# Handling climate-important cumulus cloud models, regardless of scale

April 17 2015

Researchers at PNNL developed a new way for global climate and weather forecasting models to represent cumulus clouds, accounting for updrafts and downdrafts in a manner that is far more accurate, regardless of the scale of the model.

Even as computing power increases, current climate model formulas struggle to handle storm clouds at today's higher resolutions and smaller model grid sizes. Cumulus storm cloud systems are still only partially resolved. Armed with a new formula developed by a research team led by Pacific Northwest National Laboratory, scientists can now represent cumulus in grid sizes as fine as 2 kilometers to as coarse as 256 kilometers. The team's approach breaks the storm cloud gridlock by more accurately depicting how cumulus clouds transport moisture through the atmosphere.

"This study helps us understand the scale-dependency of moisture and heat transported by cumulus clouds," said Dr. Jiwen Fan, an atmospheric scientist at PNNL, who led the team. "Our new formulation improves how the vertical transport of moisture by cumulus clouds is depicted in climate models at all scales."

Representing these ubiquitous storm clouds in large-scale global climate models is crucial to obtaining accurate simulation of the climate, how it varies, and how it could change in the future. The old formulas can miss vital information necessary for accurate weather and climate prediction. Published in the *Journal of Geophysical Research*: Atmospheres, the new approach accounts for the variability of strong lifting currents in cumulus clouds.

Researchers at PNNL and collaborators from Scripps Institution of Oceanography and NASA Langley Research Center plugged real-world data into the Weather Research and Forecasting (WRF) model to simulate three storms: two over the U.S. Southern Great Plains in May of 2011 during the Midlatitude Continental Convective Clouds Experiment and one in the western Pacific near Australia in January 2006 during the Tropical Warm Pool International Cloud Experiment. The scientists started with a model grid size of 1 kilometer over an area 560 kilometers square. The researchers divided that 560 by 560 kilometer region into smaller squares with the lengths of 2, 4, 8, 16, 32, 64, 128, 256, and 512 kilometers to emulate the WRF and climate model grid sizes, and then examined the vertical transport of moisture as a benchmark at each of these scales.

The researchers discovered that the vertical transport by the cumulus clouds that cannot be resolved is strongly dependent on grid size. Evaluating the conventional formula that is used to represent the unresolved transport in the climate model, they found that it underestimates the transport at all scales. The new formula's accounting for the variability of ascending motions in convective updrafts much more closely approximates the benchmark results at all scales.

Scientists will add the new formula to the National Center for Atmospheric Research's Community Atmosphere Model to improve climate and weather modeling.

**More information:** "Improving Representation of Convective Transport for Scale-Aware Parameterization, Part II: Analysis of Cloud-Resolving Model Simulations." *Journal of Geophysical Research* Atmospheres, accepted. DOI: 10.1002/2014JD022145

Provided by Pacific Northwest National Laboratory