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Climate Change and Extreme Heat

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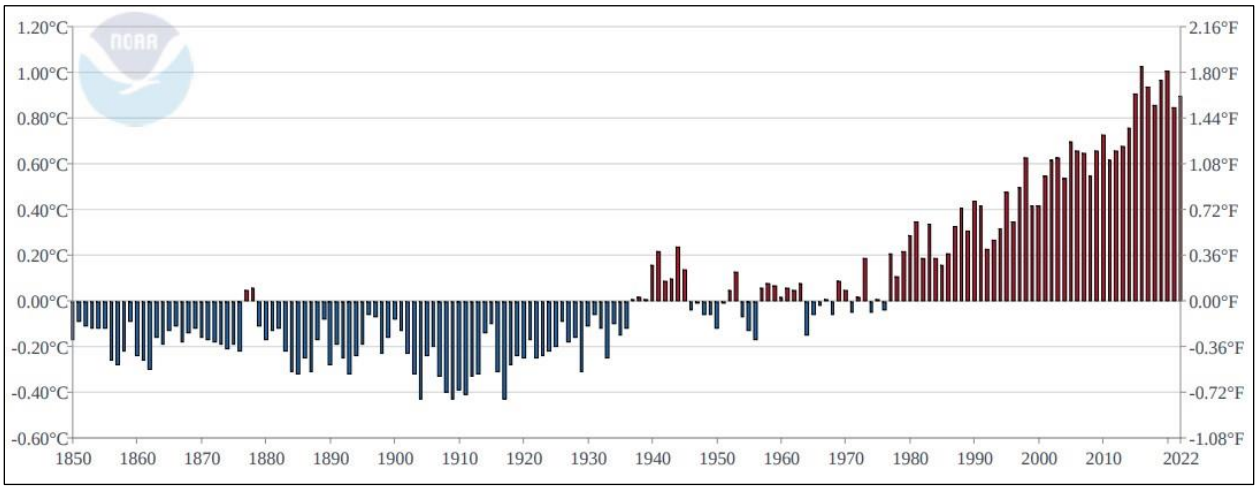
The United States experienced a series of record-breaking heat waves during the summer of 2023. The heat waves brought extreme temperatures to various U.S. regions, including Puerto Rico, the southern Plains, and the Northeast and Mid-Atlantic states, with life threatening conditions in some areas.

These heat waves are part of a trend of rising global temperatures. The National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) maintain datasets of global average surface temperatures. According to these datasets, as of January 2023, the warmest years since the advent of modern recordkeeping occurred in 2010-2022, with 2016 and 2020 tied (i.e., statistically indistinguishable) as the warmest years on record (**Figure 1**).

Figure 1. Global Average Temperature Anomalies 1850-2022



Source: NOAA, National Centers for Environmental information, Climate at a Glance: Global Time Series.
Note: Global average temperature anomalies calculated as deviations from the 1901-2000 baseline average.

Independently developed global temperatures datasets that differ from the NASA and NOAA datasets in duration and methodology, including analyses using different baseline reference temperatures, show close agreement (**Figure 2**) with respect to global temperatures and trends.

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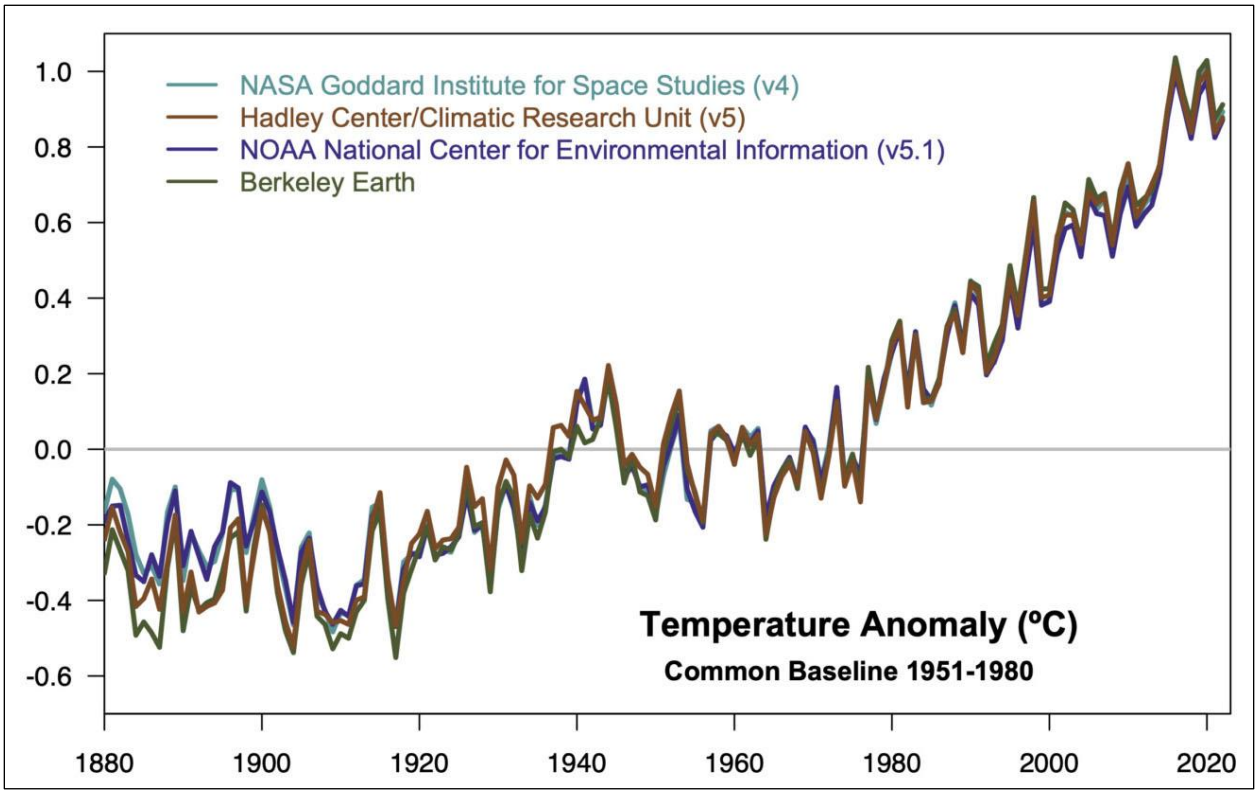
Figure 2. Global Average Temperatures Anomalies: Four Independent Datasets



Source: Alan Buis, "The Raw Truth on Global Temperature Records," National Aeronautics and Space Administration (NASA), March 25, 2021, https://climate.nasa.gov/explore/ask-nasa-climate/3071/the-raw-truth-on-global-temperature-records/.

Note: Global average temperature difference from a baseline reference average value (1951-1980).

The Connection Between Human-Influenced Climate Change and Extreme Heat

The observed rising global temperatures are associated with increasingly frequent and intense climate change impacts, including extreme high temperatures and periods of abnormally hot weather known as *heat waves*. The Intergovernmental Panel on Climate Change (IPCC) *Sixth Assessment Report* states (with associated confidence levels) the following:

> The frequency and intensity of hot extremes (including heatwaves) have increased, and those of cold extremes have decreased on the global scale since 1950 (virtually certain).

Climate change attribution is the study of whether, or to what degree, human influence may have contributed to extreme climate or weather events. Some climate change attribution studies of extreme heat events in the United States from 2011 to 2014 have attributed increases in the frequency or intensity of these extreme heat events to human-influenced climate change. Human-driven emissions of greenhouse gases are likely to be the cause of the increased temperatures that have been associated with these extreme heat events. The U.S. Global Change Research Program (USGCRP) Fourth National Climate Assessment (NCA4) states, "It is extremely likely that human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century." Similarly, the IPCC Sixth Assessment Report states that "human-induced greenhouse gas forcing is the main driver of the observed

changes in hot and cold extremes on the global scale (virtually certain) and on most continents (very likely)."

Climate Change and Estimates of Future Extreme Heat

The NCA4, using scenarios of greenhouse gas emissions and climate policies, states that "statistically significant warming is projected for all parts of the United States throughout the century." This warming is part of the ongoing, observed global increase in average temperature discussed above. Researchers measure this increase by comparing the current and projected global average temperatures with a historical period before large-scale industrialization, such as 1850-1900 (pre-industrial period). The estimated warming level in June 2023 was 1.2°C (2.2°F), indicating that the global temperature has risen 1.2°C (2.2°F) since the pre-industrial period. The Paris Agreement climate treaty recognizes that limiting warming to 1.5°C (2.7°F) reduces climate change risk and impacts. The IPCC estimates warming may reach the 1.5°C (2.7°F) level between 2030 and 2052.

Increases in global average temperature affect the way the climate behaves, including the incidence of heat extremes. While there is no universally agreed on definition of extreme heat, one IPCC metric is the average annual number of days in which temperatures exceed thresholds of 35°C (95°F) and 40°C (104°F), compared with a 1986-2005 baseline period. These temperature thresholds have been associated with adverse impacts on agriculture and human health.

In models presented by the IPCC, the average annual number of extreme heat days for geographic regions containing the United States would increase under global warming potentially occurring during the 21st century. Estimates of extreme heat associated with global warming may change with scientific developments.

Considerations for Congress

The 117th Congress passed the legislation known as the Inflation Reduction Act and the Infrastructure Investment and Jobs Act, which, among other goals, aimed to address extreme heat by reducing climate-changing greenhouse gas emissions. Example activities included

- enhancing electricity grid resilience,
- reducing the impacts on transportation infrastructure, and
- reducing urban heat islands.

Members of the 118th Congress have expressed interest in addressing the health effects of extreme heat and improving the preparation and response to heat waves and other extreme heat events.

The Biden Administration has announced activities to address extreme heat, which are subject to congressional oversight. They include the formation of the National Integrated Heat Health Information System, a collaborative effort by the Centers for Disease Control and Prevention (CDC), NOAA, and other federal agencies, as well as activities funded under the Inflation Reduction Act that include grants to increase urban green spaces, loans to upgrade residences to provide protection from extreme heat, and improvements to extreme heat forecasting by NOAA.

Author Information

Jonathan D. Haskett
Analyst in Environmental Policy

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