NWP related activities @SHMU

44th EWGLAM & 29th SRNWP meetings, 26.9.-29.9.2022, Brussels, Belgium

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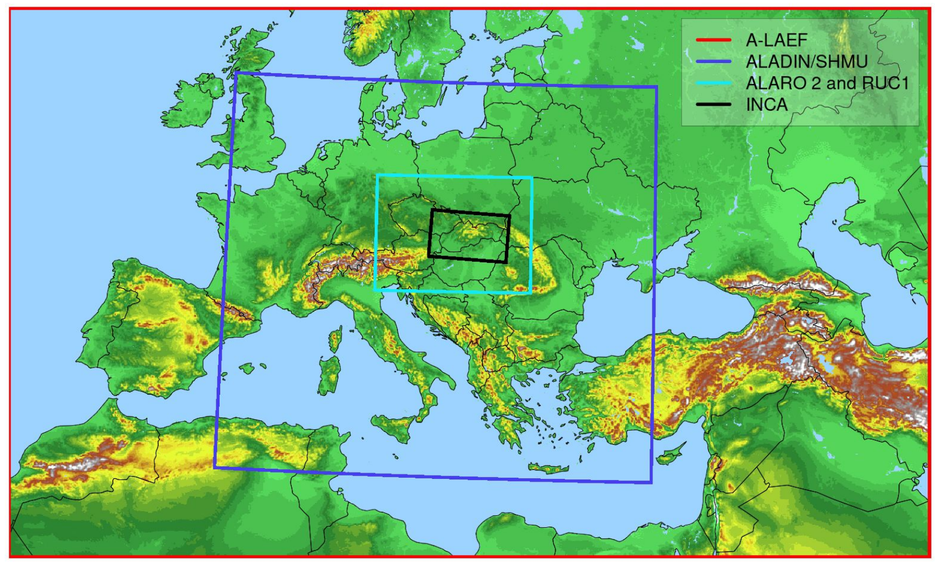
In cooperation with the Department of Hydrological Forecasts and Warnings: Hana Hlaváčiková

ALADIN (ALARO) systems at SHMU

CMC	**ALADIN/SHMU**	**A-LAEF**	**ALARO 2**		**RUC1**
status	operational	operational (common RC LACE)	test mode		test mode
code version	CY43T2bf11	CY40T1bf07+	CY43T2bf11		CY43T2bf11
physics	ALARO-1vB	ALARO-1vB (multi-physics + surface SPPT)	ALARO-1vB		ALARO-1vB
dx	4.5 km	4.8 km	2.0 km		1.0 km
points	625 x 576	1250 x 750	512 x 384		512 x 384
vertical levels	63	60	87		63
tstep	180 s	180 s	120 s		60
forecast ranges	78/72/72/60 (a' 1h)	72/-/72/- (a' 1h)	78/72/72/60 (a' 1h)	81/-/81/- (a' 1h)	Run hourly, up to +12h (a' 1h)
coupling model	ARPEGE (long- & short cut off), 3h	ECMWF ENS (c903@cy46t1), 6h	ARPEGE (short cut-off), 1h	ECMWF, 3h	ARPEGE, 1h (time-lagged LBC)
assimilation	upper air spectral blending by DFI CANARI surface assimilation	ensemble surface data assimilation (ESDA) by CANARI for 16+1 members, upper-air spectral blending by DFI	CANARI	A-LAEF control member init downscaling	CANARI+3DVAR, 1 hour cycling
initialization	no initialization	no initialization	DFI		no initialization
HPC	NEC HPC – 240 nodes, 6230 Intel Xeon Gold Scalable Processors (Cascade Lake), Omni-Path, Linux	Cray (ECMWF), 4896 CPUs [migration to Atos]	NEC HPC – 240 nodes, 6230 Intel Xeon Gold Scalable Processors (Cascade Lake), Omni-Path, Linux		
nodes	40	153	80 (but only 20 cores used out of 40)	80 (but only 20 cores used out of 40)	80 (but only 20 cores used out of 40)



Highlights of the research and development

Dynamics: Stability of NH dynamics tested (J. Vivoda, currently at ECMWF)

Data assimilation: Tuning of 3D-Var parameters, comparison of the BlendVar and VarBlend

RUC: A prototype of a high-resolution RUC established, case studies

EPS: A-LAEF development and migration to Atos HPCF in Bologna, new products (meteograms, etc.), a feature article published in ECMWF Newsletter No. 172 - Summer 2022

Physics and diagnostics: Continuation of the development of the parameterisation of maximum subgrid wind and gust

Verification: The harpSpatial package implemented and tested, comparison of RUC1 and ALADIN/SHMU model with HARP regrid functions

Near future plans

Optimization of the RUC, switch to cy46, HR modelling & DEODE project participation

A-LAEF epsgrams

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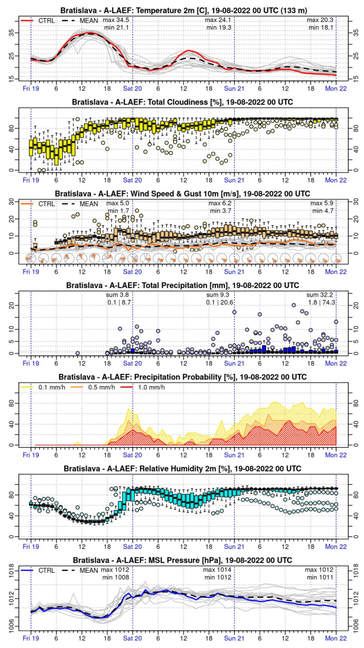
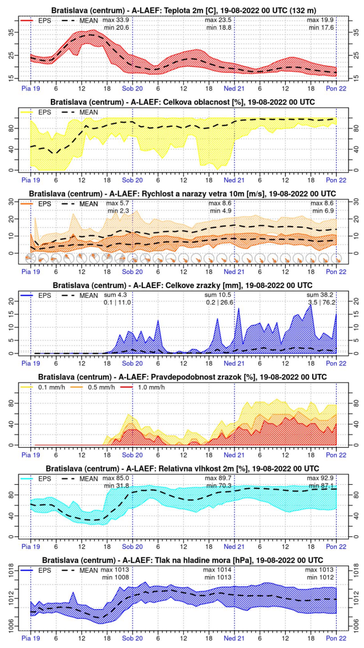
Except the work done on the migration and technical upgrade of A-LAEF TC2 suite to the new HPCF Atos in Bologna, there were some innovations related to the user products - epsgrams. A wind direction display was implemented, as well as precipitation probabilities for the different thresholds. Details at time axes were also added, together with the Slovak and English language mutations controlled by an argument. New simplified version of A-LAEF epsgrams was introduced and published on the SHMU website for over 1000 Slovak towns and villages.

Bratislava (airport)



Detailed A-LAEF epsgrams for SHMU forecasters and RC LACE portal (ENG mutation).

Bratislava (city center)



Simplified version of A-LAEF epsgrams published on SHMU website (SVK mutation).

HARP implementation

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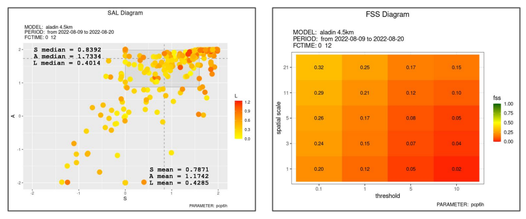
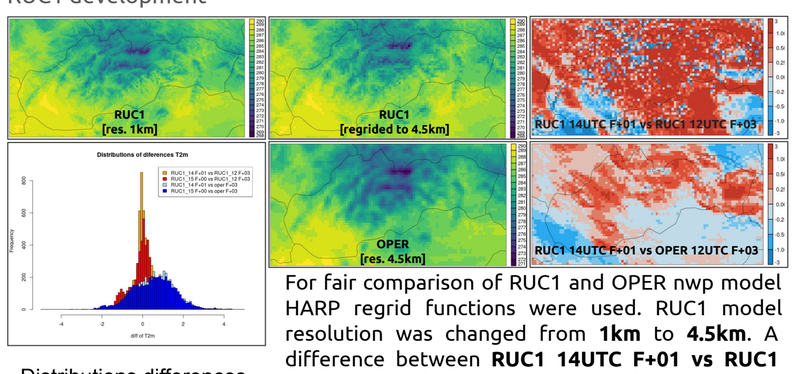
The **harpSpatial** package used for spatial verification:



6h precipitation SAL and FSS score for ALADIN 4.5km. For verification purposes harpSpatial version 0.0.1.9004 was used. Verification period from 2022/08/09 to 2022/08/20

RUC1 development



Distributions differences of T2m are shown in the figure above.

For fair comparison of RUC1 and OPER nwp model HARP regrid functions were used. RUC1 model resolution was changed from **1km** to **4.5km**. A difference between **RUC1 14UTC F+01 vs RUC1 12UTC F+03** is on the top right image. **RUC1 14UTC F+01 vs OPER 12UTC F+03** difference is on the bottom right . **RUC1** is calculated each hour. Cut-off is 30 minutes. Presented example is from the date of 2022-09-18.

RUC1 tests

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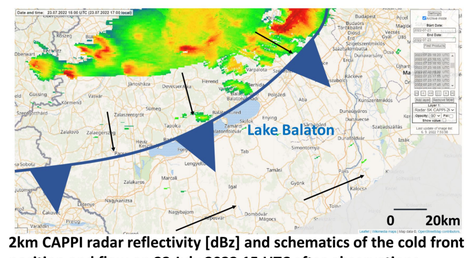
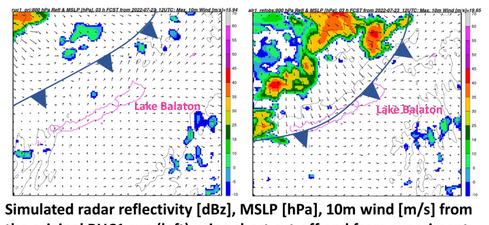
The RUC1 prototype is in test suite from June 2022. Runs are initiated at every 35 minute, using short cut-off archive for CANARI and 3DVAR (mainly AWS data and TEMPS). The setup is still under development, increase of the number of vertical levels (-> 87L) and changes in physics are planned.

Tests of the RUC1 prototype for the case of cold front passage and thunderstorms at the Lake Balaton, 23 July 2022 (cross-swimming contest)

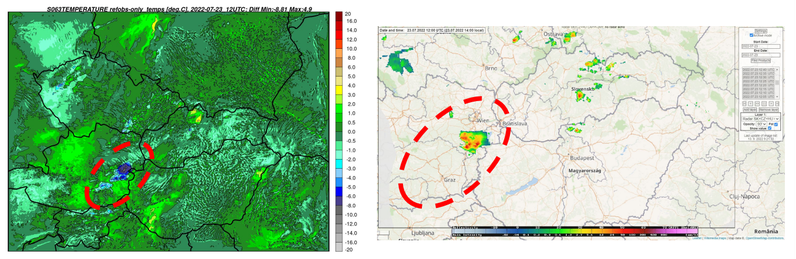
The RUC1 was tested "live" from forecasting and severe weather warning point of view during two major sport events at the Lake Balaton (Hungary). Though the simulated wind field largely matched local observations at the Lake, delays in forecasts of cold front passage (up to 2h) occurred in both cases.
Sensitivity tests revealed that additional observations from the long cut-off archive (e.g. EHS) would substantially improve the 3h forecast of reflectivity and wind (right Figure)



2km CAPPI radar reflectivity [dBz] and schematics of the cold front position and flow on 23 July 2022 15 UTC after observations



Simulated radar reflectivity [dBz], MSLP [hPa], 10m wind [m/s] from the original RUC1 run (left) using short cut-off and from experiment with long cut-off data (right)



Differences in the 23 July 2022 12 UTC analyses between the long cut-off and short cut-off run (left), radar reflectivity (right). Large differences emphasized.

Differences in the analyses indicate that additional observations result in a cold pool in the area of thunderstorms observed in eastern Austria, which probably had a positive impact on the forecast of the front motion.

Large scale information in 3D-Var: comparison of BlendVar vs VarBlend

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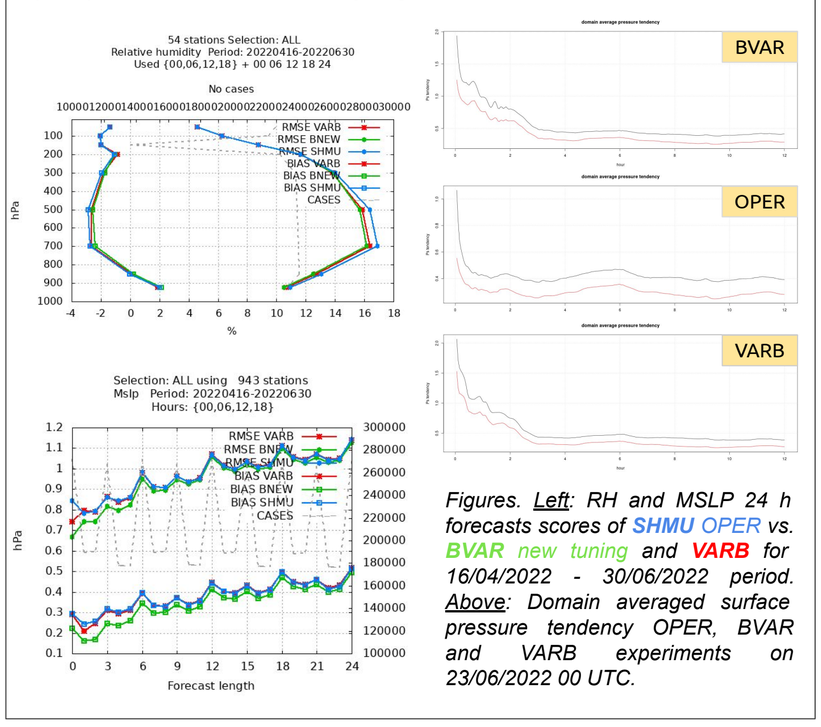
Strategies to find an optimal solution for taking into account the large scales information in 3D-Var assimilation have been explored via a comparison of the BlendVar and VarBlend approaches. Scores of the 11 weeks of parallel suites have been computed. According to the objective scores BlendVar seems to be more optimal for the current ALADIN/SHMU 4.5 km/L63 setup (see figures on the left). Echkevo diagnostics revealed that there seems to be no issue with the noise in the initial state - BlendVar and VarBlend oscillations are similar in the magnitude and the time scale (see figures on the right). Evaluation of precipitation case studies is ongoing.



Figures. Left: RH and MSLP 24 h forecasts scores of SHMU OPER vs. BVAR new tuning and VARB for 16/04/2022 - 30/06/2022 period. Above: Domain averaged surface pressure tendency OPER, BVAR and VARB experiments on 23/06/2022 00 UTC.

Applications: Hydrology

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The quality of precipitation data has a great impact on results of hydrological modelling. Precipitation analysis in Fig. 1 shows a significant underestimation of predicted rainfall compared to observations in July and August 2020 in the Torysa river catchment .

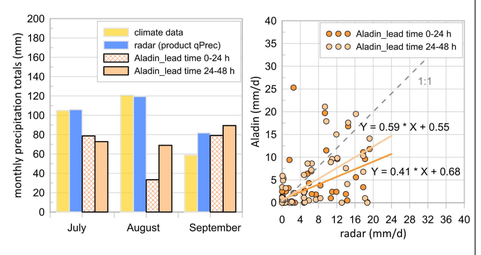

Fig.1: Monthly precipitation totals (left) from rain gauges (climate data), radar (qPrec product), and forecasted by the ALADIN deterministic model, daily precipitation totals (right)

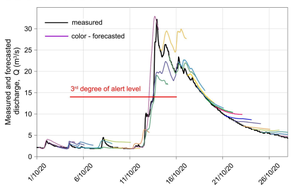

Fig.2: Measured and morning forecasted flows (at 4:00 UTC) modelled by the HBV model. Gauging station Hronec, the Hron river.

NWPs from the ALADIN deterministic model (res. 4.5 km) are used to predict flows with the HBV semi-distributed hydrological model for about 120 gauging stations in Slovakia. An example of forecasted flows in October 2020 as they were issued by operational hydrological service of the SHMU (Fig. 2).

Tuning of the BLENDVAR suite

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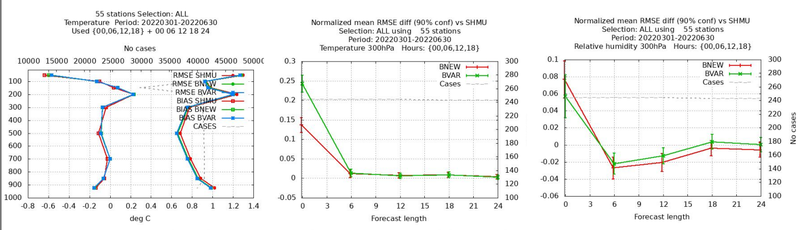
The tuning of the 3D-Var namelist parameters, REDNMC and SIGMAO_COEF, for the SHMU/SK configuration was carried out by tuneBR package with guidance of A. Trojaková and A. Bučánek. In two weeks long assimilation experiment SYNOP (1), AMDAR+EHS+MRAR (2), HRWIND (3) and TEMP (5) observations were used. After first estimation of the ratios of REDNMC and SIGMAO_COEF the REDNMC was changed from value 0.7 to 0.5 and SIGMAO_COEF was changed from [1.00,1.00,1.00,1.00,1.00] to [0.52,0.57,0.52,1.00,0.87] respectively to the assimilated observation types. After second iteration the ratios of REDNMC and SIGMAO_COEF were close to 1, so we decided to keep the namelist variables estimated from first iteration. Afterwards, four months long experiments were carried out, one with old setup (BVAR) and second with changed namelist variables (BNEW). These experiments were compared to ALADIN/SHMU operational setup. As you can see on the figures below, the impact of 3D-Var is positive. However, the impact of tuning is mostly slightly negative, in some rare cases positive.



Figures: Vertical profile of temperature forecast scores of SHMU OPER vs. old and new BVAR settings (left), forecast-range course of RMSE for 300 hPa temperature (middle) and relative humidity (right) for the BVAR experiments, all provided for the 01/03/2022-30/06/2022 period.