



# Are We Doomed?

*An optimist's guide to how research and policy can reduce the harmful effects of climate change, protect Wisconsin's landscapes, and grow the economy*

**Ankur Desai**

**Dept of Atmospheric & Oceanic Sciences  
University of Wisconsin-Madison**

Image: 20<sup>th</sup> Century Fox

**UW-LaCrosse**

Three things about me

# Three things about me

- I was born and raised in New Jersey



PHILLYSKYLINE.COM : ATLANTIC CITY FROM



©2005 WrmLiu

# Three things about me

- I was born and raised in New Jersey
- I live in Madison with my wife and three daughters



# Three things about me

- I was born and raised in New Jersey
- I live in Madison with my wife and three daughters
- I am a climate scientist who has spent that past 2 decades studying how plants, climate, and weather all influence each other

# THE CENTER FOR CLIMATIC RESEARCH

THE NELSON INSTITUTE FOR ENVIRONMENTAL STUDIES | UNIVERSITY OF WISCONSIN-MADISON

ABOUT

CCR NEWS

RESEARCH

RESOURCES

SUPPORT CC

## Welcome to CCR

### Biogeochemistry

CCR researchers are investigating global and regional biogeochemistry, with a particular focus on the carbon cycle of the land biosphere, oceans and Great Lakes. Using data and models to elucidate natural carbon fluxes and the factors controlling them, and work to use this information to improve predictive models.



### Climate Impacts

### Land Surface Processes

### Oceanography and Limnology

### Past Climates



## Department of Atmospheric and Oceanic Sciences

### Who We Are

Since 1948 we have grown into one of the leading departments in our field of Atmospheric and Oceanic Sciences. We have strong graduate and undergraduate programs which are nationally recognized. We graduate about 15 Ph.D. and M.S. students each year; our graduates are active in research labs and universities around the world. We graduate approximately 20 B.S. students each year; they choose options allowing a focus on weather systems or general atmospheric science.

Our faculty of 15 has long maintained breadth and special strength in three areas:

- Climate systems, including the ocean
- Satellite and remote sensing
- Weather systems, including synoptic-dynamic meteorology

## North Temperate Lakes Long Term Ecological Research

Member of the US LTER Network

### Welcome to NTL-LTER



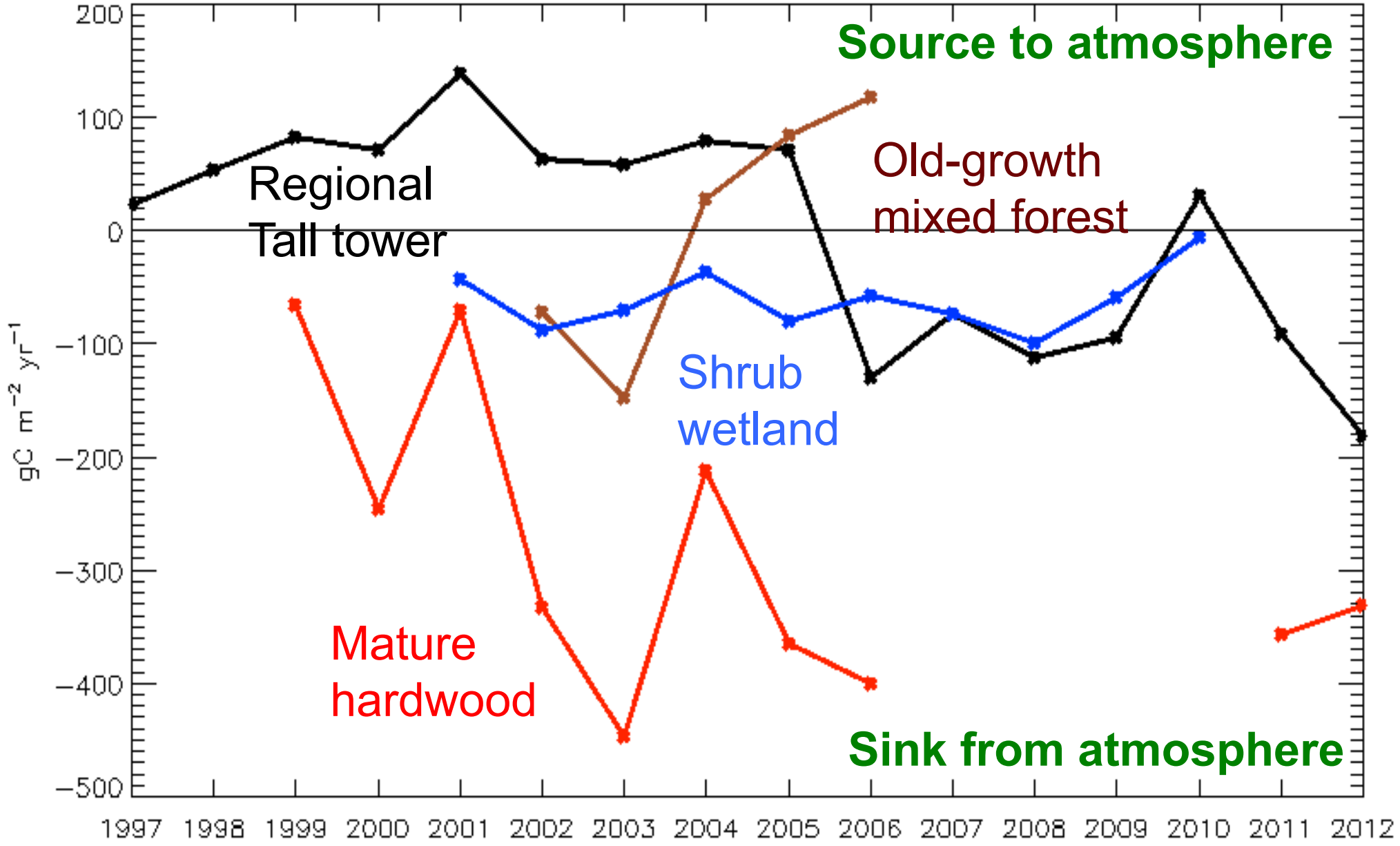
North Temperate Lakes sites established by the University of Wisconsin-Madison (and changing land use in the present, future).

Our primary study site is the Trout Lake Region, Wisconsin. Our primary study site is the Trout Lake Region, Wisconsin. Our primary study site is the Trout Lake Region, Wisconsin.





Annual NEE



Source to atmosphere

Regional Tall tower

Old-growth mixed forest

Shrub wetland

Mature hardwood

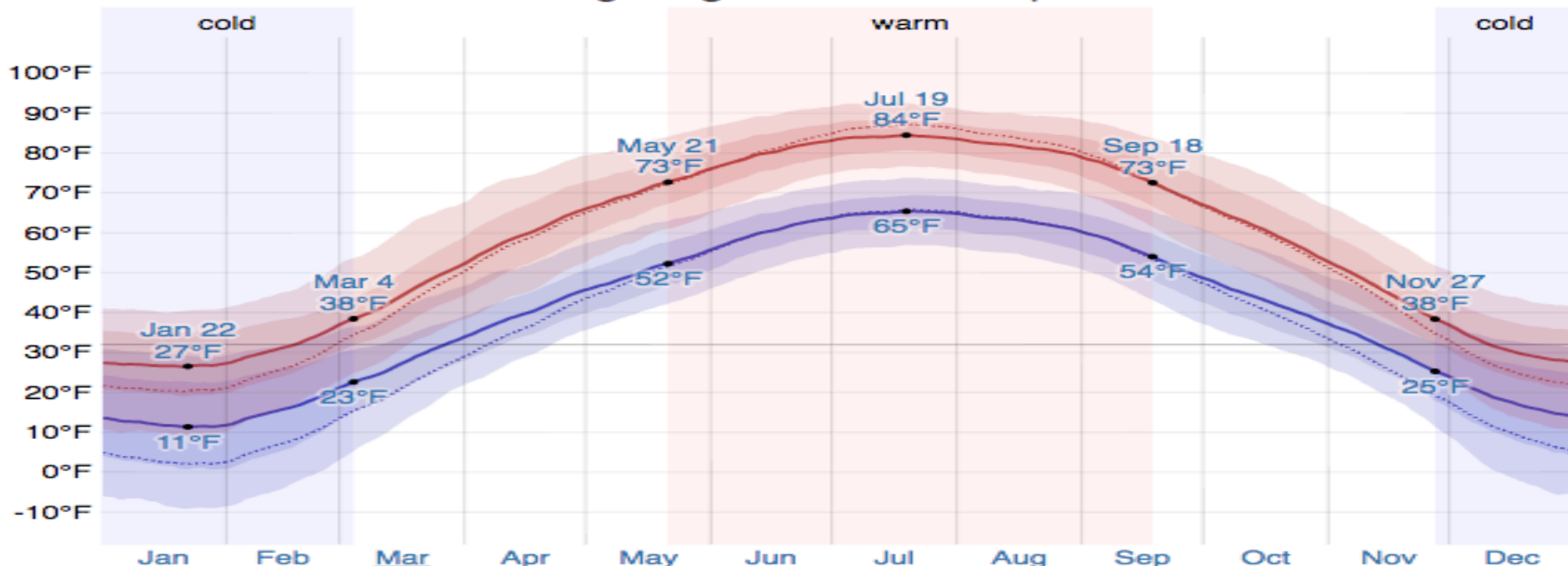
Sink from atmosphere

# Three things about climate

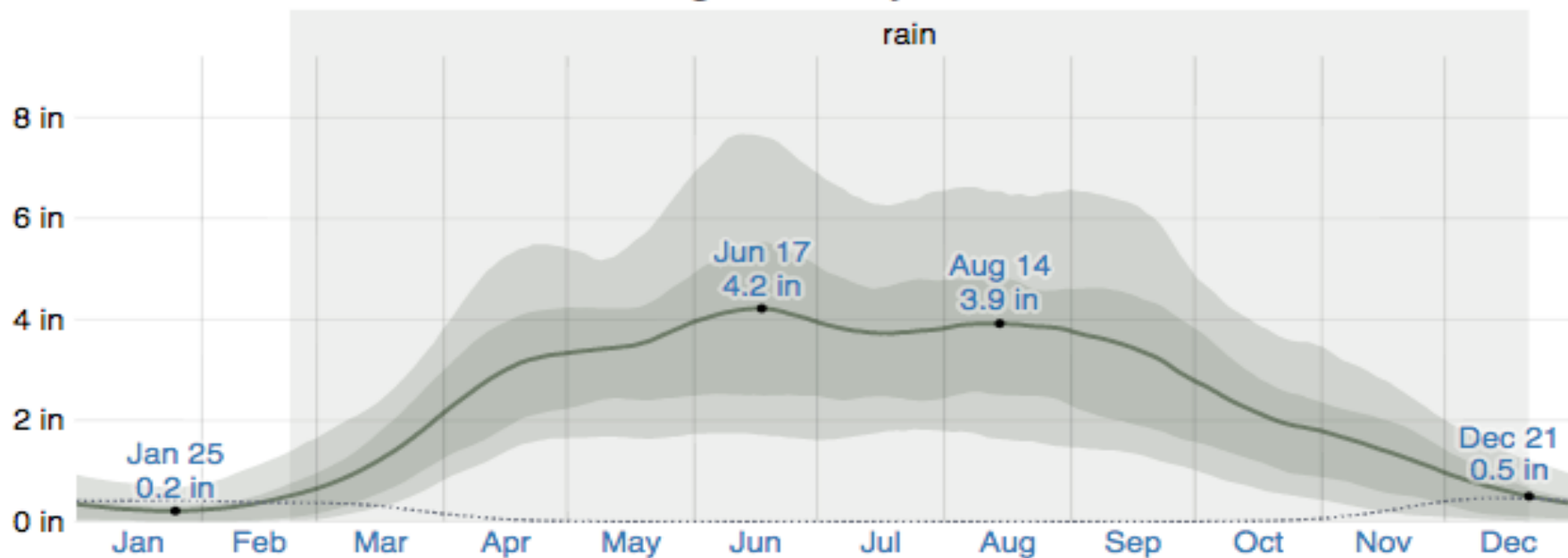
# Three things about climate

- Climate is the average of weather

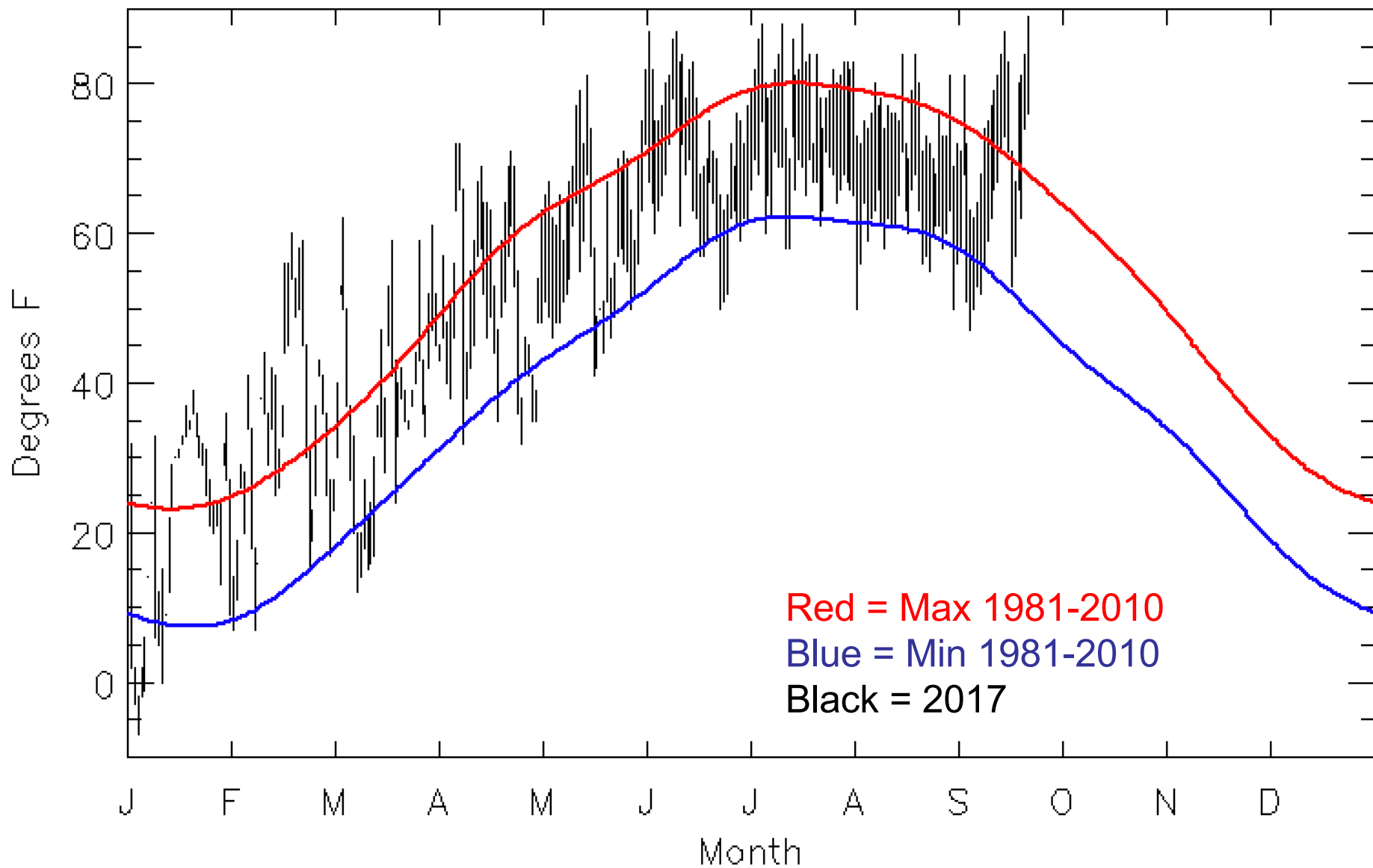
### Average High and Low Temperature



### Average Monthly Rainfall



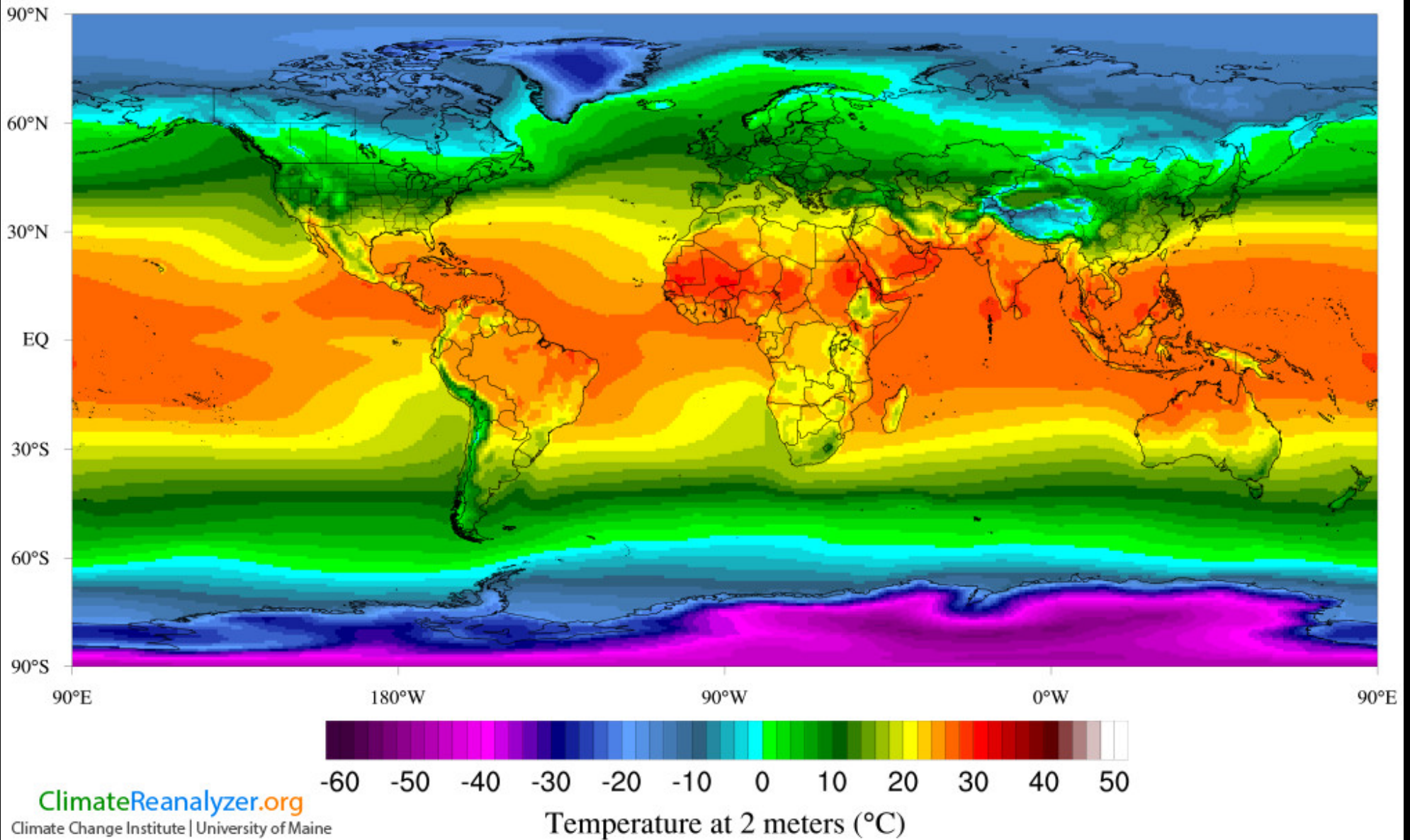
# LaCrosse, WI temperature



Red = Max 1981-2010  
Blue = Min 1981-2010  
Black = 2017

ECMWF ERA-Interim

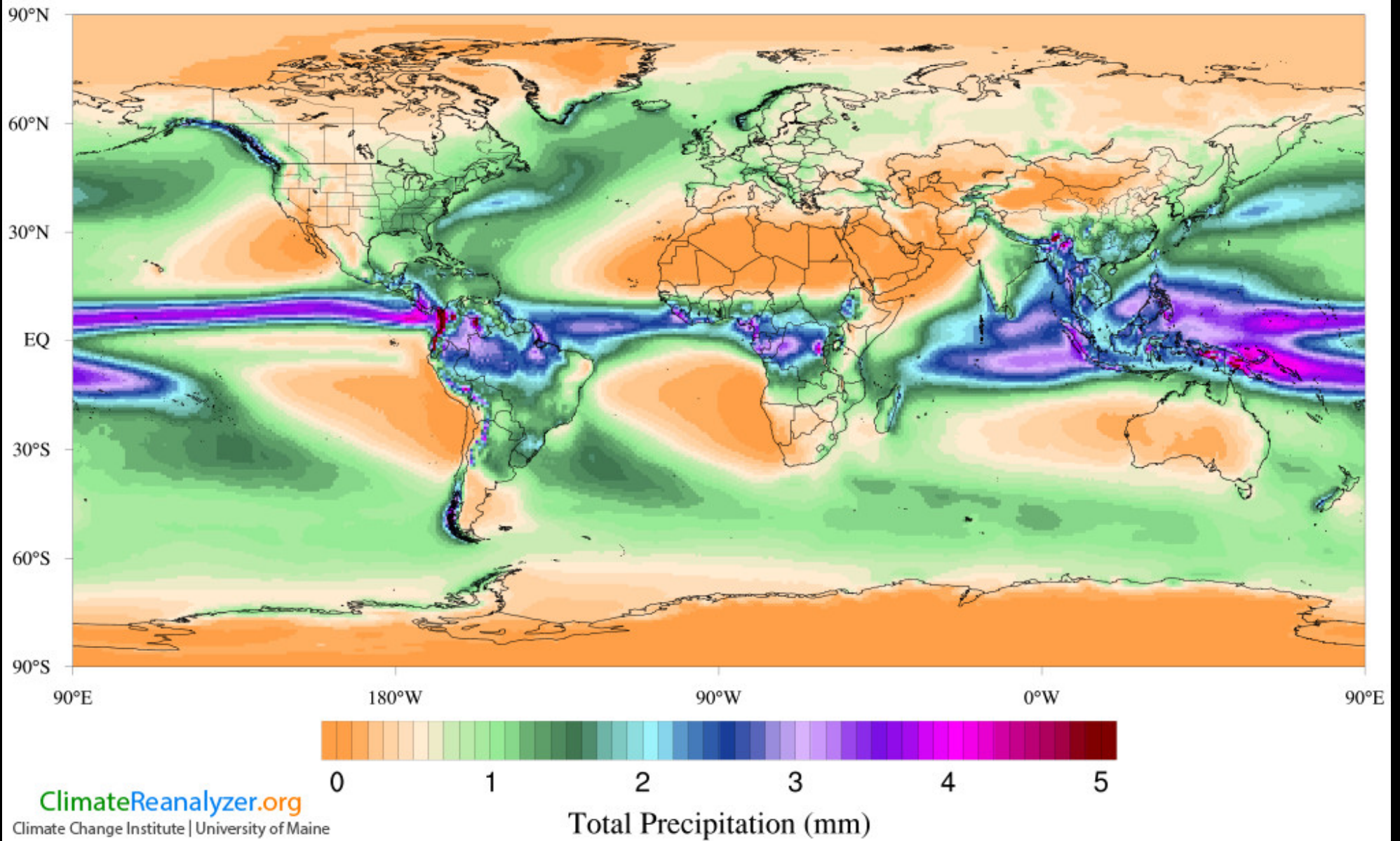
Annual 1979-2013



<http://cci-reanalyzer.org/>

ECMWF ERA-Interim

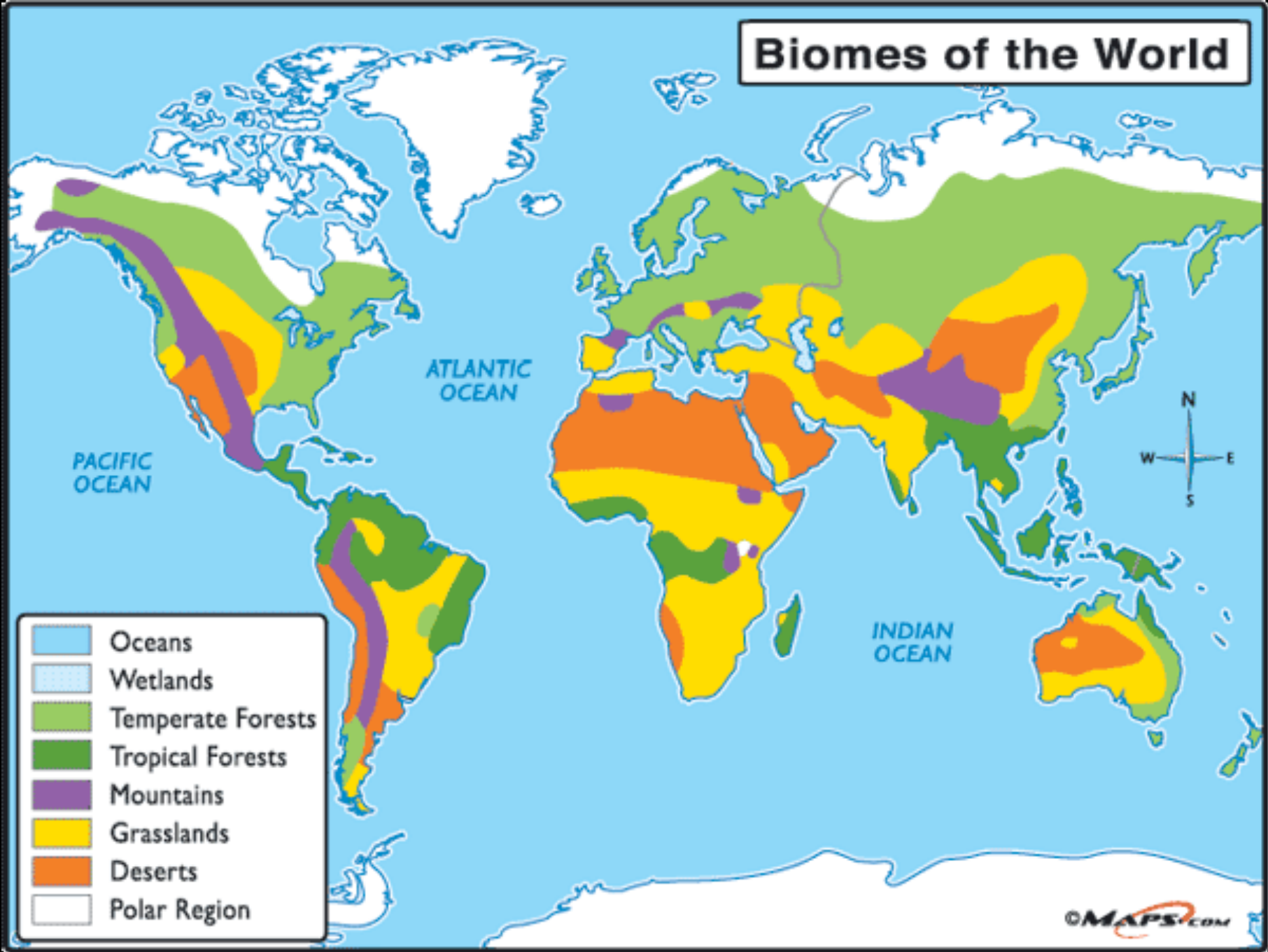
Annual 1979-2013



<http://cci-reanalyzer.org/>



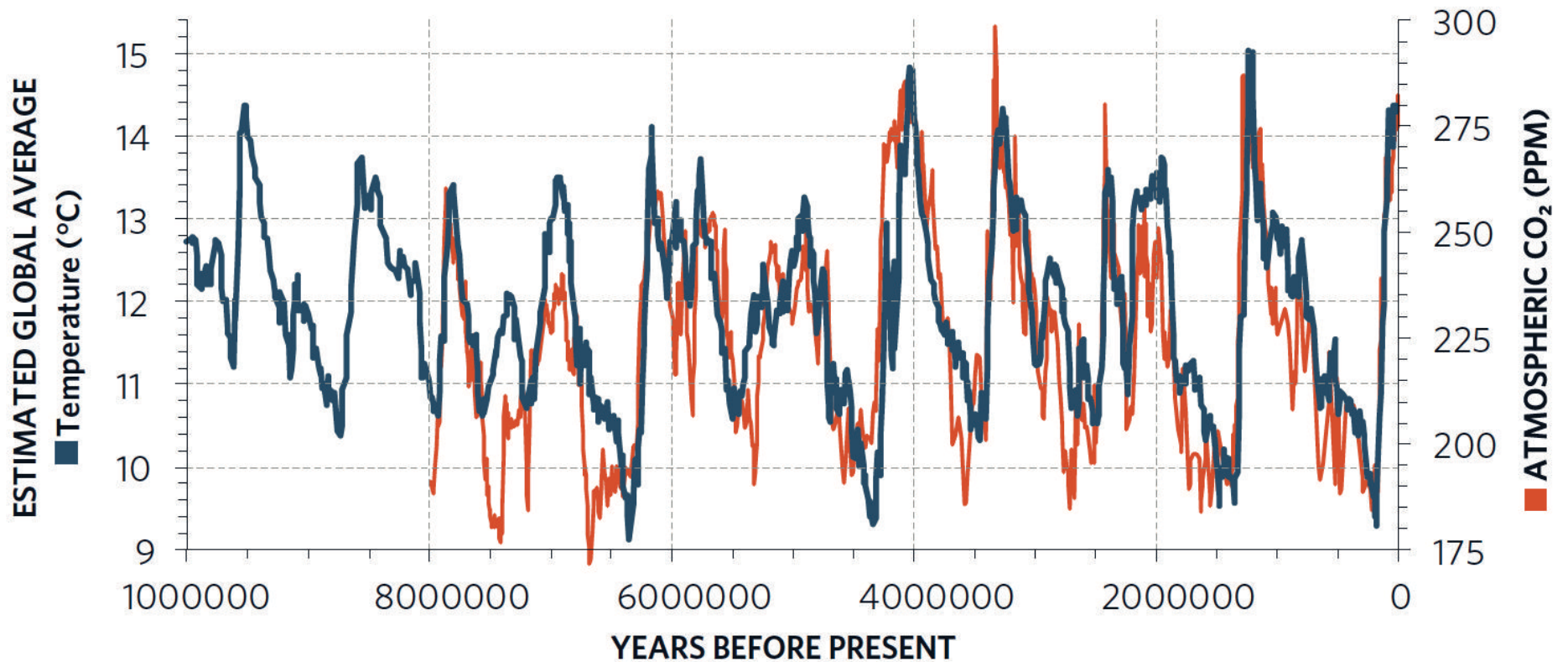
# Biomes of the World



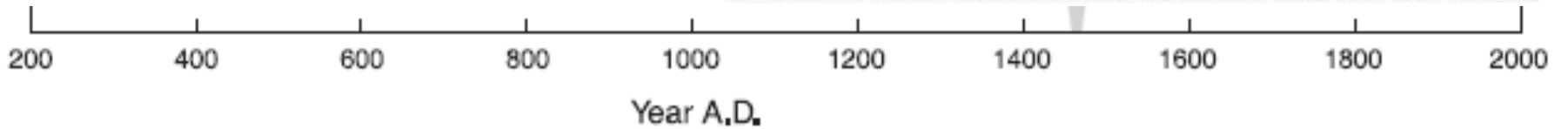
# Three things about climate

- Climate is the average of weather
- Climate changes naturally

# AVERAGE GLOBAL SURFACE TEMPERATURE AND ATMOSPHERIC CO<sub>2</sub>



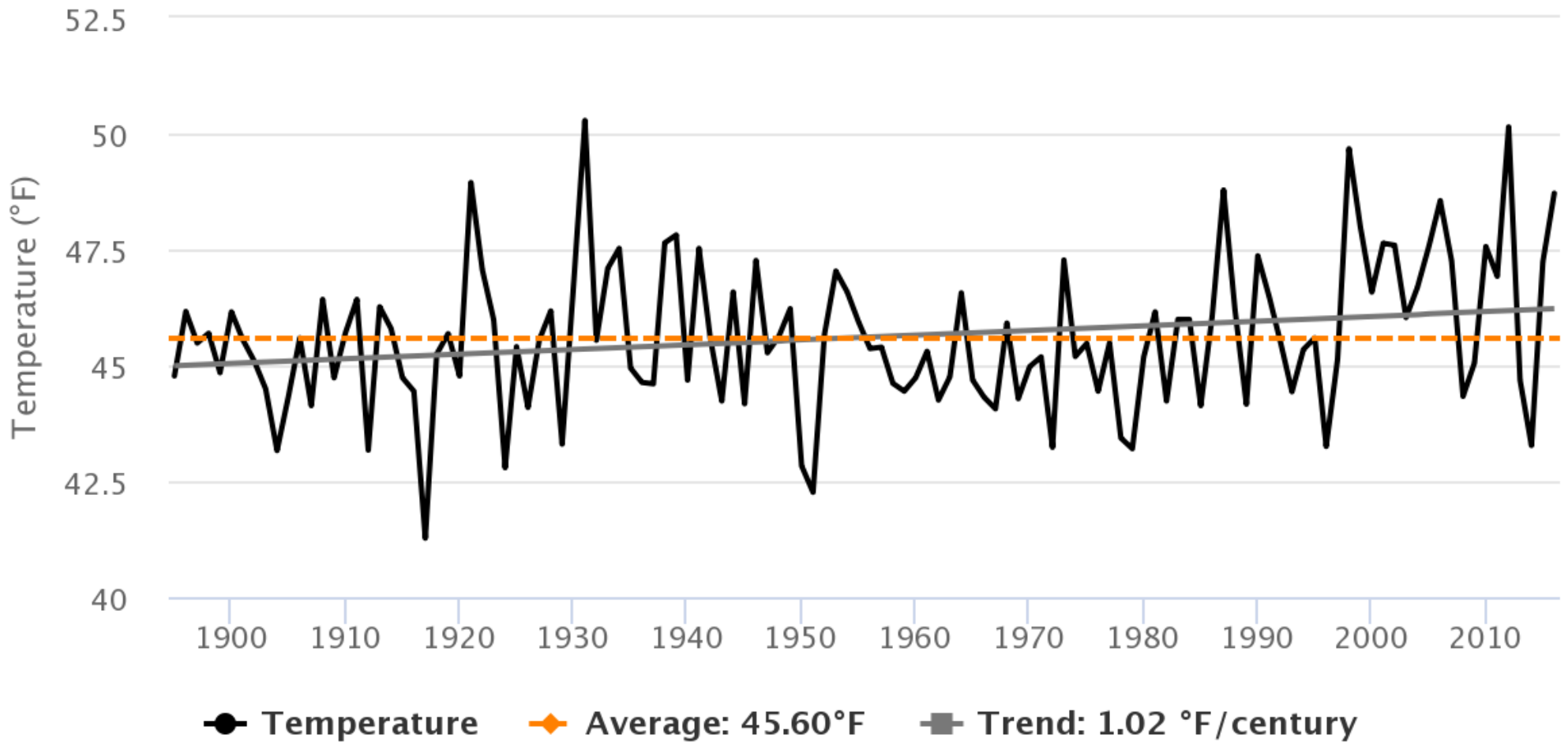
TEMPERATURE DATA: ZACHOS ET AL., 2001 TRANSFORMED AS IN HANSEN & SATO, 2012; CO2 DATA: LUTHI ET AL., 2008



# SW Wisconsin

## WI07 Annual Temperature based on 1895–2016

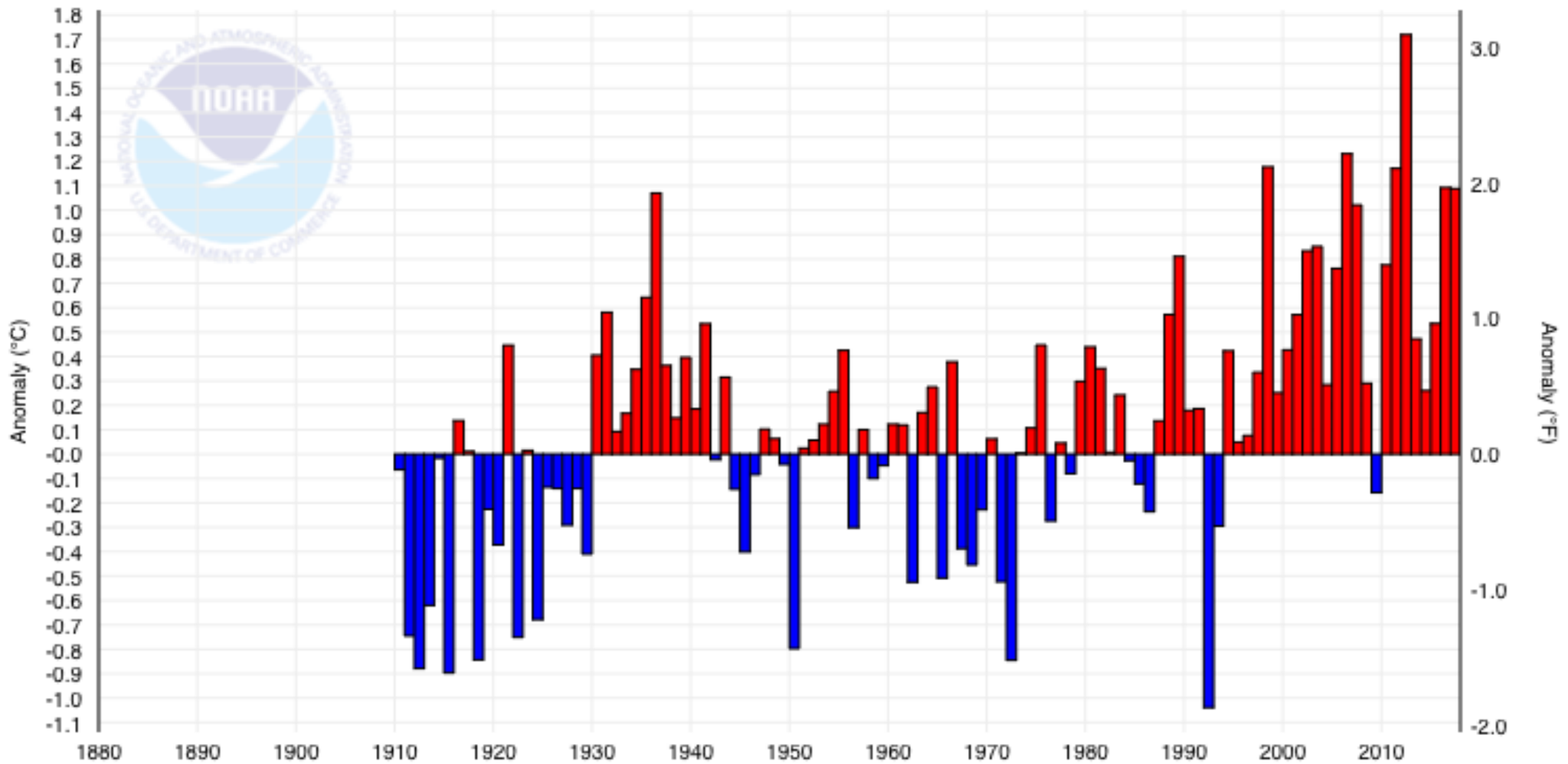
Midwestern Regional Climate Center



Click and drag to zoom

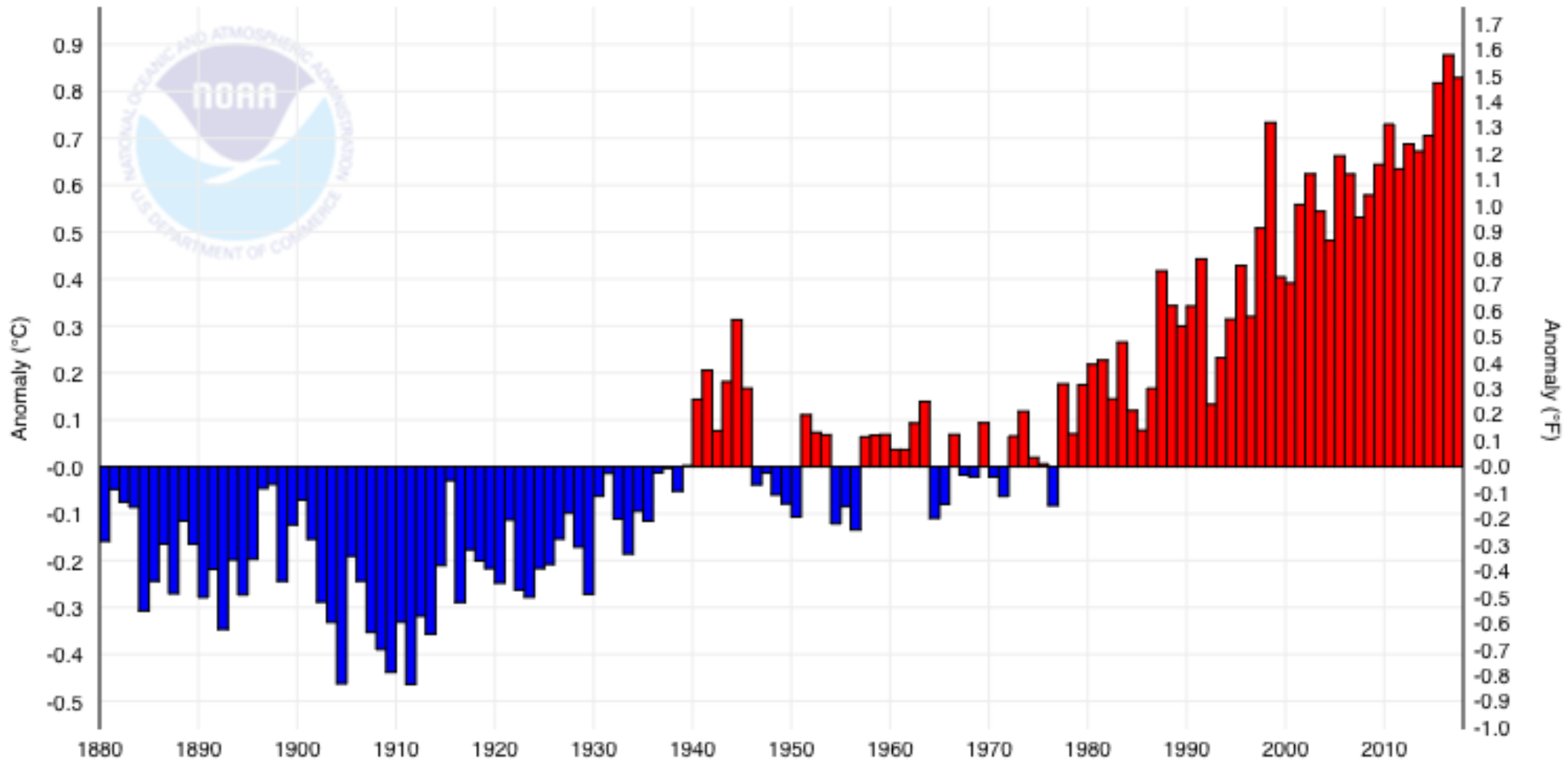
# N America

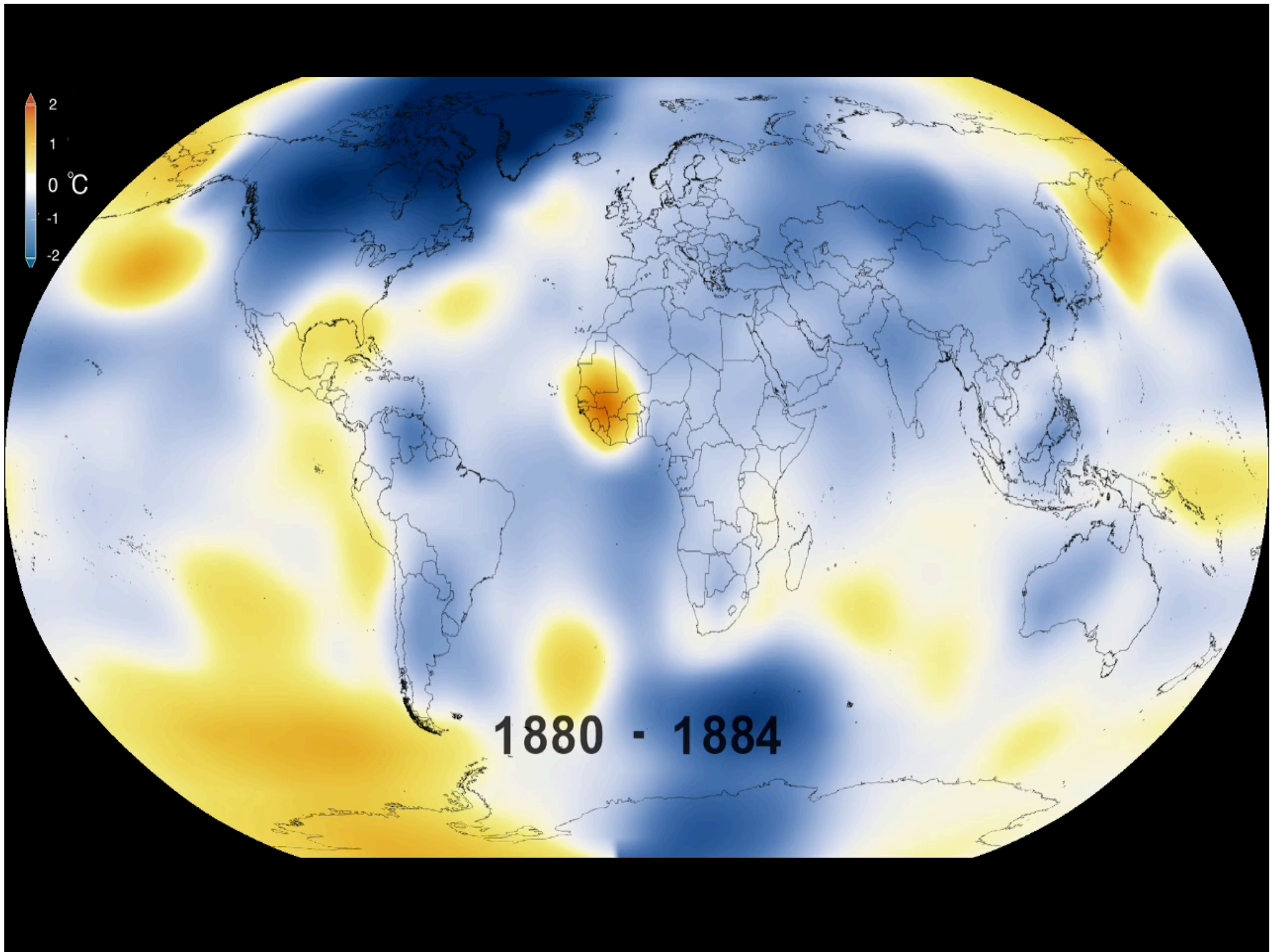
North America Land Temperature Anomalies, July



# WORLD

Global Land and Ocean Temperature Anomalies, July

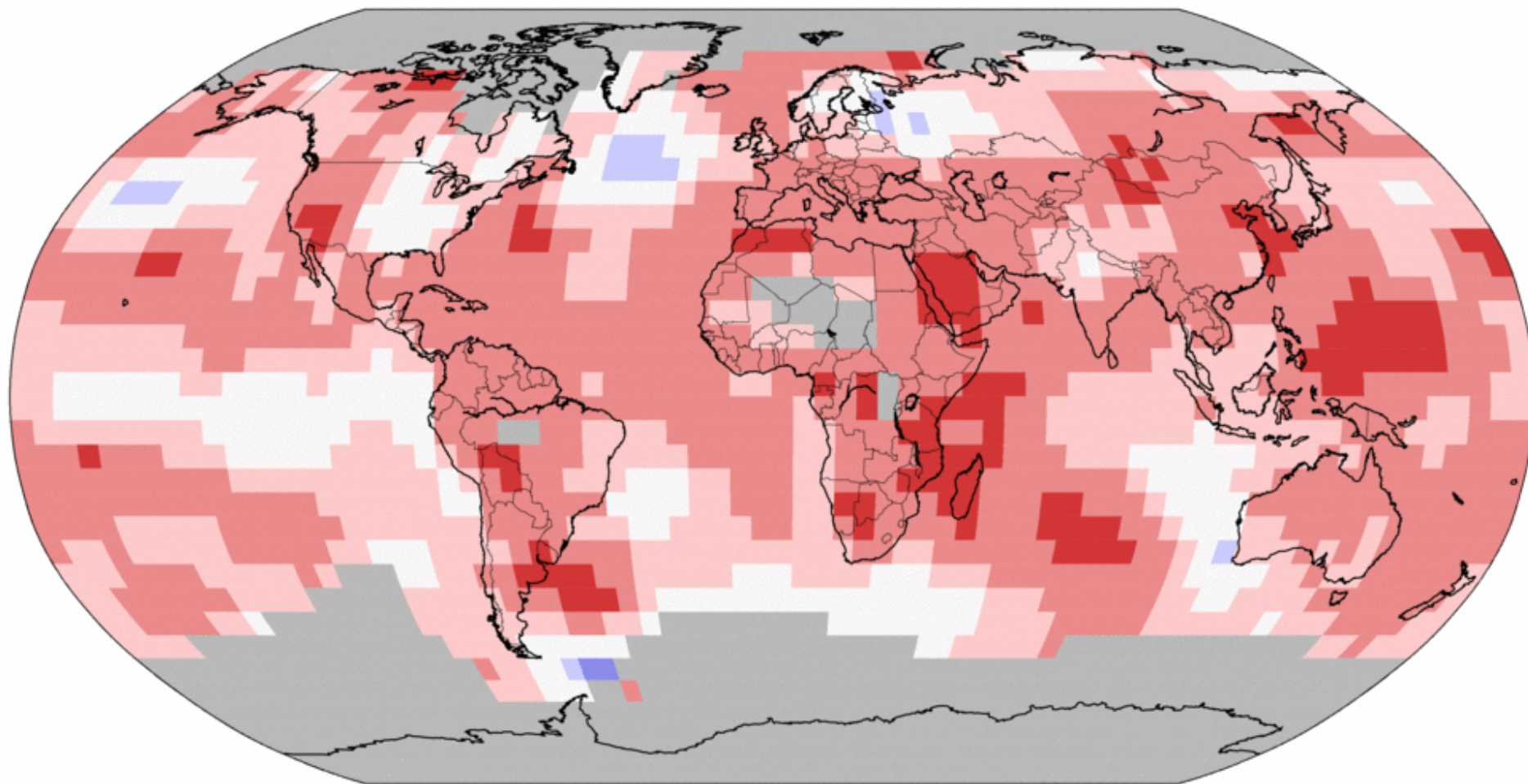




# Land & Ocean Temperature Percentiles Jun 2017–Aug 2017

NOAA's National Centers for Environmental Information

Data Source: GHCN-M version 3.3.0 & ERSST version 4.0.0



  
**Record  
Coldest**

  
**Much  
Cooler than  
Average**

  
**Cooler than  
Average**

  
**Near  
Average**

  
**Warmer than  
Average**

  
**Much  
Warmer than  
Average**

  
**Record  
Warmest**



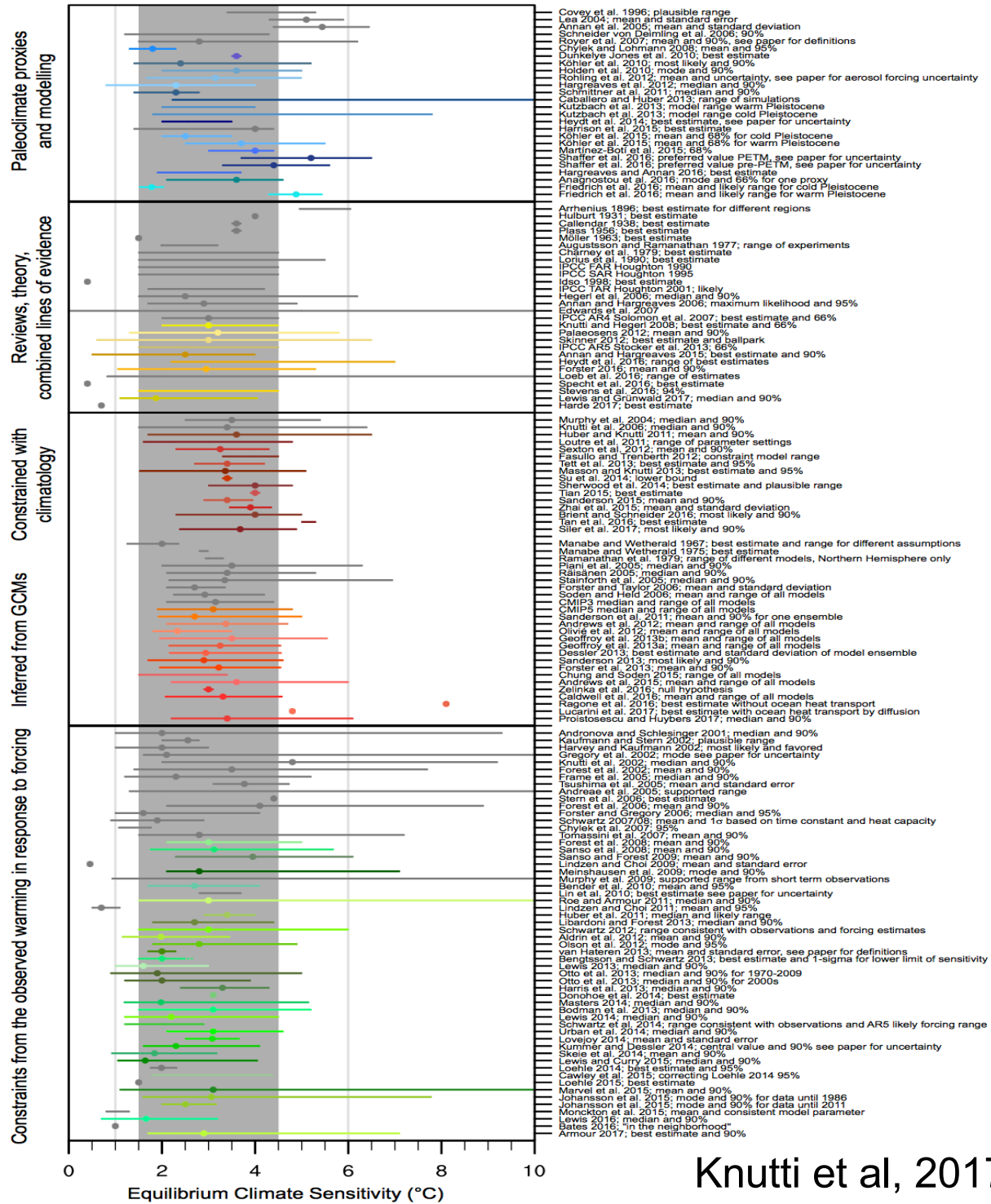


# Three things about climate

- Climate is the average of weather
- Climate changes naturally
- The study of climate change is well-established. We know how climate changes and what's is mostly causing current change



In model  
determined  
from the



ature is  
energy

e.

Hotter

## What's Really Warming the World?

Skeptics of manmade climate change offer various natural causes to explain why the Earth has warmed 1.4 degrees Fahrenheit since 1880. But can these account for the planet's rising temperature? Watch to see how much different factors, both natural and industrial, contribute to global warming, based on findings from NASA's Goddard Institute for Space Studies.

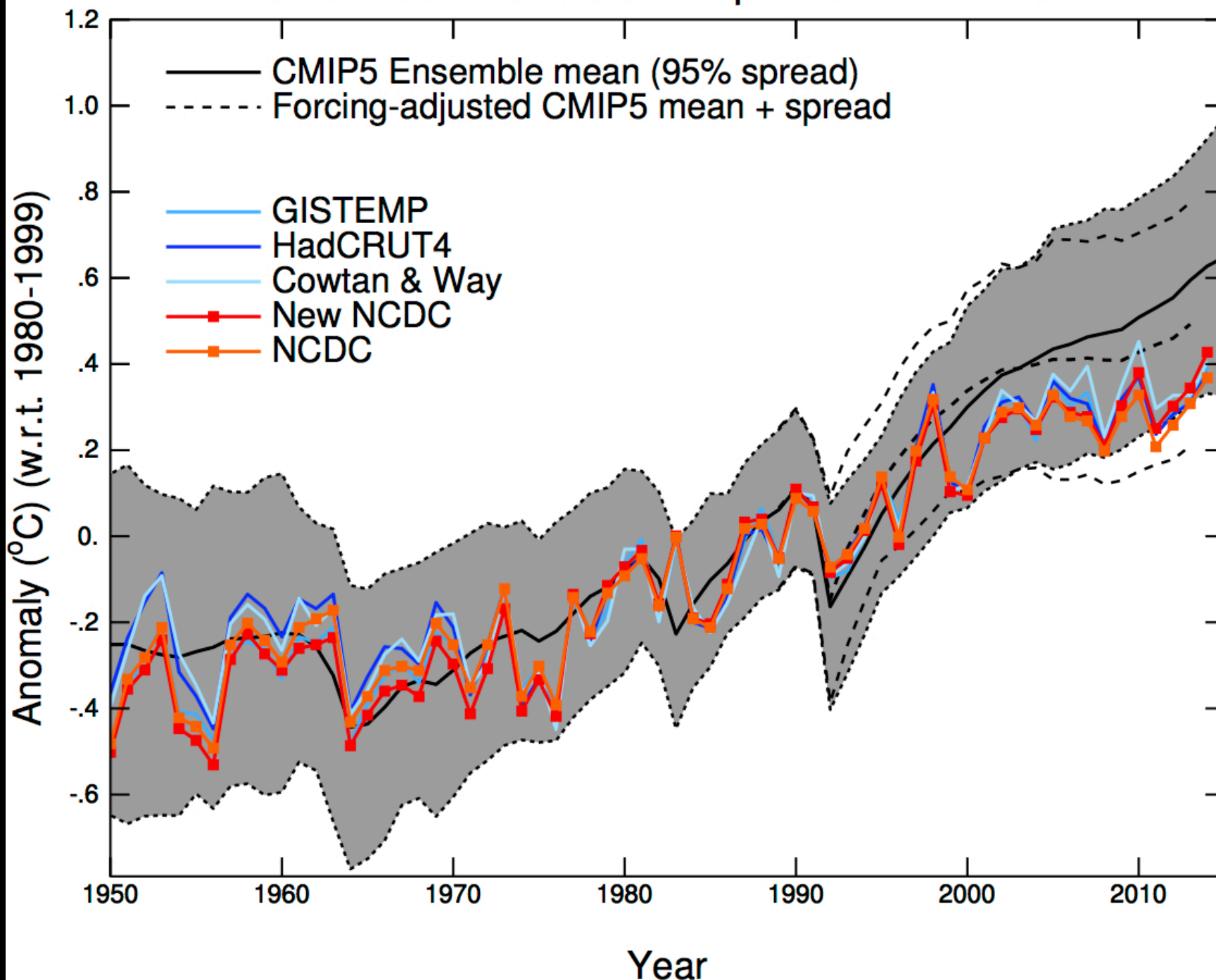
Colder

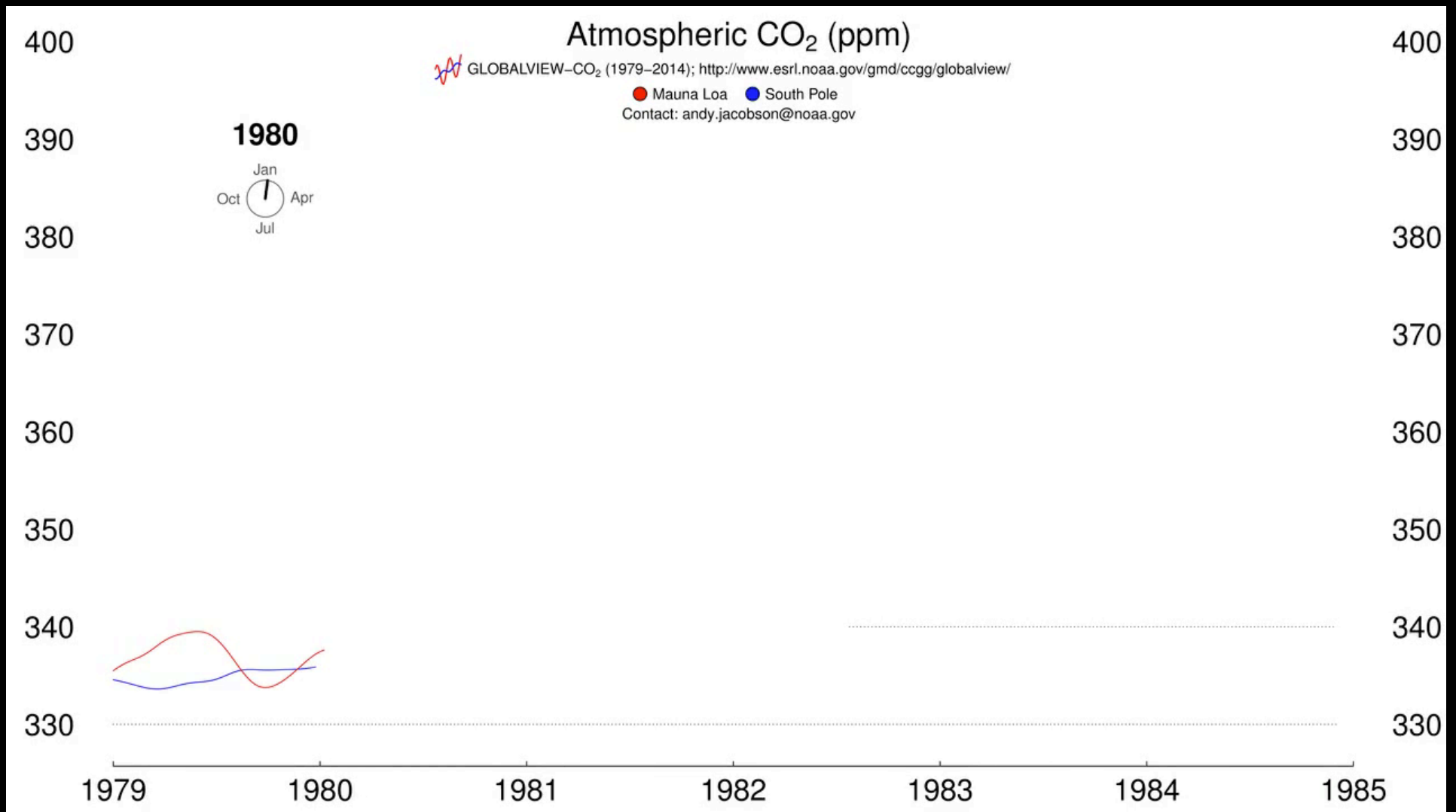


Based on an interactive by Bloomberg

Bloomberg

# Global Mean Surface Temperature Anomalies



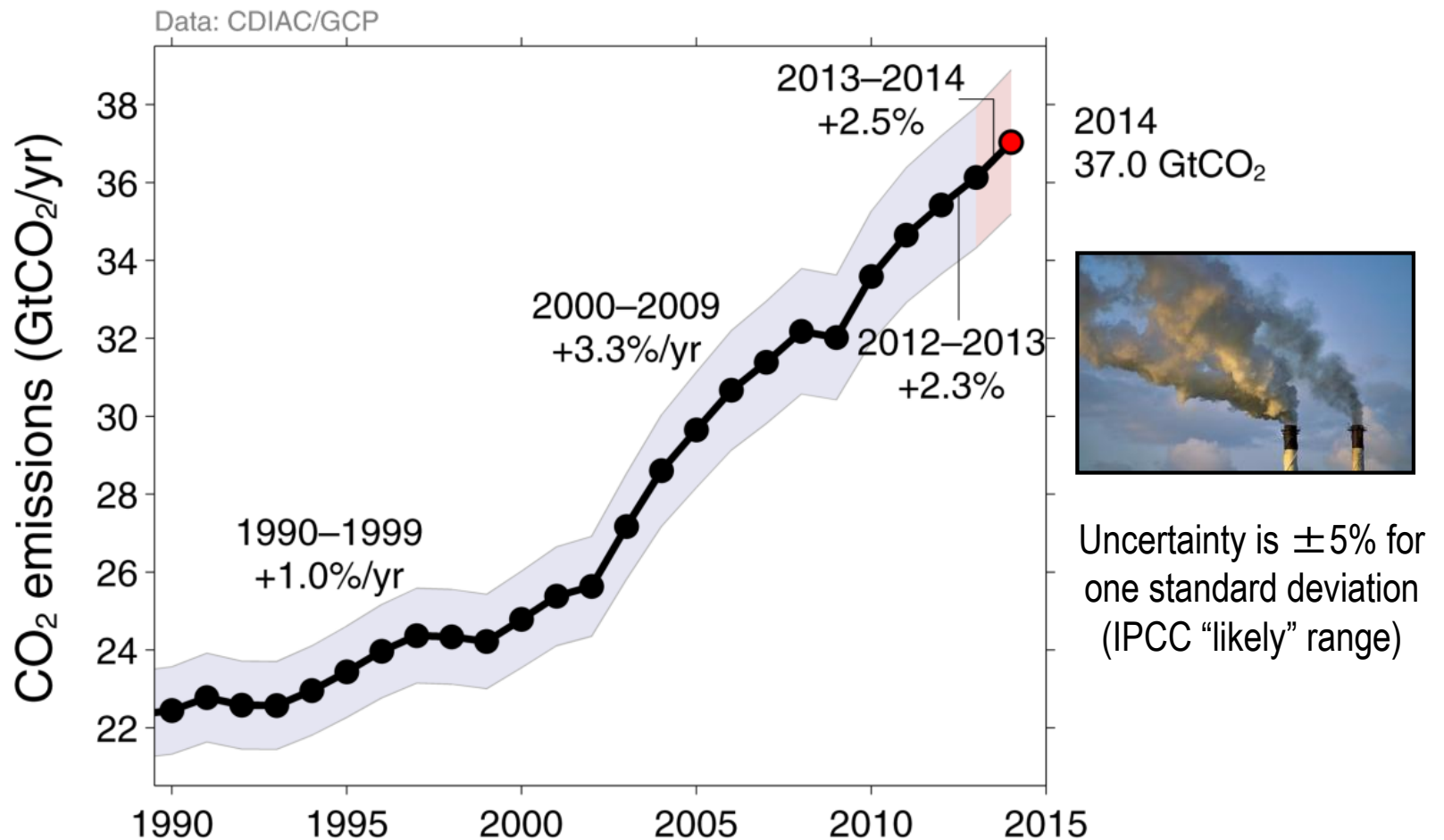


Other evidence: decreasing radiocarbon content of atmosphere, acidification of ocean, increased water use efficiency of plants, concentrations tracks emissions

# Fossil Fuel and Cement Emissions

Global fossil fuel and cement emissions:  $36.1 \pm 1.8$  GtCO<sub>2</sub> in 2013, 61% over 1990

- Projection for 2014 :  $37.0 \pm 1.9$  GtCO<sub>2</sub>, 65% over 1990

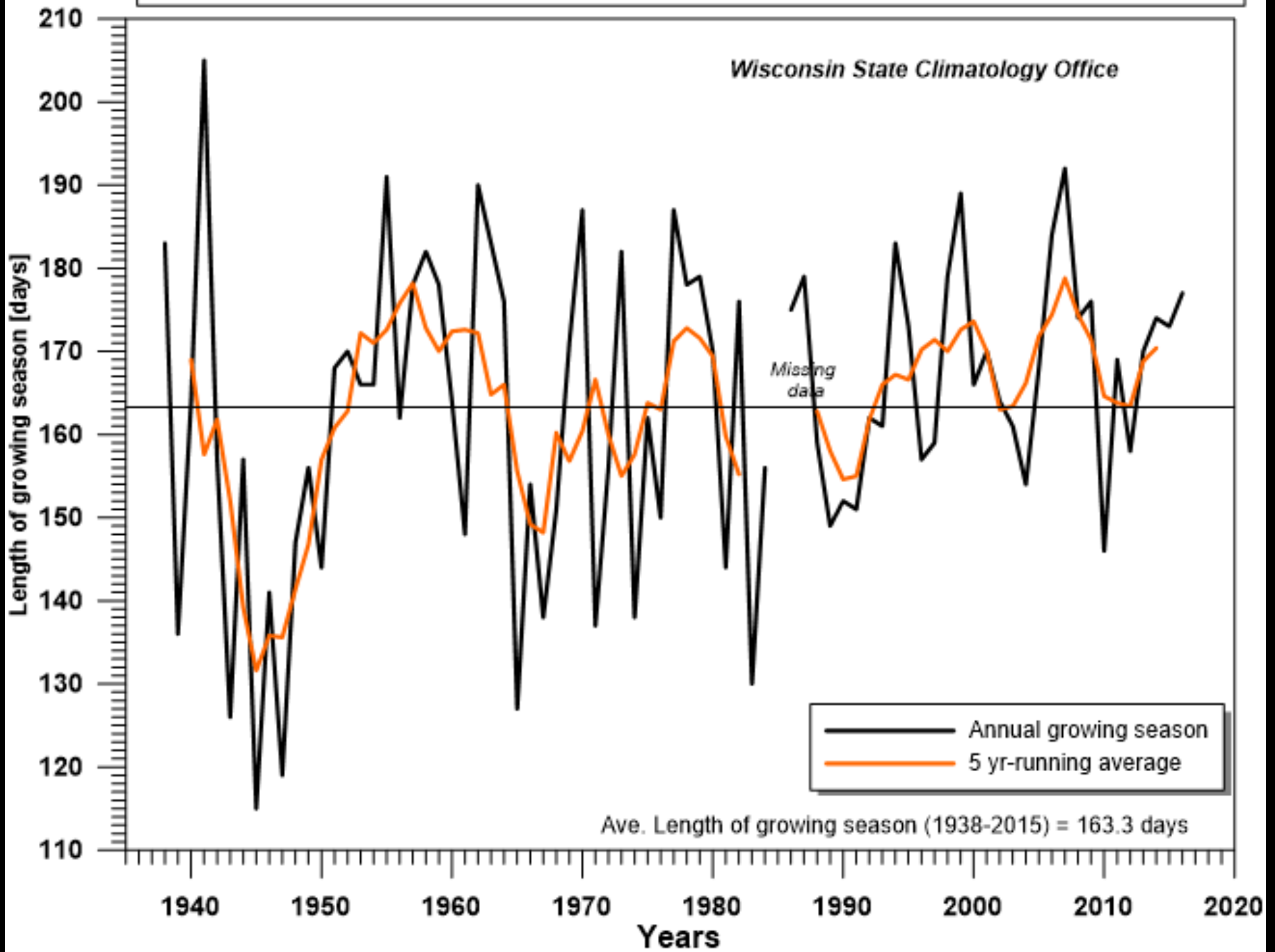


Estimates for 2011, 2012, and 2013 are preliminary

Source: [CDIAC](#); [Le Quéré et al 2014](#); [Global Carbon Budget 2014](#)

So what's the big deal?

# Length of growing season (32°F base): La Crosse WSO Airport (1938-2016)





# Earlier arrival of spring in Wisconsin

Bird migration	Vegetation
Geese Arrival: 29 days	<i>Baptista</i> first bloom: 18 days
Cardinal first song: 22 days	<i>Butterfly weed</i> first bloom: 18 days
Robin arrival: 9 days	<i>Marsh milkweed</i> first bloom: 13 days



**Nina Leopold Bradley**

Photo: Jeffrey Phelps, Milw. Journal Sentinel



**Leopold Shack**

Photo: Aldo Leopold Foundation

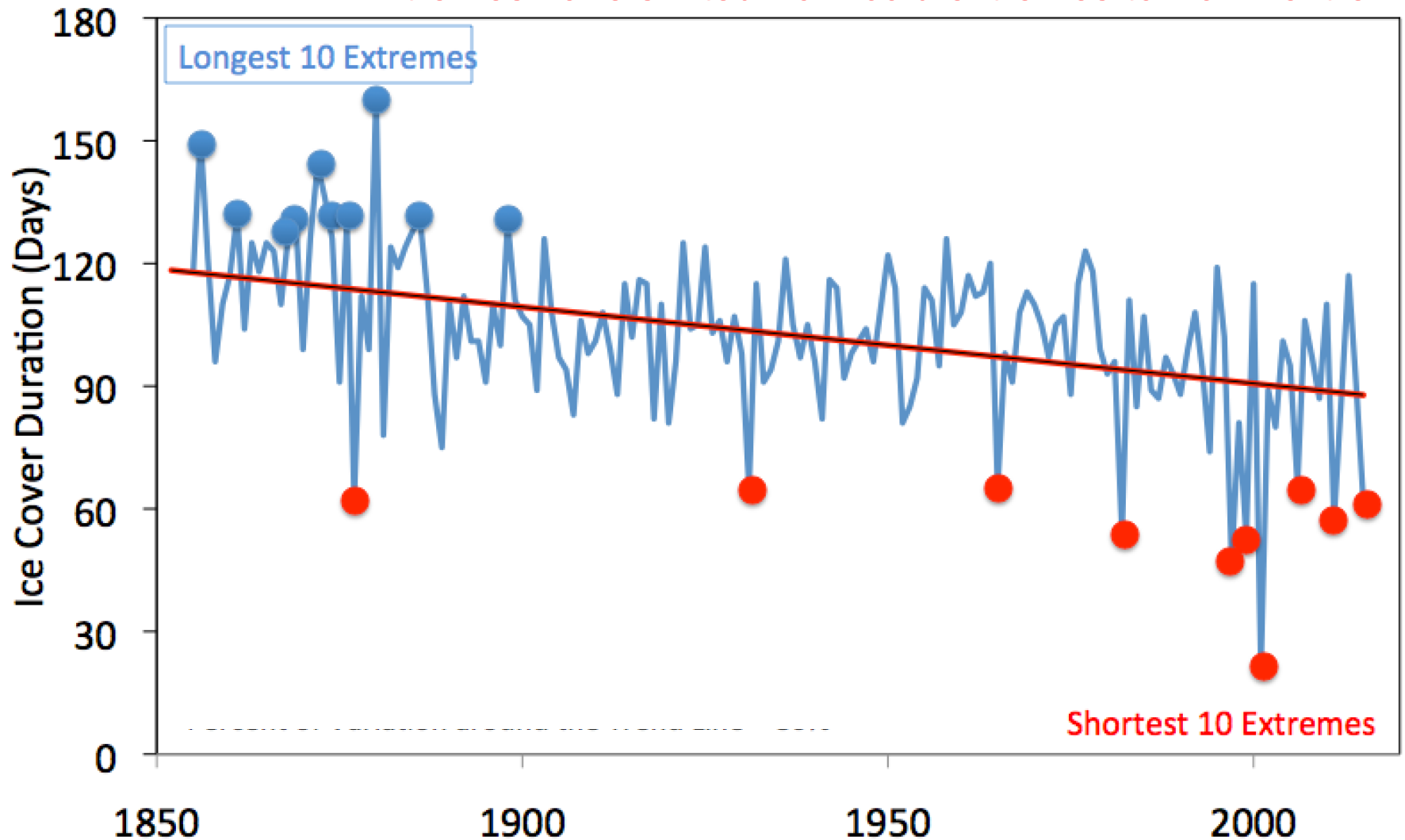
**55 ecological indicators of spring occurred on average 1.2 days earlier per decade from 1936 to 1998.**

Source: Bradley et al., 1999. Phenological changes reflect climate change in Wisconsin. Proc. Natl. Acad. Sci., 96: 9701-9704.

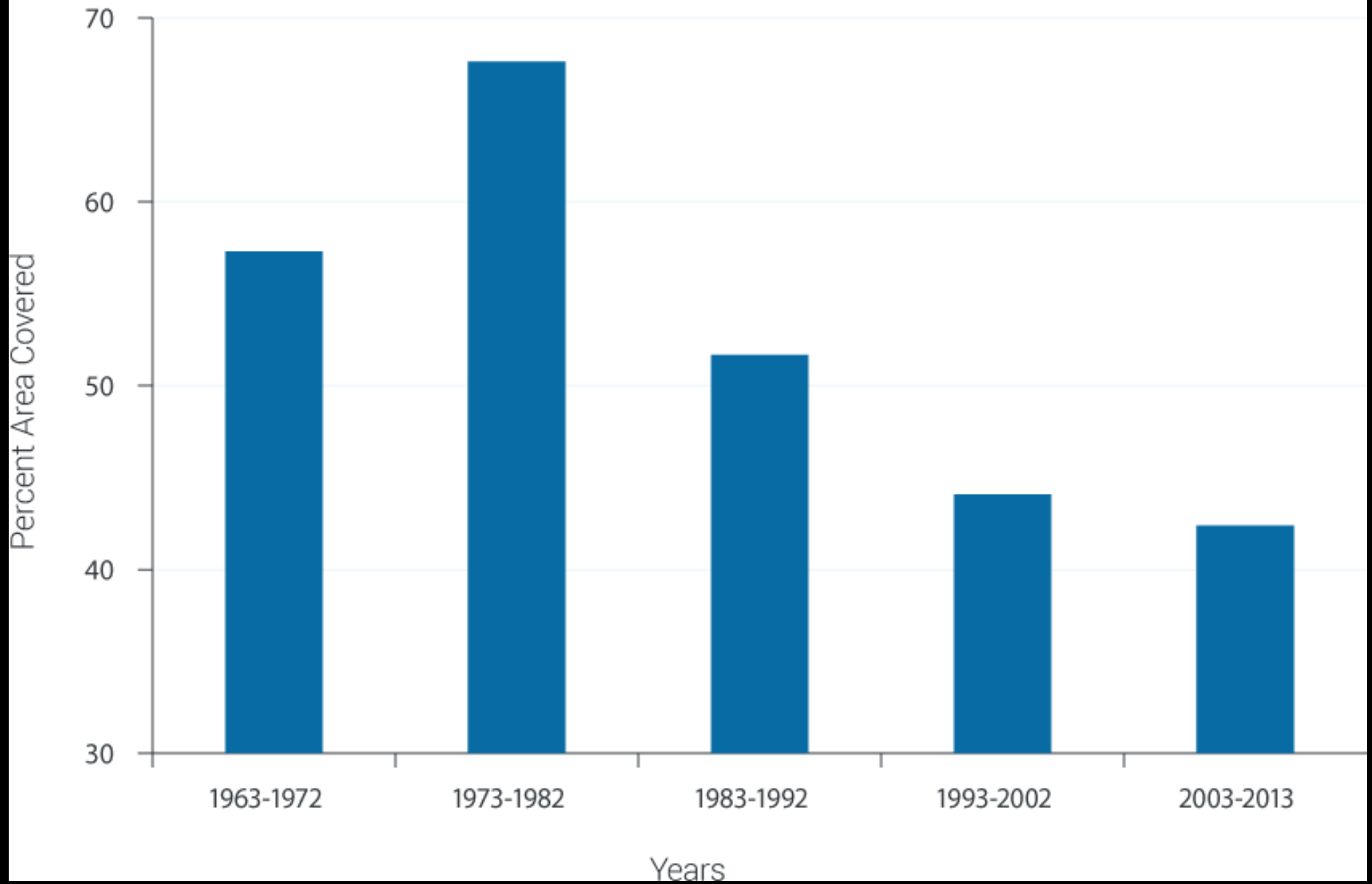
Slide adapted from C. Kucharik, UW-Madison

# A change in Extreme Winters for Lake Mendota, Wisconsin

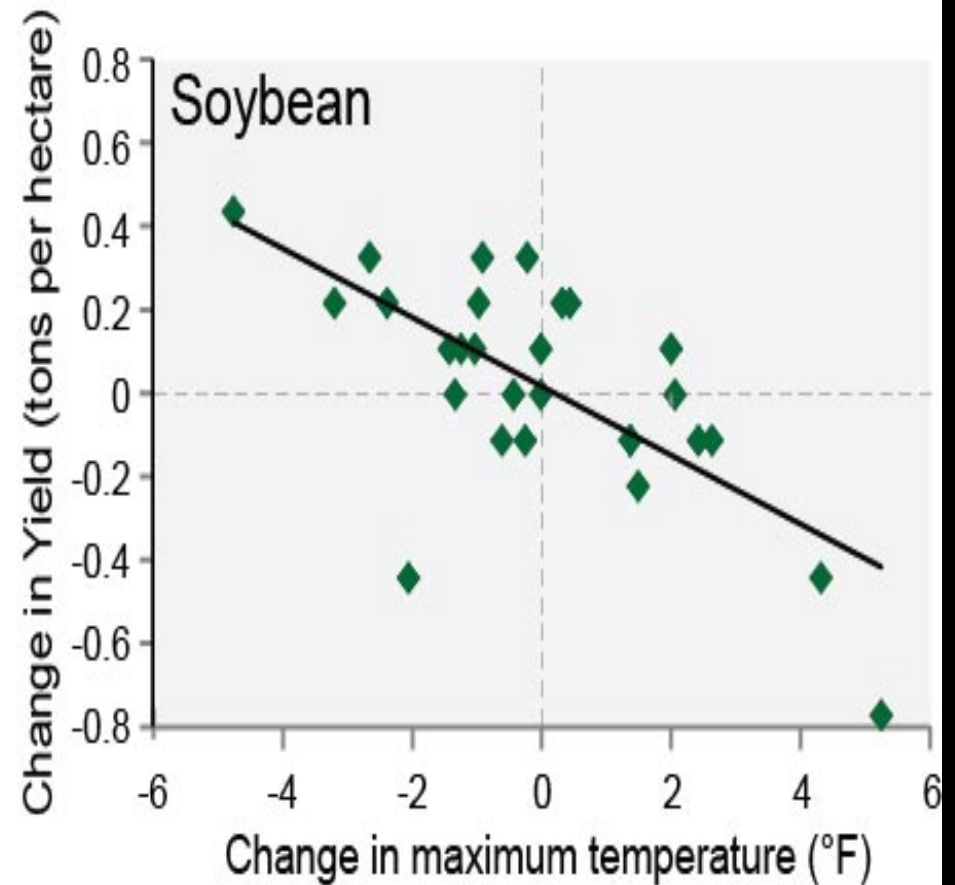
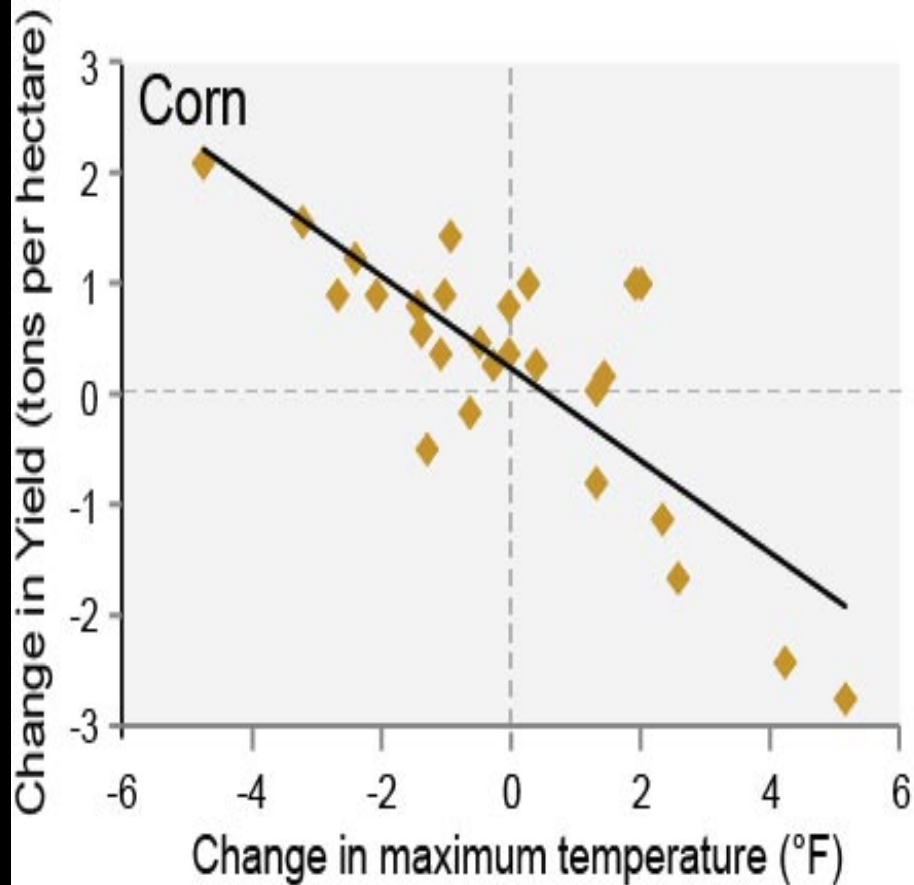
Extremes have shifted from cold extremes to warm extremes



## Ice Cover in the Great Lakes

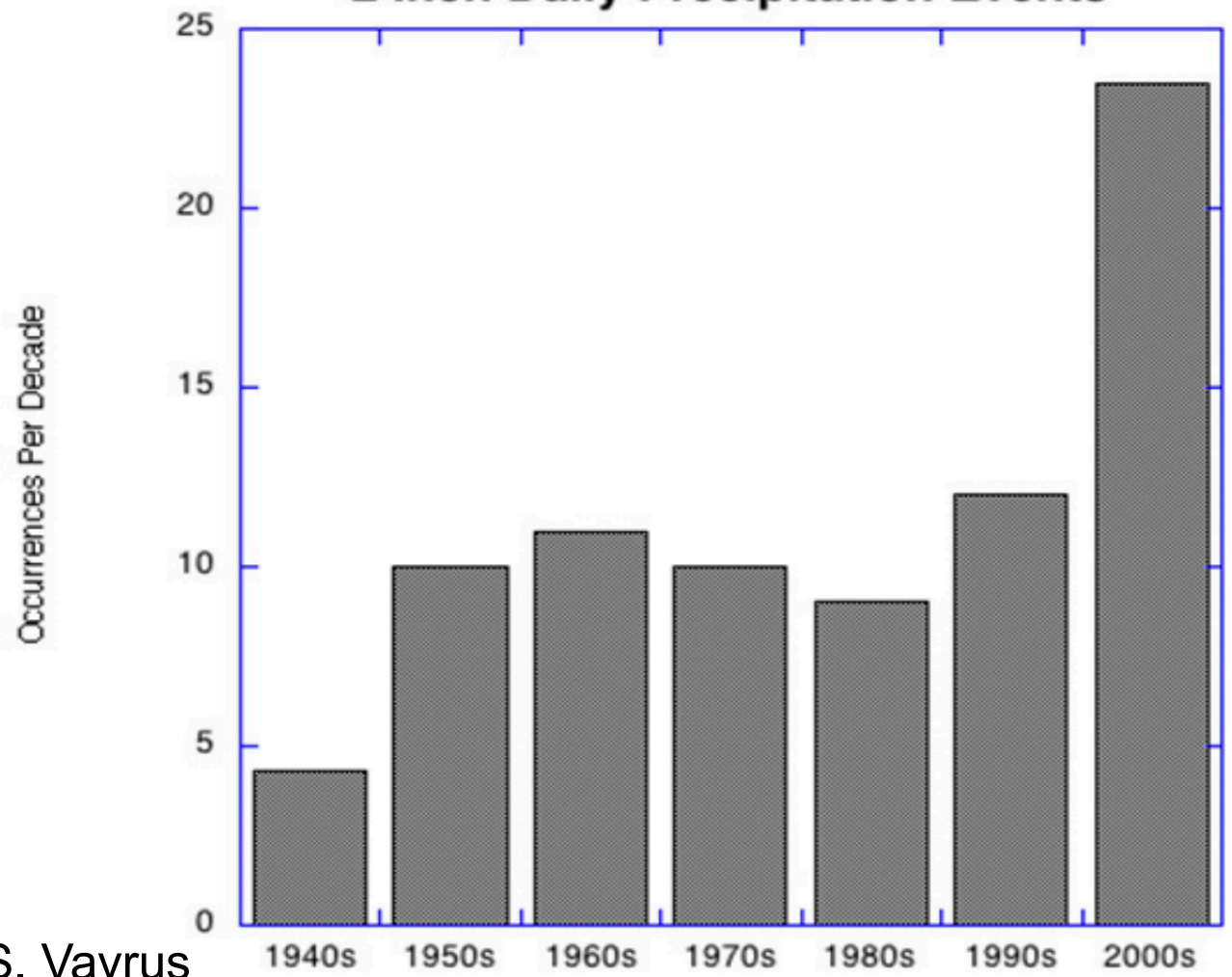


# Crop Yields Decline under Higher Temperatures



R Lathrop

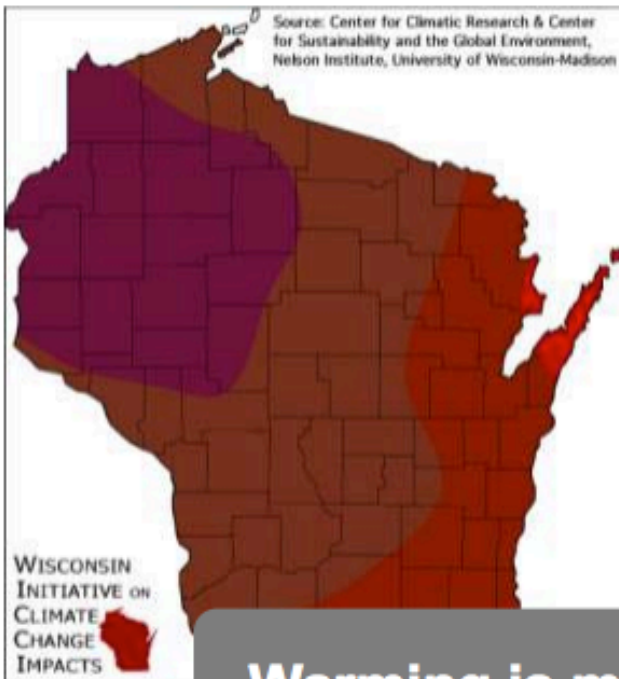
### 2 Inch Daily Precipitation Events



S. Vavrus

# Projected Change in Seasonal Temperatures 1980 to 2055 (° F)

Winter



Spring

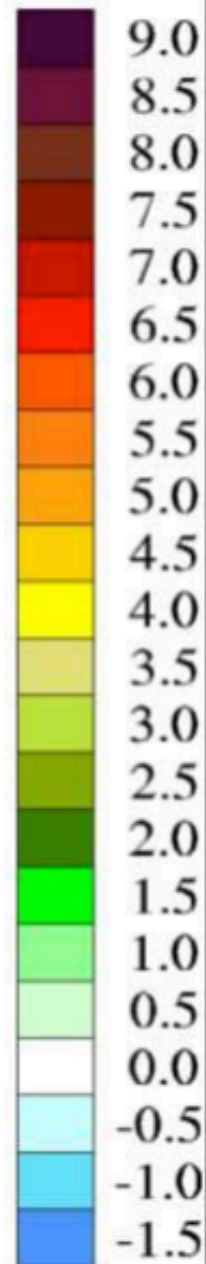


Warming is most pronounced in winter

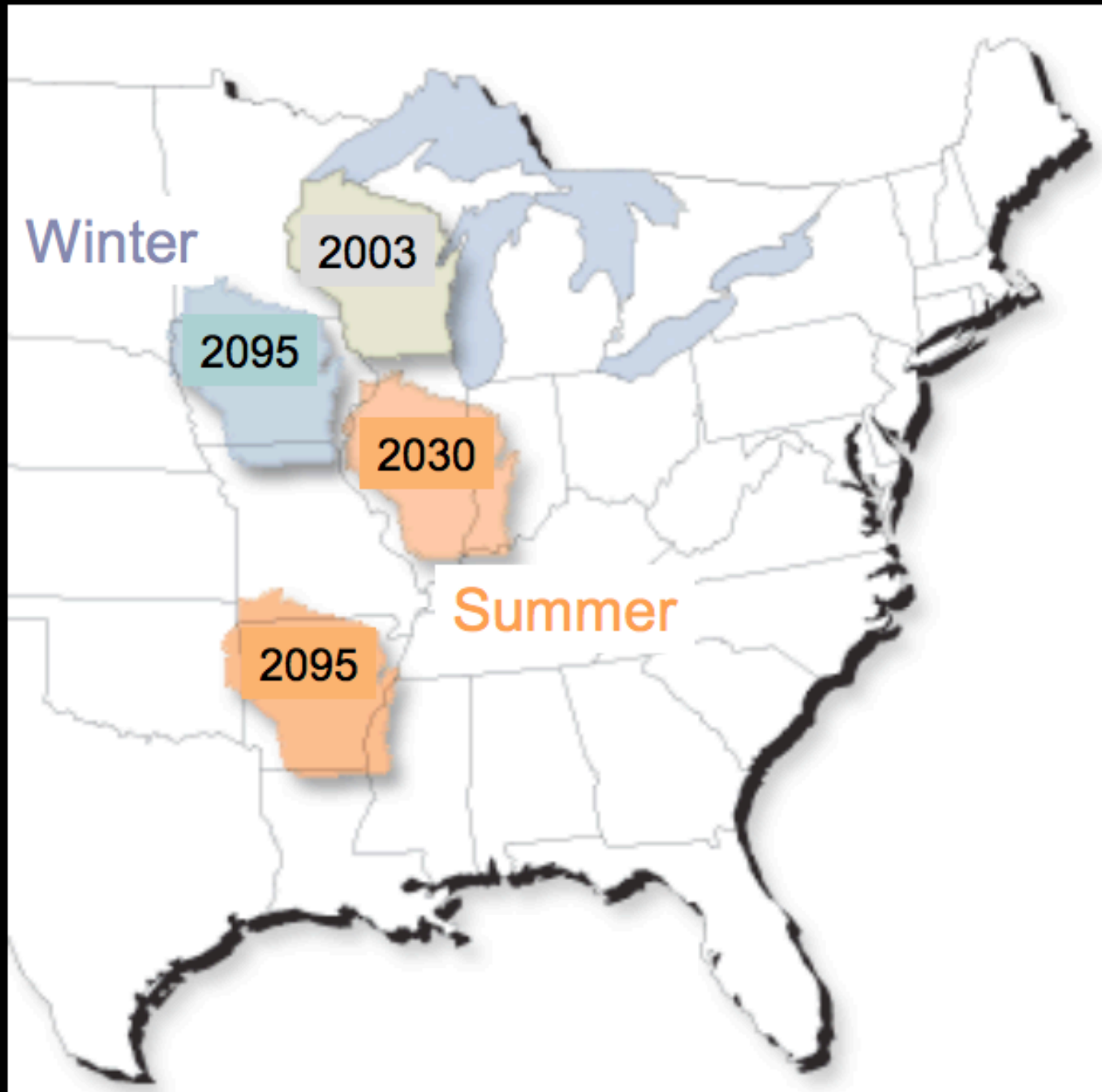
Summer



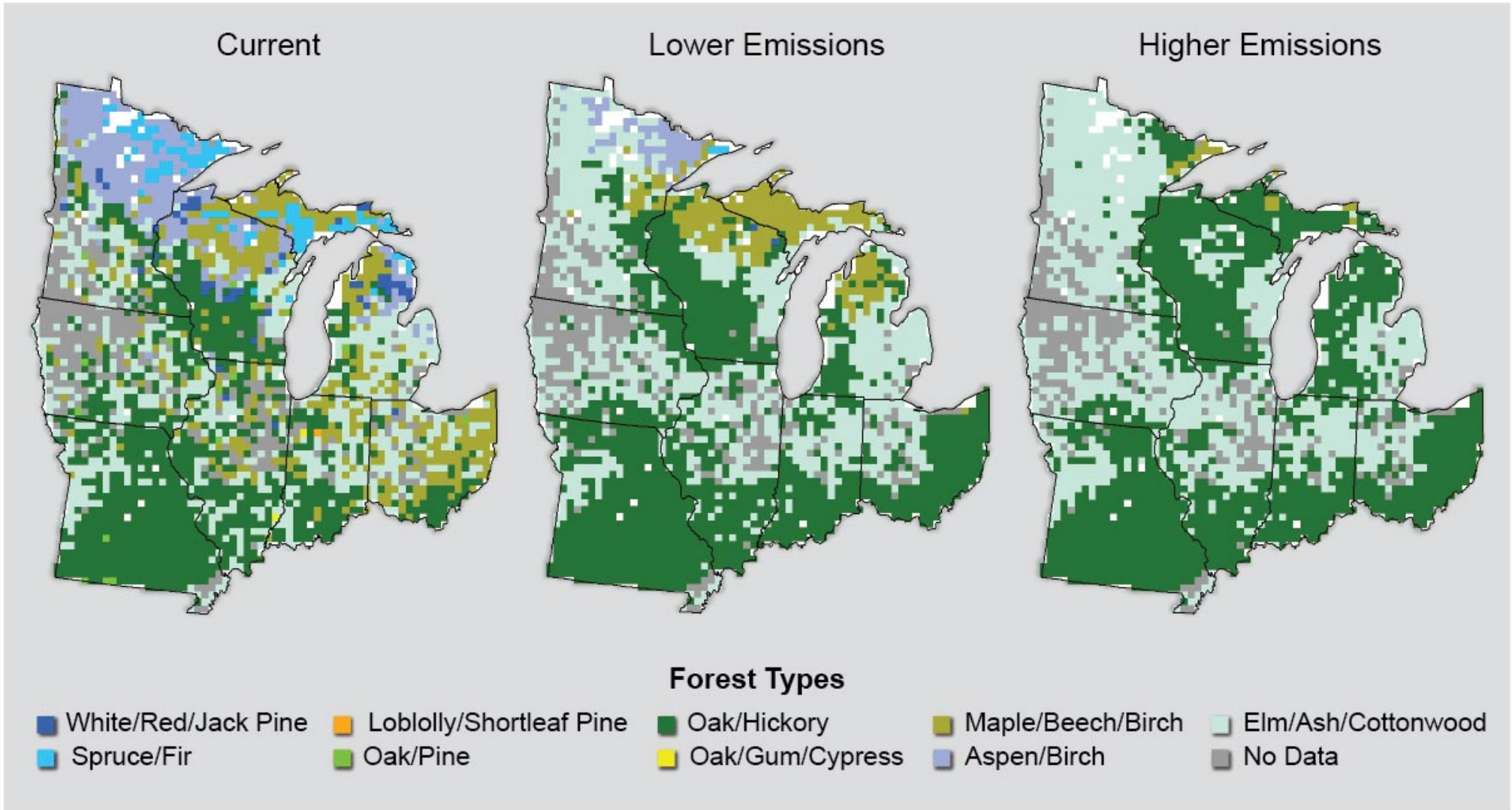
Fall



# Wisconsin Migrating Climate

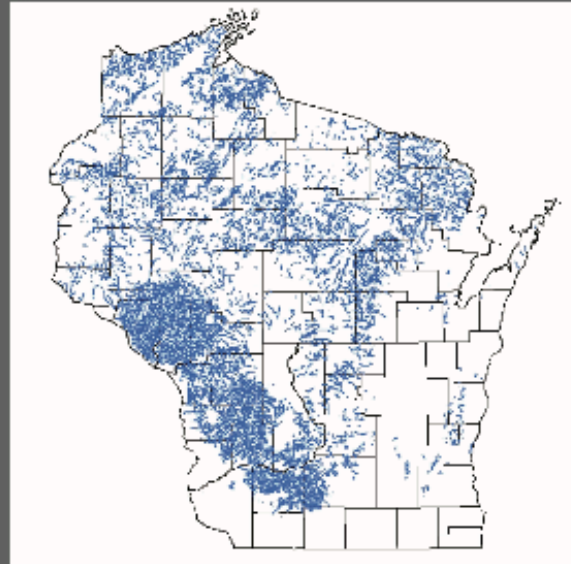


# Forest Composition Shifts

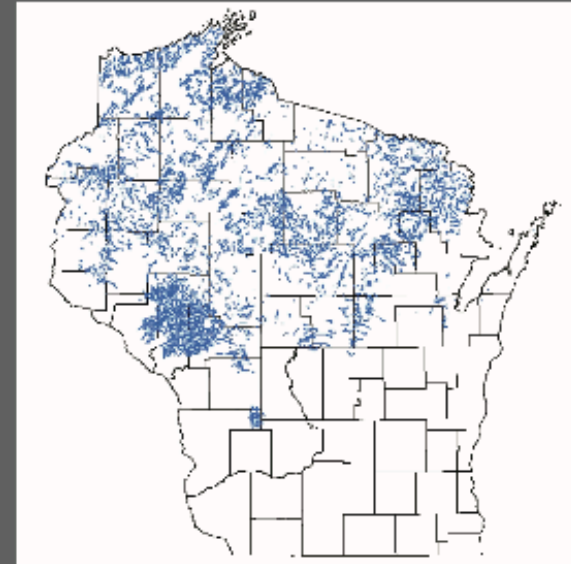




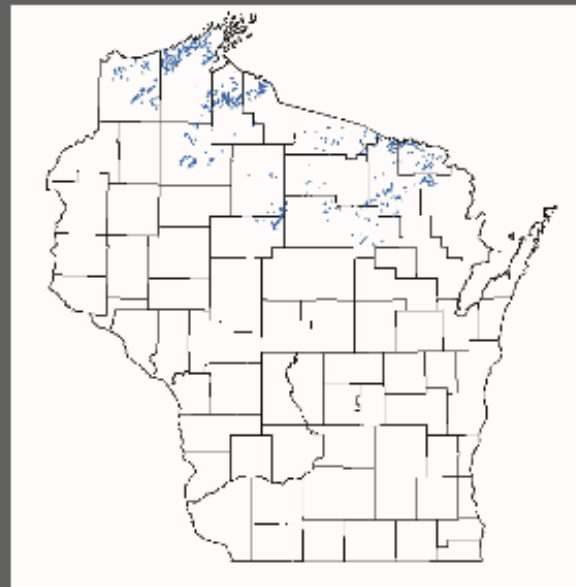
Brook trout streams  
Source: WICCI



**Current climate**



**Best case**  
**+1.4°F = 44% loss**



**Moderate case**  
**+4.3°F = 94% loss**



**Worst case**  
**+7.2°F = total loss**

Why aren't we doing  
something about it then?

The continued release of CO<sub>2</sub> to the atmosphere from burning fossil fuels would “almost certainly cause significant changes” and “could be deleterious from the point of view of human beings [...] and marked changes in climate, not controllable through local or even national efforts.



U.S. President's Science Advisory to President Lyndon B. Johnson 1966

# DOOMSDAY Thinking

- The imagery of the impossible leads to the art of the no deal



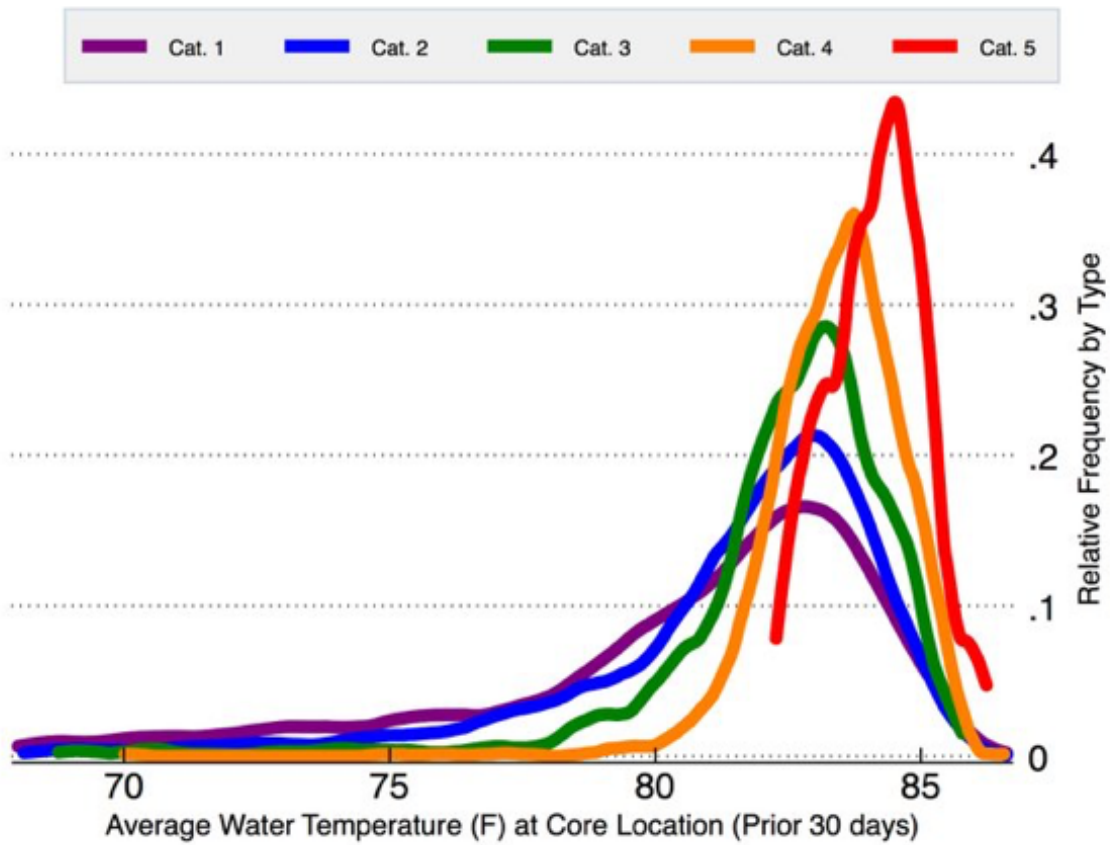
## DATE WITH DISASTER Conspiracy theorist David Meade says the world will NOT end on September 23rd – but we're in for SEVEN years of chaos

The Christian conspiracy theorist says people have misunderstood his prophecy - and September 23rd will just be a "sign".

**EXCLUSIVE** By Emma Parry, Digital US Correspondent  
22nd September 2017, 9:35 am | Updated: 22nd September 2017, 12:26 pm



## Hurricane Strength and Ocean Temperatures



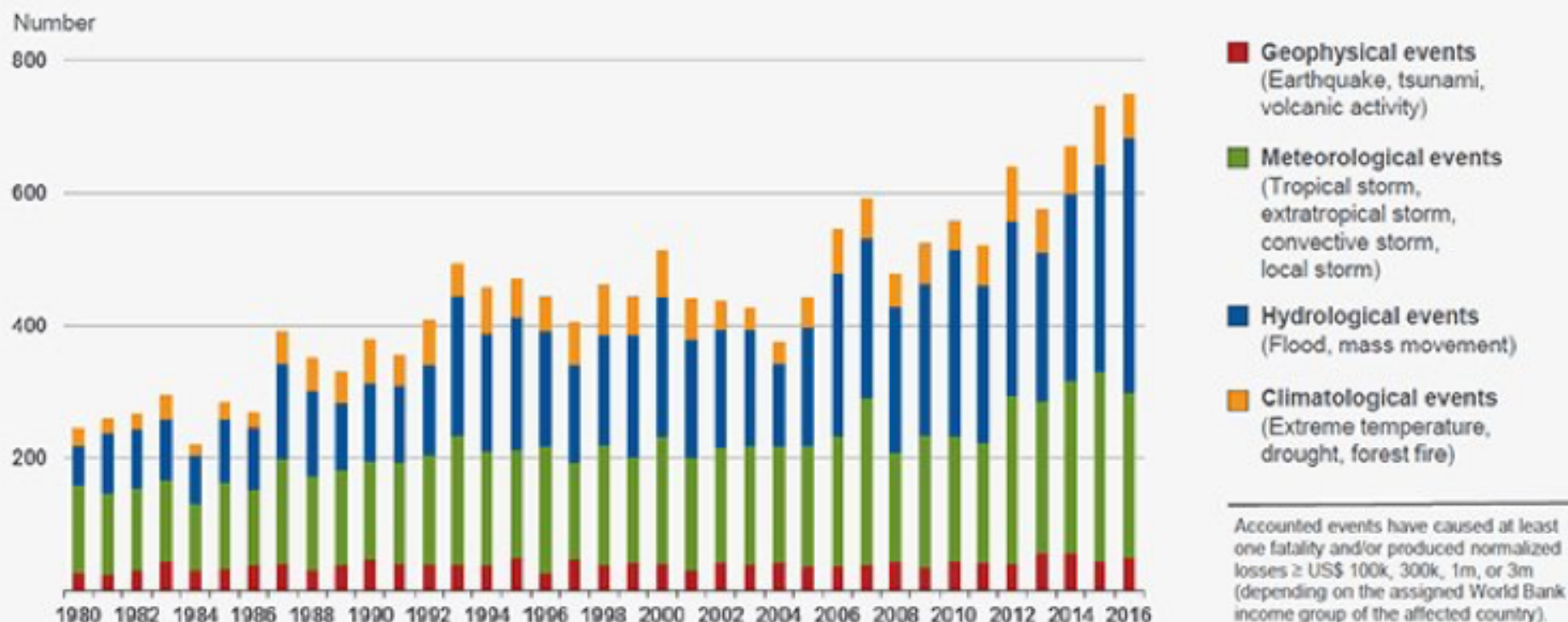
Kernel density functions of SSTs by hurricane category. Area under each curve represents 100% of hurricanes of that type. Hurricane wind speeds via HURDAT.



# Fires, droughts and hurricanes: What's the link between climate

## Number Of Natural Catastrophes Global - 1980-2016

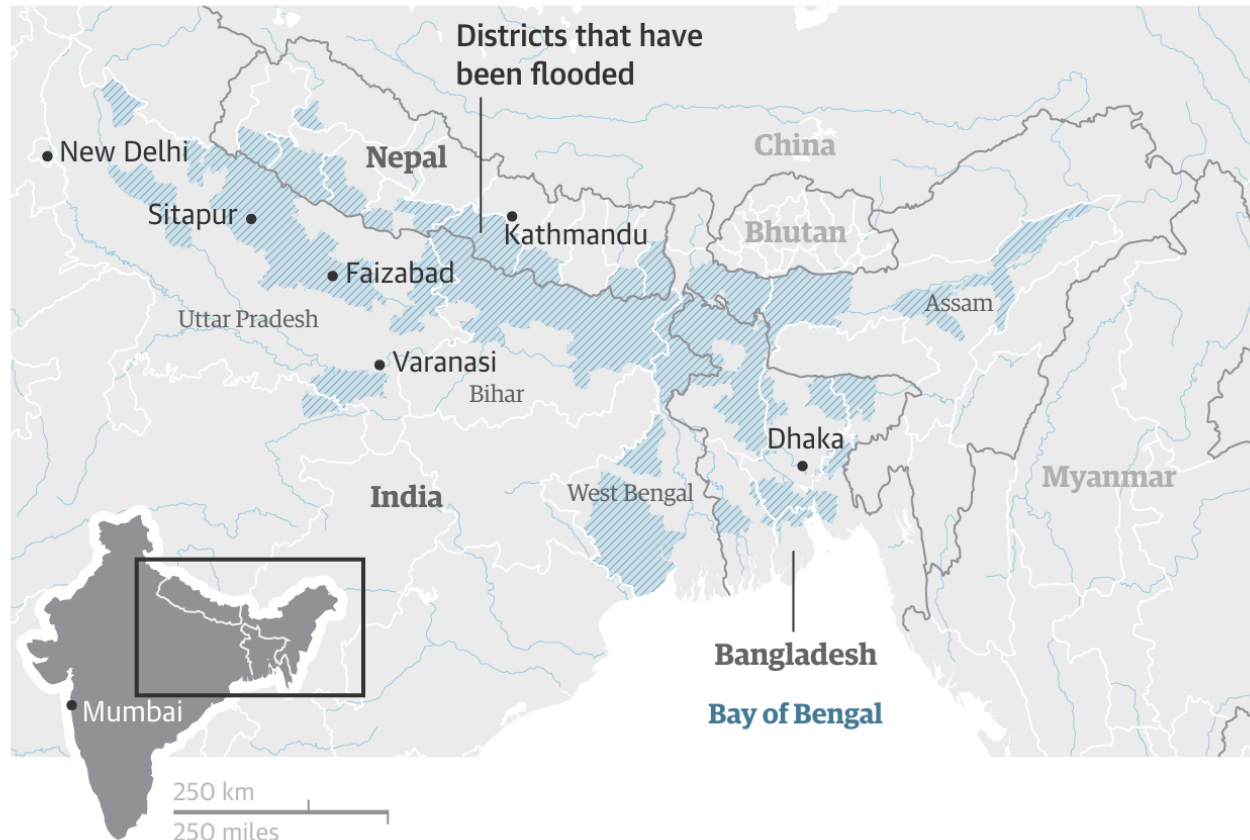
Source: Munich Re, Geo Risks Research



## Wildfires?

It was supposed to be a quiet year.

## More than 1,200 people have died across India, Bangladesh and Nepal as a result of flooding







U.S. +

Live TV

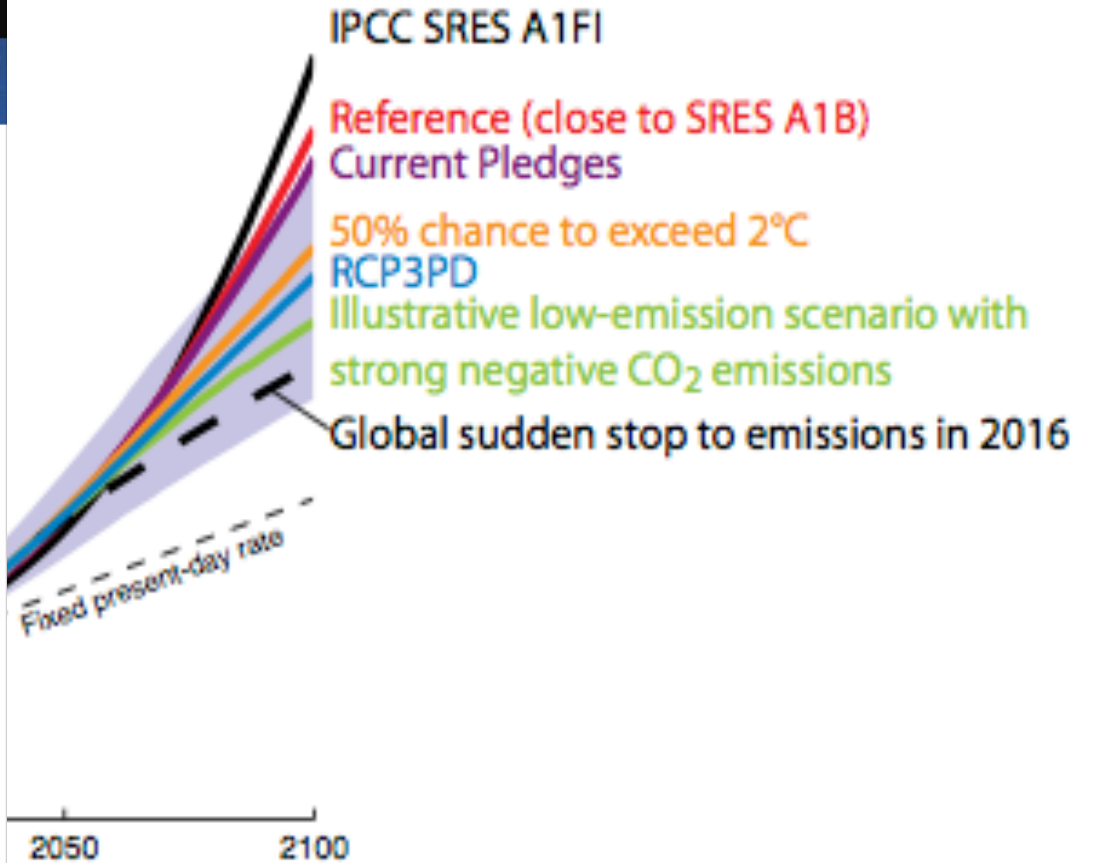


ZAKARIA

# Neil deGrasse Tyson says it might be 'too late' to recover from climate change

By **Alexandra King**, CNN

Updated 4:18 PM ET, Sun September 17, 2017



Maarten van Aalst / World Bank

# So what do you do about climate change?

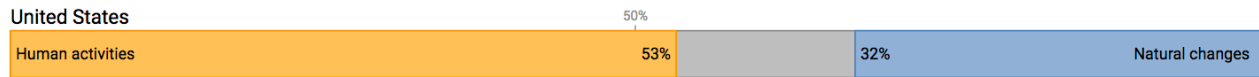
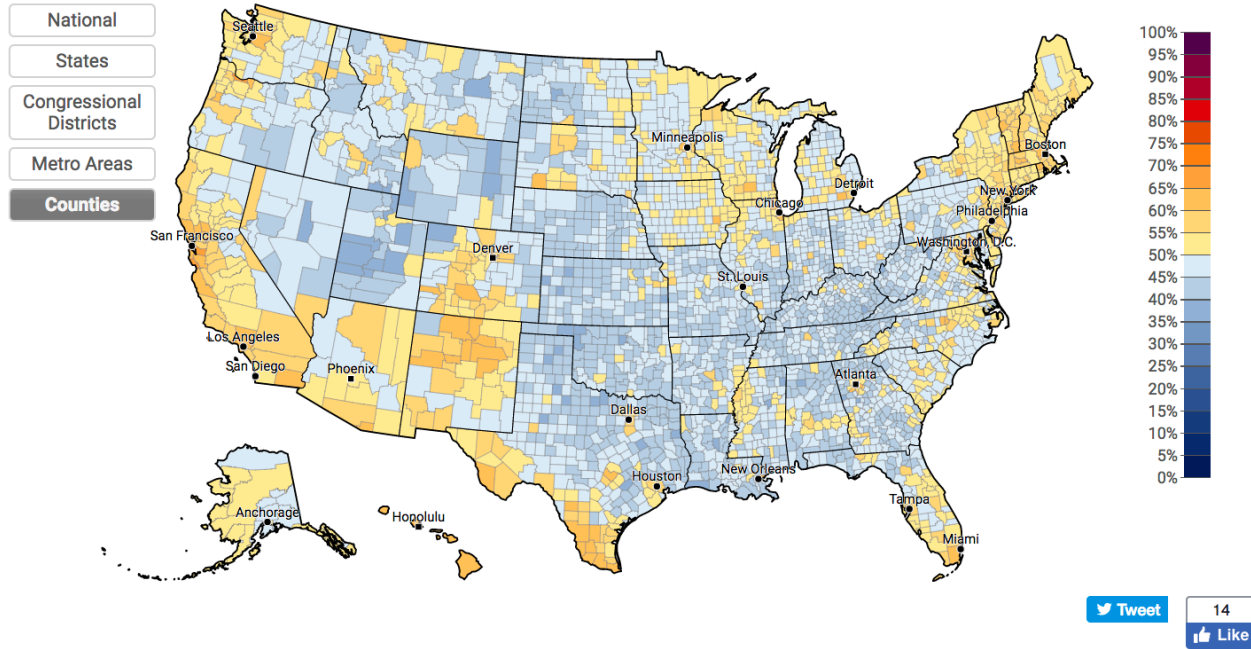
- Denialism is a normal doomsday response
- So is alarmism. Trying an “all of the above” solution is paralyzing
- But, there are some levers we know work:
  - Rethinking agriculture
  - Reducing deforestation
  - Expanding our energy choices
  - Providing incentives to change

# We do and believe like our neighbors

- Or at least, what we think are neighbors do and believe...

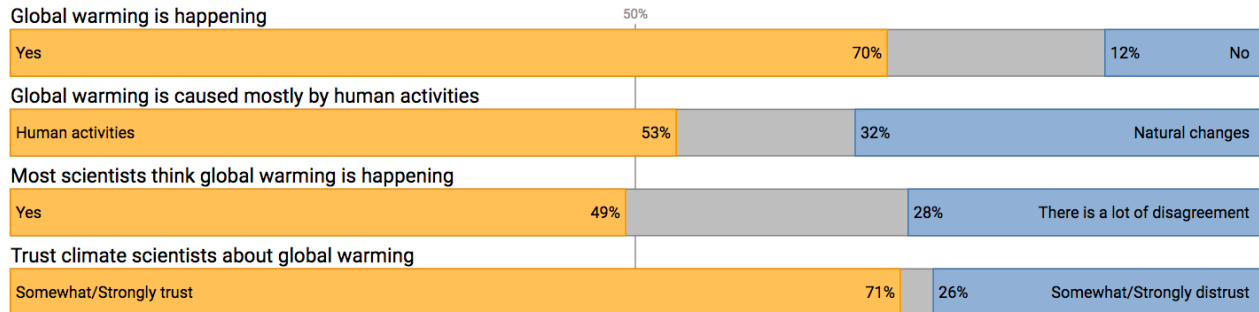
# Estimated % of adults who think global warming is mostly caused by human activities, 2016

Display model output:  Absolute Value [Permalink](#)  
 Click on map to select geography, or:



## Public Opinion Estimates, United States, 2016

### BELIEFS



### RISK PERCEPTIONS

- “If you like to talk about this making the world a better place, you have to prove the accuracy of the global warming data. It’s not enough to say the government is lying. Every



Jon Foley added 2 new photos.

Yesterday at 10:17 PM · San Francisco, CA · 🌐

Ah, people can be so nice on social media.

This is in response to a post about how scientists have been warning the world about climate change for decades, but politicians have deliberately been using delaying techniques...



Jon Foley and 41 others

34 Comments



Like



Comment



Share



Mark I @markiwankow · 2m

Replying to @GlobalEcoGuy and @wwxchaser

You’re using a natural disaster to bolster your grant payments. Shove it up your ass. We will figure this all out and you should go to jail



Like



Comment



Share



Biffit Morgalesh @BiffitM · 5h

...y don't  
[...] I read  
1970s  
data  
then all  
shifted to  
interestingly

and

Washington Post

# We do and believe like our neighbors

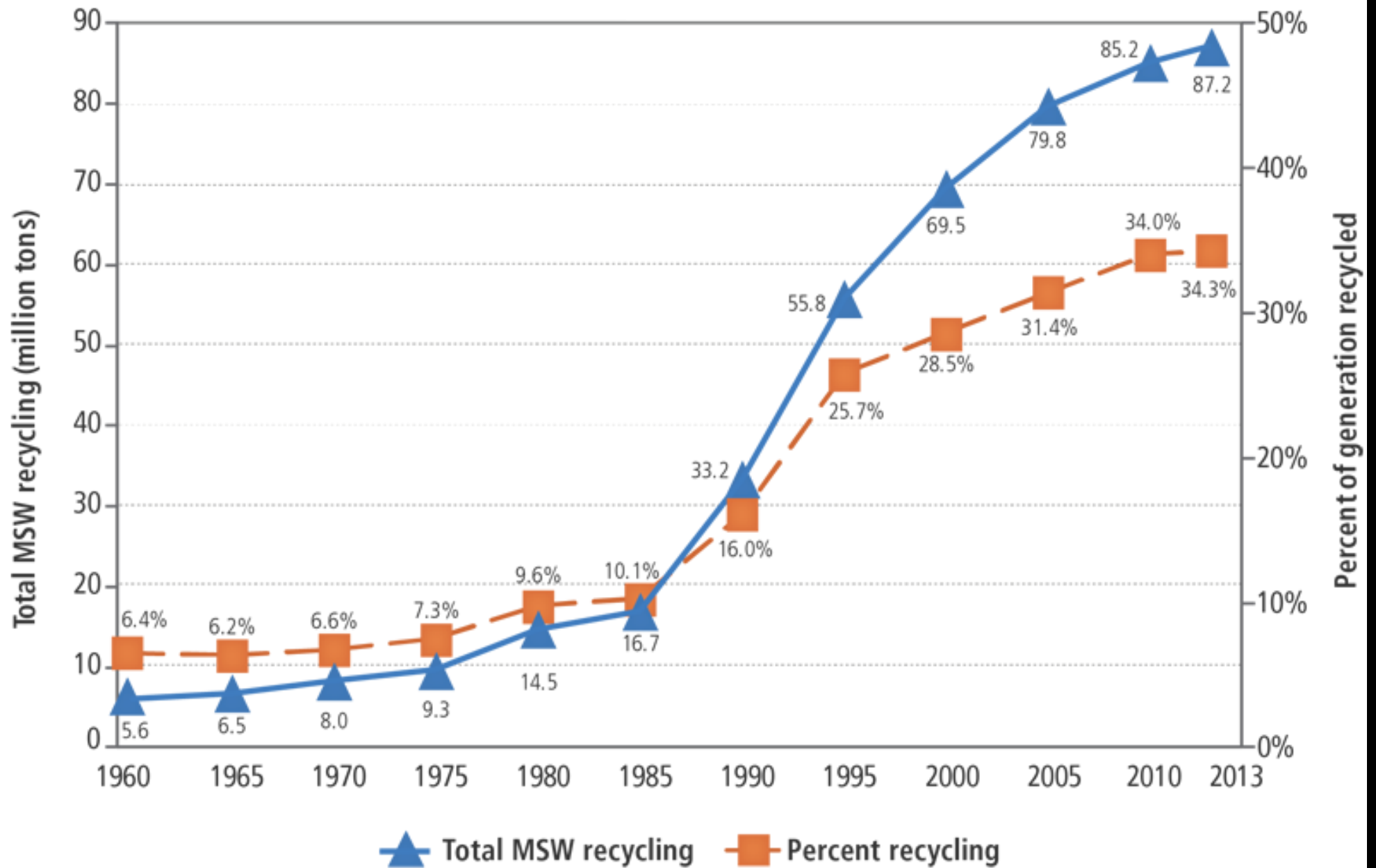
- Or at least, what we think are neighbors do and believe...
- BUT

Community standards can  
change

# Community standards can change

- Education and generational change
  - Recycling



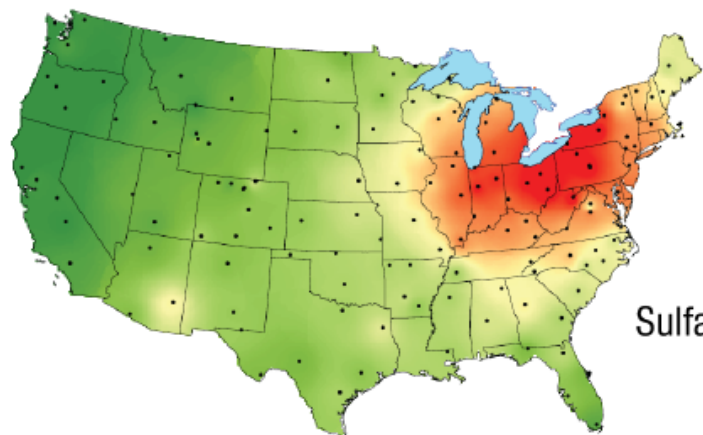


# Community standards can change

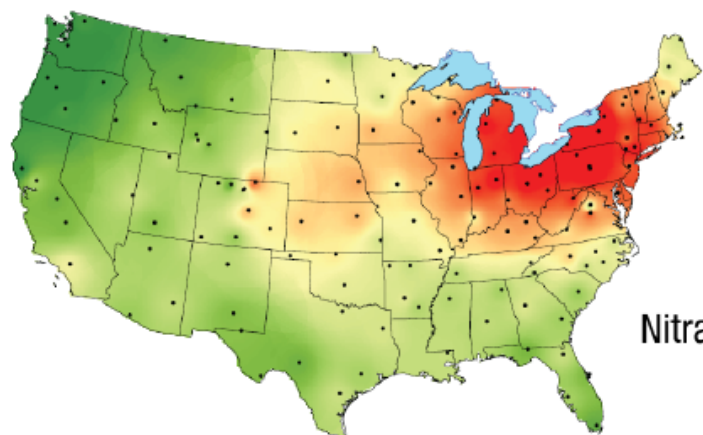
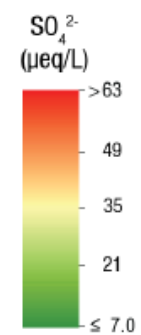
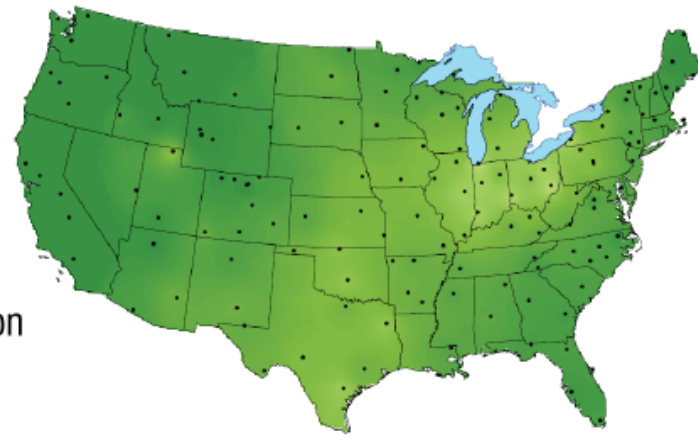
- Education and generational change
  - Recycling
- Regulation
  - Acid rain

1984-1986

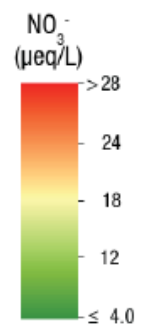
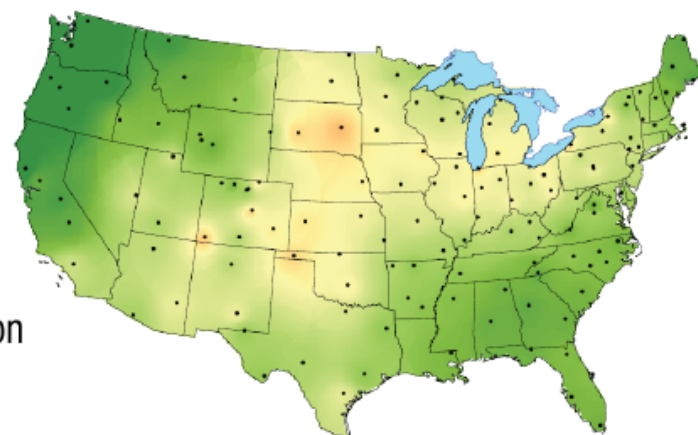
2012-2014



Sulfate Ion

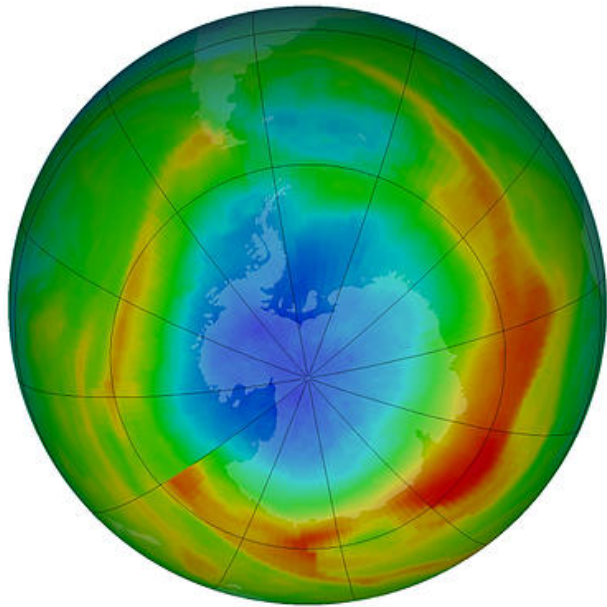


Nitrate Ion

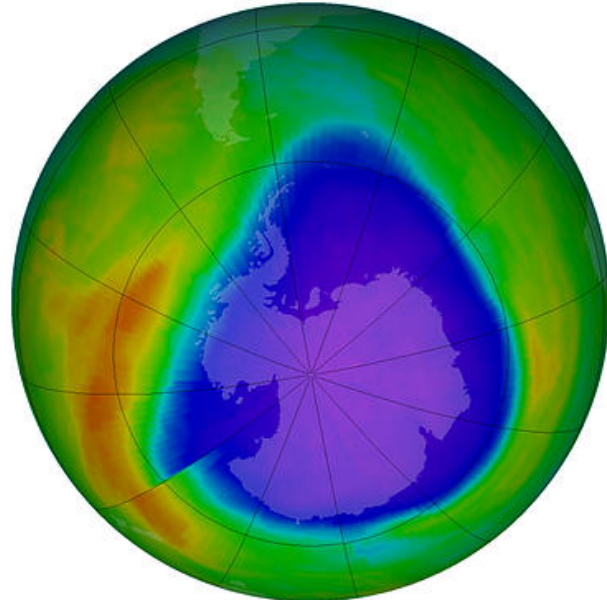


# Community standards can change

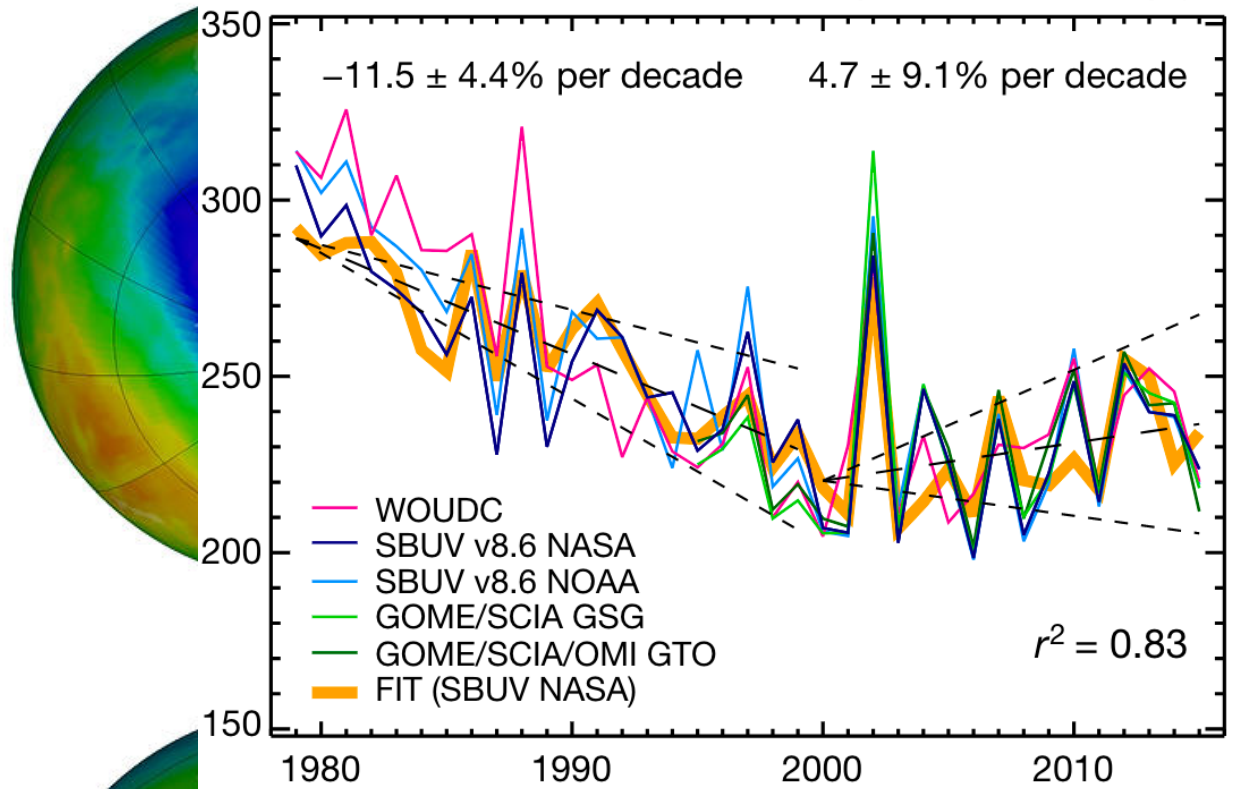
- Education and generational change
  - Recycling
- Regulation
  - Acid rain
- Innovation
  - The Ozone Hole



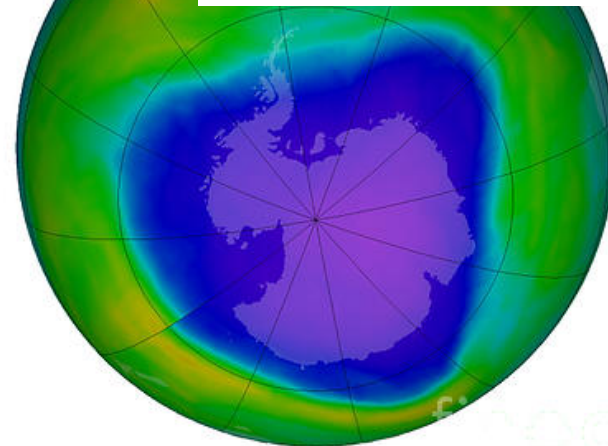
1980



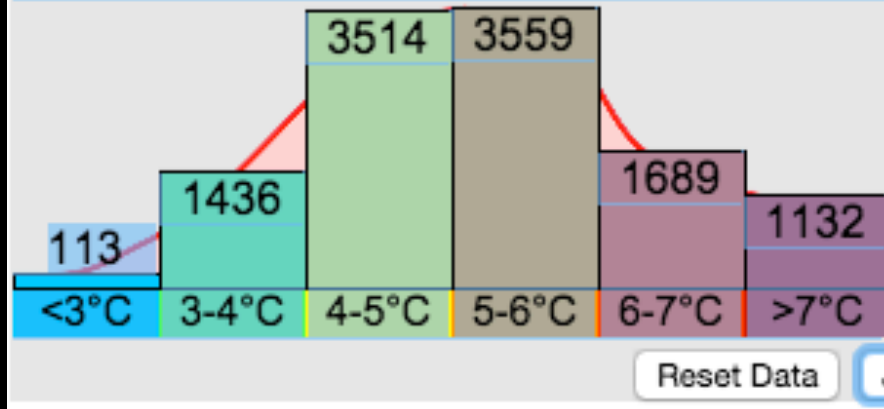
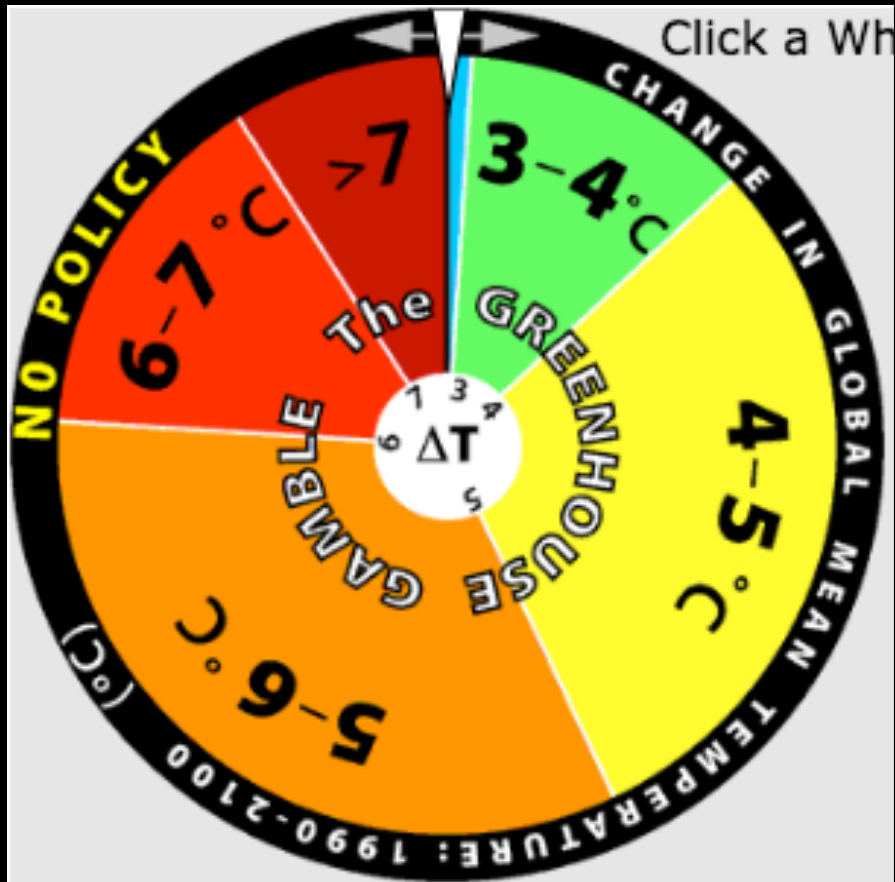
2000



Year  
Chipperfeld et al., 2017



2015



<http://globalchange.mit.edu/focus-areas/uncertainty/gamble>

**F = Global CO<sub>2</sub> emissions**  
Includes combustion, flaring of natural gas, cement production, oxidation of nonfuel hydrocarbons, and transport.

28.56  
gigatons CO<sub>2</sub>

**g = Consumption per person**

$$\left( \frac{\text{Gross world product}}{\text{Population}} \right)$$

\$10,000

**P = Global population**  
Total number of human beings—call it 6 billion.



6.8 billion people

$$F = P g e f$$



**e = Energy intensity of gross world product**

$$\left( \frac{\text{Global energy consumption}}{\text{Gross world product}} \right)$$



7,000 BTUs  
per dollar

**f = Carbon used to make all that energy**

$$\left( \frac{\text{Global CO}_2 \text{ emissions}}{\text{Global energy consumption}} \right)$$



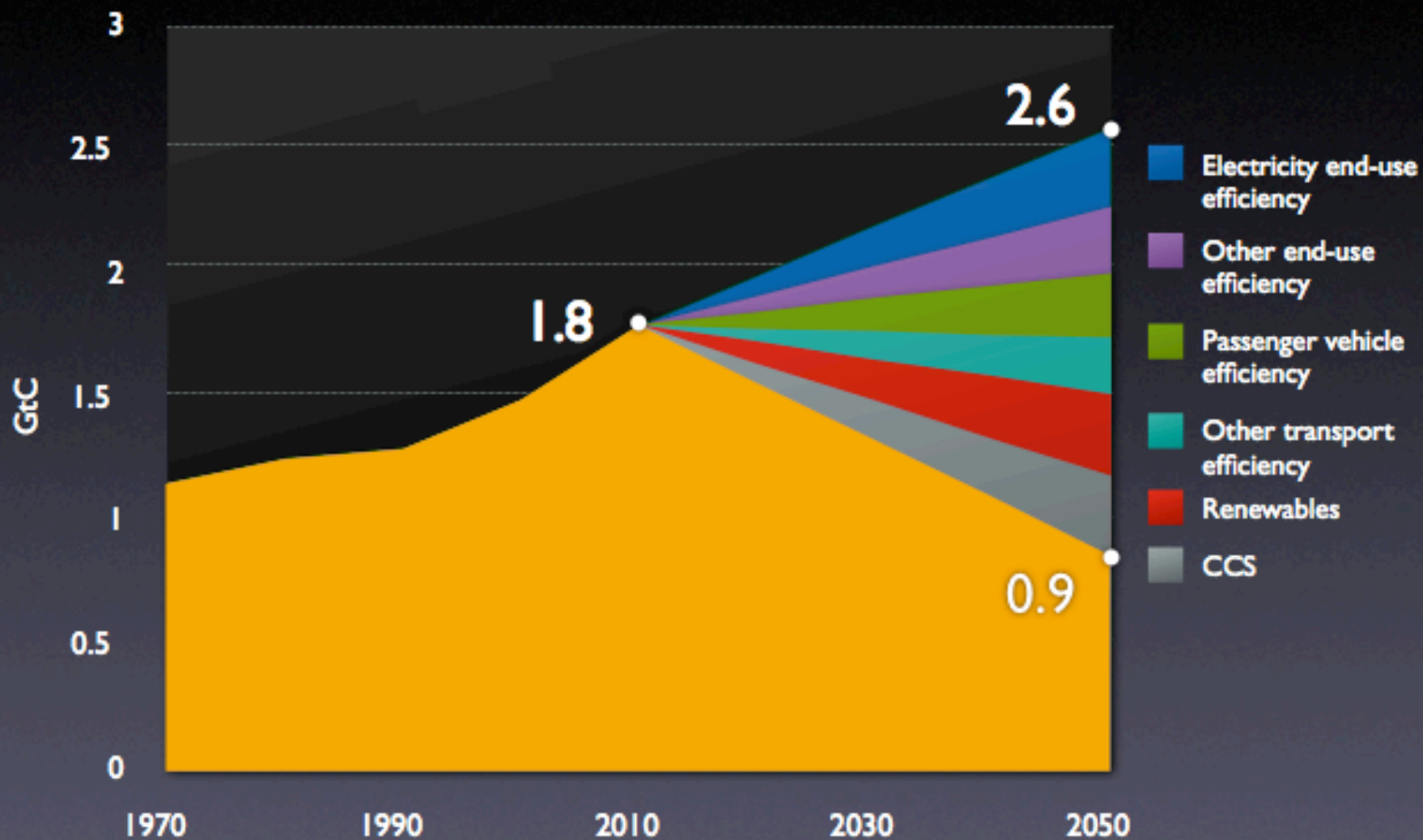
60 tons of CO<sub>2</sub>  
per billion BTUs

KAYA IDENTITY

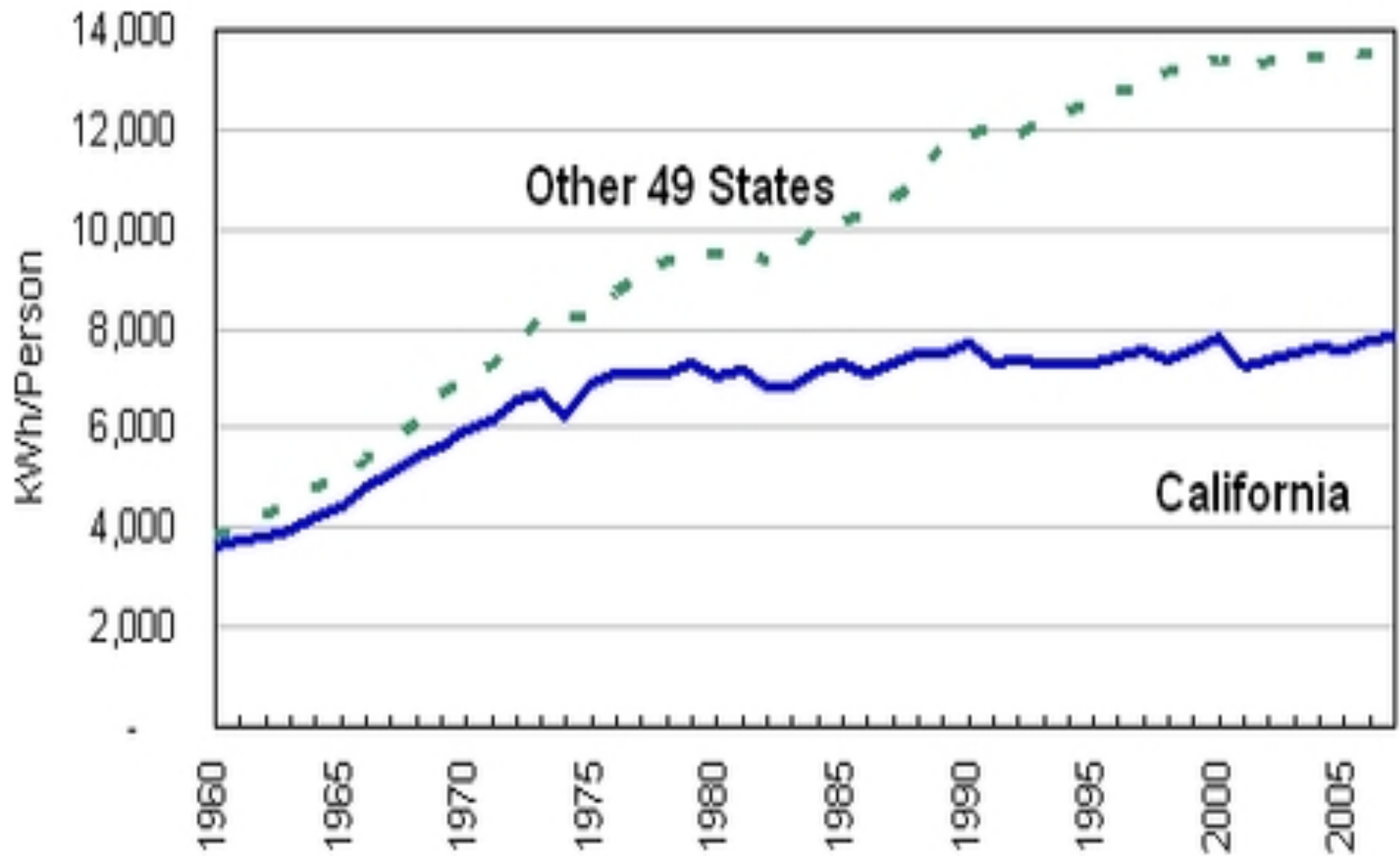
# U.S. Emissions

After Pacala and Socolow, 2004;  
ARI CarBen3 Spreadsheet

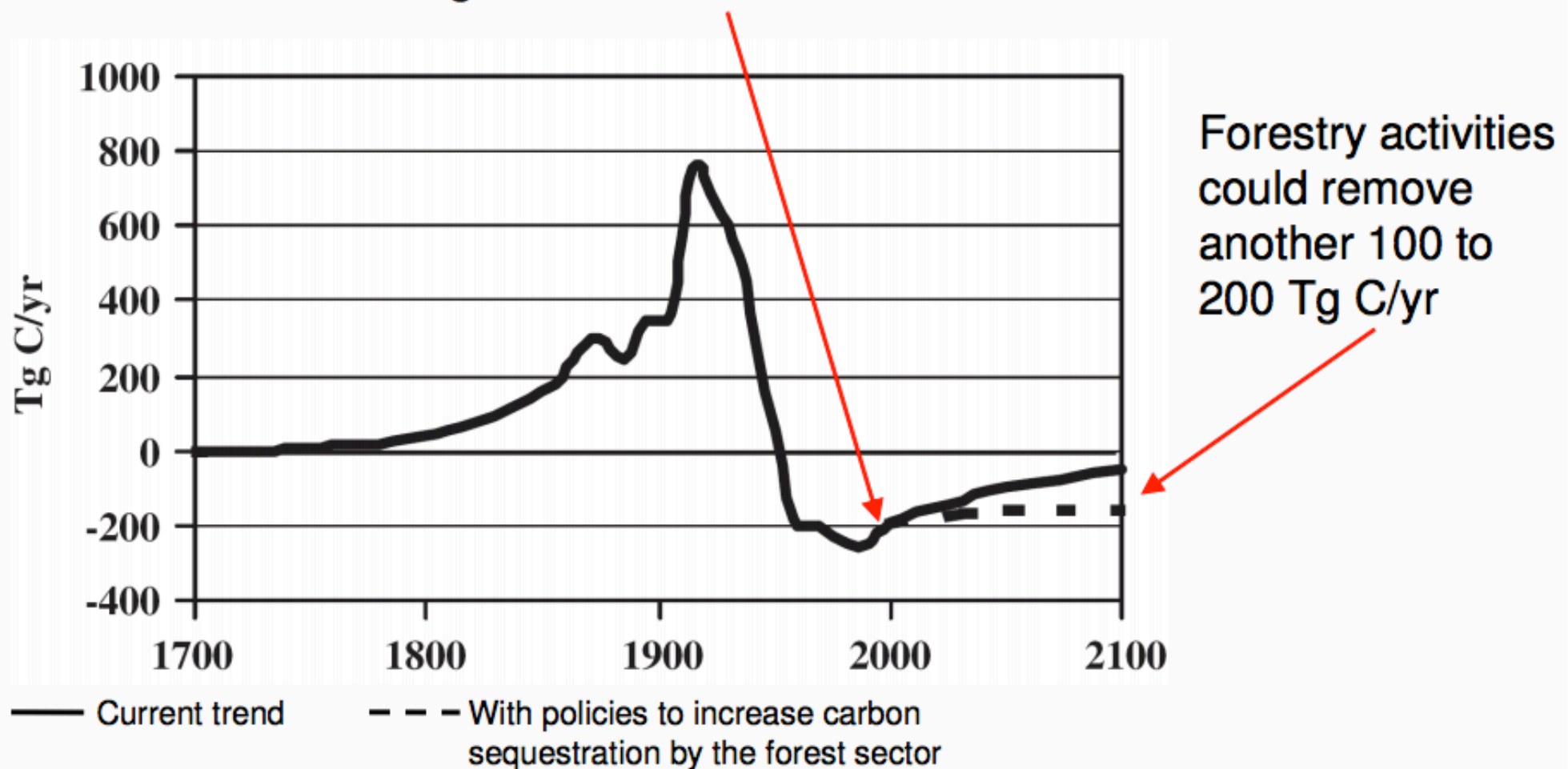
## • Carbon Capture & Storage







US forests annually sequester the equivalent of 10% of US carbon dioxide emissions from burning fossil fuels



*Smith and Heath 2004, EPA 2005, Birdsey et al. 2006*

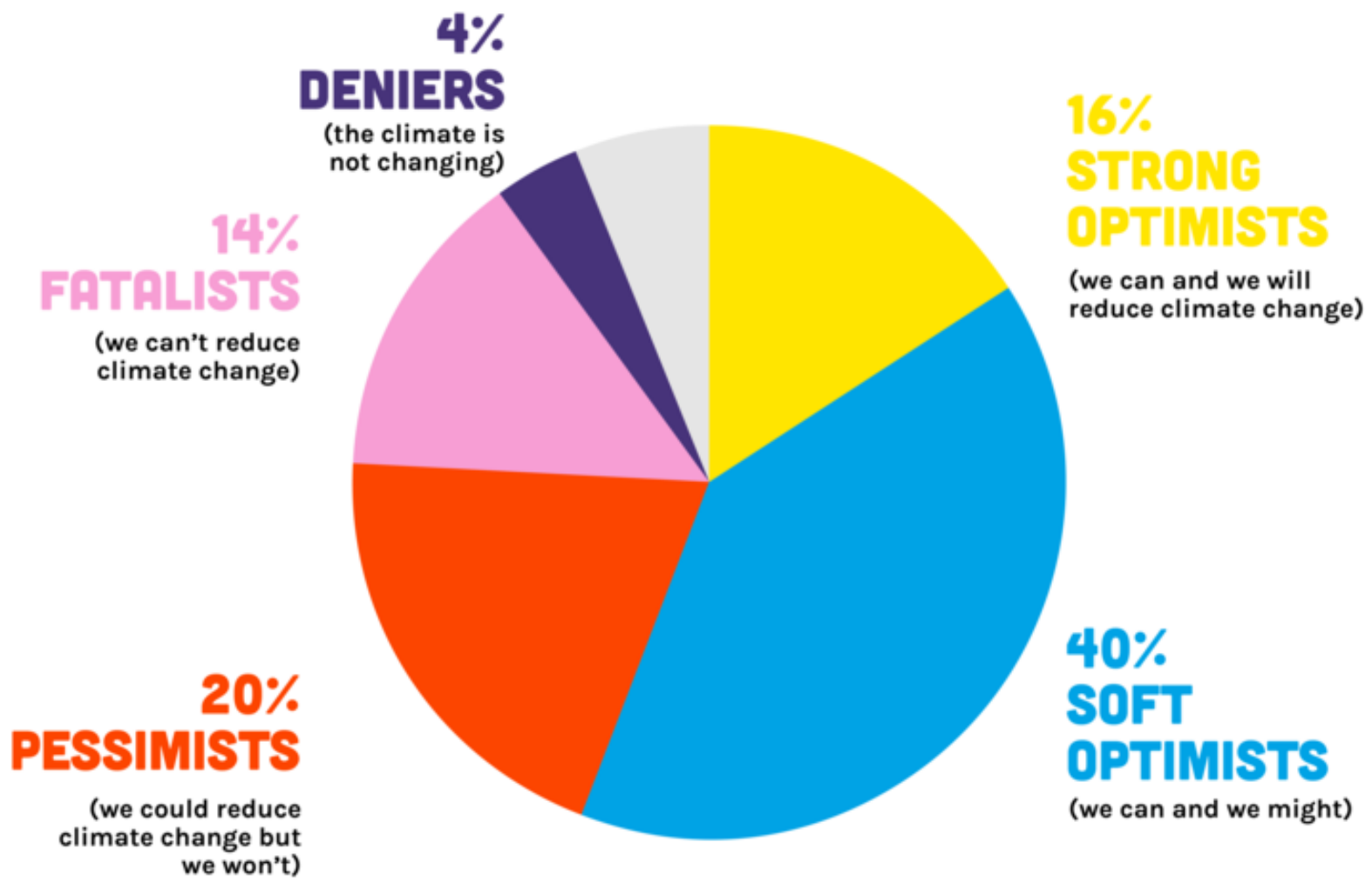
# Death of gas and diesel begins as GM announces plans for ‘all-electric future’

By **Peter Holley** October 2 at 2:53 PM 

Wash Post

After nearly a century of building vehicles powered by fossil fuels, General Motors — one of the world’s largest automakers — announced Monday that the end of GM producing internal combustion engines is fast approaching.

The acceleration to an all-electric future will begin almost immediately, with GM releasing two new electric models next year and an additional 18 by 2023.



Climateoptimist.org

- “Higher temperatures and less-predictable weather would hurt poor farmers [...] It would be a terrible injustice to let climate change undo any of the past half-century’s progress against poverty and disease—and doubly unfair because the people who will be hurt the most are the ones doing the least to cause the problem.”

LinkedIn.com



# What can **you** do?

- Be mindful of how choices you make today influence the lives for your and other folks' grandchildren
- Denialism and alarmism are both symptoms of doomsday thinking, be wary of either position
- Seemingly small changes in habits of transportation, energy use, efficiency, many of which require limited government role, can influence your community, might even save money, & make a big impact
- Some level of climate change is inevitable, so local adaptation to flooding, extreme heat, sea level are an essential role for local governments

# THANKS!

- [desai@aos.wisc.edu](mailto:desai@aos.wisc.edu)

Don't be afraid, be curious

