Project name：Numerical study on cloud systems using NICAM
（NICAM による雲降水システムの研究）

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1. Research purpose

An evaluation and improvement of cloud properties and precipitations in the cloud system resolving model is important for the mesoscale and climate study. The satellite data are used for evaluations of cloud properties and precipitations in the cloud system resolving model because large coverage of space and time. The microwave radiometers on satellites are used to retrieve precipitation rates. The purpose of this research is to compare characteristics of passive microwaves using two different microwave simulators and investigate the effects of microphysics on the passive microwaves over the tropical open ocean using NICAM.

2. Research plan

We compare two microwave simulators like Joint simulator (Hashino et al. 2013) (J-simulator) and Liu's microwave simulator (Liu 2008) (Liu's model) in order to investigate the uncertainties of microwave models. And we investigate effects of microphysics and non-spherical assumption of snow using Liu's model. Liu's model can study effects of the non-scattering assumptions for snow based on their discrete dipole approximation (DDA) databases.

3. Research progress

We tested two microwave simulators for the tropical open ocean case in January 2007 using a stretched NICAM and the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E). Figure 1 shows horizontal distributions of the 89 GHz polarization corrected brightness temperatures (PCT89) for AMSR-E, J-simulator, and Liu's model. NICAM reproduces the convective band near north latitude 5 degrees like observation. Horizontal distributions of PCT89 are almost same in both microwave simulators. We investigate the probability distribution functions of 19 and 89 GHz channels. Both results by two microwave simulators are also almost same for 19 and 89 GHz channels. It means differences of two microwave simulators are not important factors such as surface emissivity model and scattering approaches in this case.

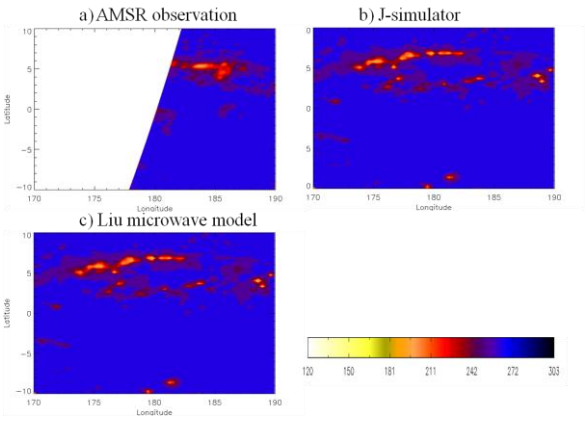

Fig. 1. Horizontal distributions of PCT89 for AMSR-E (a), J-simulator (b), and Liu's microwave model (c) on 12 UTC 2nd Jan. 2007 with a 38 km horizontal resolution.

The probability distribution functions of 19 GHz channels are very similar among observation, J-simulator and Liu's model. However, two simulators overestimate frequencies from 150 to 200 K in PCT89 comparing to observation. We think it means NICAM reproduce more extreme deep convective precipitation than observation, because PCT89 are sensitive to scattering of precipitating hydrometeors such as snow and graupel.

We investigate the non-spherical assumption of snow in two microphysics such NSW6 (Tomita 2008) and modified NSW6 (Roh and Satoh 2014). The effects of non-spherical assumption are different in two microphysics. The NSW6 is more sensitive to shape assumptions of snow comparing to the modified NSW6.

4. Future plan

We will analyze microwave characteristics in the global results of NICAM with a 3 km horizontal mesh for June 2008 case. We will compare it with the previous

results simulated by the stretched NCIAM. We will investigate the effects of surface conditions and temperatures over land on passive microwave results.

5. Record of supercomputer use （1 st June 2015 ～30 th September 2015, SX-ACE）

Number of users: 3

CPU hours v_deb: 0.00 hours, v_32cpu: 0.00 hours, v_96cpu: 0.00 hours, v_160cpu: 0.00 hours, 計: 0.00 hours

6. Summary of last year's research project

6.1. Previous project name

Numerical study on cloud systems using NICAM

6.2. Previous research purpose

The evaluation of microphysics in NICAM using observations such as ground observations and satellite data is an important issue. We compared and analyze two simulations using two microphysics schemes utilizing Joint simulator and a merged dataset for CloudSat radar and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) lidar (Hagihara et al. 2010) (hereafter, CSCA-MD) and Joint simulator. We investigated cloud frequencies based on CloudSat radar and CALIPSO lidar. We followed the methodology of Hashino et al. 2013, i.e. used diagrams called cloud-top beta-temperature radar-conditioned (CT BETTER) diagrams, and contoured frequency by temperature diagrams (CFEDs) method was used to evaluate the effects of microphysics on the cloud properties of NICAM.

6.3. Outline of the previous research project

The modified NSW6 had a better agreement with the CFEDs of cloud mask C3 and CT BETTER diagram than CON. However, there were biases such as an overprediction of cloud masks and an underestimation of maximum 94 GHz radar reflectivities and 532 nm back scattering coefficients. The reasons for these biases can be the following. First, Roh and Satoh (2014) focused on precipitating hydrometeors such as snow, graupel, and rain. These were more sensitive to low-frequency microwave channels. In a higher-frequency active sensor such as CloudSat and lidar, the size distribution of cloud ice and cloud water is more important than in low frequency channels. Second, the Joint simulator use a lookup table based on effective radius and ice water contents. The lookup table has been compiled on the assumption of log-normal distribution based on cirrus clouds (Okamoto et al. 2003). It is possible that this size distribution assumption leads to an underestimation of the effective radius. Hashino et al. (2013) noted that one of the reasons for the underestimation of the effective radius probably was related to the possibility that the size distribution of the NICAM simulation could be multimodal.

6.4. Previous record of supercomputer use（1st April 2014 ～ 31th March 2015, SX-9/A(ECO)）

Number of users: 3

CPU hours v_deb: 11.76 hours, v_cpu: 0.00 hours, v_8cpu: 8.87 hours, v_16cpu: 0.00 hours, 計: 20.62 hours