Experimental operation of a high-resolution local forecast model at JMA (2)

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1. Introduction

Since 01 June 2006, an experimental operation of a high-resolution Local Forecast Model (LFM) has been executed 3-hourly (8 times a day) to produce forecasts for 12 hours. The horizontal grid spacing of the LFM is 2 km at present. And the initial condition is prepared by a rapid update cycle with the 3D-Var version of JNoVA*[1]. (Nakayama et al. 2007, hereafter N07)

This report describes the refinements after N07, presents the verification results in 2007 and discusses some remaining issues.

2. Refinements after N07

On 16 May 2007, the operational meso-scale model (MSM) was improved (Hara et al. 2007). The same improvements were basically applied to the LFM. In addition, convective parameterization was applied as explained in Section 4 (i) on 01 June 2007.

3. Verification results

The verification results for the period from June 2007 to December 2007 are presented in this report. Figure 1 shows the bias score and the equitable threat score of precipitation forecasts against the Radar-raingauge Analyzed Precipitation and Figure 2 shows the mean error and the root mean square error of surface temperature and wind speed forecasts against the surface observations (AMeDAS *[2]). The verification results of the MSM, which prepares the boundary condition for the LFM, are presented to compare with the LFM.

The bias score (BS) of precipitation on the average shows that the LFM produces heavy precipitation (> 15 mm/hr) excessively and this tendency is stronger than that for the verification period of N07. Meanwhile, the BS of precipitation on the maximum is closer to 1 than that of N07.

The mean error (ME) of surface temperature shows that the LFM has a negative bias in the day time and a positive bias in the night time, and the root mean square error (RMSE) of the LFM is smaller than that of the MSM almost throughout the day. As for surface wind speed, both the ME and the RMSE are almost the same between the LFM and the MSM.

4. Issues

<u>(i) excessive rainfall in grid point scale</u>

In summer 2006, excessive rainfalls in grid point scale had occasionally happened. Figure 3 shows one example (03 UTC on 08 September 2006). The organized convections developed in the southern sea area of the experimental domain. To cope with this problem, a modified version of the Kain-Fritsch scheme for the LFM has been temporarily applied to the experimental run since 01 June 2007. However, even with this scheme, the LFM still produces heavy rains more excessively as described in Section 3. Therefore, we are investigating the need for convective parameterization and seeking an appropriate scheme for the LFM at the present.

<u>(ii) Background error covariance in the analysis system</u>

The background error covariance in the analysis system is produced by the NMC method (Parrish and Derber 1992), which uses the differences between 6-hour and 12-hour forecast by the MSM. However, it is likely that the calculated correlation length scales of background error are too long. As a result, the influence of each assimilated observations extends over a very large area. Figure 4 shows one example (09 UTC on 29 October 2007) of this problem. Although there were no assimilated observation data on sea surface, the increment spread over sea far from land surface observation points. We need to find an optimum background error covariance for the LFM system, for example, by introducing spatial inhomogeneities and anisotropies into the covariance.

Additionally, the assimilation of new data such as MTSAT-1R AMV, Ground-based GPS, retrieved ATOVS, SYNOP and Upper Soundings is considered.

Reference

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Hara, T., K. Aranami, R. Nagasawa, M. Narita, T. Segawa, D. Miura, Y. Honda, H. Nakayama, and K. Takenouchi, 2007: Upgrade of the operational JMA non-hydrostatic mesoscale model. *CAS/JSC WGNE Res. Activ. Atmos. Oceanic Modell.*, **37**, 0511–0512.

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*[1] JNoVA is Japan Meteorological Agency (JMA) Non-hydrostatic Model based Variational Data Assimilation System.

*[2] AMeDAS (Automated Meteorological Data Acquisition System) is a high-density surface observation network covering Japan.

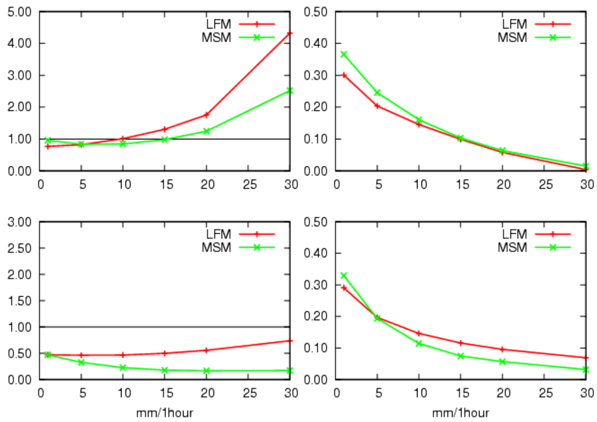

Fig 1. The bias score and the equitable threat score of precipitation forecasts against the Radar-raingauge Analyzed Precipitation for the period from June 2007 to December 2007. The red line indicates the LFM and the green line indicates the MSM. Left : bias score, Right : equitable threat score. Upper : average, Lower : maximum, both in every 20 km square mesh over land and over sea near the coast.

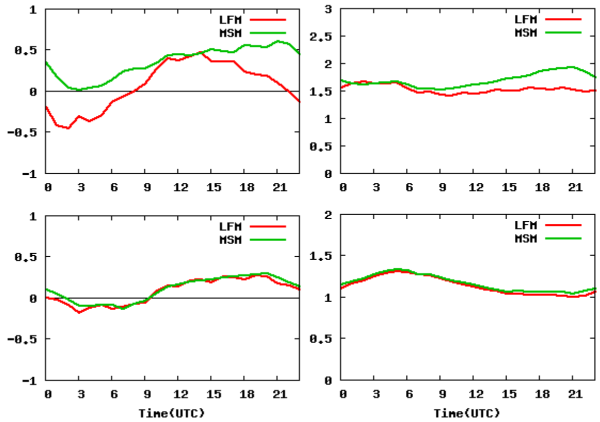

Fig 2. The Diurnal Change of the mean error (ME) and the root mean square error (RMSE) of surface temperature and surface wind speed forecasts against the AMeDAS data of about 80 points in the domain for the same period as Figure 1 (03 UTC is noon and 15 UTC is midnight at local time). The red line indicates the LFM and the green line indicates the MSM. Left: ME, Right: RMSE, Upper: surface temperature, Lower: surface wind speed.

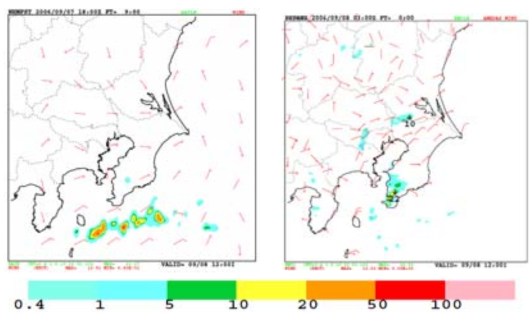

Fig 3. The 1-hour accumulated precipitation (mm/hr) and the surface wind (Each full wind barb is 10kt and each half-barb is 5kt.) at 03 UTC on 08 September 2006. Left : the LFM (Initial time = 18UTC, Forecast time = after 9 hours, without convective parameterization), Right : The Radar-raingauge Analyzed Precipitation and the surface wind observed by the AMeDAS.

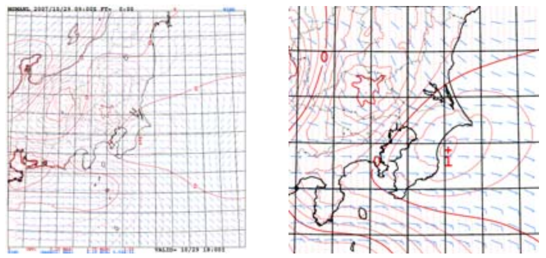

Fig 4. The analyzed increments of the surface temperature and the surface wind in a rapid update cycle at 09 UTC on 29 October 2007. The spacing of isoline is 0.2 degrees, the hatched area indicates the area which has negative increment on temperature. Each full wind barb is 2 m/s and each half-barb is 1 m/s. Right : the zoomed-in image of the central portion of the Left image.