Comparison of COSMO models and Multimodel SuperEnsemble outputs in Piemonte

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1 Introduction

In the framework of the COSMO consortium we have already developed the Multimodel SuperEnsemble technique (Krishnamurti et al., 2000). We applied it to temperature, relative humidity, wind speed and precipitation during the XX Olympic Winter Games of Torino 2006 over the Olympic area (Cane and Milelli, 2005). Moreover we use it operationally over Piemonte, in comparison with other post-processing results (Milelli and Cane, 2006, Cane and Milelli, 2006). The technique consists in weighting the forecasts from several models with a set of weights calculated in the so-called training period by comparison with the observed data. For a complete description of our implementation of Multimodel SuperEnsemble please refer to the publications listed above. In this paper we will show the scores of this technique over a long period and over a wide sample of weather stations covering Piemonte region, together with a comparison of the results of the COSMO models covering the area. In order to better compare the post-processing outputs with the direct model outputs, the results of the models are unbiased with respect to their mean BIAS in the verification period. The Multimodel SuperEnsemble here shown is the operational version calculated with the ECMWF IFS model and the COSMO-I7 model, combining the 00 UTC and 12 UTC runs. The training period of 145 days is obtained with a moving window before the day of the forecast, then the model weights are not fixed in time but vary from day to day, as described in Cane and Milelli, 2006. The statistics here shown are relative to a whole year, from September 2007 to August 2008.

2 Temperature results

The observed data come from the very dense non-GTS weather station network managed by Arpa Piemonte. The stations are grouped by height: 127 low-lying stations (h $<$ 700 m), 77 middle-mountain stations (700 m $<$ h $<$ 1500 m) and 72 high-mountain stations (h $>$ 1500 m). These three groups reflect a standard height division and allow us to distinguish between plains, valleys and higher mountain areas of Piemonte. We evaluated the forecast improvement by comparison with observed values in the given period. The models are interpolated to the station point with horizontal bi-linear interpolation and a vertical correction with station height is applied. Here are shown the results of 6h values of temperature up to +72h forecast, because 6h is the common interval of data availability for the different models. Only the 00 UTC results are shown, but the 12 UTC runs scores do not differ very much. For each height we draw the mean error and the root mean square error. Fig. 1 shows the results for the diurnal cycle of temperature: the COSMO models usually underestimate the 12 UTC forecasts, while they overestimate the 00 UTC temperatures. The biases increase with the height. COSMO-I7 is slightly better in the evaluation of the plains temperatures in comparison to the other models, while it worsens in the higher levels, where a slight predominance of COSMO-7 can be observed, in particular at noon. Multimodel SuperEnsemble is

working very well in the bias (close to 0 °C) and RMSE (near 2 °C), always obtaining better results than the models; the SuperEnsemble errors are also stable with the forecast time.

Fig. 2 shows the results for the extreme temperatures: as expected, the COSMO models underestimate maxima and overestimate minima. Again, the COSMO-I7 model is better in the lower-level stations, while in this case there is no difference in the behavior of the models at higher elevations. The Multimodel SuperEnsemble behaves very well again, with a reduction of the bias practically to zero and RMSE in the range of 10-15 %.

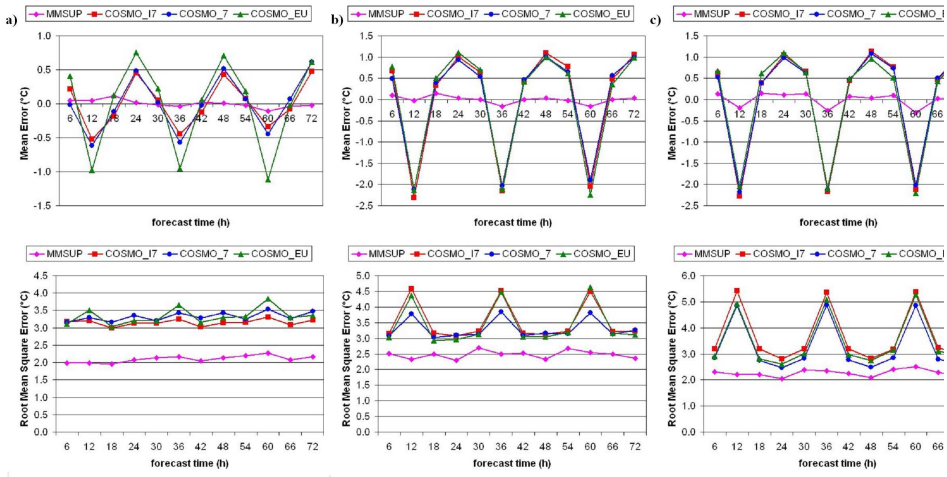

Figure 1: Temperature forecast errors compared to observations by Multimodel SuperEnsemble (purple), COSMO-I7 (red), COSMO-7 (blue) and COSMO-EU (green) in the period September 2007-August 2008. a) stations below 700 m; b) stations between 700 m and 1500 m; c) stations above 1500 m.

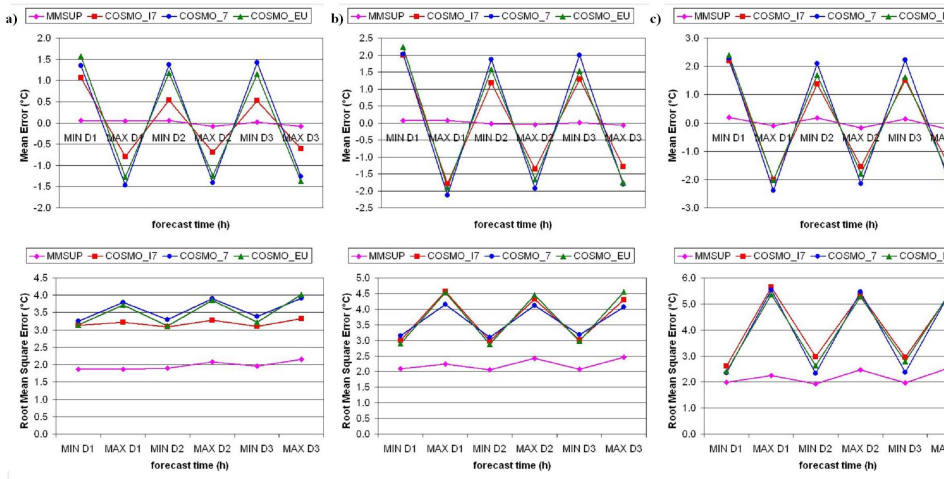

Figure 2: Extreme temperature forecast errors compared to observations by Multimodel SuperEnsemble (purple), COSMO-I7 (red), COSMO-7 (blue) and COSMO-EU (green) in the period September 2007-August 2008. a) stations below 700 m; b) stations between 700 m and 1500 m; c) stations above 1500 m.

3 Humidity results

For the relative humidity the models are again interpolated to the station point with horizontal bi-linear interpolation and vertical correction with station height is applied. Fig. 3 shows the results for humidity: the COSMO models usually overestimate RH at 12 UTC forecasts and underestimate at 00 UTC forecasts. In this case the error decreases with the height, as expected due to difficulty of forecasting the humidity at lower locations. The three models behave quite similarly, apart from the stations over the plains, where COSMO-I7 has slightly better results, while COSMO-7 is clearly worse than the others. The Multimodel SuperEnsemble is working again very well in the bias and RMSE reduction, always obtaining better results than the models; the SuperEnsemble errors are also stable with the forecast time. It is quite noticeable the behavior of this post-processing technique applied to a parameter like the relative humidity, which is quite difficult to manage with other post-processing techniques (like Kalman filter, see Kalman, 1960) because gaussian distribution of the forecast errors is required. This hypothesis is not required by the Multimodel SuperEnsemble technique.

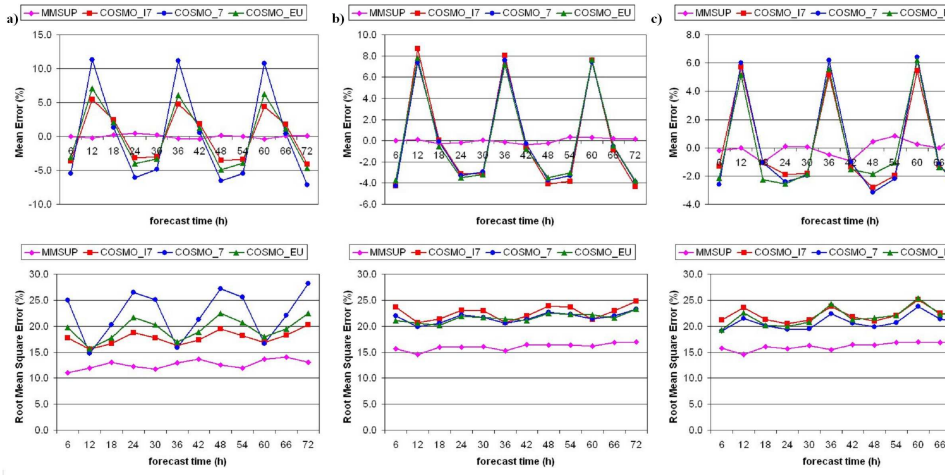

Figure 3: Relative humidity forecast errors compared to observations by Multimodel SuperEnsemble (purple), COSMO-I7 (red), COSMO-7 (blue) and COSMO-EU (green) in the period September 2007-August 2008. a) stations below 700 m; b) stations between 700 m and 1500 m; c) stations above 1500 m.

4 Wind speed results

Wind speed is calculated from the model by extracting the nearest grid point to the station, both in the horizontal and in the vertical. Due to data availability, only the COSMO-I7 and COSMO-EU results are shown here. Fig. 4 shows the results for the wind speed: the COSMO models underestimate the wind intensity at 12 UTC forecasts, while they usually overestimate at 6 UTC forecasts. The COSMO-I7 model performs better for the lower level stations, while the COSMO-EU is better at higher elevations. The post-processed data by Multimodel SuperEnsemble are again performing well, with RMSE in the range of 1-1.5 m/s.

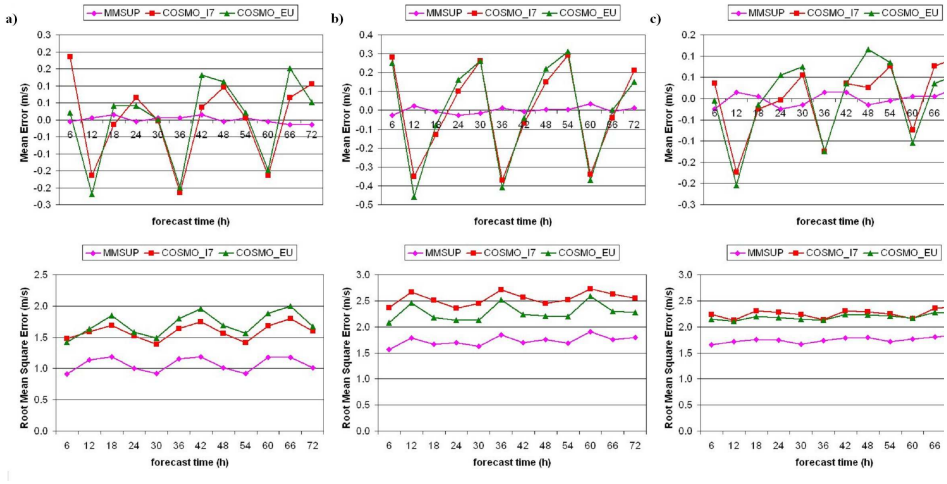

Figure 4: Wind speed forecast errors by compared to observations Multimodel SuperEnsemble (purple), COSMO-I7 (red), COSMO-7 (blue) and COSMO-EU (green) in the period September 2007-August 2008. a) stations below 700 m; b) stations between 700 m and 1500 m; c) stations above 1500 m.

4 Conclusion

A large number of stations are used for the validation of the COSMO models and the Multimodel SuperEnsemble outputs in the Piemonte area over a whole year. There is a slight prevalence of COSMO-I7 in the parameters over the plains, while COSMO-7 and COSMO-EU show better results at higher elevations. The Multimodel SuperEnsemble technique is very effective in reducing the forecast errors at every height and forecast time.

References

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