Project name：Numerical study on cloud systems using NICAM

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1. Research purpose

The representation of clouds has a large uncertainty in global climate models (GCMs). The results of GCMs depend on a cumulus parameterization. Several global storm resolving models (GSRMs) such as NICAM have developed to reproduce convections without cumulus parametrizations with a few kilometers horizontal resolution. It is important to intercompare GSRM simulations and investigate the characteristics for cloud and precipitation. One of intercomparison projects for GSRMs is the DYAMOND (DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains).

It is known the three typical cloud types like shallow cumulus, cumulonimbus, and congestus (e.g. Johnson et al. 1999). In this study, we investigate the vertical cloud structures over the Atlantic using DYAMOND data..

The purpose of this study is an intercomparison of GCRMs and understanding of characteristics of NICAM for the performance of tropical clouds.

2. Research plan

The DYAMOND data are initialized on 1st Aug. 2016 with same ECMWF 9 km reanalysis data. Total integration time is 40 days. 9 models participated this project: the global non-hydrostatic model of the Météo-France (ARPEGE-NH), The GFDL Finite Volume Cubed-Sphere Dynamical Core (FV3), The Goddard Earth Observing System (GEOS), a non-hydrostatic model discretised over an icosahedral (ICON), ECMWF Integrated Forecasting System (IFS), the Model for Prediction Across Scales (MPAS), a Non-hydrostatic ICosahedral Atmospheric Model (NICAM), System for Atmospheric Modeling (SAM), and Unified Model (UM).

4 models did not use cumulus parameterization (ARPEGE-NH, ICON, NICAM, and SAM) and the other models used the shallow or full parametrization for clouds. The simulations except UM simulation are done with less than 5 km horizontal resolution. NICAM, IFS and ICON simulations are done with coarser resolutions for the sensitivity experiments.

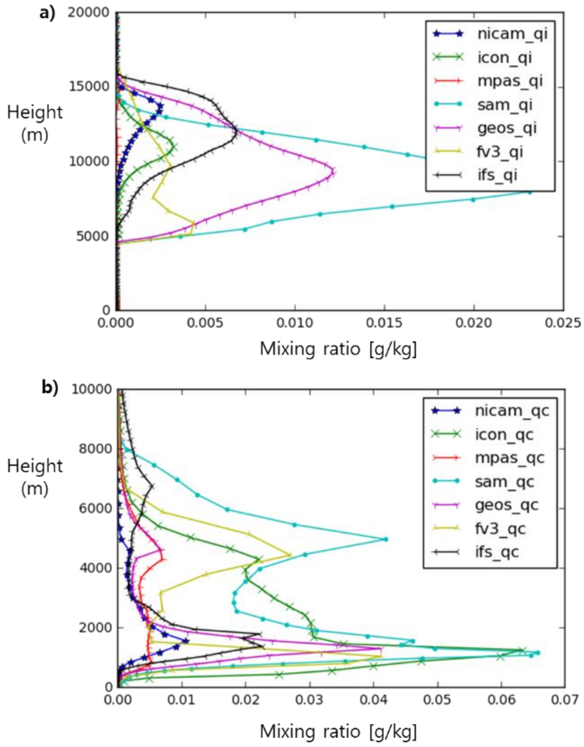

Fig. 1 Vertical profiles of domain-average mixing ratio of cloud ice (a) and cloud water (b) on 00UTC 11th Aug. 2016.

We focus on the domain over the Atlantic with 30°W – 50°W and 0°N – 20°N using CDO..

3. Research progress

This year, I learned how to handle with DYAMOND data and analyze some data. Figure 1 shows the vertical profiles of domain-average mixing ratio of cloud water and cloud ice on 00UTC 11th Aug. 2016. All simulations reproduce the triple modes of cloud systems like shallow, congestus, and deep clouds. The distribution of cloud water describes shallow and congestus clouds. The peaks of cloud water amount in shallow clouds are between 1.5 and 2 km altitudes in DYAMOND data. The peaks of cloud water amount in cumulus vary from 4 km to 7 km altitudes. It means the dynamics for congestus are different in simulations. IFS reproduces the highest peak of cloud water amount than the other models. The most of models reproduce the 5 km altitudes of congestus. The distribution of cloud ice shows the deep cloud mode. NICAM shows large amount of cloud ice near 14 km. SAM and GEOS reproduces lower height of maximum cloud ice amount near 9 km.

4. Future plan

We will intercompare and analyze the cloud fraction of shallow, congestus, and deep clouds in DYAMOND data. And we will investigate the resolution dependency on vertical structure of cloud types.

We will also evaluate the cloud fraction of DYAMOND data using cloud mask data from CALIPSO and CloudSat.

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 2018 - 30th November 2019）

Number of Users: 3

CPU 時間 v_deb: 0.00 hours, v_32cpu: 418.18 hours, v_96cpu: 0.00 hours, v_160cpu: 0.00 hours, 計: 418.18 hours