Data assimilation experiments using a nested LETKF system

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1. Introduction

Because analysis errors are included in the initial fields of numerical forecasts, ensemble forecasts in which the probability is considered are desirable. High-resolution models are needed to reproduce local heavy rainfalls that cause urban flash floods because rainfall intensity cannot be reproduced by low-resolution models. To predict local heavy rainfalls efficiently, a nesting system of local ensemble transform Kalman filter (LETKF) has been developed. In this presentation, the nested LETKF system is explained and results of data assimilation experiments are introduced.

2. Results of data assimilation experiments

a. Thunderstorm observed at the Osaka City on 5th September 2008.

On 5th September, southerly flow and northeasterly flow were converged at the Osaka Plain, and then an intense thunderstorm that caused 1-hour rainfall of more than 90 mm was generated. In its mature stage, the rainfall region was extended northwestward. When the nested LETKF system was applied, the large scale convergence was reproduced by the Outer LETKF with a grid interval of 15 km, and the northwestward extension of the rainfall region was reproduced by the Inner LETKF with a grid interval of 1.875 km. When the radial velocity of Doppler radar, GPS-derived water vapor data were added to the assimilation data, the reproduced rainfall region became more similar to the observed one.

b. Yamase phenomenon in July 2011

The Yamase phenomenon that brings cold air to the northern part of the Tohoku Region by cold easterly flows occurred on 30th-31st of July 2011. The nested LETKF system was applied to the Yamase phenomenon and investigated whether cold easterly

and low-level stratus clouds could be reproduced. When cloud images obtained by the Outer LETKF and those of the geostationary meteorological satellite were compared, the clouds on the east of the Tohoku Region that were clearly seen in the visible image and obscure in the infrared image were common. These cloud images indicate that clouds existed at low-levels. When the temperature and cloud images obtained by the Inner LETKF were compared with those observed by the Automated Meteorological Data Acquisition System of Japan Meteorology Agency and MODIS, their distributions were similar to the observed ones.

c. Mesoscale vortices occurred on 6th May 2012

Three tornados occurred near the southern edge of cloud bands over the Kanto Plain on 6th May. Downscale experiments with a grid interval of 350 m were performed from the analyzed fields of the nested LETKF (Fig. 1a). The results of downscale experiments indicate that there are three regions where vertical vortices exceed 0.1 (1/s). These regions were close to the positions where the tornados occurred though the positions of the northern two vortices were shifted northward. The durations of the intense vortices depended on the ensemble members. To investigate the factors that determine the durations, the low-level water vapor flux between two ensemble members, one of which a vortex was maintained for a long time, and other in which a vortex was not generated, were compared. In this case, the difference of low-level water vapor flux at the region far from the positions of tornados was not large. The factors that cause the vortices will be further investigated by the comparison of the ensemble members.

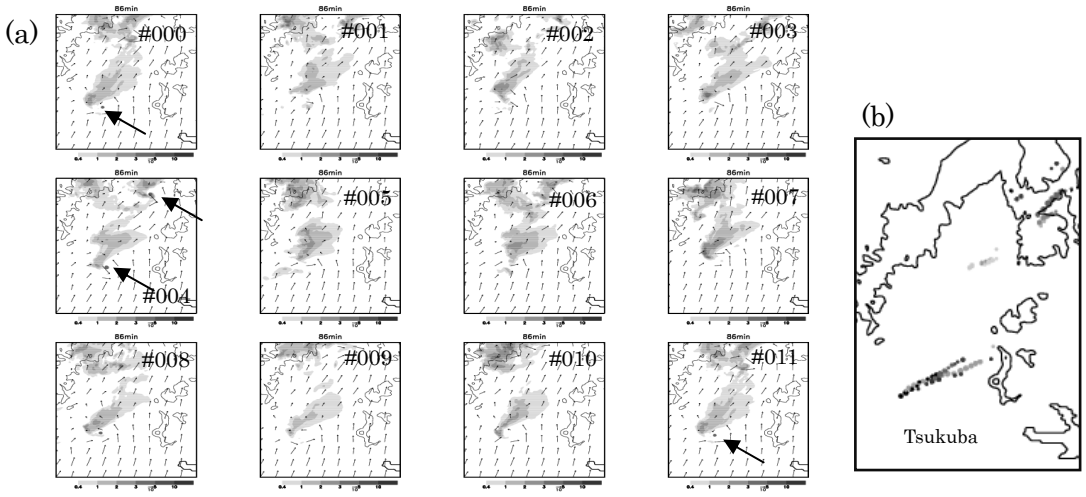

Fig. 1. (a) Rainfall regions at 1258 JST obtained by the nested LETKF system. Arrows in (a) indicate the positions of the intense vortices (>0.1 (1/s)). (b) Positions of the intense vortices reproduced by 12 ensemble members.