Applications of Joint simulator for the ULTIMATE project

Woosub Roh[1]*, Masaki Satoh[1], Yuichi Ohno[2], and Tempei Hashino[3]
([1]AORI, the University of Tokyo, [2]NICT, [3]Kochi University of Technology)

1. Introduction

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.

The previous presentation of Prof. Satoh is about the general features of ULTIMATE project. In this study, we introduce application and development of Joint simulator to simulate radiances from in-situ observations for ULTIMATE project.

2. In-situ observations

There are several observation instruments over the Kanto region. For examples, the High Spectral Resolution Lidar (HSRL, 355 nm), Doppler lidar, and the Cloud Profiling Radar (CPR, 94 GHz) are located in NICT. HSRL and Doppler lidar can observe the aerosols and optically think clouds.

The Polarimetric radars are located in Haneda and Narita airports with 5.3 GHz wavelength.

Polarimetric radar can observe the precipitation hydrometeors and retrieve the hydrometeor identification based on polarimetric variables.

The WInd profiler Network and Data Acquisition System (WINDAS) data is available in Kawaguchiko, Mito, and Kumagaya. WINDAS can observe 3D wind fields.

3. Applications of Joint simulator

Joint simulator is developed for The EarthCARE satellite, which have CPR and HSRL. The EarthCARE Active Sensor Simulator (EASE, Okamoto et al. 2007, 2008; Nishizawa et al. 2008) in Joint simulator can simulate signals of CPR and HSRL in NICT.

Recently, 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 (K_{dp}), co-polar cross-correlation coefficient (ρ_{hv}), and Doppler velocity of a polarimetric radar using Mueller scattering matrix.

We used the stretched version of NICAM for test data of Joint simulator. We selected three cases for September 2019. Figure 1 shows the horizontal distribution of precipitation in one of the cases on 22 UTC 15th September 2019 by NICAM. The figure 2 shows examples of the simulated signals of polarimetric radar in Narita airport at 2.25 km altitude. For examples, Figure 2b implies the shape of raindrop, Z_{dr} increases with a size of raindrop. The K_{dp} is proportional to a size of raindrop and a number concentration of hydrometeors.

We will introduce results of Joint simulator for ULIMTATE project. And We will discuss with issues of simulations of in-situ observations.

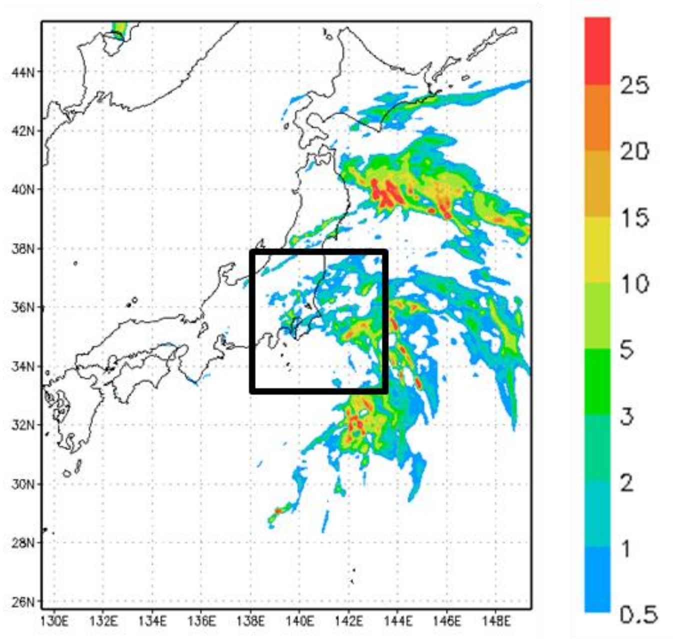

Figure 1. Horizontal distrubtions of precpitaion of NICAM on 22 UTC 15th Sep. 2019. The black box is the domain of Fig. 2.

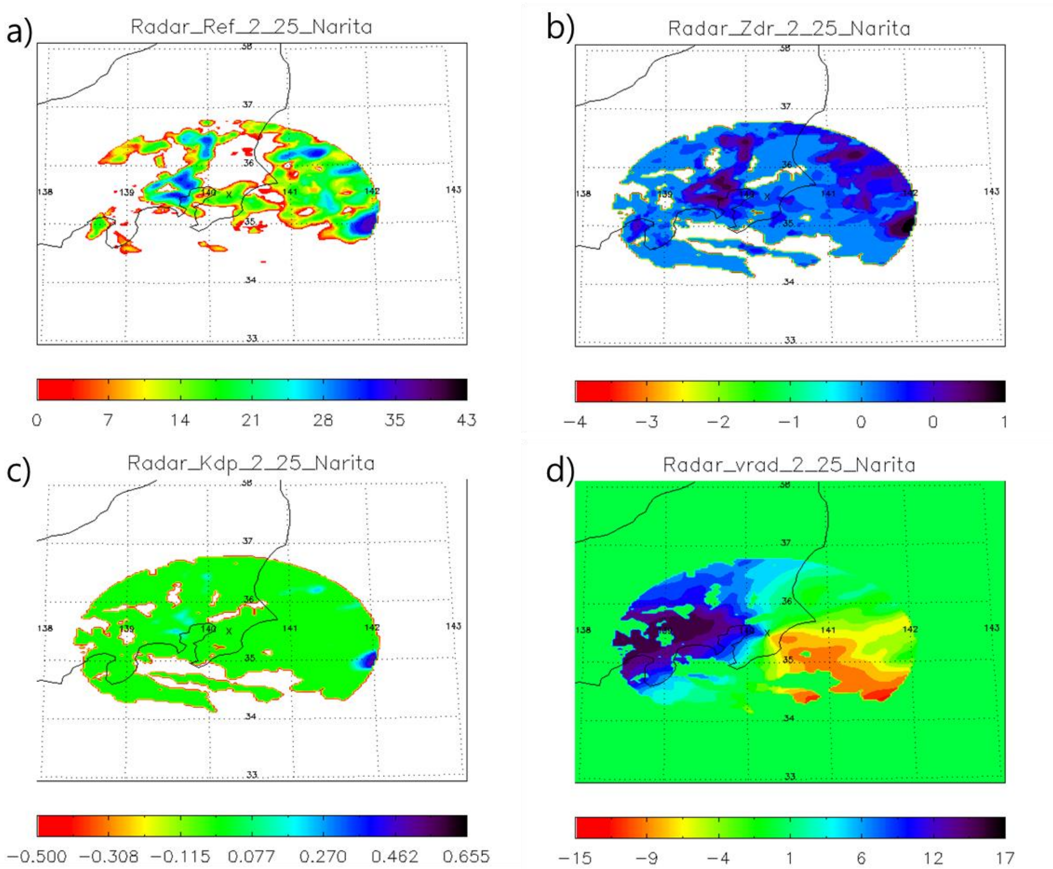

Figure 2. The simulated radar refeltivities (a), Z_{dr} (b), K_{dp} (c), and Doppler velocities (d) of NICAM at 2.25 km atlitude in the polarimetric rdar in Narita using POLARRIS of Joint simulator on 22UTC 15th Sep. 2019.