

JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2006

China 2006

1. Summary of highlights

"[Major changes in the data processing and forecasting system during the last year]"

1.1 Development of operational NWP

- The GDAS system is upgrade from OI system to SSI system. The ATOVS data can be assimilated into Medium range forecasting system. one day improving in south hemisphere and 0.5 day improving in north hemisphere are made for T213 NWP system.
- The Global T213L31 was upgraded to T639L60, and the data the physical processes were carefully selected to match this upgrade. This system will be upgrade to T639L60 in end of 2007.
- An updated global Ensemble Prediction System was put into Quasi-operational at the end of 2006, 15-members,14 perturbed members based on T213L31.
- CMA new generational NWP model: Global and regional assimilation and prediction system for mesoscale (Grapes-meso), was quasi-operational running since Aug. 2006.
- Sea wave forecasting model was operational running since Dec. The model is run on the 00Z and 12Z model cycles, and it provides 120 hour forecasts for 00Z and 240 hour forecasts for 12Z.

1.2 Developments of GRAPES

GRAPES is a short form of Global /Regional Assimilation and PrEdiction System. The GRAPES development project was launched in 2001 in CMA. The progresses have been steadily made since then.

The main features of GRAPES: GRAPES is designed as a multi-scale unified model. The main features of GRAPES includes (Fig.1) as: (1) full compressible dynamical core with hydrostatic or non-hydrostatic approximation in options ; (2) a semi-implicit and semi-Lagrangian scheme (A. Staniforth and J. Cote, 1991); (3) height terrain following vertical coordinate(Gal-Chen and Somerville, 1975); (4) full physical package; (5) 3DVAR/4DVAR for data assimilation; (6) modularized and parallelized code architecture; (7) latitude-longitude grid and regional/global unified system.

In 2006, a lot of works related to the GRAPES were focused on the operational implementation of Regional GRAPES_Meso, quasi-operational tests of Global GRAPES, Regional GRAPES_ 4DVAR development, GRAPES_AGCM development, extended applications of GRAPES_meso in tropical cyclone prediction, sand and dust forecast, meso-scale ensemble prediction, nowcasting, and so on.

2. Equipment in use

"[information on the major data processing units]"

CMA imported IBM CLUSTER 1600 parallel computer system in 2004. The new system mainly serves as the platform for running operational short-term climate model、 global weather model and some other high-resolution regional weather forecast models.

The high performance IBM CLSUTER 1600 system consists of 376 calculate nodes、 3152 calculate CPUs、 8224GB memory、 8 I/O nodes and 128TB capacity of disks. Its theoretic peak performance is 21 TFLOPS.

In Sep. 2006, CMA upgraded its internet connection by linking with CSTnet (China Science and Tech network) via 1Gbps access line and 100Mbps protocol rate. It is being used for supporting TIGGE data exchange between CMA and ECMWF, NCAR.

3. Data and Products from GTS in use

At RTH Beijing, there are about 100,000 bulletins received from GTS everyday. The daily statistics results of the main type bulletins are SYNOP-8909, TEMP-3897, SATEM-1492, GRIB-14654, and there are about 231 facsimile charts received from RJTD, EDZW and RKSL everyday.

In 2006, RTH Beijing also has some new data received via GTS, including NOAA satellites ATOVS 1b data, BOM NWP products and EUMESAT images.

4. Forecasting system

4.1 System run schedule and forecast ranges

"[general structure of a prognostic system, models in operational use, run schedule, forecast ranges]"

The global data assimilation with global satellite data (ATOVS) had been put into continuous experiments since 1 Apr, 2006, At the end of 2006, the new system ran in quasi-operational. It produces routine global analyses for the four main synoptic hours 00, 06, 12 and 18 UTC and global 10-day forecasts at 00UTC and 12 UTC, 3-day forecasts based on 06UTC and 18UTC .The regional model GRAPES_Meso (Global and Regional Assimilation and Prediction Enhanced System) run in operational for forecasting 60 hours on 00uct and 12utc on the new IBM Cluster in Aug 2006 .The old regional mdoel (HLAFS) has been stopped in Oct 2006.The typhoon track forecast system based on global model T213L31 increased to four times forecast per day in 2006.The global ensemble forecast system based T213L31(15members) is running in operational. New forecast systems in sand storm based MM5 and wave based wavewatch 3 is running in qusi-operational.The regional ensemble forecast system based WRF(15members) is running in experiment.

Following is the run schedule of the NWP Systems in NMC

Systems	Data cut_off time (GMT)	Wall clock	Computer
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		(GMT)	
Global Model (T213L31)	03:30 (00Z_ASSIM+120HR_FCST)	03:35~04:00	IBM Cluster 1600
	06:30 (00Z_ASSIM.)	06:35~06:40	IBM Cluster 1600
	10:30 (06Z_ASSIM +72HR_FCST)	10:35~10:45	IBM Cluster 1600
	16:30 (12Z_ASSIM.+240HR_FCST)	16:35~17:15	IBM Cluster 1600
	22:10 (18Z_ASSIM.+72HR_FCST)	22:15~22:25	IBM Cluster 1600
Global Model (T213L31_SSI)	04:00 (00Z_ASSIM +240HR_FCST)	05:00~05:40	IBM Cluster 1600
	07:00 (00Z_ASSIM. +6HR_FCST)	07:00~07:15	IBM Cluster 1600
	13:00 (06Z_ASSIM.+72 HR_FCST)	13:00~13:20	IBM Cluster 1600
	16:30 (12Z_ASSIM.+240HR_FCST)	16:30~17:40	IBM Cluster 1600
	19:00 (12Z_ASSIM. +6HR_FCST)	19:00~19:15	IBM Cluster 1600
	01:00 (18Z_ASSIM. 72 HR_FCST)	01:00~01:20	IBM Cluster 1600
Regional Model(MM5V3)	03:00(00Z+48HR_FCST)	03:05~03:35	IBM Cluster 1600
	16:00(00Z+48HR_FCST)	16:05~16:35	IBM Cluster 1600
Regional Model(GRAPES)	04:15(00Z_ASSIM +60HR_FCST)	04:20~04:40	IBM Cluster 1600
	13:40(06Z_ASSIM)	13:45~13:55	IBM Cluster 1600
	16:50(00Z_ASSIM +60HR_FCST)	16:55~17:15	IBM Cluster 1600
	22:30(18Z_ASSIM)	22:35~22:40	IBM Cluster 1600

Typhoon Track model (MTTP)	04:00 (00Z_120HR_FCST)	04:00~04:15	IBM Cluster 1600
	11:00 (06Z_120HR_FCST)	11:00~11:15	IBM Cluster 1600
	17:00 (12Z_120HR_FCST)	17:00~17:15	IBM Cluster 1600
	22:40 (18Z_120HR_FCST)	22:40~23:00	IBM Cluster 1600
Ensemble Prediction 15 members (T213L31)	07:30(00Z_ASSIM+6HR_FCST)	07:30~07:35	IBM Cluster 1600
	12:30(06Z_ASSIM+6HR_FCST)	12:30~12:35	IBM Cluster 1600
	18:30(12Z_ASSIM+240HR_FCST)	18:30~20:15	IBM Cluster 1600
	23:30(18Z_ASSIM+6HR_FCST)	23:30~23:35	IBM Cluster 1600
Prediction 15 members (WRF) Ensemble	07:00(36HR_FCST)	07:00~07:40	IBM Cluster 1600
	14:00(00Z_ASSIM+6HR_FCST)	14:00~14:15	IBM Cluster 1600
	14:15(06Z_ASSIM+6HR_FCST)	14:15~14:30	IBM Cluster 1600
	19:00(36HR_FCST)	19:00~19:40	IBM Cluster 1600
	00:00(12Z_ASSIM+6HR_FCST)	00:00~00:15	IBM Cluster 1600
	00:15(18Z_ASSIM+6HR_FCST))	00:15~00:30	IBM Cluster 1600
Sand Storm (MM5)	05:30(72HR_FCST)	05:30~06:30	IBM Cluster 1600
	18:30(72HR_FCST)	18:30~19:30	IBM Cluster 1600
Wave Watch(WW3)	07:00(120HR_FCST)	07:00~07:20	IBM Cluster 1600
	19:00(120HR_FCST)	19:00~19:20	IBM Cluster 1600

4.2 Medium range forecasting system (4-10 days)

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

"[information on Data assimilation, objective analysis and initialization]"

The Spectral Statistical Interpolation (SSI) data assimilation scheme introduced from NECP was developed and run in operational since December 2006. It is 3D variational data assimilation scheme. The conventional observational data from GTS and the NOAA satellites ATOVS 1b data are assimilated. Compare with I/O data assimilation scheme, one day improving in south hemisphere and 0.5 day improving in north hemisphere are made for T213 NWP system.

4.2.1.2 Research performed in this field

"[Summary of research and development efforts in the area]"

Based on the theoretical framework of regional GRAPES_3DVAR, the global GRAPES_3DVAR has been basically established in CMA. The new version of GRAPES_3DVAR is more flexible in both regional and global uses. The validation experiments for global GRAPES_3DVAR are carrying out with the conventional data sets. In the next step, the global GRAPES_3DVAR will be connected with the global GRAPES_SISL model to set up a complete assimilation and prediction system.

4.2.2 Model

4.2.2.1 In operation

"[Model in operational use, (*resolution, number of levels, time range, hydrostatic?, physics used*)] "

There is no change, except the initialisation scheme of parameters on surface. Originally, the Initial data of soil temperature and moisture are fixed value. From May 19 2006, the Initial data of soil moisture are calculated by the average of 6-hour background and fixed value and soil temperature evolve freely, that is using 6-hour background as initial value.

4.2.2.2 Research performed in this field

"[Summary of research and development efforts in the area]"

By using reduced linear Gaussian grid and improving the stability of semi-Lagrangian scheme, global model is upgraded to TL639L60 with little extra computation. The cloud and convection scheme were improved to make convection more active, reduce large scale precipitation and so raise TS and reduce blank forecast.

TL639L60 was coupled with 3DVAR analysis scheme to build TL639 medium-range weather forecast system. After one summer (June to August 2006) parallel running, this system will be quasi-operationally run at the end of this year.

The GRAPES_SISL model is a unified model for both regional and global simulations. The current version of the global GRAPES_SISL model is with horizontal resolution of 0.5Ox0.5O degree, 31 vertical levels and full physical parameterization schemes. The top of the model reaches about 33 km. The global GRAPES_SISL model has been tested in real-time since the beginning of 2006. The dynamical core of GRAPES_SISL model is optional for both hydrostatic and non-hydrostatic approximation. The non-hydrostatic dynamical core was selected for the current global runs. The impacts of the non-hydrostatic core are neutral but stable for the real simulations. We are planning to compile the global GRAPES_SISL model with the global GRAPES_3DVAR in the coming year 2007.

4.2.3 Operationally available Numerical Weather Prediction Products

"[brief description of variables which are outputs from the model integration]"

variables	unit	Forecast hours	Levels (hpa)	Area
Temperature	K	00,03,06 , 09,12,15 ,18,21,2 4,27,30, 33, 36,39,42 ,45,48,5 1,54,57,	10,20,	Global grid(0.5625* 0.5625)
Height	M		30,50,	
U-wind	m/s		70,100,	
V-wind	m/s		150,200,	
W	pa/s		250,300,	
			400,500,	
			600,700,	
			850,925,	
			1000	
q	Kg/kg		60,	
		63,66,69	150,200,	
		,72,	250,300,	
rh	%	84,96,	400,500,	
		108,120,	600,700,	
		144,	850,925,	
		168	1000	
Sea level press	hPa	192	Sea level	
		216		
		240		

variables	unit	Forecast hours	levels	Area
vorticity	s ⁻¹	00,03,06 ,	10,20,30,5 0,70,	Global grid(0.5625 *0.5625)
divergence	s ⁻¹	09,12,15 ,	100,150,2 00,250,	
		18,21,24 ,27,30,3 3,	300,400,5 00,600, 700,850,9	
		36,39,42	25,1000	
Temperature	K	,45,48,5	surface	
Pressure	hPa	1,54,57,	surface	
10mU	m/s	60,	9999	

10mV	m/s	63,66,69	9999	
2mT	K	,72,84,9	9999	
2mRH	%	6,	9999	
Soil temperature	K	108,120,	1,2,3,4	
Soil moisture	kg/m ²	144,	1,2,3,4	
		168		
		192		
		216		
		240		
Rainfall	mm	03,06,09	9999	
Convection rainfall	mm	,12,15,1	9999	
		8,21,24,		
		27,30,33		
		,36,39,4		
		2,45,48,		
51,54,57				
,60,63,6				
6,69,72,				
84,96,10				
8,120,13				
2,144,15				
6,				
168,180,				
192,204,				
216,228,				
240				
Temperature Advection	10 ⁻⁶ C/s		200,500	North-east hemispher e
Vorticity advection	10 ⁻¹¹ /s ²		700,850	
			925,1000	
T-TD	10 ⁻¹ °C		00,06,12	
			,18,24,3	
		0,36,42,	500,700	
		48,		
Vapor Flux	10 ⁻¹ g/ hap-cm-s	60,72,	850	
		96,		
Vapor Flux divergence	10 ⁻⁷ g/ hap-cm ² s	120,144,		
		168		

θse	K			
K index	°C			
Height variable	m	24,48, 72,96,	500	
Error of height forecast	m	120,144, 168	200,500	
Error of Temperature forecast	K		700,850 1000	
Error of sea pressure forecast	hPa		Sea level	

4.2.4 Operational techniques for application of NWP products (*MOS, PPM, KF, Expert Systems, etc..*)

4.2.4.1 In operation

"[brief description of automated (formalized) procedures in use for interpretation of NWP output]"

In operational MOS system, many diagnosis predictors were added, and precipitation was preprocessed through relative humidity before modeling. Summer verification result of 2006 indicated that new scheme is better than old scheme. In September 2006, new scheme replaced old scheme used in operation.

4.2.4.2 Research performed in this field

"[Summary of research and development efforts in the area]"

The diagnose module of the global GRAPES is not yet established in use for interpolation of NWP output.

4.2.5 Ensemble Prediction System (EPS)

4.2.5.1 In operation

"[Number of runs, initial state perturbation method, perturbation of physics?]" (*Describe also: time range, number of members and number of models used: their resolution, number of levels, main physics used*)

An updated global Ensemble Prediction System was put into Quasi-operational at the end of 2006. The configuration consists of running:

- **Number of members:**

15-members; 14 perturbed members (from adding/subtracting perturbations from 7 independent breeding cycles) plus control run.

- **Initial state perturbation:** method: Breeding method

- **Number of models used:** 1 model used, T213L31

- **Perturbation of physics:** No
- **Running cycle :** 12Z running each day
 - T213L31 resolution control out to 10 days.
 - 14 perturbed forecasts each run at T213L31 resolution and out to 10 days.
 - The perturbations are from seven independent breeding cycles.

4.2.5.2 Research performed in this field

"[Summary of research and development efforts in the area]"

We are planning to establish a new EPS for medium range forecast based on the global GRAPES system. The possible approaches for generating the initial perturbations are Breeding of Growing Model (BGM) method and ETKF (Ensemble Transformed Kalman Filter) method. The model uncertainty will be taken into account by physical perturbation.

4.2.5.3 Operationally available EPS Products

"[brief description of variables which are outputs from the EPS]"

- **Post-processing:**

Mean/spread: Hgts(mean) and vorticity(spread) at the level of 250hPa, 500hPa;

relative humidity at 700hPa, 850hPa;

temperature at 850hPa, 700hPa, 500hPa, 250hPa;

wind at 850hPa, 700hPa, 500hPa, 250hPa;

10m wind;

2m temperature

1000-850 mb thickness, 1000-500mb thickness, 850-700mb thickness;

precipitation

sea level pressure

Spaghetti: 2m temperature,

MAY-SEP: Highest(30,35), OCT-APR: Lowest(-8,5); (0,12)

850mb temperature: MAY-SEP (12,24), or OCT-APR (-12,0,12)

500mb Hgts

MAY-SEP: (512,564); (568,588)

OCT-APR: (512,560); (544,588)

sea level pressure, 24 hr total precipitation,

Probability: 10m wind, 2m temperature, precipitation.

4.3 Short-range forecasting system (0-72 hrs)

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

"[information on Data assimilation (*if any*), objective analysis and initialization,]" (*Indicate boundary conditions used*)

From 2006 July, the Global and regional assimilation and prediction system for mesoscale (Grapes-

meso) has been as the operation regional data assimilation forecast system in NMC. HLAFS025 system had not been used.

The horizontal resolution of Grapes-meso system is 30km, vertical pressure coordinate is 17 layers. The multi-variable three-dimension incremental analysis is applied for streamfunction, uncorrelated velocity potential, unbalanced mass variable (p/M) and relative humidity. The first guess fields for cold starting and the boundary conditions for the assimilation model, including geopotential height, zonal and meridional wind and relative humidity are interpolated from the global model forecast field (T213L31). Then the following first guess fields are provided by the 6-hour forecast of the regional data assimilation model itself.

4.3.1.2 Research performed in this field

"[Summary of research and development efforts in the area]"

The regional GRAPES_3DVAR has become operational since July 2006 for use of conventional observations mainly via GTS. The background co-variances were reanalyzed and the analysis scales were optimized by reducing the vertical scales for humidity analysis. The GRAPES_3DVAR is under tests with the radar (radial winds and reflectivity) and satellite (AMSU-A/B) data sets.

A framework of GRAPES_4DVAR has been established. The TL model and the adjoint model were well tested with the idealized cases. The simplified vertical diffusion scheme and large-scale condensation scheme were included in the adjoint model. The GRAPES_4DVAR is ready for a long time validation runs with the conventional data sets.

4.3.2 Model

4.3.2.1 In operation

"[Model in operational use, (*domain, resolution, number levels, range, hydrostatic?, physics used*)] "

The GRAPES-MESO operational system is performed on the IBM-1600 Cluser in Aug 2006.

The operational system 's horizontal resolutions are about 30KM cover China. The vertical resolution of the model is 31 sigma layers.

The main parameterization schemes include: rrtm scheme,Dudhia scheme,NCEP 3-class simple ice scheme,Monin-Obukhov scheme,thermal diffusion scheme,mrf scheme,Kain-Fritsch (new Eta) scheme.

The first-guess data are provided by medium-range prediction model (T213) that is performed in NMC of CMA.

No changes on NMC-MM5

4.3.2.2 Research performed in this field

"[Summary of research and development efforts in the area]"

The regional GRAPES_Meso has become operational since July 2006 at NMC/CMA. The operational GRAPES_Meso of NMC is characterized by non- hydrostatical dynamical core, horizontal resolution of 0.30X0.30 (about 30km), 31 vertical levels, and full physical package. The GRAPES_Meso is now upgrading to the GRAPES_meso_15km in addition of the GWD (Gravity Wave Drag) scheme.

Slope Irradiance Effect on Numerical Simulations: Solar radiation is obviously an important factor in many aspects of surface forcing. In the currently short wave radiation scheme used in the meso-scale model (i.e. GRAPES, WRF or MM5 (Dudhia, 1989), the slope irradiance effects are often ignored. The estimation of the GSW radiation in such way may lead to considerable errors when the model resolution is highly increased and the model terrain becomes steep. To improve solar short wave radiation parameterization, slope irradiance has been implemented into nonhydrostatic mesoscale model. The results of the slope irradiances and the effect on the simulation of a Meiyu front precipitation process. showed that the influence of slope and orientation of terrain on the calculations of GSW is large. The radiation minima's are reduced up to 60 % , and the maximums are up to 60 % larger compared to the reference run , which are much larger than at other times during the day and the 12 or 24h average.

4.3.3 Operationally available NWP products

"[brief description of variables which are outputs from the model integration]"

The operationally available products of GRAPES-MESO as the follow table.

Variables	unit	Initial time	Forecast hours	Levels(hpa)	Area
U-WIND	m/s	00, 12	00,03,	1000 925	55° E-145° E 5° N-65° N Grid (0.3°*0.3°)
V-WIND	m/s		06,09,	850 700 600	
Temperature	K		12,15,	500 400 300	
Geopotential height	M		18,21,	250 200 150	
Specific humidity	kg/k g		24,27,	100 70 50	
Quantity cloud	kg/k g		30,33, 36,39,	30 20 10	
Quantity rain	kg/k g		42,45, 48,51,		
Vertical wind	m/s		54,57, 60		
Surface pressure	hPa				
Sea level pressure	hPa				
Convection Precipitation(rainc)	mm				

Not Convection Precipitation(rainn c)	mm				
Surface temperature	K				
Surface long wave radiation flux	W/m ²				
Surface short wave radiation flux	W/m ²				
sueface heat flux	W/m ²				
sueface vapour flux	kg/m ² / s				
2mrh	kg/k g				
2mt	K				
10mU-wind	m/s				
10mV-wind	m/s				

No changes on NMC-MM5

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

"[brief description of automated (formalized) procedures in use for interpretation of NWP ouput]"
(MOS, PPM, KF, Expert Systems, etc..)

No changes.

4.3.4.2 Research performed in this field

"[Summary of research and development efforts in the area]"

The post_VAR module of GRAPES_Meso system has been connected with a dynamical diagnose module for both interpretation of NWP output and analysis of the GRAPES' behaviour. The MOS, DMO products need to be further verified before the operational applications.

4.3.5 Ensemble Prediction System

4.3.5.1 In operation

"[Number of runs, initial state perturbation method, perturbation of physics?]" (Describe also: time range, number of members and number of models used: their domain, resolution, number of levels, main physics used)

4.3.5.1 Parallel run (In operation?)

The WRFV2.1 is firstly put into parallel-run as Meso-scale Ensemble Prediction Sytem (viz. MEPS) at the end of July 2006 in CMA/NMC. The domain of this system covers the main land of eastern China (95°E~130°E and 25°N~53°N) . The horizontal resolution is about 15 km. Terrain-following mass coordinate is used as vertical coordinate, and vertical resolution is 35 layers, and model top reaches 10 hPa. The configuration of running:

- **Number of members:**

15-members, control run plus 14 perturbed members (from 7 independent breeding cycles)

- **Initial condition perturbation method:** Breeding method

- **Lateral boundary perturbation condition:**

Provided by the results of CMA/NMC Global EPS

- **Perturbation of physics:** None

- **Number of models used:** 1 model used WRF V2.1

- **Running cycle:**

run twice a day starting at 00 UTC and 12 UTC. The 36 hours forecast was made for both control run and perturbation forecast

- **Main physics used:**

Grid-scale Clouds and Precipitation: WSM 3-class simple ice scheme with prognostic treatment of vapor, cloud water/ice, and rain/snow.

Moist Convection: Betts-Miller-Janjic scheme.

Vertical Diffusion: YSU scheme with diagnostic K-closure method.

Surface Layer: Similarity theory Using stability functions from Paulson (1970), Dyer and Hicks (1970), and Webb (1970) to compute surface exchange coefficients for heat, moisture, and momentum.

Soil Processes: MM5 5-layer soil temperature model.

Long wave radiation: RRTM, which is taken from MM5, is based on Mlawer et al. (1997), and it is a spectral-band scheme using the correlated-k method.

Short wave radiation: base on Dudhia (1989) and taken from MM5. It is a simple downward integration of solar flux, accounting for clear-air scattering, water vapor absorption (Lacis and Hansen 1974), and cloud albedo and absorption. It uses look-up tables for clouds from Stephens (1978). Further options: Goddard scheme is base on Chou and Suarez (1994); GFDL scheme of the Lacis and Hansen (1974) parameterization.

4.3.5.2 Research performed in this field

"[Summary of research and development efforts in the area]"

GRAPES_MEPS: The mesoscale ensemble prediction system using a non-hydrostatic mesoscale NWP model (GRAPES-Meso), is developed in LaSW/CNPR for the motivations of improvements of the heavy rain forecasts in summer season in China, specially for participation of WMO-B08 RDP (Beijing 2008 Olympic Games Research Demonstration Project). This system, called GRAPES-MEPS for short, consists of 8 members. In generating the initial perturbations, the Breeding of Growing Mode (BGM)

method was adopted with a 12h time window cycle. In addition, the multi-physical parameterizations and stochastic perturbations on the sensitive factors to the convections were also introduced for consideration of the model uncertainties. Some convective events were preliminarily chosen for the case studies, such as flash flooding, squall line and heavy rainfall. The preliminary results showed that GRAPES-MEPS could capture some characteristics of the meso-scale system, improving the location and intensity of the heavy rain forecasts. The remarks are preliminary but encouraging, it could need more research and experiments to further improve the GRAPES-MEPS.

4.3.5.3 Operationally available EPS Products

"[brief description of variables which are outputs from the EPS]"

MEPS products utilize GRIB2 format as coding of the output data, which is the same as global EPS. Output every 3 hours. Horizontal grid is 0.15 degree, within the area (105°~125°E and 30°~45°N), vertical levels is taken as the computational levels. Now only 6 surface variables can be provided in four categories as follows:

- **Mean/spread:** 2m temperature, 10m wind(U and V), relative humidity at surface, sea surface pressure and precipitation
- **Spaghetti:** 2m temperature, 10m wind(U and V), relative humidity at surface, sea surface pressure and precipitation
- **Probability:** precipitation.

4.4 Nowcasting and Very Short-range Forecasting Systems (0-6 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

"[information on processes in operational use, as appropriate related to 4.4]"

No operation.

4.4.1.2 Research performed in this field

"[Summary of research and development efforts in the area]"

- Since the early of 2006, a Rapid Update Cycle system (WRF_RUC) is beginning to be developed in NMC. The WRF_RUC system is based on WRF model and assimilation system, with a 3-h intermittent assimilation cycle, in which a new analysis is produced every 3-h using the previous 3-h forecast as a background. In order to suppress the high-frequency oscillation caused by the dynamic imbalance of analysis fields in the beginning period of the assimilation model integration, the digital filtering scheme (Lynch 1992) have been developed for WRF_RUC system. The data used for data assimilation system include the exchanged observation data from GTN and NTS.

Table 1 gives the data list used for this system.

Table 1. The data used for WRF_RUC system

Type	Record
TEMP	Height, Temperature, Humidity, Wind

PILOT	Wind
SYNOP	Pressure, Temperature, Humidity, Wind
SHIP	Pressure, Temperature, Humidity, Wind
STAOB	Wind
AIREP	Wind, Temperature
RADAR	VAD winds(WSR_88Ds), Reflectivity
GPS	Precipitable water vapor

The domain of analysis system covers South of China. Its horizontal resolution is 15km. It has 35 levels in the vertical.

Further study and work will be done to combine products of WRF_RUC with radar data to do nowcasting service.

- GRAPES-Based Nowcasting System GRAPES_SWIFT design and Progress: The motivations are to exploit the potentials of GRAPES for (1) improving the warning of mesoscale severe weather events in advance of 3-6hr; (2) promoting the application of remote sensing and in situ data to monitoring meso scale weather systems; meeting the needs of high quality weather services for Beijing Olympic Games 2008. The GRAPES_SWIFT system structure consists of: (1) Data Input: Conventional observation (RA & Synop), AWS, Weather Radar, Satellite, Profiler, Lightning positioning, GPS, Aircraft; (2) Data Analysis: Quick look at basic elements: (Qlable) usage of Initializing NWP, First Guess of SA, CA, and Background of system id and forecast; Surface Analysis: (SA) usage of Initializing NWP, System id and forecast, display; Cloud Analysis: (CA) usage of NWP hot start, System id and forecast, display. The domain of GRAPES_SWIFT is movable. Currently, it is mainly tested in Beijing area and Guangzhou area. GRAPES_SWIFT is hourly run for 0~12 hrs forecast. It provides the outputs of 10m-wind, precipitation, temperature, and so on, in hourly interval.

4.4.2 Models for Very Short-range Forecasting Systems

4.4.2.1 In operation

"[information on models in operational use, as appropriate related to 4.4]"

No operation.

4.4.2.2 Research performed in this field

"[Summary of research and development efforts in the area]"

Since the early of 2006, a Rapid Update Cycle system (WRF_RUC) is beginning to be developed in NMC. The WRF_RUC system is based on WRF model and assimilation system, with a 3-h intermittent assimilation cycle, in which a new analysis is produced every 3-h using the previous 3-h forecast as a background. In order to suppress the high-frequency oscillation caused by the dynamic imbalance of analysis fields in the beginning period of the assimilation model integration, the digital filtering scheme (Lynch 1992) have been developed for WRF_RUC system. The data used for data

assimilation system include the exchanged observation data from GTN and NTS. Table 1 gives the data list used for this system.

Table 1. The data used for WRF_RUC system

Type	Record
TEMP	Height, Temperature, Humidity, Wind
PILOT	Wind
SYNOP	Pressure, Temperature, Humidity, Wind
SHIP	Pressure, Temperature, Humidity, Wind
STAOB	Wind
AIREP	Wind, Temperature
RADAR	VAD winds(WSR_88Ds), Reflectivity
GPS	Precipitable water vapor

The domain of analysis system covers South of China, with a horizontal resolution of 15km and 35 levels in the vertical.

In rainfall season of 2007, this system will be tested to provide short range forecast products (3-h, 6-h and 12-h forecast) every day.

A specific high resolution GRAPES_Meso was developed for GRAPES_SWIFT. It is a three-one-way nested model: the outer model with grid size of 36km using F.G. and L.B.C. from the operational global model for 24 hrs forecast; the middle model with grid size of 12km using L.B.C. (F.G. from the model-12km itself) from the model-36km for 12 hrs forecast; and the inner model with grid size of 3km using the initial fields and L.B.C. from the model-12km for 6 hrs forecast. The outer model is run with a cold-start using GRAPES_3DVAR for assimilation. The middle model is run with a continuous cycling of GRAPES_3DVAR assimilation system. The inner model is run without data analysis and assimilation.

4.5 Specialized numerical predictions

[Specialized NP on sea waves, sea ice, tropical cyclones, pollution transport and dispersion, solar ultraviolet (UV) radiation and air quality forecasting etc.]

4.5.1 Assimilation of specific data, analysis and initialization (where applicable)

4.5.1.1 In operation

"[information on the major data processing steps, where applicable]"

No.

4.5.1.2 Research performed in this field

"[Summary of research and development efforts in the area]"

In Shanghai regional meteorological centre of CMA, the GRAPES_TCM (Tropical Cyclone Model) was developed and became operational since 2005. A BDA (Bogusing Data Assimilation) scheme was used for the initialization of GRAPES_TCM.

In Guangzhou regional meteorological centre of CMA, the GRAPES_TMM (Tropical Meteorological Model) was developed and became operational since 2005. The South China Sea monsoon products generated by GRAPES_TMM are available on the web site of G-RMC: <http://www.itmm.gov.cn/>.

4.5.2 Specific Models

4.5.2.1 In operation

"[information on models in operational use, as appropriate related to 4.5]"

- **A global ocean wave forecast system was put into operation**

A global ocean wave forecast system was put into operation in 19 March 2007. The system combines the WAVEWATCH III model (download from NOAA/NECP website) and the spectral model T213L31.

Global WW3 is forced by surface winds provided by the operational global medium range analysis-forecast system. The spatial resolution is 1.0*1.0 longitude-latitude grid extending from 80°S to 80°N. The model runs twice per day, producing wave forecasts out to 120 hours from 0000 GMT and 240 hours from 1200 GMT. The model is initialized from the directional wave spectra, at time 0, of the previous run and integrating forward in time. This ensures the wave model is using the most accurate wind fields possible. There is no ice coverage and currents as inputs in the model.

- The GMTTP (Global Model for TC Track Prediction) system was put into operational running in 2006. The mean track errors for 2006 are 154.3km(24h), 293.6km(48h) and 459.2km(72h).
- No further modification has been taken a air pollution prediction system.
- No further modification has been taken a Environmental Emergency Response model
- Dust-Strom prediction system: The dust storm system was operational running. The first-guess data are provided by medium-range prediction model (T213) that is performed in NMC of CMA. The system couples a wind erosion scheme, a dust transportation model and the Penn State/UCAR modeling system (MM5) with a geographic information database. The operational system can provide at least 72 hours prediction products with 3-hrs interval. The products are delivered to China local meteorological bureau by the 9210 satellite communication system.

4.5.2.2 Research performed in this field

"[Summary of research and development efforts in the area]"

A family of the GRAPES_Based models was developed for the UV forecast (GRAPES_UVM), for the sand and dust forecast (GRAPES_DAM), for the lightning simulation (GRAPES_LTM).

4.5.3 Specific products operationally available

"[brief description of variables which are outputs from the model integration]"

- The GMTTP (Global Model for TC Track Prediction) system. The outputs from the GMTTP system include: 120h track, 10-m wind, 925hPa wind, 850hPa wind.

- **Dust-Strom prediction system**

The main products of dust storm model:

- surface dust concentration (mg m^{-3})
- integration dust concentration (mg m^{-2})
- dust deposition ($\text{mg m}^{-2}\text{s}^{-1}$)
- soil moisture for 4 layer (10, 30, 60 100cm deep) (m^3m^{-3})
- friction velocity (m s^{-1})

- **A global ocean wave forecast system was put into operation**

Both graphical and binary model outputs are available. The guiding products with the horizontal 1.0 plus 1.0 are provided to the observatories all over the country by satellite communication. More high guiding products are uploaded to the NMC ftp server so that the customers can download the real-time products from the internet. In addition, the graphical products are provided by NMC web site:

http://www.nmc.gov.cn/product/MS/HLMS_DYS_DXY_12H/1.html

The operational system can provide 240 hours prediction products with 6-hrs interval. The main products of the global wave model are as follows :

- Significant wave height (m)
- Mean wave direction (radian)
- Mean wave period (s)
- Mean wave length (m)
- Air-sea temperature difference (degree)
- wind U (m s^{-1})
- wind V (m s^{-1})

- **Environmental Emergency Response model**

NMC is designed by the WMO as a Regional Specialised Meteorological Centre (RSMC) with specialization in Atmospheric Transport Modelling Products for Environmental Emergency Response.

4.6 Extended range forecasts (ERF) (10 days to 30 days)

Based on NWP products of the monthly Dynamic Extended Range Forecasting (DERF) model run by National Climate Center (NCC) of China Meteorological Administration (CMA), the extended range objective prediction system was developed and put into operation in the National Meteorological Center (NMC) / CMA in 2005. The verification of extended range forecast was explored in 2006 for the system assessment and improvement. The extended range objective prediction system performs data getting and format transition, the DERF data process and analysis, and makes extend range

objective forecasts by means of the combination technique of the synoptic, dynamic, and statistic method. With aid of this system, NMC have been issuing the extended range forecasts to public on website since September of 2005, which includes the ten-day precipitation and its anomaly percentage prediction, the ten-day average temperature and its anomaly prediction for the coming second and third decades.

The Dynamical Extended Range Forecast model system of Beijing Climate Center (BCC-DERF) consists of 3 parts. The first involves initial condition generation with Singular Vector (SV) method, which generates 16 initial fields in addition to 16 LAF (Lagged Average Forecast) initial fields. The second is the global spectral model of T63L16, with the horizontal resolution of approximate 180km and 16 vertical levels up to 10 hPa. The third deals with information extraction and ensemble forecast output. The current experimental MEDERF system consists of 32 ensemble members. Researches on the application of MEDERF were carried out by combining dynamical and statistical forecasts, which established a link between monthly precipitation in China and monthly circulation represented by 500hPa geopotential height. This downscaling model is skillful in all months. Its score skills for monthly local precipitation forecast were higher than those of the operational forecast.

Since Dec. 2005, the model has been operated in monthly prediction. Based on it, BCC issues the 10-day and 30-day global prediction in the first day of every pentad, i.e., 1st, 6th, 11th, 16th, 21st and 26th, the prediction length includes 1-10day, 11-20 day, 21-30 day and 31-40 day for dekadly prediction, 1-30 day and 11-40 day for monthly prediction. The predicted variables include precipitation, 2-meter temperature, geopotential heights (200hPa, 500hPa and 700hPa), sea level pressure, zonal winds (200hPa and 700hPa) and meridional winds (200hPa and 700hPa). For the temperature and precipitation, we issue both the deterministic prediction and the probabilistic prediction.

The ensemble methods include the equal-weight, the linear-weight and the parabolic-weight.

4.6.1 Models

4.6.1.1 In operation

"[information on Models and Ensemble System in operational use, as appropriate related to 4.6]"

No.

4.6.1.2 Research performed in this field

"[Summary of research and development efforts in the area]"

A new version of AGCM (Atmospheric General Circulation Model) is under development from the global GRAPES_SISL model. The stability, and the mass and energy conservation of GRAPES_SISL even with non-hydrostatical dynamical core are tested for a long period of the model integration. It is expected that the GRAPES_AGCM become a key component of the climate system model in the near future.

4.6.2 Operationally available NWP model and EPS ERF products

"[brief description of variables which are outputs from the model integration]"

4.7 Long range forecasts (LRF) (30 days up to two years)

4.7.1 In operation

"[Describe: Models, Coupled? (1 tier, 2 tiers), Ensemble Systems, Methodology and Products]"
NO.

4.7.2 Research performed in this field

"[Summary of research and development efforts in the area]"

4.7.2 Operationally available EPS LRF products

"[brief description of variables which are outputs from the model integration]"

The National Climate Center Global Atmosphere-Ocean Coupled General Circulation Model (NCC-CGCM) was first established in 2002. The atmospheric and oceanic components are coupled through the coupling scheme of Daily Flux Anomaly on the open sea surface. Two radiation schemes (Mocrette, 1991; Gu-Liao, 2001) were tested and implemented respectively in NCC-T63L16, the atmospheric component of NCC-CGCM.

In 2002, a climate model prediction system for seasonal forecast was established based on the Global Atmosphere-Ocean Coupled Model for Seasonal Prediction. The global coupled ocean-atmosphere model currently used in NCC is composed of an AGCM (Version 1.0, named T63L16 AGCM_1.0) which is developed on the basis of the operational medium-range prediction model of National Meteorological Center of China Meteorological Administration (NMC/CMA) and an OGCM (Version 1.0, named GT63L30 OGCM_1.0) which is developed by the National Laboratory of Atmospheric Science and Geohydrodynamics (LASG) of IAP/CAS on the basis of the original LASG OGCM (20 levels in vertical direction and 4°X5° horizontal resolution). The atmospheric and oceanic models are coupled through the coupling scheme of Daily Flux Anomaly on the open sea surface.

Compared with the original components of the models, BCC-CGCM was enhanced by a number of improvements for seasonal forecasting purposes. For AGCM, the improvements involve the following items a) the reference atmosphere, b) the mass conservation scheme, c) negative moisture caused by the Semi-Lagrange method, d) new radiation scheme (Morcrett), e) new cumulus convection parameterization scheme (K→G), f) simple land surface process models (SAST(3)+BATS(10)). For OGCM, the improvements include: a) a higher resolution, b) free ocean surface, c) adoption of Gent-MacWilliams'along/across Isopycnal mixing scheme, and d) a thermal-dynamical sea ice model

BCC-CGCM has 16 vertical levels in the atmospheric model with a horizontal resolution of 1.875° east-west and 1.875° north-south. There are 30 vertical levels in the oceanic model with a horizontal resolution of 1.875° east-west and 1.875° north-south.

There are 6 schemes for Ocean and 8 schemes for Atmosphere, so there are totally 48 members for both forecasts and hindcasts. The hindcast products are available since Jan. 1983.

The products of BCC-CGCM cover the globe with a lead time of 0-6 months and BCC-CGCM can provide 3-month rolling seasons forecasts. The predicted variables include precipitation, 2-meter temperature, 500hPa geopotential height, 850hPa temperature, and sea surface temperature. For the 2-meter temperature and precipitation, both deterministic and the probabilistic predictions are issued.

5. Verification of prognostic products

5.1 "[annual verification summary to be inserted here]"

5.1.1 The verification against analysis of operational numerical forecast model(T213) in 2006 are as shown in the following table(a).

(a) RMSE of Z(500) and W(250)

Month	Valid time	Z(500)		W(250)			W(850)
		NH	SH	NH	SH	Tropics	Tropics
1	24	21.2	21.1	7.6	6.3	6	2.5
	72	61.1	58.6	16.9	14.5	11.2	4.3
	120	96.9	87.7	23.1	20.2	15.2	5.4
2	24	15.1	20	5.8	6.3	5.6	2.2
	72	42.9	56.6	11.6	15	9.4	3.5
	120	73.7	82.2	17.3	19.7	12.3	4.2
3	24	14.2	21	5.6	6.2	5	2.2
	72	39.6	60.2	10.9	15.1	7.9	3.5
	120	67.7	89.9	16.2	20.5	10.6	4.1
4	24	13.1	20.7	5.4	6.2	5.3	2.1
	72	34.8	60.5	10.6	14.7	8.3	3.4
	120	57.5	95.3	15.4	20.6	11.2	4.1
5	24	11.8	21.1	5.4	6.3	5.5	2.1
	72	32	58.4	11.1	14.3	9.2	3.4
	120	53.7	90	16.3	20.5	12.1	4.2
6	24	11.8	21.1	5.4	6.3	5.5	2.1
	72	32	58.4	11.1	14.3	9.2	3.4
	120	53.7	90	16.3	20.5	12.1	4.2
7	24	12.1	24.6	5.4	7	5.7	2.3
	72	32	67.7	11.1	16.6	9.2	3.8
	120	51	101.9	15.6	22.4	11.4	4.5
8	24	11.9	23.1	5.5	6.3	5.8	2.4
	72	31	65.4	11.2	15.5	8.9	4.1
	120	48.3	101.2	15.1	21.8	10.9	4.9
9	24	12.6	21.5	5.5	6.2	5.1	2.3
	72	34.5	61.1	11.7	15.2	8.3	3.7
	120	57	93.3	16.5	20.7	11	4.5
10	24	12.6	21.5	5.5	6.2	5.1	2.2
	72	34.5	61.1	11.7	15.2	8.3	3.7
	120	57	93.3	16.5	20.7	11	4.3

11	24	14.1	20.5	5.6	6	5.1	2.1
	72	41.6	56	12.1	14.9	8.4	3.4
	120	71.3	84.6	18.3	20.3	10.8	4
12	24	15.8	19.8	5.7	5.9	5.1	2.3
	72	40.2	53.5	11.5	14.3	8.3	3.5
	120	64.7	76.6	16.8	19.5	11.4	4.1

5.1.2 The verification against observations of operational numerical forecast model(T213) in 2006 are as shown in the following table(b).

(b) RMSE of Z(500) and W(250)

Month	Valid time	Z(500)				W(250)			
		N.A	Europe	Asia	Australia	N.A	Europe	Asia	Australia
1	24	34.3	25.7	28.5	30.6	12.4	7.7	8.1	12.1
	72	85.8	55.6	52.3	56.7	23.1	16.7	12.7	15.9
	120	117.8	119	83.6	77.4	28.3	27.2	17.3	20
2	24	21.7	16.6	17.9	49.7	9.7	6.4	7.9	15
	72	58.1	41.1	31.9	66.4	16.3	12.1	11.8	21.1
	120	88.6	83	56.5	86.9	20.6	20.4	17.3	22.8
3	24	19	24.2	18.5	49.1	8.4	7	8.6	16.8
	72	43.5	41	33	75.5	13.4	10.6	11.9	21.9
	120	76.6	74.6	57.7	99.6	20.4	16.4	14.7	23.7
4	24	18.2	24.4	17.3	39.3	8.2	6.4	8.4	15.5
	72	38.7	48	32.3	60.9	13	12.8	12	18.7
	120	60.5	69.1	50.9	80.6	18.2	17.7	16.1	22.6
5	24	17.3	16.5	16.8	48.8	8	7	8.5	13.5
	72	37.3	31.2	30.9	73.2	13.7	12.1	13	17.9
	120	57.6	58.2	48.9	90	18.7	16.7	17.6	24.8
6	24	17.3	16.5	16.8	48.8	8	7	8.5	13.5
	72	37.3	31.2	30.9	73.2	13.7	12.1	13	17.9
	120	57.6	58.2	48.9	90	18.7	16.7	17.6	24.8
7	24	16	21.3	17.1	51.8	7.8	6.8	8.4	17.1
	72	37	35.5	29.2	76.2	14.3	11.4	12.4	22.4
	120	54.9	52	44	100.3	18.7	16.4	15.9	24
8	24	12.5	21	16.9	57.3	7.3	6.9	7.8	13.7
	72	28.5	34.1	29.3	81	12.2	11.6	11.7	20.2
	120	45.8	53.7	38.6	101.9	16.2	16.1	14.2	23.4

9	24	25.4	22.7	16.1	62.7	8.6	7.9	7.1	17
	72	44.3	46.2	27	88.5	14.3	15.2	10.8	21.8
	120	71.1	72	42	101.1	19.9	20.6	14.7	23.3
10	24	28.2	18.9	15.3	57	8.4	7.7	6.7	14.5
	72	56.9	38.3	29.8	79.9	15.5	12.8	10.1	20
	120	89.2	74.7	48	93.3	23	18.6	14.2	23.6
11	24	21	16.5	18.5	58.3	9.7	6.7	7.9	13.8
	72	53.9	34.8	34.5	80	17.5	12.1	11.5	19.8
	120	78.3	81.8	54.1	98.1	21.9	21.3	14	20.8
12	24	21.7	17.3	21.2	62.2	9.2	7.3	7.3	14
	72	50.7	39	36	85.7	15.7	12.1	11.3	19.8
	120	74.4	70.5	55.6	99.4	21	19.4	16.2	23.6

5.2 Research performed in this field

"[Summary of research and development efforts in the area]"

Verification of EPS is developing.

a) verification system of meso-scale EPS is in building

- Parameters to be verified include: probability of precipitation occurrence, 2m temperature, 10m winds, 3, 6 and 24 hour accumulated total precipitation, 2m relative humidity or 2m dew point temperature, sea level pressure, 850mb and 250mb temperature and wind, 500mb temperature and height, 850mb relative humidity, and other variables verification group cares.
- Verification methods include: Rank histogram, spread and RMSE, The continuous rank probability score (CRPS), Brier Score, Brier Skill score, reliability and resolution, ROC graph and area under the ROC, relative value score, etc.
- Verification interval: For surface forecast variables is 6 hour, and for upper-air variables is 12 hour.
- Besides verification of pdf or probability forecast, the deterministic forecast (control run and individual perturbation members) and ensemble mean are verified.

b) verification system of globe EPS is in building

- Parameters to be verified include: probability of precipitation occurrence, 24 hour accumulated total precipitation, 500mb and 200mb height, 850mb and 250mb temperature and wind, 850mb relative humidity, and other variables verification group cares.
- Verification methods are similar to the methods of meso-scale EPS.
- Verification interval is 24 now.

6. Plans for the future (*next 4 years*)

6.1 Development of the GDPFS

6.1.1 "[major changes in the Operational DPFS which are expected in the next year]"

More channel NESDIS-ATOVS will be assimilated into Global-3DVAR system, including the EUMetCAST-ATOVS data. T639L60-3DVAR and Model system will be put into the optional running.

6.1.2 "[major changes in the Operational DPFS which are envisaged within the next 4 years]"

2010 Operational Systems (planned)

• Basic Operational Systems:

- Global -3DVAR & GFS (T639L60+3DVAR, GRAPES+3DVAR 50Km, ATOVS+AIRS+GPS/COSMIC,+Track wind+ QuikSCAT >90%,)
- Regional-3DVAR & Model (GRAPES_Meso+3DVAR 15km, ATOVS+Radar+AWS+GPS/MET >90%, 1hour GRAPES-RUC)
- Ensemble Prediction (T639L60control + T213L31/50 member, ET perturbation, WRF/GRAPES-meso EPS, 50m, TIGGE products)
- Typhoon Track (T639L60-GTTP, GRAPES-meso-RTTP, Global/Regional Typhoon EPS)
- Verification (6 hour real-time verification, RTVS)
- Operation Support System (SMS+WEB+PrepIFS+Database+GRID)

• Basic Environment Prediction Systems:

- Wave Forecast (T639L60-wave, 15/5km wave, wave-EPS)
- Environment Emergency (T639L60-HYSPLIT, 15/5/1km HYSPLIT)
- Hydrological Forecast (two way nest)

6.2 Planned research Activities in NWP, Nowcasting and Long-range Forecasting

"[Summary of planned research and development efforts in NWP, Nowcasting and LRF for the next 4 years]"

6.2.1 Planned Research Activities in NWP

A tentative operational plan for T213

Mdl/DAS	2007	2008	2010
E.A. regional model	15km/33L	10km/40L	5km/70L
Global model	T639L60 30km/60L	GRAPES 50km/61L Quasi-ope.	25km/81L
E.A. regional DAS	3DVAR 110km/17L	4DVAR 60km/40L	4DVAR/EnKF 30km/70L
Global DAS	3DVAR 50km/17L	3DVAR 50km/61L	4DVAR 80km/81L

A tentative operational implementation of the whole GRAPES family is listed in the following table:

A tentative operational plan for GRAPES

Mdl/DAS	2007	2008	2010
E.A. regional model	15km/33L	10km/40L	5km/70L
Global model	50km/31L	50km/61L Quasi-ope.	40km/81L
E.A. regional DAS	3DVAR 110km/17L	4DVAR 60km/40L	4DVAR/EnKF 30km/70L
Global DAS	3DVAR 50km/17L	3DVAR 50km/61L	4DVAR 80km/81L

CMA will continue to be in charge of implementation of TIGGE-Archiving centre. The T-PARC-China component will be launched to accelerate the improvement of the High Impact Weather. One of the goals of T-PARC-China component is to test the feasibility of a GRAPES_Based_Interactive Observation-Prediction System.

6.2.2 Planned Research Activities in Nowcasting

The GRAPES_Based_Nowcasting system GRAPES_SWIFT will continue to be further tuned in the extrapolation algorithm and rapid updated cycling of data assimilation.

GRAPES_SWIFT and GRAPES_MEPS will participate in the second trial of B08FDP/RDP in 2007, and will be run in real time in 2008 during B08-Olympic Games.

6.2.3 Planned Research Activities in Long-range Forecasting

The GRAPES_AGCM will be further performed in the mass and energy conservation, and will be tested with a full physical package for a long period.

7. References

"[information on where more detailed descriptions of different components of the DPFS can be found]"

(Indicate related Internet Web sites also)

No.