

Working Area Predictability

Work Plan

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| Prepared by: | Area Leader: Clemens Wastl |
| Period: | 2023 |
| Date: | September 2022 |

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, ZAMG and OMSZ, respectively. Although these systems are very much different in their focus and content it would be much more effective and efficient to merge some work or at least to increase the scientific exchange in research topics. Stronger collaboration is at least planned between Austria and Hungary in 2023 (planned stays on exchange of knowledge), since these two EPSs are very similar and share large parts of their domains. The idea of somehow merging all of the regional EPSs to one common RC-LACE system on 1km is stagnating at the moment, because of missing computer power, but also because of too different views (ALARO/AROME physics, surfex, etc.). However, for the future we have to think about this to meet the fast development in the EPS area worldwide. Another source of uncertainty for the EPS area in RC-LACE at the moment is the EU initiative Destination Earth (DestinE), where ACCORD is developing a hyper-resolution on demand EPS for Europe.

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 (mostly online, but also some physical meetings) have been recently initiated and should continue in the future.

Goals

The main goals for 2023 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 (ECMWF-HPC, planned new ZAMG HPC) 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. At least for the local EPSs (C-LAEF, AROME-EPS, new ALARO-EPS) it should be possible to go towards 1km until 2025, especially with the expectation of some new technologies (single precision, GPU code, etc.). However, we have to think about alternative ways to improve/extend our EPSs. One way would be for example the generation of ensemble members by deep learning algorithms.

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 AI based methods in the EPS area. To reach all of these goals it will be crucial to strengthen the cooperation within RC-LACE and ACCORD on this topic.

The EU initiative Destination Earth will of course be another important issue in the near future, since many of our staff working on EPS will be working in 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 HPCF and the AROME-EPS running at the HPCF at OMSZ. Migration and implementations to new HPCFs, operational upgrades, new cycles, optimizations and tunings. Implementation of new EPSs.

The main topics for 2023 are:

- A-LAEF and C-LAEF: Maintenance/monitoring of operational EPSs on new ECMWF's computer in Bologna, upgrades
- A-LAEF: Upgrade of the upper-air IC uncertainty simulation by ENS BlendVar
- A-LAEF: Development of an ALARO-based convection-permitting EPS coupled to the regional ensemble A-LAEF, running at new SHMU HPC
- C-LAEF: Operationalization of SPP scheme in C-LAEF
- C-LAEF: Upgrade of C-LAEF to 1km – test suites, optimizations, verification, single precision
- C-LAEF: New HPC at ZAMG – migration, first tests for C-LAEF 1km
- C-LAEF: Adaptation of C-LAEF to Turkish Domain
- AROME-EPS: Optimization and tuning of convection-permitting ensemble system on HPCF at OMSZ;
- AROME-EPS: Introduction of EDA in operational AROME-EPS

Proposed contributors & Estimated efforts: Martin Belluš, Mária Derková (SHMU), Katalin Jávorné-Radnóczy, Gabriella Tóth (OMSZ), Clemens Wastl, Florian Weidle, Christoph Wittmann (ZAMG), Simona Tascu (METRO) – 21.5 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 ZAMG) – 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 2023 are:

- A-LAEF: Stochastic perturbation of fluxes instead of tendencies in order to preserve the energy balance in perturbed model.
- C-LAEF: Improvement of stochastic parameter perturbations (SPP) with special focus on convective hazards (e.g. processes in microphysics); make SPP cheaper (not perturbing every time-step)
- C-LAEF: Development of flow-dependent model perturbations
- AROME-EPS: Add model perturbations to AROME-EPS at OMSZ. Work on SPPT, SPP.

Proposed contributors & Estimated efforts: Martin Belluš (SHMU), Clemens Wastl (ZAMG), Endi Keresturi (DHMZ), Gabriella Tóth (OMSZ) – 5.25 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 Tóth (4 weeks at ZAMG) – model perturbations in AROME-EPS
2. Endi Keresturi (4 weeks at ZAMG) – improve SPP in C-LAEF, flow dependent 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 2023 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.

Proposed contributors & Estimated efforts: Martin Belluš (SHMU) - 1 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 ZAMG) - 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 2023 are:

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:

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 2023 are:

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 2023 are:

- A-LAEF: Continuation work on methods for analog-based post-processing of probabilistic fields on a regular grid
- C-LAEF: Work on statistical post-processing of EPS data (e.g. new calibration methods)
- C-LAEF: Generation of ensemble members by deep learning algorithms
- ALL: Development of new probabilistic products
- 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 (ZAMG), Martin Bellus (SHMU), Katalin Jávorné-Radnóczy (OMSZ), Simona Tascu (METRO) – 14.25 PM (2 of them in Deode)

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 (4 weeks at ZAMG) - analog-based post-processing methods

7 Action/Subject: **Collaboration and Publication**

Description and objectives: Activities merging different areas, collaboration with other consortia, applications, projects. Publication and presentation of relevant scientific output at international workshops and in scientific journals.

The main topics for 2023 are:

- A-LL: Collaboration with DA group on ensemble assimilation methods (flow dependent B-matrix, EnVar, etc.)
- ALL: Contributions to workshops and meetings.
- ALL: Collaboration with ACCORD predictability area
- ALL: Participation in EPS Working Week
- ALL: Publications in scientific journals

Proposed contributors & Estimated efforts: ALL

Planned time-frame and deliverable: Ongoing. Presentations at the workshops; reports; publications.

Summary of resources [PM]

| Subject | Manpower | LACE | ACCORD |
|---|-----------|----------|--------|
| S1: Preparation, evolution and migration | 21.5 | 1 | |
| S2: Model perturbations | 5.25 | 2 | |
| S3: IC perturbations | 1 | 1 | |
| S4: Surface perturbations | | | |
| S5: LBC perturbations | | | |
| S6: Statistical EPS and user-oriented approaches | 14.25 | 1 | |
| S7: Collaboration and publication | 0 | | |
| Total: | 42 | 5 | |

Meetings and events (2023)

- 40th LSC Meeting, March 2023
- 3rd ACCORD All Staff Meeting, Tallinn, 27-31 March 2023
- 2nd ACCORD EPS working week, Helsinki, April 2023
- 41st LSC Meeting, September 2023
- 45th EWGLAM and 30th SRNWP joined meetings, October 2023
- Other international EPS related conferences and workshops