

# ATOC 1060-001, Spring 2021

## Our Changing Environment



# Thursday, January 14, 2021

1. Welcome to ATOC 1060-001

2. The syllabus can be found on Canvas, and an unofficial course website

<http://atoc.colorado.edu/~toohey/ATOC1060-S2021.html>

3. Announcements

4. Logistics

- Remote, synchronous lectures Thursdays
- Asynchronous with Tuesday Open House
- Four exams, all equal length, grade based on best 3 of 4
- Exams (55%), Quizzes (20%), Homework (20%), Participation (10%), 90/80/70/60 A-/B-/C-/D
- Set up iClicker Cloud

5. Textbook (reading assigned every week, pages listed in syllabus, asynchronous assessment – e.g., quiz – typically Wednesday

# iClicker Cloud setup

Register for an account at iClicker Cloud

Search “University of Colorado Boulder”

“Our Changing Environment”

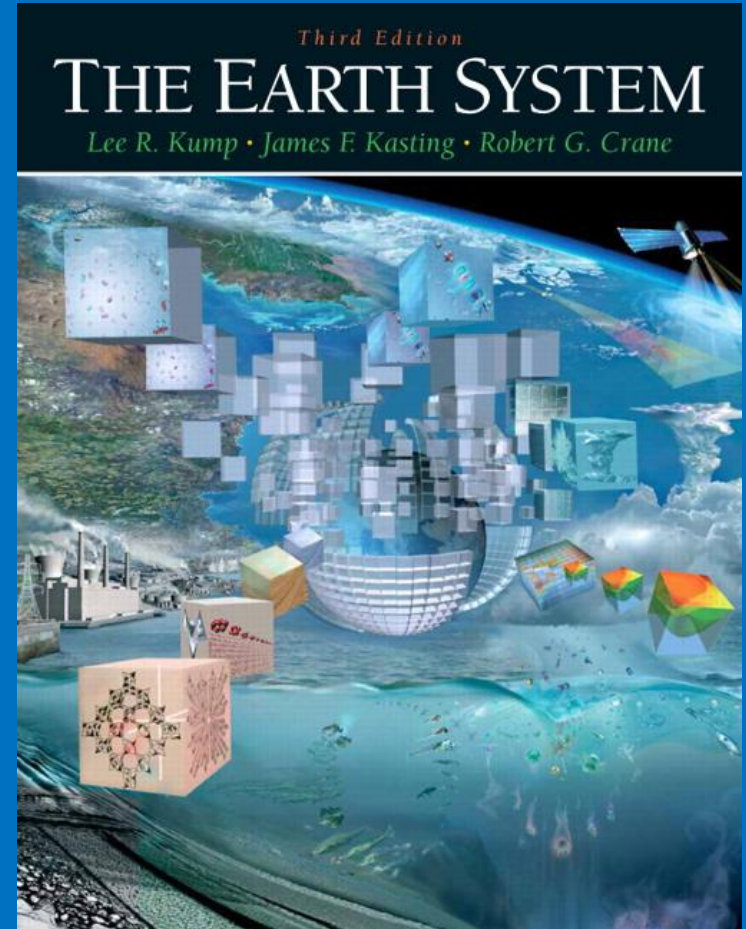
“Darin Toohey”

“Spring 2021”

“ATOC 1060-001”

# The Book

- The Earth System, 3Ed, Lee Kump, James Kasting, and Robert Crane (Prentice Hall, 2010) is the official text.
- We will discuss social aspects of the material. Additional reading material will be provided on-line as pdf files, videos, or web links.
- Chapters will be uploaded into a Canvas Module called “Reading”



Weather or Climate? Climate or Weather?

Lessons from the past – the ozone hole (an example of a “tipping point”)

Measuring change – a quick exercise (we’ll look at results later...)

- Why so much talk about urgent action regarding climate change?
- Please read Chapter 1 from “The Earth System” for Week 1 (there will be a quiz “Chapter 1 Review” due Wednesday, January 20)

## Why are we concerned about environmental change?

As ATOC, our focus is on climate, but it is important to recognize that there are many ways that mankind influences the environment, including pollution of local and regional air and water, land-use changes, competition for resources, and wars.

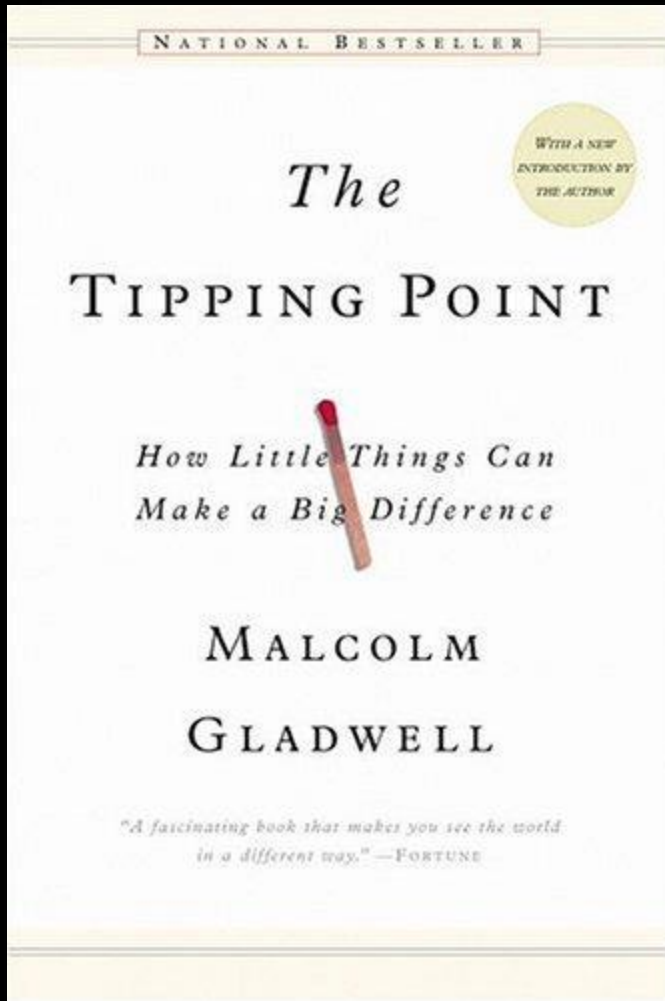
## Weather or Climate? Climate or Weather?

Lessons from the past – the ozone hole (an example of a “tipping point”)

Measuring change – a quick exercise (we’ll look at results later...)

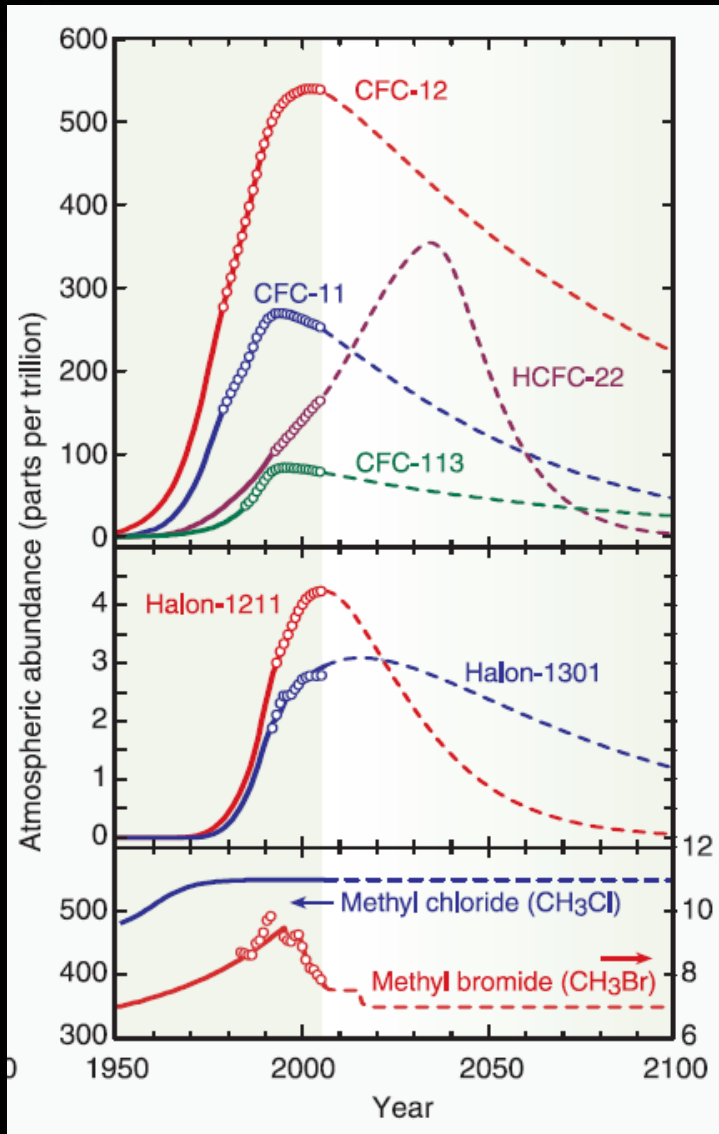
- Why so much talk about urgent action regarding climate change?
- Please read Chapter 1 from “The Earth System” for Week 1 (there will be a quiz “Chapter 1 Review” due Wednesday, January 20)

# What is a tipping point?



The word "Tipping Point", for example, comes from the world of epidemiology. It's the name given to that moment in an epidemic when a virus reaches critical mass. It's the boiling point. It's the moment on the graph when the line starts to shoot straight upwards.

# Lessons from the Ozone Hole



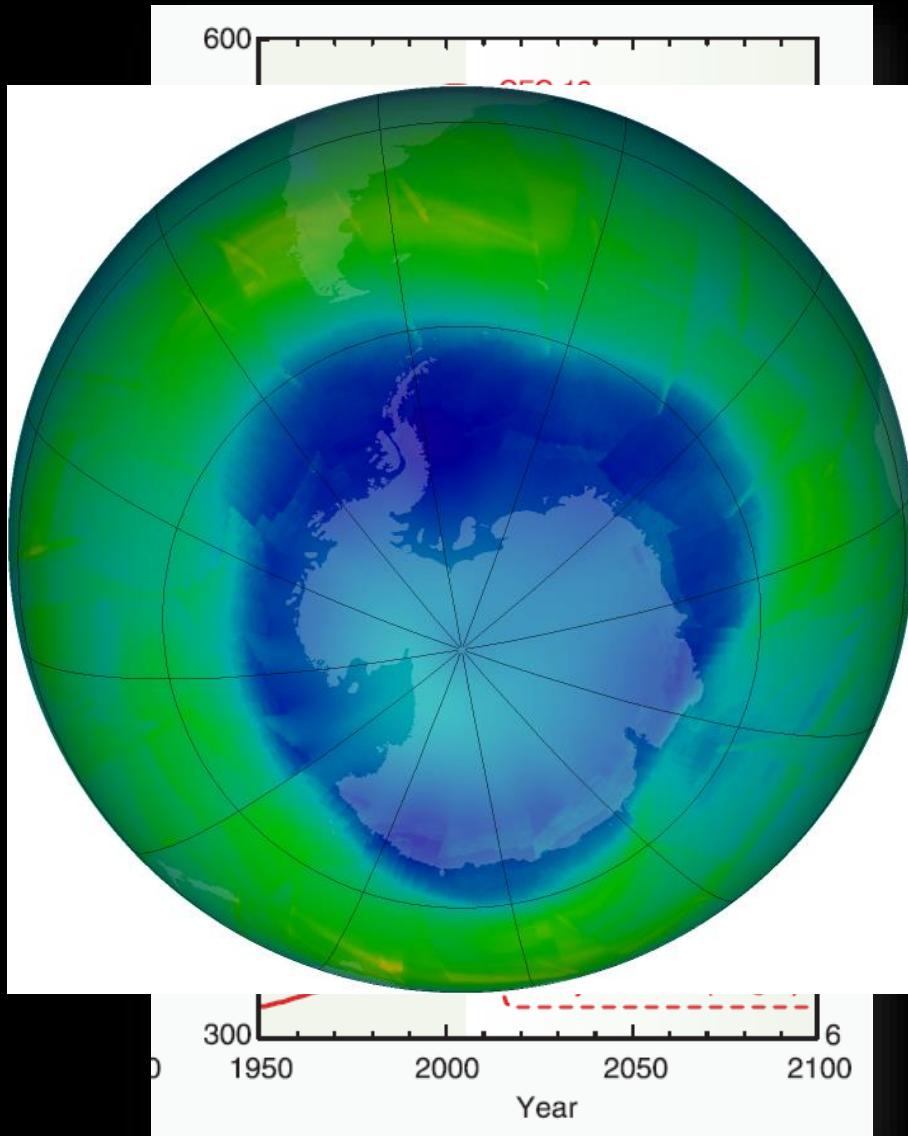
CFC production increased rapidly throughout the 1960s, as new applications were discovered (inert propellants for spray cans, foam blowing, air conditioners)

In early 1980s, even after scientists had warned about ozone depletion, production increased

In 1985, scientists 'discovered' massive losses of ozone over Antarctica



# Lessons from the Ozone Hole

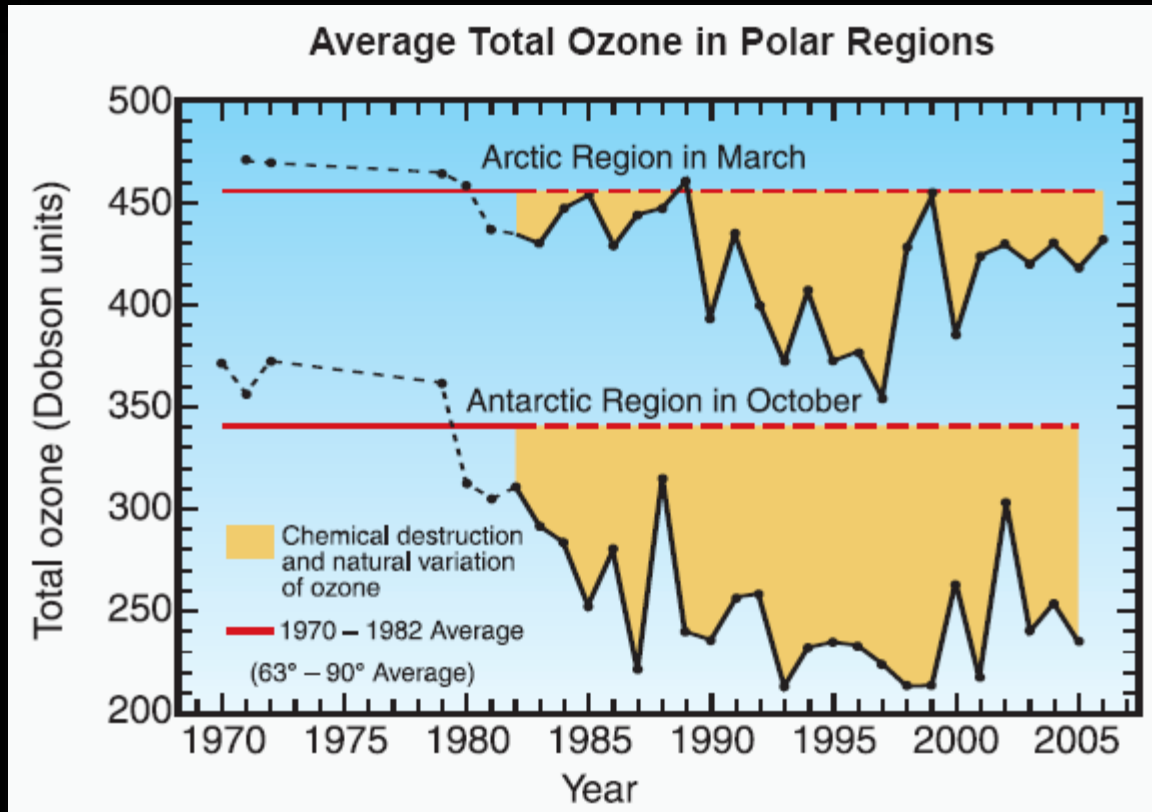


CFC production increased rapidly throughout the 1960s, as new applications were discovered (inert propellants for spray cans, foam blowing, air conditioners)

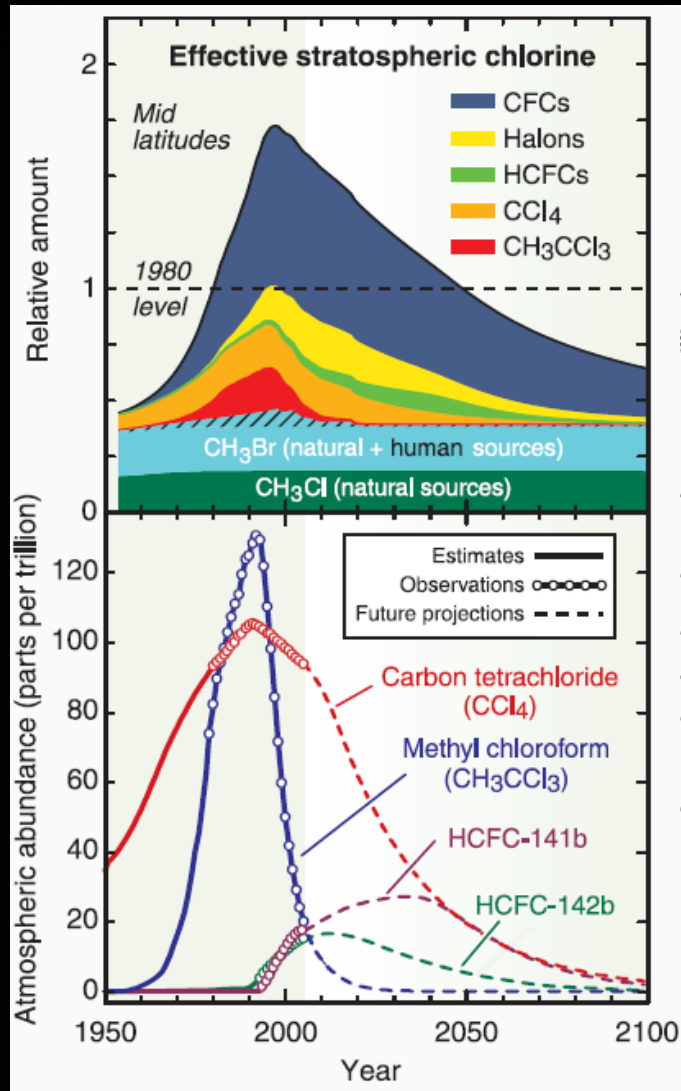
In early 1980s, even after scientists had warned about ozone depletion, production increased

In 1985, scientists 'discovered' massive losses of ozone over Antarctica

By 1985, it was too late to reverse the course that was set in motion by 30 years of accumulated emissions. We had passed the tipping point!



# Will the ozone hole ever disappear?



Yes, now that CFCs have been banned, chlorine will return to pre-1980 levels in about 2050...it will tip back the other way.

Tipping points don't mean that the changes will last forever, it just means that it takes time for the system to get back to the original state – and it probably can't get there unless there is a cure for the disease.

The ozone hole is an example of a global environmental problem that is due to pollution from humans. In this case, the pollution was a class of compounds called “chlorofluorocarbons” (CFCs) that were initially used as refrigerants to replace chemicals like ammonia and sulfur dioxide that were very toxic when inhaled. As more uses were found for CFCs, their production increased nearly exponentially, to the point where they built up in the atmosphere to levels that ultimately resulted in the destruction of ozone all across the globe. The Antarctic and Arctic were particularly vulnerable to ozone destruction primarily because the upper atmospheres there get extremely cold in winter, and that is when special reactions of the chlorine compounds released by breakdown of CFCs destroy ozone more rapidly.

Note – depletion of ozone in the upper atmosphere causes more ultraviolet (UV) light to reach the surface, and UV light is harmful to life (it causes destruction of DNA). However, the sun does not put out very much UV light, so this does not cause the earth to get significantly warmer. Global warming is a VERY DIFFERENT phenomenon that is related to a class of molecules that trap infrared (IR) light, which causes Earth’s surface to get a little warmer than it would be otherwise.

What are some examples of what might be happening on Earth's surface due to a warming climate?

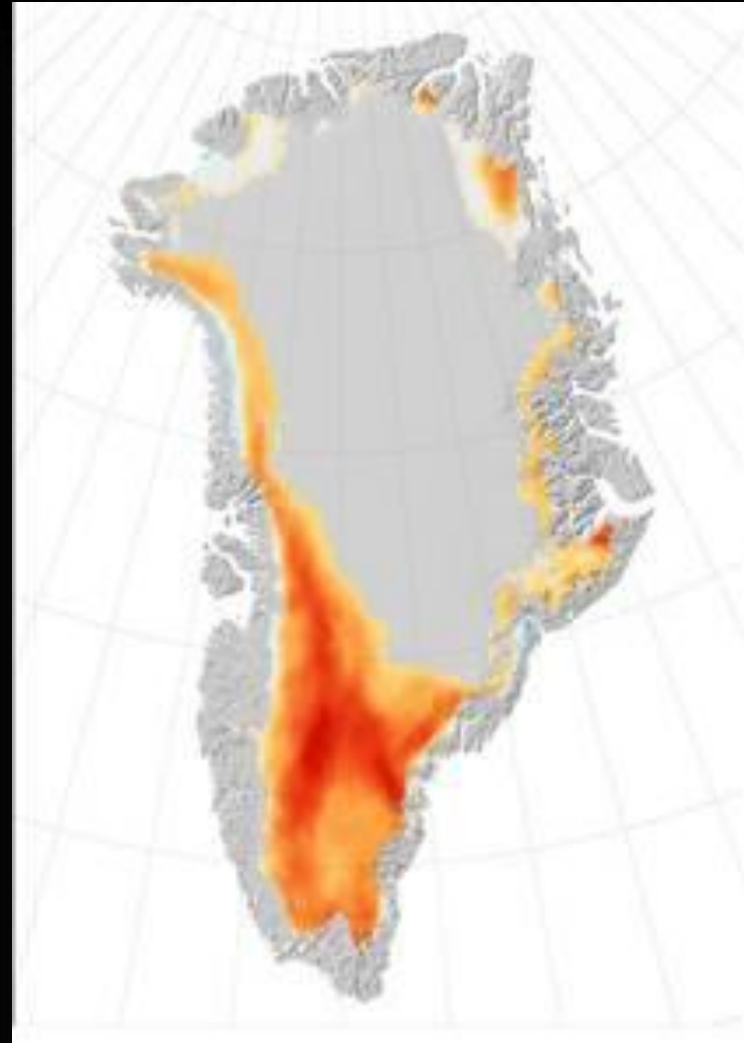
In this course we will look at a few – droughts, famine, change in location and frequency of severe weather events, loss of glaciers, melting ice caps, etc...

Let's start by considering:

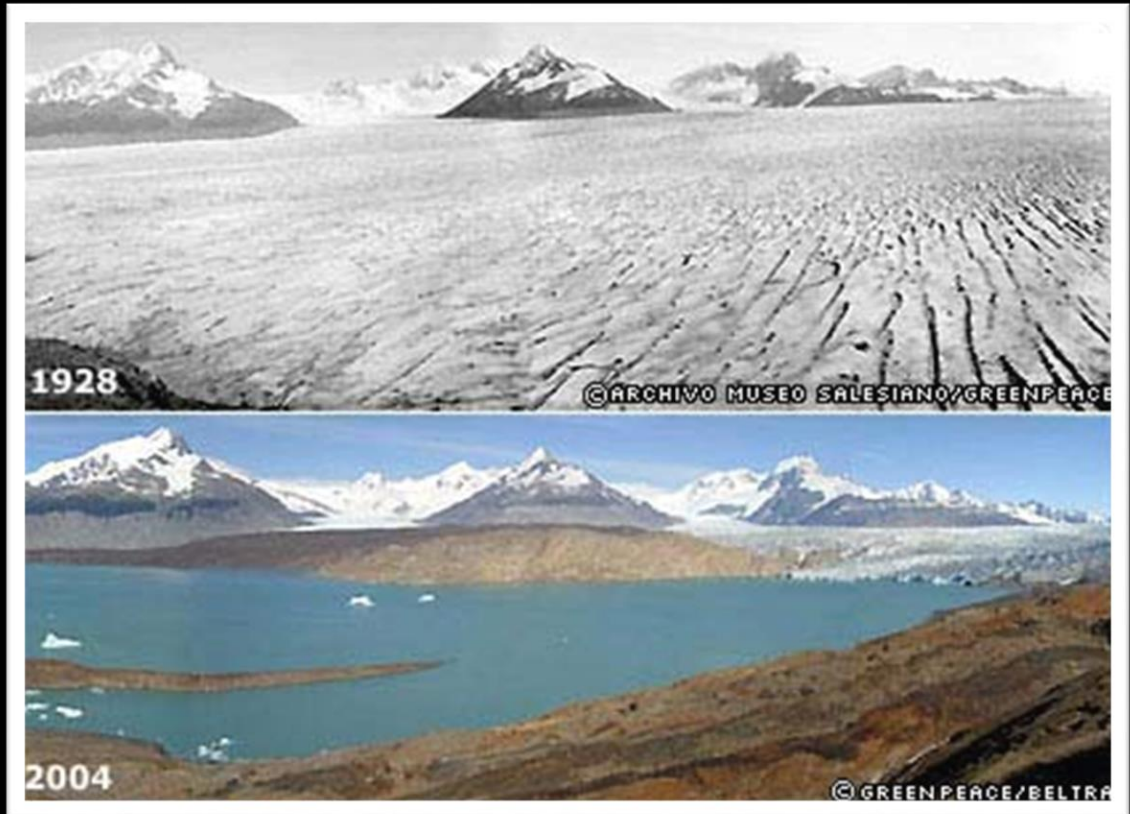
“Global Average Surface Temperature”

(chapter 1, Figure 1-4)

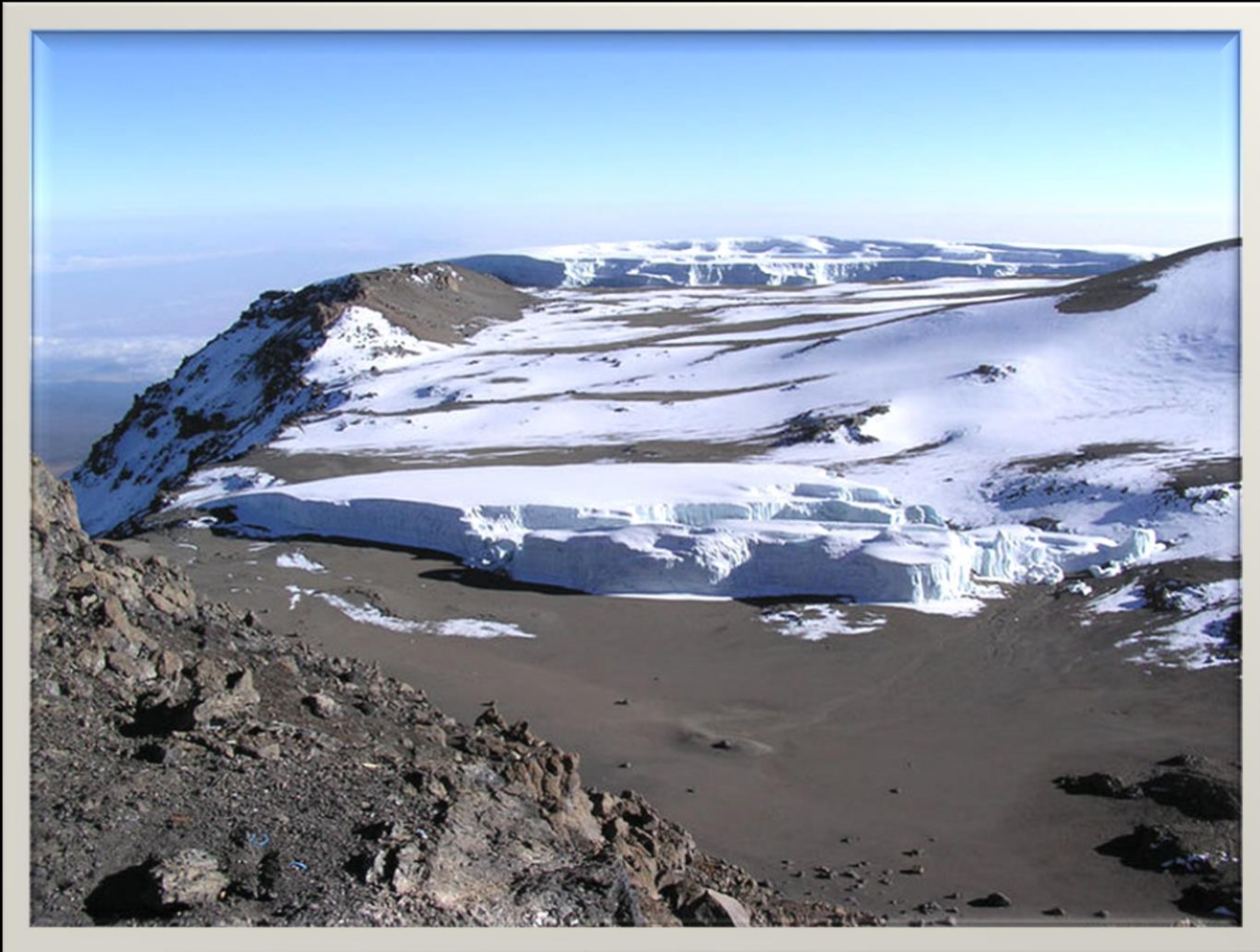
# Melting of ice caps (example, Greenland)



# Methane from Thawing Tundra



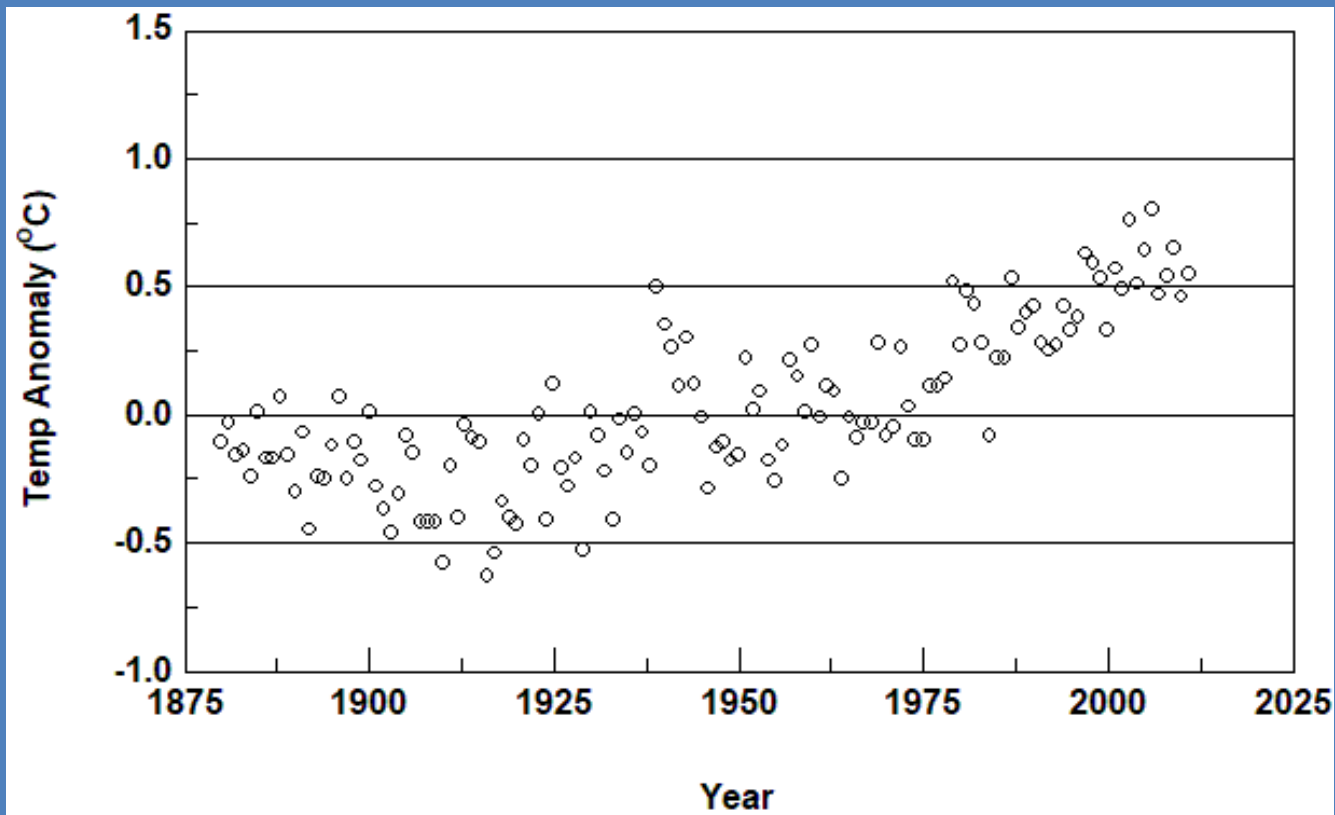
# Sublimation of high altitude glaciers Summit of Mount Kilimanjaro





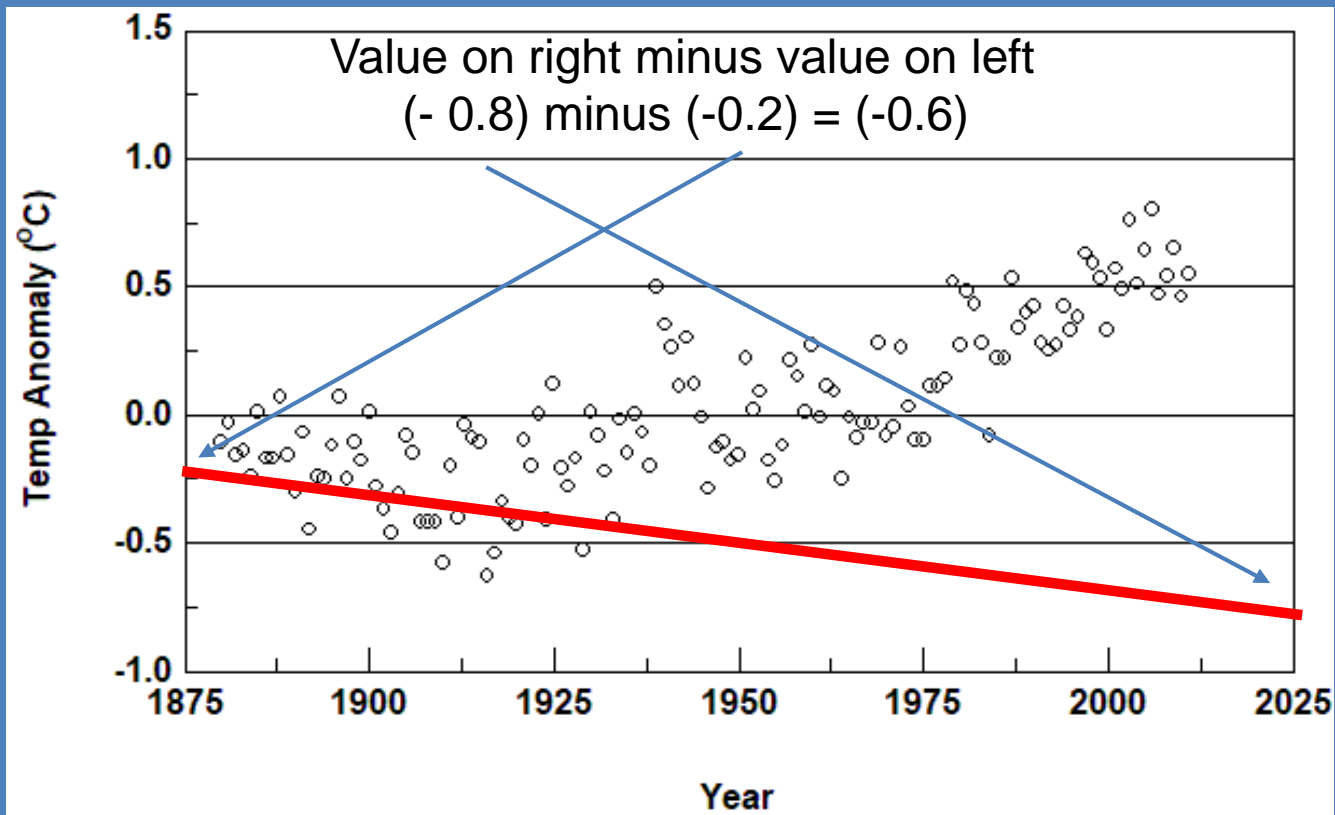
Clicker test/exercise: Let's talk about "Annual Global Mean Temperatures"

Clicker Graphing exercise – use your judgment to determine the "best fit" of a straight line to the set of data plotted below. Make sure the line starts at 1875 and ends at 2025. Write down the temperatures ( $^{\circ}\text{C}$ ) at these two end points, and take the difference. Enter the difference as the answer for the iClicker question. There is no right or wrong answer. We will discuss what the numbers mean after closing out the question.



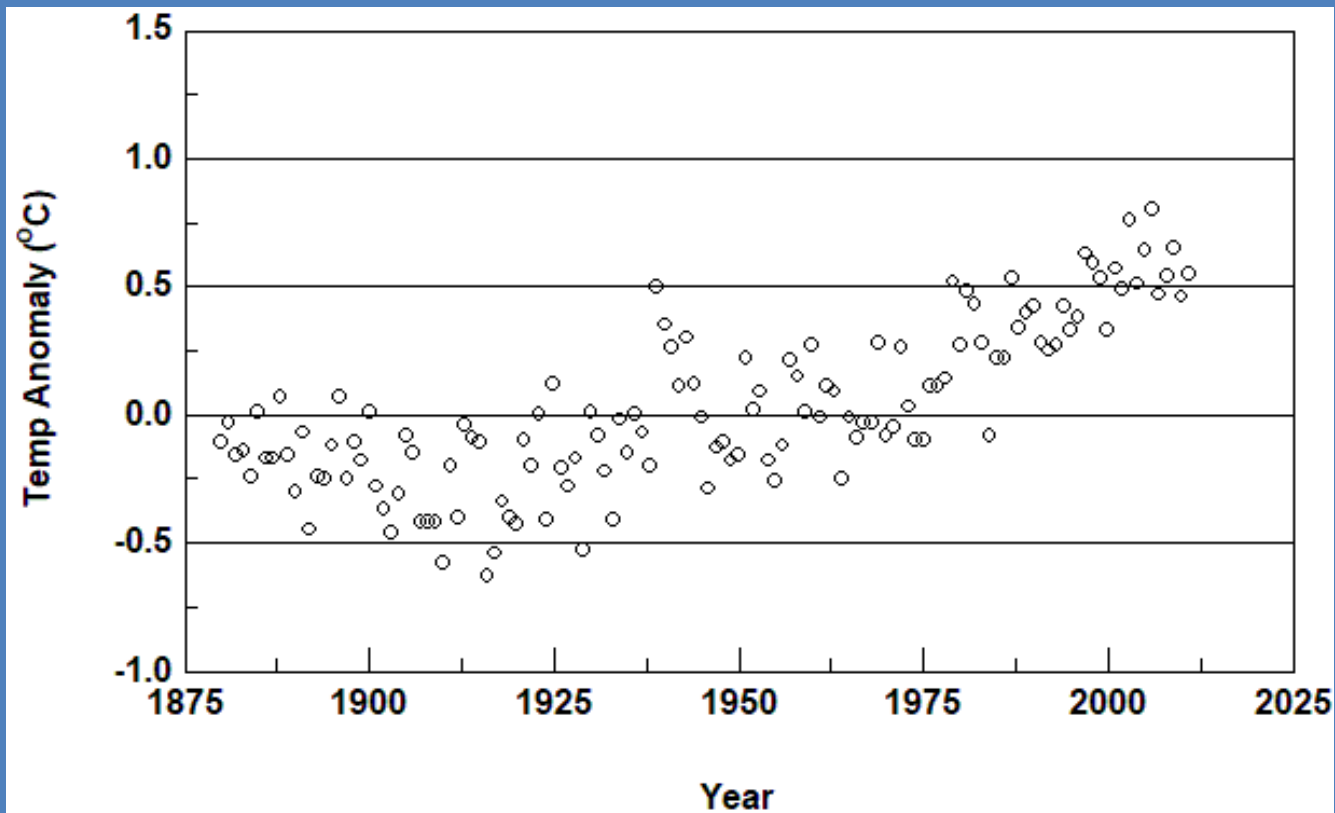
Clicker test/exercise: Let's talk about "Annual Global Mean Temperatures"

Clicker Graphing exercise – use your judgment to determine the "best fit" of a straight line to the set of data plotted below. Make sure the line starts at 1875 and ends at 2025. Write down the temperatures (°C) at these two end points, and take the difference. Enter the difference as the answer for the iClicker question. There is no right or wrong answer. We will discuss what the numbers mean after closing out the question.



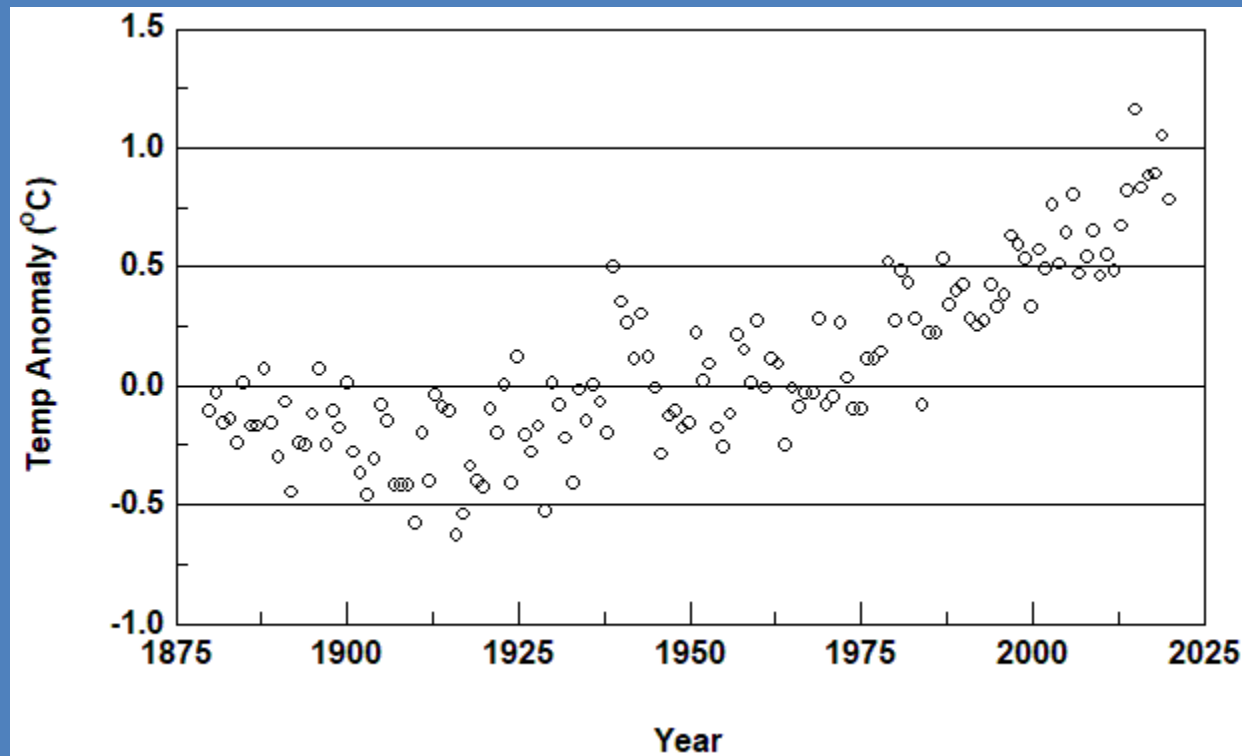
Clicker test/exercise: Let's talk about "Annual Global Mean Temperatures"

Clicker Graphing exercise – use your judgment to determine the "best fit" of a straight line to the set of data plotted below. Make sure the line starts at 1875 and ends at 2025. Write down the temperatures ( $^{\circ}\text{C}$ ) at these two end points, and take the difference. Enter the difference as the answer for the iClicker question. There is no right or wrong answer. We will discuss what the numbers mean after closing out the question.



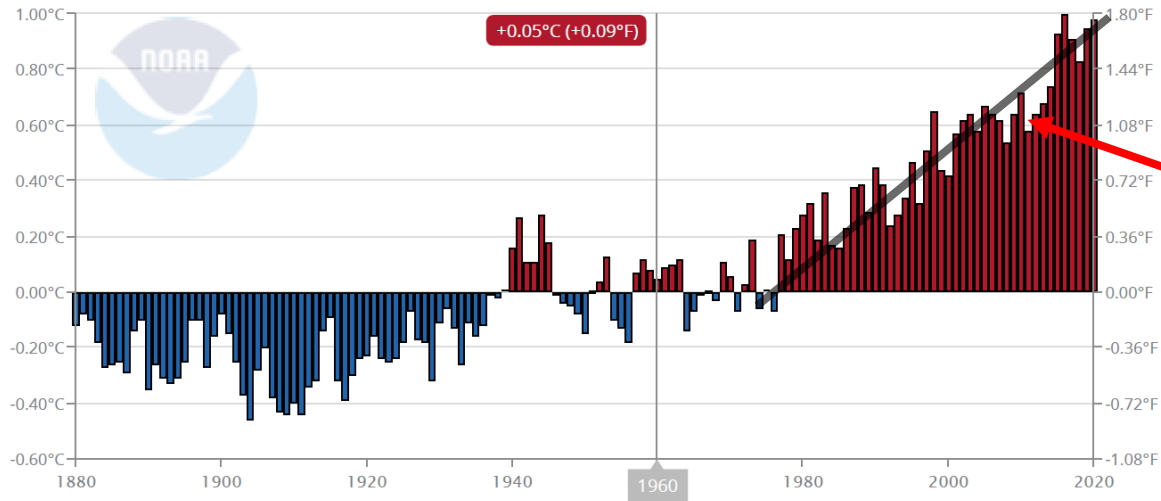
Clicker test/exercise: Let's talk about "Annual Global Mean Temperatures"

Clicker Graphing exercise – use your judgment to determine the "best fit" of a straight line to the set of data plotted below. Make sure the line starts at 1875 and ends at 2025. Write down the temperatures ( $^{\circ}\text{C}$ ) at these two end points, and take the difference. Enter the difference as the answer for the iClicker question. There is no right or wrong answer. We will discuss what the numbers mean after closing out the question.

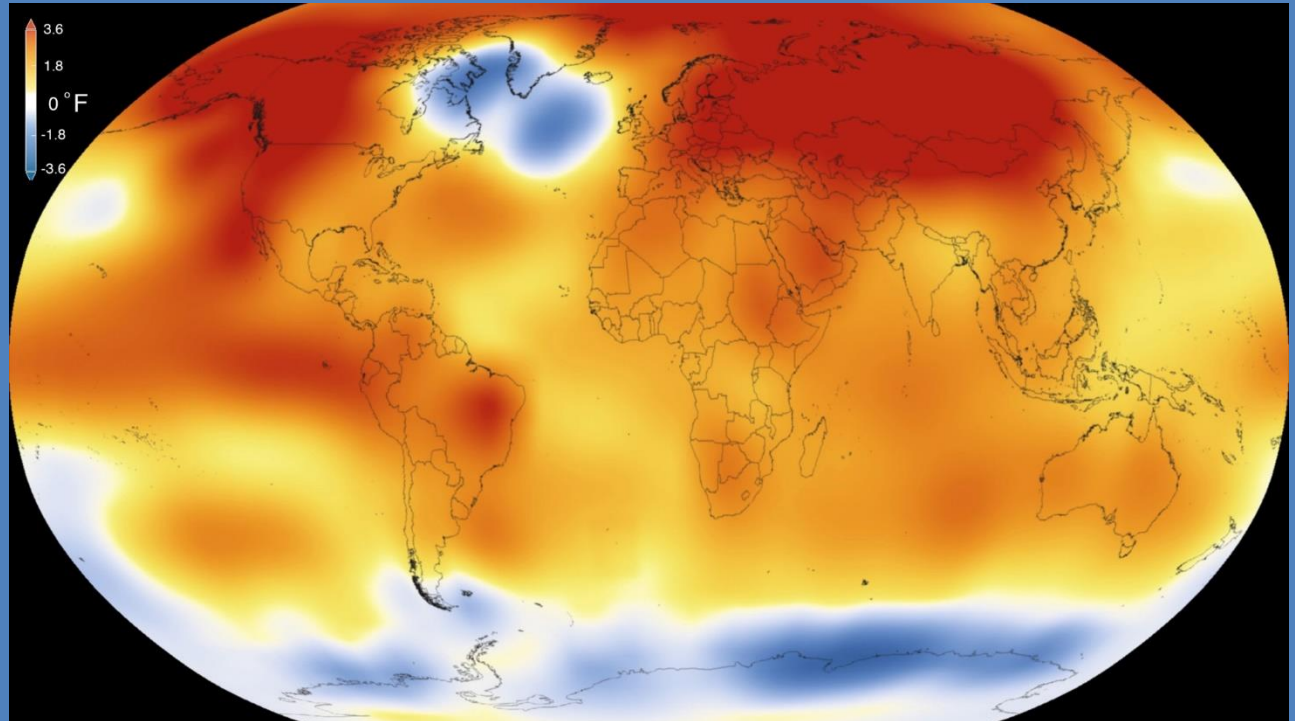


# Global Land and Ocean

## January–December Temperature Anomalies

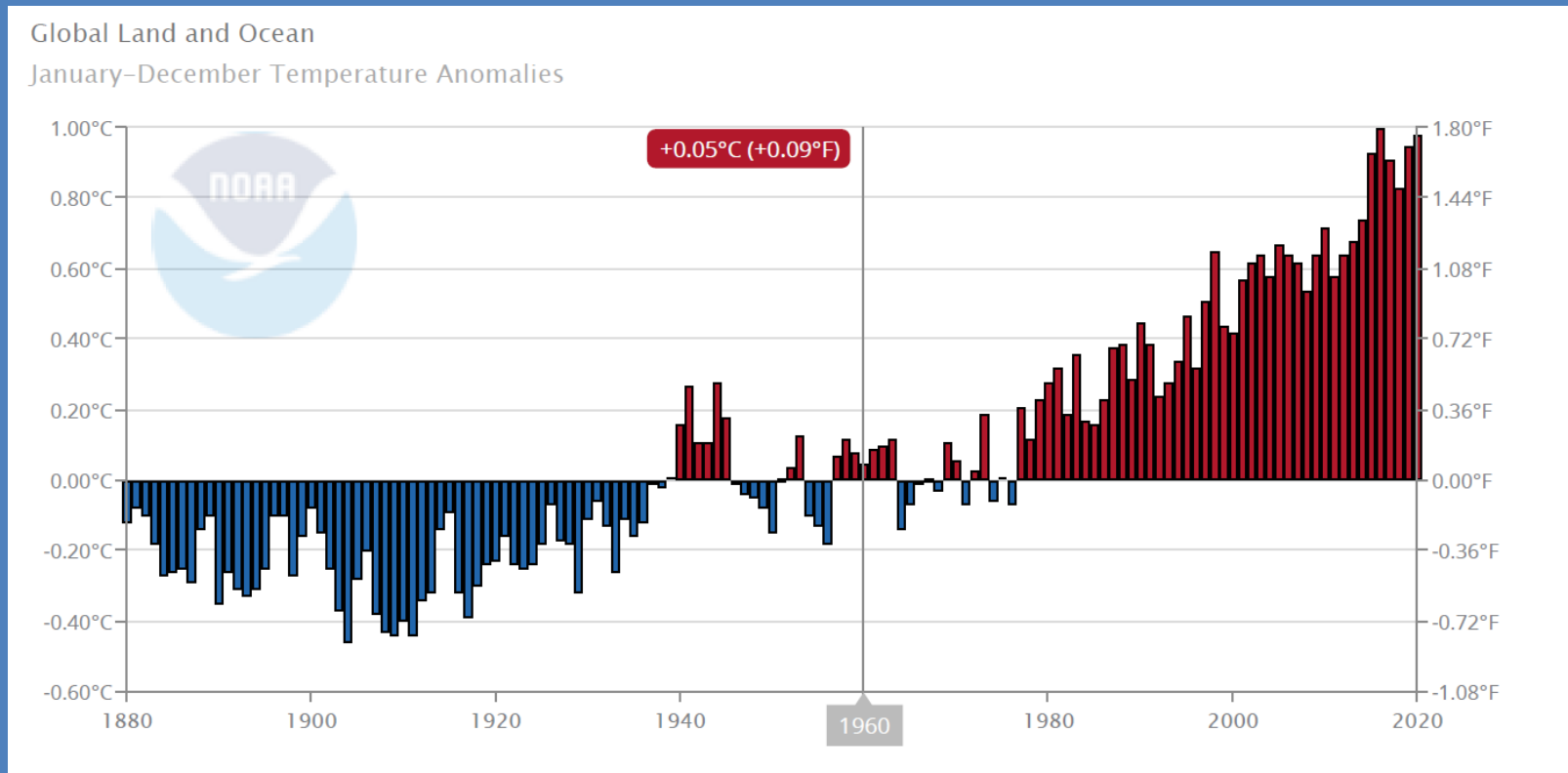


Looking back, the temperature “pause” of the 2000s looks pretty insignificant.



# Are we at a climate tipping point?

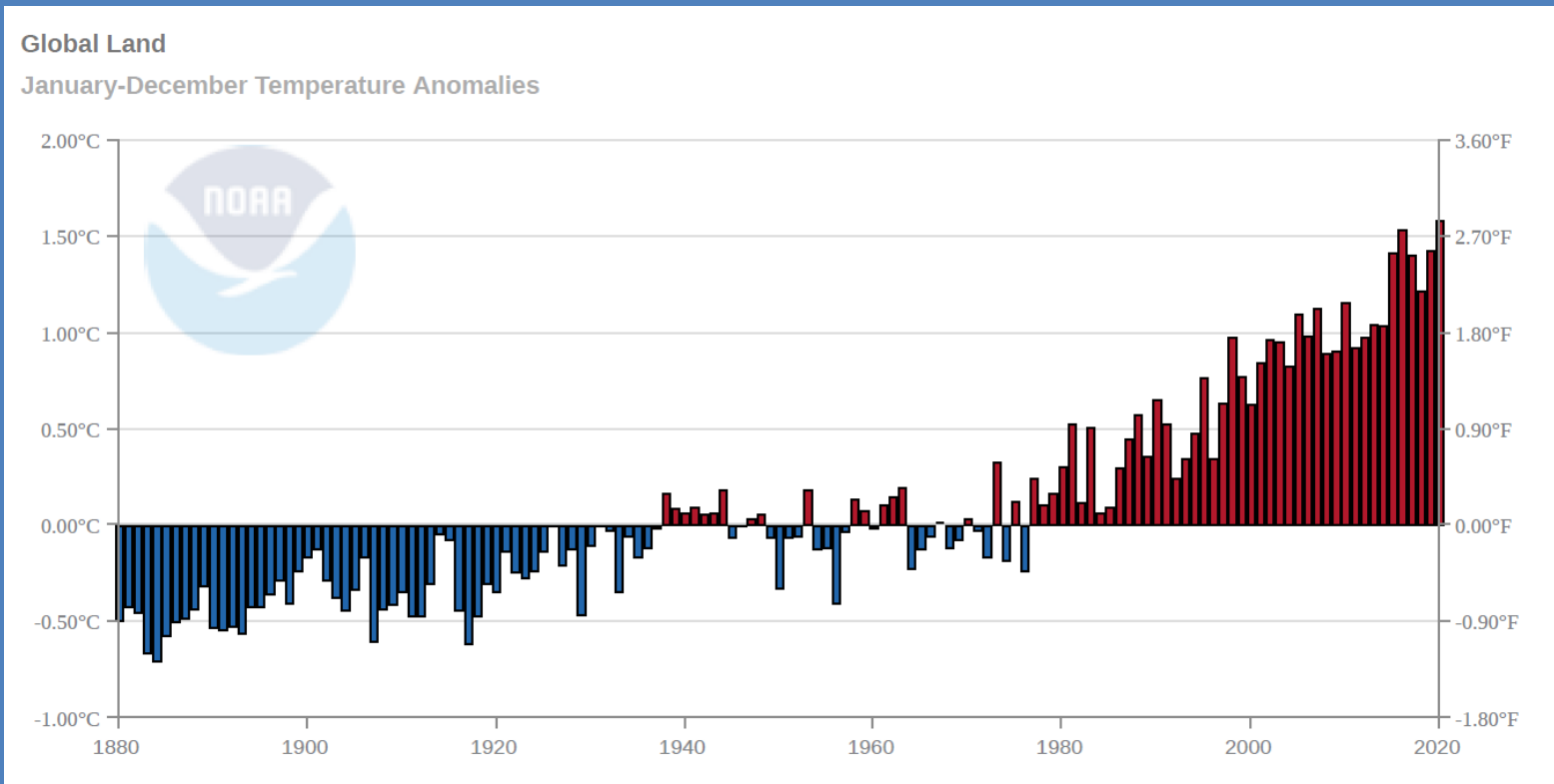
Since 1960 (when I was born), the global average temperature has increased by 1.7 °F or 0.9 °C



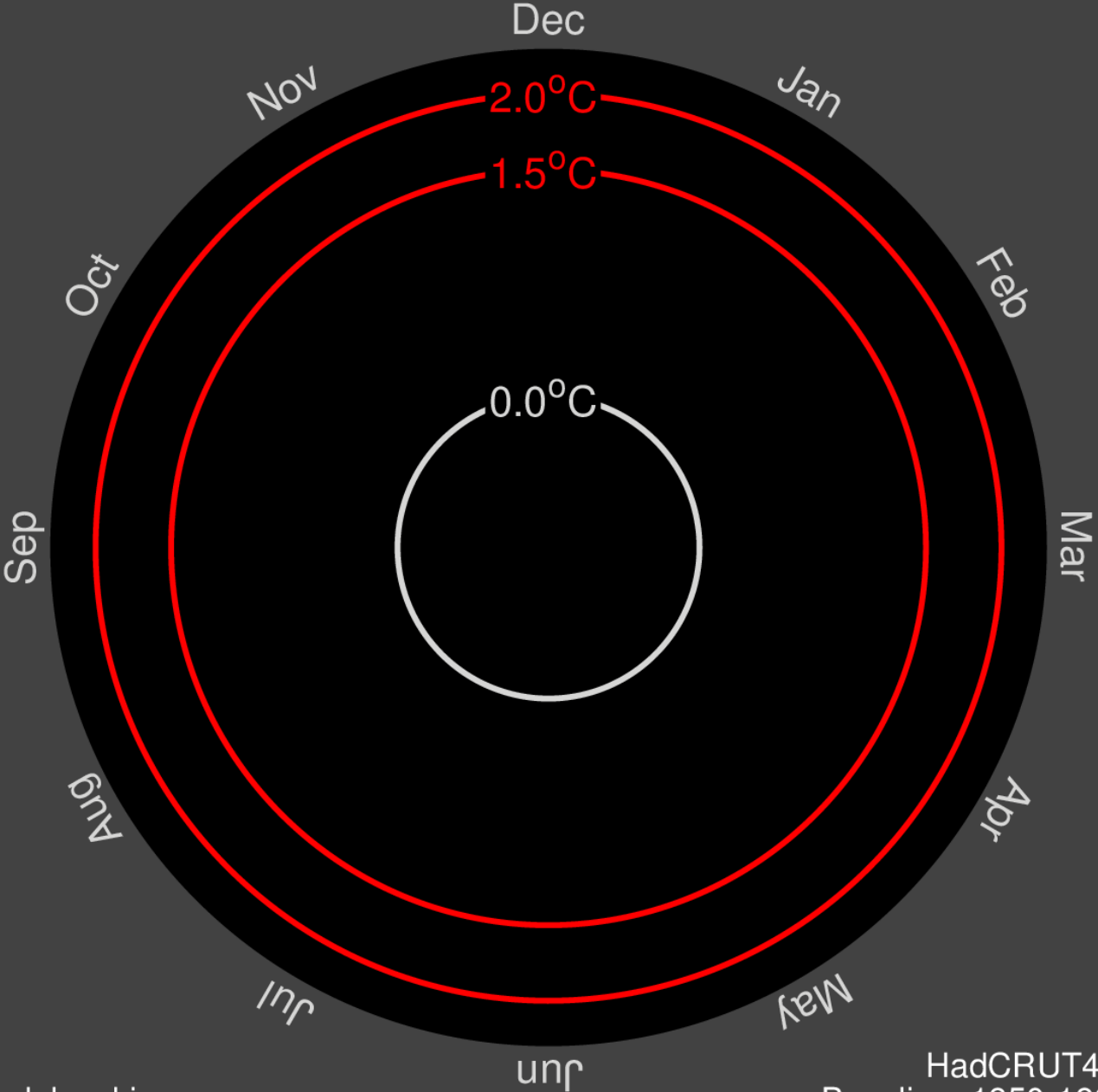
# Are we at a climate tipping point?

Over land (where most people in the world live) the global average temperature has increased by nearly 2.7 °F or 1.5 °C.

In this class we will learn about how, where, and why temperatures are changing so rapidly. This isn't due mainly to natural causes (although there are many factors we need to consider, some natural)



# Global temperature change (1850-2020)



@ed\_hawkins

HadCRUT4.6  
Baseline: 1850-1900



The NOAA web page noted that for 2009, the global mean temperature anomaly was 0.56 °C.

2016 was the warmest year ever recorded, with a mean temperature anomaly of nearly 1°C. Some of the impact was due to El Nino.

2017 is likely to be about as warm as 2017, despite NOT being an El Nino year.

What else is happening this year?

## What is happening in 2021?

A large iceberg broke free in Antarctica in late 2020 and is headed for South Georgia Island (made famous by Ernest Shackleton)



# What is happening in 2021?



What else is happened in 2020 (besides a global pandemic)?

The 2020 Atlantic hurricane season produced an extraordinary 30 named storms (highest on record), 13 hurricanes (second-highest on record), and 6 major hurricanes (tied for second-highest on record): more than double the activity of an average season (12 named storms, 6 hurricanes, and 3 major hurricanes).

From Ecowatch.com

Beware of records! – Taken alone they aren't "proof" of anomalous climate change. But taken as a probability, they represent important pieces of the puzzle. Putting these pieces together and making sense of them is the job of climate scientists.

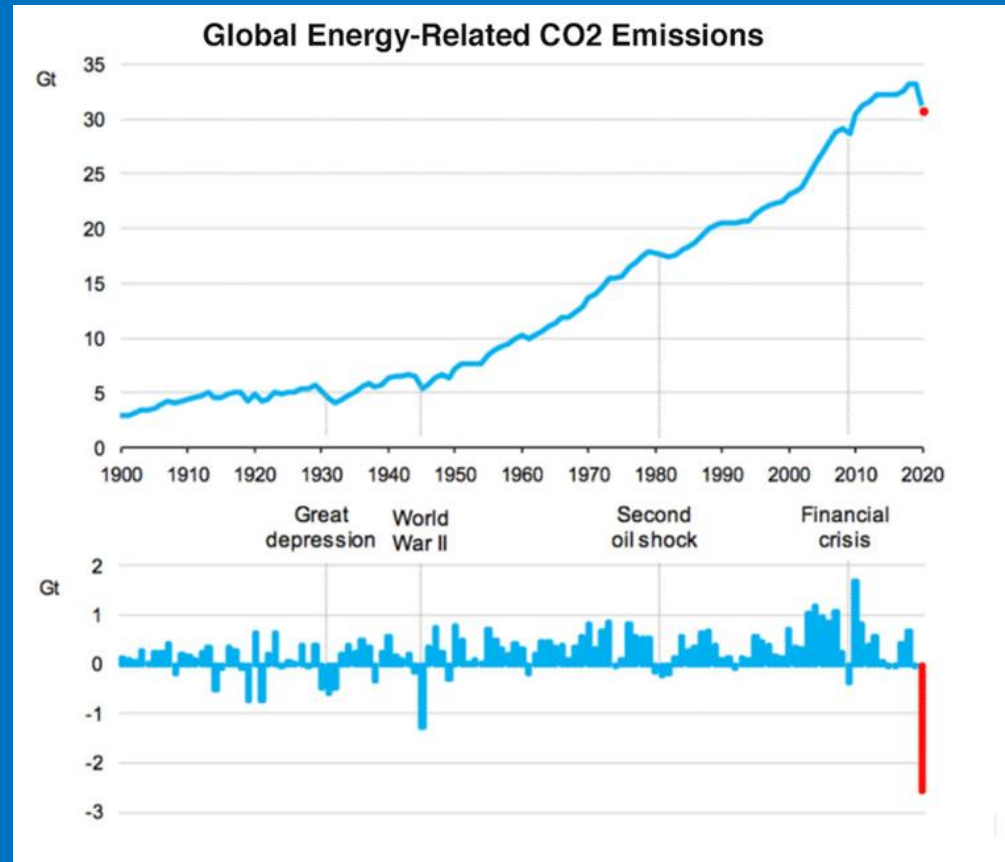
What else is happened in 2020 (besides a global pandemic)?

The 2020 Atlantic hurricane season produced an extraordinary 30 named storms (highest on record), 13 hurricanes (second-highest on record), and 6 major hurricanes (tied for second-highest on record): more than double the activity of an average season (12 named storms, 6 hurricanes, and 3 major hurricanes).

From Ecowatch.com

Beware of records! – Taken alone they aren't "proof" of anomalous climate change. But taken as a probability, they represent important pieces of the puzzle. Putting these pieces together and making sense of them is the job of climate scientists.

What else is happened in 2020 (besides a global pandemic)?

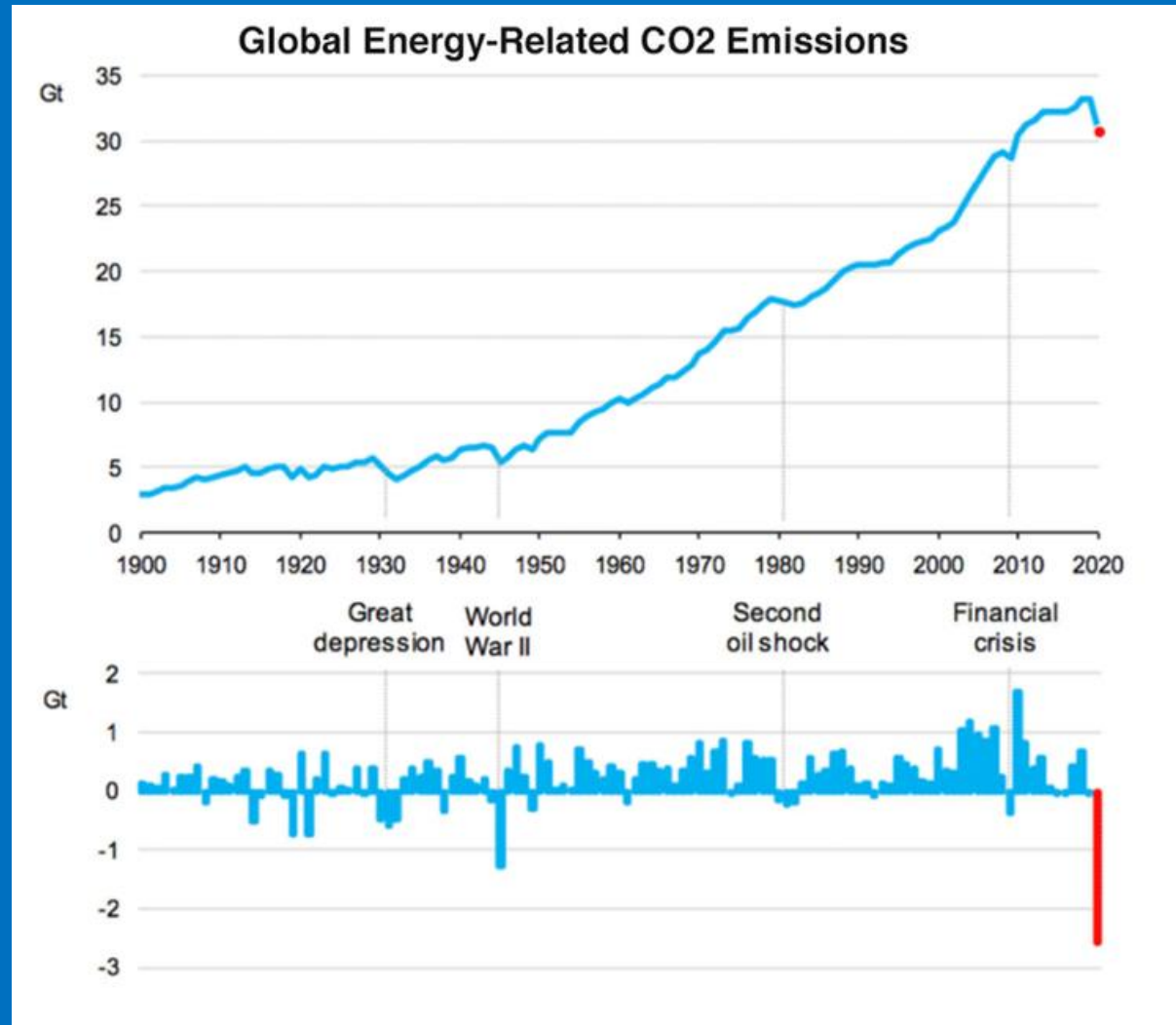


From Ecowatch.com

Beware of CO<sub>2</sub> “trends”!

A decrease in emissions DOES NOT MEAN that CO<sub>2</sub> itself is decreasing in the atmosphere – just that for one year we didn’t add it to the atmosphere as fast as we did the year before.

Note – despite the pandemic, energy related CO<sub>2</sub> emissions in 2020 were still greater than EVERY year prior to 2011. Humans ARE NOT reducing their rate of consumption of fossil fuel to produce energy.



What else is happened in 2020 (besides a global pandemic)?

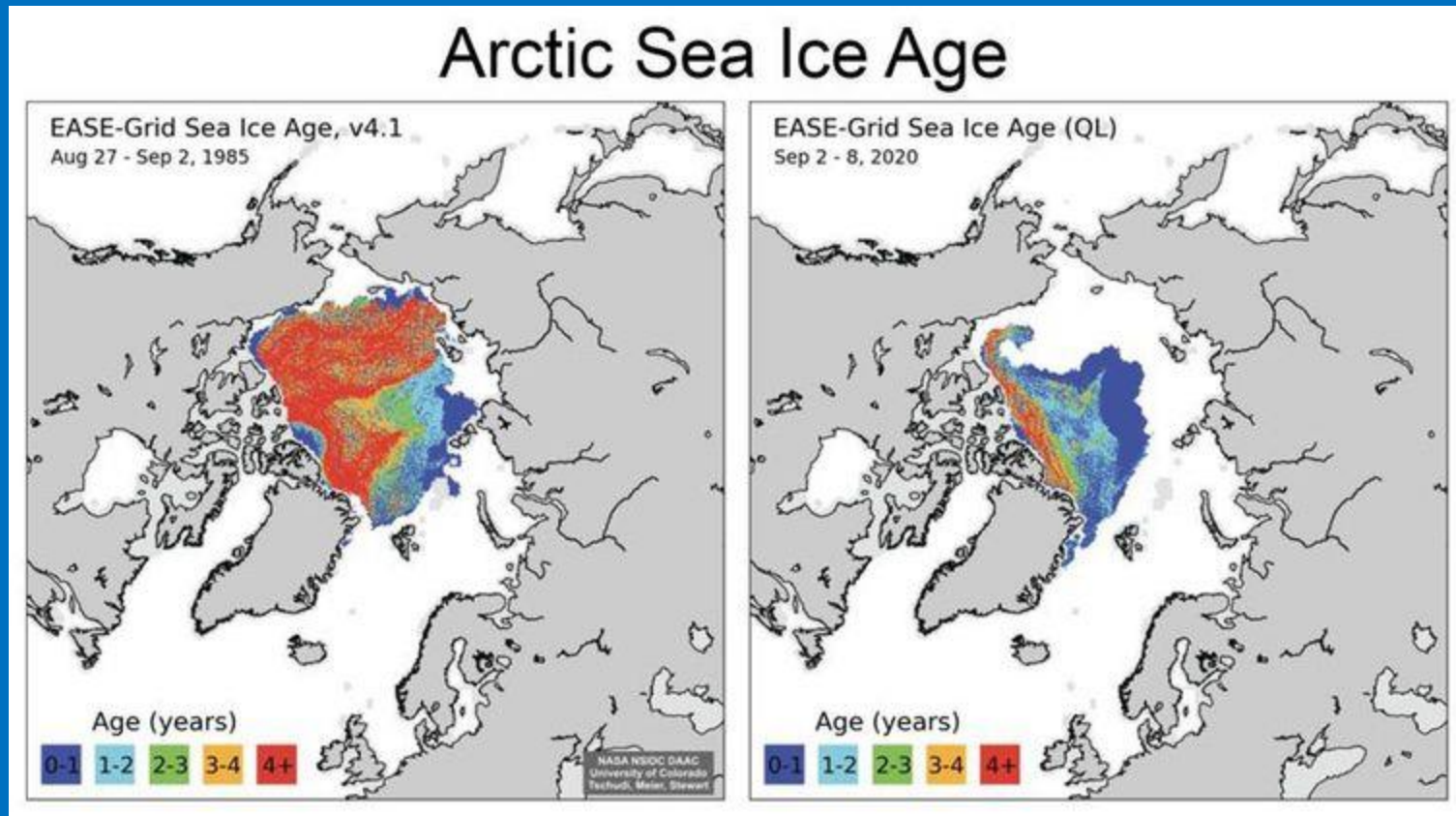
The year 2020 brought record levels of fire activity to the U.S. and Arctic, but unusually low levels in Canada and tropical Africa, resulting in a below-average year for global fire activity, according to the Copernicus Atmosphere Monitoring Service. According to Insurance broker Aon, the global direct cost of wildfires in 2020 was \$17 billion, ranking as the fifth-costliest wildfire year, behind 2017, 2018, 2015 (major Indonesian fires), and 2010 (major Russian fires).

From Ecowatch.com



What else is happened in 2020 (besides a global pandemic)?

Near record-low Arctic sea ice (again)



From Ecowatch.com

What else is happened in 2020 (besides a global pandemic)?

The United States suffered 25 weather disasters costing over \$1 billion each in 2020, surpassing Aon's previous U.S. record of 20 in 2017. The record number of U.S. disasters led to the American Red Cross's providing record levels of disaster sheltering in 2020, according to a December 2 article by E&E News.

From Ecowatch.com

For next time... (Thursday, January 21)

Reading. Please read through all of Chapter 1 (posted on Canvas)

Next week we will look at the subject of Chapter 2,  
Feedbacks

Watch for “Syllabus Quiz” on Canvas – will be due Friday 8 pm, just to test the quiz feature. The real quizzes will start next week, based on Chapter 1 and a bit of Chapter 2

Will be called “Quiz 0”, won’t be included in final grade

Videos of synchronous lectures will be posted after class in calendar entry for that date.