Comparison between bulk and bin cloud microphysical schemes for warm rain

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Two-moment bin and two-moment bulk cloud microphysical schemes were compared using a two-dimensional kinematic driver model and a forward simulator of satellite measurements. The conversion process from cloud droplets to raindrops was focused. From numerical experiments, the following results were found. The bulk and bin schemes studied in this paper show the effect of cloud droplet number on precipitation sufficiently, and the difference in rainfall amount between these schemes was small in contrast to previous studies. The vertical distributions of mass of rain water and number of raindrops in these schemes are quite different. It can be caused by overestimation of falling velocity of rainwater and underestimation of self-collection process (or overestimation of collisional breakup process) of raindrops in the bulk scheme. Time evolutions and patterns of the relationships between horizontally averaged reflectivity and optical depth from cloud top were similar between these schemes. The slope factor of this relationships (changing rate of horizontally averaged reflectivity for optical depth from cloud top) near the cloud top in a later stage of cloud lifetime is smaller in bulk scheme than bin scheme. Previous studies showed that the slope factor relates to bulk collection efficiency. However, it was shown that bulk collection efficiency assumed in this bulk scheme is almost same as that estimated in the bin scheme, and that overestimated falling velocity of raindrops leads to the smaller slope factor in this bulk scheme.

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