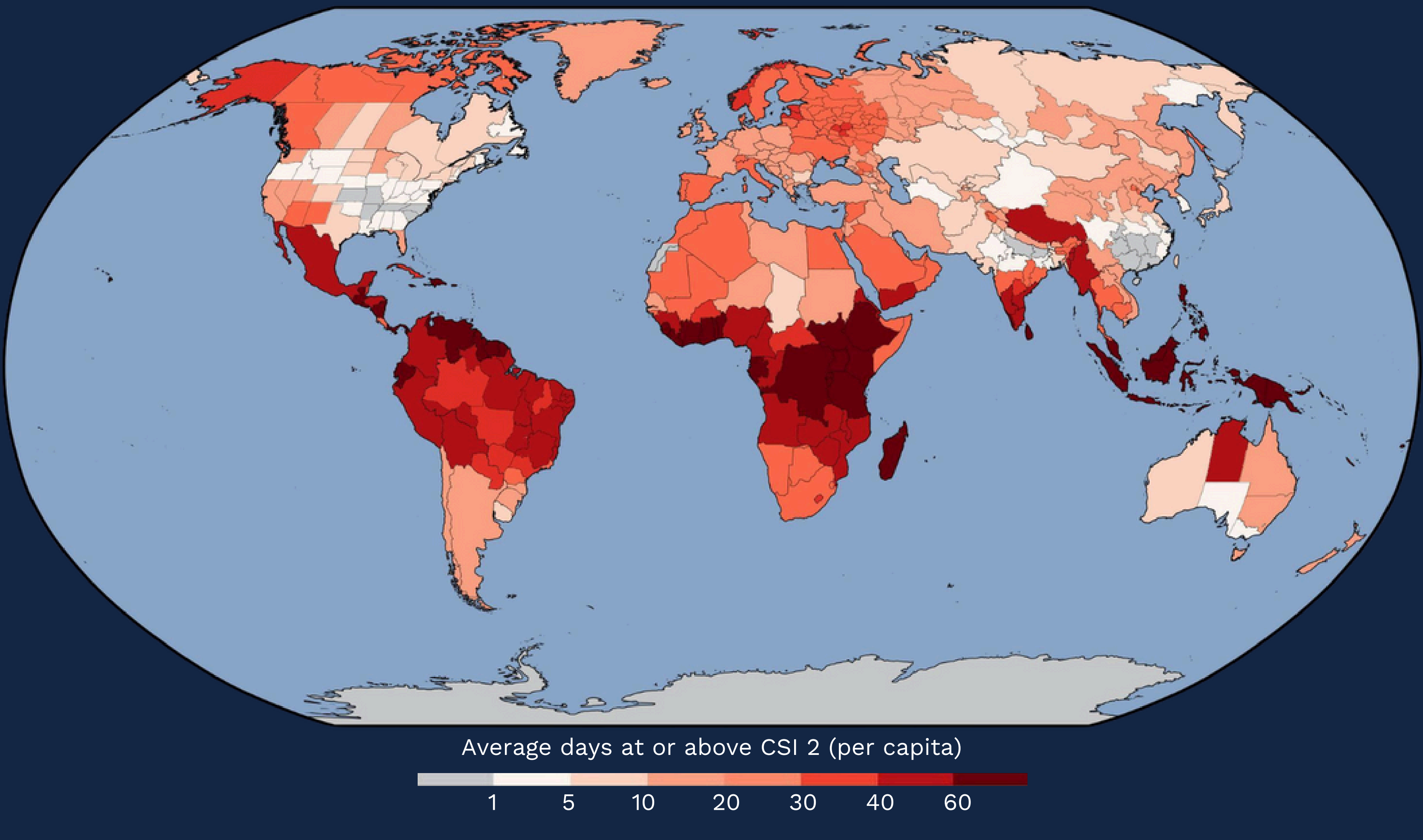
People Exposed to Climate Change: December 2024-February 2025

A Climate Central seasonal analysis of how climate change boosted temperatures worldwide between December 2024 and February 2025



CLIMATE CENTRAL

March 19, 2025

People Exposed to Climate Change: December 2024 to February 2025

A Climate Central seasonal analysis of how climate change boosted temperatures worldwide between December 2024 and February 2025

March 19, 2025

Key Facts

During the past three months (December, January, and February), the effects of human-induced climate change — mainly from burning coal, oil, and methane gas — were evident in most regions of the world, particularly in the form of extreme heat. This analysis uses Climate Central's Climate Shift Index (CSI) to determine the influence of climate change on temperatures around the globe during this period.

This report finds that human-caused climate change increased heat-related health risks for billions and made extreme heat events more likely around the globe. Key findings include:

- At least one in five people globally felt a *strong* climate change influence every day from December 2024 to February 2025.

- Nearly 394 million people experienced 30 or more days of risky heat added by climate change during the last three months. Most of these people (74%) live in Africa. Risky heat days are days with temperatures hotter than 90% of the temperatures recorded in a local area from 1991-2020. Heat-related health risks rise when temperatures climb above this local threshold.

- In half of the analyzed countries (110 out of 220), the average person experienced temperatures *strongly* influenced by climate change for at least one-third of the season (30 days or more).

- In 287 cities, the average person experienced temperatures with a *strong* influence of climate change one-third of the season (30 days or more).

Data

➢ **Download data** for Dec. 1, 2024, to Feb. 28, 2025: Climate Shift Index (CSI) levels for 220 countries and 940 cities around the world.
➢ **Explore interactive maps** for countries and cities across six continents.

INTRODUCTION

Humans have raised Earth's temperature, mainly by burning coal, oil, and methane gas. Heat-trapping pollution from these and other human activities has caused global temperatures to rise by nearly 1.2°C (2.2°F) compared to early-industrial (1850-1900) levels.

From December 2024 to February 2025, the effects of human-induced climate change were evident in nearly all regions of the world, particularly in the form of extreme heat. See the ***Heat and Beyond*** box below.

This report documents how human-caused climate change influenced temperatures during this three-month period for people worldwide. We use two primary tools for this analysis:

1. **Temperature anomalies:** These show how much warmer or cooler conditions were than the 1991-2020 average. Note that this baseline period already includes about 0.9°C (1.6°F) of warming above pre-industrial levels. Temperature anomalies highlight conditions that people would recognize as unusual.

2. **Climate Shift Index (CSI):** This metric, developed by Climate Central's scientists, quantifies the influence of climate change on daily temperatures. Positive CSI levels 1 to 5 indicate temperatures that are increasingly likely in today's climate. A CSI level of 2 (3, etc.) means the temperature is at least 2 times (3 times, etc.) more likely in today's climate than in a world without human-caused climate change. See *the* ***Climate Shift Index (CSI)*** box below for details.

This analysis focuses on the average person's experience of unusually warm conditions *strongly* influenced by climate change (CSI level 2 or higher) from December 2024 to February 2025. To quantify this, we compute the average per capita exposure to CSI level 2 or higher for people in 220 countries. We also compute citywide CSI signals for 940 cities.

RESULTS

1. More than one in five people globally felt a strong climate change influence each day

- At least 1.8 billion people (22% of the global population) experienced temperatures made at least twice as likely because of climate change (CSI level 2 or higher) every day from Dec. 1, 2024, to Feb. 28, 2025. In other words, they experienced temperatures *strongly* influenced by climate change all season long.

- Global exposure peaked on Feb. 28, 2025, when 3 billion people (37% of the global population) experienced temperatures strongly influenced by climate change (CSI level 2 or higher).

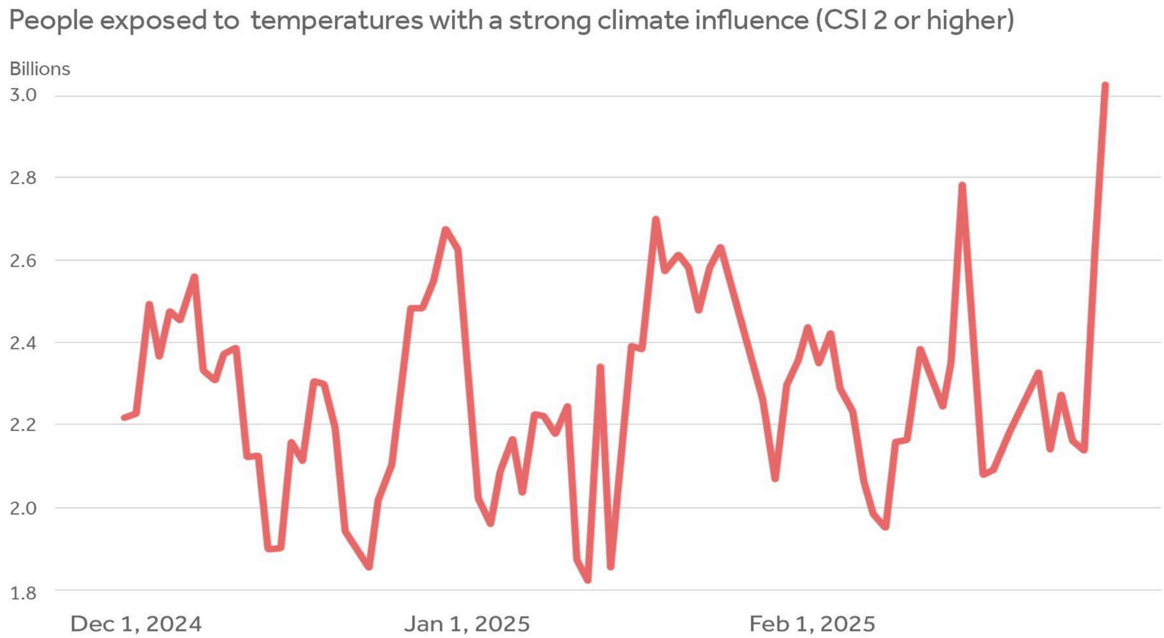


Figure 1. Daily global population exposed to temperatures with a Climate Shift Index (CSI) level 2 or higher during the period of analysis (Dec. 1, 2024, to Feb. 28, 2025). Analysis based on ECMWF ERA5 data. Produced March 6, 2025.

2. Climate change increased risky heat — especially in Africa

Risky heat days are days with temperatures hotter than 90% of temperatures observed in a local area over the 1991-2020 period, also referred to as temperatures above the 90th percentile (see ***Risky Heat Days*** box below).

For this analysis, we first counted the number of days with temperatures above the 90th percentile from Dec. 1, 2024, to Feb. 28, 2025. We then used the CSI system to calculate the number of risky heat days that would have occurred without human-caused climate change (i.e., in a counterfactual scenario). Finally, we subtracted the number of times the counterfactual temperatures exceeded this level to determine the number of risky heat days caused by climate change.

- The average person on the planet experienced six days of risky heat from December 2024 to February 2025. This analysis shows that **human-induced climate change added five risky heat days** to the average person's experience during this time period. Without climate change, the average person's exposure to risky heat would have been only one day during the last three months.

- More than **394 million people experienced 30 or more days of risky heat added by climate change** during the last three months — most of these people (293 million or 74%) live in Africa (Table 1).

- Countries across Africa and Oceania experienced the most risky heat days added by climate change from December 2024 to February 2025 (Figure 2 and Table 2).

- Explore the **full dataset** or **interactive maps** for details on specific countries with risky heat days added by climate change.

Risky Heat Days

Risky heat days are days with temperatures hotter than 90% of temperatures observed in a local area over the 1991-2020 period. Heat-related health risks rise when temperatures climb above this local threshold. This is a conservative approximation of the local minimum mortality temperature (MMT), an indicator of the local links between temperature and mortality based on peer-reviewed research by Tobias et al. (2021) and Gasparrini et al. (2015).

A location's MMT is the daily average temperature at which the risk of heat-related death is lowest. The relative risks of heat-related illness and mortality increase steeply as temperatures climb above the local MMT because people are not used to or cannot cope with these temperatures.

MMTs vary across climatic zones because health-related heat thresholds depend on the local climate and related long-term adaptation among local populations. MMTs are generally higher in the temperature distribution in temperate and continental climates and lower in arid and tropical climates. See ***Methodology*** below for details.

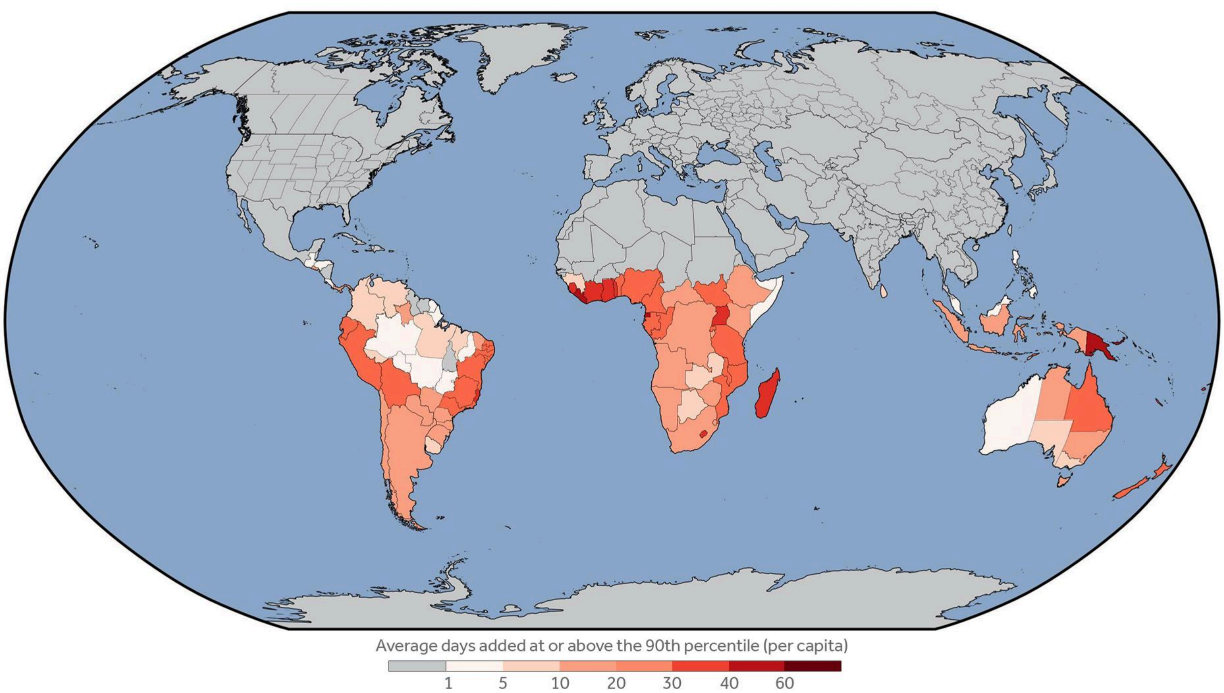


Figure 2. Additional days, from Dec. 1, 2024, to Feb. 28, 2025, with temperatures above the 90th percentile (risky heat days), added by climate change. Presented as per capita averages for countries and states. Analysis based on ECMWF ERA5 data and the Climate Shift Index (CSI) system. Produced March 6, 2025.

Continent	Country	People exposed to 30+ days of risky heat (% of country population)	People exposed to 30+ days of risky heat added by climate change (% of country population)
Africa	Nigeria	104.2 million (46%)	77.5 million (34%)
Asia	Indonesia	48.6 million (17%)	45.1 million (16%)
Africa	Democratic Republic of the Congo	34.6 million (30%)	29.3 million (25%)
Africa	Uganda	35.2 million (75%)	28.4 million (60%)
Africa	Ghana	26.1 million (79%)	25.1 million (77%)
Africa	United Republic of Tanzania	23.7 million (36%)	22.1 million (34%)
Africa	Côte d'Ivoire	22.5 million (70%)	20.8 million (65%)
South America	Brazil	56.1 million (27%)	19.6 million (10%)
Africa	Madagascar	27.4 million (89%)	19.3 million (63%)
Oceania	Papua New Guinea	13.5 million (99%)	13.4 million (99%)
Africa	Cameroon	14.3 million (52%)	11.9 million (44%)

Table 1. Countries with the most people exposed to risky heat days added by climate change during the period of analysis (Dec. 1, 2024, to Feb. 28, 2025). Analysis based on ECMWF ERA5 data and the Climate Shift Index (CSI) system.

Continent	Country	Days of risky heat	Days of risky heat added by climate change
Africa	Comoros	57	52
Oceania	Solomon Islands	57	49
Oceania	Papua New Guinea	51	47
Africa	Liberia	54	45
Oceania	Vanuatu	52	44
Africa	Equatorial Guinea	42	42
Oceania	Federated States of Micronesia	43	41
Oceania	Tuvalu	41	41
Africa	Ghana	43	40
Africa	Mauritius	52	36

Table 2. Countries with the most risky heat days added by climate change during the period of analysis (Dec. 1, 2024, to Feb. 28, 2025). Analysis based on ECMWF ERA5 data and the Climate Shift Index (CSI) system.

3. Countries with unusual heat made twice as likely by climate change

We analyzed daily temperatures in 220 countries to understand where there was unusual heat and how climate change influenced those temperatures.

- In half of the analyzed countries (110 out of 220), the average person experienced daily temperatures with a *strong* influence of climate change for at least one-third of the last three months (Table 3).

- Notably, about **84% of all people in South America** and **69% of all people in Africa** experienced **at least 30 days** at the CSI level 2 during the last three months.

- Explore the **full dataset** or **interactive maps** for details on specific countries across six continents.

Continent	Countries with days at CSI 2 or higher for 30+ days	Country with most days at CSI 2 or higher	Continent-wide population exposed to 30+ days at CSI 2 or higher
Africa	36 out of 54	Rwanda (87 days)	1.0 billion (69%)
Asia	10 out of 51	Brunei (83 days)	554 million (12%)
Europe	4 out of 43	Malta (34 days)	550,000 (1%)
North America*	31 out of 37	Jamaica (89 days)	221 million (36%)
South America	10 out of 13	Suriname (78 days)	364 million (84%)
Oceania	19 out of 22	Commonwealth of the Northern Mariana Islands (USA) (87 days)	17 million (61%)

Table 3. Summary of countries where the average person experienced the most days with temperatures at CSI 2 or higher (per capita average) from Dec. 1, 2024, to Feb. 28, 2025. All CSI values refer to daily average temperature. *Includes Central America and the Caribbean. Analysis based on ECMWF ERA5 data.

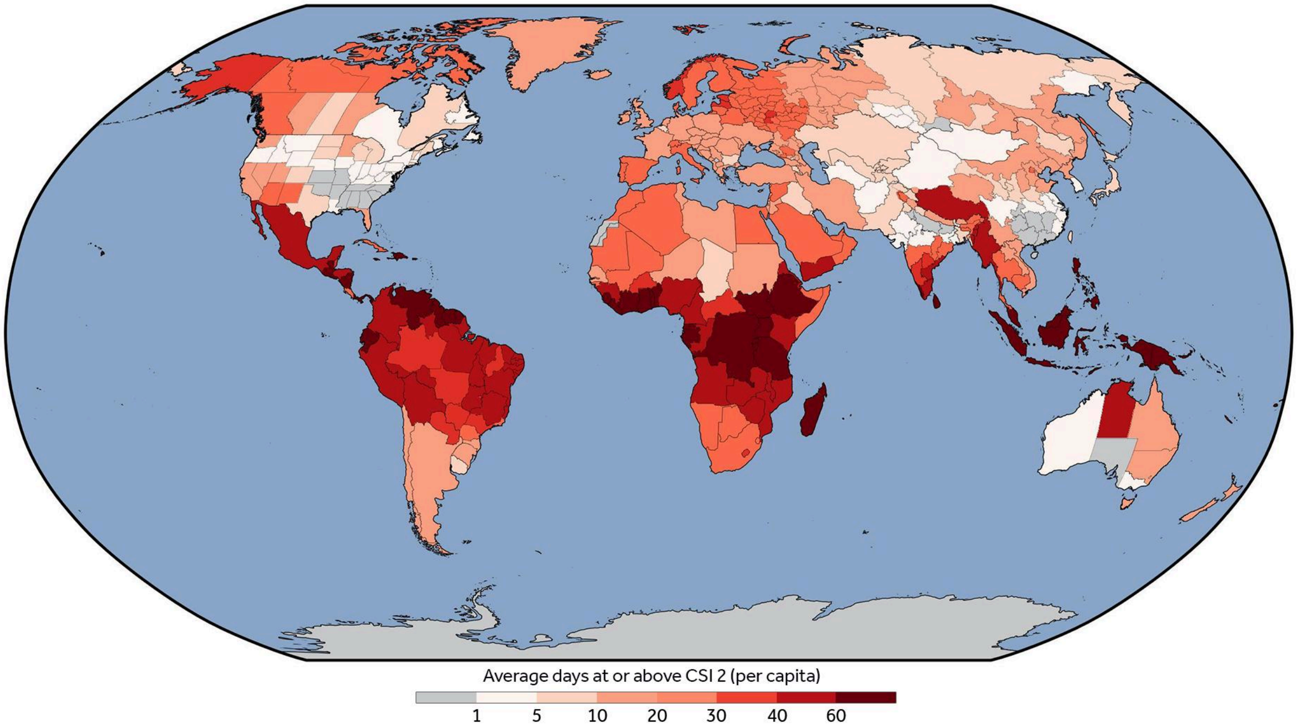


Figure 3. Number of days with temperatures made twice as likely by climate change (CSI 2 or higher) during Dec. 1, 2024, to Feb. 28, 2025. Presented as per capita averages for countries and states. Analysis based on ECMWF ERA5 data and the Climate Shift Index (CSI) system. Produced March 6, 2025.

4. Global cities with unusual heat boosted by climate change

We analyzed daily temperatures in 940 global cities to understand where there was unusual heat and how climate change influenced those temperatures. The cities in Table 4 experienced the most days this season with a CSI 2 or higher.

- In 287 global cities (of 940 analyzed), the average person experienced a *strong* influence of climate change for one-third of the season (30 days or more).

Continent	City	Country	Days at CSI 2 or higher	Seasonal temperature anomaly (°C)
Africa	Saint-Denis	Reunion	90	0.8
Africa	Freetown	Sierra Leone	90	0.7
South America	Caracas	Venezuela	90	1.0
South America	Barquisimeto	Venezuela	90	1.0
North America	Kingston	Jamaica	90	1.0
North America	Davy Hill	Montserrat	89	0.8

North America	Brades	Montserrat	89	0.8
North America	Plymouth	Montserrat	89	0.8
Africa	Lagos	Nigeria	89	1.0
North America	San Juan	United States	89	0.9

Table 4. Global cities with the most number of days with a strong (CSI 2 or higher) climate influence on average daily temperatures (Dec. 1, 2024, to Feb. 28, 2025), alongside each city's average seasonal temperature anomaly during this time period. Analysis based on ECMWF ERA5 data.

4.1. Global megacities

Cities are hotspots of heat risk due to their high population density and land development patterns that intensify heat in urban heat islands. This is especially true for the world's largest cities. The analysis includes 38 megacities — cities with populations over 10 million.

- Of those 38 megacities, 11 (with a combined population of more than 210 million) endured heat that was *strongly* influenced by climate change (CSI level 2 or higher) for at least one-third of the season (30 days or more) (Table 5).

Continent	Megacity	Country	Days at CSI 2 or higher	Seasonal temperature anomaly (°C)
Africa	Lagos	Nigeria	89	1.0
Asia	Tamil Nadu	India	81	1.0
Asia	Manila	Philippines	69	0.4
Asia	Jakarta	Indonesia	69	0.7
Africa	Kinshasa	Democratic Republic of the Congo (Kinshasa)	57	0.6
North America	Ciudad de México	Mexico	49	0.5
Asia	Maharashtra	India	36	1.2
Asia	Telangana	India	36	0.8
South America	São Paulo	Brazil	34	0.4
Asia	Tehran	Iran	34	1.6
Asia	Karnataka	India	31	0.7

Table 5. Global megacities with temperatures at CSI 2 or higher for at least 30 days during the season analyzed (Dec. 1, 2024, to Feb. 28, 2025), alongside the city's average seasonal temperature anomaly during this time period. All CSI values refer to average daily temperature. Analysis based on ECMWF ERA5 data.

4.2. U.S. cities

- Around 45% of U.S. cities analyzed (110 of 247) experienced average temperatures that were normal or warmer-than-normal (i.e., with an anomaly greater than or equal to 0) during the Northern Hemisphere winter (Table 6).

- Fourteen U.S. cities — primarily located in western regions — experienced at least **three weeks' worth of days** with average temperatures made twice as likely by climate change (Table 7).

- Around three-quarters of U.S. cities (194) experienced at least one day at CSI level 2.

- Explore interactive maps for more data on U.S. states and cities, showing how this year's winter temperature anomaly ranks compared to the 1991-2020 average in each location.

City	State	Seasonal temperature anomaly (°C)	Days at CSI 2 or higher
Fairbanks	Alaska	4.6	8
Anchorage	Alaska	4.2	51
Flagstaff	Arizona	2.5	26
Juneau	Alaska	2.3	47
Grand Junction	Colorado	2.1	15
Salt Lake City	Utah	2.0	15

Table 6. U.S. cities with the highest average temperature anomalies from Dec. 1, 2024, to Feb. 28, 2025. All CSI levels refer to average temperature. Analysis based on ECMWF ERA5 data.

City	State	Days at CSI 2 or higher	Seasonal temperature anomaly (°C)
San Juan	Puerto Rico	89	0.9
Honolulu	Hawaii	77	1.0
Anchorage	Alaska	51	4.2
Juneau	Alaska	47	2.3
Prescott	Arizona	27	1.5

San Francisco	California	27	0.8
Flagstaff	Arizona	26	2.5
Tucson	Arizona	26	1.7
Albuquerque	New Mexico	25	1.4
San Jose	California	24	0.9
Phoenix	Arizona	23	1.3
Las Cruces	New Mexico	23	1.3
El Paso	Texas	23	1.3
Salinas	California	21	0.8

Table 7. U.S. cities with the most number of days at CSI 2 or higher from Dec. 1, 2024, to Feb. 28, 2025. Shown here are average temperature anomalies for this time period. All CSI levels refer to average temperature. Analysis based on ECMWF ERA5 data.

The Climate Shift Index (CSI)

Humans have caused global average temperatures to increase by 1.2°C (2.2°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 is grounded in peer-reviewed attribution science and was launched by Climate Central in 2022. The data is accessible via our free map tool — explore the map for temperatures today, tomorrow, and any day this past year.

The CSI scale is centered on zero. A CSI level of zero means that there is no detectable influence of human-caused climate change — 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 1.5 times more likely). CSI levels 2 and higher correspond with the multipliers (2 = at least 2 times more likely, 3 = at least 3 times more likely, etc.). 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 is 2 times less likely due to human-caused climate change.

Heat and Beyond: Impacts of extreme weather over the past 3 months

December 2024 was the second-warmest December on record, while January 2025 became the warmest January on record, surpassing the previous record set in 2024 by 0.05°C (.09°F). The impacts of climate change were felt all over the world — not only through extreme heat but also in the form of intense rainfall, destructive storms, and severe cyclones.

South America experienced multiple heat waves, fueling wildfires across **Chile** and Patagonia. **Uruguay**, **Paraguay**, and **Brazil** faced extreme heat, prompting rare heat alerts. While much of the continent baked under record temperatures, some regions suffered devastating floods. In **Brazil**, several rainstorms triggered catastrophic flooding and landslides, leading to multiple fatalities in Minas Gerais, Santa Catarina, Recife, and Maceió. **Peru**, **Ecuador**, and **Bolivia** endured weeks of heavy rain that caused rivers to overflow, forced residents to take shelter, and killed at least 50 people.

North America saw a series of extreme weather events. In the **United States**, California experienced deadly wildfires fueled by climate change, and subsequent storms led to life-threatening debris flows. Deadly floods in southern and eastern states claimed 16 lives. Parts of the country recorded the heaviest snowfall in at least a decade, while New Orleans experienced a once-in-a-lifetime winter storm. In **Canada**, Toronto struggled to clear snow after back-to-back storms.

Eastern Africa endured deadly cyclones, with Cyclone Chido claiming 24 lives and Cyclone Dikeledi killing another 11 people. **Madagascar's** capital was submerged as heavy rains flooded five regions, affecting over 16,000 people. In **Botswana**, flash floods forced school closures and disrupted transportation. Thousands of people living in informal settlements in **South Africa** were displaced by fires caused by excessively hot, dry, and windy conditions.

Europe experienced one of its warmest winters on record. In **Russia,** unseasonably warm temperatures in Moscow led to the early blooming of flowers. Western **France** endured its worst floods in decades, while the **United Kingdom** faced Storm Éowyn, the most powerful wind storm in over a decade, prompting rare red warnings. Just days after, Storm Herminia caused widespread disruption across the **United Kingdom, Portugal, France,** and **Italy**.

Asia also faced consecutive extreme rainfall events, leading to numerous fatalities. Cyclone Fengal claimed 20 lives in **Sri Lanka** and **India**, while severe floods killed another 30 people in **Malaysia** and **Thailand**. In southwest **China**, emergency teams scrambled to find 28 people missing after a landslide triggered by the rain. In **Indonesia**, torrential rains caused rivers to overflow, resulting in 21 deaths in Java Island. Northern **Japan** saw record snowfall, with 129 cm in 12 hours.

Australia was struck by multiple extreme weather events. Cyclone Sean, a category 4 storm, lashed the west coast, followed by Cyclone Zelia, which uprooted trees and forced port closure. Meanwhile, other parts of the country saw temperatures around 40°C (72°F), leading to a surge in hospitalizations.

METHODOLOGY

Calculating the Climate Shift Index
All Climate Shift Index (CSI) levels reported in this brief are based on daily average temperatures and ECMWF ERA5 data from Dec. 1, 2024, to Feb. 28, 2025. 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 2 or higher. We then used the proportion of population based on the Gridded Population of the World v4 estimate for 2020 living in each cell, summed over the globe where CSI values were 2 or higher, and then multiplied by the estimated global population of 8.2 billion to get an up-to-date estimate of the global population distribution and population exposure to CSI 2.

Country Analysis
The country-level analysis includes 220 countries and territories. It excludes entities that are smaller than 0.25°, the size of a grid cell.

For this analysis, we calculated the average temperature anomaly, number of days at or above CSI 2, and population exposure to CSI 2 (based on average temperature) over the Dec. 1, 2024, to Feb. 28, 2025, period. For each country, we then selected the data within its geographical boundary and found the population-weighted temperature anomaly and the population-weighted number of days at CSI level 2. Reported temperature anomalies are relative to each country's or region's 1991-2020 normal daily December, January, and February temperatures.

Where possible, population estimates were drawn from Encyclopedia Britannica. Other estimates were drawn from the Gridded Population of the World v4.

U.S. State Analysis
The state-level analysis includes 50 states and the District of Columbia in the United States. It excludes entities that are smaller than 0.25°, the size of a grid cell.

For this analysis, we calculated the temperature anomaly, number of days at or above CSI 2, and population exposure to CSI 2 (based on average temperature) over the Dec. 1, 2024, to Feb. 28, 2025, period. For each state, we then selected the data within its geographical boundary and found the population-weighted temperature anomaly and the population-weighted number of days at CSI 2. Reported temperature anomalies are relative to each state/province's 1991-2020 normal daily December, January, and February temperatures.

Population estimates were drawn from the Gridded Population of the World v4.

City Analysis
We analyzed 940 cities from around the world, drawn from simplemaps. These cities are cities with populations exceeding one million people and various U.S. cities. For each city, we found the CSI and temperature anomaly time series from the nearest 0.25° grid cell. We then computed the mean temperature anomalies over December 2024, January 2025, and February 2025 and the number of days at CSI level 2 (based on average temperature). Reported temperature anomalies are relative to each city's 1991-2020 normal daily December, January, and February temperatures. The entire list of cities and their statistics is available for download.

The cities identified in the text above were selected based on the intensity of the particular statistic as well as their population.

Risky Heat Days
The analysis of risky heat days considered days with temperatures hotter than 90% of temperatures observed in a local area over the 1991-2020 period. The 90th temperature percentile is a conservative approximation of the local minimum mortality temperature (MMT), an indicator of the local links between temperature and mortality. Tobías et al. (2021) estimated local MMT in 683 global locations using local temperature and mortality data and calculated the MMT percentile (MMTP) for each location, defined as "the percentile of the temperature distribution corresponding to the MMT." The MMTP varies globally. Across countries, MMTPs ranged from the 5th to the 99th percentile. Across climatic zones, MMTPs generally decreased from temperate climates (80th percentile) to continental (75th), arid (68th), tropical (59th), and alpine (41st) climates. This is broadly consistent with an earlier study (Gasparrini et al. (2015)) that found that the MMT percentile ranged from approximately the 60th percentile in the tropics to the 80th-90th percentile in temperate regions.

To find the days added by climate change above various thresholds, we calculated counterfactual temperatures. A counterfactual temperature is an estimate of the temperature a location would have experienced in a world without climate change. We used the probabilistic underpinning of our CSI model by finding the probability of meeting or exceeding an observed temperature in today's climate and finding the temperature with the same probability in a world without climate change. This is the counterfactual temperature. Then, for each day and each location, we checked if the counterfactual temperature was below the threshold and if the observed temperature was above the threshold. If both of these conditions were met, we qualified that day as a day above that threshold added by climate change.

REPORT CONTRIBUTIONS

Analysts: Joseph Giguere (lead), Kaitlyn Trudeau (Observable data visualization)
Writer: Raina DeFonza
Editors: Arielle Tannenbaum, Kristina Dahl, Abbie Veitch
Designer: Megan Martin

Climate Central is an independent group of scientists and communicators who research and report the facts about our changing climate and how it affects people's lives. Climate Central is a policy-neutral 501(c)(3) nonprofit.

Major funding provided by the Bezos Earth Fund