Results on Precipitation Verification over Italy

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1 Introduction

In this report we sum up the most significant results on QPF verification of the three COSMO model versions (German, Swiss and Italian, hereafter called LME, aLMo and LAMI respectively for sake of comprehension) over Italy. The considered observation dataset is composed by a collection of high resolution rain gauges network coming from the Civil Protection Department (about 1300 stations have been taken into account due to their high performance in term of data quality, see Fig. 1). It has to be noted that about 400 of these stations are already shared in the COSMO common database. The considered verification period depends on the archived models availability: in fact we have got a common and complete dataset for the three versions only from January 2006. So, we carry out the skills and scores comparison among them for the first half of 2006 (200601 - 200606) considering 24h cumulated precipitation (forecasted and observed) averaged over the meteo-hydrological Italian basins.

Figure 1: Italian observation network (1300 rain gauges distributed over the most part of the territory).

2 Scatter plot of QPF

We performed a direct comparison between observed and forecasted 24h cumulated precipitation (D+1) averaged over Italian basins for the first 6 months of the year 2006 considering 00UTC runs of the three model versions (Fig. 2).

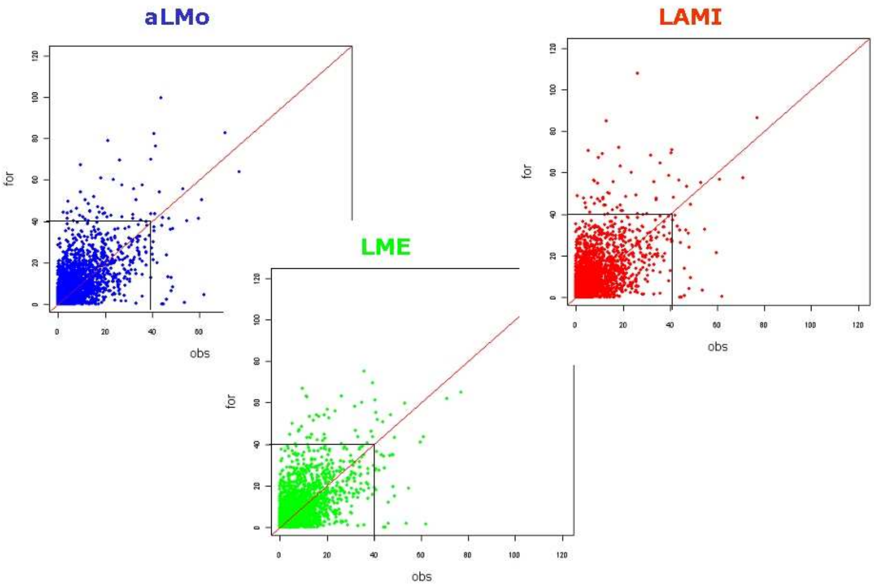

Figure 2: Scatter plot of QPF averaged over Italian basins D+1: 200601 - 200606.

There is a general overestimation in all the versions, especially for LAMI. Then, fixed a threshold at 40 mm (for both observations and forecasts), we can see that: most of the points above the threshold are situated in the upper left part of the box that means the model has more false alarms than misses. LME seems to have a better agreement between observed and forecasted data with a dispersion less pronounced than the other ones.

3 Statistical indices

We calculate the statistical indices (BIAS and ETS), considering the period from 200601 to 200606, over each Italian meteo-hydrological basins to evaluate the different behaviour of the three model versions (00UTC runs) with respect to the territory and orography (Fig. 3).

In order to reach a good statistics we fixed a low threshold of 2 mm in 24h. Remarkable comments:

- The BIAS has a similar pattern for the three versions (with a general more noticeable overestimation for LAMI). There is an overestimation over the alpine chain with a peak on the Ticino area (probably due to a strong impact of the orography) and over central Italy; slight underestimation over south Italy. On the other hand, we obtain a different performance over the Po valley, with good results on average for aLMo and LME but a higher BIAS for LAMI over the eastern part.
- The ETS has a good performance for aLMo and LME; in general the lowest scores are over the alpine chain and Liguria (the lowest ETS values in the Abruzzo region maybe are due to observed data problems).

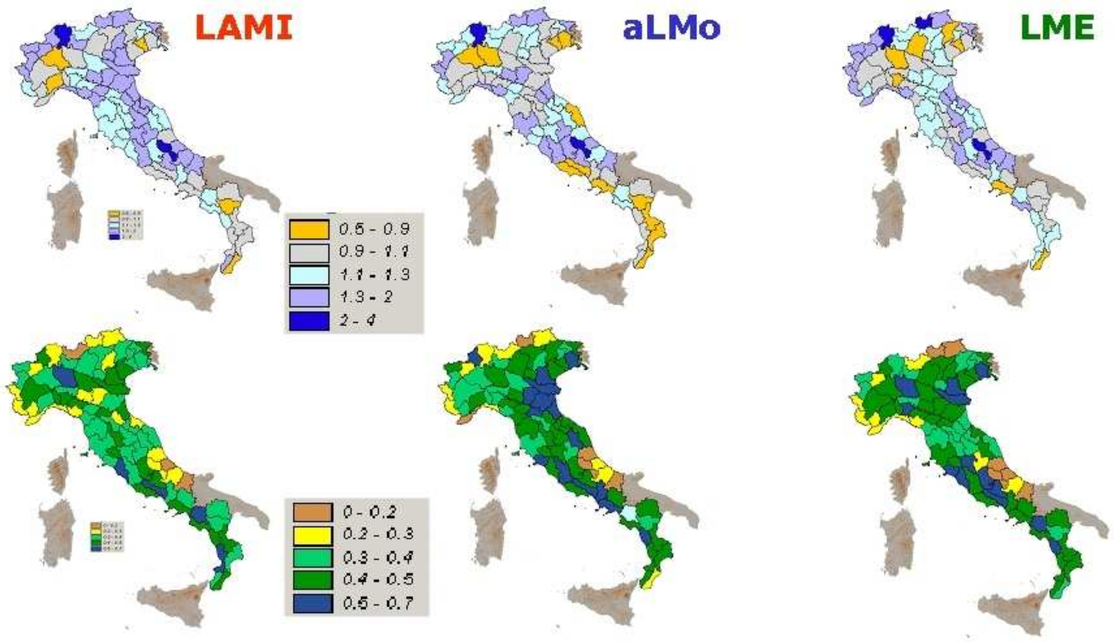

Figure 3: BIAS and ETS over each meteo-hydrological basins for 2 mm/24h: 200601 - 200606.

On the other hand, to evaluate a statistically significant difference among the versions we plot again (over the same period 200601 - 200606) the scores with a sample made by all the 24h cumulated precipitation average over the basins (Figs. 4, 5, 6).

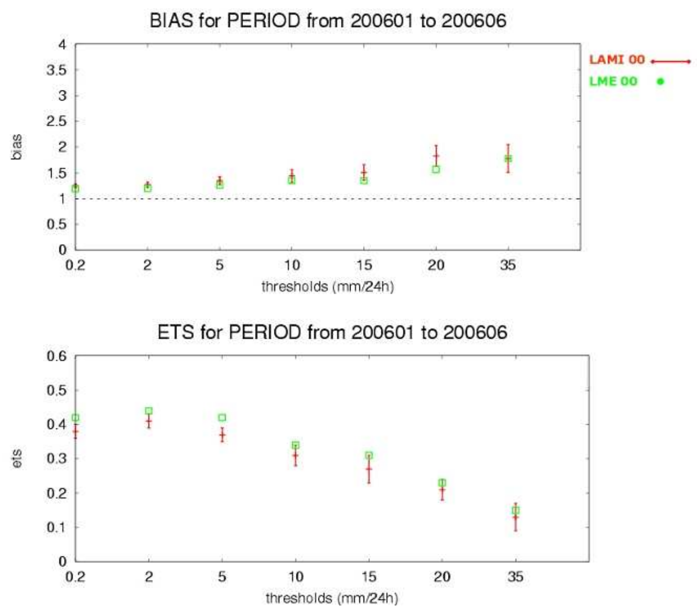

Figure 4: Scores at D+1: cumulated average precipitation over Italian basins (200601 - 200606) for LME and LAMI.

In this case, the Hamill Hypothesis test (bootstrap resampling technique, see Hamill, 1999) is used to calculate a confidence interval to evaluate if the model performance differences are statistically significant. The error bars indicate 2.5th and 97.5th percentiles of resampled distribution, applied to the "reference" model (see Turco et al., 2005). In Fig. 4 is plotted

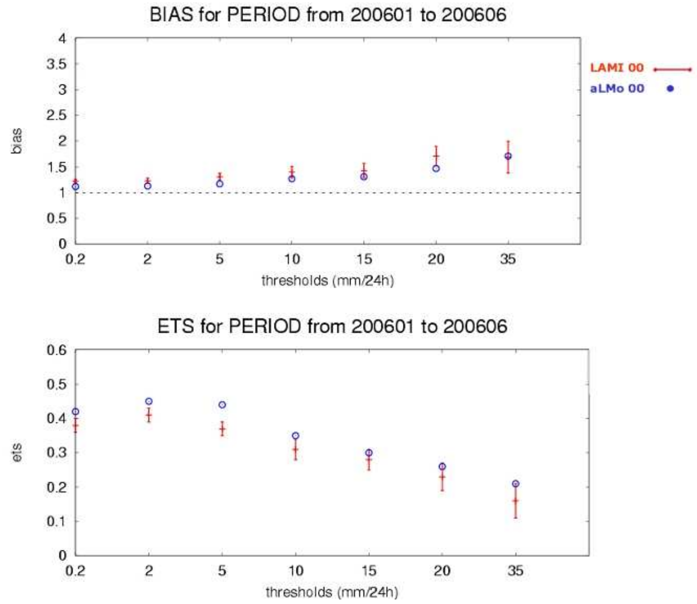

Figure 5: Scores at D+1: cumulated average precipitation over Italian basins (200601 - 200606) for aLMo and LAMI.

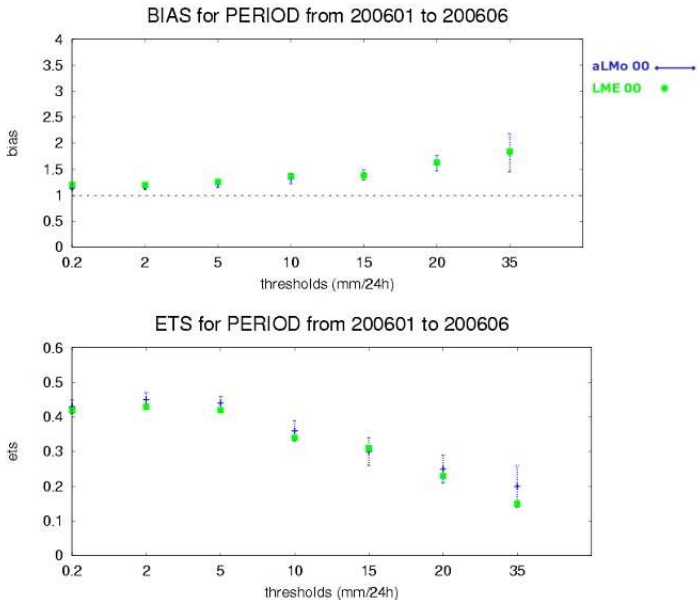

Figure 6: Scores at D+1: cumulated average precipitation over Italian basins (200601 - 200606) for aLMo and LME.

the comparison between LAMI and LME: we obtain quite similar values with respect to the BIAS (except for 20 mm) for all the thresholds, but there is a little statistically significant improvement for LME in terms of overestimation, on the other hand we obtain a significant better ETS for LME for thresholds below 20 mm. In Fig. 5 is plotted the comparison between LAMI and aLMo: we obtain a statistically significant improvement in the BIAS of aLMo with respect to LAMI for almost all the thresholds (except 15 mm and 35 mm) and better ETS below 15 mm. In Fig. 6 is plotted the comparison between aLMo and LME: except for very low thresholds, where aLMo BIAS is better then LME BIAS, both versions are comparable.

In the following figures we plotted BIAS and ETS for the three versions considering 6h average cumulated QPF over Italian basins for a fixed thresholds (10 mm) to evaluate the models behavior versus the forecast time. In this case we could not apply the bootstrap technique due to the data time correlation (Fig. 7).

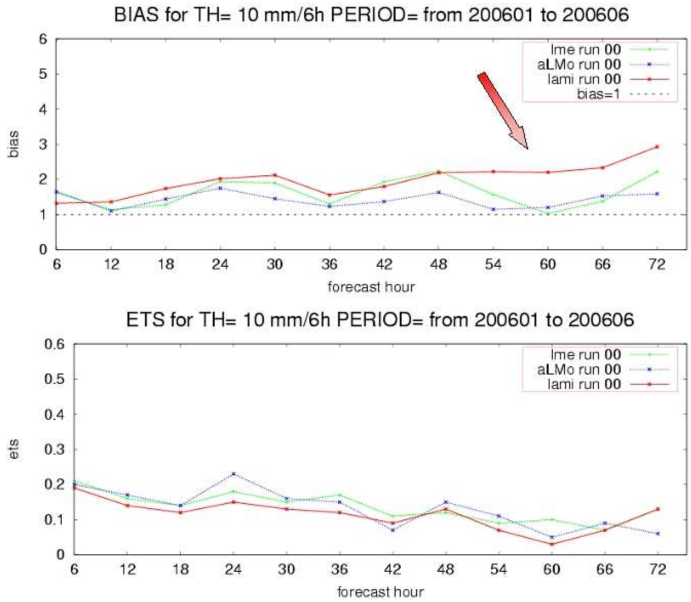

Figure 7: Daily trend over Italian basins.

Anyway, some important observations can be summarized:

- LAMI has the worst skill with a sharp worsening after D+2.
- Similar results for aLMo and LME, with a slightly better skills for aLMo.
- There is an evident diurnal cycle for the BIAS index: lower values at midday and greater at night.

4 Focus on LAMI

In this part we consider a longer data period to study the long term LAMI performances and features. So, in Fig. 8 we show the seasonal trend for BIAS and ETS starting from winter 2003 to spring 2006, both for the first (red line in the plot) and the second day (green line in the plot), having chosen a fixed thresholds of 20 mm: a worsening with respect to the forecast day is evident. There is no significant trend in time but there is a seasonal trend, in which the higher overestimation occurs during the summer and the better performance is obtained in autumn.

It is interesting to study the spatial error distribution for LAMI, on average over a long period. So, starting from winter 2003 to spring 2006 we calculated and plotted BIAS, ETS, POD and FAR over each of the Italian meteo-hydrological basins with respect to a fixed thresholds of 10 mm (the minimum to have a sufficient statistics). In Fig. 9 we show the BIAS for D+1 and D+2: there is an overestimation over most of the basins, especially over the mountains and Central Italy, with a noticeable deterioration for D+2 (the higher BIAS values in the Abruzzo region maybe are due to observed data problems).

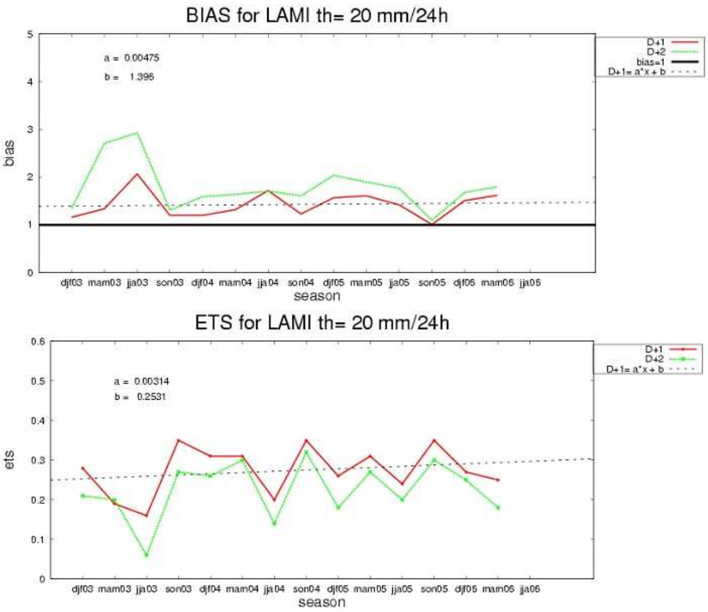

Figure 8: Seasonal trend for LAMI for 20 mm starting from DJF03 to MAM06: the red line refers to the first 24h and the green line to the second one.

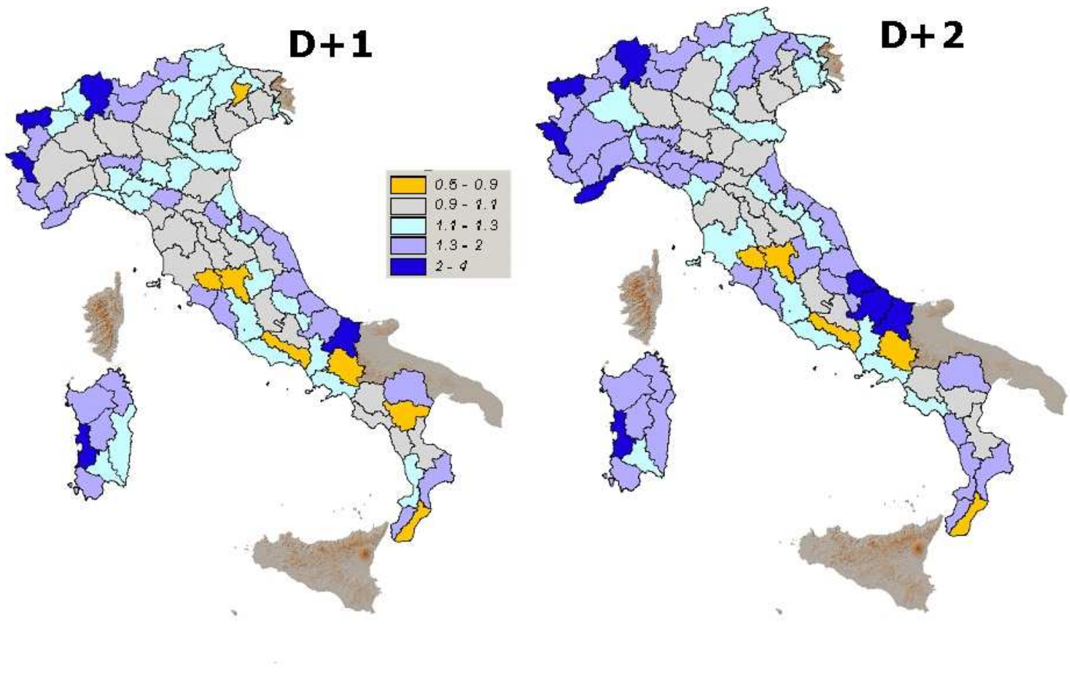

Figure 9: D+1 and D+2 BIAS over each basin (200212 - 200606).

In the same way, in Fig. 10 we show the ETS for D+1 and D+2: we find a rather good performance for the first 24h especially in Northern Italy and Tyrrhenian regions and worse performance over Sardinia and Adriatic regions (the low ETS values in the Abruzzo region maybe are due to observed data problems).

In Fig. 11 we show the POD for D+1 and D+2 and we can see a good performance for D+1 especially in north-western Italy; the worst performance is over Sardinia and central-south Italy.

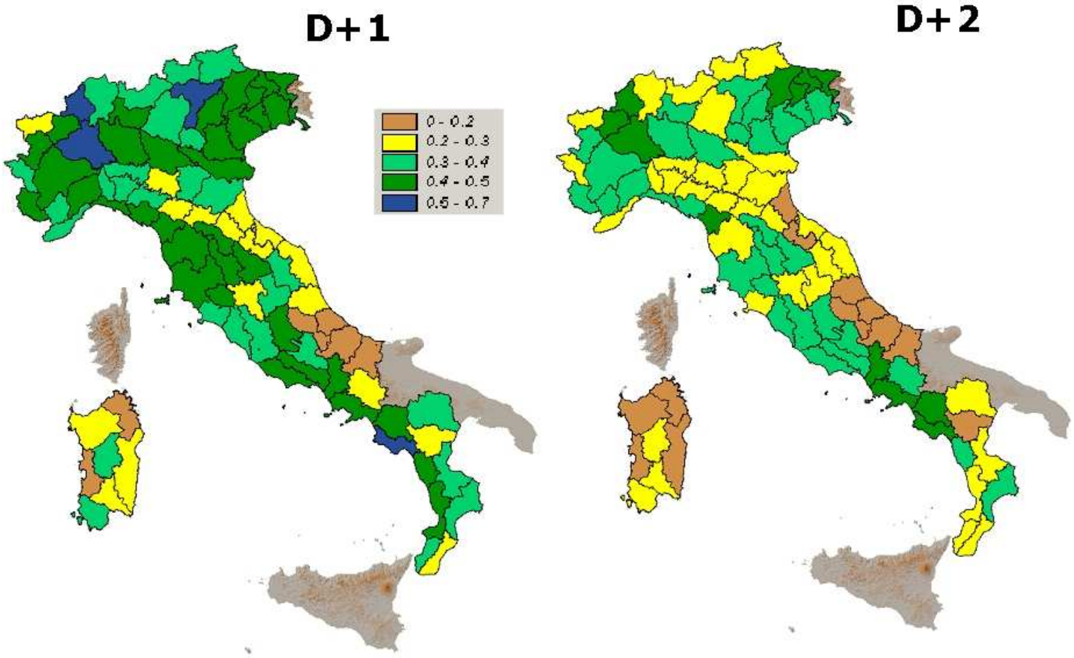

Figure 10: D+1 and D+2 ETS over each basin (200212 - 200606).

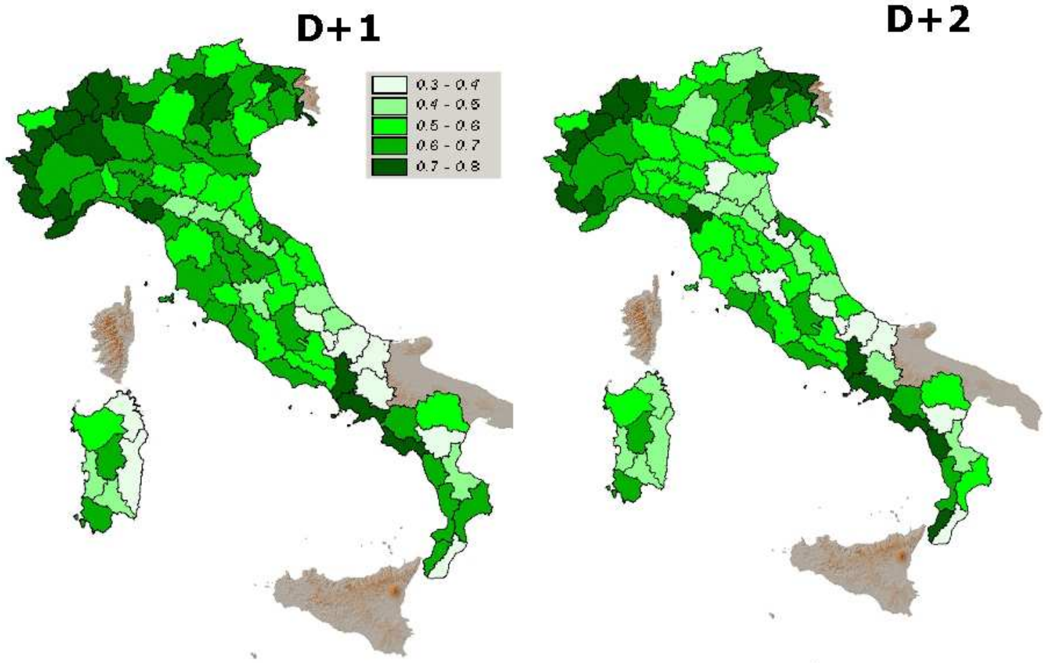

Figure 11: D+1 and D+2 POD over each basin (200212 - 200606).

Finally, the FAR in Fig. 12 shows a strong worsening with the forecast time and higher values over mountainous regions (the alpine chain and the Apennines) and Sardinia.

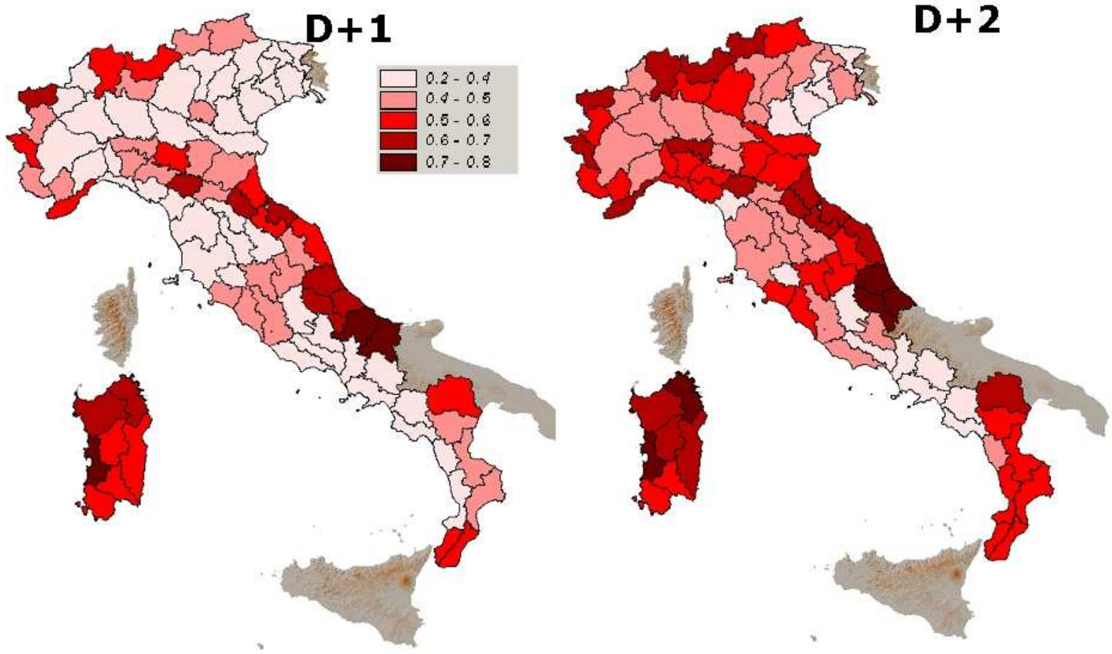

Figure 12: D+1 and D+2 FAR over each basin (200212 - 200606).

References

Hamill, T. M., 1999: Hypothesis tests for evaluating numerical precipitation forecasts. Wea. Forecasting, 14, 155-167.

Turco, M., Oberto, E. and Bertolotto, P., 2005: Progresses on LAMI, LM-DWD, aLMo verification over Northern Italy. COSMO Newsletter 5.