

Climate Change: Evidence, Effects, and Actions



CERN Greek National
Teacher Program 2023



Olga



Laura

Black Box

Building and Revising Scientific Models





Activity 1: Carbon Dioxide 10

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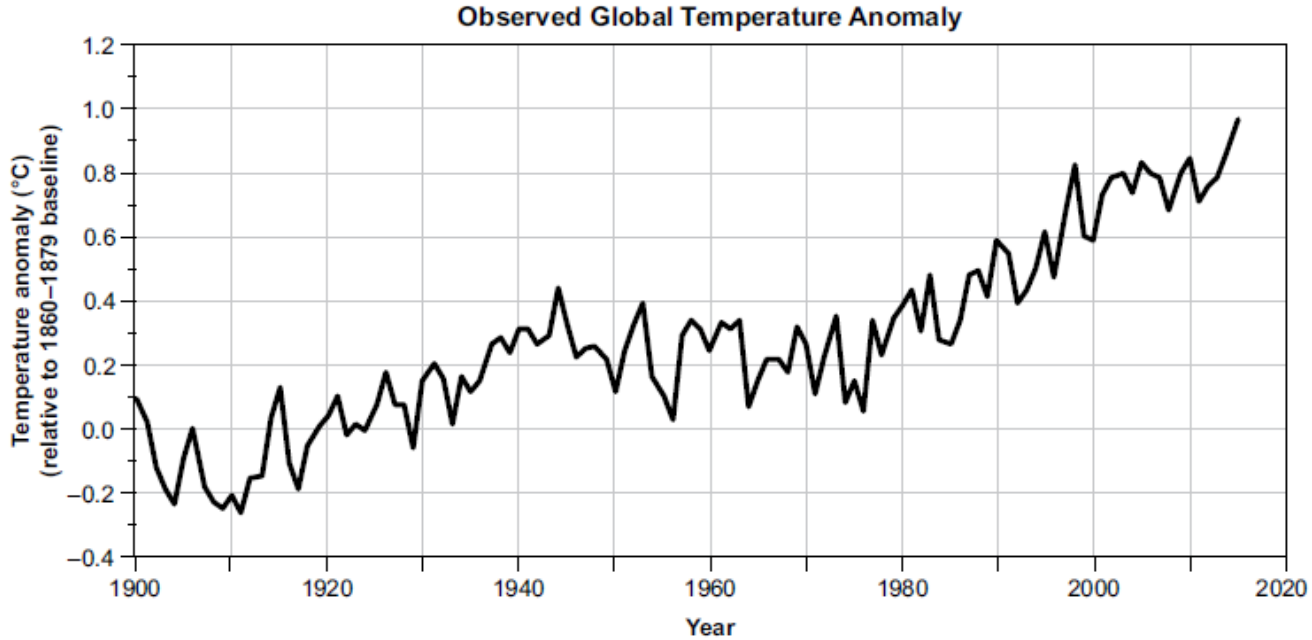
Design Challenge: Climate in a Container 53

SCIENCE

MATH

resources.perimeterinstitute.ca

Earth is getting warmer



Source: NASA GISS

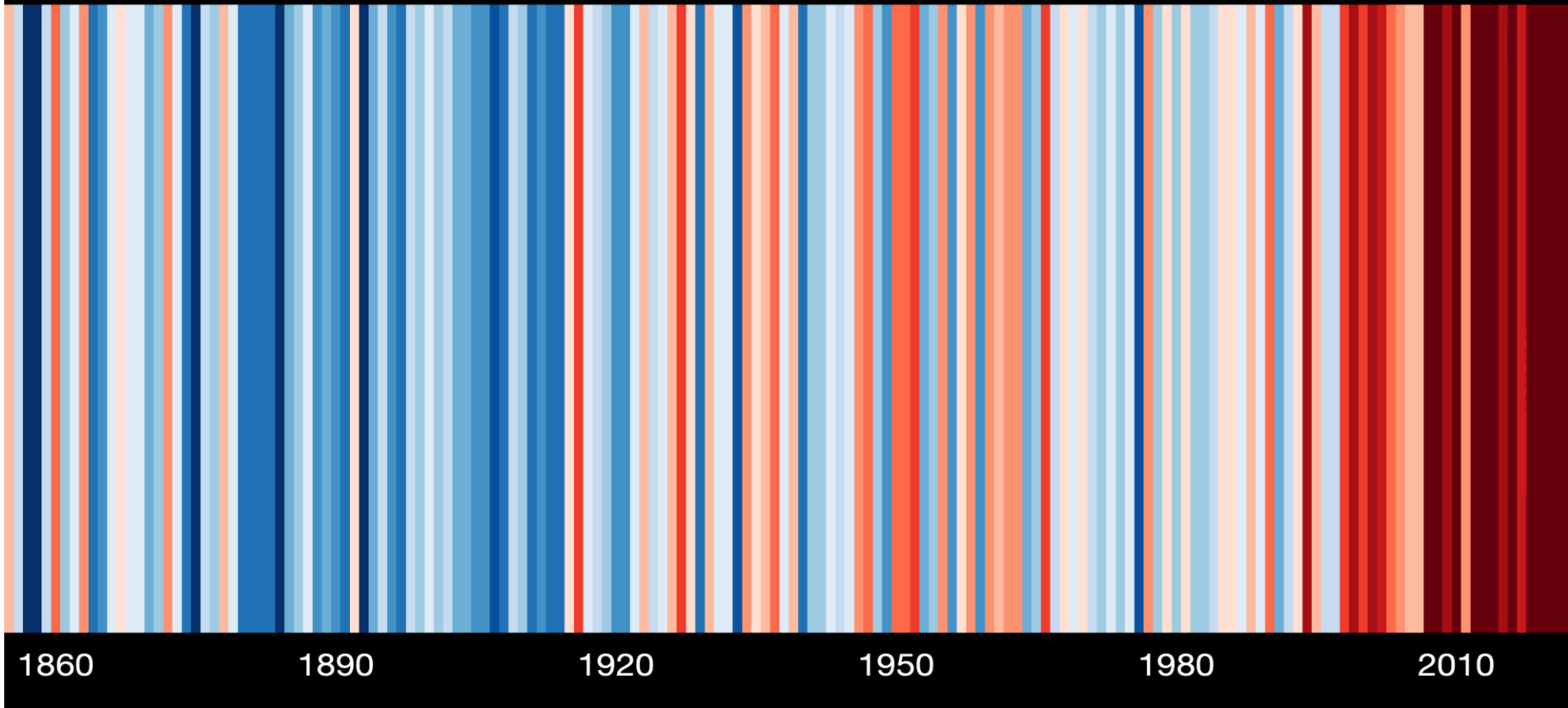
“World just got its first real taste of life at 1.5 degrees Celsius above preindustrial times.”

**- The Washington Post
August 3, 2023**

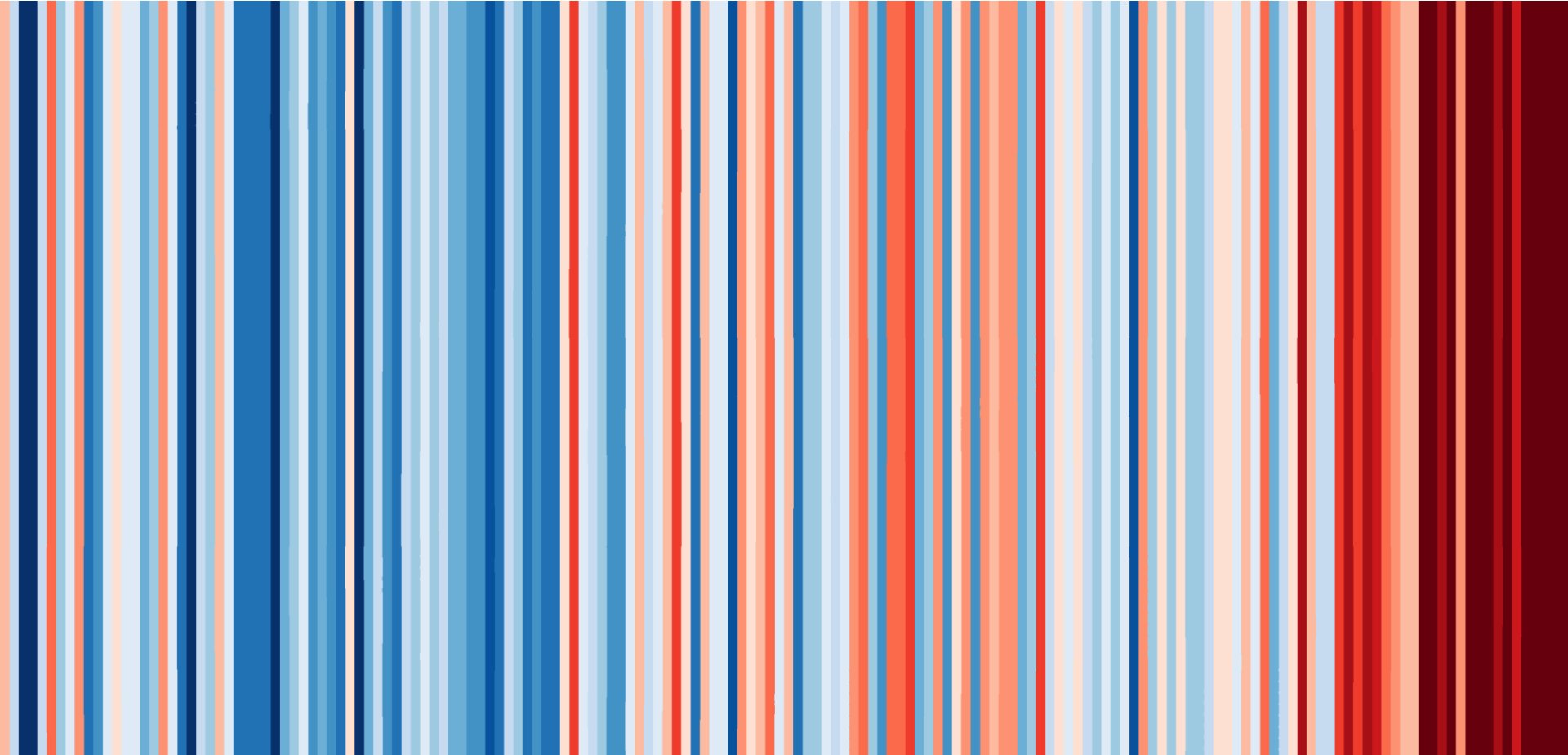
<https://www.washingtonpost.com/climate-environment/2023/08/03/july-blows-away-temperature-records-testing-key-climate-threshold/>

Greece (1855 – 2022)

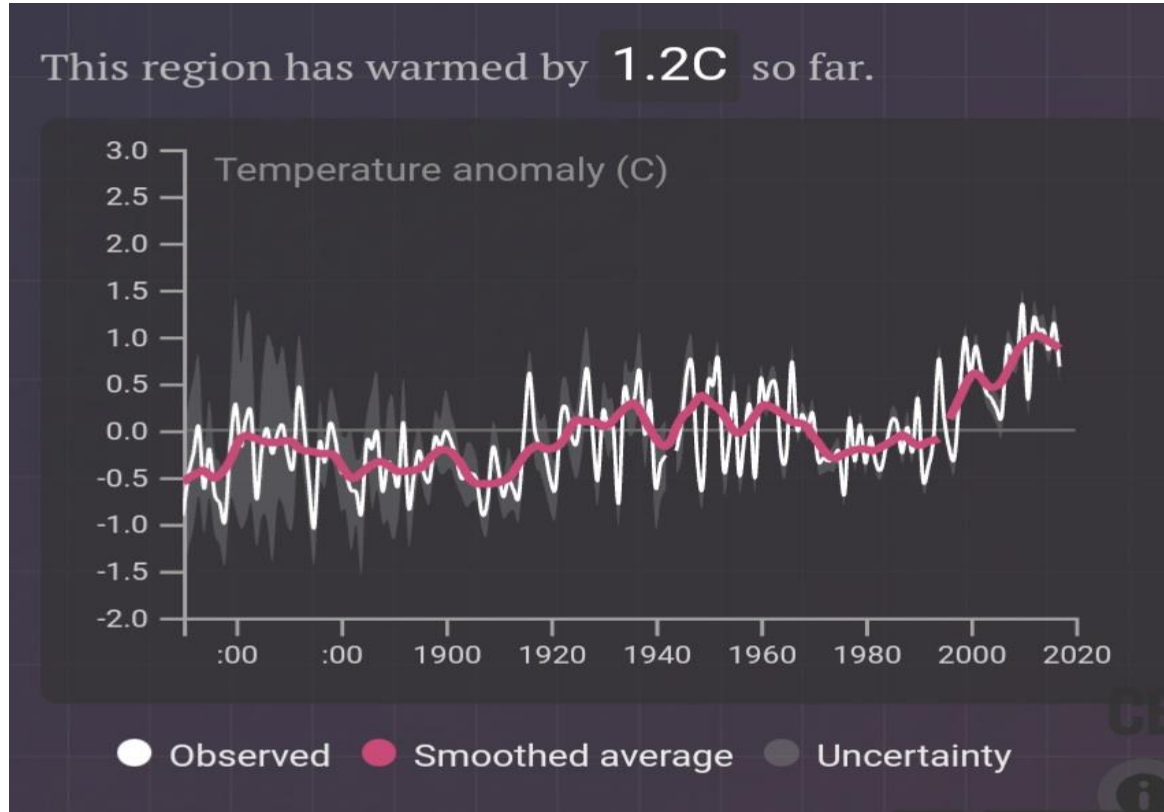
Temperature change in Greece since 1855



Greece (1855 – 2022)



Athens is getting warmer



<https://www.carbonbrief.org/mapped-how-every-part-of-the-world-has-warmed-and-could-continue-to-warm>

A few degrees may not seem like much...

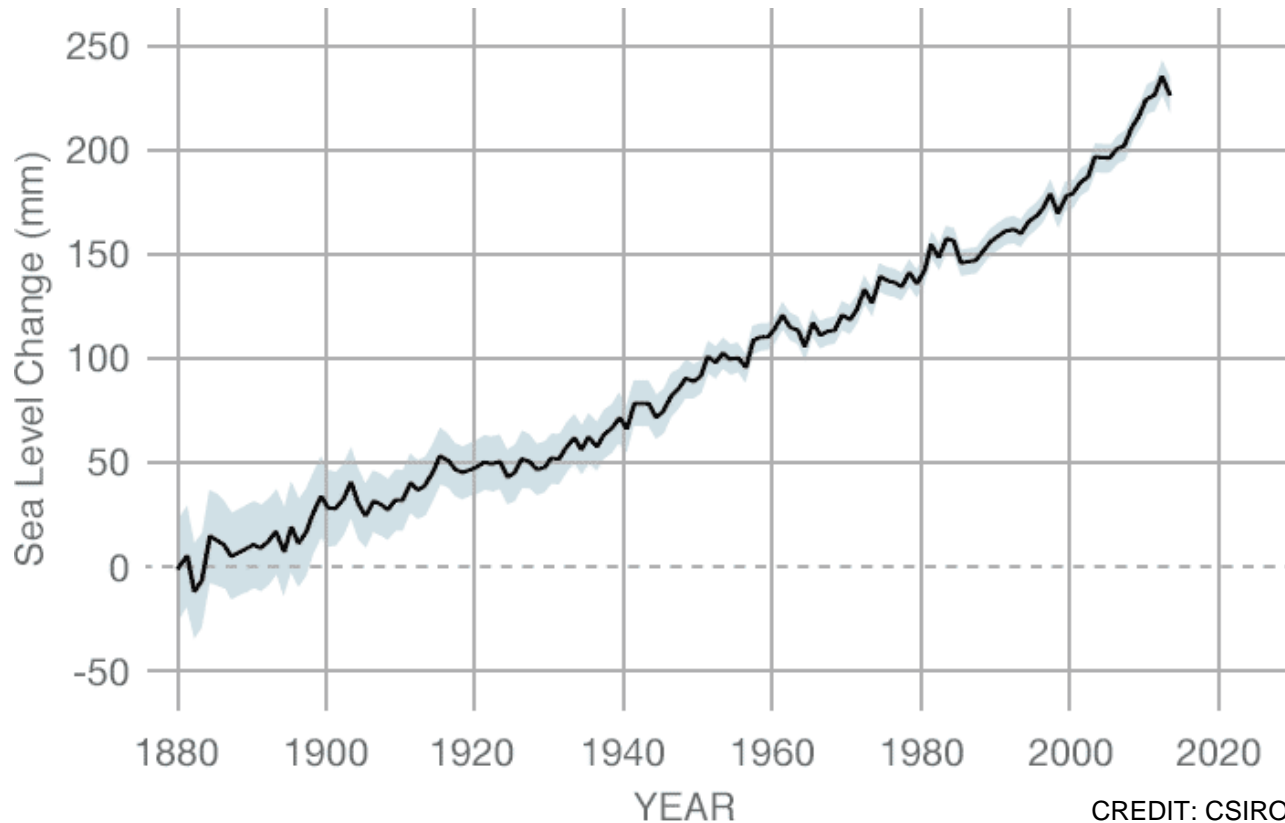


37°C = healthy



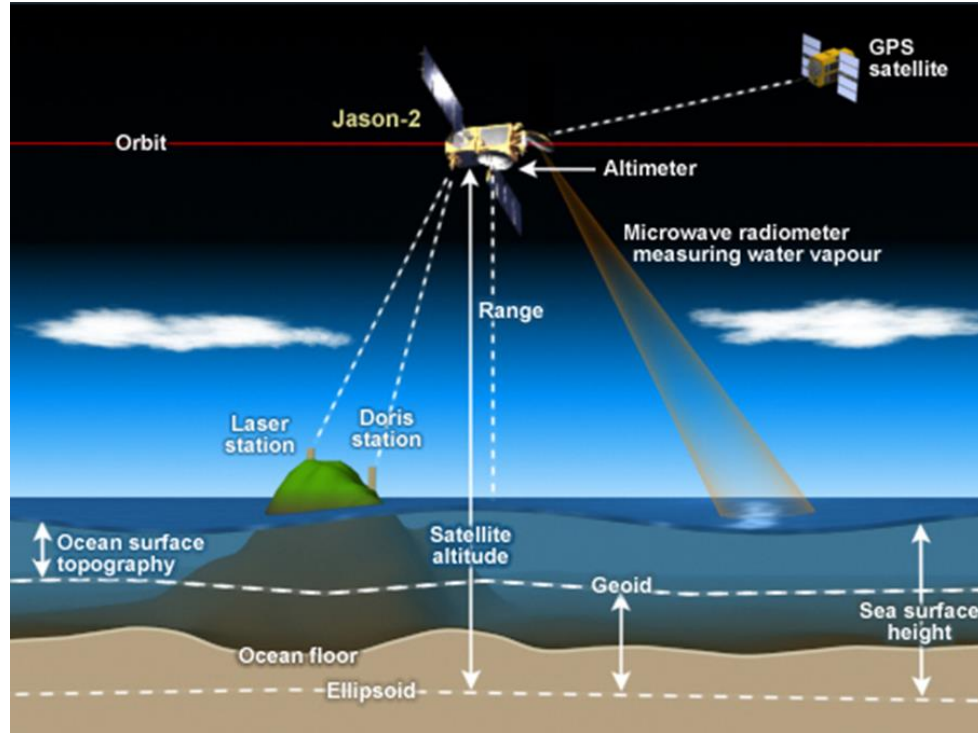
39°C = sick

Sea Levels are rising



CREDIT: CSIRO

Satellite Altimetry: Measuring Sea Level

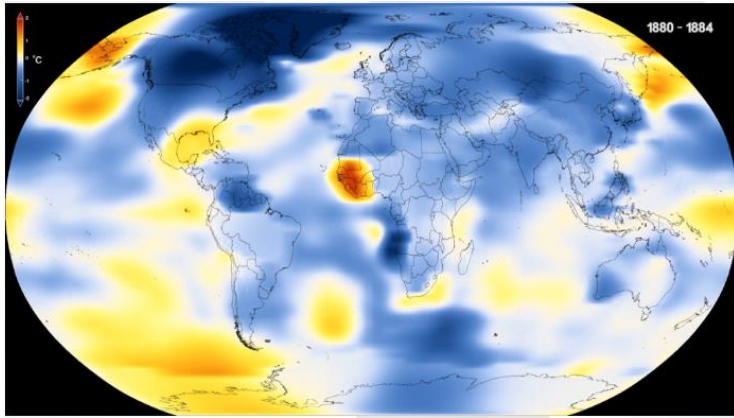


A few centimetres may not seem like much...

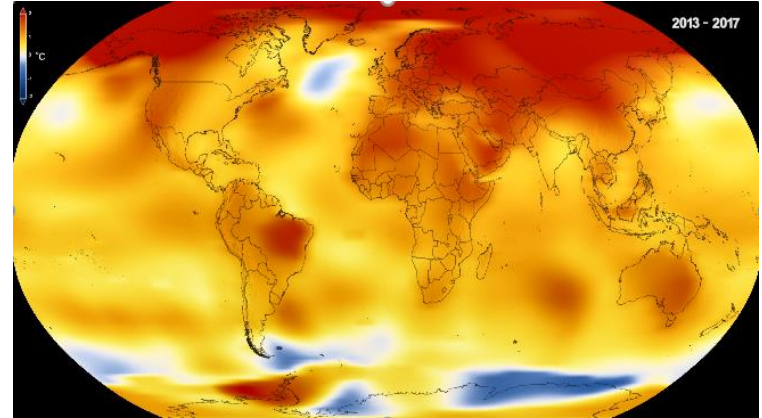


2004

The question is: Why?



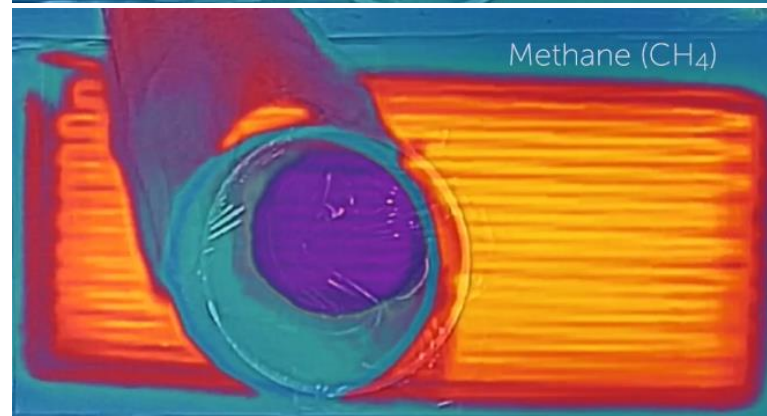
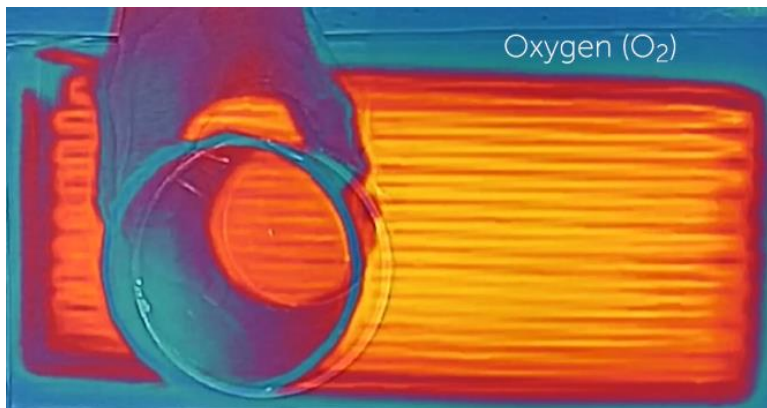
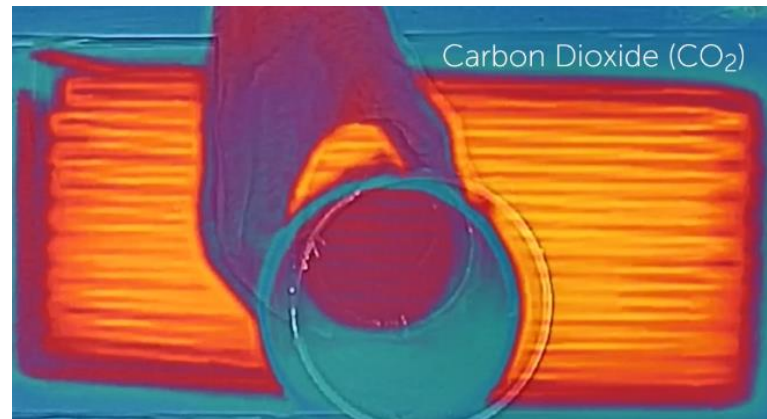
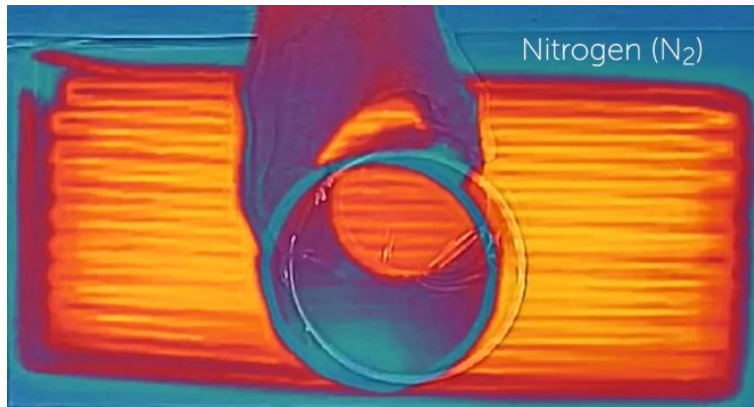
1880



2017

And what can we do about it?

Which gases are transparent to infrared radiation?



Keeling Curve

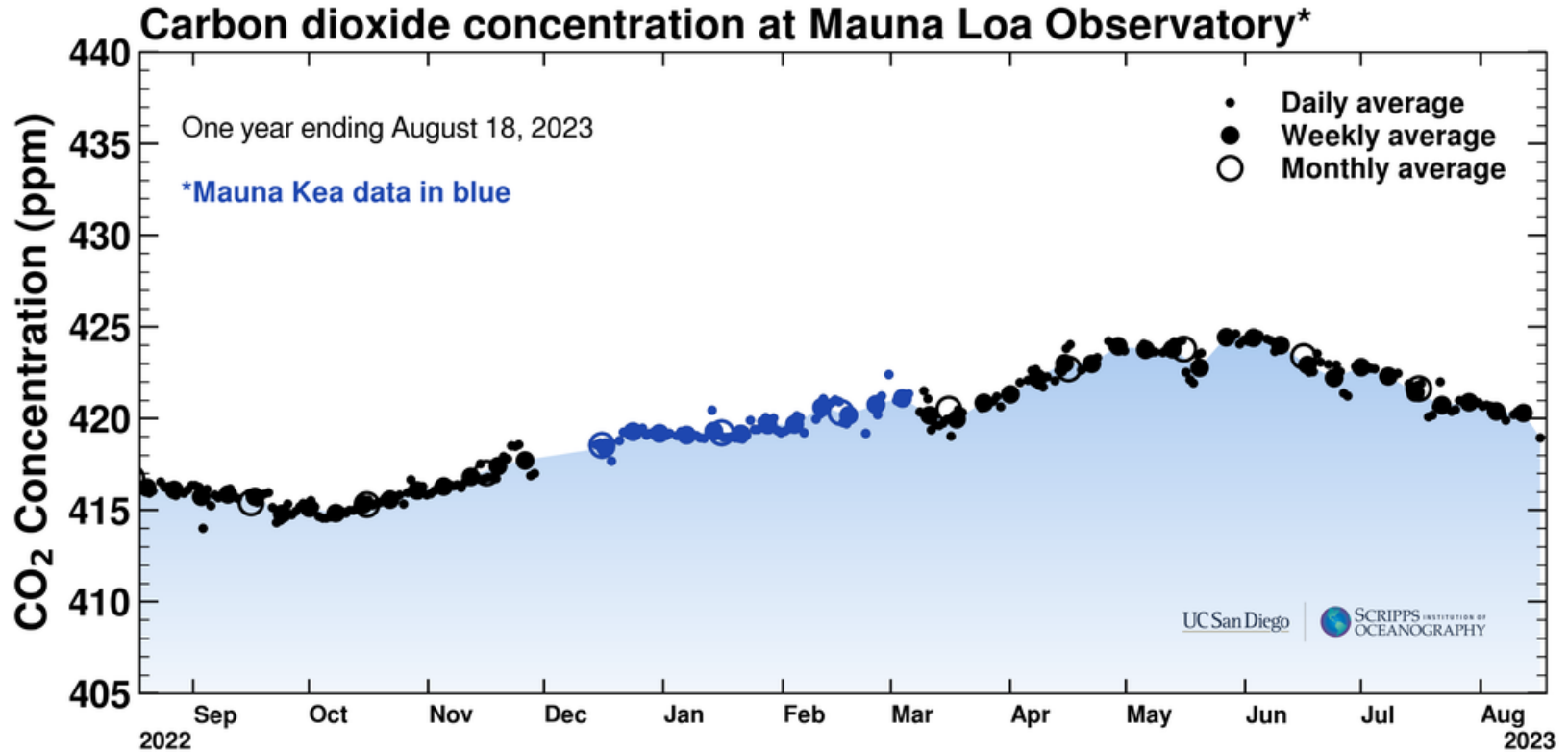
<https://keelingcurve.ucsd.edu/>

- Measurement of the concentration of CO₂ in the atmosphere
- Continuous record at Mauna Loa since 1958

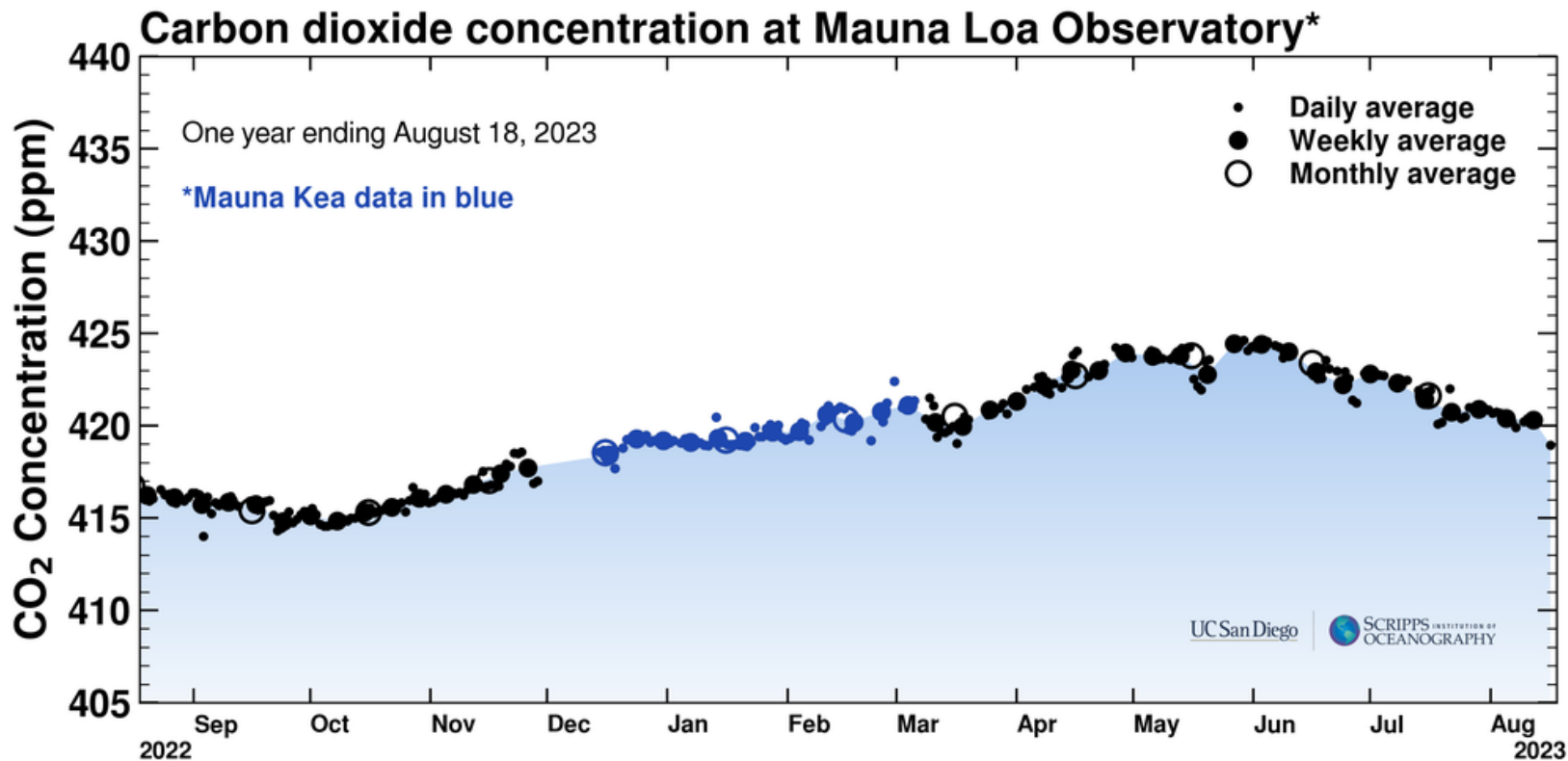
*Latest CO₂ reading: **418.83 ppm**

(August 18, 2023)

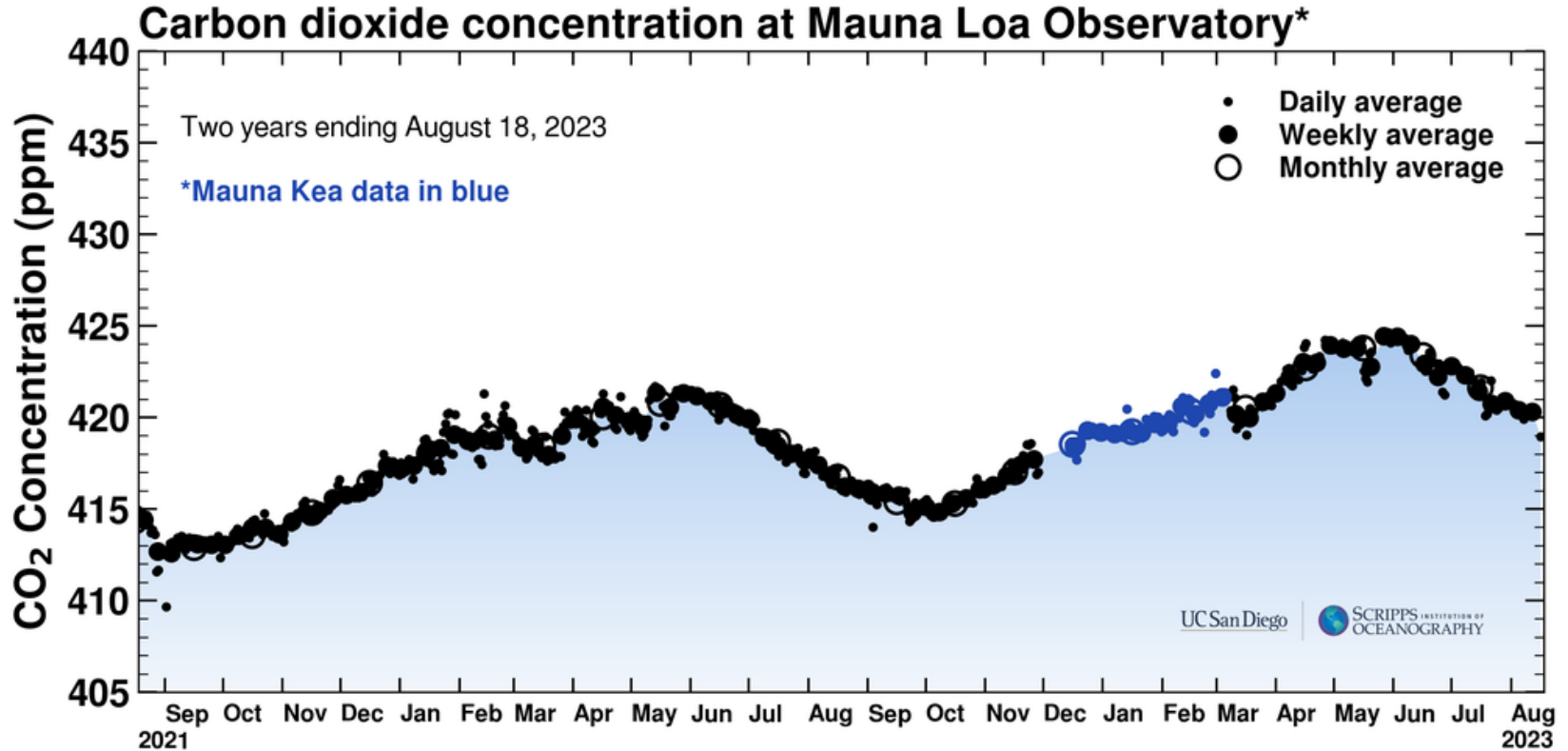
One month



1 year

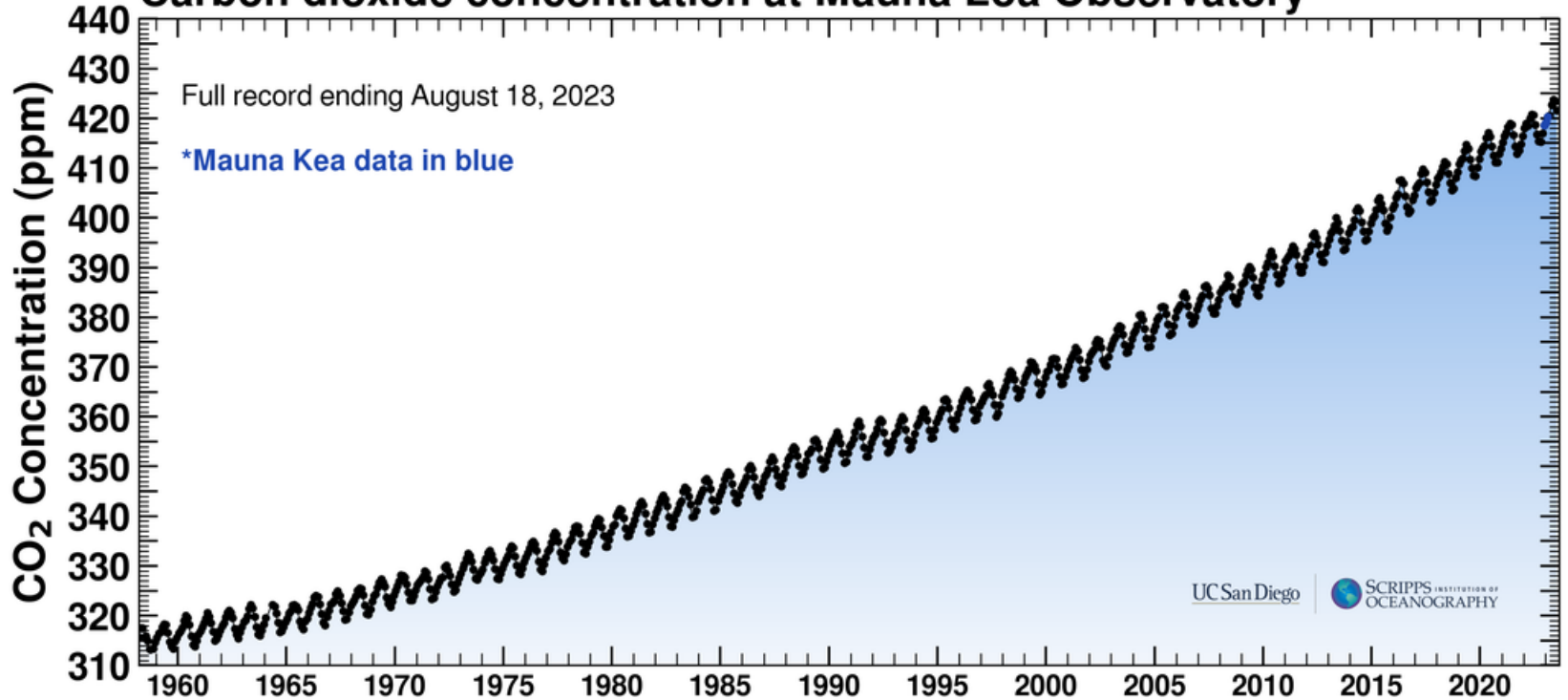


Last two years



Full record

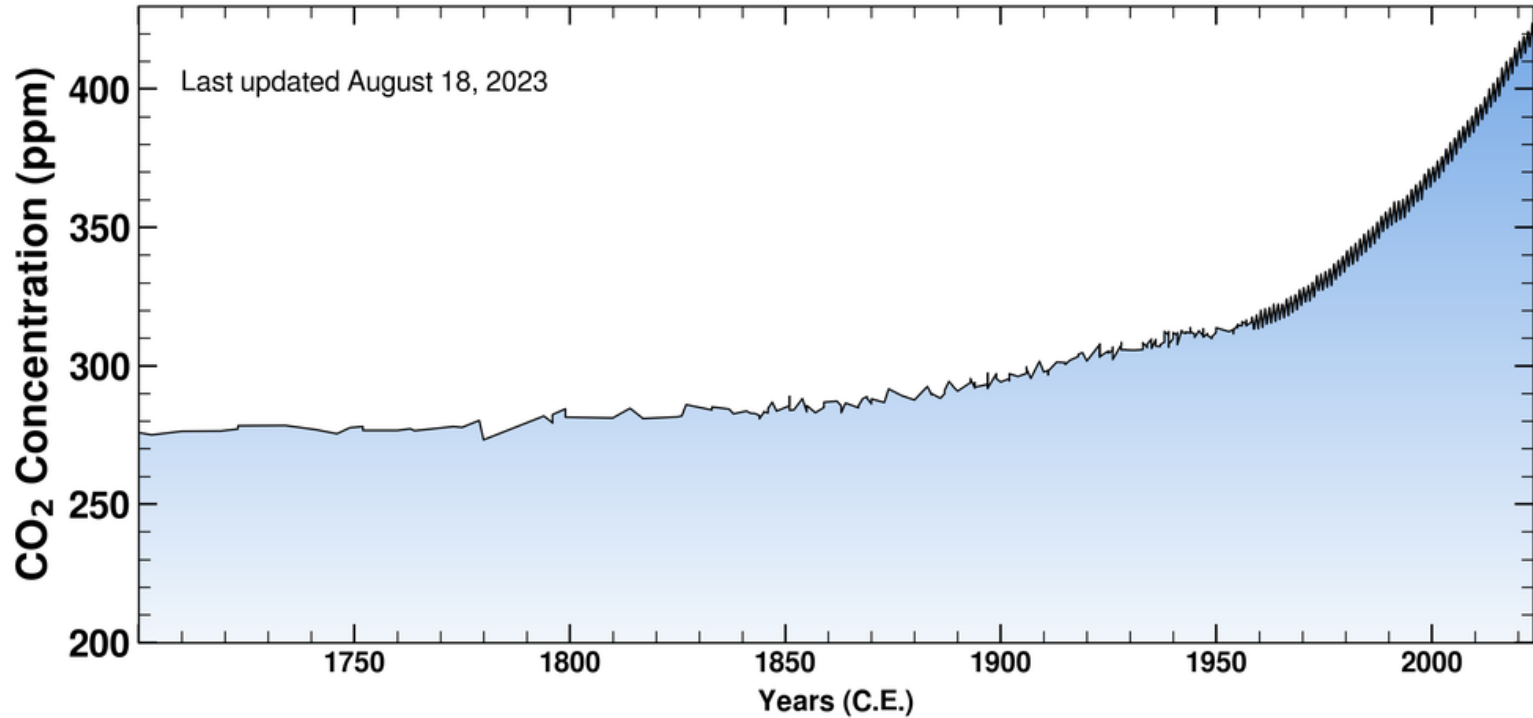
Carbon dioxide concentration at Mauna Loa Observatory*



1700 - present

August 18, 2023.

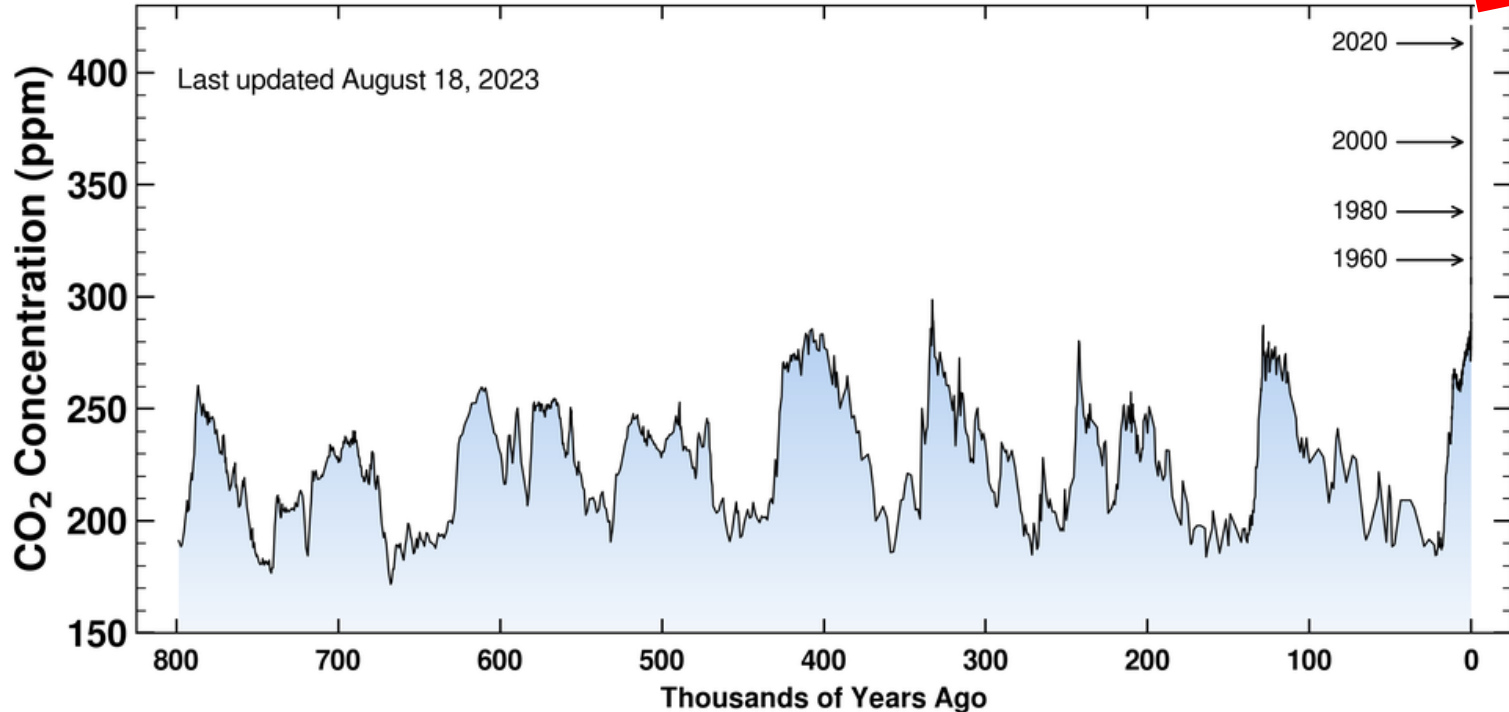
Ice-core data before 1958. Mauna Loa data after 1958.



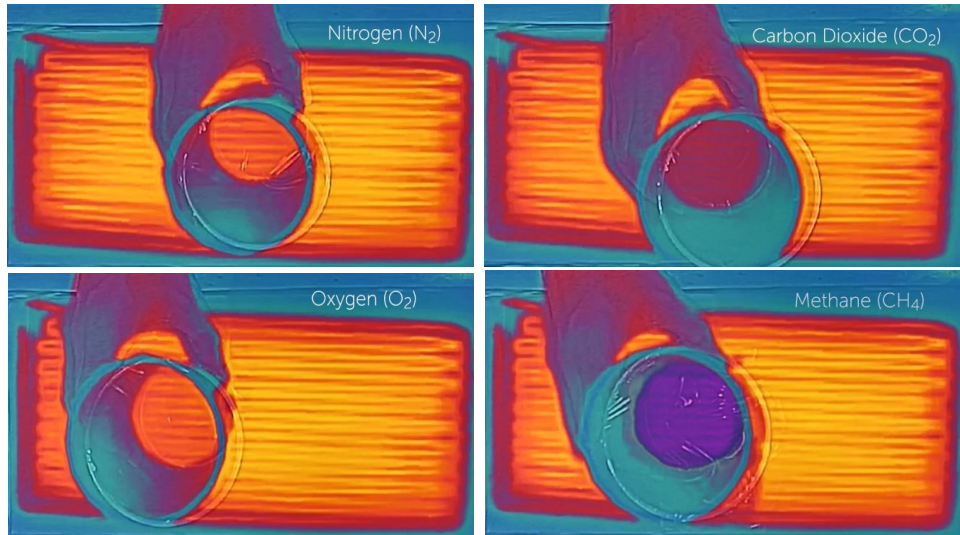
Last 800,000 years

August 18, 2023.

Ice-core data before 1958. Mauna Loa data after 1958.



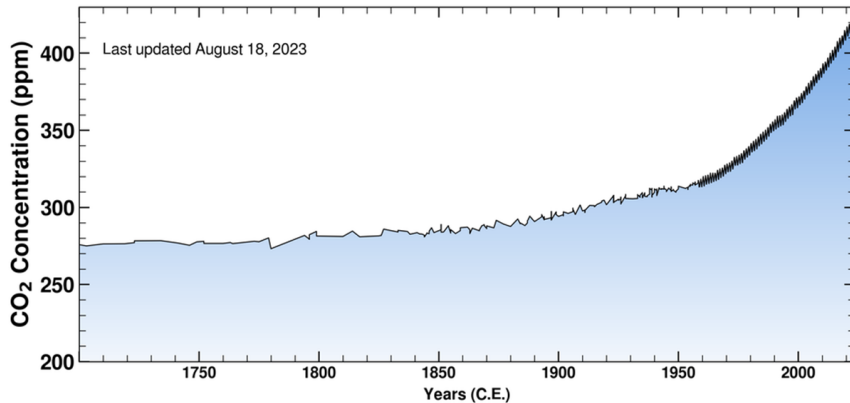
THIS IS US



Greenhouse gases, like CO₂ and methane, absorb infrared radiation.

CO₂ levels have been increasing since industrial revolution

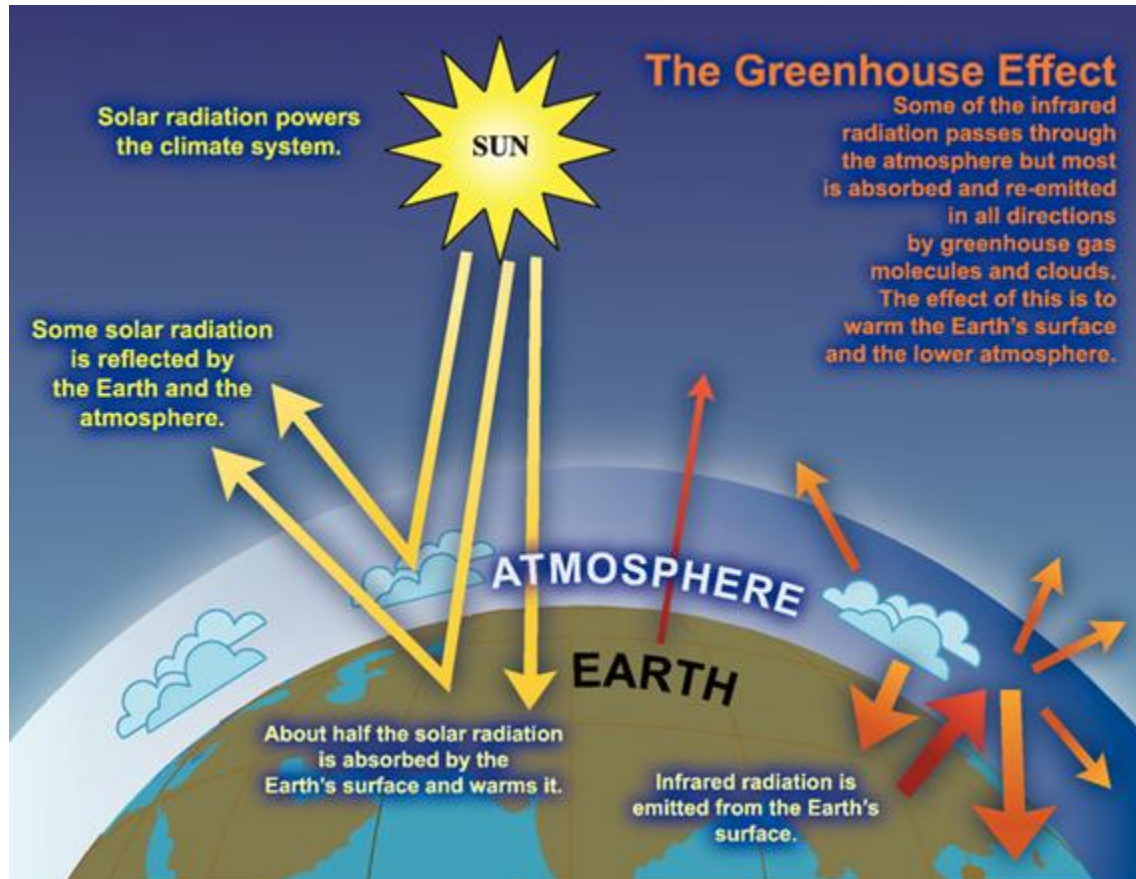
August 18, 2023.
Ice-core data before 1958. Mauna Loa data after 1958.



How do these observations
relate to the Earth?



Earth's atmosphere traps heat

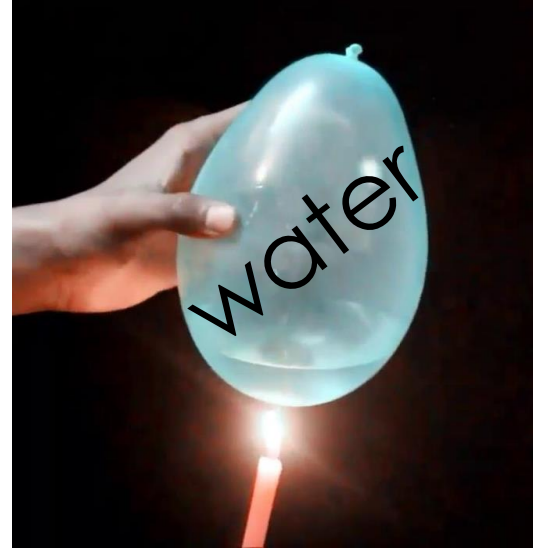


Heat

- Predict
- Observe
- Explain
- Apply

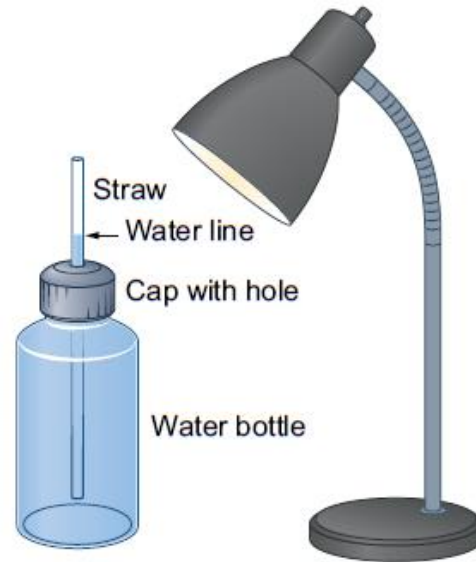


Predict: What happens to the balloons?



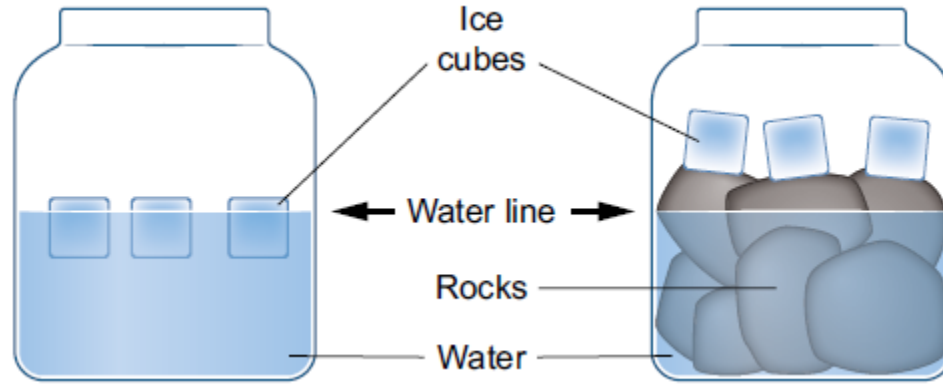
Will the balloons pop at the same time?
If not, which will pop first? Why?

Predict: What happens when water heats up?



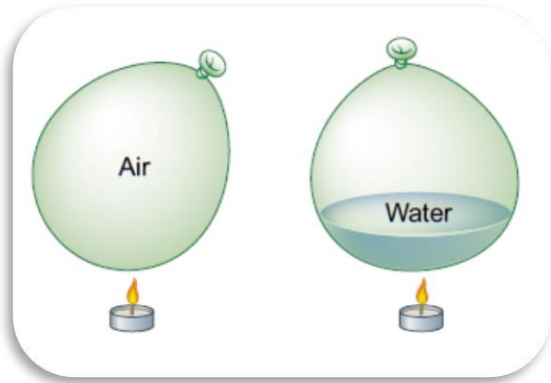
Will the water level rise, fall or stay the same?
Why?

Predict: What happens when ice melts?

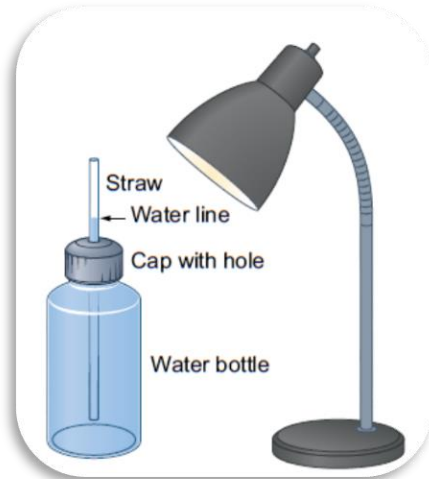


What will happen to the water level in each container? Why?

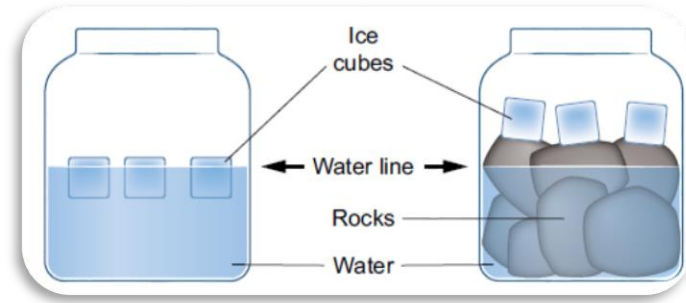
Make your 3 predictions and explanations!



Popping time



Water level

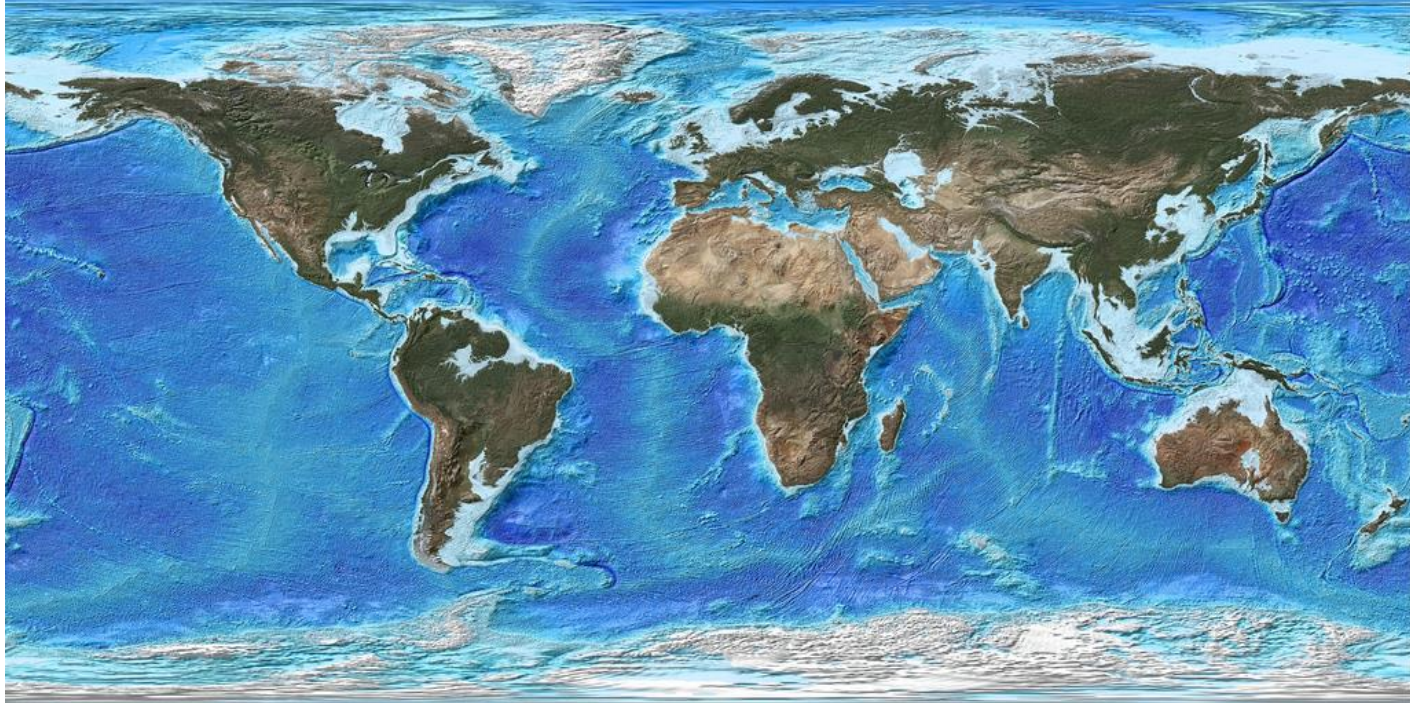


Water level

Observe and Explain

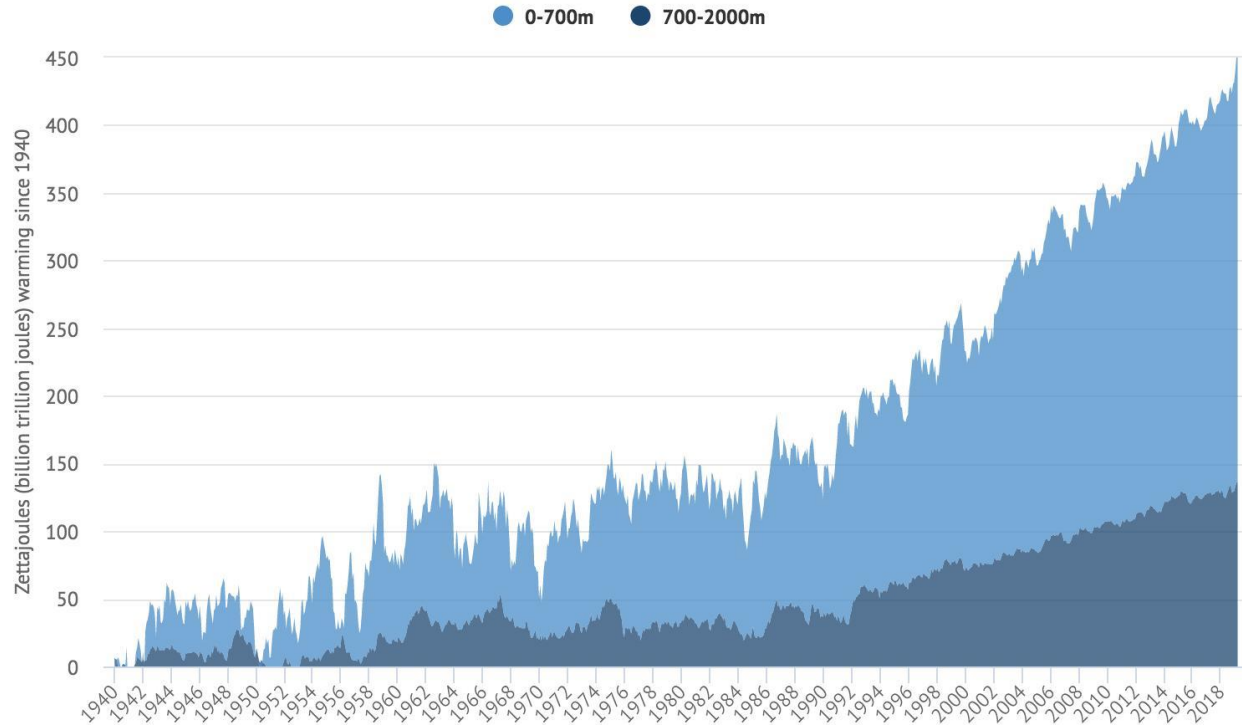


Apply:
70% of the Earth is covered by water

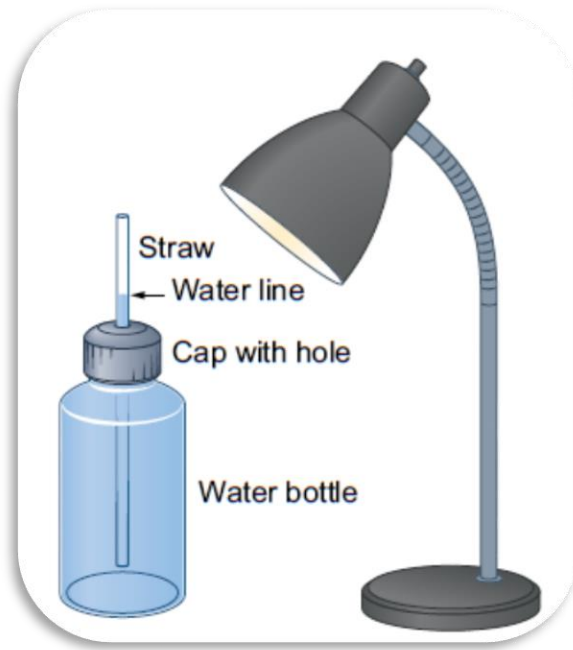


Oceans are hotter

Global ocean heat content



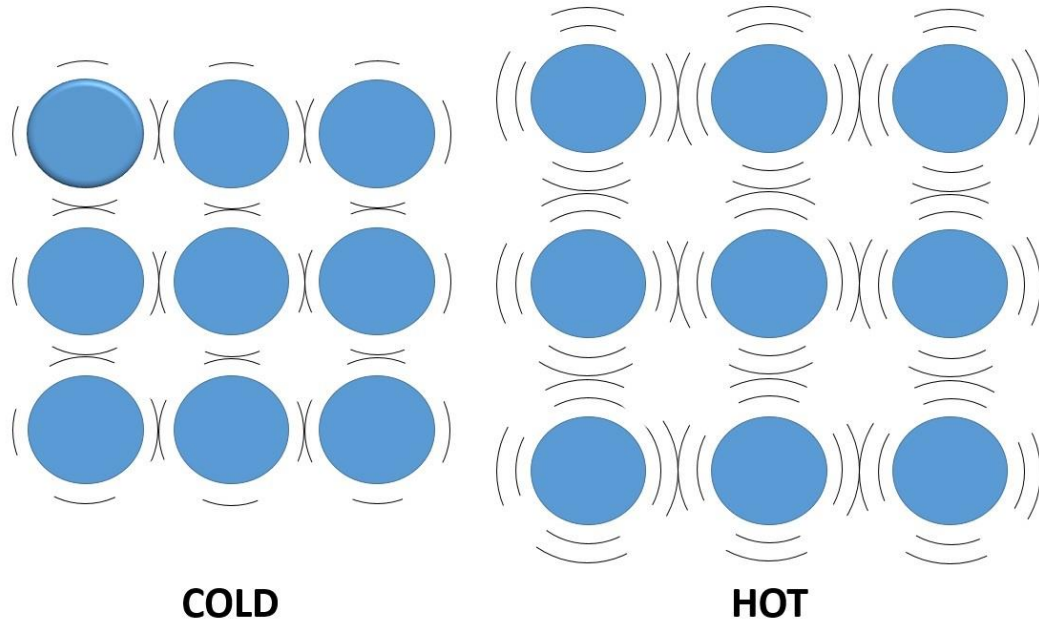
What happens when water heats up?



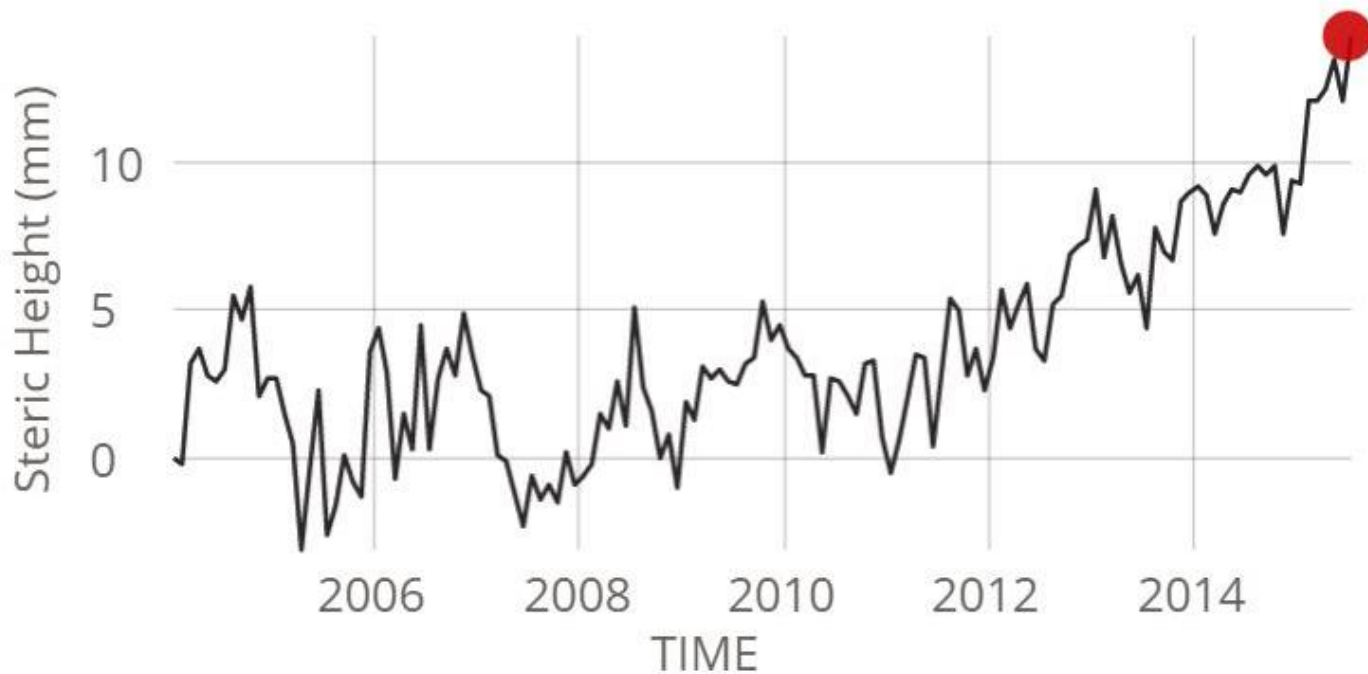
How does this relate to the Earth?



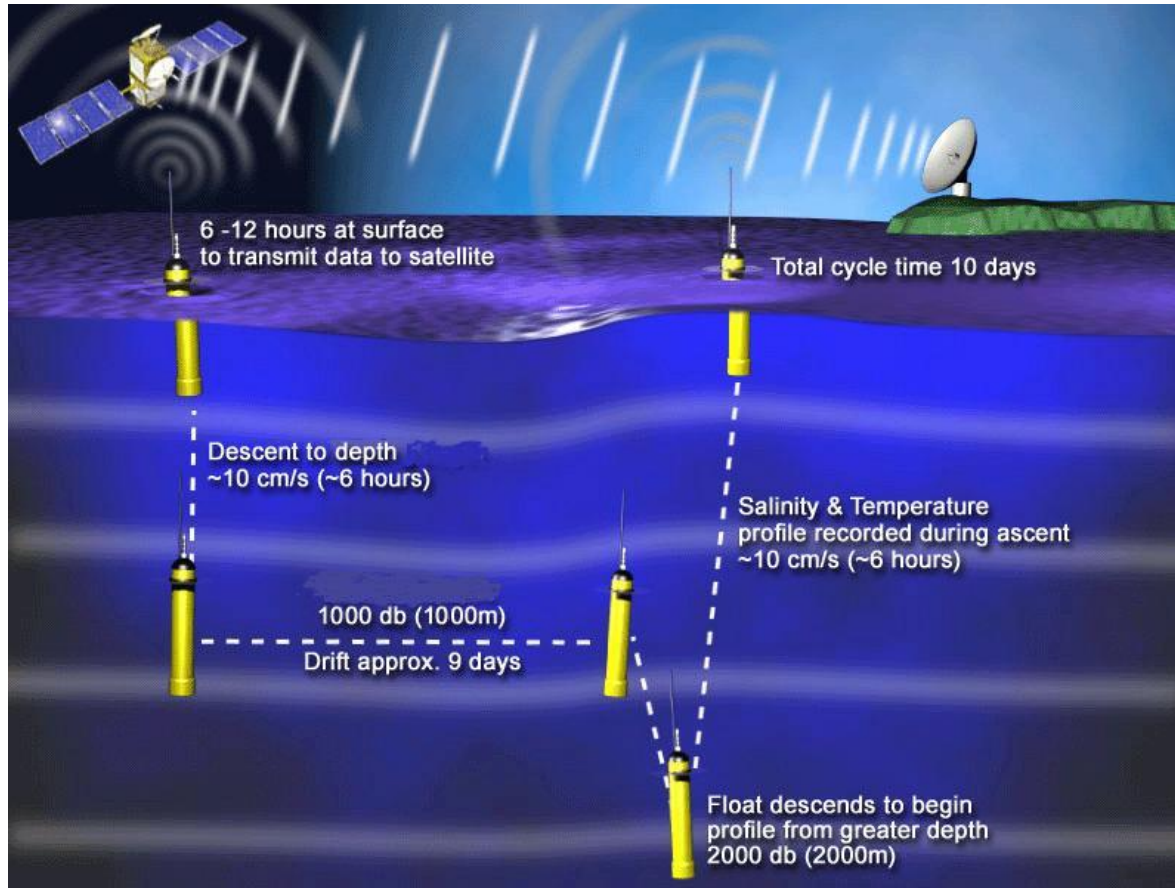
Thermal Expansion of Water



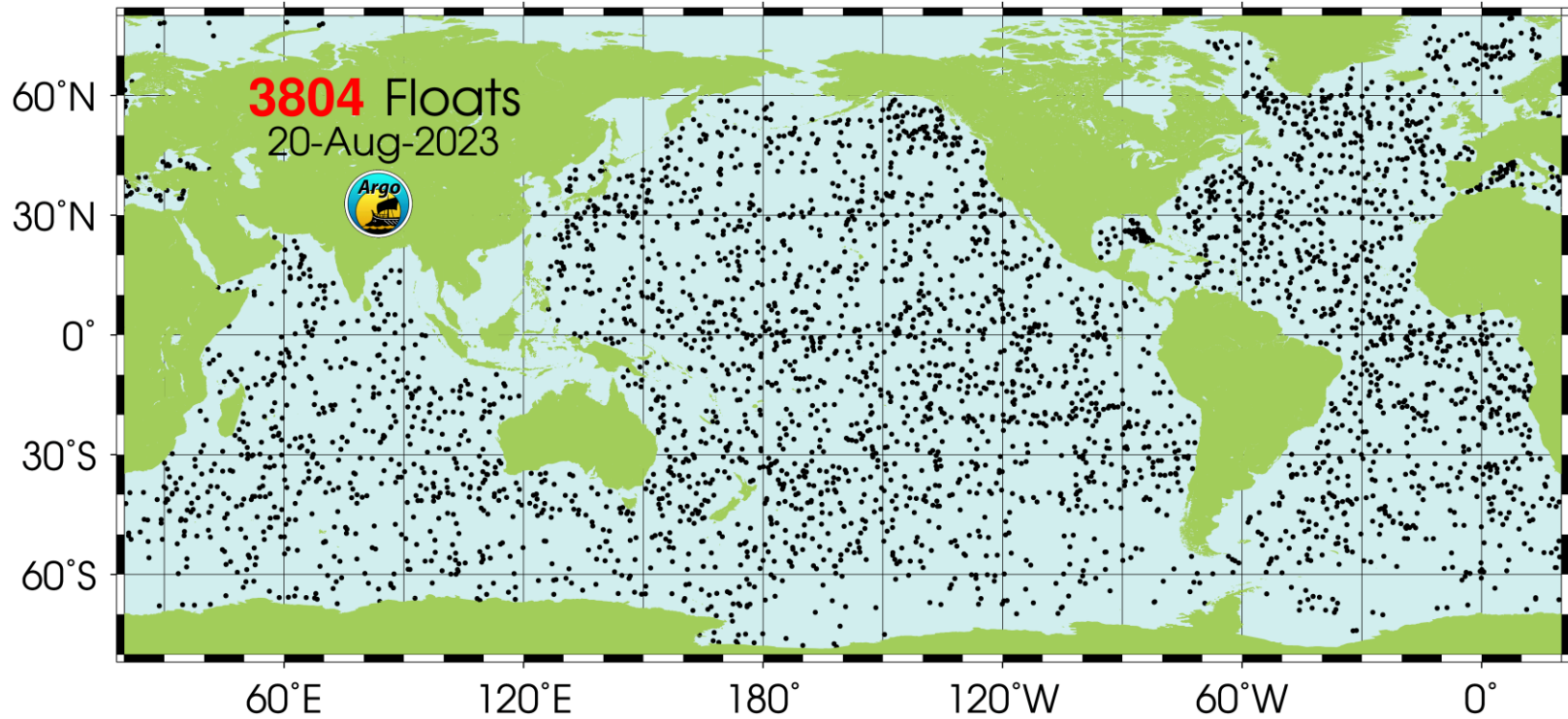
Apply: Measuring the Ocean's Volume



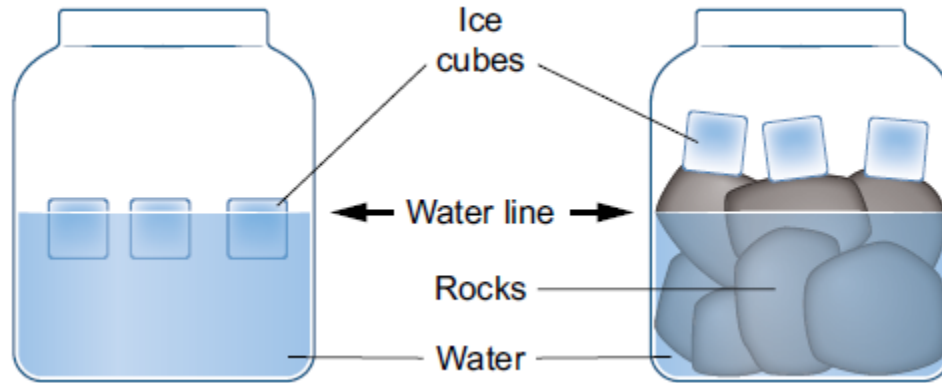
ARGO: Measuring the Ocean's Volume



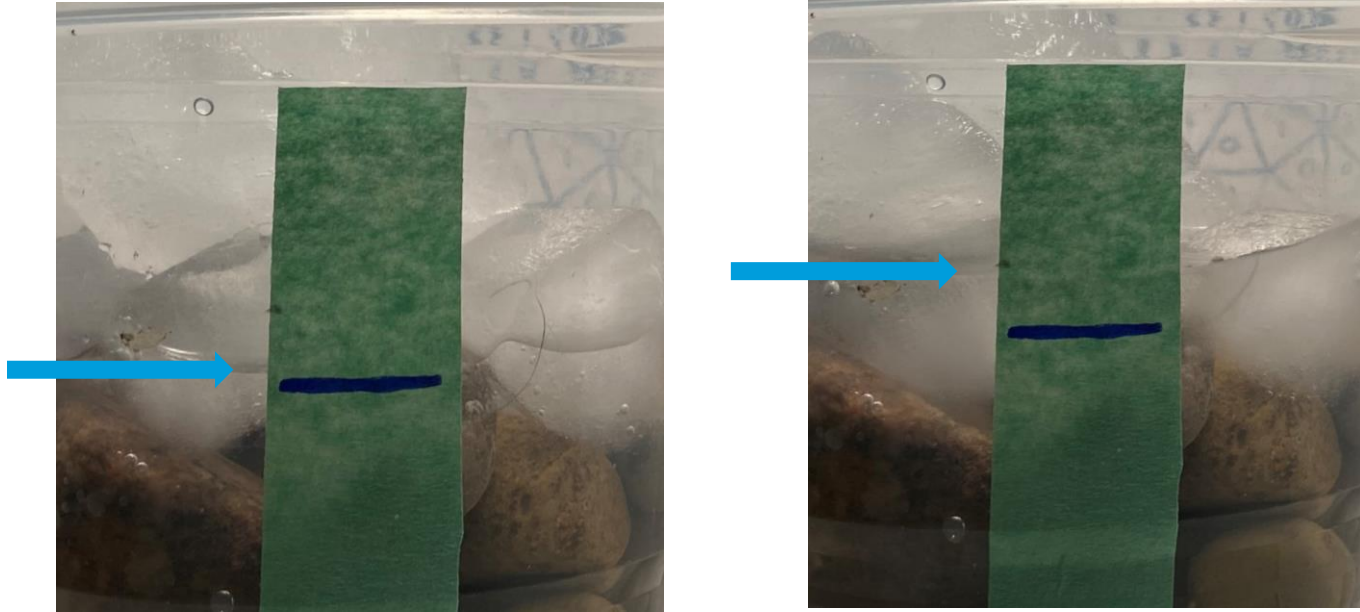
ARGO: Measuring the Ocean's Volume



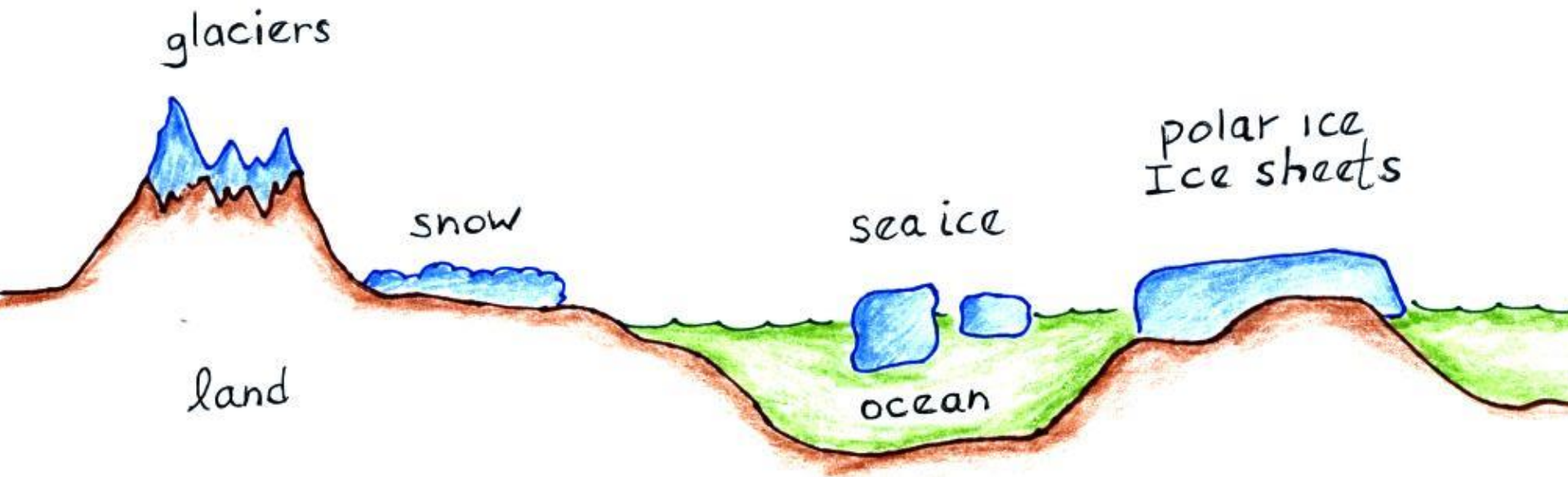
Observe and Explain



How does this relate to the Earth?



Apply: Land Ice vs Sea Ice



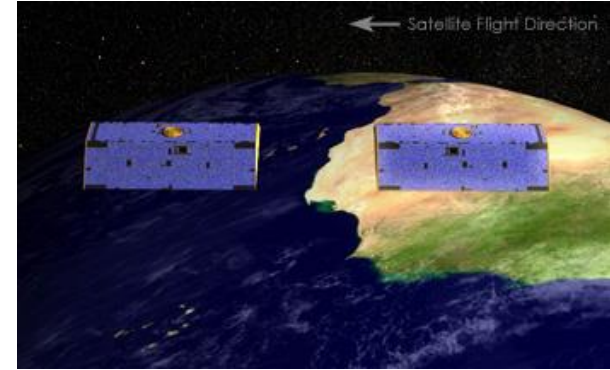
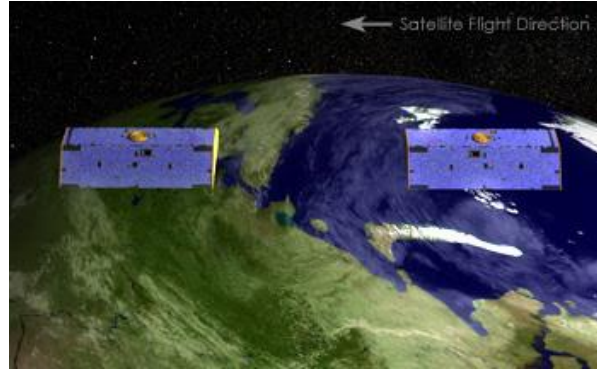
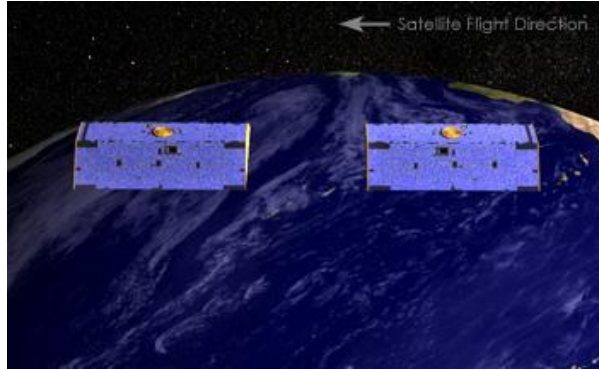


A melting iceberg does not cause a direct change in sea level



A melting glacier adds water to the ocean and causes a direct change in sea level

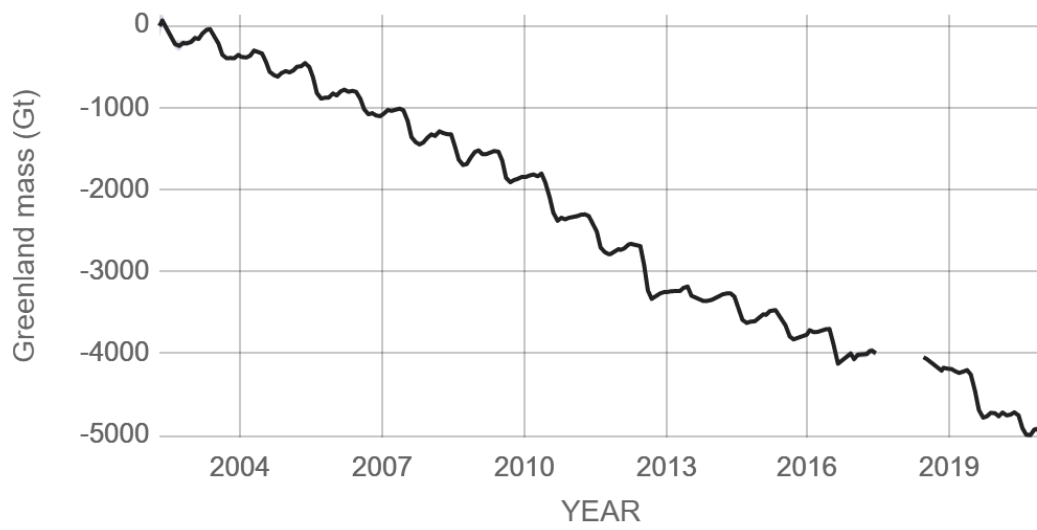
GRACE: Measuring Land Ice Mass





Antarctica ice mass is decreasing at 150 Gt per year

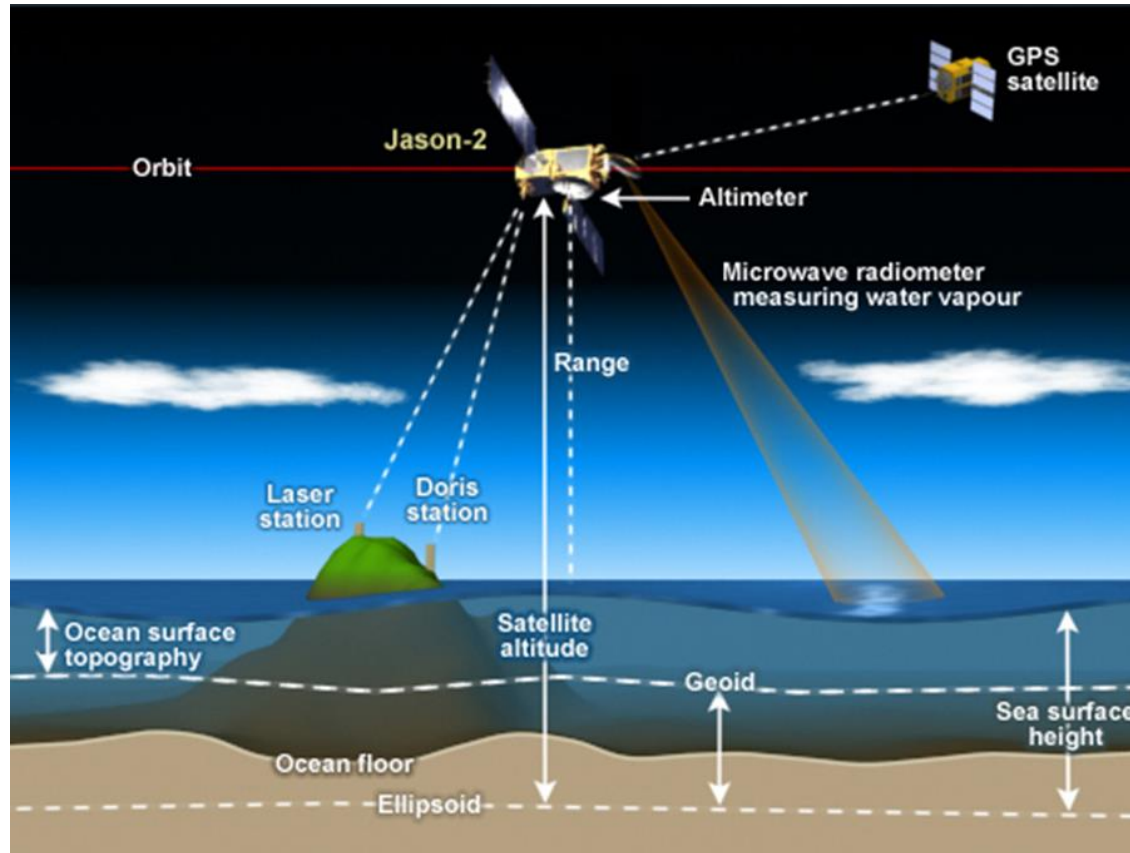
> 420 Gt per year!



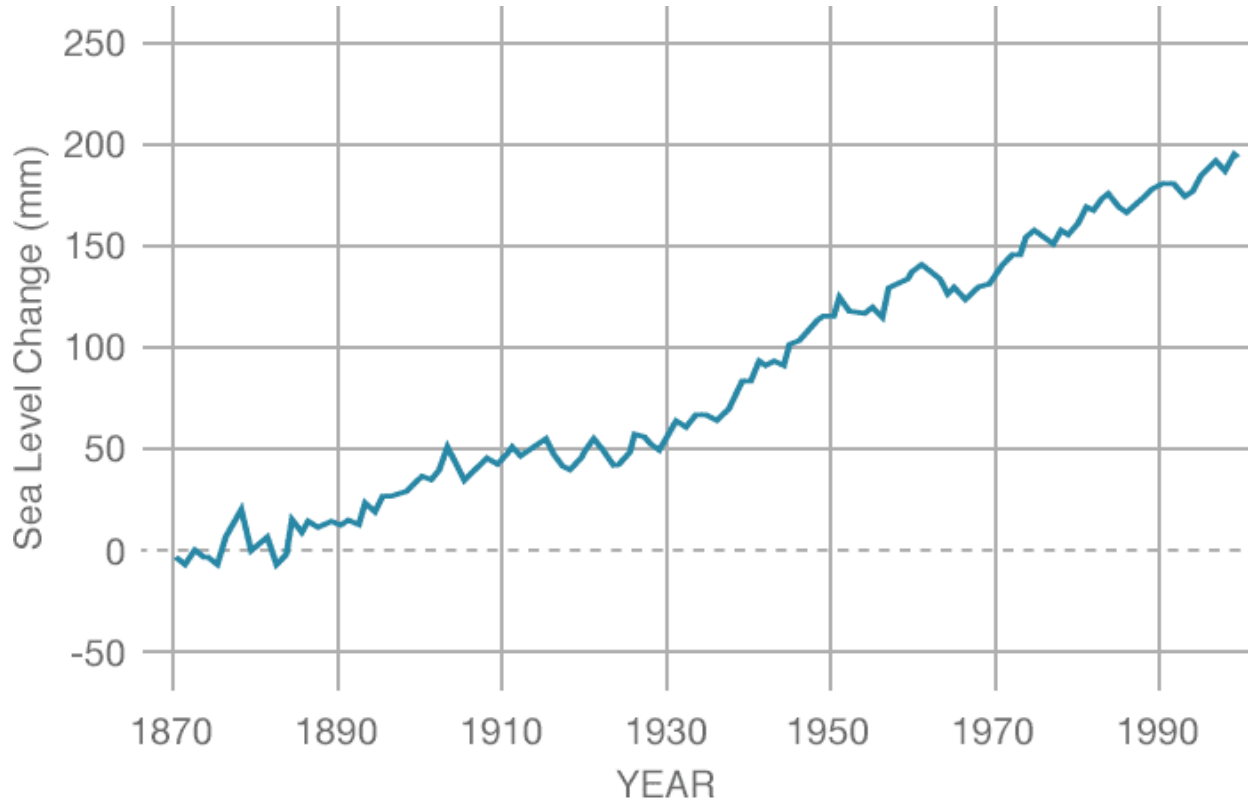
Greenland ice mass is decreasing at 278 Gt per year

Source: climate.nasa.gov

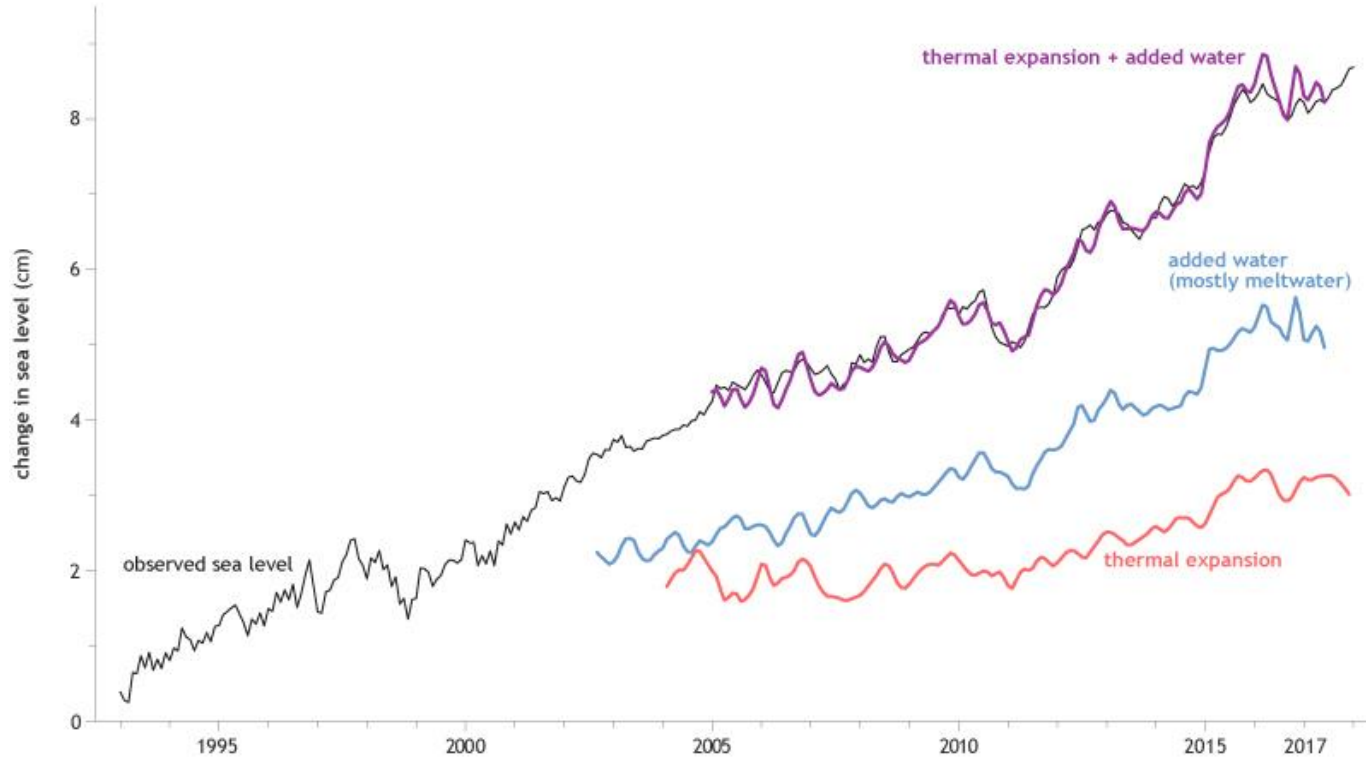
Satellite Altimetry: Measuring Sea Level



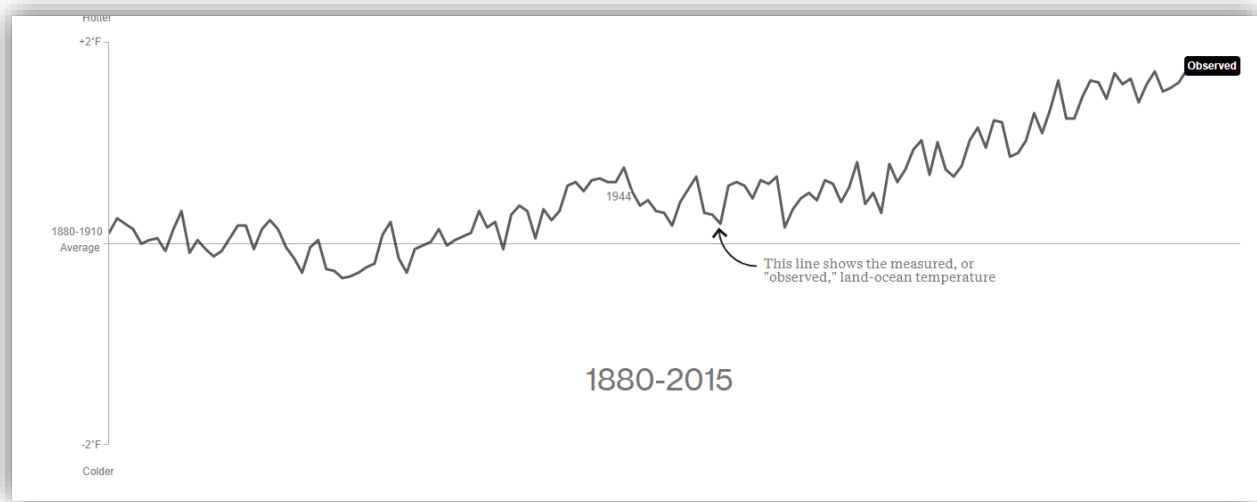
Measuring the Height of the Sea



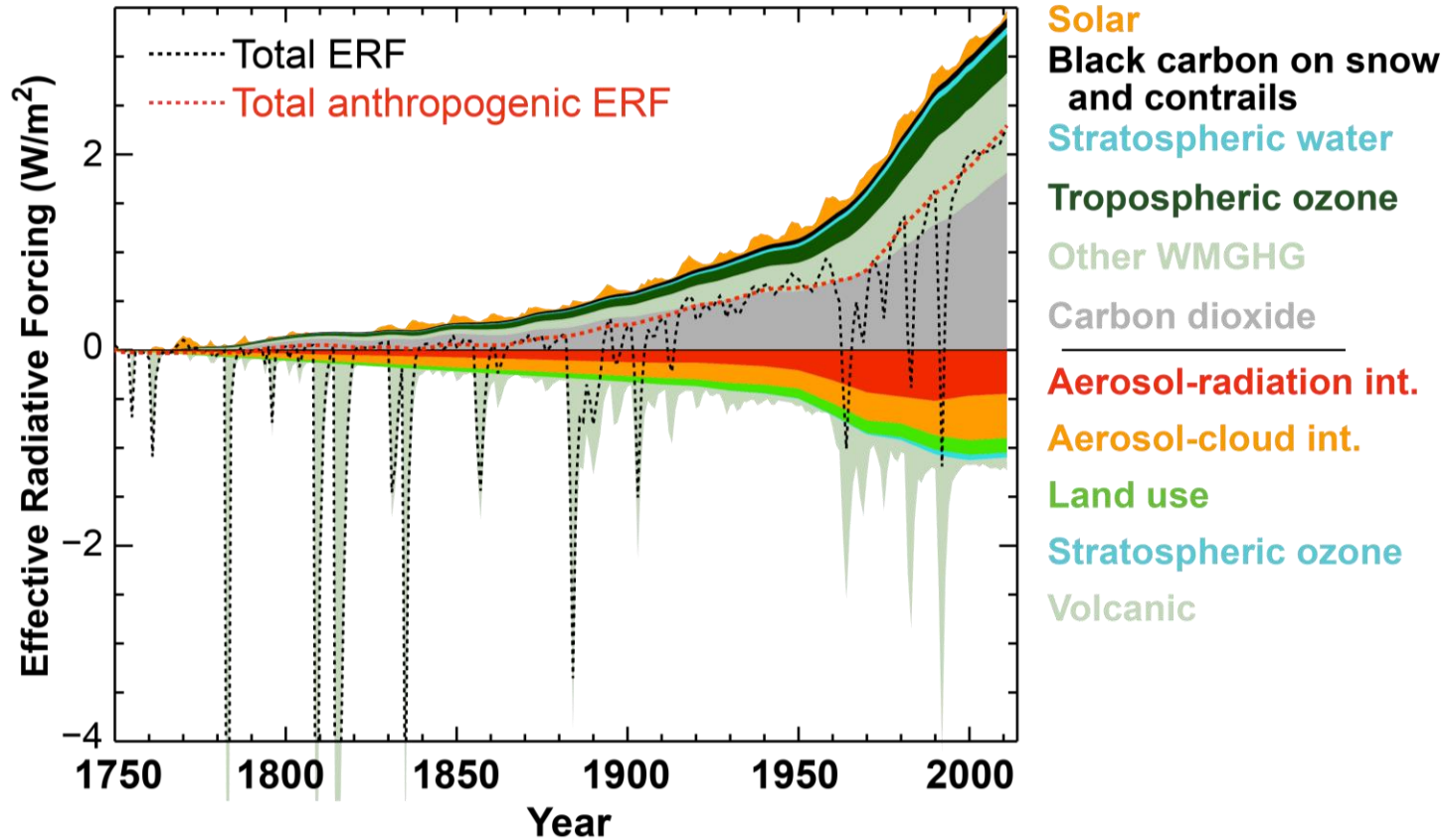
Sea Level Budget



What's causing the warming?



Forcing factors



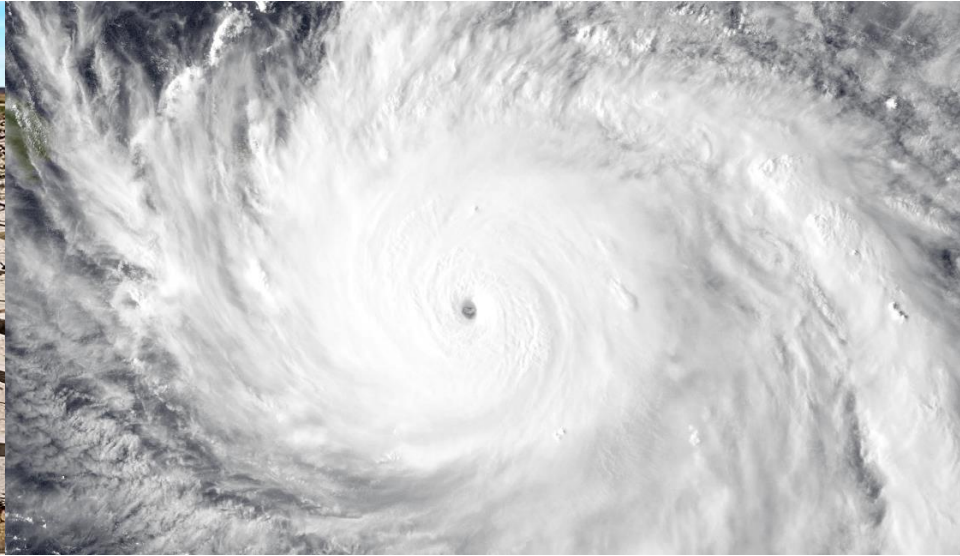
Effects of climate change

Increased flooding

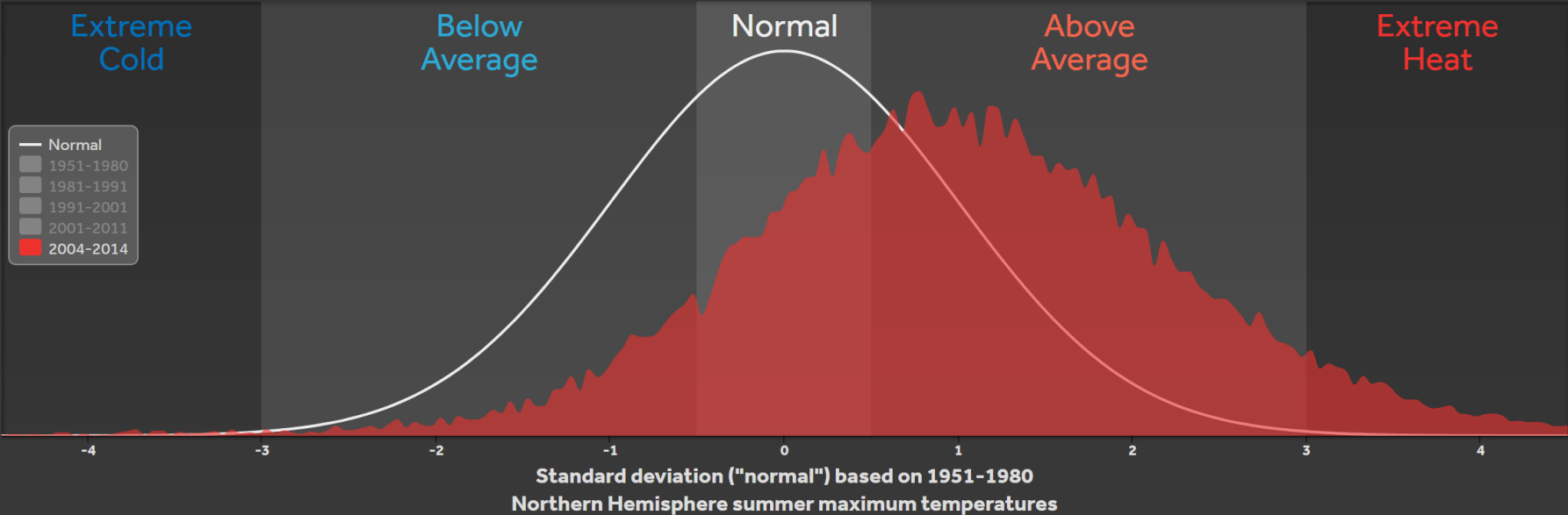


Effects of climate change

More extreme weather events



More heat waves



Effects of climate change

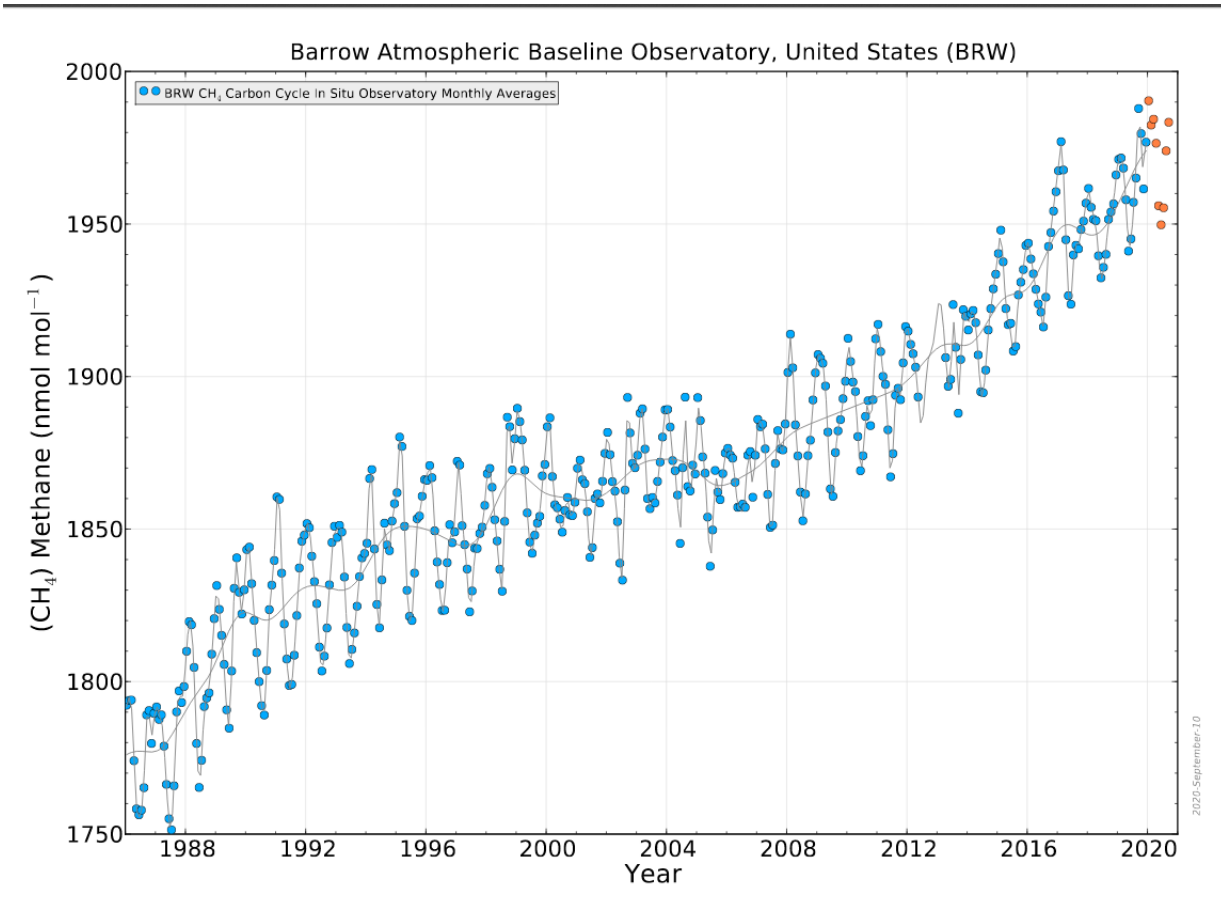
More intense wildfires



Effects of climate change

Thawing permafrost





Effects of climate change

Shifting Ecosystems



Effects of climate change

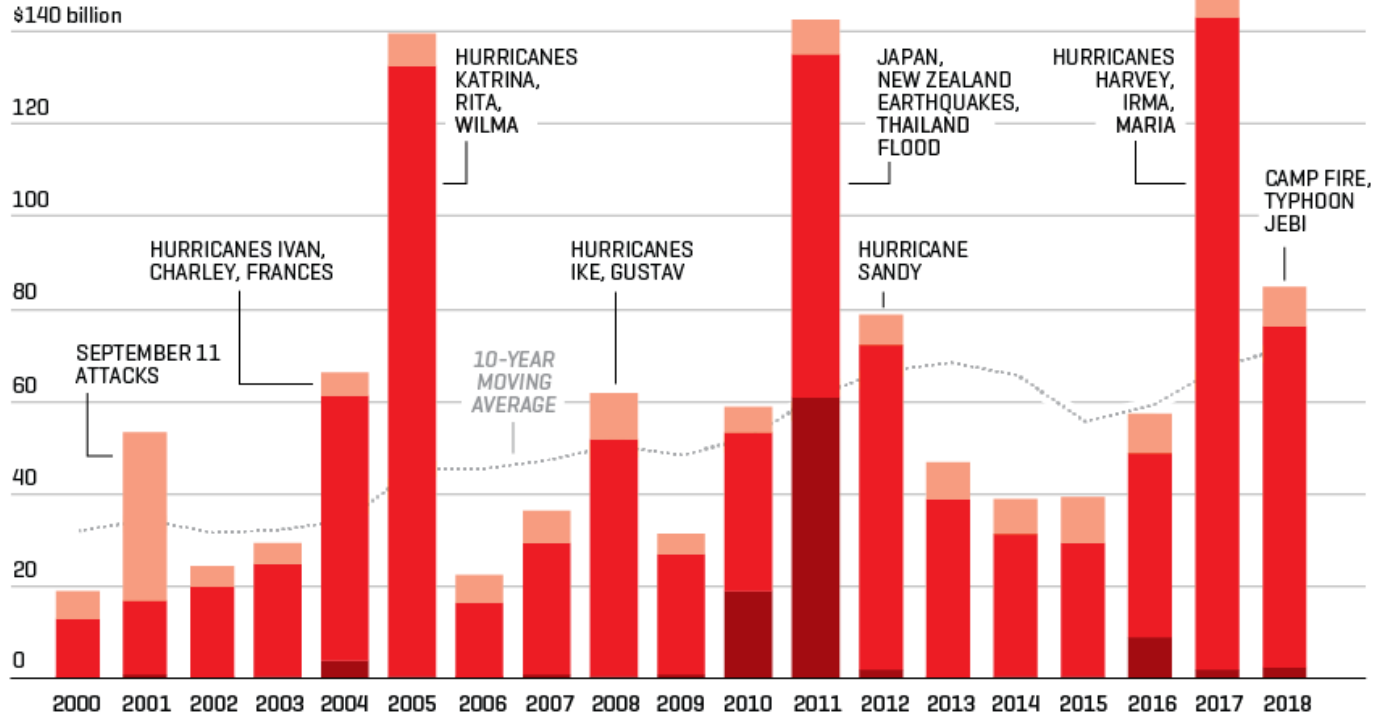
Spreading diseases



Economic costs of climate change

INSURED CATASTROPHE LOSSES [2018 dollars]

■ EARTHQUAKE/Tsunami
 ■ WEATHER-RELATED DISASTERS
 ■ MAN-MADE DISASTERS



SOURCE: SWISS RE INSTITUTE

Social costs of climate change



Climate Change



It's real...

It's us...

It's serious...

And the window of time to prevent dangerous impacts is closing fast.

Katharine Hayhoe, Texas Tech



**HUMANITY'S GREATEST
CHALLENGE IS ALSO OUR
GREATEST OPPORTUNITY**

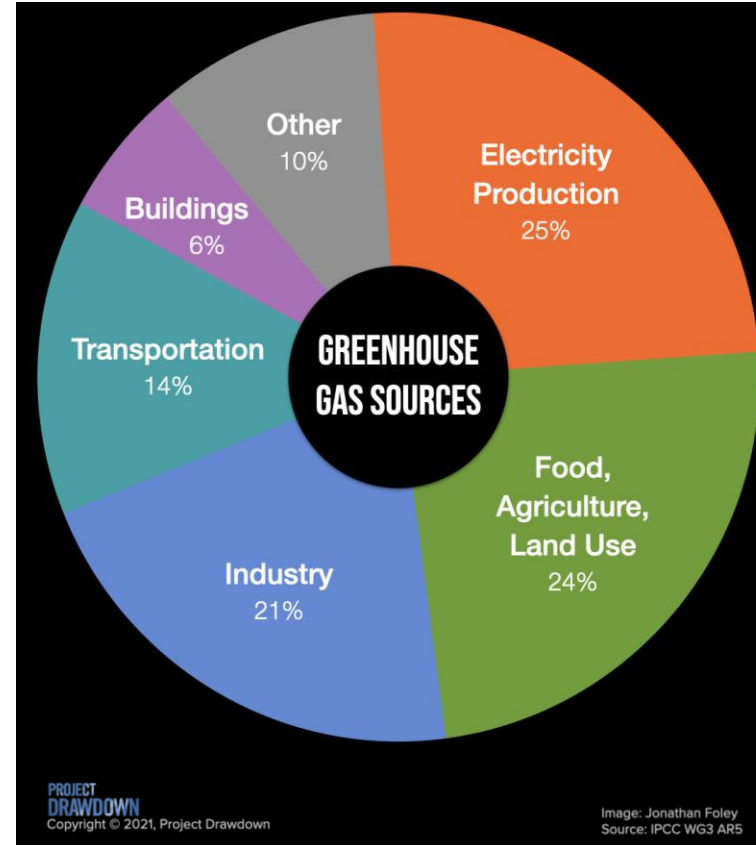
[DRAWDOWN.ORG/CLIMATE-SOLUTIONS-101](https://drawdown.org/climate-solutions-101)

“We basically have three choices: *mitigation*, *adaptation*, and *suffering*. We’re going to do some of each. The question is what the mix is going to be. The more mitigation we do, the less adaptation will be required and the less suffering there will be.”

- John Holdren (climate expert)

Mitigation: Sources and Sinks

- *Reducing GHGs at the source*
 - Renewables
 - Plant-based diet
 - EVs
- *Enhancing carbon sinks*
 - Reforestation
 - Carbon Capture and Sequestration
 - Direct Air Capture



Project Drawdown Top 10

The logo for Drawdown.org, featuring the text "DRAWDOWN.ORG" in a bold, blue, sans-serif font. The text is set against a background of a blue sky with white clouds.

2.0°C by 2100

1.5°C by 2100

Reduced Food Waste

Onshore Wind Turbines

Health and Education for Girls/Women

Utility-Scale Solar Photovoltaics

Plant-Rich Diets

Reduced Food Waste

Refrigerant Management

Plant-Rich Diets

Tropical Forest Restoration

Health and Education for Girls/Women

Onshore Wind Turbines

Tropical Forest Restoration

Alternative Refrigerants

Improved Clean Cookstoves

Utility-Scale Solar Photovoltaics

Distributed Solar Photovoltaics

Improved Clean Cookstoves

Refrigerant Management

Distributed Solar Photovoltaics

Alternative Refrigerants

Adaptation

Adjusting to the current and future effects of climate change. A few centimetres may not seem like much...



www.david.baxendale.com/Flickr

The coastline of Mykonos could move 150m inland as the sea level rises.

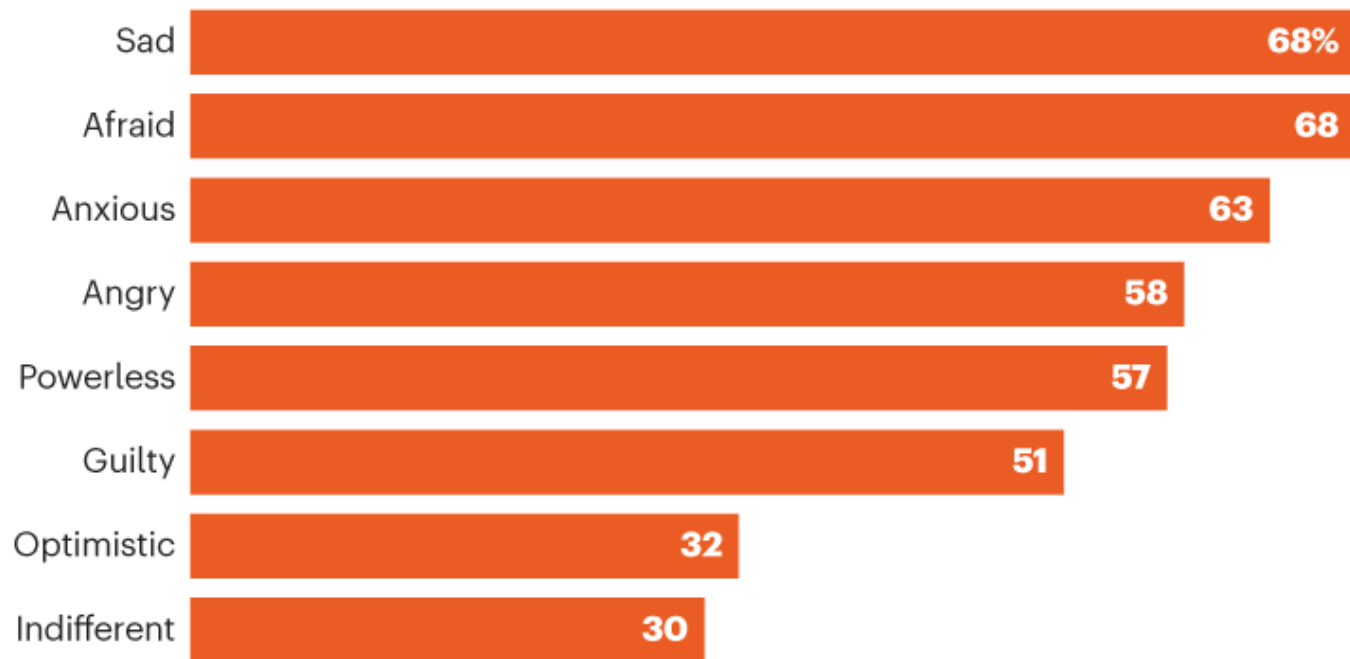
Recognize that this is a complex issue

- Inter-generational conflict
- Racial inequality
- Defence Mechanisms
- Hopelessness
- Shame
- Anxiety



Climate Anxiety

Climate change makes me feel...



What good will personal actions do?

PRACTICE WHAT
YOU PREACH!

ACTION IS HOPE.
THERE IS NO HOPE
WITHOUT ACTION.

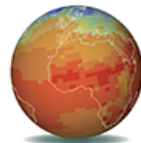
- RAY BRADBURY



Simple actions you can take:

- Talk about Climate Change
- Reduce your own personal footprint
 - Transportation and energy choices
 - Carbon offsets
 - Dietary choices
- Lobby for systemic change
 - Political, social, economic

Resources



climateprediction.net

the world's largest climate modelling experiment for the 21st century

PI PERIMETER INSTITUTE