**RUSSIAN FEDERATION**

**RUSSIAN FEDERAL SERVICE FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING**

# WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM (GDPFS) FOR 2006

**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 (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 The operational exploitation of a new version of 30L regional atmospheric model in sigma-system coordinates is being continued. The forecast area is covered with 137x209 grid points of lat-lon grid with horizontal resolution of 75 km in polar stereographic projection. The maximum forecast range is 48 hours. The forecasts being issued, besides the standard set of meteorological fields on isobaric surfaces with 6 h interval lead time, include also forecast of precipitation totals and surface wind values with 1 hour lead time.

1.3 An experimental-operational exploitation of semi-Lagrange 28-level prognostic global atmospheric model (SLAV) 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 0.9x0.7° is being continued.

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

1.5 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 spectral model has continued during 2005-2006. Monthly mean fields on isobaric levels 500 and 850 hPa over the Northern hemisphere were also regularly allocated on the web-site http://www.meteoinfo.ru together with a synoptic analysis of possible large-scale processes.

1.6. The release of the operative 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 current month once a week. Monitoring quality of the forecasts for basic variables using WMO recommended criteria is carried out.

1.7. Within the framework of MGO participation in the international project APCN seasonal hydrodynamical forecasts with the model T42L14 were quarterly made and sent to APCC (Seoul, Korea). At the request of the chiefs of the project, in connection with the El-Nino development monitoring, in November there was compiled and sent the additional forecast for January – February – March.

**2. Equipment in use at the center.**

Basic technologies – employment of basic operational technologies on the computing system 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 (averaged number of reports for 24 h.)

| | Moscow |
|---|---|
| SYNOP | 53200 |
| TEMP | 5000 |
| PILOT | 1100 |
| SATEM | 14700 |
| SATOB | 92 300 |
| BUOY | 57500 |
| AMDAR | 50000 |
| AEREP | 1850 |

Products:

ECMWF Reading (GRIB 2.5x2.5°), RSMC Exeter (GRIB 2.5x2.5°, GRIB 150x150 км, digital facsimile), RSMC Offenbach (GRIB 1.5x1.5°, digital facsimile), WMC Washington (GRIB 2.5x2.5°, GRID 5°x5°).

**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 and its displacement in 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.

## 7.1. System-run schedule and forecast ranges.

Basic initial times of the Forecasting system (model T85L31, regional model 75x75 km) are 00 and 12 UTC. Forecasts are issued 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 accessible for the users forecasts 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 6-h. intervals (standard set of fields) and 1-hour interval (precipitation, pressure, wind).

## 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-dimentional 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 modes.

### 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 on the basis of a new 30-level regional model (with 75 km horizontal resolution, maximum forecast range 48 hours) have been fulfilled at the Hydrometcentre of Russia. Forecasts of precipitation are recommended for the use in the operational practice.

Computations in the mode of the experimental exploitation of the semi-Lagrange atmosphere model for the territory of Russia with 30 km resolution of the joint development of the Hydrometcentre of Russia and the Institute for the Computational Mathematics of the Russian Academy of Sciences are being carried out.

Non-hydrostatic mesoscale model of the Hydrometcentre of Russia with 10 km resolution for the St.-Petersburg region (area 300x300 km) has been put into the experimental-operational exploitation. The maximum term of forecast is 36 h.

The experimental exploitation of MM5 model for the European part of Russia is being carried out.

**7.2.3, 7.3.3. Numerical Weather Prediction Products**.

Global forecasts 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 on isobaric surfaces, wind velocity, temperature and air humidity on the standard isobaric surfaces. Spatial resolution 1.25x1.25º and 2.5x2.5º (GRIB).

Forecasts for the regions of Russia using various versions of the regional model: pressure at mean sea level, 1 and 3 h. precipitation totals, surface wind, spatial resolution 75 km – users are provided with forecasts in graphical formats, and also 2.5x2.5º (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 transmitted via GTS.

The users of the Hydrometcentre of Russia on the basis of Regional model are provided with information with 3 hours discrete time about prognostic values of meteofields and with 1 hour discrete time about the precipitation totals expected.

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 and precipitation forecasts with 1 h. detailing for the Moscow and St.-Petersburg regions. Spatial resolution is 10 km.

**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.

On the basis of MOS the forecasts of mean decade air temperature anomalies for the nearest 10 days are calculated 3 times a month, which as charts are sent to the territorial Hydrometeorologival services of Roshydromet.

**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 daily extreme air temperature values. Forecasts are placed on the 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 lead time 36h, 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) with lead time up to 72h.

## 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 2,5x2,5°.

### 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.

## 7.5. Extended Range Forecasts (10-30 days)

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. 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.

From November 2006 the operational forecasting of meteorological conditions for a "rolling season" (three months) with zero lead-time are being issued. The products of the "seasonal" forecast comprise statistics of monthly and three-month global averages for the following parameters: 500 hPa heights (z500), temperature (t850), sea level pressure (slp), surface air temperature (t2m) and accumulated total precipitation. In contrast to the "monthly forecast" exploiting different interpretation procedures, the seasonal forecast scheme utilizes the only GCM products. All anomalies, quantiles and probabilities are calculated with the use of 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 and occupies up to 55 Mb disc memory.

## 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 | 38. | 37. |
| 48 | 3.4 | 3.3 | 0.91 | 0.92 | 47. | 47. |
| 72 | 4.6 | 4.6 | 0.85 | 0.85 | 56. | 56. |
| 96 | | 5.7 | | 0.76 | | 64. |
| 120 | | 7.0 | | 0.65 | | 71. |
| 144 | | 8.0 | | 0.56 | | 77. |
| 168 | | 8.9 | | 0.47 | | 81. |
| 192 | | 9.5 | | 0.39 | | 83. |
| 216 | | 10.2 | | 0.33 | | 86. |
| 240 | | 1.8 | | 0.27 | | 87. |

### 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 | 17.2 | 17.0 | 0.98 | 0.98 | 24. | 24. |
| 48 | 29.7 | 29.7 | 0.95 | 0.95 | 34. | 34. |
| 72 | 42.9 | 42.6 | 0.89 | 0.89 | 42. | 42. |
| 96 | | 56.6 | | 0.81 | | 50. |
| 120 | | 72.5 | | 0.71 | | 56. |
| 144 | | 85.8 | | 0.60 | | 62. |
| 168 | | 96.7 | | 0.51 | | 66. |
| 192 | | 105.4 | | 0.42 | | 72. |
| 216 | | 114.2 | | 0.34 | | 73. |
| 240 | | 120.8 | | 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 | 21.5 | 21.3 | 0.98 | 0.99 | 20. | 20. |
| 48 | 38.4 | 38.1 | 0.95 | 0.96 | 29. | 28. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 72 | 57.0 | 56.7 | 0.90 | 0.90 | 37. | 37. |
| 96 | | 76.2 | | 0.82 | | 44. |
| 120 | | 101.3 | | 0.72 | | 51. |
| 144 | | 120.3 | | 0.61 | | 57. |
| 168 | | 135.9 | | 0.52 | | 60. |
| 192 | | 148.8 | | 0.43 | | 63. |
| 216 | | 161.0 | | 0.35 | | 66. |
| 240 | | 171.7 | | 0.28 | | 68. |

**8.1.4. 500 hPa temperature**

| Forecast range | RMSE (K) | | KA | |
|---|---|---|---|---|
| (hours) | 00 UTC | 12 UTC | 00 UTC | 12 UTC |
| 24 | 1.3 | 1.3 | 0.94 | 0.94 |
| 48 | 1.9 | 1.9 | 0.88 | 0.88 |
| 72 | 2.6 | 2.5 | 0.80 | 0.80 |
| 96 | | 3.2 | | 0.70 |
| 120 | | 3.8 | | 0.59 |
| 144 | | 4.4 | | 0.49 |
| 168 | | 4.8 | | 0.39 |
| 192 | | 5.3 | | 0.32 |
| 216 | | 5.6 | | 0.25 |
| 240 | | 5.9 | | 0.19 |

**8.1.5. 250 hPa temperature**

| Forecast Range | RMSE (K) | | KA | |
|---|---|---|---|---|
| (hours) | 00 UTC | 12 UTC | 00 UTC | 12 UTC |
| 24 | 1.5 | 1.5 | 0.90 | 0.90 |
| 48 | 2.0 | 2.0 | 0.80 | 0.80 |
| 72 | 2.4 | 2.5 | 0.70 | 0.70 |
| 96 | | 2.9 | | 0.59 |
| 120 | | 3.2 | | 0.49 |
| 144 | | 3.6 | | 0.40 |
| 168 | | 3.8 | | 0.33 |
| 192 | | 4.1 | | 0.28 |
| 216 | | 4.3 | | 0.24 |
| 240 | | 4.4 | | 0.21 |

**8.1.6. 500 hPa wind**

| Forecast range | MEAN SPEED ERROR (m/s) | | RMSEV(m/s) | |
|---|---|---|---|---|
| (hours) | 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 |

### 8.1.7 250 hPa wind

| Forecast range | MEAN SPEED ERROR (m/s) | | RMSEV(m/s) | |
|---|---|---|---|---|
| (hours) | 00 UTC | 12 UTC | 00 UTC | 12 UTC |
| 24 | -1.8 | -1.8 | 7.0 | 6.9 |
| 48 | -2.0 | -1.9 | 10.0 | 10.0 |
| 72 | -2.0 | -2.0 | 12.7 | 12.6 |
| 96 | | -2.1 | | 15.2 |
| 120 | | -2.1 | | 17.6 |
| 144 | | -2.2 | | 19.7 |
| 168 | | -2.2 | | 21.3 |
| 192 | | -2.2 | | 22.6 |
| 216 | | -2.0 | | 23.7 |
| 240 | | -2.0 | | 24.6 |

**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 (2007 - 2008)

9.1. Development of the prognostic system within GDPFS

- Preparation for the operational tests and running of new Global Data Assimilation System version with step of horizontal coordinates not more than 150 km.

- Putting of a new version of global spectral model of the atmosphere T169L31 into the operational running.

- Putting into the operational use of the Global semi-Lagrange model of the atmosphere of the Hydrometcentre of Russia and the Institute for Computational Mathematics of the Russian Academy of Sciences with spatial resolution of 0.9x0.7° (SLAV-model).

- Forecast operational testing of the version of SLAV-model with variable resolution (30 km for the entire territory of Russia).

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

- To adjust and to start testing in the real time the three-dimensional multi-element global 3D-Var analysis scheme.

- Putting into the experimental-operational exploitation of the COSMO model adapted for the European part of Russia;

- Improvement of the version of non-hydrostatic atmosphere model of the Hydrometcentre of Russia with spatial resolution 10 km for 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.

## 9.2. Research Activities in NWP

- The work is being continued on the optimization of parallel computations in the Global spectral model of the Hydrometcentre of Russia (on versions T169L31, T339L31, T679L31). Continuation of work on multiprocessor computers are planned to be performed (Astakhova, Alferov, 2006)

- Work is being continued on the development of 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.

- Research version of the ensemble forecasting system for short and medium ranges on the basis of T85L31 model has been created. The verification system of the ensemble forecasts results has been improved (Astakhova, 2006, Bundel, 2006).

- Development of a new three-dimensional 3D-Var data assimilation system is continued. A new three-dimensional spatial covariance model for the first guess fields in the analysis was proposed. The model is based on spatial digital filters. The distinctive feature of the model is its capability of modeling spatially-variable three-dimensional structure of meteorological flow-depending fields on the local structure of the atmosphere and also applicability for the analysis both in global and limited area both in spherical and Cartesian geometry.(Tsyroulnikov, 2006)

- Three-dimensional one-element linear version of a new analysis scheme is realized (Tsyrulnikov and Svirenko, 2006). Creation of three-dimensional multi-element system for the global analysis of the type 3D-Var-PSAS is planned.

- Development of the three-dimensional version of non-hydrostatic dynamical block for global model SLAV is planned.

- Operational use of standardized verification methods on the basis 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.

10. References


1. Astakhova, E.D., and Alferov Yu. V. Tsvetkov V.I. Organization of Task of Numerical Medium-Range Weather Forecasting on the multi-processor systems in: Proc. of the Intern. Conf. "Scientific service in INTERNET", Novorossiisk, Sept. 18-23, 2006. – Izd-vo Mosk. Univ., 2006 (in Russian)

2. Astakhova, E.D. Initial fields ensemble construction for the short- and medium- range ensemble weather forecasting systems. – Proceedings, Hydrometcnter of Russia, 2007, No 342 (in Russian)

3. Elena D. Astakhova and Yuri V. Alferov. Parallel version of the spectral model of the Hydrometcenter of Russia – Res. Activityes, , ed.J.Cote Section 3. Computational studies including new techniques, the effect of varying model resolution, parallel processing - rep. No 36, WMO/TD – No 1347. Apr.2006 p.3-01

4. Bogoslovskii N.N., Tolstykh M.A., Implementation of a data assimilation scheme for soil variables in a global semi-Lagrangian weather prediction model. Computational technologies, 2006, V.11, special issue ENVIROMIS-2006, part 2 (accepted). (in Russian)

5. Boundel A.Y. Quality assessment of the medium- range forecasts precipitation based on the ensemble forecasting system using the spectral model of the Hydrometcenter of Russia. – Proceedings, Hydrometcenter of Russia, 2007, No 342 (in Russian)

6. Fadeev R.Yu., Construction of a reduced latitude-longitude grid for a global numerical weather prediction problem. Russian Meteorology and Hydrology, 2006, N 9, p. 5-20. (in Russian)

7. Frolov, A.V. and Tsvetkov, V.I. Uniform Approximation of Geophysical Fields on a Sphere by Trigonometric Polynomials. Doklady of Russian Academy of Sciences, Mathematics, 2006 (in press). (in Russian)

8. Muraviev A.V., Kruglova E.N., Kulikova *I.A.* Distribution of extreme atmospheric circulation characteristics based on observations and hydrodynamically modeled data - Abstracts of the International Conference on the Problems of Hydrometeorological Security, Moscow, Sept 26-29, 2006, p. 51. (in Russian)

9. Rozinkina I., Astakhova E., Alferov Y., Tsvetkov V., Ponomareva T. Prediction of fast weather changes of the global spectral model of Hydrometeorological center of Russia using new computer technique data // Abstracts of the International Conference on the Problems of Hydrometeorological Security, Moscow, Sept 26-29, 2006(in Russian)

10. M.A.Tolstykh, R.Yu Fadeev, Semi-Lagrangian weather prediction model and its further development. Computational technologies, 2006, V.11, special issue ENVIROMIS-2006, part 1, p. 176-185. (in Russian)

11. Tsyrulnikov M. D. Stochastic modelling of model errors: a simulation study. - Quart. Journal of the Royal Meteorological Society, 2005, v. 131, 3345-337

12. Tsyrulnikov M. D. Stochastic modelling of model errors for data assimilation and ensemble forecasting: a simulation study. - Proc. of the 4th WMOInternational Symp. on Assimilation of Observations in Meteorology and Oceanography, April 18-22, 2005, Prague, Czech Republic, WMO report WWRP-N9, WMO/TD N 1316, 2006.

13. Tsyrulnikov M.D., Svirenko P.I. and Zaripov R.B. Development of a 3-D spatial ARMA-filters based analysis scheme. - Research Activities in Atmospheric and Oceanic Modelling, WMO, 2006, Rep. N 36, pp. 1.39.-1.40.

14. M.Tsyrulnikov and P.Svirenko. A new flexible and parsimonious 3-D physical-space covariance model for variational assimilation. - Proc. of 2nd THORPEX Int. Sci. Symp., 4-9 Dec. 2006, Landshut, Germany, WMO/TD No. 1355 WWRP/THORPEX No. 7, WMO, 2006, pp. 142-143.

## Country: Russian Federation Centre: RSMC Khabarovsk

### 1. Summary of highlights

1.1 Operational exploitation of the regional atmospheric model with 75 km resolution (joint development with Hydrometcentre of Russia) adapted to the Far Eastern region in continued.

1.2 A new version of the regional model of the atmosphere (50 km resolution) for the Far Eastern region (developed at the Hydrometcentre of Russia) is prepared for putting into the operational practice.

1.3 A system for forecasts of the precipitation totals in the points of the Far Eastern regions based on the interpretation of the atmosphere regional model results is prepared for putting into operational practice.

### 2. Equipment in use

Basic operative technologies remain unchanged since 2005. The approbation and the assumed implementation of new developments (of a new version of the atmosphere regional model and the respective prognostic systems) are performed on the XEON-2 platform.

### 3. Data and products from GTS in use.

Observation information (number of reports for 24 h.)

| Code | Number |
|---|---|
| SYNOP | 5100 |
| TEMP | 1920 |
| PILOT | 0 |
| SATEM | 5400 |

Products of:
ECMWF, Reading (GRIB 2.5x2.5°, digital faximile), Exeter (GRIB 2.5x2.5°), Washington (GRID 5°x5°), Tokyo (digital faximile).

### 4. Data input system.

Automatic.

### 5. Quality control system.

Without changes.

### 6. Monitoring of the observing system

Is not performed.

### 7. Forecasting System

Prognostic system consists of the following blocks:
A – initial control, information displacement, regional objective analysis

B – regional model of the atmosphere
C – system for interpretation of hydrodynamic forecasts.

## 7.1. System-run schedule and forecast ranges.

Basic initial times of the Forecasting system are 00 and 12 UTC. The maximum term of forecast is 48 h (Regional model output products, technology "Region – Far East") and 120 h (statistical interpretation system products).

## 7.2. System for medium-range forecasting

A system of statistical interpretation of the modeling results with lead time 120 h is in the operational practice.

## 7.2.3. Numerical Weather Prediction Products (medium ranges)

Forecasts of semi-diurnal precipitation totals and of elements of surface weather for 48 points of the Far-Eastern region with the lead time up to 120 h on the basis of the statistical interpretation system (MOS).

The initial time is 00 UTC.

## 7.3. System for the short-range forecasting

An integrated automated technology "Region – Far East" is in operational practice, enabling to calculate analyses and forecasts with the lead time up to 48 h (namely, the fields of the geopotential heights, of horizontal components of the wind velocity, temperature and humidity on standard isobaric surfaces, mean sea surface pressure, precipitation; semi-diurnal precipitation totals for 170 points of the Russian Far-Eastern region.

The calculations are performed twice a day; for pressure and precipitation fields the lead time is 1 h; for remaining meteorological values – 3 h

The products are disseminated among the prognostic centers of the Far-Eastern region by e-mail and as charts-slides.

## 7.3.1. Data assimilation, objective analysis and initialization

Objective analysis for the Far-Eastern region using RSMC Exeter`s forecasts as the first guess fields

## 7.3.2 Model

The Regional atmosphere model (joint development of the Hydrometcentre of Russia and RSMC Khabarovsk) adapted to the Far-Eastern region.
Operational tests of the forecasts with a new version of the regional atmosphere model (50 km resolution) have been implemented.

## 7.3.3 Numerical Weather Prediction Products

Forecasts of fields with lead time of 48 hour based on regional model:

- geopotential heights, horizontal components of wind velocity;
  temperature and humidity on standard isobaric surfaces,
  mean sea level pressure, precipitation.

Levels: 100,150,200,250,300,400,500,700,850,925,1000 hPa.

- semi-diurnal precipitation totals for 170 points of the Far Eastern region of Russia.

Forecasts of fields 1 h precipitation totals, wind surface and wind water surface values, mean sea level pressure are produced with lead time 1 and 3 hours. Forecasts are put to the data bases and are sent to the users in the form of sequential images.

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

The system of statistical interpretation of the results of medium range hydrodinamic modeling (MOS) for 48 points of the Far Eastern region provides forecast values of extreme temperature, semi-diurnal precipitation totals with lead time up to 5 days.

**7.3.4 Operational technologies for application NWP products. Short range forecasts**

The system of statistical interpretation of the results of medium range of hydrodinamic modeling (MOS) for 48 points of the Far Eastern region provides forecast values of extreme temperature, semi-diurnal precipitation totals with lead time up to 5 days.
A new system for forecasting precipitation totals in the points of the Far Eastern region on the basis of the regional atmosphere model interpretation results has been prepared for the introduction in the operational exploitation.

**7.4 Specialized numerical forecasts**

These are not issued

**7.5 Extended Range Forecasts (10-30 days)**

Forecasts with 1-month lead time for the Far-Eastern region are developed jointly with the Hydrometcentre of Russia.

**8. Verification of prognostic products**

**8.1.1 500-h Pa height**

| Forecast Ranges | RMSE (m) | KT | S1 |
|---|---|---|---|
| 12 | 15 | 0.91 | 23 |
| 24 | 21 | 0.93 | 29 |
| 36 | 27 | 0.92 | 35 |
| 48 | 24 | 0.84 | 34 |

**8.1.2 250 hPa height**

| Forecast Ranges | RMSE (m) | KT | S1 |
|---|---|---|---|
| 12 | 19 | 0.93 | 18 |
| 24 | 28 | 0.93 | 23 |

| | | | |
|---|---|---|---|
| 36 | 38 | 0.92 | 29 |
| 48 | 44 | 0.88 | 28 |

Abbreviations:
RMSE – root – mean - square error of forecast;
RMSEV – root mean – square error of wind vector velocity;
KA – anomaly correlation coefficient;
KT – tendency correlation coefficient;
S1 – skill score of the gradient forecast.

## 9. Plans for the future (2007 – 2008)

### 9.1 Development of Prognostic system within GDPSF

- Putting into the operational mode a new regional atmosphere model version for the Far Eastern region with 50 km resolution (Hydrometcentre of Russia model);
- Putting into the operational mode of the system for the forecasting precipitation totals in the points of the Far Eastern region on the basis of the regional atmosphere model interpretation results;
- Introduction of a new objective analysis version for the Northern Hemisphere.

### 9.2 Research activities in NWP

Work on the improvement of the method for 12 h. precipitation totals forecast within the MOS systems for the points of the Far Eastern region is being continued.

## 10. References

Е.М.Вербицкая, В.М.Лосев. Региональная гидродинамическая модель прогноза полей метеоэлементов для территории Восточной Сибири и Дальнего Востока. Труды ДВНИГМИ, выпуск 151, стр. 3 – 42. (E.M.Verbitskaya, V.M. Losev. Regional hydrodinamical model for meteoelements fields forecast over the territory of the Eastern Siberia and Far East. DVNIGMI Proceedings, issue 151, pp. 3 – 42.)

**Country: Russian Federation** **Centre: RSMC Novosibirsk**

## 1. Summary of highlights

1.1 An operational exploitation of the regional atmosphere model for the Western Siberia region (developed by the Siberian Scientific and Research Hydrometeorological Institute) is continued (SSRHMI).
1.2 Reception of the forecasts (in graphical format) using a new version of the regional atmosphere model (50 km resolution developed by the Hydrometcentre of Russia) adapted to the Western and Central Siberian region has started. The work on assessment of precipitation forecasts quality using the giving technology has begun.
1.3 There have been carried out the operational tests and put into the operational exploitation the technology for the forecast of the semi-diurnal winter precipitation with lead time up to 5 days for the administrative regions of the Novosibirsk district based on the MOS method developed in the WSSRI (West Siberian Scientific and Research Institute).

## 2. Equipment in use

Basic operative technologies remain unchanged since 2005. The approbation and the assumed implementation of new developments (of a new version of the atmosphere regional model and the respective prognostic systems) are performed on the XEON-2 platform.

## 3. Data and products from GTS in use.

Observation information (number of reports for 24 h.)

| Code | Number |
|---|---|
| SYNOP | 5100 |
| TEMP | 1920 |
| PILOT | 0 |
| SATEM | 5400 |

Products of:
ECMWF, Reading (GRIB 2.5x2.5°, digital faximile), Exeter (GRIB 2.5x2.5°), Washington (GRID 5°x5°), Tokyo (digital faximile).

## 4. Data input system.

Automatic.

## 5. Quality control system.

Without changes.

## 6. Monitoring of the observing system

Is not performed.

## 7. Forecasting System

Prognostic system consists of the following blocks:
A – initial control, information displacement, regional objective analysis

B – regional model of the atmosphere
C – system for interpretation of hydrodynamic forecasts.

## 7.1. System-run schedule and forecast ranges.

Basic initial times of the Forecasting system are 00 and 12 UTC. The maximum term of forecast is 48 h (Regional model output products) and 120 h (statistical interpretation system products (MOS)).

## 7.2. System for medium-range forecasting

A system of statistical interpretation of the modeling results with lead time 120 h is in the operational practice.

### 7.2.3. Numerical Weather Prediction Products (medium range forecasting)

Forecasts of semi-diurnal precipitation totals and of elements of surface weather for 48 points of the Far-Eastern region with the lead time up to 120 h on the basis of the statistical interpretation system (MOS).

The initial time is 00 UTC.

## 7.3 System for the short-range forecasting

### 7.3.1 Data assimilation, objective analysis and initialization

Objective analysis for the Northern hemisphere using RSMC Exeter`s forecast as the first guess fields.
Data assimilation system using 6 h forecasts on hemispheric version of the spectral atmosphere model (RHMC) as the first guess fields.

### 7.3.2 Model

Regional atmosphere model (Sib-SRHMI) for the region of the Western and Central Siberia. Testing of precipitation quality forecasts using the Hydrometcentre of Russia regional atmosphere model is continued.

### 7.3.3 Numerical Weather Prediction Products

Field Forecasts with lead time up to 48 hours based on the regional model:
Geopotential heights, horizontal components of wind velocity, temperature and humidity on standard isobaric surfaces, mean sea level pressure, precipitation.
Levels: 100,150,200,250,300,400,500,700,850,925,1000 hPa.

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

The system of statistical interpretation of the results of medium range hydrodinamic modeling (MOS) for points of the Western and Central Siberia region.

## 7.4 Specialized numerical forecasts

Not issued.

## 7.5 Extended Rang Forecasts (10-30 days)

Forecasts with 1-month lead time for the Western and Central Siberia region are developed jointly with Hydrometcentre of Russia.

## 8. Verification of prognostic products

### 8.1.1 500 hPa height

| Forecast range | RMSE (m) |
|---|---|
| 24 | 22 |
| 36 | 28 |
| 48 | 36 |
| 60 | 44 |

Abbreviation:
RMSE – root-mean-square error of forecast

## 9. Plans for the future (2007-2008)

### 9.1 Development of prognostic system

Tests in the operational mode of the technology of frosts forecasting up to 5 days for administrative regions of Novosibirsk district based on the MOS approaches (Zdereva M.Ya.).

### 9.2 Research activities in NWP

- Completion and processing of the results of the operational tests of the long-range forecasting method for air temperature anomaly in the South-East of the Western Siberia in the cold season based on the expanded solar-terrestrial physics data base and the atmosphere characteristics archives (Zavalishing N.N.).
- Development of a new version of the regional model for the Siberian region with lead time 72 hours.
- Realization and assessment of forecast quality using semi-Lagrangian regional atmosphere model (of the Hydrometcentre of Russia and the Institute of the Computational Mathematics of the Russian Academy of Science) combined with the Data assimilation system (development of the Hydrometcentre of Russia).
- Continuation of the operational tests of the model for the state of plantings (sowings) and field forecasting on the base of USA EPIC model interpretation (Evtyushkin A.B. and al., Ugorsky Scientific and Research Institute for Information Technologies (town of Khanty-Mansijsk).