Development of a high-resolution meso-scale model at JMA

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1 Introduction

The Japan Meteorological Agency (JMA) has been operating the JMA nonhydrostatic model (NHM) with a horizontal resolution of 10-km since 1 September 2004, and is planning to enhance the horizontal and vertical resolution of the model. Preliminary experiments are conducted with a 5-km NHM, which has been developed for next computer system introduced in March 2006. Tests of even higher-resolution models are also carried out to examine the prospects of very high-resolution simulations.

2 Simulation of 2004 Niigata/Fukushima heavy rainfall

A heavy rainfall event occurred over Niigata/Fukushima area on 13 July 2004. A 5-km mesh simulation was attempted for this case by using the same initial and boundary conditions as those used in the operational model forecast. The specifications of the model simulation are shown in Table 1, and the initial time of the forecast is 12 UTC, 12 July 2004. Figure 1 shows the predicted precipitation by the operational model (left), the 5-km model (center) and from T+9 to T+12 along with the corresponding Rader-AMeDAS data[1](right). Although the precipitation intensity of the model simulations is not as strong as observation, the band-shaped structure is reproduced more realistically in the 5-km simulation than in the 10-km. We conclude that the horizontal resolution plays a very important role for the simulation of the meso-scale rain band.

Table 1: Specifications of the model simulation

Initial time	12UTC 12 July 2004
Forecast time	18 hours
Number of grid points	$719 \times 575 \times 50$
Horizontal resolution	5 km
Vertical resolution	40-904 m
Time step	24 seconds
Time integration	split-explicit methods
Advection scheme	horizontally 4th order centered flux form
Prognostic variables	$U, V, W, p, \theta, qv, qc, qr, qi, qs, qg$

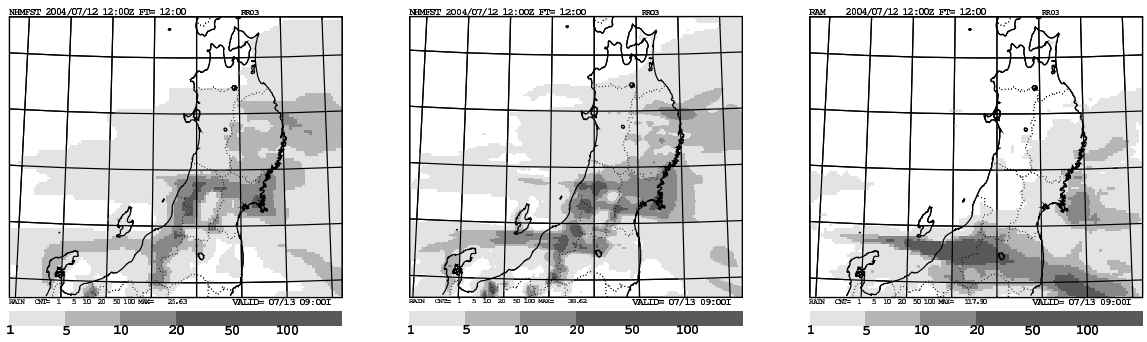

Figure 1: The simulation result of 2004 Niigata/Fukushima heavy rainfall. Left:The result of operational NHM. Center: The result of 5km NHM. Right: The Radar-AMeDAS precipitation. Three-hour accumulated precipitation is presented. The initial time is 12 UTC, 12 July 2004.

[1]Rader-rain gauge composite rainfall data.

3 High-resolution model simulations for the typhoon T0406

JMA has been investigating the usability of model simulation at very high resolution for detailed aviation weather information in a joint research with the Japan Aerospace Exploration Agency (JAXA). The simulations are made for a case of the typhoon T0406 on 21 June 2004 by using NHM. The simulations were conducted with 5-km, 2-km and 500-m horizontal resolutions. The initial and boundary conditions of 5-km NHM are provided by the operational system of JMA, and those for higher-resolution models are by the coarser models.

Table 2 shows the specifications of the simulations. The forecast domain and the prediction of sea surface pressure, surface wind and rainfall at 06 UTC on the day of each simulation are presented in Figure 2.

Table 2: Specifications of the simulations

Resolution	5 km	2 km	500 m
Initial condition	MANAL[2]	5-km NHM	2-km NHM
Boundary condition	RSM	5-km NHM	2-km NHM
Grid size	719 ×575 ×50	500 ×500 ×60	500 ×500 ×60

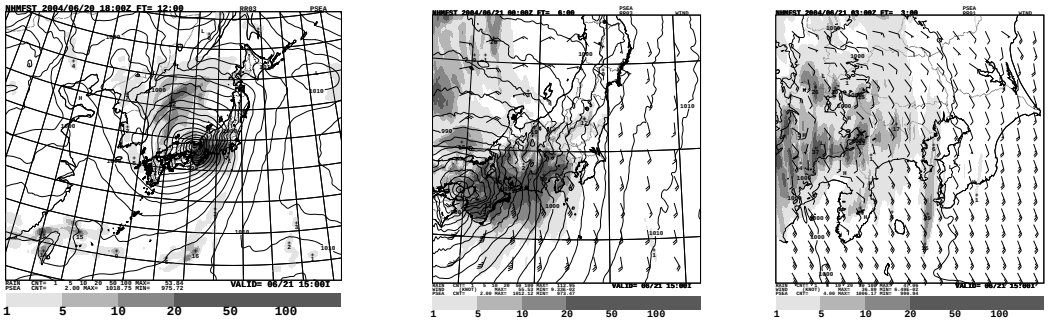

Figure 2: Sea surface pressure, surface wind and rainfall at 06 UTC, 21 June 2004 simulated by NHM. Left: 5-km NHM. Center: 2-km NHM. Right: 500-m NHM.

Figure 3 shows the simulated and observed changes of wind speed from 03 to 10 UTC on the day at Kofu City, which is located in the mountain area in Central Japan. The 500-m NHM roughly corresponds with the observation in predicting the intensification around 04, 07 and 09 UTC while the lower resolution simulations do not show that tendency. Figure 4 presents the mean error of surface wind speed for all the surface observation sites in the forecast domain. The finer resolution model yields smaller mean error.

Further analyses of the case and testing of the model are still continued.

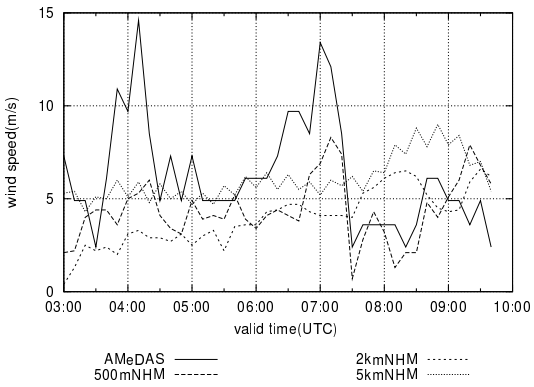

Figure 3: Time series of the wind speed at Kofu.

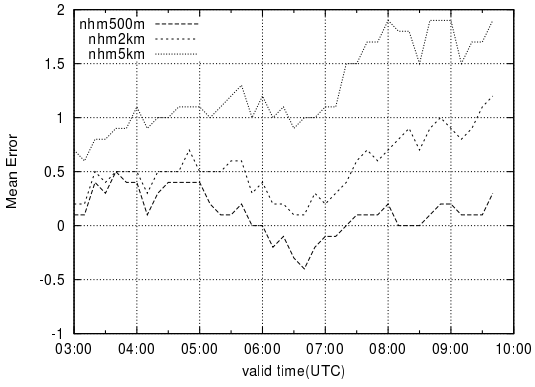

Figure 4: Time series of the mean error of wind speed for all the observation sites.

[2]Operational analysis for the meso-scale model at JMA.