Five years of COSMO–LEPS at ARPA–SIM

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Introduction

COSMO–LEPS is the Limited–area Ensemble Prediction System developed and implemented by ARPA–SIM within COSMO (COnsortium for Small–scale MOdelling; the members of the Consortium are Germany, Greece, Italy, Poland, Romania and Switzerland). COSMO-LEPS project aims to generate "short to medium–range" (48–132 hours) probabilistic predictions of severe weather events based on the non–hydrostatic regional COSMO–model, nested on a number of ECMWF EPS members, chosen via a clustering selection technique (Marsigli et al., 2005). The "experimental–operational" COSMO–LEPS suite (following the methodology described by Montani et al., 2003) was set–up in November 2002 so as to produce probabilistic forecasts over a domain covering all countries involved in COSMO. After 5 years of activity, COSMO–LEPS application (now, an "ECMWF member–state time–critical application" managed by ARPA–SIM) is composed of 16 ensemble members, running at the horizontal resolution of 10 km with 40 model levels in the vertical. Perturbations to the initial and boundary conditions are provided by the different EPS members driving the limited–area integrations. In addition to this, the following model perturbations are introduced:
(1) perturbations to the convection scheme: within each COSMO–LEPS integration, a random choice between Tiedtke or Kain–Fritsche convection scheme is made;
(2) perturbations in the maximal turbulent length scale;
(3) perturbations in the length scale of thermal surface patterns.
In this contribution, it is assessed the state–of–the–art of the system, showing its ability to provide warnings of heavy precipitation events.

Results of verification

A big verification effort was undertaken so as to assess objectively how the system changed in its five years of activity and the extent to which modifications have actually improved precipitation forecasts over mountainous areas. In order to carry on this evaluation, a fix set of SYNOP stations (about 470) was selected, over an area covering the Alps (43-50N, 2-18E) and for the period ranging from December 2002 to November 2007. Precipitation accumulated over 12 hours (18-06 and 06-18 UTC) was verified, comparing the values forecast on the grid–point nearest to each station against the observed values at that station. As an example of COSMO–LEPS performance, Fig. 1 shows the time–series of the Brier Skill Score (BSS), for 4 different thresholds (1, 5, 10, 15 mm/12h) at the 78–90h forecast range (to increase readability, the 3–month running mean is actually shown). At the beginning of the verification period, the BSS is always negative, increasing to positive values at least for the lower thresholds starting from summer 2004. The BSS is steadily positive from spring 2005, for all the thresholds except the highest (15mm/12h). A different behaviour is exhibited in autumn 2006, which was a very dry season: COSMO–LEPS performance is not satisfactory. On the other hand, the BSS is almost always above zero throughout 2007 for most thresholds, indicating a skillful system in the prediction of precipitation at the day–4 range. A marked seasonal variability is also evident, the system often performing better in the summer season. In the overall evaluation of the

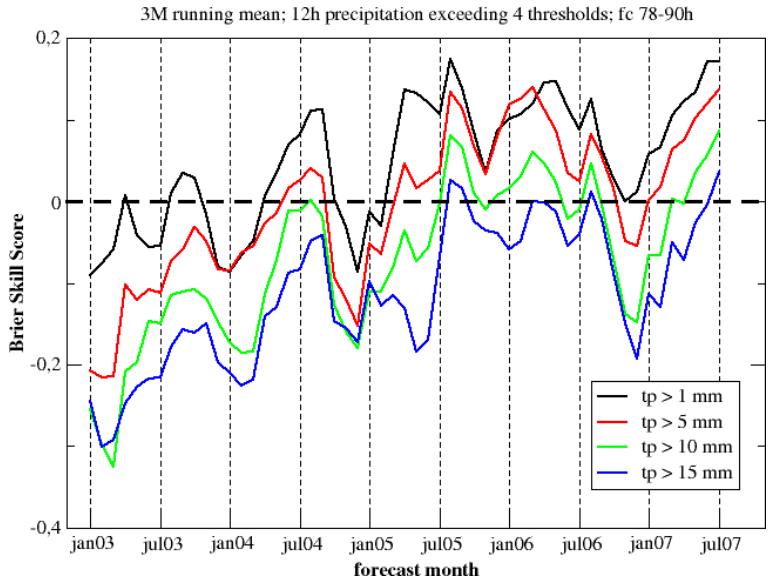

Figure 1: Forecast range 78–90h: Brier Skill Score time–series (from January 2003 to July 2007) for COSMO–LEPS 12-hour precipitation exceeding 1,5,10,15 mm. The BSS is computed for each month. A 3-monthly running mean is applied to improve the readability.

system performance, it has to be kept in mind that, in addition to the upgrades in the COSMO–model itself, COSMO–LEPS configuration was subject to two major changes during the verification period:
(1) June 2004: the ensemble members were increased from 5 to 10 and only two EPS instead of three were considered to select the global–model members to drive the COSMO–LEPS integrations.
(2) February 2006: the ensemble members were increased from 10 to 16 and the vertical resolution of COSMO–LEPS integrations from 32 to 40 levels.
The former change seems to have led to better scores, since an improvement is evident from spring 2004. The impact of the latter change is more difficult to be judged, due to the already underlined problem in autumn 2006. Nevertheless, a positive trend is evident in the scores obtained during 2007, especially in view of the various meteorological experiments which took place during that year (e.g. COPS and MAP D-PHASE). This is even more true if other scores, like the area under the ROC curve and the percentage of outliers, are considered (not shown). Nowadays, COSMO–LEPS products are well–established in met–ops rooms within COSMO community. They have been recently used with success in EC projects (e.g. Windstorms PREVIEW) as well as in the field campaigns of the above–mentioned meteorological experiments. As future developments, it is planned to introduce more model perturbations, so as to improve the spread–skill relationship of the system, and to develop "calibrated" COSMO–LEPS forecasts.

References

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