Impact of high-resolution boundary conditions on the quality of COSMO-LEPS forecasts

Andrea Montani, C. Marsigli, T. Paccagnella

ARPA–SIMC, Bologna, Italy

Introduction

In the framework of the development of European LAMEPSs, the ECMWF Research Department performed a number of global-model ENS reruns at the resolution of about 16 km. Data were provided for three two-week periods (in total 46 days), selected in such a way to encompass several high-impact weather events occurred over Europe (further details under `https://software.ecmwf.int/wiki/display/LAMEPS/LAMEPS+Home`). The availability of this unique dataset made possible the performance of several tests by the LAMEPS community. As for the experimentation with COSMO–LEPS (Montani et al., 2011), the limited-area-model ensemble prediction system operationally run by ARPA-SIMC on behalf of the COSMO Consortium (`http://www.cosmo-model.org`), the attention was focused on the performance of the system driven by this high-resolution ENS experiments.

Methodology and results

Four different sets of ensembles were compared:

1. **opecleps** ($\Delta x = 7$ km, 40 Model Levels, 16 members), the operational COSMO-LEPS running at the time of the weather events (COSMO version 4.12) and nested on the operational ECMWF ENS;
2. **TESTcleps_OldModel** ($\Delta x = 7$ km, 40 Model Levels, 16 members), the test version of COSMO-LEPS nested on high-resolution ENS (COSMO version 4.12);
3. **TESTcleps_NewModel** ($\Delta x = 7$ km, 40 Model Levels, 16 members), the same as "TESTcleps_OldModel", but with COSMO version 4.26, with new microphysics;
4. **H_ENS** ($\Delta x = 16$ km, 62 Model Levels, 21 members), the high-resolution global ENS, driving both "TESTcleps" systems.

In order to compare the skill of the 4 systems, we considered the probabilistic prediction of total precipitation exceeding a number of thresholds for several forecast ranges, analysing the performance of the runs starting at 12UTC. The evaluation of the models' performances was carried out over the full COSMO-LEPS domain, covering the area [35-58N, 10W-30E]. As for observations, it was decided to use the data obtained from the SYNOP reports available on the Global Telecommunication System, about 1440 in the verification domain. The comparison of model forecasts against observations was carried out by selecting the model grid-point closest to the observation. The skill of the different systems was examined for 6 different precipitation thresholds: 1, 5, 10, 15, 25 and 50 mm/12h. The following probabilistic scores were computed: the Brier Skill Score (BSS), the Ranked Probability Skill Score (RPSS), the Relative Operating Characteristic Curve (ROC) area, the Rank Histograms (RK) and the Percentage of Outliers (OUTL). For a description of the scores, the reader is referred to Wilks (1995).

The forecast skills of COSMO ensembles and H_ENS are summarised in Fig. 1, which presents the results in terms of probabilistic prediction of 12-hour cumulated precipitation for the full length of the verification exercise. The left panel of the figure reports the values of the RPSS plotted against the forecast range. It can be noticed that very similar results are obtained by opecleps and TESTcleps_OldModel (red and green lines, respectively) for almost all forecast ranges. These two systems differ mainly on the quality of the boundaries, which are

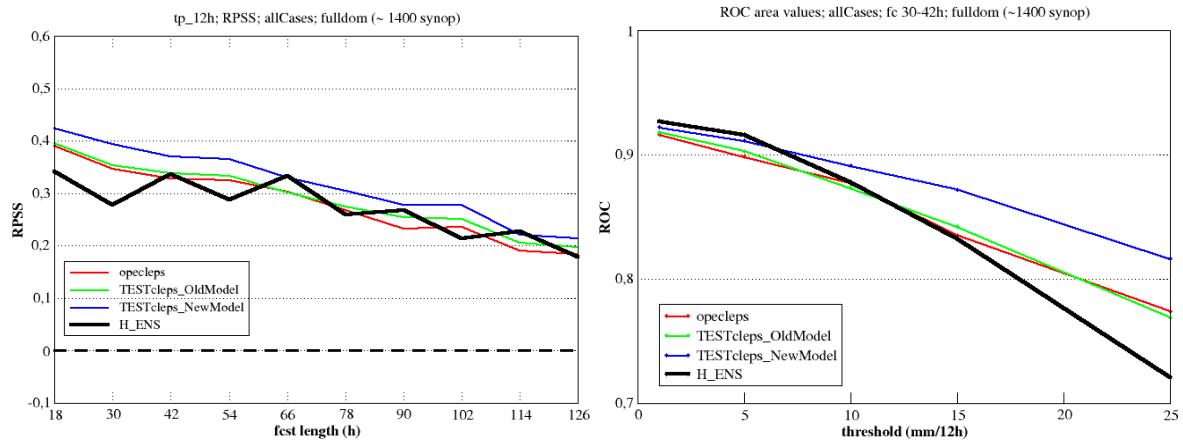

Figure 1: Verification of 12-hour cumulated precipitation: RPSS values as a function of the forecast range (left panel) and ROC area values as a function of the threshold value for the range 30-42h (right panel). Scores are reported for the following systems: opecleps (red), TESTcleps_OldModel (green), TESTcleps_NewModel (blue) and H_ENS (thick–black).

provided at higher resolution in the latter configuration. Therefore, it looks as if the benefits of more detailed boundaries are only partly transferred to the skill of the limited-area integrations. A slight positive impact can be noticed for ranges longer than 78 hours, when TESTcleps_OldModel shows higher scores than opecleps. The best results are obtained by the TESTcleps_NewModel configuration (blue line), where COSMO–LEPS benefits of both higher-resolution boundaries by H_ENS and improved model set-up. The better performance of TESTcleps_NewModel is evident for all ranges and is especially true for short forecast steps. As for the global ensemble H_ENS, it can be noticed that its performance is the worst one in the short range, while the system gets more valuable for longer ranges. The right panel of the Fig. 1 shows the ROC area values for the forecast range 30-42h as a function of precipitation intensity. The above–mentioned results are confirmed: the highest scores are obtained by TESTcleps_NewModel, with similar performances by opecleps and TESTcleps_OldModel. As for H_ENS, the performance of the model is satisfactory for low threshold events, while the system shows a performance decay for high-precipitation cases, suggesting the added value of limited–area ensemble forecasting for cases of heavy rain.
Therefore, the main results of the verification exercise carried out in the framework of LAMEPS experimentation can be summarised as follows:

- the impact of using high-resolution boundaries with respect to the operational configuration is limited;
- a clear improvement in limited-area model integrations is obtaibed if, in addition to high resolution boundaries, a newer model version with updated microphysics is used;
- in either cases, the added value with respect to the global ensemble is noticeable, especially in the short range.

As for the future, it is planned to consolidate the verification results, by considering the performance of all systems for other variables, considering also the spread/skill performance for the different periods.

References

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