JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2017

SLOVAKIA, Slovak Hydrometeorological Institute (SHMU)

1. Summary of highlights

Slovak Hydrometeorological Institute (SHMU) operationally exploits the ALADIN numerical weather prediction system. New upgraded version of ALADIN/SHMU with increased horizontal and vertical resolution and enhanced physical parametrisations has been declared operational in March 2017.

2. Equipment in use

operational HPC	IBM Flex System p460, 12 nodes of 4x Power7+ 8core CPUs (3.6GHz), 256 GB RAM, Red Hat Enterprise Linux
old HPC	10 nodes of IBM p755 with 4x 8-core 3.3 GHz POWER7, 256 GB RAM per node Managment servers: 2x IBM Power750: 1x Power7 6core CPU (3.6GHz), 64 GB RAM
Archiving	IBM Tivolli Storage 3310 (120 date tapes LTO5 1.5TB)
Data processing	HP Integrity RX6600; linux PC
EUMETCAST receiving system	AYECKA receiver (3 x), 1.8 m antenna, linux PC for data processing
Visualization	Fault-tolerant Cluster 2xHP Proliant DL 160G6 for IBL Software product VisualWeather
Telecommunication	Lenovo system x3550 M5 (Fault-tolerant cluster)
Polar satellite receiver	MEOS by Konsberg, 3.8m antenna
Radar data	Network of 4 dualpolarisation radars, SELEX METEOR 735 CDP, full volume scan @ 5 min.

3. Data and Products from GTS in use

SYNOP (SM, SI, SN)	SYNBUFR (ISM, ISI, ISM)	METAR (SA)	GRIB (H)	RADAR (PA)	TEMP (US, UK, UL, UE, UX)	TEMPBUFR (IUK, IUS)	AMDAR (IUAD, UD)	WINDPROFILER (IUPD)
4824	5784	2148	180	192	2148	216	60	48

Internet, RMDCN and EUMETCAST systems are used for data reception as well (gribs, satellite products).

4. Forecasting system

4.1 System run schedule and forecast ranges

The limited area NWP model ALADIN (ALADIN/SHMU) is operationally run at SHMU 4 times/day. The schedule of the operational suite is summarized in the table below:

start time (UTC)	***lead time***	***forecast range***
02:55	00 UTC	+78h
09:45	06 UTC	+72h
14:35	12 UTC	+72h
21:45	18 UTC	+60h

INCA2 nowcasting system runs hourly 15min after the lead time.

4.2 Medium range forecasting system (4-10 days)

The products provided by ECMWF from their medium range global model (both deterministic and EPS forecasts) are used.

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

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

The so-called blending by digital filter technique is used for upper air variables to mix the high-resolution first guess field of local model with the 4DVAR analysis of the driving model ARPEGE. For surface, the optimal interpolation of screen level parameters from SYNOP measurements is used to update the increments of soil variables. The sea surface temperature field is copied from the global model ARPEGE. Analyses are running in full horizontal and vertical resolutions. For both methods a 6h assimilation interval is applied. No initialisation is used.

4.3.1.2 Research performed in this field

All research and development is carried out within ALADIN/ALARO/AROME/HARMONIE and ALADIN/LACE scientific plans. Our focus is on assimilation of high resolution data, namely radar measurements and GNSS ZTD data, and surface data assimilation (so-called SURFEX scheme).

4.3.2 Model

4.3.2.1 In operation

Operational ALADIN/SHMU system is based on Termonia et al (2018), the high resolution limited area NWP system jointly developed within 16 N(H)MS of the ALADIN Consortium. Recent upgrade put into operations is described in Derkova et al (2017). Main ALADIN/SHMU system characteristics are summarized in the table below.

ALADIN	**operational**
model code version	CY40T1_bf05_export
horizontal resolution	4.5km
domain size	2882x2594km
number of grid points	625 x 576
spectral resolution	312x287 (linear grid)
orography	mean orography
number of levels	63
time-step	180s
model dynamics	hydrostatic primitive equations, 2TLSL
horizontal diffusion	so-called SLHD (local semiLagrangian HD)
coupling model	ARPEGE (long- & short cut off), 3h
assimilation	upper air spectral blending with CANARI surface assimilation
initialization	none
forecast ranges	78/72/72/60 (a' 1h)
physics	ALARO-1vB
independent variables	spectral T, q, (vorticity, divergence) -> (U, V), Ps

4.3.2.2 Research performed in this field

All research and development is carried out within ALADIN/ALARO/AROME/HARMONIE and ALADIN/LACE scientific plans. Our focus is on research on the non-hydrostatic dynamics (Vivoda et al, 2018) and physical parametrisations.

4.3.3 Operationally available NWP products

The model parameters (temperature, wind, relative humidity, screen level parameters, other derived and/or diagnostics parameters…) are available on model grid or in lat/lon, on model levels, standard pressure or

height levels with hourly output frequency. Various specialized products are produced for downstream applications and internal and external end users.

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

The NWP products are mainly directly visualized or delivered to customers. 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. The area averaged data over river basins are prepared for new hydrological applications within the Flood warning system POVAPSYS

4.3.5 Ensemble Prediction System

4.3.5.1 In operation

The ECMWF EPS data and ALADIN-LAEF system (that runs at ECMWF) data are operationally used.

4.3.5.2 Research performed in this field

All research and development is carried out within ALADIN/LACE scientific plans (Wang et al, 2018). Our focus is on physical perturbations of surface parameters, perturbation of initial conditions of the LAEF system and cycling methods in general including 3DVAR.

4.4 Nowcasting and Very Short-range Forecasting Systems (0-12 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

The INCA2 nowcasting system is operationally applied at SHMU, with hourly runs up to 12h. Temperature, dew point temperature, wind filed and wind gust, specific humidity, snow line, zero isotherm are computed using 2mT, 2mRH, 10m wind observations. Also, computation of parameters based on NWCSAF - cloud type, cloud top height, precipitation probabilities - is implemented. The precipitation analyses based on combination of radar measurements and rain gauge measurements are performed every 5 min. Outputs are available on SHMU web pages and in the HYPOS flood warning system.

4.4.1.2 Research performed in this field

The research is focused on the quality control of radar data.

4.4.2 Models for Very Short-range Forecasting Systems

none

4.5 Specialized numerical predictions

Set of specialized outputs are routinely produced for:
- hydrological models (precipitation forecasts for river catchments - QPF). Data from all kinds of NWP systems are provided for the HYPOS (Hydrological Flood Forecasting System), namely deterministic and probabilistic ALADIN and ECMWF forecasts and INCA nowcasts.
- 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 modelling system can be fed with ALADIN/SHMU data
- NWCSAF (nowcasting SAF)
- INCA2 nowcasting system
- METRO model for road conditions prediction

4.5.2 Specific Models (as appropriate related to 4.5)

4.5.2.1 In operation

The Canadian road forecast system METRo (Model of the Environment and Temperature of Roads) is running operationally at SHMU. The input parameters are data from RWIS (road weather information system); and screen level temperature and wind speed, precipitation, surface pressure and downward solar and infrared fluxes from ALADIN model. The INCA2 data can be used as well.

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

none

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

none

5. Verification of prognostic products

The outputs from ALADIN/SHMU are regularly verified against SYNOP stations as well as the radio-sounding measurements (point-to-point) in the Central Europe area. Standard scores (BIAS, RMSE, STD) for G, T, WS, WD, RH as well as for screen level parameters are computed. The results are available on intranet. Data are also dispatched to be processed in the frame of the common ALADIN verification project. Local long-term verifications scores (NWP index) are computed for internal purposes.

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

6.1 Development of the GDPFS

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

Exploitation of the 3DVAR data assimilation in the ALADIN/SHMU system using high resolution observations.

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

Test of the convection permitting model.

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

6.2.1 Planned Research Activities in NWP

SHMU will further participate in the R&D work on ALADIN/ALARO/AROME NWP systems.

6.2.2 Planned Research Activities in Nowcasting

SHMU will focus on research in the probabilistic precipitation nowcasting.

6.2.3 Planned Research Activities in Long-range Forecasting

none

6.2.4 Planned Research Activities in Specialized Numerical Predictions

The implementation of the SURFEX parameters as the input to the road weather expert system will be studied. Its outputs will be debiased using the Kalman filter.

7. References

www.shmu.sk
www.rclace.eu
www.cnrm.meteo.fr/aladin/

Derkova, M., Vivoda, J., Bellus, M., Spaniel, O., Dian, M., Nestiak, M., Zehnal, R., 2017: Recent improvements in the ALADIN/SHMU operational system.
(Slovak) Meteorological Journal, Vol. 20, No. 2, pp 45-52.

Termonia, P., Fischer, C., Bazile, E., Bouyssel, F., Brožková, R., Bénard, P., Bochenek, B., Degrauwe, D., Derkova, M., El Khatib, R., Hamdi, R., Mašek, J., Pottier, P., Pristov, N., Seity, Y., Smolíková, P., Spaniel, O., Tudor, M., Wang, Y.,, Wittmann, C., and Joly, A., 2018: The ALADIN System and its Canonical Model Configurations AROME CY41T1 and ALARO CY40T1.
Geosci. Model Dev., https://doi.org/10.5194/gmd-11-257-2018

Vivoda, J., Smolikova, P. and Simarro, J. (2018): Finite elements used in the vertical discretization of the fully compressible core of the ALADIN system.
Monthly Weather Review
https://doi.org/10.1175/MWR-D-18-0043.1

Wang, Y., Bellus, M., Ehrlich, A., Mile, M., Pristov, N., Smolikova, P., Spaniel, O., Trojakova, A., Brozkova, R., Cedilnik, J., Klaric, D., Kovacic, T., Masek, J., Meier, F., Szintai, B., Tascu, S., Vivoda, J., Wastl, C., and Wittmann, C., 2018: 27 years of Regional Cooperation for Limited Area Modelling in Central Europe (RC LACE)
Bulletin of the American Meteorological Society, 2018, Vol. 99, Issue 7, pp 1415-1432
DOI 10.1175/BAMS-D-16-0321.1