Impact of cloud microphysics on vertical properties of tropical cloud systems in a cloud resolving simulation using satellite simulators

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1. Introduction

Cloud resolving models (CRMs) with a horizontal grid spacing of a few kilometers is one of useful tools to study mesoscale convective systems. CRMs has many uncertainties in physical schemes like microphysics. Satellite observations have been used to evaluate tropical cloud properties of CRMs. Inoue et al. (2008) investigated the cloud horizontal size distribution of cloud clusters using equivalent blackbody temperature (TBB) of the infrared channel of 11 um. Satoh et al. (2010) evaluated vertical structures of cloud systems using Cloudsat and CALIPSO data and they tested impact of more comprehensive microphysics scheme. Matsui et al. (2009) proposed the TRMM Triple Sensor ThreeStep Evaluation Framework (T3EF) for the systematic evaluation of precipitating cloud types and microphysics in CRMs. In this study, we introduce short evaluation results related to horizontal distribution of cloud systems in our simulations using previous methodology. We evaluate the joint diagram and CFAD of echo top height of TRMM PR and TBB based on Matsui et al (2009). We focus on the sensitivity tests about effects of microphysics on the vertical structures in order to improve the results in comparison with observation data.

2. DATA

2.1 NICAM

NICAM simulations are performed from 00 UTC 1 January to 00 UTC 6 January 2007. The actual analysis was made for the period of from 00 UTC 2 to 00 UTC 6 January. The central point of the simulation is 180E on the equator and analysis domain is 10S-10N and 170E-170S. We used the stretched grid system, and the minimum horizontal grid is set to 3.5. Most of the horizontal grid spacing is under 5 km. vertical levels is 40. The one moment bulk microphysics scheme (NSW6) is used in this study.

2.2 Satellite data and satellite simulator

11 um infrared channel data of MTSAT geostationary satellite and TRMM PR 13.8 Ghz attenuation corrected reflectivity were used. We simulated corresponding infrared brightness temperature, radar reflectivity of NICAM using the Satellite Data Simulation Unit (SDSU, Masunaga et al. 2010).

3. Results

NICAM has good agreement of cloud size distributions and propagation of cloud systems. However, there are schematic bias related joint diagram such as higher echo top height and lower cloud top temperature. We focus on improvement of the two biases about higher echo top height and lower TBB in the joint diagram. We found the size distribution parameter for snow and graupel had some impact on the location of high frequency of echo top height. According to Heymsfeild et al., 2002, there are relationship between λ and N_0 in deep cirrus and stratiform precipitation clouds. When we applied for these relationships for snow category in our microphysics scheme, we could reduce frequency of higher echo top height. This parameterization could explain the aggregation term in same category. We also would investigate the impact of parameterization of N_0 in rain category on the distribution of reflectivity of warm cloud in CFADs.

$$n(D)=N_0\exp(-\lambda D) \quad (1)$$

References

Heymsfield, A. J. et al. 2002. “Observations and parameterizations of particle size distributions in deep tropical cirrus and stratiform precipitating clouds: Results from in situ observations in TRMM field campaigns”. *J. Atmos. Sci.* **59** (24): 3457–3491.

Masunaga, H. et al. 2010. “Satellite Data Simulator Unit (SDSU): A multi-sensor, multi-spectral satellite simulator package.” *Bul. Am. Meteorol. Soc.*

Matsui, T. et al. 2009. “Evaluation of long-term cloud-resolving model simulations using satellite radiance observations and multifrequency satellite simulators.” *J. Atmos. Sci.* **26**(7): 1261–1274.

Satoh, M. et al. 2008. “Nonhydrostatic icosahedral atmospheric model (NICAM) for global cloud resolving simulations.” *J. Compu. Phys.* **227**(7): 3486–3514.