

## Carbon pollution boosted heat for billions during Earth's hottest summer

### Key Facts

The three-month June-August 2023 season was the warmest on record globally — by a large margin. During this period, many parts of the globe experienced record-shattering and dangerous heat.

Analysis using the [Climate Shift Index®](#), Climate Central's daily temperature attribution system, indicates that human-caused climate change made the unprecedented June-August heat far more likely across the globe. This analysis included 202 countries and territories.

**Nearly half (48%) of the world's population experienced at least 30 June-August days** with a Climate Shift Index (CSI) level 3 or higher. A CSI level 3 indicates that human-caused climate change made those temperatures *at least three times more likely*.

**On each day in June-August, between 1.5 and 4.2 billion people** felt a very strong influence of climate change (CSI level 3 or higher).

Heat at CSI level 3 or higher **persisted for at least half the June-August period in 79 countries** throughout Central America, the Caribbean, the Arabian Peninsula, and parts of Africa.

Countries with the lowest historical emissions experienced **three to four times more June-August days** with CSI level 3 or higher than G20 countries (the world's largest economies).

- [Download data](#): Climate Shift Index (CSI) levels for June-August 2023, daily and by country

## INTRODUCTION

The three-month June-August 2023 season was the [warmest on record](#) globally — by a large margin.

The record-shattering Northern Hemisphere summer temperatures brought dangerous heat waves to many parts of the globe and fueled wildfires in North America, Europe, and Africa.

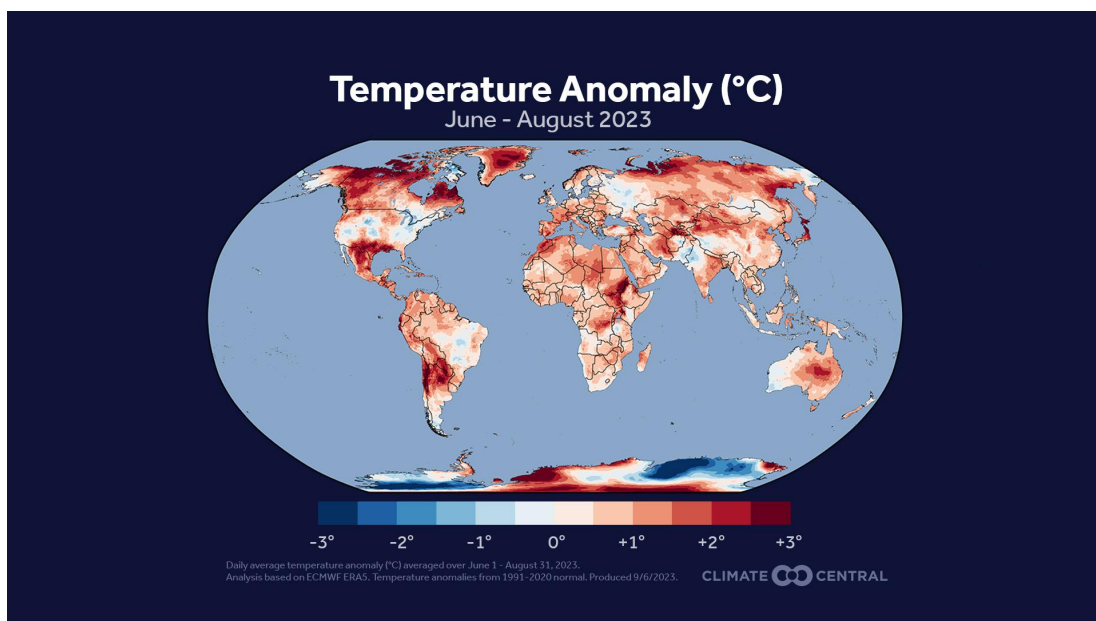
[Record-breaking heat also occurred in the ocean](#), elevating the risk of rapidly-intensifying tropical cyclones like Hurricane Idalia and coral bleaching events like those impacting Florida and the Caribbean.

Heat waves are the deadliest weather-related hazards, and their rising global frequency and intensity is consistent with [well-established scientific understanding](#) of the consequences of carbon pollution—mainly from burning coal, oil, and natural gas.

Climate change attribution uses statistical methods to quantify whether and to what extent human-caused climate change altered the likelihood of specific events.

Climate Central's daily attribution tool, the [Climate Shift Index](#)®, or CSI, applies the [latest peer-reviewed methodology](#) to map the influence of human-caused climate change on temperatures across the globe, every day.

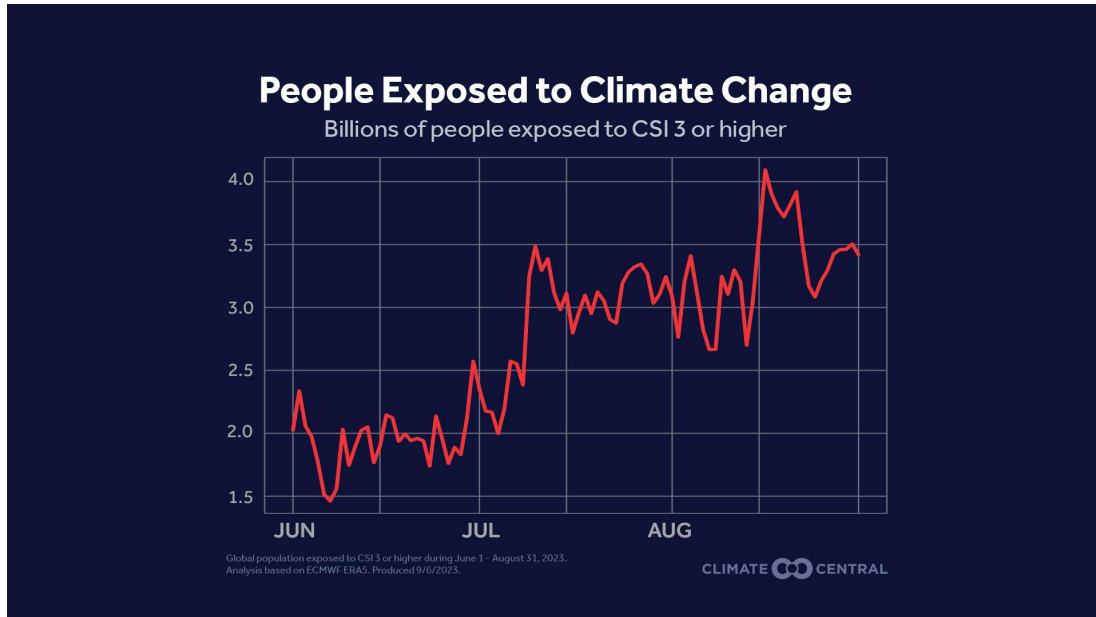
This report presents the results of a Climate Central analysis that uses the CSI to quantify the influence of human-caused climate change on daily average temperatures experienced across the globe, in 202 countries and territories, from June 1, 2023 to August 31, 2023.



## RESULTS

### 1. Billions experienced climate-driven heat during June-August 2023

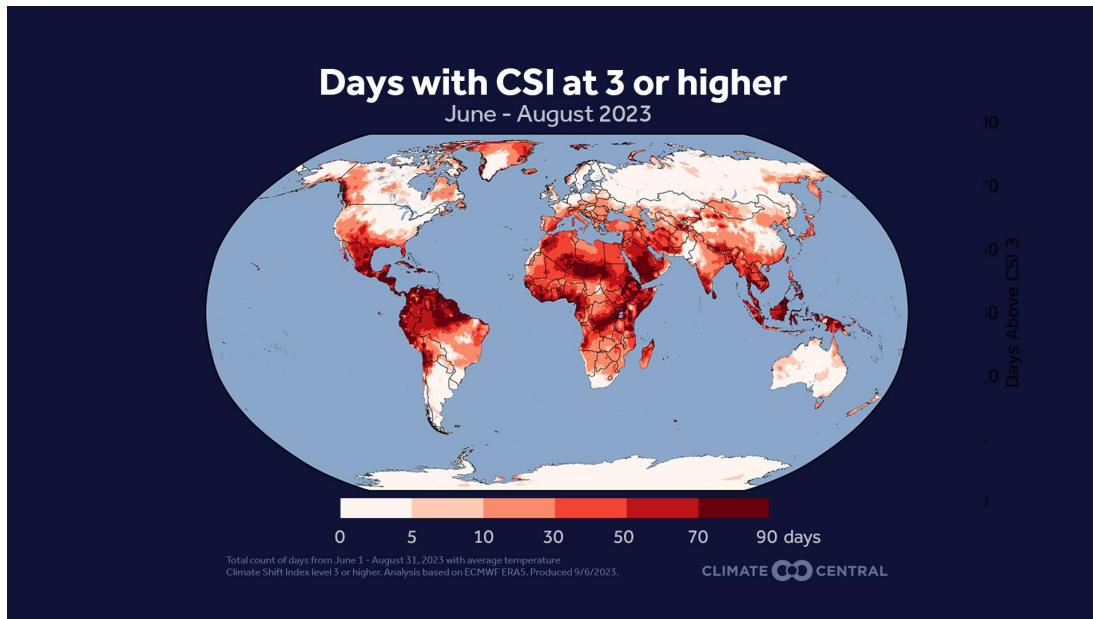
Over 3.8 billion people — 48% of the global population — experienced at least 30 days during June-August with a CSI level 3 or higher. A CSI level 3 indicates that human-caused climate change made those temperatures *at least three times more likely*.



**At least 1.5 billion people felt a very strong influence of climate change (CSI level 3 or higher) on each day during June-August 2023.** Global exposure peaked on August 16, 2023, when 4.2 billion people worldwide experienced extreme heat at CSI level 3 or higher.

➤ **Download data:** Daily global population exposed to CSI level 3 or higher

**Positive CSI levels (1 to 5) indicate conditions that will become more likely and more frequent as climate change accelerates.** Approximately **two-thirds of the global population (5.3 billion people)** experienced an average CSI level 1 or higher during June-August 2023. These numbers will grow over time until humans stop burning coal, oil, and natural gas.



## 2. Hot spots: persistent heat linked to climate change

Very strong fingerprints of climate change (CSI level 3 or higher) persisted for at least half of the June-August 2023 period in: north Africa; the Gulf of Guinea coastline; parts of central Africa, the Sahel, and the Horn of Africa; the Arabian Peninsula; the Mediterranean Basin; parts of India; the Malay Archipelago; the Amazon Basin; the Andes; Central America and the Caribbean; Mexico; the southern tier of the United States; western Canada; and northern Greenland.

### The Climate Shift Index (CSI)

Humans have caused global average temperatures to increase by **1.1°C (2°F) since 1850**. But people do not experience global average temperatures. Instead, we mainly experience climate change through shifts in the daily temperatures and weather patterns where we live.

Climate Central's **Climate Shift Index (CSI)** system quantifies the local influence of climate change on daily temperatures around the world.

The CSI quantifies how much human-caused climate change has shifted the odds of daily temperatures that people experience locally. The CSI tool is grounded in **peer-reviewed attribution science** and was launched by Climate Central in 2022. The tool is free to access.

**The CSI scale is centered on zero.** A CSI level of zero means that there is no detectable influence of human-caused climate change. In other words, that day's temperature is equally likely in both the modern climate and one without global warming.

**Positive CSI levels 1 to 5 indicate conditions that are increasingly likely in today's climate.** A CSI level of 1 means that climate change is detectable (technically, the temperature is at least 1.5x more likely). CSI levels 2 and higher correspond with the multipliers (2 = at least 2x more likely, 3 = at least 3x more likely, etc.). The CSI scale is currently capped at level 5 which means that a CSI of 5 includes higher values and thus should be read as *at least* 5. CSI level 5 events would be very difficult to encounter in a world without climate change—not impossible, but extremely unlikely.

**The CSI can also be applied to temperatures that are unusually cool.** For instance, a CSI level -2 means that the temperature in question is two times less likely (equivalently 1/2 as likely) due to human-caused climate change.

### 3. Inequitable burden of climate fingerprints

**Seventy-nine countries experienced at least half of all June-August days at CSI level 3 or higher.** More than half of these (49 countries, or 62%) were U.N.-designated [least developed countries](#) and [small island developing states](#), which together account for approximately 7% of cumulative historical greenhouse gas emissions.

➤ [Download data](#) for all 202 countries and territories.

**Countries with lowest emissions experienced approximately three to four times more June-August days with very strong climate fingerprints than the G20 countries (the world's largest economies).**

Group	Countries and territories analyzed	Days at CSI = 3 or higher, June-August 2023 (area-weighted average)	Share of cumulative total greenhouse gas emissions
Least developed countries (LDC)	45	47	6%
Small island developing states (SIDS)	27	65	1%
Group of 20 (G20)	43 (19, plus European Union)	17	73%

However, states and regions within several G20 countries had notable exposure to climate-driven heat.

- For example, the U.S. states of Hawai'i, Louisiana, Texas, New Mexico, Florida, and Arizona, along with parts of Spain and Italy, experienced 30 or more days at CSI level 3.
- At least half of all June-August days were a CSI level 3 or higher in: Saudi Arabia, Indonesia, Mexico, 11 Indian states (Kerala, Puducherry, Andaman and Nicobar, Meghalaya, Goa, Karnataka, Mizoram, Manipur, Tripura, Nagaland, and Tamil Nadu), and five Brazilian states (Amapá, Roraima, Pará, Amazonas, and Acre).

According to the United Nations, [small island developing states](#) are a group of low-lying island nations that are home to approximately 65 million people and are extremely vulnerable to the impacts of climate change — despite being responsible for less than 1% of global greenhouse gas emissions.

There are currently 46 [least developed countries](#) designated by the United Nations as “low-income countries confronting severe structural impediments to sustainable development.” The least developed countries have a collective population of around 880 million people, and account for approximately 6% of global greenhouse gas emissions.

### CSI: Tools, Data, Custom Maps, and Local Alerts

Here are four ways to use this attribution analysis from Climate Central:

1. **Use the tools.** Climate Central's [Climate Shift Index map tool](#) shows which parts of the world are experiencing high CSI levels, every day. Explore the global CSI map for today, tomorrow, and any day during June-August 2023.
2. **Download the data.** Summary data from this report are available to [download](#) and explore in more detail how human-caused climate change has affected people around the world in June-August 2023.
3. **Create custom CSI maps.** The Climate Shift Index is now available in KML format. [Fill out this form](#) to join our pilot project, receive the KML links, and start creating custom CSI maps.
4. **Sign up for alerts.** [Sign up here](#) to receive custom email alerts when strong CSI levels are detected in your local area.

## Methods

### Calculating the Climate Shift Index

All Climate Shift Index (CSI) levels reported in this brief are based on daily average temperatures from June 1, 2023 to August 31, 2023. For this analysis, Climate Central used [ERA5 data](#) from June 1 to August 31, 2023. See the [frequently asked questions](#) for details on computing the Climate Shift Index, including a summary of the multi-model approach described in [Gilford et al. \(2022\)](#).

### Daily Global Population Exposure

For each day, we identified the grid cells with CSI values of 3 or higher. We then totalled the estimated population based on the [Gridded Population of the World v4](#) estimate for 2020, and proportionally scaled the population up to current estimates for global population.

### Country Analysis

The country-level analysis includes 202 countries and territories. It excludes entities that are smaller than 0.25°, the size of a grid cell.

For this analysis, we calculated the temperature anomaly, mean CSI, and number of days at CSI level 3 or higher (all based on average temperature) over the [June 1 to August 31, 2023 period](#). For each country, we then selected the data within its geographical boundary and spatially averaged the temperature anomaly, mean CSI, and the number of days at CSI level 3 or higher. Reported temperature anomalies are relative to each country's 1991-2020 normal June - August average temperature.

Data on cumulative greenhouse gas emissions (1851-2021) by country are reported in [Jones et al. \(2023\)](#) and available for download, along with various country groupings as defined by the United Nations Framework Convention on Climate Change (UNFCCC) at: <https://zenodo.org/record/7636699>.

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