Working Area Predictability

Progress Report

Prepared by:	Theresa Gorgas
Period:	March – August 2013
Date:	09/09/2013

1 Progress summary

ALADIN-LAEF has been run operationally at the ECMWF-HPC since 2011. A revised version with enhanced resolution, optimized multi-physics and ensemble surface data assimilation has become operational in July this year. A lot of efforts have been made to improve the system ahead of this step. Further, extensive verification activities proved the advantages of the new system over the old one. The tests revealed also new items for further improvements and future developments. The verification package used for the evaluation has been made much faster and more user-friendly. It is essential for gaining feed-back from tests and new model versions and, hence, is an important tool for further model developments. There is also more focus now on convection-permitting EPS.

Tests for AROME-EPS have been performed with different driving models, with SPPT and with a simplified perturbation of ICs based on AROME-DA.

Collaboration between EPS and data assimilation and EPS and physics has been enhanced in the framework of several workshops. Joint developments and ideas for shared experiments have been discussed. They shall lead to better knowledge about the predictability of parameters, about model errors and the generation of perturbations in LAM-EPS.

2 Scientific and technical main activities and achievements, major events

1 Action/Subject/Deliverable: Implementation of operational ALADIN-LAEF at ECMWF

Description and objectives: The new version of ALADIN-LAEF has been built up on the HPC system at ECMWF. It has been set up in pre-operational mode at the beginning of March and got operational status on July 9. It replaced the older version which had been run at ECMWF since 2011. The system has been tested and evaluated. Fall-back solutions have been installed to enable higher stability. Further, existing applications for breeding, surface assimilation and blending have been unified for better maintenance.

Horizontal resolution is enhanced from 18km to 11km, vertical resolution from 37 levels to 45 levels. The upgrade involves optimized multi-physics and ensemble land surface data assimilation via CANARI.

The new multi-physics use different combinations of ALARO and Météo-France ALADIN schemata. They are aimed at the perturbation of sub-grid-scale deep convection and shallow convection, cloud microphysics, radiation, turbulence, low level wind and gusts and screen level diagnostic parameters (2m temperature and humidity).

For the ensemble CANARI, surface observations are perturbed before the OI-data assimilation. This results in overall better scores compared to non-cycling-surface breeding (NCSB) which was used in the old version.

A further benefit of the data assimilation is that the integration can start as soon as the observations are available. Output can be provided much earlier (3:30 UTC instead of 8:30 UTC).

Efforts: 3.5 person months (0.5 LACE stay)

Contributors: Florian Weidle, Martin Bellus (LACE stay), Theresa Gorgas, Christoph Wittmann, Yong Wang

Documentation: LAEF flow charts, Stay Report Martin Bellus

Status: Completed

2 Action/Subject/Deliverable: Optimization of ALADIN-LAEF

Description and objectives: This subject summarizes on-going and completed task of ALADIN-LAEF research and development.

- Verification of the new LAEF (11km) versus the old version and versus pure downscaling of ECMWF-EPS for a historical 2months period: The evaluation which was also performed for each single ensemble member revealed that the new tuning of multi-physics is rather aggressive. Further, the initial spin-up is bigger due to the perturbed observations. After all, the new LAEF was clearly better than the old one and than the pure downscaling of ECMWF.

- Verification of the new operational LAEF (11km) versus an ALARO (5km) time-lagged ensemble system (5 members with 6h-shift between them): LAEF 11km shows better performance than the time-lagged ensemble system except for the

initial time: There are biases in MSLP and 2m temperature, which may be due to assimilation problems. Note: There is only one analysis in the lagged ensemble at this forecast range.

- Verification of the new operational LAEF (mean, median and control) versus deterministic ALARO-AUSTRIA: There is the same bias as in the ensemble results. However, LAEF 11km shows better results for forecast ranges longer than 12h. For 12h precipitation the control forecast is better than mean and median. But the highest percentage of correct forecasts, highest correlation and equitable threat score for precipitation is given by the deterministic ALARO model.

- Revision of the surface assimilation for relative humidity in LAEF 11km: The assimilation increments for the surface liquid water content were null. Some input fields in the input files were missing.

- A switch for time consistent versus space consistent coupling has been implemented. For the "space-consistent" approach the first LBC is equal to the initialisation from LAM assimilation cycle. "Time-consistent" means, that the first LBC comes from the driving model. For the overall evaluation of a longer period showed hardly any difference in the verification scores. However, for individual cases differences can be quite large. Tests for a selected case (15 May, 2011) revealed that the differences are advected towards the domain centre. They are not homogenous, but mainly located around frontal zone positions (e.g. for T2m). These results lead to the idea to create a targeted perturbation for LAM-EPS, which acts locally where it matters most.

Further issues:

- Fix the SST problem which is due to land-sea mask in climate files

- Find other physical parameterisations for the most aggressive members in ALADIN-LAEF

- Further tests with a surface stochastic physics scheme (see Report of 03/2013)

- Near future: Set up of a LAEF version with a resolution of 5km. This will be a matter of available resources.

Efforts: 5 person months (2 LACE stay)

Contributors: Martin Bellus (LACE stay), Florian Weidle, Simona Tascu (LACE stay), Christoph Wittmann, Yong Wang

Documentation: Stay reports of Martin Bellus and Simona Tascu

Status: Ongoing

3 Action/Subject/Deliverable: ALARO-LAMEPS & AROME-EPS

Description and objectives: Development of ALARO-LAMEPS and AROME -EPS

At the Hungarian Met Service two LAM-EPSs are in development:

- ALARO-LAMEPS (8km): The implementation of a full EDA using 3DVAR and CANAR is on-going and is near a quasi-operational status. The EDA uses the same number of observation as in the deterministic system. All observations are perturbed.

- AROME-EPS (2.5km): The primary version is coupled with PEARP (1h coupling frequency) but also other coupling strategies are tested. It is planned to gain knowledge about the sensitivity of the system to different LBCs. Among them are:

    o IFS-HR LBCs (T1279, available for special periods)

    o ALARO-LAMEPS

    o ALADIN-LAEF

AROME-EPS uses a simplified scheme for initial perturbations: ICs for the control run are provided by the data assimilation cycle of the deterministic AROME at OMSZ. For the other members the downscaled PEARP perturbations are added to the perturbed ICs. In doing so, the symmetric structure of perturbations can be maintained. Evaluations showed very promising results.

Tests have also performed with SPPT for a 2-week period during winter 2011/2012. IFS-HR LBCs were used for coupling, and different correlation length parameters for the perturbations, i.e. L=500km and L=125km. The choices for the other parameters were ⍺=0.5 for the perturbation spread and 2h for the time component. The experiments revealed that the results were not sensitive to the correlation length scales. SPPT, in general, produced a slight improvement for MSLP and worse results for clouds.

At ZAMG a basic version has been set up for AROME-EPS (2.5km) for the pure downscaling of ALADIN-LAEF (11km). The set-up is similar as for the deterministic AROME at ZAMG. The domain covers most of the LACE countries (except Romania). Evaluation of the first few test cases (convection) is on-going. The result shall be compared to the outcomes of the Hungarian AROME-EPS and of the deterministic AROME of ZAMG. Further developments (tests with a full EDA, tests with SPPT) are planned in the framework of a LACE stay.

Efforts: 6 PM

Contributors: Mihaly Szűcs, Gergely Bölöni, Theresa Gorgas, Christoph Wittmann, Florian Weidle, Yong Wang

Documentation: Reports and presentation of HMS

Status: Ongoing

4 Action/Subject/Deliverable: EPS verification package

Description and objectives: Optimization of the verification package for surface and upper level parameters

The verification package which has been used hitherto to evaluate new developments in EPS (mostly ALADIN LAEF) was very slowly. To enhance the usefulness and practicability it has been revised. The new version is much more flexible and efficient. Following adaptions have been made:

- The configuration is more user-friendly. For most applications changes are needed in no more than a single routine.

- The reading of GRIB files is based on GRIB-API applications.

- It is easier to switch between surface and upper air verification

- A new score concerning the spread-skill relationship (Wang and Bishop, 2003) has been implemented.

The package produces daily verification scores for a selected period as well as averaged scores for the whole period and for different lead times. A detailed description of the package can be found in the stay report of Simona Tascu on RC LACE web page /section Predictability. Further improvements are planned: Adaption of the plotting routines, the reading of input data (ASCII AND GRIB) and implementation of further, more deterministic scores.

Efforts: 2 PM (LACE stays)

Contributors: Simona Tascu, Martin Bellus, Florian Weidle

Documentation: Stay reports of Simona Tascu and Martin Bellus

Status: The improved package is available, further changes are still planned

5 Action/Subject/Deliverable: Miscellaneous: Activities merging different areas, collaboration with other consortia, applications

Description and objectives:

Merge of DA-EPS-PHY activities:

Discussions have been initiated on how different areas of modelling can benefit from each other and merge their activities in order to solve fundamental questions for future model developments. Two occasion for these discussions took place at the ALADIN workshop /HIRLAM Meeting in Reykjavik (April 2013) and at the SRNWP-PHY-EPS Workshop in Madrid (June 2013). At both meetings participants agreed on the aim to run sensitivity studies to address the main questions. This is, of course, also a matter of resources. Main points of the discussions may be summarized as:

- DA-EPS: Fit observations according to their range of predictability. Use EPS to find out about their predictability.

- Design of perturbations: Which (spatio-temporal) scales shall be perturbed for which parameters? This is an issue for both, DA and PHY, in combination with EPS.

- PHY-EPS: Where in the model shall perturbations be introduced to produce which effects? Learn more about forecast error propagation.

- Which evaluation tools can be used for sensitivity studies?

- What will be the future role of EPS?

SRNWP-EPS activity:

SRNWP-EPS activity project Phase 1 has been started (Kick-Off in February). The aim of the activity is to strengthen collaboration of project contributors to develop a Europe-wide ensemble at about 2km grid length to emphasize probabilistic prediction of severe and high-impact weather (time frame 2013-2020). Phase 1 (2013-2014) is directed towards the identification of expertise, the schedule of scientific experiments, definition of technical constraints, etc.

A second meeting in Madrid was intended to concretize the objectives which shall be pursued in the near future. Four issues were selected which should be emphasized and

prepare the fundament for the project proposal of Phase 2 (a 3-year EPS demonstration project) of the activity project:

1) Interaction of EPS with data assimilation in the convection-permitting scale.

2) Modelling and data assimilation of ground surface properties.

3) Accounting for model uncertainties and how EPS could help understanding model sensitivities

4) Use and interpretation of probabilistic products.

The LACE EPS group accepted responsibility of issue 2) and started collecting ideas for further activities on the topic and information about expertise in the EPS-community.

En-INCA Nowcasting Tool:

The analysis and nowcasting system INCA (Integrated Nowcasting through Comprehensive Analysis) is operated by ZAMG. The system is based on blending observations and results from NWP. It uses radar, satellite and topographic information. The INCA system provides frequently updated forecasts in the nowcasting range (up to +6 h) with a resolution of 1km and improves numerical weather prediction (NWP) forecasts for up to +48 h through downscaling and bias.

Ensemble-INCA (En-INCA) is coupled with ALADIN-LAEF. The nowcasting approach of INCA is blended with the ALADIN-LAEF members to derive an ensemble of forecasts in the nowcasting range. The advantages of both systems are combined: the observation-based nowcasting on very high resolution and the uncertainty estimation of the LAM-EPS.

Efforts: 2 PM

Contributors: Theresa Gorgas, Mihaly Szucs, Barbora Stuhl, Florian Weidle, Christoph Wittmann, Yong Wang

Documentation: Minutes of workshop discussions, presentations

Status: Ongoing

6 Action/Subject/Deliverable: Publication of scientific results (Update)

Description and objectives: The scientific achievements of the ALADIN-LAEF R&D activities are presented at international workshops and published in scientific journals. In the following an overview is provided of published journal papers and documents in preparation.

Published:

- Weidle, F., Y. Wang, W. Tian, T. Wang, 2013: Validation of strategies using Clustering of ECMWF EPS for initial perturbations in Limited Area Model Ensemble Prediction System. Atmosphere-Ocean, 51, 284-295.

Submitted/in review/accepted:

- Wang, Y., M. Bellus, J.-F. Geleyn, X. Ma, W. Tian, F. Weidle, A new method for generating initial condition perturbations in regional ensemble prediction system: blending**. Submitted** 2012 to Monthly Weather Review (in revision)

In preparation:

- Smet, G., Y. Wang, F. Weidle, 2013: Comparison of ECMWF and NCEP coupling for the ALADIN-LAEF LAM-EPS – in preparation of Wea. Forecasting (ALADIN flat rate stay of Geert Smet).

- Paper of comparison between NCSB and CSB – in preparation for Wea. Forecasting.

- Paper of Ensemble-CANARI vers. NCSB – in preparation for Mon. Wea. Rev. or Quart J.

- Paper dealing with different approaches to LBC interpolation (spatio-temp. consistency) - in preparation for Mon. Wea. Rev. or Quart J.

- Paper of LAEF performance in B08RDP – in preparation for MAP.

Efforts: 2 person month

Contributors: Yong Wang, Florian Weidle, Geert Smet, Martin Bellus, Simona Tascu, Christoph Wittmann

Documentation: Reviewed papers, see above

Status: Ongoing

3   List of actions, deliverables including status

1 Subject: LAEF technical implementation

Deliverables: New LAEF on ECMWF HPC with operational status

Status: Completed

2 Subject: Optimization of ALADIN-LAEF

Deliverables: Reports on verification results and on further experiments (On RC-LACE web page)

Status: Ongoing

3 Subject: AROME-EPS

Deliverables: Reports and presentations of HMS on EPS-development and experiments

Status: Ongoing

4 Subject: Verification package

Deliverables: Software package, Documentation of package in LACE-stay report

Status: Ongoing (near completion)

5 Subject: Miscellaneous

Deliverables: Minutes of work shops

Status: Ongoing

6 Subject: Publications

Deliverables: See publication list

Status: Ongoing

4   Documents and publications

- Weidle, F., Y. Wang, W. Tian, T. Wang, 2013: Validation of strategies using Clustering of ECMWF EPS for initial perturbations in Limited Area Model Ensemble Prediction System. Atmosphere-Ocean, 51, 284-295.

- Stay reports and internal reports, minutes

5   Activities of management, coordination and communication

- Joint 24th ALADIN Workshop/HIRLAM All Staff Meeting, 15-19 April, 2013, Reykjavik, Iceland (presentation Theresa Gorgas)

- Joint SRNWP Workshop on Model Physics and Ensemble Prediction Systems + SRNWP-EPS activity workshop, 18-21 June, 2013 (presentations Mihaly Szucs, Theresa Gorgas (Yong Wang))

- Planned: 35th EWGLAM and 20th SRNWP Meeting, 30 September-03 October 2013, Antalya, Turkey (presentation Theresa Gorgas)

6   Summary of resources/means

Subject/Action/deliverable	Resource		LACE		ALADIN	
	planned	realized	planned	realized	planned	realized
S1: LAEF implementation	3	3.5		0.5		
S2: LAEF Optimization	6	5	3	1 (1.5)		
S3: Arome-EPS	10	6	1.5	(1.5)		
S4: Verification package	3	2	2	2 (0.5)		

S5: Miscellaneous	**3**	**1.5**				
S6: Publications	**5**	**3**				**0.5**
Total:	**30**	**22 (3.5)**	**6.5**	**3.5 (3.5)**	**0**	**0.5**

1: In Brackets (): stays are fixed, but not realized yet