Construction of Mesoscale LETKF Data Assimilation Experiment System

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A development of a mesoscale LETKF (Local Ensemble Transform Kalman Filter) data assimilation system is ongoing in the field 3 task “Projection of Planet Earth Variations for Mitigating Natural Disasters” of the SPIRE (Strategic Programs for Innovative Research) project supported by the Ministry of Education, Culture, Sports, Science and Technology, aiming achievements by means of the high performance of K computer. The system consists of assimilation cycles each of which has ensemble forecast and analysis parts, and is considered to be suitable for the parallel computer since its ensemble forecast can be executed as concurrent jobs, and the LETKF analysis is a well parallelized scheme. We plan to apply this system to obtain precise analysis that enables a forecast on severe whether such as a localized torrential downpour.

This system applies the Japan Meteorological Agency (JMA) Nonhydrostatic Model (NHM) as the forecast model, and uses an LETKF analysis which is based on that of Miyoshi and Aranami (2006). The ensemble forecast with the size of 40 members and with a 10km horizontal resolution is conducted in an assimilation cycle with a six hour time window, and a control forecast runs at the same time. Perturbations for initial values of ensemble forecast in the first analysis cycle and that for lateral boundary in the every cycle are given by the perturbation of the JMA weekly global ensemble forecast. Diagram of data assimilation cycle is shown in Figure 1 (T. Fujita, NPD/JMA, 2011).

Six hourly cycle data assimilation is performed with one hour slots in the way of 4D-LETKF. After the LETKF analysis, another analysis on the initial value of the control forecast is executed applying a Kalman gain obtained in the LETKF procedure, and then an outer-loop forecast is executed using the analysis as the initial value.

A final value of the outer-loop 6 hour forecast is used as an initial value of control forecast, and contributes to initial value of ensemble forecast in the subsequent cycle.

Adaptive inflation (Miyoshi 2010) is applied in addition to multiplicative inflation. Horizontal and vertical localizations are implemented, too. Observations on surface, upper layer, aviation, doppler radar, wind profile, satellite wind, satellite brightness temperature can be assimilated by this system. Quality control procedure ported from the JMA operational system (JMA, 2007, Kazumori 2010) is applied on these observations to choose data to be assimilated.

Figure 2 shows a performance of LETKF for the spread of temperature and east-west wind component fields at the altitude of about 5500 m. We can see a spread in the analysis fields which is smaller than that in the guess fields around land area where observation is comparatively dense. After the LETKF analysis, an 6 hour forecast of outer loop gives a rainfall rate as shown in Fig. 3.

We will apply this system to cases with more spatiotemporal resolution in order to solve storm scale severe phenomena although it requires so huge calculation cost as to need to use K computer. We continue to develop this system with investigating appropriate parameter which concerned with covariance error statistics, localization and inflation, and with improving the computational performance.

References

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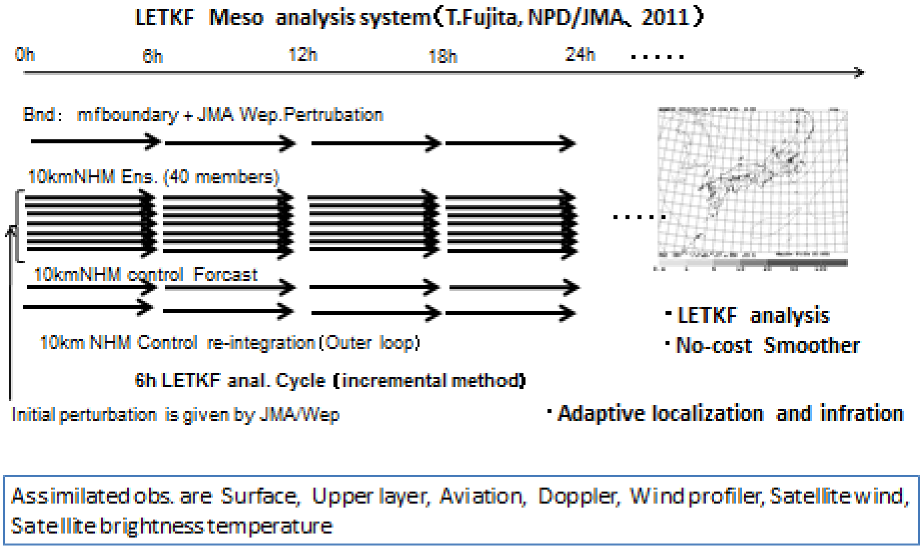

Fig. 1. Data Assimilation Cycles.

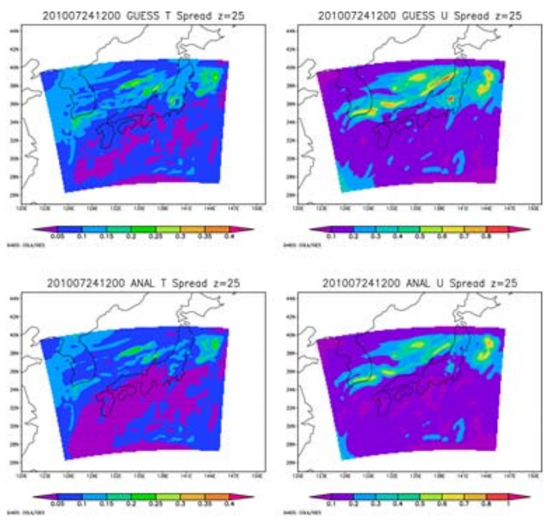

Fig. 2. Spreads on guess by ensemble forecast and on analysis obtained by LETKF analysis.

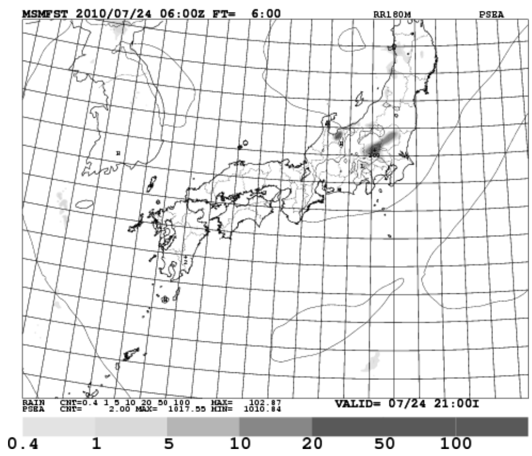

Fig. 3. Rainfall rate given by outer loop.