

Five Years of Limited-Area Ensemble Activities at ARPA-SIM: The COSMO-LEPS system

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1 Introduction

COSMO-LEPS is the Limited-Area Ensemble Prediction System developed and implemented by ARPA-SIM within COSMO (Consortium for Small-scale MOdeling; 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., 2001).

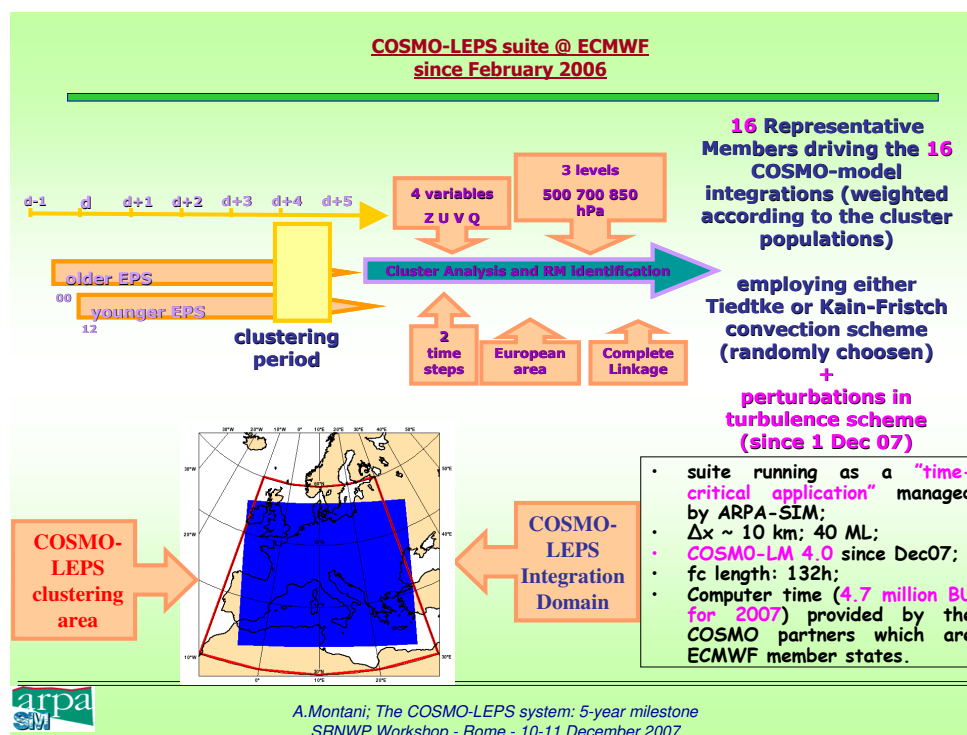


Figure 1: Present set-up of COSMO-LEPS operational suite.

The “experimental-operational” COSMO-LEPS suite (following the methodology described by Montani et al., 2003 and Marsigli et al., 2005) was set up in November 2002 to produce probabilistic forecasts over a domain covering all countries involved in COSMO. After 5 years of activity, COSMO-LEPS application has become an “ECMWF member-state time-critical application” managed by ARPA-SIM and its present configuration is shown in Fig. 1. COSMO-LEPS is made up of 16 members, running at the horizontal resolution of 10 km with 40 model levels in the vertical. The computer-time to run COSMO-LEPS application

on ECMWF supercomputers is provided from allocations to the ECMWF COSMO partners (i.e. Germany, Greece, Italy and Switzerland), whose contributions are joined into a unique “COSMO-account”. 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:

- perturbations to the convection scheme: within each COSMO–LEPS integration, a random choice between Tiedtke or Kain–Fritsch convection scheme is made;
- perturbations in the maximal turbulent length scale;
- perturbations in the length scale of thermal surface patterns.

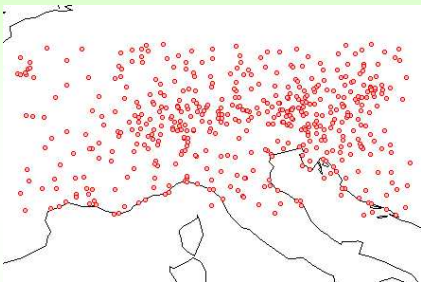
In this contribution, it is assessed the state-of-the-art of the system, showing its ability to provide warnings of severe weather events (e.g. heavy rainfall, strong winds, cold temperature anomalies).

2 Results of verification

As already mentioned, COSMO–LEPS has recently passed the 5-year milestone of activity. Therefore, a big verification effort was undertaken so as to assess objectively how the system changed in these years and the extent to which modifications have actually caused an improvement in terms of precipitation forecasts over mountainous areas.

Objective verification of COSMO-LEPS

- SYNOP on the GTS (COSMO-LEPS only):



Main features:

variable: 12h cumulated precip (18-06, 06-18 UTC);

period: **from Dec 2002 to Nov 2007;**

region: 43-50N, 2-18E (**MAP D-PHASE area**);

method: nearest grid point; no-weighted fcst;

obs: synop reports (about 470 stations/day);


fcst ranges: 6-18h, 18-30h, ..., 102-114h, 114-126h;

thresholds: **1, 5, 10, 15, 25, 50 mm/12h;**

system: COSMO-LEPS;

both (60) monthly and (20) seasonal scores are computed.

work is in progress for verification over the full domain (1500 stations)



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Figure 2: Main features of COSMO–LEPS verification.

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 UTC 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. The other main features of the verification exercise are summarised in Fig. 2. Several probabilistic scores were used and the performance of the system was analysed both in terms of monthly and seasonal scores so as to identify the occurrence of possible seasonal variability.

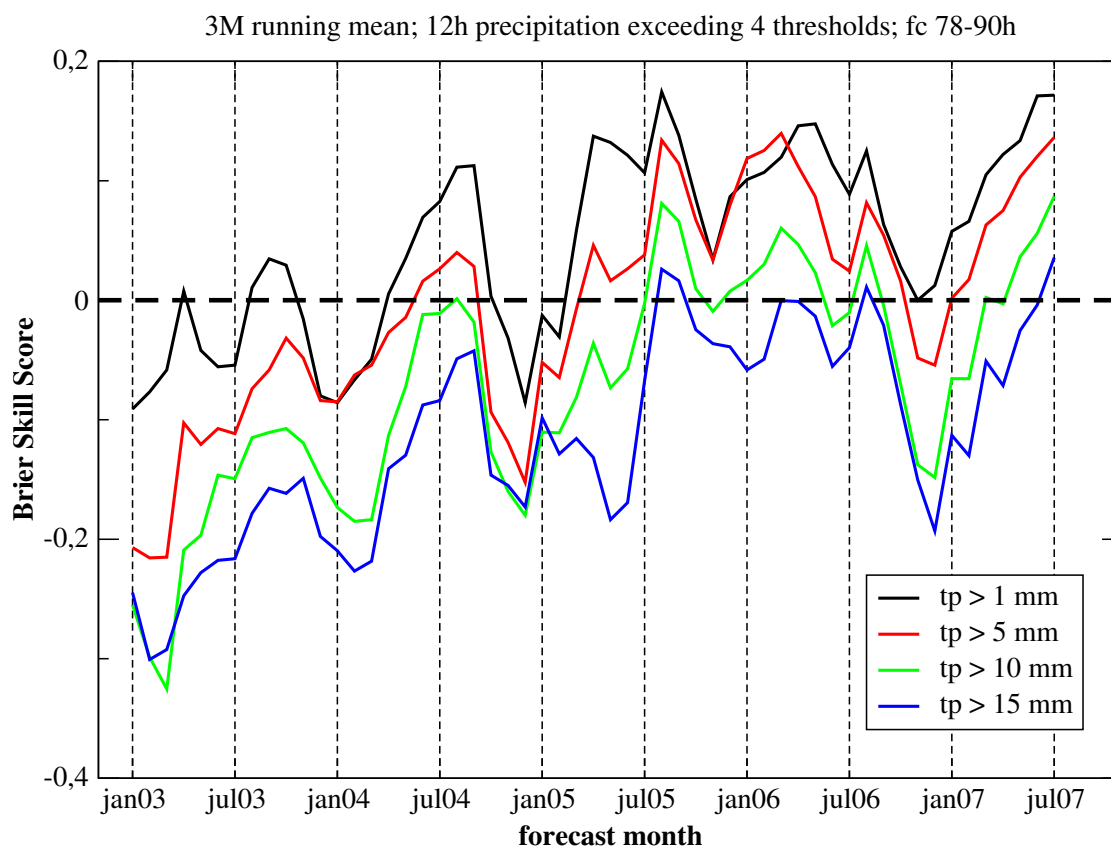


Figure 3: Brier Skill Score of COSMO–LEPS 12-hour precipitation forecasts for the forecast range 78–90h. The BSS was computed for each month, from January 2003 to July 2007. A 3-monthly running mean was applied to the scores to improve the readability.

As an example of the obtained results, Fig. 3 shows the performance of COSMO–LEPS in terms of the Brier Skill Score (BSS), for 4 different thresholds (1, 5, 10, 15 mm/12h) at the 78–90h forecast range. Although the score is computed monthly, the 3-month running mean is actually shown in the plots to increase readability, due a marked month-to-month variability of the score itself. At the beginning of the verification period (early 2003), the BSS was 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, 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 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:

- 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;
- 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).

As a final remark, it has to be pointed out that nowadays COSMO-LEPS forecast products are well-established in met-ops rooms across 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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