Cloud resolving ensemble prediction of a local heavy rainfall event on 26 August 2011 observed by the Tokyo Metropolitan Area Convection Study (TOMACS)

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1. Introduction

On 26 August 2011, a local heavy rainfall event occurred in the Tokyo metropolitan area. In Tokyo and Kanagawa prefectures, very intense rains more than 90 mm hr^{-1} were observed (Fig. 1a) and several houses were inundated. This heavy rainfall event was caused by a mesoscale convective system (MCS) which was triggered by low level convergence, and its characteristics were captured by a dense observation network deployed by the Tokyo Metropolitan Area Convection Study (TOMACS). Despite its relatively larger spatial scale as a local rainfall in Japan and existence of well-defined low level convergence by a front, operational mesoscale model (MSM) of JMA failed to predict this event (Fig. 1b). Studies on model physics, predictability, and data assimilation should be conducted to improve the forecasts.

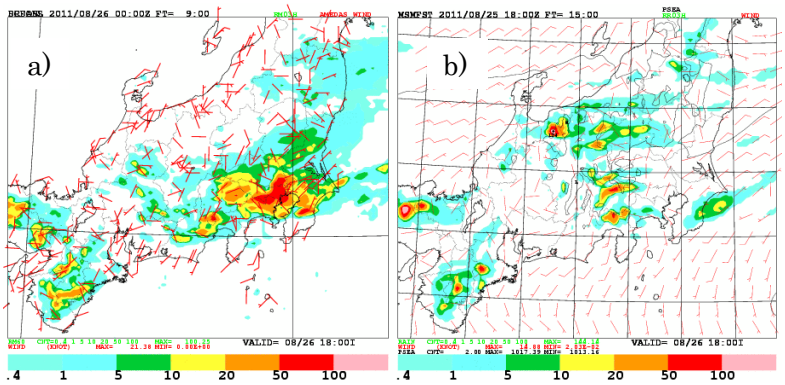

Fig. 1. a) Observed precipitation for 15-18 JST, 26 August 2011.
b) Three-hour accumulated precipitation for 15-18 JST by MSM. Initial condition is 18 UTC 25 August 2011 (FT=15).

2. Numerical experiments

Preliminary numerical experiments for this event have been performed. As a first trial, a downscale experiment from the mesoscale analysis of JMA was conducted using the JMA nonhydrostatic model (NHM) with horizontal resolutions of 10 km and 2 km. Fig. 2a shows three-hour accumulated precipitation for 15-18 JST by the 2 km NHM. Initial and boundary conditions were given by the 6 hour forecast of the 10 km NHM whose initial time was 12 UTC 25 August. The intense rainfalls appeared in southwestern part of the Kanto Plain. A mesoscale ensemble forecast was conducted using perturbations

from the JMA one-week global ensemble prediction system (WEP) at 12 UTC 25 August. Only a few members intensified the rainfall around Tokyo and some fake precipitations appeared in the Hokuriku district (figure not shown).

In NHM, the model cloud amount to compute radiation processes is evaluated from relative humidity considering subgrid scale partial condensation. Magnitude of the subgrid fluctuation is determined by the MYNN3 turbulent closure model. Recently, JMA has changed the lower limit of the fluctuation in their operational local model (LFM) to ameliorate an overestimation tendency of the cloud amount. Fig. 2b indicates the result of the 2 km NHM when the lower limit was changed. Surface temperatures increase about 1 C in southern part of the Kanto Plain, and modify the position of low level convergence which triggered the MCS.

Additional mesoscale ensemble experiment was conducted using a mesoscale singular vector method (MSV; Kunii, 2010) based on the adjoint model of NHM. Figure 2c is the corresponding precipitation by the 2 km NHM for 15-18 JST, where perturbations from member 'P04' by MSV were added to the initial condition of the 10 km NHM. Fake precipitations in the north of the Kanto Plain were reduced.

A data assimilation experiment using the JMA nonhydrostatic variational data assimilation system (JNOVA) is underway, where the first guess field of the 4DVAR is given by the ensemble forecast. The cost function for observation term at the first iteration process will be used as the norm to select a candidate of the best member.

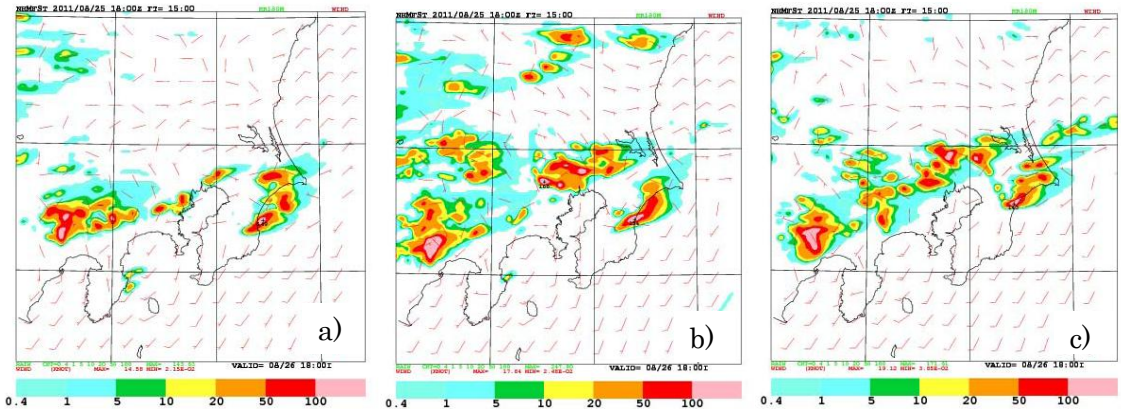

Fig. 2. a) Three-hour accumulated precipitation for 15-18 JST by the 2 km NHM (FT=15). b) Same as in a) but the limit of subgrid fluctuation of partial condensation in NHM was reduced. c) Same as in b) but ensemble member P04 with the MSV method.

Reference

Kunii, 2010: Mesoscale singular vector (MSV) method. *Tech. Rep. MRI*, **62**, 13-17 and 73-77. (available online at http://www.mri-jma.go.jp/Publish/Technical/DATA/VOL_62/62.html)