

Climate Science Essentials for Sustainable Investing

September 8, 2024

- *Climate Change and Business Strategy (3 units), Spring and Fall*
- *Climate Change Essentials for Business Leaders (1 unit), Fall only*

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Framing - 1

Things you can do:

- Mitigation
- Adaptation

Framing - 2

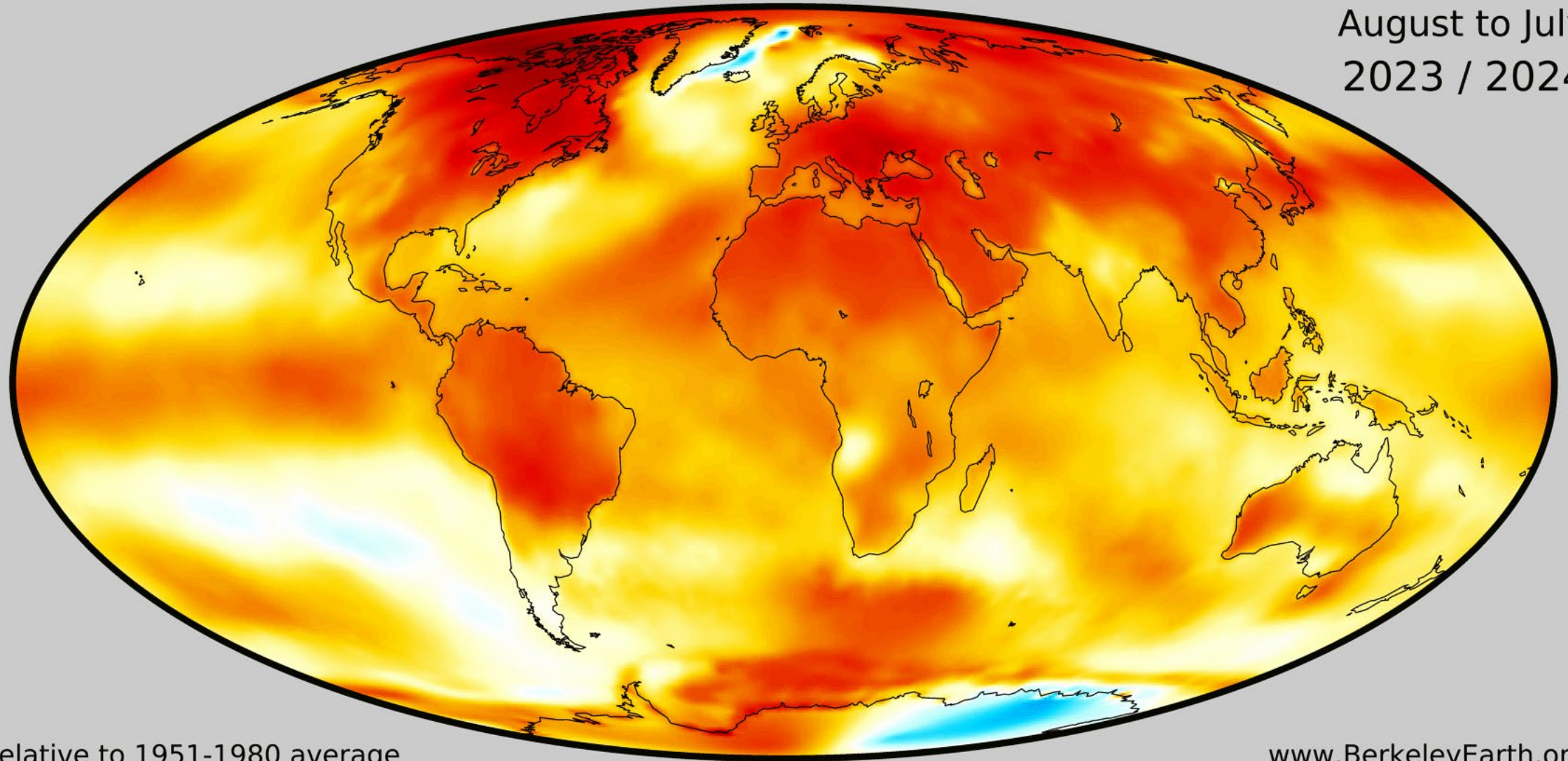
What this pop-up class is and isn't:

- Is: A crash course on Climate Change, mainly its causes and effects
- Isn't: Investment advice

Framing - 3

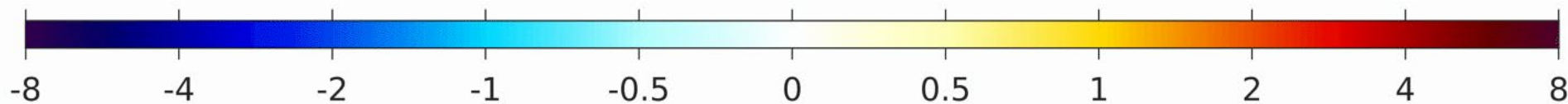
Climate is long-term weather.

August to July
2023 / 2024



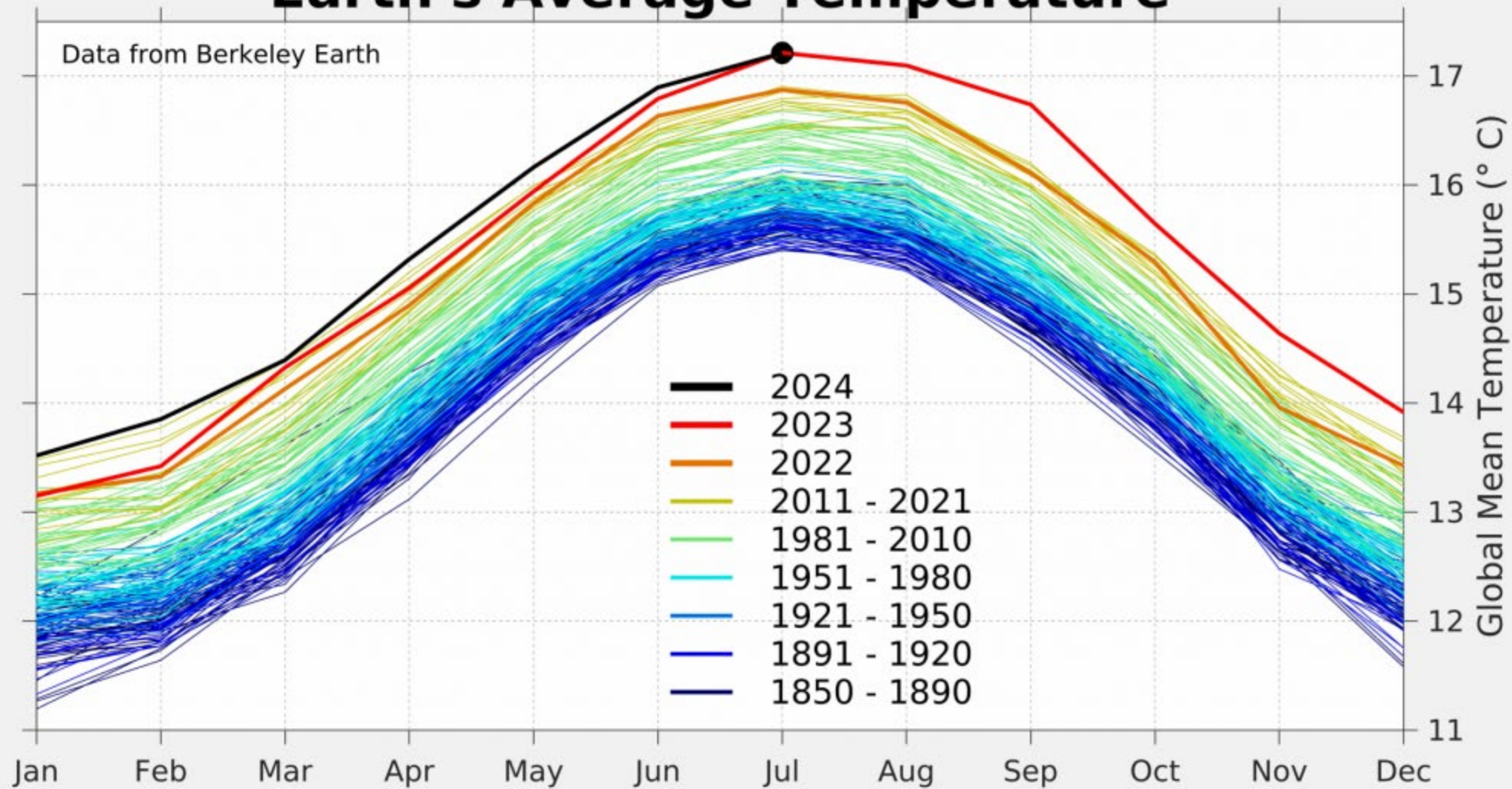
Relative to 1951-1980 average

www.BerkeleyEarth.org

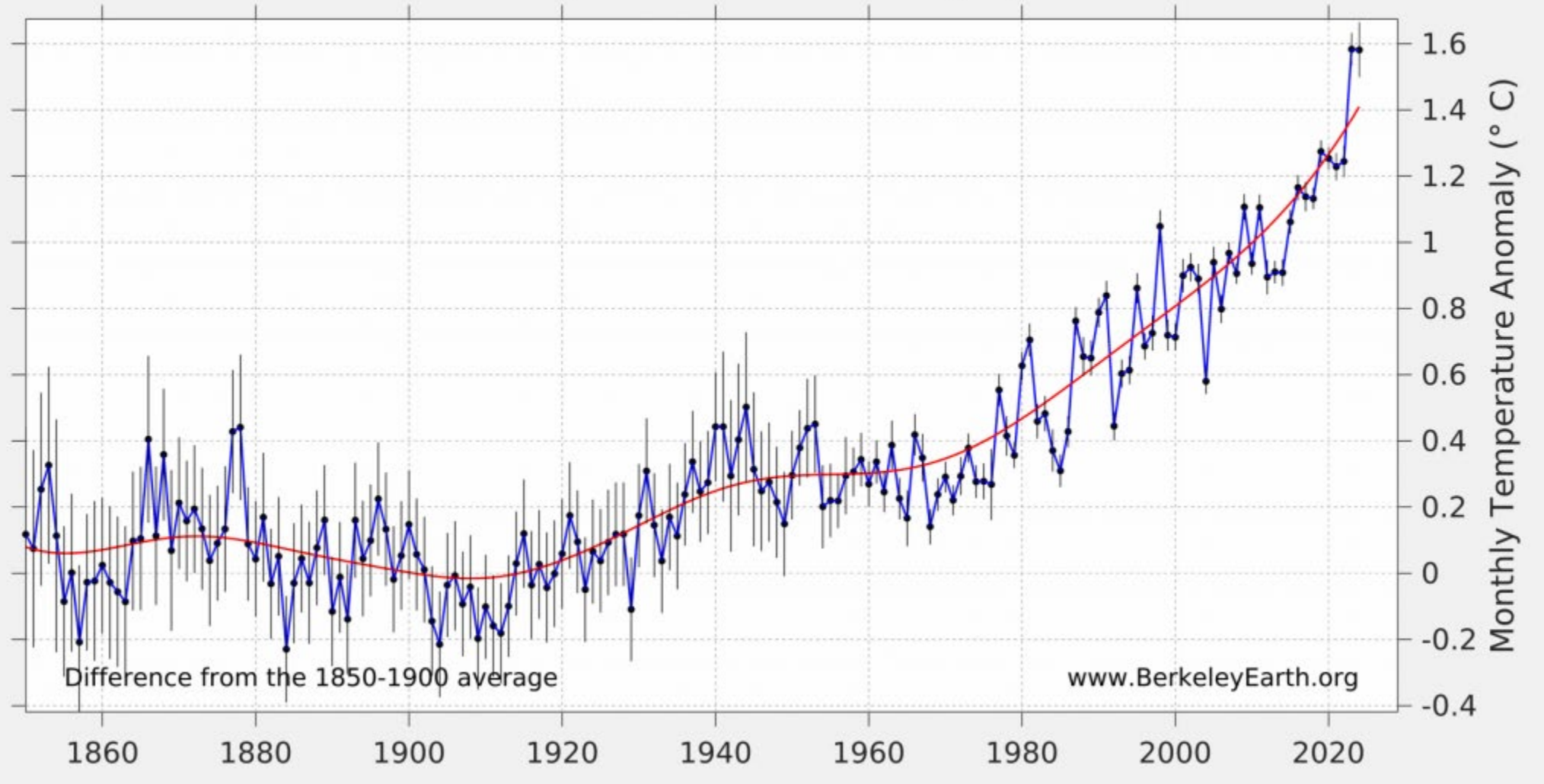


Temperature
Anomaly ($^{\circ}$ C)

Earth's Average Temperature



Berkeley Earth - Global - July





Ivanka Trump ✓

@IvankaTrump



FACT: Greenhouse gases generated by the U.S. will slide 9.2% this year, tumbling to the lowest level in at least three decades. [@EPA](#)

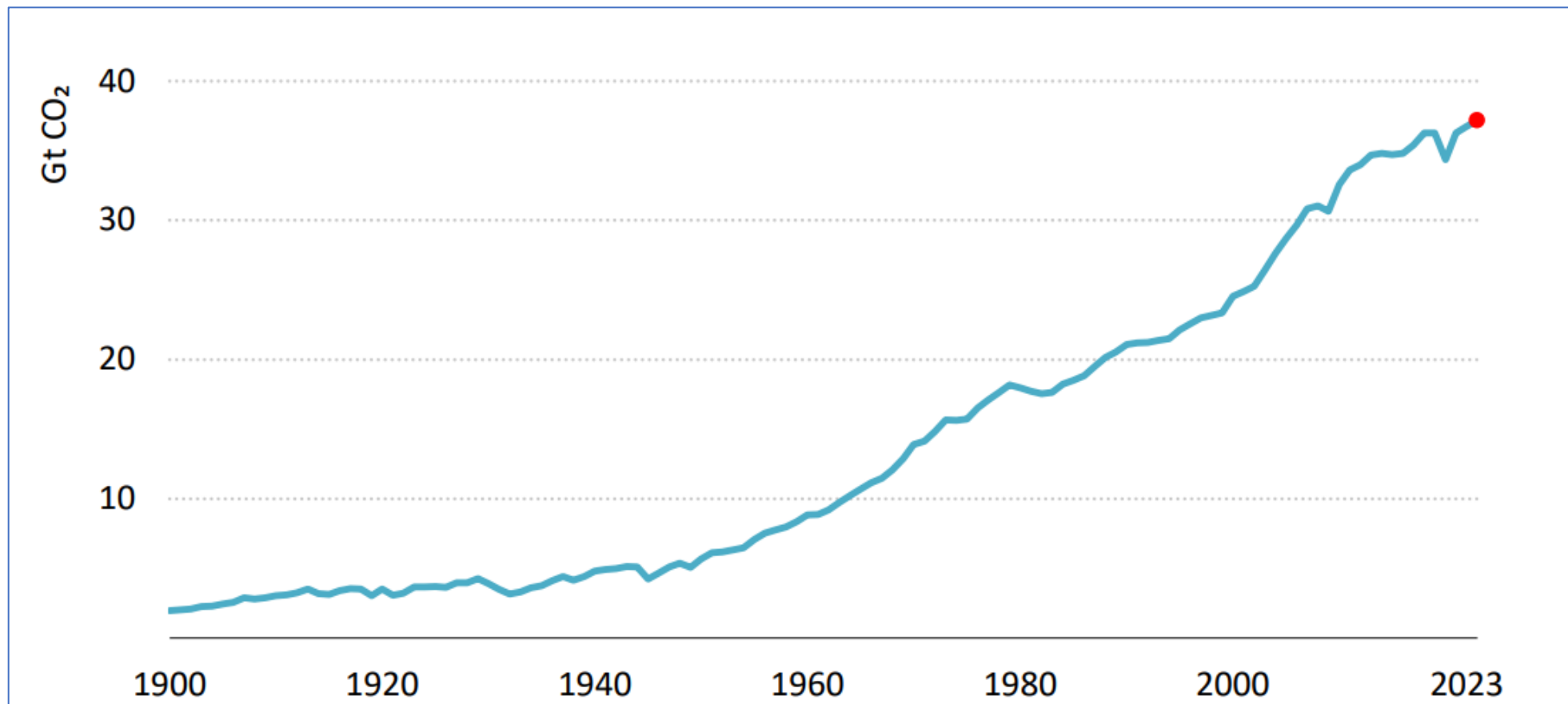
7:40 AM · Nov 24, 2020



♡ 60.6K

💬 33.3K people are Tweeting about this

Global CO₂ emissions from fossil fuel combustion









99% =

$\text{N}_2 + \text{O}_2 + \text{Ar}$

Greenhouse Gas	Formula	100-year GWP (AR4)
Carbon dioxide	CO ₂	1
Methane	CH ₄	25
Nitrous oxide	N ₂ O	298
Sulphur hexafluoride	SF ₆	22,800
Hydrofluorocarbon-23	CHF ₃	14,800
Hydrofluorocarbon-32	CH ₂ F ₂	675
Perfluoromethane	CF ₄	7,390
Perfluoroethane	C ₂ F ₆	12,200
Perfluoropropane	C ₃ F ₈	8,830
Perfluorobutane	C ₄ F ₁₀	8,860
Perfluorocyclobutane	c-C ₄ F ₈	10,300
Perfluoropentane	C ₅ F ₁₂	13,300
Perfluorohexane	C ₆ F ₁₄	9,300

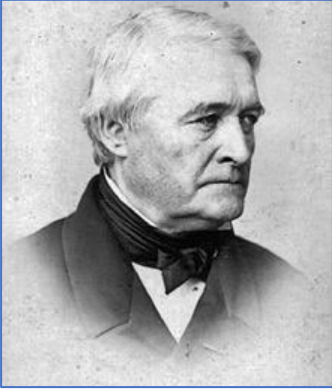


Who figured this out?



1824: Joseph Fourier

- Proposed that Earth's atmosphere retains heat that would otherwise be emitted back into space



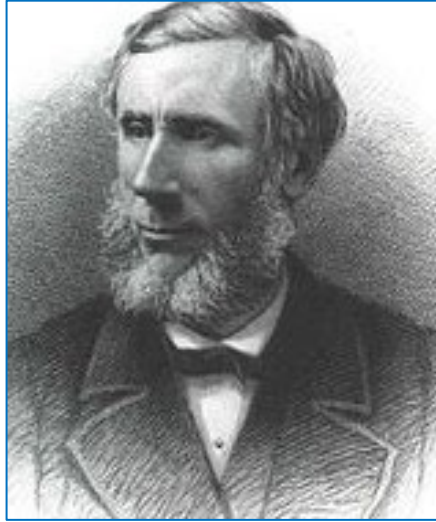
1827: Claude Pouillet

- Developed the first mathematical treatment of the greenhouse effect
- Speculated that water vapor and carbon dioxide might trap heat in the atmosphere



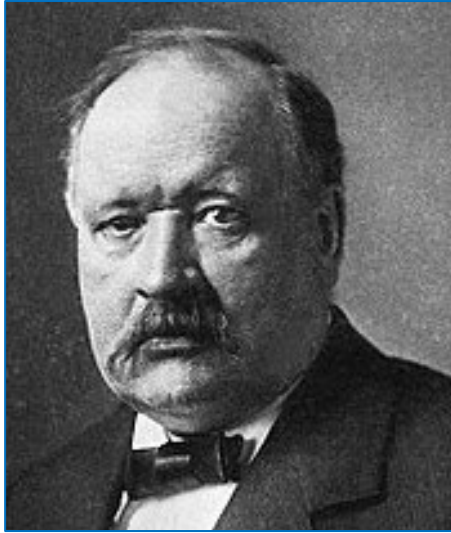
1856: Eunice Newton Foote

- First to show in experiments and put in print that if carbon dioxide levels were higher, the planet would be warmer



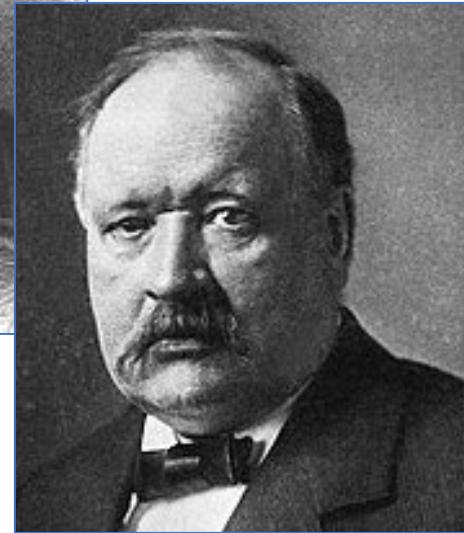
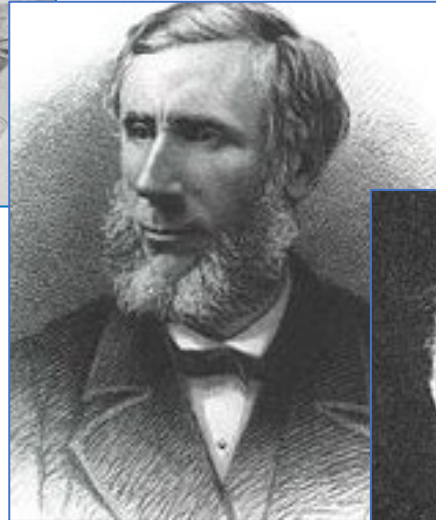
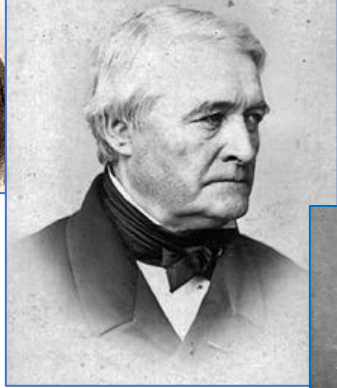
1859: John Tyndall

- Showed the ability of gases like water vapor, carbon dioxide, ozone and hydrocarbons to absorb and re-emit heat



1896: Svante Arrhenius

- First to use modern principles of physical chemistry to calculate how increases in CO_2 will increase Earth's surface temperature
- Concluded that human-caused CO_2 emissions, from fossil-fuel burning and other combustion processes, are large enough to cause global warming



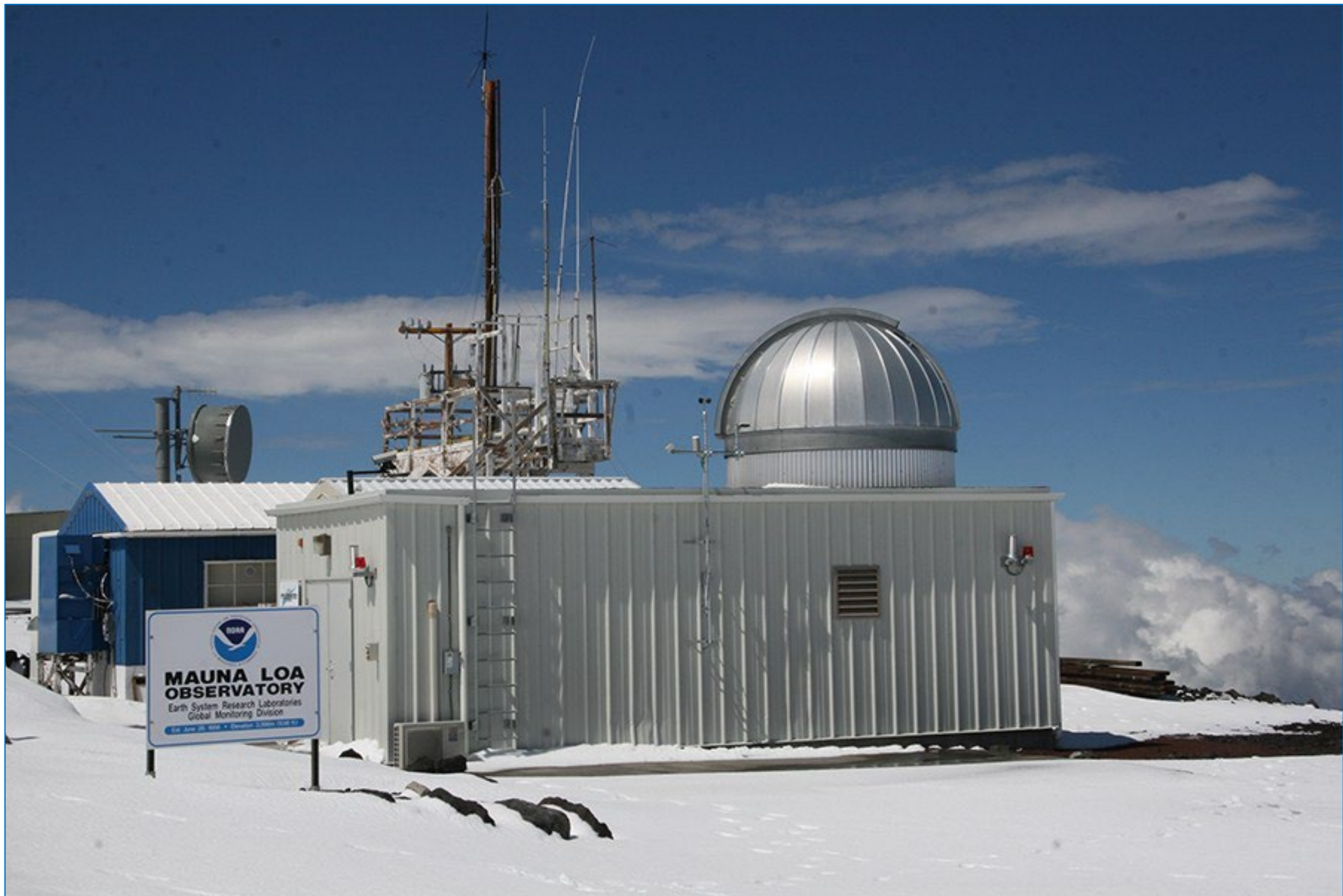
1824 ~ 1896

1958: Keeling

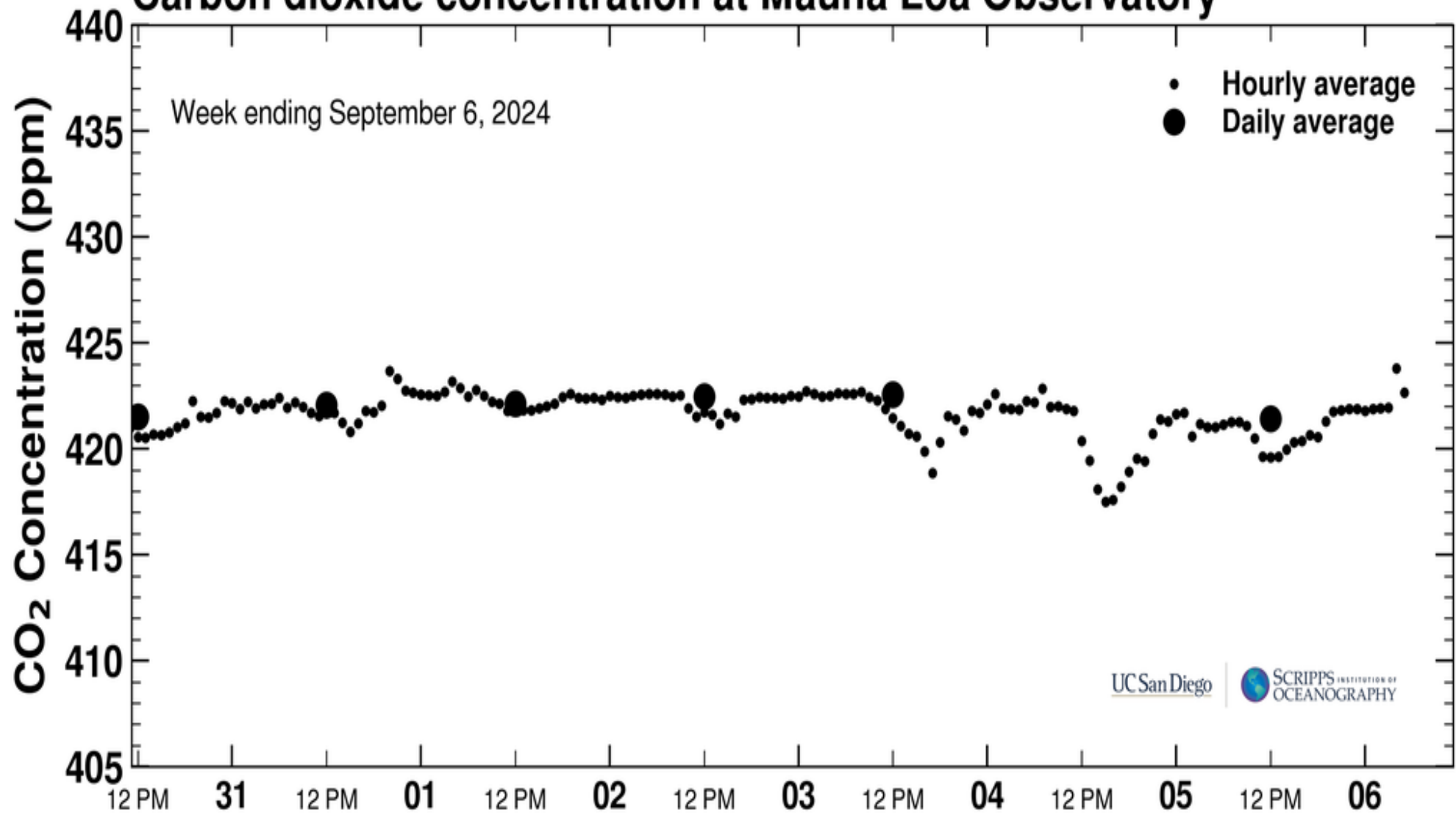




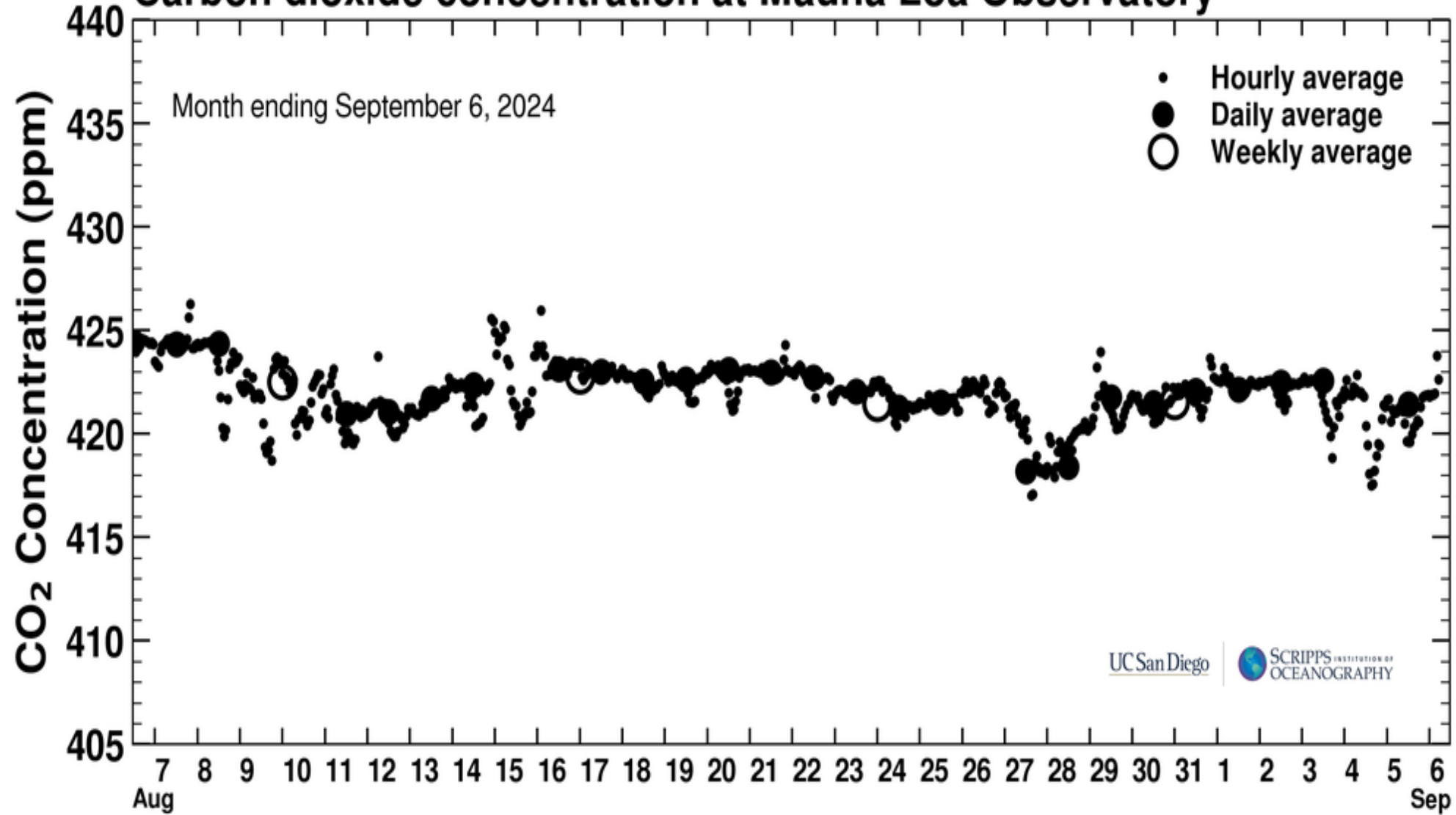




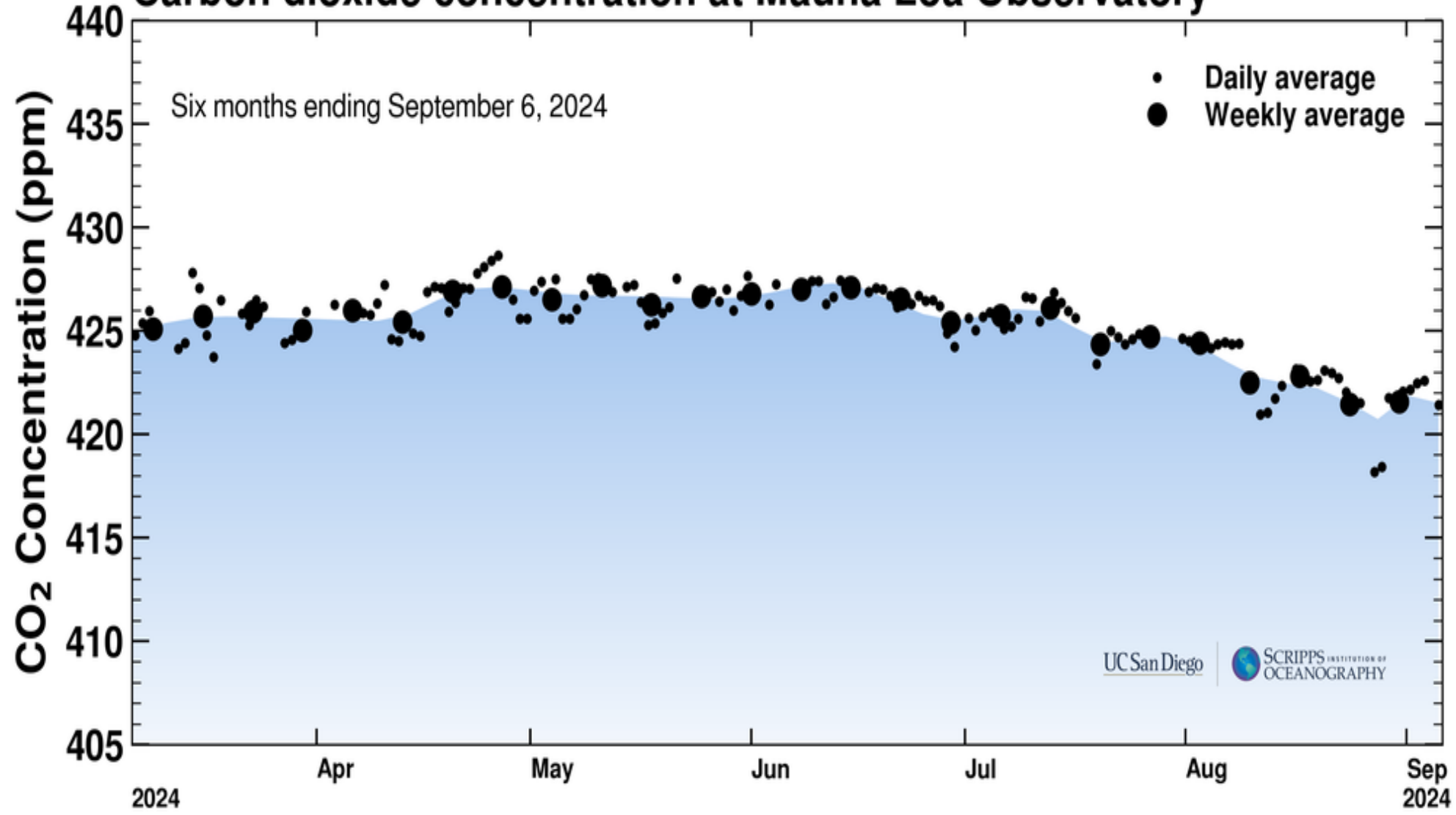
Carbon dioxide concentration at Mauna Loa Observatory



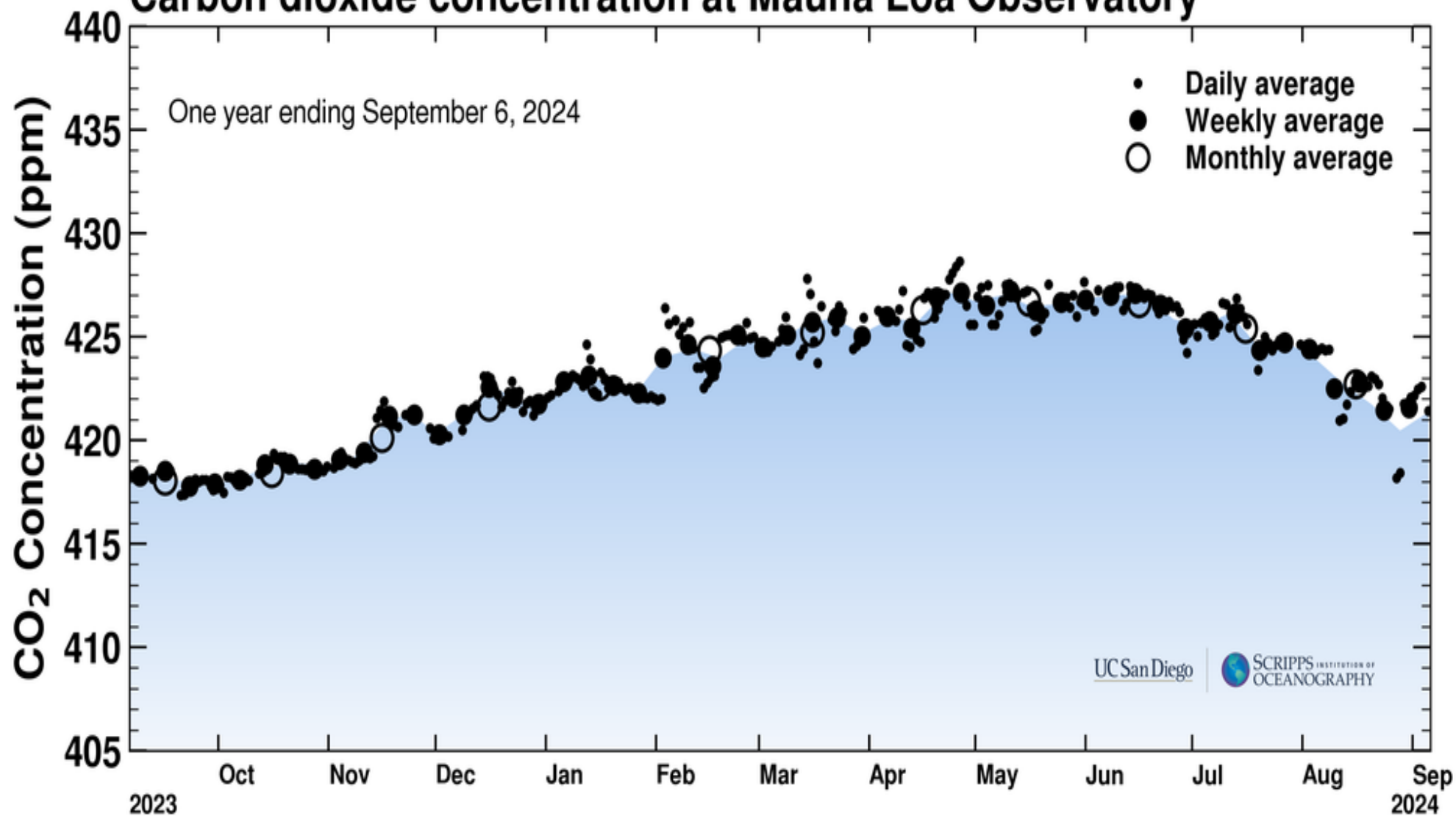
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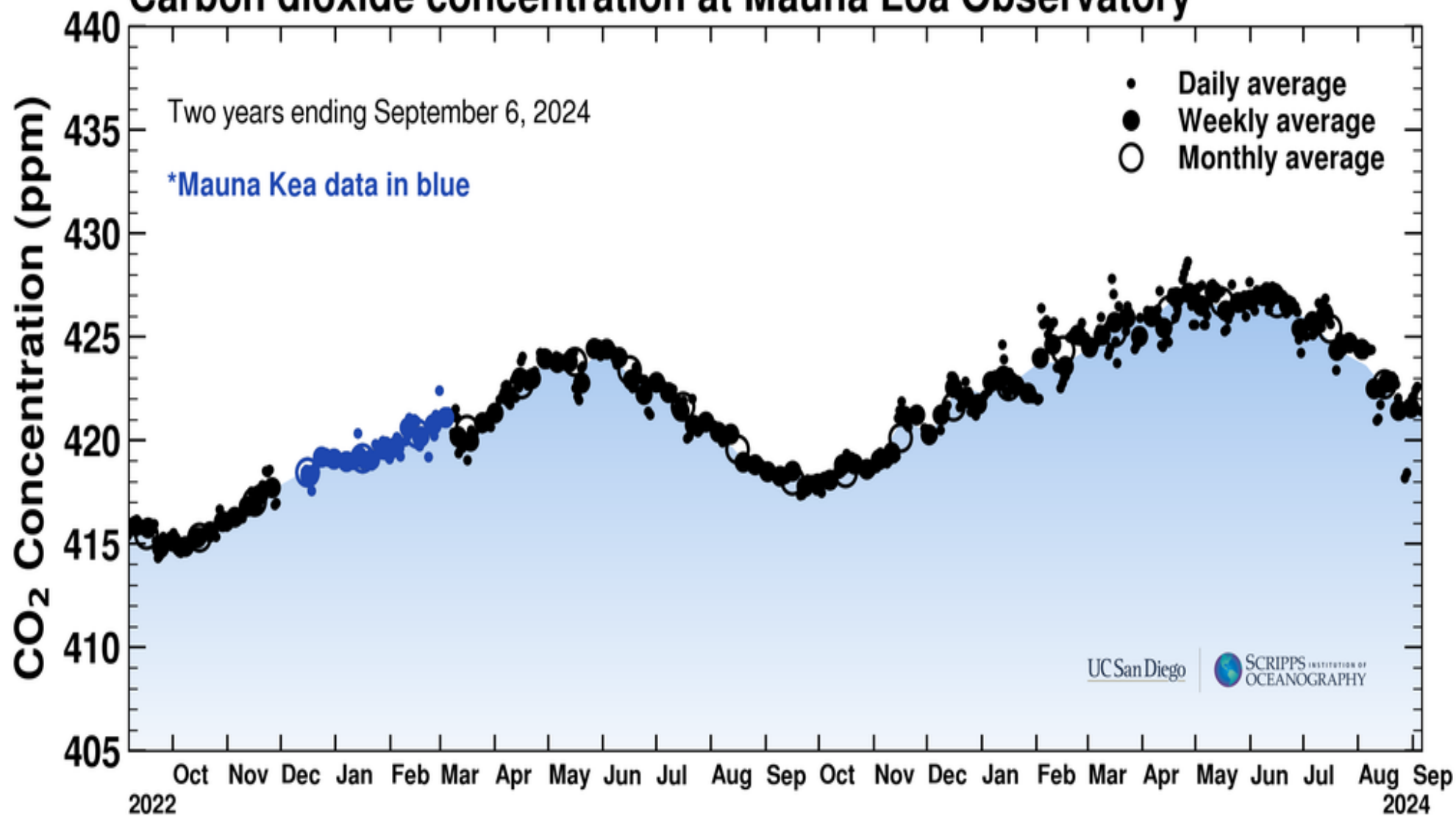
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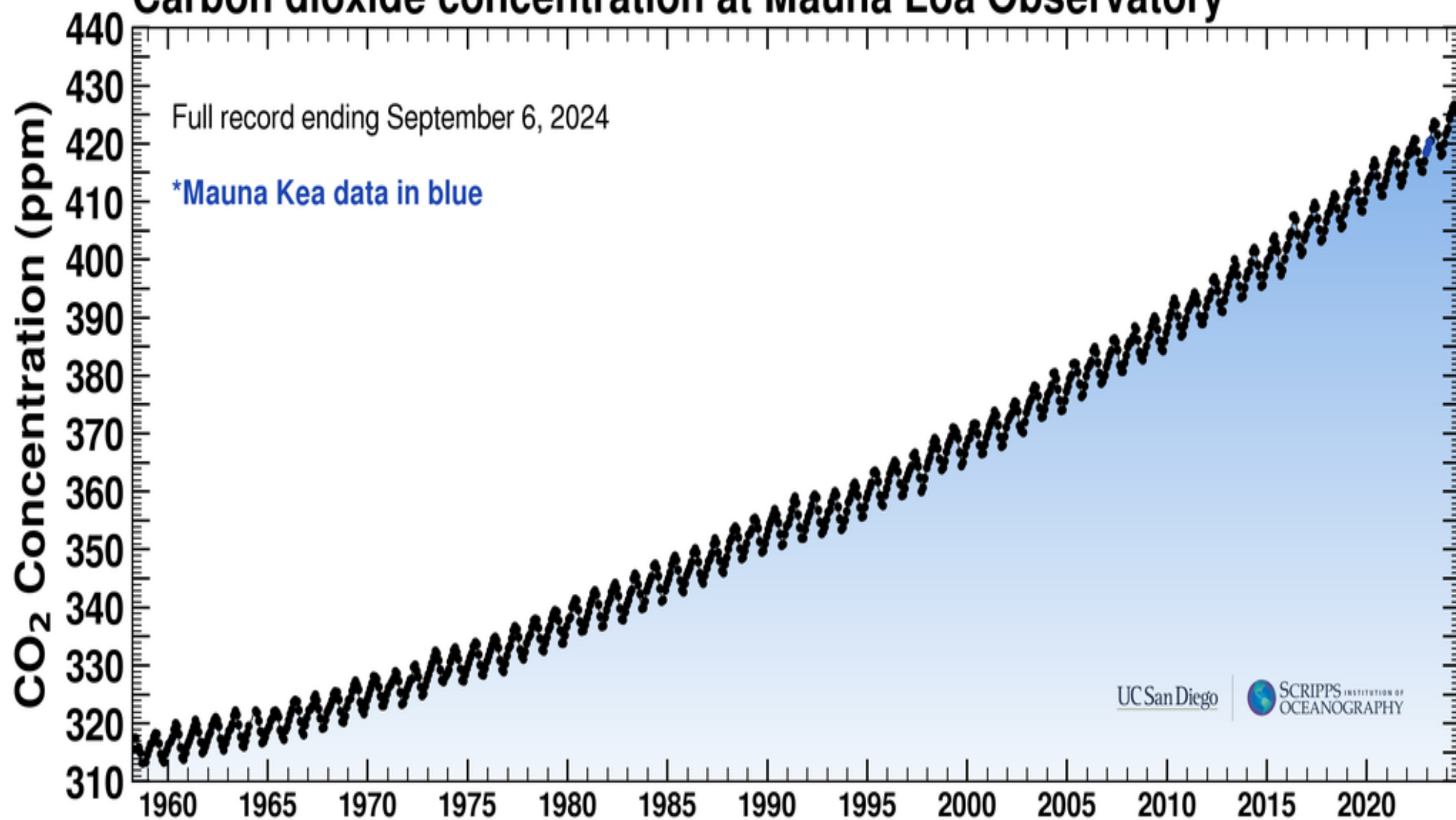
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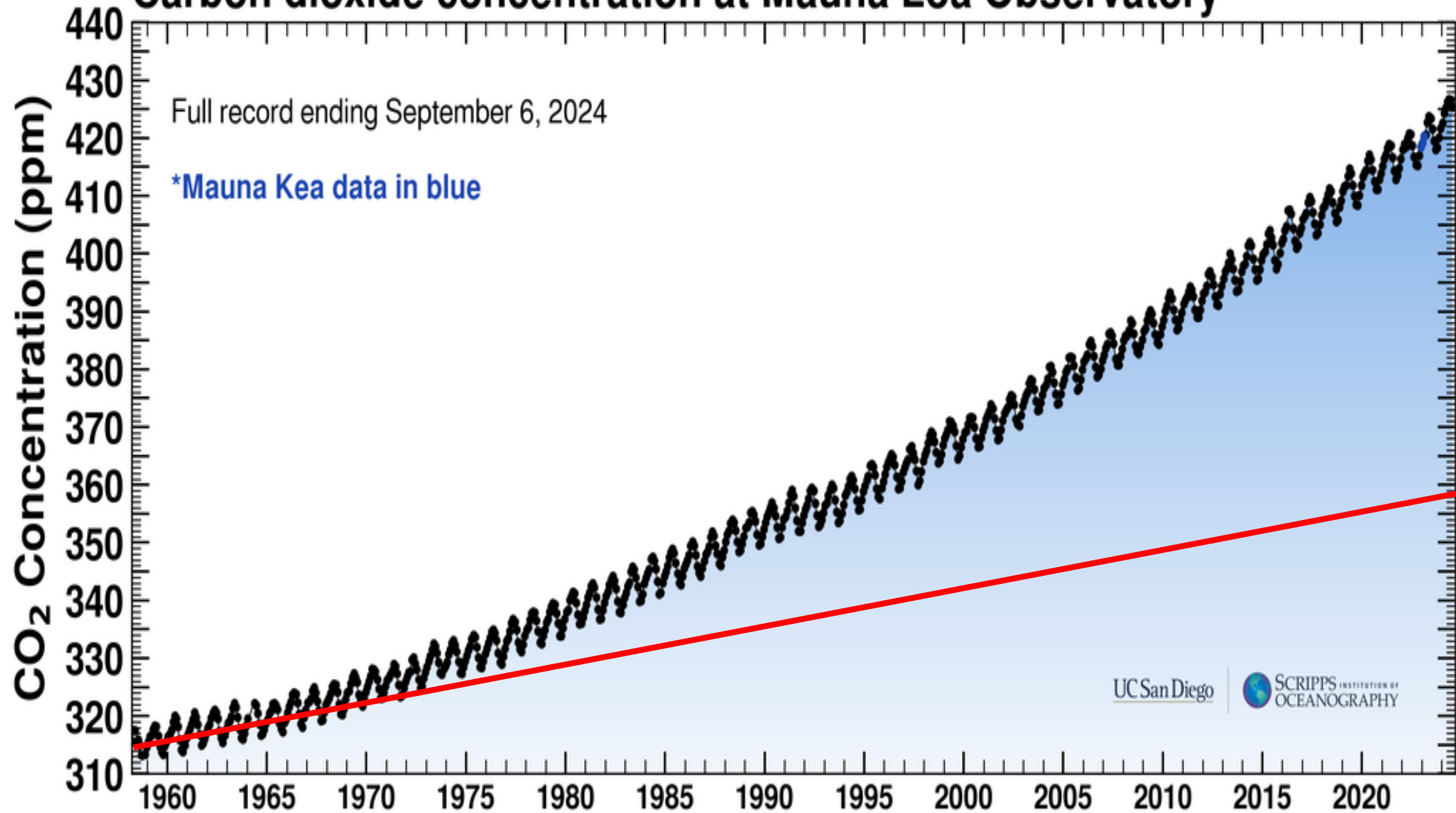
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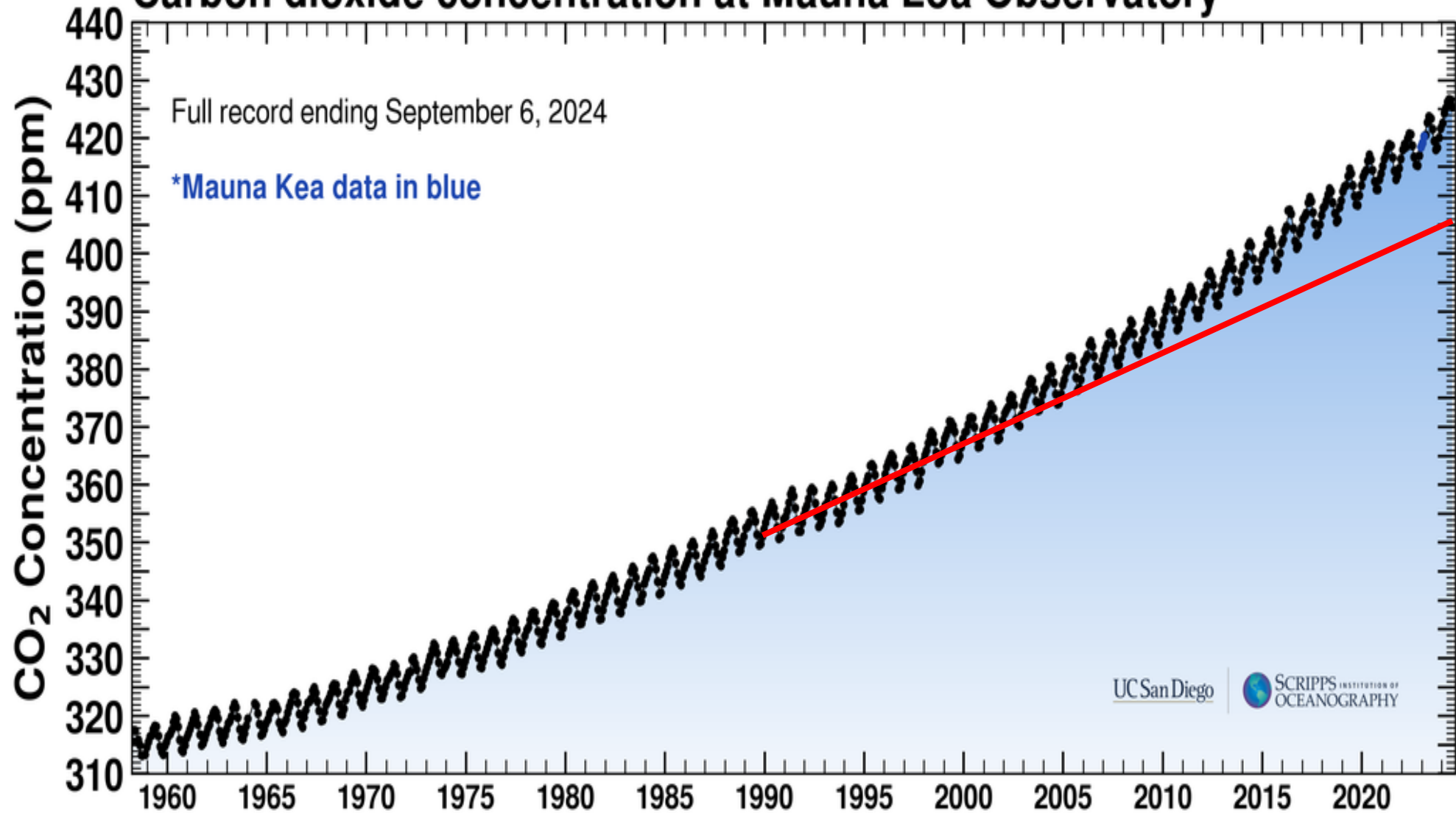
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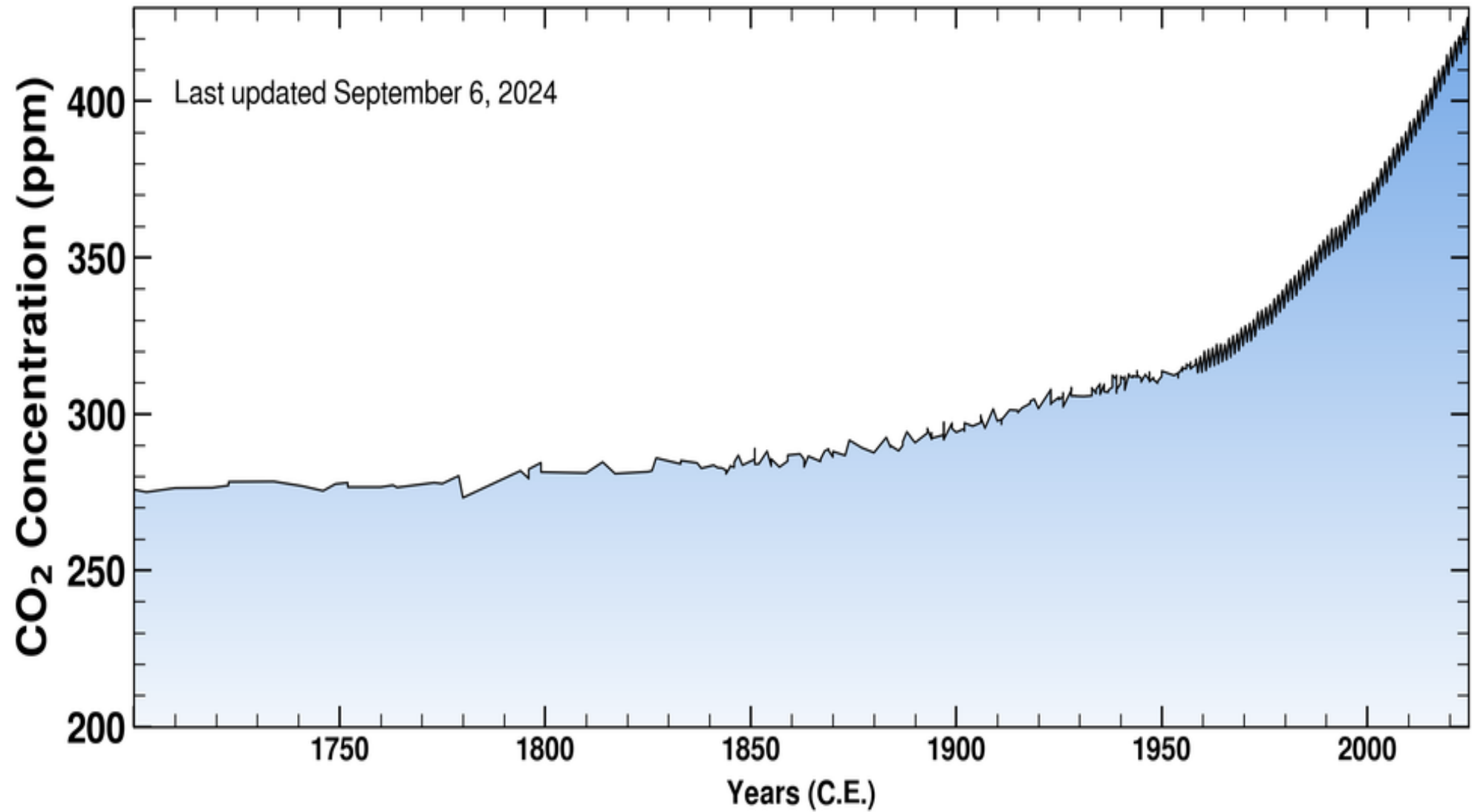


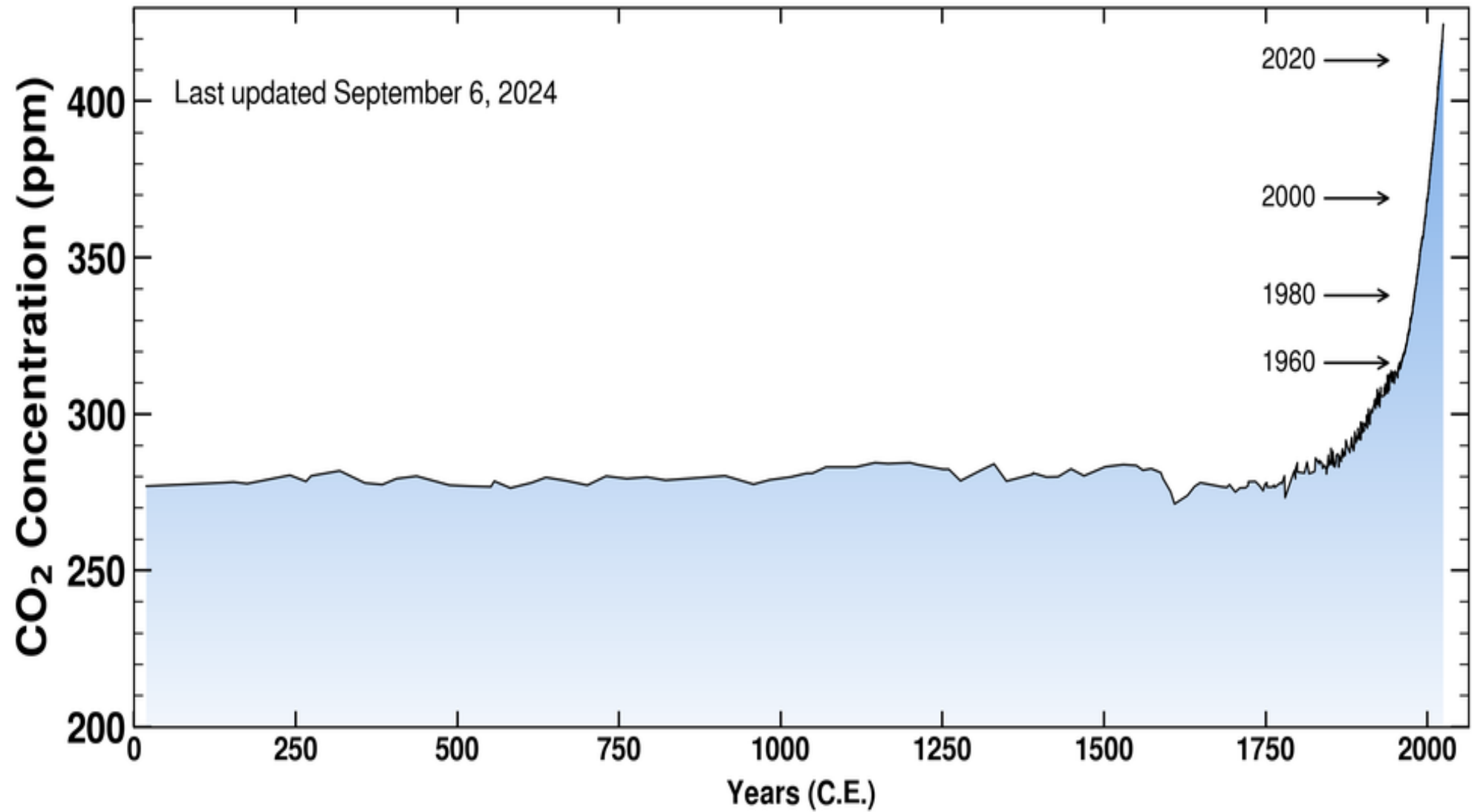
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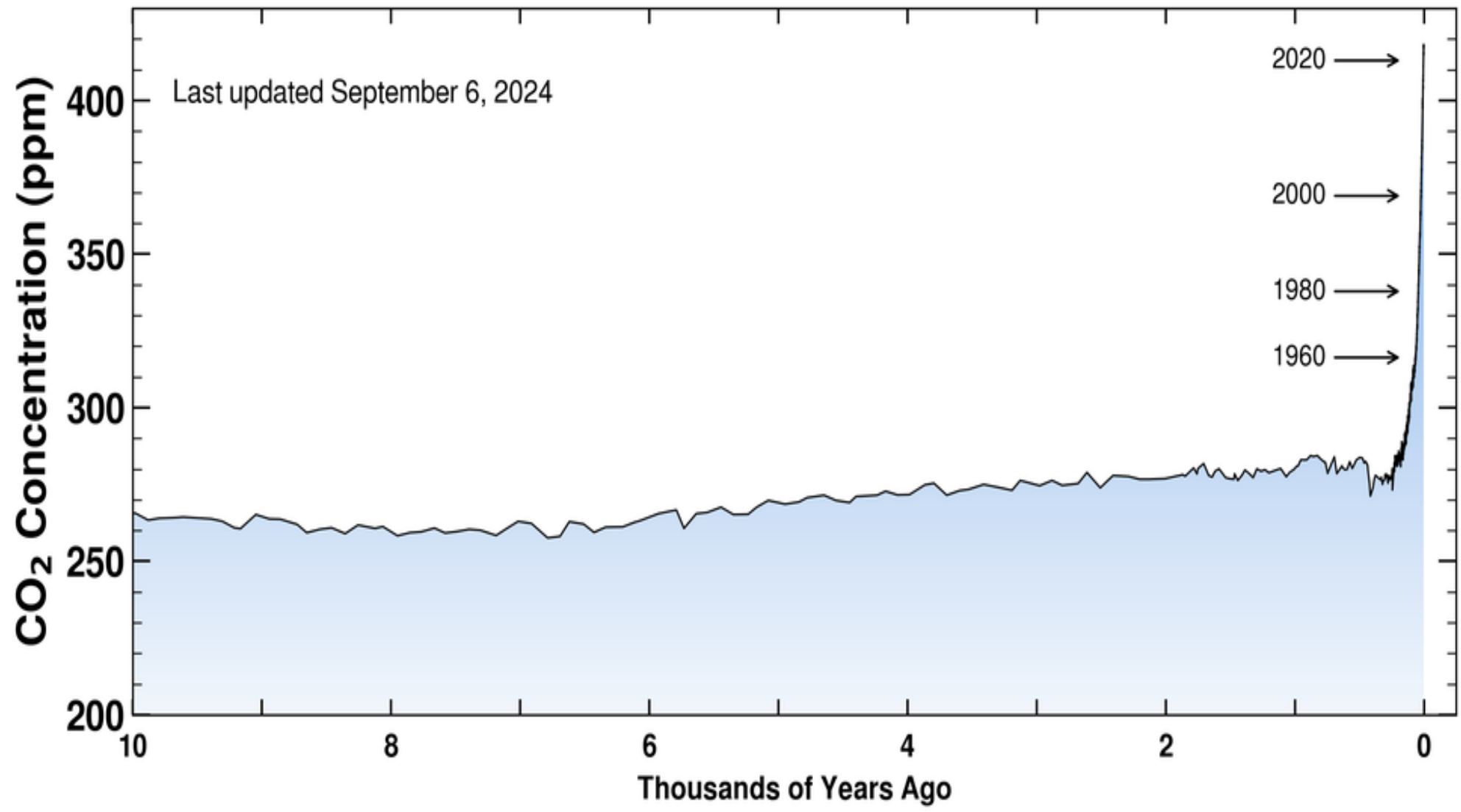


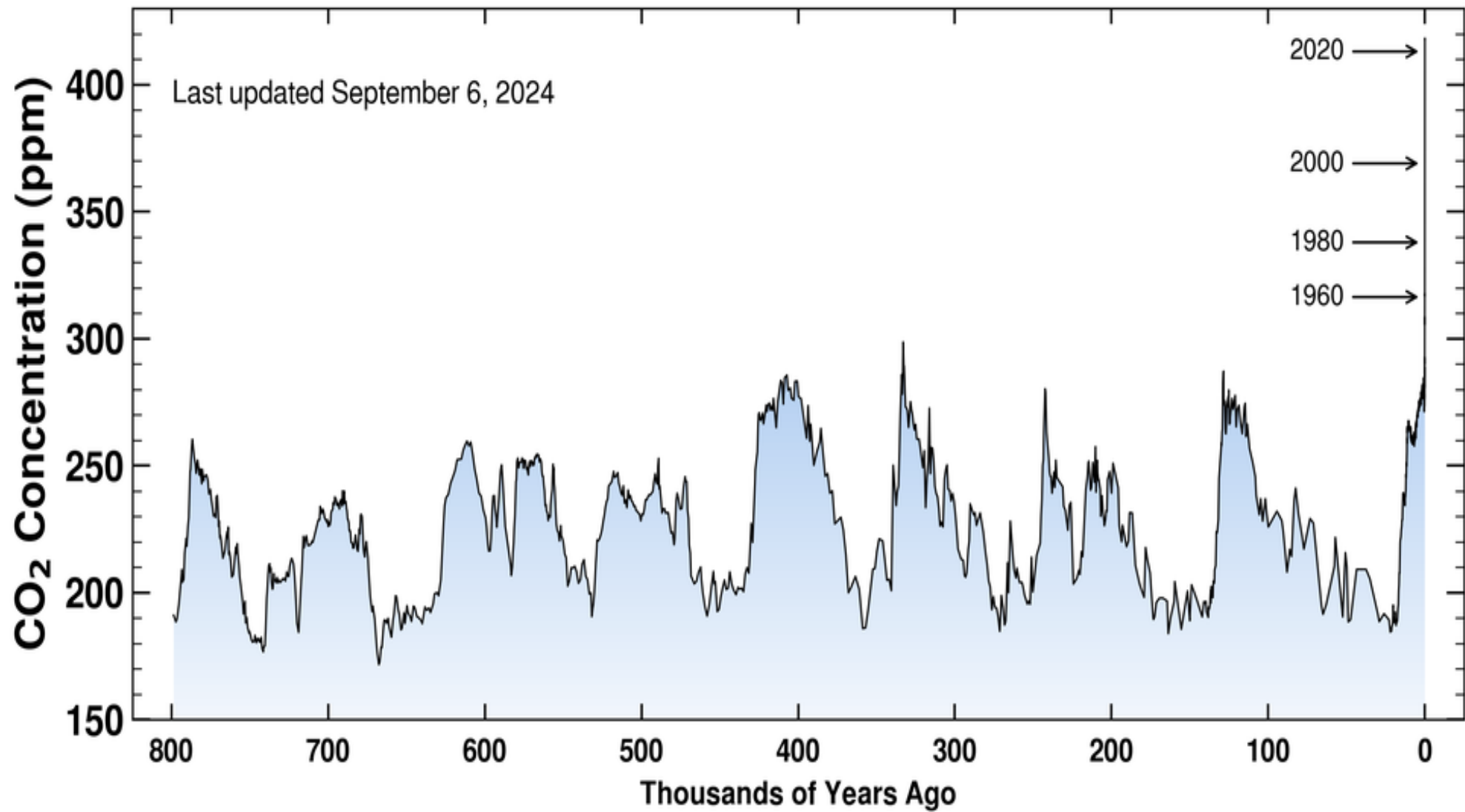
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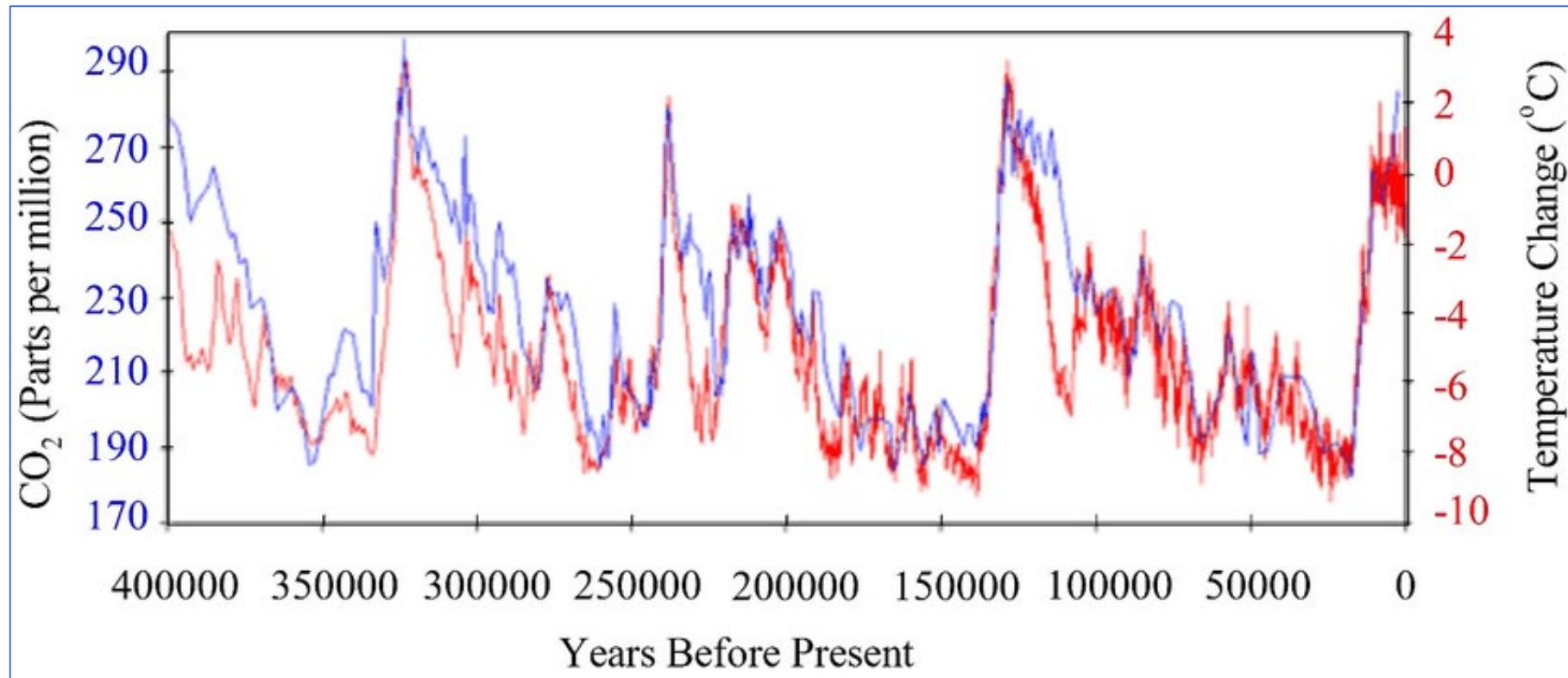




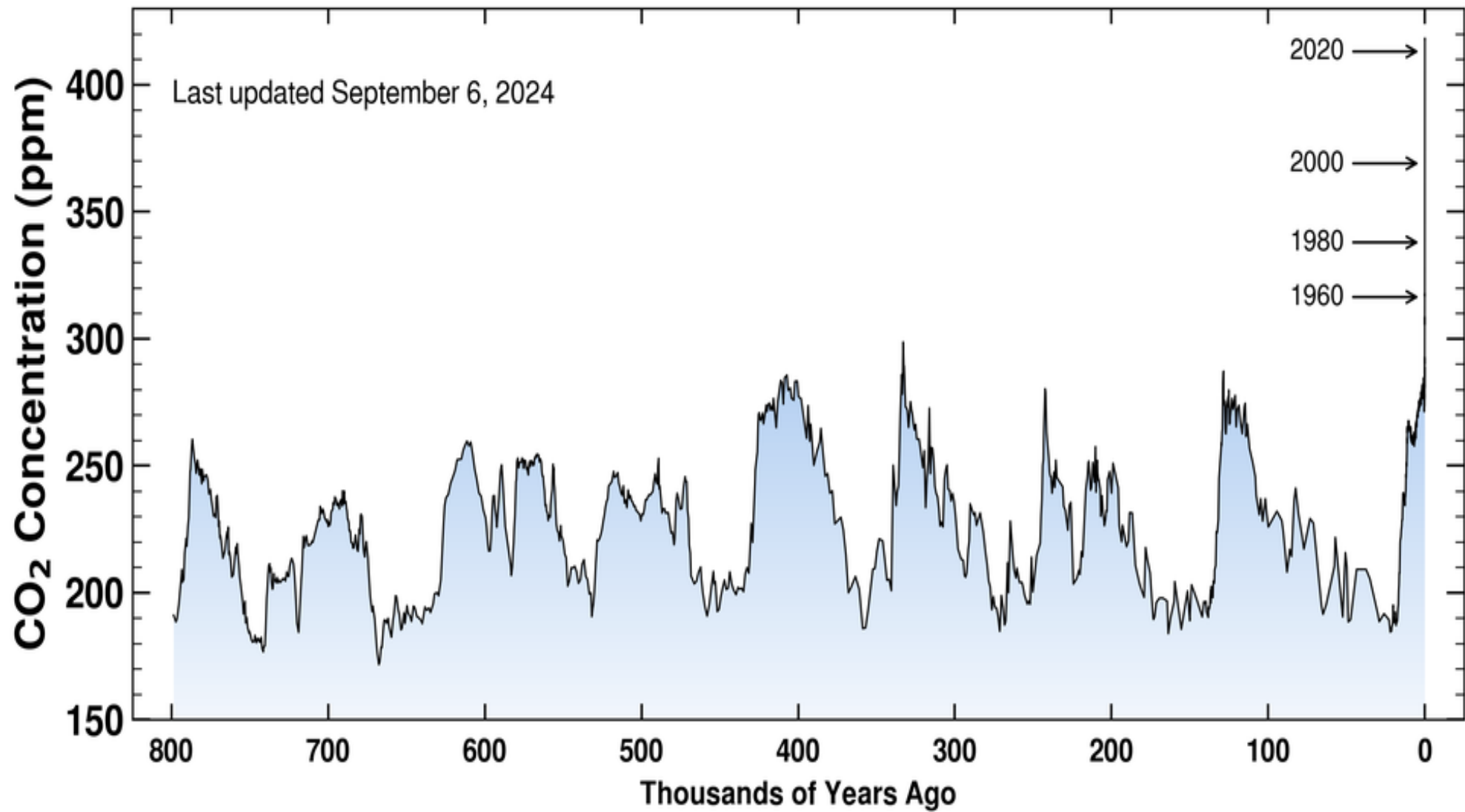








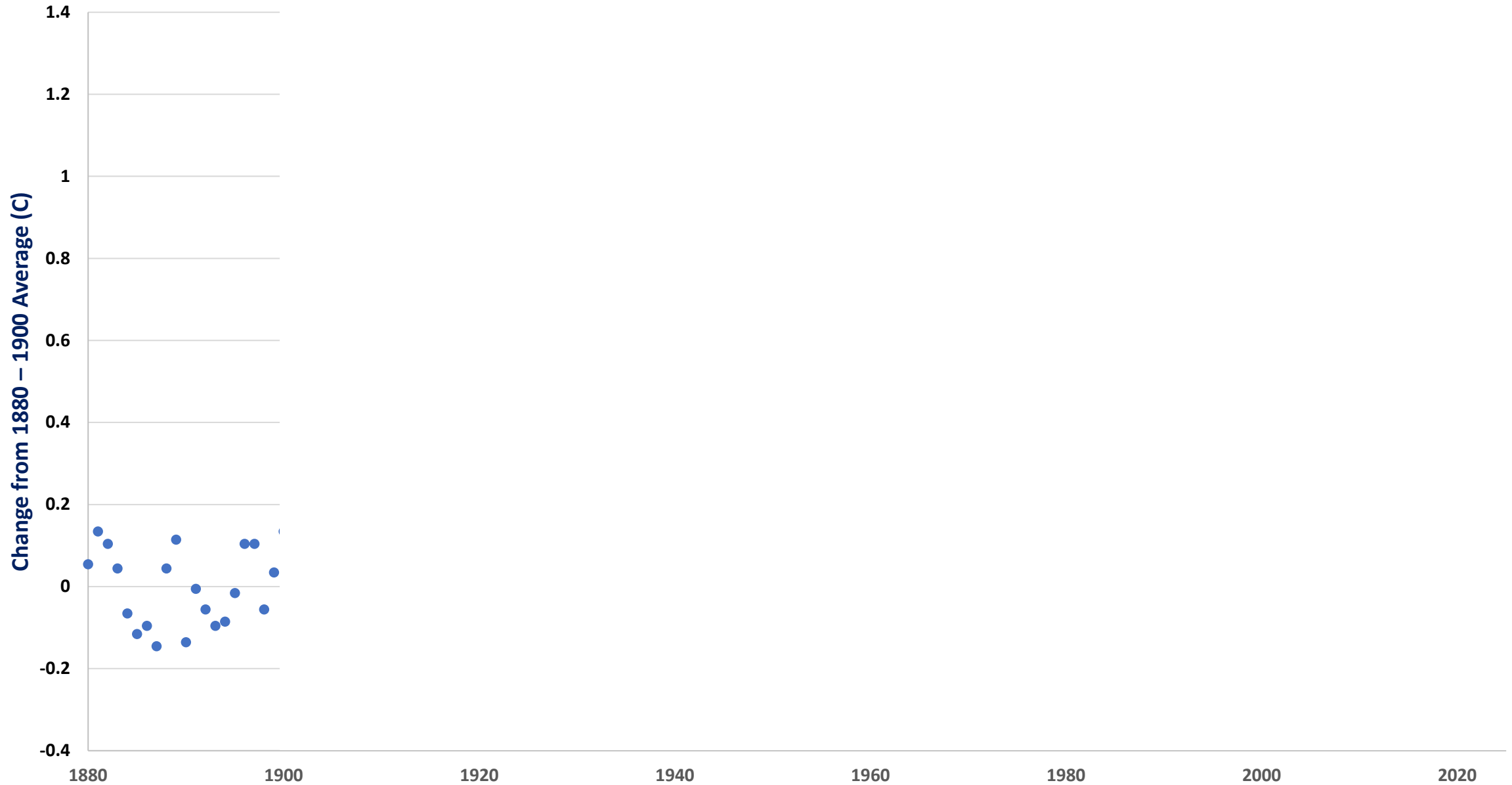
https://www.researchgate.net/figure/Vostok-ice-core-records-for-carbon-dioxide-concentration-and-temperature-change-CO2-lags_fig2_340835138



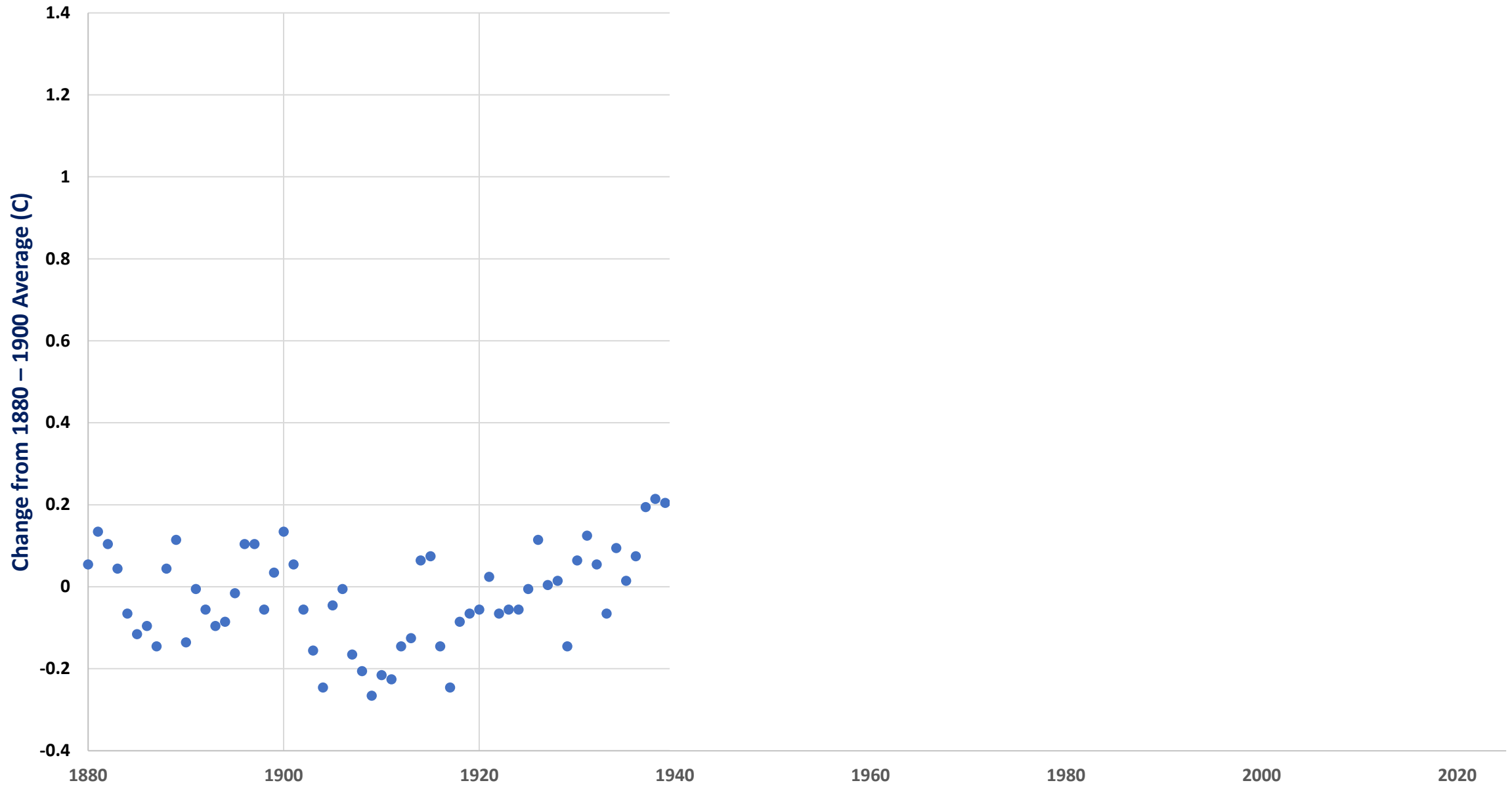
Where is all the CO₂ coming from?



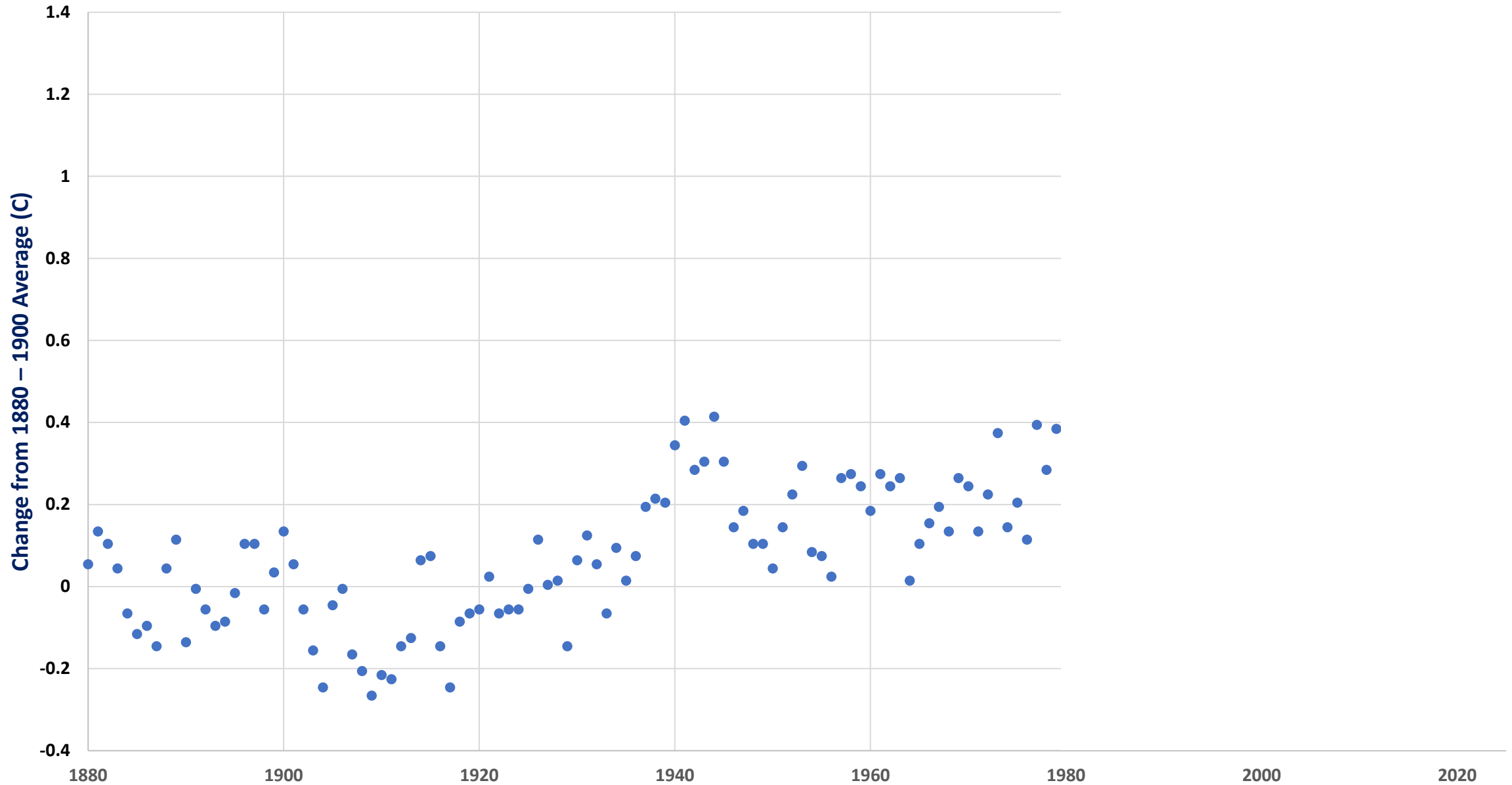
NASA – Average annual global temperature (land + ocean)



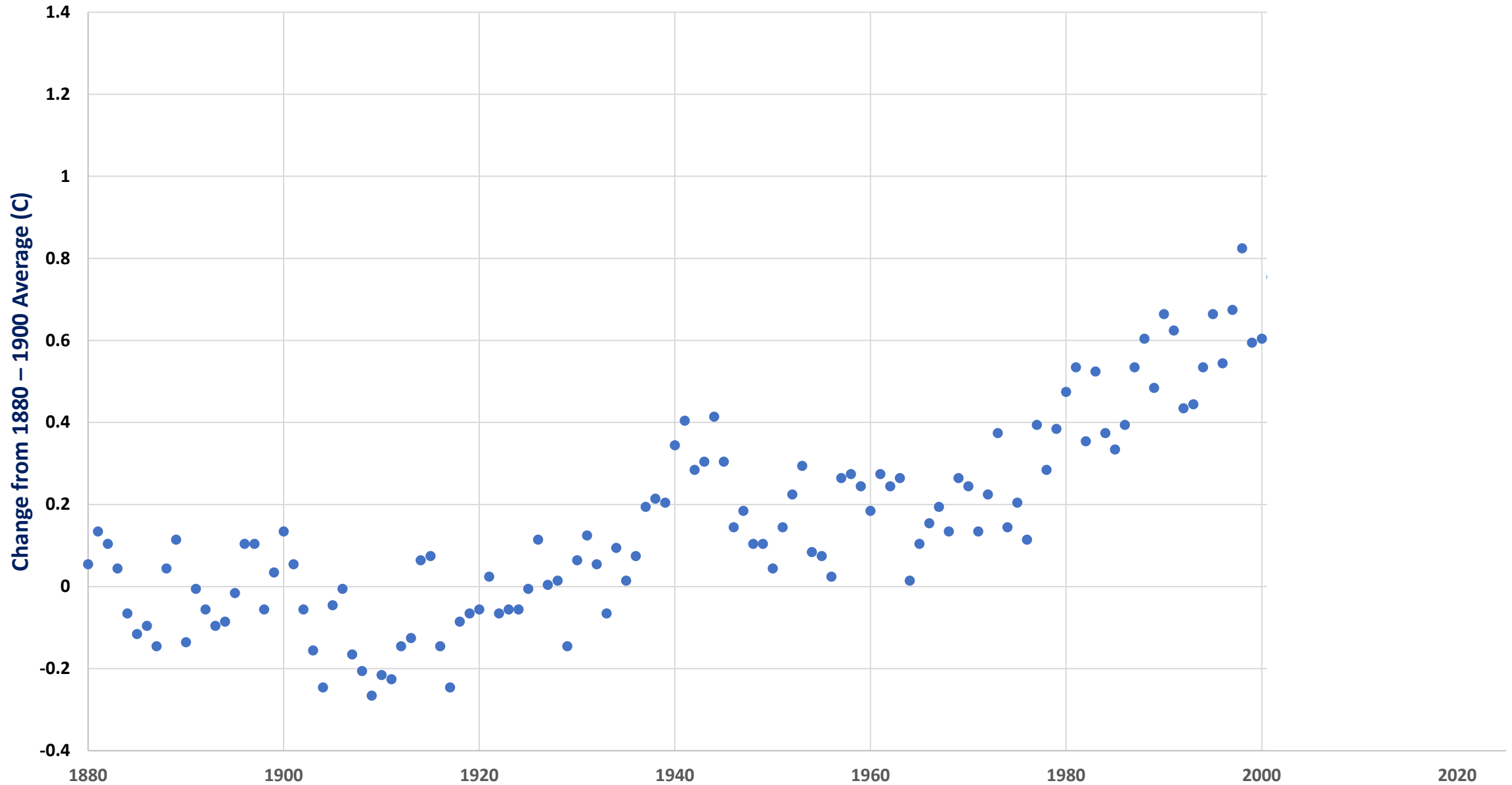
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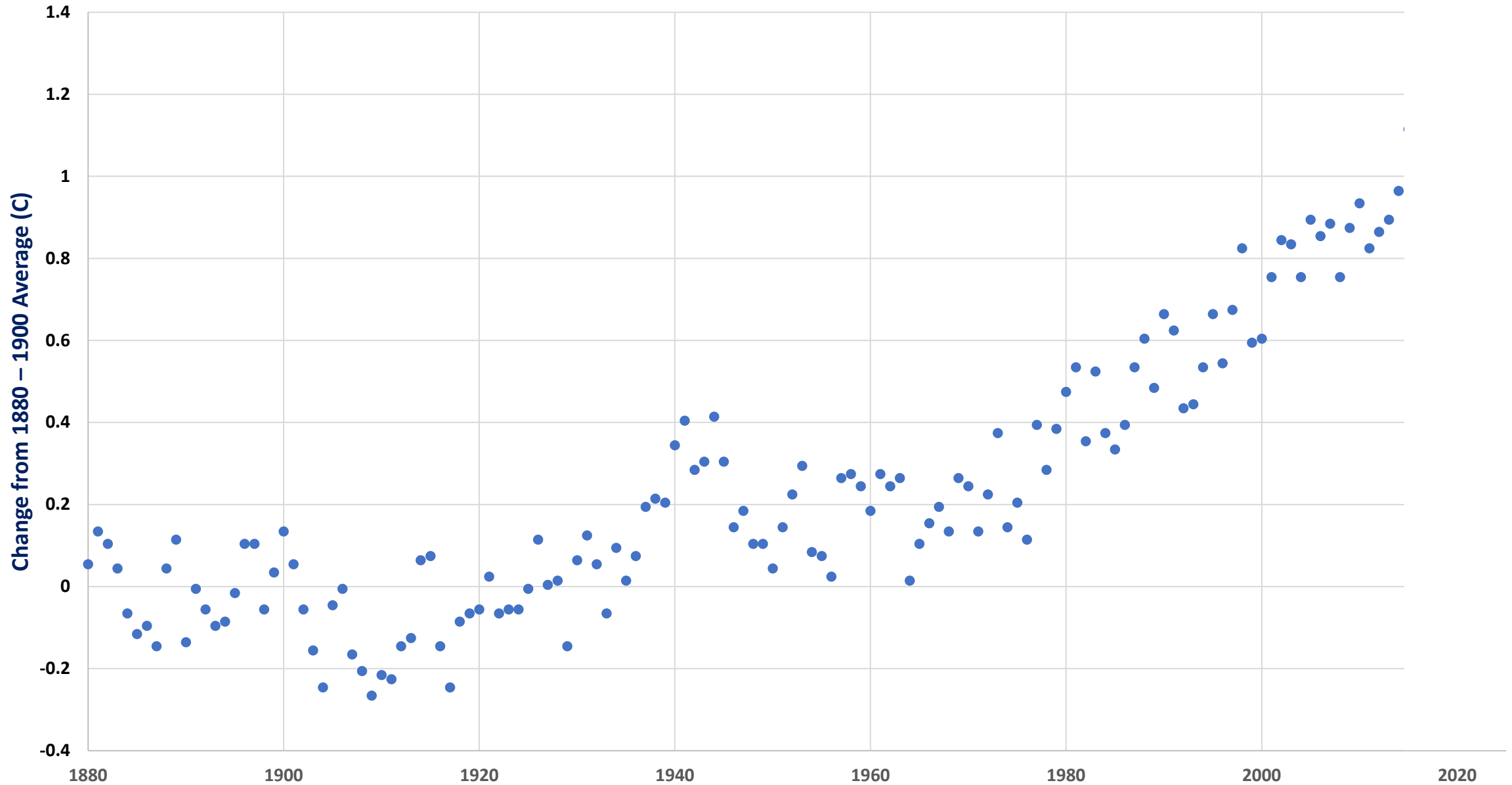
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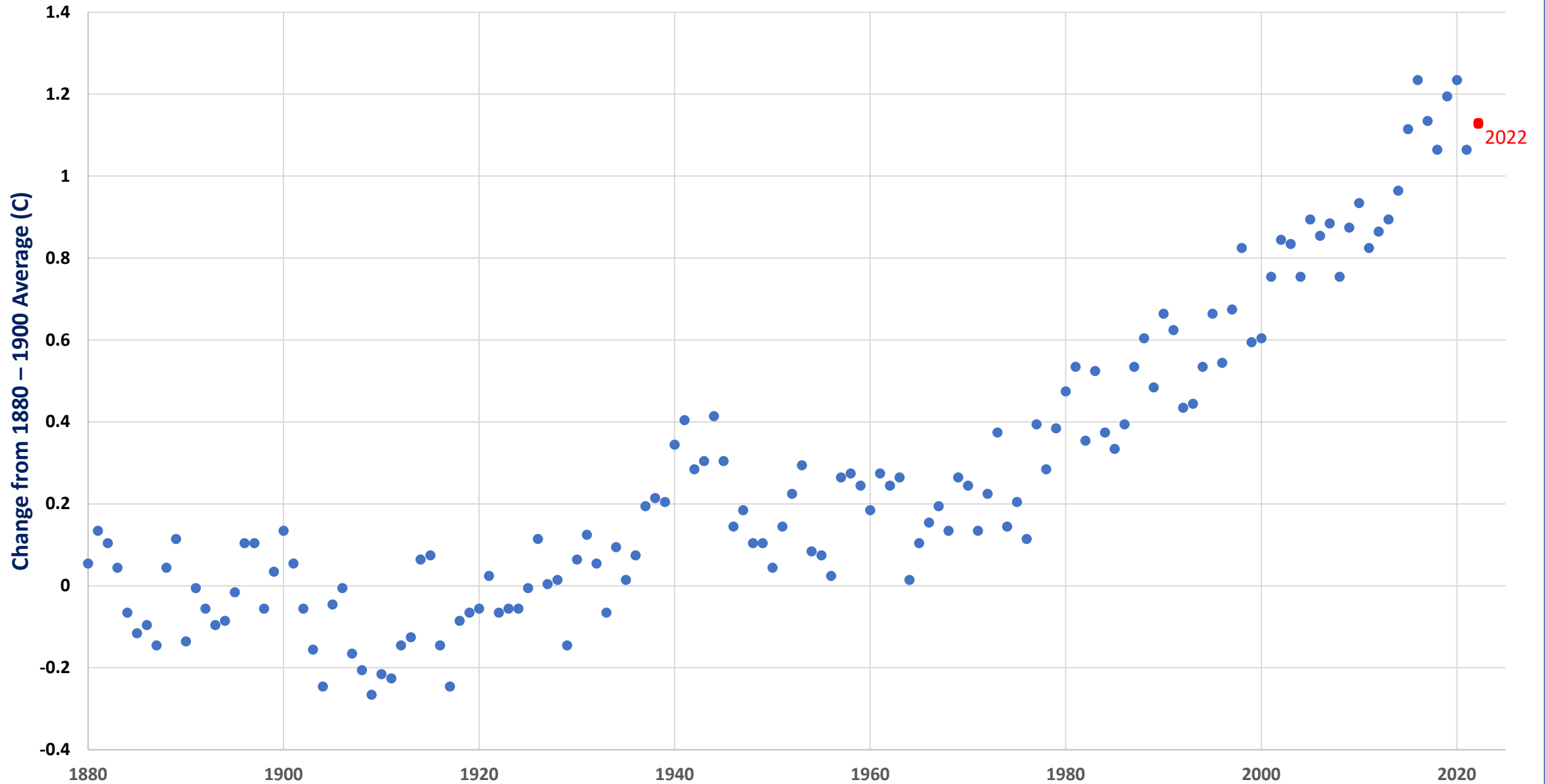
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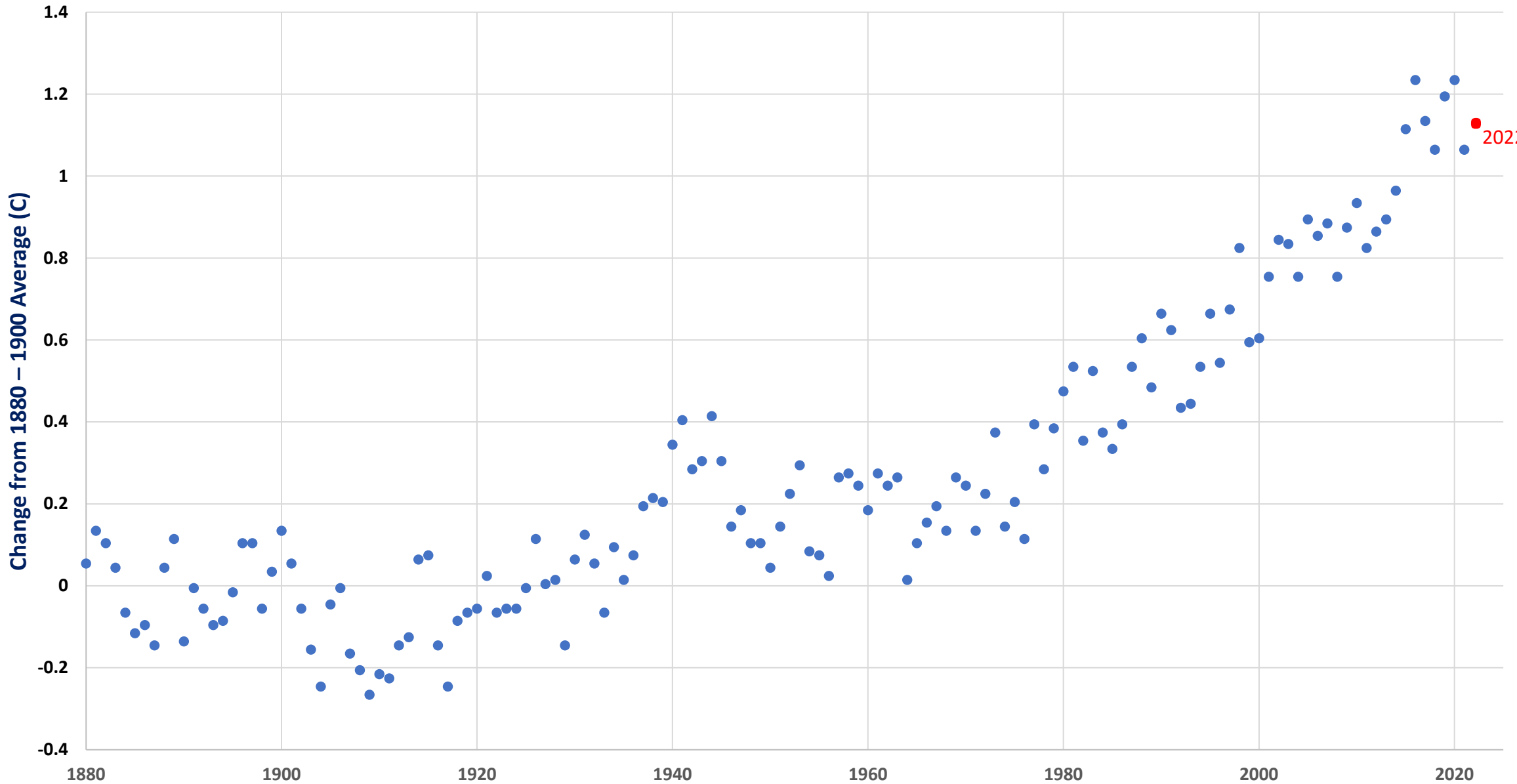
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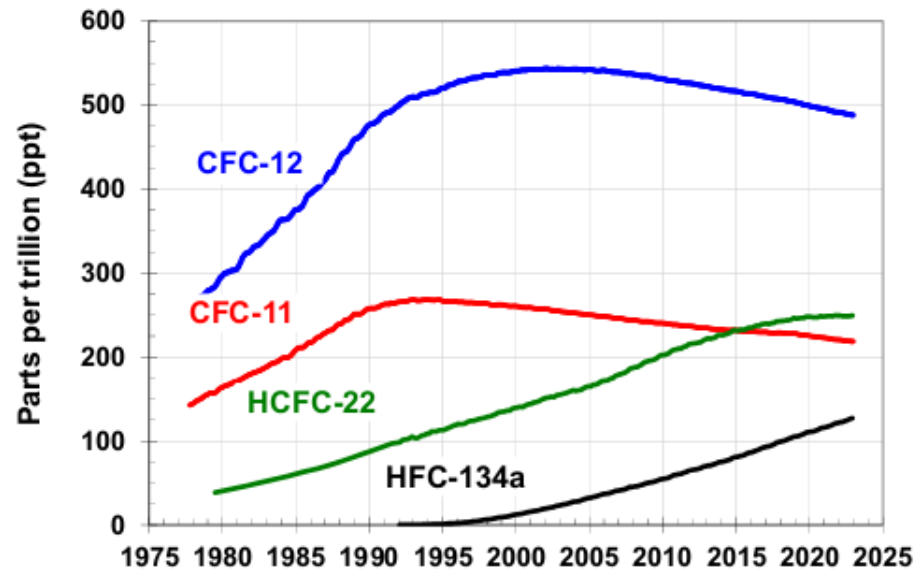
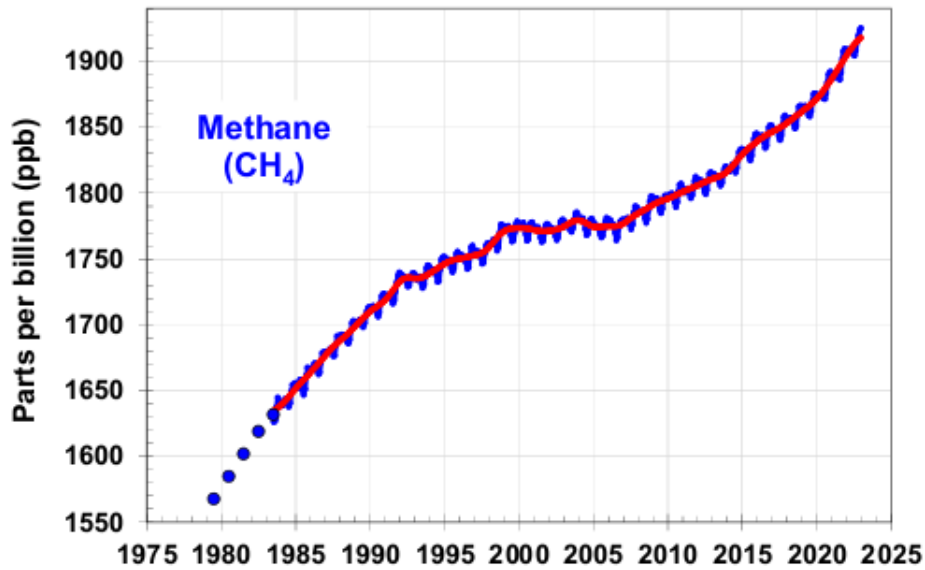
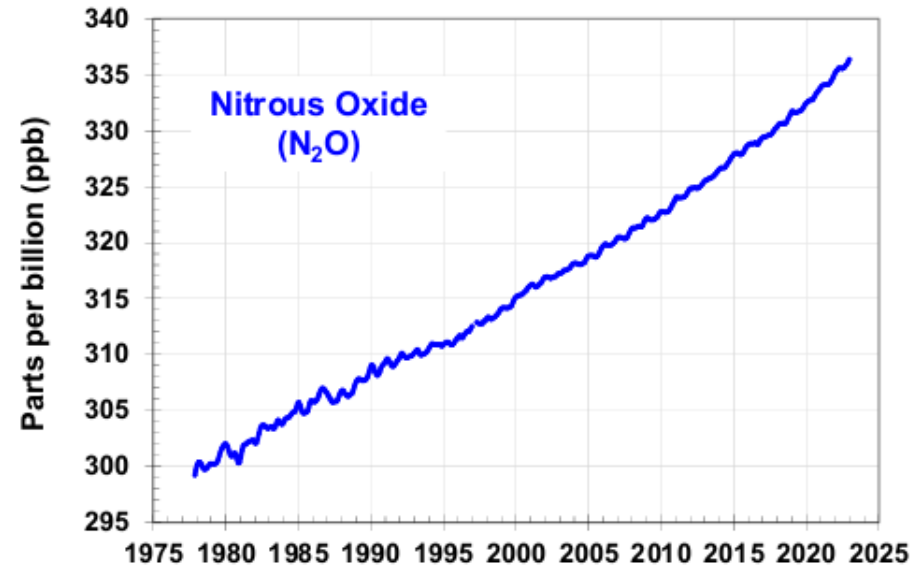
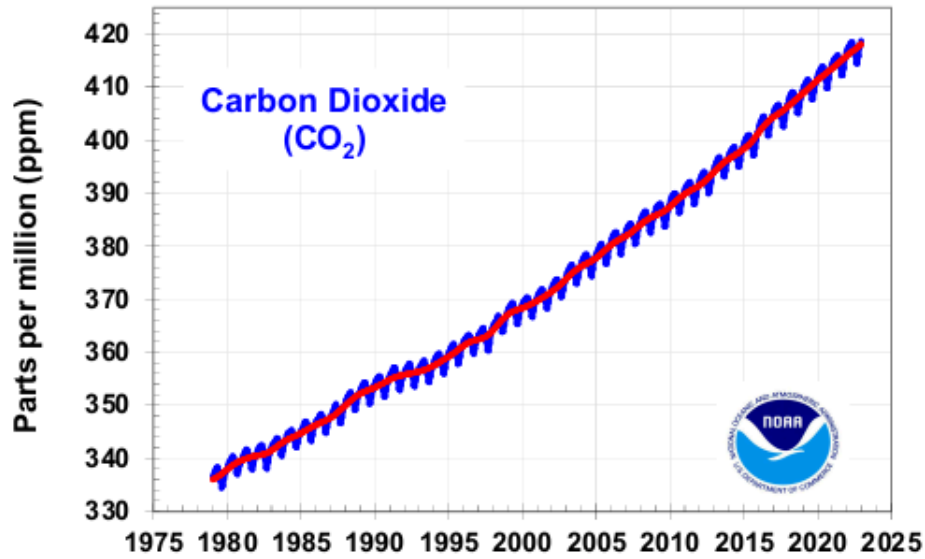
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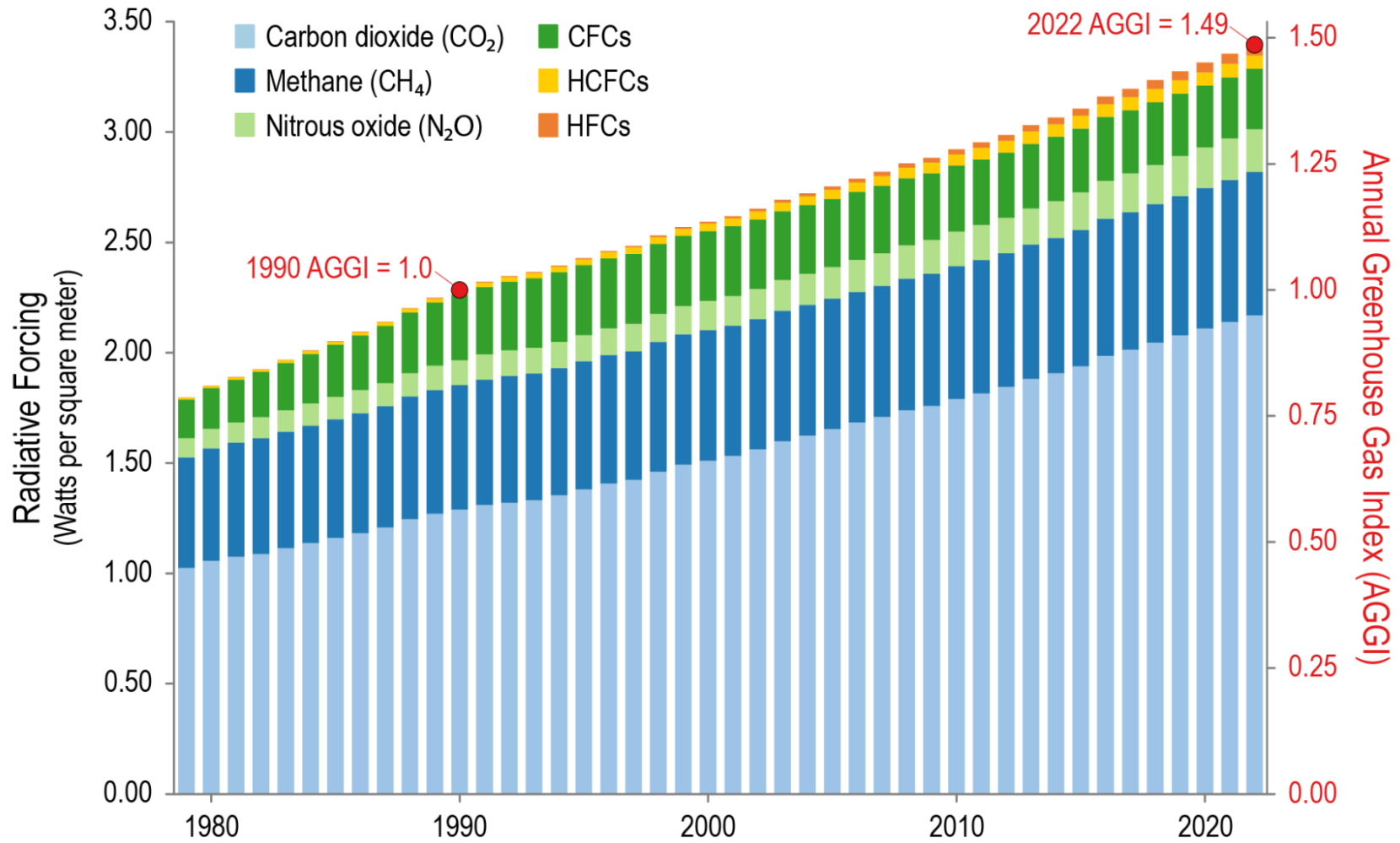
1.54 ± 0.06 °C above the 1850 – 1900 average - <https://berkeleyearth.org/global-temperature-report-for-2023/>

<https://climate.nasa.gov/vital-signs/global-temperature/>

About those other GHGs...

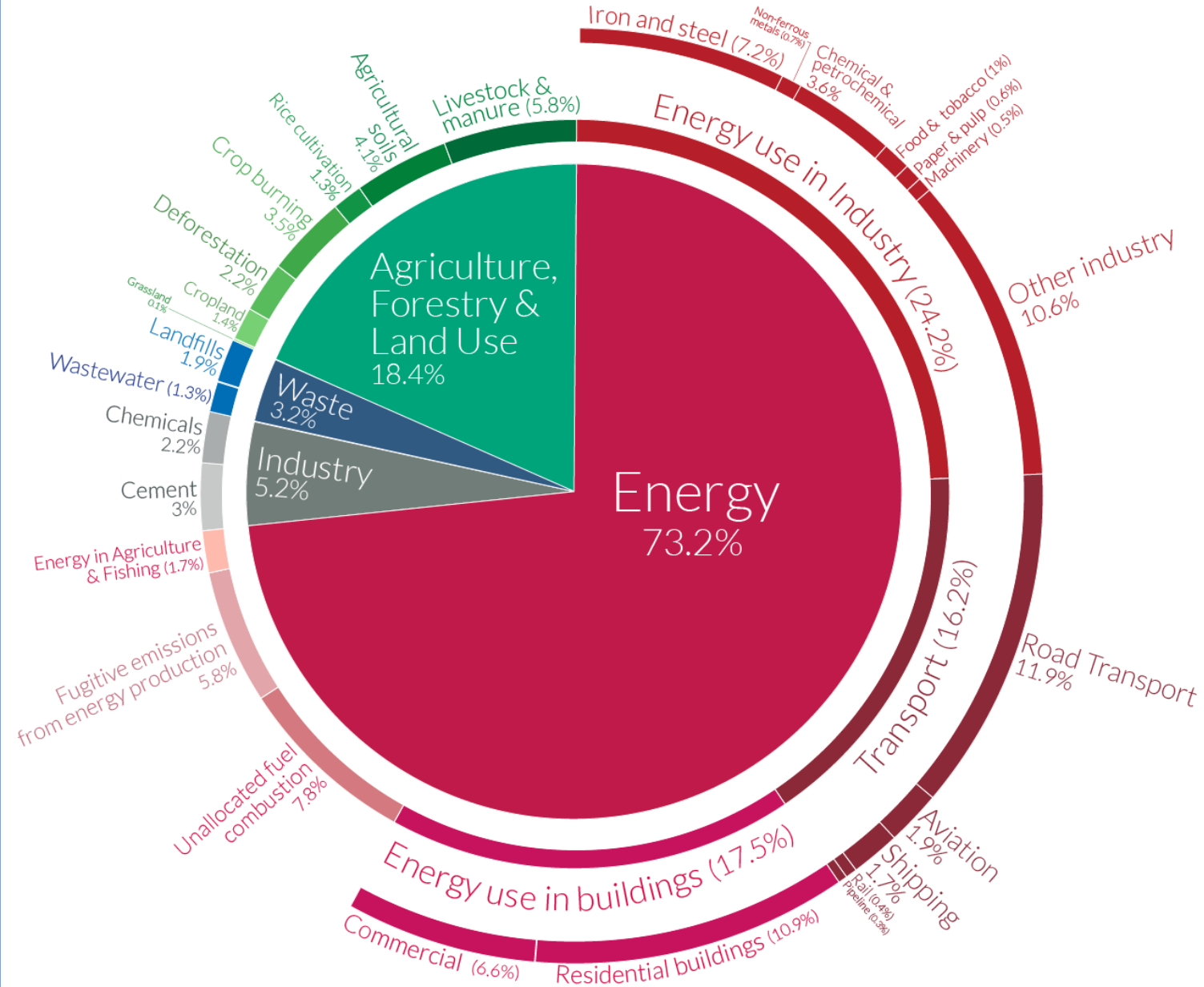


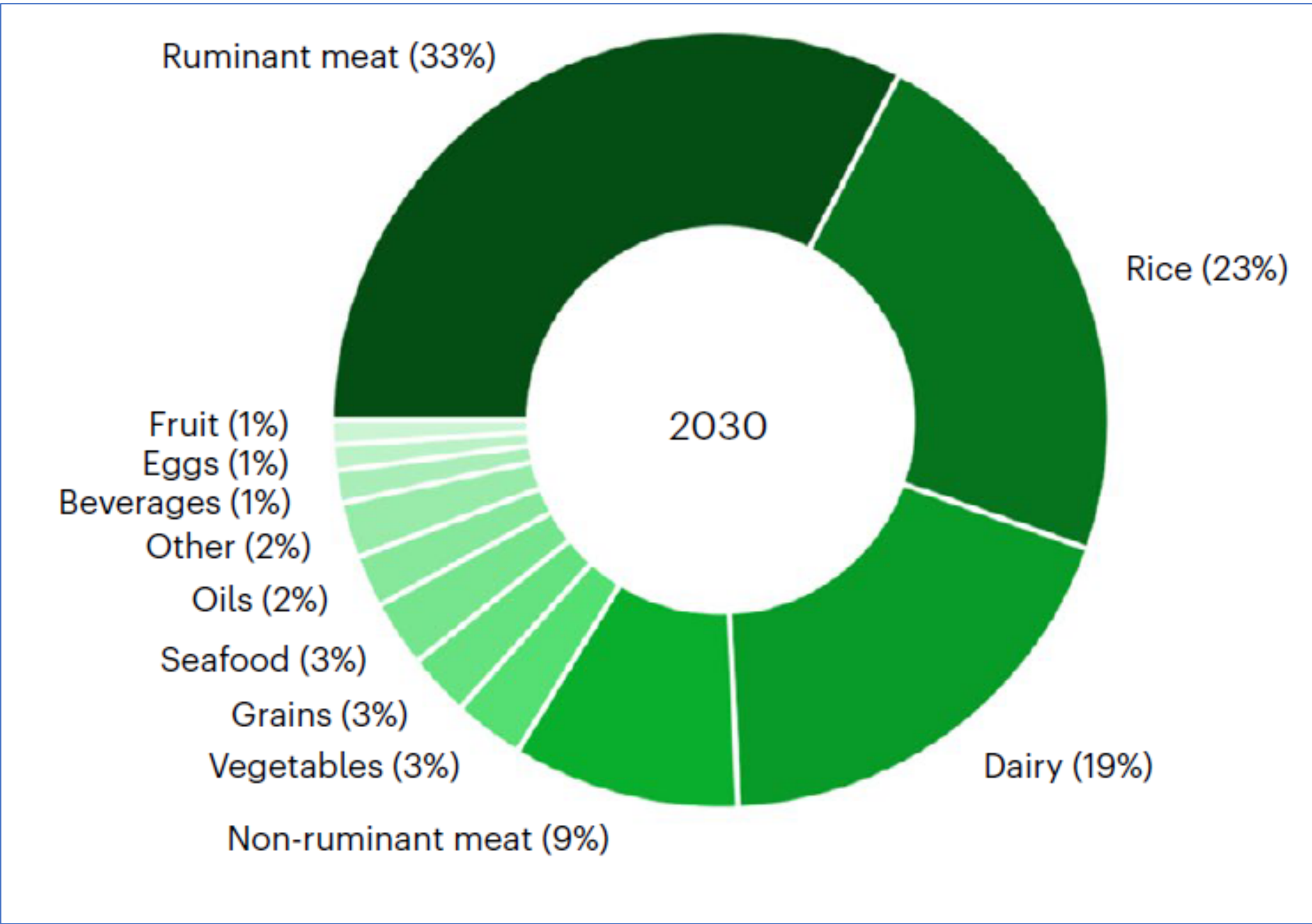
Annual Greenhouse Gas Index



Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.



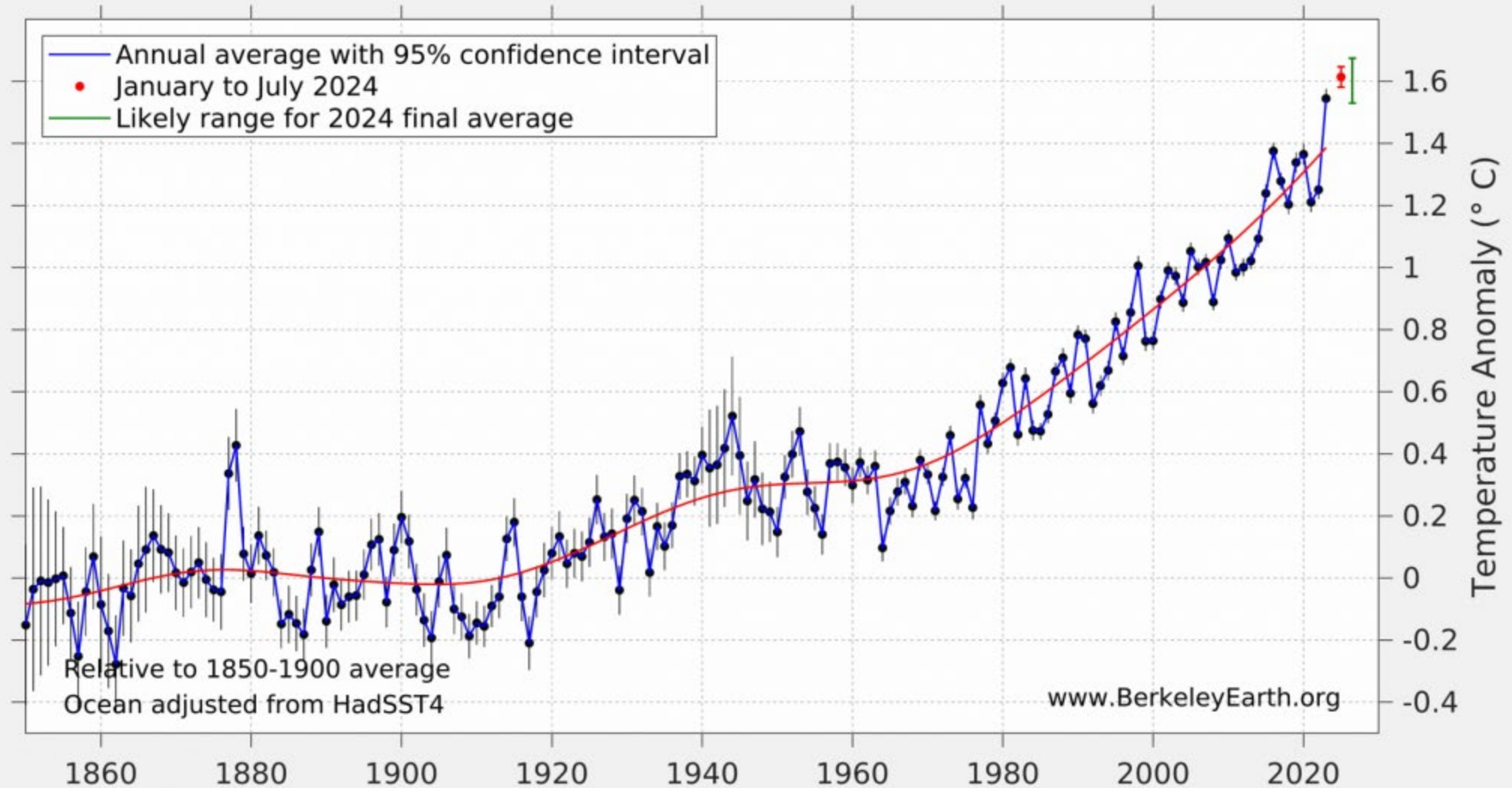


- The atmospheric concentration of CO₂ is the highest in at least 2 million years.
- The atmospheric concentration of CH₄ and N₂O are the highest in at least 800,000 years.
- Since 1950, increases in CO₂ and CH₄ far exceed the natural multi-millennial cycles of the past 800,000 years.

- 2023 was the warmest year ever recorded
- 77 countries set record high annual average temperatures, including China, Brazil, Japan, Germany and Mexico
- Both land and ocean individually also set new records for the warmest year

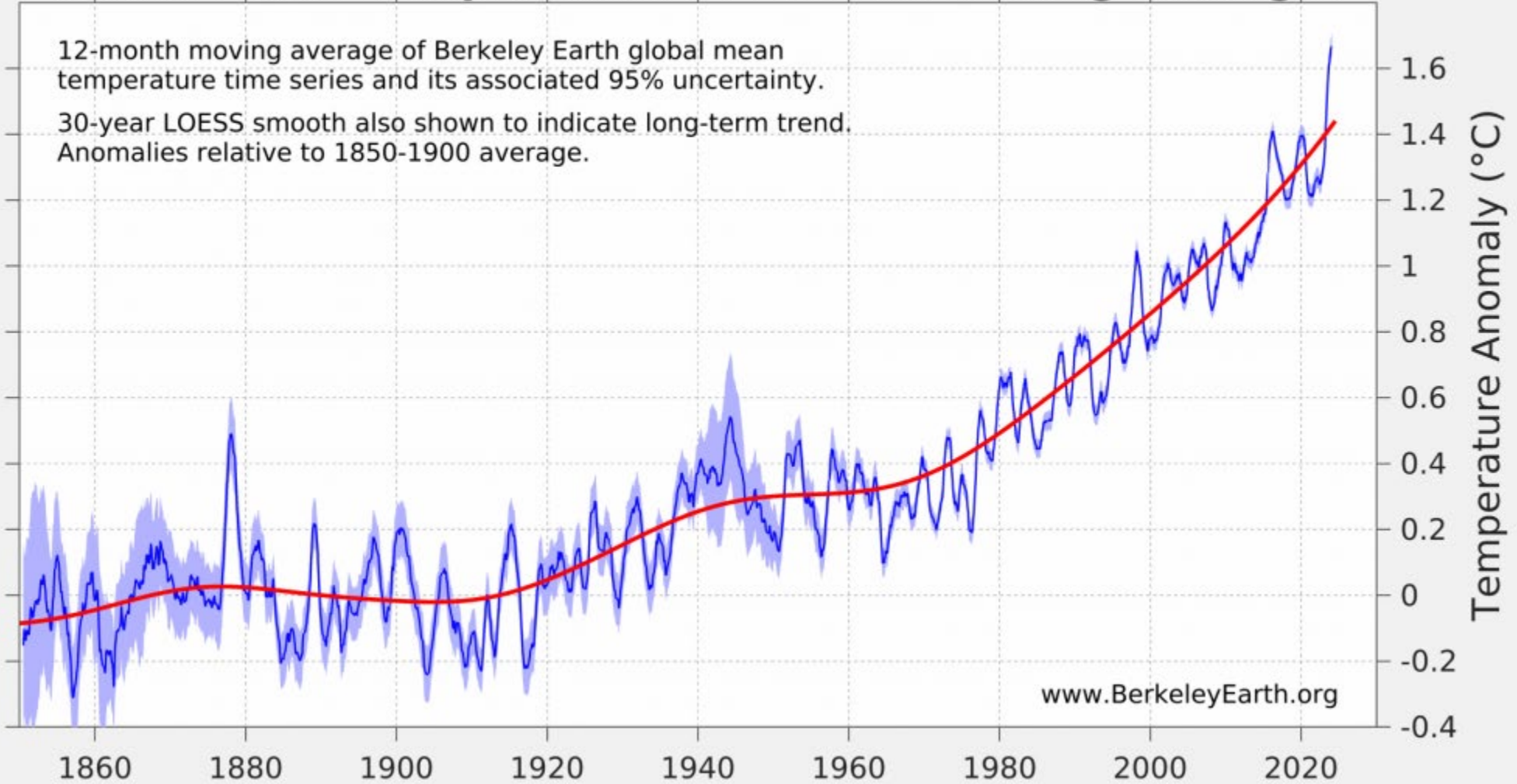
- 2023 was the first time that any year has exceeded the key 1.5 °C threshold (1.54 °C)
- The last nine years have included all nine of the warmest years observed in the instrumental record

Berkeley Earth - Global



Global Mean Temperature (12-month moving average)

12-month moving average of Berkeley Earth global mean temperature time series and its associated 95% uncertainty.
30-year LOESS smooth also shown to indicate long-term trend.
Anomalies relative to 1850-1900 average.



www.BerkeleyEarth.org

How screwed are we?

When do we get to the happy part?

Which industry will be impacted the least?

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