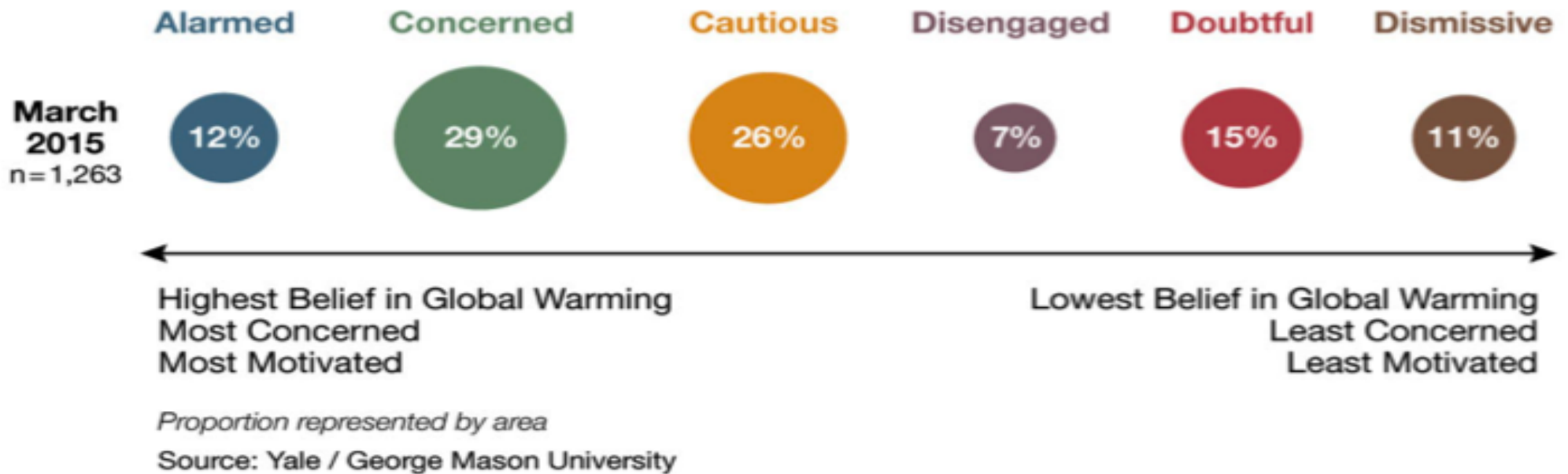


Your Audience Cares About Climate Change and Its Local Impacts



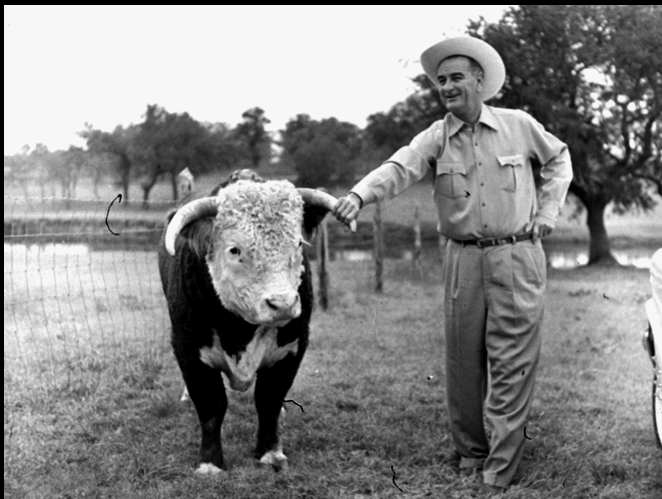
Professor Ankur Desai
Dept of Atmospheric & Oceanic Sciences
University of Wisconsin-Madison

Nov 4, 2018

Bottom Line

- Climate is warming and change is projected to accelerate in next century with continued increases in fossil fuel emissions
- Vulnerable aspects of society and ecosystems are at risk from these changes without appropriate mitigation or adaptation measures
- The public increasingly supports action on climate change and is hungry for credible, legitimate, salient information on how to do so

The continued release of CO₂ 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

The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance

WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

3d. per Copy.

Science Notes and News.

COAL CONSUMPTION AFFECT- ING CLIMATE.

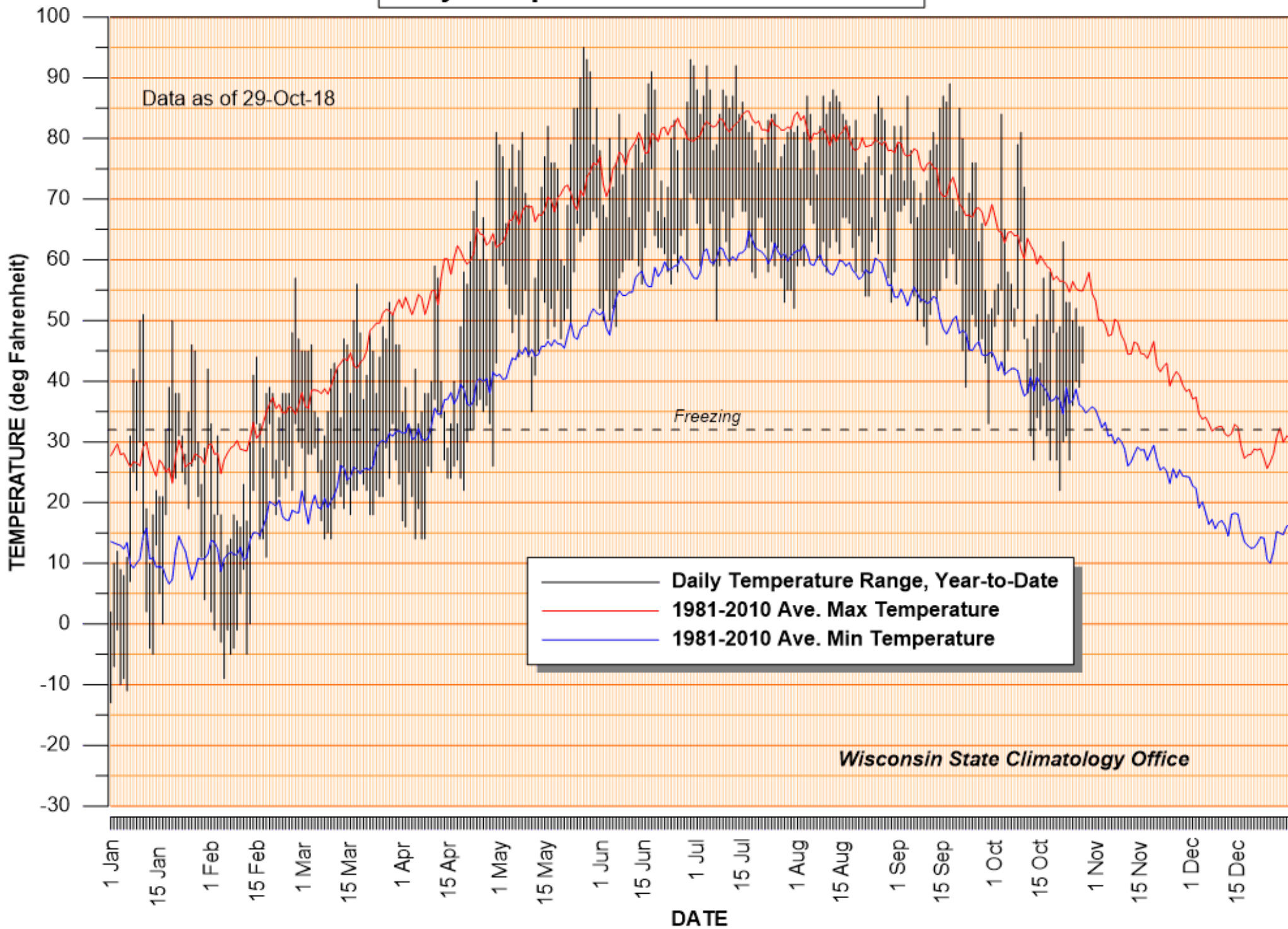
The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

H/T
Andrew
Revkin
Dot Earth
NY Times

What is Climate?

- Climate is the average of weather
 - “Climate is what you expect, weather is what you get” –Andrew John Herbertson
 - “Climate is your personality, weather is your mood” –Marshall Shepherd
- Climate changes naturally (over eons) and by humans (over centuries)

Daily Temperatures: MADISON 2018

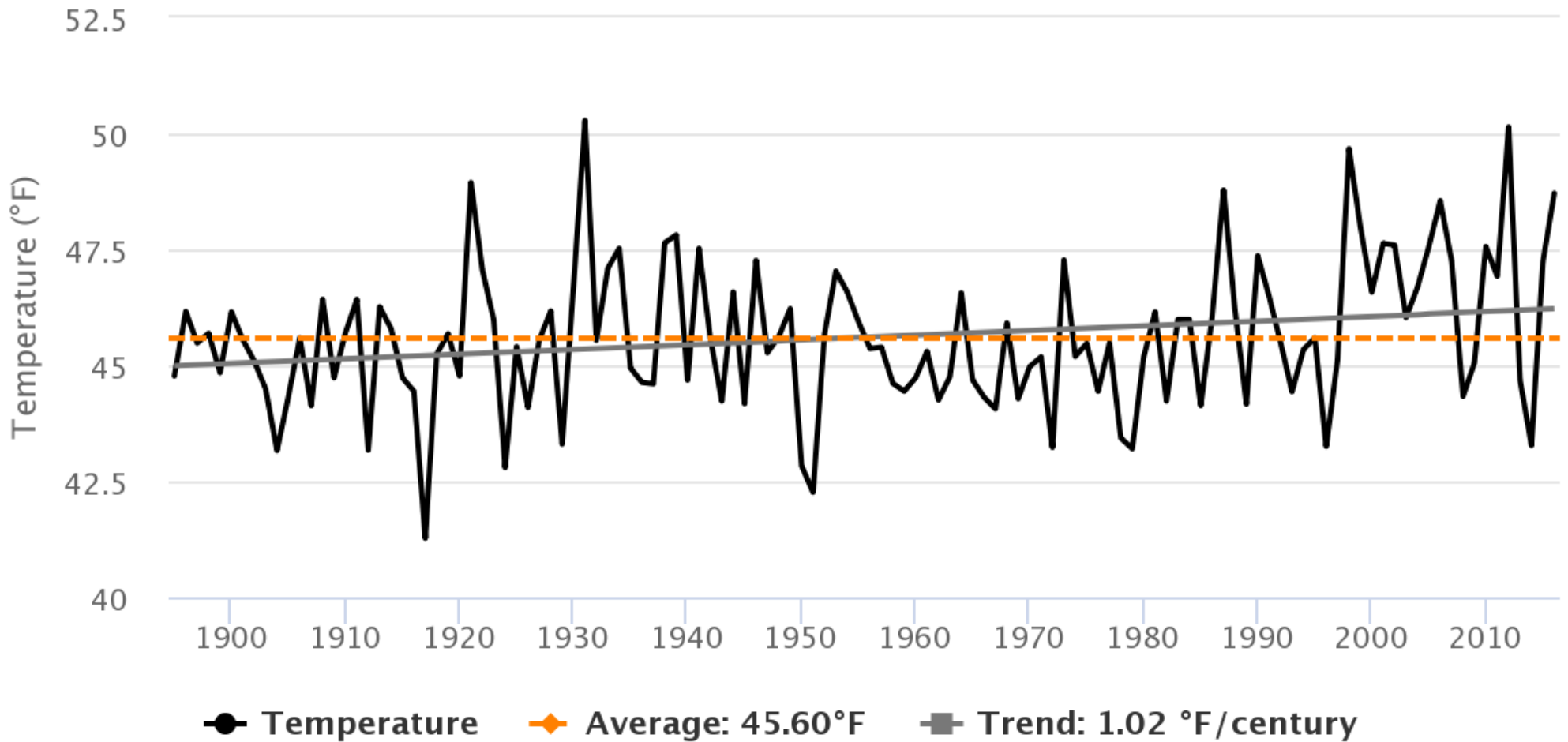


Wisconsin State Climatology Office

Southern Wisconsin

WI07 Annual Temperature based on 1895–2016

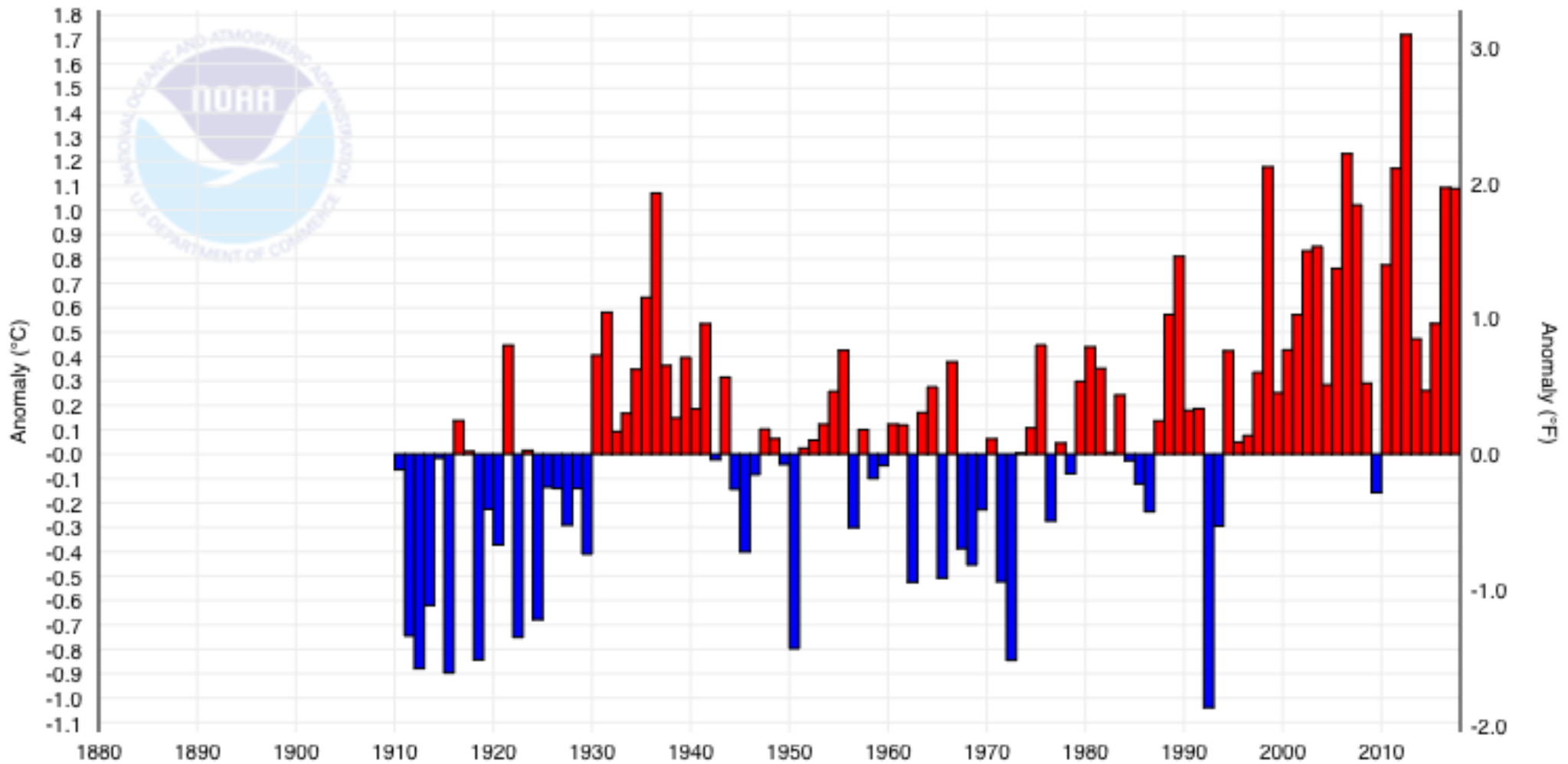
Midwestern Regional Climate Center



Click and drag to zoom

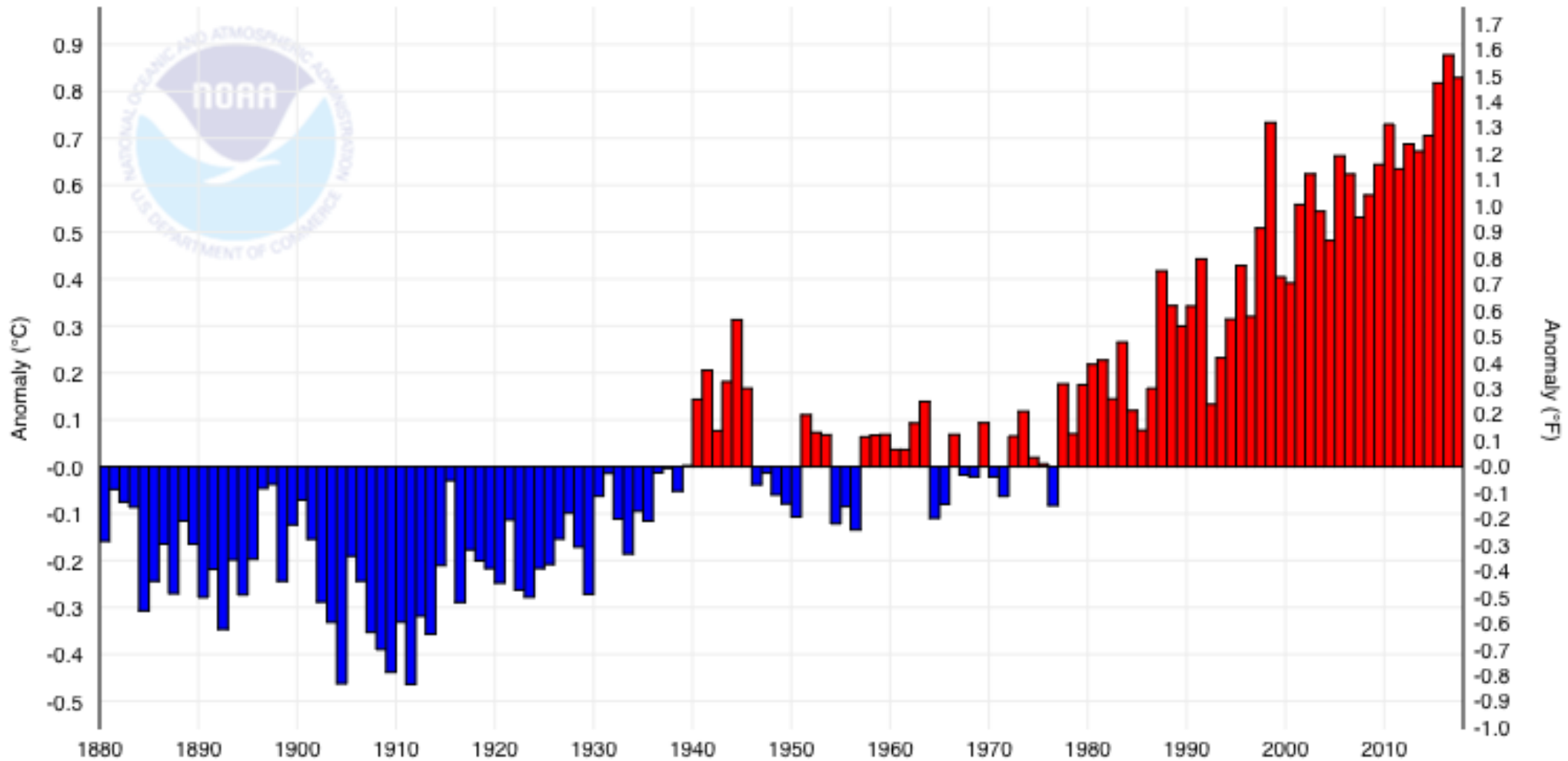
N America

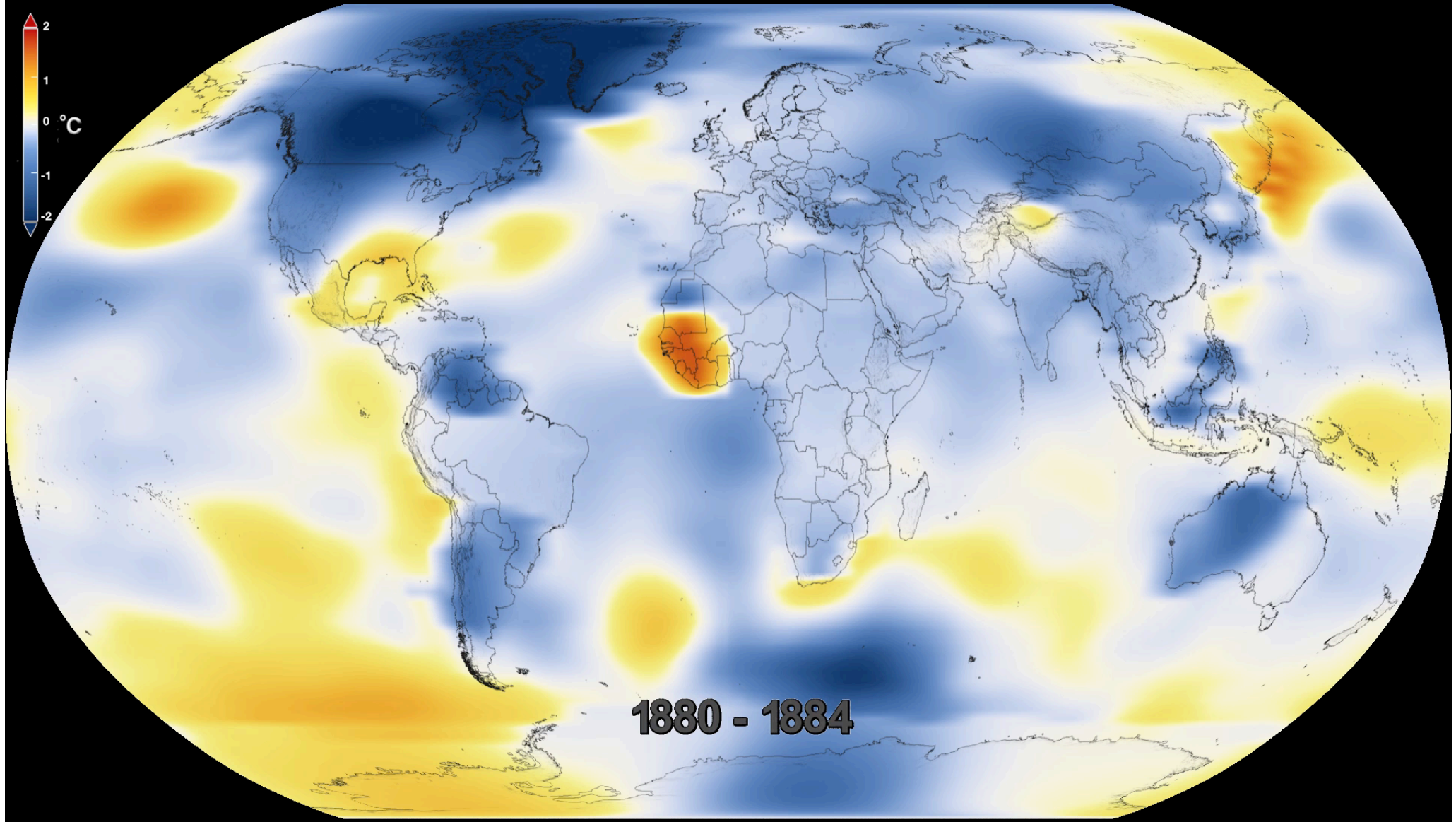
North America Land Temperature Anomalies, July



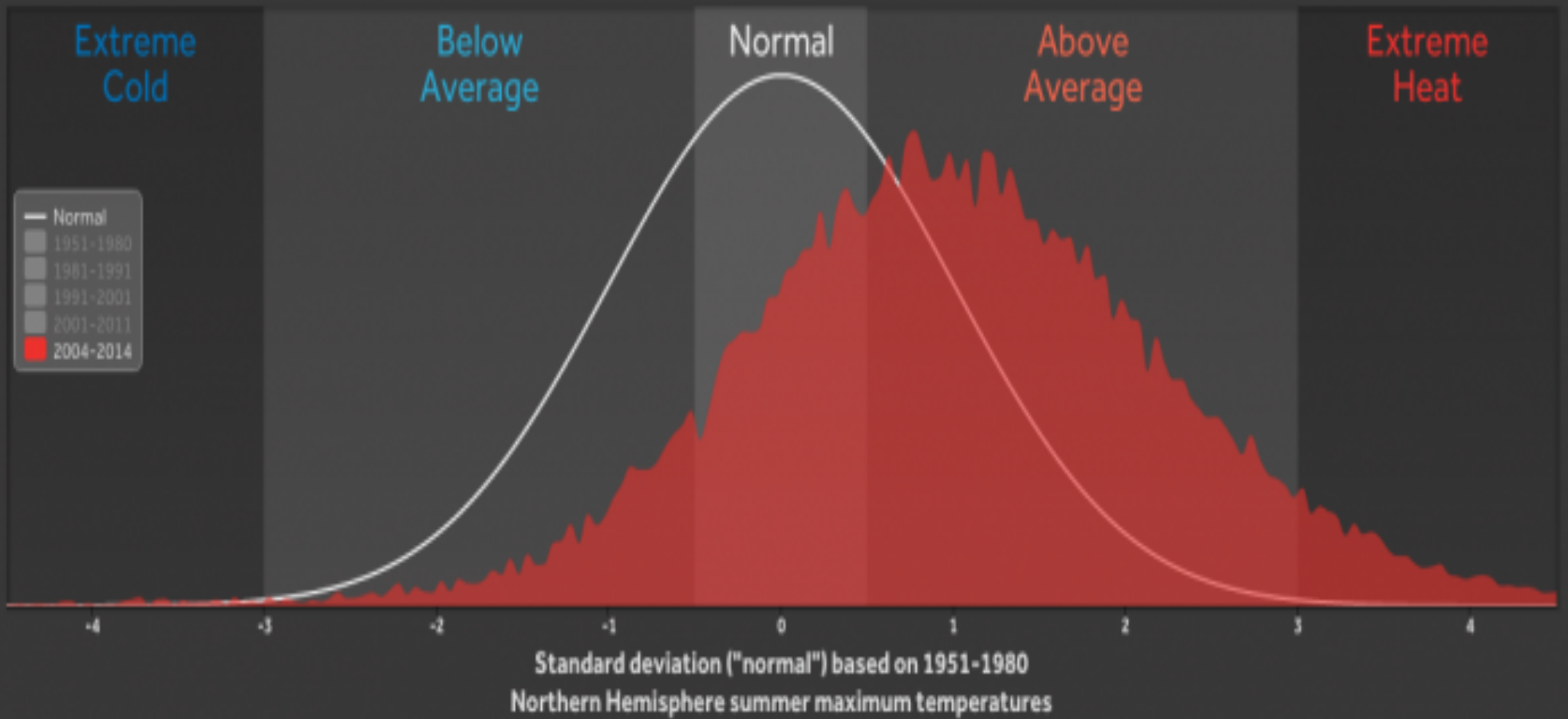
WORLD

Global Land and Ocean Temperature Anomalies, July





1880 - 1884



- The study of climate change is well-established. We know how climate changes and what is mostly causing current change

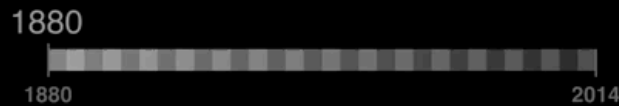
“CO₂ is to climate what steroids was to baseball...” –Jason Samenow

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

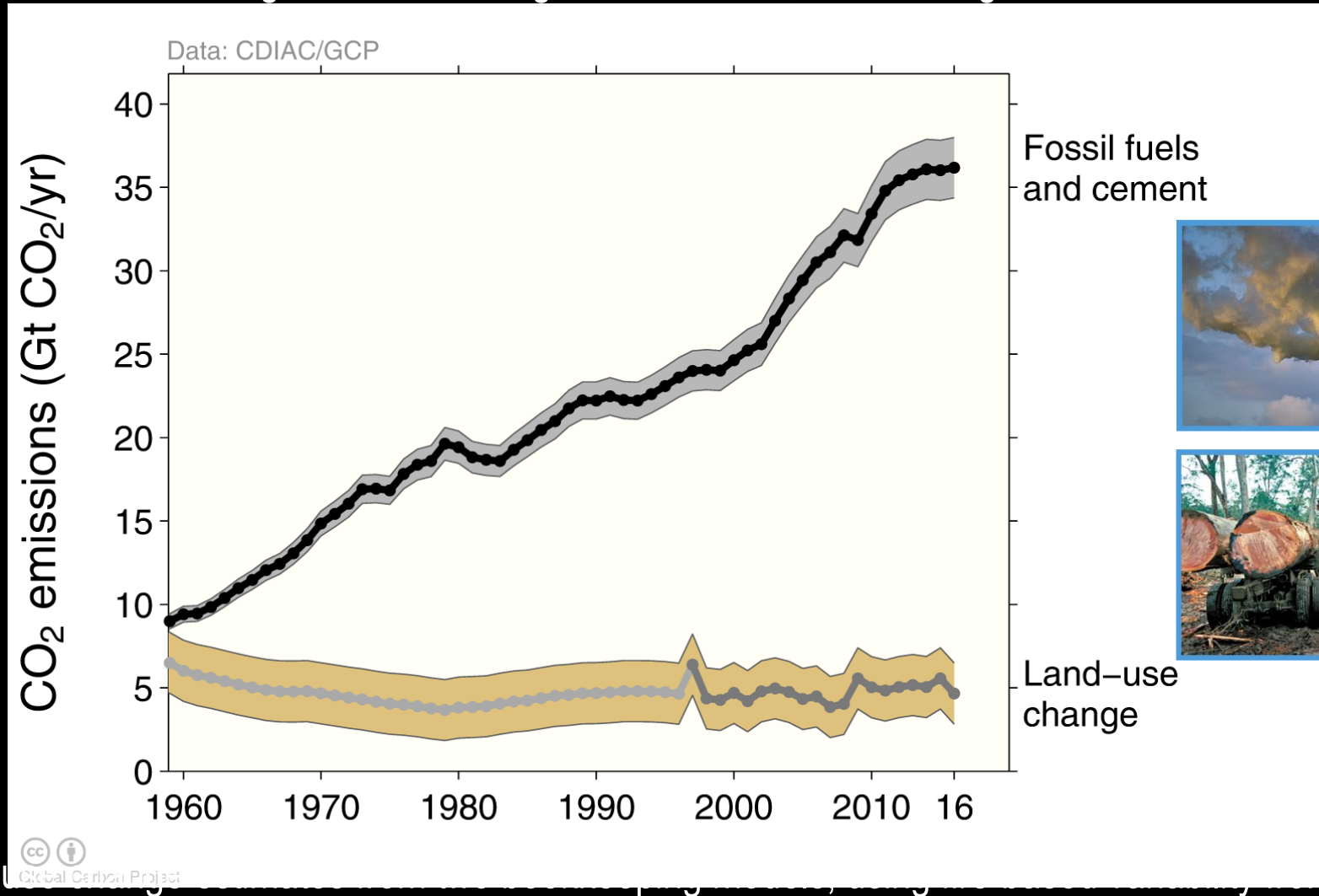


Based on an interactive by Bloomberg

<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

Total global emissions

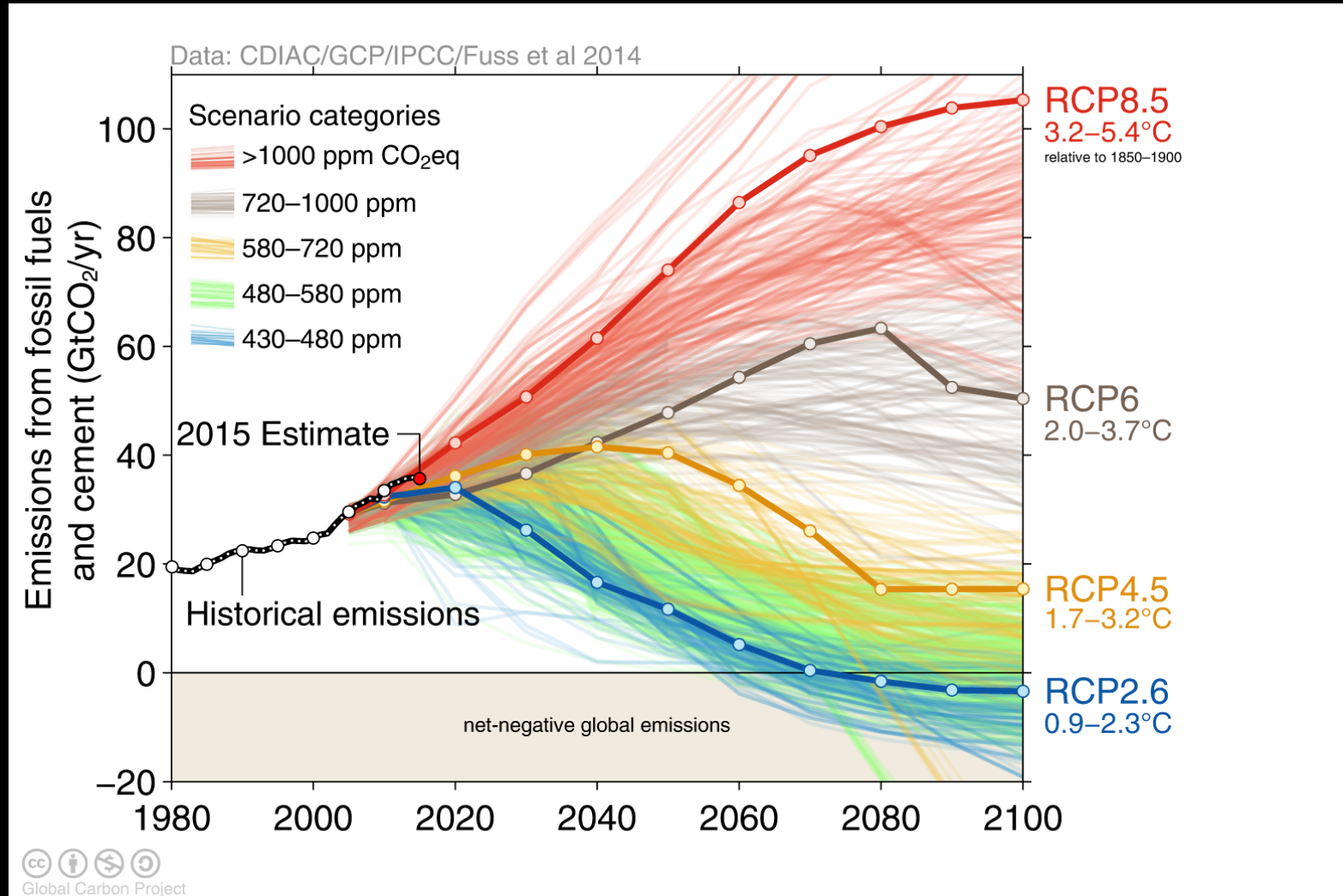
Total global emissions: 40.8 ± 2.7 GtCO₂ in 2016, 52% over 1990
 Percentage land-use change: 42% in 1960, 12% averaged 2007-2016



Source: [CDIAC](#); [Houghton and Nassikas 2017](#); [Hansis et al 2015](#); [van der Werf et al. 2017](#); [Le Quéré et al 2017](#); [Global Carbon Budget 2017](#)

Observed emissions and emissions scenarios

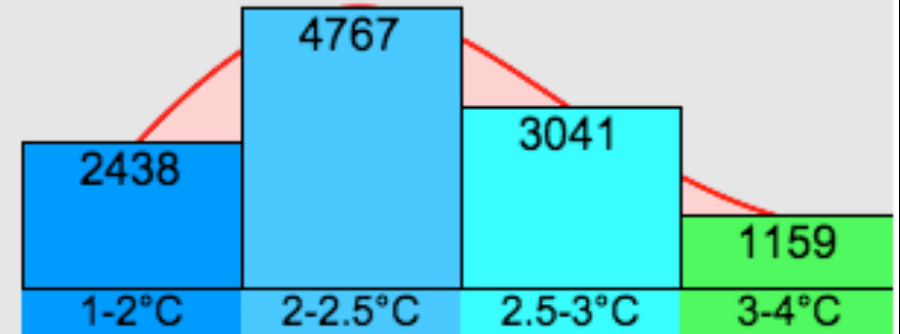
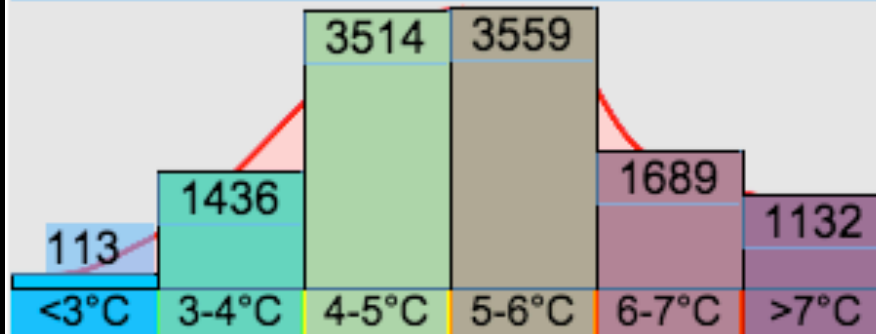
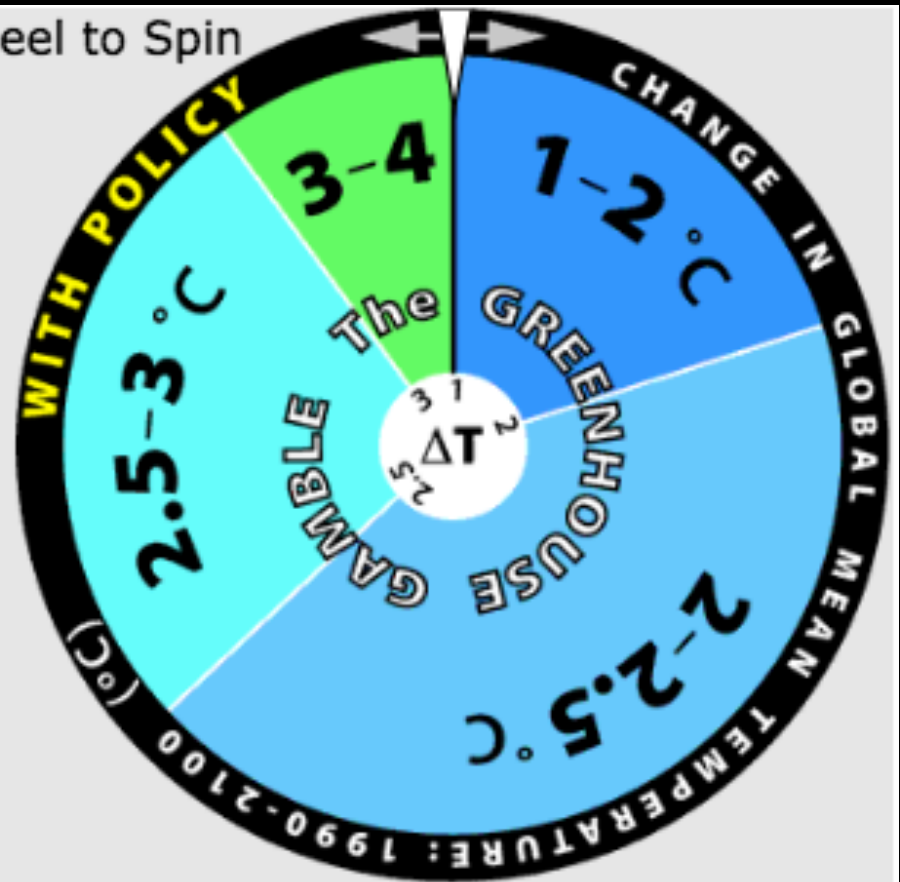
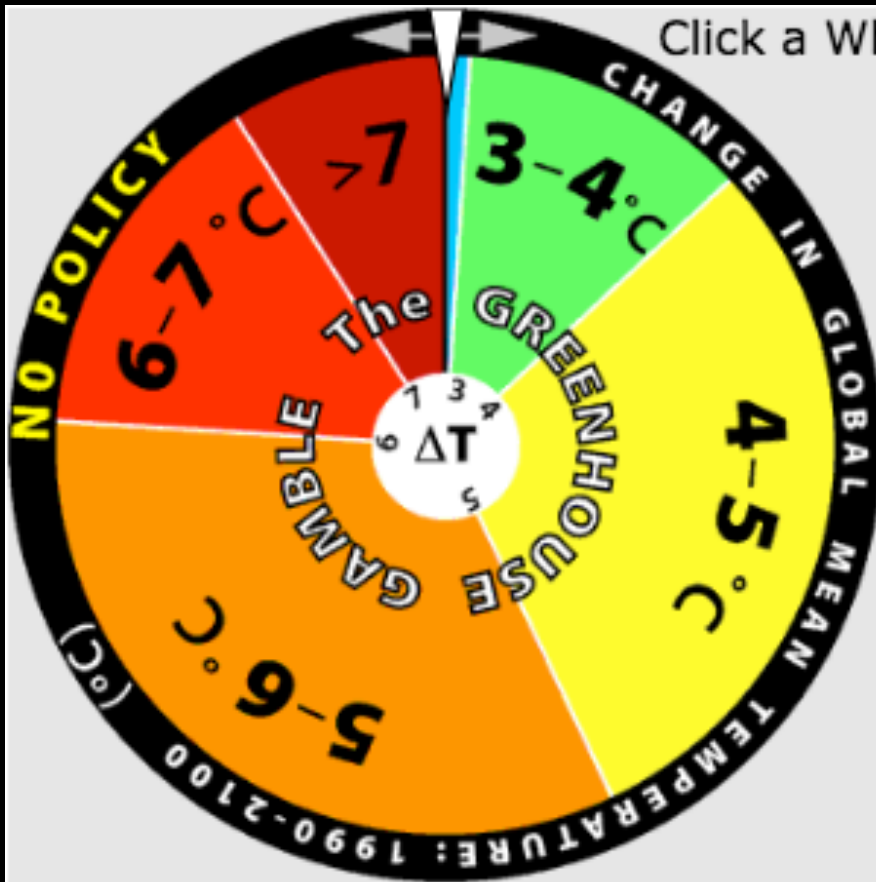
The emission pledges submitted to the Paris climate summit avoid the worst effects of climate change (red), most studies suggest a likely temperature increase of about 3° C (brown)



Over 1000 scenarios from the IPCC Fifth Assessment Report are shown

Source: [Fuss et al 2014](#); [CDIAC](#); [Global Carbon Budget 2015](#)

Click a Wheel to Spin



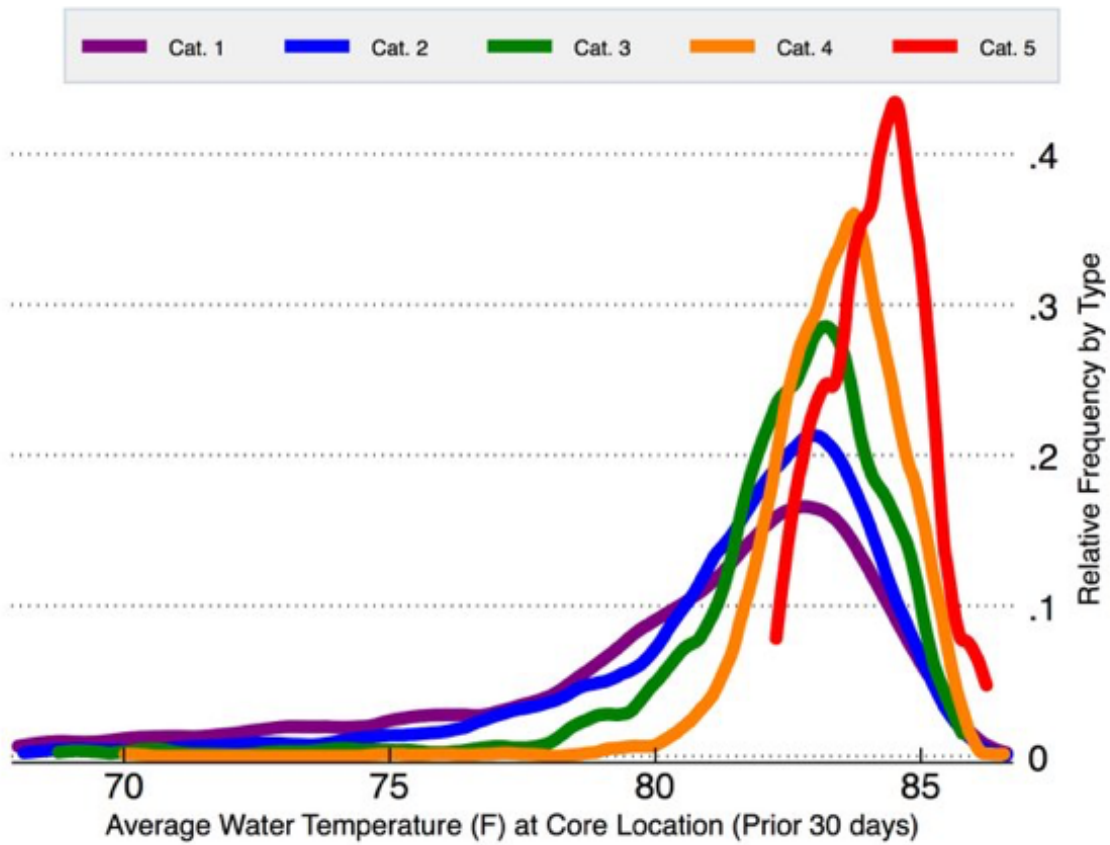
Reset Data

Just Recent Spins

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

So what's the big deal?

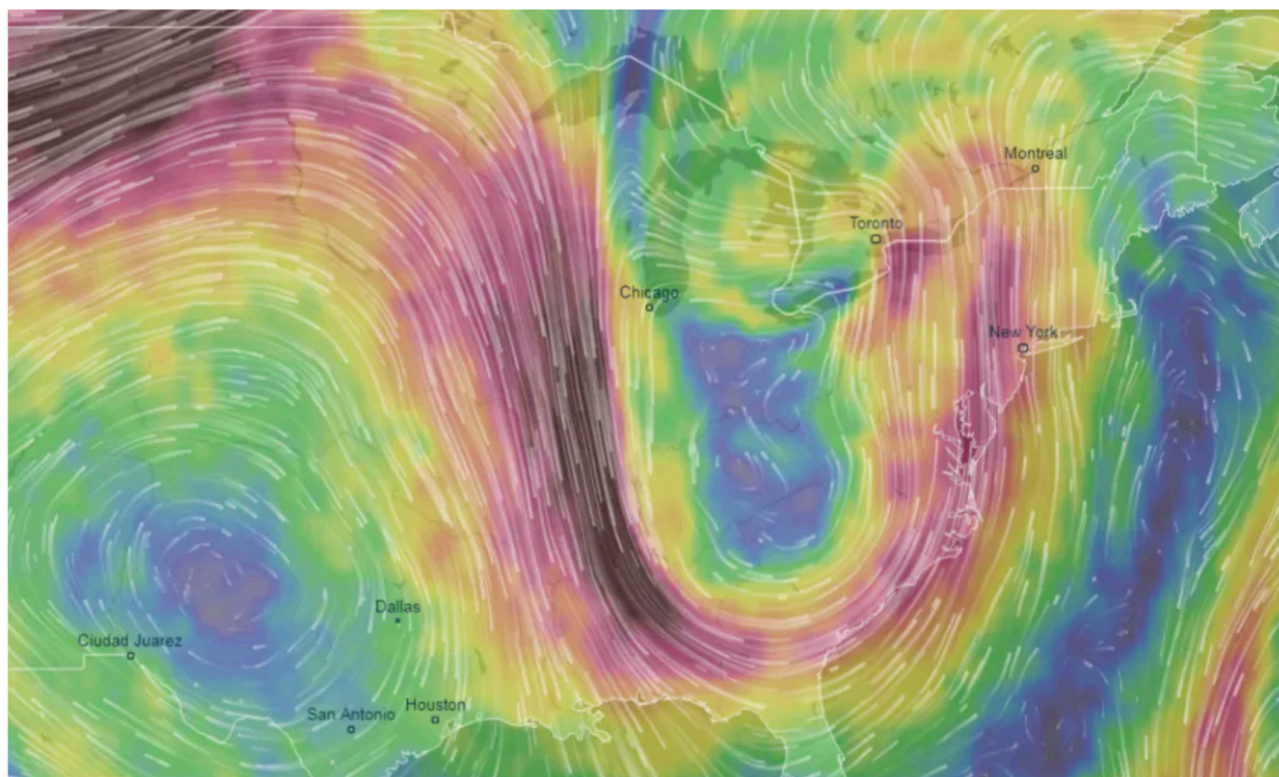
Hurricane Strength and Ocean Temperatures



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



Study: Freak summer weather and wild jet-stream patterns are on the rise because of global warming



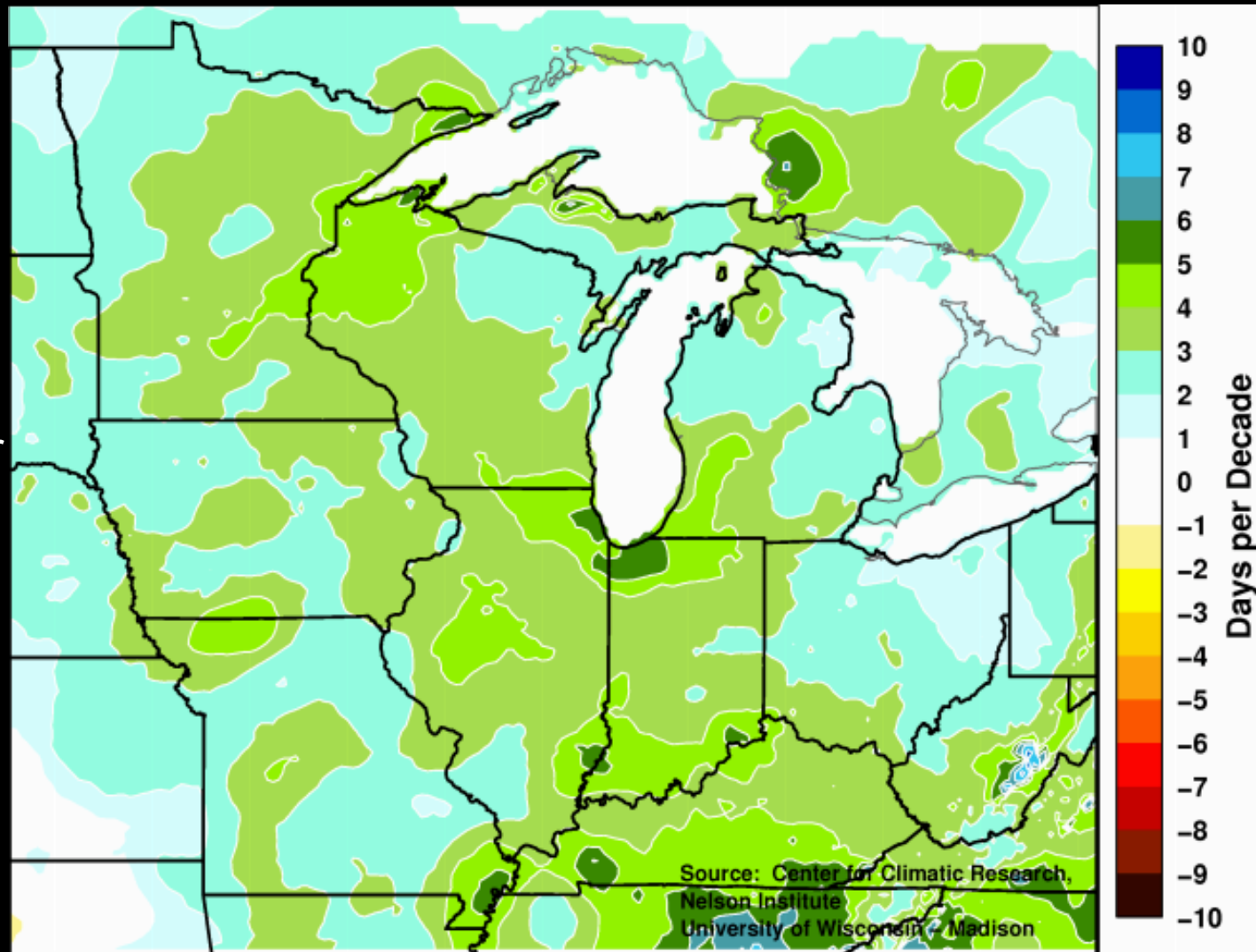
Simulation of jet stream pattern July 22. (Ventusky.com)

By **Jason Samenow**
October 31 at 2:16 PM

Projected Heavy Rainfall

Change in 2"+ inches per 24 hr rain events:
Statistically downscaled GCM, 1980-2055 (SRES A1B)

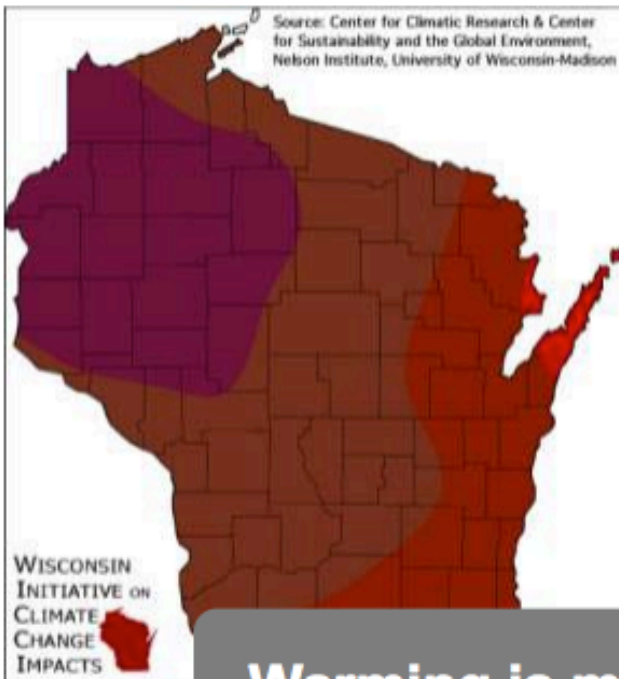
2-5 days
more per
decade



Source: UW-Madison
Nelson Institute
Center for Climatic Research

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

Winter



Spring



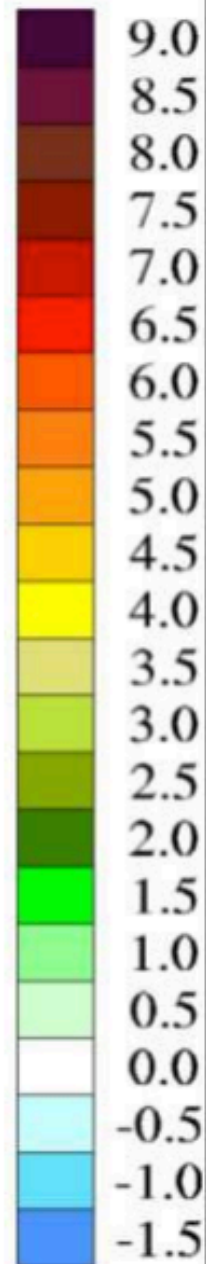
Summer



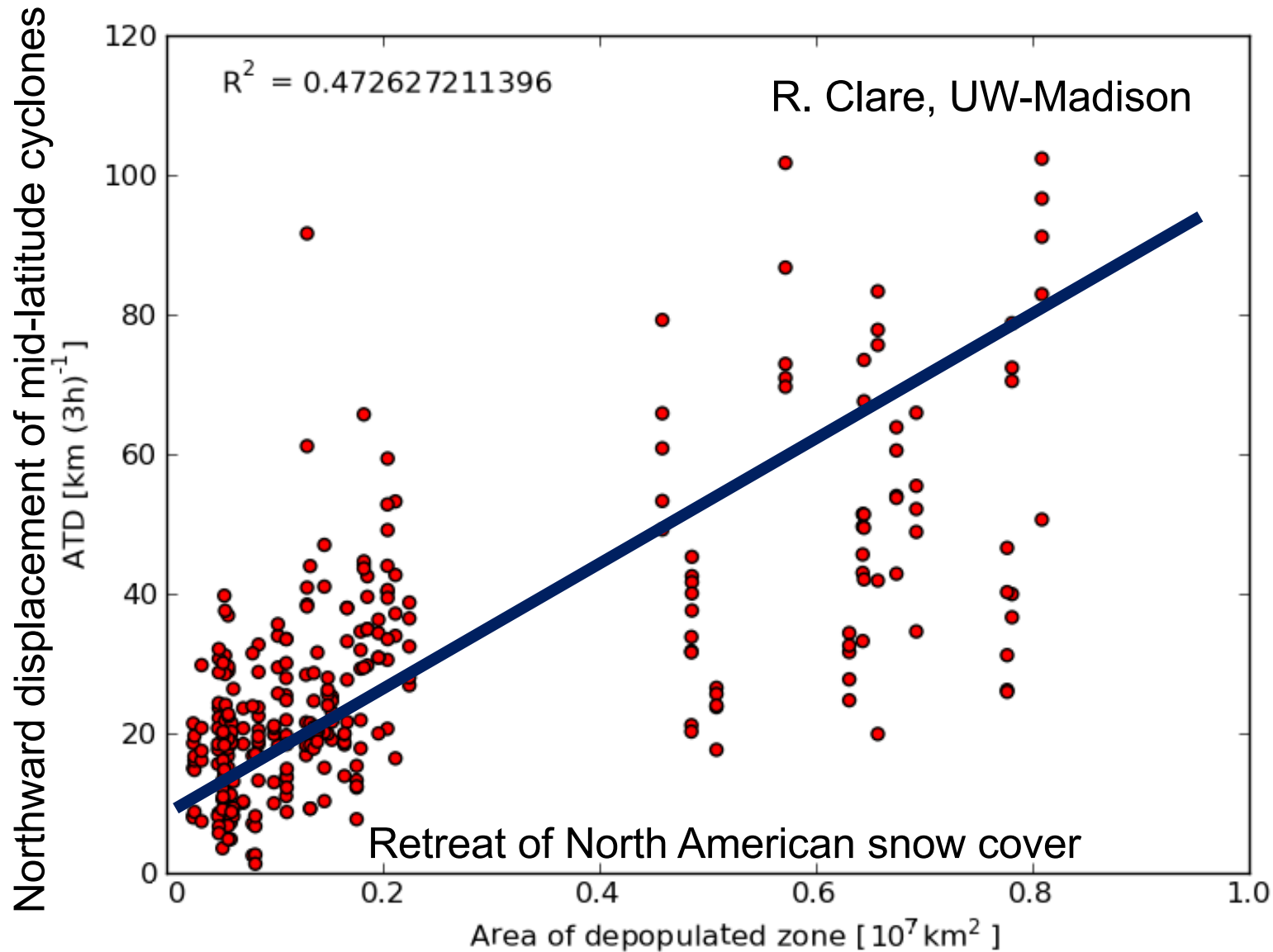
Fall



Warming is most pronounced in winter



Northward retreat of snow cover leads to northward track shift of synoptic mid-latitude cyclones



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.**

Ellwood et al., 2013

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

Increased Stressors

Many forests are already under stress from other causes.

Climate change could make forests more susceptible to existing or new stressors.



Hemlock woolly adelgid:
Pest limited by cold temps

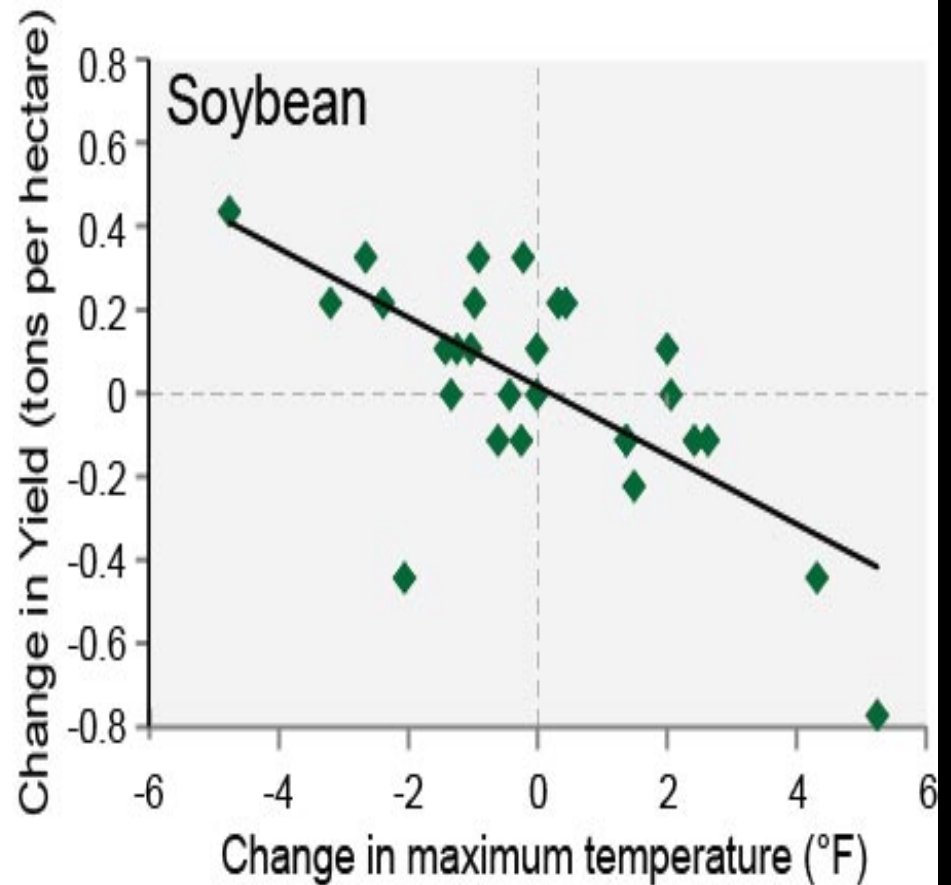
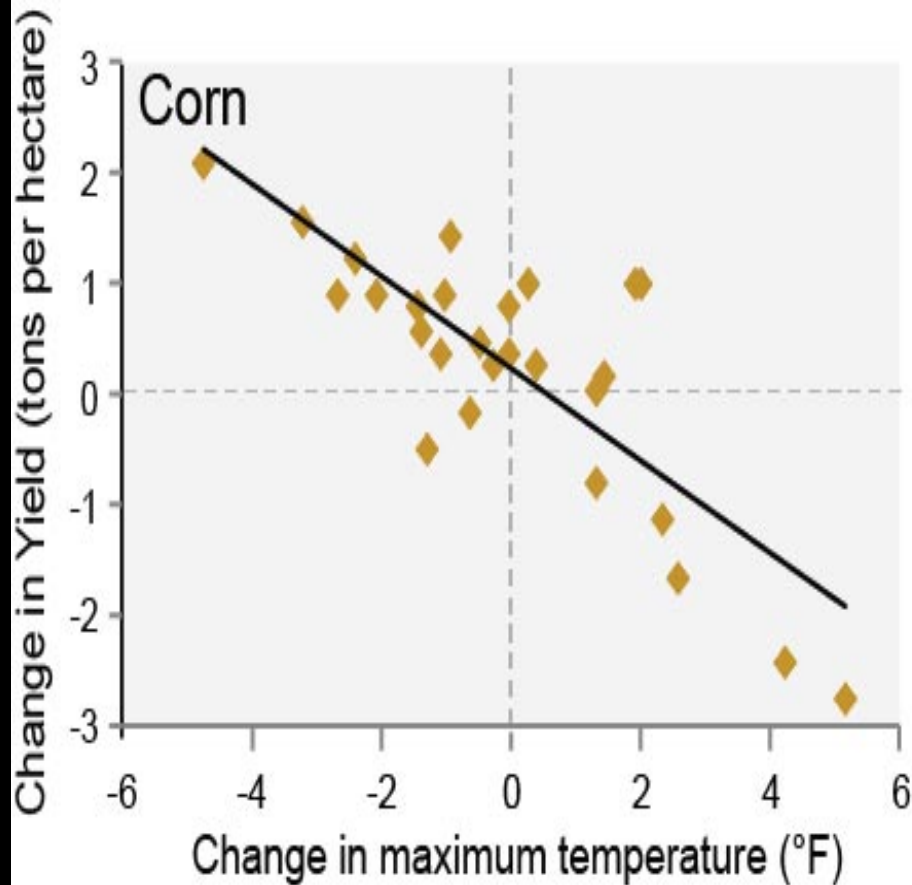


Exotic Earthworms:
Increase drought
susceptibility




Invasive Plants:
Outcompete stressed trees

Crop Yields Decline under Higher Temperatures



Wetland flux controls: how does interacting water table levels and temperature influence carbon dioxide and methane fluxes in northern Wisconsin?

Carolyn A. Pugh · David E. Reed  · Ankur R. Desai · Benjamin N. Sulman

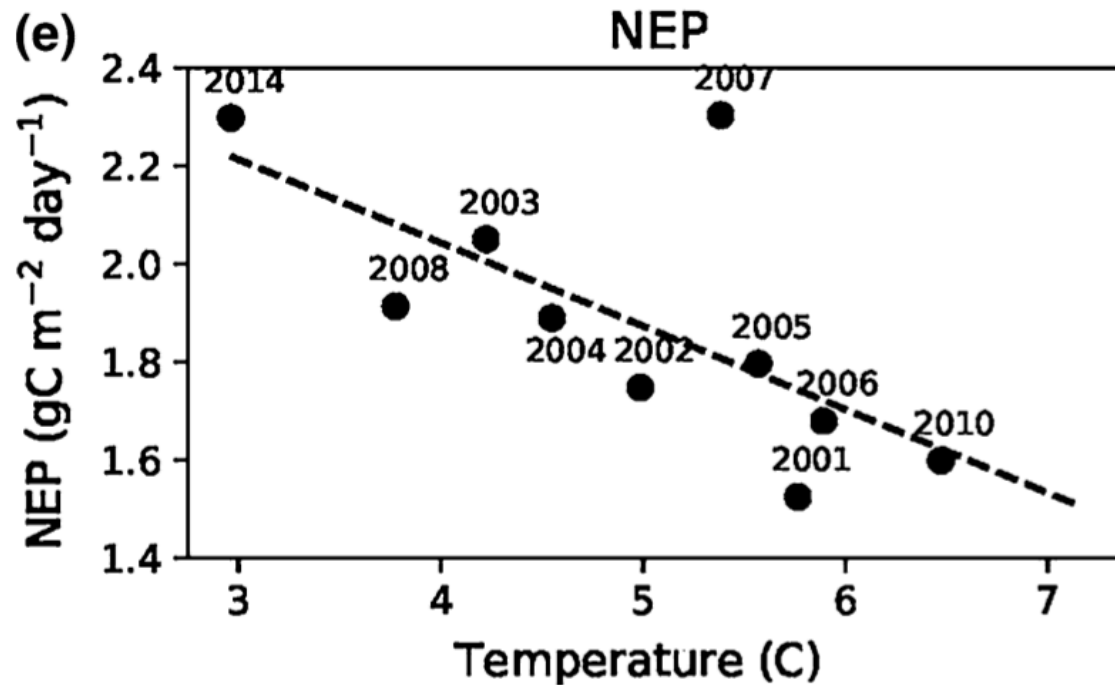
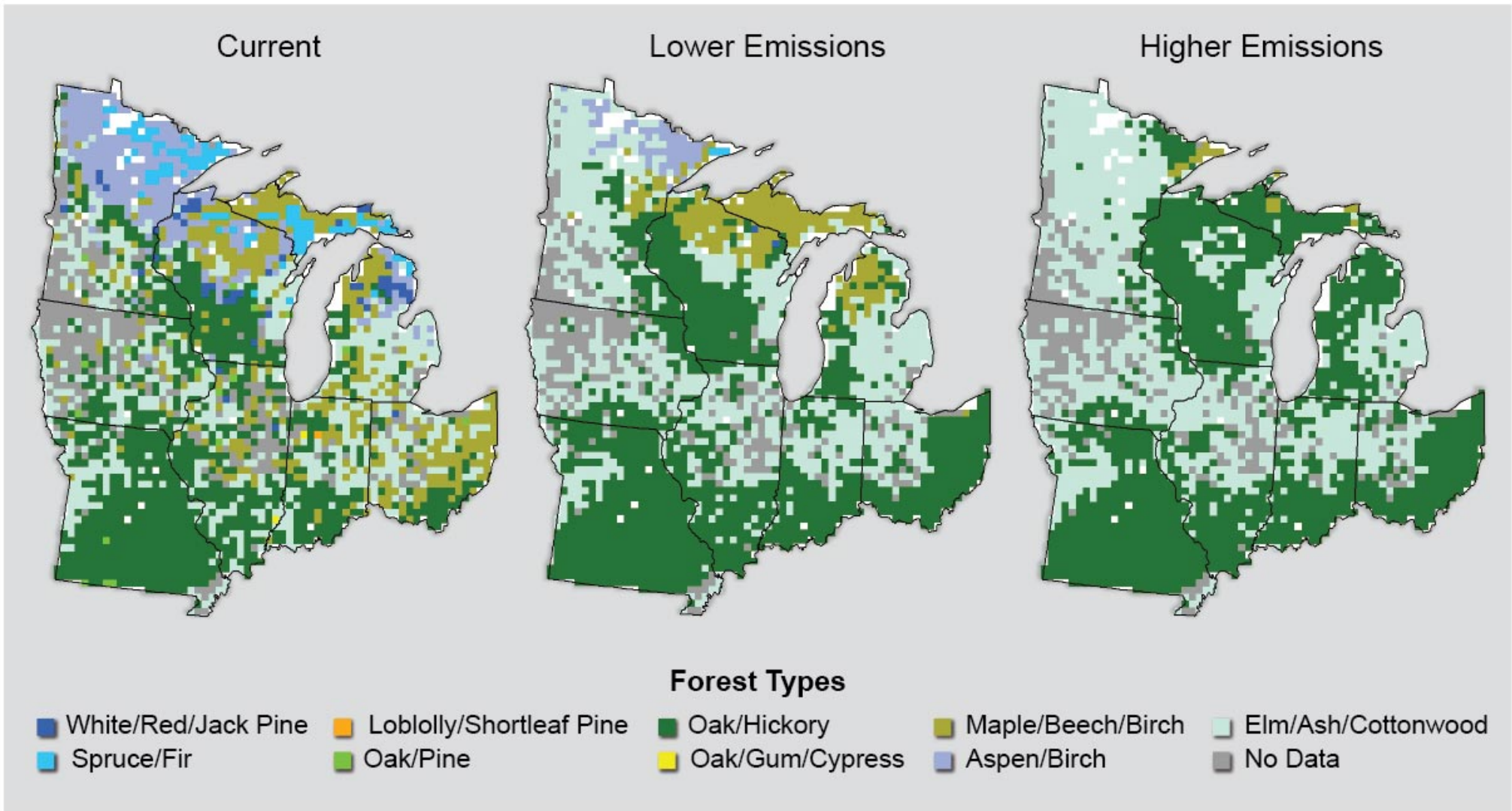
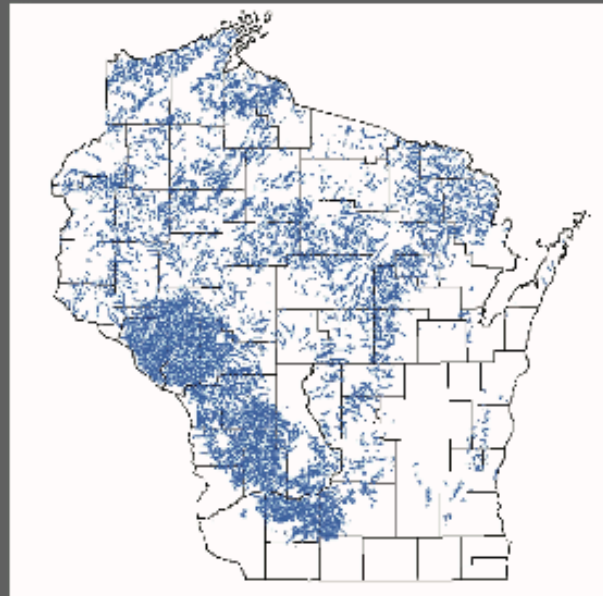


Photo: J Thom, SSEC

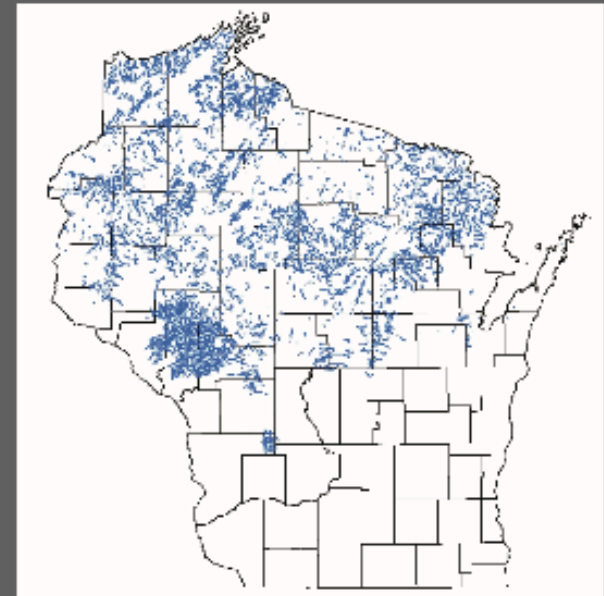
Forest Composition Shifts



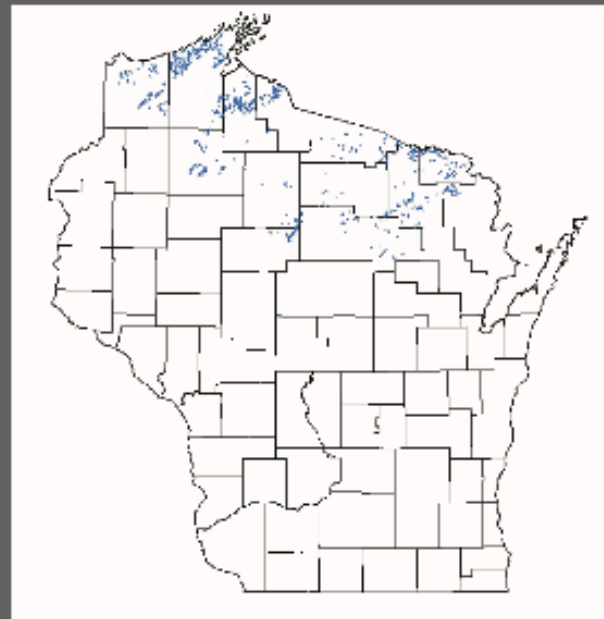
Brook trout streams
Source: WICCI



Current climate



**Best case
+1.4°F = 44% loss**



**Moderate case
+4.3°F = 94% loss**



**Worst case
+7.2°F = total loss**

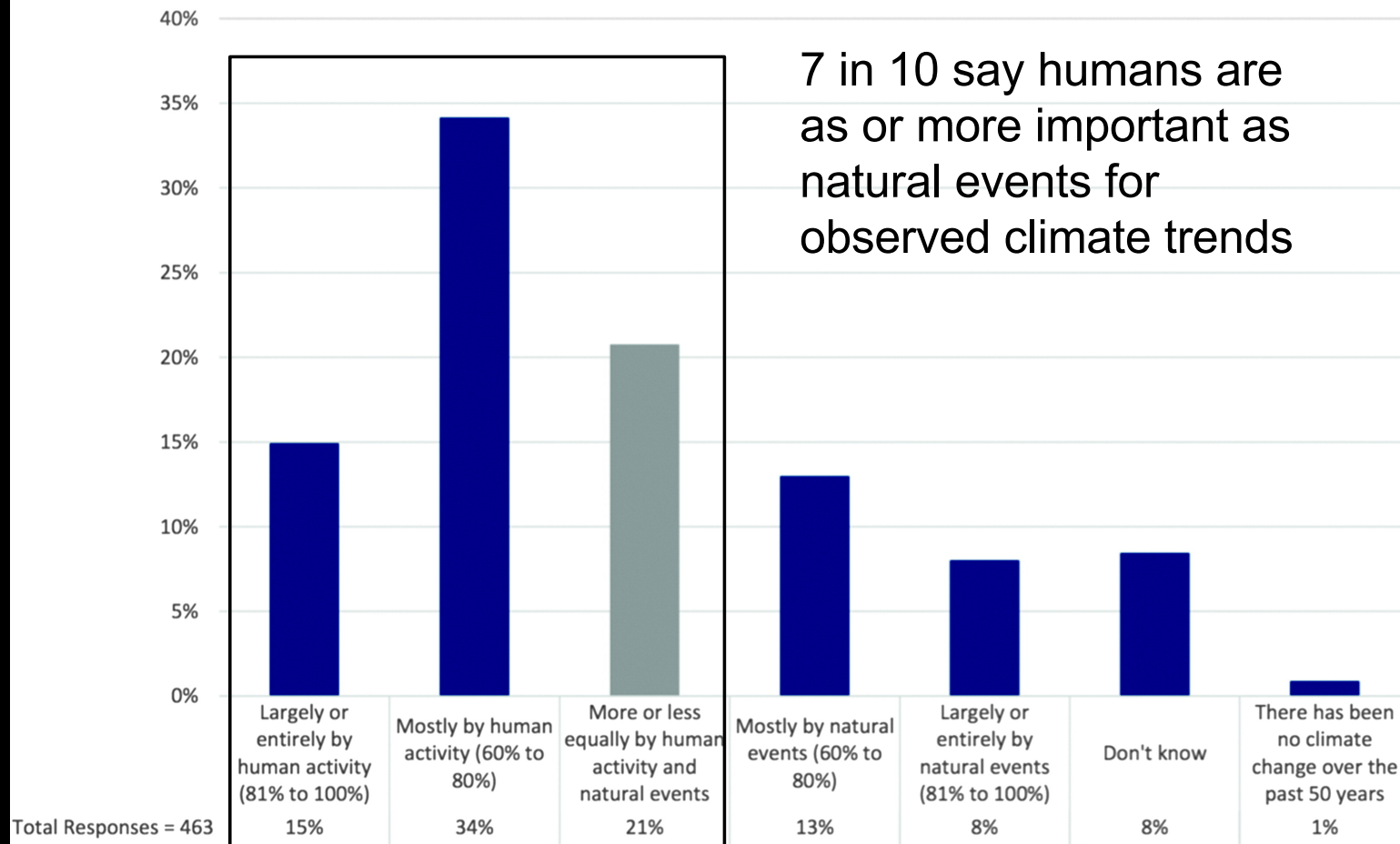
Badgers want change but rarely hear or talk about it

- 7 in 10 believe global warming is happening and trust climate scientists
 - Around half believe it is caused mostly by humans or worry about its harms
- Up to 8 in 10 support policies to support research, regulation, renewables
- But only 1 in 4 hear about global warming or discuss it occasionally

TV Weathercasters' Views of Climate Change Appear to Be Rapidly Evolving

Edward Maibach, Raphael Mazzone, Robert Drost, and Teresa Myers

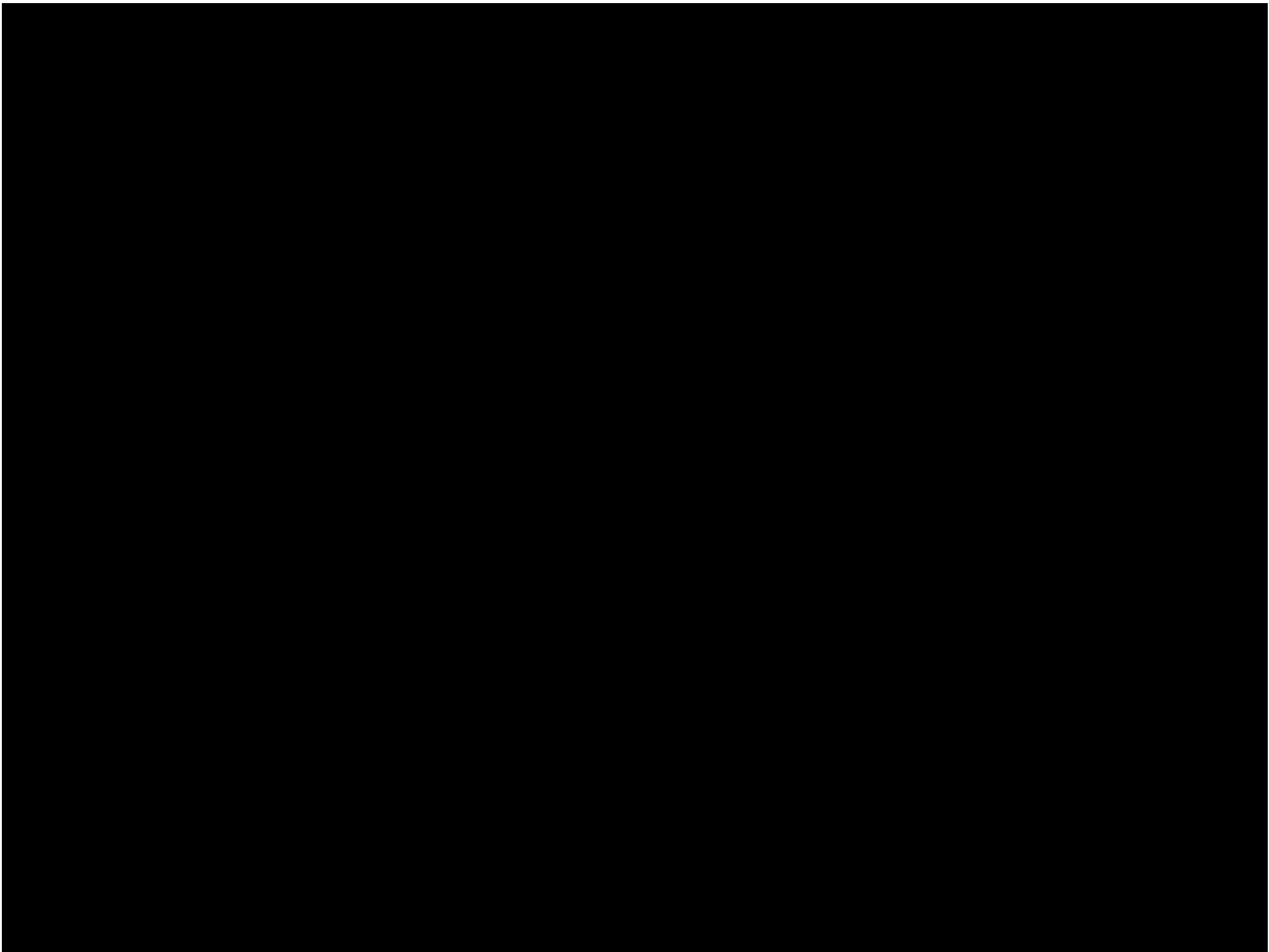
Do you think that the climate change that has occurred over the past 50 years has been caused...

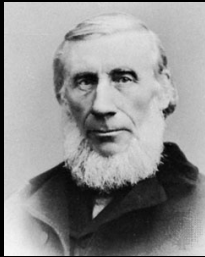


Thanks!

Ankur Desai, desai@aos.wisc.edu, <http://flux.aos.wisc.edu>, Twitter: @profdesai

- We have nearly 2 centuries of research on a change climate, human's contribution and its impacts
- There is much to be done in communication of impacts, risks, evaluation of policies
- Broadcast met and NWS forecasters have an opportunity to be at the forefront of that discussion





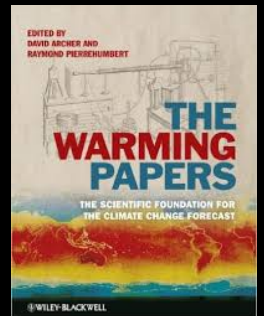
- Planetary (inc. Earth) temperature is determined by interaction of sunlight warming Earth's surface, and "greenhouse" gases that absorb infrared radiation (Fourier 1824, Tyndall 1861)



- CO₂ is a greenhouse warming gas and emitted from coal, oil, gas (Arrhenius 1896)



- Oceans can only take up a fraction of CO₂ produced by combustion (Revelle 1957)

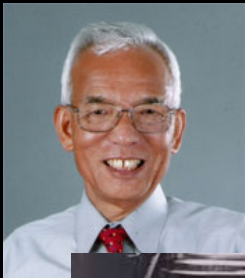




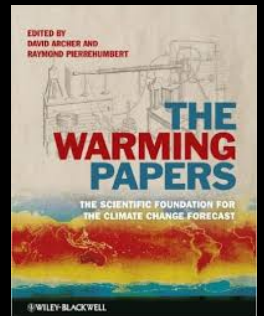
- Atmospheric CO₂ increasing ~ 2 ppm/yr from fossil fuel combustion, with 50% going into land and ocean sinks (Keeling 1960, Tans 1990)



- Short and long term observed warming patterns are linked to greenhouse gases (Callendar 1938, Mann 1999)



- Significant warming in the 20th century is mostly explained by atmospheric CO₂ (Manabe 1967, Hansen 1984)



Shorter lake ice conditions influences recreation, fisheries, and algal blooms

