Including cloud microphysics parameterization into cumulus parameterization of NCAR CESM and TaiESM

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Abstract

A two–moment bulk cloud microphysical scheme (Chen and Liu, 2004; Cheng et al., 2007, 2010, i.e. CLR2) has been implemented into cumulus parameterizations and stratiform cloud microphysics of CAM5.3 of NCAR CESM version 1.2.2 model in preparation for cloud-related processes of Taiwan Earth System Model (TaiESM). In the presentation, we will introduce our work related to implementation of the warm cloud parameterization of CLR2 for convective clouds of CESM and TaiESM model. Many significant improvements regarding to precipitation and clouds can be observed. Inclusion of warm cloud parameterization of CLR2 into deep convection scheme of CAM5.3 tends to increase stratiform precipitation over the tropical to subtropical regions. Such changes in cumulus parameterization will also increase cloud liquid and cloud ice over the tropics and subtropics. Spatial distribution patterns of cloud liquid water path simulated by our modification are also quite comparable to those of AMSR-E. Moreover, such changes influence not only cloud liquid water but also cloud ice simulations. According to the comparisons to CloudSat satellite observations, such modification can also significantly improve the model skills in simulating spatial and vertical distributions of non–precipitating and precipitating cloud ice (i.e. snow). It highlights the importance of applying more physical meaningful approach for converting cloud liquid mass to rain water in the cumulus parameterization scheme in modern GCMs. More importantly, this model framework is also very useful for studying processes related to aerosol–cloud–precipitation interaction in GCMs.

Keywords: Cloud microphysics, cumulus parameterization, cloud-radiation interaction, aerosol-cloud-precipitation interaction, NCAR CESM, and TaiESM model