High Resolution QPF Verification of LM Using Non-GTS Data over Piedmont and Central-Northern Italy

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Introduction

We verified LM (DWD) and LAMI precipitation fields using a very dense non-GTS network over Piedmont region and central-northern Italy.

We collected non-GTS precipitation data of several Italian regions at synoptic hours: Liguria, Emilia Romagna, Trentino, Veneto, Marche, Sardegna, and we used the standard verification schemes of contingence table to calculate the statistical indices (BIAS, TS, FAR, HRR) for studying the model performance.

Moreover we carried out a parametric study averaging over different sized boxes ($0.25° \times 0.25°$, $0.50° \times 0.50°$, $0.75° \times 0.75°$) in order to find the optimum area for QPF evaluation.

The Method

- ***LM (DWD) verification***

  1. *Verification over Piedmont basins*

  We considered eleven basins, whose mean size is 3000 km^2, and containing about 1-2 ECMWF grid points and 60 LM grid points, on average. Each basin is a group of neighbouring hydrological catchments and represents the warning area for which it is necessary to supply the QPF to depict the hydrological risks and the critical territorial effects (Fig. 1). We verified the precipitation field from January 2000 to June 2002 (24h average).

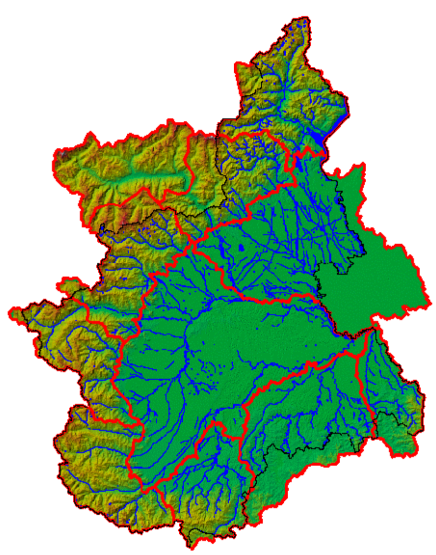

Figure 1: Hydrological Piedmont basins.

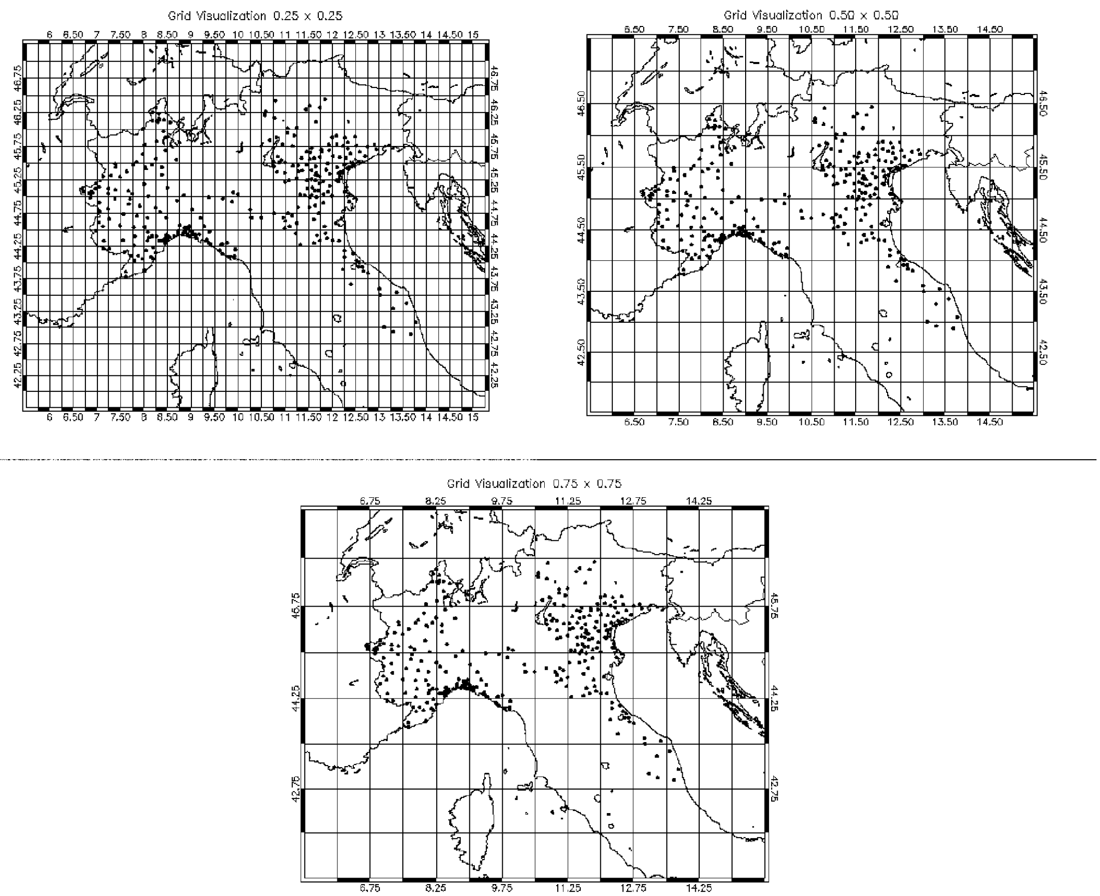

Figure 2: Different boxes subdivision of the LM subdomain.

2. Verification over Italian regions

We divided the Lokal DWD subdomain (41°58' – 41°9' N, 5°32' – 15°1' E) into several different sized boxes (0.25° × 0.25°, 0.50° × 0.50°, 0.75° × 0.75°) in order to find the optimum area for QPF evaluation in relation to data density and spatial distribution (Fig. 2).

We collected data from Liguria, Emilia Romagna, Trentino, Veneto, Marche, Sardegna, but we did not use Sardegna data set because its domain is outside from the considered subdomain. The following scheme describes some general parameters characterizing each regional data set: the area, the number of stations and the mean spatial resolution (in comparison to model resolution of about 7.5 km).

	AREA (kmq)	STATIONS	RESOLUTION (km)
PIEMONTE	25400	87	17
LIGURIA	5400	35 (65 from 03/02)	12 (9 from 03/02)
VENETO	18000	83	15
EMILIA ROMAGNA	22000	42	23
TRENTINO	6800	18	19
MARCHE	9700	12	28

We took into account the boxes containing al least two stations, so we have the following scheme describing the mean number of grid and station points falling in each considered box.

BOX (°)	LAT (Km)	LON (Km)	TOTAL BOXES	USED BOXES	LM POINTS	STATIONS
0.25	28	20	141	51	16	3
0.5	55	40	55	47	64	6
0.75	83	60	29	28	144	9

We verified the precipitation field from March 2001 to June 2002 (24h average).

- ***LAMI verification***

  We verified the precipitation field over Piedmont basins from June 2002 to August 2002 (24h average).

Main Results and Observations

First of all, we show the results regarding LM (DWD) skill over Piedmont basins where we have 312 station points homogeneously distributed. The following pictures represent the statistical indices BIAS, TS and ROC (FAR versus HRR) (Fig. 3, Fig. 4 and Fig. 5 respectively) calculated averaging 24h precipitation over the whole period from January 2000 to June 2002 for different precipitation thresholds (from 5 to 75 mm). We compare the first and the second 24h of 00UTC and 12UTC runs to evidence the different performance both in time and in the run. The results can be here summarized:

- LM12 is slightly better than LM00.
- There is a general deterioration of results with the threshold.
- The first 24h are generally better than the second.
- The results are globally good (all the points are in the upper left part of the ROC diagram, that is, %HR>>%FAR.

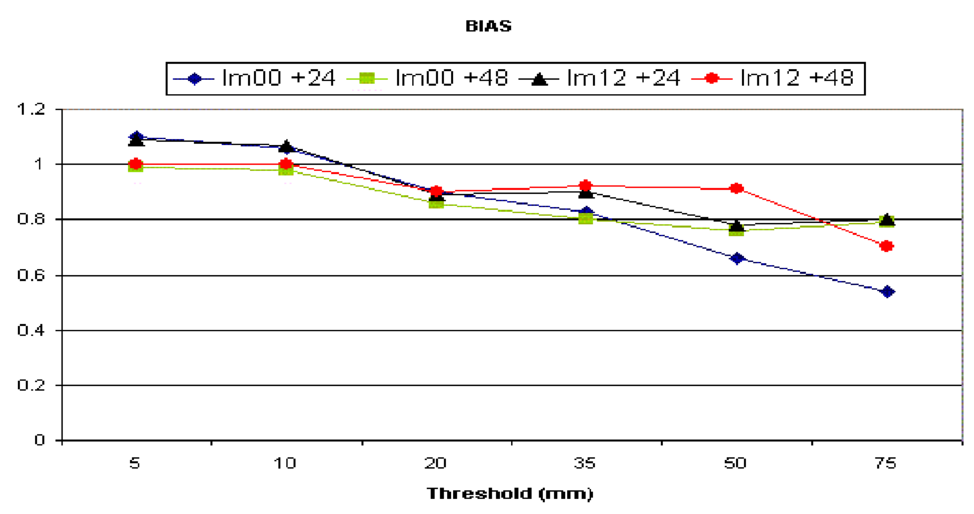

Figure 3: BIAS index over Piedmont basins, average in 24h (01/2000-06/2002), for LM00 (+24, +48) and LM12 (+24, +48).

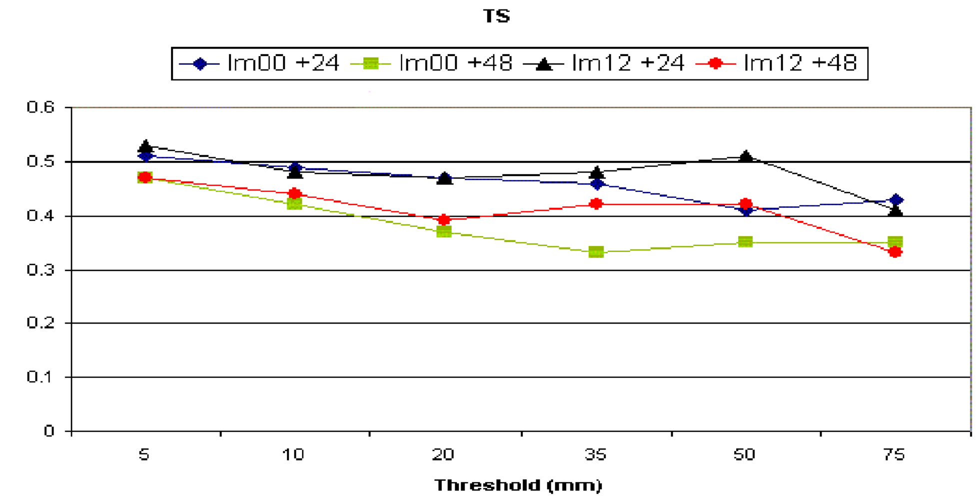

Figure 4: TS index over Piedmont basins, average in 24h (01/2000-06/2002), for LM00 (+24, +48) and LM12 (+24, +48).

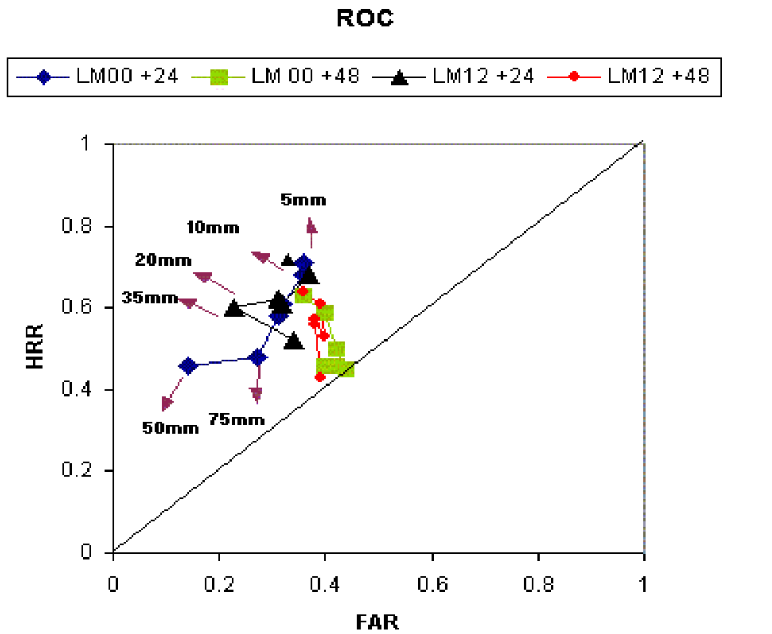

Figure 5: ROC diagram for Piedmont basins, average in 24h (01/2000-06/2002), for LM00 (+24, +48) and LM12 (+24, +48).

Besides, in order to test the possible change in the results when we average over different area sizes, we calculate the same indices (for LM00, first and second 24h) using also the boxes method (Fig. 6 and Fig. 7). In this way we obtain slightly different scores, and this denotes a sensitivity to the area averaging definition and evidences a better performance with the hydrological basins.

As a second exercise we studied the LM performance over a larger domain represented by northern Italian regions. We show some of the main results for the first 24h of LM00 run over a period from 03/2001 to 06/2002 averaging the precipitation over 0.25°, 0.5° and 0.75° boxes (Fig. 8 and Fig. 9). We obtain different indices values in relation to the box size

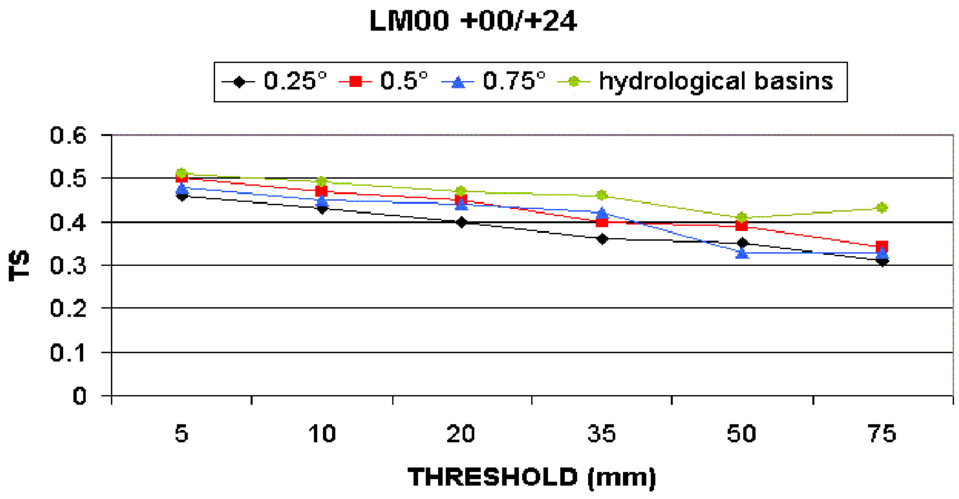

Figure 6: Comparison of TS index for the first 24h precipitation of LM00 obtained by different methods: the black, red, blue line represents TS calculated averaging respectively over 0.25°, 0.5°, 0.75° boxes and the green line over hydrological basins.

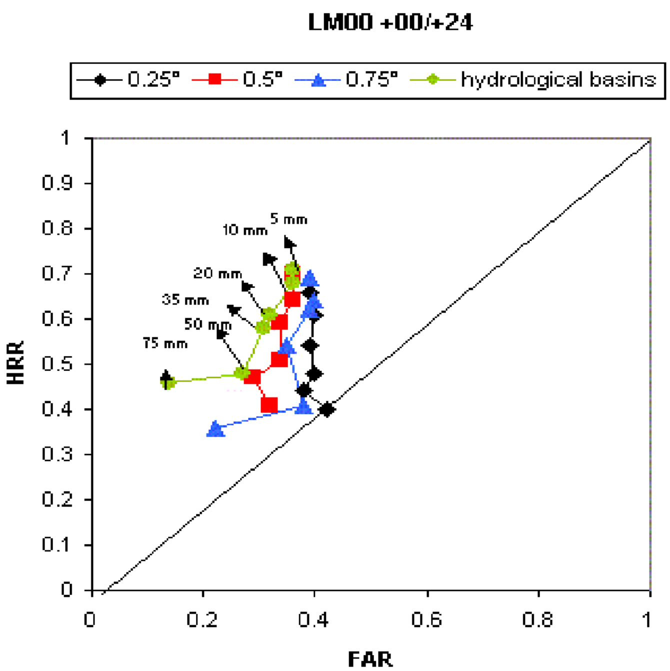

Figure 7: ROC diagram for the first 24h precipitation of LM00 obtained by different methods (see Fig. 6 for details).

used and this means it is difficult to find the correct average area that better represents the model resolution. In this case it could depend also on the data density and on the non-homogeneous spatial distribution that may cause a non-representativity of the stations for high precipitation regimes. So we can not drive conclusions about the model performance: in fact when we use 0.75° boxes we obtain a great overestimation for all the thresholds; on the contrary, when we use the other box sizes we have a great underestimation (Fig. 8). In the first case we probably average over too big boxes where there are in average 144 grid points in comparison to 9 station points. In the other cases, we do not consider all the

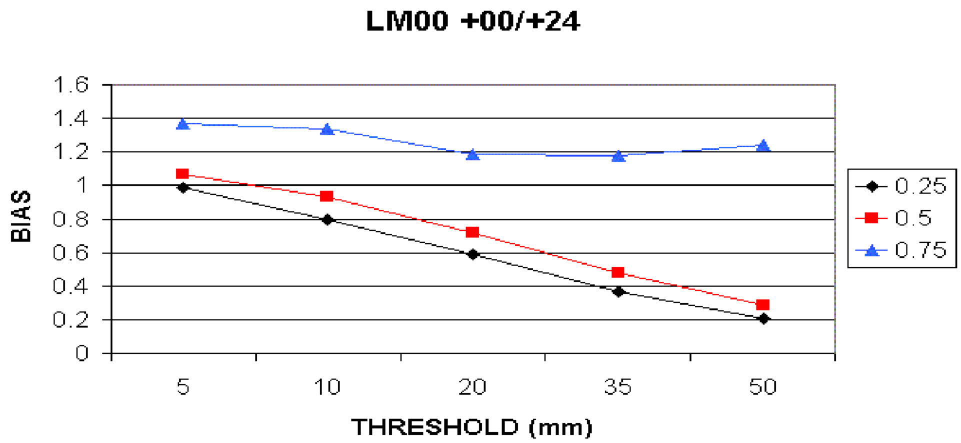

Figure 8: BIAS index for LM00 (+00/+24) obtained averaging over different boxes: 0.25°, 0.5°, 0.75° for the period 03/2001 - 06/2002.

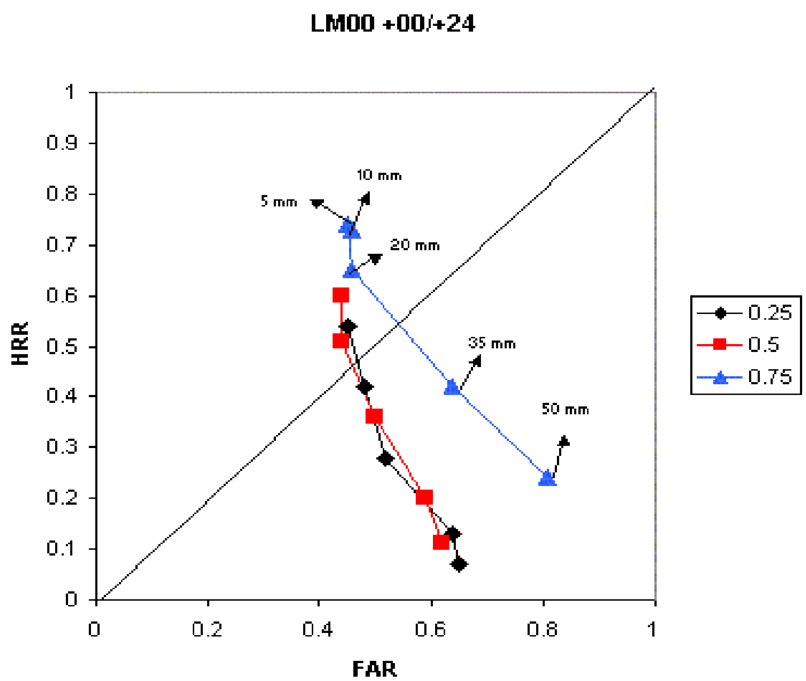

Figure 9: ROC diagram for the first 24h precipitation of LM00 obtained by averaging over different boxes: 0.25°, 0.5°, 0.75° for the period 03/2001 - 06/2002.

boxes (because the boxes must have at least two station points) but we exclude a lot of them producing an underestimation error.

Finally, we discuss the results of the LAMI verification using high resolution non-GTS data from Piedmont region (312 stations) during the period 06/2002 - 08/2002. The following graphic (Fig. 10) represents the BIAS indices versus the threshold: the first and the second 24h of 00UTC and 12UTC runs are compared with the 24h precipitation averaged over hydrological basins. We see that LAMI00 +24 and LAMI00 +48 have about the same performance for low thresholds where the model overestimates the precipitation. Instead for high thresholds we note a divergent behaviour (see the blue and green lines in the Fig. 10

for the 00 run): there is a big gap (spin up) between the first and the second 24h, and most of the precipitation is forecasted in the first 24h. The 12 run skill is generally better than the previous, in fact the spread between the first and the second day is smaller (see the red and black lines in the Fig. 10) and we achieve the best score for 10 mm, 20 mm and 35 mm thresholds.

Conclusions

In this report we discuss the main results of QPF verification of LM (DWD) and LAMI model. We use the common statistical indices that give us some information about the performance and the skill of the models in term of predictability. In our results we find a great dependency of the QPF skill on the area definition: it is necessary to define a size and a shape of the averaging basins related with the territory morphology and the climatology of severe events. It is also necessary to have an homogeneous, and comparable with model resolution, data distribution (3D) to perform the precipitation validation.

We can summarise the results in the following statements:

- Generally, the 12UTC runs give better score than 00UTC ones for LM (DWD) and LAMI model: is there more inertia in the atmosphere at 00 in precipitation triggering? Is it more important an older analysis but based on a greater number of observations?
- The first 24h of LAMI model overestimate the precipitation for all the thresholds: this is probably due to the missing data assimilation cycle (started on December 2002 only).
- The QPF skill for hydrological risk assessment over Piedmont is good and indicates the importance of working with end-user targeted verification.

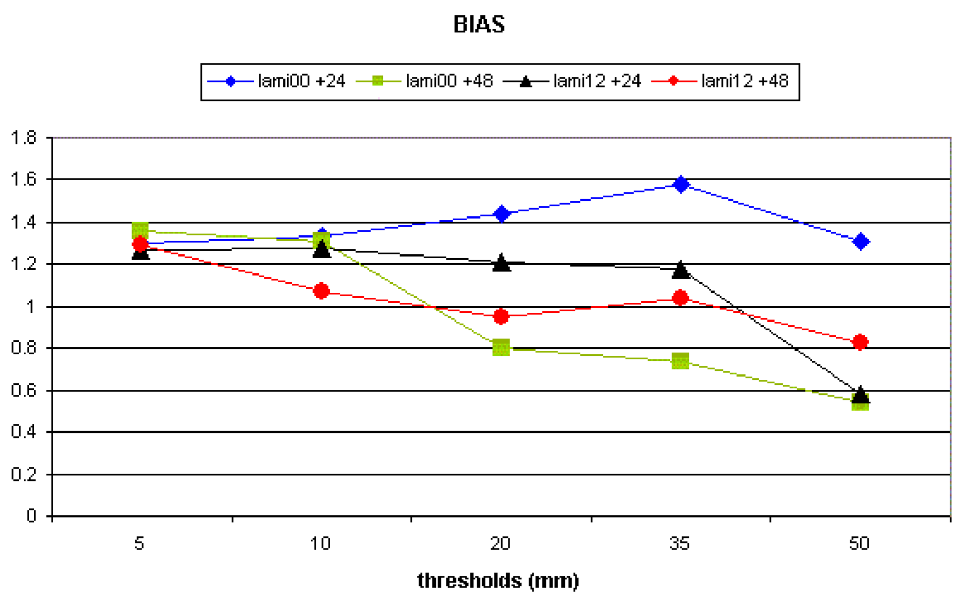

Figure 10: BIAS index over Piedmont basins, average in 24h (06/2002 – 08/2002), for LAMI00 (+24,+48) and LAMI12 (+24,+48).