Does the Earth Have a Fever?

Donald Colliver
dcolliver@uky.edu

https://www.un.org/en/climatechange/what-is-climate-change

The Science of Climate Change

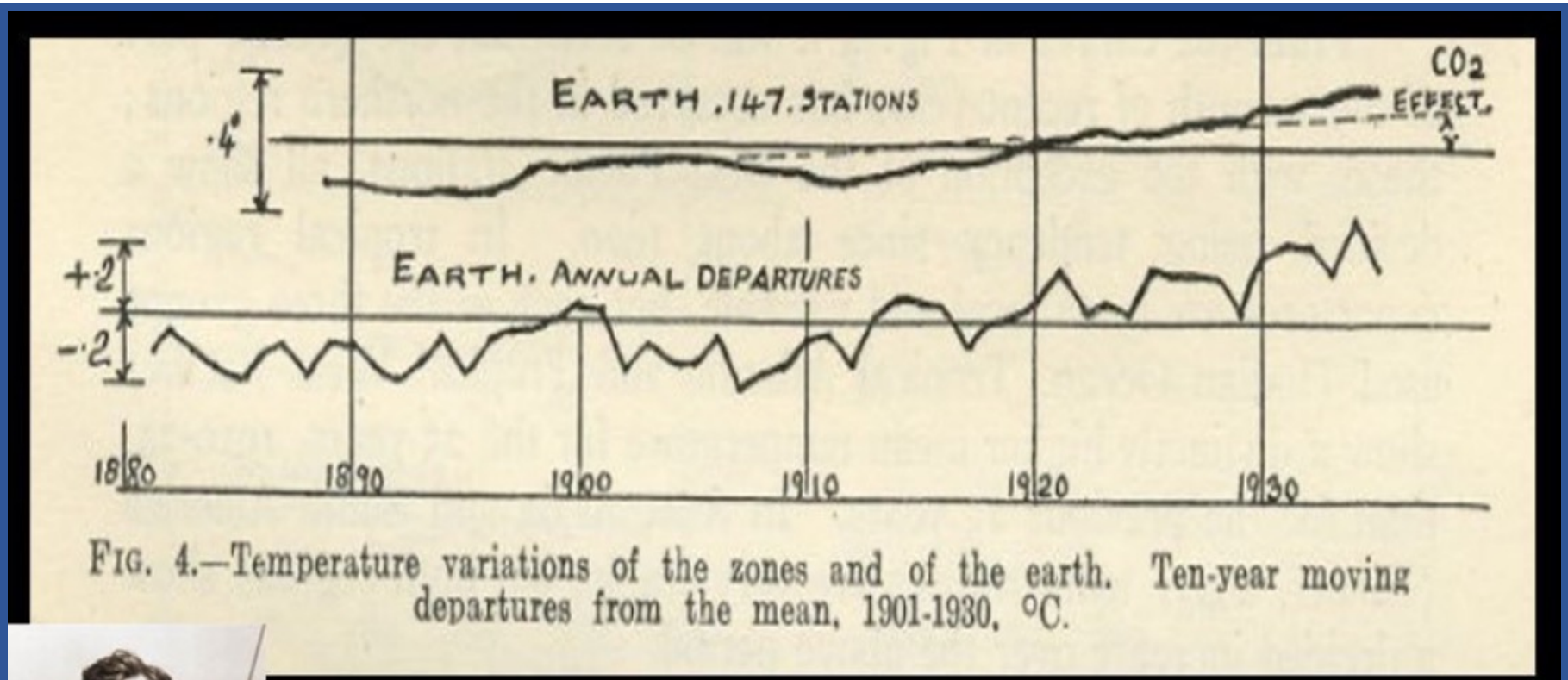
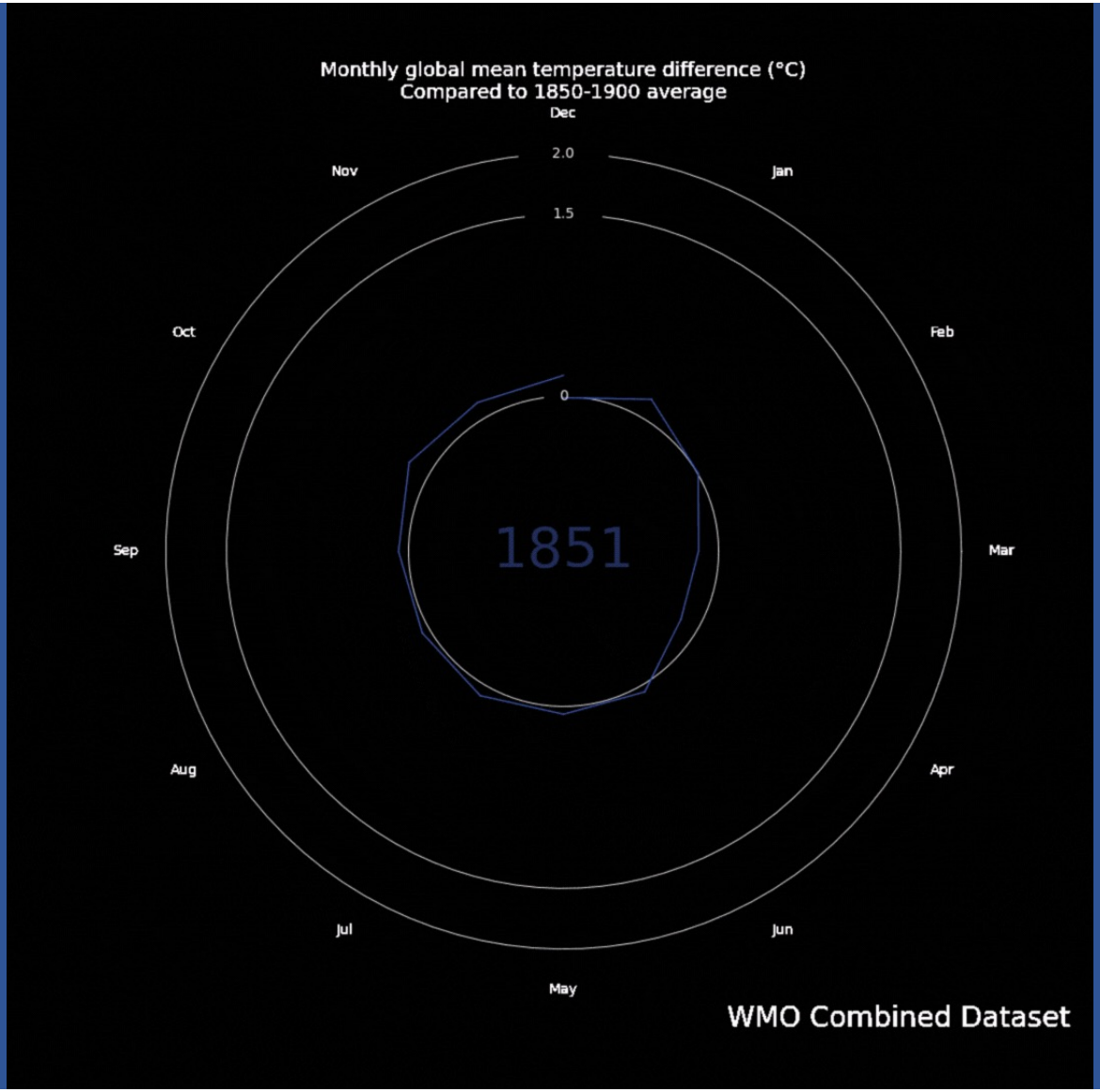
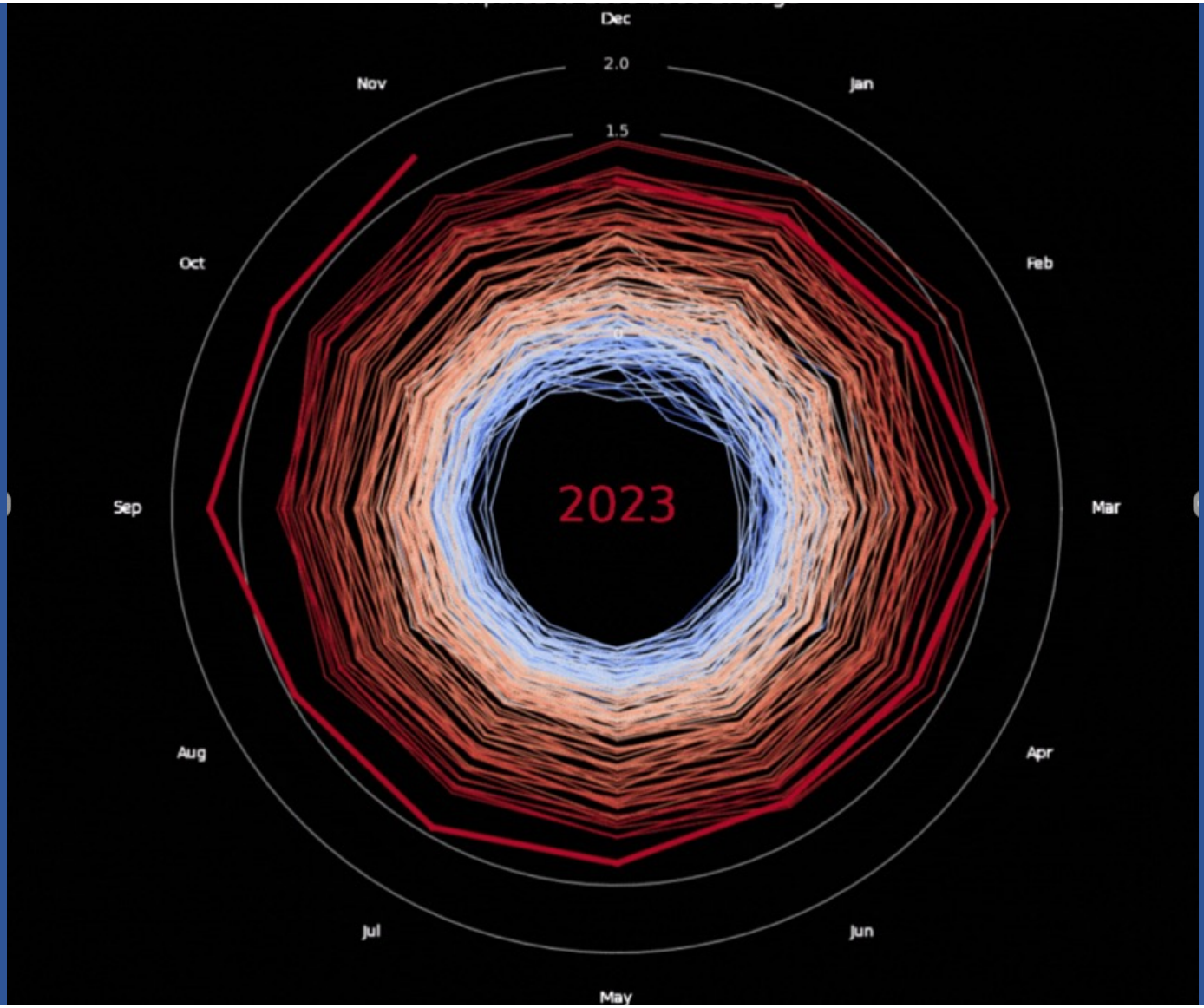


FIG. 4.—Temperature variations of the zones and of the earth. Ten-year moving departures from the mean, 1901-1930, °C.

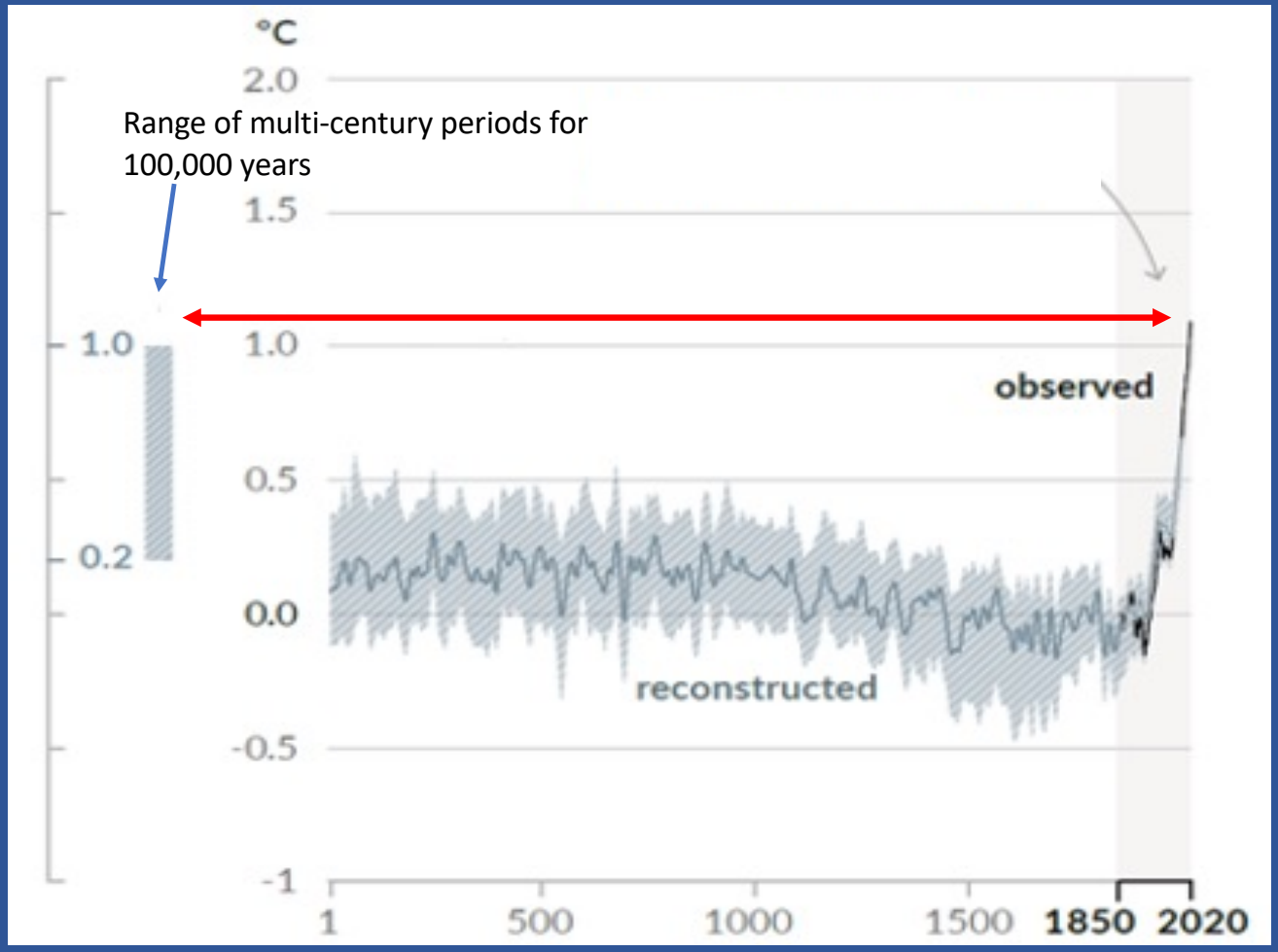
Guy Callendar first discovered the world was warming in 1938

https://twitter.com/ed_hawkins


Monthly global mean temperature difference (°C)
Compared to 1850-1900 average
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2.0
1.5
0
1851
WMO Combined Dataset

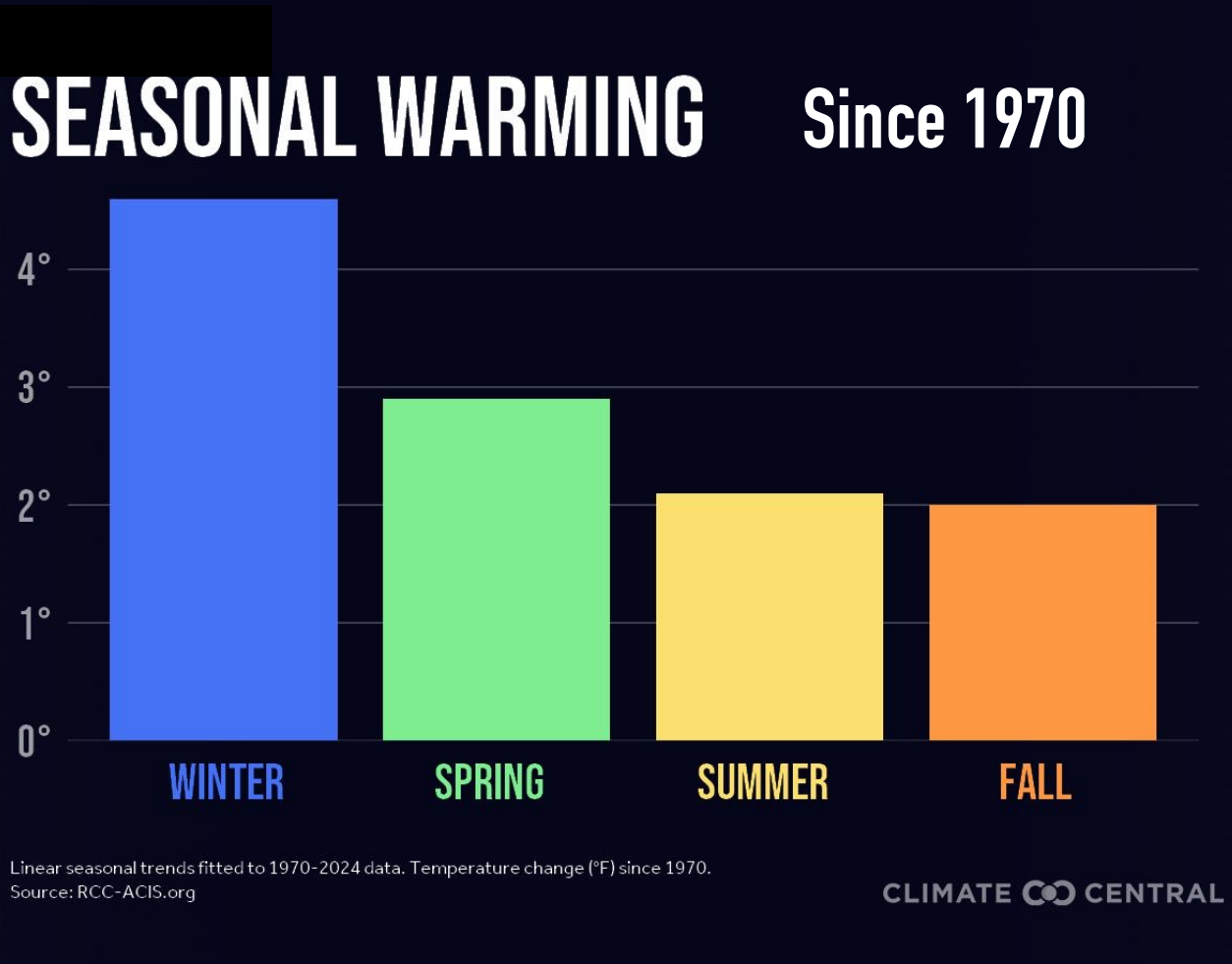

Dec
2.0
Jan
1.5
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2023

History of Global Temperature Change



- Source: IPCC AR6 WG1 SPM 1 Change in global surface temperature (decadal average) as Reconstructed (1-2000) and Observed (1850-2020)

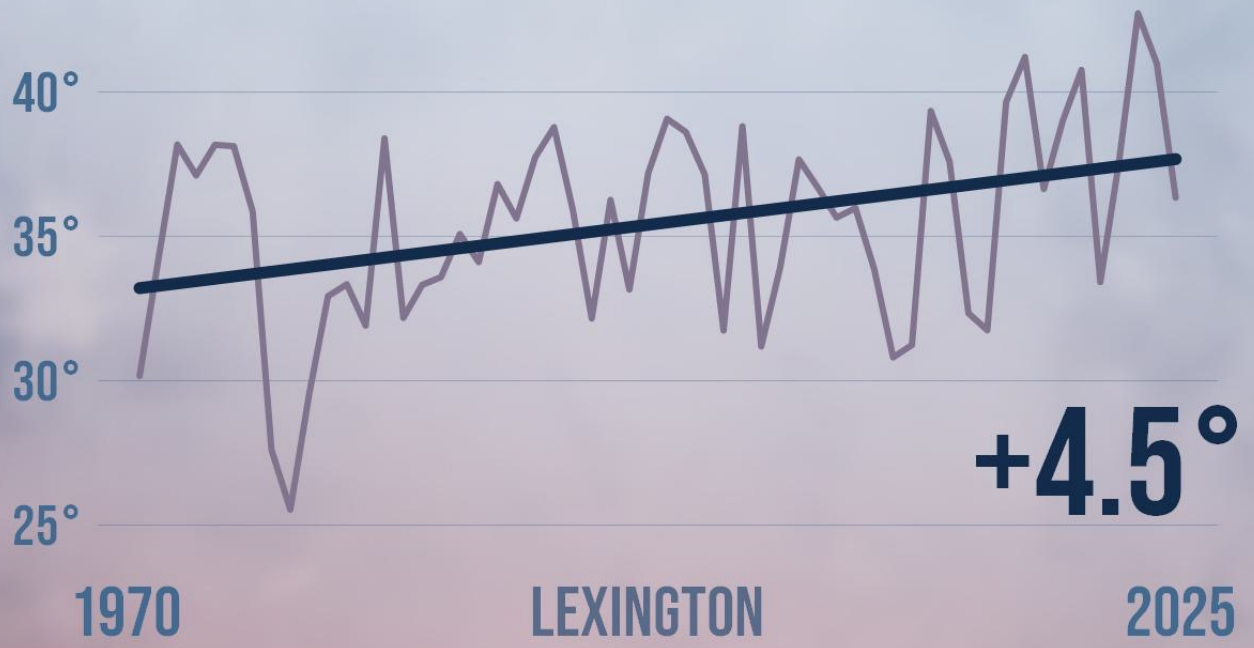
WHAT ABOUT LEXINGTON ?




The Twelve Days of
Christmas
50°
45°
40°
35°
30°
25°
20°
+5.1°
1969-70
LEXINGTON
2020-21
Source: RCC-ACIS.org
Change in average temperature (°F) over the Dec 25-Jan 5th period (the 12 days of Christmas).
CLIMATE CENTRAL

WINTER WARMING

AVERAGE TEMPERATURE (Dec–Feb)

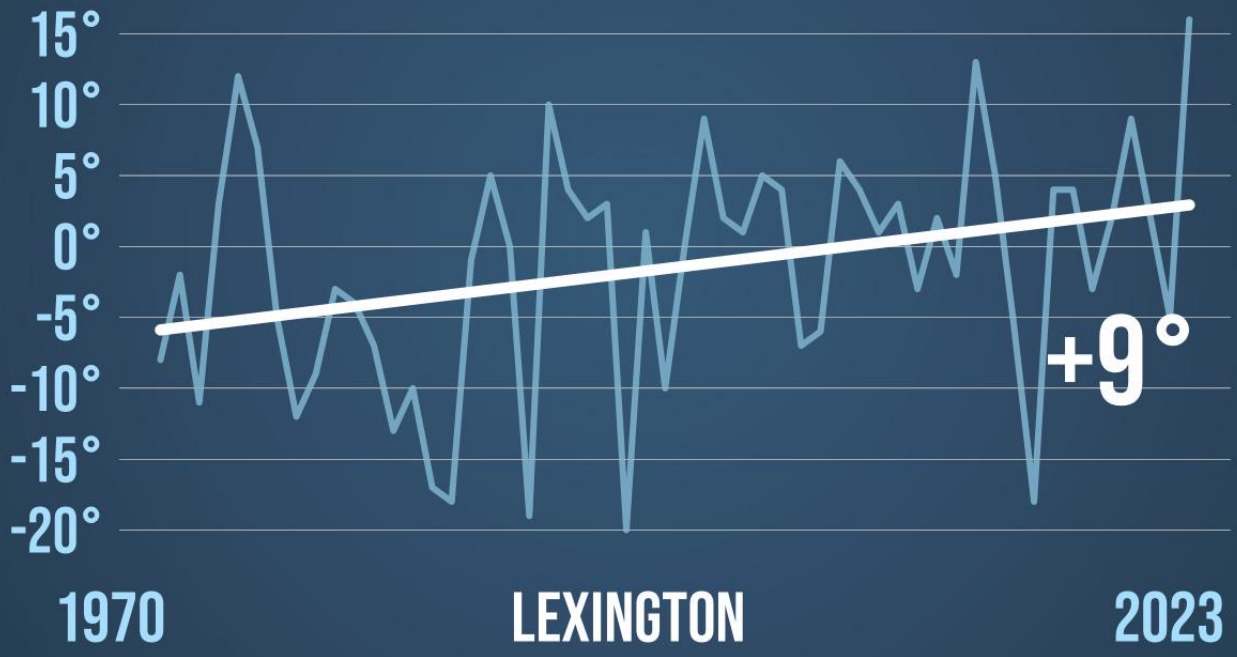


Average winter (December, January, February) temperatures in °F
Source: NOAA (ACIS)

CLIMATE CENTRAL

LESS EXTREME COLD

LOWEST TEMPERATURE OF THE YEAR



Lowest minimum temperature of the year (°F).
Source: RCC-ACIS.org

CLIMATE CENTRAL

SUMMER WARMING

AVERAGE TEMPERATURE

Jun–Aug

Average summer (June, July, August) temperatures in °F
Source: NOAA (ACIS)

LINGERING SUMMER HEAT

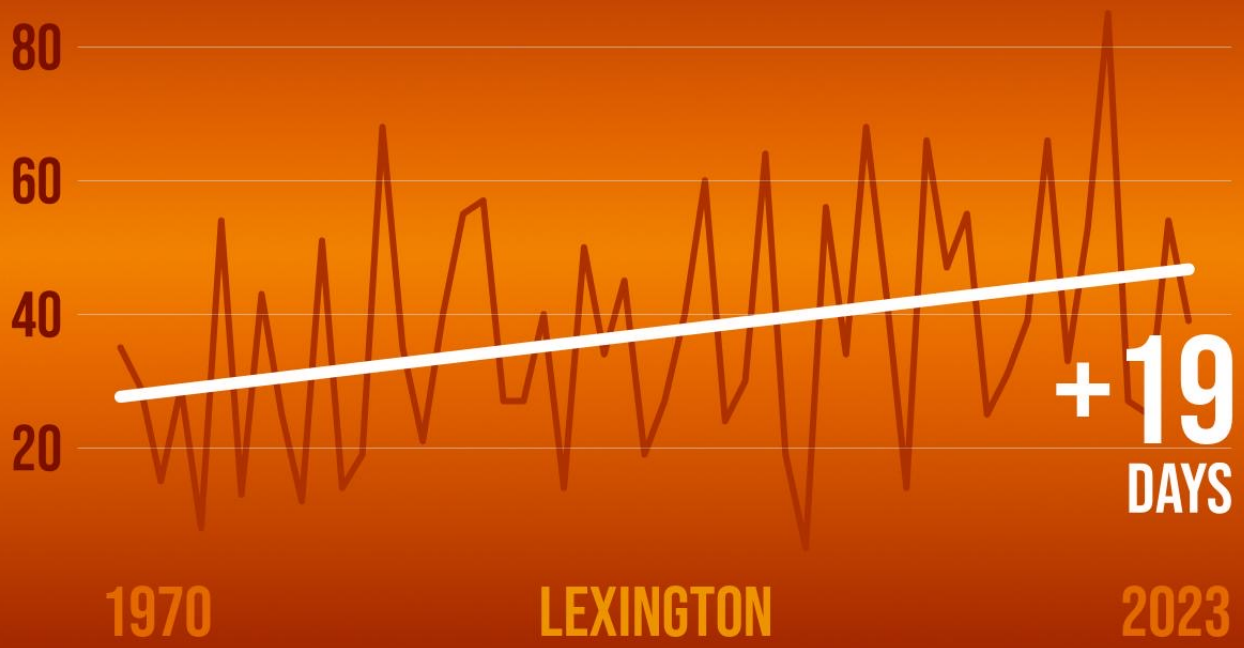
Last day above 80°F

Annual date of the last day with maximum temperature at or above the historical (1991-2020) 75th percentile.
Source: NOAA (ACIS)

CLIMATE CENTRAL

MORE EXTREMELY HOT DAYS

DAYS ABOVE 88°



Change in annual days above 95th percentile of average annual summer maximum temperatures (87.705°F), 1970–2023. Source: RCC-ACIS.org

CLIMATE CENTRAL

MORE HIGH HEAT INDEX DAYS

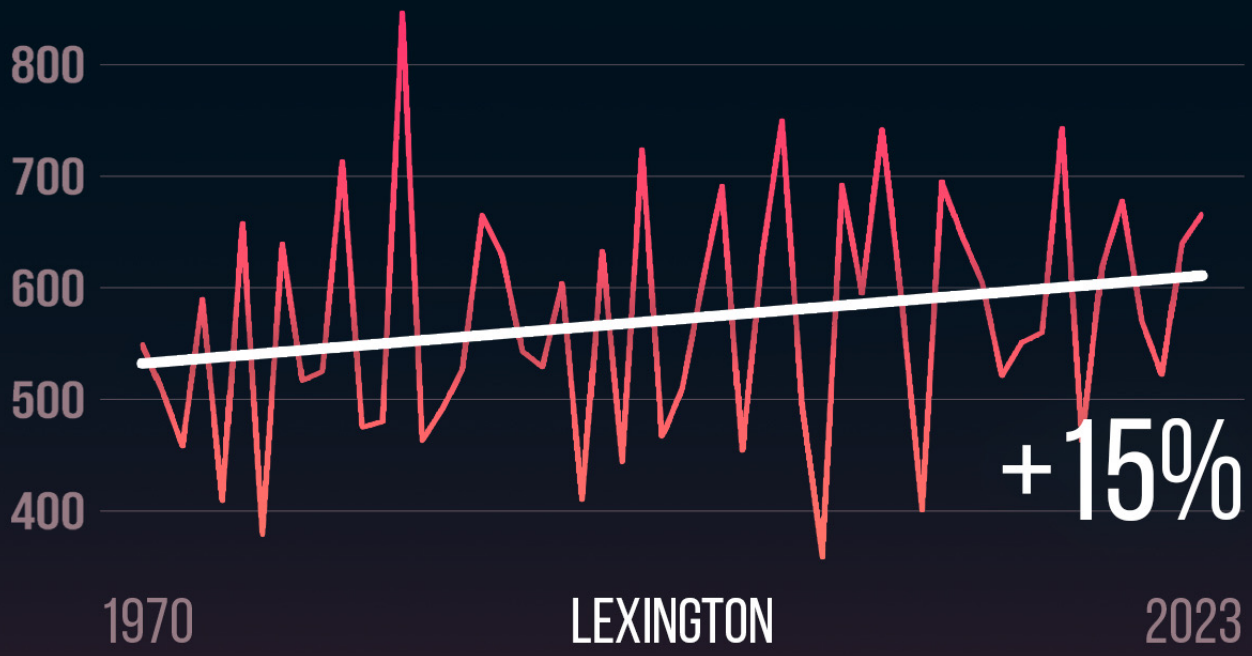
Days with a heat index of 90°+

Annual days with heat index of 90°F+.
Source: gridMET minimum relative humidity & maximum temperature datasets

CLIMATE CENTRAL

BACK-TO-SCHOOL COOLING DEMAND

Annual cooling degree days (July 17 - September 8)

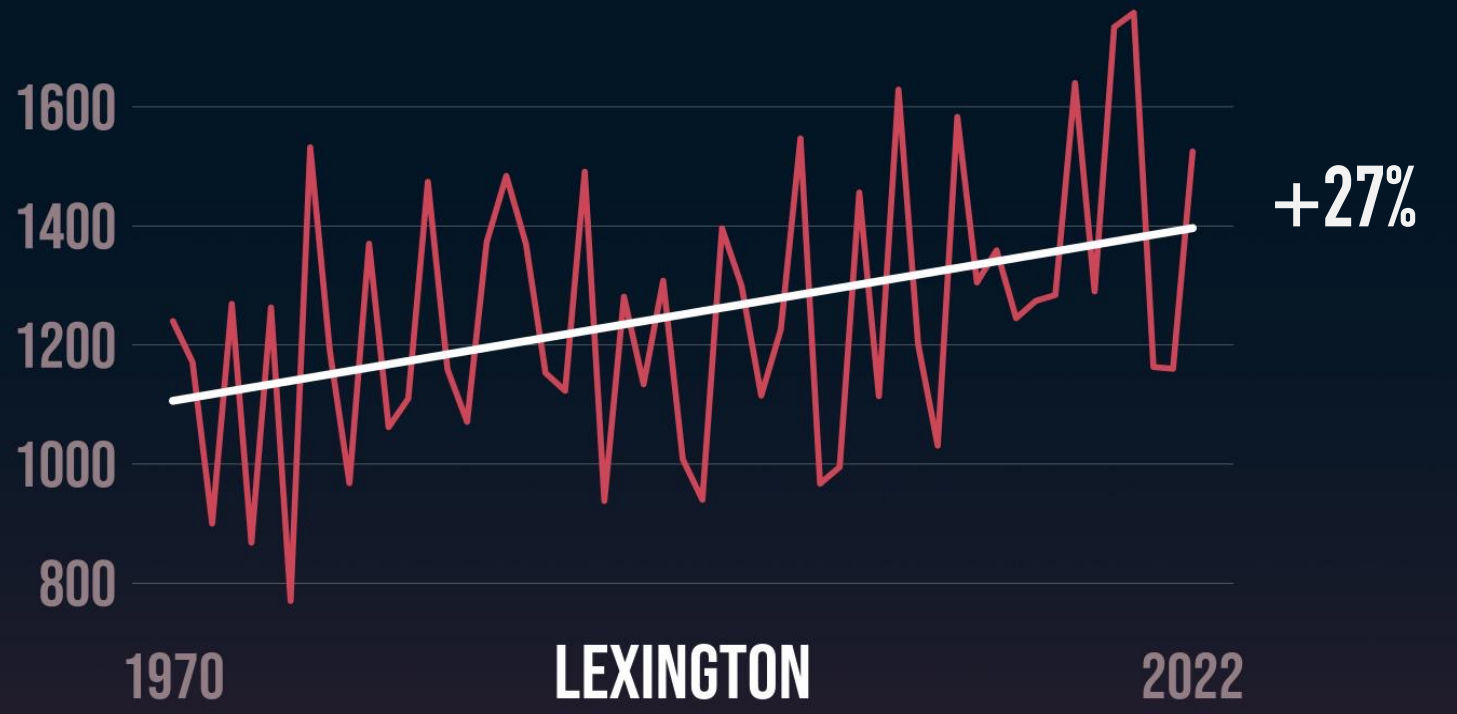


Annual back-to-school cooling degree days = sum of daily average degrees above 65°F from July 17 - September 8. Source: RCC-ACIS.org

CLIMATE CENTRAL

INCREASED COOLING DEMAND

Yearly cooling degree days



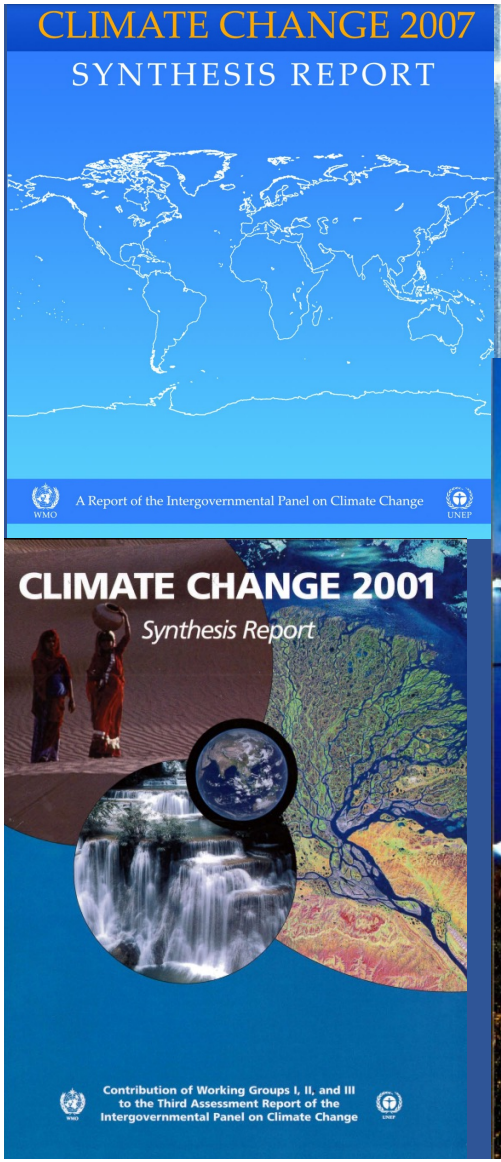
Yearly cooling degree days = annual sum of daily average degrees above 65°F
Source: RCC-ACIS.org

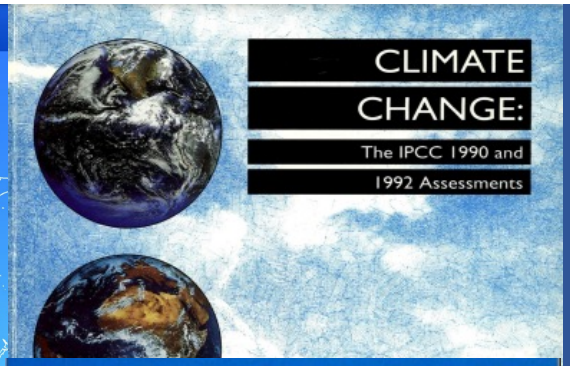
CLIMATE CENTRAL

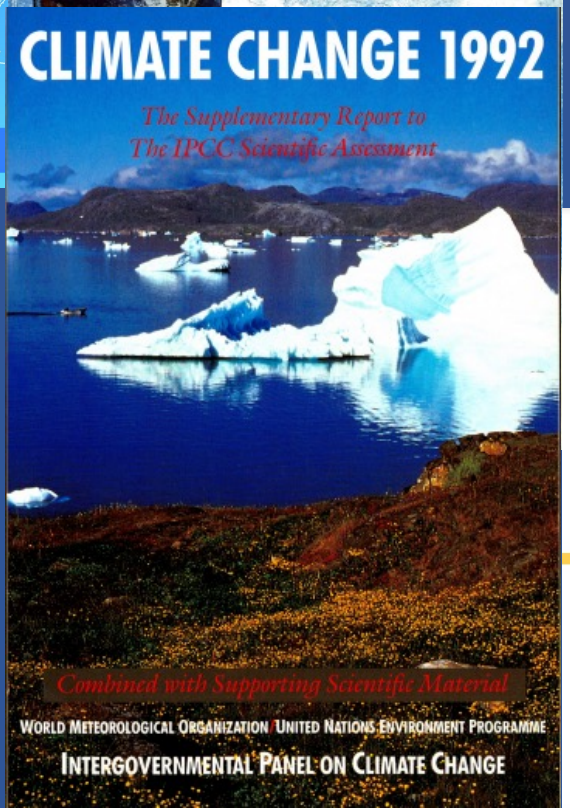
Why Does The Earth Have a Fever?

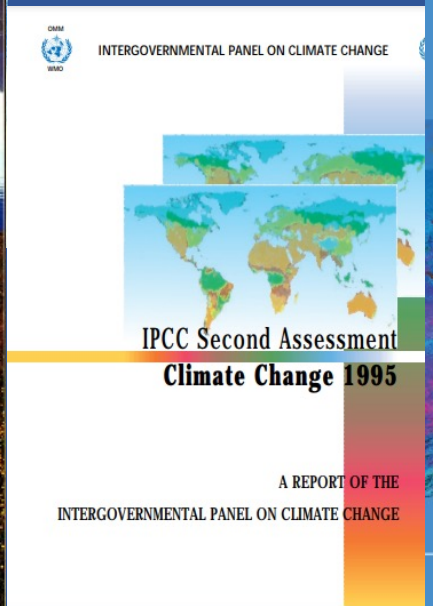
nasa.jpl.gov

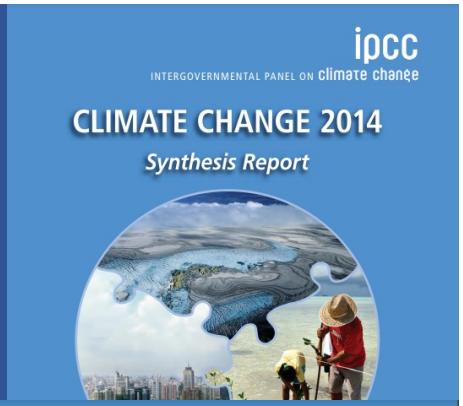
UN IPCC Assessment Reports

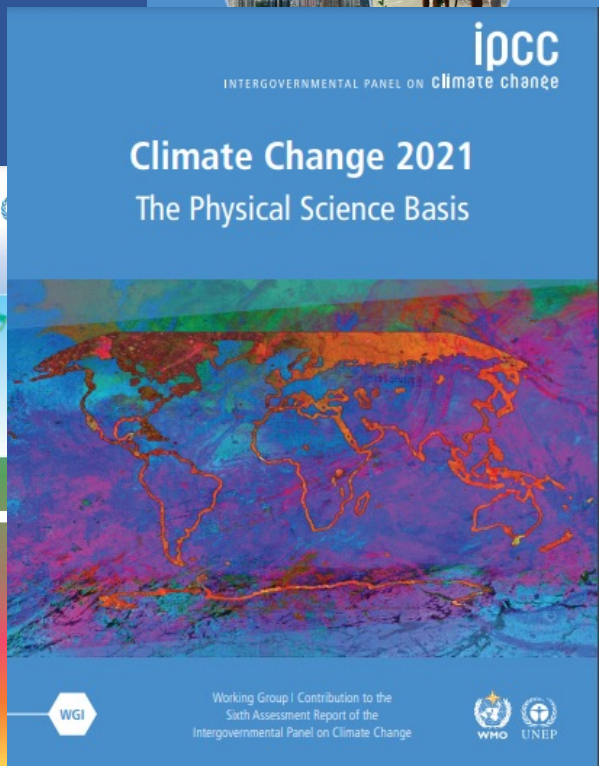






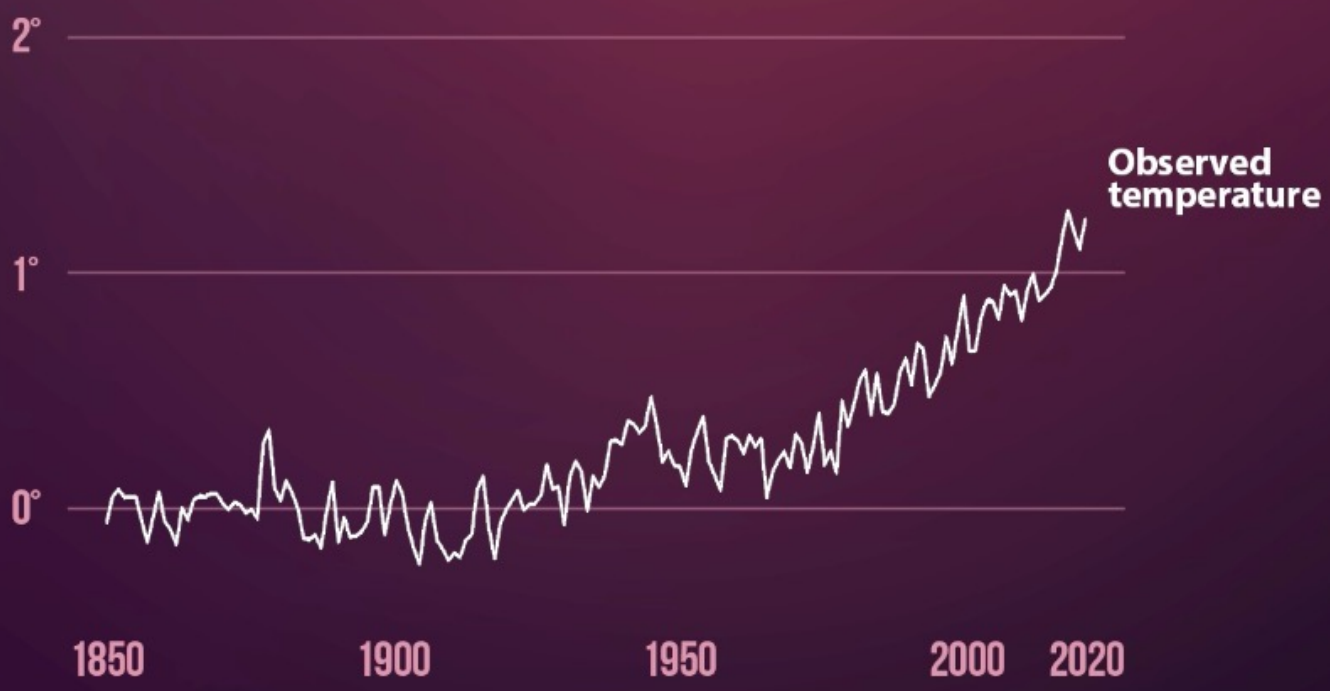






WHAT'S WARMING THE WORLD?

Global temperature change since 1850 (°C)

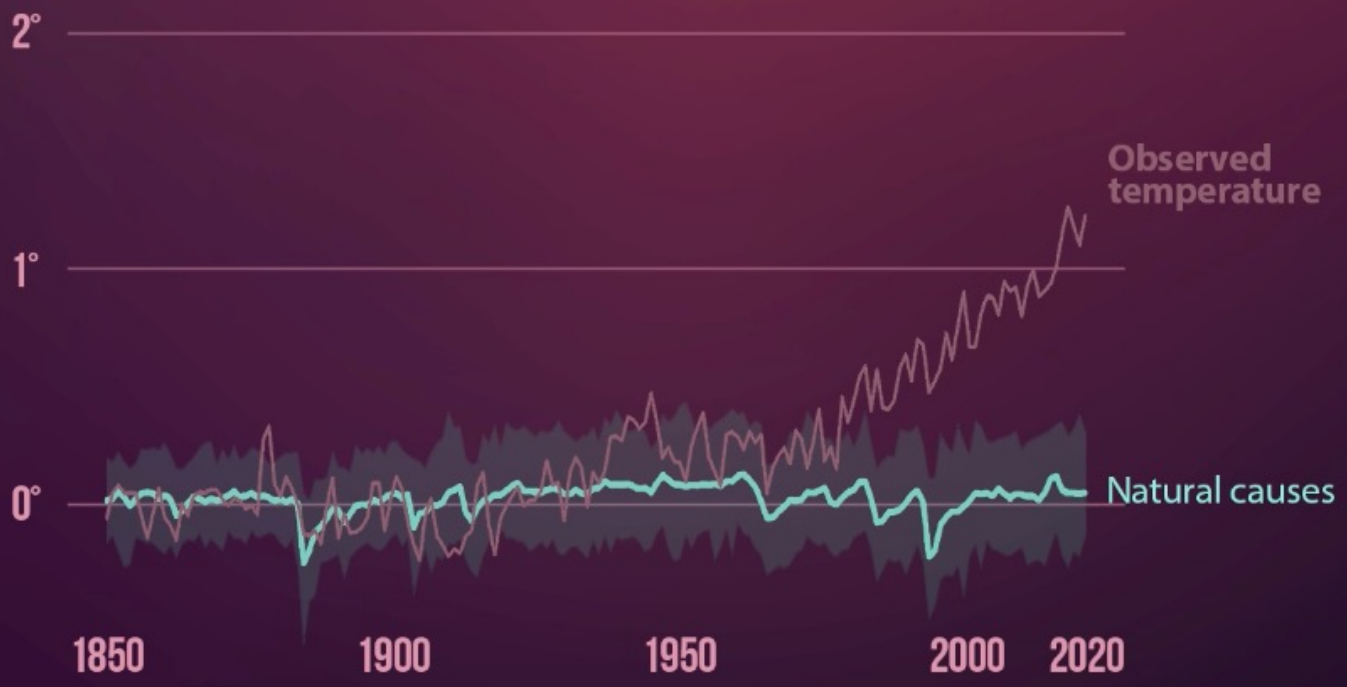


Observed global surface temperature anomalies relative to 1850-1900 (white). Modeled effects of: combined human and natural forcings (orange: including GHG emissions and aerosols); natural forcings only (green: solar activity and volcano emissions). Bands: 5-95% range of models.
Source: IPCC AR6 WGI Chapter 3 (2021)

CLIMATE CENTRAL

WHAT'S WARMING THE WORLD?

Global temperature change since 1850 (°C)

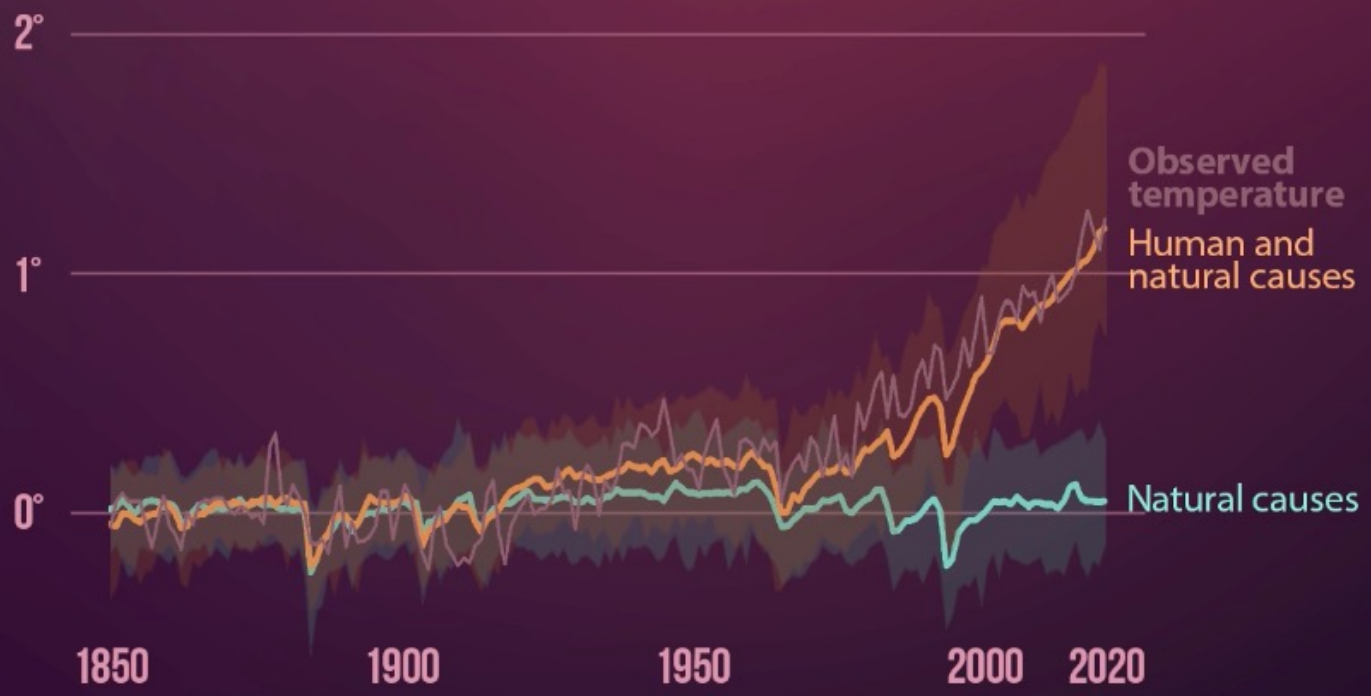


Observed global surface temperature anomalies relative to 1850-1900 (white). Modeled effects of: combined human and natural forcings (orange: including GHG emissions and aerosols); natural forcings only (green: solar activity and volcano emissions). Bands: 5-95% range of models.
Source: IPCC AR6 WGI Chapter 3 (2021)

CLIMATE CENTRAL

WHAT'S WARMING THE WORLD?

Global temperature change since 1850 (°C)

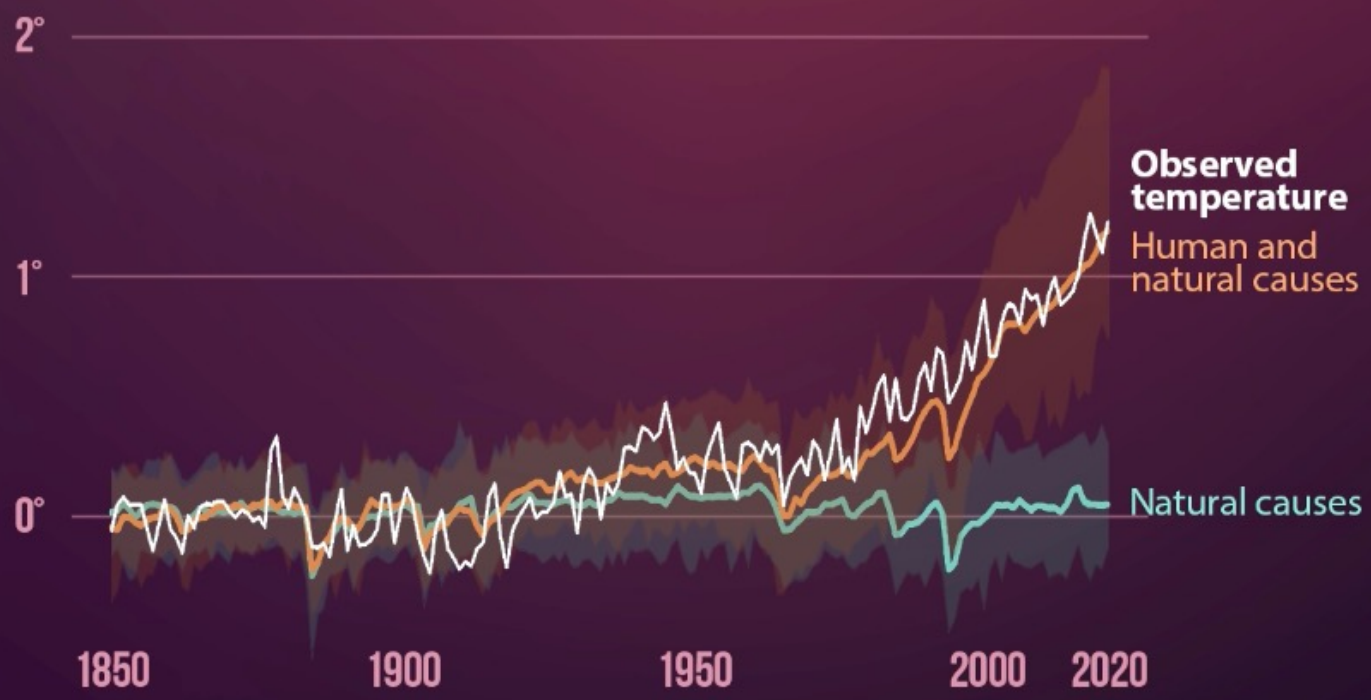


Observed global surface temperature anomalies relative to 1850-1900 (white). Modeled effects of: combined human and natural forcings (orange: including GHG emissions and aerosols); natural forcings only (green: solar activity and volcano emissions). Bands: 5-95% range of models.
Source: IPCC AR6 WGI Chapter 3 (2021)

CLIMATE CENTRAL

WHAT'S WARMING THE WORLD?

Global temperature change since 1850 (°C)



Observed global surface temperature anomalies relative to 1850-1900 (white). Modeled effects of: combined human and natural forcings (orange: including GHG emissions and aerosols); natural forcings only (green: solar activity and volcano emissions). Bands: 5-95% range of models.
Source: IPCC AR6 WGI Chapter 3 (2021)

CLIMATE CENTRAL

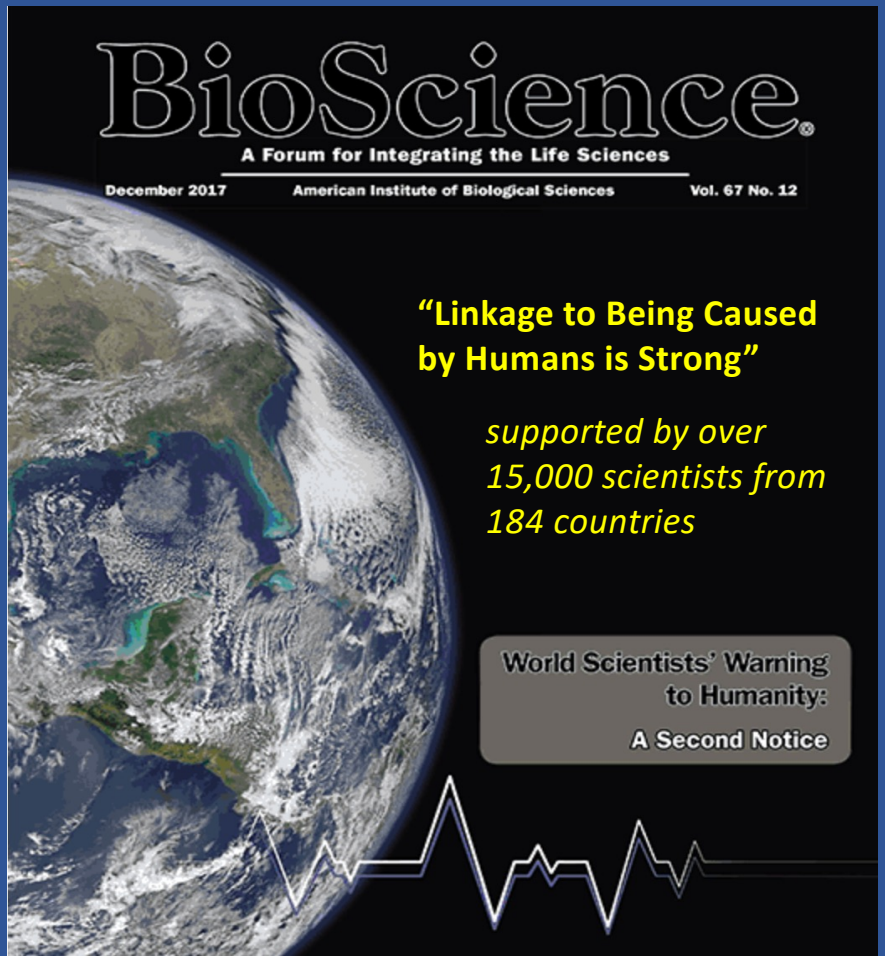
Climate Change – It Is Real
Do humans affect it?

Carbon Dioxide and Climate: A Scientific Assessment

Report of an Ad Hoc Study Group on Carbon Dioxide and Climate
Woods Hole, Massachusetts
July 23–27, 1979
to the
Climate Research Board
Assembly of Mathematical and Physical Sciences
National Research Council

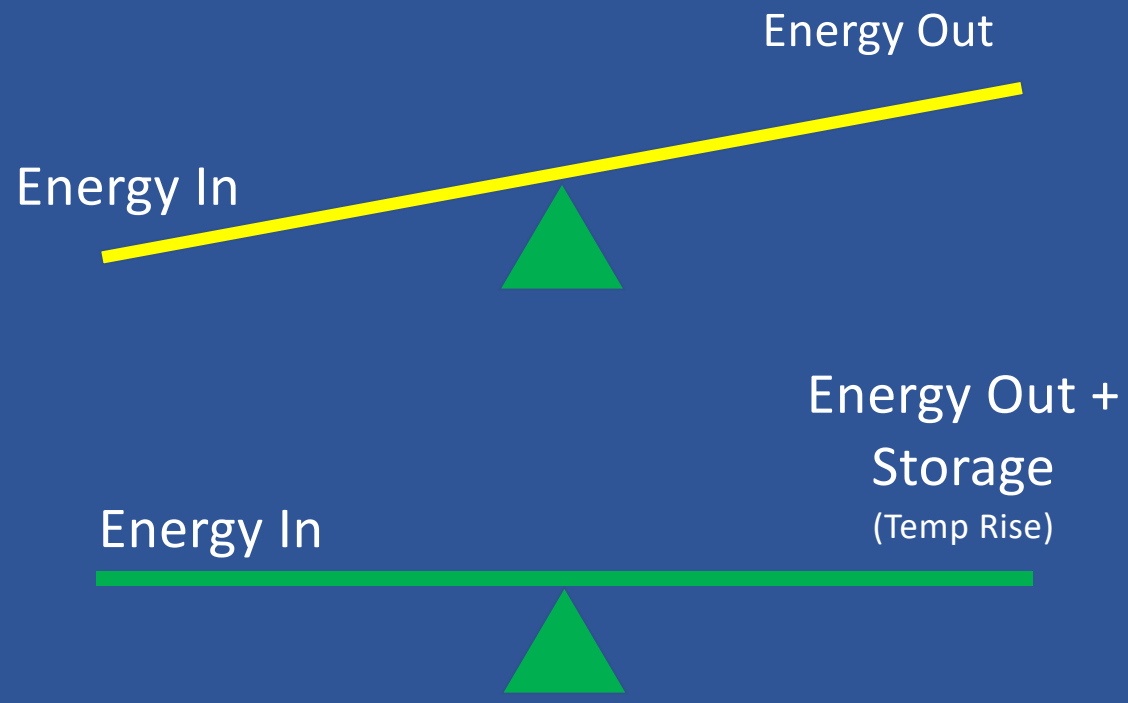
"It's Linked to CO2 Increase"

DOI: 10.17226/12181

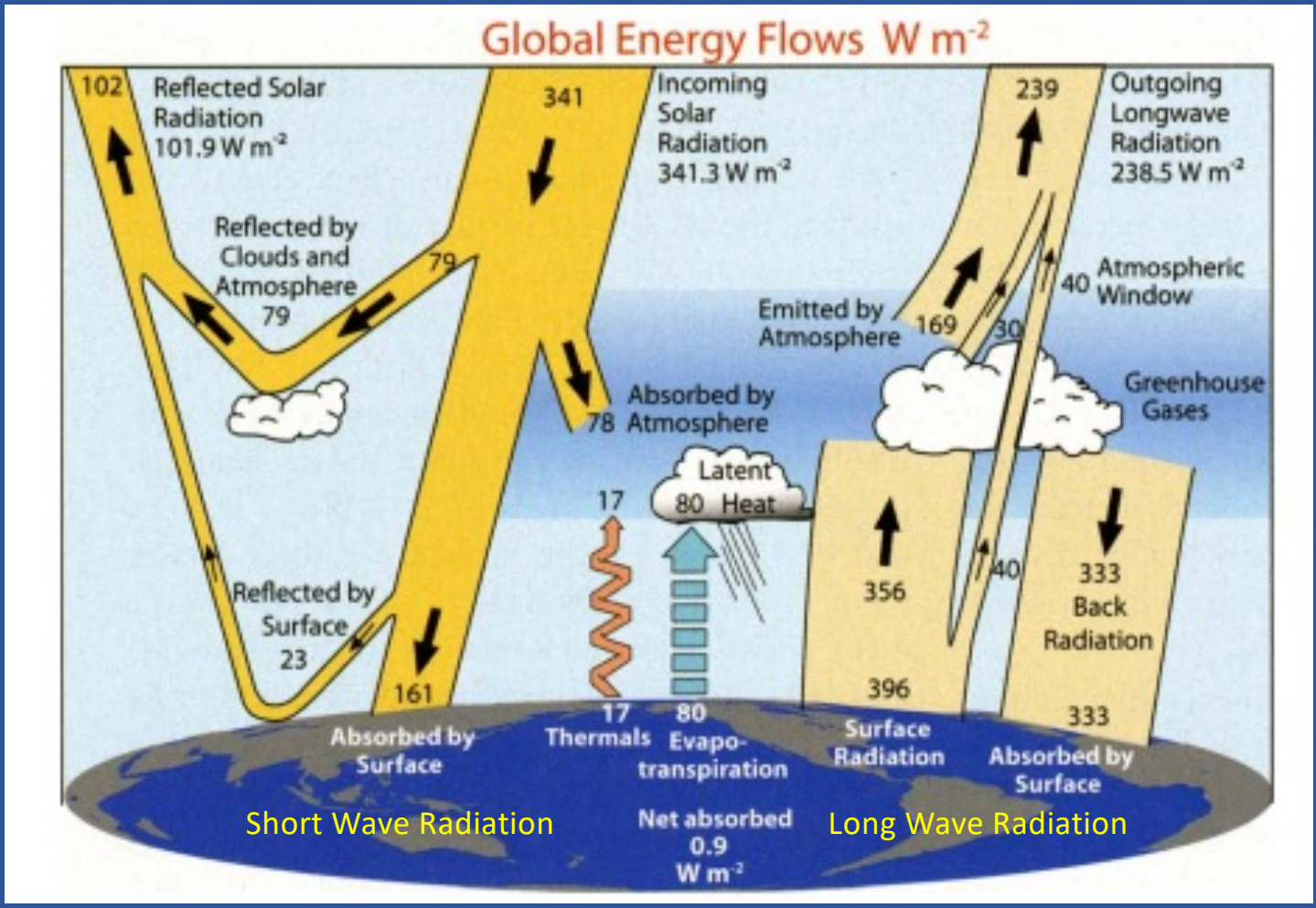



The Earth is Warming – and
Humans are Causing It

Why Does the Earth Have a Fever?
Look at the Energy Balance



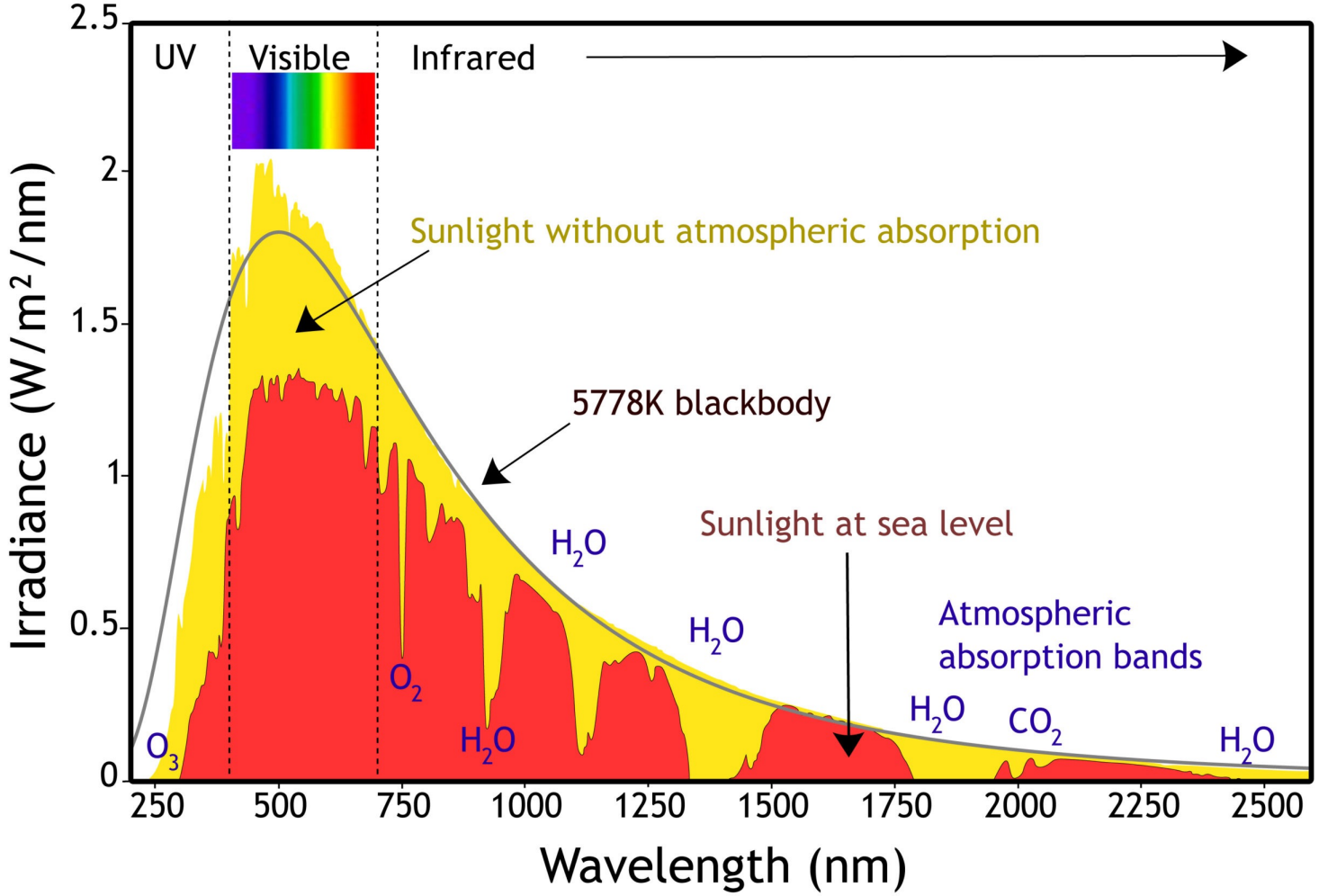
Sun – Earth Energy Balance

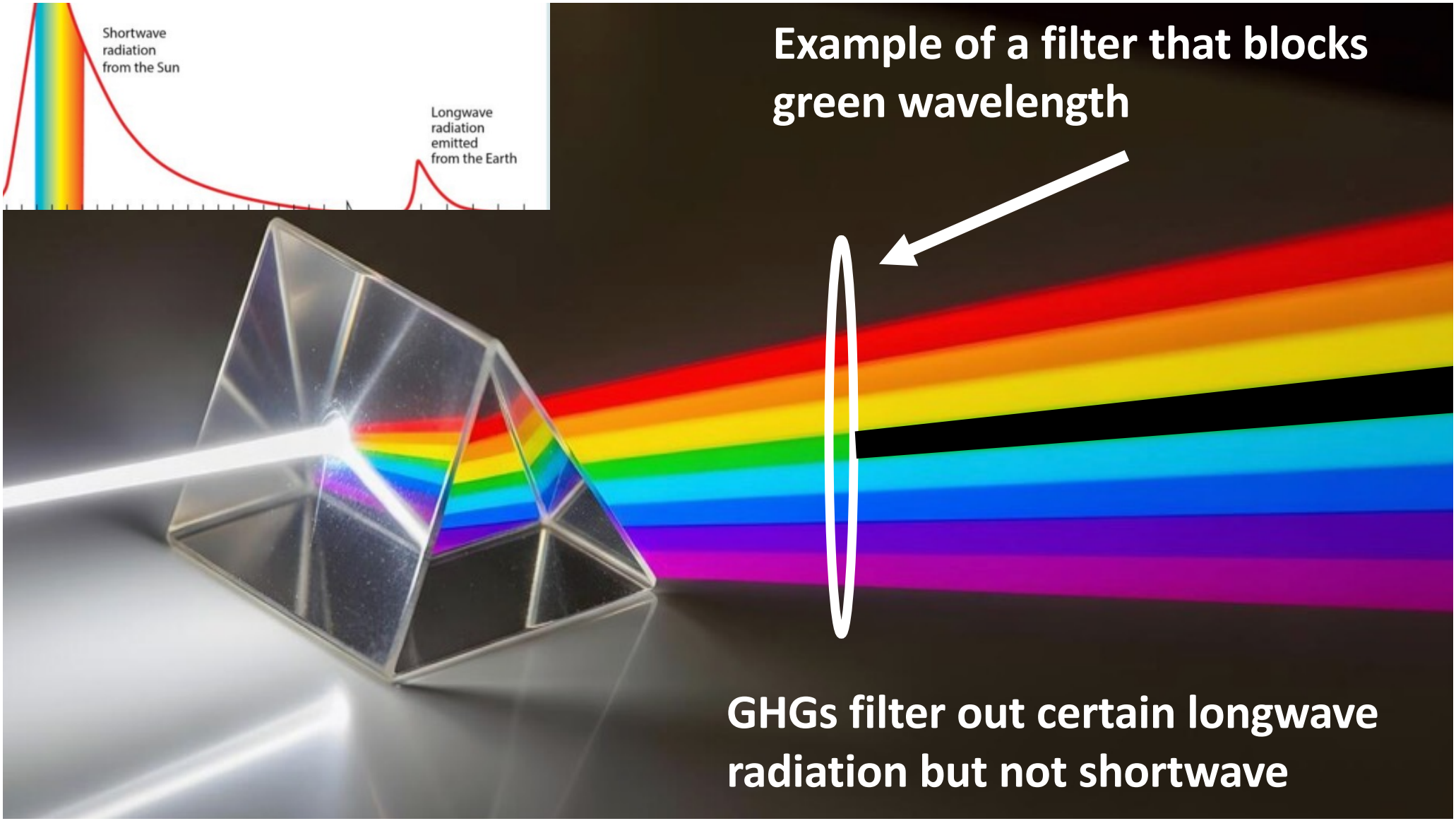


DOI: 10.1175/2008BAMS2634.I

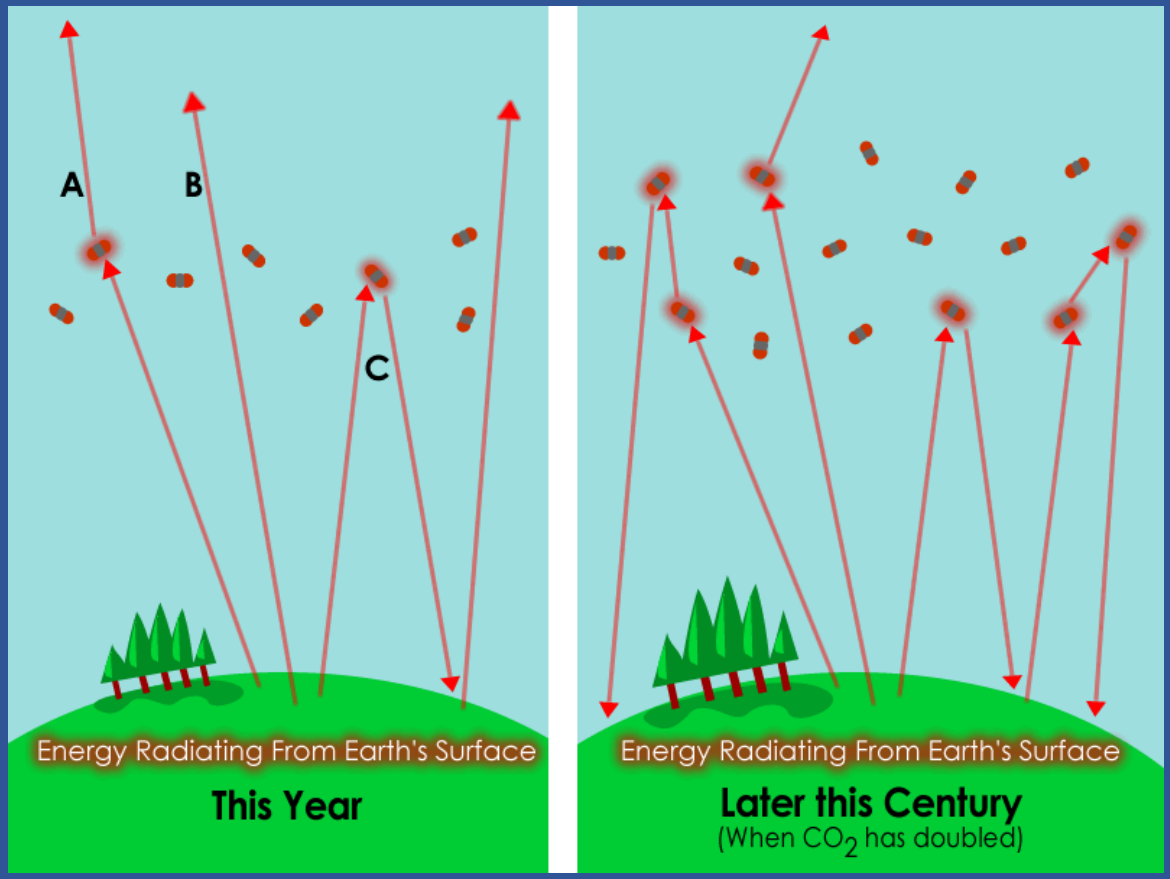
The global annual mean Earth's energy budget for the Mar 2000 to May 2004 period (W/m^2)

Spectrum of Solar Radiation (Earth)

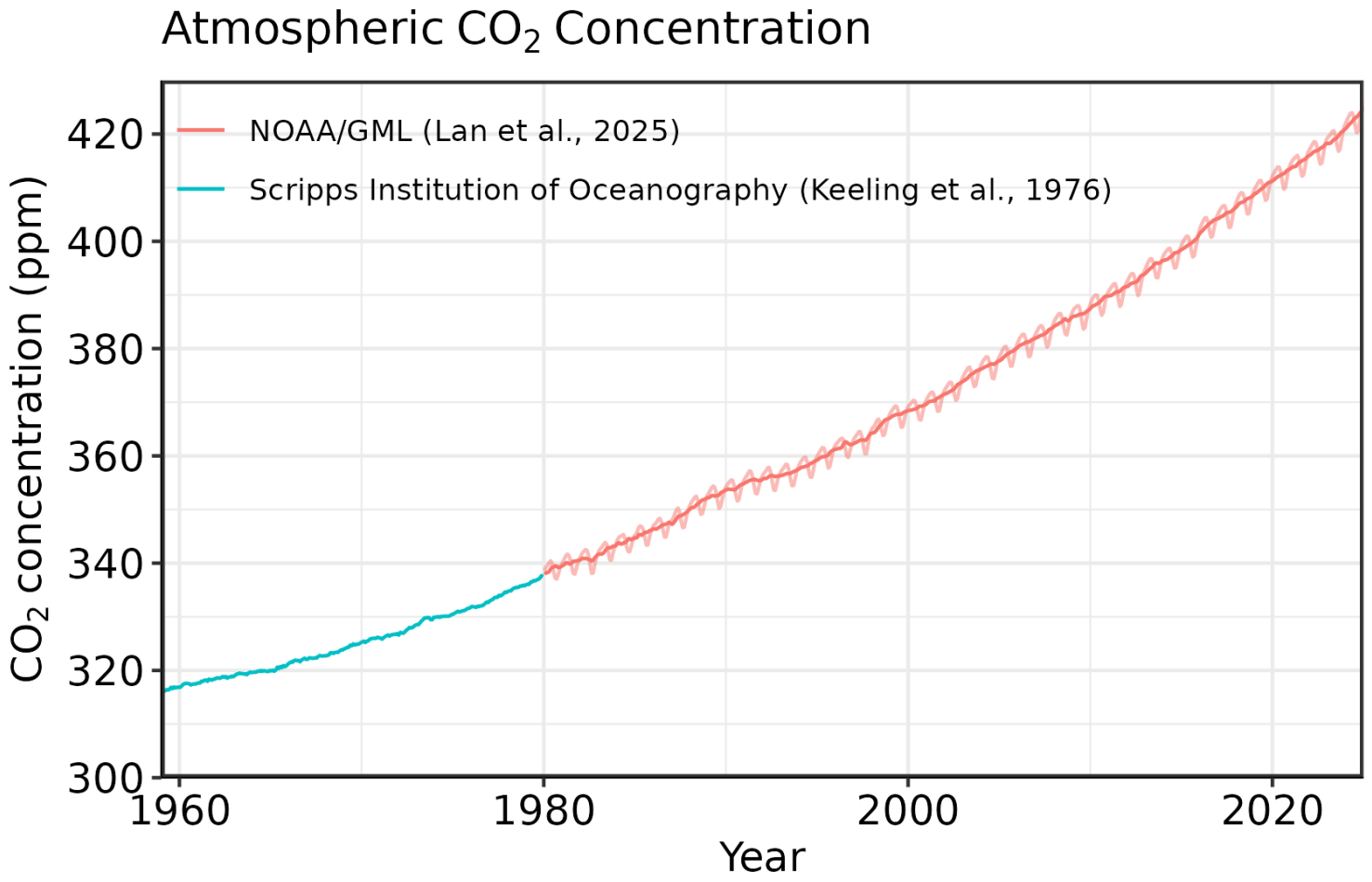



Shortwave radiation from the Sun
Longwave radiation emitted from the Earth
Example of a filter that blocks green wavelength
GHGs filter out certain longwave radiation but not shortwave

Sun – Earth Energy Balance
Impact of Additional GHGs

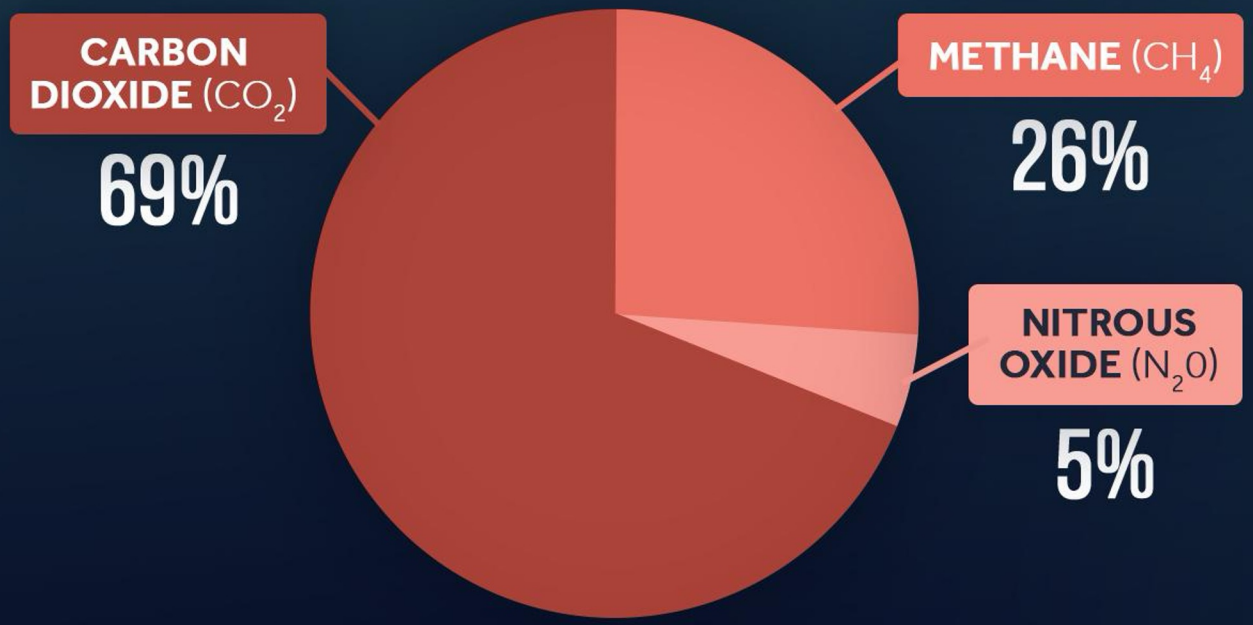


- https://scied.ucar.edu/learning-zone/how-climate-works/greenhouse-effect



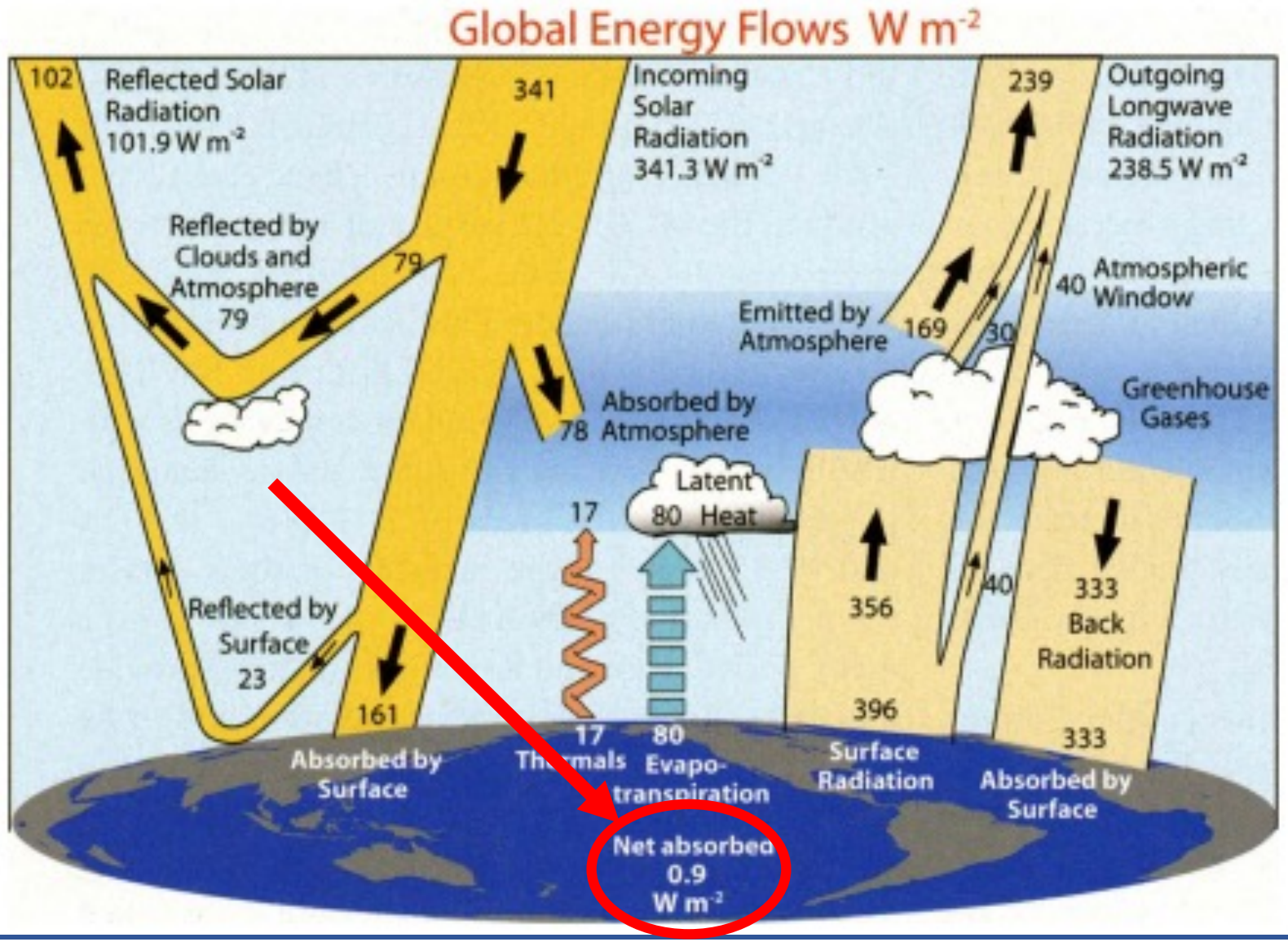
Source: Global Carbon Budget

WARMING FROM MAIN GREENHOUSE GASES



CO2, CH4, and N2O are key human-driven GHGs widely regulated by the UNFCCC.
Source: Jones et al. (2023)

CLIMATE CENTRAL


Global Energy Flows W m-2
102
Reflected Solar Radiation 101.9 W m-2
341
Incoming Solar Radiation 341.3 W m-2
239
Outgoing Longwave Radiation 238.5 W m-2
Reflected by Clouds and Atmosphere 79
79
Emitted by Atmosphere
169
30
40
Atmospheric Window
Absorbed by 78 Atmosphere
Greenhouse Gases
Latent 80 Heat
17
Reflected by Surface 23
161
356
40
333 Back Radiation
396
333
17 Thermals
80 Evapo-transpiration
Absorbed by Surface
Surface Radiation
Absorbed by Surface
Net absorbed 0.9 W m-2

DOI: 10.

Where is the energy stored?

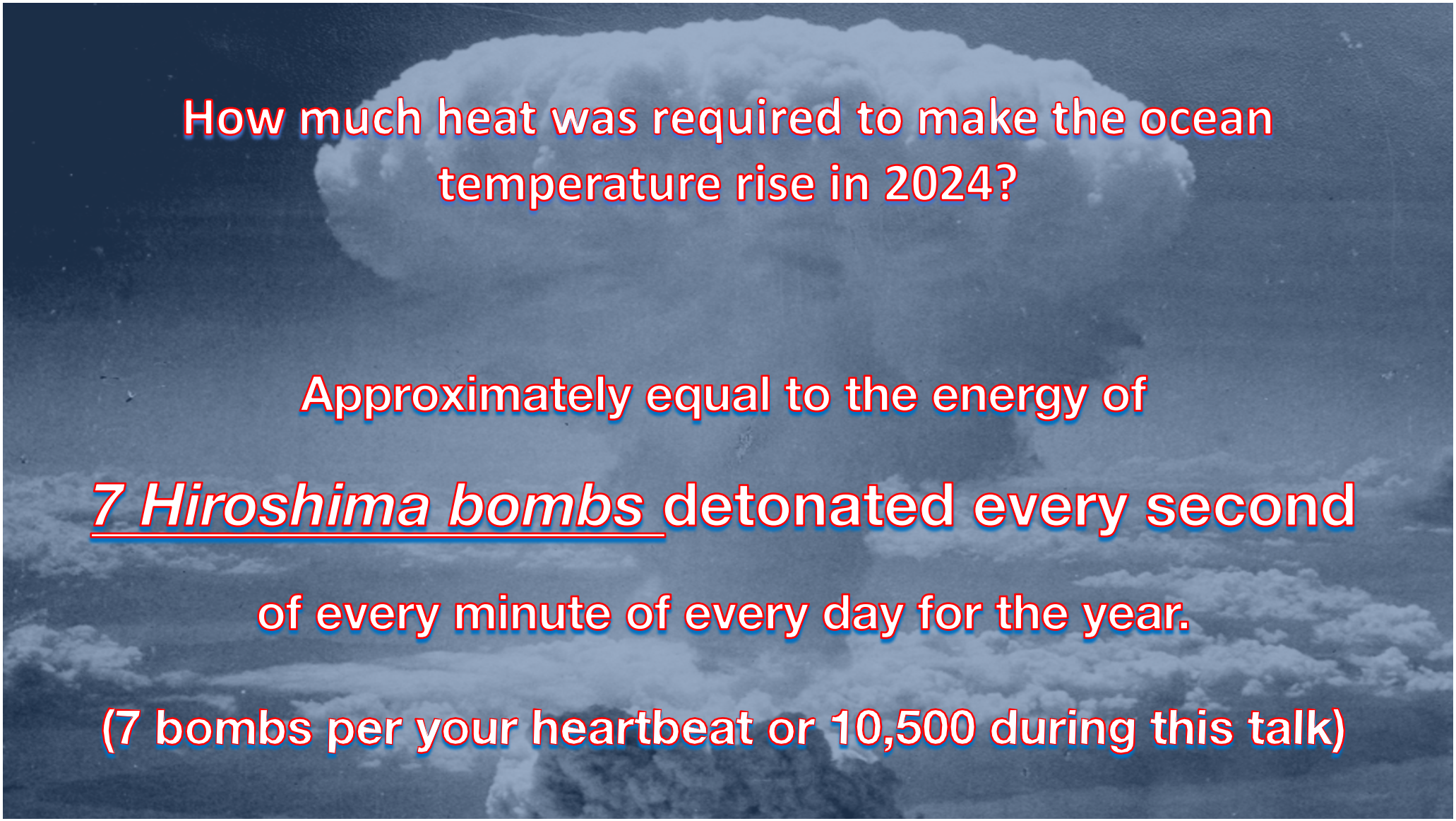
Oceans - and ocean temperatures drive weather

How much heat was required to make the Ocean Temperature Rise in 2024?

The amount of heat trapped in the ocean from global warming in 2024 was 16 sextillion j/yr or

16,000,000,000,000,000,000,000 j/yr

1 WMO State of the Climate – Update for COP30


How much heat was required to make the ocean temperature rise in 2024?
Approximately equal to the energy of
7 Hiroshima bombs detonated every second
of every minute of every day for the year.
(7 bombs per your heartbeat or 10,500 during this talk)

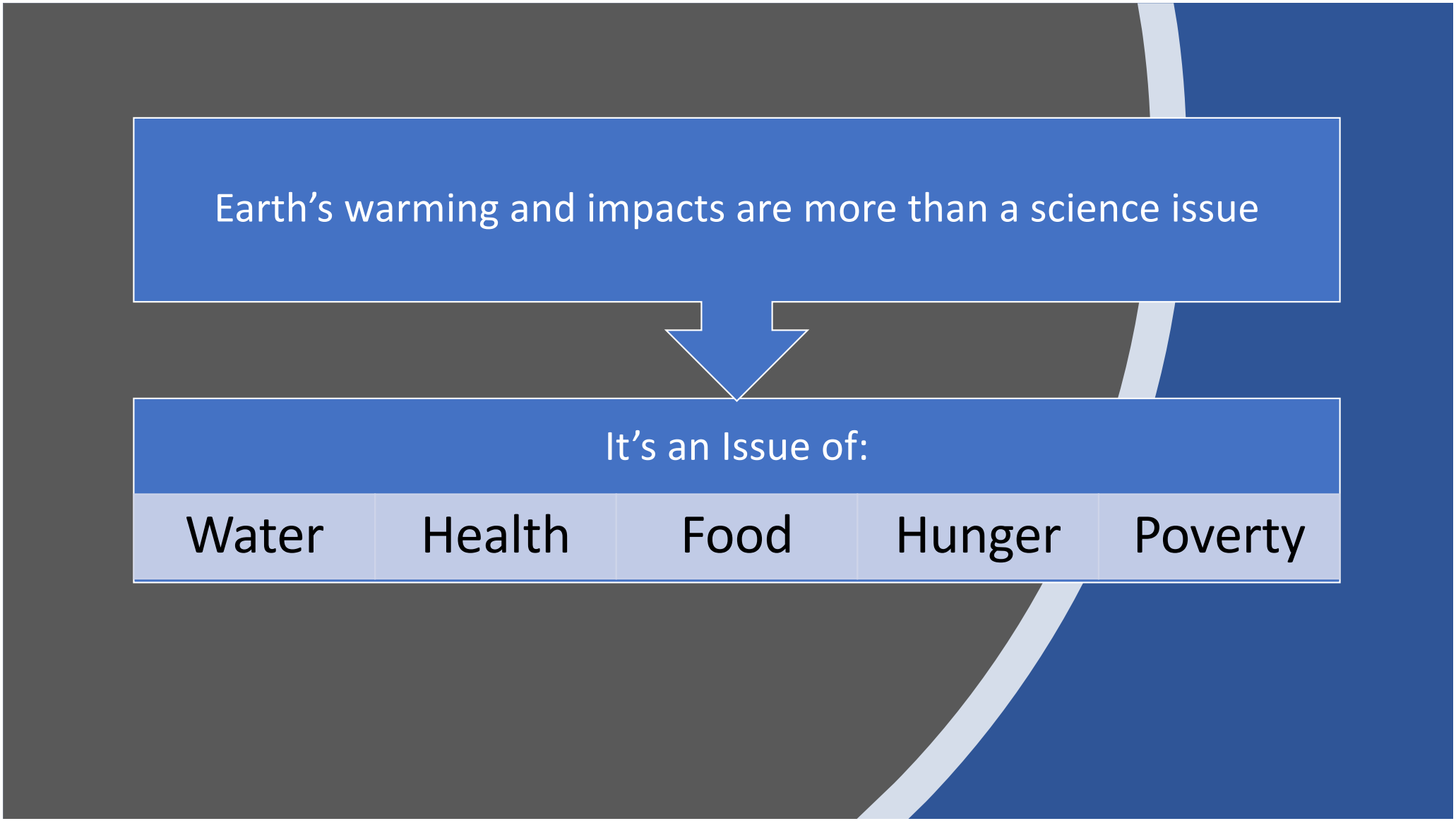
Why Does It Matter?

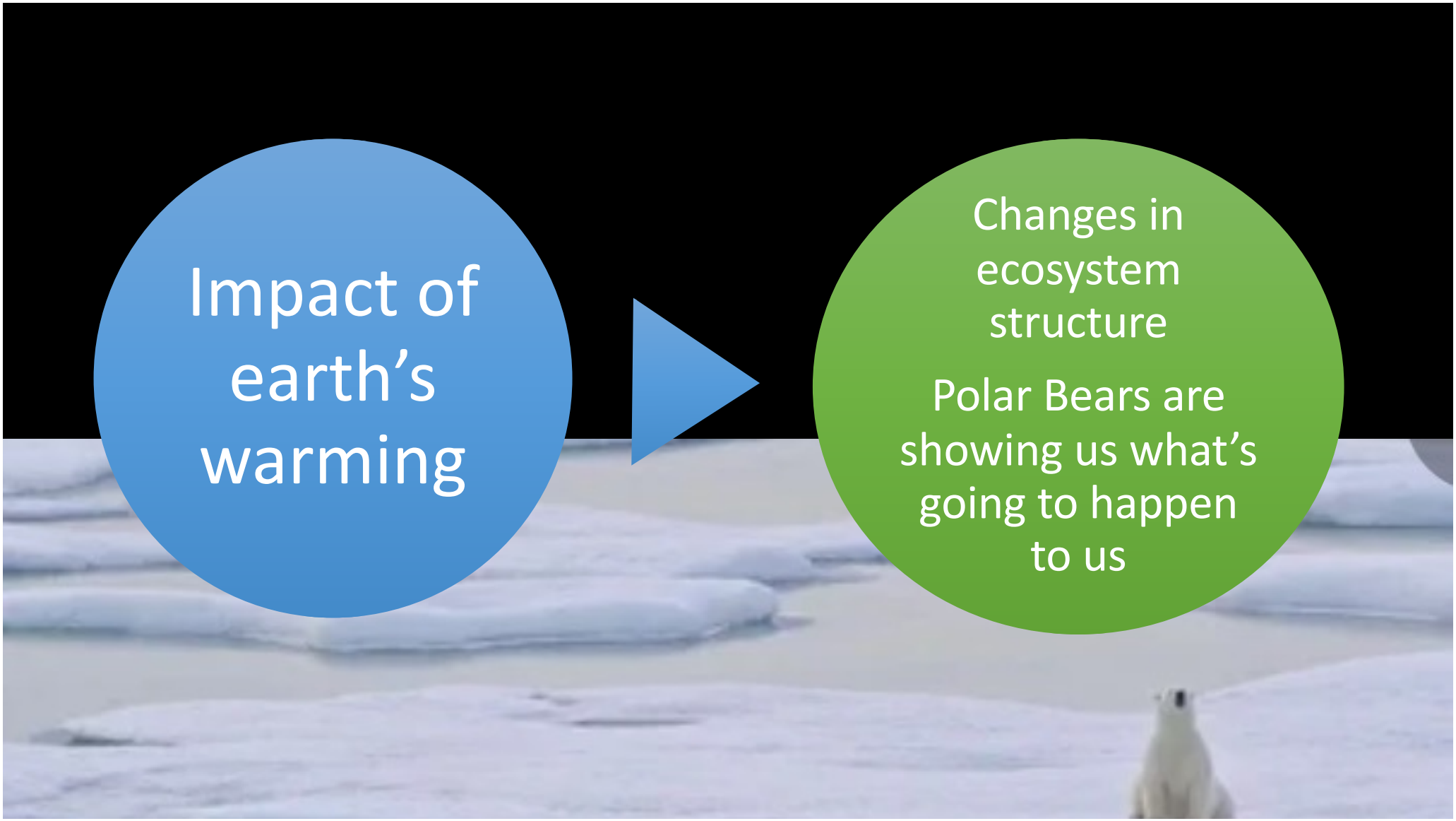
Human's Fever = Other Problems

Earth's Fever ≠ Primary Issue

THE EARTH WILL SURVIVE

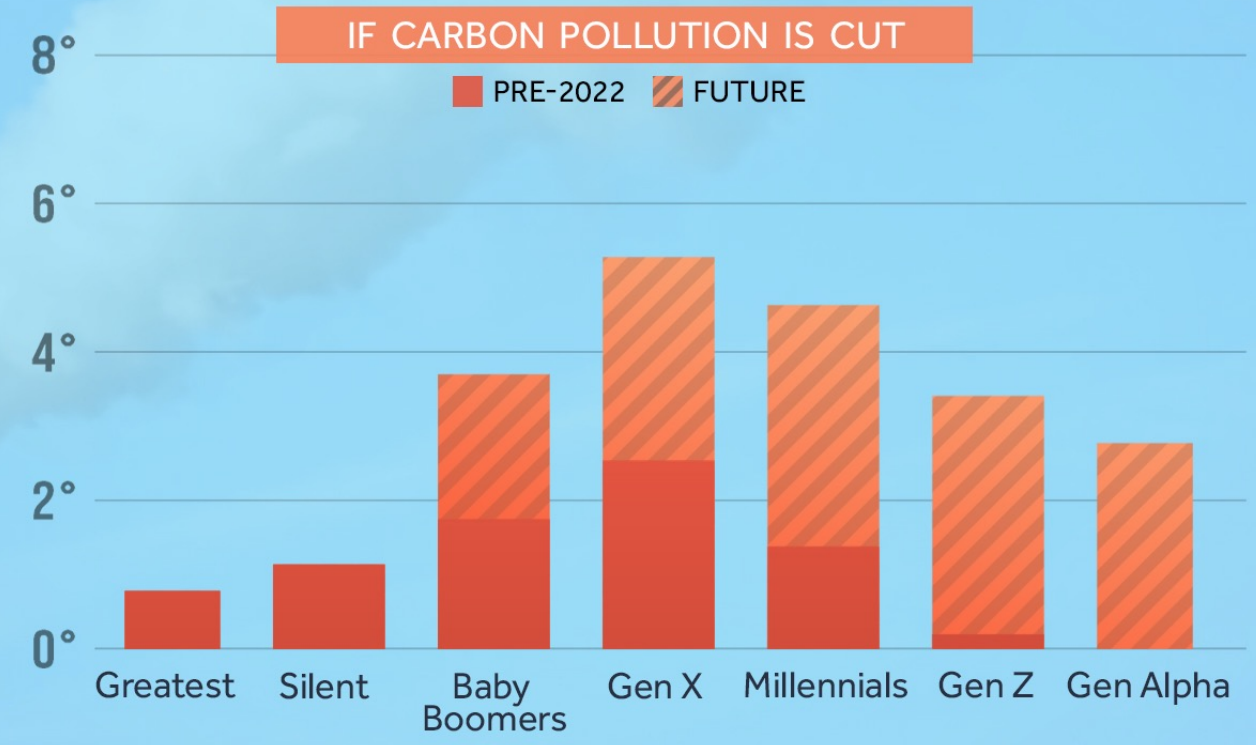
It's the impact on our human systems that are at risk


Earth’s warming and impacts are more than a science issue
It’s an Issue of:
Water
Health
Food
Hunger
Poverty


Impact of earth's warming
Changes in ecosystem structure
Polar Bears are showing us what's going to happen to us

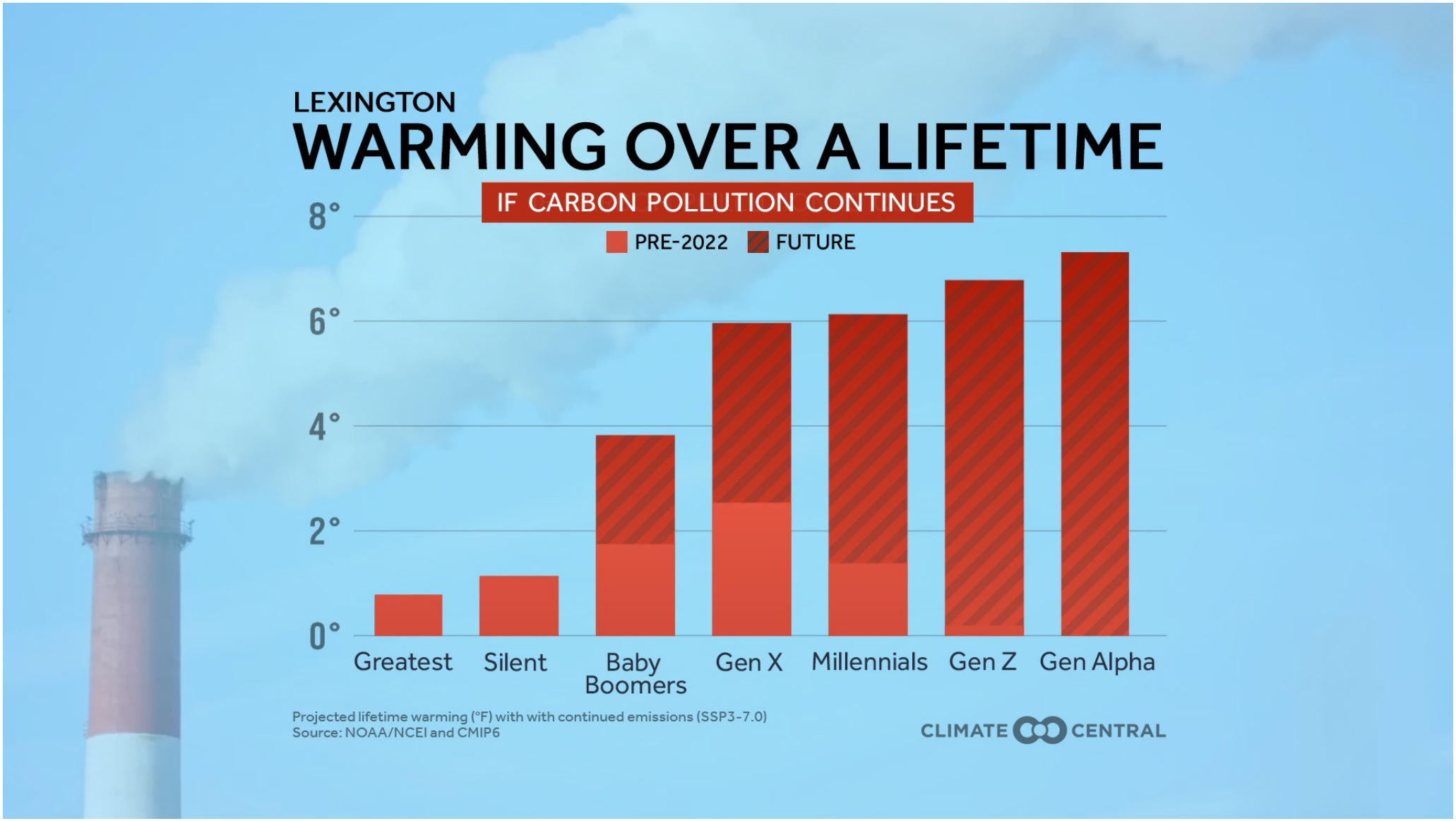
LEXINGTON

WARMING OVER A LIFETIME

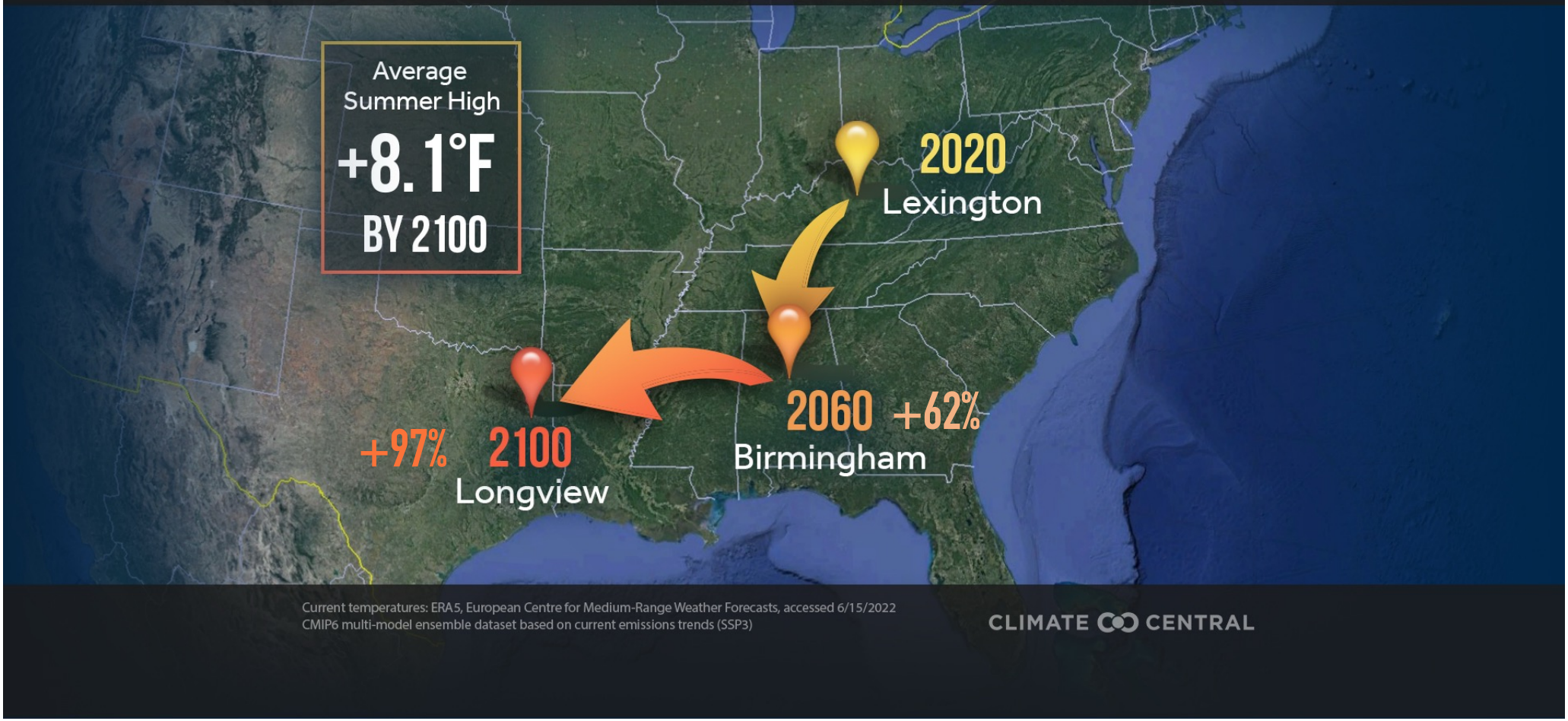


Projected lifetime warming (°F) with significant emissions cuts (SSP1-2.6)
Source: NOAA/NCEI and CMIP6

CLIMATE CENTRAL

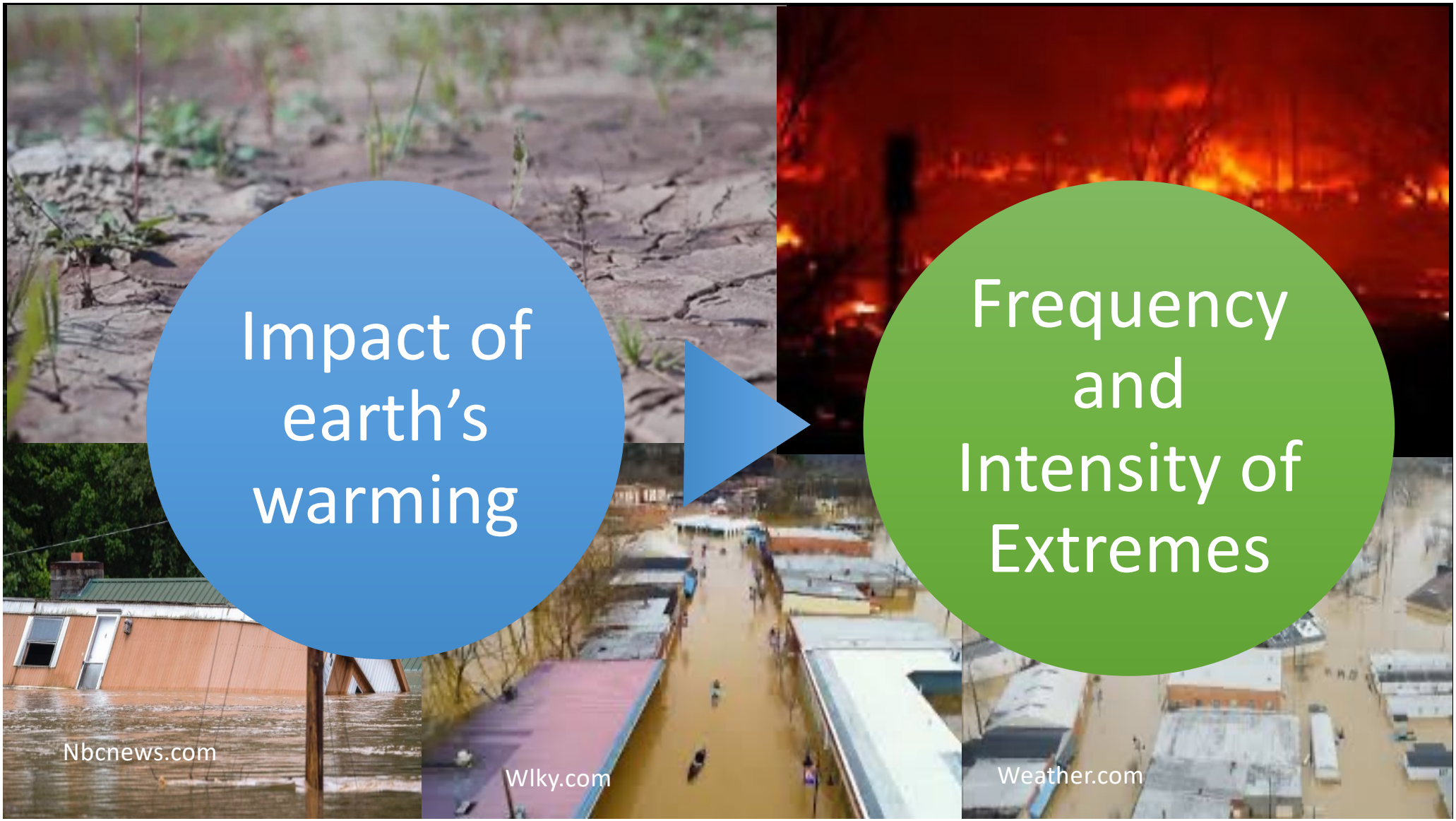

LEXINGTON
WARMING OVER A LIFETIME
IF CARBON POLLUTION CONTINUES
PRE-2022
FUTURE
8°
6°
4°
2°
0°
Greatest
Silent
Baby Boomers
Gen X
Millennials
Gen Z
Gen Alpha
Projected lifetime warming (°F) with with continued emissions (SSP3-7.0)
Source: NOAA/NCEI and CMIP6
CLIMATE CENTRAL

WHERE OUR SUMMER IS HEADED



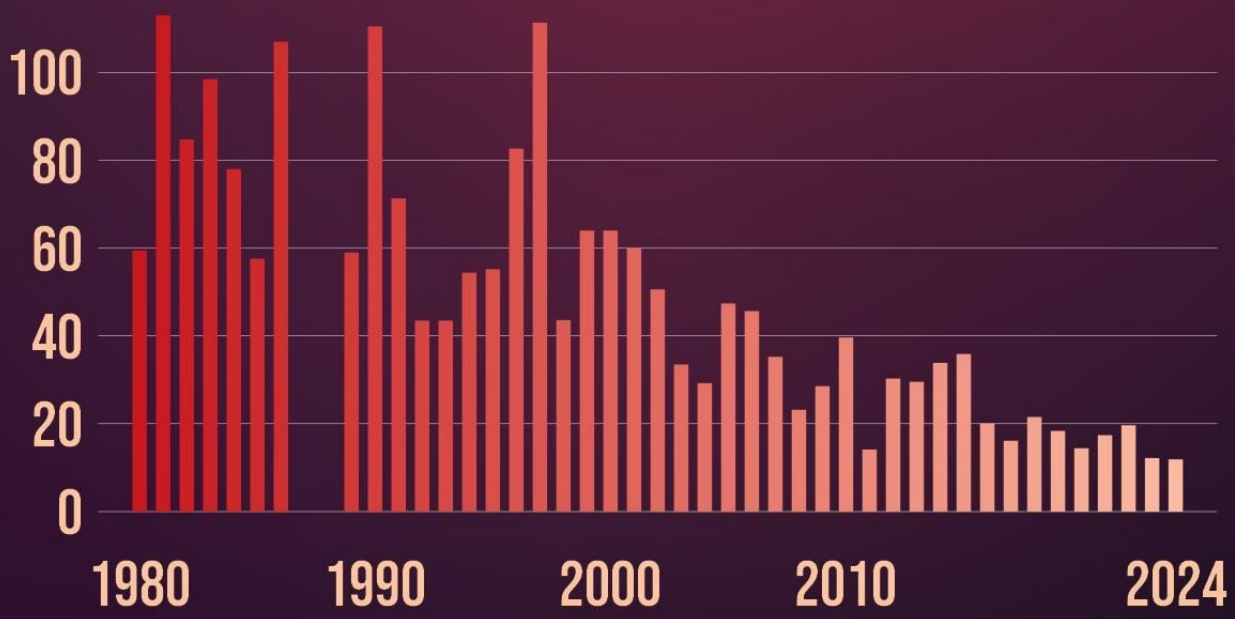
Current temperatures: ERA5, European Centre for Medium-Range Weather Forecasts, accessed 6/15/2022
CMIP6 multi-model ensemble dataset based on current emissions trends (SSP3)

CLIMATE CENTRAL


Impact of earth's warming
Frequency and Intensity of Extremes
Nbcnews.com
Wlky.com
Weather.com

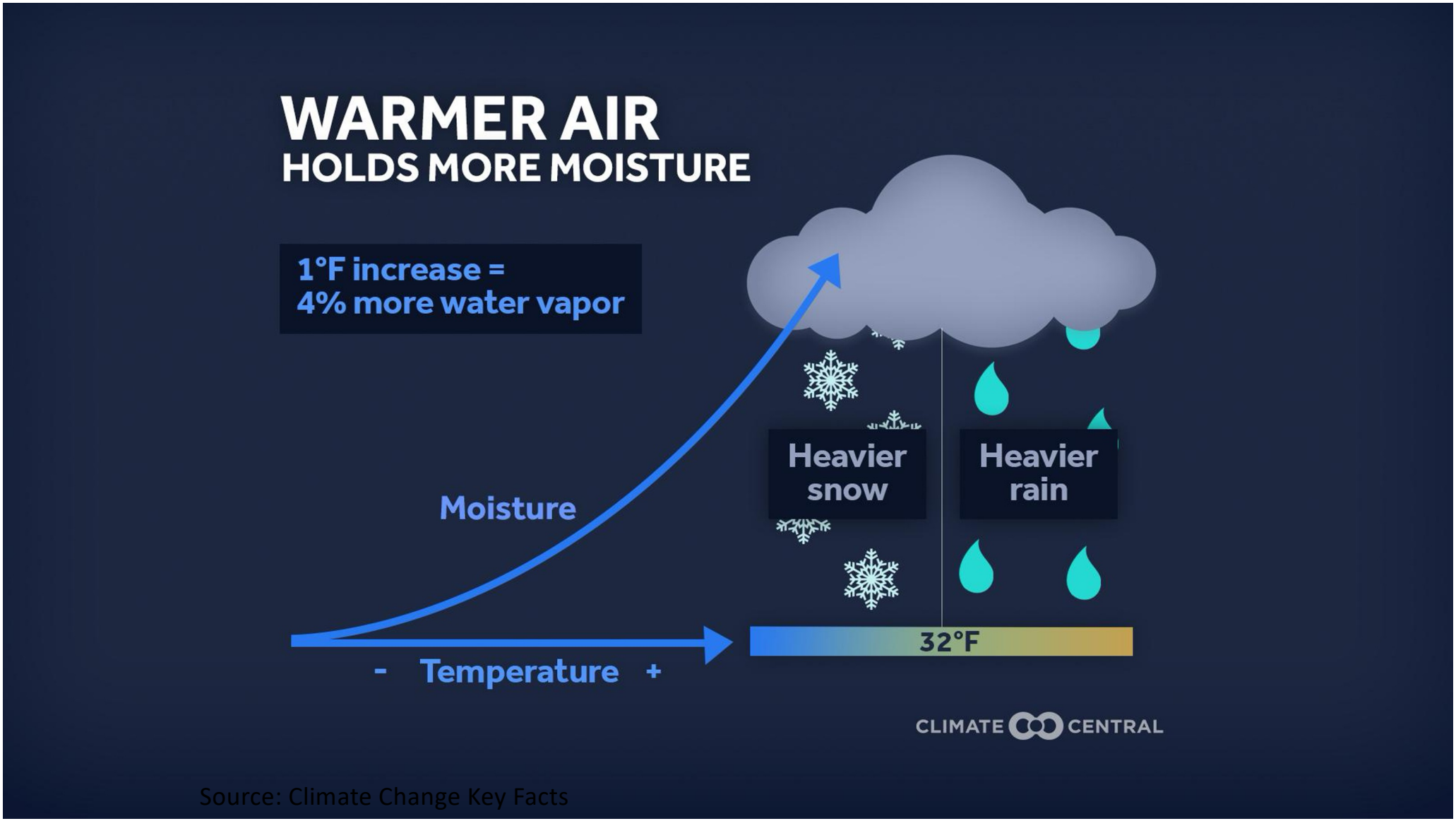
LESS TIME BETWEEN DISASTERS

Days between billion-dollar events



Average number of days between billion-dollar disasters each calendar year.
No disasters in 1987; one in 1988. Data through 12/31/2024.
Source: NOAA/NCEI

CLIMATE CENTRAL

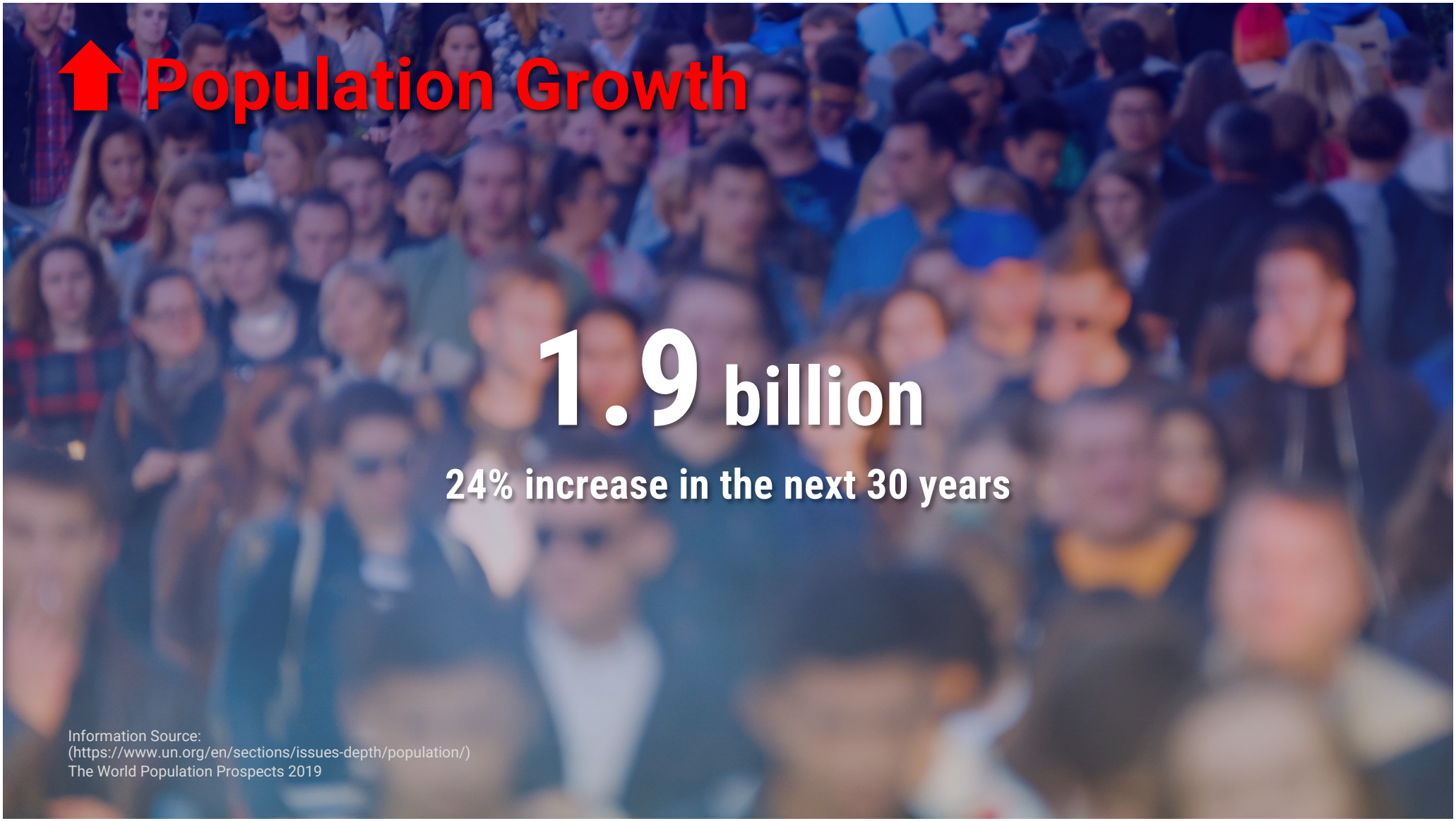


Source: Climate Change Key Facts


Extreme heat
CDC.gov
Air pollution
nationalgeographic.com
Water borne diseases
E. Coli USGS.gov
tyson.com
Impact of earth's warming
physical health
mental health
and wellbeing
Extreme event trauma
thedailybeast.com
Poverty
rk Times
Loss of culture

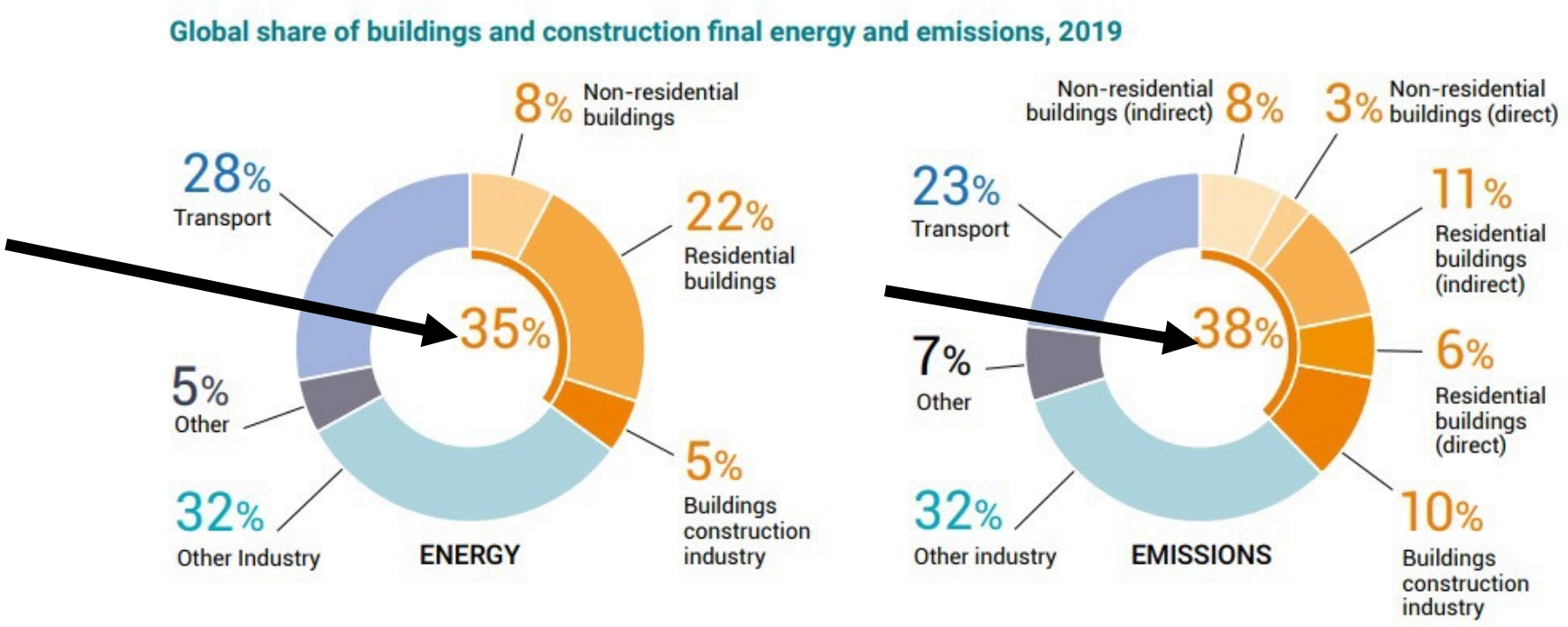

“What Can WE Do?

Three Opportunities


Population Growth
1.9 billion
24% increase in the next 30 years
Information Source:
(https://www.un.org/en/sections/issues-depth/population/)
The World Population Prospects 2019

Information Source: https://architecture2030.org/new-buildings-operations/
By 2060, the world is projected to add 230 billion m² (2.5 trillion ft²) of buildings, or an area equal to the entire current global building stock*. This is the equivalent of adding an entire New York City to the planet every 34 days for the next 40 years.
*UN Environment, Global Status Report 2017

Energy Usage and Anthropogenic Source of Emissions



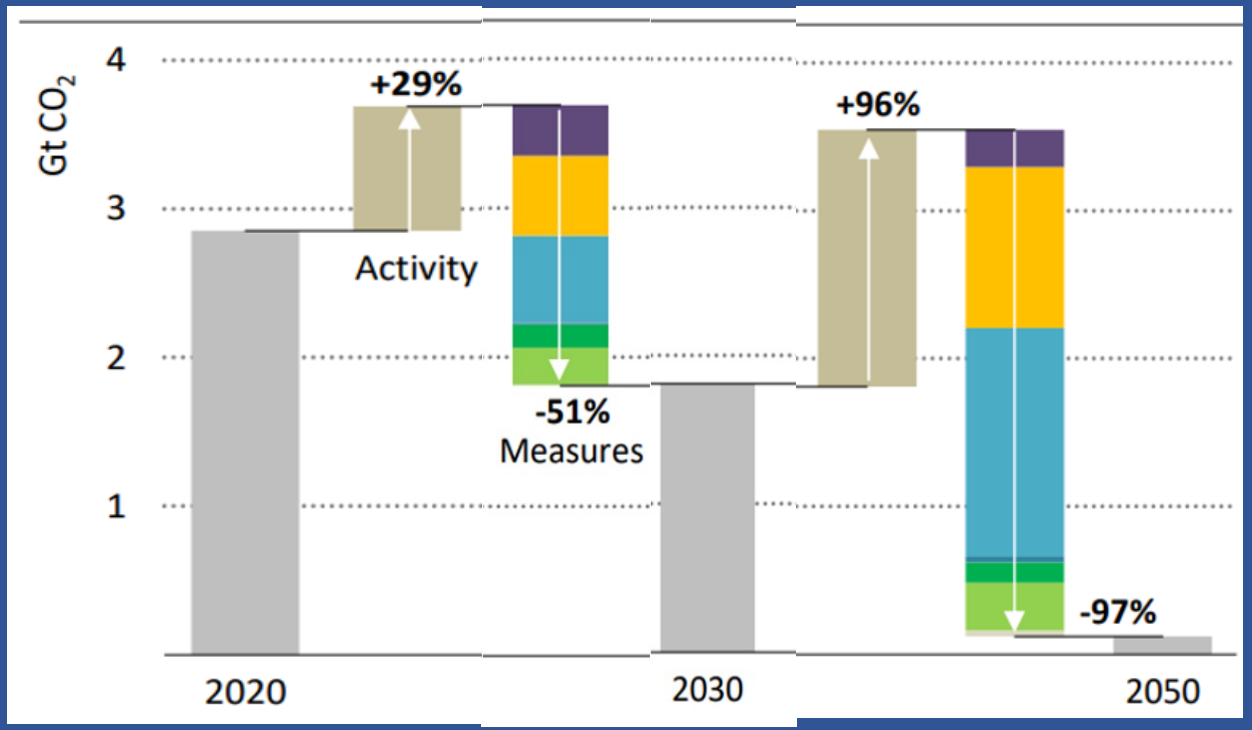
Notes: Buildings construction industry is the portion (estimated) of overall industry devoted to manufacturing building construction materials such as steel, cement and glass. Indirect emissions are emissions from power generation for electricity and commercial heat.

Sources: (IEA 2020d; IEA 2020b). All rights reserved. Adapted from "IEA World Energy Statistics and Balances" and "Energy Technology Perspectives".

IEA's Key Pillars of Decarbonization

Net Zero by 2050 Roadmap

Figure 3.27 ▷ **Global direct CO_2 emissions reductions by mitigation measure in buildings in the NZE**



IEA, May 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector


What Can We Do Locally?
Educate / Be Leaders
Turn Things Off
Use Energy More Efficiently
Use Low Carbon Energy Sources
Convert to Renewables
Land Use Management
New Zion
Monterey
Duckers
Fenwick
Versailles
Westmoreland
Lexington
Columbus
Centerville
Locust Grove

“Why do we have to make changes now?”

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“How many contacts with carcinogenic materials can I have before I get Cancer?”

We can’t ask how much we can delay our actions before the extreme events hit us

THE TIME FOR ACTION IS NOW

Thank You

- The earth has a fever – CO_2 is major cause
- Humans are responsible
- Energy In = Energy Out + Storage
- GHGs are causing the energy out to be reduced – Therefore storage (heating is occurring)
- Climate models are based on energy balance
- Building decarbonization can play a big role in reducing the GHGs produced

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Good Resources:

https://iea.blob.core.windows.net/assets/5306bae2-1f99-402f-8d14-542bfa0ae96e/WorldEnergyOutlook2025.pdf
https://www.climatecentral.org
https://unfccc.int/sites/default/files/resource/Yearbook_GCA_2025.pdf
https://library.wmo.int/records/item/69674-state-of-the-climate-update-for-cop30