Data assimilation experiments of the local intense rainfall using LETKF

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1. Introduction

In the Meteorological Research Institute, assimilation methods have been developed to predict accurately local heavy rainfall that developed in the urban area in Japan. Besides variational data assimilation methods, mesoscale ensemble methods, such as the Local Ensemble Kalman Transform Filter (LETKF) (Miyoshi and Aranami, 2006), can produce accurate initial conditions and reduce the miss of severe phenomena. In this study, we focused on the severe thunderstorm event occurred on 5th Sep. 2008 at Sakai City in Osaka Prefecture. The results of ensemble forecast by using LETKF, and the assimilation results of radial wind of Doppler radar using 3D-Var are presented.

2. Thunderstorm on 5th Sep. 2008

The atmospheric condition was unstable, because of the cold air at the upper level and the low-level convergence of warm and humid airflows. This low-level convergence was produced by the local low-pressure that was produced by the insolation. Under this unstable condition, an intense thunderstorm, which produced the rainfall over 90 mm/hour, was developed at Sakai City in Osaka Prefecture (Fig.1a).

3. Thunderstorm reproduced by the LETKF system

Mesoscale ensemble forecasts were performed with the LETKF system at 20 km grid spacing interval. In the analysis procedure, the observation data used in the operational global and mesoscale analyses of the Japan Meteorological Agency (JMA) were assimilated. Ensemble size is chosen to be 20. The LETKF successively produced weak rainfall regions near Osaka Prefecture.

Furthermore, downscale forecast experiments were performed from the initial conditions that were obtained by the LETKF. The predicted rainfall regions near Osaka Prefecture were scattered among the ensemble members, which corresponds to large uncertainties of the forecasts. However, one of the ensemble members (#005) reproduced the intense thunderstorm near Sakai City very well, though the time of the development was delayed by 2 hours (Fig. 1b).

4. Assimilation of radial winds of Doppler radars using the NHM-3DVar system

We assimilated the radial winds of Osaka and Kansai Doppler radars to the analyzed fields of member #005, in which large scale convergence was roughly reproduced. When the radial winds were assimilated, the convergence was intensified and the temperature near the Sakai City was increased. The rainfall regions became closer to the observed ones (Fig. 1c). Moreover, the mixing ratio of rain and snow were estimated from the observed reflectivity fields and then introduced in the initial fields. Then precipitation was further introduced, the rainfall regions became more similar to the observed ones (Fig. 1d). However, in other members, thunderstorms were not reproduced, even if the same method were applied. The results suggest that large scale fields reproduced by the ensemble forecast are important before the convective scale assimilation.

5. Summary

In this case, the large scale distribution was reproduced by the LETKF method. When the member with good large scale distribution was used, the thunderstorm was reproduced by assimilation of the radial winds of the Doppler radars. The thunderstorms were not reproduced successfully in the other ensemble member, even if the same method was used. The reproduction of large scale convergence is needed to reproduce the mesoscale thunder storm.

References

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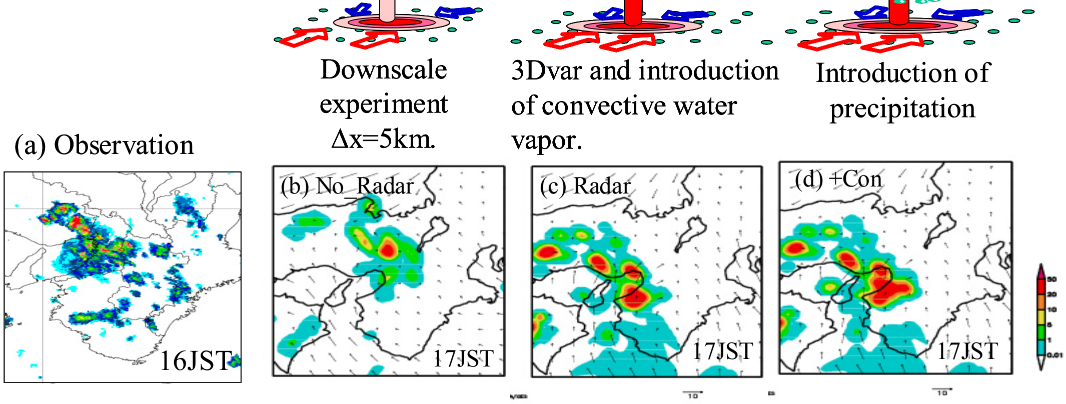

Fig. 1. Forecast of member #005 after the assimilation of radial wind and introduction of rainfall. Assimilation method is the same as Seko et al. (2007).