The Big Picture

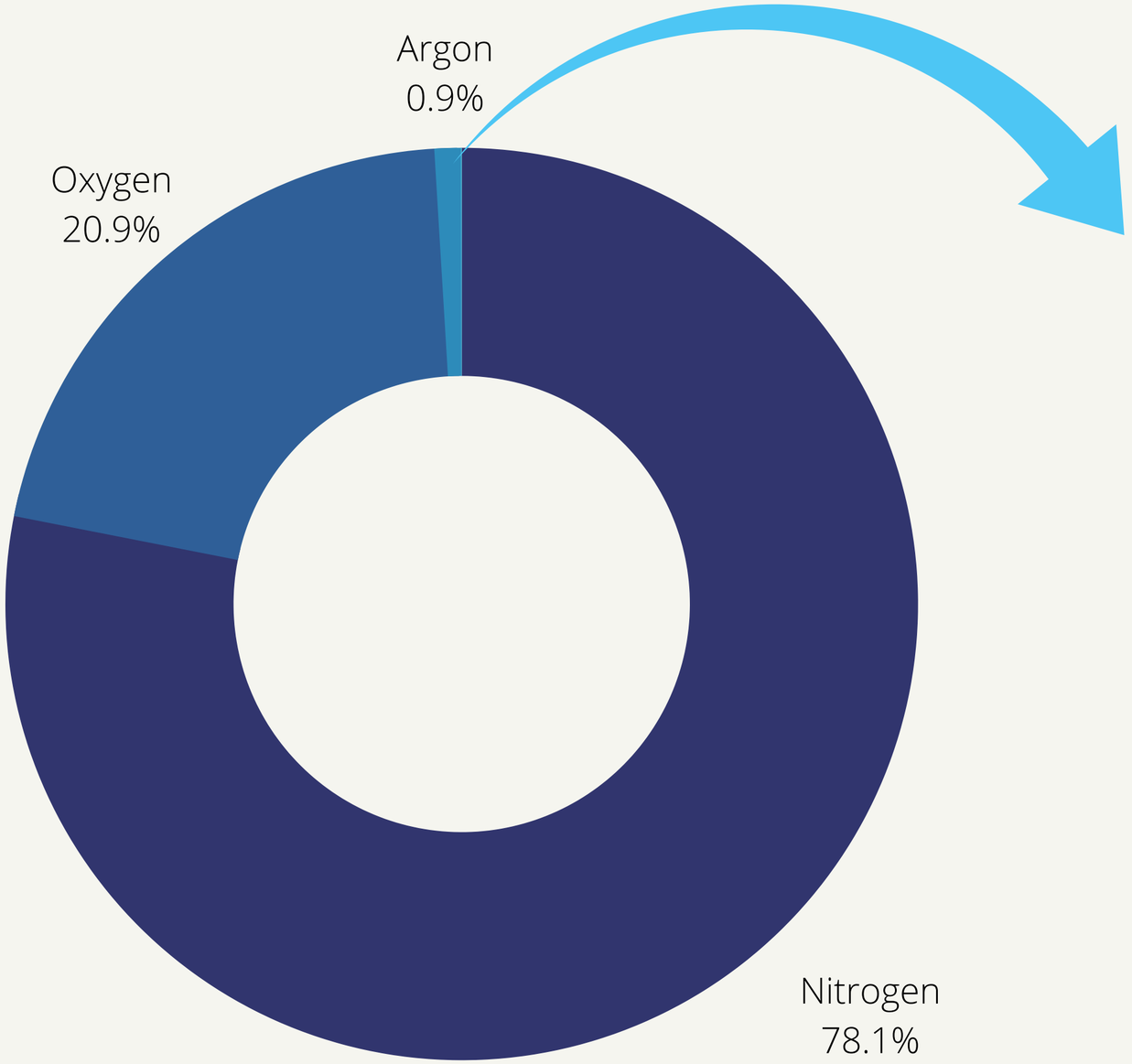
Global Carbon Cycle and Greenhouse Gases

Part 1: Climate Change Program

What do you know about greenhouse gases?

Accessing Prior Knowledge

Earth's Atmosphere



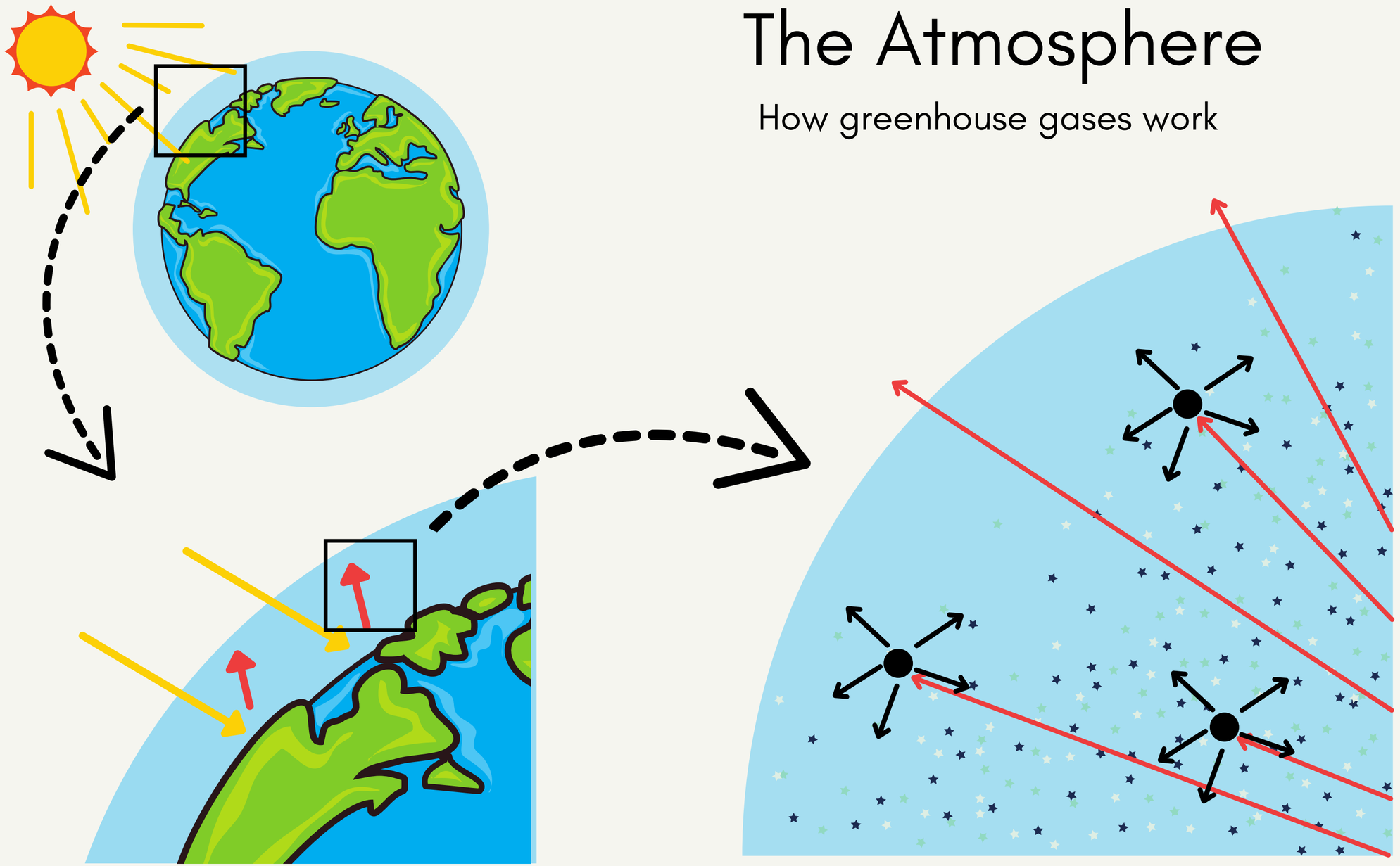
A brew of trace gases accounts for the other 0.03 percent, including the greenhouse gases carbon dioxide, methane, nitrous oxide and ozone.

Yet while these greenhouse gases make up just a tiny percentage of our atmosphere, they play major roles in trapping Earth’s radiant heat and keeping it from escaping into space, thereby warming our planet and contributing to Earth’s greenhouse effect.

https://climate.nasa.gov/news/2915/the-atmosphere-getting-a-handle-on-carbon-dioxide/

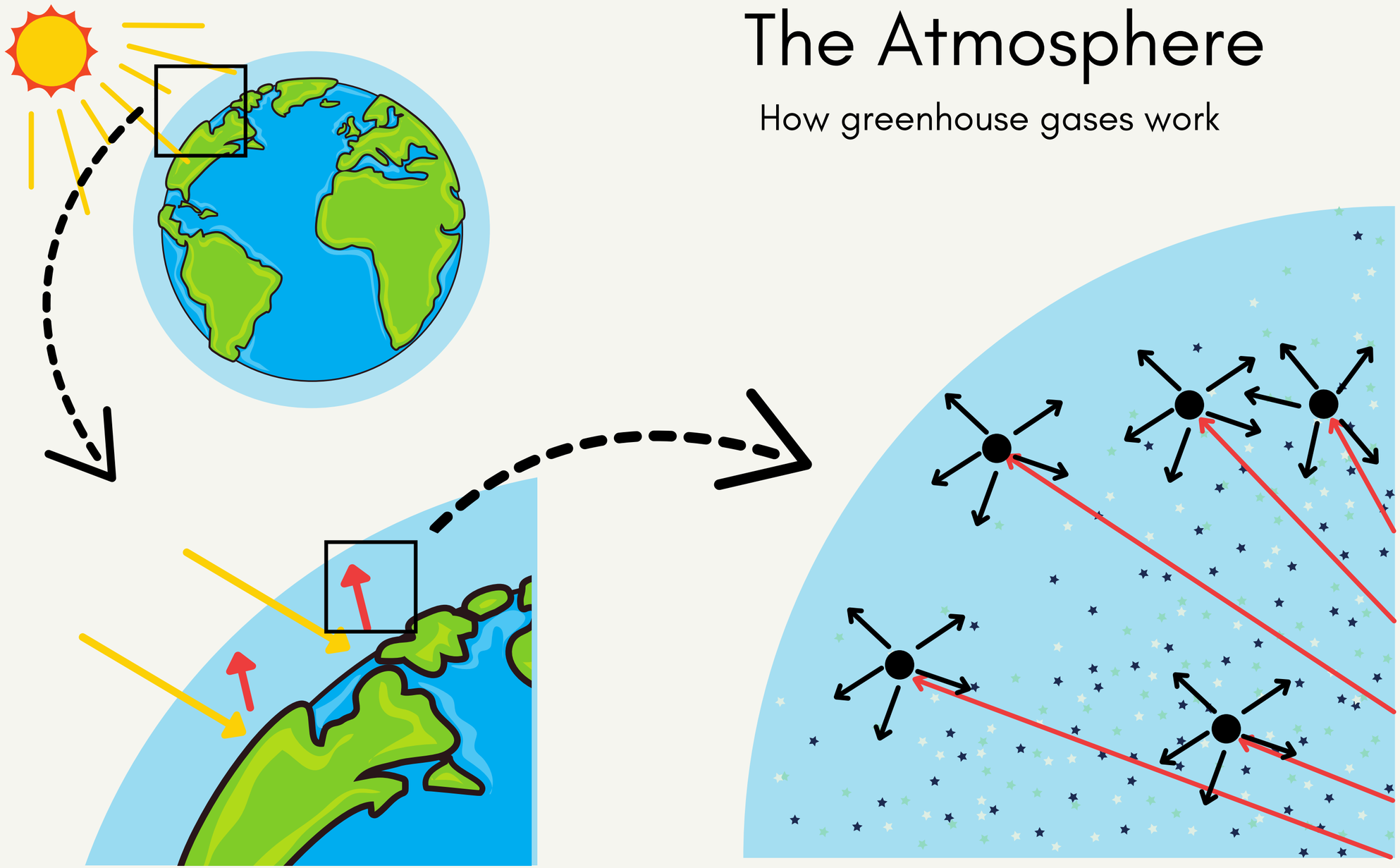
The Atmosphere

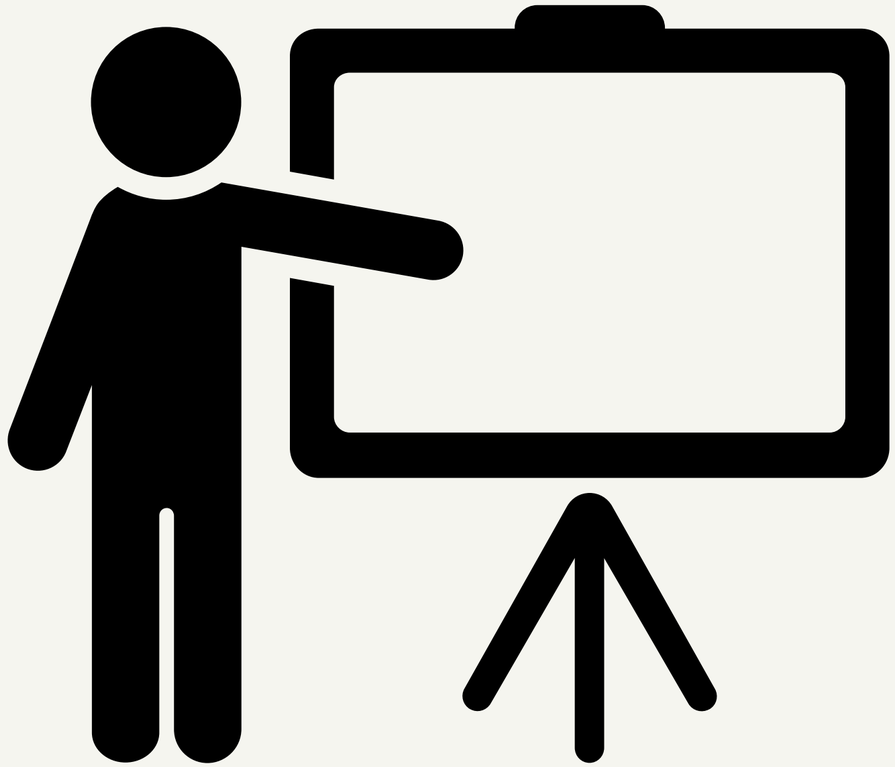
How greenhouse gases work



The Atmosphere

How greenhouse gases work



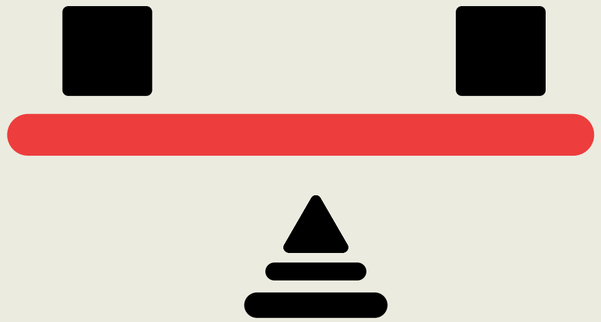


What is the carbon cycle?

https://oceanservice.noaa.gov/facts/carbon-cycle.html

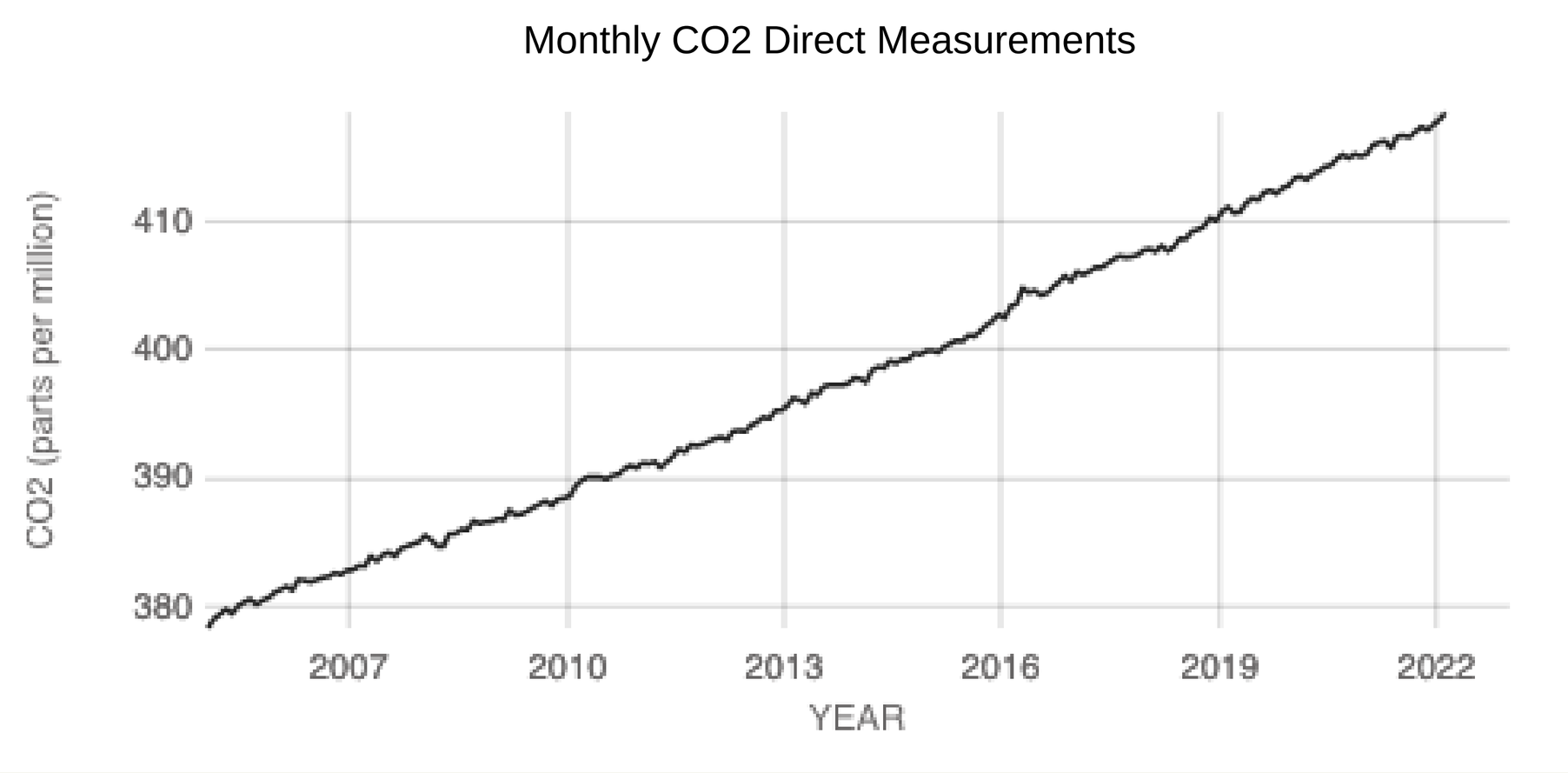
What is the Carbon Cycle?

- How carbon moves through Earth's systems
- ALL living things part of it
- Pre-industrial revolution: equilibrium



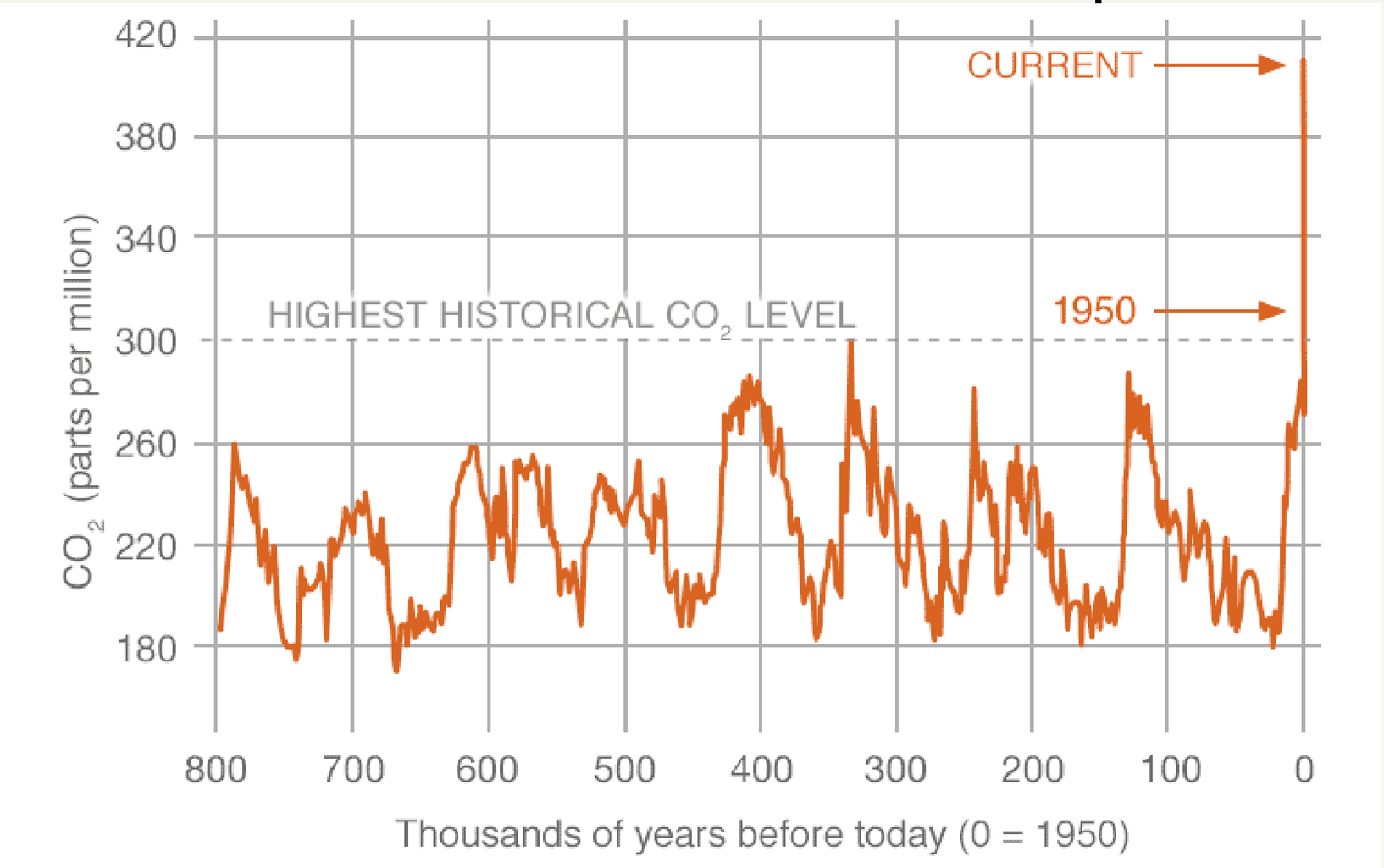
- Burning of fossil fuels (e.g., coal, oil, natural gas) added extra carbon into the atmosphere and oceans
- Result: imbalance

Current Carbon Dioxide Level: **418 ppm**
(as of February 2022)



https://climate.nasa.gov/vital-signs/carbon-dioxide/

Current-Historical CO2 Comparison



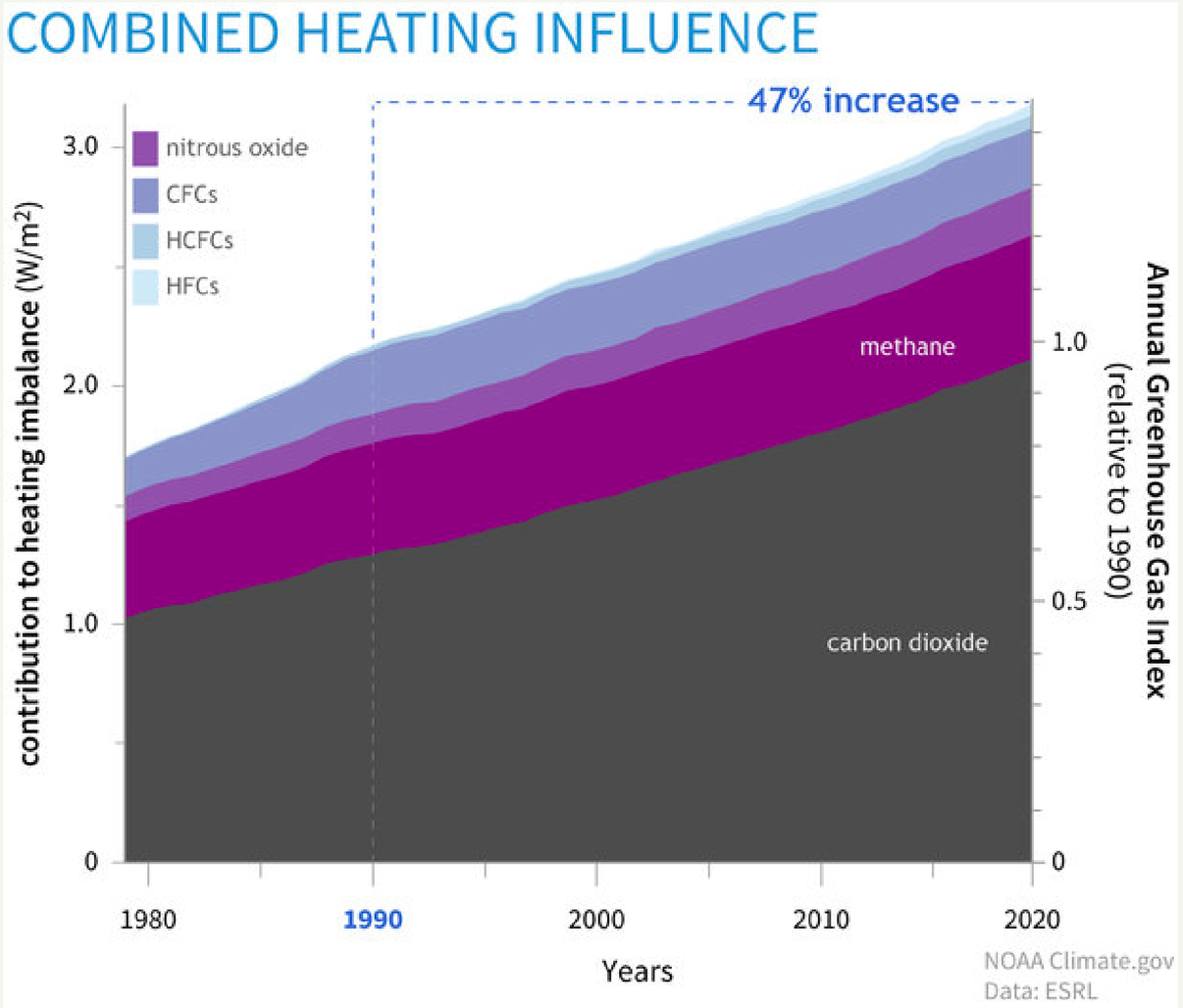
https://climate.nasa.gov/vital-signs/carbon-dioxide/

GHGs' Contribution to Warming

The Annual Greenhouse Gas Index (AGGI), developed by NOAA and updated yearly, compares the combined warming influence of the long-lived greenhouse gases to their influence in 1990.

In 2020, the AGGI hit 1.47, indicating a 47 percent increase in the warming influence of greenhouse compared to 1990; carbon dioxide accounts for about 80 percent of the increase.

Relative to pre-industrial times, the atmosphere today absorbs an extra 3 watts of energy per square meter of Earth's surface.



https://www.climate.gov/news-features/understanding-climate/climate-change-annual-greenhouse-gas-index

Global Greenhouse Gas Emissions

Methane

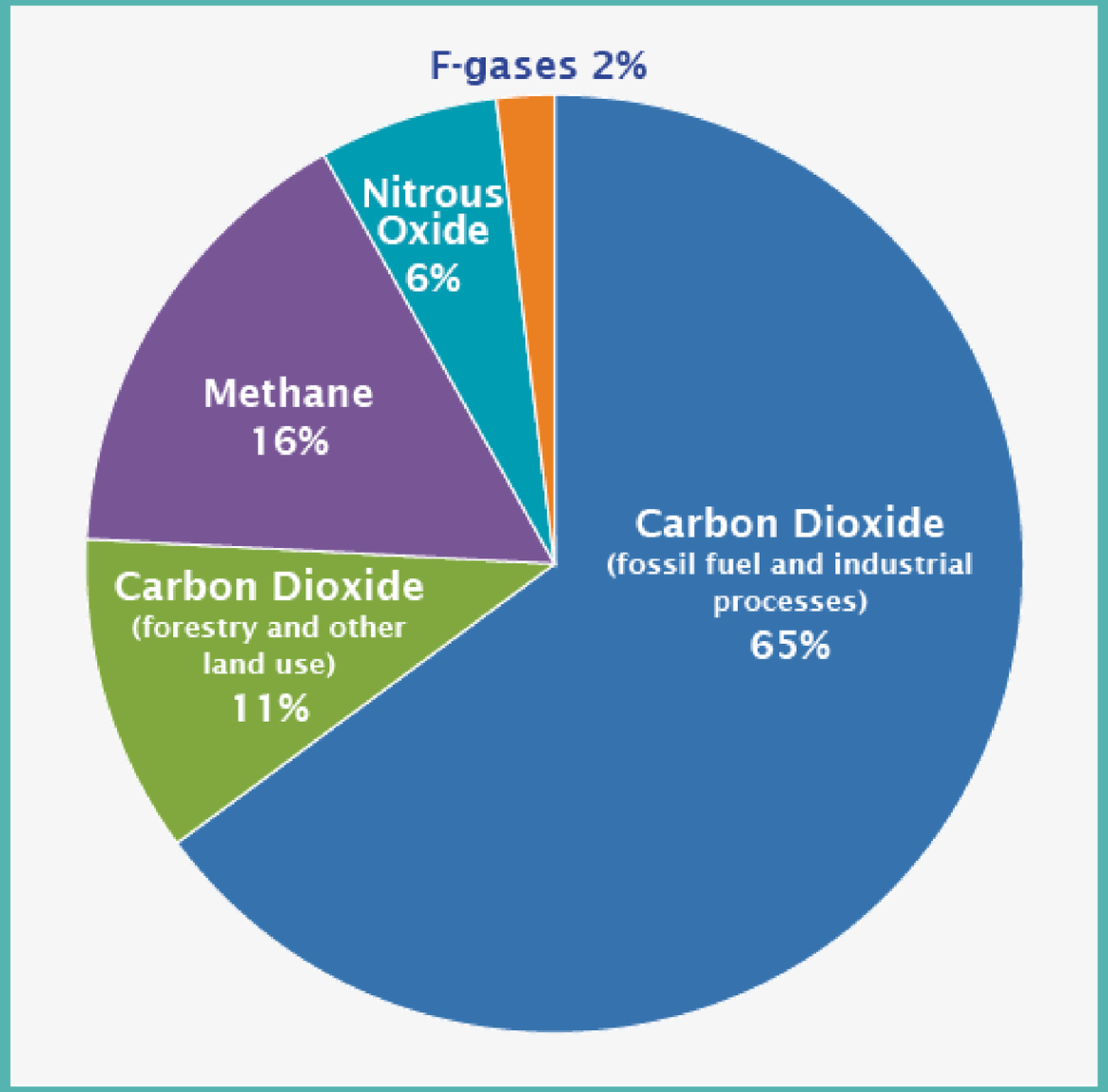
- Residence time: ~12 years
- Pound for pound, methane 25 times more efficient at trapping radiation than CO2 over a 100 year period
- Globally, 50-65% of total methane emissions come from human activities
- Emissions from agricultural activities, waste management, and energy use

Nitrous oxide

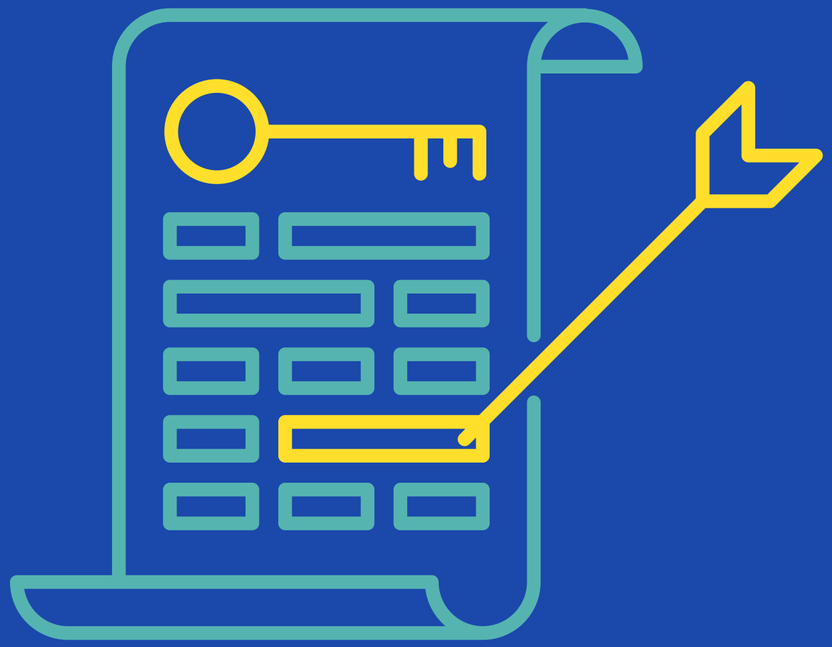
- Residence time: just over 100 years
- Global warming potential: ~300 times as powerful as CO2
- Primarily from agricultural activities, such as fertilizer use

Industrial gases

- Residence time: a few weeks to thousands of years
- Ex. hydrofluorocarbons, perfluorocarbons.
- Global warming potential: tens of thousands times more poweful than CO2
- Emitted from industrial process, refrigeration, and some consumer products.



https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data



Key Points

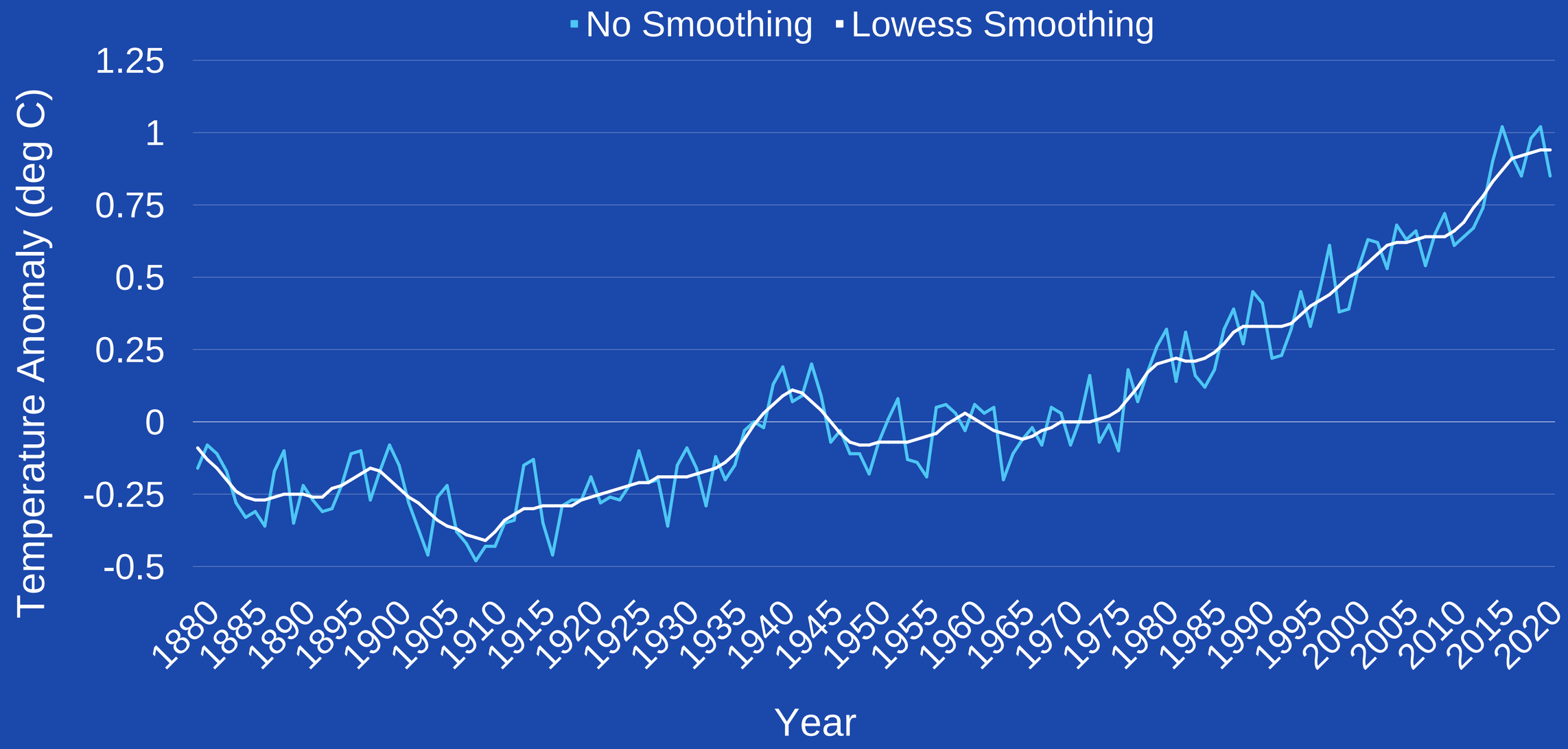
Greenhouse gases in the atmosphere act as a blanket around the Earth, keeping our global climate habitable.

Historically, annual fluctuations in greenhouse gases are balanced.

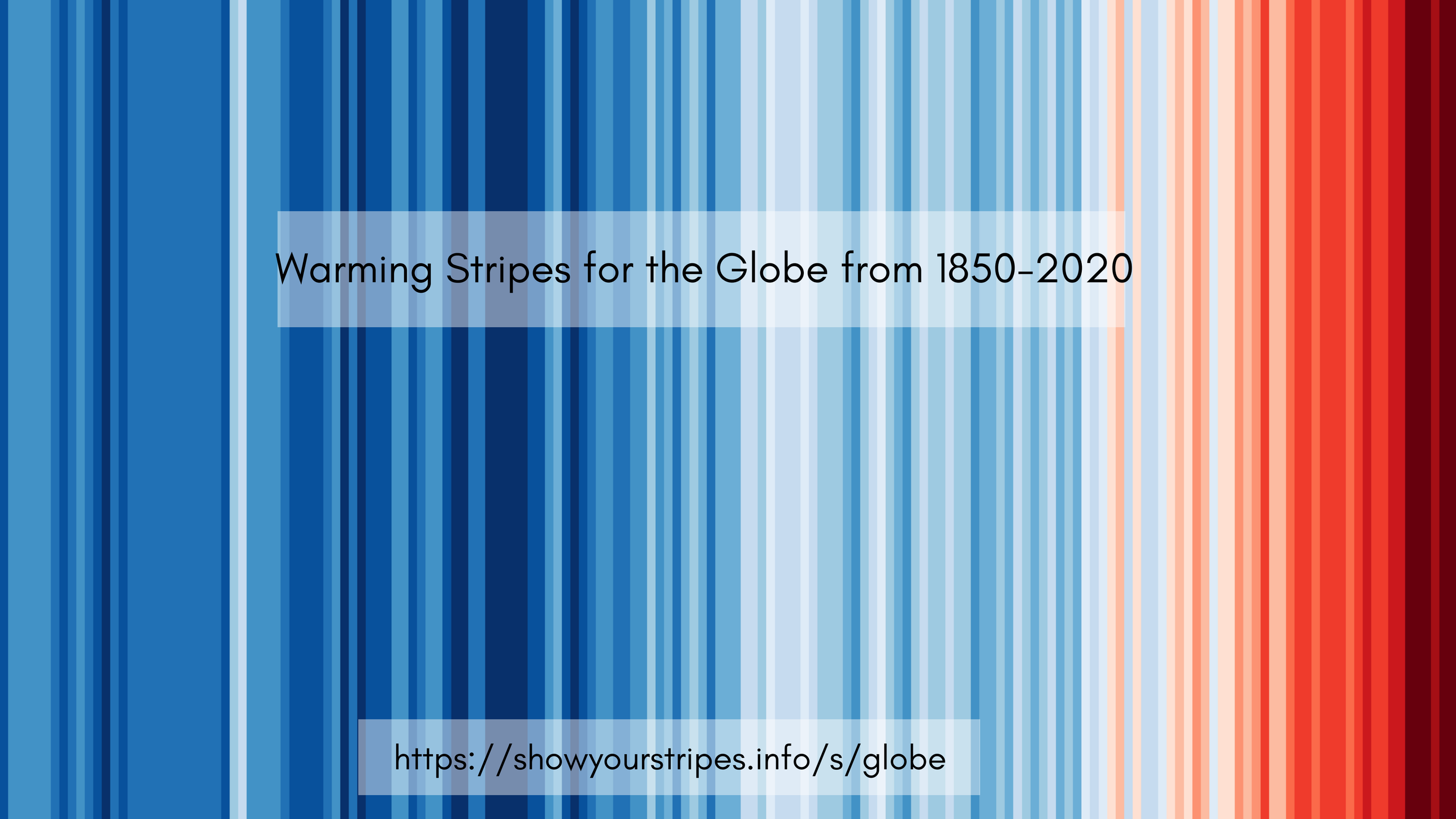
As humans have burned fossil fuels (e.g., coal, oil, natural gas), we have added more greenhouse gases to the atmosphere, and they are trapping more heat.

This trapped heat is warming the planet and is causing impacts across the globe (i.e., rapid climate change).

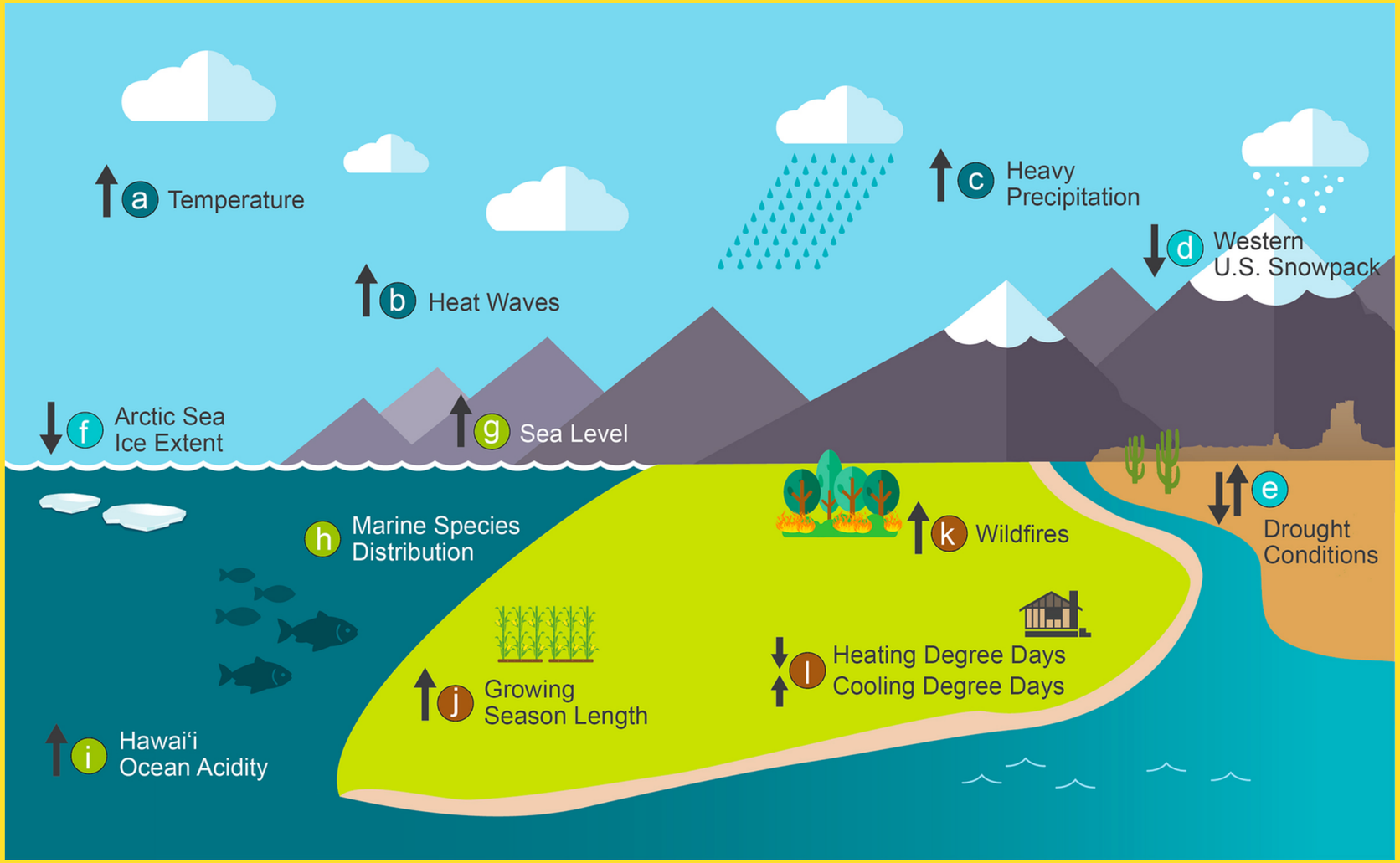
Global Temperature Anomaly



https://climate.nasa.gov/vital-signs/global-temperature/


Warming Stripes for the Globe from 1850-2020
https://showyourstripes.info/s/globe

Indicators of Change



https://nca2018.globalchange.gov/chapter/1/

What warming (and other changes) have we observed in North Carolina?

Explore - Climate Trends Plotter

https://products.climate.ncsu.edu/climate/trends/

Step 01

Write a question or hypothesis about how your local climate has (or has not) changed.

Brainstorm: How can you answer/test this using historic temperature or precipitation data?

Step 02

Go to the NC State Climate Office Historic Trends Plotter.

This tool enables users to view and plot historic trends for long-term monitoring stations in NC.

Spend a few moments playing around with this tool

Step 03

Revisit your hypothesis/question and us the Trends Plotter to answer it.

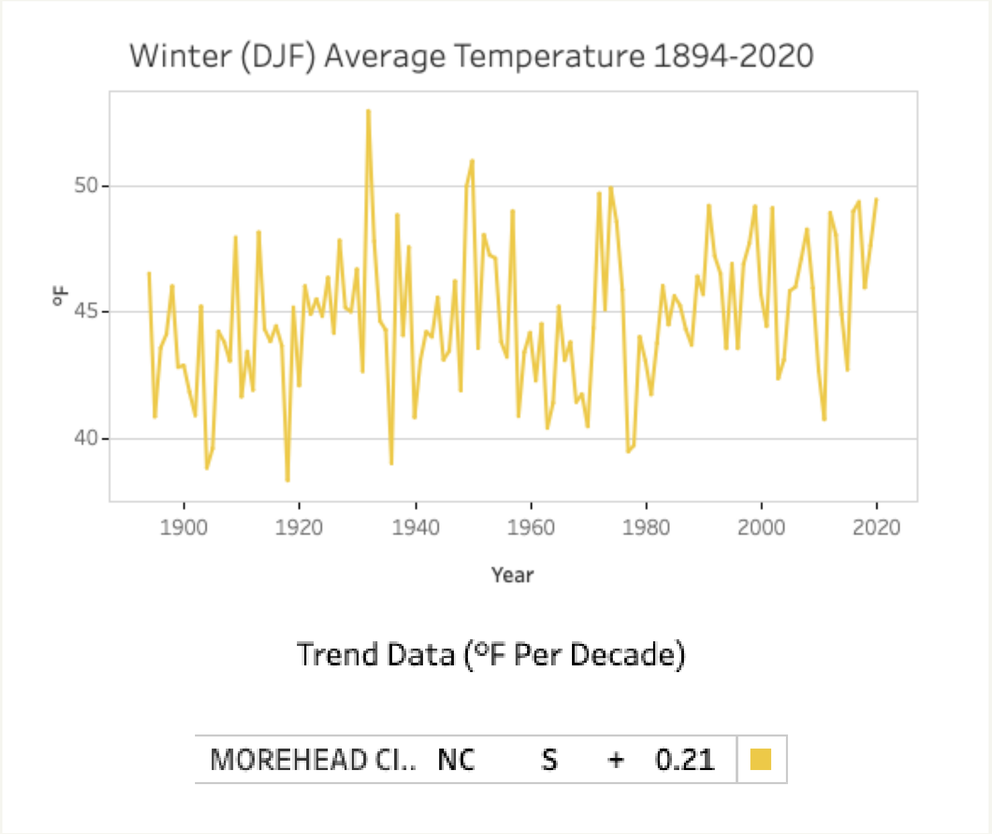
Write down your findings. Were they what you expected?

Example: Using the Climate Trends Plotter

https://products.climate.ncsu.edu/climate/trends/

01

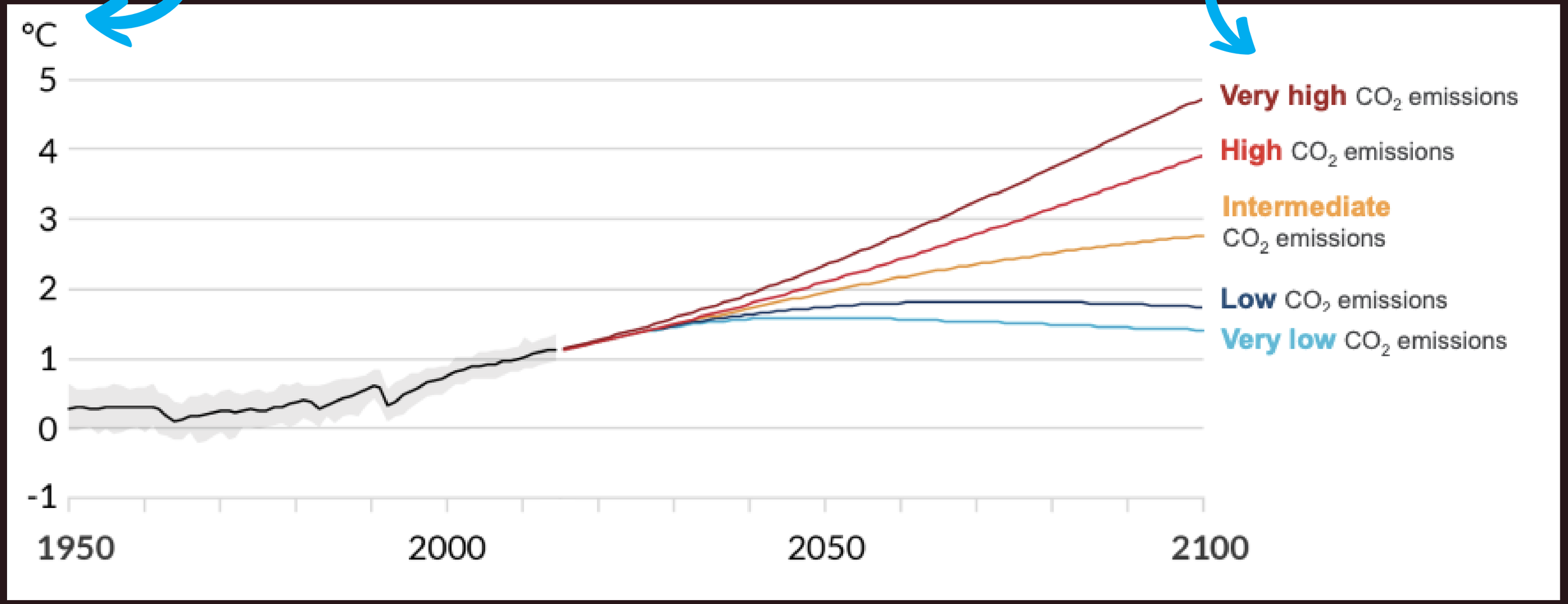
Are winters getting warmer in Morehead City, NC? If they are, by how much?



03

Winters in Morehead City are very variable year-to-year, and have been warming at a statistically significant rate of 0.21°F per decade.

Future warming depends on future emissions



Graph source: IPCC Working Group I Contribution to the 6th Assessment Report. https://www.ipcc.ch/

Climate Actions

Adaptation

Actions taken at the individual, local, regional, and national levels to reduce risks from even today's changed climate conditions and to prepare for impacts from additional changes projected for the future.

Mitigation

Actions to reduce the amount and speed of future climate change by limiting emissions or removing carbon dioxide from the atmosphere.

End of Lesson Reflection

Think back to the exercise where you explored historic climate trends for a location in North Carolina. Reflect on the prompts below:

- What was your hypothesis or question and why was this of interest to you?
- What did you learn from exploring the data?
- How can this information help you (or others) make plans about how to respond to our changing climate?
- What questions do you have about climate change in North Carolina after doing this exercise?

Thank you

NC State Climate Office

climate.ncsu.edu

@ncsco

Link to Evaluation