NWP at the Hungarian Meteorological Service

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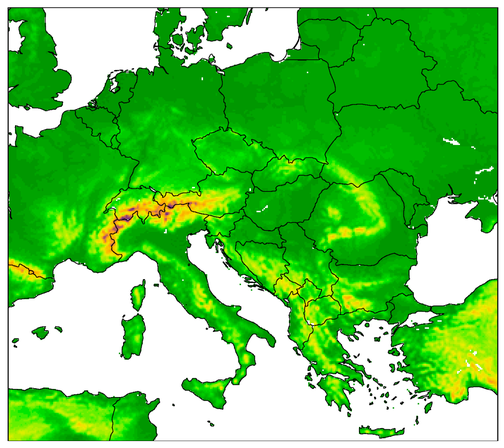
Operational configurations

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 initialisation
- 4 runs per a day:
  00 UTC (60h); 06 UTC (48h); 12 UTC (60h); 18 UTC (36h)
- 3 hourly lateral boundary conditions from ECMWF-HRES
- Hourly outputs

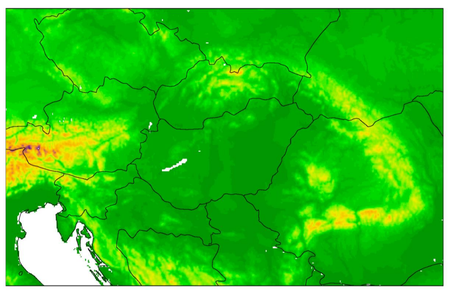


ALADIN/HU model domain

AROME/HU

- Model version: CY40T1
- 2.5 km horizontal resolution, 60 vertical levels (preparation for 90 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 trough data assimilation cycle
  - Experiments for hourly rapid update cycle (see on the right)
- Initialization: space-consistent coupling (no DFI)
- 8 runs per 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	
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 – see the results on the right) • Slovenian Mode-S MRAR • GNSS ZTD



AROME/HU and AROME-EPS domain

Convection-permitting ensemble system

- 11 ensemble members using AROME
- Downscaling, no local perturbations
- Initial conditions and hourly LBCs from 18 UTC ECMWF EPS
- One run per a day, from 0 UTC up to 48 hours
- Resolution, physics etc. as in AROME/HU
- Operational since February 2020 (see below)
- Backup ALARO suite: 11-member ensemble at 18 UTC up to 60h with 8 km resolution

Computer system

- HPE Apollo 6000 server
- 40 Intel XeonE5-2698 (2.2 GHz, 20 cores) processors, 2 CPU/node
- 128 GB RAM/node
- Maui 3.3.1 job scheduler, Torque 6.1.2 queue manager
- Transfer of IFS LBCs from ECMWF via Internet, backup ARPEGE LBCs from Météo-France via Internet & ECMWF re-routing
- AROME data assimilation on 40, model integration on 160 processor cores
- Continuous supervision & monitoring in a combined SMS & web based system

Operational Preprocessing for LACE (OPLACE)

- Real-time pre-processing of observations for data assimilation
- General data handling (fetching, partition, uploading), quality control, format conversions, derived products, monitoring
- Hosted by OMSZ since 2009
- RC-LACE NHMSs exchange their dense national surface synoptic measurements and high-resolution aircraft Mode-S MRAR data in real time in OPLACE
- Data (see tables on the right) are available on the FTP server of OMSZ for LACE countries
- Also for non-LACE countries in framework of a special agreement

Observations available in OPLACE

Observations	Obstype number	Type/Sensor	Platform
Surface synoptic	1	SYNOP, SHIP	
Aircraft	2	AMDAR	
Atmospheric motion vectors	3	AMV HRW	Meteosat 11 Meteosat 11 + NWCSAF
Upper-air sounding	5	TEMP	
Wind profiler	6	E-PROFILE	
Satellite radiances	7	SEVIRI AMSU-A/B, MHS, HIRS IASI ATMS	Meteosat 11 Metop-A/B/C, NOAA-18/19 Metop-A/B/C SNPP,NOAA-20
Ocean/sea winds	9	ASCAT OSCAT	Metop-A/B/C ScatSat

Observations	Obstype number	Type/Sensor	Data provider
Surface synoptic	1	SYNOP, AWS	Austria
			Croatia
			Czech Republic
			Hungary (internal data)
			Slovakia
			Slovenia
			Romania (via GTS)
			Poland
Aircraft	2	Mode-S MRAR	Slovenia
			Czech Republic
		Mode-S EHS	Netherlands (KNMI)
GNSS	1	ZTD	E-GVAP

Reference:

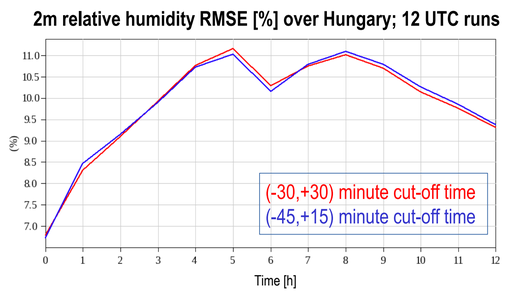
Trojáková, A., Mile, M., Tudor, M., 2019: Observation Preprocessing System for RC LACE (OPLACE), Adv. Sci. Res. 16, 223–228, https://doi.org/10.5194/asr-16-223-2019

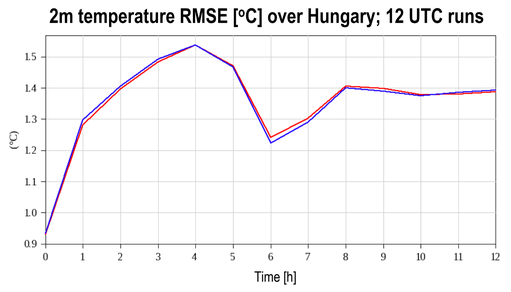
AROME hourly rapid update cycle experiments

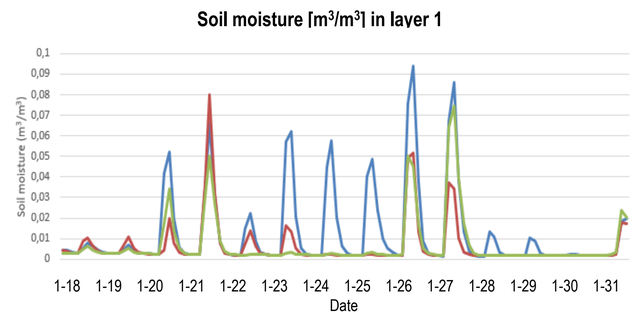
Two configurations for cut-off time were tested in hourly RUC experiments from 4 May to 2 June 2019:

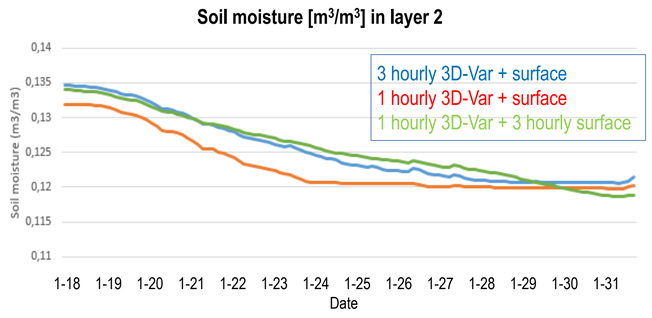
- a symmetric **-30 and +30-minute cut-off time**;
- a shifted **-45 and +15-minute cut-off time**.

Both experiments were run with **hourly cycle for 3D-VAR and 3 hourly cycle for surface data assimilation**. The 15-minute shift in the cut-off time does not show substantial impact on the forecasts. It is an important information to design the operational configuration later.







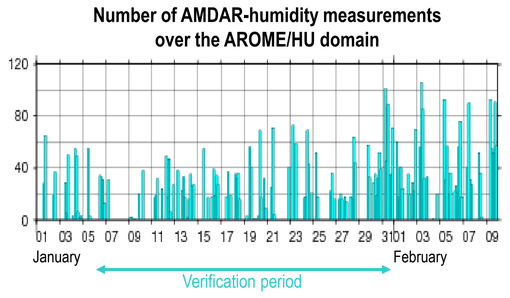


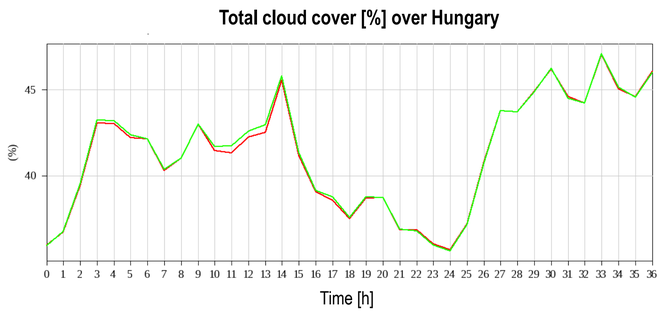
It was previously concluded that reduced frequency of surface data assimilation yields better forecasts. In the current study, we examined the increments of soil temperature and soil moisture provided by the surface assimilation from 18 to 31 January 2017.

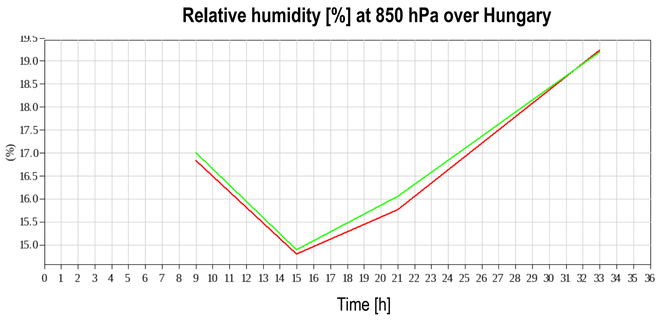
Soil temperature increments seem normal, but soil moisture increments are 0 during the whole period. It indicates that the soil moisture was driven by the model only, no real assimilation was performed, meanwhile all configurations yielded different soil moisture content.

Forecast sensitivity to assimilation of AMDAR humidity measurements

Impact of assimilating AMDAR humidity data in AROME/HU was already investigated for a summer period. In the current study, experiments were extended over a winter period, from 6 January to 1 February 2020. The experimental setup was similar to the operational AROME/HU running 8 forecasts a day. Monitor statistics show quite few AMDAR humidity measurements over the model domain in these weeks.







The quality of AMDAR-humidity measurements is comparable to that of radiosondes, however, small dry bias in lower levels is observed.

Pointwise verification against SYNOP and TEMP observations shows generally neutral impact. Small improvement can be detected in cloudiness in the forecasts started at 15 UTC, in relative humidity at 850 hPa in the 9 and 15 UTC runs.

Conclusion cannot be drawn for precipitation as there was only one day with significant (> 1 mm) amount in the selected period.

*RMSE in the 15 UTC runs for AROME/HU **with** & **without** AMDAR humidity measurements.*

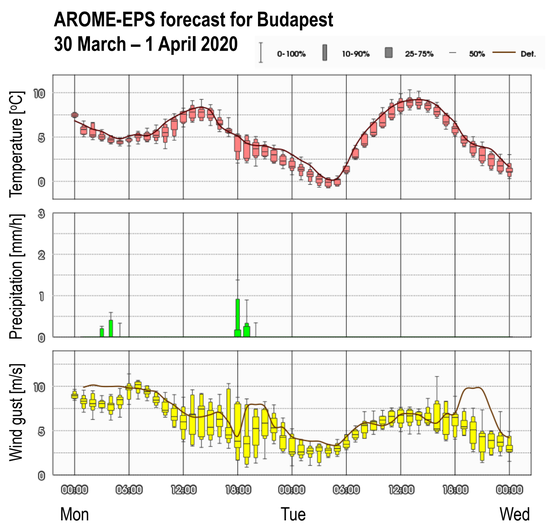
Operational convection-permitting AROME ensemble forecasts

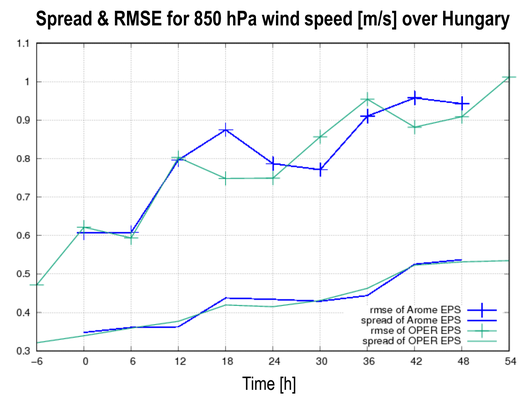
After a half-year pre-operational run, we turned the status of AROME-EPS to operational on 4th February 2020.

Results of **AROME-EPS** and **ALARO-EPS** were compared for 28 May – 19 June 2019 (a partly dry and warm period, with some heavy precipitation events induced by convection in a part of Hungary). AROME-EPS resulted in clearly better forecasts for geopotential, wind and cloud parameters (see top figure).

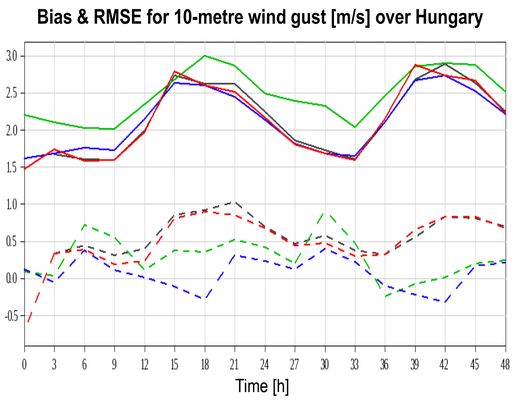
Next step is to introduce local data assimilation. First results show positive impact of **data assimilation** (see bottom right figure on verification of control members and **AROME/HU**).

We plan to study the effect of ensemble data assimilation with rising perturbation strength on AROME-EPS forecast.





*Spread (–) and RMSE (+) for **AROME-EPS** & **ALARO-EPS**. Verification reference: ECMWF analysis.*

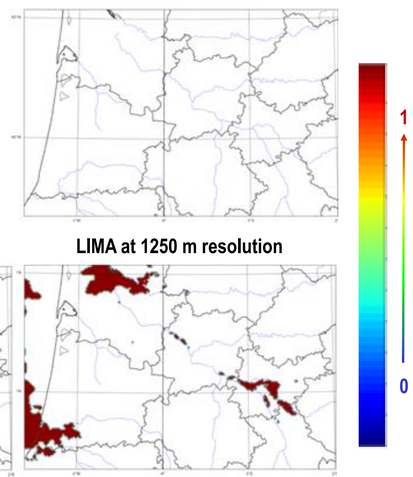


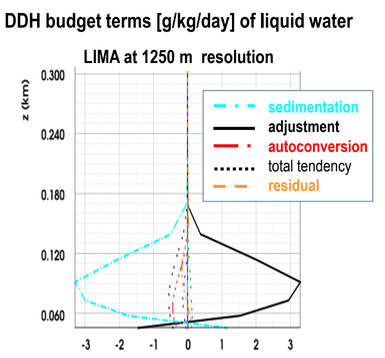
*RMSE (–) and bias (- -) for **AROME/HU**, **AROME-EPS**, **AROME-EPS_DA**, **ALARO-EPS**. Verification reference: ECMWF analysis.*

Sensitivity tests with LIMA scheme in fog cases

Implementation of LIMA (Liquid Ice Multiple Aerosols) 2-moment microphysical scheme in AROME is ongoing. Experiments were carried out for a fog case, 30 October 2016, over Garonne valley, at 1250 and 500 m horizontal resolution with 90 levels. Budgets of prognostic variables over a **horizontal domain (DDH)** were also calculated and compared with that of ICE3 scheme.

Too strong autoconversion is concluded leading to rain drops falling out and less cloud. Two other autoconversion approaches (for Cu and for Sc) were tested, but they give similar results for cloud cover.





30-hour forecasts for low cloud cover. Grey rectangle shows the DDH domain.