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

It is important to evaluate and improve the cloud properties in global non-hydrostatic models like a Nonhydrostatic ICosahedral Atmospheric Model (NICAM, Satoh et al. 2014) using observation data. One of the methods is a radiance-based evaluation using satellite data and a satellite simulator (here Joint simulator, Hashino et al. 2013), which avoids making different settings of the microphysics between retrieval algorithms and NICAM.

The satellite data with active sensors has a limitation to observe the specific case of cloud and precipitation systems. And it is needed to validate satellite observations using in-situ observation. There are intensive observation stations over the Kanto region. The ULTIMATE (ULTra sIte for Measuring Atmosphere of Tokyo metropolitan Environment) is proposed to verify and improve high resolution numerical simulations based on these observation data.

This research is for evaluation and improvement of clouds and precipitation systems in NICAM using the intensive observation data over the Kato area.

2. Research plan

There are several observation instruments over the Kanto region. Figure 1 shows the ultra-site observation networks in Kanto area. In the previous fiscal, we achieved the observation data like C-band polarimetric radars in Narita and Haneda airport and WINDAS data. And we got the observation data of the Cloud Profiling Radar (CPR, 94 GHz) in NICT.

POLArimetric Radar Retrieval and Instrument Simulator (POLARRIS, Matsui et. al. 2019) was implemented in Joint simulator. The POLARRIS can simulate differential reflectivity (ZDR), specific differential phase shift (Kdp), co-polar cross-correlation coefficient (ρhv), and Doppler velocity of a polarimetric radar using Mueller scattering matrix.

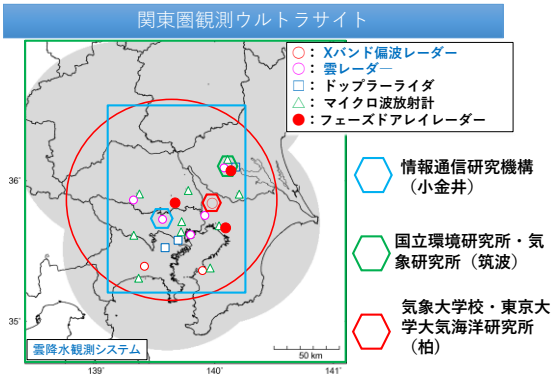

Fig. 1. Ultra-site observation networks in Kanto area.

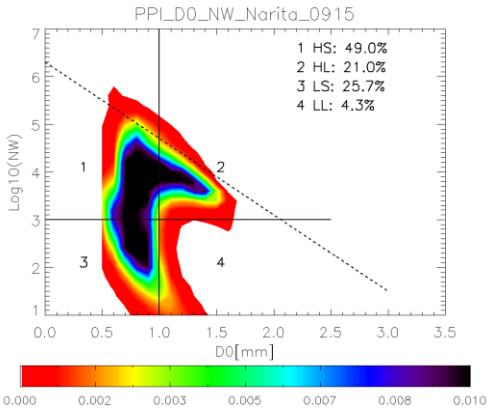

Fig. 2. An example of the joint histograms of D0 and NW from radar reflectivity and ZDR on 16th Sep. 2019 from the C-band radar in Narita airport.

We used the stretched version of NICAM. We selected three cases for September 2019. We calculate the signals of CPR and C-band polarimetric radar using Joint simulator.

In this study, we evaluate our microphysics schemes using CPR in NICT. And we apply for the evaluation results to understand the performances of the EarthCARE CPR.

And we understand the characteristic of a polarimetric radar for microphysics, and develop new evaluation method using the data.

Finally, we improve our microphysics schemes using these observation data in the Tokyo metropolitan area.

3. Research progress

The last fiscal year, we evaluated a single moment scheme (NSW6) in NICAM using the CPR in NICT and investigated the performance of the EarthCARE CPR using a random error based on the observation window.

We briefly introduced a rain microphysics evaluation method using a polarimetric radar. The figure 2 shows the example of joint histograms of D0 and NW from radar reflectivity and ZDR on 16th Sep. 2019 from the observation in Narita airport. D0 means the retrieved median volume diameter of rain and NW is the retrieved normalized interceptor parameter from the rain size distribution. The previous study used this diagram for the separation between convective and stratiform precipitation (the dotted line in fig. 2). We applied this diagram for the evaluation of the rain microphysics schemes. Our interpretation was the regime 2 is related to coalescence process and the regime 4 is related to evaporation process.

This fiscal year, we had sensitivity tests of rain microphysics scheme in a double moment scheme (NDW6) for the coalescence and evaporation process. We checked our interpretations for the evaluation method and understand the performance of our microphysics. We found the overestimation of rain diameter related to the evaporation process, and the mismatch of the frequencies in the regime 4 related to a coalescence process parameter.

4. Future plan

We will find the suitable parameters of NDW6 for the coalescence and evaporation processes using C-band polarimetric radar. We will investigate the impact of these parameters on the storm dynamics like precipitation size and precipitation intensity.

We will consider how to evaluate the riming process using a polarimetric radar and the lightning observation data.

We will consider the simulations of X-band phased array radar and WINDAS using Joint simulator.

5. Previous project name

Numerical study on cloud systems using NICAM（Project leader：Masaki Satoh）
NICAM による雲降水システムの研究（課題代表者：佐藤正樹）

6. Record of supercomputer use （November 1, 2021～October 31, 2022）

Number of Users: 3
VE node time product　v_debug: 0.00 hours, v_normal: 0.00 hours, Total: 0.00 hours（Occupancy rate of the whole VE node time product: 0.0 %）