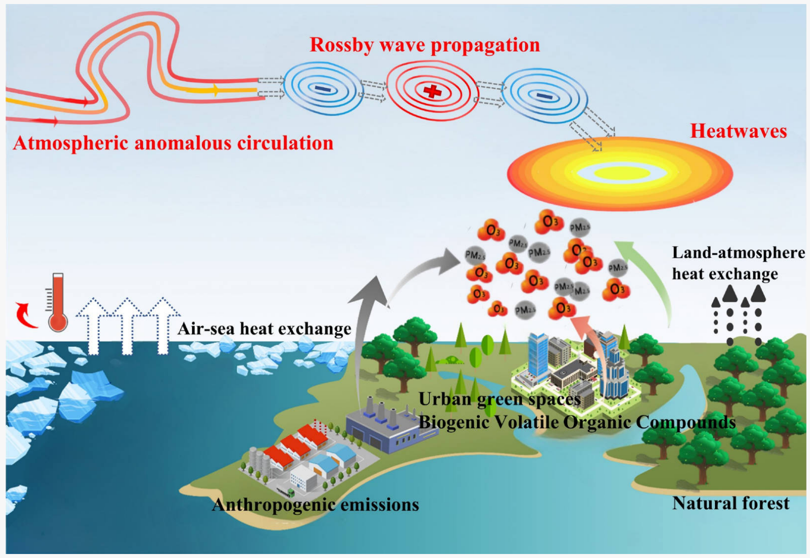
Weather gone wild: scientists use fine-scale models to predict pollution surges

GA, UNITED STATES, June 20, 2025 /EINPresswire.com/ -- As the planet warms, extreme weather and air pollution are converging into a dangerous feedback loop. This new study brings to light how high-resolution Earth system models can untangle their intricate connections. By zooming into kilometer-scale atmospheric and oceanic processes, researchers reveal how extreme weather events can worsen air quality—and vice versa. The enhanced models offer sharper, more realistic simulations of these twin threats, enabling scientists to identify the hidden dynamics that drive pollution spikes during climate extremes. The findings promise to reshape how we anticipate environmental risks and build smarter early-warning systems.



Interconnected Climate and Pollution Feedbacks in a Warming World.

Over the last two decades, the scientific community has made rapid strides in understanding climate change and air pollution—but progress on their combined effects remains limited. Traditional models often gloss over the complex web of interactions between land, sea, and sky, especially when simulating compound events like heatwaves coinciding with stagnant air. These gaps are particularly troubling in densely populated coastal and urban zones, where human exposure is highest. Researchers now recognize that capturing fine-scale processes is critical to improving both forecasts and public health responses. Due to these challenges, there is an urgent need to deepen our understanding of how climate extremes and air pollution interact through high-resolution modeling.

A research team led by the Ocean University of China and Tsinghua University has published (DOI: [10.1007/s11783-025-2020-9]) a perspective [article] on May 19, 2025, in Frontiers of Environmental Science & Engineering. The study explores how advanced high-resolution Earth system models can better simulate the coupled effects of extreme weather and air pollution. By bridging gaps in current modeling capabilities, the work offers a more detailed and accurate picture of environmental hazards under climate change.

The team's research dives into the mechanics of how extreme weather intensifies air pollution, and vice versa. Using next-generation Earth system models with kilometer-scale resolution, the study sheds light on how poorly represented processes—like ozone dry deposition or urban–rural emission differences—can distort pollution forecasts. The new simulations corrected these issues, reducing ozone overestimates by an average of 62% in heavily polluted regions.

Compound climate extremes, involving simultaneous or sequential events, have become increasingly frequent. High-resolution Earth system models are crucial for capturing the intricate fine-scale processes underlying these compound events. To tackle the heavy computing demands of such simulations, the researchers also propose to integrate artificial intelligence techniques—speeding up calculations while preserving accuracy. Their work highlights the immense value of modeling tools that can reflect the complex, nonlinear reality of our atmosphere in a changing climate.

“Understanding how extreme weather and air pollution amplify each other is essential to protecting lives and ecosystems,” said Professor Yang Gao and Deliang Chen, corresponding authors of the study. “High-resolution Earth system models allow us to uncover interactions that were previously invisible, giving decision-makers the knowledge they need to prepare for tomorrow's climate risks.”

As climate-related disasters escalate, tools that can pinpoint where and when pollution and weather will collide are more critical than ever. High-resolution models could revolutionize environmental forecasting—offering cities, coastal communities, and health systems the foresight to act swiftly. Combined with artificial intelligence, these models can deliver real-time, localized warnings and guide investments in climate adaptation. By capturing the full complexity of Earth's systems, this research lays the foundation for more resilient societies in an uncertain future.

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Lucy Wang
BioDesign Research
email us here
