# 論文の内容の要旨

## 論文題目

## An improvement of a single-moment bulk microphysics scheme for mesoscale convective systems using a satellite simulator

## (メソ対流システムを対象とした人工衛星シミュレーター—を利用したシングルバルク雲微物理スキームの改良)

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Clouds and precipitations in the tropics are important because of the energy budget of atmosphere and the amounts of precipitation to about two-thirds of the global precipitation.. It is important to improve cloud statistics reproduced by numerical simulations due to lack of observations and also to uncertainties in retrieved physical parameters such as ice water content and effective radius. The purpose of this study is to improve the simulation of clouds and precipitation by a cloud system resolving model using the Tropical Rainfall Measuring Mission (TRMM) data with a satellite simulator. This study is the comprehensive evaluation of the model performance using a variety of dataset and the identification of an efficient method by a single-moment bulk scheme to improve it.

Deep convective systems over the tropical open ocean are evaluated based on the joint histogram of cloud-top temperature and precipitation echo-top heights, which were simulated by a nonhydrostatic model using a satellite simulator. The control experiment shows systematic discrepancies compared to the TRMM data, which are due to underestimation of stratiform precipitation and a higher frequency of precipitating deep clouds whose top height is higher than 12 km. Nevertheless, it shows good agreement with the data with regard to the horizontal distribution and statistical cloud size distributions of deep convective systems. The biases in the joint histogram can be improved by modifying the cloud microphysics parameters in the framework of a single-moment bulk microphysics scheme. Specifically, the effects of the size distribution of precipitating hydrometeors are examined in detail. It is found that the size distribution of precipitating hydrometeors improved the probability distributions of the joint histogram and contoured frequency by altitude diagrams (CFADs) of the convective precipitation clouds.

Simulations of global clouds and precipitations by a global cloud system resolving model with a 3.5 km horizontal resolution are performed and evaluated using the TRMM and CloudSat data. The characteristics of vertical cloud structures among different regions are investigated. The simulation with the modified microphysics improves the joint histogram patterns related to stratiform precipitation. The cross-section of the tropical cyclone Fengshen is investigated. The regional differences of the joint histograms are examined over the tropics. It is found that the improved microphysics in the regional scale is capable to advance the results of global cloud simulations.

Additional evaluations are performed using 85-GHz microwave channel, OLR, and effective radius. We find small effects of the modified simulations on the cumulative probability distribution of polarization corrected 85-GHz brightness temperatures in mesoscale convective systems. The modified simulation generally improves the OLR but tends to underestimate the observation. The vertical structure of retrieved effective radius is improved from the other active sensor satellite data. However, the OLR and the simulated 85 Ghz brightness temperatures remained to improve in this study.

In summary, the improvement of cloud/precipitation microphysics can successfully reproduce the OLR and accumulated precipitation over the tropical ocean. The improvement of microphysics in a regional scale model would be directly applicable to the analysis of cloud statistics based on TRMM and CloudSat. We believe the better performance of cloud statistic simulation would give a more promise results for prediction of climate change and understanding of cloud and precipitation systems.