Testing a multi-model approach for providing boundary conditions to a regional ensemble.

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Aiming at the development of an ensemble forecasting system for the short-range, the COSMO Consortium has chosen to explore the validity of a multi-analysis multi-model (MAMM) approach for providing initial and boundary condition perturbation to an ensemble based on the COSMO Limited-area model.

This approach has been implemented in the experimental COSMO-SREPS ensemble (COSMO Short-Range Ensemble Prediction System, Marsigli et al., 2009), which receives initial and boundary conditions by few state-of-the art operational deterministic runs (the IFS model of ECMWF, the GME model of DWD, the GFS model of NCEP). The performance of COSMO-SREPS is compared against COSMO-LEPS (Montani et al., 2011), the operational regional ensemble of the COSMO Consortium, which receives initial and boundary condition perturbations from some members of the global ensemble of ECMWF. Both systems are made up by 16 integrations of the COSMO model with 7 km horizontal mesh-size and they both benefit also of perturbations of the COSMO model physics parameters. Two different combinations of COSMO-LEPS and COSMO-SREPS have also been evaluated: a 20-member ensemble made up of the 16 COSMO-LEPS runs plus 4 COSMO-SREPS runs (mix20) and a 16-member ensemble made up by the first 12 COSMO-LEPS runs plus 4 COSMO-SREPS runs (mix16). The 4 COSMO-SREPS runs selected are nested on the 3 different global models, plus a control member.

Verification is performed in terms of Probabilistic Quantitative Precipitation Forecast (PQPF), using a dense raingauge network covering northern Italy. The verification period is winter 2010/2011.

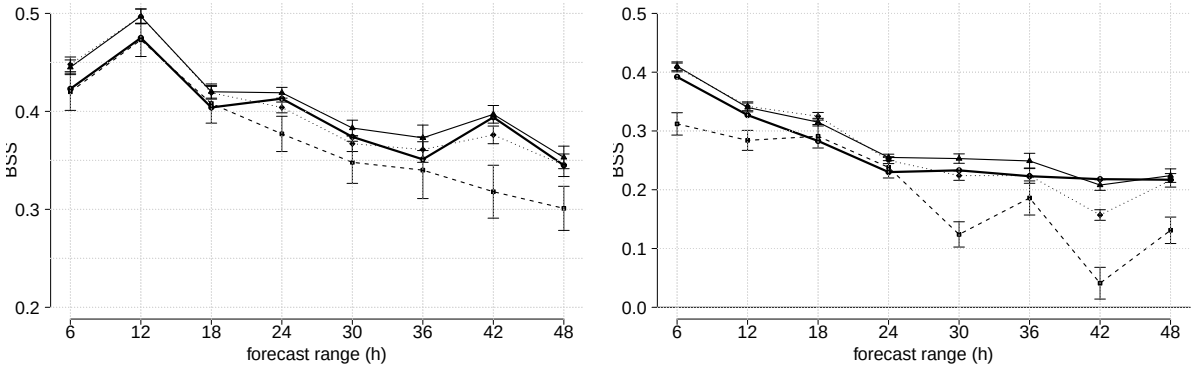

Figure 1: Brier Skill Score as a function of the forecast range for the event "mean of the precipitation exceeding 1mm/6h" (left) and "5mm/6h" (right). The solid thick line is for COSMO-LEPS, the dashed line is for COSMO-SREPS, the dotted line for mix16 and the solid thin line for mix20.

In Figure 1, the Brier Skill Score is plotted as a function of the forecast range. The average of the precipitation values on the grid points falling in each box of 0.5 x 0.5 degrees covering the verification area is compared against the average of the observed values falling in the same box, for all the boxes and for the whole period.

COSMO-LEPS performs better than COSMO-SREPS for almost all the forecast ranges, the difference between the two ensembles being more pronounced for the 5mm/6h threshold. The error bars are

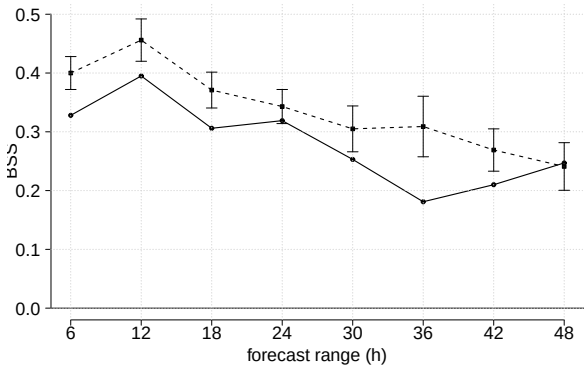

Figure 2: Brier Skill Score a function of the forecast range for the event "mean of the precipitation exceeding 1mm/6h" for the 3-member COSMO-LEPS (solid line) and COSMO-SREPS (dashed line).

obtained with an hypothesis testing, at 95% of confidence, that the score differs from the COSMO-LEPS one. Mix16 performs better than COSMO-LEPS for the first 18-24 h, while mix20 performs better than COSMO-LEPS for almost the whole forecast range, especially for the higher precipitation threshold. Therefore, keeping the ensemble size fix, to drive some COSMO members with the MAMM system, instead of with few more members of the EPS, brings some benefit, but only in the first 24 h. A longer-lasting skill increase could be obtained by adding the 4 MAMM-driven members to the already existing COSMO-LEPS.

The unsatisfactory performance of the MAMM approach for boundaries is probably due to the few models available for providing perturbations to COSMO-SREPS, with respect to the somehow large (16 members) ensemble size. Then, the relation between the number of different initial and oundary conditions perturbations and the ensemble size is addressed, by computing the scores relative to the 3-member versions of the two ensembles (Figure 2). The 3-member COSMO-LEPS is made up by the first 3 members, while the 3-member COSMO-SREPS is made up by members driven by the 3 different global runs. The 3-member COSMO-SREPS perfoms better than the 3-member COSMO-LEPS, within the 95% confidence level. This result stresses the importance of the availability of as many as possible global model runs to provide boundary conditions to a LAM ensemble. On the other hand, it indicates that, when only a small size LAM ensemble is feasible, the multi-model approach for boundaries gives better results.

On the basis of these results, an hybrid approach will be tested, where the 16 COSMO-LEPS runs are merged with some COSMO-SREPS. The performance of the hybrid system and its affordability will be subject to further studies.

REFERENCES

Marsigli, C., 2009: COSMO-SREPS Priority Project "Short Range Ensemble Prediction System (SREPS): final report. COSMO Technical Report No. 13, available at http://www.cosmo-model.org/public/techReports.htm

Montani, A., Cesari, D., Marsigli, C. and Paccagnella, T., 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.