Weather Extremes Series: Quarterly Global Warming Report

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Quarterly Global Warming Report

January 2026

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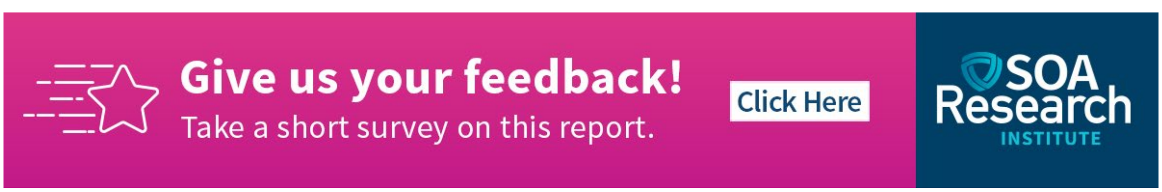
Contents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Quarterly Global Warming Report

January 2026

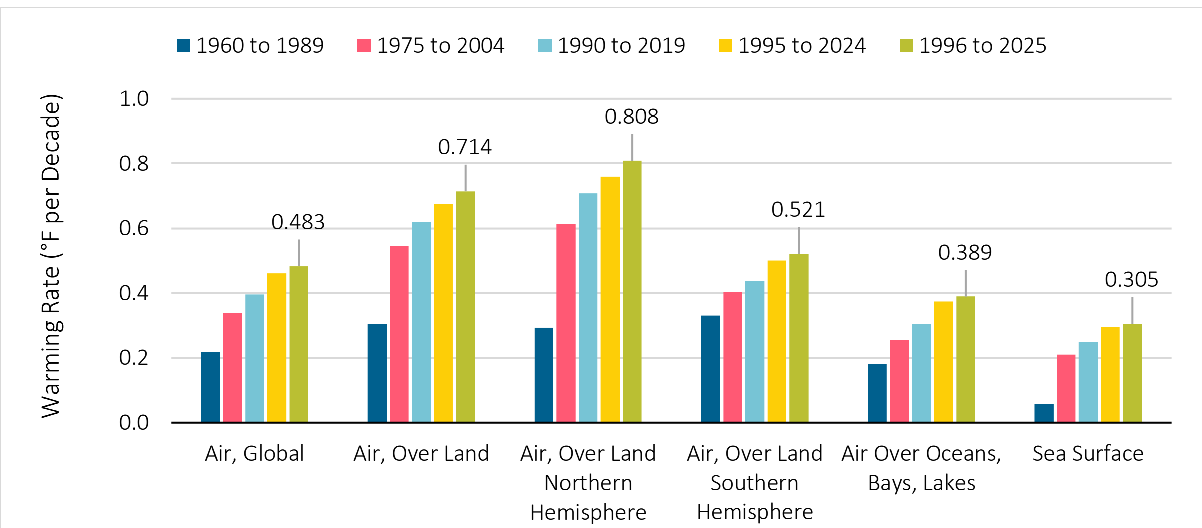
Executive Summary

This report presents a statistical analysis of global warming trends and is updated quarterly to reflect the latest available air and sea surface temperature data. The previous edition analyzed data from January 1960 through September 2025; this update extends the analysis through December 2025. All results are based on the ERA5 reanalysis dataset produced by the European Centre for Medium-Range Weather Forecasts (ECMWF).

A key metric in this report is the estimated temperature trend, expressed in degrees Fahrenheit per decade and calculated using linear regression over rolling 30-year periods. Thirty years is widely regarded as sufficient to smooth the effects of short-term climate variability—such as El Niño and La Niña events—that can temporarily influence global temperatures. Figure 1 summarizes estimated trends across successive 30-year periods for global air temperature (average across Earth's entire surface), air temperature over land, and sea surface temperature. Confidence intervals associated with these results are presented in the main body of the report.

Figure 1

TEMPERATURE TRENDS ESTIMATED USING LINEAR REGRESSION ACROSS 30-YEAR PERIODS



Trend Unit = Degrees Fahrenheit Increase per Decade

Key observations from Figure 1 include:

- Estimated warming rates have increased across successive 30-year periods, consistent with an acceleration in global warming. For the most recent 30-year period, the estimated trend in global air temperature is approximately 0.48°F per decade.
- The warming rate over land exceeds that of sea surface temperature, consistent with the greater heat capacity of water (relative to air) and the vertical mixing of heat within the ocean.
- Due in part to hemispheric differences in land-ocean distribution, land areas in the Northern Hemisphere are warming at a faster rate than those in the Southern Hemisphere.

Later sections of this report show that, within the Northern Hemisphere, warming rates are strongly correlated with latitude, with the fastest warming observed in the Arctic region.

Global Air Temperature Trends: Point Estimates and Confidence Intervals

Figure 2 shows changes in Earth's global average air temperature over time. The overall pattern indicates a warming trend, but temperatures also rise and fall naturally from year to year. This natural variability can obscure the underlying long-term trend and make precise estimation more challenging. In addition, the rate of warming may vary over time. The solid line in Figure 2 shows the linear trend (estimated using linear regression) over 1960–1989, with the dotted extension illustrating how temperatures would have evolved if that earlier trend had continued. Observed temperatures from 2001 onward lie above this extension, providing a visual indication that warming in recent decades has been higher than would be expected based on the earlier trend. Because warming trends cannot be precisely quantified and may change over time, this report estimates temperature trends over successive 30-year periods and shows the associated uncertainty around each estimate (Figure 3).

Figure 2
ANNUAL AVERAGE GLOBAL TEMPERATURE WITH ILLUSTRATIVE 30-YEAR TREND AND EXTENSION

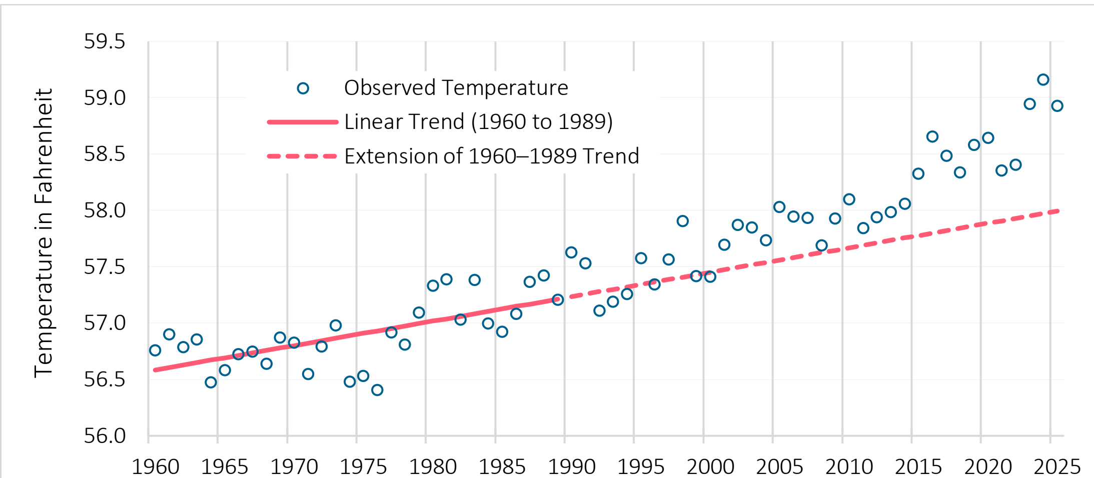
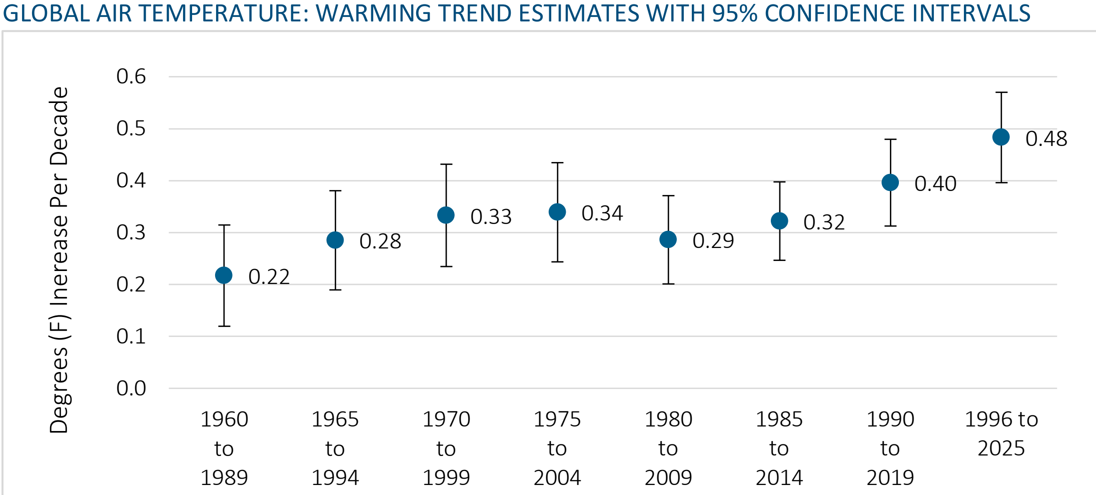


Figure 3
GLOBAL AIR TEMPERATURE: WARMING TREND ESTIMATES WITH 95% CONFIDENCE INTERVALS



Trend Unit = Degrees Fahrenheit Increase per Decade. The vertical bars represent 95% confidence intervals derived from linear regression, while dots indicate the corresponding point estimates.

The confidence intervals shown in Figure 3 overlap substantially. This overlap is expected because the trend estimates are based on successive 30-year periods that share many of the same underlying temperature observations. As a result, adjacent trend estimates are correlated rather than independent. Overlap among the confidence intervals should not be interpreted as evidence that warming trends are unchanged or statistically indistinguishable; instead, the estimates should be viewed collectively as describing the evolution of warming rates over time.

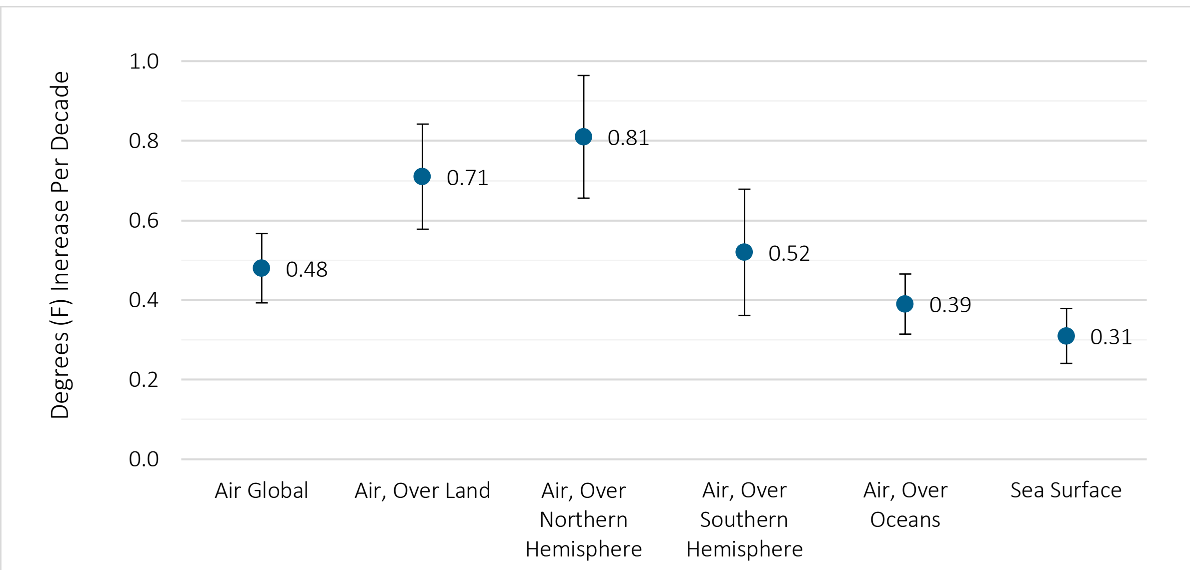
Air and Ocean Temperature Trends (1996 to 2025)

The previous section focused on average air temperature across Earth's entire surface. However, warming is not uniform across locations; some broad zones are warming more rapidly than others. For the 30-year period from 1996 to 2025, Figure 4 presents linear-regression-based temperature trend estimates for the following zones:

- Air temperature over land (representing approximately 30% of Earth's surface)
- Air temperature over land in the Northern Hemisphere (about 20% of Earth's surface)
- Air temperature over land in the Southern Hemisphere (about 10% of Earth's surface)
- Air temperature over water (oceans, seas, bays, and lakes), representing approximately 70% of Earth's surface
- Sea surface temperature

Figure 4

TEMPERATURE TREND ESTIMATES AND 95% CONFIDENCE INTERVALS BY SURFACE TYPE AND REGION (1996-2025)



Trend Unit = Degrees Fahrenheit Increase per Decade. The vertical bars represent 95% confidence intervals derived from linear regression, while dots indicate the corresponding point estimates.

The results in Figure 4 indicate that average air temperature is increasing at a significantly faster rate than sea surface temperature (SST). In addition, air temperature over land is increasing at a faster rate than air temperature over water. Lastly, with respect to air temperature over land, the Northern Hemisphere is warming at a faster rate than the Southern Hemisphere.

A key reason these zones exhibit different warming rates is the fundamental difference in how land and water respond to incoming energy from the sun and changes in Earth's energy balance. Land surfaces warm more quickly than oceans because water has a much higher heat capacity and can absorb and mix heat more deeply, whereas land warms and cools more rapidly for the same energy input, which in turn drives faster warming of the air above land surfaces. Water's high heat capacity and vertical mixing mean that a greater proportion of energy input goes into increasing the heat content of the upper ocean rather than raising surface temperature, while land's lower heat capacity leads to larger surface temperature changes for a given amount of energy. This basic thermal contrast is a robust feature of both observations and climate model simulations of global warming and contributes to the land–ocean warming contrast seen in Figure 4.[1]

The Northern Hemisphere warms faster than the Southern Hemisphere in part because it contains a much larger fraction of land (nearly 40% of the Northern Hemisphere is land, versus less than 20% in the Southern Hemisphere). With more land area subject to the same global radiative forcing, the Northern Hemisphere exhibits a stronger averaged surface warming signal relative to the more ocean-dominated Southern Hemisphere. Studies of hemispheric temperature differences suggest that land–ocean distribution and associated climate feedbacks are among the factors that influence this asymmetry in warming trends.

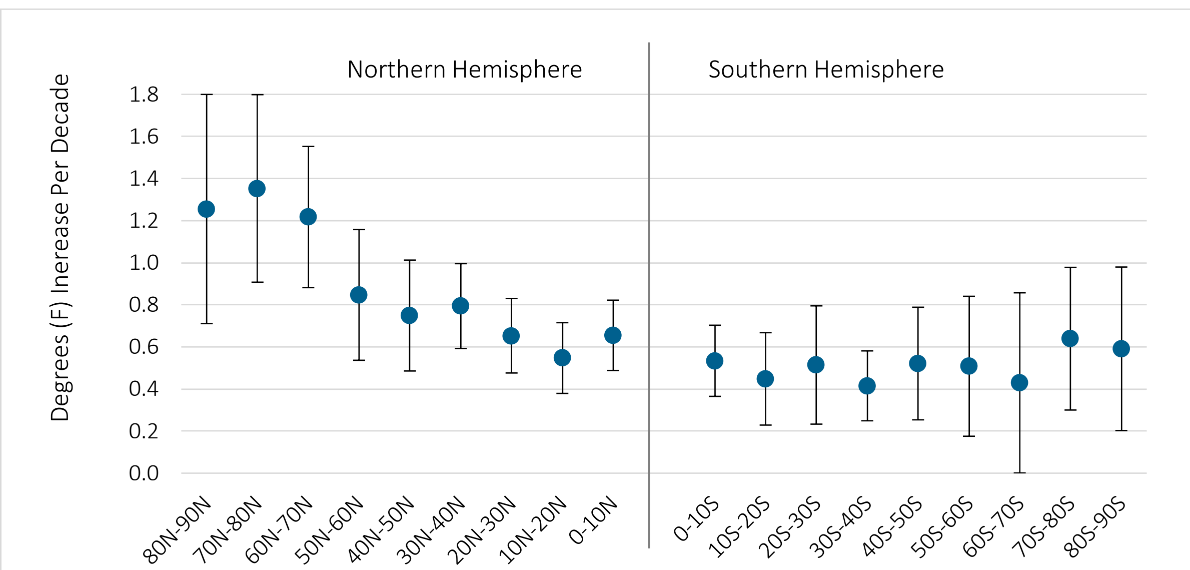
Air Temperature Trends for Land Areas, by Latitude (1996 to 2025)

As discussed in the prior section of the report, the Northern Hemisphere is warming at a faster rate than the Southern Hemisphere. To examine more closely the relationship between latitude and the rate of warming, this analysis partitions the Earth's land surface into 10-degree latitude bands. The first band covers latitudes from 80°N to 90°N, the second from 70°N to 80°N, and so on, resulting in nine latitude bands in each hemisphere. For each latitude band, a linear regression was applied to estimate the band's average air temperature (over land areas) from 1996 to 2025; results are shown in Figure 5.

Figure 5

TEMPERATURE TREND ESTIMATES AND 95% CONFIDENCE INTERVALS FOR LAND AREAS, BY LATITUDE BAND (1996-2025)

(Trend Unit = Degrees Fahrenheit Increase per Decade)



Trend Unit = Degrees Fahrenheit Increase per Decade. The vertical bars represent 95% confidence intervals derived from linear regression, while dots indicate the corresponding point estimates.

[1] Readers interested in additional background may refer to See Wallace, C. & Joshi, M. (2018). "Comparison of land–ocean warming ratios in updated observed records and CMIP5 climate models," Environmental Research Letters, 13(11), 114012. https://doi.org/10.1088/1748-9326/aae46f. This is an open-access study showing that observed surface warming over land exceeds that over oceans in both observational records and climate model simulations.

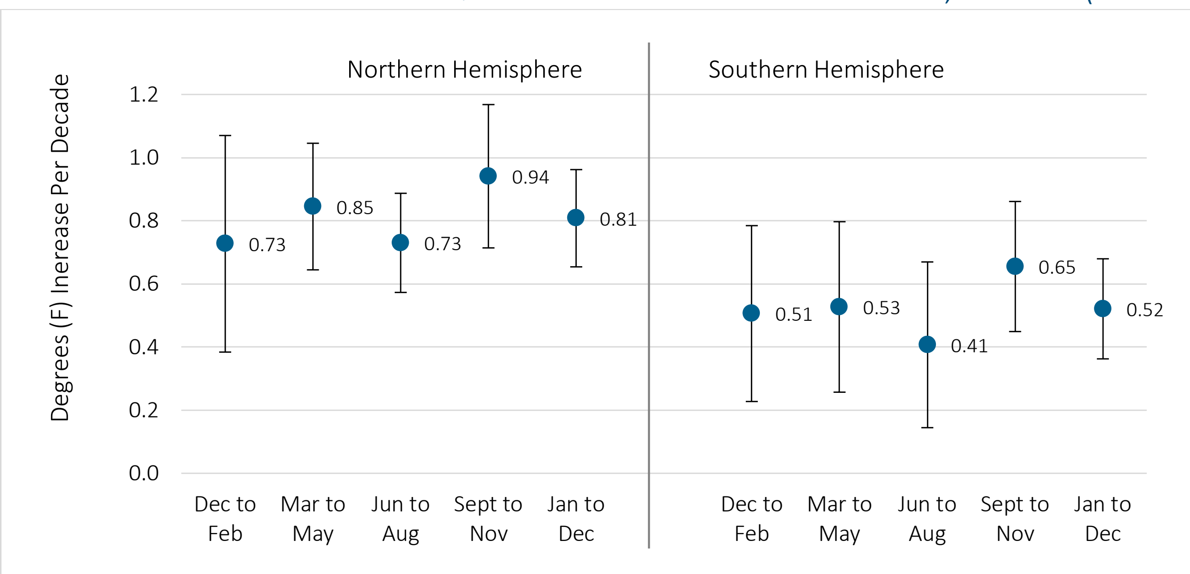
Figure 5 reveals a strong gradient in warming rates across the Northern Hemisphere, with the northernmost latitudes warming more rapidly than the mid-latitudes, and the mid-latitudes warming more rapidly than areas near the equator. By contrast, differences in warming rates across latitude bands in the Southern Hemisphere are less pronounced.

Air Temperature Trends for Land Areas, by Season (1996 to 2025)

The prior sections of this report presented temperature trends estimated from annual time series in which each observation reflects temperature averaged across all 12 calendar months. However, seasonal differences may exist in warming rates. To investigate this possibility, the underlying monthly data were compiled into seasonal time series with each observation equal to the temperature averaged across a three-month period. Seasons were defined as follows: December to February, March to May, June to August, and September to November. Separate seasonal time series for 1996 to 2025 were compiled for the Northern and Southern Hemispheres, and only land areas were included. Each seasonal time series was analyzed using linear regression, and the results are shown in Figure 6.

Figure 6

TEMPERATURE TREND ESTIMATES AND 95% CONFIDENCE INTERVALS FOR LAND AREAS, BY SEASON (1996–2025)



Trend Unit = Degrees Fahrenheit Increase per Decade. The vertical bars represent 95% confidence intervals derived from linear regression, while dots indicate the corresponding point estimates.

Figure 6 shows that seasonal land temperature warming rates vary across the year in both hemispheres, with higher estimated trends observed during late-year and spring seasons. Across all seasons, warming rates are consistently higher in the Northern Hemisphere than in the Southern Hemisphere, and this hemispheric difference is evident in both the central estimates and their associated confidence intervals. While estimated warming rates vary across seasons, the associated confidence intervals overlap, indicating that seasonal differences should be interpreted as descriptive patterns rather than statistically distinct estimates.

Appendix

A DATA SPREADSHEET ACCOMPANIES THIS REPORT

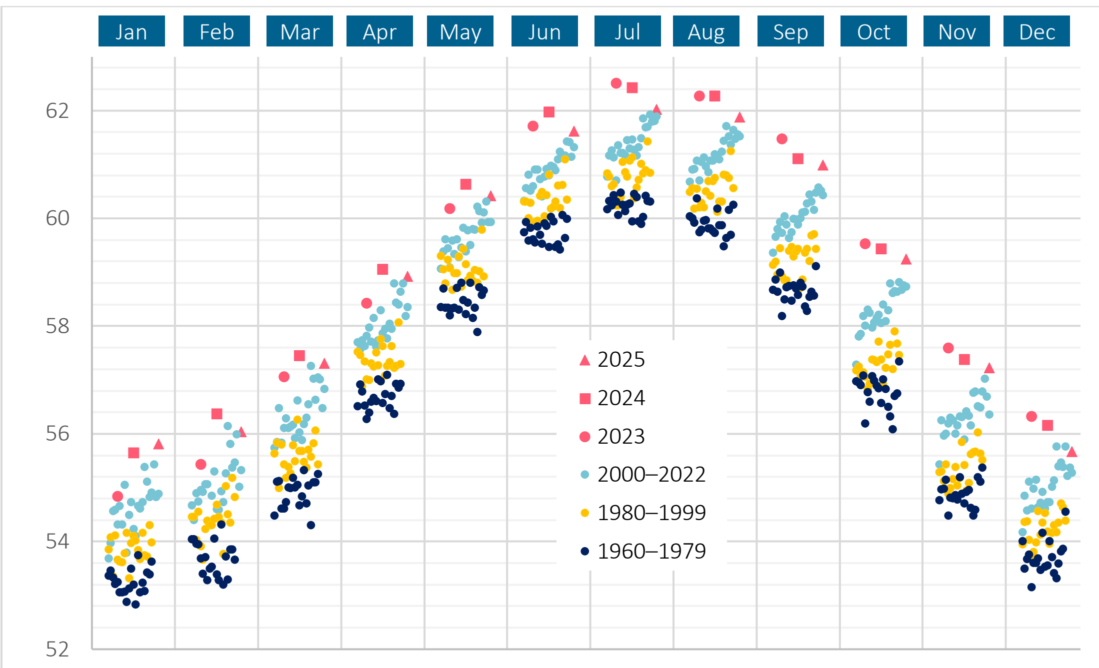
Detailed numerical results underlying the figures in this report are available in a downloadable Excel file that accompanies this publication.

GLOBAL AVERAGE MONTHLY AIR TEMPERATURE

Figure A1 is provided for context and illustrates the monthly time series of global average air temperature. Unlike the figures in the main body of this report, which focus on long-term temperature trends, Figure A1 highlights the seasonal variability present in the underlying temperature data.

Figure A1

GLOBAL AVERAGE AIR TEMPERATURE (°F) BY MONTH



In 2023 and 2024, record-high global temperatures occurred in 13 consecutive months. In 2025, global average air temperature was slightly below its prior record-highs.

It is useful to briefly describe the seasonal cycle in global average air temperature illustrated in Figure A1. At first glance, this seasonality may appear counterintuitive, as the Earth receives approximately the same total amount of solar energy each day over the course of a year. When the Northern Hemisphere experiences fall and winter, the Southern Hemisphere experiences spring and summer, and vice versa, suggesting that seasonal changes in one hemisphere should be offset by opposing changes in the other. However, because the Northern Hemisphere contains more than two-thirds of the Earth's land mass—and because land heats and cools more rapidly than water—global average air temperature reflects a strong imprint of the Northern Hemisphere's seasonal temperature cycle.

SPATIAL AVERAGING AND LATITUDE WEIGHTING

For this report, global air temperature was calculated by averaging data across Earth's entire surface. To calculate average sea surface temperature, latitudes north of 60°N and south of 60°S were excluded—a convention commonly used in climate analyses. This approach focuses on the open ocean and provides a more stable representation of long-term warming trends.

ERA5 grid points are evenly spaced with respect to degrees of latitude and longitude, but they are not evenly spaced when measured in miles or kilometers. As one approaches the poles, lines of longitude converge, reducing the distance between grid points. Consequently, an unweighted global average across grid points would result in the overweighting of data near the North and South Poles.

The standard remedy used by climate scientists—and the approach used for the analysis presented in this report—is to weight each data point by the cosine of its latitude. At the equator, the resulting weight is 1.0; at 45 degrees north or south, the weight is approximately 0.71; at 60 degrees north or south, the weight is 0.50, declining toward zero as latitude approaches either pole. This decline counterbalances the increasing density of grid points at high latitudes, resulting in an even spatial weighting across the surface of the Earth.

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