Test of a COSMO-based convection-permitting ensemble in the Hymex framework

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1 Introduction

In view of the development of an ensemble system for the convection-permitting scale over Italy, in the recent years some tests aiming at defining the set-up of physics parameter perturbations for such an ensemble have been carried out at ARPA-SIMC (Marsigli, 2012). Thanks to the results of this study, a simple ensemble set-up has been defined and implemented for the first SOP (Special Observing Period) of the Hymex Project. Hymex (www.hymex-project.org) is a long lasting Project, aimed at the study of the Hydrological cycle over the Mediterranean. The first SOP was in Autumn 2012 and it permitted to collect a dense and rich observation network The ensemble set-up for the Hymex SOP period can be regarded as a "reference" ensemble, against which to compare other, more advanced, configurations. In particular, it is widely recognised that for this spatio-temporal scale a crucial ingredient is a good perturbation strategy for Initial Conditions (ICs). In the COSMO Consortium, great effort has been devoted to the development of a LETKF (Localised Ensemble Transform Kalman Filter) scheme for providing COSMO model analyses at the km-scale (KENDA, http://www.cosmo-model.org/content/tasks/priorityProjects/kenda/default.htm). Perturbed ICs derived from KENDA for the convection-permitting ensemble will be tested on the same period, in order to perform a clean comparison.

In this short paper, the behaviour of this reference ensemble is shown, to provide a reference against which to evaluate successive ensemble developments.

2 Ensemble set-up

COSMO-H2-EPS (which stands for COSMO Hymex 2.8km Ensemble Prediction System) consists of 10 runs of the COSMO model, with a horizontal resolution of 2.8km and 50 vertical level. It has been implemented over a north-western Mediterranean domain (figure 1), which covers north and entral Italy, including the whole Alpine chain, southern France, Switzerland and most of the Tyrrenean Sea. In the figure, the orography of the region as seen by the 2.8km model is shown.

Initial and boundary conditions are provided to the COSMO-H2-EPS members by the first 10 members of the COSMO-LEPS ensemble, which is running operationally with 7km horizontal resolution, nested on 16 ECMWF EPS members (see Montani et al., 2011, for further details). Therefore, no IC perturbations are applied at the small scale, both IC and BC being provided by COSMO-LEPS runs.

The COSMO-H2-EPS runs are differentiated also in the model physics set-up, since simple parameter perturbations are applied, following the previous experience of the SREPS and CONSENS Priority Projects. Perturbations are partly derived from those currently applied in the COSMO-DE-EPS ensemble (Gebhardt et al., 2011). The set-up of the suite, included perturbed values of the physics parameters, in decribed in Table 1.

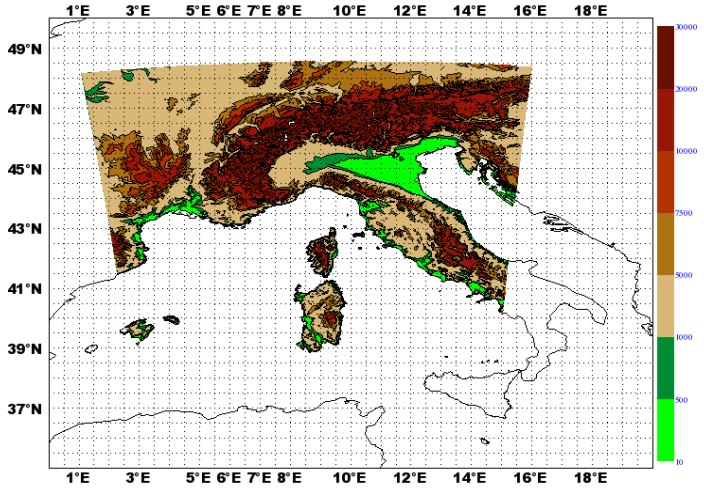

Figure 1: Orography of the COSMO-H2-EPS ensemble, showing also the model domain.

COSMO-H2-EPS was run for the whole SOP period (from 5th of September to 6th of Novembre 2012) and few products were sent to the Hymex SOP web site, where they were made available to the Hymex forecasters for the planning of the operations.

3 Results

The performance of the COSMO-H2-EPS ensemble for one event of the SOP (IOP16) is here briefly presented, in comparison with that of the driving ensemble COSMO-LEPS. In figure 2 the precipitation observed on the 26th of October 2012 is shown.

Stamp maps of the precipitation forecasted for the same period by the COSMO-LEPS ensemble starting at 12 UTC of the 25th of October are shown in figure 3. The forecast range is between 12 and 36 hours. The prediction can be regarded as good from a regional perspective, with some members forecasting high precipitation over the coasts of the Liguria region. Nevertheless, intense precipitation tends to be forecasted mainly over the central part of the region and on the Genova area, while the most intense precipitation was observed on the eastern part of the region and at the boundary with Tuscany (just above 44 N and around

Table 1: Set-up of the COSMO-H2-EPS system.

member	tur_len	rlam_heat	cloud_num	entr_sc	pat_len	crsmin
1	150	0.1	5.00e+08	0.0003	500	150
2	150	1	5.00e+07	0.0003	500	150
3	150	1	5.00e+08	0.0003	500	200
4	150	1	5.00e+08	0.002	500	150
5	500	1	5.00e+08	0.0003	500	150
6	150	1	5.00e+08	0.0003	500	150
7	150	1	5.00e+08	0.0003	1000	150
8	150	1	5.00e+07	0.002	500	150
9	500	0.1	5.00e+08	0.0003	500	150
10	150	1	5.00e+07	0.0003	500	150

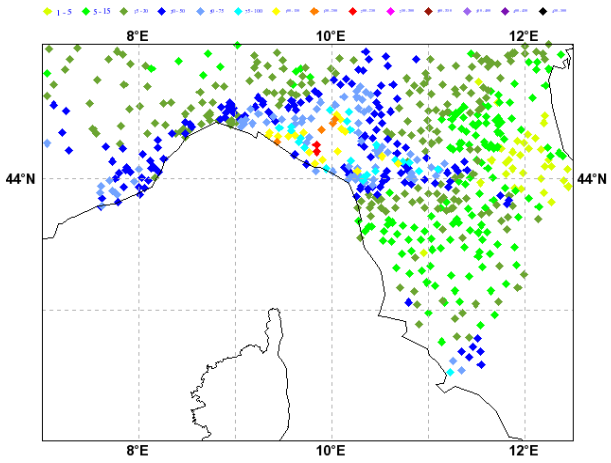

Figure 2: Observed precipitation accumulated over 24h, for the 26th October 2012.

10 E).

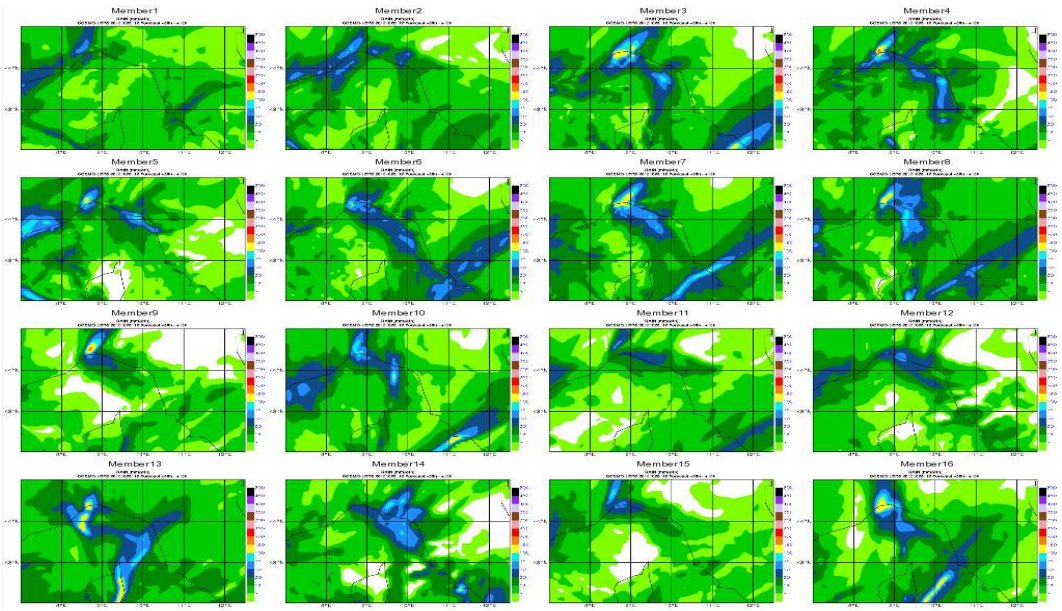

Figure 3: Precipitation forecasted by the COSMO-LEPS members starting at 12 UTC of the 25th of October, 12-36h forecast range.

Stamp maps relative to COSMO-H2-EPS for the same period are shown in figure 4, with the same 12-36h forecast range. The differences between each run and its father run are quite large for this case, with a general tendency of the higher-resolution run to forecast higher precipitation values and to modify the shape and location of the heavy precipitation pattern. Some members are now better able to indicate the eastern coast of Liguria as the area interested by heavy precipitation, extending the rainfall pattern towards northern Tuscany. This signal puts in evidence the importance of the high-resolution and of a better description of the orography of the area. Nevertheless, it is clear that the localisation of the phenomenon is an issue for the model, since precipitation over Northen Tuscany is still underestimated.

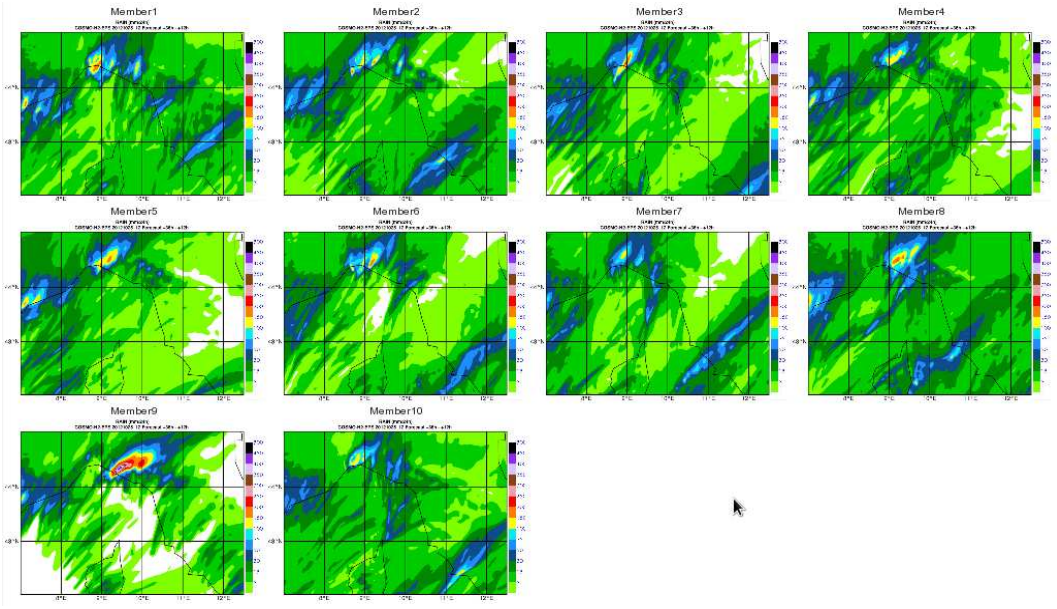

Figure 4: Precipitation forecasted by the COSMO-H2-EPS members starting at 12 UTC of the 25th of October, 12-36h forecast range.

In figure 5, the probability of precipitation exceeding 50 (left panel) and 100 (right panel) mm/24h as forecasted by the two ensemble is also shown.

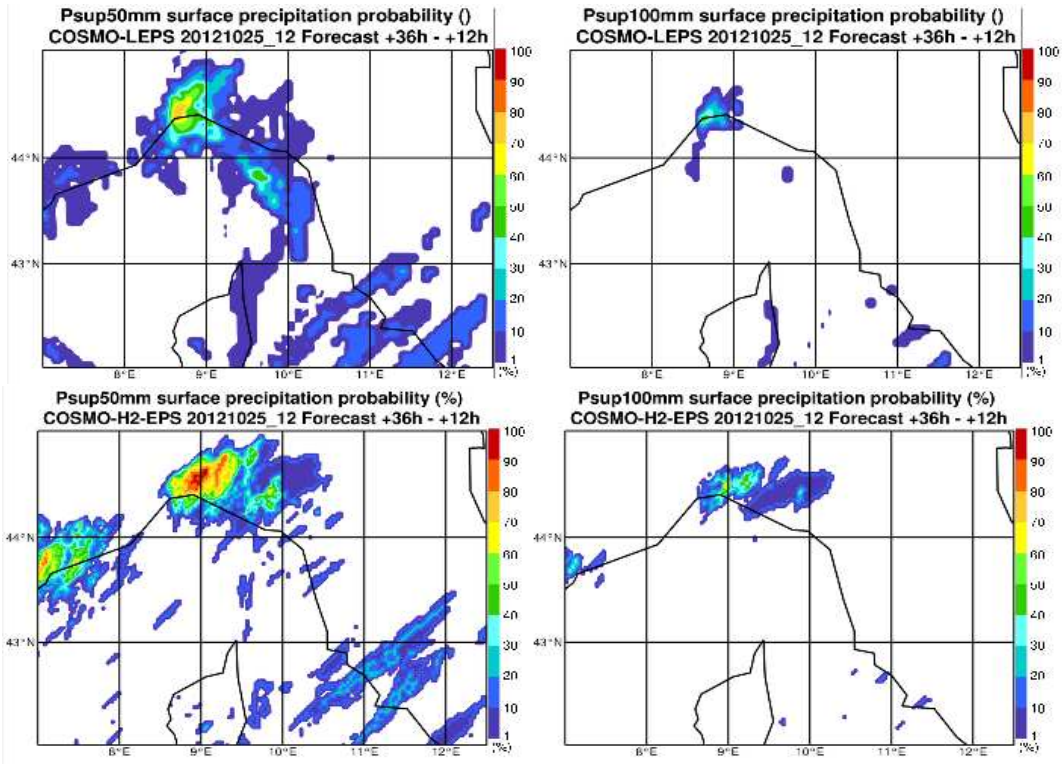

Figure 5: Probability maps for precipitation exceeding 50 (left) and 100 (right) mm/24h, for COSMO-LEPS (top panels) and COSMO-H2-EPS (bottom panels).

These maps provides a sort of summary of the signals which have been highlighted from

an inspection of the stamp maps: the area which is more likely to be interested by heavy precipitation according to COSMO-H2-EPS is different from the one indicated by COSMO-LEPS. In particular, the occurrence of precipitation exceeding 100mm/24h, an event which was observed between 44 and 44.5 N and 9.5 and 10.5 E, is indicated as probable mainly over Genova and its surrounding by COSMO-LEPS, where it was not actually observed. Instead, only COSMO-H2-EPS indicate the event as likely also over the eastern part of the Liguria region, though the localisation is not perfect.

It is not possible to address, on the basis of few events only, the extent to which the different model perturbations influence the response of the COSMO runs. Therefore, it is not possible here to discuss why member 9 of this ensemble is so greatly overforecasting precipitation. Nevertheless, a statistical analysis over the whole period will likely permit to check if there are perturbations unsuitable for being included in the ensemble configuration .

4 Summary and Outlook

In the framework of the Hymex Project, a simple convection-permitting ensemble based on the COSMO model has been implemented and run for the first SOP of the Project. This basic set-up will serve as a reference run, against which to test all the further improvement to the ensemble methodology that are being made available in the COSMO Consortium.

First results show that the high-resolution ensemble can bring benefit in terms of PQPF with respect to the driving 7km ensemble.

In the next future, a new version of the ensemble will be run over the same period, with ICs derived from the KENDA system, exploiting the opportunity offered by this project framework, since the observation network made available for the SOP could be used for the ensemble data assimilation.

Further work will be devoted to the determination of how to best get BC perturbations. The reference ensemble, where BCs are derived from COSMO-LEPS, will be compared with a direct downscaling of the ECMWF EPS. The impact of model perturbations will be also addressed, by considering new parameters to be perturbed and by testing the stochastic tendencies methodology which is being recently implemented in the COSMO model.

This extensive testing will hopefully permit to define: the set-up of KENDA for providing IC perturbations to a 2.8km ensemble over Italy, a set of model perturbations for this resolution and a strategy for the BC perturbation. These ingredients will be then combined for testing the complete ensemble set-up.

References

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[2] Marsigli, C., 2012. Testing the impact of model perturbations applied to the COSMO model at a convection-permitting scale over Italy. ECMWF Special Project report 2012. accessible at: http://www.ecmwf.int/about/special_projects/index.html#2012.

[3] Montani, A., D. Cesari, C. Marsigli and T. Paccagnella, 2011: Seven years of activity in the field of mesoscale ensemble forecasting by the COSMO-LEPS system: main achievements and open challenges. *Tellus*, **63A**, 605-624.