NWP activities at the Hungarian Meteorological Service

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OMSZ

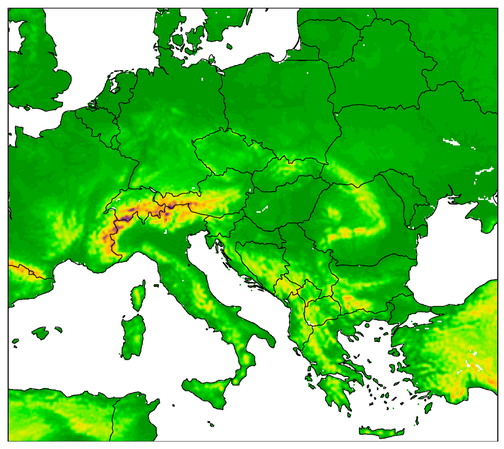
LACE nwp central europe

ACCORD A Consortium for COnvection-scale modelling Research and Development

Operational configurations

ALADIN/HU

- Model version: cy40t1 (ALARO-v1b physics)
- 8 km horizontal resolution, 49 vertical levels
  - Local data assimilation:
  - 3D-Var in upper air, optimal interpolation at surface
  - 6-hour assimilation cycle
  - Short cut-off analysis for the production runs
  - Downscaled ensemble background error covariances
- Digital filter initialization
- 4 runs a day: 00/12 UTC up to 60h; 06 UTC up to 48h; 18 UTC up to 36h
- 3 hourly lateral boundary conditions from ECMWF-HRES
- Hourly outputs

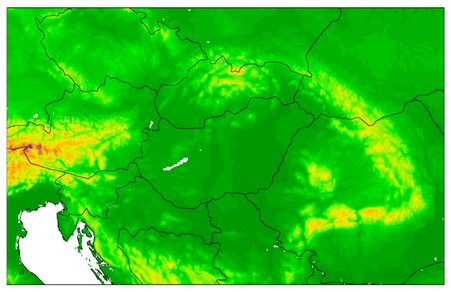


ALADIN/HU model domain

AROME/HU

- Model version: cy43t2_bf11
- 2.5 km horizontal resolution, 60 vertical levels
- Local data assimilation:
  - 3D-Var in upper air, SEKF at surface
  - 3-hour assimilation cycle
  - Lake temperature initialized from measurements at Lake Balaton
  - Hydrometeors & snow cycled through assimilation cycle
- Initialization: space-consistent coupling (no DFI)
- 8 runs a day: 00/06/12/18 UTC up to 48h;
  03/09/15/21 UTC up to 36h;
- LBCs from ECMWF-HRES with 1h coupling frequency
- SBL scheme over nature & sea to calculate the screen level variables
- Hourly outputs for forecasters, special outputs in every 15 minutes for commercial users & hail prevention system

Assimilated observations (via OPLACE)	
ALADIN/HU	AROME/HU
• SYNOP (u, v, T, RH, z) • SYNOP-SHIP (u, v, T, RH, z) • TEMP (u, v, T, q) • AMDAR (u, v, T) • ATOVS (AMSU, MHS radiances) • MSG/GEOWIND (AMV) • MSG/SEVIRI (radiances)	• SYNOP (u, v, T, RH, z) • TEMP (u, v, T, q) • AMDAR (u, v, T, q) • Slovenian & Czech Mode-S MRAR (u, v, T) • GNSS ZTD • **AMV, HRWIND**



AROME/HU and AROME-EPS domain

Convection-permitting ensemble system

- 11 ensemble members using AROME
- Local perturbations:
  ensemble data assimilation (from March)
- 2 runs a day, from 0 and 12 UTC up to 48 hours
- Hourly LBCs from 18/6 UTC ECMWF-ENS
- Resolution, physics etc. as in AROME/HU (cy43t2)

Computer system

- HPE Apollo 6000 server
- 22 nodes x 2 CPU x 20 cores, 2.2 GHz Intel XeonE5-2698 processors
- 128 GB RAM/node
- Transfer of IFS LBCs from ECMWF via Internet, backup ARPEGE LBCs from Météo-France

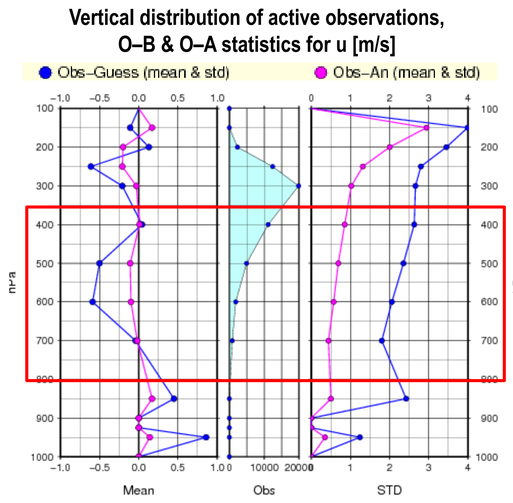
Assimilation of AMV data in AROME/HU

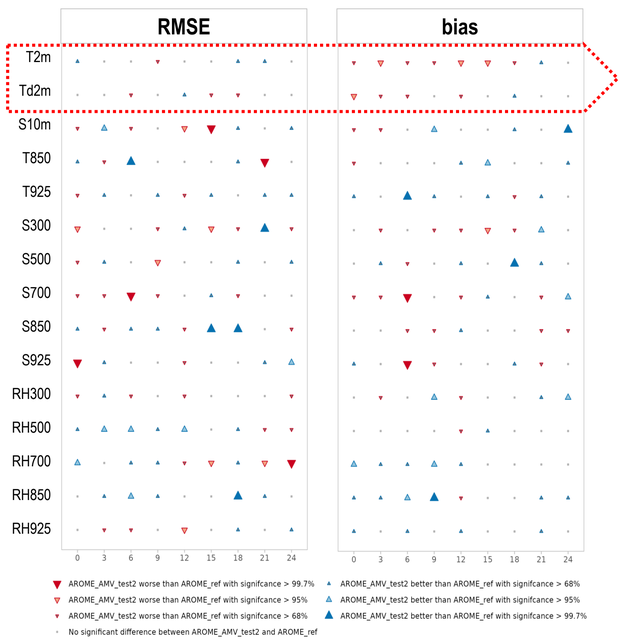
Geowind data have already been assimilated in ALADN/HU for long time. Adopting the same setting to assimilate **EUMETSAT AMV and NWCSAF HRW** in AROME/HU, many – potentially valuable – observations were blacklisted. Therefore, a revised setting was applied adding **extra observations between 800 and 350 hPa**. The setup was tested carefully with cy40 and mostly neutral to positive impacts were obtained. The experiments with cy43t2_bf11 led to the same conclusions.

Besides our normal verification procedure, we also used HARP to check the significance of the verification scores (with bootstrap method). The scorecard mostly supports the neutral impact seen in the previous verification. We can observe significant bias for the 2-metre temperature and dewpoint when we use the AMVs. However, this bias is less than 0.02 ºC which we consider negligible.

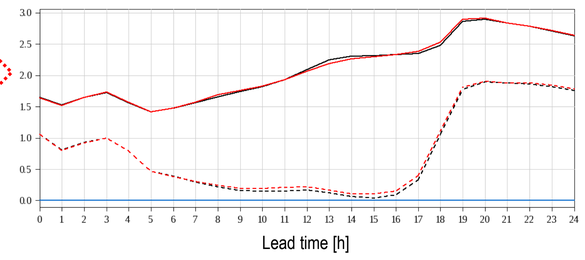
Based on the results, data (also using AMVs between 350 and 800 hPa) have been included in the operational assimilation flow since February 2023.

Vertical distribution of active observations, O–B & O–A statistics for u [m/s]

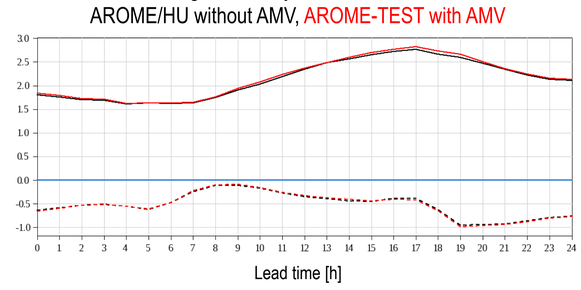




2-metre temperature bias (- -) & RMSE (–) [ºC]
1 August – 1 July 2021, 0 UTC runs
AROME/HU without AMV, AROME-TEST with AMV



2-metre dewpoint bias (- -) & RMSE (–) [ºC]
1 August – 1 July 2021, 0 UTC runs
AROME/HU without AMV, AROME-TEST with AMV



Experiments and e-suite for EDA in AROME-EPS

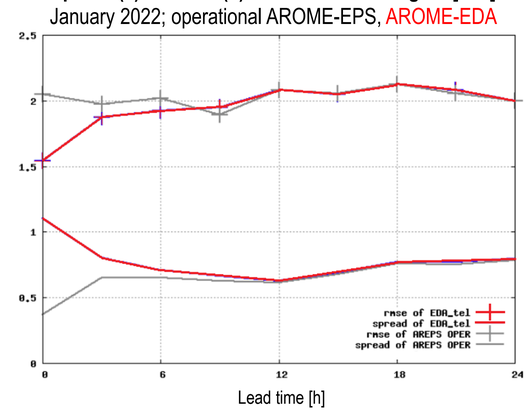
Operational AROME-EPS is a downscaling of 11 ECMWF-ENS members. Experiments to introduce local perturbations were continued using **EDA** technique for 2 winter periods. The same conventional and GNSS ZTD measurements were assimilated as in AROME/HU (i.e. no AMV) 3 hourly. For surface, OI-main and SEKF was used in January 2022 and November-December 2022, respectively.

Compared to the results of the summer experiment, EDA caused less improvement. Positive impact was obtained for 10-metre wind speed and wind gust: RMSE of the ensemble mean and CRPS decreased during the first hours. The ensemble spread increased in the first 9-18 hours. EDA slightly reduced the underestimation of the afternoon precipitation.

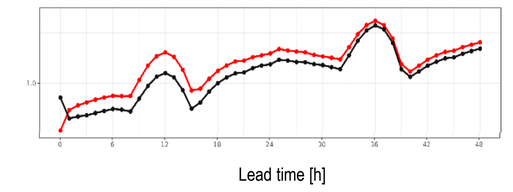
In November and December, EDA predicted lower 2-metre dewpoint and temperature than the operational AROME-EPS, the latter was advantageous in many cases. However, it overestimated the amount of low level clouds.

EDA is introduced to the operational AROME-EPS in March 2023.

Spread (–) & RMSE (+) for 10-metre wind gust [m/s]
January 2022; operational AROME-EPS, AROME-EDA



2-metre temperature CRPS [ºC]
15/11-15/12/2022; operational AROME-EPS, AROME-EDA



Computation of new B-matrix at 1.3kmL90 resolution

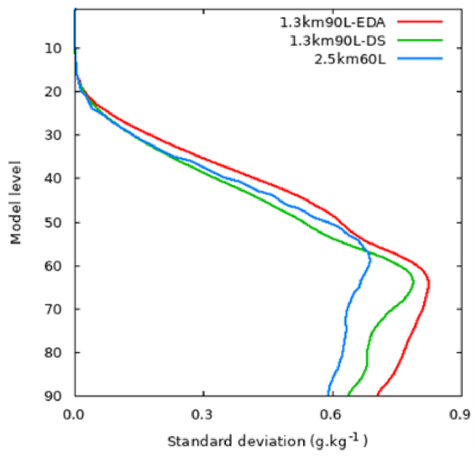
We are testing AROME at 1.3 km resolution and with 90 vertical levels. This requires new data assimilation setups, especially a new background error covariance matrix. First the **downscaled B-matrix** and then the **EDA B-matrix** were constructed by perturbing the assimilated observations.

We selected two 15-day periods from summer and winter during which 6 ensemble members of AROME have been initialized at 00 UTC, 06 UTC, 12 UTC and 18 UTC. We used 3-hour guess files, as there is a 3-hourly assimilation cycle in operational AROME/HU. The EDA B-matrix was calculated based in the differences of 6 perturbed members, using a 7-day spin-up period and a REDNMC value of 0.7.

The new 1.3 km EDA B-matrix has larger variances than the **2.5 km B-matrix** for all variables and most of the vertical levels. EDA B-matrix also contains larger variances than the downscaled B-matrix at the same resolution. The biggest differences are seen at the lower model levels.

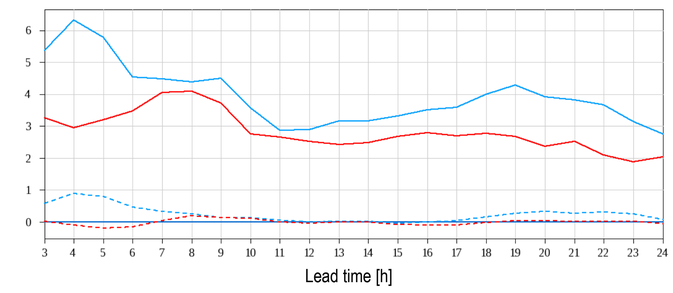
Forecast experiments were run for 8–21 July 2021 (OI-main was used for surface). The new EDA B-matrix and higher resolution improve the precipitation overestimation in the first forecast hours. However, the 2.5kmL60 resolution forecasts still overperform the 1.3kmL90 resolution version for 10-metre wind gust. We will continue to test the new B-matrix for several periods and make some tuning (e.g. for wind gust).

Vertical profile of std. deviation of specific humidity
downscaled & EDA B-matrix at 1.3kmL90,
EDA B-matrix at 2.5kmL60

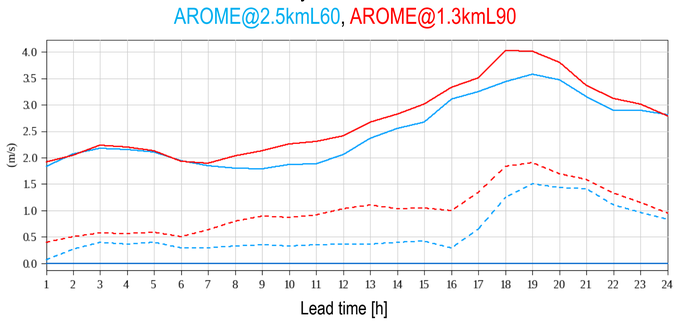


3-hour precipitation [mm] at 6 UTC, 18 July 2021

Bias (- -) & RMSE (–) of 3-hour precipitation sum [mm]
8–21 July 2021, 12 UTC runs
AROME@2.5kmL60, AROME@1.3kmL90



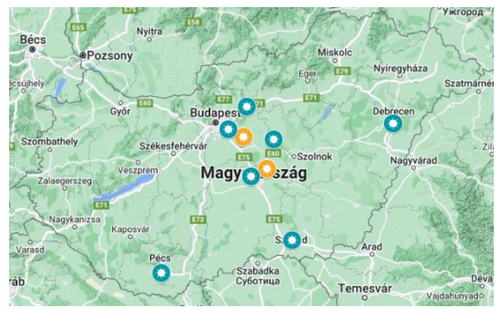
10-metre wind gust bias (- -) & RMSE (–) [m/s]
8–21 July 2021, 0 UTC runs
AROME@2.5kmL60, AROME@1.3kmL90



Post-processing of AROME-EPS radiation forecasts

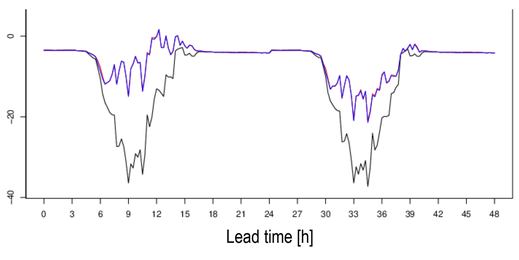
Some post-processing methods based on ensemble model output statistics (EMOS) were elaborated in order to improve the raw radiation forecasts supplying input for estimation of short-term solar energy production. Two kinds of probabilistic distributions were tested to calibrate AROME-EPS radiation forecasts for fitting better to its diurnal characteristics: **censored logistic (CL0)** and **censored normal (CN0)** distributions. On top of the partner observations, SYNOP measurements are used to train the model over a year with a 31-day rolling training period.

The methods are added to the AROME-EPS e-suite. Verification was achieved from October 2022 to February 2023. The CRPS for the first and second forecast days improved by around 11 and 7%, respectively, with reduced underestimation and growing spread. The post-processing turns to operational in March 2023. We plan to largely extend the number of applied observations.



Observations used in post-processing: radiation from solar energy farms and SYNOP stations

Radiation bias [W/m²]; location: Debrecen
Raw AROME-EPS, censored logistic, censored normal



Flowchart of the operational post-processing

Collection of input data (netCDF)
Actual AROME-EPS outputs
Radiation observations from the preceding day

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Treatment of data gaps (shell)
Handling missing data
Calculation of 15-minute data from 10-minute observations

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Post-processing (R)
Application of CL0/CN0 EMOS

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Outputs (ascii, csv)
Post-processed point forecasts in form of percentiles

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Monitoring (R)
Daily verification, statistics, visualization