Working Area Predictability

Work Plan

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Introduction and background

The striving for a higher spatial resolution in NWP is what can be seen nowadays from everywhere. ECMWF is soon going to increase the horizontal resolution of both their deterministic (16 to 9 km) and ensemble (32 to 18 km) systems, even if it is bound to the upgrade of Gaussian grid solely and the spectral resolution of the model will remain unchanged. A lot of national centers in Europe also integrate their limited area models on scales around 5 km.

The small scale uncertainties tend to grow up along the forecast lead time into the synoptic scales and eventually, in the unstable situations with very little predictability, are capable to change completely the weather scenario even on the short ranges. This phenomenon is the characteristic attribute of the nature itself. It even becomes more pronounced when going towards the higher resolutions in NWP and thus shall be definitely considered.

For a reliable forecasts on short ranges it is necessary to deal with very small spatial scales. Moreover, increased sensitivity to the initial conditions and model accuracy is often connected to the evolution of severe weather situations, which are of our highest interest. Undoubtedly, a probabilistic approach seems to be inevitable and the only answer to this. Therefore, one of the most important tasks in NWP these days is to answer the question, how to create the appropriate perturbations of the initial and boundary conditions and how properly simulate the model uncertainty. This remains as the biggest challenge for the Predictability area.

Goals

The regional ensemble forecasting system ALADIN-LAEF provides the probabilistic forecasts for the LACE partners operationally on daily bases. Many changes and upgrades within the last few years took place in order to make the system more reliable and accurate. In current operational version, the model uncertainty is simulated by several combinations of different micro-physics, deep and shallow convection, radiation and turbulence schemes. Some of them are related to the older ALADIN cycles, or even to the obsolete code. That is indeed very difficult to maintain, not to speak about the guarantee of its functionality on higher spatial resolutions (which is also a part of the plan for 2016).

Therefore, it was decided to limit the multi-physics configurations to the recent ALARO-0 and ALARO-1 developments and upgrade ALADIN-LAEF to cycle 40t1. The main idea is to keep it more simple and also more up-to-date. To ensure reasonable model uncertainty even with the reduced number of multi-physics members, a supplementary stochastic perturbation of physics tendencies will be introduced. The impact on ALADIN-LAEF statistical reliability shall be tested for the new multi-physics setup in combination with the upper-air and surface stochastic physics (SPPT).

Further upgrade of ALADIN-LAEF is foreseen in the new methodology for generating the initial condition perturbations of the atmospheric fields. So far we are using breeding-blending pseudo-assimilation cycle to combine the large-scale perturbations provided by driving global ensemble (ECMWF-EPS), with the small-scale perturbations generated by ALADIN-LAEF breeding vectors. Obvious disadvantage of the current method is the absence of local measurements for the atmosphere.

Thus the implementation of ensemble of 3D-Var assimilations with the perturbed observations is believed to produce the members with less initial bias and improved uncertainty. The consistency of such initial perturbations of the upper-air fields with the perturbed coupling files of the driving ensemble system shall be ensured by the spectral blending method again. BlendVar is already successfully used in Prague for their operational deterministic model, therefore without the perturbation of the upper-air fields. The novelty of BlendVar usage within the limited area ensemble forecasting system will be in its method for generating the background error statistics (B-matrix).

The ALADIN-LAEF 5 km version is planned, but the investigation of its feasibility and real benefits has to be done very carefully. The preliminary results, involving just the pure dynamical downscaling of ALADIN-LAEF 11 km to 5 km grid, were satisfactory after the corrections in the integration namelist. A clear answer must be provided, whether the ALADIN-LAEF with the new configuration (revised multi-physics plus stochastic physics and possibly BlendVar) on higher spatial resolution is operationally feasible keeping the current 16+1 ensemble members and preferably the whole LAEF domain size. In case it would be really necessary to reduce the domain size, it must be guaranteed that the quality of the ensemble is not affected.

Development of convection-permitting ensemble system AROME-EPS remains still as a second main topic, however due to the limited computer resources some of the experiments have to be carried out using ALARO code instead. Another possibility how to cope with the current situation is to use the deterministic AROME runs of e.g. RUC to construct the lagged ensemble. The research proceeds at ZAMG and OMSZ in parallel. Except the conceptual and technical differences, the similar issues like in ALADIN-LAEF are to be solved.

Last but not least, the scientific cooperation with HIRLAM group working on their HarmonEPS system should be broadened. Both groups could profit from the exchange of their expertise and experience, since we all are facing the similar challenges.

Main R&D activities

1 Action/Subject: Optimization of ALADIN-LAEF

Description and objectives: ALADIN-LAEF upgrades and related R&D

- Revision of ALADIN-LAEF multi-physics as the main source of the simulated model uncertainty. The goal would be the reduction of multiple (even obsolete and not high-resolution ready) parameterizations to a few maintainable configurations restricted to the recent ALARO-0 and ALARO-1 physics and their different tunings. New reduced multi-physics should be supplemented with the stochastically perturbed physics tendencies (SPPT) for the upper-air and surface prognostic variables to keep a reasonable ensemble spread.

- Implementation and testing of the ensemble of 3D-Var assimilations in ALADIN-LAEF system using the perturbed atmospheric observations. New method BlendVar joining 3D-Var with the upper-air spectral blending by digital filter will be used for generating the IC perturbations of the atmospheric fields. BlendVar is expected to produce the ensemble members with less initial bias and improved uncertainty. In case of positive impact it will be eventually included in the ALADIN-LAEF operational configuration instead of the current breeding-blending method.

- Preparation and the initial feasibility study of ALADIN-LAEF 5 km version with 16+1 members, revised multi-physics (ALARO-0/1 on cy40t1) supplemented by the stochastic perturbation of physics tendencies and re-tuned upper-air spectral blending. In case it would be necessary to reduce the current domain size in order to run such configuration operationally, it must be guaranteed that the quality of the ensemble is not affected for Central Europe.

Proposed contributors & Estimated efforts: Florian Weidle, Yong Wang, Christoph Wittmann (all ZAMG), Martin Belluš (SHMU), Alena Trojáková (CHMU), Simona Taşcu (NMA) - 10 PM (including 5 PM LACE stays at ZAMG)

Planned time-frame and deliverable: Whole year 2016. State-of-the-art ensemble system capable to deliver operational probabilistic forecasts, the evaluation results, stay reports.

Planned stays:
1. Alena Trojáková, 25/04~20/05 (4 weeks)
2. Martin Belluš, 25/04~13/05 + 06/06~10/06 (4 weeks)
3. Simona Taşcu, 04/07~26/08 (8 weeks)
4. Martin Belluš, 2nd half of 2016 (4 weeks)

2 Action/Subject: ALADIN-LAEF maintenance

Description and objectives: Maintain and monitor the operational suite of ALADIN-LAEF running on Cray HPCF at ECMWF.

There is an important operational change at ECMWF planned for March this year involving the upgrade of spatial resolution. However, since this upgrade concerns the changes of Gaussian grid only (while the model spectral resolution will be untouched) there is no need for the upper-air spectral blending retuning in the operational ALADIN-LAEF system.

Proposed contributors & Estimated efforts: Florian Weidle (ZAMG) - 1 PM

Planned time-frame and deliverable: Ongoing. Stable ALADIN-LAEF operational suite and reliable delivery of the probabilistic forecast products (GRIB files, plots) for the LACE partners.

3 Action/Subject: Development of AROME-EPS

Description and objectives: Development of convection-permitting ensemble system based on non-hydrostatic AROME model. The aim would be to probabilistically forecast high-impact weather on local spatial scales and with short life-cycle. Activities planned at ZAMG and OMSZ:

- ❏ Continue tests with different coupling possibilities for the data assimilation cycle (source, resolution, update, frequency). A strong impact on the quality of control member analysis and hence on the whole ensemble system accuracy was observed in the former experiments.
- ❏ Continue work on stochastic perturbation of physics tendencies as a tool to simulate the model uncertainty. Since preliminary experiments have shown only slight impact on the upper-air fields, continue with a) testing the stochastic physics as a combination of both the upper-air and surface perturbations; b) implementing different weights for perturbing individual variables.
- ❏ Parallel experiments with lagged convection-permitting ensemble system formed by several deterministic AROME runs (AROME-PEPS). Evaluate this "cheap" solution to the current AROME-EPS.
- ❏ Evaluate the benefits of current convection-permitting EPS compared to the existing EPS systems running on coarser resolutions and exploiting hydrostatic models. Are the convection-permitting EPS capable of providing better precipitation and temperature forecasts already at this stage of their evolution?

Proposed contributors & Estimated efforts: Mihály Szűcs, Panna Sepsi (both OMSZ), Clemens Wastl, Christoph Wittmann (both ZAMG) - 10 PM (including 1 PM LACE stay at ZAMG)

Planned time-frame and deliverable: Ongoing. Reports on the experiments, exchange of the technical expertise.

Planned stays:
1. Mihály Szűcs, 23/05~17/06 (4 weeks)

4 Action/Subject: Verification

Description and objectives: Further development of the verification tools for both ALADIN-LAEF and AROME-EPS forecasts.

Proposed contributors & Estimated efforts: Simona Taşcu (NMA), Martin Belluš (SHMU) - 1 PM

Planned time-frame and deliverable: Ongoing. Enhanced verification tools.

5 Action/Subject: Contributions to international projects, collaboration

Description and objectives:

- Contributions to PHASE II of the SRNWP-EPS activities. The second phase of the project will continue to the end of 2017, focusing on the development of new probabilistic methodologies to predict severe weather conditions like thunderstorms and fog and studying the underlying sensitivity of the models to soil conditions and the boundary layer.
- Closer collaboration with HIRLAM group and the exchange of know-how related to their HarmonEPS and our ALADIN-LAEF systems, especially the expertise on a) initial conditions perturbation generation (EDA and 3D-Var, LETKF) and b) model uncertainty simulation (SPPT, multi-physics using ALARO-1 package with the different tunings).
- Contributions to the other workshops and meetings.

Proposed contributors & Estimated efforts: Florian Weidle, Yong Wang (both ZAMG), Mihály Szűcs (OMSZ), Martin Belluš (SHMU) - 2 PM

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

6 Action/Subject: Publications

Description and objectives: Publication of the scientific results achieved within the project. The scientific achievements of the project will be presented at the international workshops and published in the scientific journals.

Proposed contributors & Estimated efforts: Florian Weidle, Florian Meier, Yong Wang, Christoph Wittmann, Clemens Wastl (all ZAMG), Martin Belluš (SHMU), Simona Taşcu (NMA), Mihály Szűcs (OMSZ) - 6 PM

Planned time-frame and deliverable: Ongoing. Reviewed papers and the workshop contributions.

Summary of resources [PM]

Subject	Manpowe	LACE	ALADIN	Other
S1: Optimization of LAEF	**10**	**5**		
S2: LAEF maintenance	**1**			
S3: AROME-EPS	**10**	**1**		
S4: EPS - Verification	**1**			
S5: Collaboration	**2**			
S6: Publications	**6**			
Total:	**30**	**6**	**0**	**0**

Meetings and events (2016)

- Joint 26th ALADIN Workshop & HIRLAM All Staff Meeting 2016, 4-8 April 2016, Lisbon, Portugal
- SRNWP-EPS II Project Workshop on Probabilistic prediction of severe weather phenomena, 17-19 May 2016, Bologna, Italy
- 38th EWGLAM/23st SRNWP joined meetings, 3-6 October 2016, Rome, Italy
- International EPS related conferences or workshops (e.g. SRNWP EPS-DA /EPS –PHY)