AN OPERATIONAL MEDIUM–RANGE NWP SYSTEM IN NMC, CHINA

Qiu Guoqing,Huangfu Xueguan, Tu Weiming, Zhang Jianchun etc.
(National Meteorological Center,China)

1. Introduction

The power of computer in NMC, China was increased by 1 order in last two years. Fig 1 shows the new computer system in NMC.The computer VAX 6320 is devoted to pre–processing of real–time observation data, graphic, and distribution of NWP products etc. Main parts of NWP System is run in computer Cyber992 (24MIPS for scaler, 34.6 MIPS for vector; 64MB). The computer Cyber962 / 11(8.9 MIPS;64MB) is for back–up of NWP operation systems.Ten work–stations of Cyber910 are used for weather forecast.

An old version of T42 Medium–range NWP system was put into operation in September 1989 in computer M–360 AP (3.5 MIPS, 16MB). A new version of T42 system has been run on Cyber992 Since 12 Sept 1991. The main differences of two version are global prediction instead of northern hemisphere prediction and four–times per day data assimilation in new version but two–times in old version.

2. T42 medium–range NWP operational system.

The components of T42 system are show in Fig 2. The global data assimilation and global NWP model are the core of the system.

The global data assimilation system consists of the quality control of observation data, analysis, p–sigma conversion, initialization, forecast model and post–processing.

The observation reports recieved from telecommunication are decoded, checked for primary quality–control, transformed into BUFR form, resorted and stored in Element Data Bank (EDB).

The observation data are attracted from the EDB in which the data have been sorted into 11 types of observation. Then gross error check, vertical consistency check and horizontal consistency check (including check against first guess field) are implemented.

The optimum interpolation method for mutivariate in wind and geopotential height with constraint on quasi–geostrophic balance is adopted. U,V components of wind, geopotential height H and relative humidity RH on 12 mandatory levels(50, 70, 100, 150, 200, 250, 300, 400, 500, 700, 850, 1000hPa) with an equal–area longitude–latitude grid are analysed. The first guess fields are based on 6 hours forecast and climate data in tropics.

The horizontal interpolation is done on mandatory levels. The values of

U,V,H,RH at model grid points are calculated from the spherical harmonic coefficients which are obtained from the analysis values on an equal–area grid.

Data are interpolated from the pressure coordinate to the sigma coordinate,in which U,V,RH are linear with ln(p), and H are quadratic with ln(p). A surface pressure is computed from the height and temperature of the mandatory levels. Temperatures are constructed based on thickness. Specific humidity is computed from RH,T,and P only on the lowest 6 mandatory levels.the increment interpolation scheme is employed in new version of operation sysem.

Non–linear adiabatic normal mode initialization scheme is contained in the forecast model, only the first five modes are used for initializdtion. After two adiabatic iterations, the scheme converges and more reasonable initial balanced fields can been obtained.

The global spectral model T42L9 is used in the data assimilation and for 5–day prediction.The sigma system and finite difference scheme are used in the vertical.The midel uses a conventional leap frog semi–implicit time integration scheme with a time step of 30 minutes. The basic formulation of horizontal diffusion in the model is a simple linear fourth–order diffusion for the vorticity ζ,divergence(D),humidity and temperature equations. In order to ensure stability, the selectively enhanced horizontal diffusion in the stratosphere and strong flow damping in the tropospheric levels where the maximum wind exceeds a critical value have been introduced.The model also uses physical package which consists of large scale condensation, kuo convection scheme, boundary eddy fluxes, free–atmosphere turbulent fluxes,the radiation scheme influenced by CO_2,H_2O and climatic clouds.

The schemes of post–processing are similar to those in p–sigma interpolation.H at half–level are calculated from T at full–level.After vertical interpolation, horizontal interpolation is implemented at p–level. Instead of U,V,horizontal interpolation of D and ζ are done, then U,V, at 2.5×2.5 degree latitude–longitude grid are calculated from D,ζ.

The results of analysis, prediction and post–processing are stored in Field Data Bank(FDB) in GRIB form, and used by graphic, verification, products formation, archive, data assimilation ete. The layer structure is adoped for FDB logical structure according to date, time, type of field, valid time, code of element and level in sequence. The data access path is the same with logical structure. The FDB consists of main index file and several data files. The index is direct–file and have the data on which the field data is created and clean pointer etc. The data files is included the index file (for VAX / VMS)or key–file (for Cyber NOS / VE) at the begin of the data file, in which there are valid time, code of element,level,record mark etc.

The T42 system run once a day and is started at 14:15Z for data assimilation. The products for 12Z analysis are ready for use at 03:20 local time (19:20Z) and five–day prediction products can be used befor 05:35 local time (21:35Z). it takes about 3 hours 50 minutes (wall clock) in Cyber992 to finish four times data assimilation and five days global prediction. The data cut off times are 14,10,6,7 hours for 00,06,12,18Z respectively.

The NWP products can be used in the form of GRID code and graphic in work–station of Cyber910 connected with Cyber962 using AMIGAS or VAX work–station connected with VAX–6320 using MAGICS.

3. The performance of T42 NWP system.

For illustration of the performance of the system, assimilation statistics is done. Table 1 shows the number of observation reports in ± 3 hours of analysis time, which are attracted from EDB. These figures are very close to those of other RSMCS and WMCS except less satellite and aircraft data. About 274 observation records are rejected by gross check, 460 by vertical consistency check,453 by horizontal consistency check.Table 2 shows the numbers of observation for each element and at each mandatory level,which are finally used in analysis.

The analysis verification against radiosonds reports are shown in table 3. The deviations are about 10,14,24 m for H and 4,4,5 m / s for vector wind at 850,500,250hPa respectively. They show the assimilation system is good and can be used in operational run.

The forecast verification of northern hemisphere model is shown in Fig 3 and 4 for height and wind respectively. The verifications against radiosondes for American and Europe region only at 500 hPa are presented. Comparing the curves of T42 (new system) and B (old system), the improvement is obvious. But there still is some gaps between T42 and UK or JMA.

Fig 5 is the monthly mean D+5 prediction error chart of T42 northern hemisphere model for January and July with corresponding monthly mean height field. Systematic errors are obvious. Such as, the positive error are located at trough region, the negative error at ridge region. The negative error of the model in summer is serious.

Table 1. The number of reports recieved from GTS

(March 3, 1990)

	00Z	06Z	12Z	18Z	total
synop/ship	7175	7160	7240	6966	28991
Temp A	837	228	799	255	2119
Temp B	458	18	412	7	895
Temp C	601	43	548	75	1267
Temp D	401	9	355	8	773
AIREP	688	960	855	1013	3516
SATOB	3708	1542	3399	1254	9903
SATEM	1130	1223	1137	1287	4777
DRIBU	367	268	380	384	1399
PAOB	123	0	0	0	123
TOTAL	15488	11901	15125	11249	53763

Table 2. The number of observation used in analysis

(30 day mean 9.16--10.15, 1989)

	H	U	RH
1000mb	1708	589	1015
850mb	1118	1362	567
700mb	1112	675	587
500mb	1184	656	586
400mb	1110	644	563
300mb	1105	709	433
250mb	1099	803	
200mb	1094	1089	
150mb	1082	579	
100mb	1057	544	
70mb	1046	469	
50mb	1032	444	

Table 3. Analysis Verification against radiosonde

(January- November, 1990)

(3 regions of North American, Europe and Asia mean)

	Geopotential Height(m)		Wind (m/s)	
levels	mean error	RMSE	mean speed error	RMSVWE
250 hPa	-2.17	24.2	0.47	5.4
500 hPa	-1.08	14.3	0.35	4.1
850 hPa	-1.61	10.4	0.32	3.7

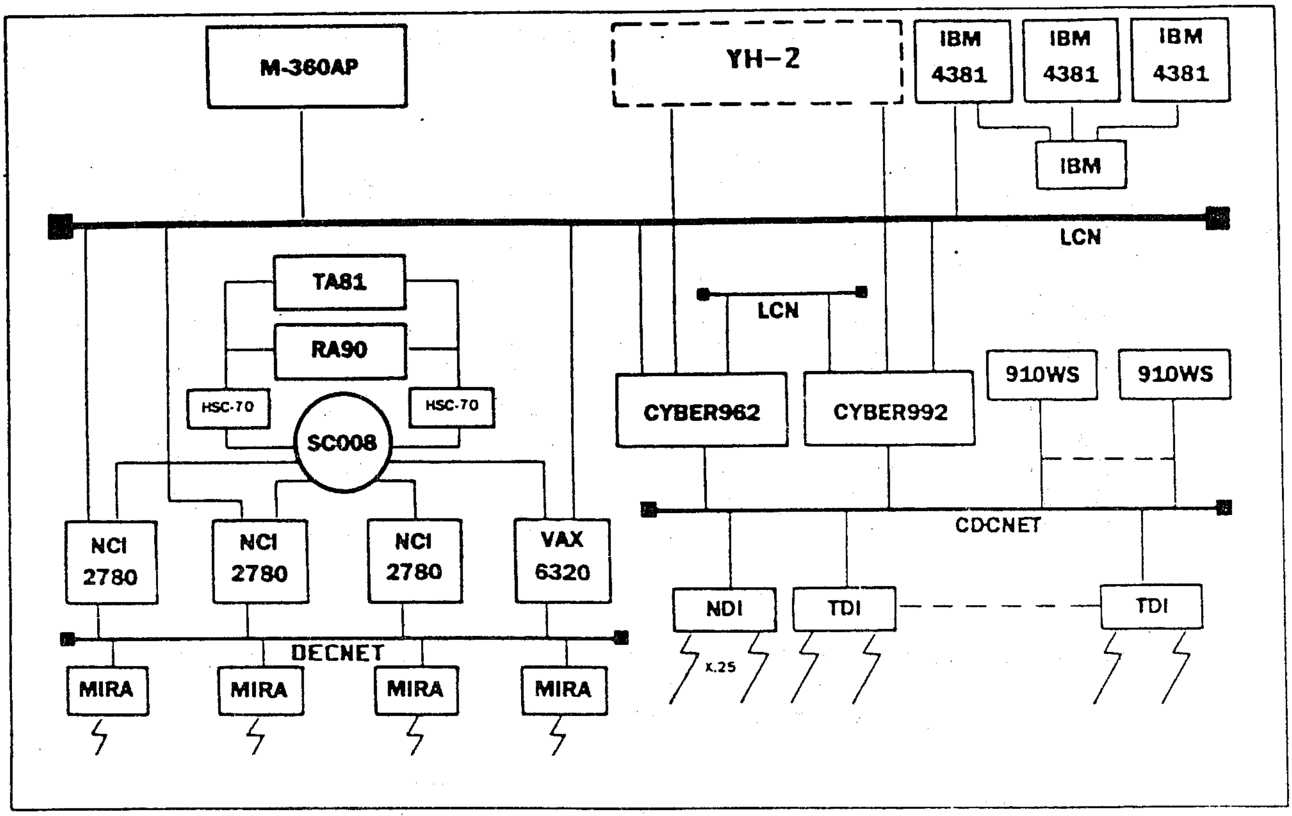

Fig.1 COMPUTER NETWORK AT SMA

The SMA Loosely Coupled Network designed for heterogeneous largecomputers is a high speed and high performamce local area network.It provides shared computer resources and data among different computers.

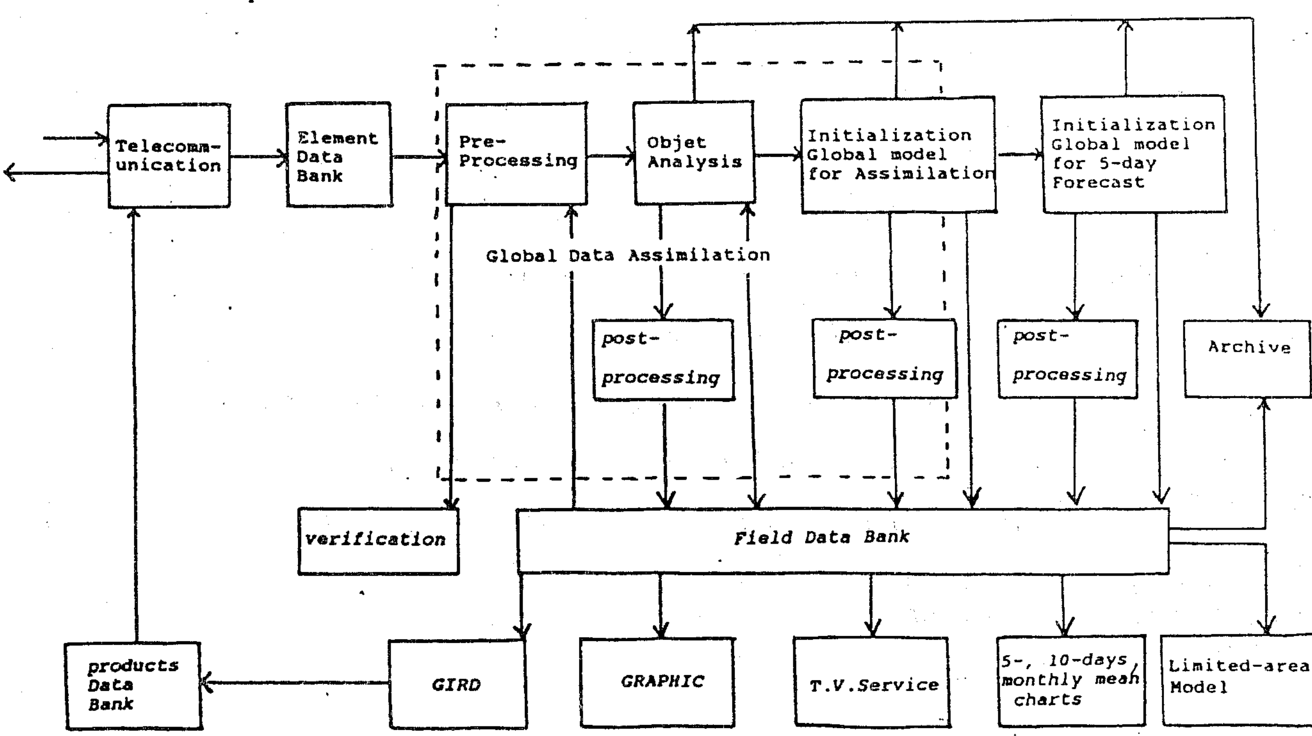

Fig.2 T42 NWP Operational System

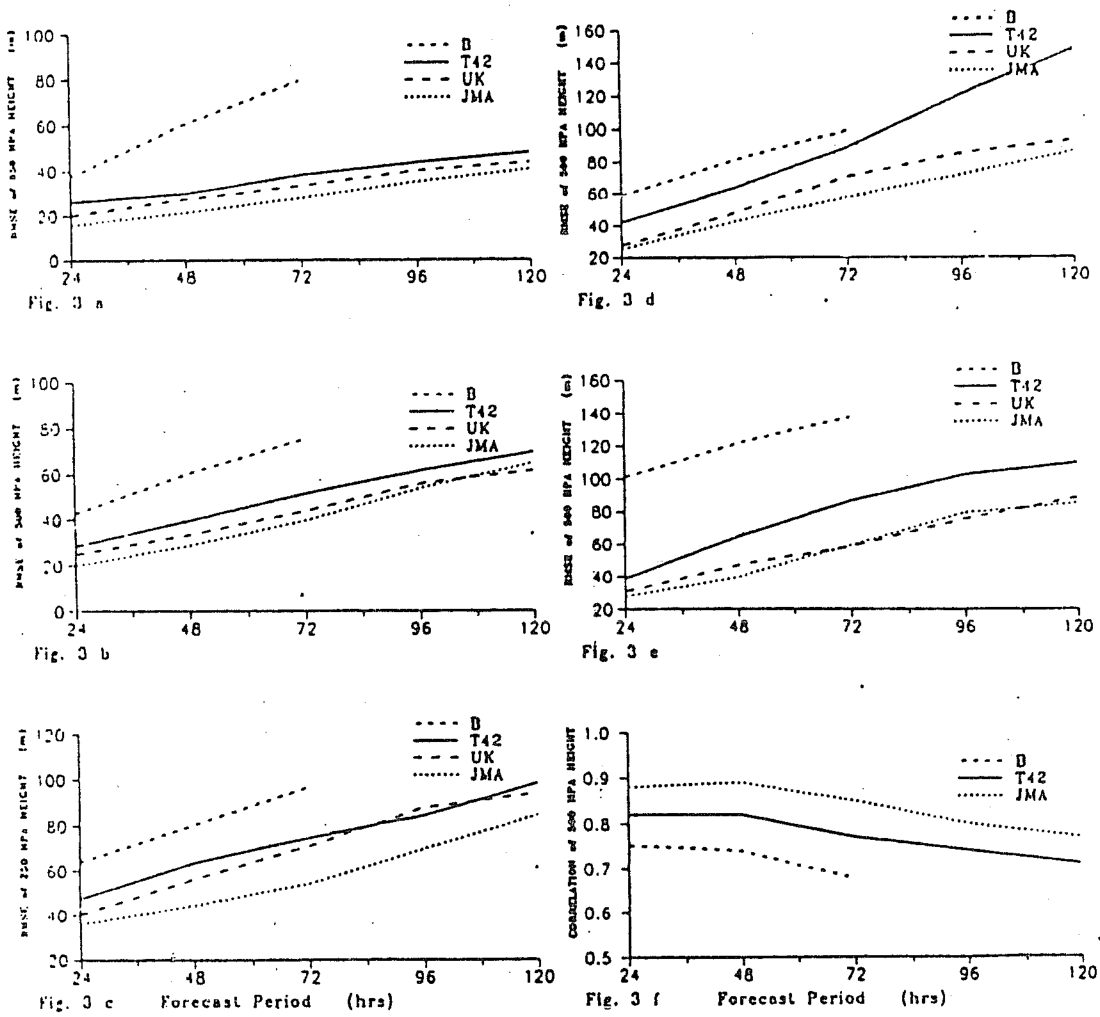

Fig.3 Comparison of Height
Forecast Verification against Radiosondes
among B, T42, UK and JMA Model
January 1990

3a: 850 HPA RMSE Asia	3b: 500 HPA RMSE Asia
3c: 250 HPA RMSE Asia	3d: 500 HPA RMSE N.A.
3e: 500 HPA RMSE EU.	3f: 500 HPA COR. Asia

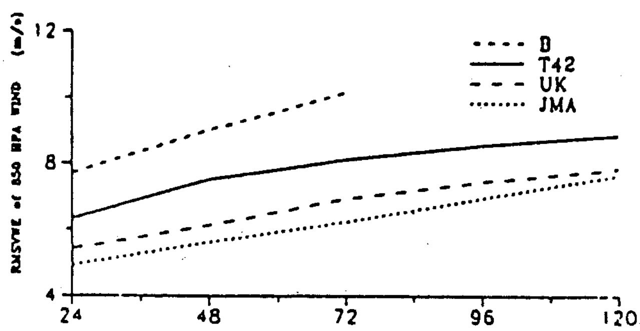

Fig.4a

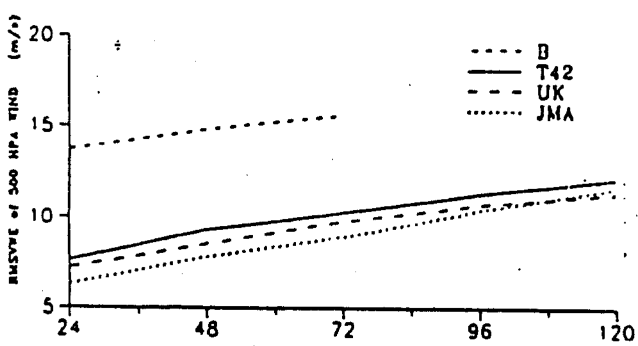

Fig.4b

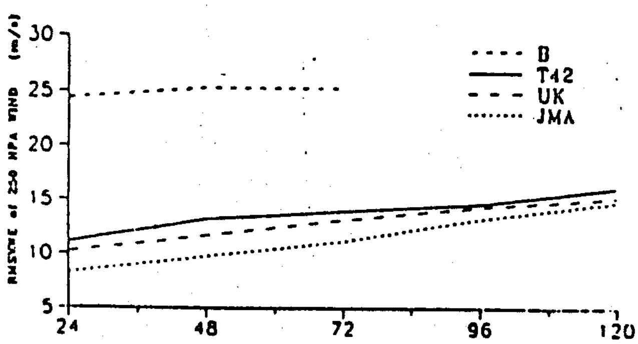

Fig.4c Forecast Period (hrs)

Fig.4 Comparison of Wind Forecast Verification against Radiosondes among B, T42, UK and JMA Model in Asia Area January 1990
5a: 850 HPA 5b: 500 HPA 5c: 250 HPA

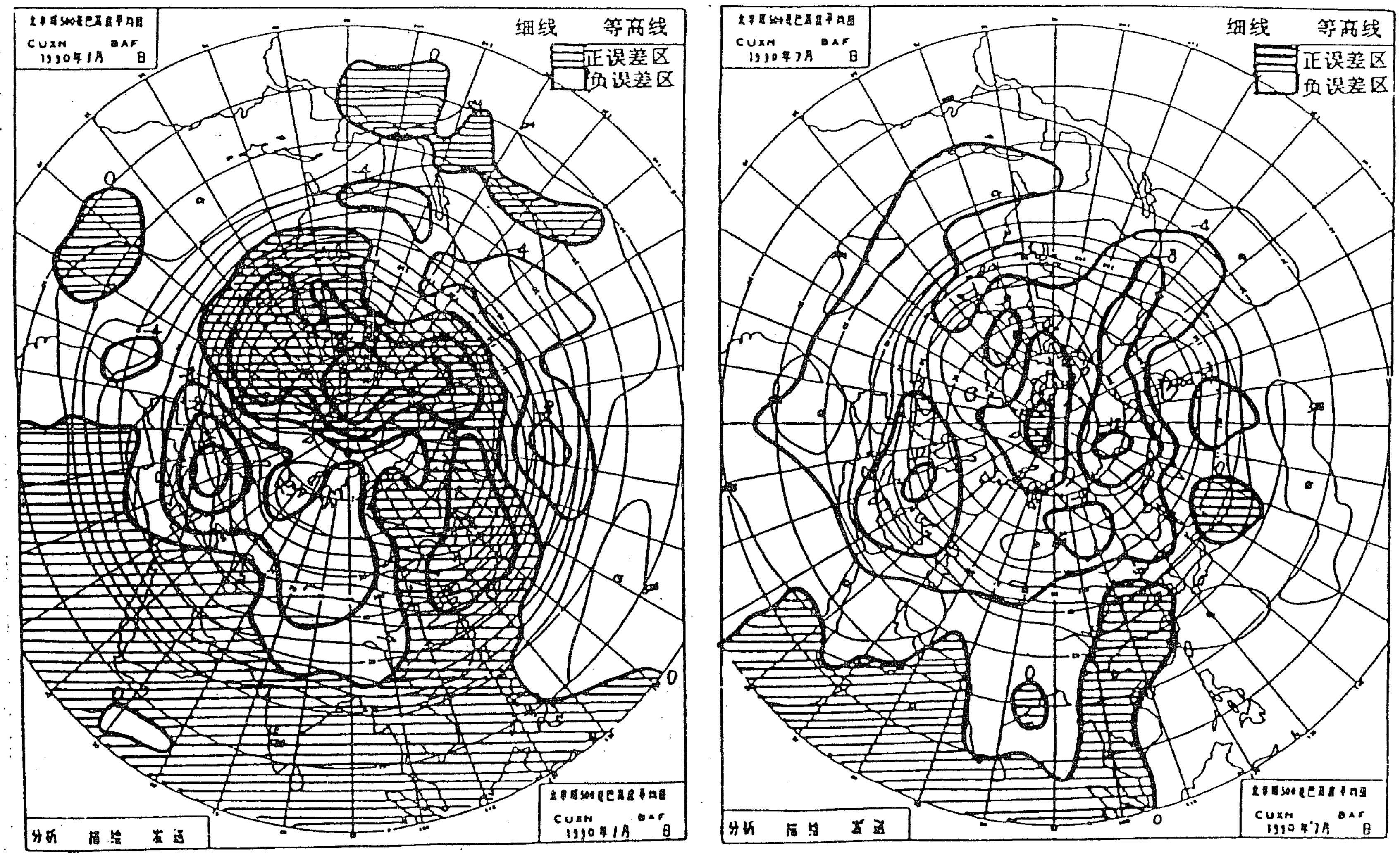

Fig.5 monthly mean day 5 error chart for Janary and July