Introduction to Climate Change

EES 3310/5310

Global Climate Change

Jonathan Gilligan

Class #1: Wed. Aug. 22 2018

Questionnaire

- Please fill out the questionnaire and return it to me.
  - Page 1: About you
  - Page 2: About this course

Some Housekeeping:

- The main class website is at https://ees3310.jgilligan.org
- Copies of the
  - syllabus,
  - reading assignments,
  - lab assignments,
  - slides from class (also link from QR code on title slide)
- Next week
  - I will be out of town Monday and Wednesday
  - Kelsea Best, our graduate teaching assistant will lead the classes and the Monday laboratory.
  - Before lab on Monday, sign up for a free account on GitHub https://github.com, and then register as a student at https://education.github.com/students
  - I will be back for class on Friday and through the rest of the semester.

Is the Climate Changing?

Is the Climate Changing?

- What does it mean for climate to change?
- How would you know whether it’s changing?

Are People Causing Climate to Change?

- How can we tell?
- How certain can we be?

How Will Climate Change Affect Our Lives in Years to Come?

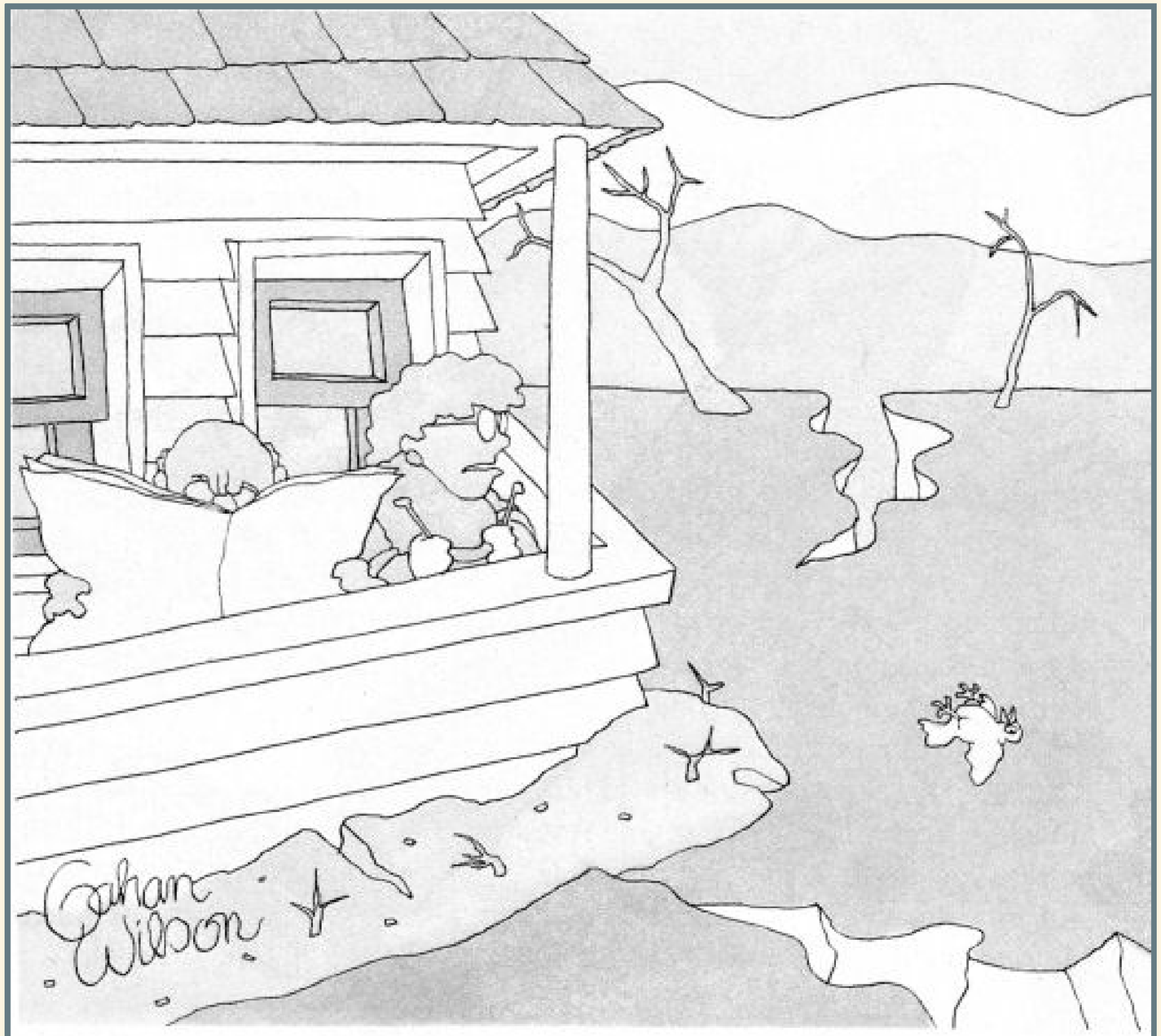
- What kinds of changes might affect us?
- How can we tell whether they will happen?
  - And when?
  - And how severely?

What Does Science Say?

How Can We Answer These Questions?

- How can you know whether climate is changing?
- How can you know what's causing it?
- How can you know what it will do in the future?

- How can you persuade someone else?
- What would you need to know to be more certain?
- If it is a problem …
  - What can we do about it?
  - What should we do about it?



"It's a pity those awful people were right about the environment."

Nuts and Bolts about the Course

Goals for the Course

- Scientific Understanding:
  - What do we know about climate?
  - How do we know it?
  - How certain are we?
- Applied to:
  - Past climate conditions
  - Causes of climatic change
  - Predictions of future climate change
  - Impact of climate on people’s lives

Structure of the Course

- Science
  - What determines the earth's temperature?
  - What are people doing that might change this?
  - What do we observe?
  - How will things change in the future?
- Policy:
  - How will these changes affect people's lives?
  - What can we do?
  - **How much will it cost?**
  - What actions will others agree to?

Overview of the Semester

Syllabus and Planning for the Semester:

Important Dates:

- Wed. Oct. 3: Midterm Exam
- Mon. Nov. 5: Role-Playing Exercise on Cap-and-Trade in Lab
- Take-Home Final Exam:
  - Open book, essay format.
  - Focus on applying big concepts.
  - Due Wed. Dec. 13. (turn in electronically)

Laboratory

- Goals:
  - Work with interactive computer models
  - Download and analyze climate data
  - Learn about **reproducible research**
- Computational Tools:
  - Free, open source
  - R and RStudio for data analysis
  - Markdown and RMarkdown for writing reports
  - git and Github for managing files
- For Monday:
  - Sign up for free account on github.com
  - Read introductory documentation for lab tools
  - Don’t worry if you don’t understand all the details.
    - We will go over it in Lab

Class and Lab Material

- Main source of material: ees3310.jgilligan.org
  - Syllabus
  - Reading assignments for the semester
    - Do the assigned reading **before** class on the day it's assigned for.
    - Reading for Lab on Monday
- Slides from class:
  - Web-based and PDF versions
  - Posted on ees3310.jgilligan.org

Science, Policy, and Climate

Science of Climate

- What determines earth's temperature?
  - Sunlight
  - Greenhouse effect
  - Other factors
- Chemistry of the atmosphere:
  - What are greenhouse gases?
  - What happens when people release them into the atmosphere?
- Consequences of climate change

Climate Policy

- What are consequences of climate change?
  - What alternatives to fossil fuels?
  - What would they cost?
- How to transition to low-carbon energy?
- Who should pay?
- How to build political agreement?

How Politicians Talk about Climate Change

Stereotype of Democrats

Video of Hillary Clinton in 2016, saying, “We’re going to put a lot of coal miners and coal companies out of business”

Stereotype of Republicans

Video of Marsha Blackburn in 2016, saying, “The earth is no longer warming, and has not for the past 13 years. It has begun to cool.”

It Wasn’t Always Like This

Video of many Republicans, including Newt Gingrich, Rudy Giuliani, Mitt Romney, and John McCain, saying that global warming is real and is a serious problem that we need to address.

It Wasn’t Always Like This

Video of Chris Christie saying that when more than 90% of the scientists say global warming is real, we should listen to the experts.

It Wasn’t Always Like This

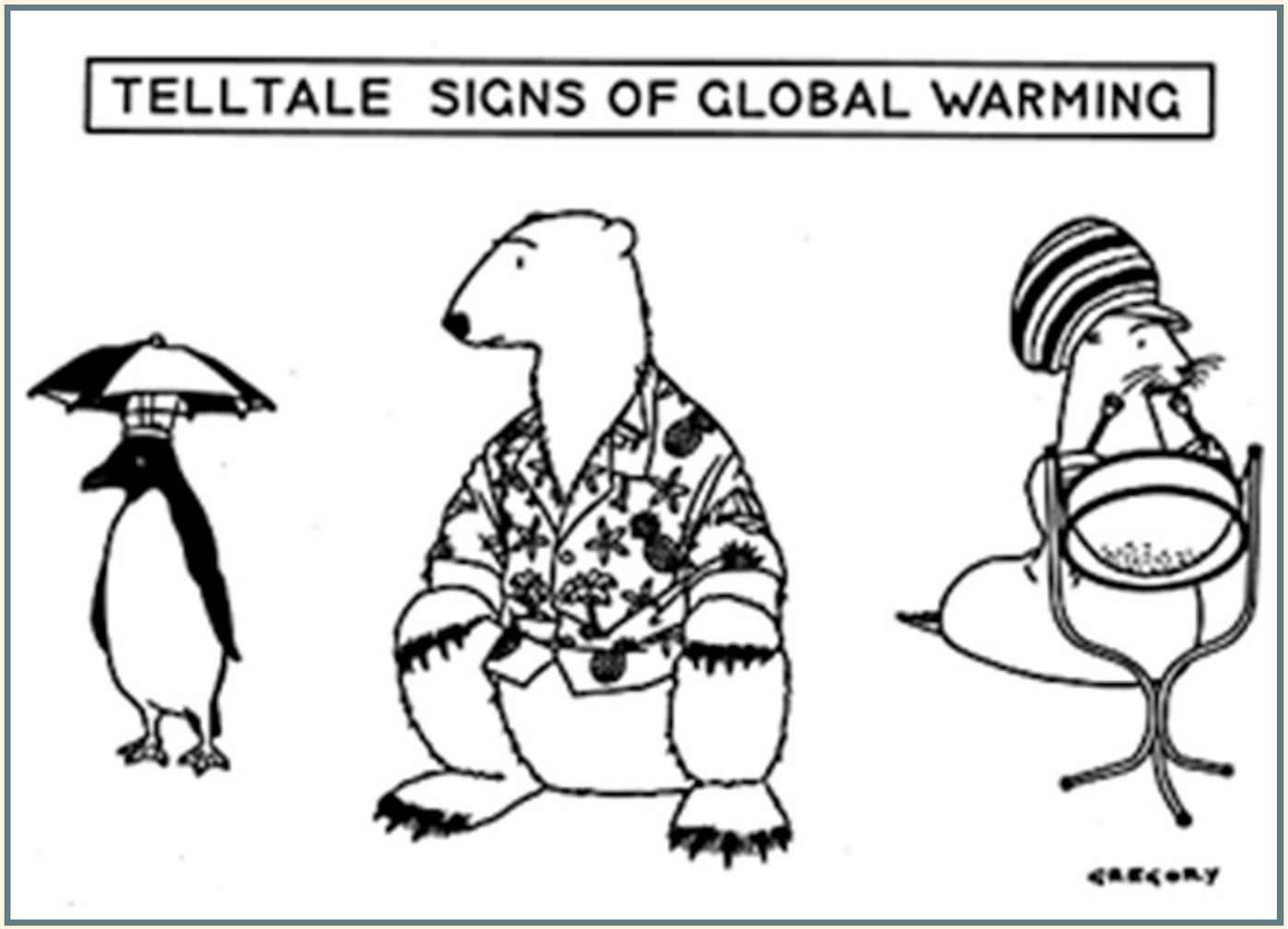
A John McCain campaign ad from 2008, saying that global warming is real, caused by people, and is a threat to national security, and calling for cap-and-trade regulations.

Today's GOP Climate Activists

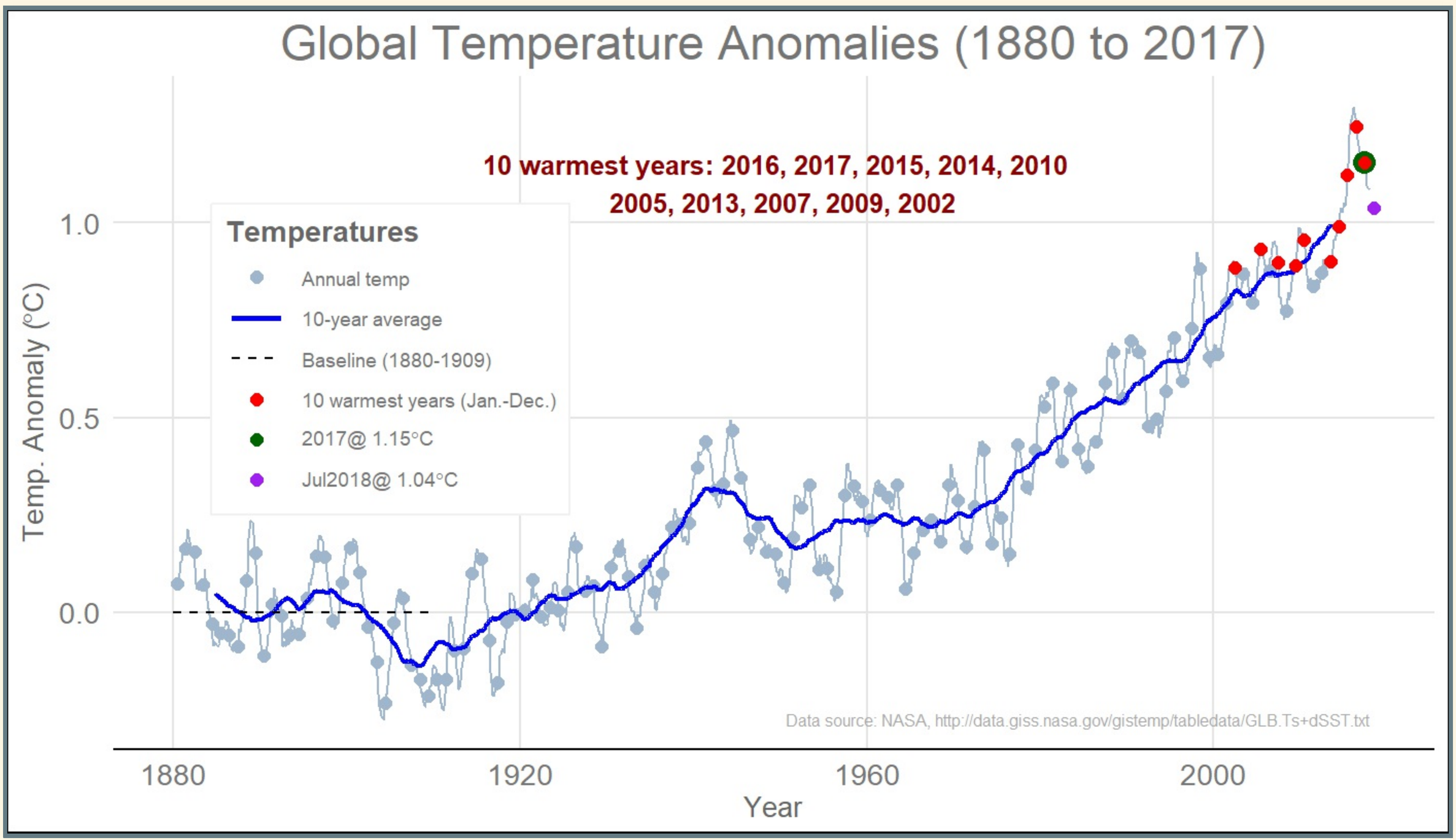
- Arthur Laffer (Economic Adviser to President Reagan)
- Bob Inglis (Former Republican Congressman from South Carolina)

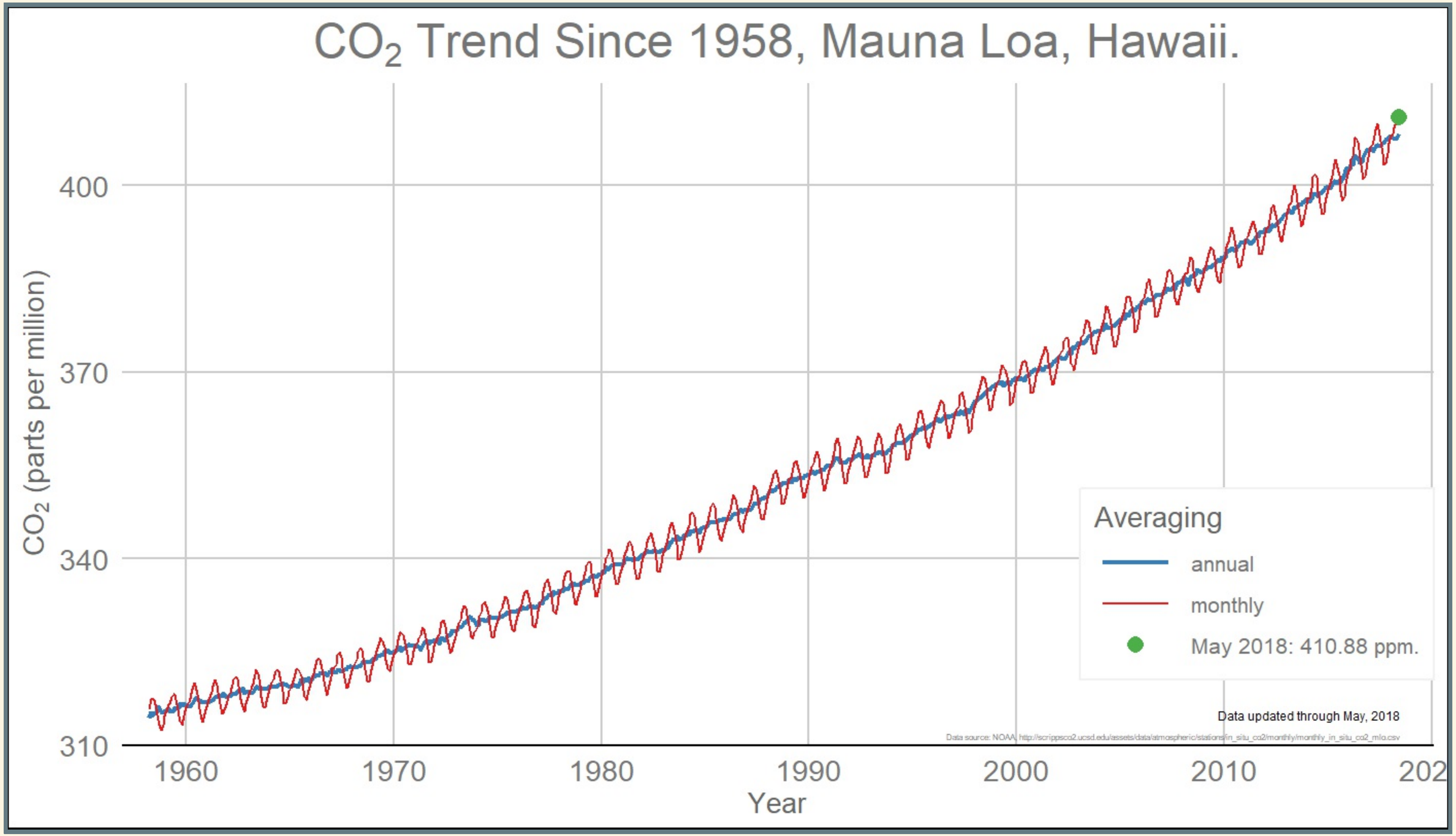
Video of Arthur Laffer and Bob Inglis saying that putting a tax on carbon emissions would be a good conservative way to deal with global warming without hurting the economy.

What's Happening?

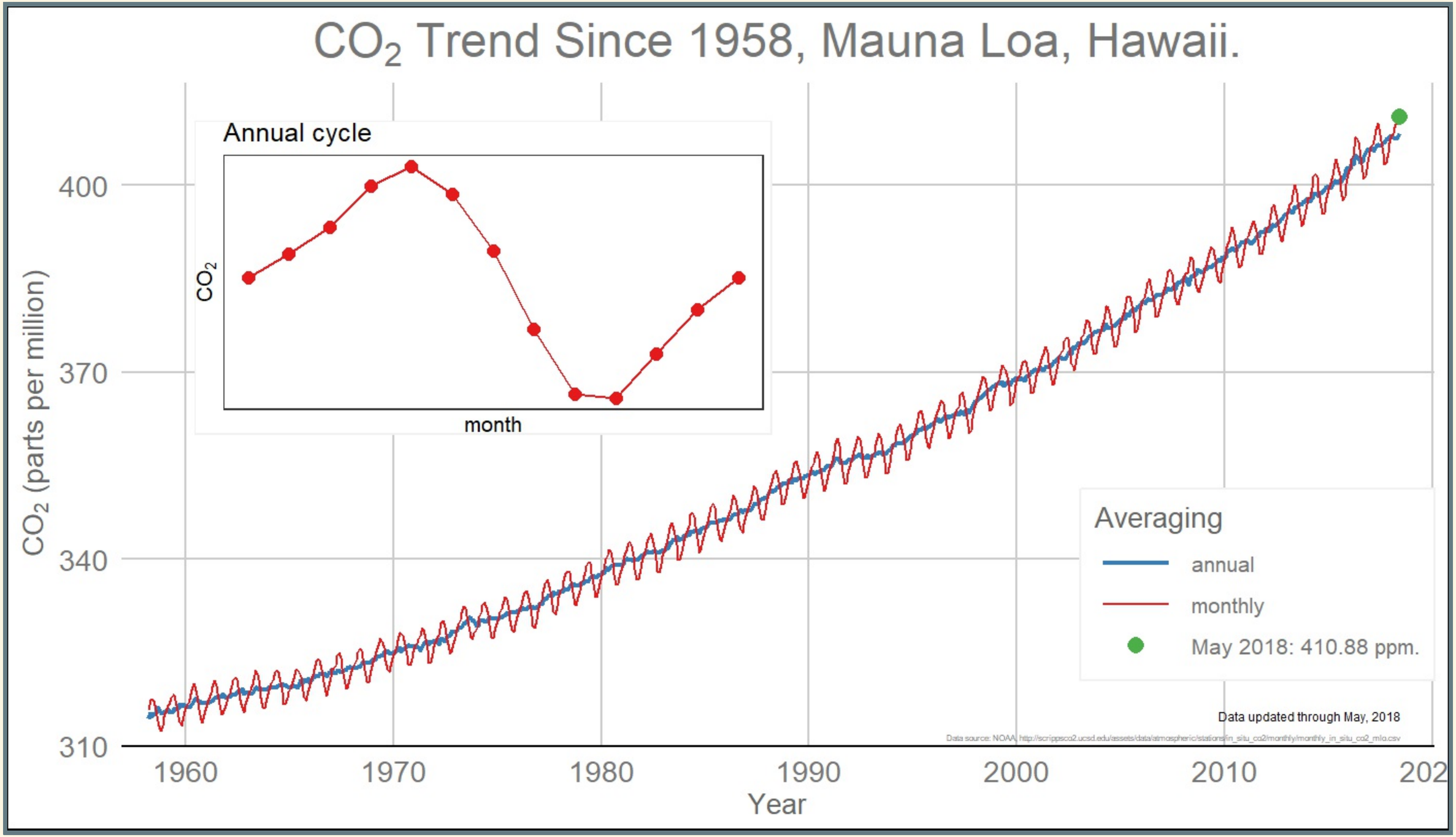


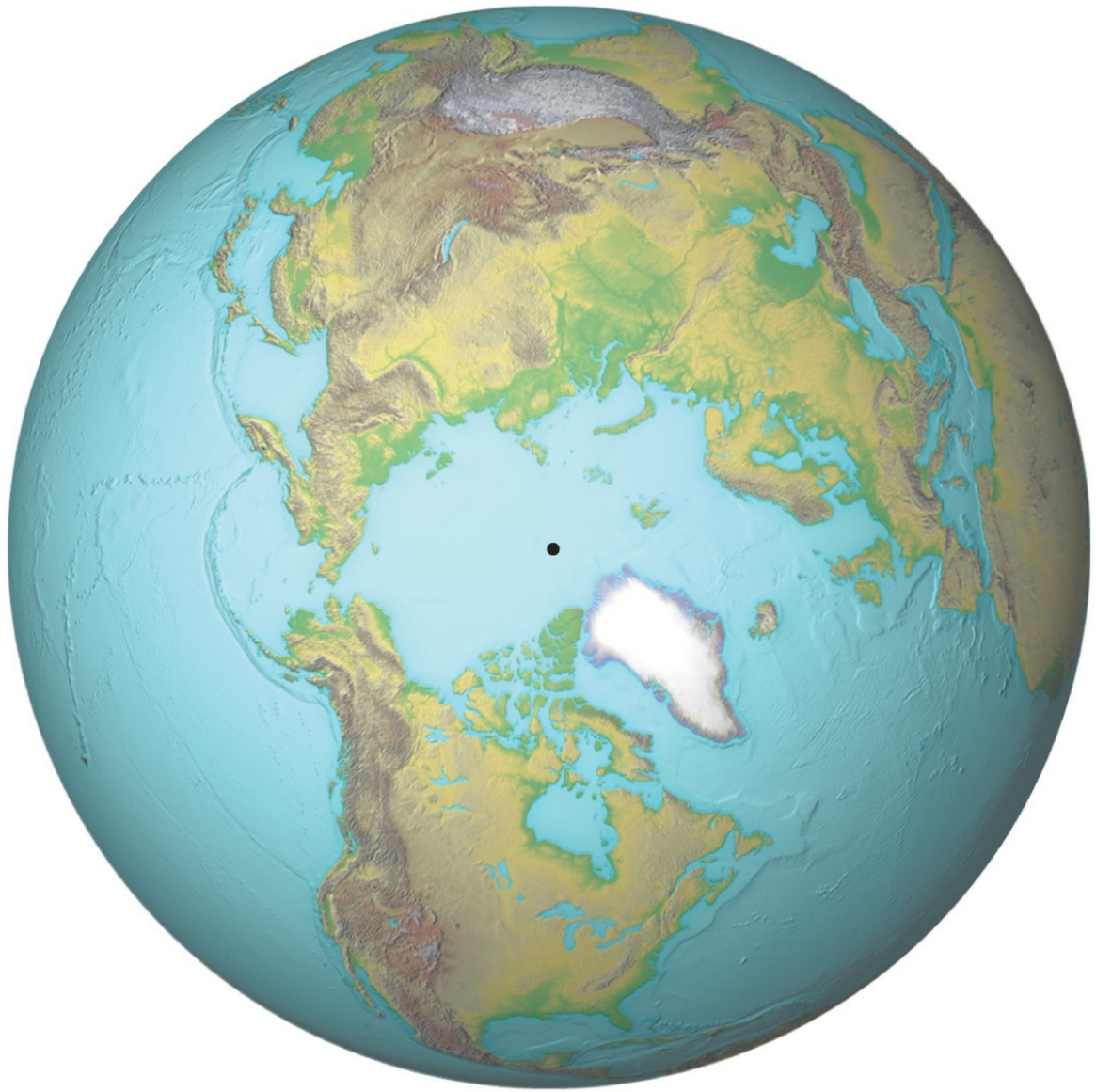
Global Temperature Anomalies (1880 to 2017)

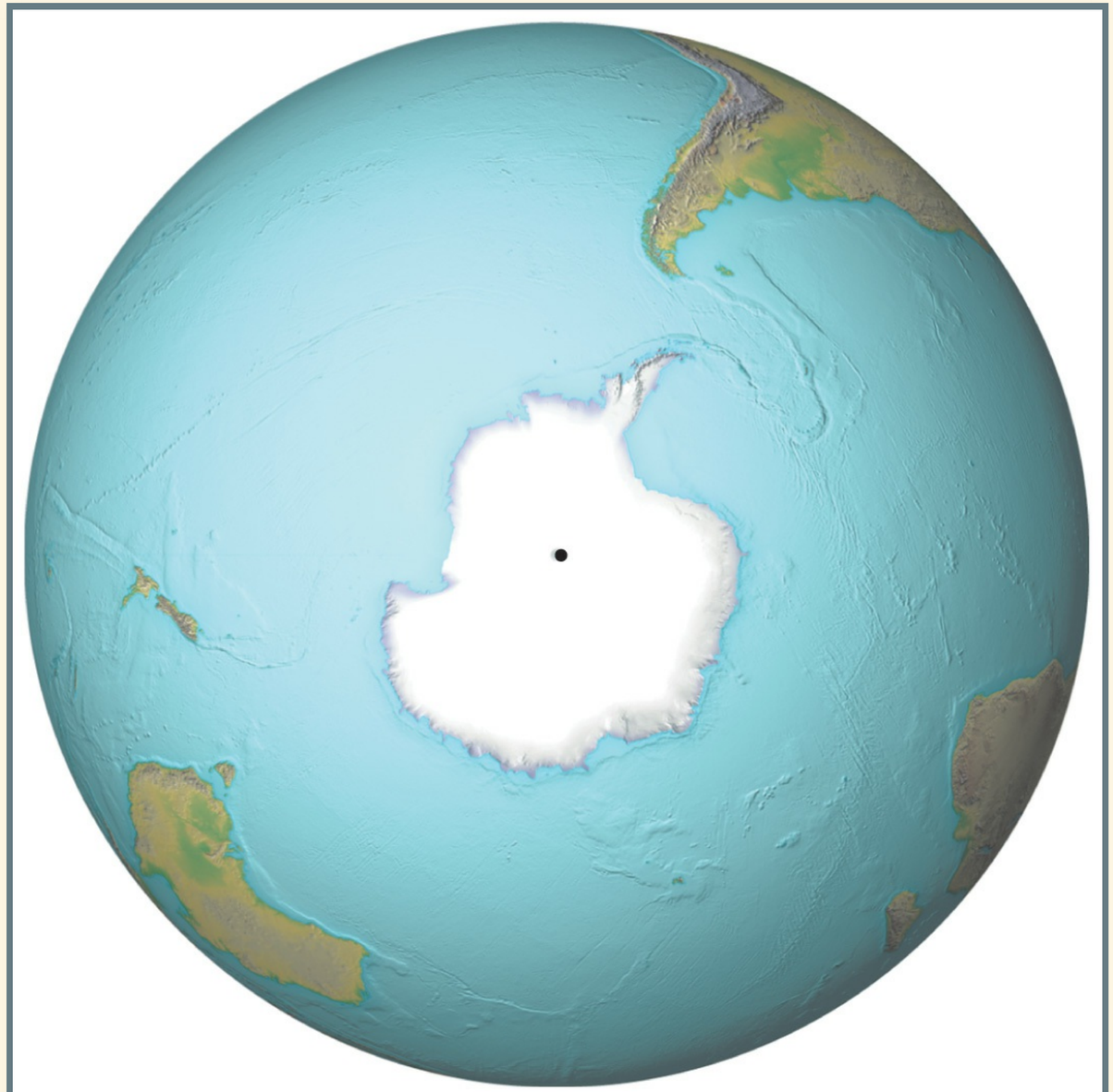



CO_2 Trend Since 1958, Mauna Loa, Hawaii.
400
370
340
310
CO_2 (parts per million)
1960
1970
1980
1990
2000
2010
202
Year
Averaging
annual
monthly
May 2018: 410.88 ppm.
Data updated through May, 2018
Data source: NOAA, http://scrippsco2.ucsd.edu/assets/data/atmospheric/stations/in_situ_co2/monthly/monthly_in_situ_co2_mlo.csv

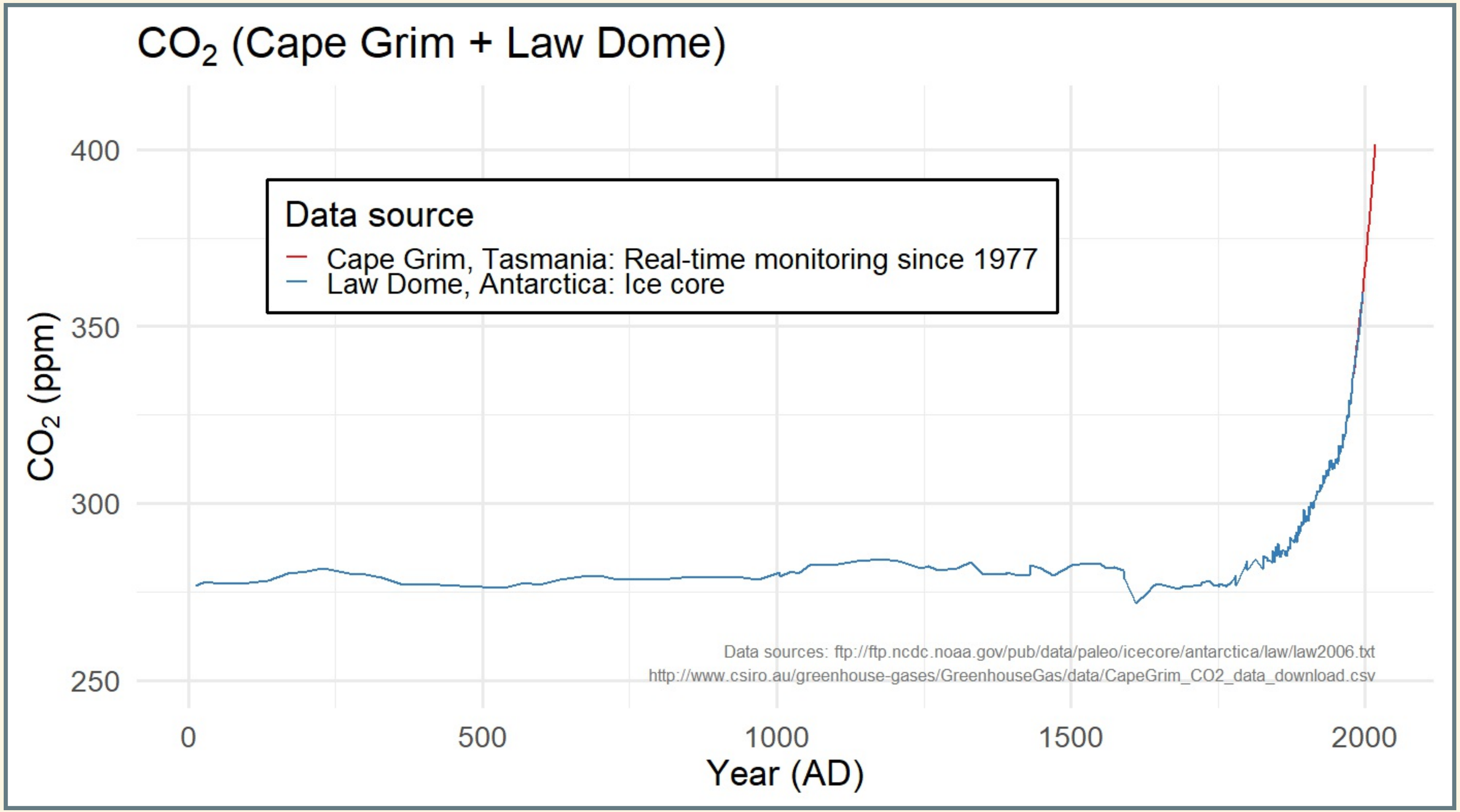
CO_2 Trend Since 1958, Mauna Loa, Hawaii.



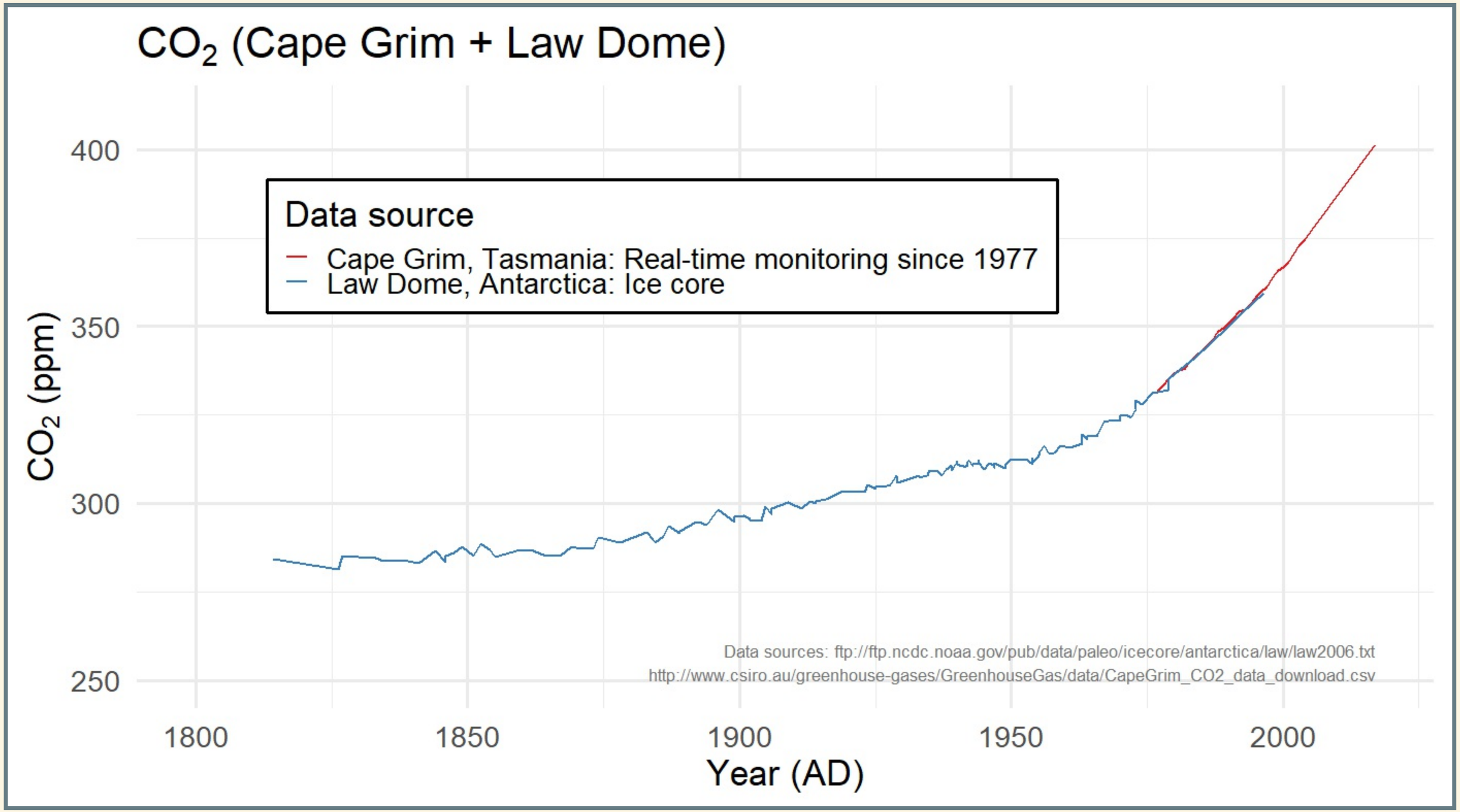




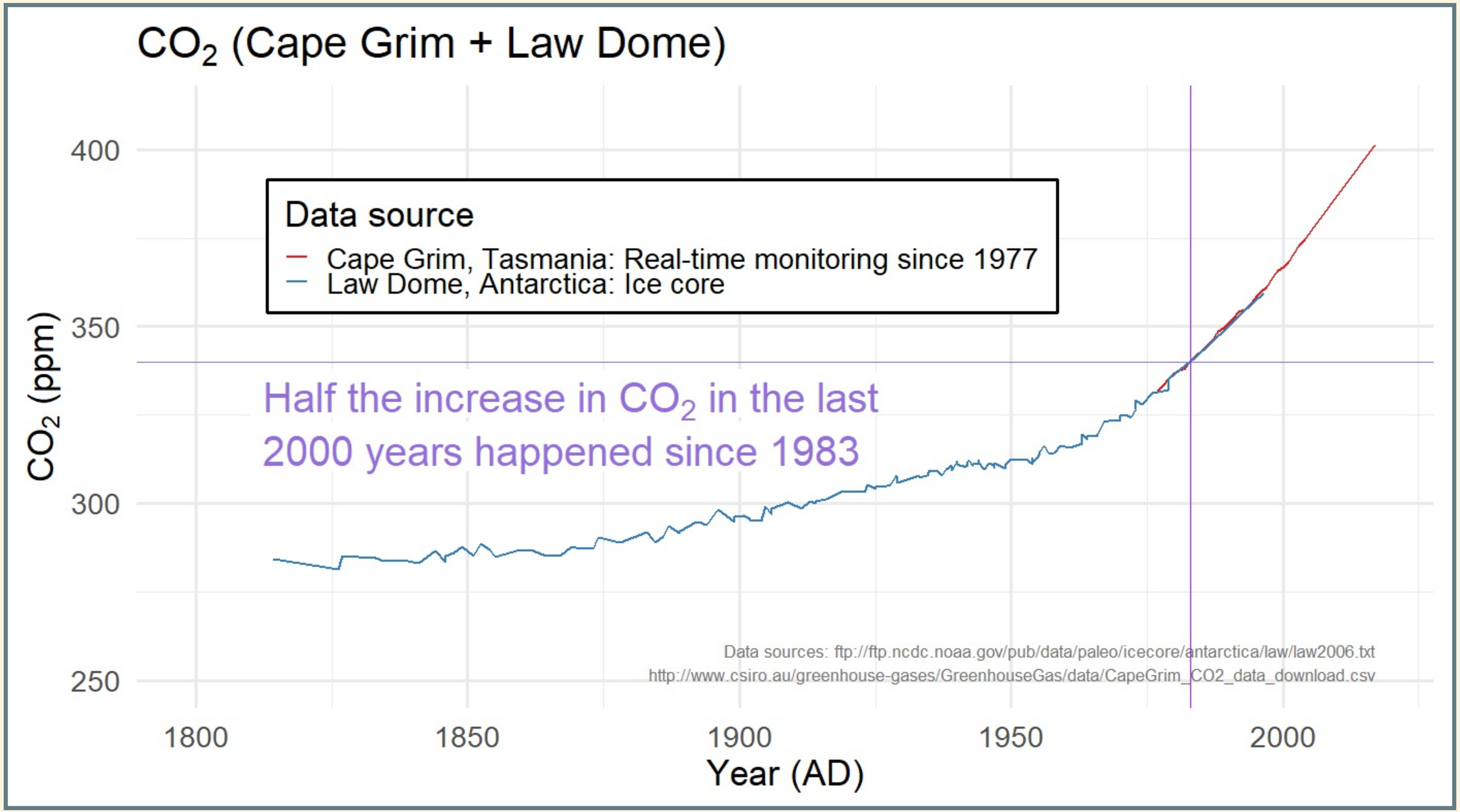
Past 2000 Years



Since 1800…


CO_2 (Cape Grim + Law Dome)
Data source
Cape Grim, Tasmania: Real-time monitoring since 1977
Law Dome, Antarctica: Ice core
400
350
300
250
CO_2 (ppm)
1800
1850
1900
1950
2000
Year (AD)
Data sources: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/law/law2006.txt
http://www.csiro.au/greenhouse-gases/GreenhouseGas/data/CapeGrim_CO2_data_download.csv

Since 1800…


CO_2 (Cape Grim + Law Dome)
Data source
Cape Grim, Tasmania: Real-time monitoring since 1977
Law Dome, Antarctica: Ice core
Half the increase in CO_2 in the last 2000 years happened since 1983
Data sources: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/law/law2006.txt
http://www.csiro.au/greenhouse-gases/GreenhouseGas/data/CapeGrim_CO2_data_download.csv
CO_2 (ppm)
400
350
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250
1800
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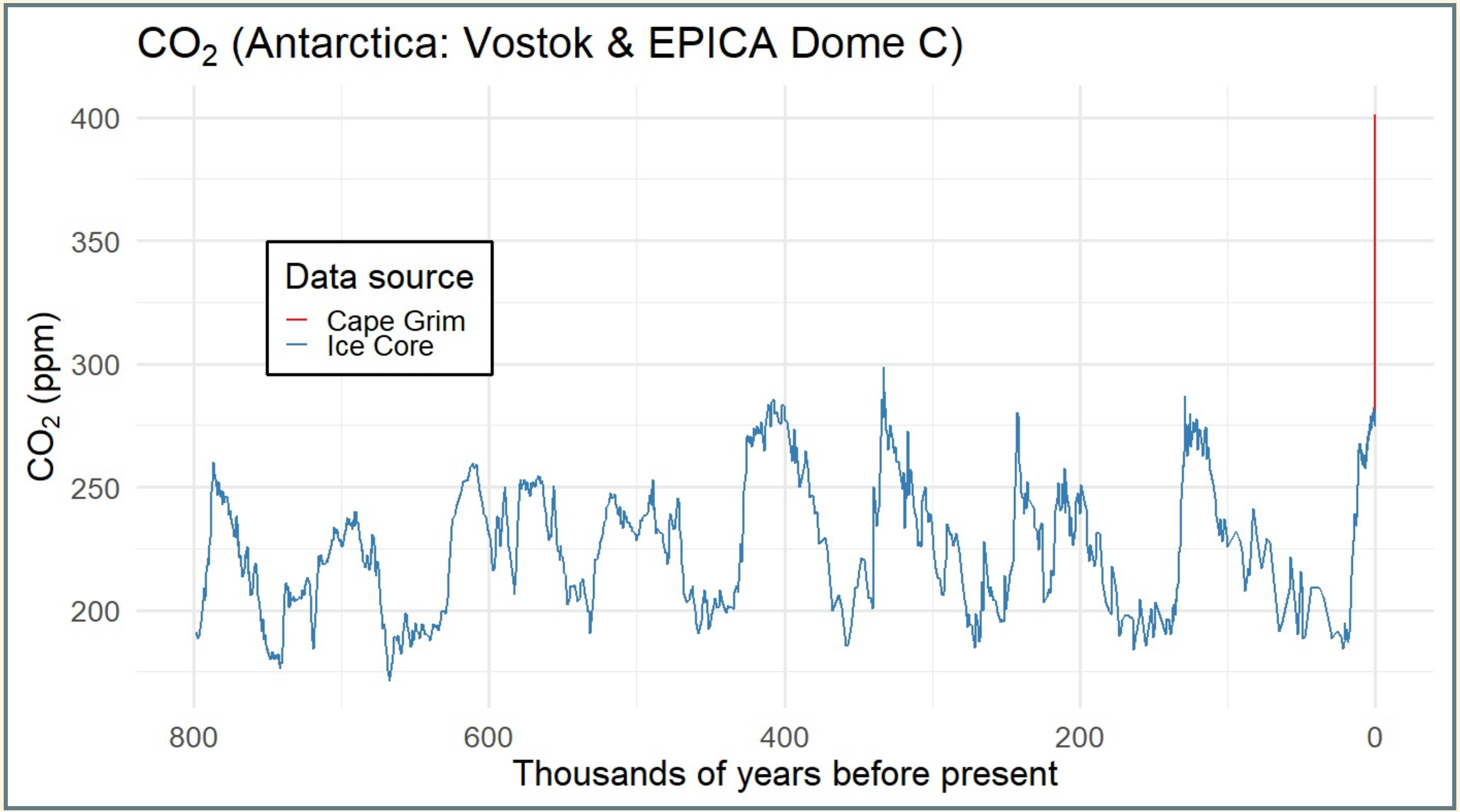
Year (AD)

800,000 years of CO_2



800,000 years of CO_2 and Temperature