Annual Technical Progress Report on the Global Data Processing System 2003

CHINA

1. Summary of highlights

Several changes were made to the archive of the products from operational global medium range forecast system which was based on the GDAS and T213L31 model and put into operation in Sep. 1, 2002. More products began to be disseminated to local observatories.

The operational regional data assimilation and short range forecast system was upgraded from HLAFS05 to HLAFS025 with several significant changes. HLAFS025 has been put into operation since Sep. 1, 2003.

A bogus cyclone has been embedded into the 00UTC cycle forecast of the global spectral model since Sep. 10, 2003. The results from two months of run show the marked improvements over operational regional MTTP.

The six-hour forecasts from the operational GDAS based on the T213L31 spectral model instead of T106L19 spectral model has been used as the reference fields for monitoring of observing system since Jan. 1, 2003.

A new UV Index forecast system has been developed and tested by the NMC/CMA to support the China daily UV Index forecasts issued by Central Meteorological Observatory.

5. Quality Control System

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

6. Monitoring of observing System

The reference fields for monitoring of observing system has been supplied by the six-hour forecasts from the operational GDAS based on the T213L31 spectral model instead of based on the T106L19 spectral model since Jan. 1, 2003.

In order to exclude the effect of gross errors in observational data, a Complex Quality Control (CQC for temperatures and heights from Radiosones) and checks (of other observational data) against the reference fields are used prior to make the statistics calculations in the monitoring system.

The monitoring system executes two parts of tasks: daily calculating and displaying the availability of various observations over global received from GTS at NMC/CMA in real time and monthly statistical calculating the availability, mean biases and standard deviations of various observations over global received from GTS at NMC/CMA in non-real time. The types of observations and elements to be monitored are listed in Table 1. The method of comprehensive evaluation to the quality of observations on a station or a single

kind of report in terms of the biases and standard deviations over a given period of time is quite similar to that used in ECMWF and NCEP.

Majority of outputs, in terms of various kinds of temporal and spatial varying curves, scatter plots and statistic lists, from the monitoring system are displayed through an internal dedicated web page, which is constructed with the HTML, JavaScript and CGI languages and has the functions of active searching, plots auto-creating and maps auto-drawing. Contents of monitoring on daily availability of the observations are listed as Table 2. Content of monitoring on monthly availability of the observations are listed in table 3. Content of Monitoring on daily biases of the observations against reference fields are listed in Table 4. Contents of monitoring on monthly averaging biases of the observations against reference fields are listed in Table 5.

Table 1 The types of observations and elements to be monitored

Observation type	Element
TEMP	height、temperature、U &V components, 100-30hPa thickness
PILOT	U&V components
SYNOP	Sea level pressure, station level pressure
SHIP	Sea level pressure
SATOB	U&V components
SATEM	Thickness
AIREP	U&V components
DRIBU	Sea level pressure

Table 2 Monitoring on daily availability of the observations

Observation type	Contents of monitoring
TEMP, PILOT	The number of reports; List of stations with missing report; List of minimum pressures that balloon reach for each observation;
SYNOP	The number of reports; List of stations with missing report;
SHIP , DRIBU	The number of reports; The distribution of the number of reports over a cell of 10x10 degrees;
SATOB, SATEM, AIREP	The number of reports; The distribution of the number of reports over a cell of 10x10 degrees in terms of three vertical layers;

Table 3 Monitoring on monthly availability of the observations

Observation type	Content of monitoring
TEMP, PILOT	Average receiving ratio and minimum pressures that balloon reach for each station;
SYNOP	Average receiving ratio of each station;
SHIP, DRIBU	The distribution of the average number of reports over a cell of 10x10 degrees;
SATOB, SATEM, AIREP	The distribution of the average number of reports over a cell of 10x10 degrees in terms of three vertical layers;

Table 4 Monitoring on daily biases of the observations against reference fields

Observation type	Element	Content of monitoring
TEMP	Height, temperature, wind direction, wind speed, 100hPa-30hPa thickness	Biases for a single station; Globally average bias; Average bias over each WMO block;
PILOT	Wind direction, wind speed	Same as those of TEMP;
SYNOP	Sea level pressure, surface pressure	Bias for a single station; Globally average biases;
SHIP, DRIBU	Sea level pressure, surface pressure	Average biases over a cell of 10x10 degrees;
SATOB, AIREP	U&V components	Average biases over a cell of 10x10 degrees in terms of three vertical layers;
SATEM	Thickness	Average biases over a cell of 10x10 degrees in terms of three vertical layers;

Table 5 Monitoring on monthly averaging biases of the observations against reference fields

Observation type	Element	Content of monitoring
TEMP	Height, temperature, wind direction, wind speed, 100hPa-30hPa thickness	Mean biases and standard deviations; Ratio of anomaly value; Mean biases, standard deviations and ratio of anomaly values over each WMO block; Comprehensive evaluation on the observation of each single station; Globally average bias;
PILOT	Wind direction, wind speed	Same as those of TEMP;
SYNOP	Sea level pressure, surface pressure	Mean bias and standard deviations; Ratio of anomaly value;
SHIP, DRIBU	Sea level pressure, surface pressure	Mean biases and standard deviations over a cell of 10x10 degrees;
SATOB, AIREP	U & V components	Mean biases and standard deviations over a cell of 10x10 degrees in terms of three vertical layers;
SATEM	Thickness	Mean biases and standard deviations over a cell of 10x10 degrees in terms of three vertical layers;

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 6.

Table 6 The schedules for the run of the current NWP Operational Systems in NMC

Systems	Data cutoff time (GMT)	Wall clock (GMT)	Computer
Global Model (T213L31)	03:00 （00Z_72HR_FCST）	03:04～06:20	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.+240 HR_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.+60H R_FCST）	15:55～18:59	IBM/SP
	00:30（18Z_ASSIM.）	00:30～01:10	IBM/SP
Typhoon Track Model (MTTP)	03:00 （00Z_48HR_FCST）	03:20～04:30	SW- Ⅰ
	18:45 （12Z_48HR_FCST）	17:30～18:50	SW- Ⅰ
Ensemble Prediction (T106L19) (32 members)	23:30（18Z_ASSIM.） *	14:00～14:28	SW- Ⅰ
	12:30（00Z_ASSIM.）	14:28～14:55	SW- Ⅰ
	13:30（06Z_ASSIM.）	14:55～15:20	SW- Ⅰ
	16:05 （12Z_ASSIM.+240 HR_FCST）	17:00～23:20	SW- Ⅰ

7.2 Medium range forecasting system (4-10days)

7.2.1 Data 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 from May 1st to Sep.30th. Based on analyzing the results from the experiments, some significant modifications had been further made to the global 3DVAR scheme (such as the reconstruction of background error covariance, the revise of J_b term, etc.). The new version of 3DVAR data assimilation scheme will be put into the quasi-operational run in the early of 2004.

7.2.2 Model

No change in the T213L31 global model.

7.2.3 Numerical Weather Prediction Products

Several changes were made to the archive of the products from GDAS and T213L31 model in fields database. The horizontal resolution of products was increased from 1.125 to 0.5625 degrees, the first 3-day products is now archived in a 3-hour interval, day 4-5 products in 12-hour interval, and the products after day 6 in 24-hour interval. In addition, the precipitation after day 3 from T213L31 is archived in 12-hour interval, and the extent of the precipitation archived was changed from Northeast hemisphere to globe.

The products provided to the observatories across the country by satellite communication system are kept the same as those from T106L19 except increasing frequency of outputs and global precipitation. Parts of graphic products are also disseminated through the CMA radio facsimile broadcast and published through NMC/CMA website.

7.2.5 Ensemble Prediction System (Number of runs, initial state perturbation method, clustering)

No change in Ensemble Prediction System.

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

7.3.1 Data Assimilation, Objective analysis and initialization

Instead of the old operational version of the Limited area data Assimilation System with 0.5° horizontal resolution in NMC, a new version of the Limited area data Assimilation System with 0.25° has been put into operation on IBM-SP computer since Sep. 1, 2003.

In the new system, the first guess fields for cold starting and the boundary conditions for the assimilation model are interpolated from the new generation global model forecasts (T213L31). The source code of objective analysis and forecast model were paralleled using both MPI and OpenMP on IBM-SP in order to fit the new computer architecture. The digital filtering scheme (Lynch 1992) is used in initialization.

The new regional data assimilation scheme based on 3DVAR (GRAPES) has begun to be tested with the conventional observational data.

7.3.2 Model

The model in HLAFS (Higher resolution Limited area Assimilation and Forecast System) operational system was modified in 2003. Firstly, the horizontal resolution was increased from 0.5°×0.5° to 0.25°×0.25° in latitude and longitude. Secondly a simple mixed-phase explicit cloud scheme was implanted, in which the freezing of cloud /rain water and melting of snow were considered and the snow as well as super-cooling water was allowed to exist in the model atmosphere, instead of warm rain explicit moisture scheme used before. The modification was finished in the summer and began operational run on 1st September of 2003 (new system is called as HLAFS025). The comparison between two schemes with real-time data showed that large improvement was achieved in precipitation prediction.

7.3.3 Numerical weather prediction products

Six-hour accumulated precipitation amount forecasts were added in numerical weather prediction products.

The horizontal resolution of products archived in fields database was increased from 0.50 of HLAFS to 0.25, the outputs from HLAFS025 was changed in a 6-hour interval for two

days and the output of precipitation is in a 3-hour interval. The guiding products provided to the observatories across the country by satellite communication system are kept the same as those of HLAFS05. Parts of products are also disseminated through the CMA radio facsimile broadcast and published through NMC website.

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

7.4.1 Data Assimilation, Objective Analysis and Initialization (where applicable)

Not applicable.

7.4.2 Models (as appropriate, related to 7.4)

MTTP (Model for Typhoon Track Prediction)

The MTTP on SW was put into operational running in this year. The forecast track errors are shown in the following table 7.

Table 7 Mean Track Errors for SW-I System (unit in KM)

Forecast period	12h	24h	36h	48h
Error	96.5 (171)	172.6 (144)	252.4 (129)	340.1 (114)

Note: the numbers in the brackets are the forecast numbers.

G-MTTP (Global Model for Typhoon Track Prediction)

The new Typhoon track prediction system based on T213L31 and bogusing scheme used in MTTP (G-MTTP) was put into quasi-operational running in Sep. G-MTTP was run once a day during the Typhoon season on the way out, the forecast track errors for this period are shown as follow (table 8):

Table 8 Mean Track Errors for G-MTTP (unit in KM)

Forecast period	12h	24h	36h	48h	60h	72h	84h	96h
errors	64.7 (56)	118.3 (52)	170.3 (49)	229.5 (43)	307.5 (38)	336.7 (28)	405.1 (24)	430.8 (18)

Solar ultrviolet raditation forecast system

A new UV Index forecast system has been developed and tested by the NMC/CMA to support the China daily UV Index forecasts issued by Central Meteorological Observatory and will be put into operational run in early of 2004. The surface ultraviolet radiation calculations are performed with a Short-wave Radiation transfer model. In the SW-RT model, the reflectivity and transmissivity of each atmospheric layer are first computed using the delta-Eddington approximation, the fluxes are then computed by using a two-stream adding method for a composite of layers. The total flux at each pressure level and at the surface is the weighted sum of these fluxes .The model using the

meteorological fields from the operational global medium range numerical weather prediction model (T213L31) and ozone mixing ratio derived from a climate base field .In the UV Index forecast system the erythemally weighted dose-rate is given in terms of a dimensionless ultraviolet index (UV Index), which is derived from all sky downward instantaneous UV fluxes at the surface according to experienced value. The UV Index forecast system computes all sky UV Indexes 4 times for each day of the three forecast days.

The post process is to interpolate the values of grid point to locations of the main cities across the country and expressed in text and MICAPS (Meteorological Information Comprehensive Analysis and Process System) input data file formats.

Air Pollution Prediction

No Further Modification has been taken to air pollution prediction system except some minor changes of operational chart.

8. Verification of prognostic products

8.1. The verification against analysis of operational numerical forecast model(T213L31) in 2003 are as shown in the following table 9.

Table 9 RMSE of Z(500) and W(250)

Month	Valid time	Z(500)	W(250)	W(850)			
		NH	SH	NH	SH	Tropics	Tropics
1	24	15.7	19.5	6.1	6.3	5.5	2.1
	72	41.7	49.4	11.8	13.9	9.1	3.6
	120	67.6	76.6	16.1	18.8	10.9	4.4
2	24	16.3	20.5	6.1	6.3	5.5	2.1
	72	46.6	55.0	12.7	14.9	8.6	3.5
	120	81.8	81.8	19.1	19.7	10.2	4.3
3	24	14.2	21.7	5.7	6.6	5.0	2.0
	72	40.3	59.4	11.5	15.1	8.0	3.3
	120	70.0	89.0	17.3	20.4	9.7	4.1
4	24	14.2	23.1	5.9	6.7	5.2	2.0
	72	39.8	61.5	12.0	15.3	8.6	3.3
	120	68.6	95.0	17.2	21.6	10.3	4.1
5	24	14.3	24.2	5.8	6.7	5.5	2.2
	72	38.2	66.9	12.2	16.2	9.1	3.7
	120	61.5	103.4	17.2	22.5	10.9	4.4
6	24	12.9	24.1	5.5	6.6	5.1	2.2
	72	30.9	66.9	10.9	15.9	8.3	3.6
	120	46.8	103.5	15.1	22.5	10.0	4.5
7	24	13.7	24.3	5.7	6.3	5.3	2.4
	72	32.3	66.8	11.3	15.6	8.8	3.9

	120	48.3	102.9	14.6	22.0	10.4	4.7
8	24	11.9	23.6	5.4	6.5	5.4	2.3
	72	30.1	62.5	11.1	15.2	8.8	3.9
	120	48.5	94.6	15.3	20.8	10.2	4.7
9	24	13.5	23.4	5.4	6.4	5.0	2.3
	72	34.7	63.8	11.6	15.7	8.0	3.8
	120	55.3	97.4	15.9	21.7	9.9	4.7
10	24	14.2	23.1	5.6	6.5	5.0	2.1
	72	39.4	61.5	11.8	15.7	8.3	3.6
	120	64.5	96.2	16.8	21.6	10.1	4.5
11	24	15.3	23.6	5.8	6.8	4.9	2.0
	72	46.3	59.0	12.7	15.7	8.2	3.4
	120	76.6	84.8	18.5	20.6	10.1	4.3
12	24	16.9	20.0	6.1	6.2	5.3	2.1
	72	46.2	52.5	12.2	14.4	8.8	3.5
	120	72.8	78.1	17.2	19.7	10.8	4.4

8.4、The verification against observations of operational numerical forecast model(T213) in 2003 are as shown in the following table 10.

Table 10 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	26.8	32.5	20.7	25.2	11.5	8.4	7.8	7.9
	72	72.4	63.8	36.0	42.1	20.2	14.5	10.7	12.7
	120	108.8	105.7	56.3	58.3	25.7	24.6	13.6	16.7
2	24	21.2	29.6	21.9	36.8	9.7	7.4	8.7	11.5
	72	50.2	52.5	34.2	60.7	15.1	14.7	12.4	17.4
	120	77.1	90.2	53.5	67.2	19.7	22.0	15.3	19.9
3	24	22.0	20.0	18.4	35.6	9.6	7.8	8.5	11.2
	72	225.2	225.1	210.1	235.0	15.3	14.4	12.7	16.3
	120	250.4	256.6	225.0	245.0	20.2	20.5	15.9	19.4
4	24	18.6	24.9	19.5	42.2	9.0	7.6	8.9	12.4
	72	43.2	55.7	34.6	58.8	14.4	13.7	13.1	18.3
	120	73.0	84.1	50.7	79.5	18.8	20.2	16.8	21.8
5	24	20.2	27.9	16.9	45.8	8.7	7.1	8.8	13.3
	72	41.3	42.4	32.4	70.3	15.4	12.1	13.6	20.0
	120	64.3	69.2	44.7	87.8	20.1	17.1	16.7	24.6
6	24	18.4	24.0	16.5	43.9	8.2	7.3	8.5	13.7
	72	32.7	38.7	27.7	71.3	13.3	11.5	13.2	20.6
	120	48.4	57.9	36.9	95.3	17.0	17.6	15.9	27.3

7	24	16.8	17.8	18.6	42.5	7.8	7.6	8.0	17.3
	72	31.7	33.0	27.8	70.4	13.4	12.4	12.2	25.1
	120	45.7	53.3	35.8	98.5	16.4	17.8	14.5	30.9
8	24	15.1	27.4	17.7	42.9	7.6	7.0	7.6	17.3
	72	34.4	44.4	26.3	68.3	14.0	12.2	11.6	23.6
	120	52.6	63.2	35.5	80.6	18.6	16.5	14.1	28.2
9	24	18.8	16.7	15.7	46.9	7.8	7.6	7.5	14.4
	72	39.2	47.9	28.2	72.8	13.7	14.7	11.2	20.2
	120	64.0	77.9	41.9	95.1	10.0	20.6	14.9	25.6
10	24	21.9	37.3	16.3	38.5	9.1	7.9	7.6	12.9
	72	53.6	55.5	26.8	66.8	16.9	14.2	10.4	19.8
	120	85.1	85.1	39.4	92.8	21.8	21.0	12.9	25.9
11	24	27.3	26.6	16.9	50.3	9.5	7.5	7.6	15.3
	72	74.7	50.5	32.5	67.3	19.1	13.1	11.0	18.4
	120	112.0	90.7	47.8	70.4	26.1	21.0	14.3	20.0
12	24	31.2	24.2	23.1	33.9	10.8	8.0	7.6	12.9
	72	70.4	56.4	37.6	55.1	18.5	14.5	10.9	18.2
	120	90.0	100.8	59.0	65.4	22.6	22.4	13.7	20.8