Hot European summers may be predictable years in advance from North Atlantic warming

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Tourists enjoy hot European summers, but there's increasing pressure on local resources to keep everyone safe in the heat. Credit: Pixabay/CC0 Public Domain

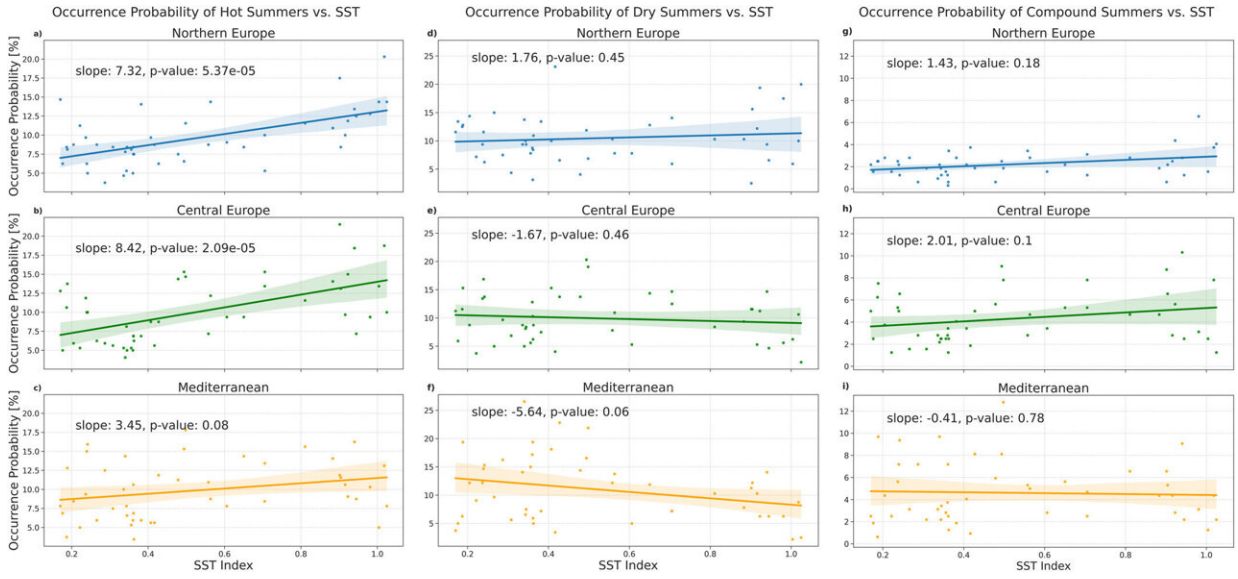
A buildup of warmth in the North Atlantic Ocean could provide an early warning that Europe is more likely to experience unusually hot summers years later, according to a new study published in *Geophysical Research Letters*.

Scientists at the University of Hamburg in Germany found that warmer-than-normal sea surface temperatures in parts of the North Atlantic are linked to an increased chance of hot summers across Europe up to several years in advance. The findings suggest that conditions in the ocean could help improve long-range forecasts of summer heat, although predicting drought remains far more challenging.

Europe is experiencing more frequent and intense heat extremes as the climate warms, bringing growing risks for human health, agriculture and ecosystems. While weather forecasts are highly accurate over days and weeks, looking several years ahead is much more difficult because natural climate variations can influence temperatures and rainfall over long timescales.

Clues beneath the waves

Scientists have long known that the oceans act as enormous reservoirs of heat. Because water warms and cools more slowly than the atmosphere, changes in ocean temperatures can influence weather patterns months or even years later through a gradual accumulation of heat.



Probability of extreme summer heat, drought, or a combination of both in relation to elevated sea surface temperatures. Credit: *Geophysical Research Letters* (2026). DOI: 10.1029/2025gl119820

To test this, the researchers used a set of climate model simulations and compared predictions that included information about North Atlantic sea surface temperatures with those that did not. They focused on events occurring several years into the future, a timescale known as decadal prediction. Incorporating the resulting warmer sea surface temperatures improved predictions of summer heat compared with conventional approaches.

However, forecasting drought proved more challenging. Although dry conditions often accompany heat waves, rainfall is influenced by many interacting processes and tends to vary more from year to year. As a result, the researchers found much lower skill in predicting drought events several years ahead.

Combined hot-and-dry summers, which can have especially severe impacts on crops, water resources and ecosystems, also remained difficult to forecast accurately.

This highlights both the promise and limitations of long-range climate prediction. While ocean temperatures appear to provide a useful indicator of future heat risk, they do not offer a simple way to predict all aspects of extreme summer weather.

A chain of atmospheric changes

The connection between the ocean and European summer temperatures is linked to changes in the exchange of heat between the sea and atmosphere. Changing atmospheric circulation patterns can influence the jet stream—a fast-moving band of winds high in the atmosphere—and increase the likelihood of persistent high-pressure systems over northern Europe. These high-pressure systems tend to bring clear skies and warmer conditions, creating favorable conditions for unusually hot summers.

The ocean's ability to store heat also means these changes develop slowly compared with atmospheric weather patterns, which evolve over days. According to the researchers, this slow-moving behavior makes the North Atlantic an important part of Europe's climate system and offers an opportunity to extend useful forecasts beyond the timescales normally associated with weather prediction.

Earlier warnings for society

Improved predictions of hot summers could eventually help governments, health agencies and other sectors prepare for periods of extreme heat. Heat waves are among the deadliest natural hazards and can place heavy strain on hospitals, energy systems and agriculture. Having an indication years in advance that the risk of hot summers is elevated could support long-term planning and adaptation measures.

At the same time, the researchers caution that these forecasts are probabilistic. A warmer North Atlantic does not guarantee that a particular summer will be exceptionally hot. Instead, it shifts the odds, making such events more likely.

The findings also underline that some aspects of climate variability remain difficult to predict. Although the ocean offers an important source of information, summer rainfall and drought are influenced by

additional processes that are not yet captured with the same level of confidence.

But as climate change continues to raise temperatures across Europe, understanding how natural ocean variations affect the likelihood of extreme summers could become increasingly important.

More information: Leocardia Zheng et al, Decadal Predictions of the Link Between European Hot-Dry Compound Summers and North Atlantic Sea Surface Temperature, *Geophysical Research Letters* (2026). DOI: 10.1029/2025gl119820