Limited Area Ensemble Forecasting System ALADIN-LAEF at ZAMG

Introduction

During recent years, Limited Area Model Ensemble Prediction Systems (LAMEPS) have become more important as a scientific tool for improving prediction of high impact weather and for identifying sources of model error on the mesoscale. At ZAMG (ZentralAnstalt für Meteorologie und Geodynamik), the Central European regional ensemble system ALADIN-LAEF (Aire Limitée Adaptation Dynamique Développement InterNational – Limited Area Ensemble Forecasting) has been developed within the framework of the international cooperation of LACE (Limited Area modelling in Central Europe). The main goal of ALADIN-LAEF is to 'add value' to probabilistic mesoscale short-range forecasts compared to global ensemble systems. ALADIN-LAEF has run quasi-operationally since 2007, and the current configuration was implemented in February 2009.

Generation of initial perturbations

One of the most challenging tasks for a meaningful LAMEPS is the generation of appropriate initial perturbations. The simplest way to produce initial perturbations for a LAMEPS is by dynamical downscaling of a global ensemble system. The drawback of this method is that it provides meaningful initial perturbations only on scales resolved by the global ensemble system, which usually runs at a coarser resolution than the LAMEPS. The method of dynamical downscaling was used in the first generation of ALADIN-LAEF with ECMWF-EPS as the coupling model. In the current configuration, a more sophisticated method to generate appropriate initial perturbations is implemented, which assures that meaningful perturbations on the ALADIN-LAEF scale are included.

The generation of initial perturbations for ALADIN-LAEF is done separately for atmospheric and surface fields. For the initial perturbation of atmospheric fields, a so-called Breeding-Blending method is used, which combines large scale perturbations from ECMWF-EPS with small scale perturbations from 12h forecasts from the previous ALADIN-LAEF forecasts by digital filtering. The surface initial perturbations are generated by a 12h forecast of ALADIN-LAEF, where in the initial fields ECMWF-EPS surface fields are exchanged with the current ARPEGE analysis. After a 12h forecast the surface fields for each member differ, due to different lateral boundary conditions, provided by ECMWF-EPS, and different model setups. The surface initial perturbations that are created during this short-range forecast are merged with initial atmospheric perturbations from Breeding-Blending and build the initial conditions for the main ALADIN-LAEF forecasts. To account for model uncertainties' every forecast-integration uses a different ALADIN-configuration. The configurations differ in model cycles of ALADIN and different combinations of parameterization schemes of cloud physics, deep convection, radiation turbulent transport shallow convection and mixing length. More details can be found in Wang et. al 2010.

Operational setup of ALADIN-LAEF

The current configuration of ALADIN-LAEF was implemented in February 2009. The system consists of 16 perturbed members and one control run, where the

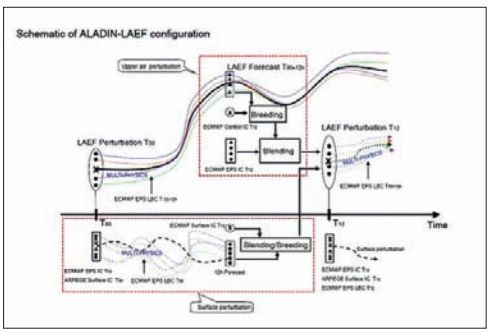

Figure 1
Schematic of ALADIN-LAEF configuration (from Wang et al, 2010)

latter is driven by the ECMWF-EPS control run. The 16 perturbed members differ in their initial conditions, in the lateral boundary conditions (interpolated from first 16 ECMWF-EPS members) and in the ALADIN-configurations. The horizontal resolution of ALADIN-LAEF is about 18km with 37 levels in the vertical. The system runs twice a day at 00 and 12 UTC with a forecast range of 60h. The model domain covers Central Europe and large parts of the North Atlantic (see Fig. 2). The results of ALADIN-LAEF are archived in the MARS-archiving system at ECMWF with an output frequency of one hour. A number of products like Epsgrams, probability charts or stamp maps are provided to forecasters. These products are available approximately at 9:30/21:30 UTC for the 00/12 UTC runs, respectively.

Validation of ALADIN-LAEF

The current ALADIN-LAEF configuration has been verified for a test period of two summer months in 2007 and compared to the 50 member ECMWF-EPS, which had a resolution of about 50km at that time. It was shown that ALADIN-LAEF is superior to ECMWF-EPS for precipitation and 10m wind forecasts in terms of probabilistic scores. Figure 4 shows the Continuous Ranked Probability Skill Score (CRPSS) for 12 hourly total precipitation, verified for the period from 15/06/2007 to 20/08/2007. The CRPSS is defined such that a skill of 1 represents a perfect model and a value of 0 means that the ensemble system does not have a 'more-added' value compared to a reference model. In the results presented, the operational deterministic model of ZAMG is used as reference, so positive values indicate a 'more-added' value of the ensemble systems with respect to the operational deterministic model. It is shown that ALADIN-LAEF system (BBSM in Fig. 4) is superior to ECMWF-EPS for precipitation forecasts up to 42 hours and both ensemble systems 'add value' to the deterministic model.

Conclusion

ALADIN-LAEF is a powerful limited area ensemble system especially designed for probabilistic mesoscale short-range forecasts. The sophisticated method to generate initial perturbations, as well as the use of different model configurations to account for uncertainties in the model itself, leads to skilful probabilistic forecasts. ALADIN-LAEF has a 'more-added' value on the mesoscale, especially in short forecast ranges up to 36h compared to global EPS-systems.

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References

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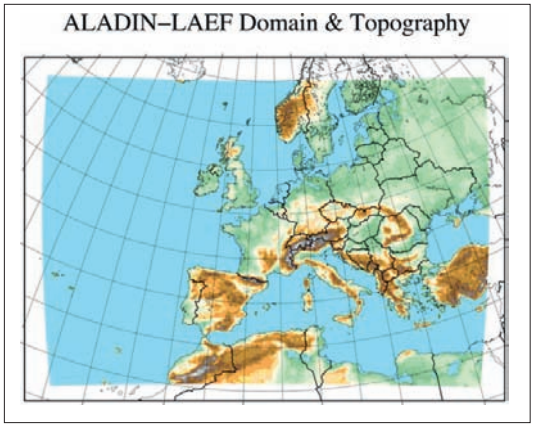
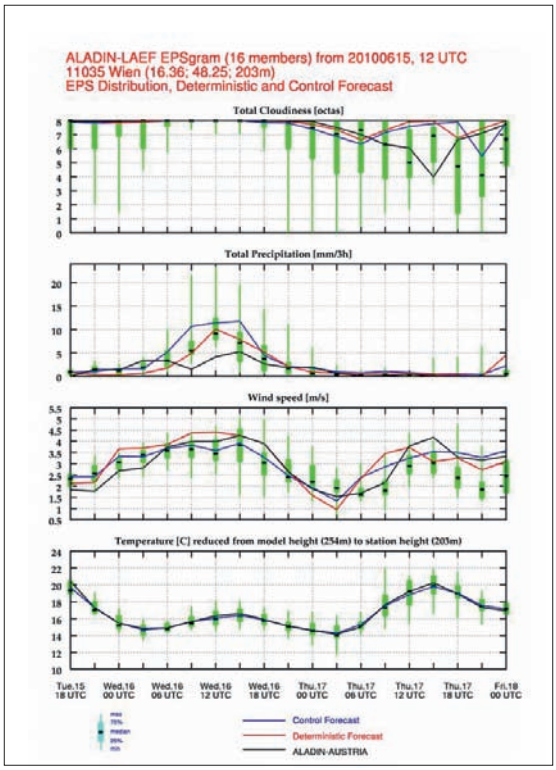
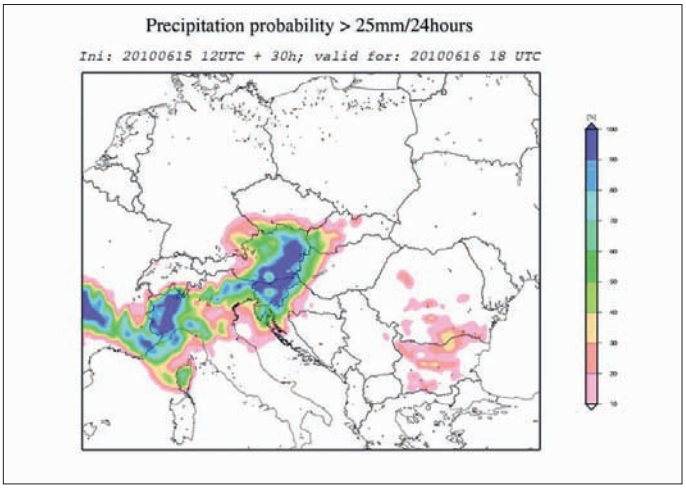


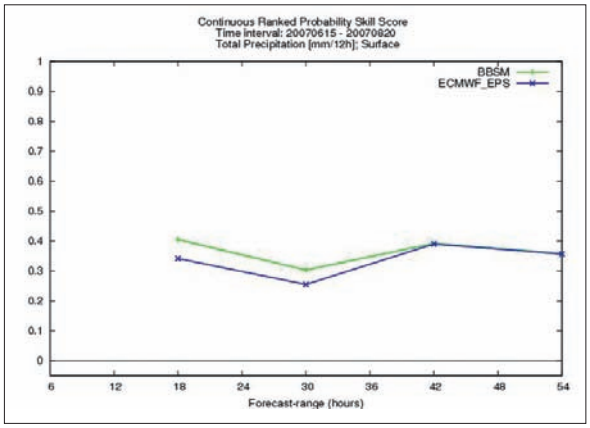
▲ *Figure 2*
LAEF Domain and topography



▶ *Figure 3a*



◀ *Figure 3b*



▶ *Figure 4*
Continuous Ranked Probability Skill Score of ALADIN-LAEF (BBSM) and ECMWF-EPS of 12 hourly Total Precipitation.