Project name：Numerical study on cloud systems using NICAM

Project leader：Masaki Satoh, Atmosphere and Ocean Research Institute, The University of Tokyo
Project members：Woosub Roh, Atmosphere and Ocean Research Institute, The University of Tokyo
Tempei Hashino, Kochi University of Technology

Research period：April 2018－March 2019

1. Research purpose

It is important to evaluate and improve the cloud properties in non-hydrostatic models such as NICAM (Satoh et al. 2014) using observation data. One of methods is a radiance-based evaluation using satellite data and a satellite simulator, which avoids making different settings of the microphysics between retrieval algorithms and NICAM.

It is difficult to represent mixed-phase clouds using weather prediction models and climate models because of their poor understanding of cloud physics and dynamics. The mixed-phase clouds consist of water vapor, Super-Cooled liquid Water (SCW), and ice particles. They are found at temperatures from 0 to -40℃ over the globe. The cloud albedo increases because of SCW clouds. The amount of mixed-phase clouds affects climate change. Tan et al. (2016) showed that an underestimation of mixed-phase cloud leads to negative cloud phase feedback in global warming.

The purpose of this study is an evaluation and improvement of mixed phase clouds in NICAM using a Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) and a satellite simulator.

2. Research plan

We evaluate simulations of SCW clouds over the Southern Ocean by two different microphysics schemes like a single moment scheme and a double-moment scheme in NICAM using Joint simulator. We investigate and improve mixed phase clouds in the boundary layer using a single column model.

3. Research progress

This year, we evaluated two microphysics like the NICAM Single-moment Water 6-categories (Tomita 2008b; Roh and Satoh 2014, herein NSW6) and the NICAM Double-moment scheme of 6-Water categories (Seiki and Nakajima 2014, herein NDW6) over the Southern Ocean using a regional version of NICAM. We investigated the vertical structure of ice water contents (IWC) and liquid water contents (LWC) in order to investigate the mixed-phase clouds (Fig. 1). NSW6 had larger deficits of SCW clouds than NDW6. In addition, it underestimated the backscatters in the boundary layer clouds (not shown). NDW6 showed good agreement with the observation with regard to SCW clouds in the top layer of clouds (not shown).

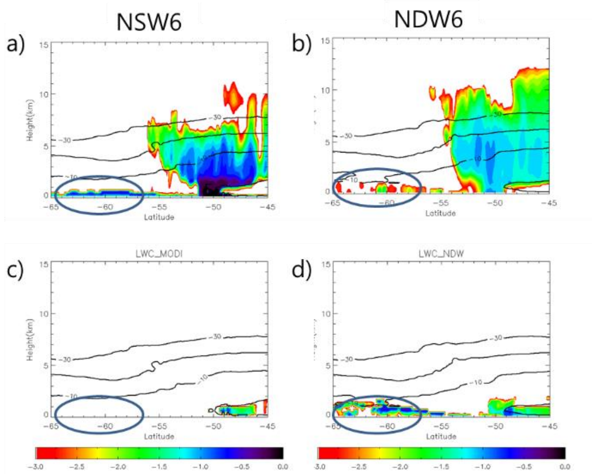

Fig. 1. Latitude-height distributions of ice water contents (upper) and liquid water contents (bottom). The left figures are from NSW6 simulations and the right figures are from NDW6 simulations. The unit of the color bar is logarithm of g m^{-3}.

The simulated prognostic number concentrations of ice particles were lower in the boundary layer clouds than NSW6, and it decreases the deposition process of ice particles. According to Forbes and Ahlgrimm (2014), the deposition process on the cloud top is important to reproduce the SCW clouds, and it is related to the size distribution of ice and liquid particles. We investigated the important microphysical processes about SCW clouds and improved the single moment scheme using a single column model and NDW6.

4. Future plan

We expand to global experiments using the improved single moment scheme and a global version of NICAM. We investigate the impact of SCW clouds on climate sensitivity using two microphysics.

5. Previous project name

Numerical Study on Cloud Systems using NICAM
（NICAM による雲降水システムの研究）

6. Record of supercomputer use （1st October 2017 ～30th November 2018 ）

Number of users: 3

CPU hours v_deb: 0.00 hours, v_32cpu: 1,236.20 hours, v_96cpu: 0.00 hours, v_160cpu: 0.00 hours, Total: 1,236.20 hours