Verification of LAMI at Synop Stations

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1 Introduction

A synthesis of LAMI (the Italian version of LM) verification results for year 2003 is presented. The surface parameters analysed are 2m Temperature (2m T), 2m Dew Point Temperature (2m TD), 10m Wind Speed (10m WS), Mean sea Level Pressure (MSLP) and precipitation (PP). Rainfall verification has been considered only for the last quarter, since in October there was a change in LAMI version (from lm_f90 3.0 with initial state interpolated from GME, to lm_f90 3.5 version with initial state given by Nudging data assimilation scheme).

These five parameters are not explicit model variables but they are computed through some internal post-processing which may introduce extra errors. Nevertheless, since the internal post-processing is generally based on some diagnostic balance among the model variables, which is derived from physical constraints, it is still possible to have some important information about problems in the formulation and in the configuration of the model itself.

The observations forming the control data set were collected on 3-hourly basis from synoptic Italian network, including 91 manned stations and distributed over the Italian area; Fig. 1. shows the distribution of the stations used to compute verification. Stations were divided in three classes according to geographical location; mountain stations ($>$ 700m), valley stations or inner lowland stations and coastal stations. Station subdivision in classes has designed in order to check systematic errors related with different geographical and surface conditions. This approach can give two type of results: information about models ability in reproducing correct surface processes through a correct climatology in different geographical areas and indication of possible error source through error comparison in different areas.

In the following it will be given account of the results obtained in the verification of daily cycle for 2m T, 2m TD, 10m WS, MSLP and in categorical rainfall verification for precipitation.

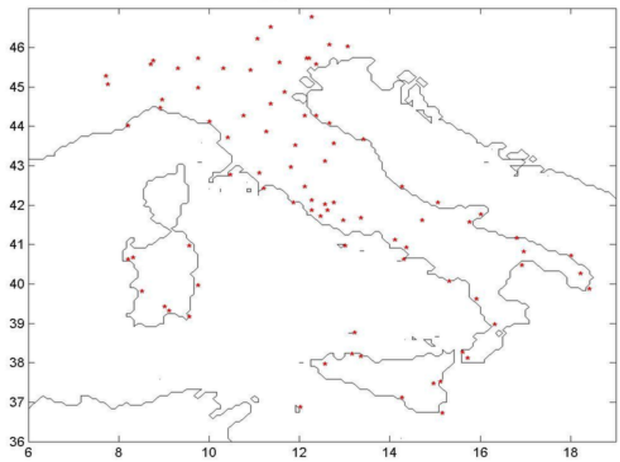


Figure 1: Synoptic Italian network.

2 Daily Cycle

In order to verify the diurnal behaviour of the model, the couples observation-forecast were stratified according to the hour of the day (3-hourly frequency), the month of the year and the forecast range (day 1 and day 2). Synchronous and co-located couples observation-forecast independently from the station position then form each sample. In such way systematic errors due to inconsistency in the surface representation of the model (inconsistency in the terrain elevation and in the percentage of the surface covered by water are the main error sources over Italy) are somewhat dumped and the signal of daily and seasonal oscillation is retained. For each of the 192 obtained samples, whose size is about 200 elements, the mean error (ME, forecast-obs) and mean absolute error (MAE) were computed.

Fig. 2a, 2b, 2c shows the behaviour of 2m-Temperature forecast error for coastal, valley and mountain stations. A clear diurnal cycle is present for all months in the mean error pattern. Coastal and valley stations ME patterns present, both for day 1 and day 2, positive peaks around sunrise hours (06 UTC in the cold months and 03 UTC in the warm months) and negative peaks near sunset. Negative peaks in ME mountain stations pattern still occur near sunset while positive peaks have a delay of 3-6 hours respect to coastal-valley stations, since occur at 09 UTC during the warm months and at 12 UTC during the cold months.

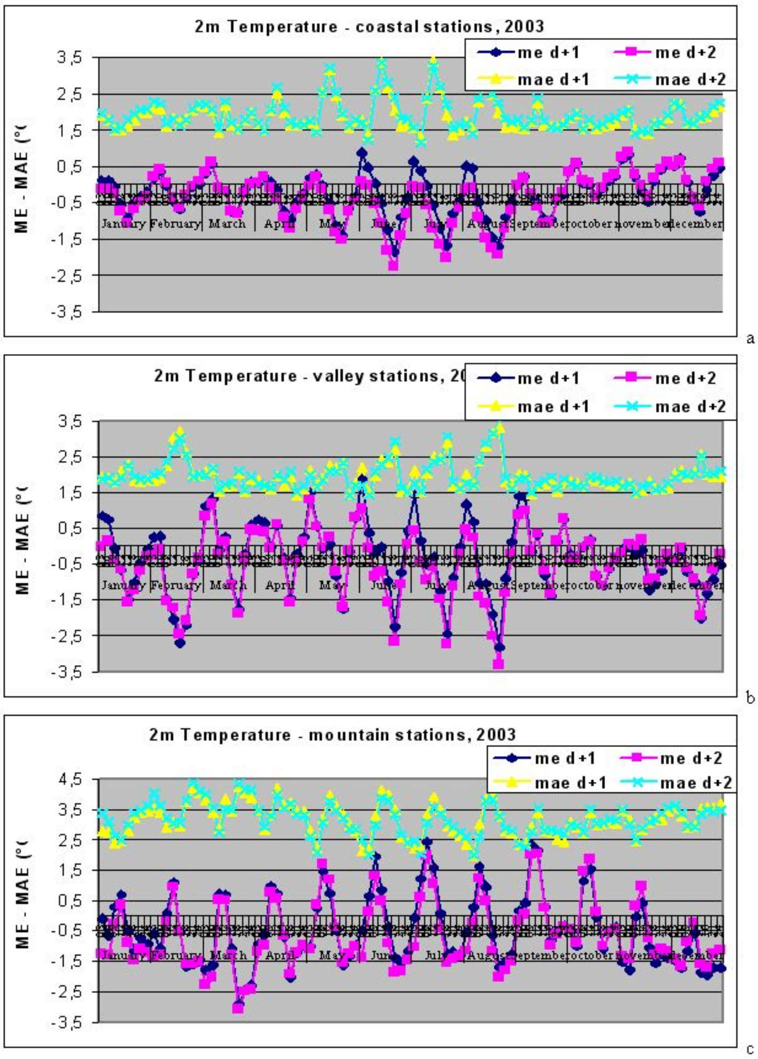


Figure 2: LAMI monthly mean error and mean absolute error of 2m Temperature for 2003.

Concerning the Mean Absolute Error a diurnal cycle is still present in the curve, even if not so clear like in ME curves. Minimum in MAE curves, corresponding to better absolute accuracy, occur in the early morning.

A diurnal cycle is also presents in ME curves of 2m Dew Point Temperature, see Fig. 3a, 3b, 3c. Beginning with coastal stations, Fig 3a, positive peaks in ME pattern occur in nocturnal hours like 2m Temperature ME. An increase in ME, with positive BIAS, occurs in the last three months of the year probably associated to nudging data assimilation scheme.

For valley stations peaks in ME curves occur in the afternoon in correspondence of low absolute accuracy (MAE peaks, 3-4.5 °C); then, a rapid decrease of ME occurs between 18 and 21 UTC. The same happens for mountain stations but with a delay of 3 hours and with high ME-MAE values. A great improvement, in MAE and ME, is associated to nudging data assimilation scheme; in fact, from October a discontinuity in the curves is well visible. For valley stations is possible to observe an amplitude reduction of ME cycle with curves oscillation centred close to zero while for mountain stations is obtained a great ME-MAE reduction but is still present a small positive BIAS.

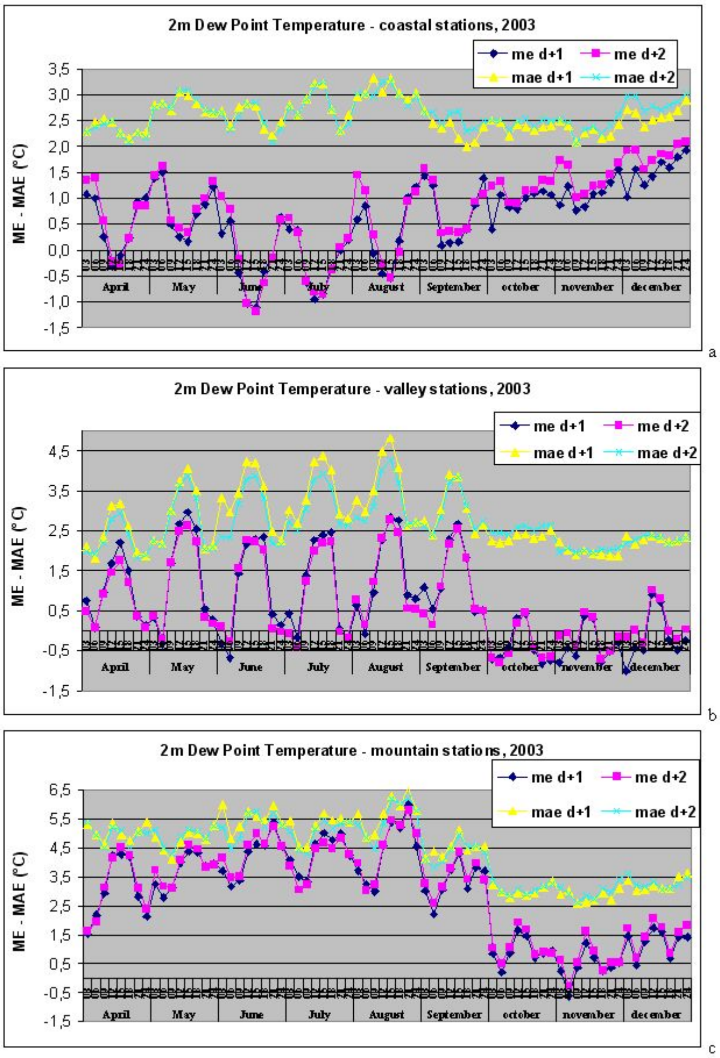


Figure 3: LAMI monthly mean error and mean absolute error of 2m Dew Point Temperature for 2003.

In Fig. 4 the curves relative to mean error and mean absolute error of 10m wind speed are showed. Even if the amplitude is small (less then 1 m/s for coastal stations, 1.5-2 m/s for valley and mountain stations) a diurnal cycle is present in ME curves. An overestimation of wind speed, positive bias, occurs during the cold months for valley and coastal stations, when dynamical circulation is dominant. Is interesting to point the attention to low ME and MEA values in summer months for coastal stations meaning a good model interpretation of local breeze circulation. Cycle peaks occur during the nocturnal hours or at sunrise for valley-coastal stations and at mid-day for mountain stations.

Fig. 5 shows MSLP mean error and mean absolute error for 2002 and 2003. A negative slope in the MAE linear tendency is present in the figure, meaning an improvement of the model performance during the last two years. Mean error curves does not show any diurnal cycle; in the warm months there is an opposite phase between ME d+1 curve and ME d+2 curve. MAE curves in Fig. 5 shows how the mean sea level pressure is less affected by local circulations or by model physics and is dominated by atmosphere dynamic; in fact, MAE increases quasi-linearly in function of forecast range (for each month, d+1 curve starts with +03 hrs and stops with +24 hrs while d+2 curve starts with +27 hrs to +48hrs forecast

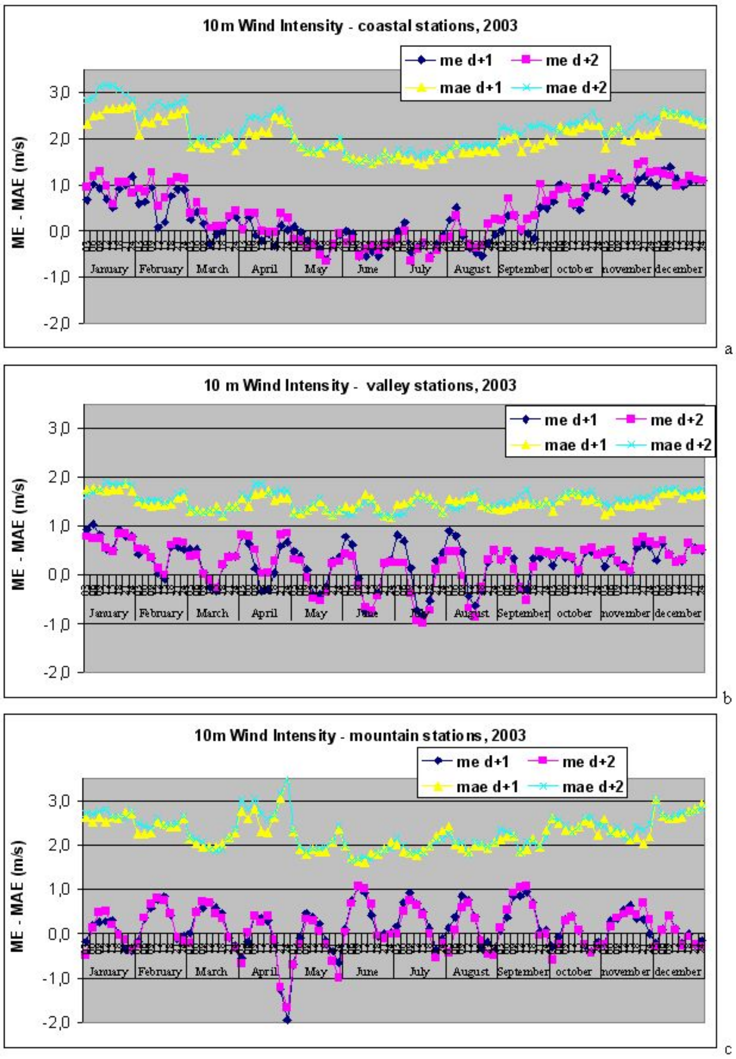


Figure 4: LAMI monthly mean error and mean absolute error of 2m Dew Point Temperature for 2003.

range) with an high degradation in MAE values during the months characterized by strong atmospheric motions.

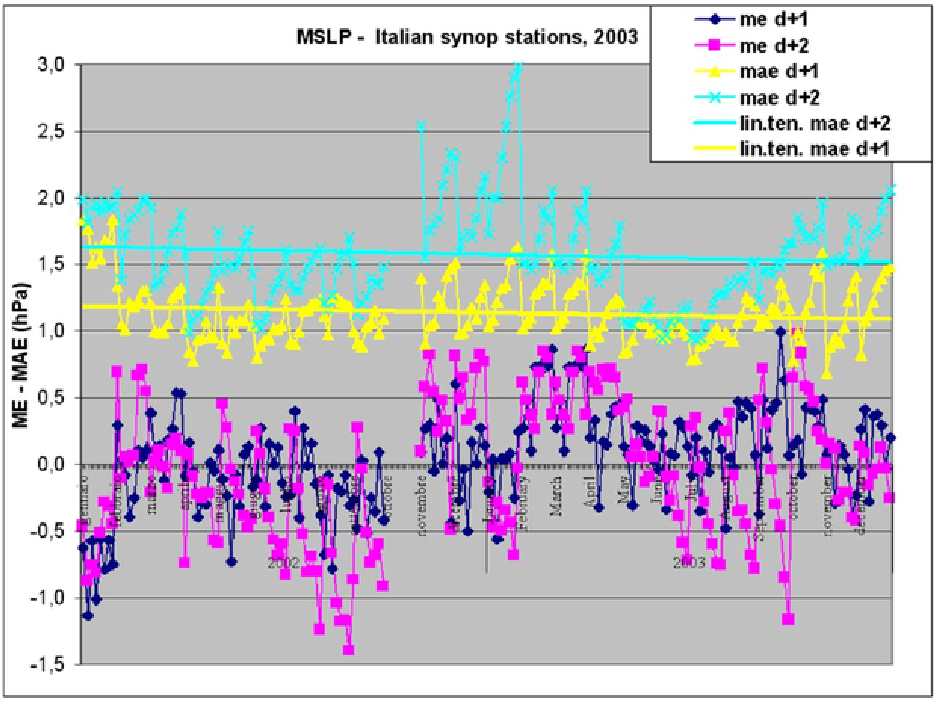


Figure 5: LAMI monthly mean error and mean absolute error of MSLP for 2003.

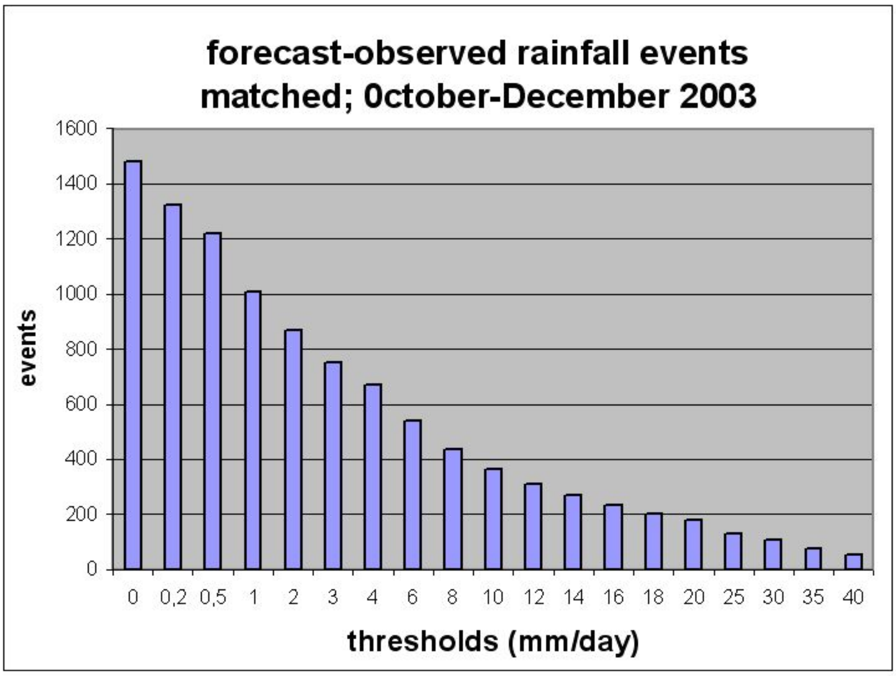
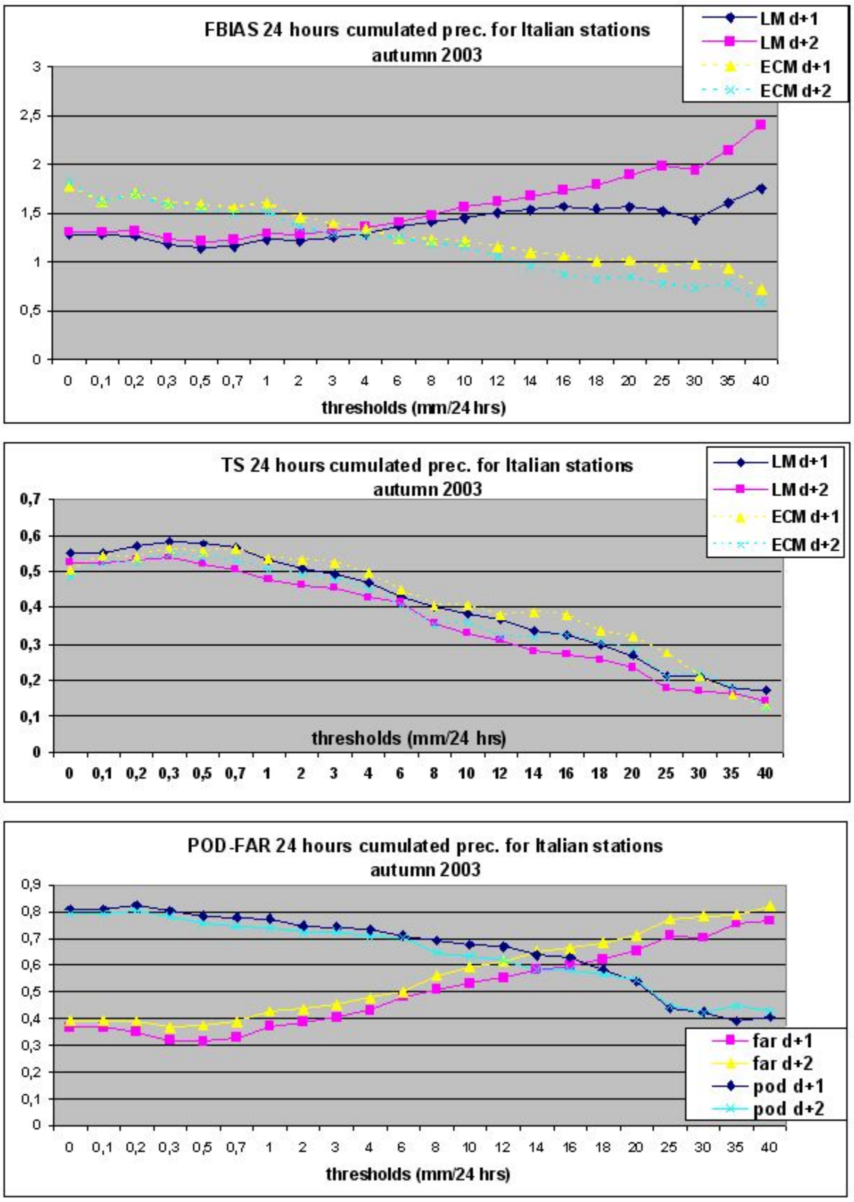


Figure 6: Number of forecast-observed rainfall events matched for verification during the last quater 2003.

3 Precipitation

The results for 2003 last quarterly precipitation are summarized in Fig. 6, 7, and 8, where FBIAS, TS, POD and FAR scores are presented for all Italian stations, without any stratifications (for details about stratified precipitation score see COSMO web site).

Fig. 7a shows a FBIAS comparison between LAMI, 00-UTC run, and ECM global model, 12-UTC run; for low threshold values, until 4mm/day, LAMI shows an overestimation of 20-30% (60% for ECM model). LAMI FBIAS increases with threshold values and a split between the forecast curves of the first and the second day occurs. The first day curve has a small FBIAS increment, showing for high threshold values an overestimation of about 50%, while the second day curve increase up to an overestimation of 100%.



a b c

Figure 7: a: LAMI (00UTC-run) and ECM (12UTC-run) POD/FAR for 24/hours cumulated rainfall. b: FBIAS for 12/hours cumulated rainfall (both for LAMI and ECM model). c: LAMI FBIAS for 6/hours cumulated rainfall.

Threat Score for 24 hours cumulated rainfall are reported in Fig 7b. Both models show comparable TS values decreasing in function of thresholds.

LAMI Probability of detection and False Alarm Ratio plots, Fig. 7c, give useful information to understand the threshold range where forecast can be used with high benefit, that is the plot area where POD >FAR. This interpretation is more clear in Fig. 8a, where POD/FAR ratio is plotted against thresholds. In this way, model usefulness is represented by green area (POD/FAR>1) and for LAMI day-1 curve this transition threshold is around 16-18 mm/day while for day-2 curve the cross point happens at a threshold of 12mm/day. Both LAMI and ECM model seem to have the same behaviour except for intense precipitation, >30mm/day, where LAMI score results grater than ECM model score.

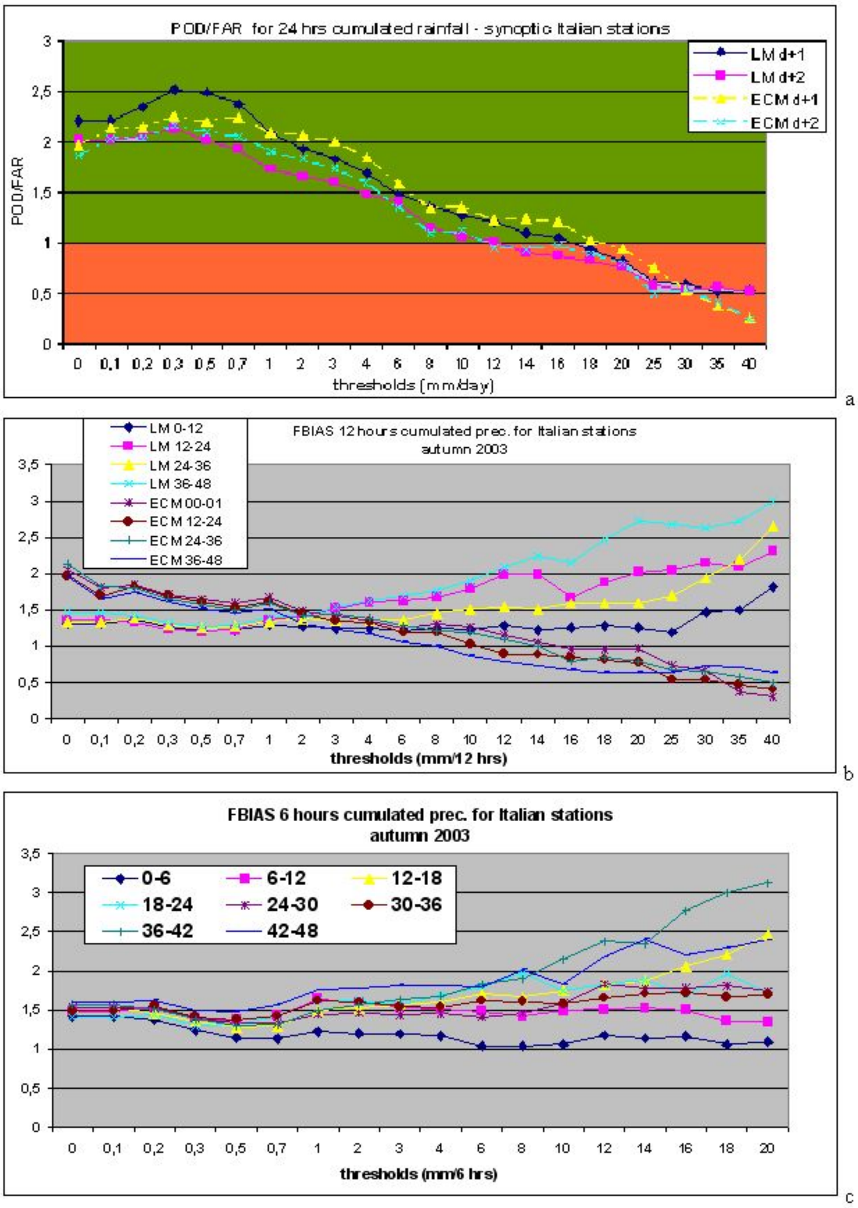


Figure 8: a: LAMI (00UTC-run) and ECM (12UTC-run) POD/FAR for 24/hours cumulated rainfall. b: FBIAS for 12/hours cumulated rainfall (both for LAMI and ECM model). c: LAMI FBIAS for 6/hours cumulated rainfall.