LACE
nwp central europe

LAM-EPS activities in LACE

Clemens Wastl with contributions of RC LACE partners

Operational ensembles

3 independent LAM EPSs operationally running within RC-LACE

- **A-LAEF**
  Common RC-LACE EPS with 4.8 km horizontal resolution based on ALARO-1 physics.

- **C-LAEF**
  Convection-permitting EPS of Austria with 2.5 km horizontal resolution based on AROME physics.
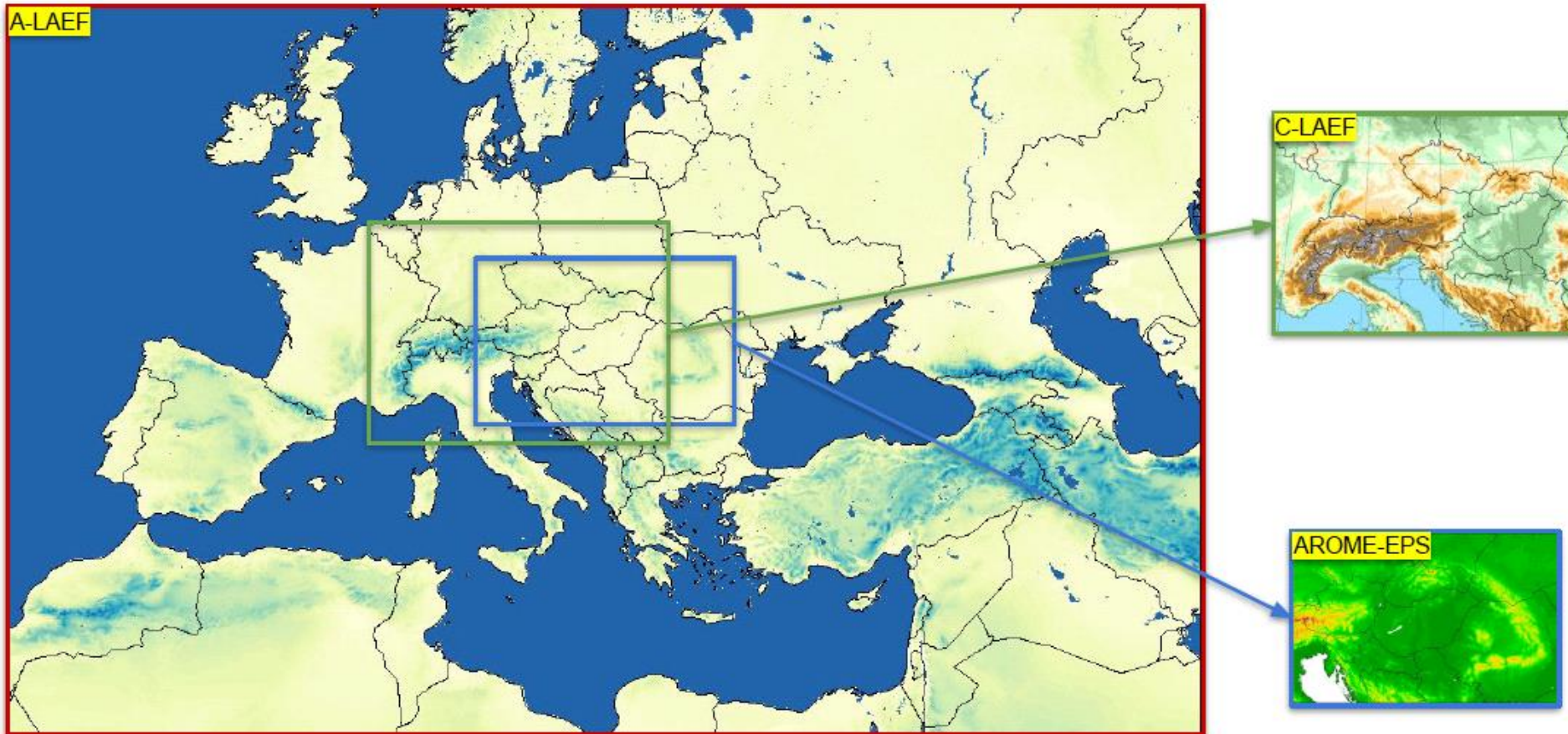
  ECMWF HPC

- **AROME-EPS**
  Convection-permitting EPS of Hungary with 2.5 km horiziontal resolution based on AROME physics.

  Local HPC

Operational ensembles

Operational ensembles

|	A-LAEF	C-LAEF	AROME-EPS
CMC	ALARO	AROME	AROME
Code version	cy40	cy40	cy40
Horizontal resolution	4.8 km	2.5 km	2.5 km
Vertical levels	60	90	60
Runs per day	2	4	1
Forecast length	+72h (00/12 UTC)	+60h (00 UTC), +48h (12 UTC), +6h (06/18 UTC)	+48h (00 UTC)
Members	16+1	16+1	10+1
Assimilation cycle	yes (12h)	yes (6h)	-
IC perturbation	ESDA [surface], spectral blending by DFI [upper-air]	ESDA [surface], EDA, Ensemble-JK [upper-air]	downscaling (AROME-EDA is being tested)
Model perturbation	ALARO-1 multi-physics + surface stochastic physics (SPPT)	hybrid stochastic scheme with a combination of parameter and tendency perturbations	-
LBC perturbation	ECMWF ENS (c903@cy46)	ECMWF ENS (c901+e927)	ECMWF ENS (c901+e927)

A-LAEF (LACE)

A-LAEF suite work in 2020:

- Addition of unperturbed control run (member=00)

- Prolongation of forecast to 72 hours

- Approve of time-critical 2 by ECMWF on July 22, 2020 – since then timing of the operational A-LAEF tasks is very stable and the output grib files are available at about 04:00 UTC and 16:00 UTC for 00 and 12 UTC runs, respectively

- Implementation of multi-domain off-line LATLON fullpos for Turkey and Czech Rep.

- conversion of LATLON FA files to multi-GRIBs and dissemination to Turkey and Czech Rep.

- new post-processed fields in A-LAEF Lambert multi-GRIBs (snow line, 0-isotherm height, @H100 - T, U, V, RH)

- implementation of parallel ecflow suite (e-suite) at ECMWF for testing new A-LAEF upgrades and modifications

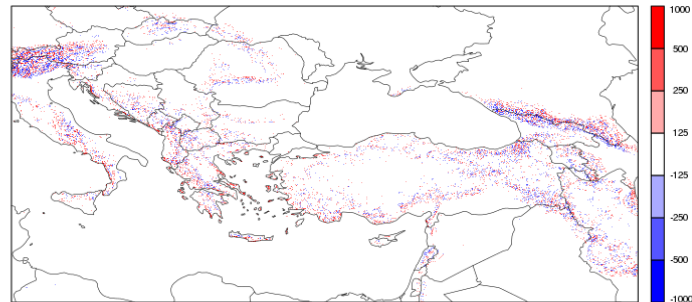- automatic download of VOBs files from ECMWF (for the HARP verifications)

A-LAEF (LACE)
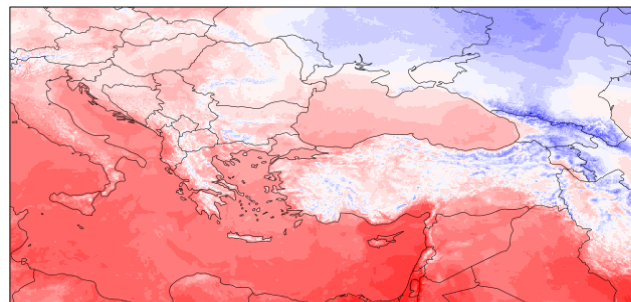
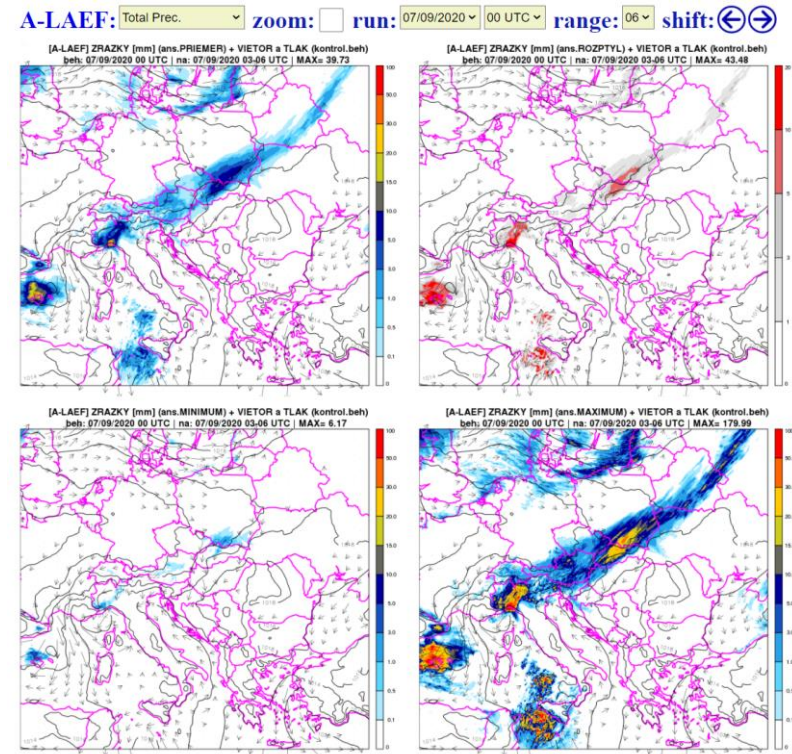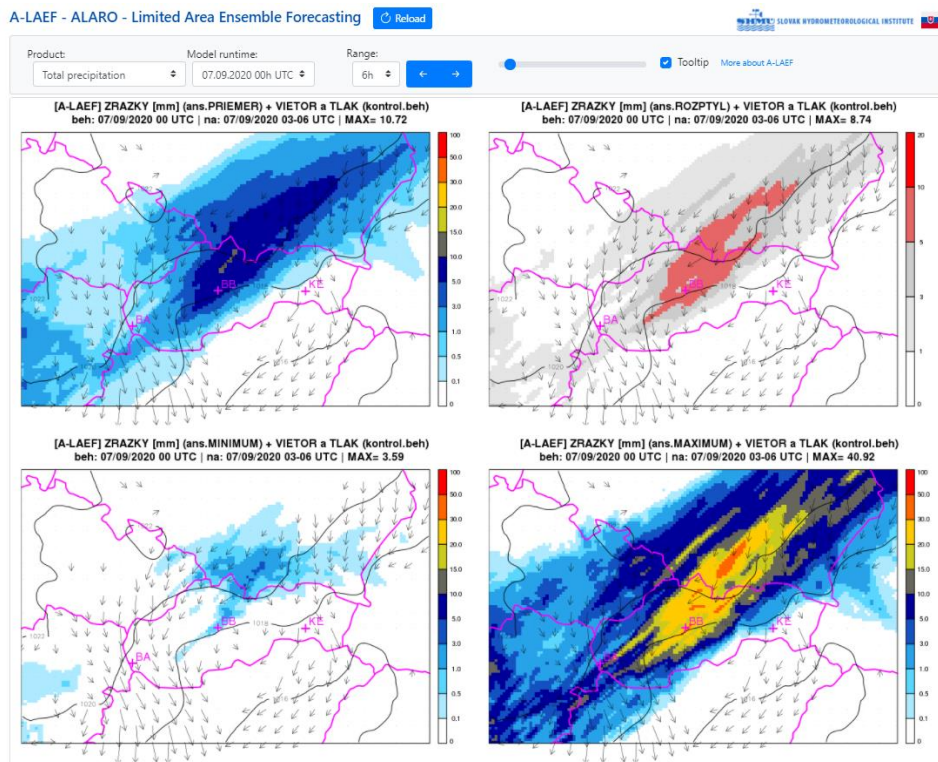## LATLON fullpos for Turkey (impact of using CLIM files)
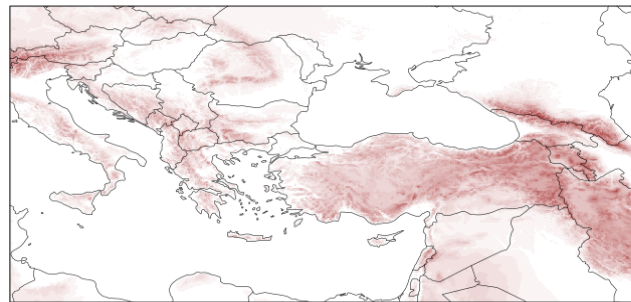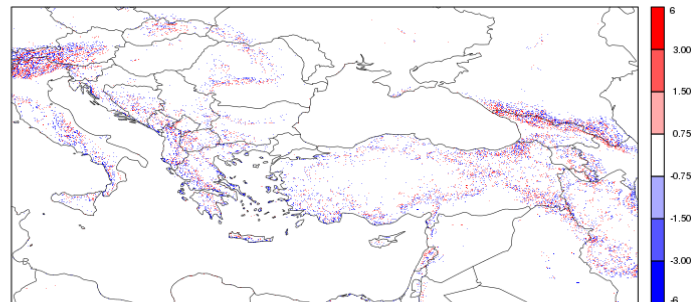
The impact of using separate CLIM files in fullpos with fitted orography for the target domain (NFPCLI=1 in fullpos namelist block NAMPHY) instead of using the interpolated original orography from the model (NFPCLI=0 in fullpos namelist block NAMPHY).

A-LAEF (LACE)

Operational maps:

- set of probabilistic A-LAEF maps was prepared at SHMU and put to operations
- Perl and R-script coding is used exploiting parallel processing on HPC
- user interfaces for public website and SHMU intranet were created
- public URL: http://www.shmu.sk/produkty/nwp/alaef/

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A-LAEF (LACE)

Case Studies:

- Several case studies in 2020 (flood events, storm events, fog events) which were investigated
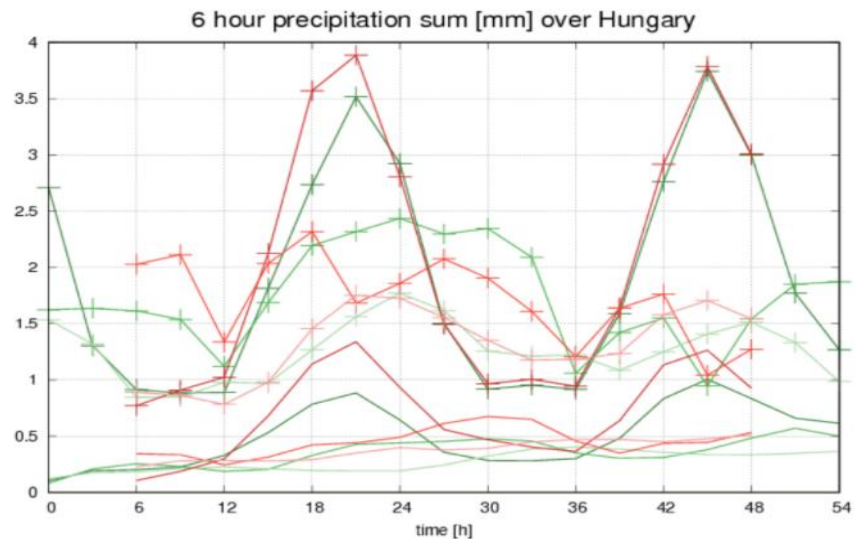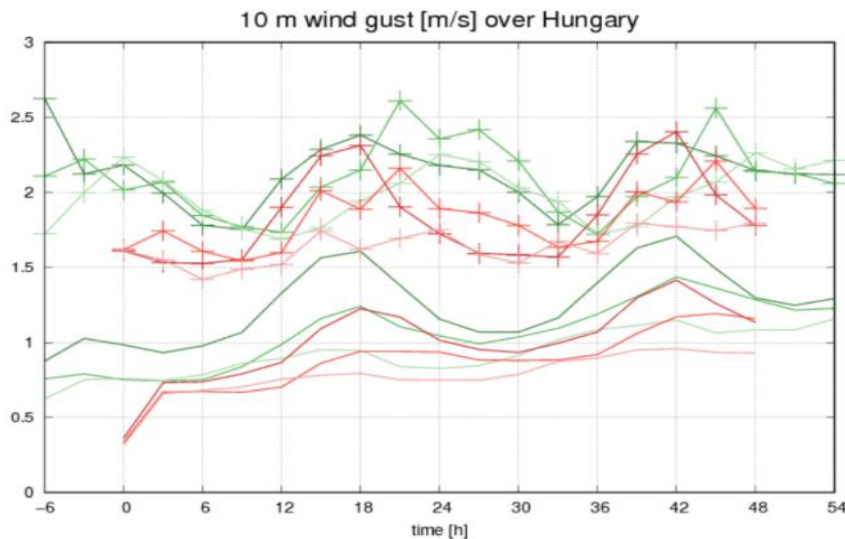
- E.g. Fog event on November 24, 2020
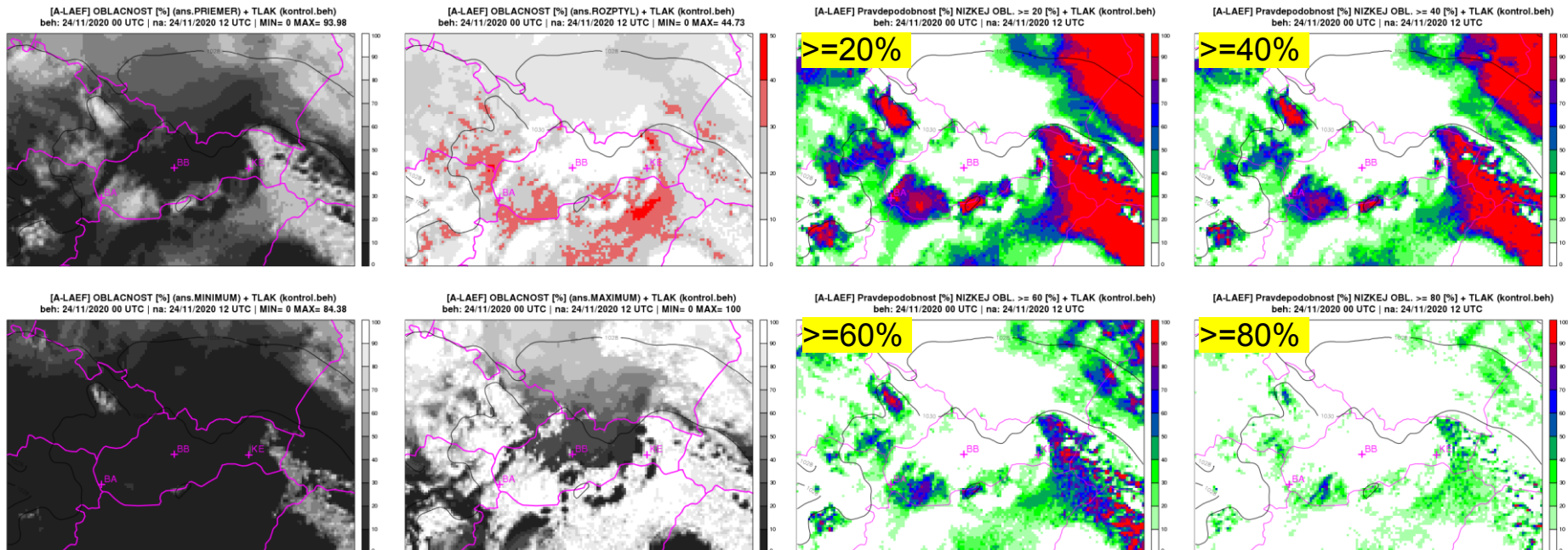
A-LAEF: EPS cloudiness [%] 24/11/2020 12 UTC   *A-LAEF: low cloudiness PROB [%] 24/11/2020 12 UTC*

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AROME-EPS (Hungary)

EDA experiments in AROME-EPS

- 3 hourly assimilation cycle identically to the operational deterministic AROME analysis

- conventional and GNSS ZTD measurements were used, the same as in AROME/HU assimilation

- 3 hourly coupling to ECMWF ENS

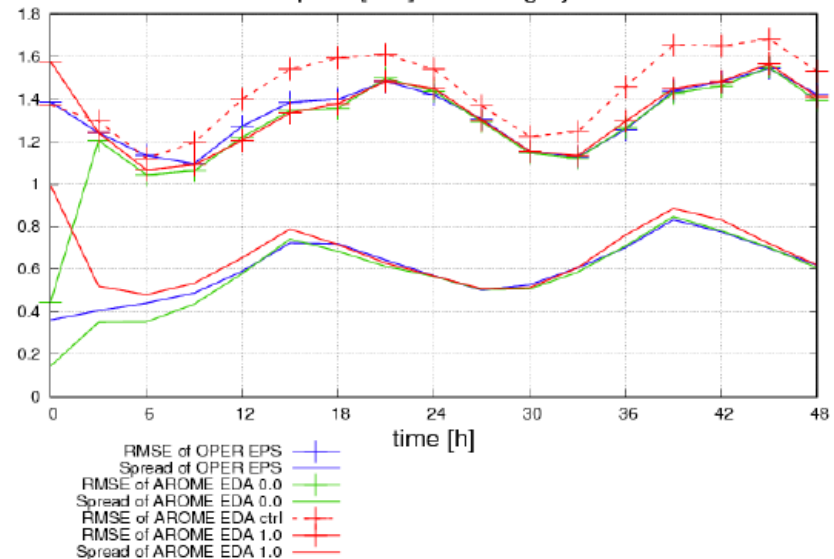- operational AROME/HU domain (over the Carpathian Basin), resolution of 2.5 km, 60 vertical levels

- Perturbation of observations was executed offline before surface assimilation and after screening

  Perturbation scaling was added (multiplication of perturbations with real number)

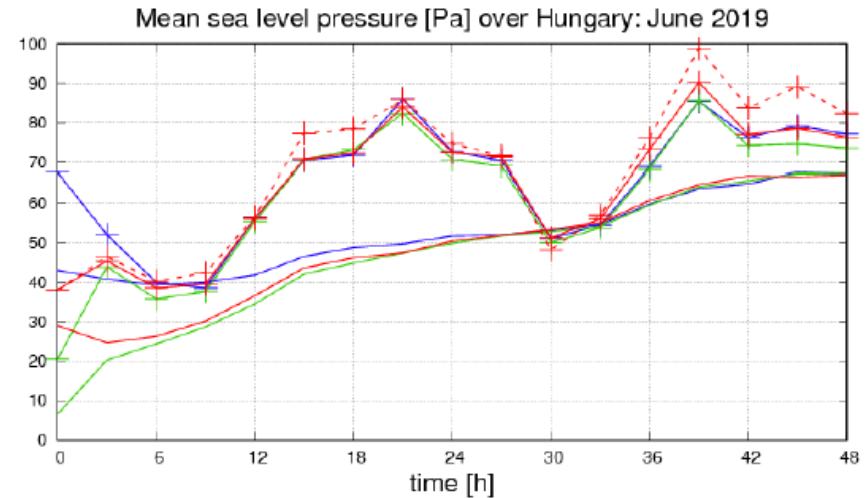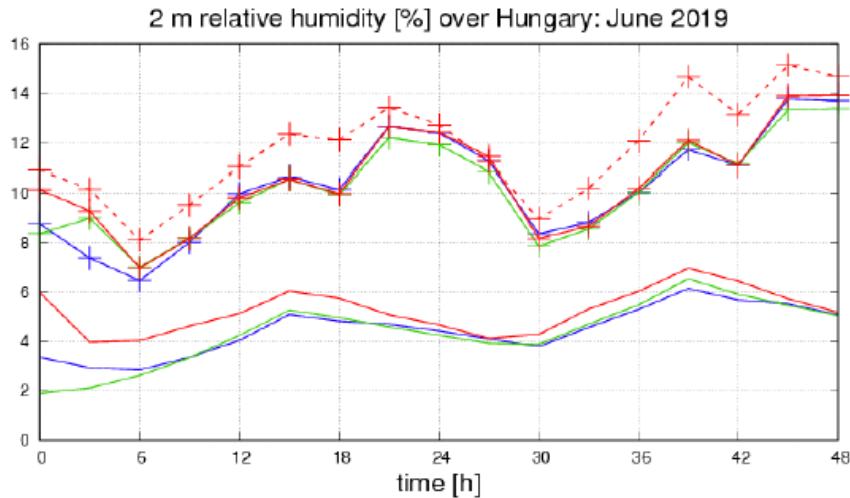- 3 Test periods of about 1 month each (1 in winter 2020, 2 in summer)
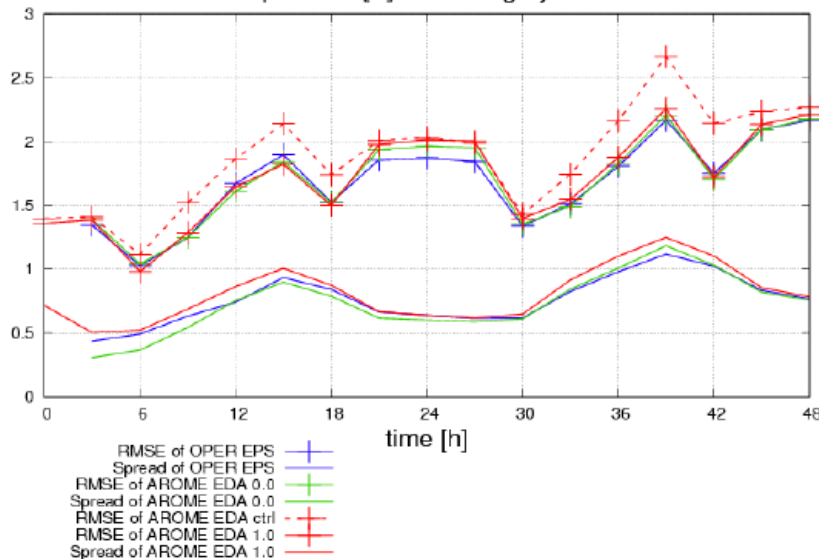
AROME-EPS (Hungary)

Spread (–) and RMSE (+) of surface parameters in the experiments from 28 May to 19 June 2019; Operational EPS mean (blue), EDA with (red) and without perturbations (green), control member of EDA (dashed)

- adding ensemble data assimilation to AROME-EPS can improve forecasts of surface parameters

- Especially for wind, temperature, mean sea level pressure and precipitation in the summer season

- Humidity and cloudiness seem to have higher error values at the beginning of the forecasts, probably caused by assimilation problems

- Some tuning of perturbations still has to be done.
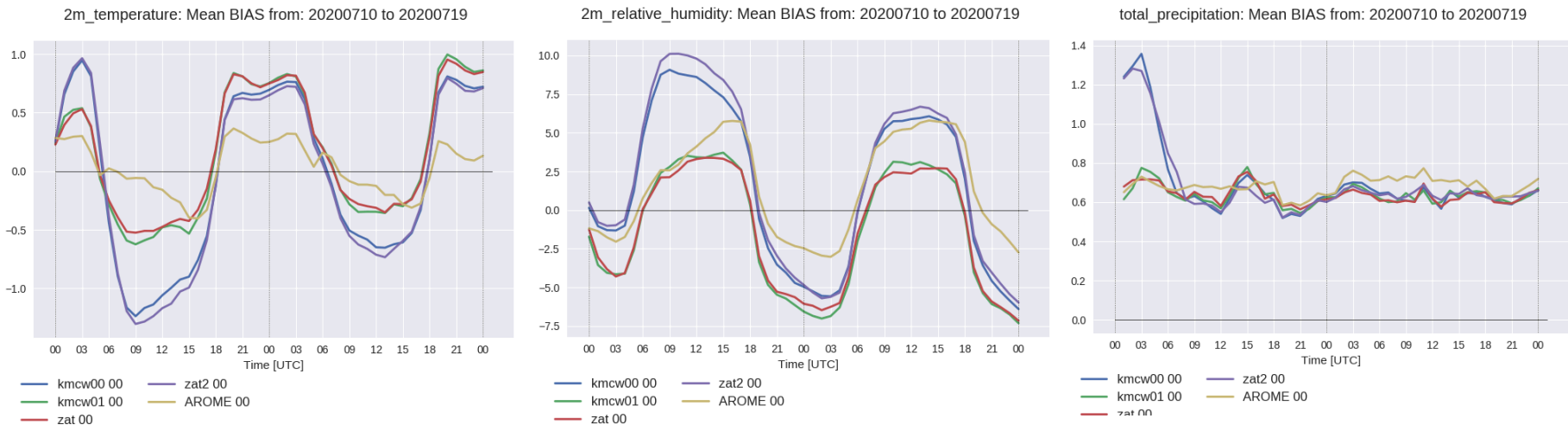
C-LAEF (Austria)

C-LAEF suite changelog in 2020:

- Implementation of new cy43t2 at the ECMWF HPCF

- Set-up of a complete C-LAEF Esuite with cy43t2 including adaption of scripting system

- New observations (GNSS, Mode-S, satellite data) were tested in C-LAEF EDA; several short Esuites with different sets of new observations were prepared and verified

- Investigation of 2m temperature and humidity problem in C-LAEF – development of a new 2m diagnostics with weights depending on stability and orography

- C-LAEF SPP scheme was extended by additional perturbations in physics parametrizations

- Time lagged EPS out of AROME-RUC was created using neighborhood methods

- Development and operational production of EPS maps and EPSgrams with Visual weather for forecasters and customers

C-LAEF (Austria)

Verification of new OBS in EDA:

- First results show a problem with **T2m** and **RH2m** during the day

- Too much soil moisture, caused by a positive precipitation bias in the first forecast hours

- The problem was identified to come from the VarBC for GNSS data (too long adaptation time)

- Adaptation was made but scores are still bad – GNSS switched off for C-LAEF at the moment

Verification of different sets of "new observations" for 1 week (July 10 – July 19, 2020). BIAS of 2-meter temperature (left), 2-meter relative humidity (middle) and precipitation (right).

C-LAEF (Austria)

2m temperature and humidity problem in C-LAEF

- Verification of C-LAEF showed strong temperature and relative humidity bias during the night

- Especially strong in Alpine valleys during clear nights in winter

- The problem was identified to come from the Canopy scheme

- Development of a new 2m diagnostics with weights depending on stability and orography
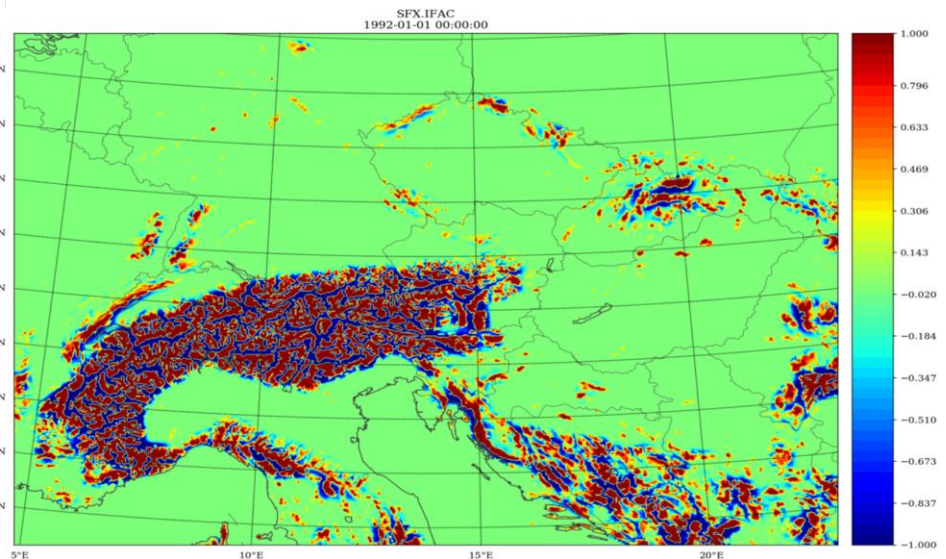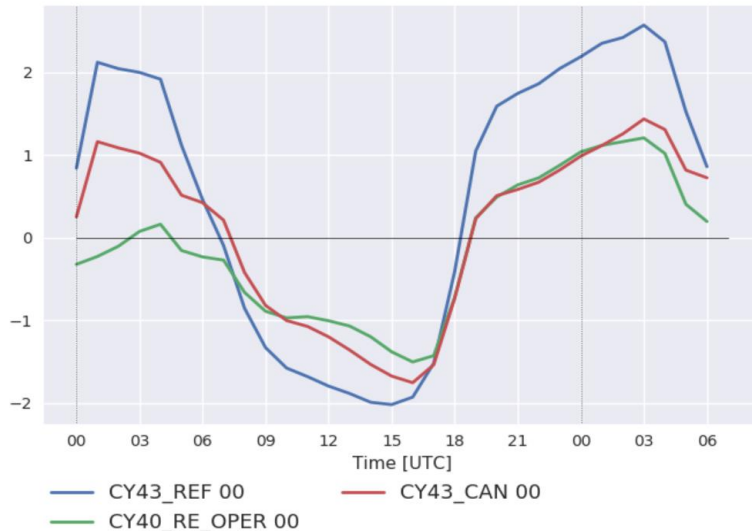
2m temperature bias for stations in Alpine valleys for a test case on July 23 2020.   *Inversion factor in dependence of orography.*

C-LAEF (Austria)

Extension of SPP scheme in C-LAEF

- Operational C-LAEF: combination of tendency perturbation (shallow convection, radiation, microphysics) with parameter perturbation (turbulence)

- Extension of SPP scheme to microphysics, shallow convection and radiation scheme

- Code from HIRLAM (cy43t2) – add new relevant parameters for C-LAEF

- Implementation of SPG pattern generator (Tsyrulnikov) in C-LAEF Esuite
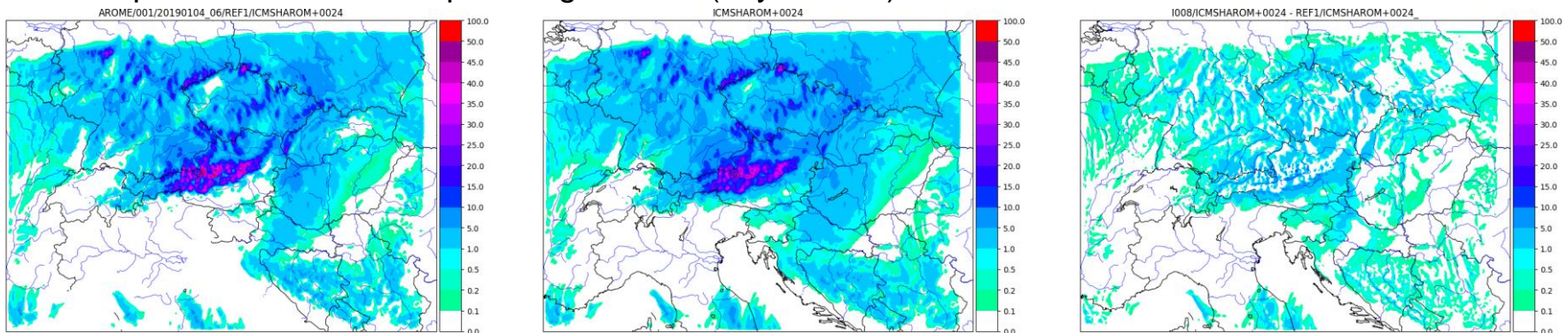

Sensitivity tests on sublimation of snow/graupel in wintertime in modified C-LAEF perturbation scheme (reference left, experiment with reduced sublimation middle, difference between EXP and REF right).

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C-LAEF (Austria)

## Time lagged AROME-RUC-PEPS:

It was technically implemented for precipitation. It runs regularly for selected INIT times of the AROME-RUC, generating a lagged ensemble with 5 members (lag=0h, -1h, …, -4h), with forecast range up to +8h and output frequency of 15 minutes, using neighborhood methods. AROME-RUC-PEPS visualization was implemented in Visual Weather.
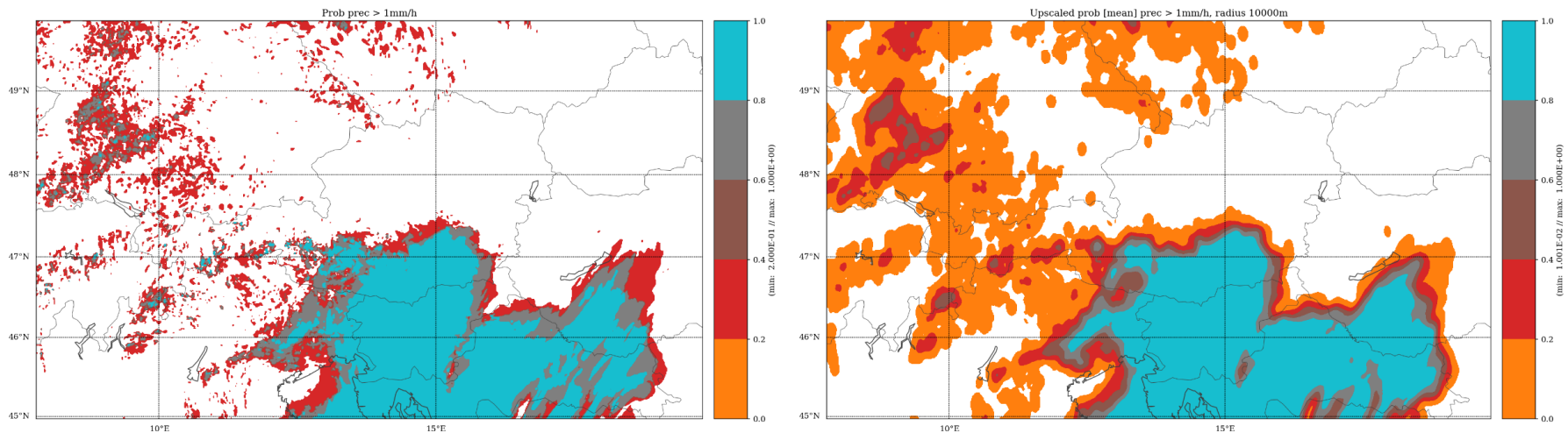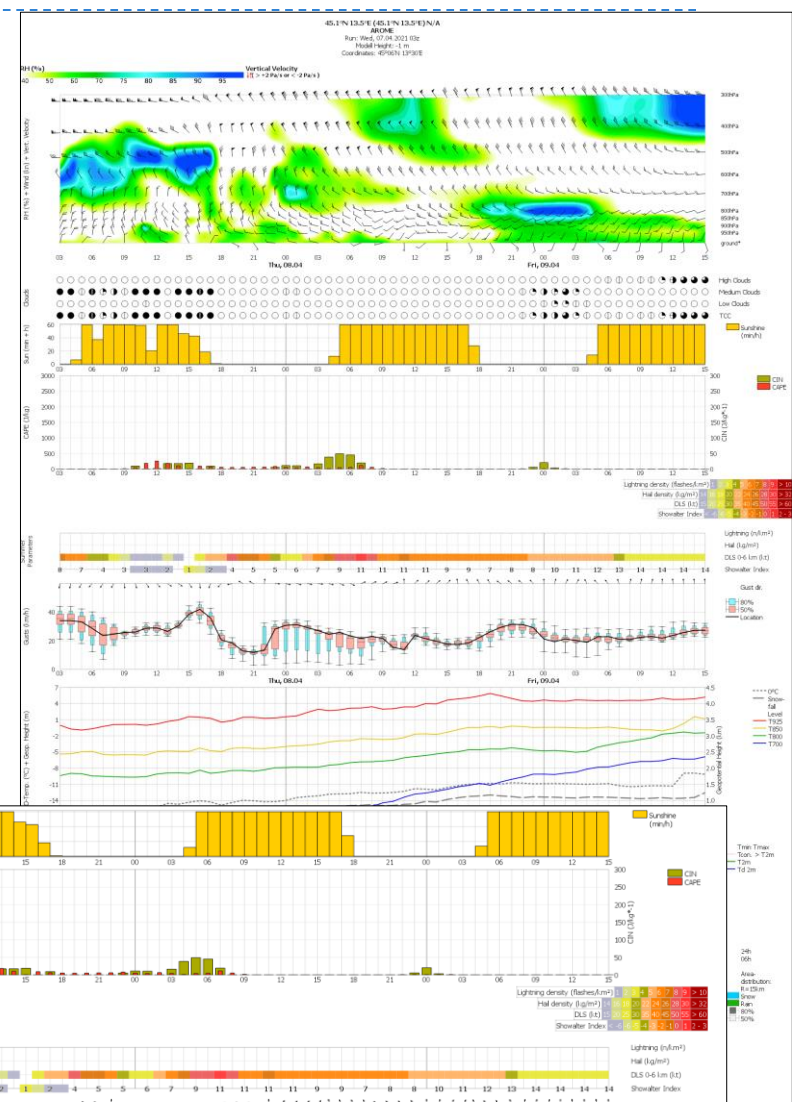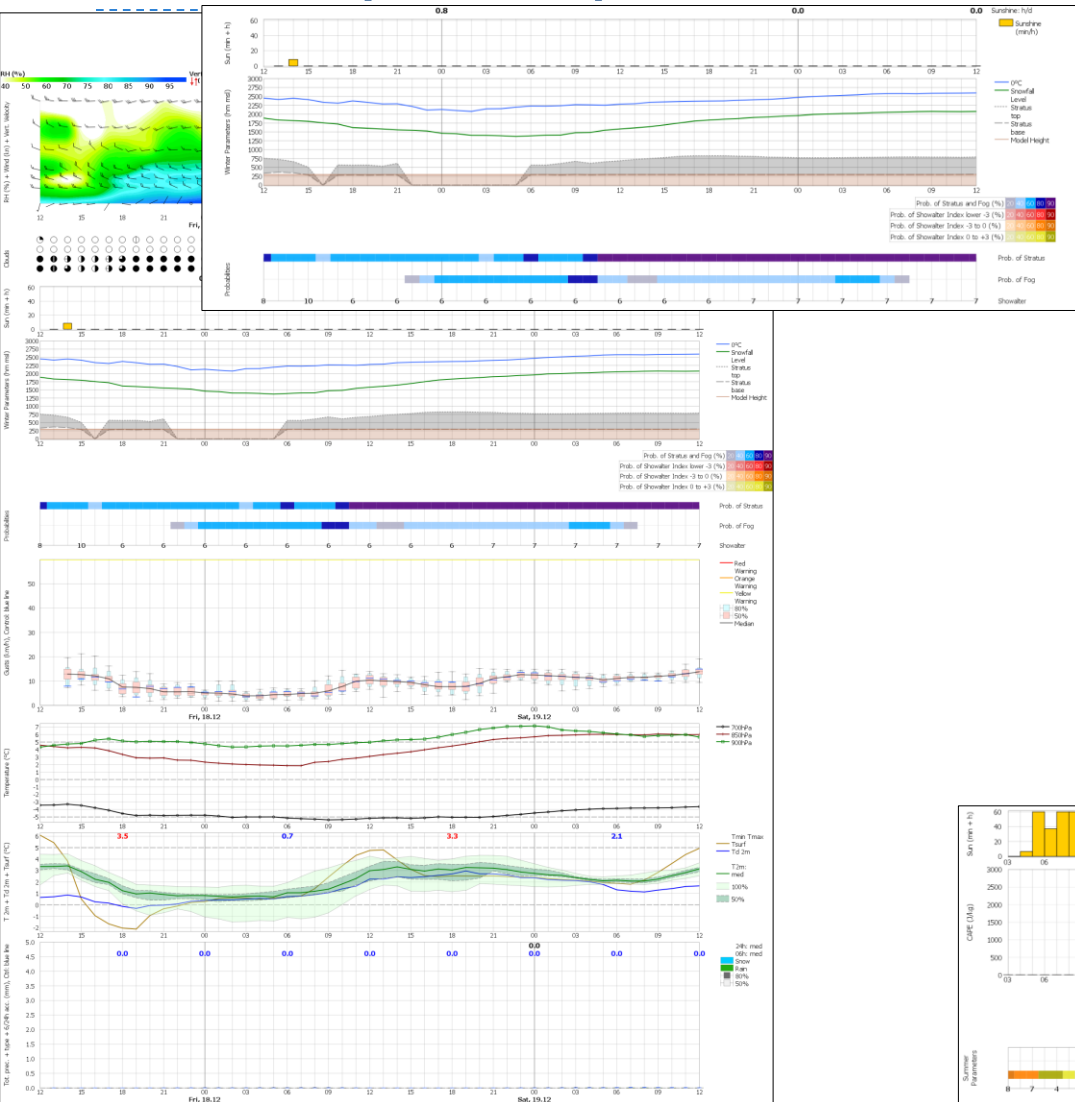

AROME-RUC-PEPS grid-point wise probability (left) and upscaled probability using mean of all grid-points within 10 km radius (right).

C-LAEF (Austria)

Development and operational production of EPS maps and EPSgrams with Visual weather for forecasters and customers:
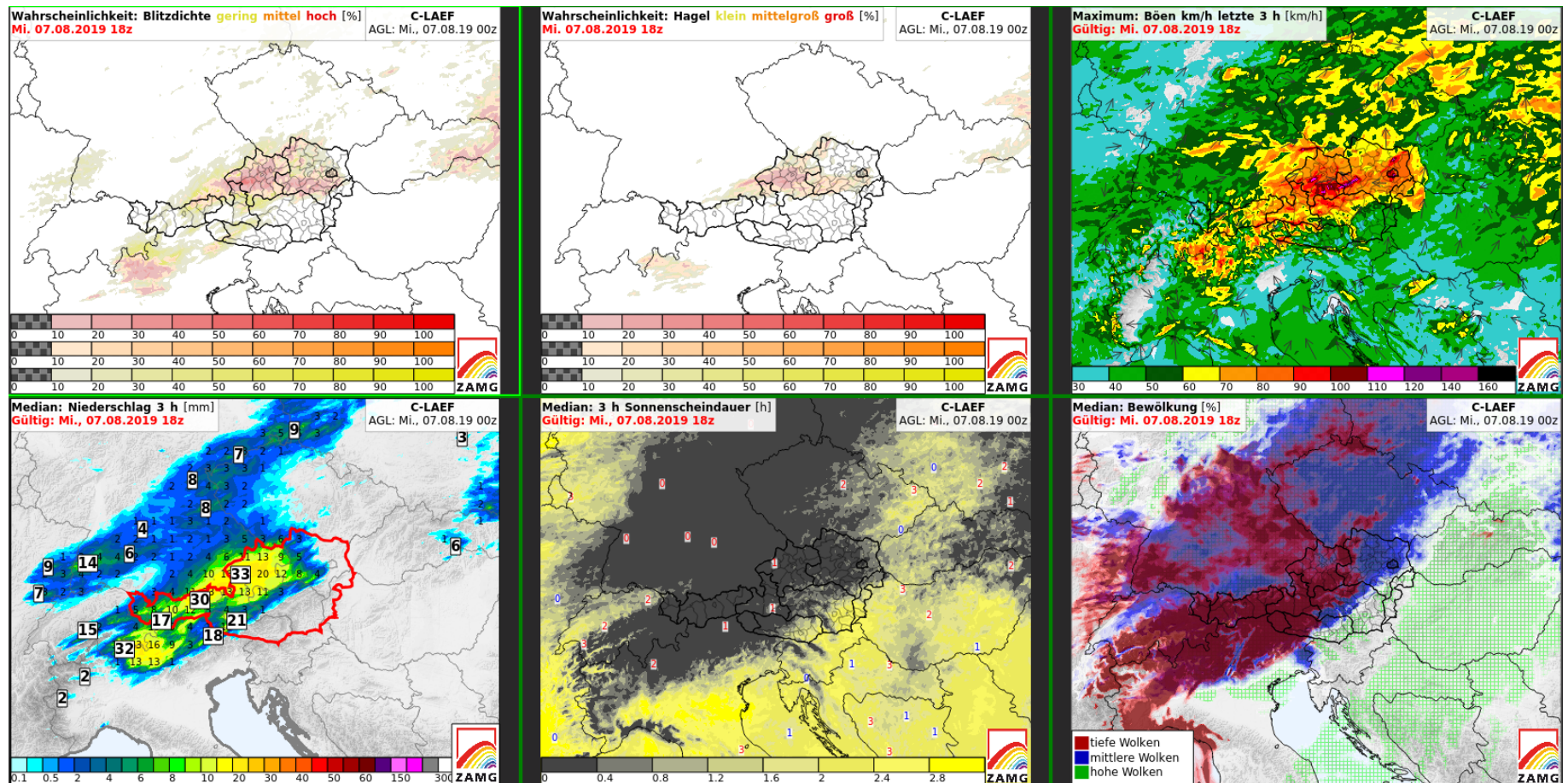
C-LAEF (Austria)

Publications

Published papers:

- Belluš M., 2020: New high-resolution ensemble forecasting system A-LAEF. Meteorologický časopis, 23 (2), pp. 75-86, ISSN 1335-339X (in Slovak)

- Plenković, I. O., I. Schicker, M. Dabernig, K. Horvath, E. Keresturi, 2020: Analog-based post-processing of the ALADIN-LAEF ensemble predictions in complex terrain, Quarterly Journal of the Royal Meteorological Society, 146: 1842– 1860, https://doi.org/10.1002/qj.3769

- Taşcu S., M. Pietrişi, C. Wittmann, F. Weidle and Y. Wang, 2020: Forecast skill of regional ensemble system compared to the higher resolution deterministic model. IDŐJÁRÁS / Quaterly Journal of the Hungarian Meteorological Service, 124 (3). pp. 401-418. ISSN 0324-6329

- Wastl C., Y. Wang, A. Atencia, F. Weidle, C. Wittmann, C. Zingerle, E. Keresturi, 2021: C-LAEF: Convection-permitting Limited-Area Ensemble Forecasting system. Quarterly Journal of the Royal Meteorological Society, 147: 1431-1451, https://doi.org/10.1002/qj.3986

Doctoral thesis:

Iris Odak Plenković successfully defended her doctoral thesis "Wind speed prediction using the analog method over complex topography" in July, at Faculty of Science, Department of Geophysics, University of Zagreb.

Endi Keresturi successfully defended his doctoral thesis "Initial condition perturbations in a convective scale ensemble prediction system" in February 2021, at the Faculty of Science, Department of Geophysics, University of Zagreb.