Evidence for Climate Change

Scotland 2019

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Greg Dick

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

What's happening inside?

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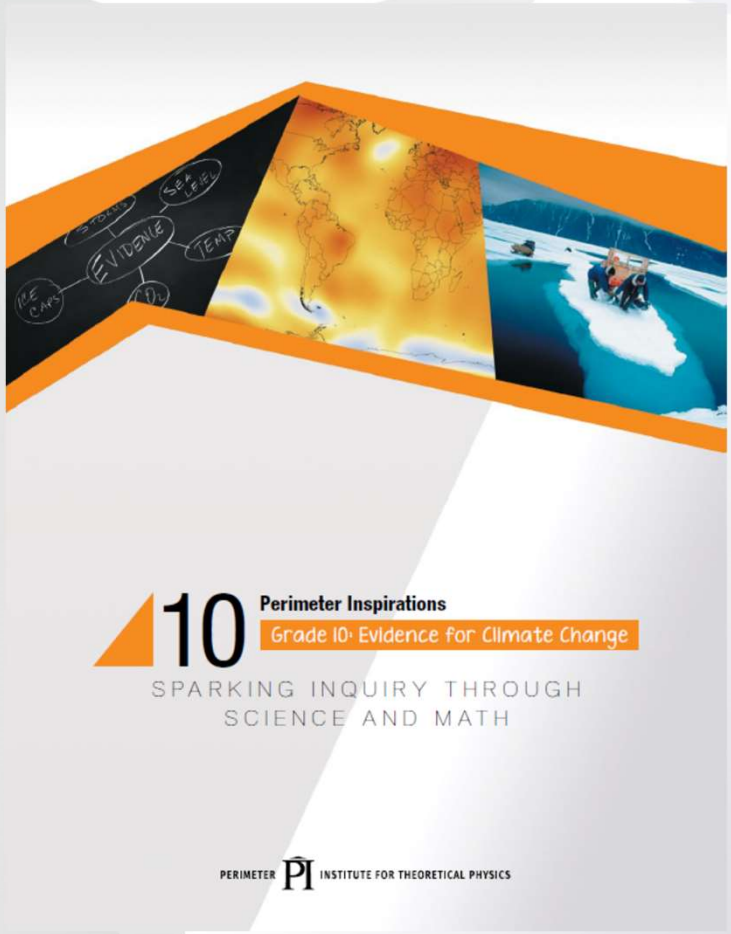
Resource: Evidence for Climate Change

Students use the data, and learn how that data was collected.

The conlcusion is unesacapable.



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Goals

- What do you hope to get from this session? What is the question that you are most worried about being asked?

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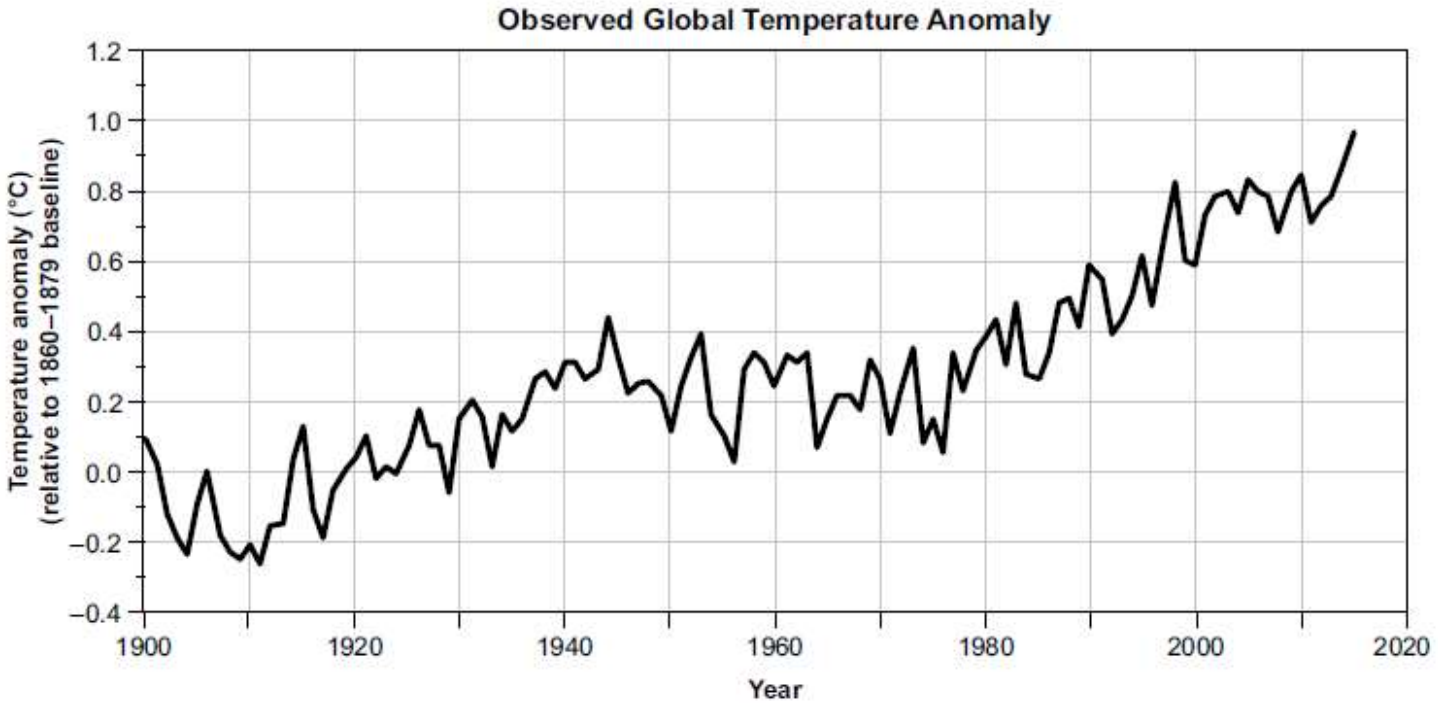
Earth is getting warmer



Source: NASA GISS

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2 degrees may not seem like much…

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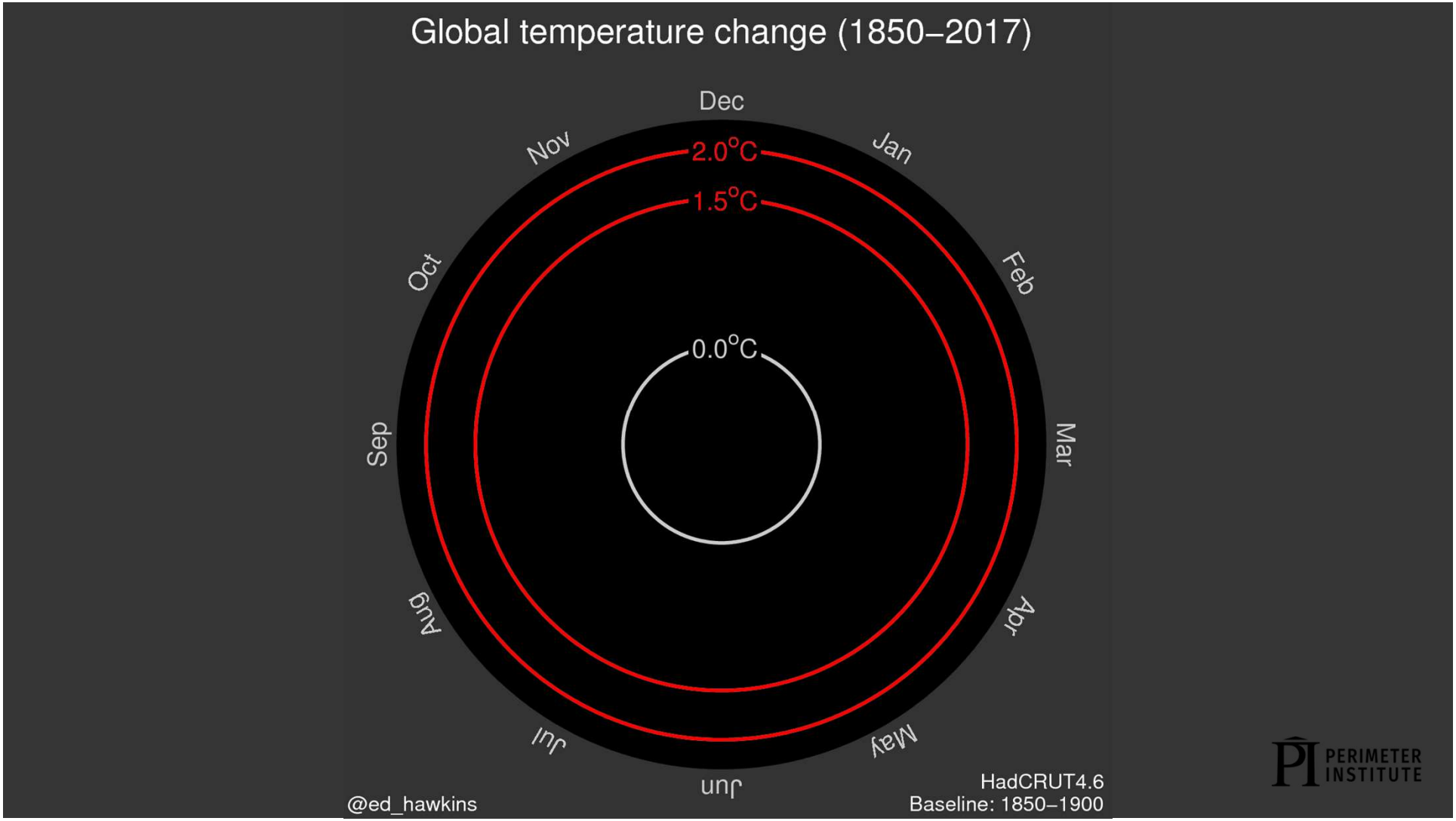
Global temperature change (1850–2017)
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2.0°C
1.5°C
0.0°C
@ed_hawkins
HadCRUT4.6
Baseline: 1850–1900
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Climate Change

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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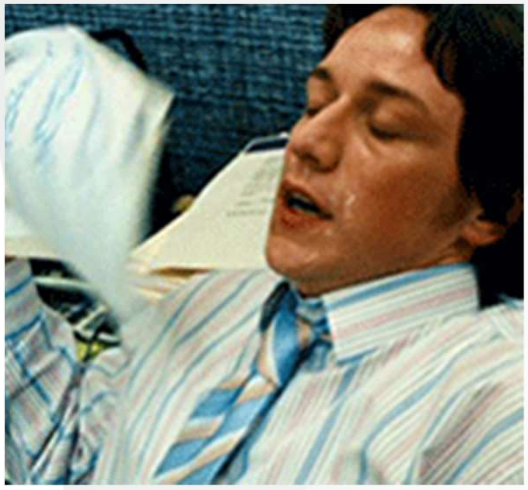
POE extended



- Predict
- Explain
- Observe
- Explain
- Apply

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Predict and Explain
What happens when the ice melts?

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Predict and Explain
What happens when water heats up?

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Predict and Explain
What happens to the balloons?

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Predict and Explain
How will this feel?

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Gases in the atmosphere

- Watch video: https://youtu.be/l7rqlvzWrEw

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How do these predictions relate to the Earth?

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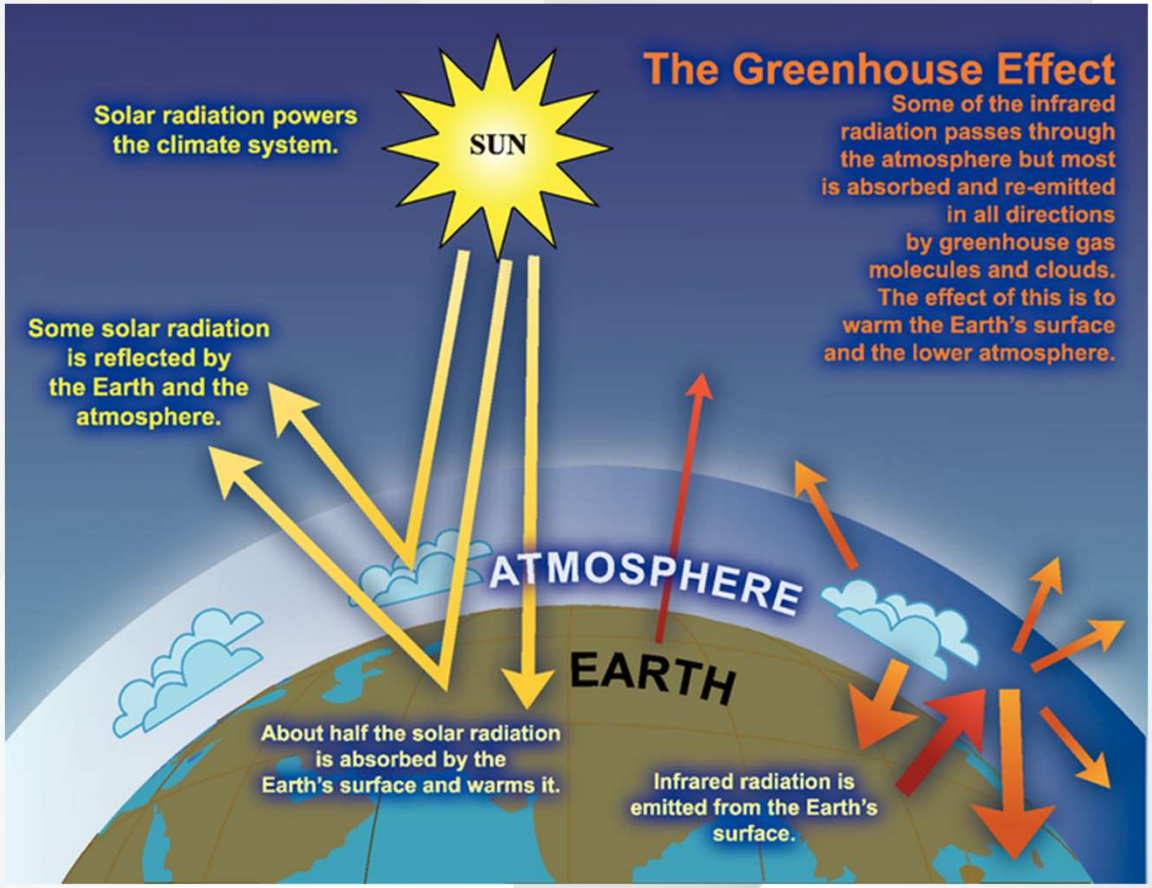
Earth's atmosphere traps heat



IPCC 2007

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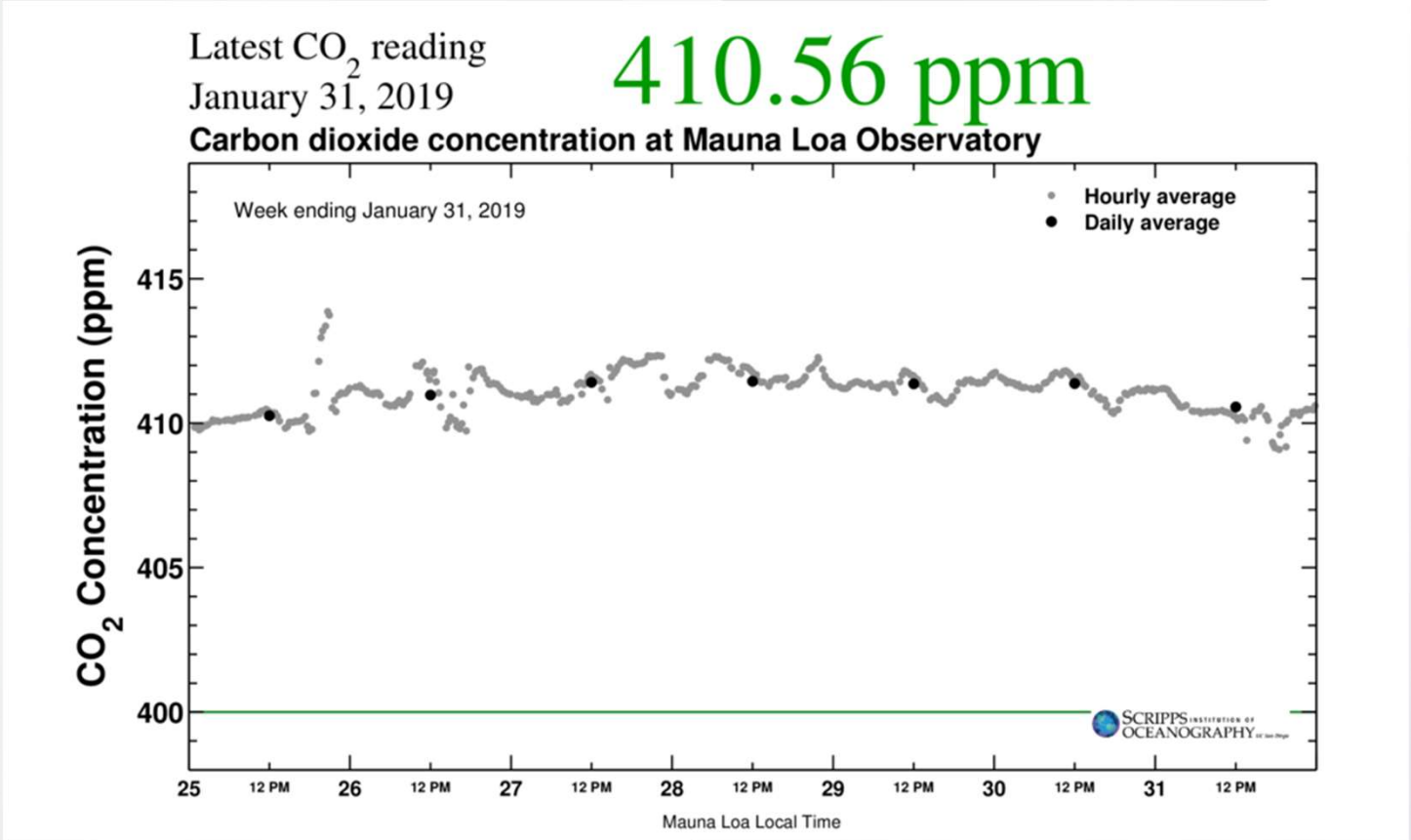
Keeling Curve

- Measurement of the concentration of CO_2 in the atmosphere
- Continuous record at Mauna Loa since 1958

One week



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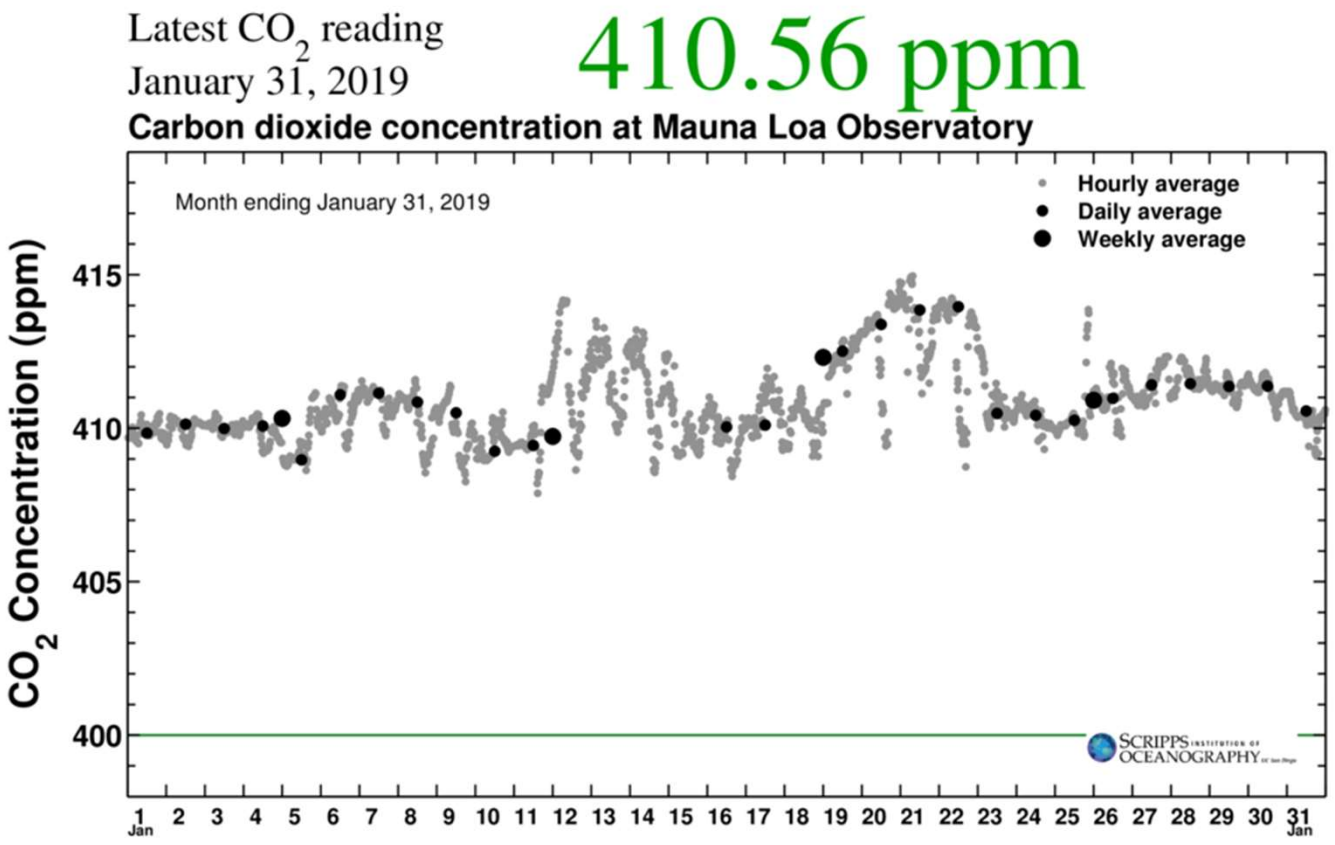
One month



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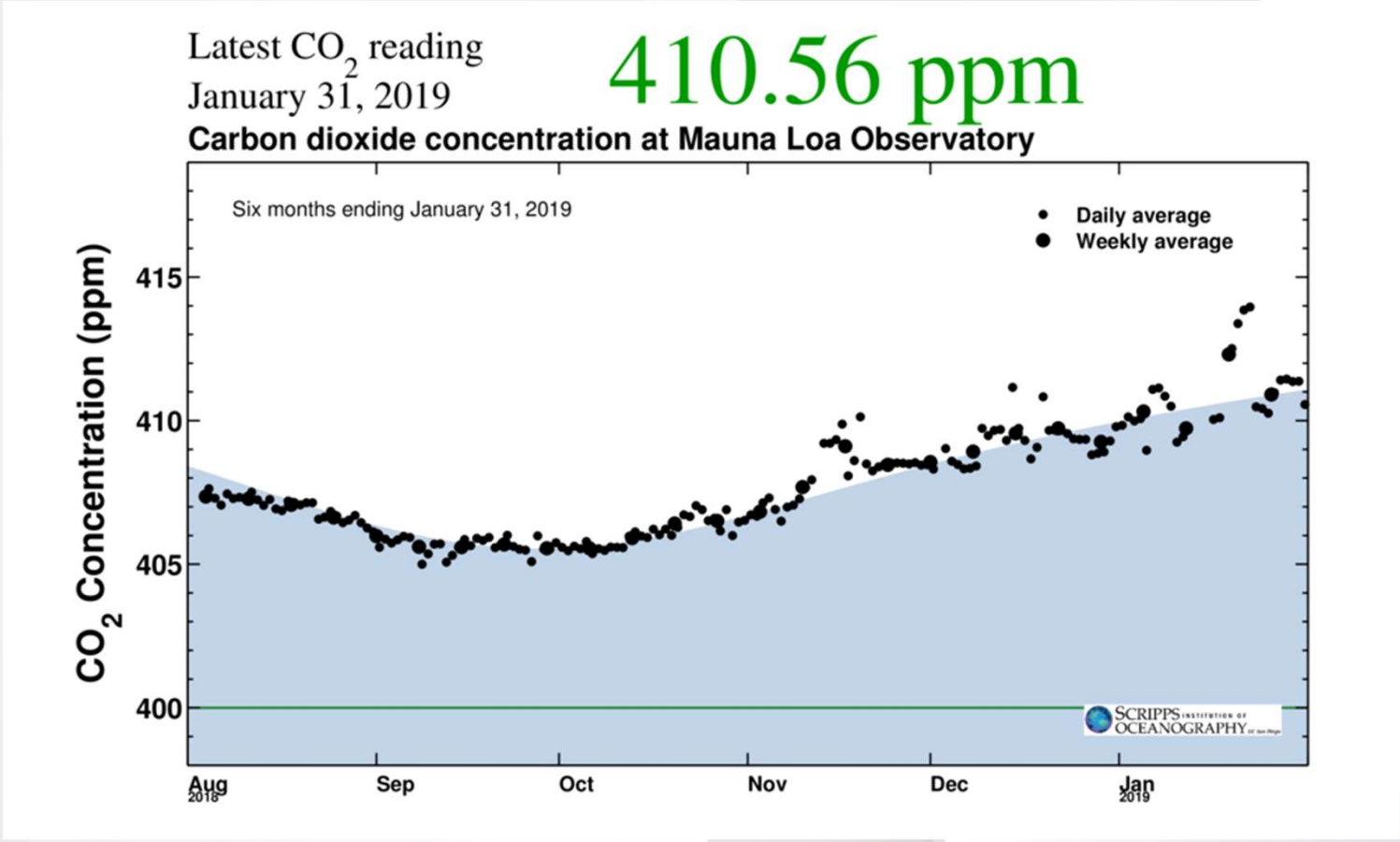
six months



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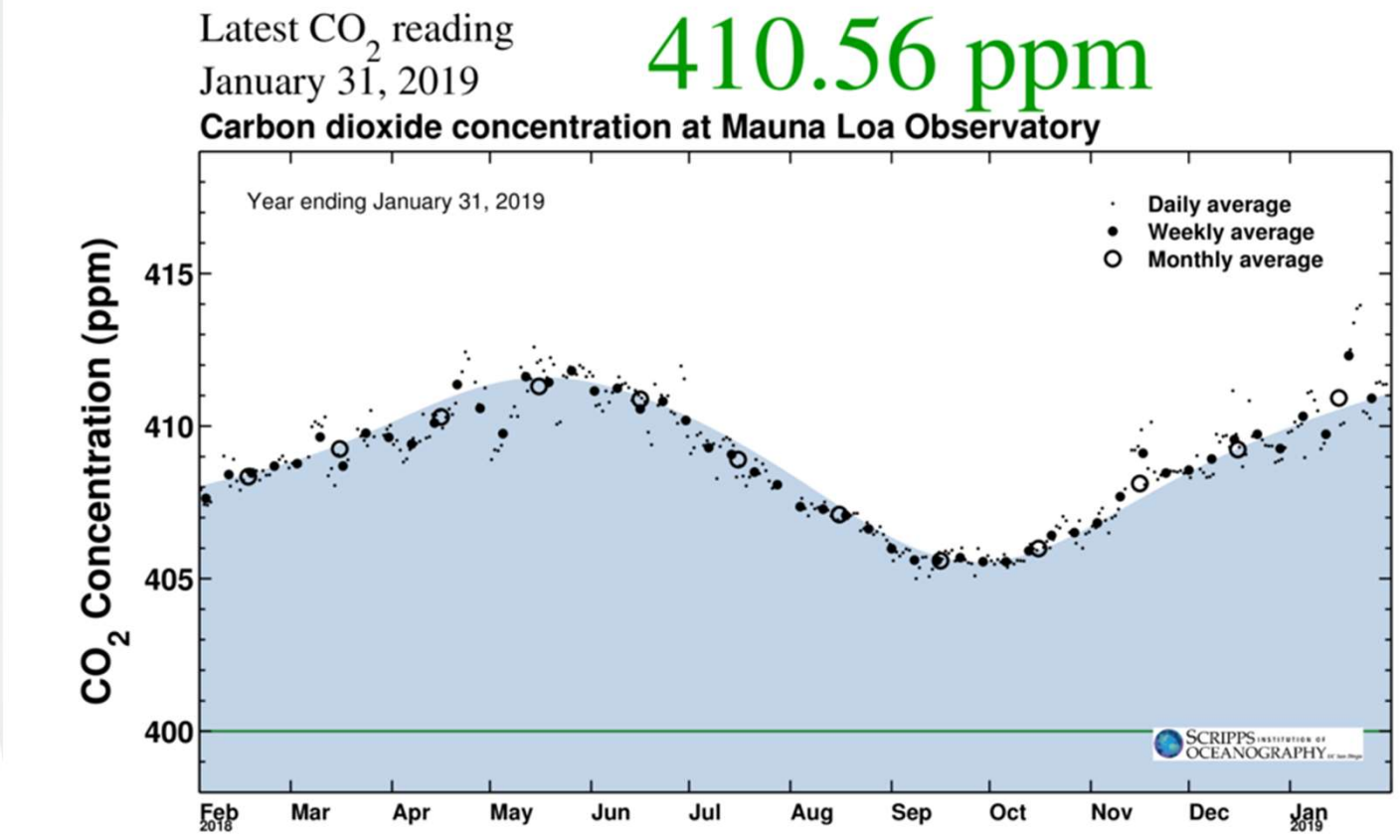
1 year



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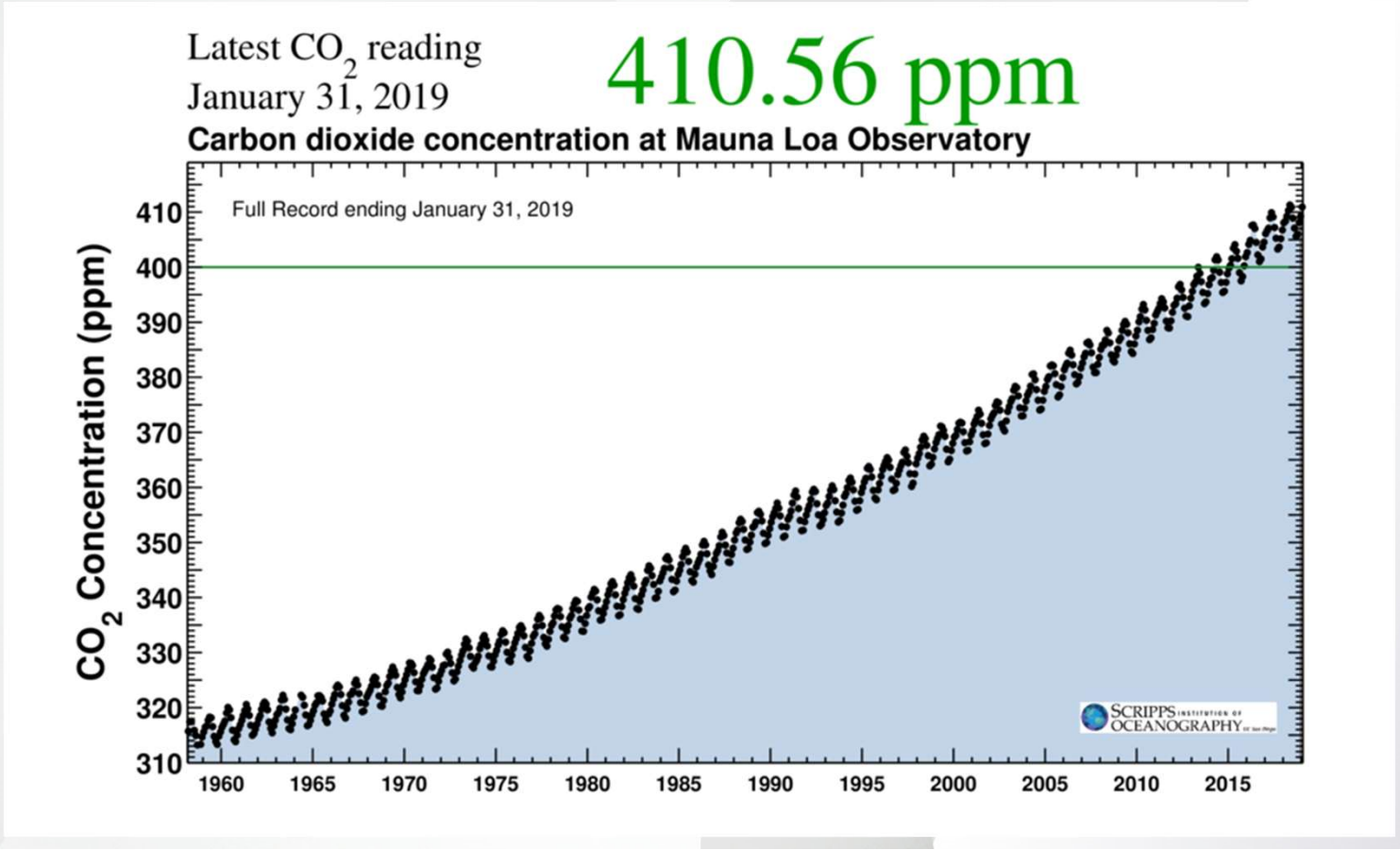
Full record



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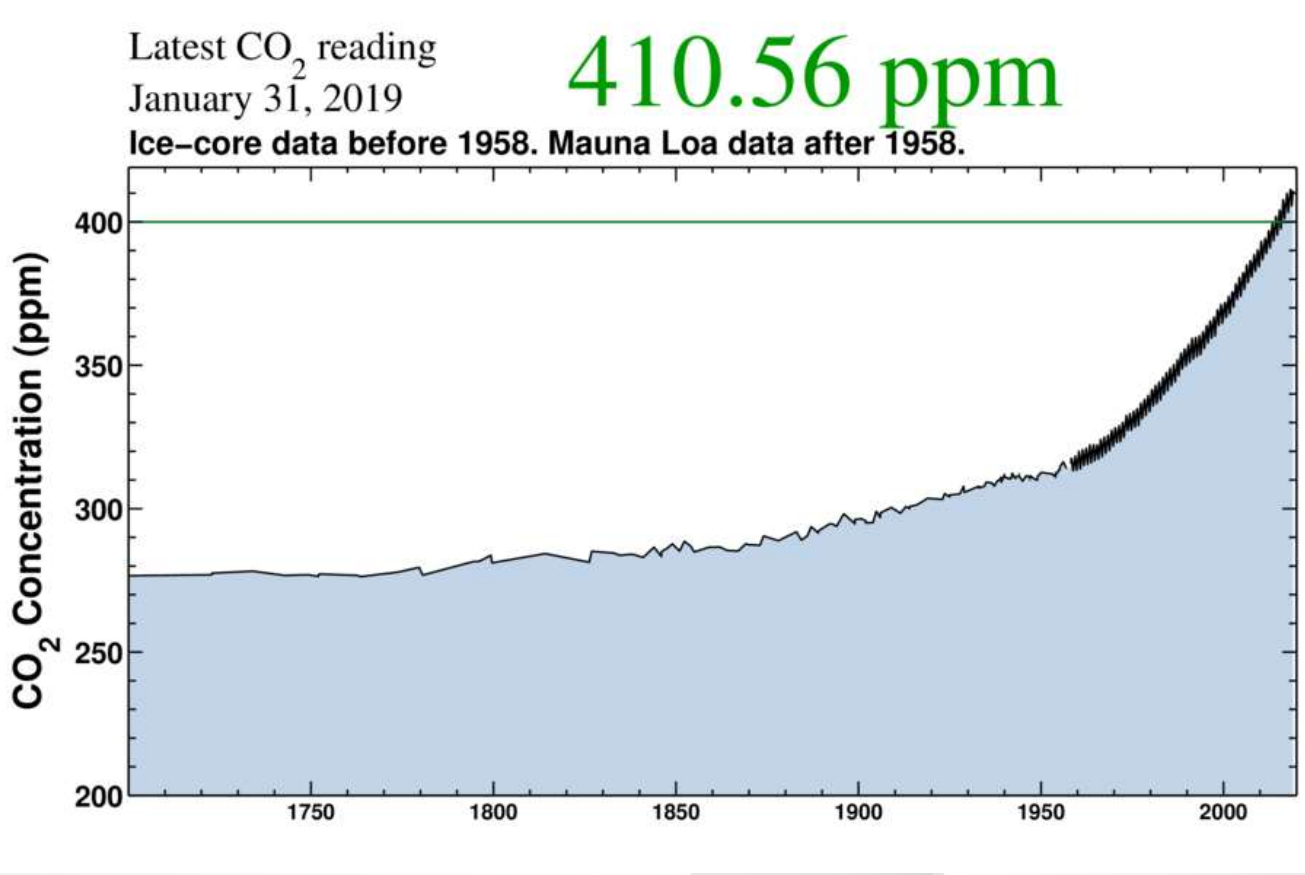
1700 - present



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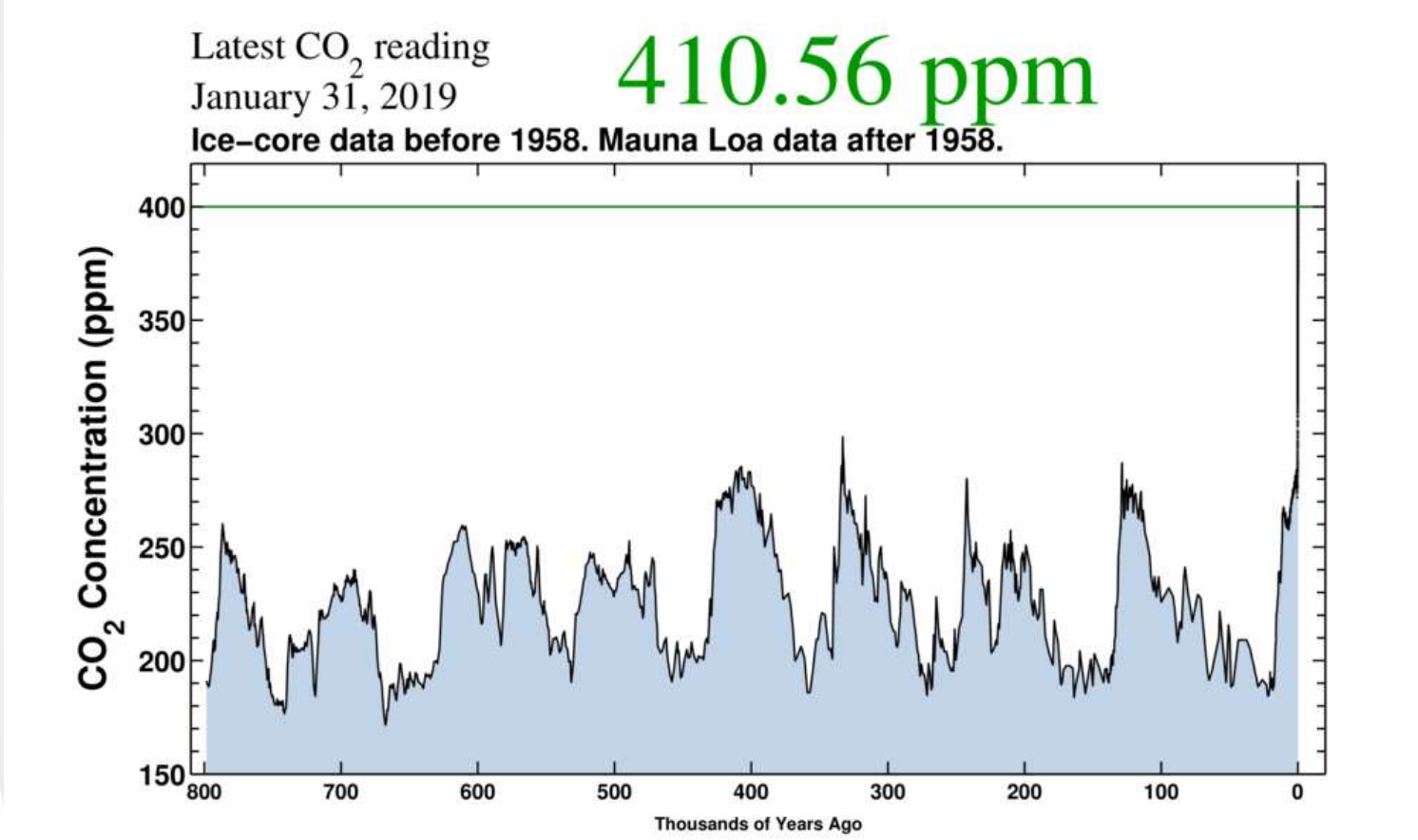
Last 800,000 years



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Observe and Explain

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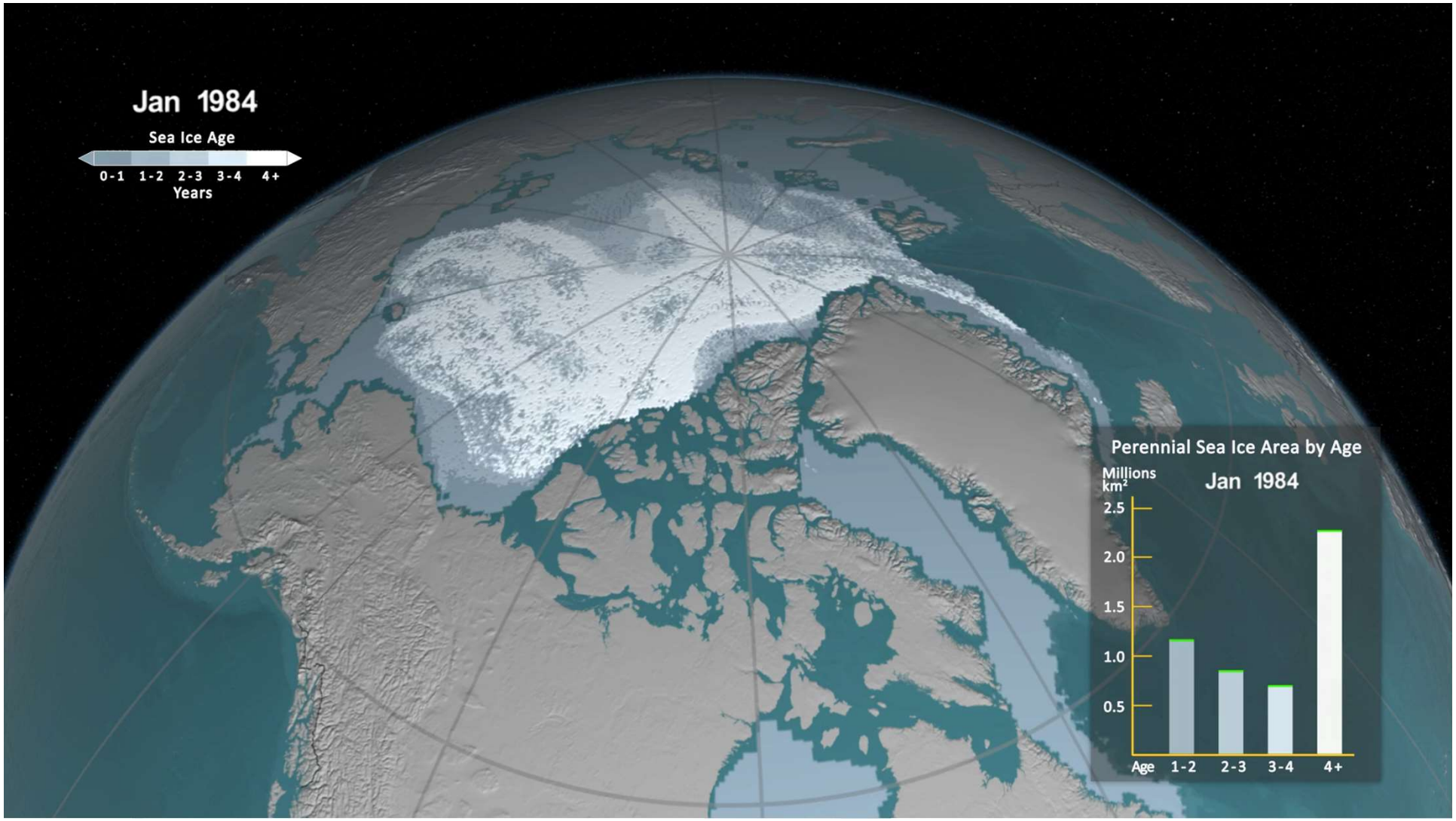
Jan 1984
Sea Ice Age
0-1 1-2 2-3 3-4 4+
Years
Perennial Sea Ice Area by Age
Jan 1984
Millions km²
2.5
2.0
1.5
1.0
0.5
Age 1-2 2-3 3-4 4+

Observe and Explain

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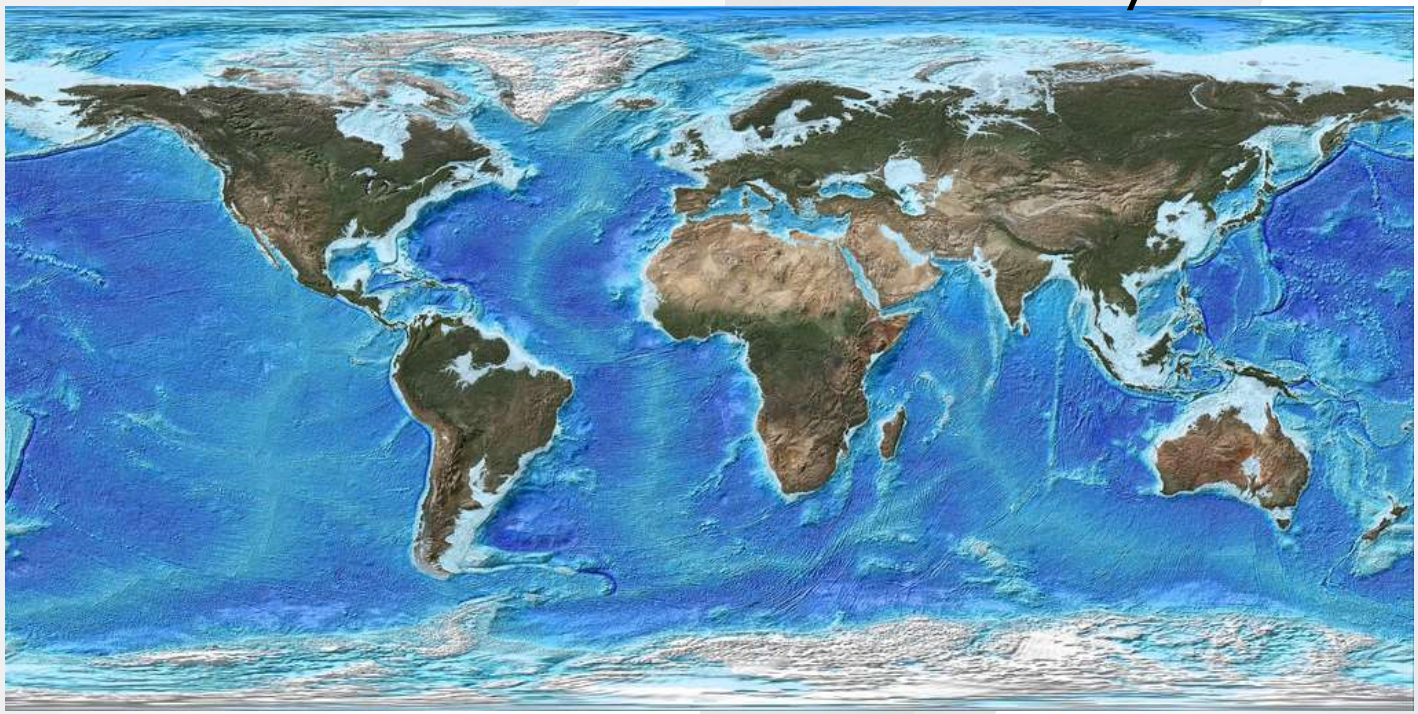
Apply
70% of the Earth is covered by water



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Observe and Explain

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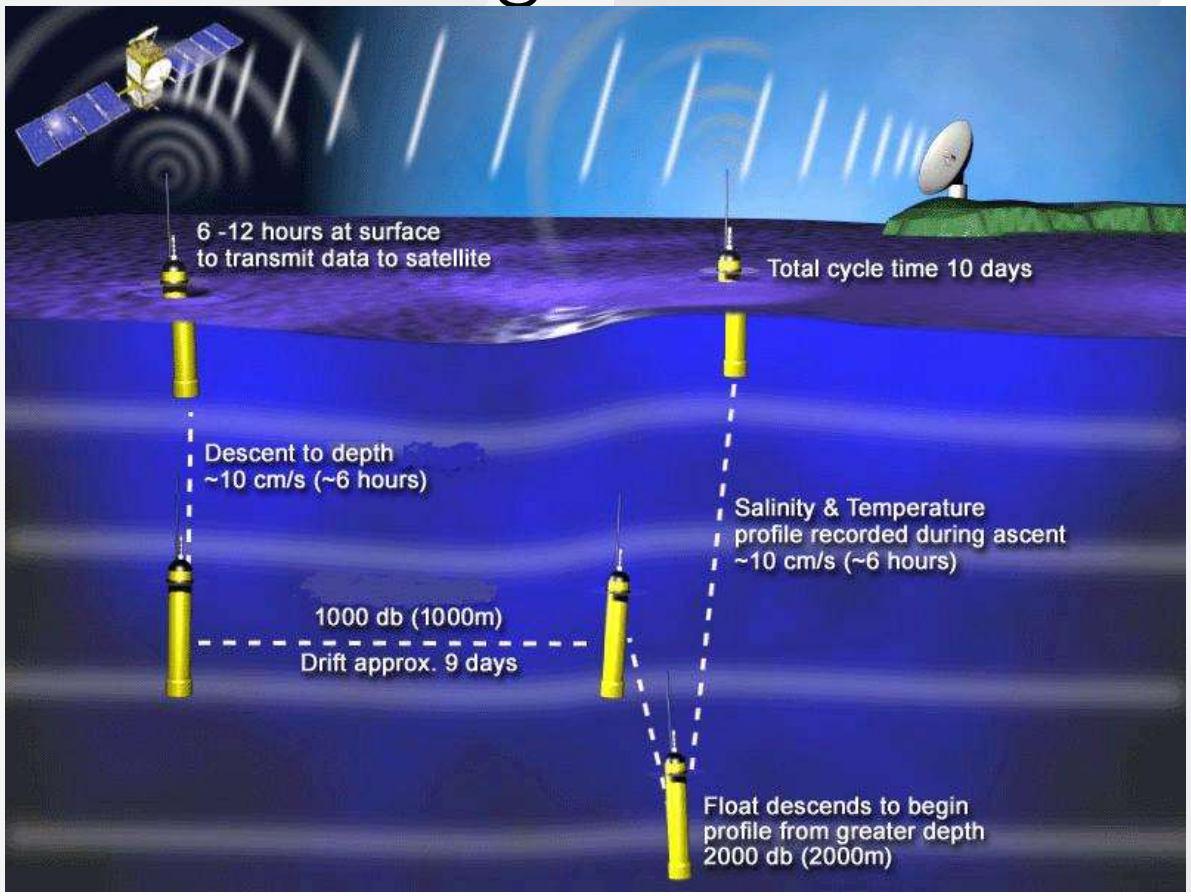
Apply
ARGO: Measuring the Ocean's Volume



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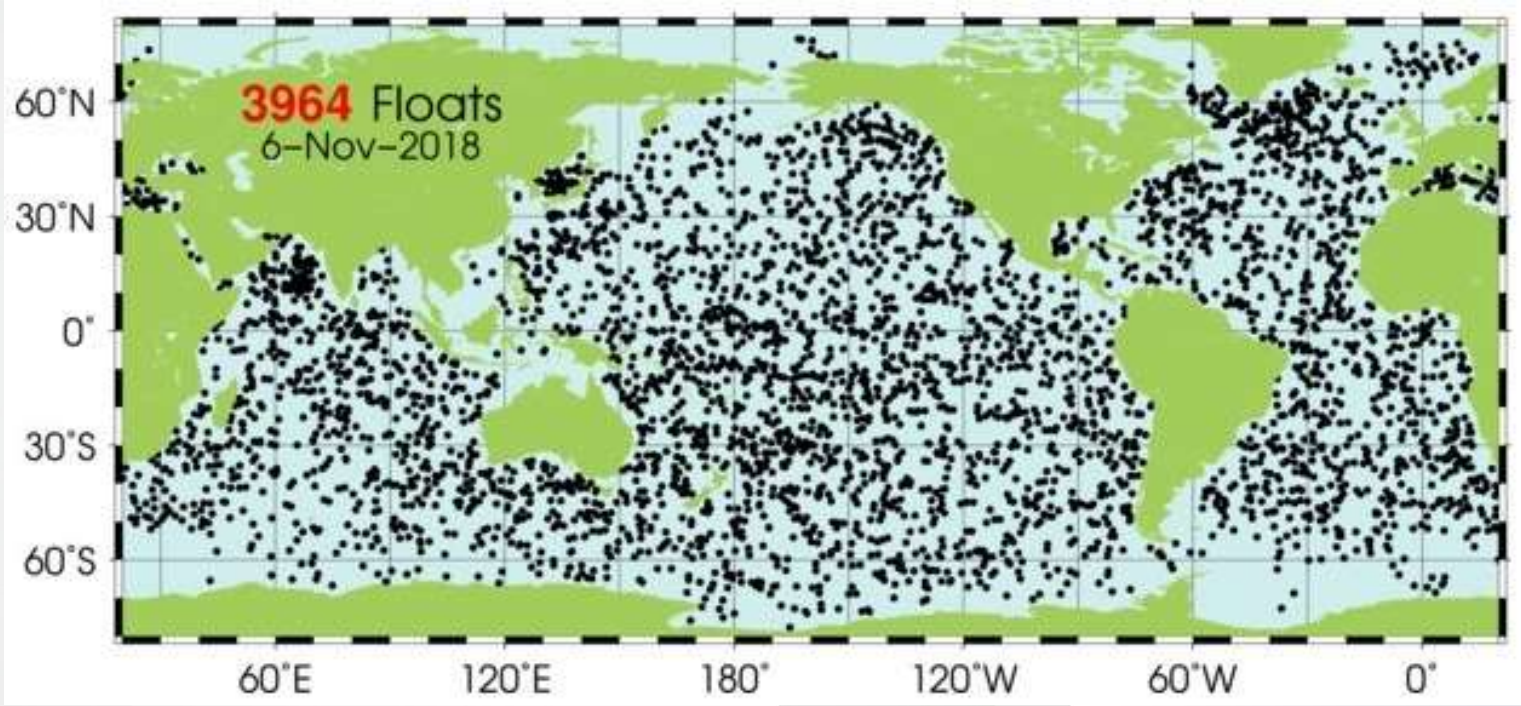
ARGO: Measuring the Ocean's Volume



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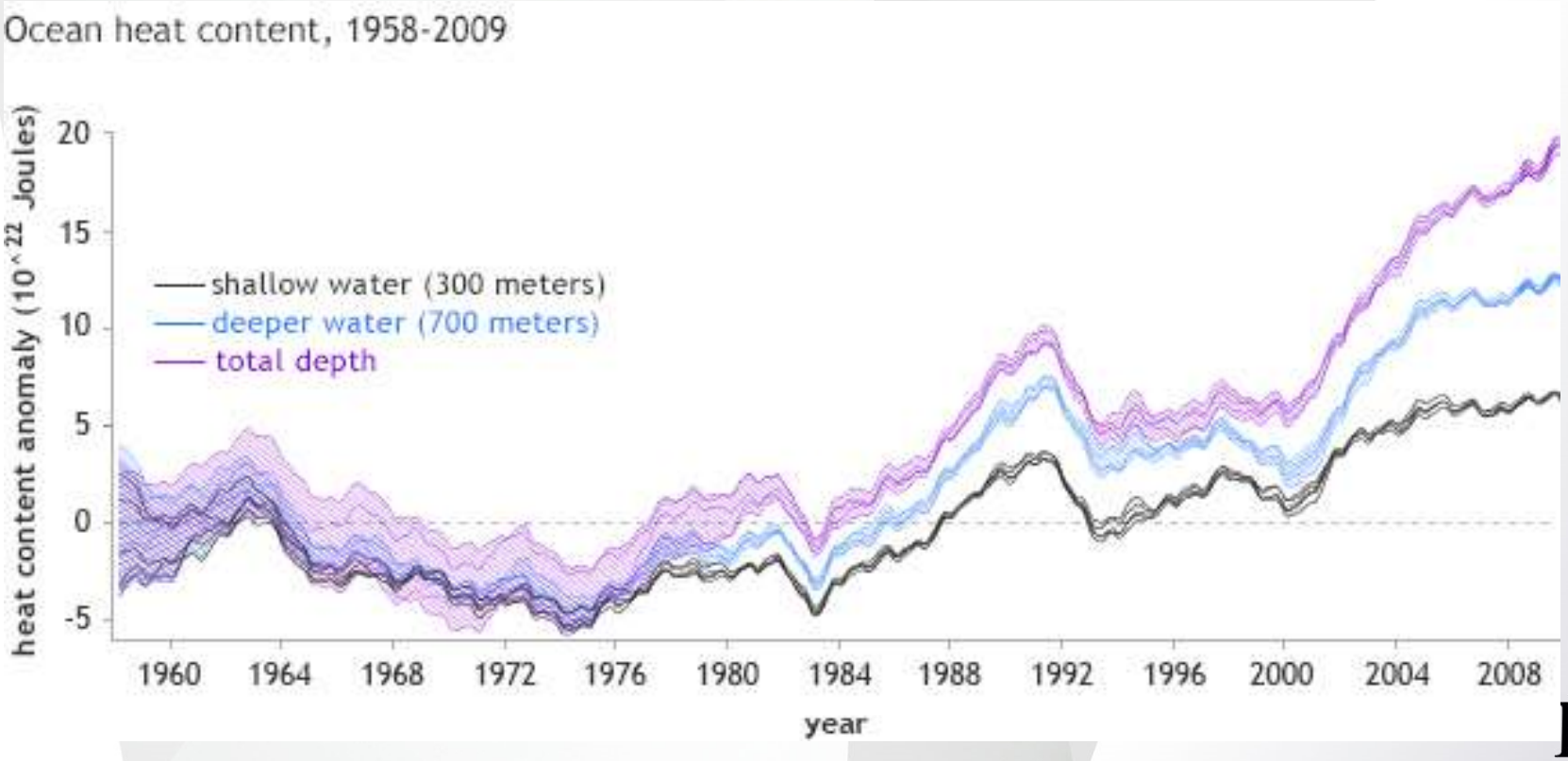
ARGO: Measuring the Ocean's Volume



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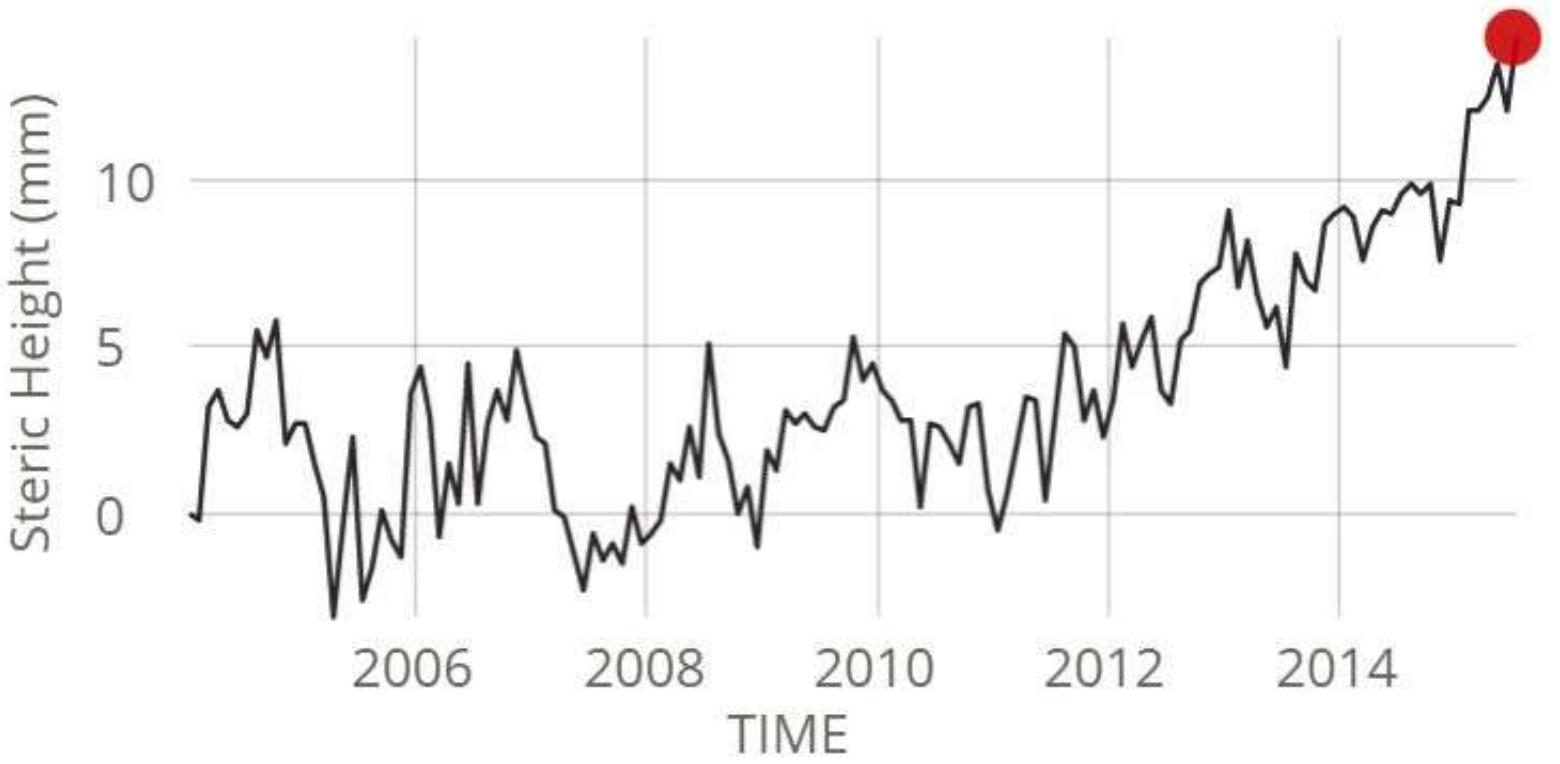
ARGO: Measuring the Ocean's Volume



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Observe and Explain

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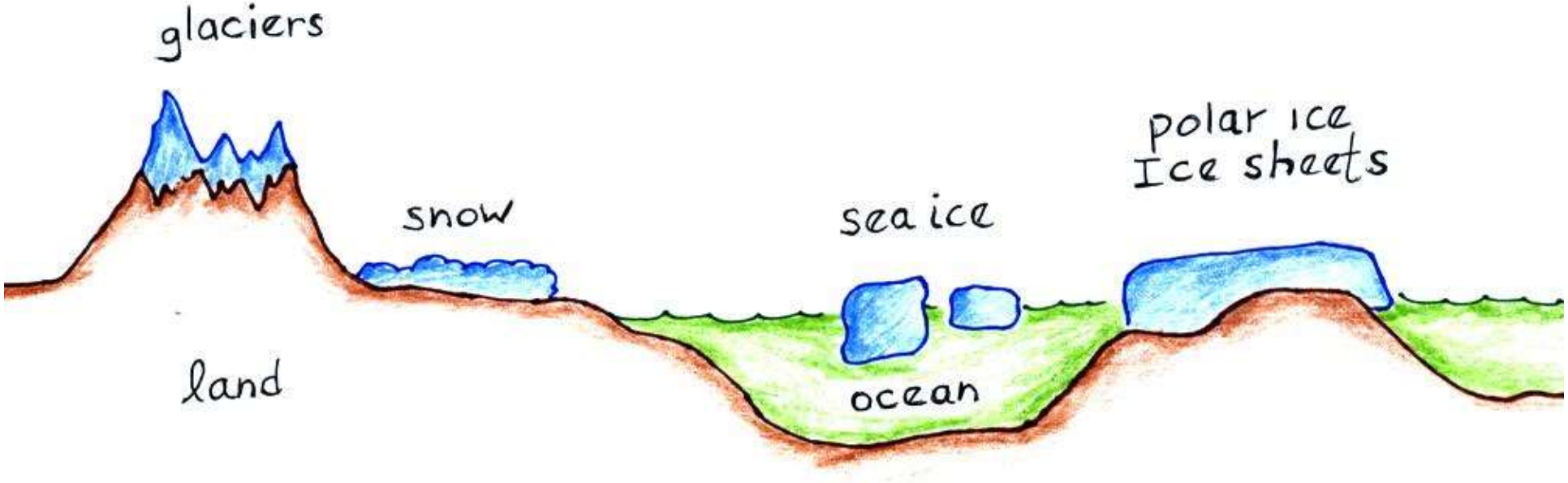
Apply
Land Ice vs Sea Ice



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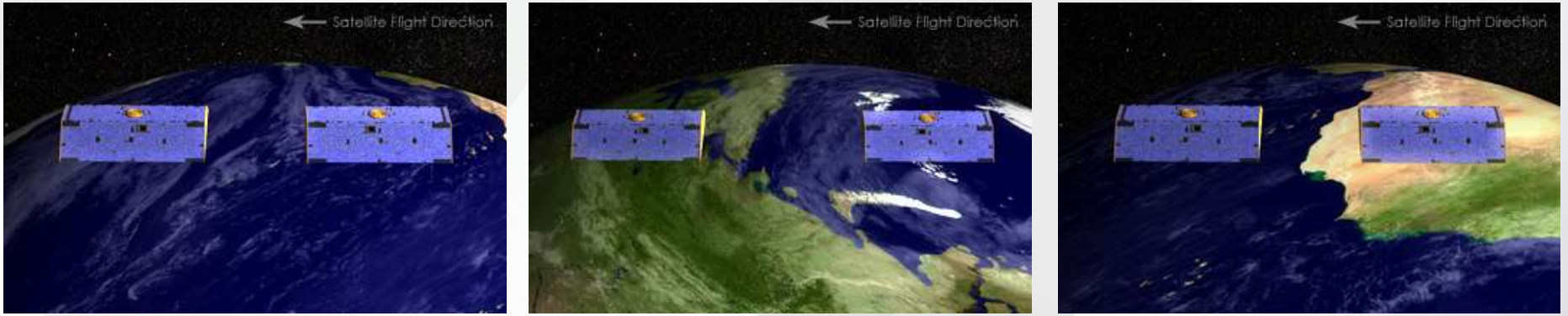
GRACE: Measuring Land Ice Mass



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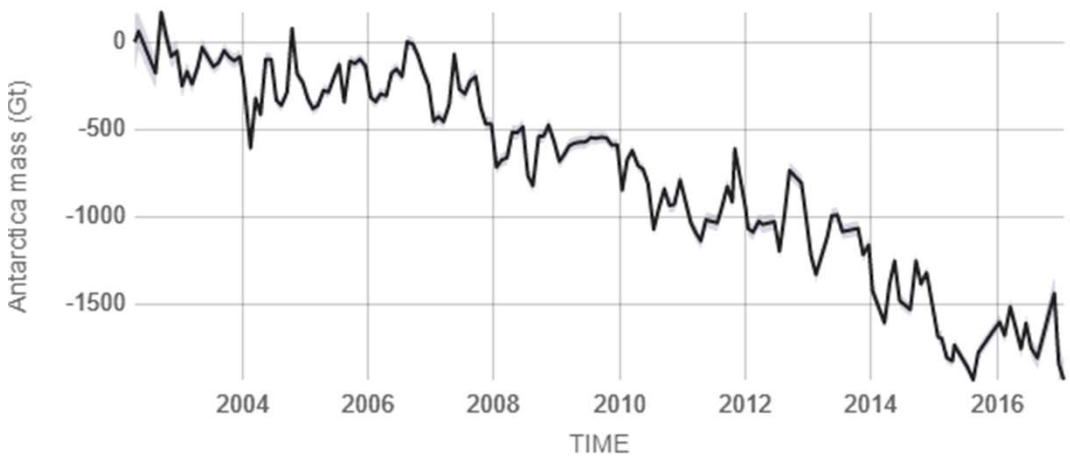
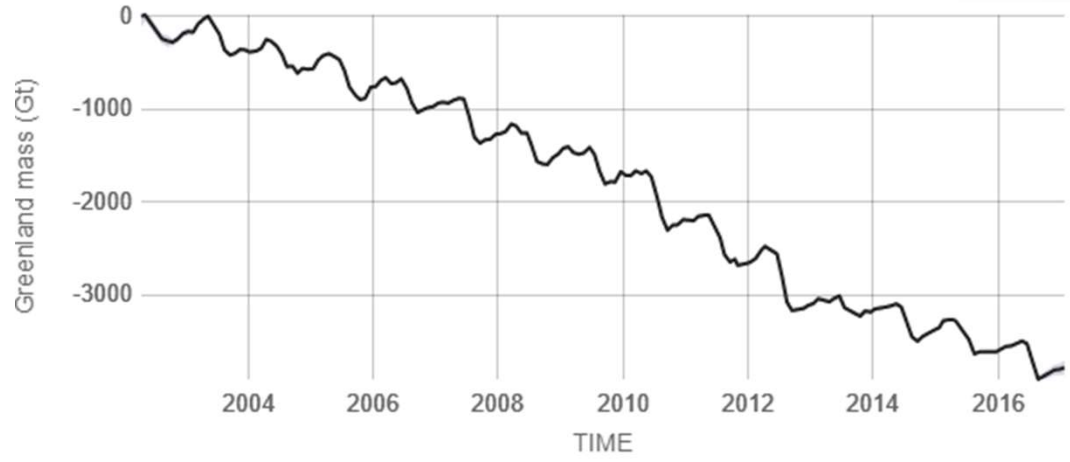


Source: climate.nasa.gov



Source: climate.nasa.gov

Antarctica ice mass is decreasing at 127 Gt per year

> 400 Gt per year!

Greenland ice mass is decreasing at 286 Gt per year

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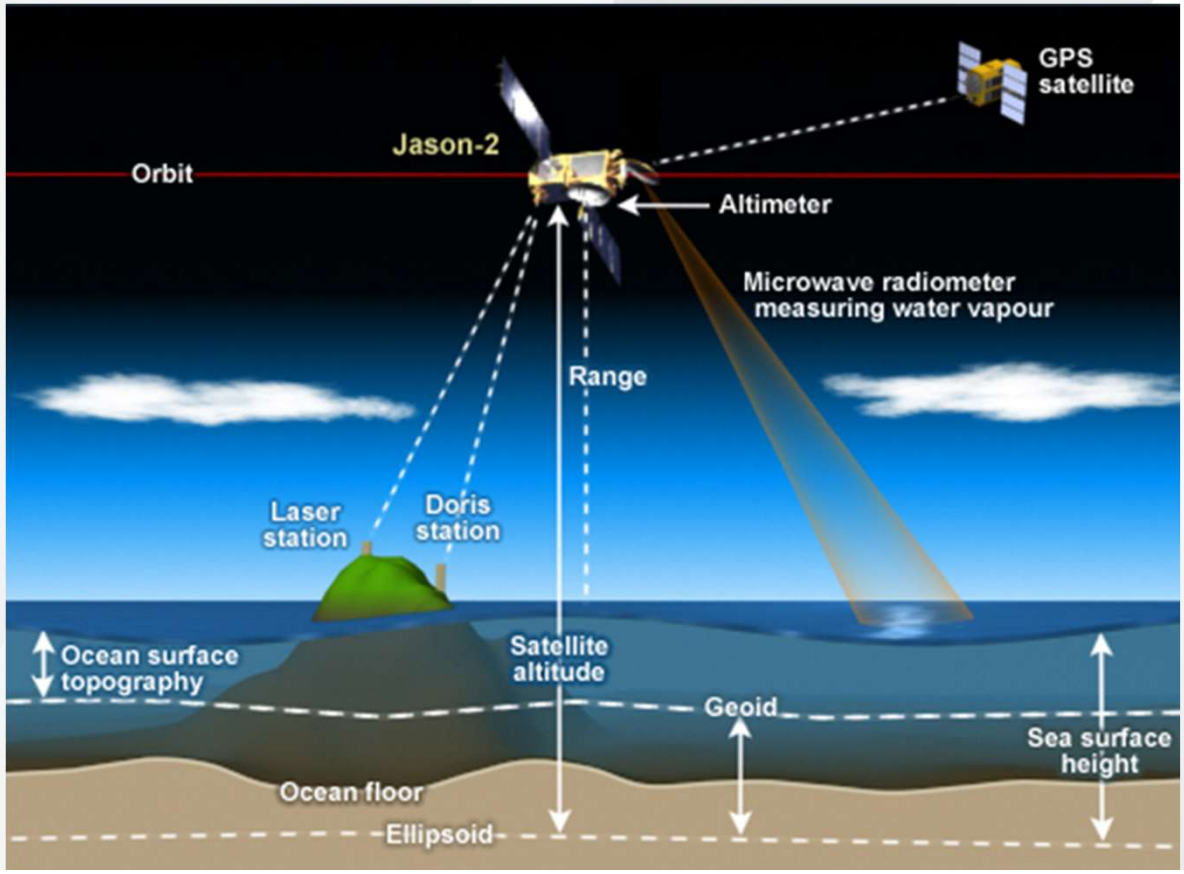
Satellite Altimetry: Measuring Sea Level



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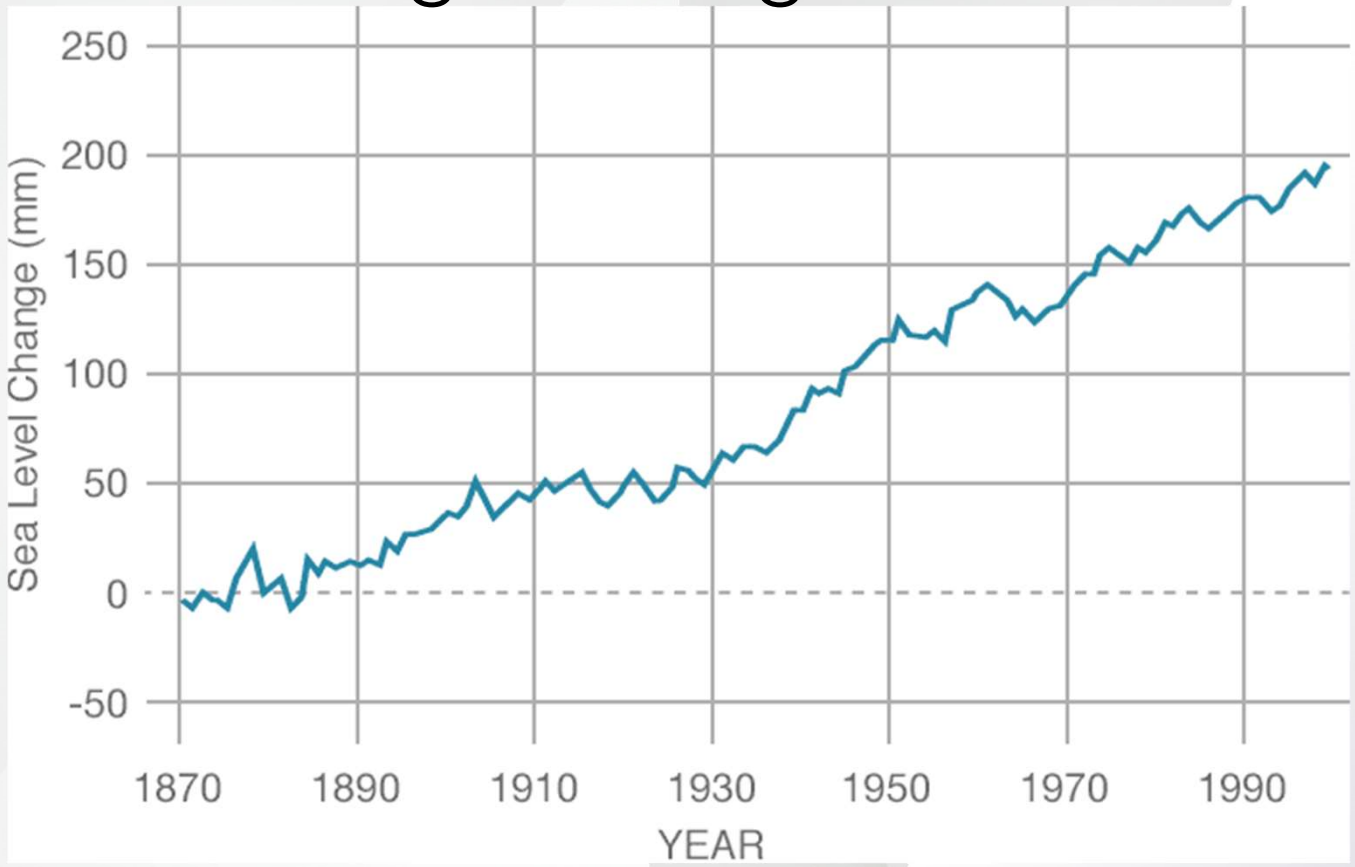
Measuring the Height of the Sea



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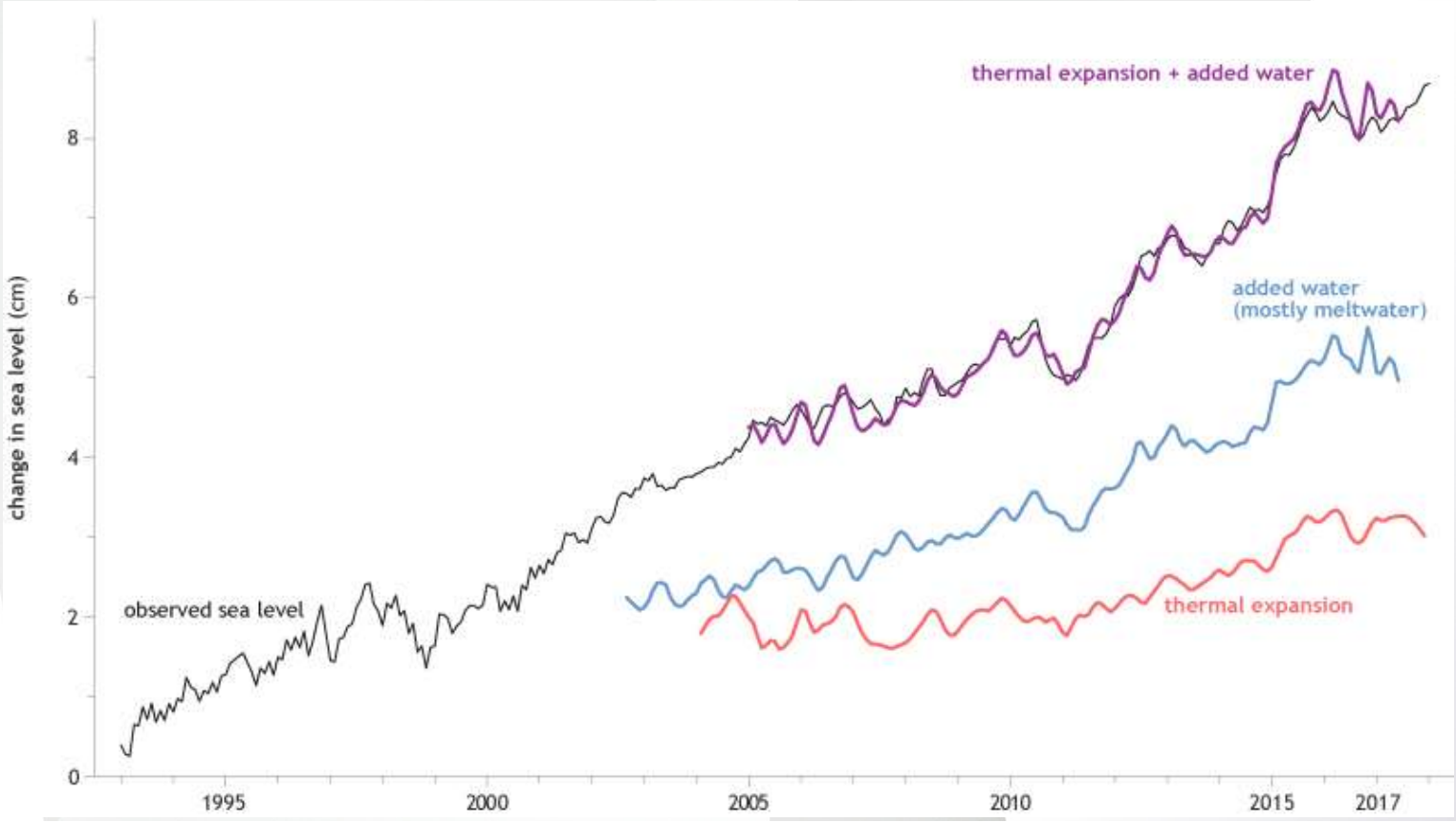
Sea Level Budget



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Effects of climate change

Rising sea levels

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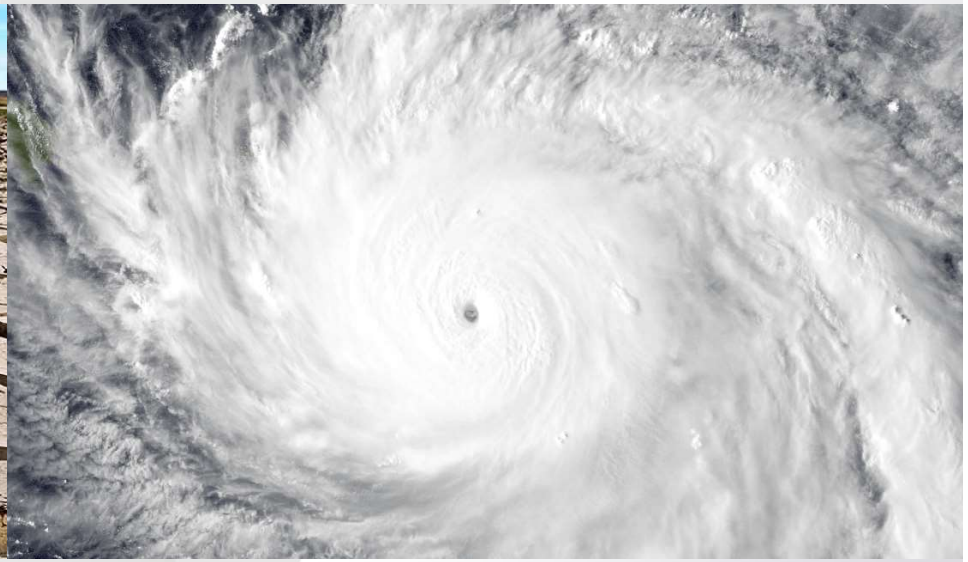
Effects of climate change

More extreme weather events



and worse winter storms…but probably not more polar vorticies…

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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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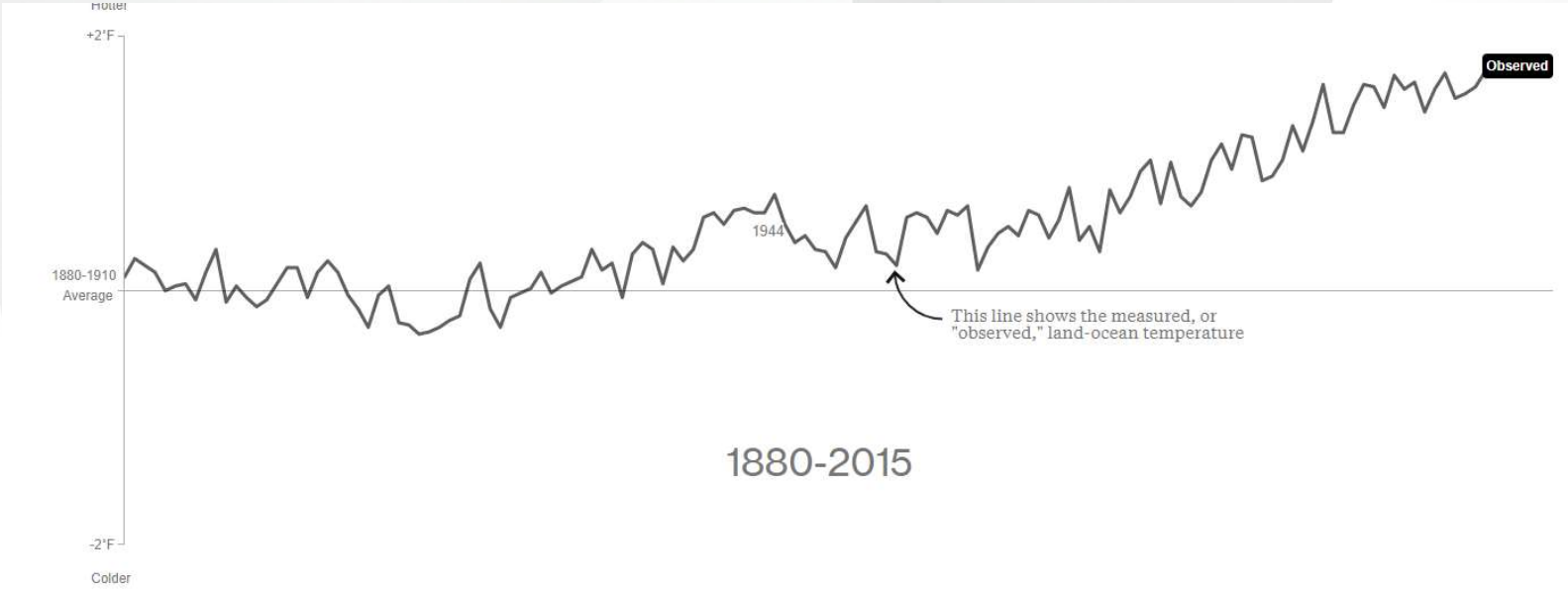
What's causing the warming?



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Examine your graphs

1. Look for patterns in the data.

   Are there cycles? Trends? Exceptions?

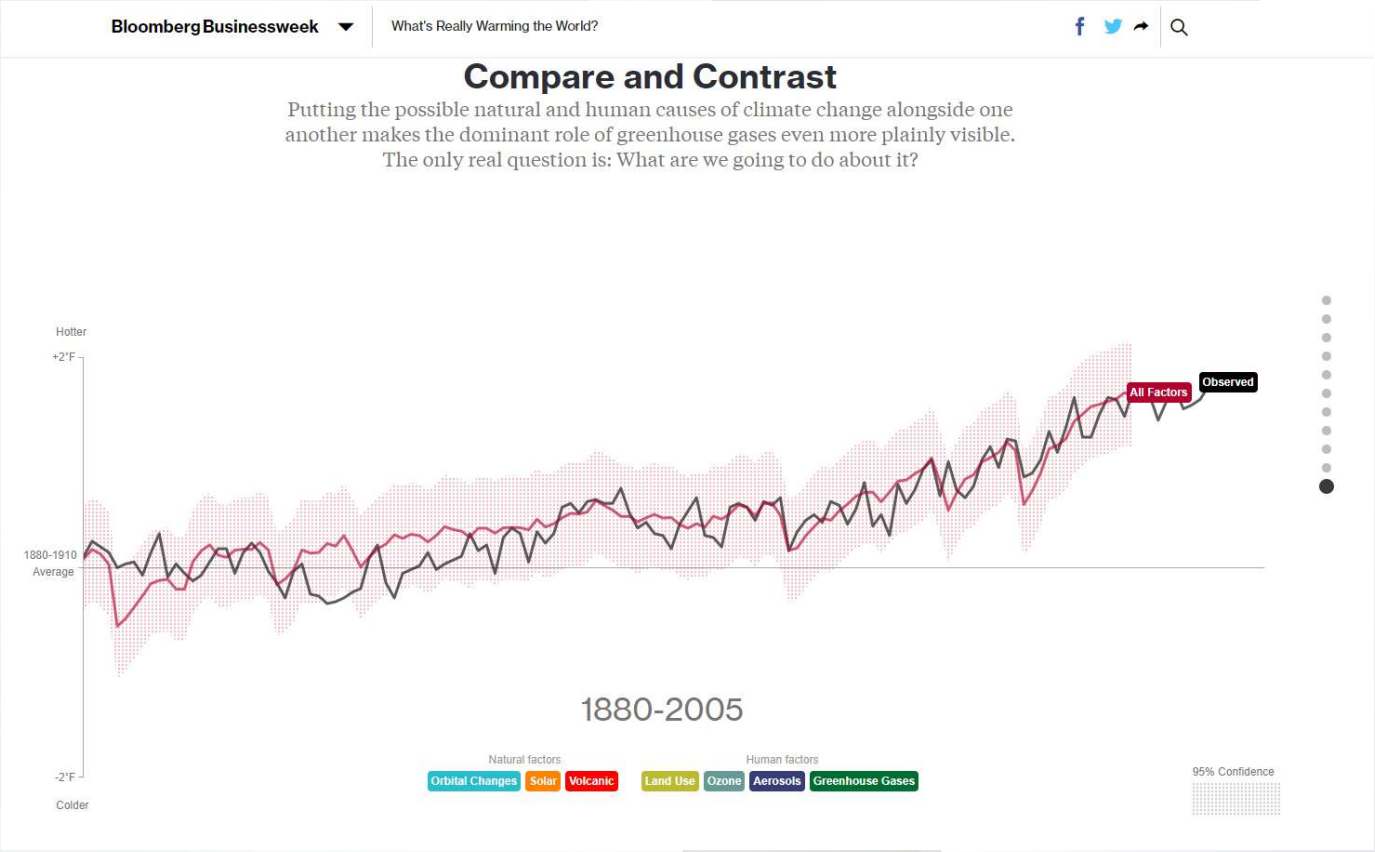
   Briefly describe three patterns that you notice.

2. What questions do you have about the data?

Examine all the data

1. Arrange the factors from largest to smallest contributor.
2. Which ones are positive forcings?
3. Which ones are anthropogenic?
4. Predict the overall temperature

Bloomberg interactive



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Other activities in the PI Climate Change resource
Impact of Transportation activity

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Other activities in the PI Climate Change resource

Math: How Much Carbon in that Tree?

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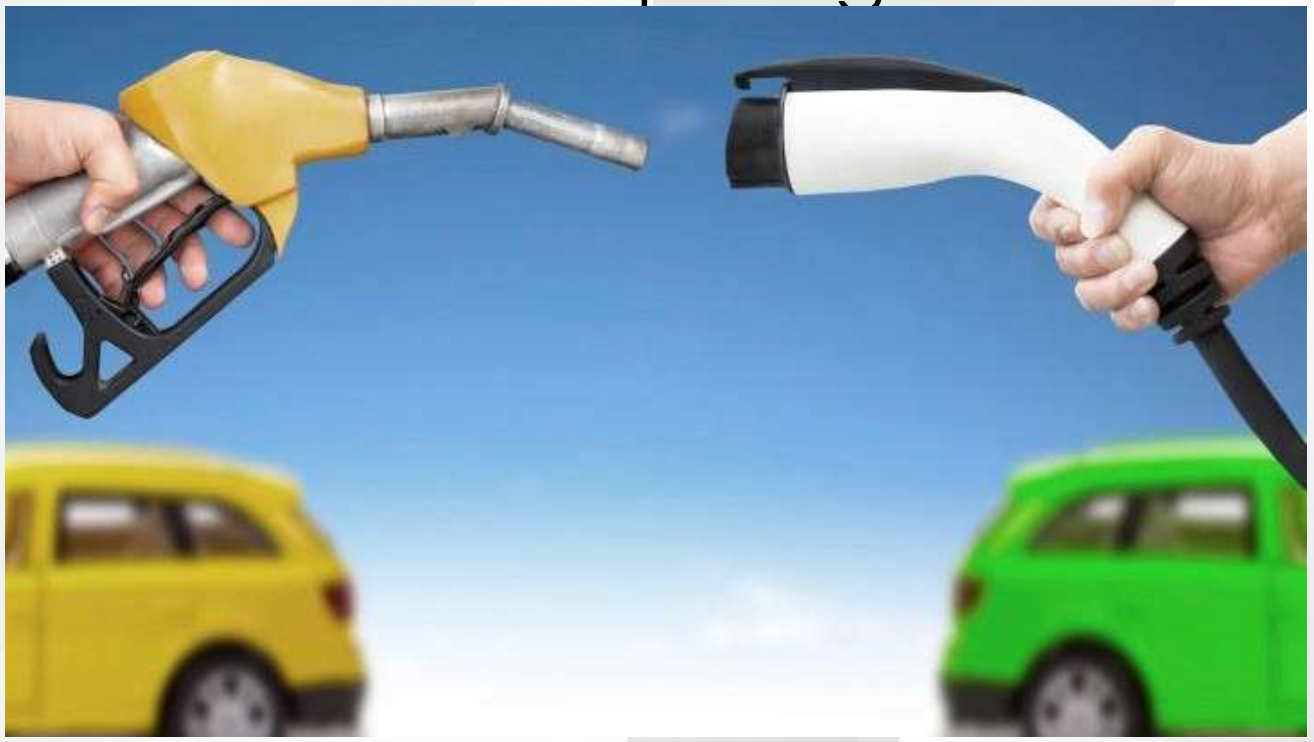
Other activities in the PI Climate Change resource

Math: Comparing Costs



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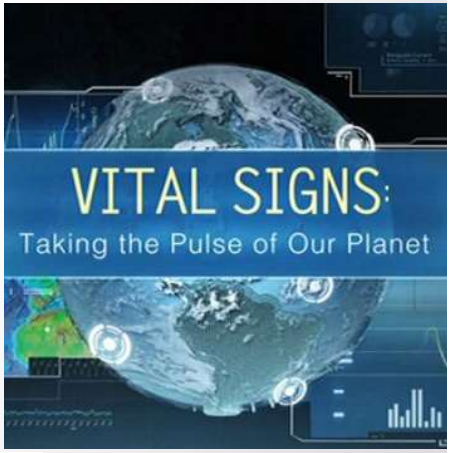
Resources



climate*prediction*.net

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

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Some positive actions being taken:

- Pakistan to plant one billion trees by 2018
- Ozone layer is recovering
- World bank no longer funding fossil fuel exploration
- 98GW of solar capacity added in 2017

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Project Drawdown Top 10

1. Refrigerant Management ($3M Global Cooling Prize)
2. Wind Turbines
3. Reduced Food Waste
4. Plant-Rich Diet
5. Tropical Forests
6. Educating Girls
7. Family Planning
8. Solar Farms
9. Silvopasture
10. Rooftop Solar

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Extend

- What actions can we personally take?
- What actions will I commit to?

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What Questions Remain?

- What are the tough questions your students ask, or that you are worried they will ask?

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Free classroom resources

https://resources.perimeterinstitute.ca/

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Thanks!!

www.perimeterinstitute.ca

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