

Overview of Climate Science and Policy

EES 3310/5310

Global Climate Change

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Class #2: Fri. Aug. 24 2018



Organizational Things:

- Next Week
- Preparing for lab on Monday

Aral Sea



Questions from Reading?

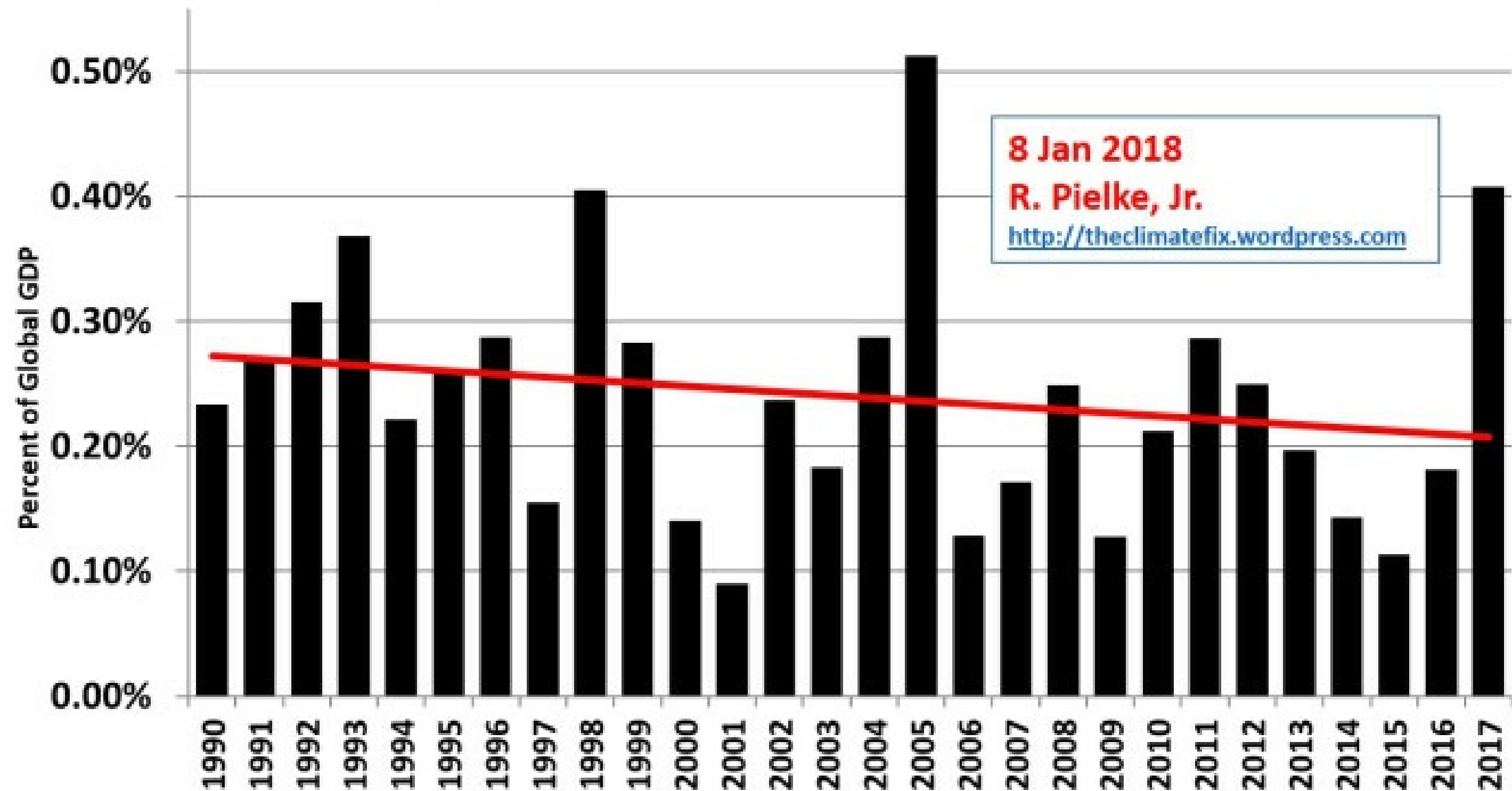
Severe Storms and Disasters

- Are severe storms, such as hurricanes and tornadoes becoming more severe because of climate change?

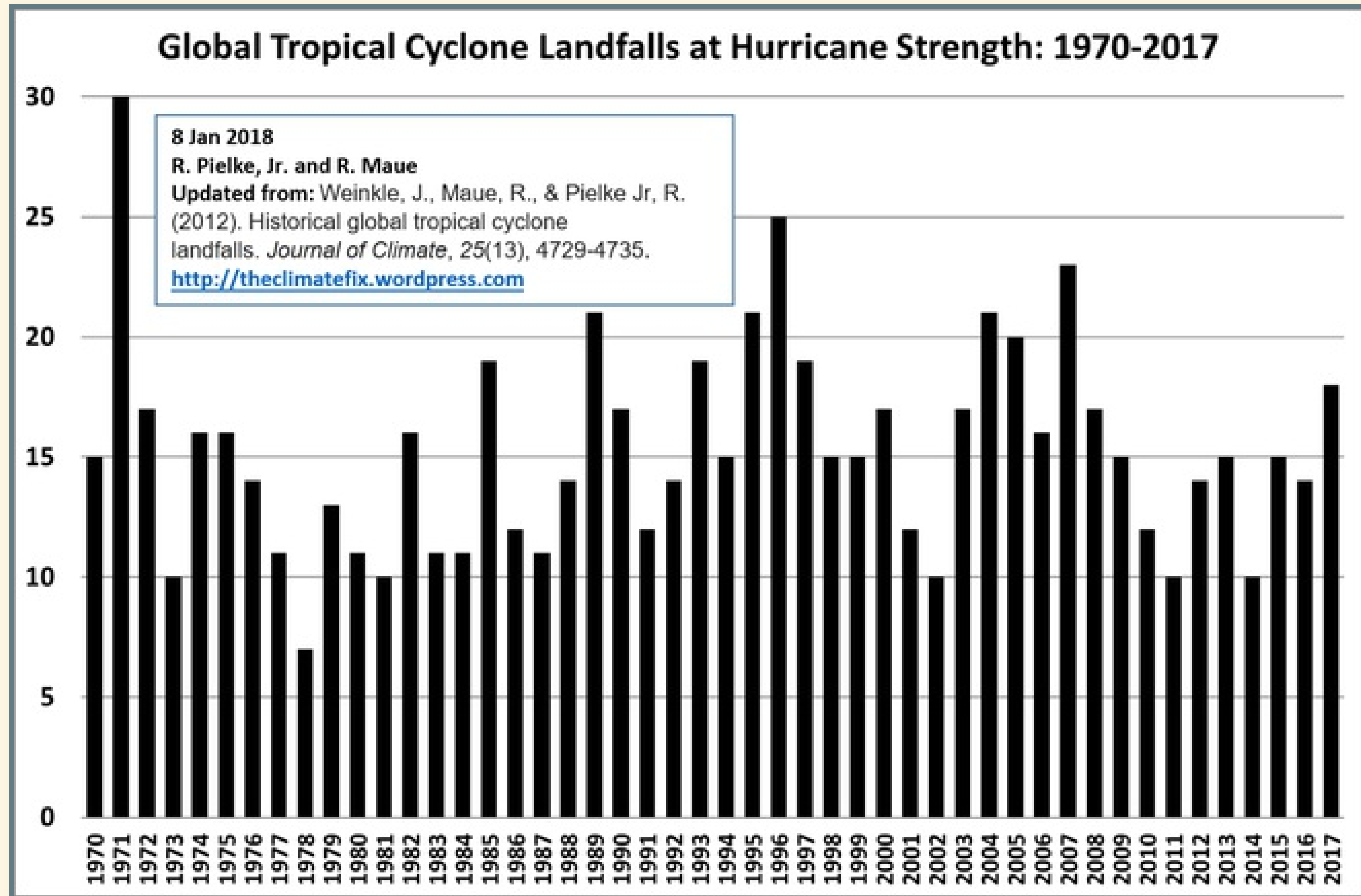
Hurricane Damages

Global Weather-Related Disaster Losses as a Proportion of Global GDP: 1990-2017

(Sources: Munich Re, UN; and based on Pielke, 2015)

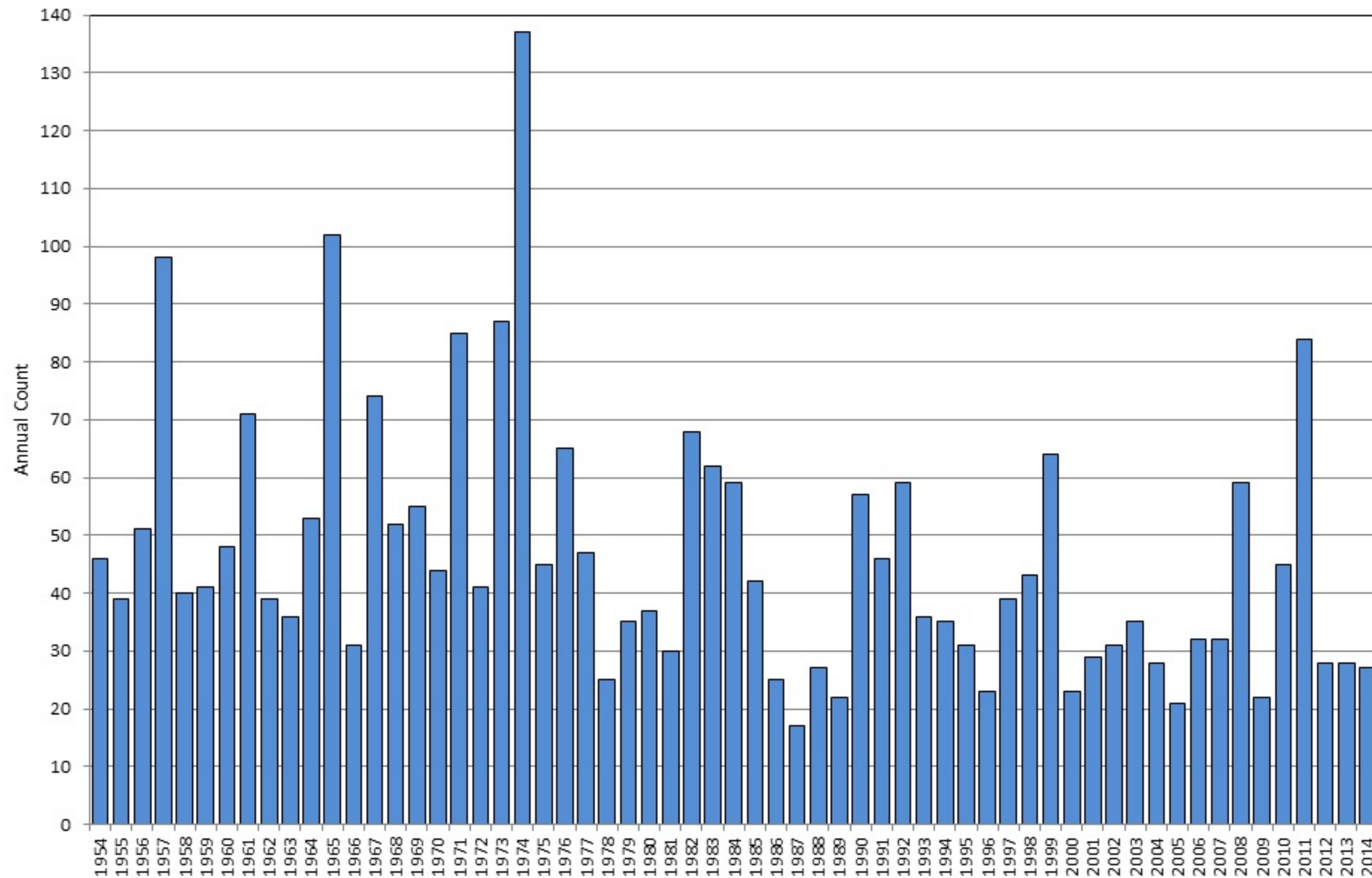


Hurricane Landfalls



Severe Tornadoes

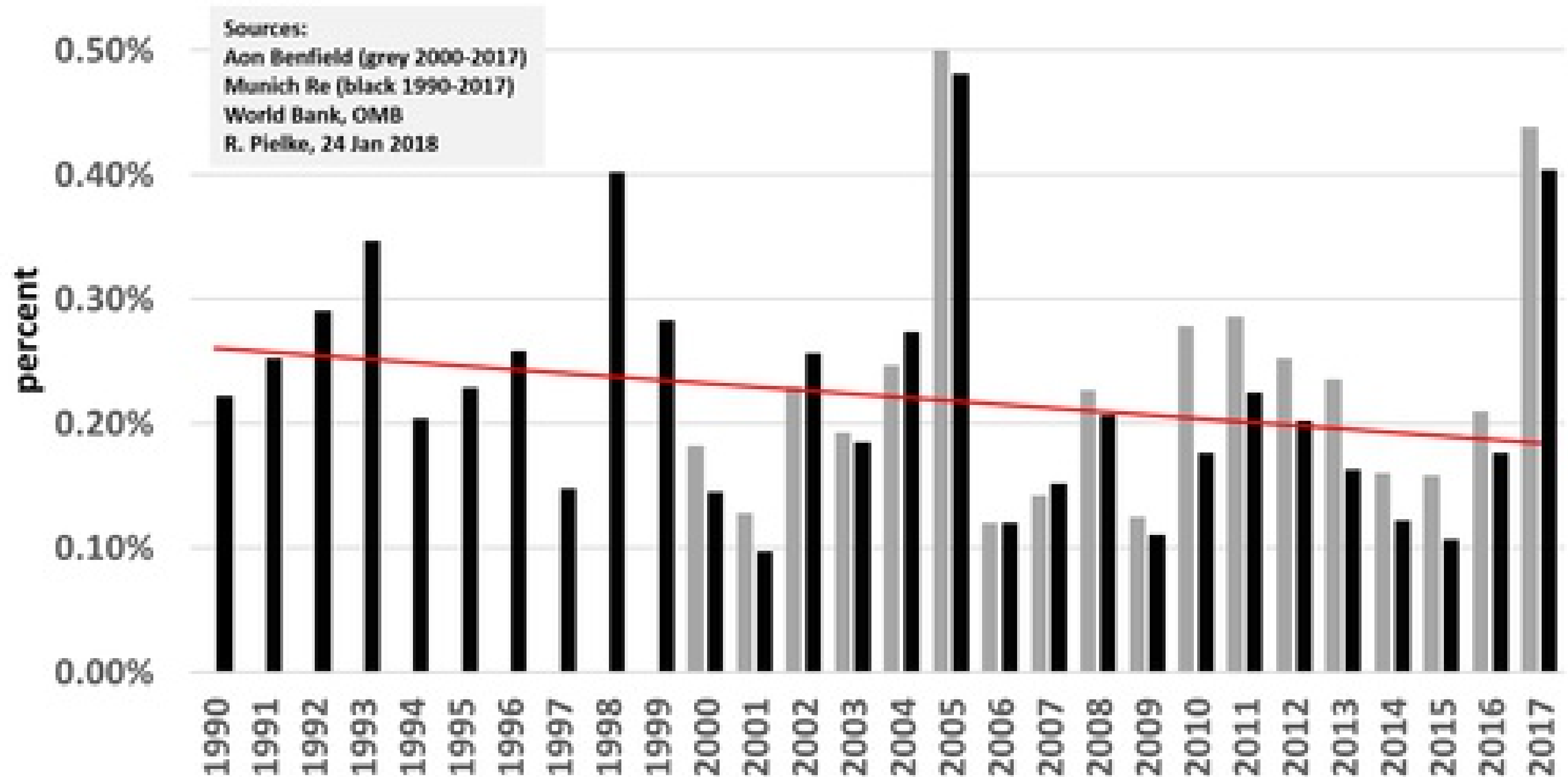
U.S. Annual Count of Strong to Violent Tornadoes (F3+), 1954 through 2014



Data Source: NOAA/ NWS Storm Prediction Center

All Weather Disasters

Global Weather Losses as Percent of Global GDP: 1990-2017



Human Impact on Climate System:

Important Concepts:

- What kinds of things can cause the global temperature to change?
 - Energy Balance:
 - Temperature is steady when $\text{Heat}_{\text{in}} = \text{Heat}_{\text{out}}$.
 - What happens when $\text{Heat}_{\text{in}} > \text{Heat}_{\text{out}}$?
 - What kinds of things can cause Heat_{in} to change?
 - What kinds of things can cause Heat_{out} to change?

Temperature Change

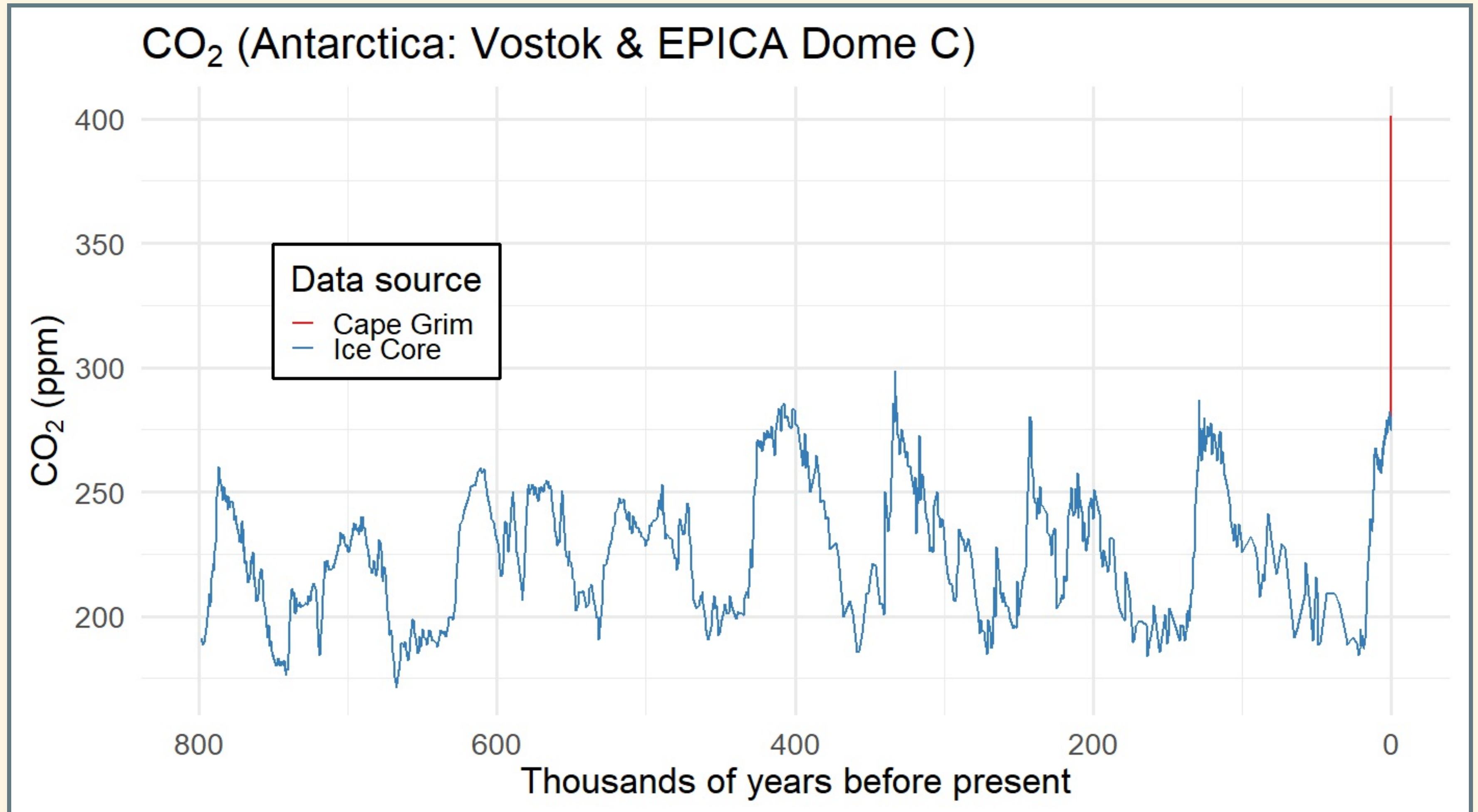
- How much has earth warmed in the last century or so?
 - About 1.0°C (1.8°F)
- If CO₂ emissions keep rising, how much do scientists expect it to warm in the next century?
 - Somewhere around 3–6°C (5–11°F)
- What is the seasonal temperature change in Nashville (winter to summer)?
 - Around 23°C (42°F) 47°F in January, 89°F in August.
- What is the average daily temperature range in Nashville (night to day)?
 - Around 11°C (20°F)
 - **So why do people worry about global warming?**

Predictions

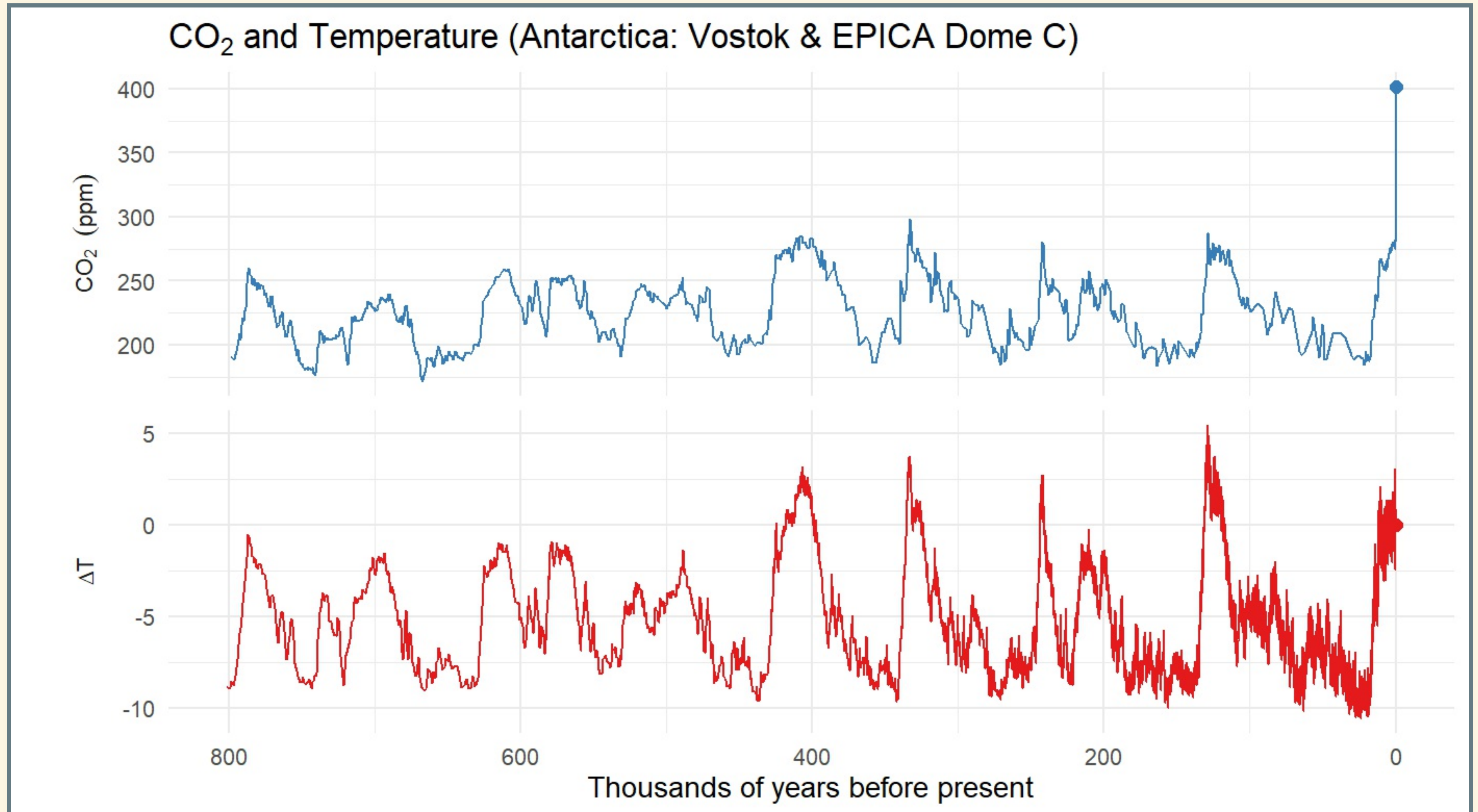
- Meteorologists can't predict whether it will rain three weeks from today with any confidence.
- So how can I trust predictions about the climate 100 years from now?

What Earth's History Tells Us

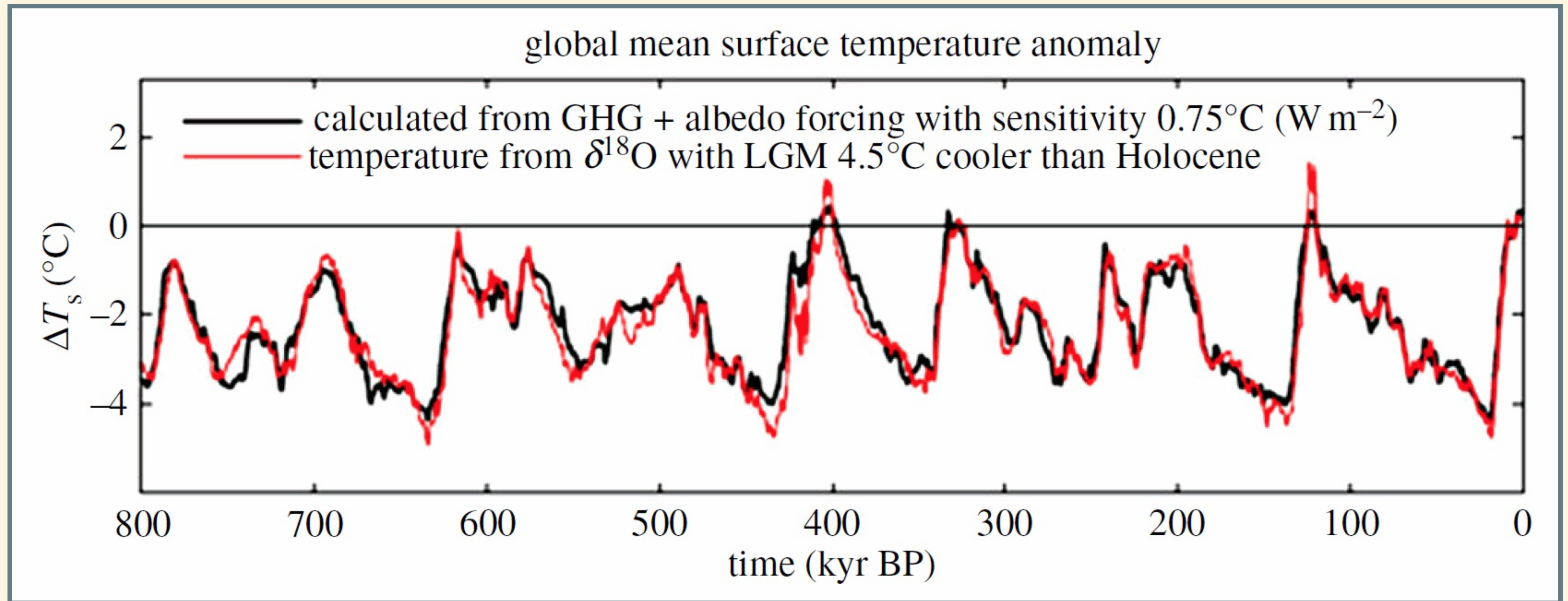
800,000 years of CO₂



800,000 years of CO₂ and Temperature

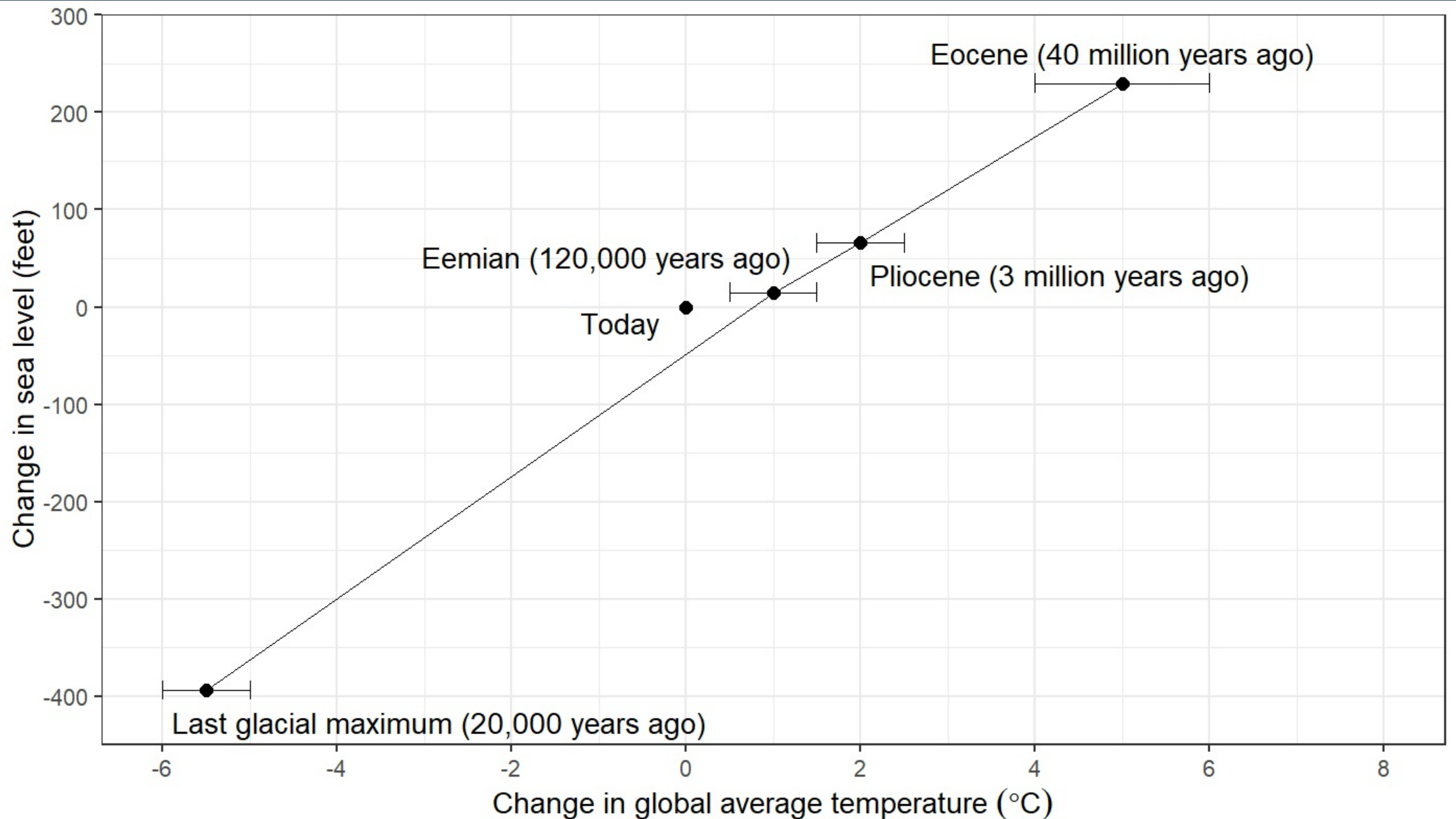


Using Past Climates to Test Theory

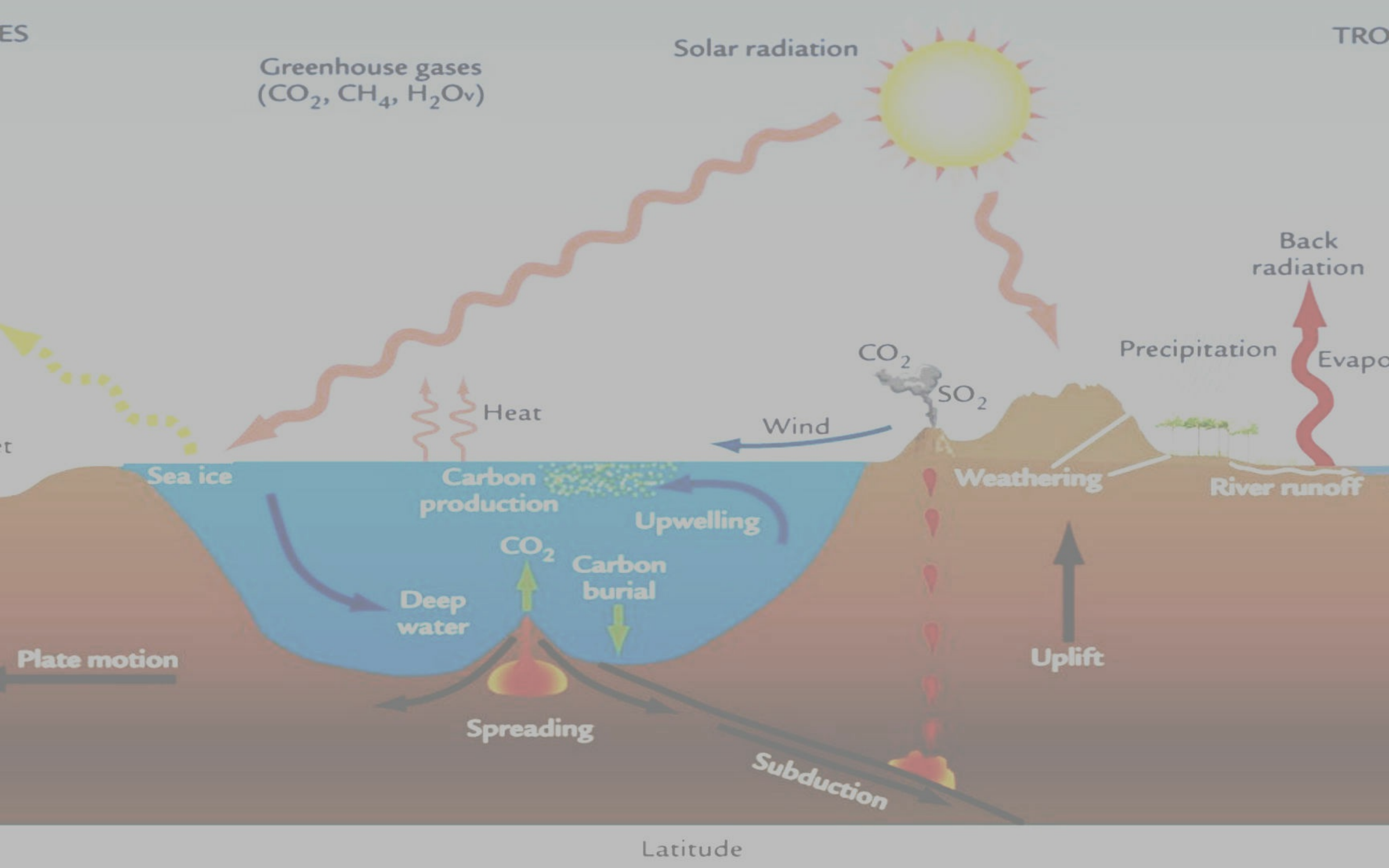


Source: J. Hansen *et al.*, Phil. Trans. Roy. Soc. A **371**, 20120394 (2013).

Temperature and Sea-Level



Key Concepts: Dynamics and Time Scales



Dynamics:

- Forcing:
 - Something that pushes a system out of equilibrium
 - The sun gets brighter
- Response:
 - How the system responds to the forcing
 - The earth gets warmer
- Feedback:
 - The response causes a new forcing



Characteristic Time Scales

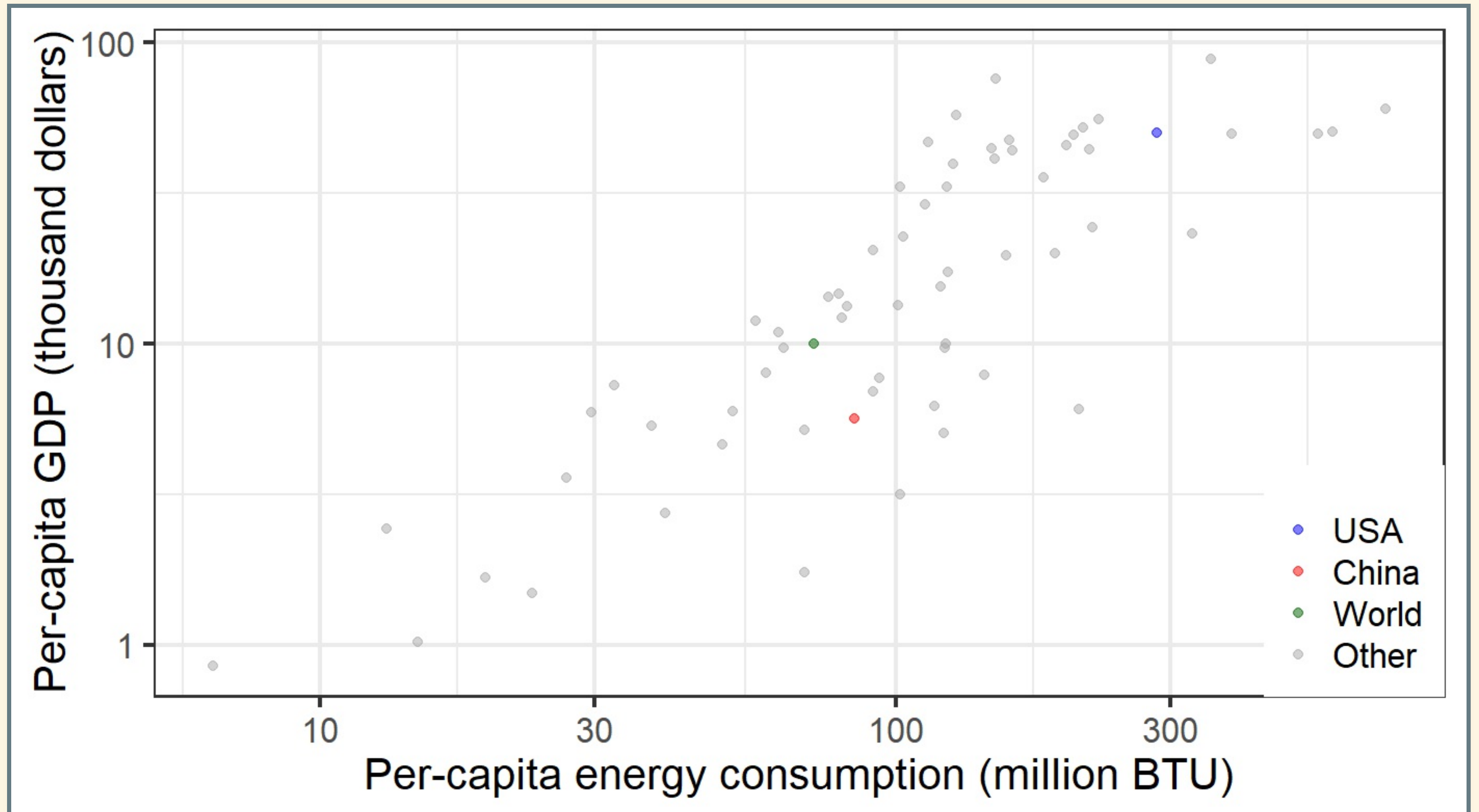
Component	Response Time
Atmopshere	Hours to weeks
Land surface	Hours to months
Ocean surface	Days to months
Vegetation	Hours to decades/centuries
Sea ice	Weeks to years
Mountain glaciers	Decades to centuries
Deep ocean	100–1500 years
Ice sheets	centuries–10,000 years
Carbon dioxide	10s–100s of thousands of years

Outline of climate science

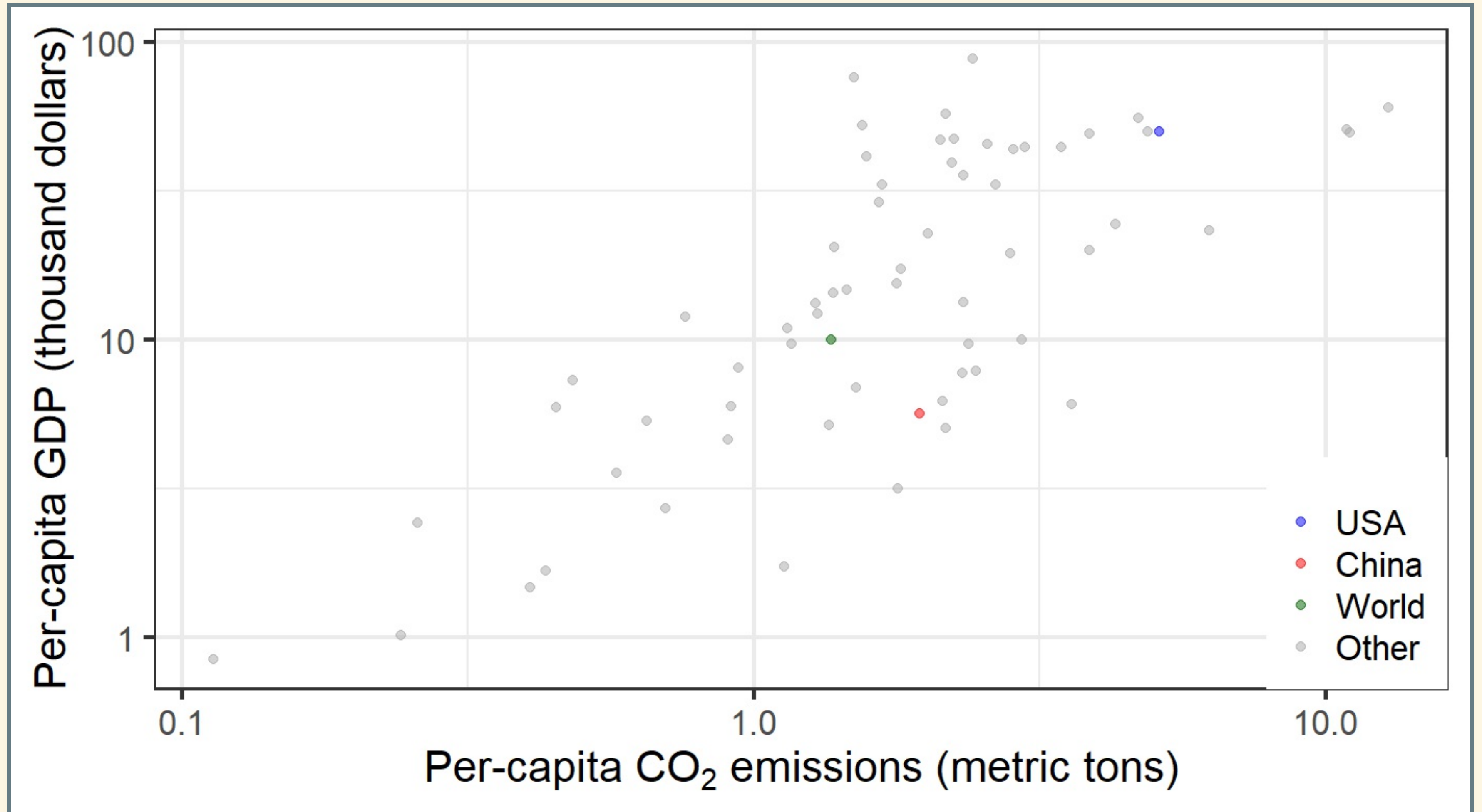
- Earth's Temperature
 - Set by energy balance: $H_{\text{out}} = H_{\text{in}}$.
- Greenhouse Effect:
 - Natural phenomenon (discovered 1827)
 - Due mostly to CO_2 , H_2O . (discovered in 1863)
 - Greenhouse gases affect H_{out}
- Global warming from burning fossil fuels
 - Predicted in 1896
 - Detailed calculations impossible without computers (1956)

Economy-Energy-Environment

Wealth & Energy Use



Wealth & CO₂ Emissions



Economics, Policy, Climate

- Why don't markets manage greenhouse gas emissions well?
 - Pollution is an **externality**
- How does Nordhaus propose to fix this problem?
 - Ronald H. Coase (1920–2013):
 - Solve externality problems by assigning property rights
 - Cap-and-trade: Permits
 - Emissions tax: Put price on emissions

Economics and Vulnerability

- For an economist, what are the big dangers associated with climate change?
 - **Managed vs. unmanaged, unmanageable** resources