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A comparative experiment of warm rain bin schemes using Kinetic Driver for microphysics intercomparison

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1. Introduction

Boundary layer clouds have a significant effect on global radiation budget, and the improvement of their modeling is an important issue for climate study. In order to improve the microphysical model, we have developed a bin microphysical scheme for warm rain called Kuba-Fujiyoshi scheme (Kuba and Fujiyoshi, 2006), and incorporated the scheme into a cloud resolving model called Cloud Resolving Storm Simulator (CReSS) developed at Nagoya University. The model was applied to the 'Rain In Cumulus over the Ocean' (RICO) measurement campaign, and works generally well. However, there are few problems in the results, and in order to improve the model, we compare the scheme with other bin and bulk schemes using the Kinematic Driver (KiD) intercomparison framework developed at Met Office (Shipway and Hill, 2012).

2. Setting of the experiments

In the original KiD, the wind is represented as a simple function of time and space. We modified it to incorporate the wind resulted in a 2-dimensional simulation of RICO using CReSS. We stored the wind field every 1 second, which is the time interval used in the simulation. The initial profiles of potential temperature, specific humidity are set for the case of RICO. We compared the results using Kuba and Fujiyoshi scheme (KF scheme) with the results using the Tel-Aviv University bin scheme (TAU scheme).

3. Discussions

The warm bin model is divided into three parts, i.e., the activation process of aerosols, the deposition process, and the collision process. We set the model as we can select K-F scheme or TAU scheme for each of the three processes. Then we can discuss the effect of each scheme by comparing the results of 8 runs. Figure 1 shows the time change of the surface rain in the 8 runs. The top four figures show the effect of the selection of activation scheme. The center four figures show the effect of deposition scheme, and the bottom four figures the collection scheme. In each figure red line shows the results using KF scheme, and the green line shows the results using TAU scheme. For the activation scheme, KF scheme produces more precipitation, and for the deposition and collection scheme, TAU scheme produces more precipitation. We will discuss how these results are produced.

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Fig. 1. Time change of liquid water at the lowest level for the 8 runs. The ac, dp, and cl indicates activation, deposition, and collision process, and K and T means Kuba-Fujiyoshi scheme and TAU scheme respectively.

Keywords: bin micro physical model, boundary layer cloud, kinetic driver

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