NWP related activities @SHMU

43rd EWGLAM & 28th SRNWP meetings, 27.9.-1.10.2021, videoconference

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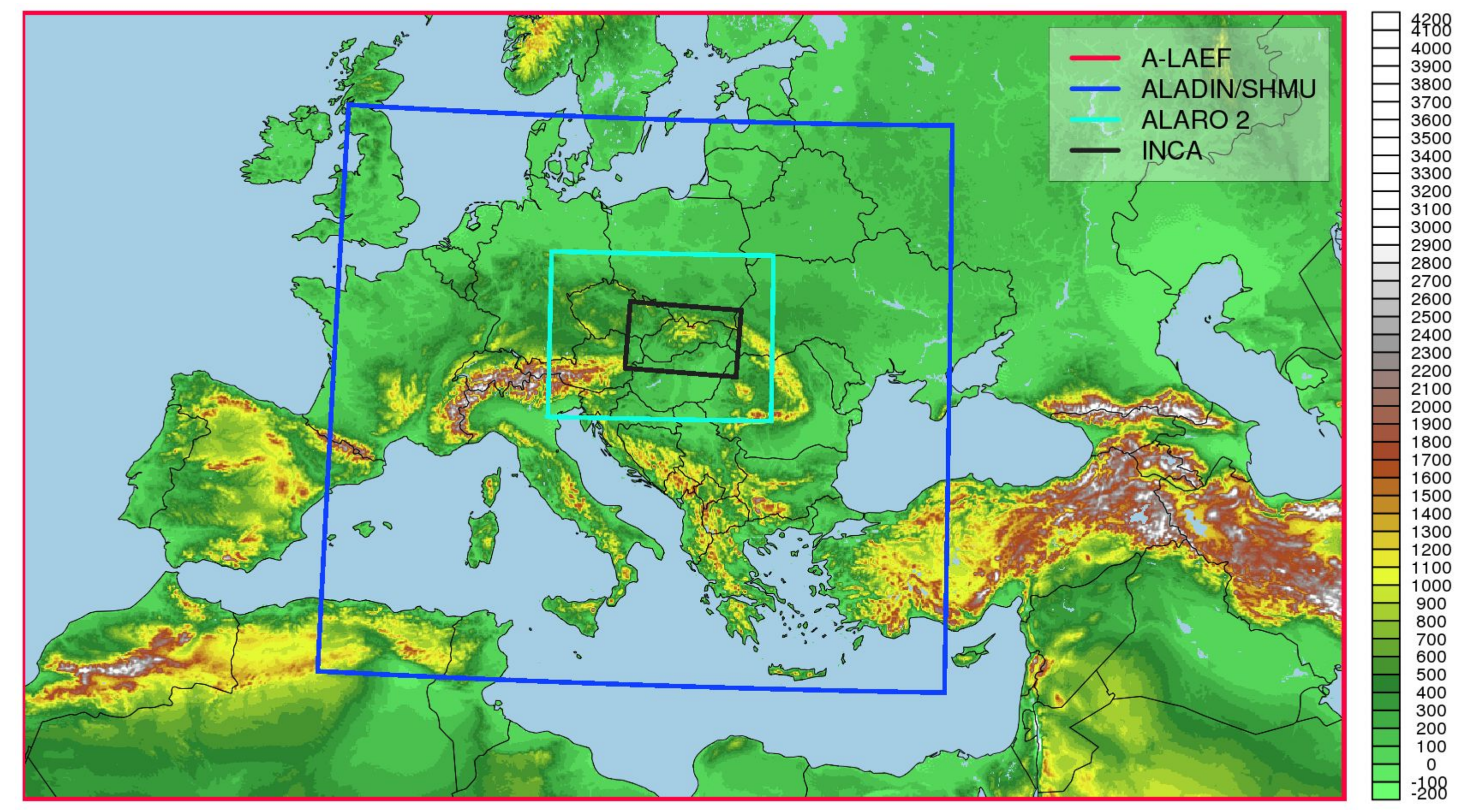
with assistance of the distance measurements group: Ján Kaňák, Ľuboslav Okon

ALADIN (ALARO) systems at SHMÚ

CMC	ALADIN/SHMU	A-LAEF	ALARO 2	
status	operational	operational (common RC LACE)	test mode	
code version	CY43T2bf11	CY40T1bf07	CY43T2bf11	
physics	ALARO-1vB	ALARO-1vB (multi-physics + SPPT)	ALARO-1vB	
dx	4.5 km	4.8 km	2.0 km	
points	625 x 576	1250 x 750	512 x 384	
vertical levels	63	60	87	
tstep	180 s	180 s	120 s	
forecast ranges	78/72/72/60 (a' 1h)	72/-/72/- (a' 1h)	78/72/72/60 (a' 1h)	81/-/81/- (a' 1h)
coupling model	ARPEGE (long- & short cut off), 3h	ECMWF ENS (c903), 6h	ARPEGE, 1h	ECMWF, 3h
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
initialization	no initialization	no initialization	DFI	
HPC	IBM Flex System p460, linux	Two CRAY XC40 clusters (ECMWF)	IBM p755 running with IBM Flex System p460	
HW	4x Power7+ 8 core CPUs (3.6 GHz), 256 GB RAM	36xIntel Broadwell CPUs (2.1 GHz), 128 GB	4x Power7 8 core CPUs (3.6 GHz), 256 GB RAM	
nodes	12	3610	8	8



Highlights of the research and development

Dynamics: NHHY scheme with operators containing weighted non-hydrostatic departure terms

Data assimilation: GNSS ZTD, HRWIND AMV, BLENDVAR, BUFR TEMP RS, Radial Doppler wind velocity

EPS: A-LAEF development and maintenance, new products (types of precipitation, etc.)

Physics and diagnostics: SURFEX, turbulence parameterization, wind at high resolution

Verification: HARP implementation, case studies in extreme weather situations

Installation of a new HPC in progress

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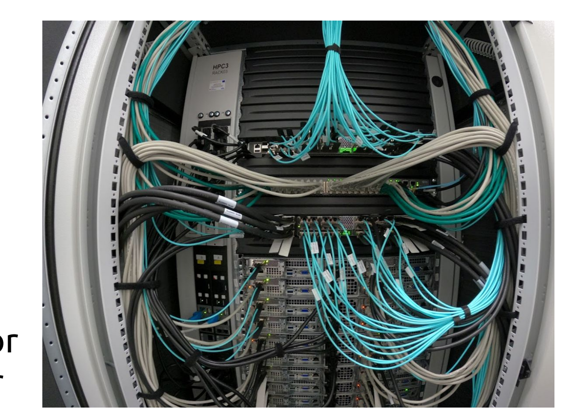
Objectives:
- Provide comprehensive Air quality modelling system
- 2.5 km ALARO model in RUC mode
- Local high-resolution EPS system with A-LAEF LBC

NEC HPC1804Ri 2, 2x Intel XEON SP processor 6230, 240 nodes, 40x more computing power



A-LAEF forecast of devastating rainfall in Germany and Belgium on 13-15 July 2021

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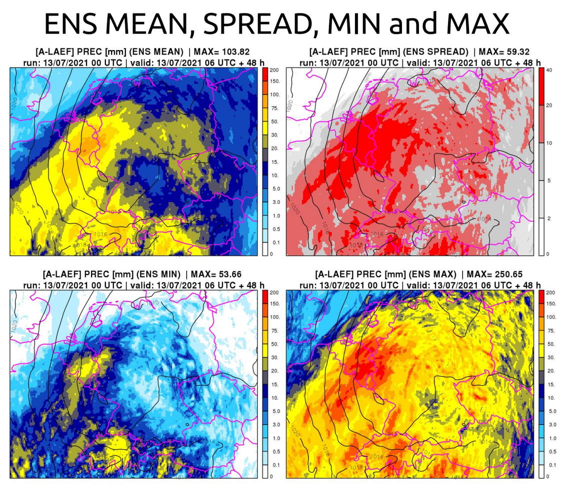
After several episodes of heavy rain, the cyclonic weather system (Bernd) caused persistent or recurring heavy rainfall. The central parts of Germany were touched mostly locally, but the west of Rhineland-Palatinate and the southern half of North Rhine-Westphalia were largely affected. As a result of intensive precipitation, small rivers and flash floods began to expand locally. In addition to immense property damage, more than 200 people lost their lives.

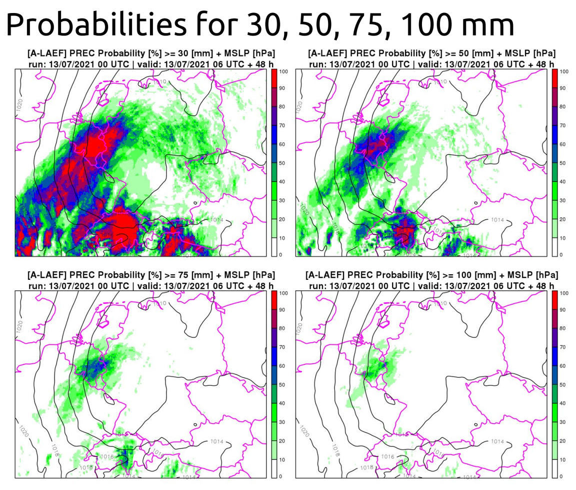
A-LAEF ensemble successfully captured the precipitation event - with well localized patterns, even with unusually high probabilities of extreme precipitation amounts (see the images below).

48-hourly precipitation accumulation (13/07 06 UTC ~ 15/07 06 UTC)

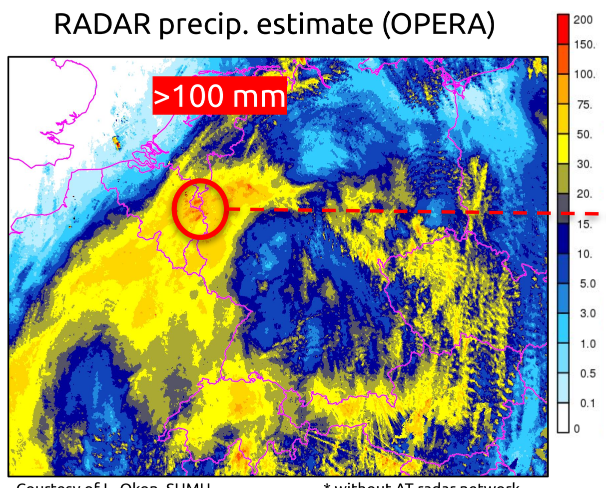
ENS MEAN, SPREAD, MIN and MAX



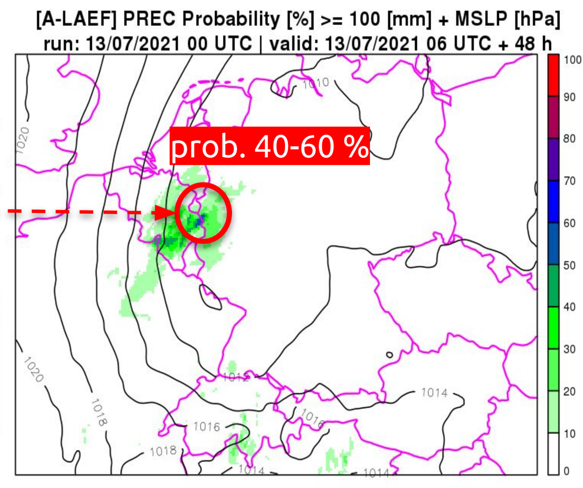
Probabilities for 30, 50, 75, 100 mm



RADAR precip. estimate (OPERA)



[A-LAEF] PREC Probability [%] >= 100 [mm] + MSLP [hPa] run: 13/07/2021 00 UTC | valid: 13/07/2021 06 UTC + 48 h



Courtesy of L. Okon, SHMU * without AT radar network

HARP implementation

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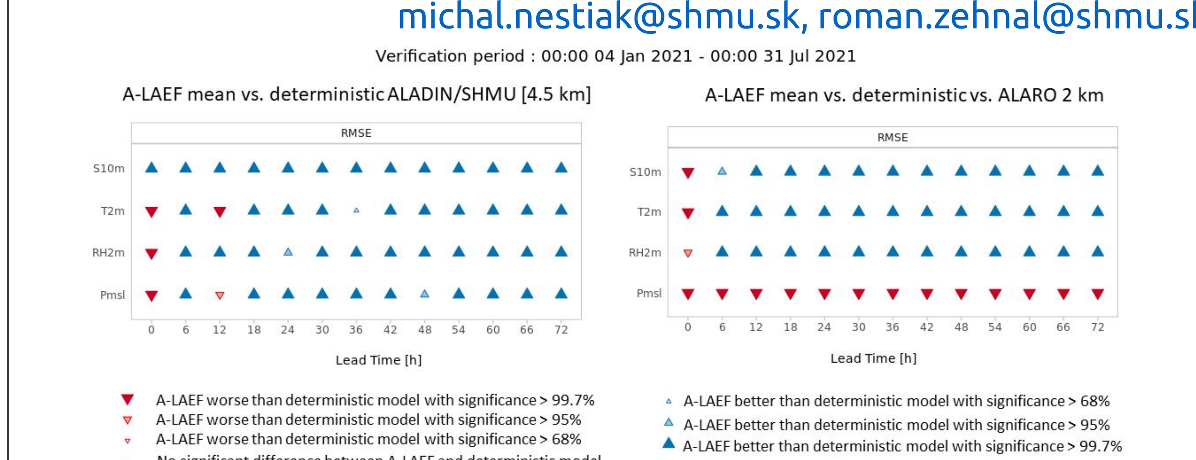

HARP bootstrap method to compare scores between A-LAEF (eps mean), ALADIN SHMÚ (operational) and ALARO 2 (test). Verification process is based on observation data from approximately 96 SHMÚ AWS stations.

Algorithmic amelioration of the deficiencies in the screen level parameters forecast based on a dynamical downscaling approach

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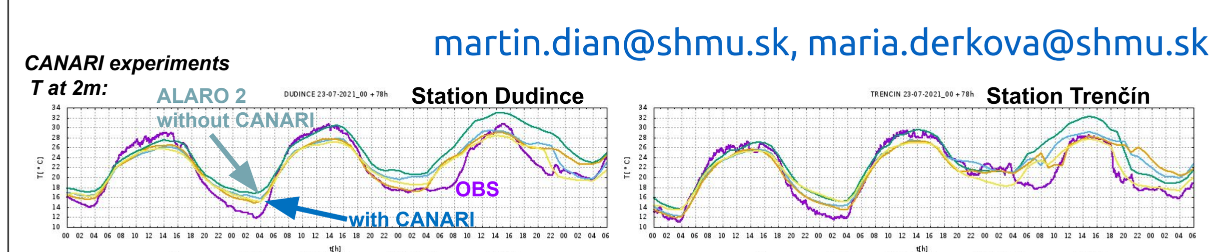

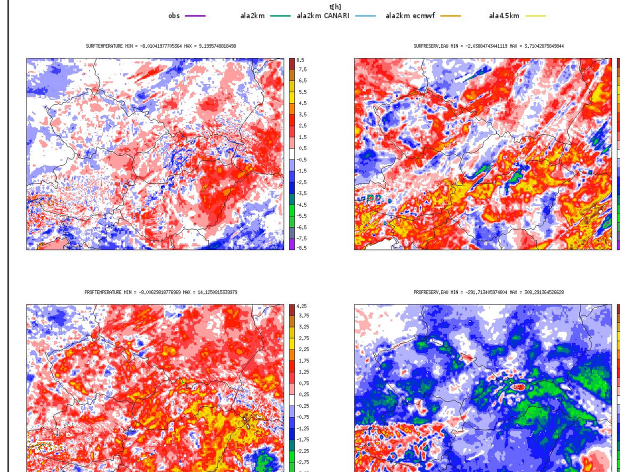

A serious deterioration of the 2 m temperature forecast of the ALARO 2/L87 version running in dynamical adaptation mode has been noticed this summer. The problem was traced down to the surface fields originating from a driving model ARPEGE that are converted from SURFEX fields. Utilization of CANARI analysis partly alleviated the issue.

Differences between ARPEGE INIT file interpolated in 2 km horizontal resolution and 2 km CANARI analysis for surface and deep soil temperature and surface and deep soil wetness are shown.

Severe convection simulations

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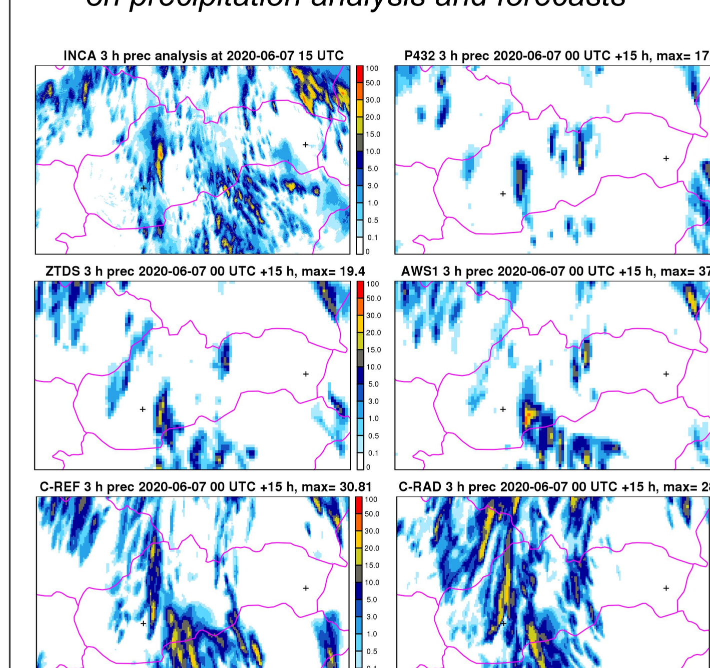
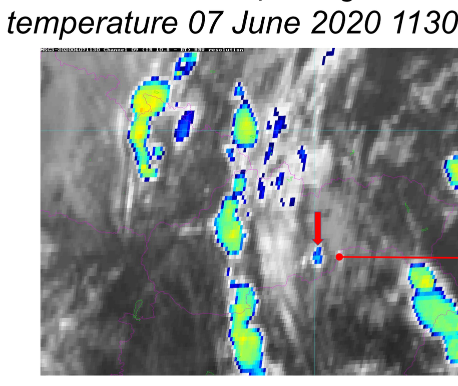
Multicell thunderstorms of 7 June 2020
3h precipitation analysis and forecasts

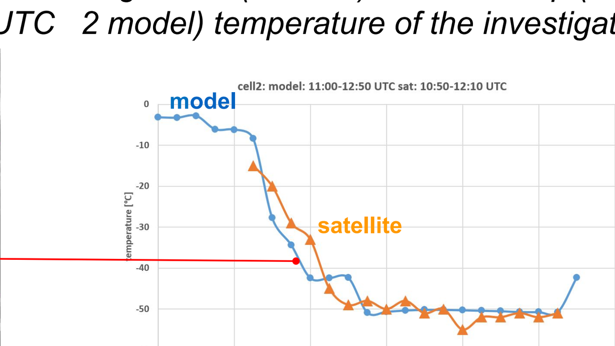


A case study to be published in the special issue of *Időjárás* journal: The reference (P432) ALADIN/SHMÚ forecast underestimated precipitation amounts and forecasts of data assimilation (e.g. GNSS ZTD, AWS) significantly improved the forecasts of position and intensity of the patterns. Experiments with radar data assimilation (C-RAD) were provided in the frame of an RCLACE stay on the ALADIN/CHMI model.

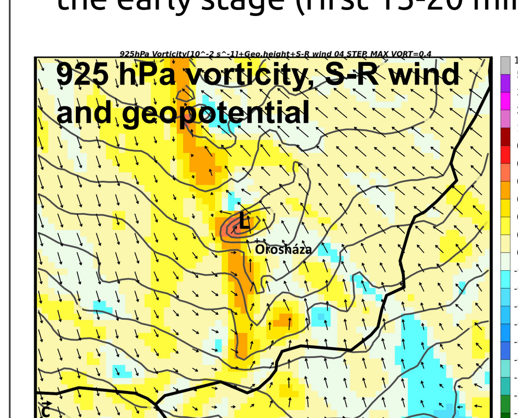
METEOSAT 10.8 μm brightness temperature 07 June 2020 1130 UTC



Brightness (satellite) and cloud top (ALARO 2 model) temperature of the investigated cell



The cloud top temperature development in the model was usually faster in the early stage (first 15-20 minute) of the cell and slowed down later.



Simulated supercell thunderstorm in the neighbourhood of Orosháza (southeast Hungary) on 17 May 2021 (12 UTC run of ALARO 2). The model several times forecast mesocyclonic storms in situation, when such were observed (refer also to Šinger and Púčik, 2020). However, the intensity of vertical motions and vorticity were possibly underestimated.

Parallel BLENDVAR suite

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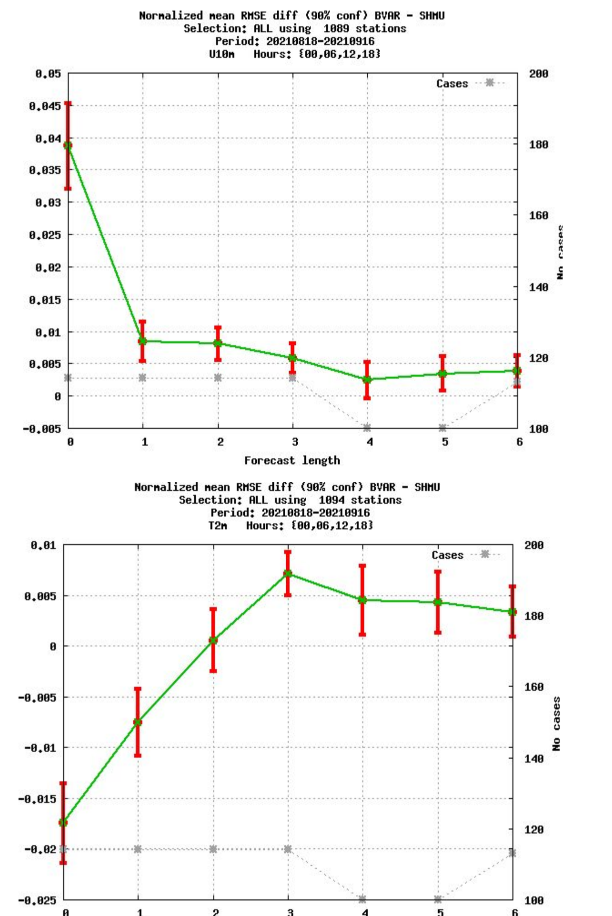

This parallel suite is a mirror of operational ALADIN/SHMU with addition of the 3D-Var assimilation of SYNOP, TEMP, AMDAR, MRAR, EHS and AMV(GEOWIND) data.

Negligible improvement in T2m was noticed in the first hour. However, deterioration were noticed afterwards. The U10 parameter showed small, but significant deterioration since analysis.

Tuning of REDNMC, SIGMA_COEF parameters and case study validation are required.

Testing 3D-Var with BUFR TEMP RS

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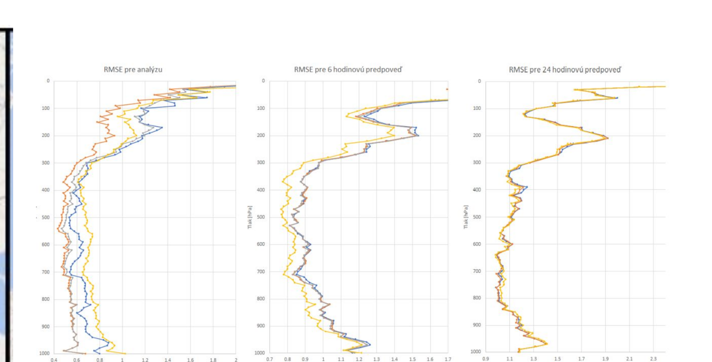
An utilization of the BUFR TEMP RS messages in the 3D-Var data assimilation has been tested in frame of diploma thesis. During a 2 weeks period 22.2.-5.3.2020 the analyses and the forecast using standard TEMP obsoul (**OBS**) were compared to an experiment with high resolution TEMP (**TT**), experiment with RS drift activated (**FF**), and to operational Blending by DF performance (**SHM**). At analysis time any of 3D-Var experiments are better than operational; full RS drift outperforms high-res RS above 700 hPa. At +6 h some improvement of BUFR TEMP is still visible, but the operational forecast is better. Scores for all experiments are similar for +24h forecast (prevailing effect of LBCs). Further validation is planned.

Figure: vertical profile of RMSE for temperature (legend in the text), and RS drift for testing period.



Applications: Road forecasting

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Short term road surface temperature (RST) forecast is of primary importance in road meteorology. It is more challenging for areas with high urban development because incident solar flux can be significantly altered by the local screening effects. Existing options for solar flux correction were extended to take these effects into account. In Fig. 2 is a comparison of RST forecasts with screening correction turned off, with simple 'binary' screening and with more advanced screening algorithm based on decomposition to direct and diffusive components. Calculated visible horizon is shown in Fig. 1. Use of advanced screening method markedly improved RST forecast and it proved superior over binary screening method which can even degrade original forecast. Fig. 3 shows RST bias distribution.

Fig. 1 : visible horizon *Fig. 2: RST forecasts* *Fig. 3: RST bias*