This work is supported by generous donations to the American Physical Society (APS) and the Physics Teacher Education Coalition (PhysTEC).

# Understanding the Magnitude of the Climate Crisis

M. J. Wright

We designed a conference for high school and college students to drive interest in physics.

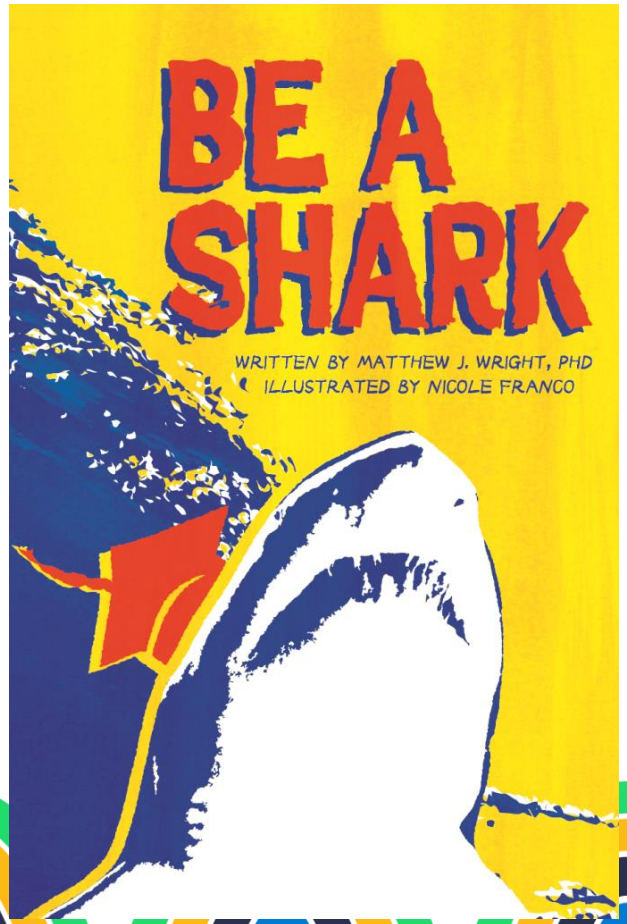
It took place on a Saturday in NYC at City College New York in November 2024.

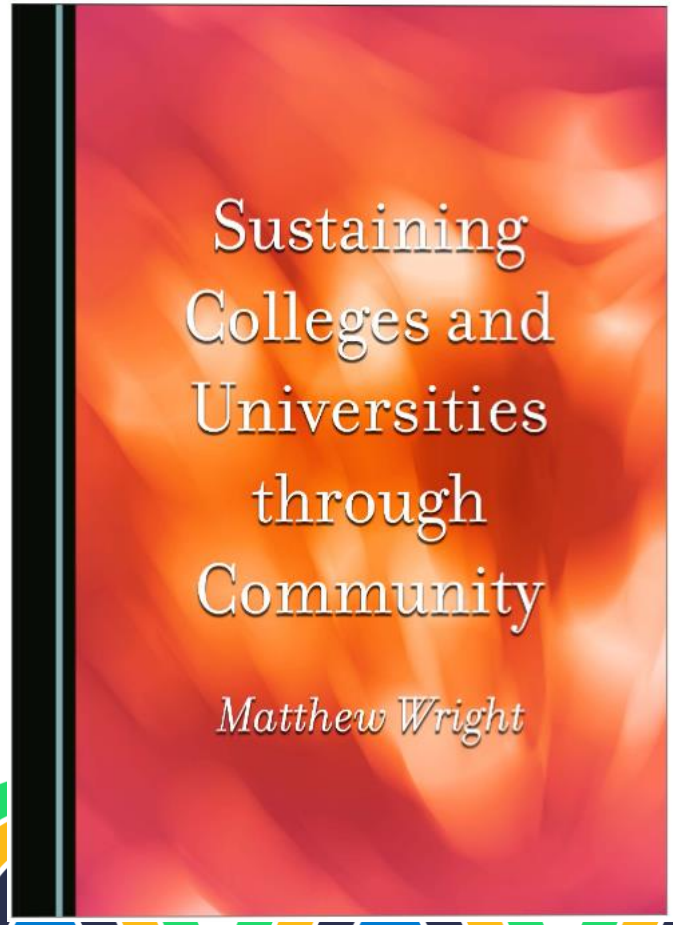
- It’s free
- It’s regional
- It talks about careers
- It’s student focused
- It’s fun
- There was free food!

COSMIC PATHWAYS

# Cosmic Pathways II

# Lots of Exciting Projects



# Adelphi Lab for Kids

- 13+ High schools every year
- Adelphi students practice teaching
- High school students get fun day of science
- Relationship strengthens bonds with community

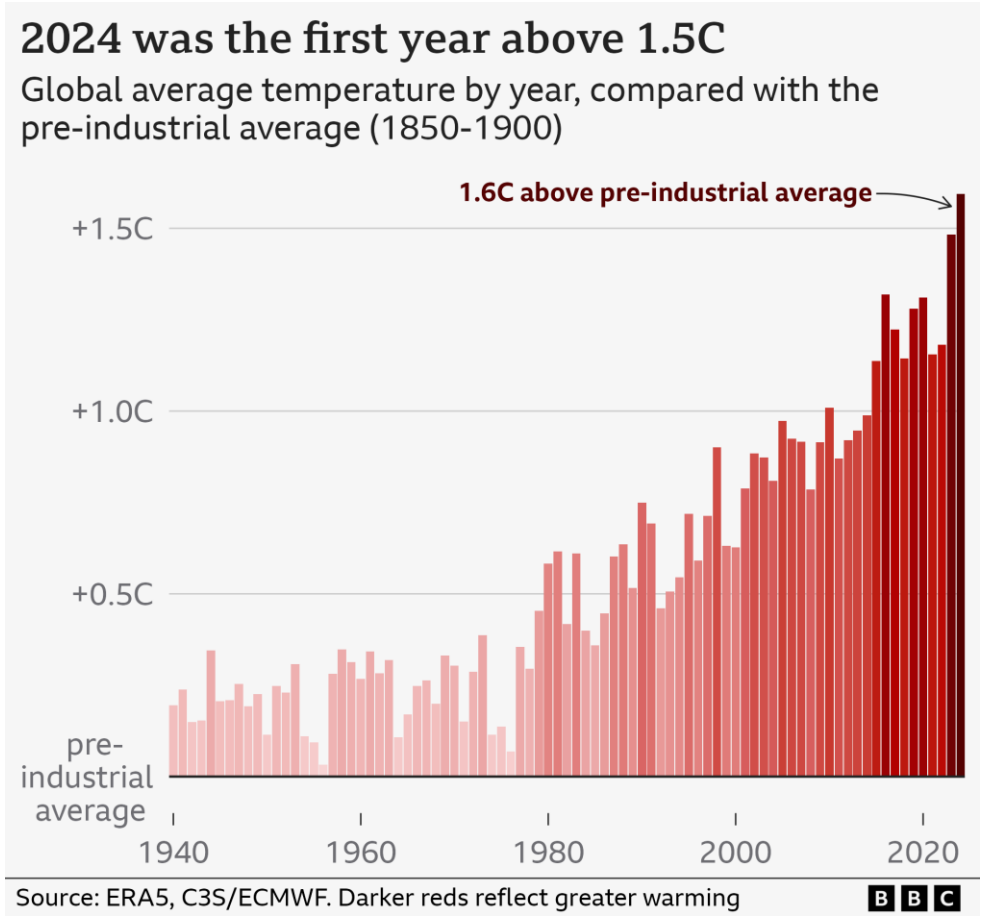
# Current Lab Team

- **Quantum Research Team**
- Dominick Guadagno, Senior Physics Major
- Amanda Bowen, Sophomore Physics Major
- Natalie Ion, North Shore High School Student
- Sara Shiker, North Shore High School Student

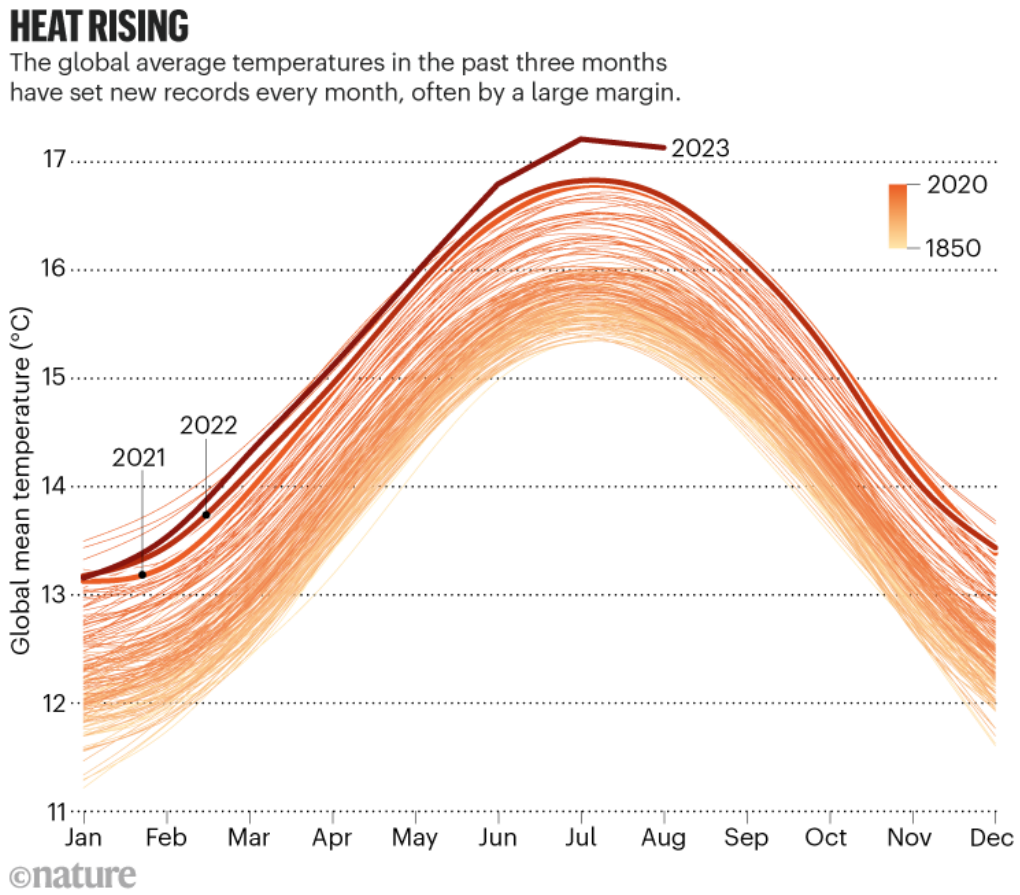
- **Physics Education Team**
- Kylie Goldade, Senior Physics Major
- Alyssa Zambuto, Senior Physics Major

# Temperatures Are Rising

# BBC (and Everyone Else) Reports Temperature Increases



# Temperature is up year round!

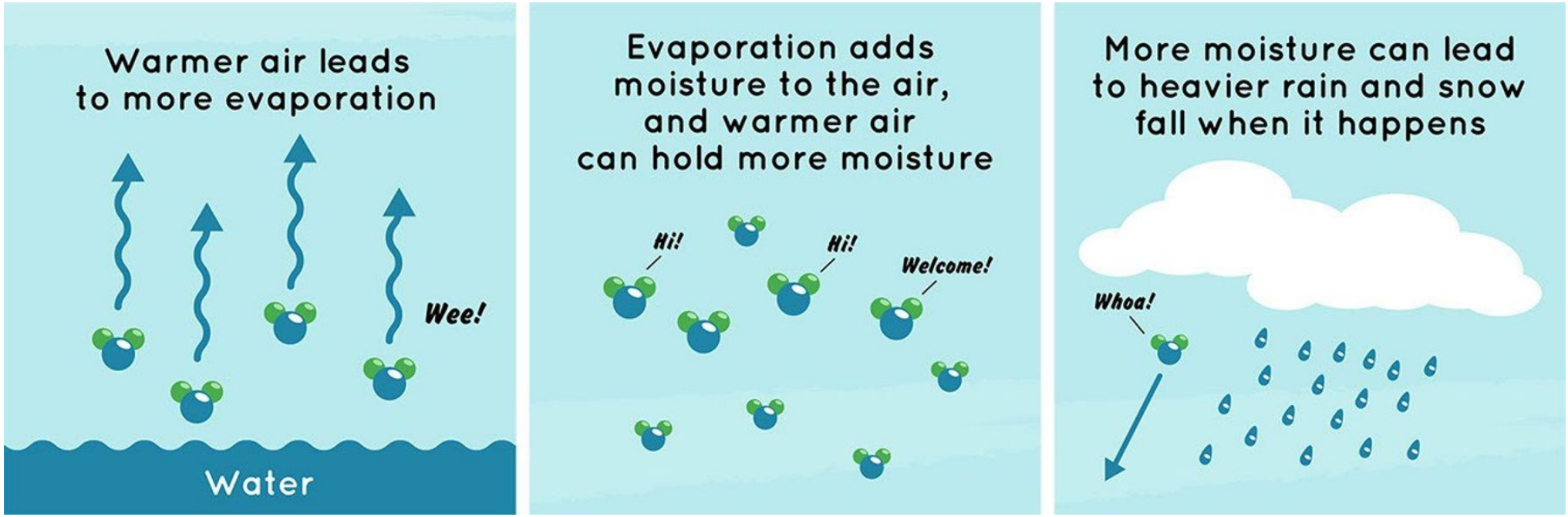


# Increased Temperatures Lead To:

- Sea Level Rise
- Melting Glaciers
- Increased extreme weather
  - Droughts
  - Large rain storms
  - More Intense Hurricanes


https://www.oneearthonechance.com/consequences-of-global-warming.html

# I find the Amount of Rain Surprising



# Climate vs. Weather

- Weather happens on short time scales and is constantly in flux
- Climate happens on longer time scales and is the average multiple days if not years.

# Why Is the Temperature Getting Hot?

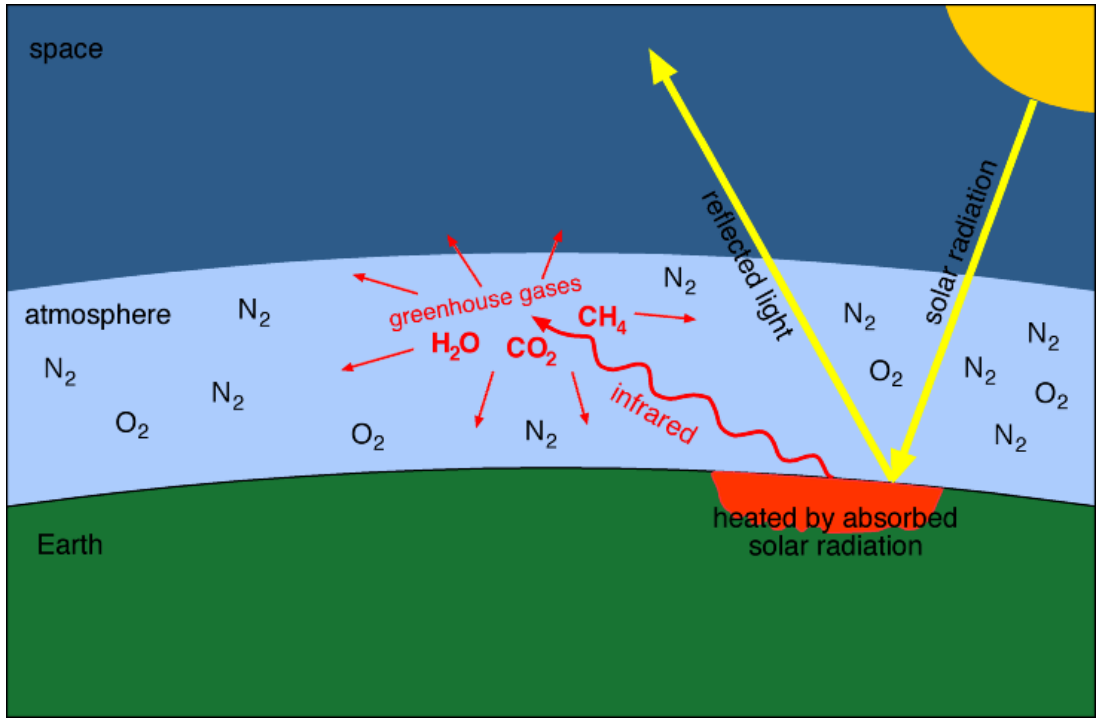



Image from Columbia

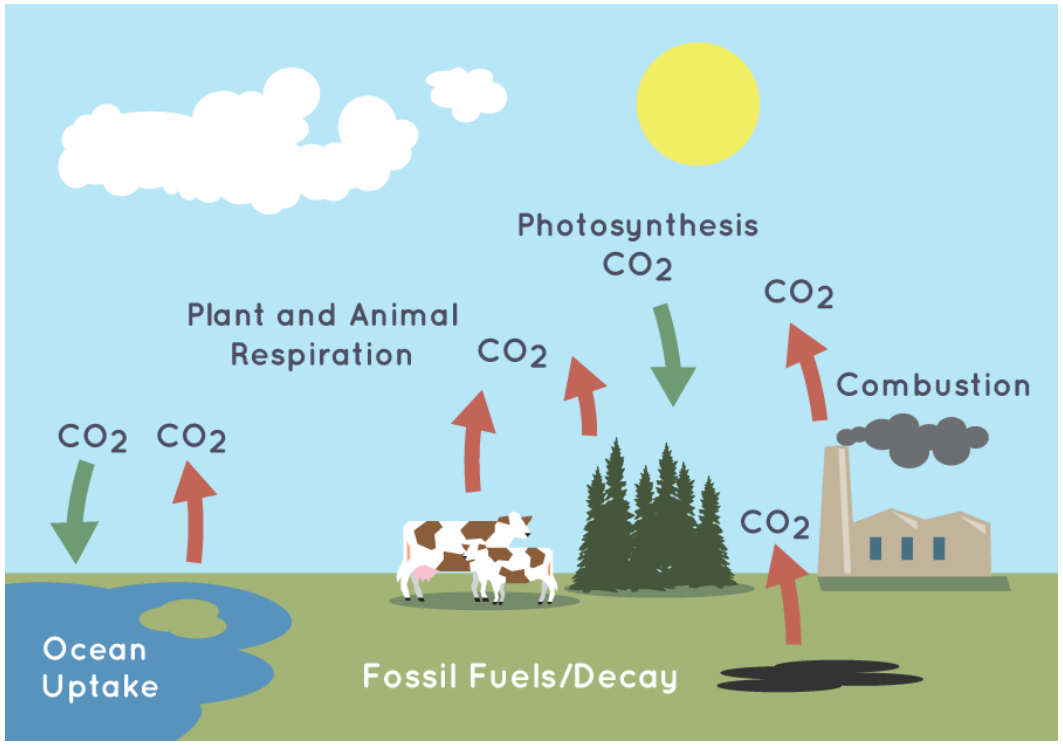
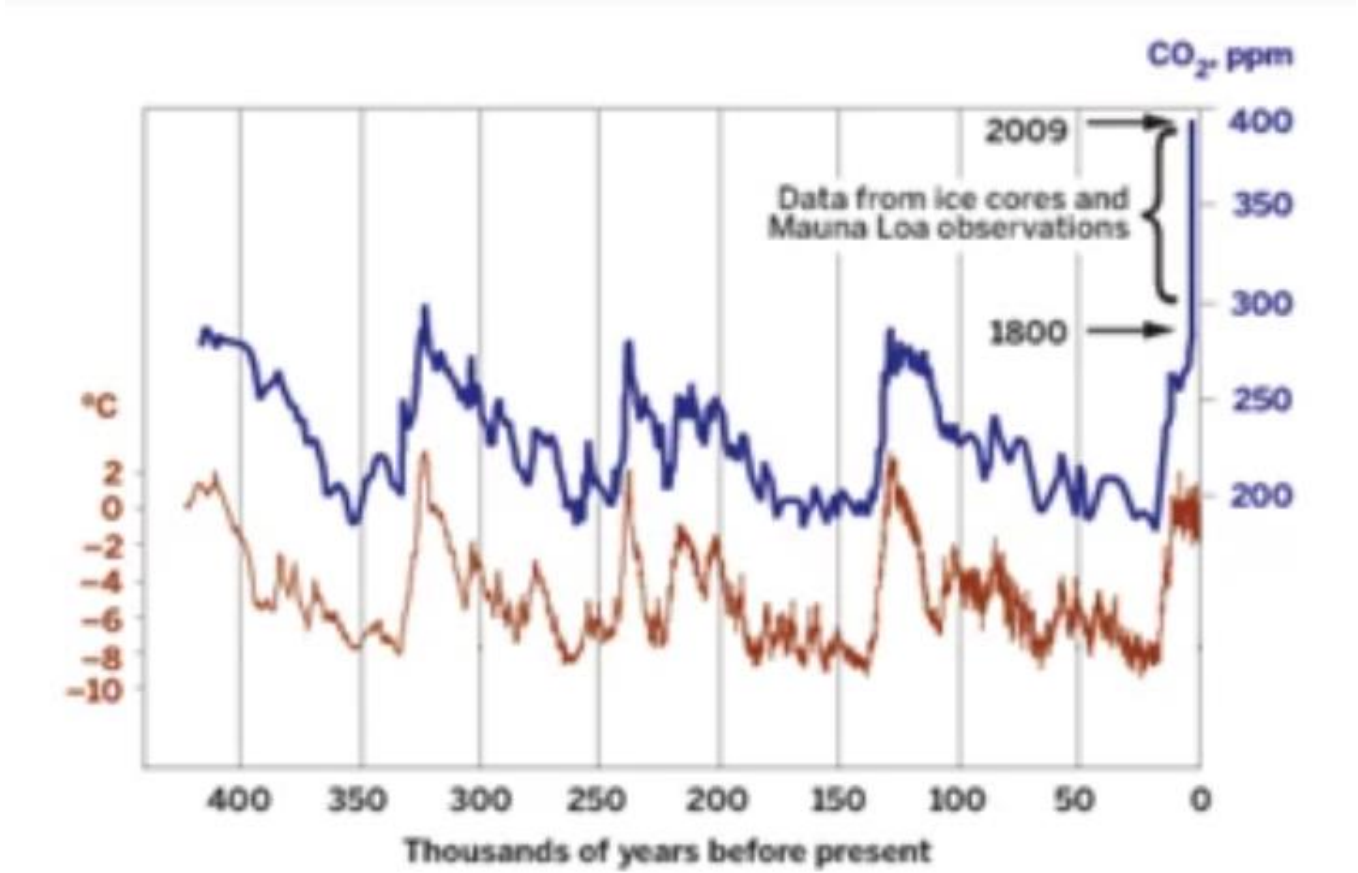
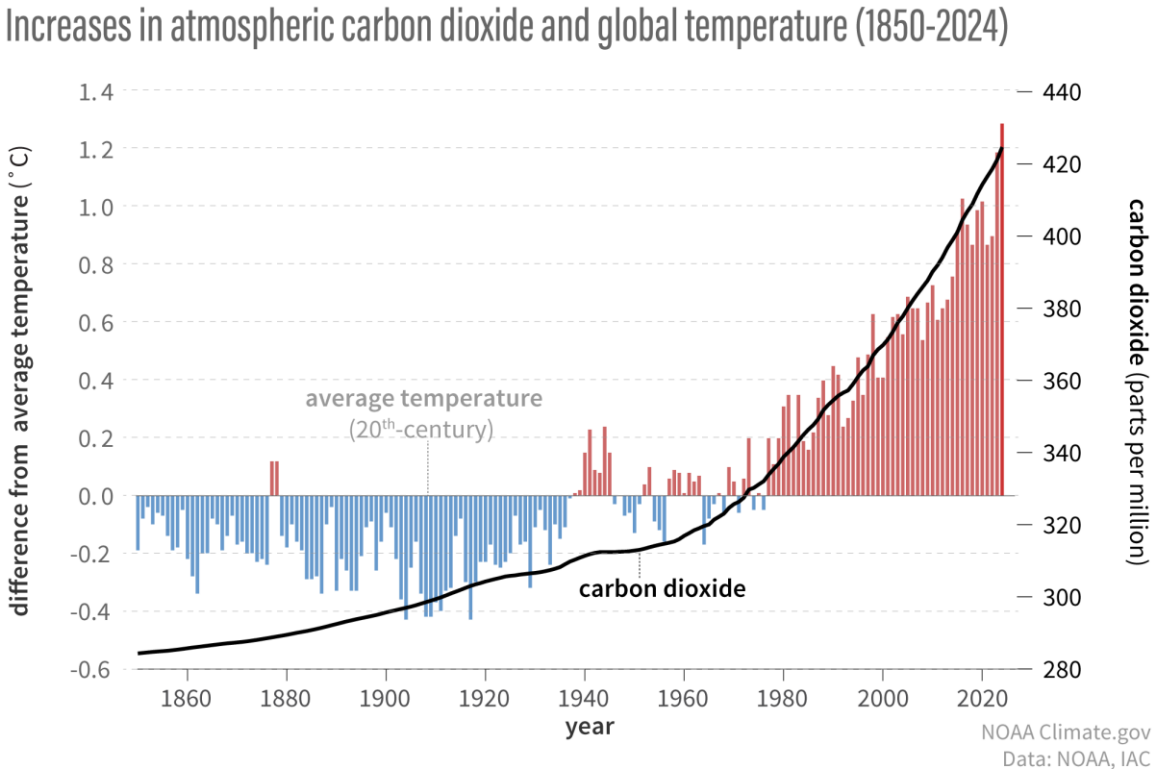



Image from NASA

# Temperature and $CO_2$ are Correlated

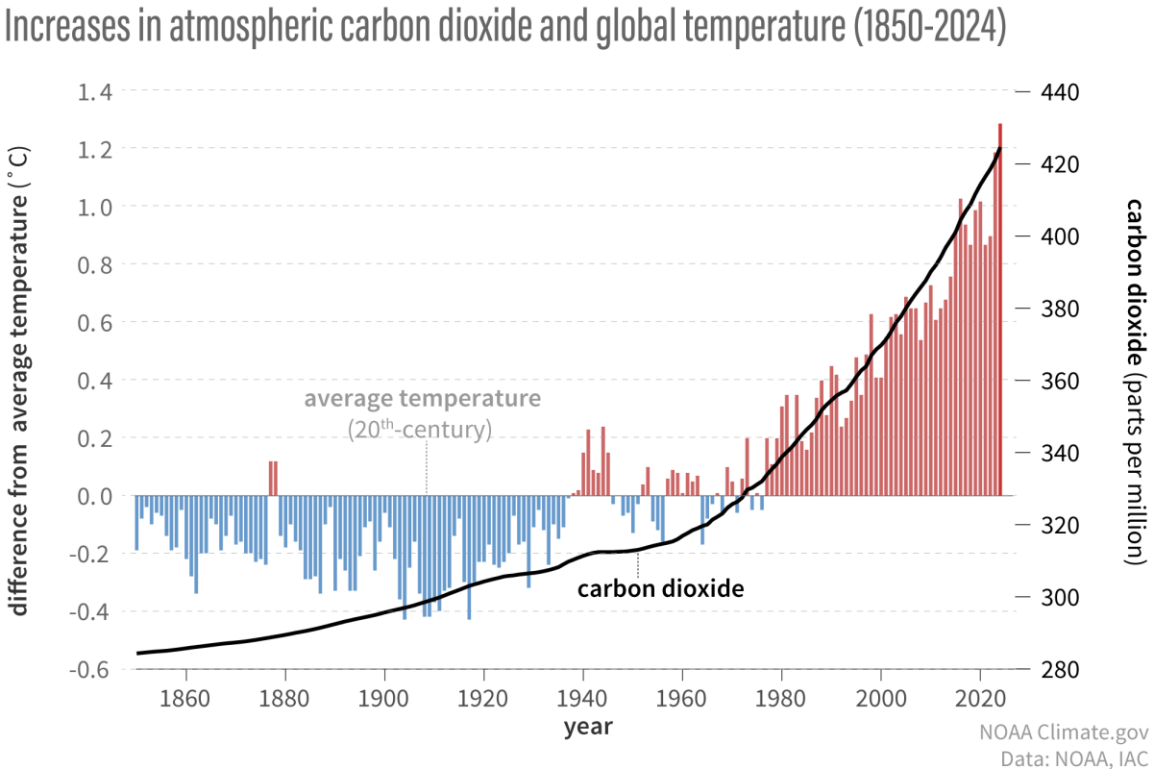


# Expected Sudden Jump In Temperature

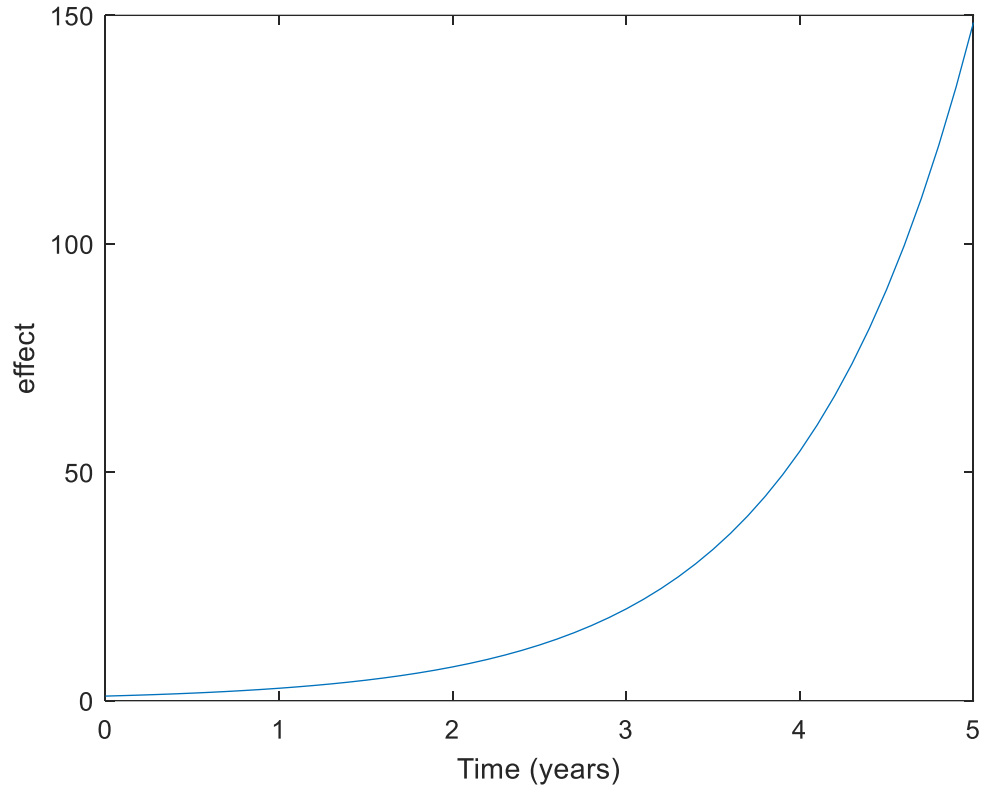


# Activity 1:  System Response Time

- Compare and contrast $CO_2$ and Temperature?
  - At what parts of the curve are they behaving the same?
  - At what parts or the curve are the behaving differently?
  - Can you determine the system response (or lag) time?



# Look Like Exponential Functions



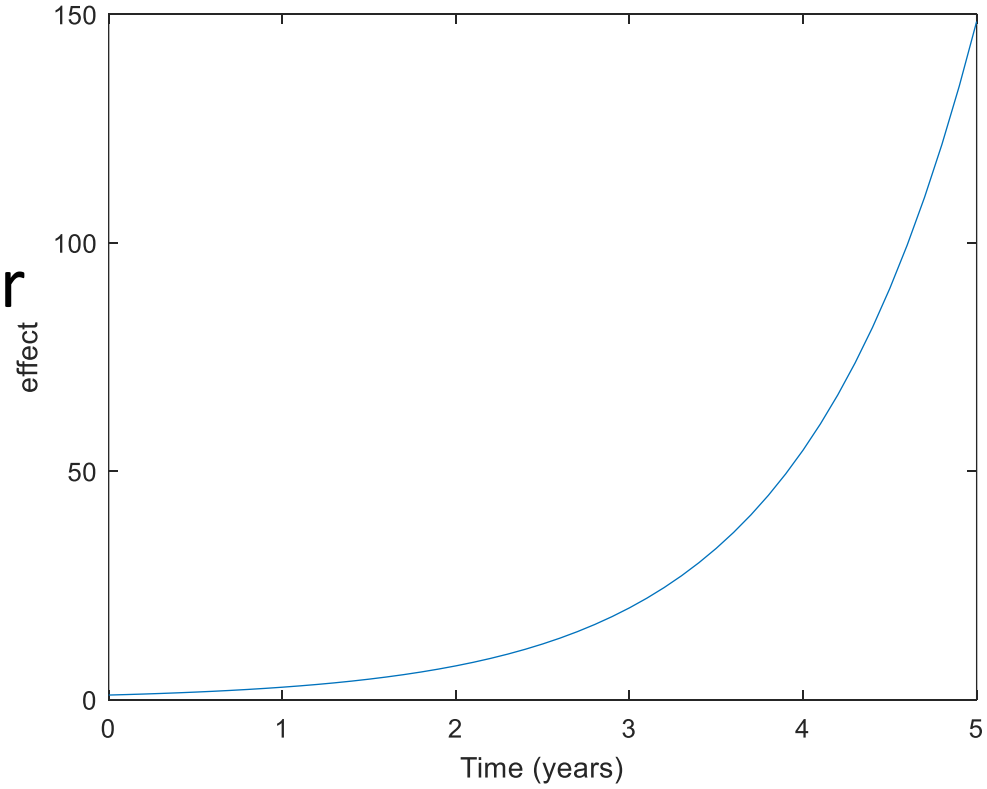

*The Equation Looks Straightforward*

$$f(t) = e^t = 2.7183^t$$

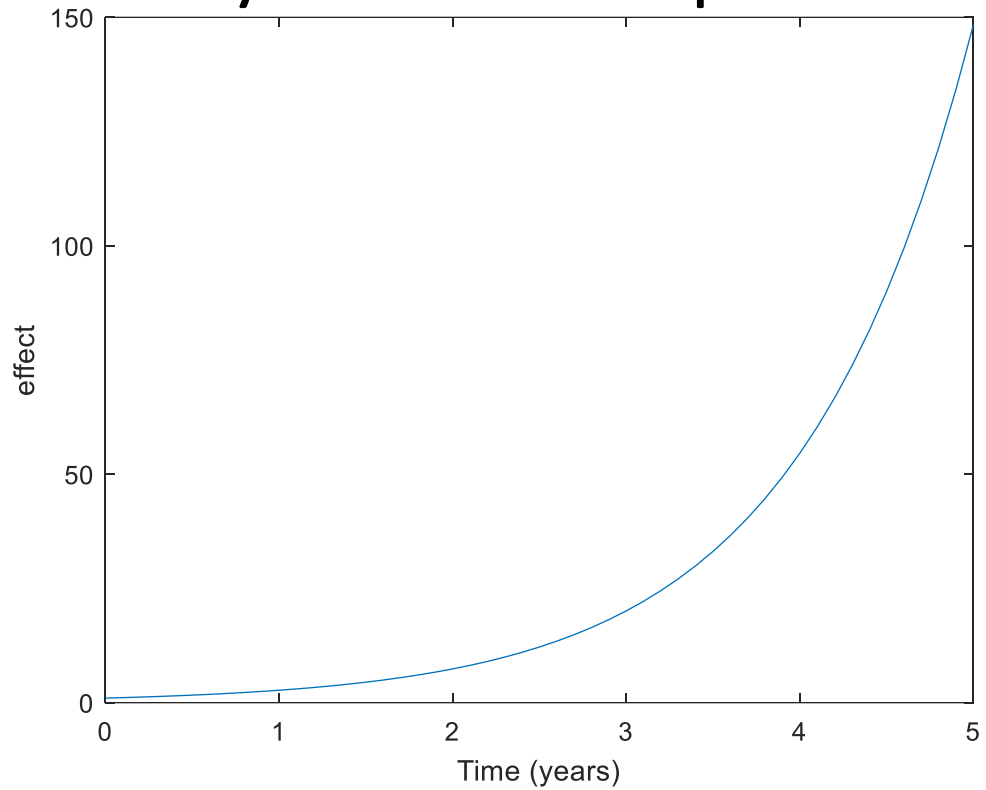
# Activity II: The slope

- Discuss with your peeps how you would find the slope of this curve?

- How much did the effect change from year 1 to 2 and from year 4 to year 5?



# Activity II:  Let's plot the slope




*The  Equation Looks Straightforward*

$$f(t) = e^t = 2.7183^t$$

# Exponential Functions are Weird Like That

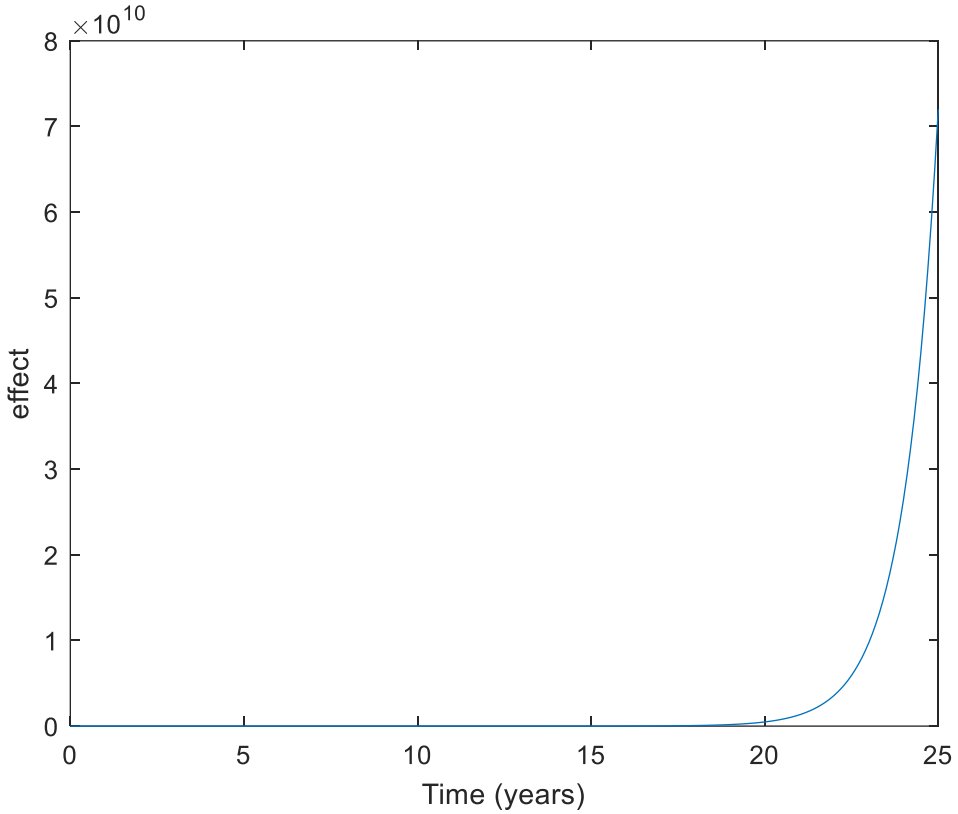
If

$$f(t) = e^t = 2.7183^t$$

Then its slope is also:

$$f(t) = e^t = 2.7183^t$$

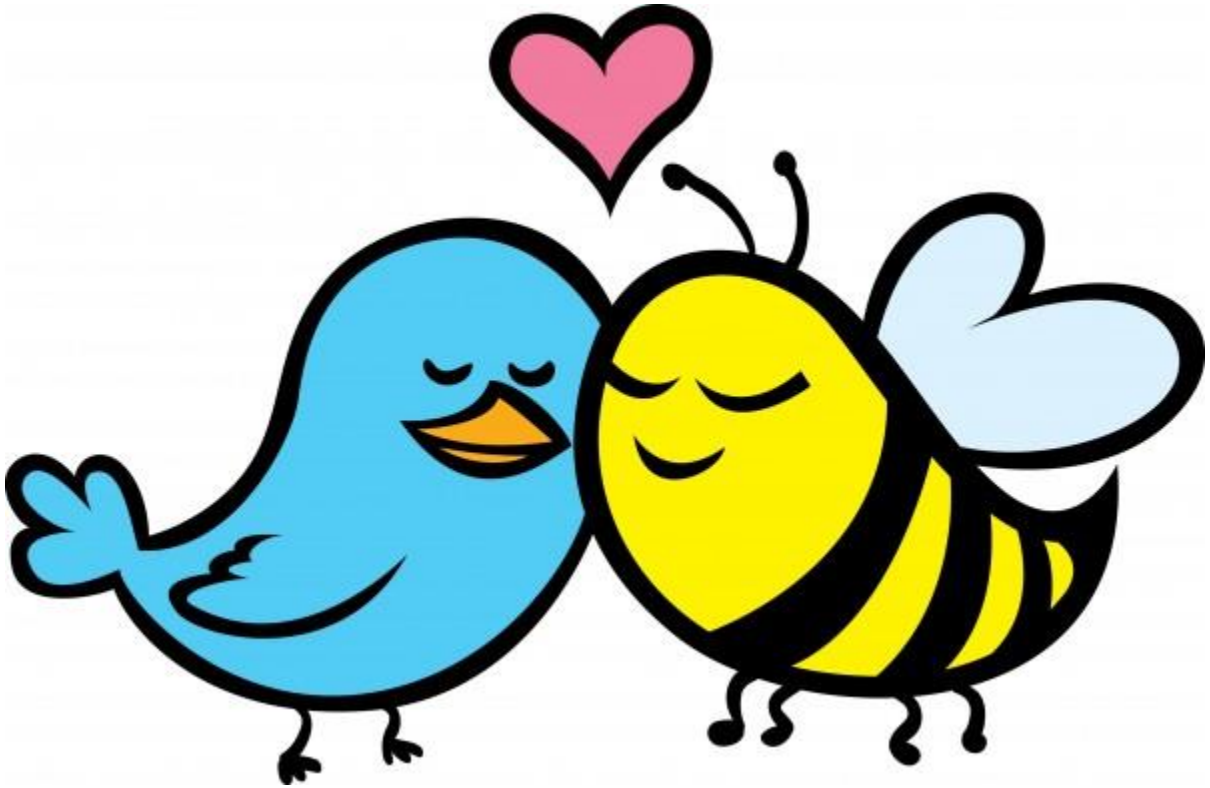
# Look Like Exponential Functions




*The Equation Looks Straightforward*

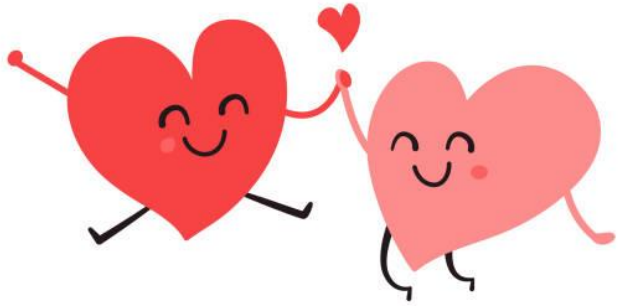
$$f(t) = e^t = 2.7183^t$$

# Think About the Problem From Population Point of View



# Think About the Problem From Population Point of View

- Let's say you have 1000 people → which means 500 families

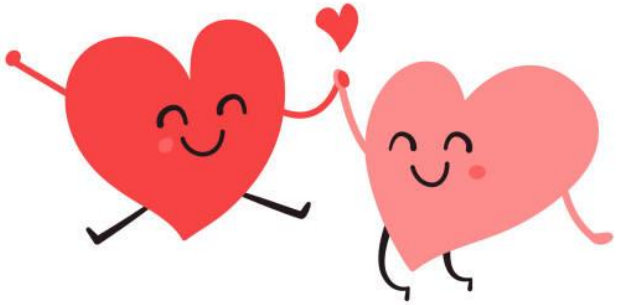


- Each Family has three babies # = 1000 + 3*500 = 2500 people


- Parents die 2500 – 1000 = 1500

# Activity III : What are the numbers of another generation

- Let’s say you have 1500 people → which means 750 families




- Each Family has three babies # =

- Parents die, what's the population

# Now Extend…

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Generation | People | Families | babies | Pop before parents die | After Parents die |
| 2 | 0 | **1,000** | 500 | 1500 | 2500 | 1500 |
| 3 | 1 | 1500 | 750 | 2250 | 3750 | 2250 |
| 4 | 2 | 2250 | 1125 | 3375 | 5625 | 3375 |
| 5 | 3 | 3375 | 1687 | 5061 | 8436 | 5061 |
| 6 | 4 | 5061 | 2530 | 7590 | 12651 | 7590 |
| 7 | 5 | 7590 | 3795 | 11385 | 18975 | 11385 |
| 8 | 6 | 11385 | 5692 | 17076 | 28461 | 17076 |
| 9 | 7 | 17076 | 8538 | 25614 | 42690 | 25614 |
| 10 | 8 | 25614 | 12807 | 38421 | 64035 | 38421 |
| 11 | 9 | 38421 | 19210 | 57630 | 96051 | 57630 |
| 12 | 10 | 57630 | 28815 | 86445 | 144075 | **86,445** |
| 13 | | | | | | |
| 14 | | 10 generations is like 300 years | | | | |

# Understanding the True Magnitude of Climate Change

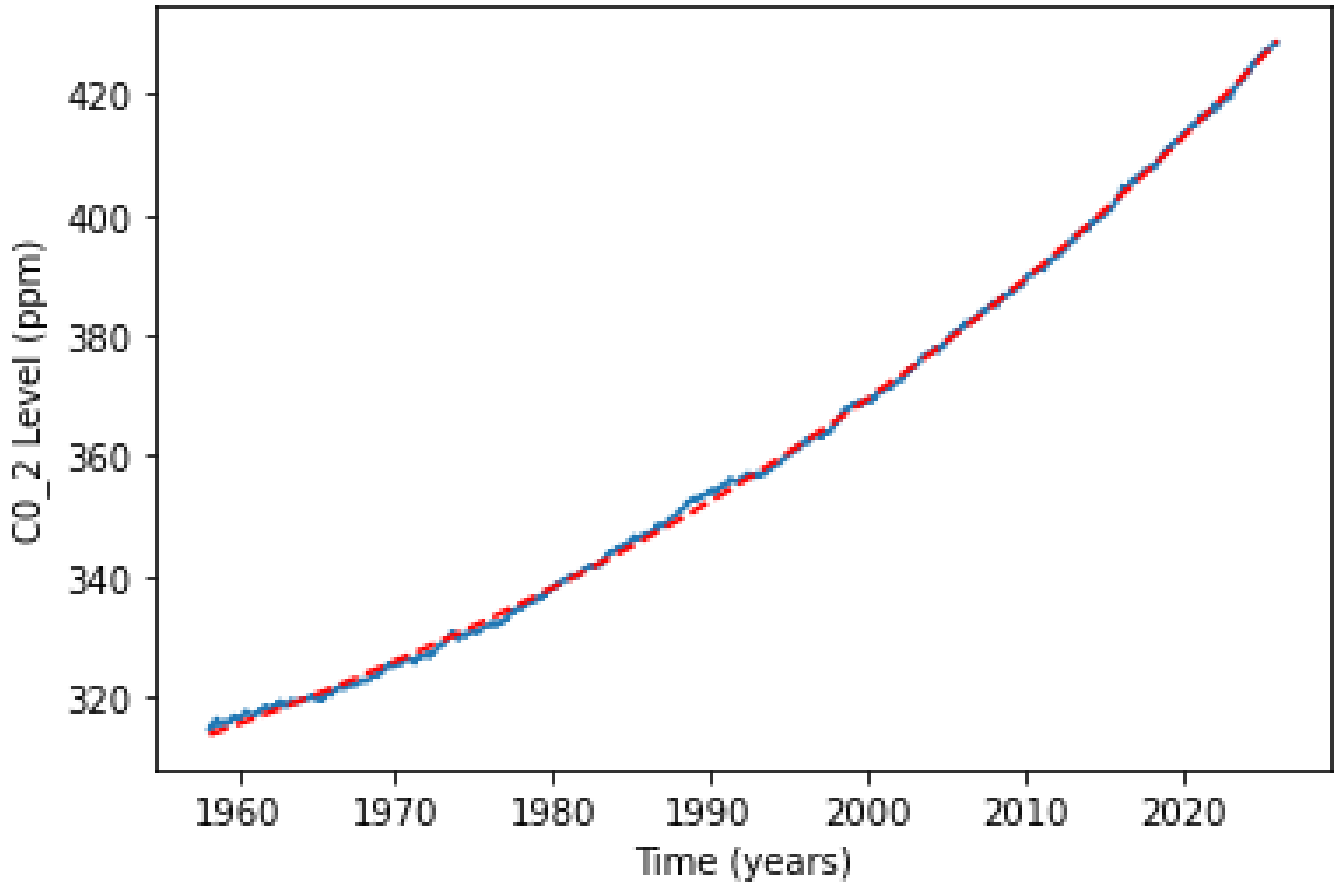
- There is roughly a 50 year lag between $CO_2$ entry and Temperature Effect
- Temperature has already increased exponentially more than 1.6C (We already feel the impacts)
- We are expecting a continued exponential rise to temperature that we have little control of
- World population is still increasing and so carbon usage
- Small increases (due to solar electricity generation, green cars, etc) may make a dent, but we need major change.

# Thanos

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Generation | People | Families | babies | Pop before parents die | After Parents die |
| 2 | 0 | **1,000** | 500 | 1500 | 2500 | 1500 |
| 3 | 1 | 1500 | 750 | 2250 | 3750 | 2250 |
| 4 | 2 | 2250 | 1125 | 3375 | 5625 | 3375 |
| 5 | 3 | 3375 | 1687 | 5061 | 8436 | 5061 |
| 6 | 4 | 5061 | 2530 | 7590 | 12651 | 7590 |
| 7 | 5 | **3,795** | 1897 | 5691 | 9486 | 5691 |
| 8 | 6 | 5691 | 2845 | 8535 | 14226 | 8535 |
| 9 | 7 | 8535 | 4267 | 12801 | 21336 | 12801 |
| 10 | 8 | 12801 | 6400 | 19200 | 32001 | 19200 |
| 11 | 9 | 19200 | 9600 | 28800 | 48000 | 28800 |
| 12 | 10 | 28800 | 14400 | 43200 | 72000 | **43,200** |
| 13 | | | | | | |
| 14 | | 10 generations is like 300 years | | | | |

# Summary of Effects

- Is $CO_2$ exponential?




Data from Mauna Loa Observatory (MLO

# Summary of Effects

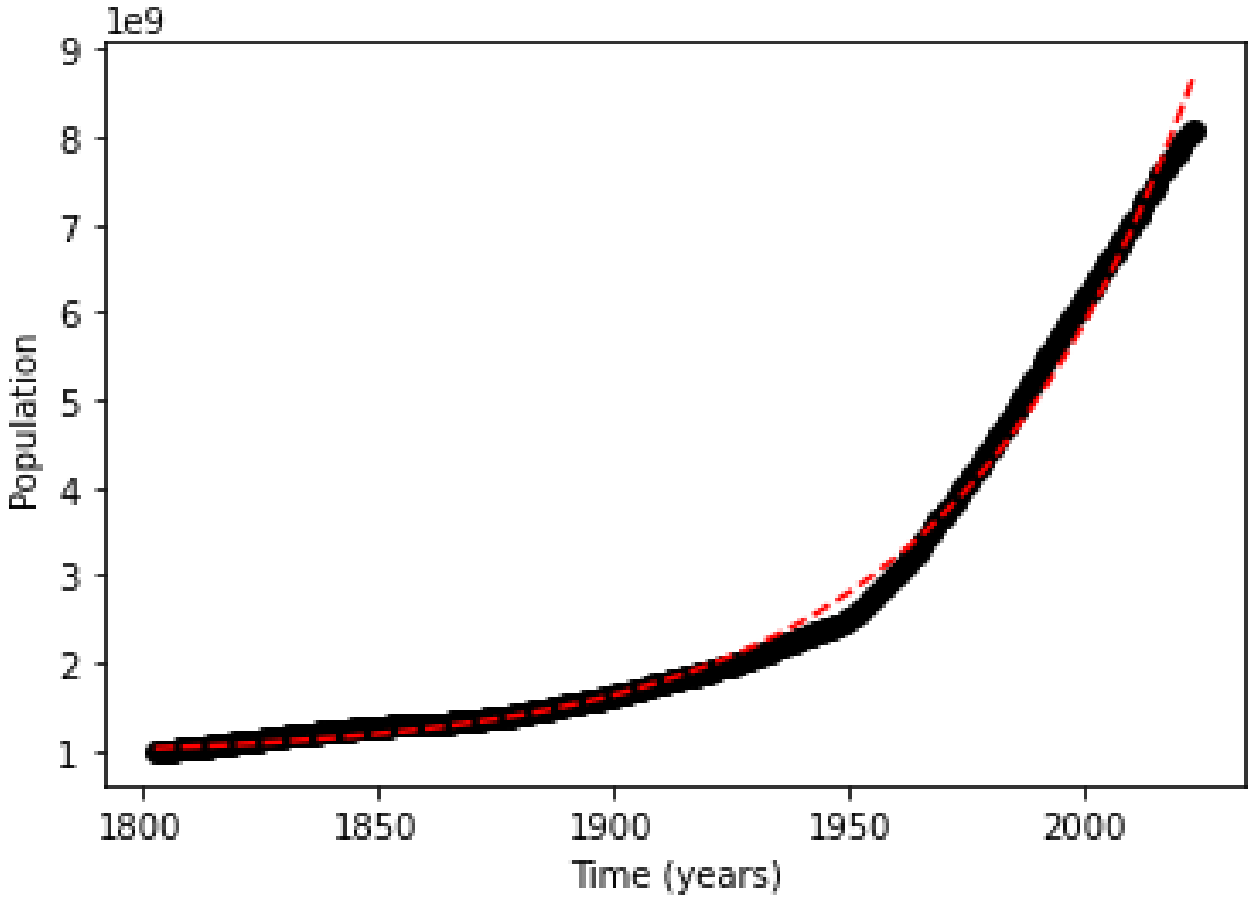
Is the population exponential?

No, growth rate is slowing down

Especially in developed countries

But the jury is still out

Data from Our World in Data



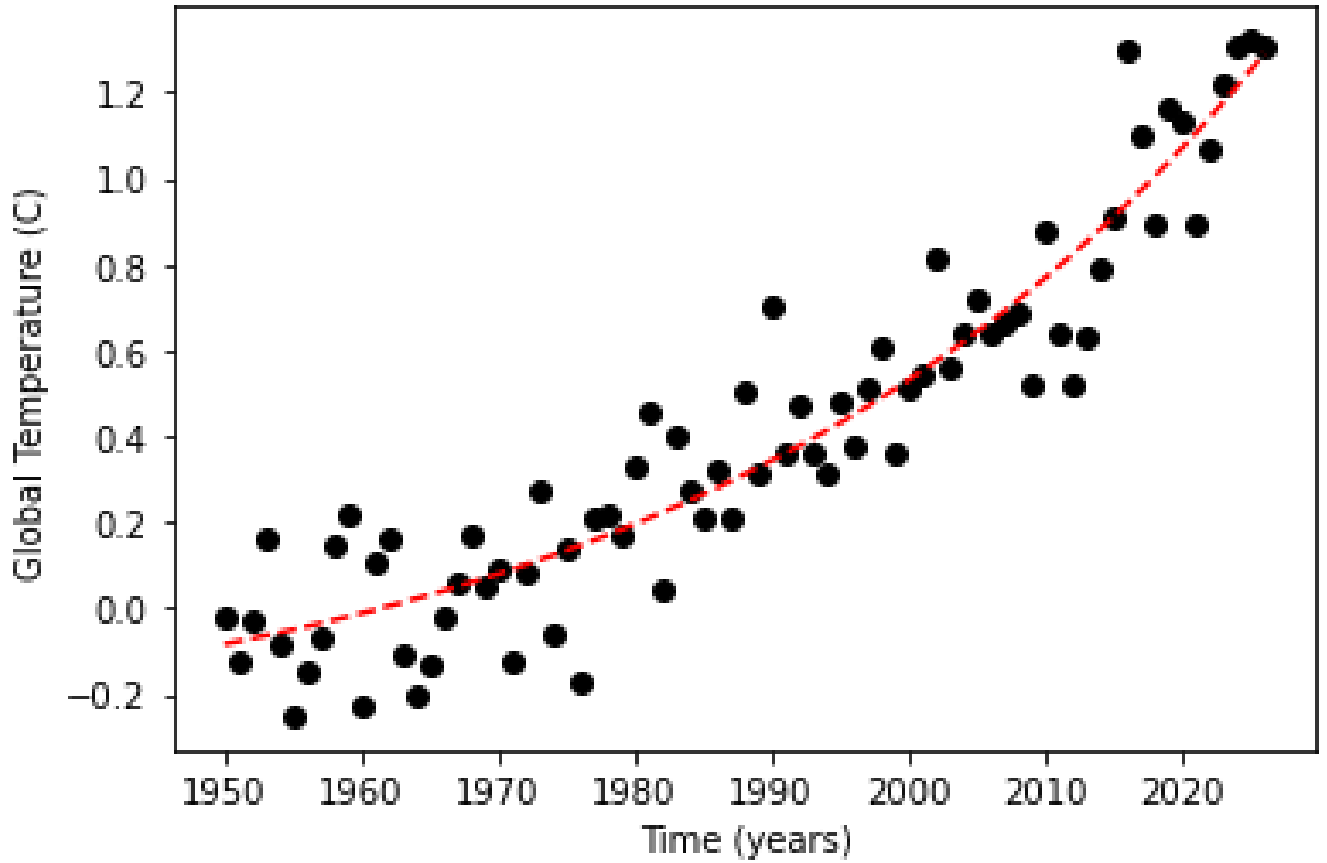
# Global Temperature

Is the Temperature exponential?

Likely is exponential.

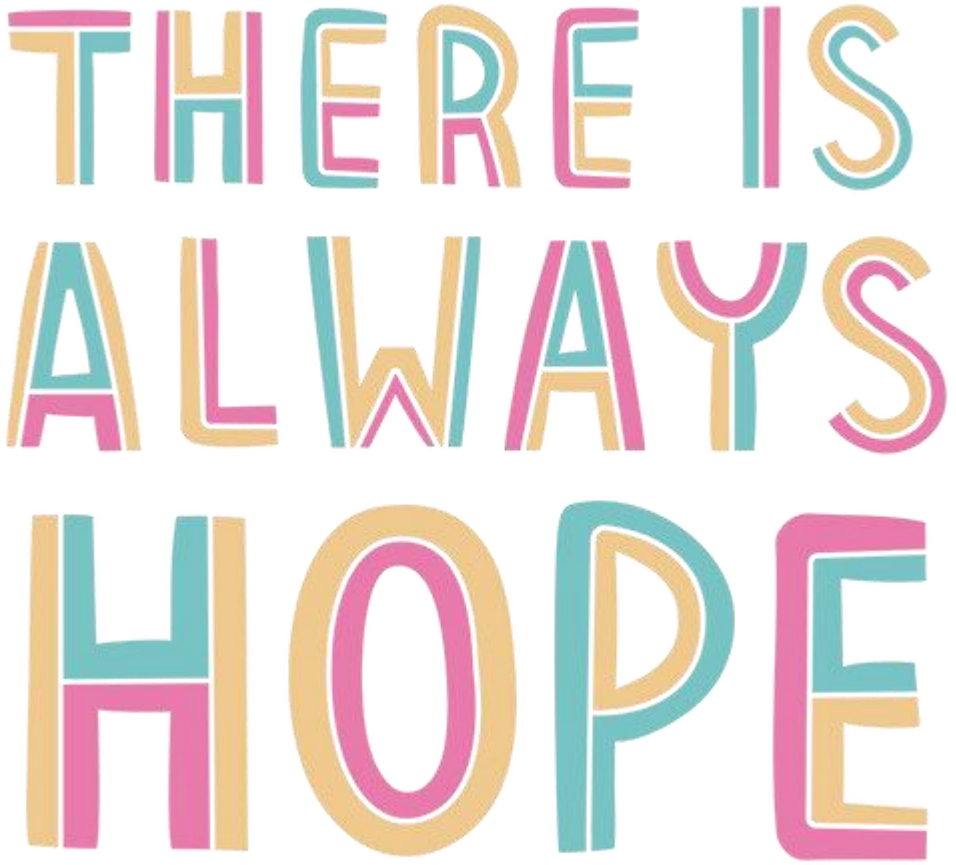
Jury Still out

Depends on $CO_2$ and population



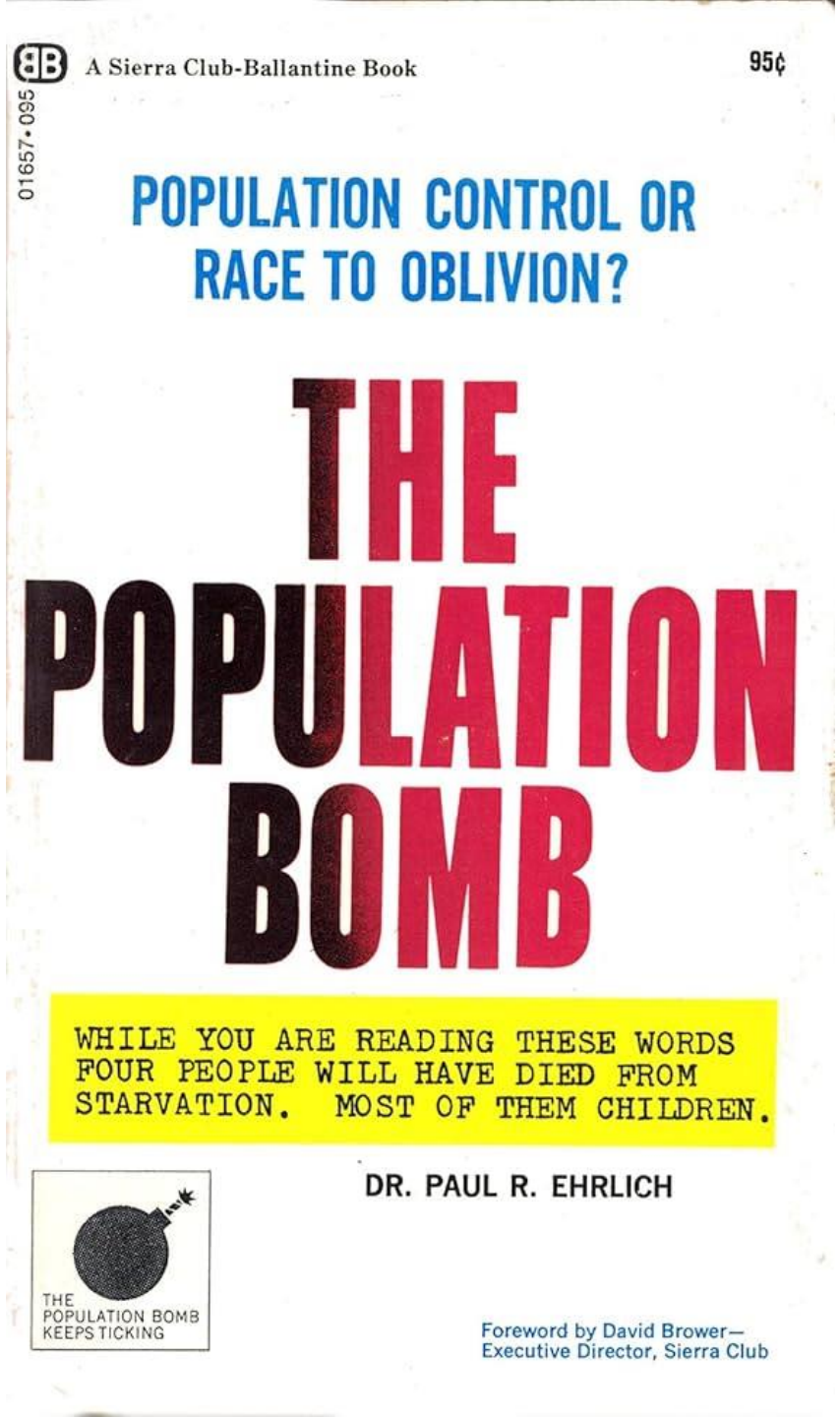

Data from NOAA based on pre-industrial Temperature average

# Is there any hope?

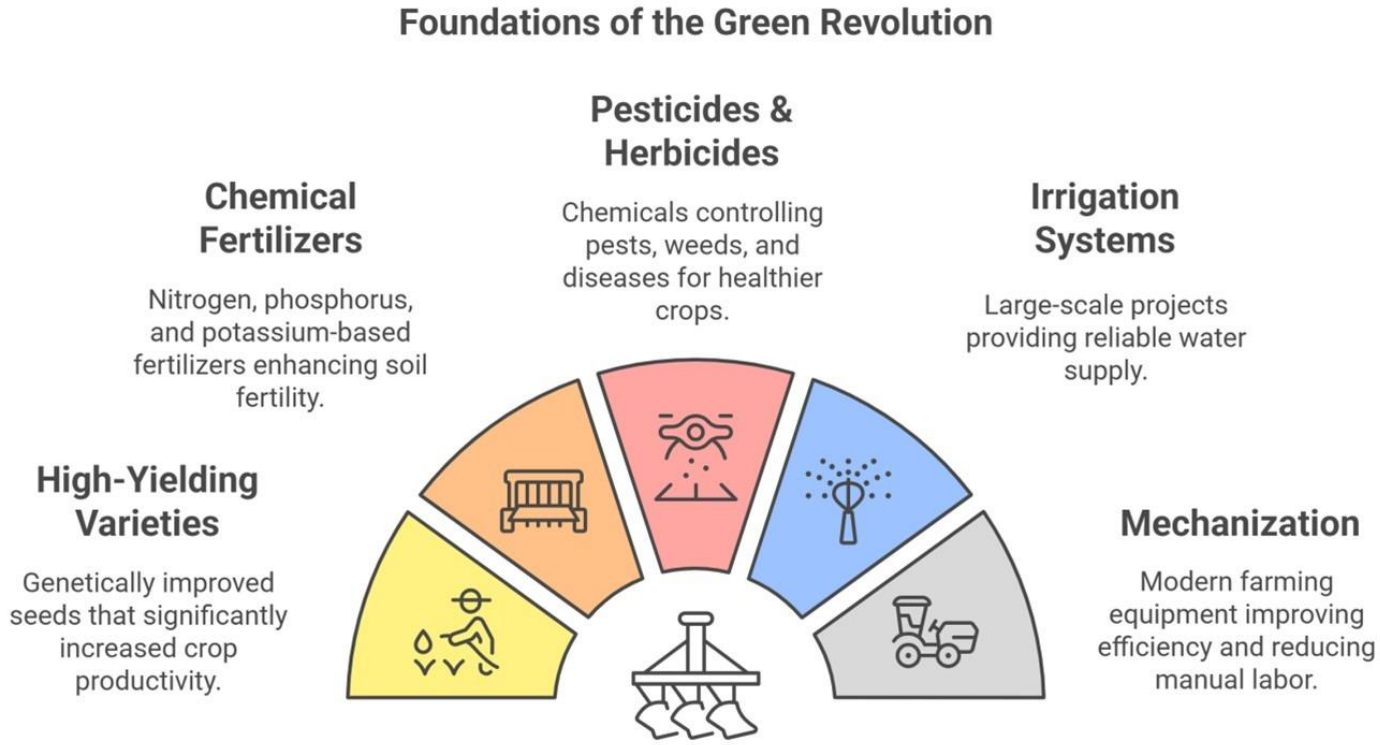


# Story Time

- The Population Bomb (1968)
- Author Looked at Growth Rate, estimated a world with 8 billion people.
- Estimated the world's ability to grow food
- Determined it was impossible to feed that many people



# The Solution (for better or worse) Green Revolution



# We must invest in technology

- We must invest in ALL fundamental sciences (its not linear)
- Develop New Technologies:
  - Renewable Energy
  - Carbon Capture
  - Optimization
  - sustainable agriculture
- Culture Change