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Mesoscale ensemble prediction trial for the WWRP Beijing 2008 Research and Development Project

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1. Introduction
2. Tier-1 meso-EPS at MRI
   -First experiment 2006-
3. Advances on Tier-1 EPS at MRI/JMA
   -Second experiment 2007-

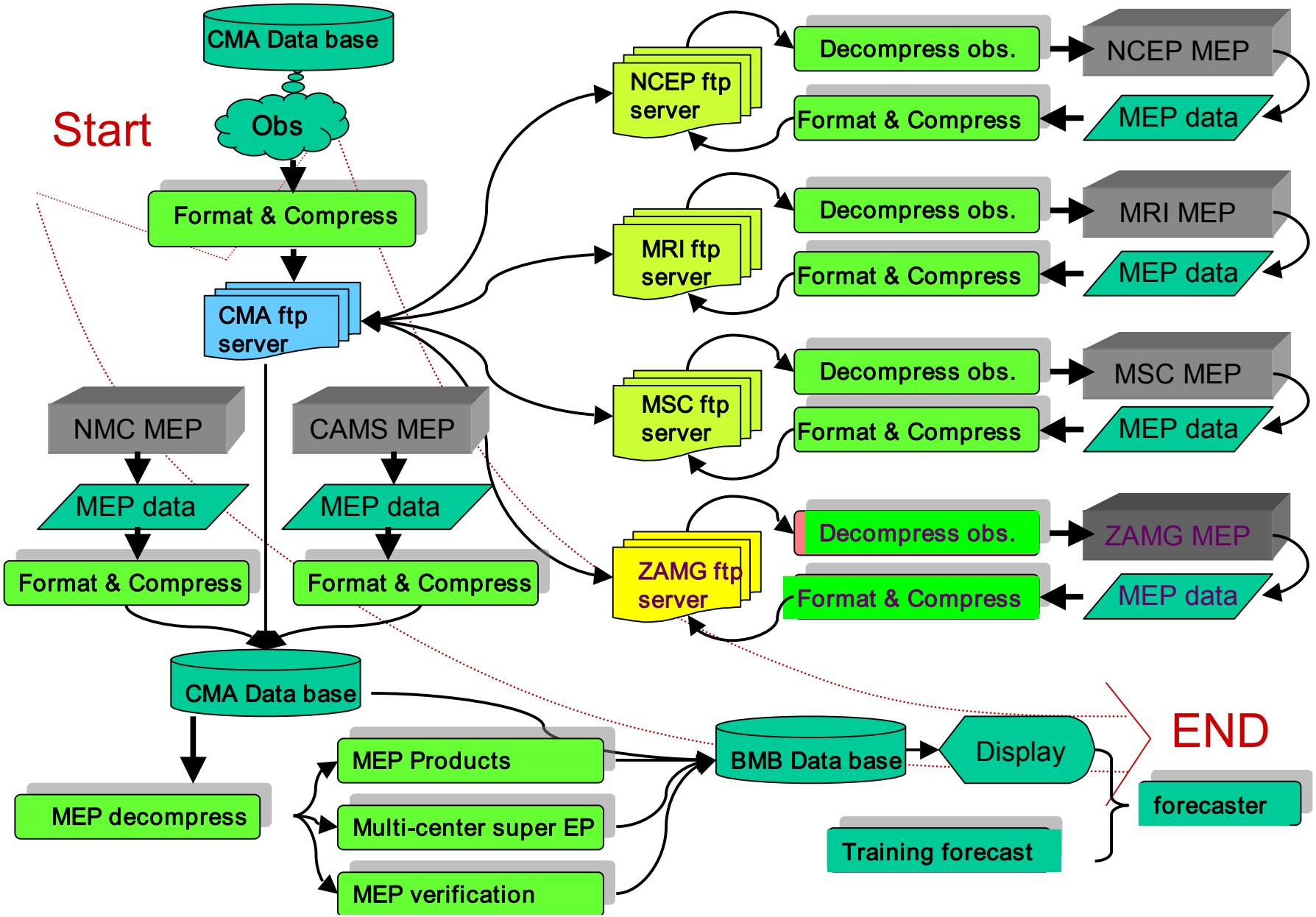
What is the Beijing 2008 FDP/RDP (B08FDP/RDP) ?

- WWRP Beijing 2008 FDP/RDP is a WWRP short range weather forecasting research project which is conducted corresponding to the Beijing Olympic Games of August 2008.
- Approved as a WWRP research project succeeding to the Sydney 2000FDP.

- The project is divided into 2 components:
- FDP component: Forecast Demonstration for FT=0-6 hour forecasts based on nowcasting
- RDP component: Research and Development for FT=6-36 hour forecasts based on Mesoscale ensemble prediction.

Goals of the RDP Project

- To **improve understanding** of the high-resolution and very short range probabilistic prediction processes through numerical experimentation
- To **share experiences** in the development of the real-time MEP system
- To study and **develop adequate methods** on the assessment of the capability and forecast skill of MEP systems
- To **demonstrate** how MEP system can improve quality of forecasts compare with deterministic run and/or Global EPS
- To **train forecasters** to apply ensemble forecasting products & support a better meteorological service for 2008 Olympic game
- To **setup shareable database** for future research in the community



The data flow chart of B08RDP between CMA and participant countries are setup completely

The 2006 Tier-1 preliminary experiment

24 July – 24 Aug 2006

	Model	Members	Initial perturbations
NCEP	WRF-NMM WRF-ARW	10	Breeding
MRI/JMA	JMANHM	11	Global EPS (BGM)
MSC	GEM	16	Global SV
NMC/CMA	WRF-ARW	15	Breeding
CAMS/CMA	GRAPES	9	Breeding

How to do verification of the first test

- The parameters to be verified are 2m temperature and probability of precipitation.
- The verification time interval is 6 hours, based on the condition of observation data collected;

After Yinglin (2006)

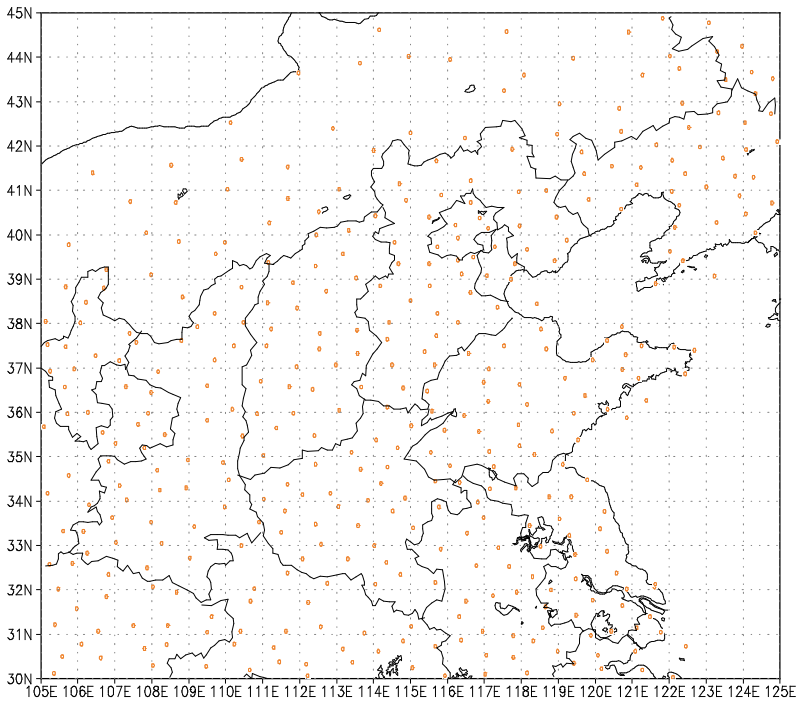
Comparison with Observation data

The 400 stations are taken as a core subset of stations;

which consists of all national commutative stations, majority of them belong to the national basic synoptic stations;

And 239 stations in which have a long-term historical record;

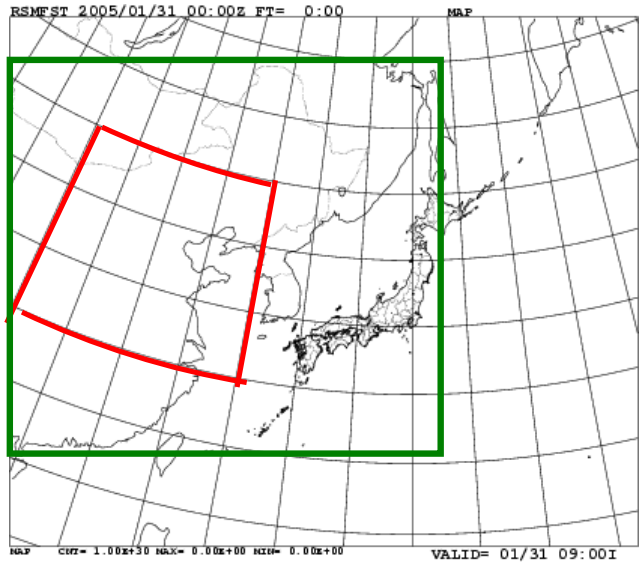
The data quality of them is more reliable, and the data from them are taken as a core subset of observation data, and were used in this test.



Core subset of observation (400 stations)

After Yinglin (2006)

Tier-1 meso-EPS of MRI/JMA in the 2006 experiment



Green: Test Domain
（3300km*x3000km)
*slightly smaller than recommended domain

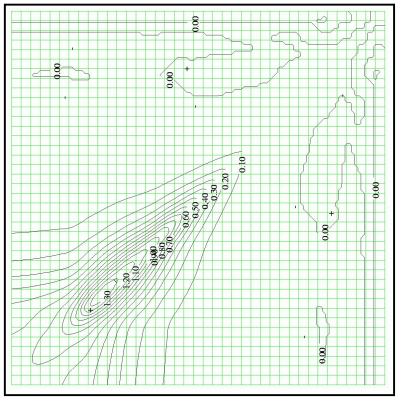
Red: Domain of common grid for verification (20 deg x15 deg)

Forecast	36 hour, 12 UTC, 11 members
Horizontal mesh	221 x 201 (DX=15 km), Lambert conformal
Vertical levels	40 terrain following, DZ=40-1180m
Initial condition (CNTL)	JMA regional 4D-Var analysis at 12 UTC
Lateral boundary	JMA RSM forecast
Initial perturbation	JMA weekly global EPS (normalized)
Dynamics	HE-VI, DT=1 min, Dt=17 sec
Moist physics	3 ice bulk microphysics
Convection	Kain-Fritsch (modified at JMA)
Turbulence	Diagnostic TKE
Ground temperature	4 soil, initialized by RSM

11 members 36 hour EPS forecast are conducted for 1-24 August in every morning at MRI, with the increment using the normalized global EPS perturbation.

Normalization of perturbation of Global EPS

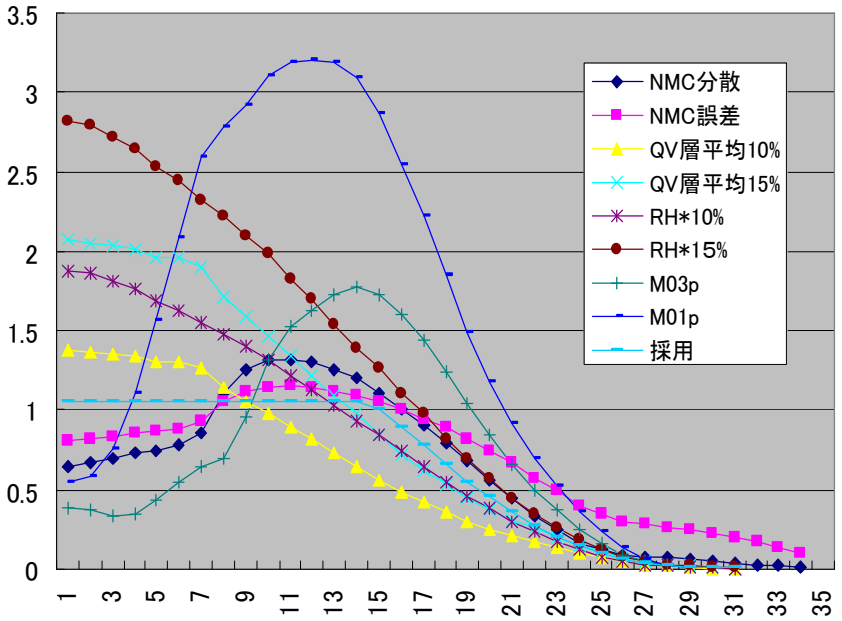
Back ground error for Meso 4D-Var :
PS: 0.7 hPa
U,V: about 2 m/s in lower troposphere
about 3.5 m/s around jet stream
T: about 0.8K in lower troposphere
about 1K in upper troposphere
RH: about 10 % in lower troposphere
about 15 % in upper troposphere



Vertical error covariance obtained by NMC method in Meso 4D-Var

80 % of background error was used
as the rough estimation of the analysis error
PS: 0.6 hPa
rU, rV: 1.8 m/s*(Kg/m$^{3)}$
q: 0.7 K
Qv: 12% of RH,
8% of RH at 850 hPa

Perturbation is normalized if its RMS exceeds above values in each level.

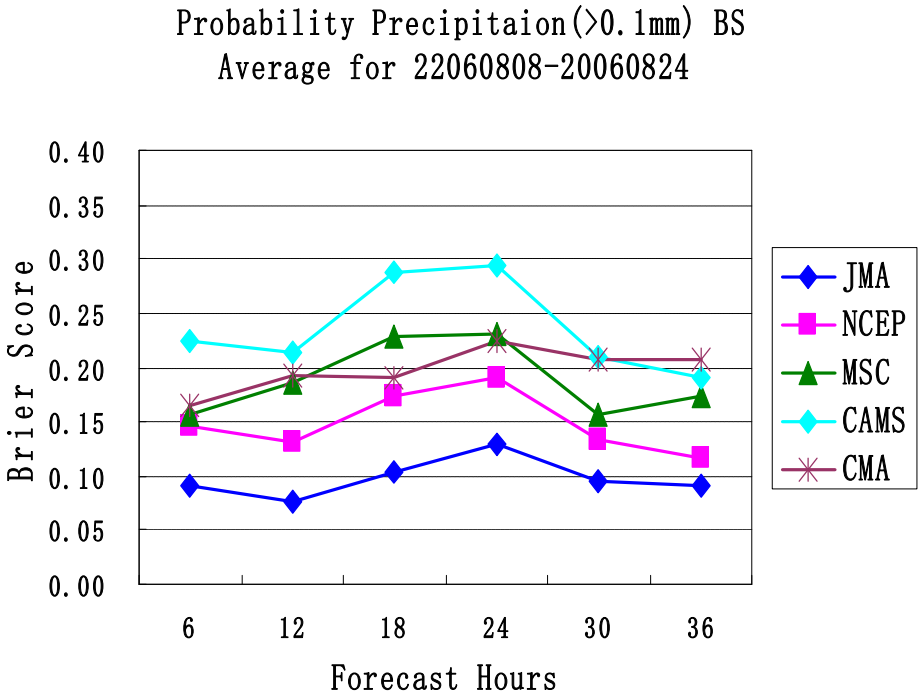


Brier Score (BS)

$$BS = \frac{1}{N}\sum_{i=1}^{N}(f_i - O_i)^2$$

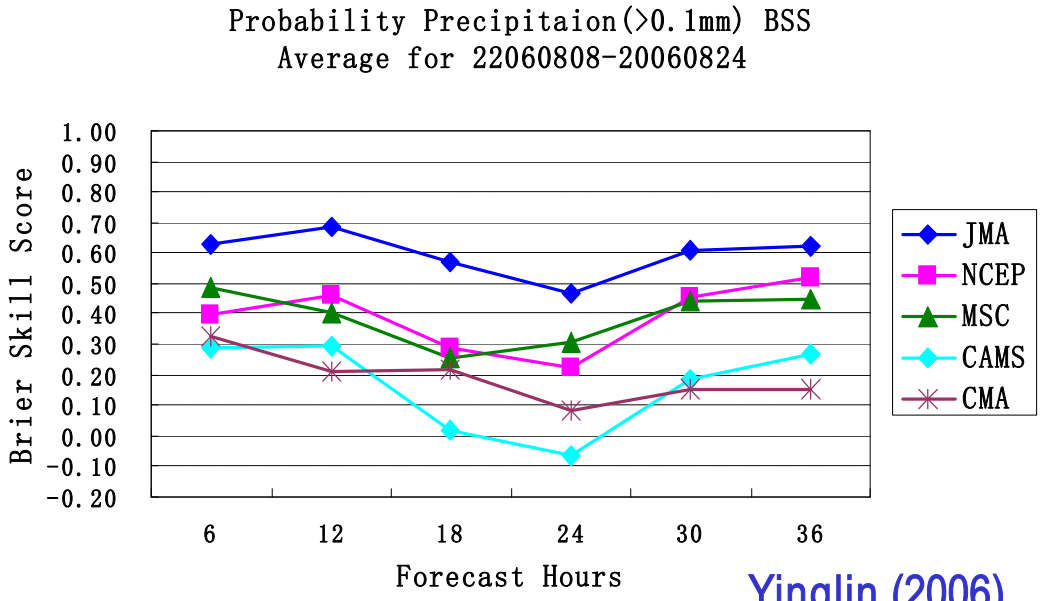
f_i ——forecast probability;

$O_i = 1$ the event occurred in obs;

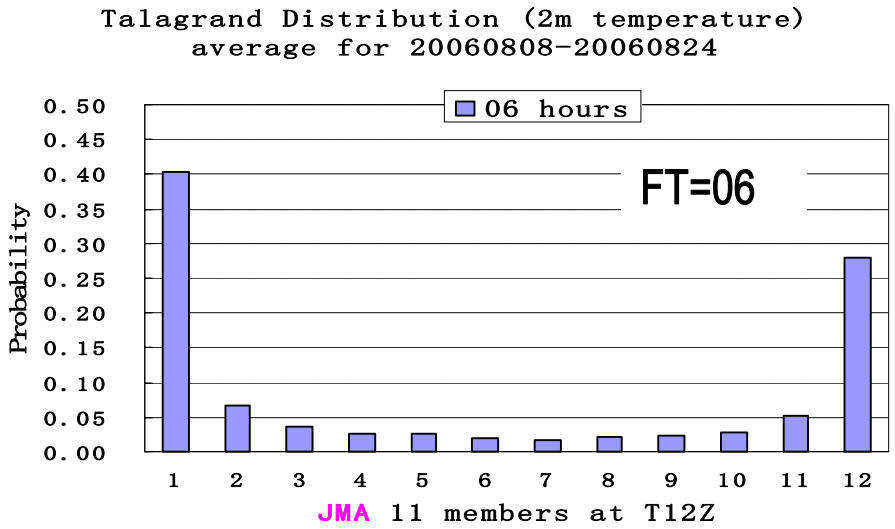


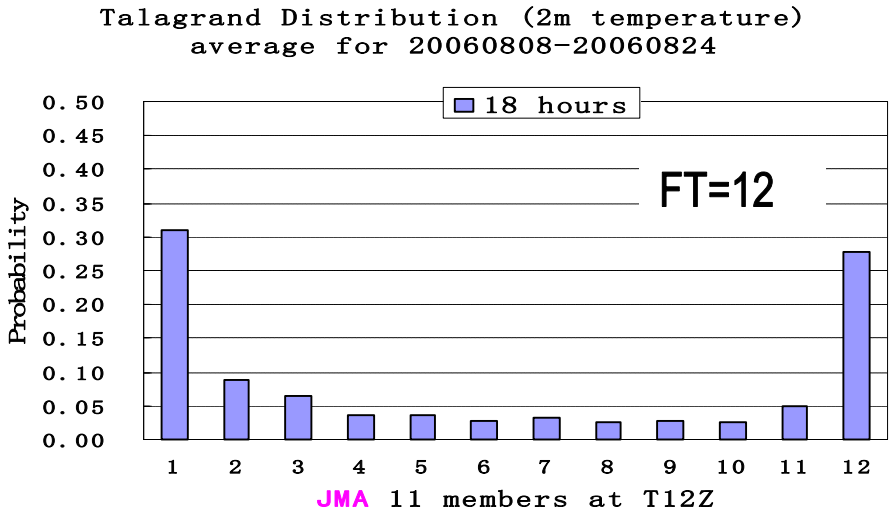
Brier Skill Score (BSS)

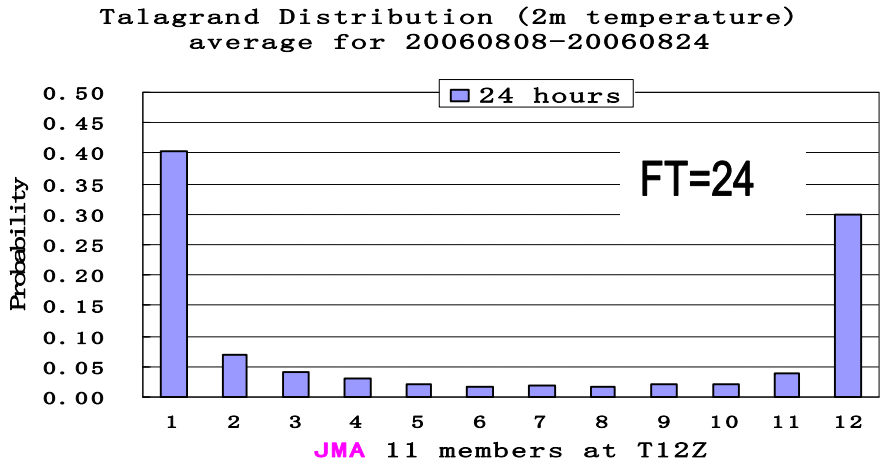
BSS=1-BS / BSclim

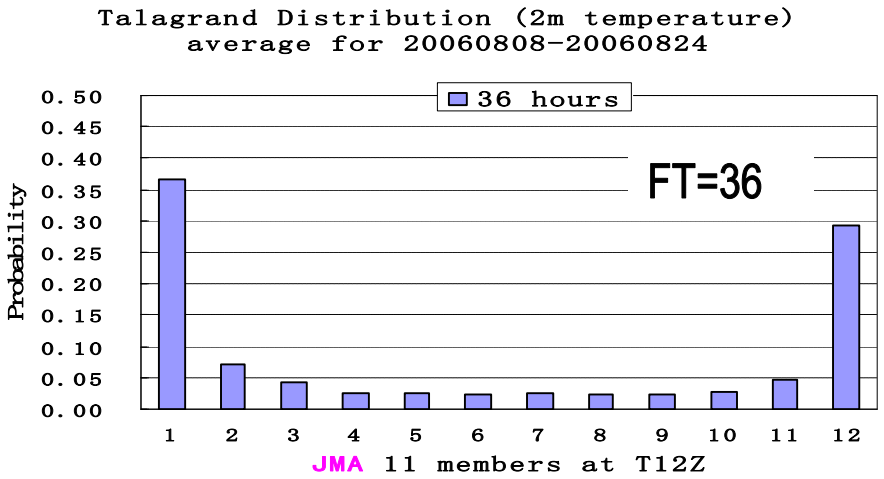


Yinglin (2006)









Talagrand distribution of JMA/MRI (T2m)

There are many obs. outside of forecast range.

After Yinglin (2006)

Main changes of MRI/JMA in 2007 experiment

1) Latest version of JMA-NHM was employed.
2) Domain was enlarged and shifted to westward.
3) Global targeted SV method was adopted as the initial perturbation method.
4) Initial soil temperatures are perturbed.

Test of alternative schemes for initial perturbation

1) JMA one-week EPS (WEP)

Perturbation of JMA's operational one week global EPS (TL159L40) is normalized with the statistical analysis error. Used in the 2006 experiment.

2) SV method using JMA-NHM (MSV)

SV (30kmL40) is given by the Lancios method using TL/ADJ models of JMA-NHM (developed for the operational nonhydrostatic Meso-4DVAR).

3) BGM method using JMA-NHM (MBD)

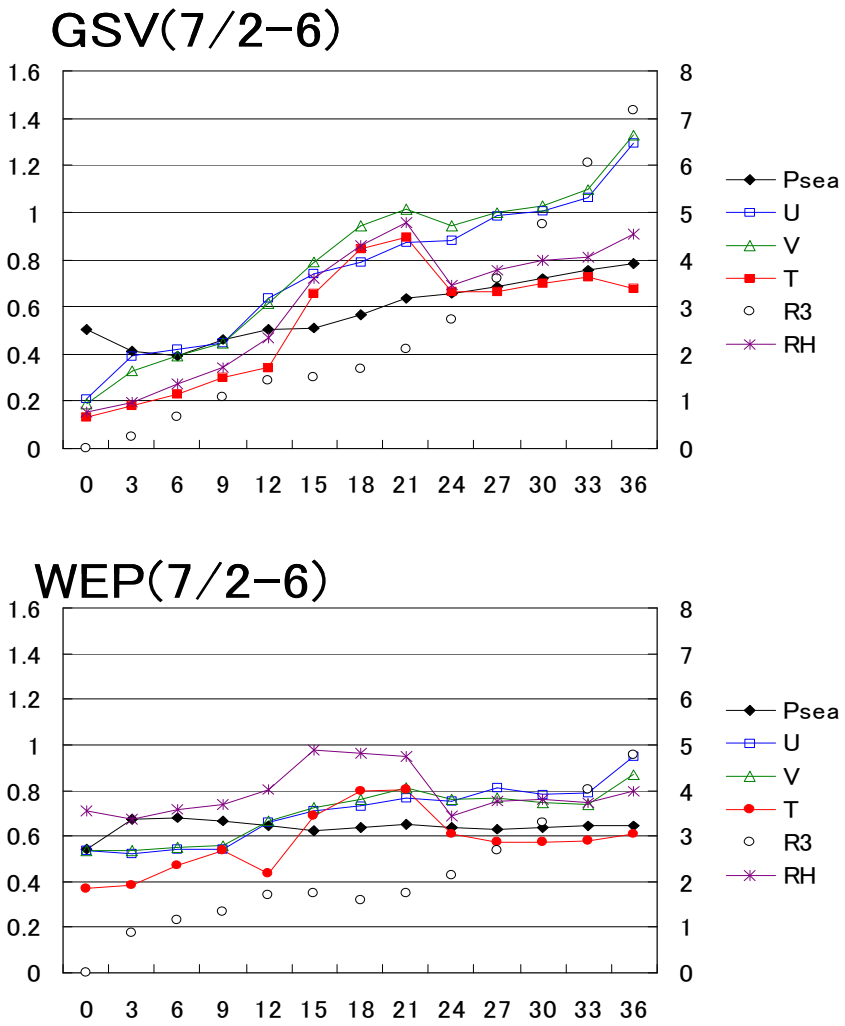
Initial seed by JMA operational one-week EPS is bred by 15kmL40 NHM with tow 12 hour breeding cycles.

4) Global targeted SV method (GSV)

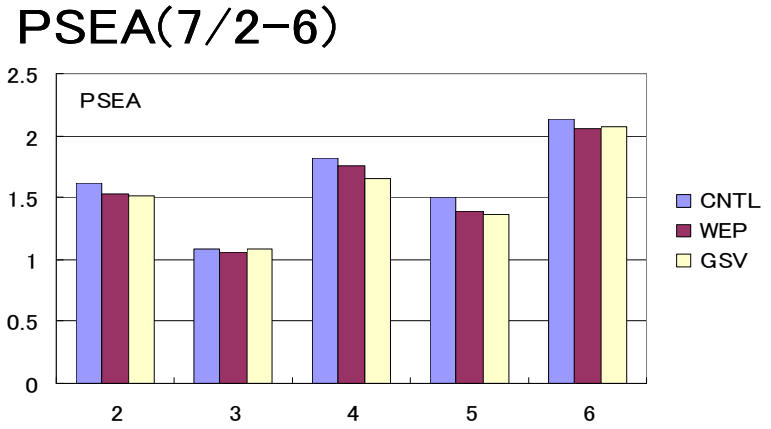
Global moist SV method developed for the JMA's typhoon EPS (T63L40; to be in operation 2008). Final norm is targeted to the common verification area in B08RDP.

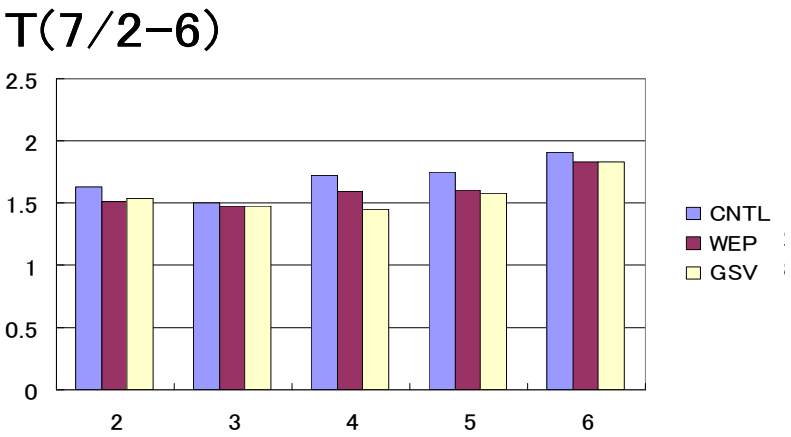
GSV vs. WEP

Time sequence of spreads



RMSE (FT=24) against initial

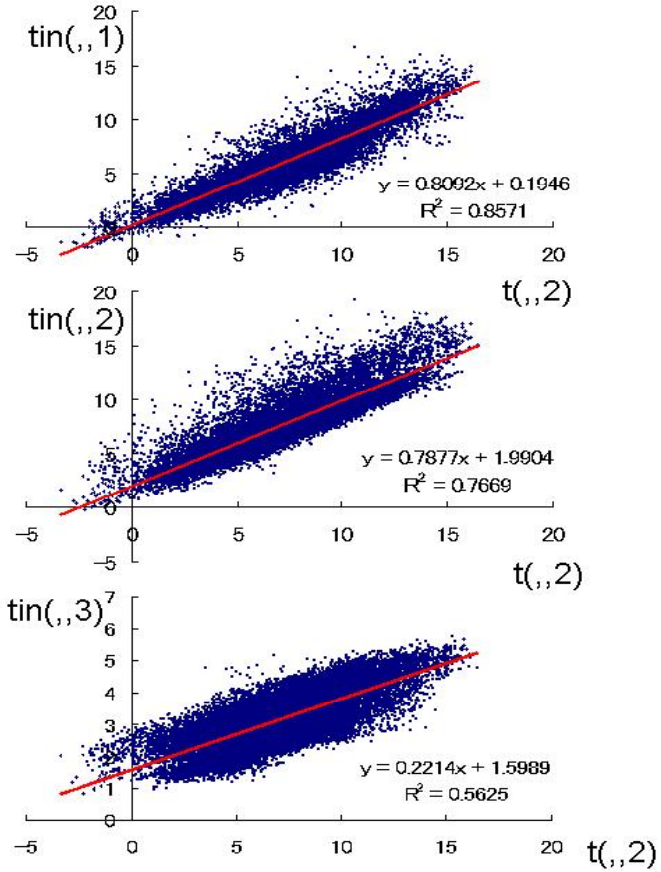




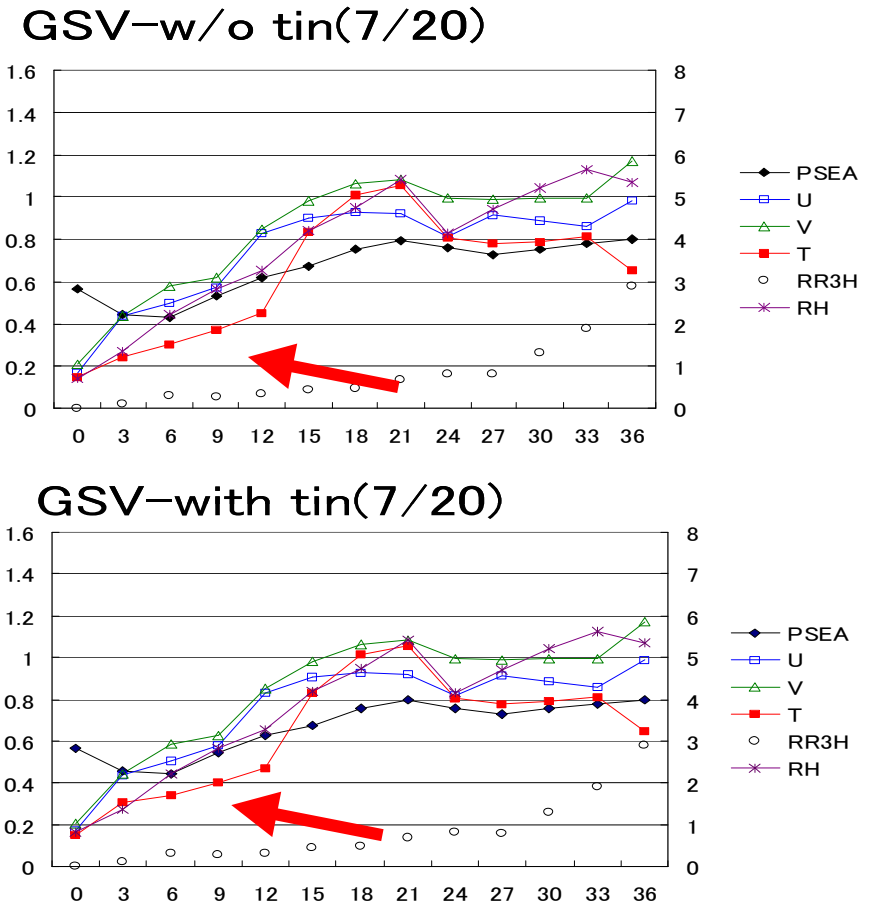
Spreads increase with time.

RMSEs of Ens mean are smaller than WEP.

Initial perturbation in soil temperatures



Relationships between simulated soil temperatures and the lowest level atmospheric temperatures. Perturbations from climatological temperatures at FT-24.



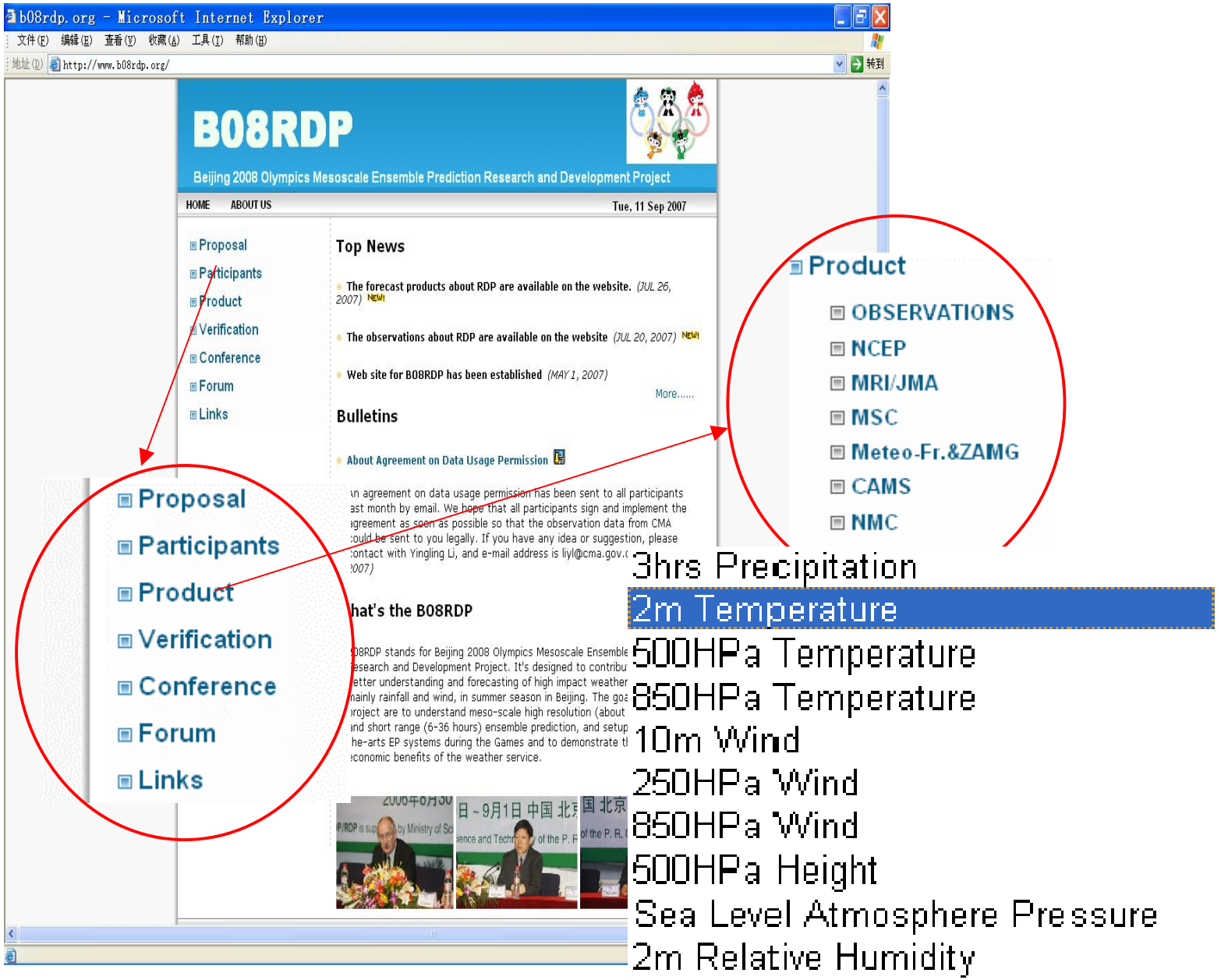
Spread of 2m temperature is slightly increased with the initial perturbation in soil temperature, though the effect is not large.

Tier-1 MEP systems 2007

Participants	Model	IC	IC perturbation	LBC
NCEP*	WRF-NMM WRF-ARW	NCEP Global 3DVAR	Breeding	Global EPS
MRI/JMA	JMA-NHM	JMA Regional 4DVAR	Targeted Global SV	JMA Regional Forecast
MSC	GEM	MSC Global 4DVAR	Targeted Global SV	MSC Global EPS
ZAMG & Meteo-Fr.	ALANDIN	ECMWF Global 4DVAR	ECMWF Global SV	ECMWF Global EPS
NMC/CMA	WRF-ARW	WRF-3DVAR	Breeding	Global EPS
CAMS/CMA	GRAPES	GRAPES-3DVAR	Breeding	Global EPS

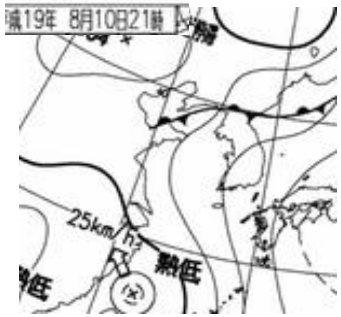
*EP system of NCEP is as of the 2006 experiment: NCEP submitted results by global EPS in the 2007 experiment

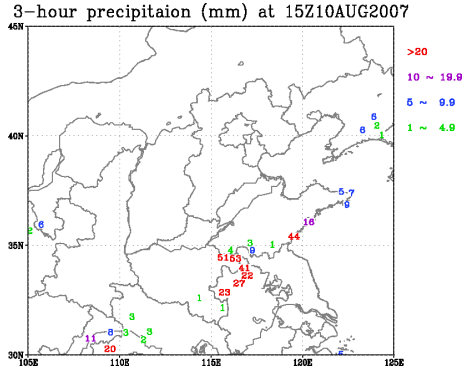
Website: www.b08rdp.org

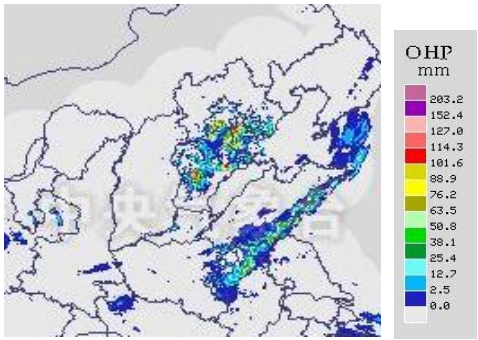


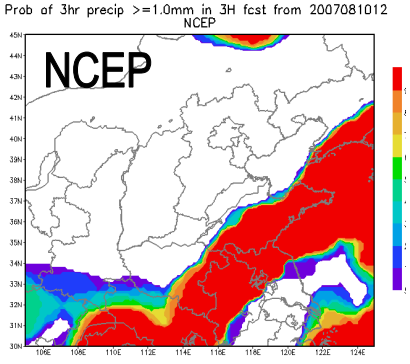
Example of Participants' forecast

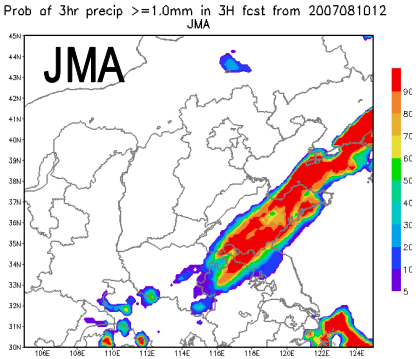
Probability of RR3h>1mm ; 8/10 15UTC (FT=3hur)

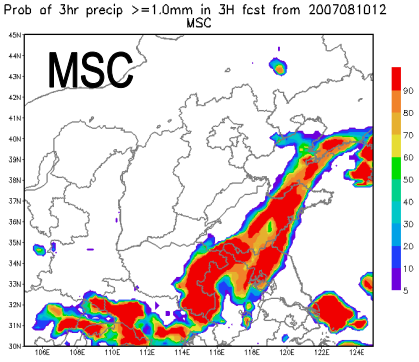


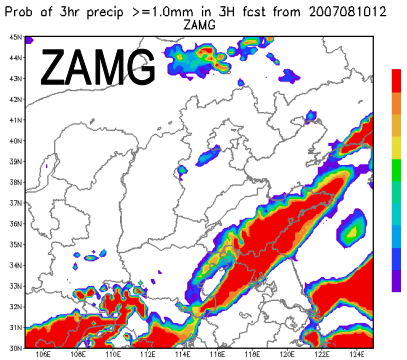


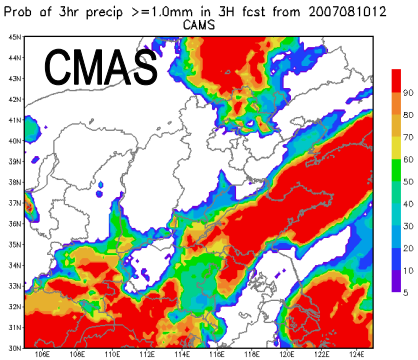


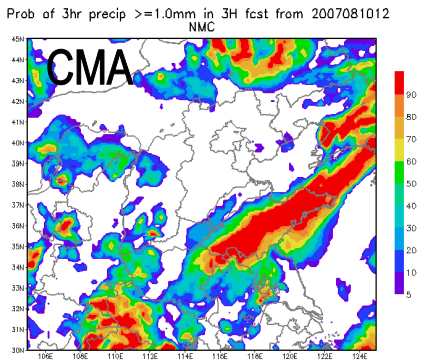










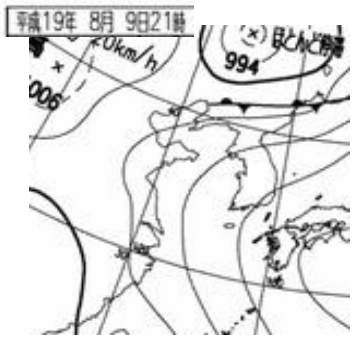


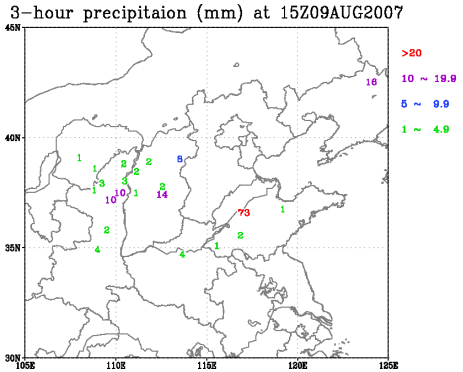
Model of all participants forecasted well the rainfall region of stationary front.

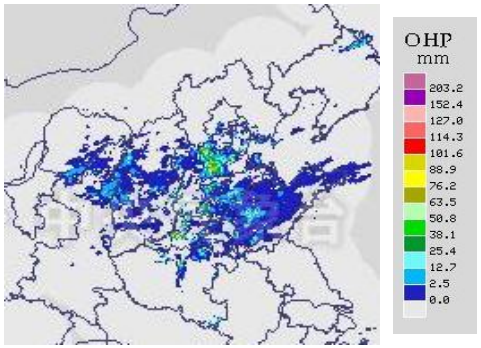
China (CMA,CAMS),
U.S (NCEP),
Canada (MSC)、
Austria/France (ZAMG)

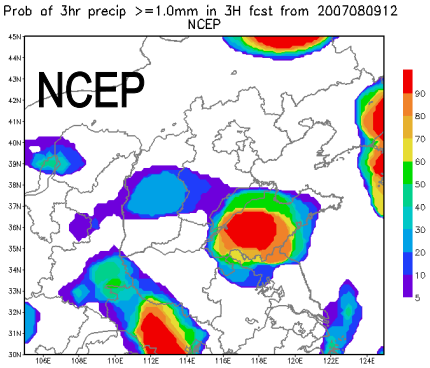
Example of Participants' forecast

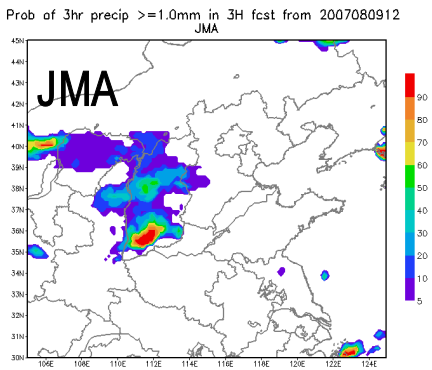
Probability of RR3h>1mm ; 8/9 15UTC (FT=3hur)

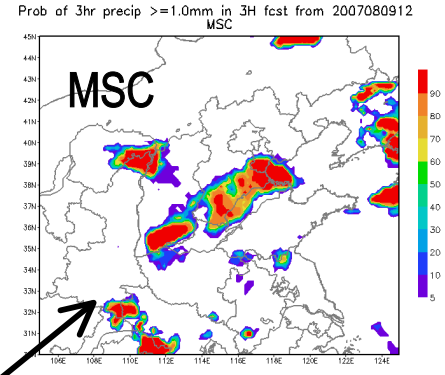




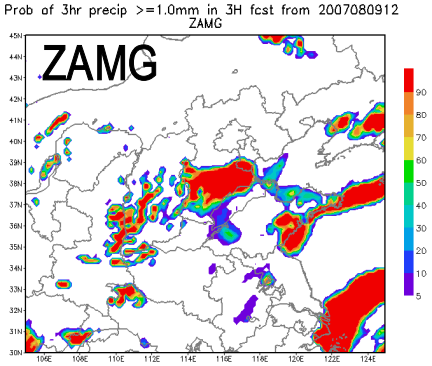


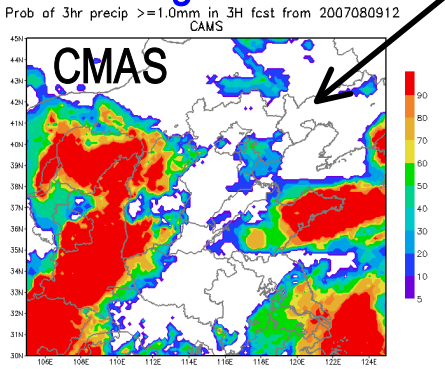


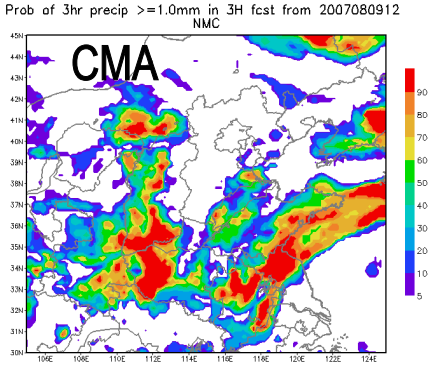




Large difference

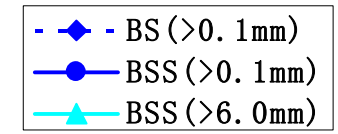




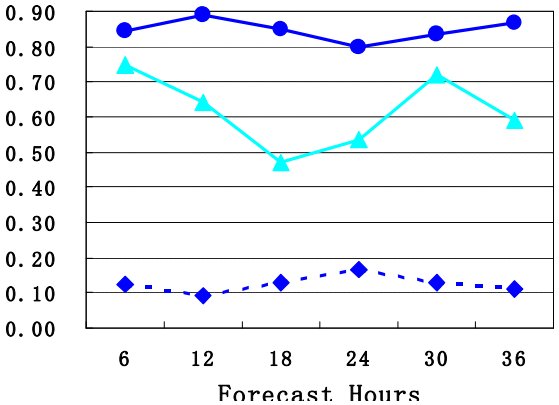


Forecast of rainfall due to the weak confluence was largely diverged

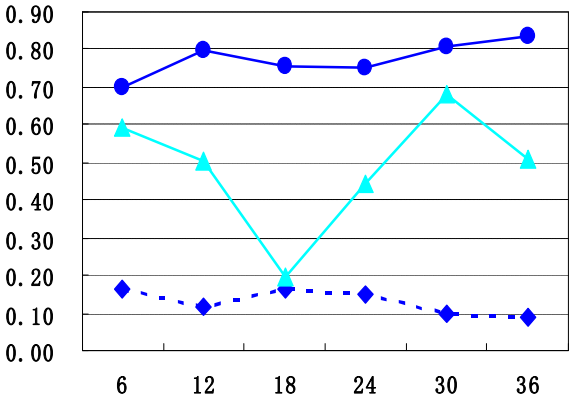
Probability Precipitation BS(BSS) at 12 UTC Average for 20070724-20070831



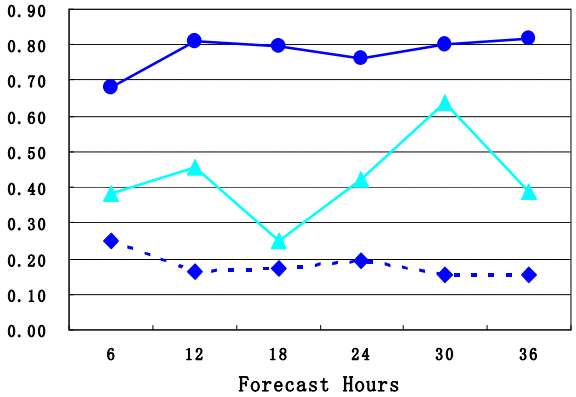
MRI/JMA



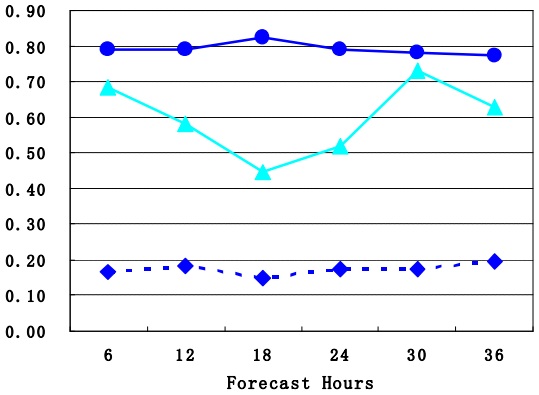
CMA



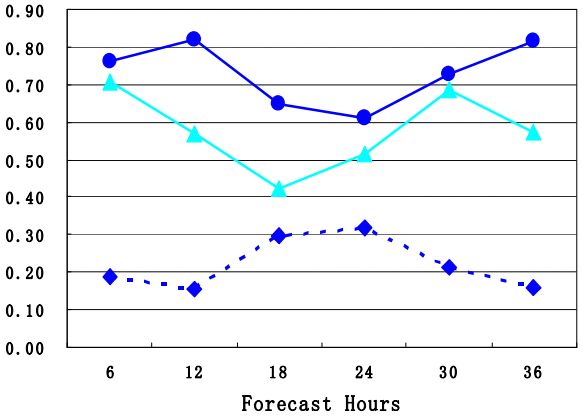
CAMS



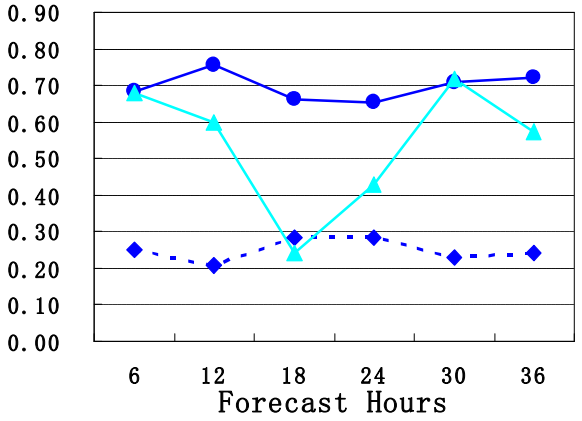
MSC



ZAMG

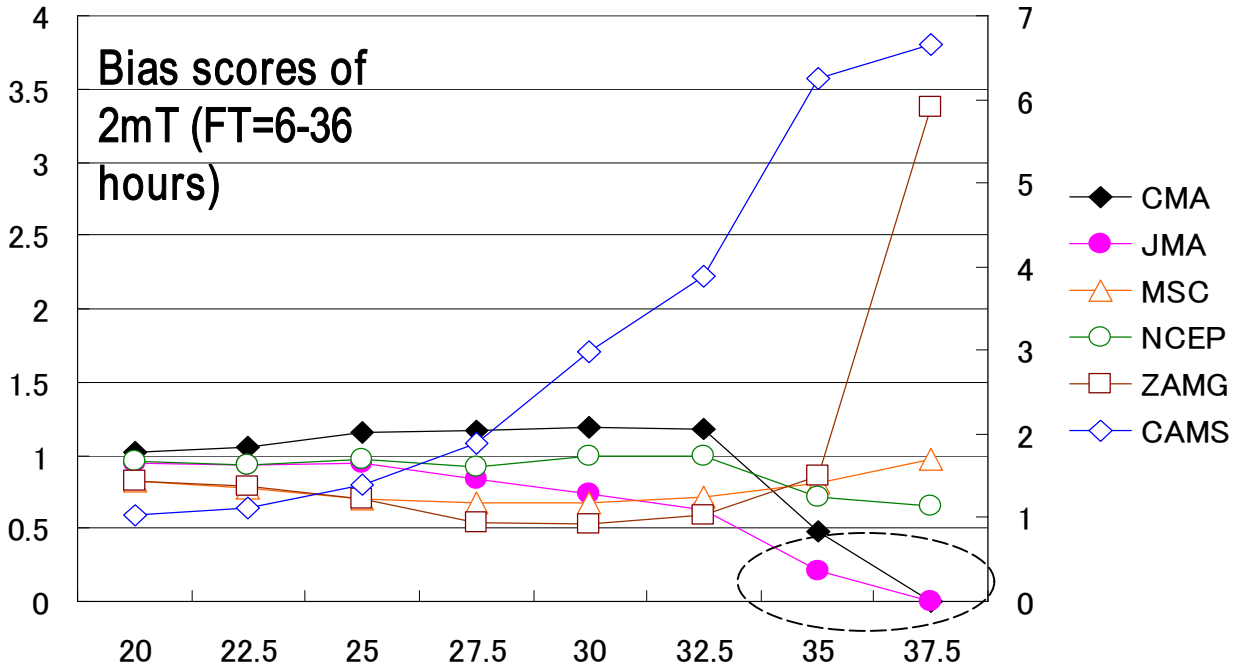


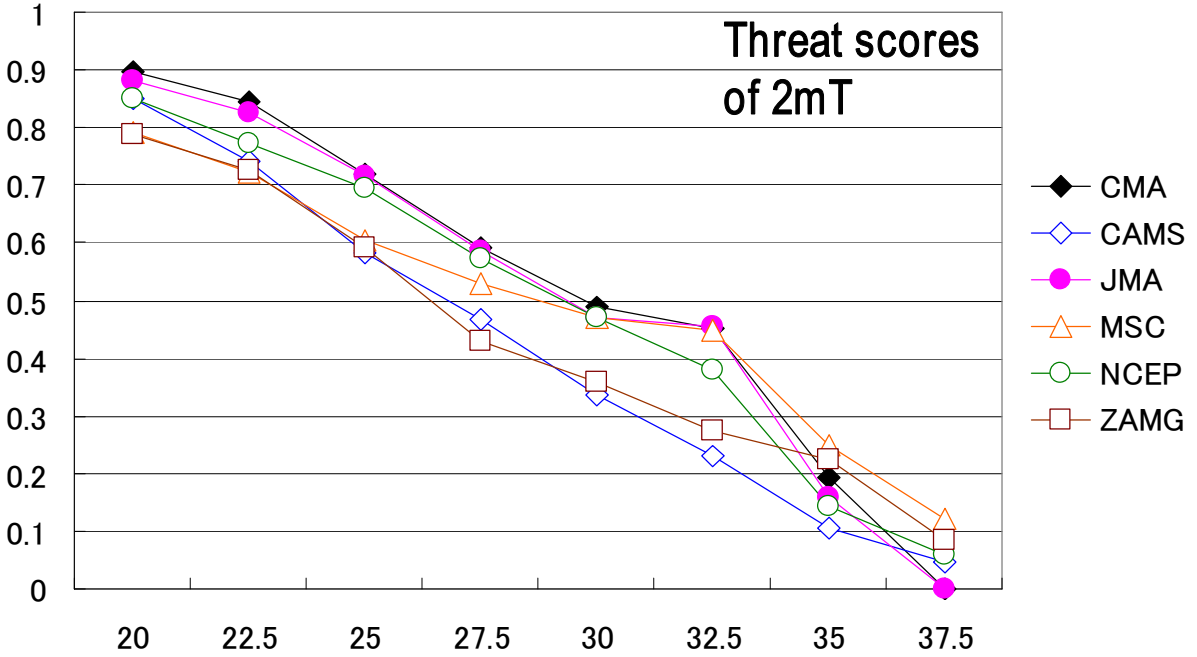
NCEP



After Y. Li (2007)

Preliminary verification of ensemble mean for 7/26-8/5





Subjects of MRI ensemble model for the 2008 experiment

Forecast model

- Amelioration of the underestimate of convective rain (especially in initial start-up and diurnal ones)
- Amelioration of the underestimate of (the maximum) temperature
- Use of the hybrid vertical coordinates (operationally, already implemented)

Initial condition

- Application of the Meso 4DVAR analysis to Beijing area

Perturbation

- Test of other/modified methods for initial perturbation method including LETKF
- Implementation of perturbation in the lateral boundary condition