Climate Change:
Evidence, Effects, and Actions

CERN HST 2023

Dave

Sean

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

resources.perimeterinstitute.ca

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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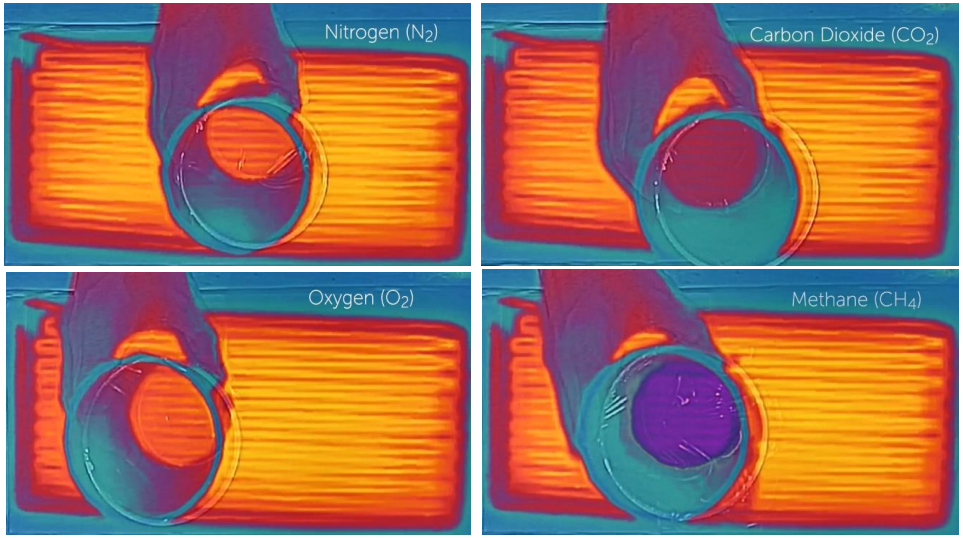
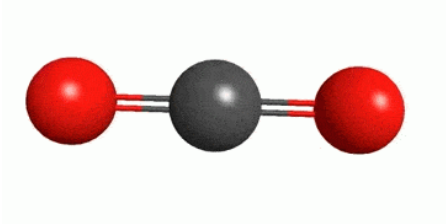
Climate Change Story



Greenhouse gases, like CO_2 and methane, absorb infrared radiation.



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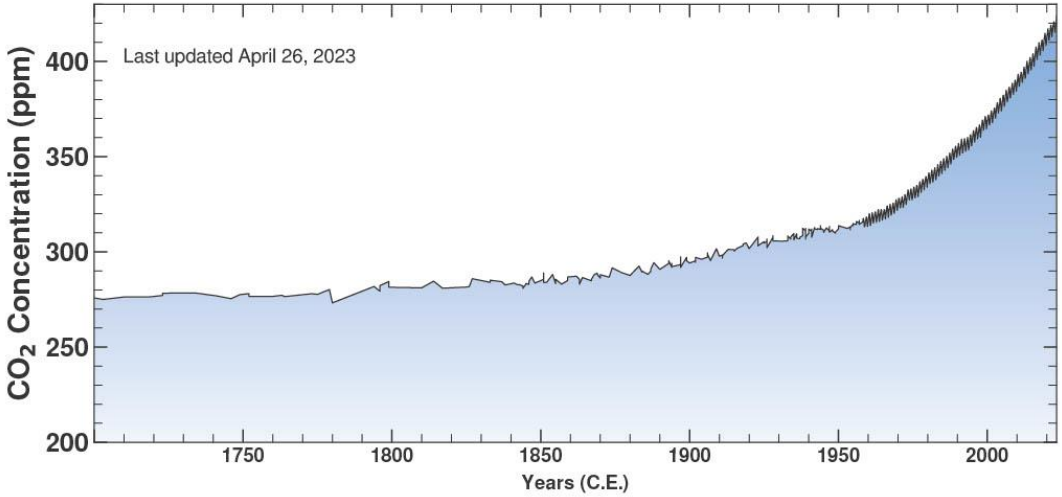
Climate Change Basics

CO_2 levels have been increasing since industrial revolution



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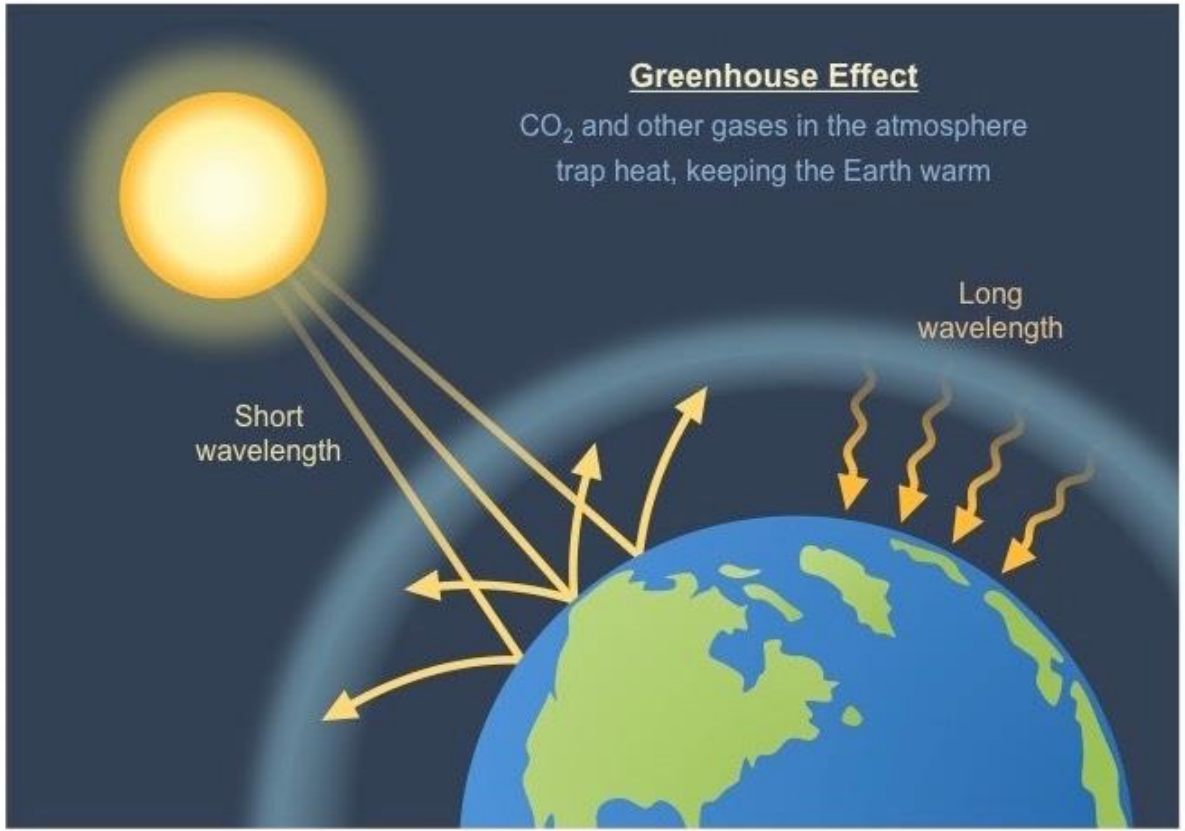
Leading to a enhanced greenhouse effect



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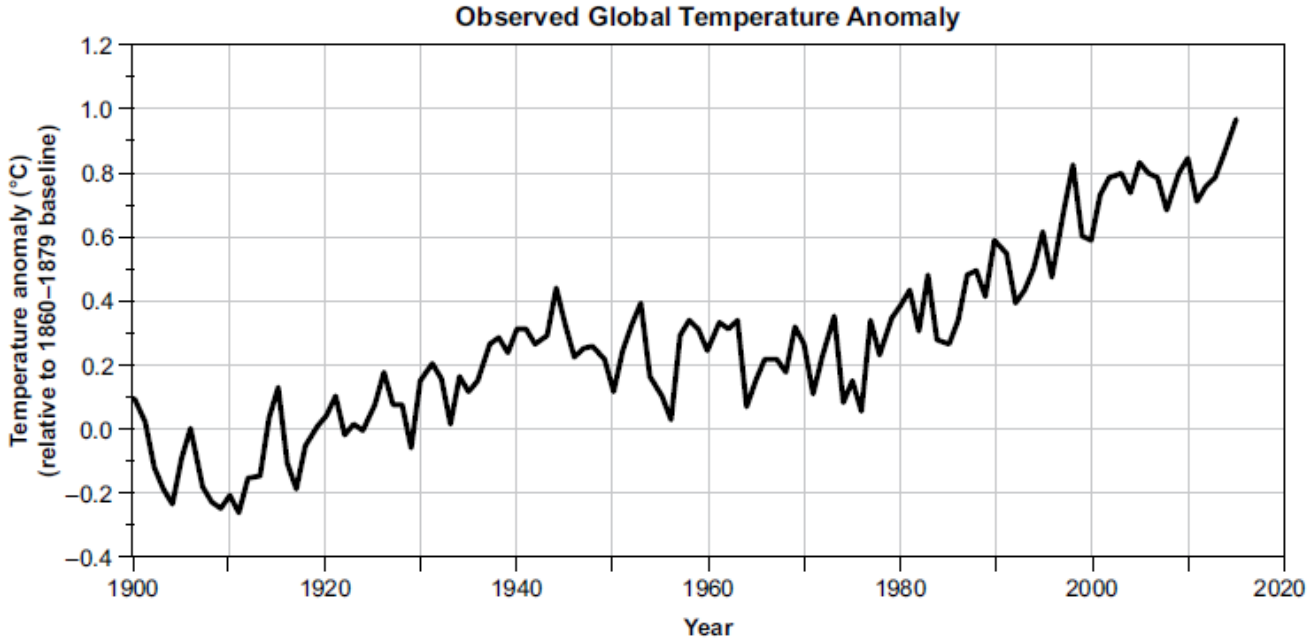
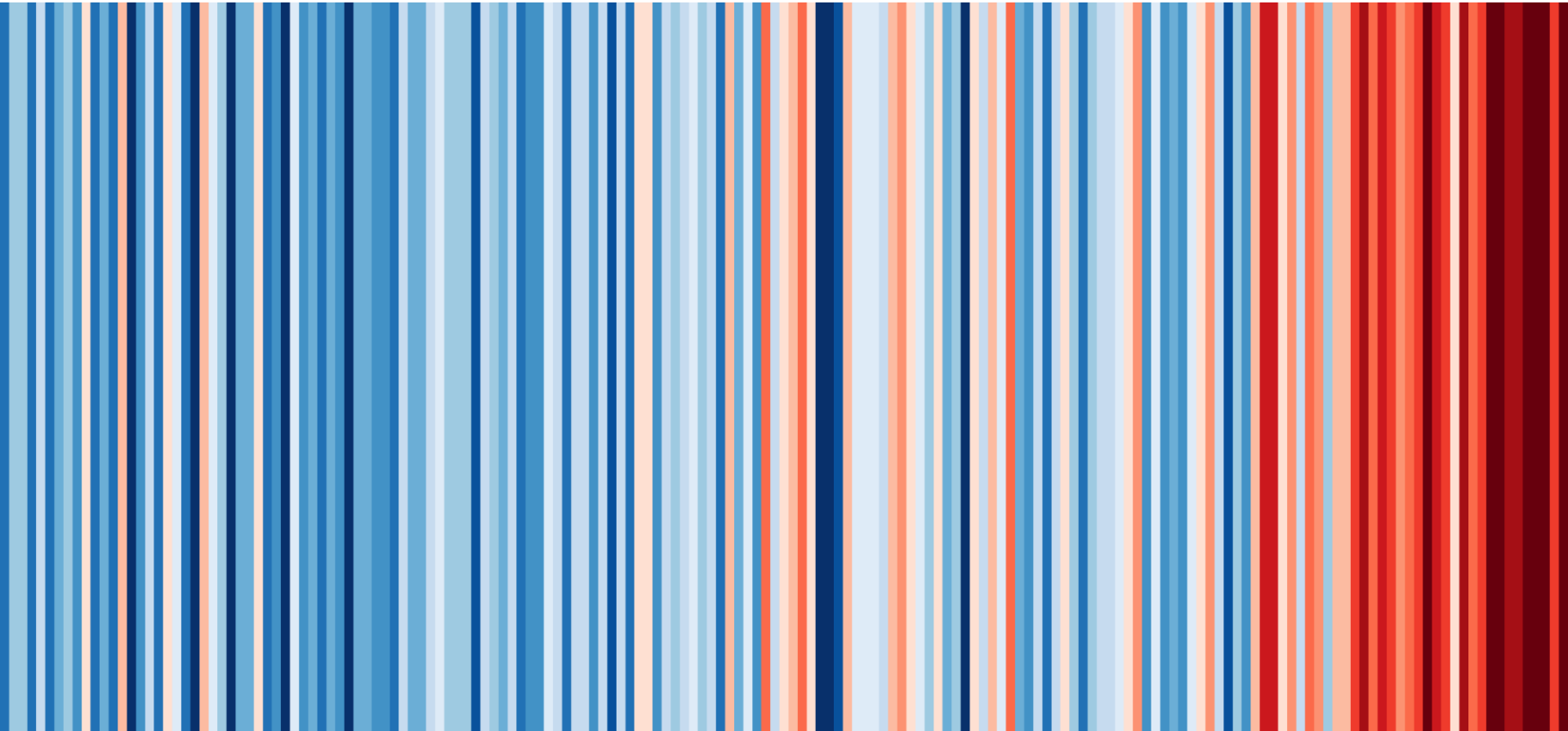
Earth is getting warmer

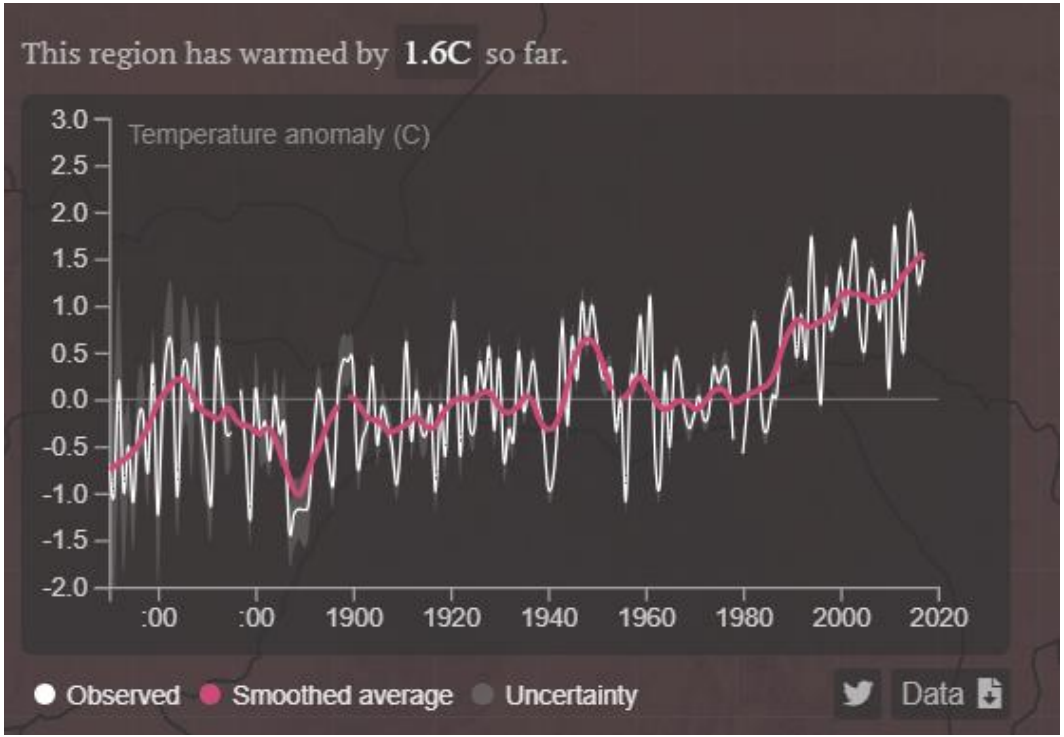


Source: NASA GISS

Europe (1864 – 2022)



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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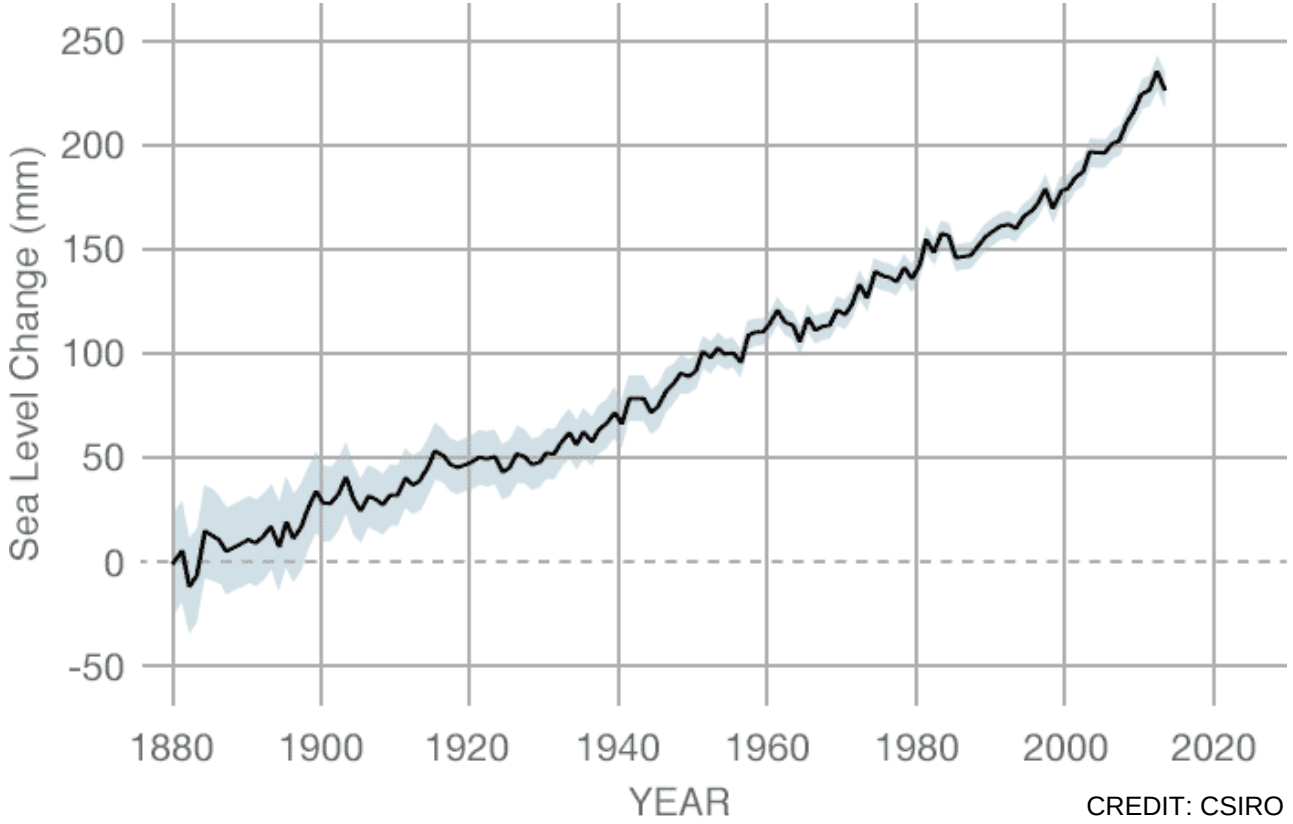
A few degrees may not seem like much…

37°C = healthy

39°C = sick

Sea Levels are rising



CREDIT: CSIRO

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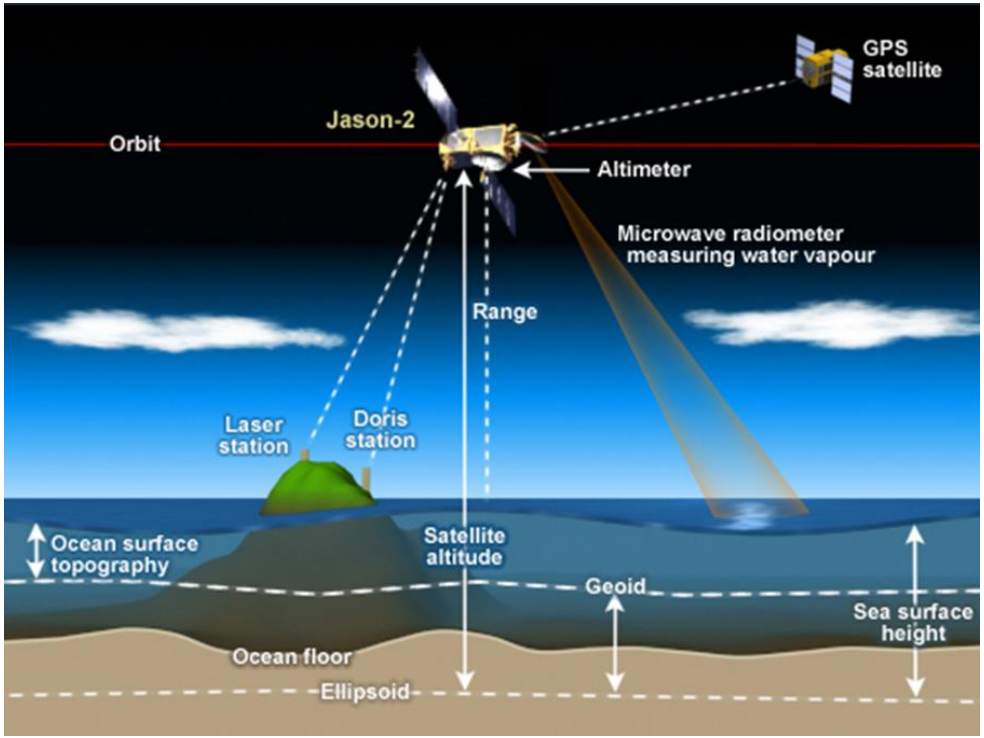
Satellite Altimetry: Measuring Sea Level



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A few centimetres may not seem like much…

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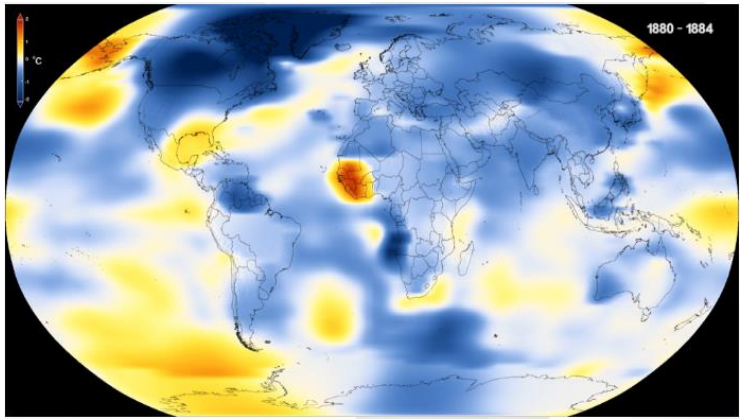
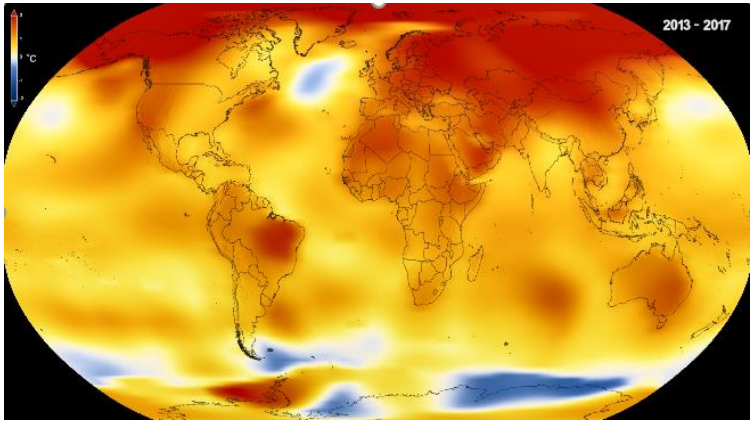
The question is: Why?



1880



2017

And what can we do about it?

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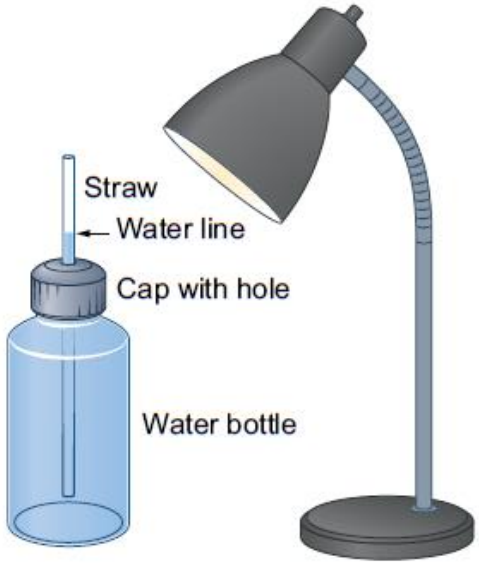
Heat

- Predict
- Observe
- Explain
- Apply

Predict: What happens to the balloons?

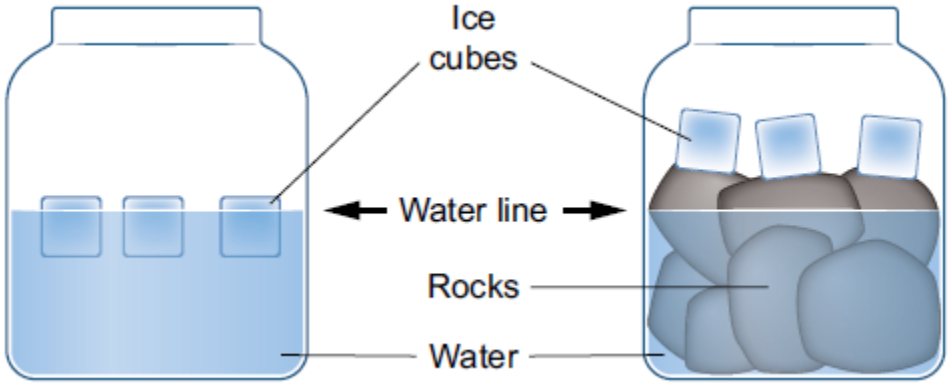
Will the balloons pop at the same time?
If not, which will pop first? Why?

Predict: What happens when water heats up?



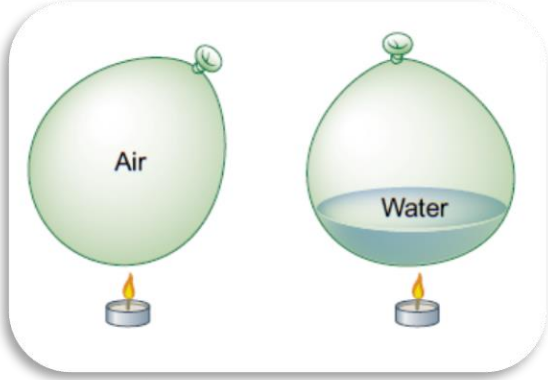
Will the water level rise, fall or stay the same?
Why?

Predict: What happens when ice melts?



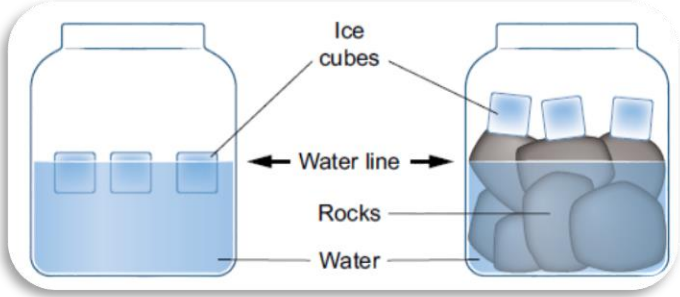
What will happen to the water level in each container? Why?

Make your 3 predictions and explanations!



Popping time

Water level



Water level

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How do these observations relate to the Earth?

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Observe and Explain

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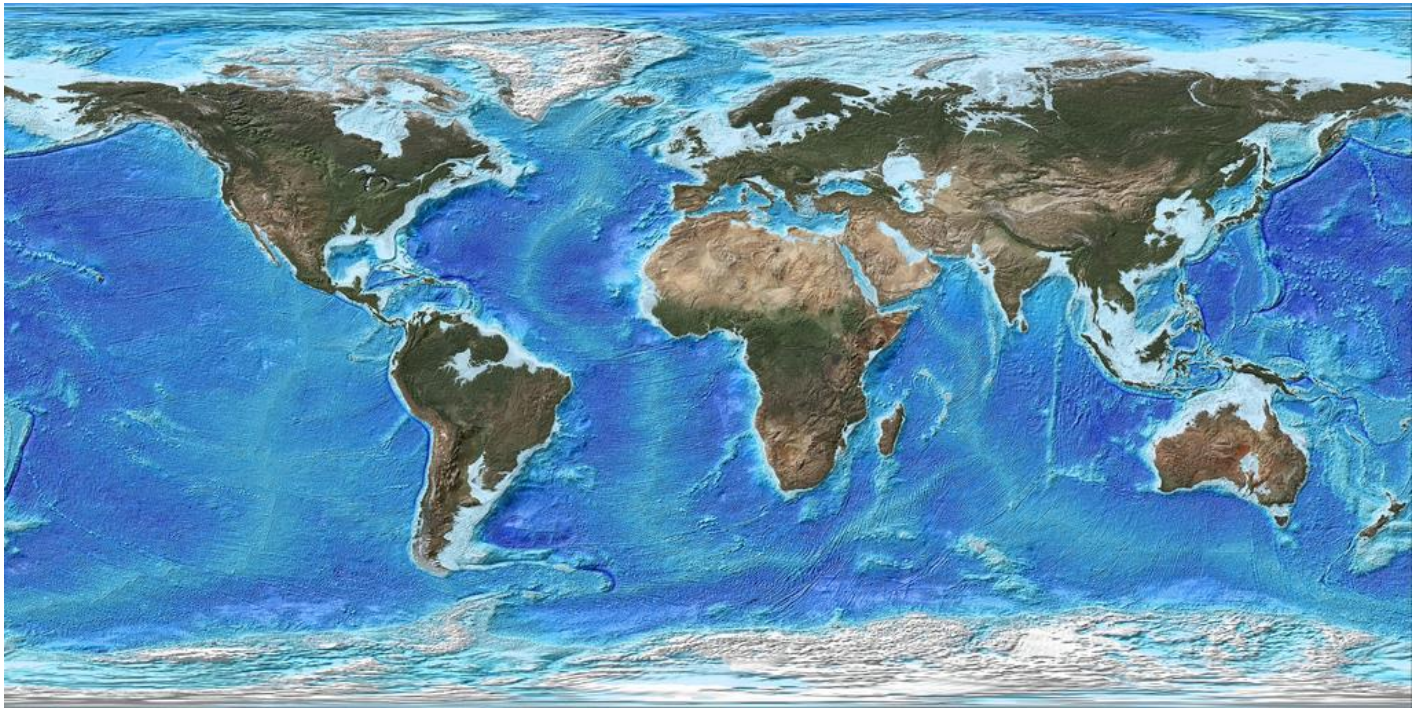
Apply:
70% of the Earth is covered by water



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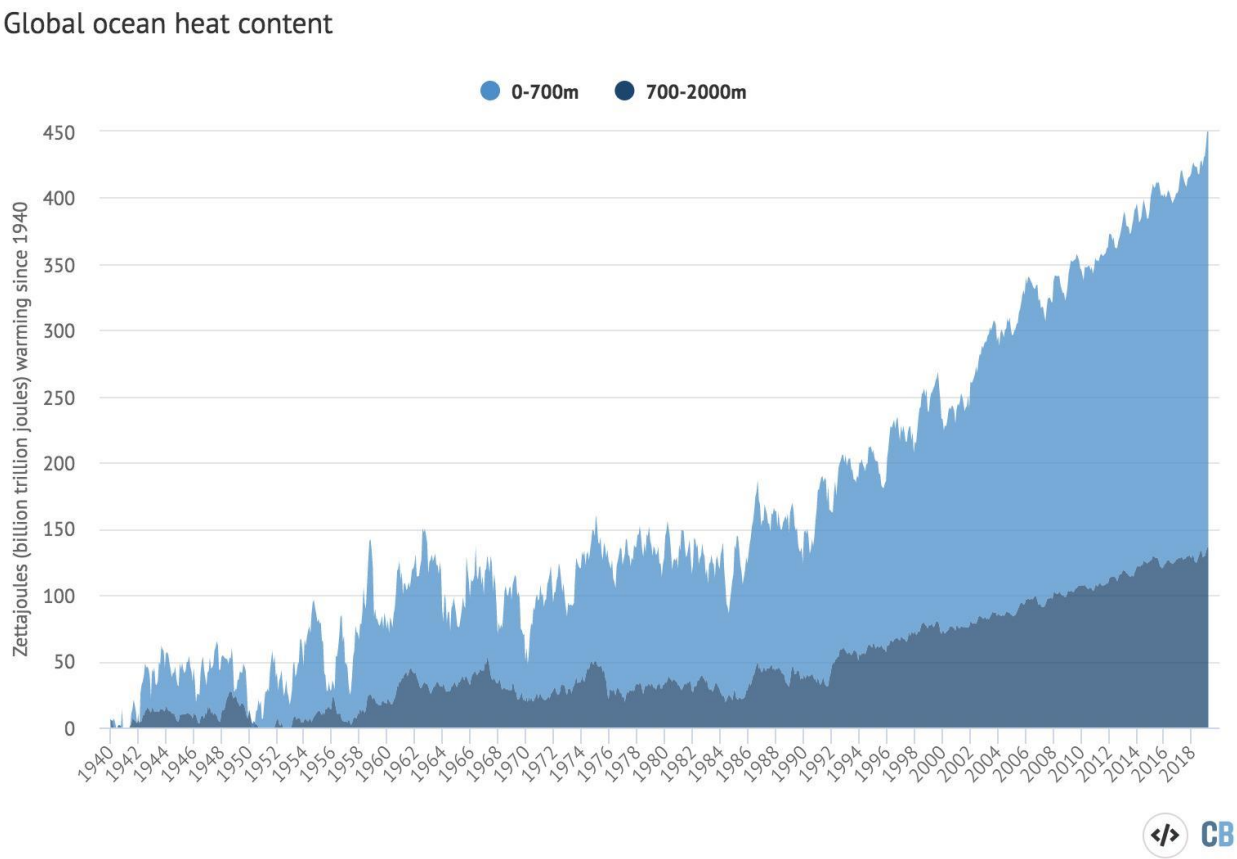
Oceans are hotter



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What happens when water heats up?

How does this relate to the Earth?

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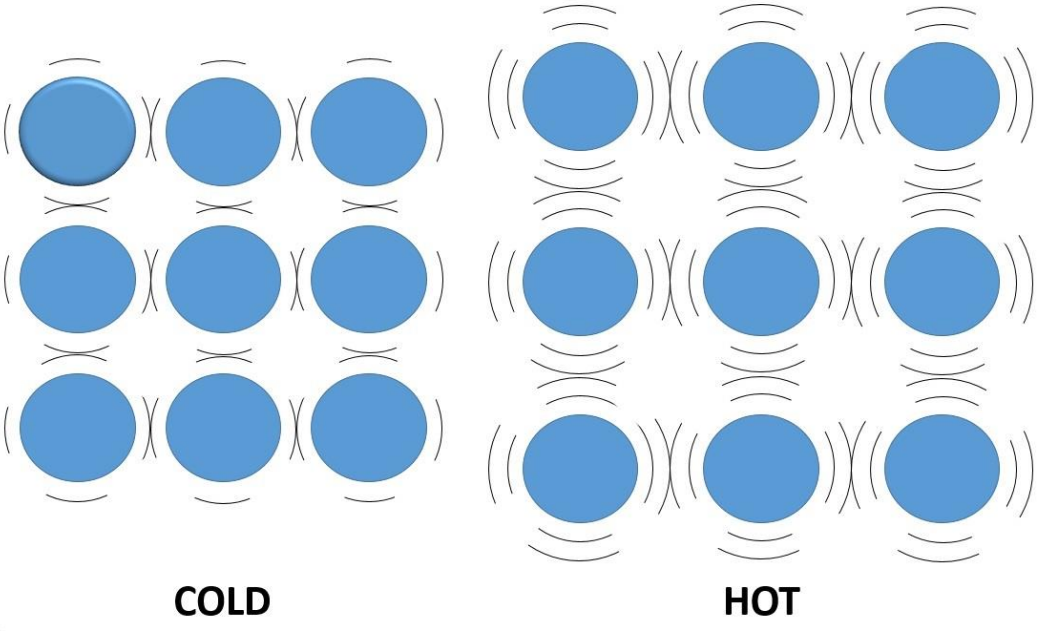
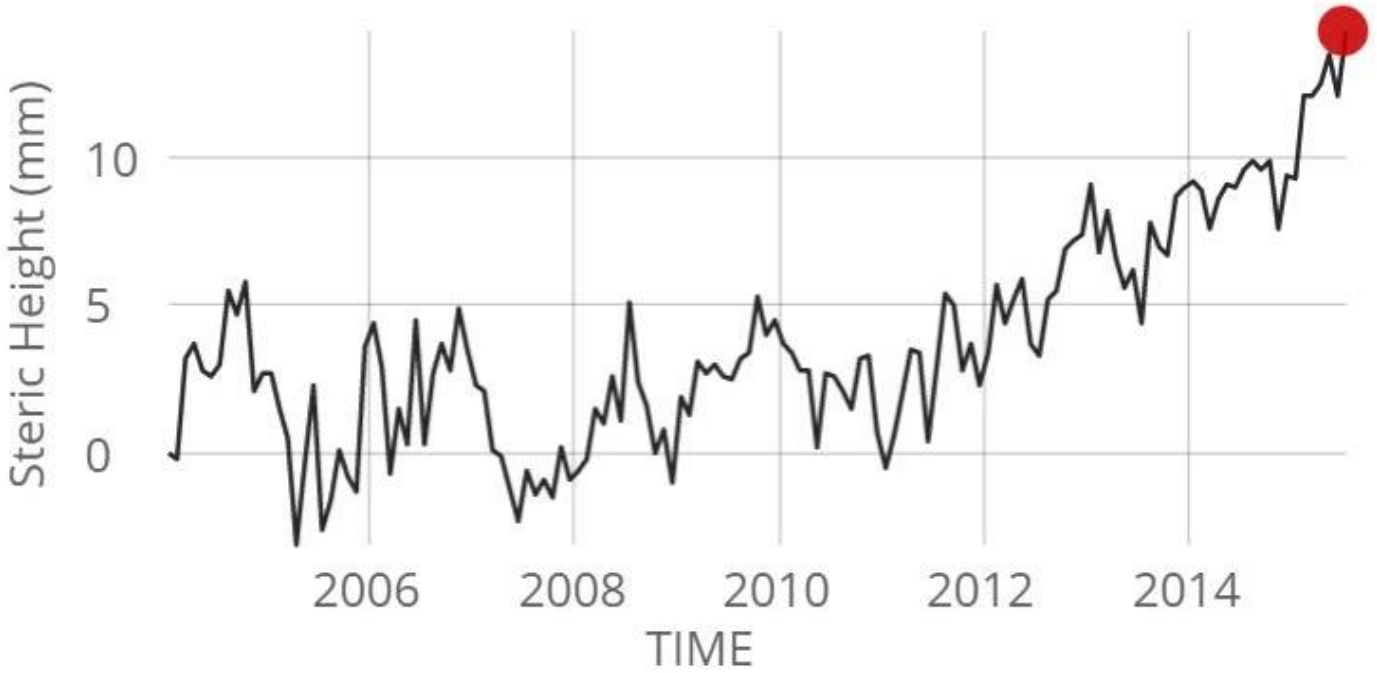
Thermal Expansion of Water



Apply:
Measuring the Ocean's Volume



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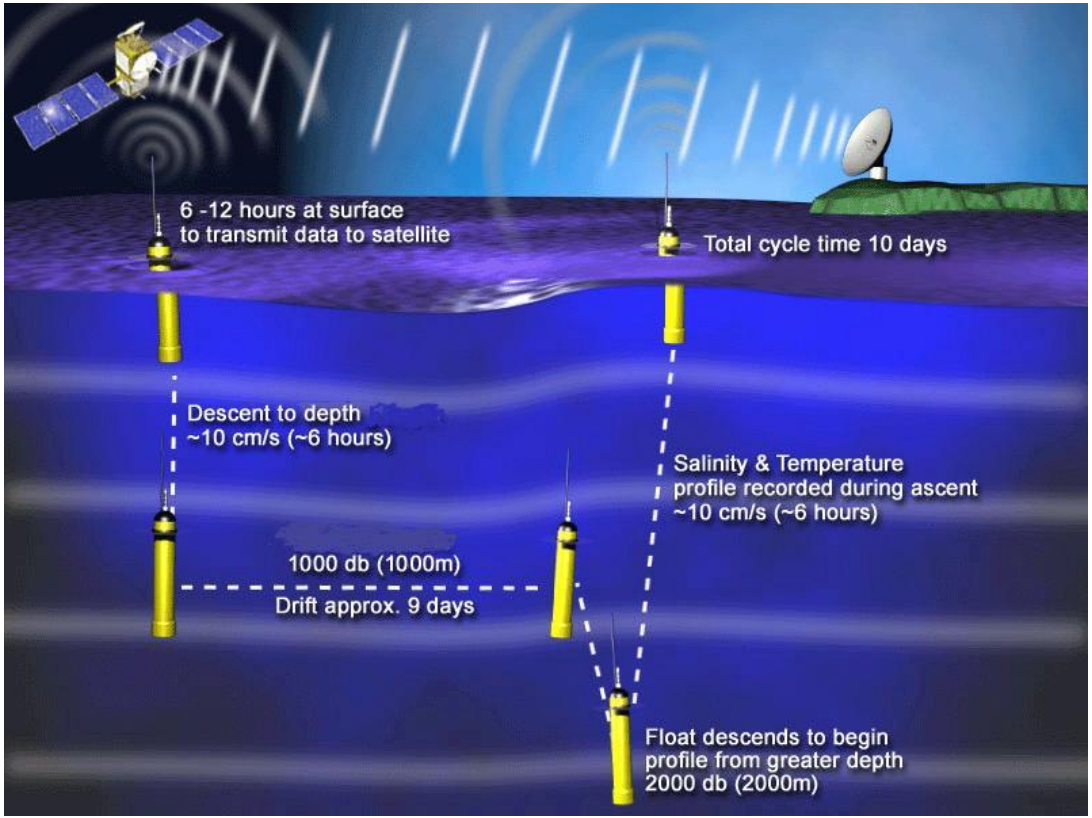
ARGO: Measuring the Ocean's Volume



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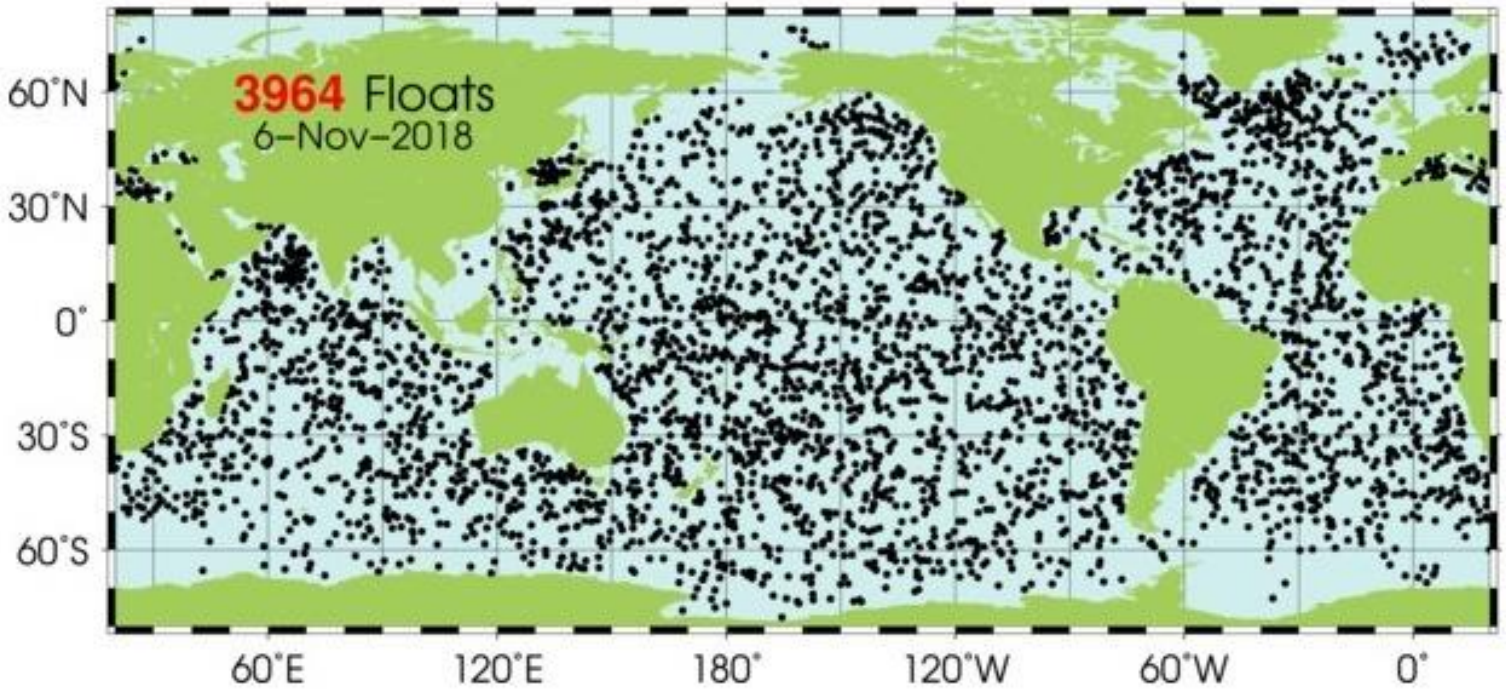
ARGO: Measuring the Ocean's Volume



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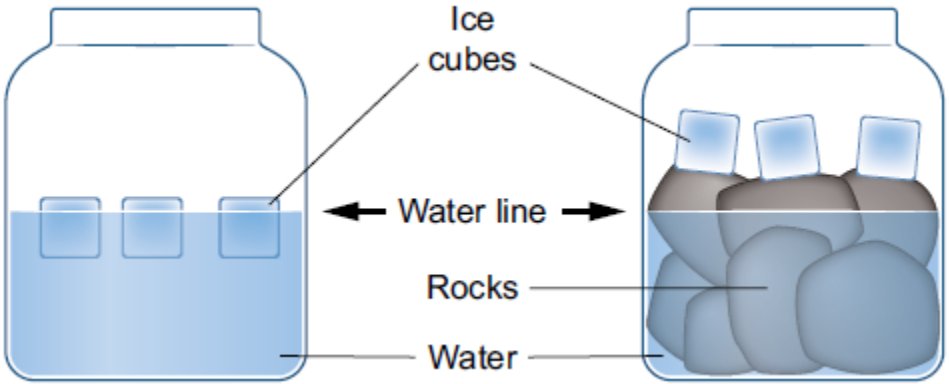
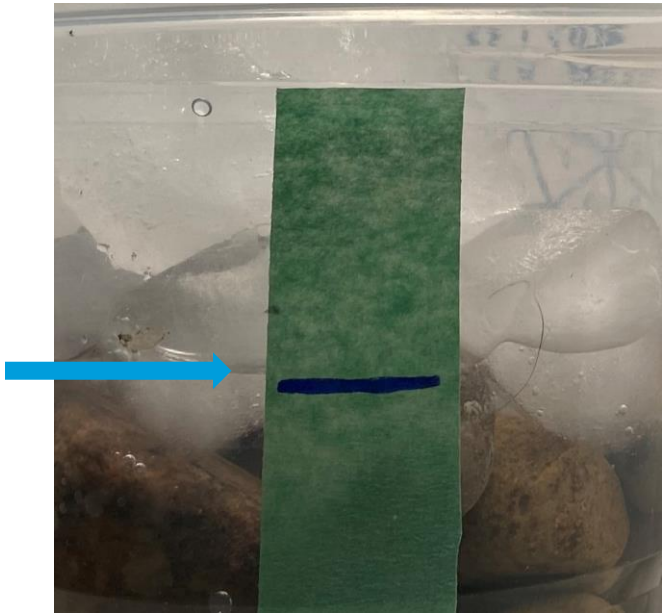
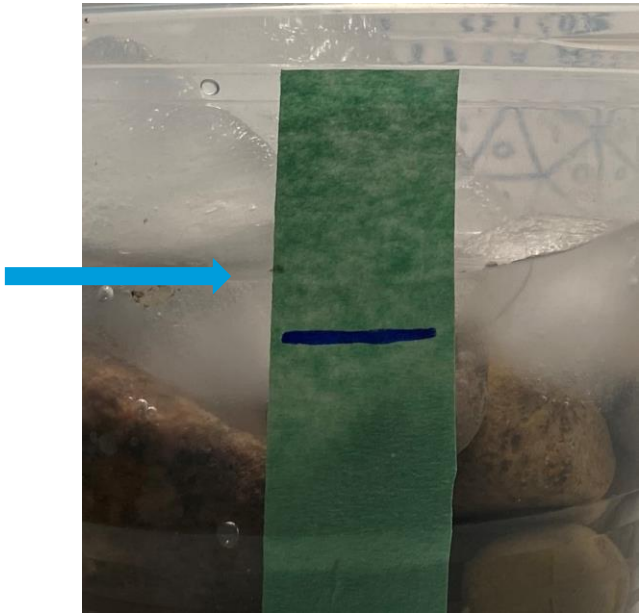
Observe and Explain

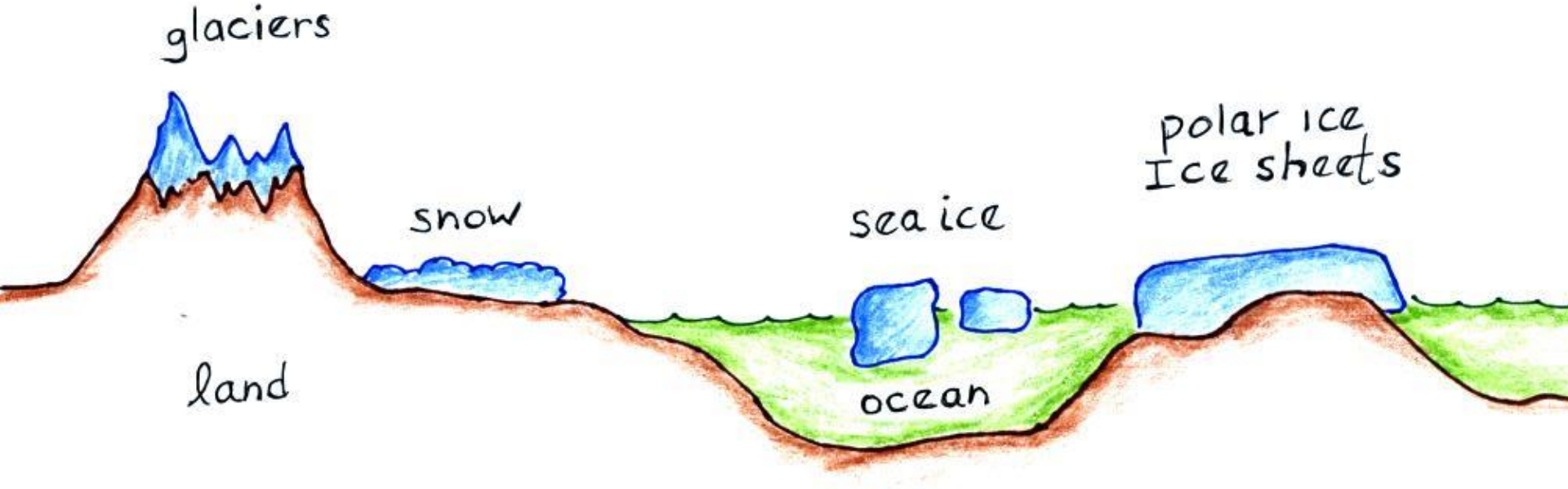


How does this relate to the Earth?





Apply:
Land Ice vs Sea Ice



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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

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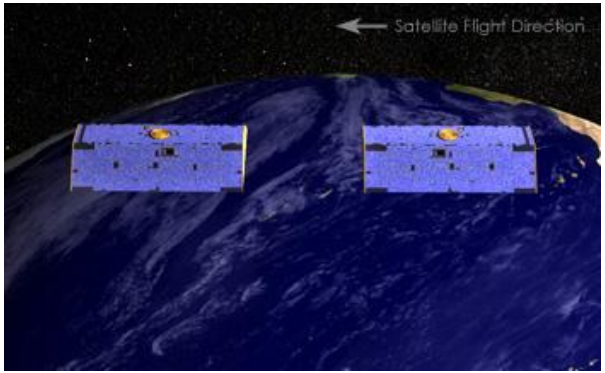
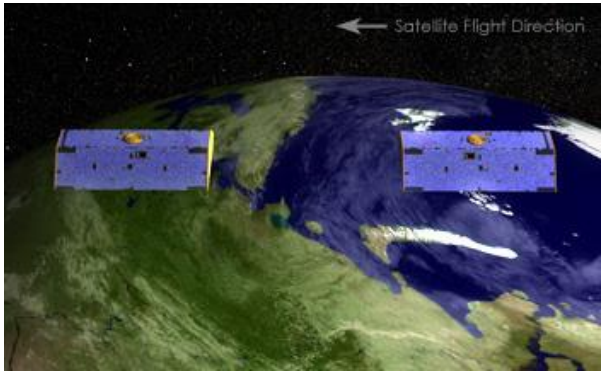
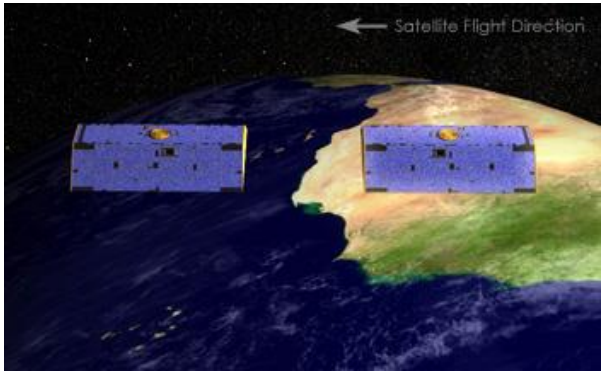
GRACE: Measuring Land Ice Mass







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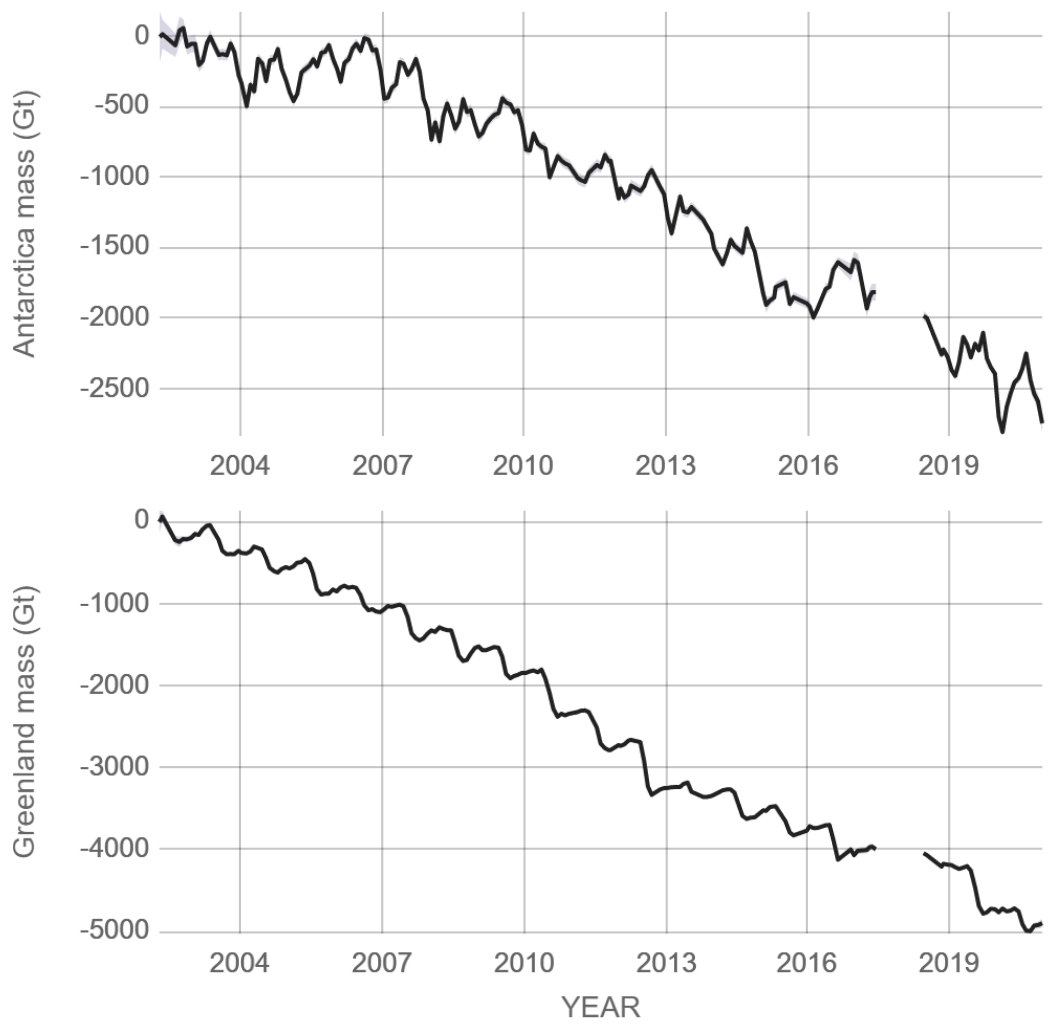

Source: climate.nasa.gov

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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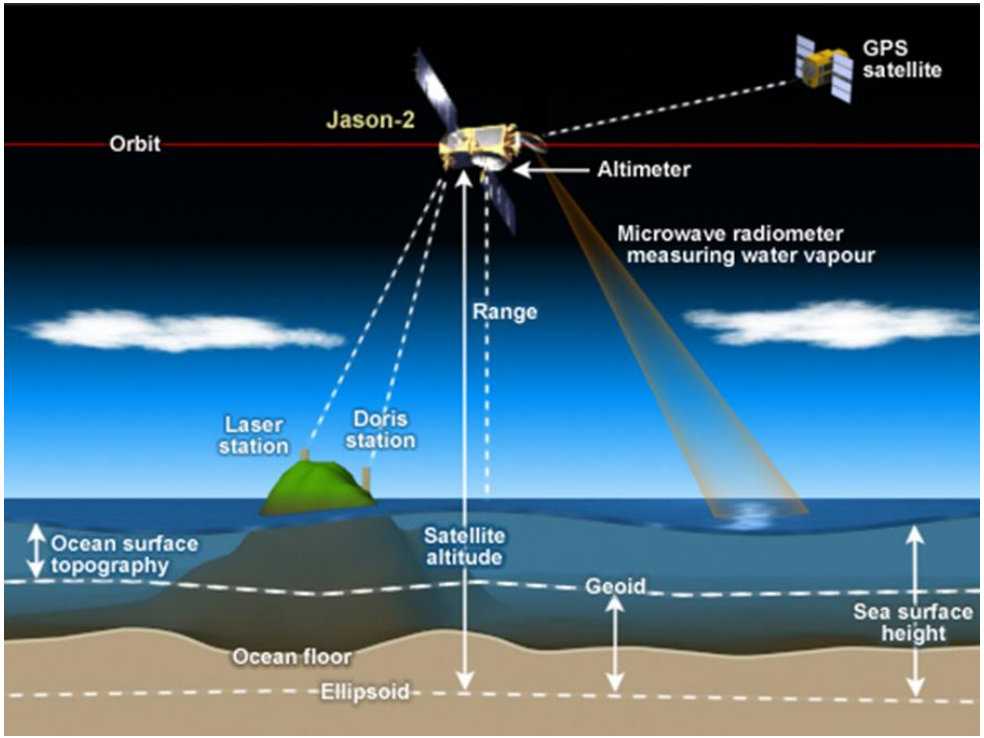
Satellite Altimetry: Measuring Sea Level



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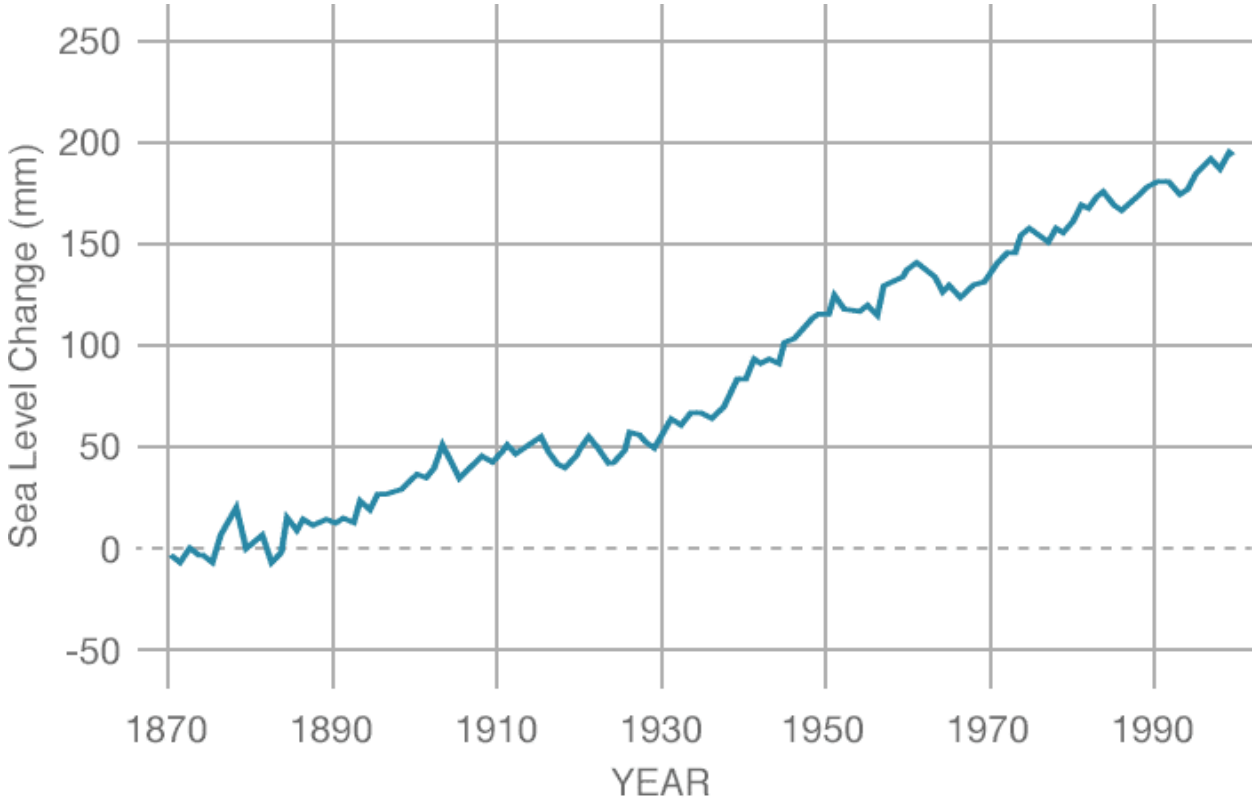
Measuring the Height of the Sea



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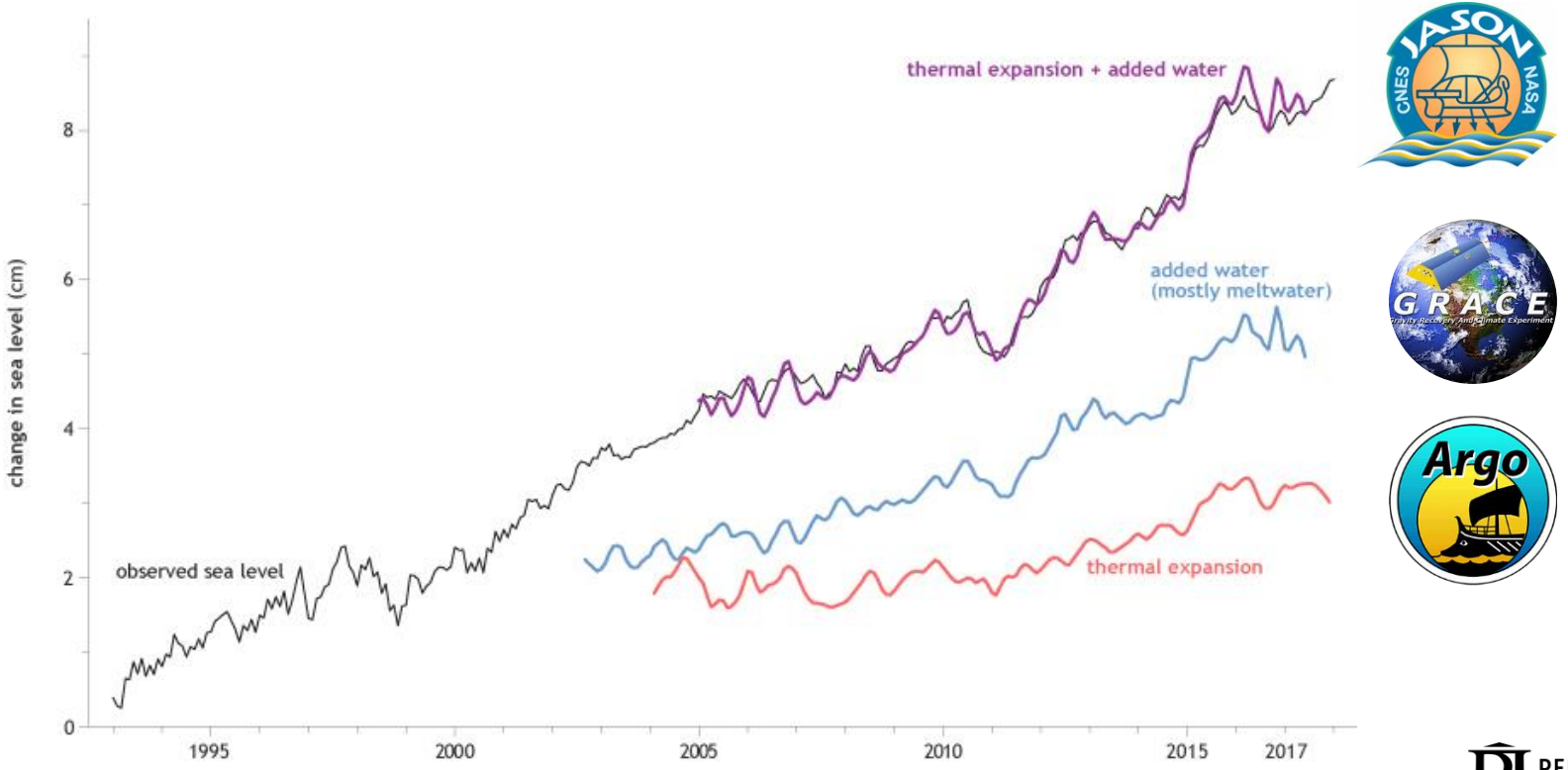
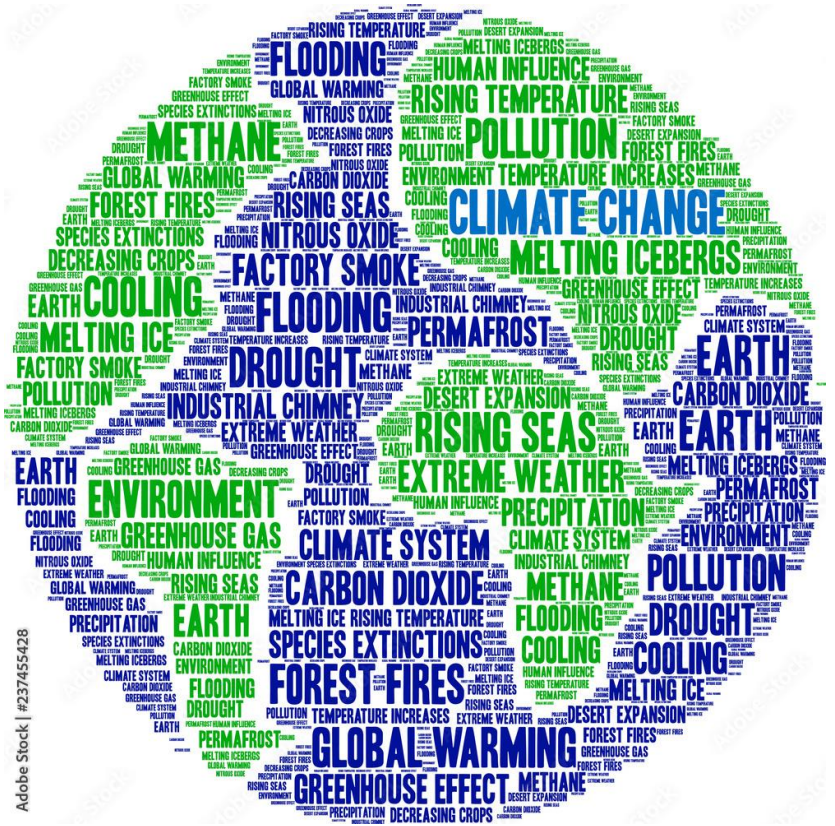
Sea Level Budget



How has climate change impacted you?



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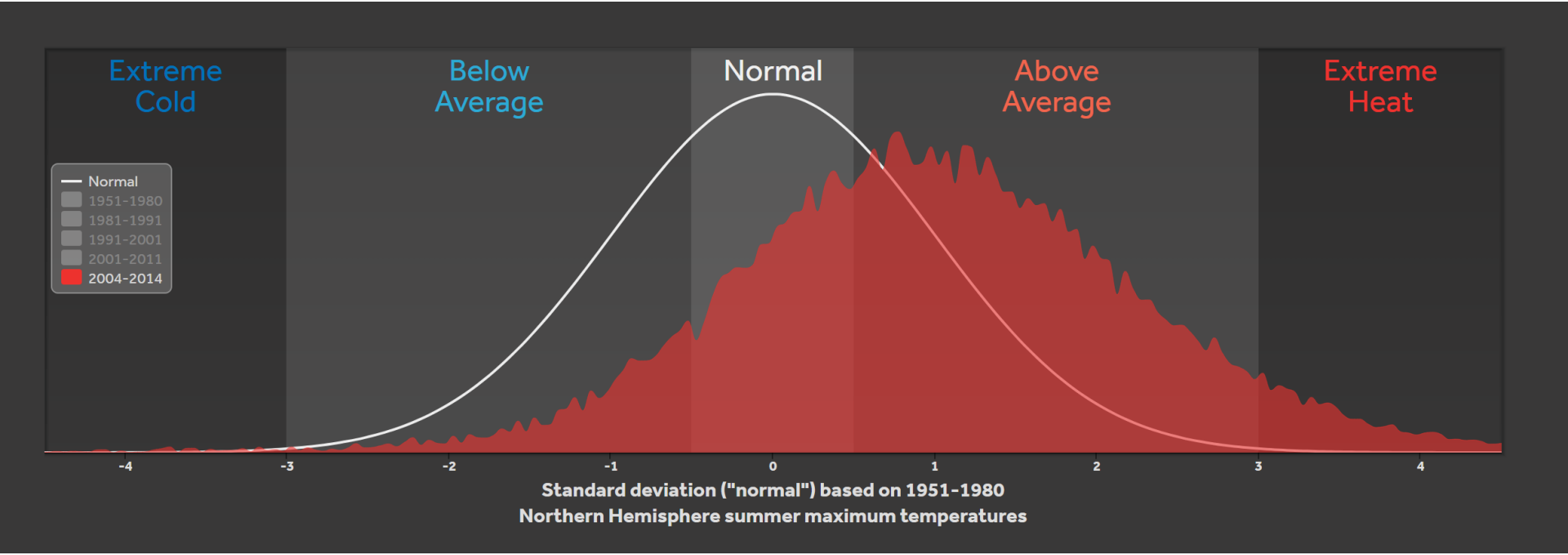
More heat waves



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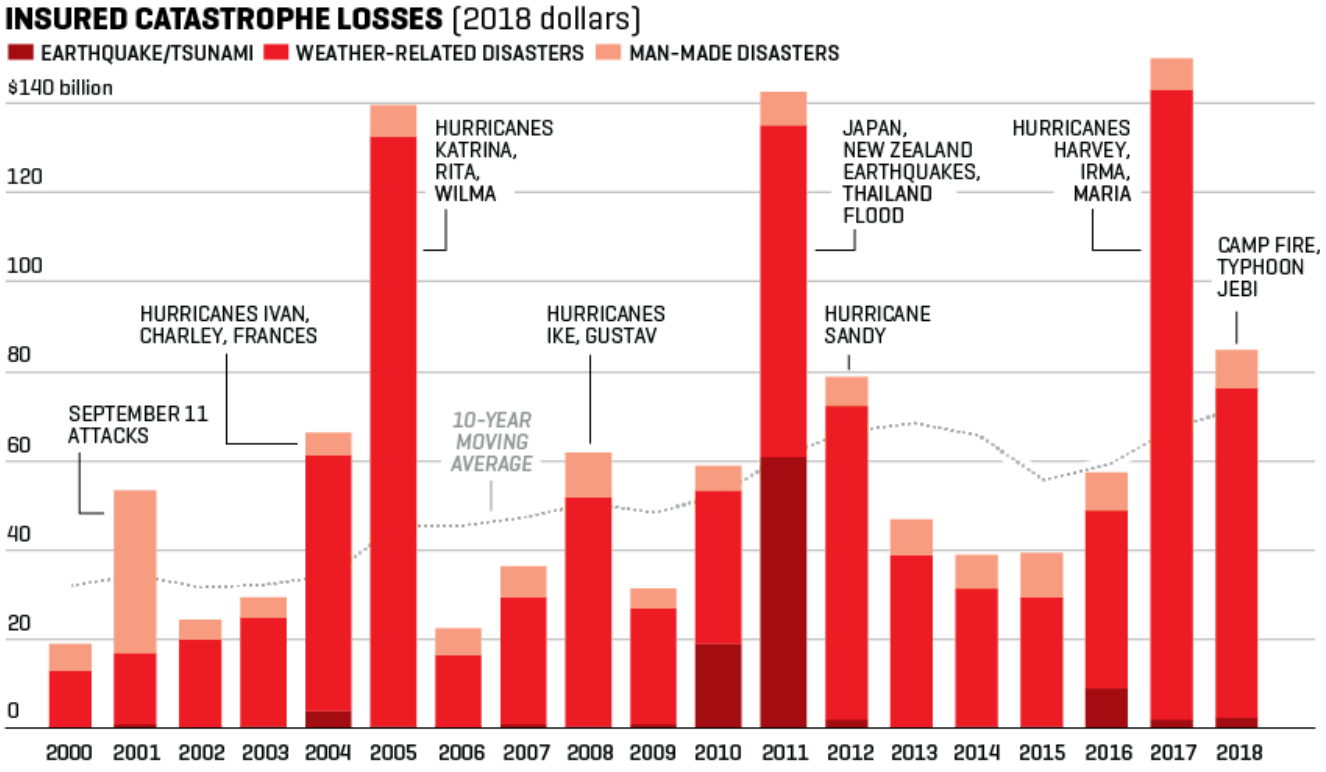
Economic costs of climate change



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Social costs of climate change

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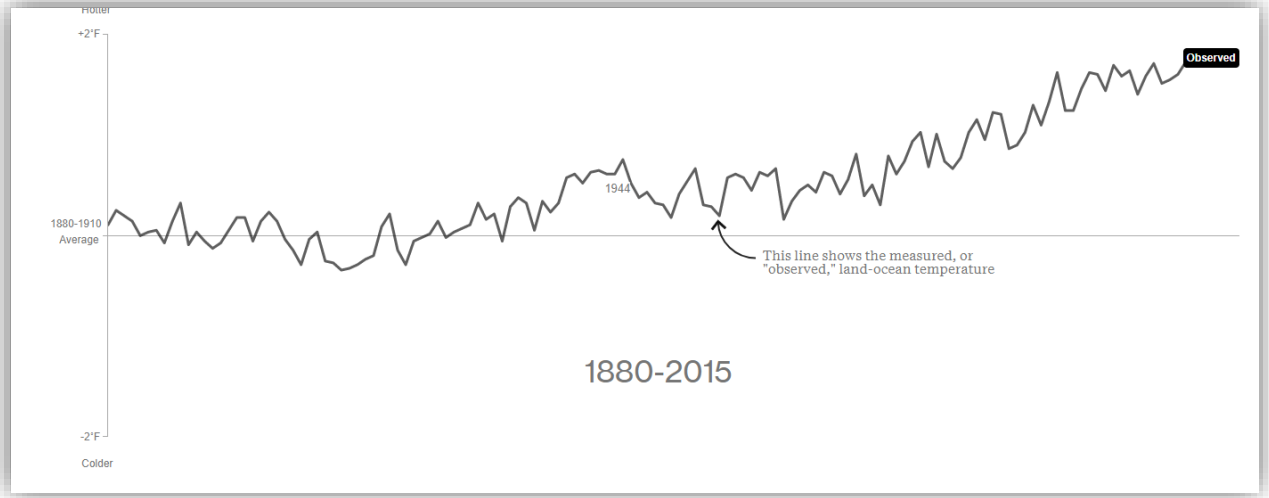
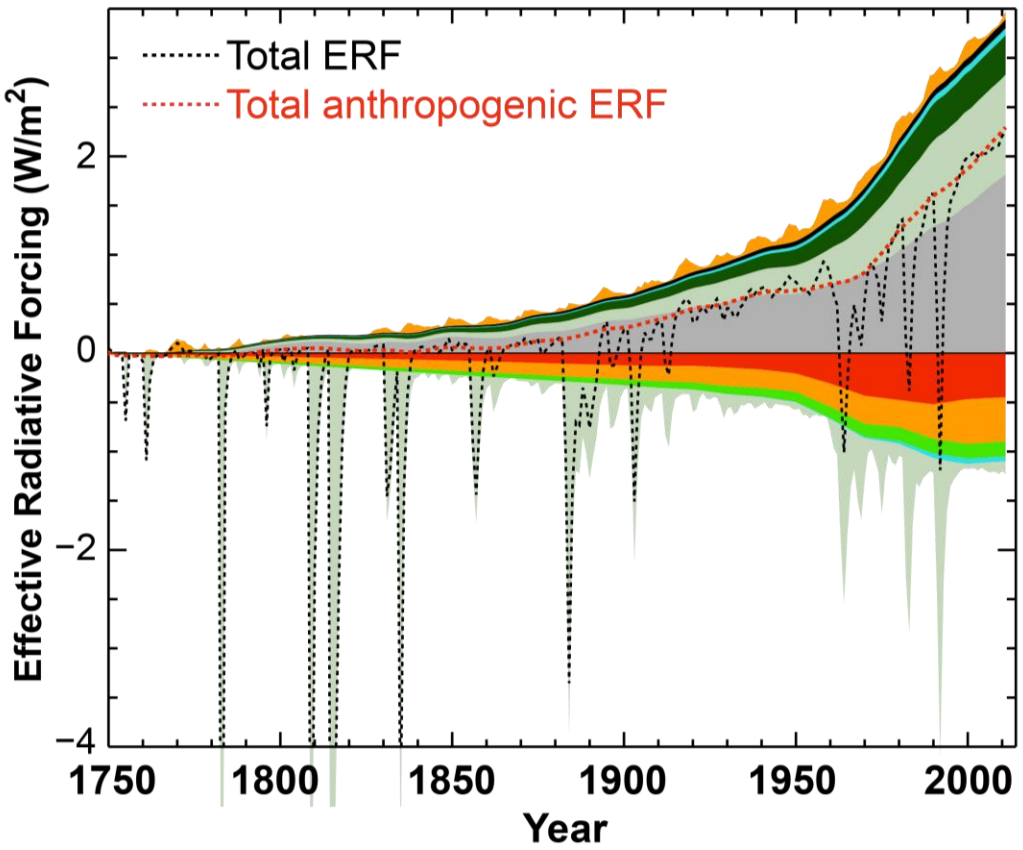
HUMANITY'S GREATEST CHALLENGE IS ALSO OUR GREATEST OPPORTUNITY

DRAWDOWN.ORG/CLIMATE-SOLUTIONS-101

What's causing the warming?



Forcing factors



Solar
Black carbon on snow and contrails
Stratospheric water
Tropospheric ozone
Other WMGHG
Carbon dioxide

Aerosol-radiation int.
Aerosol-cloud int.
Land use
Stratospheric ozone
Volcanic

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"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 (US climate expert)

Mitigation: Sources and Sinks

Reducing GHGs at the source and/or enhancing carbon sinks.

Rank the sources of GHGs (highest to lowest)

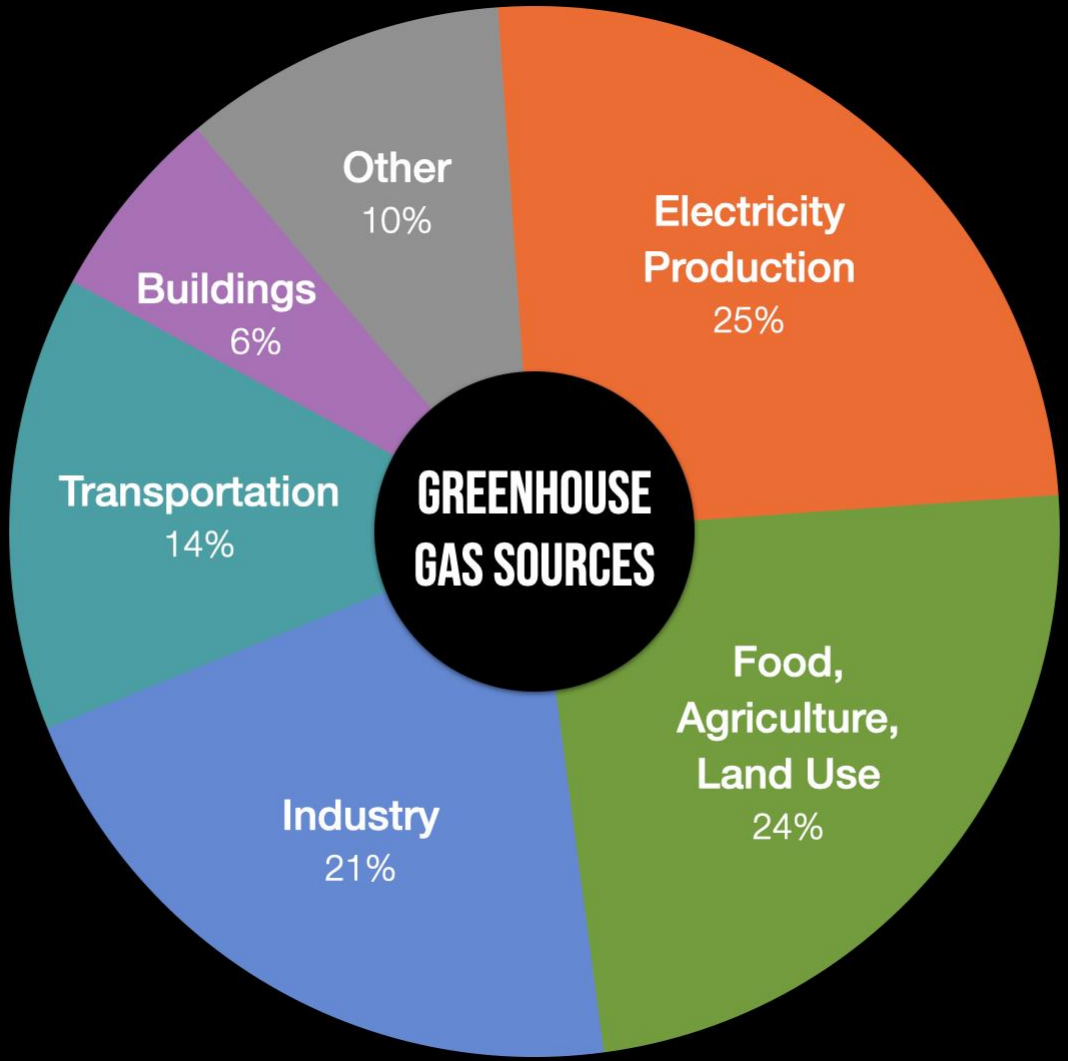

Image: Jonathan Foley
Source: IPCC WG3 AR5

Mitigation: Sources and Sinks

Reducing GHGs at the source and/or enhancing carbon sinks.

Rank these possible solutions for effectiveness*

*CO^2 reduced per dollar spent

(based on 1.5ºC by 2100)

Project Drawdown Top 10

1.5°C by 2100
Onshore Wind Turbines
Utility-Scale Solar Photovoltaics
Reduced Food Waste
Plant-Rich Diets
Health and Education for Girls/Women
Tropical Forest Restoration
Improved Clean Cookstoves
Distributed Solar Photovoltaics
Refrigerant Management
Alternative Refrigerants

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Every contribution helps

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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Personal Action vs Corporate Action

It is NOT either OR but BOTH

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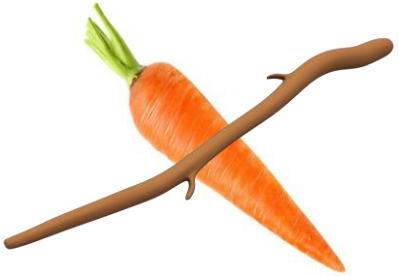
How do we get corporations to change?

- Voluntary mandates
- Change laws
- Consumer pressure (boycotts)
- Public pressure (demonstrations)
- Government incentives
- Economics



Personal choices to reduce your contribution to climate change

Low Impact

< 0.2 tCO_2e

Moderate Impact

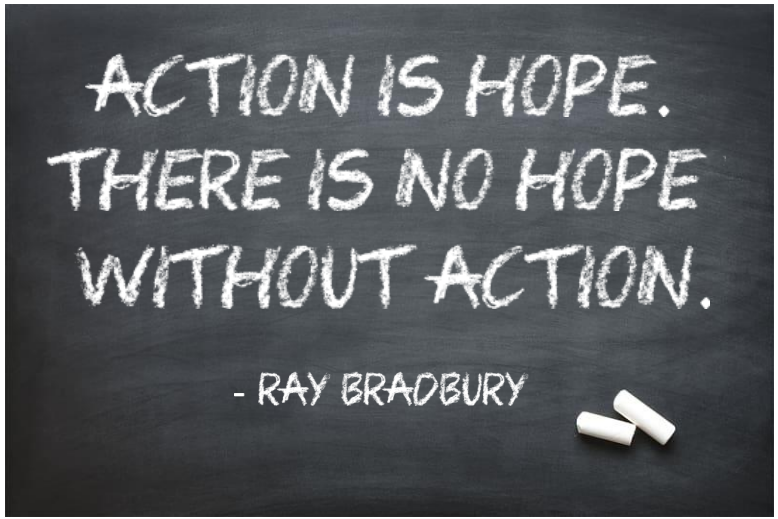
0.8-0.2 tCO_2e

High Impact

> 0.8 tCO_2e

Seth Wynes & Kimberly Nicholas, 2017, Environmental Research Letters

What difference do personal actions make?



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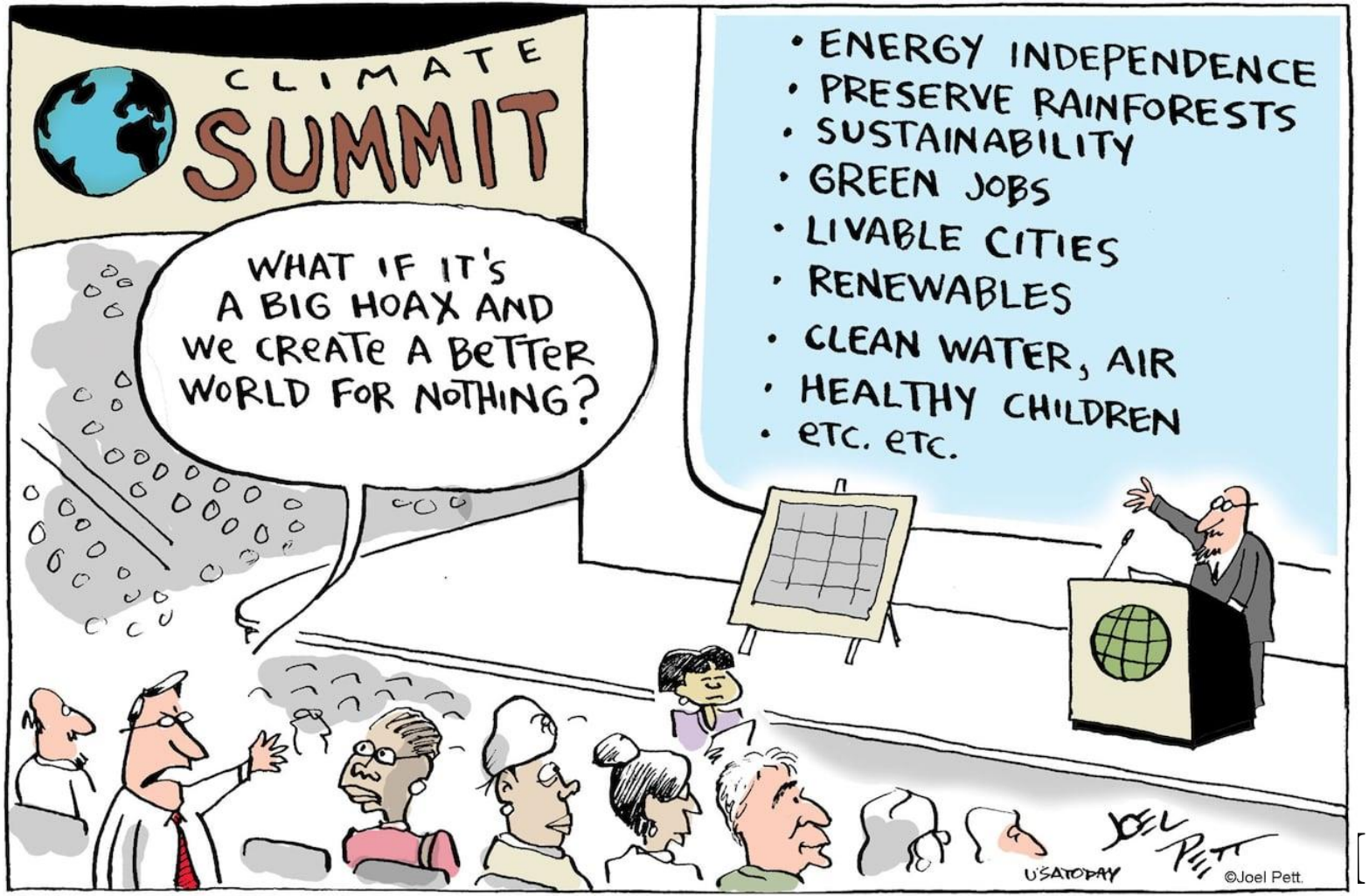

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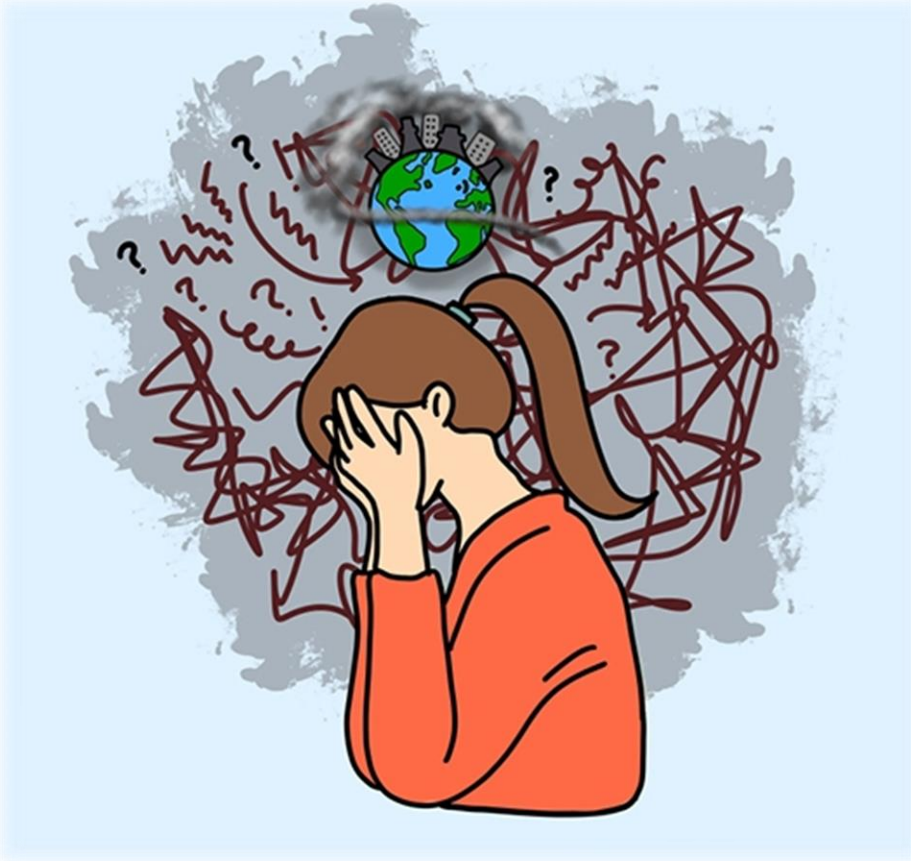
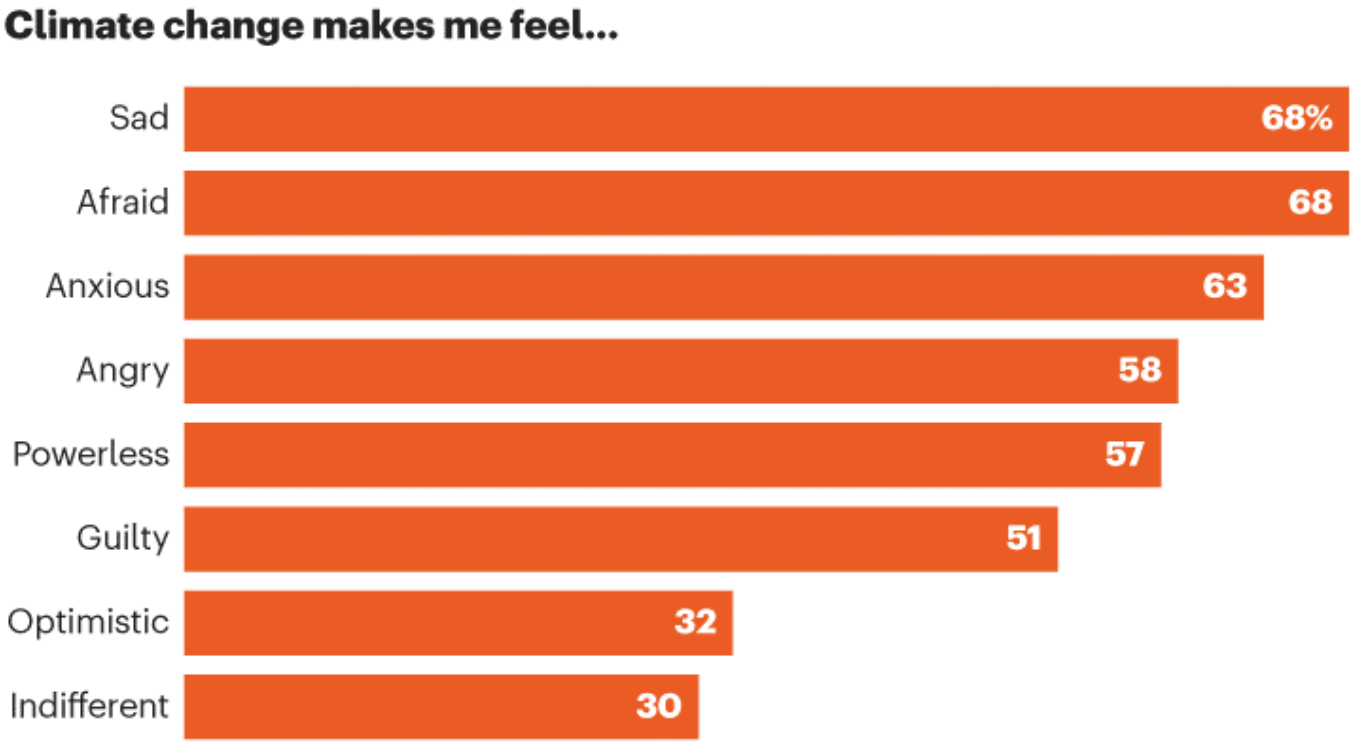
Recognize that this is a loaded issue

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



Climate Anxiety



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Teaching Climate Change

- Give room for emotional response
- Give immediate and concrete steps to take
- Encourage collective response, *we are in this together*
- Model hope and intentionality

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“

The thing about climate is that you can either be overwhelmed by the complexity of the problem or fall in love with the creativity of the solutions.

MARY ANNAISE HEGLAR

CLIMATE JUSTICE WRITER/PODCAST HOST

@100ISNOW

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

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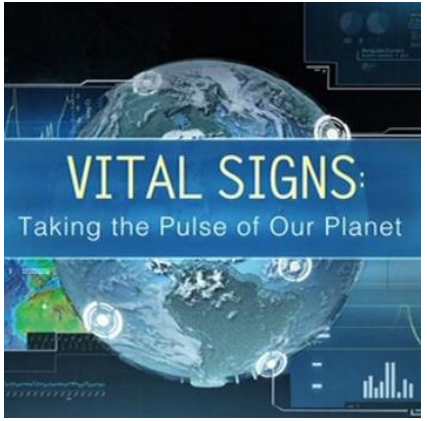
Resources



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