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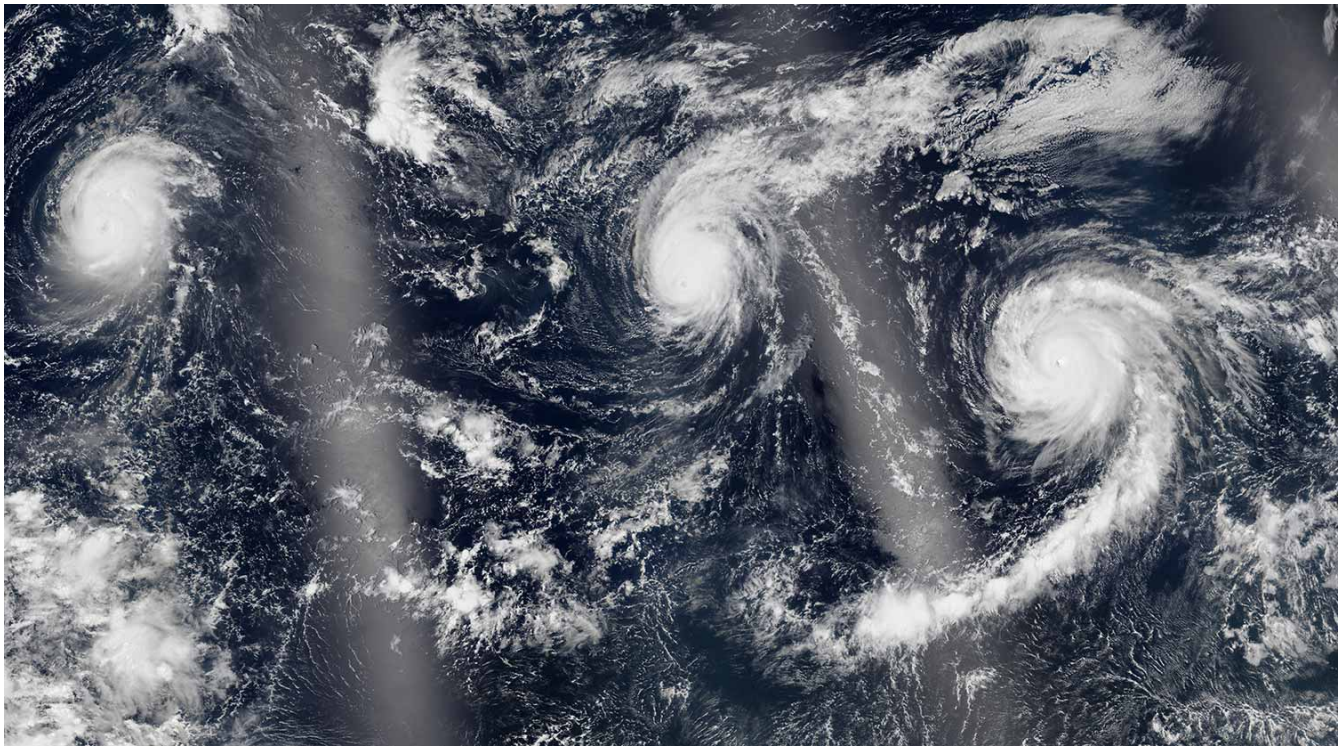
For Accurate Regional Climate Forecasts, Atmospheric Circulation is Key

Predictions that could help society adapt to climate change need to consider an overlooked variable, says a Scripps-led review



For the first time in recorded history, three category-4 hurricanes formed in the Pacific Ocean in August. Photo: NASA Earth Observatory

Society needs forecasts tailored to individual regions to be able to adapt to climate change, but a new paper says the most important consideration for creating accurate models has been largely overlooked.

In a National Science Foundation and NOAA-funded review of recent advances in regional modeling, Scripps Institution of Oceanography, UC San Diego, climate scientist Shang-Ping Xie and co-authors say that a better understanding of atmospheric circulation is the key to improving region-scale predictions. Studying in particular the tropics, where atmospheric circulation interacts strongly with ocean processes, affords an opportunity to improve models.

Regional climate models provide high-resolution views at regional levels and are often perceived as the solution to regional climate forecasts. But the review says that regional models are not a silver bullet as they inherit the inaccuracies of global-scale simulations of climate change. For instance, outside the tropics, variables such as seemingly random fluctuations of atmospheric pressure and wind velocity are important factors in creating regional patterns, but their complexity hampers the effectiveness of regional climate models. Accounting for the built-in uncertainty would be a major step toward forecasting regionally specific phenomena ranging from drought in California to hurricanes on the eastern seaboard.

“Global warming research tends to focus on global mean temperature, but nobody lives in global mean temperature,” said Xie, the Roger Revelle Chair in Environmental Science at Scripps. “Rainfall change is perhaps far more consequential and is fundamentally regional: precipitation might increase in Canada but decrease in the Southwest U.S. Different processes govern uncertainties in the projections of global mean and regional changes. We show that the atmospheric circulation change holds the key to improving regional climate projections. We suggested a way forward to tackle this problem.”

The paper, “Toward predictive understanding of regional climate change,” appears in online editions of the journal *Nature Climate Change* on Sept. 7.

For instance, global surface temperatures are expected to keep rising because of climate change. In the tropics, ocean warming patterns determine rainfall change by driving atmospheric circulation change. In regions of enhanced ocean warming, the atmosphere becomes unstable and conducive to convection, an upward movement of warm air that causes rainfall.

Portraying that properly could bring greater accuracy to predictions of climate phenomena with profound societal impact, such as El Niño. A major El Niño event is being forecast later this year, which increases chances of above-normal precipitation over California to relieve the decadal drought. Climate models forecast that under global warming, El Niño effects on the atmospheric circulation over the North Pacific will intensify and move *eastward* from the central Pacific, meaning the West Coast would likely receive more intense rainfall during such events.

The authors call for the collection of more comprehensive data and for a greater understanding of atmospheric physics to achieve more accurate regional forecasts.

“In the tropics where towering thunderstorms drive the global atmospheric circulation, we showed that the interaction with the ocean is the key,” Xie said. “Advances in physical understanding of this interaction enabled the prediction of El Niño, which has become routine.”

Besides Xie and Scripps co-author Nathaniel Johnson, contributors to the review include researchers from the National Center for Atmospheric Research in Boulder, Colo., the Geophysical Fluid Dynamics Laboratory in Princeton, N.J., the University of Exeter, UCLA, the National Centre for Atmospheric Science in Reading, U.K., the University of Hawaii at Manoa, Princeton University, CNRS in Cedex, France, Columbia University, and University of Tokyo.

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