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Uncertainty Quantification and Parameter Tuning in CAM5 Zhang-McFarlane Convection Scheme and Physical Impact of Improved Convection on the Global Circulation and Climate

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In this study we apply an Uncertainty Quantification (UQ) technique to attempt to improve the convective precipitation modeling in a global climate model CAM5 in which the convective and stratiform precipitation partitioning is misrepresented. We examine the sensitivity of precipitation and circulation to several key parameters in the Zhang-McFarlane deep convection scheme in CAM5, using a stochastic importance-sampling algorithm which can progressively converge to the optimal parameters. The impact of improved representation of deep convection on the global circulation and climate is further evaluated.

Our results show that the simulated convective precipitation is most sensitive to the parameters of Convective Available Potential Energy (CAPE) consumption time, parcel fractional mass entrainment rate and maximum downdraft mass flux fraction. Using the identified optimal parameters constrained by the observed TRMM convective precipitation remarkably improves the simulation in convective and stratiform precipitation ratio and rain rate spectrum. When the convections are suppressed, precipitation tends to be more confined over the regions with strong atmospheric convergence. As the optimized parameters are used, the positive impacts on some aspects of the atmospheric circulation and climate, e.g. mitigated double-ITCZ, improved East Asia monsoon precipitation, and the annual cycles of the cross-equator jets, can be found, resulting from the re-distribution of latent heat release associated with the modified convective system. The positive impacts of the optimized parameters revealed in 2-degree simulations are also transferable to 1-degree simulations to some extent.