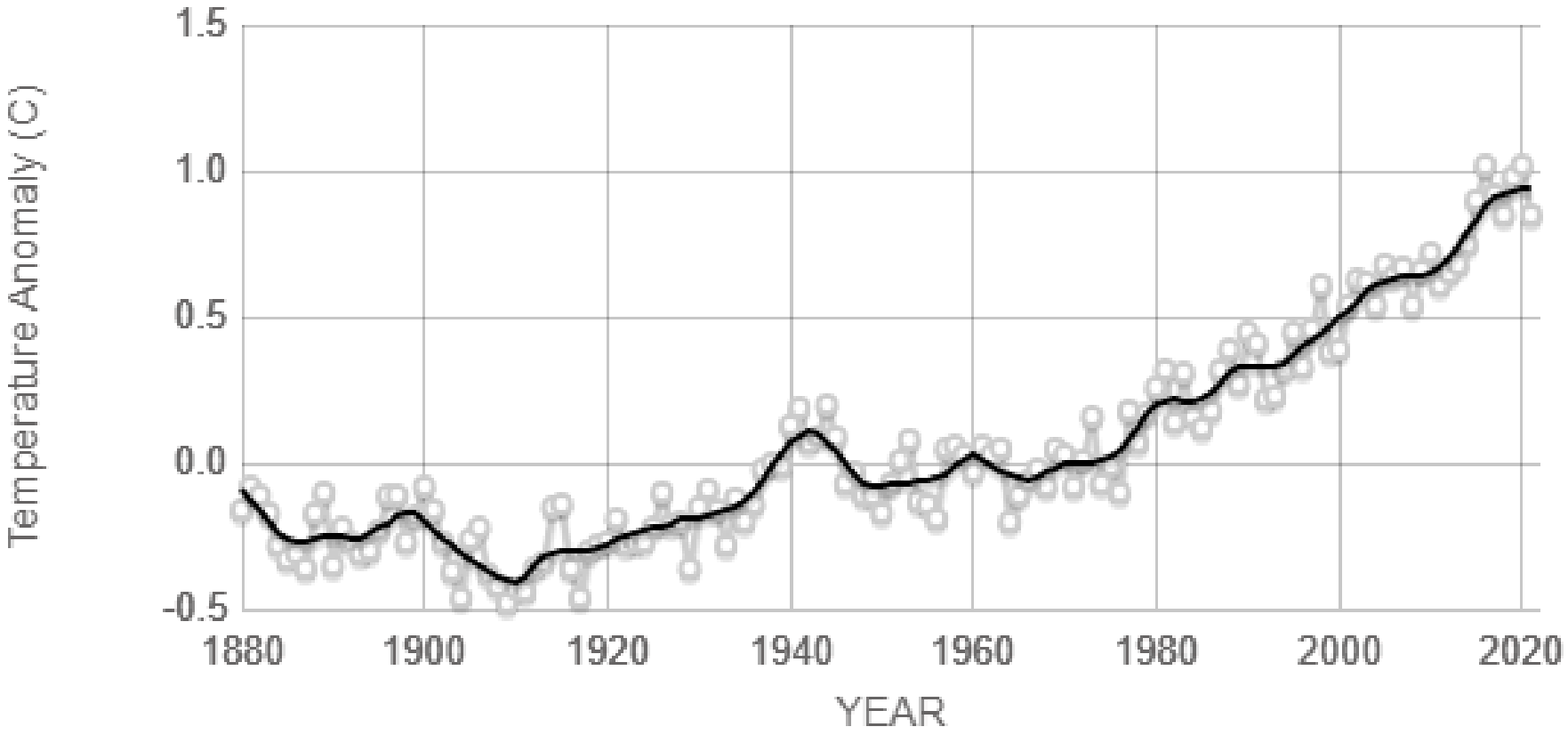
Climate Change

IB PHYSICS | ENERGY PRODUCTION

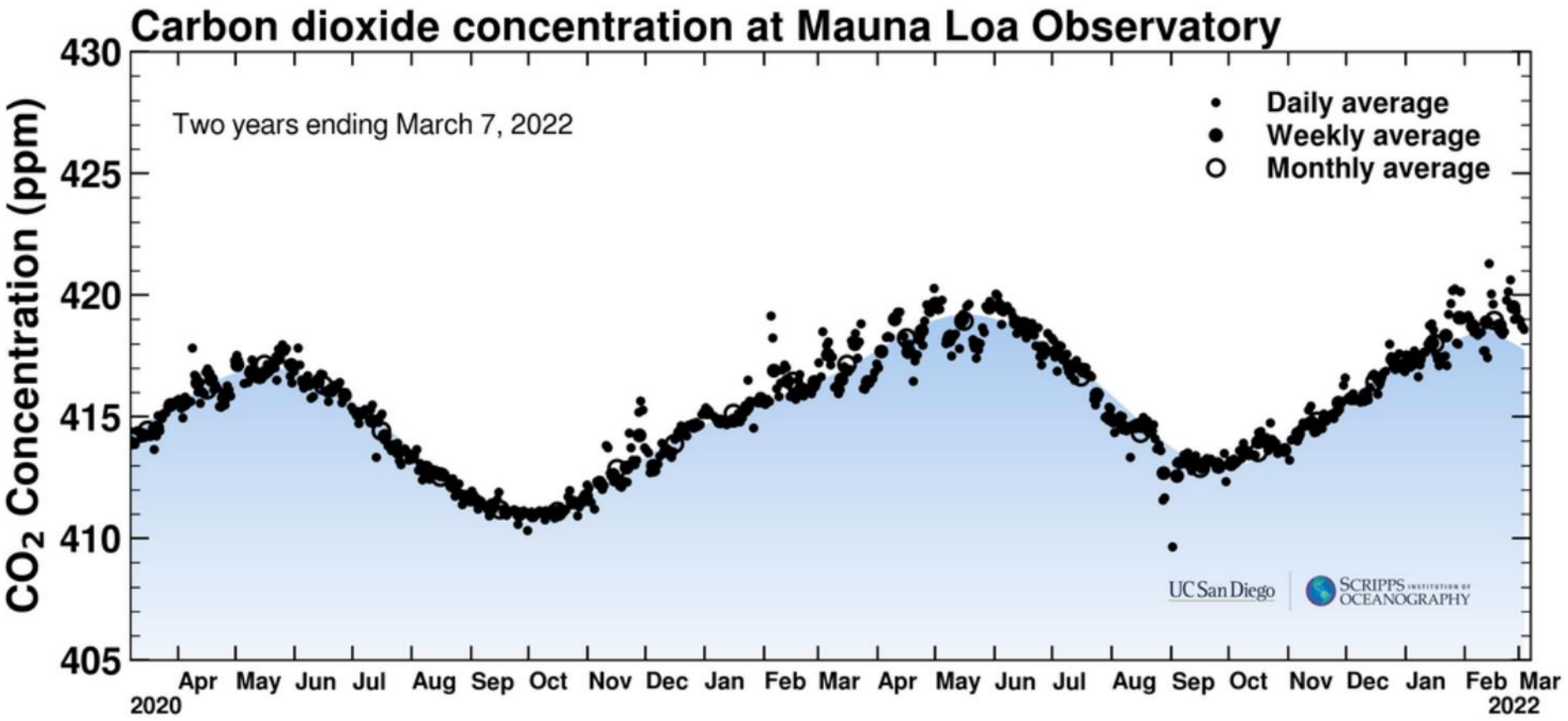
Temperature has been Rising



Source: climate.nasa.gov

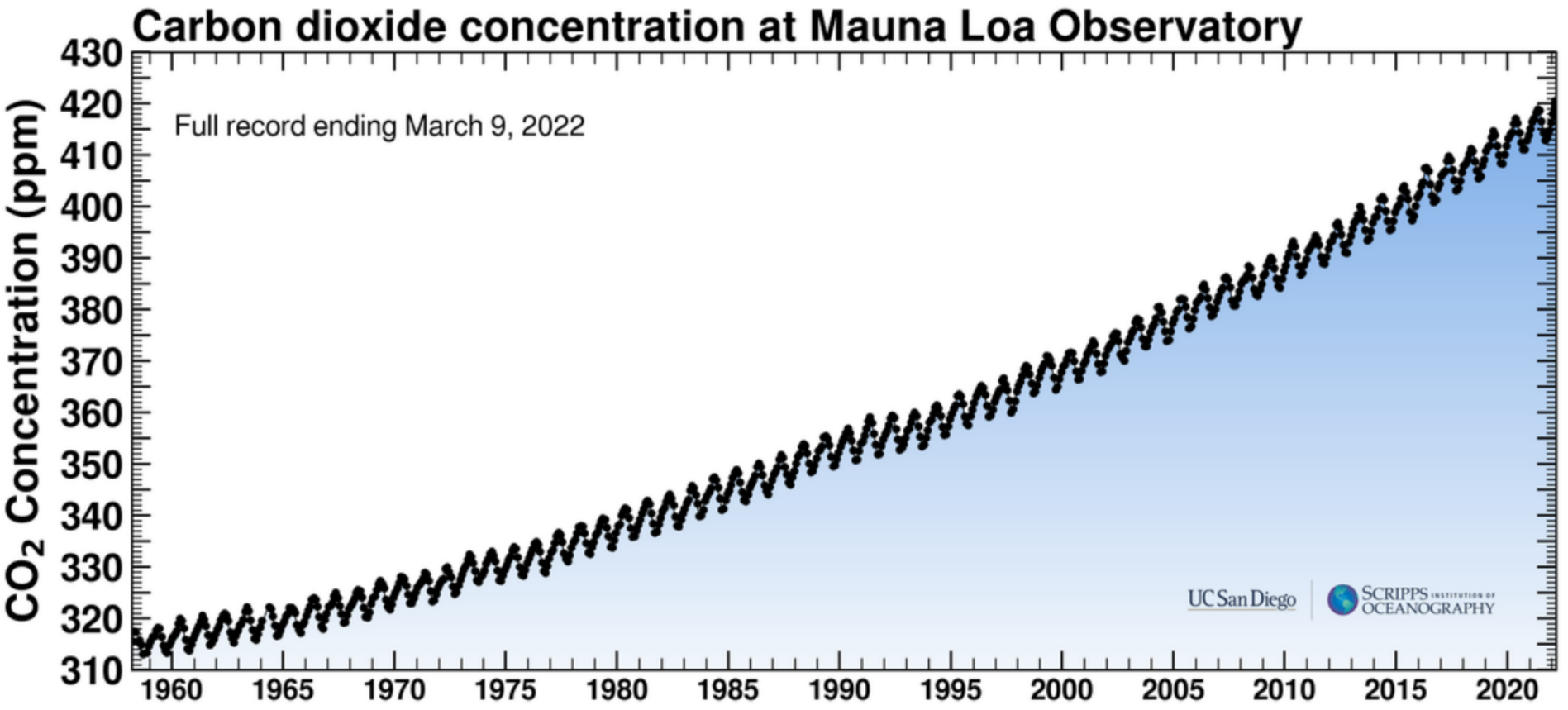
CO_2 Concentration | 2 years

Latest CO_2 Reading: **417.88 ppm**



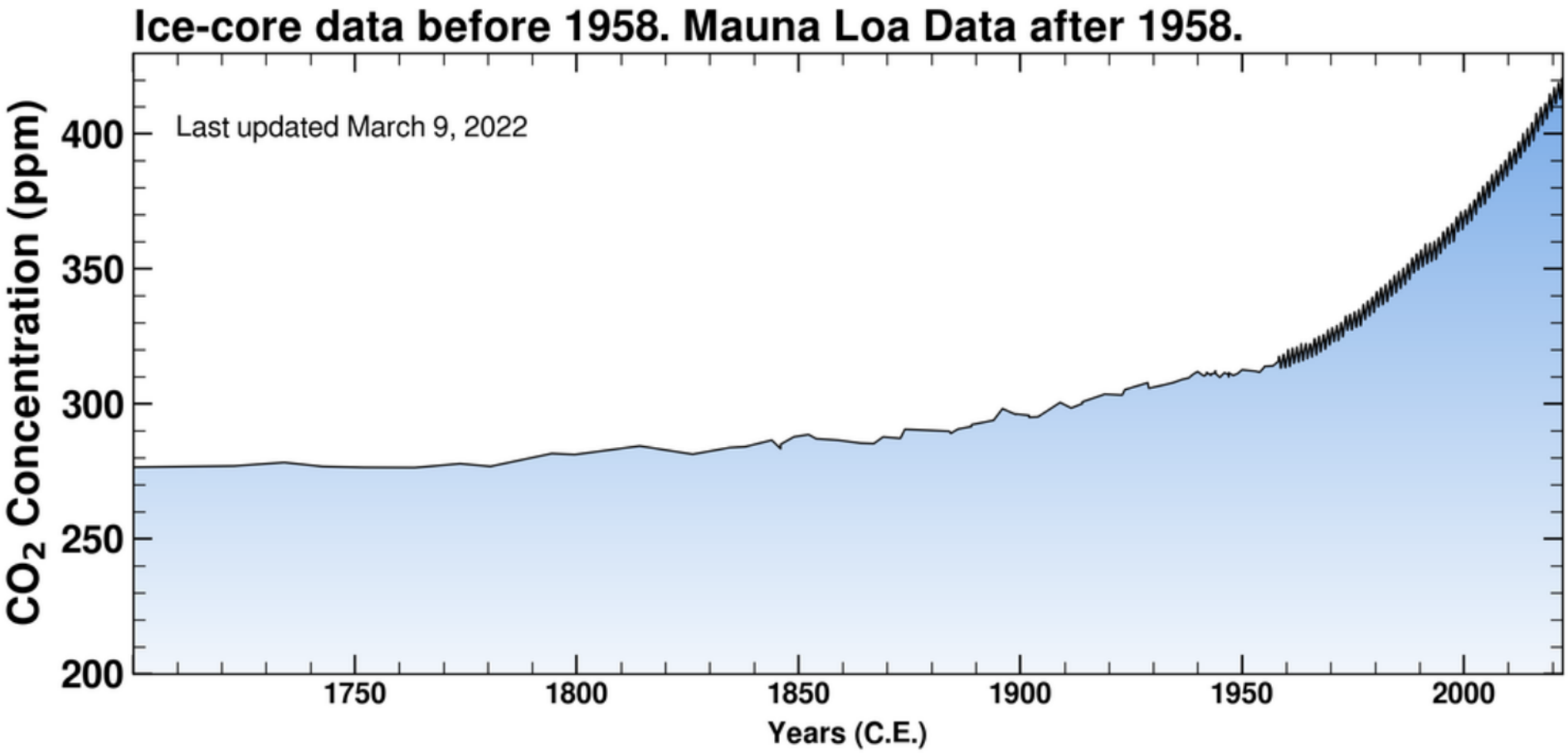
https://scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration | 63 years



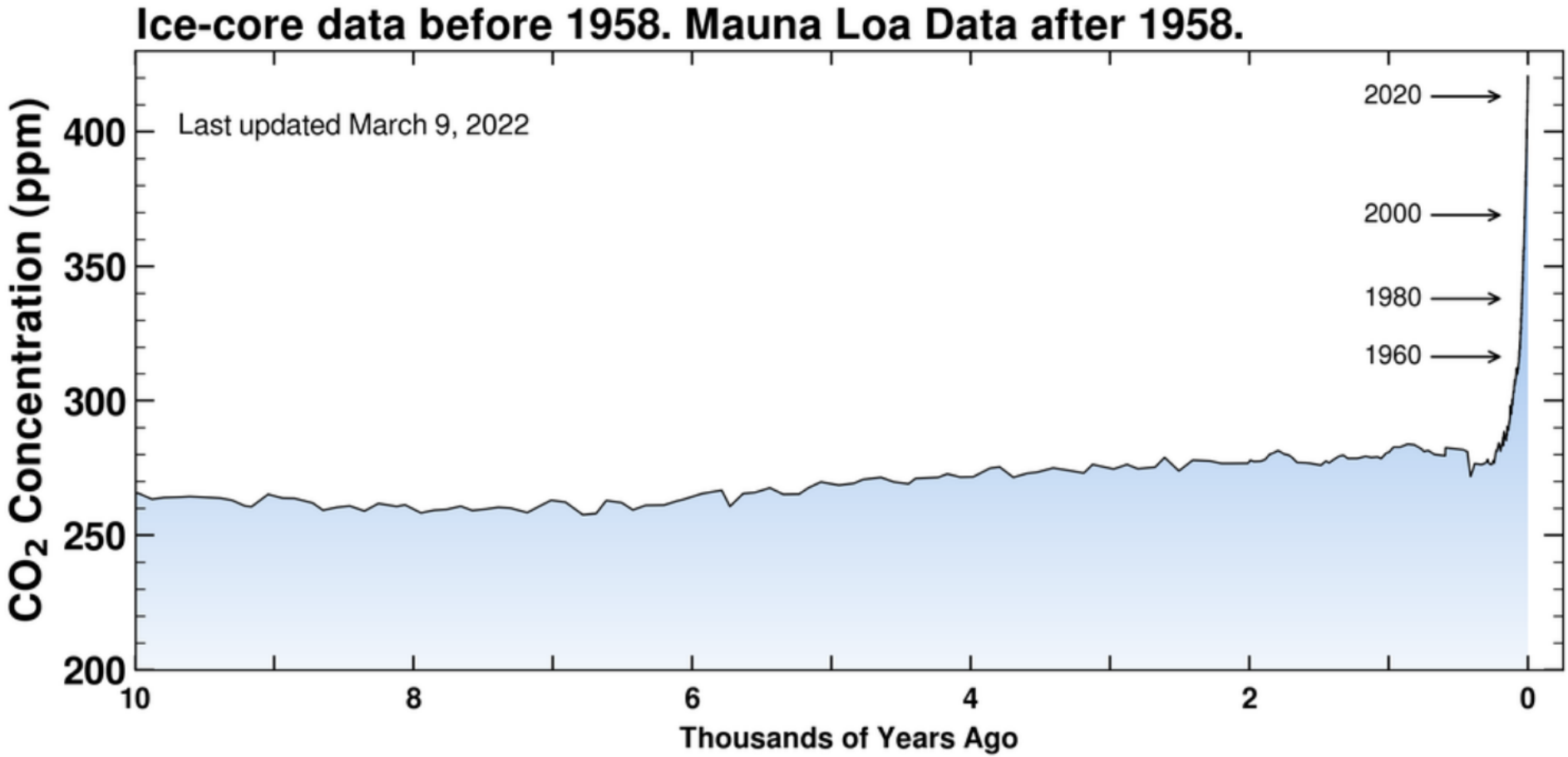
https://scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration | 300 years



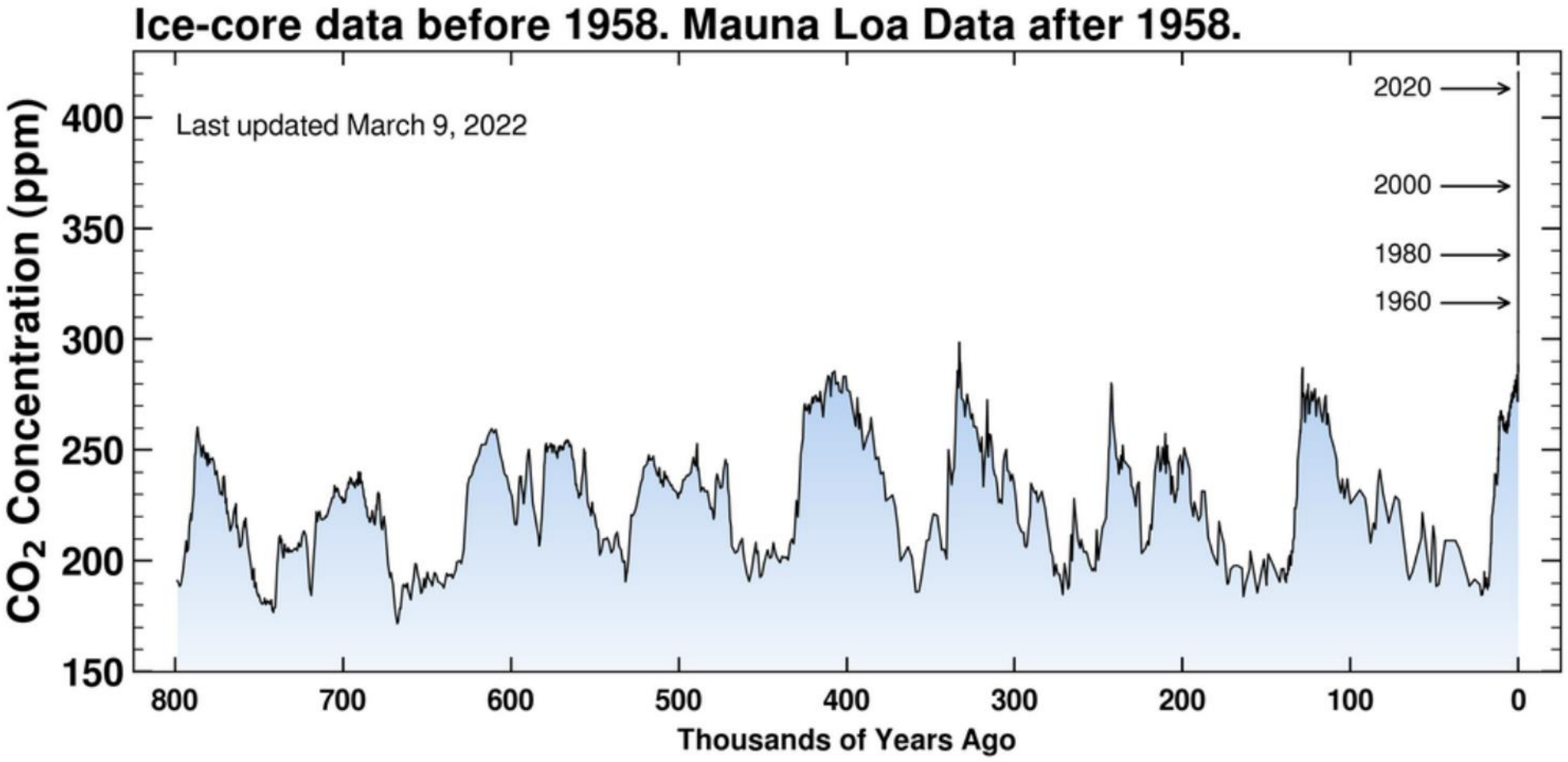
https://scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration | 10,000 years



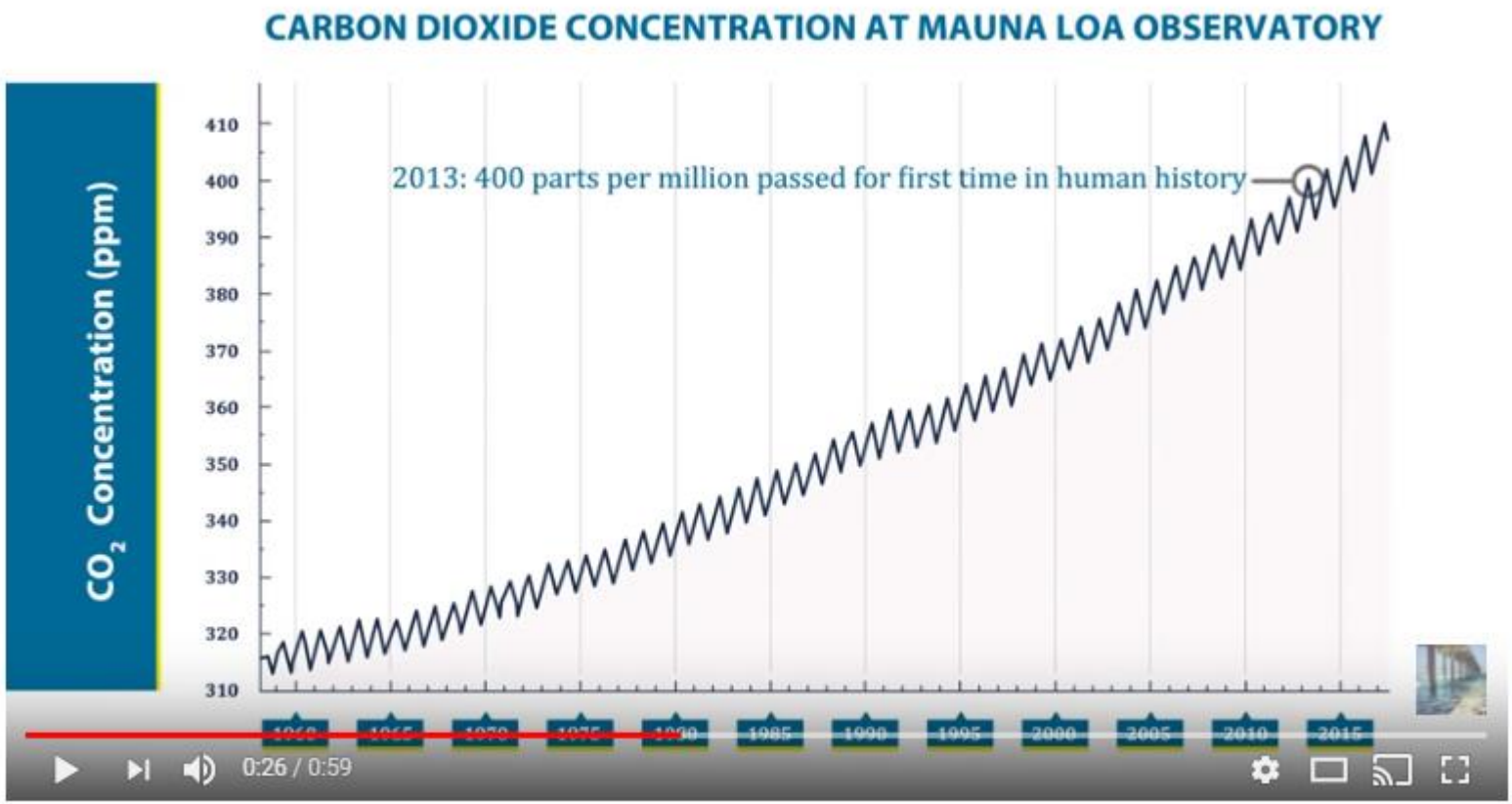
https://scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration | 800,000 years



https://scripps.ucsd.edu/programs/keelingcurve/

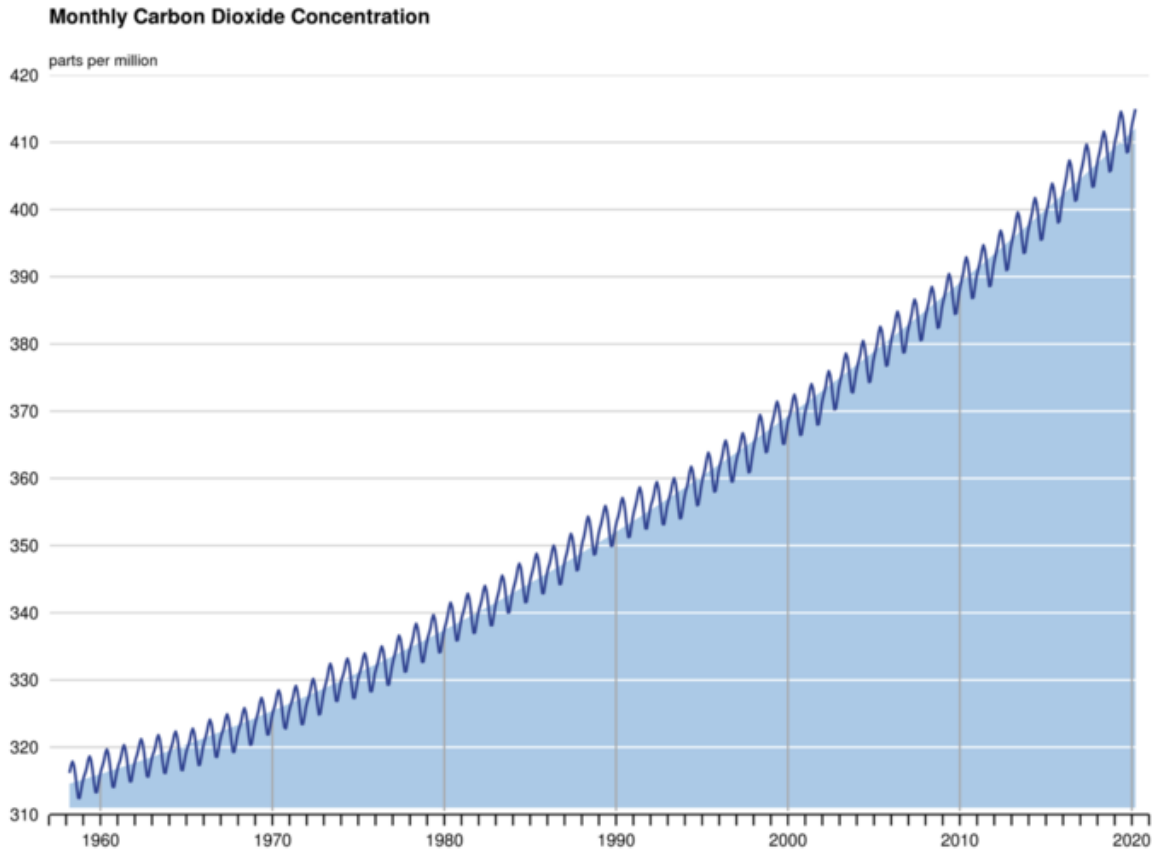
CO_2 Concentration



The Keeling Curve animation

https://scripps.ucsd.edu/programs/keelingcurve/

Why does the level fluctuate yearly?



Seasons

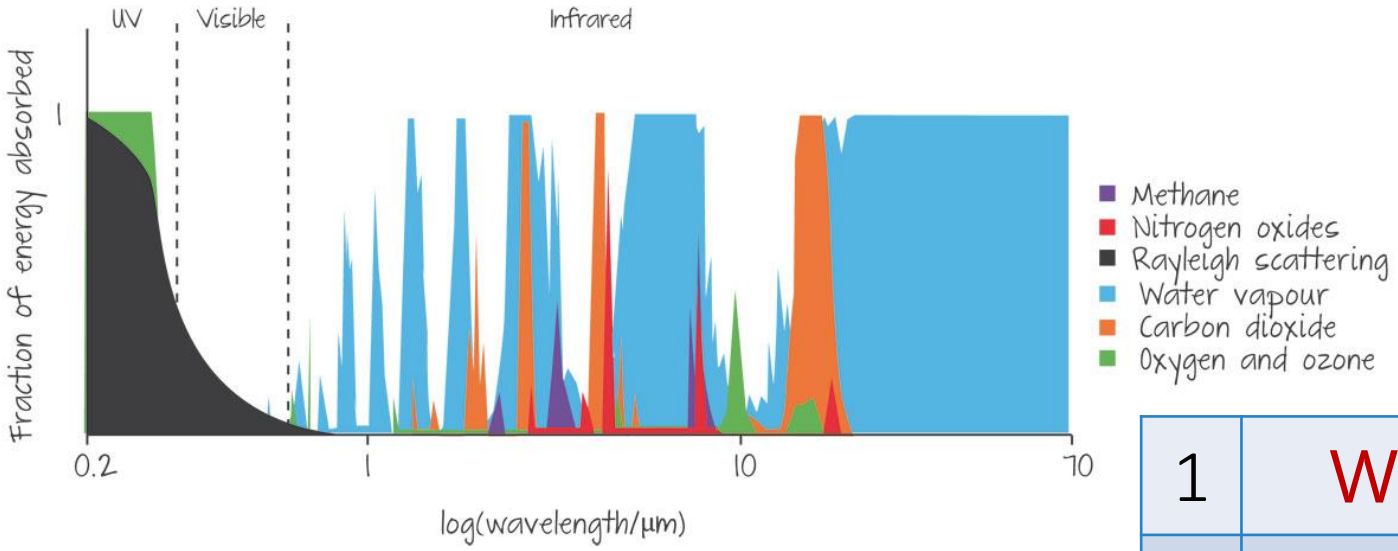
**There are more land (plants) in the Northern Hemisphere that remove CO_2 from the atmosphere during the summer months*

The Greenhouse Effect

Gas molecules absorb and reemit infrared radiation

**This happens because the shape of these molecules means that they have natural vibration frequency that matches the frequency of infrared waves*

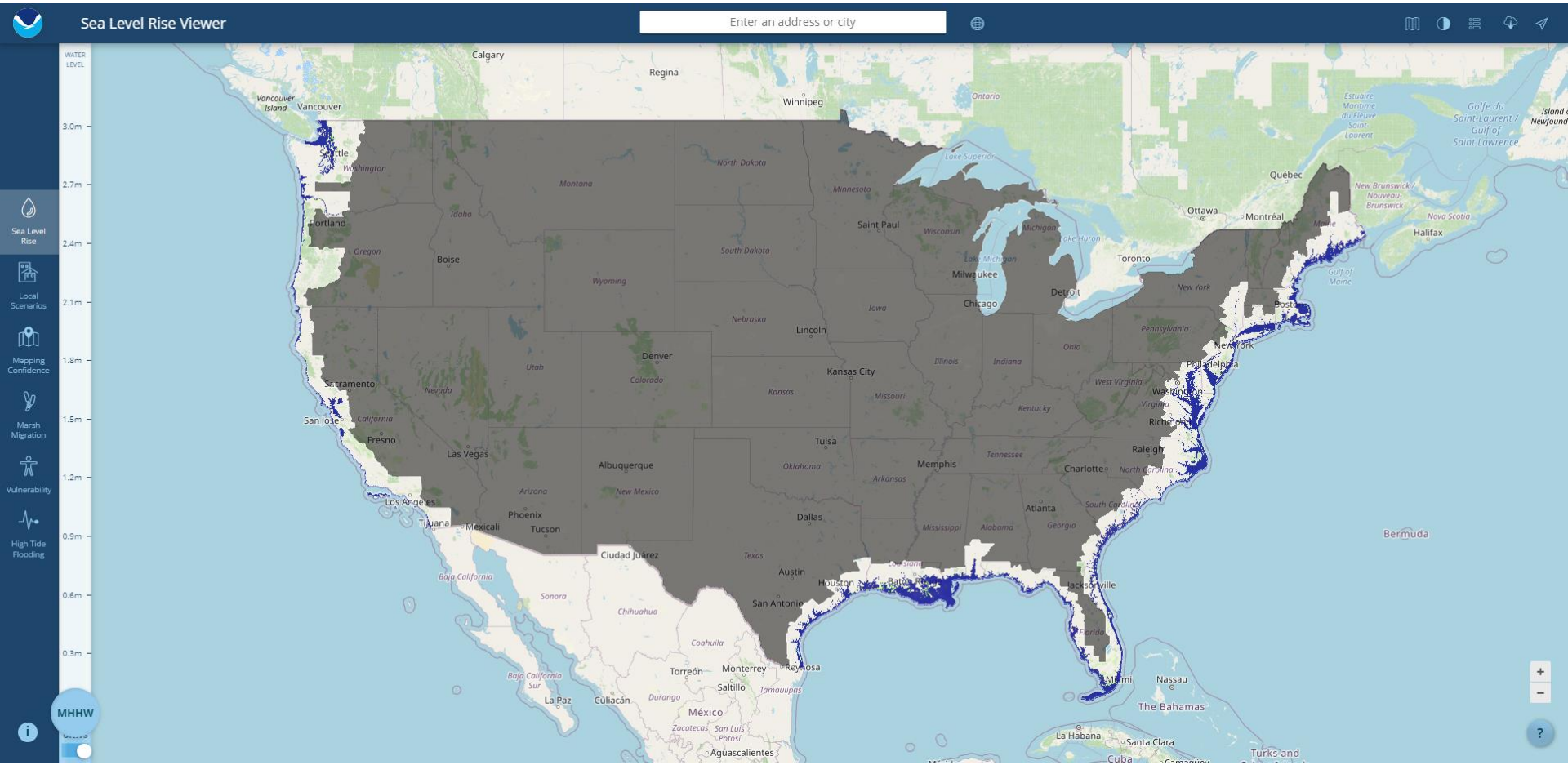
The Top Greenhouse Gases



Rank the following Greenhouse Gases based on the amount of infrared energy they absorb

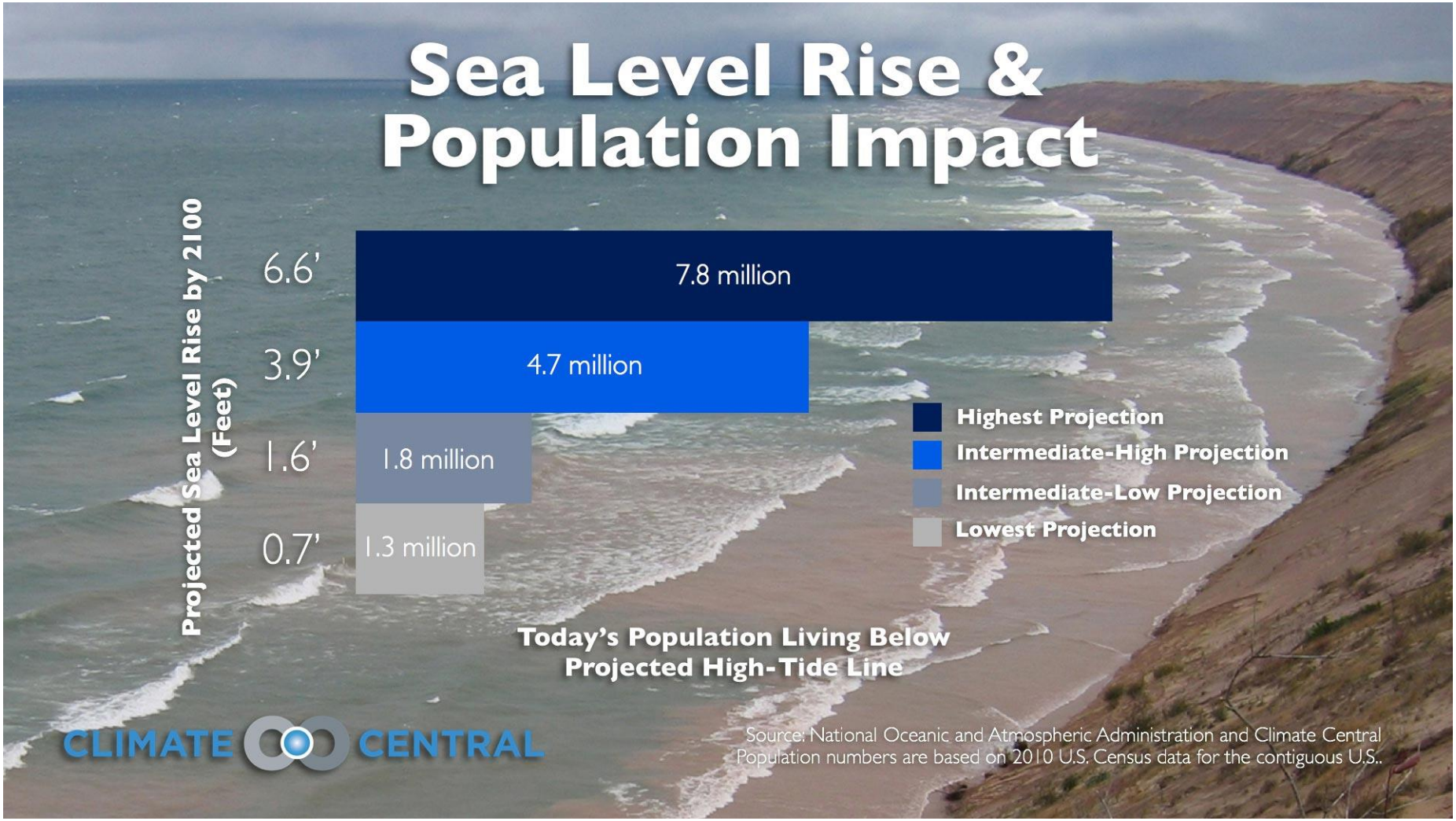
1	Water Vapor
2	Carbon Dioxide
3	Methane
4	Nitrogen Oxides
5	Oxygen/Ozone

Impacts of Climate Change



https://coast.noaa.gov/slr/#

Impacts of Climate Change



https://www.climatecentral.org/gallery/graphics/sea-level-rise-and-population-impact

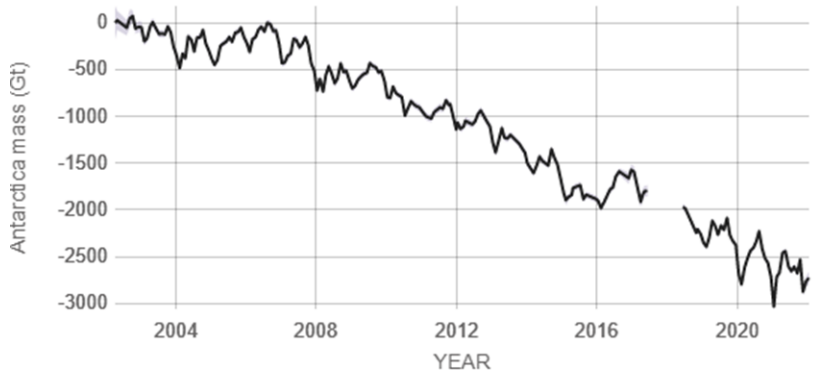
Sea Levels Rising | Melting Ice

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

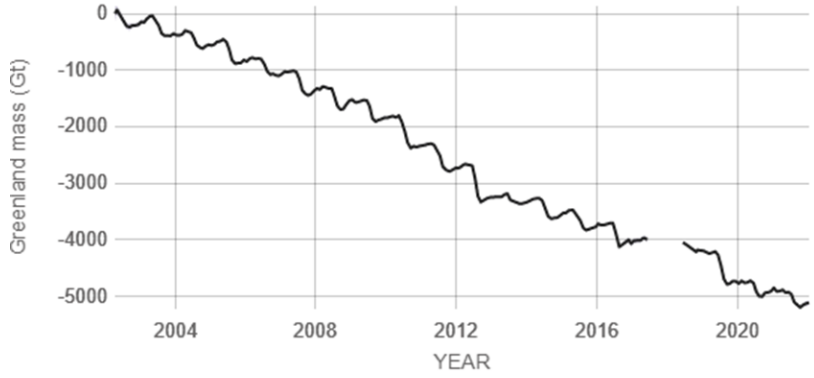
Why?

Sea Levels Rising | Melting Ice



Source: climate.nasa.gov

Antarctica ice mass is decreasing at a rate of 1521 billion tons per year

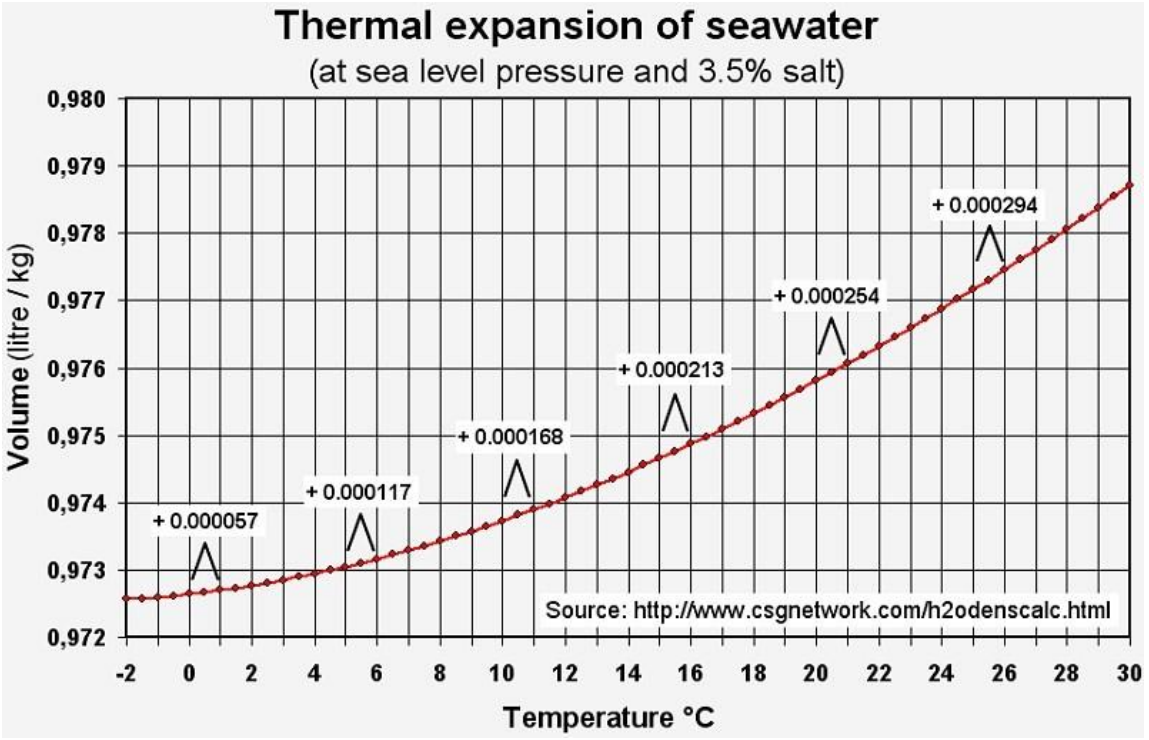


Source: climate.nasa.gov

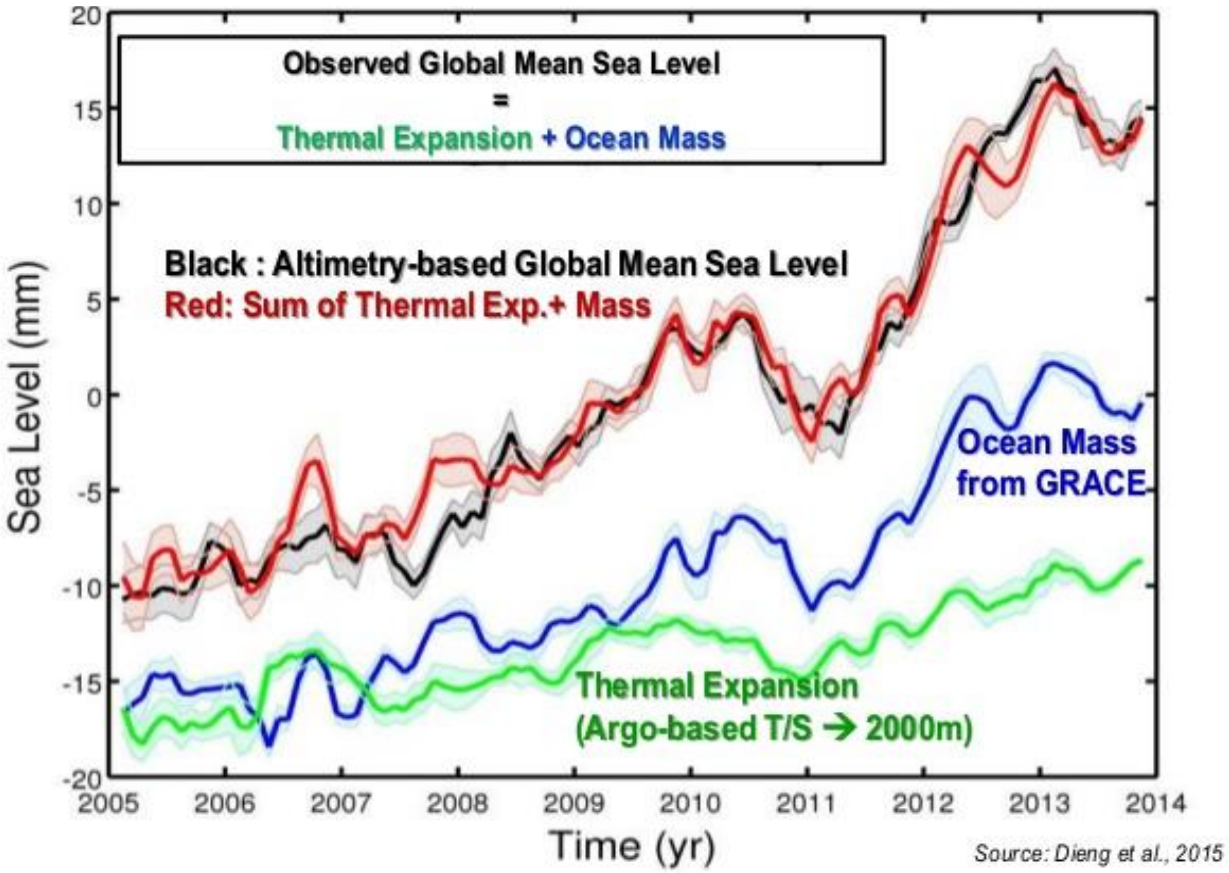
Greenland ice mass is decreasing at a rate of 275 billion tons per year

Sea Levels Rising | Expansion

When most objects are heated they expand. Water is no different.

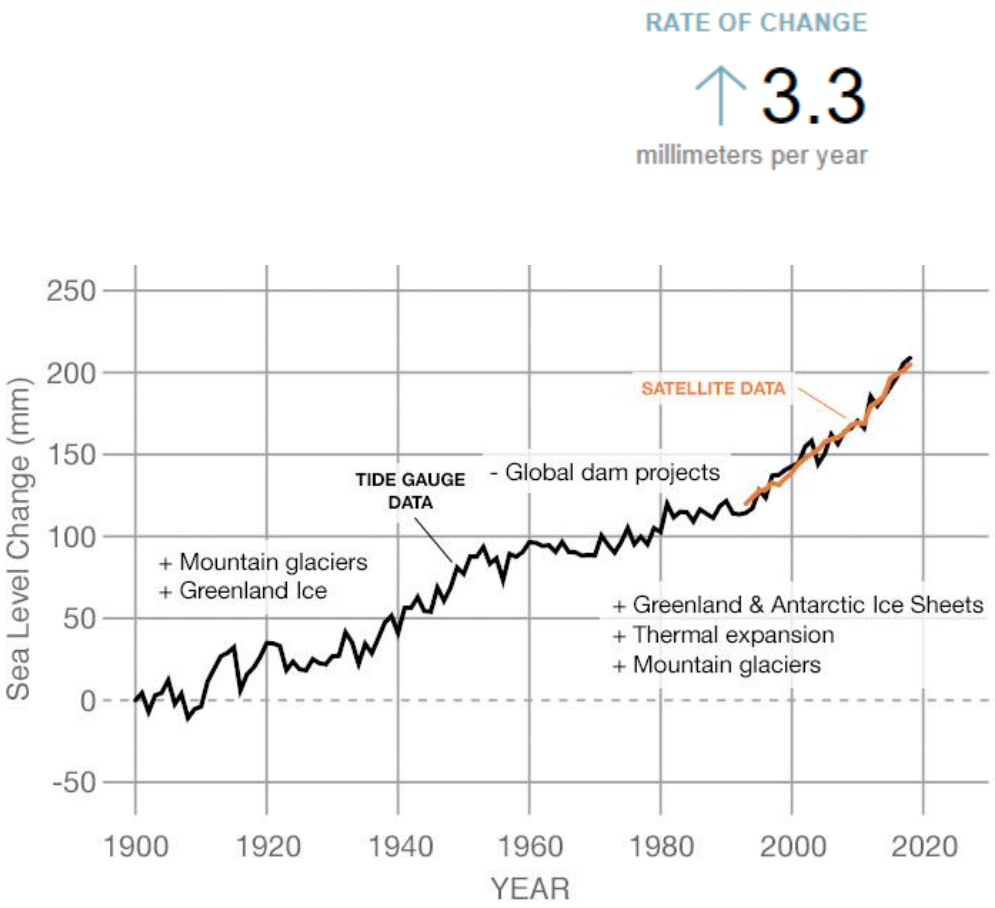


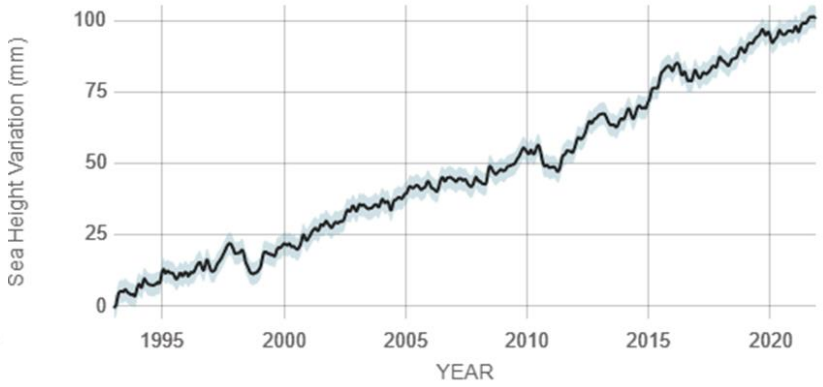
Sea Levels Rising



Source: Dieng et al., 2015

Ground Based Sea Level | 1900-Present

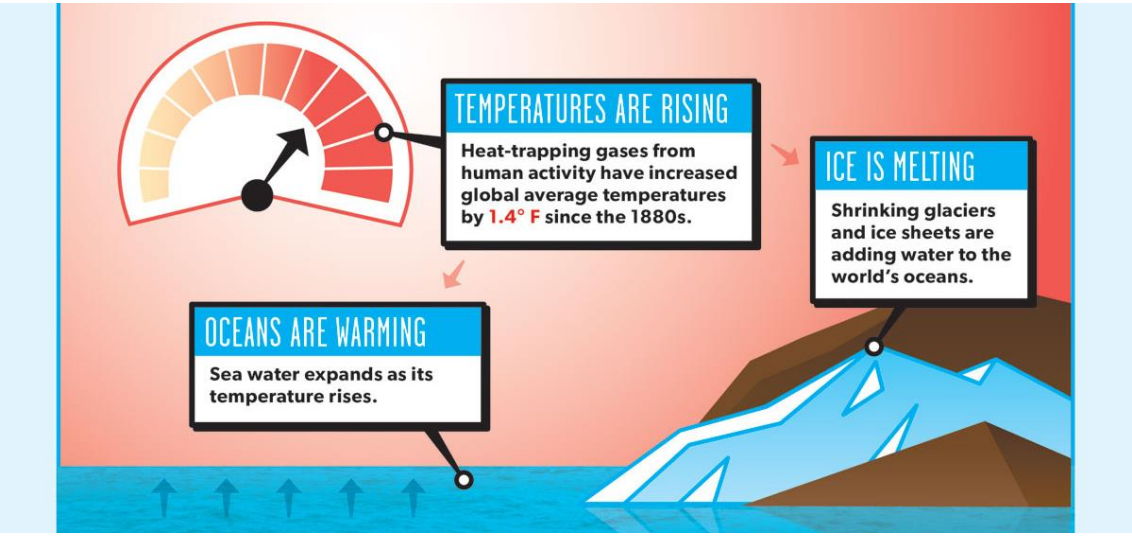


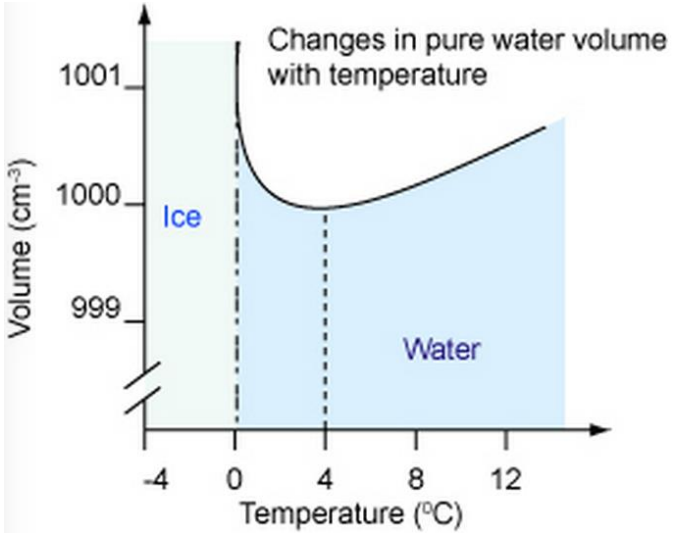


Source: climate.nasa.gov

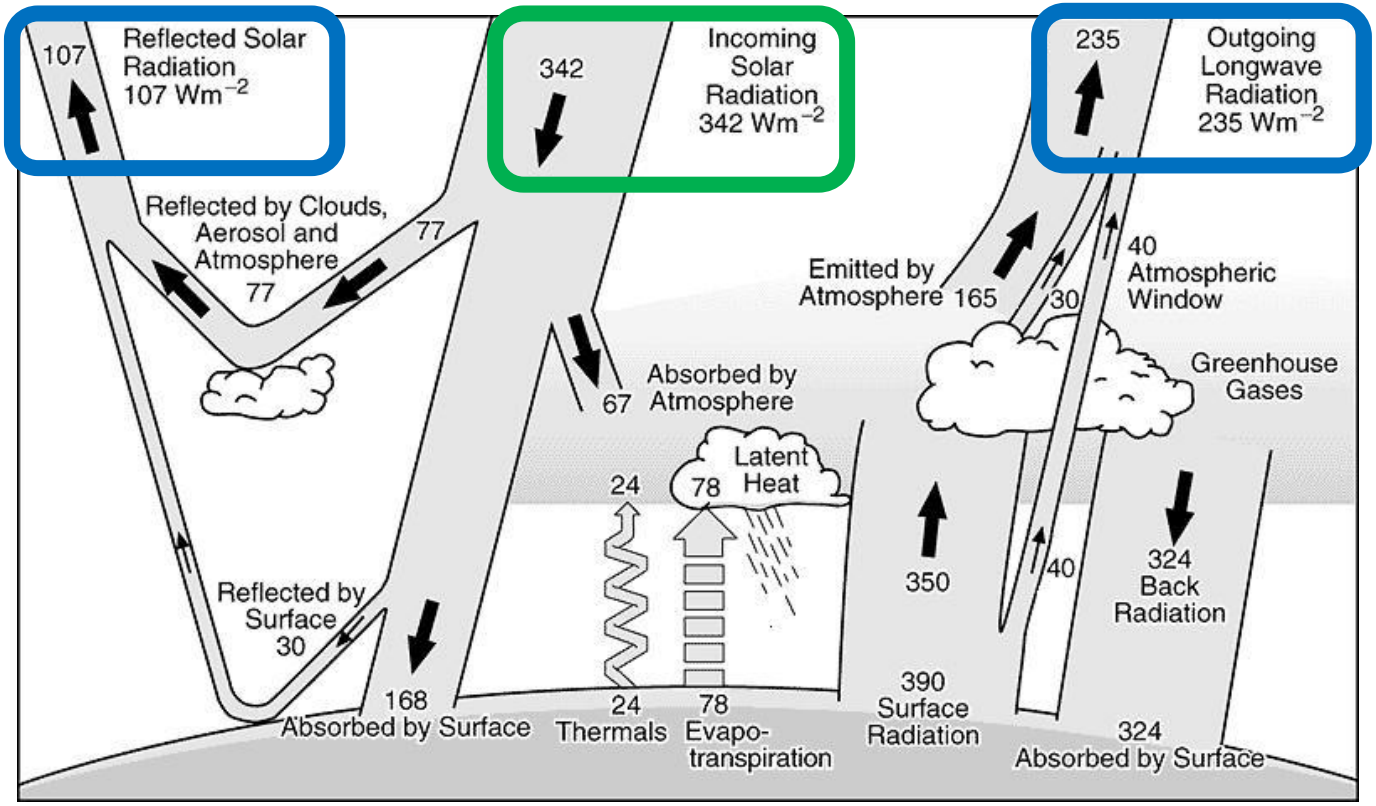
https://climate.nasa.gov/vital-signs/sea-level/

Sea Levels Rising



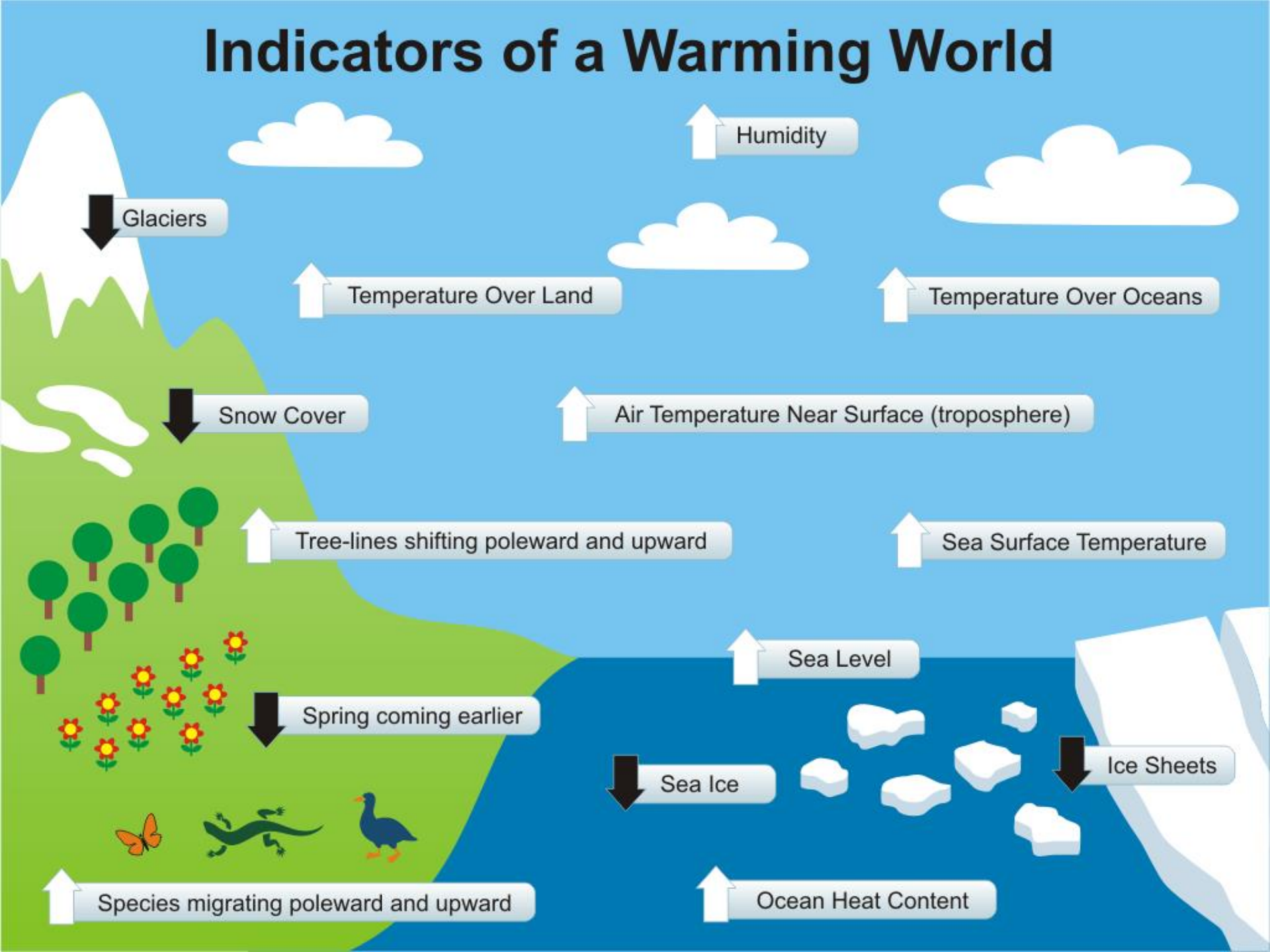


Thermal Equilibrium



(in) **342 W m^{-2} = 342 W m^{-2}** (out)

Indicators of a Warming World



Feedback Loops

Positive Feedback Loop

Warming of Earth leads to events that further warm the Earth

- Melting ice
  - Higher temps decrease ice cover on the planet
  - Decreases albedo
- Melting permafrost
  - Releases methane
- Methane on ocean floor
  - Higher ocean temperatures release frozen methane deposits

Negative Feedback Loop

Warming of Earth leads to events that start to cool the Earth

- More Clouds
  - Higher temps evaporate more water
  - Increase Albedo
- Increased Photosynthesis
  - More CO_2 leads to more plant life that absorbs CO_2
- Renewable Investment
  - Higher temperatures lead to a greater urgency for change

How we know we're causing global warming

Shrinking upper atmosphere

Less heat escaping to space

Cooling upper atmosphere

Rising tropopause

Winter warming faster than summer

More fossil fuel carbon in the air

Less oxygen in the air

Nights warming faster than days

More heat returning to Earth

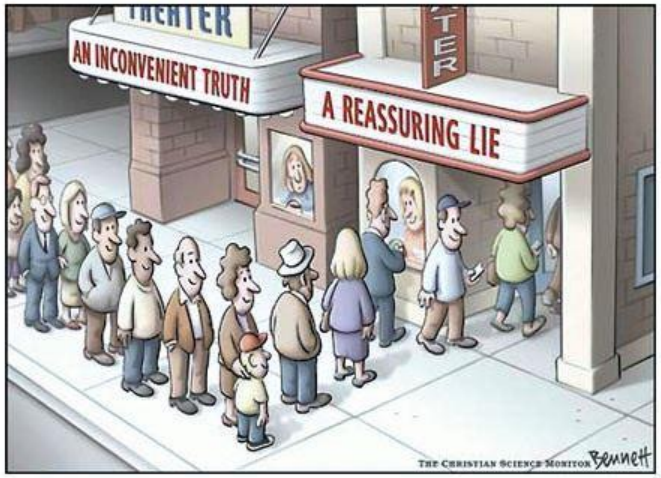
Pattern of ocean warming

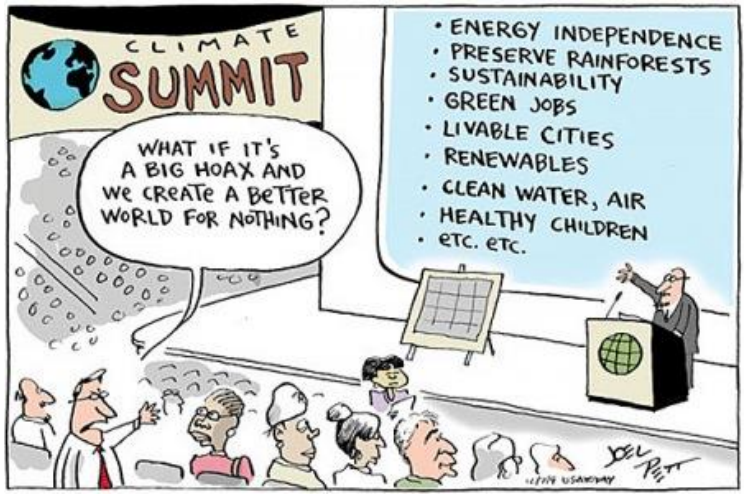
More fossil fuel carbon in trees

More fossil fuel carbon in coral

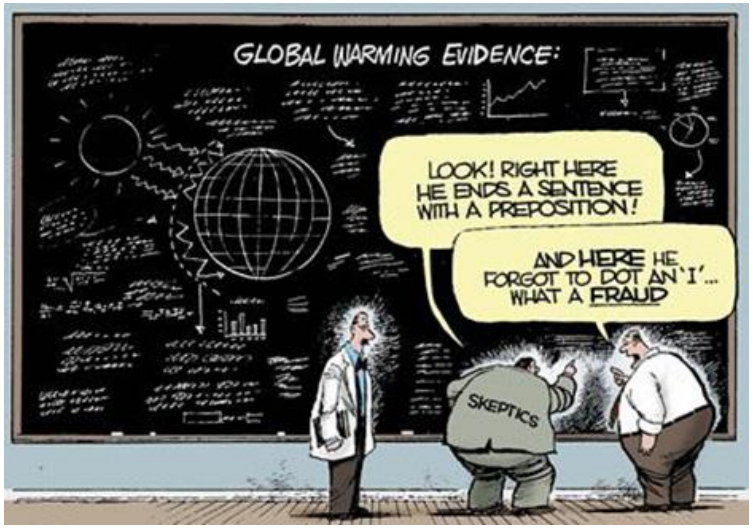
More fossil fuel carbon in ocean

Why Deny?


AN INCONVENIENT TRUTH
A REASSURING LIE
THE CHRISTIAN SCIENCE MONITOR
Bennett


CLIMATE SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.


AN AGE-OLD ARGUMENT
2nd Edition
15th CENTURY
IF the EARTH IS ROUND, then EXPLAIN THIS!
17th CENTURY
IF GRAVITY IS REAL, EXPLAIN THAT!
19th CENTURY
IF EVOLUTION IS REAL, then EXPLAIN THIS!
21st CENTURY
IF GLOBAL WARMING IS REAL, EXPLAIN THAT!


GLOBAL WARMING EVIDENCE:
LOOK! RIGHT HERE HE ENDS A SENTENCE WITH A PREPOSITION!
AND HERE HE FORGOT TO DOT AN 'I'... WHAT A FRAUD
SKEPTICS