# Development of an LETKF Nested System for a Cloud Resolving Model

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## 1. Introduction

Assimilation methods for remote sensing data, such as radial wind of Doppler radars, have been developed at the Meteorological Research Institute (MRI) to improve the accuracy of the heavy rainfall forecast; the 3 dimensional data assimilation system for cloud resolving models and the mesoscale 4 dimensional data assimilation system and the Local Ensemble Transform Kalman Filter (LETKF) for mesoscale models. The results of these studies indicated that the horizontal convergence of low-level water vapor is essential to reproduce the heavy rainfalls. It was also reported that the large scale convergence (the environment of convections) of the first guess field should be modified by the ensemble forecast methods before the assimilation of cloud-scale data when the positional lag of the large scale convergence existed. In this report, an LETKF nested system, which modifies the large scale convergence by assimilation of conventional data and reproduces intense convection by assimilation of high resolution data, such as GPS PWV data, is explained and the preliminary results are also reported.

## 2. Outline of the LETKF nested system

The horizontal grid interval of the outer LETKF was 15 km, which is the same interval of the former studies (e.g. Seko et al. 2011). The domain was as large as 1900 km x 1900 km, which covers most of Japan. Surface and upper sounding data that were used in the operational mesoscale 4-dimensional assimilation system of the Japan Meteorological Agency were used as assimilation data of the outer model. These data were assimilated every hour in the 6-hour assimilation windows. The outer assimilation was performed from 00 UTC,1st September 2008 (5 days before the occurrence of an intense rainfall). The grid interval of the inner LETKF is set to 1.875 km to resolve individual convections. The initial and boundary conditions were produced by interpolating outputs of the outer LETKT. The domain of the inner LETKF is 300 km x 300 km that covers the local districts where the heavy rainfall occurred. The same data used for the outer LETKF were assimilated for the inner LETKF every 10 minutes with the assimilation windows of 1 hour. The analyzed fields of the outer LETKF were replaced every 6 hours by the analyzed fields produced by the inner LETKF (Figure 1).

## 3. Preliminary results of the nested LETKF system

On 5th September 2008, the intense rainfall, of which 1-hour rainfall exceeded 93 mm, was developed in the Osaka Plain, western Japan. This intense rainfall was chosen as the target event of assimilation experiments. Figure 2 shows the 1-hour rainfall distributions reproduced by the nested LETKF system at 06 UTC 5th. The outer LETKF reproduced the scatter rainfall regions on

the Pacific Ocean side of Japan. The rainfall region at Osaka was also reproduced in several ensemble members, though their rainfall intensities were much weaker than observations. In the inner LETKF, the predicted rainfall intensity exceeded 50 mm, in a few ensemble members. These rainfall amounts became larger than those of the outer LETKF, although they were still smaller than observations. This result indicates that the LETKF nested system has the potential to reproduce the intense rainfall. Other high-resolution data, such as radial winds of Doppler radar, are needed to reproduce the intense rainfall more properly.

## References

H., Seko, T., Miyoshi, Y. Shoji, and K. Saito, Data assimilation experiments of precipitable water vapor using the LETKF system: intense rainfall event over Japan 28 July 2008, 2010, *Tellus A*, 63A (in printing).

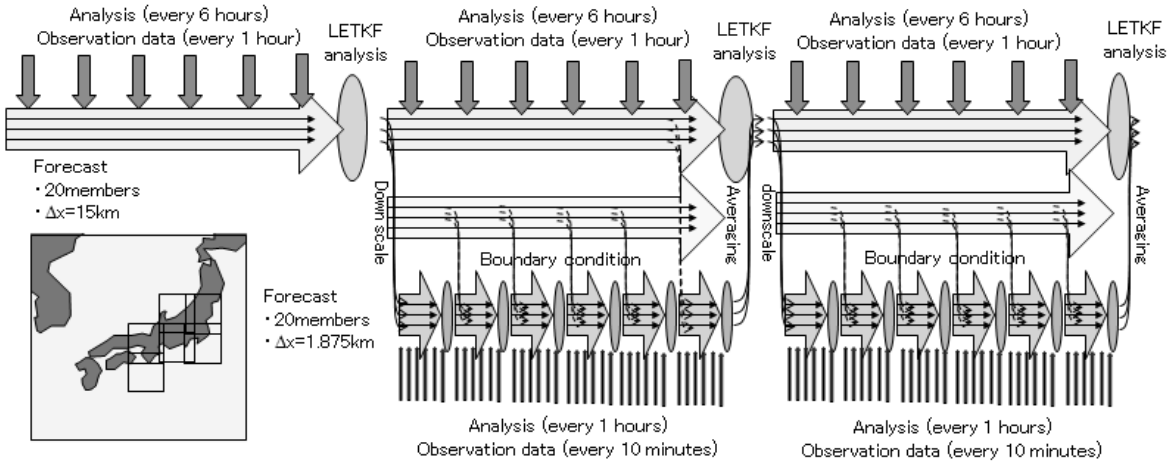


**Fig. 1 Data flow chart of the LETKF nested system.**

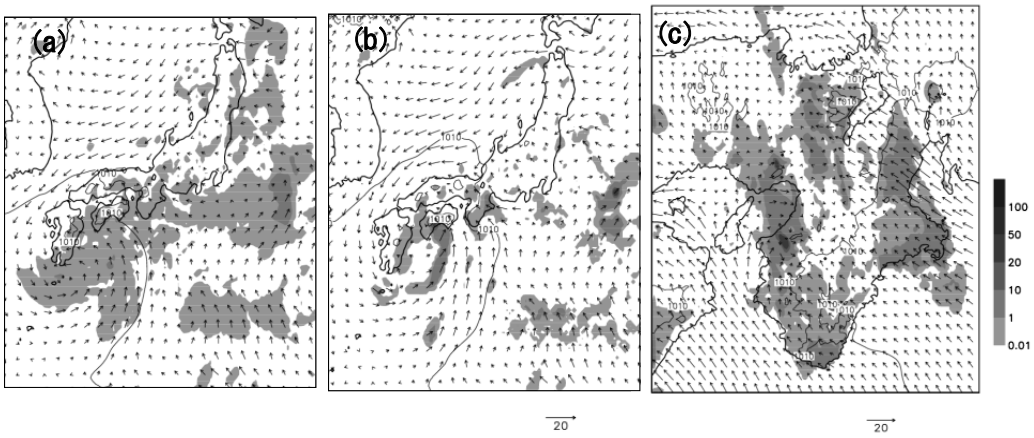


**Fig. 2 Preliminary results of the LETKF nested system**. (a) One hour rainfall distribution (shade) and horizontal wind (vector) of the ensemble mean of the outer LETKF at 06 UTC. (b) Same as (a) except for the member of #012. (c) Same as (b) except for the inner LETKF.