

Data Assimilation experiment of Tsukuba tornado on May 6, 2012 using MRI Doppler Radar data

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A strong tornado with F3 scale caused serious damage in Tsukuba city on May 6, 2012. This tornado was generated at the southern tip of a precipitation area, which was moving northeastward over the Kanto Plain. Besides the Tsukuba tornado, two tornadoes were observed a few ten kilometers north of the Tsukuba tornado. The lower vortex associated with the Tsukuba tornado, as well as its precipitation area, was well captured by the Doppler Radar of the Meteorological Research Institute (MRI), because the Tsukuba tornado passed 15 km north of the MRI. However, data assimilation experiments using the high-resolution data, such as Radar data, have not been performed yet. In this study, Doppler wind data observed by the MRI-Radar were assimilated with an ensemble Kalman filter so as to evaluate the impact of the assimilation of Doppler wind.

In this experiment, a Nested Local Ensemble Transform Kalman Filter (Nested- LETKF) system, with 12 ensemble members, was used. In Outer-LETKF (horizontal grid interval: 15 km), hourly operational observation data used in the Japan Meteorological Agency (JMA) operational model were assimilated with 6 hour intervals. In Inner-LETKF (horizontal grid interval: 1.875 km), data obtained every 10 minutes was assimilated with 1 hour intervals. To assess the impact of the Doppler wind observations, we basically performed two experiments. The "CTL" experiment used conventional observations, that is, the original settings of the Nested-LETKF. The other "VR" experiment assimilated the Doppler wind data observed by MRI-Radar additionally in Inner-LETKF, while all other settings were the same as CTL. After the data assimilation experiments, downscaling ensemble experiments (horizontal grid interval: 350m) were carried out by using the analyses and 12 perturbations of each CTL and VR at 10:00 JST on May 6, 2012 as initial conditions.

In the downscaling ensemble experiments, two vortices were formed although three vortices were actually observed. The southern vortex in VR was stronger and passed about 2 km closer to the observed tornado than that in CTL. To clarify those differences, we focused on Storm Relative Helicity (SReH) and low level humidity (Low-Qv) at 10:00 JST. The SReH and Low-Qv were compared to the maximum velocity of the Tsukuba tornado vortex (Vmax) and to the latitude where the vortex existed when it passed 140E (L140), using the analyses and 12 perturbations of VR. As a result, Vmax had a positive correlation to SReH in and south of the precipitation area. It also had a positive correlation to the Low-Qv in the south of the precipitation area, and in the south of the genesis point of the vortices. In fact, Low-Qv in the south of the genesis point of vortices in VR was increased by the assimilation of Doppler wind. On the other hand, L140 had a negative correlation with Low-Qv in the south of the precipitation area. It shows that the precipitation area was elongated in the meridian directions and that the vortex was generated further to the south if humidity was higher in the south of the precipitation area.

The wind speed and location of the vortex had correlations with SReH in and south of the precipitation area. They also had correlations with Low-Qv in the south of the precipitation area and in the south of the genesis point of vortices. Therefore, proper correction of these values by data assimilation is important to better reproduce the vortex.

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