

**Climate Disruption Basics:
Science, Impacts,
& How to Avoid the Worst**

May 16, 2024

New Jersey Sierra Club

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CLIMATE CHANGE



Healthcare!

Immigration!

Guns!

Free school!

Justice!

Legal weed!

- 1) We've known about this for a long time, the impacts are becoming obvious, and it's getting worse
- 2) We're not on track to solve the problem soon enough to avoid major impacts; more actions are needed
- 3) Local actions won't be sufficient; only steps that lead to national and international measures will save us from major impacts

1) We've known about this for a long time, the impacts are becoming obvious, and it's getting worse



Eunice Foote identified the greenhouse effect in 1856



In 1896, Svante Arrhenius calculated that a doubling of atmospheric CO₂, when effects of water vapor were included, would warm the Earth about 4 degrees C.

This is close to what today's sophisticated climate models predict.

The Greenhouse Effect



Some sunlight that hits the earth is reflected. Some is transformed to heat.

ATMOSPHERE

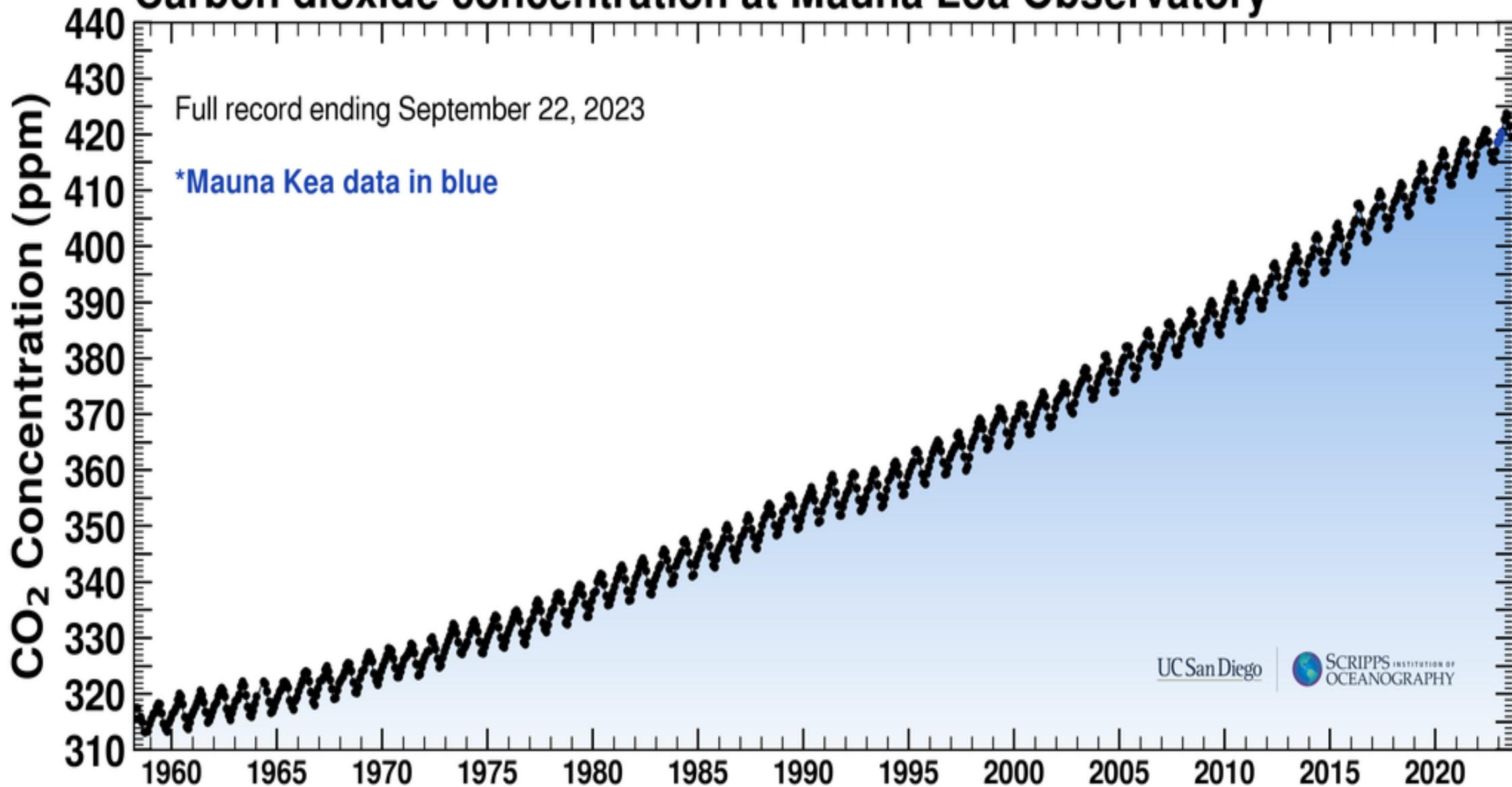


ATMOSPHERE

CO₂ and other gases in the atmosphere trap heat, keeping the earth warm.

CO₂, the major greenhouse gas,
is building up in the atmosphere,
and the build-up is human
caused

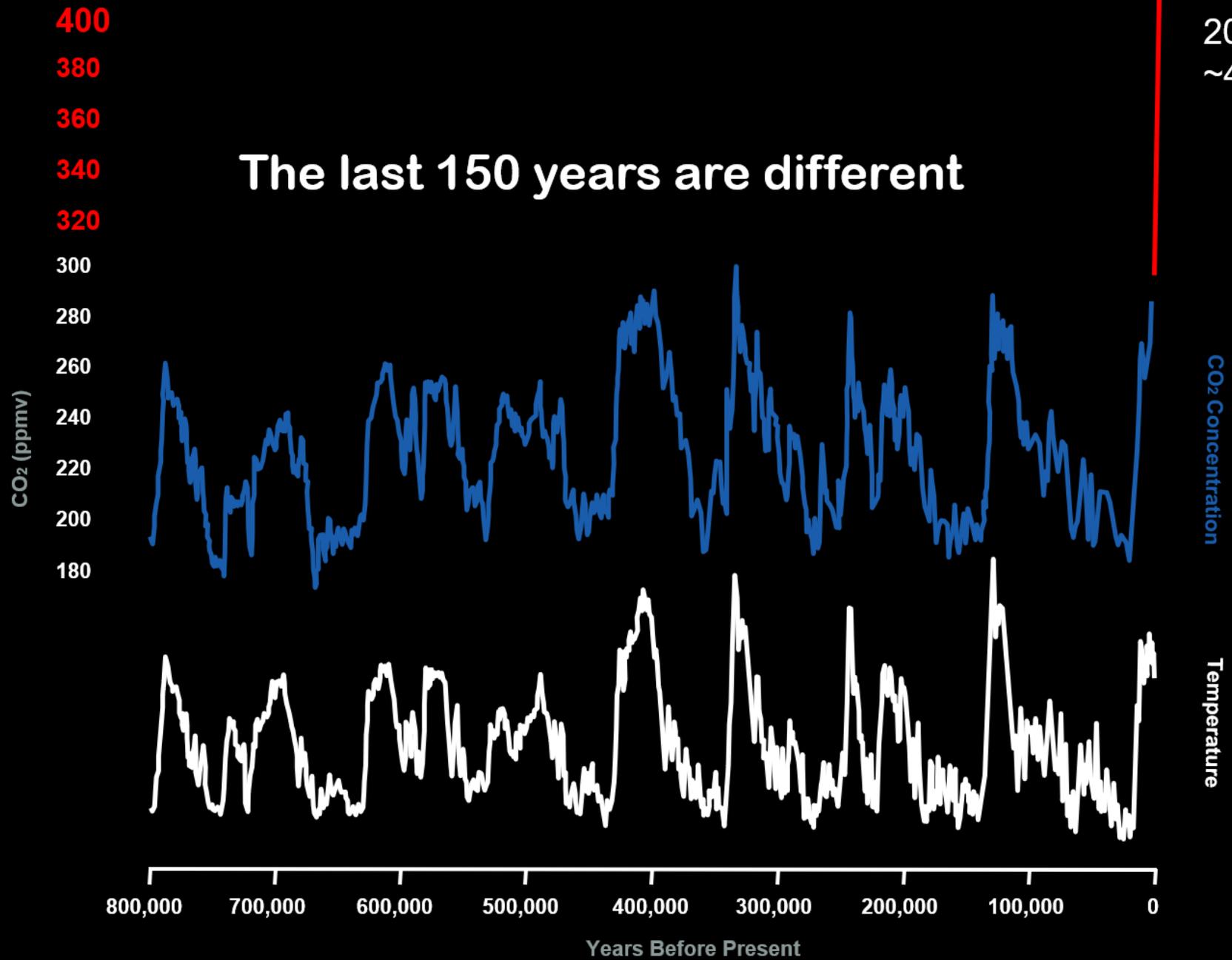
Carbon dioxide concentration at Mauna Loa Observatory*



A close-up photograph of a gas burner with a blue flame. The flame is bright blue and has a distinct, repeating pattern of ridges or fingers. The burner itself is dark and partially visible on the left side of the frame. The background is black, making the blue flame stand out prominently.

CO₂ mostly
comes from
combustion

The rapid pace of the buildup is
unprecedented in the geological
record



2023 concentration,
~423 ppm

The two other major greenhouse gases, methane and nitrous oxide, are also building up

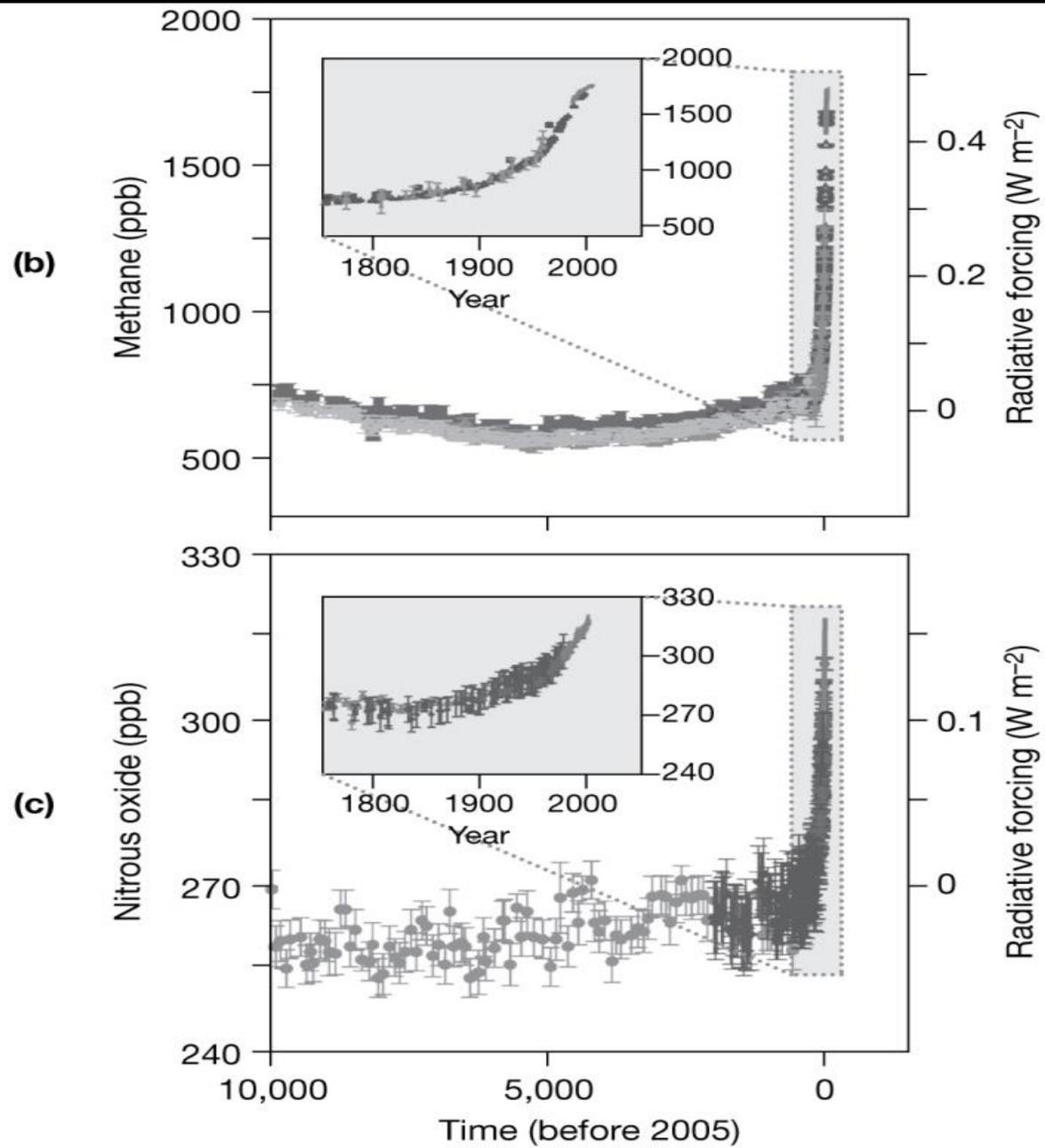
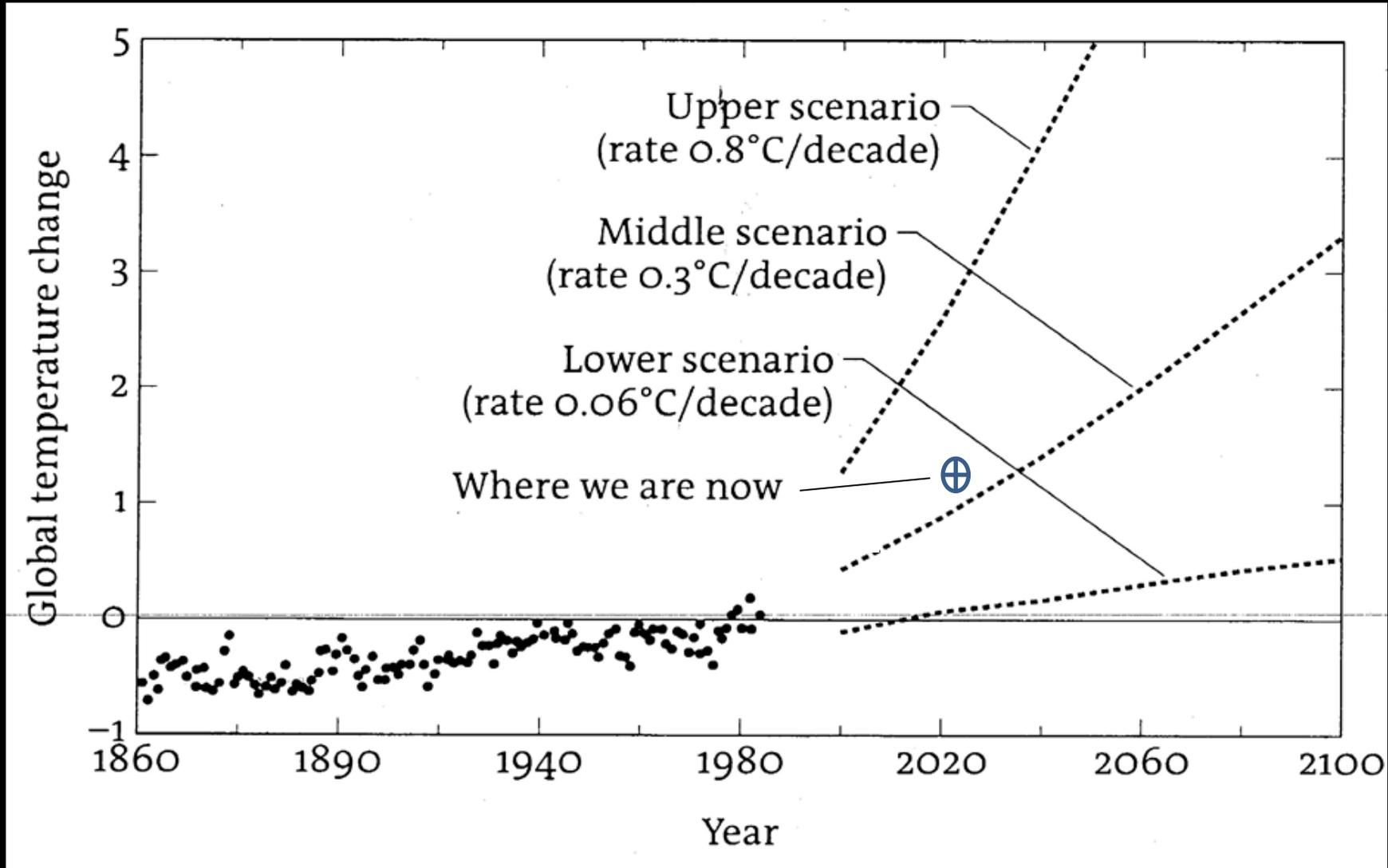


Figure 6.12 copyright 2011 University Science Books

The Earth is heating up..as
predicted

2023 was the hottest year since
record keeping began, and the 9
years since 2015 are the warmest
on record

Forecasts made in 1988

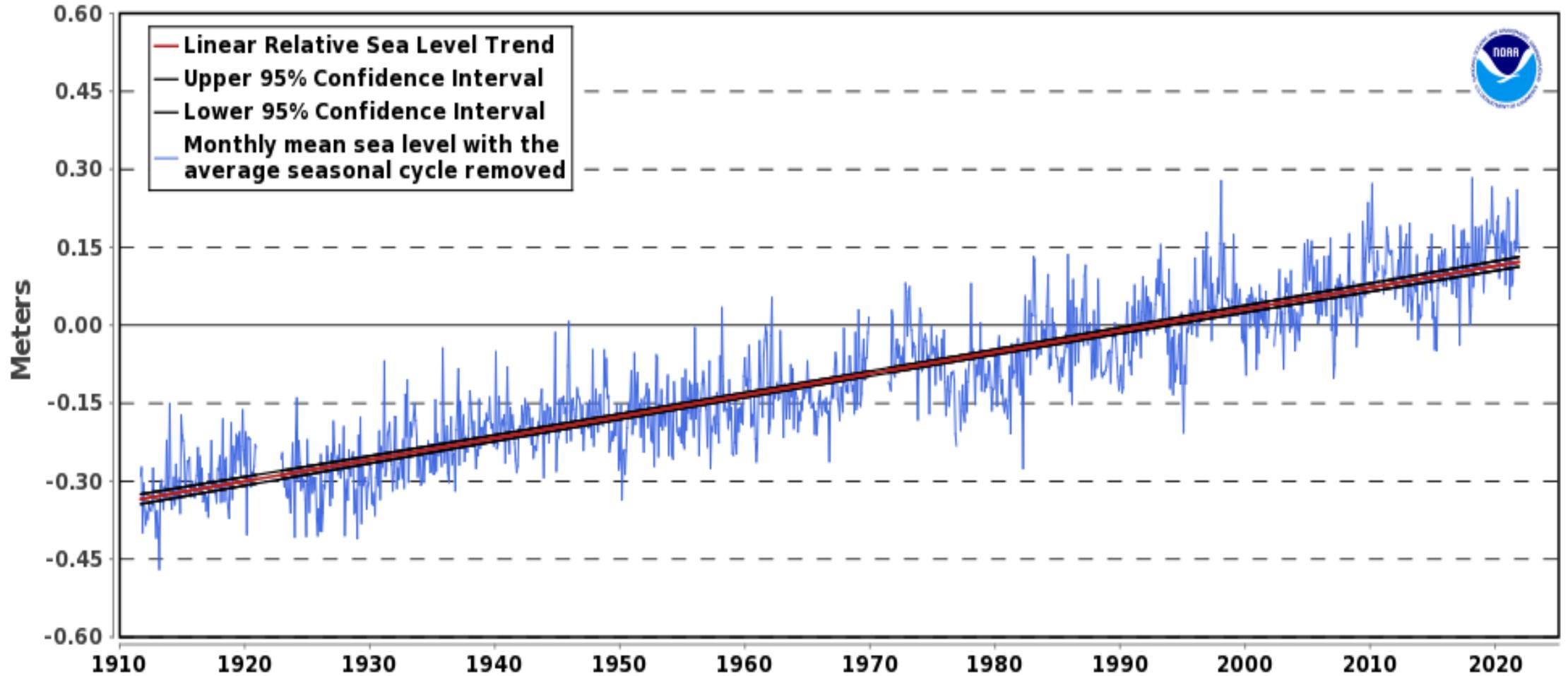


From: Schneider, Steven, 1989, Global Warming

Many impacts are becoming obvious..

8534720 Atlantic City, New Jersey

4.14 +/- 0.15 mm/yr



From: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8534720





Atlantic City high tide street flooding



<https://pcntv.com/weather-world/>

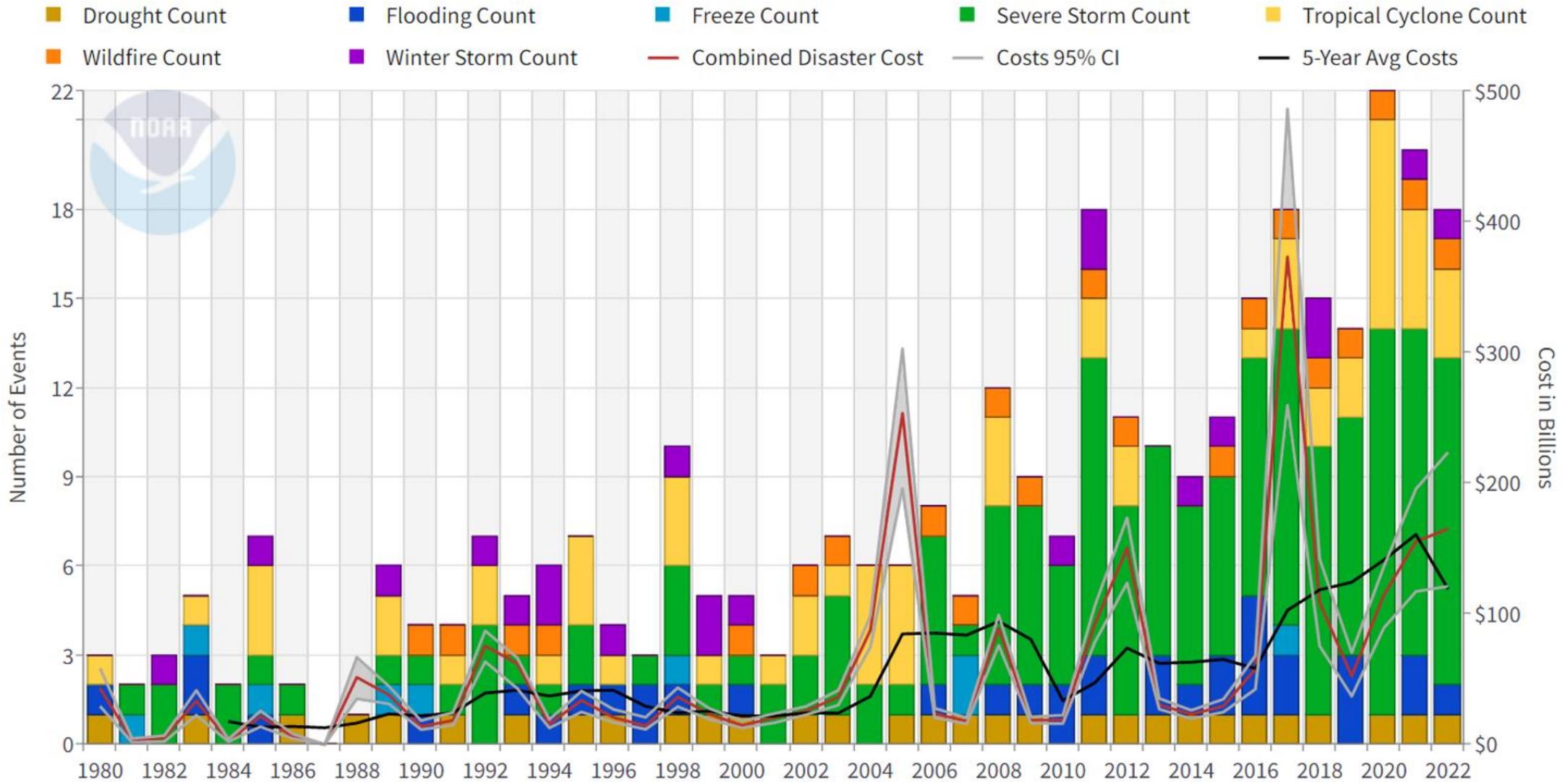
Reuters

PCN



June 7, 2023

United States Billion-Dollar Disaster Events 1980-2022 (CPI-Adjusted)



Updated: January 10, 2023

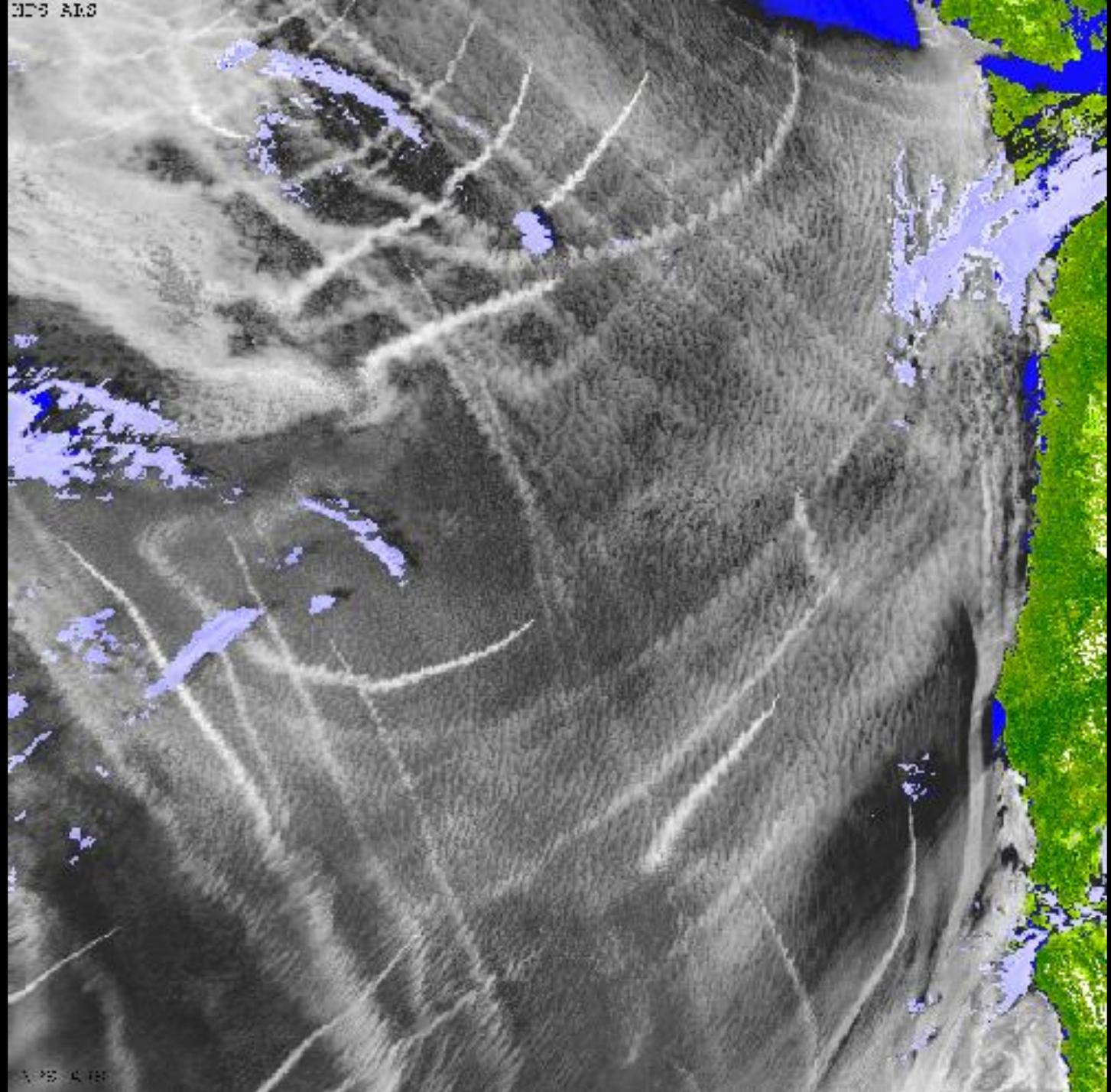
Powered by ZingChart

from <https://www.climate.gov/media/14990>

The heating appears to be accelerating



015 413



015 413



A church in Sancourt, France, is pictured at sunset during a July 2023 heat wave.

CLIMATE CHANGE

The hottest year was even hotter than expected

Greenhouse gases, El Niño, and cleaner air fueled record heat in 2023

By Paul Voosen

It comes as no surprise to anyone who sweated through it: 2023 was the hottest year in human history. Average surface temperatures rose nearly 0.2°C above the previous record, set in 2016, to 1.48°C over preindustrial levels, the European Union's Copernicus Climate Change Service reported this week. Only Australia was spared record-setting heat. The extreme conditions are a "dramatic testimony of how far we now are from the climate in which our civilization developed," said Carlo Buontempo, Copernicus's climate director, in a statement.

Yet 2023's record temperatures—confirmed days later by analyses from NASA, the U.S. National Oceanic and Atmospheric Administration, the United Kingdom's Met Office, and Berkeley Earth—come with a mystery. Humanity's unabated burning of fossil fuels is the dominant driver of the long-term trend, but it is insufficient to explain 2023's sudden spike, says Michael Diamond, an atmospheric scientist at Florida State University.

One exacerbating factor was the end of a La Niña climate pattern, which from 2020 to 2022 stirred up an increased amount of deep cold water in the eastern Pacific Ocean that absorbed heat and suppressed global temperatures. In 2023, the pattern flipped into an El Niño event, which blanketed the

equatorial Pacific with warm waters and began to boost global temperatures.

But the flip is not enough to explain 2023's record, Gavin Schmidt, director of NASA's Goddard Institute for Space Studies, wrote in a blog post last week. Typically, El Niño plays a larger role in global temperatures the year after it starts—in this case, this year. And in 2023 heat surged far from El Niño's influence, above the northern Atlantic and Pacific oceans, Schmidt noted.

The 2022 eruption of Hunga Tonga-Hunga Ha'apai, a volcano in the south Pacific, had been a suspect in the global temperature jump because of the vast amounts of climate-warming water vapor it injected into the stratosphere. But early studies neglected the sulfate particles it also sent into the upper atmosphere, which reflected light and canceled out the water vapor's warming effect, says Mark Schoeberl, an atmospheric scientist at the Science and Technology Corporation. "For 2022, it was a nonevent. I have continued my computations into 2023—still a nonevent."

Perhaps the best explanation for the extra warming is the continued drop in light-blocking pollution as society shifts to cleaner sources of energy, says Tianle Yuan, an atmospheric physicist at NASA's Goddard Space Flight Center. In 2022, satellites began to detect this decrease from space (*Science*, 22 July 2022, p. 353). In 2020, new regulations from the International Mari-

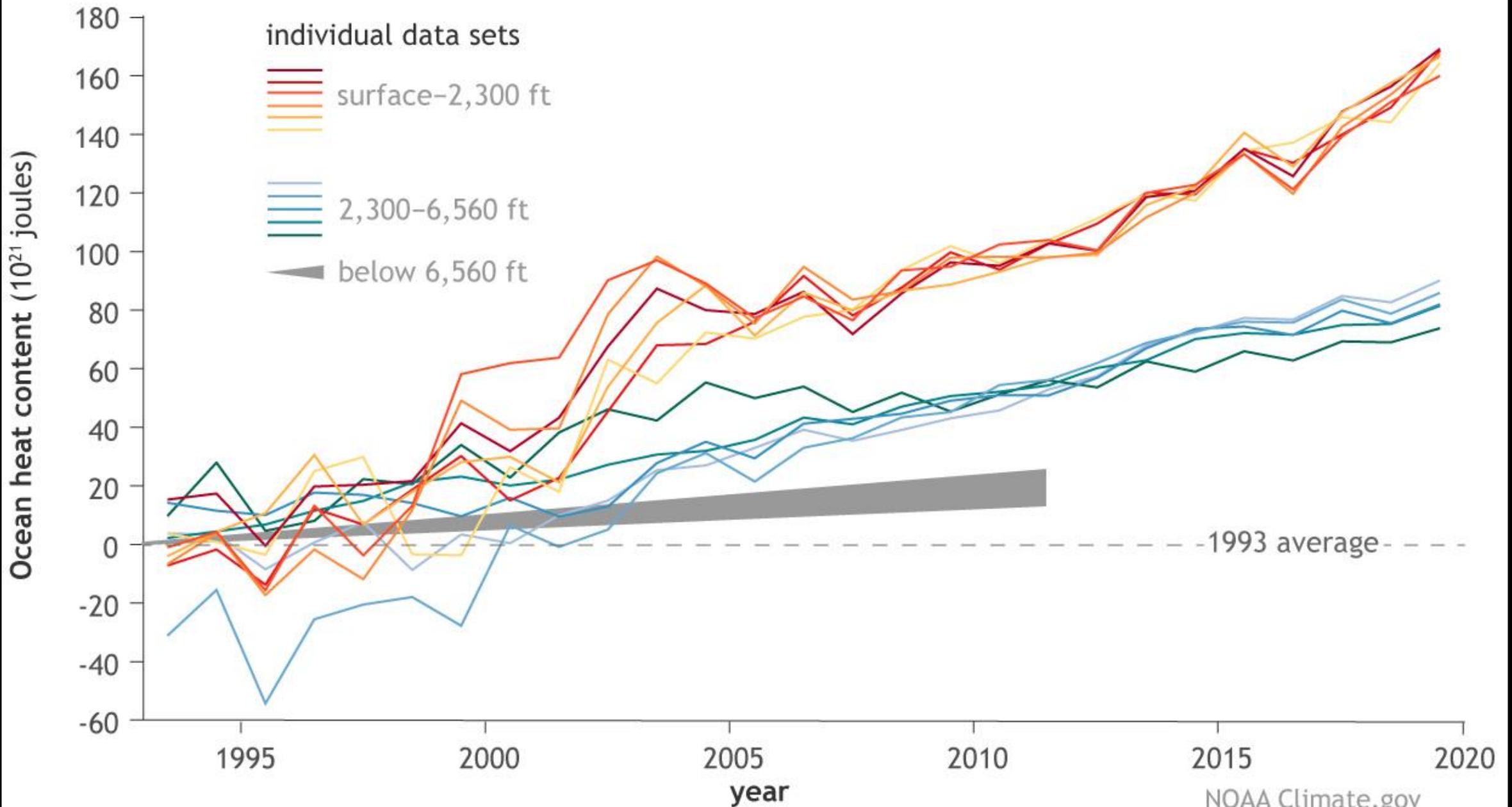
time Organization added to the effect when ships began to cut sulfur pollution—and inadvertently curbed the light-reflecting clouds that the sulfur particles help create (*Science*, 4 August 2023, p. 467). A preprint on Research Square suggests the loss of these clouds alone can explain half of the increase in the warming rate seen so far this decade, says Yuan, who led the work. "[I] would not account for all the warming we see this year, but it would represent a significant additional warming."

In a November 2023 paper, famed climate scientist James Hansen suggested curbing pollution has accelerated warming to 0.27°C per decade, up from the 0.18°C per decade rate experienced from 1970 to 2010. But the acceleration has yet to show up in records of heat in the ocean depths, which resist the short-term fluctuations of the atmosphere and offer a truer sense of long-term trends.

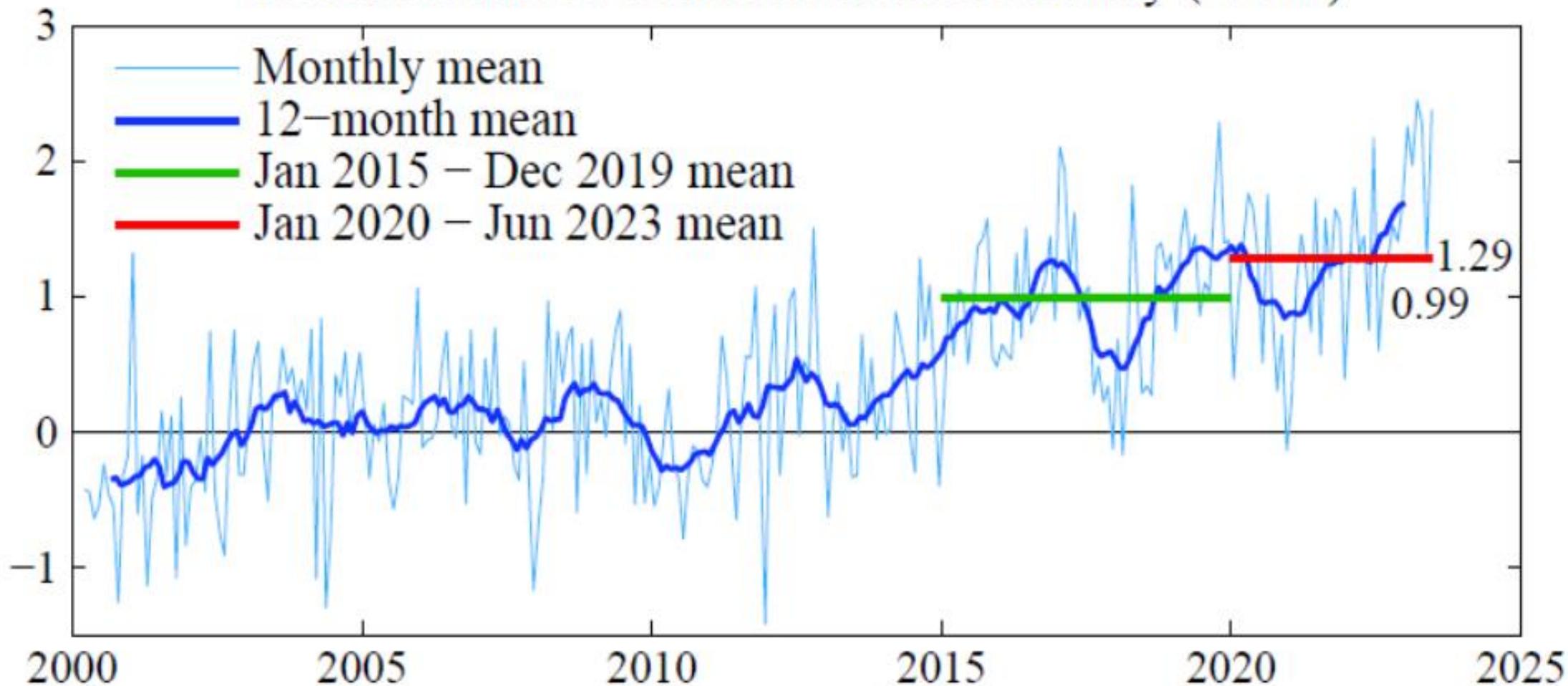
The mystery of the past year leaves projections for this year less certain than usual. El Niño may inflate temperatures further, pushing the world briefly past the arbitrary 1.5°C "limit" settled on by policymakers in 2015's Paris agreement to protect small island nations from extreme sea-level rise. But extreme heat will again have to develop over the northern oceans for the world to breach the threshold—hardly a sure bet.

Regardless, the long-term warming pattern is certain to continue, as it has for decades—until fossil fuel burning ends. ■

Annual ocean heat content compared to average (1993-2019)

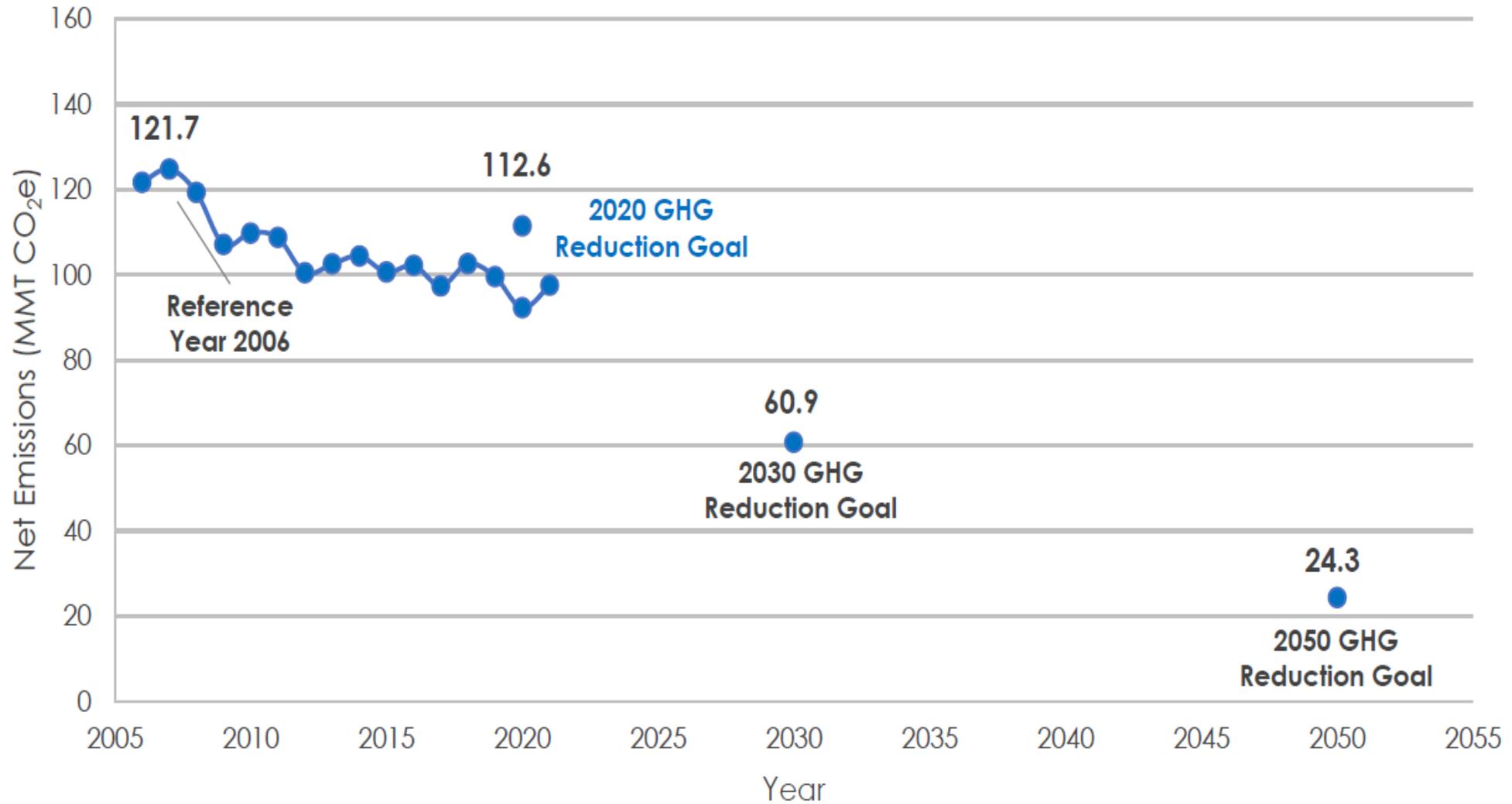


Global Absorbed Solar Radiation Anomaly (W/m^2)

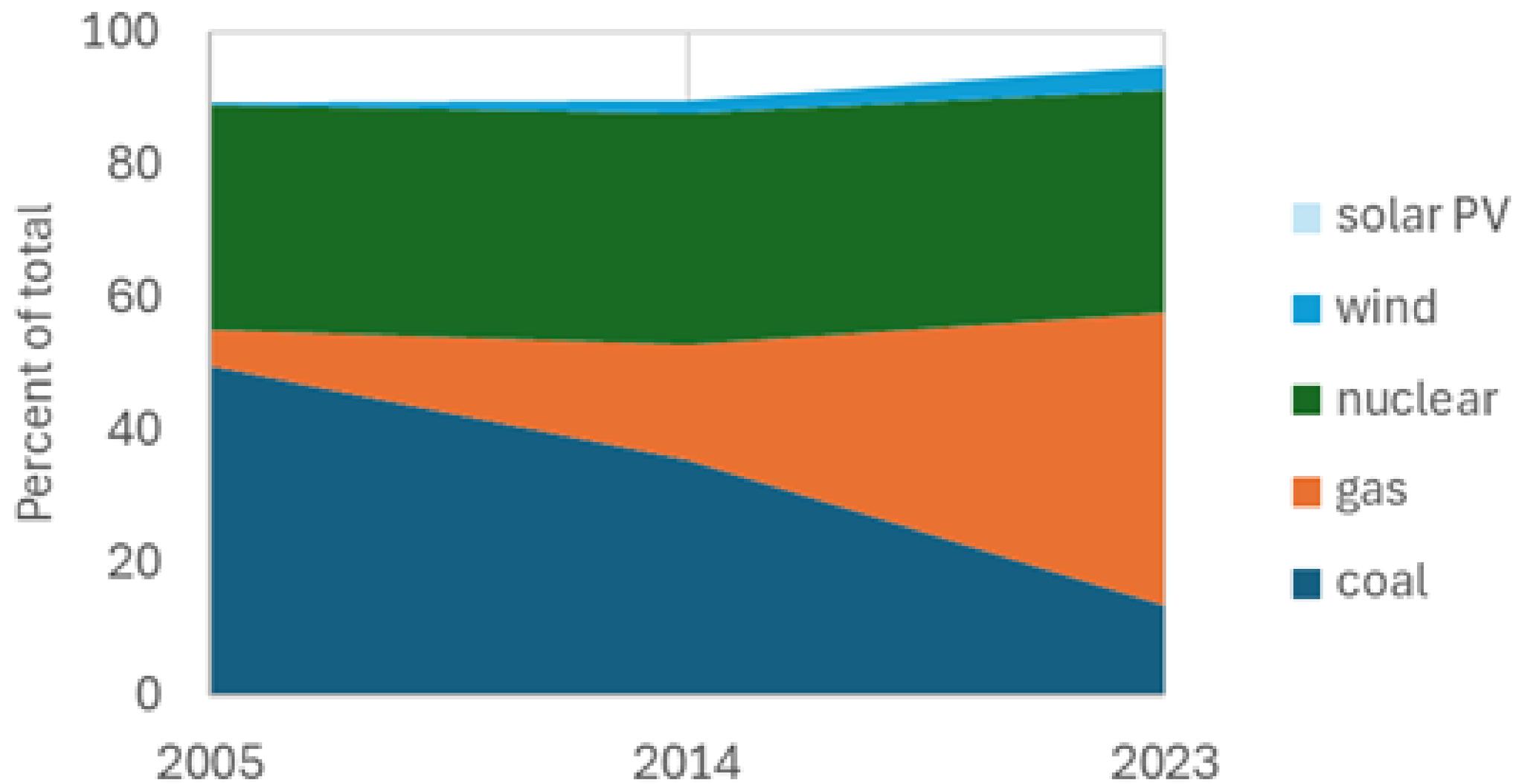


2) We're not on track to solve the problem soon enough to avoid major impacts; more actions are needed

New Jersey Greenhouse Gas Emissions and Goals

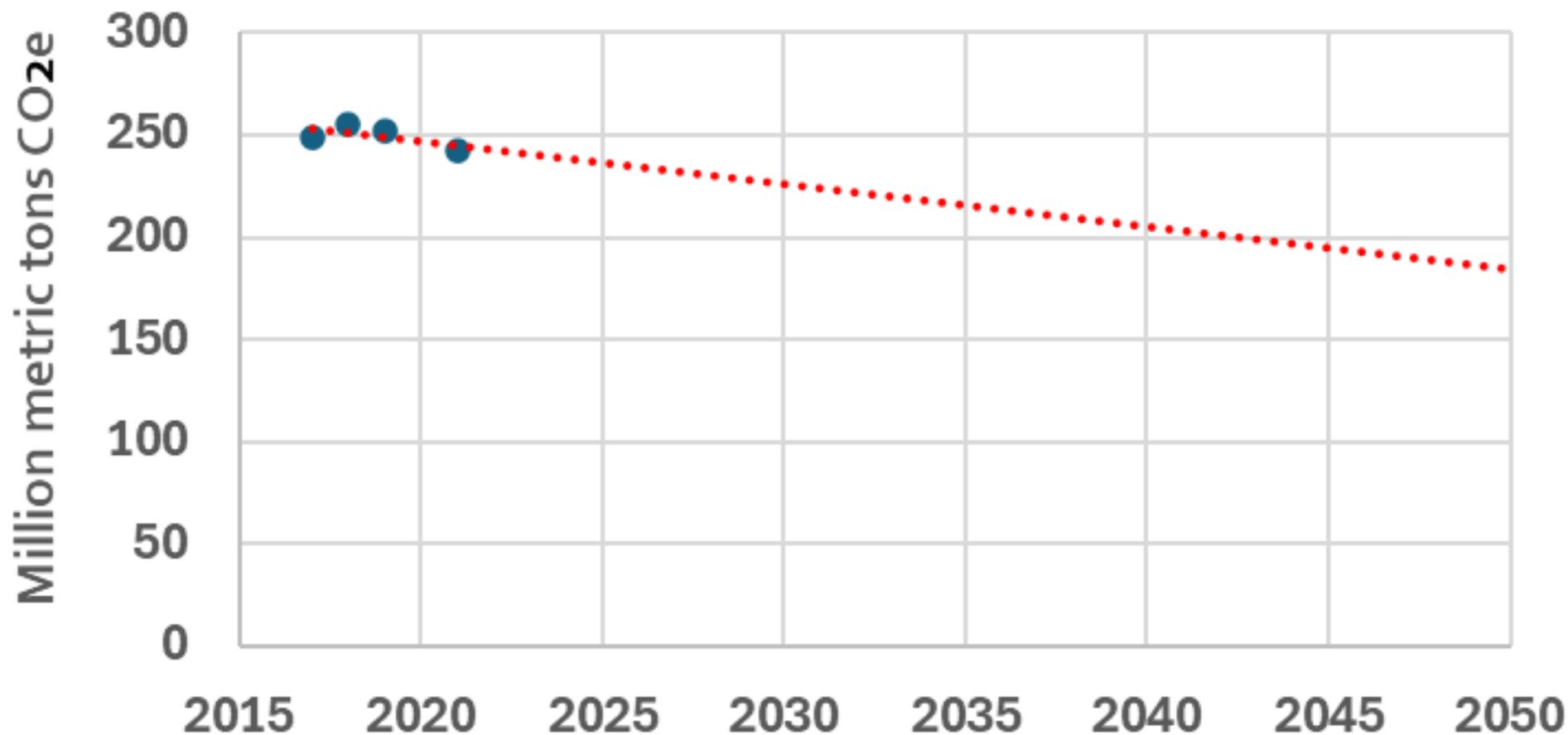


PJM fuel mix



Pennsylvania GHG Emissions, 2017-2021

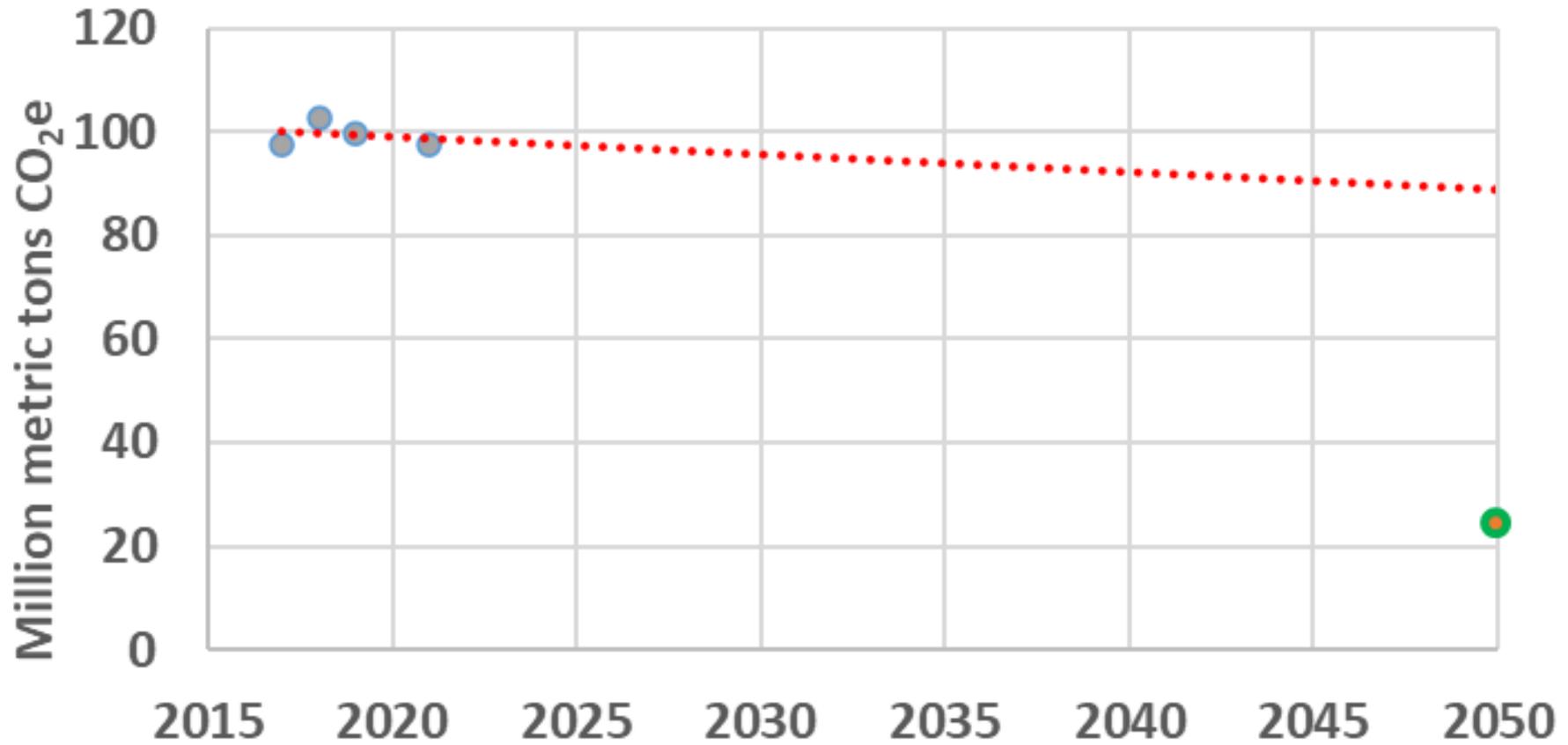
and best-fitting linear trend line; 2020 excluded as outlier



Data from: <https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals>

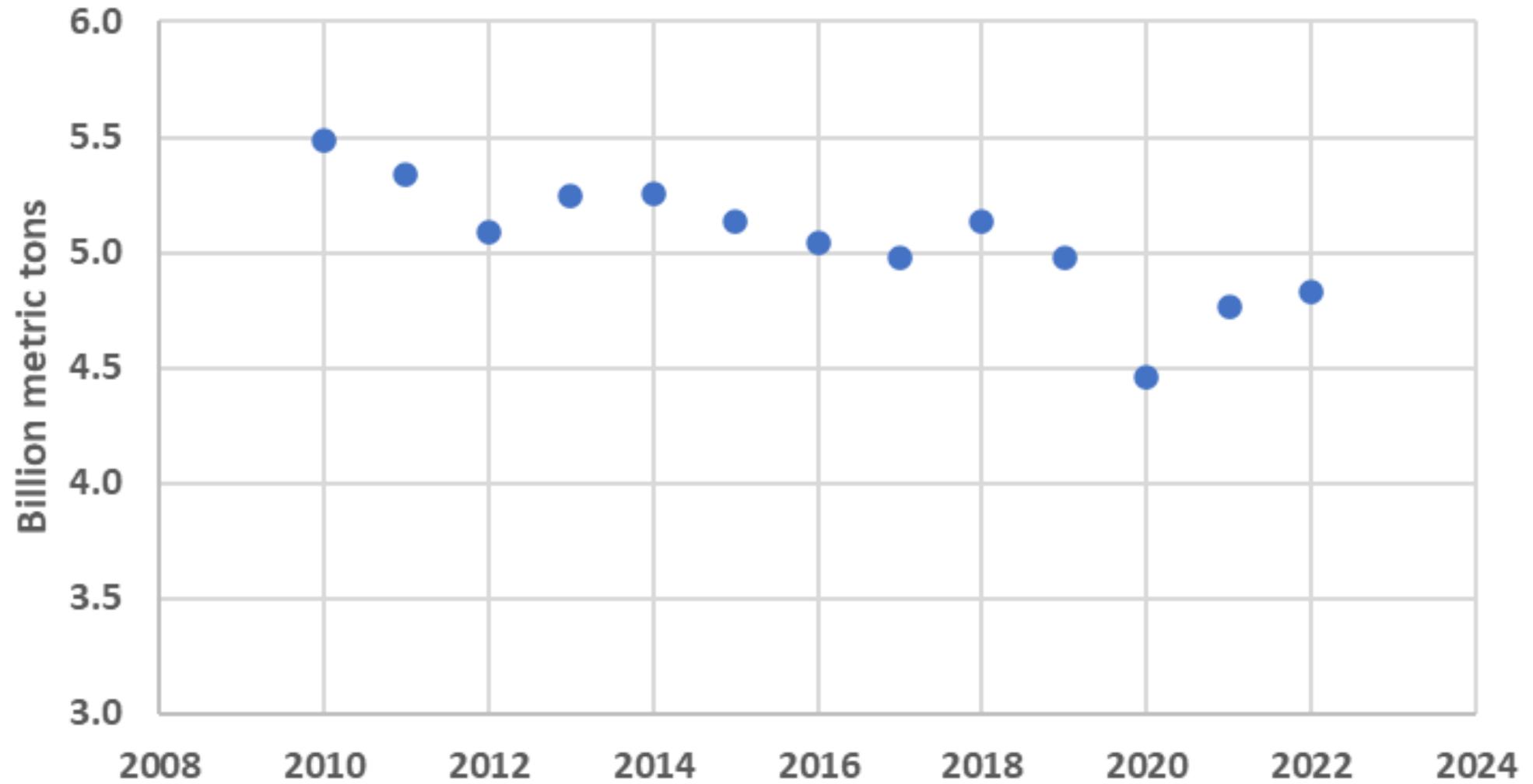
New Jersey GHG Emissions, 2017-2021

and best-fitting linear trendline; 2020 excluded as outlier



Data from: https://dep.nj.gov/wp-content/uploads/climatechange/nj_pcap_final-1.pdf

CO₂ emissions from energy, U.S.



From: 2023 statistical review of world energy, <https://www.energyinst.org/statistical-review>

There are some promising initiatives, many driven by the Inflation Reduction Act...



2019 NEW JERSEY

ENERGY MASTER PLAN PATHWAY TO 2050

From:

https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf



NJEDA
ECONOMIC DEVELOPMENT AUTHORITY

DCA
DEPARTMENT OF COMMUNITY AFFAIRS





NEW JERSEY'S

PRIORITY CLIMATE ACTION PLAN

MARCH 2024



From:
<https://www.epa.gov/system/files/documents/2024-03/nj-pcap.pdf>

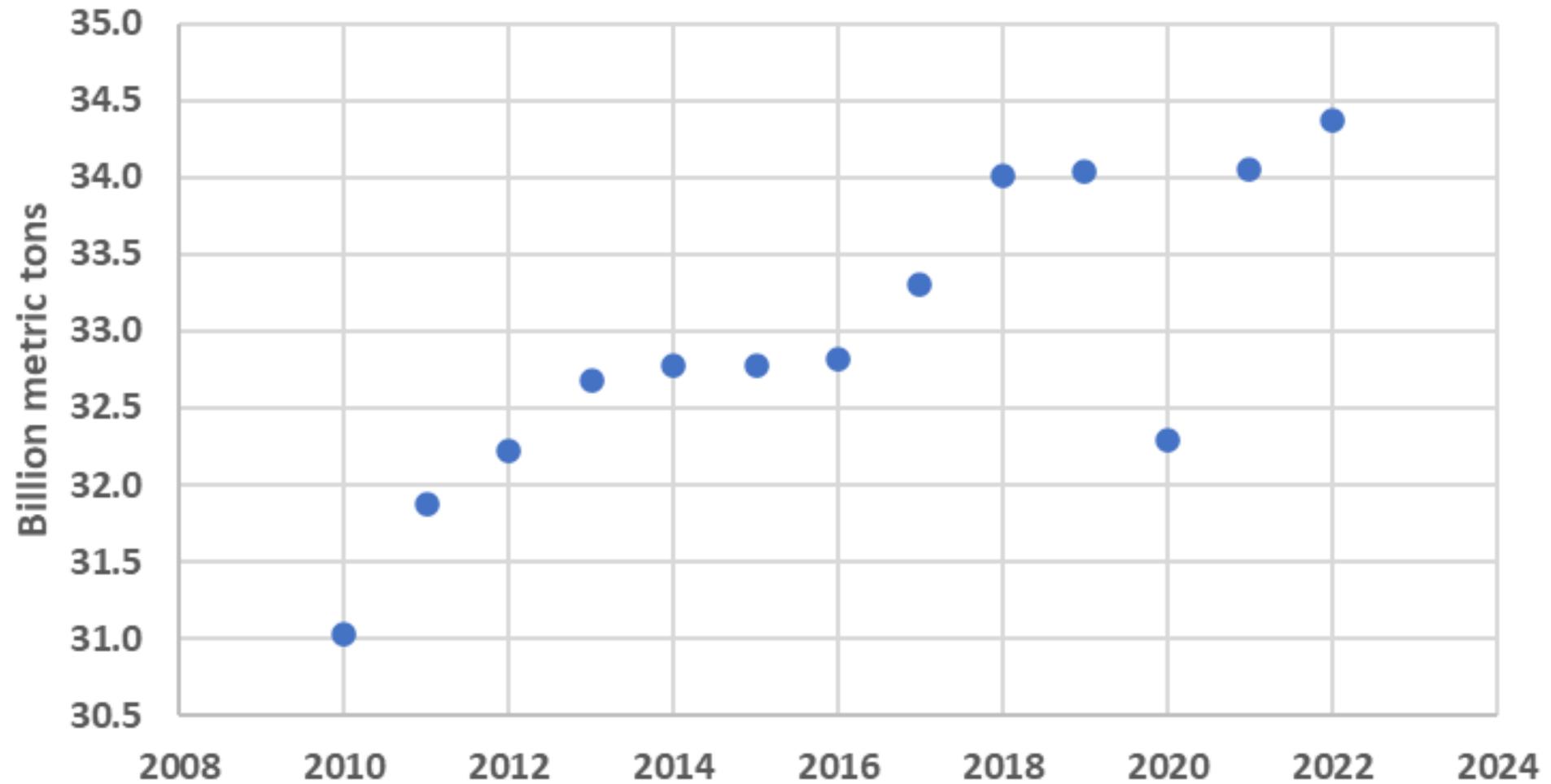
Are we ignoring something?



We're ignoring

- a) Globally, CO₂ emissions are still increasing, fossil fuel use is still increasing
- b) Climate disruption is a global problem

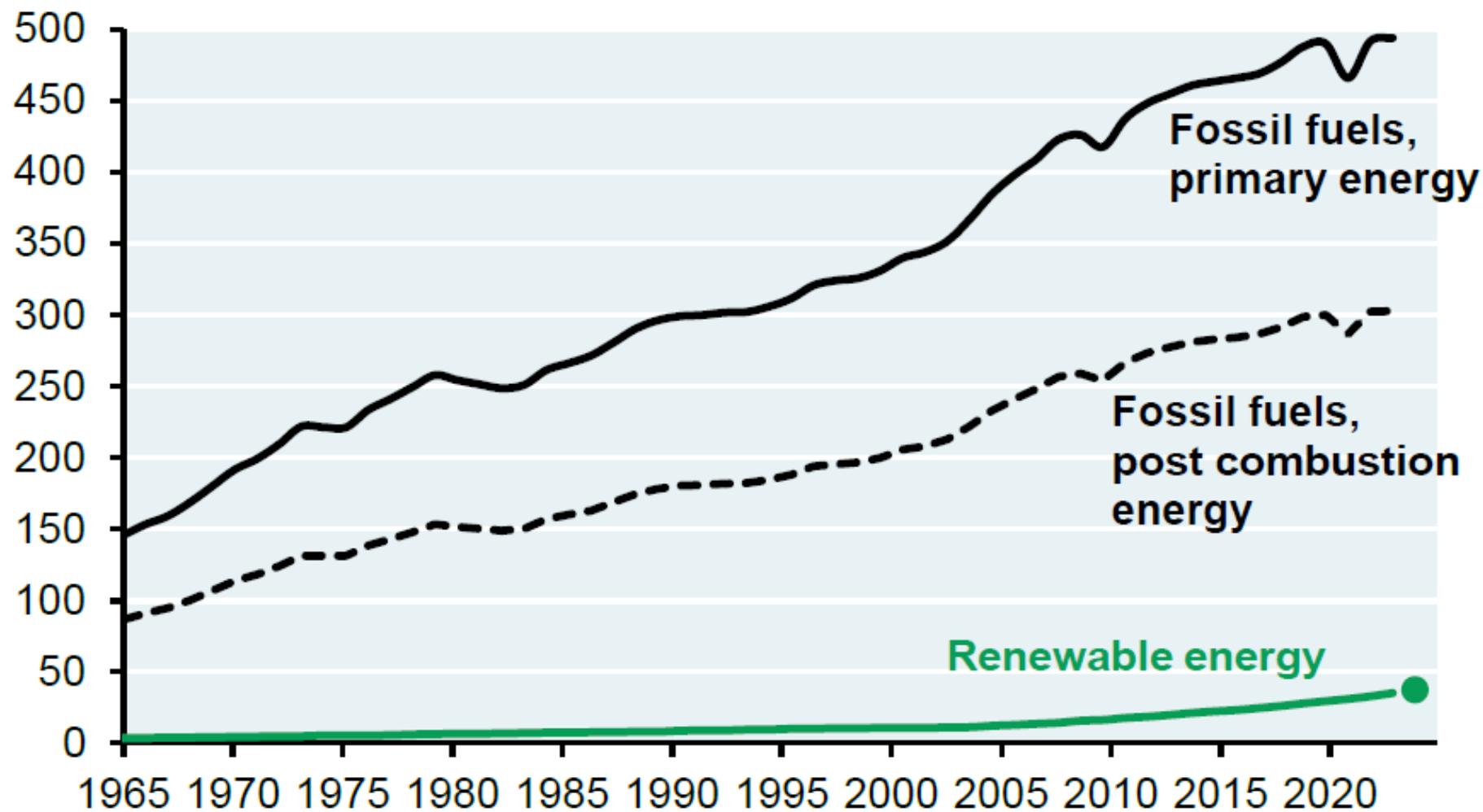
CO₂ emissions from energy, world



From: 2023 statistical review of world energy, <https://www.energyinst.org/statistical-review>

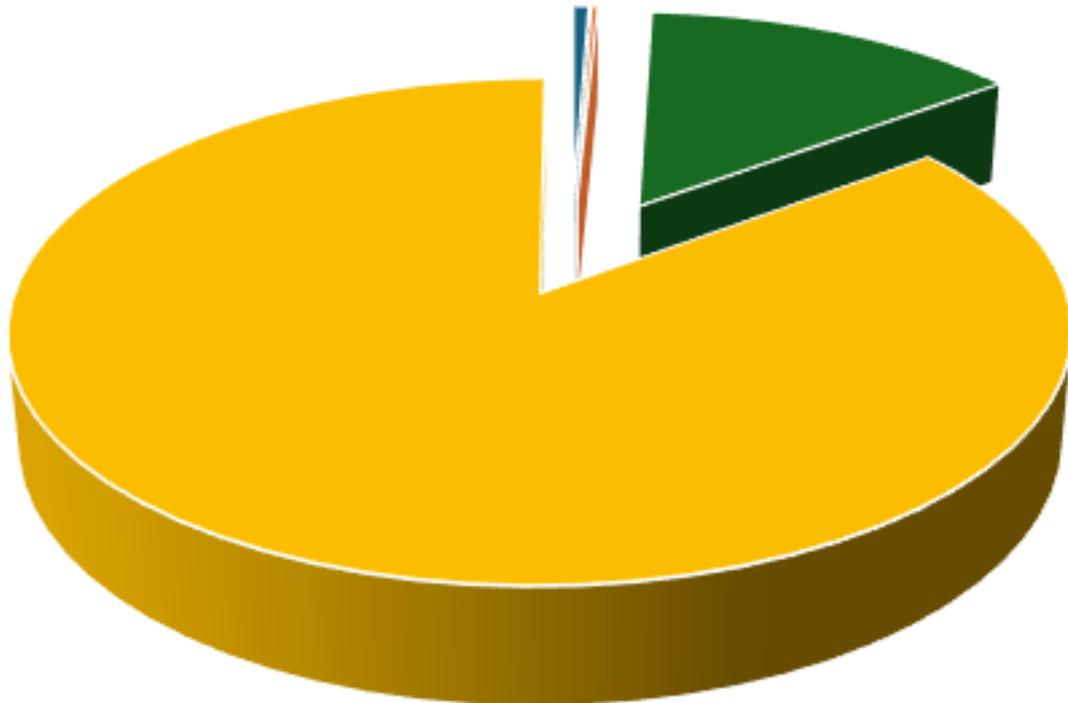
Global fossil fuel and renewable energy use

Exajoules



Source: EI Statistical Review of World Energy, IEA, JPMAM, 2024

Humanity's GHG Emissions



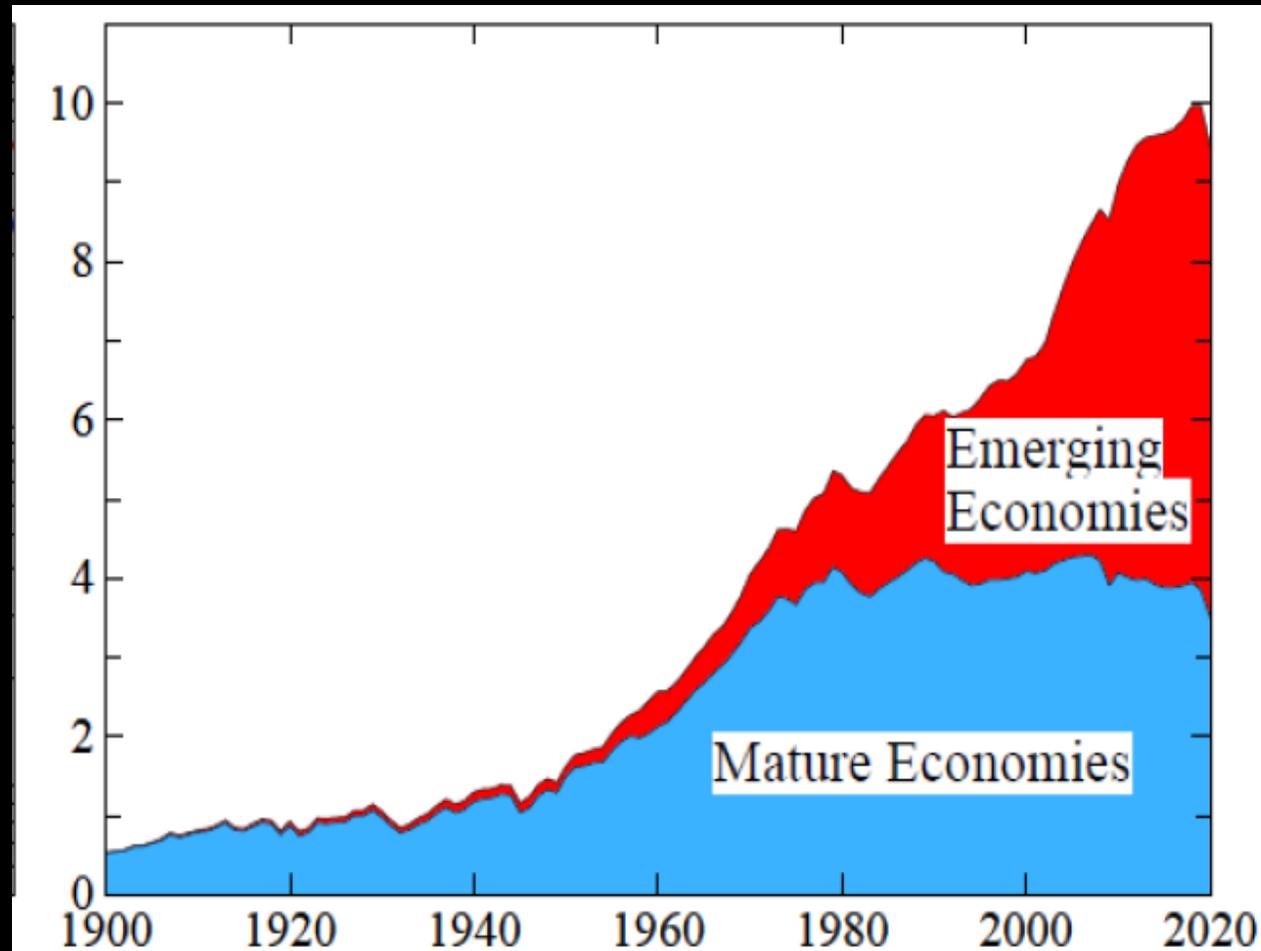
■ PA

■ NJ

■ Rest of the U.S.

■ Rest of the world

Global emissions of carbon, gigatons per year



From: <http://www.columbia.edu/~jeh1/Documents/PipelinePaper.2023.07.05.pdf>

Emerging economies need electricity available 24/7, and they need heat for industrial processes.

Global electricity demand is likely to double or triple by 2050.



Coal powerplant in India

If emerging economies can't get the energy they need to raise their standard of living from clean sources, they'll get it by burning gas, and coal

3) Local actions won't be sufficient; only steps that lead to national and international measures will save us from major impacts

Fossil fuels enjoy a huge hidden subsidy - the waste product of their combustion, CO₂, is dumped into the air for free

This hidden subsidy could be addressed by a fee on carbon dioxide emissions.

This would raise the price of gasoline and heating oil, but if the \$ collected was refunded to families, it wouldn't hurt low and moderate income people

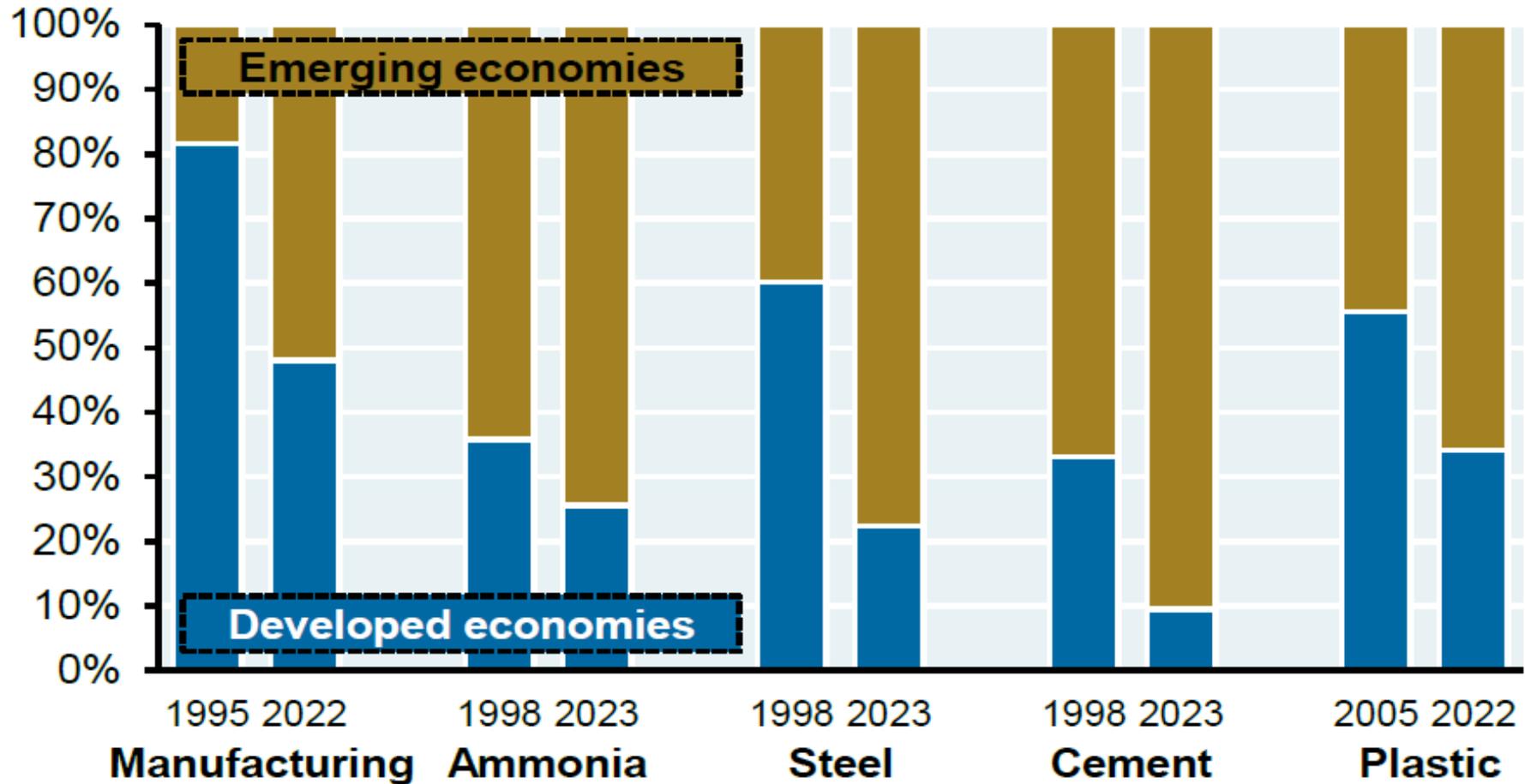
There are carbon pricing bills before Congress;
two of these are..

- H.R. 5744, the Energy Innovation and Carbon Dividend Act; co-sponsored by Bonnie Watson Coleman on April 5, 2024
- H.R. 6665, the MARKET CHOICE Act (sponsored by Brian Fitzpatrick)

How could U.S. policy drive global action?

A promising legislative proposal is the PROVE IT Act

A shift in energy intensive manufacturing to the emerging world, % of global production



Source: UN DESA, Worldsteel, PlasticsEurope, USGS, JPMAM, 2024

Senators Coons, Cramer introduce legislation to study global emissions intensity and hold countries with dirty production accountable

An essential step to countering global emissions from polluting countries, the PROVE IT Act would gather the necessary data to quantify the advantage of the United States' cleaner manufacturing practices against countries with little to no environmental standards

AUGUST 09, 2023

The PROVE IT Act could set the stage for a carbon border adjustment mechanism, (CBAM) which would curb industrial carbon emissions at the global level

The European Union is implementing a CBAM

U.S. efforts to reestablish leadership in nuclear energy could lead to carbon-free technology that would be adopted globally

Six features contribute to advanced nuclear power's differentiated value proposition for a decarbonized grid



1. Additional applications include clean hydrogen generation, industrial process heat, desalination of water, district heating, off-grid power, and craft propulsion and power
 2. Renewables + storage includes renewables coupled with long duration energy storage or renewables coupled with hydrogen storage

Senate Passes Bipartisan Nuclear Energy Bill from Capito, Carper, Whitehouse

July 27, 2023

ADVANCE Act would boost development and deployment of new nuclear technologies, incentivize expansion in America, retool and support the NRC, and help position the U.S. as the world's leader in nuclear energy.

U.S. Seeks to Boost Nuclear Power After Decades of Inertia

Measures moving through Congress to encourage new reactors are receiving broad bipartisan support, as lawmakers embrace a once-contentious technology.



By **Brad Plumer**

Reporting from Washington

March 1, 2024

The House this week overwhelmingly passed legislation meant to speed up the development of a new generation of nuclear power plants, the latest sign that a once-contentious source of energy is now attracting broad political support in Washington.

The 365-to-36 vote on Wednesday reflected the bipartisan nature of the bill, known as the [Atomic Energy Advancement Act](#). It received backing from Democrats who support nuclear power because it does not emit greenhouse gases and can generate electricity 24 hours a day to supplement solar and wind power. It also received support from Republicans who have downplayed the risks of climate change but who say that nuclear power could bolster the nation's economy and energy security.

In summary..

- 1) The need for action has been clear for a long time
- 2) Current efforts aren't enough – more is needed
- 3) We can protect ourselves from the worst impacts of climate disruption only by fostering actions that will scale to the nation and the world

What to Do?

Become more informed, make climate-friendly choices

Encourage people to vote for climate friendly candidates (e.g., Environmental Voter Project)

Join a group working for national and international solutions (e.g., Citizens' Climate Lobby)

Citizens' Climate Lobby



Happy to try to answer any questions!

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RESOURCES

Groups:

- Citizens' Climate Lobby, <https://citizensclimatelobby.org/>
- Environmental Voter Project, <https://www.environmentalvoter.org/>
- Climate Leadership Council, <https://clcouncil.org/>

Books:

- Hansen, James, 2009, *Storms of My Grandchildren*, Bloomsbury, NY
- Gates, Bill, 2021, *How to Avoid a Climate Disaster*, Knopf, NY

Reports:

- New Jersey's Priority Climate Action Plan: <https://www.epa.gov/system/files/documents/2024-03/nj-pcap.pdf>
- New Jersey's Strategic Climate Action Plan: <https://dep.nj.gov/strategic-climate-action-plan/>
- New Jersey's Global Warming Response Act 80x50 Report: <https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf>
- New Jersey Energy Master Plan - Pathway to 2050: https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf
- The Pathway to Advanced Nuclear Commercial Liftoff: <https://liftoff.energy.gov/advanced-nuclear/>

Online resources:

- Carbon Tax Center, <https://www.carbontax.org/>
- En-ROADS, <https://en-roads.climateinteractive.org>