Taming uncertainty in climate prediction

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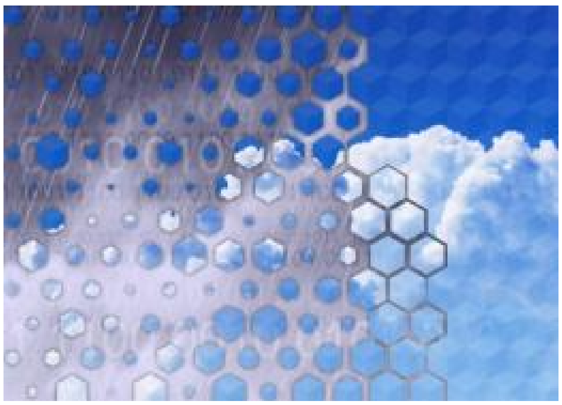

The results of the UQ process show an improved predictive model making it more reliable in projecting future climate change.

(PhysOrg.com) -- Uncertainty just became more certain. Atmospheric and computational researchers at Pacific Northwest National Laboratory used a new scientific approach called "uncertainty quantification," or UQ, that allowed them to better simulate precipitation. Their study is the first to apply a stochastic sampling method to select model inputs for precipitation representations and improve atmospheric simulations within a regional weather research and forecasting model. Their approach marks a significant advancement in representing precipitation, one of the most difficult climate components to simulate.

The word "uncertain" always seems to appear when describing Earth and atmospheric systems in numerical models. Trying to represent complexity through computer simulations has limitations, not the least of which is a lack of sufficient computing power. Consider trying to model human body systems with numbers. Humans come in all shapes, sizes, ages, locations, and temperaments. It's the same with atmospheric systems. Getting a handle on the systems' uncertainties, to effectively and efficiently represent current weather and climate systems in a computer model, paves the way for scientists to apply those same techniques to predict the future climate changes. Sound predictions will give planners the tools to forecast the probability of extreme weather and climate events.

A PNNL team of atmospheric scientists and computational modelers used the Weather Research Forecasting (WRF) model to validate a new approach to improving parameters used to estimate precipitation. Using observational data from the Southern Great Plains (SGP), gathered by a U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Climate Research Facility, they reduced the uncertainty for several parameters in the convective cloud scheme in WRF to improve the precipitation calculations.

"We used an interdisciplinary team and the powerful computing resources at multiple locations to tackle this challenge," said Dr. Yun Qian, a climate scientist at PNNL. "Precipitation is much more challenging to represent in climate simulations than, for example, temperature. And it's harder to predict. The UQ methodology provides a way to assess key parameters that are critical for precipitation calculation in regional and global climate models."

Using the vast amount of data collected at SGP, the team used a numerical technique to identify and improve the precipitation calculations in WRF. The team was the first to use a stochastic algorithm, an important sampling method to study parameterizations in regional climate simulations. The method, called Multiple Very Fast Simulated Annealing (MVFSA), randomly chooses numbers within distributions to minimize model errors. MVFSA is computationally more efficient, requiring a lower number of simulations to better match the observational data.

MVFSA identified five optimal parameters to reduce the model precipitation bias at a 25 kilometer climate grid. The team then improved precipitation simulations on a 12 kilometer grid, as well as temperature and wind results. Testing the model on another climate region showed that the MVFSA process produces improved results across spatial scales, processes, and other climatic regions.

The results of the UQ process show an improved model with better predictability making it more reliable in projecting future climate change.

Working within the Community Atmospheric Model (CAM5), a global climate model, the team will test the optimized representations in convective precipitation scenarios. Finding that some representations were more important than others, the UQ approach will focus on how improving representations of convection in climate model helps to improve simulations of the global circulation and climate.

More information: Yang B, et al. 2012. "Some Issues in Uncertainty Quantification and Parameter Tuning: A Case Study of Convective Parameterization Scheme in the WRF Regional Climate Model," *Atmospheric Chemistry and Physics*, 12, 2409-2427, doi:10.5194/acp-12-2409-2012

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