Romanian Contribution in Quantitative Precipitation Forecasts Project

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1. Introduction

The performance of LM model on Romanian territory is evaluated by means of objective and subjective verification for the period of February-August 2005, corresponding to first preoperational model runs in NMA Bucharest. Combination of these methods will facilitate the understanding of model limits and its capacity to simulate realistically physical processes on the integration domain and will suggest directions of improvement of model performances. Some special weather situations are investigated concerning quantitative precipitation forecast, using LM Romanian operational version and LM standard version, and the results of a qualitative analysis for three studied cases are presented.

Starting from March 2005, LM model is run in a pre-operational regime in NMA, Bucharest. The assessment of model performances has been done by objective verification measures as well as by subjective evaluation methods. The aim of this paper is to make a comparison between the observed precipitations and simulated precipitation fields from both LM versions. Regarding the forecast precipitations we can conclude that there are some situations where the simulated field is very realistic, but in general both model versions overestimate. There are also few centers of high amounts with location errors. LM Romanian operational version is integrated using a 14 km horizontal resolution and 35 vertical levels. The time step is 80s. Initial and lateral boundary conditions are provided by GME run for 00 UTC, with a frequency of updating LBC of 3 hour. The two-category ice scheme is used for grid-scale precipitation and Tiedtke scheme is used for convection parameterization. There is no data assimilation. The forecast anticipation is 54 hour.

2. Parallel experiments

In order to identify the characteristics of cases with very poor performance of LM model on Romanian territory with respect to precipitation, the results of pre-operational runs of the model in the period February-September 2005 were compared with the observed fields of precipitation. The comparison was only a qualitative one and it has been restricted to the Romanian territory, where observational data from stations were available. The comparison allowed to choose some extreme cases, characterized by:

- Errors in the location of area with, mainly, heavy precipitation.
- Significant over- or underestimation of observed amounts, that is at least twice larger / smaller than observed.

The seven cases selected took place in May-June-July, a period characterized in general by very intense precipitation in Romania. For these cases, the analysis concentrates on:

- Analysis of the synoptic situation.

- Comparison with the observed field of precipitation with respect to location and amounts.
- Type of precipitation (in reality and in the model).
- Comparison of 24 hour and 48 hour anticipation for each case.

In choosing the significant cases, we did not start with the analysis of seasonal verification, since our data set used here covers only 8 months. Instead, daily qualitative analysis of model results, using also the input from forecasters, showed that May-July and September were periods characterized by heavy precipitations, thus meaningful for the aim of this report.

The situations analyzed here represent episodes when precipitations over Romania were mainly of frontal nature, but having, each time, a support in the middle troposphere due to some cold troughs moving toward Romania. The geographical position of our country determines the existence of two principal frontal approaches: on one hand, there are the systems associated with baric depressions in Mediterranean Sea, often extended toward Black Sea, and on the other hand the category of West-North-West approaches, in this case the frontal systems being associated to the trough of Icelandic Low. An intermediate situation between the two categories, often generating heavy precipitation in Romania, is represented by cases when the trough of Icelandic Low extends until the Mediterranean basin. A cold advection, well defined in the middle troposphere, accentuates the ascending and contributes to reactivate the cyclonic processes near the surface, generating, too, important quantities of precipitations.

23 June 2005

In the middle troposphere, the development, toward central and southern part of the continent, of the trough associated to the baric low over Russian Plain favored the penetration of cold air mass over the Romanian region. In the second part of the day and during night the axis of the trough was located over Romania, the closed nucleus accentuating the ascending motion in the eastern and southeastern regions. In the lower troposphere, the mass separation was manifested through a cold atmospheric front, which crossed Romania from NW to SE. The real location of the altitude nucleus during the night, more to the north than it is simulated in the model, might explain the underestimation of precipitation in the model for Eastern Carpathians. On the other hand, the values for the geopotential at 500 mb (Fig. 2) are lower than in reality, which may be the reason for the excessive quantities forecasted for the extreme east of the country.

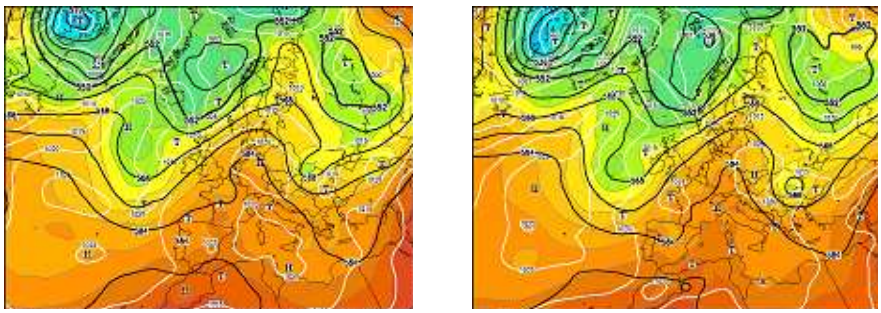

Figure 1: Synoptic situation (GME reanalysis) for 23.06.2005: 12 UTC (left) and 24 UTC (right).

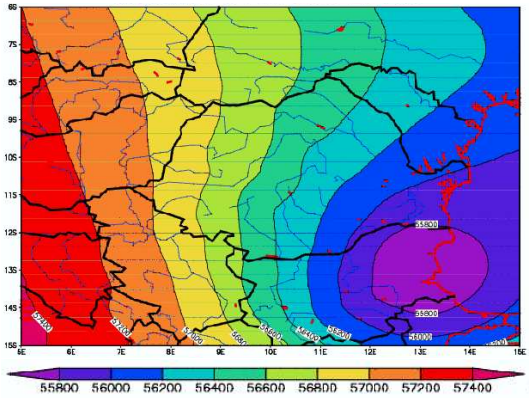

Figure 2: Geopotential field at 500mb, for 23.06.2005, 30h anticipation.

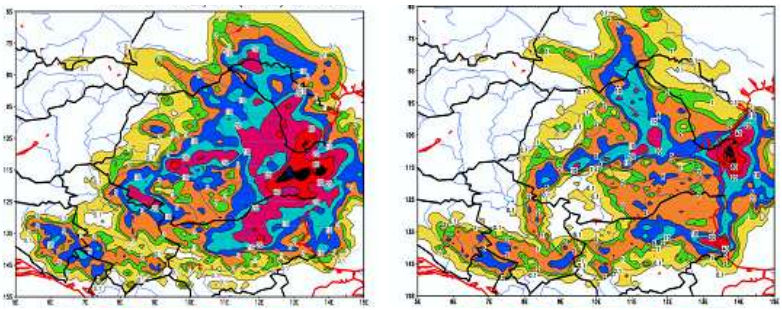

Figure 3: Operational Romanian version. 24 hour accumulated precipitation for 23.06.2005: 24 hour anticipation (left); 48 hour anticipation (right).

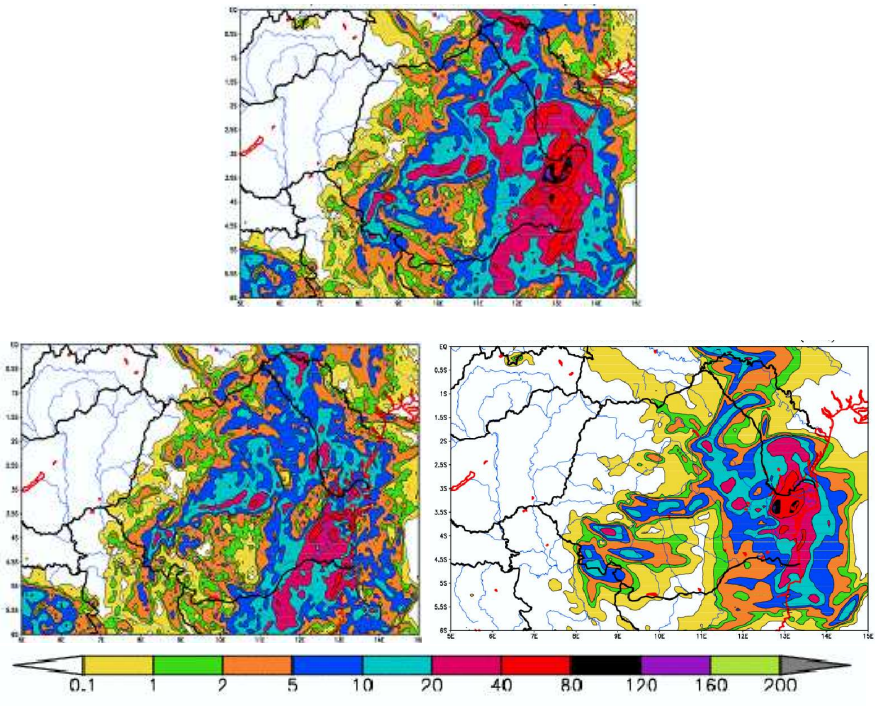

Figure 4: Standard version. 24 hour accumulated precipitation, for 23.06.2005: total precipitation (above); convective precipitation (below left); grid scale precipitation (below right).

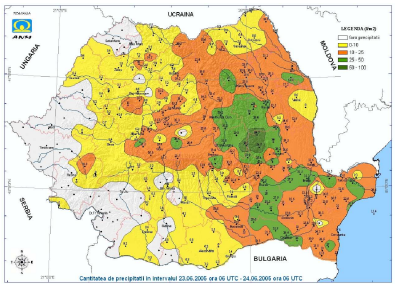

Figure 5: 24 accumulated observed precipitation for 23.06.2005.

For 24 hour anticipation, both model versions Romania operational LM (14 km) and standard version LM (7 km), show a false maxima in the SW of the country (about 40 l/m^2 in the model, no observed precipitation). The eastern part of the country is in generally overestimated, more specifically in SE (Dobrogea region) there is a strong overestimation in the models (about 80-120 l/m^2), while in the observed field, the values are around 15-20 l/m^2. In this region the convection seems to play in important role in the model, leading to about 55 l/m^2 in 24hour. In this case, the overestimation in all regions seems to be determined by convective processes. The operational version simulated field at 48 hour anticipation is very similar with respect to spatial distribution, but with smaller values, especially in the East, thus being more realistic for this area.

02 July 2005

The tropical air mass, from the previous case, still persists at the beginning of the interval 2-3 July over the south of the continent but it was slowly replaced by a mass with polar characteristics, associated to troughs in Nordic regions. One of these troughs extends significantly toward south, forming a closed nucleus over south-western part of Romania. The pressure field at surface presents a low in the eastern basin of Mediterranean Sea, in extension toward Black Sea, having an energetic support from the altitude nucleus. In these conditions, there was precipitation in the most parts of the country. The model overestimated the quantities in East, where, in reality, the altitude ridge blocking persisted (too fast trough evolution to east in the model?)

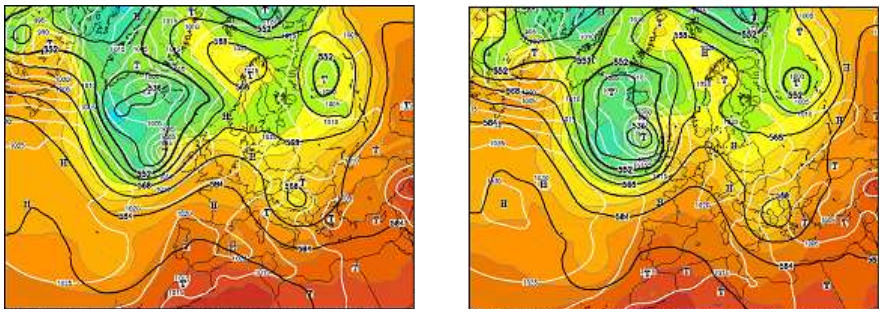

Figure 6: Synoptic situation (GME reanalysis) for 02.07.2005: 12 UTC (left) and 24 UTC (right).

In NE-E of the country where no precipitation was observed, both models overestimated the quantity of precipitation (40 l/m^2 simulated). The high precipitation amounts, simulated by the models in extreme West, intra-Carpathian region and in the south-eastern part of South Carpathians, were not observed in reality. At the same time, the area with high amounts of precipitation observed (66-110 l/m^2) is significantly underestimated by both model versions

(20 l/m^2 in the models). There is a little bit difference between LM Romanian operational version and LM standard version. In the LM standard version you can see that the position of center with the high precipitation amounts is slightly moved to the west. For the anticipation of 48 hour, the eastern part of the country is better simulated by the Romanian operational version, while there still is an overestimation on a small region in the W-NW, but in the rest of the country the amounts are underestimated, like in the previous cases.

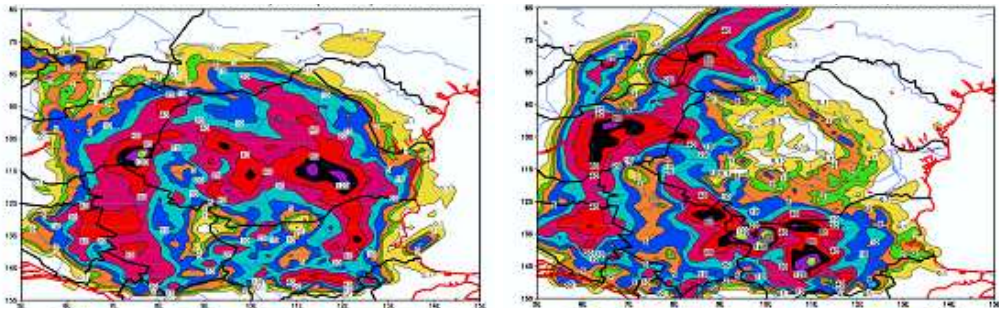

Figure 7: Operational Romanian version. 24 hour accumulated precipitation for 02.07.2005: 24 hour anticipation (left); 48 hour anticipation (right).

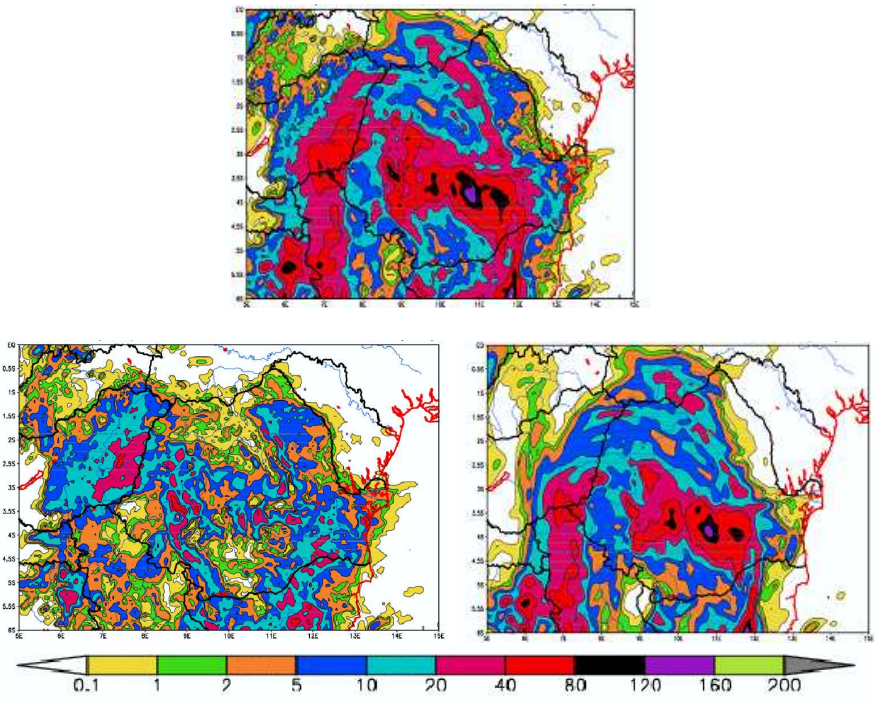

Figure 8: Standard version. 24 hour accumulated precipitation, for 02.07.2005: total precipitation (above); convective precipitation (below left); grid scale precipitation (below right).

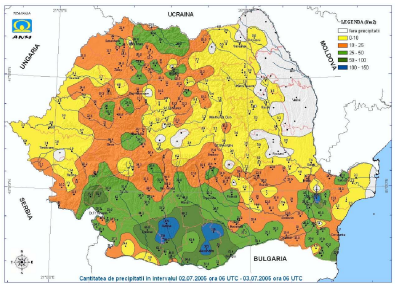

Figure 9: 24 accumulated observed precipitation for 02.07.2005.

12 July 2005

The circulation in the middle troposphere between 11-13 July was ultra-polar, meaning that over North-East of Europe the geopotential had very low values, looking like a vast trough, with a NE-SW axis. This structure assures the transport of polar air mass from the extreme north of the continent and Polar Seas toward center and South of Europe. Over the Mediterranean basin, the air mass enriched its moisture, afterward being drawn on a south-western component of the flow toward our country. The ultra-polar circulation is specific to cold season, when very cold arctic and polar air masses penetrate fast and easy until and over the Mediterranean basin. It is a less common situation for the warm season, especially because it persisted for three days. It should be noticed, too, the isolated cold nucleus in the Romanian region surface, the gradual decrease of pressure in the western part of the country, together with the extension and enforcement of the anticyclone in the NW, suggest the organization of a frontal system, the contrast in the air masses being secured by advection from the East of Mediterranean Sea. In these conditions, in Romania there was precipitation in all regions, more important quantitatively in the first day (11 July) in SE, center of the country and in the mountains, and in the second day in east of the country. The model overestimates the amounts of precipitation in NE, probably due to a faster advance to the east of the altitude nucleus.

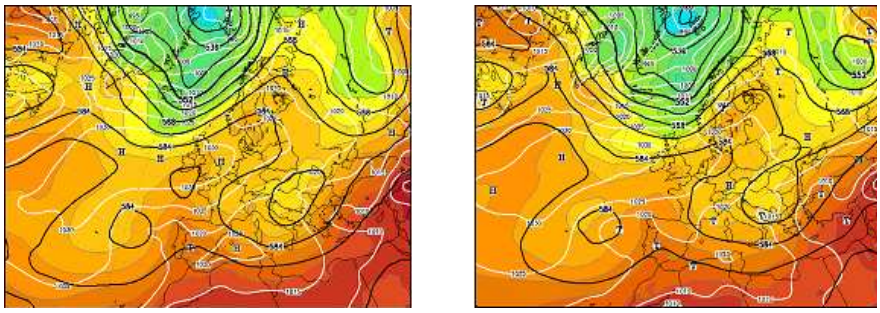

Figure 10: Synoptic situation (GME reanalysis) for 12.07.2005: 12 UTC (left) and 24 UTC (right).

The operational LM simulated precipitation field for 24 hour anticipation shows that for the SE and littoral area the amounts are in general overestimated, but not in a very high degree. Also an overestimation is found for the NW of the country, where the model shows up to 40 l/m^2, while in the observations there are amounts of 10 l/m^2 for this area. The general spatial distribution is well reproduced and also the center of maximum amounts near the Carpathians Bend. For the 48 hour anticipation there are more significant errors compared with the observed precipitation field: there are no precipitation in East of the country (in observations there are 10-60 l/m^2); the band of intense precipitation is located in the SW, in

the model, while in reality it is on E-SE; West of the country is strongly overestimated. In LM standard version the precipitation amounts are underestimated in the Western part of the country and littoral area (1-2l/m^2 observed - 40-80 l/m^2 simulated). There are also two other regions (SW and SE of Romania) where the precipitation amounts are overestimated (100-150 l/m^2 observed - 10-20 l/m^2 simulated).

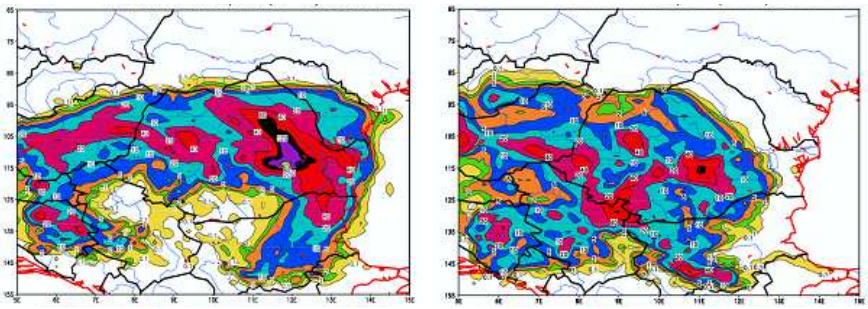

Figure 11: Operational Romanian version. 24 hour accumulated precipitation for 12.07.2005: 24 hour anticipation (left); 48 hour anticipation (right).

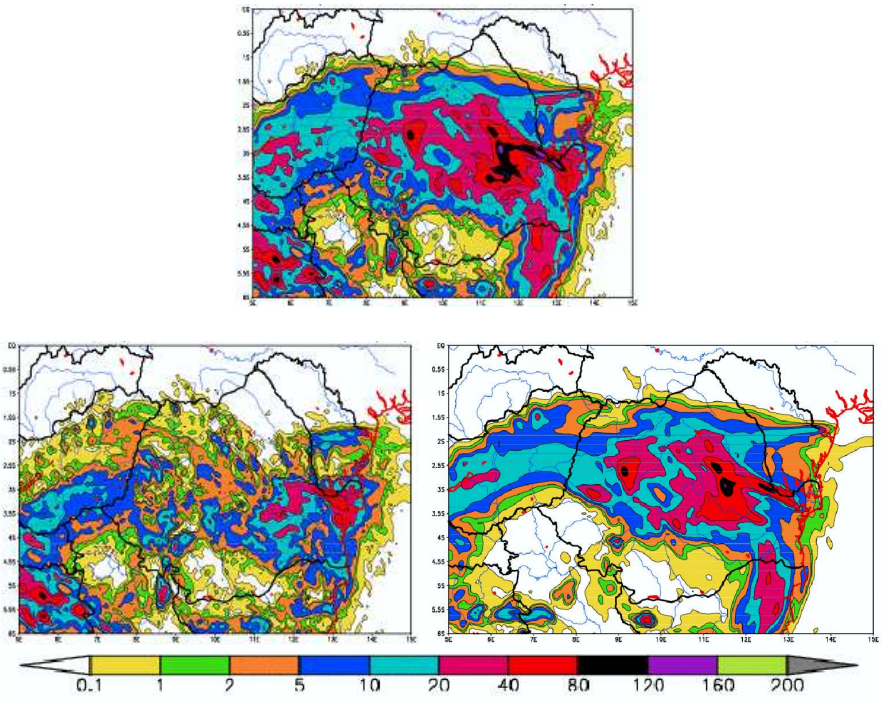

Figure 12: Standard version. 24 hour accumulated precipitation, for 12.07.2005: total precipitation (above); convective precipitation (below left); grid scale precipitation (below right).

3. Conclusion

A qualitative comparison between the observed and simulated precipitation field for both models, LM Romanian operational version and LM standard version, was done. For this kind of analysis 10 cases with poor QPF from February to September 2005 were selected. The choice of these cases was done using two main criteria:

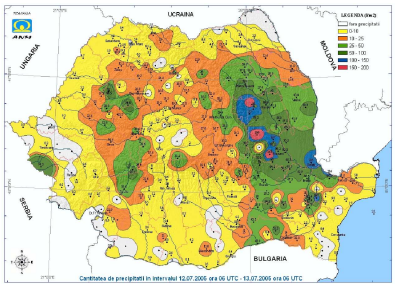

Figure 13: 24 accumulated observed precipitation for 12.07.2005.

- Errors in location of important amounts of precipitation and with regard to the extension of the area with intense precipitation.
- Significant over- or underestimation, especially of the heavy precipitation

Also, a qualitative comparison was done between the model forecast with 24 hours and 48 hours anticipation, for the same day. In all cases, the precipitation was determined mainly by frontal systems, being accentuated by convection in some areas for some situations (31 May, 19 July). In most of the cases the precipitations were quantitatively overestimated and regions with high amounts present only in the model (false maxima) are found in 5 cases (31.05, 23.06, 30.06, 2.07, 19.07), some determined by strong convection in the model (e.g. 23.06). However, there was one case with significant underestimation of observed precipitation, namely 19.07. Also, in few cases, errors in location of areas with important precipitations are found in the model. Comparing the results from the 24h and 48 h anticipation for Romanian operational version, it seems that possible causes for these errors in QPF forecast, for these cases, may be: a simulated large-scale circulation faster than in reality (e.g. for 04.05, 19.05, 02.07, 11.07); lows of geopotential at 500 mb are deeper in the model than in the German analysis (e.g. for 23.06); or improper estimation/simulation of specific humidity in the considered area (e.g. for 31.05, 19.07).

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