LACE
nwp central europe

ALADIN Numerical Weather Prediction Project

NWP at the Hungarian Meteorological Service

Antal Fischer, Viktória Homonnai, Katalin Jávorné Radnóczi, László Kullmann, Dávid Lancz, Máté Mester, Máté Mile, Réka Suga, Balázs Szintai, Mihály Szűcs

(szűcs.m@met.hu)

OMSZ
Hungarian Meteorological Service

Operational ALADIN configuration

Main features of the operational ALADIN/HU model

- Model version: CY38T1 (ALARO-1 physics)
- Initial conditions: local analysis (atmospheric: 3dVar, surface: OI)
- Four production runs a day: 00 UTC (60h); 06 UTC (48h); 12 UTC (60h); 18 UTC (36h)
- Lateral Boundary conditions from the ECMWF/IFS global model

Assimilation settings

- 6 hour assimilation cycle
- Short cut-off analysis for the production runs
- Downscaled Ensemble background error covariances
- Digital filter initialisation
- LBC coupling at every 3 hours

Model geometry

- 8 km horizontal resolution (349*309 points)
- 49 vertical model levels
- Linear spectral truncation
- Lambert projection

Forecast settings

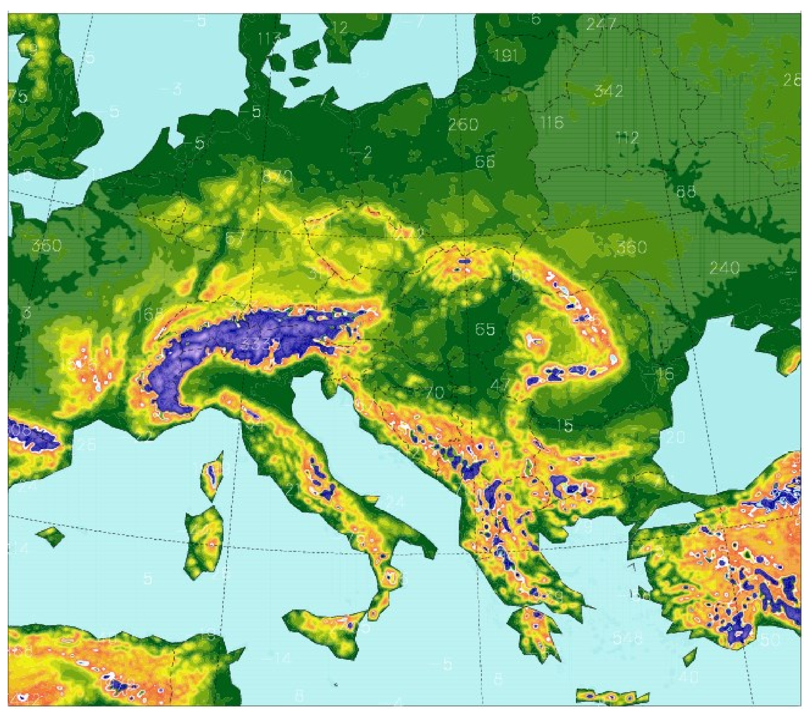
- Digital filter initialisation
- 300 s time-step (two-time level SISL advection scheme)
- LBC coupling at every 3 hours
- Output and post-processing every 15 minutes

Operational suite / technical aspects

- Transfer ECMWF/IFS LBC files from ECMWF via Internet, ARPEGE LBC files (as backup) from Météo France (Toulouse) via Internet and ECMWF re-routing.
- Model integration on 32 processors
- 3D-VAR and Canari/OI on 32 processors
- Post-processing
- Continuous monitoring supported by a web based system

The computer system

- IBM iDATAPLEX Linux cluster
- CPU: 500 Intel Xeon processors (2,6 Ghz)
- 1.5 Tbyte internal memory
- IBM FlashSystem 840
- Torque job scheduler



The ALADIN/HU model domain and orography

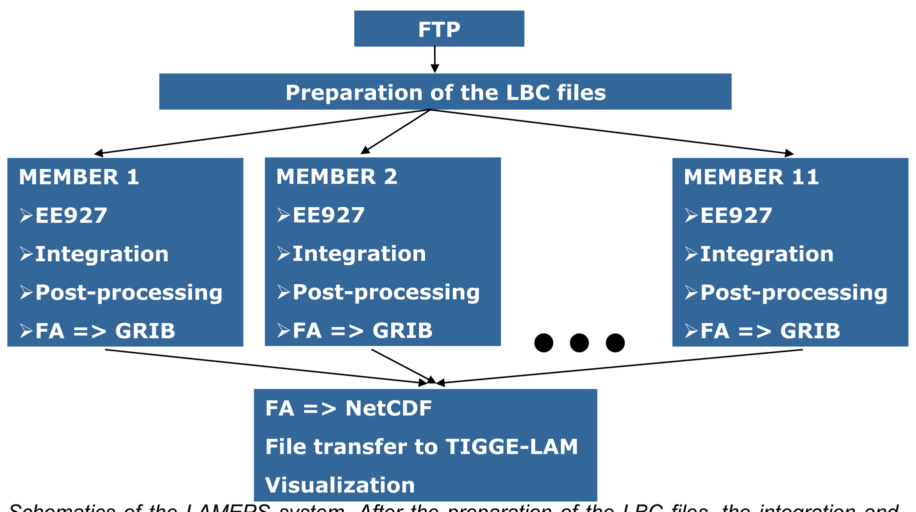
Observation usage

- Maintenance and use of the OPLACE system (Operational Preprocessing for LACE)
- SYNOP (T, Rh, Z)
- SHIP (T, Rh, Z, u, v)
- TEMP (T, u, v, q)
- ATOVS/AMSU-A (radiances from NOAA 18) with 80 km thinning distance, passively NOAA 19, Metop A/B
- ATOVS/AMSU-B (radiances from NOAA 17 and 18) with 80 km thinning distance, passively NOAA 19, Metop A/B
- METEOSAT-10/SEVIRI radiances (Water Vapor channels only)
- AMDAR (T, u, v, q) with 25 km thinning distance and 3 hour time-window
- Slovenian Mode-S data
- Variational Bias Correction for radiances
- AMV (GEOWIND) data (u, v)
- Wind Profiler data (u, v)
- Web-based observation monitoring system

Operational ALADIN ensemble system

The main characteristics of the operational short-range limited area ensemble prediction system of HMS is listed below.

- The system is based on the ALADIN limited area model and has 11 members.
- For the time being we perform a simple downscaling, no local perturbations are generated.
- The initial and lateral boundary conditions are provided by the global ECMWF ENS system.
- LBCs are coupled in every 3 hours
- The LAMEPS is running once a day, starting from the 18 UTC analysis, up to 60 hours.
- The integration of the single members is similar than in 'deterministic' ALADIN/HU case (see above): same resolution, same physics, etc.
- The forecast process starts every day from cron at 00:45 UTC and finishes around early morning.

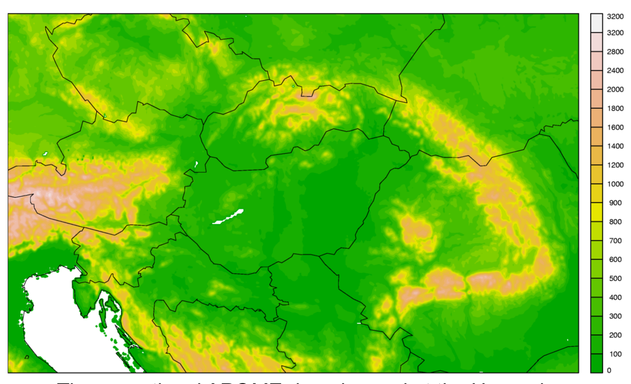


Schematics of the LAMEPS system. After the preparation of the LBC files, the integration and the post-processing are running in parallel for all the members. The preparation of the NetCDF files is done in one go for all members.

Operational AROME configuration

Main features of the AROME/HU model

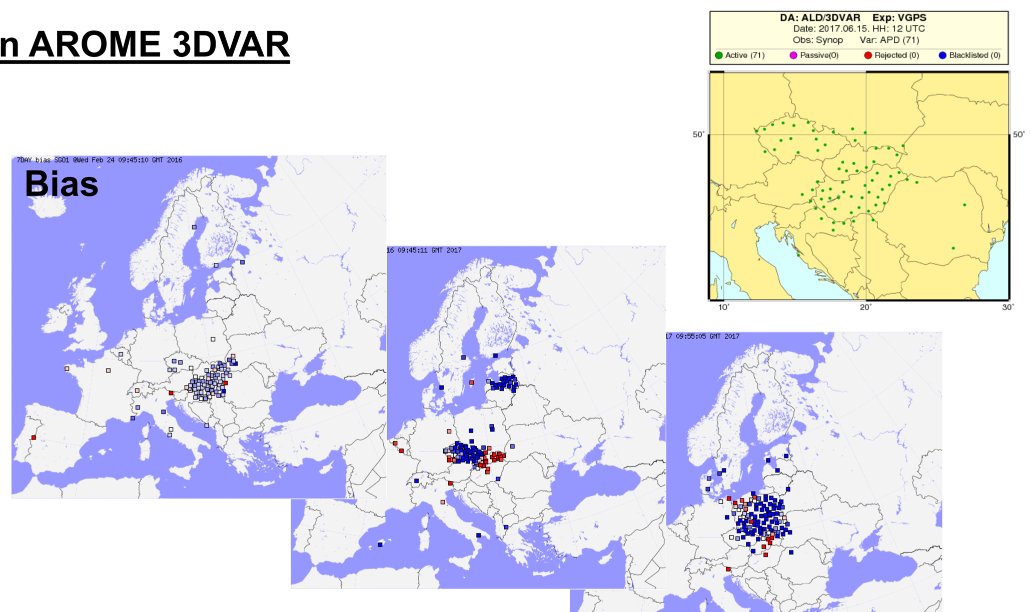
- Model version: CY40T1
- 2.5 km horizontal resolution (500*320 points)
- 60 vertical model levels
- Eight production runs a day: 00 UTC (48h); 03 UTC (36h); 06 UTC (48h); 09 UTC (36h); 12 UTC (48h); UTC (36h); 18 UTC (48h); 21 UTC (36h)
- Initial conditions: 3DVAR (upper air), OI_main (surface)
- Lateral Boundary conditions from ECMWF/IFS with 1h coupling frequency
- To calculate the screen level fields we use the SBL scheme over nature and sea



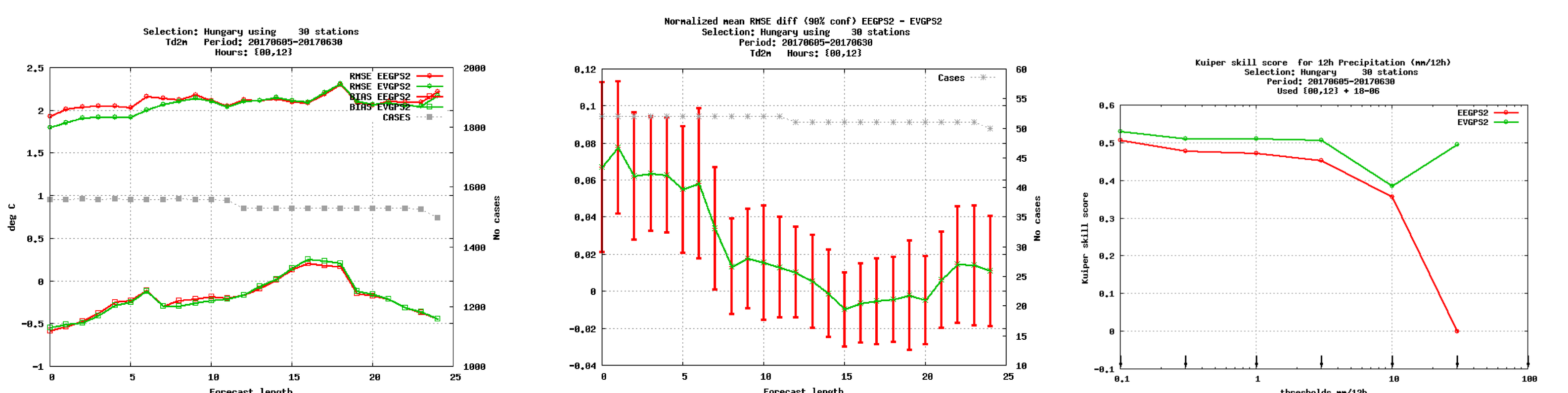
The operational AROME domain used at the Hungarian Meteorological Service.

Assimilation of GNSS ZTD observations in AROME 3DVAR

For the time being, the operational AROME data assimilation system includes only conventional observations. In order to extend the current observation set, the impact of Zenith Total Delay (ZTD) measurements of Global Navigation Satellite System (GNSS) are studied in the three hourly updated AROME 3DVAR system. During the OSEs, ZTD measurements from Hungarian(SGO1), Czech(GOP1) and Polish(WUEL) E-GVAP networks were pre-processed, pre-selected and studied providing dense ZTD observations over AROME/Hungary domain. Before the pre-selection procedure, the optimal thinning distance of ZTD stations was determined and a whitelist was generated according to the pre-selection criterias. During the impact studies both static and variational bias correction approaches were tested and compared on a summer and a winter period.
The operational implementation of GNSS ZTD assimilation happened on 5th of September, 2018.



The map of the three different E-GVAP network which was used in our assimilation studies

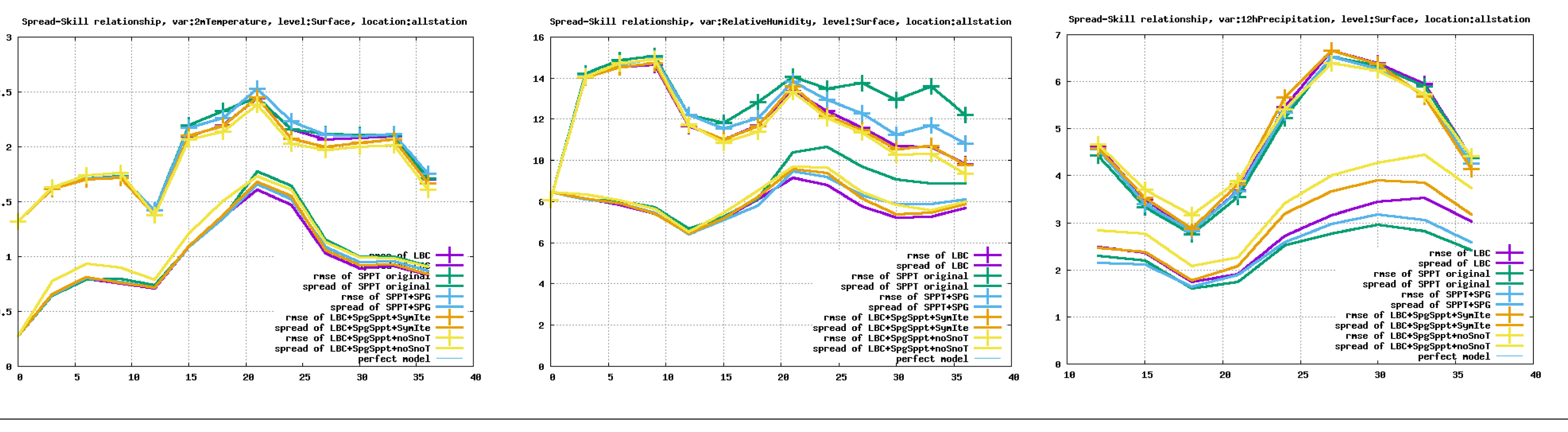


2) RMSE and BIAS of 2 metre dewpoint (left panel) for AROME operational (red) and AROME with ZTD assimilation and variational bias correction (green). Normalized RMSE differences of 2m dewpoint between AROME operational and AROME with ZTD assimilation based on variational bias correction for the period 2017-06-05 – 2017-06-20. Right panel shows Kuiper skill scores (the bigger the better is) for 12h precipitation with the same colours. Verification was made against EWGLAM SYNOP.

SPPT results with the new stochastic pattern generator

In previous national posters and in LACE stay reports two important issues were highlighted around SPPT. First one is the random pattern generator which has not operated properly in LAMs under the current cycles. To meet this challange a new stochastic pattern generator developed by Tsyrulnikov and Gayfulin were implemented in ALADIN code (referred as SPG). The second problem was the so called „drying effect" which was connected to the supersaturation check part which filters more perturbation in the direction of saturation state than opposite. That problem motivated a new type of supersaturation check which filters perturbation in a symmetric way. Finally there were experiment where supersaturation check and tapering function were both switched-off but on the other hand the amplitude of the perturbations were also moderated to 0.4. On the figures below:

- LBC (purple) – reference, SPPT is not activated;
- SPPT original (green) – default pattern generator and supersaturation check, it cuts immediately all the perturbations to 0 which cause supersaturation;
- SPPT+SPG (blue) – SPG used for pattern generation but default supersautration check;
- SpgSppt+SymIte (orange) – SPG used for pattern generation with a new „symmetric" supersaturation check;
- SpgSppt + noSnoT (yellow) – SPG used for pattern generation with moderated amplitude but supersaturation check and tapering function were both switched-off .



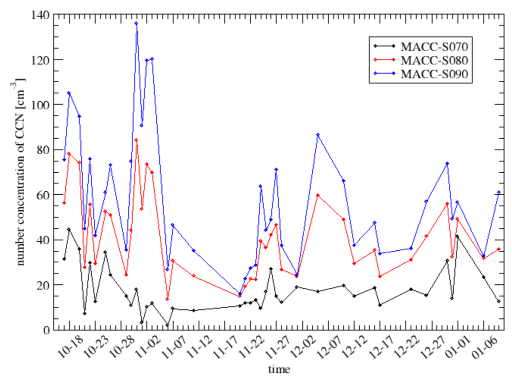
Sensitivity tests in fog cases with LIMA scheme

LIMA (Liquid Ice Multiple Aerosols) scheme is a two-moment microphysical scheme, which was developed in MESO-NH to improve modeling of the complex aerosol–cloud interactions. For now the scheme has been implemented in AROME model and an important task is the initialization of aerosols. The source of the initial conditions for aerosols in LIMA scheme was studied with constant value (~LIMA-REF) and MOCAGE data, and later it was extended with the C-IFS MACC (Monitoring Atmospheric Composition and Climate) project, so now three different possibilities are available for aerosol initializations. As it is needed to convert and interpolate MOCAGE fields, the same situation occurs in the case of MACC. The unit conversion is necessary from mixing ratio to number concentration with the help of the size distribution function. However, the parameters of this function are different in the two distinct models, so in spite of the similar mixing ratio values the number concentrations could be very different as well.

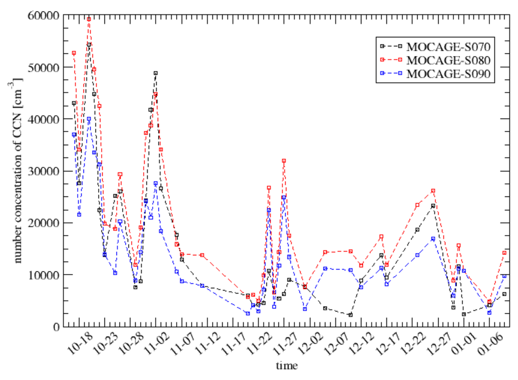
Bure station in France

The comparison of these different initializations was studied in 39 fog cases between October 2015 and January 2016 over a small domain around Bure (France) station. Time-height cross-section of liquid water content was plotted in order to compare the model to the observations. In the case of LIMA-MACC there is less aerosol particles, so there are only few cloud drops, however, they can increase in size. The large raindrops finally fall down, so less LWC remain in the cloud. In the case of LIMA-MOCAGE the number of aerosols is too big and most of the particles probably can not take part in cloud formation.

Results show the importance of the subgrid condensation in the model, which is apparently missing from the LIMA scheme, so instead of this the cloud sedimentation parameter (LSEDC) was switched on. With this change the LWC content can be higher at low levels like in ICE3 scheme with subgrid condensation (LOSUBG_COND=T default).

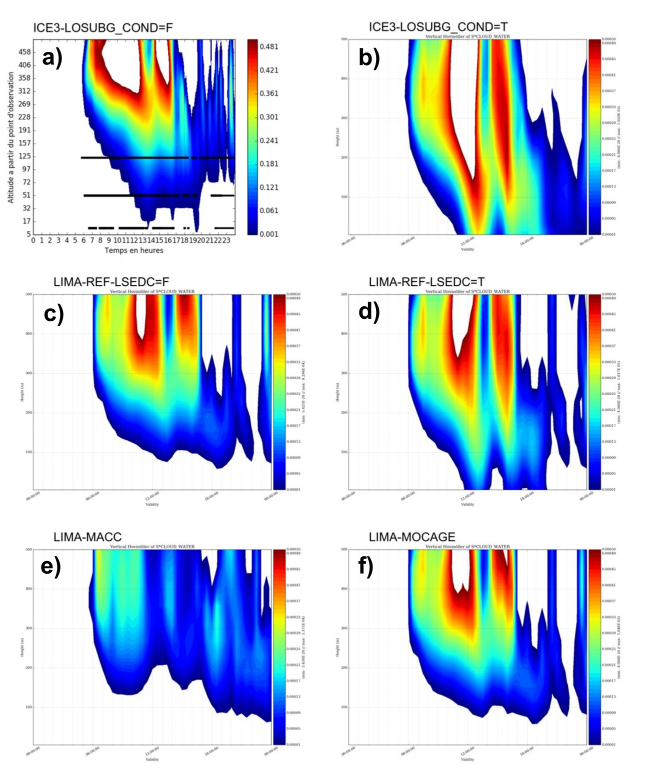


*Number concentration of aerosols at 3 different model levels (S070, S080, S090) from **MACC** data*



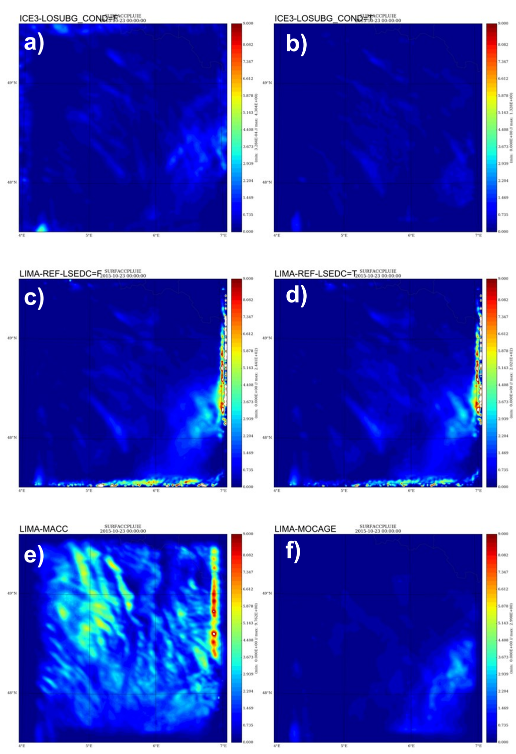
*Number concentration of aerosols at 3 different model levels (S070, S080, S090) from **MOCAGE** data*

LIQUID WATER CONTENT



*Time-height cross section of **LWC** on 22nd October 2015 in 6 different cases: ICE3 with (b) and without (a) subgrid, LIMA-REF with (d) and without (c) cloud sedimentation, LIMA with McondensationACC (e) and LIMA with MOCAGE (f). In figure (a) the black horizontal lines show the observations: the duration of the fog (3 levels: 10m, 50m, 120m)*

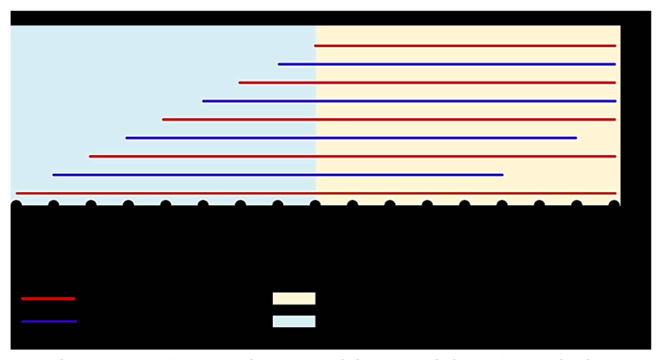
PRECIPITATION



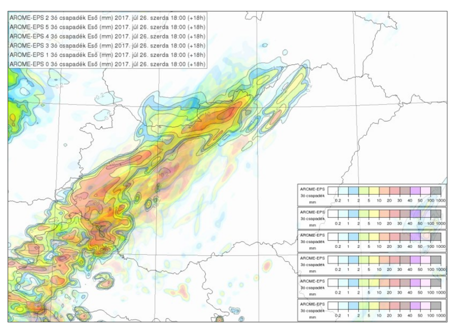
*24-h **precipitation** fields on 22nd October 2015 in 6 different cases: ICE3 with (b) and without (a) subgrid condensation, LIMA-REF with (d) and without (c) cloud sedimentation, LIMA with MACC (e) and LIMA with MOCAGE (f)*

AROME model outputs as time-lagged EPS

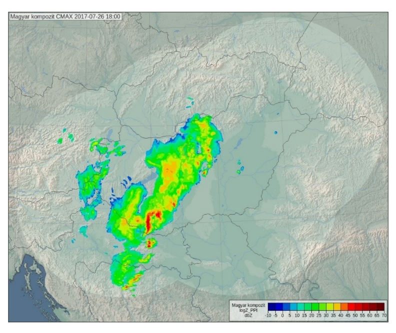
At OMSZ the operational ensemble system of the limited-area model is called ALADIN-EPS, which is based on the hydrostatic ALADIN model, with 8 km horizontal resolution and parametrized deep convection. Work is in progress to refine this system by using non-hydrostatic AROME, which predicts small-scale phenomena such as deep convection more properly thanks to explicit description. Deterministic AROME has a horizontal resolution of 2.5 km, which makes computational costs too high for an operational EPS. In order to eliminate this problem, we are testing a time-lagged EPS, including 7 members, which are AROME runs from the previous 24 hours, without initial value perturbation. The ensemble of these members gives us 24-hour forecast. This offers forecasters to see model runs together and examine the probability of high-impact weather events. This method is referred to as quasi-AROME-EPS (shortly Q-AREPS). The verification results made up for July 2016 and case studies for convective season of 2017. Below some examples for comparison with ALADIN-EPS (shortly ALEPS) and different members of Q-AREPS can be seen. Case studies consist of downbursts, supercells, cluster. HAWK-3 was used to visualize the products of Q-AREPS.



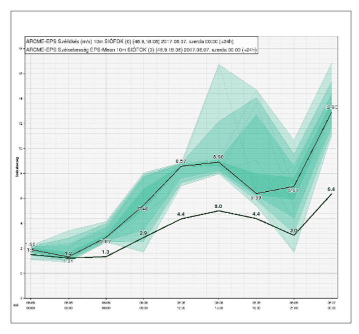
Constucting 24-hour forecast of Q-AREPS from 00 UTC. Only seven AROME runs cover the forecasted time intervall completely, so in that case there will be 7 members of Q-AREPS.



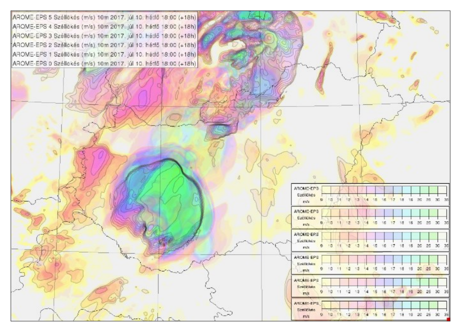
3-hour precipitation map to 18 UTC on July 26, 2017.



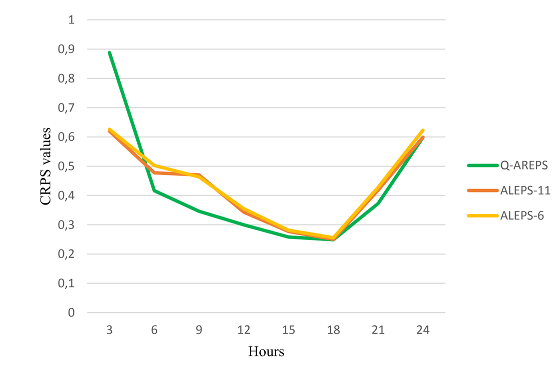
Radar reflectivity map to 18 UTC on July 26, 2017.



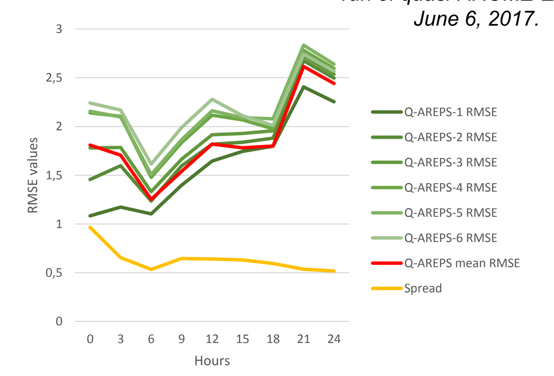
Meteogram of wind gust [m/s] and mean wind speed from 00 UTC run of quasi-AROME-EPS on June 6, 2017.



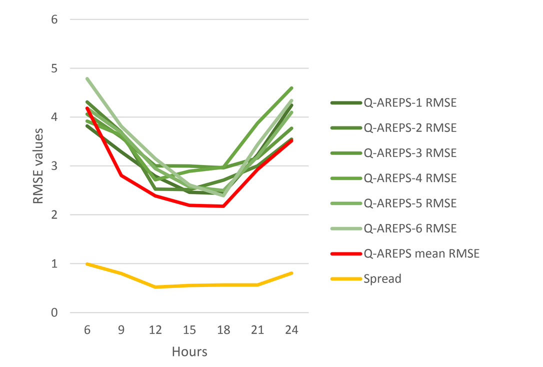
10 meter's wind gust map to 18 UTC on July 10, 2017.



Q-AREPS and ALEPS 3 hour precipitation CRPS value



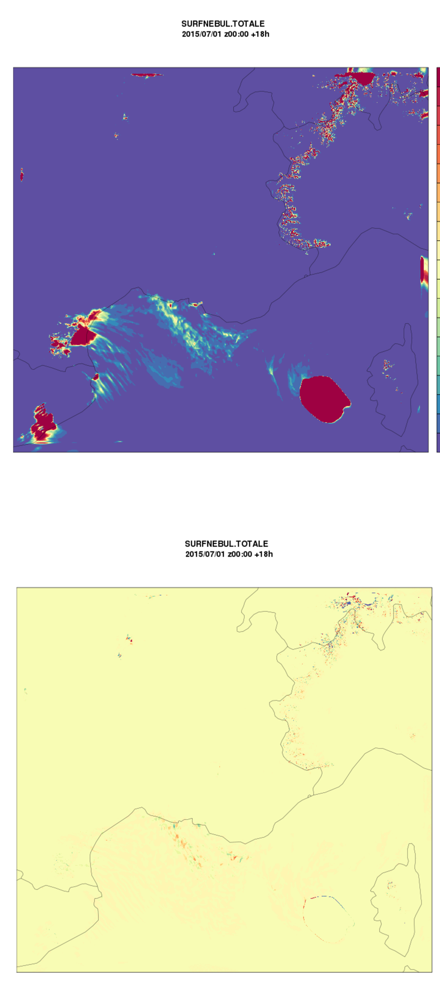
Spread-Skill diagram of Q-AREPS for 2m temperature



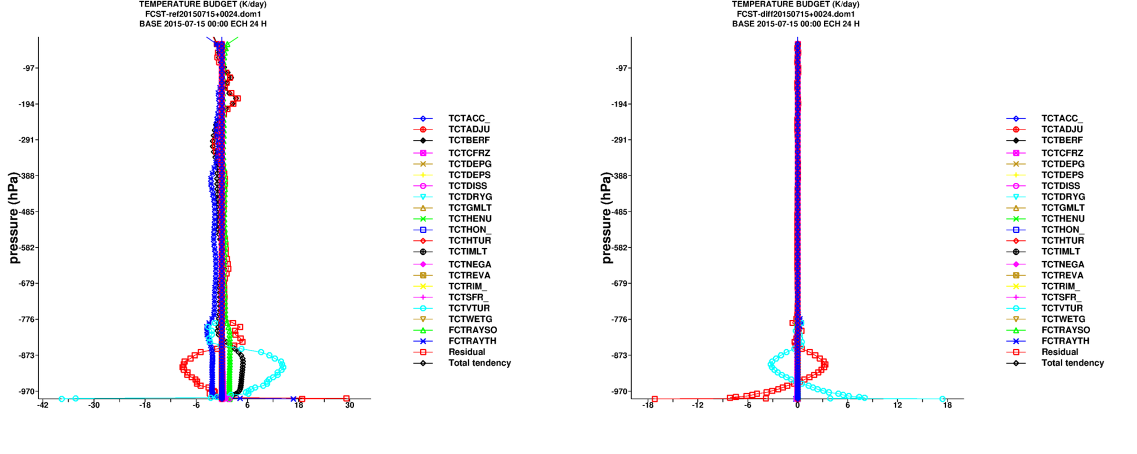
Spread-Skill diagram of Q-AREPS for 6 hour precipitation

Testing of a modified shallow convection parametrization with high resolution AROME experiments in the turbulence gray zone

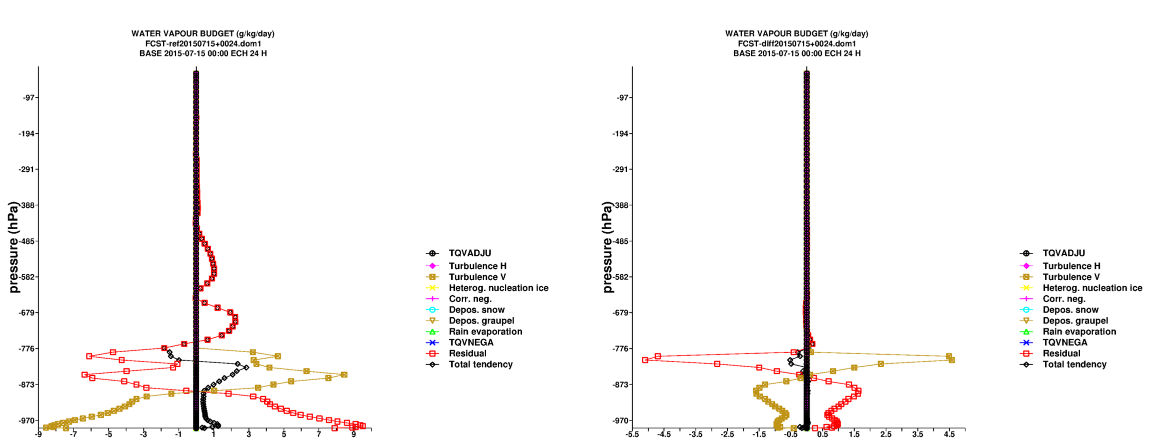
A series of high resolution experiments were made to examine the effect of a modification of the shallow convection parametrization in AROME, which scale-adaptively moderate it in the turbulence gray zone. These experiments were made with 500 m horizontal resolution on a dry hot summer period. The DDH diagnostic tool was used to get a closer look at the turbulent budgets and the differences caused by the modification. Unfortunately the DDH is not able to distinguish the Eddy Diffusion and Mass Flux part of the vertical turbulence, so only their sum was examined.
The effect of the modification is visible in the 24 h vertical turbulence budgets. It it also visible, that this effect is mostly compensated by the resolved turbulence (the vertical advection in this case), which is expected. When this compensation differs from the effect, the difference of the total tendencies has a bigger magnitude, but in overall, the summarized effect of the modification is low.
The more detailed description of the modification can be found in the article: Lancz, D., Szintai, B. & Honnert, R. (2018): Modification of a Parametrization of Shallow Convection in the Grey Zone Using a Mesoscale Model, Boundary-Layer Meteorology, 1-21, DOI: 10.1007/s10546-018-0375-1.
The final conclusion about the tested modification is that though its effect is low, it changes the turbulent fluxes in the expected way. It is clearly not enough alone to treat the shallow convection gray zone problem (true, its effect can be forced to be stronger through a parameter), but it can be a part of a final solution, which includes further developments like 3D turbulence and a more suitable set of mass flux equations for high resolution.



1) Cloudiness of the reference (top) and the difference from it caused by the modification (bottom)



2) Profile of 24 h temperature budget differences (made by DDH) between the reference and modified. Red square – residual (in this case it should be mostly the vertical advection), cyan circle – vertical turbulence. In optimal conditions: the decrease in the turbulence is compensated by the vertical advection, thus the final effect is low.



3) Profile of 24 h water vapour budget differences (made by DDH) between the reference and modified. Red square – residual (in this case it should be mostly the vertical advection), brown square – vertical turbulence. In optimal conditions: the decrease in the turbulence is compensated by the vertical advection, thus the final effect is low.