Assimilation Experiment On A Local Heavy Rainfall Event Using Doppler Lidar Observations

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1. Introduction

We have developed a cloud resolving 4D-Var assimilation system in order to investigate mechanisms of meso β-γ scale convective systems. This assimilation system is called as NHM-4DVAR (Kawabata et al. 2007, 2011), which consists of a full-nonlinear nonhydrostatic model (JMANHM; an operational mesoscale model in JMA) and an adjoint model based on simplified JMANHM with warm rain process as cloud microphysics. NHM-4DVAR has been applied to data assimilation experiments with a 2-km horizontal grid spacing. Several observation operators have been implemented for radial winds by meteorological Doppler radars, radar reflectivity, GPS precipitable water vapor, GPS zenith total delay, GPS slant total delay, virtual temperature profile by RASS, and conventional observations.

In this study, we will demonstrate the impact of new available observation data to the rainfall forecast: radial wind observations by Doppler Lidar, which has been developed and operated by the National Institute of Information and Communications Technology (NICT, Iwai et al. 2011).

2. Assimilation Experiment

Two assimilation experiments were conducted for a local heavy rainfall event (Fig. 1). This event occurred on 5 July 2010 in the west of Tokyo and induced maximum rainfall amount of 107 mm and urban flush flood. Cumulonimbi which induced this event passed near the NICT Lidar observation site and their surrounding air flow was observed. The assimilation window was set for that period (1600 – 1630 Japan Standard Time; JST). In the control assimilation experiment (CTL), the radial wind field by meteorological Doppler Radars and GPS precipitable water vapor were assimilated every 1-min and 5-min, respectively. In the test experiment (LDR), radial winds by Lidar further to above observations were assimilated every 1-min. After the assimilation, 1-h forecasts were performed.

3. Results

Compared with the observed rainfall distribution (Fig. 1), 1-h accumulated rainfall amount in the LDR forecast is significantly better than the CTL forecast (Fig. 2). Intense rainfall region in the west of Tokyo was reproduced by the LDR forecast with a good agreement of intensity and horizontal scale.

Figure 3 shows the difference of zonal wind (U) between CTL and LDR at 225 m height level at the initial time of these experiments. The low level easterly winds in southeast of the cumulonimbus is weakened by the assimilation of Lidar radial wind observations. It is likely that the cumulonimbi were intensified by this change of the direction of the inflow wind.

References

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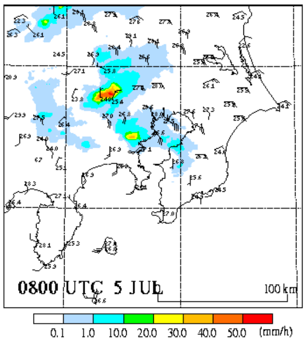

Fig. 1. Horizontal distribution of 1-h accumulated rainfall amount (1600-1700 JST) by JMA operational radars.

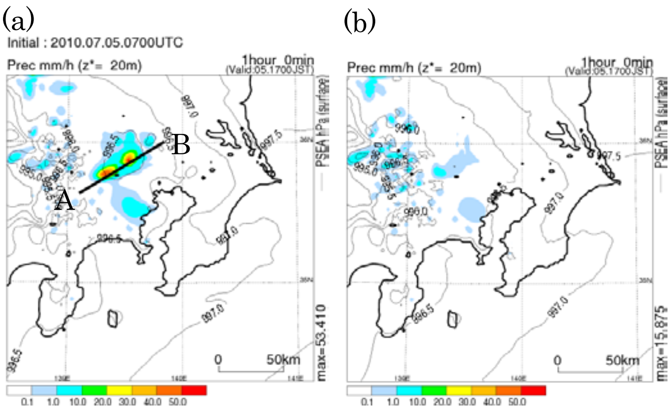

Fig. 2. Horizontal distribution of 1-h accumulated rainfall amount (shades) from 1600 to 1700 JST and sea level pressure (contours) at 1700 JST of LDR forecast (a) and the CTL forecast (b).

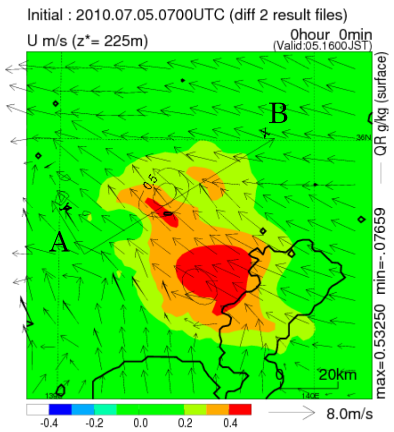

Fig. 3. Difference of zonal wind fields between CTL and LDR (shades), horizontal wind field (vectors), and mixing ratio of rain water (contours) in LDR at 225 m height level at 1600 JST.