Regional Cooperation for Limited Area Modeling in Central Europe

LACE
nwp central europe

LAM-EPS activities in LACE

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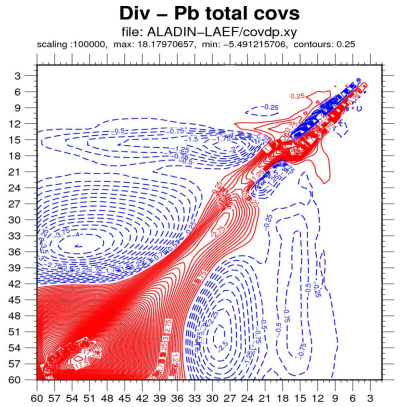
DHMZ SHMU ARSO METEO Slovenia OMSZ ZAMG ROMANIA ANM

LAM-EPS activities in LACE

Ongoing changes in operations:

- **ALADIN-LAEF 5 km - phase I (RC LACE)** [RWP-2018 E4.5 | RWP-2019 E4.4]
- **C-LAEF 2.5 km (ZAMG)** [RWP-2018 E3.5 | RWP-2019 E3.5] …(see presentation of Clemens)
- **AROME-EPS 2.5 km (OMSZ)** installation on local computer to replace ALARO-EPS 8 km

Other topics we've tackled:



- **B-Matrix for new ALADIN-LAEF** [RWP-2018 E4.3]
  - based on 256 samples (5 km, 60 levels, ALARO-1 physics, Phase I)
  - used for ENS 3DVar validation
- **Validation of ENS 3DVar within ALADIN-LAEF Phase II** [RWP-2018 E4.3]
  - various data types were implemented into the 3DVar of new ALADIN–LAEF
  - SYNOP, TEMP, AMDAR, GEOWIND (OPLACE) and GNSS (SUT)
  - impact is rather small but positive (first several hours)
- **3D version of new SPG** [RWP-2018 E3.2]
  - external program of SPG can produce 3-dimensional patterns
  - ratio of vertical and horizontal spatial correlation can be set by namelist
  - previous implementation of SPG in ALADIN code involved only 2D patterns
  - decision to test the effect of 3D pattern by a simpler way (otherwise too complicated)
  - code was modified to allow the definition of more patterns (1-5) at the same time
  - depending on patterns count the whole column is divided into subparts
  - one dominant pattern is active on each level
  - additional patterns are combined by level-dependent weight-function

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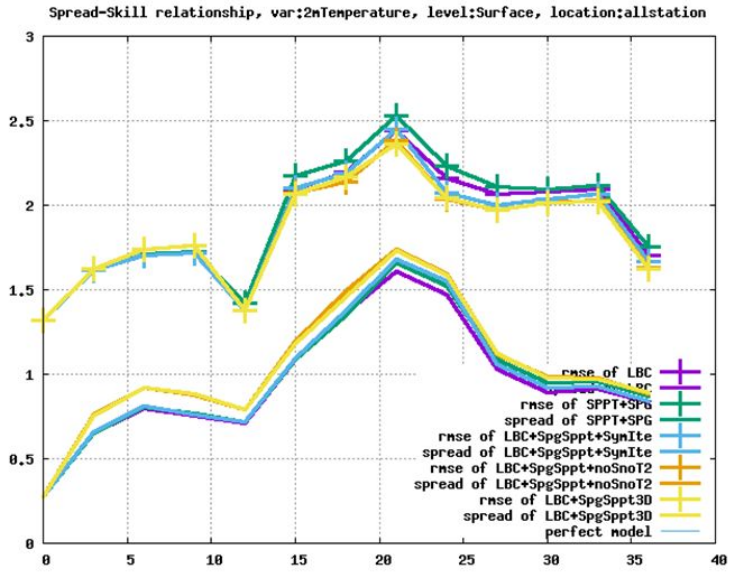
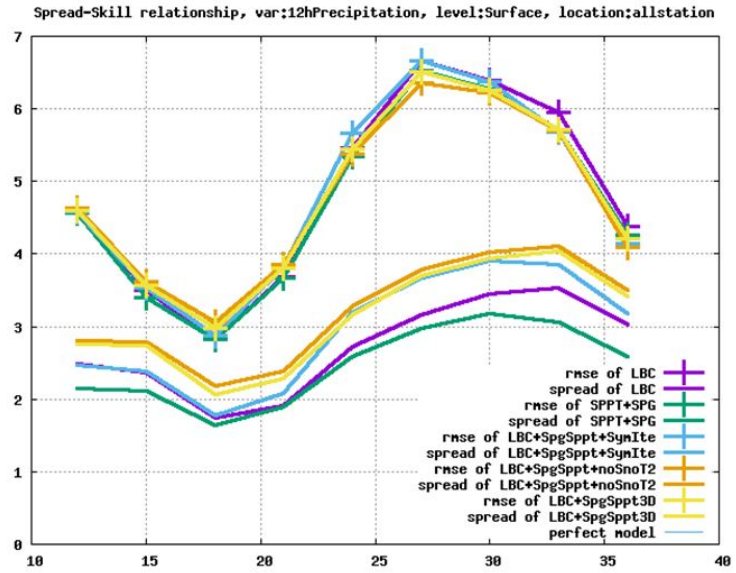
A short sensitivity study with the new method was carried out for 10 days period from the convective season in 2015. Test system contained 10+1 members integrated for 36 hours over the Hungarian AROME domain.

Conclusions:

- such moderate 3D did not bring any additional value over 2D pattern
- more intensive setting can change conclusions
- case-studies should be considered





Spread-skill scores for 2m temperature (left) and 12h accumulated precipitation (right) for several experiments. One should concentrate on the reference (orange lines) and 3D experiment (yellow lines).

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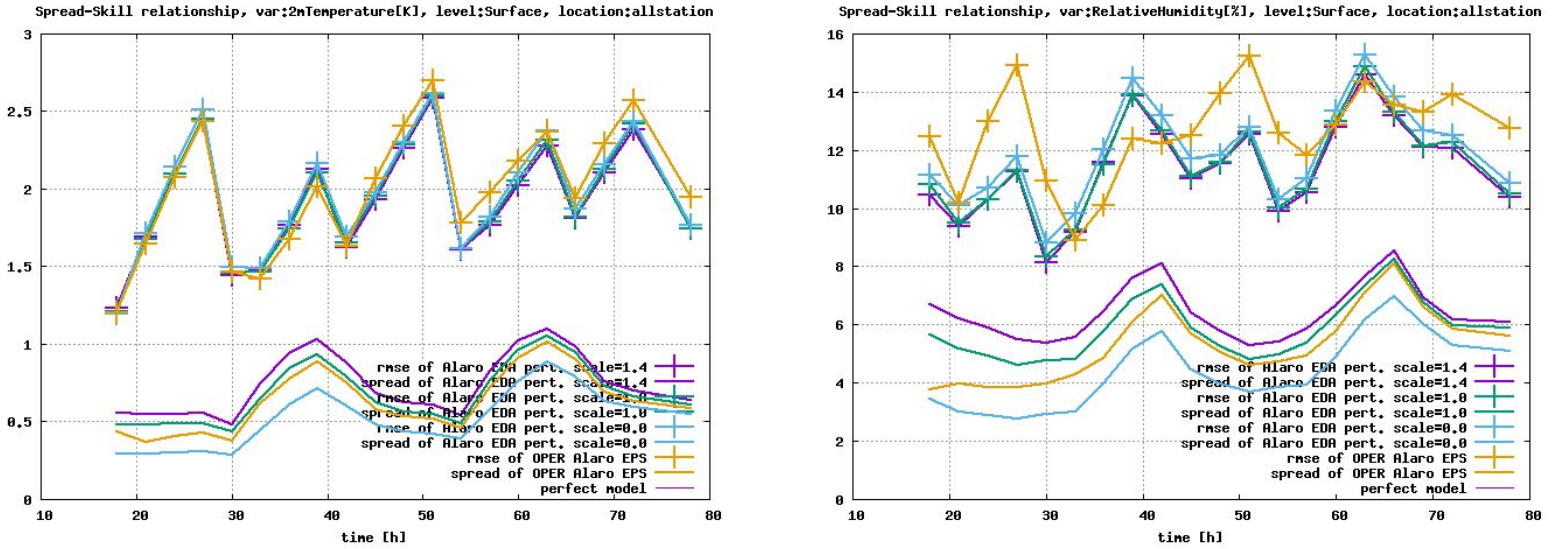
★ **ALARO EDA experiments at OMSZ** [RWP-2019 E3.6]

- three EDA experiments with different scales of perturbation (1.0, 1.4, 0.0)
- setup of experiments based on the Hungarian operational ALARO-EPS
- containing 10+1 ALARO-1 members at 8 km horizontal resolution
- testing period May 2018 (convective season, ECMWF LBCs available 4x per day)
- operational ALARO-EPS runs in dynamical adaptation
- EDA experiments have 6-hourly assimilation cycle (canari+3DVar)

The main aim was to test EDA on ALARO in order to determine its properties and its influence on the forecast. The outcome is planned to be used later for new AROME-EPS system, when ready in 2019.

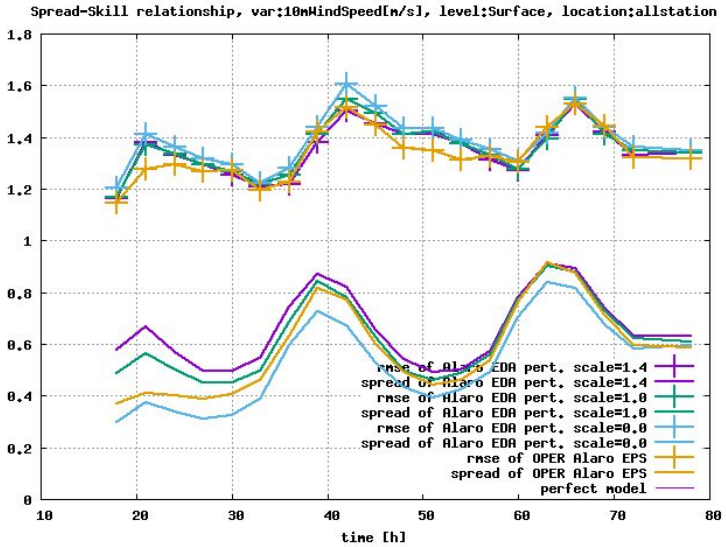


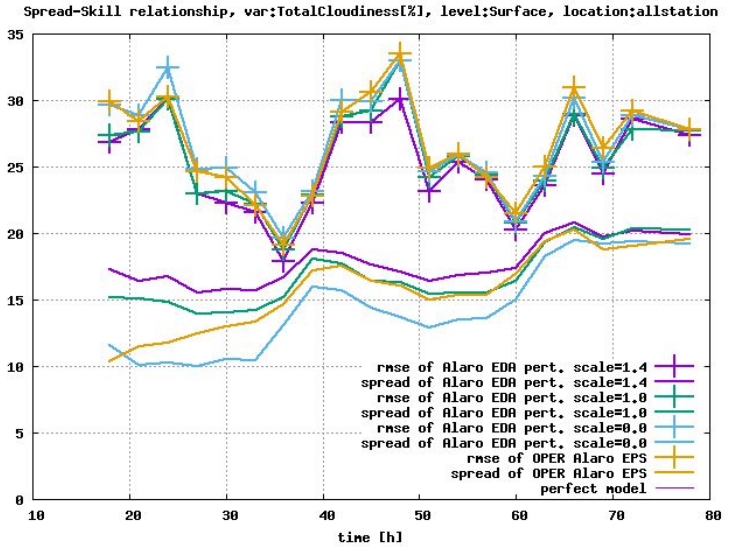
Spread-skill scores for different ALARO EDA experiments for T2m (left) and RH2m (right).

LAM-EPS activities in LACE

- the ALARO-EPS was tested with and without the initial perturbations (scale=0.0)
- assimilation worsens forecast quality (yellow vs. light blue)
- but the goal is to improve forecast through EDA (yellow vs. purple)
- conventional assimilation did not lower the RMSE
- EDA with perturbed OBS decreased RMSE and increased spread
- with stronger perturbation spread becomes bigger and RMSE smaller

Conclusion: Spread, induced by the perturbations of observation errors, has positive impact on the ALARO-EPS forecast quality.





Spread-skill scores for different ALARO EDA experiments for FF10m (left) and total cloudiness (right).

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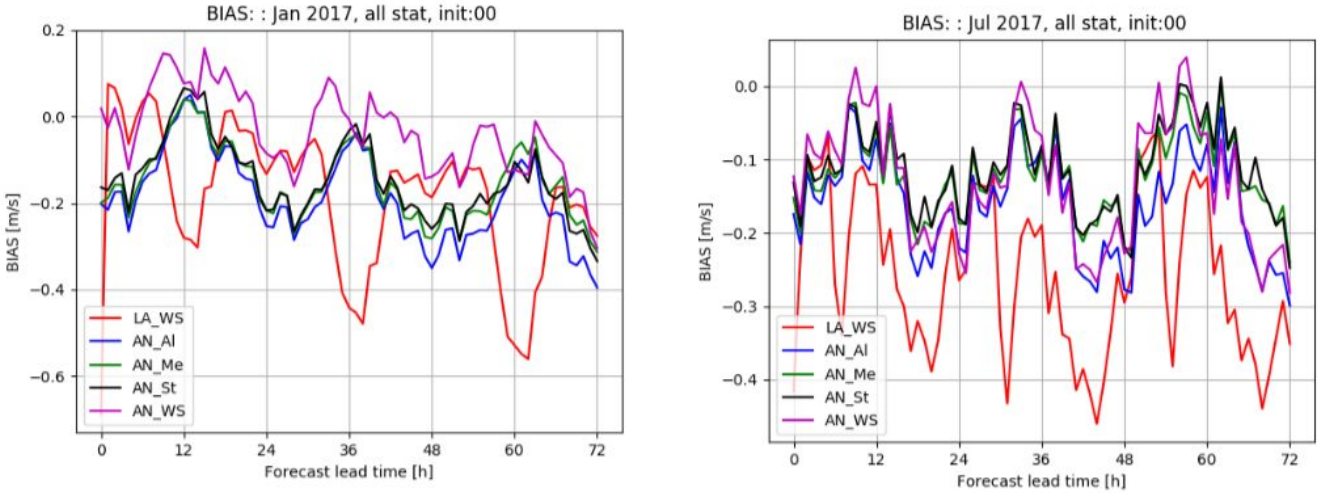
★ **Analog-based post-processing method for wind field** [RWP-2018 E4.7 | RWP-2019 E4.6]

- point-based analog-based post-processing method
- firstly tested on AROME deterministic model input
- later extended to ALADIN-LAEF probabilistic input (4 configurations)
  - AN_WS: all wind speed members (17 predictors)
  - AN_Me: ens mean of wind FF/DD, T2m, RH2m, MSLP, precipitation (6 predictors)
  - AN_St: ens mean and stdev of wind FF/DD, T2m, RH2m, MSLP, precipitation (12 predictors)
  - AN_Al: all members for wind speed/direction, T2m, RH2m, MSLP, precipitation (17x6 predictors)
- algorithm tested for two months: January 2017 (winter) and June 2017 (summer)
- the same training period (2015-2016)

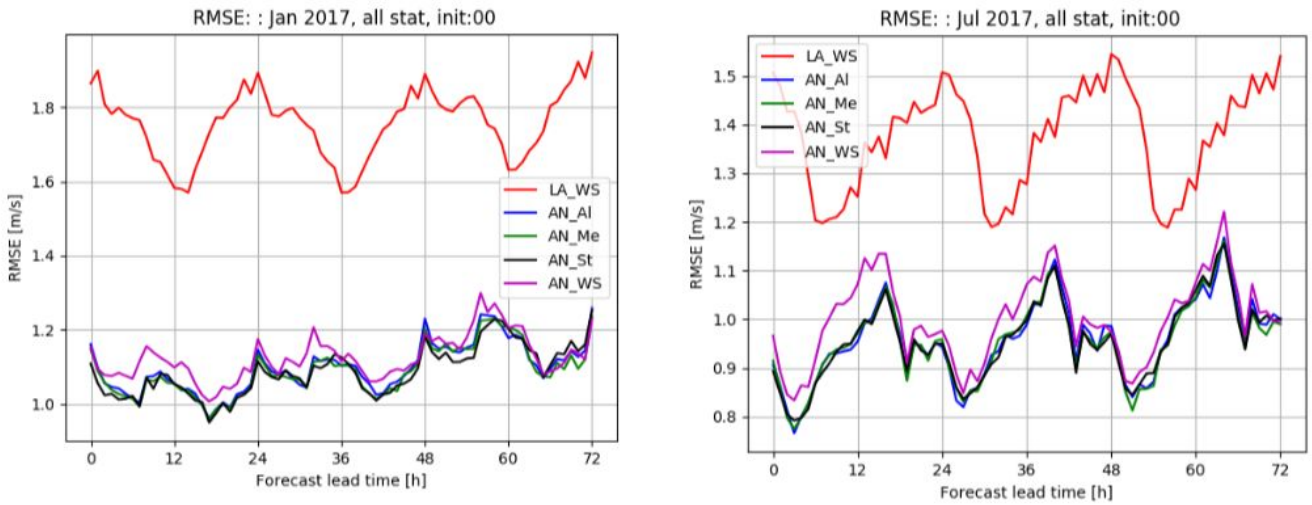


BIAS of the ensemble mean of ALADIN-LAEF wind speed forecast LA_WS (red line - reference) and four different analog ensemble configurations (AN_WS, AN_Me, AN_St, AN_Al) for January (left) and July (right) 2017.

LAM-EPS activities in LACE

Conclusions:

- for January AN_WS has smallest BIAS also in comparison to reference (LA_WS)
- for July the improvement over LA_WS is more evident for all tested configurations
- BIAS is generally small even for LA_WS forecast
- RMSE shows great improvement of analog post-processing method over LA_WS



RMSE of the ensemble mean of ALADIN-LAEF wind speed forecast LA_WS (red line - reference) and four different analog ensemble configurations (AN_WS, AN_Me, AN_St, AN_Al) for January (left) and July (right) 2017.

ALADIN-LAEF

★ **ALADIN-LAEF 5 km - phase I** [RWP-2018 E4.5 | RWP-2019 E4.4]

- ecFlow suite prepared at ECMWF HPCF from scratch (Python + Perl)
- Python API allows the entire suite definition structure to be
  - specified
  - checked
  - loaded into the ecFlow server
- first functional suite created/tested under kmxy user at ecgate (should be moved to zla)
- LBCs created via c903 (cy46) directly from the ECMWF gribs (Ryad and Martina helped a lot)

Task	nproc	wallc time	output	SBUs	Total SBUs
	values per member (*per 12 hour integration)				16+1 mem (*72h, 2x day)
canari	288	240-300s	518 MB	280-370	~11050
blend	288	480-540s	518 MB	660-720	~23460
laeff	288	900-960s	7.15 GB	~1200*	~244800*
Total SBUs consumption per year (an approximation only)					**~102 mio**

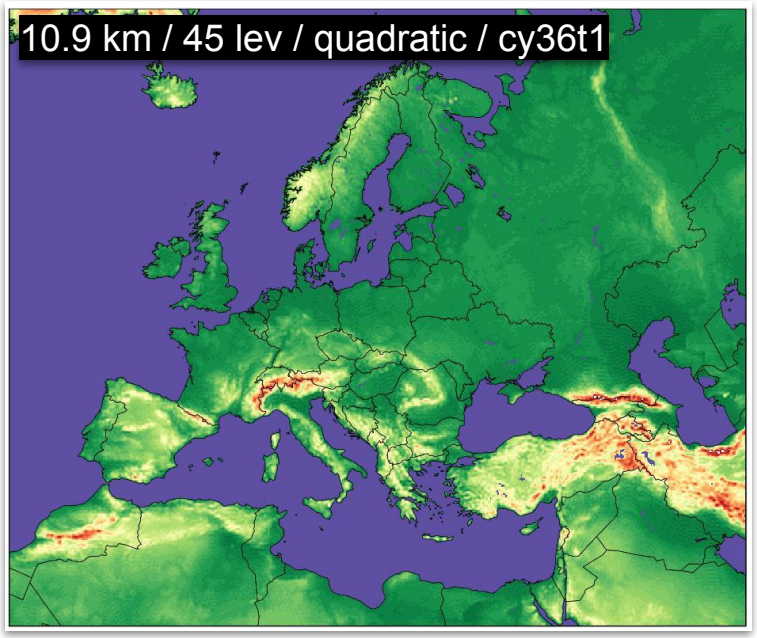
The summary of resources and estimated total per year consumption of SBUs.

ALADIN-LAEF (system specifications)

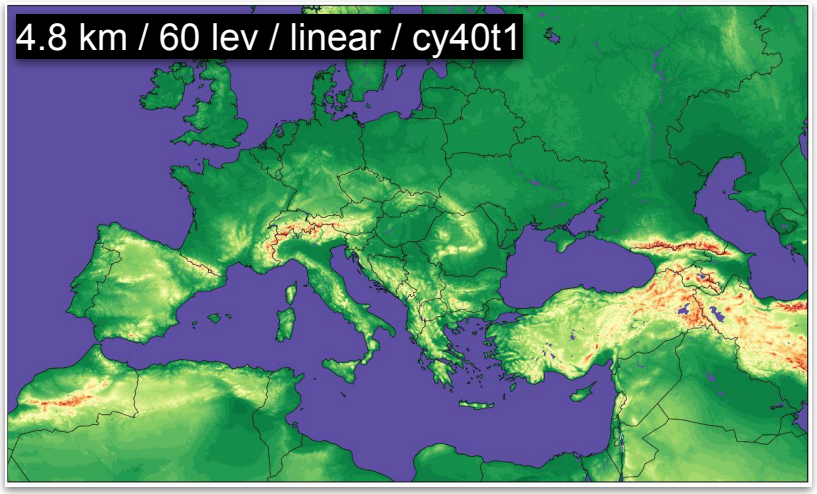
ALADIN-LAEF	current →	new
Code version	cy36t1	cy40t1
Horizontal resolution	10.9 km	4.8 km
Vertical levels	45	60
Number of grid points	500x600	750x1250
Grid	quadratic	linear
Time step	450s	180s
Forecast length	72 h (00/12 UTC)	72 h (00/12 UTC)
Members	16+1	16+1
IC perturbation	ESDA [surface], breeding-blending [upper-air]	ESDA [surface], blending (Phase I) / ENS BlendVar (Phase II) [upper-air]
Model perturbation	ALARO-0 multi-physics	ALARO-1 multi-physics + surface SPPT
LBC perturbation	ECMWF ENS	ECMWF ENS
Scripting	SMS/Shell/Perl	ecFlow/Python/Perl

ALADIN-LAEF (domain)

current



new



ALADIN-LAEF (multi-physics)

16

4x4

ALADIN-LAEF (scripting system)

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:

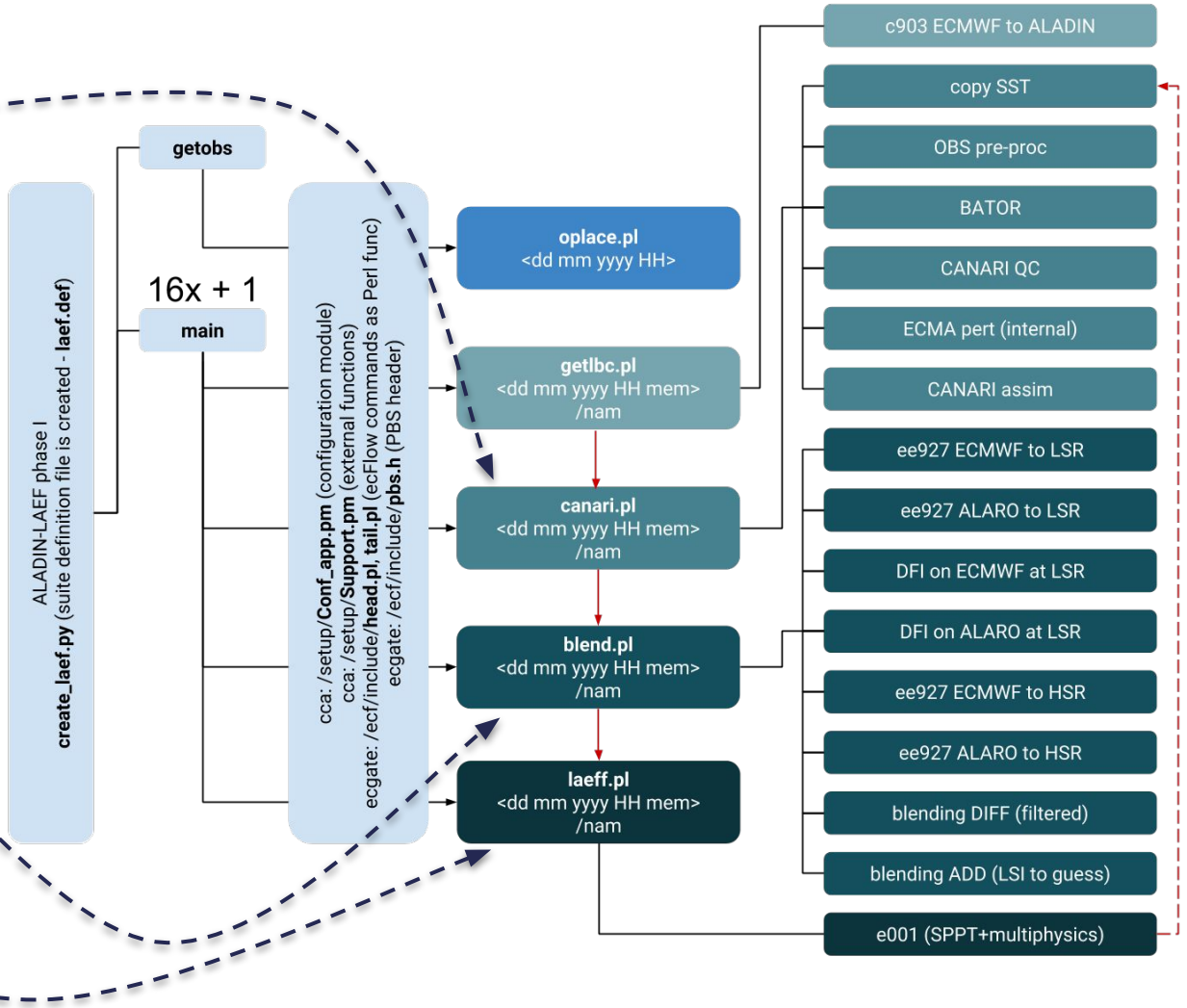
$$IC^n_{blend} = a^n_{breed} + \{\overline{(a^n_{sv})_{trunc}} - \overline{(a^n_{breed})_{trunc}}\}$$

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

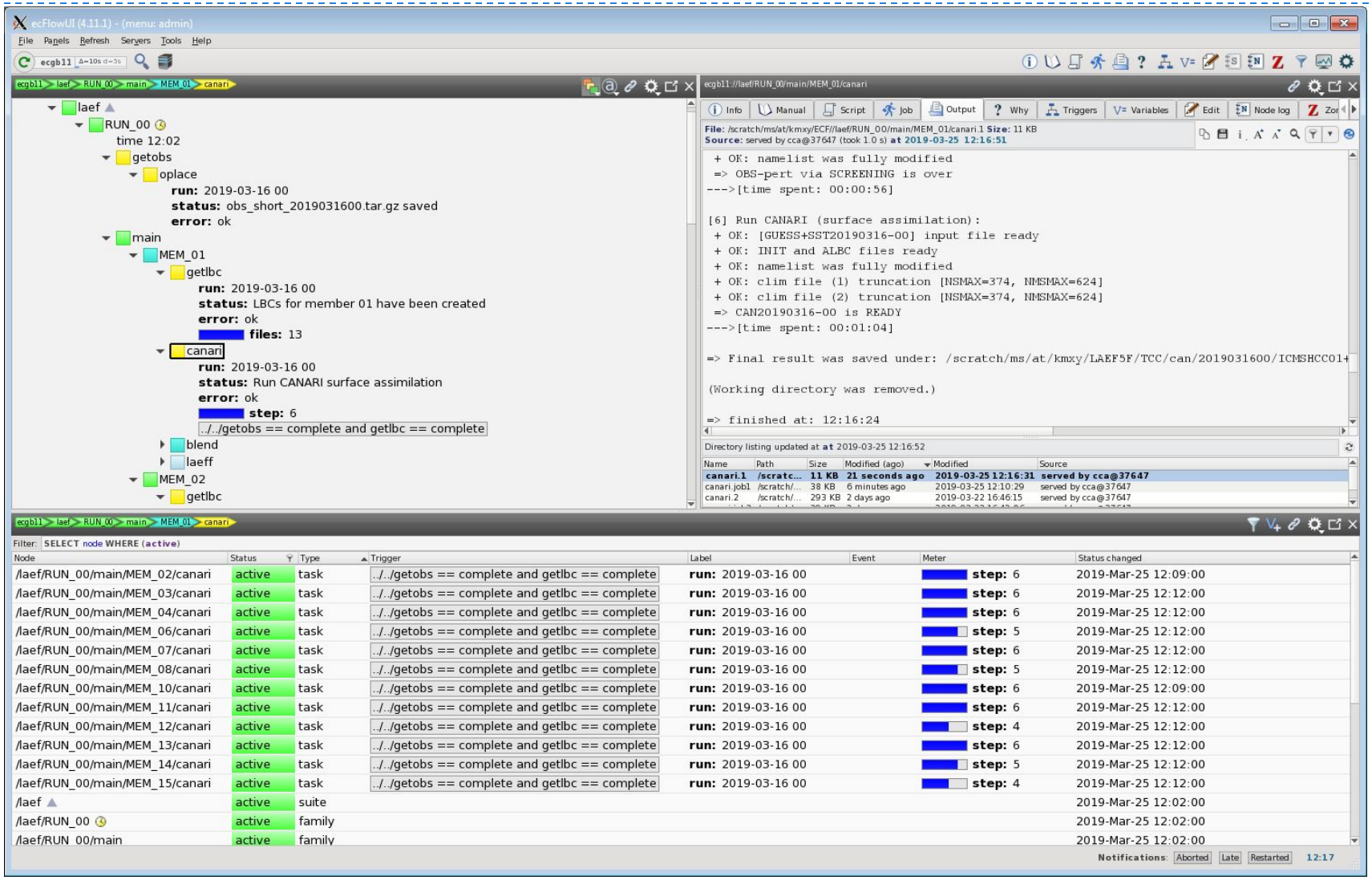
SPPT + MP:

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

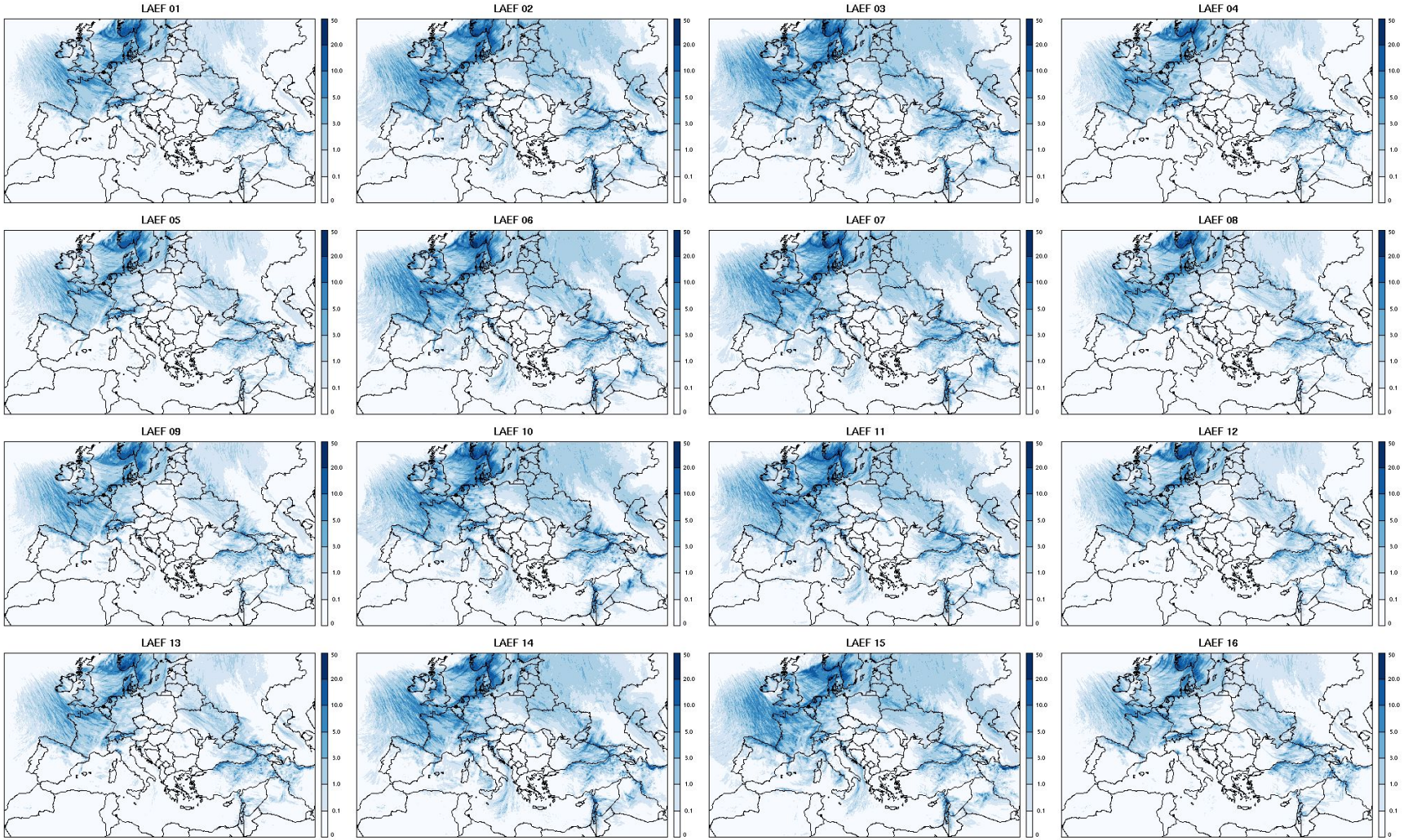
$$P'_j(e_j,t) = (1 + r_j(\lambda,\varphi,t)_{D,T}) P_j(e_j,t)$$



ALADIN-LAEF (ecFlow suite)

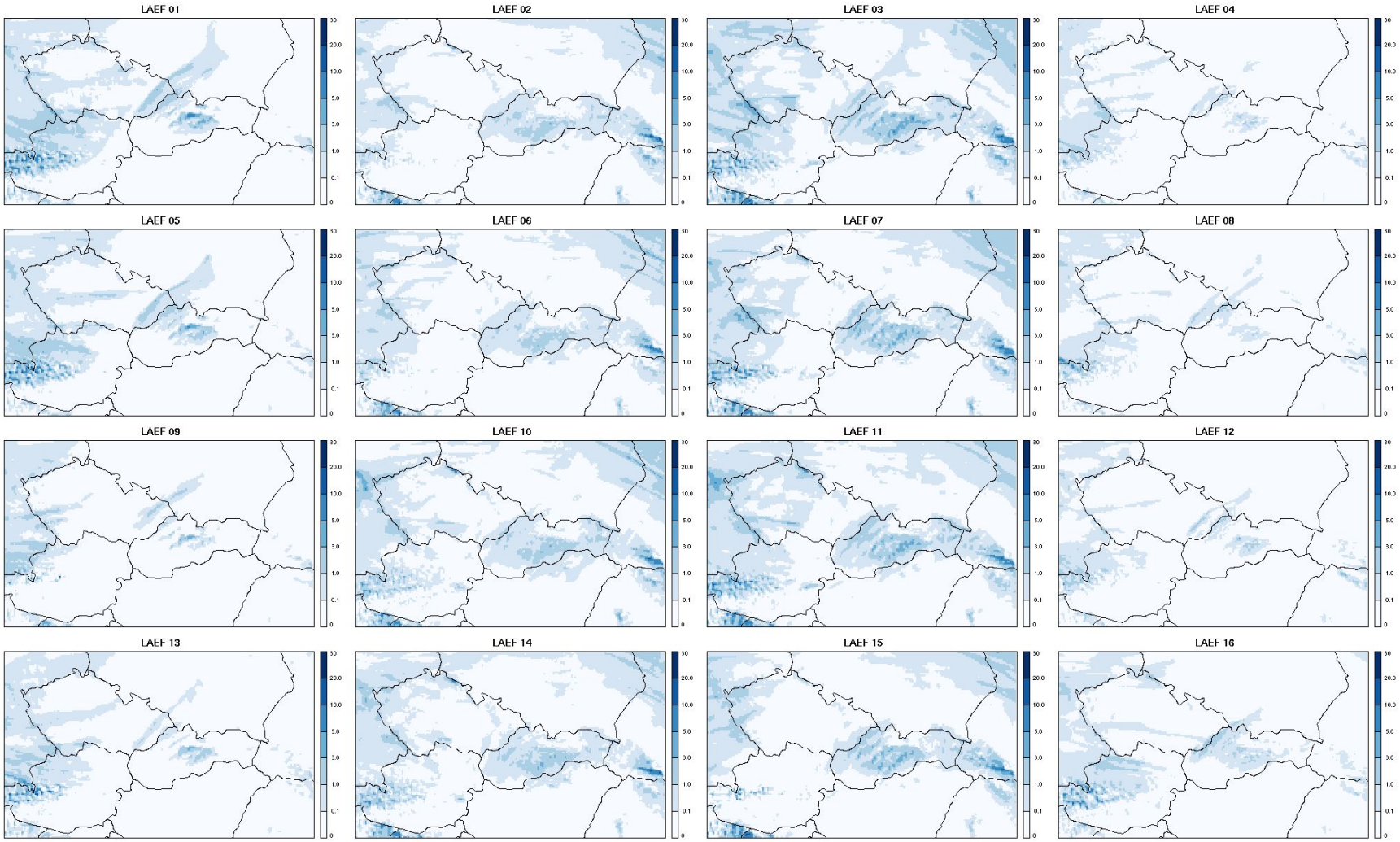


ALADIN-LAEF (total precipitation)



16-03-2019 00 UTC +48h

ALADIN-LAEF (convective precipitation)



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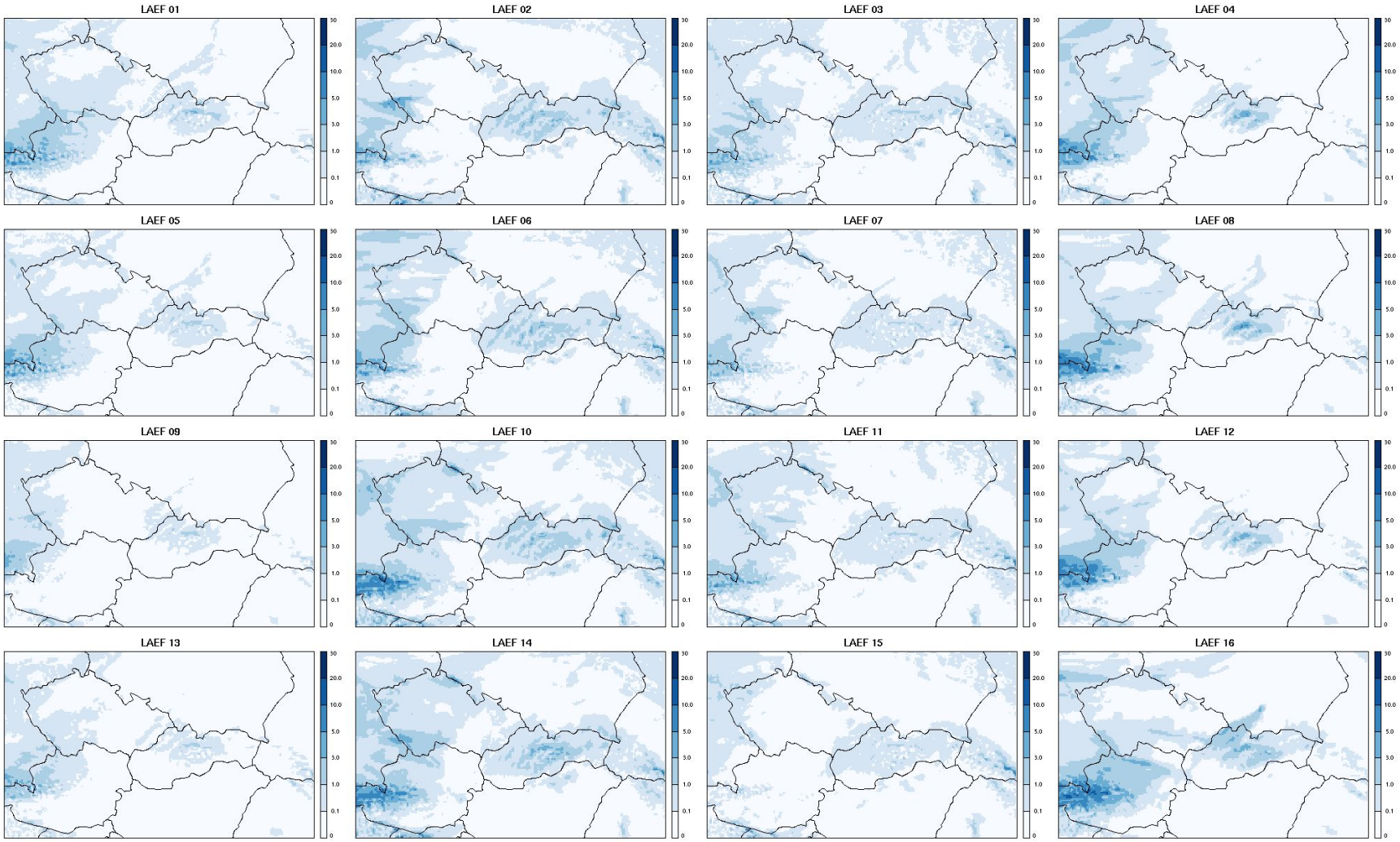
ALADIN-LAEF (stratiform precipitation)



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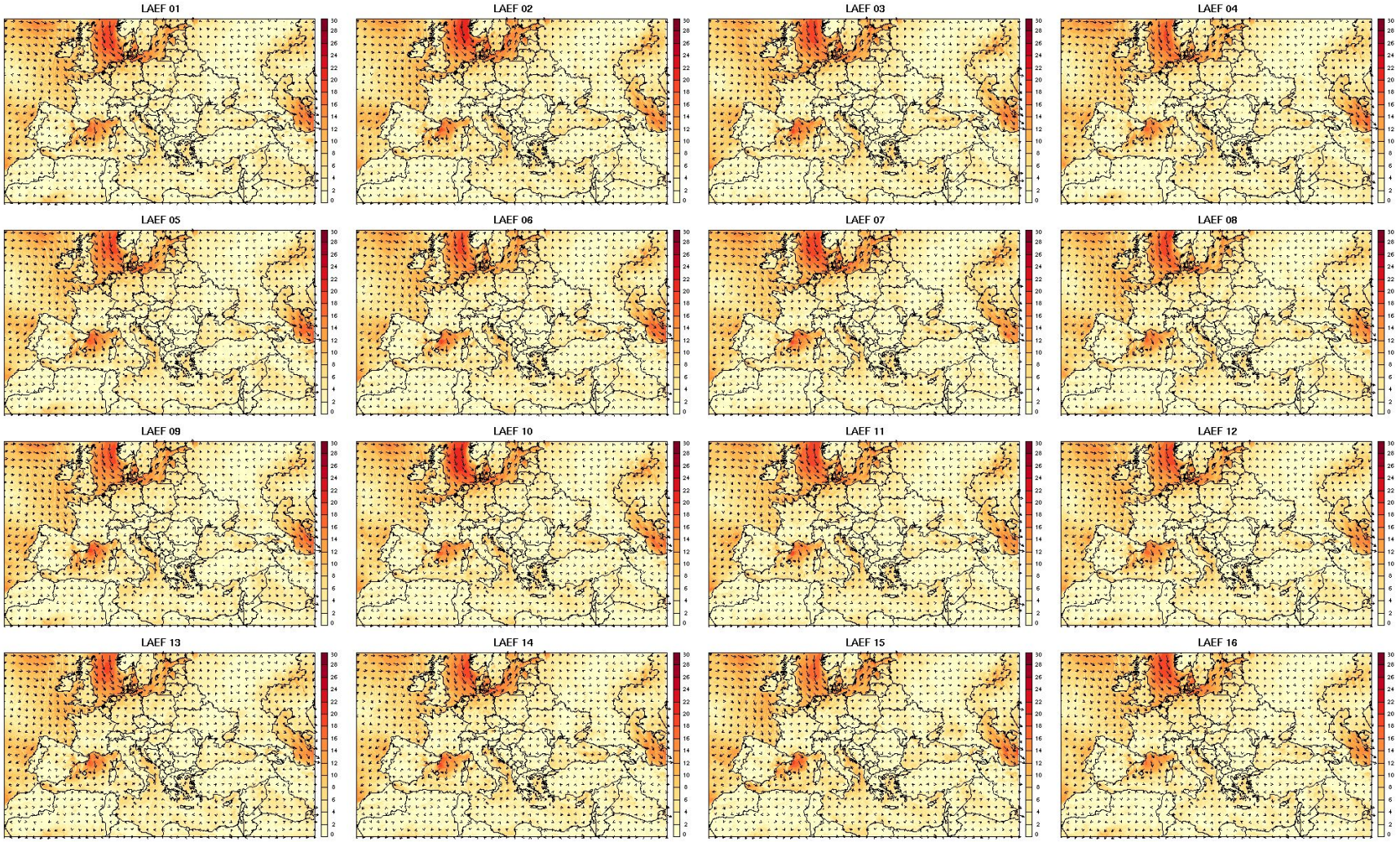
ALADIN-LAEF (wind speed and direction)



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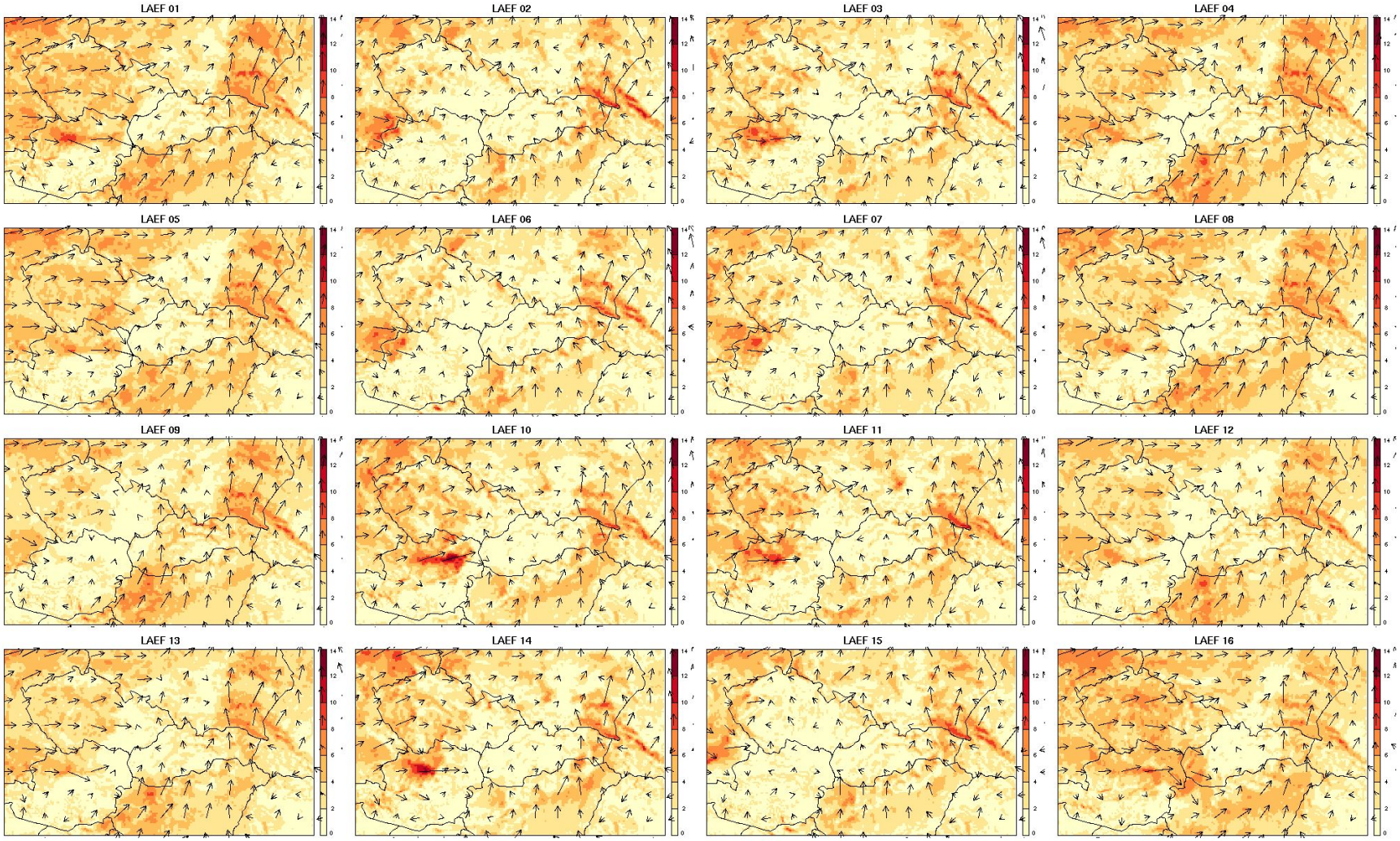
ALADIN-LAEF (wind speed and direction)



16-03-2019 00 UTC +48h

Publications

Published papers:

- Wang Y., M. Belluš, A. Ehrlich, M. Mile, N. Pristov, P. Smolíková, O. Španiel, A. Trojáková, R. Brožková, J. Cedilnik, D. Klarić, T. Kovačić, J. Mašek, F. Meier, B. Szintai, S. Tascu, J. Vivoda, C. Wastl, Ch. Wittmann, 2017: "**27 years of Regional Co-operation for Limited Area Modelling in Central Europe (RC LACE)**", published online on 23 July 2018 in BAMS, DOI: 10.1175/BAMS-D-16-0321.1
- 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

Submitted papers:

- Belluš M., F. Weidle, Ch. Wittmann, Y. Wang, S. Taşku, M. Tudor: "**Aire Limitée Adaptation dynamique Développement InterNational - Limited Area Ensemble Forecasting (ALADIN-LAEF)**", submitted to Advances in Science and Research (ASR) on 7 December 2018 for the Special Issue: 18th EMS Annual Meeting: European Conference for Applied Meteorology and Climatology 2018 (accepted for publication)
- Wang Y., M. Belluš, F. Weidle, Ch. Wittmann, J. Tang, F. Meier, F. Xia, E. Keresturi: "**Impact of land surface stochastic physics in ALADIN-LAEF**", submitted to Quarterly Journal of the Royal Meteorological Society on 25 January 2019 (currently under review - manuscript needs major revisions)
- Wastl C., Y. Wang, A. Atencia, C. Wittmann, 2019: "**A hybrid stochastically perturbed parametrization scheme in a convection permitting ensemble**", submitted to MWR

Publications

RC LACE stay reports:

- Iris Odak Plenković: **Work on analog-based post-processing method**, Report on stay at ZAMG, 05/02~02/03, 2018, Vienna, Austria
- Mihály Szűcs: **3D version of SPG**, Report on stay at ZAMG, 04/06~15/06, 2018, Vienna, Austria
- Martin Belluš: **Operational ecFlow suite for new ALADIN-LAEF**, Report on stay at ZAMG, 30/07~24/08, 2018, Vienna, Austria
- Martin Imrišek: **Validation of ENS 3DVar within ALADIN-LAEF Phase II**, Report on stay at ZAMG, 30/07~24/08, 2018, Vienna, Austria
- Réka Suga: **Adaptation of Stochastic Pattern Generator (SPG) for Austrian AROME domain**, Report on stay at ZAMG, 08/10~02/11, 2018, Vienna, Austria

Area report:

- Martin Belluš: **Working Area Predictability - Progress Report 2018**, March 2019

available online at www.rclace.eu

Future plans

Operational status of:

- **New ALADIN-LAEF** suite at ECMWF (TC2 app under LACE account) [RWP-2019 E4.4]
- **C-LAEF** suite at ECMWF (TC2 app under AT account) [RWP-2019 E3.5]
- **AROME-EPS** system on new HPC at OMSZ [RWP-2019 E3.6]

Other topics:

- Perturb the upper-air fields in ALADIN-LAEF system with **new SPG**. Review drying issue and necessity of tapering function application. [RWP-2019 E4.1]
- Computation of **flow-dependent B-matrix** using the ALADIN-LAEF outputs. Make it available for local DA systems. [RWP-2019 E4.3]
- Apply the **analog-based post-processing** method on ALADIN-LAEF wind field. Extend the method for the other surface parameters like T2m or RH2m. [RWP-2019 E4.6]
- Finalize ALADIN-LAEF Phase II configuration involving **ENS BlendVar**. [RWP-2019 E4.5]
- Combine different methods to **simulate the uncertainty in a convection-permitting system** (i.e. stochastic perturbation of partial model tendencies/parameters, ENS Jk 3DVar blending, etc.). [RWP-2019 E3.3]

Longer term:

- Investigate the possibilities of **stochastic perturbation of fluxes** instead of tendencies. This should be beneficial with respect to the energy balance preservation in perturbed model.