

NWP activities at the Hungarian Meteorological Service

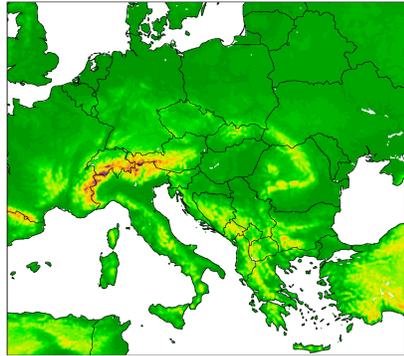
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Operational configurations

ALADIN/HU

- Model version: cy40t1 (ALARO-v1b physics)
- 8 km horizontal resolution, 49 vertical levels
- Local data assimilation:
 - 3D-Var (upper air), optimal interpolation (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 UTC (60h); 06 UTC (48h); 12 UTC (60h); 18 UTC (36h)
- 3 hourly lateral boundary conditions from ECMWF-HRES
- Hourly outputs

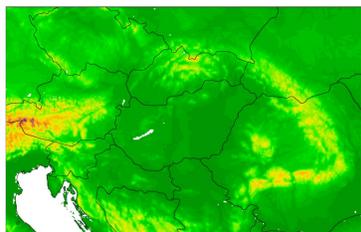


ALADIN/HU model domain

AROME/HU

- Model version: cy43t2_bf11
- 2.5 km horizontal resolution, 60 vertical levels
- Local data assimilation:
 - 3D-Var (upper air), OI-main (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 UTC (48h); 03 UTC (36h); 06 UTC (48h); 09 UTC (36h); 12 UTC (48h); 15 UTC (36h); 18 UTC (48h); 21 UTC (36h)
- LBCs from ECMWF-HRES with 1h coupling frequency
- SBL scheme over nature & sea to calculate the screen level fields
- Hourly outputs for forecasters, special outputs in every 15 minutes for commercial users & the hail prevention system

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



AROME/HU and AROME-EPS domain

Convection-permitting ensemble system

- 11 ensemble members using AROME
- Atmospheric initial conditions and hourly LBCs from 18 UTC ECMWF-ENS, surface initial condition from 0 UTC AROME/HU
- Downscaling, no local perturbations
- 2 runs a day, from 0 and 12 UTC (from April) up to 48 hours
- Resolution, physics etc. as in AROME/HU (cy43t2)

Computer system

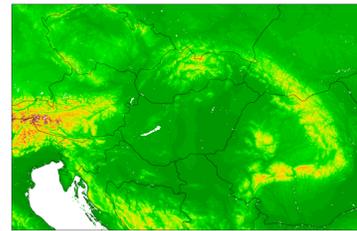
- HPE Apollo 6000 server
- 12 nodes x 2 CPU x 20 cores, 2.2 GHz Intel XeonE5-2698 processors
- 128 GB RAM/node
- Transfer of IFS LBCs from ECMWF via Internet, backup ARPEGE LBCs from Météo-France via Internet & ECMWF re-routing

High-resolution hourly RUC experiments

AROME experiments at 1.3 km horizontal resolution and 90 vertical levels started in 2021. Different options of the statistical cloud scheme (LOSIGMAS, VSIQSAT) were tested on 1-month summer and winter periods without data assimilation. Final setting was chosen similarly to the operational AROME/France (with the only difference of VSIQSAT=0.06).

We continued the experiments with data assimilation to investigate the effect of hourly rapid update cycle (RUC). Two experiments were conducted on two resolutions (1.3 km with 90 levels and 2.5 km with 60 levels). The main characteristics were as follows:

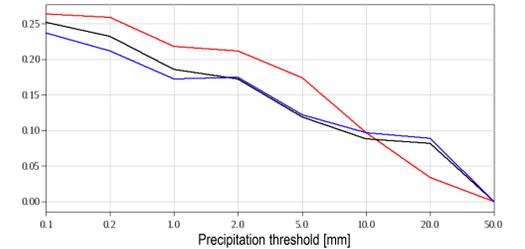
- Hourly cycling with symmetrical (-30/+30 min) assimilation window for OI-main and 3D-Var
- Downscaled B-matrix in high-resolution experiment
- Verification period: 7–28 July 2021 (spin-up between 1 and 7 July)
- Daily forecasts at 0 UTC up to 30 hours.



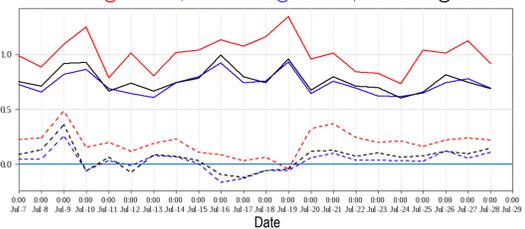
Domain and orography of 1.3 km resolution AROME

Verification shows an improvement in forecasts of 2-meter temperature and precipitation in the high resolution experiment with respect to AROME/HU. However, 10-meter wind and gust are roughly the same or somewhat worse than in the 2.5 km setup. The 10-meter wind analysis shows considerable error that is not present in the 2.5 km setup. The verification of upper air variables yielded mostly neutral results, although some degradation is detected in the upper air wind for both experiments.

ETS for 6-hour precipitation sum at 21 UTC, 2021/7/7–28
AROME-RUC @ 1.3kmL90, AROME-RUC @ 2.5kmL60, AROME/HU @ 2.5 kmL60



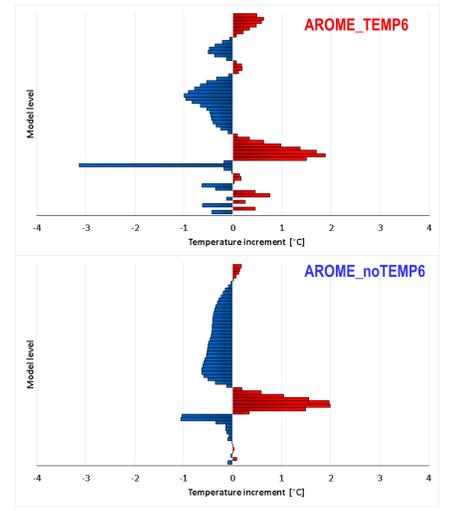
10m wind speed analysis bias (-) & RMSE (-) [m/s] at 0 UTC, 2021/7/7–28
AROME-RUC @ 1.3kmL90, AROME-RUC @ 2.5kmL60, AROME/HU @ 2.5kmL60



Sensitivity study for assimilation of extra radiosonde data

At 6 UTC on 12 December 2021 an extraordinary radiosonde measurement was performed at Szeged station (12982; in addition to the normal sounding at 0 and 12 UTC) because of the weather situation with mixed phase precipitation. This sensitivity study focuses on the effect of assimilating extra TEMP data on the forecast. Two case studies were run: AROME_TEMP6 represents the operational AROME/HU which includes all available observations, while AROME_noTEMP6 represents the run without the extraordinary 6 UTC sounding data.

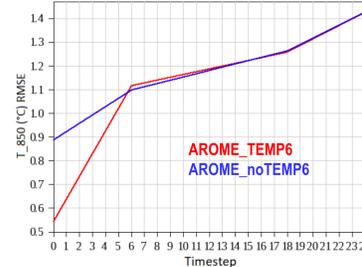
Analysis-guess temperature increments [°C] at model levels
6 UTC on 12 December 2021



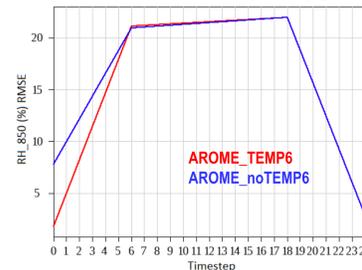
The analysis-guess temperature increments at Szeged clearly shows that the extra measurement has considerable effect on all model levels, especially on the lower levels.

The improved analysis affects positively the forecast. For instance, looking at RMSE of temperature and relative humidity at 850 hPa over the AROME/HU domain, AROME_TEMP6 forecast is significantly better for both parameters during the first 6 hours than AROME_noTEMP6, however this advance disappears later.

850 hPa temperature RMSE [°C]



850 hPa relative humidity RMSE [%]



E-suite with SEKF

The operational AROME/HU uses optimum interpolation (OI-main) for surface data assimilation. From 15 November 2021, a 1-month AROME-TEST SEKF parallel suite was launched with the following assimilation settings:

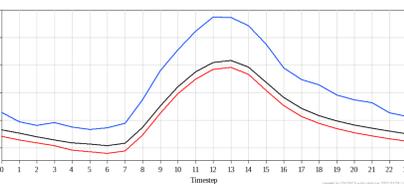
- XERROBS (T2M,HU2M) = 1.0,0.07
- XSIGMA (WG2,WG1,TG2,TG1) = 0.15,0.1,2.0,2.0
- XTPRT (WG2,WG1,TG2,TG1) = 10-4,10-4,10-5,10-5

In addition to the verification, some subjective evaluations were carried out: forecasters routinely recorded their comments on differences between the operational and test forecasts at 0, 6 and 12 UTC; model developers ranked the 2-meter temperature, 10-meter wind and gust, cloud and precipitation forecasts in interesting weather situations.

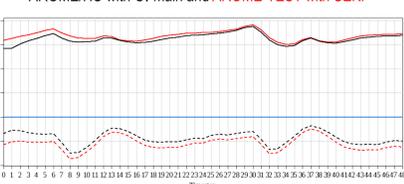
A systematic underestimation of 2-meter temperature and dewpoint was experienced during the test period. Especially the maximum temperature was underestimated which was even greater when using Kalman filter. The reasons behind are manifold: overestimation of low-level cloud (fog) in November, some fake snow persistence in December.

An additional verification campaign is planned in May.

2-meter temperature [°C]
19 November–17 December 2021
AROME/HU with OI-main, AROME-TEST with SEKF, SYNOP

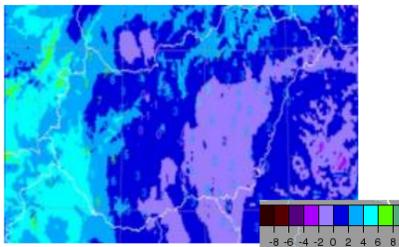


2-meter dewpoint bias (-) & RMSE (-) [°C]
19 November–17 December 2021
AROME/HU with OI-main and AROME-TEST with SEKF

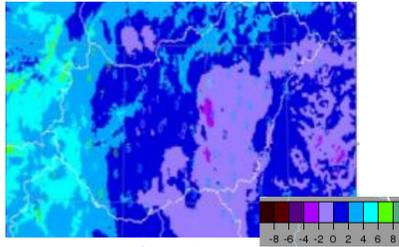


2-meter temperature [°C] at 12 UTC, 14 December 2021

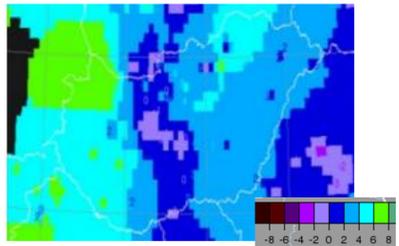
12-hour forecast of AROME/HU with OI-main



12-hour forecast of AROME-TEST with SEKF

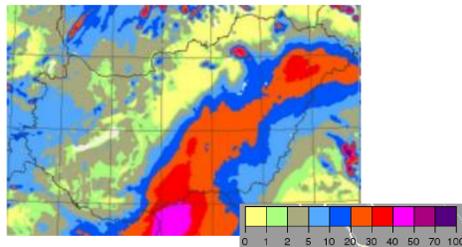


Observations

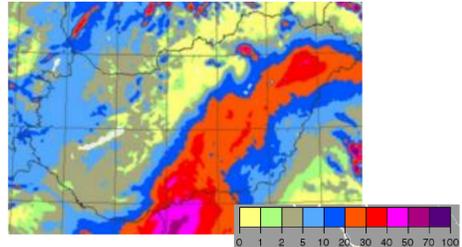


Snow depth [cm] on 14 December 2021

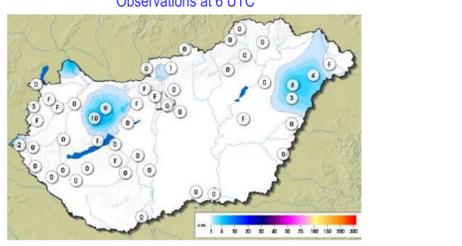
12-hour forecast of AROME/HU with OI-main



12-hour forecast of AROME-TEST with SEKF



Observations at 6 UTC



Daily 2 AROME-EPS forecasts

With increased computing capacity we introduced an additional AROME-EPS forecast initialized at 12 UTC per day. All properties of the operational AROME-EPS are kept. The advantage of the new run comes from the more fresh global forecast.

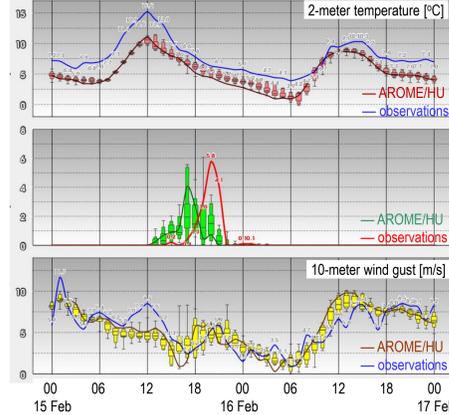
The product is available for forecasters since February 2022 and it turns to operational in April 2022.

Up to now some qualitative evaluation was done (see figure for high-precipitation event). The added value of this additional EPS run can be higher in summer convective cases.

We are working on inserting a third run at 6 UTC. This requires some reorganization of the current operational suites.

AROME-EPS initialized at 0 UTC on 15 February

Location: Iklódbördőce



AROME-EPS initialized at 12 UTC on 15 February

Location: Iklódbördőce

