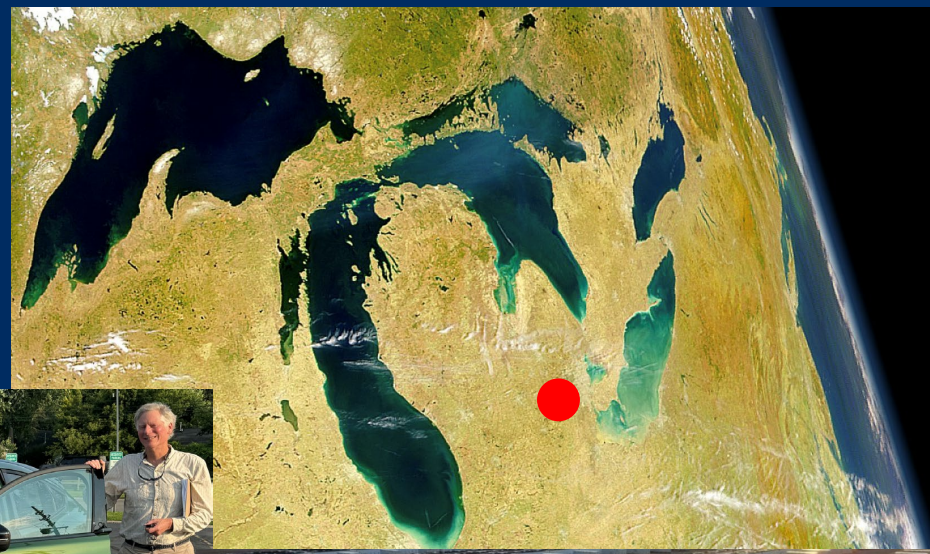
The Challenges and Opportunities of a Changing Climate: A Michigan Perspective

Jonathan Overpeck

School for Environment and Sustainability

University of Michigan



Photos: EnergyAsia.org, Earth.org, NY Times, energy-storage.news

Today's talk…

- The **BAD** news (some climate science)
- The **GOOD** news (solutions are known, available and getting cheaper fast)
- BUT… we're not moving fast enough
- Transportation perspectives along the way

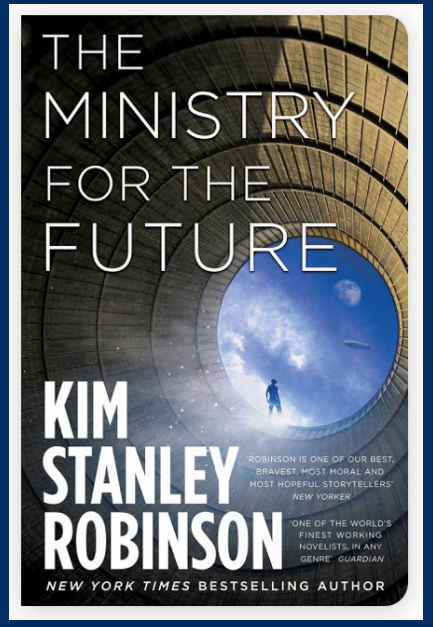
The **Bad News**…

"the planet is now in a meltdown phase – literally and figuratively"

Jonathan Overpeck - *Washington Post*, March 20, 2024

"Extreme temperatures caused ~**489,000 heat-related deaths annually** between 2000 and 2019, with 36 per cent occurring in Europe and 45 per cent in Asia" (WMO 8/7/25)

Anyone read this book?



Extended heatwave in India, Pakistan to test survivability limits, with temperatures reaching Death Valley levels


By Sophia Saifi, Rhea Mogul and Aishwarya S. Iyer, CNN
4 minute read · Updated 3:51 AM EDT, Tue April 15, 2025

April 15, 2025

*The globe is warming almost everywhere**

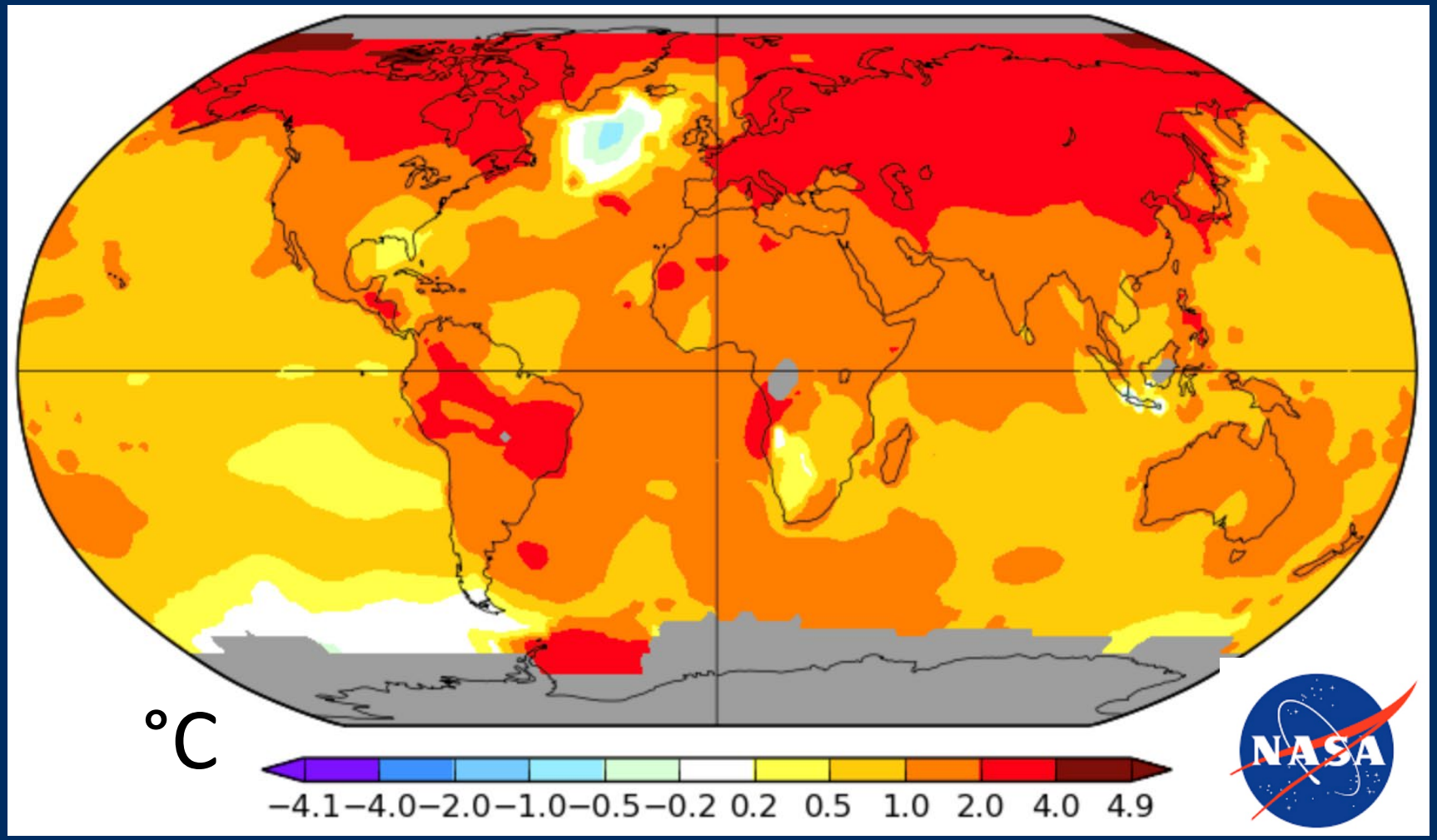
2023 Global Temperature Smashed Previous Records

2024 was warmer

2025 closer to 2023 (preliminary)

Now 3 years warmer than the 1.5°C Paris Agreement Target

Mean Annual Temperature **Trend** 1880-2024



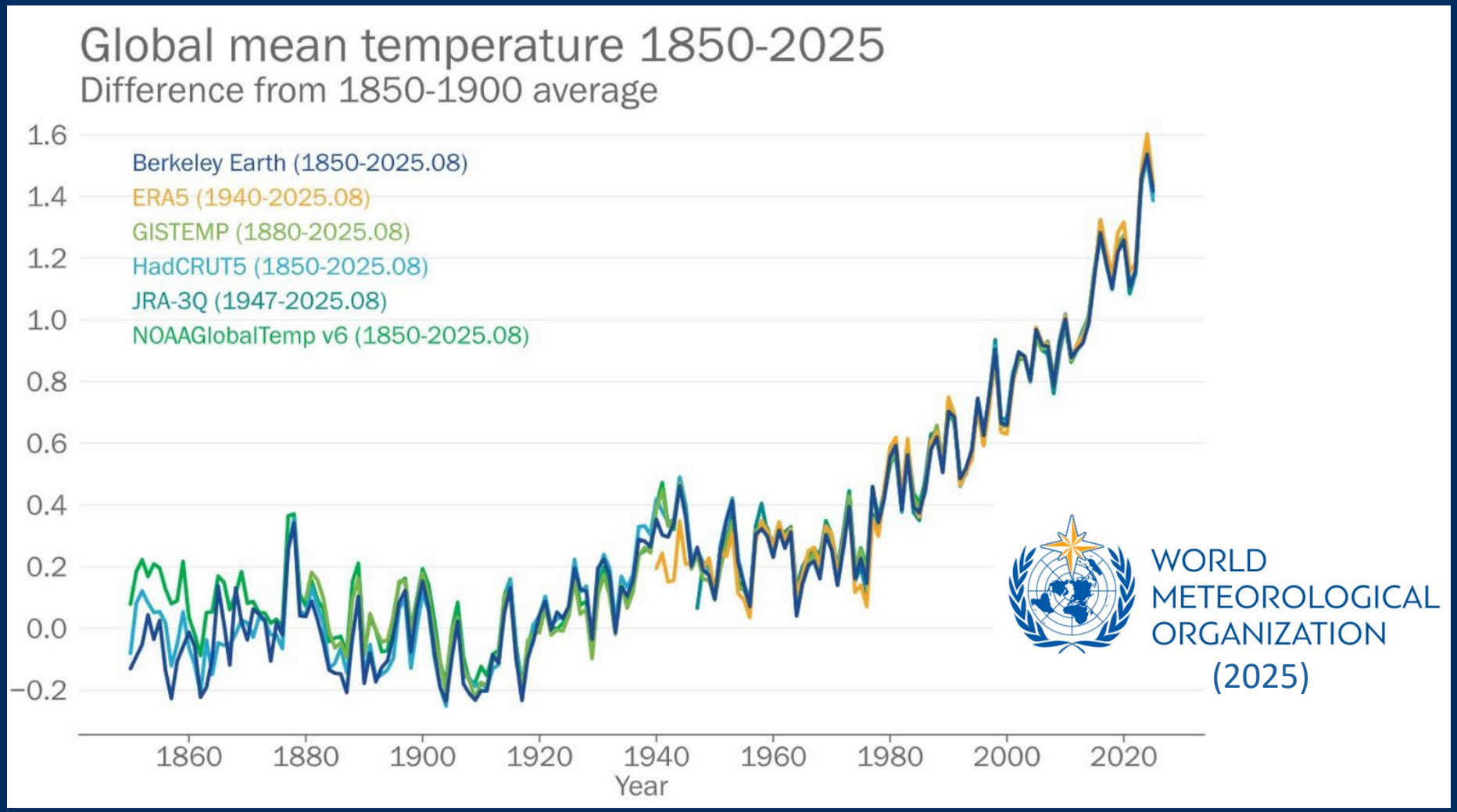
* **NOTE**: North Atlantic cooling as predicted - due to Greenland Ice Sheet melting and precipitation change

Global Warming Has Accelerated: Are the United Nations and the Public Well-Informed?

James E. Hansen, Pushker Kharecha, Makiko Sato, George Tselioudis, Joseph Kelly, Susanne E. Bauer, ...show all

Pages 6-44 | Published online: 03 Feb 2025

Environment (2025) – Science and Policy for Sustainable Development



We were on track to < 3°C global warming, but now we are likely on track for greater warming

Global climate change impacts are continuing to accelerate

A record 63 billion-dollar weather disasters hit Earth in 2023

Seven nations had their most expensive weather disaster on record, and the continent of Africa suffered two of its deadliest.

by **JEFF MASTERS**
JANUARY 18, 2024

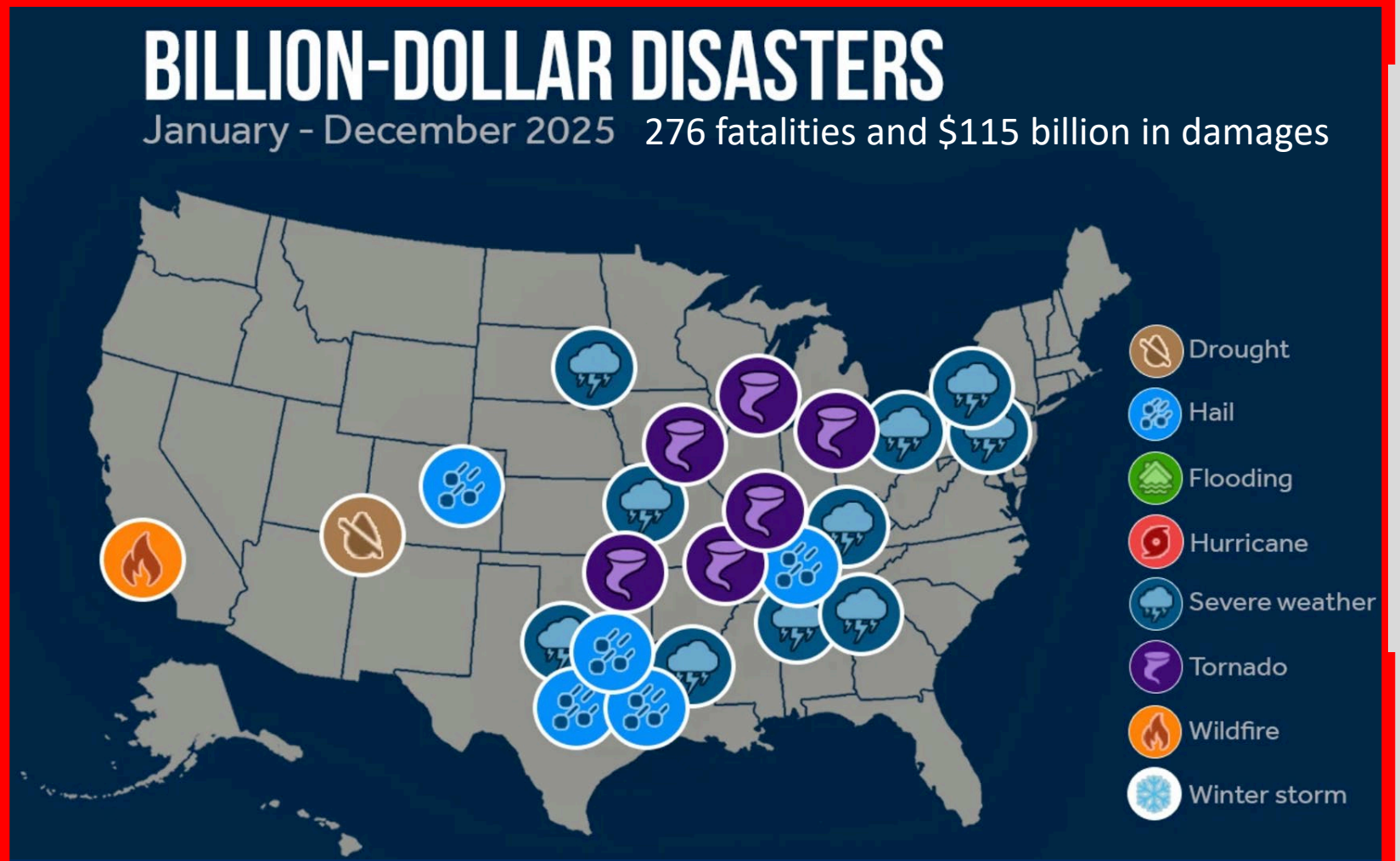
YALE Climate Connections

Rescue workers evacuate flood-affected people in Zhuozhou, China, on August 2, 2023, in the wake of Typhoon Doksuri. The typhoon and its remnants caused $18.5 billion in damage, making it Earth's most expensive weather disaster of the year. (Image credit: China News Service, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=135517949)

- **Extreme heat**
- **Supercharged hurricanes, typhoons, tropical cyclones**
- **Extreme rainfall & flooding**
- **Hot drought & megadrought**
- **Unprecedented wildfire**

Warming supercharges them all

U.S. climate change impacts are continuing to accelerate



- **Extreme heat**
- **Supercharged hurricanes, typhoons, tropical cyclones**
- **Extreme rainfall & flooding**
- **Hot drought & megadrought**
- **Unprecedented wildfire**

Warming supercharges them all

U.S. climate change impacts are continuing to accelerate

Key fact #1: every 1°C increase in temperature means the atmosphere can hold ~7% more water

- **Extreme heat**
- **Supercharged hurricanes, typhoons, tropical cyclones**
- **Extreme rainfall & flooding**
- **Hot drought & megadrought**
- **Unprecedented wildfire**

Warming supercharges them all

U.S. climate change impacts are continuing to accelerate

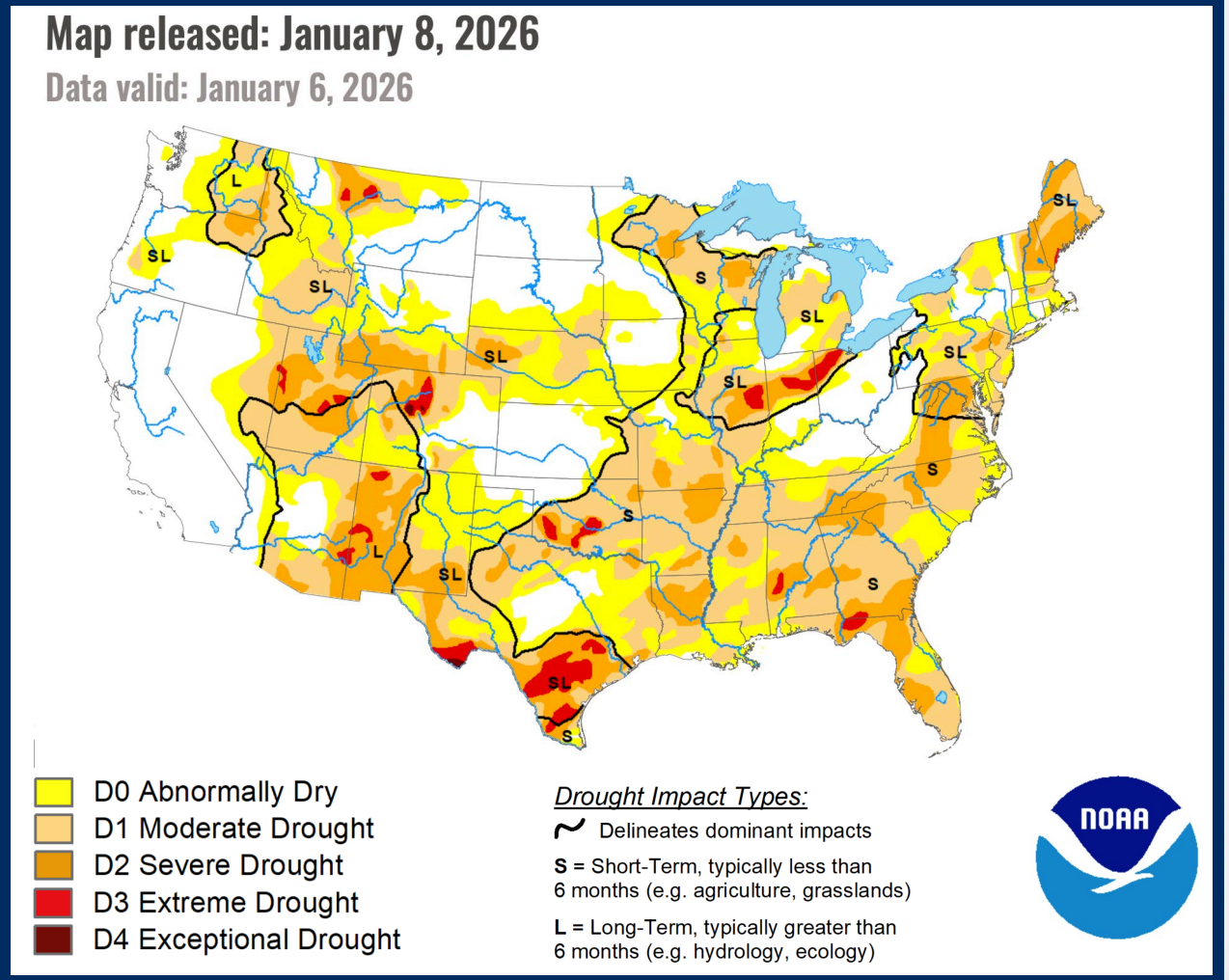
Key fact #1: every 1°C increase in temperature means the atmosphere can hold ~7% more water

Key fact #2: we know with high confidence that global temperatures will continue to go up as long as we emit greenhouse gases to the atmosphere *(primarily via the burning of fossil fuels)*

- **Extreme heat**
- **Supercharged hurricanes, typhoons, tropical cyclones**
- **Extreme rainfall & flooding**
- **Hot drought & megadrought**
- **Unprecedented wildfire**

Warming supercharges them all

The dry side: 26th year of Southwest megadrought is really climate change aridification



Aridification Spreading in North America a New Study Finds

MAY 26, 2020 ARIDIFICATION, CALIFORNIA, DROUGHT,

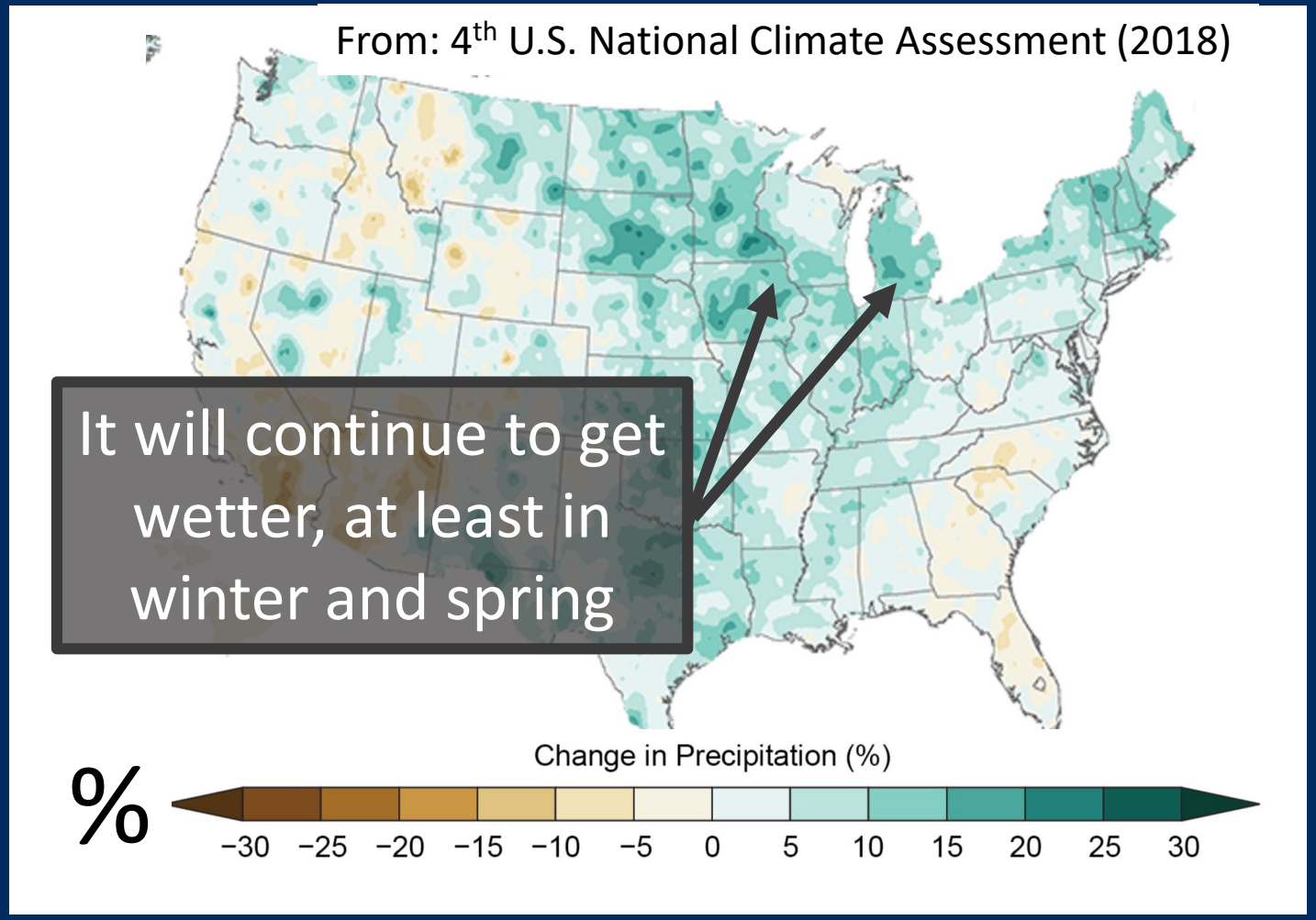
Share Tweet

Remember - this is a tale of two hydrologic extremes

An intensified hydrological cycle can yield increases in:

- **Average Precipitation**

% Change: last 30 years versus 1901-60 average

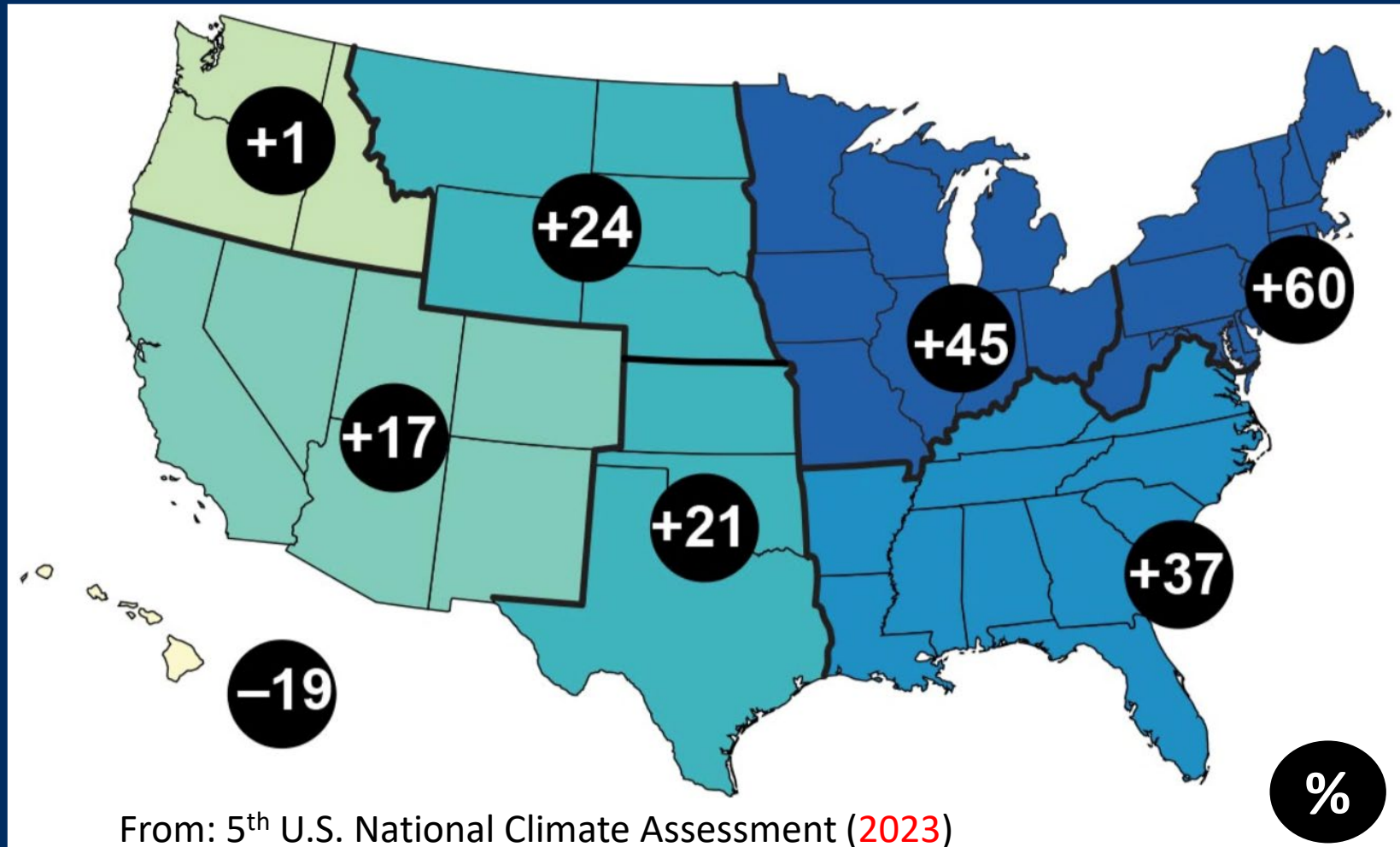


Remember - this is a tale of two hydrologic extremes

An intensified hydrological cycle can also yield increases in:

- **Average Precipitation**
- **Extreme Rainfall**
- **Flooding**

% falling in heaviest 1% of events



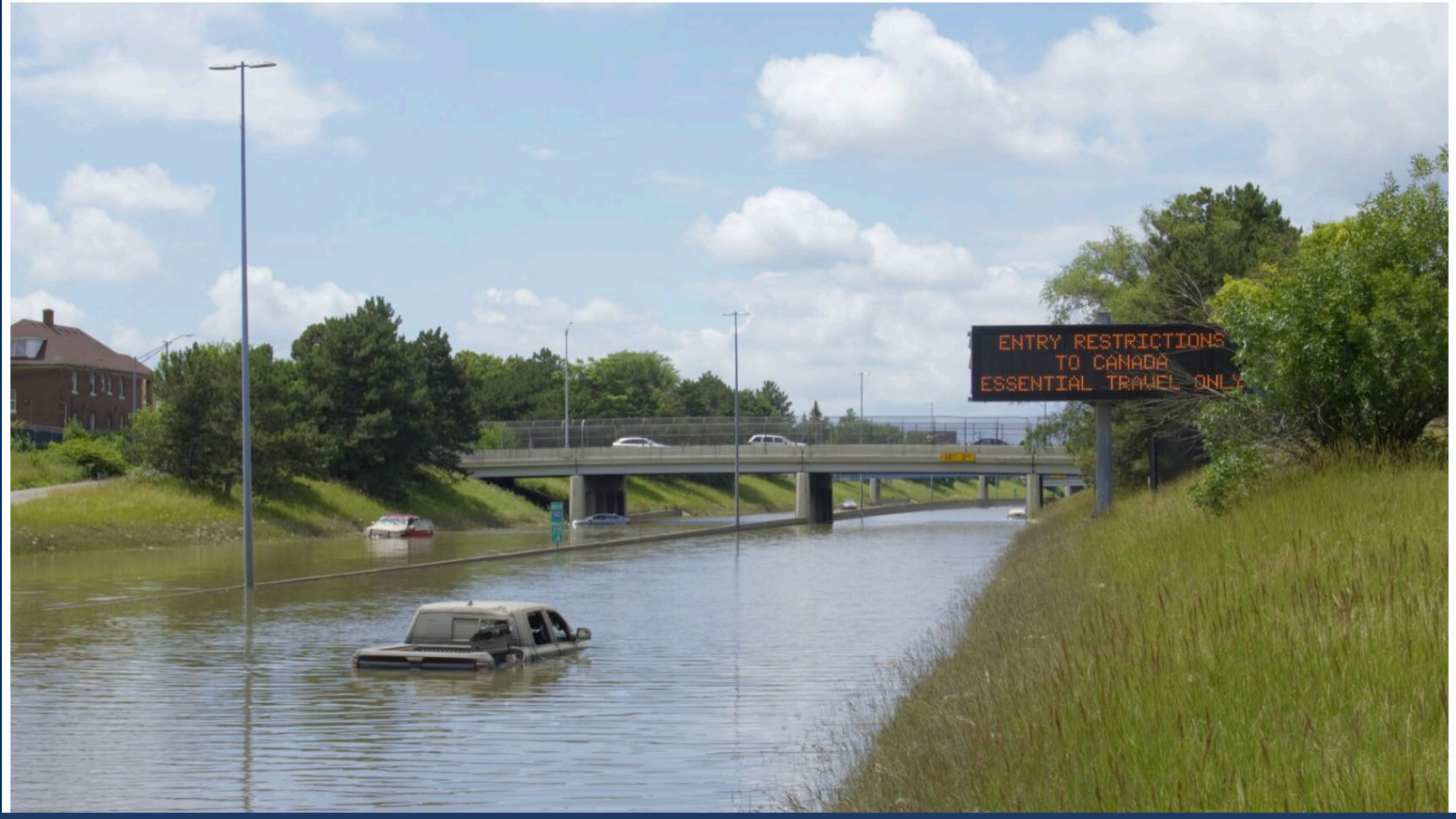
From: 5th U.S. National Climate Assessment (2023)

An intensified hydrological cycle can also yield increases in:

- **Average Precipitation**
- **Extreme Rainfall**
- **Flooding**

Why Metro Detroit keeps flooding —and how to fix it

Michigan Radio | By Stateside Staff
Published June 29, 2021 at 1:07 PM EDT



An intensified hydrological cycle can also yield increases in:

- **Average Precipitation**
- **Extreme Rainfall**
- **Flooding**

Thousands fled for their lives when two Michigan dams collapsed. More disasters are coming, experts say.

Aging dams around the country weren't built for today's weather. Without a major investment in repairs, thousands of people's homes – and lives – could be in danger.

NBCNews.com – June 13, 2020

An intensified hydrological cycle can also yield increases in:

- **Average Precipitation**
- **Extreme Rainfall**
- **Flooding**

Algae blooms also grow worse with warming

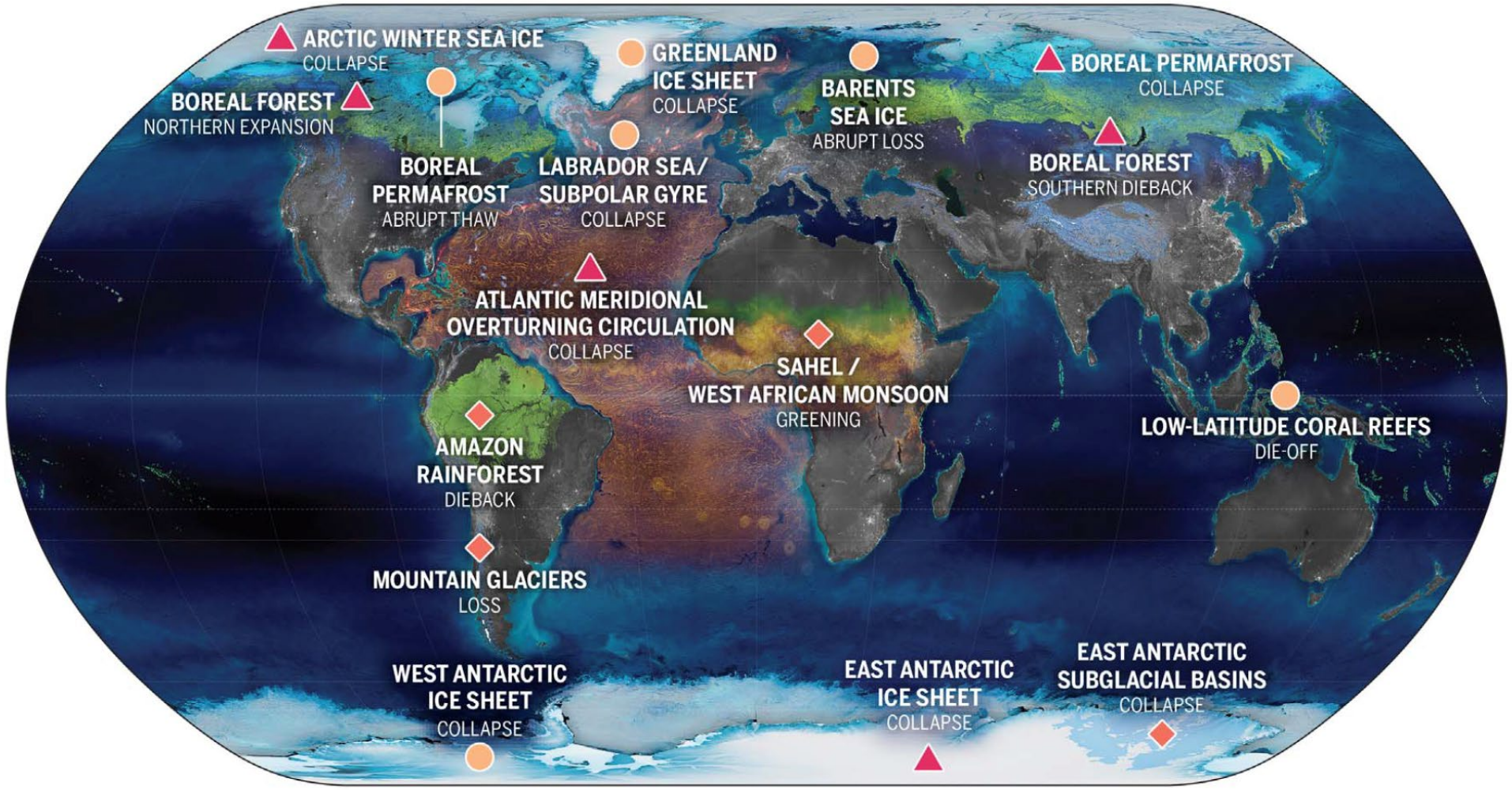
*But there is a **bigger** issue*

One that too many ignore

Exceeding 1.5°C global warming could trigger multiple climate tipping points

Science (2022)

David I. Armstrong McKay*, Arie Staal, Jesse F. Abrams, Ricarda Winkelmann, Boris Sakschewski, Sina Loriani, Ingo Fetzer, Sarah E. Cornell, Johan Rockström, Timothy M. Lenton*



SEA LEVEL CHANGE
Observations from Space

NEWS | February 25, 2025

Rate of Sea Level Rise Doubled over 30 Years, New Study Shows

By Ethan Huang, NASA's Sea Level Change Team

https://sealevel.nasa.gov/news/280/rate-of-sea-level-rise-doubled-over-30-years-new-study-shows/

Article

The Paris Climate Agreement and future sea-level rise from Antarctica

Nature (2021)

https://doi.org/10.1038/s41586-021-03427-0

Received: 15 October 2018

Accepted: 8 March 2021

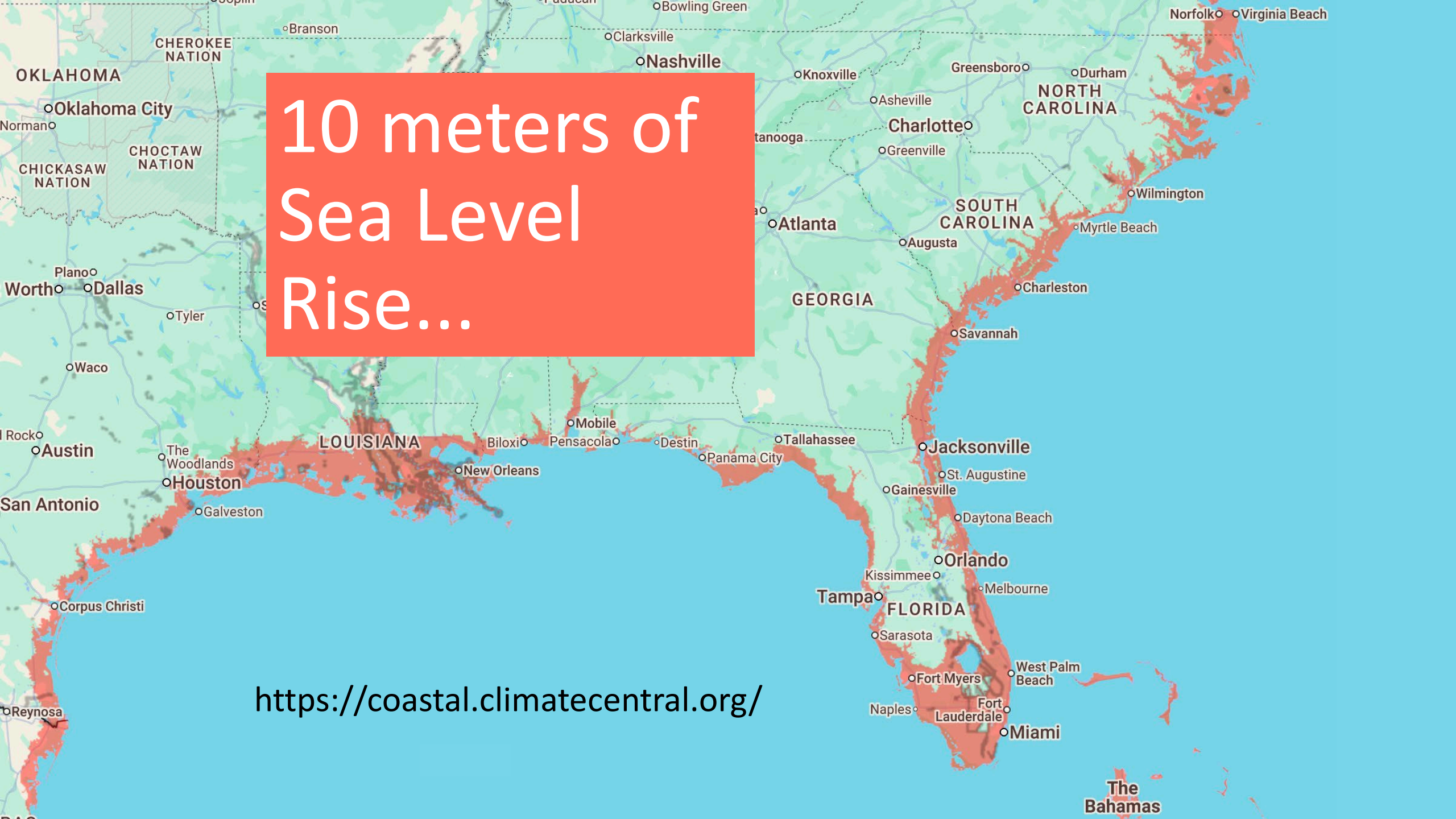
Robert M. DeConto[1]✉, David Pollard[2], Richard B. Alley[2,3], Isabella Velicogna[4], Edward Gasson[5], Natalya Gomez[6], Shaina Sadai[1], Alan Condron[7], Daniel M. Gilford[8], Erica L. Ashe[8], Robert E. Kopp[8], Dawei Li[1,9] & Andrea Dutton[10]

"These results demonstrate the possibility that rapid and unstoppable sea-level rise from Antarctica will be triggered if Paris Agreement targets are exceeded."

IPCC (2021):

If > 3°C peak warming ➔ 6-12m sea-level rise possible

(Largely irreversible on century to millennial timescales)

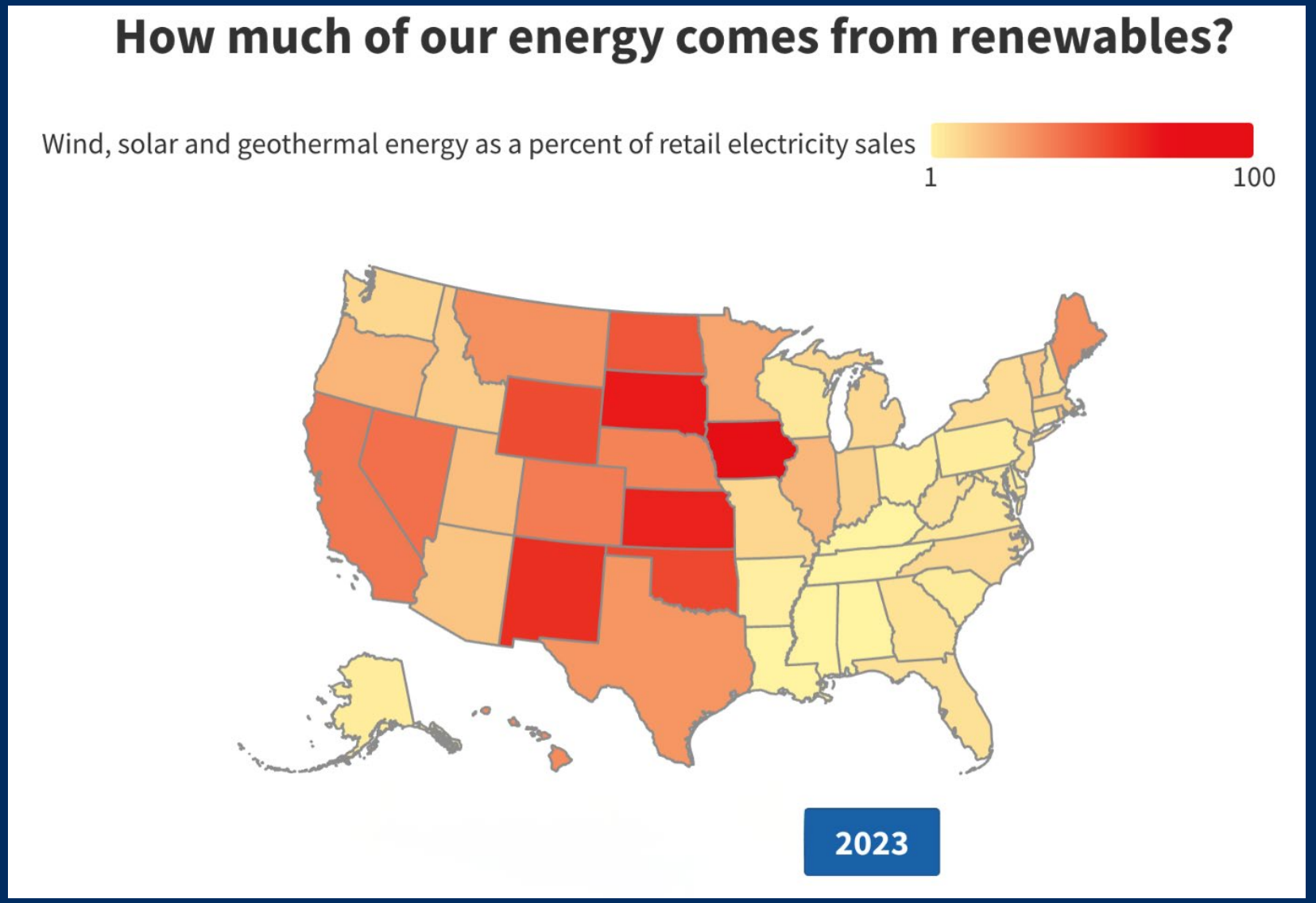

10 meters of Sea Level Rise...
https://coastal.climatecentral.org/
Norfolk
Virginia Beach
Bowling Green
Branson
CHEROKEE NATION
Clarksville
Nashville
OKLAHOMA
Knoxville
Greensboro
Durham
NORTH CAROLINA
Oklahoma City
Asheville
Norman
Charlotte
CHOCTAW NATION
CHICKASAW NATION
Greenville
Wilmington
SOUTH CAROLINA
Atlanta
Myrtle Beach
Augusta
Plano
Worth
Dallas
Charleston
GEORGIA
Tyler
Savannah
Waco
Mobile
Austin
LOUISIANA
Biloxi
Pensacola
Destin
Tallahassee
Jacksonville
The Woodlands
Houston
New Orleans
Panama City
St. Augustine
Gainesville
San Antonio
Galveston
Daytona Beach
Orlando
Kissimmee
Melbourne
Corpus Christi
Tampa
FLORIDA
Sarasota
West Palm Beach
Fort Myers
Reynosa
Naples
Fort Lauderdale
Miami
The Bahamas

The news is not all bad

The **Good News** – The **development** and **deployment** of solutions are also accelerating

- To reduce, mitigate, **halt** climate change
- To **build resilience** and **adapt** to the climate change that cannot be avoided or halted
- To **recover** from impacts

Renewable energy deployment in the U.S.?



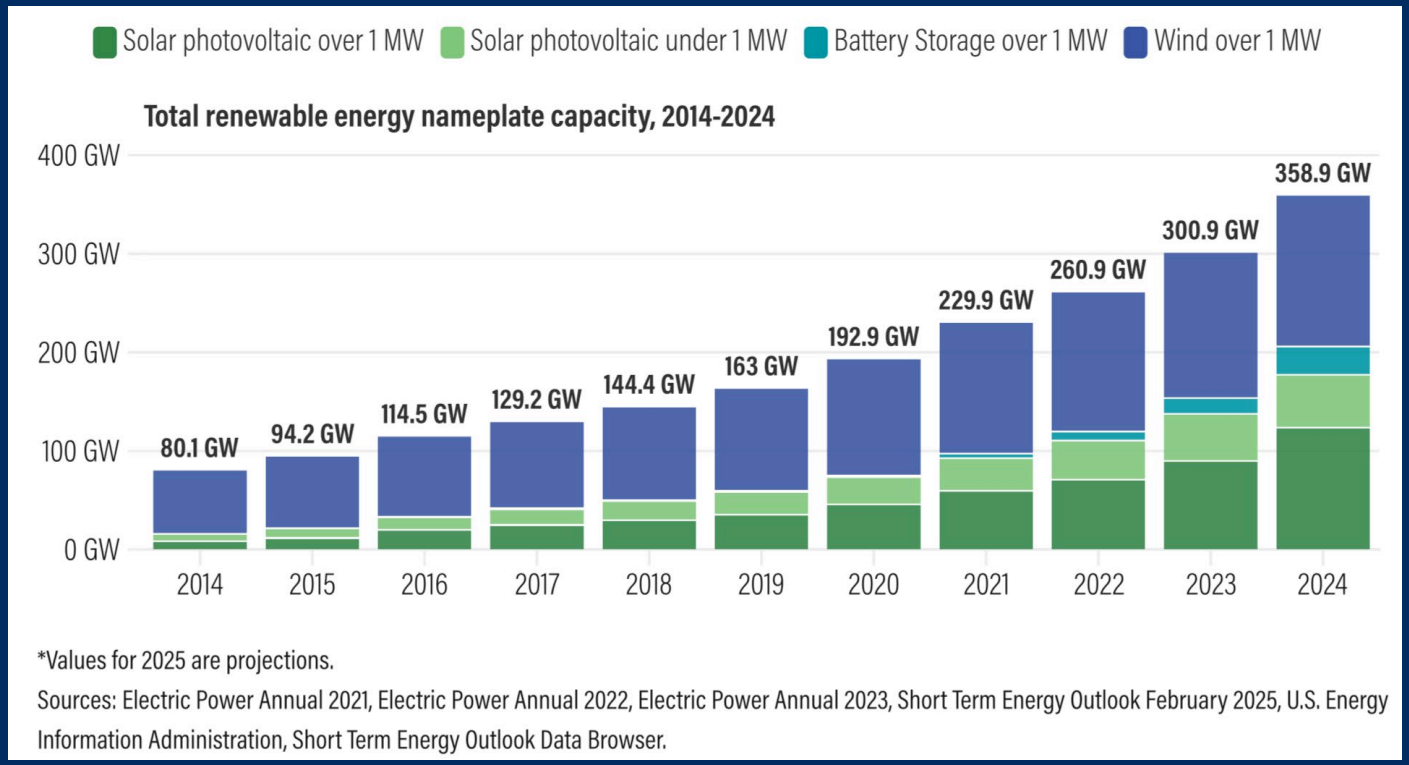
In 2024:

Renewables ~90% new installed capacity:

~50 GW Solar Installed
20 GW in just 3 states:
Texas – 12GW
California – 5GW
Florida – 4.7GW

Also, the many states in the US Climate Alliance – pledged to hit net-zero by 2050

Renewable energy deployment in the U.S.?



In 2024, all low-carbon electricity sources, including wind, solar, geothermal, hydro and nuclear, supplied nearly 44% of electricity, while renewables, supplied nearly 25%.

AND: EV sales hit 8.7% of total vehicle sales

(source: World Resources Institute, 2025)

41%
Global share of clean electricity in 2024

+29%
Solar generation growth in 2024

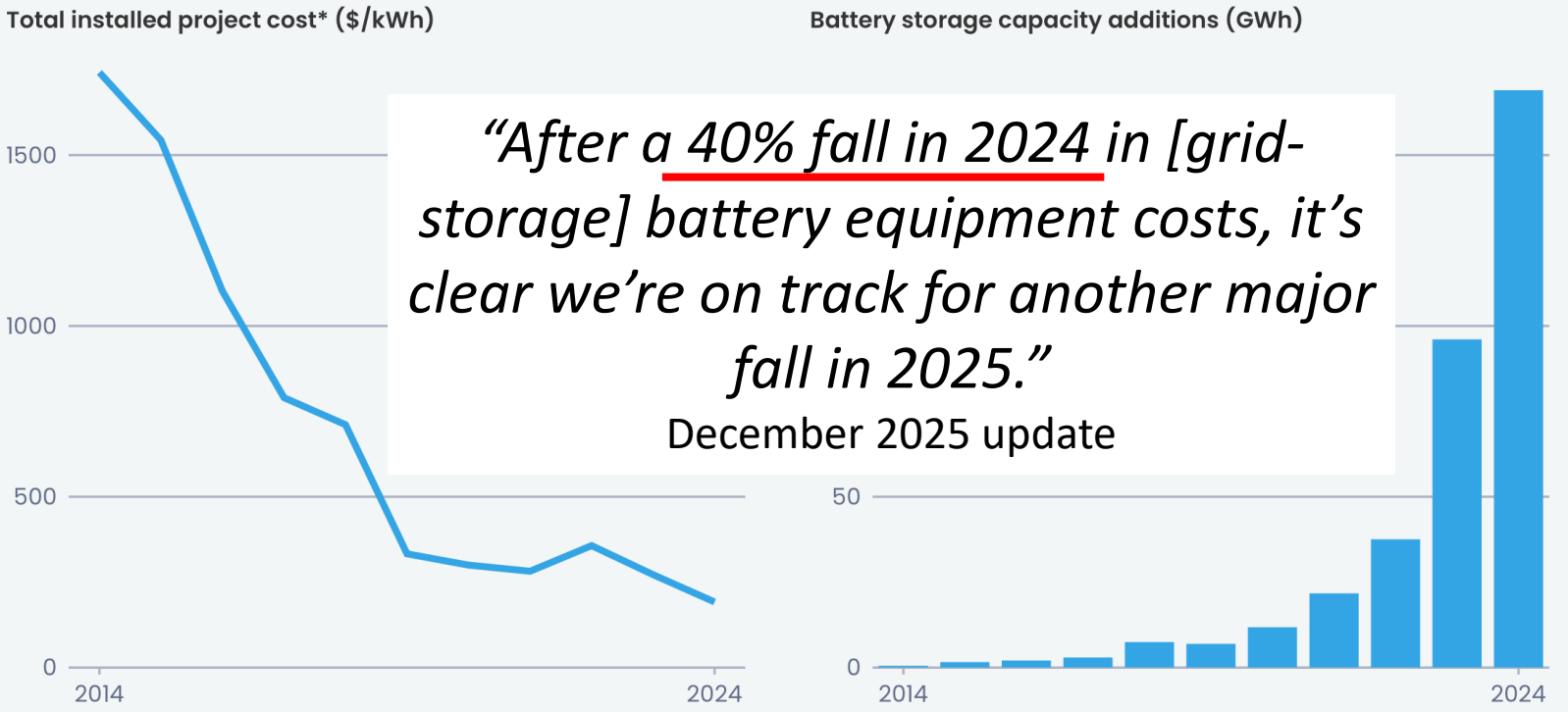
+7.9%
Wind generation growth in 2024

+1.4%
Fossil generation growth in 2024

EMBER

Renewable (solar & wind) energy is now least expensive energy around the globe (expanding faster than total energy demand)

Battery cost fell by an average 20% per year over the last decade as annual installations rose by 80% per year



"After a 40% fall in 2024 in [grid-storage] battery equipment costs, it's clear we're on track for another major fall in 2025."
December 2025 update

Source: IRENA • *Costs of a fully installed and commissioned battery storage project, 2024 prices in USD/kWh of usable capacity

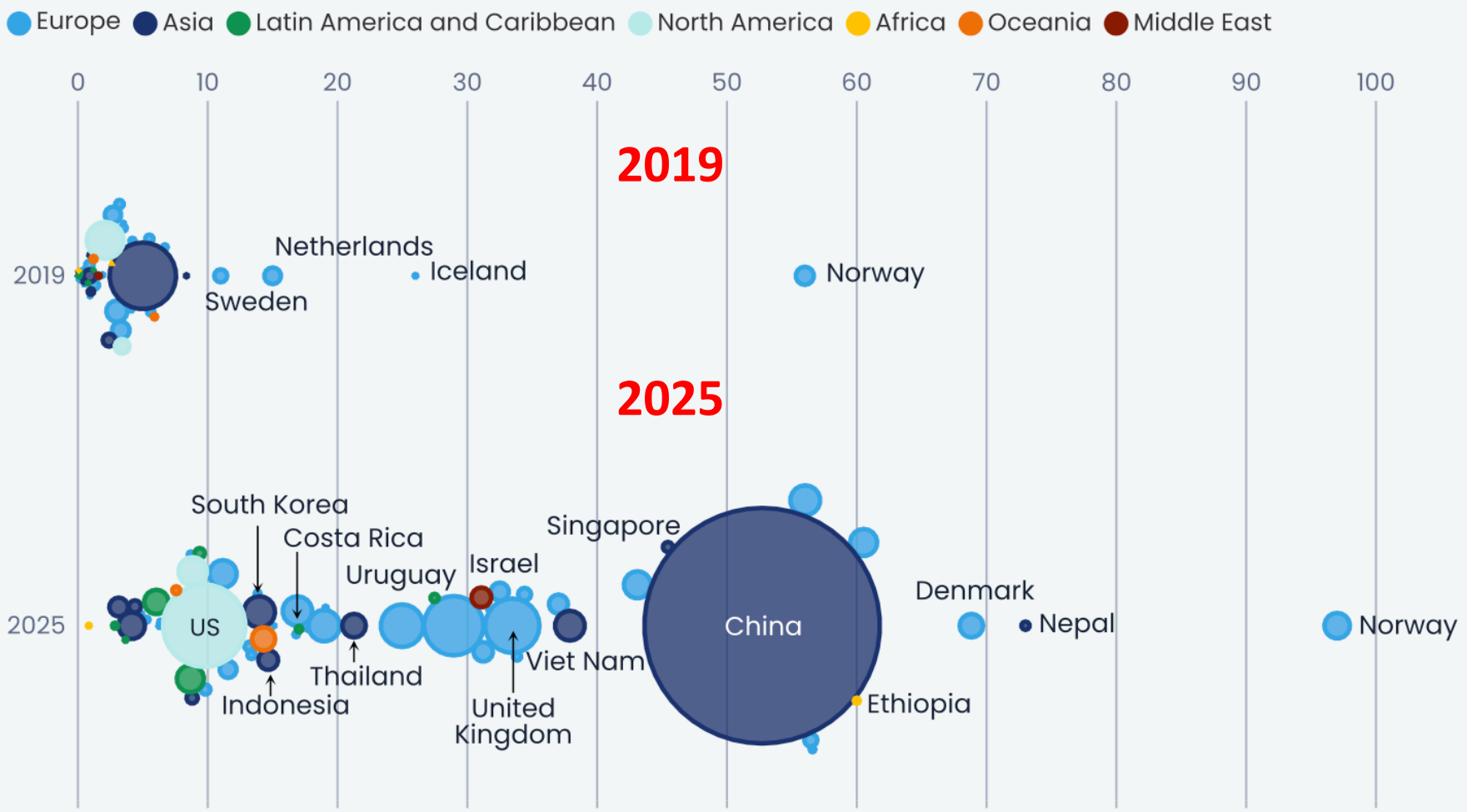
EMBER

The globe is transitioning rapidly to **electrified mobility (EVs),** even as the US slows down

The race to 100% EV sales is well underway

EV share of new passenger car sales (%)

Bubble sizes are relative to total EV sales

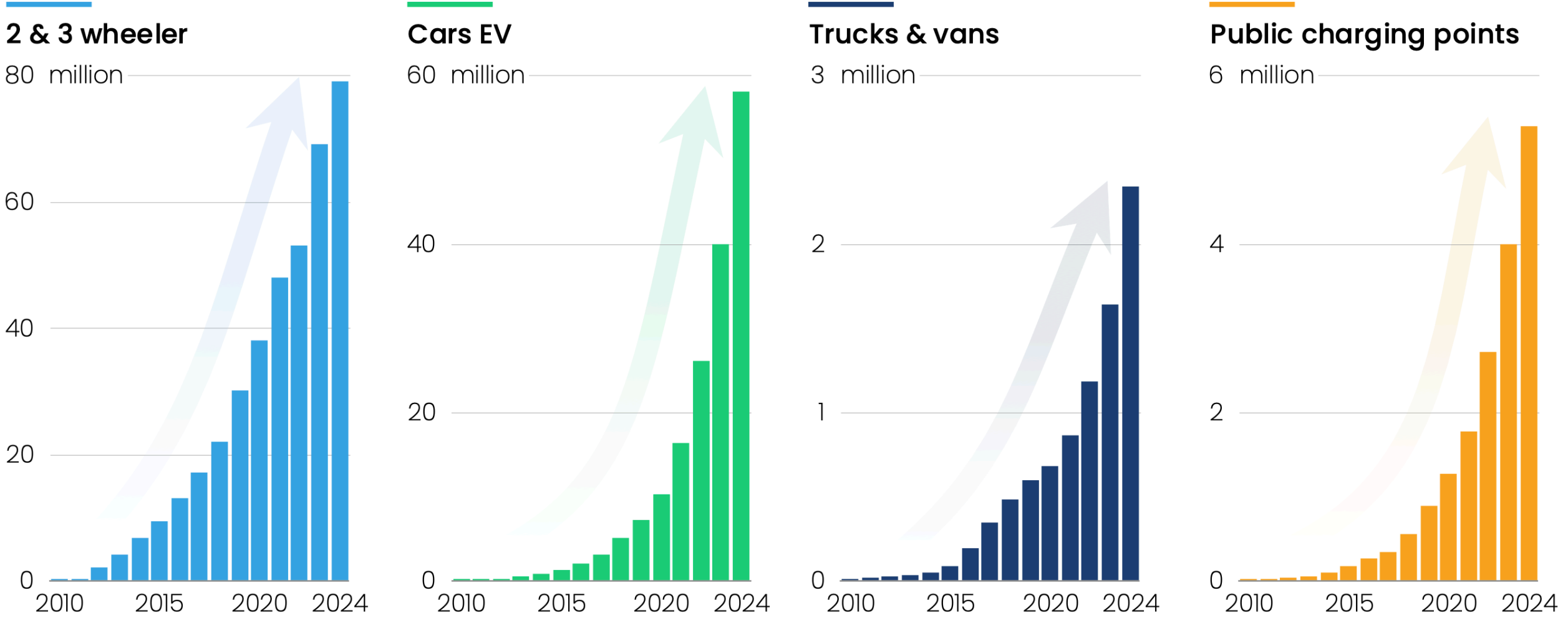


Source: IEA (2019 data), Ember analysis of publicly available national data for Jan-Oct 2025.
EVs include plug-in hybrid electric vehicles and battery electric vehicles. Sales figures in 2025 are an estimate assuming the same year-on-year change seen so far in 2025 continues until the end of the year. For Ethiopia and Nepal, 2024 data is used as more recent annual data is not publicly available.

EMBER

The EV revolution is taking off (GLOBAL)

Electric mobility is growing exponentially across vehicle sizes



Sources: IEA. Note these figures are for the size of the fleet


So, what’s the problem?


We need to go faster
(including in the U.S.)
So, what's the problem?
WHY?

Yet more reason for hope:

A large majority of Americans know climate change is real, and are worried

In 2024:

National average 71%

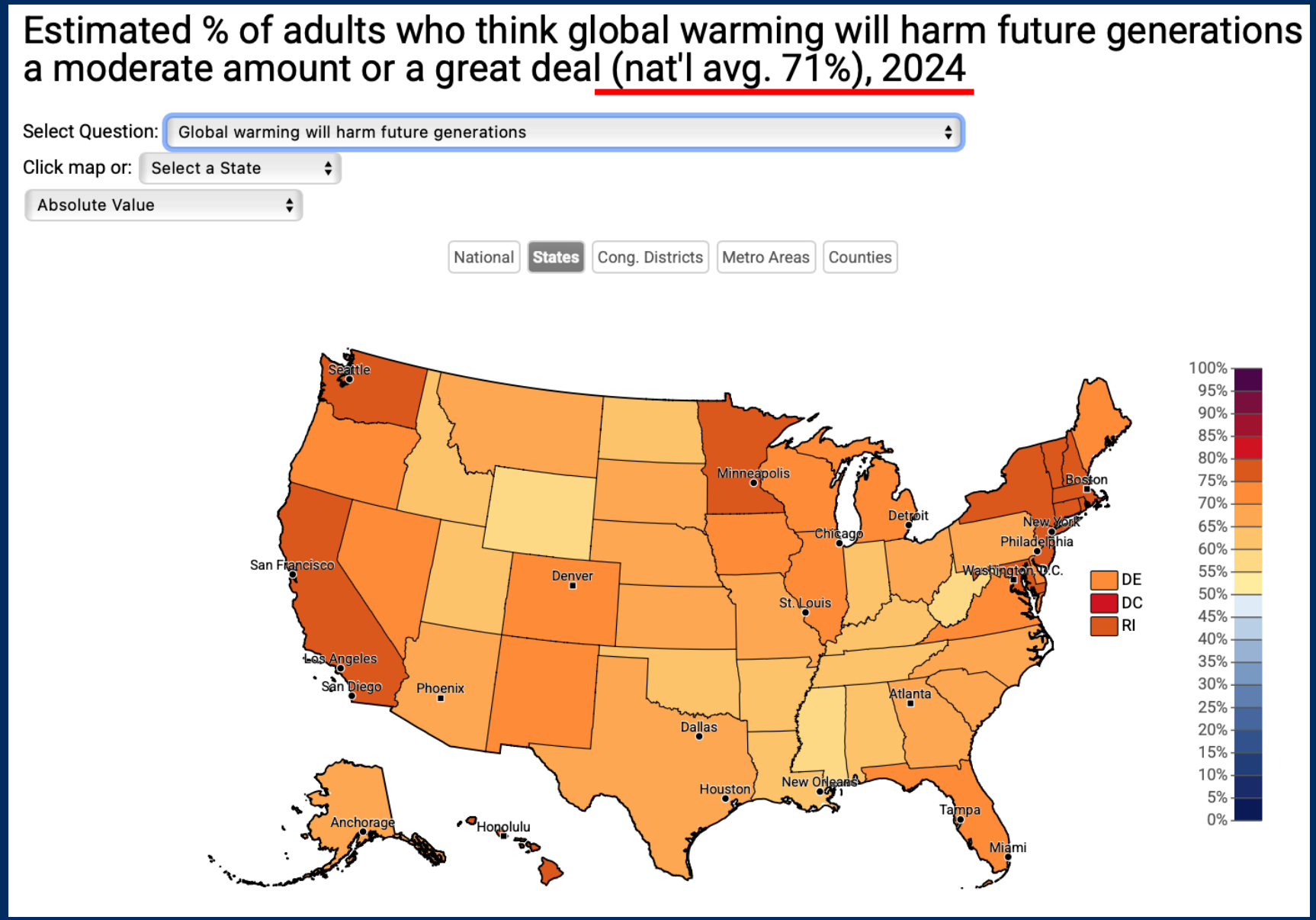
Michigan steady at 71%

Ohio at 68%

Texas at 70%

Florida at 70%

California at 77%



https://climatecommunication.yale.edu/visualizations-data/ycom-us-2024/

Conclusions…

- Climate change, **impacts** and **costs** are accelerating
- Solution cost reductions are accelerating
- Solution deployment is accelerating
- BUT solutions are still being deployed too slowly
- "Fairness" not being emphasized enough – if everyone benefits, the energy transition will speed up, in the US and globally
- **Plan on substantial increases in further climate change impacts going forward, at least 2x what we've seen so far, and probably more.**

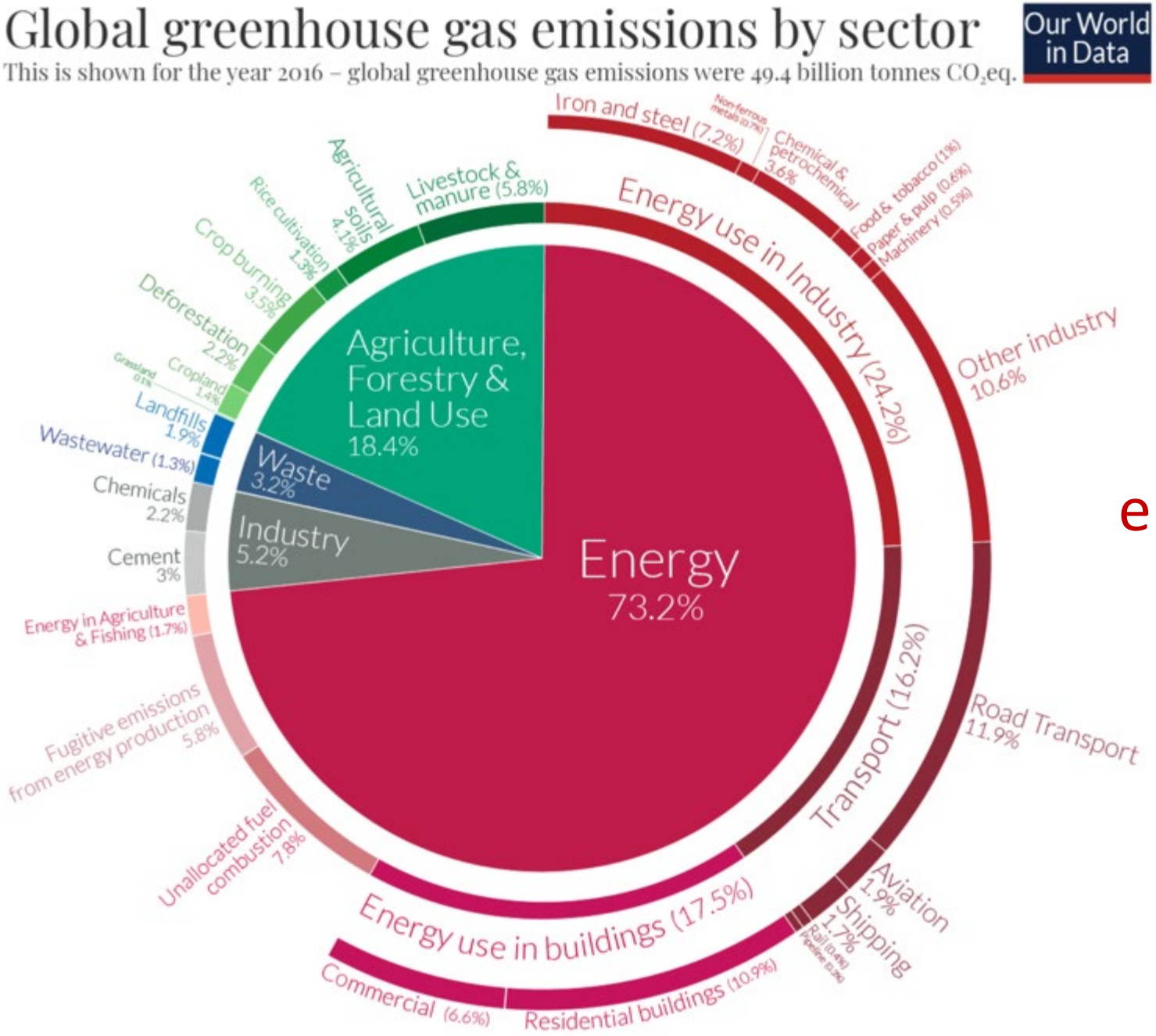
Thanks!

Did you know the Great Lakes hold over 20% of the world's unfrozen surface water?

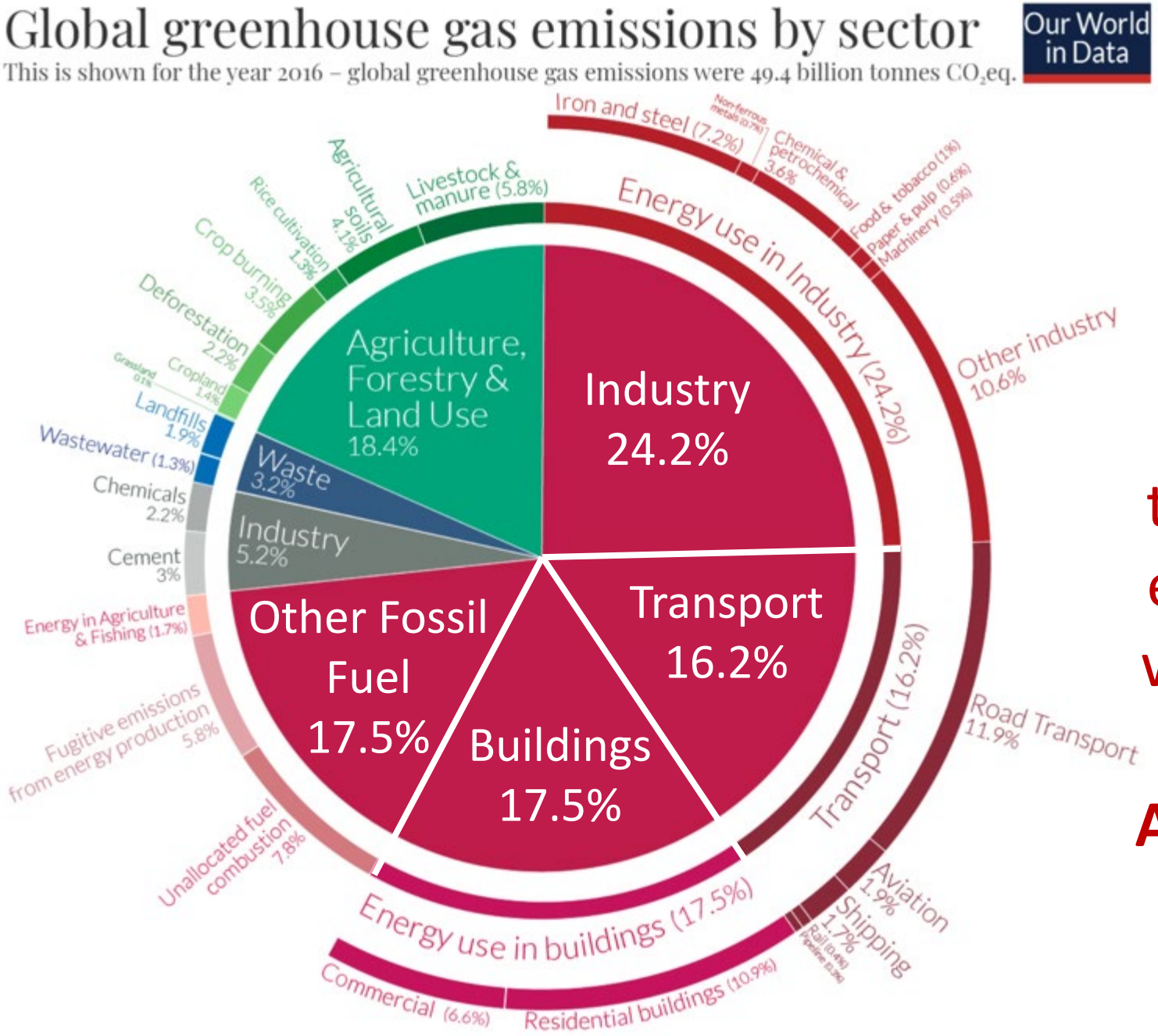
M | SEAS

@GreatLakesPeck

@GreatLakesPeckTwo



Decarbonizing our energy systems is the biggest job



Developing and implementing low-carbon solutions = the 21st century new economy requiring a wide range of talents

And fairness must be a factor in all solutions

Past and future global transformation of terrestrial ecosystems under climate change

Science (2018)

Connor Nolan[1], Jonathan T. Overpeck[2,1], Judy R. M. Allen[3], Patricia M. Anderson[4], Julio L. Betancourt[5], Heather A. Binney[6], Simon Brewer[7], Mark B. Bush[8], Brian M. Chase[9], Rachid Cheddadi[9], Morteza Djamali[10], John Dodson[11,12], Mary E. Edwards[6,13], William D. Gosling[14,15], Simon Haberle[16], Sara C. Hotchkiss[17], Brian Huntley[3], Sarah J. Ivory[18], A. Peter Kershaw[19], Soo-Hyun Kim[17], Claudio Latorre[20], Michelle Leydet[10], Anne-Marie Lézine[21], Kam-Biu Liu[22], Yao Liu[23], A. V. Lozhkin[24], Matt S. McGlone[25], Robert A. Marchant[26], Arata Momohara[27], Patricio I. Moreno[28], Stefanie Müller[29], Bette L. Otto-Bliesne
Caiming Shen[31], Janelle Stevenson[32], Hikaru Takahara[33], Pavel E. Tarasov[29], John Tipton[34], Annie Vincens[35], Chengyu Weng[36], Qinghai Xu[37], Zhuo Zheng[38], Stephen T. Jackson[39,1]*

Too much global warming will profoundly impact ecosystems (and their biodiversity) around the planet

Amount of Global Warming

<1.5°C 4°C