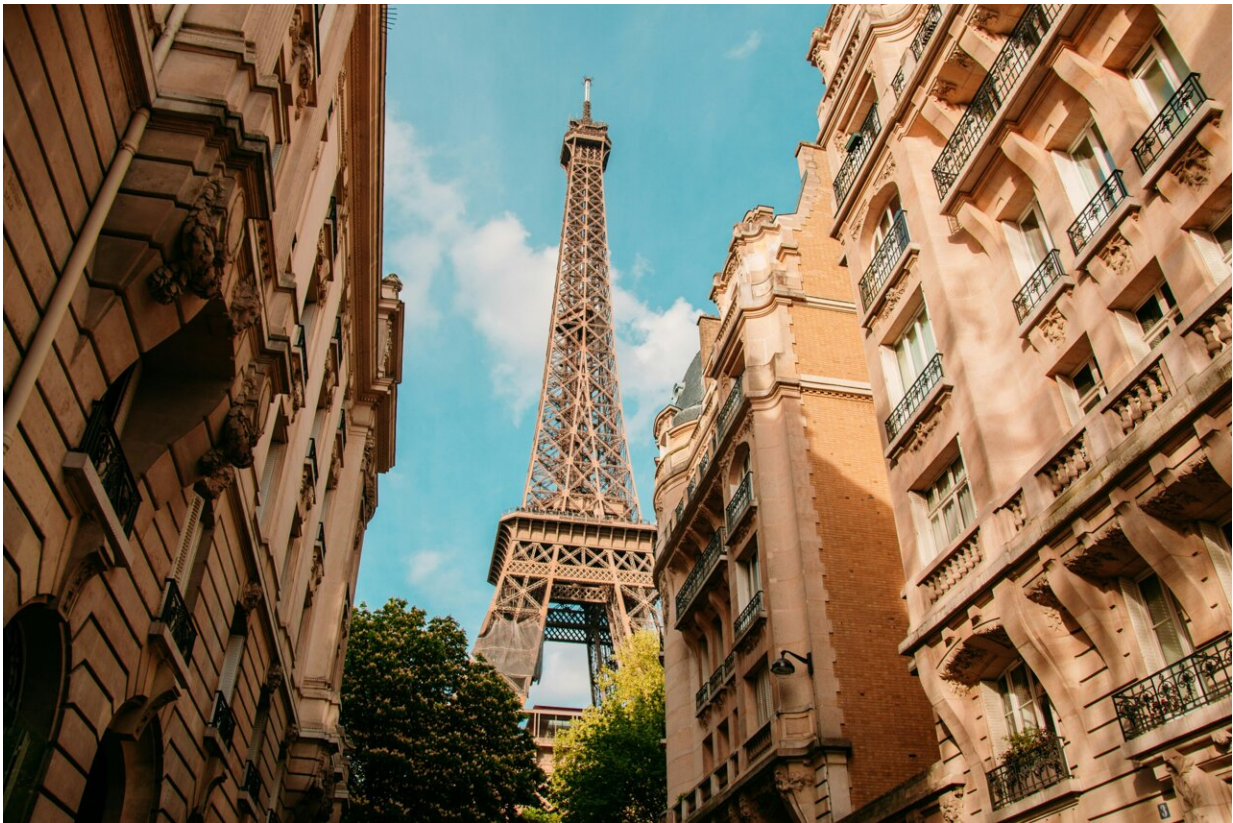


Cleaner skies, sizzling summers: How falling pollution may amplify Europe's heat

July 3 2026, by Sayan Tribedi



Credit: Unsplash/CC0 Public Domain

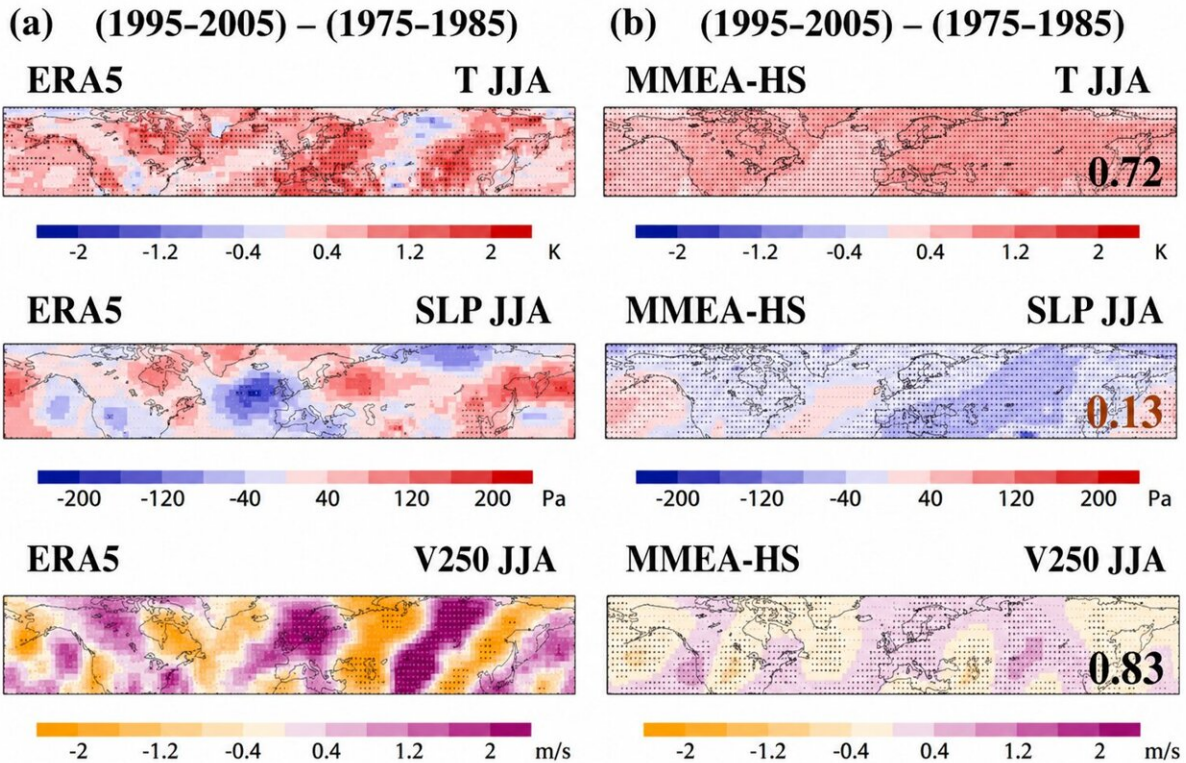
Cities from Paris to Prague have sweltered under record-breaking heat waves in recent years. In fact, Western Europe's average summer temperature has climbed by roughly 2.3°C since 1980, about triple the

0.8°C global rise. This discrepancy, where observed warming far outpaces what climate models initially predicted, has puzzled scientists. It strongly suggested that a crucial yet overlooked factor was at play, intensifying Europe's summer heat beyond the expected impact of greenhouse gases alone.

High above Europe, in the atmospheric currents known as the jet stream, giant waves can form, capable of locking in weather patterns for extended periods. These are called Rossby waves, and they naturally steer warm air toward the poles, sometimes creating stubborn, persistent weather systems.

A [new study](#), published in *Geophysical Research Letters*, reveals that recent European summers have been characterized by an increase in these "quasi-stationary" wave patterns, effectively trapping heat over the continent and creating what feels like a giant, unmoving heat dome.

But what could be causing these powerful atmospheric shifts? To unravel this mystery, researchers compared a vast array of climate-model simulations—including experiments that isolated the effects of only greenhouse gases or only aerosols—against detailed observations from the past few decades. Their analysis points to a surprising, almost counterintuitive, driver behind this intensified summer heat: a significant change in the very air above Europe.



Observed versus modeled climate changes over Europe between 1995–2005 and 1975–1985. The left panels (ERA5 observations) show much stronger summer warming, sea-level pressure changes, and upper-level wind shifts than the climate model ensemble (right panels). These differences highlight why many models have underestimated the rapid increase in European summer temperatures and point to missing atmospheric circulation changes linked to declining sulfate aerosol pollution. Credit: *Geophysical Research Letters* (2026). DOI: 10.1029/2026g1122424

Aerosols: The disappearing sunshade

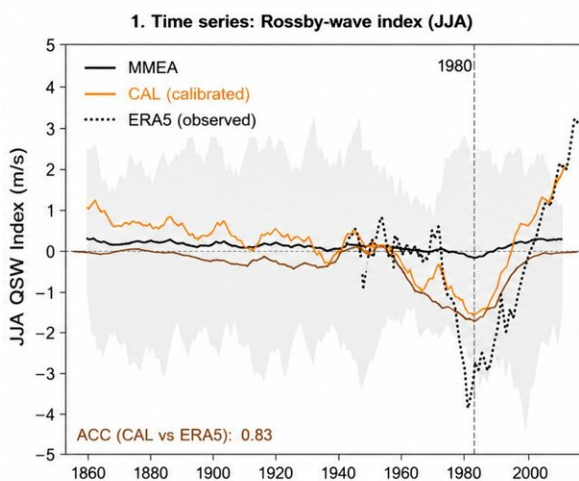
For decades, sulfate aerosols from coal plants and smokestacks acted like a dimmer on the sunlight over Europe. One researcher notes these particles "have masked the warming...by just over one degree on

average" in summer. But once clean-air laws kicked in and sulfates fell, "the temperature increased rapidly."

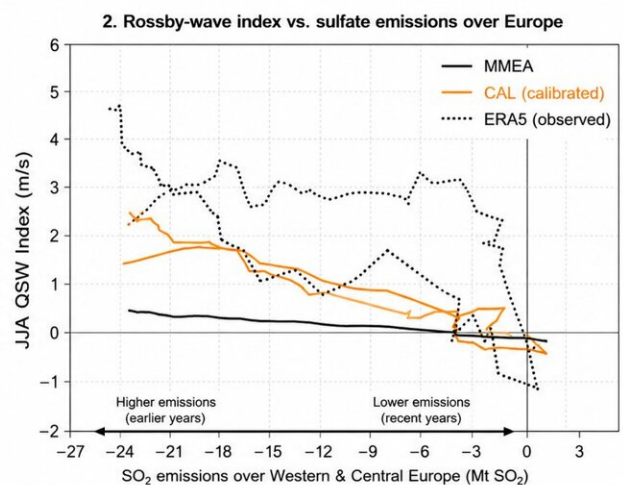
Building on [previous research](#), the authors of this study demonstrated that in their model runs, removing Europe's aerosols unleashed extra summer warmth and rearranged pressure patterns to lock that heat in place. In short, cutting sulfate emissions unveiled hidden heating that the winds then trapped over Europe.

The climate-model experiments make the mechanism unmistakable. When only greenhouse-gas levels changed, the models produced one warming pattern. But when only aerosols were removed, a clear east–west temperature split emerged—exactly the pattern that bends the jet stream into strong stationary ridges over Europe. In fact, the authors write that in summer "the decline in aerosol forcing has been an important driver of the observed excess warming over Europe." Clearing away Europe's pollution haze directly added a chunk of extra warming beyond what greenhouse gases alone would cause.

Rossby-wave index and European sulfate emissions: divergence after 1980 and improved match after calibration



Before 1980, the model (black) underestimates the observed Rossby-wave index (dotted). After 1980, the model diverges sharply downward, while the calibrated model (orange) tracks the observations much more closely.



The observed Rossby-wave index (dotted) increases as sulfate emissions decline. The raw model (black) shows little sensitivity, while the calibrated model (orange) matches the observed inverse relationship much better.

The relationship between European sulfate emissions and atmospheric circulation over time. The left panel shows how a calibrated climate model better matches observed changes in the Rossby-wave index after 1980, while the right panel reveals a strong inverse relationship between declining sulfate emissions and Rossby-wave activity. Together, the figures illustrate how cleaner air reshaped atmospheric circulation, helping intensify Europe's summer warming. Credit: *Geophysical Research Letters* (2026). DOI: 10.1029/2026gl122424

Why forecasts missed the heat

If these critical atmospheric processes, like the behavior of Rossby waves, are indeed part of our climate models, then why were Europe's recent summers so consistently underpredicted? The answer lies in a subtle but significant flaw: The models simply underplay how strongly these jet-stream waves amplify heat over Europe.

The research team delved into this discrepancy, comparing the models' output with real-world observations. They found that while the models did show some circulation trends, these trends would actually dampen Europe's warming by about minus 4%. This is in stark contrast to the ERA5 observations, which reveal a substantial 29% boost to the excess warmth specifically due to these atmospheric circulation changes. In essence, the models were not just slightly off; they were simulating a circulation effect that worked against the observed warming, rather than enhancing it.

This means that, in their raw form, the climate models initially captured only about half of the observed extra warming over Europe. They understood the greenhouse gas effect, but they were missing a large piece of the puzzle related to atmospheric dynamics.

However, this isn't a dead end for climate modeling. The scientists discovered that if they manually "boosted" that weak Rossby-wave signal within the models, essentially correcting for the models' underestimation of the waves' intensity and impact, the simulated summer temperatures then climbed much closer to reality.

This adjustment effectively "restored the missing heat," demonstrating that the underlying physics were present in the models, but their sensitivity to these wave patterns needed recalibration. This breakthrough highlights a path forward for significantly improving regional climate predictions.

Heat ahead: Forecasts and consequences

This is the paradox of Europe's recent heat. The improvement in air pollution proved to be one of the biggest achievements in terms of public health; however, it unintentionally took away a natural regulator of climate. Now, since there is much less atmospheric aerosol in Europe, this "unmasking" process will become weaker. In this regard, future summer warming in Europe will primarily depend on greenhouse gases.

The importance of understanding this complicated link cannot be underestimated, especially from a practical point of view. Scientists will now be able to forecast climate and seasonal changes based on the inclusion of stronger wave patterns in their models. Moreover, this study reveals another important aspect that policymakers need to pay attention to. Improved air quality will definitely bring some immediate advantages, but it will also reveal a certain share of warming that was hidden before. Thus, projections of future heat risks should take this into account.

Ultimately, Europe's accelerated heat waves are a stark reminder of an environmental double-edged sword. When the next scorching summer

arrives, we'll know it's not solely the work of rising greenhouse gases, but also the unexpected consequence of the clearer skies we fought so hard to achieve.

More information: P. J. Roldán-Gómez et al, Accelerated European Summer Warming Driven by Atmospheric Circulation Changes in Response to Aerosol Forcing, *Geophysical Research Letters* (2026). [DOI: 10.1029/2026gl122424](https://doi.org/10.1029/2026gl122424)

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