Working Area Predictability

Work Plan

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Period:	2026
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Future of Ensemble Prediction Systems in RC LACE: Upgrades and Collaboration

The Regional Cooperation for Limited Area Modelling in Central Europe (RC LACE) operates several ensemble prediction systems (EPS) that play a central role in improving short- and medium-range weather forecasts. Currently, the consortium maintains three separate EPS setups: A-LAEF, which serves as the common system of RC LACE, and two convection-permitting systems: the C-LAEF Alpe Adria system for Austria, Croatia and Slovenia, and AROME-EPS in Hungary. Additionally, the Slovak Hydrometeorological Institute (SHMU) is developing a high-resolution ALARO-based EPS for a smaller domain.

While these systems have been developed independently at SHMU, GeoSphere Austria, and HungaroMet, their separate maintenance increases complexity and limits efficiency. To streamline operations, RC LACE aims to consolidate efforts and increase collaboration on advanced EPS solutions. A key step in this direction is the joint development of the next-generation convection-permitting system, C-LAEF Alpe Adria. Initiated through collaboration between Austria, Slovenia, and Croatia, this EPS introduces higher resolution, advanced data assimilation techniques, and improved error representation. It is planned to become operational at the beginning of 2026. This collaboration extends beyond shared computing resources, encompassing joint scientific work in areas such as EnVar, flow-dependent perturbations, and post-processing methods. Such cooperation ensures that improvements benefit all partners and accelerate the adoption of innovative approaches.

The upgrades planned for 2026 are for A-LAEF an upgrade from cy40t1 to cy46t1 together with a new upper-air spectral blending method and an upgraded version of the multi-physics package. For AROME-EPS in Hungary the introduction of model perturbations (SPP) and surface perturbations (SURFEX SPP) are planned and C-LAEF AA should become operational at the beginning of 2026. This upgrade comprises beside an updated model cycle (cy43t2 to cy46t1) also an increase of the horizontal resolution from 2.5km to 1km and some substantial improvements in data assimilation (new observation types, EnVar), model error representation (new SPP, flow dependency), dynamics setup and post processing (multiple FPOS domains, grib2). Work on an EnVar based assimilation systems are continued. The long-term vision is to create a single convection-permitting EPS that integrates the expertise and needs of all member countries of RC LACE.

Besides that, we are working on alternative ways to improve/extend our EPSs. One important approach in this direction is the use of machine learning (ML) technologies, e.g. the generation of ensemble members by deep learning algorithms, or the creation of data-driven ML-ensembles in post-processing.

Beyond internal collaboration, RC LACE maintains strong links with the broader ACCORD consortium. Joint workshops, shared code development, and participation in thematic working groups provide additional platforms for advancing ensemble systems. Furthermore, many RC LACE experts contribute to the EU project Destination Earth On-Demand Extremes (DEODE) Phase II. This initiative aims to develop hectometric-scale ensemble systems with resolutions down to 750 meters.

1 Subject: Preparation, evolution and migration

Description and objectives: Maintain and monitor the operational suites of A-LAEF and C-LAEF AA running on ECMWF's HPC and the AROME-EPS running at the HPC at HungaroMet. Migration and implementation to new HPCs, operational upgrades, new cycles, optimizations and tunings. Implementation of new EPSs.

The main topics for 2026 are:

- ❏ Maintenance/monitoring of operational EPSs (A-LAEF, C-LAEF AA) on ECMWF's HPC in Bologna
- ❏ Development of an ALARO-based convection-permitting EPS coupled to ECMWF ENS and A-LAEF
- ❏ Implementation of SURFEX in ALARO-EPS
- ❏ Implementation of ENS BlendVar assimilation method in the A-LAEF system to improve the simulation of upper-air ICs uncertainty
- ❏ C-LAEF AA for Austria, Slovenia and Croatia, operationalization; implementation of EnVar based EPS assimilation system
- ❏ Extension of C-LAEF based Ensemble Reanalysis dataset (ARA) from 2021 to 2025
- ❏ Introduction of model perturbations (SPP) in operational AROME-EPS

Proposed contributors & Estimated efforts: N.N. (SHMU), Katalin Jávorné-Radnóczi, Zsofia Szalkai (HungaroMet), Clemens Wastl, Florian Weidle, Florian Meier, Nauman Awan (GeoSphere Austria), Jure Cedilnik, Benedikt Strajnar, Neva Pristov (ARSO), Endi Keresturi (DHMZ), Jadwiga RóG (IMGW) – 18 PM

Planned time-frame and deliverable: Permanent. Stable and state-of-the-art operational suites of all three EPSs in RC LACE.

Planned stays:

1. Jadwiga RóG (4 weeks at SHMU) – Development of an ALARO-based convection-permitting EPS coupled to A-LAEF

2 Action/Subject: Model perturbations

Description and objectives: Research and development concerning model perturbations in the three EPSs within RC LACE. Study ways to represent uncertainty in the atmospheric models themselves and how to best incorporate this into the models.

The main topics for 2026 are:

- ❏ Stochastic perturbation of fluxes instead of tendencies in order to preserve the energy balance in perturbed model.
- ❏ Introduction of new SPP parameters to C-LAEF AA – dynamics parameters, etc.
- ❏ Development of flow-dependent model perturbations in C-LAEF AA; Investigate the possibility of using AI
- ❏ Add more parameters to the SPP scheme in AROME-EPS at HungaroMet, tests, verification, optimization

Proposed contributors & Estimated efforts: N. N. (SHMU), Clemens Wastl (GeoSphere Austria), Endi Keresturi (DHMZ), Katalin Jávorné-Radnóczi and Zsofia Szalkai (HungaroMet) – 9 PM

Planned time-frame and deliverable: Ongoing. Reports on the experiments; exchange of expertise; improvements of the operational implementations of convection-permitting ensembles; scientific publications and presentations

Planned stays:

1. Endi Keresturi (4 weeks at GeoSphere Austria) – flow dependent SPP perturbations in C-LAEF AA

3 Action/Subject: Initial condition perturbations

Description and objectives: Research and development concerning initial condition perturbations in the three EPSs within RC LACE.

The main topics for 2026 are:

- ❏ Preparation of flow-dependent B-matrix for local 3D-Var assimilation systems based on ALARO CMC using A-LAEF operational outputs
- ❏ EnVar and Hybrid EnVar in C-LAEF AA to create initial conditions for ensemble members. Test what perturbations are suitable and perform the best.
- ❏ Perturbation of initial conditions in global AI models to be used in regional NWP models

Proposed contributors & Estimated efforts: N. N. (SHMU), Florian Meier and Florian Weidle (GeoSphere Austria), Benedikt Strajnar (ARSO), Bogdan Bochenek, Jadwiga RóG (IMGW) - 2 PM

Planned time-frame and deliverable: Ongoing. Reports on the experiments; exchange of expertise; improvements of the operational implementations of convection-permitting ensembles; scientific publications and presentations

Planned stays:

4 Action/Subject: Surface perturbations

Description and objectives: Research and development concerning surface perturbations in the three EPSs within RC LACE.

The main topics for 2026 are:

- ❑ Implementation of surface perturbations in AROME-EPS
- ❑ SPP in SURFEX, implementation and testing

Proposed contributors & Estimated efforts: Clemens Wastl, Daniel Deacu (GeoSphere Austria), Zsofia Szalkai (HungaroMet) - 2 PM

Planned time-frame and deliverable: Ongoing. Reports on the experiments; exchange of expertise; improvements of the operational implementations of convection-permitting ensembles; scientific publications and presentations

Planned stays:

1. Zsofia Szalkai (4 weeks at GeoSphere Austria) – SPP in SURFEX

5 Action/Subject: Lateral boundary condition perturbations

Description and objectives: Research and development concerning lateral boundary condition perturbations in the three EPSs within RC LACE.

The main topics for 2026 are:

No topics planned for 2026

Proposed contributors & Estimated efforts:

Planned time-frame and deliverable: Ongoing. Reports on the experiments; exchange of expertise; improvements of the operational implementations of convection-permitting ensembles; scientific publications and presentations

Planned stays:

6 Action/Subject: Statistical EPS and user-oriented approaches

Description and objectives: Research and development concerning statistical calibration of EPS data to reduce systematic errors; integration of AI technologies to EPS creation; research and development of new products; user-oriented approaches to increase the reputation of EPS

The main topics for 2026 are:

- ❏ Work on statistical post-processing of EPS data (e.g. more flexible calibration methods, etc.)
- ❏ Work on EPS post-processing by different machine learning (ML) methods: focus on solar radiation and wind
- ❏ Generation of ensemble members by deep learning algorithms
- ❏ Work on the new ensemble technique CEM (Cascading Ensemble Method)
- ❏ Development of new probabilistic products to meet users' requirements

Proposed contributors & Estimated efforts: Iris Odak, Endi Keresturi, Ivan Vujec (DHMZ), Alexander Kann, Markus Dabernig, Irene Schicker (GeoSphere Austria), N. N. (SHMU), Katalin Jávorné-Radnóczi (HungaroMet), Bogdan Bochenek, Jadwiga RóG (IMGW) – 14 PM

Planned time-frame and deliverable: Ongoing. Reports on the experiments and on new products; exchange of expertise; scientific publications and presentations

Planned stays:

1. Iris Odak (4 weeks at GeoSphere Austria) – ML based post-processing methods
2. Ivan Vujec (4 weeks at GeoSphere Austria) – ML based post-processing methods

Summary of resources [PM]

Subject	Person Months	LACE	ACCORD
S1: Preparation, evolution and migration	**18**	**1**	**0**
S2: Model perturbations	**9**	**1**	**0**
S3: IC perturbations	**2**	**0**	**0**
S4: Surface perturbations	**2**	**1**	**0**
S5: LBC perturbations	**0**	**0**	**0**
S6: Statistical EPS and user-oriented approaches	**14**	**2**	**0**
Total:	**45**	**5**	**0**

Meetings and events (2026)

- ❑ 46th LSC Meeting, Zagreb Croatia, March 2026
- ❑ 6th ACCORD All Staff Meeting, Marrakech, Marocco, April 13 - April 26 2026
- ❑ 47th LSC Meeting, Bucharest, Romania, September 2026
- ❑ 47th EWGLAM and 32nd SRNWP joined meeting, ???, September 2026
- ❑ 6th ACCORD EPS working week, ???, spring 2026
- ❑ Other international EPS related conferences and workshops