Increase of COSMO–LEPS horizontal resolution: impact on the prediction of precipitation events

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Introduction

In the framework of limited–area ensemble forecasting, the COSMO–LEPS system (Montani et al., 2003) was the first mesoscale ensemble application running on a daily basis in Europe since November 2002. A number of system upgrades had a positive impact on COSMO–LEPS forecast skill of precipitation in the short and early medium–range, documented by Montani et al., 2011. As computer power resources increase, it was investigated the extent to which an increase in horizontal resolution of COSMO–LEPS runs could have a benefit on the probabilistic prediction of those surface fields, like precipitation and 2–metre temperature, heavily affected by orography and mesoscale processes. For this reason, a number of system upgrades were tested and their impact was studied, focusing the attention to the performance of COSMO–LEPS for heavy precipitation events. More precisely, the following modifications were introduced:

- increase of the horizontal resolution from 10 to 7 km;
- enlargement of the integration domain so as cover Central and Southern Europe;
- introduction of new "stochastic" perturbations in COSMO–LEPS runs.

From June to November 2009, both the operational system (referred to as "oper") as well as the new one (referred to as "test") were run in parallel and the performance of both systems were analysed considering the probabilistic prediction of 12–hour accumulated precipitation exceeding a number of thresholds for several forecast ranges.

Methodology and results

As for observations, we use the data obtained from the SYNOP reports available on the Global Telecommunication System (GTS). In order to assess the skill of the system over complex topography, verification is first performed over the domain ranging from 43N to 50N and from 2E to 18E, the MAP D-PHASE area (Mesoscale Alpine Programme, Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the alpine region). Within this domain (referred to as "mapdom"), a fixed list of 412 SYNOP stations is considered and the relative reports in terms of total precipitation are used to evaluate the COSMO–LEPS skill. In addition to this, it has been also considered a second (larger) domain, which includes approximately the full COSMO–LEPS domain, ranging from 35N to 58N and from 10W to 30E. Within this further domain (referred to as "fulldom"), a list of 1542 stations is taken and the performance of "oper" and "test" is also assessed. As for the comparison of model forecasts against SYNOP reports, we select the grid point closest to the observation. The performance of COSMO–LEPS is examined for 6 different thresholds: 1, 5, 10, 15, 25 and 50 mm/12h. The verification is performed over a 6–month period, from June to November 2009. Over this period, the following probabilistic (scores Marsigli et al., 2008) are presented: the Ranked Probability Skill Score (RPSS) and the Percentage of Outliers (OUTL).

The skill of the two systems in terms of prediction of 12–hour accumulated precipitation is summarised in Fig. 1, where the RPSS is plotted (left panel) against the forecast range for both "oper" and "test" configurations. It can be noticed that "test" COSMO-LEPS has higher RPSS for all forecast ranges. The difference between the two systems is consistent throughout the full forecast range, up to day 5, with a larger gap in favour of "test" COSMO-LEPS more evident for the first two days of integrations. This holds when verification is performed either in the

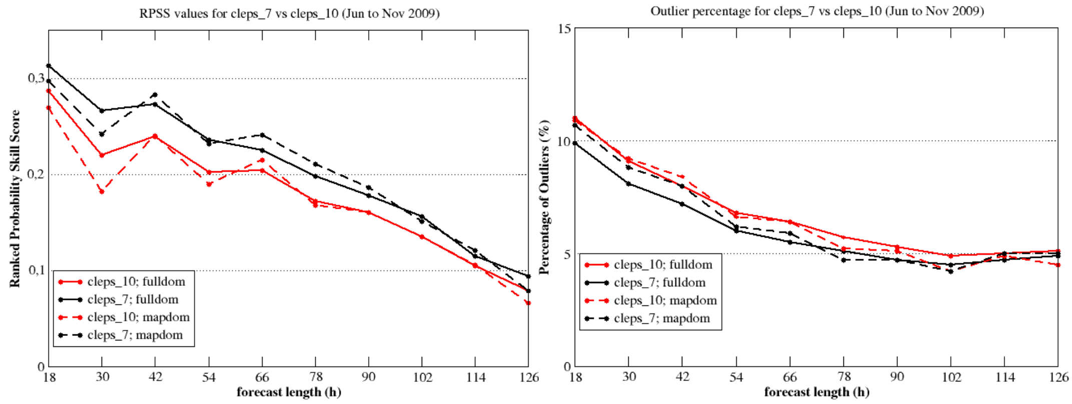

Figure 1: Ranked Probability Skill Score (left panel) and Percentage of Outliers (right panel) for "oper" (red) and "test" (black) COSMO–LEPS. Solid (dashed) lines refer to scores over the "fulldom" ("mapdom"). Scores are calculated over the period June–November 2009.

Alpine area (dashed lines, relative to "mapdom") or over the entire integration domain (solid lines, relative to "fulldom"). Then, the attention is focused on the ability of the "test" system to reduce the number of outliers with respect to "oper", thanks to the higher resolution as well as to the introduction of new perturbations which should ensure a larger spread among "test" forecasts. The right panel of Fig. 1 shows that, in the 7–km system (black lines), the OUTL is reduced for all forecast ranges, except the longest one, with respect to the operational system. The impact is more evident over the "fulldom", where the higher–resolution system outperforms "oper' with a 12–hour gain in predictability. It can also be noticed that, for all configuration and verification networks, there is a sort of "plateau" at about 5% of outliers, which seems, at the moment, a limit for the number of outliers in COSMO–LEPS systems.
The above–mentioned results show the potential of the higher–resolution COSMO–LEPS, which can provide more accurate rainfall forecasts, thanks to a better description of orographic and mesoscale–related processes. In addition to this, the introduction of new model perturbations proved to have a positive effect on the forecast skill of the ensemble system. Following the indications provided by the different probabilistic scores, the 7–km COSMO–LEPS was implemented operationally in December 2009 and has been running on a daily basis since then. As for the future, it is envisaged to continue the systematic verification of the system, to monitor the added value of the higher resolution in the ensemble runs and to study new possible ameliorations.

References

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