WWW TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS), AND THE ANNUAL NUMERICAL WEATHER PREDICTION (NWP) PROGRESS REPORT FOR THE YEAR 2005

RUSSIAN FEDERATION

RUSSIAN FEDERAL SERVICE FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING

1. Summary of highlights

1.1 At the center WMC/RSMC Moscow the issue of operational forecasts on term 1-10 days on global spectral model T85L31 including the full set of prognostic fields on standard isobaric surfaces, and also basic weather elements (precipitation, surface temperature and wind, cloudiness) is continued. Operative exploitation of the global data assimilation system based on the T40L15 model is being continued to run.

1.2 A new version of 30L regional atmospheric model in sigma-system coordinates has been put into the operational use. The forecast area is coved with 137x209 grid points of lat-lon grid with horizontal resolution of 75 km in polar stereographic projection. The forecast range is 48 hours. The forecasts being issued, except meteorological fields on isobaric surfaces, include also precipitation totals and surface wind values.

1.3 Operational technologies for dissemination of NWP products of the HMC of Russia including weather element forecasts on Internet-sites of the Hydrometcentre of Russia have been put into operation.

1.4 An experimental exploitation of semi-lagrangian prognostic global atmospheric model of the Hydrometcentre of Russia and the Institute for the Computational Mathematics of the Russian Academy of Sciences for issue of meteorological fields forecasts on the isobaric surfaces and water sea level pressure with the horizontal resolution of 75 km has been started.

1.5 In the Khabarovsk RSMC the version of the regional model in sigma-system coordinates with 75 km resolution developed at HMC of Russia has been introduced in the operational regime.

2. Equipment in use at the center. Basic technologies without substantial changes in comparison with 2002. Introduction of reserve operational technologies on XEON-platform.

3. Data and products from GTS in use.

Observation information

	Moscow	Khabarovsk	Novosibirsk
SYNOP	53200	5100	1880
TEMP	5000	1920	1650
PILOT	1100	0	20
SATEM	14700	5400	12706
SATOB	92 300		20
BUOY	57500		
AMDAR	50000		
AEREP	1850		

Products:
For centers Moscow, Novosibirsk, Khabarovsk: ECMWF (GRIB 2.5x2.5°), Exeter (GRIB 2.5x2.5°, GRIB 150x150 км, digital facsimile), Offenbach (GRIB 1.5x1.5°, digital facsimile), Washington (GRIB 2.5x2.5°, GRID 5°x5°),
for centers Novosibirsk, Khabarovsk, except from listed, - Moscow (GRIB 2.5x2.5°, digital facsimile),
for centers Khabarovsk, except from listed – Tokyo (digital facsimile)

4. Data input system.

Automatic.

5. Quality control system.

The system is used for the Data observations to be disseminated:
At the observation stations the quality control is made manually.

For the GRIB-information to be disseminated:
Automated control for completeness of data.

For the received data observations:
Control on the departure from the first guess field.
Horizontal control for the surface information.
Provisional control on stations.

6. Monitoring of the observing system

There is carried out the monitoring of arriving and the quality of the radiosonde observations for the territory of Russia (on global and national levels). Monitoring of arriving and the quality of the Russian observations SYNOP, and measurements of pressure receiving from the Russian commercial ships is also made.

7. Forecasting System

Prognostic system consists of the following blocks:
A – initial control of information,
B – data assimilation system and objective analysis,
C – global and regional atmosphere models,

D – system for interpretation of results of computions.

7.1. System-run schedule and forecast ranges.

Basic initial terms of the Forecasting system (model T85L31, regional model 75x75 km) are 00 and 12 UTC. Forecasts are precomputed 2 times a day: at 00 UTC by the model T85L31 with the maximum term of forecast 84 h. with intervals 6 hours; at 12 UTC by T85L31 model maximum term of forecasts is 240 h. with 6-h. intervals up to 84 h., further – 12 hours.
Regional model runs in the same regime for the both time hours – maximum term of forecasts is 48 hours with discreteness 3 h.

7.2,7.3. System for the medium and short range forecasting

7.2.1,7.3.1. Data assimilation, objective analysis and initialization.

- Cyclic – assimilation system – 4 times a day: 3.00, 9.00, 15.00, 21.00.
- Objective analysis: 2-dymentional interpolation for 1-level characteristics and 3-dymentional optimum interpolation for geopotential fields and wind.
- Products – sea level pressure, surface air temperature, smoothed temperature of underlying surface, surface air humidity and wind velocity, total cloudiness in octant, snow cover height, sea surface temperature, geopotential heights of isobaric surface, wind velocity, temperature and air humidity on standard isobaric surfaces.
- First guess for the Global assimilation system – T40L15, for an objective analysis system GRIB 2,5x2,5° UKMO .
- Horizontal resolution – 2,5x2,5°, 1,25x1,25°.
- Levels – 10,30,50,70,100,150,200,250,300,400,500,700,850,925,1000,hPa, sea level – for pressure, underlying surface for surface characteristics.
- Initialization – non-adiabatic, on normal mods.

7.2.2, 7.3.2. Model.

The Global spectral atmosphere model T85L31 is the basic model for the operational issue of forecasts for 1-10 days for the entire territory of Russia.

Operational tests of the forecasts for precipitation and surface temperature on the basis of a new 30-level regional model (with 75 km horizontal resolution, maximum forecast range 48 hours) have been continued at the HMC of Russia.

For the Moscow Region (area 300 x 300 km) there has been put into operational use a non hydrostatic mesoscale model with 10 km. resolution. Maximum forecast range is 36 hours.

Works are being carried out aimed at creation of the mesoscale model version of the Hydrometcentre of Russia for the Saint-Petersburg region. Experimental exploitation of MM5 model is carried out.

7.2.3, 7.3.3. Numerical Weather Prediction Products.

Global issue of forecasts: geopotential heights, temperature, wind velocity at 15 standard isobaric surfaces up to 10 hPa, relative air humidity up to 300 hPa, mean sea level pressure, surface air temperature, frontal cloudiness and underlying surface temperature with spatial resolution 1,25x1,25° and 2,5x2,5 are coded in GRIB form and transmitted over GST and Internet.

Hydrodynamic forecasts 6 hours precipitation totals surface air temperature, frontal and total cloudiness (1,25x1,25° and 2,5x2,5°, GRIB).The forecasting digital facsimile charts of the mean sea level pressure, heights at 500 hPa, surface temperature at 850 hPa, relative humidity at level 850 (700) hPa for the Northern Hemisphere and Europe depending on the season are also transmitted via GTS.

The users of the Hydrometcentre of Russia on the basis of Regional model are provided with information with discrete time 6 hours about prognostic values of meteofields and with discrete time 1 hour about precipitation totals-expected.
On the basis of the mesoscale model for the Moscow region users are operationally provided with the forecast of surface air temperature and precipitation with detailing of 1h.

7.2.4. Operational technologies for application NWP products. Medium range forecasts.

System of statistical interpretation of the results of the Medium range of the hydrodynamic modeling is used (MOS system). Initial time - any. An automated system provides the issue of meteorological forecasts of extreme temperature values, precipitation totals for 24 hours, probability of precipitation occurrence, cloudiness with lead time up to 7 days for 5000 towns of the Globe including also the towns of the Russian Federation.

7.3.4. Operational technologies for application NWP products. Short Range Forecasts.

System of statistical interpretation of the results of the Medium range of the hydrodynamic modeling is used (MOS system). An automated system provides the issue of meteorological forecasts of extreme temperature values, precipitation totals for 24 hours, probability of precipitation occurrence, cloudiness with lead time up to 1-7 days for 5000 towns of the Globe including also the towns of the Russian Federation.

There are daily calculated for the towns of the Central Russia short-range surface air temperature forecasts, humidity, precipitation, wind velocity with interval 1-hour and also the extreme air temperature values for 24-hours.

There is in performance the automated System for physical-statistical interpretation of numerical modeling results producing short-range forecasts of significant weather phenomena (thunderstorms, showers, hail, squalls) characteristics of convective cloudiness (heights of upper and low boundaries), heights and maximum wind velocities values, heights of dynamic tropopause, and also – complex indexes of (frontal parameter).

7.4. Specialized numerical forecasts.

a) Sea wave forecast.

There is produced an operational issue of forecasts on the basis of spectral-parametric model of wind wave. Forecast is issued for 2 components: wind waves and waves of swell. For wave forecast the objective analysis data and the products of the Hydrometcentre of Russia the Global Spectral T85L31 atmosphere model are used, diagnosis and wind velocity forecast on grid 2,5 x 2,5°.

b) Long-Range forecasting of sea ice on non-Arctic seas of Russia.

Long-Range forecasting (with lead time of several months) of sea ice cover, based on a notion of the cyclicity of individual hydrometeorological elements and of active interaction

between the atmosphere and hydrosphere in the winter period is regularly issued. On the basis of the sea-ice cover forecast of high validity the forecasts are issued for ice boundary disposition, ice thickness (including maximum one), ice period duration, dates of sea ice removal. The method uses the technique of decomposition with natural orthogonal components. The atmospheric circulation characteristics and air temperature for the previous periods are used as the predictors for ice parameters forecasting.

7.5. Extended Range Forecasts (10-30 days)

An integrated hydrodynamical statistical forecasting scheme with lead time 10-30 days of air temperature fields at land surface and at standard isobaric surfaces 500, 850 hPa, and also surface air temperature values for 75 points of the former USSR has been used operationally. It is based on an ensemble approach (model T40 L15). Forecasts of mean monthly temperature fields are regularly placed to the web-site http://www.meteoinfo.ru.

There has been developed the system for presentation of monthly forecasts at 10 days intervals of surface temperature anomalies, sea level pressure, heights AT 500, precipitation averaged over 10-, 20- and 30-days' period.

The forecasts are compiled in the operational mode at the end of each month and put at the site of the Hydrometcentre of Russia.

Programming tools for ensemble forecast scoring were developed and implemented. Brier skill score, ROC-curves, rank histograms and economic value assessment are used for results verification.

8. Verification of prognostic products

In accordance with the WMO standards there is carried out the monitoring of quality of the basic operational model of the Hydrometcentre of Russia – the Global spectral model of the Hydrometcentre of Russia for initial times of 00 UTC and 12 UTC. The main results of monitoring are given below.

8. 1.1. Mean sea level pressure

Forecast range	RMSE (hPa)		KA		S1	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC
24	2.2	2.2	0.96	0.96	37.	37.
48	3.3	3.6	0.92	0.92	47.	47.
72	4.5	4.7	0.85	0.85	56.	56.
96		5.9		0.76		64.
120		7.1		0.66		71.
144		8.4		0.55		77.
168		9.3		0.46		81.
192		9.9		0.38		84.
216		10.5		0.31		86.
240		11.1		0.25		88.

8.1.2. 500 hPa height

Forecast range	**RMSE** (m)		KA		S1	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC
24	16.8	16.7	0.98	0.98	23.	23.
48	29.1	28.8	0.95	0.95	33.	33.
72	42.6	42.7	0.90	0.90	42.	42.
96		57.4		0.82		50.
120		71.9		0.71		57.
144		85.8		0.60		63.
168		96.7		0.50		67.
192		105.7		0.41		71.
216		113.1		0.33		73.
240		119.0		0.27		75.

8. 1.3 250 hPa height

Forecast range	RMSE (m)		KA		S1	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC
24	21.2	21.2	0.99	0.99	19.	19.
48	37.9	37.5	0.96	0.96	28.	28.
72	56.4	56.7	0.90	0.90	36.	36.
96		76.9		0.82		44.
120		97.1		0.72		51.
144		115.7		0.61		57.
168		130.4		0.52		61.
192		143.5		0.43		64.
216		154.2		0.35		67.
240		162.7		0.29		69.

8.1.4. 500 hPa temperature

Forecast range	RMSE (K)		KA	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC
24	1.2	1.2	0.94	0.94
48	1.8	1.8	0.88	0.88
72	2.5	2.5	0.80	0.80
96		3.1		0.69
120		3.7		0.58
144		4.2		0.48
168		4.7		0.39
192		5.1		0.31
216		5.4		0.24
240		5.7		0.19

8.1.5. 250 hPa temperature

Forecast range	RMSE (K)		KA	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC
24	1.46	1.42	0.91	0.91
48	2.00	1.99	0.81	0.81
72	2.48	2.48	0.71	0.71
96		2.88		0.61
120		3.19		0.51
144		3.50		0.42
168		3.70		0.35
192		3.87		0.30
216		4.00		0.25
240		4.12		0.22

8.1.6. 500 hPa wind

Forecast range	MEAN SPEED ERROR (m/c)		RMSEV(m/c)	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC
24	-0.4	-0.5	5.2	5.1
48	-0.5	-0.4	6.9	7.0
72	-0.5	-0.4	8.7	8.8
96		-0.4		10.6
120		-0.4		12.3
144		-0.1		14.0
168		-0.1		15.1
192		-0.1		15.9
216		-0.1		16.6
240		0.0		17.2

8.1.7 250 hPa wind

Forecast range	MEAN SPEED ERROR (m/c)		RMSEV(m/c)	
(hours)	00 UTC	12 UTC	00 UTC	12 UTC
24	-1.5	-1.46	7.0	6.9
48	-1.6	-1.56	9.7	9.7
72	-1.6	-1.51	12.4	12.5
96		-1.46		15.3
120		-1.46		17.8
144		-1.52		20.1
168		-1.52		21.8
192		-1.54		23.1
216		-1.61		24.3
240		-1.65		25.1

Abbreviation:

RMSE – root-mean-square error of forecast;

RMSEV – root-mean-square error of wind vector velocity;

KA – anomaly correlation coefficient;

S1 – skill score of the gradient forecast.

9. Plans for the future (2006 - 2007)

9.1. Development of the GDPFS

- Preparation for the operational running and experimental tests of new Global Data Assimilation System with spatial resolution not less then 150 km.

- Introduction of the operational running of a new version of global spectral model T168L31.
- Preparation for the operational use of a new version of the Global semi – Lagrange model of the atmosphere

- Development for the ensemble forecasting system for short and medium ranges.

- Preparation to the operational tests of the MM5 model version for the European part of Russia;

- Improvement and development of meso-scale non-hydrostatic atmosphere model of Hydrometcenter of Russia with spatial resolution 10 km for different regions of Russia;

- Creation of technological infrastructure (based on the development web-technologies) for issues seasonal and inter - annual forecasts for the territory of Russia.

9.2. Research Activities in NWP

- A parallel version of the global spectral model of the Hydrometcenter of Russia was developed. It is based on the MPI technology and uses one-dimensional decompositions for computations in grid and spectral spaces. The parallel versions of the T169L31 and T339L31 spectral model were tested on SMP computers based on Intel Itanium and XEON processors for up to 32 processors (Astakhova and Alferov, 2005, 2006). Further experiments on multi-processor computers are to be performed.

- A new method of approximation of vector and scalar geophysical fields on a sphere by trigonometric polynomials was suggested. The resulting series uniformly converge at all points of the sphere, including poles; the series are derived by computation of the Fourier integrals over the domain that is the direct product of the entire meridian and latitude rows (Frolov and Tsvetkov, 2006). The method is to be implemented on a computer for numerical experimentation.

- The development of short- and medium-range ensemble prediction system based on the T85L31 model will be continued.

- Influence of random and deterministic errors of the atmosphere model on the statistical structure of the field of errors of forecast was investigated. There was revealed a critically important role both the random and determinate (depending on the state) errors of the model (Tsyrulnikov, 2006).

- Development of a new original three-dimensional 3D-Var-PSAS type data assimilation system is started. A new spatial covariance model based on spatial digital filters is proposed. The distinctive feature of the model is its capability of modeling spatially-variable flow-dependent three-dimensional structure of meteorological fields. Currently. a 2-D univariate version of the new analysis scheme is realized (Tsyrulnikov, 2006) (Develop the three-dimensional multivariate global 3D-Var-PSAS type analysis scheme).

- Algorithm for retrieval of 3-h and 6-hours precipitation totals for meteostations of the Globe with the use of GTS information in code “SYNOP” (precipitation totals for a day or a half day and the information on the present weather and the information between time-hour) is realized (Alferov, 2005). It is planned to implement investigations of the influence of the satellite information as supplementary input parameters.

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