Popular Summary

Improving a Spectral Bin Microphysical Scheme Using TRMM Satellite Observations

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Comparisons between cloud model simulations and observations are crucial in validating model performance and improving physical processes represented in the model. These modeled physical processes are idealized representations and almost always have large rooms for improvements. In this study, we use data from two different sensors onboard TRMM (Tropical Rainfall Measurement Mission) satellite to improve the microphysical scheme in the Goddard Cumulus Ensemble (GCE) model. TRMM observed mature-stage squall lines during late spring, early summer in central US over a 9-year period are compiled and compared with a case simulation by GCE model. A unique aspect of the GCE model is that it has a state-of-the-art spectral bin microphysical scheme, which uses 33 different bins to represent particle size distribution of each of the seven hydrometeor species. A forward radiative transfer model calculates TRMM Precipitation Radar (PR) reflectivity and TRMM Microwave Imager (TMI) 85 GHz brightness temperatures from simulated particle size distributions. Comparisons between model outputs and observations reveal that the model overestimates sizes of snow/aggregates in the stratiform region of the squall line. After adjusting temperature-dependent collection coefficients among ice-phase particles, PR comparisons become good while TMI comparisons worsen. Further investigations show that the partitioning between graupel (a high-density form of aggregate), and snow (a low-density form of aggregate) needs to be adjusted in order to have good comparisons in both PR reflectivity and TMI brightness temperature. This study shows that long-term satellite observations, especially those with multiple sensors, can be very useful in constraining model microphysics. It is also the first study in validating and improving a sophisticated spectral bin microphysical scheme according to long-term satellite observations.