Regional Cooperation for Limited Area Modeling in Central Europe

LACE
nwp central europe

LAM-EPS activities in RC LACE

Martin Belluš with contributions of RC LACE partners

DHMZ SHMU ARSO METEO Slovenia OMSZ ZAMG ROMANIA ANM

Introduction

Since last EWGLAM huge effort in RC LACE was put into the preparation of new operational ensembles. A lot of technical and validation work was done. Currently, there are three independent systems developed in parallel, however they are very much different in their focus:

1. Common RC LACE EPS with 4.8 km horizontal resolution based on ALARO-1 physics running on a big European domain (**A-LAEF**).

2. Austrian convection-permitting EPS with 2.5 km horizontal resolution utilizing AROME model on a middle European domain (**C-LAEF**).

3. Hungarian convection-permitting EPS based on nonhydrostatic AROME, which is going to replace their former **ALARO-EPS**.

Implementation and testing of A-LAEF under TC user

- **solving cold bias issue**

Implementation and testing of A-LAEF under TC user

Cold bias:

- Generally, there is a big discrepancy between the IFS soil/surface moisture fields and those of ARPEGE/ALADIN as well as for the corresponding temperature fields.
- Since the cold start of new A-LAEF was carried out from the IFS ENS boundary conditions, the soil moisture and surface moisture were initially too large and hence the surface temperature cold bias was developed within the several integration hours.
- This undesirable effect should be normally progressively reduced by the assimilation of RH2m (already after several assimilation loops). But it was not, because of null moisture increments!
- Surface moisture assimilation increments are given by the differences between the analysed and predicted T2m and RH2m values following the equation:

$$\Delta w_s = \alpha_s^T \Delta T_{2m} + \alpha_s^{RH} \Delta RH_{2m}$$

- The optimum coefficients for soil moisture analysis are modulated or switched off depending on several meteorological fields like **precipitation**, **cloudiness**, **surface evaporation**:
  - ATMONEBUL.BASSE (**cumulated low cloud cover**) ← LNEBPAR=.T. in NAMCFU
  - SURFXFLU.MEVAP.E (**instantaneous evaporation flux**) ← LXSOIL=.T. in NAMXFU
  - SURFXEVAPOTRANSP (**instantaneous evapotranspiration**) ← LXSOIL=.T. in NAMXFU

Implementation and testing of A-LAEF under TC user

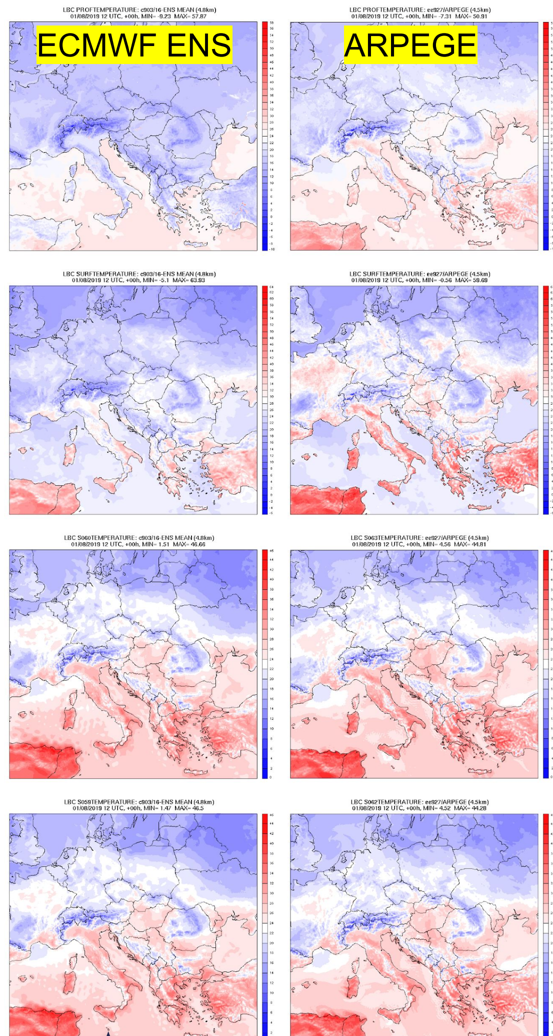
temperature:

soil →

surface →

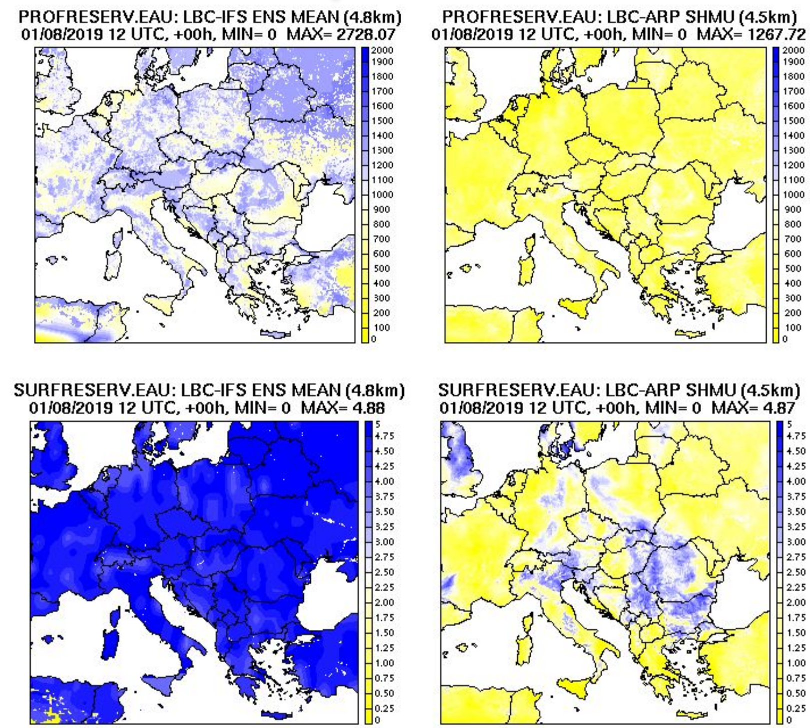
two lowest model levels

ENS mean - - - coupling files (LBCs)



moisture:

ENS mean



soil and surface moisture discrepancy between IFS and ARPEGE models

Implementation and testing of A-LAEF under TC user

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Implementation and testing of A-LAEF under TC user

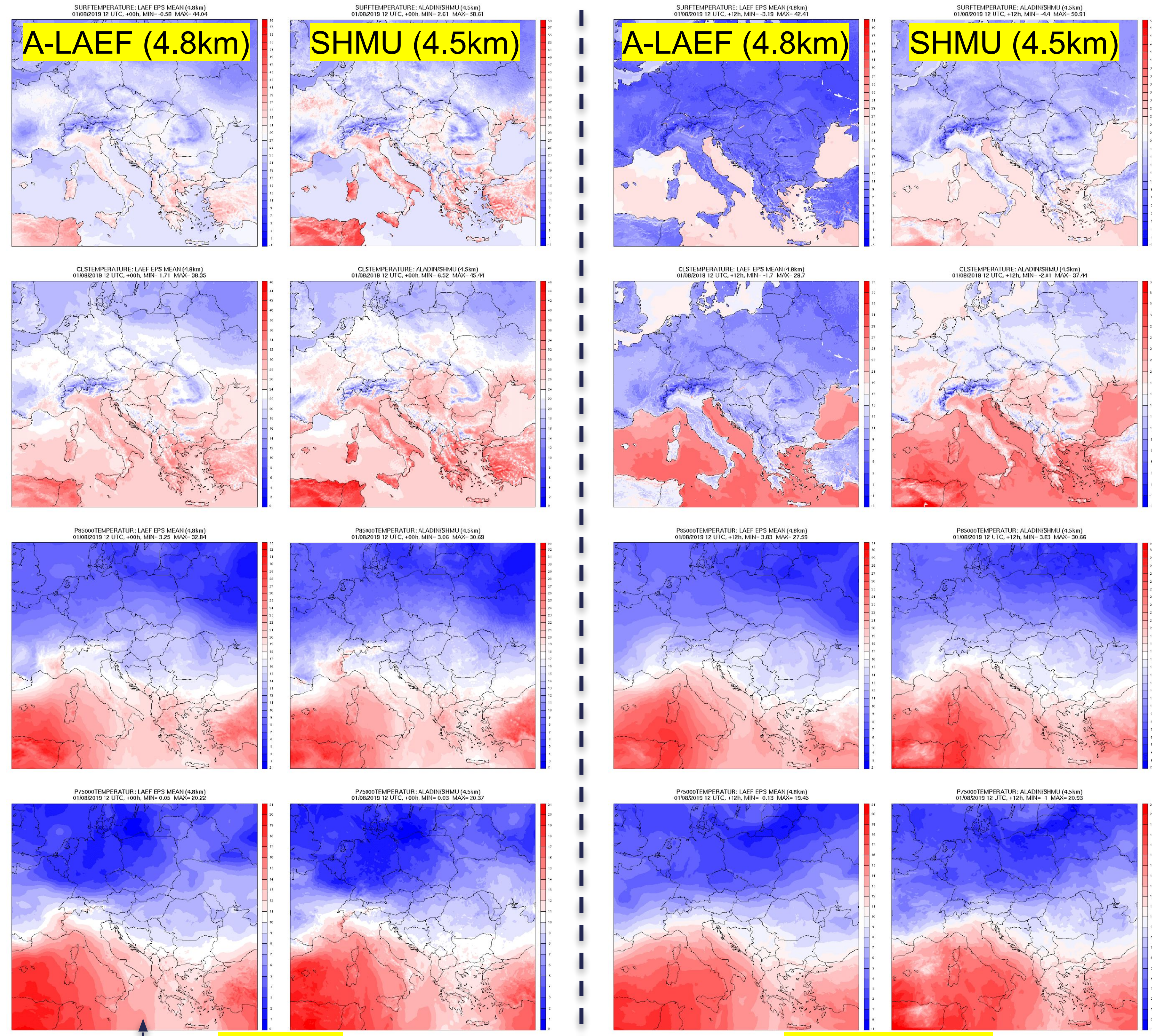
temperature:

surface →

2 meter →

850 and 750 hPa levels

ENS mean



analyses

+12h forecasts

Implementation and testing of A-LAEF under TC user

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Implementation and testing of A-LAEF under TC user

moisture: (soil)

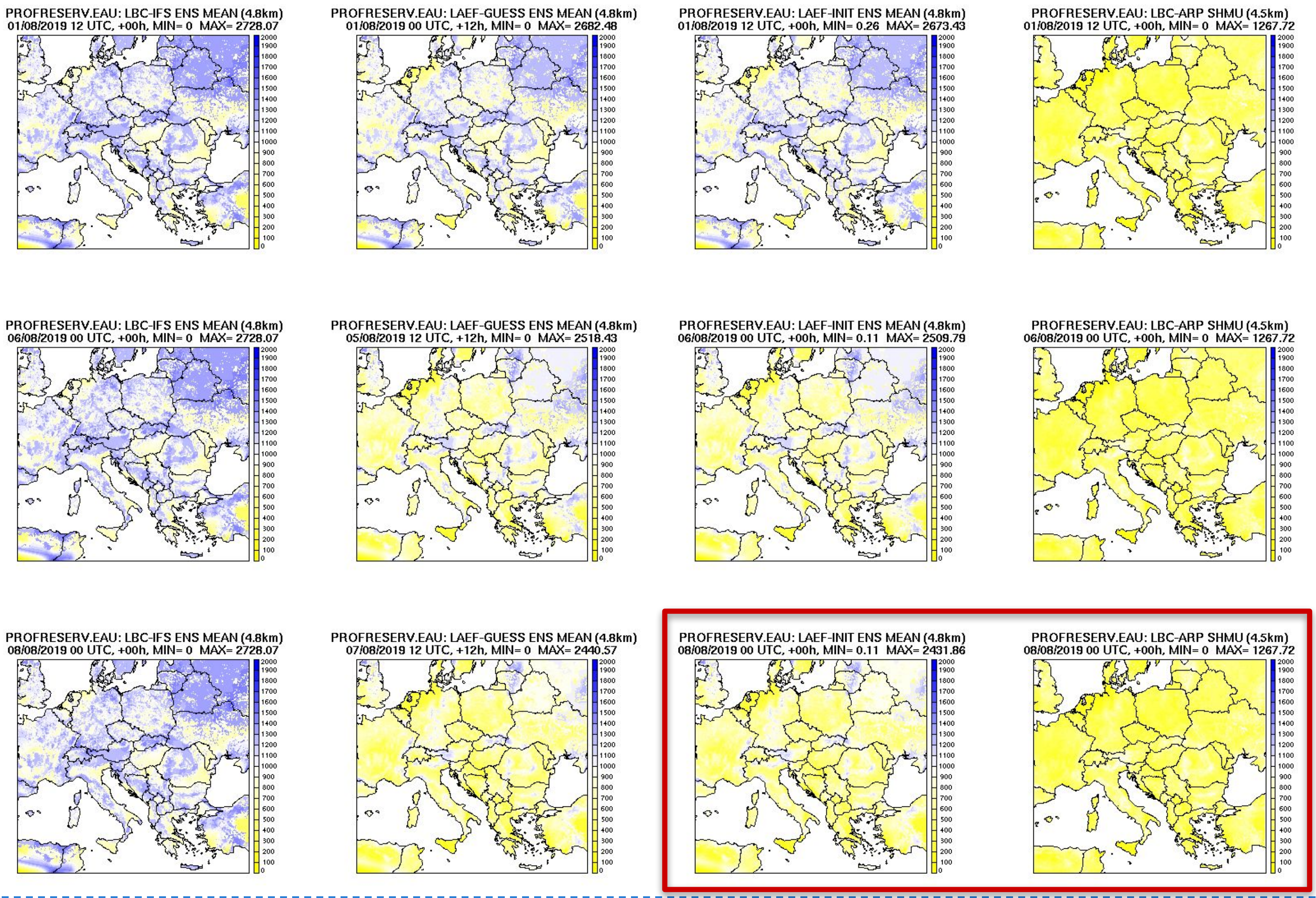
ECMWF ENS | first guess | INIT | ARPEGE

ensemble of surface data assimilations (ESDA)

0 cycles

6 cycles

10 cycles



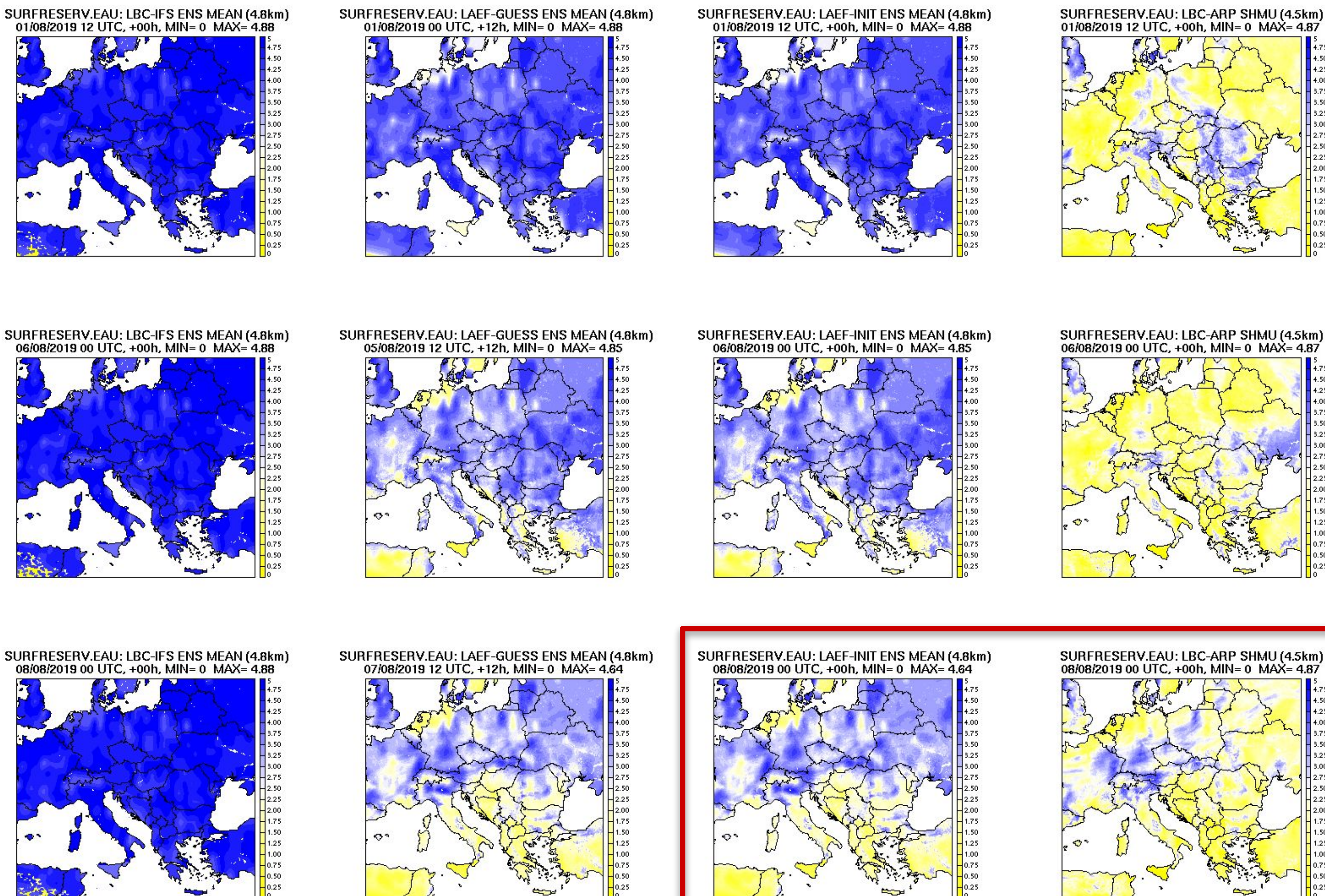
Implementation and testing of A-LAEF under TC user

moisture: (surface)

ECMWF ENS | first guess | INIT | ARPEGE

ensemble of surface data assimilations (ESDA)

0 cycles → 6 cycles → 10 cycles



Implementation and testing of A-LAEF under TC user

temperature: (soil)

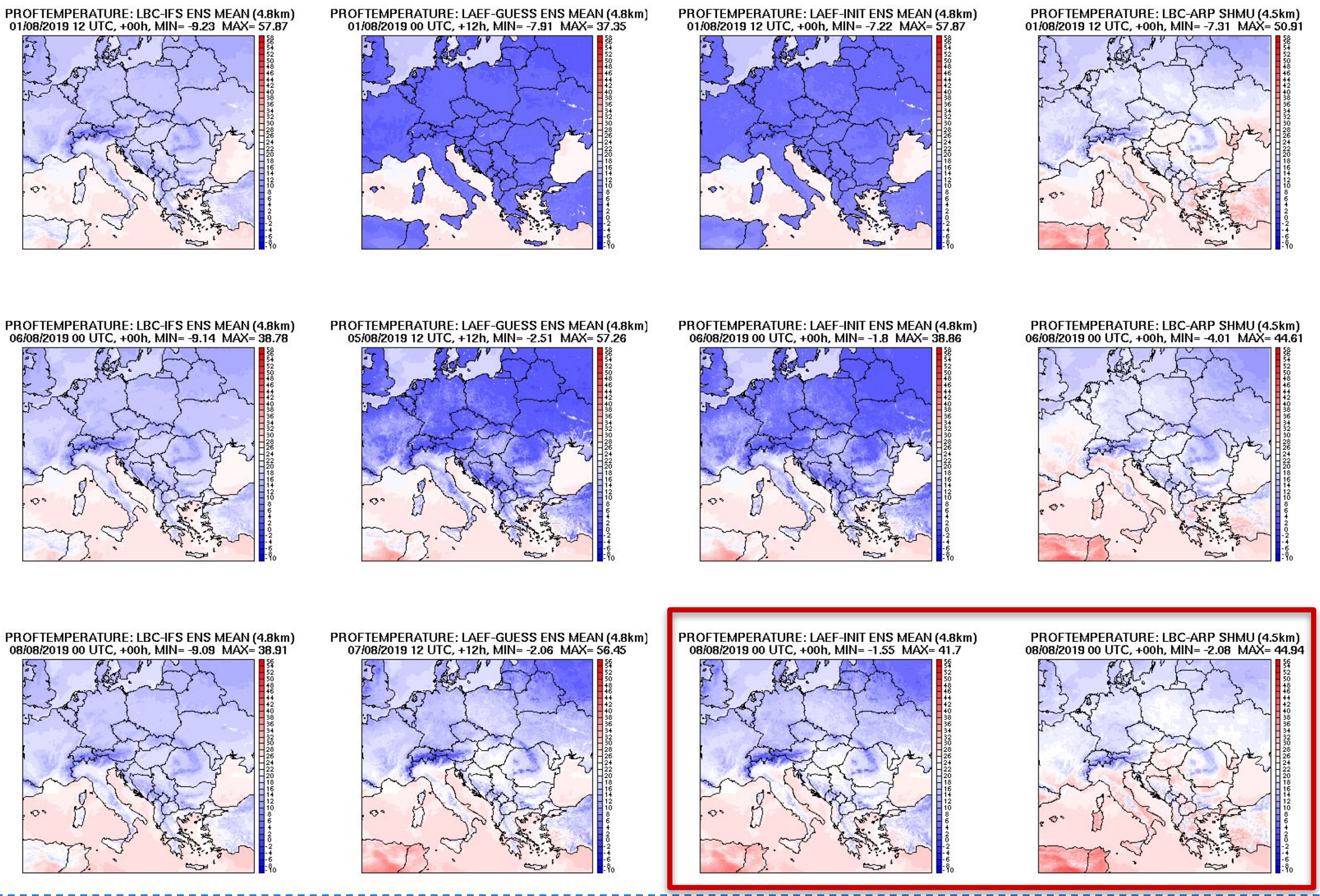
ECMWF ENS | first guess | INIT | ARPEGE

ensemble of surface data assimilations (ESDA)

0 cycles

6 cycles

10 cycles



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Implementation and testing of A-LAEF under TC user

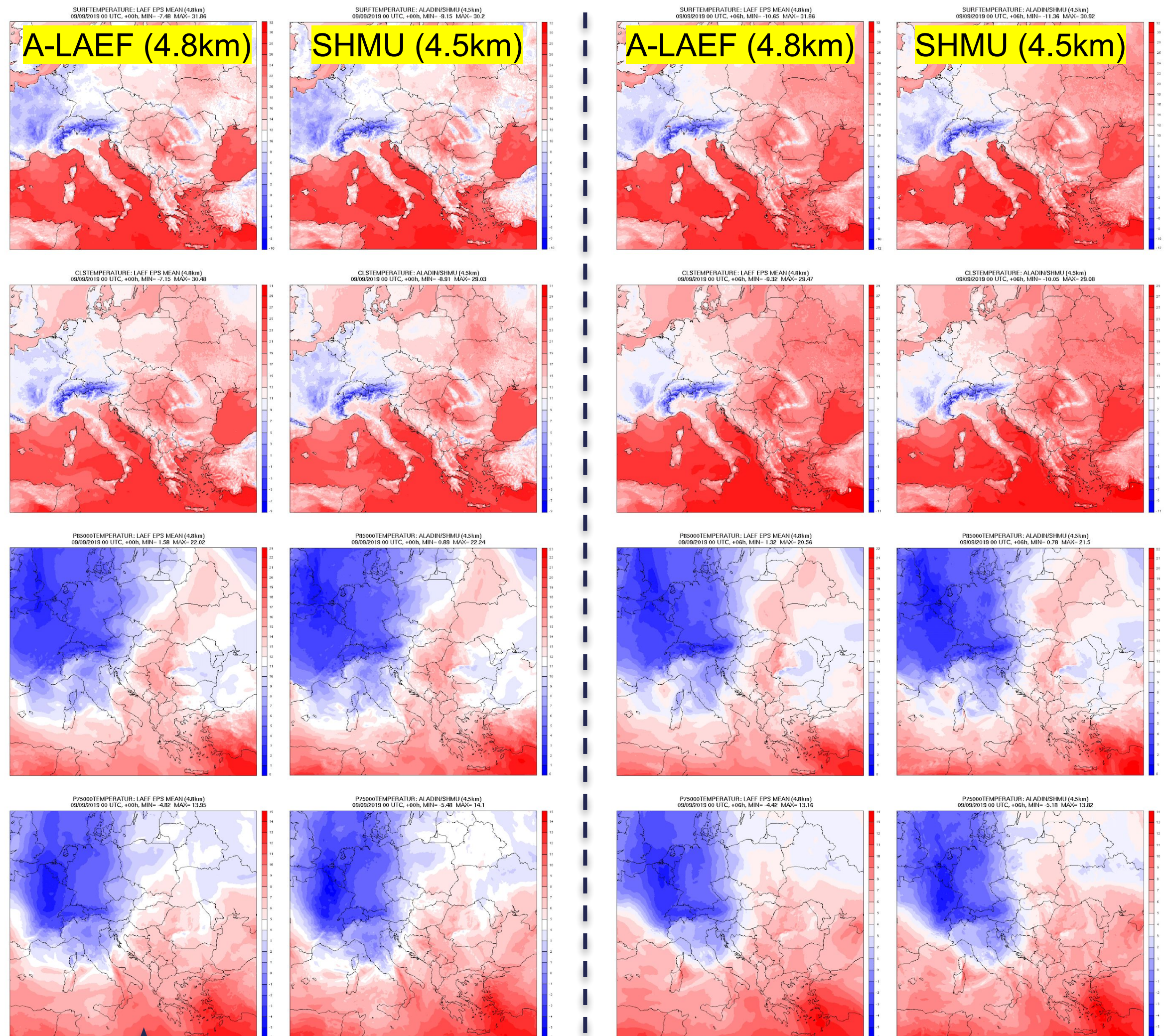
Temperature:
(+30d cycle)

surface →

2 meter →

850 and 750
hPa levels

ENS mean



analyses

+6h forecasts

A-LAEF operational suite under ecFlow

- regular runs since end of July

A-LAEF operational suite under ecFlow

ESDA:

$$\Delta T_s = \Delta T_{2m}$$

$$\Delta T_p = \frac{1}{2\pi} \Delta T_{2m}$$

$$\Delta W_s = \alpha_s^T \Delta T_{2m} + \alpha_s^H \Delta H_{2m}$$

$$\Delta W_p = \alpha_p^T \Delta T_{2m} + \alpha_p^H \Delta H_{2m}$$

BLENDING:

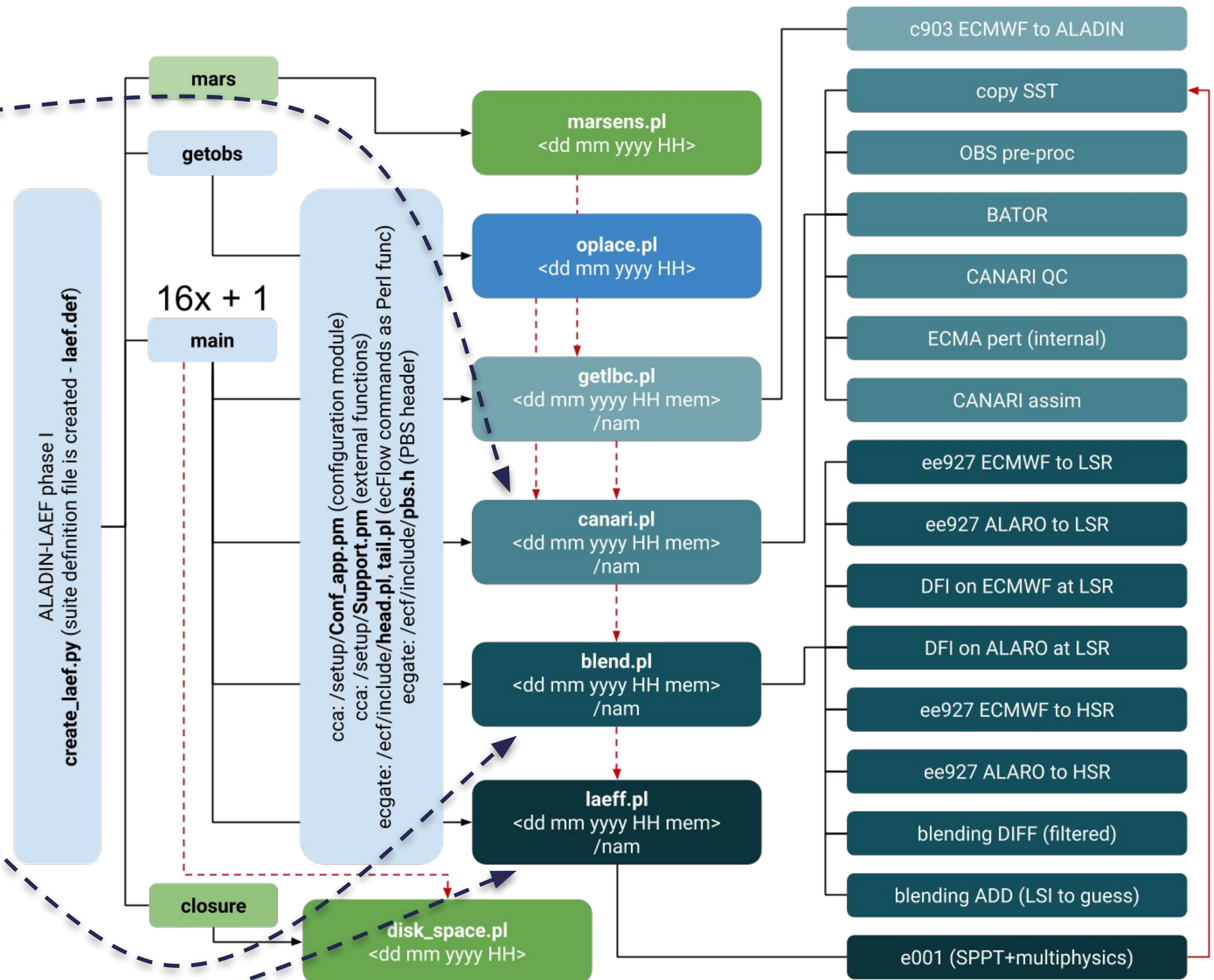
$$IC^n_{blend} = a^n_{breed} + \{ \overline{(a^n_{sv})_{trunc}} - \overline{(a^n_{breed})_{trunc}} \}$$

$$IC^n_{blend} = LS^n + a^n_{breed}$$

SPPT + MP:

$$\frac{\partial e_j}{\partial t} = A(e_j,t) + P'(e_j,t)$$

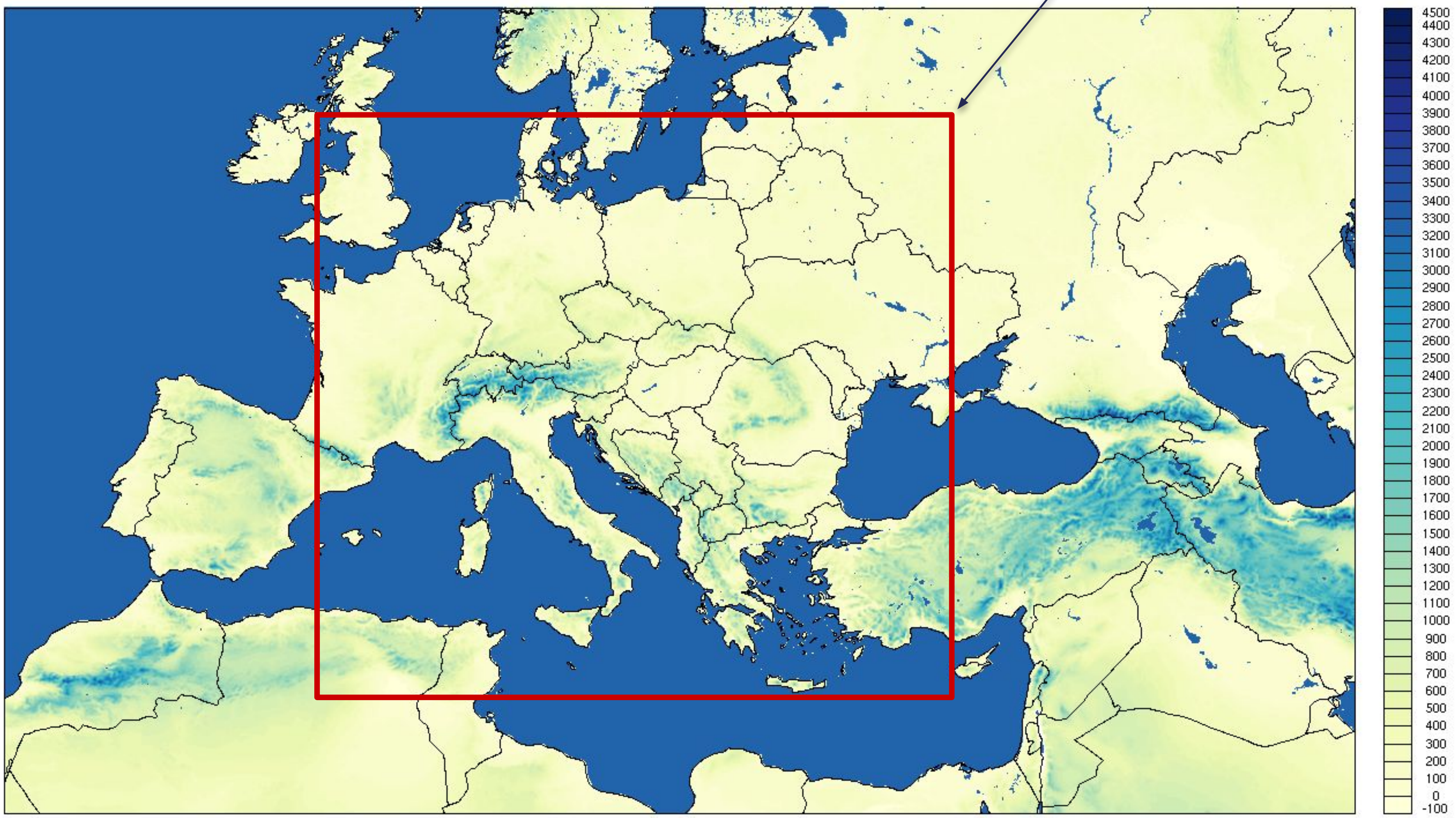
$$P'_j(e_j,t) = (1 + r_j(\lambda,\varphi,t)_{D,T}) P_j(e_j,t)$$



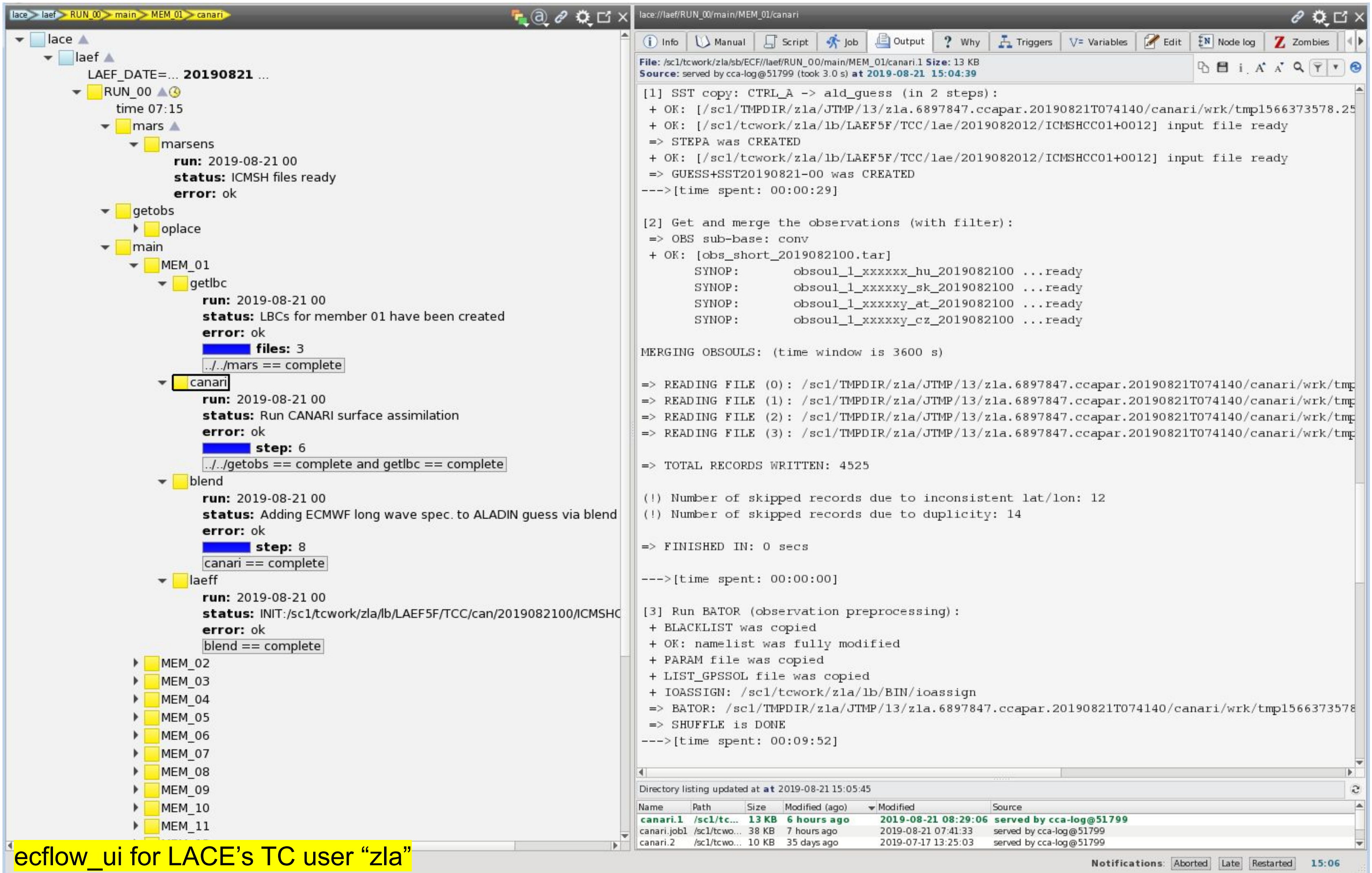
A-LAEF operational suite under ecFlow

A-LAEF integration (and fullpos) domain:

equal to LACE domain



A-LAEF operational suite under ecFlow



ecflow_ui for LACE's TC user "zla"

A-LAEF operational suite under ecFlow

- **MCS case studies**

Turkey - Flash floods of 17 August 2019

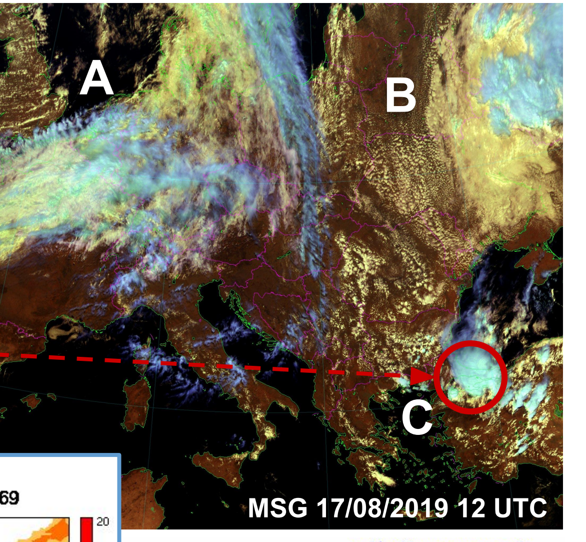
- Heavy rainfall affected several districts of Istanbul (particularly Fatih, Kartal and Bakirkoy) on 17 August causing widespread flash floods.
- According to media reports, one person died in Fatih District, some houses have been damaged and several streets were flooded leading to significant transport disruptions.

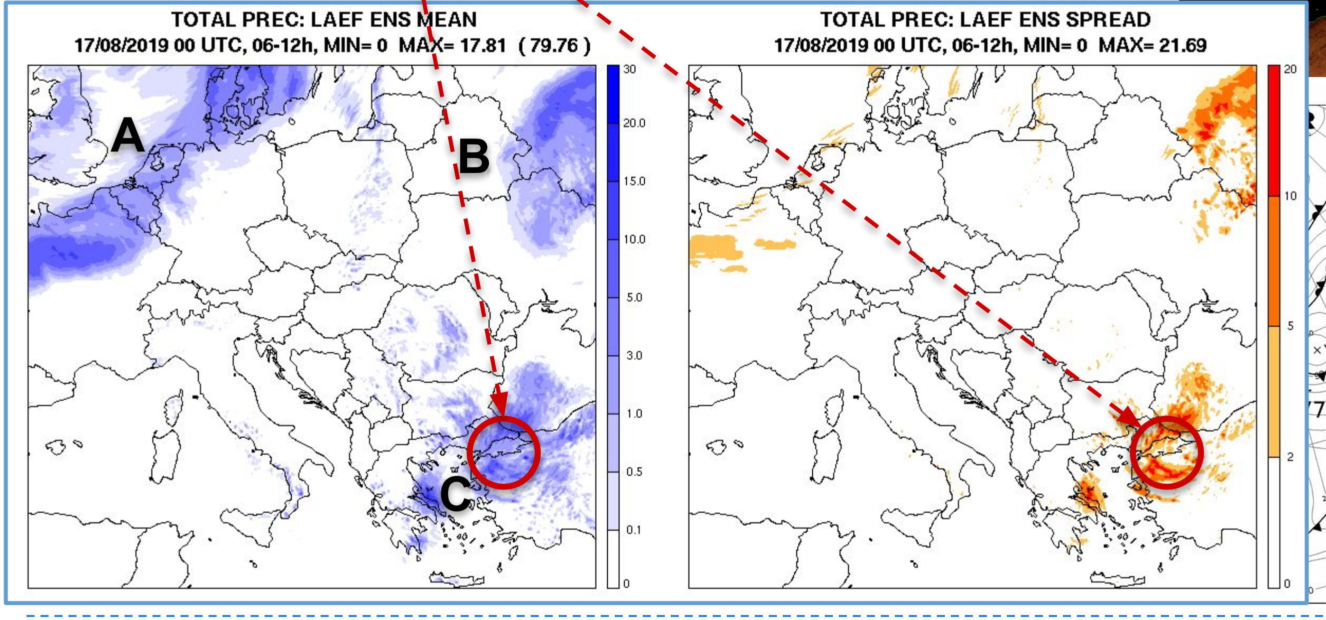
Turkey - Flash floods of 17 August 2019

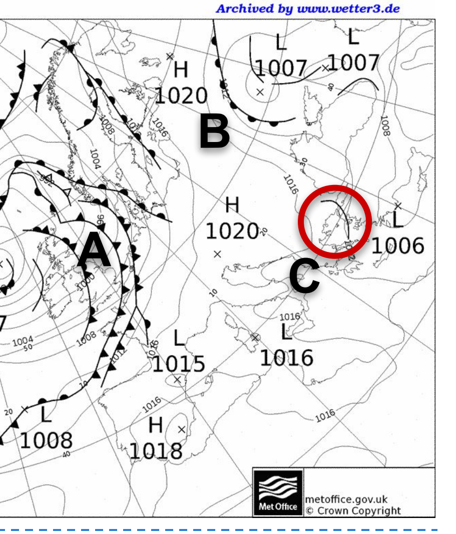
(pre-oper) A-LAEF precipitation forecast:

A, **B**: synoptic scale systems

C: mesoscale convective system (MCS)

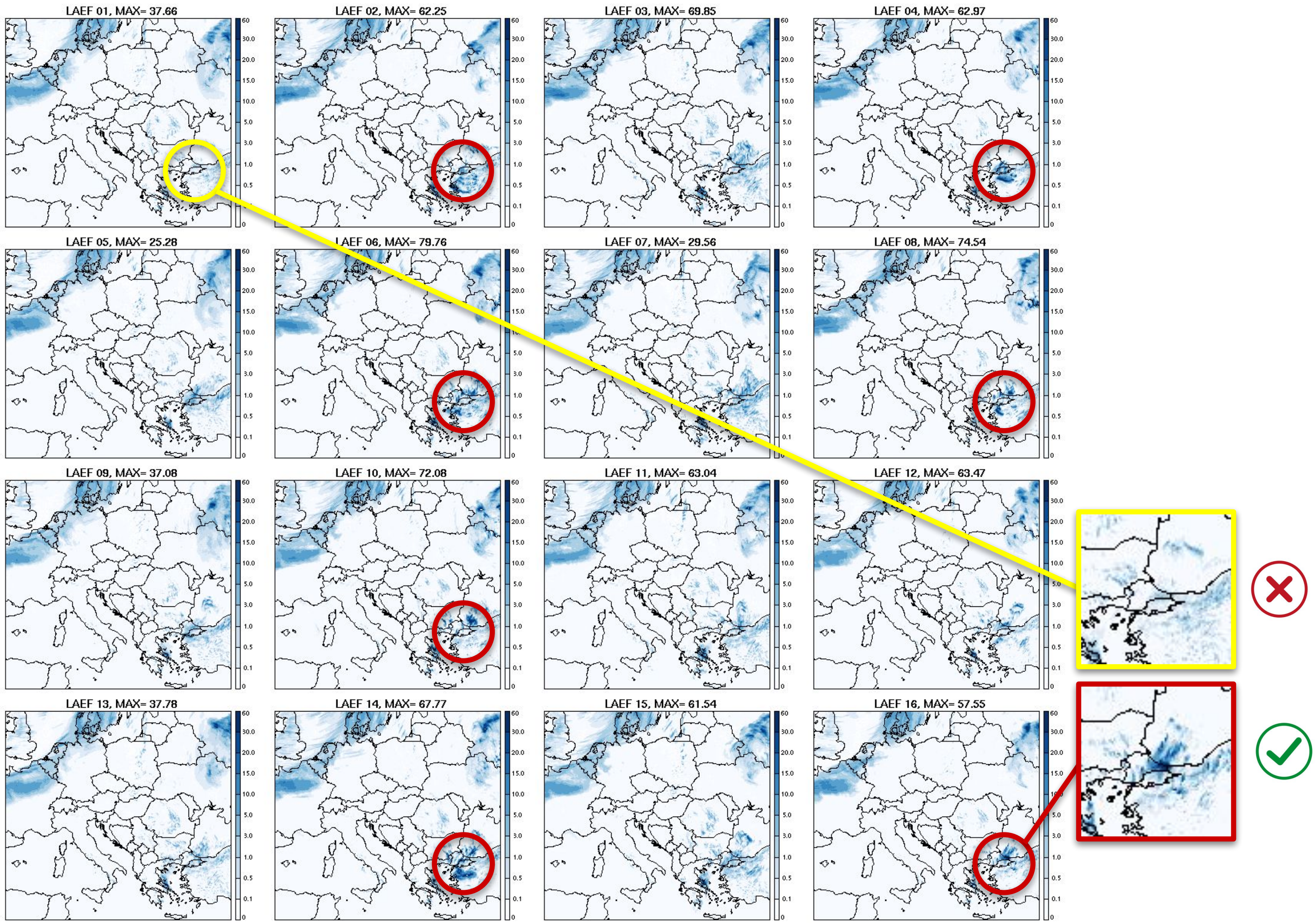






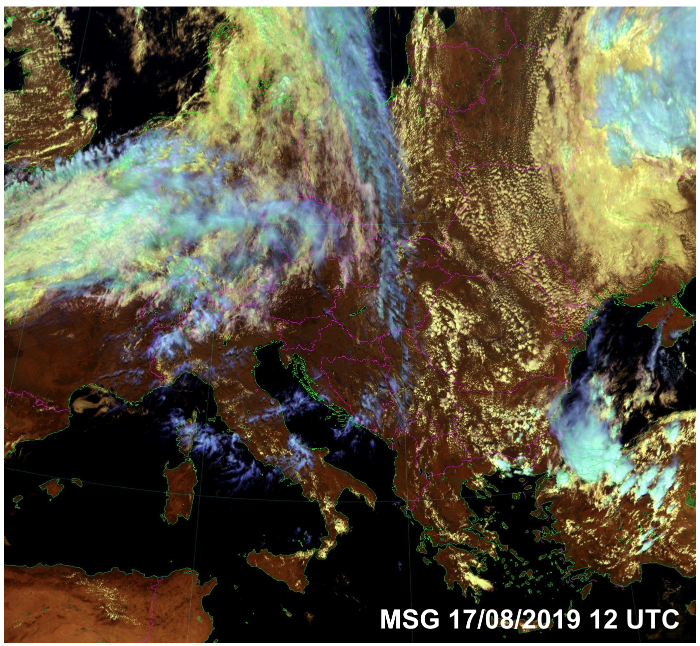
Turkey - Flash floods of 17 August 2019

(pre-oper) A-LAEF precipitation forecast:

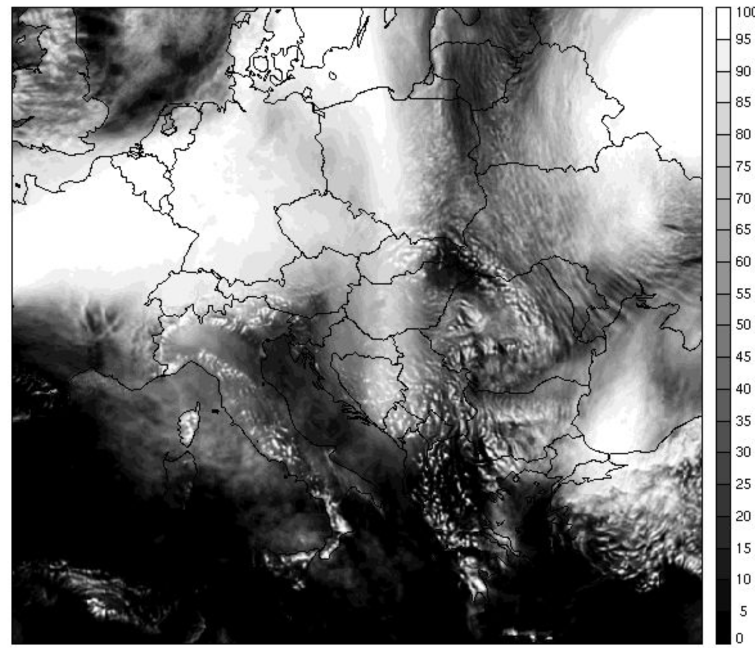


Turkey - Flash floods of 17 August 2019

(pre-oper) A-LAEF cloudiness forecast:

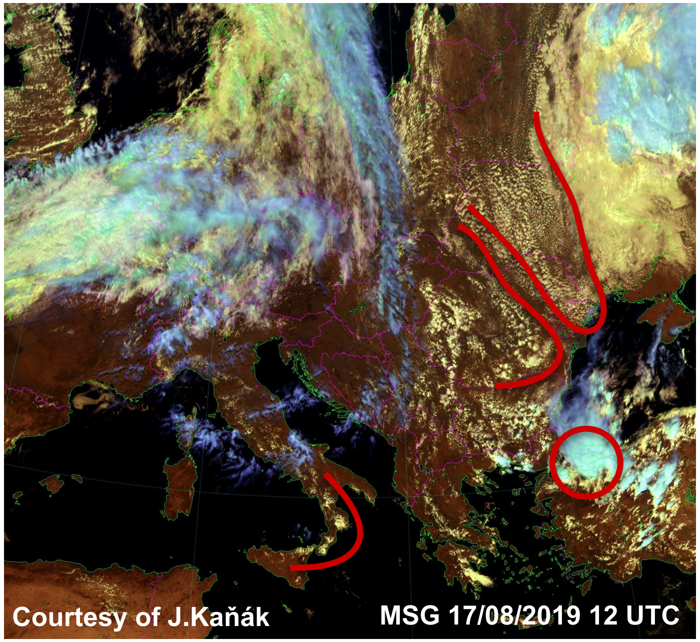


SURFNEBUL.TOTALE: LAEF ENS MEAN
17/08/2019 00 UTC, +12h, MIN= 0 MAX= 100

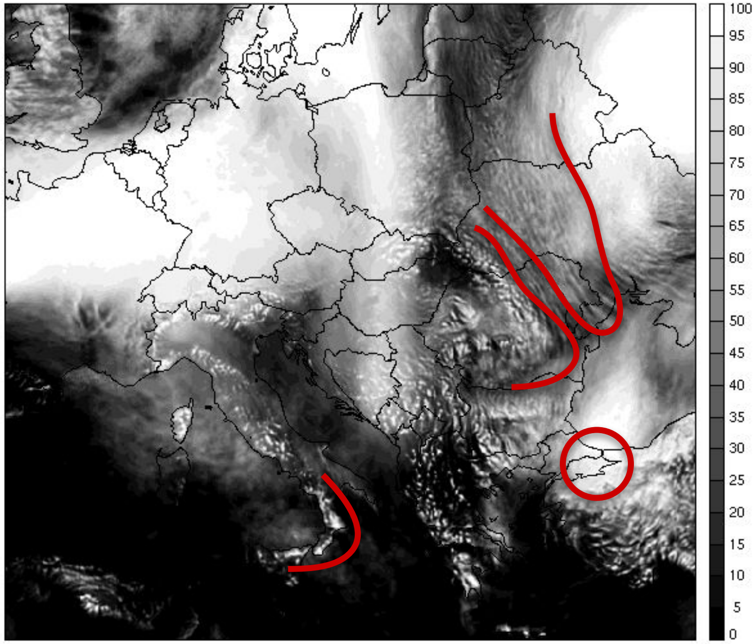


Turkey - Flash floods of 17 August 2019

(pre-oper) A-LAEF cloudiness forecast:



SURFNEBUL.TOTALE: LAEF ENS MEAN
17/08/2019 00 UTC, +12h, MIN= 0 MAX= 100



Central Europe - Night storm of 24 August 2019

- During the night hours the southwestern part of Slovakia was hit by strong thunderstorms. The total number of lightning strikes was about 15,000 with about 15 to 50 millimeters of rain.
- The thunderbolts also hit the 30-meters flagpole, which had been erected in front of Parliament by Andrej Danko, President of the Slovak Parliament.

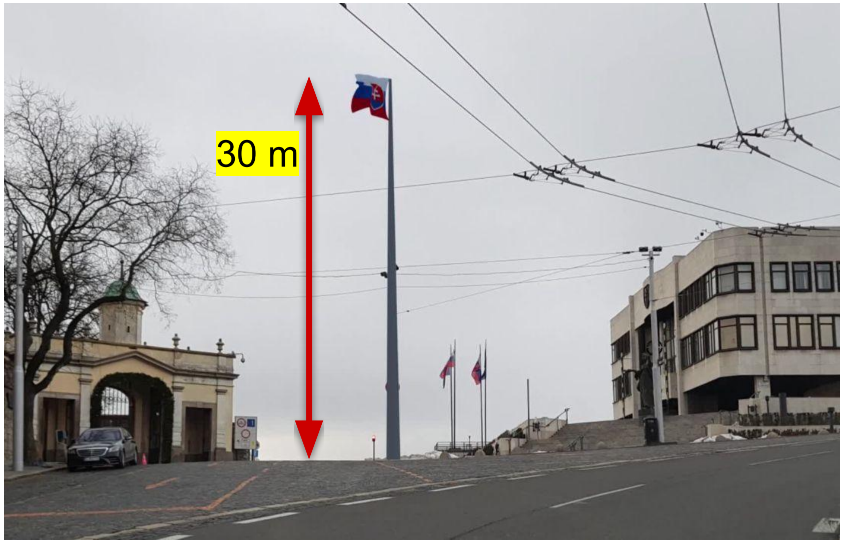
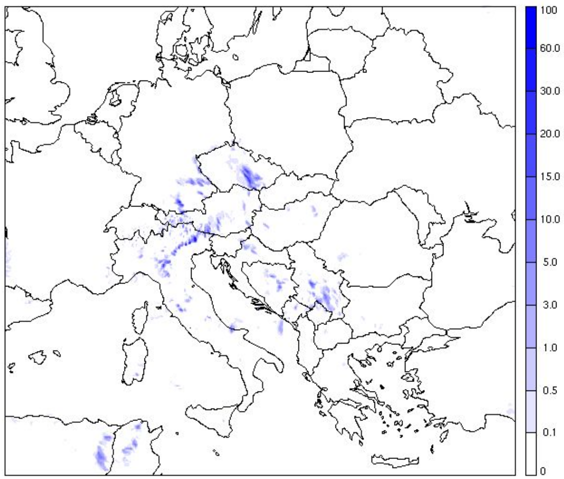


Photo: Adam Kováč, 2019.08.24/25, Bratislava

Central Europe - Night storm of 24 August 2019

ALADIN/SHMU (4.5 km):

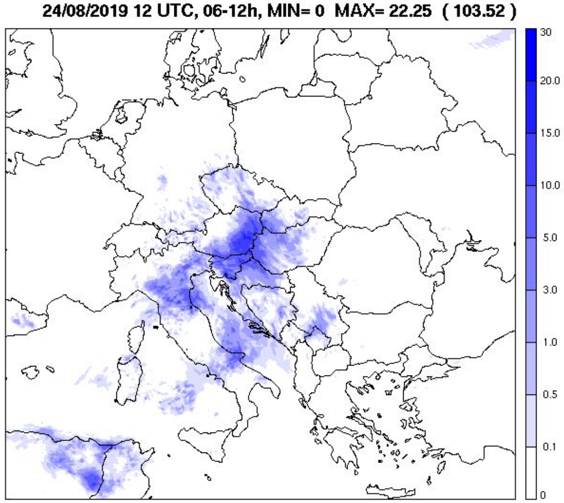
TOTAL PREC: ALADIN/SHMU
24/08/2019 12 UTC, 06-12h, MIN= 0 MAX= 55.22



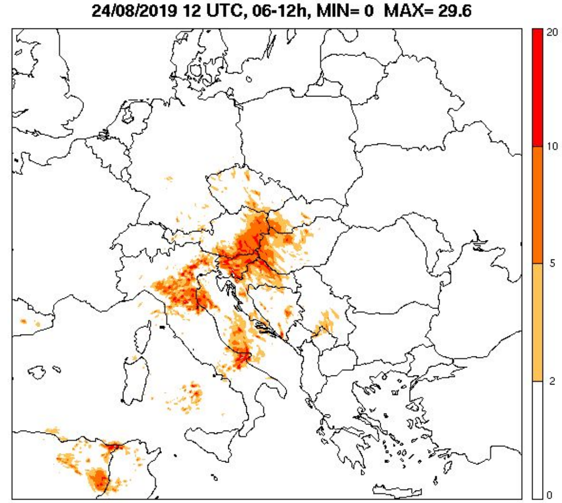
Although, the deterministic ALADIN/SHMU forecast from August 24, 12 UTC was completely missing this convective precipitation event during the night hours, A-LAEF ensemble for the same network time captured the case nicely.

A-LAEF (4.8 km):

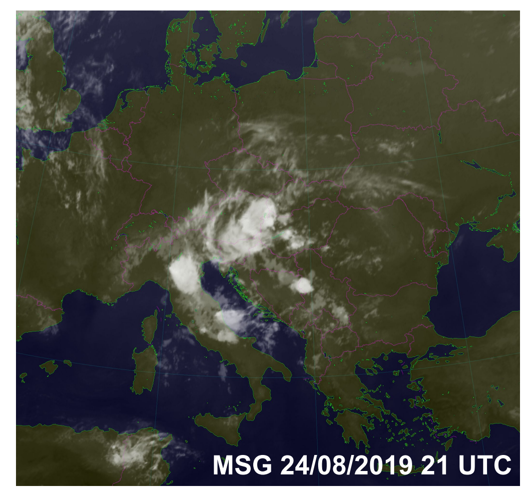
TOTAL PREC: LAEF ENS MEAN
24/08/2019 12 UTC, 06-12h, MIN= 0 MAX= 22.25 (103.52)



TOTAL PREC: LAEF ENS SPREAD
24/08/2019 12 UTC, 06-12h, MIN= 0 MAX= 29.6

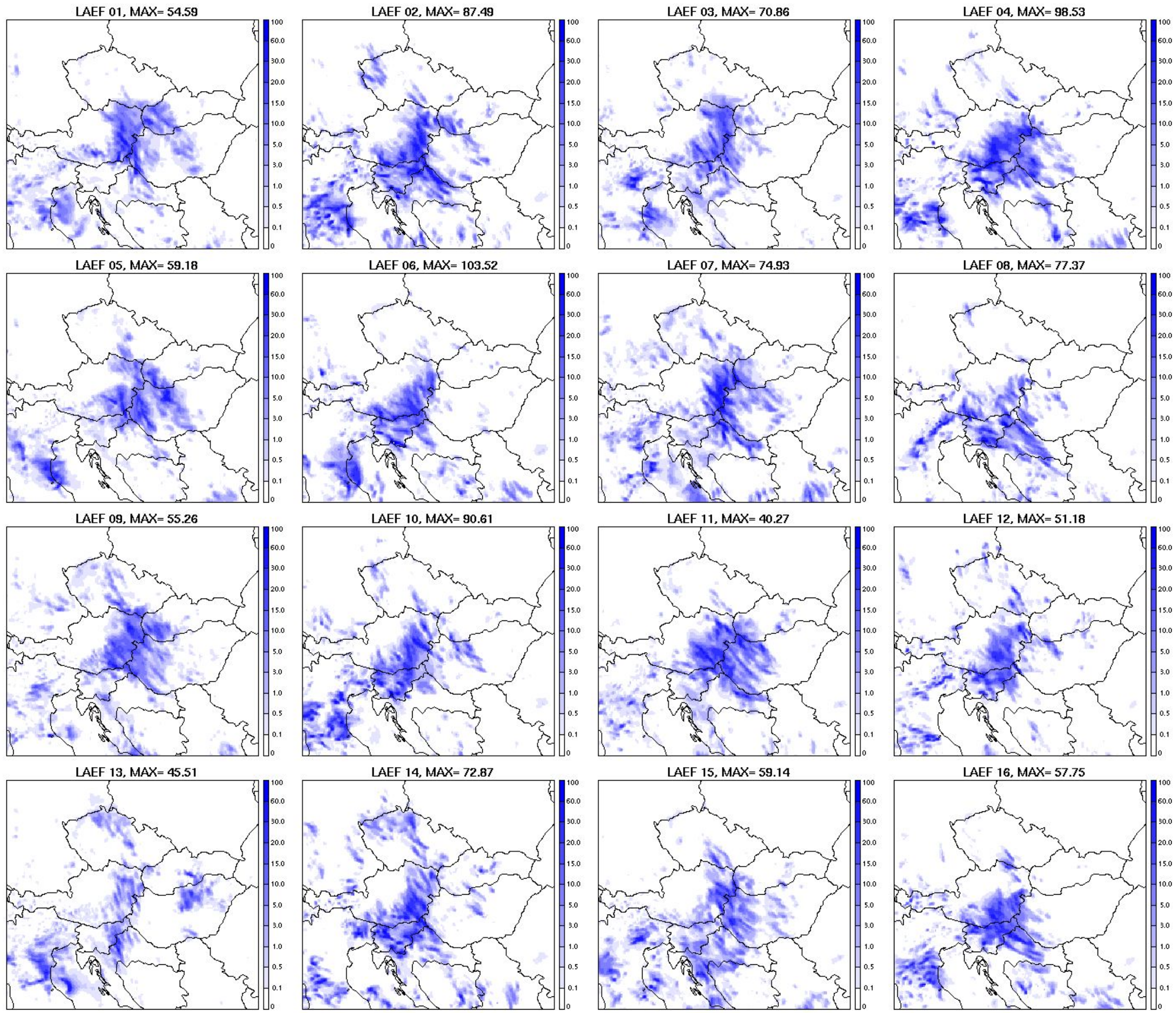


MSG:

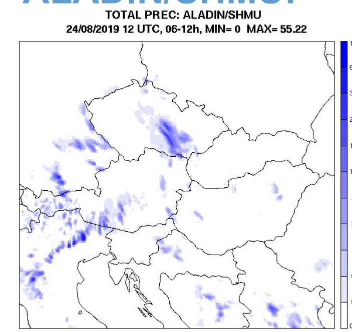


Central Europe - Night storm of 24 August 2019

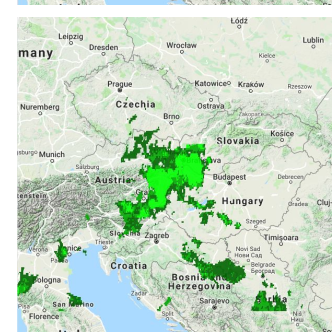
(pre-oper) A-LAEF precipitation forecast:



ALADIN/SHMU:



Radars/NWCSAF:



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Publications

- **published and submitted papers**

Publications

Published papers:

- Belluš, M., F. Weidle, C. Wittmann, Y. Wang, S. Taşku, and M. Tudor, 2019: "Aire Limitée Adaptation dynamique Développement InterNational – Limited Area Ensemble Forecasting (ALADIN-LAEF)", Adv. Sci. Res., 16, 63–68, https://doi.org/10.5194/asr-16-63-2019
- Wang, Y., M. Belluš, F. Weidle, et al., 2019: "Impact of land surface stochastic physics in ALADIN-LAEF", Quarterly Journal of the Royal Meteorological Society, 1–19, https://doi.org/10.1002/qj.3623
- Keresturi E., Y. Wang, F. Meier, F. Weidle, Ch. Wittmann, A. Atencia, 2019: "Improving initial condition perturbations in a convection permitting ensemble prediction system", published on 22 January 2019 in Quarterly Journal of the Royal Meteorological Society, DOI: 10.1002/qj.3473
- Wastl C., Y. Wang, A. Atencia and C. Wittmann, 2019: "Independent perturbations for physics parametrization tendencies in a convection-permitting ensemble (pSPPT)", published on 16 January 2019 in Geosci. Model Dev., 12, 261-273, DOI: 10.5194/gmd-12-261-2019
- Wastl C., Y. Wang, A. Atencia, C. Wittmann, 2019: "A hybrid stochastically perturbed parametrization scheme in a convection permitting ensemble", Mon. Wea. Rev., 147, 2217-2230. doi: https://doi.org/10.1175/MWR-D-18-0415.1

Submitted papers:

- Wastl C., Y. Wang, C. Wittmann: "A comparison of different stochastically perturbed parametrization tendencies schemes", submitted to Meteorologische Zeitschrift
- Plenković, I. O., I. Schicker, M. Dabernig, K. Horvath: "Analog-based post-processing of the ALADIN-LAEF ensemble predictions in complex terrain", submitted to Quarterly Journal of the Royal Meteorological Society on August 2019

Future plans

- hot topics

Future plans

Hot topics:

- Commencing of the **operational utilization of A-LAEF** (and local convection-permitting systems).
- Implementation of **new random number generator** (SPG) suitable for LAM EPS environment in A-LAEF 5km.
- Investigation of the possibilities of **stochastic perturbation of fluxes** instead of tendencies. This should be beneficial with respect to the energy balance preservation in perturbed model.
- Preparation of **flow-dependent B-matrix** using the A-LAEF 5km operational outputs.
- Creation of new A-LAEF **probabilistic products** to meet the different users requirements.
- Implementation of A-LAEF 5km Phase II configuration involving **ENS BlendVar** to improve the simulation of upper-air ICs uncertainty.
- Continuation work on **analog-based post-processing** method to improve the point forecast of high-resolution wind field. Investigation of the possibility to use such method for the ensemble of other surface parameters like T2m or RH2m. Spatial implementation.
- **Calibration of precipitation**. Methodology for post-processing over the river catchments according to the needs of hydrological models.

Thank you for your attention!