Development of MRI/JMA mesoscale EPS at the WWRP Beijing Olympic Research and Development Project (B08RDP)

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The WWRP Beijing Olympic 2008 Forecast Demonstration / Research and Development Project (B08FDP/RDP) is an international research project for a short range forecast of the WMO World Weather Research Programme (WWRP), which succeeds the Sydney 2000FDP. The B08FDP/RDP is divided into two components; the FDP component for a very short range forecast up to 6 hours based on the nowcasting, and the RDP component for a short range forecast up to 36 hours based on the mesoscale ensemble prediction system (MEPS). Aims of the RDP project are to improve understanding of the high-resolution probabilistic prediction processes through numerical experimentation and to share experiences in the development of the real-time MEP system.

In 2008, the B08RDP experiment was conducted from 24 July to 24 August by six participants; the Meteorological Research Institute (MRI), NCEP, Meteorological Service of Canada (MSC), Austrian Zentral Anstalt fur Meterologie und Geodynamik (ZAMG), National Meteorological Center of the China Meteorological Administration (NMC/CMA) and the Chinese Academy of Meteorological Sciences of CMA (CAMS/CMA). Intercomparisons of 36 hour EPS forecasts were conducted, and the forecast products were uploaded on the website of the B08RDP (http://www.b08rdp.org) in near real time.

MRI has developed a mesoscale ensemble prediction system collaborating with the Numerical Prediction Division of JMA. JMA nonhydrostatic model (NHM) was adopted as the forecast model. To ameliorate underestimations of convective rains and maximum temperatures in abnormally hot days found in the 2007 experiment (Saito et al., 2008a), tunings of model parametersfor physical processes (K-F scheme and surface wetness) were done. As for initial condition, the JMA mesoscale 4D-var system was applied to Beijing area, assimilating rain gauge observations and precipitation analysis conducted in B08FDP project (Kunii et al., 2008).

As for initial perturbation methods, following five methods, i) Downscale of JMA one-week EPS (WEP), ii) Targeted global Singular vector (GSV), iii) Mesoscale Singular Vector (MSV), iv) Mesoscale BGM (MBD), v) Ensemble transform (LET) based on NHM-LETKF (Miyoshi and Aranami, 2006), were developed.

Lateral boundary perturbation methods were developed, where perturbations from the global ensemble prediction are added as the increment to lateral boundary conditions given by the JMA's high resolution global forecast. The global ensemble prediction was initiated with the Global singular vectors for GSV, while the JMA one-week EPS was adopted for other 4 methods (WEP, MSV, MBD and LET) according to Saito et al (2008b).

Prior to the 2008 experiment, performance of above methods were verified by checking the ensemble spreads and the root mean square errors (RMSEs) of ensemble mean. Figure 1 shows time evolution of ensemble spreads of surface variables for 3-4 July 2008. Spreads by GSV are largest after FT=18, while in MSV, spread of surface precipitation grows most rapidly at first 6 hours. Spread of LET is relatively small and growth was slow. Figure 2 shows RMSEs of control run and the ensemble means by five methods at FT=24 for surface variables against analysis. RMSEs of ensemble means are smaller than control run except surface pressure by LET and WEP. RMSEs of GSV is the smallest, and MSV and MBD are the second best. Figure3 shows the area of ROC. GSV is best for weak rains less than 3mm, while MBD and MSV are suitable for moderate or intense rain. The reason is likely that GSV tends to perturb synoptic scale disturbances while MBD and MSV tend to perturb mesoscale disturbances which are relate to local intense rains.

Considering above results, we selected GSV as the initial perturbation method at B08RDP experiment in 2008. Specifications of the mesoscale ensemble prediction system of MRI/JMA are listed in Table 1. Preliminary validations have shown the good performance of the MRI/JMA's mesoscale ensemble system.

References

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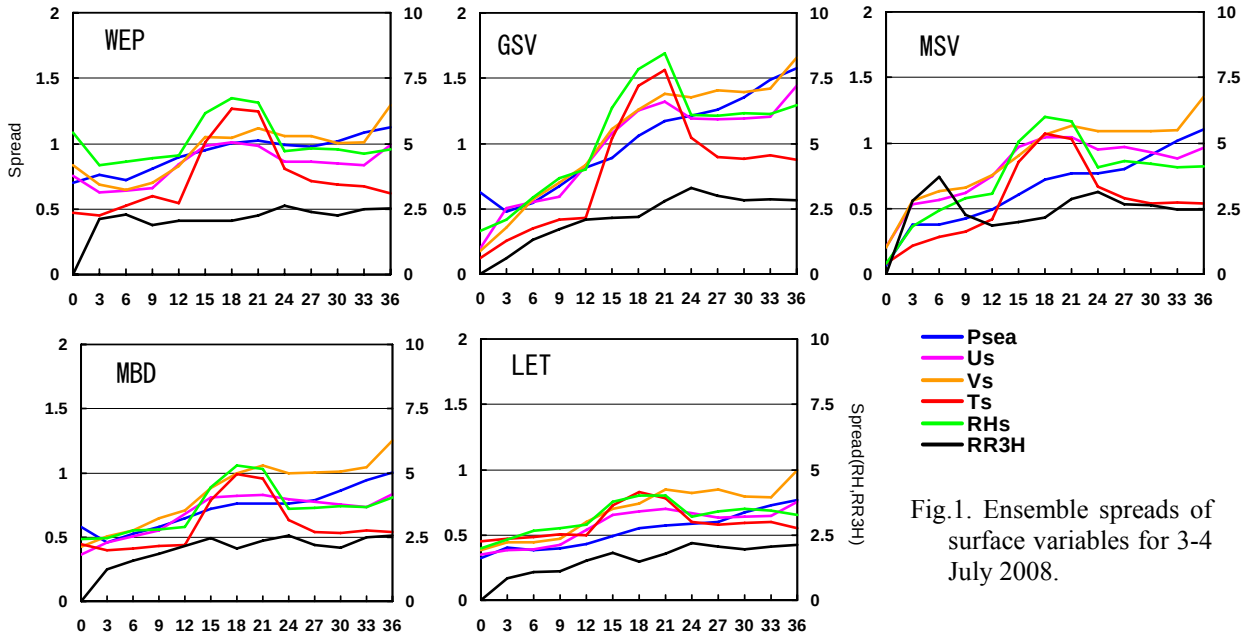

Fig.1. Ensemble spreads of surface variables for 3-4 July 2008.

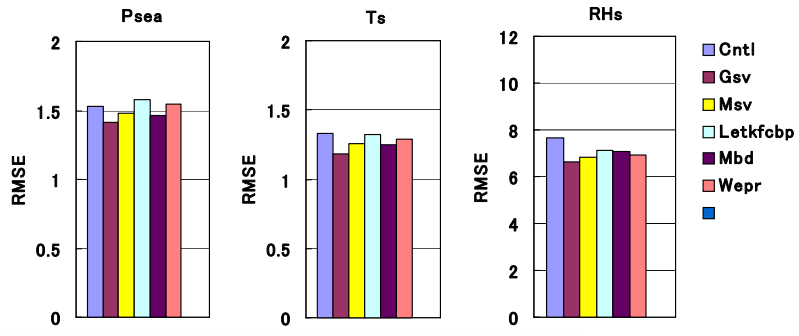

Fig. 2. RMSEs of surface variables against analysis for 3-4 July 2008.

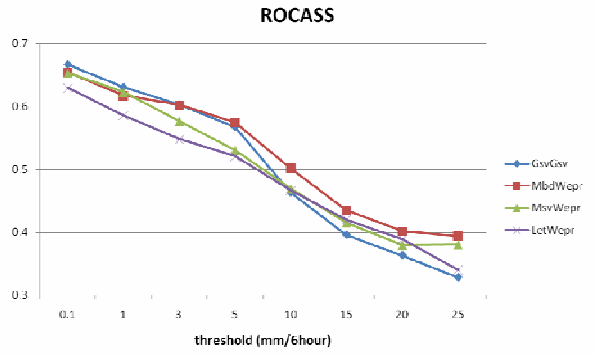

Fig. 3. Area of ROC against 6 hour precipitation intensity for 3-4 July 2008.

Table 1. Specifications of the B08RDP MEP system of MRI/JMA.

	2006 Experiment	2007 Experiment	2008 Experiment
Forecast model	NHM as of March 2006	NHM as of May 2007	NHM as of August 2008
Horizontal grid	221×201 (Δx = 15km)	232×200 (Δx = 15km),	No change
Vertical grid	Terrain-following coordinates, 40 levels	No changes	Generalized hybrid coordinates
Number of members	11 members	No changes	No changes
Initial condition	JMA operational regional 4D-Var analysis	No changes	Meso 4DVAR analysis for Beijing area
Initial perturbation	JMA one-week global EPS (TL159)	Targeted moist global SV (T63L40)	Targeted moist global SV (T63L40) (modified)
Lateral boundary	JMA RSM forecast (no perturbation)	No changes	JMA GSM forecast (20km L60)
Soil temperatures	4 layer prognostic soil temperatures	Initial perturbations are added	No changes