Working Area Predictability

Work Plan

Prepared by:	Area Leader: Clemens Wastl
Period:	2024
Date:	March 2024

Introduction and background

Currently three different EPSs are operated within RC LACE: A-LAEF the common EPS of RC LACE and the two convection-permitting EPSs C-LAEF (Austria) and AROME-EPS (Hungary). Furthermore, SHMU in Slovakia is working on a high resolution ALARO based EPS for a smaller domain. The development and maintenance of all of these systems is carried out separately at SHMU, GeoSphere Austria and OMSZ, respectively. The operation of the common A-LAEF system is guaranteed for 2024 since enough SBUs of the partners (Croatia, Slovenia, Turkey) could be allocated.

Austria, Slovenia and Croatia have initiated an intensive cooperation to develop a common C-LAEF 1km system. A first test version has already been set up by GeoSphere Austria and is running continuously since summer 2023 with output data provided to Slovenia and Croatia as well. Besides sharing of computer resources (SBUs at the ECMWF) this cooperation also includes some scientific collaboration - e.g. work on the development of EnVar for an ensemble system, flow dependent model perturbations, etc. The aim is to have a common operational system in 2025.

Strong cooperation and collaboration is currently going on between RC LACE and ACCORD in the EPS area. Sharing of code, participation in common EPS working weeks, regular thematic workshops take place and will continue in the future.

Goals

The main goals for 2024 are in many points very similar to those of the previous years. Three EPSs are already running operationally within RC LACE, but continuous work has to be spent on maintenance, migration and further improvements. For the near future significant upgrades of the EPSs are foreseen, especially in the direction of higher resolution (towards 1km). However, despite the HPC upgrades (e.g. new HPC at GeoSphere Austria) we will definitely not have enough HPC capacity to run a common 1km EPS on the large RC LACE domain in the next few years. Therefore, Austria, Slovenia and Croatia initiated a cooperation on a common 1km C-LAEF system. Beside that, we have to think about 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.
Another important point in the EPS area is to ensure that the EPS outputs are being accordingly utilized in order to maximize their potential. Therefore a lot of work is planned in the subject S6 (Statistical EPS and user-oriented approaches) which also covers the implementation of new ML based methods. To reach all of these goals it will be crucial to strengthen the cooperation within RC LACE and ACCORD on this topic. Another important issue in the near future is phase 2 of the EU initiative Destination Earth which also contains EPS and therefore some LACE manpower will be dedicated to this project (DEODE).

1 Subject: Preparation, evolution and migration

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

The main topics for 2024 are:

- ❏ A-LAEF and C-LAEF: Maintenance/monitoring of operational EPSs on ECMWF's HPC in Bologna, upgrades
- ❏ A-LAEF: Implementation of SURFEX for ALARO
- ❏ A-LAEF: Development of an ALARO-based convection-permitting EPS coupled to the regional ensemble A-LAEF, running at new SHMU HPC
- ❏ C-LAEF: C-LAEF 1k for Slovenia and Croatia, extension of domain, data provision, product generation, R&D, pre-operational status
- ❏ C-LAEF: New HPC at GeoSphere Austria – migration, tests for C-LAEF 1k
- ❏ C-LAEF: Migration of SPP code to export version of cy49t1 (cooperation with Ulf Andrea – stay in Innsbruck)
- ❏ AROME-EPS: Optimization and tuning of convection-permitting ensemble system on HPC at OMSZ
- ❏ AROME-EPS: Introduction of model perturbations (SPP) in operational AROME-EPS

The operation of the common A-LAEF system on the ECMWF HPC is guaranteed for 2024 since enough SBUs could be allocated (Figure 1). Beside that, a special project proposal for additional SBUs has been submitted. This comprises 15 Mio SBUs/year for the period 2024 – 2026 and will be used for an upgrade of the model cycle to the cy46t1 (export version + development), for new definitions of perturbed physics, updates in the surface data assimilation, re-runs of extreme weather case studies (with different tunings) and testing of new software upgrades by ECMWF before their operational deployment.

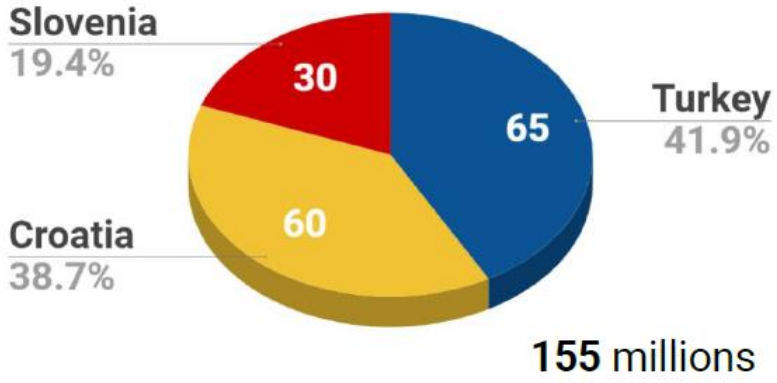

Figure 1: SBUs (millions) for A-LAEF TC2 operations in 2024.

Proposed contributors & Estimated efforts: Martin Belluš and Maria Derkova (SHMU), Katalin Jávorné-Radnóczi, Gabriella Tóth (OMSZ), Clemens Wastl, Florian Weidle, Christoph Wittmann (GeoSphere Austria), Jure Cedilnik (ARSO), Endi Keresturi (DHMZ) – 20 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. Martin Belluš (4 weeks at CHMU) – A-LAEF upgrade

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 itself and how to best incorporate this into the models.

The main topics for 2024 are:

- ❏ A-LAEF: Stochastic perturbation of fluxes instead of tendencies in order to preserve the energy balance in perturbed model.
- ❏ C-LAEF: Introduction of new parameters in SPP – dynamics parameters; testing
- ❏ C-LAEF: Development of flow-dependent model perturbations
- ❏ AROME-EPS: Add model perturbations to AROME-EPS at OMSZ. Work on SPP, tests, verification, optimization

Proposed contributors & Estimated efforts: Martin Belluš (SHMU), Clemens Wastl (GeoSphere Austria), Endi Keresturi (DHMZ), Gabriella Tóth and Katalin Jávorné-Radnóczi (OMSZ) – 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:

1. Endi Keresturi (4 weeks at GeoSphere Austria) – flow dependent SPP perturbations

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 2024 are:

- ❏ A-LAEF: Utilization of A-LAEF operational forecasts for flow-dependent B-matrix computation to be used in local assimilation cycles of RC LACE members.
- ❏ C-LAEF: The use of EnVar and Hydrid EnVar in C-LAEF 1k; development, implementation and testing

Proposed contributors & Estimated efforts: Martin Belluš (SHMU), Florian Meier and Florian Weidle (GeoSphere Austria) - 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. Martin Belluš (4 weeks at GeoSphere Austria) - flow-dependent B-matrix

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 2024 are:

- ❑ C-LAEF and AROME-EPS: Implementation of surface perturbations in AROME-EPS; SPP in SURFEX, implementation testing, verification

Proposed contributors & Estimated efforts: Clemens Wastl (GeoSphere Austria), Gabriella Tóth (OMSZ) - 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. Gabriella Toth (4 weeks at GeoSphere Austria) – surface perturbations in AROME-EPS

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 2024 are:

No topics planned for 2024

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 2024 are:

- ❏ A-LAEF: Continuation work on methods for analog-based post-processing of probabilistic fields on a regular grid
- ❏ C-LAEF and AROME-EPS: Work on statistical post-processing of EPS data (e.g. new calibration methods)
- ❏ C-LAEF: Generation of ensemble members by deep learning algorithms
- ❏ C-LAEF: Extension of data-driven ML ensemble modelpoint nowcasting towards a hybrid (data-driven + NWP) and days-ahead; extension of spatial nowcasting with physics-informed ML using NWP data for the days-ahead and looking into ensemble generation;
- ❏ ALL: Development of new probabilistic products to meet users requirements
- ❏ ALL: Development of decision-making criteria based on EPS for various users (e.g. hydrology, renewable energy, road safety, mountaineers, etc.)

Proposed contributors & Estimated efforts: Iris Odak Plenković, Endi Keresturi, Ivan Vujec (DHMZ), Alexander Kann, Markus Dabernig, Irene Schicker (GeoSphere Austria), Martin Belluš (SHMU), Katalin Jávorné-Radnóczi (OMSZ) – 11 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 Plenković/Ivan Vujec (4 weeks at GeoSphere Austria) - analog-based post-processing methods

Summary of resources [PM]

Subject	Person Months	LACE	ACCORD
S1: Preparation, evolution and migration	**20**	**1**	
S2: Model perturbations	**6**	**1**	
S3: IC perturbations	**2**	**1**	
S4: Surface perturbations	**2**	**1**	
S5: LBC perturbations			
S6: Statistical EPS and user-oriented approaches	**11**	**1**	
Total:	**41**	**5**	

Meetings and events (2024)

- ❑ 3rd ACCORD EPS working week, Budapest, 22 – 26 January 2024, maybe another one in autumn/winter 2024
- ❑ 42nd LSC Meeting, Budapest, 27 - 28 February 2024
- ❑ 4th ACCORD All Staff Meeting, Norrköping, 15 – 19 April 2024
- ❑ 43rd LSC Meeting, Vienna, September 2024
- ❑ 46th EWGLAM and 31st SRNWP joined meeting, Czech Republic, September 2024
- ❑ Other international EPS related conferences and workshops