

Working Area Predictability

Work Plan

Prepared by:	Area Leader: Clemens Wastl
Period:	2027
Date:	September 2026

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

The 2027 work plan focuses on maintaining and further advancing the RC LACE ensemble prediction systems (EPS), with the overarching goal of ensuring robust and state-of-the-art operational forecasting capabilities while preparing the next generation of convection-permitting ensemble systems. Activities cover the full spectrum from operational suite maintenance and HPC migrations to scientific developments in uncertainty representation, data assimilation, surface processes, and AI-supported post-processing.

A major priority in 2027 will be the continued operation, monitoring, and optimization of the existing EPS infrastructure, including A-LAEF and C-LAEF AlpeAdria on ECMWF's HPC and AROME-EPS at HungaroMet. Particular emphasis will be placed on adapting the systems to evolving HPC environments, implementing new model cycles, improving computational efficiency, and introducing innovative ensemble configurations. Key developments include the implementation of an ALARO-based convection-permitting EPS, the integration of SURFEX into ALARO-EPS, the operationalization of advanced ensemble-based data assimilation techniques (EnVar), and the preparation of reanalysis datasets for C-LAEF AlpeAdria.

Scientific developments will focus on improving the representation of forecast uncertainty. Research on model perturbations will continue through stochastic parameter perturbation approaches, flow-dependent perturbation strategies, and investigations into AI-supported methods. Initial condition uncertainty will be further addressed through Ensemble-Var/Hybrid Ensemble-Var methodologies and the development of flow-dependent background-error statistics. Surface-related uncertainty will be tackled through the implementation and testing of stochastic perturbations within SURFEX and advanced land-surface schemes (e.g. multilayer ISBA-DIF).

Another strategic focus area is the integration of artificial intelligence and machine learning into ensemble forecasting workflows. Planned activities include ML-based post-processing, statistical calibration, AI-generated ensemble members, the development of the Cascading Ensemble Method (CEM), and the creation of user-oriented probabilistic products with special attention to the renewable energy sector.

Beyond internal cooperation, RC LACE maintains strong ties with the broader ACCORD consortium. Joint workshops, shared code development, and participation in thematic working groups provide additional opportunities to advance ensemble technologies. Moreover, many RC LACE experts are involved in the DEODE project where 750 m EPSs have been developed.

1 Subject: **Preparation, evolution and migration**

Description and objectives: Maintain and monitor the operational suites of A-LAEF and C-LAEF AlpeAdria running on ECMWF's HPC and 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 2027 are:

- ☐ Maintenance/monitoring of operational EPSs (A-LAEF, C-LAEF AlpeAdria) on ECMWF's HPC in Bologna; new HPC at ECMWF?
- ☐ Maintenance/monitoring of operational AROME-EPS at HungaroMet; operationalization of model perturbations
- ☐ Development of an ALARO-based convection-permitting EPS; implementation in Tactus
- ☐ First tests with 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 AlpeAdria: dynamics update, operationalization of EnVar based EPS assimilation system
- ☐ Reanalysis data for C-LAEF AlpeAdria

Proposed contributors & Estimated efforts: Katalin Jávorné-Radnóczy, Zsolia Szalkai (HungaroMet), Clemens Wastl, Florian Weidle, Florian Meier, Nauman Awan, Brigitta Goger (GeoSphere Austria), Jure Cedilnik, Benedikt Strajnar, Neva Pristov (ARSO), Endi Keresturi (DHMZ), Jadwiga RÓG (IMGW) – 15 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 DHMZ) – A-LAEF; Implementation of ALARO-EPS in Tactus

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 2027 are:

- ☐ Work on dynamics perturbations; SPP in dynamics; multi-dynamics approach
- ☐ Development of flow-dependent model perturbations in C-LAEF AlpeAdria; 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: Clemens Wastl, Adhi Neduncheran (GeoSphere Austria), Endi Keresturi (DHMZ), Katalin Jávorné-Radnóczy and Zsófia Szalkai (HungaroMet) – 6 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:

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 2027 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 AlpeAdria to create initial conditions for ensemble members. Test what perturbations are suitable and perform the best. Preparation for operationalization
- ☐ Perturbation of initial conditions in global AI models to be used in regional NWP models

Proposed contributors & Estimated efforts: 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 2027 are:

- ☐ SPP in SURFEX, implementation and testing
- ☐ Surface perturbations in the Multilayer diffusion scheme (ISBA-DIF)

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 2027 are:

No topics planned for 2027

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 2027 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 renewable energy sector
- ☐ 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, Ivan Vujec (DHMZ), Alexander Kann, Markus Dabernig, Irene Schicker (GeoSphere Austria), Katalin Jávorné-Radnóczy (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	15	1	0
S2: Model perturbations	6	0	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:	39	4	0

Meetings and events (2027)

- ☐ 48th LSC Meeting, Bratislava, Slovakia, March 2027
- ☐ 7th ACCORD All Staff Meeting, Toulouse, April 5 - April 9 2027
- ☐ 49th LSC Meeting, Prague, Czech Republic, September 2027
- ☐ 48th EWGLAM and 33rd SRNWP joined meeting, ???, September 2027
- ☐ 7th ACCORD EPS working week, LACE country, autumn 2027
- ☐ Other international EPS related conferences and workshops