

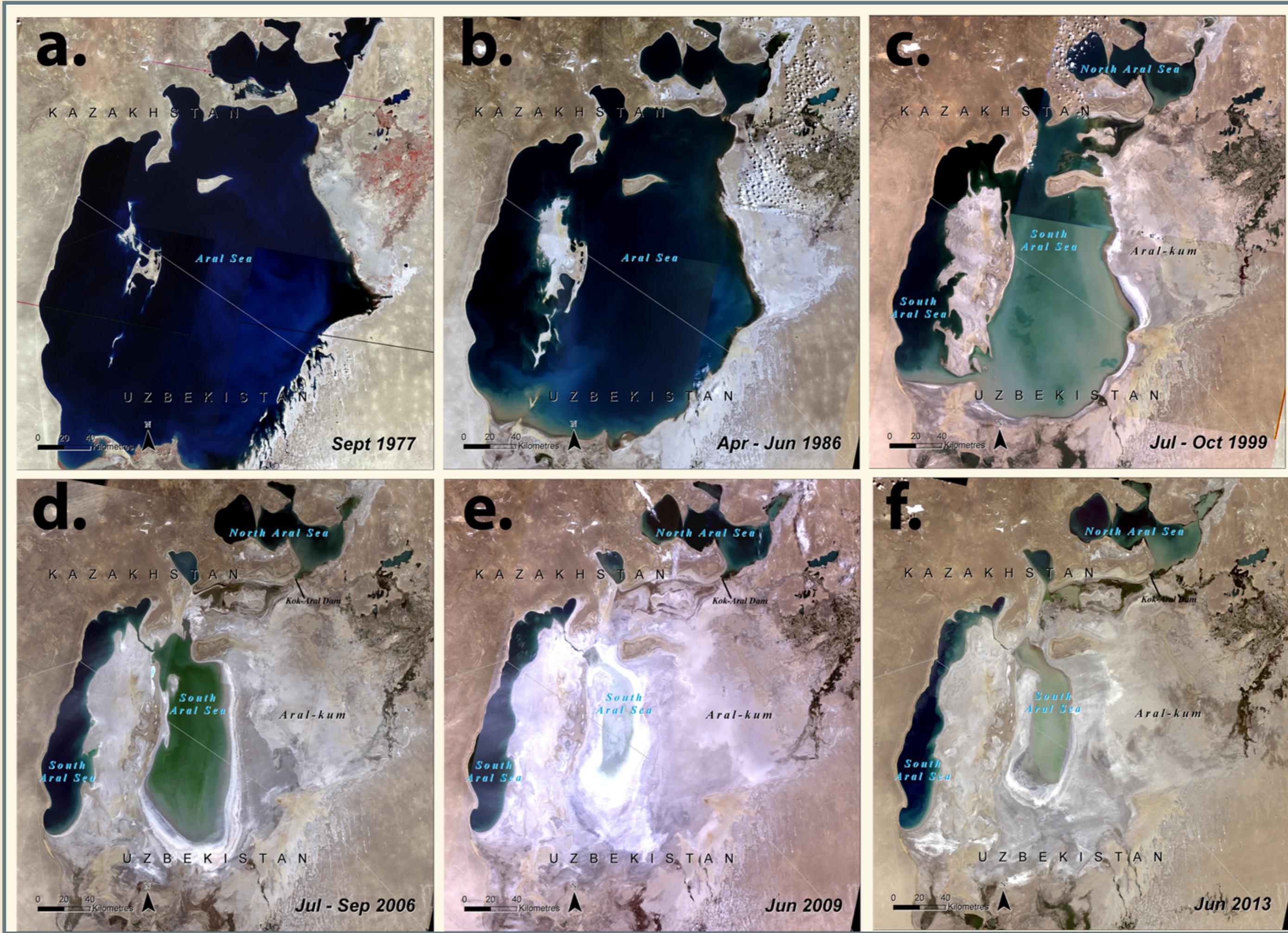
Overview of Climate Science and Policy

EES 3310/5310
Global Climate Change
Jonathan Gilligan
Class #2: Friday, January 21 2022

Housekeeping

- Remember when you email me:
include “EES 3310” or “EES 5310” in your subject line.
- Wednesday evening Zoom office hour
 - Link is posted on Brightspace, under “Office Hours”

Aral Sea



Questions from Reading?

Important Concepts:

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- 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

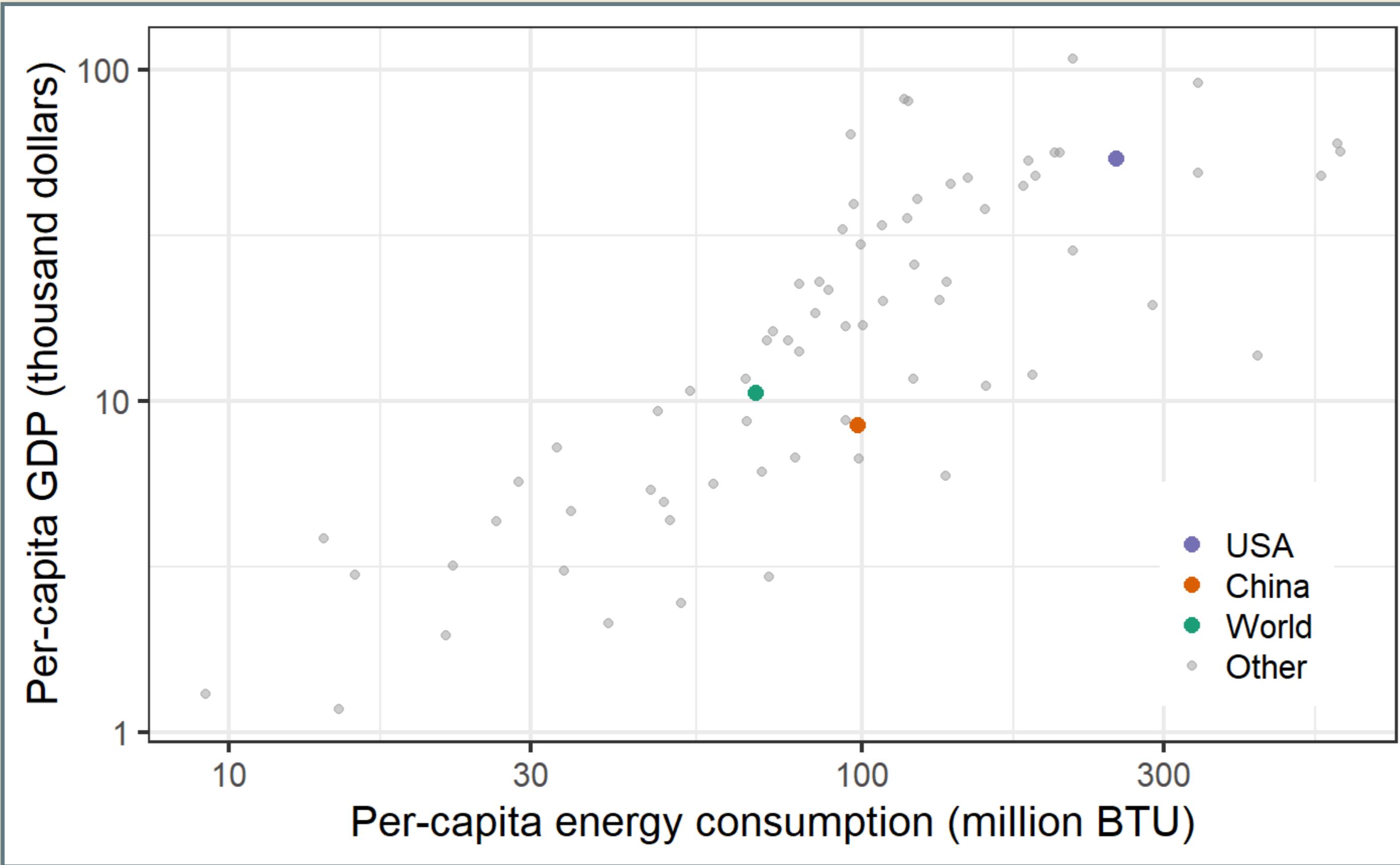
- How much has earth warmed in the last century or so?
 - About 1.1°C (2.0°F)
- If CO_2 emissions keep rising on their current path, how much do scientists expect it to warm in the next century?
 - Somewhere around $2\text{--}5^{\circ}\text{C}$ ($3.5\text{--}9^{\circ}\text{F}$)
- What is the seasonal 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

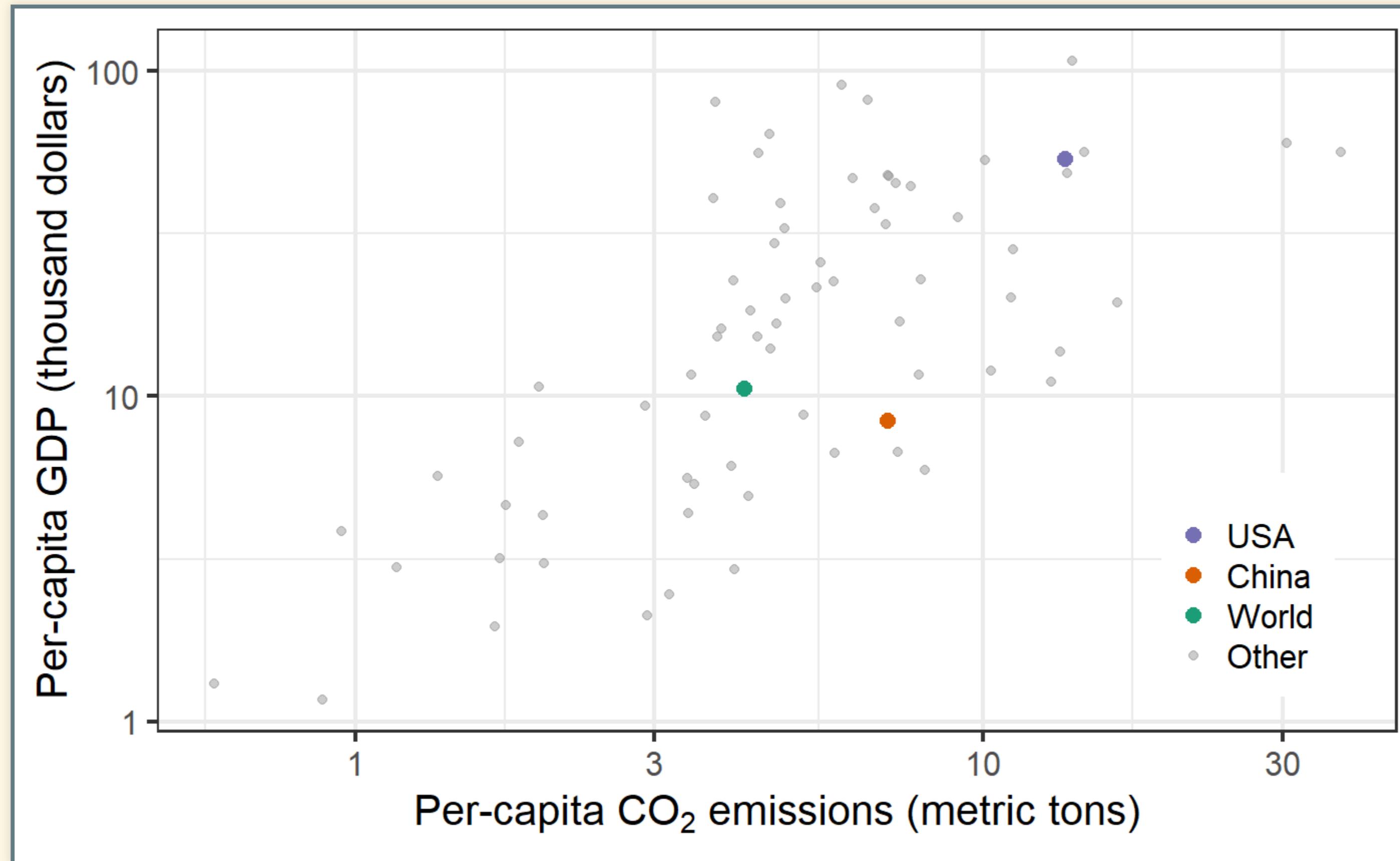
- Meteorologists can't predict whether it will rain three weeks from today with any confidence.
- So how can I trust predictions about the climate 100 years from now?

Economy-Energy-Environment

Wealth & Energy Use



Wealth & CO₂ Emissions



US Emissions

- 4 billion metric tons CO₂ per year total
- 14 metric tons CO₂ per person per year
- 22 pounds carbon per person per day



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



Ronald H. Coase

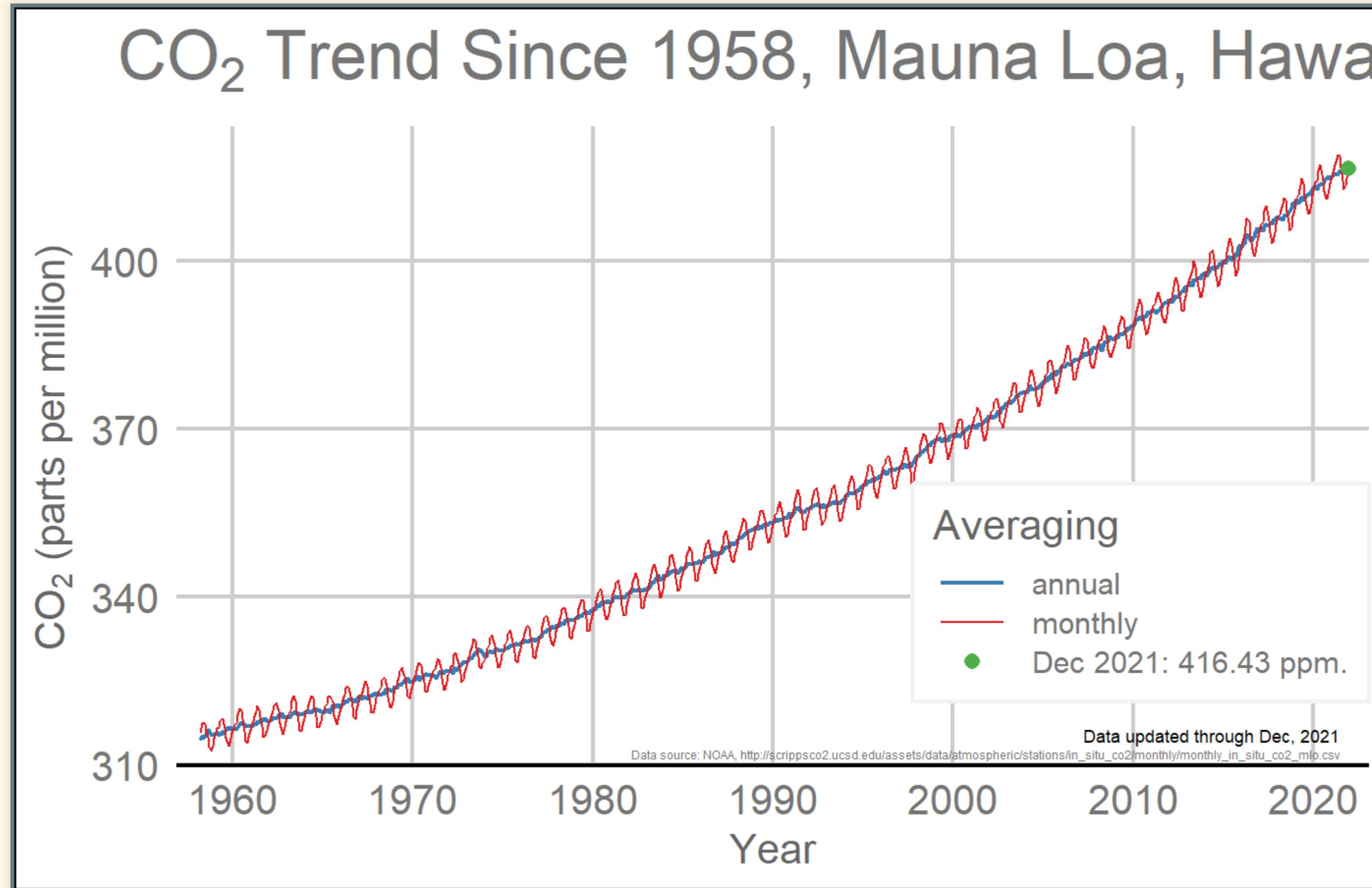
Economics and Vulnerability

Think, Pair, Share (5 minutes)

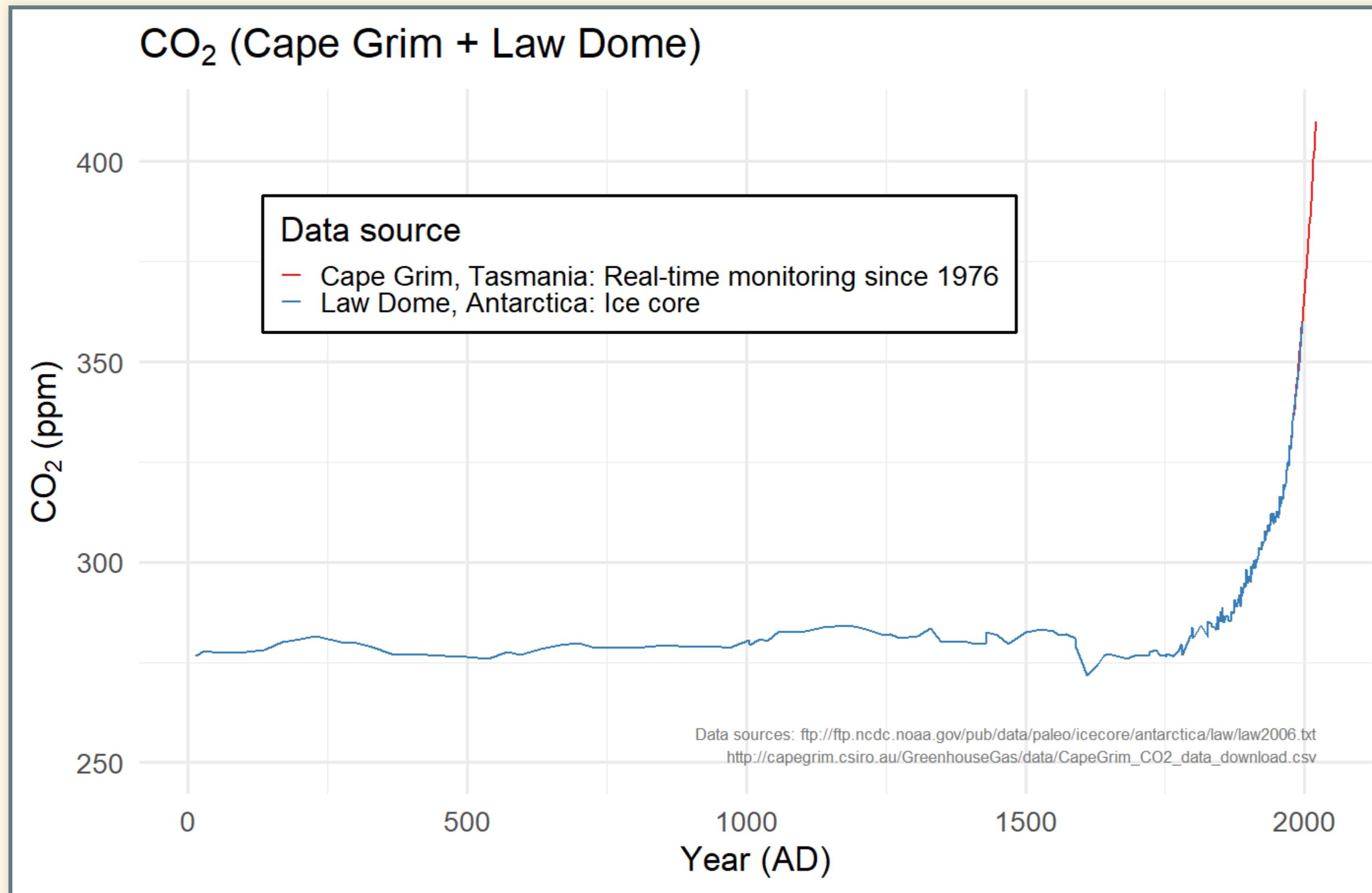
- Can you think of examples of **managed**, **unmanaged**, and **unmanageable** resources?
- How would you respond to climate change differently for the 3 kinds of resources?

Carbon Dioxide and Temperature

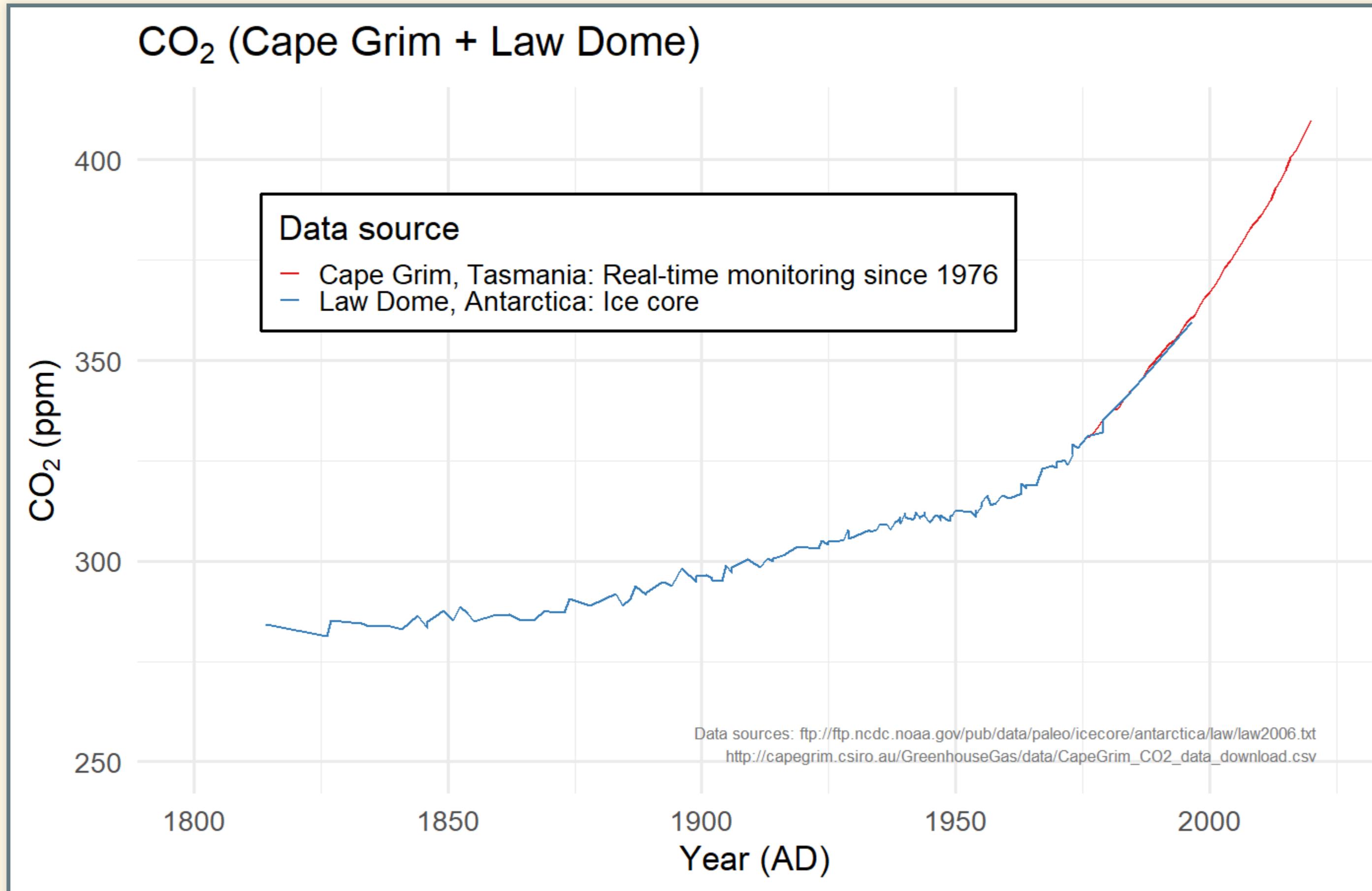
Carbon Dioxide in the Atmosphere



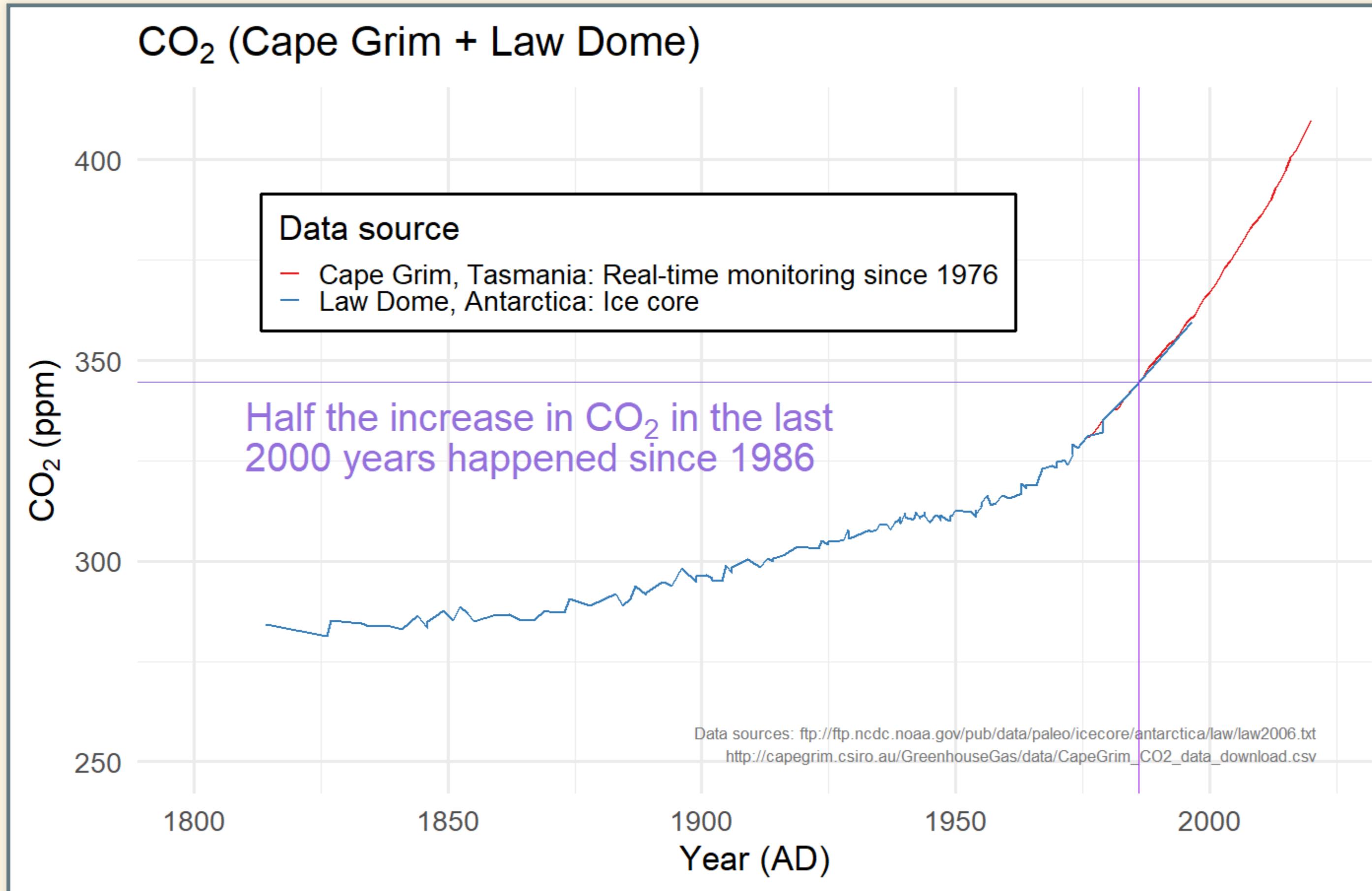
2000 Years of CO₂



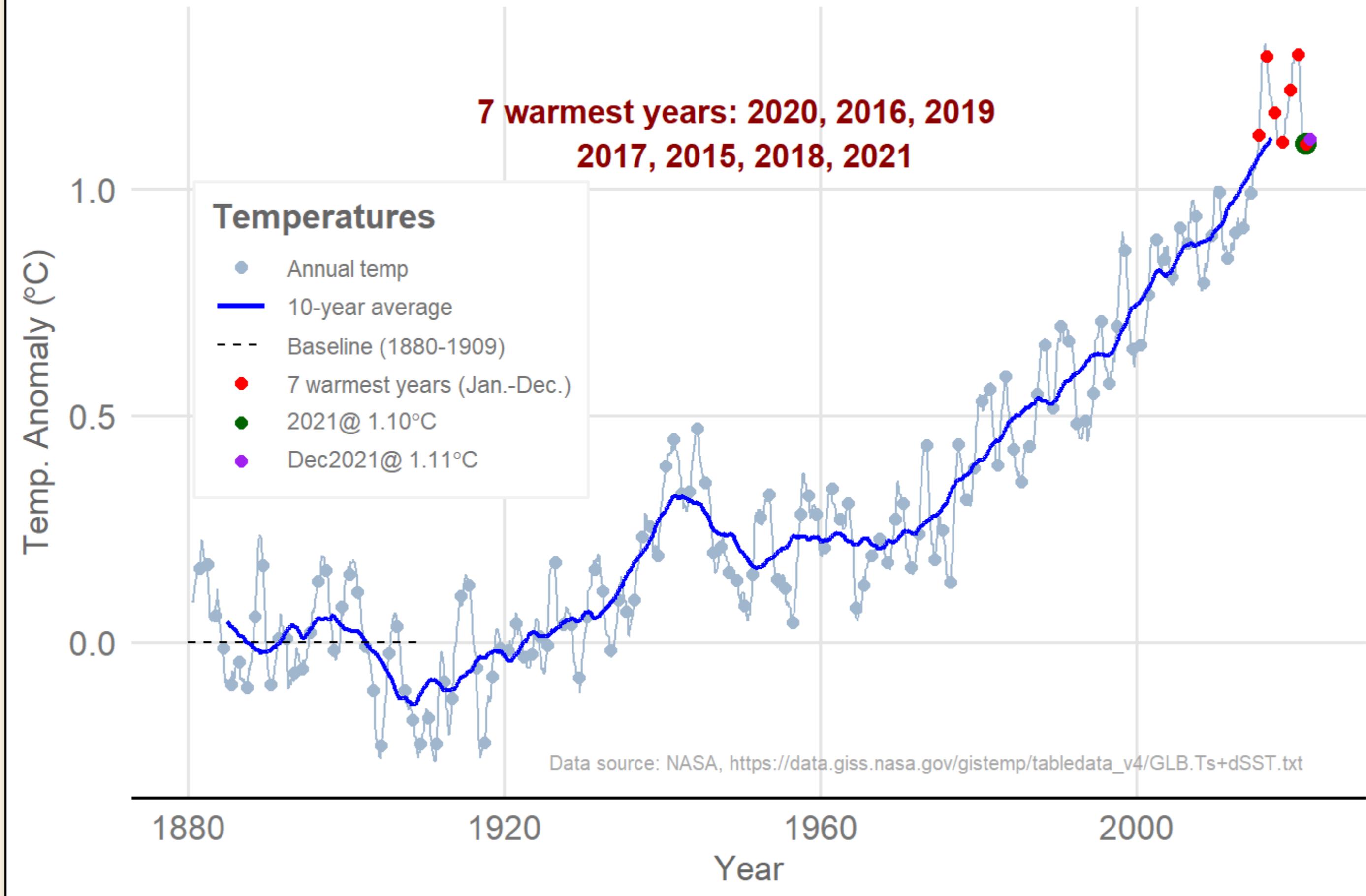
Since 1800...



Since 1800...

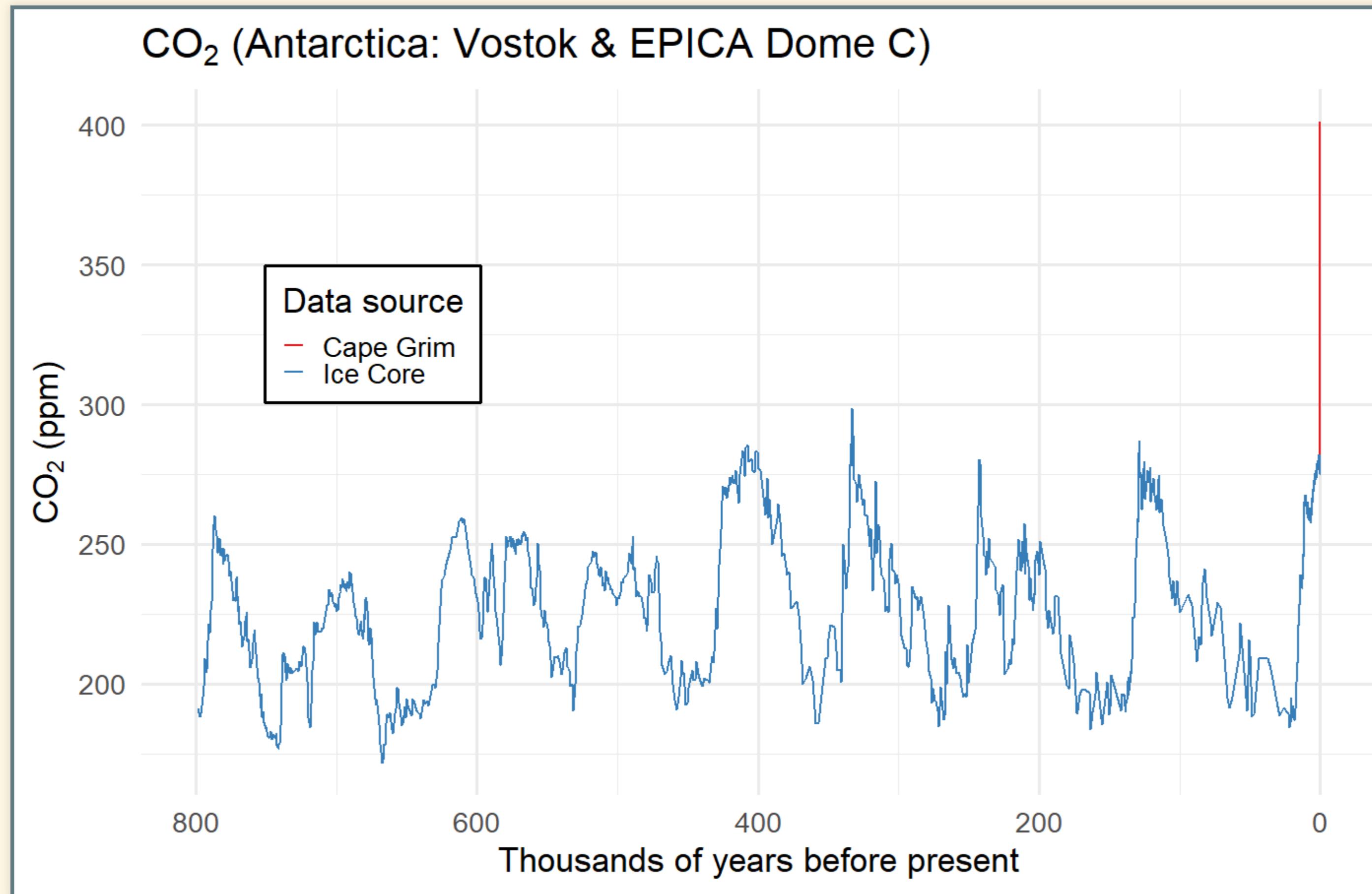


Global Temperature Anomalies (1881 to 2021)

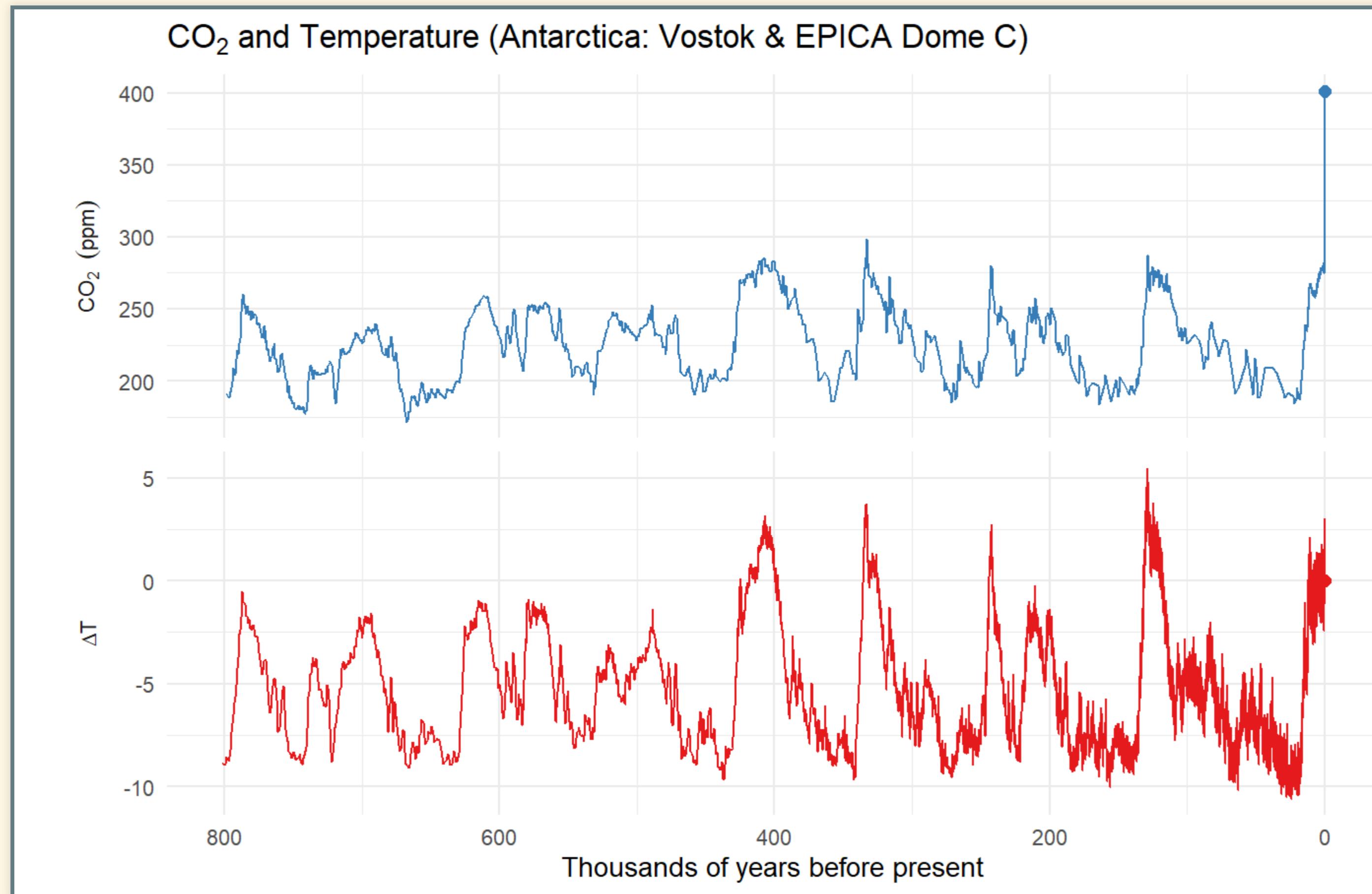


What Earth's History Tells Us

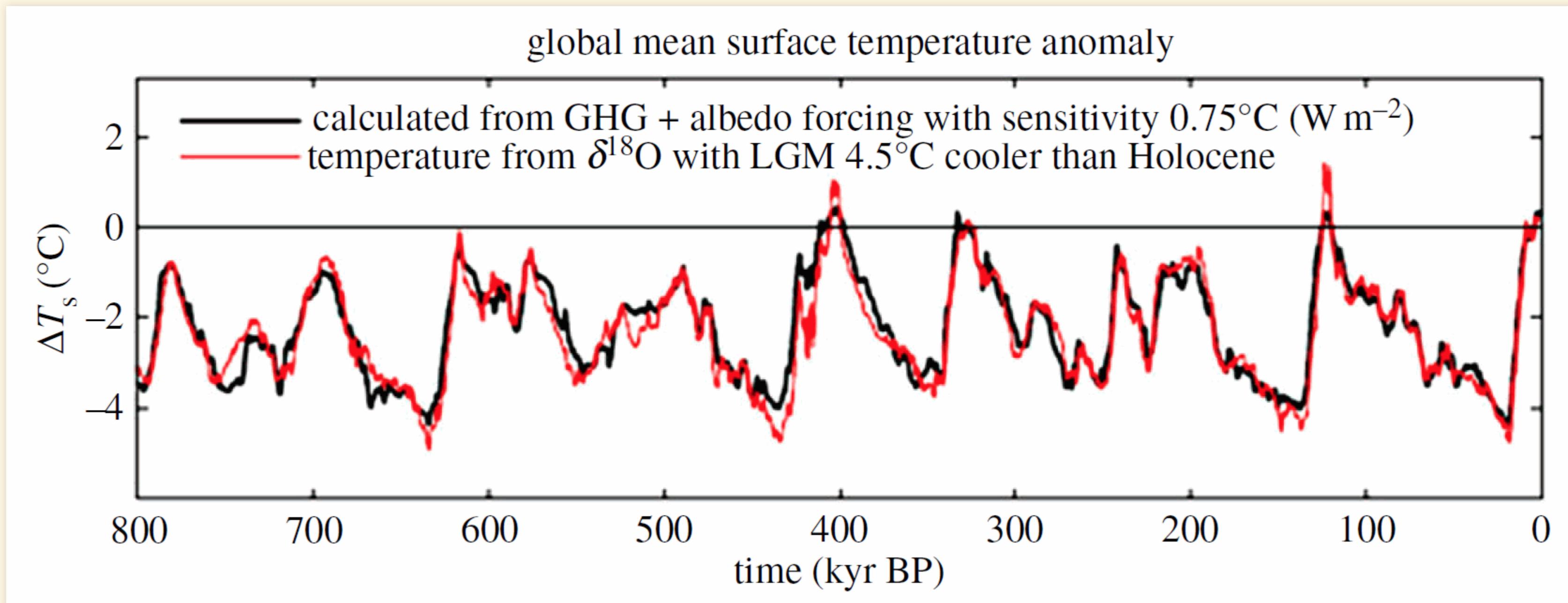
800,000 years of CO₂



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).

Tipping Points

Tipping Points

- Consider a wooden stick
- Bend it a little
 - When you let it go, it springs back to its original shape
- Bend it too far
 - It snaps
 - When you let it go, it does not return to its original shape

Amplification of Climate Change



Climate Tipping Points

- Unknown, uncertain, but dangerous
- We may have crossed a tipping point in sea-level rise
 - West Antarctic ice sheet may be past saving
- Less likely:
 - Runaway warming
 - Temperature rises
 - Biomass in Arctic tundra thaws and decays
 - Releases methane & CO₂
 - Further warming
- Climate tipping points:
 - We don't know if they exist
 - We don't know where they are
 - How do we make policy for those risks?