Using Ensemble Short-term Initialized Coupled NASA GEOS5 Climate Model Integrations to Study Convective Bias Growth

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The representation of convective processes, particularly deep convection in the tropics, remains a persistent problem in climate models. In fact structural biases in the distribution of tropical rainfall in the CMIP5 models is hardly different than that of the CMIP3 versions. Given that regional climate change at higher latitudes is sensitive to the configuration of tropical forcing, this persistent bias is a major issue for the credibility of climate change projections.

In this study we use model output from integrations of the NASA Global Earth Observing System Five (GEOS5) climate modeling system to study the evolution of biases in the location and intensity of convective processes. We take advantage of a series of hindcast experiments done in support of the US North American Multi-Model Ensemble (NMME) initiative. For these experiments a nine-month forecast using a coupled model configuration is made approximately every five days over the past 30 years. Each forecast is started with an updated analysis of the ocean, atmosphere and land states. For a given calendar month we have approximately 180 forecasts with daily means of various quantities. These forecasts can be averaged to essentially remove "weather scales" and highlight systematic errors as they evolve.

Our primary question is to ask how the spatial structure of daily mean precipitation over the tropics evolves from the initial state and what physical processes are involved. Errors in parameterized convection, various water and energy fluxes and the divergent circulation are found to set up on fast time scales (order five days) compared to errors in the ocean, although SST changes can be non-negligible over that time. For the month of June the difference between forecast day five versus day zero precipitation looks quite similar to the difference between the June precipitation climatology and that from the Global Precipitation Climatology Project (GPCP). We focus much of our analysis on the influence of SST gradients, associated PBL baroclinicity enabled by turbulent mixing, the ensuing PBL moisture convergence, and how changes in these processes relate to convective precipitation bias growth over this short period.