Annual WWW Technical Progress Report

On the Global Data Processing and Forecasting System 2005

CHINA

1. Summary of highlights

- The Global T213L31 was upgraded to T319L31, and the date the physical processes were caretully selected to match this upgrade. After one year (August 2004 to August 2005) parallel running, this system will be upgrade to T639L60 in 2006.
- The operational system NMC-MM5 was upgraded to the horizontal resolution increased 12KM, one domain cover whole China.
- The WRFV2.0.3 is used as meso-scale numerical prediction model in CHLAFS. The domain of this operational system covers the main land of China. The horizontal resolution is 20km, vertical resolution is 35 layers, time step is 90 seconds. The 48 hours forecast was made. CHLAFS model is parallel running since July.
- CMA new generational NWP model: Global and regional assimilation and prediction system for mesoscale (Grapes-meso), was quasi-operational running since April.
- Dust-storm forecasting model was operational running since March.
- Sea wave forecasting model was quasi-operational running since Oct. 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.

2. Equipment in use at the Centre

New IBM CLUSTER1600 platform, which was introduced in December 2004. It consists of P690 servers, with 32 crus at 1.7GHz per node and P655+ servers, with 8 CPUs at 1.5 GHz per node. The total peak performance of the whole platform will reach 20TFLOPS in full configuration.

In the year 2005, three new computer systems were put into use. These computer systems with their major capabilities are summarized in the following Table:

Table: Computer systems put into use in 2005

Machine	Nodes	Processors	Peak Performance	Memory	Storage	Operating System
IBM Cluster 1600	382	3200 POWER 4+	21.76 TFLOPS	8224GB	30TB	AIX5.2
HP 9000 Superdome Server	2	2*12=24	84GFLOPS	40GB	64TB	HP_UX 11i
IBM P550	2	2*2=4 POWER5	26.5GFLOPS	8 GB	3TB	AIX5.3

IBM Cluster 1600 was put in real-time operation on June 1, 2005. IBM Cluster 1600 is used to host the following activities:

(i) NWP operations, including Global (T213L31), Regional (Hlafs025), WRF, Sandstorm forecast, Ultraviolet radiation forecast, Typhoon1 (hlafs), Typhoon2 (T213L31), Potential fire index forecast, Medium-Range MM5, Ensemble forecast, Air pollution forecast, NWP operational system;

(ii) Research, including high-resolution numeric model of China's wind energy resources assessment, REGCM, CGCM, DERF, ENSO, IPCC, CAM3, MOM4, GRAPES etc.

The two HP 9000 Superdome servers are the core part of CMA's Meteorological Data Storage System (MDSS). One hosts a real-time database and the other a comprehensive database.

IBM P550 was put in real-time operation on July 21, 2005. IBM P550 is used for domestic communication, namely, reception, processing and dissemination operations of domestic meteorological data.

3. Data and Products from GTS in use(信息中心)

4. Data input system

IT is the same as last year.

5. Quality control system

There is no change in quality control scheme in operation numerical weather prediction system.

6. Monitoring of the observing system

There is no change in Monitoring of observations system.

7. Forecasting system

7.1 System run schedule and forecast ranges

The global data assimilation and medium range forecast system based on global spectral model T213L31 has formally been put into operation since 1 Sep, 2002, It has been migrated to the new IBM Cluster 1600 in 2005.It produces routine global analyses for the four main synoptic hours 00, 06, 12 and 18 UTC and global 10-day forecasts at 12 UTC, and it also produce global 5-day forecasts based on 00UTC，3-day forecasts based on 06UTC and 18UTC .The regional model GRAPES_Meso ((Global and Regional Assimilation and Prediction Enhanced System) run for forecasting 60 hours on 00uct and 12utc on the new IBM Cluster.It will take the place of mdoel (HLAFS) before June 2006.A new typhoon track forecast system based on global model T213L31 was set up in July，2005.New ensemble forecast system based T213L31(15members) is running in quasi-operational

Following is the run schedule of the NWP Systems in NMC

Systems	Data cut_off time (GMT)	Wall clock (GMT)	Computer
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
Regional Model	04:10（00Z_ ASSIM +48HR_FCST）	04:15～07:00	IBM/SP
	10:00（00Z_ASSIM.）	10:00～10:40	IBM/SP

（HLAFS）	14:00（06Z_ASSIM.）	14:00～14:40	IBM/SP
	15:45 （12Z_ASSIM.+48HR_FCST）	15:30～18:59	IBM/SP
	01:00（18Z_ASSIM.）	01:10～01:33	IBM/SP
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 32 members （T106L19）	23:30（18Z_ASSIM.）*	14:00～14:28	SW-1
	12:30（00Z_ASSIM.）	14:28～14:55	SW-1
	13:30（06Z_ASSIM.）	14:55～15:20	SW-1
	16:05 （12Z_ASSIM.+240HR_FCST）	17:00～23:20	SW-1
Ensemble Prediction 15 members （T213L19）	07:30(00Z_ASSIM)	07:30～07:35	IBM Cluster 1600
	12:30(06Z_ASSIM)	12:30～12:35	IBM Cluster 1600
	18:30(12Z_ASSIM+240HR_FCST)	18:30～20:15	IBM Cluster 1600
	23:30(18Z_ASSIM)	23:30～23:35	IBM Cluster 1600

7.2 Medium Range Forecast System (4-10 days)

7.2.1 Data assimilation, objection analysis and initialization

There is no change.

7.2.2 Model

- **Basic equations**

-Momentum equations:

$$\frac{\partial U}{\partial t}+\frac{1}{a\cos^2\theta}\left\{U\frac{\partial U}{\partial \lambda}+V\cos\theta\frac{\partial U}{\partial \theta}\right\}+\dot{\eta}\frac{\partial U}{\partial \eta}$$
$$-fV+\frac{1}{a}\left\{\frac{\partial \phi}{\partial \lambda}+R_{dry}T_v\frac{\partial}{\partial \lambda}(\ln p)\right\}=P_U+K_U$$

$$\frac{\partial V}{\partial t}+\frac{1}{a\cos^2\theta}\left\{U\frac{\partial V}{\partial \lambda}+V\cos\theta\frac{\partial V}{\partial \theta}+\sin\theta(U^2+V^2)\right\}+\dot{\eta}\frac{\partial V}{\partial \eta}$$
$$-fU+\frac{\cos\theta}{a}\left\{\frac{\partial \phi}{\partial \theta}+R_{dry}T_v\frac{\partial}{\partial \theta}(\ln p)\right\}=P_V+K_V$$

-Thernodynamic equation

$$\frac{\partial T}{\partial t}+\frac{1}{a\cos^2\theta}\left\{U\frac{\partial T}{\partial \theta}+V\cos\theta\frac{\partial T}{\partial \theta}\right\}$$
$$+\dot{\eta}\frac{\partial T}{\partial \eta}-\frac{\kappa T_v\omega}{(1+(\delta-1)q)p}=P_T+K_T$$

-Moisture equation

$$\frac{\partial q}{\partial t}=\frac{1}{a\cos^2\theta}\left\{U\frac{\partial q}{\partial \lambda}+V\cos\theta\frac{\partial q}{\partial \theta}\right\}+\eta\frac{\partial q}{\partial \eta}=P_q+K_q$$

-Continuity equation

$$\frac{\partial}{\partial t}(\frac{\partial p}{\partial \eta})+\nabla\cdot(\nu_H\frac{\partial p}{\partial \eta})+\frac{\partial}{\partial \eta}(\dot{\eta}\frac{\partial p}{\partial \eta})=0$$

-Hydrosatic equation

$$\frac{\partial \phi}{\partial \eta}=\frac{R_{dry}T_v}{p}\frac{\partial p}{\partial \eta}$$

-Vertical velocity

$$\omega = \int_0^{\eta} \nabla \cdot (\nu_H \frac{\partial p}{\partial \eta}) d\eta + \nu_H \cdot \nabla p$$

-Independent variables

Vorticity ζ, Divergence D

Temperature T

Moisture equation q

Log surface pressure $\ln p_{surf}$

-Dependent variables

Geopotential Φ

Vertical velocity ω

-Numerical technique (in horizontal, vertical and in time), hydrostatic or non hydrostatic

Horizontal : spectral , reduced Gaussian grid

Vertical : hybrid coordinate , finite-difference

Time : semi-implicit semi-lagrangian

Hydrostatic model

-Integration domain (in horizontal and vertical)

Horizontal: global

Vertical: from surface to 10hPa

-Horizontal and vertical resolution time step

Horizontal resolution: T213 (0.5625˚) time step: 900s

Vertical resolution: 31layers (uneven) time step: 900s

-Orography, gravity wave drag

Mean topography (terrain height, US Navy data-set, 10 minutes of arc resolution)

Gravity wave drag (Lott and Miller, 1996)

-Horizontal diffusion

Fourth-order linear diffusion

-Vertical diffusion

No vertical diffusion

-Planetary boundary layer

Turbulent diffusion (Louis et al.,1982)

-Treatment of sea surface earth surface and soil

sea surface temperature is from NMC Washington analysis - update daily. Three surface and sub-surface levels (allowing for vegetation cover, gravitational drainage, capillarity exchange, surface and sub-surface runoff, deep-layer soil temperature and moisture). Soil temperature evolve freely, soil moisture is the average of 6-hour forecast from last cycle and climatic value.

-Radiation

short wave: morcrette,1991

long wave: Fouquart and Bonnel,1980

-Convection (deep and shallow)

Mass flux scheme (tiedtke,1989)

-Atmospheric moisture

spectral

-Boundaries

Vertical Boundary: $\dot{\eta} = 0, at \eta = 0 and \eta = 1$

7.2.3 Numerical Weather Prediction Products

The basic messages which are stored are kept the same as the previous system running on the old IBM/SP. The horizontal resolution of products in field database is 0.5625, the vertical resolution remains 17 layers, the frequency of output is 3-hour interval in first three forecasting days and 12-hour interval from 4^{th} to 5^{th} day and 24-hour interval after 6 days. The quantity of the sorts of prediction products has no change.. 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.

7.2.4 Operational technique for application of NWP products

No changes.

7.2.5 Ensemble Prediction system (Number of members, initial state perturbation method, number of models used, perturbation of physics, post-processing: calculation of indices, clustering)

A new Ensemble Prediction System was put into Quasi-operational at the end of 2005. 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,T213lL31
- **Perturbation of physics:** No
- **Post-processing:**

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

  relative humility at 700hPa, 850hPa;

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

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

10m wind;

2m temperature

1000-850 mb thickness, 1000-5000mb thickness, 850-700mb thickness;

Spaghetti： 2m temperature, sea level pressure, 24 hr total precipitation, 850mb temperature, 500mb Hgts;

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

- **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.

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

7.3.1 Short-range forecasting system -

Since 2004, NMC-MM5 has been running as an operational short-range forecasting system in NMC of CMA. This system is based on MM5 which was developed by PSU/NCAR.

7.3.1.1 Data Assimilation, Objective analysis and initialization

In NMC-MM5, 12 hours FDDA (Only the analysis nudging technique) is used to incorporate the observations. The observation data (include conventional upper and surface observations) are provided by local database of NMC.

7.3.1.2 Model

The NMC-MM5 operational system is performed on the SW-I high performance parallel computer.

The MM5V3.4 is used as meso-scale numerical prediction model in NMC-MM5.

The operational system includes three domains. The horizontal resolutions are 27KM, 9KM and 3KM and cover China, north China and Beijing area, respectively. The vertical

resolution of the model is 24 sigma layers.

The main parameterization schemes include: explicit simple ice scheme, Grell (Domain1) / Grell (Domain2) / None (Domain3) cumulus schemes, MRF planetary boundary layer scheme and Dudhia cloud radiation scheme.

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

7.3.1.3 Numerical Weather Prediction Products

The products of NMC-MM5 are delivered to China local meteorological bureau by the 9210 satellite communication system.

The 27KM resolution data has been interpolated to the regular latitude-longitude grid (the resolution is 0.25o×0.25o). The format of product data set is GRIB code.

The operational system can provide at least 48 hours prediction products, which are shown as follows:

Product name	Levels(hPa)
H T U V	100 150 200 250 300 400 500 700 850 1000
RH	300 400 500 700 850 1000
Vor Div	200 300 500 700 850
TTD Theta-se Wind speed W vapor flux vapor flux divergence	500 700 850
SLP	9998 (Sea level)
Surface pressure Surface temperature 2m T 2m RH 10m U 10m V	9999 (Surface)
3 hours accumulate precipitation	
12 hours accumulate precipitation	

24 hours accumulate precipitation	
48 hours accumulate precipitation	

7.3.2 Short-range forecasting system -

In the rainfall season of 2005, a new short range assimilation and forecast system (CHLAFS) was set up. This system is based on WRF model which was developed jointly by the NCAR, NOAA, and a number of collaborating institutions and university scientists.

7.3.2.1 Data Assimilation, Objective analysis and initialization

In CHLAFS, the three-Dimension Variational (3DVAR) Data Assimilation Method is used to incorporate the observations. The observation data (include conventional upper and surface observations) are provided by local database of NMC. The data used for the regional 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 the regional data assimilation 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

The regional data assimilation system is an intermittent assimilation system with four analyses per day forming an assimilation cycle. It includes three hours data in cut-off time.

The three-dimensional variational data assimilation system was developed and experimented. It will be used in the operational forecast system in NMC. The multi-variable three-dimension incremental analysis is applied for streamfunction, uncorrelated velocity potential, unbalanced mass variable (p/M), ground temperature 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.

The domain of analysis system covers China. Its horizontal resolution is 15km. It has 35 levels in the vertical. 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) will be developed for this system.

7.3.2.2 Model

The CHLAFS operational system is performed on the IBM CLUSTER high performance parallel computer. The WRFV2.0.3 is used as meso-scale numerical prediction model in CHLAFS.

The domain of this operational system covers the main land of China. It's horizontal resolution is 20km, vertical resolution is 35 layers, time step is 90 seconds. The 48 hours forecast was made. This year (2006) the horizontal resolution will move to 15km. In the eastern of China, some nest domains with horizontal resolution of 5km will also be implemented within the coarse domain.

The main parameterization schemes include: explicit simple ice scheme, Grell (Domain1) / Grell (Domain2) / None (Domain3) cumulus schemes, MRF planetary boundary layer scheme and Dudhia cloud radiation scheme.

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

7.3.2.3 Numerical Weather Prediction Products

The products of CHLAFS are delivered to Central Weather Prediction Office of China.

The format of product data set have two type: one is the MICAPS data type which is used in operational system in Central Weather Prediction Office of China, the other is GIF graph.

The operational system can provide at least 48 hours prediction products, which include rain, temperature, wind, humidity and geopotential height.

7.3.4 Operational technique for application of NWP products

Based on forecast of operational middle-range model of China, operational model of German Meteorological Administration and operational model of Japan Meteorological Agency and temperature observations of China, a consensus forecast system is developed through method of artificial neural network. Product of the system is station forecast of China with 3h interval within 72h. Forecast elements are temperature, relative humidity, wind and precipitation.

7.4 Specialized numerical predictions

7.4.1 Air Pollution Prediction Model

No change was made to air pollution prediction model .

7.4.2 A New Global Ocean Wave Forecast Experiment System

A new global ocean wave forecast experiment system began to run on IBM-CLUSER. The system combined the WAVEWATCH III model (download from NOAA/NECP website) and the spectral model T213L31.Using operational products of T213L31 model as input, the global wave forecast system provides a wave forecast for ocean regions in the world. The spatial resolution is 1.0*1.0 longitude-latitude grid extending from 80oS to 80oN. 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. The model inputs includes wind at 10 m level and air-sea temperature difference from operational global medium range analysis-forecast system , the frequency of both inputs is 3-hour interval in first three forecasting days and 12-hour interval from 4th to 5th day and 24-hour interval after 6 days. There is no ice coverage and currents as inputs in the model. Both graphical and binary model output is available.

7.4.3 Typhoon forecasting

The MTTP was replaced by the new global TC track prediction system in 2005 year. The global TC track prediction system reduces the mean track errors by 15% for 24h and 21% for 48h compared with the MTTP system. The global TC track prediction system runs four times a day and produces 120h track forecasts.

The mean track errors are 142.18km for 24h, 234.42km for 48h and 375.50km for 72h in 2005.

7.4.4 Solar Ultraviolet (UV) Radiation

No further modification has been taken a air pollution prediction system.

7.4.5 Environmental Emergency Response model

Currently, the operational Environmental Emergency Response system consists of the Hybrid Single_Particle Lagrangian Integrated Trajectories (HY-SPLIT using Version 4.7) system, developed at the NOAA Air Resources Laboratory, with meteorological input from the operational NWP systems in T213L31. Analysed backward and foreward trajectories, concentration and of toxic gas Dispersion in operations. Based on this operational capability, the NMC is designed by the WMO as a Regional Specialised Meteorological Centre (RSMC) with specialization in Atmospheric Transport Modelling Products for Environmental Emergency Response.

7.4.6 Dust-Strom prediction system

The dust storm system was operational running in spring 2004, the dust storm CEMSYS is introduced from the university of New South Wales. In 2005, an new integrated dust storm modeling system is developed for the prediction of dust storms and going the operational running during March to May 2005. 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. The model description is follow:

Dust Model	Shao(2001)，Shao et al.(2002)
Meteorological data base or model	MM5V3, with Globe model T213L31 data base
Model domain	**Lambert Conformal Preprojected** (center 42 deg north and 105 deg east) Horizontal 45km (with 160×140 grids), vertically 22 layer (upto 16km)
Dust Emission Scheme	
threshold velocity or friction velocity	**u_*t:**Shao(2000) ; u_***:**Hong and Pan(1996)
dust size range	diameters between 2.0 - 125 um
dust size bins	6 bins
dust density	2600 kg/m3
dust particle size distribution	log-normal
snow cover	None
soil wetness	output by MM5 OSU/Eta land surface model
drag effects	Drag partition included (Raupach 1992 scheme)
slope effect	None
treatment of vegetation	LREIS monthly data & threshold of ustar, vertical dust flux is a function of LREIS
initial vertical mixing (or lift up) method	None
Boundary condition	
Land use data	for region inside China LREIS vegetation data (0.05 deg resolution), for region outside China EOSDIS vegetation data (1deg resolution)
Soil Texture information	China soil type grouped into USDA soil texture classes

Roughness length	Specified value for bare surfaces and estimated from LAI and vegetation height for vegetated surfaces
Depositions scheme	
Dry deposition	parameterized following Raupach et al.(2001)
Wet deposition	None
Gravitational settling	Yes
References	Shao. JGR ,2001 106, p20239
LREIS:Laboratory of Resources and Environment Information System	

The main products of dust storm model:

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

7.5 Extended range forecasts

On the basis of the NWP products of the monthly Dynamic Extended Range Forecasting (DERF) model that is run by National Climate Center (NCC) of China Meteorological Administration (CMA), the extended range objective prediction system is developed and put into operation in the National Meteorological Center (NMC) / CMA. It includes the getting data and format transition, the NWP data process and analysis, extend-range objective prediction and the data display. With the historical data and a great deal of NWP data from the DERF model, this prediction system makes 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 by means of the combination technique of the synoptic, dynamic, and statistic methods. With aid of this extended range objective prediction system, NMC started to issue the extended range weather forecasts officially on September 10th, 2005. These

prediction products have been paid more and more attention by society and all departments gradually.

7.6 Long range forecasts(30 days up to two years) (models, Ensemble, Methodology and Products)

No changes.

8. Verification

8.1 The verification against analysis of operational numerical forecast model (T213) in 2005 are as shown in the following table (a).

Table 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	16.1	18.6	6.1	6	5.5	2.2
	72	42.8	50	11.6	13.8	8.7	3.6
	120	70.8	75.2	17	18	10.4	4.5
2	24	14.9	18.8	5.8	6	5.4	2.1
	72	40.4	48.7	11	13.4	8.6	3.5
	120	68.9	73.3	16.1	18.2	10.4	4.3
3	24	16.1	18.9	6.3	6	5	2.0
	72	43.5	53.7	12.3	14.2	7.8	3.3
	120	71.5	83.9	17.4	19.8	9.3	4.0
4	24	14.9	22.5	6.1	6.6	5.3	2.0
	72	40.6	62.8	12.7	15.6	9	3.4
	120	68	101.9	17.9	22.3	10.9	4.2
5	24	13.6	24.9	6	6.7	5.2	2
	72	36	65.6	12.3	15.8	8.8	3.4
	120	58.4	95.7	17.2	21.5	10.8	4.1
6	24	12.6	22.6	5.8	6	5	2.1
	72	32.7	59.3	11.6	14.2	8.3	3.4
	120	52.9	90.4	16	20.1	10	4.2
	24	12.2	24.3	5.4	7	5.3	2.3

7	72	31.4	68.2	11	16.7	8.8	3.7
	120	48.9	102.9	14.5	23.1	10.3	4.5
8	24	12.3	22.9	5.2	6.4	5.8	2.4
	72	32.7	62.1	10.6	15.2	9.1	4.1
	120	53.4	102.9	15.2	22.3	10.6	5.0
9	24	12.4	23.3	5.2	6.3	5.8	2.4
	72	31.2	61.2	10.9	14.8	8.8	3.9
	120	51.6	89	15.5	19.7	10.4	4.7
10	24	13.3	21.9	5.5	6.6	5.5	2.3
	72	36.8	60.8	11.4	15.8	8.6	3.6
	120	63.1	95.2	17.3	21.6	10.4	4.4
11	24	16.4	21.7	6.3	6.5	5.7	2.3
	72	45.4	61	13.8	15.6	9	3.8
	120	80.1	90.4	20	20.8	11	4.6
12	24	19.3	17.8	7.2	5.6	6.1	2.3
	72	54.1	45	15.6	12.5	10.1	4.0
	120	88.9	67.4	21.6	16.8	12.4	4.8

8.2 The verification against observations of operational numerical forecast model(T213) in 2005 are as shown in the following table(b).

Table 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	23	23.5	19.2	44.8	9.9	7.6	7.5	14.2
	72	58	59.3	33.1	73	16.5	12.9	10.1	19.6
	120	88.8	90.4	52.4	100.2	22.1	19.6	13.4	23.5
2	24	20.9	25.7	19.6	37.3	9.3	6.6	8.6	11.3
	72	54.4	46.4	33.8	56.4	14.9	12.5	11.5	17.3
	120	85.7	88	60	70.9	19.6	19.5	14.4	20.1

3	24	24.5	21.1	19.3	40.8	10.3	7.6	8.6	12.8
	72	57.8	44.1	36	65.6	17.1	13.1	12.4	20
	120	90.3	73.1	59.4	88.3	22.6	18.2	16.1	22.9
4	24	21.4	17.9	18.9	65.5	9.1	7.2	8.5	15.3
	72	48.2	42.9	33.9	89.1	15.3	12.4	12.4	21.7
	120	82.8	79.8	54.3	106.7	20.8	19.5	15.7	25.6
5	24	22.1	20.3	18.2	78.4	8.9	7.1	8.6	20.3
	72	44	41.8	33.8	101.2	16.3	12.9	13.3	25.5
	120	65.8	66.2	51.1	101.7	21.7	17.8	17.1	26.3
6	24	17.9	16.9	16.7	56.8	8.8	7.7	8.4	13.7
	72	37.8	39.5	29.1	85.2	14.5	13.3	13.5	19.3
	120	56.4	69.4	43.4	99.9	18.4	18.6	16.1	23.5
7	24	17.1	13.8	16.3	67.5	7.4	8.2	7.4	22.5
	72	294.9	291.4	279.8	346.1	12.6	13.7	11.1	28.6
	120	311.2	313.5	287.6	363.9	16.3	18.9	13.9	34.7
8	24	13.4	18.2	15.6	55.9	6.9	7.8	7.2	16.2
	72	31.1	37.1	26.9	93.4	11.7	13.4	11.2	22
	120	53.5	65.2	39.4	109.6	16.4	19.7	13.9	24.4
9	24	14.5	14.9	15.6	38.4	7.7	7.7	6.9	12.9
	72	35.7	37.7	25.2	65.1	13.8	15.1	10.2	19.7
	120	56.4	65.8	41.1	99.2	18.8	21	13.2	24.4
10	24	28	15.8	20.1	38.9	8.2	7.2	7.1	13.6
	72	50.1	36.2	35.8	80.9	14.8	11.9	10.6	22.4
	120	82.4	61.1	57.8	94.3	20.8	18.9	15.4	24.5
11	24	24.1	22.3	19.1	39.7	8.7	7.6	7	12.6
	72	55.5	53.6	33.8	71.4	15.8	14.9	10.5	20.8
	120	100.2	87	57.8	94	24	20.5	14.5	25.1
12	24	29.5	23.5	27.3	33.2	11.5	7.8	7.6	11.8
	72	70.1	58.4	47.6	52.2	21.8	15.5	11.6	16.5
	120	87.4	112.1	79.5	64.1	25.6	26.6	16.7	20.7

9. Plans for the future

9.1 Development of the GDPFS （陈德辉）

9.2 Research Activities in NWP （龚建东）

10. References

No references.