Process-oriented evaluation of warm rain process in global models with satellite observations

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There is a growing interest in the climate research community toward novel “process-oriented” evaluations of global climate models from traditional “performance-oriented” evaluations to substantially advance our capability of climate modeling. Given this new trend of research that is particularly fueled by recent progress in satellite observations, this presentation highlights our recent studies that propose a novel approach for evaluating climate models in their representation of warm rain process with a combined use of multi-sensor, multi-platform satellite observations. The approach exploits and combines different satellite observables of cloud and precipitation obtained from different sensors and platforms in a particular manner to construct particular statistics that “fingerprint” signatures of warm rain processes. The methodology is also applied to output from state-of-the-art global climate models to construct the corresponding statistics to compare with those obtained from satellite observations. The comparison identifies a key common bias in the process representation including the “too fast, too frequent” rain formation in the models. With the aid of a process model analysis, this common model bias is then attributed to fundamental uncertainty in formulation of the process parameterizations. Satellite-based information in the form of the statistics constructed provides a process-level constraint on the uncertainty that have been regarded as “tunable knobs” in climate models. This process-based model constraint has also been contrasted against a traditional performance-based constraint to expose a key dichotomy between them in a state-of-the-art global climate model. This underscores the importance of process-level model constraint and also exposes a new challenge confronting us for advancing climate modeling.