NWP activities at the Hungarian Meteorological Service

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OMSZ

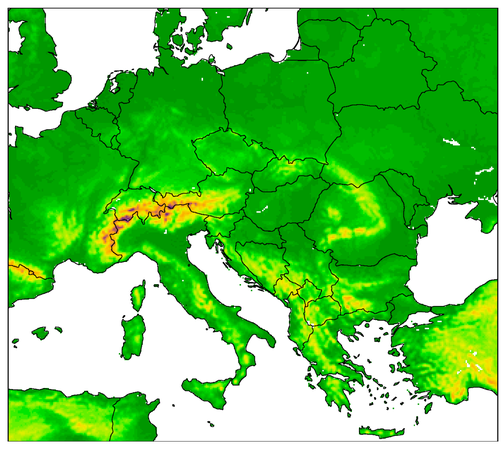
LACE nwp central europe

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: at 00/06/12/18 UTC up to 60/48/60/36 h
- 3 hourly lateral boundary conditions from ECMWF-"HRES"
- Hourly outputs

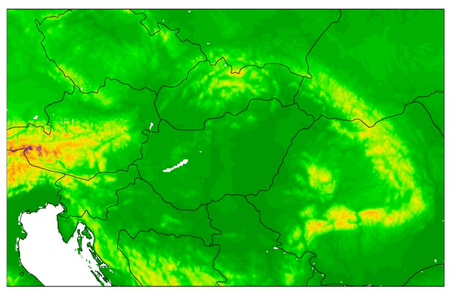


ALADIN/HU model domain

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 in assimilation
- 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 (IWV) • AMV, HRWIND (u, v)



AROME/HU and AROME-EPS domain

AROME-EPS

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

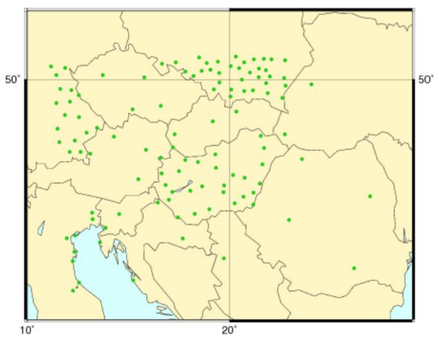
Computer system

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

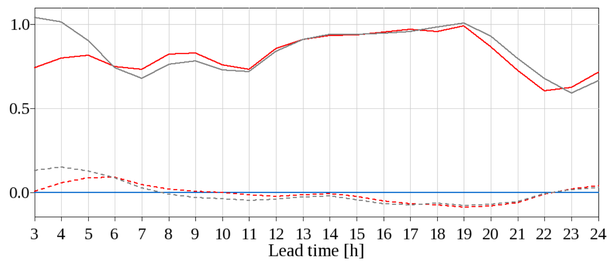
Update of GNSS ZTD assimilation in AROME/HU

The quality of SGO1 GNSS ZTD data dropped significantly in 2023, also negatively affecting the forecasts. We removed these data from the assimilation in April, but continued to assimilate the data from WUEL, GF1R and ASI networks.

At the same time, Budapest University of Technology and Economics started to provide GNSS ZTD data under the **BMEG** network for E-GVAP in February with similar coverage to **SGO1**. A new whitelist was prepared with 30, 34, 40, 11 stations from BMEG, WUEL, GF1R, and ASI networks, respectively.



3-hour precipitation bias (- -) & RMSE (–) [mm]
7–18 April 2023, 0 UTC AROME runs using SGO1 or BMEG



The verification shows mainly neutral to positive impact on the forecasts and an improvement of the precipitation overestimation in the beginning of the forecasts.

Assimilation of BMEG data with the new whitelist is operational in AROME/HU since June and BMEG is already one of the operational networks.

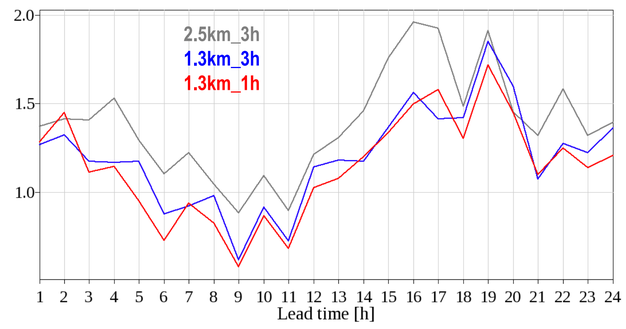
Experiments at 1.3kmL90 resolution and with hourly assimilation

We are testing AROME at **1.3 km resolution with 90 levels** and in the recent experiments we combined the **high resolution with hourly assimilation** cycle. The assimilation window in this system is -/+30 minutes.

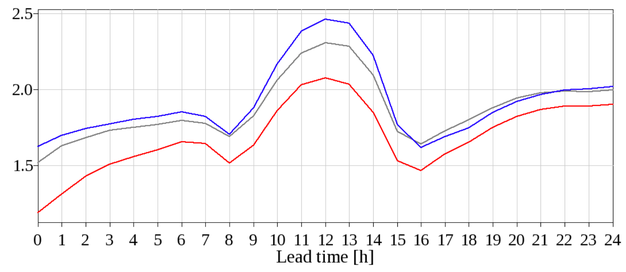
The new configuration was tested for two periods: between 8 July and 7 August 2021, and between 14 December 2022 and 13 January 2023. Apart from the GNSS ZTD data, the same observation types were involved in the assimilation as in the corresponding **operational AROME/HU**.

RMSE of summer precipitation reduces with the increasing resolution and further improvement is gained with the 1-hourly cycle. In winter, the amelioration due to the resolution change is not so clear, but the hourly cycle has positive impact on 2-metre temperature and relative humidity forecasts.

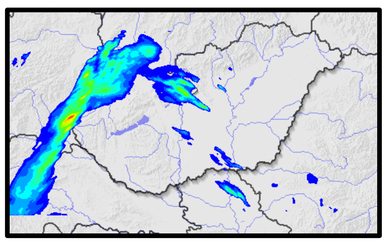
1-hour precipitation RMSE [mm]
8 July – 7 August 2021, 0 UTC runs



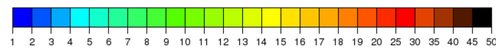
2-metre temperature RMSE [°C]
14 December 2022 – 13 January 2023, 0 UTC runs



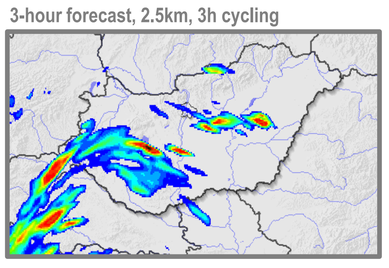
Radar



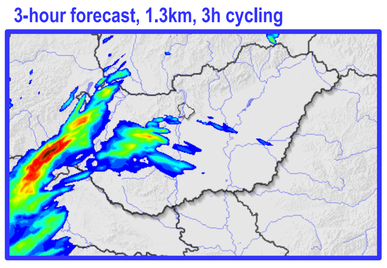
Precipitation [mm] between 2 and 3 UTC on 17 July 2021



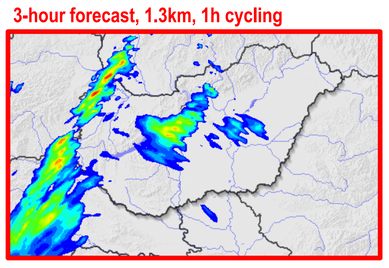
3-hour forecast, 2.5km, 3h cycling



3-hour forecast, 1.3km, 3h cycling

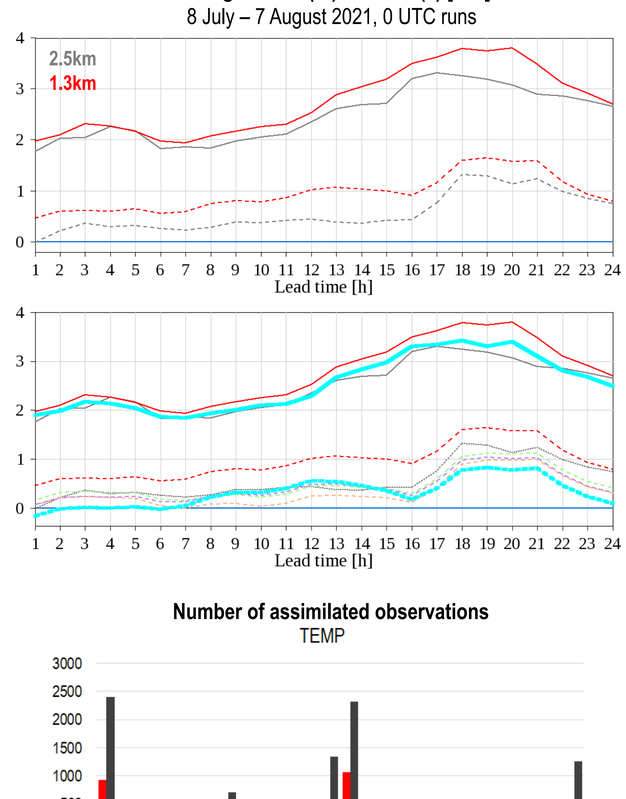


3-hour forecast, 1.3km, 1h cycling



The overestimation of wind gust became larger at 1.3 km resolution (in both cycling configurations) applying the **operational settings of Météo-France** for gust diagnostics. Thus, we have started some high-resolution experiments with tuning the FACRAF and HTKERAF parameters. The best results are provided by **EXP4** in which the 10-metre wind gust is computed using the TKE values at 60 meters.

Wind gust bias (- -) & RMSE (–) [m/s]
8 July – 7 August 2021, 0 UTC runs

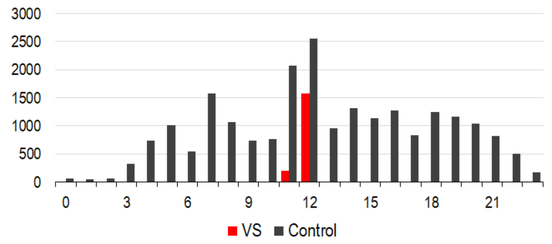


Experiments	REF	EXP1	EXP2	EXP3	EXP4
FACRAF	3.8	3.0	3.2	3.2	3.2
HTKERAF	20	20	20	30	60

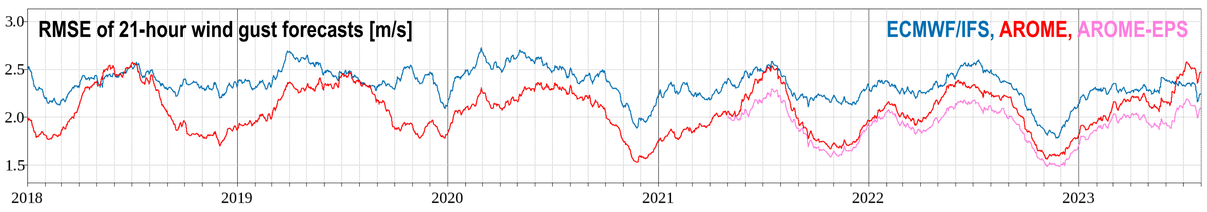
In May and June, we ran real-time e-suites with -/+ 30 min assimilation window to estimate the number of incoming measurements in an hourly RUC system. 3 configurations were tested with **0- (VS, very short)**, 30- and 60-minute cut-off time. The **control experiments** were run several hours after the nominal assimilation windows. Most SYNOP and AMV data arrive on time in VS experiment, while GNSS ZTD data can be used only after 1 hour waiting time. TEMP measurements are available the latest, not completely even after 1 hour. Most aircraft data (consisting of AMDAR and Mode-S MRAR in AROME/HU) arrive 90 minutes after the nominal initial time and only a few of them can be used in VS experiments (even in summer period). Mode-S EHS can be an alternative of current aircraft data.

Number of assimilated observations
TEMP

AMDAR, Mode-S MRAR



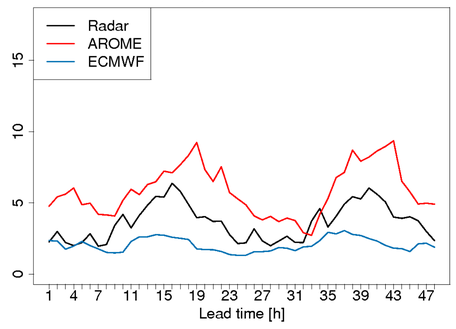
Case studies from summer 2023



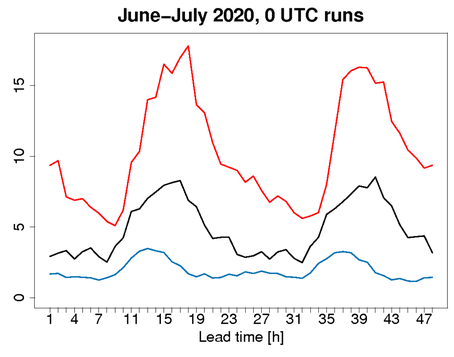
Several weather situations challenged the Hungarian forecasters in summer 2023. While 2021 and 2022 were years of drought and heatwaves in the Carpathian Basin, in first half of 2023 – similarly to 2020 – more than average precipitation fell in form of thunderstorms often with hail and severe wind gust. Thus, forecasts of this summer were evaluated with special care.

Although subjective feeling of the forecasters suggested extraordinarily weak model performance, the objective verification does not confirm this. The verification scores from the last 6 years show similar magnitude. Moreover, **AROME-EPS** (available for 3 years) has a considerable added value wrt. **AROME** (see top figure and bottom meteogram for wind gust). The intensity of precipitation objects are usually underestimated by **ECMWF/IFS** and overestimated by AROME wrt. **radar** data (maps below), however, this latter has greatly reduced since 2020 (right).

Average maximum intensity of top 3 precipitation objects [mm]
June–July 2023, 0 UTC runs

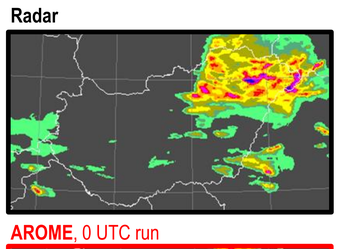


June–July 2020, 0 UTC runs

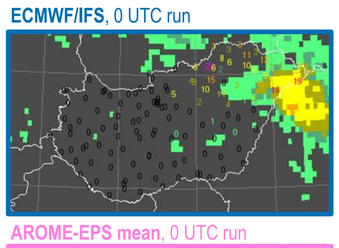


Precipitation [mm] between 15 and 18 UTC on 17 July 2023

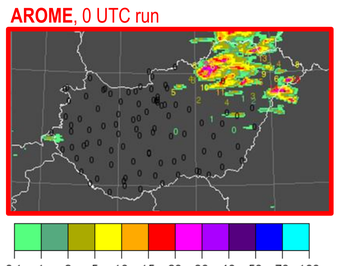
Radar



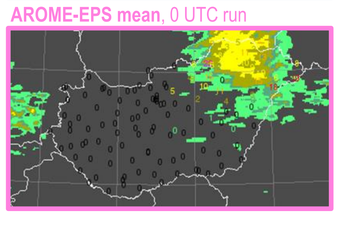
ECMWF/IFS, 0 UTC run

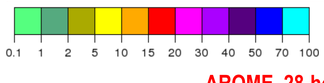


AROME, 0 UTC run

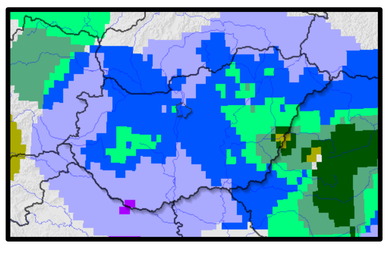


AROME-EPS mean, 0 UTC run

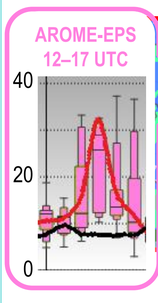




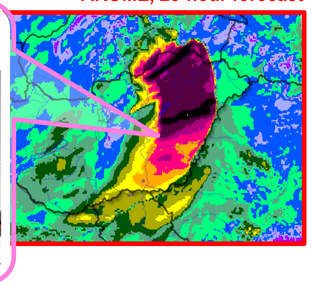
Wind gust [m/s] at 16 UTC on 25 July 2023
SYNOP



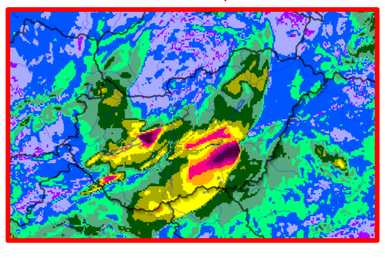
AROME-EPS 12–17 UTC



AROME, 28-hour forecast



AROME, 16-hour forecast



ECMWF/IFS, 16-hour forecast