

RUSSIAN FEDERATION

RUSSIAN FEDERAL SERVICE FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING

WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM (GDPFS) FOR 2007

Country: Russian Federation

Centre: WMC/RSMS Moscow

1. Summary of highlights

1.1. At the centers WMC/RSMC Moscow the issue and forecast dissemination via GTS for the Northern and Southern hemispheres on global spectral model T85L31 including the full set of prognostic fields on standard isobaric surfaces, and also basic weather elements, with 6-h. lead time interval and with maximum range of forecast 240 h. is continued. The global data assimilation system based on the T40L15 model is being operationally run.

1.2. The operational exploitation of a new version of 30L regional atmospheric model (with resolution 50 km) in sigma-system coordinates performing calculations for Europe and adjacent Atlantic is continued. The products include the standard complex of meteorological fields on isobaric surface as well as that of surface characteristics, with 6 h lead time interval and additionally, that of pressure on sea level, of 1-h amounts of precipitation, surface wind with a 1-h lead time. The version of the regional model for the Far-Eastern region is upgraded to be run at RSMC Khabarovsk. The tests of the regional model version developed for the Siberian region began at RSMC Novosibirsk.

1.3. The experimental-operational exploitation of semi-Lagrangian 28-level prognostic global atmospheric model (SLAV) ($0.72^{\circ} \times 0.9^{\circ}$) of the Hydrometcentre of Russia and the Institute for the Computational Mathematics of the Russian Academy of Sciences is continued. The forecasts of pressure and geopotential fields in the middle troposphere of the Northern Hemisphere substantially improved in quality. Beginning from 01.07.2007 the parameterization of processes on land surface (ISBA) developed in Meteo-France as well as the scheme of assimilation of soil variables implemented in conformity with (Giard, Bazil, MWR 2000) became operational in the model SLAV.

1.4. The experimental-operational exploitation of non-hydrostatic mesoscale model of the Hydrometcentre of Russia with the resolution 10 km for the Moscow and Leningrad regions (area 300x300 km for each region) is continued. The maximum lead time is 36 hours.

1.5. New version of T169L31 model (with resolution approximately $0.7 \times 0.7^{\circ}$) has been put into the experimental exploitation mode; there has been implemented substantial verification of the used climatic and morphometric characteristics of underlying surface.

1.6. There has been started the experimental exploitation of the mesoscale model COSMO-ru for the European territory of Russia (resolution 14 x 14 km).

1.7. Operational exploitation of the integrated hydrodynamic-statistical ensemble scheme for long-range forecasting of meteorological fields and site surface air temperature values using the global T41L15 model is continued. Mean monthly fields on isobaric levels 500 and 850 hPa over the Northern hemisphere are also regularly allocated on the web-site <http://www.meteoinfo.ru>

together with a synoptic analysis of possible development of large-scale processes. Monitoring quality of the forecasts for basic variables using WMO recommended criteria is carried out.

1.8. The release of the operational hydrodynamic-statistical monthly forecasts on the basis of the MGO* model T42L14 is continued. The release of the forecasts is carried out for calendar months, and also for the nearest 30-days period once a week. Monitoring quality of the forecasts for basic variables using WMO recommended criteria is carried out.

1.9. WMC-Moscow started issuance of seasonal forecasts with 1-month lead time on monthly basis in October 2007 (before that the seasonal forecasts had been issued once for three months). Once a month the results of seasonal forecasts and corresponding hindcast data of WMC Moscow are conveyed to the Asian Pacific Climate Centre (APCC) (Busan, Republic of Korea) as a contribution to the multi-model ensemble seasonal forecast in the framework of the international APCN (Asia-Pacific Climate Network) project on LRF.

2. Equipment in use at the center.

Basic operational technologies are carried out on the computing complex formed by two 4-processors servers (XEON processors). A number of procedures for operational data processing is carried out on the computing cluster on the processors Itanuim-2 (16 processors).

3. Data and products from GTS in use.

Observation information (average number of reports for 24 h.)

	Moscow
SYNOP+SHIP	77000
TEMP	5500
PILOT	1100
SATEM	21700
SATOB	61300
BUOY	57500
AMDAR	49000
AIREP	2100

Products:

ECMWF Reading (GRIB 2.5x2.5°), RSMC Exeter (GRIB 2.5x2.5°, GRIB 1.25x1.25 “thin”, digital facsimile), RSMC Offenbach (GRIB 1.5x1.5°, digital facsimile), WMC Washington (GRIB 5x2.5°, using Internet (FTP) 1x1°).

4. Forecasting System.

Prognostic system consists of the following blocks:

A – initial control of information and inclusion of the observation data into the specialized data bases

B – data assimilation system and objective analysis,

C – global and regional atmosphere models,

D – system for interpretation of results of computations.

4.1. System-run schedule and forecast ranges.

Basic initial times of the forecasting system of global and regional models are 00 and 12 UTC. Forecasts are issued twice a day: at 00 UTC by the Global 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. time intervals for forecasts up to 84 h., further with 12-h intervals.

Semi-Lagrangian global model performs computations twice a day for 00 and 12 UTC, maximum range of forecast is 7 days. The products for the operational users are available only for the Northern Hemisphere (with 6-hour time interval).

Regional model runs in the same mode for both observation hours – maximum term of forecasts is 48 hours with 6-h. time intervals (standard set of fields) and 1-hour interval (precipitation, pressure, wind).

Mesoscale models for the Moscow and St.-Petersburg regions perform computations twice a day (lead-time steps of output) from 1 hour to 36 hours.

4.2., 4.3. System for the medium and short range forecasting

4.2.1., 4.3.1. Data assimilation, objective analysis and initialization.

4.2.1.1., 4.3.1.1. In operation

- Cyclic – assimilation system – 4 times a day: 00, 06, 12, 18 UTC;
- Objective analysis using the first guess fields of RSMC Exeter and WMC Washington – 2 times a day for 00, 12 UTC.
- Method of analysis: 2-dimensional interpolation for 1-level characteristics and 3-dimensional 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 surfaces, wind velocity, temperature and air humidity on standard isobaric surfaces.
- First guess for the Global assimilation system – T40L15, for an objective analysis system GRIB 1°x1° NCEP, GRIB 1.25°x1.25° – “thin” UKMO.
- Coverage – the Globe
- 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, level of underlying surface for surface characteristics.
- Initialization – non-adiabatic, on normal modes.

4.2.1.2., 4.3.1.2. Research performed in this field:

- Development of the three-dimensional global multivariate 3D-Var data assimilation scheme working with operational in-situ and microwave satellite data and with high detailization on vertical and with a possibility “to tune” flexibly to any spatial resolution of the first guess fields.

- In the 3D-Var system under development, a multivariate scheme was elaborated. An assimilation technology for ATOVS/AMSU-A data was developed, including a bias correction scheme. A comparison of radio-occultation (GPS/COSMIC) data with short-term numerical forecasts was accomplished as a step towards their assimilation.

4.2.2., 4.3.2. Model

4.2.1.1., 4.3.1.1. In operation

The Global spectral atmosphere model T85L31 is the basic model for the operational issue of forecasts for 1-10 days for the prognostic centers of the Russian Federation (horizontal resolution is approximately 1.4°, 85 spherical harmonics, 31 levels), operational products are available for the Northern and Southern Hemispheres (maximum forecast range is 240 h.).

Regional non-hydrostatic model for the whole region of Europe (area of forecast 137x209 points of equal Cartesian grid (horizontal resolution 75 km) on the chart of stereographic projection, 30 levels, sigma-system coordinates) produces more detailed information on the weather expected, in particular: precipitation and surface characteristics – for large regions with high discreteness of lead time (1 hour). An adaptive version of the regional model of the Hydrometcentre of Russia has been put into operation at RSMC Khabarovsk.

Non-hydrostatic mesoscale 20-level model for the Moscow and Saint-Petersburg regions is used for producing of detailed forecasts of surface fields (surface temperature and wind) with 10 km resolution within the limits of indicated regions (maximum range of forecasts is 36 hours).

Semi-Lagrangian model (joint development of the Hydrometcentre of Russia and the Institute of the Computational Mathematics of Russian Academy of Sciences), horizontal resolution 0.72°x0.9°, 28 vertical levels) operates in the mode of experimental exploitation. It produces a standard set of prognostic products. Detailed verification was fulfilled for the forecasts of the Northern Hemisphere.

4.2.1.2., 4.3.1.2. Research performed in this field:

- Preparation of the research version of the model T339L63. Upgrading of a number of physical parameterizations of the spectral atmosphere model and archival data of high spatial resolution on the state of the underlying surface.
- Upgrading a number of physical parameterizations of the Global atmosphere model SLAV. Impact assessment of these changes on the practical predictability using the results of series of the experiments of the type SMIP-2/HFP.
- The land surface parameterization ISBA (Noilhan, Planton, MWR 1989) and assimilation scheme for soil variables corresponding to this parameterization (Giard, Bazile, MWR 2000) (Bogoslovskii N.N., Tolstykh M.A., 2006) are introduced into the operational version of the model SLAV. To provide its proper functioning, new analyses of temperature and relative humidity at 2m level were needed to implement (Bogoslovskii N.N., Shlyayeva A.V., Tolstykh M.A., 2008). As a result, 2m temperature forecast in the model has been significantly improved.
- The reduced latitude-longitude grid was implemented in the prototype of the SL-AV model based on the shallow-water equations on the sphere. The number of points in longitude at each latitudinal circle in this grid decreases while approaching the pole. It is shown that when choosing the number of points properly, the application of the reduced grid practically does not change the results for the standard test set intended for shallow-water models on the sphere (Williamson et al, J. Comput. Phys. 1992) (Tolstykh, Fadeev, 2008).

4.2.3, 4.3.3. Operationally available Numerical Weather Prediction (NWP) Products

The products of Global model T85L31: The users of the Hydrometcentre of Russia and prognostic centres of Roshydromet and Hydrometcervices of other countries receive via GTS the forecasts for the Northern and Southern Hemispheres with 6-h lead time interval: sea level pressure, surface temperature and air humidity, smoothed temperature of underlying surface, water surface wind, cloudiness total, low level clouds and medium level clouds in octant, 6 h. precipitation totals, geopotential heights of isobaric surfaces, wind velocity, temperature and air humidity on the standard isobaric surfaces. Spatial resolution 1.25x1.25° and 2.5x2.5° (GRIB).

The forecast of rangers 12 – 84 h. are available for 00 UTC, the forecast of rangers 12 – 240 h. are available for 12 UTC. The forecasting digital facsimile charts of the 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 transmitted via GTS.

The products of the global semi-LaGrange model: the forecasters of the Hydrometcentre of Russia through the data base system and the users of Roshydromet by means ftp-technologies

are provided with the forecasts for the Northern Hemisphere with lead time 6 h.: interval sea level pressure, surface temperature and air humidity, smoothed temperature of underlying surface, 6 h. precipitation totals, geopotential heights of isobaric surfaces, wind velocity, temperature and air humidity on the standard isobaric surfaces. Spatial resolution is 1.25x 1.25°. Forecasts for the regions of Russia using the regional model: sea level pressure, 1 and 3 h. precipitation totals, surface wind. Spatial resolution 50 km – users are provided with forecasts in graphical formats, and also 2.5x2.5° (GRIB) – are disseminated via e-mail and ftp technology.

On the basis of the mesoscale model the forecasters of the Hydrometcentre of Russia and the North-Western Territorial Hydrometeorological Service are operationally provided with the surface air temperature forecasts and wind with 1 h. detalization for the Moscow and St.-Petersburg regions. Spatial resolution is 10 km. The information transmission – by means of FTP.

4.2.4. Operational techniques for application of NWP products (MOS, PPM, KF, Expert Sysetms etc.), medium range forecast (72 – 240 h.).

4.2.4.1. In operation

System of statistical interpretation of the results of the medium range hydrodynamic modeling is used (MOS system). An automated system provides once a day the issue of meteorological forecasts of extreme temperature values, semi-diurnal precipitation totals, probability of precipitation occurrence, cloudiness with range of forecast up to 7 days for 5000 towns of the Globe including also the towns of the Russian Federation.

On the basis of MOS system the forecasts of mean air temperature anomalies for the nearest 10 days are daily calculated, which as gif-charts and tables are sent to the territorial Hydrometeorological services of Roshydromet three times a month.

4.2.4.2. Research performed in this field

The issuance of MOS forecasts is performed twice a day.

4.3.4. Operational techniques for application of NWP products MOS, PPM, KF, Expert Sysetms etc.), short range forecasts (0 – 72 h.).

4.3.4.1. In operation

System of statistical interpretation of the results of the medium range hydrodynamic modeling is used (MOS system). An automated system provides once a day the issue of meteorological forecasts of extreme temperature values, semi-diurnal precipitation totals, probability of precipitation occurrence, cloudiness with range of forecast up to 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 1 hour interval and also the daily extreme air temperature values based on the combined system of the interpretation of the Global Numerical Forecasts with the model of detalized boundary layer of the atmosphere. Forecasts are placed on the web-site of the Hydrometcentre of Russia.

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) with maximum range of forecast 36h, characteristics of convective cloudiness (heights of upper and low boundaries), heights and maximum wind

velocities values, heights of dynamic tropopause, and also – complex indices of (frontal parameter) with range of forecast up to 72h.

4.3.4.2. Research performed in this field

The issuance of MOS forecasts is performed twice a day.

4.2.5., 4.3.5. Ensemble Prediction System (EPS) (Number of members, initial state, perturbation method, model(s) and number of models used, perturbation of physics, post-processing: calculation of indices, clustering)

4.2.5.1., 4.3.5.1. In operation

The ensemble forecasting system for short and medium ranges (12 – 240 h.) has been prepared for putting it into the operational mode and is functioning in the daily calculation mode.

System's characteristics:

number of members:12

perturbation method: breeding with global rescaling and the total energy norm

model: Global model T85L31

no perturbation of physics

4.2.5.2., 4.3.5.2. Research performed in this field

Increase of the number of the ensemble members.

Development of post-processing and the forecast verification system.

4.2.5.3., 4.3.5.3 Operationally available NWP products

Spaghetti-charts (on the basis of processing using the systems of automated worksites of the Hydrometcentre of Russia).

4.5. Specialized numerical predictions (on sea waves, sea ice, tropical cyclones, pollution transport and dispersion, solar ultraviolet (UV) radiation, air quality forecasting, smoke, sand and dust etc.)

4.5.2. Specialized models

4.5.2.1. In operation

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 2,5x2,5°.

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 cyclic recurrence 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.

4.6. Extended range forecasts (10 days to 30 days) (Models, Ensemble, Methodology)

4.6.1. In operation

An integrated hydrodynamic 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. There was developed the system of compilation and graphical presentation in the operational mode of monthly forecast with 10-days intervals.

4.6.2. Research performed in this field

Development of the unified technology of the global hydrodynamical-statistical forecast for one month and one season.

4.6.3. Operationally available EPS products

Forecasts of mean monthly temperature fields are regularly placed on the web-site of the Hydrometcentre of Russia <http://www.meteoinfo.ru>.

Forecasts 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 are available for the users at the request.

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.

4.7. Long range forecasts (30 days up to two years) (Models, Ensemble, Methodology)

4.7.1. In operation

The issue of forecast of meteorological conditions for a “rolling season” (three months) with zero lead-time is performed. In contrast to the “monthly forecast” in which statistical interpretation procedures are used, the characteristics in the seasonal forecast are only calculated by the data of hydrodynamic modeling. All anomalies, quantiles and probabilities are calculated in comparison with ensemble model integrations performed on the basis of the NCEP/NCAR reanalysis (for the period 1983-2002). Ordinary statistics (means, variances, extremes, skewness, excess) and probability characteristics (quantiles, bin frequencies, significance levels) are calculated and visualized. The total forecast data set consists of approximately 1000 fields.

4.7.2. Research performed in this field

Conducting numerical experiments on coupling the models of the General circulation of the atmosphere and the ocean.

Updating and expanding physical parameterizations set of forecast models and investigation of its influence on the predictability.

4.7.3. Operationally available products

Results of seasonal forecasts of WMC-Moscow together with the corresponding hindcast verifications for primary calendar seasons are presented at the address: <http://wmc.meteoinfo.ru/season> .

Once a month the results of seasonal forecasts and corresponding hindcast data of WMC Moscow are conveyed to the Asian Pacific Climate Centre (APCC) (Busan, Republic of Korea)

as a contribution to the multi-model ensemble seasonal forecast in the framework of the international APCN (Asia-Pacific Climate Network) project on LRF.

Statistic characteristics of mean monthly and three-month global fields of heights 500 hPa, temperature at level 850, sea level pressure, surface air temperature and precipitation total.

5. Verification of prognostic products

5.1. Annual verification summary

5.1.1. Global spectral model T85L31 of the Hydrometcentre of Russia. The results are shown for the Northern Hemisphere. The forecasts for the Southern Hemisphere are issues in the same mode and are almost of the same quality.

5.1.1.1. Mean sea level pressure

Forecast range (hours)	RMSE (hPa)		KA		S1	
	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC
24	2.2	2.1	0.96	0.96	36	36
48	3.3	3.3	0.92	0.92	46	46
72	4.5	4.5	0.85	0.85	55	55
96		5.7		0.77		64
120		6.8		0.67		71
144		7.8		0.57		76
168		8.7		0.48		81
192		9.3		0.40		84
216		9.9		0.34		86
240		10.4		0.29		87

5.1.1.2. 500 hPa height

Forecast range (hours)	RMSE (m)		KA		S1	
	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC
24	16.9	16.8	0.98	0.98	23	23
48	28.8	28.4	0.95	0.95	33	33
72	41.9	41.6	0.89	0.90	41	41
96		55.0		0.82		49
120		68.3		0.72		55
144		81.0		0.61		61
168		91.6		0.51		66
192		100.5		0.41		69
216		108.5		0.33		72
240		113.9		0.27		73

5.1.1.3. 250 hPa height

Forecast range (hours)	RMSE (m)		KA		S1	
	00 UTC	12 UTC	00 UTC	12 UTC	00 UTC	12 UTC

24	21.5	21.8	0.99	0.99	19	20
48	38.2	38.0	0.95	0.95	28	28
72	56.8	56.1	0.90	0.90	36	36
96		75.3		0.83		44
120		93.8		0.73		50
144		111.2		0.63		56
168		125.9		0.52		60
192		138.7		0.43		63
216		149.4		0.35		66
240		156.9		0.29		67

5.1.1.4. 500 hPa temperature

Forecast range (hours)	RMSE (K)		KA	
	00 UTC	12 UTC	00 UTC	12 UTC
24	1.3	1.2	0.94	0.94
48	1.9	1.9	0.88	0.88
72	2.5	2.5	0.80	0.80
96		3.2		0.71
120		3.8		0.60
144		4.3		0.50
168		4.8		0.41
192		5.2		0.33
216		5.5		0.26
240		5.8		0.22

5.1.1.5. 250 hPa temperature

Forecast Range (hours)	RMSE (K)		KA	
	00 UTC	12 UTC	00 UTC	12 UTC
24	1.4	1.4	0.90	0.90
48	1.9	1.9	0.80	0.81
72	2.4	2.4	0.70	0.71
96		2.8		0.61
120		3.2		0.51
144		3.5		0.44
168		3.8		0.37
192		4.0		0.31
216		4.2		0.27
240		4.4		0.24

5.1.1.6. 500 hPa wind velocity

Forecast range (hours)	MEAN SPEED ERROR (m/s)		RMSEV(m/s)	
	00 UTC	12 UTC	00 UTC	12 UTC
24	-0.7	-0.8	5.4	5.4
48	-0.8	-0.9	7.1	7.2

72	-0.9	-0.9	8.9	8.9
96		-1.0		10.6
120		-1.0		12.2
144		-1.0		13.6
168		-1.0		14.7
192		-1.0		15.6
216		-0.8		16.3
240		0.8		16.9

5.1.1.7. 250 hPa wind

Forecast range (hours)	MEAN SPEED ERROR (m/s)		RMSEV(m/s)	
	00 UTC	12 UTC	00 UTC	12 UTC
24	-1.5	-1.4	7.2	7.2
48	-1.6	-1.6	9.9	9.8
72	-1.6	-1.5	12.5	12.4
96		-1.5		15.0
120		-1.6		17.4
144		-1.6		19.5
168		-1.6		21.2
192		-1.7		22.5
216		-1.7		23.5
240		-1.8		24.5

5.1.2. The Global semi-Lagrangian model of the Hydrometcentre of Russia and the Institute of the Computational Mathematics of the Russian Academy of Sciences for the Northern Hemisphere for the initial time 12 UTC is in the experimental-operational exploitation.

5.1.2.1. Sea Level Pressure

Forecast range (hours)	RMSE (hPa)	S1
	12 UTC	12 UTC
24	2.4	34
48	3.1	42
72	3.9	51
96	4.9	59
120	5.9	66
144	7.0	73
168	7.7	77

5.1.2.2. 500 hPa height

Forecast range (hours)	RMSE (m)	KA	S1
	12 UTC	12 UTC	12 UTC
24	17.6	0.98	21
48	26.4	0.96	29
72	36.7	0.91	37
96	48.7	0.84	45

120	60.7	0.75	52
144	74.8	0.63	59
168	84.2	0.53	64

5.1.2.4. 850 hPa temperature

Forecast range (hours)	RMSE (K)
	12 UTC
24	2.0
48	2.4
72	2.6
96	3.0
120	3.5
144	3.9
168	4.2

5.1.2.7. 250 hPa wind

Forecast range (hours)	RMSEV (m/c)
	12 UTC
24	6.7
48	9.2
72	11.6
96	14.1
120	16.4
144	19.0
168	20.8

Abbreviations:

RMSE – root-mean-square error of forecast;

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

KA – anomaly correlation coefficient;

KT – tendency correlation coefficient;

S1 – skill score of the gradient forecast.

6. Plans for the future (2008 – 2011)

6.1. Development of the GDPFS

6.1.1. Major changes in the operational DPFS which are expected in the next year.

– Putting into operational practice of a new version of the Global Spectral model of the atmosphere in the configuration T169L31.

– Execution of forecast operational testing on the version SLAV-model with variable resolution (30 km over the territory of Russia).

- Formation of the ensemble forecasting system for short and medium ranges on the basis of the Global atmosphere model using “breeding-method”.
- Putting into experimental operational exploitation of the version COSMO model adapted for the European territory of Russia.
- Operational use of standardized verification methods on the basis of the WMO Recommendations (2002) is planned for the long-range forecasting practices including the following skill scores: the mean square skill score (MSSS), the relative operating characteristics (ROC), the reliability diagrams (RD) and the Gerriti skill score (GSS). Additionally several usual statistics are used, such as the anomaly correlation coefficient (ACC), the sign correlation coefficient (SCC) and so on. Several cross-validation procedures for obtaining robust characteristics are planned for use in operational mode.
- Development of the unified technology of the global hydrodynamical-statistical forecast for one month and one season.

6.1.2. Major changes in the operational DPFS which are envisaged within the next 4 years

- Development of the three-dimensional global multivariate 3D-Var data assimilation scheme working with operational in-situ and microwave satellite data and with high detalization on vertical and with a possibility “to tune” flexibly to any spatial resolution of the first guess fields.
- Putting into the operational exploitation of a new version of the Global Spectral model of the atmosphere T339L63.
- Putting into the operational exploitation of the Global Semi-Lagrangian model of the atmosphere with the spatial resolution less than 40 km.
- Improvement of the versions of non-hydrostatic atmosphere model of the Hydrometcentre of Russia with spatial resolution 10 km for the Moscow and St.-Petersburg regions.
- Creation of technological infrastructure (based on the development of web-technologies) for issuing seasonal and inter-annual forecasts for the territory of Russia.

6.2. Planned Research Activities in NWP, Nowcasting and Long-range Forecasting in 2008– 2011

6.2.1. Planned Research Activities in NWP

- Improvement and updating of physical parameterizations of the Global Spectral model of the Hydrometcentre of Russia for new configurations of the atmosphere models.
- Selection of the optimal vertical structure of the Global Spectral model of the Hydrometcentre of Russia for versions T169L63, T339L63 with upper boundary 1 hPa. Experimental exploitation of the "raised" upper boundary.
- Development of the forecast ensemble system at the account of the increase of the number of the ensemble members. Incorporating of the results of other models, realization of the method for ensemble transformations.

– Optimization of parallel computations in the Global spectral model of the Hydrometcentre of Russia (on versions T169(339,679). L31(63). Continuation of work on multiprocessor computers is planned to be performed.

– Work is continued on the development of a new method of approximation of vector and scalar geophysical fields on a sphere by trigonometric polynomials providing uniform converge series at all points of the sphere, including poles using computations of the Fourier integrals over the domain that is the direct product of the entire meridian and latitude rows (Frolov A.V. and Tsvetkov V.I., 2008). The method is to be implemented for carrying out numerical experimentation.

6.2.3. Planned Research Activities in Long-range Forecasting

Coupling the models of the General circulation of the atmosphere and the ocean.

Studying the predictability dependence on the phases of the large-scale variability modes.

Studying the predictability in the cases when different schemes of physical parameterizations are used.

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