NWP activities at the Hungarian Meteorological Service

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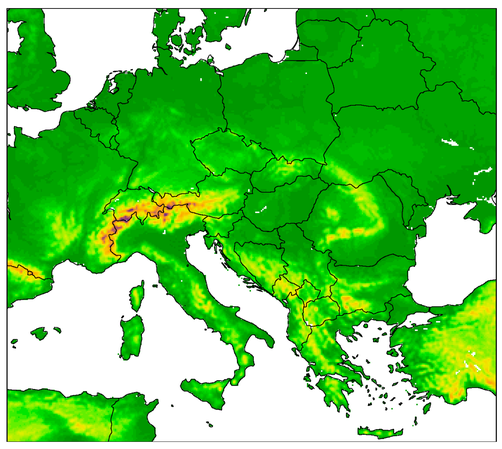
Operational configurations

ALADIN/HU

- Model version: cy40t1 (ALARO-v1b physics)
- 8 km horizontal resolution, 49 vertical levels
- Local data assimilation:
  - 3D-Var 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

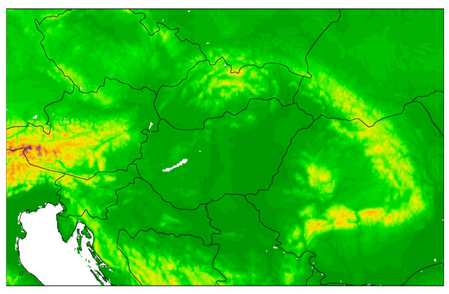


ALADIN/HU model domain

AROME/HU

- Model version: **cy46t1_bf07**
- 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: 3 hourly ensemble data assimilation
- 2 forecast 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

Testing assimilation of snow data in AROME/HU

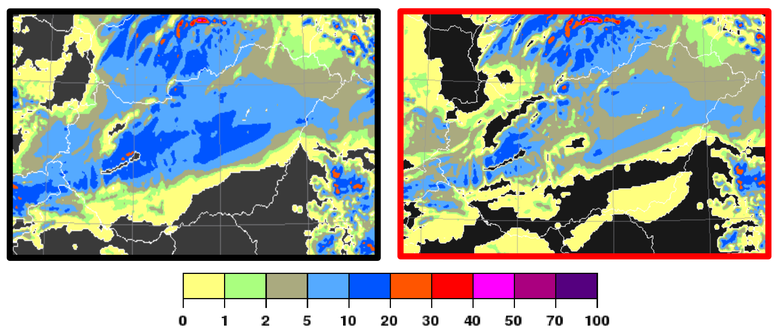
Assimilation of SYNOP snow depth observations is tested in AROME cy46t1. In Hungary, snow depth is measured only at 6 UTC. In the experiment, the 1-layer D95 snow scheme was used with 3 prognostic variables: snow-water equivalent (SWE), snow density and snow albedo. The snow depth measurements are converted into SWE using snow density in CANARI OI-MAIN, and then SWE is updated during the assimilation process. Some settings were prescribed in CANARI namelist:

- LAESNM =.T. (active snow assimilation)
- REF_S_SN = 5 kg/m^2
  (background error standard deviation)
- ECTERO(1,1,92,1) = 4 kg/m^2
  (observation error standard deviation)

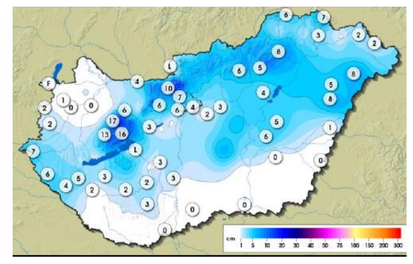
Experiment was launched for a snowfall case at 6 UTC on 22 November 2024 (with spin up from 18 November). The snow depth calculated from **assimilation of the snow-water equivalent** at 6 UTC on 22 November corresponds better with the observations than in the **reference run** in which the initial snow depth is taken from the 3-hour forecasts of the previous run.

The work will continue with different settings in CANARI OI-MAIN and we plan to test the bugfix of *Florian Meier* to set up a height-dependent rejection limit for observations with high deviations between station and model orographies.

Snow depth [cm] analyses at 6 UTC on 22 November



Snow depth [cm] observations at 6 UTC on 22 November



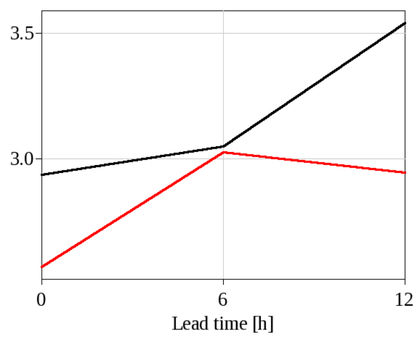
Testing assimilation of Mode-S EHS data in AROME-RUC

We set up the **assimilation of EMADDC EHS data** in AROME-RUC at 1.3 km resolution and hourly assimilation with 30-minute cut-off time for June 2024. We used the thinning parameters of box_heights: 300,300,600,1000 m; box_width: 40 km and SIGMA_COEF=2.8. The first results show some impact in high level winds (where no AMDAR data is available) and in precipitation, though the improvement is not clear.

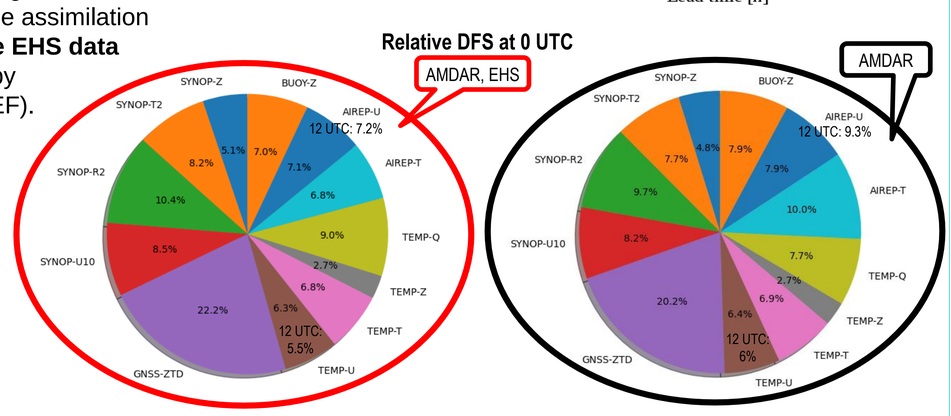
We implemented the tool to calculate the DFS (Degree of Freedom Signal) to compare the impact of different data types. Based on the DFS calculation the overall impact of the EHS data could be big because the calculated DFS is relatively big compared to other data due to lots of data points.
On the other hand, a single AIREP-U data has bigger impact on the assimilation result if we **exclude the EHS data** (which can be caused by increased SIGMA_COEF).

We are going to investigate the error correlations and find an optimal thinning, also we are exploring different thinning methods based on *Vivien Pourret*'s work.

RMSE of wind speed [m/s] at 100 hPa
June 2024, 0 UTC runs



Relative DFS at 0 UTC

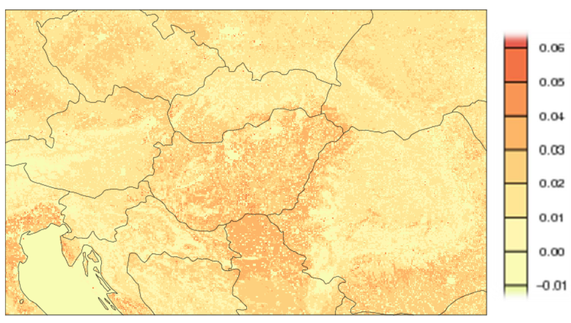


Reduced town fractions of ECOCLIMAP-II in AROME/HU

Our forecasters pointed out large warm biases in 2-meter temperature forecasts of AROME/HU and AROME-EPS in dry, anticyclonic weather situations in summer. Because of strong contrasts between neighbouring grid points, the reason were first sought in the soil characteristics (structure, type).

Later, the colleagues of CHMI found too high town fractions over Europe in ECOCLIMAP-II that generates too high night temperatures over Hungary using SURFEX/TEB. *Ján Mašek* created a Fortran program to modify the PGD file. A namelist variable is introduced, FTOWN_MIN, which sets the threshold for removing town fraction. By default this threshold is 0.05, all urban tiles with fraction smaller than FTOWN_MIN are converted to nature in the new PGD file.

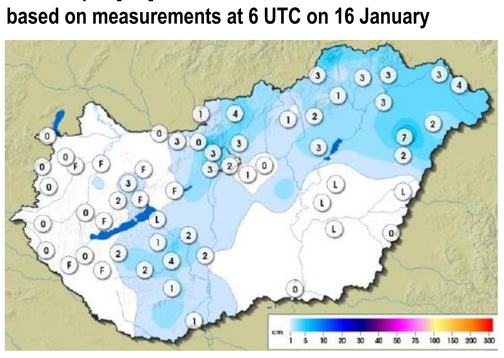
Difference between the new and original town fraction



The impact was further tested between 9 January and 7 February 2025 using AROME cy46t1_bf07 (the standalone impact of cy46 was neutral wrt. cy43). The period was characterized by temperature higher than mean and precipitation events with low amount and intensity. The main forecasting challenge was the precipitation type and cloud of partial cold air pads.

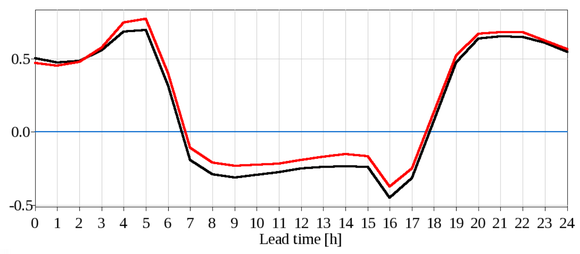
As expected the modification resulted in more atmospheric humidity which improved the cloud underestimation and the temperature overestimation, especially in anticyclonic cases.

Snow depth [cm]
based on measurements at 6 UTC on 16 January

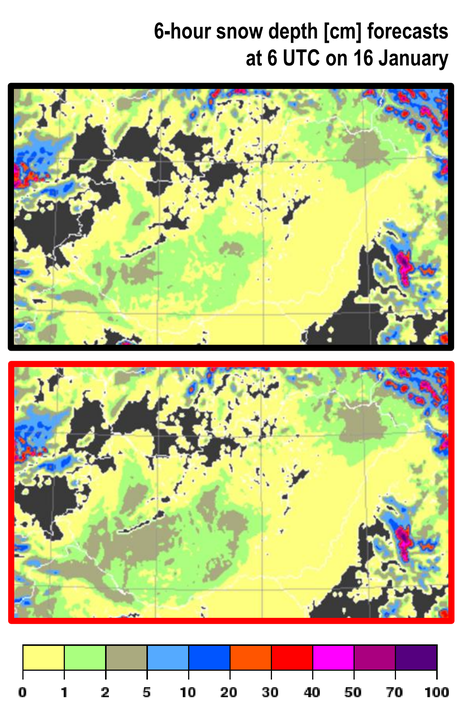


The impact was checked in a case when the temperature in the south of the country was still above 30°C in the evening hours, which was overestimated by **operational AROME** forecasts in some places. With **modification of the urban fraction**, temperatures near the surface moderated and humidity increased, especially at night in the critical areas. When the study was extended to June, and not only the anticyclonic weather conditions were taken into account, the positive effects somewhat reduced.

Bias of 2-meter dewpoint temperature [°C]
June 2024, 12 UTC runs



6-hour snow depth [cm] forecasts at 6 UTC on 16 January



In a case with considerable amount of snow in January, the forecast with **reduced urban fraction** led to higher snow amount which proved to be more realistic (although based on a single event this cannot be considered as a general impact).

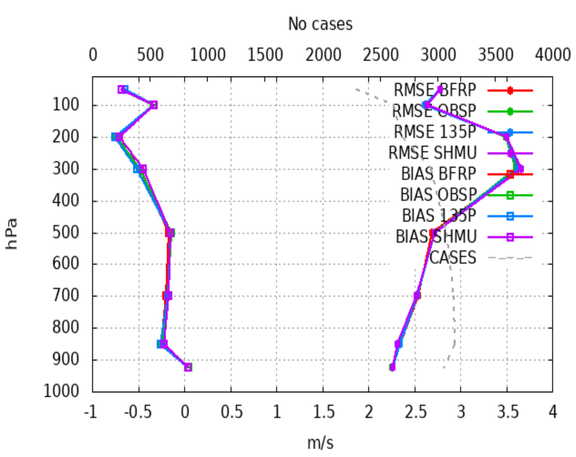
The modification is operational since the end of February 2025 in AROME/HU with cy46t1_bf07.

Experiments to assimilate BUFR TEMP data in ALARO/SK & AROME/HU

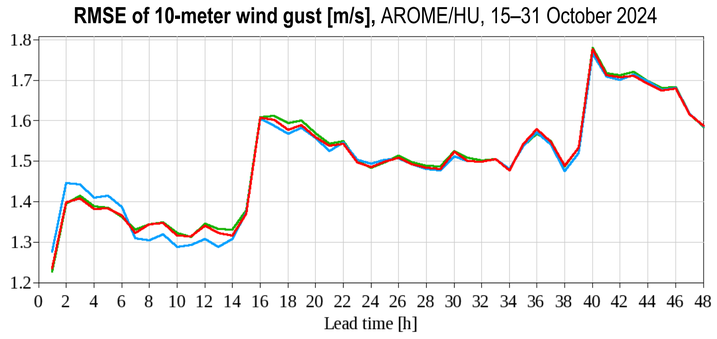
During an RC-LACE stay at the Slovak Hydrometeorological Institute supervised by *Maria Derková* we examined the impact of using high resolution TEMP in BUFR format instead of the OBSOUL format. By using the BUFR format two additional options are available: (1) to use the data from the descending radiosonde (with codetype 135) and (2) to take the trajectory of the radiosonde into account. The trajectory computation requires too much computational memory, thus we primarily tested option 1.

For the unbiased examination of OBSOUL and BUFR format of TEMP we needed to exclude the stations which provide only one of these two types. This was done by a blacklist, which also filtered out the data from the descending radiosonde. With this blacklist two experiments were made from 15 to 31 October 2024 running 48-hour forecasts at 0, 6, 12 and 18 UTC: using the **OBSOUL TEMP** and using the **BUFR TEMP**. A third experiment was also done for the same period with BURF TEMP but it used a blacklist which did not filter out the data from the **descending radiosonde**.

RMSE (o) and bias (□) of wind speed [m/s]
ALARO/SK, 15–31 October 2024



RMSE of 10-meter wind gust [m/s], AROME/HU, 15–31 October 2024



These 3 experiments and the **operational ALARO** model of the SHMU were verified by the vfld system. The results show that neither the change from OBSOUL to BUFR TEMP, nor the data from the descending radiosonde have significant impact, bigger differences are obtained with the data from the descending radiosondes. Corresponding experiments are ongoing using AROME/HU.

The usage of BUFR TEMP does not have negative effect on the forecasts and it allows us to utilize denser measurements. Thus we plan to replace the OBSOUL TEMP assimilation in AROME/HU. The impact of descending radiosondes will be further evaluated using AROME/HU for two 3-4 weeks measurement campaigns when radiosondes with parachute were emerged in Budapest.

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