Overview of Climate Science and Policy

EES 3310/5310

Global Climate Change

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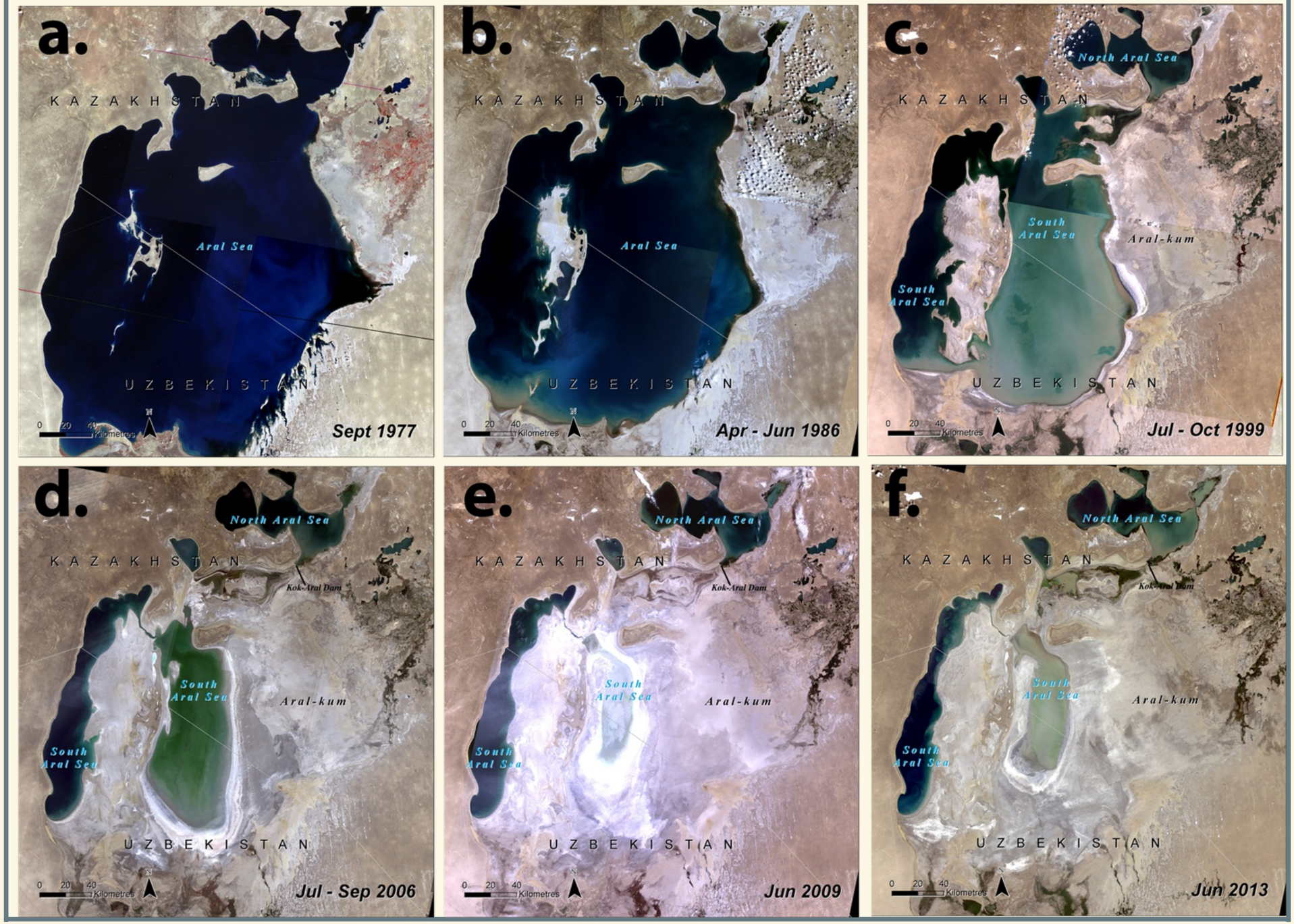
Class #2: Fri. Aug. 24 2018

Organizational Things:

- Next Week
- Preparing for lab on Monday

Aral Sea

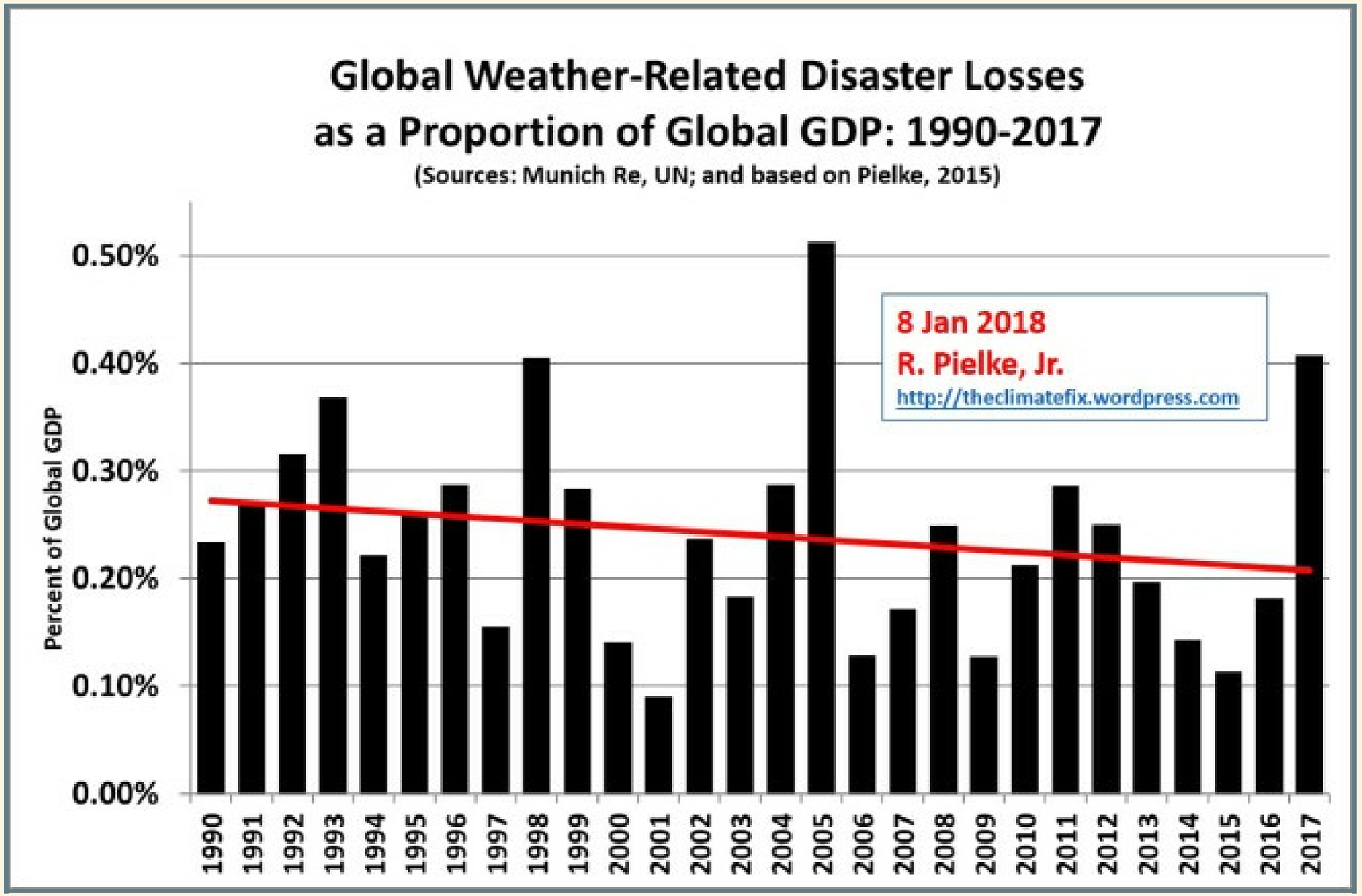

a.
KAZAKHSTAN
Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Sept 1977
b.
KAZAKHSTAN
Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Apr - Jun 1986
c.
North Aral Sea
KAZAKHSTAN
South Aral Sea
Aral-kum
South Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Jul - Oct 1999
d.
North Aral Sea
KAZAKHSTAN
Kok-Aral Dam
South Aral Sea
Aral-kum
South Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Jul - Sep 2006
e.
North Aral Sea
KAZAKHSTAN
Kok-Aral Dam
South Aral Sea
Aral-kum
South Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Jun 2009
f.
North Aral Sea
KAZAKHSTAN
Kok-Aral Dam
South Aral Sea
Aral-kum
South Aral Sea
UZBEKISTAN
0 20 40 Kilometres
Jun 2013

Questions from Reading?

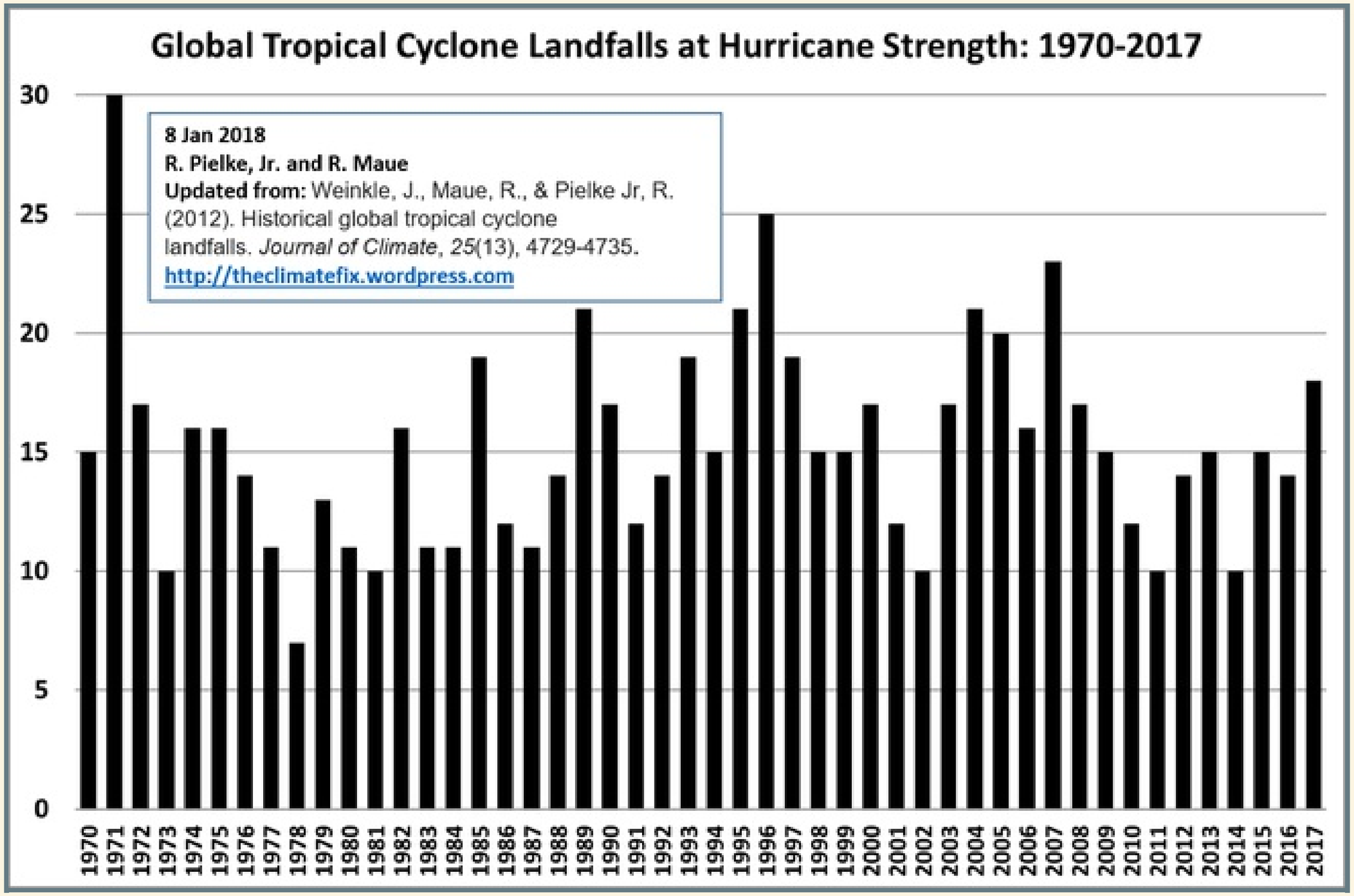
Severe Storms and Disasters

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

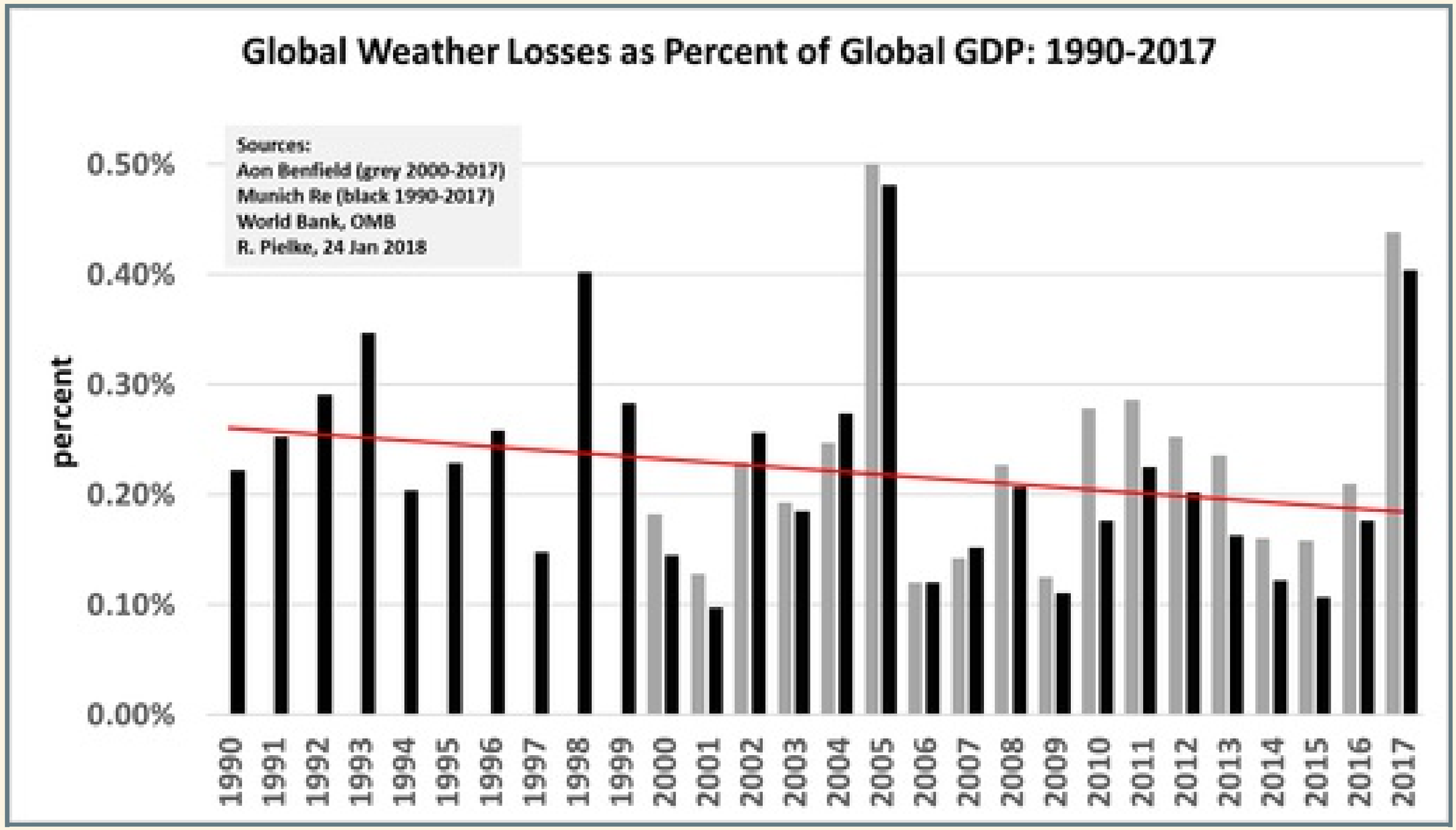
Hurricane Damages



Hurricane Landfalls



All Weather Disasters



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

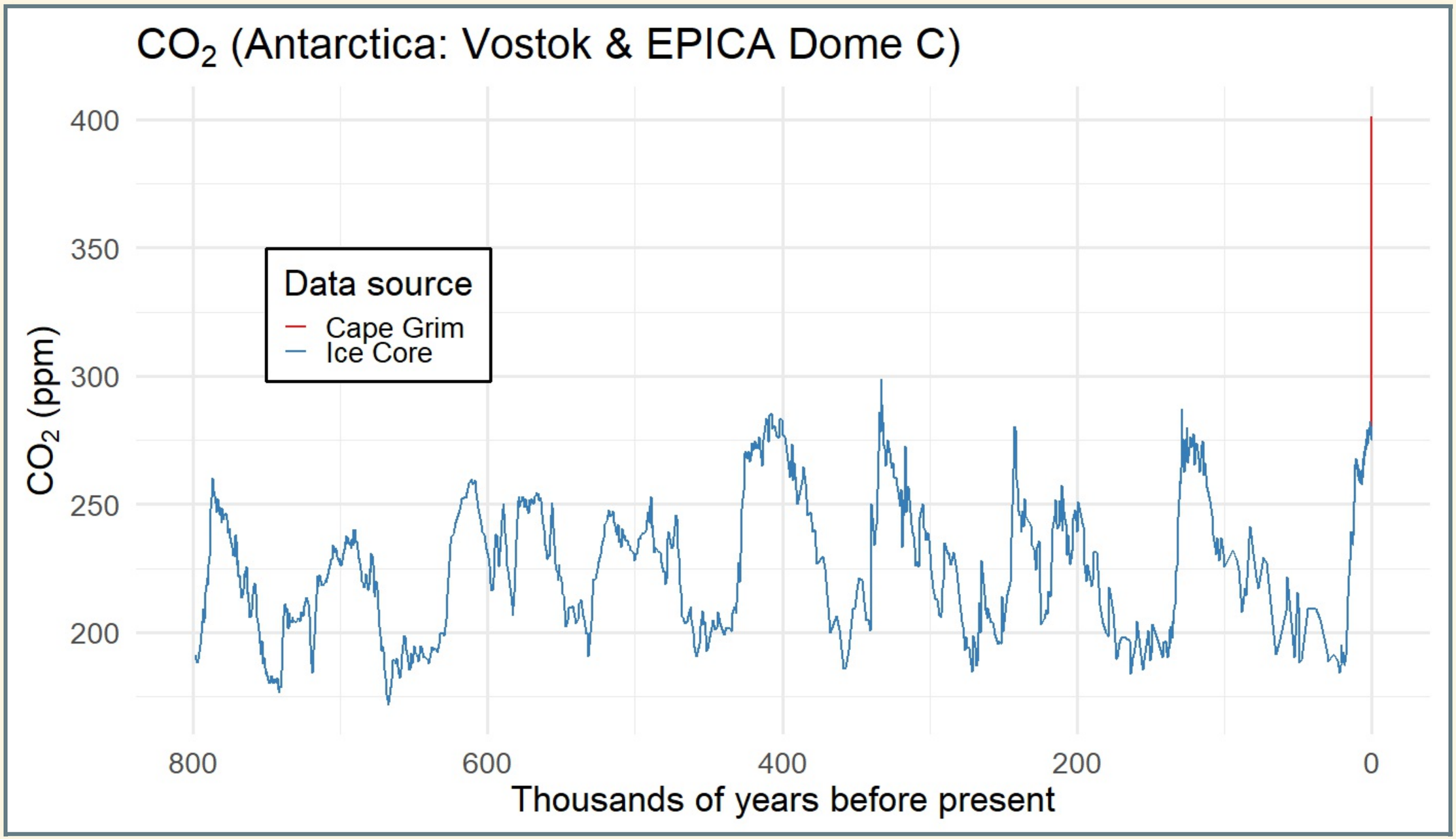
- How much has earth warmed in the last century or so?
  - About 1.0°C (1.8°F)
- If CO_2 emissions keep rising, how much do scientists expect it to warm in the next century?
  - Somewhere around 3–6°C (5–11°F)
- What is the seasonal temperature change in Nashville (winter to summer)? - Around 23°C (42°F) 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

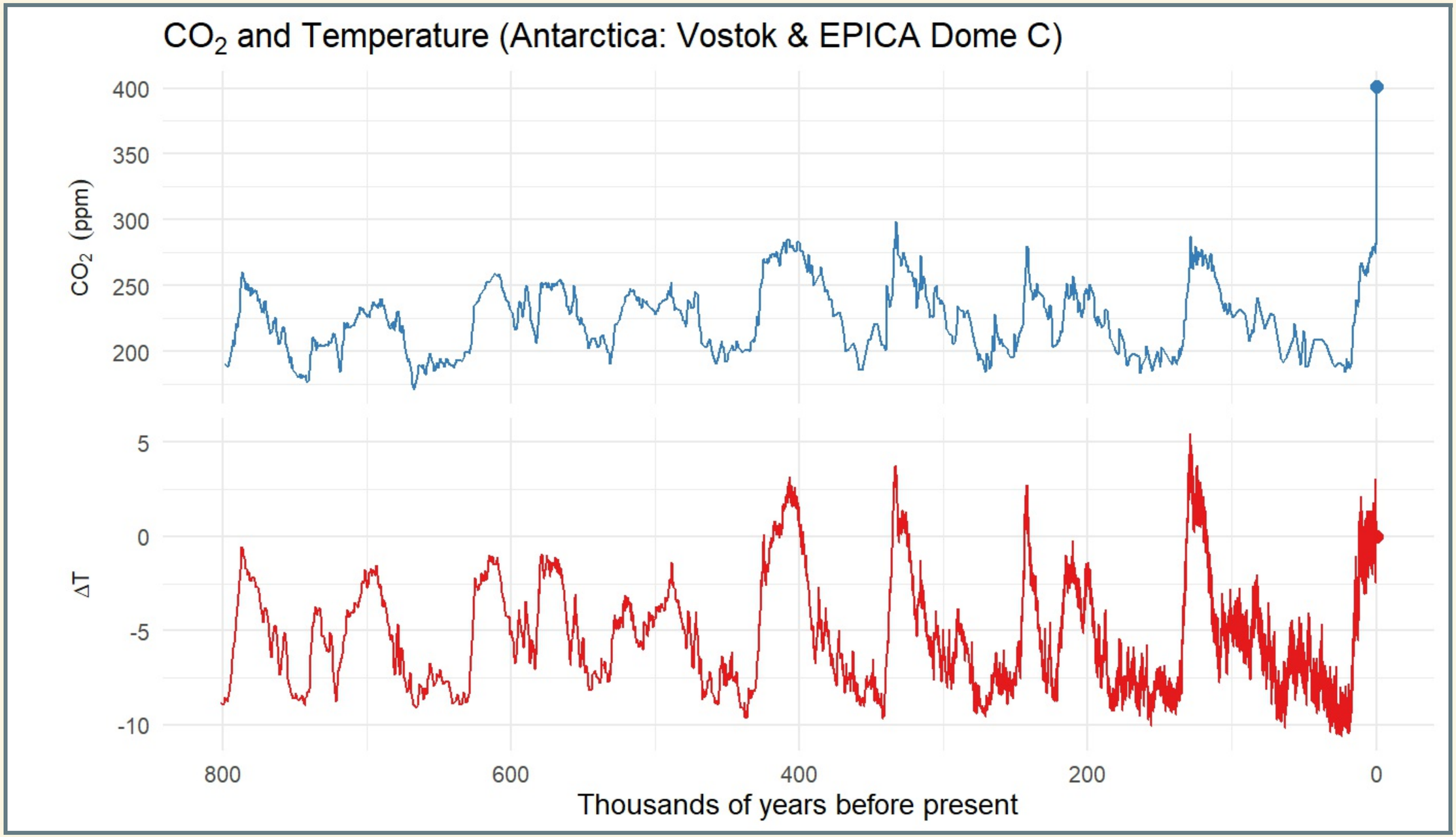
- Meteorologists can’t predict whether it will rain three weeks from today with any confidence.
- So how can I trust predictions about the climate 100 years from now?

What Earth's History Tells Us

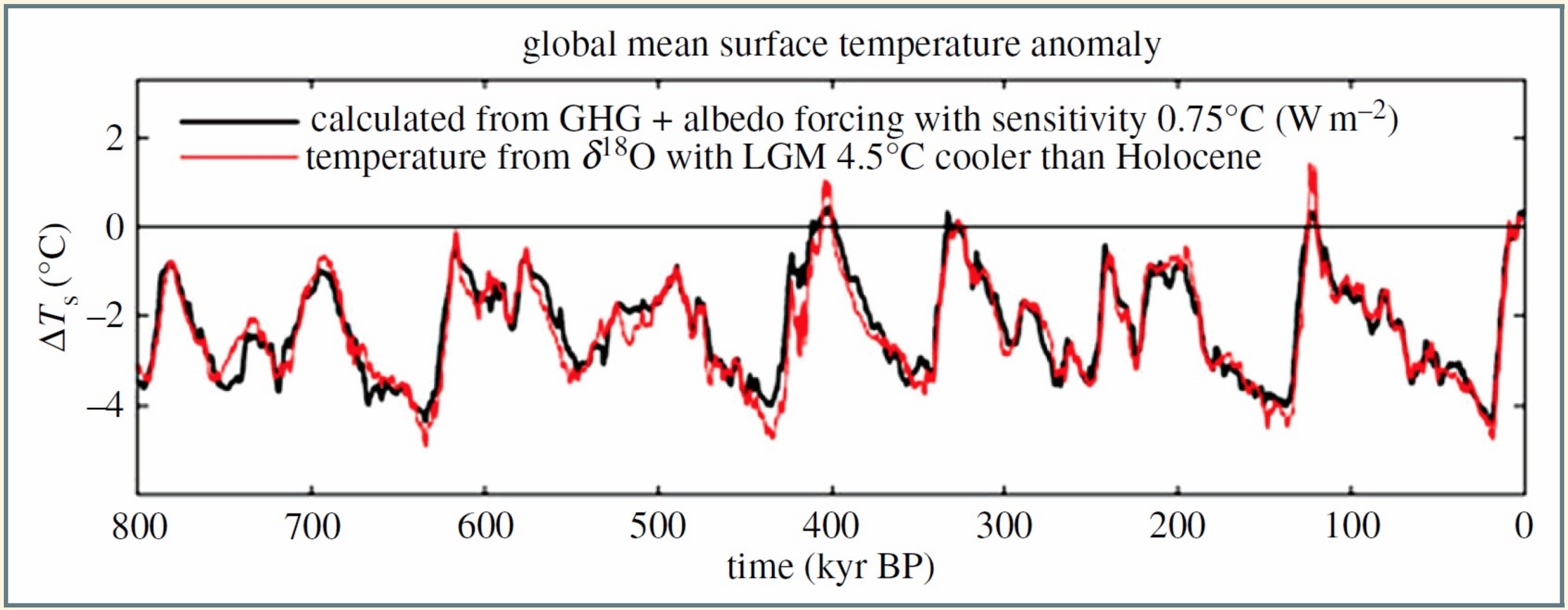
800,000 years of CO_2



800,000 years of CO_2 and Temperature

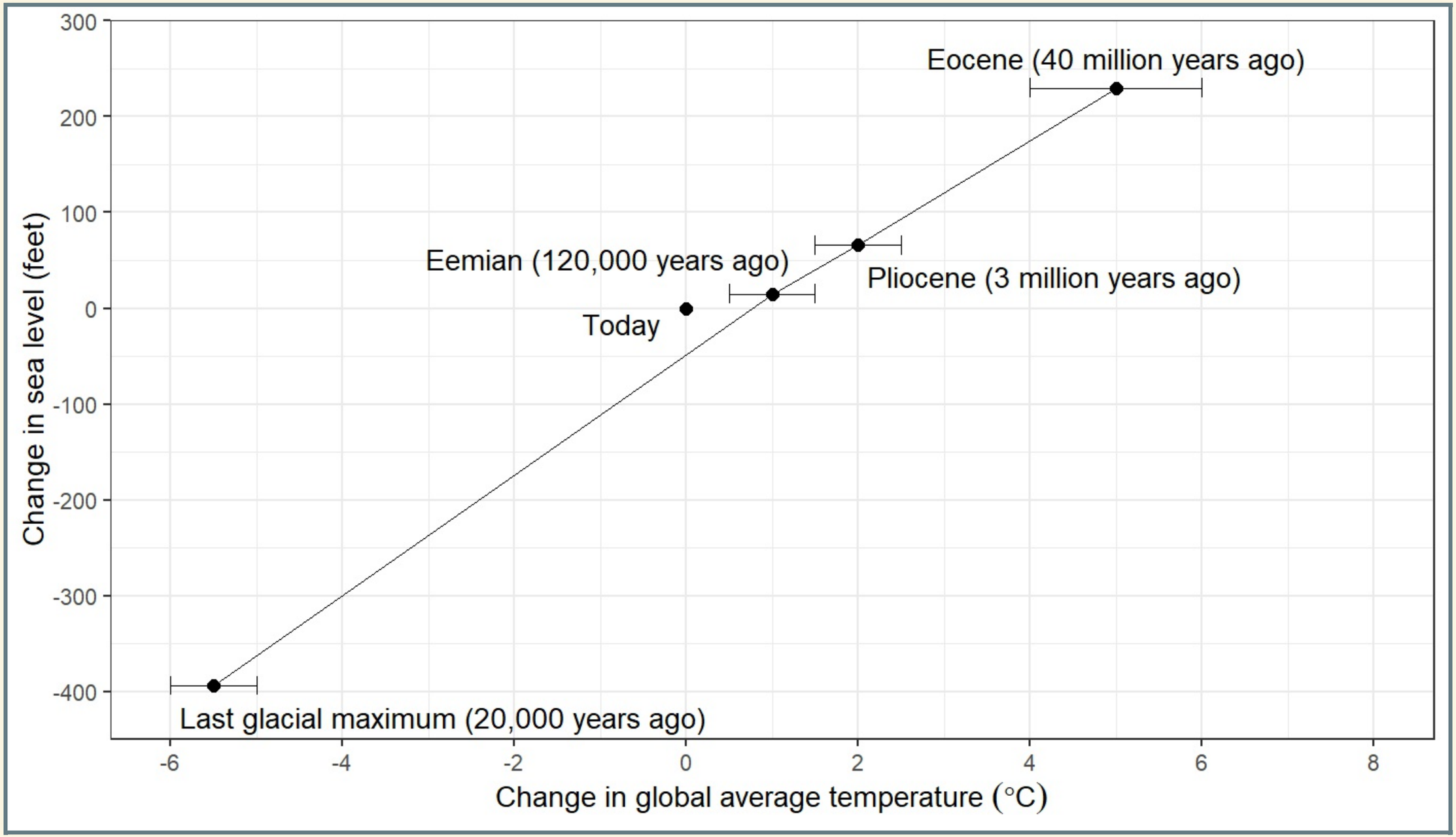


Using Past Climates to Test Theory



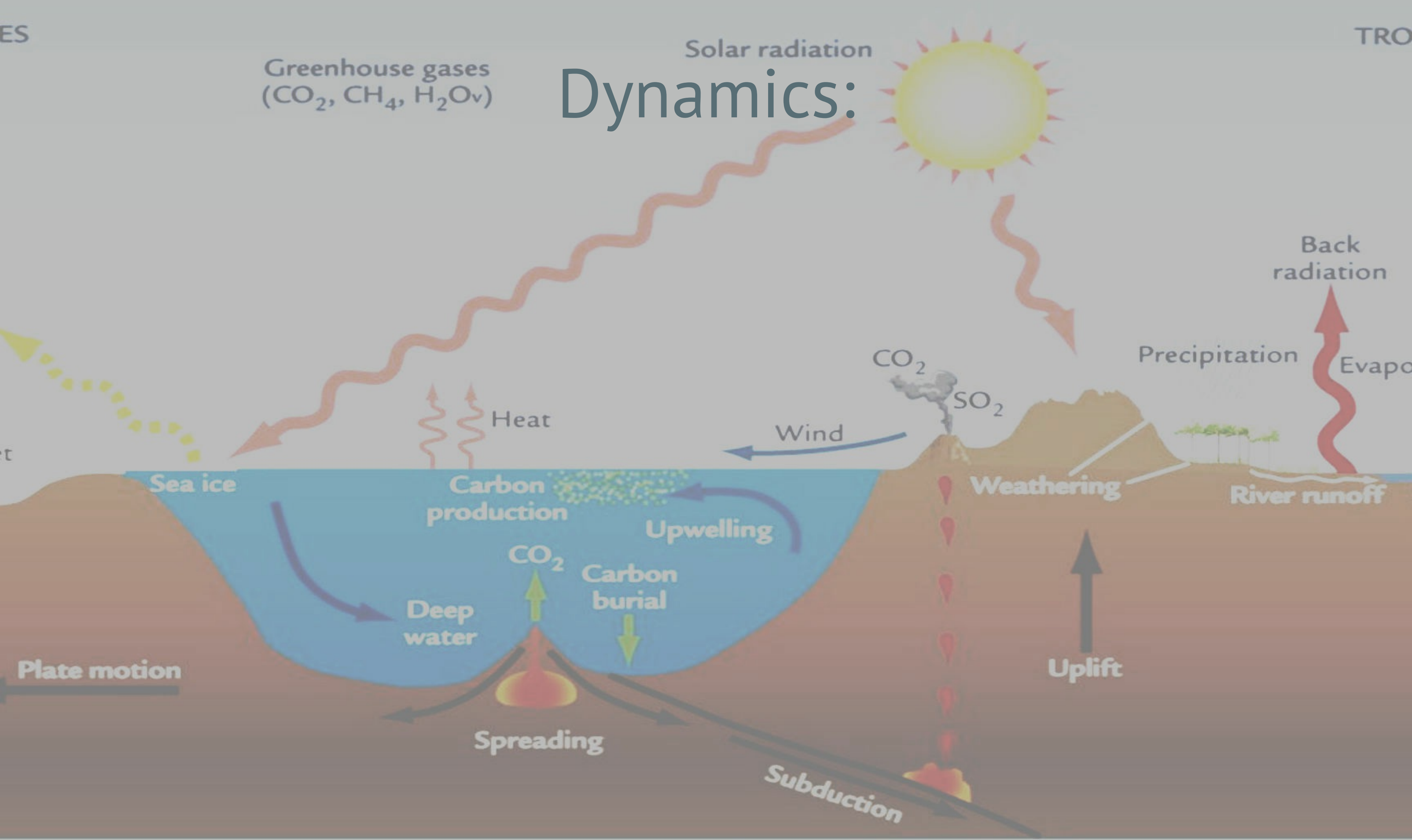
Source: J. Hansen *et al.*, Phil. Trans. Roy. Soc. A **371**, 20120394 (2013).

Temperature and Sea-Level



Key Concepts: Dynamics and Time Scales

Dynamics:



Latitude

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

Ice-Albedo Feedback

Characteristic Time Scales

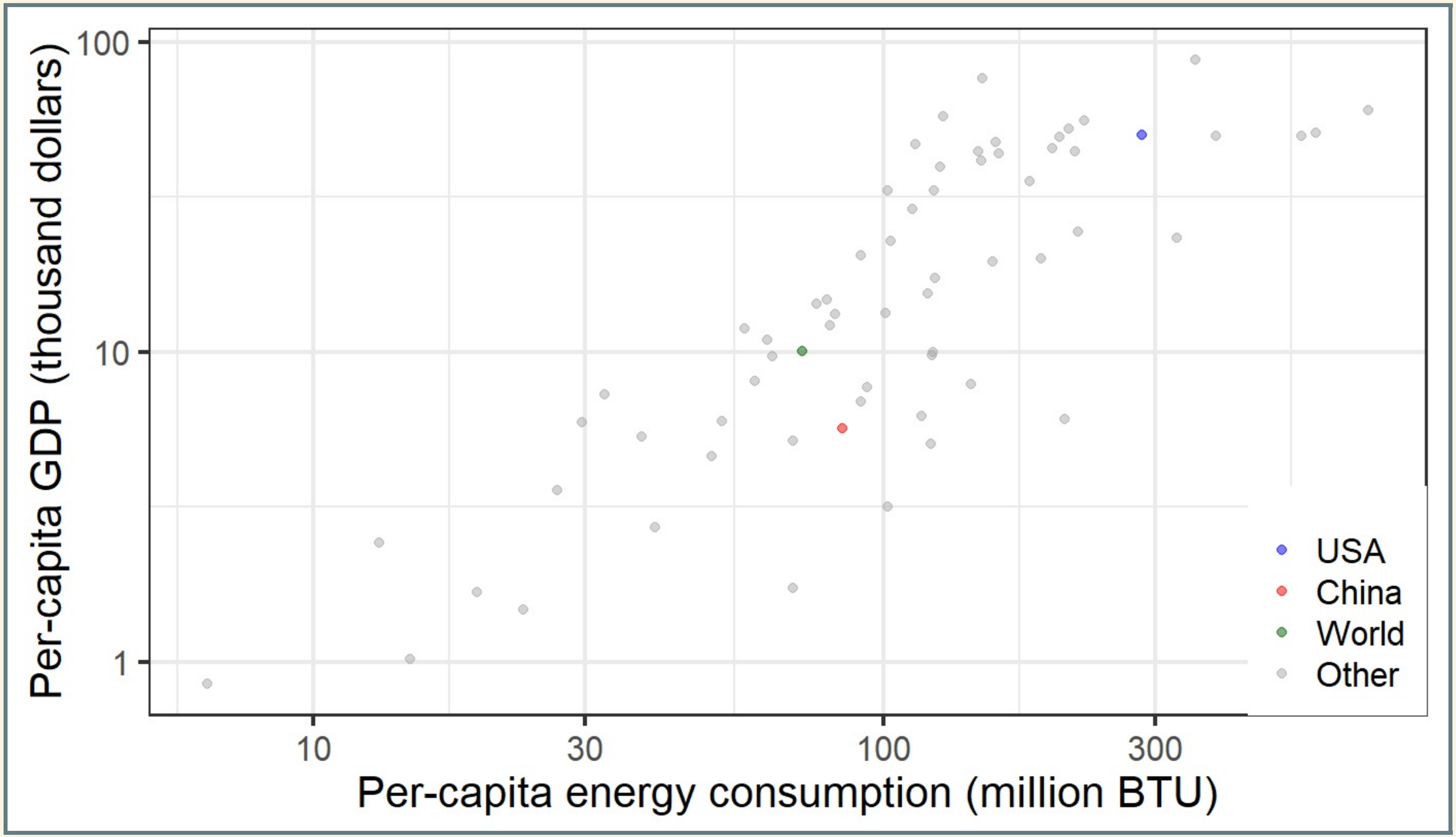
Component	Response Time
Atmopshere	Hours to weeks
Land surface	Hours to months
Ocean surface	Days to months
Vegetation	Hours to decades/centuries
Sea ice	Weeks to years
Mountain glaciers	Decades to centuries
Deep ocean	100–1500 years
Ice sheets	centuries–10,000 years
Carbon dioxide	10s–100s of thousands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

Outline of climate science

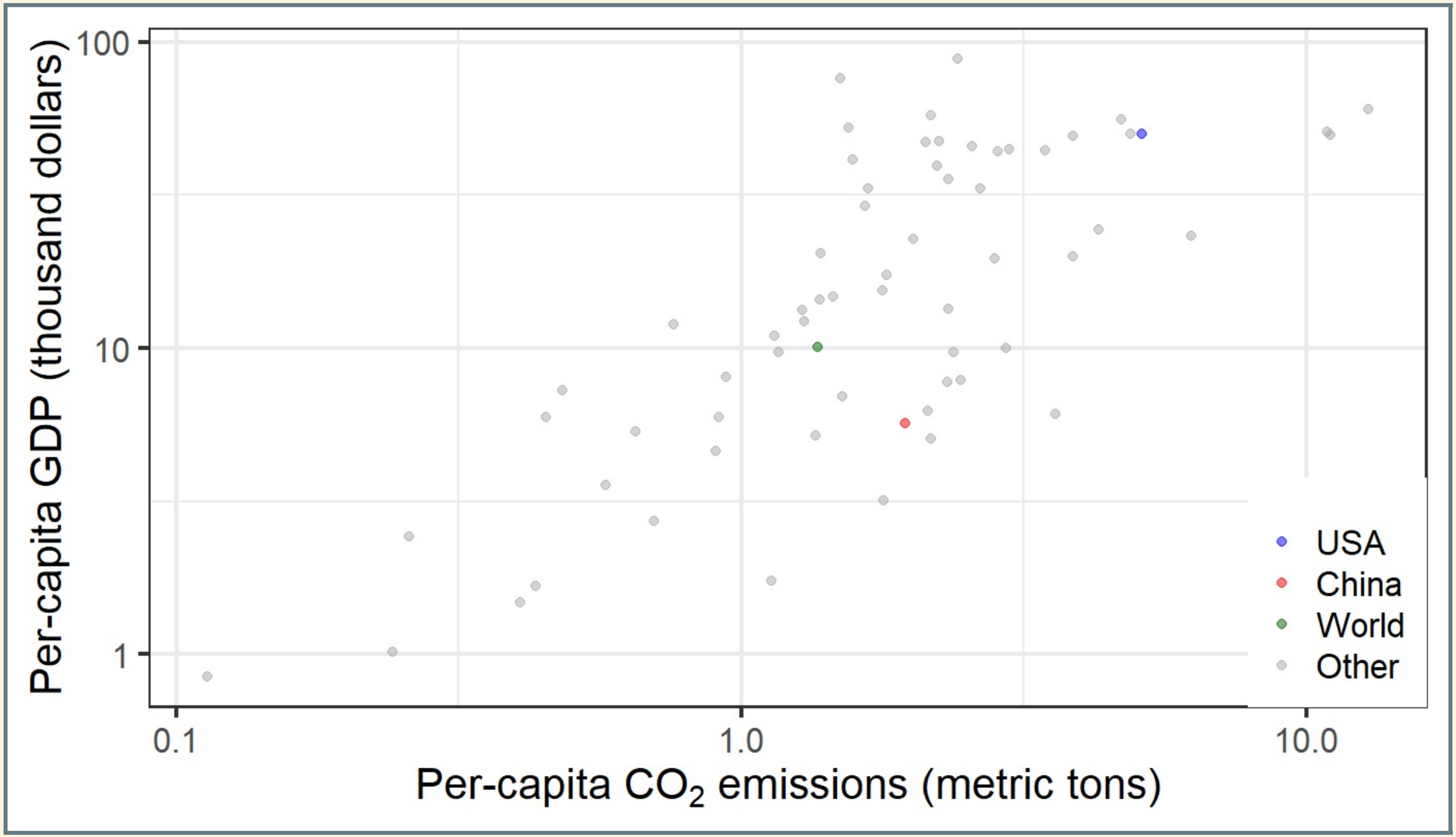
- Earth's Temperature
  - Set by energy balance: $H_{\text{out}} = H_{\text{in}}$.
- Greenhouse Effect:
  - Natural phenomenon (discovered 1827)
  - Due mostly to CO_2, H_2O. (discovered in 1863)
  - Greenhouse gases affect H_{out}
- Global warming from burning fossil fuels
  - Predicted in 1896
  -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

Economy-Energy-Environment

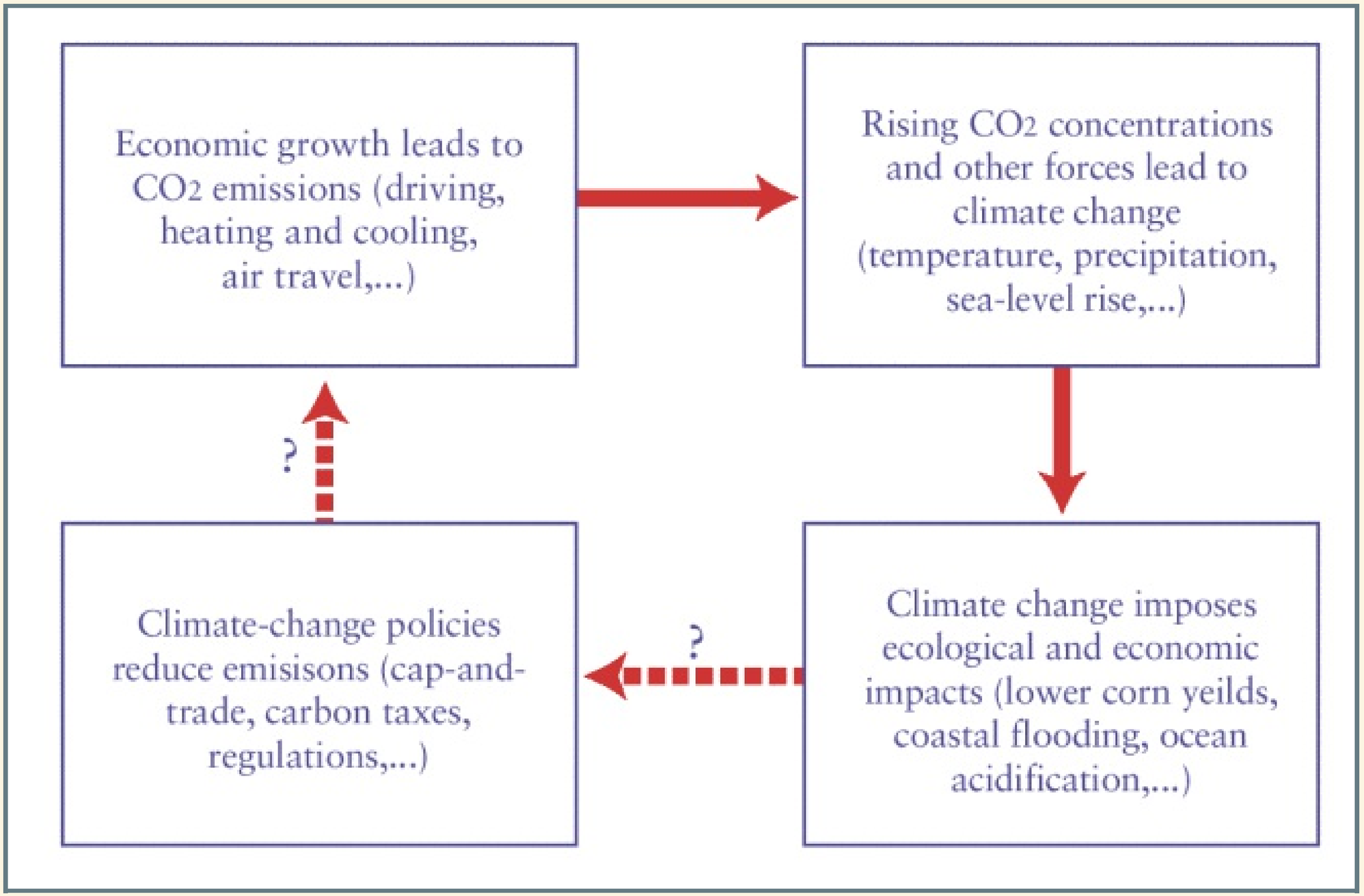
Wealth & Energy Use



Wealth & Emissions



Circular flow: Science, Impacts, Policy



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

Managing Pollution

- Obama's EPA Clean Power regulations (Aug. 2015):
  - Power must plants cut CO_2 emissions 32% by 2030.

What would Nordhaus think?

- Hard targets are bad policy. Why?
- Hard targets do not balance the costs and benefits.

  What if it's really expensive to reduce emissions?
  - Also, free-rider problem from other countries.

But...

- Obama EPA regulations (Aug. 2016):
  - Stricter fuel-efficiency standards for medium- and heavy-duty trucks
  - Expected to cut CO_2 emissions by more than 1 billion tons per year
- What will Trump Administration do?
  - It's gone back and forth
- Is this another bad regulation?
  - Supported by trucking industry
  - Expected to save $170 billion a year in fuel costs.
- Why does government need to pass a regulation if cutting pollution would save money?