Development of a New Storm-Scale 4D-Var Assimilation System

Takuya Kawabata[a], Kosuke Ito[b], Kazuo Saito[a], and Yuki Honda[c]

[a] *Forecast Research Department, Meteorological Research Institute, Japan, tkawabat@mri-jma.go.jp,*
[b] *Extreme Weather Events Projection Research Team, Japan Agency for Marine-Earth Science and Technology, Japan,* [c] *Administration Department, Japan Meteorological Agency, Japan.*

The Meteorological Research Institute has been developing a nonhydrostatic 4D-Var assimilation system (NHM-4DVAR; [1], [2], [3]) since 2002. NHM-4DVAR is based on the Japan Meteorological Agency (JMA) Nonhydrostatic Model (JMANHM), and is designed to reproduce and predict MCSs at storm scales. The full model of JMANHM, which includes three-ice bulk cloud microphysics, is adopted as the forward model. The adjoint model considers perturbations to dynamics and warm rain process. The horizontal resolution of NHM-4DVAR is 2km.

Several assimilation experiments have been conducted for local heavy rainfall cases using NHM-4DVAR. Through these experiments, assimilation methods of advanced observations have been developed (i.e., Doppler radar radial winds [1], precipitable water vapor data derived by the Global Positioning System (GPS) [1], radar reflectivies [2], GPS slant total delay data [3], radial winds by Doppler lidar [4]), and positive imacts of these data on the forecasts of local heavy rainfall events have also been confirmed.

On the other hand, JMA has operated an operational mesoscale nonhydrostatic 4D-Var assimilation system (JNoVA; [5]) since April 2009. JNoVA has several advantages to NHM-4DVAR (e.g., a wide assimilation area, a penalty term, physical processes), but its horizontal resolution is 15 km.

Development of a new unified assimilation system of NHM-4DVAR and JNoVA is underway for application to the storm-scale assimilation. The new assimilation system implements advanced observation operators, a penalty term, optimizing procedure for lateral boundary conditions, cloud microphysics based on the warm rain process, and other physical processes. The tangent linear, and adjoint models have already been developed, and the framework of the 4D-Var system has been almost fixed. A result of a data assimilation experiment with actual observations will be presented in the symposium.

References

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