



The Basics of Climate Change

TEMPERATURE

**GLOBAL
WARMING**

**WHERE ARE
WE NOW?**

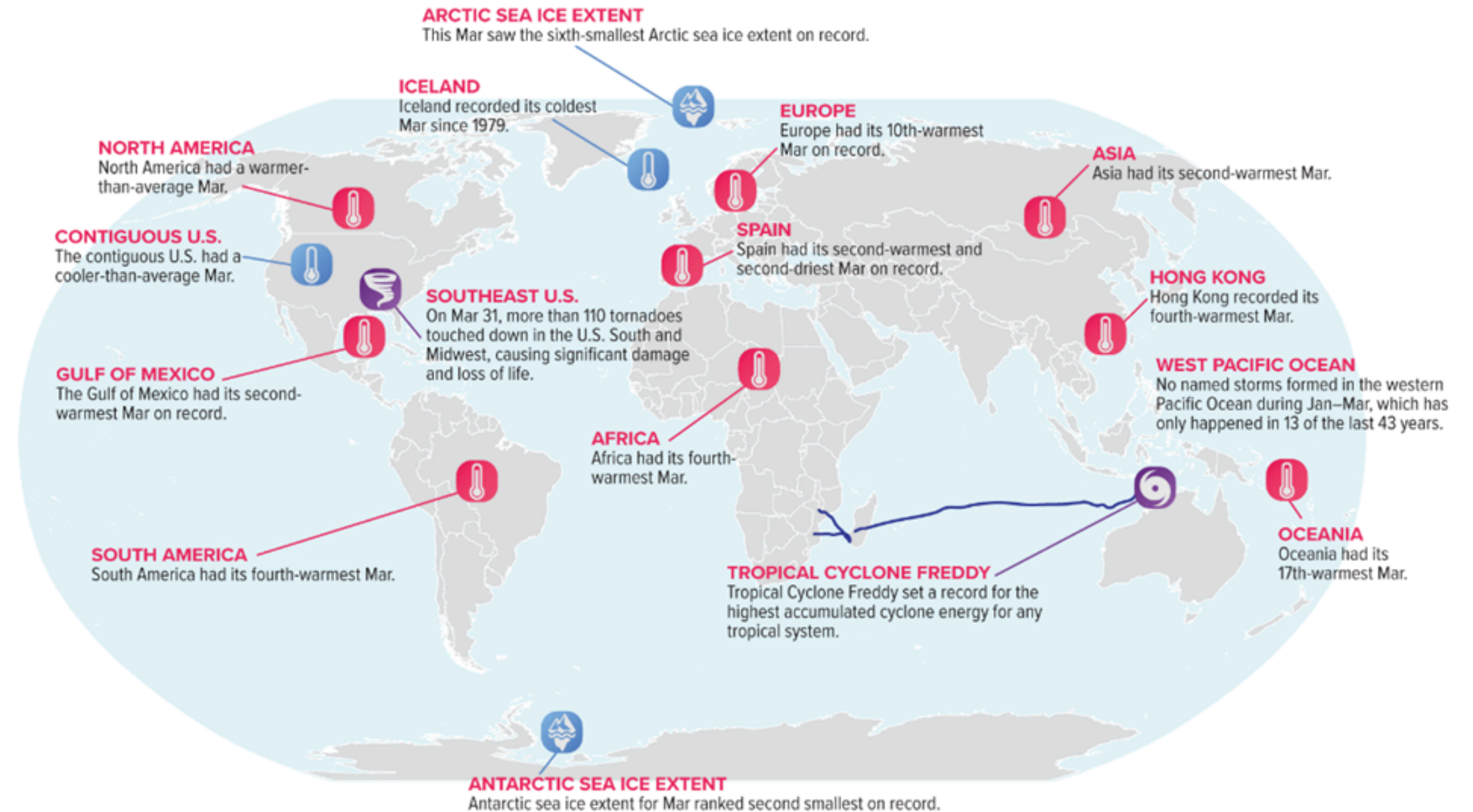
**WHERE ARE
WE GOING?**

GLOBAL AVERAGE TEMPERATURE

Selected significant events and anomalies: March 2023

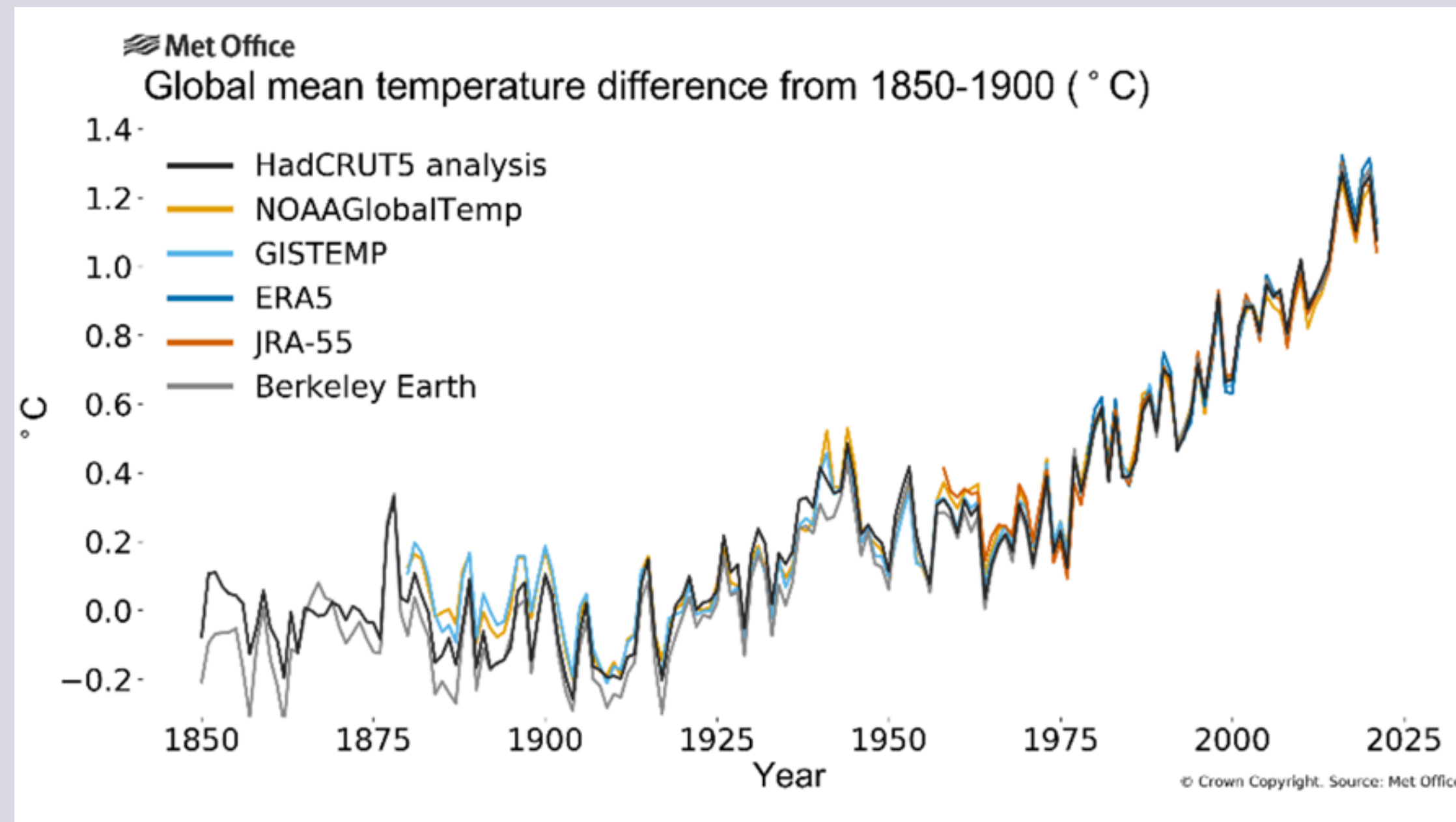


GLOBAL AVERAGE TEMPERATURE
Mar 2023 average global surface temperature was the second highest for Mar since global records began in 1850.



MARCH 2023 average global surface temperature was the second highest for March since global records began 1850

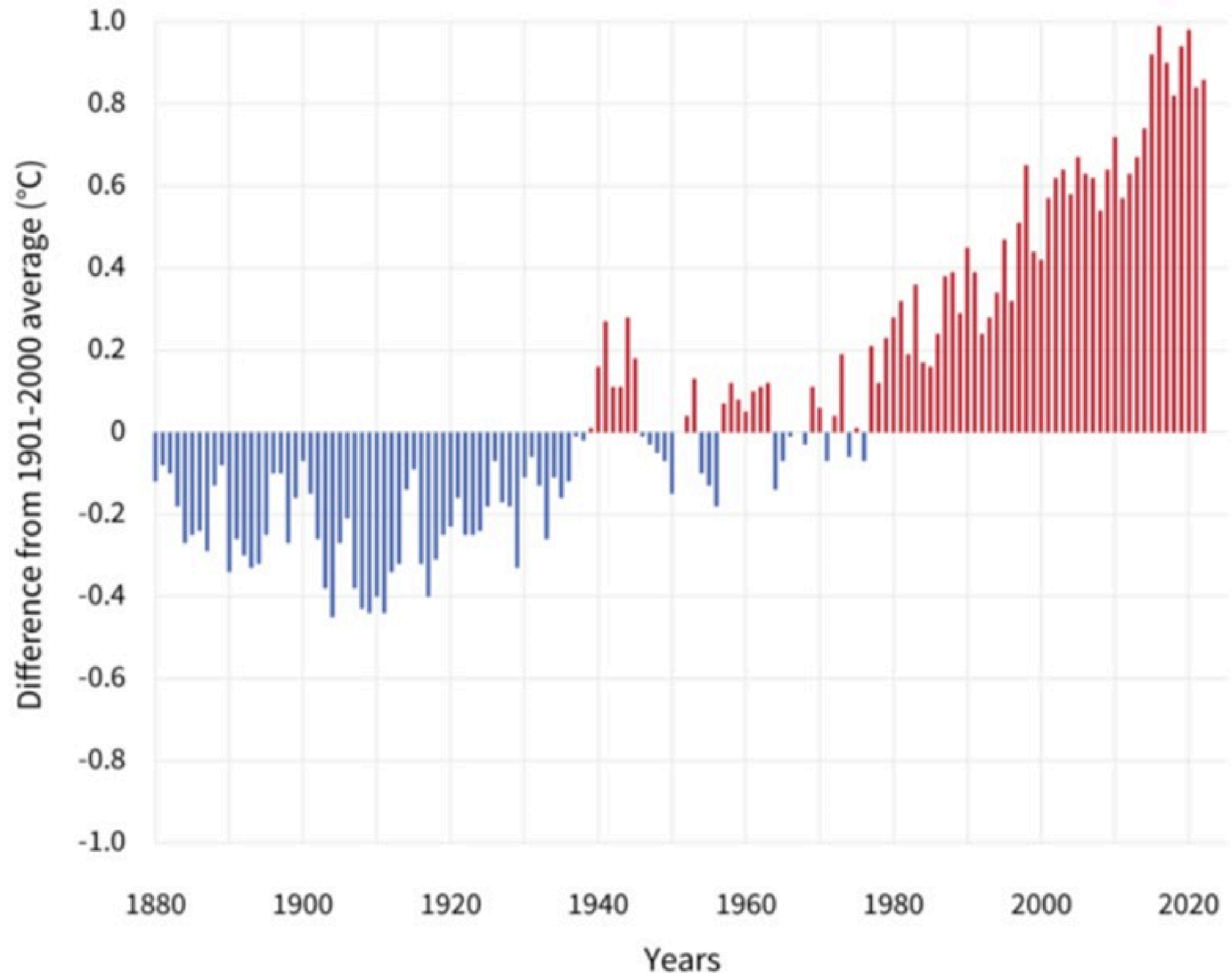
The rankings of individual years should be considered in the long-term context, especially since the differences between individual years are sometimes marginal. Since the 1980s, each decade has been warmer than the previous one. This is expected to continue. (public.wmo.int)



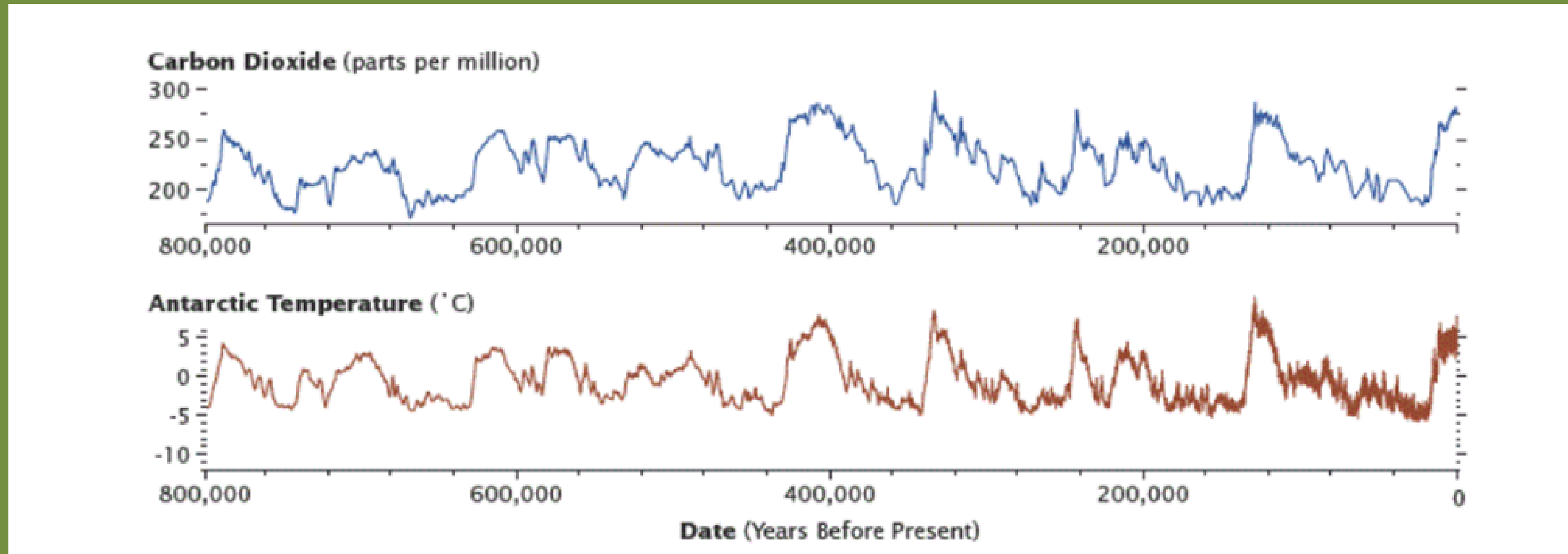
Data source: World Meteorological Organization (WMO), 2023

Yearly surface temperature compared to the 20th-century average from 1880–2022. Blue bars indicate cooler-than-average years; red bars show warmer-than-average years.

NOAA Climate.gov graph, based on data from the National Centers for Environmental Information. (climate.gov, 2023)



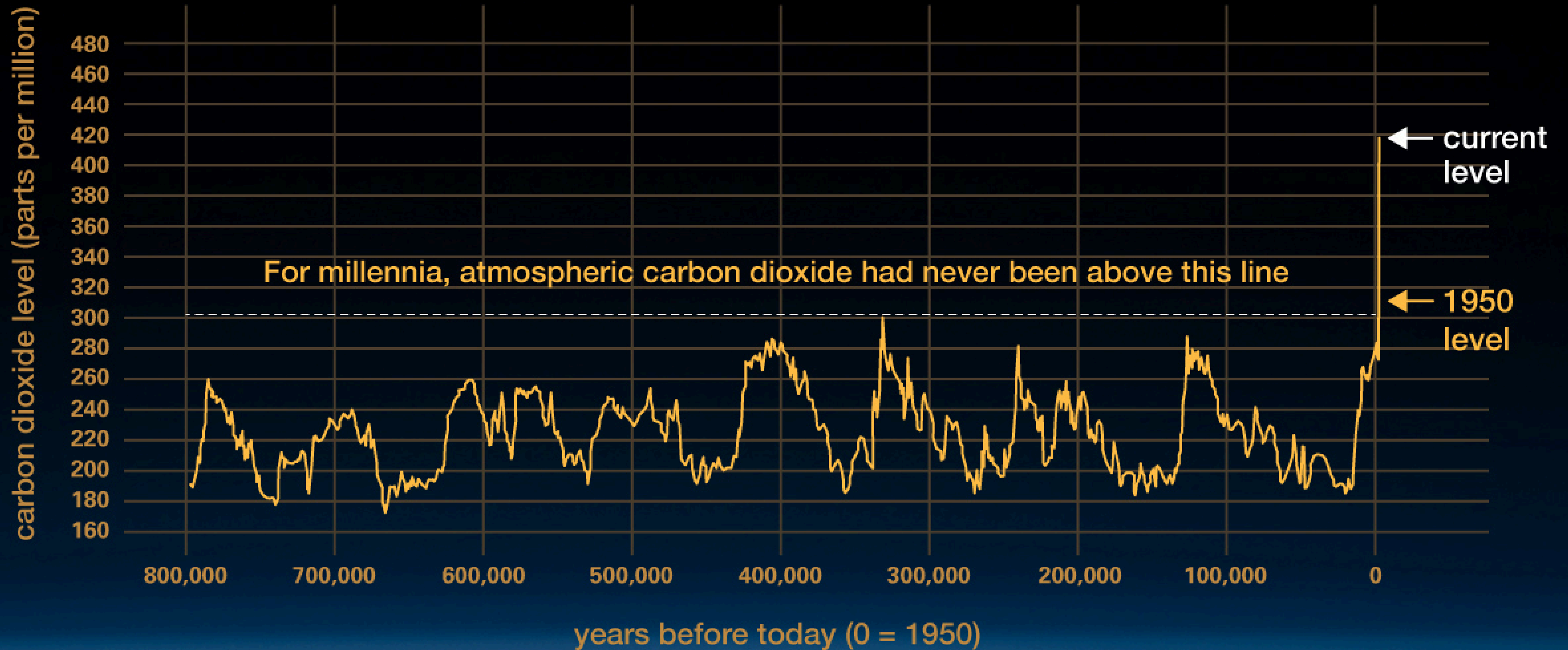
The temperature of the Earth's atmosphere and the carbon dioxide level in the atmosphere have moved together for at least 800,000 years: NASA Earth Observatory
<https://www.feedbackreigns.net/evidence/temperature-co2/>



'The blue line shows the "carbon dioxide level in the atmosphere" over the 800,000 years before 1950. (It does not show the rapid rise in CO2 levels, since 1950, to over 400 parts per million (ppm)).

The red line shows the "Antarctic air temperature" over this same period.'

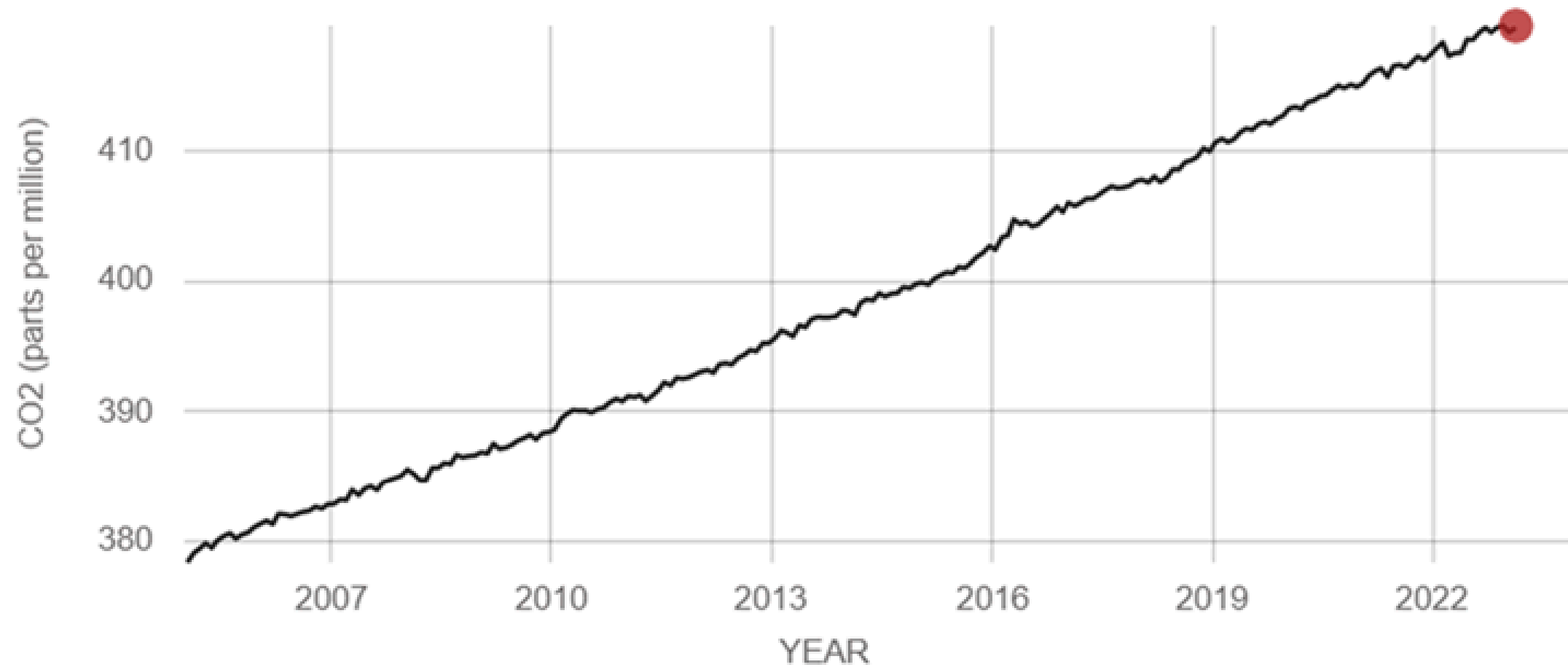
(<https://www.feedbackreigns.net/evidence/temperature-co2/>)



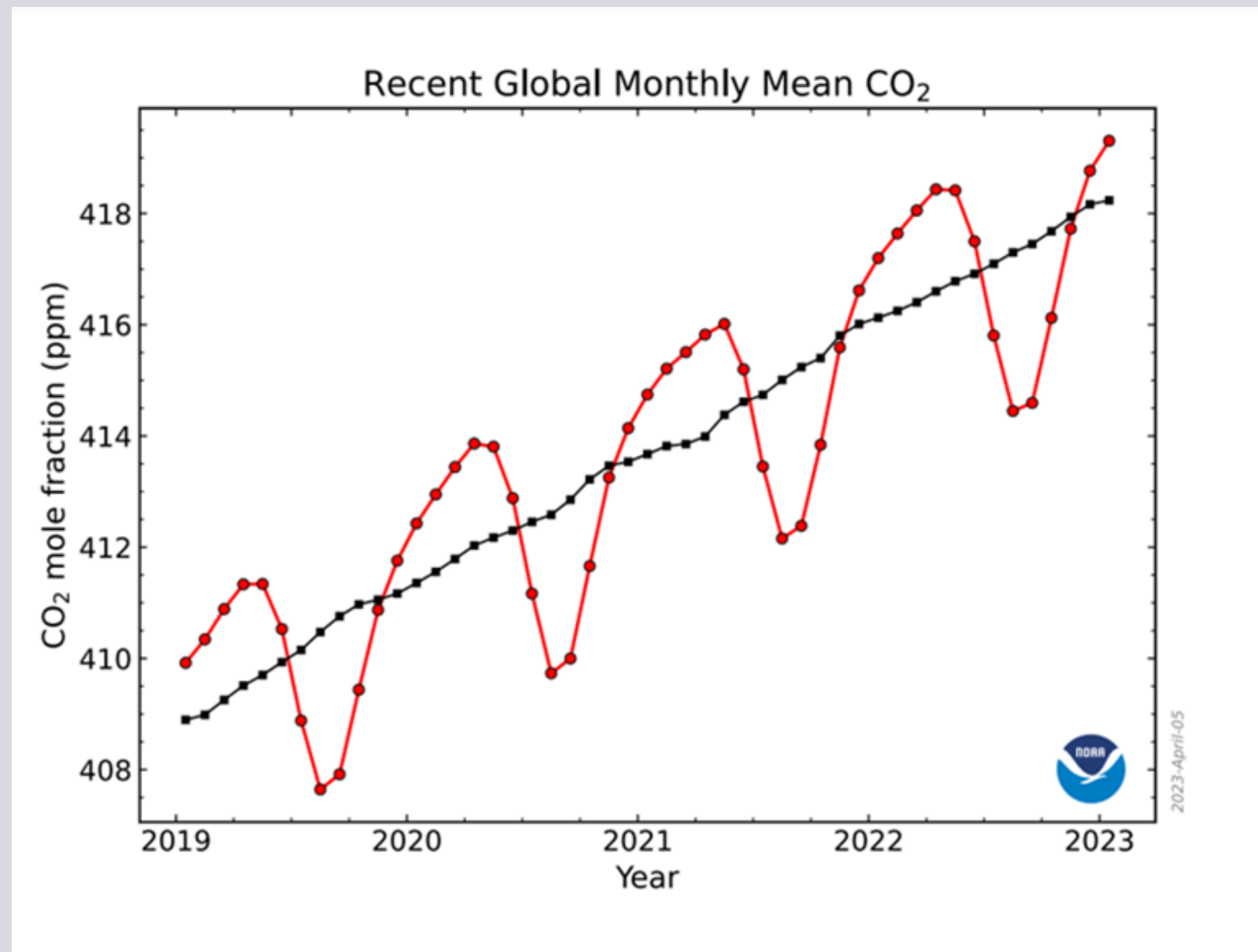
During ice ages, CO₂ levels were around 200 parts per million (ppm), and during the warmer interglacial periods, they hovered around 280 ppm (see fluctuations in the graph). In 2013, CO₂ levels surpassed 400 ppm for the first time in recorded history. (climate.nasa.gov)

DIRECT MEASUREMENTS: 2005-PRESENT


Data source: Monthly measurements (average seasonal cycle removed). Credit: [NOAA](#)



Since the beginning of industrial times (in the 18th century), human activities have raised atmospheric CO2 by 50% – meaning the amount of CO2 is now 150% of its value in 1750. This is greater than what naturally happened at the end of the last ice age 20,000 years ago. Carbon Dioxide, Latest measurement: February 2023, 419 ppm ([nasa.gov](#))



Global Monthly Mean CO₂, the graphs show monthly mean carbon dioxide globally averaged over marine surface sites. January 2023: 419.31 ppm, January 2022: 417.20 ppm Last updated: Apr 05, 2023 (gml.noaa.gov)

A wide-angle photograph of a desert landscape. In the foreground, a caravan of three camels is walking across the sand, with a person riding the lead camel. The middle ground shows a vast, flat desert plain with sparse, low-lying vegetation. In the background, there are several mountain ranges under a clear sky. The overall scene is bathed in warm, golden light, suggesting late afternoon or early morning.

Earth's temperature has risen by an average of 0.08° Celsius per decade since 1880. The rate of warming since 1981 is more than twice as fast: 0.18°C per decade.

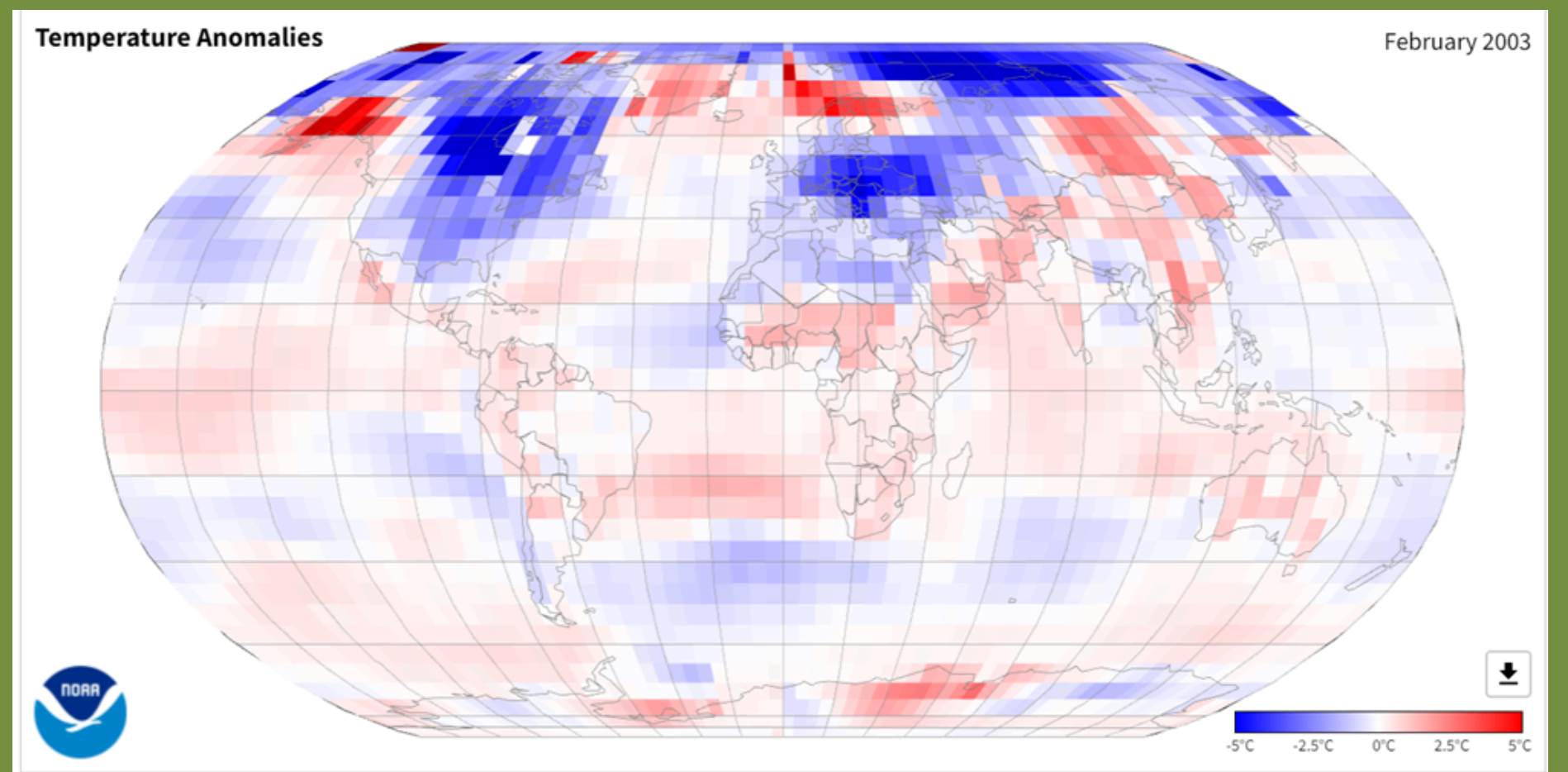
(climate.gov;NOAA)



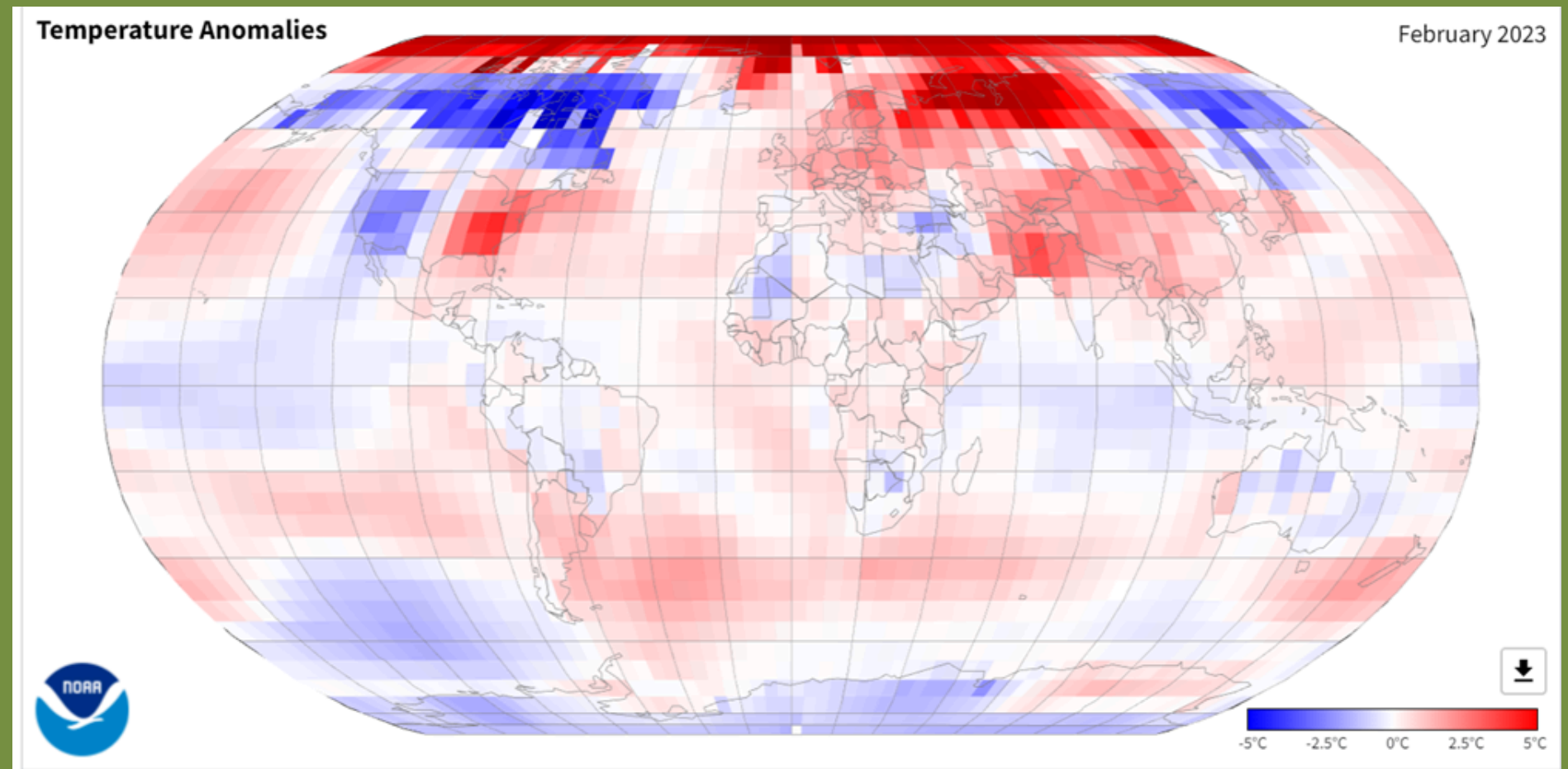
The graphs show the average daily temperatures. It can be seen quite clearly that there has been a sharp increase in temperatures worldwide since the 1980s. Particularly noticeable are the developments in Europe, North America and Asia, where there are considerable temperature increases. (worlddata.info)

The warmest eight years have all been since 2015, with 2016, 2019 and 2020 constituting the top three. An exceptionally strong El Niño event occurred in 2016, which contributed to record global temperatures.

(public.wmo.int)



Temperature anomalies are based on the 1991-2020 mean (NOAA, 2023)



2022 was the sixth-warmest year on record based on NOAA's temperature data.

The 2022 surface temperature was 0.86 °Celsius warmer than the 20th-century average of 13.9 °C and 1.06 °C warmer than the pre-industrial period (1880-1900).

The 10 warmest years in the historical record have all occurred since 2010.
(climate.gov)



The average global temperature in 2022

The average global temperature in 2022 was about 1.15 [1.02 to 1.27] °C above the pre-industrial (1850-1900) levels. 2022 is the 8th consecutive year (2015-2022) that annual global temperatures have reached at least 1°C above pre-industrial levels, according to all datasets compiled by WMO. 2015 to 2022 are the eight warmest years on record. Long-term warming continues. (IPCC)



2021 ranked between the third and the fourth warmest year on record for Africa. (wmo.int)

Without immediate and deep emissions reductions across all sectors and regions, it will be impossible to keep warming below 1.5° C. (IPCC)

In 2020, the COVID-19 pandemic lockdowns led to the single biggest drop in CO₂ emissions on record. Since then, however, CO₂ emissions have exceeded pre-pandemic levels recorded in early 2019. (wmo.int)

Global mean surface temperature (GMST) and Sea surface temperature (SST)

Global mean surface temperature (GMST)

Estimated global average of near-surface air temperatures over land and sea-ice, and sea surface temperatures over ice-free ocean regions, with changes normally expressed as departures from a value over a specified reference period. When estimating changes in GMST, near-surface air temperature over both land and oceans are also used.

Sea surface temperature (SST)

The sea surface temperature is the subsurface bulk temperature in the top few meters of the ocean, measured by ships, buoys, and drifters. From ships, measurements of water samples in buckets were mostly switched in the 1940s to samples from engine intake water. Satellite measurements of skin temperature (uppermost layer; a fraction of a millimeter thick) in the infrared or the top centimeter or so in the microwave are also used, but must be adjusted to be compatible with the bulk temperature.

Land surface air temperature LST and Global mean surface air temperature GSAT

Land surface air temperature (LST)

The near-surface air temperature over land, typically measured at 1.25–2 m above the ground using standard meteorological equipment.

Global mean surface air temperature (GSAT)

Global average of near-surface air temperatures over land and oceans. Changes in GSAT are often used as a measure of global temperature change in climate models but are not observed directly.

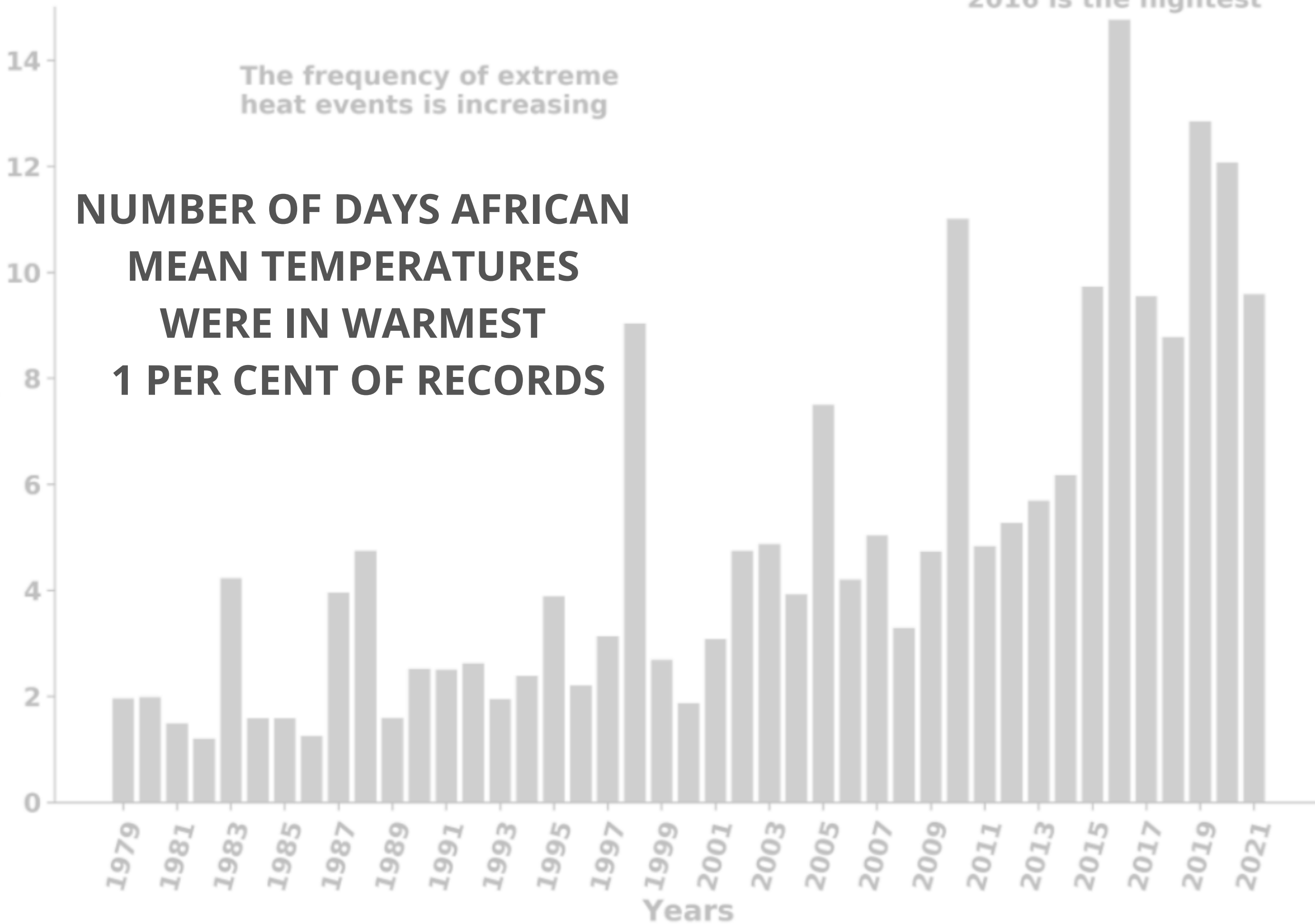


Number of days African mean temperatures were in warmest 1 per cent of records

NUMBER OF DAYS AFRICAN MEAN TEMPERATURES WERE IN WARMEST 1 PER CENT OF RECORDS

The frequency of extreme heat events is increasing

2016 is the highest



Africa had an annual temperature of $+1.01^{\circ}\text{C}$ ($+1.82^{\circ}\text{F}$), which is the 10th highest in the continent's 113-year record. Despite being above-average, this value was the smallest annual temperature for Africa since 2014. The year 2022 marked Africa's 46th consecutive year with temperatures above average. Africa's 10 warmest years have occurred since 2005. Africa's annual temperature has increased at an average rate of 0.13°C (0.23°F) per decade since 1910; however, it has more than doubled to 0.28°C (0.50°F) since 1981. (ncei.noaa.gov 2023)