Climate Change:
Evidence, Effects, and Actions

CERN HST 2022

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

10 Perimeter Inspirations

Grade 10: Evidence for Climate Change

SPARKING INQUIRY THROUGH SCIENCE AND MATH

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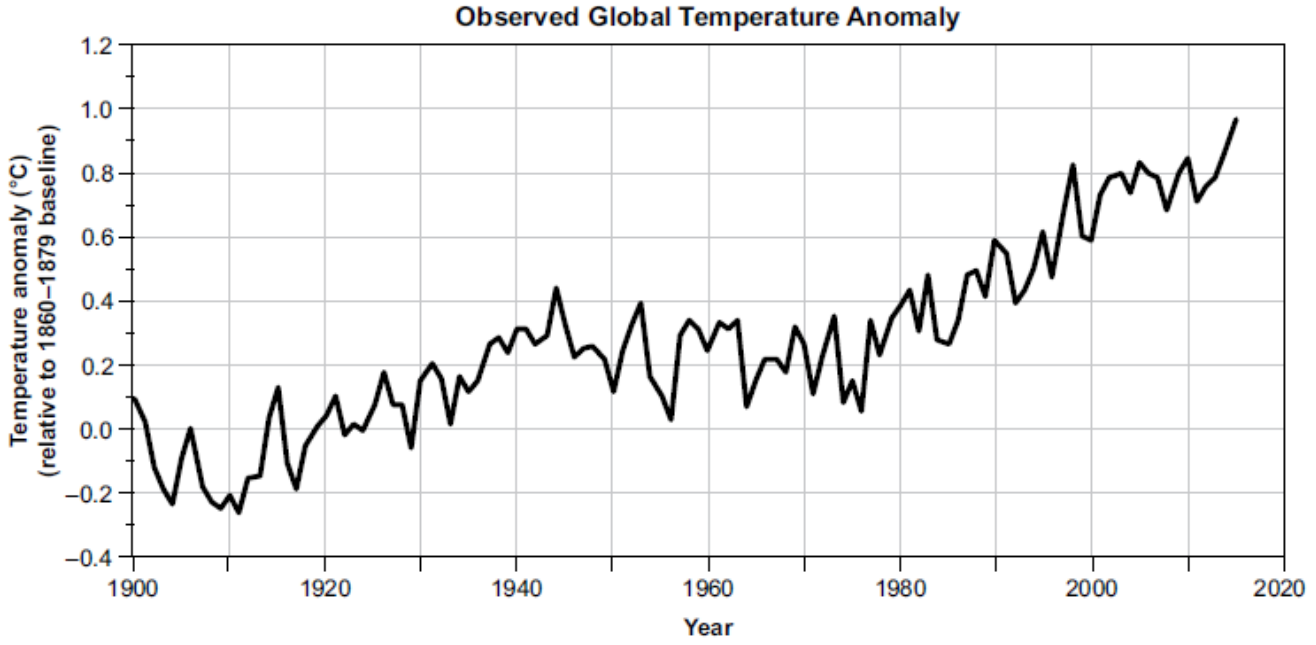
Earth is getting warmer



Source: NASA GISS

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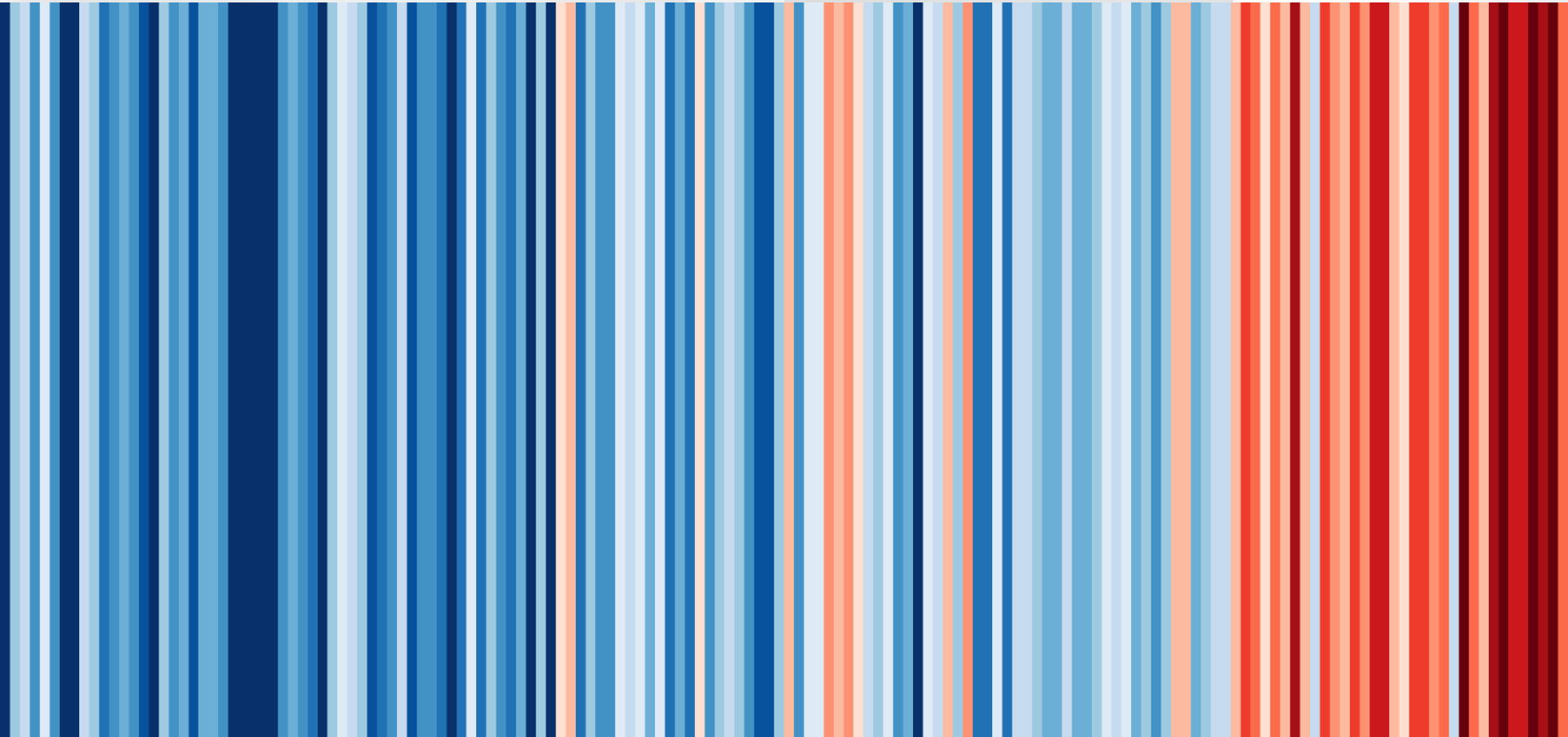
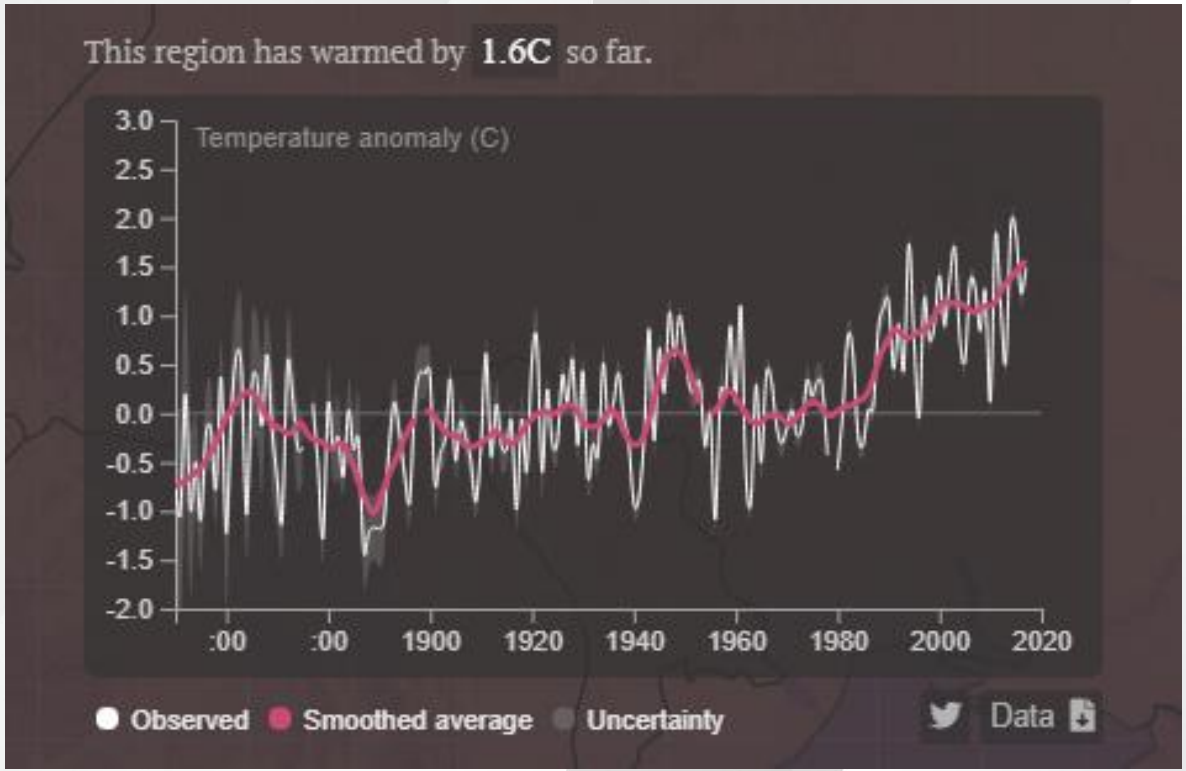
Switzerland (1864 – 2021)



Geneva is getting warmer



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

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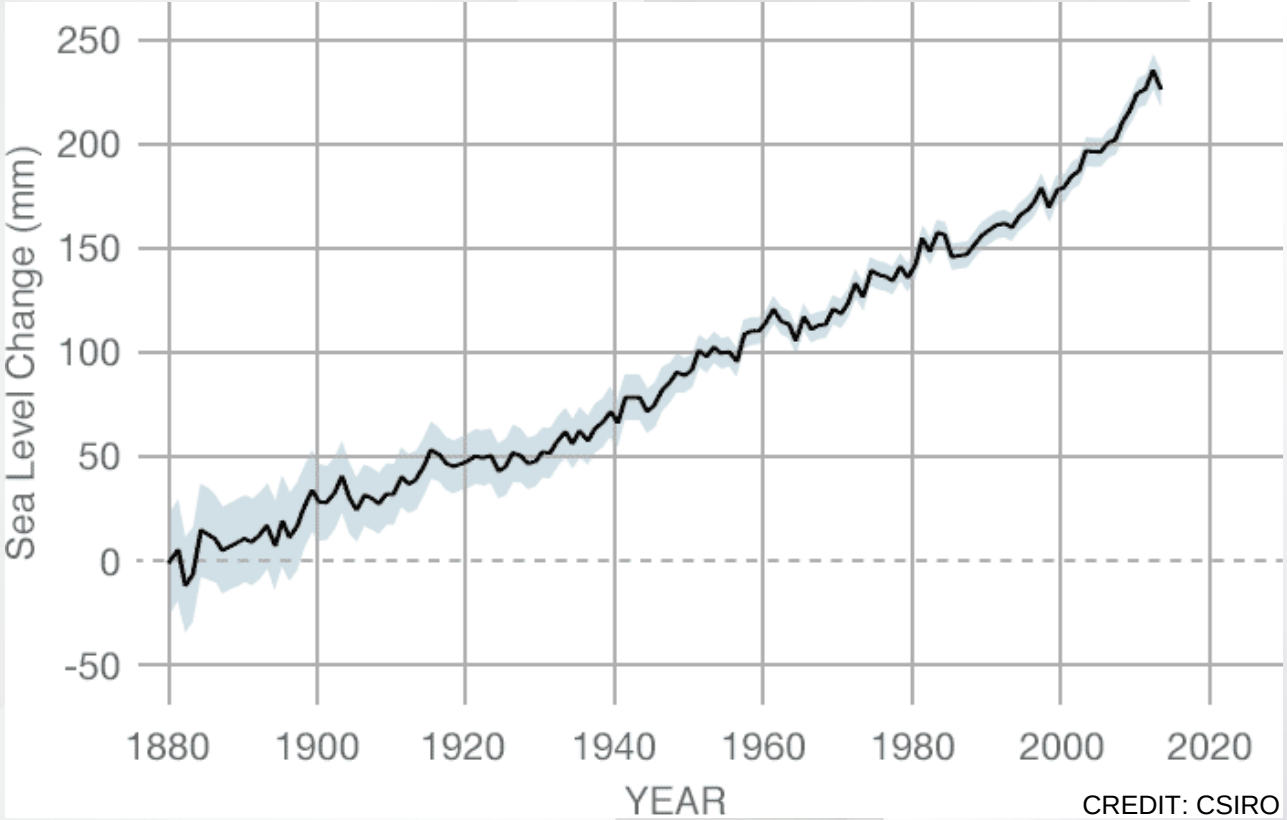
A few degrees may not seem like much…

37°C = healthy

39°C = sick

Sea Levels are rising



CREDIT: CSIRO

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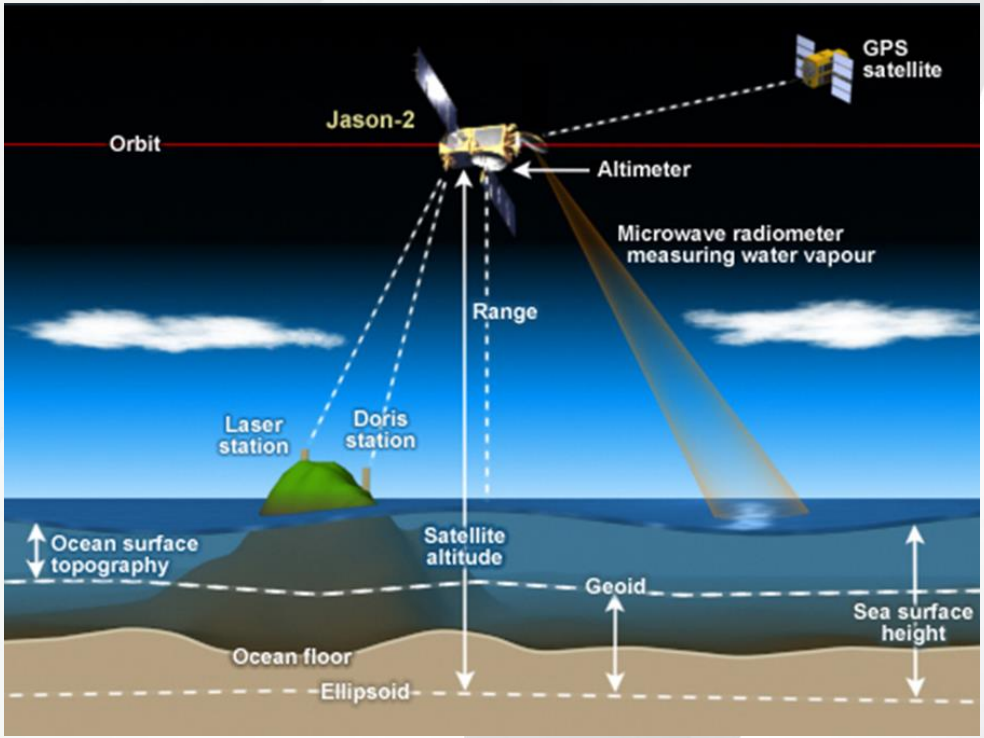
Satellite Altimetry: Measuring Sea Level



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A few centimetres may not seem like much…

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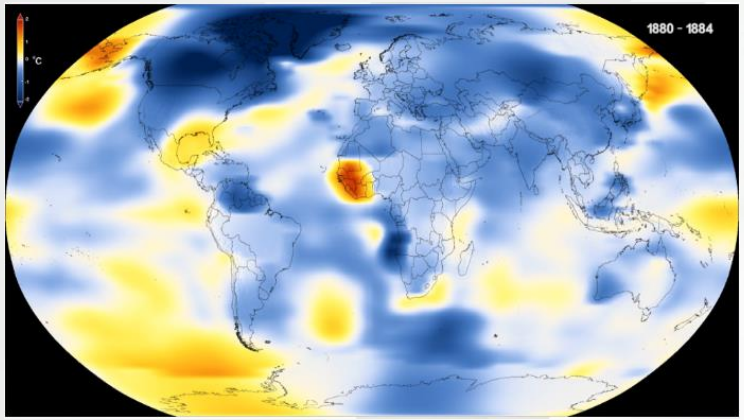
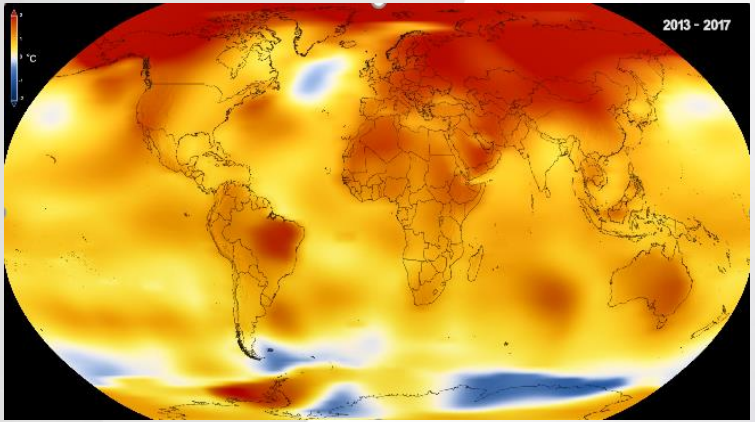
The question is: Why?



1880



2017

And what can we do about it?

A Climate Change demo

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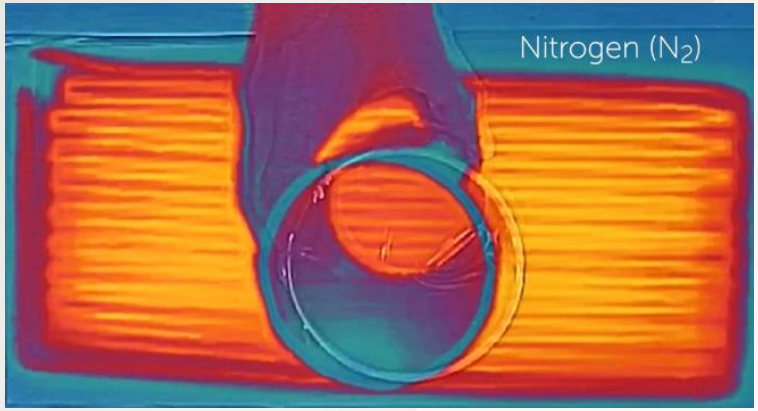
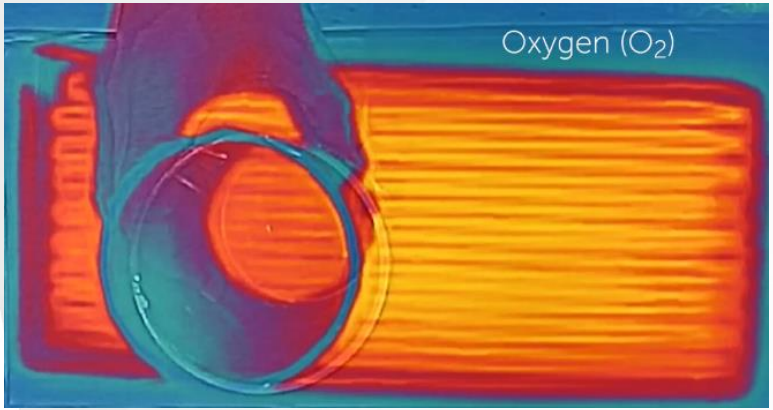
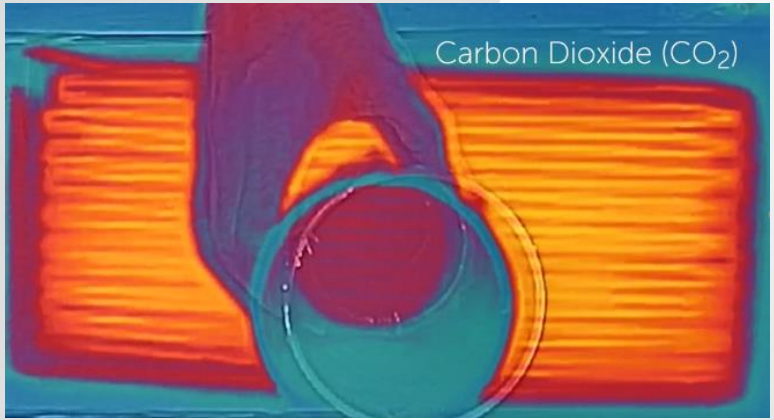
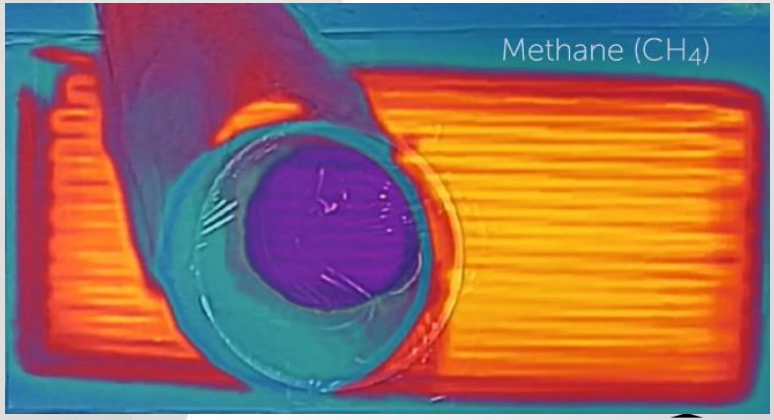
Which gases are transparent to infrared radiation?









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Keeling Curve

https://keelingcurve.ucsd.edu/

- Measurement of the concentration of CO_2 in the atmosphere

- Continuous record at Mauna Loa since 1958

Latest CO_2 reading: 420.10 ppm

(May 4, 2022)

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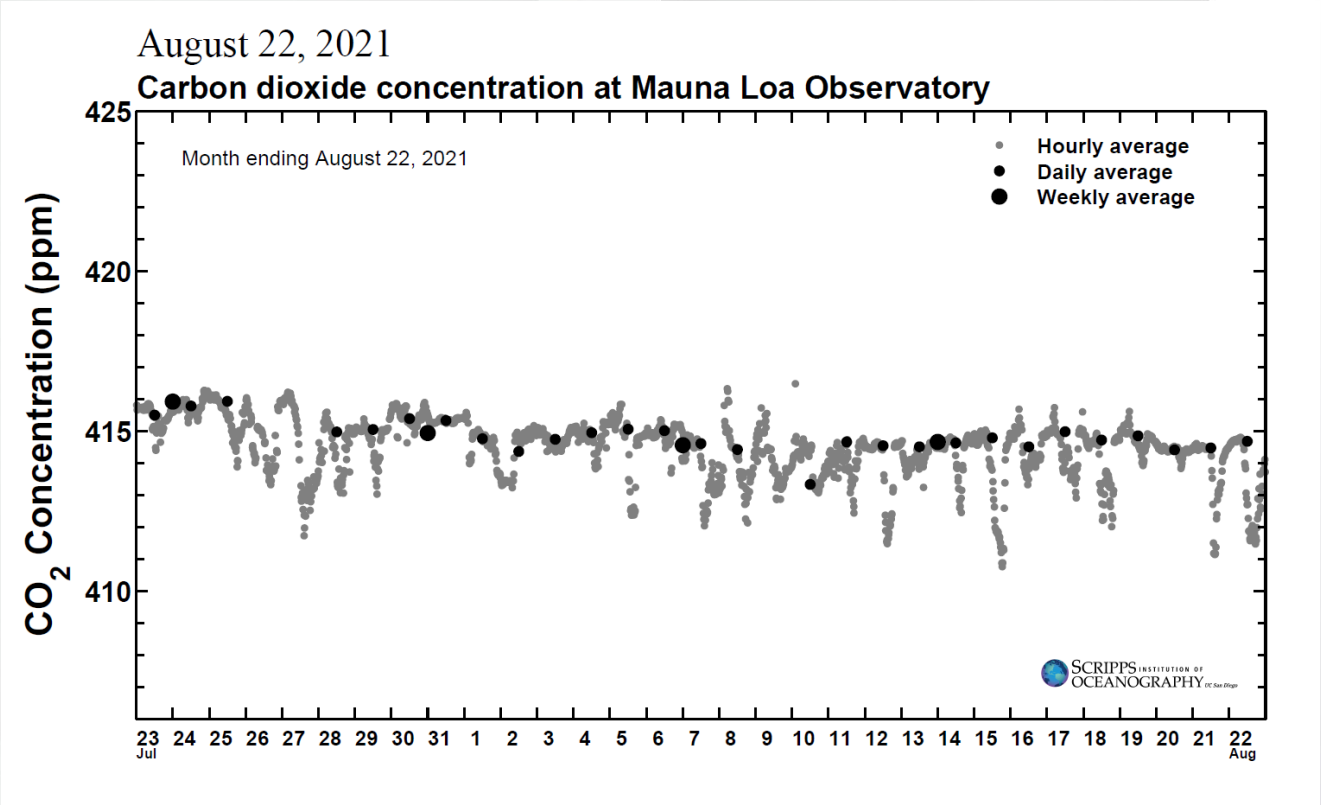
One month



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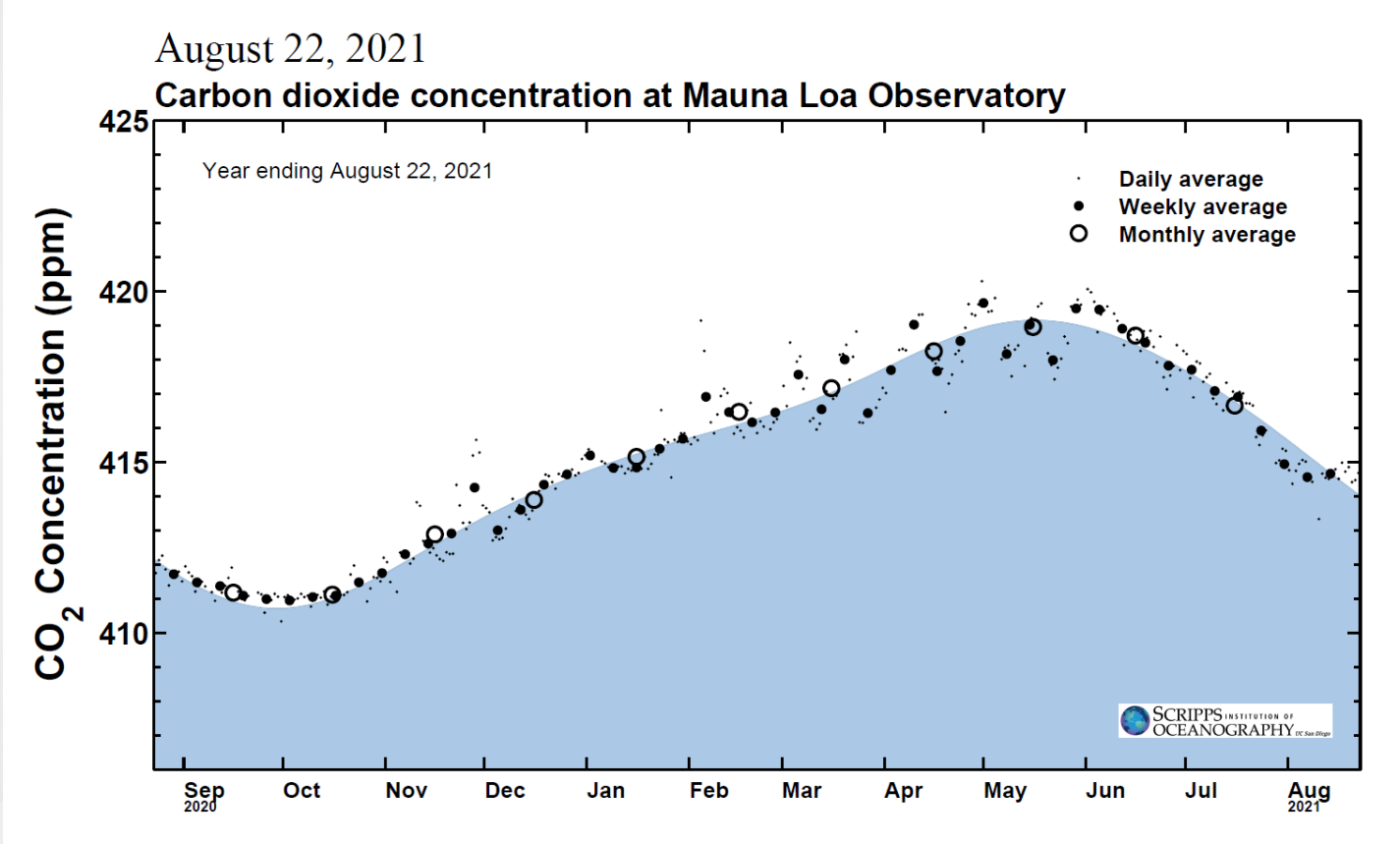
1 year



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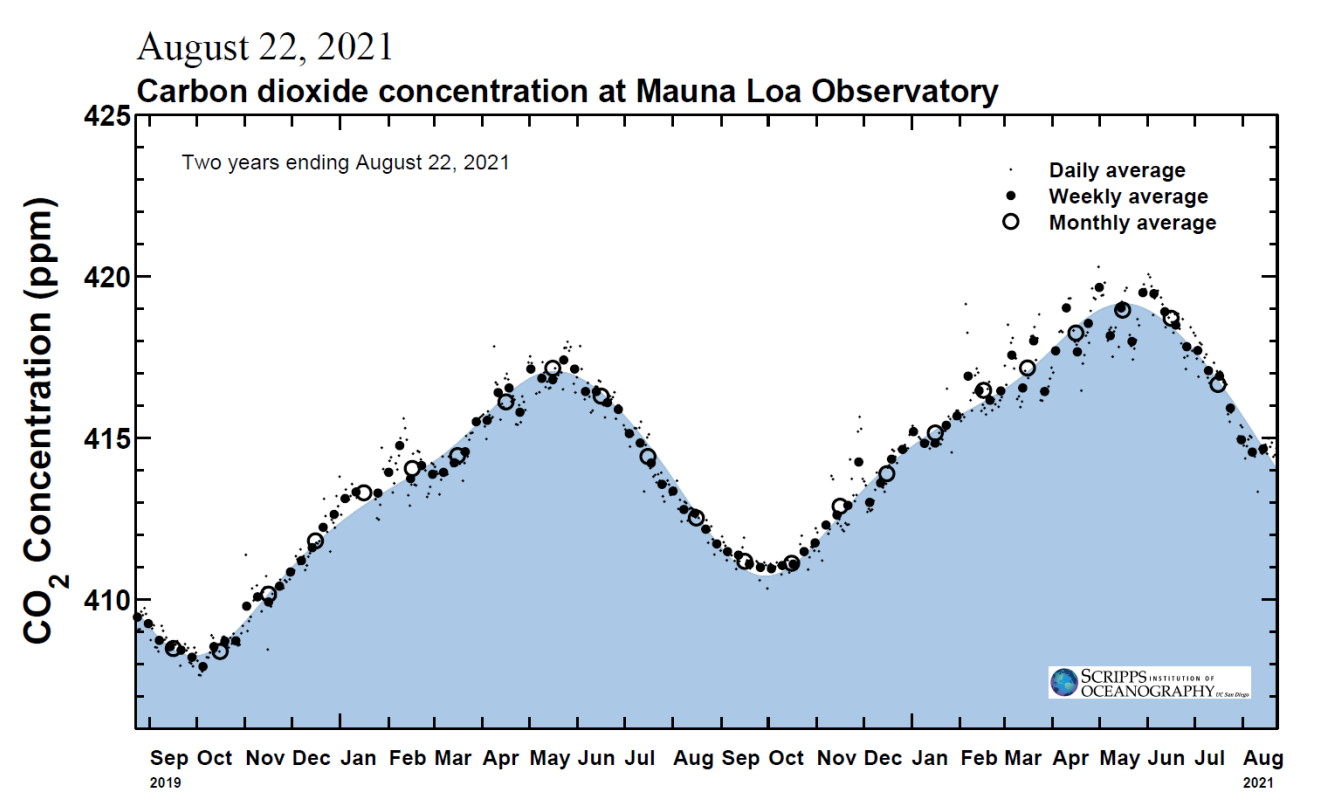
Last two years



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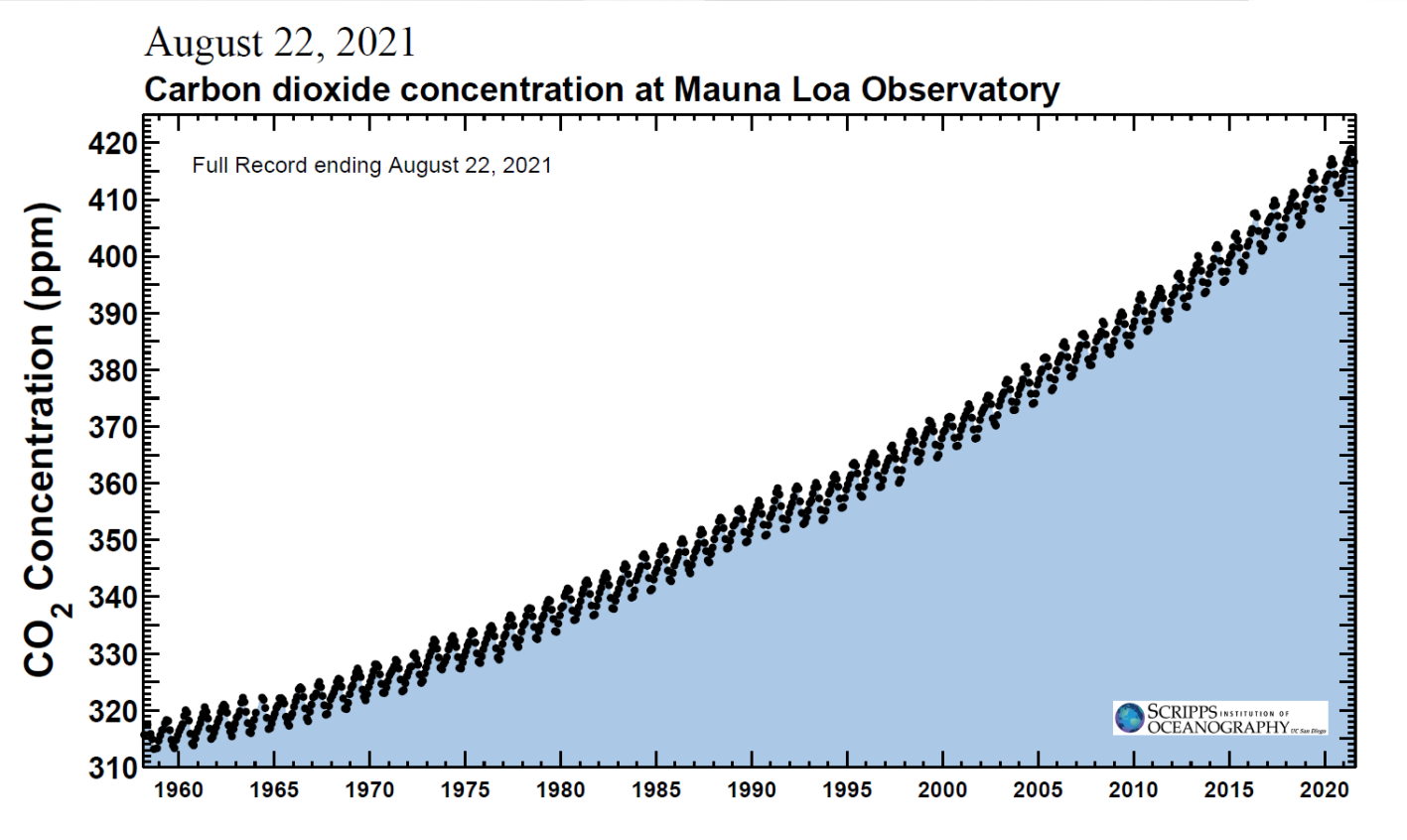
Full record



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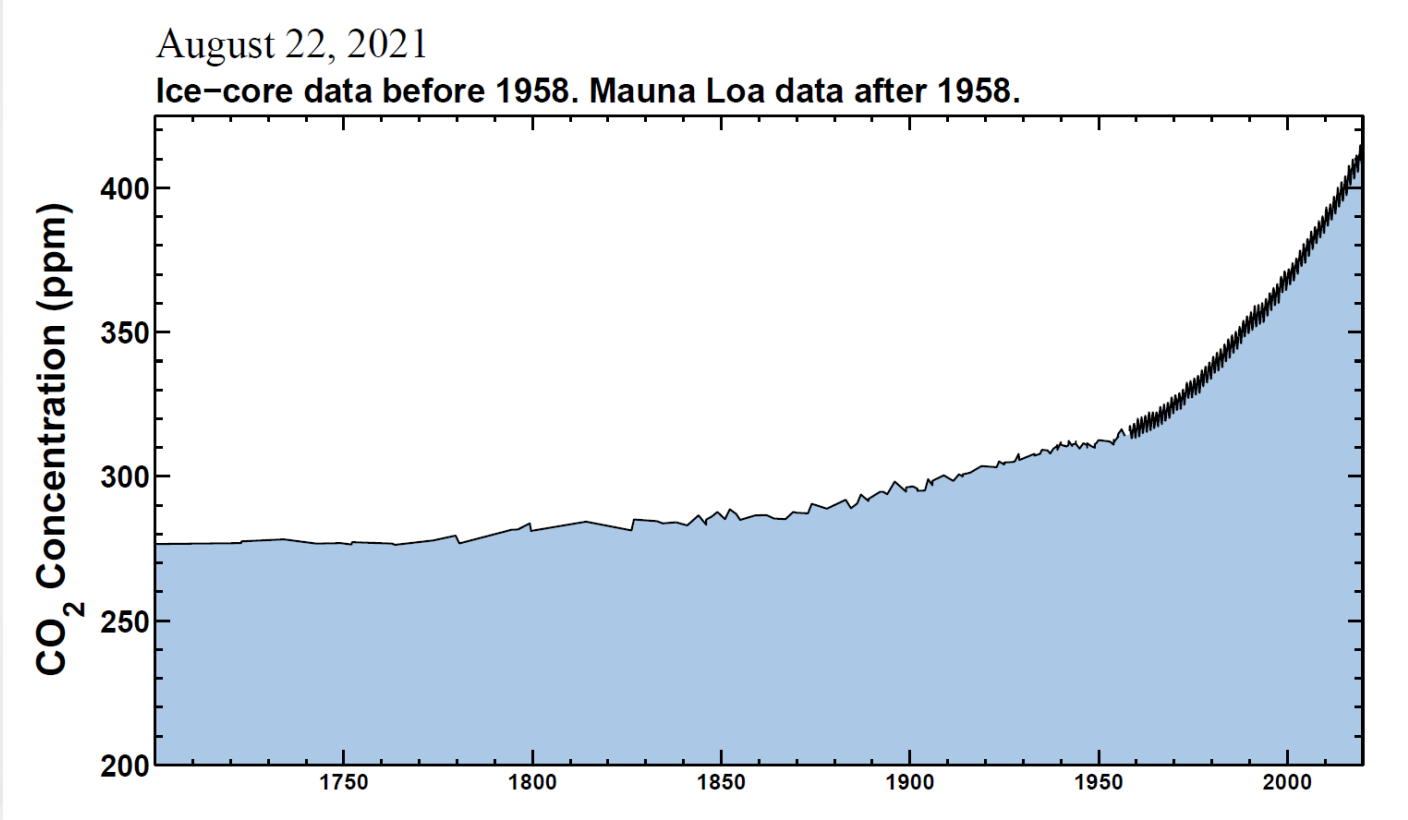
1700 - present



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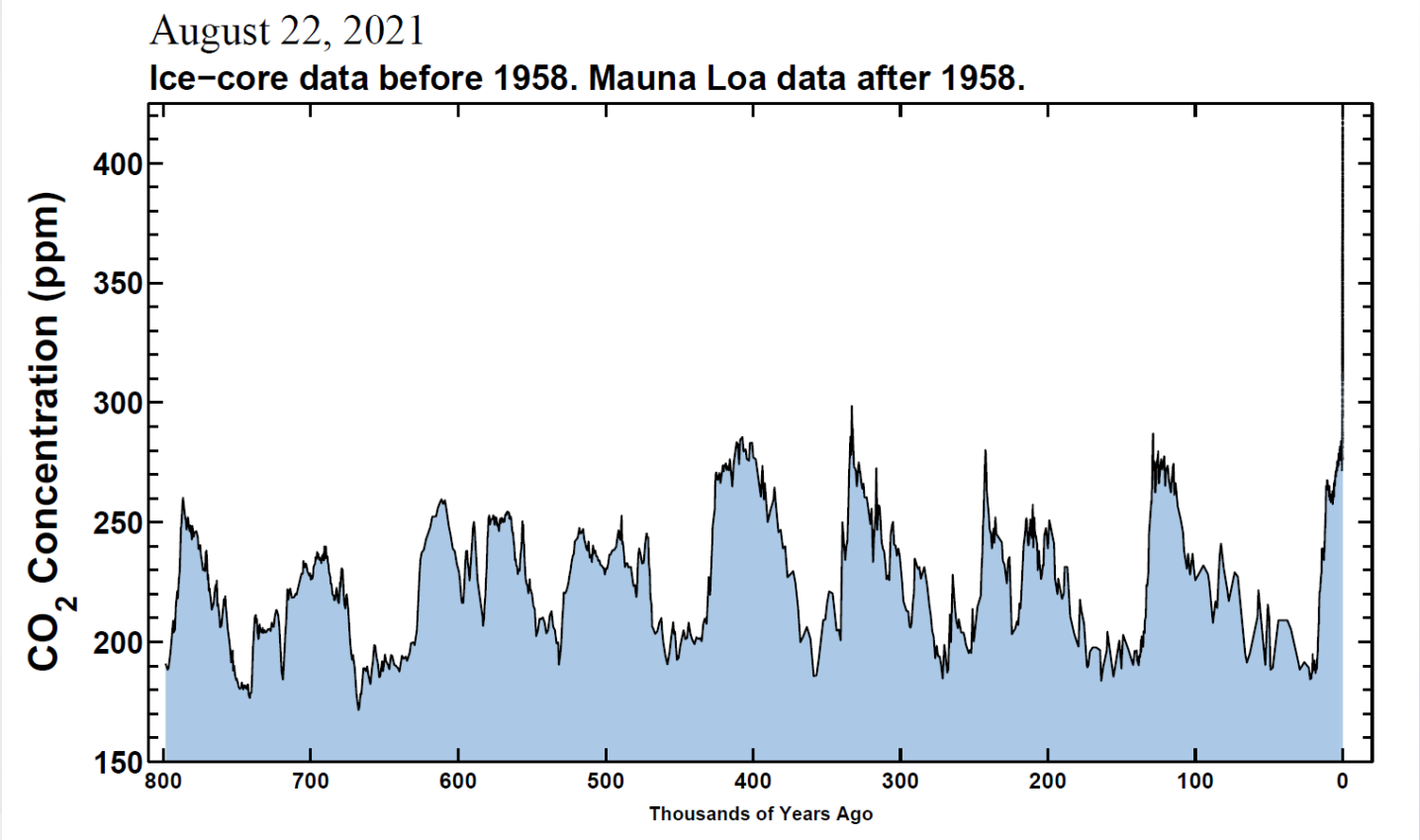
Last 800,000 years



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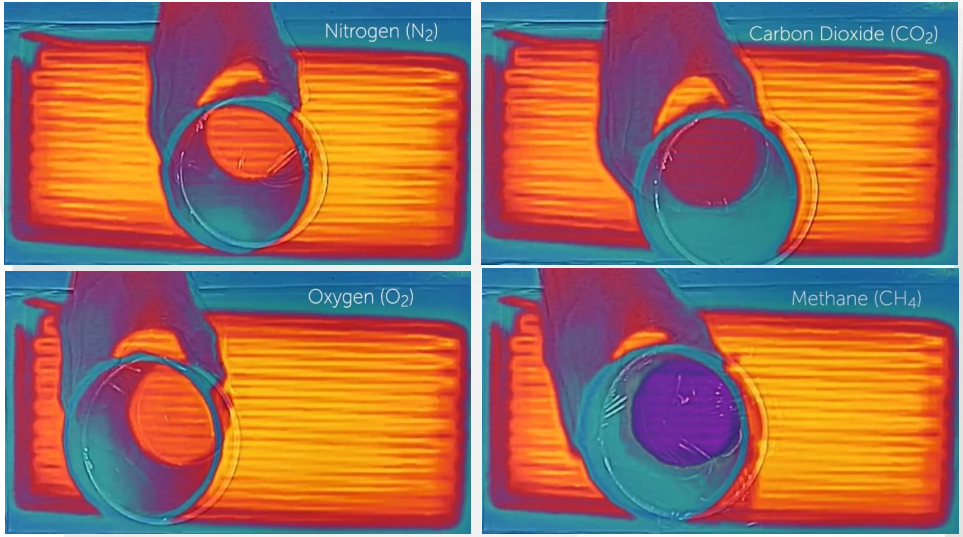
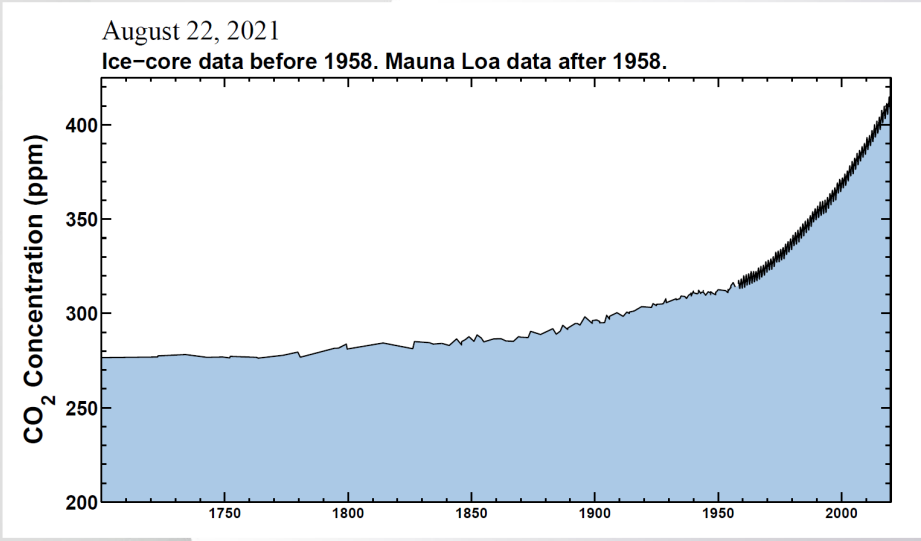


Greenhouse gases, like CO2 and methane, absorb infrared radiation.

CO2 levels have been increasing since industrial revolution



How do these observations relate to the Earth?

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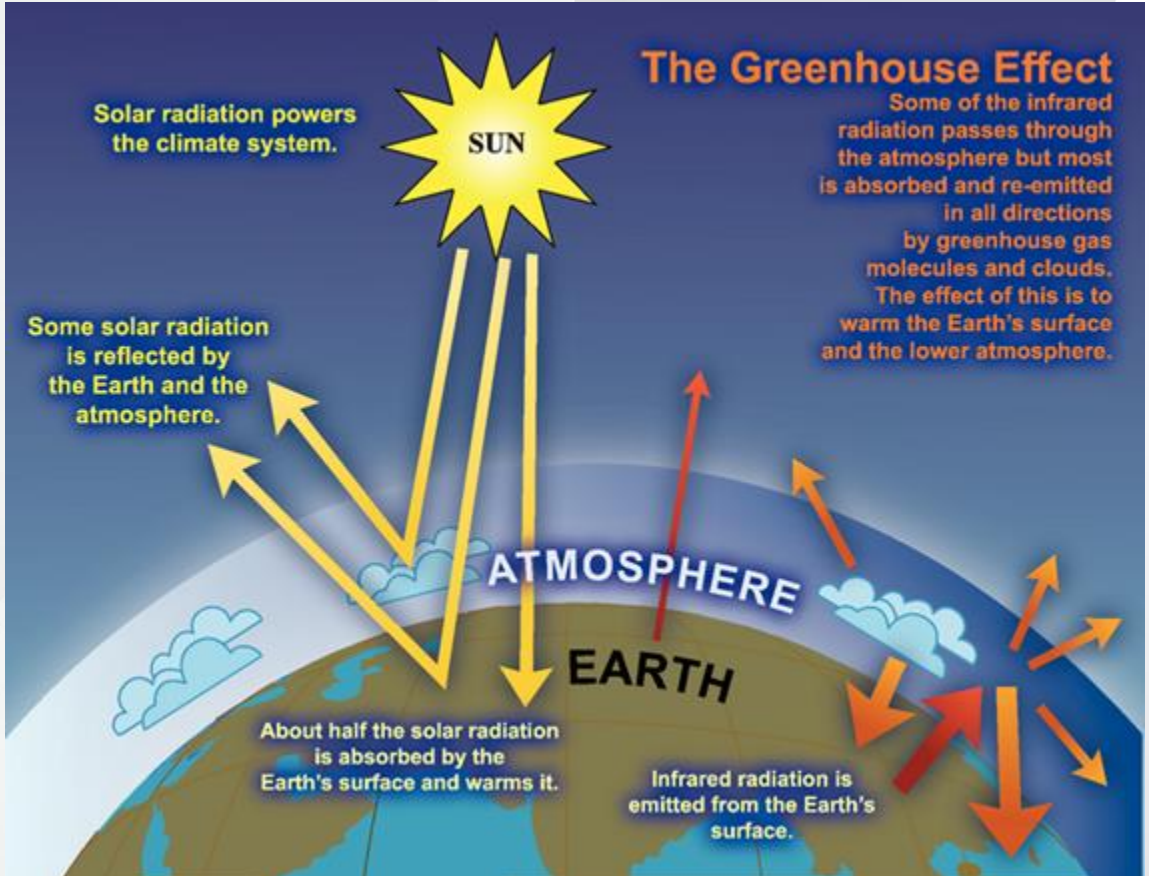
Earth's atmosphere traps heat



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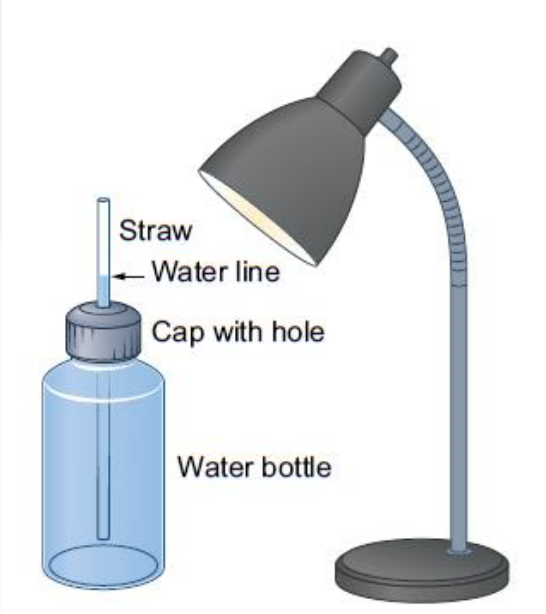
Heat

- Predict
- Observe
- Explain
- Apply

Predict: What happens to the balloons?

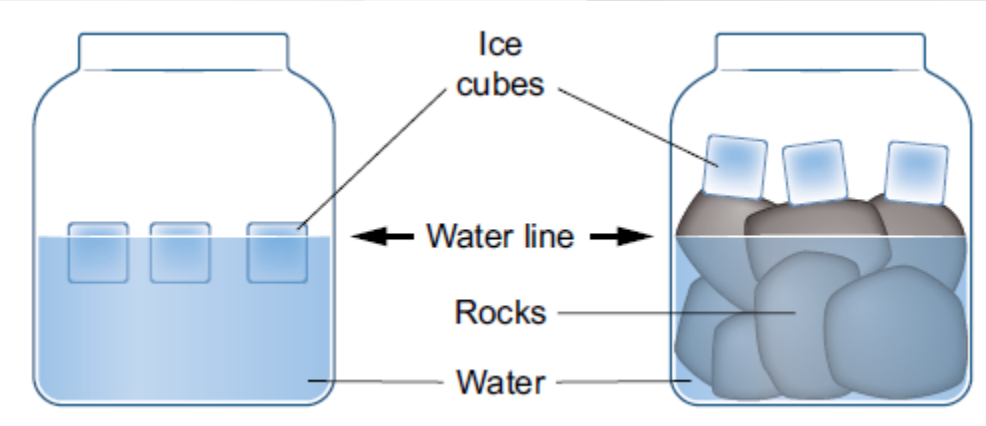
Will the balloons pop at the same time? If not, which will pop first? Why?

Predict: What happens when water heats up?



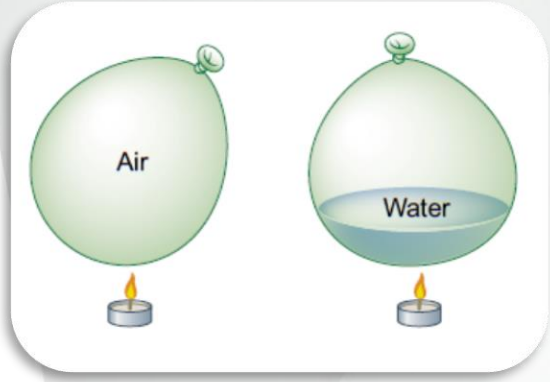
Will the water level rise, fall or stay the same?
Why?

Predict: What happens when ice melts?

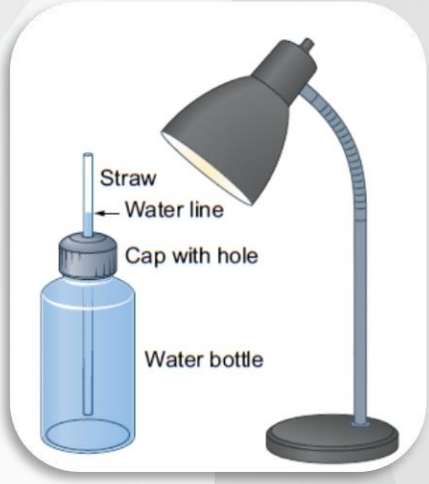


What will happen to the water level in each container? Why?

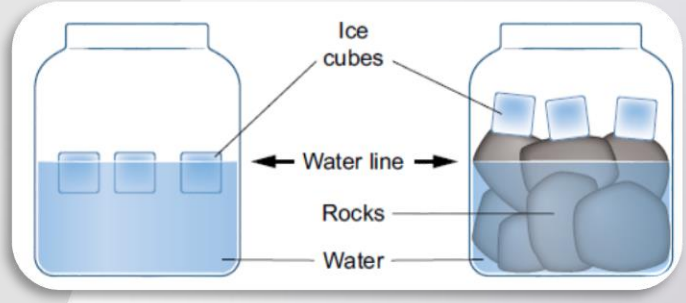
Make your 3 predictions and explanations!



Popping time



Water level



Water level

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Observe and Explain

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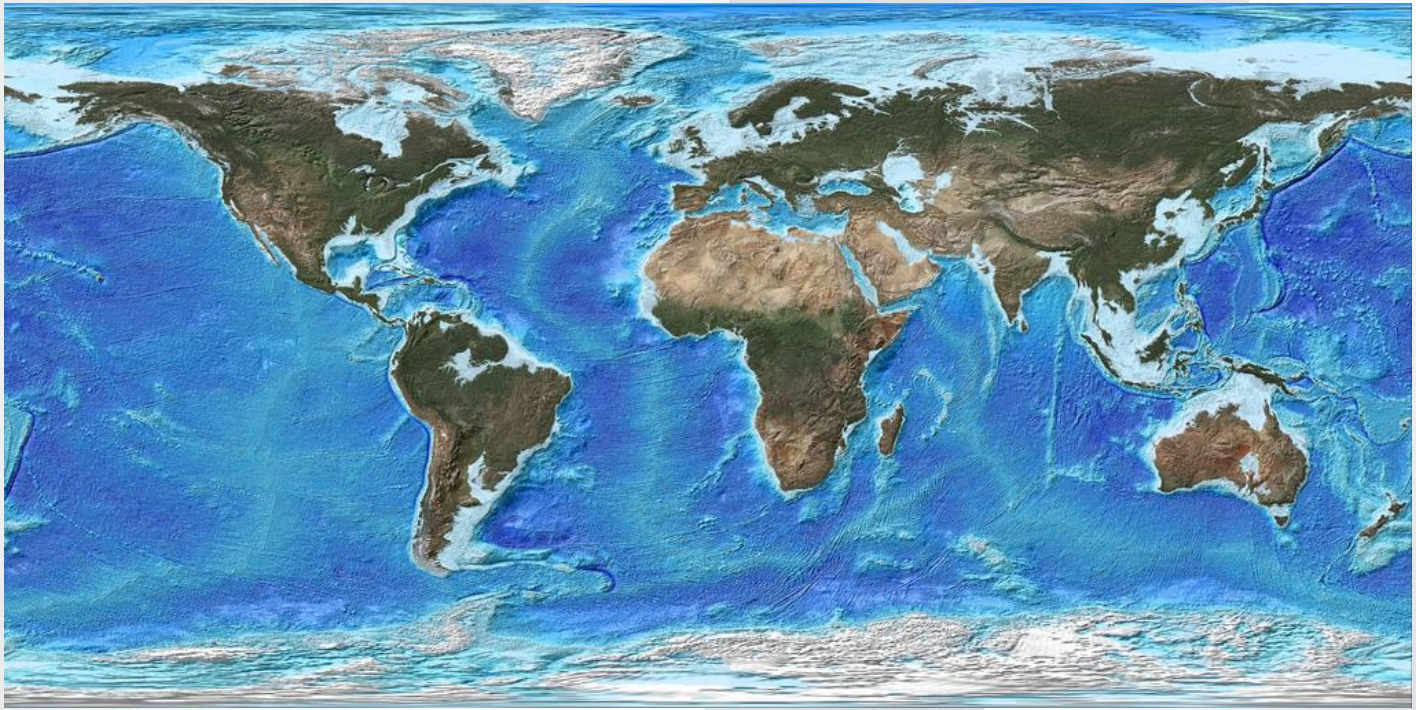
Apply:
70% of the Earth is covered by water



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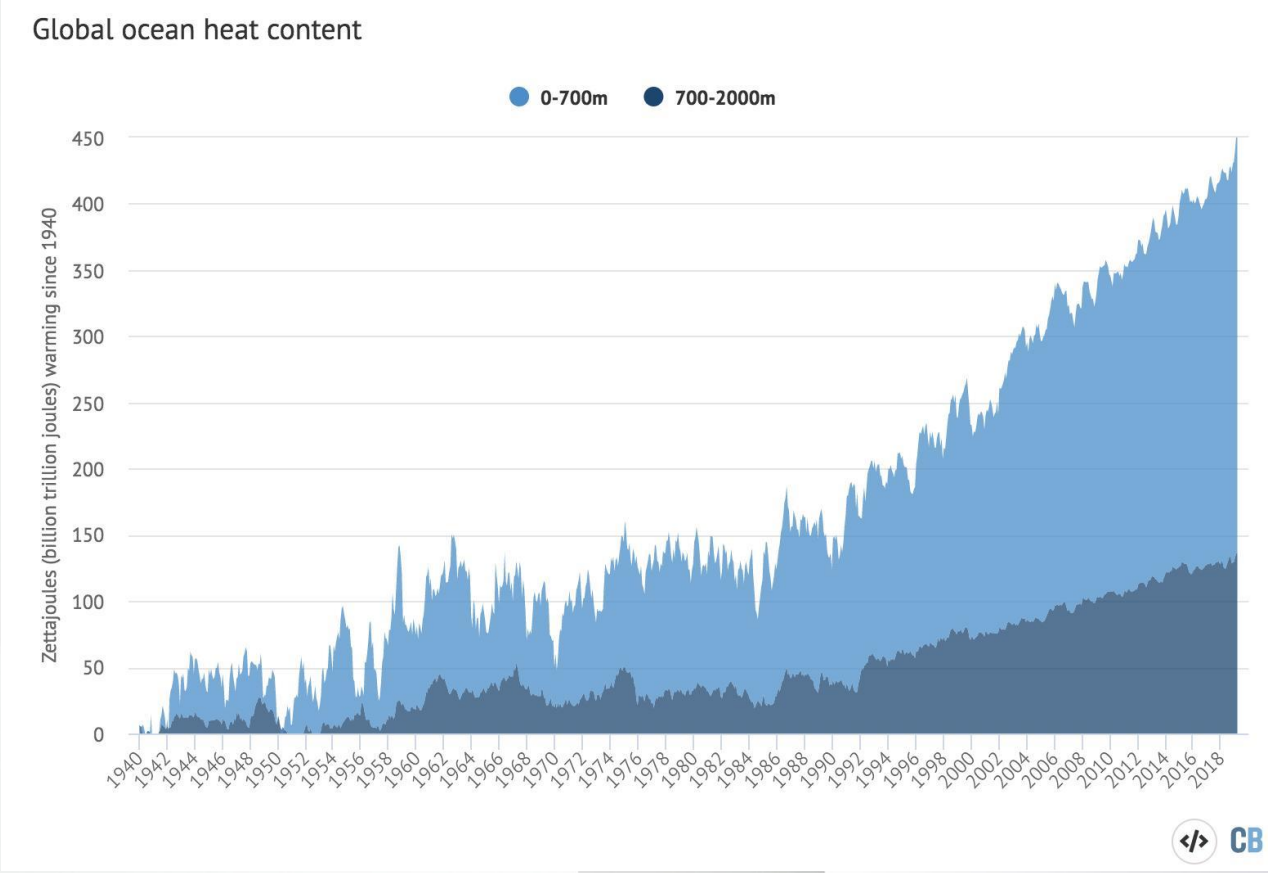
Oceans are hotter



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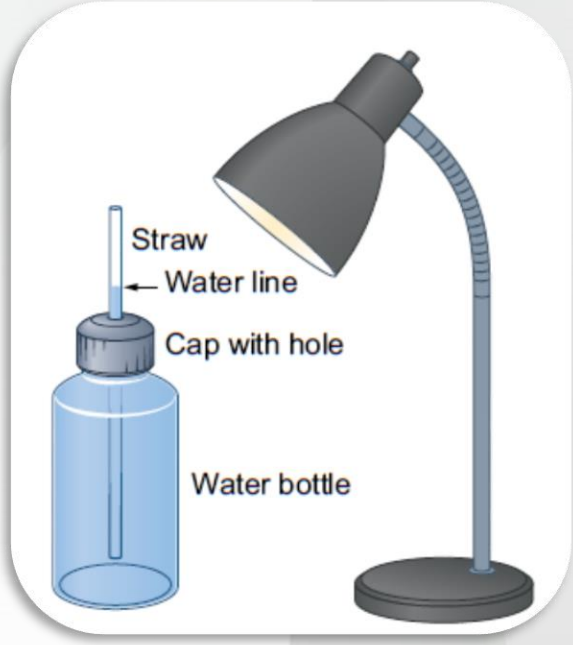
What happens when water heats up?



How does this relate to the Earth?

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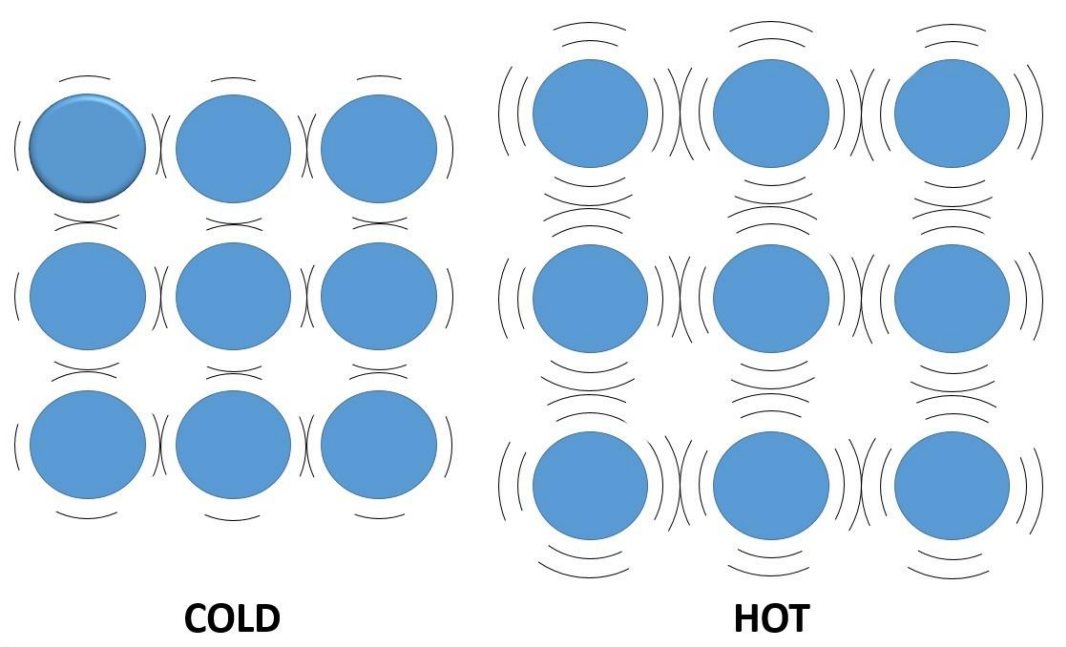
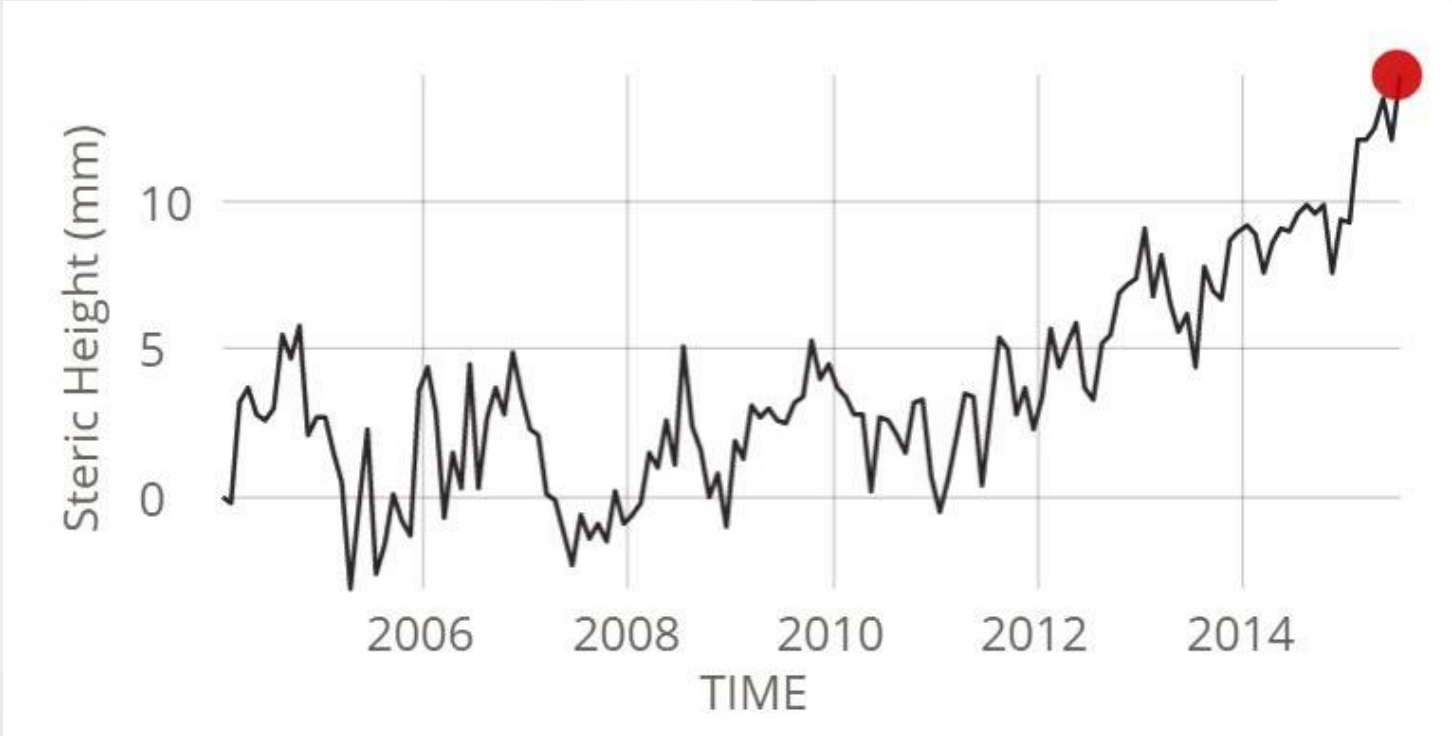
Thermal Expansion of Water



Apply:
Measuring the Ocean's Volume



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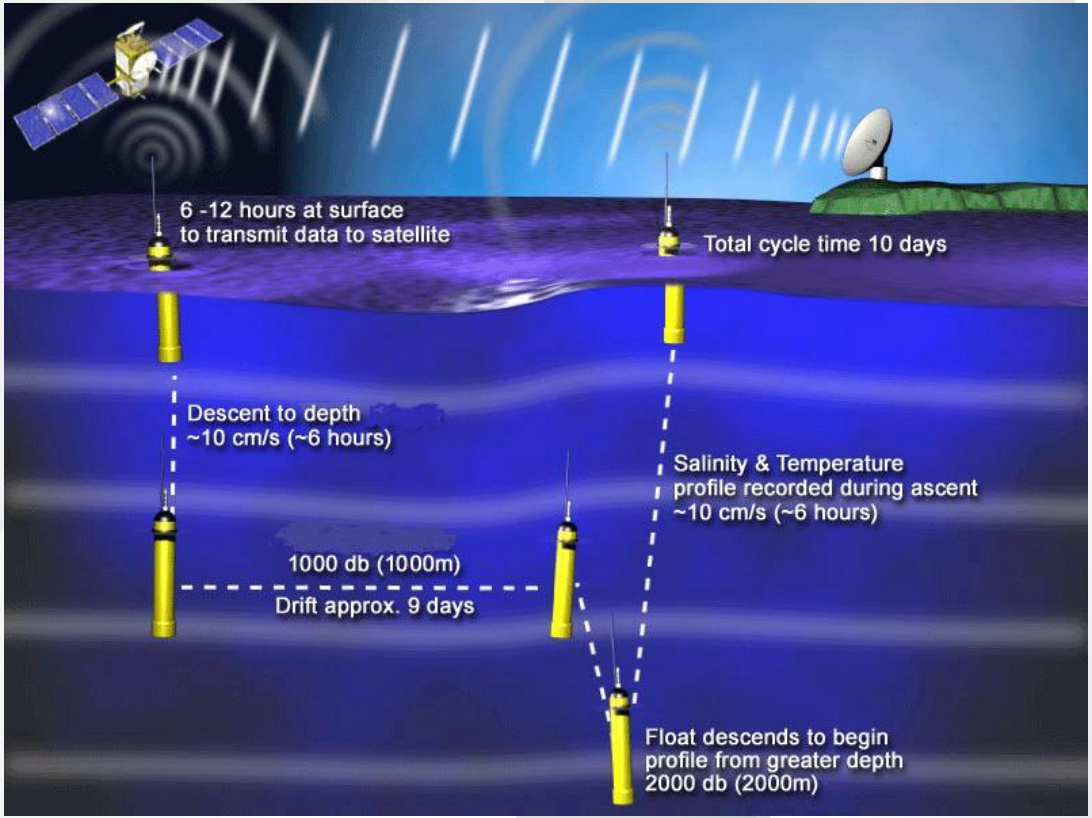
ARGO: Measuring the Ocean's Volume



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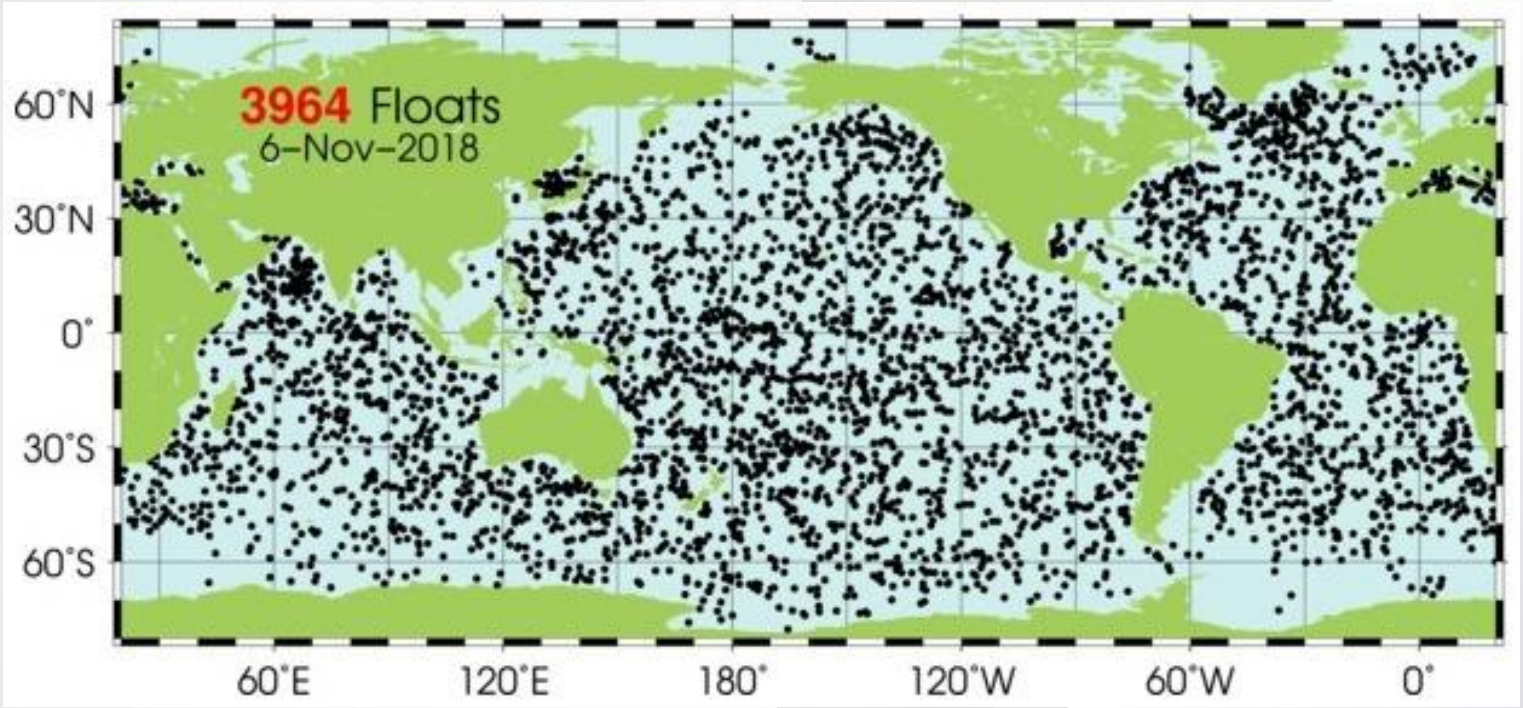
ARGO: Measuring the Ocean's Volume



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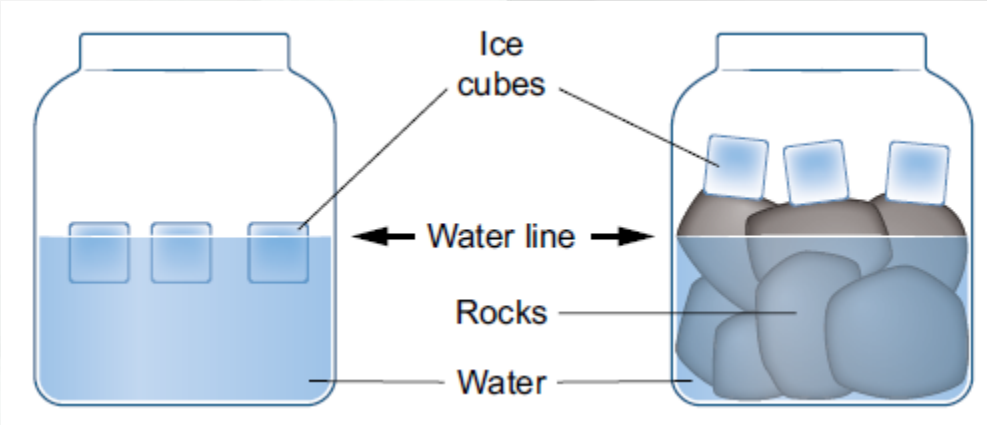
Observe and Explain



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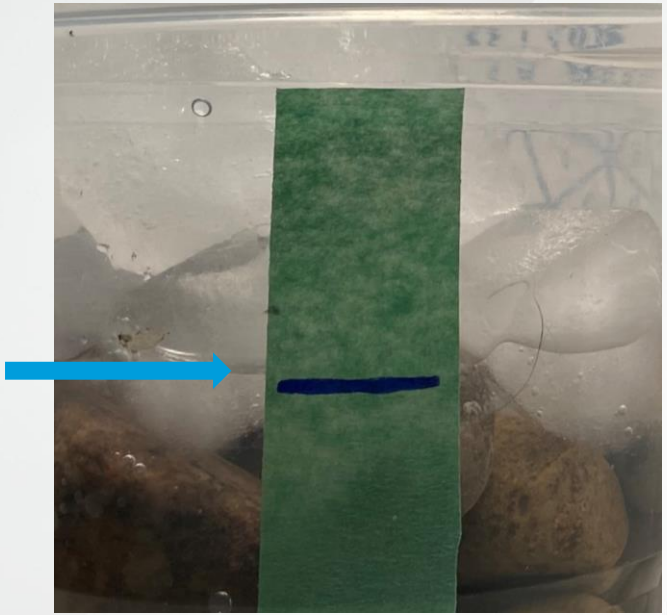
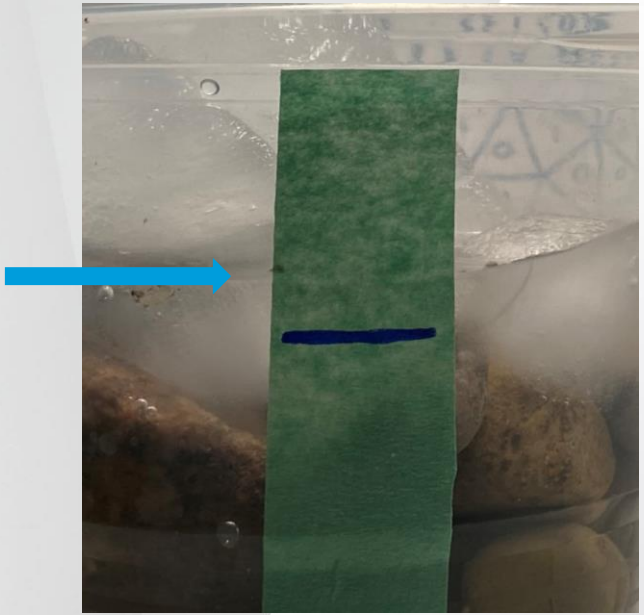
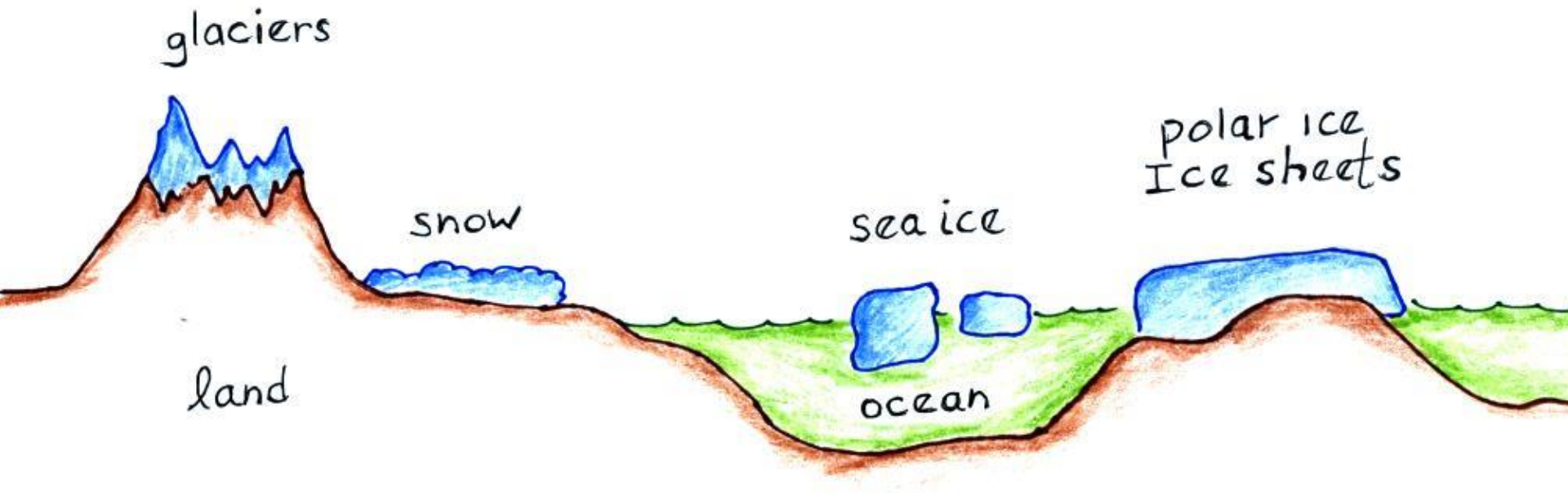
How does this relate to the Earth?





Apply:
Land Ice vs Sea Ice



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A melting ice berg 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

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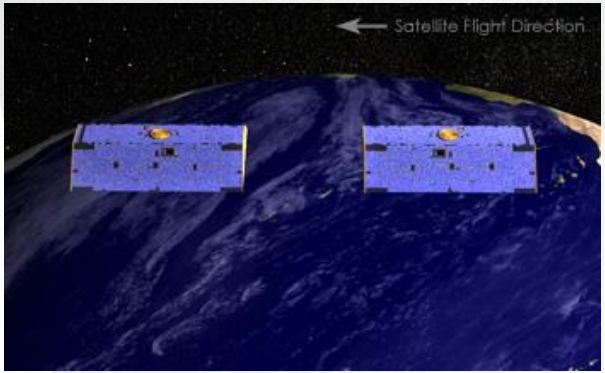
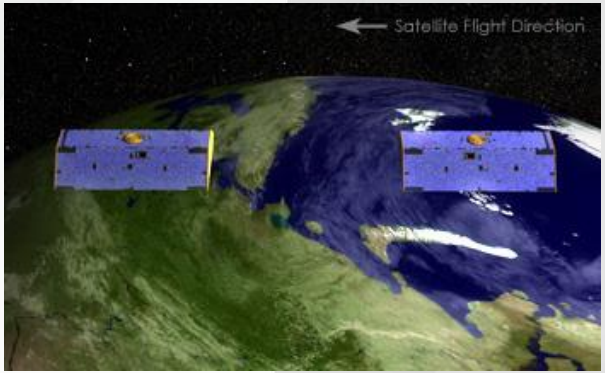
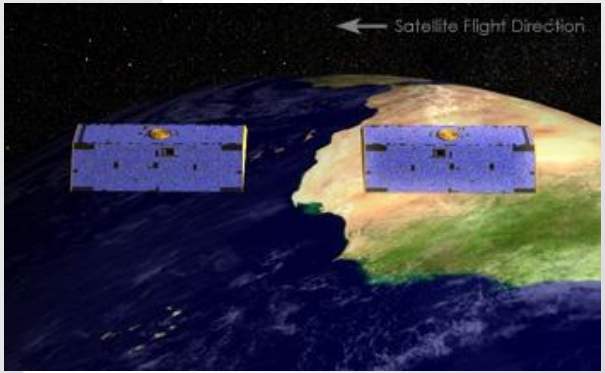
GRACE: Measuring Land Ice Mass







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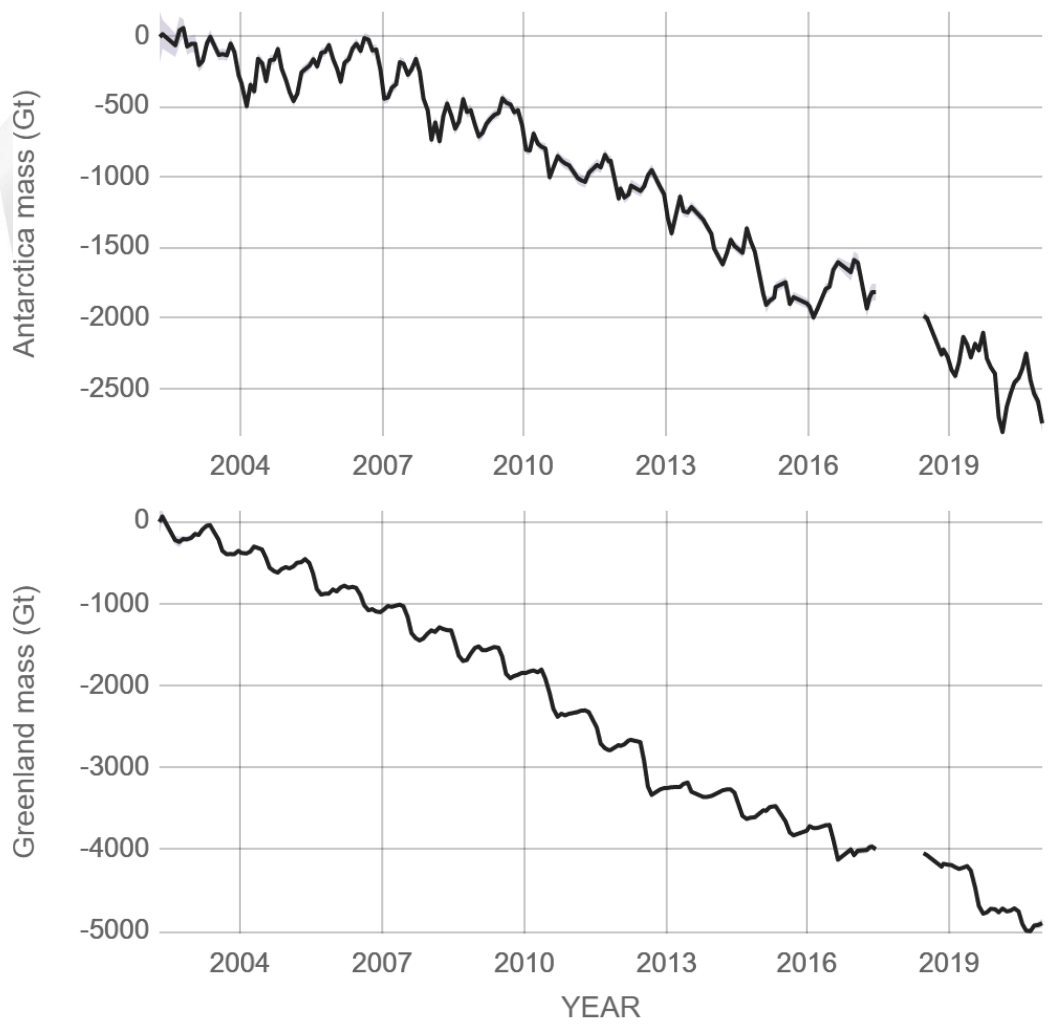

Source: climate.nasa.gov

Antarctica ice mass is decreasing at 150 Gt per year

> 420 Gt per year!

Greenland ice mass is decreasing at 278 Gt per year

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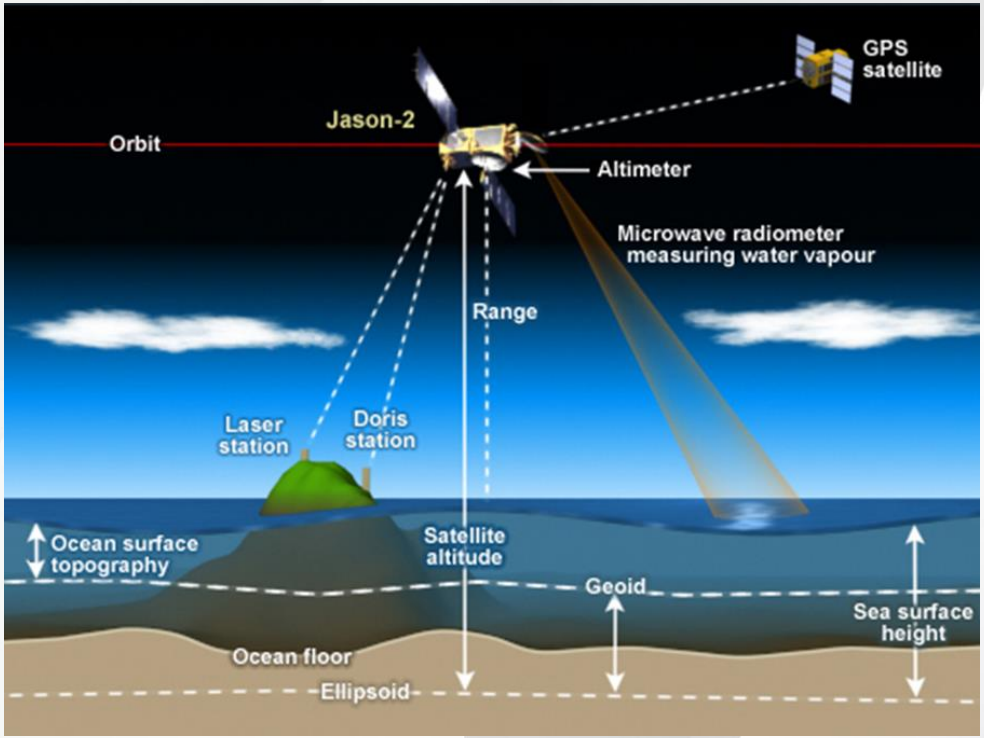
Satellite Altimetry: Measuring Sea Level



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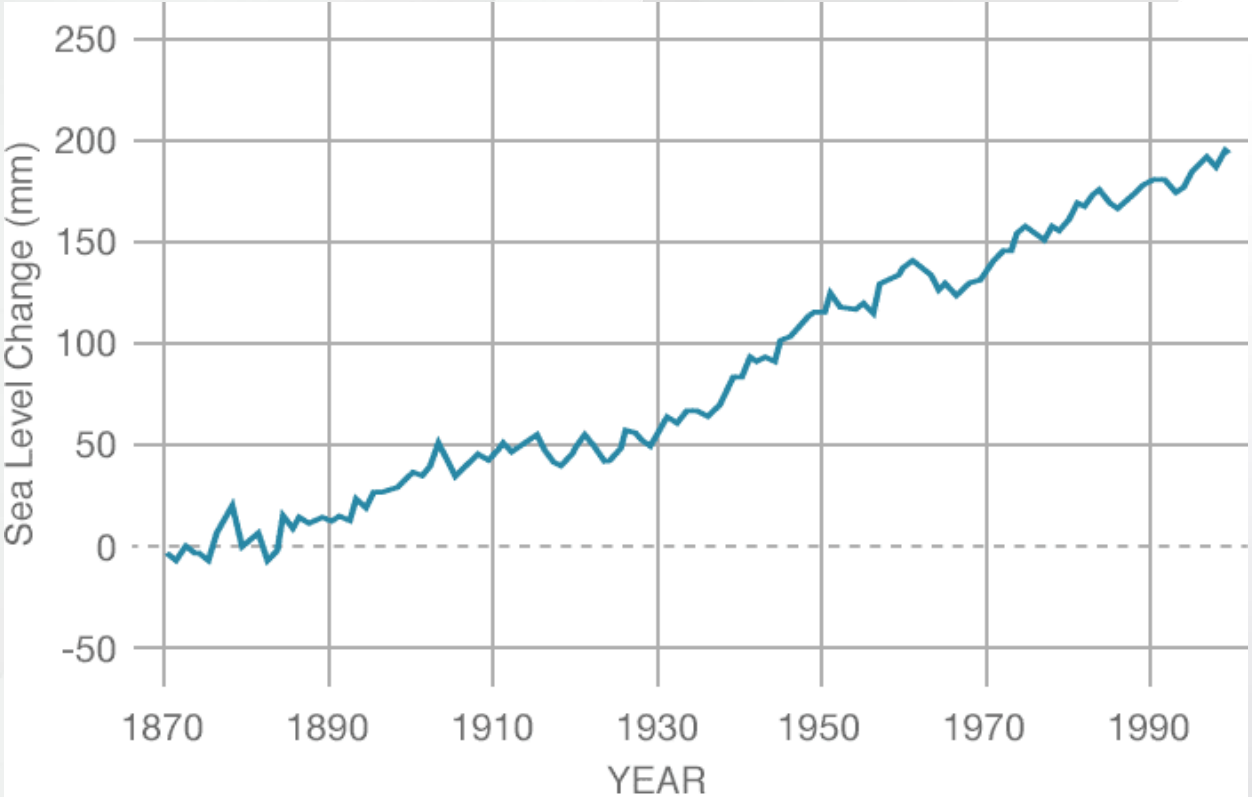
Measuring the Height of the Sea



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Sea Level Budget

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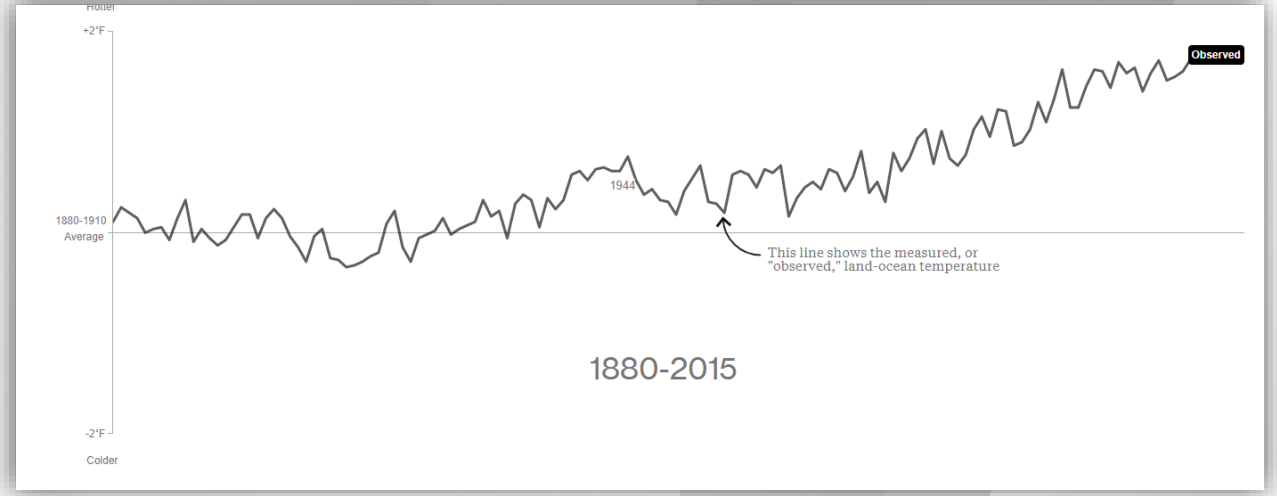
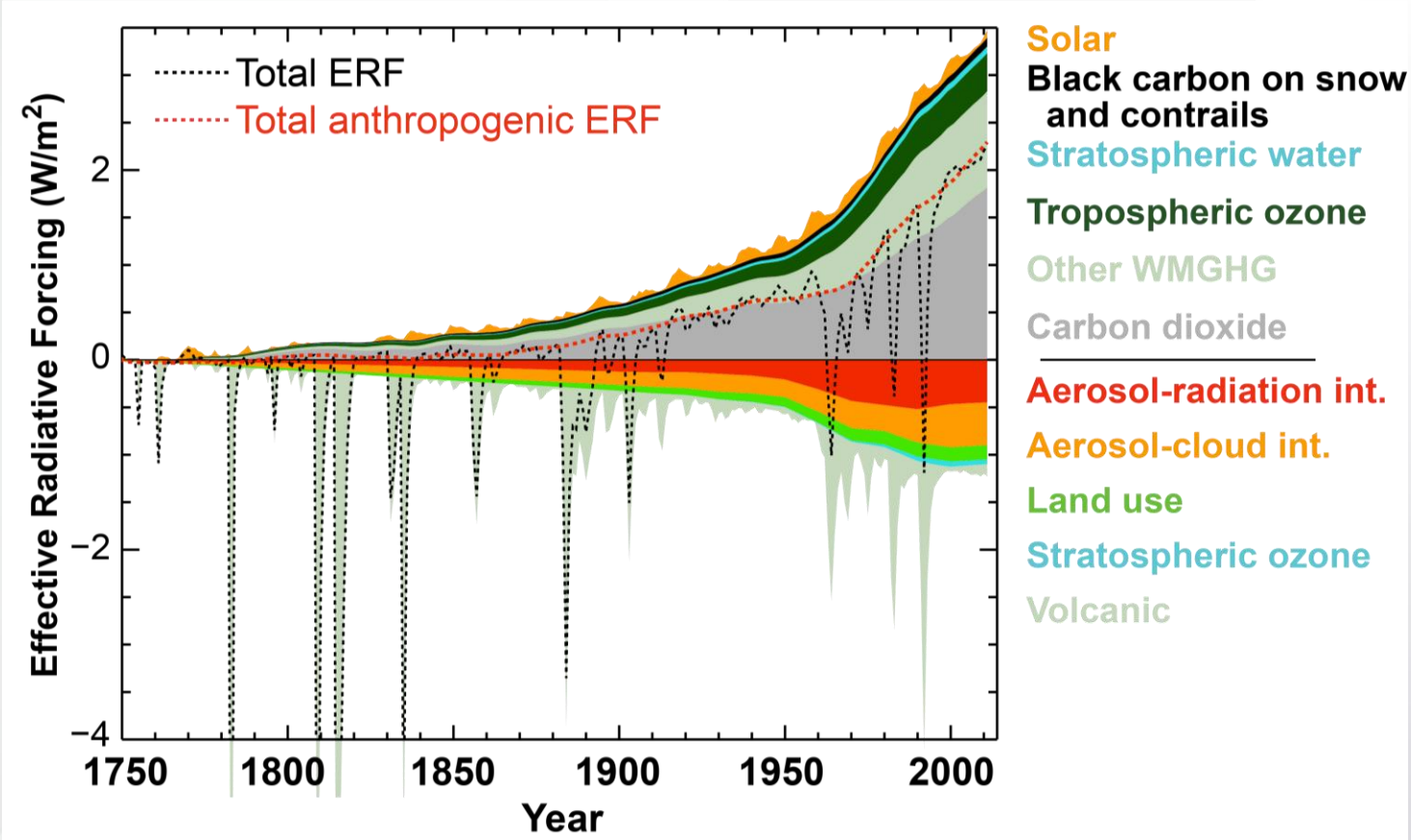
What's causing the warming?



Forcing factors



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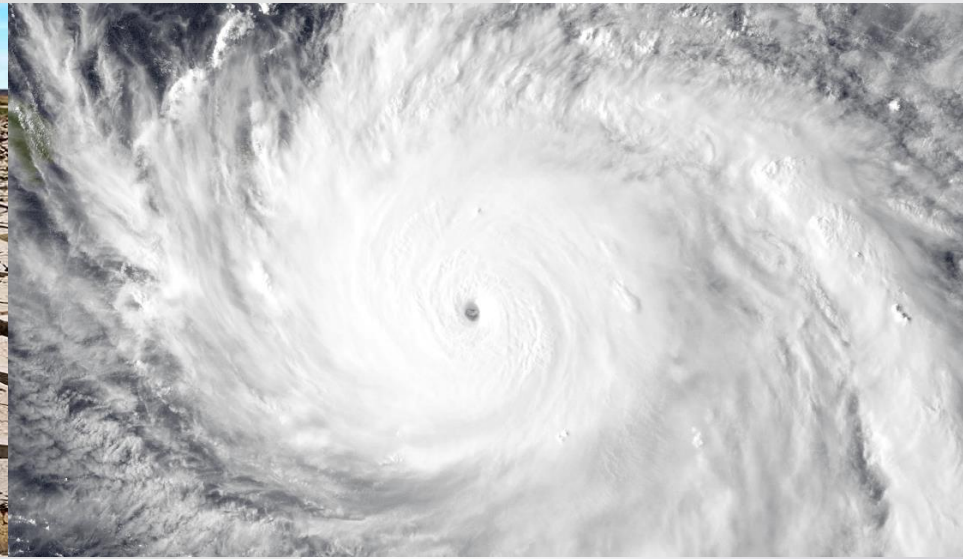
Effects of climate change

Increased flooding

Effects of climate change

More extreme weather events



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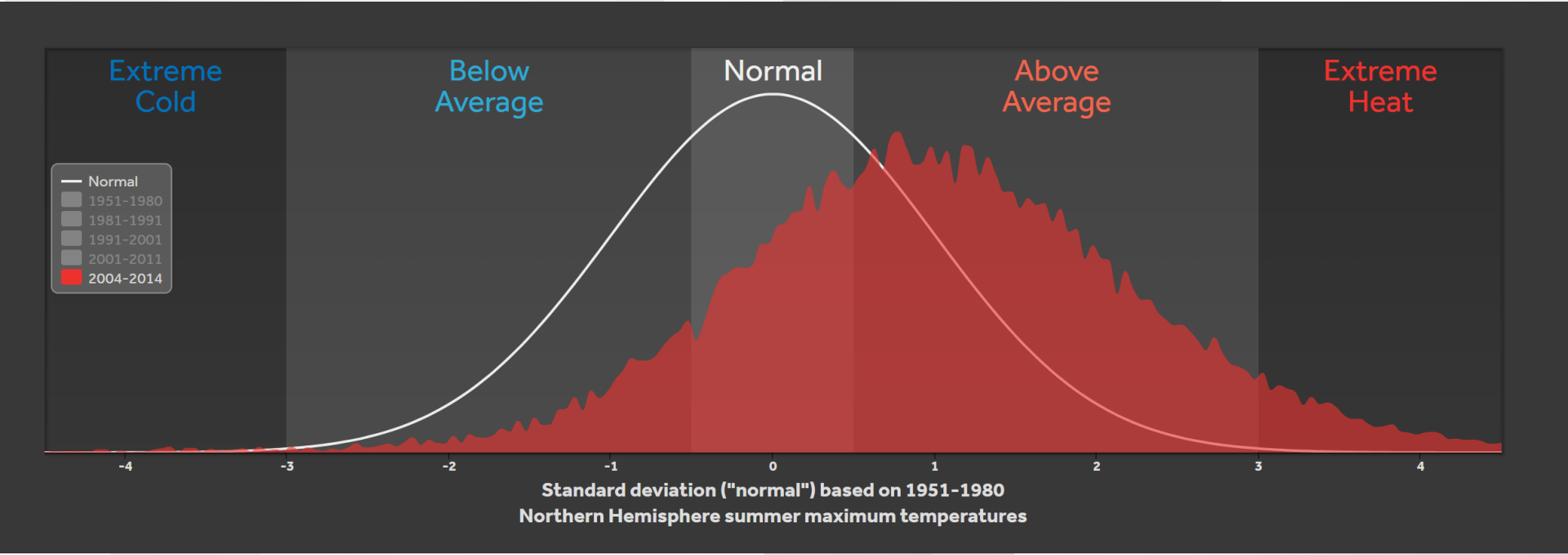
More heat waves



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Effects of climate change

More intense wildfires

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Effects of climate change

Thawing permafrost

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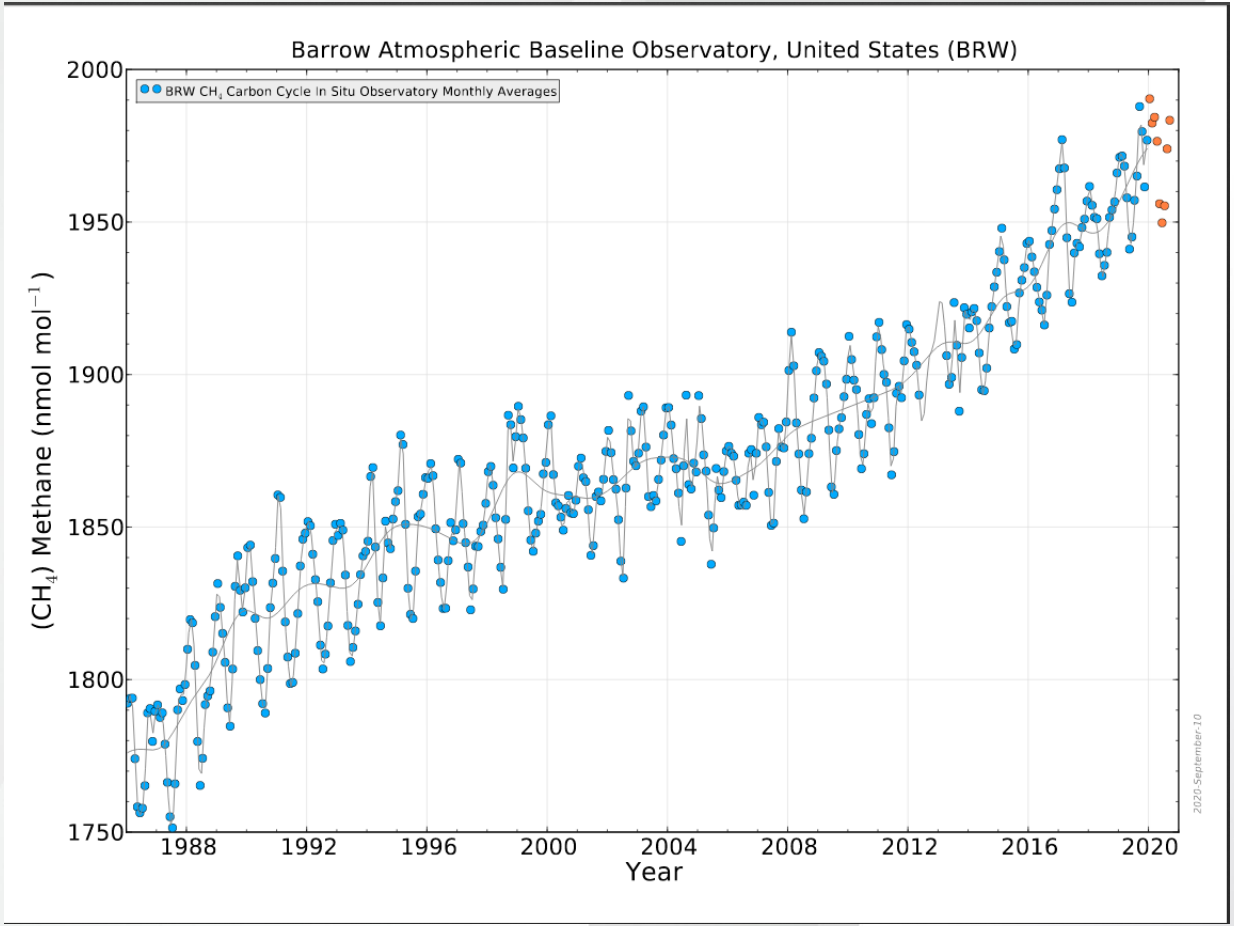

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Effects of climate change

Shifting Ecosystems

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Effects of climate change

Spreading diseases

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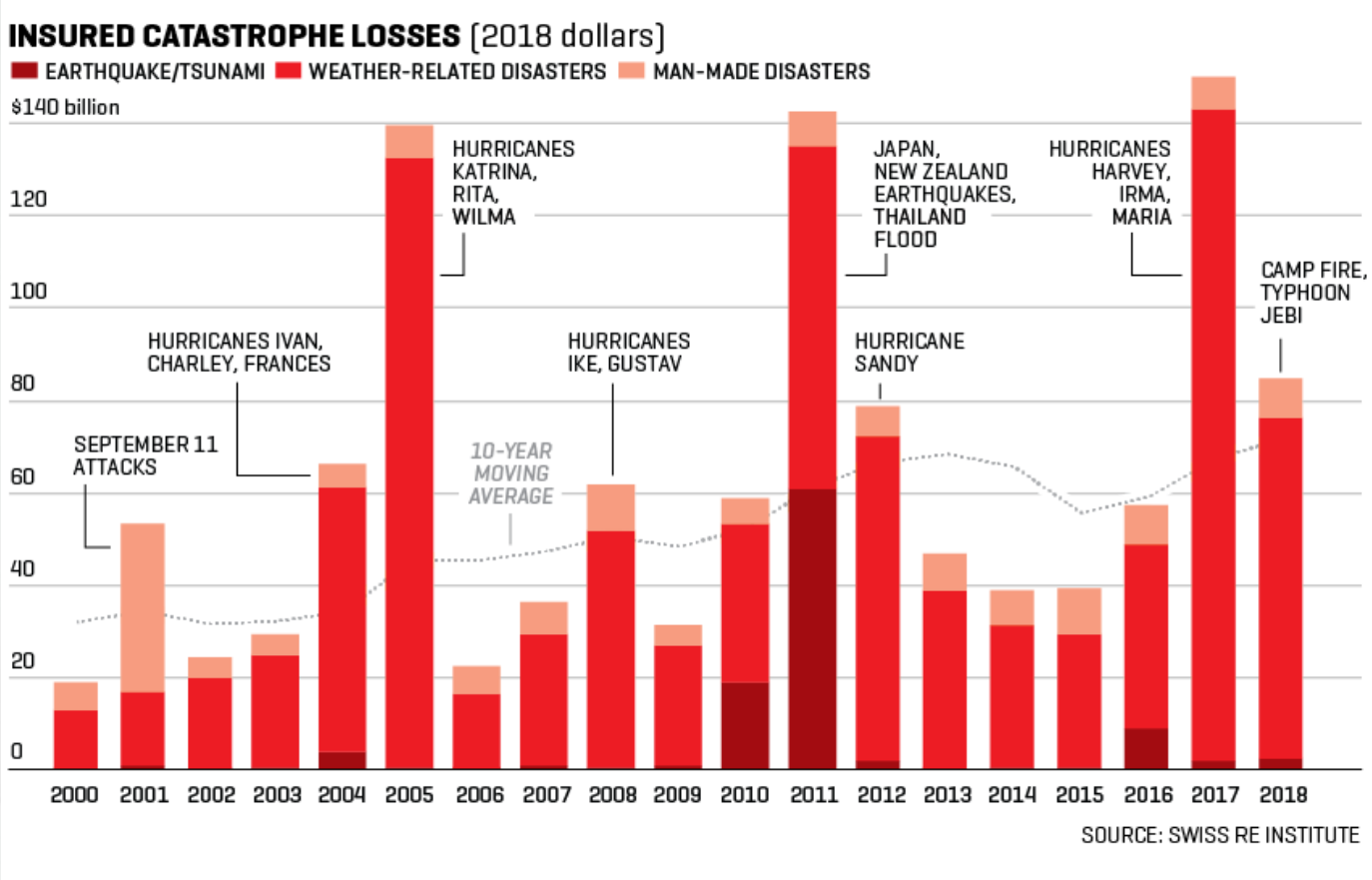
Economic costs of climate change



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Social costs of climate change

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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

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HUMANITY'S GREATEST CHALLENGE IS ALSO OUR GREATEST OPPORTUNITY

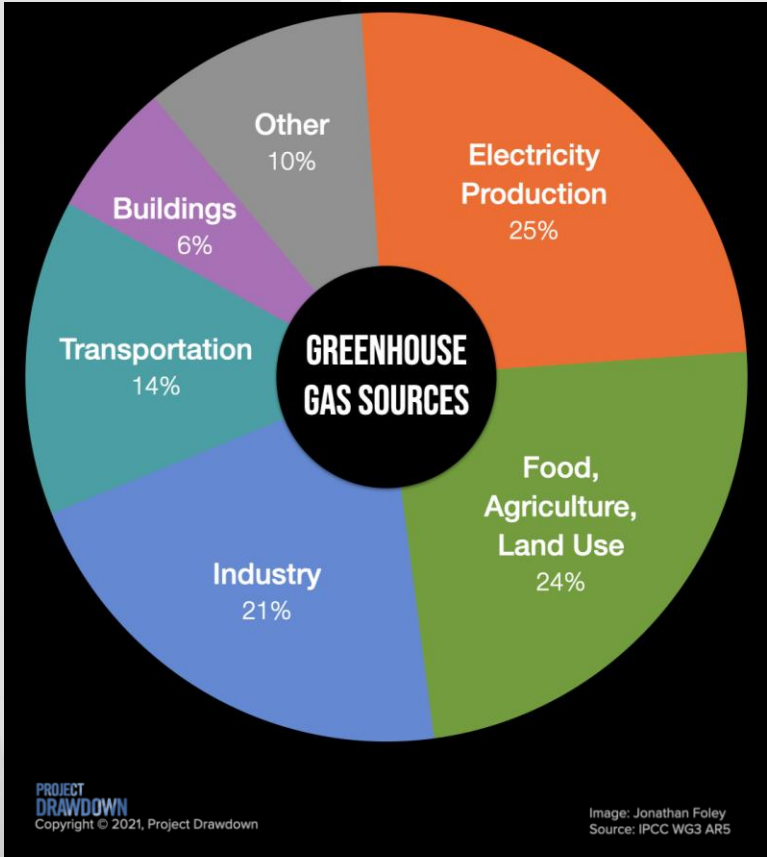
DRAWDOWN.ORG/CLIMATE-SOLUTIONS-101

"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

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.

Miami Says It Can Adapt to Rising Seas. Not Everyone Is Convinced.

Officials have a new plan to manage rising water. Succeed or fail, it will very likely become a case study for other cities facing climate threats.

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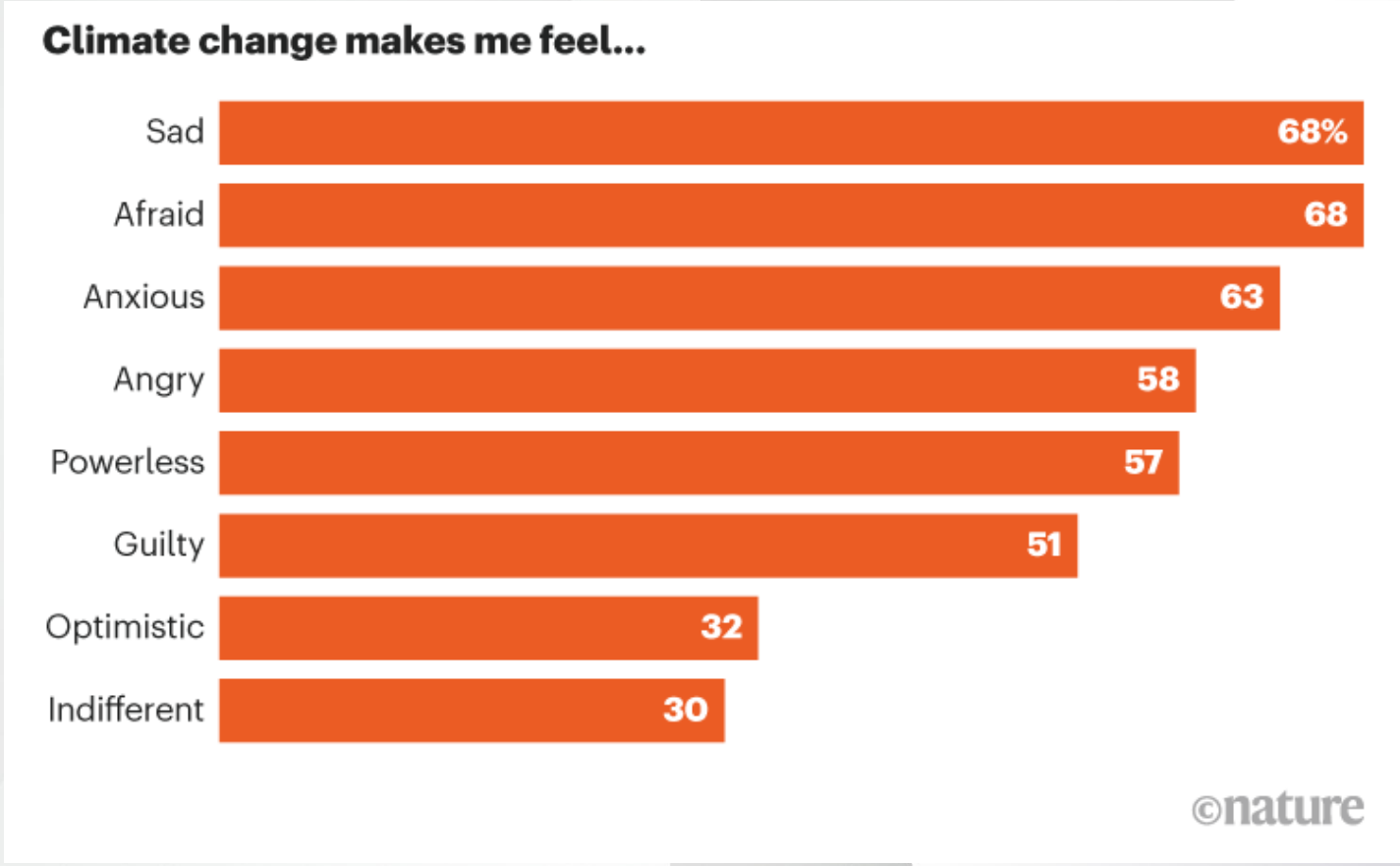
Recognize that this is a complex issue

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

Climate Anxiety



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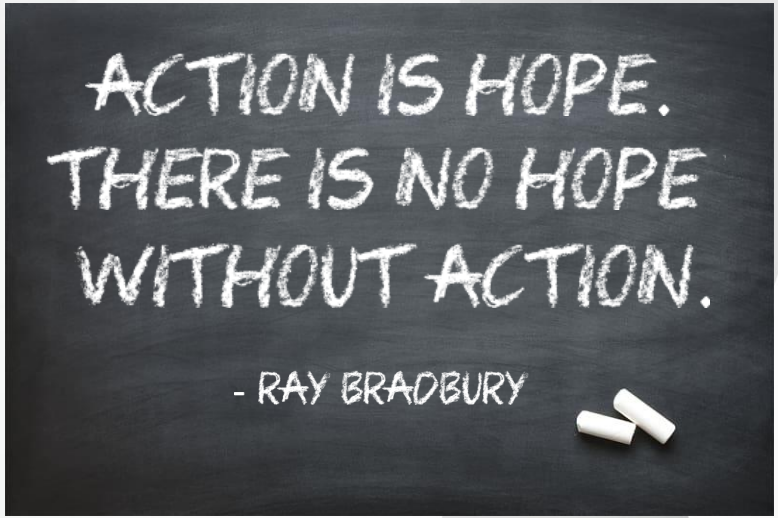
What good will personal actions do?



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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

DRAWDOWN.ORG

Skeptical

CarbonBrief
CLEAR ON CLIMATE

VITAL SIGNS:
Taking the Pulse of Our Planet

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

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