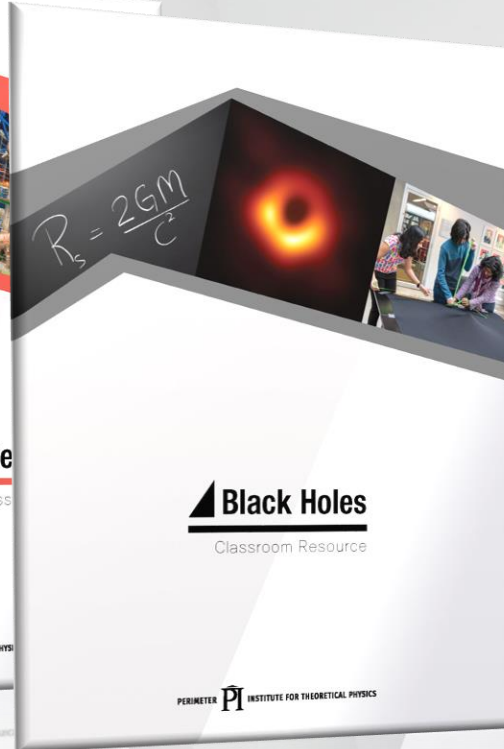
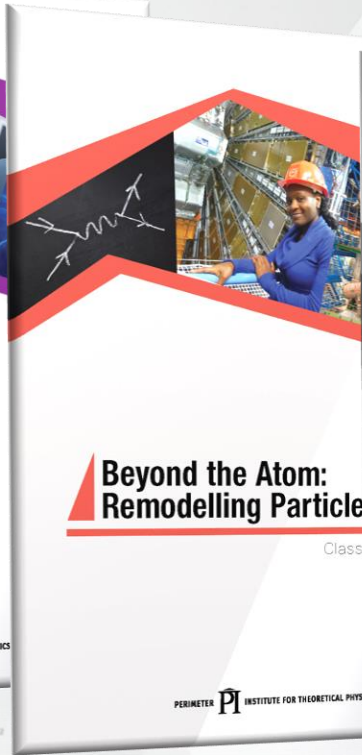
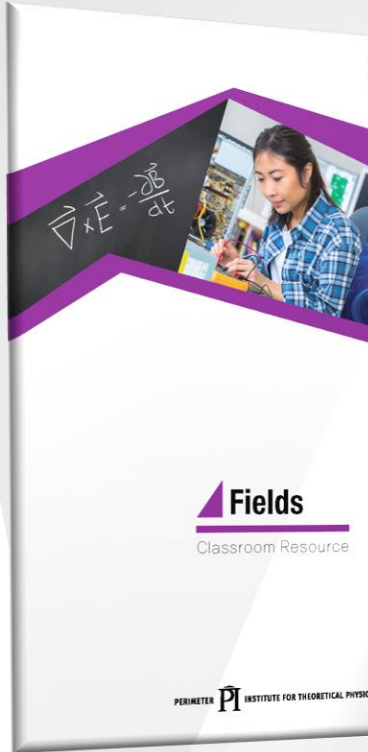


Teacher Programs

www.perimeterinstitute.ca/outreach/teachers



IN-CLASS RESOURCES



Experienced
teachers

Perimeter
researchers

Pedagogy and
teaching strategies

High School Student Programs

www.perimeterinstitute.ca/outreach/students

Go Physics!

1-day workshops (online)



ISSYP

INSPIRING THE NEXT GENERATION



STUDENTS

10 MILLION⁺/year



TEACHERS

40,000⁺
teachers trained

In-class resources



130 countries



PUBLIC

100,000⁺ on site

2 MILLION online views

PI PERIMETER
INSTITUTE
PUBLIC LECTURE
SERIES

EinsteinFest

Q2Cfestival

 BRAINSTEM

PI PERIMETER
INSTITUTE



Educational Resources

By Perimeter Institute

Free Educational Resources for Teachers

<https://resources.perimeterinstitute.ca/>

Climate Change: Evidence, Effects, and Actions



CERN
Greek HST 2022



SCIENCE

Activity 1: Carbon Dioxide 10

Activity 2: Climate Modelling 18

Activity 3: A Warming World 24

Activity 4: The Impact of Transportation 31

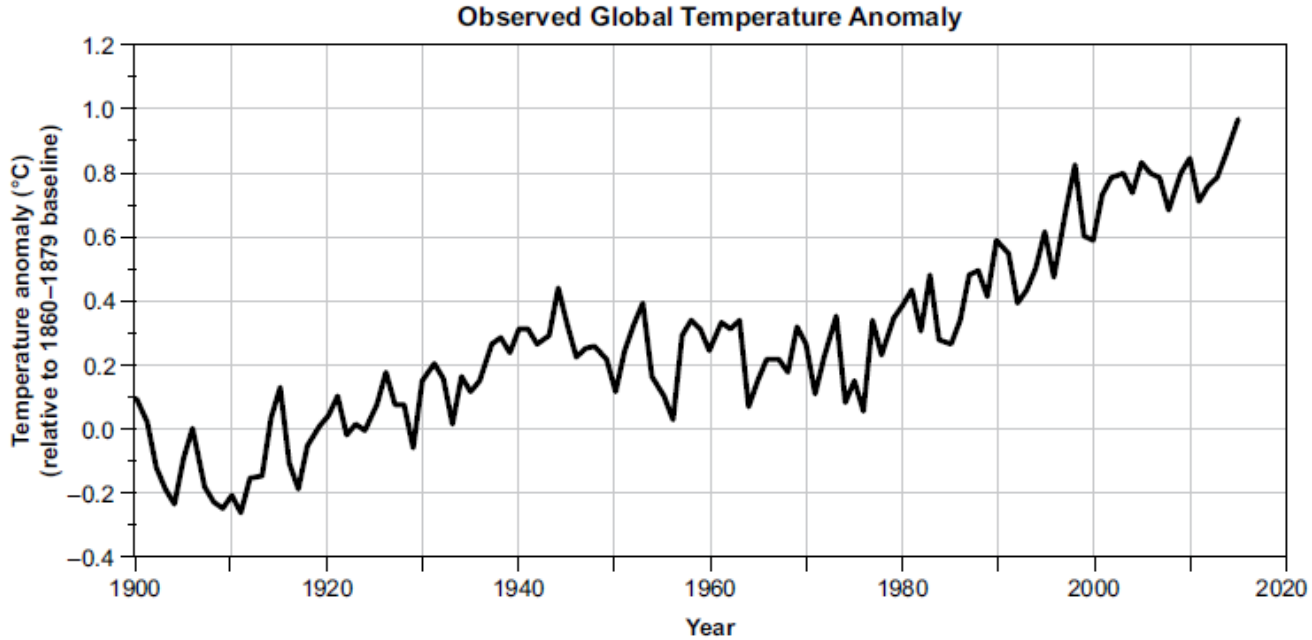
MATH

Activity 5: How Much Carbon Is in That Tree? 38

Activity 6: When Does It Make Sense to Switch? 48

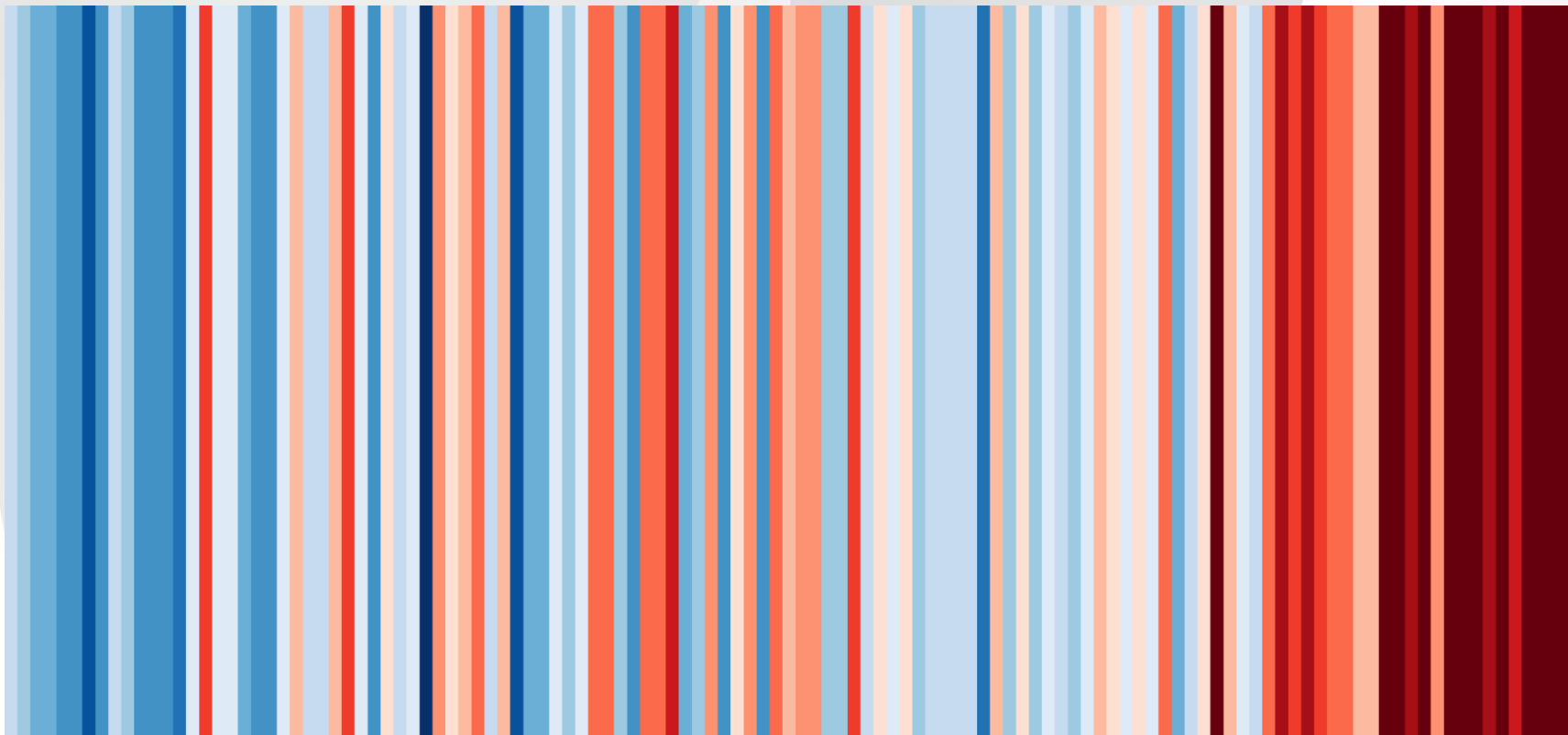
Design Challenge: Climate in a Container 53

Earth is getting warmer



Source: NASA GISS

Greece (1901 – 2021)



A few degrees may not seem like much...

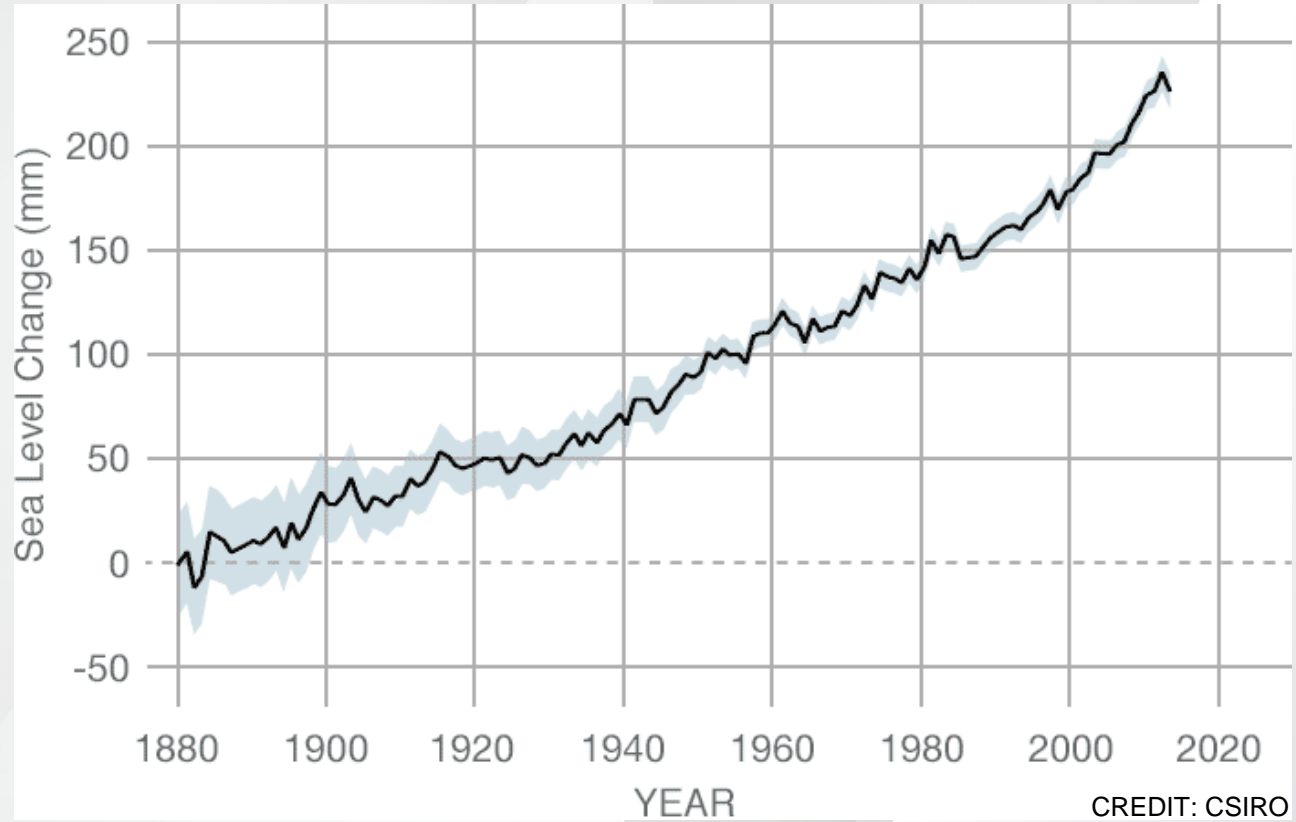


37°C = healthy



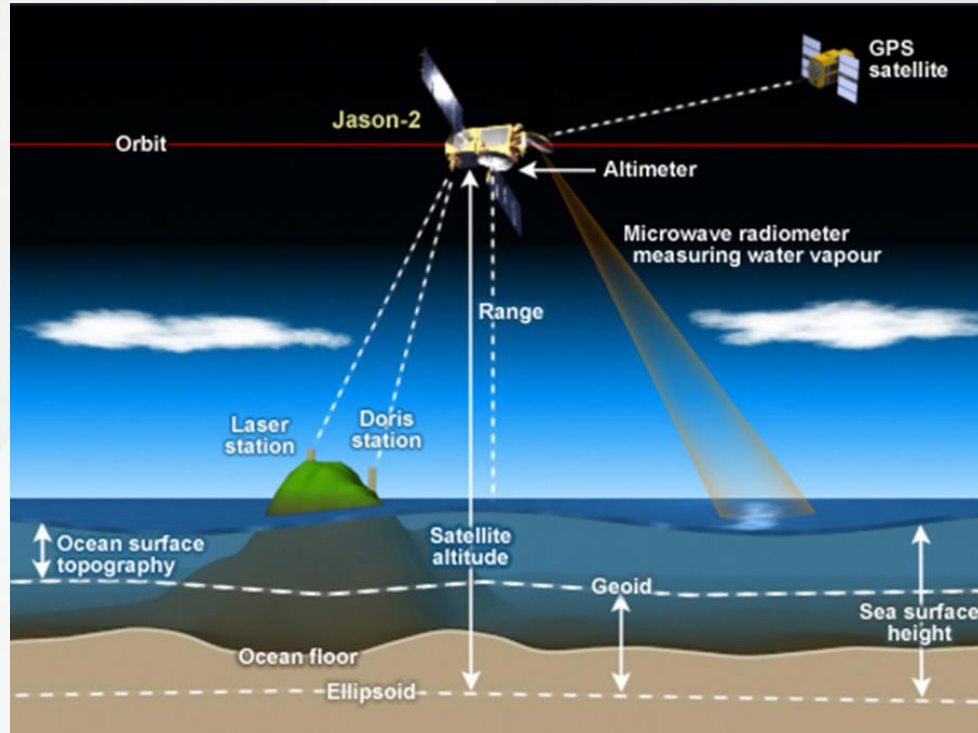
39°C = sick

Sea Levels are rising



CREDIT: CSIRO

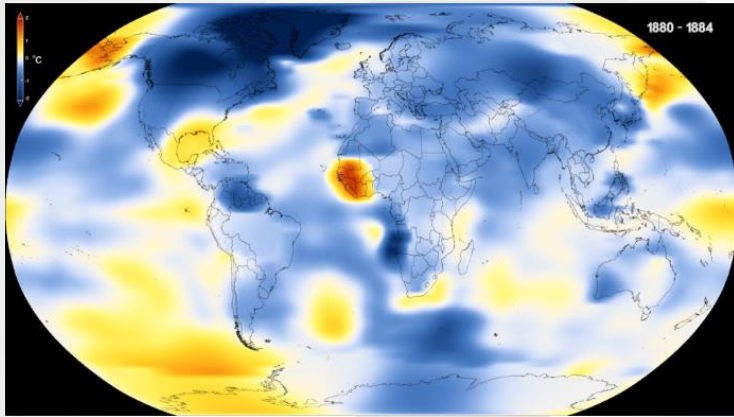
Satellite Altimetry: Measuring Sea Level



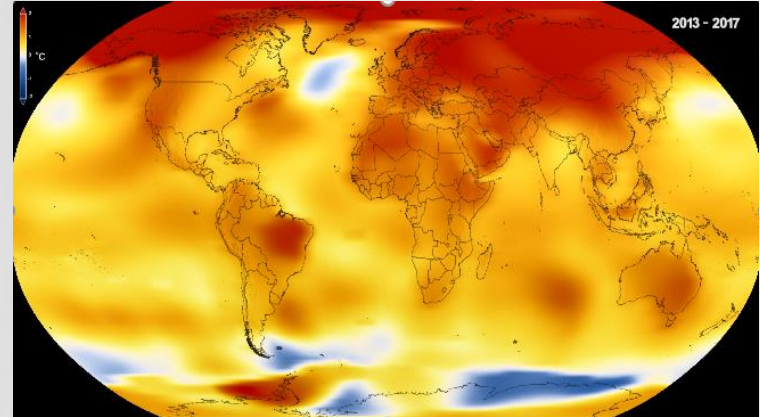


Myrtos Beach now and by 2100

The question is: Why?



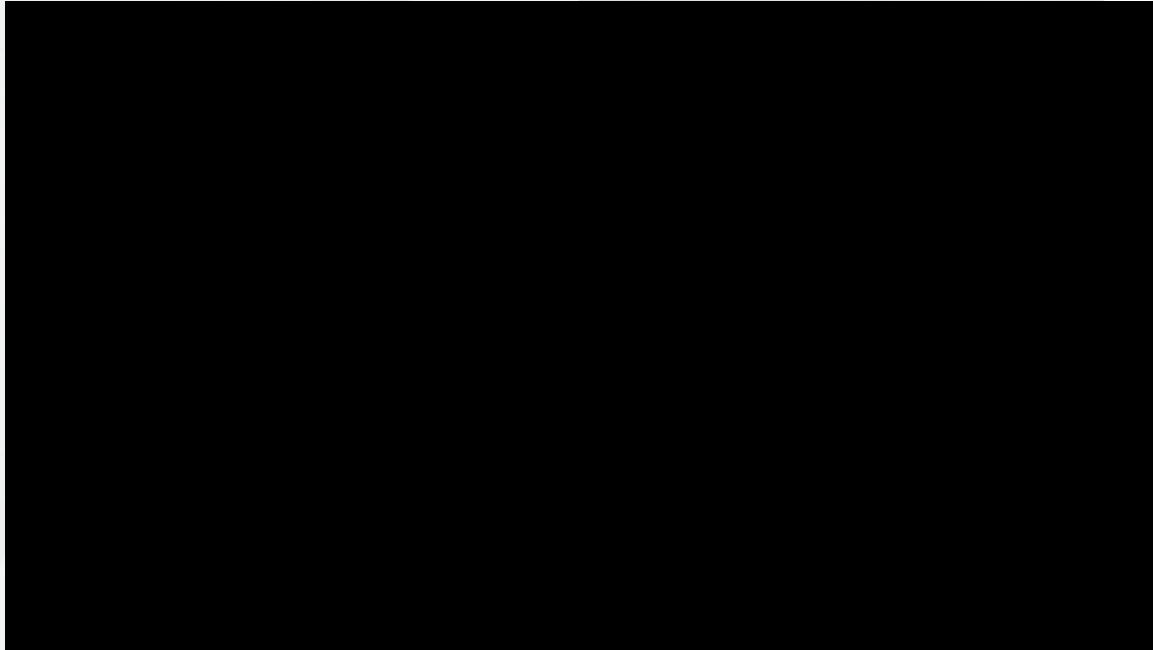
1880



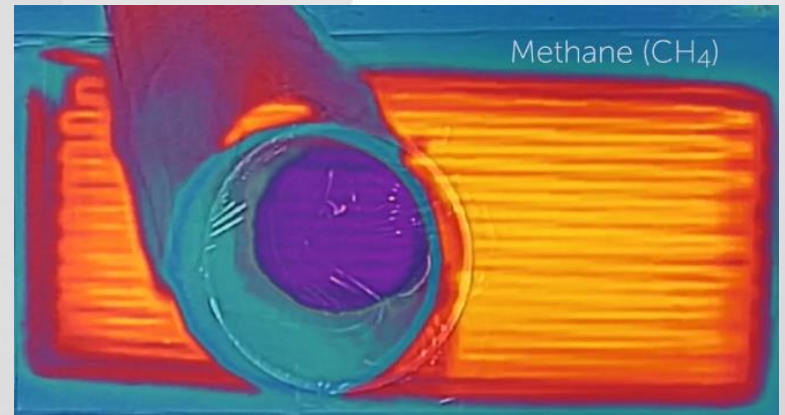
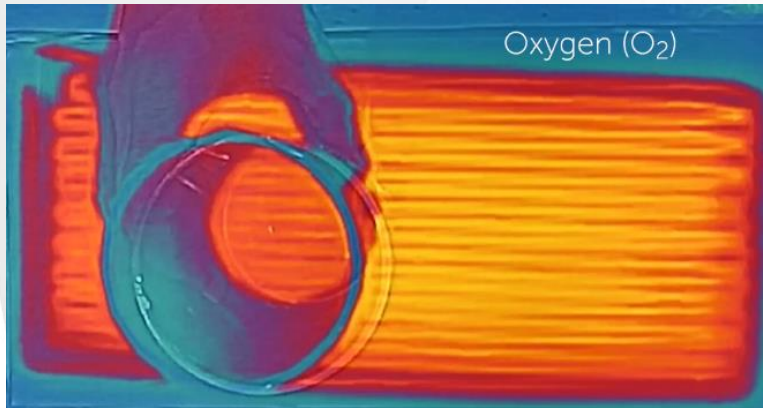
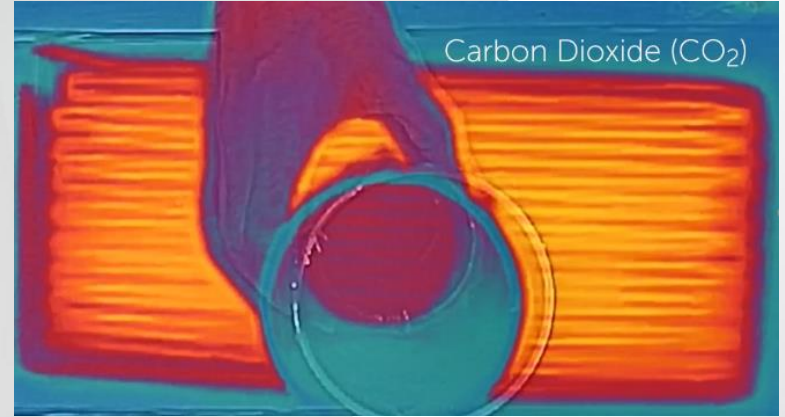
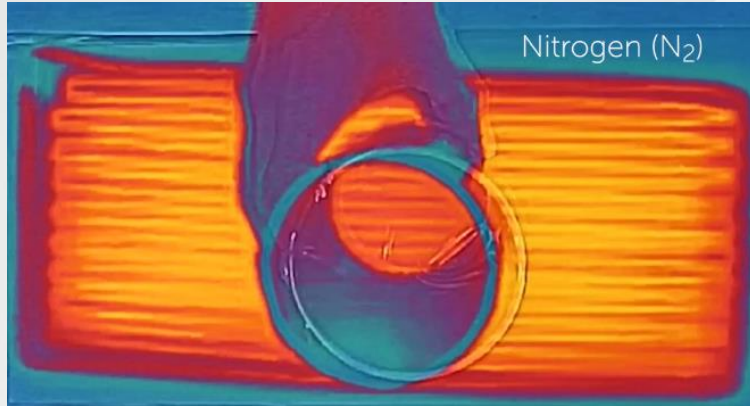
2017

And what can we do about it?

A Climate Change demo



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

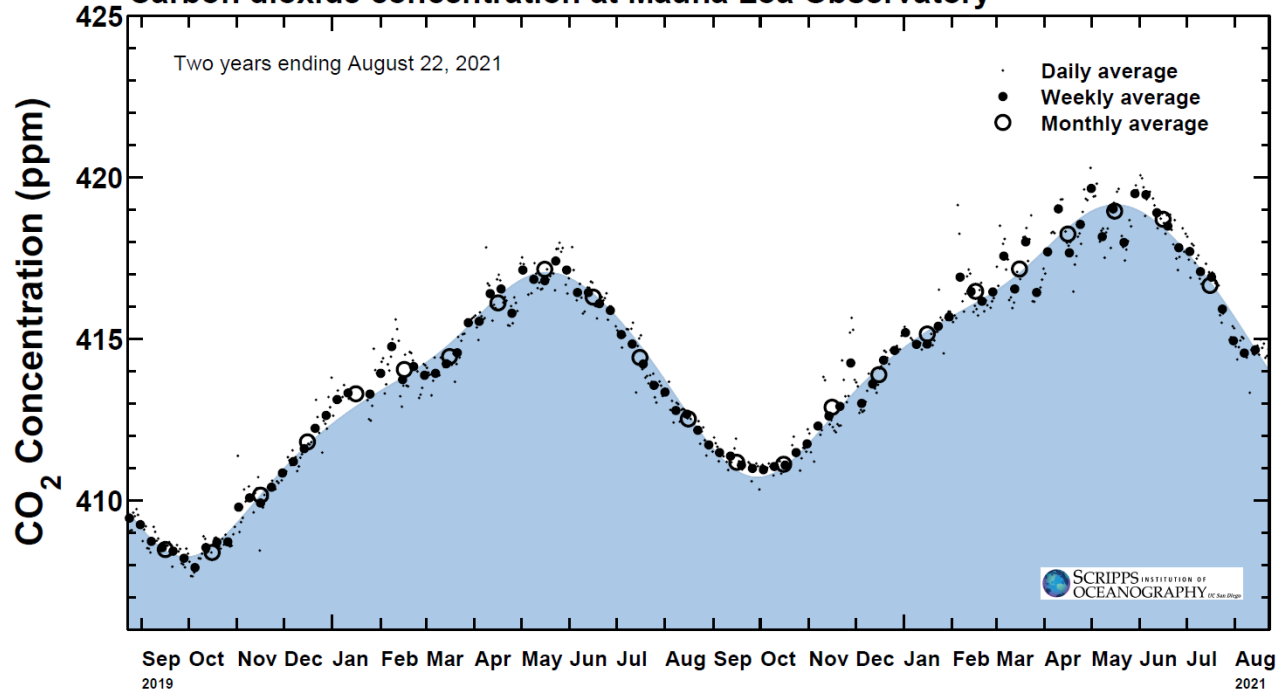
Latest CO₂ reading: **420.10 ppm**

(May 4, 2022)

Last two years

August 22, 2021

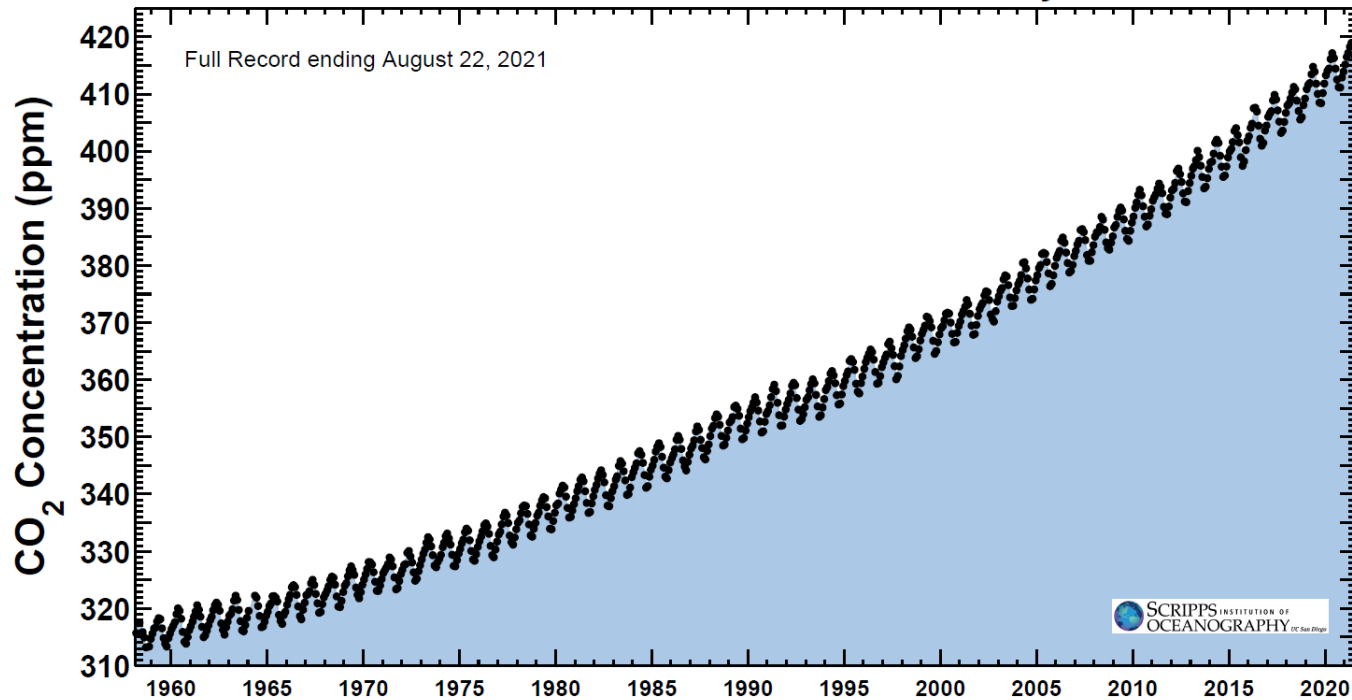
Carbon dioxide concentration at Mauna Loa Observatory



Full record

August 22, 2021

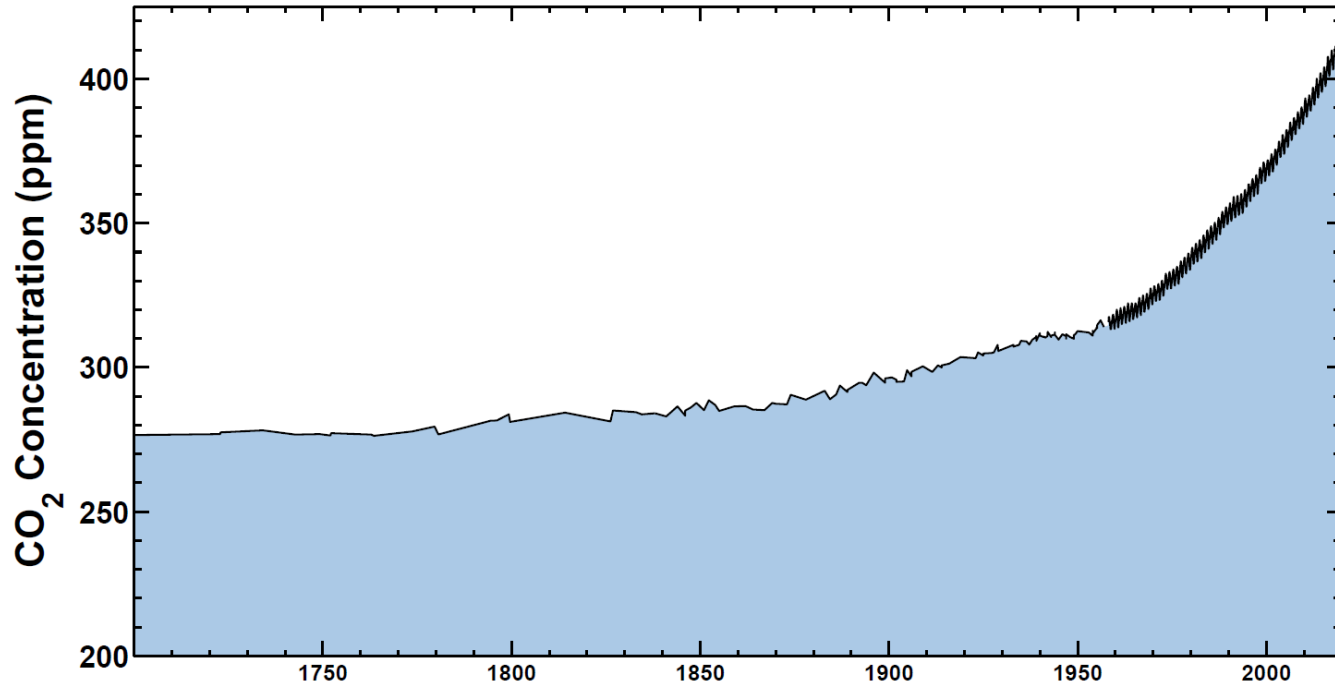
Carbon dioxide concentration at Mauna Loa Observatory

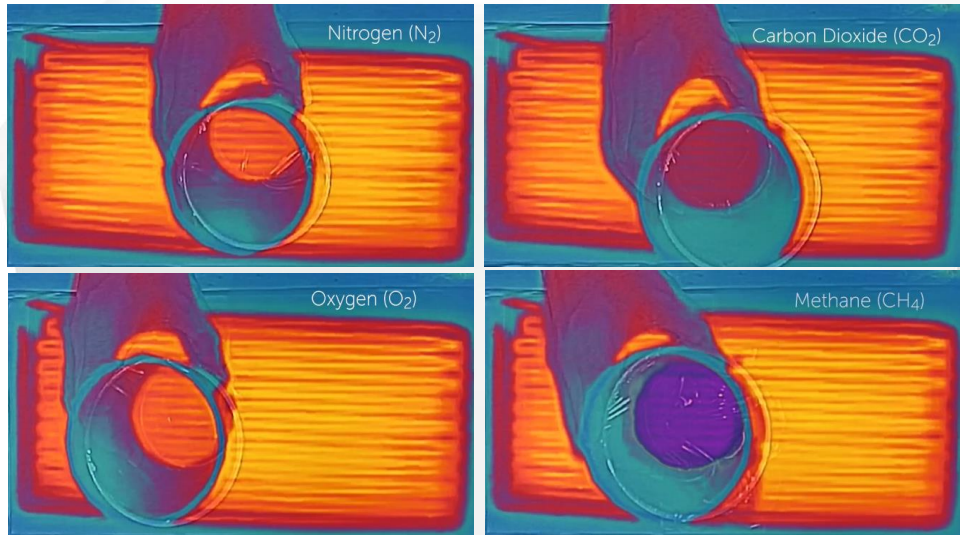


1700 - present

August 22, 2021

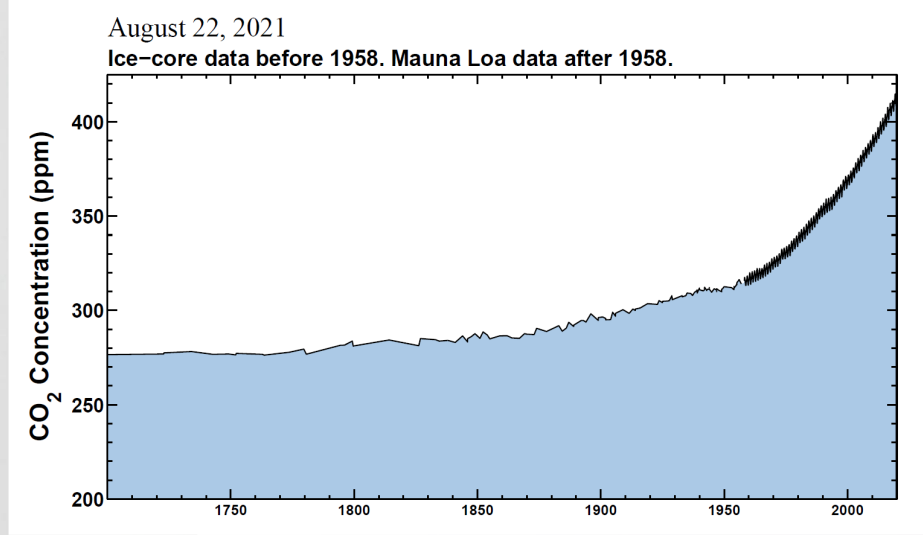
Ice-core data before 1958. Mauna Loa data after 1958.





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

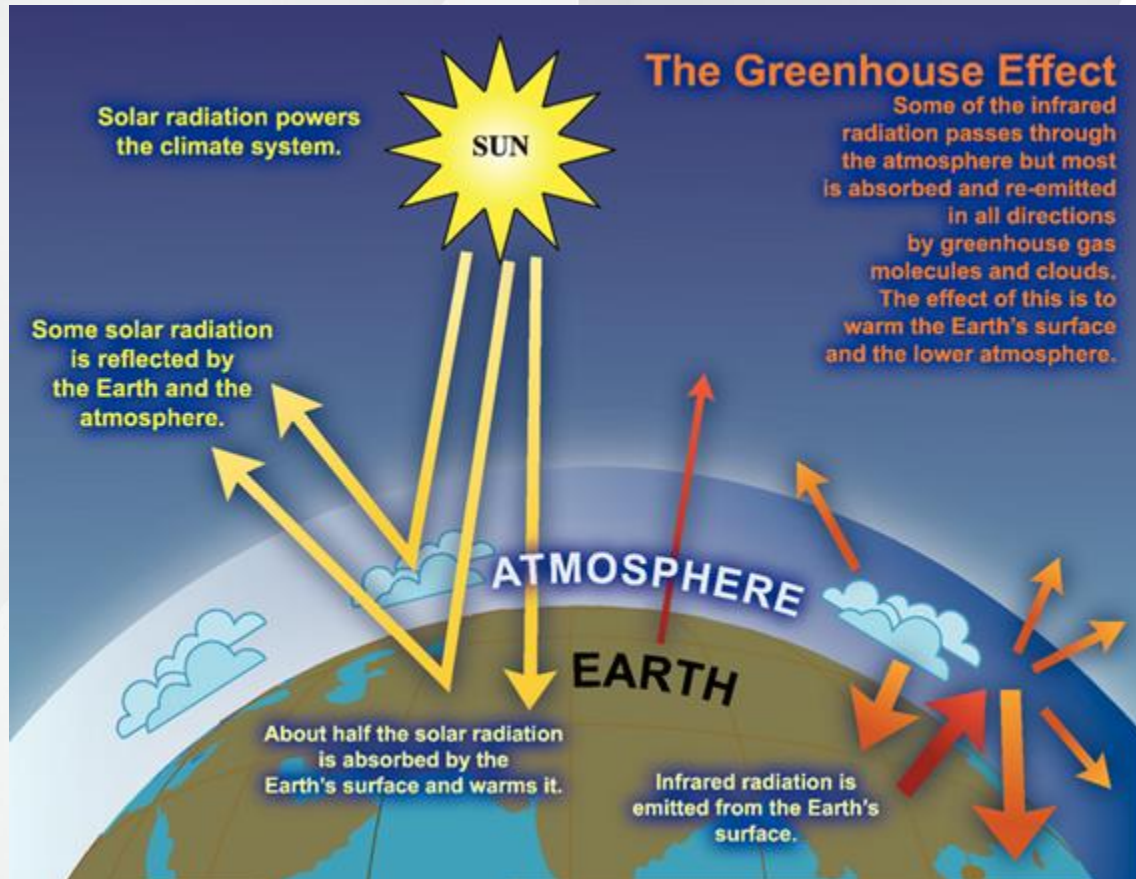
CO_2 levels have been increasing since industrial revolution



How do these observations
relate to the Earth?

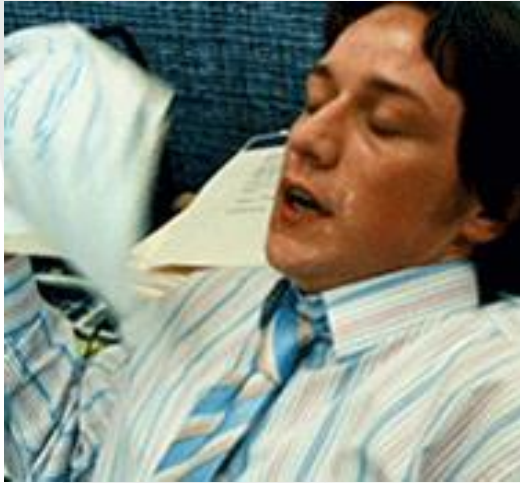


Earth's atmosphere traps heat

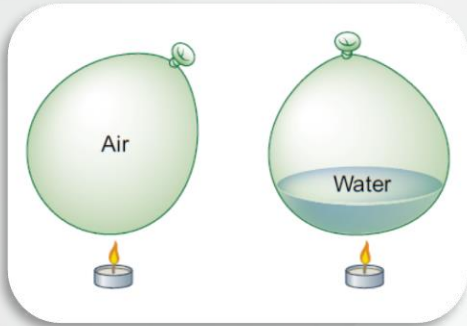


Heat

- Predict
- Observe
- Explain
- Apply



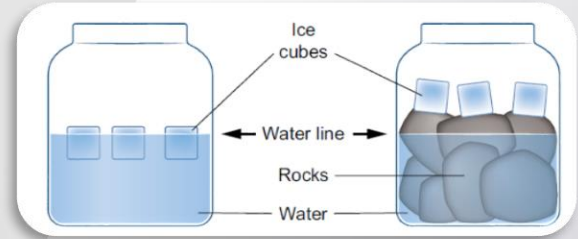
Predict and Explain



What will happen to the balloons?



What will happen when water heats up?



What will happen when ice melts?

Discuss with your neighbour

Observe and Explain



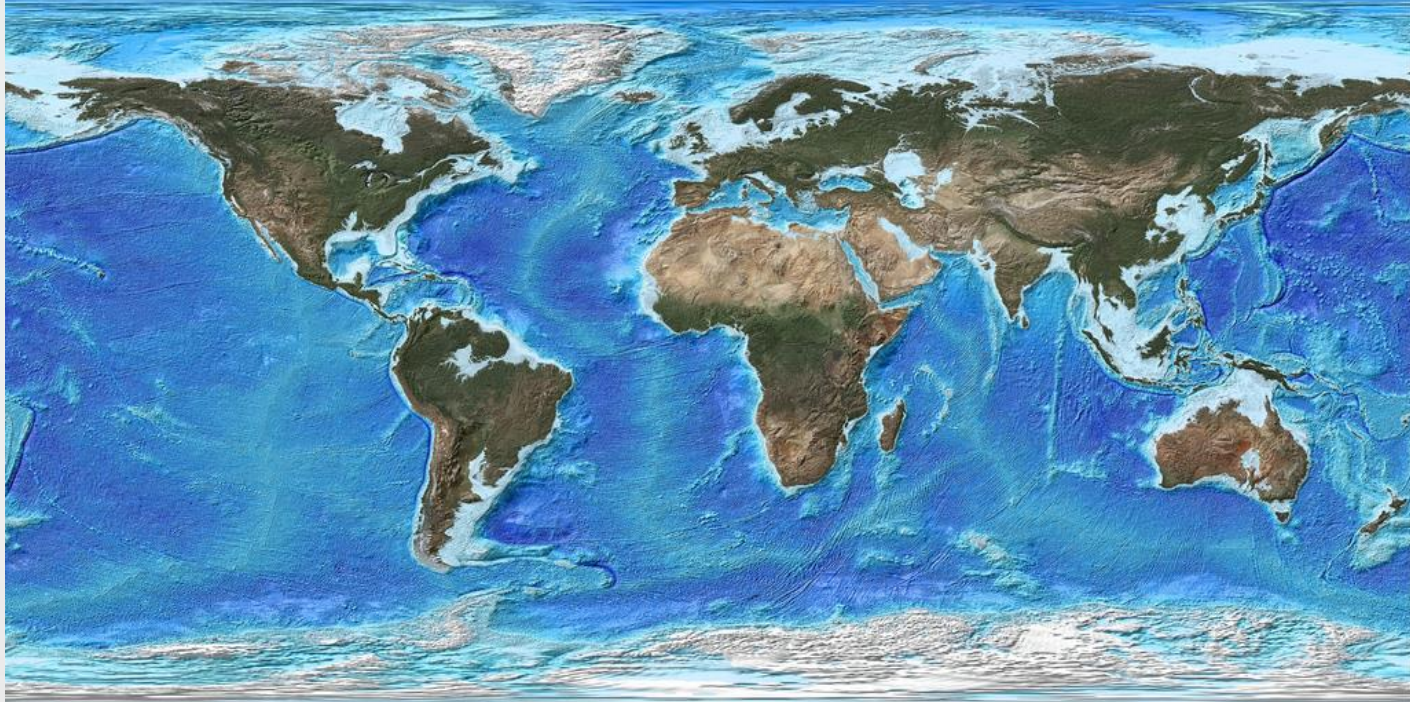
Balloon filled with air



Balloon with water

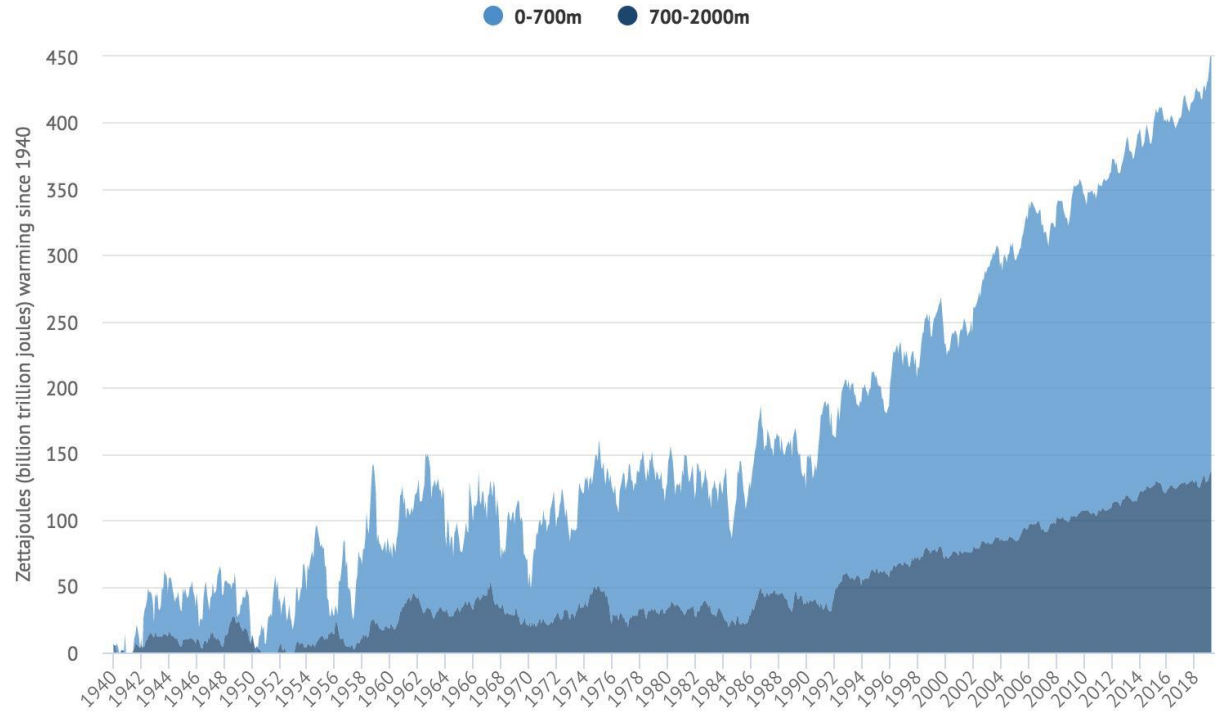


Apply:
70% of the Earth is covered by water

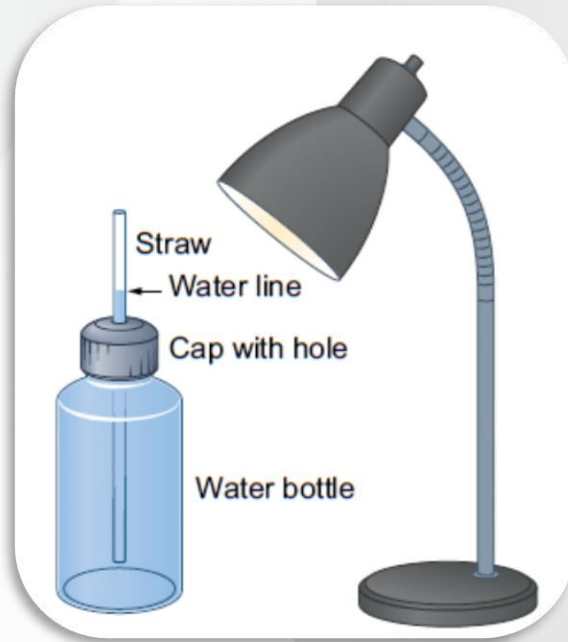


Oceans are hotter

Global ocean heat content



Observe and Explain



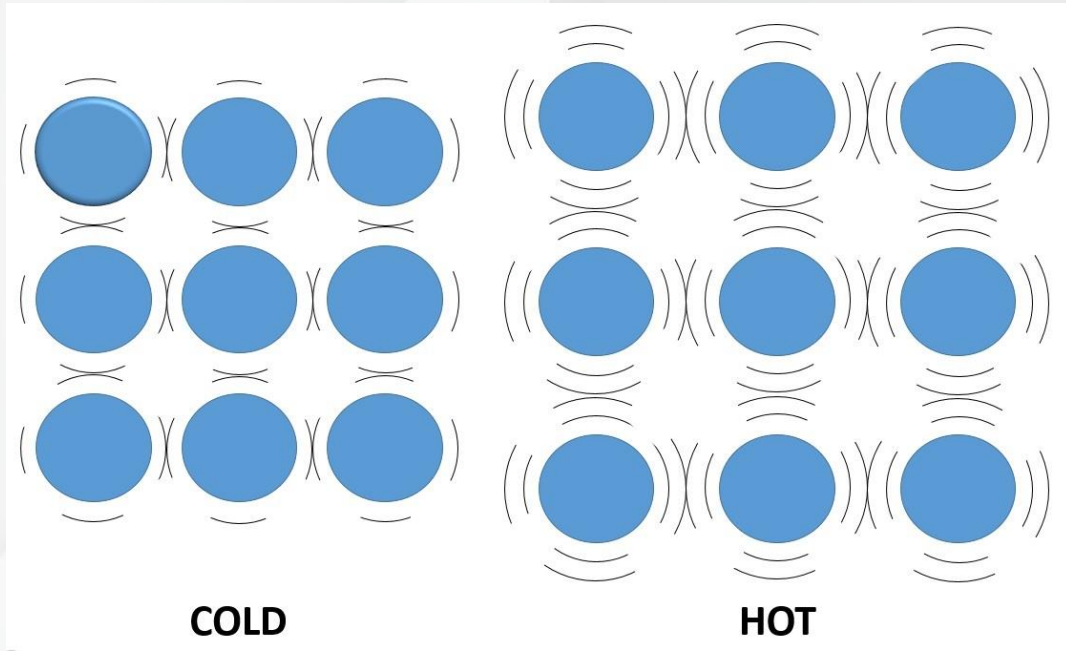
What happens when water heats up?



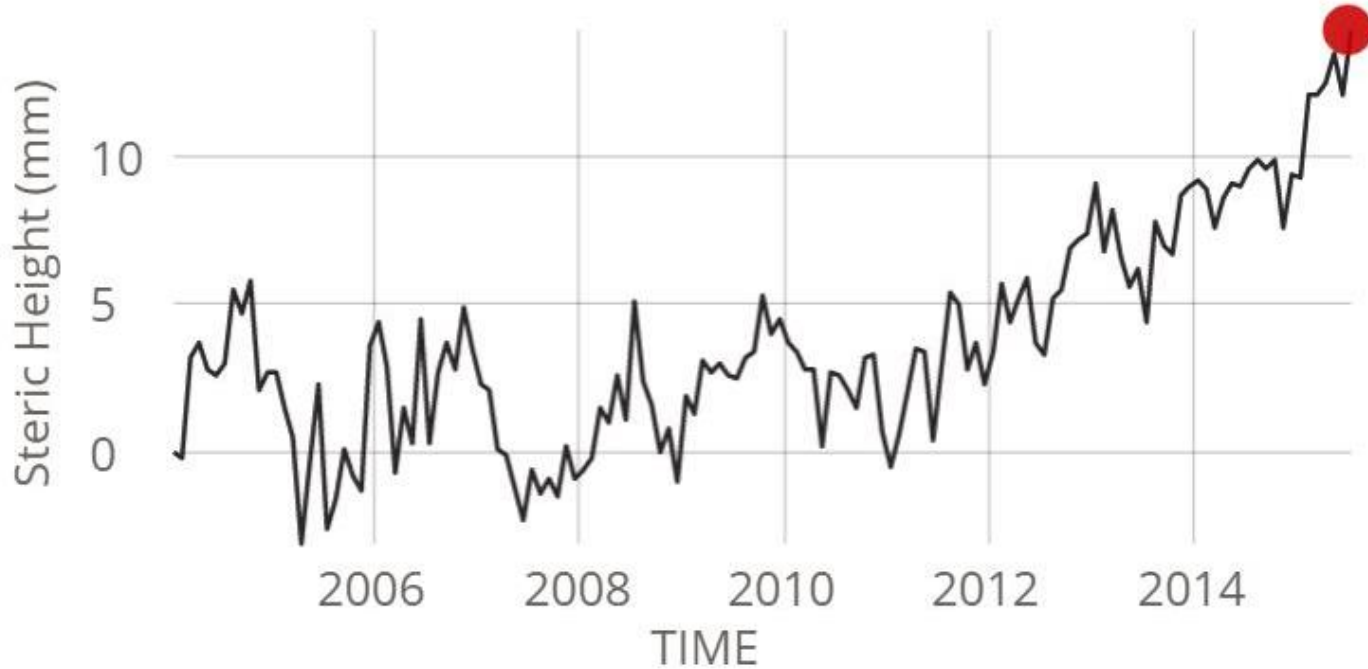
How does this relate to the Earth?



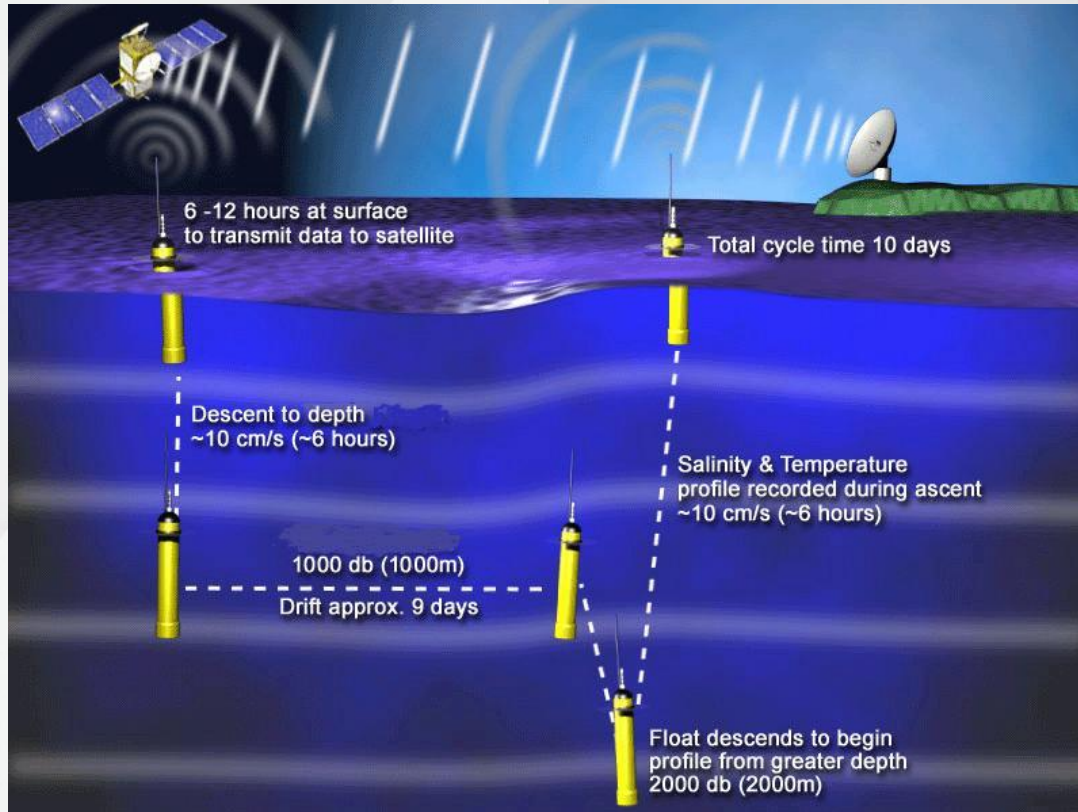
Thermal Expansion of Water



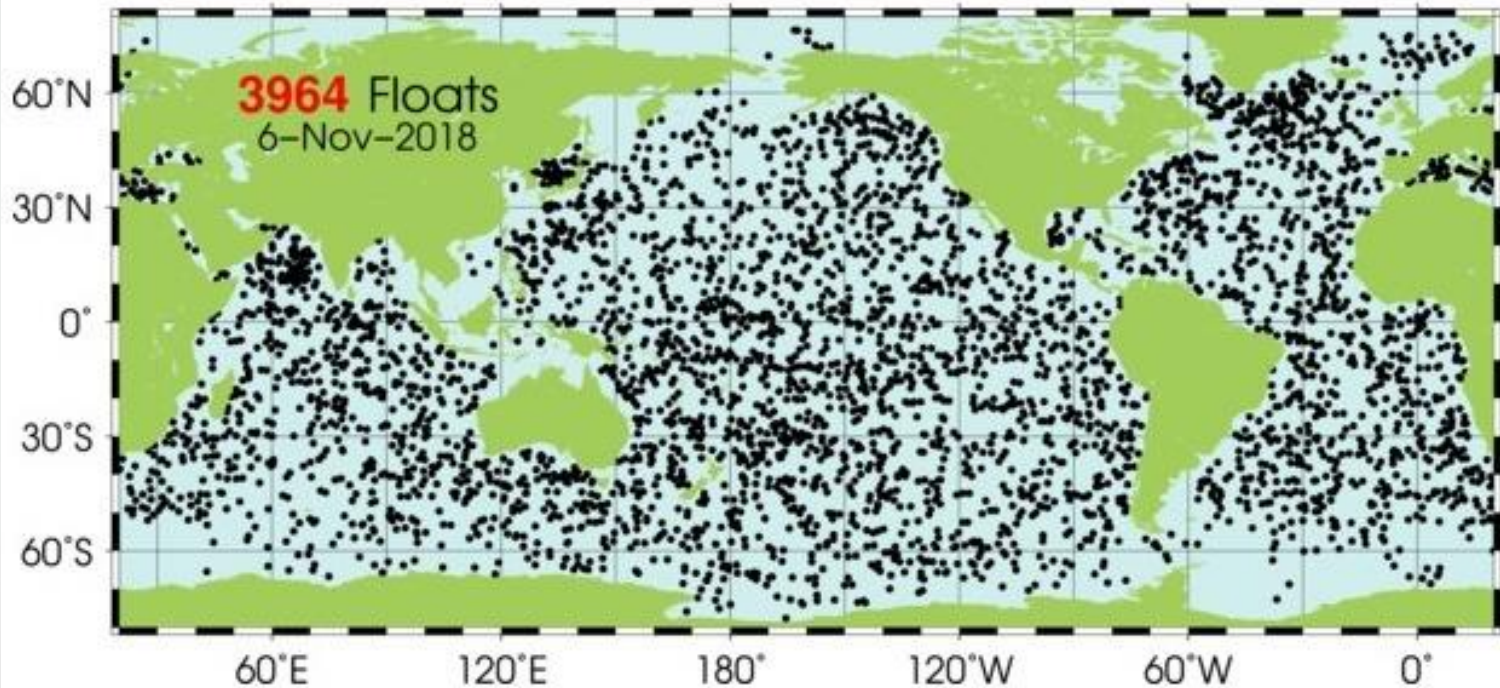
Apply: Measuring the Ocean's Volume



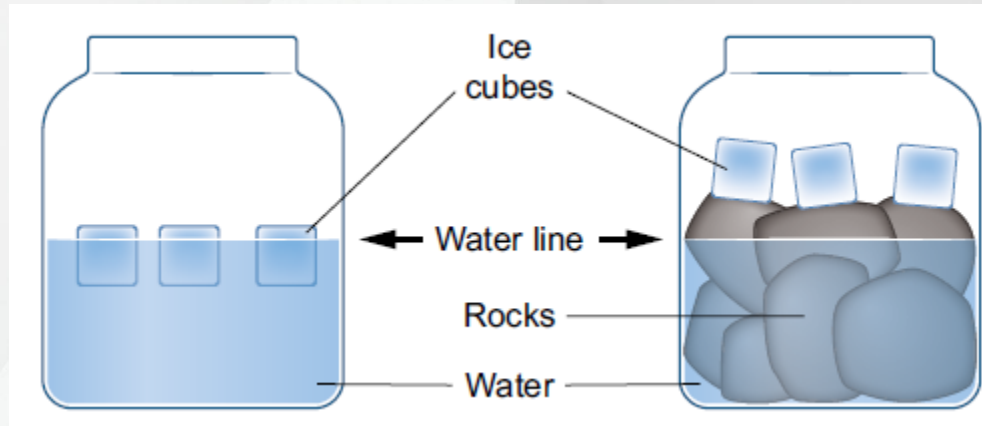
ARGO: Measuring the Ocean's Volume



ARGO: Measuring the Ocean's Volume



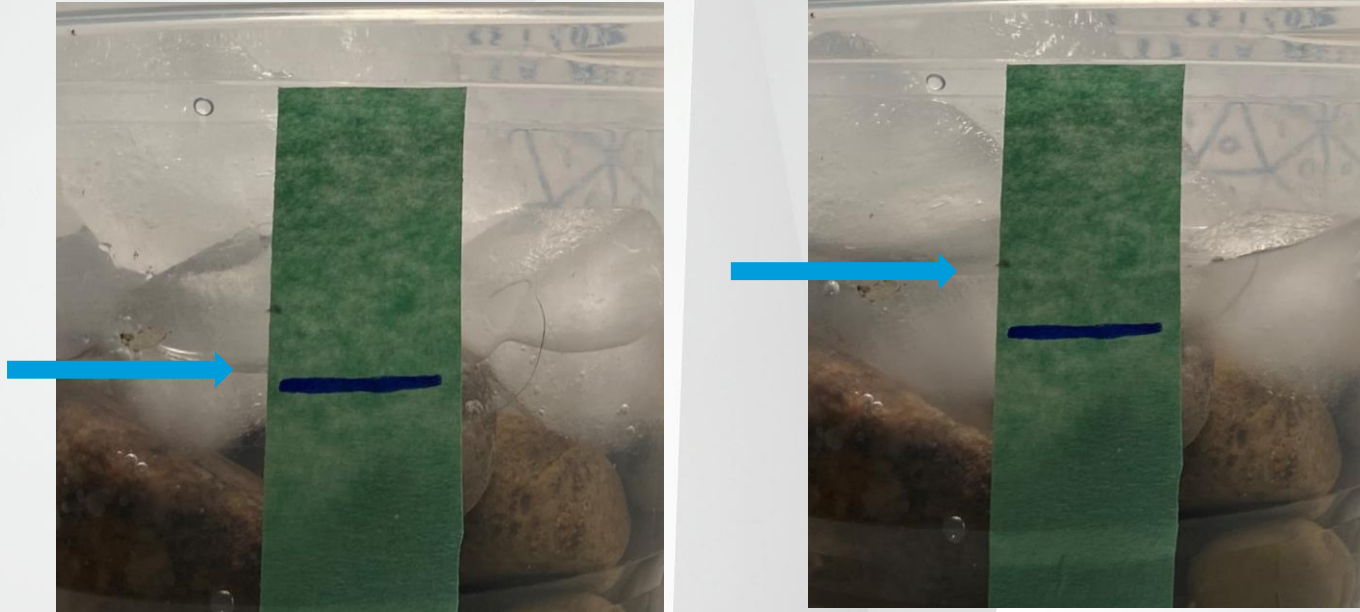
Observe and Explain



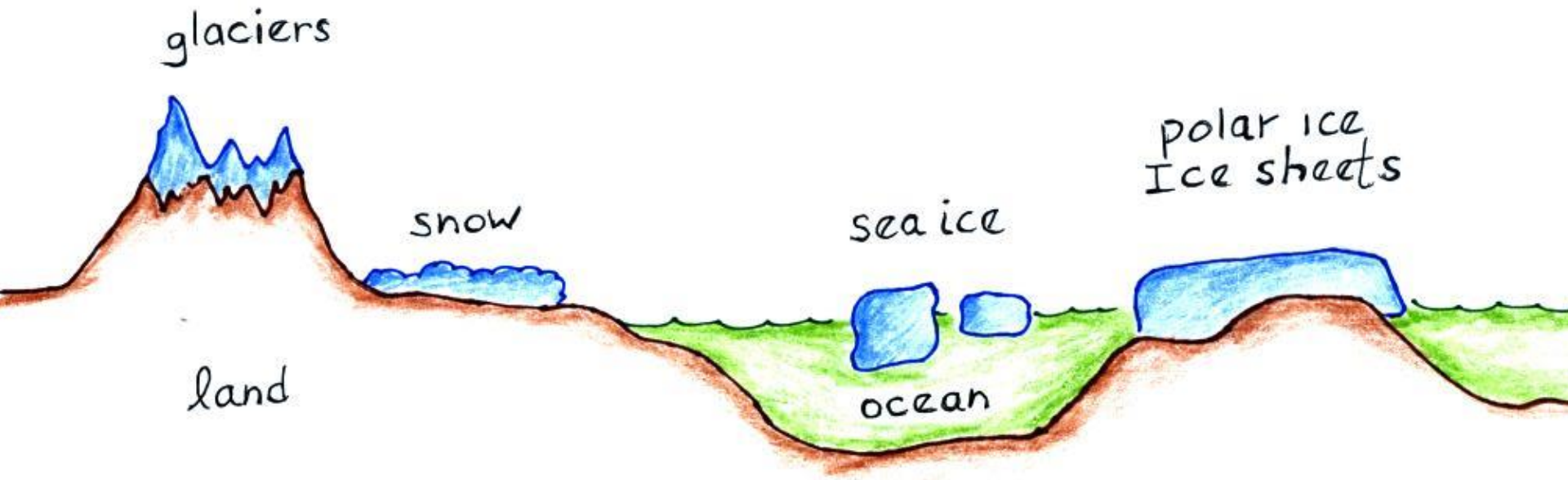
Where does the melting ice go?



How does this relate to the Earth?



Apply: Land Ice vs Sea Ice



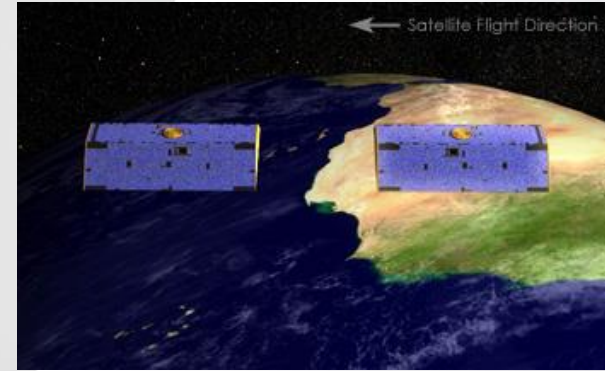
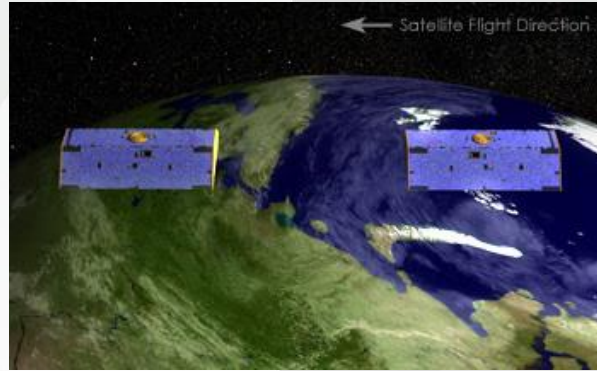
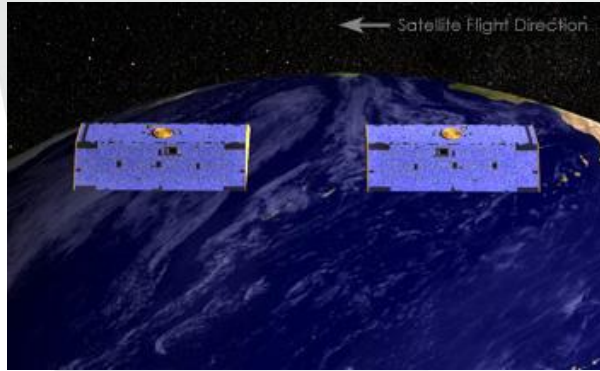


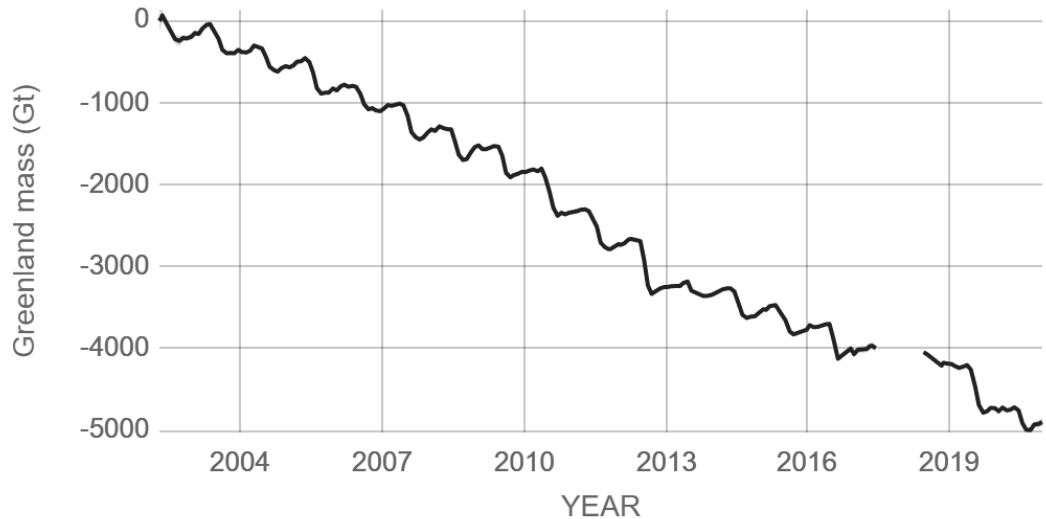
A melting iceberg does not cause a direct change in sea level



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

GRACE: Measuring Land Ice Mass





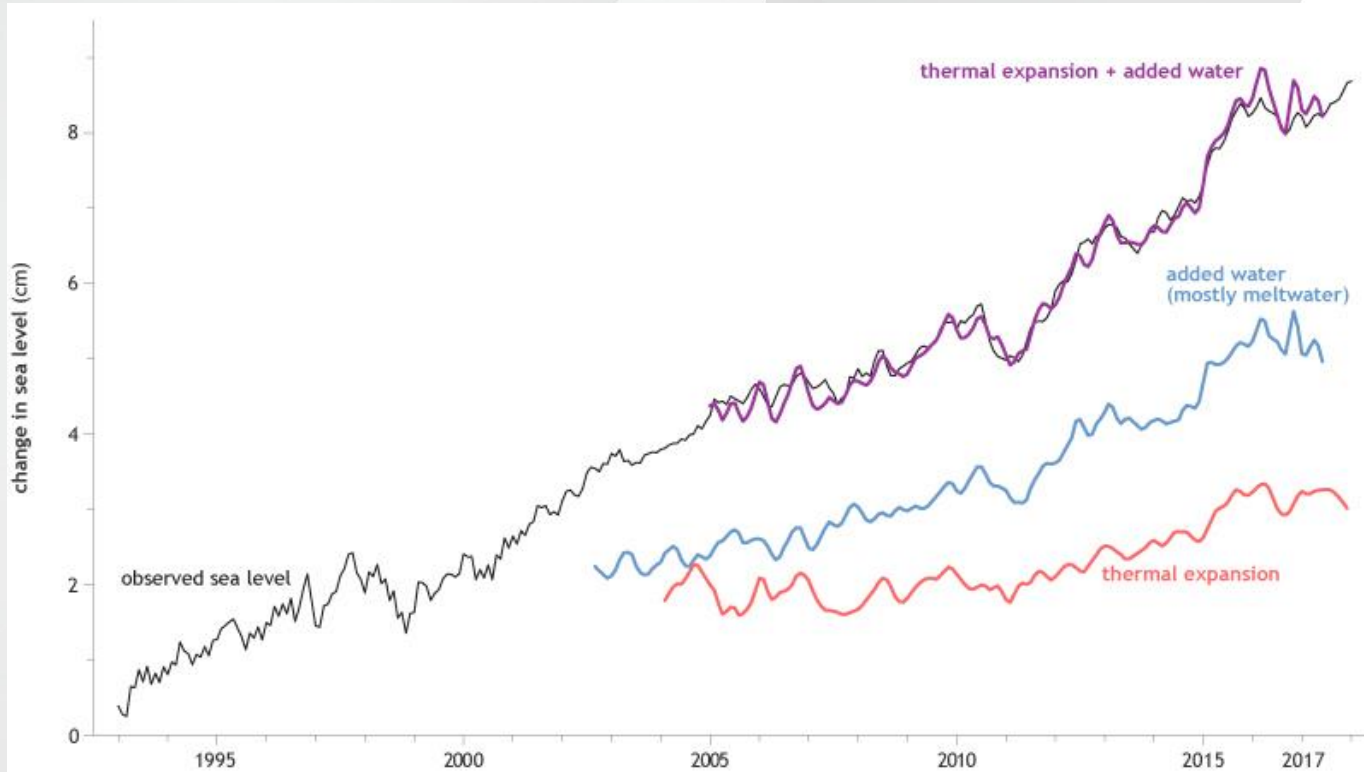
Antarctica ice mass is decreasing at 150 Gt per year

> 420 Gt per year!

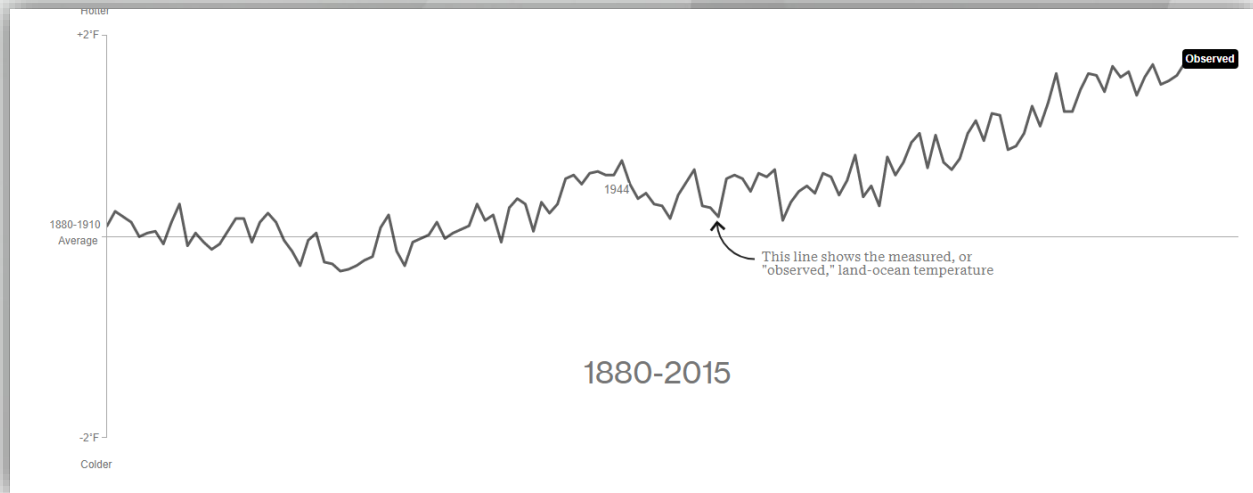
Greenland ice mass is decreasing at 278 Gt per year

Source: climate.nasa.gov

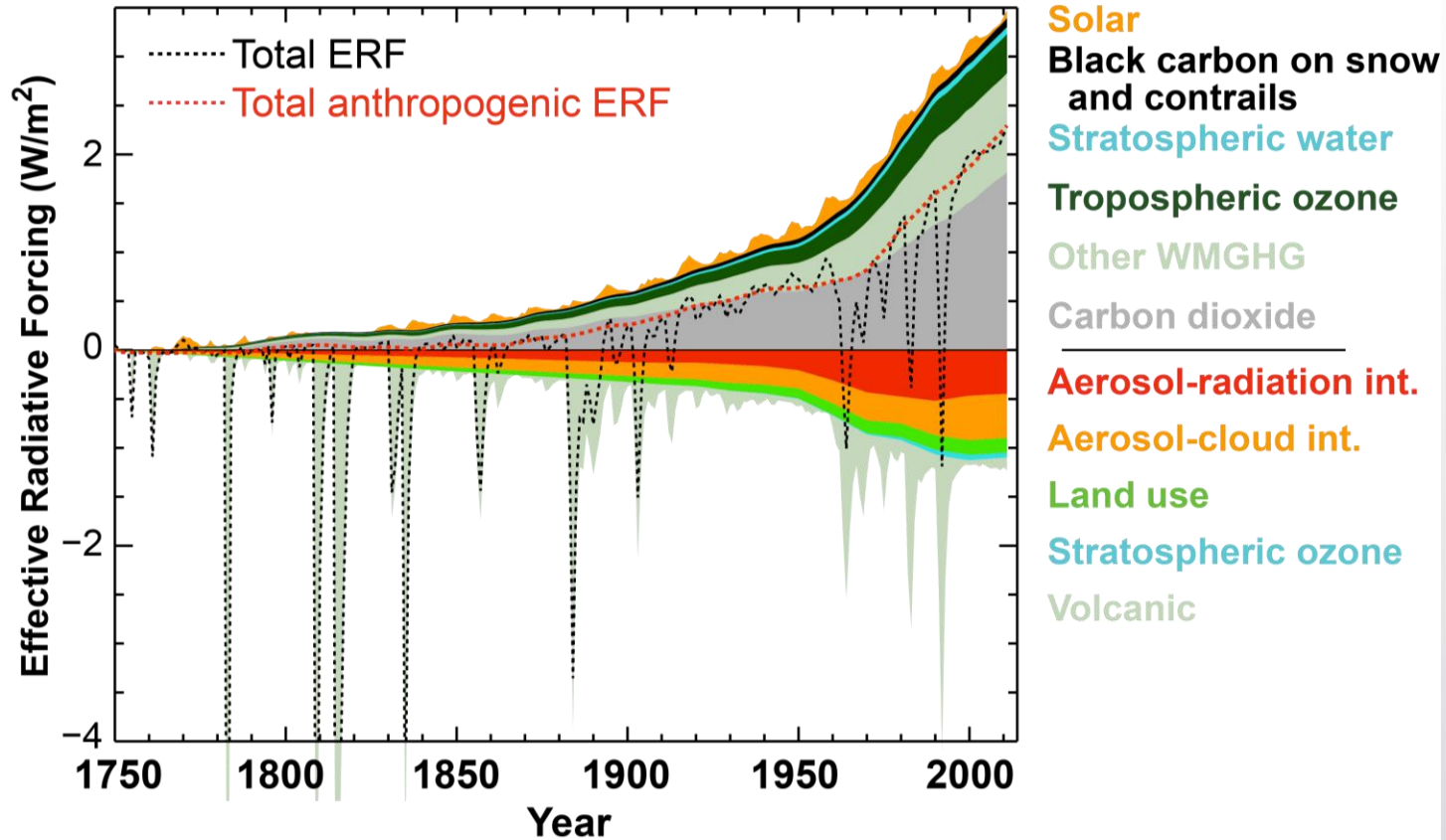
Sea Level Budget



What's causing the warming?



Forcing factors



Climate Change



It's real...

It's us...

It's serious...

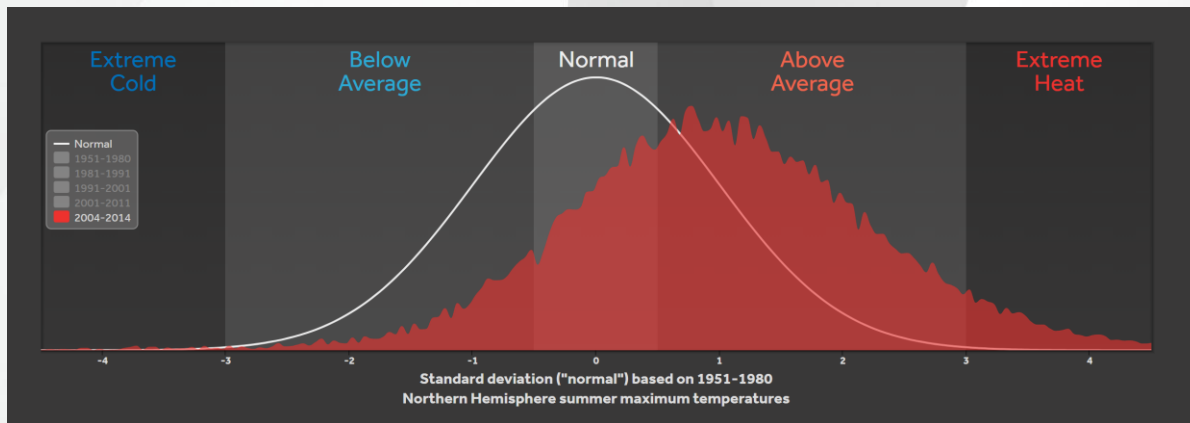
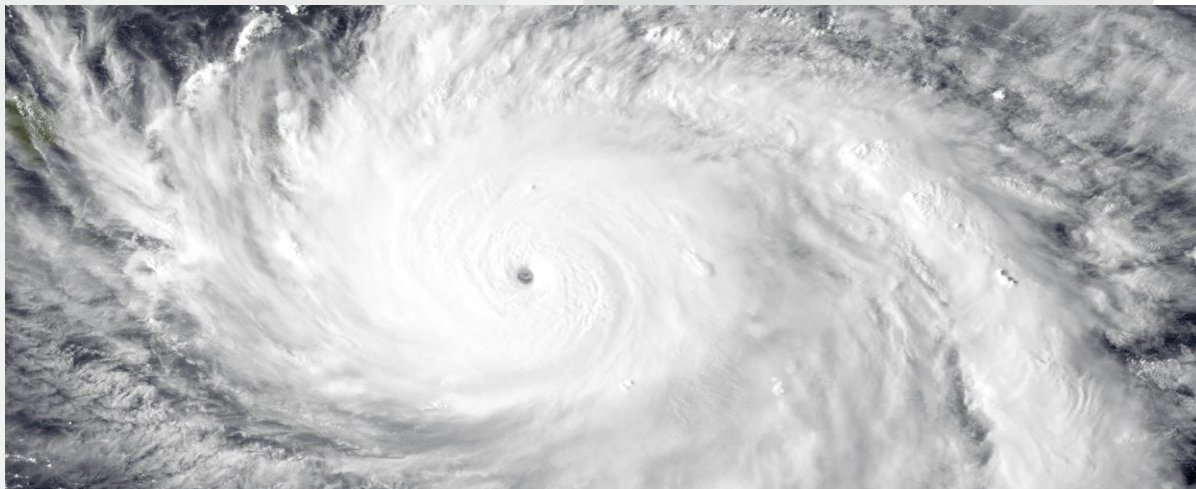
And the window of time to prevent dangerous impacts is closing fast.

Katharine Hayhoe, Texas Tech

Flooding and drought



Wetter hurricanes and hotter heat waves



Intense wildfires and thawing permafrost

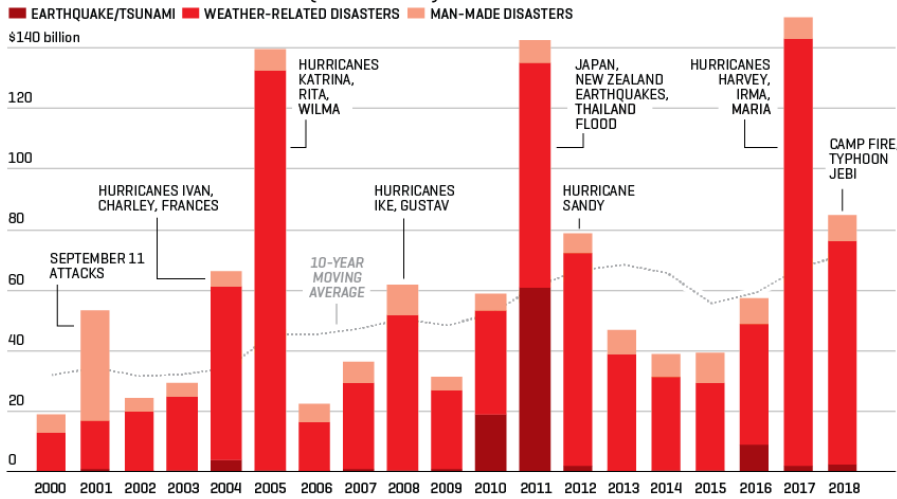


Shifting ecosystems and spreading disease



Economic costs and social costs

INSURED CATASTROPHE LOSSES (2018 dollars)



This summer...



Germany



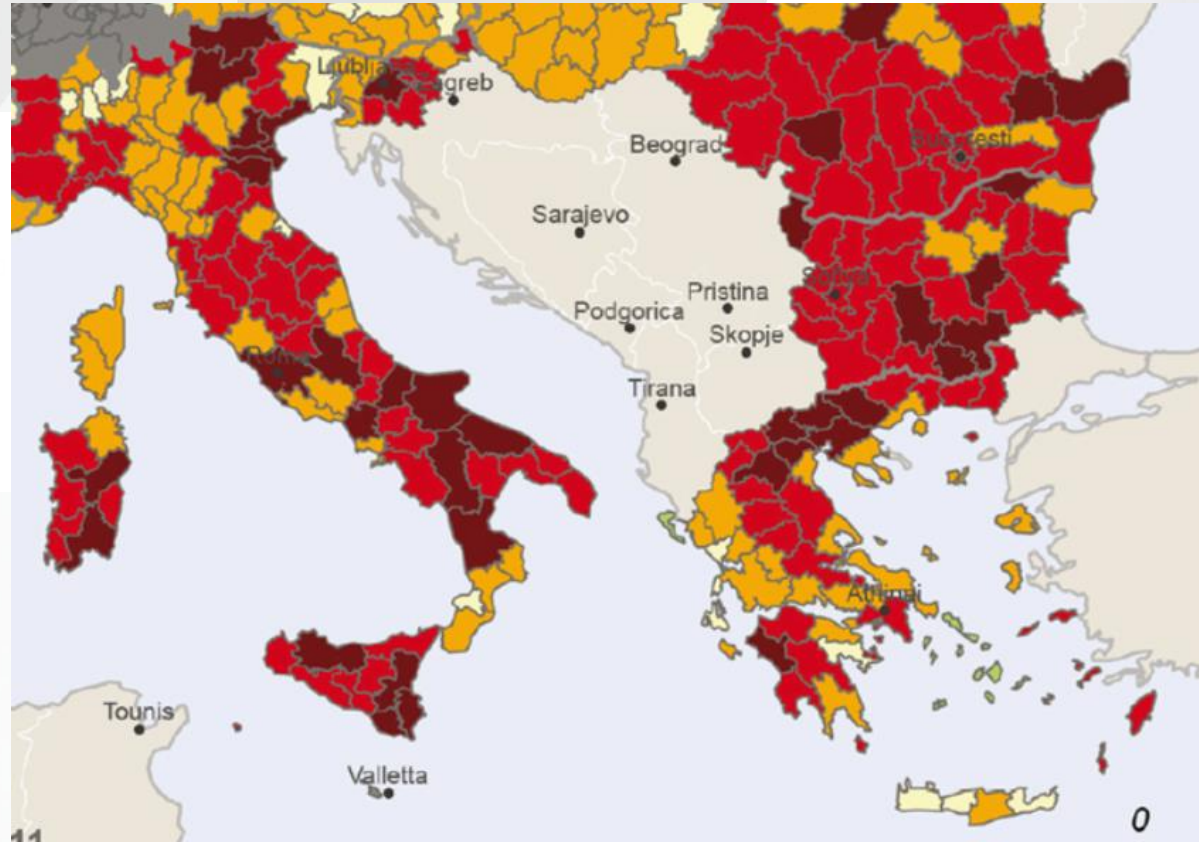
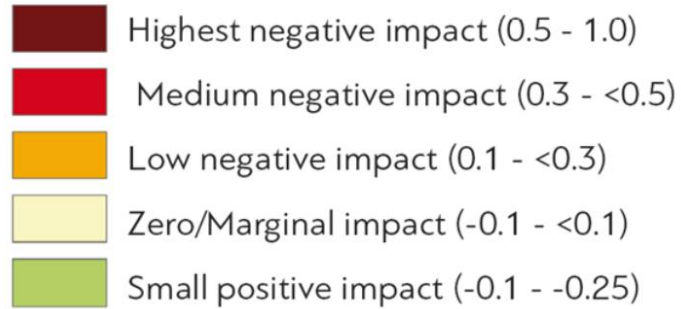
France



China

Greece is vulnerable

Potential vulnerability to climate change





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

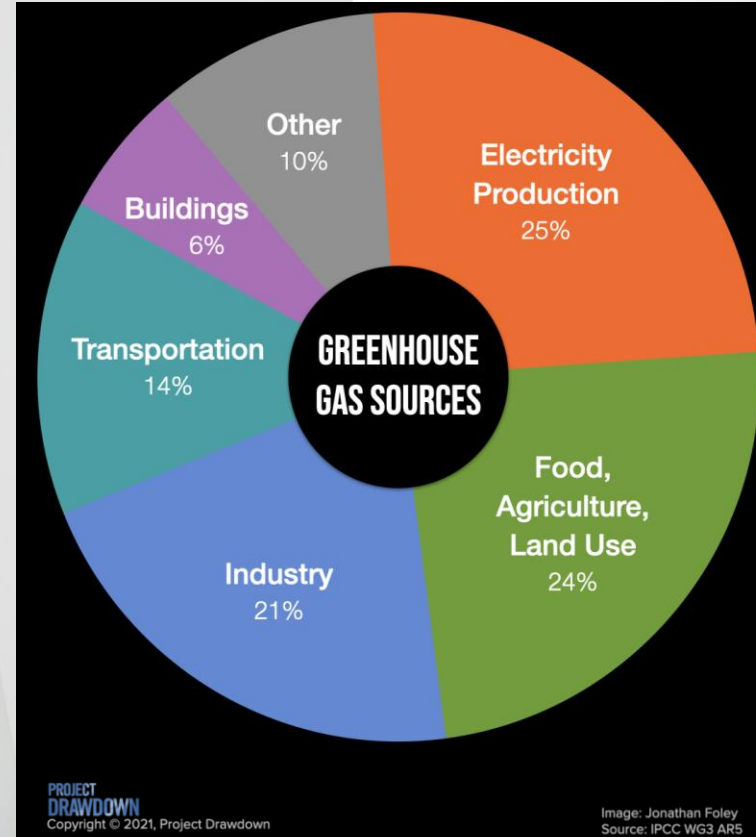
[DRAWDOWN.ORG/CLIMATE-SOLUTIONS-101](https://drawdown.org/climate-solutions-101)

“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



DRAWDOWN.ORG

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.



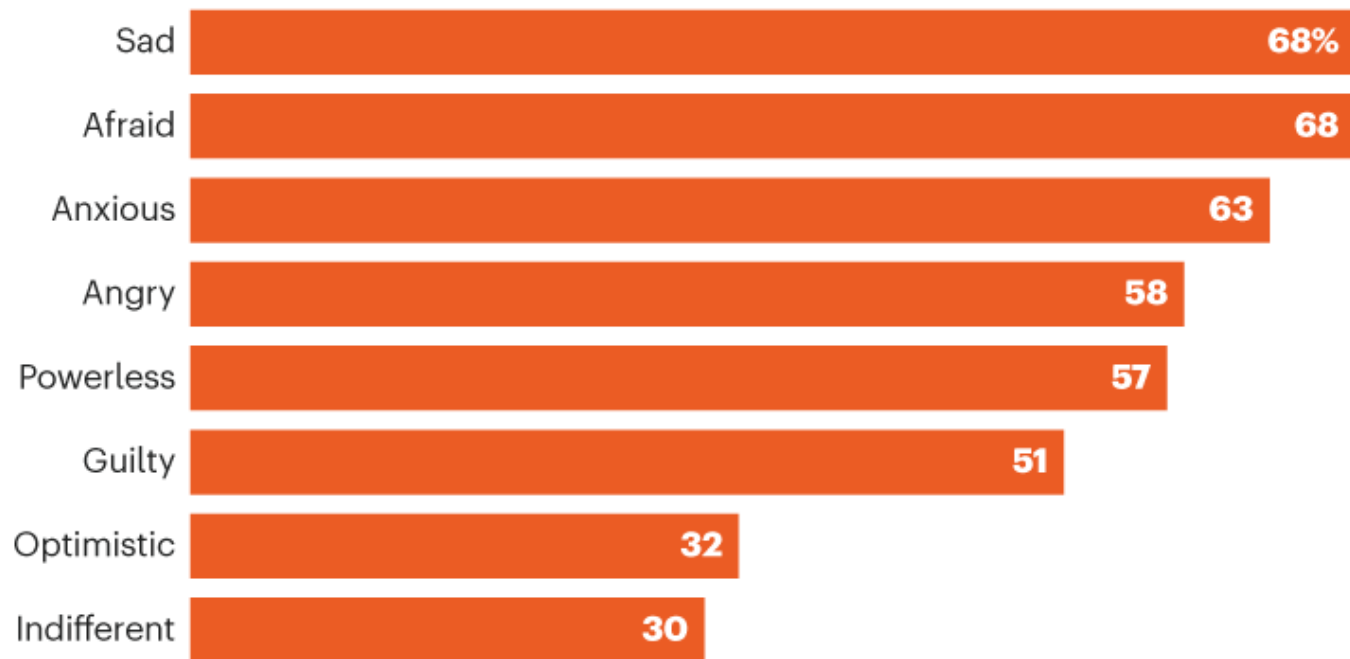
Recognize that this is a complex issue

- Inter-generational conflict
- Inequality
- 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
 - Dietary choices
 - Consumer habits
- Lobby for systemic change
 - Political, social, economic

Resources

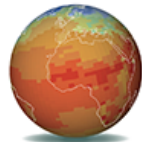
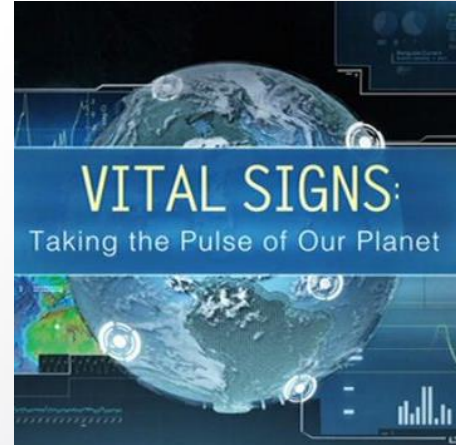


DRAWDOWN.ORG

GLOBAL WEIRDING
WITH KATHARINE HAYHOE



NEW EPISODES
EVERY OTHER WEDNESDAY
GLOBALWEIRDINGSERIES.COM KTTZ.ORG



climateprediction.net

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