# The too fast, too frequent precipitation simulated in GCMs

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The cloud-to-precipitation transition process simulated by some state-of-the-art global climate models (GCMs), including both traditional climate models and a global cloud-resolving model, is evaluated against A-Train satellites observations. The models and satellite observations are compared in the form of the statistics obtained from combined analysis of multiple satellite observables that probe signatures of the cloud-to-precipitation transition process. One common problem identified among these models is the too-fast triggering of precipitation, before clouds are developed to a stage when cloud particle sizes are large enough to collide into precipitating particles. Another common problem closely related to the too fast triggering of precipitation is the overestimated (underestimated) occurrence frequency of precipitation (non-precipitating clouds).
The cloud-to-precipitation transition process is represented in GCMs by bulk auto-conversion schemes. A sensitivity test with two widely used auto-conversion schemes in the global cloud-resolving model shows that a more realistic auto-conversion scheme significantly improved the model representation of cloud-to-precipitation transition process: the typical cloud radius where precipitation occurs is shifted close to the observations. However, precipitation occurrence frequency is still overestimated, implying that the parameterization of cloud particle size, besides the auto-conversion scheme, also contributes to the model bias of precipitation occurrence.
Results here demonstrate that both auto-conversion and the growth of non-precipitating cloud particles need to be better represented to achieve realistic precipitation rate and frequency.

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