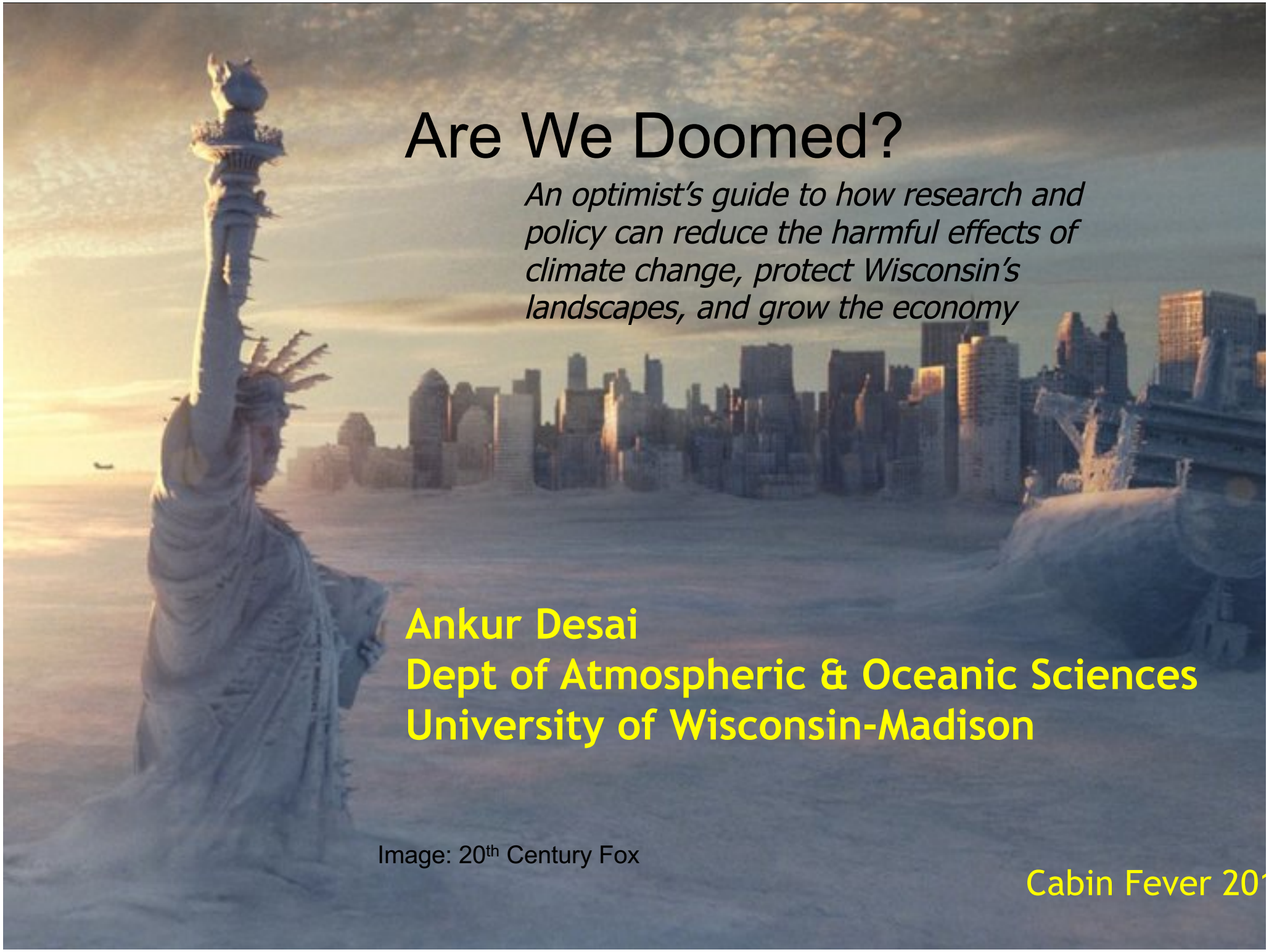


Are We Doomed?

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: 20th Century Fox

Cabin Fever 20

Three things about me

Three things about me

- I was born and raised in New Jersey

PHILLYSKYLINE.COM : ATLANTIC CITY FRO

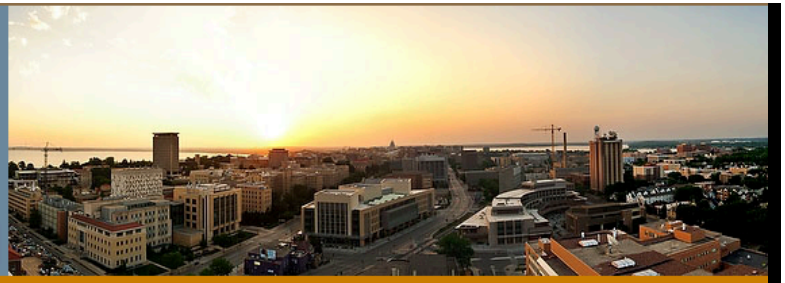
Three things about me

- 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



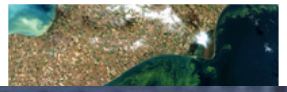
THE NELSON INSTITUTE FOR ENVIRONMENTAL STUDIES | UNIVERSITY OF WISCONSIN-MADISON

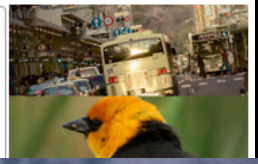
ABOUT | CCR NEWS | RESEARCH | RESOURCES | SUPPORT CC

Welcome to CCR

- Biogeochemistry

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





- Climate Impacts
- Land Surface Processes
- Oceanography and Limnology
- Past Climates

North Temperate Lakes Long Term Ecological Resear

Member of the US LTER Network

Welcome to NTL-LTER

North Temperate Lak
sites established by t
and changing land us
present, future).

Our primary study sit
their surrounding lan
Limnology at the Uni

University of Wisconsin-Madison

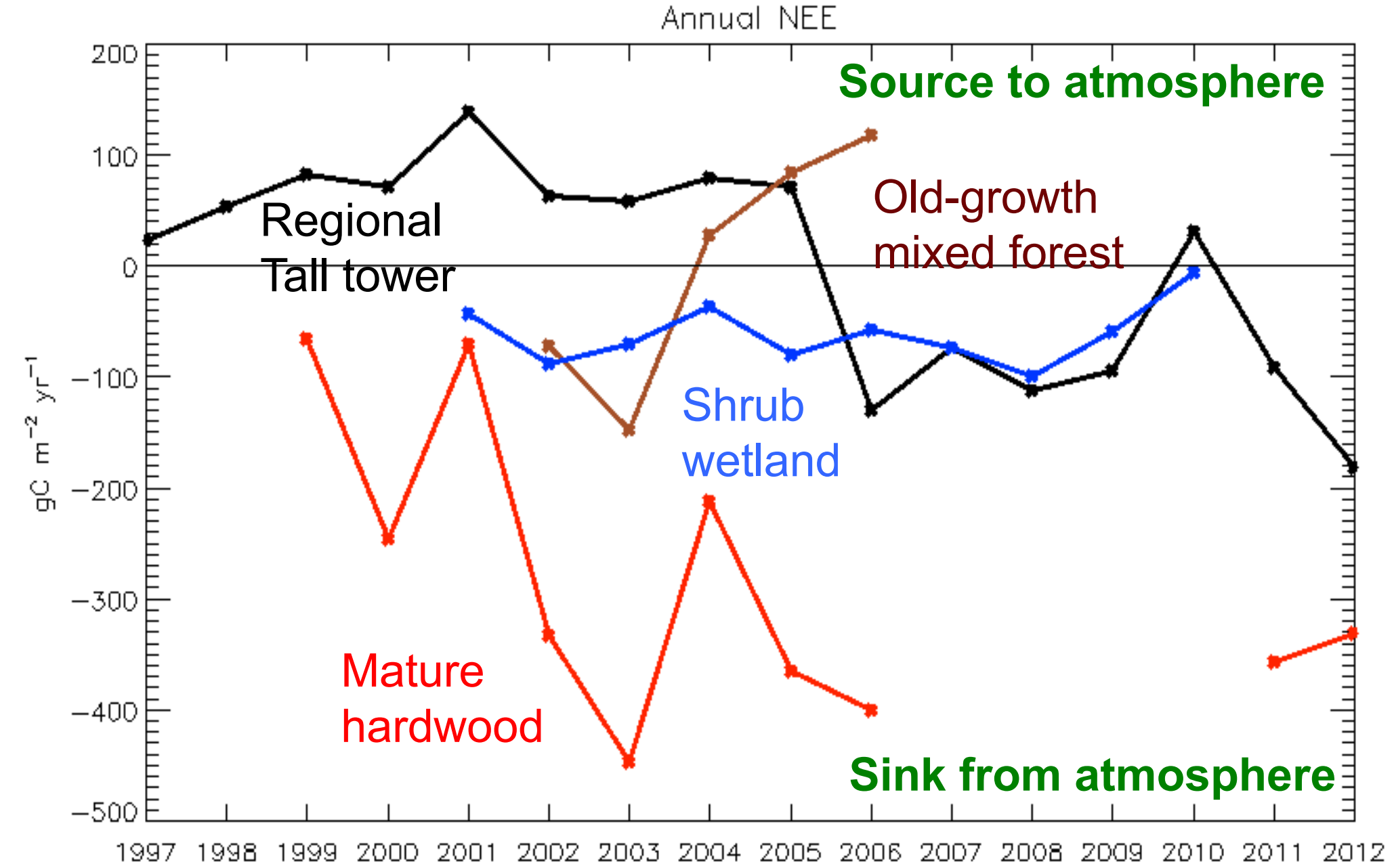
Department of Atmospheric and Oceanic Sciences

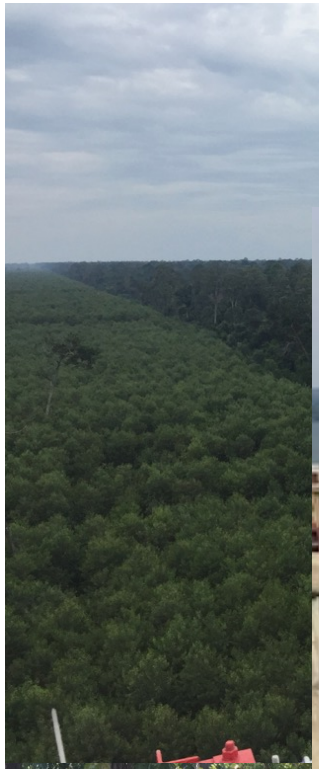
Who We Are

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:

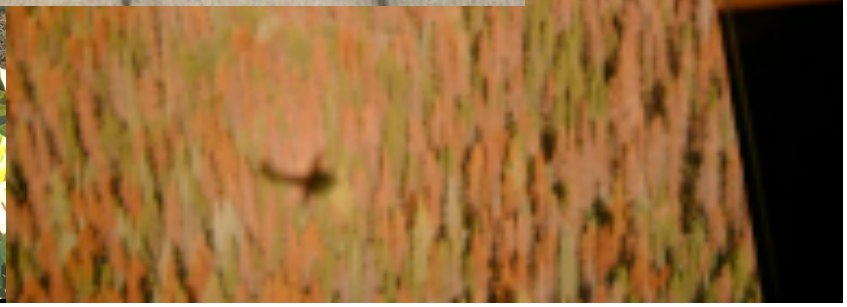
- Climate systems, including the ocean
- Satellite and remote sensing
- Weather systems, including synoptic-dynamic meteorology


Annual NEE
Source to atmosphere
Regional
Tall tower
Old-growth
mixed forest
Shrub
wetland
Mature
hardwood
Sink from atmosphere
gC m^{-2} yr^{-1}
200
100
0
−100
−200
−300
−400
−500
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012



Waneta
W9968-5

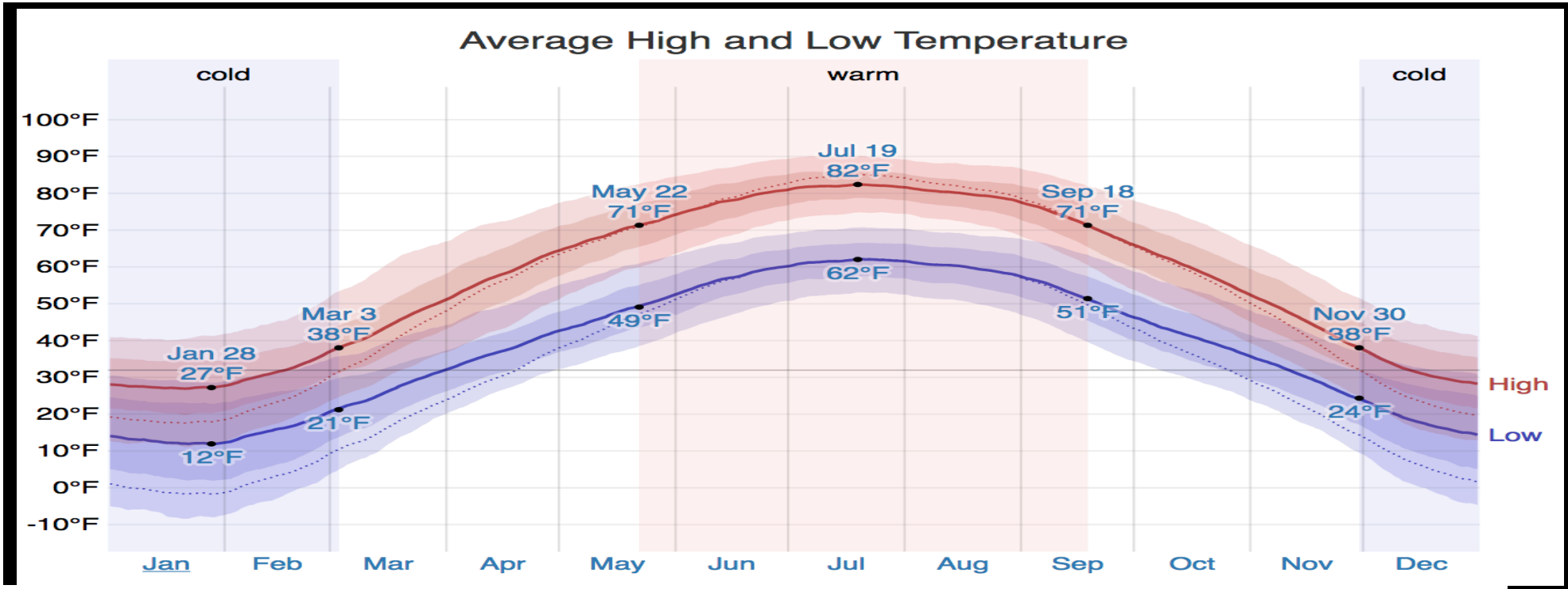


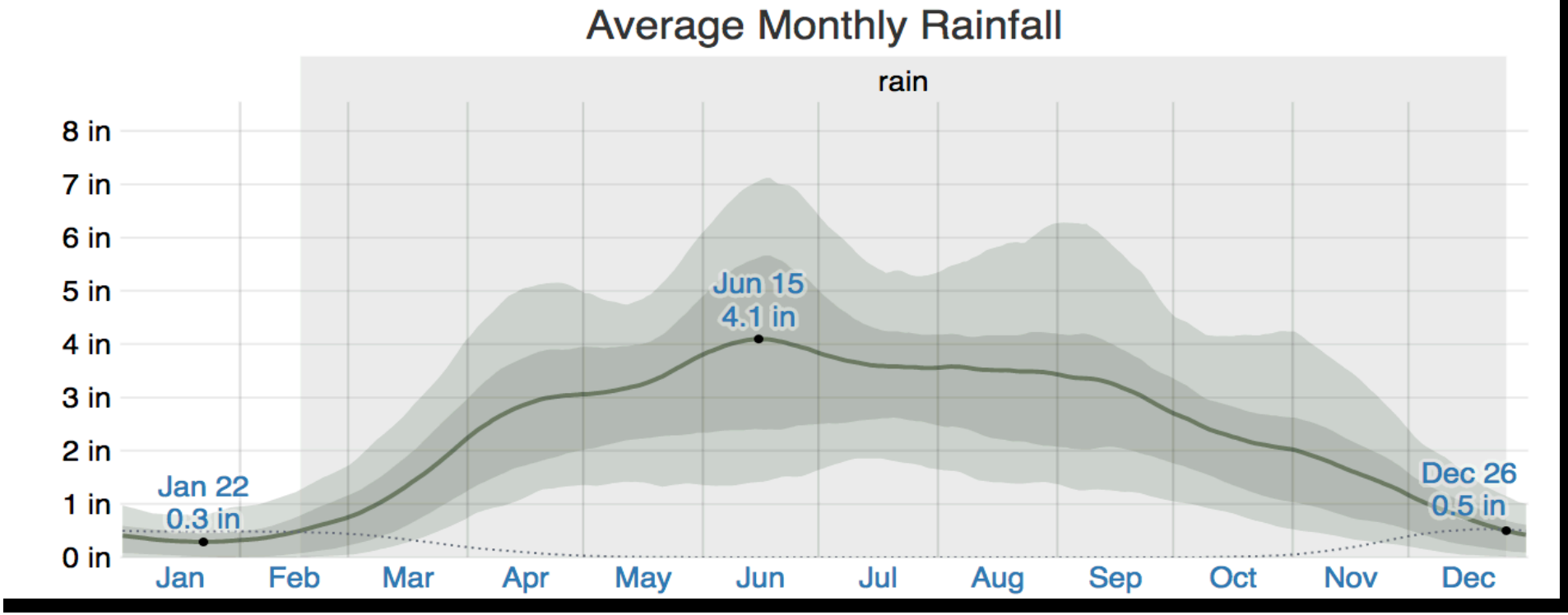



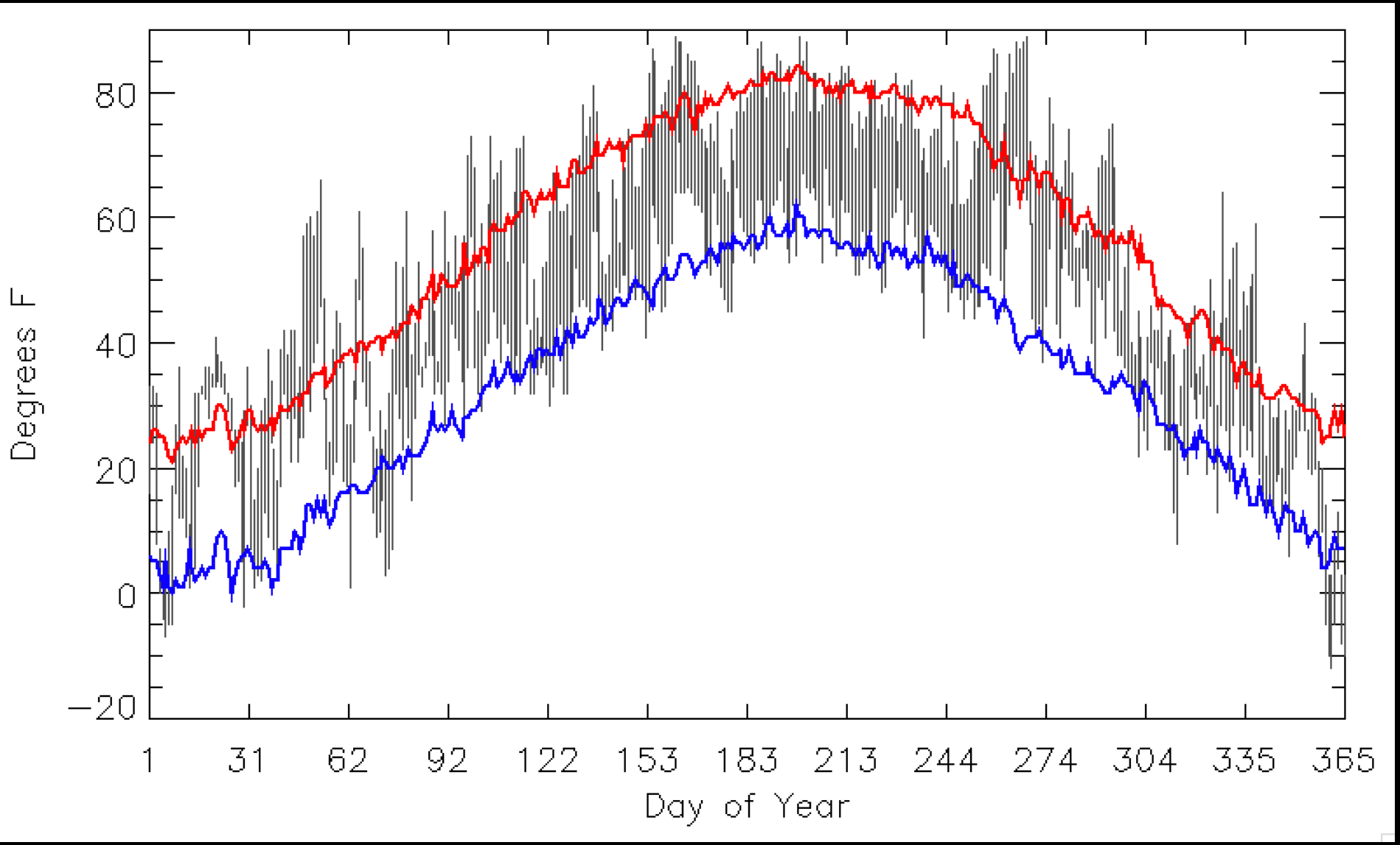
Three things about climate

Three things about climate

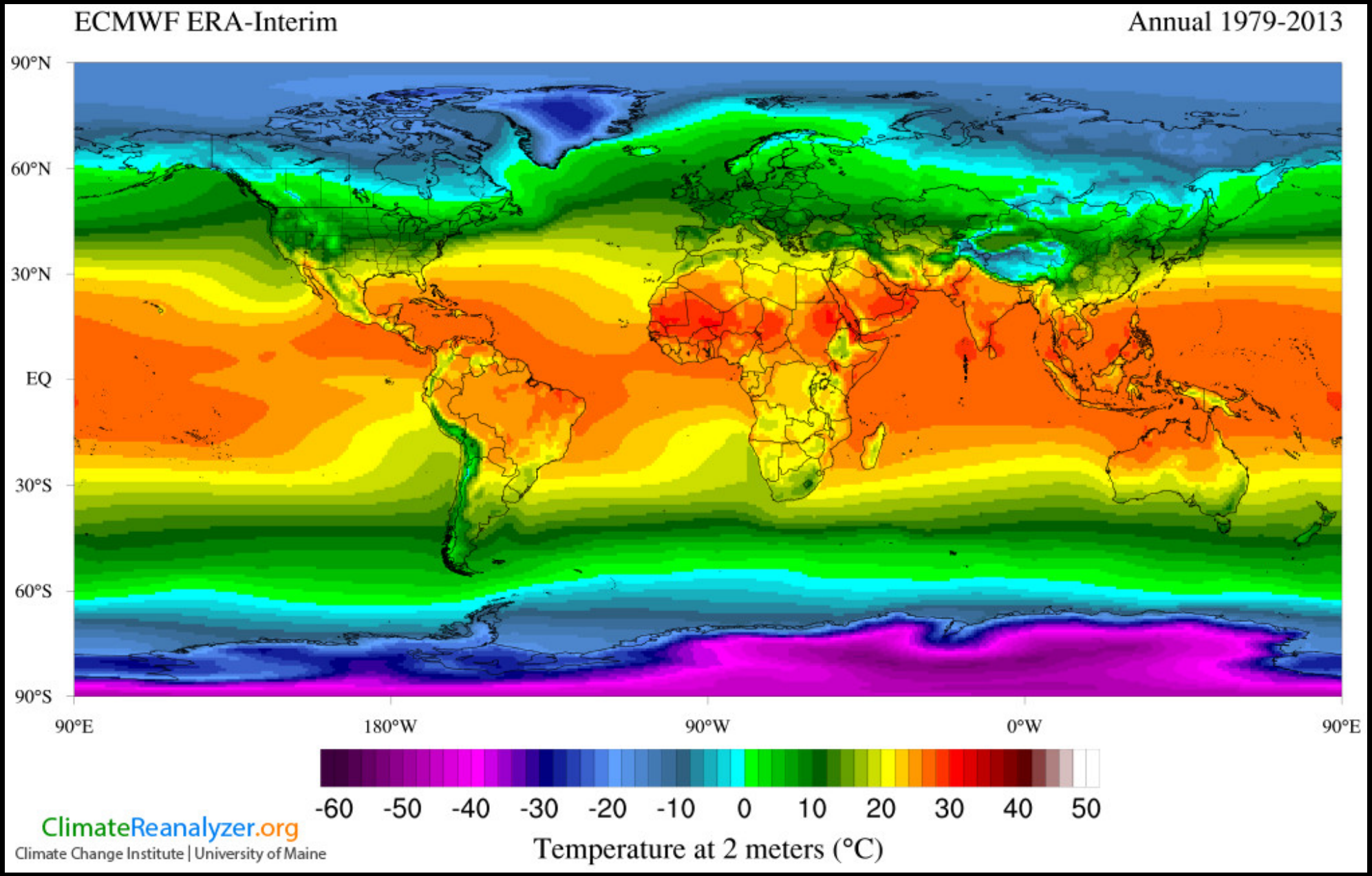
- Climate is the average of weather


Average High and Low Temperature
cold
warm
cold
100°F
90°F
80°F
70°F
60°F
50°F
40°F
30°F
20°F
10°F
0°F
-10°F
Jan 28
27°F
12°F
Mar 3
38°F
21°F
May 22
71°F
49°F
Jul 19
82°F
62°F
Sep 18
71°F
51°F
Nov 30
38°F
24°F
High
Low
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

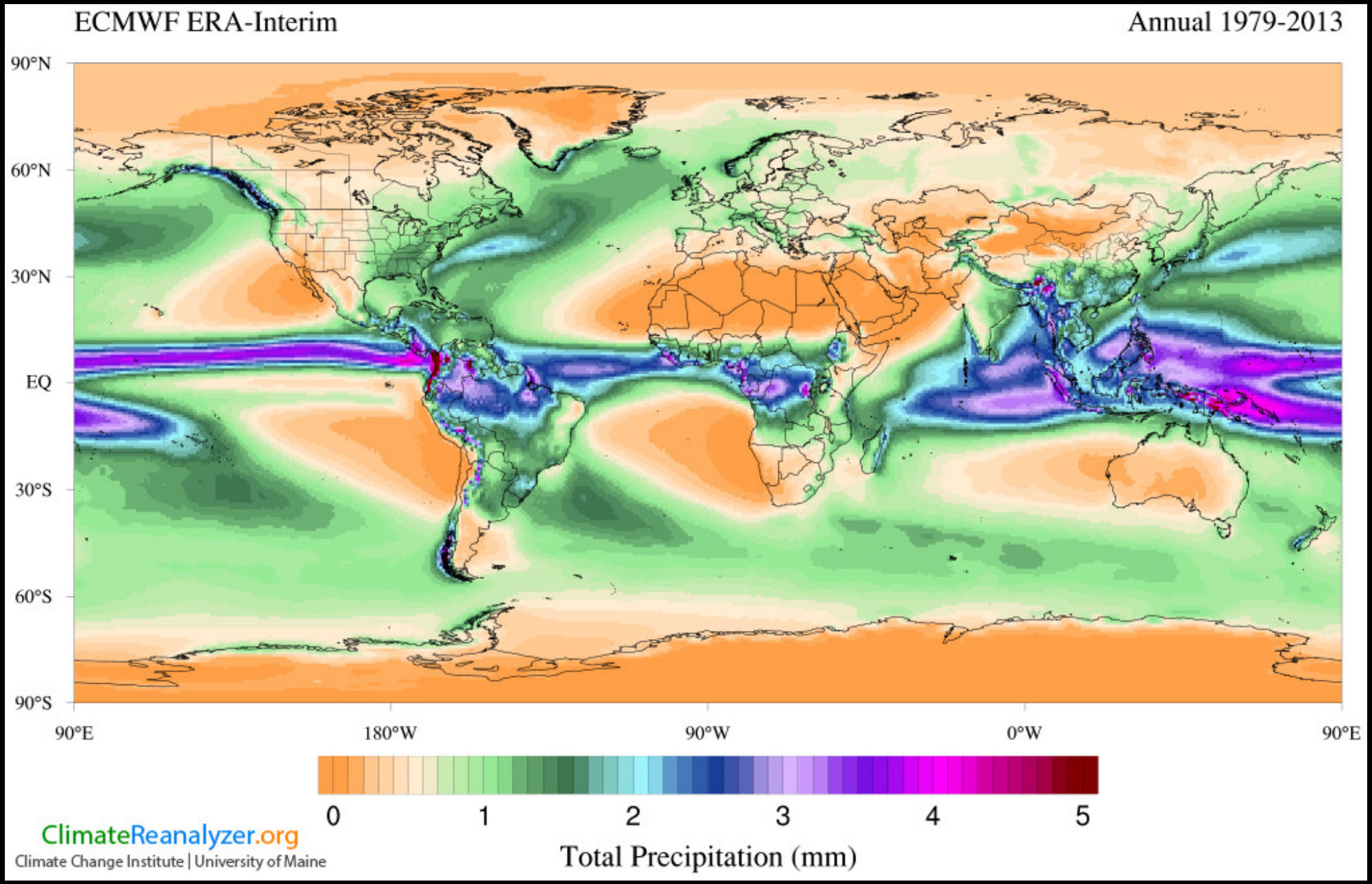

Average Monthly Rainfall
rain
8 in
7 in
6 in
5 in
4 in
3 in
2 in
1 in
0 in
Jan 22
0.3 in
Jun 15
4.1 in
Dec 26
0.5 in
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Baraboo, WI
2000-2010 average high and low temperature and 2017 weather



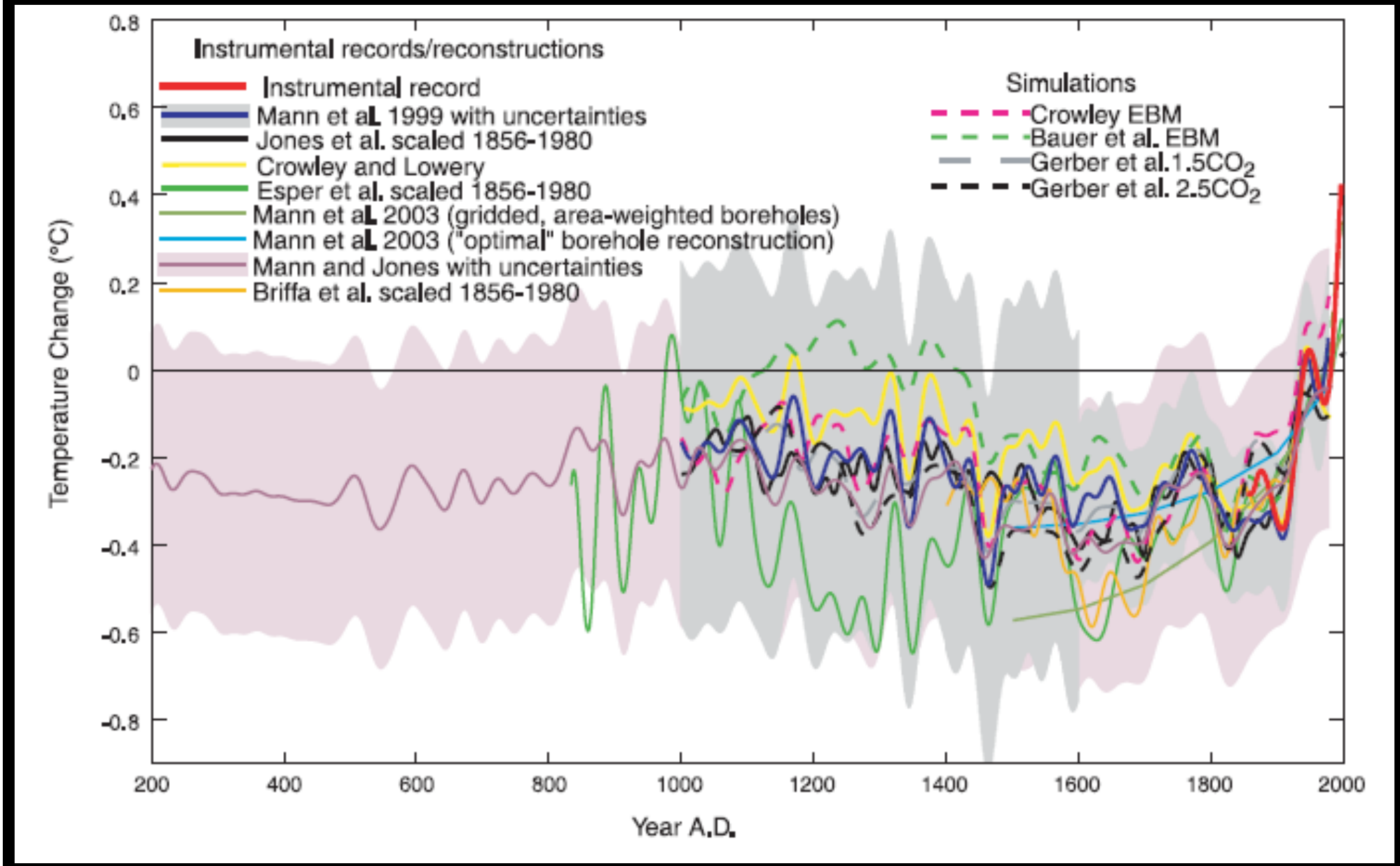
http://cci-reanalyzer.org/



http://cci-reanalyzer.org/

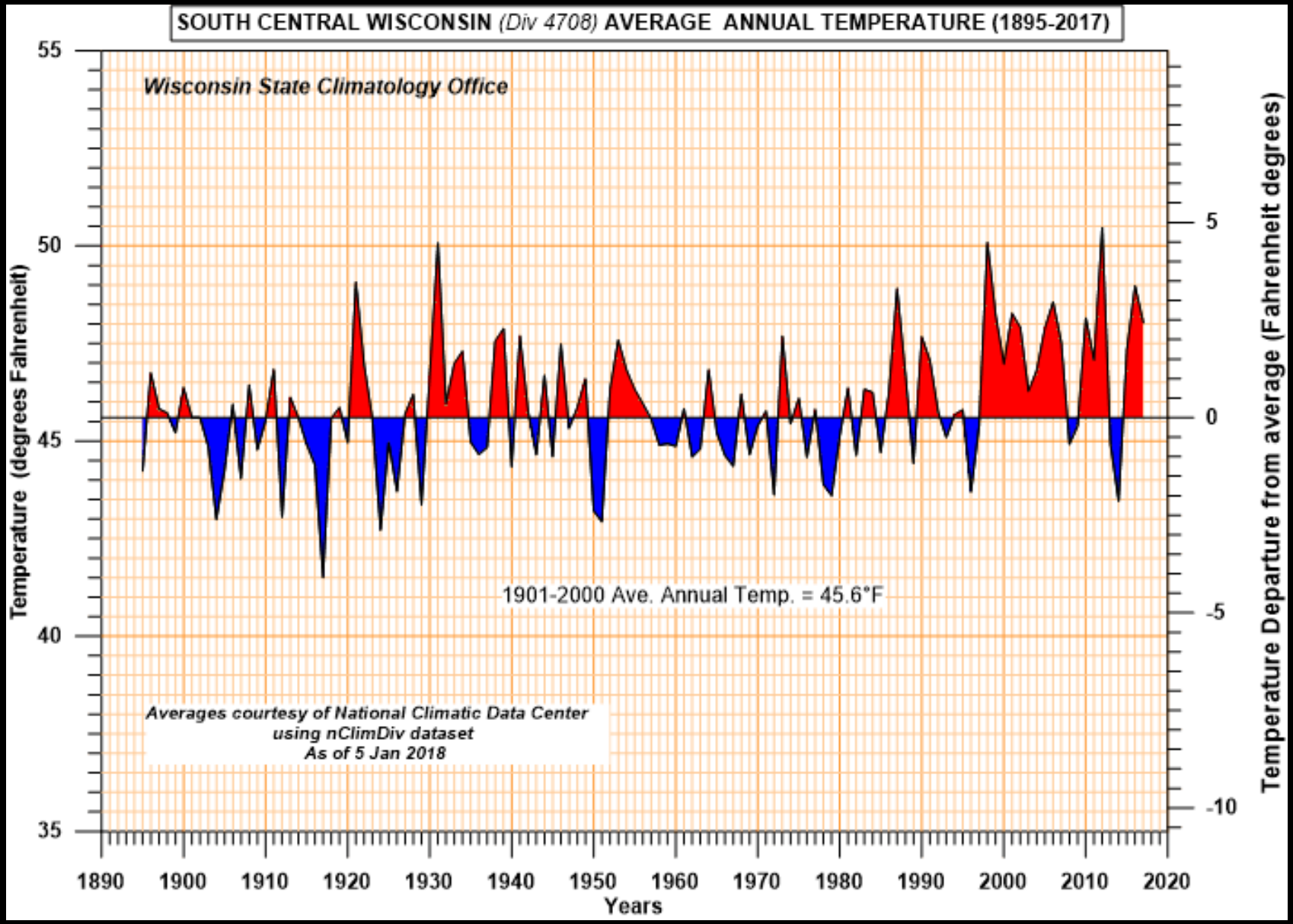
Three things about climate

- Climate is the average of weather
- Climate changes naturally and by humans

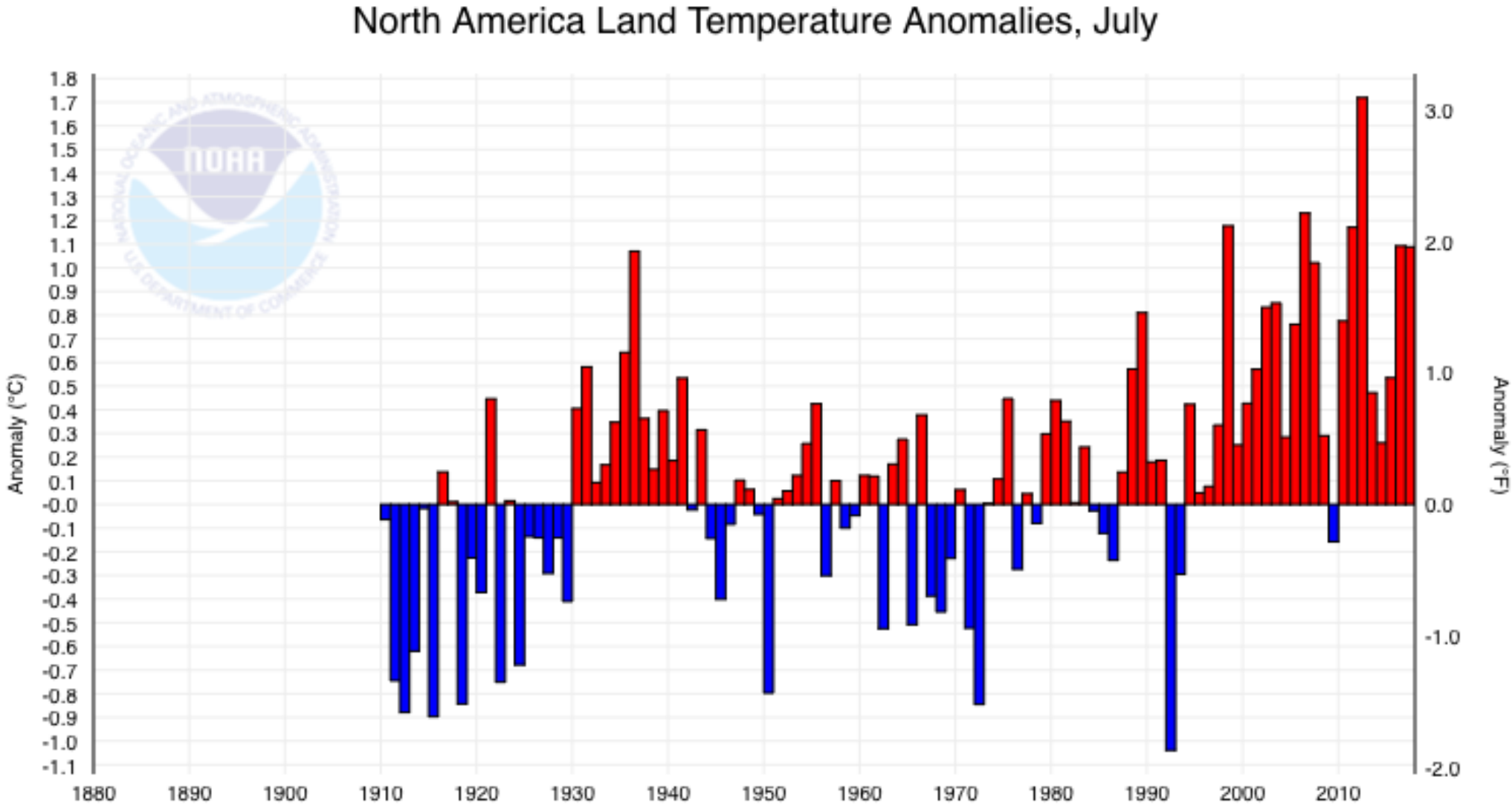


Mann et al., 2003, EOS

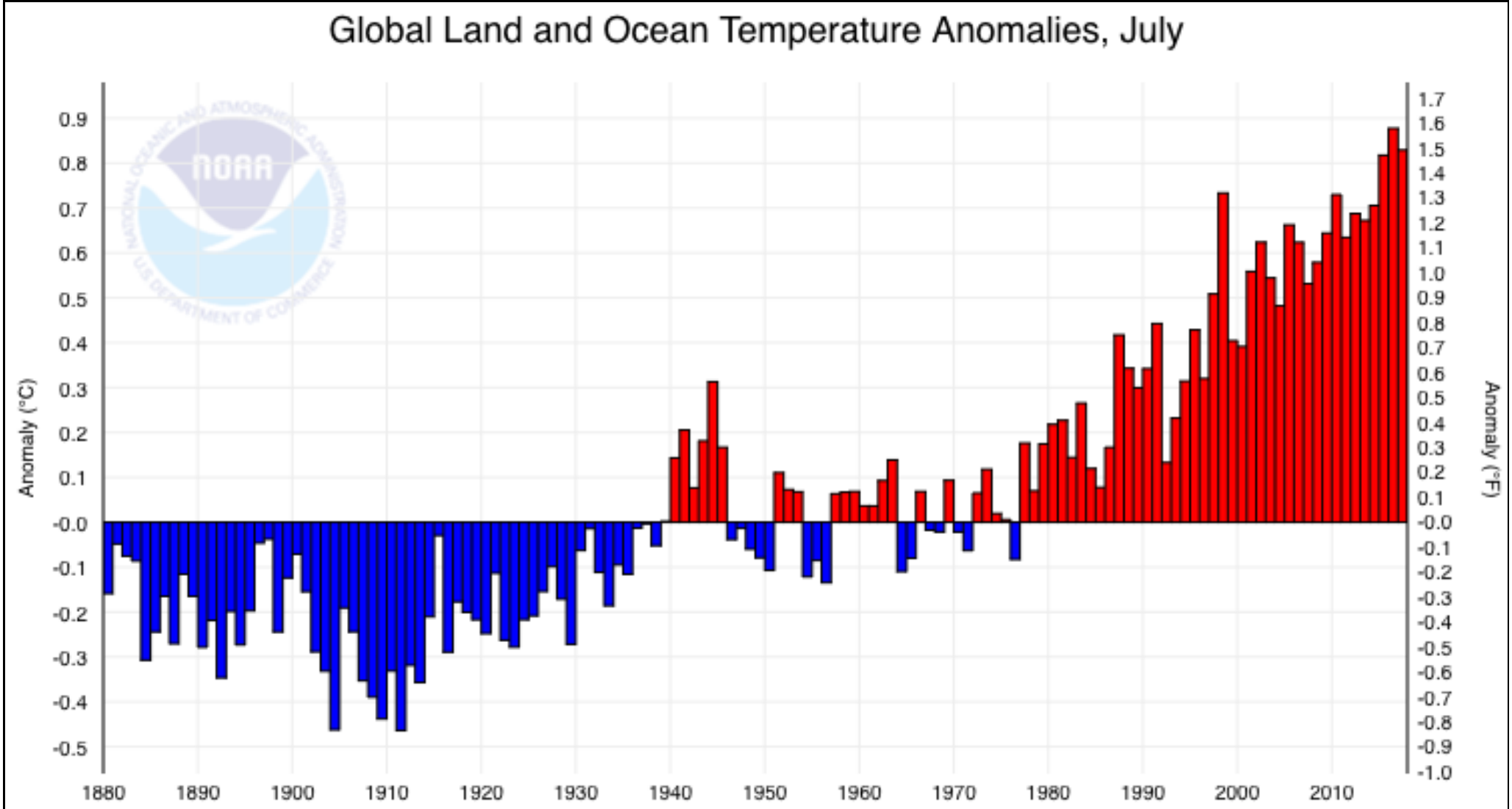
SC Wisconsin

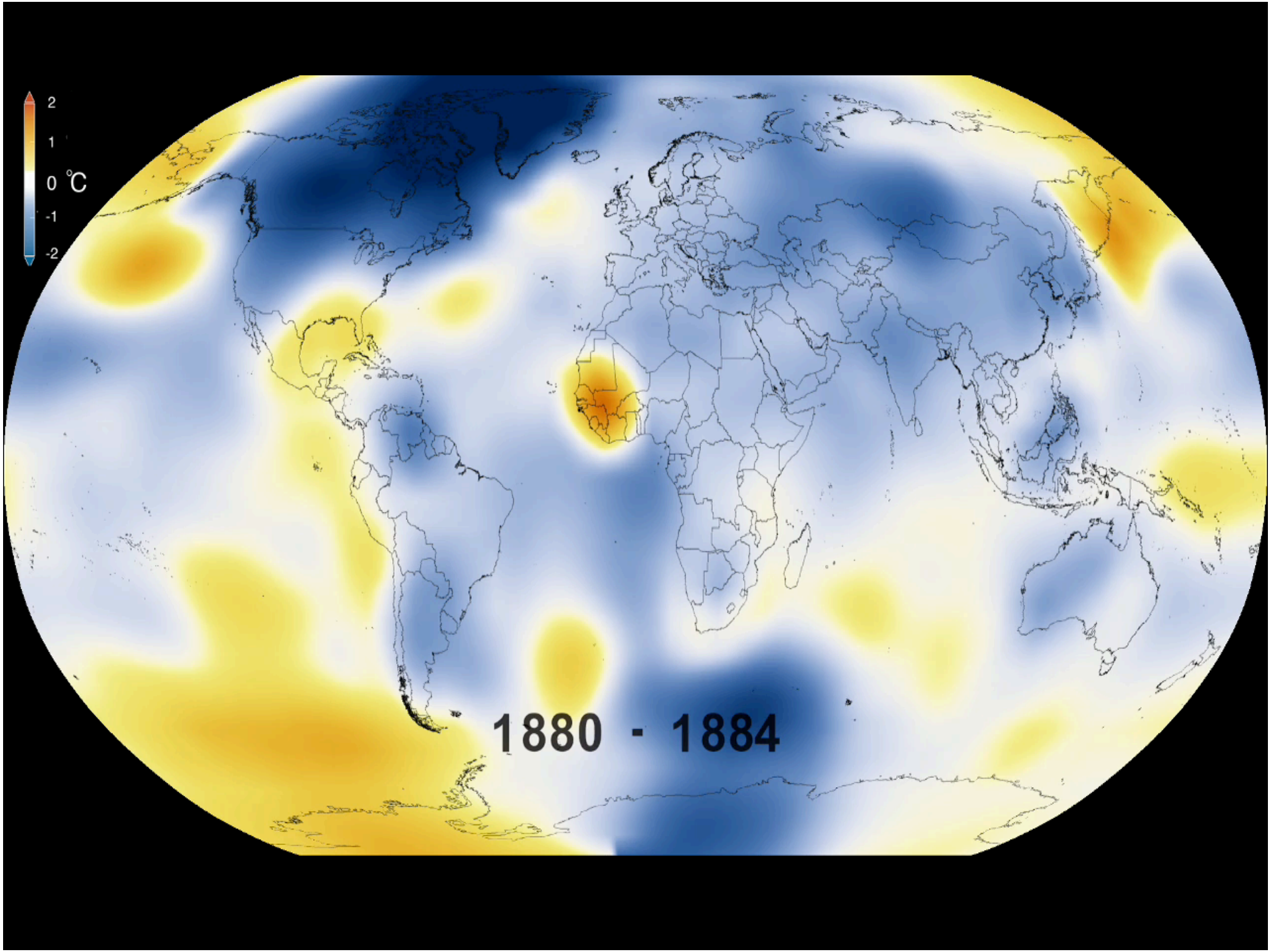


N America


North America Land Temperature Anomalies, July
Anomaly (°C)
Anomaly (°F)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
3.0
2.0
1.0
0.0
-1.0
-2.0
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

WORLD

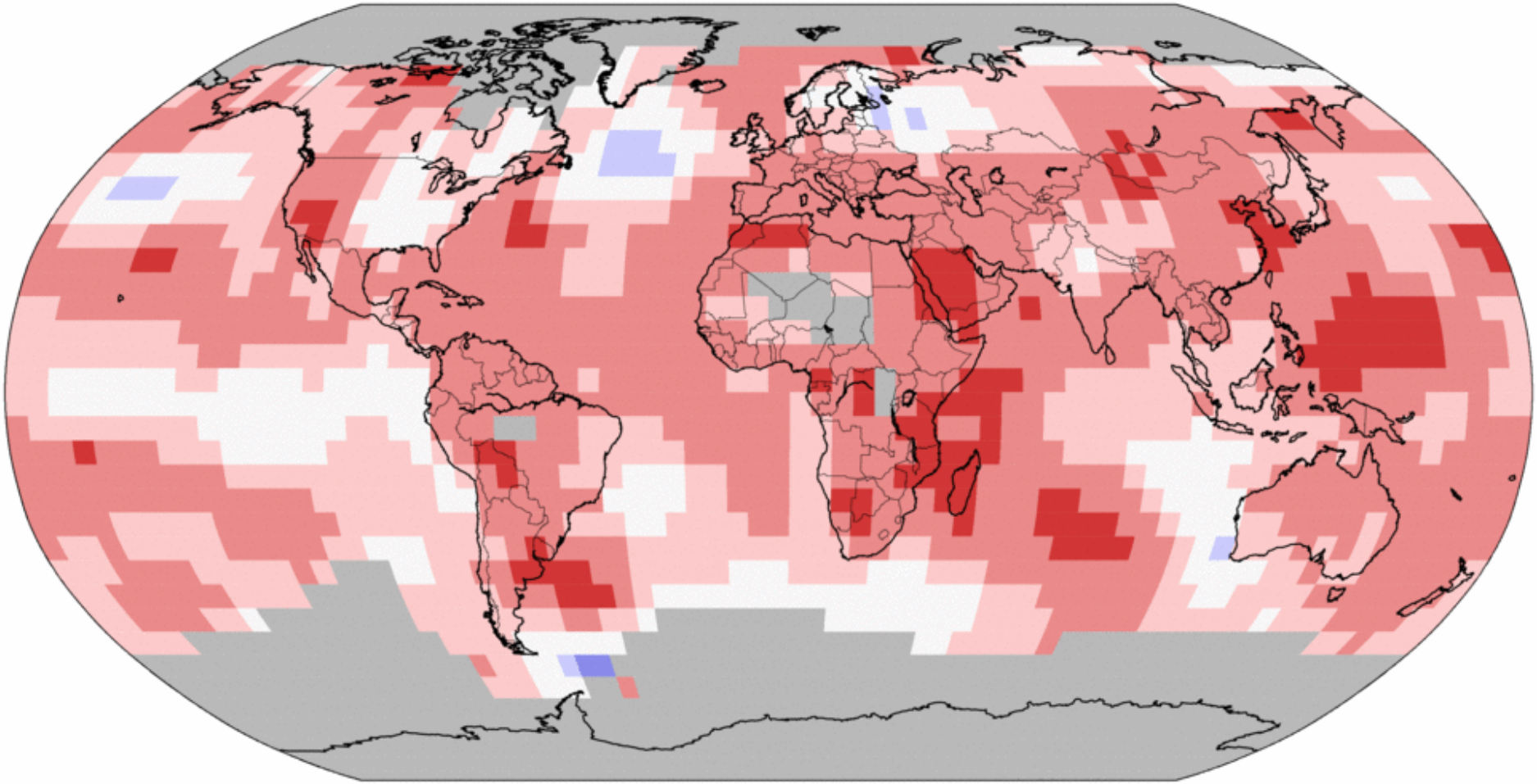

Global Land and Ocean Temperature Anomalies, July
Anomaly (°C)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-0.0
-0.1
-0.2
-0.3
-0.4
-0.5
Anomaly (°F)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010


2
1
0 °C
-1
-2
1880 - 1884

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

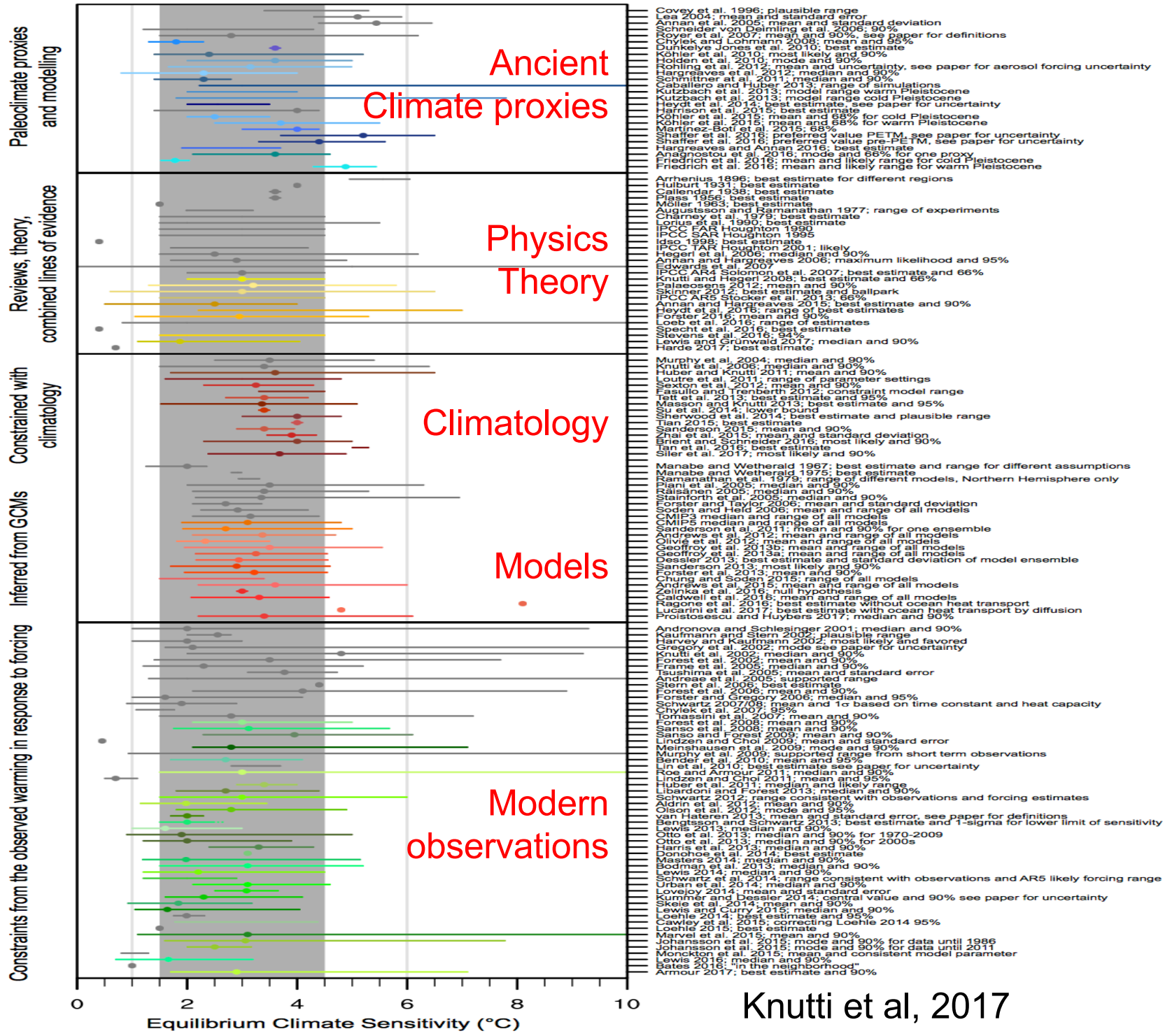
Wed Sep 13 07:29:21 EDT 2017

Three things about climate

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

Planet
E

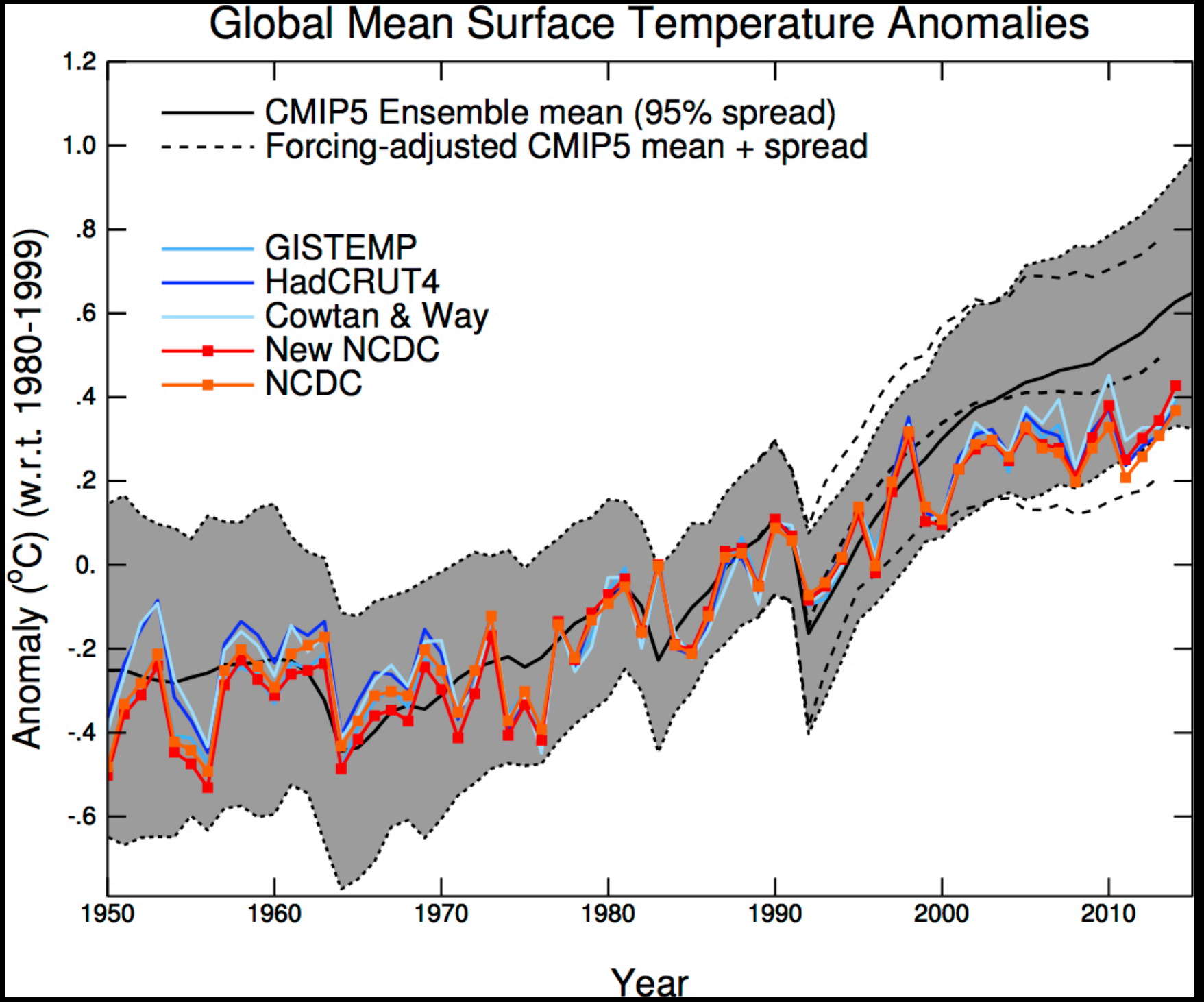
In most general terms, the Earth's temperature is determined by the balance between incoming energy from the sun and the heat it radiates back to space.

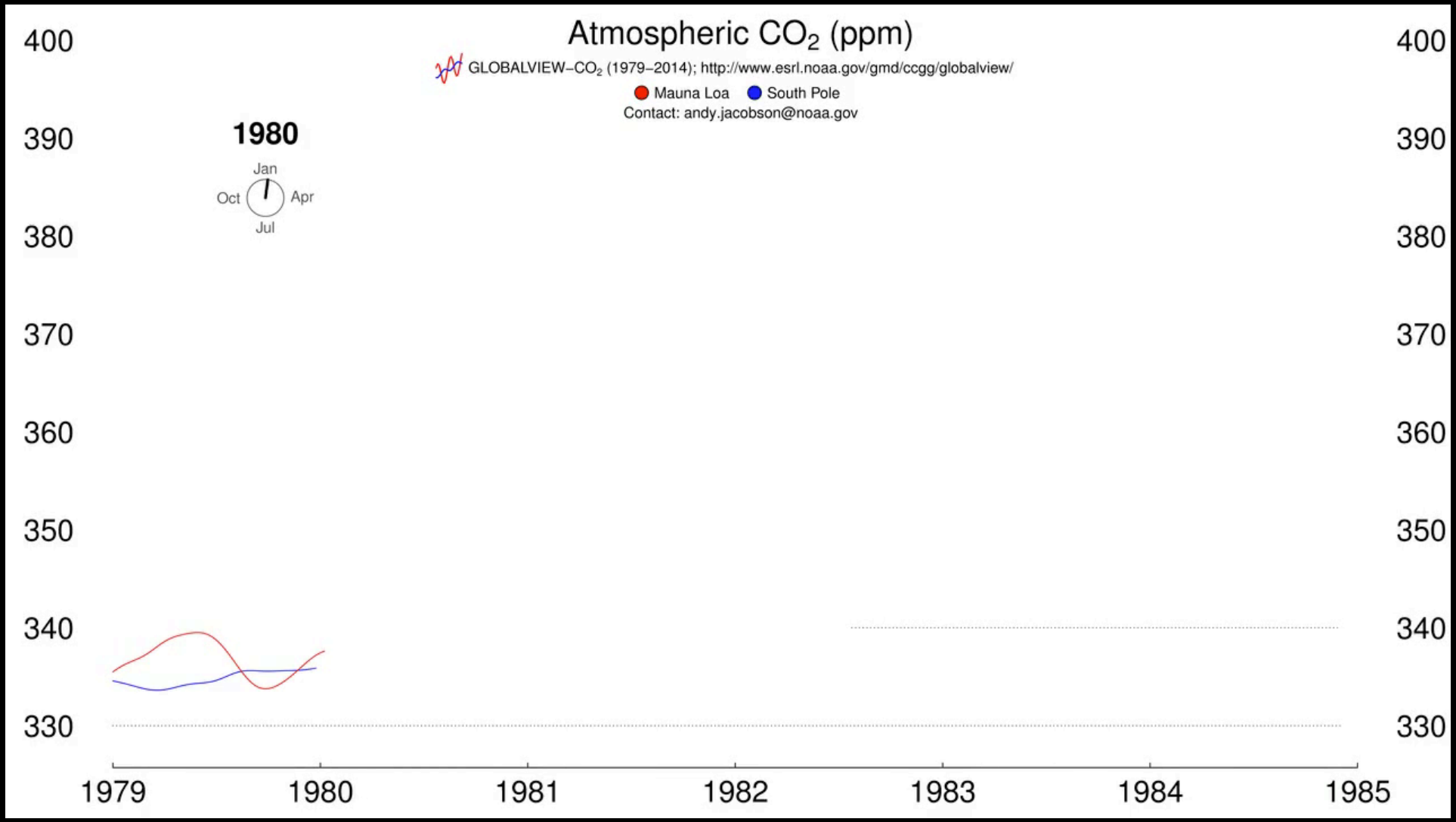


Knutti et al, 2017


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.
1880
1880
2014
Colder
Based on an interactive by Bloomberg

Bloomberg


Global Mean Surface Temperature Anomalies
CMIP5 Ensemble mean (95% spread)
Forcing-adjusted CMIP5 mean + spread
GISTEMP
HadCRUT4
Cowtan & Way
New NCDC
NCDC
Anomaly (°C) (w.r.t. 1980-1999)
1.2
1.0
.8
.6
.4
.2
0.
-.2
-.4
-.6
1950
1960
1970
1980
1990
2000
2010
Year

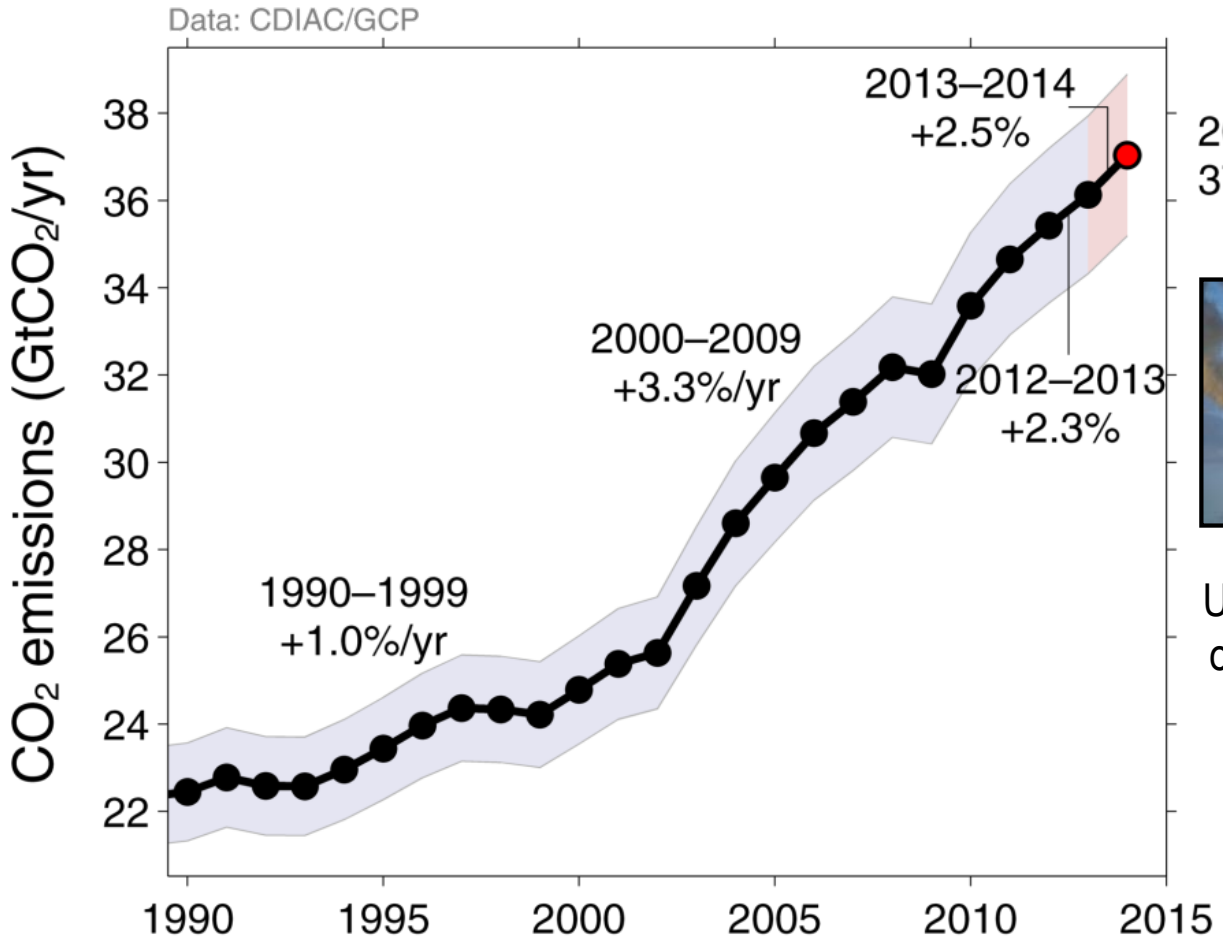


Other evidence: decreasing radiocarbon content of atmosphere, acidification of ocean, increased water use efficiency of plants, concentrations tracks emissions

Fossil Fuel and Cement Emissions

Global fossil fuel and cement emissions: 36.1 ± 1.8 $GtCO_2$ in 2013, 61% over 1990

- Projection for 2014 : 37.0 ± 1.9 $GtCO_2$, 65% over 1990



Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

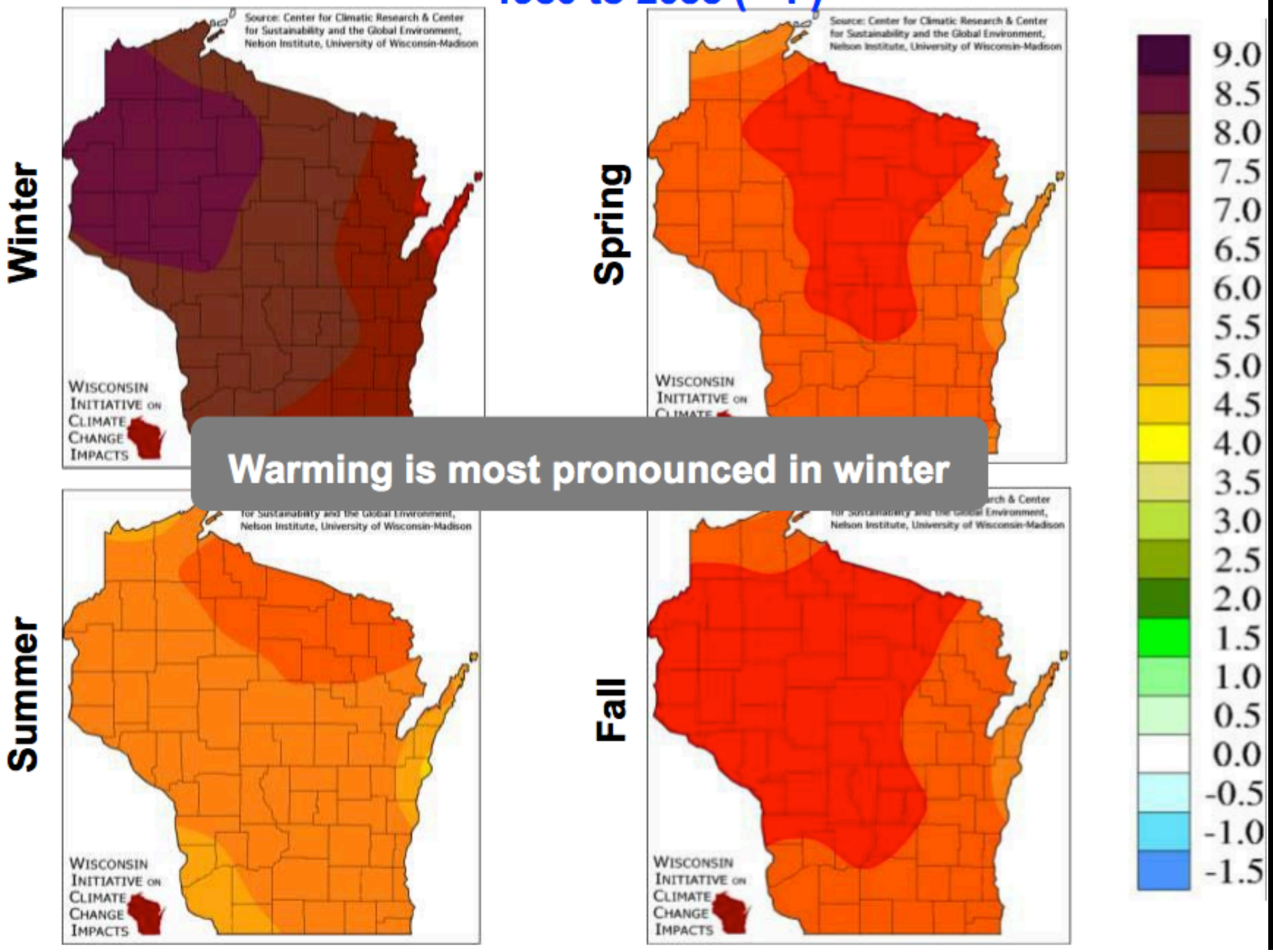
Estimates for 2011, 2012, and 2013 are preliminary

Source: CDIAC; Le Quéré et al 2014; Global Carbon Budget 2014

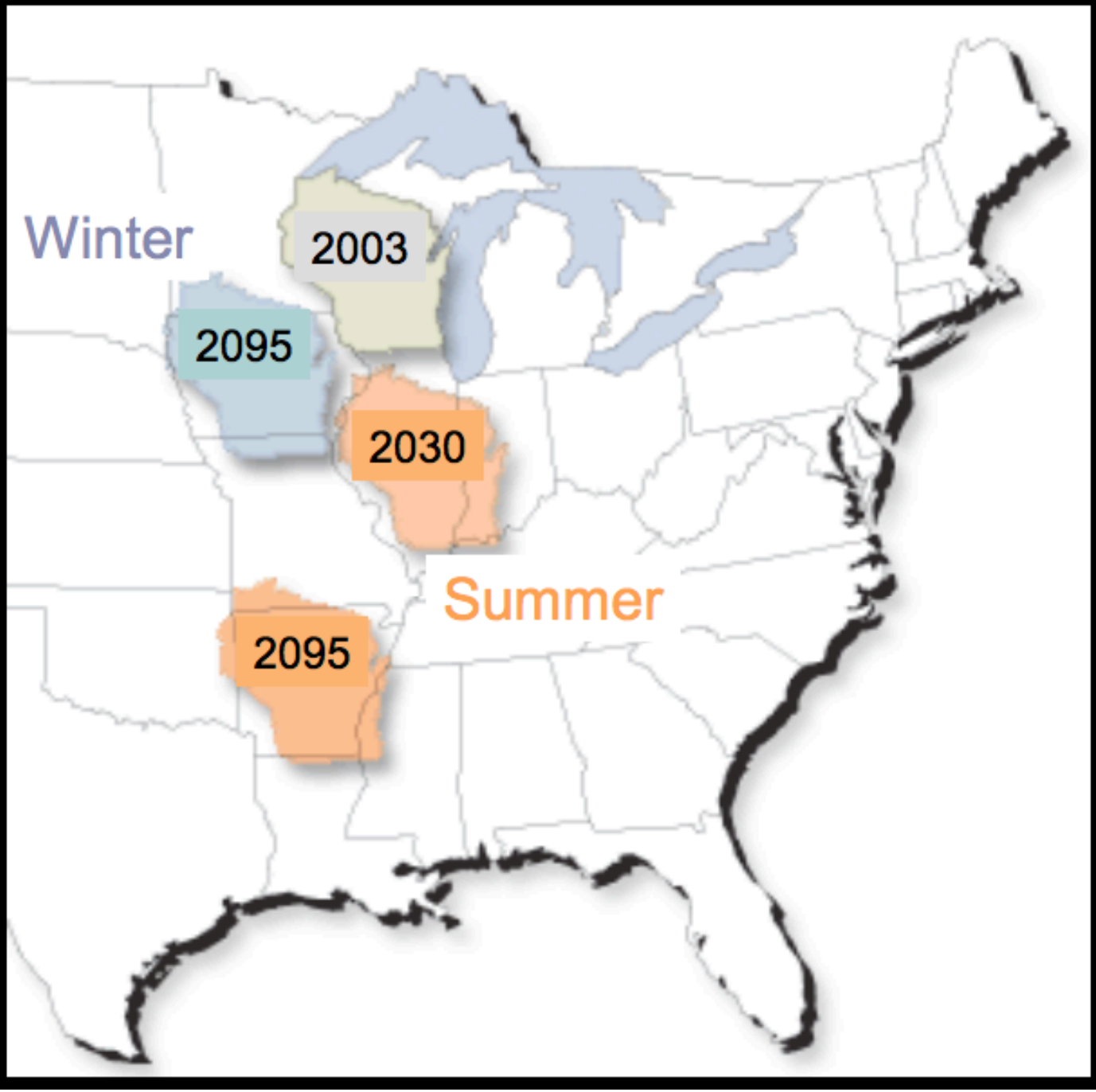
So what’s the big deal?

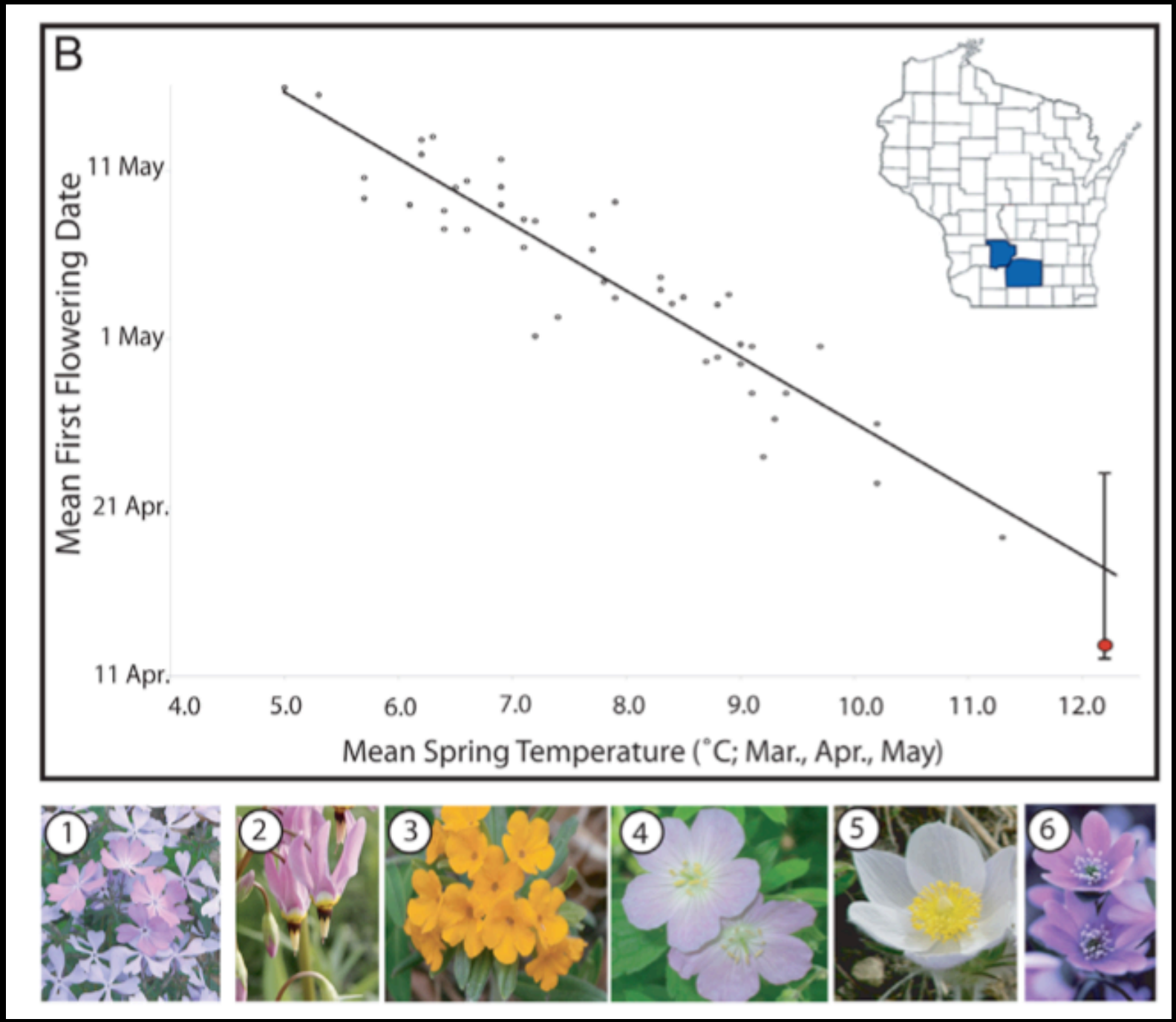
Projected Change in Seasonal Temperatures

1980 to 2055 (° F)



Wisconsin Migrating Climate





Ellwood et al., 2013

Earlier arrival of spring in Wisconsin

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

Nina Leopold Bradley

Photo: Jeffrey Phelps, Milw. Journal Sentinel

Leopold Shack

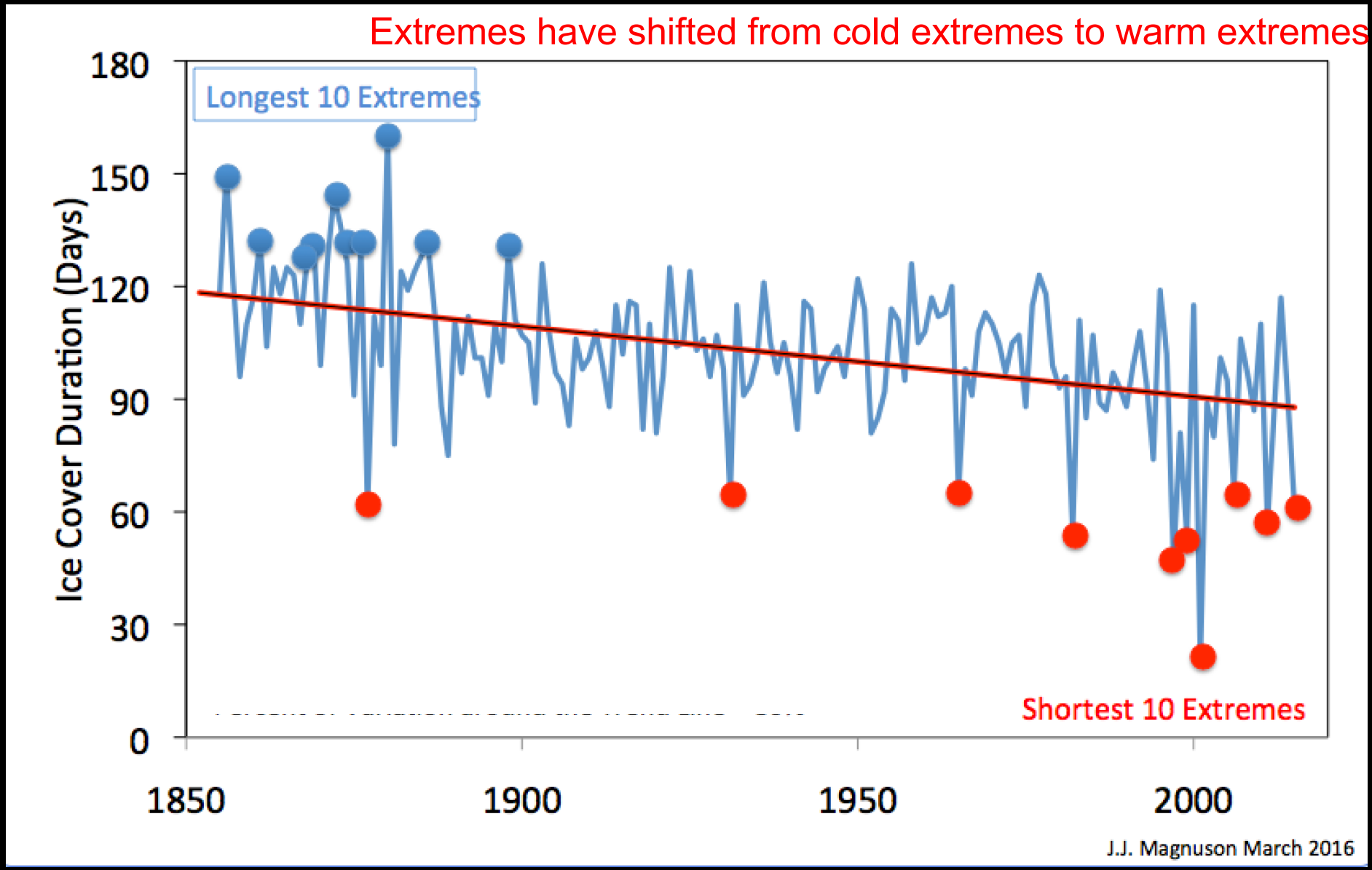
Photo: Aldo Leopold Foundation

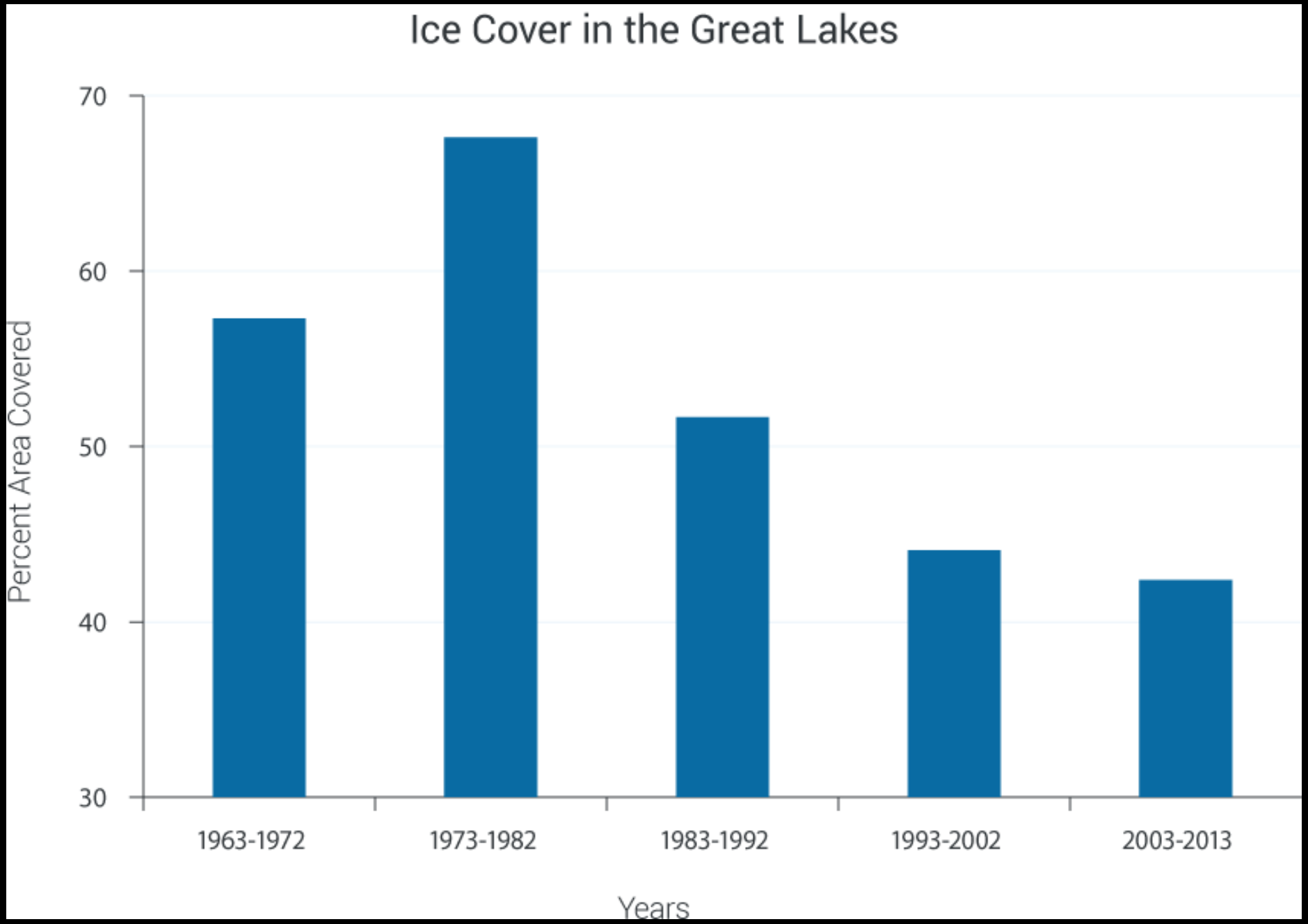
55 ecological indicators of spring occurred on average 1.2 days earlier per decade from 1936 to 1998.

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

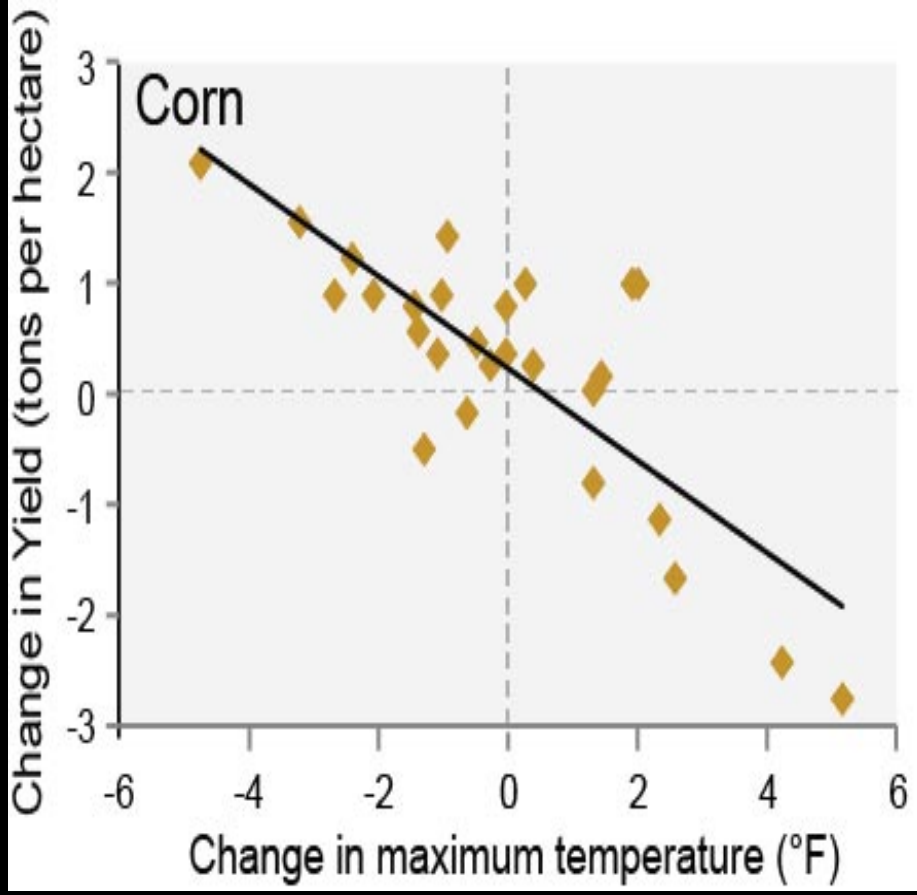
Slide adapted from C. Kucharik, UW-Madison

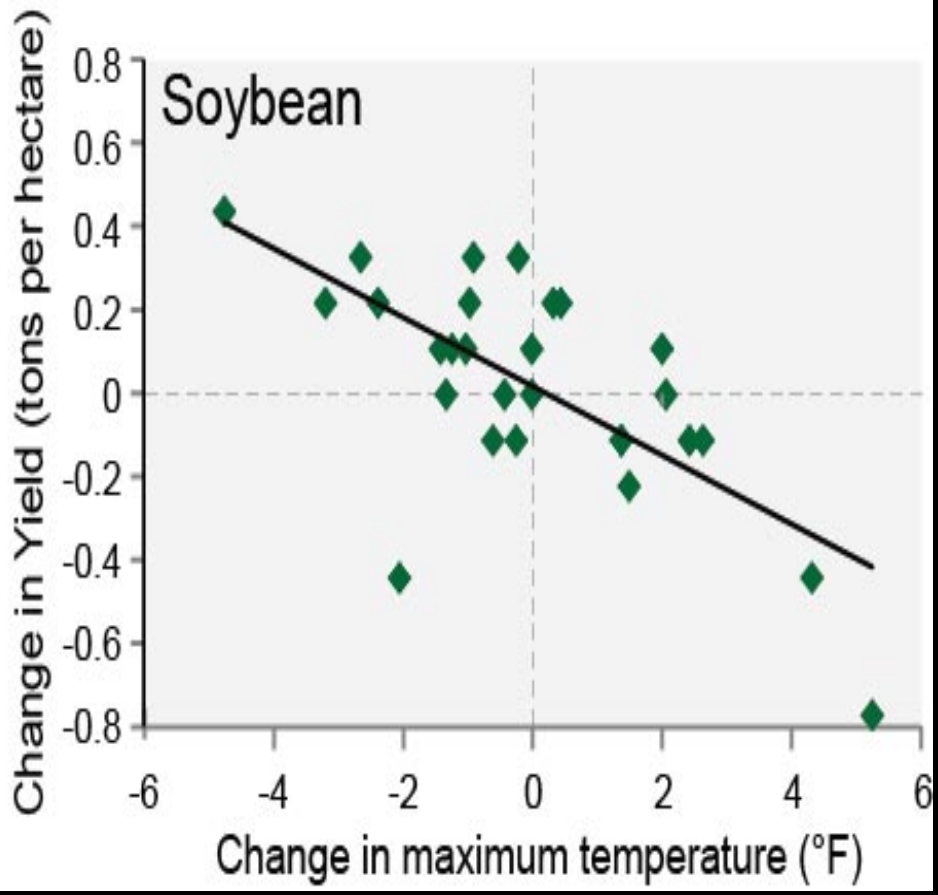
A change in Extreme Winters for Lake Mendota, Wisconsin

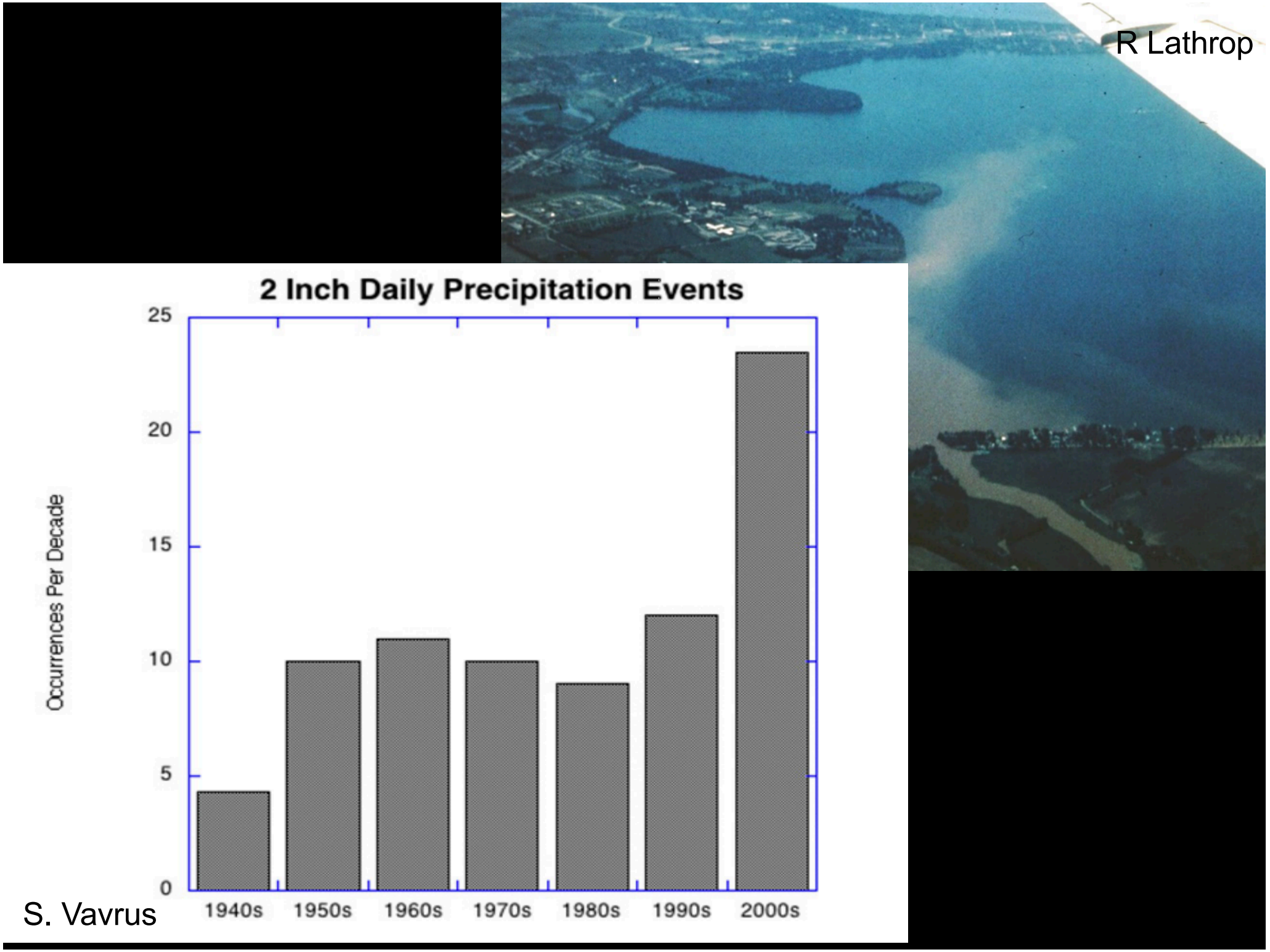



Ice Cover in the Great Lakes
70
60
50
40
30
Percent Area Covered
1963-1972
1973-1982
1983-1992
1993-2002
2003-2013
Years

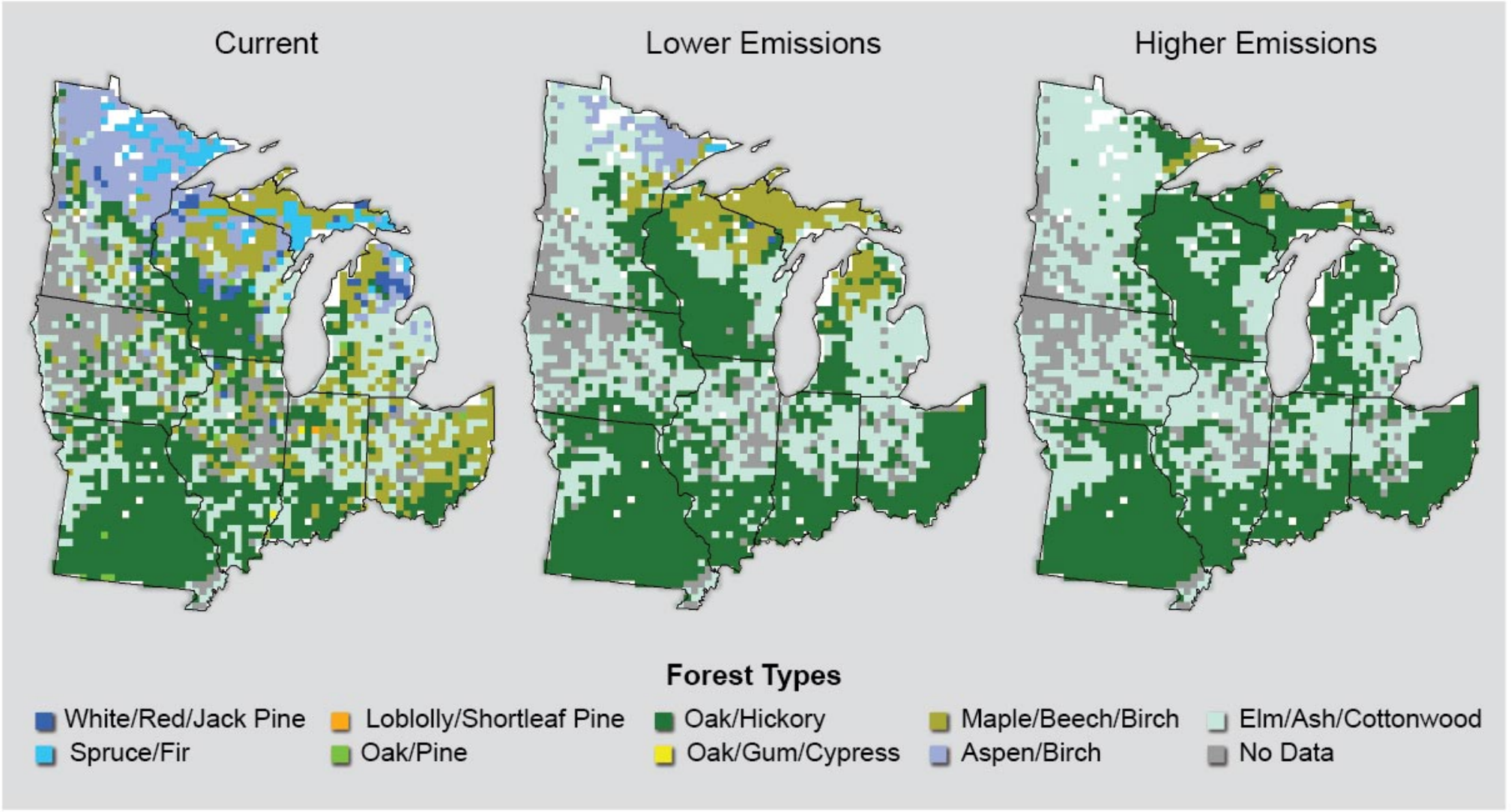
Crop Yields Decline under Higher Temperatures



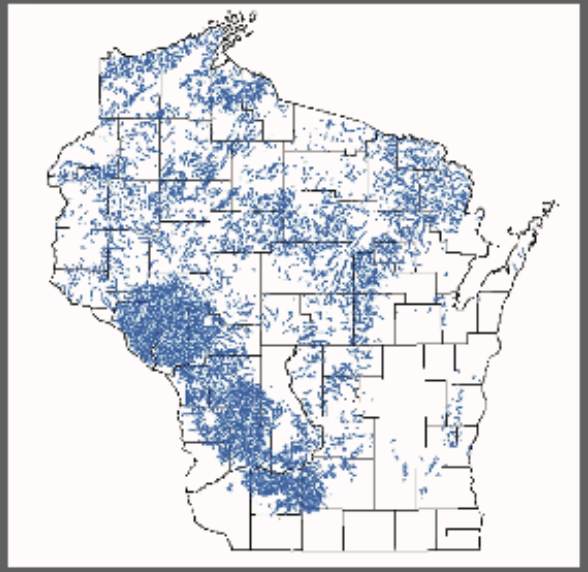



R Lathrop
2 Inch Daily Precipitation Events
Occurrences Per Decade
25
20
15
10
5
0
1940s
1950s
1960s
1970s
1980s
1990s
2000s
S. Vavrus

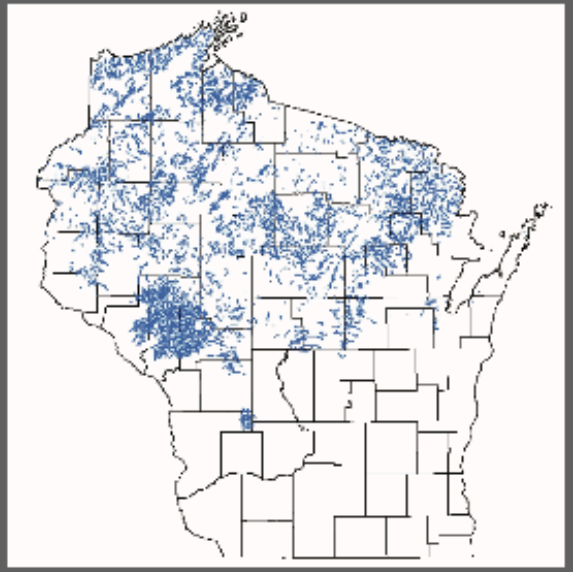
Forest Composition Shifts



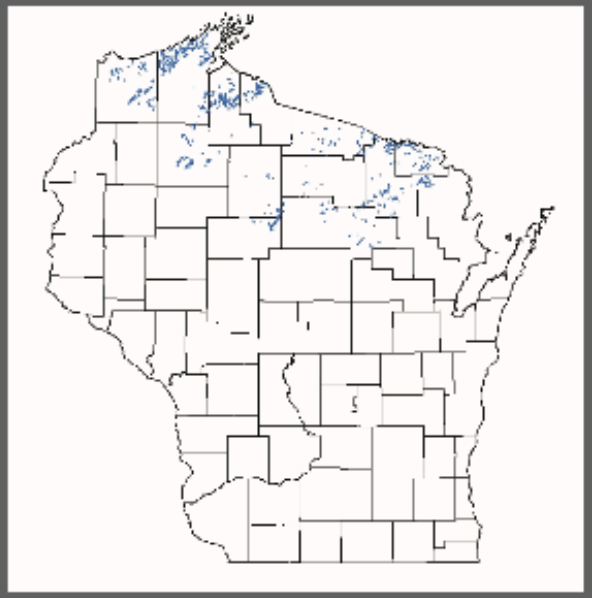
Brook trout streams
Source: WICCI



Current climate



Best case
+1.4°F = 44% loss

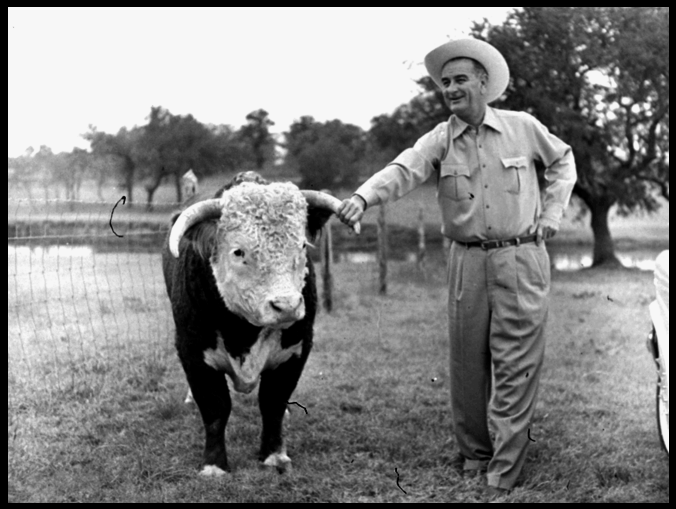


Moderate case
+4.3°F = 94% loss

Worst case
+7.2°F = total loss

Why aren’t we doing something about it then?

The continued release of CO_2 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

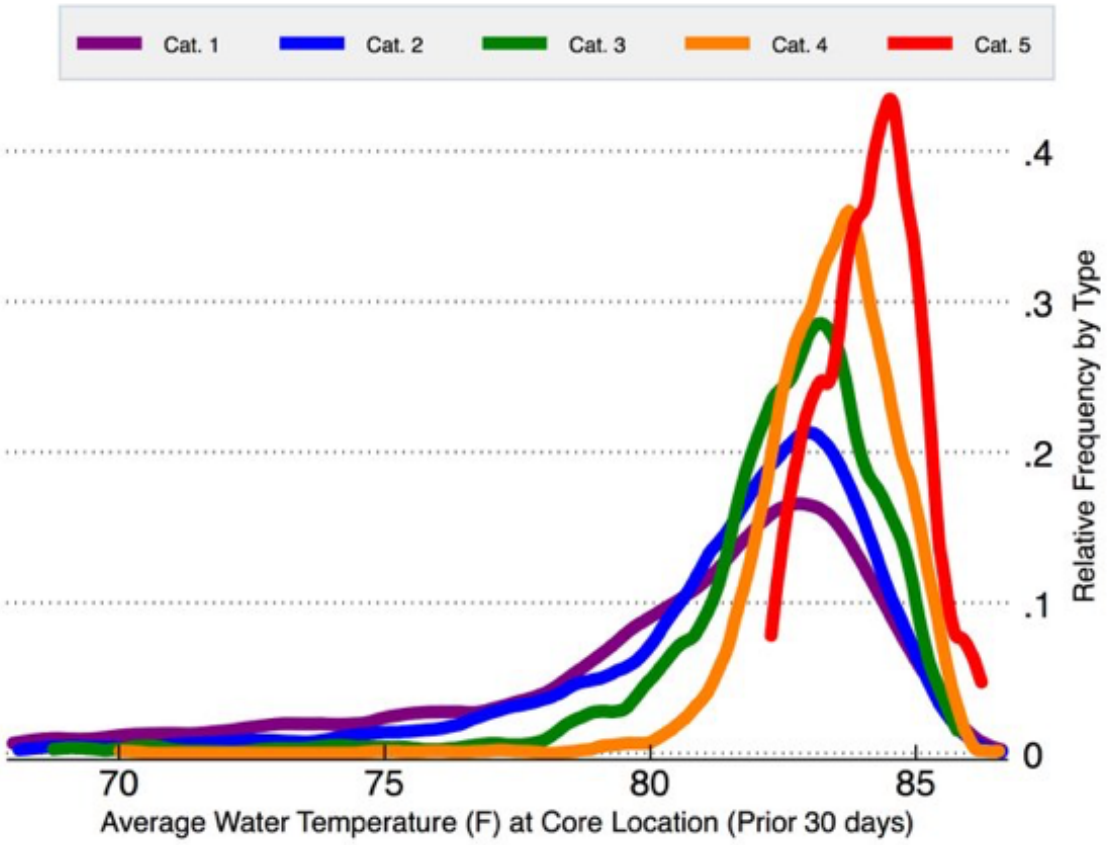
- The imagery of the impossible leads to the art of the no deal

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



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

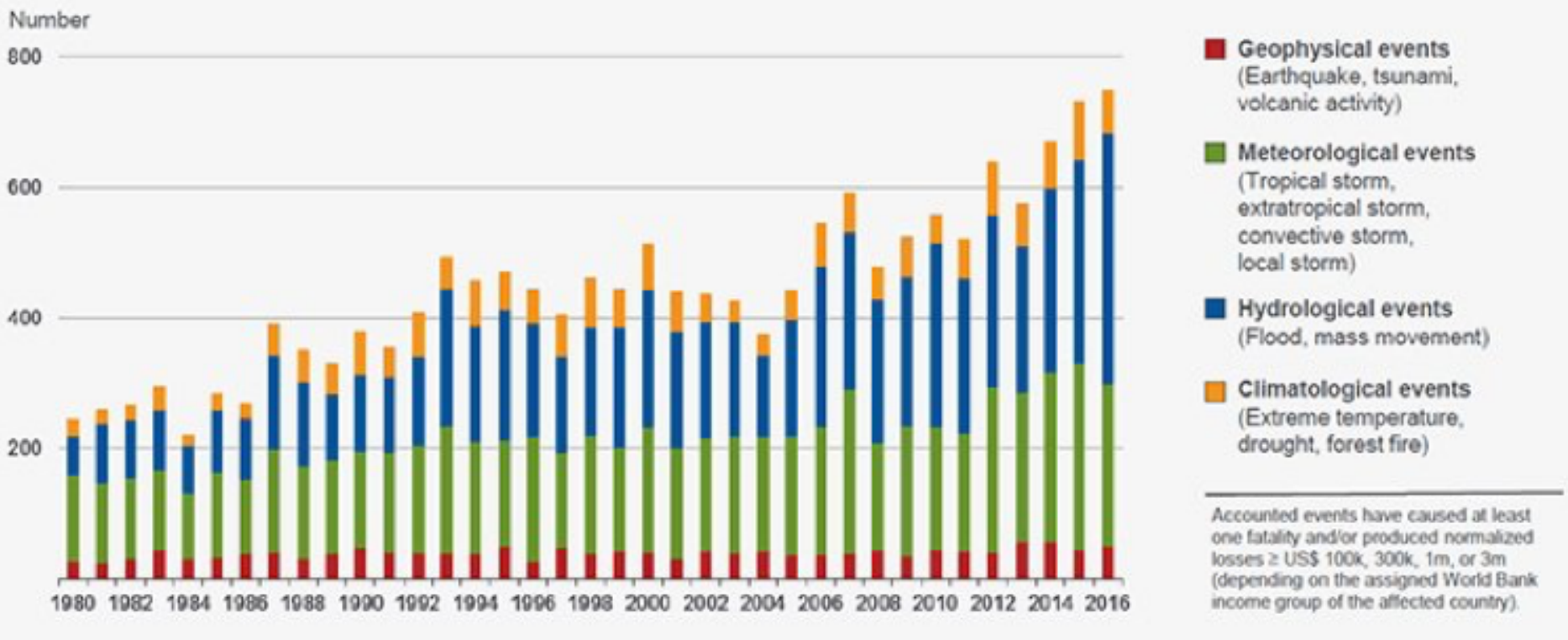
LA Times

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

Number Of Natural Catastrophes

Global - 1980-2016

Source: Munich Re, Geo Risks Research

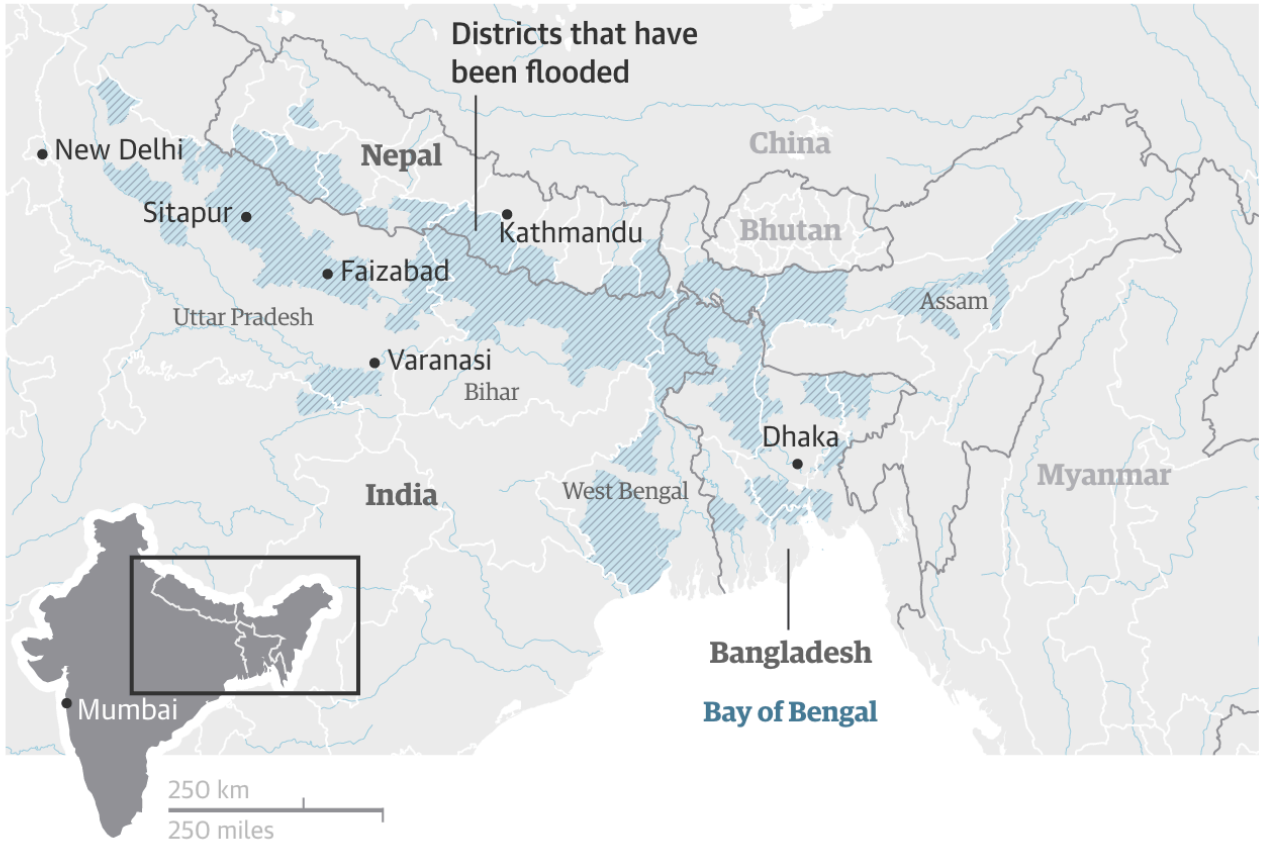


N

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



●●○○○ CC 6:56 PM 48%

cnn.com

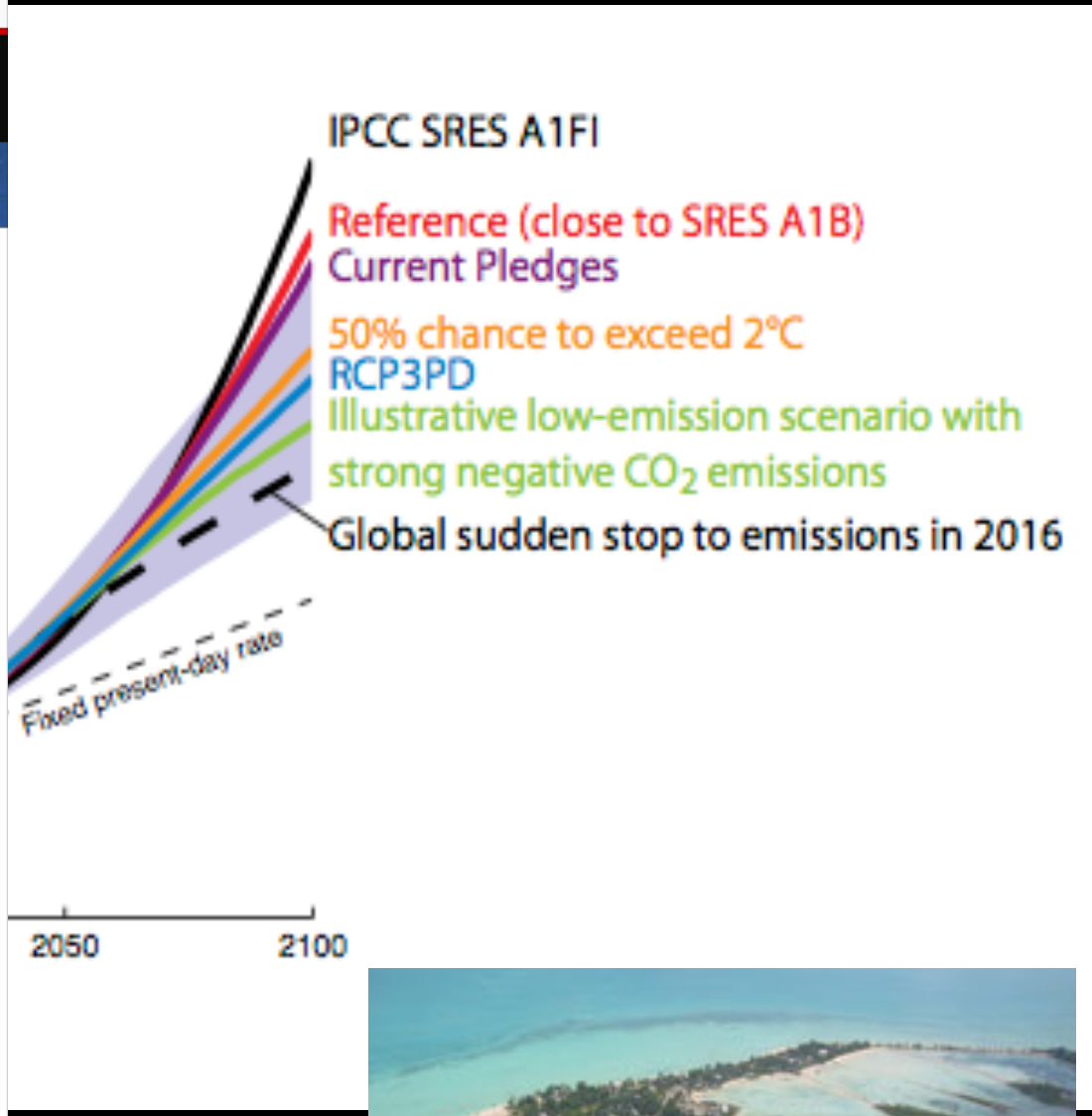
CNN U.S. + Live TV

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

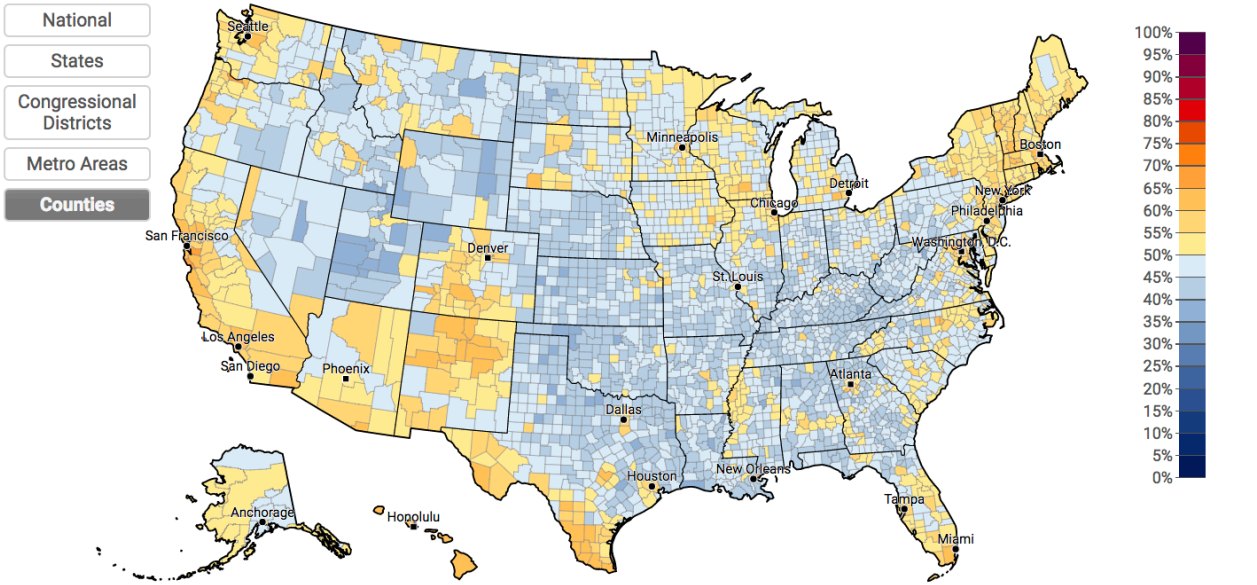
We do and believe like our neighbors

- 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

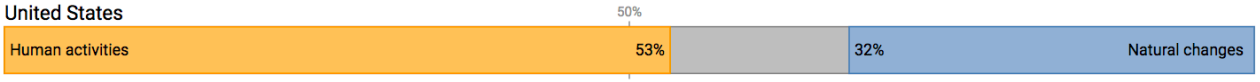
Display model output: Global warming is caused mostly by human activities | Absolute Value | Permalink

Click on map to select geography, or: Wisconsin | Select a County



Tweet 14 Like

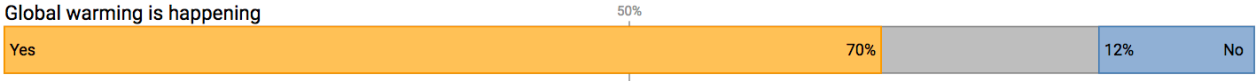
United States



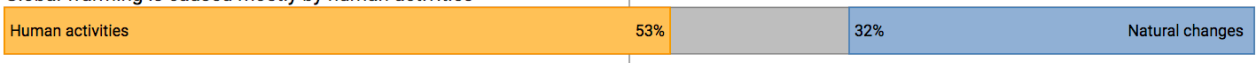
Public Opinion Estimates, United States, 2016

BELIEFS

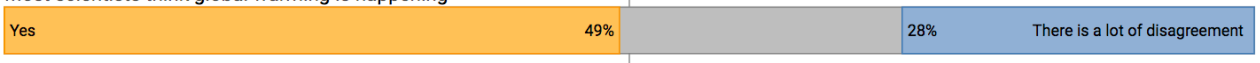
Global warming is happening



Global warming is caused mostly by human activities



Most scientists think global warming is happening

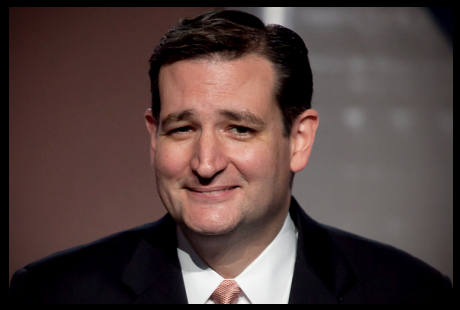


Trust climate scientists about global warming

RISK PERCEPTIONS

- “If you look at global warming alarmists, they don't like to look at the actual facts and the data. […] I read this morning a Newsweek article from the 1970s talking about global cooling. [...] Now, the data proved to be not backing up that theory. So then all the advocates of global cooling suddenly shifted to global warming […] and the **solution interestingly enough was the exact same solution -- government control of the energy sector and every aspect of our lives.**”

Washington Post, 2 Aug 2015



We do and believe like our neighbors

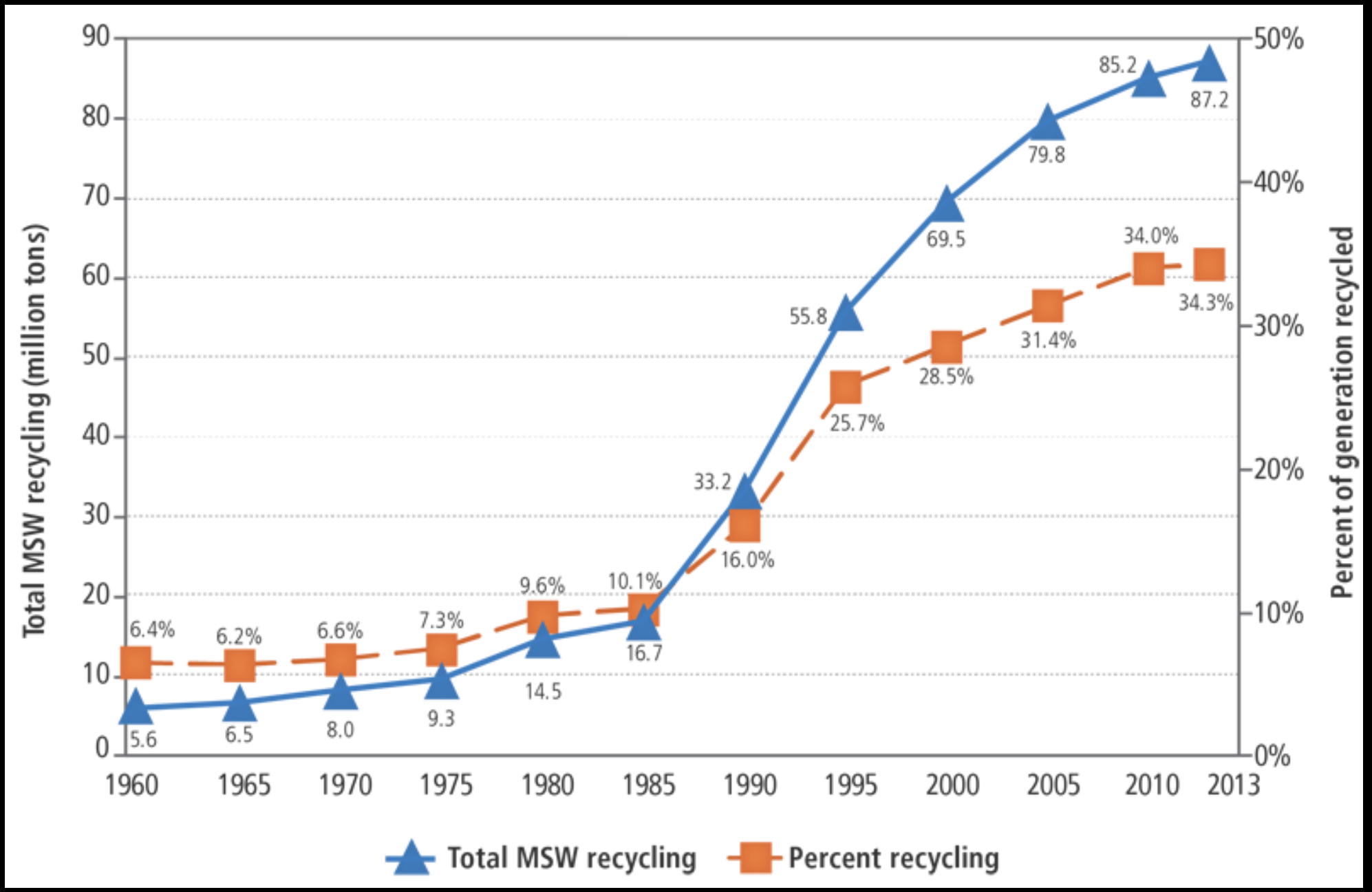
- Or at least, what we think are neighbors do and believe…

- BUT

Community standards can change

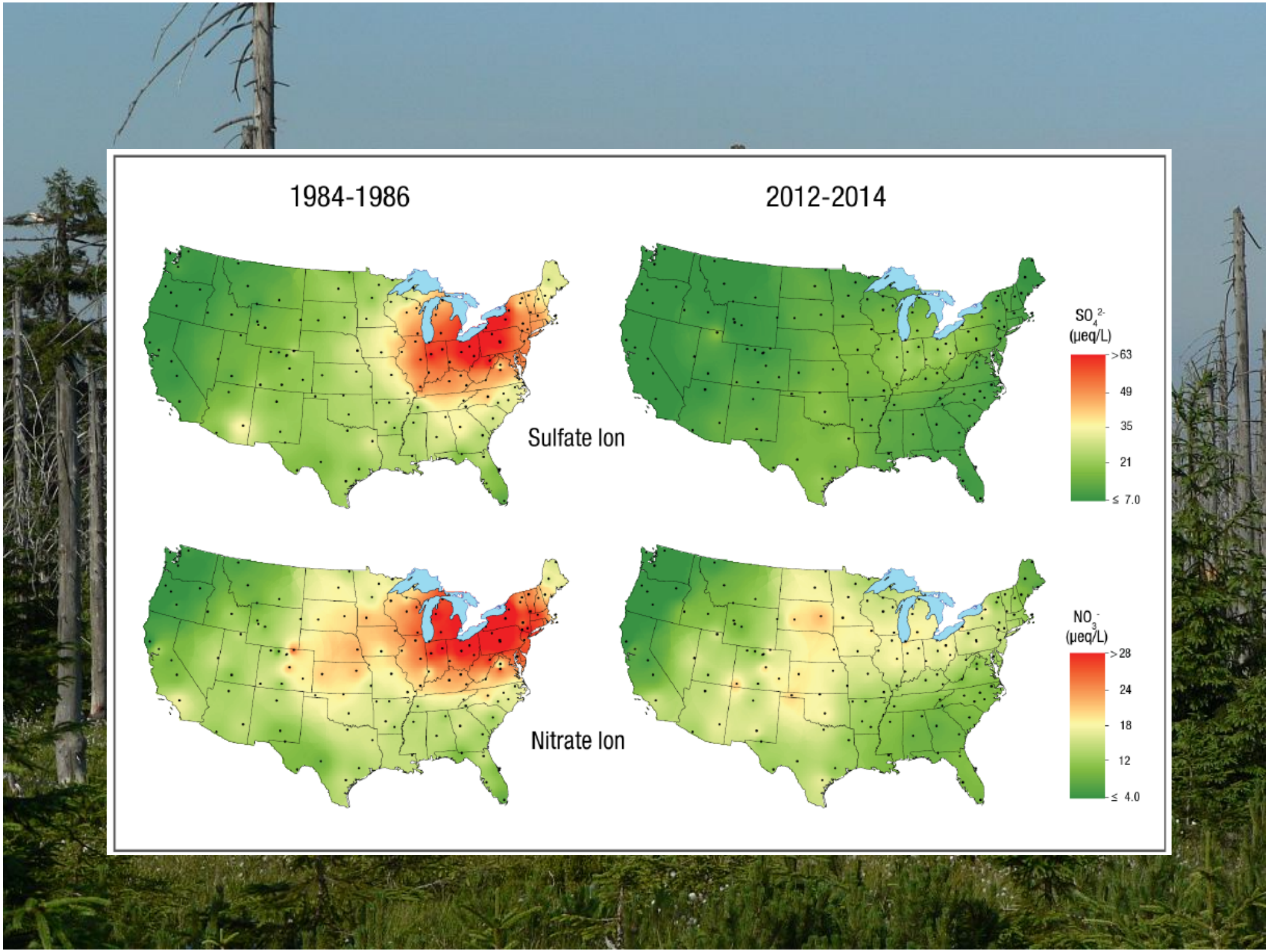
Community standards can change

- Education and generational change
  - Recycling


Total MSW recycling (million tons)
Percent of generation recycled
90
80
70
60
50
40
30
20
10
0
50%
40%
30%
20%
10%
0%
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2013
5.6
6.5
8.0
9.3
14.5
16.7
33.2
55.8
69.5
79.8
85.2
87.2
6.4%
6.2%
6.6%
7.3%
9.6%
10.1%
16.0%
25.7%
28.5%
31.4%
34.0%
34.3%
Total MSW recycling
Percent recycling

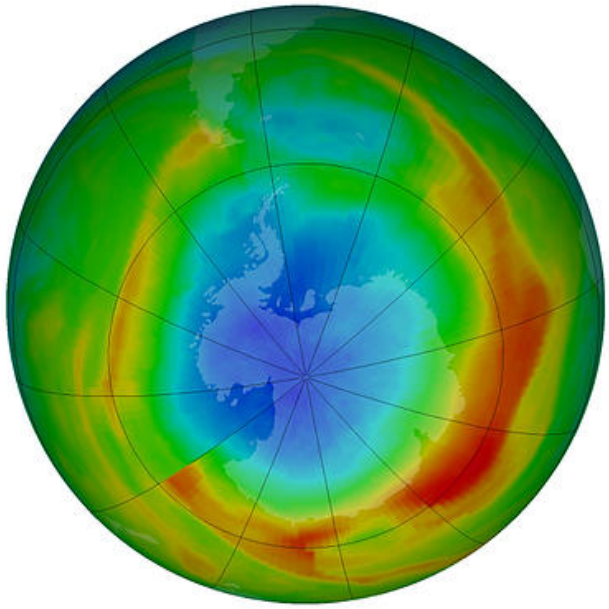
Community standards can change

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

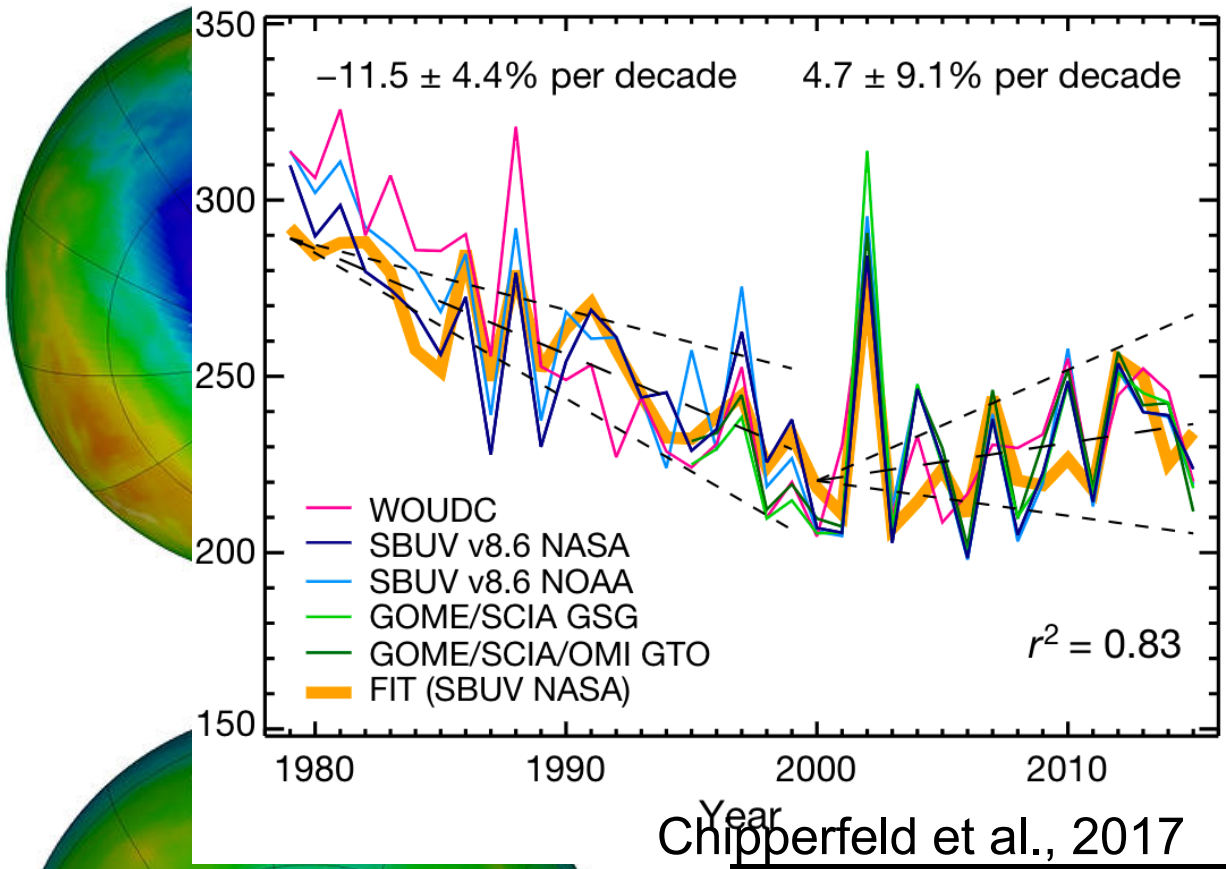

1984-1986
2012-2014
Sulfate Ion
SO_4^{2-} (µeq/L)
>63
49
35
21
≤ 7.0
Nitrate Ion
NO_3^- (µeq/L)
>28
24
18
12
≤ 4.0

Community standards can change

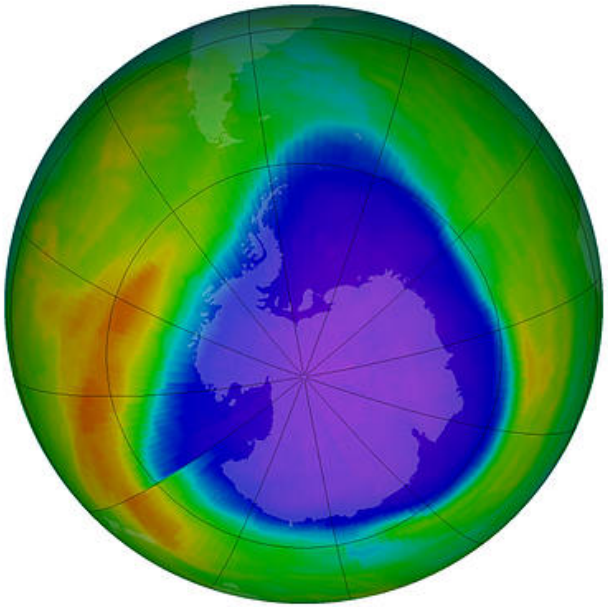
- Education and generational change
  - Recycling
- Regulation
  - Acid rain
- Innovation
  - The Ozone Hole



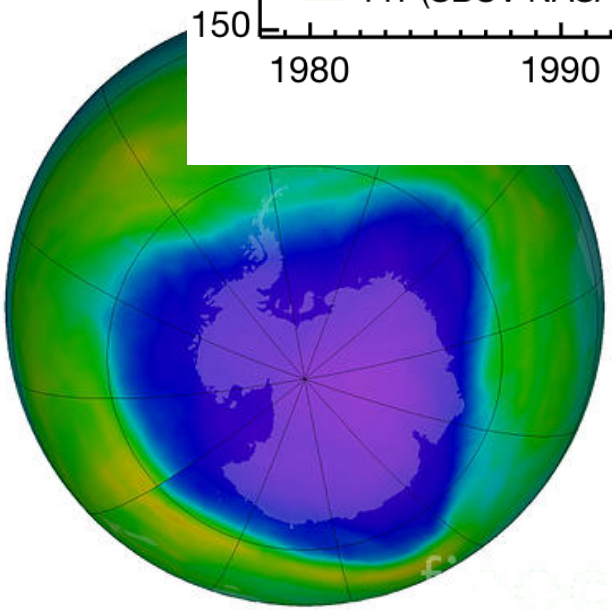
1980



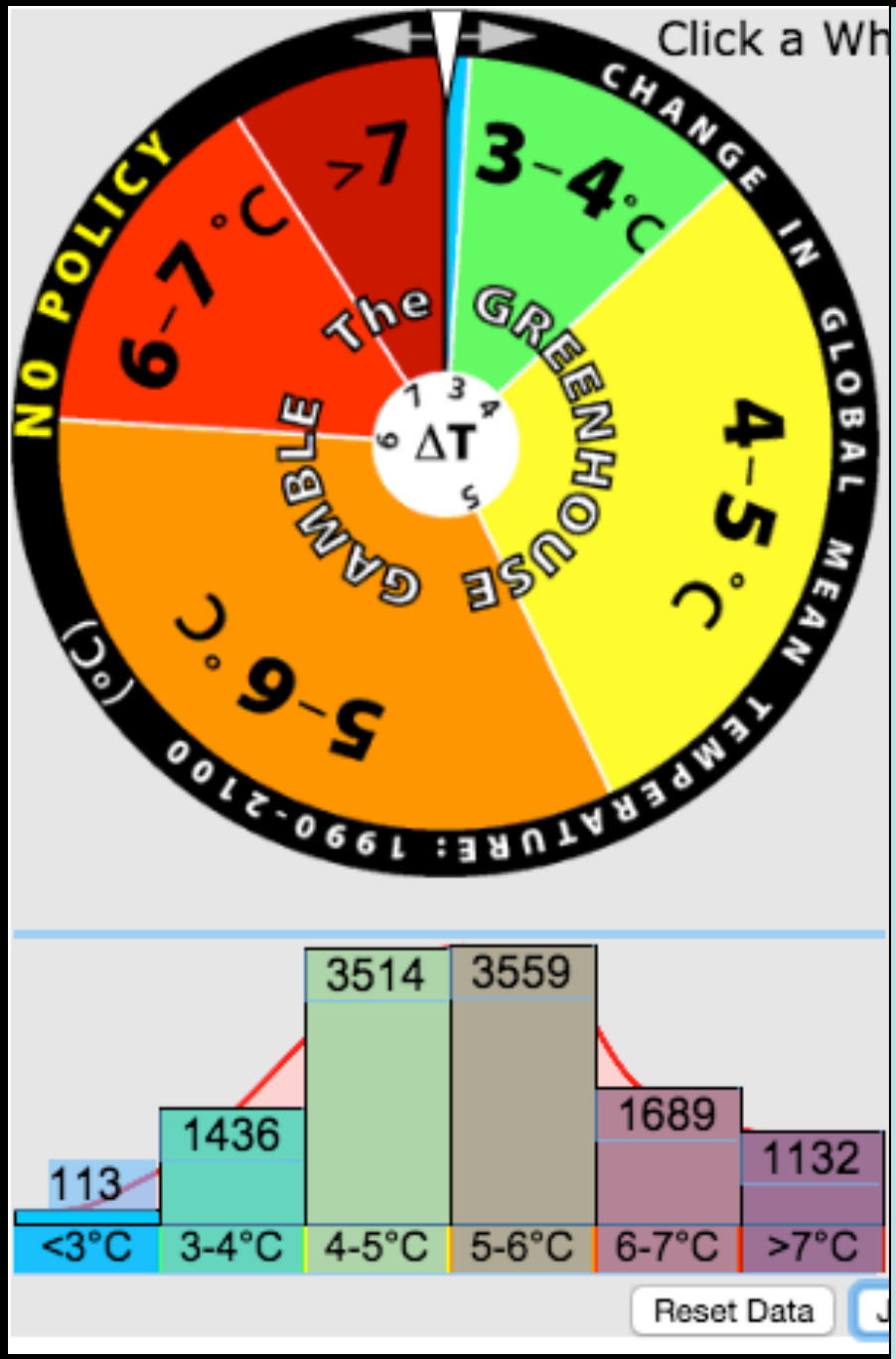
Chipperfeld et al., 2017



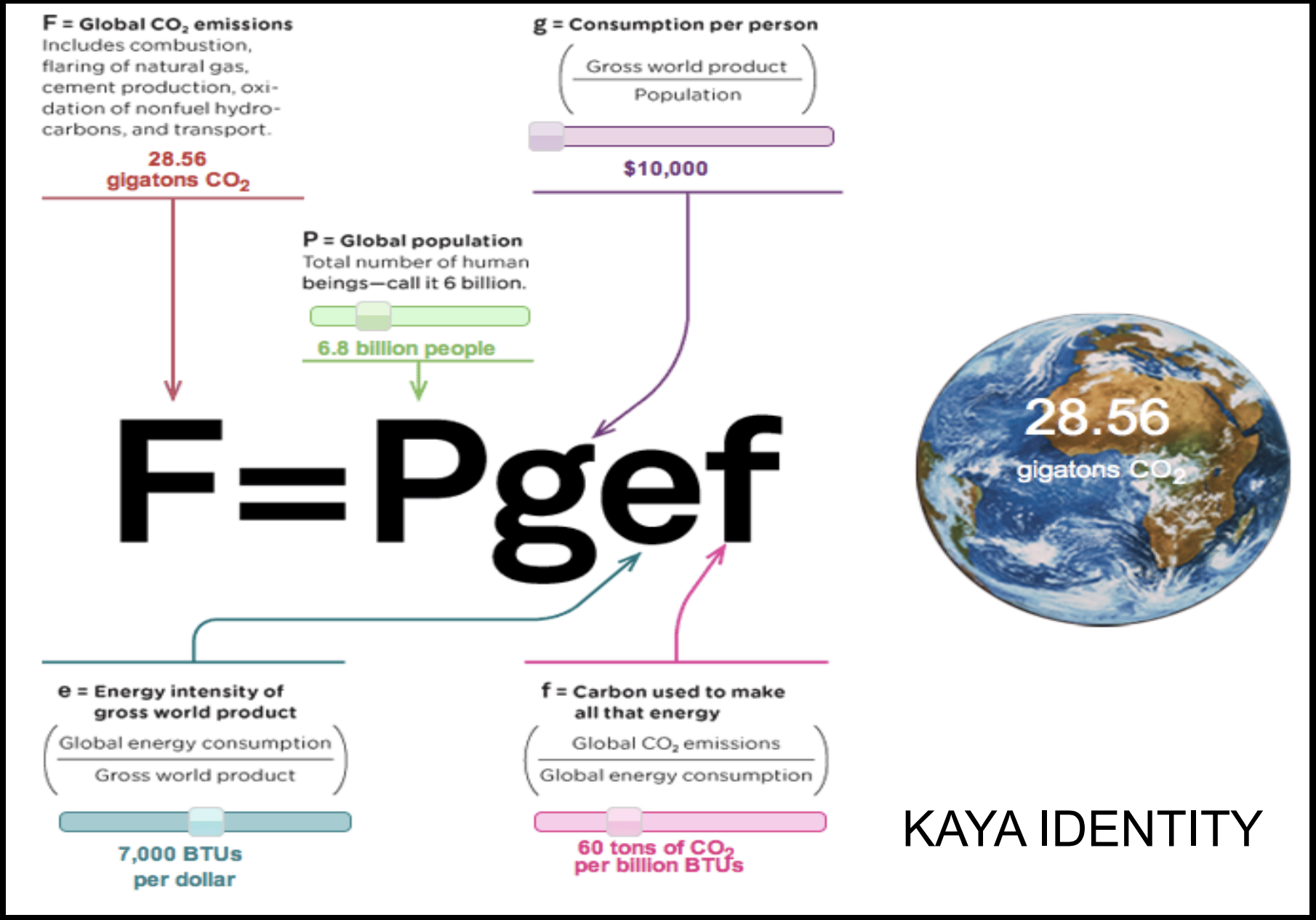
2000



2015



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



http://climatemodels.uchicago.edu/kaya/

Paris

- Refocuses goal on temperature below 2 C
  limit (global emissions will need to peak in

CLIMATE

Syria Joins Paris Climate Accord, Leaving Only U.S. Opposed

By LISA FRIEDMAN NOV. 7, 2017

- $100 billion fund for developing countries
- Is set to be in force, now that > 55% of emissions included in ratified countries*
- Compliance and monitoring will be a key challenge

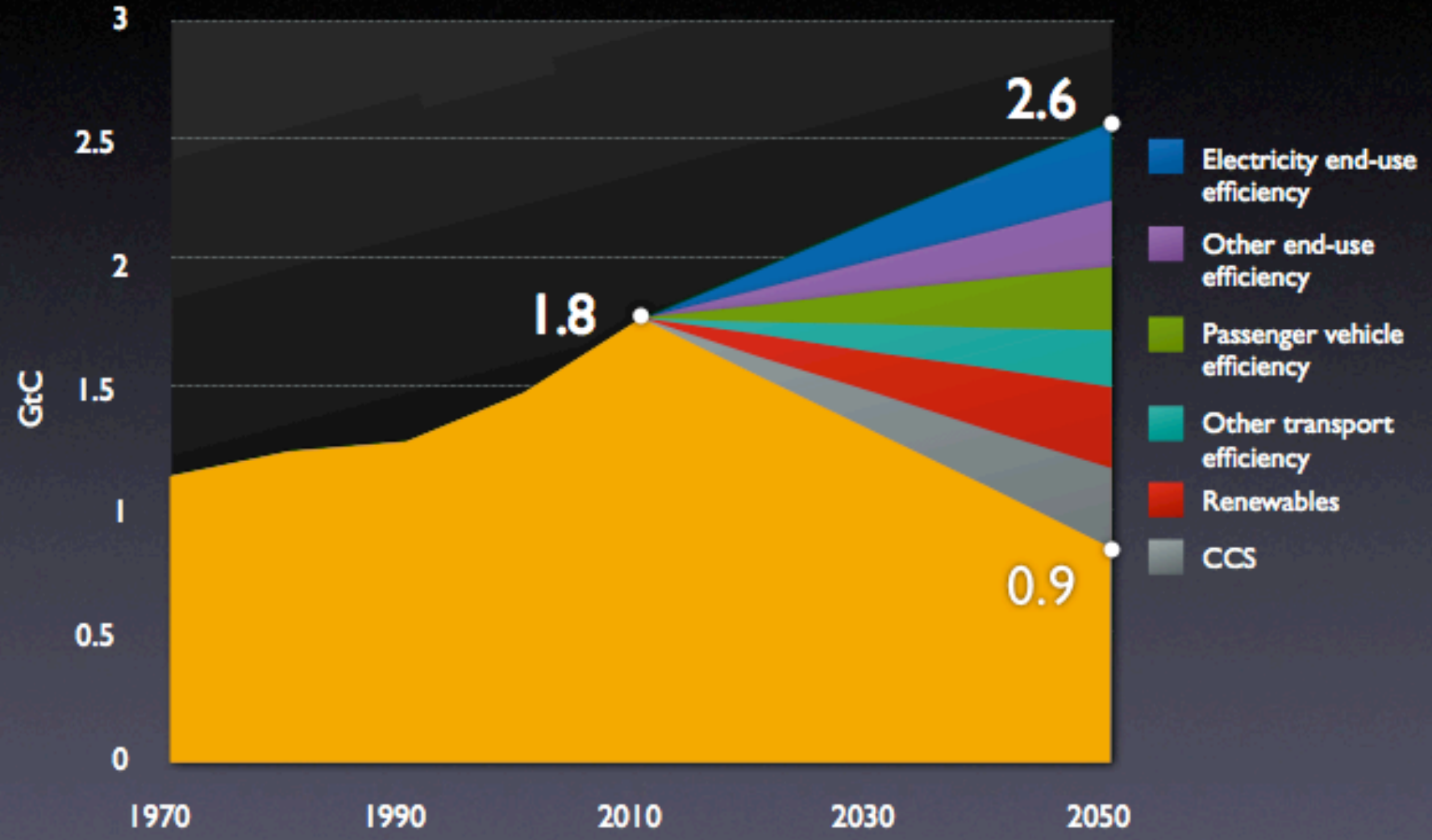
Commitments

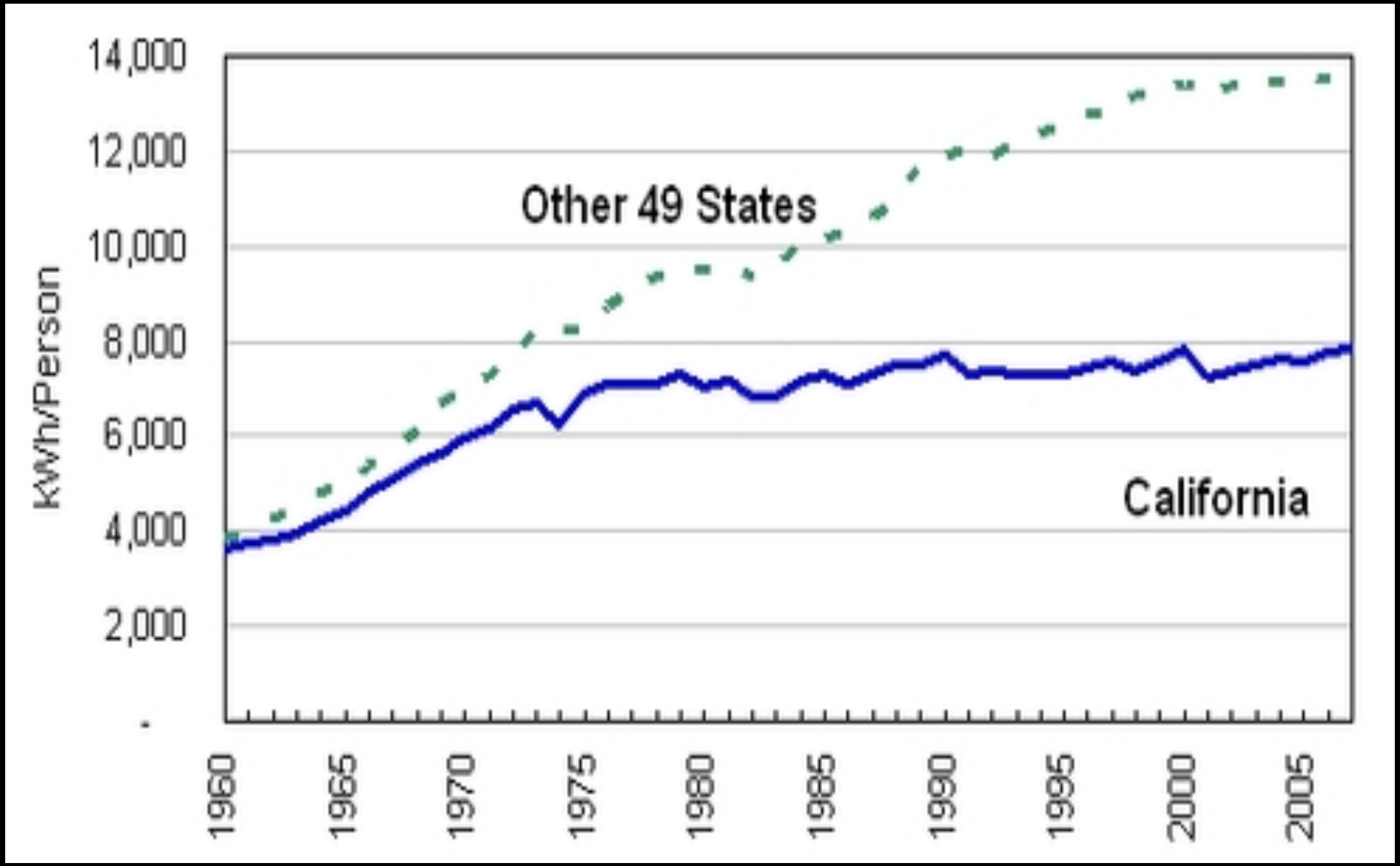
- China: carbon intensity in 2020 40% below 2005 (emissions still rise), peak carbon emissions 2030
- U.S.: 2025 26-28% emissions below 2005 (double earlier pace), 2050 83% below
- South Korea: 30% below business as usual by 2020 (emissions doubled 1990-2005)
- Russia: 25%
- Brazil: 38-42% below 2020 projection, half by deforestation reduction (REDD)
- Australia: 5-20% below 2000 by 2020
- India: carbon intensity 20% lower by 2020

U.S. Emissions

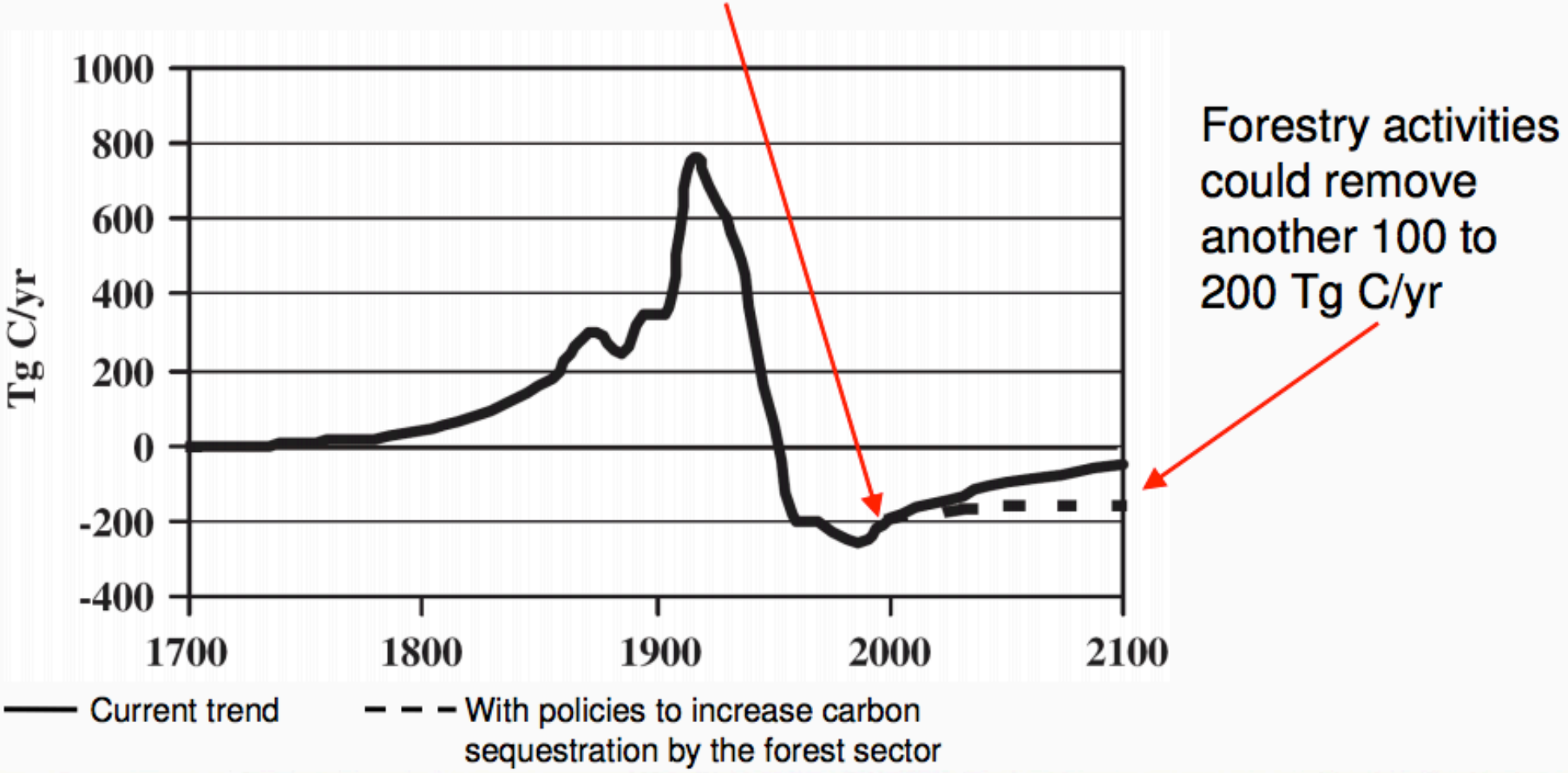
After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

- Carbon Capture & Storage




14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
KWh/Person
Other 49 States
California
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

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

Innovations

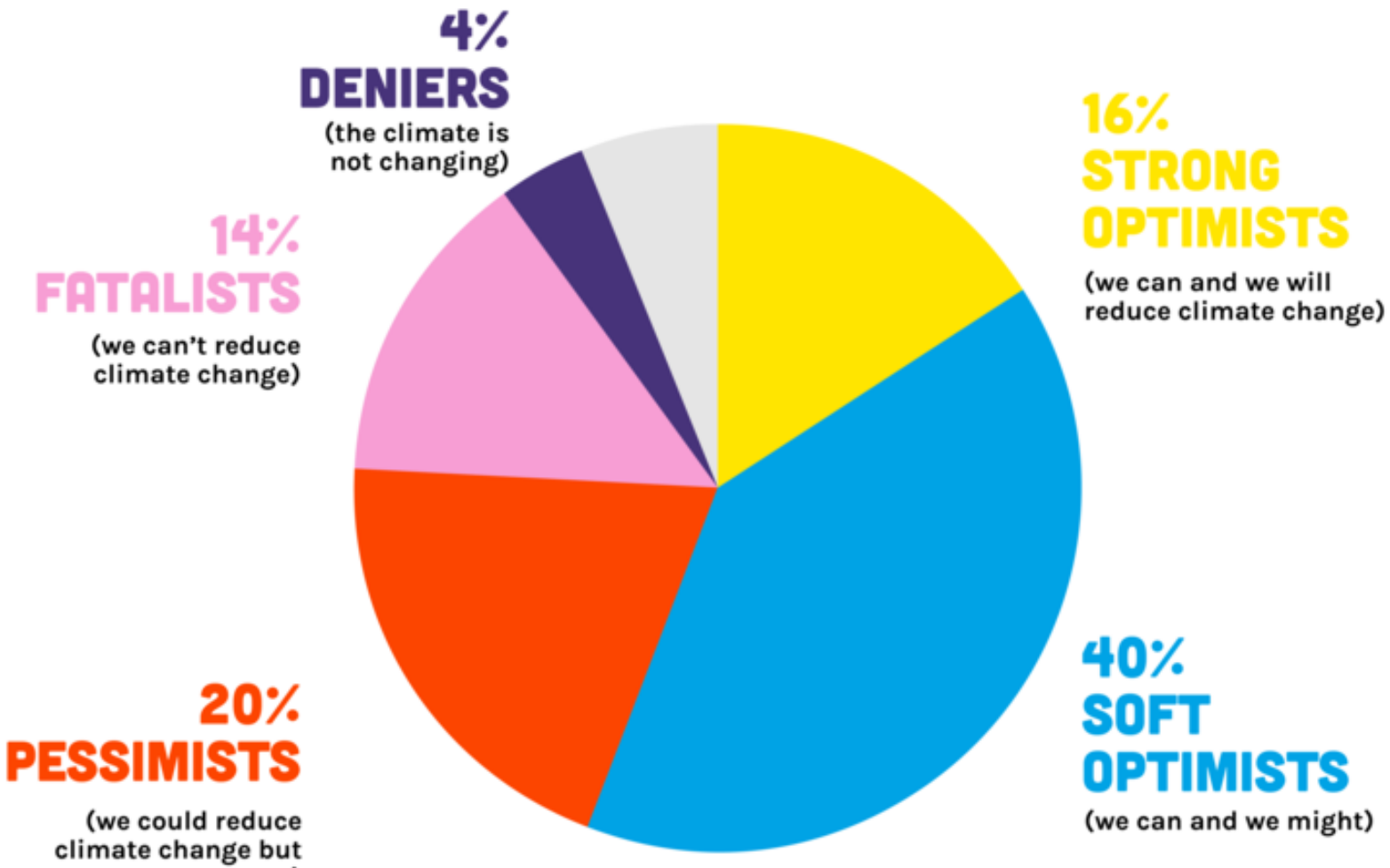
Death of gas and diesel begins as GM announces plans for 'all-electric future'

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.


4%
DENIERS
(the climate is not changing)
16%
STRONG OPTIMISTS
(we can and we will reduce climate change)
14%
FATALISTS
(we can't reduce climate change)
20%
PESSIMISTS
(we could reduce climate change but we won't)
40%
SOFT OPTIMISTS
(we can and we might)
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

Don’t be afraid, be curious