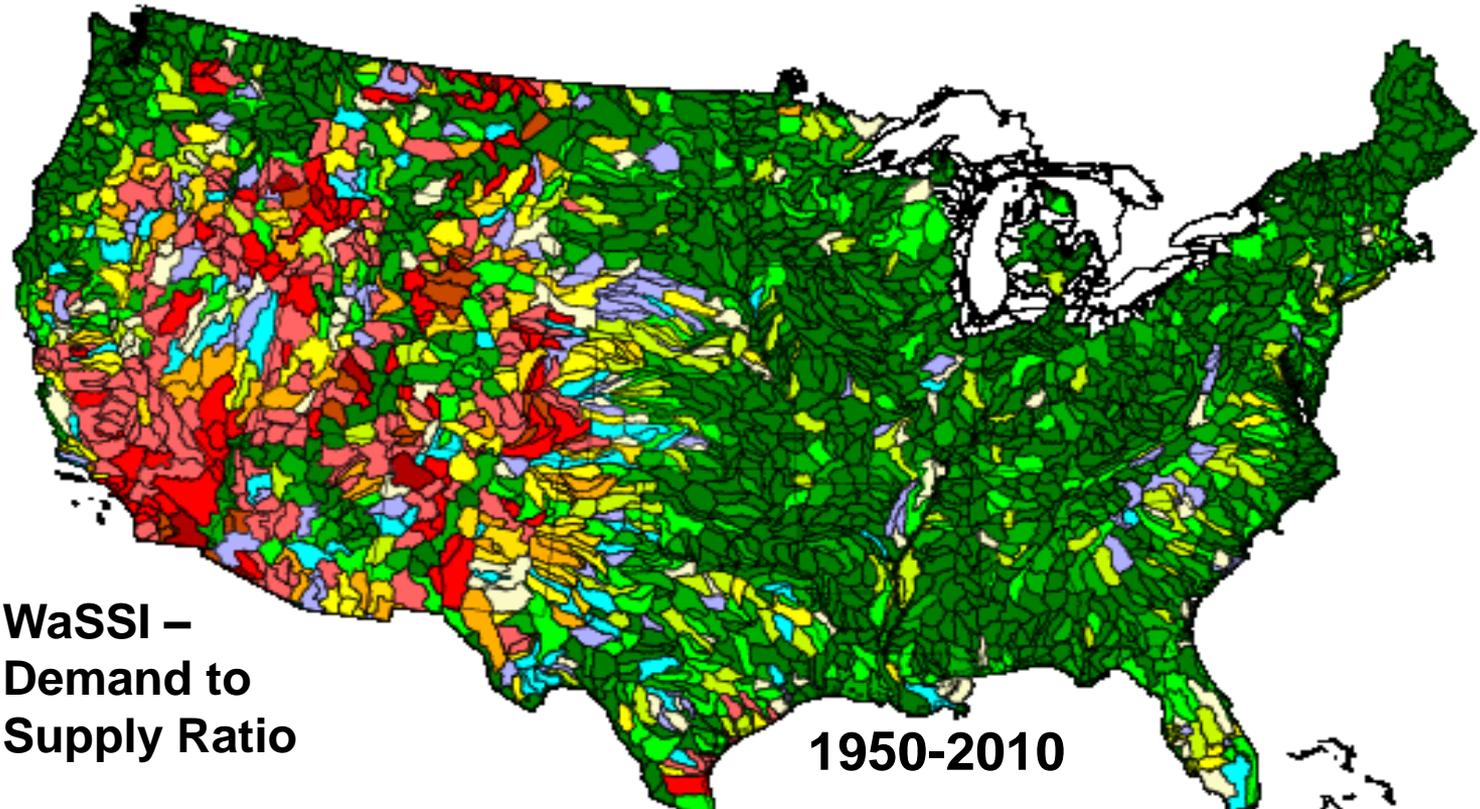
# Even if anthropogenic climate change does not occur the West may be in trouble.



Recent reconstruction of climate indicate that the past 70 years may have been abnormally wet and future supply could be much less.

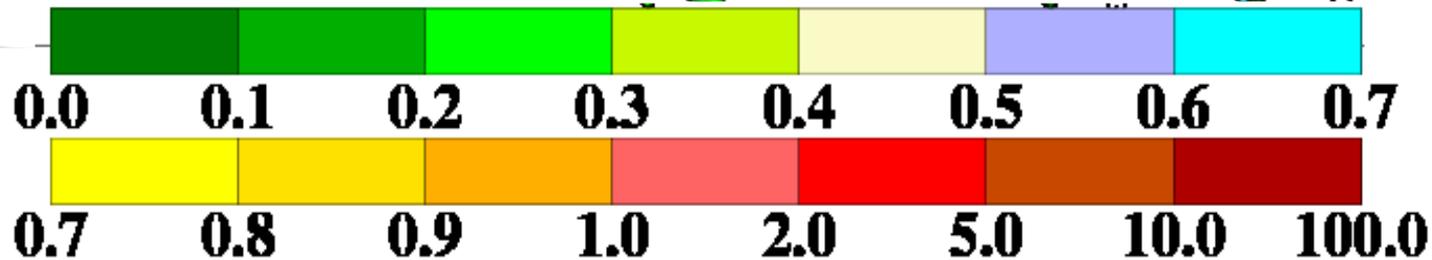


# Considering all uses of water – the Eastern U.S. has far more available water



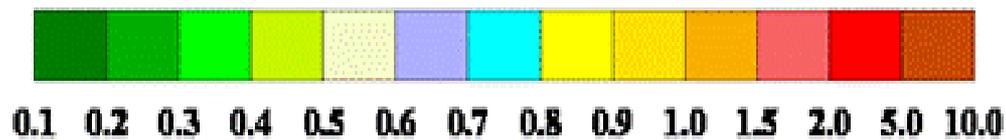
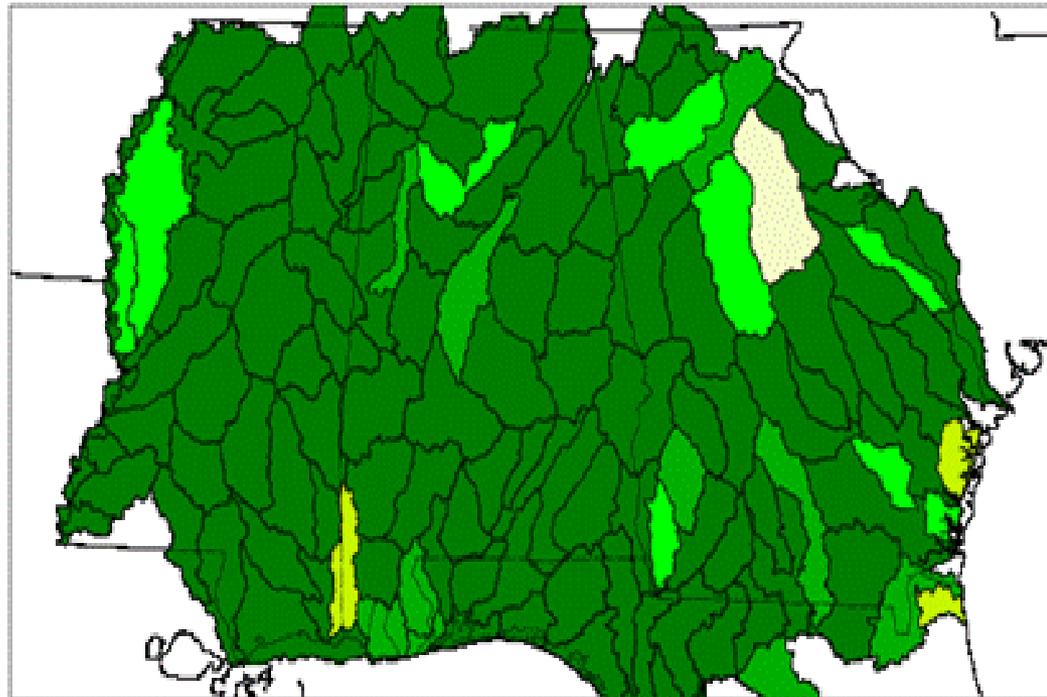
**WaSSI –  
Demand to  
Supply Ratio**

**1950-2010**

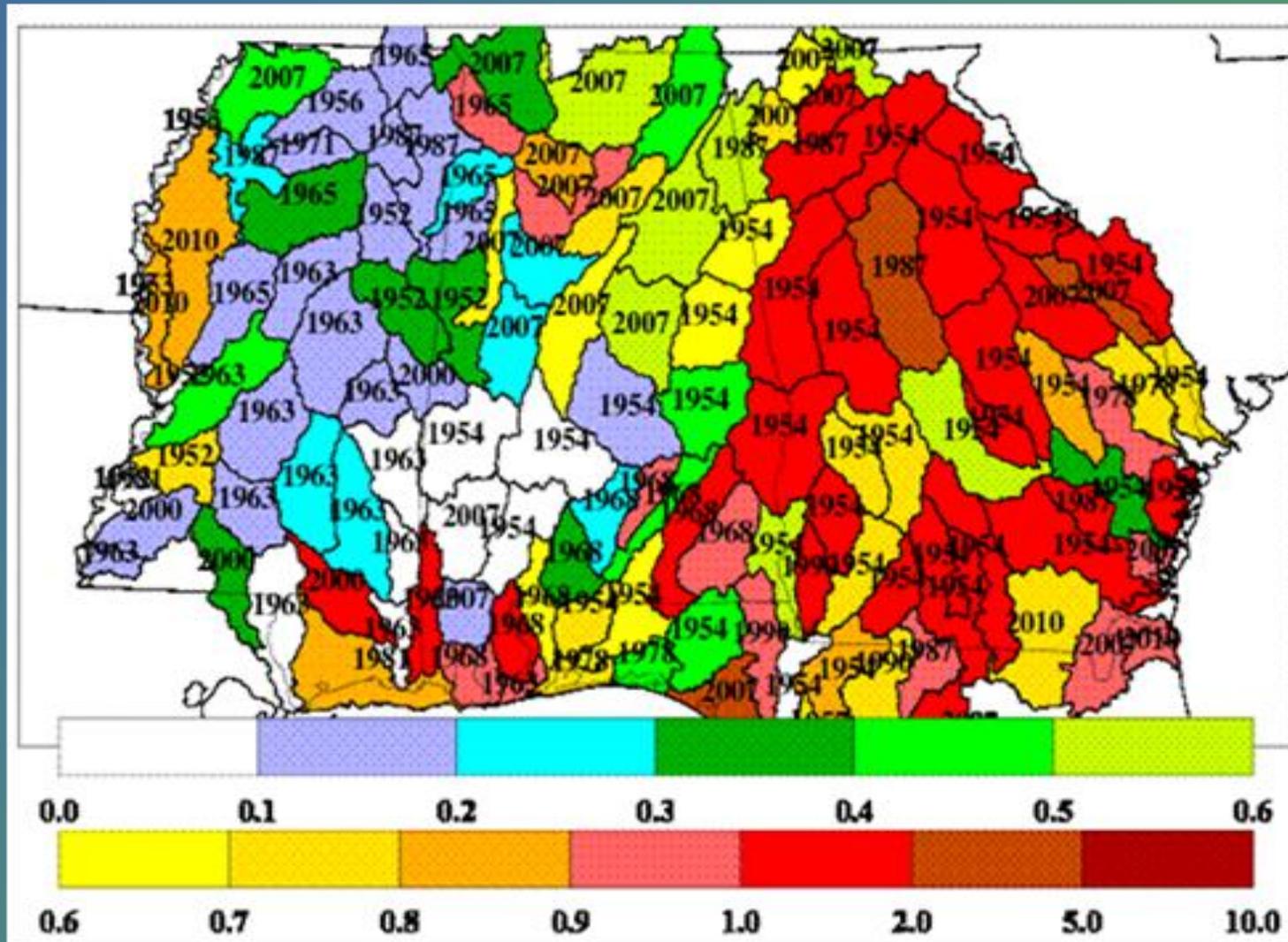


re  
on

## Mean Demand to Supply Ratios – 1950-2010

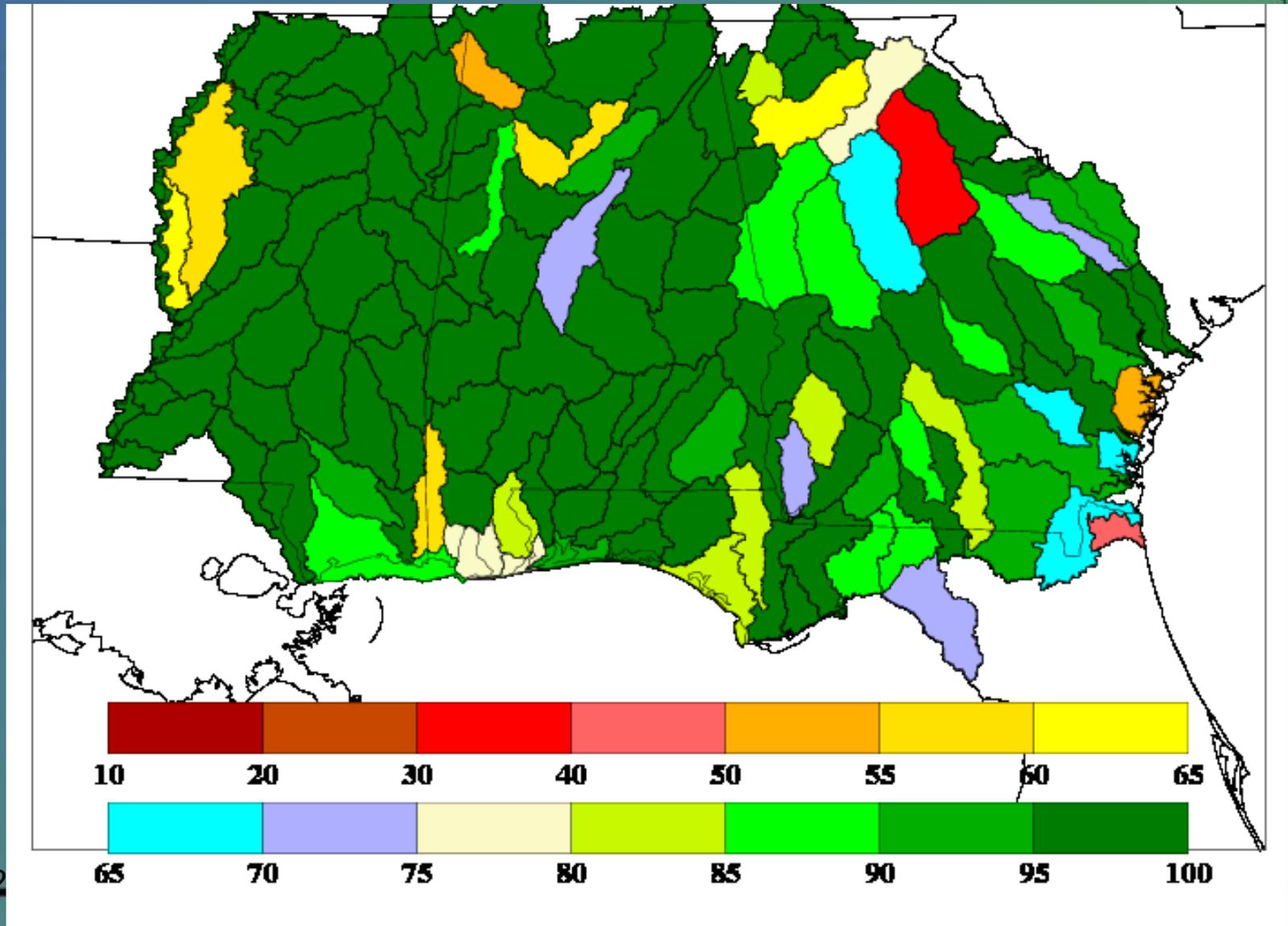


# Maximum Demand to Supply Ratios and Year (1951-2010)



Southeastern Irrigation

# % Time WaSSI Less Than .40 (1951-2010)





***The challenge for water resource management in the Southeast is to avoid policies that restrict water use during the majority of times that water resources are not stressed trying to protect the resource the few times when extreme droughts do strain water availability.***

**Rather than not letting farmers access water at all let them have access to water during most years and only restrict withdrawals during extreme hydrological drought occurring once every 12-20 years.**

**Historical data can be used to set actuarial rates for water insurance.**

It is our opinion that the nation cannot continue to subsidize desert agriculture to support low value high water use crops such as cotton, corn and alfalfa. The value of water in the west is vastly overvalued relative to what can equivalently be derived from eastern agriculture.



The recent DOI agreement on allocation of Colorado River water included a requirement to line the American canal at a cost of \$200 million which will save 77,000 acre-ft per year. This would equivalently serve **20,000** irrigated acres.

In Alabama \$200 million would build on- farm storage for 300,000 acre-ft which would support **300,000-600,000** acres of irrigated land.



The efficiency of SE irrigation infrastructure costs is 10 to 1 better than California

The Temperance Flat Dam Project has been proposed as a solution to catch more water in the San Joaquin Basin near Fresno, CA. The cost of this project is estimated to be \$2.0 billion. It would add 180,000 acre-ft of additional storage which would serve up to **60,000** irrigated acres.

In the Southeast this \$2 billion would add over nearly a million acre-ft of storage and support over **a million** acres of irrigated land.

# We need tax incentives and investment in irrigation infrastructure in the East.



Farm Bill language to build on-farm reservoirs introduced by Sen. Sessions and Cog. Everett



Irrigation Tax Credit bill with water protection language passed and signed by Governor

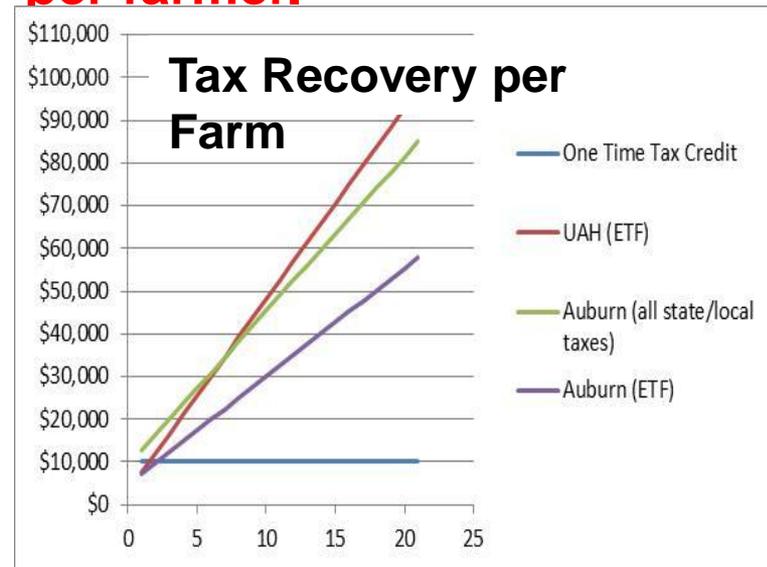


# Tax Recovery of Irrigation Tax Credit Bills

In 2011 an Irrigation Investment Tax Credit Bill was introduced by Sen. Orr and Rep. Fincher and in 2012 an amended bill by Sen Orr and Rep. Booth to extend the time the tax credit could be used was introduced. Both pass quickly and were signed into law by Gov. Bentley.

Based on information obtained by ALFA from the Department of Revenue , UAH and Auburn University performed two independent analyses of the payback to the State. This was based on the added economic benefit and taxes of construction of the irrigation systems and the continued return of increased tax revenue due to enhanced production and profit.

**In 2011 and 2012 156 farmers claimed the tax credit for a total credit of \$719,000 or about \$4600 per farmer.**



**In summary the State is paid back the tax credit almost immediately and over twenty years the State gains a total of 9-15 million in increased tax revenue to the Educational Trust Fund**