Higher resolution alone will not fix climate models' daytime precipitation cycle problems

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PNNL researchers identified certain tradeoffs in climate models as they investigated how models depict the timing of storm system processes. The work highlights modeling challenges when moving from coarse to high-resolution simulations.

Using increased computing power, climate modelers divide Earth's atmosphere into smaller areas so that global models can represent more details in the climate. But how do these large models behave with this

higher resolution? Using a regional atmospheric model as a proxy for upcoming high-resolution global climate models, researchers at Pacific Northwest National Laboratory found that global models carry many biases into the higher resolution regional output despite its finer detail. The research identified certain tradeoffs that highlight modeling challenges when moving from coarse to high-resolution simulations.

"By extending the convective timescale to understand how quickly storm clouds impact the air around them, the model produced too little rain," said Dr. William I. Gustafson, Jr., lead researcher and atmospheric scientist at PNNL. "When we used a shorter timescale it improved the rain amount but caused rain to occur too early in the day."

At the community level—what climate modelers describe as the regional scale—is where climate change matters most to businesses, citizenry and policy makers. This level of detail will require higher resolution models that are able to depict small-scale features—such as rain, snow, and cloud cover. Researchers also expect higher resolution will lead to overall improved accuracy of large-scale climate simulations. In anticipation of the global models using a high resolution within the next couple years, researchers in this study tested a common method's behavior when used at higher resolution. In this way, researchers are improving today's methodologies to prepare for the next generation climate models.

For their investigation, PNNL researchers used the physics packages from the Community Atmosphere Model Version 5 (CAM5) in a regional model. This enabled them to combine higher resolutions with realistic weather conditions to determine if the simulated precipitation improved using higher resolutions.

The resulting paper is one in a series to examine the resolution dependence and behavior of the CAM5 physics suite within the Weather

Research and Forecasting (WRF) model. Earlier work studied the resolution dependence of the cloud microphysics and the aerosol components. For this study, they focused on precipitation behavior and the Zhang-McFarlane deep convection parameterization combined with simulating the Midlatitude Continental Convective Clouds Experiment (MC3E) field campaign period (see sidebar, MC3E Field Campaign) over the central United States. The transition period between spring and summer exhibited weather conditions with strong contrasting local and large-scale effects. By breaking the period into sub-periods, they examined how the precipitation behavior changed based on the meteorological conditions.

The results clarified that underlying assumptions in the handling of convection need to be changed to improve simulations and that higher resolution alone will not solve existing biases. Additional work will use a more idealized model configuration to control the inputs and more easily test alternative solutions.

More information: "Precipitation Characteristics of CAM5 Physics at Mesoscale Resolution during MC3E and the Impact of Convective Timescale Choice." *Journal of Advances in Modeling Earth Systems* 6(4): 1271-1287. DOI: 10.1002/2014ms000334

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