Annual Technical Progress Report on the Global Data Processing System 2004

China

1. Summary of highlights

The quasi-operational system HB-MM5 (HuaBei-MM5) was upgraded to NMC-MM5, model from version 3.2 to 3.4, and the horizontal resolution increased from 54/18/6KM to 27/9/3KM. The physical processes were carefully selected to match this upgrade. After one year parallel & quasi-operational running, this system was operational running in June 21st. The products of 27km began to be disseminated to local observatories.

The global model for typhoon track prediction (G-MTTP) was operational running since July 10, to replace old MTTP system. G-MTTP forecasting time is 72 hours for 00Z and 96 hours for 12Z.

Dust-storm forecasting was operational running in March, forest-alarm forecasting system in September, and Solar Ultraviolet index forecasting system in February.

CMA new generational NWP model: Global and regional assimilation and prediction system for mesoscale (Grapes-meso), was parallel running since March.

2. Equipment in use at the Centre

The operational system was running on an IBM RS6000 NH1 SP platform in CMA, which consists of 10 computing nodes and 2 I/O nodes. Each computing node contains 8 CPUs operating at 222 MHz interconnected via a shared memory crossbar switch. The total peak performance of the whole platform is 71GFLOPS.

Some experiments were carried on another new IBM CLUSTER1600 platform, which was introduced in December 2004. It consists of P690 servers, with 32 CPUs 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.

5. Quality Control System

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

6. Monitoring of observing System

There is no change in observing system monitoring in operation numerical weather prediction systems.

7. Forecasting system

7.1 system run schedule and forecast ranges

The schedules for the run of the current NWP Operational Systems in NMC is shown as

table 1.

table 1 The schedules for the run of the current NWP Operational Systems in NMC

Systems	Data cutofftime (GMT)	Wall clock (GMT)	Computer
Global Model (T213L31)	03:00 (00Z_84HR_FCST)	03:04~06:40	IBM/SP
	12:30(00Z_ASSIM.)	13:35~14:00	IBM/SP
	13:30(06Z_ASSIM.)	14:05~14:20	IBM/SP
	16:05(12Z_ASSIM. +240HR_FCST)	16:10~21:08	IBM/SP
	23:30(18Z_ASSIM.)	23:35~00:02	IBM/SP
Regional Model (HLAFS)	04:10 (00Z_60HR_FCST)	04:17~07:00	IBM/SP
	13:00(00Z_ASSIM.)	13:10~13:33	IBM/SP
	14:00(06Z_ASSIM.)	14:10~14:38	IBM/SP
	15:45(12Z_ASSIM. +60HR_FCST)	15:55~18:59	IBM/SP
	03:00(18Z_ASSIM.)	00:30~01:10	IBM/SP
Regional Model (NMC-MM5)	02:30 (00Z_48HR_FCST)	02:40~06:10	SW-1
	15:30 (12Z_48HR_FCST)	16:59~19:50	SW-1
Typhoon Track Model (MTTP)	03:00 (00Z_48HR_FCST)	03:20~04:30	SW-1
	18:45 (12Z_48HR_FCST)	17:30~18:50	SW-1
Typhoon Track Model (G-MTTP)	03:00 (00Z_72HR_FCST)	03:40~05:10	IBM/SP
	18:45 (12Z_96HR_FCST)	19:30~20:50	IBM/SP
Ensemble prediction (T106L19) (32members)	23:30 (18/00/06Z_ASSIM.)	14:00~15:20	SW-1
	12:30(00Z_ASSIM.)	12:28~14:55	SW-1
	16:05(12Z_ASSIM +240HR_FCST	17:00~23:20	SW-1

7.2 Medium range forecasting system (4-10 days)

7.2.1Data assimilation, Objective analysis and initialization

There is no change to be made to the operational T213L31 global data assimilation system based on the 3D-OI

The global data assimilation system based on 3DVAR had been experimentally run in the rainfall season in the 2004. Based on analyzing the results from the experiments, some significant modifications had been further made to the global 3DVAR scheme.

7.2.2 Model

No change in the T213L31 global model

7.2.3 Numerical weather Prediction Products

The 00Z forecast was extended from 72 hours to 84 hours. The rainfall products were also extended.

7.2.4Operational techniques for application of NWP products

No change

7.2.5 Ensemble Prediction system

No change in ensemble prediction system

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

7.3.1Data assimilation, Objective analysis and initialization

There is no change for data assimilation of 025HLAFS system.

New operational short-range forecasting system based on MM5-V3.4 was operational running in June 21st (NMC-MM5). The data assimilation is nudging method.

The CMA new generational Global and Regional Assimilation and PrEdiction system (GRAPES) use 3DVAR techniques, it can assimilate NOAA's satellite ATOVS data.

7.3.2 Model

There is no change for 025HLAFS system.

The NMC-MM5 horizontal resolution is 27/9/3 Km, model physical processes were carefully selected to match this horizontal resolution.

The mesoscale version of Grapes was parallel running since March. The horizontal resolution was 60km, no nested grid technique was taken.

7.3.3 Numerical weather prediction products

The NMC-MM5 27Km products provided to the observatories across the country by satellite communication system. The 9Km products only provided to North-Eastern part of observatories of China.

The grapes regional version system products provide to NMC for operational verification.

7.3.4 Operational technique for application of NWP products

No change.

7.4Specialized forecasts(Sea waves, tropical cyclones, pollution transport and dispersion, solar ultraviolet (UV) radiation)

7.4.1 Data Assimilation, Objective Analysis and initialization

Not applicable

7.4.2 Models

G-MTTP (Global Model for Typhoon Track Prediction)

The new global typhoon track prediction system based on T213L31 and bogus scheme (G-MTTP) was operational running in July 10, G-MTTP was running twice a day during the Typhoon season on the way out. G-MTTP beginning time is same as MTTP, except the forecasting time is 72 hours for 00Z and 96 hours for 12Z. The forecast track errors for this period as shown in table 2.

Table 2 Mean Track Errors for G-MTTP (units in KM)

Forecast Period	12h	24h	36h	48h	60h	72h	84h	96h
Errors	89.9	150.4	206.9	262.9	316.6	369.0	420.1	462.3

(Total number of Swatch)	(297)	(275)	(253)	(231)	(210)	(190)	(86)	(76)

Solar Ultraviolet radiation forecast system

SUV system was quasi-operational running in February, and was operational running in September.

Air Pollution Prediction system

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

Dust-Strom prediction system

The dust storm system was operational running in spring.

Forest Fire alarm system

The forest fire alarm system based on T213L31 database was operational running in September.

Sea waves forecast

The global sea waves forecast system was developed. The forecasting model was WAVEWATCHIII, and coupled with T213 L31 model.

7.4.3Numerical weather prediction products

The SUV index products provided to the observatories across the country by satellite communication system.

The dust-storm products were sent to local observatories by satellite communication system from March.

The forest fire alarm products extend 00Z analysis, 24Z and 48 Z forecasting.

7.4.4Operational techniques for application of NWP products

No change.

7.5Extended range forecasts (10-30days) (Models, Methodology and Products)

During 2003, the dynamical extended range forecast (DERF) system was launched into quasi-operation run every 10-days to make 30 days forecast. The DERF system was established on YH-III Super-Computer (MPI-parallel version) which consists of 3 parts. The first part is a sub-system of initial conditions generation with Singular Vector (SV) method, which generates 16 initial fields besides 16 LAF initial fields. The 2nd part is the global spectral model of T63, with the horizontal scale of approximately 180km and 16 vertical levels up to 10 hPa(more detail see section 2). And the 3rd part is a sub-system of information extraction and ensemble forecast output.

Products of monthly forecast are ensemble monthly mean of grid point values of direct model output and its dynamic reexplanation on China rainfall archived at 12 UTC by 3 kind of information extraction methods(equivalent weighted mean, linear weighted mean and parabola weighted mean).

Table 3 Products of monthly DERF

forecast element	Forecast area	Forecast period	Forecast type
500 hPa Height Anomaly	northern hemisphere/Europe Asian	30-day mean with 0 and 1 dekad lead time	Ensemble mean and spread
Temperature anomaly (T) Precipitation anomaly percent (R)	East Asian/China		

A hindcast experiments were carried out for 10 years from 1991 to 2000. The ensemble forecast was initiated from 00 06 12 18UTC of NCEP-reanalyses data on 19th and 20th each month. SV Perturbation are generated in 12UTC of 19th and 20th. The model was forced with anomaly fixed sea surface temperature (SST) of last week and was integrated for 45 days.

PC(Percent Correct), AC(Anomaly Correlation) and RMSSS(Root Mean Square Skill Score) are used to evaluate the skill of deterministic forecast in terms of ensemble average and compared with that of operational monthly forecast mainly by statistic and experiential methods. Forecasts were verified with NCEP reanalysis data. The model climatology is constructed with the output of the experiment and systematic error correction is performed simply.

The ACC of the Deterministic forecast skills of ensemble averaged 500 hPa height (Z500) in Northern Hemisphere is about 0.35.

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

The National Climate Center Global Atmosphere-Ocean Coupled General Circulation Model (NCC-CGCM) was preliminarily 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 and Gu-Liao 2001) were tested and implemented respectively in NCC-T63L16, the atmospheric component of NCC-CGCM.

In 2003, BATS was implemented in NCC-CGCM to improve its land surface process scheme, some of the source codes were optimized, the machine time is decreased by 60%, and the operational flow is simplified to make it easy to operate. Based on the latest version (CGCM1.1), NCC-CGCM-EPS (Ensemble Prediction System) has been established and put into experimental seasonal-interannual climate prediction. With 8 ensemble members in a prediction, 6 predictions are made each year, including four seasonal predictions: spring (issued in February), summer (in May), autumn (in August), winter (in November), plus flood season (from June to August) prediction (in March) and interannual prediction (in October). Using the NCC-CGCM-EPS, 20-year hindcasts (1983-2002) for 6 forecasts of the year have been completed. The parallel version of the CGCM has also been finished.

In summary, monthly and seasonal climate prediction products at global and regional scales provided by NCC are listed in the following table 4:

table 4 monthly and seasonal climate prediction products at global and regional scales provided by NCC

Categories of prediction	Model prediction				
	monthly	seasonal			
		spring	summer	autumn	winter
Date of Issuance	2nd 12nd 22nd	30th Oct 22nd Feb	30th Mar 22nd May 30th Oct	22nd Aug	30th Oct 22nd Nov
Lead time	≈10days	4 month ≈10days	2 month ≈10days	≈10days	1 month ≈10days

contents	Precipitation	√	√	√	√	√
	Temperature	√	√	√	√	√
	Circulation	H200/H500/T850/Wind 200/700 etc.				
Area		China/East Asia/NH/Global (2.5x2.5 grids)				

With the above mentioned models as the essential part, the State Key Project: "Studies on Short Term Climate Prediction System in China" won the first prize of National Science and Technology Advancement Award of China in 2003 for its outstanding performances in climate prediction in the past years

8. Verification of prognostic products

The verification against analysis of operational numerical forecast model (T213) in 2004 are as shown in the following table 5.

Table 5 RMSE of Z(500) and W(250)

Month	Valid time	Z(500)		W(250)			W(850)
		NH	SH	NH	SH	Tropics	Tropics
1	24	15.8	19.6	6	6	5.6	2.2
	72	44.1	51.2	11.9	13.8	8.9	3.5
	120	74.8	77.9	17.3	18.5	10.7	4.2
2	24	16.9	20.3	6.2	6.3	5.5	2.1
	72	47.6	53.3	12.5	14.3	9.2	3.6
	120	74.6	82.8	17.7	19.8	11.1	4.6
3	24	15.9	22.1	6.1	6.5	5.5	2.1
	72	43.3	60.1	11.9	15.2	9	3.6
	120	72.2	90.9	17.3	20.1	10.7	4.4
4	24	14.5	21.8	6.1	6.3	5.3	1.9
	72	41.4	62.8	12.2	15.3	8.7	3.3
	120	66	95.7	17.3	21.2	10.7	4.1
5	24	13.3	23.1	5.8	6.3	5.3	2.1
	72	34.4	62.3	11.7	14.5	8.5	3.6
	120	56.4	93.9	16.3	20.5	10.3	4.3
6	24	13	24.3	5.5	6.7	5.4	2.3
	72	33.4	63.2	11.1	15.6	8.8	3.9
	120	53.4	100.7	15.9	22	10.5	4.7
7	24	11.8	23.2	5.3	6.1	5	2.2
	72	29.5	62.8	10.6	14.7	7.8	3.7
	120	45	98.6	14.5	21.3	9.4	4.5
8	24	12.7	24.6	5.5	6.3	5.3	2.3
	72	31.7	64	11.2	15	8.7	4.1
	120	49.6	100.2	15.2	21.2	10.4	5
	24	13.3	23.3	5.6	6.3	4.8	2.1

9	72	37	60.6	12.3	14.8	7.8	3.6
	120	62.2	92.8	17.6	20.6	9.5	4.3
10	24	13.1	22.2	5.4	6.2	5.1	2.1
	72	36.7	55.9	11.3	14.8	8.1	3.5
	120	62.8	86.2	16.9	20.8	9.8	4.3
11	24	14.7	19.9	5.8	6.2	4.9	2
	72	40.4	51.5	11.7	14.1	7.8	3.3
	120	67.1	77.7	16.9	19.4	9.5	4.1
12	24	15.4	19	6	6	5	2.1
	72	41.9	51	11.8	13.9	7.9	3.4
	120	73.6	78.9	17.6	19.5	9.8	4.1

The verification against observations of operational numerical forecast model (T213) in 2004 are as shown in the following table 6.

Table 6 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	23.2	21.3	19.4	32	10.2	9.2	8.2	10
	72	55.5	60	36.3	51.7	15.4	16.3	11.9	14.4
	120	83.5	96.6	59.2	61	20.5	23.6	16.1	16.9
2	24	25.5	31.8	23.5	35.9	11	7.1	8.8	9.6
	72	64.9	54.7	37.1	51.8	18.9	13.1	11.8	13.8
	120	90.7	83.2	55.6	60.8	24.6	19.5	15.8	17.9
3	24	28.4	17.9	19	52.2	9	7.4	8.8	13.2
	72	61.1	43.3	35.9	71.1	16.7	12.4	12.5	19.6
	120	86.7	71.5	54	83.7	21.2	18.5	15.8	22.1
4	24	24.4	22.4	17.7	49.9	9.5	7.3	8.9	11.4
	72	55.2	41	31	68.6	16.7	12	12.4	15.9
	120	84.4	69.6	47.2	84.3	23	17.3	15.4	19
5	24	19.8	18.5	17.1	52.7	8.3	6.7	8.9	15.4
	72	39	34.3	31.7	77.9	14.1	11.2	12.8	22.2
	120	59.7	64.5	47	95.8	18.2	17	17.4	26.7
6	24	16.4	23.6	17.7	55.2	8	7.5	8.5	18
	72	33.7	42.9	32.4	81.1	13.1	12.2	13.3	25.3
	120	56.6	70.6	40.5	95.3	18.9	18.8	16.2	30.4
7	24	16.4	29.7	15.9	47.5	7.3	7.5	7.7	15.5
	72	30.1	46.1	26.8	69.7	12.1	12.7	11.8	22.2
	120	42.9	61.1	34.5	83.3	16.6	16.8	14	25.8
8	24	13.7	25.1	18.9	51.9	7.7	7.6	7.4	14.5
	72	31	41.3	30.4	79.8	12.5	12.1	12	19.6
	120	48.4	64.4	41.9	105.4	16.4	17	15.3	23.4
	24	20.1	28.8	16.5	48.6	7.9	8.5	7.3	15.6

9	72	43.5	54.3	31.8	67.1	13.9	14.7	12.3	23
	120	73.4	92.9	50.8	77	20.2	23.2	17.2	26.6
10	24	19.2	26.7	16.8	42.6	8.6	8.2	6.9	13.3
	72	47.9	47.8	32.2	63.3	15.3	13.4	11.2	19.1
	120	81.7	77.8	49.7	74.2	22.5	18	15	22.5
11	24	23.7	26.1	17.3	35.4	9.6	8.2	7.6	11.3
	72	56.5	56.8	33.2	58.9	17.2	14.8	11.1	16.5
	120	82.1	122.3	56	74.2	22.8	25.4	14.5	21.2
12	24	22.9	31.7	19.5	30.2	9.4	8	7.8	10.5
	72	51.3	55.3	34	58	15.7	13.8	10.9	16.2
	120	83.1	81.7	53.4	86.4	22.3	19.8	14.4	21.1

9. Plans for the future

Transplant all operational system from various kind of computers to new IBM/SP cluster.
Upgrade global medium range forecasting. The data assimilation upgrade from 3D-OI to 3D-VAR, and model resolution from T213L31 to T639L60.
Upgrade global medium range ensemble prediction system, from T106 to T213, from singular method to breeding method.
Grapes-meso will operational running before rainfall season.

10. References

None