Impact of soil-moisture initialisation on the quality of short-range COSMO-LEPS forecasts

Andrea Montani, C. Marsigli and T. Paccagnella

ARPA–SIMC (HydroMeteoClimate Service of Emilia-Romagna), Bologna, Italy
E-mail: amontani@arpa.emr.it

Introduction

In the framework of limited–area ensemble forecasting, the COSMO–LEPS system was the first mesoscale ensemble application running on a daily basis in Europe since November 2002 (Montani et al., 2003). In the following years, several upgrades were made with a positive impact on COSMO–LEPS forecast skill of precipitation in the short and early medium–range (Montani et al., 2011). As a further amelioration of the system, it was decided to test different approaches to initialise the soil fields of COSMO–LEPS ensemble members (mainly temperature and soil water–content). It was studied the impact of the different initialisations on the quality of short-range forecasts provided by the system during winter and spring 2011. In this work, the attention is focused on the forecast skill of 2-metre temperature and 2-metre dew-point temperature (T2M and TD2M, respectively), which are heavily influenced by the soil properties, for ranges up to 48 hours. From December 2010 up to mid-March 2011, the following experimentation was undertaken: in addition to the operational ensemble (referred to as "ope") where the lower boundary conditions are interpolated from ECMWF EPS members, it was run in parallel a further 16–member ensemble (referred to as "test"), where the soil fields were provided by COSMO-EU, the deterministic model integration operationally run at the German Weather Service. The COSMO-EU fields passed to COSMO-LEPS members included temperature, water content and ice content of the soil layers, temperature of snow surface, water content of snow and density of snow. These fields were used as lower boundary conditions for all COSMO-LEPS members before the beginning of the model integrations. Like COSMO–LEPS, COSMO–EU runs at 7km and the grids, as well as the properties of the soil, are the same for both systems. Therefore, it is hoped that the provision of lower-boundary conditions at higher resolution and from the same type of model can enhance the description of soil temperature and humidity in COSMO–LEPS members, this having an overall positive impact on the forecast skill of near–surface fields. In the next section, the performance of "ope" and "test" will be assessed, considering the forecast skill of the ensemble mean from fc+0h to fc+48h every 3h.

Methodology and results

As for observations, we used the data obtained from the SYNOP reports available on the Global Telecommunication System (GTS). In order to assess the skill of the system in a comprehensive way, verification was performed over three different domains:

1. "fulldom": about 1400 stations over the entire COSMO-LEPS integration domain;
2. "mapdom": about 410 stations over the area 43N–50N, 2E–18E;
3. "flatdom": the same as "mapdom", but for stations with altitude below 100 m (on average, about 50 stations).

As for the comparison of model forecasts against SYNOP reports, we selected the grid point closest to the observation and we corrected the T2M forecasts according to the difference between the elevation of the station and the height of the selected grid-point. The verification was performed over a 100–day period, from 1 December 2010 to 15 March 2011 and the following deterministic scores (Wilks, 1995) were computed: the mean-absolute error (MAE) and the bias.

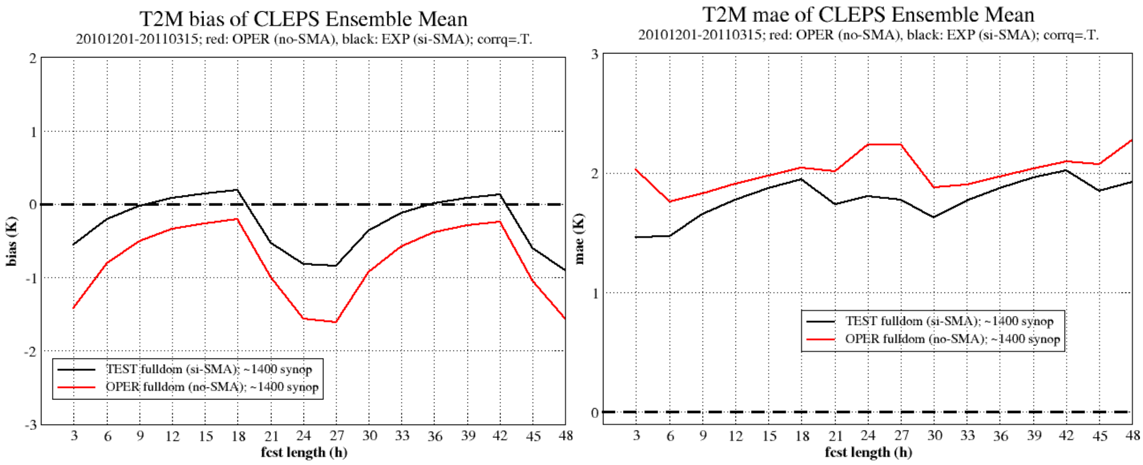

Figure 1: Bias (left panel) and mean–absolute error (right panel) of the 2–metre temperature ensemble mean of "oper" (red) and "test" (black) over the "fulldom" (in Kelvin). Scores are calculated over the period 1 December 2010 - 15 March 2011.

The skill of the two ensembles in terms of T2M over "fulldom" is summarised in Fig. 1, where the bias (left panel) of the ensemble mean is plotted against the forecast range for both "oper" and "test" configurations. It can be noticed that the bias is closer to zero for the "test" ensemble, which takes the soil fields from COSMO-EU. The improvement is systematic for all forecast ranges, contributing to the reduction of the cold bias in COSMO–LEPS integrations. In addition to that, the bias oscillations with forecast range have smaller amplitudes for the "test" ensemble. As for the MAE (right panel of Fig. 1), the better performance of the "test" ensemble is confirmed for all forecast ranges up to 48 hours. The positive impact of using more accurate lower boundary conditions is particularly evident for day–time verification (forecast ranges +24-27h). These results are confirmed when verification is performed over either "mapdom" or "flatdom", where the reduction of the MAE is even more evident for day–time verification. In addition to that, the "test" ensemble outperforms "oper"also in terms of prediction of TD2M over al domains (not shown). Following the indications provided by the above–mentioned scores and thanks to the neutral impact on total precipitation, the new initialisation of soil fields was implemented operationally on 11 April 2011 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 new soil initialisation and to study new possible ameliorations.

References

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