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SUPERPARAMETERIZATION - A Promise towards a better Earth System Model : An Indian Summer Monsoon perspective

B. B. Goswami (1), P. Mukhopadhyay (1), M. Khairoutdinov (2), and B.N. Goswami (1)

(1) Indian Institute of Tropical Meteorology, Pune, India, (2) School of Marine and Atmospheric Science, New York University, Stony Brook, USA

The atmosphere is comprised of convection of all scales ranging from few kilometers to several thousands of kilometers. In a numerical model irrespective of its kind e. g. General Circulation Model (GCMs) or Earth System Model etc., the scale which is bigger than the grid resolution are resolved and rest all remain sub-grid and unresolved. The model uncertainties are largely attributed to the parameterization of sub-grid scale convection, although the simulation of the resolved large-scale processes too shows biases. This is because of the fact that there is no scale separation between the resolved scales and the unresolved sub-grid scales. Henceforth, the efficiency of all the earth system models depends on their ability to realistically represent these sub-grid scale convection processes. Because of the multiscale character of organized convection, it has always been a challenge for the earth system models to simulate the tropical precipitation.

Traditionally, the way to account for the sub-grid scale processes in an earth system model is through parameterization, which is to include the effect of clouds as a function of large scale parameters. We here discuss a newer approach, the Superparameterization (SP) or the Multiscale Modelling Framework (MMF). The MMF guarantees better resolved sub-grid scale processes in an earth system model, through a few embedded Cloud Resolving Models in each grid of the earth system model, compared to the traditional parameterization. Superparameterized models, though computationally a little demanding, are a good compromise between the coarse resolution earth system models and highly computationally expensive global cloud resolving models. Most importantly, the MMF approach serves as a "laboratory" to better understand the shortcomings in models with traditional convective-parameterization.

We here intend to discuss the fidelity of MMF to represent the unresolved sub-grid scale convective processes in an earth system model by analyzing the simulated Indian summer monsoon and its variability. We have taken up two version of the same earth system model, one uncoupled (AMIP style run) and the other coupled both superparameterized. The motive behind this is, to assess the impact of superparameterization in a greater detail with coupling on and off. We not only analyze the superparameterized model output for Indian summer monsoon, but also explore the root cause behind the biases and propose a way to correct them.
The results show considerable promise in simulating the Indian summer monsoon and its variability. The mean Indian summer monsoon is reasonably generally well simulated but the coupled version of the model does an even better simulation by reducing the biases over maritime continents and Bay of Bengal. But, deficiencies are there in the simulation of the intraseasonal oscillations of the Indian summer monsoon; which remain uncorrected in the coupled version too. This once again puts the role of sub-grid scale convective processes, in simulating the Indian summer monsoon and its variability, in the first place. So, to get the Indian summer monsoon right in MMF, we need better representation of the sub-grid scale convective processes for which, we need to improve the cloud resolving model embedded within each grid of the earth system model.