Validation of Diurnal Variation of Summertime Precipitation in Kanto Region Simulated by a Nonhydrostatic Model (JMA-NHM)

Masaomi Nakamura[1], Teruyuki Kato[2] and Syugo Hayashi[1]
[1]Meteorological Research Institute, Japan; [2]Japan Meteorologicala Agency
(Masaomi Nakamura, manakamu@mri-jma.go.jp)

1. Introduction

The Kanto District consists of the Kanto Plain and mountainous areas in its north and west and it faces the Pacific Ocean in the south and east (Fig. 1). Due to its geographical features, convective activities associated with the thermally-induced circulation are frequently observed in the afternoon and evening in summer. Summertime convective precipitation associated with diurnal cycle is one of important targets of forecast in the Kanto District and to evaluate the performance of numerical model and to clarify the problem in reproducing it is an interesting work still left.

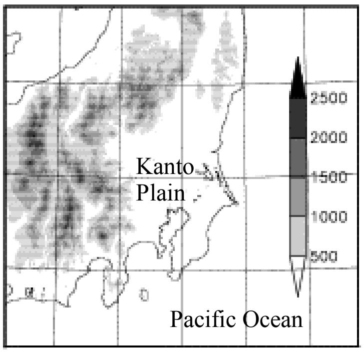

Fig.1 Topography around the Kanto District (same as the NHM1km domain).

2. Experimental design

The Japan Meteorological Agency Nonhydrostatic Model (JMA-NHM: Saito et al., 2007) is used with horizontal resolutions of 5km (NHM5km) and 1km: (NHM1km). The specifications of NHM5km and NHM1km are nearly the same. Both models use an improved Mellor-Yamada level-3 scheme (Nakanishi and Niino, 2004) and cloud microphysics predicting both the mixing ratio and number density of water cloud, ice cloud, rain, snow and graupel. They have horizontal grid numbers of 500 and 400 in the x and y directions, respectively, and stretched 50 vertical layers with a depth of 40m near the surface and 904m at the model top of 21.8km. A big difference between the two models is in that NHM5km uses the Kain-Fritsch cumulus convection scheme, while NHM1km does not. NHM5km is initialized at 03JST and run for 18 hours. The initial and 3-hourly boundary conditions are given from JMA operational mesoscale analysis with a horizontal resolution of 10km. NHM1km is initialized at 04JST and run for 17 hours. Its initial and hourly boundary conditions are given from NHM5km results. The experiments are carried out for one month of August 2008.

3. Results

The models well reproduce general features of the spatial distribution of active precipitation areas over land in the afternoon and evening, associated with the thermally-induced circulation (Fig.2). However, they tend to underestimate an increase of precipitation and precipitable water in the afternoon, which trend is larger in NHM1km. These can be seen in Fig.3, in which areal-mean precipitation frequency (PF), precipitation amount (R1) and precipitable water increment (dPW: difference from a value at 6JST) are validated against observation (RA: radar-raingauge analyzed rainfall amount; GSP: GPS precipitable water). A rapid increase of precipitation tends to cease 2-3 hours earlier in the models than observation. On the other hand, the model precipitable water reaches maximum 2-3 hours later than observation. The precipitable water peaks about one hour earlier than (or nearly the same time as) the precipitation maximum in observation. The models fail to reproduce this feature.

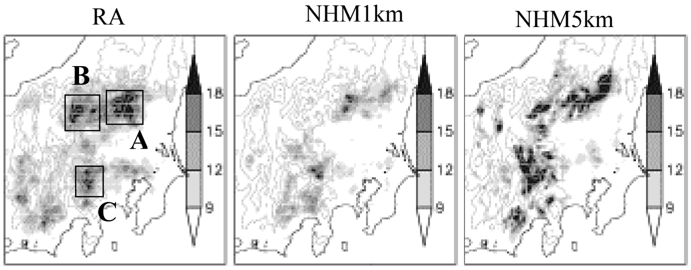

Fig.2 Distribution of monthly precipitation frequency for 15-18 JST from RA(observation), NHM1km and NHM5km. Contours show terrain height for 500, 1000, 1500 and 2000m. Rectangular regions A, B and C are used to calculate area average in analysis. The precipitation frequency is counted for hourly precipitation exceeding 1mm. The precipitation amount from RA and NHM1km are used after averaging on NHM5km grid.

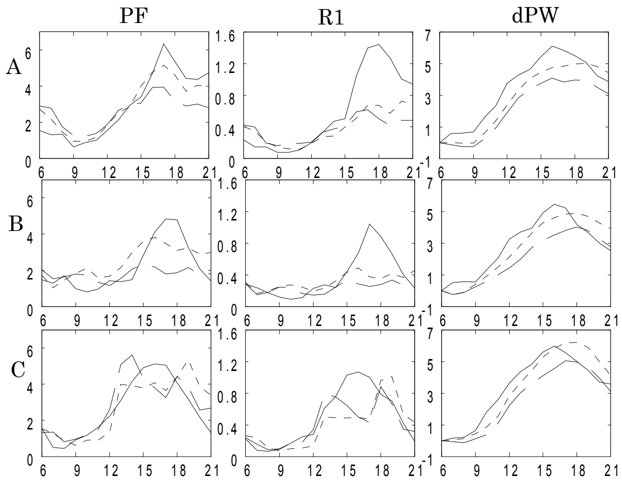

Fig.3 Temporal variation of monthly-mean PF (left), hourly precipitation amount R1 (middle) and dPW (right) averaged over region A (top panel), B (middle) and C (bottom) in Fig.2 for RA or GPS (solid), NHM1km (long-dashed) and NHM5km (dashed). The abscissa is JST.

There are some factors coming up to our mind which could cause the errors seen in the models, such as a systematic error of insufficient moisture in the initial fields and/or defects in the models, relating to resolution, surface fluxes and cloud physics schemes. The possibility of these factors as the cause of the model errors is studied.

References

Saito, K., J. Ishida, K. Aranami, T. Hara, T. Segawa, M. Narita, and Y. Honda, 2007: Nonhydrostatic atmospheric models and operational development at JMA. *J. Meteor. Soc. Japan*, **85**, 271-304.