Development of the local ensemble transform Kalman filter with the WRF model

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1. Introduction

The local ensemble transform Kalman filter (LETKF, Hunt et al. 2007) is a realistic implementation of ensemble Kalman square root filters for advanced data assimilation and ensemble prediction. The LETKF has been successfully applied to various numerical models including global and regional numerical weather prediction (NWP) models, global and regional ocean models, and even a Martian atmospheric model; the results have been very encouraging. Recently the LETKF has been applied to the Weather Research and Forecasting (WRF) model, a widely used nonhydrostatic regional NWP model. The LETKF system includes the recently developed adaptive inflation method. In this presentation, the WRF-LETKF system is presented with preliminary results of assimilating real observations.

2. The WRF-LETKF system

The interface of the WRF-LETKF system is chosen to be simple 4-byte binary data files. This allows adapting to other regional NWP models relatively easily and visualizing the data with the widely-used GrADS software. The adaptive inflation scheme allows estimating spatially and temporally varying covariance inflation by itself, although this scheme has two tuning parameters of the initial prior inflation value and the time-smoothing parameter, both of which are only global constant. Spatial covariance localization is implemented with two tuning parameters of horizontal and vertical localization length scales. The MPI/Fortran code and run scripts are available at http://code.google.com/p/miyoshi/.

3. Assimilation results of real observations

The WRF-LETKF system has been tested by assimilating real observations in September 2008. The WRF model version 3.2 is configured in the Northwestern Pacific domain at a 60-km grid spacing. The observation data from the NCEP global data assimilation system (GDAS), known as the PREPBUFR, are decoded for input to the LETKF. The 20-member WRF-LETKF cycle is initialized by fields of randomly chosen date, and observations are assimilated every 6 hr from 00 UTC 3 September 2008. The localization parameters are chosen to be 400 km in the horizontal and 0.4 ln *p* in the vertical. For adaptive inflation, the initial inflation prior of 3% and the prior inflation variance of 0.04 are chosen. All ensemble members have the single boundary conditions from the NCEP/NCAR reanalysis (NNR).

The results are very encouraging, indicating proper performance of the LETKF. Compared with the no-assimilation case, the ensemble mean analysis rapidly approaches to the NNR. The first-guess field after the 9-day cycle experiment shows well-matured typhoon Sinlaku (2009) near Taiwan as in the NNR field, although the no-assimilation case does not generate the typhoon at all (Fig. 1).

4. Conclusion

The LETKF was applied to the widely-used WRF model and showed promising results with real observations. The general interface of the LETKF allows adapting to other regional models relatively easily. The system would be useful for various data assimilation and predictability studies using regional NWP models.

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References

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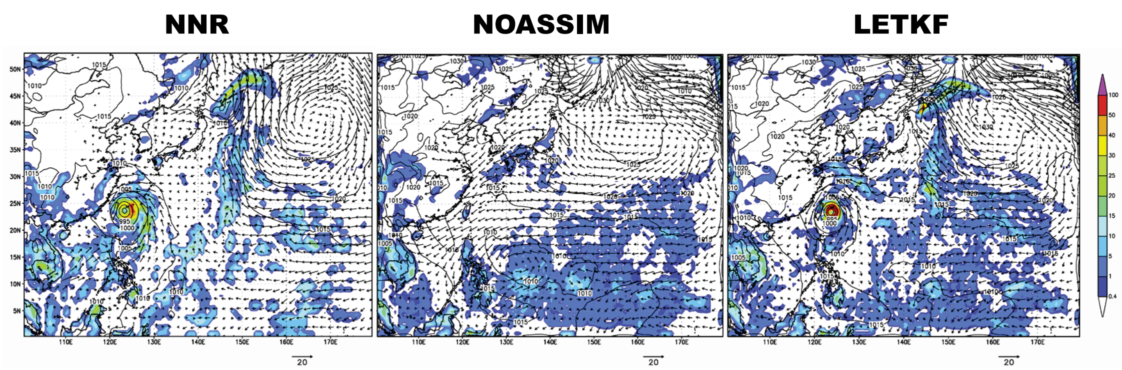

Fig. 1. 6-hr accumulated precipitation (shaded) with wind vectors and mean-sea-level pressure (contours) valid at 1200 UTC 12 September 2008 for the NCEP/NCAR Reanalysis (NNR), no assimilation (NOASSIM), and the LETKF.