

sylvania - NetCam SC IR - Fri Sep 25 2020 11:30:06 CST - UTC-6

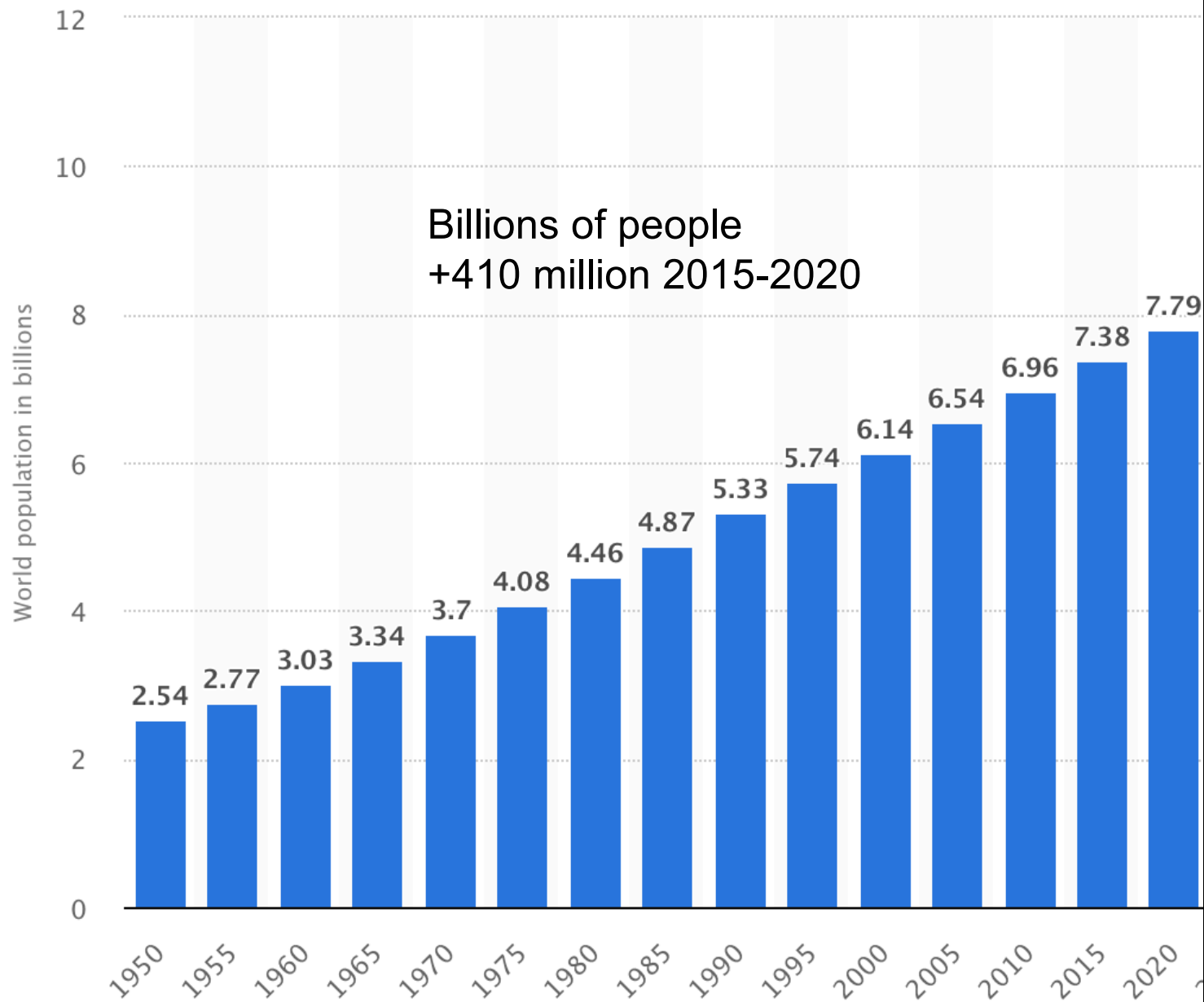
Camera Temperature: 42.5

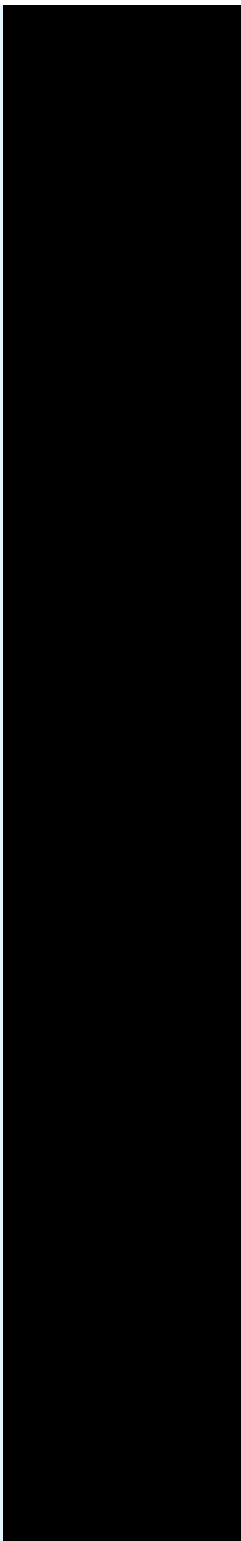
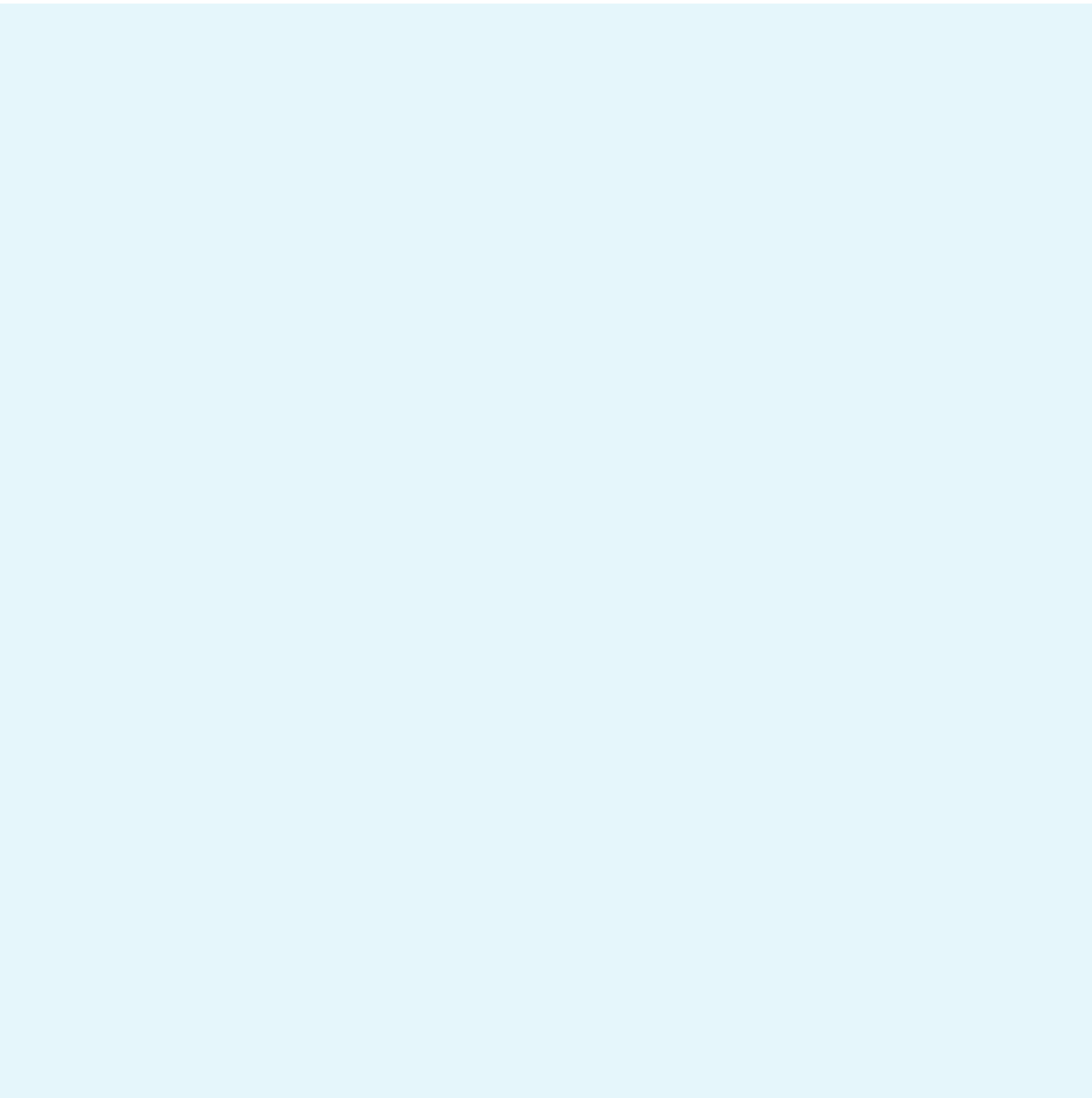
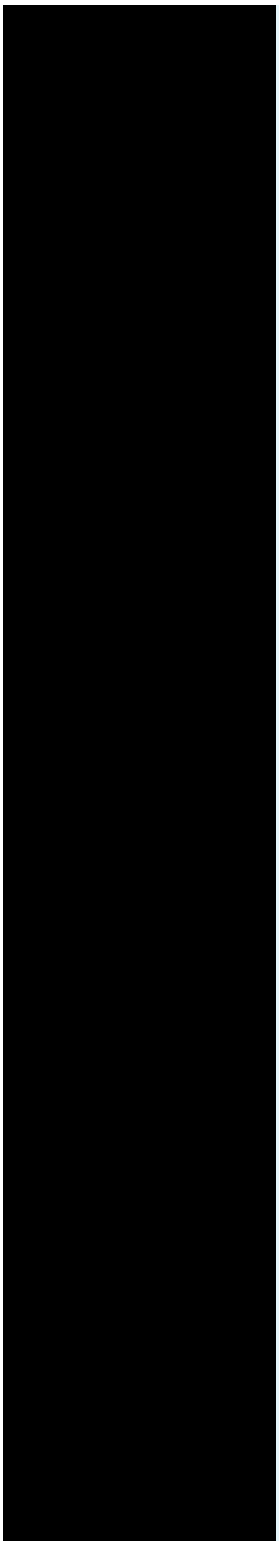
Exposure: 85

What Can *YOU* Do About Climate Change?

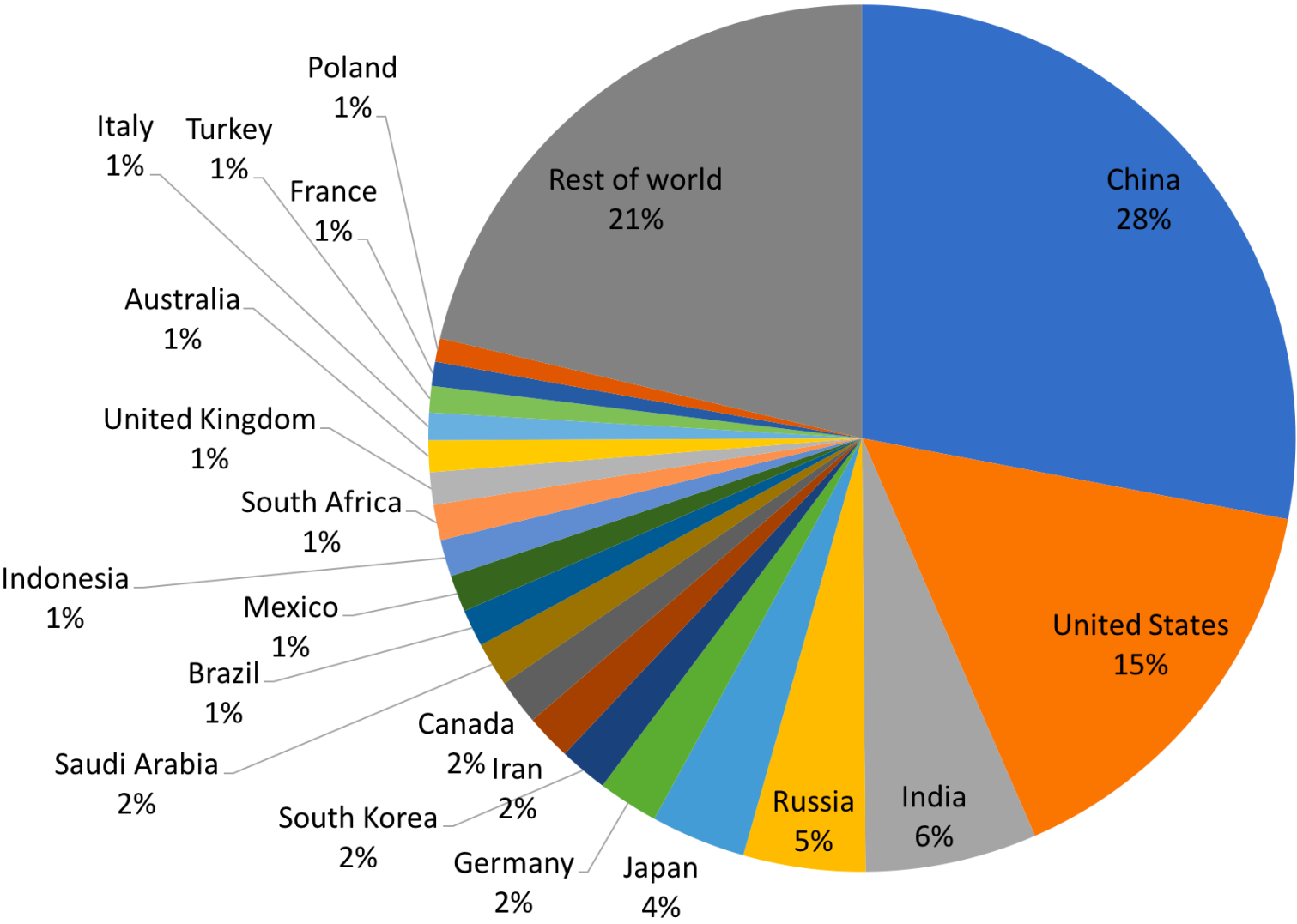
Ankur Desai
Dept of Atmospheric & Oceanic Sciences
University of Wisconsin-Madison

Nov 17, 2020
Wilberg Library
VIRTUAL EDITION



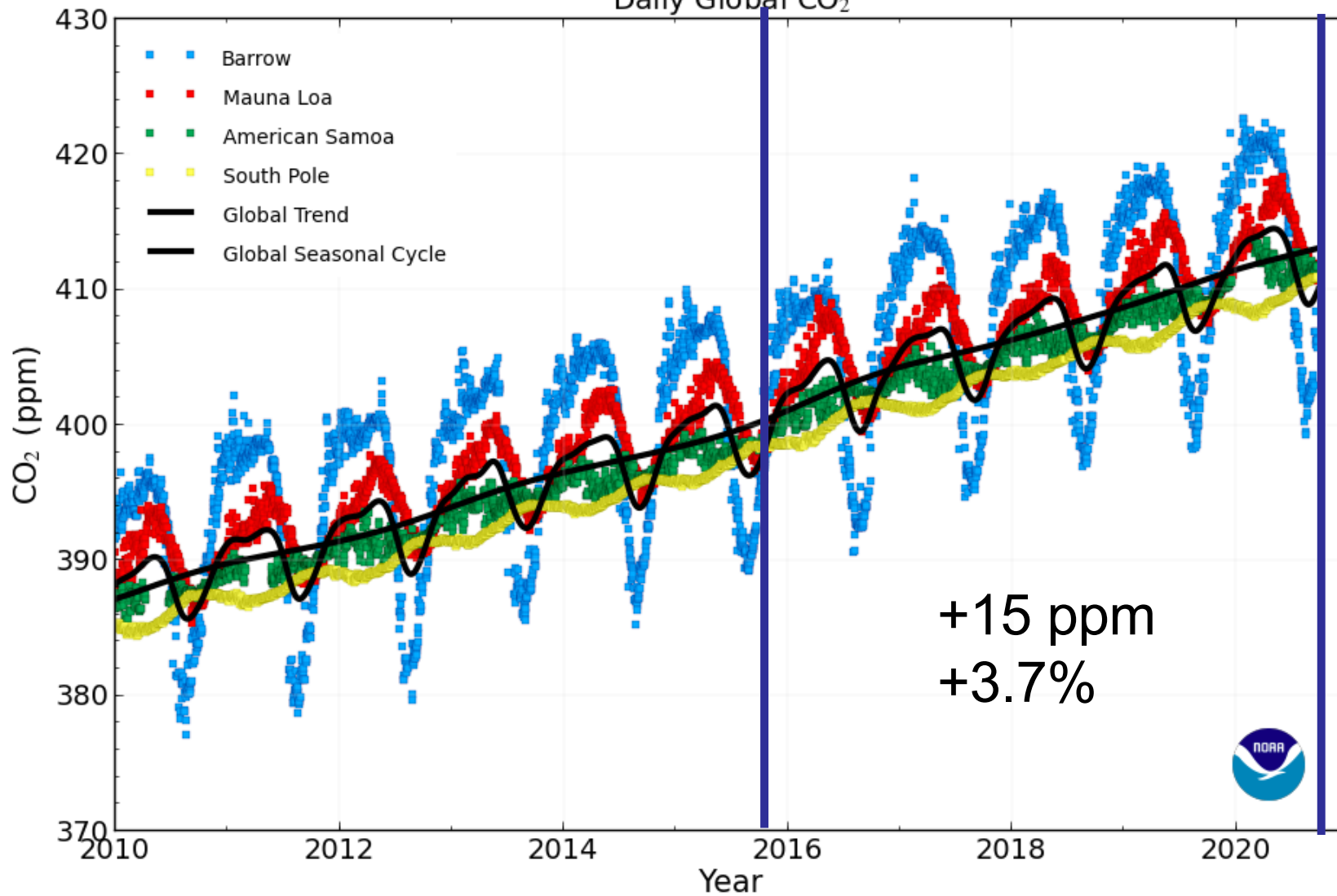


Share of global carbon dioxide emissions from fuel combustion (2015)



Data: IEA
Image: Union of Concerned Scientists

Daily Global CO₂

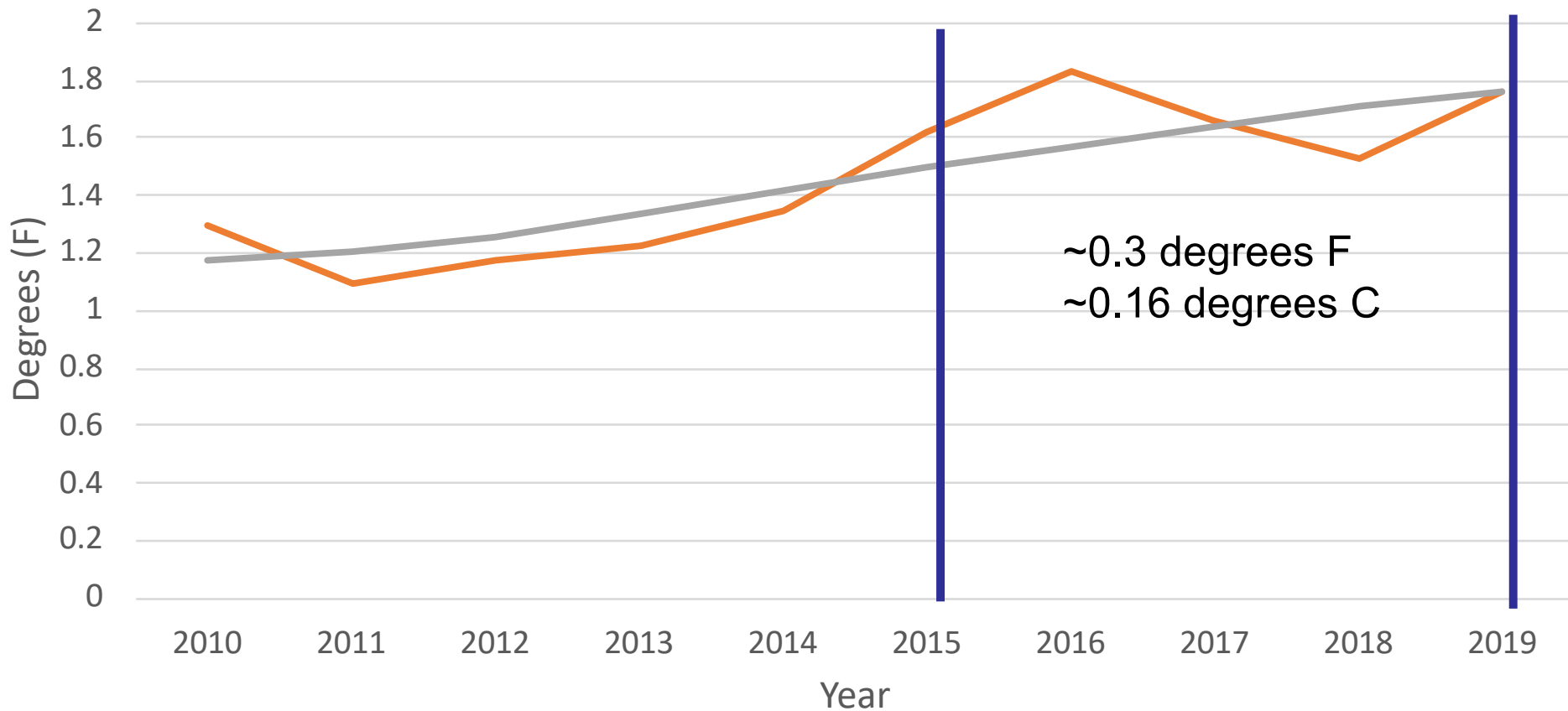


+15 ppm
+3.7%



2020-September-25

Global Temperature Difference from 1950-1980 (NASA GISS)



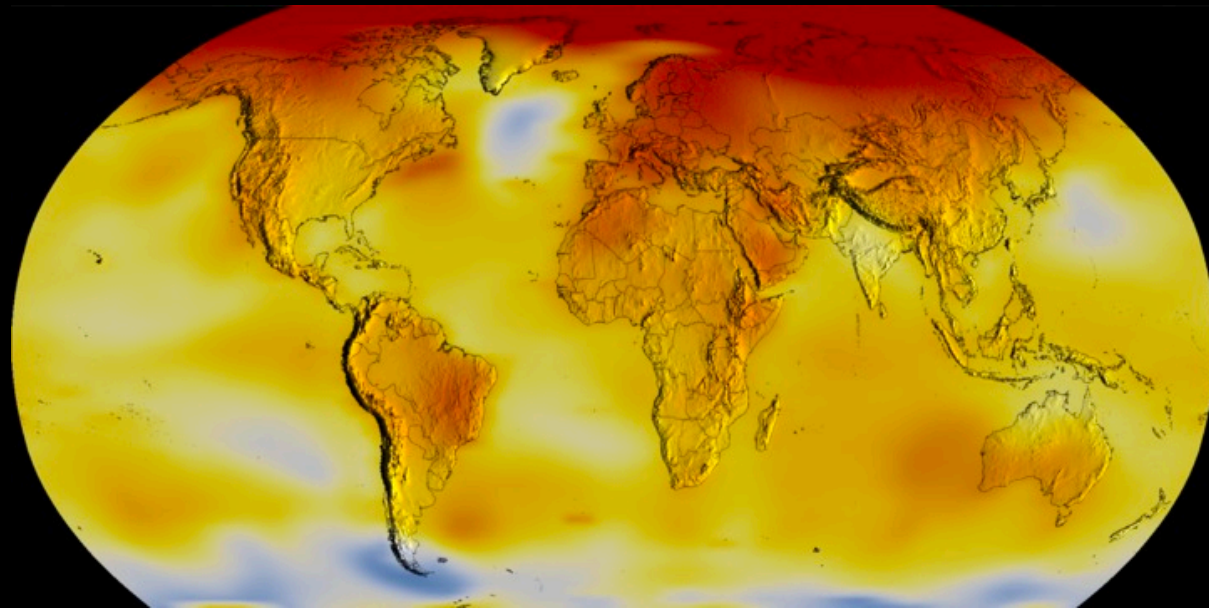
1.8 degree F per
100 ppm (20 yrs emissions)

— Anomaly — Smoothed

~3 C for doubling of CO₂

~0.3 degrees F
~0.16 degrees C

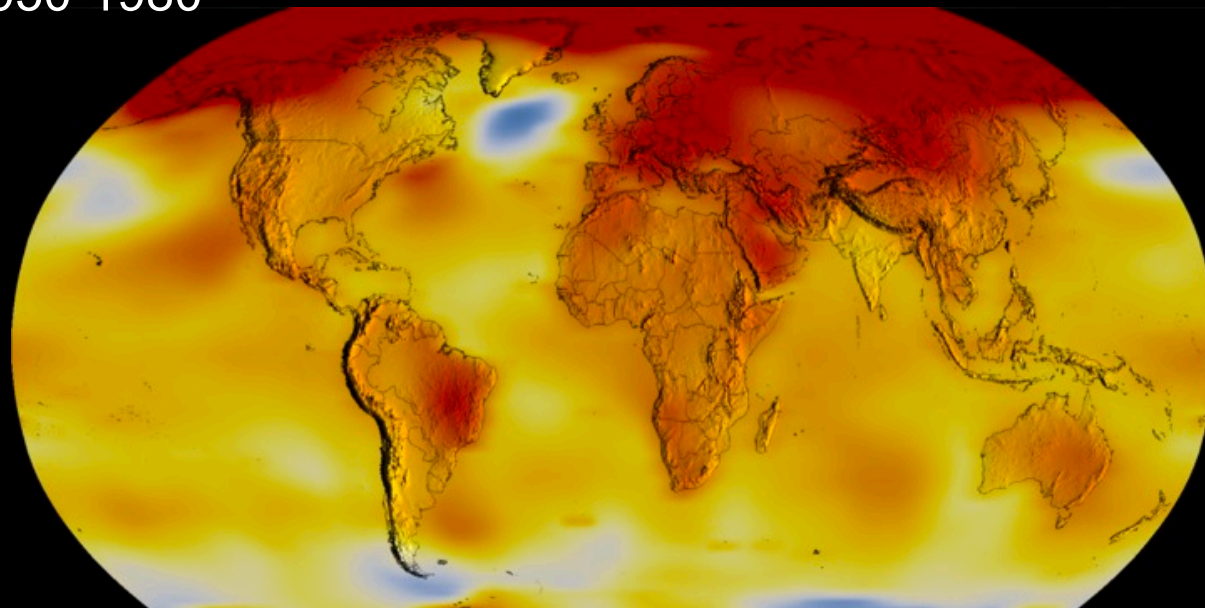
2015



Temperature Difference (Fahrenheit)
versus 1950-1980



2020



NASA GISS



REUTERS



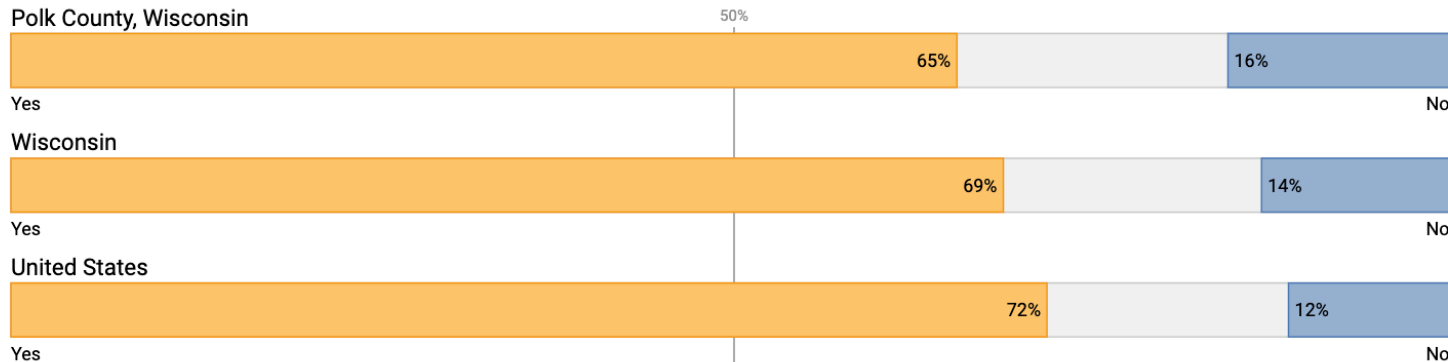
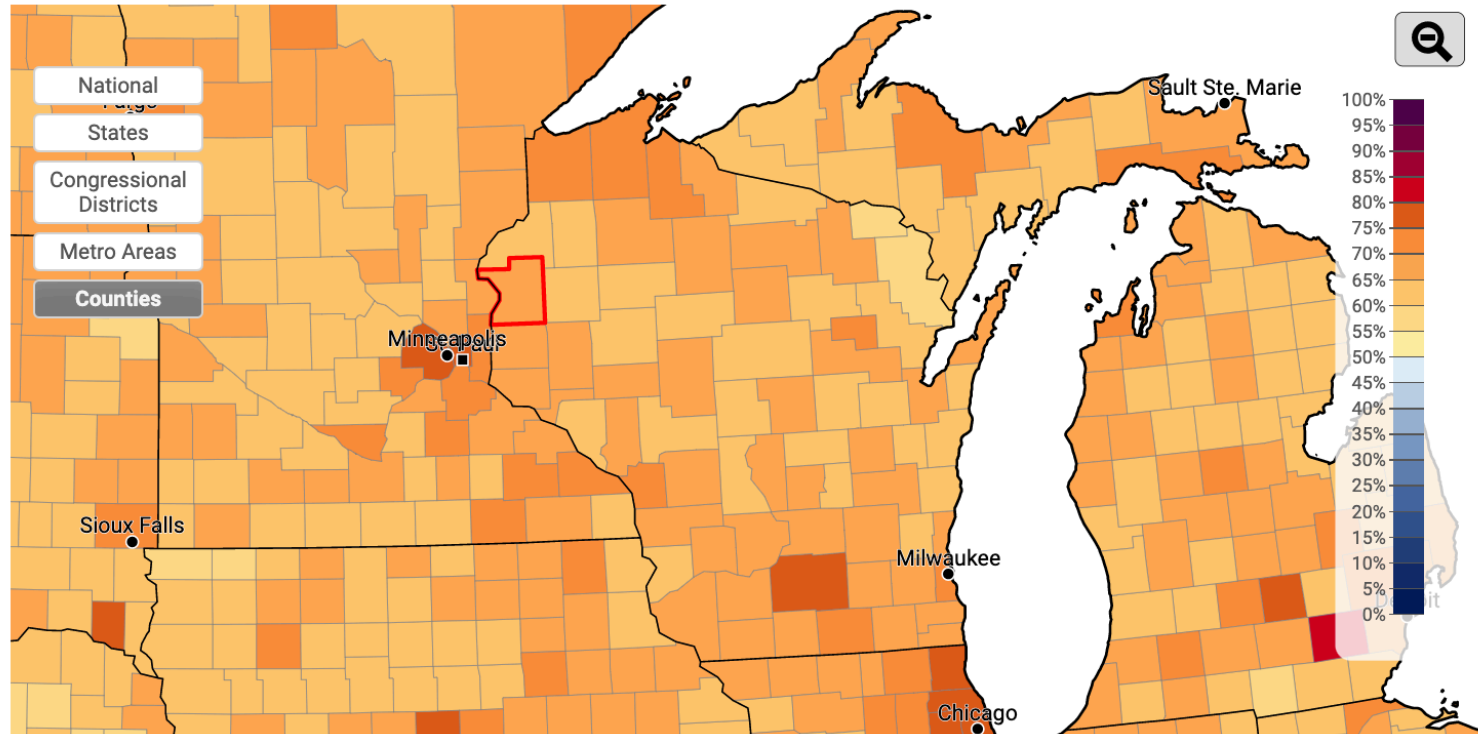
<https://www.nytimes.com/2020/01/10/world/australia/australia-wildfires-photos.html>



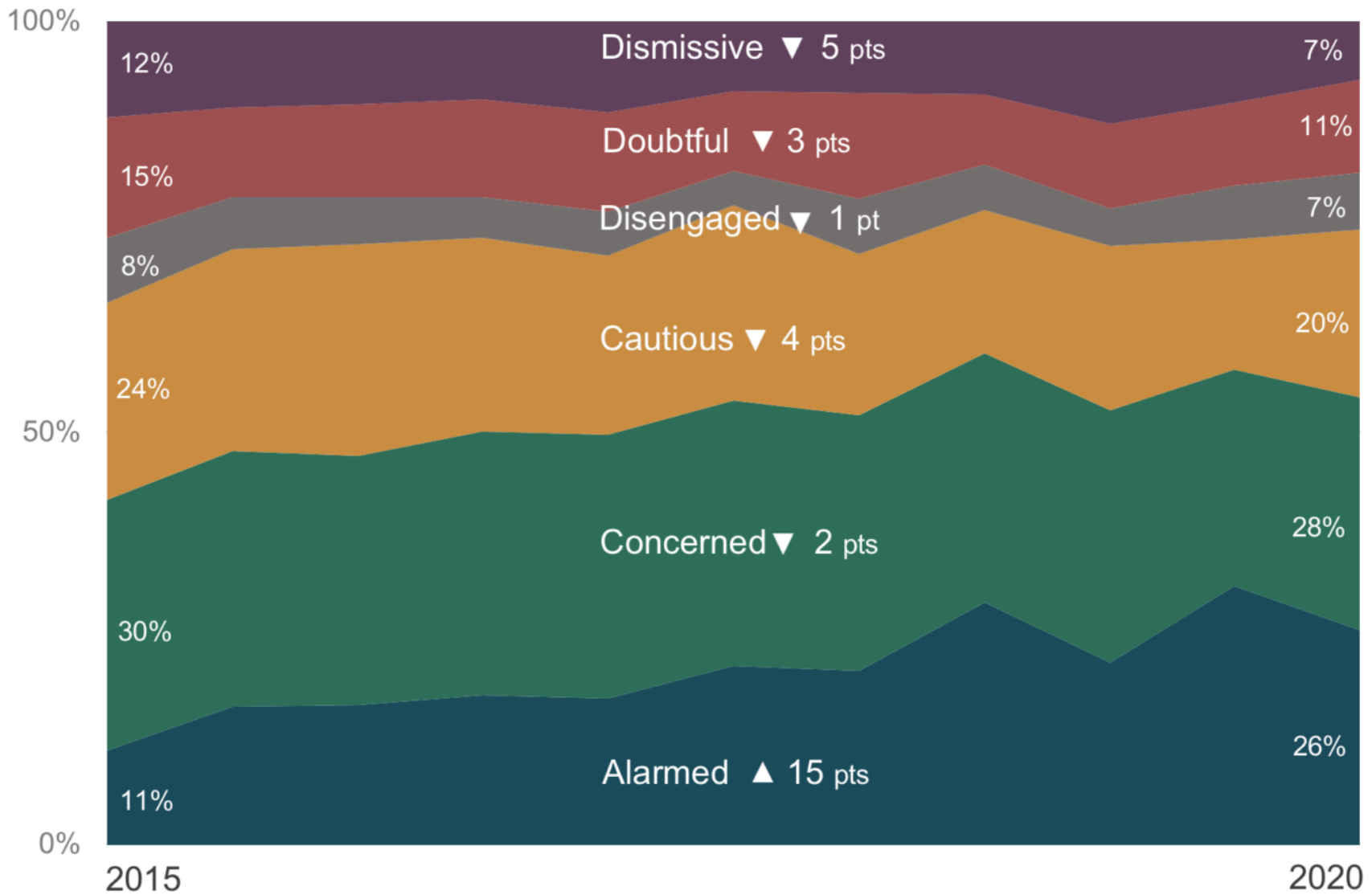
Estimated % of adults who think global warming is happening (72%), 2020

Select Question: Absolute Value

Click on map to select geography, or: Un-Select



Global Warming's Six Americas: Five Year Trend



Data from 11 national surveys ($N = 13,609$) from March 2015 to April 2020.



YALE PROGRAM ON
Climate Change
Communication



GEORGE MASON UNIVERSITY
CENTER for CLIMATE CHANGE
COMMUNICATION

Climate change: US formally withdraws from Paris agreement

FOURTH NATIONAL CLIMATE ASSESSMENT

Volume II: Impacts, Risks, and Adaptation in the United States



OFFICE OF THE GOVERNOR

EXECUTIVE ORDER #52

Relating to the Creation of the Governor's Task Force on Climate Change



WISCONSIN INITIATIVE ON CLIMATE CHANGE IMPACTS

Nelson Institute for Environmental Studies | Wisconsin Department of Natural Resources

[WORKING GROUPS](#) ▾

[TRENDS AND PROJECTIONS](#)

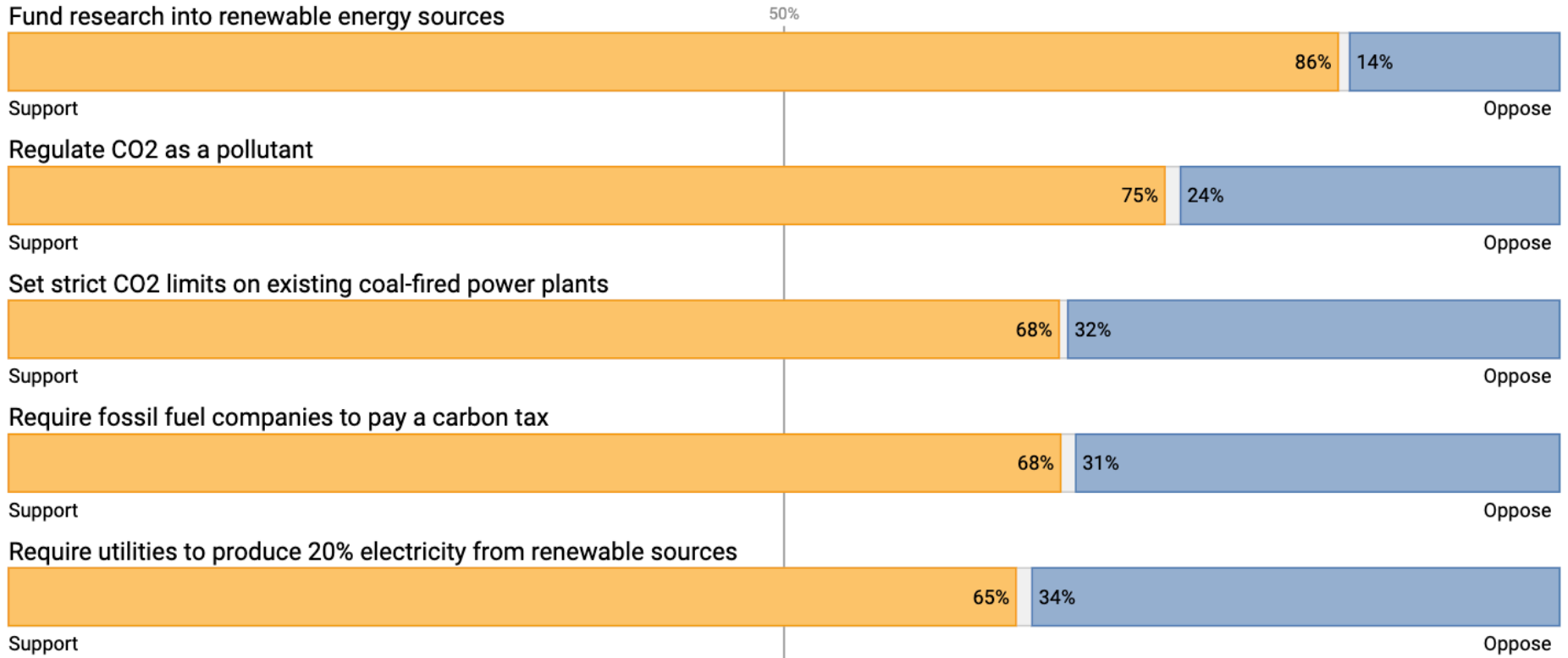
[IMPACTS AND ADAPTATION](#)

[EDUCATION AND OUTREACH](#)

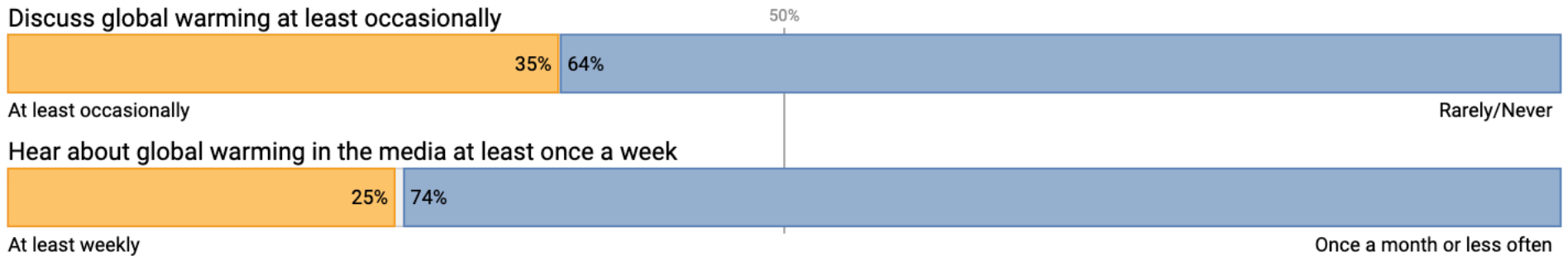
[ABOUT](#) ▾

[CONTACT US](#)

POLICY SUPPORT



BEHAVIORS






What is Climate?

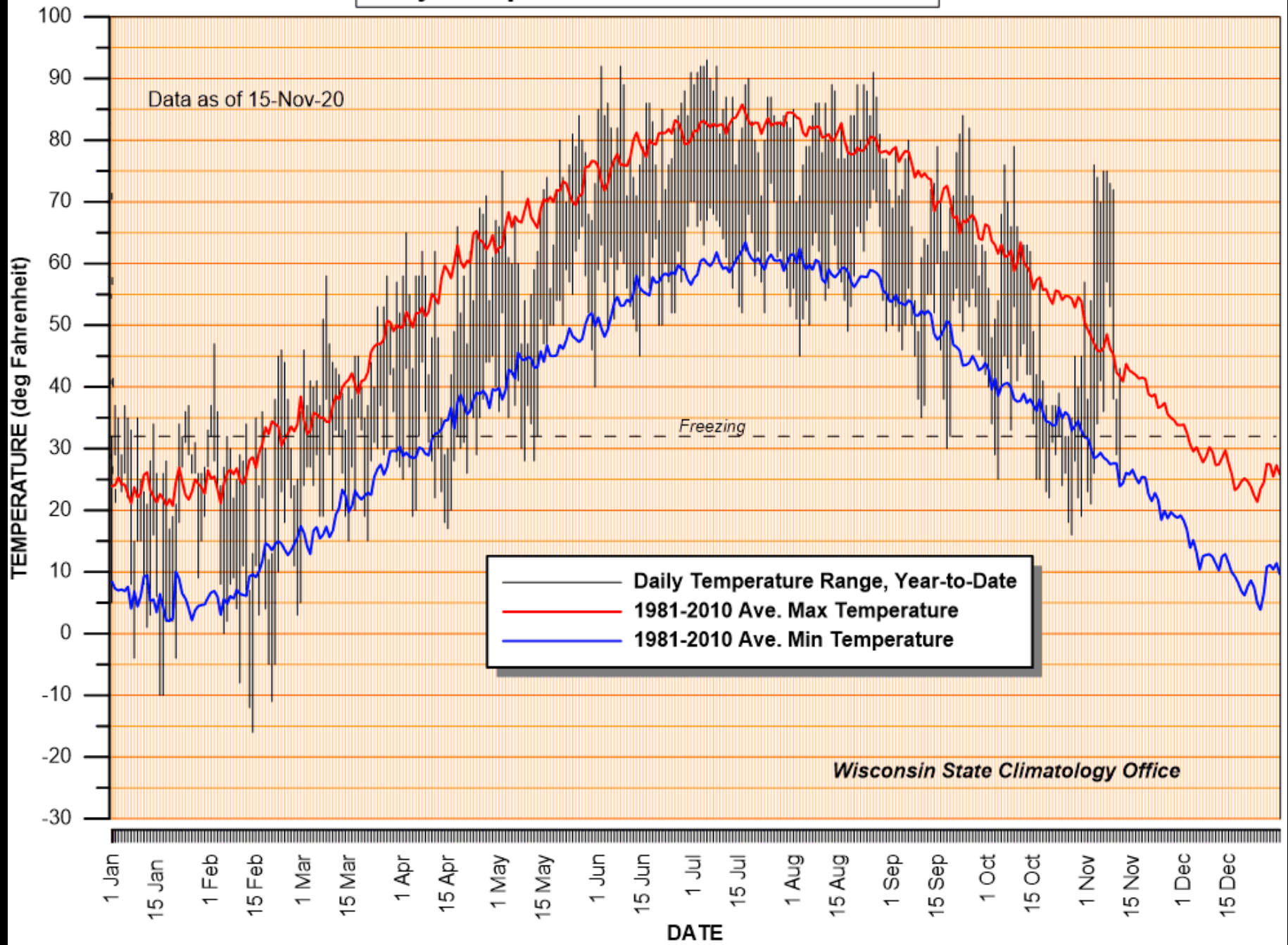
- Climate is the average of weather
 - “Climate is what you expect, weather is what you get” –Andrew John Herbertson
- Climate changes naturally (over eons) and by humans (over centuries)

Climate is your
personality
Weather is your
mood

A professional portrait of Prof. J. Marshall Shephard, a Black man with a receding hairline, smiling. He is wearing a dark suit jacket, a white dress shirt, and a red patterned tie. The background is a soft-focus outdoor scene with a blue sky and greenery.

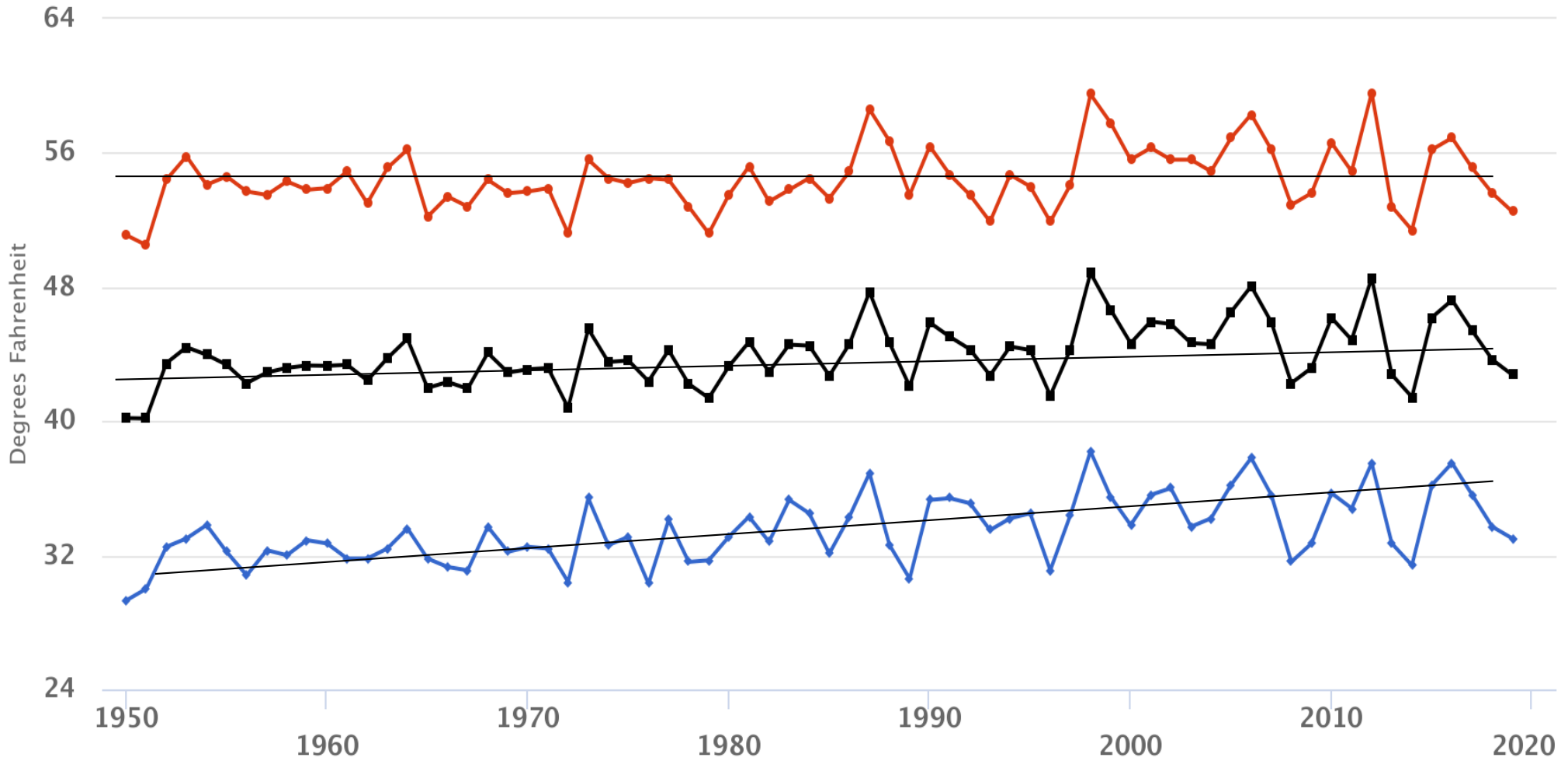
Prof. J. Marshall Shephard
U. Georgia

Daily Temperatures: EAU CLAIRE 2020



Annual Values at Eau Claire Area (WI) EAUthr 9

Midwestern Regional Climate Center

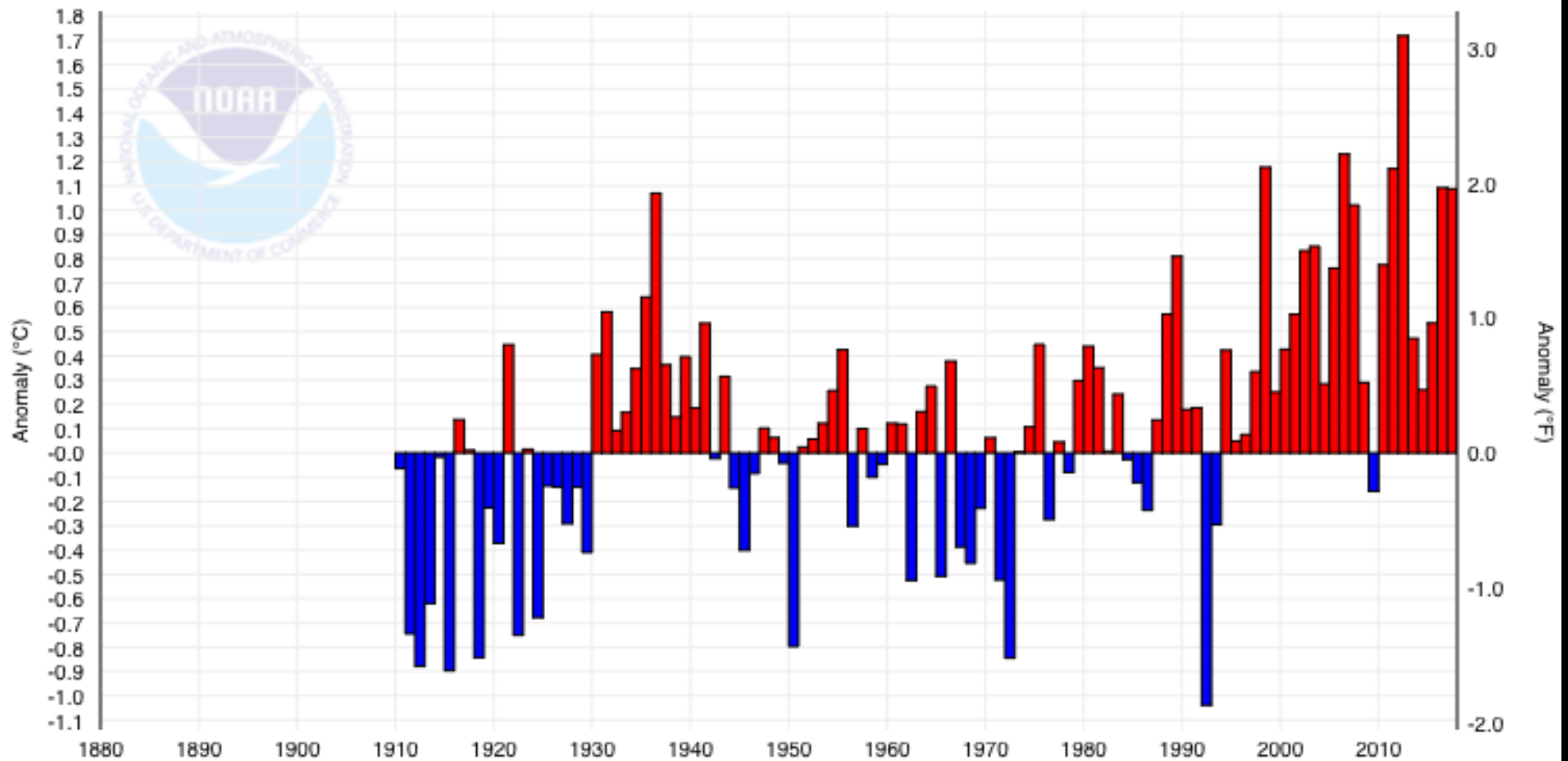


- Maximum Temperature
- Minimum Temperature
- Average Temperature
- Precipitation
- Snowfall
- Heating Degree Days
- Cooling Degree Days
- Growing Degree Days

Click and drag to zoom.

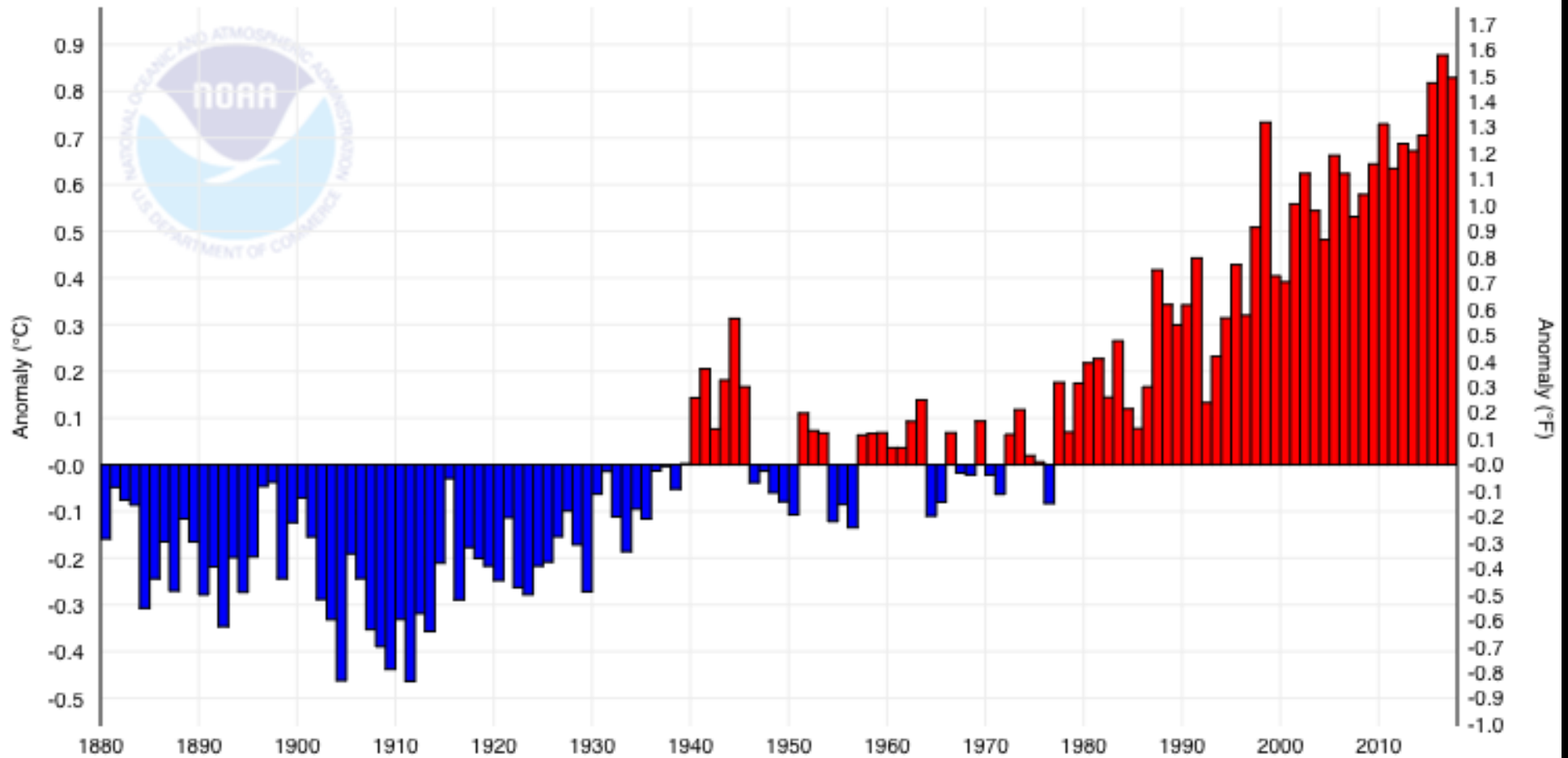
N America

North America Land Temperature Anomalies, July

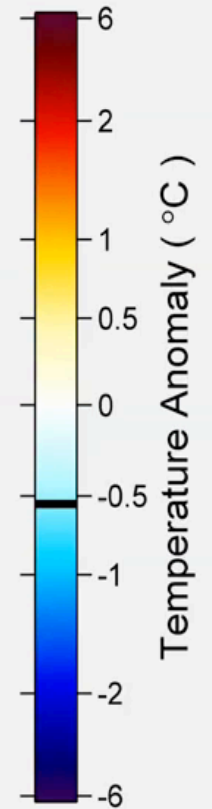
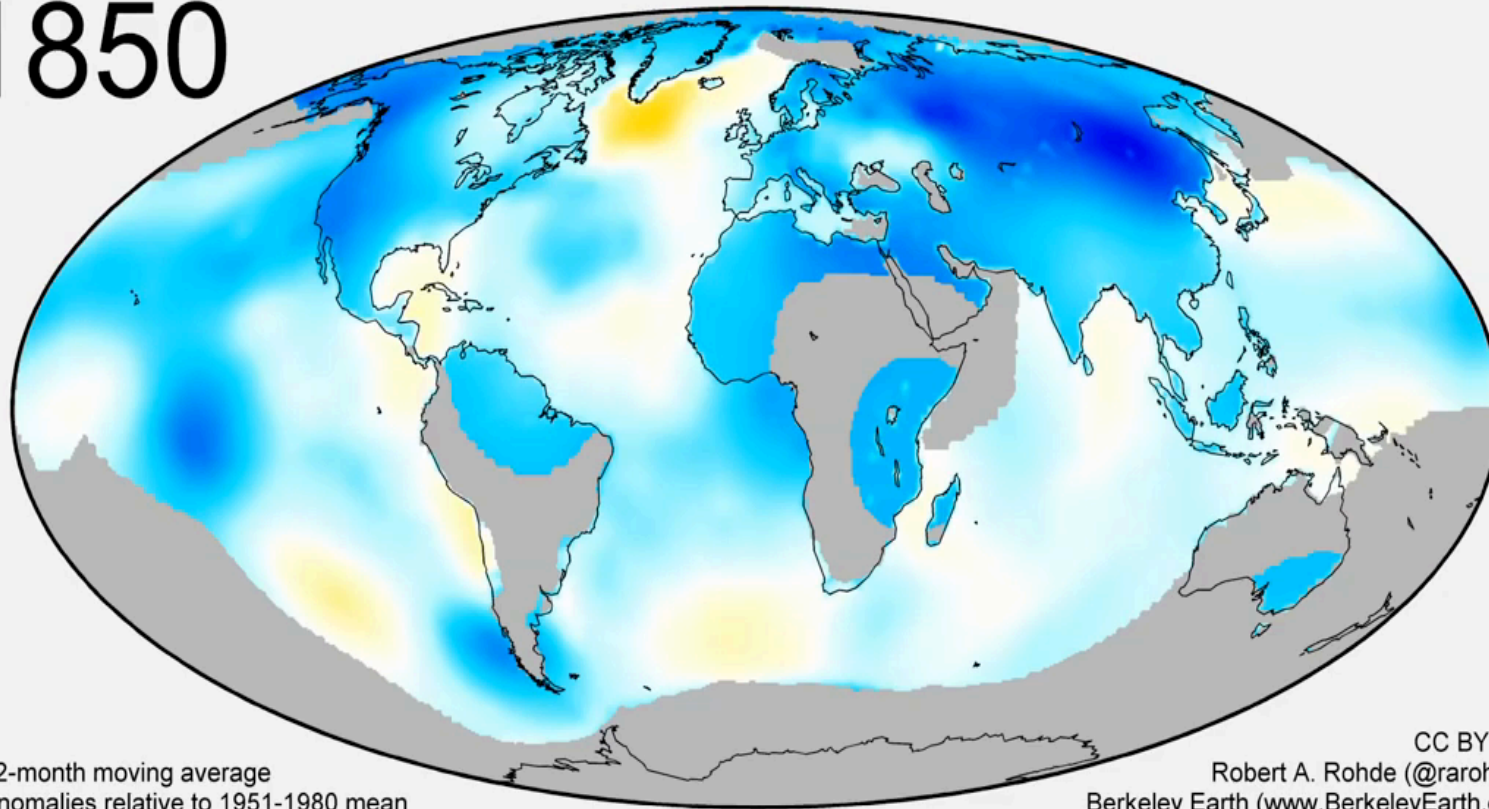


WORLD

Global Land and Ocean Temperature Anomalies, July



1850



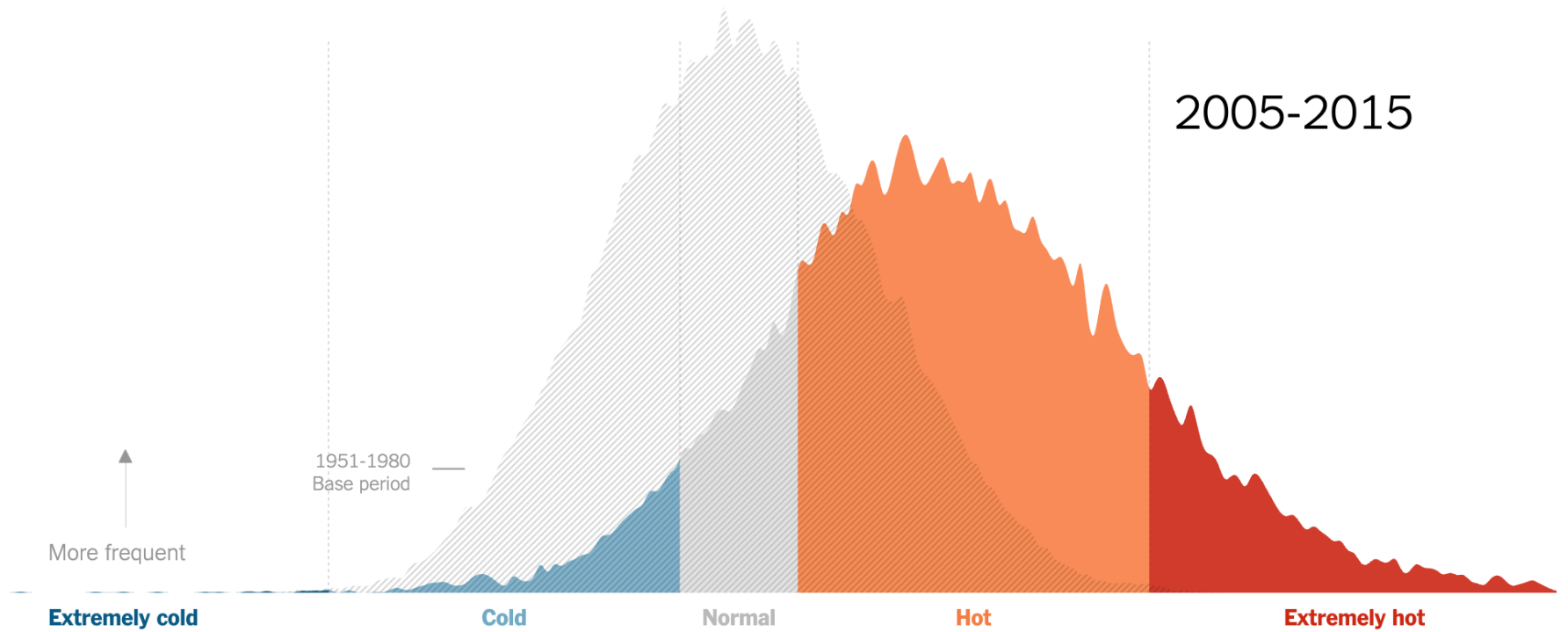
12-month moving average
Anomalies relative to 1951-1980 mean

CC BY-4.0
Robert A. Rohde (@rarohde)
Berkeley Earth (www.BerkeleyEarth.org)

Global Mean Temperature



Summer temperatures
in the Northern Hemisphere



The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance

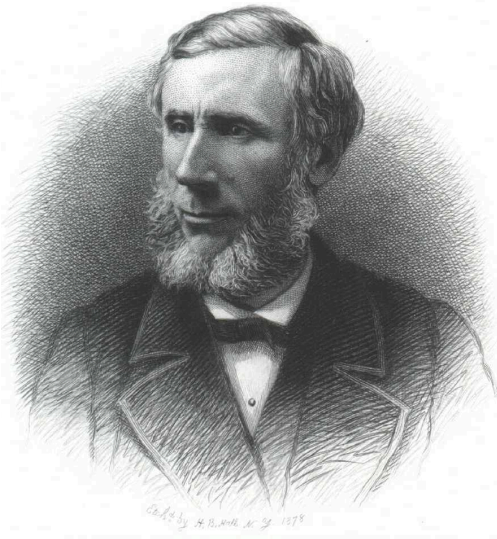
WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

3d per Copy.

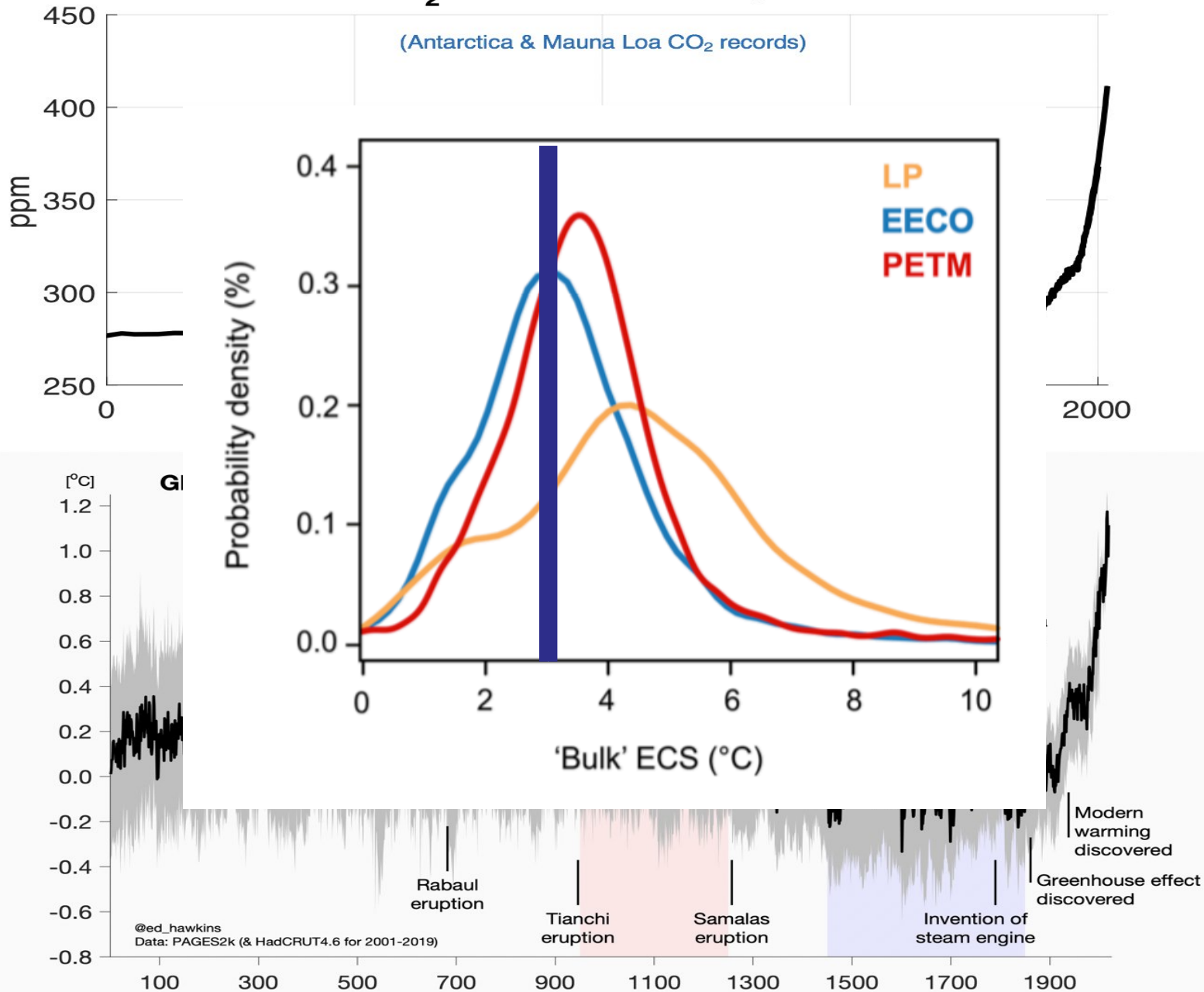
Science Notes and News.

COAL CONSUMPTION AFFECTING 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.



CO₂ over the last 2019 years



“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

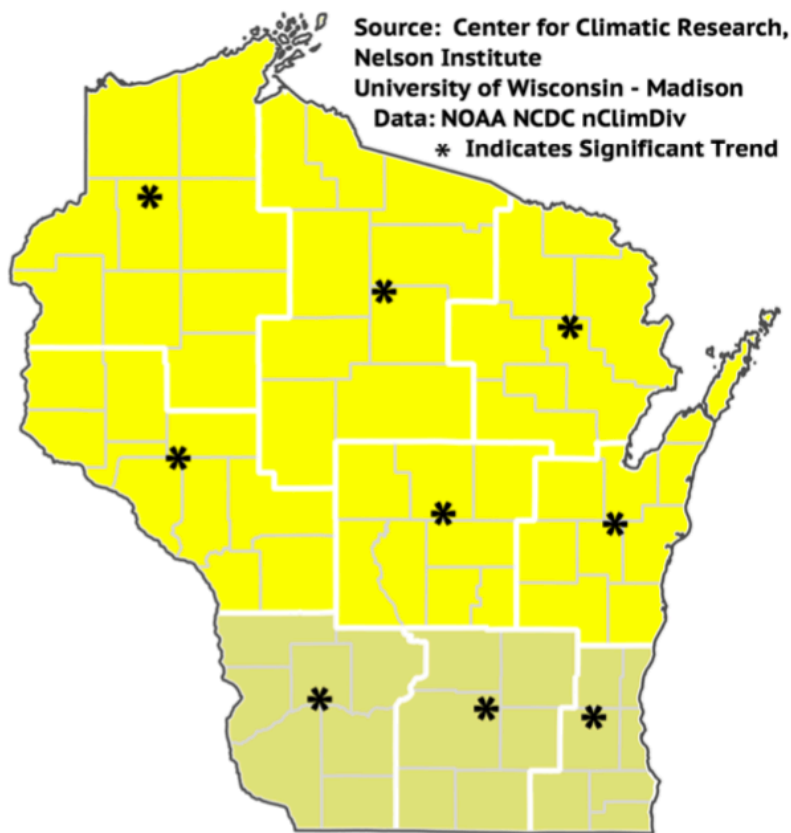


Based on an interactive by Bloomberg

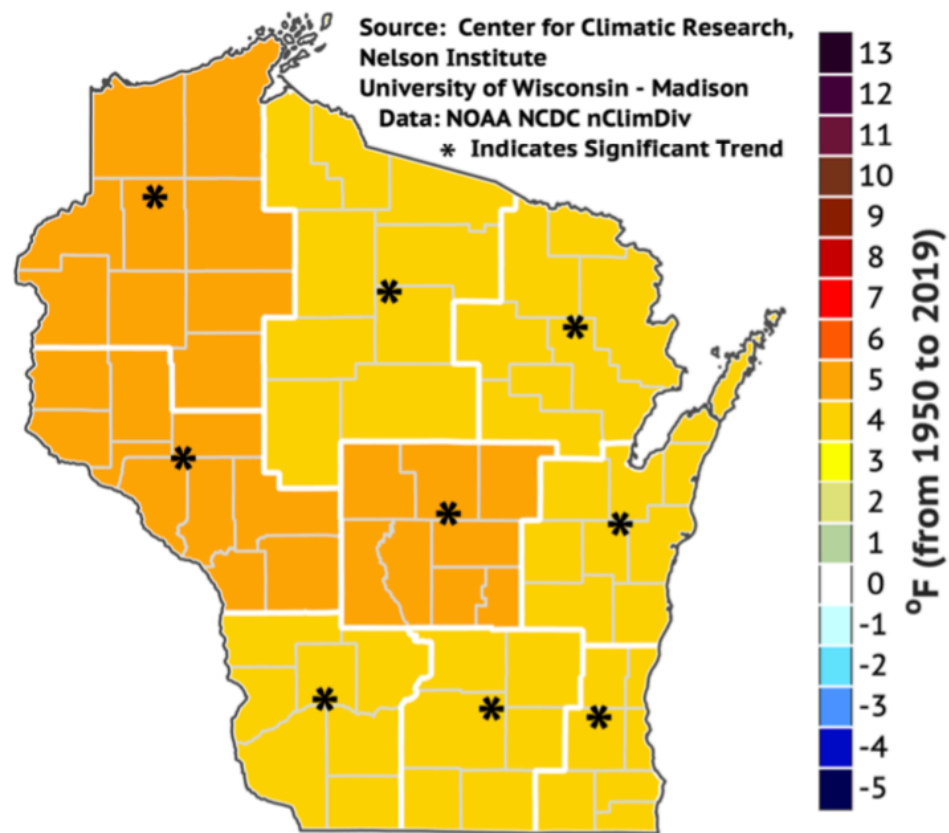
<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

Wisconsin is getting less cold

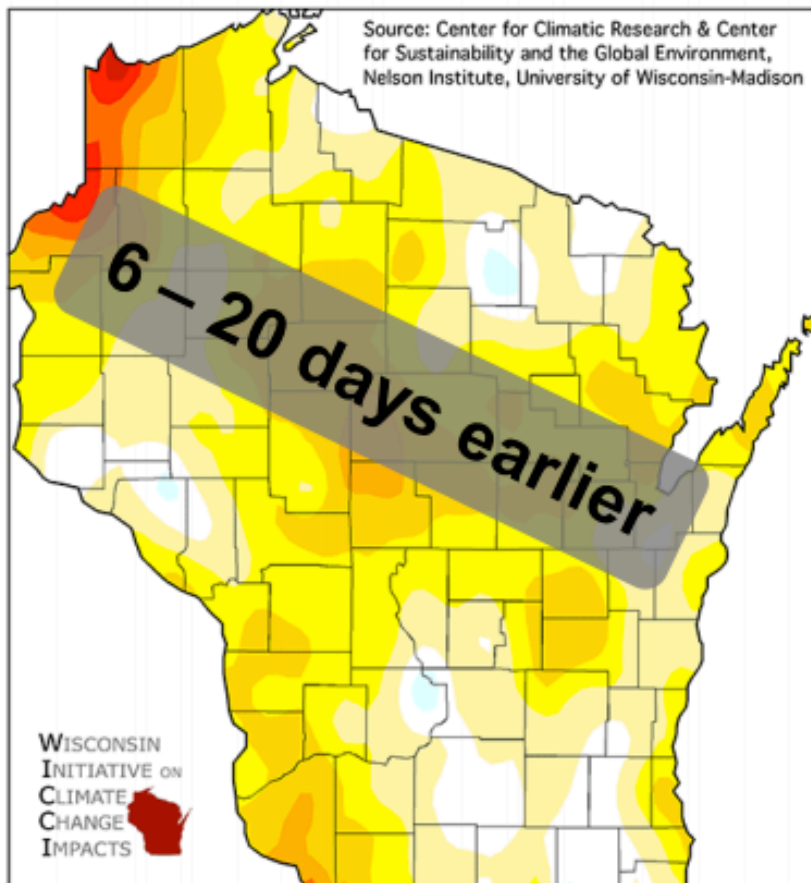
Historical Change in Annual TMEAN from 1950 to 2019



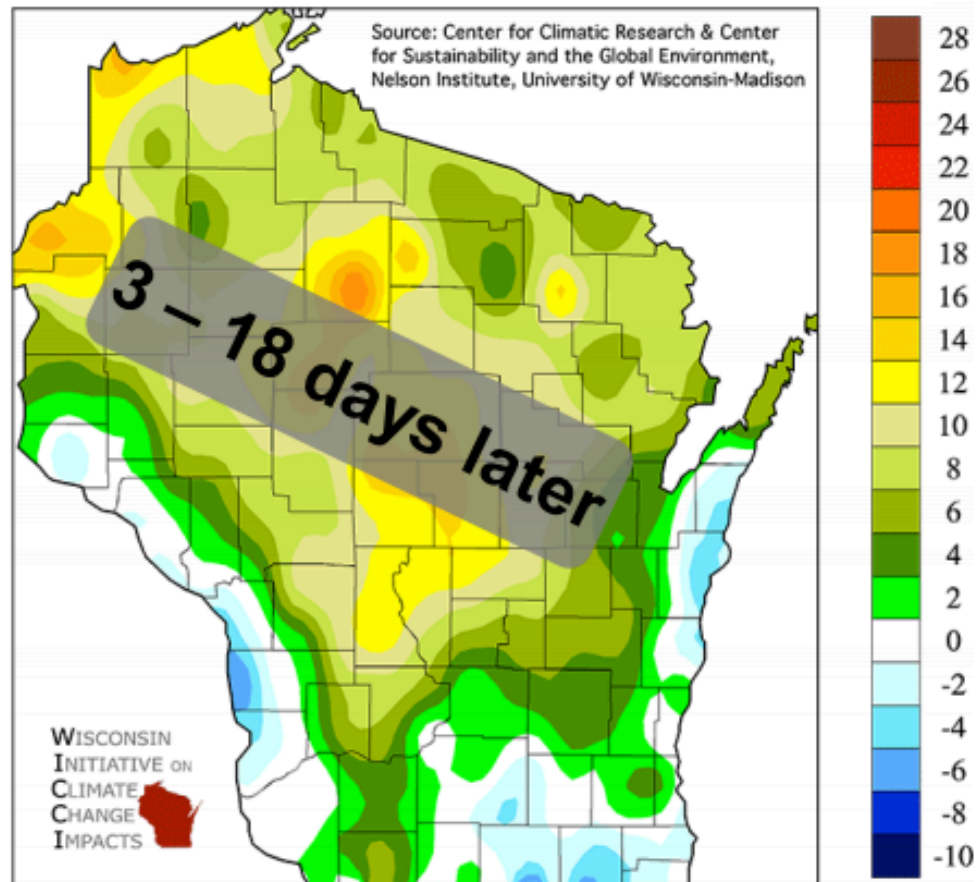
Historical Change in DJF TMEAN from 1950 to 2019



Change in Date of Last Spring Freeze from 1950 to 2006



Change in Date of First Fall Freeze from 1950 to 2006



(from Serbin and Kucharik 2009)

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

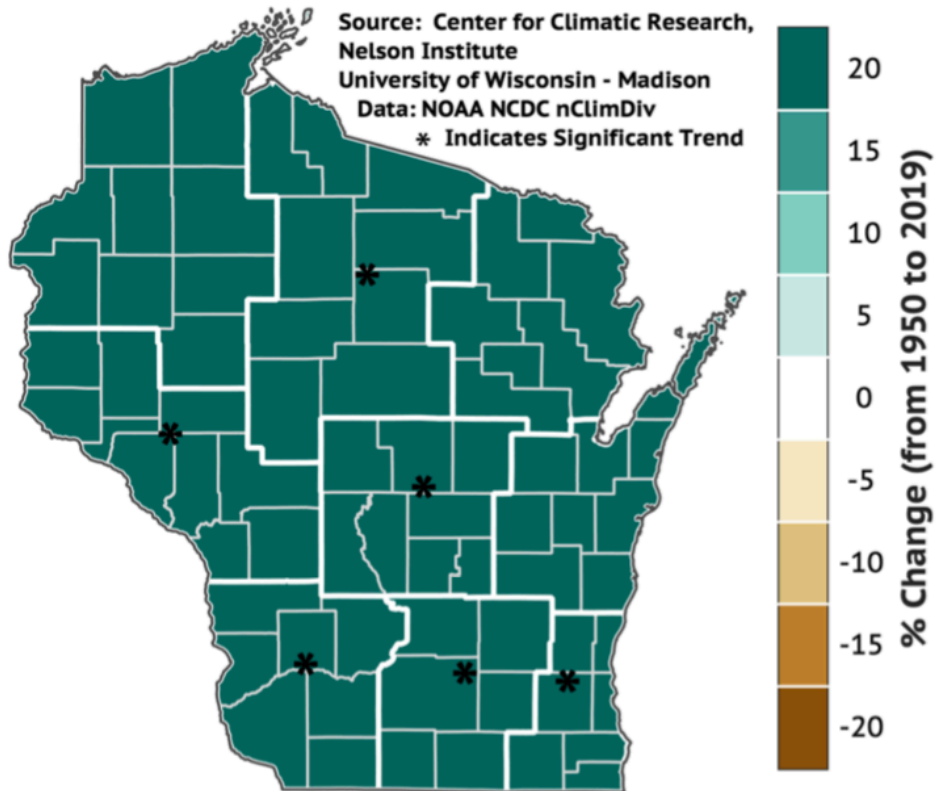
55 ecological indicators of spring occurred on average 1.2 days earlier per decade from 1936 to 1998.

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

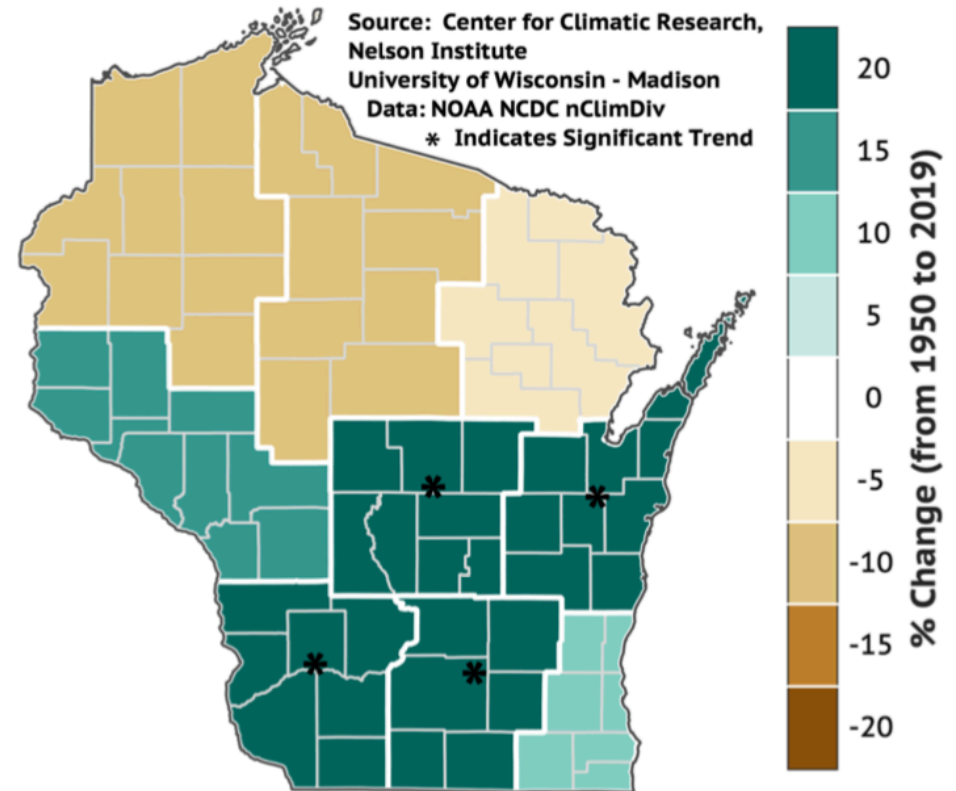
Slide adapted from C. Kucharik, UW-Madison

Wisconsin is wetter

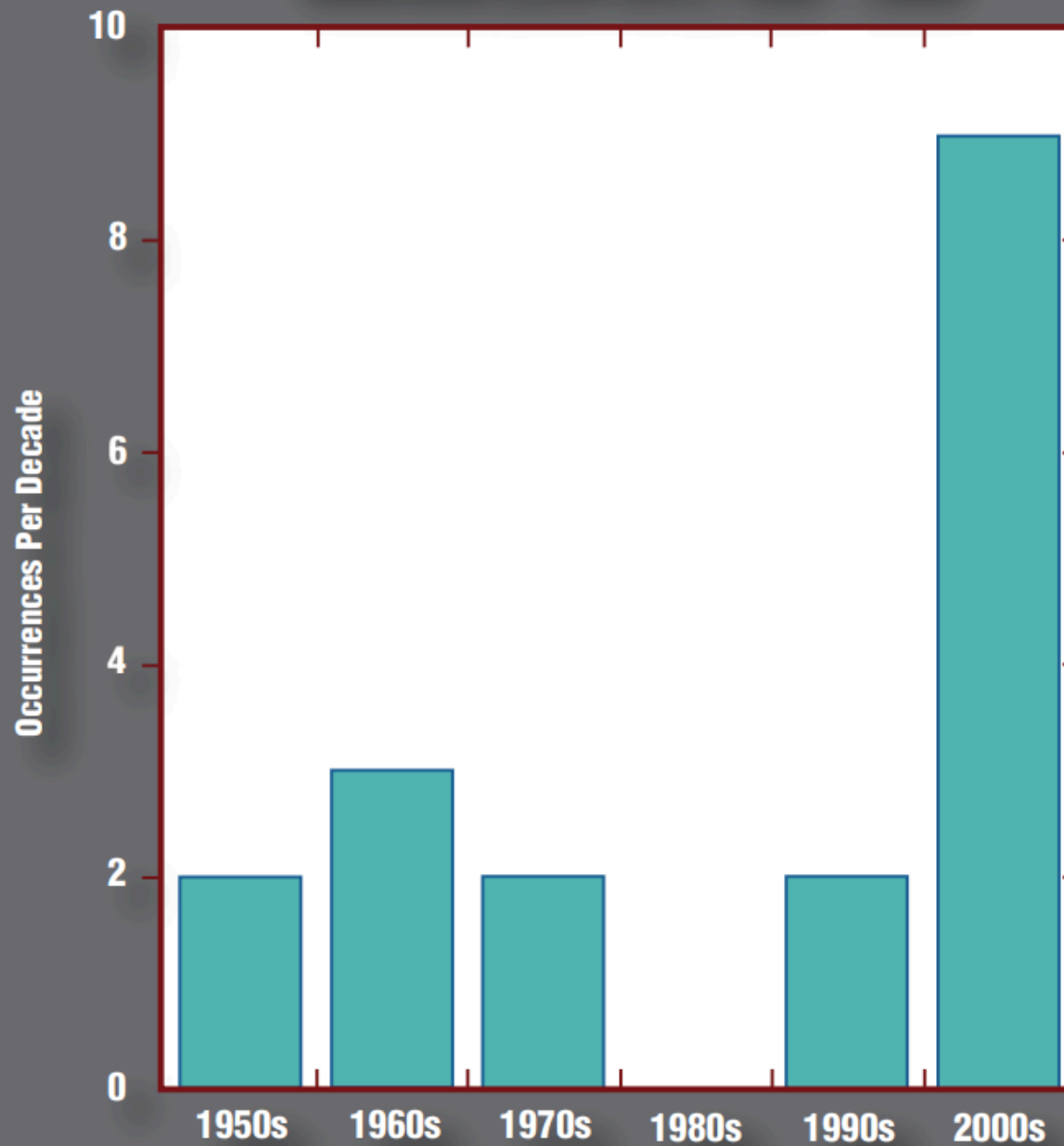
**Historical Change in DJF PRECIP (%)
from 1950 to 2019**



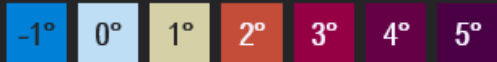
**Historical Change in JJA PRECIP (%)
from 1950 to 2019**



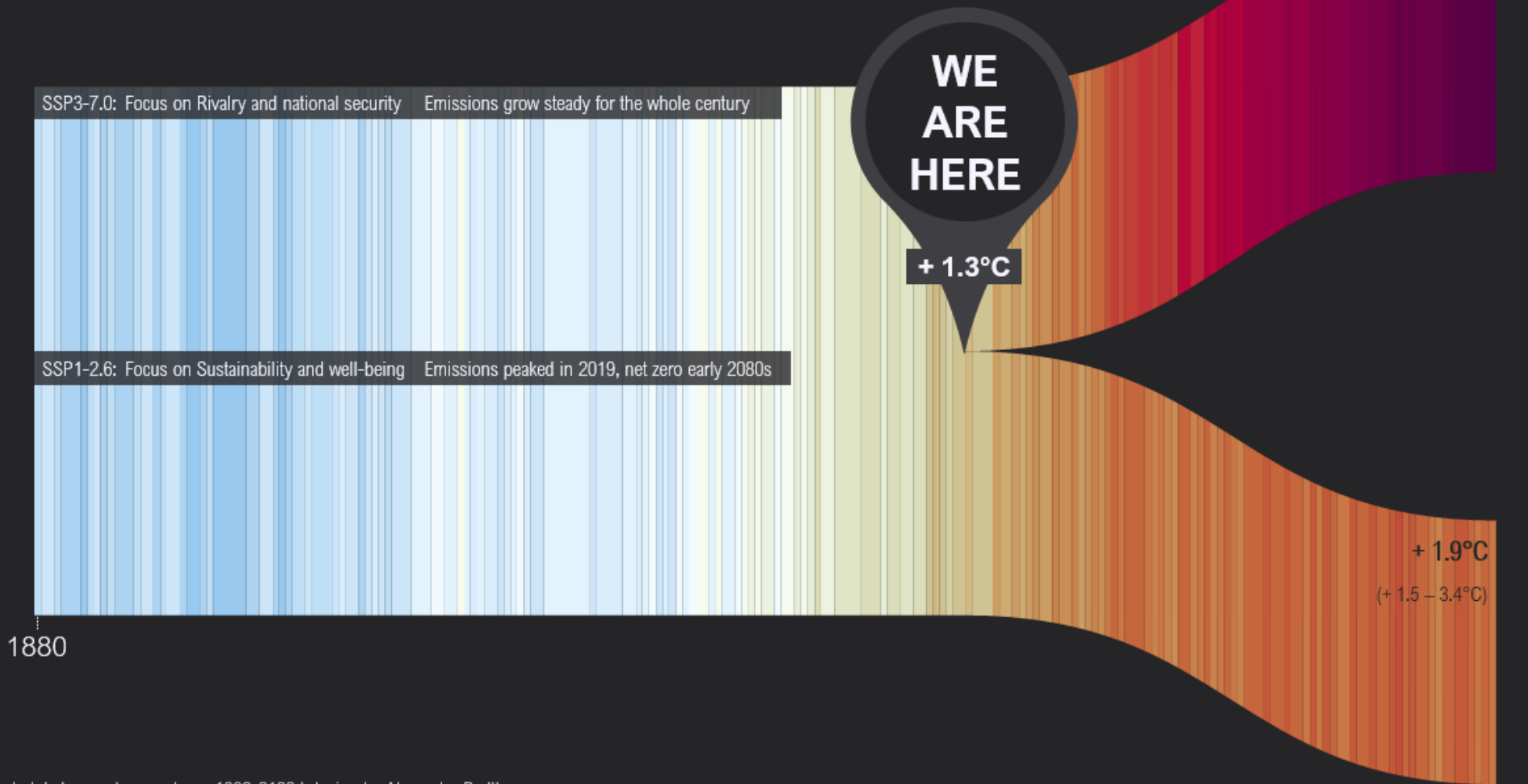
OCCURRENCES OF 3"+ DAILY PRECIPITATION MADISON (AIRPORT) 1950 - 2009



Where are we headed?



temperatures relative to 1850-1900 mean



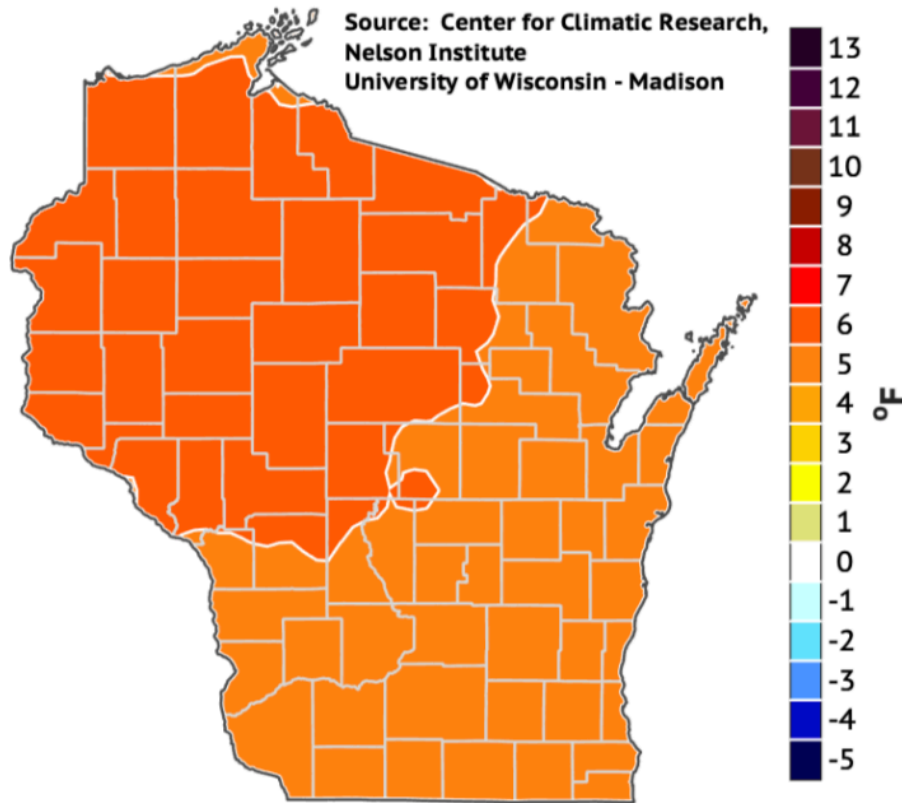
1880

2100

Projecting into Wisconsin's future

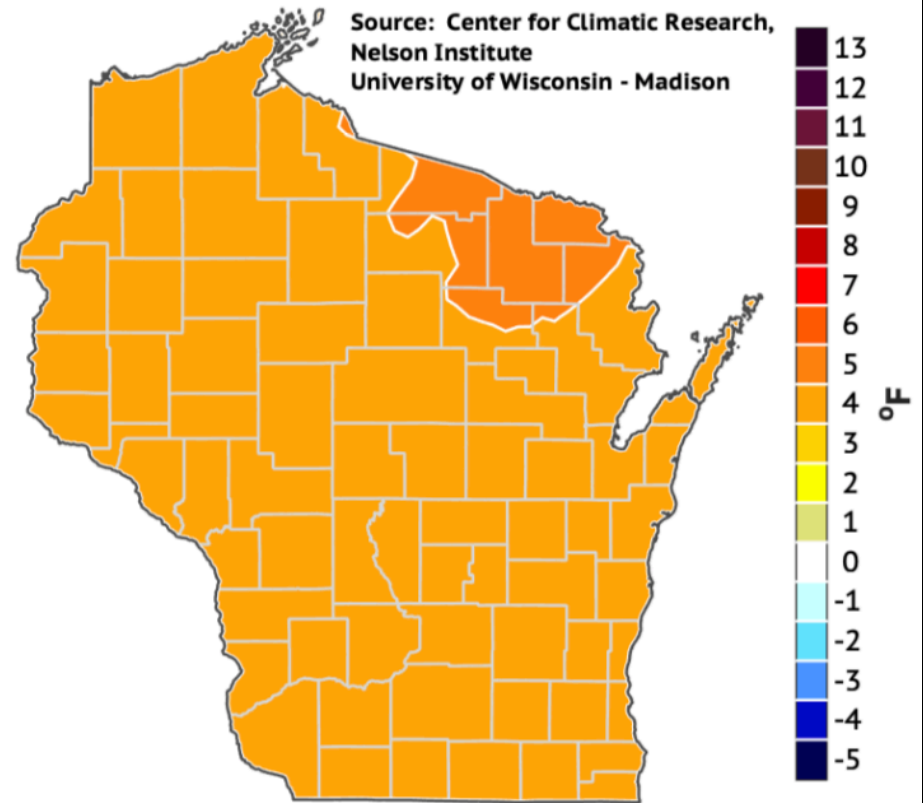
2050

Change in DJF TMEAN, RCP45:
2041-2060 minus 1981-2010



Winter

Change in JJA TMEAN, RCP45:
2041-2060 minus 1981-2010



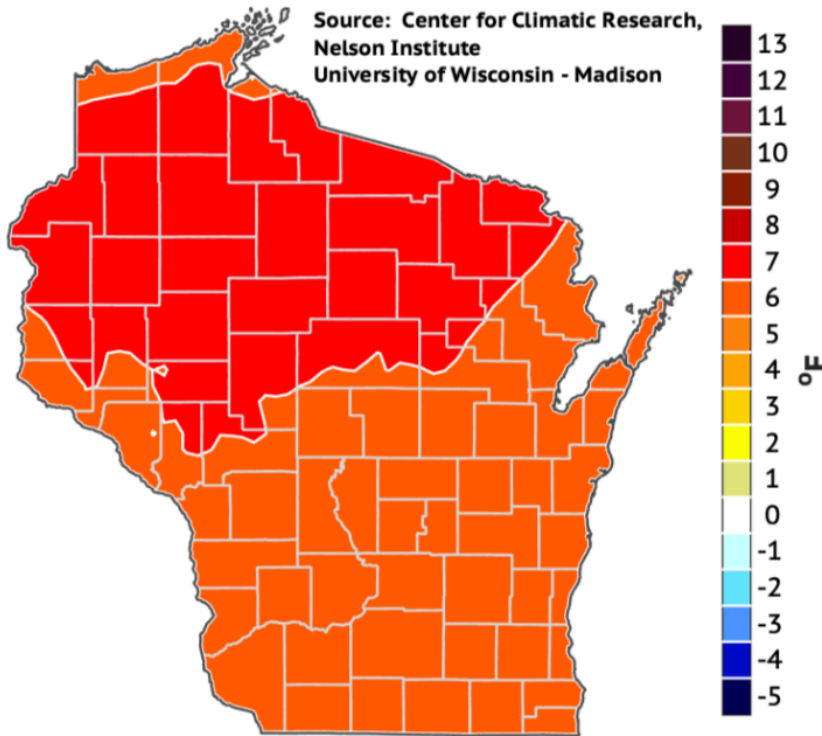
Summer

Future emissions makes a big difference

2100

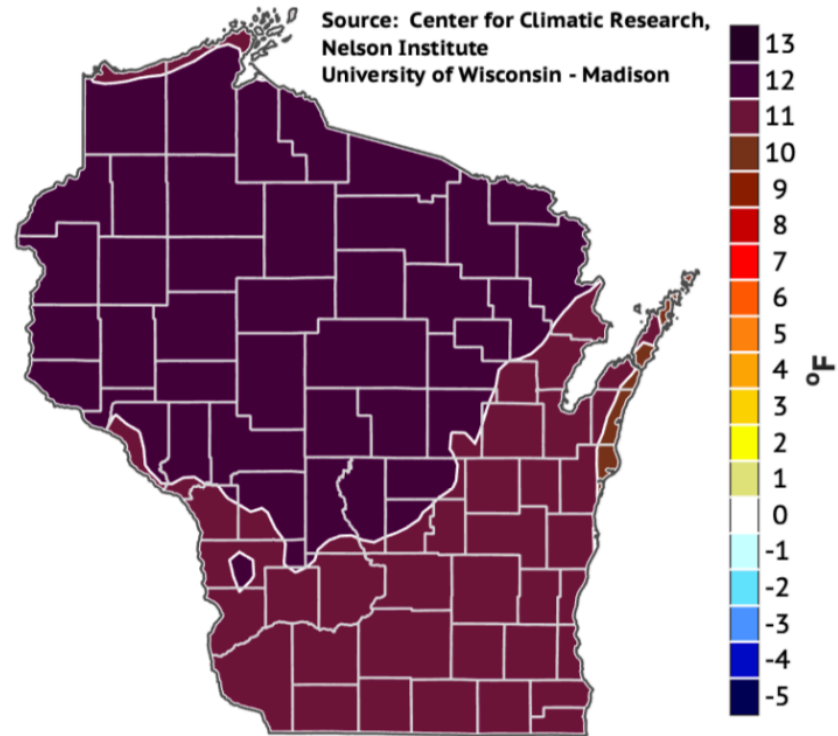
**Change in Annual TMEAN, RCP45:
2081-2100 minus 1981-2010**

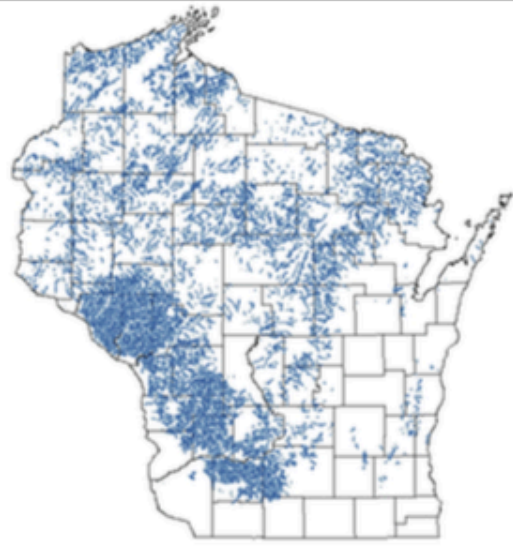
Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



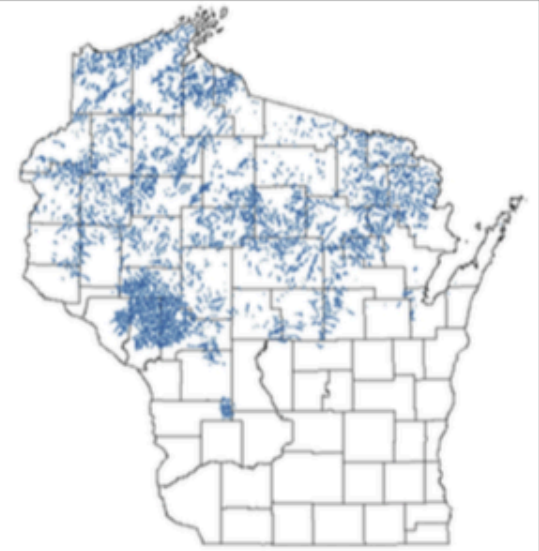
**Change in Annual TMEAN, RCP85:
2081-2100 minus 1981-2010**

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison





Current climate



**Best case
+1.4°F = 44% loss**

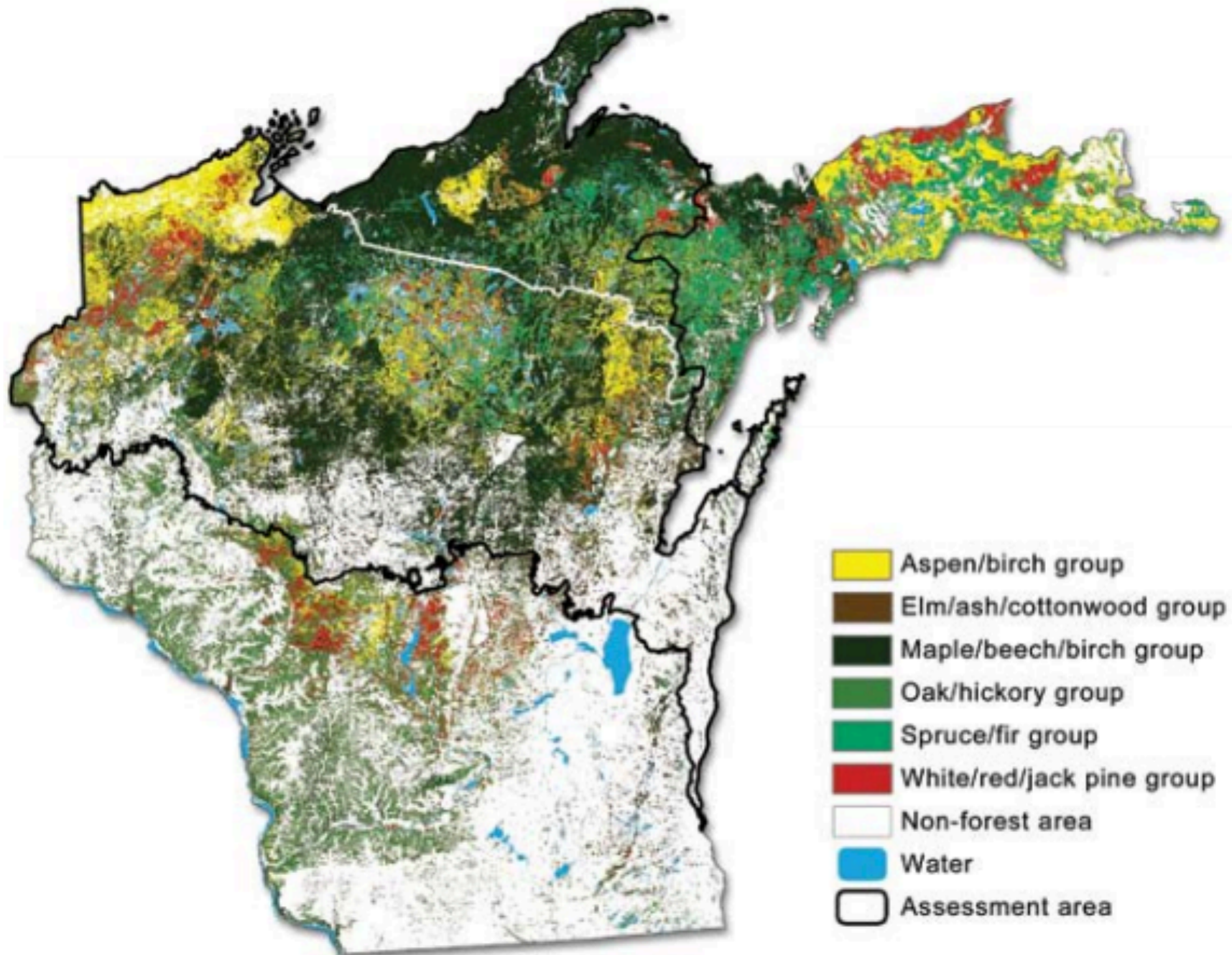


**Moderate case
+4.3°F = 94% loss**



**Worst case
+7.2°F = total loss**

Predicted distribution of brook trout in Wisconsin streams under current climate conditions and predicted losses under three climate-warming scenarios for Wisconsin by mid-century.

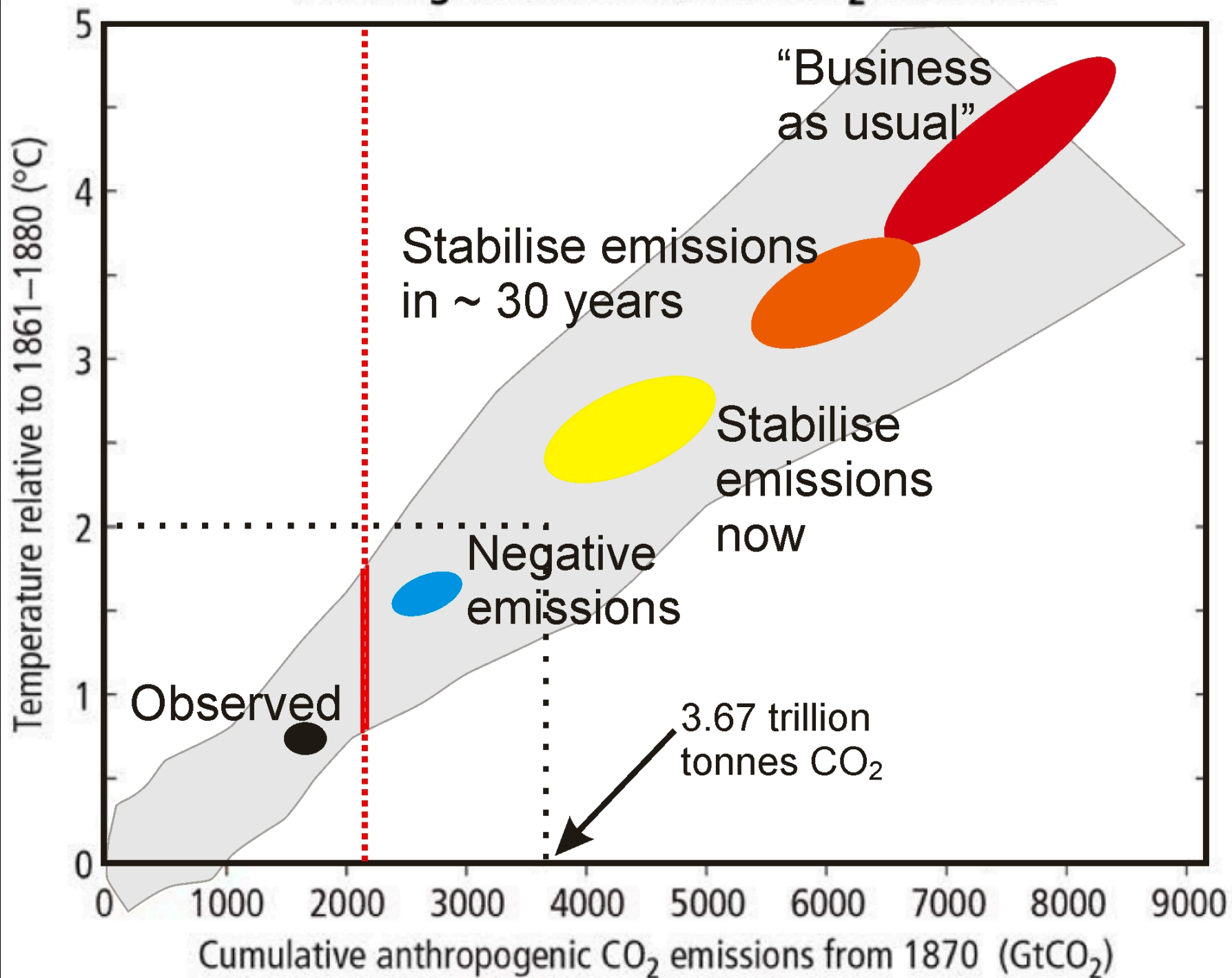


- Growing seasons across northern Wisconsin could increase by 14 to 49 days by the end of the century
- Even if total rainfall increases, these factors may lead to net drier conditions for Wisconsin's forests
- Frozen ground duration is expected to shrink by another 1–2 months by the end of the century
- Invasive plants will “disproportionally benefit” under climate change
- Deer benefit from climate change over the 21st century and could have even greater impacts on forests

What Are The Options?

- Adaptation
- Mitigation

Warming versus cumulative CO₂ emissions



What Are The Options?

- Adaptation
 - Economic/political
 - Technological
- Mitigation



What Are The Options?

- Adaptation
 - Economic/political
 - Technological
- Mitigation
 - Economic
 - Regulatory
 - Societal
 - Technological

Dane County to go all-renewable with help of proposed Alliant solar farm

Chris Hubbuch | Wisconsin State Journal | Nov 6, 2020

We Energies to retire 1.8 gigawatts of fossil fuel; utility adding solar, wind, battery storage

Chris Hubbuch | Wisconsin State Journal | Nov 6, 2020

Biden Wants to Be the Climate President. He'll Need Some Help From China.

The U.S.-China relationship is at its lowest point in a half century, but there are also converging interests on global

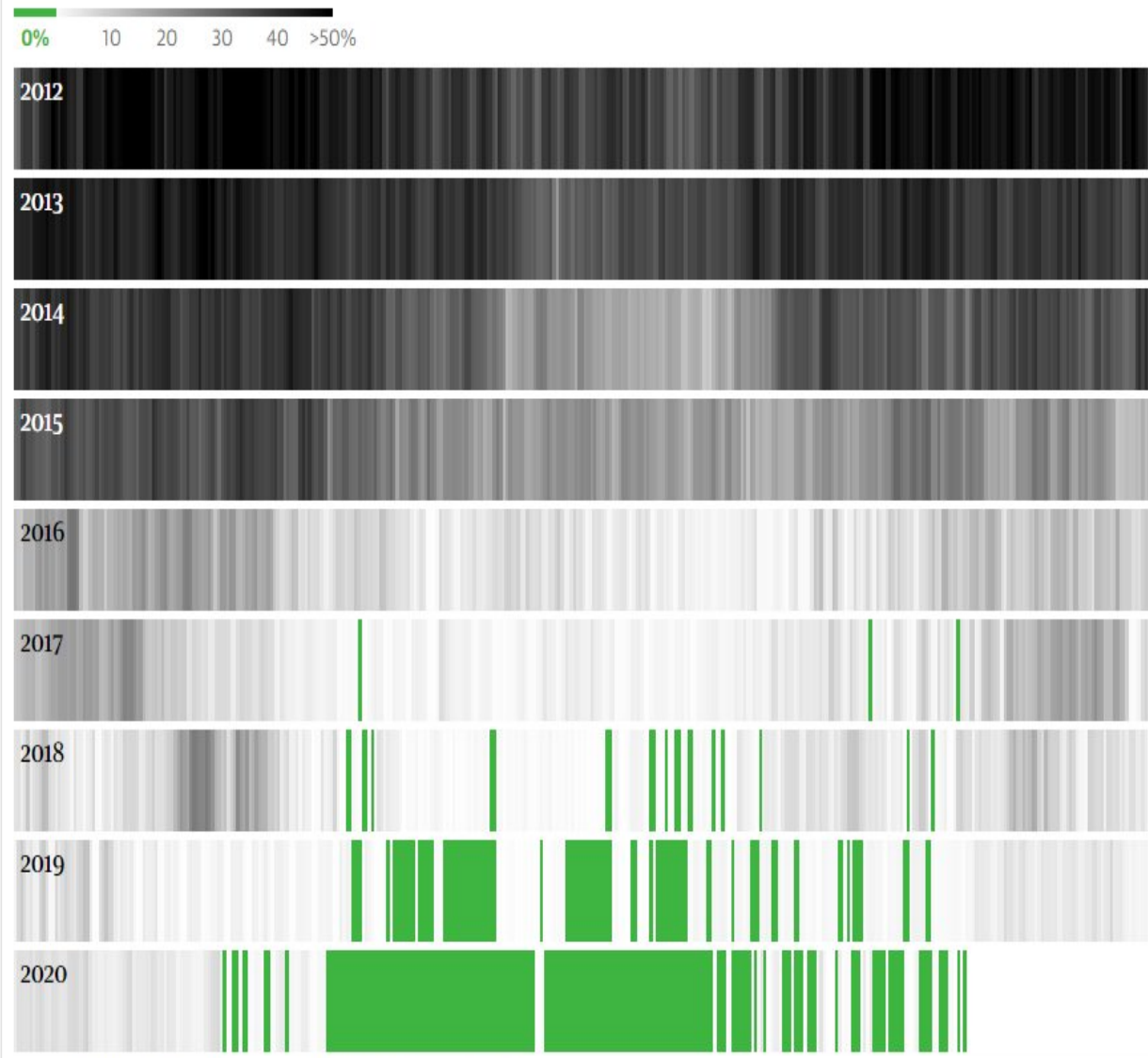
All of South Australia's power comes from solar panels in world first for major jurisdiction

Rolls-Royce plans 16 mini-nuclear plants for UK

By Justin Rowlett
Chief environment correspondent

Britain is rapidly phasing out coal

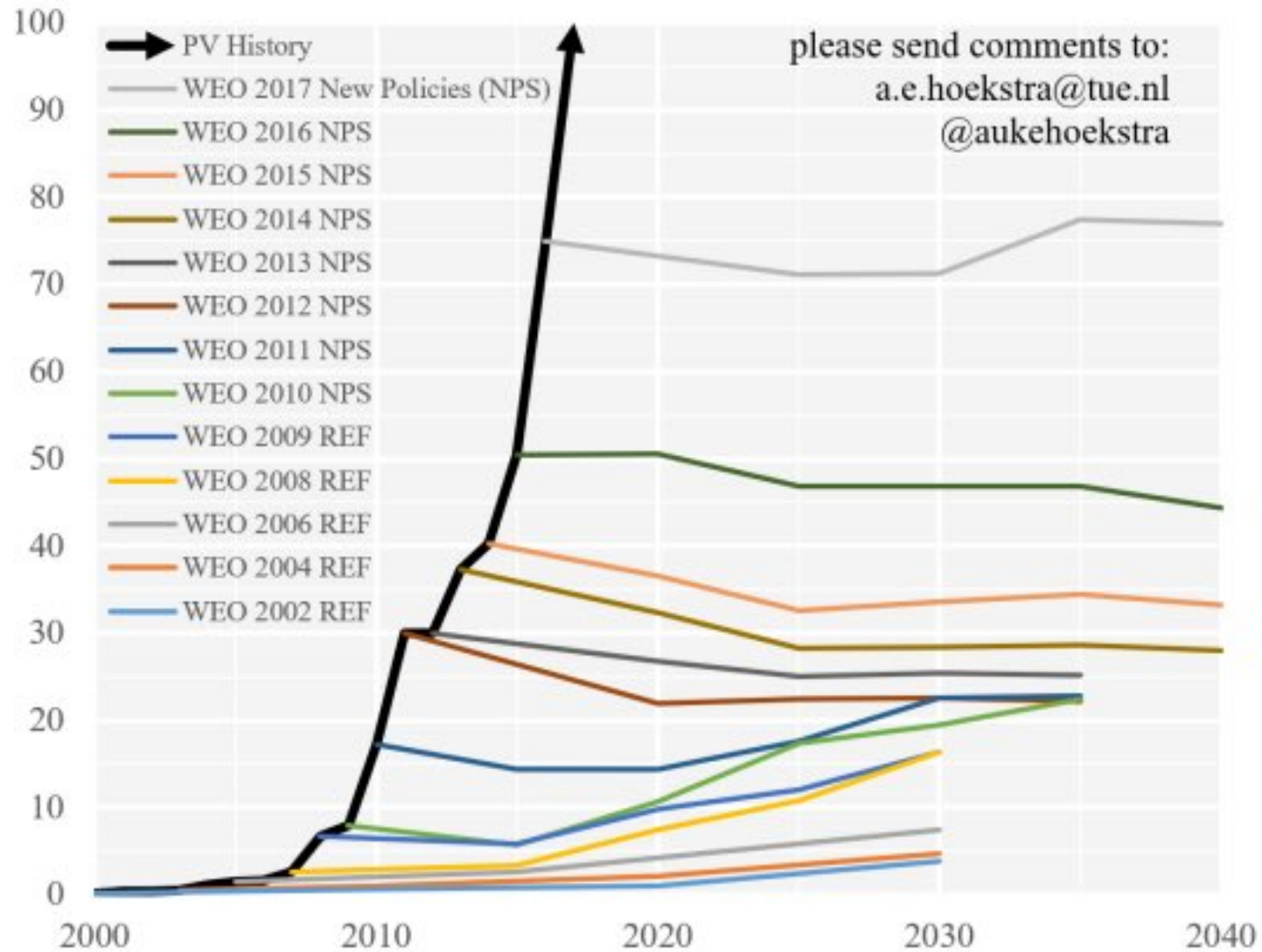
Daily share of Britain's power generated by burning coal



Source: Drax Electric Insights. Last updated at 5:55pm on 31 October

Annual PV additions: historic data vs IEA WEO predictions

In GW of added capacity per year - source International Energy Agency - World Energy Outlook



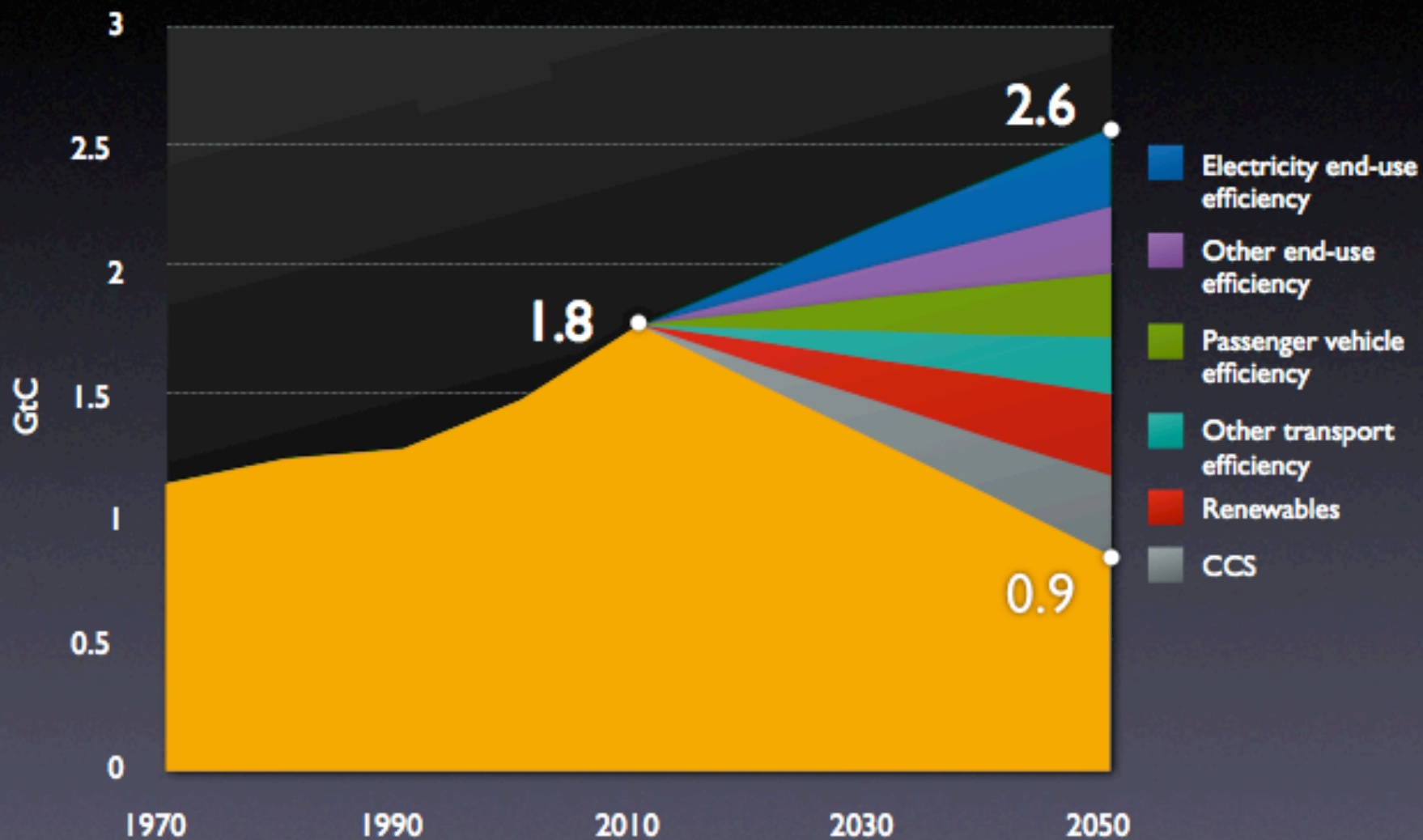
IEEFA update: Renewables surpass coal in U.S. power generation throughout the month of April 2020

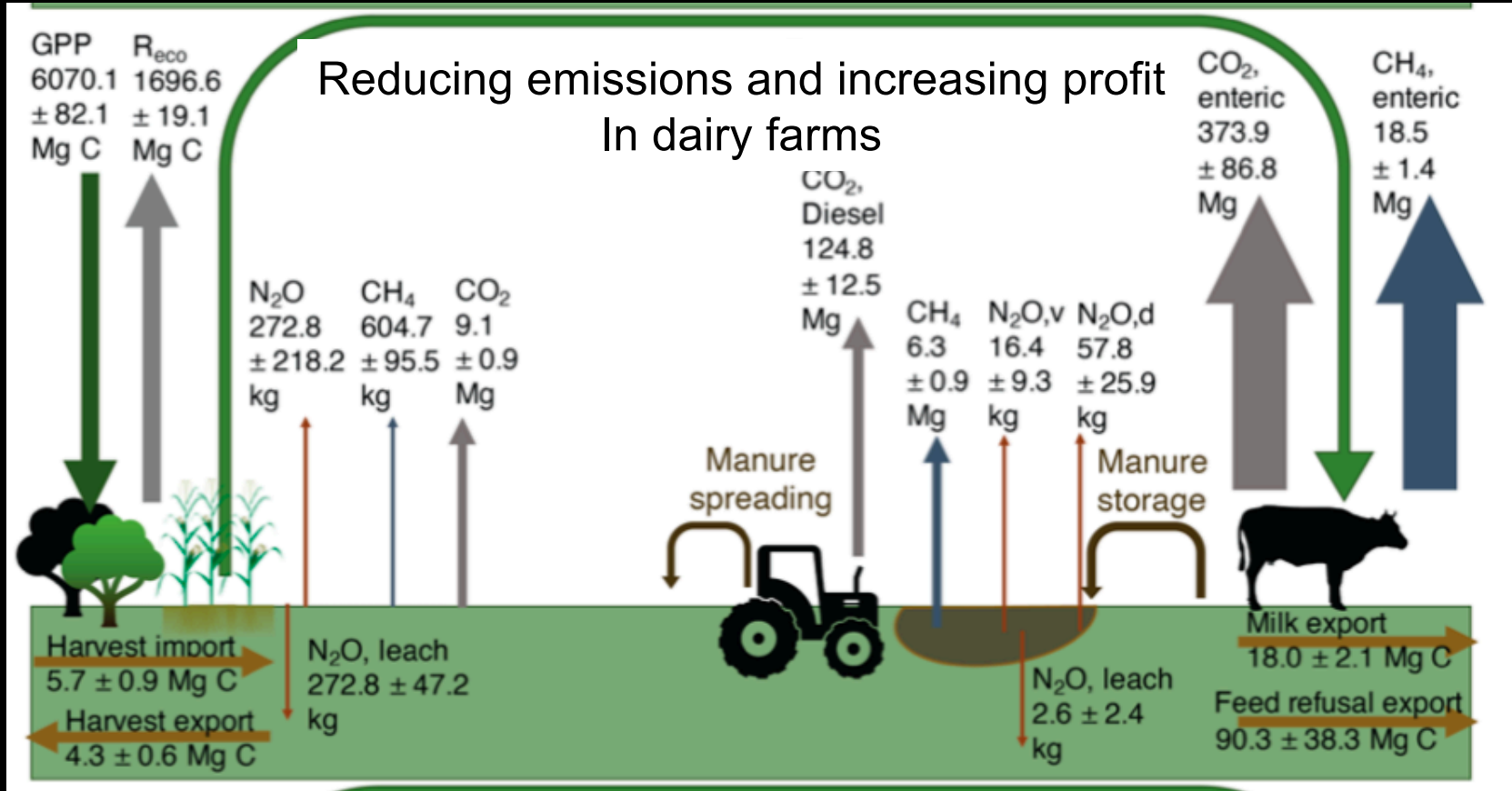
Utility-scale solar, wind, and hydro exceeded coal-generated power every single day

U.S. Emissions

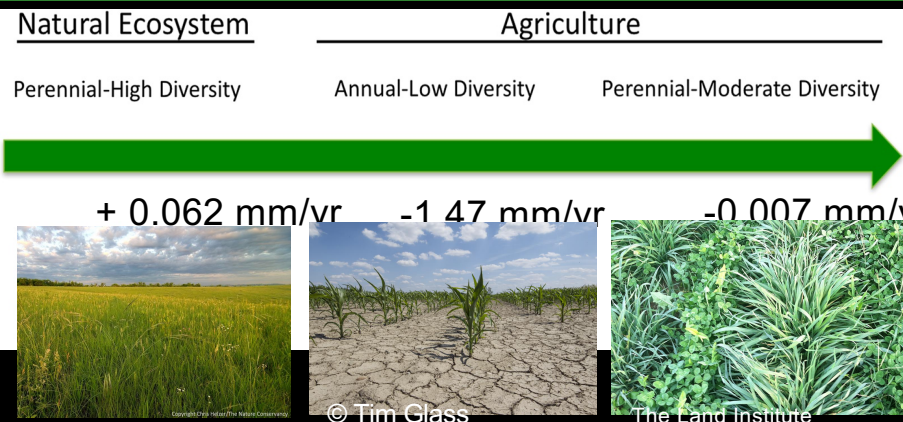
After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

• Carbon Capture & Storage





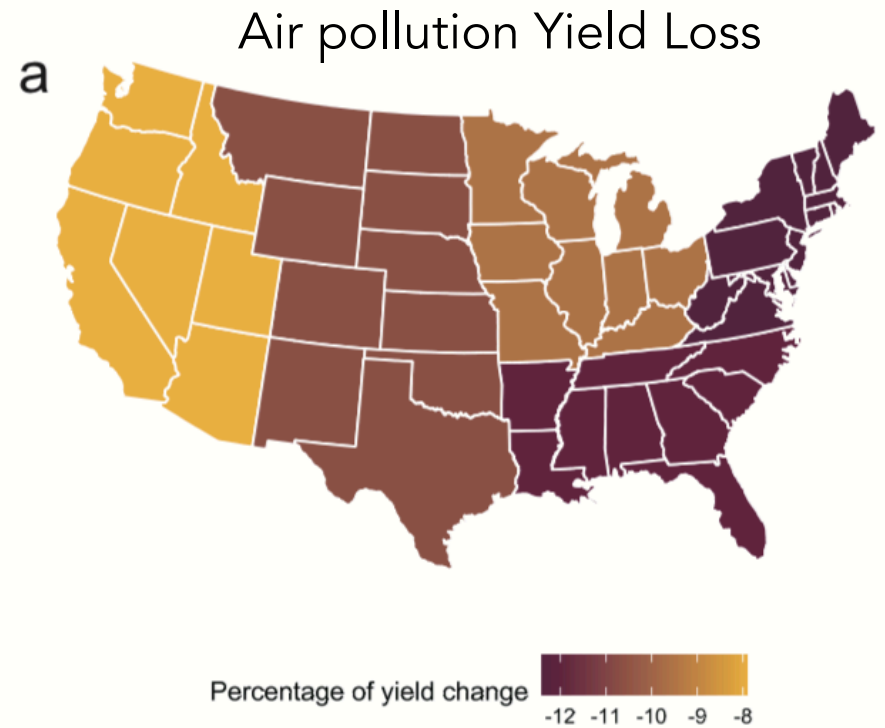
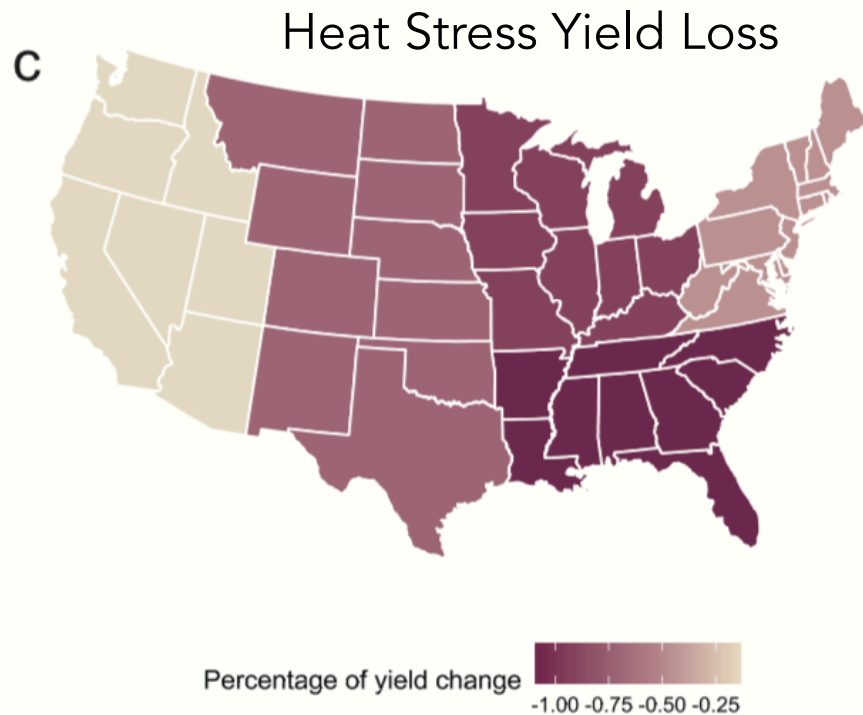
Natural Climate Solutions





Improving air quality has more than offset heat/drought related yield losses

We can further improve food security through air quality regulation



Solutions are abundant

- <https://www.drawdown.org/solutions>

* Gigatons CO2 Equivalent Reduced / Sequestered (2020–2050)

| ◆ SOLUTION | ◆ SECTOR(S) | ▼ SCENARIO 1* | ◆ SCENARIO 2* |
|-------------------------------------|--|---------------|---------------|
| Reduced Food Waste | Food, Agriculture, and Land Use / Land Sinks | 87.45 | 94.56 |
| Health and Education | Health and Education | 85.42 | 85.42 |
| Plant-Rich Diets | Food, Agriculture, and Land Use / Land Sinks | 65.01 | 91.72 |
| Refrigerant Management | Industry / Buildings | 57.75 | 57.75 |
| Tropical Forest Restoration | Land Sinks | 54.45 | 85.14 |
| Onshore Wind Turbines | Electricity | 47.21 | 147.72 |
| Alternative Refrigerants | Industry / Buildings | 43.53 | 50.53 |
| Utility-Scale Solar Photovoltaics | Electricity | 42.32 | 119.13 |
| Improved Clean Cookstoves | Buildings | 31.34 | 72.65 |
| Distributed Solar Photovoltaics | Electricity | 27.98 | 68.64 |
| Silvopasture | Land Sinks | 26.58 | 42.31 |
| Peatland Protection and Rewetting | Food, Agriculture, and Land Use / Land Sinks | 26.03 | 41.93 |
| Tree Plantations (on Degraded Land) | Land Sinks | 22.24 | 35.94 |
| Temperate Forest Restoration | Land Sinks | 19.42 | 27.85 |
| Concentrated Solar Power | Electricity | 18.60 | 23.96 |



<https://globalclimatestrike.net/>

Terrorism

Lack of
Education

Wealth
Inequality

**Climate Change
Makes These**

Water scarcity &
pollution

Land
Degradation

Rapid
Urbanization

Natural
Disasters

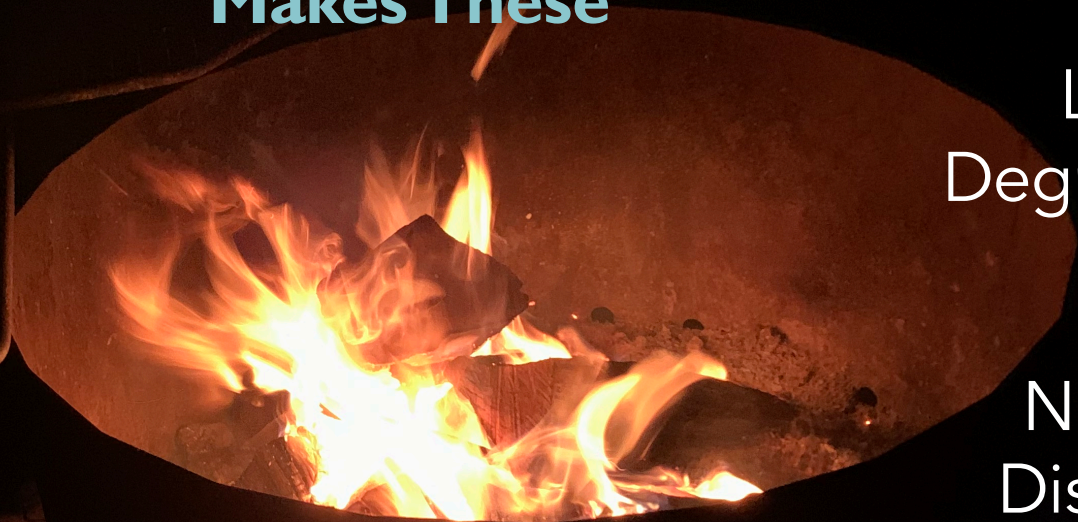
**Harder or More Expensive
to Solve**

Oppression of
minorities

Inadequate
public health

Food
Insecurity

Species
Loss

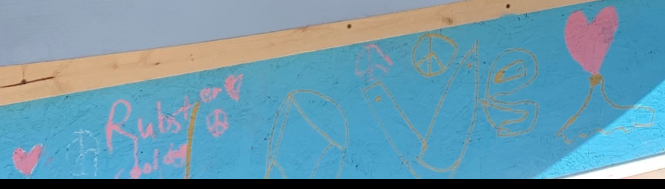


DOWNTOWN MADISON
INFORMATION

Love
is greater than
fear.



Please Respect
This Space
Reserved



Thank you!

Ankur Desai

desai@aos.wisc.edu

<https://flux.aos.wisc.edu>

@profdesai

Photo: A. Desai

