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Importance of ensembles in projecting regional climate trends

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We have performed an ensemble of simulations using RegCM4 to examine the ability to reproduce observed trends in precipitation intensity and to project future changes through the 21st century for the central United States. We created a matrix of simulations over the CORDEX North America domain for 1950-2099 by driving the regional model with two different global models (HadGEM2-ES and GFDL-ESM2M, both for RCP8.5), by performing simulations at both 50 km and 25 km grid spacing, and by using three different convective parameterizations. The result is a set of 12 simulations (two GCMs by two resolutions by three convective parameterizations) that can be used to systematically evaluate the influence of simulation design on predicted precipitation. The two global models were selected to bracket the range of climate sensitivity in the CMIP5 models: HadGEM2-ES has the highest ECS of the CMIP5 models, while GFDL-ESM2M has one of the lowestt.

Our evaluation metrics differ from many other RCM studies in that we focus on the skill of the models in reproducing past trends rather than the mean climate state. Trends in frequency of extreme precipitation (defined as amounts exceeding 76.2 mm/day) for most simulations are similar to the observed trend but with notable variations depending on RegCM4 configuration and on the driving GCM. There are complex interactions among resolution, choice of convective parameterization, and the driving GCM that carry over into the future climate projections. We also note that biases in the current climate do not correspond to biases in trends. As an example of these points the Emanuel scheme is consistently "wet" (positive bias in precipitation) yet it produced the smallest precipitation increase of the three convective parameterizations when used in simulations driven by HadGEM2-ES. However, it produced the largest increase when driven by GFDL-ESM2M. These findings reiterate that ensembles using multiple RCM configurations and driving GCMs are essential for projecting regional climate change, even when a single RCM is used.

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