Reflecting real-world precipitation extremes in climate simulations

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Massive clouds form at the ridge of the Sierras de Córdoba range in Argentina, which could cause extreme precipitation. Credit: Department of Energy Atmospheric Radiation Measurement (ARM) Office of Science user facility

Daily predictions of rainstorms are useful for helping us decide whether we should bring an umbrella or not when we run errands. But scientists, urban planners, and many others need to know about precipitation extremes on much larger time scales.

Knowing about extremes in precipitation over the course of years is important for planning for future water storage and agriculture as well as planning for destructive storms. But climate models don't always simulate these extremes as accurately as they should. For these models to be useful to city planners and others, their predictions need to match real-world observations more closely.

Scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) examined different ways to describe the processes inside of clouds and how they affected the accuracy of climate models.

The climate is massively complex. There is no way that scientists can fit every detail into simulations of the climate. The simulations would simply be too big to run, even on the most powerful supercomputers.

To deal with that complexity, scientists make certain simplifications. Climate models split the globe into columns on a grid. This allows the models to simulate individual parts and their interactions. In one form called superparameterization, each grid column has its own high-resolution model inside of it. The models inside of the columns are so high-resolution that they can simulate individual clouds! Previous studies found that these superparameterized models can simulate clouds more accurately than other types.

But it's not enough to understand entire clouds. Scientists need climate models to take into account the processes inside of clouds, called microphysics. These processes include how cloud droplets and ice crystals form and break up.

Unfortunately, climate models can't simulate these processes directly—they are simply too small. Instead, scientists choose certain ways to represent these processes.

Climate scientists at Berkeley Lab examined how the way they represented these processes affected how accurately superparameterized models simulated extreme precipitation. The scientist used the models to simulate climate of years in the past and then compared these simulations to real-world observations. These comparisons allow them to see how accurate the models are.

The researchers ran two different types of representations of the processes. One provided more detail, while the other provided less. They ran the models on computers at the National Energy Research Scientific Computing Center DOE Office of Science user facility.

Both sets of parameters affected how the model simulated extreme precipitation on both long time scales (up to a year) and short time scales (about five days). The short time scales were specifically affected in the tropics.

The different representations also produced a wide range of extreme precipitation events. The scientists found that the more detailed parameters produced clouds in the simulation with more vertical motion. These motions resulted in more extremes.

Despite the differences, the results from both representations fit within the range of real-world observations. Using microphysics processes in climate models has a lot of potential for making simulations more accurate.

Extreme precipitation events are no walk in the park. But with the help of some extreme computers and climate models, scientists can help us better predict and plan for them.

Provided by US Department of Energy

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