

# Numerical Weather Prediction activities at CHMI

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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,  $\Delta x \sim 2.3\text{km}$
- linear truncation E539x431
- 87 vertical levels, mean orography
- ICI scheme with 1 iteration, time step 90 s
- 3h coupling interval
- 00, 06, 12/18 UTC forecast to +72/54h
- hourly analysis system VarCan Pack
- ALADIN cycle 43t2pt\_op2 (ALARO-1vB)

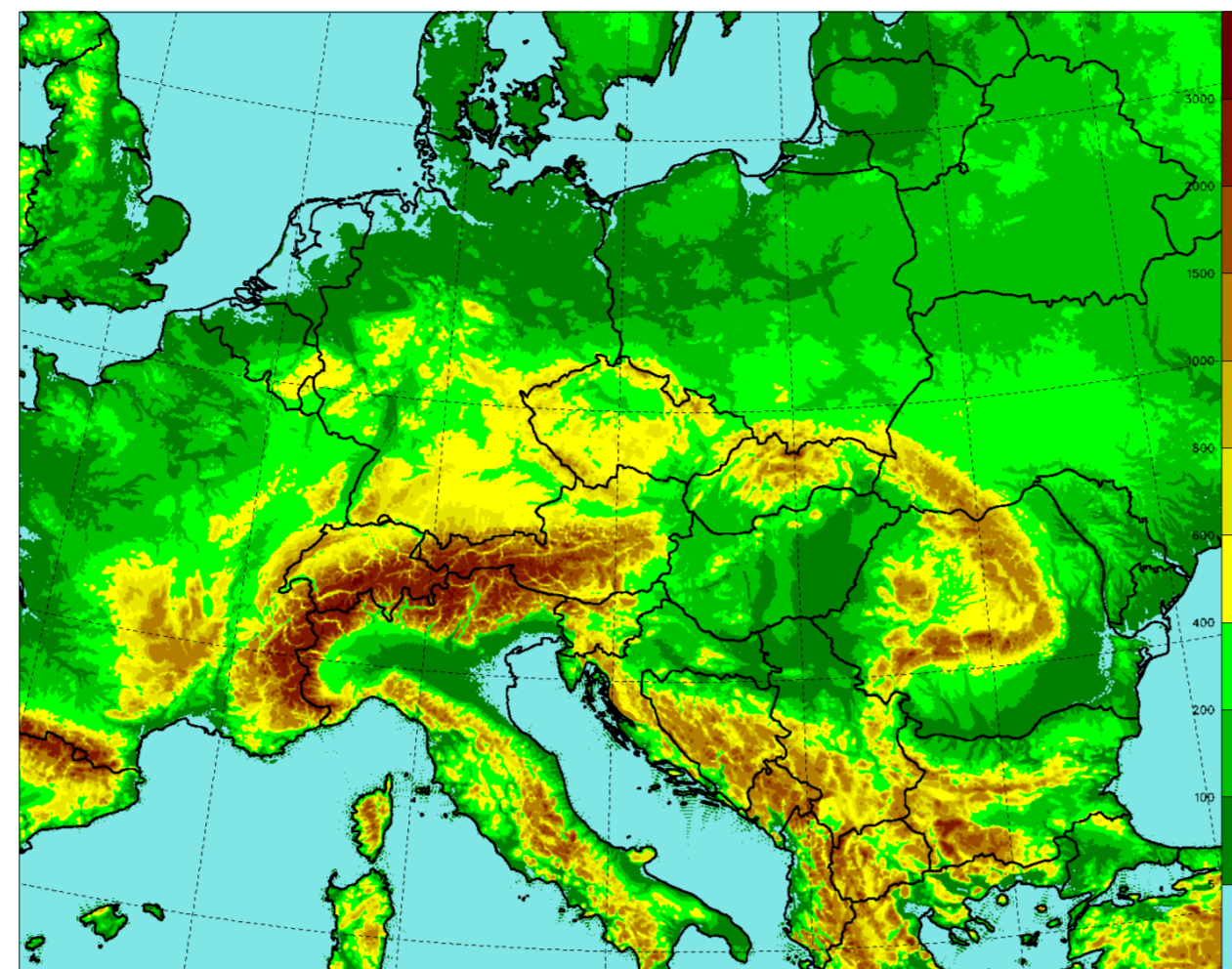
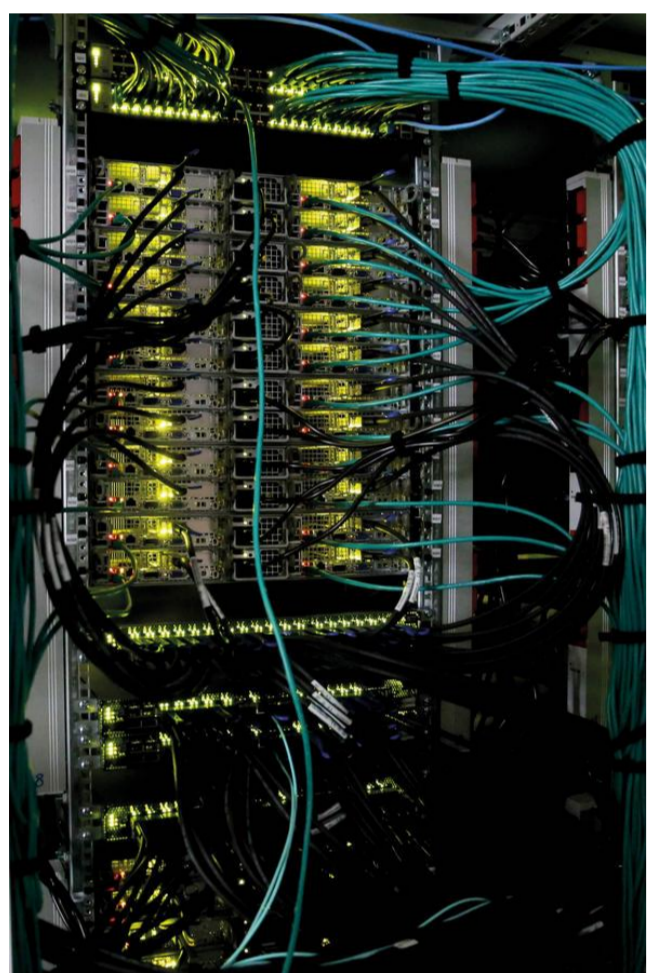


Figure 1: Orography of the domain.

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 6h cycle; incremental DFI in short cut-off production analysis
- observations: SYNOP, TEMP, AMDAR, Mode-S, SEVIRI, WP, HR-AMV, ASCAT

## HPC system



- NEC LX series HPC cluster
- 320 computing nodes connected through high-speed Mellanox EDR InfiniBand
- each node has two Intel Broadwell CPU (12 cores, 64GB RAM)
- 7680 computational cores in total
- operating system is CentOS 7.2 Linux OS
- more than 1 Petabyte of storage capacity
- SLURM scheduler
- Intel Parallel Studio XE Cluster Edition

## Major operational changes

- 16 Jun 2020 • background error covariances recomputed with EDA method
- e-suite AKR • assimilated observations extended by selected wind profilers high-resolution AMV (HR-AMV) replaced standard AMV product and ocean winds (ASCAT) added to active data assimilation
- OI structure functions length scales retuned and more national data implemented in surface analysis
- update of the topographic fields & vegetation roughness from more advanced databases (see description below)
- 24 Nov 2020 • implementation of the newly proposed time discretization of the prognostic TKE & TTE to avoid oscillations in turbulent fluxes (see talk of J. Mašek)
- e-suite AKS • retuning of surface analysis to reduce deep soil moisture increments due to precipitations
- 12 Jan 2021 • new visualization of outputs (see description in the right panel)

## Orographic and vegetation roughness

- Orographic roughness calculated from GMTED2020 with following tuning (FACZ0=0.53; Laplace-type smoothing operator applied 3 times)
- Switch off the "gravity wave drag" family of parameterizations at  $\Delta x \sim 2.3\text{km}$
- Use of vegetation roughness calculated from ECOCLIMAP II database with the tuning (tree height multiplied by factor 1.5; Laplace-type smoothing operator applied 3 times)

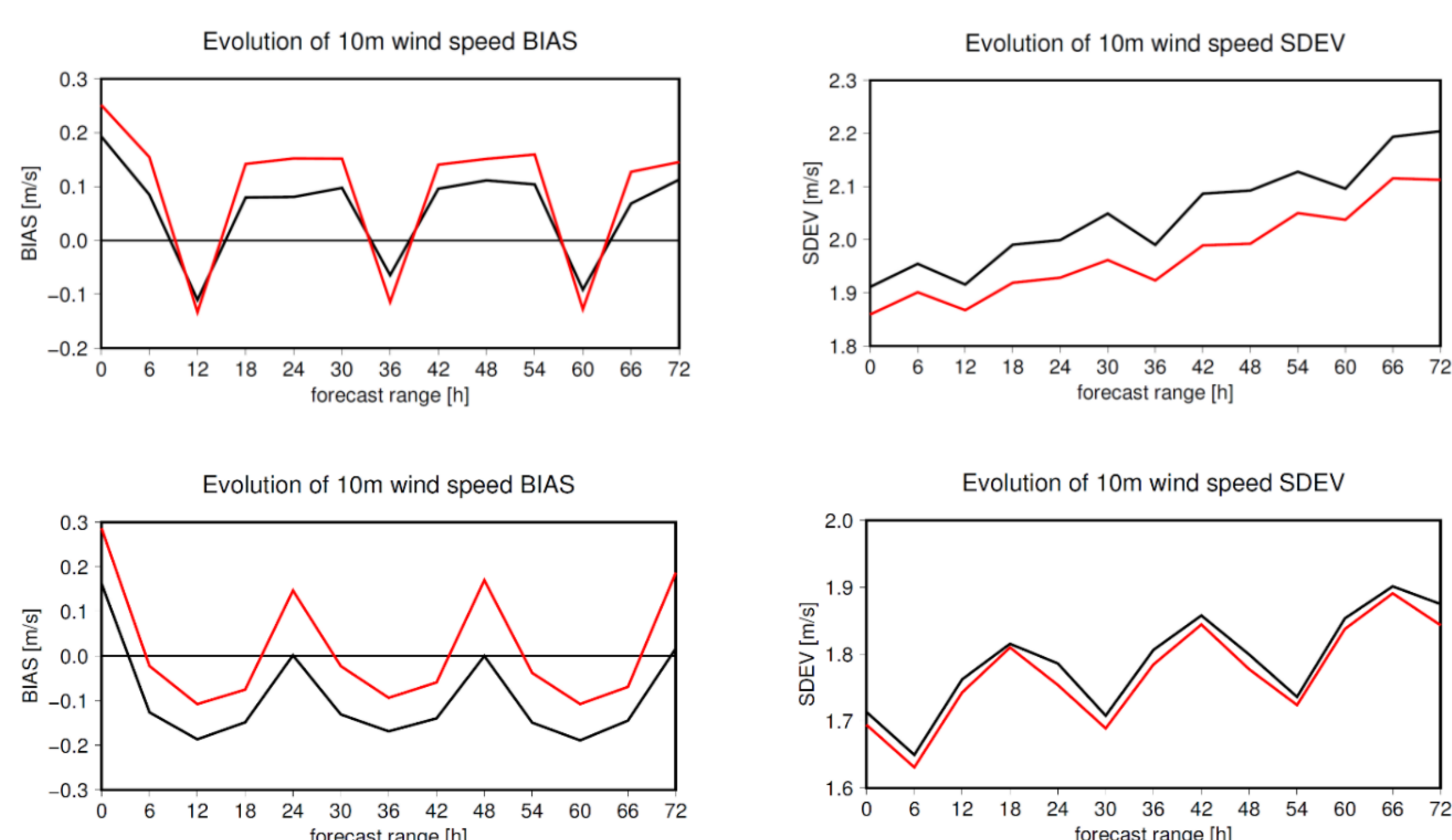


Figure 2: Scores of 10m wind speed. Reference (oper till 16 Jun 2020 in black). The e-suite becoming operational on 16 June 2020 in red. BIAS (left) and STD (right) for period 21 Nov - 10 Dec 2019 (top) and 14-31 May 2019 (bottom).

## Lightning diagnostic in ALARO-1

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Code for prognostic graupel in ALARO-1 was validated recently, with several issues discovered and fixed. Use of prognostic graupel opens a possibility to diagnose lightning intensity in the model, following McCaul et al. (2009) method. In AROME, the method is already implemented in subroutine DIAGFLASH by J. Cedilnik and C. Wittmann, together with dataflow transferring cumulated field 'SURFDIAG.FLASH' into historical files. We have interfaced subroutine DIAGFLASH with ALARO-1 graupel. Work on calibration of model lightning intensity against LINET measurements is ongoing, using hourly data covering the Czech Republic and its surroundings.

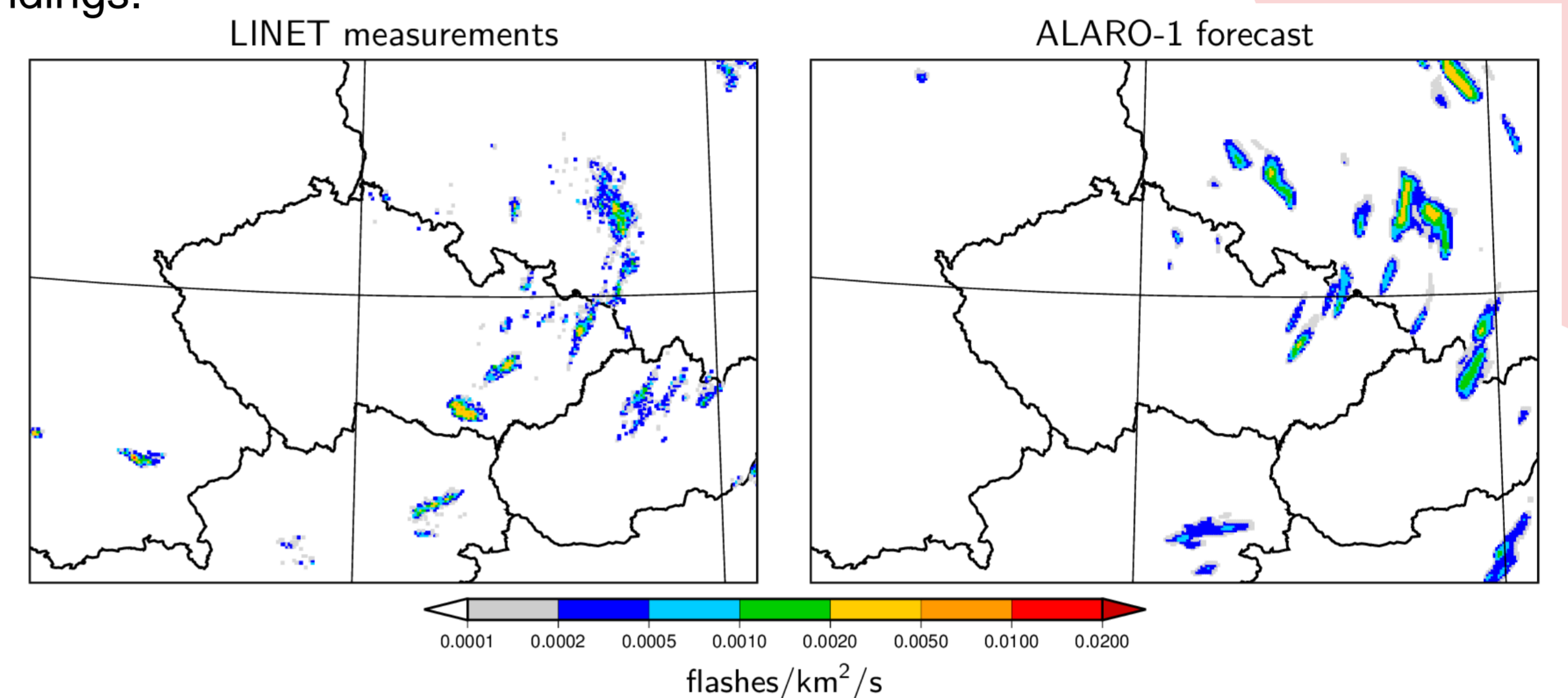


Figure 3: Average lightning intensity on 26-Jun-2020 between 16 and 17 UTC from LINET measurements (left), and from ALARO-1 forecast starting at 12 UTC (right). Method based on graupel flux across  $-15^\circ\text{C}$  level is shown, using preliminary calibration.

## ALADIN animations

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A new visualization for general public was prepared. The visualization contains animation of weather forecast post-processed to 1.5km grid at Mercator projection. The underlay is a map with orography or interactive OpenStreetMap.

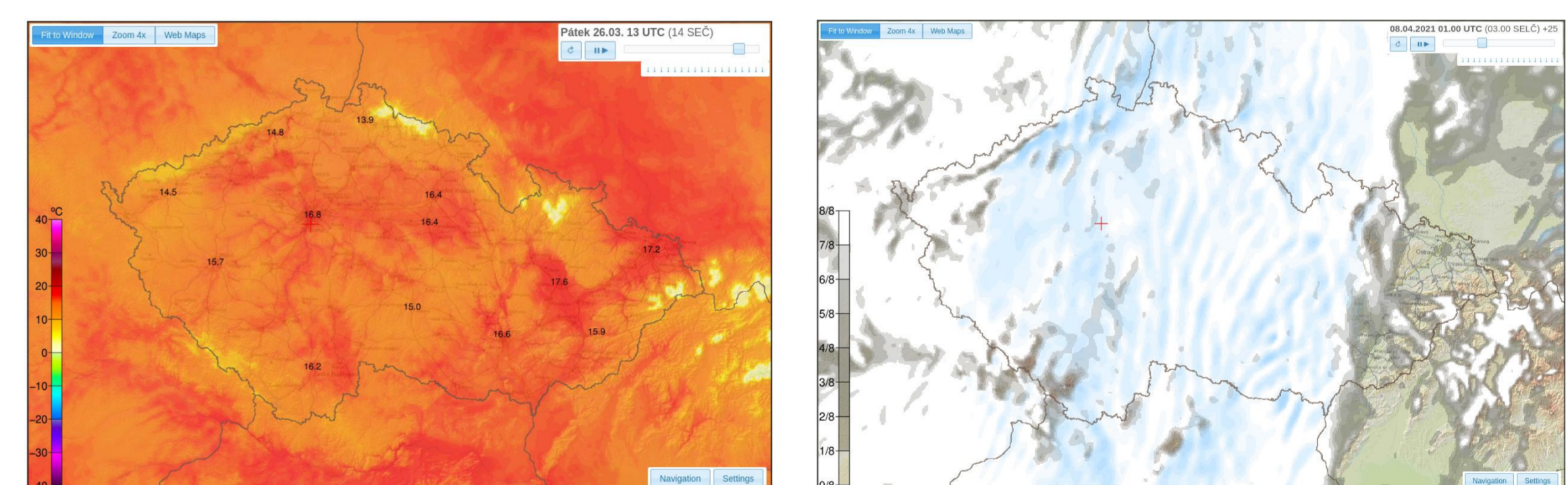


Figure 4: T2m (left) with dense palette steps (of  $0.4^\circ\text{C}$ ) with underlayed orography emphasis the mountain valleys. The combination of low and mid level clouds (right) is plotted from white to semitransparent shades of black (fully transparent equals clear sky). The high level clouds are shown by semitransparent shades of blue.

## New climate project: PERUN

Prediction, Evaluation and Research for Understanding National sensitivity and impacts of drought and climate change for the Czech Republic

Participants: CHMI, the Czech Geological Survey, Faculty of Mathematics and Physics and Faculty of Science of the Charles University, Institute of Atmospheric Physics, CzechGlobe, TG Masaryk Water Research Institute and PROGEO Ltd.

The PERUN project focuses on the research of climatic extremes, drought and the consequences of climate change in the Czech Republic. Main objective of the project is to create a research center that would focus on the research in the field of climate change in long term. This includes an analysis of the ongoing change and predicting future trends, including the identification of threats for the environment as well as for the society.

### ALARO-1vB climate configuration at convection permitting scales

- domain 1069x853 grid points,  $\Delta x \sim 2.3\text{km}$ , 87 levels, NH dynamics
- ALARO version with ISBA and SURFEX; coupling with ERA5

### Dedicated HPC system

- NEC SX Aurora TSUBASA
- 48 computing nodes (B401-8 VE20B) connected through Mellanox HDR InfiniBand
- each node has:
  - one AMD EPYC 7402 CPU (24 cores, 512GB RAM) &
  - eight NEC Vector Engines 20B (8 cores, 48GB RAM each)
- more than 2 Petabyte of storage capacity
- NQSV scheduler
- NEC SX compilers v3.1.0 and NEC MPI

