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Prospects for Modeling Global Cloud-Aerosol-Precipitation Interactions Involving Cumulus Clouds

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Although cloud-aerosol-precipitation interactions involving cumulus clouds have been studied extensively using cloud-resolving models, few studies have been attempted with global models. A multi-scale modeling framework (MMF), in which the interactions are resolved in a cloud-resolving model embedded within each grid cell of the global model, offers considerable advantages over global models with conventional representations of interactions. However, recent cloud-resolving model simulations suggest the current two-moment bulk cloud microphysics representation employed by the MMF lacks sufficient complexity to represent important aspects of the interactions. The bulk treatment, which uses saturation adjustment for water condensation/evaporation and prescribes the shape factor for the hydrometeor size distribution used for sedimentation, evaporation/sublimation and deposition processes, leads to very different aerosol impacts on convective mass fluxes and anvil-cloud properties compared with observations and with simulations using bin microphysics. In this presentation, we evaluate the interactions in the MMF using satellite data, search the MMF simulations for evidence of convection invigoration as indicated by increased cloud fraction, cloud top height and cloud thickness found from observations, and use cloud-resolving model simulations with bin microphysics to determine microphysics changes necessary to improve the MMF simulation of interactions.