

# News in focus



MARIO TAMA/GETTY

Intense heatwaves in the desert in the southwestern United States have been killing off the iconic saguaro cactus.

## EARTH'S HOTTEST MONTH: THESE CHARTS SHOW WHAT HAPPENED IN JULY AND WHAT COMES NEXT

The planet has warmed by 1.2 °C on average, but that's enough to produce big extremes.

By Jeff Tollefson

**F**rom wilting saguaro cacti in Arizona and hot-tub-like temperatures off the coast of Florida to increased heat-related hospitalizations in Europe and agricultural losses in China, last month felt unusually hot. It was: several teams have now confirmed that July 2023 was the hottest month in recorded history. And there's more to come.

July is typically the hottest month of the year, and this July shattered records going back as far as 1850 by around 0.25 °C. Overall, the average global temperature was 1.54 °C above

the preindustrial average for July, according to Berkeley Earth, a non-profit group in California that is one of several organizations tracking global warming. This increase seems small – but what many people actually experienced was a bout of long, often brutal heatwaves.

“We're in a particularly extreme period on top of a long-term warming trend, and the view from the top is a little scary,” says Zeke Hausfather, a climate scientist at Berkeley Earth.

### Loading the dice

Multiple factors might have played a small part in the record-breaking temperatures,

including a budding El Niño warming event in the equatorial Pacific Ocean and a volcanic eruption last year on the island of Tonga that injected water vapour, itself a powerful greenhouse gas, into the stratosphere. New regulations have also curbed the release of sulfur dioxide pollution from ships, which tends to have a cooling effect. But the biggest driver by far, scientists say, is increasing greenhouse-gas concentrations in the atmosphere, which have been steadily raising average global temperatures and have loaded the dice in favour of extreme weather and climate events (see ‘Going up’).

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An analysis by scientists at the World Weather Attribution initiative found that, in a world without human influence, the heatwave in China last month would have been expected only once every 250 years. Temperatures in southern Europe and North America, meanwhile, would have been “virtually impossible” in the preindustrial era. But such extremes are becoming the norm: last month’s events can now be expected every 5–15 years, and

could happen as often as every 2–5 years if global temperatures increase to 2 °C above those of the preindustrial period, which is the upper limit imposed by the 2015 Paris climate agreement.

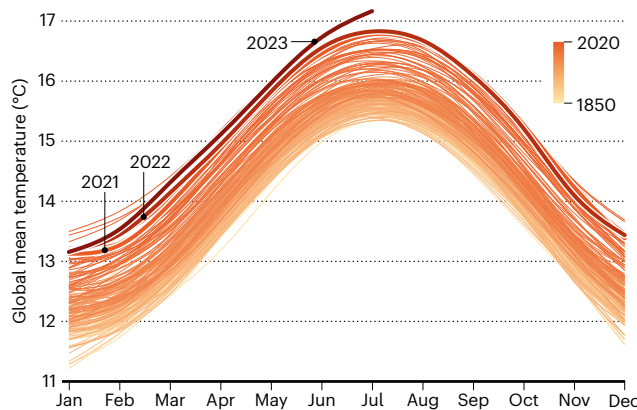
“It only takes a small change in average temperature for the frequency of extremes to completely blow out, which is what we’ve seen in the Northern Hemisphere recently,” says Sarah Perkins-Kirkpatrick, a climate scientist

at the University of New South Wales in Sydney, Australia.

Global average temperature, often measured on a rolling ten-year basis, is a metric that scientists use to track broad trends in a noisy, complex system. Thus far, the world has warmed by 1.14 °C using that metric. But no one actually lives in an average world. And although 90% of the excess heat due to the presence of greenhouse gases has gone into the oceans, the fact is that temperatures over land are both warmer and rising faster than are those of the ocean surface. Many parts of Earth’s land surface have already warmed by more than 1.5 °C in at least one season, and temperatures in numerous places last month were as much as 8 °C above the average for July (see ‘Hot spots’).

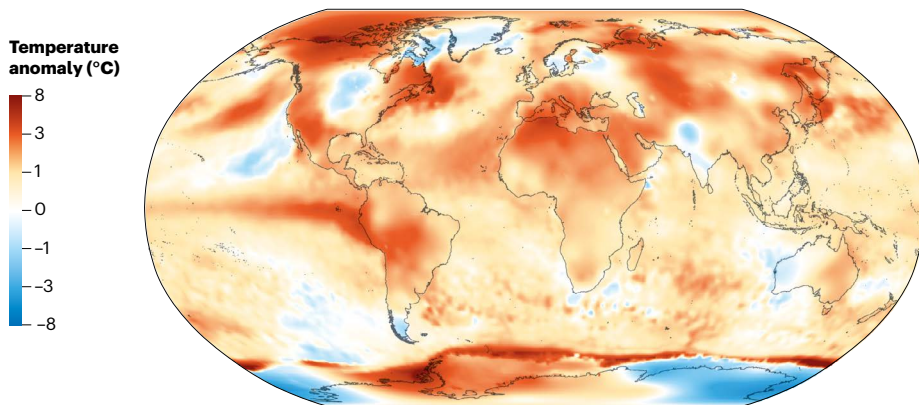
### GOING UP

Earth’s mean temperature has been rising steadily for more than a century, and this year is already setting records. July 2023 has now been declared the hottest month ever. Berkeley Earth, a non-profit environmental-data organization in California, estimates that last month was more than 1.5 °C warmer than the pre-industrial average of 1850–1900.



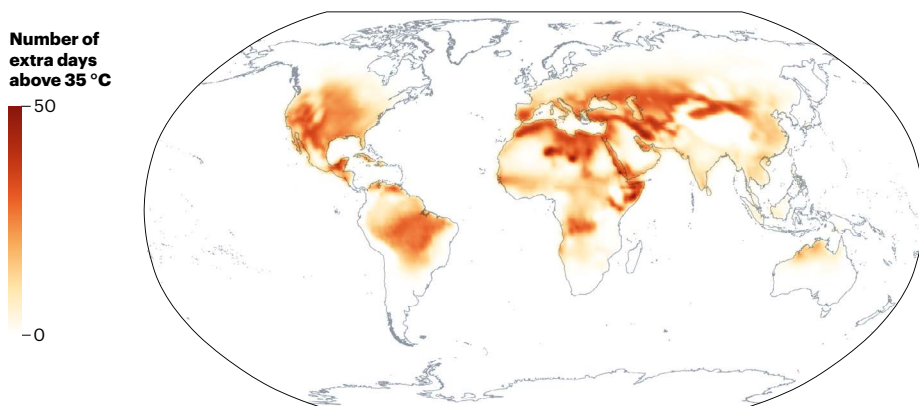
### HOT SPOTS

So far, the average global temperature has climbed by about 1.1 °C, but the changes that people actually feel around the globe can be much larger. Some of the biggest increases have been over land in the Northern Hemisphere, and in many places it has been up to 8 °C above the historical average of 1951–1980 during July 2023.



### HEATWAVE PROJECTIONS

If global temperatures were to rise by 3 °C, as some models predict could happen by the end of this century, some places on Earth could experience nearly 50 extra days each year above 35 °C, affecting public health and ecosystems globally.



### Heatwaves rising

To some extent, this should come as no surprise. The Paris agreement limits of 1.5–2 °C were intended to establish a relatively safe zone that, if maintained, would prevent many of the most severe impacts of a warming world. But a key message from the 2021–22 assessment produced by the Intergovernmental Panel on Climate Change is that every tenth of a degree of warming at the global level comes with additional – and often extreme – impacts at the local and regional level.

A few decades ago, many of the impacts were theoretical, but a growing body of research suggests that the planet is beginning to breach important ecological thresholds, says Jofre Carnicer, an ecologist at the University of Barcelona in Spain. Carnicer says that temperature and precipitation trends are already pushing many parts of Europe into entirely new fire regimes, as evidenced by extreme wildfires in Greece and elsewhere this year (J. Carnicer *et al. Sci. Rep.* **12**, 10365; 2022).

Global temperature trends have tracked fairly well with projections from climate models going back more than two decades, but research into what that means at the local level is just beginning, Carnicer says (see ‘Heatwave projections’). “This is really new science,” he says, and it suggests that even the low threshold of a 1.5 °C average – which could be breached for the first time in the next several years – might be a significant challenge for the world.

The science makes one thing clear: the warming shows no sign of stopping. This year’s El Niño event is just getting started, and many scientists suspect that 2023 could be the hottest year on record. Next year is likely to be even warmer.

“July 2023 is just the latest in a long run of extremely warm months and years,” says Sarah Kapnick, chief scientist for the US National Oceanic and Atmospheric Administration. “The long-term increase in global temperature marches on and on and on.”

SOURCE: GOING UP/HOT SPOTS: BERKELEY EARTH; HEATWAVE PROJECTIONS: IPCC