

AI Improves Extreme Weather Simulations

A new algorithm combines AI weather forecasts with a physics-based climate model to efficiently characterize rare and dangerous weather events.

By **Ryan Wilkinson**

Heatwaves, floods, and other extreme weather events pose huge societal risks, especially in a warming climate. But their rarity makes it challenging to estimate their overall frequency, intensity, and impact. Now Amaury Lancelin at the Ecole Normale Supérieure in Paris and his colleagues have demonstrated an algorithm that efficiently predicts the properties of such events by integrating fast AI weather forecasts with a highly accurate climate model [1]. This tool could help scientists develop effective mitigation and adaptation strategies for dealing with future extreme weather.

The algorithm repeatedly runs a series of climate-model simulations, each representing one possible trajectory of the climate system. At regular intervals, the tool then consults short-term weather forecasts from an AI emulator to evaluate which simulations are most likely to lead to extreme events. These simulations are split into several slightly perturbed copies that are evolved forward in time, while the rest are

discarded. In this way, the tool samples extreme events that would otherwise require prohibitively long climate simulations to capture.

To illustrate their algorithm, Lancelin and his colleagues simulated heat waves centered over France and over the US Midwest. Heat waves are the deadliest extreme weather events and are expected to worsen under climate change. The new algorithm accurately estimated the likelihood of heat waves of varying intensity while reducing computational costs by hundreds of times compared with standard climate simulations. The tool also substantially outperformed existing rare-event sampling techniques, which failed to capture the most intense heat waves.

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REFERENCES

1. A. Lancelin *et al.*, “AI-boosted rare event sampling to characterize extreme weather,” *Phys. Rev. Lett.* **137**, 064201 (2026).



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