Numerical Weather Prediction activities at CHMI

Czech Hydrometeorological Institute

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NWP system

ALADIN/CHMI couples non-hydrostatic (NH) dynamics and the set of ALARO-1vB physical parameterizations suited for modeling of atmospheric motions from planetary up to the meso-gamma scales:

- domain 1069x853 grid points, Δx~2.3km
- linear truncation E539x431
- 87 vertical levels, mean orography
- ICI scheme with 1 iteration, time step 90 s
- ALADIN cycle 48t3mas_op1 (ALARO-1vB)
- 3h coupling interval
- 00, 06, 12, 18 UTC forecast to +72h
- 03, 09, 15, 21 UTC forecast until the end of the next day
- hourly analysis system VarCan Pack

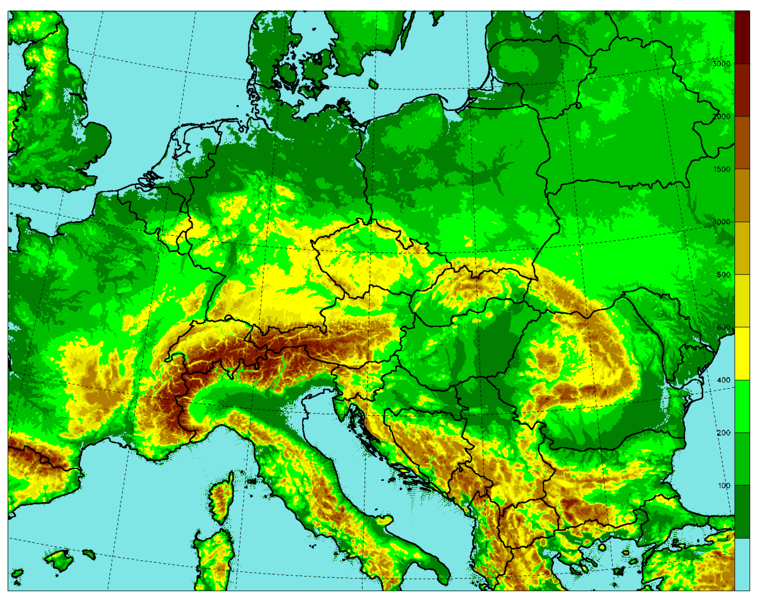

Fig. 1. Orography of the domain.

Data assimilation includes surface analysis based on an optimal interpolation (OI) and BlendVar analysis for upper air fields, which consists of the digital filter spectral blending (Brozkova et al.,2001) followed by the 3DVAR analysis (Fischer et al., 2005)

- digital filtering at truncation E102x81; space consistent coupling
- no DFI in long cut-off 3h cycle; incremental DFI in short cut-off production analysis
- observations: SYNOP, TEMP, AMDAR, Mode-S, SEVIRI, WP, HR-AMV, ASCAT, radar reflectivity

New HPC systems

New SX Aurora TSUBASA	SX Aurora TSUBASA
56 computing nodes with: - one **AMD ROME** 7443P CPU (24 cores, 512GB RAM) , and - eight **NEC Vector Engines** 20B (8 cores, 48GB RAM each) • total **1344 VH + 3584 VE cores**	48 computing nodes with: - one **AMD EPYC** 7402 CPU (24 cores, 512GB RAM) , and - eight **NEC Vector Engines** 20B (8 cores, 48GB RAM each) • total **1152 VH + 3072 VE cores**

Blending of specific humidity

Mária Derková and Radmila Brožková

During the summer, cases of missing convective precipitation in the early hours of the forecasts were reported by the CHMI duty forecasters. Hypothesising that this might be caused by a dry humidity bias in the Arpège analysis introduced via the DF blending, the impact of not blending the specific humidity (q_v) was investigated. The dry bias of the Arpège LBC is confirmed by the verification scores.

Two experiments were conducted, denoted ec1 and ec2 respectively:

- ec1: no blending of q_v was applied in either long cut-off 3h assimilation cycle or short cut-off production;
- ec2: no blending of q_v was applied in short cut-off production, but q_v was blended in long cut-off 3h assimilation cycle.

Their performance with respect to a reference (denoted ec0) was evaluated in the selected case studies as well as in the offline e-suites. Although experiments where q_v is not blended at all (ec1) seems to perform better in the summer convective situations (Fig. 2), such a setup brings worse scores in the winter stable situations with strong negative bias for relative humidity. Therefore the most promising setup seems to be a configuration where blending is omitted in the production only. Future plans involve further test e.i. no blending in the network times where there is no Arpège analysis available (03|09|15|21 UTC) or vertical modulation of q_v blending increments.

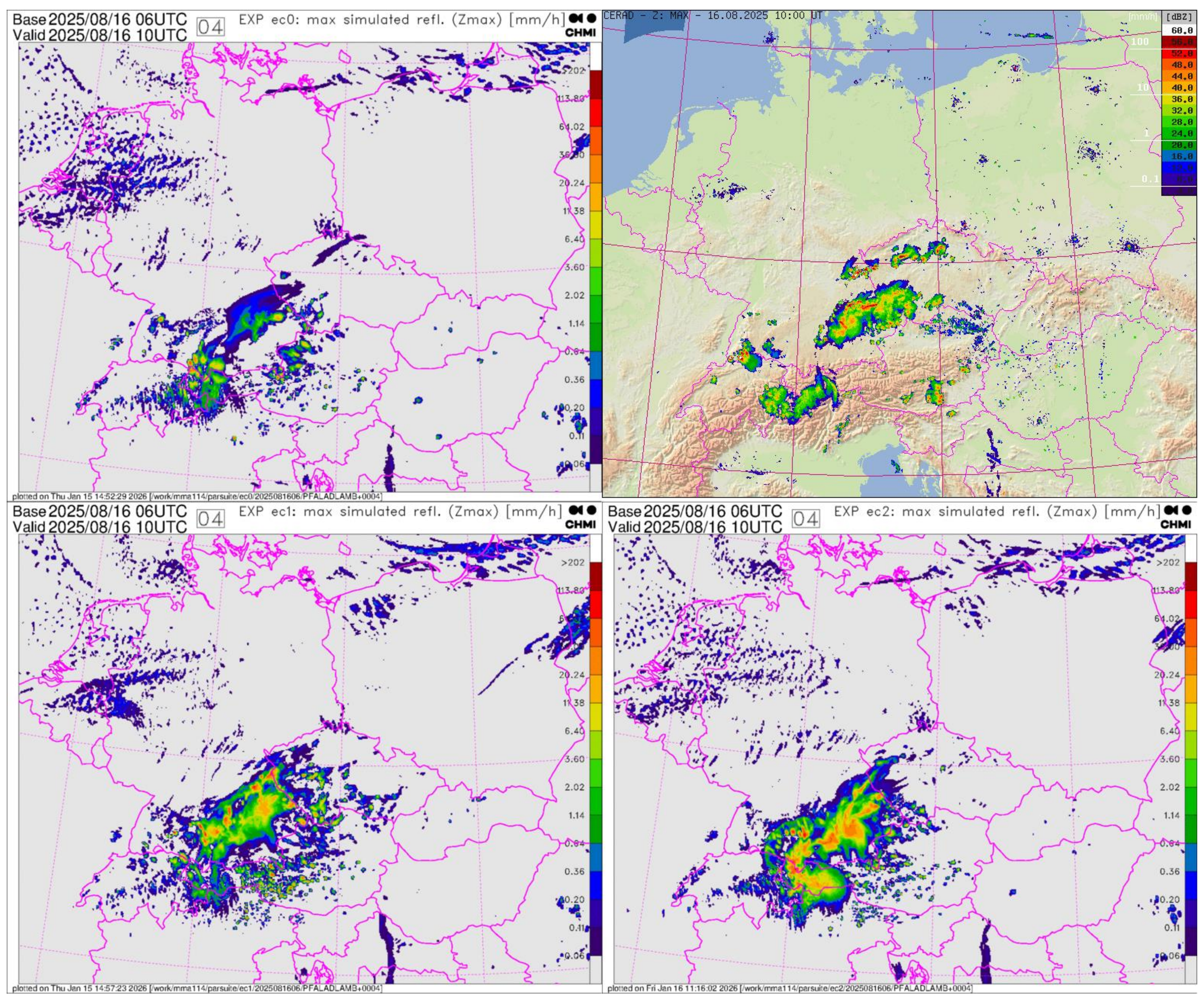

Fig. 2. Maximum simulated reflectivity (Zmax) valid at 16/08/2025 10 UTC. Top right is the CERAD/OPERA product. Top left: +4h Zmax forecast from the reference experiment ec0 - the convective activity near the border between Czechia and Bavaria was not captured well. Bottom line: ec1 and ec2 experiments with no blending of q_v in both 3h assimilation cycle and production or only in production, respectively.

Major operational changes

28 Apr 2025	1D+3D-Var data assimilation of OPERA radar reflectivity
10 Jun 2025	Implementation of 8 production runs a day
23 Sep 2025	Rain size distribution by Marshall-Palmer used instead of the Abel and Boutle one and tuning of parameters in microphysics and cloudiness in radiation
18 Dec 2025	Implementation of new model release - cy48t3
10 Mar 2026	Operational switch to the new HPC system

Snow depth analysis

Jáchym Ševčík, Alena Trojáková and Florian Meier (GeoSphere Austria)

The implementation of snow analysis for the ALARO CSC using the ISBA scheme was investigated. Three configurations of the assimilation scheme were selected:

- FR: inspired by Météo-France uses the Gaussian correlation function, default first-guess QC, no spatial QC, rejects any observation above 1500 m;
- AT-gauss: proposed by F. Meier uses the Gaussian correlation function, adapted height dependent first-guess QC, enables spatial QC, use data above 1500 m;
- AT-Mescan: proposed by F. Meier uses the adapted MESCAN correlation function, first-guess QC with height dependent σ_o, enables spatial QC, uses data above 1500 m.

The last two experiments aimed to use observations at high altitudes. A more benevolent QC was necessary to achieve this, and two alternatives were proposed.

The specific tuning parameters (correlation length scales, observation and background errors, QC thresholds) of these three configurations were tuned using the Nelder–Mead simplex method for minimizing a tailored cost function.

The results demonstrate a significant improvement in snow depth forecasting compared with both the reference without snow depth analysis and the default FR setting. However, more snow also causes a degradation in screen temperature and humidity forecasts for short lead times (cold and moist bias). This can be mitigated by adjusting the grid-box snow fraction prior to operational implementation.

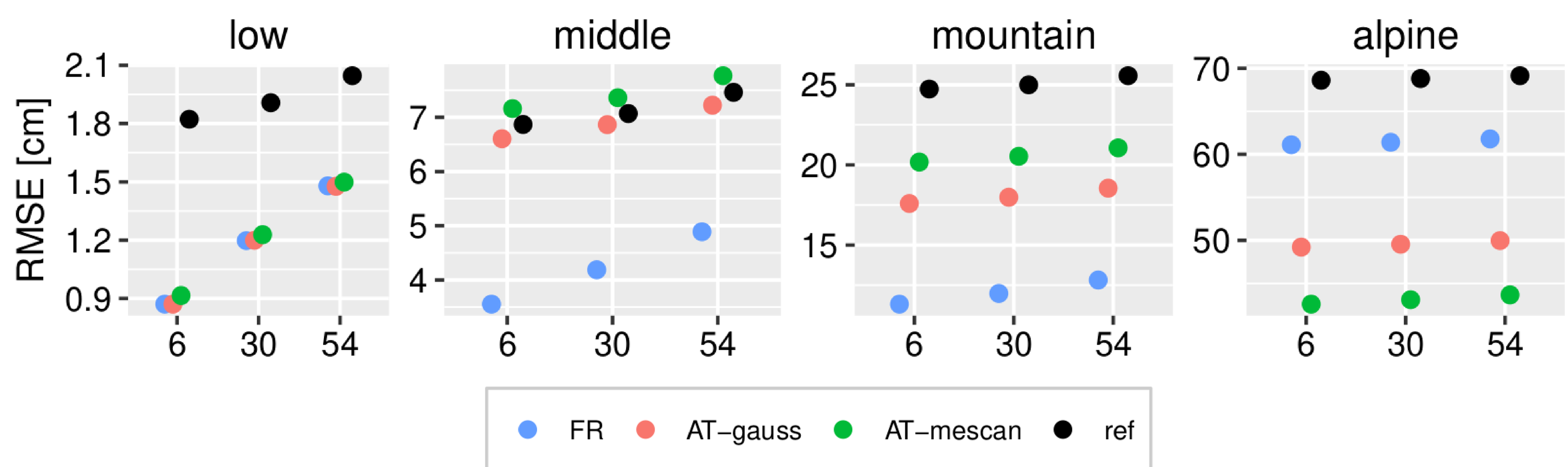

Fig. 3. RMSE of snow depth as a function of forecast lead time for period of Jan 2022 for various altitude groups: low (0-500m), middle (500-1000m), mountain (1000-1500m), and alpine (>1500m).

CAMS aerosols in ALARO+SURFEX

Piotr Sekula (IMGW) and Ján Mašek

Tests of ACRANEB2 radiation with the near-real-time (n.r.t.) CAMS aerosols revealed a systematic overestimation of surface global radiation in a clear-sky conditions, as illustrated by black curve in Fig. 4. Error of this magnitude cannot be compensated by adding stratospheric background aerosols, since their amount would have to be unrealistically high. Our investigation showed that there are multiple sources contributing to observed positive bias: 1 - used value of solar constant (5 W/m^2 higher than actual value); 2 - underestimated ozone in old e923 climatology (to be replaced by CAMS ozone climatology); 3 - Lambertian solid surfaces assumed by SURFEX scheme; 4 - underestimated short-wave transmissions in ACRANEB2 scheme; 5 - spectrally flat surface albedo. Another contributing factor can be overestimated surface albedo, via multiple ground-atmosphere reflections. Addressing of points 4 and 5 within ACRANEB2 framework would call for substantial revision of its short-wave part.

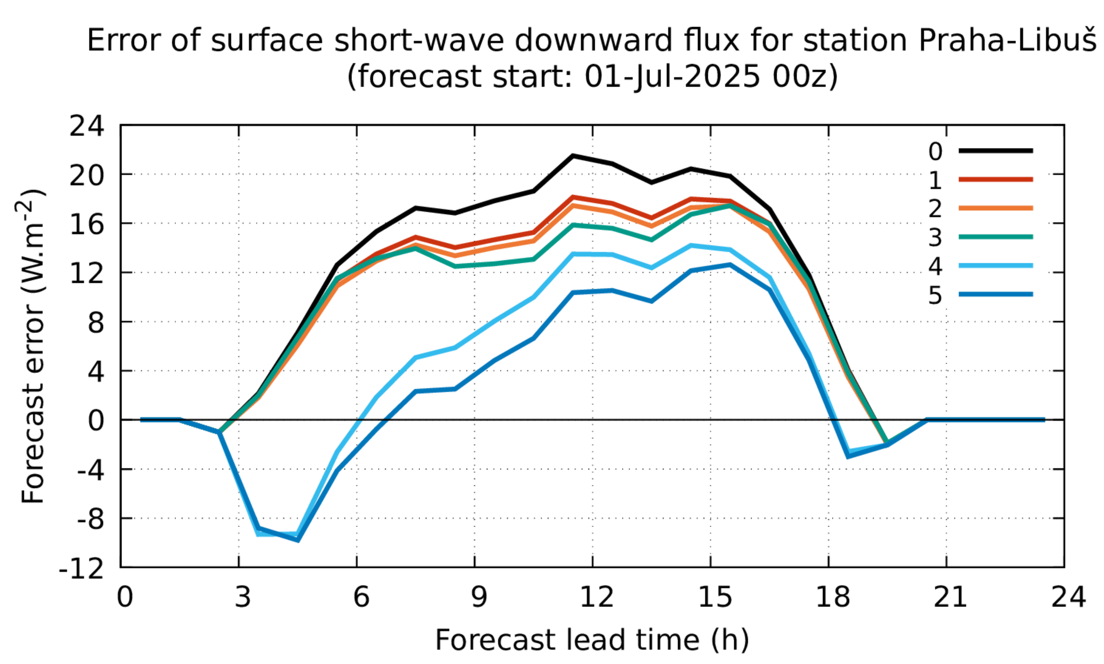

Fig. 4. Error of ALARO+SURFEX hourly global radiation on a clear day 01-Jul-2025 in Praha-Libuš: 0 = reference with ACRANEB2 radiation and n.r.t. CAMS aerosols; 1 = 0 + solar constant updated from 1366 to 1361 W/m^2; 2 = 1 + CAMS climatological ozone; 3 = 2 + non-Lambertian reflection from solid surfaces; 4 = 3 + ecRad with spectrally flat surface albedo; 5 = 4 + spectrally varying surface albedo. Experiments with ecRad scheme were run without aerosols, then the effect of CAMS aerosols was introduced approximately by multiplying fluxes by ratio of ACRANEB2 fluxes with and without CAMS aerosols.