

# Working Area Predictability

# **Progress Report**

<b>Prepared by:</b>	Area Leader Martin Belluš
<b>Period:</b>	2019 (January-September)
<b>Date:</b>	September 2019

## Progress summary

Since the beginning of the year huge effort was put into the preparation of new operational ensembles. We have currently three independent systems, the common RC LACE EPS with 4.8 km horizontal resolution based on ALARO-1 physics running on a big European domain (A-LAEF), Austrian convection-permitting EPS with 2.5 km horizontal resolution utilizing AROME model on a middle European domain (C-LAEF) and similar convection-permitting EPS configuration in Hungary which is going to replace their former ALARO-EPS.

Till September there were only 2 regular stays realized, with the total length of 2 months. Iris Odak Plenković (DHMZ) spent 4 weeks at ZAMG in continuation on her work on the analog-based post-processing method for the high resolution wind field, this time using already probabilistic analog inputs from LAEF ensemble as well. Endi Keresturi spent 4 weeks also at ZAMG combining lagged deterministic AROME forecasts with the new C-LAEF system in order to increase its reliability.

There were several other RC LACE stays planned for this year, but must have been postponed for different reasons. Nevertheless, a lot of technical and validation work was done locally within A-LAEF development at SHMU, C-LAEF development at ZAMG and AROME-EPS at OMSZ.

## Scientific and technical main activities and achievements, major events

### S1 Action/Subject/Deliverable: Optimization of A-LAEF

**Description and objectives:** This subject summarizes ongoing and completed tasks of the A-LAEF research and development. Achieved results, new tested implementations and gained expertise are going to be used for the further improvement of our common regional ensemble forecasting system.

#### ❑ Topic 1: Implementation and testing of A-LAEF under TC user

At SHMU, the development of common RC LACE regional ensemble ALARO - Limited Area Ensemble Forecasting system (A-LAEF) is being continued. During its implementation under the TC user at ECMWF HPCF several technical issues must have been defeated. In the early stage there was a problem with the jobs submission from ecgate to the computing cluster (cca/ccb). It turned out to be a bug on ECMWF side which implies the modifications on the profile scripts all users go through. Therefore, only a quick temporary solution was carried out at the time being. Secondly, in order to access the OPLACE ftp server (ftp.met.hu), the standard ecaccess gateway have been used where oplace ETrans association was created under kmxy user and the grant association was given to TC user zla. That was necessary because one can not login directly to the TC user account.

Solving the previous technical issues allowed for the execution of regular runs and that was the time when finally some serious problems could have been discovered.

There were two of them and we are going to start with the easiest one (the problems are independent and were solved in parallel).

- **DFI instability**

When there were already enough runs performed within the regular suite updates, it happened occasionally that one or more members of the ensemble crashed in blending task while processing the ECMWF coupling file. When this happened, it was always within the DFI integration in low spectral resolution, which is a part of complicated spectral blending procedure. It was recognized as an instability due to longer time steps used in low spectral resolution. The solution was to ignore the theoretically possible but practically not applicable long time steps. In reality, when this problem occurred, we always decreased RTDFI (time step for DFI), TAUS (filter time span) and increased NSTDFI (number of steps within filtration) consistently with the theory. This was of course an iterative procedure. In principle we gradually tried available configurations with shorter and shorter timesteps till the job was successfully done. The procedure was repeated when this happened again after several days. Eventually, we ended up with a stable configuration, which is already running for several weeks without a single crash (RTDFI=480s, TAUS=14400s, NSTDFI=11).

- **systematic cold bias**

Generally, there is a big discrepancy between the IFS soil/surface moisture fields and those of ARPEGE/ALADIN (see figure 1) as well as for the corresponding temperature fields (see figure 2). 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, see figures 5, 6 and 7). Unfortunately, by coincidence the new ALARO-1 integration namelists within the upgraded multiphysics configuration were missing some non-standard surface fields:

- SURFXFLU.MEVAP.E - instantaneous evaporation flux
- SURFXEVAPOTRANSF - instantaneous evapotranspiration
- ATMONEBUL.BASSE - cumulated low cloud cover

As a result the moisture increments in CANARI assimilation procedure were forced to null! Obviously, that had the fatal consequences in given coupling configuration. Such potentially dangerous behaviour of surface assimilation, where the optimum coefficients for soil moisture analysis are modulated or switched off depending on the presence of several meteorological fields like precipitation, cloudiness, surface evaporation, etc. was already discovered in 2013 (see Belluš, "Time Consistent versus Space Consistent coupling and the revision of the Ensemble of surface Data Assimilations by CANARI in ALADIN/LAEF", Report on stay at ZAMG). Nevertheless, this issue was reintroduced again with its full "potential" (see figures 3 and 4) until we reinvented the solution (see figures 5, 6 and 7).

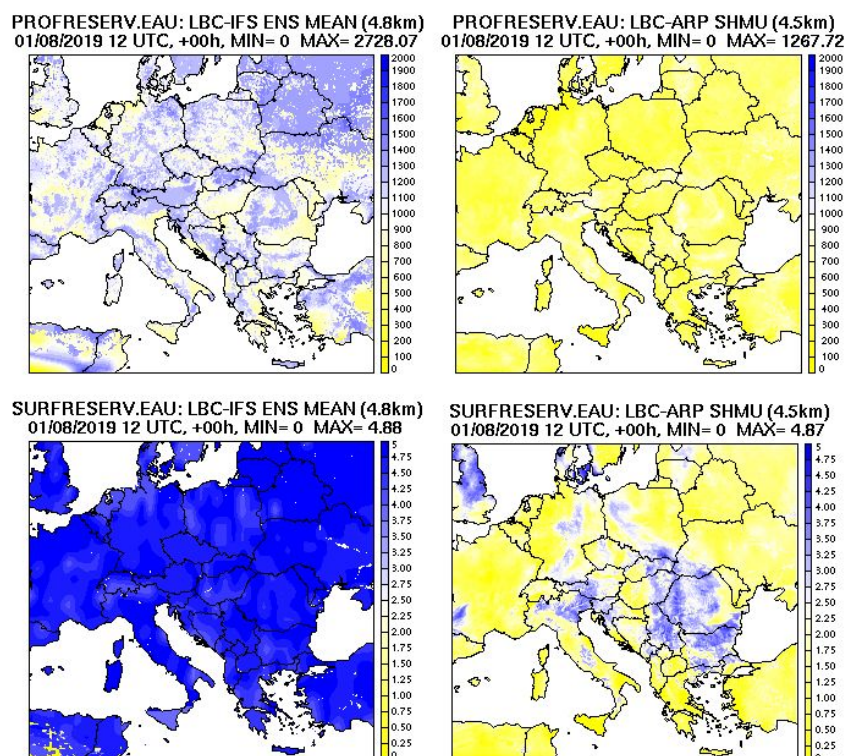


Figure 1: The first coupling - soil moisture (top) and surface moisture (bottom) for IFS ENS mean to couple A-LAEF 4.8 km (left) and ARPEGE model to couple ALADIN/SHMU 4.5 km (right).

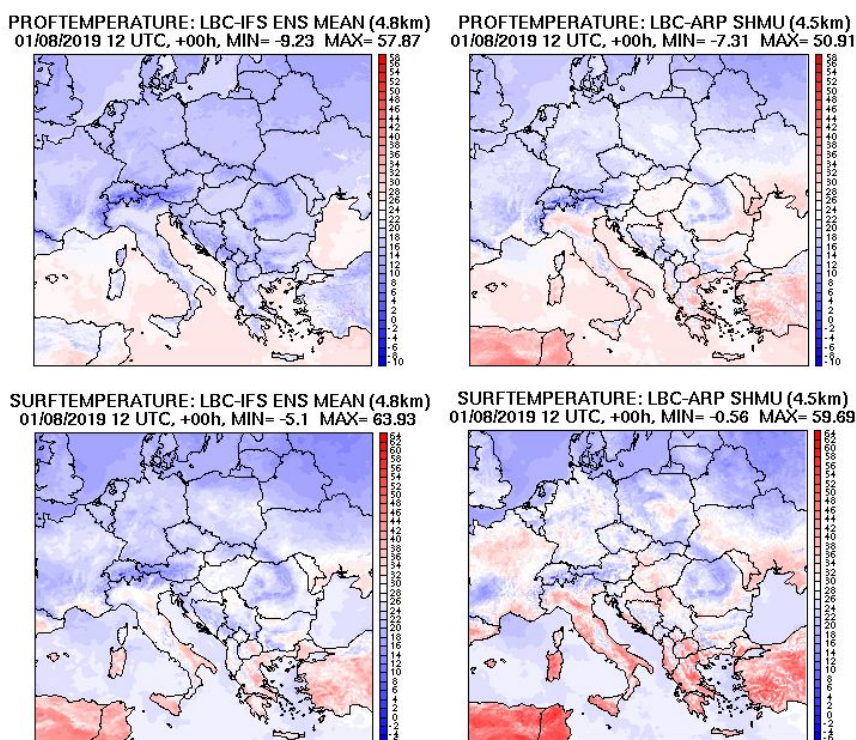


Figure 2: The first coupling - soil temperature (top) and surface temperature (bottom) for IFS ENS mean to couple A-LAEF 4.8 km (left) and ARPEGE model to couple ALADIN/SHMU 4.5 km (right).



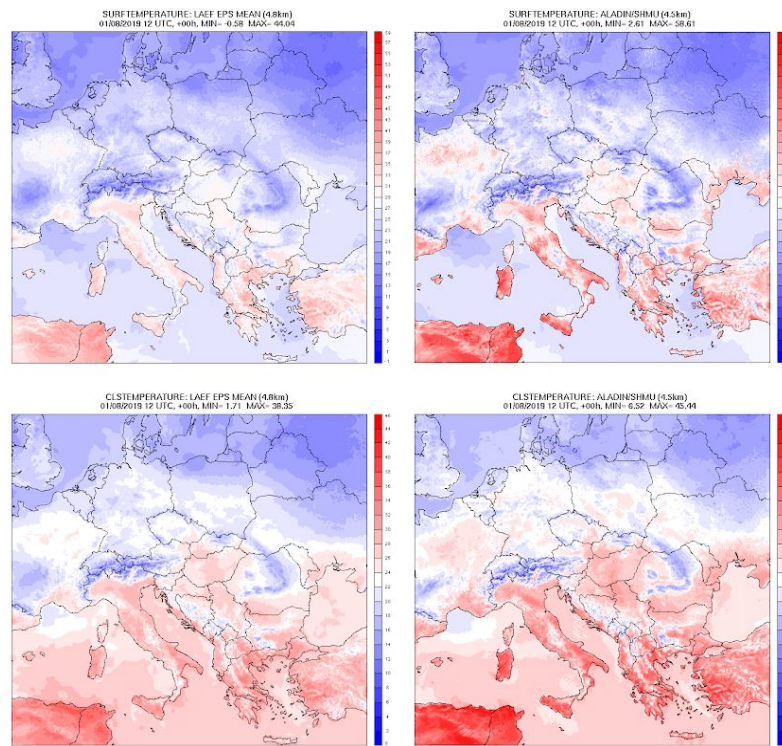


Figure 3: The surface (top) and screen level (bottom) temperature analysis for A-LAEF ensemble mean (left) and ALADIN/SHMU reference coupled to ARPEGE model (right).

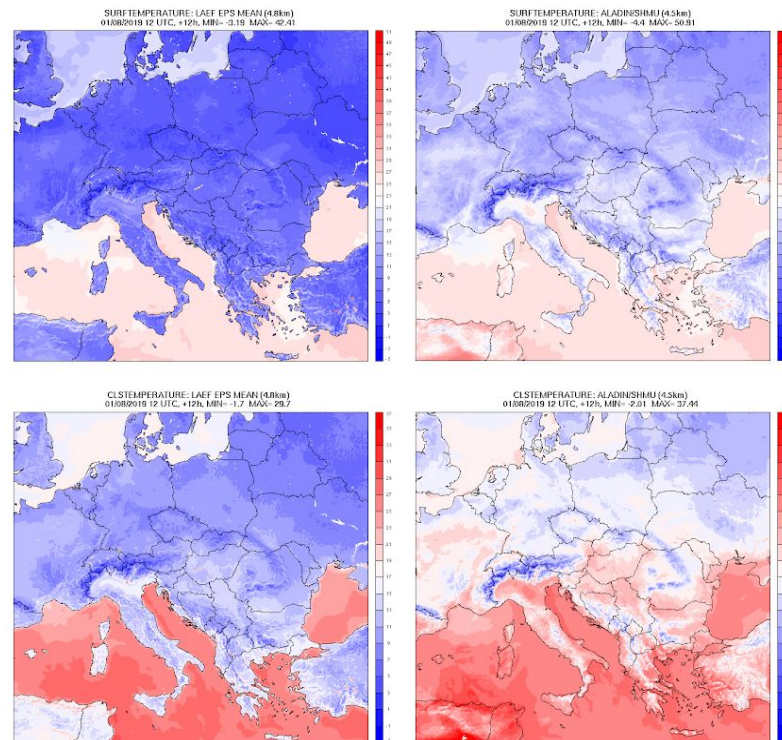


Figure 4: The surface (top) and screen level (bottom) temperature 12h forecast for A-LAEF ensemble mean (left) and ALADIN/SHMU reference coupled to ARPEGE model (right).



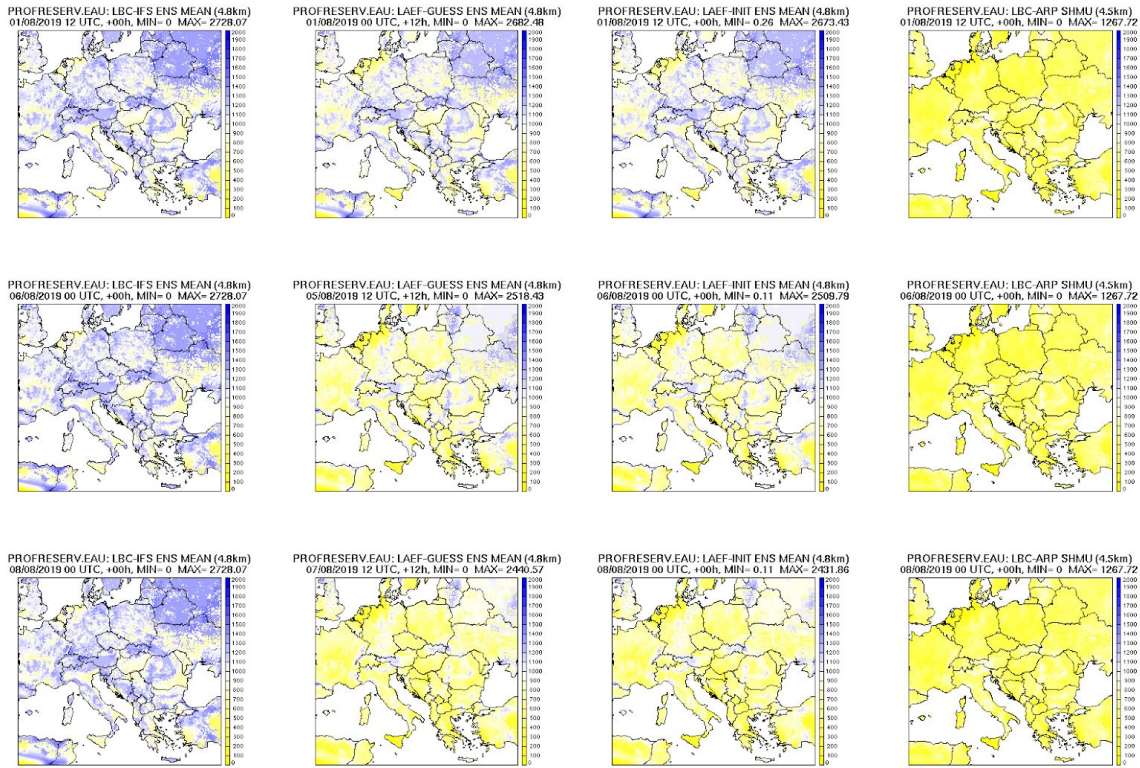


Figure 5: From left to right: the soil moisture for IFS - ENS mean (LBC), A-LAEF (first guess +12h), A-LAEF analysis (INIT file) and ALADIN/SHMU LBC (ARPEGE model reference). From top to bottom: beginning of the assimilation cycle, fields after the 6 and 10 assimilation loops, respectively.

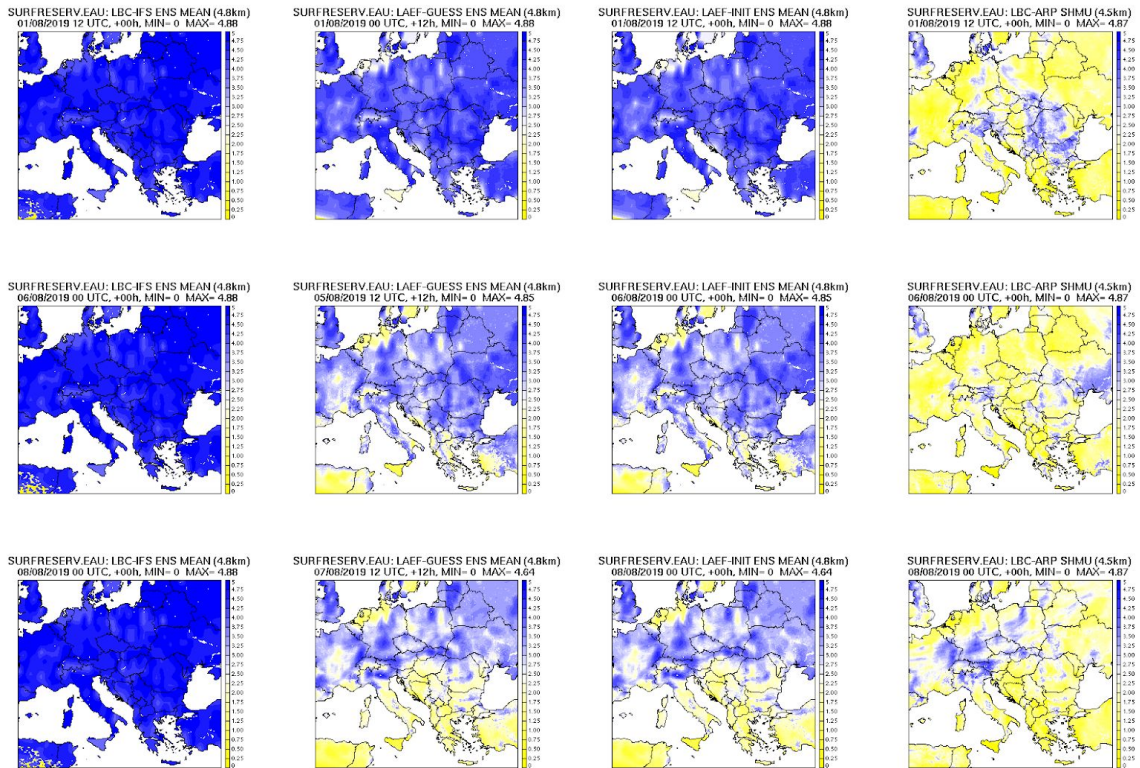
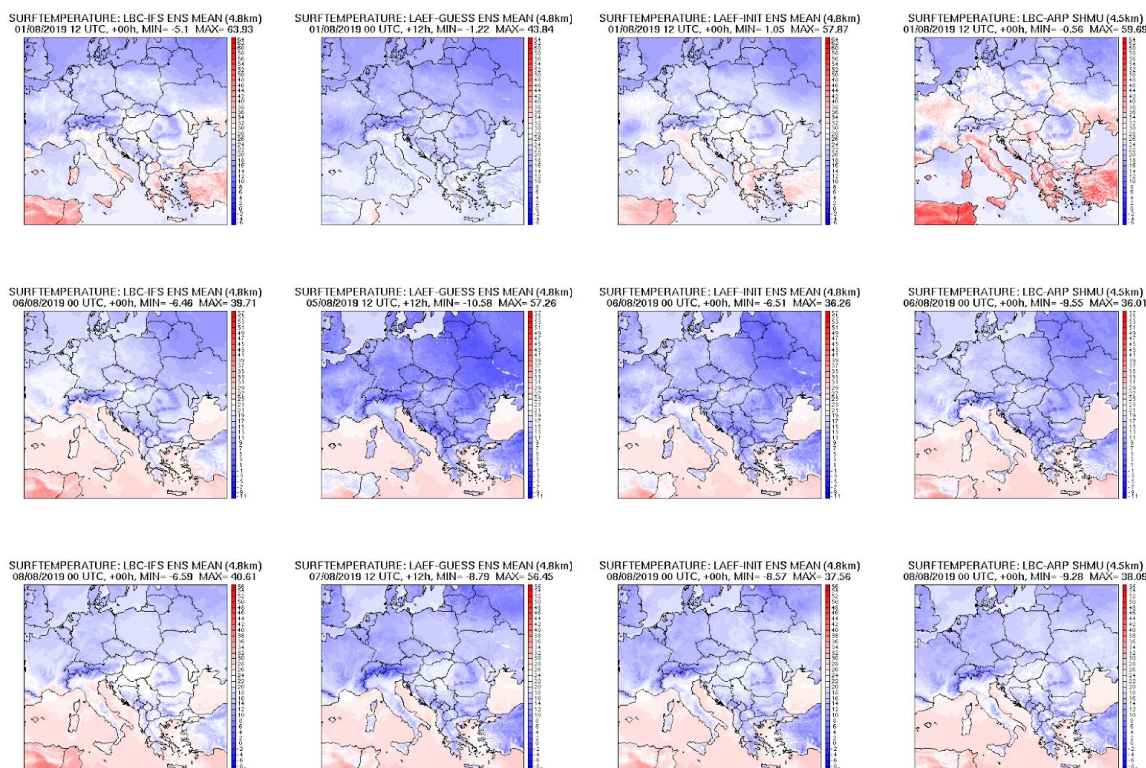


Figure 6: Exactly the same as in figure 5 but this time for the surface moisture.



*Figure 7: From left to right: the surface temperature for IFS - ENS mean (LBC), A-LAEF (first guess +12h), A-LAEF analysis (INIT file) and ALADIN/SHMU LBC (ARPEGE model reference). From top to bottom: beginning of the assimilation cycle, fields after the 6 and 10 assimilation loops, respectively.*

## ❑ Topic 2: A-LAEF preoperational runs (case studies)

After intensive validation of the assimilation cycle in A-LAEF and solving the issues concerning the RH2m increments and therefore solving the cold bias problem, it was finally time for some case studies.

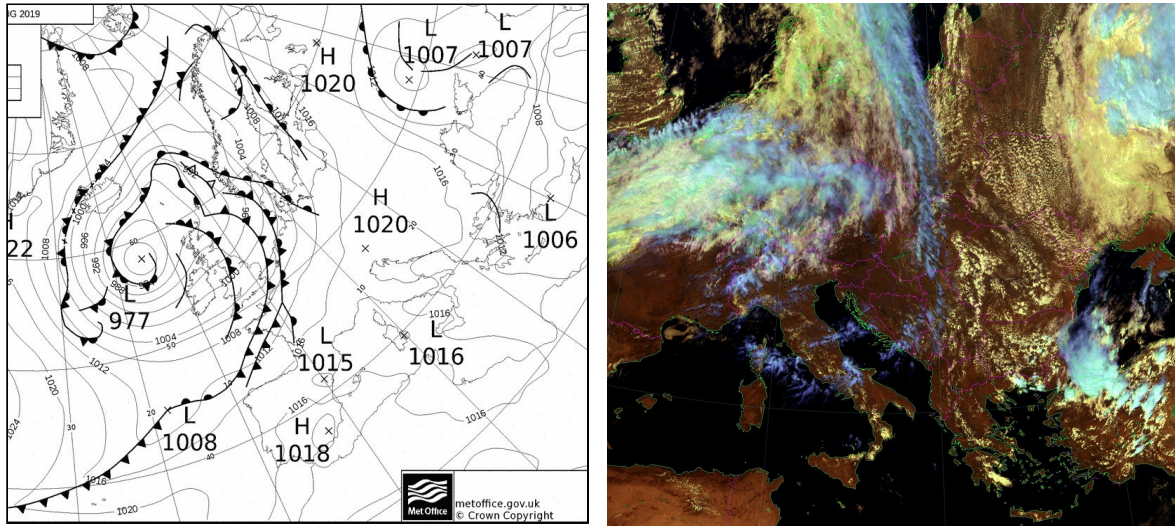
### ● Turkey - Flash floods of 17 August 2019

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. Despite unpleasant consequences, this mesoscale convective system was a good case for testing the skills of new A-LAEF system. In the following figures one can see the global synoptic analysis of the situation by MetOffice (figure 8, left), MSG satellite image (figure 8, right) and corresponding A-LAEF forecast (figure 9). It is clear, that the ensemble mean and spread of total precipitation very well correspond to the flash floods event over Istanbul. The importance of a probabilistic forecast in such situations is nicely demonstrated by figure 10, where all 16 perturbed A-LAEF members are shown. While the large-scale frontal precipitation over the north westerly Europe is captured without any doubts by each member (high predictability), the convective mesoscale system over Istanbul is well predicted only by several members. There are also some members where the event is completely missing (low predictability). If one of

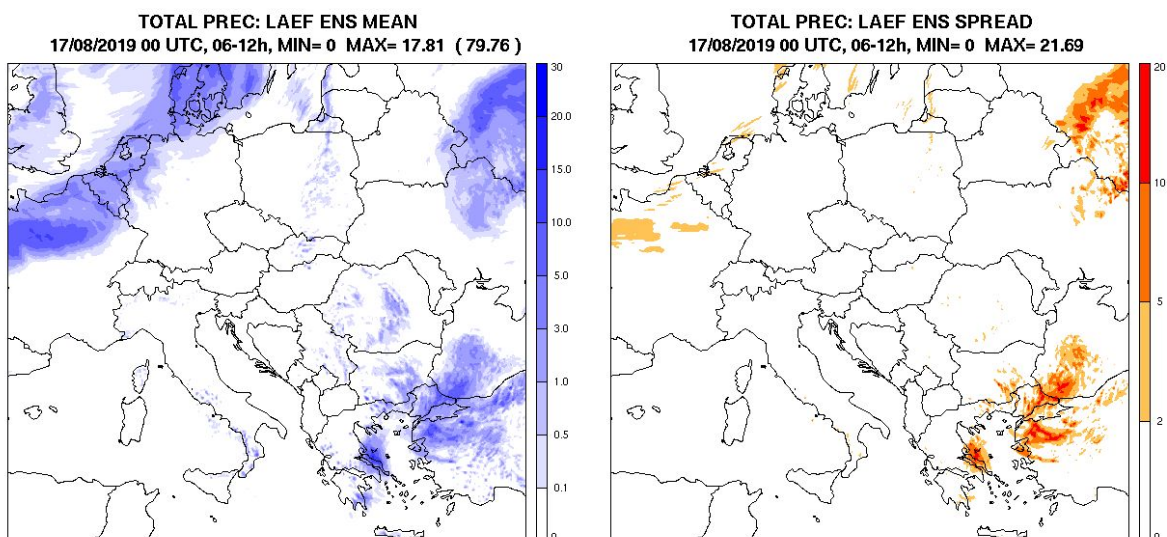


those was the only deterministic forecast, the extreme weather even could have been missed.

Furthermore, a beautiful demonstration of new ALARO-1 physics capability can be seen in figure 11, where the A-LAEF ensemble mean of total cloudiness for August 17, 12 UTC is compared to the corresponding MSG image. It is beyond the expectations, how closely the different cloud types and patterns match to each other for this 12h forecast and reality!



*Figure 8: Synoptic analysis chart by MetOffice from August 17, valid at 6 UTC (left) and MSG satellite image from August 17, 12 UTC (right).*



*Figure 9: A-LAEF total precipitation forecast for August 17, 6-12 UTC represented by the ensemble mean (left) and ensemble spread (right).*



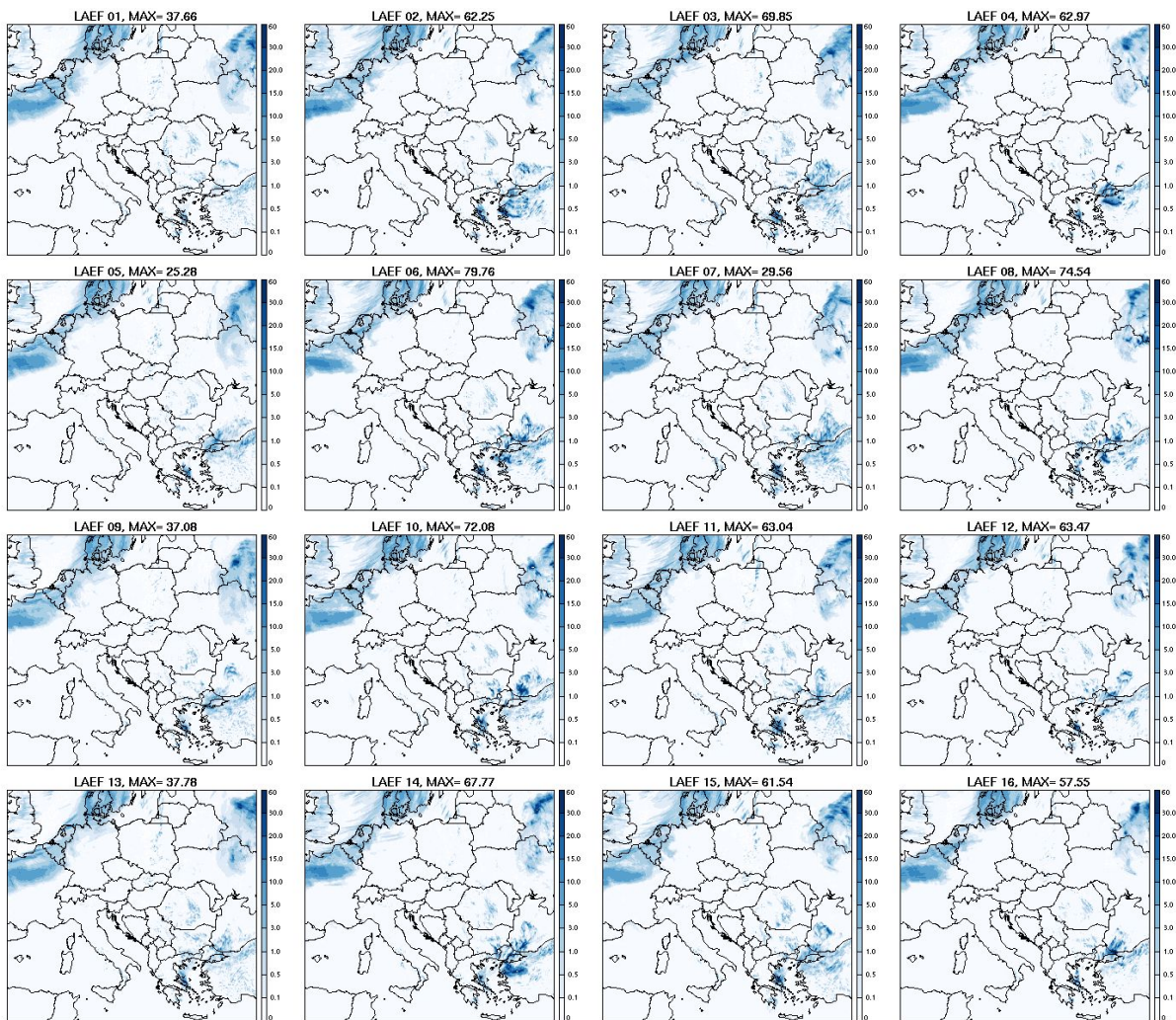


Figure 10: All 16 perturbed A-LAEF members and their total precipitation forecast for August 17, 6-12 UTC.

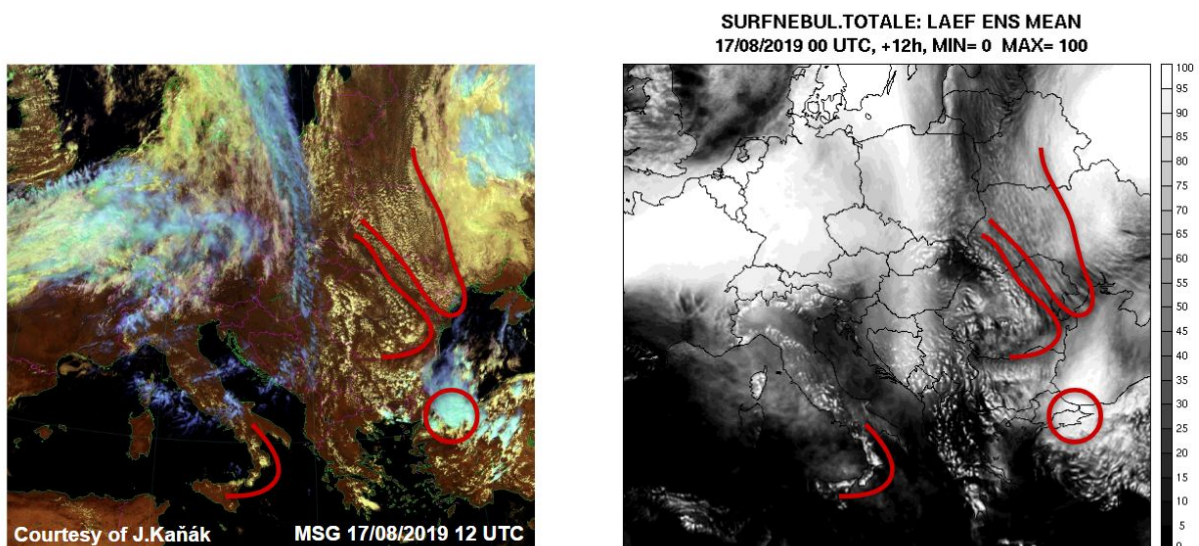
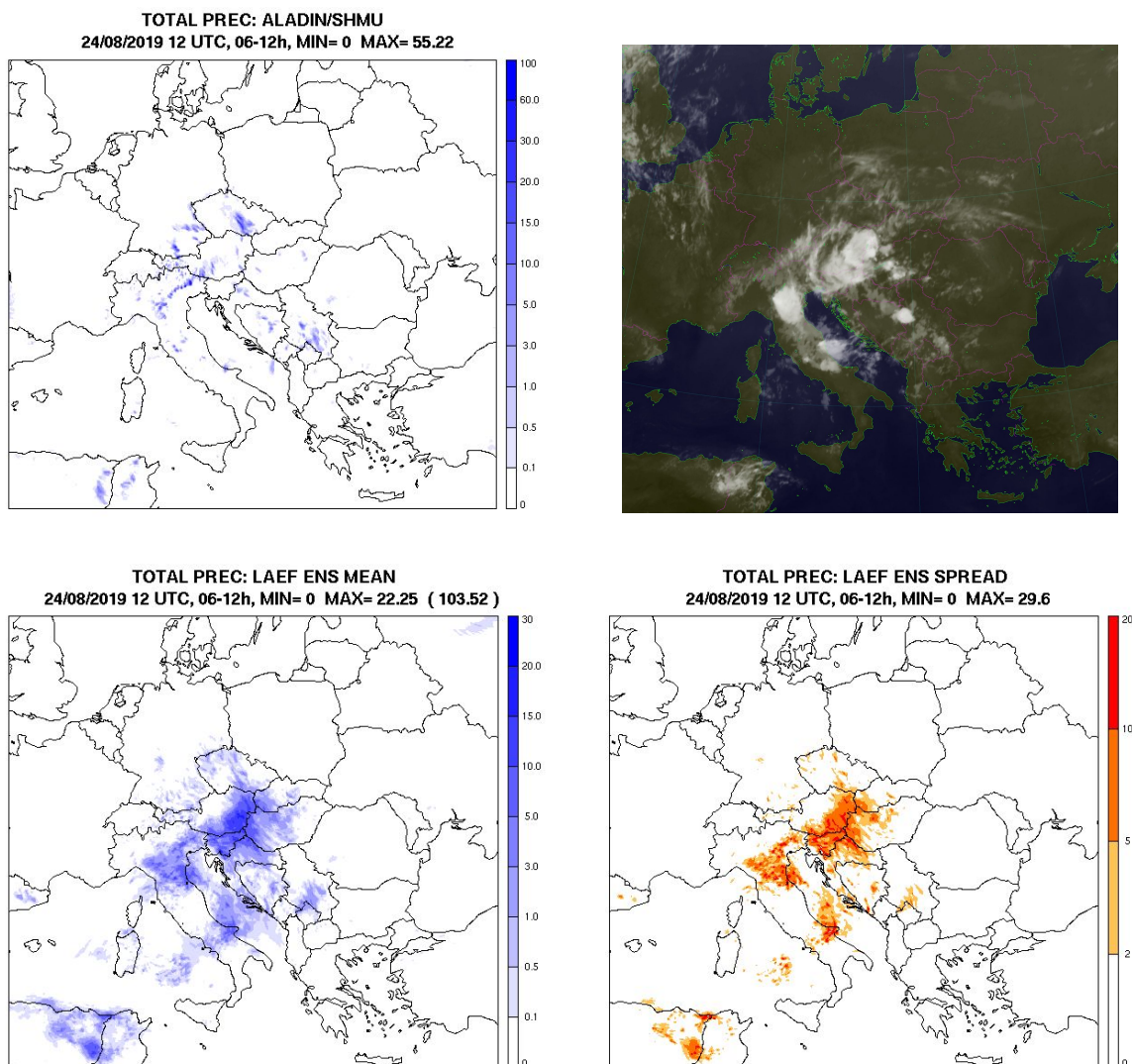


Figure 11: A-LAEF total cloudiness ensemble mean 12h forecast valid on August 17, 12 UTC (right) and corresponding MSG satellite image (left).

- **Central Europe - Night storm of 24 August 2019**

Another nice example of A-LAEF capabilities is being the night storm event which happened on August 24 over central Europe, especially in Bratislava. 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 rainfall. Several thunderbolts also hit the 30-meters flagpole, which had been erected in front of Parliament by Andrej Danko, President of the Slovak Parliament (see embedded photo).



*Figure 12: Total precipitation - deterministic forecast of ALADIN/SHMU 4.5 km (top left), A-LAEF 4.8 km ensemble mean (bottom left) and spread (bottom right) and corresponding infrared MSG image (top right).*



*Thunderbolt strikes the flagpole near Bratislava castle.  
(photo by Adam Kováč, 2019.08.24/25)*



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 (see figure 12).

### ❑ Topic 3: Analog-based post-processing method (continuation work)

Iris worked on the analog-based post-processing method applied to a NWP model output for point forecasts. It is the continuation of work carried out during the two previous stays at ZAMG, where the basic algorithm in Python was written and the usability of the analogs method was investigated for Austria territory. The method was already tested using the AROME deterministic model for 2015-2017 period and corresponding observations from local 265 TAWES sites.

The analog-based method uses historical data within the specified training period for which both the NWP model and the verifying observation are available. The analog-based method uses one consistent grid-point, which is usually the closest one to the measurement site. The best-matching historical forecasts to the current prediction (analog) may originate in any past date within the training period. The quality of the analog is evaluated by the pre-defined metric. Analog is found independently for every forecast time and location, narrowing the search within particular time of the day by a time window. The verifying observations of the best-matching analogs are then the members of the analog ensemble.

Now, two different modifications to the analog-based post-processing method were tested:

- Firstly, for the **deterministic analog forecast**, the time window to search the analogs was extended and the results for modified analog-based post-processing method were compared against previously developed analog-based post-processing method and against AROME deterministic model forecasts. The time window for analog search can be now shifted maintaining the same width. This has shown some potential, however the improvement over the former method is not statistically significant.
- Secondly, for the **probabilistic analog forecast**, several different configurations of LAEF ensemble forecast have been used as input and tested (see figures 13 and 14). These were the LAEF wind speed ensemble forecast used as 17 predictors (AN\_Ws); ensemble means of LAEF forecast for wind speed, wind direction, 2m temperature, 2m relative humidity, MSLP and precipitation used as 6 predictors (AN\_Me); the same as previous but with additional ensemble spreads used as 12 predictors (AN\_St); all LAEF members for the wind speed, wind direction, 2m temperature, 2m relative humidity, MSLP and precipitation counting 6×17 predictors (AN\_AI); and finally the most demanding member-by-member approach where 6 predictors were used, but the search algorithm was applied 17 times for each forecast (AN\_11). The raw LAEF wind speed forecasts for 17 members were used as a reference (LA\_Ws).

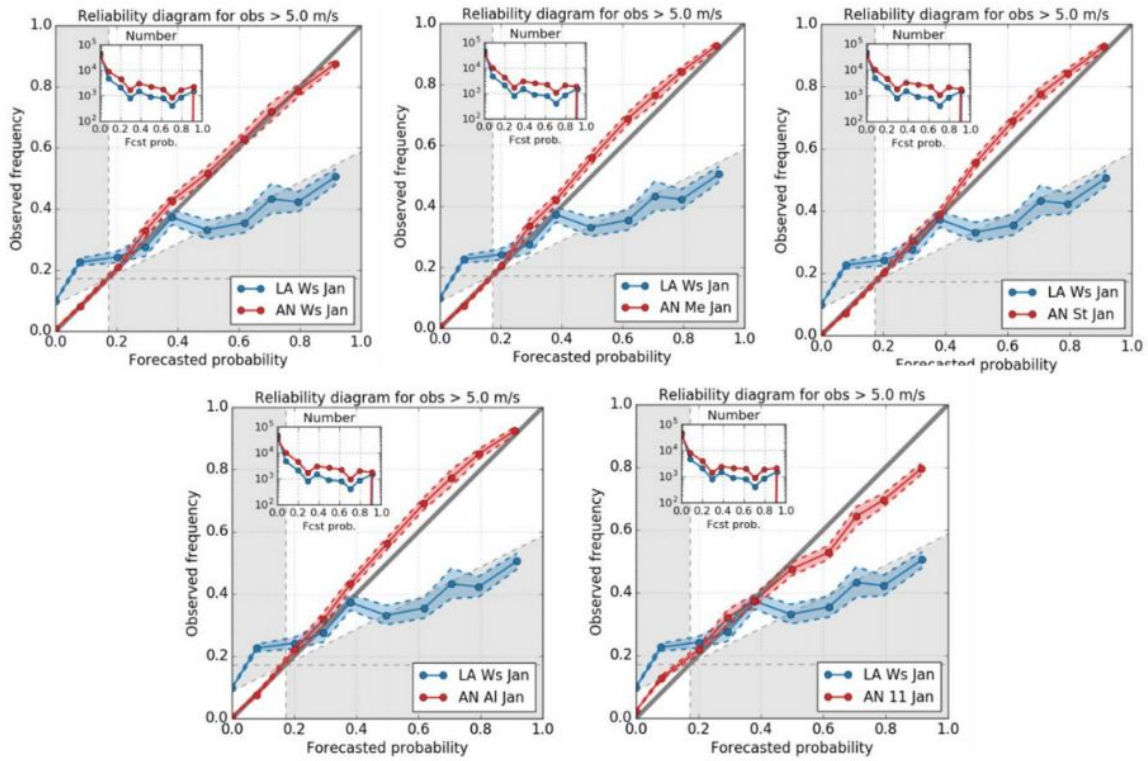


Figure 13: Reliability diagrams for five different analog forecasts compared to LAEF raw forecast (LA\_Ws) during January 2017 at all tested stations. The dashed lines show 95% confidence interval.

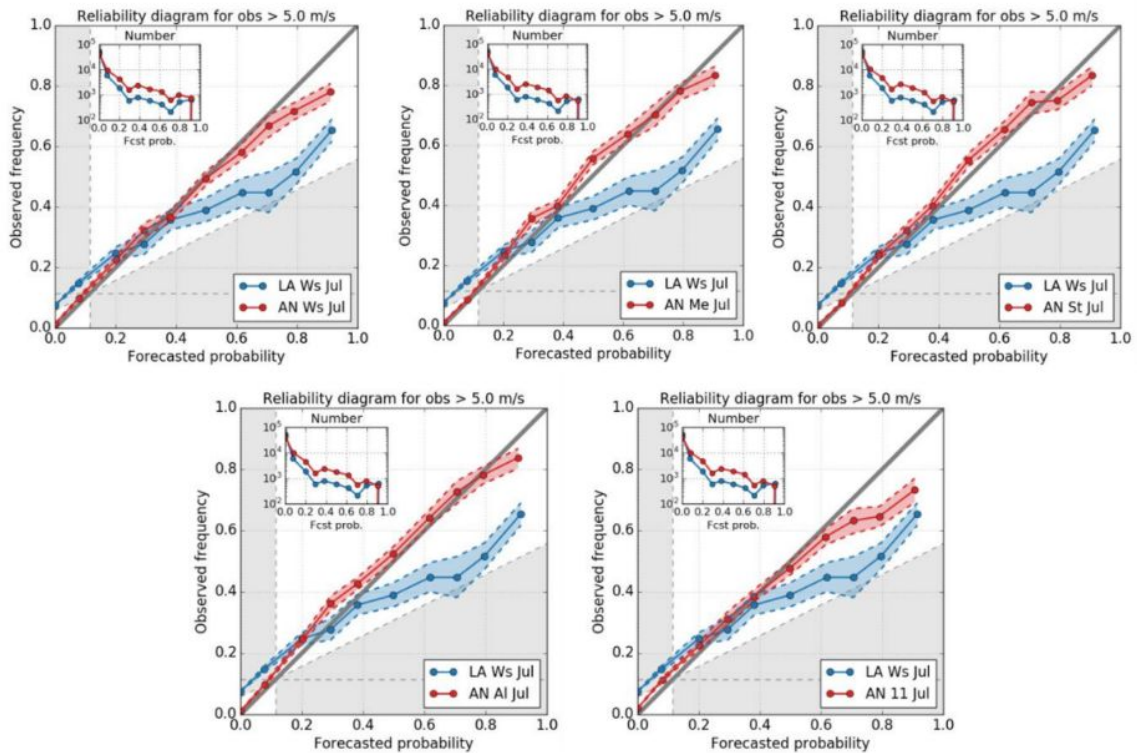


Figure 14: Reliability diagrams for five different analog forecasts compared to LAEF raw forecast (LA\_Ws) during July 2017 at all tested stations. The dashed lines show 95% confidence interval.



It was shown that using only one predictor variable as input (wind speed LAEF ensemble) already improves the forecast skills and lowers the systematic error of the ensemble mean. Even better results are achieved when using more than one predictor variable. We can also conclude that there is no need to use the full input spectrum of a raw probabilistic model, i.e. all LAEF members as predictors. Using basic information of an input ensemble, such as ensemble mean and standard deviation, improves the forecast skills the most.

**Efforts:** 4 PM (1 PM LACE stay)

**Contributors:** Martin Belluš (SHMU), Iris Odak Plenković (DHMZ)

**Documentation:** Reports on stays; papers for publication in scientific journals

**Status:** Ongoing

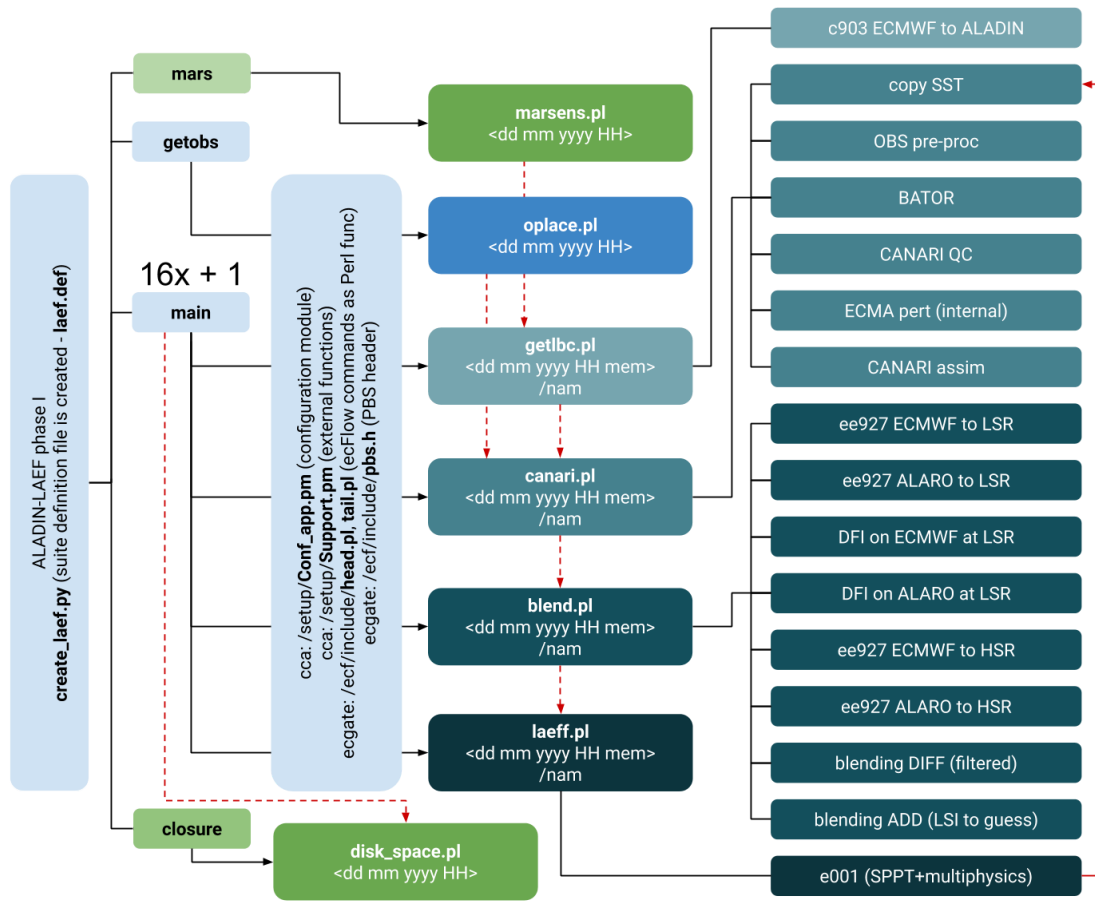
## **S2 Action/Subject/Deliverable: A-LAEF maintenance**

**Description and objectives:** The main objective of this task is to maintain and monitor the operational suite of A-LAEF running at ECMWF HPC facility. As a result a stable operational suite of A-LAEF is guaranteed and the delivery of probabilistic forecast products (GRIB files) for the LACE partners is ensured.

### **❑ Topic 1: A-LAEF operational suite under ecFlow**

As it was already mentioned above, the old common RC LACE's ensemble system ALADIN-LAEF is going to be soon replaced by more sophisticated A-LAEF system. Its first preoperational version is already running at ECMWF's HPCF regularly twice a day for 00 and 12 UTC network times since the end of July this year (see figures 15 and 16). The most important changes against the former ALADIN-LAEF system being the higher resolution (5 km / 60 levels on linear grid), new ALARO-1 perturbed physics on cy40t1, internal perturbation of OBS within ESDA, combination of ALARO-1 multi-physics with stochastic perturbation of physics tendencies, coupling files preparation directly from ECMWF ENS utilizing new 903 configuration and complete rebuild of the system within the ecFlow environment using Perl and Python scripts.

The latest configuration of A-LAEF is shown in the following figure. There are two new ecFlow families, one for gathering the current input fields of the global driving ensemble from MARS database and the second for maintaining the disk space after the suite is finished. The first one will be certainly skipped in the final TC-2 version of the A-LAEF suite, since all necessary input files will be available directly from ECPDS by ECMWF's operations, but it was inevitable to make it for the preoperational testing.



*Figure 15: New A-LAEF suite built under the ecFlow environment. Suite definition file is generated by Python code, while all tasks, include-files and configuration modules are written in Perl. Task dependencies are denoted by the red dashed arrows.*

The time duration of individual A-LAEF tasks within the current preoperational implementation and expected timing for the whole suite (+72h forecast) is shown in table 1. The slowest part is obviously the extraction of input files from MARS database, but this won't be present in TC-2 operational suite anyway. Instead, the suite will get the inputs directly from ECPDS. Processes like ensemble of surface data assimilation (ESDA) and upper-air spectral blending are not dependent on the forecast length and their duration is marginal. OBS retrieval from OPLACE archive is negligible and the preparation of coupling files - although for full forecast length (+72h) - is quite fast when using 903 configuration in NFPSEVER mode (with the loop on files inside). The only time demanding task here is the integration itself (no surprise at all ;). With the tested configuration involving 288 CPUs, +12h forecast takes about 22 minutes. It implies that the whole 3-days forecast would take almost 2 hours and a quarter. Although, it may seem too much, with the planned lagged coupling it should not be any issue and there is probably still space for some speed-up as well.



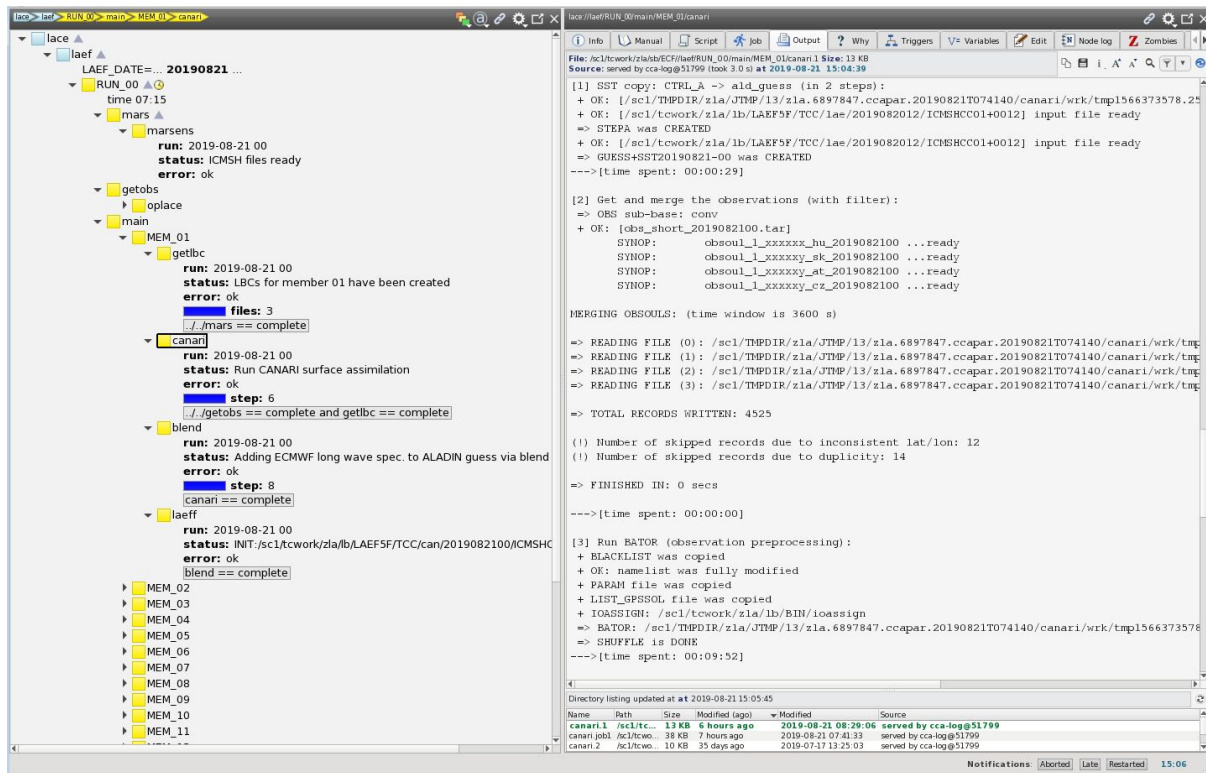


Figure 16: User interface (ecFlow) for new A-LAEF suite under RC LACE's TC user.

Table 1: Time duration of individual A-LAEF tasks within current preoperational implementation and its extrapolation for the full forecast length.

task	nproc	+12h forecast	+72h forecast
marsens	1	30 min	will be abandoned
oplace	1	0.5 min	~0.5 min
getlbc	36	1 min	~6 min
canari	288	4 min	~4 min
blend	288	8 min	~8 min
laeff	288	22 min	~132 min

Although the first preoperational version of A-LAEF is running smoothly for more than one month already, there are still some things to do. It needs to be switched to the lagged coupling mode. For that the code is already prepared. It requires enabling the ENV variable CNF\_LAGGED in the main setup file /setup/Conf\_app.pm, but it needs to be tested in full configuration and time dependency. As it was already mentioned, mars family will be excluded and the global input files will be provided

directly from ECPDS. This must be again tested with the getlbc.pl task processing those inputs via configuration 903 and creating boundary conditions for running A-LAEF. Furthermore, an unperturbed member needs to be switched on as well (for simplicity and for the sake of preserving some billing units the control forecast was not run in testing period). Last but not least, the preparation of grib files and their dissemination should be implemented. For this, the list of products must be agreed among the RC LACE partners at first.

**Efforts:** 3 PM

**Contributors:** Martin Belluš (SHMU), Martina Tudor (DHMZ)

**Documentation:** LAEF flow charts, presentations, reports

**Status:** New scripts development for ecFlow; A-LAEF suite implementation under TC environment; permanent maintenance tasks

### **S3 Action/Subject/Deliverable: AROME-EPS**

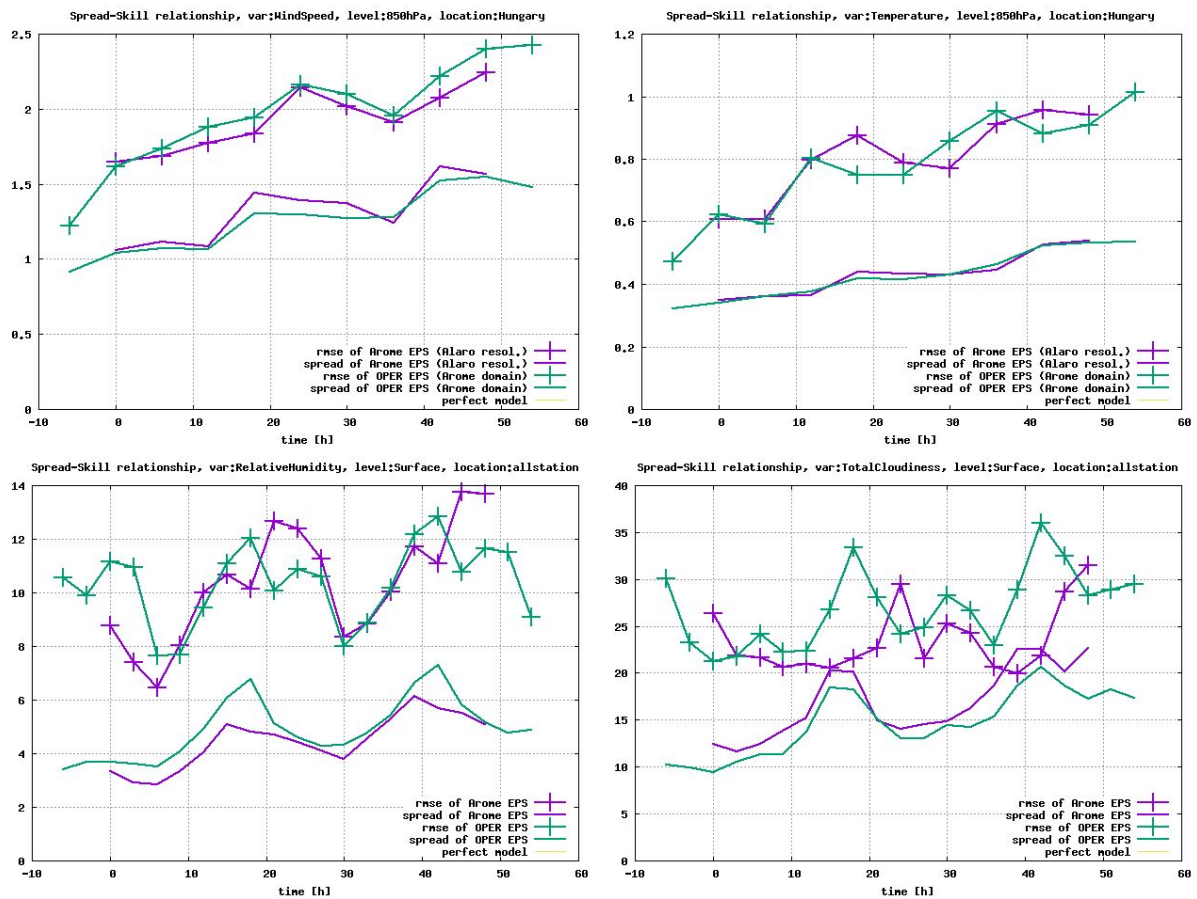
**Description and objectives:** This task covers research and development of the convection-permitting ensembles. Such high-resolution ensembles utilizing non-hydrostatic model AROME are developed concurrently at OMSZ and ZAMG institutes.

#### **❑ Topic 1: EPS related development at OMSZ**

At OMSZ, a non-hydrostatic convection-permitting system AROME-EPS is being developed and tested at new HPC. Similarly to the operational ALARO-EPS, new system runs once per day coupled to 18 UTC run of ECMWF ENS (TEFRCL=3h). In this lagged mode the forecast from 00 UTC is produced for +48h. The ensemble comprises 11 members, but covers a smaller domain (Carpathian Basin) with the horizontal grid spacing of 2.5 km. For the time being there is no assimilation cycle involved and the initialization uses first guess (hydrometeors) and surface analysis of deterministic AROME which runs with 3-hourly assimilation cycle. The upper-air fields are downscaled from boundary conditions.

The test version of AROME-EPS can be accessed by forecasters through HAWK visualization system since the end of May 2019. Comparison of both AROME-EPS and ALARO-EPS was made for May-June period (see figure 17), where also heavy precipitation events occurred. While geopotential, wind and cloud parameters have been clearly improved in AROME-EPS over ALARO-EPS forecast, humidity, temperature and precipitation fields have variable quality.

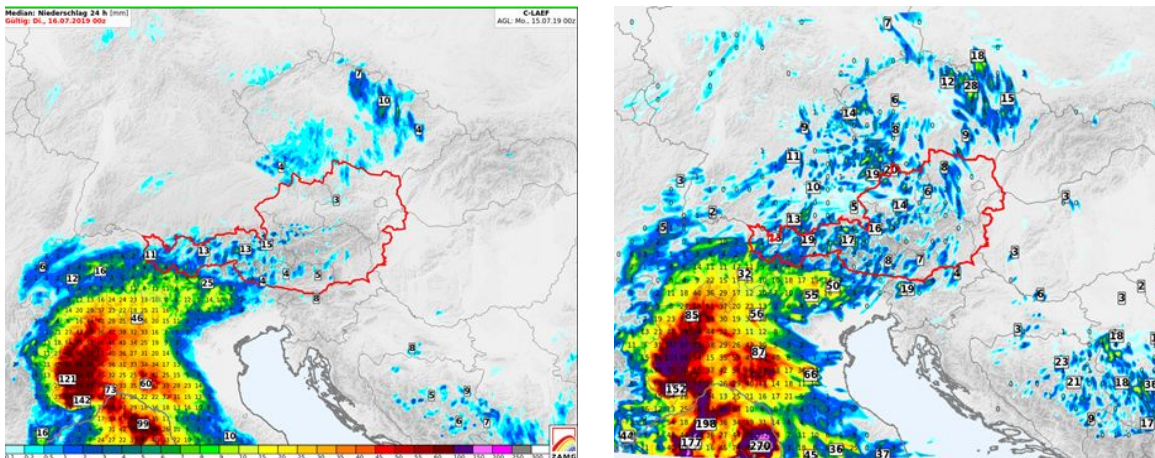




*Figure 17: Verification of AROME-EPS vs ALARO-EPS for 850 hPa wind speed (upper left) and temperature (upper right), and for surface relative humidity (bottom left) and total cloudiness (bottom right). Upper-air parameters (top) are verified against ECMWF analysis, while surface fields (bottom) are checked against the surface observations of Hungarian network.*

## ❑ Topic 2: EPS related development at ZAMG

At ZAMG, Convection-permitting - Limited Area Ensemble Forecasting system (C-LAEF) is being developed. It is based on non-hydrostatic AROME model with a horizontal resolution 2.5 km and 90 vertical levels. It has 16 perturbed members (and 1 unperturbed control run) coupled to the first 16 members of ECMWF-EPS. The initial condition uncertainties are represented by 3D-Var EDA with ensemble Jk method and by screen-level observation perturbations in CANARI. Assimilation cycles are performed every 6h with +48h forecasts issued only at 00 and 06 UTC. The model error is represented by a hybrid stochastic perturbation scheme, where tendencies perturbations in shallow convection, radiation and microphysics are combined with parameter perturbations in the turbulence scheme. C-LAEF runs currently in a preoperational mode at ECMWF HPCF since June 2019 and it is monitored intensively together with the forecasters and some users.



*Figure 18: 24h-accumulated precipitation forecast of C-LAEF median (left) versus deterministic AROME (right).*

The acceptance of AROME Austria sometimes suffers from high variability of forecasts from run to run (in particular during summer time). Therefore, in time more consistent C-LAEF median was highly appreciated by the forecasters (see figure 18).

### ❑ Topic 3: Adding lagged deterministic forecasts to a convection-permitting EPS

In this study, Endi explored a possibility of extending an LAMEPS with lagged deterministic forecasts. Such setup is possible since the operational deterministic AROME system at ZAMG is configured the same (except for 3h cycling) as C-LAEF. AROME forecast range is 60h which enables to use up to 4 older AROME runs and combine them with C-LAEF to create a new 21-member ensemble, while keeping 48h forecast range. The members of such ensemble are considered to be interchangeable and they are all equally likely.

The goal was to assess the added value of including 4 lagged AROME members to the C-LAEF ensemble. For this reason two experiments were defined:

- REF – represents C-LAEF raw ensemble (17 members)
- LAG – C-LAEF plus 4 lagged AROME runs (-3, -6, -9 and -12h)

Although it was expected to get an ensemble with exchangeable members, it was not the case due to some differences between the two models (for more details see Endi's report). However, practical benefits of this configuration were clearly visible in improved ensemble reliability, spread, and slightly higher accuracy for 10m wind speed and gusts forecasts (see figure 19).

Figure 20 shows wind speed forecast for all C-LAEF and AROME members separately and averaged over the verification period. Here we can easily see that C-LAEF and AROME members are clustering together and it looks more like a multi-model EPS, which is not what we were hoping for.

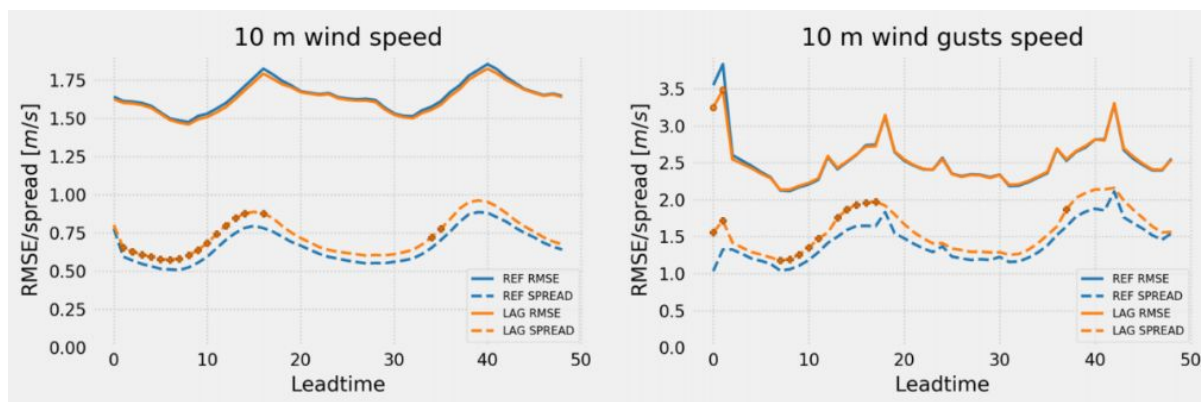


Figure 19: RMSE of the ensemble mean and ensemble spread for wind speed (left) and wind gusts (right). Forecast ranges with statistically significant differences are marked with bullets.

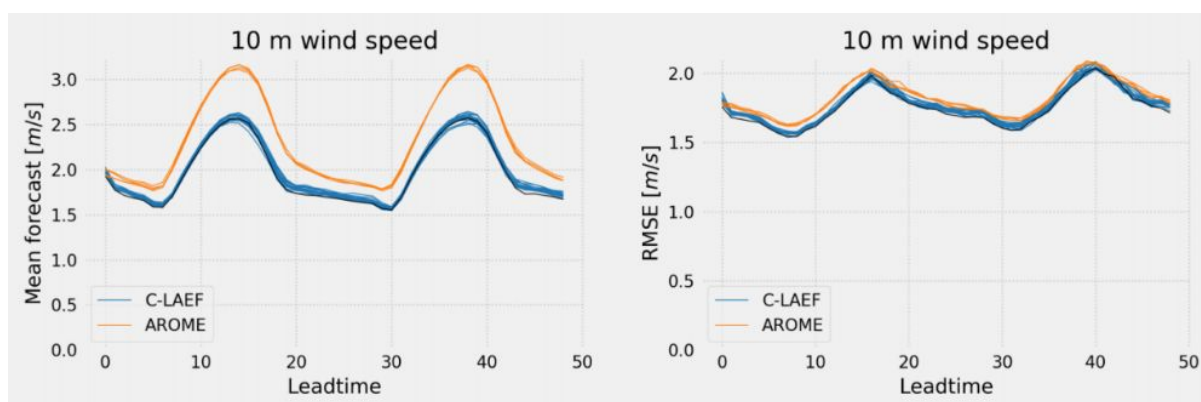


Figure 20: C-LAEF and AROME lagged members wind speed forecast (left) and RMSE (right) averaged over the verification period.

**Efforts:** 19 PM (1 PM LACE stay)

**Contributors:** Réka Suga, Mihály Szűcs, Viktória Homonnai, Katalin Jávorné-Radnóczy, Dávid Lancz (all OMSZ), Christoph Wittmann, Clemens Wastl (both ZAMG), Endi Keresturi (DHMZ)

**Documentation:** Reports on stays; papers for publication in scientific journals

**Status:** C-LAEF suite implementation under TC environment; AROME-EPS parallel runs at OMSZ

#### S4 Action/Subject/Deliverable: EPS - Verification

**Description and objectives:** A robust and reliable verification tool is very important in order to establish the quality of a weather forecasting system, either deterministic or probabilistic one. Knowing the statistical scores and limits of our forecasting system is crucial for further improvements. The huge amount of data must be processed, which requires an appropriate, optimized and flexible verification software. LAEF verification tool is being developed, maintained and used already for several years. However, distinct versions of the source code have been created in



recent years under the different users. These versions may diverge from each other and involve various levels of modifications and bug fixing. Therefore, it is necessary to merge the latest development under one common library and treat the known bugs equally. Unfortunately, after the canceled stay of Simona Taşcu in 2018, also the stay of Réka Suga planned for 2019 must have been postponed to the next year for various reasons. Therefore, there is currently no evolution within this subject.

**Efforts:** 0 PM

**Contributors:** -

**Documentation:** -

**Status:** Frozen

### **S5 Action/Subject/Deliverable: Collaborations**

**Description and objectives:** Activities merging different areas, collaboration with other consortia, applications, projects.

Except the standard cooperation between the ALADIN and HIRLAM communities and inter-area collaboration within RC LACE, there is almost nothing to report. An initiative regarding the special project at ECMWF with the aim of Limited Area Ensemble Forecasting has been started by DHMZ partner, involving researchers from SHMU, OMSZ and Meteo Romania. If successful, this can donate the expensive R&D of new A-LAEF system with some additional billing units.

**Efforts:** 1 PM

**Contributors:** Martina Tudor (DHMZ), Martin Belluš (SHMU)

**Documentation:** Request for a special project 2020-2022

**Status:** Ongoing

### **S6 Action/Subject/Deliverable: Publications**

**Description and objectives:** The scientific achievements of the LACE EPS R&D activities are being presented at the international workshops and published in the scientific journals.

The long awaited paper about the land surface perturbation methods used in ALADIN-LAEF system has been finally published in QJRMS. This paper is based on our former work from 2014 about the surface stochastic physics in combination with the ensemble of surface data assimilation.

The paper about ongoing ALADIN-LAEF system upgrade, as the common operational RC LACE regional ensemble system, was published in ASR.

Three other papers related to the currently developed convection-permitting ensemble system C-LAEF have been published in QJRMS, GDM and MWR.

The full list of recently submitted and published papers can be found in the Documents and publications chapter.

**Efforts:** 4 PM

**Contributors:** Yong Wang, Florian Weidle, Christoph Wittmann, Florian Meier, Clemens Wastl, (all ZAMG), Endi Keresturi, Iris Odak Plenković, Martina Tudor (all DHMZ), Martin Belluš (SHMU)

**Documentation:** Reviewed papers

**Status:** In progress

## List of actions, deliverables including status

### S1 Subject: **Optimization of A-LAEF**

**Deliverables:** Reports on LACE stays; papers submitted to scientific journals; improvement of current regional ensemble system through the results and outcomes of R&D

**Status:** Ongoing

### S2 Subject: **A-LAEF maintenance**

**Deliverables:** A-LAEF operational suite running at ECMWF HPCF; probabilistic forecast products delivered to the LACE partners

**Status:** New scripts development for ecFlow; A-LAEF suite implementation under TC environment; permanent maintenance tasks

### S3 Subject: **AROME-EPS**

**Deliverables:** Reports on LACE stays; papers submitted to scientific journals; convection-permitting ensemble system prototypes for preoperational and operational use

**Status:** C-LAEF suite implementation under TC environment; AROME-EPS parallel runs at OMSZ

### S4 Subject: **EPS - Verification**

**Deliverables:** Upgrades and maintenance of LAEF Verification package; bug-fixes

**Status:** Frozen

### S5 Subject: **Collaborations**

**Deliverables:** Exchange of the expertise between the other consortia or within the relevant projects

**Status:** Ongoing

### **S6 Subject: Publications**

**Deliverables:** 5 papers were published (ASR, QJRMS, GMD, MWR) and 2 papers were submitted; 2 stay reports are available online via RC LACE portal; for more details please see the list of publications down below

**Status:** In progress

## **Documents and 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



### Stay reports:

- ❑ Iris Odak Plenковиć, 2019: [Work on analog-based post-processing method](#), Report on stay at ZAMG, 04/02~01/03, 2019, Vienna, Austria
- ❑ Endi Keresturi, 2019: [Adding lagged deterministic forecasts to a convection-permitting EPS](#), Report on stay at ZAMG, 24/06~19/07, 2019, Vienna, Austria

### Activities of management, coordination and communication

- ❑ ALARO-1 WD, 11-13 March 2019, Bratislava, Slovakia
- ❑ 32<sup>nd</sup> LSC Meeting, 13-14 March 2019, Bratislava, Slovakia
- ❑ LACE MG Meeting, 15 March 2019, Bratislava, Slovakia
- ❑ Joint 29<sup>th</sup> ALADIN Workshop & HIRLAM All Staff Meeting 2019, 1-5 April 2019, Madrid, Spain (presentation of Martin Belluš)
- ❑ 33<sup>th</sup> LSC Meeting, 16-17 September, Prague, Czech Republic
- ❑ EMS Annual Meeting, 9-13 September 2019, Copenhagen, Denmark

### LACE supported stays – 2 PM till September 2019

There were only two stays executed:

- ❑ Iris Odak Plenковиć [S1], 4 February ~ 1 March 2019, ZAMG (4 weeks)
- ❑ Endi Keresturi [S3], 24 June ~ 19 July 2019, ZAMG (4 weeks)

### Summary of resources [PM] – till September 2019

Subject	Manpower		LACE		ALADIN	
	plan	realized	plan	realized	plan	realized
S1: Optimization of LAEF	7	4	3	1		
S2: LAEF maintenance	3	3	1			
S3: AROME-EPS	10	19	1	1		
S4: EPS – Verification	1.5	0	1			
S5: Collaborations	2	1				
S6: Publications	6	4				
Total:	29.5	31	6	2	0	0