UNIWERSYTET WARSZAWSKI

NAUKA O KLIMACIE
DLA SCEPTYCZNYCH

Climate change update 2023

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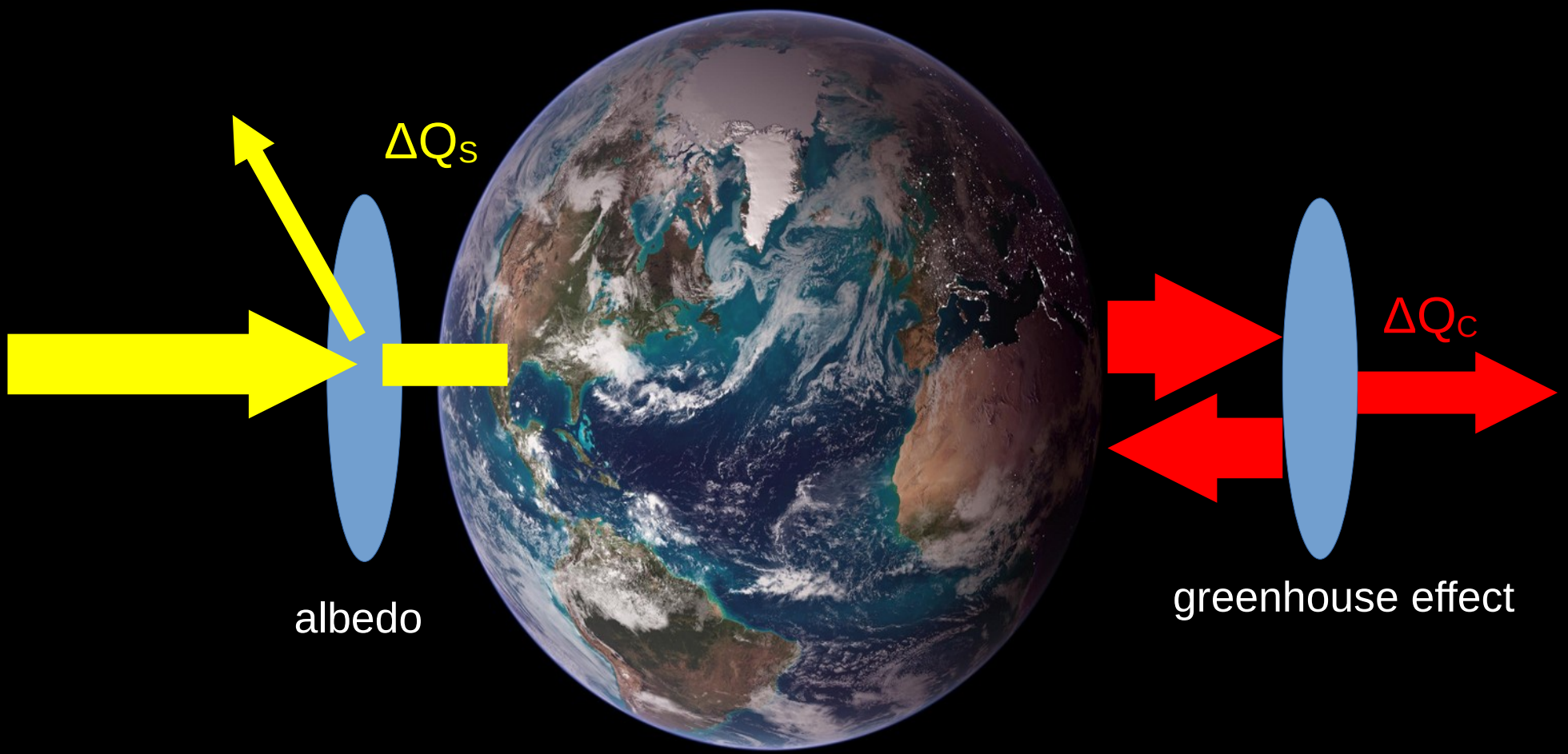
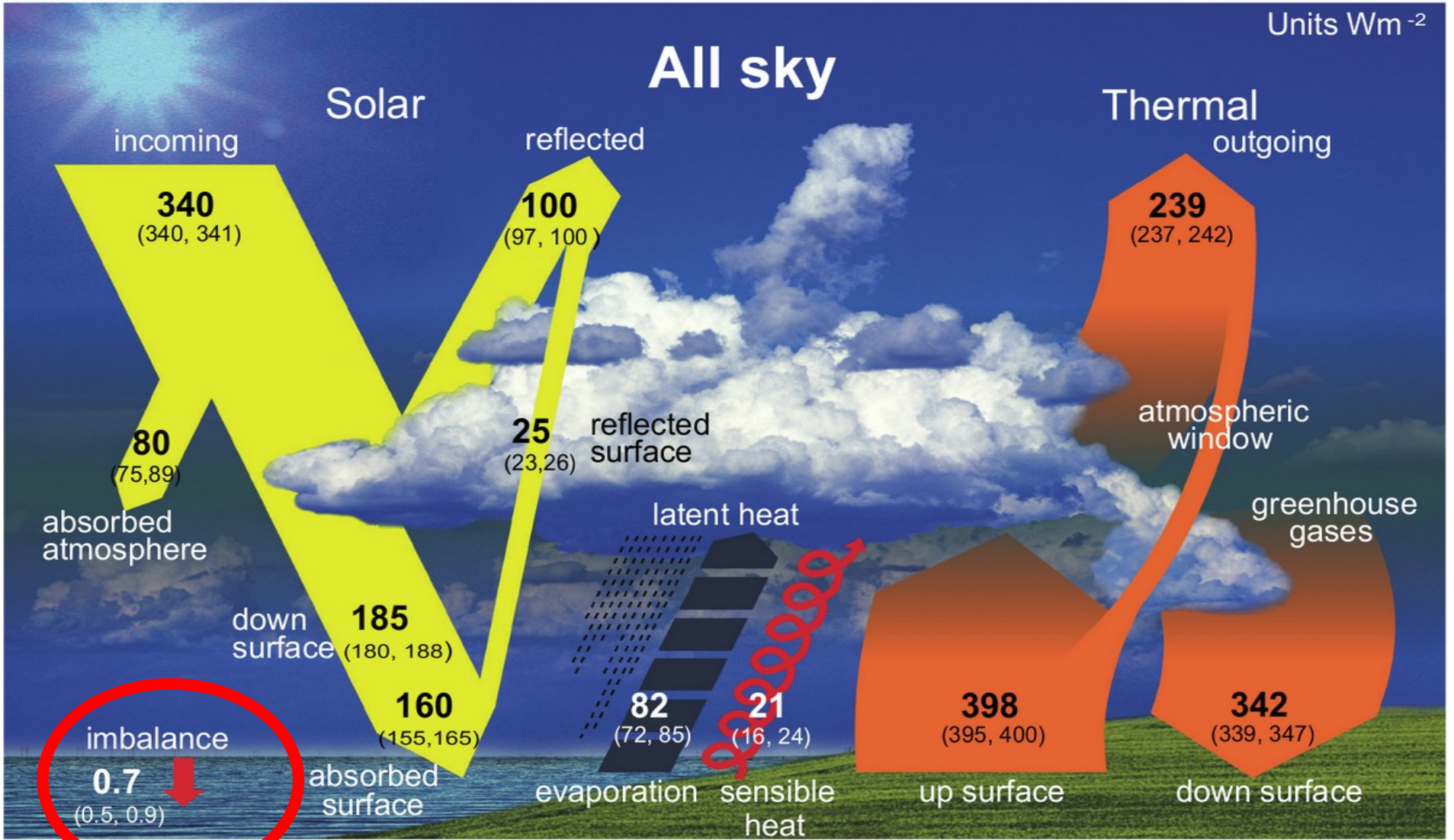
PAN
POLSKA AKADEMIA NAUK

Aby temperatura Ziemi była stała strumień ciepła otrzymywanego przez Ziemię od Słońca ΔQ_S (/Δt) musi być równoważony strumieniem ciepła oddawanym przez Ziemię w kosmos ΔQ_C (/Δt).

Temperatura Ziemi rośnie, gdy $\Delta Q_S > \Delta Q_C$
Temperatura Ziemi spada, gdy $\Delta Q_S < \Delta Q_C$

Tak jest z bardzo dobrym przybliżeniem, gdyż strumienie radiacyjne (~340W/m^2) są wielokrotnie większe niż strumień energii z wnętrza Ziemi (~0.1W/m^2) czy strumień antropogeniczny (~0.03W/m^2).

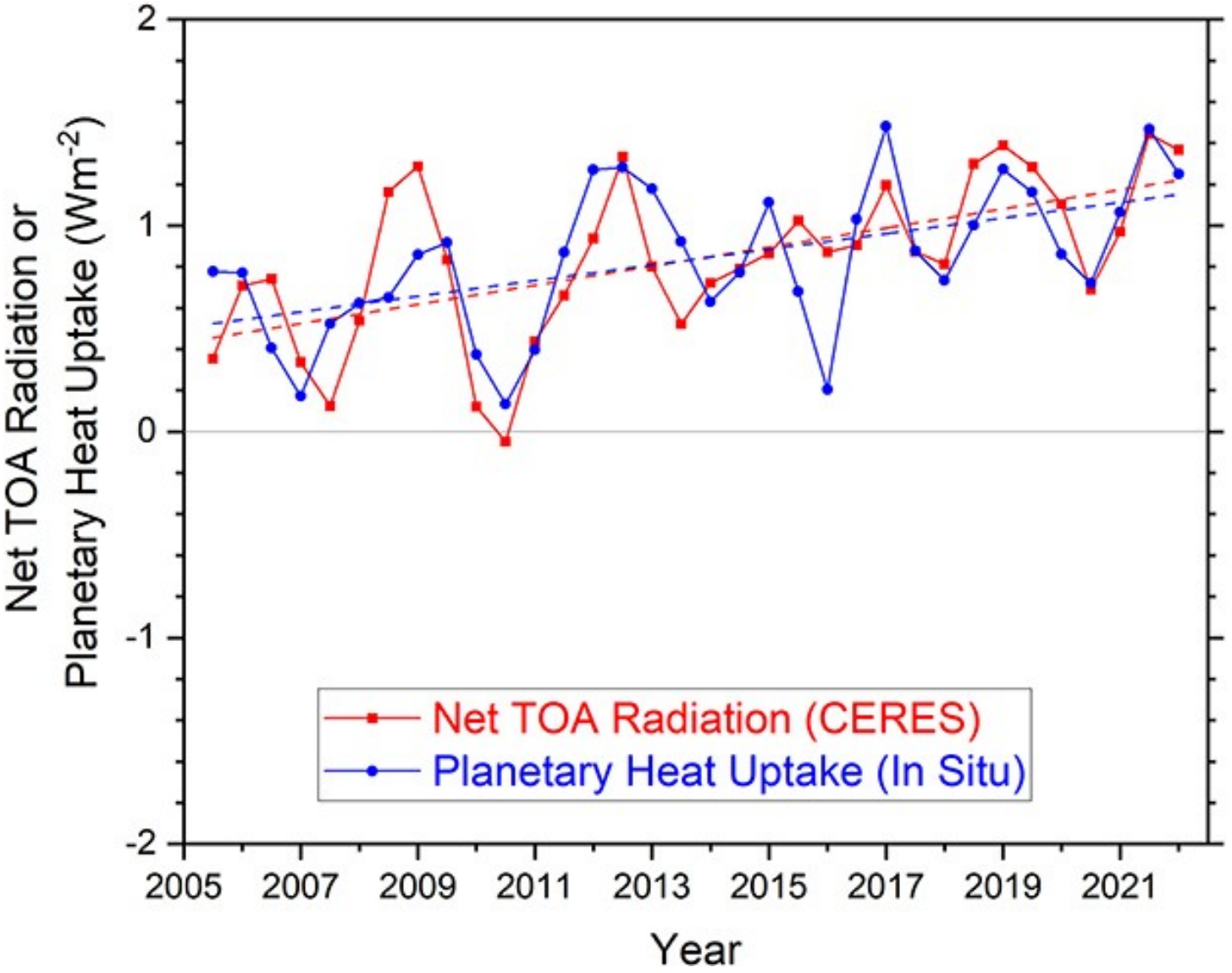

ΔQs
ΔQc
albedo
greenhouse effect



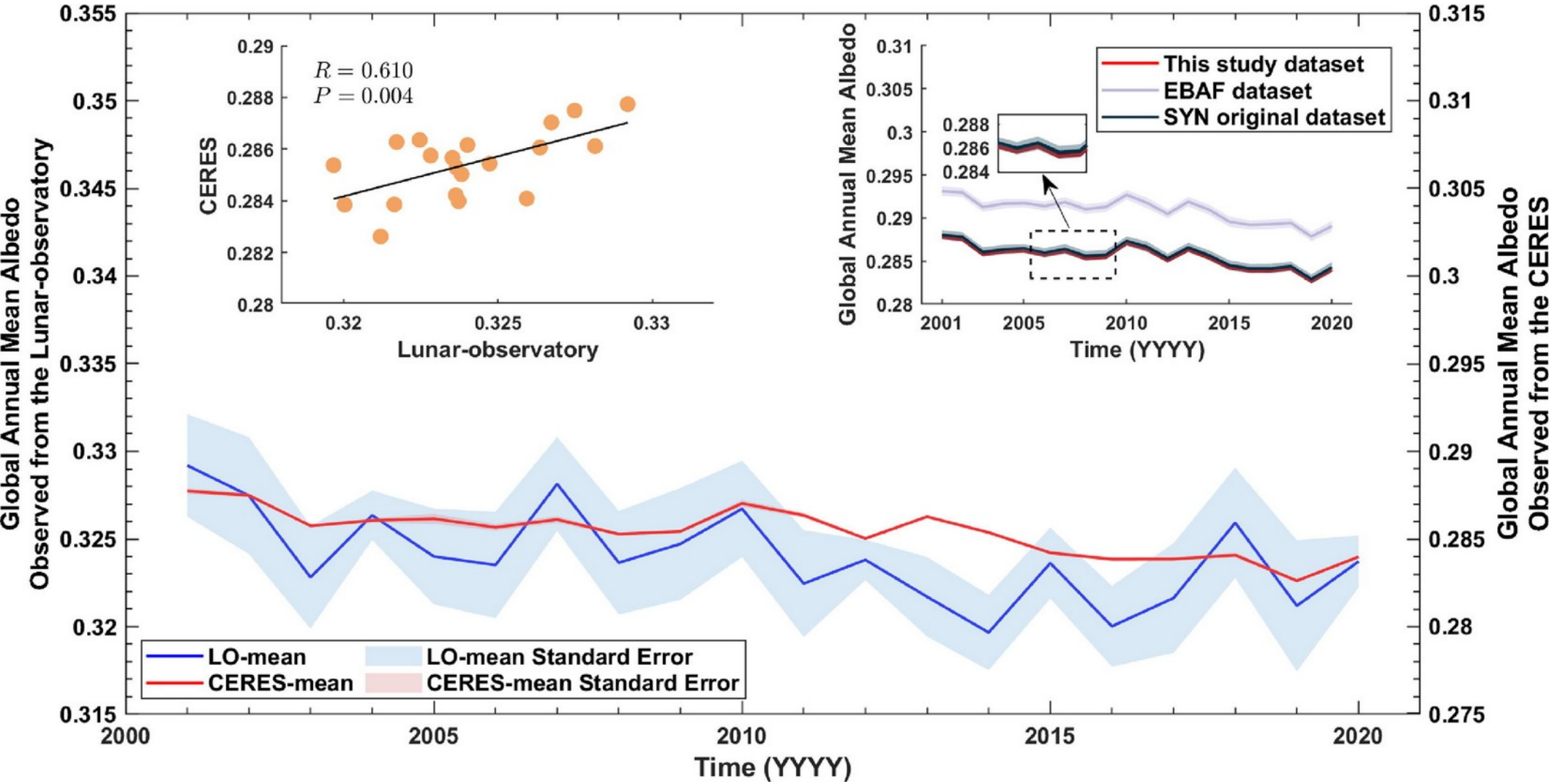
Averaged energy balance of the climate system in W/m^2.

https://www.ipcc.ch/report/ar6/wg1/

Energy imbalance increases ...

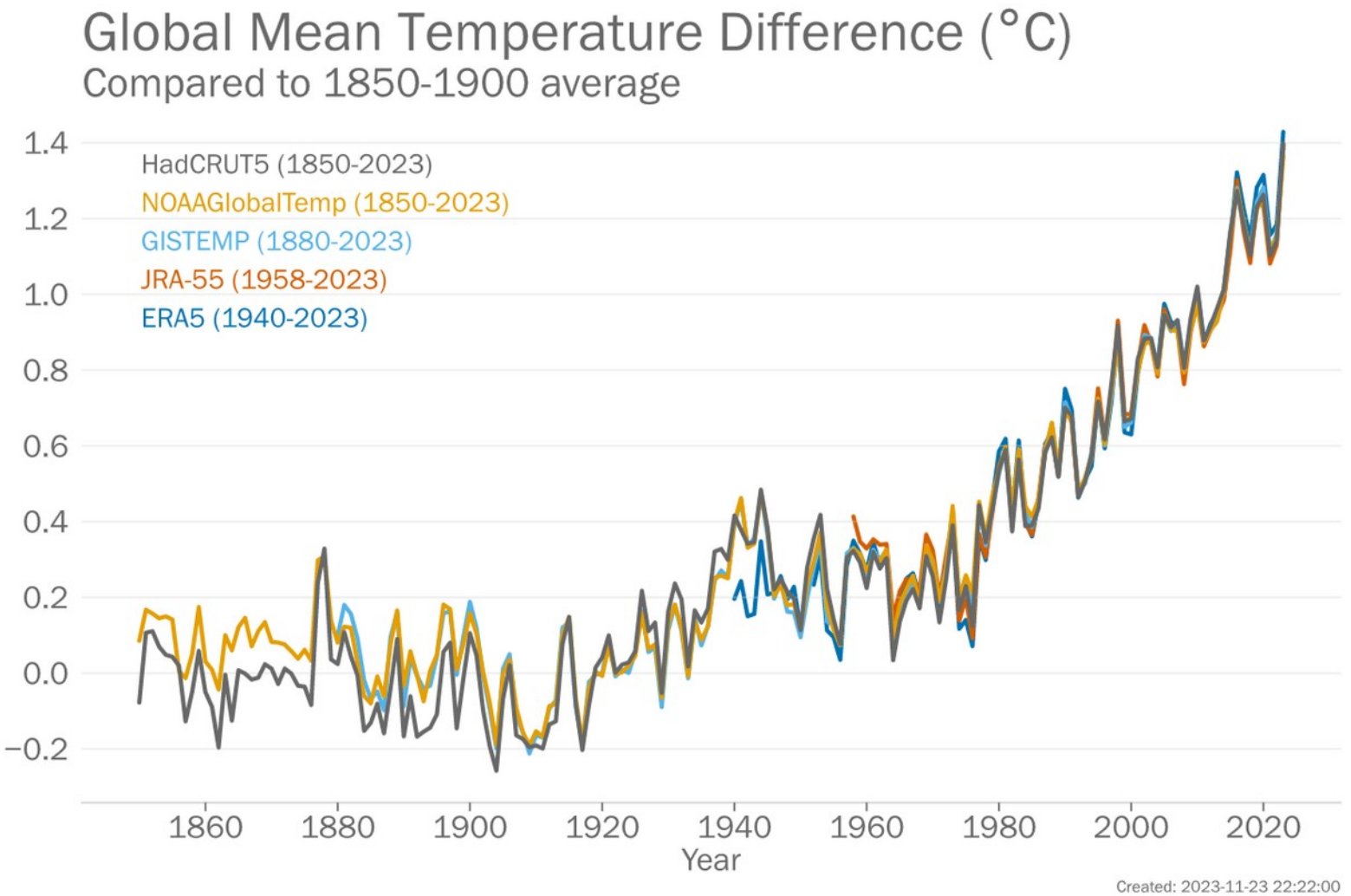


Schmidt GA, et al., 2023, CERESMIP: a climate modeling protocol to investigate recent trends in the Earth's Energy Imbalance. *Front. Clim.* 5:1202161. https://doi.org/10.3389/fclim.2023.1202161

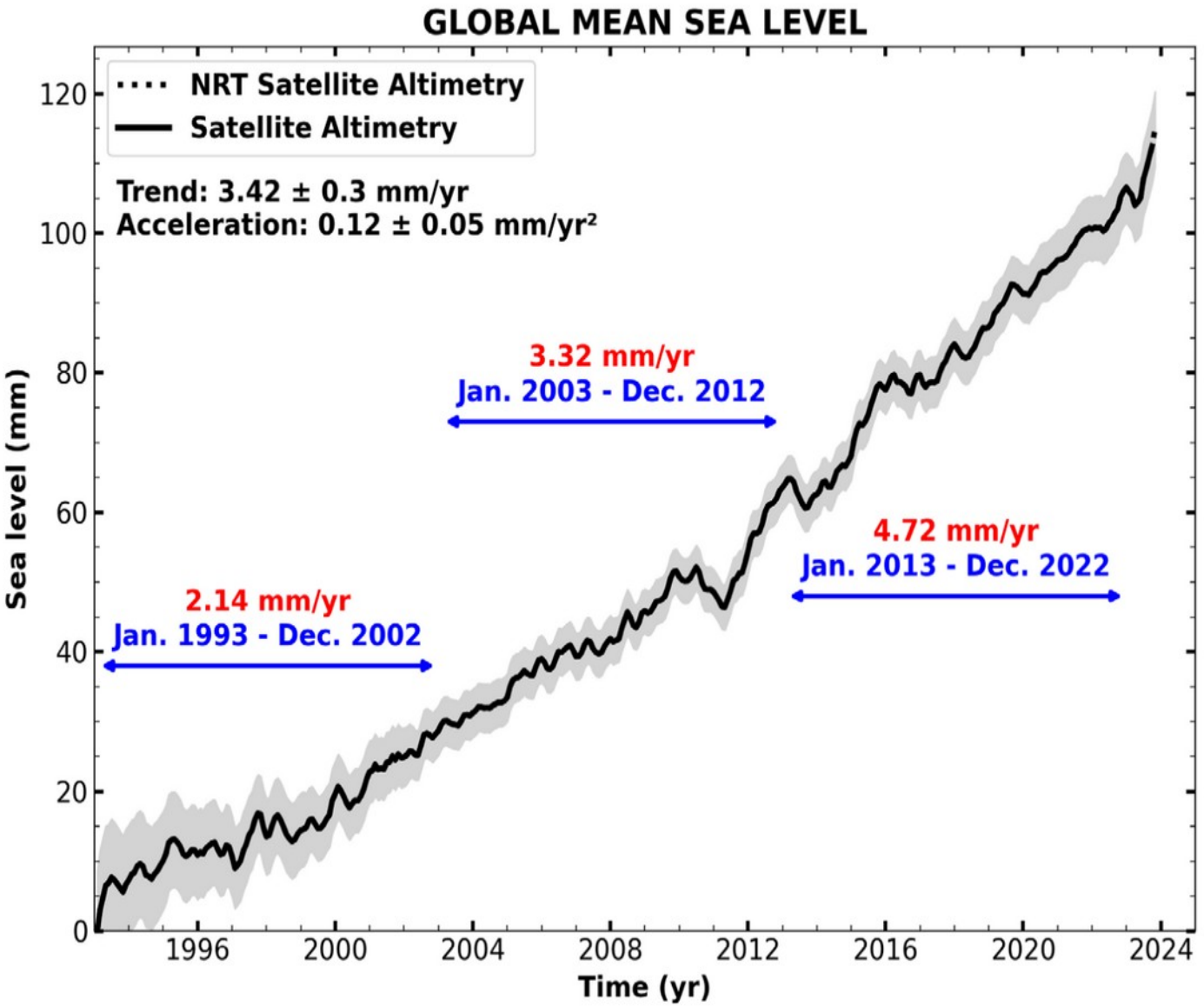


https://doi.org/10.1016/j.asr.2023.06.028

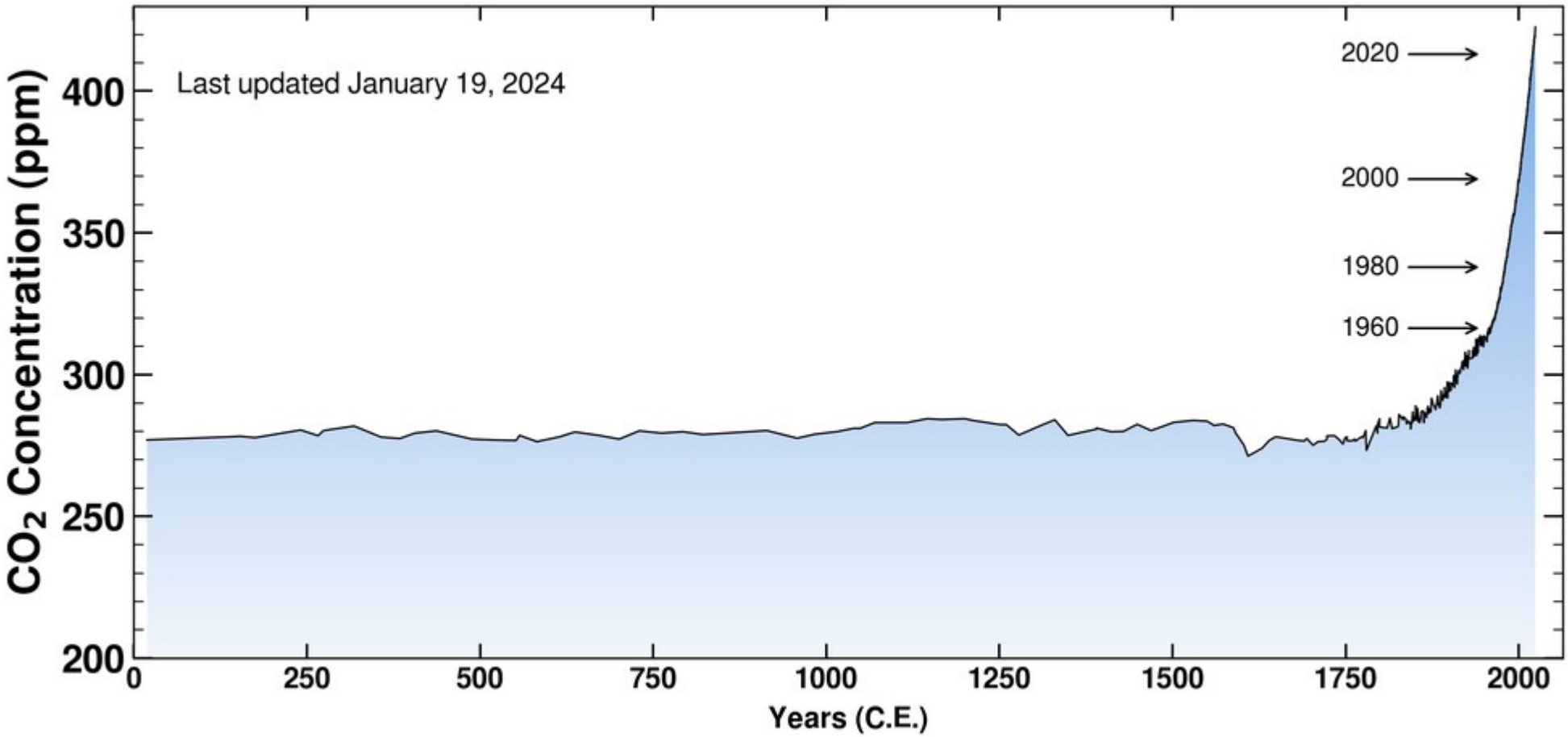
… and surface temperature increases.



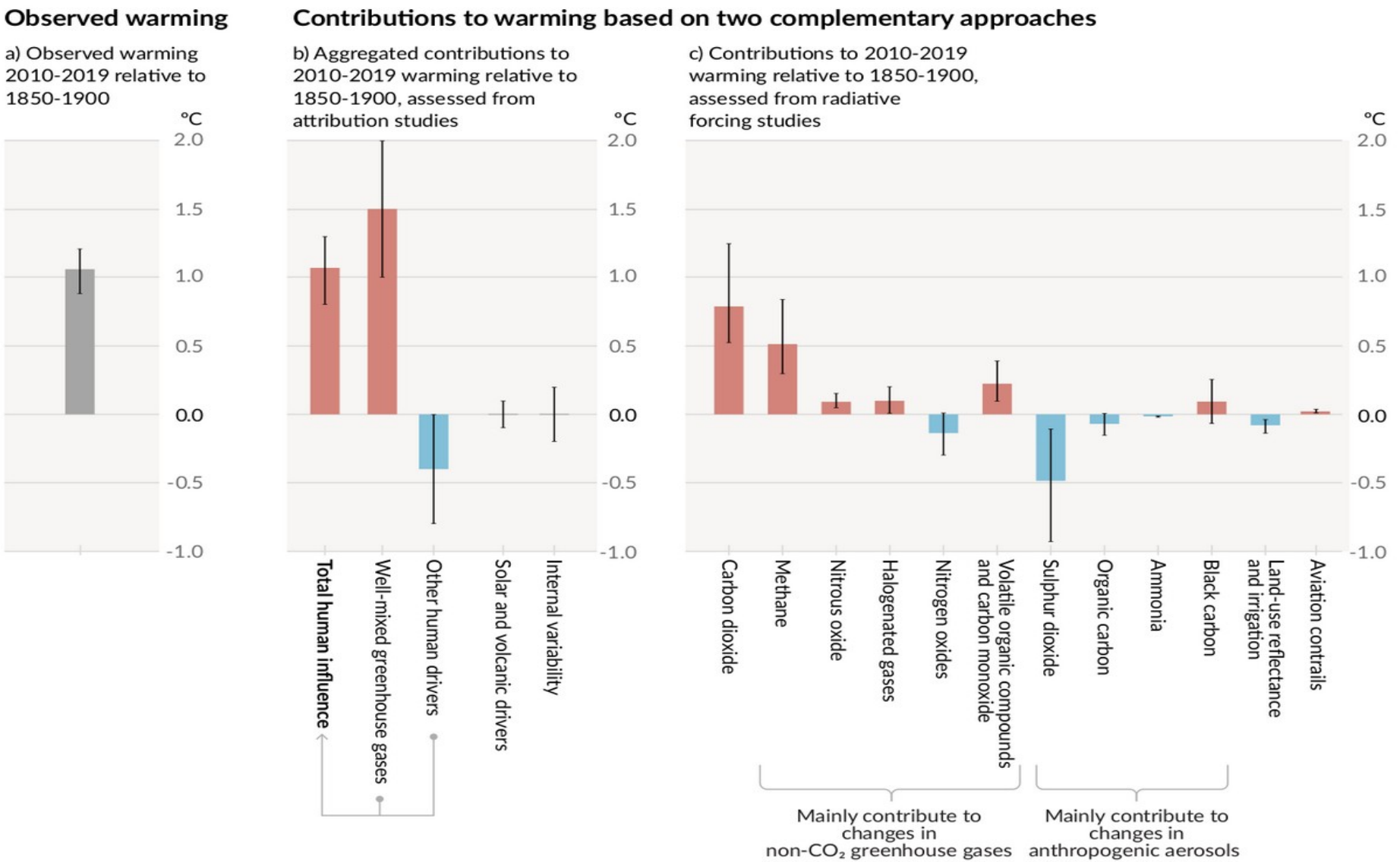
https://wmo.int/sites/default/files/2023-11/WMO%20Provisional%20State%20of%20the%20Global%20Climate%202023.pdf

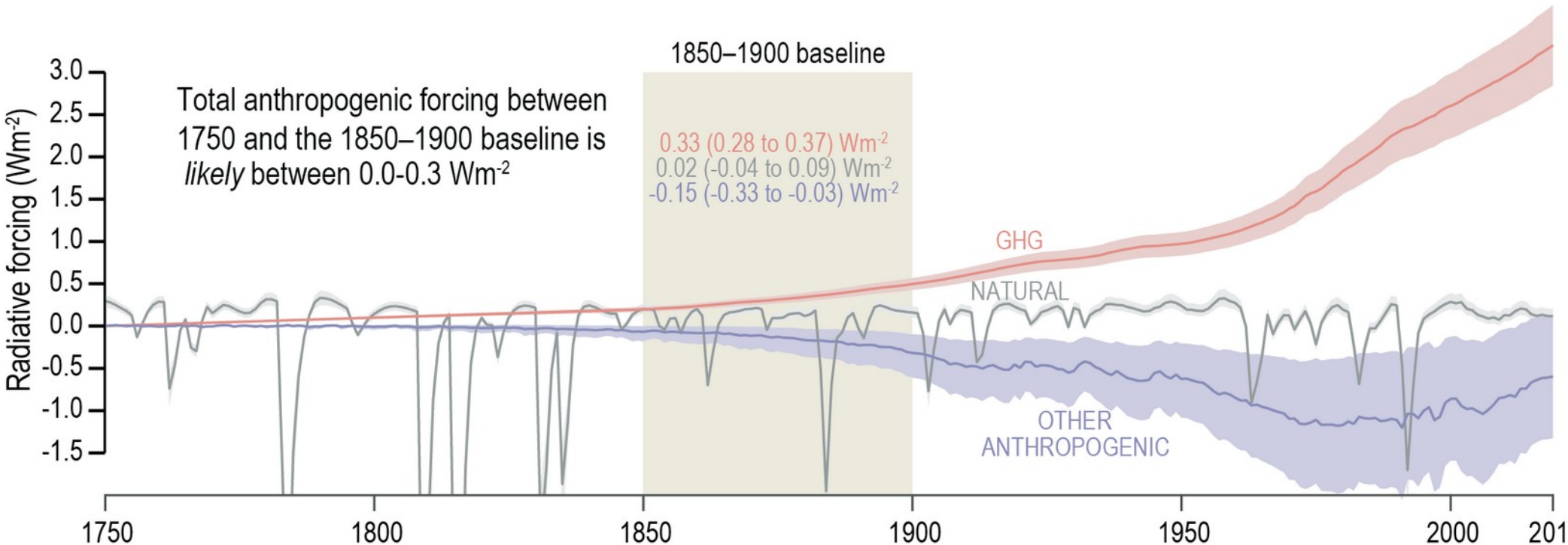


https://wmo.int/sites/default/files/2023-11/WMO%20Provisional%20State%20of%20the%20Global%20Climate%202023.pdf


Last updated January 19, 2024
2020
2000
1980
1960
CO2 Concentration (ppm)
400
350
300
250
200
0
250
500
750
1000
1250
1500
1750
2000
Years (C.E.)

Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling



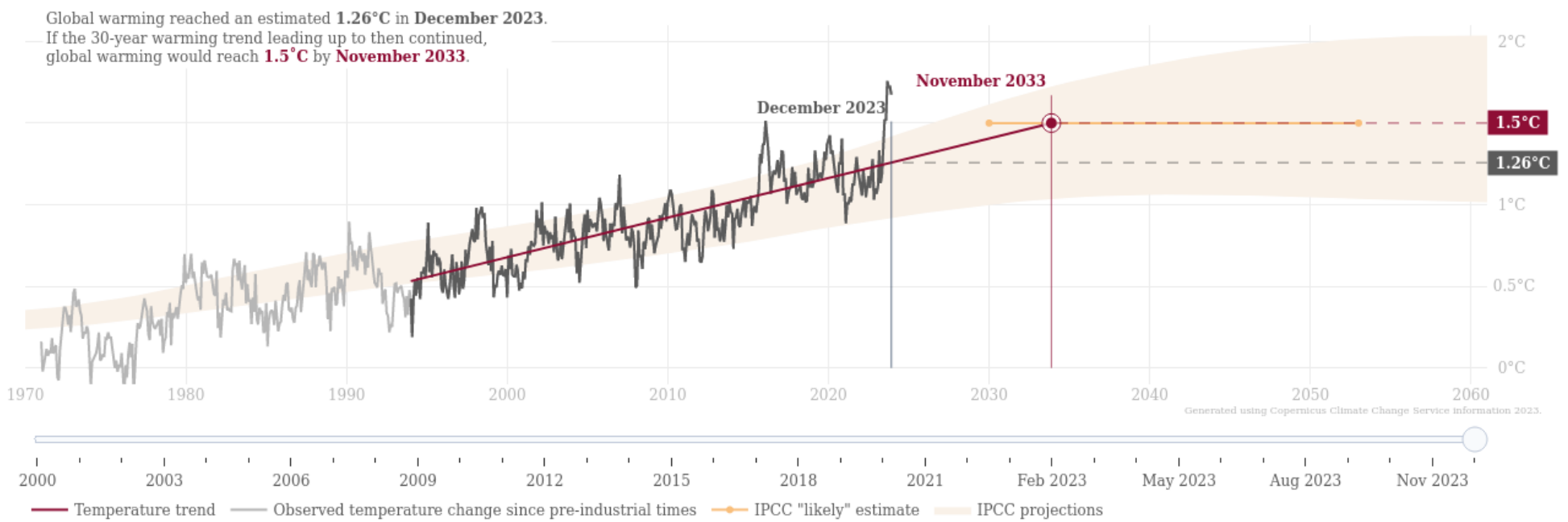


https://www.ipcc.ch/report/ar6/wg1/figures/chapter-1

How close are we to reaching a global warming of 1.5˚C?

Reaching 1.5˚C of global warming - a limit agreed under the Paris agreement - may feel like a very distant reality, but it might be closer than you think. Experts suggest it is likely to happen between 2030 and the early 2050s. See where we are now and how soon we would reach the limit if the warming continued at today's pace. **Use the slider to explore how the estimate changes in time.**

Explore the app in the CDS



Version: 4.35.4 - build f8ced5bb

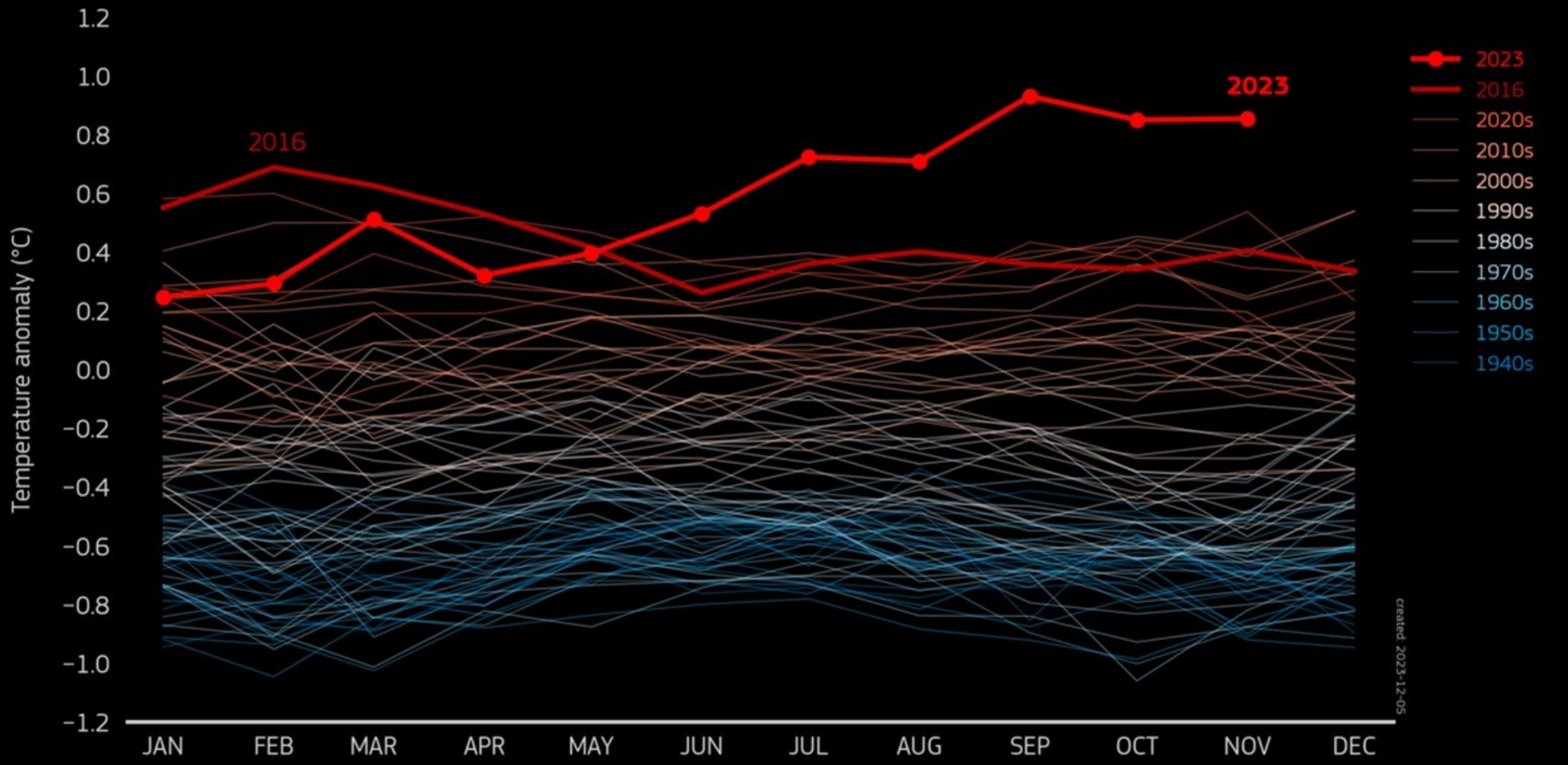
https://climate.copernicus.eu/

GLOBAL SURFACE AIR TEMPERATURE ANOMALIES

Data: ERA5 1940–2023 • Reference period: 1991-2020 • Credit: C3S/ECMWF

Climate Change Service

climate.copernicus.eu



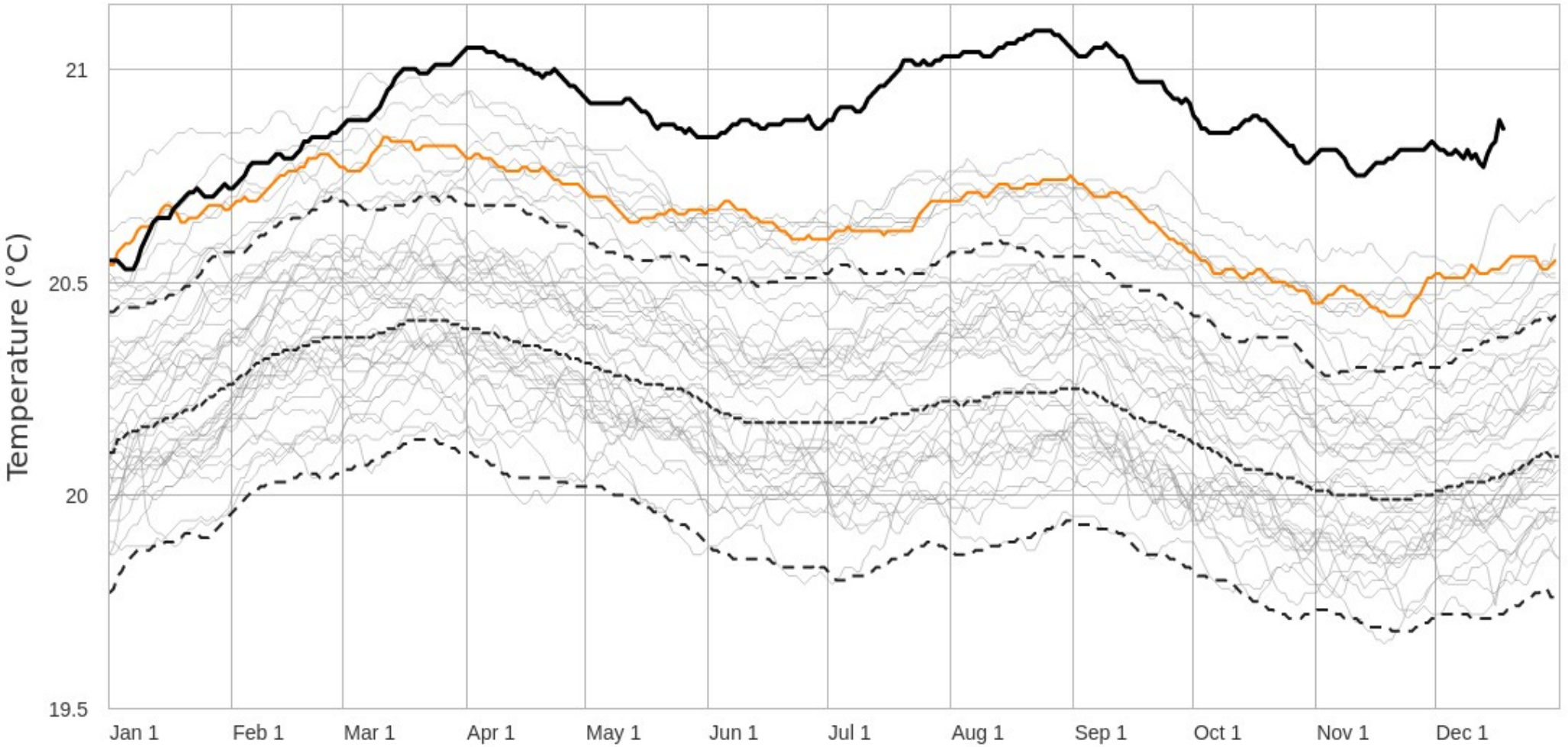
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

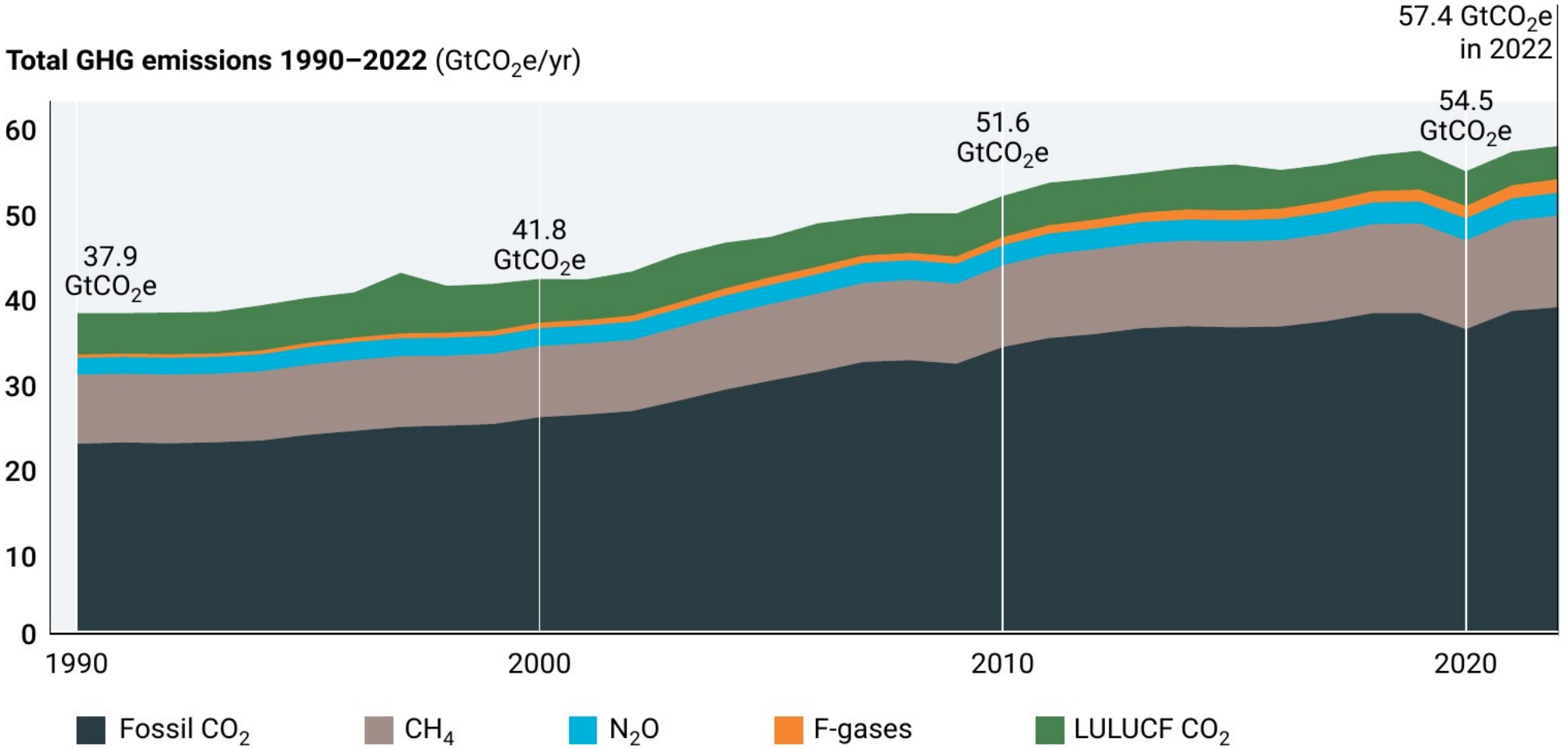
SST World (60S-60N)

Data Source: NOAA OISST V2.1 | Image Credit: ClimateReanalyzer.org, Climate Change Institute, University of Maine



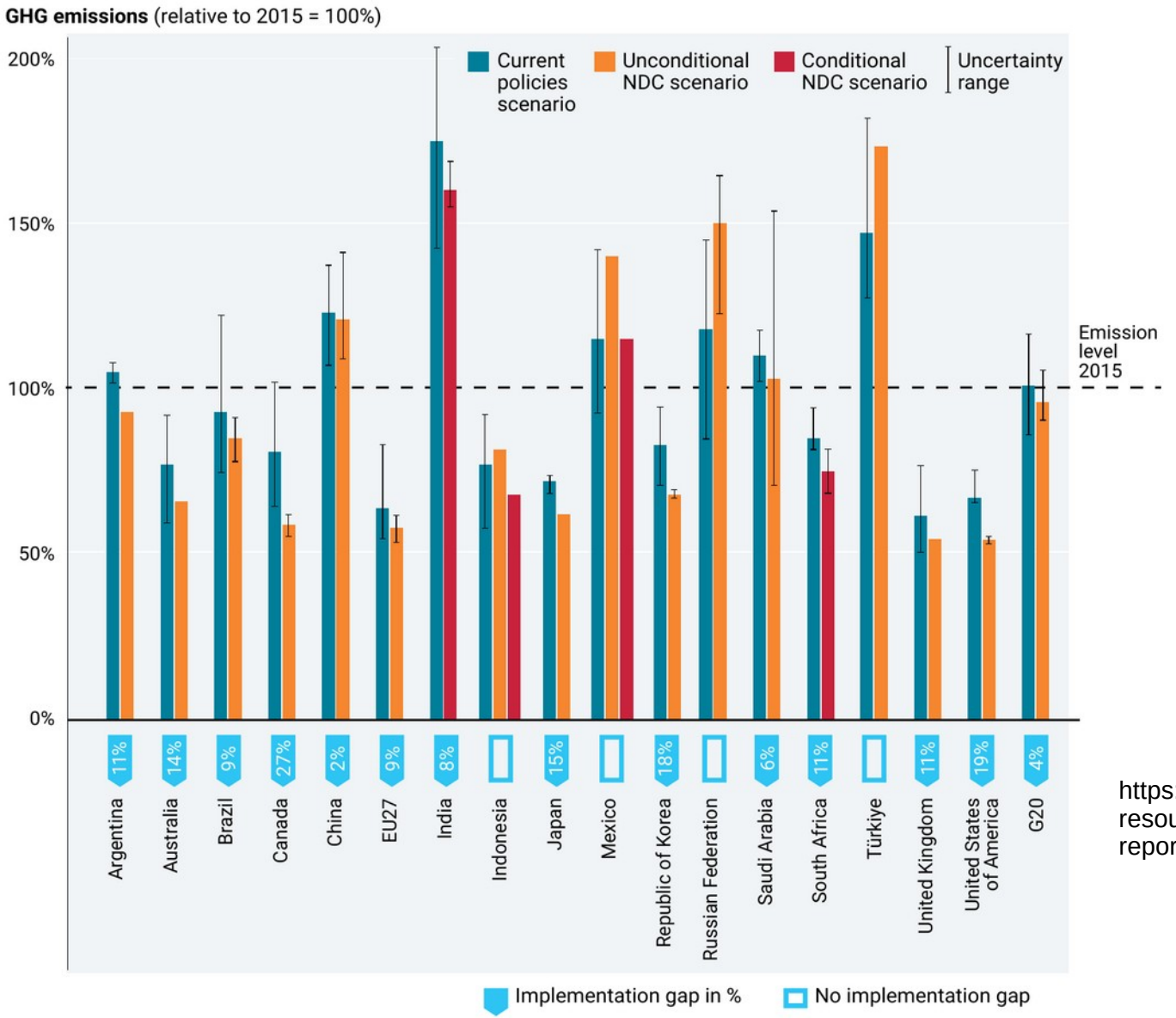
1981 1982 1983 1984 1985 1986 1987 1988
1989 1990 1991 1992 1993 1994 1995 1996
1997 1998 1999 2000 2001 2002 2003 2004
2005 2006 2007 2008 2009 2010 2011 2012
2013 2014 2015 2016 2017 2018 2019 2020
2021 2022 2023 1982-2011 mean plus 2σ minus 2σ

Figure ES.1 Total net anthropogenic GHG emissions, 1990–2022



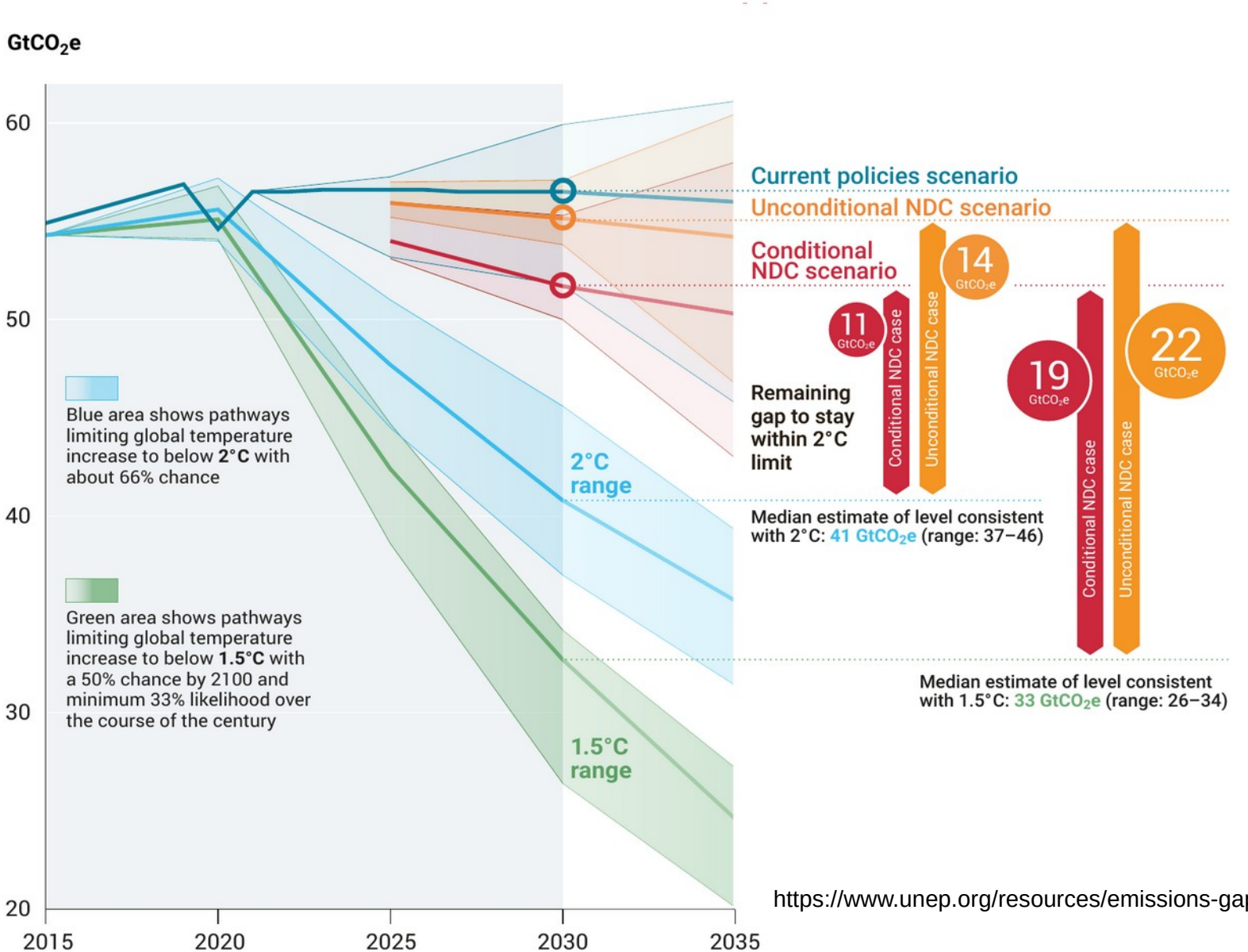
https://www.unep.org/resources/emissions-gap-report-2023

Figure ES.3 Implementation gaps between current policies and NDC pledges for the G20 members collectively and individually by 2030, relative to 2015 emissions



https://www.unep.org/resources/emissions-gap-report-2023

Figure ES.4 Global GHG emissions under different scenarios and the emissions gap in 2030 and 2035 (median estimate and tenth to ninetieth percentile range)



https://www.unep.org/resources/emissions-gap-report-2023

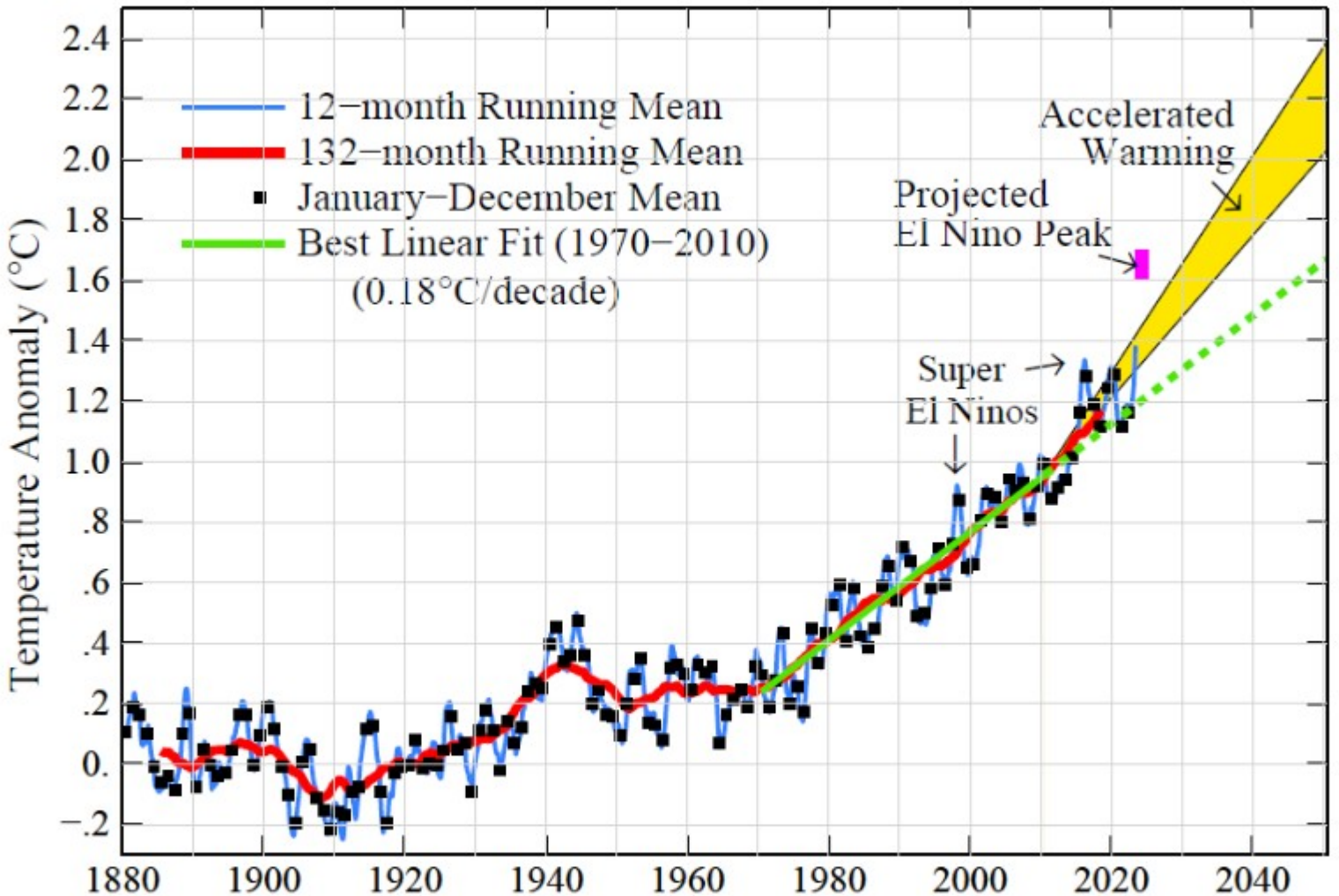
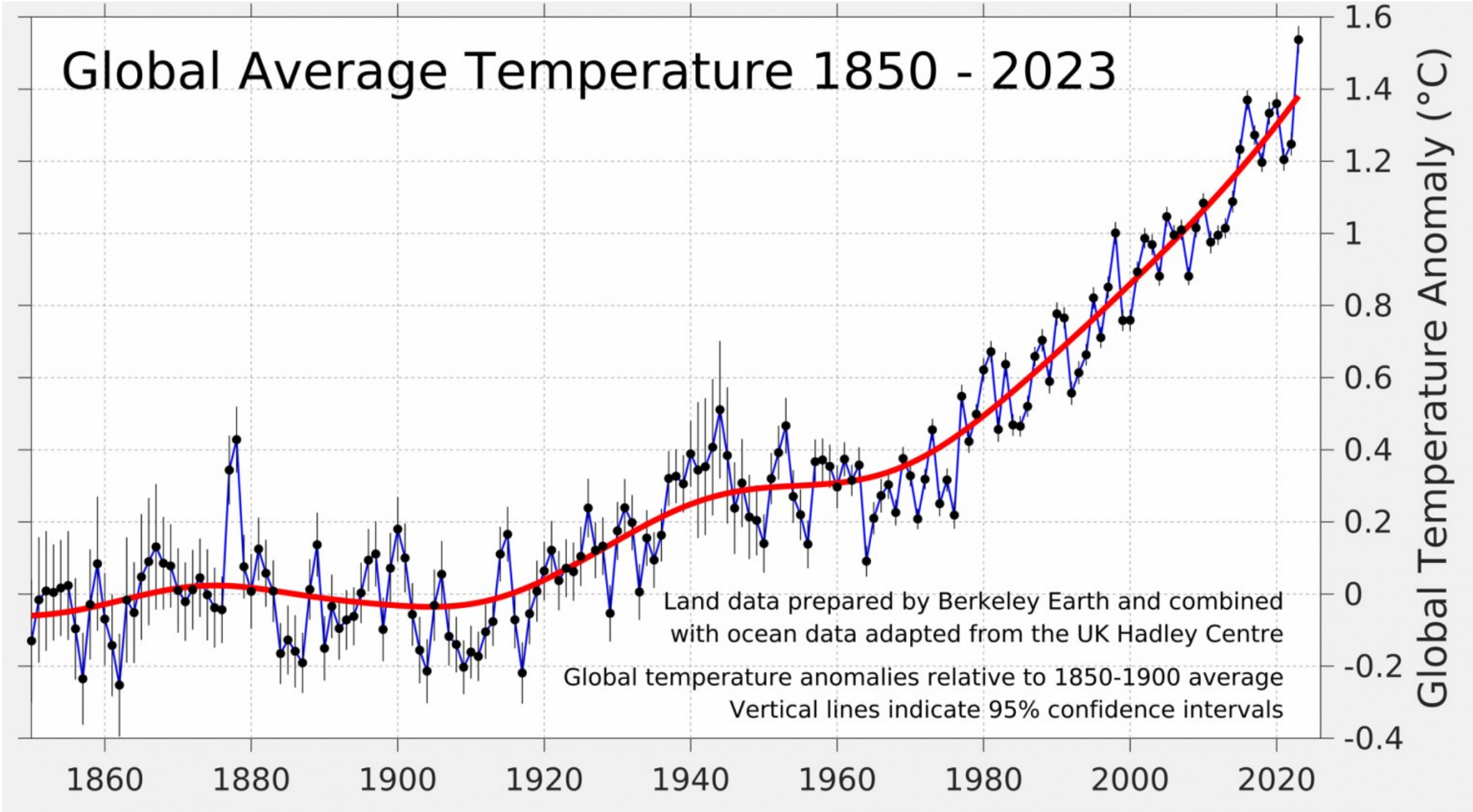
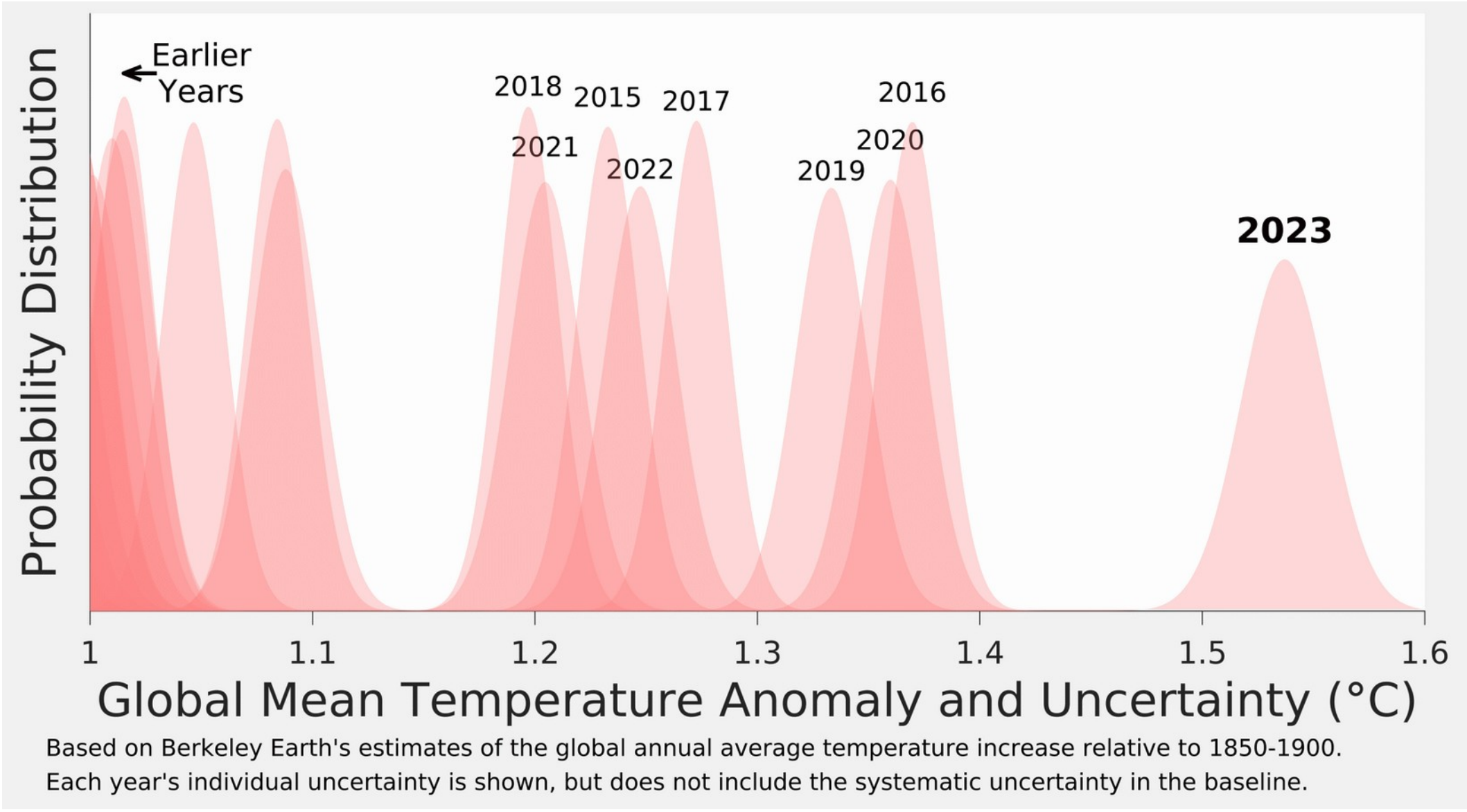


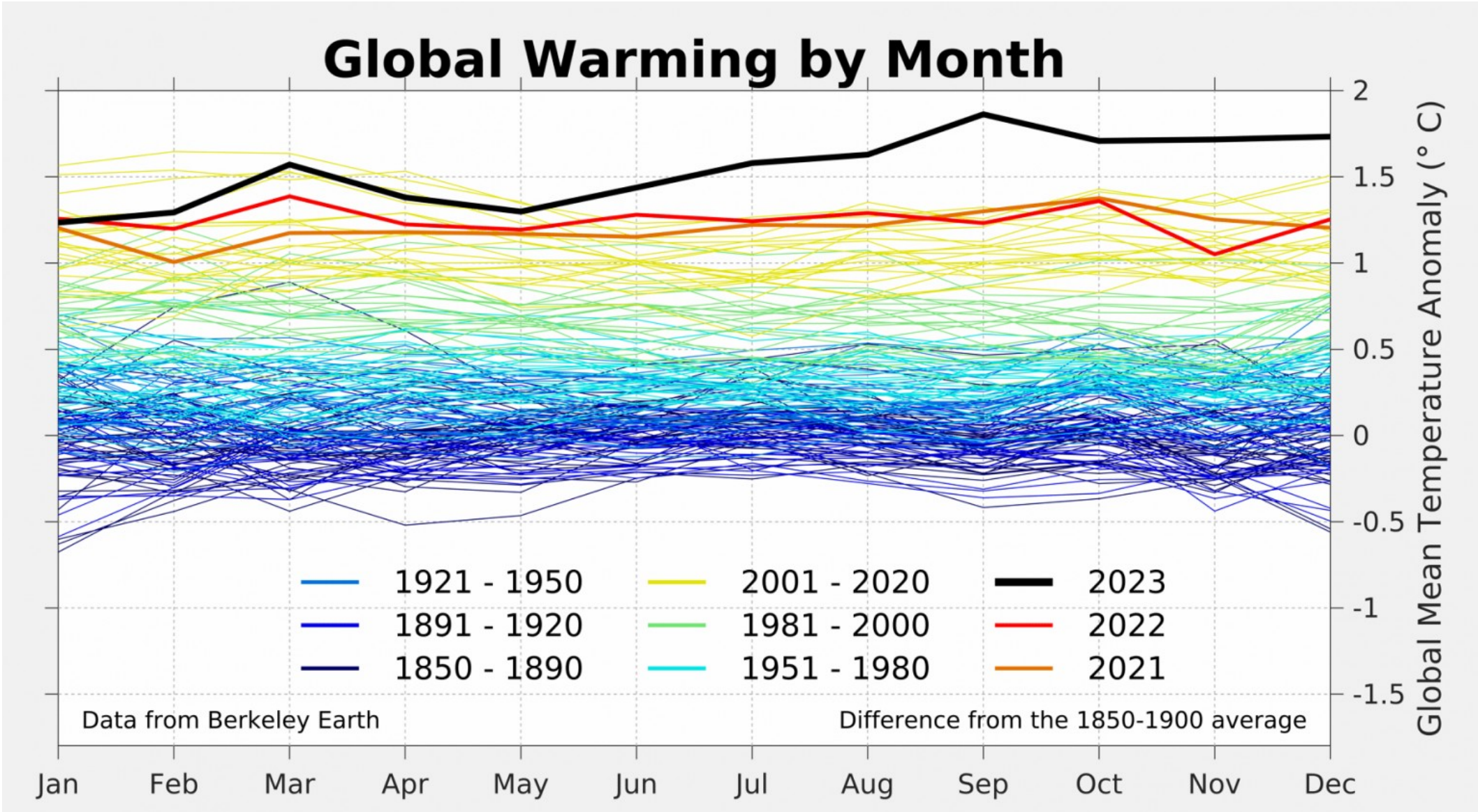
Fig. 4. Global temperature relative to 1880-1920 based on the GISS analysis.[18,19]

http://www.columbia.edu/~jeh1/mailings/2023/Miracle.2023.12.07.pdf

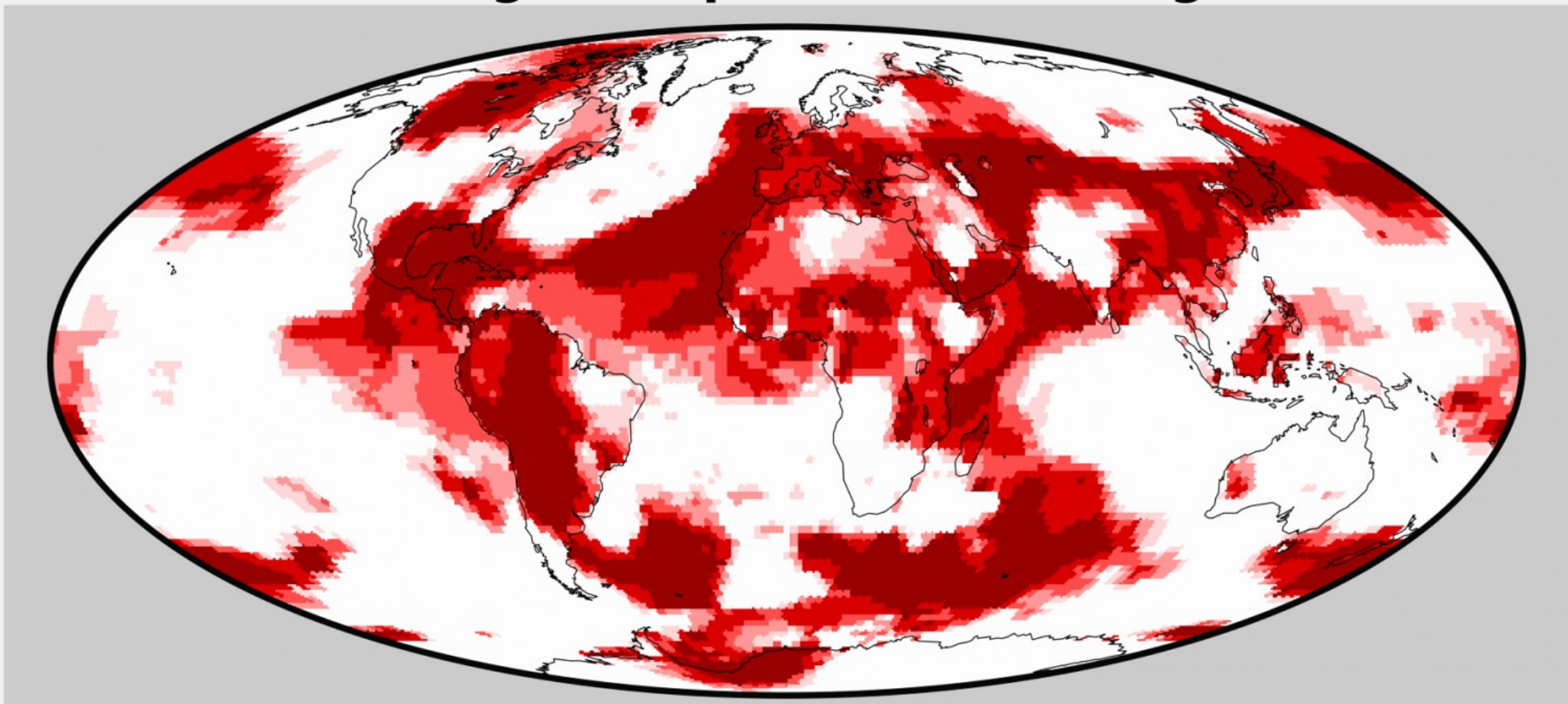

Global Average Temperature 1850 - 2023
Land data prepared by Berkeley Earth and combined
with ocean data adapted from the UK Hadley Centre
Global temperature anomalies relative to 1850-1900 average
Vertical lines indicate 95% confidence intervals
Global Temperature Anomaly (°C)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1860
1880
1900
1920
1940
1960
1980
2000
2020



Based on Berkeley Earth's estimates of the global annual average temperature increase relative to 1850-1900.
Each year's individual uncertainty is shown, but does not include the systematic uncertainty in the baseline.

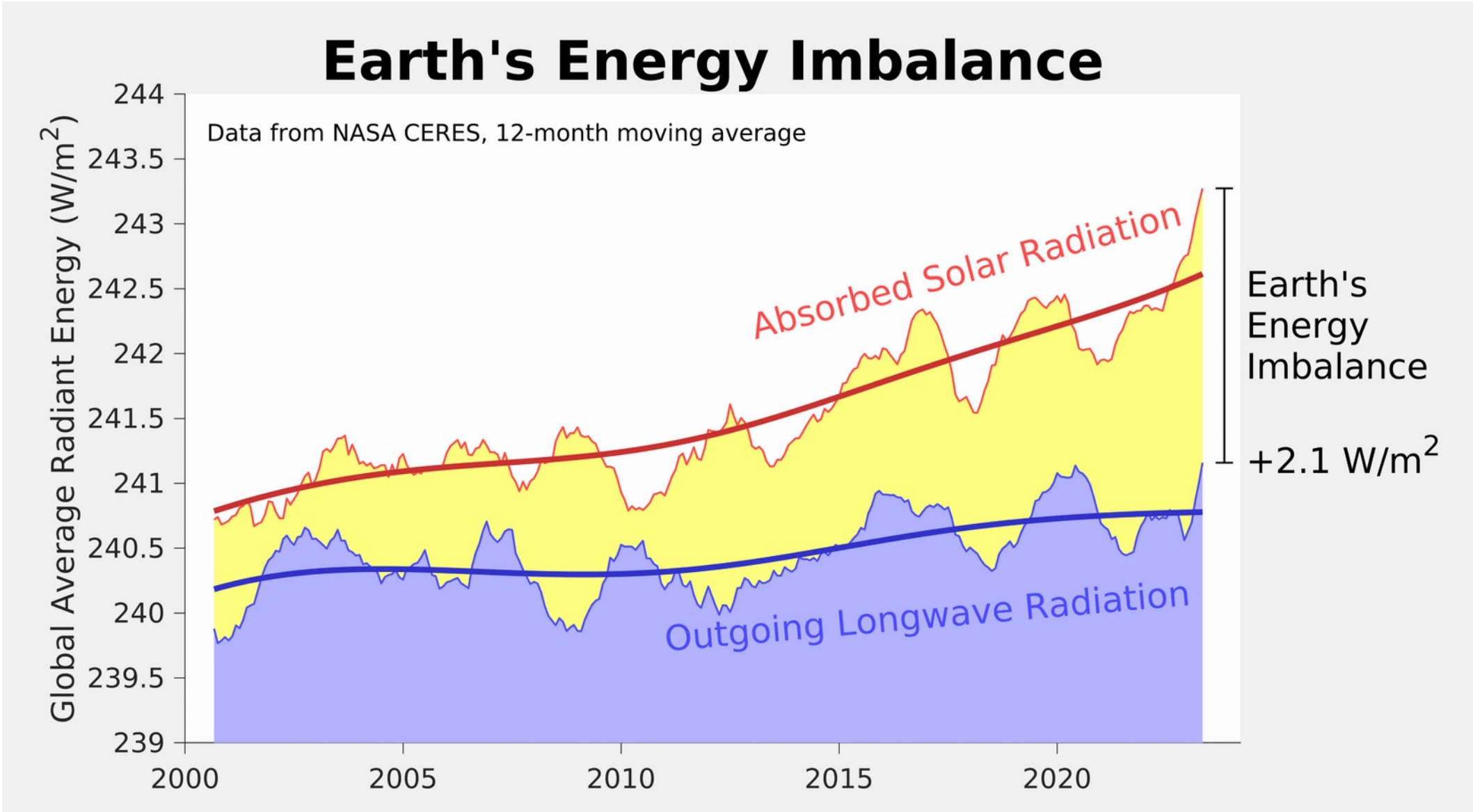

Global Warming by Month
2
1.5
1
0.5
0
-0.5
-1
-1.5
Global Mean Temperature Anomaly (° C)
1921 - 1950
1891 - 1920
1850 - 1890
2001 - 2020
1981 - 2000
1951 - 1980
2023
2022
2021
Data from Berkeley Earth
Difference from the 1850-1900 average
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

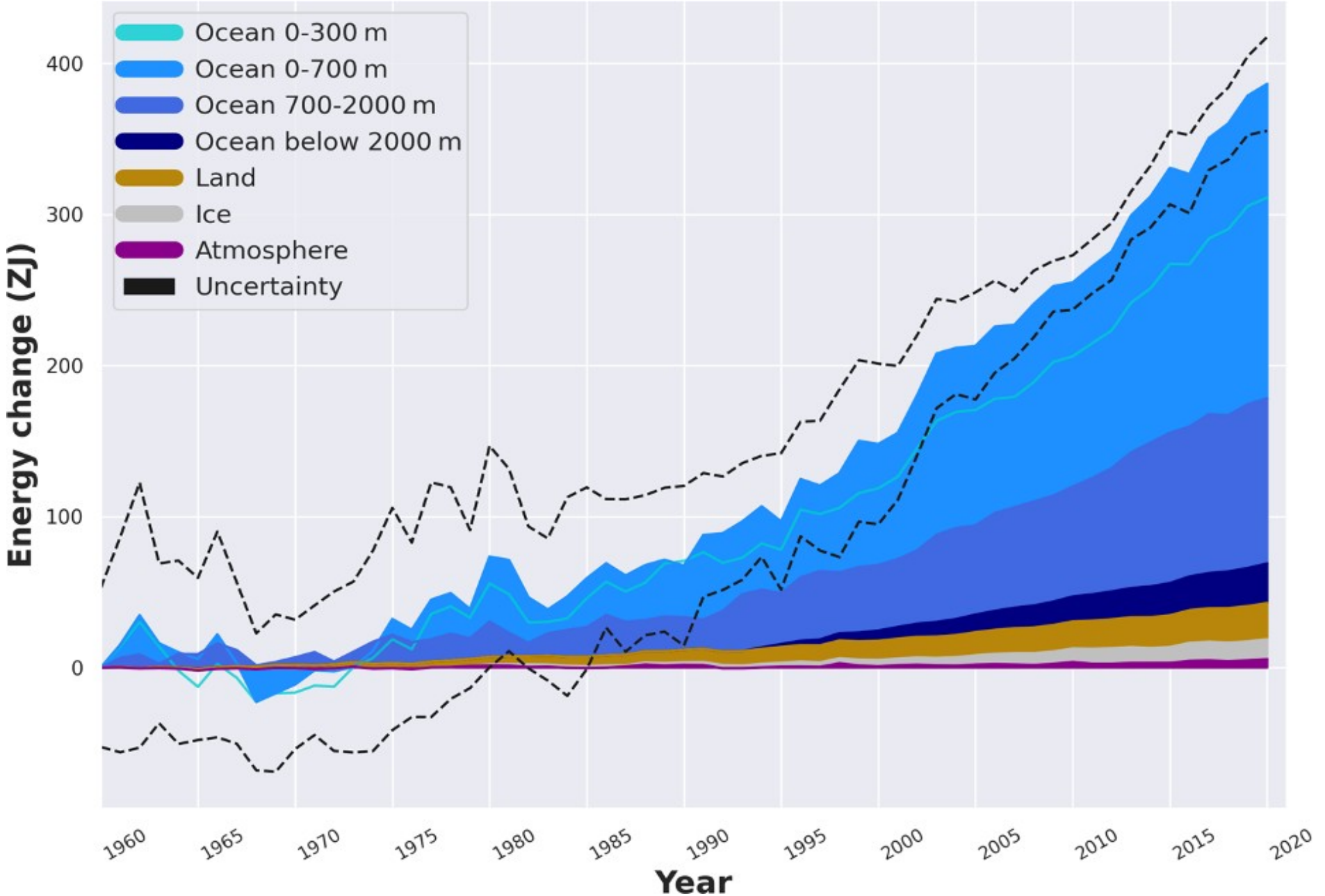
Annual Average Temperature Rankings in 2023

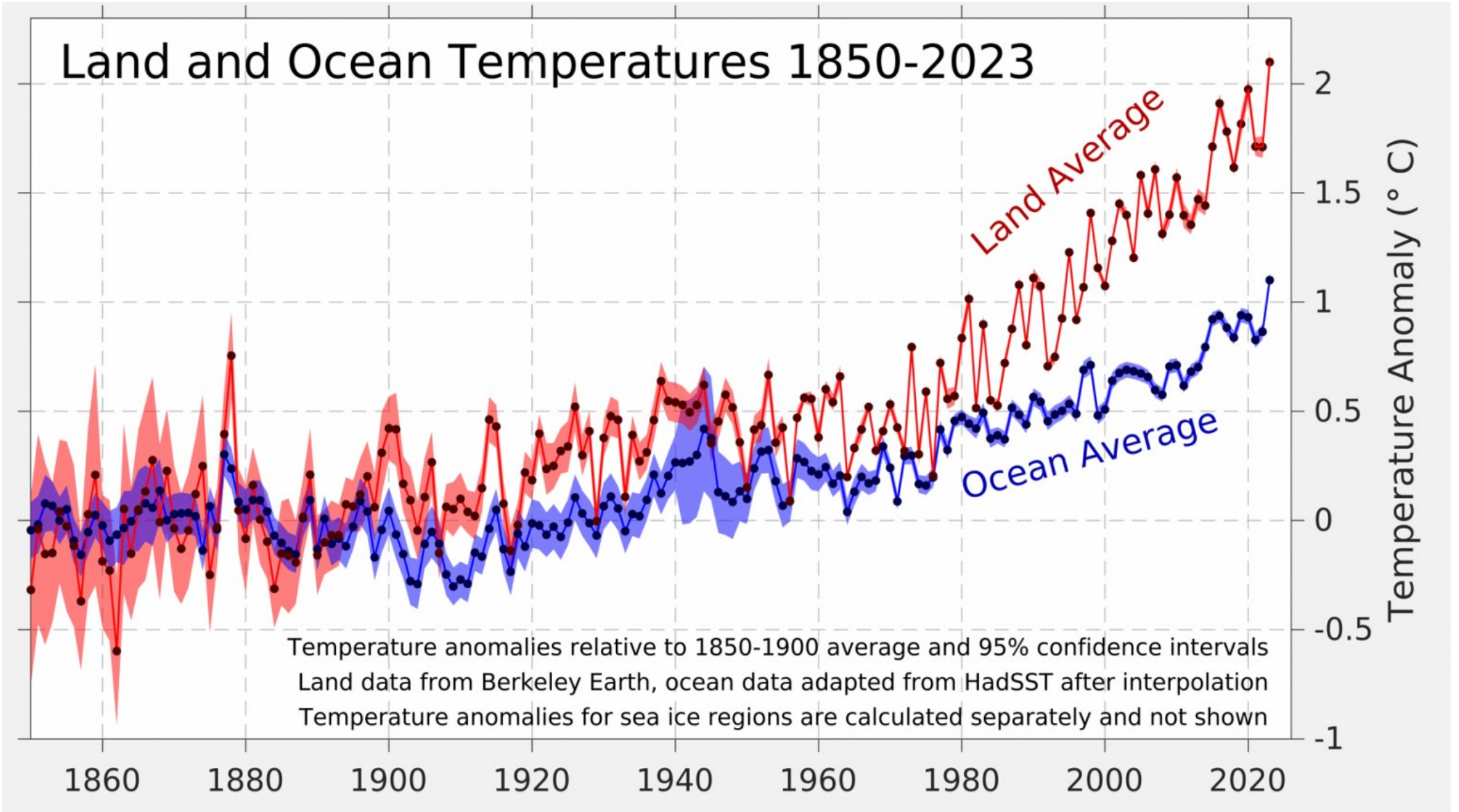


Warmest 1st 2nd 3rd 4th 5th

Coldest 1st 2nd 3rd 4th 5th

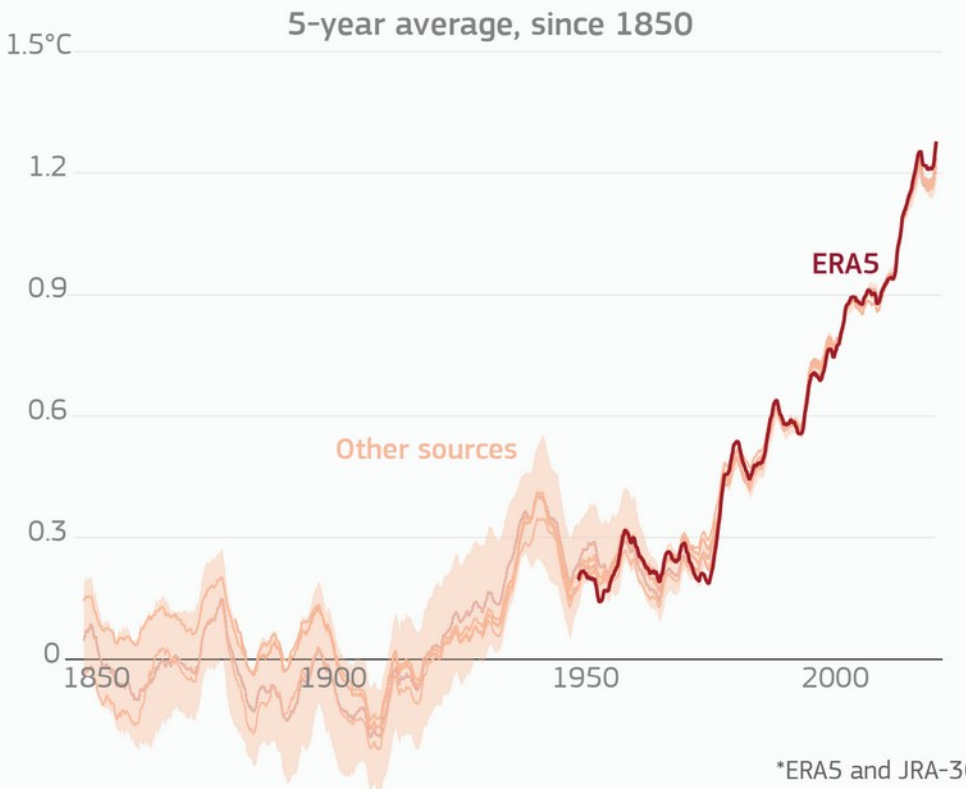

Earth's Energy Imbalance
Data from NASA CERES, 12-month moving average
Global Average Radiant Energy (W/m^2)
244
243.5
243
242.5
242
241.5
241
240.5
240
239.5
239
2000
2005
2010
2015
2020
Absorbed Solar Radiation
Outgoing Longwave Radiation
Earth's Energy Imbalance
+2.1 W/m^2

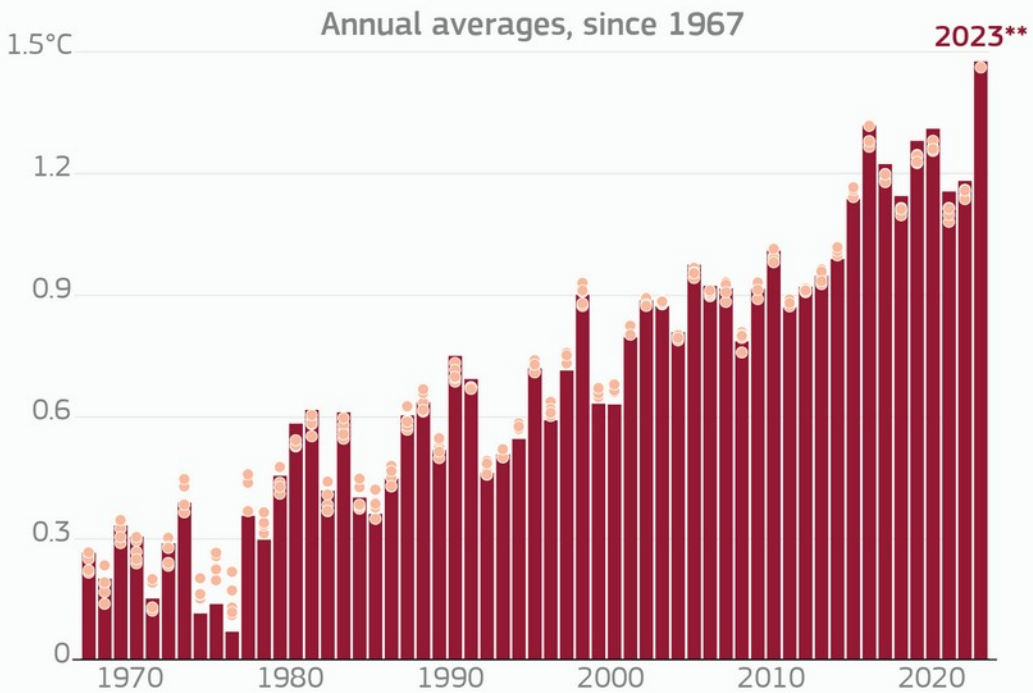

Ocean 0-300 m
Ocean 0-700 m
Ocean 700-2000 m
Ocean below 2000 m
Land
Ice
Atmosphere
Uncertainty
Energy change (ZJ)
400
300
200
100
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


Land and Ocean Temperatures 1850-2023
Land Average
Ocean Average
Temperature anomalies relative to 1850-1900 average and 95% confidence intervals
Land data from Berkeley Earth, ocean data adapted from HadSST after interpolation
Temperature anomalies for sea ice regions are calculated separately and not shown
Temperature Anomaly (° C)
2
1.5
1
0.5
0
-0.5
-1
1860
1880
1900
1920
1940
1960
1980
2000
2020

GLOBAL SURFACE TEMPERATURE: INCREASE ABOVE PRE-INDUSTRIAL LEVEL (1850-1900)

■ ERA5 data ● Other sources* (including JRA-3Q, GISTEMPv4, NOAAGlobalTempv5, Berkeley Earth, HadCRUT5)





*ERA5 and JRA-3Q data are only shown from 1948. Shaded area represents the uncertainty for HadCRUT5 data
**Estimate for 2023 based on ERA5 and JRA-3Q data only
Credit: C3S/ECMWF

PROGRAMME OF THE EUROPEAN UNION
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IMPLEMENTED BY ECMWF
Climate Change Service climate.copernicus.eu

https://www.unep.org/resources/emissions-gap-report-2023
https://library.wmo.int/records/item/56335-wmo-provisional-state-of-the-global-climate-2022
https://climate.copernicus.eu/
https://climatereanalyzer.org/
https://berkeleyearth.org/
https://naukaoklimacie.pl/