Verification of mesoscale forecasts by a high resolution non-hydrostatic model at JMA

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1 Introduction

Japan Meteorological Agency (JMA) started operating a mesoscale numerical weather prediction system for disaster prevention in March 2001 using a hydrostatic model (MSM) with a horizontal resolution 10 km. A non-hydrostatic model (JMANHM, Saito et al., 2006, hereafter 10km-NHM) has been operating since September 2004 with the same horizontal resolution. The horizontal resolution is planned to be enhanced to 5 km (5km-NHM) in March 2006 on the new computer system of JMA.

2 Specifications of 5km-NHM

In this section, the specifications which are changed from 10km-NHM are described. See Satio et al.(2006) in detail for the specifications of 10km-NHM. For both 10km-NHM and 5km-NHM, initial and boundary fields are prepared by the JMA mesoscale 4D-Var analysis and the JMA regional spectral model, respectively.

The forecast domain of 5km-NHM covers the Japan Islands and its surrounding areas with grid points 721 × 577, while 10km-NHM covers the same area with grid points 361 × 289. The number of vertical layers is also increased from 40 to 50. The frequency of forecast is increased from 4 times a day to 8 times a day. The forecast time is shortened from 18 hours to 15 hours.

The model topographies of 5km-NHM and 10km-NHM are made from GTOPO30 developed by the U.S Geological Survey. The surface parameters, heat capacity and albedo are changed according to land-use information.

The CFL conditions of JMANHM are usually restricted not by the horizontal wind speed but by the vertical wind speeds, therefore the time step for the 5km-NHM is reduced to be 24 seconds from 40 seconds of 10km-NHM. The strength of the fourth-order computational diffusion and the nonlinear damping are increased for stable computation even in a small and intense typhoon case.

The radiation scheme which is used in the JMA global spectral model was implemented. The treatment of the optical characteristic of clouds especially at high altitudes is refined by using this scheme.

The intensity of the turbulence outside the planetary boundary layer is reduced to be half of 10km-NHM. The horizontal mixing length is reduced to the same value of that of vertical.

The Kessler-type conversion threshold from convective condensate to precipitation is increased and life times of deep and shallow convection are changed in the Kain Fritsch cumulus parameterization scheme (Kain and Fritsch, 1993) that affects greatly the accuracy of precipitation forecasts.

3 Verification results

In this section, the performance of 5km-NHM is shown in terms of statistical verification scores in comparison with 10km-NHM for the period of June to July in 2004 and January to February in 2005.

The forecasted precipitation is verified against the radar-rain gauge composite precipitation data. The verifications are carried out for every 20 km square mesh over land and over sea near the coast. Figure 1 shows the bias and threat scores for three hour precipitation by 5km-NHM and 10km-NHM. The threat scores of 5km-NHM are better than those of 10km-NHM at all threshold in summer, while they are almost comparable in winter. The bias scores of 5km-NHM are much improved to be almost flat.

Figure 2 shows the mean errors of the surface temperature and surface wind by 5km-NHM and 10km-NHM against the data collected by a mesonetwork of JMA. The number of observation points which are used for verifications is about 1000 points. The mean errors of surface temperature and surface wind are reduced in nighttime both in summer and winter by 5km-NHM.

4 Concluding Remarks

5km-NHM will be in operational use in March 2006. We are planning to extend the forecast time of this operational MSM up to 33 hours for 4 of 8 times a day in 2007. It is also planned to develop a high resolution mesoscale mode with grid spacing around 2 km for the aviation weather forecast and the urban weather forecast. Furthers developments of dynamical and physical process are continued.

References

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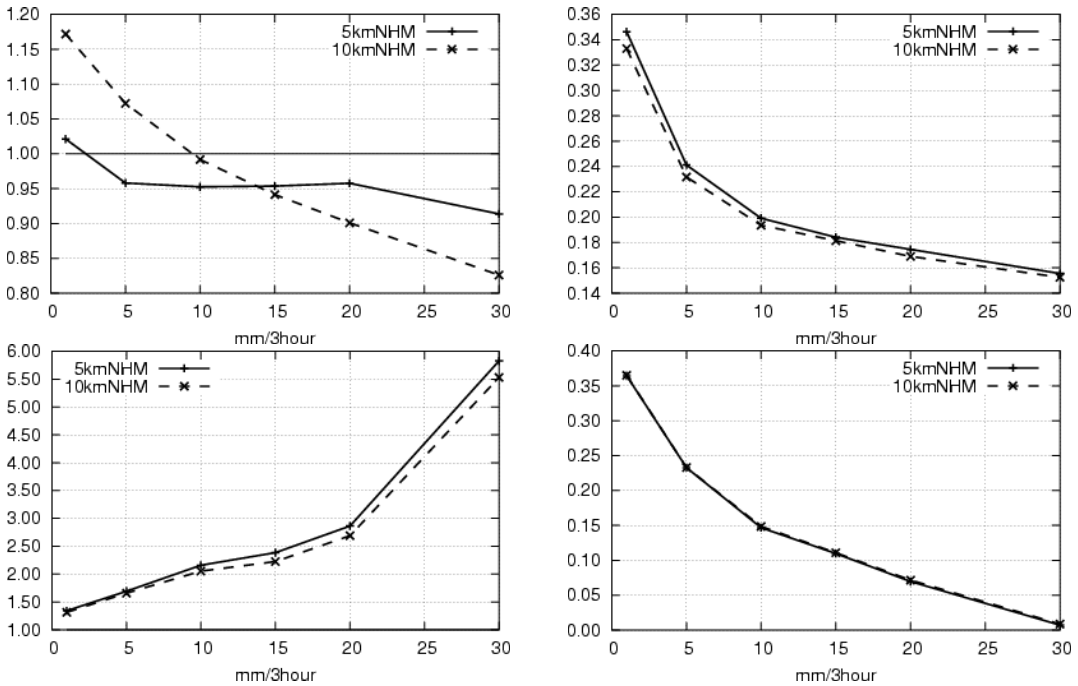

Figure 1: The bias and threat scores of precipitation forecast against radar-rain gauge composite rain data. The solid line indicates 5km-NHM and the dashed line indicates 10km-NHM. left:bias score, right:threat score, upper:in summer, lower:in winter.

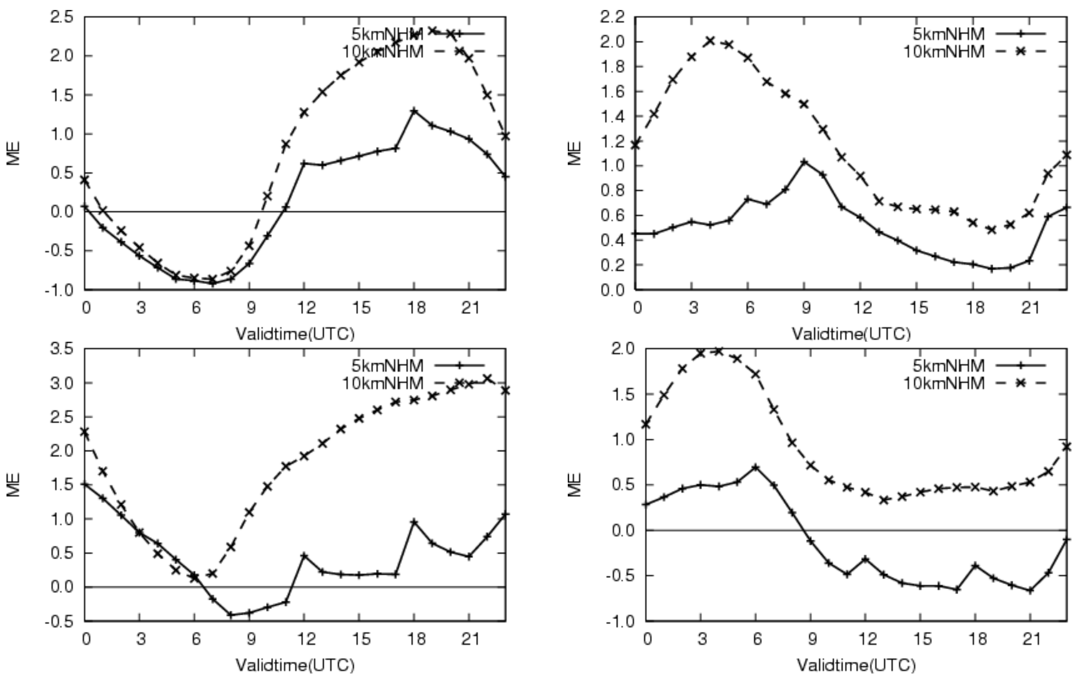

Figure 2: Diurnal change of mean errors of temperature and wind speed (03 UTC is noon and 15 UTC is midnight at local time). The solid line indicates 5km-NHM and the dashed line indicates 10km-NHM. left:temperature, right:wind speed, upper:in summer, lower:in winter.

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