JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2006

SLOVAKIA / Slovak Hydrometeorological Institute(SHMU)

1. Summary of highlights

The limited area NWP system ALADIN is operated at the Slovak Hydrometeorological Institute (full operational status declared on 01/07/2004). In 2006, the model integration was prolonged up to +72h.

2. Equipment in use

The computer facilities include the IBM @server pSeries 690, 32 CPUs POWER 4+ 1.7GHz, 32 GB RAM Memory with IBM FAST T600 Storage Server EXP700 1.5TB. For archiving, the IBM Total Storage 3584 with 24TB Tape Library and IBM Tivoli Storage Manager are used.

Database server IBM p570
Server 1:9117 Model 570, 2x 73.4 GB 10,000 RPM Ultra320 SCSI Disk Drive Assembly, 4x 2048MB (4x512MB) DIMMs, 208-pin, 8NS DDR SDRAM, 2x Processor, 0/2 Way 1.65 GHz with DDR1 memory, OS: AIX, DB Oracle

Application server IBM x460
x460, Xeon MP, 2x3.3GHz/667MHz, 1MB/8MB L2/L3, O/Bay SAS, 2x1300W p/s, 2x xSeries 3.33GHz 667MHz 1MB L2 8MB L3 Upgrade with Xeon Processor MP, 4x 73.4 GB 10K 2.5-inch SAS HDD, 4x 2 x 2GB PC2-3200 ECC DDR2 SDRAM RDIMM Kit, OS: Win 2003 ESX

Telecommunication computer
Stratus Continuum C 439 (Fault-tolerant system on hardware level), processor HP PA-RISC 8600, 480 MHz, 1.5 Cache, 2 GB operational memory, OS: HP-UX 11.0 with SVR4, POSIX, SVID, X11. Message Switching System - MSS I I - Moving Weather

3. Data and Products from GTS in use

- SYNOP – 4431
- SHIP – 817
- TEMP – 552
- TEMP SHIP – 10
- PILOT – 28
- GRIB -1712
- GRID – 535
- T4 – 75
- BUFR - 4546

We use RETIM2000 and EUMETCAST systems for receiving data as well.

4. Forecasting system

4.1 System run schedule and forecast ranges

The ALADIN/SHMU model is operationally run at SHMU 4 times a day. The operational suite is based on the in-house developed system of perl scripts and programs, and it enables on-line monitoring and documentation via the web interface. Majority of the subsequent applications is embedded into this system. The schedule of the operational suite is summarized in the following table.

start time (UTC)	*lead time*	*forecast range*
02:50	00 UTC	+72h
09:35	06 UTC	+72h
14:20	12 UTC	+72h
21:35	18 UTC	+60h

4.2 Medium range forecasting system (4-10 days)

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

There is no medium range forecast system run at SHMU. The products of DWD, Meteo-France and NCEP are used by forecasters, accessible from internet, retim2000 or eumetcast.

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

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

ALADIN/SHMU model runs in the so-called dynamical adaptation mode, i.e. the initial conditions are obtained by interpolation of the ARPEGE global model analysis into the target ALADIN/SHMU grid. The digital filter initialization is applied prior to model integration.

4.3.1.2 Research performed in this field

Pseudo-assimilation cycle using spectral blending by digital filter technique was tested and is ready for operational implementation. This semi-empirical technique enables obtaining a more realistic initial state including also small-scale features for the integration of the high-resolution limited area model by combination of large scale analysis with LAM guess.

4.3.2 Model

4.3.2.1 In operation

ALADIN model is based on the global ARPEGE/IFS system (sharing the source code). Shortly, it is hydrostatic, spectrally formulated primitive equations model, with surface pressure, temperature, wind, specific humidity independent variables (non-hydrostatic version exists as well). Two time level semi-implicit semi-lagrangian scheme is used, with 400 seconds time step. ALADIN/SHMU is applied over the limited area domain of 2882x2594km, having 320x288 points (including extension zone 11 points wide) in quadratic grid, with 106x95 spectral truncations. The horizontal resolution is 9km, in vertical there are 37 irregularly distributed levels. ALADIN model physics is similar to ARPEGE one. The lateral boundary conditions are obtained by the interpolations of the global model ARPEGE forecasts.

4.3.2.2 Research performed in this field

All research and development is carried out within ARPEGE/ALADIN and ALADIN/LACE scientific plans and common cooperation.

4.3.3 Operationally available NWP products

Except the standard meteorological fields some specialized outputs are produced for:

- hydrological models (precipitation forecasts for river catchments - QPF)
- RODOS model (the Real-time On-line Decision Support system for off-site emergency management in Europe) operated by the Nuclear Regulatory Authority

- CALLPUFF non-steady-state meteorological and air quality modeling system can be fed with ALADIN/SHMU data
- ozone modeling

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

The NWP products are mainly directly visualized. For some products, the correction of 2m temperature on the orography height is applied. The Kalman filter is used to process the screen level parameters for specific application.

Simple interpolation tool and sophisticated algorithm is used to derive automatic text forecasts for the set of predefined points.

4.3.5 Ensemble Prediction System

4.3.5.1 In operation

Only simple lagged ensemble system, consisting of 5 subsequent model integrations, is used - covering the 48 hours overlapping period. Ensemble spread and mean is visualized in epsgrams for different points.

4.3.5.3 Operationally available EPS Products

Operationally are availaible outputs from PEPS project ("Poor man's" Ensemble Prediction System), run at DWD. The following products are available to forecasters:

Products from the SRNWP-PEPS

1. Ensemble mean. Forecast periods +06...+30h (24 hours), +06...+18h and +18...+30h (12 hours)
    - Total precipitation (accumulation), sum of convective and large scale precipitation
    - Total snow (accumulation)), sum of convective and large scale snow
    - Maximum 10 m wind speed
    - Maximum 10 m wind gust speed
    - 2 m minimum/maximum temperature

2. Probabilistic products. Forecast period +06...+30h (24 hours)
    - Probabilities of total precipitation Thresholds: > 20, > 50, > 100 mm
    - Probabilities of total snow Thresholds: > 1, > 5, > 10, > 20 cm
    - Probabilities of maximum wind speed Thresholds: > 10, > 15, > 20, > 25 m/s
    - Probabilities of maximum wind gust speed Thresholds: > 10, > 15, > 20, > 25, > 33 m/s

3. Probabilistic products. Forecast periods +06...+18h and +18...+30h (12 hours)
    - Probabilities of total precipitation Thresholds: > 25, > 40, > 70 mm
    - Probabilities of total snow Thresholds: > 1, > 5, > 10, > 20 cm
    - Probabilities of maximum wind speed Thresholds: > 10, > 15, > 20, > 25 m/s
    - Probabilities of maximum wind gust speed Thresholds: > 10, > 15, > 20, > 25, > 33 m/s

4. Ensemble size per grid point (at least three members)

4.4 Nowcasting and Very Short-range Forecasting Systems (0-6 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

INCA system, developed at ZAMG Vienna, has been partially operationally implemented during 2006. The hourly analysis of temperature, wind, humidity and convective indices is performed. The

analysis of precipitation fields based on radar precipitation estimates and raingauge measurements is run every 15 minutes.

4.4.1.2 Research performed in this field
There is ongoing cooperation with Comenius University Bratislava about the local implementation of precipitation nowcasting module of INCA system. The tuning of system and its adjustment to local measurements is in process.

4.5 Specialized numerical predictions

4.5.3 Specific products operationally available

Dynamically adapted 10m wind field at 2 km resolution, prognostic TEMP profiles with additional parameters diagnosed (Brunt-Vaisala frequency, Scorer parameter, Richardson number, icing index), stability indexes and special fields (CAPE, K, KO, adedokun and Faust index, q-vector, horizontal temperature gradient).

4.6 Extended range forecasts (ERF) *(10 days to 30 days)*

4.6.1 Models

4.6.1.1 In operation
There is no extended range forecast system run at SHMU.

4.7 Long range forecasts (LRF) *(30 days up to two years)*

4.7.1 In operation
There is no long range forecast system run at SHMU.

5. Verification of prognostic products

The outputs from ALADIN/SHMU are regularly verified against SYNOP stations (point-to-point). These results are available on intranet. Data are also dispatched to be processed in the frame of the common ALADIN verification project.
The precipitations are verified against the observation from rain gauge network on irregular basis (this is due to irregular ingesting of data into regime database at Institute).

5.2 Research performed in this field
Development of precipitation verification procedure based on comparison of average areal precipitation of river catchments. The observed precipitation are interpolated into model grid taking into account the local vertical gradient computed using linear regression method.

6. Plans for the future *(next 4 years)*

6.1 Development of the GDPFS

6.1.1

Operational blending cycle, switch to ALARO-0 package of physical parameterizations (semi-Lagrangian horizontal diffusion, pseudo-prognostic TKE, prognostic hydrometeors with cycling, scale invariant convection parameterization unified with cloud microphysics, improved radiative transfer), removal of envelope orography.

6.1.2

Increase of horizontal resolution to ~5km (entering the “grey zone” of convection), increase in number of vertical levels, possible switch to NH dynamics. Handling of non-conventional

observations (decoding, quality control, archiving, bias removal), preparation for mesoscale data assimilation (first surface OI, later 3D var). Statistical adaptation of raw model outputs, generation of hourly high resolution analyses based on INCA system, exchange of local data with neighbouring countries. Development of specialized products (severe weather, turbulence, icing) using both deterministic and probabilistic approaches.

6.2 Planned research Activities in NWP, Nowcasting and Long-range Forecasting

SHMU will further participate in the R&D work on ALADIN (and ALARO and AROME) NWP system(s) and INCA nowcasting system.