SHORT-TERM CLIMATE FORECAST FOR ROMANIA BASED ON THE ECMWF PRODUCTS. PRELIMINARY RESULTS

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Abstract: This paper presents the performance of weekly forecast products, as they have been adapted for Romania from the Monthly Forecast System (MFS) of the European Center of Medium Range Weather Forecast (ECMWF). This forecast system includes the outlooks for terciles of both the weekly 2-meter temperature and total precipitation. MFS products were used in order to test the possibility of extending the deterministic part (7 to 10 days) of the medium range forecasts issued for Romania. Encouraging preliminary results were obtained for the period November 2004 - July 2005 leading to the idea of continuing this work. The conclusions include some limits of the used forecasting method.

Key words: medium range forecast, 2-metre temperature terciles, precipitation terciles, scores

1. INTRODUCTION

The short-term climate outlooks are very important for many economical and social domains. Many users ask for meteorological information for extended periods. The most common methods for this issue are the statistical ones (Barnett and Preisendorfer, 1978) and in Romania there is a tradition for the long-range weather forecast using such methods. The first studies have been based on the large-scale circulation (Topor and Stoica, 1965). Then other papers presented results based on the Markov chain (Mares, 1985), autoregressive and para-metric models (Boroneant *et* al, 1990, Boroneant and Râmbu, 1991), the analogy method (Pop, 2000) and other regression methods (Mares *et al*, 1996, Busuioc, 1998, Bojariu and Paliu 2001). By analyzing the climatic variability of the Atlantic-European Region (AER) useful information for the short-term climate forecast can be obtained (e.g. Buzdugan, 1995, Stefan, 2004).

The deterministic models used for the short-term weather forecast have been adapted for medium and long-range forecast. ECMWF developed a forecast system by the statistical processing of an ensemble of models and since 7th October 2004 has started to produce a new operational monthly forecasting system (MFS), including 4-week forecast products.

The central idea of this paper was to test these weekly forecast products and to adapt them for the Romanian territory.

2. DATA AND METHODS

The general meteorological data and information utilized in our paper are presented below:

– daily grid values from the National Center for Atmospheric Research (NCEP) analyses of mean sea-level pressure (MSLP) and the geopotential at

500 hPa for Northern Hemisphere and AER;

– daily SYNOP messages at 00, 06,12 and 18 UTC used for issuing 24-hour weather diagnosis (2-metre temperatures, total precipitation) at all the Romanian Meteorological Stations (RMS) belonging to the National Meteorological Administration (NMA) network;

– daily values of 2-metre mean temperature and total precipitation to compute their weekly means for the 130 RMS; these values are compared with the weekly climatological means and three tercile classes (below normal, normal, above normal), calculated over the last 12 years from the NMA database, as ECMWF suggested (http://www.ecmwf.int/research/monthly_forecasting/Documentation.htm.

The main MFS products analyzed once a week are as follows:

– weekly ensemble mean anomaly maps for 2-metre temperature, total precipitation, MSLP and geopotential at 500 hPa;

– probability that the same parameters be at least 10% different from the weekly means;

– tercile probability maps for 2-metre temperature and total precipitation;

The ECMWF monthly forecasting system has two components: the real-time forecasting system, which is a 51-member ensemble of coupled ocean-atmosphere 32-day integrations; a model climatology (back-statistics) computed for a 5-member ensemble of 32-day coupled integrations, starting on the same day and month as the real time forecast for each of the past 12 years; the back statistics are created every week and are ready before the real-time forecasting suite starts.

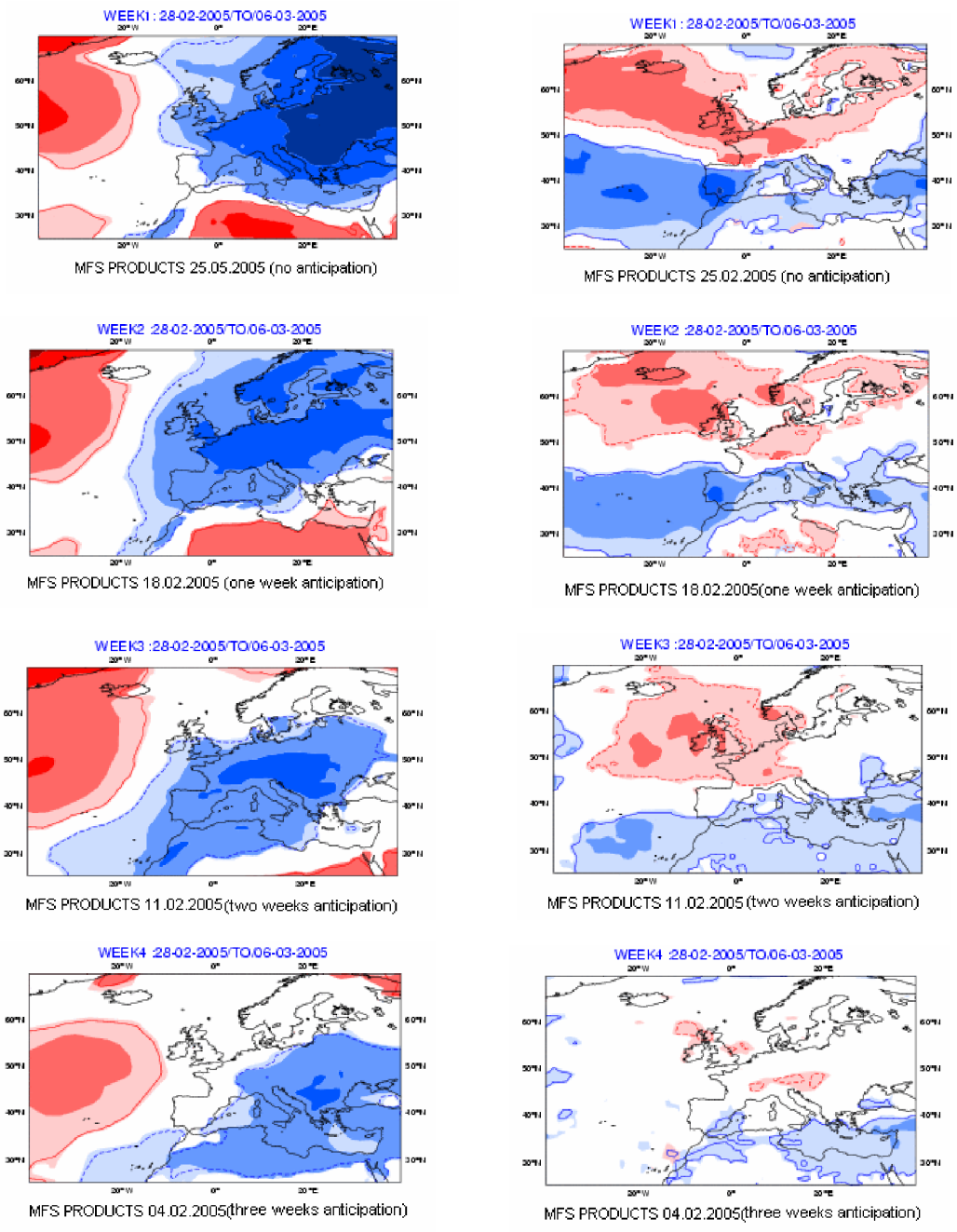
2.1 Adapting the MFS products for Romania

By analyzing all the information provided by the MFS products, maps for Romania have been made, including two very important parameters with respect to their superior and inferior terciles: the average weekly temperature and total precipitation. The difference between these maps and the corresponding MFS maps consists in the delimitation over the Romanian territory of those areas of normal limits (the predicted weekly temperature and precipitation are included in the central tercile). These are either the blanked areas represented in the MFS products or those marked with very low probability degrees (10%) for inferior or superior terciles.

If there are blanking areas on the charts it does not always mean that there is no signal in the blanked regions, but only that, with the 12-year sampling used, we cannot be sure that there is a signal. For this reason, there are likely to be many areas, not only in Romania, where a signal is real but remains undetected.

As an example, in figure 1 the ECMWF prognostic estimations for weekly mean temperature (left) and total precipitation anomalies (right) over the period 28.02 -06.03.2005 (week 09) are represented. The figure represents MFS products of the two parameters for the week 09, which is detailed in Section 3.1. It can be noticed that for the 2-metre weekly mean temperature we have a strong and constant signal in time for all the anticipations, indicating values much lower than the weekly climatological mean. As the total weekly precipitation, both for the first and the third week is a blanked case (no signal), we used the 12-year “normal” tercile for all the 130 RMS.

2-metre temperature | **Total precipitation**



Legend:

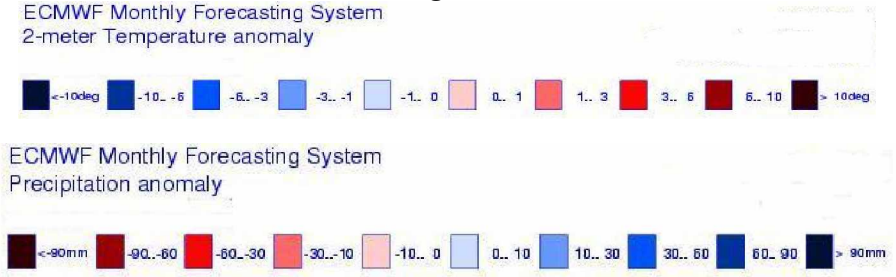


Fig. 1. MFS products for the week 09 (28.02-06.03.2005)

2.2 Validation

In order to compare the real data with those estimated through the procedure briefly described in Section 2.1, the weekly means for 2-metre temperature and total precipitation are computed for all the 130 RMS. These data are associated to three tercile classes from the NMA database in the last 12 years (1993-2004). We used the same period to calculate tercile limits as in the ECMWF outputs. After representing them in space, these data are interpolated in grid points for Romania (1^0 latitude x 1^0 longitude) in order to compute the "weekly" forecast scores with various anticipations. The scores are computed using a standard method (Preisendorfer and Mobley, 1984).

3. RESULTS

The forecasting scores are calculated for weeks 49-th to 52-nd of the last year (2004) and for the first 29 weeks of the current year (2005). Our results for Romania cover very well the cold season of 2004/2005, springtime season of 2005 and the first half of the summer season of 2005.

Table 1 presents the scores of the forecasted temperature terciles for each

Table 1. The scores of the forecasted 2-metre temperature terciles

Month	WEEK NR.		I (%)	II (%)	III (%)	IV (%)
December	49	06-12.12.2004	63.2	86.8	75.0	70.6
	50	13-19.12.2004	75.0	52.9	97.1	94.1
	51	20-26.12.2004	79.4	89.7	88.2	83.8
January	52	27.12-02.01.2005	100.0	50.0	50.0	50.0
	01	03-09.01.2005	88.2	52.9	58.8	50.0
	02	10-16.01.2005	79.4	80.9	73.5	73.5
	03	17-23.01.2005	83.8	80.9	57.4	88.2
	04	24-30.01.2005	82.4	98.5	88.2	50.0
February	05	31.01-06.02.2005	95.6	64.7	60.3	54.4
	06	07-13.02.2005	100.0	100.0	64.7	50.0
	07	14-20.02.2005	82.4	41.2	41.2	86.8
	08	21-27.02.2005	88.2	70.6	50.0	50.0
March	09	28.02-06.03.2005	100.0	100.0	100.0	100.0
	10	07-13.03.2005	95.6	95.6	95.6	95.6
	11	14-20.03.2005	82.4	41.2	63.2	44.1
	12	21-27.03.2005	98.5	88.2	97.1	83.8
April	13	28.03-03.04.2005	72.1	85.3	83.8	79.4
	14	04-10.04.2005	82.4	77.9	92.6	88.2
	15	11-17.04.2005	85.3	64.7	64.7	64.7
	16	18-24.04.2005	39.7	73.5	75.0	75.0
	17	25.04-01.05.2005	51.5	51.5	51.5	51.5
May	18	02-08.05.2005	94.1	55.9	55.9	55.9
	19	09-15.05.2005	100.0	50.0	50.0	50.0
	20	16-22.05.2005	94.1	94.1	58.8	55.9
	21	23-29.05.2005	82.4	52.9	52.9	75.0
June	22	30.05-05.06.2005	60.3	88.2	72.1	52.9
	23	06-12.06.2005	98.5	7.4	50.0	63.2
	24	13-19.06.2005	57.4	94.1	57.4	85.3
	25	20-26.06.2005	77.9	51.5	52.9	52.9
July	26	27.06-03.07.2005	77.9	58.8	52.9	52.9
	27	04-10.07.2005	66.2	100.0	50.0	50.0
	28	11-17.07.2005	97.1	29.4	55.9	52.9
	29	18-24.07.2005	98.5	98.5	51.5	51.5
		MEAN:	**82.4**	**70.5**	**66.3**	**66.1**

week. The mean scores for various weekly anticipations are 82.4% (I-no anticipation); 70.5% (II-one week anticipation); 66.3% (III- two-week) anticipation); 66.1% (IV-three-week) anticipation). Table 2 presents the similar results for total precipitation terciles. The mean scores for the same anticipations are 73.8% (I); 71.3% (II); 70.5% (III); 68.3% (IV).

It can be noticed that both for temperature terciles and total precipitation terciles, the mean scores decrease with the increasing of time anticipation and are quite good, encouraging us to go on with these experiments and finally to decide about their use for operative purposes.

However, the number of analyzed MFS products is still too small to obtain robust statistical results for Romania. In some cases (a) the scores for the no anticipation forecasted weekly temperature mean are much lower than the scores for the one week anticipation of the

Table 2. The scores of the forecasted total precipitation terciles

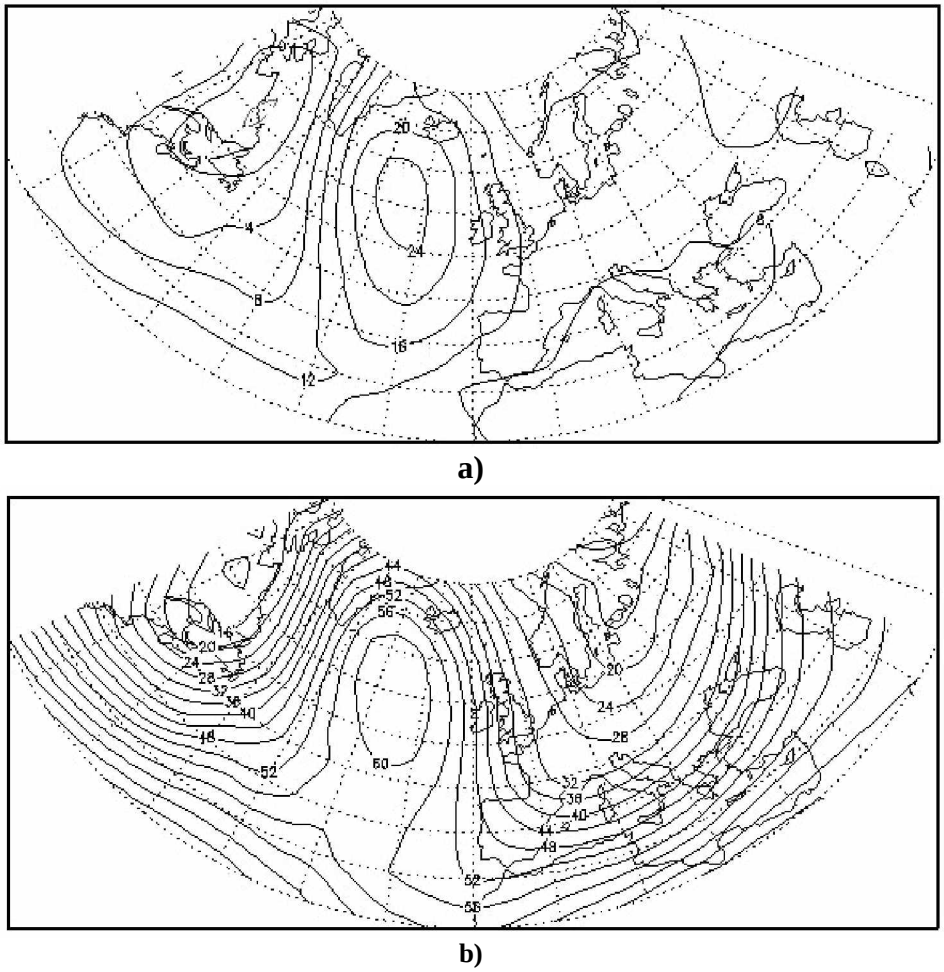
Month	WEEK NR.		I (%)	II (%)	III (%)	IV(%)
December	49	06-12.12.2004	64.7	63.2	63.2	63.2
	50	13-19.12.2004	58.8	72.1	72.1	72.1
	51	20-26.12.2004	51.5	70.6	82.4	77.9
January	52	27.12-02.01.2005	51.5	83.8	83.8	85.3
	01	03-09.01.2005	67.6	63.2	73.5	72.1
	02	10-16.01.2005	55.9	76.5	76.5	76.5
	03	17-23.01.2005	77.9	79.4	76.5	79.4
	04	24-30.01.2005	98.5	98.5	89.7	51.5
February	05	31.01-06.02.2005	61.8	88.2	83.8	86.8
	06	07-13.02.2005	52.9	75.0	72.1	80.9
	07	14-20.02.2005	92.6	91.2	57.4	63.2
	08	21-27.02.2005	88.2	88.2	83.8	58.8
March	09	28.02-06.03.2005	51.5	94.1	82.4	51.5
	10	07-13.03.2005	76.5	57.4	77.9	77.9
	11	14-20.03.2005	77.9	72.1	82.4	82.4
	12	21-27.03.2005	91.2	56.9	58.8	58.8
April	13	28.03-03.04.2005	73.5	72.1	69.1	73.5
	14	04-10.04.2005	97.1	51.5	52.9	52.9
	15	11-17.04.2005	85.3	85.3	75.0	82.4
	16	18-24.04.2005	91.2	58.8	55.9	55.9
	17	25.04-01.05.2005	63.2	63.2	63.2	63.2
May	18	02-08.05.2005	64.7	54.4	54.4	54.4
	19	09-15.05.2005	69.1	76.5	67.6	67.8
	20	16-22.05.2005	83.8	73.5	70.6	70.6
	21	23-29.05.2005	54.4	75.0	75.0	63.2
June	22	30.05-05.06.2005	77.9	80.9	80.9	80.9
	23	06-12.06.2005	98.5	48.5	51.5	51.5
	24	13-19.06.2005	83.8	70.6	70.6	48.5
	25	20-26.06.2005	55.9	67.6	54.4	67.6
July	26	27.06-03.07.2005	82.4	67.6	63.2	67.6
	27	04-10.07.2005	50.0	69.1	52.9	64.7
	28	11-17.07.2005	97.1	23.5	57.4	57.4
	29	18-24.07.2005	88.2	83.8	94.1	94.1
MEAN:			**73.8**	**71.3**	**70.5**	**68.3**

same parameter. That was the situation for the weeks 52, 1, 7, 11, 18, 21, 23, 25, 28, when either cold arctic air penetrating over Romania or warm tropical air influenced the Romanian territory and the MFS products didn't indicate similar features for the second anticipation. On the contrary, there were (b) cases with a much lower score for one-week anticipation than for no week anticipation, such as those for the weeks no. 4, 16, 22, 24, and 27. These are the situations when MFS overestimates or underestimates the mean weekly temperature at the first anticipation. It can be noted that these remarks could be different if analyzing a longer period, as to obtain more confident results.

We were interested in detecting similar (a) and (b) situations for the forecasted weekly total precipitation. So we found (a) cases for the weeks 12, 14, 16, 23, 28 and (b) cases for the weeks 52, 6, 9, 21. The examples given below represent case studies for higher and lower scores, in connection with the AER synoptic background.

3.1. Higher scores

For the week 09 (28.02-06.03.2005), the real mean 500 hPa geopotential heights show (see figure 2b) a deep and extended through over the western AER, including a great part of the Mediterranean basin. This through has permitted the coming of



a)

b)

Fig. 2. a) Real MSLP (mb) for 28.02-06.03.2005 week; **b)** Real mean 500 hPa (damgp) for 28.02-06.03.2005 week

cold arctic air from the northern Europe to its center and then to its eastern part. The pattern of MSLP (see figure 2a) indicates two deep cyclones: one over Scandinavia and the other in the central Mediterranean basin. Such synoptic conditions triggered large amounts of precipitation in Romania, and their total were much higher than the climatological weekly mean, excepting the northern part of Dobrogea.

By comparing the terciles of the real mean weekly temperature with those estimated by the MFS products, we obtained scores of 100 % for all anticipations (see figure 3, left).

The precipitation terciles were also well anticipated by some MFS products: 94.1% (II) and 82.4% (III), but for the first and the fourth anticipations (see figure 3, right) there were "no signal" cases and the scores were of only 51.5% (I and IV).

3.2. Lower scores

We analyze in this section an unusual case, whose forecasting scores are very poor, both for 2-metre temperature and total precipitation (see week 28 in table 1 and 2). Note that this score had an important influence on the mean score values. The detection of such bad results is very important and we have to find out an explanation, as the following one is. In the week no. 28 (11-17.07.2005) the Azores anticyclone was developed over the central Europe (see figure 4a), and sustained in western AER by a strong geopotential ridge (see figure 4b), which had a south-west to north-east axis. In this case the Romanian territory remained in front of this ridge and for this reason a cold polar air mass arrived here from northern Russia.

It must be added that in the first three days of this week (11 to 13.06), a cut-off in altitude occurred in south-eastern Europe. This complex synoptic situation was characterized in Romania by very heavy precipitation with values over 100 mm in all regions (peaks in southern Moldavia, 181 mm at Galati and 216 mm at Penteleu), much higher than the weekly climatological mean. The MFS products indicated below normal temperatures and in excess weekly precipitation amounts only a week before and that is why scores are very good for the first anticipation, but poor for the second one: 97.1% against 29.4% for 2-metre temperature (see figure 5) and 97.1% against 23.5% for total precipitation (see figure 5).

4. CONCLUSIONS

The results presented in this study are preliminary, due to the short analysis period. However, the rather high scores obtained justify our continuing of this kind of experiments for Romania, so as to use them systematically in the operative forecasts. As expected, the best scores were obtained for the week I. Therefore, detailed MFS products for no anticipation can be used as additional materials to the deterministic ones, in order to raise the medium range forecast quality for Romania.

The promising results obtained for weeks II and III lead to the idea that soon the medium range weather forecast could be extended over the time range of 11 to 25 days.

Poor results were obtained when week IV was concerned, although, on an average, the scores obtained were close to those for weeks II and III.

So that we would rather not use the MFS products for three-week anticipations but will wait the new improvements of MFS products.

WEEK 09 : 28.02-06.03.2005

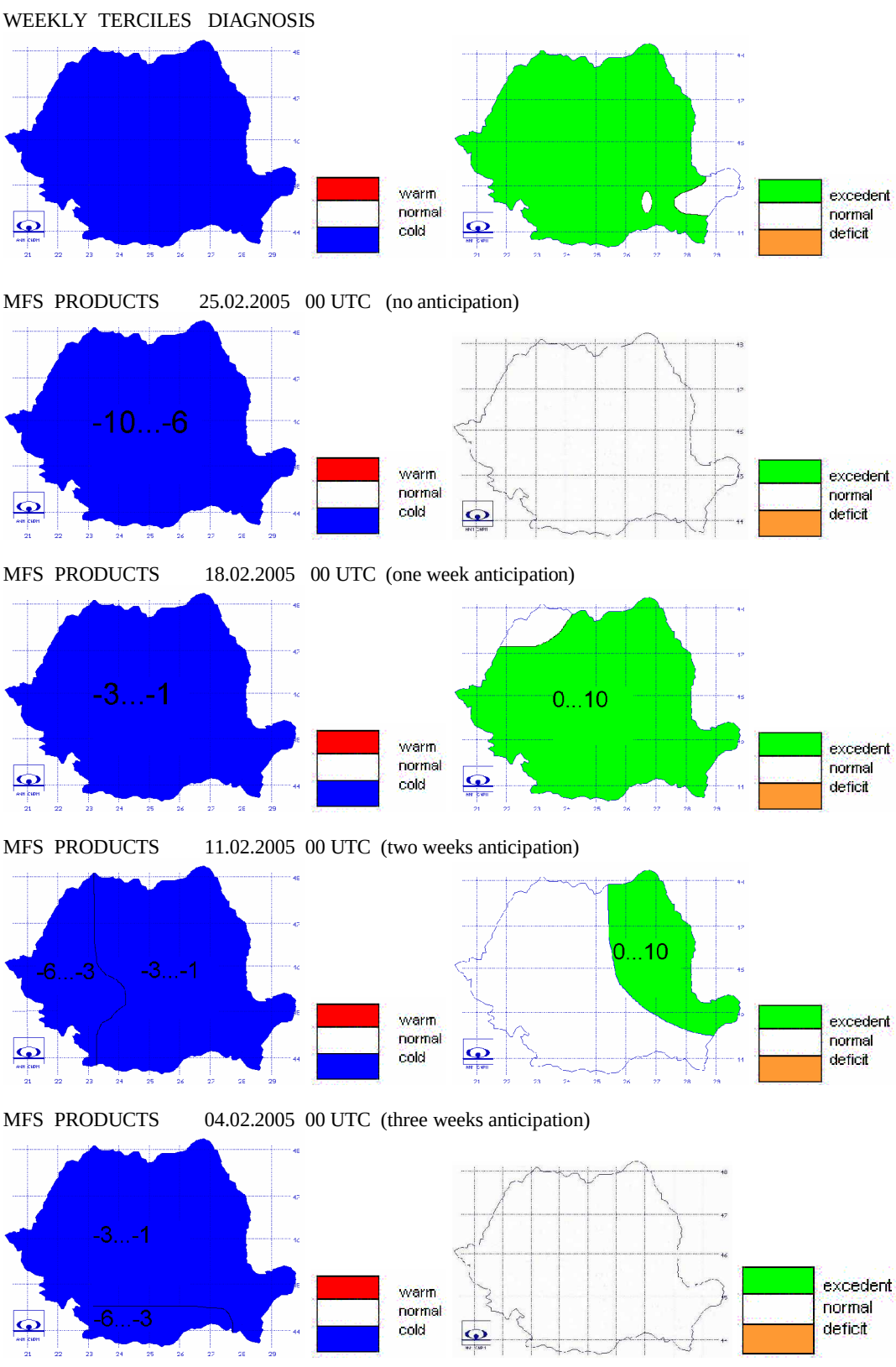


Fig. 3. MFS products for all the anticipation and terciles for 2-metre temperature (left) and total precipitation (right) for the week 09 (28.02-06.03.2005)

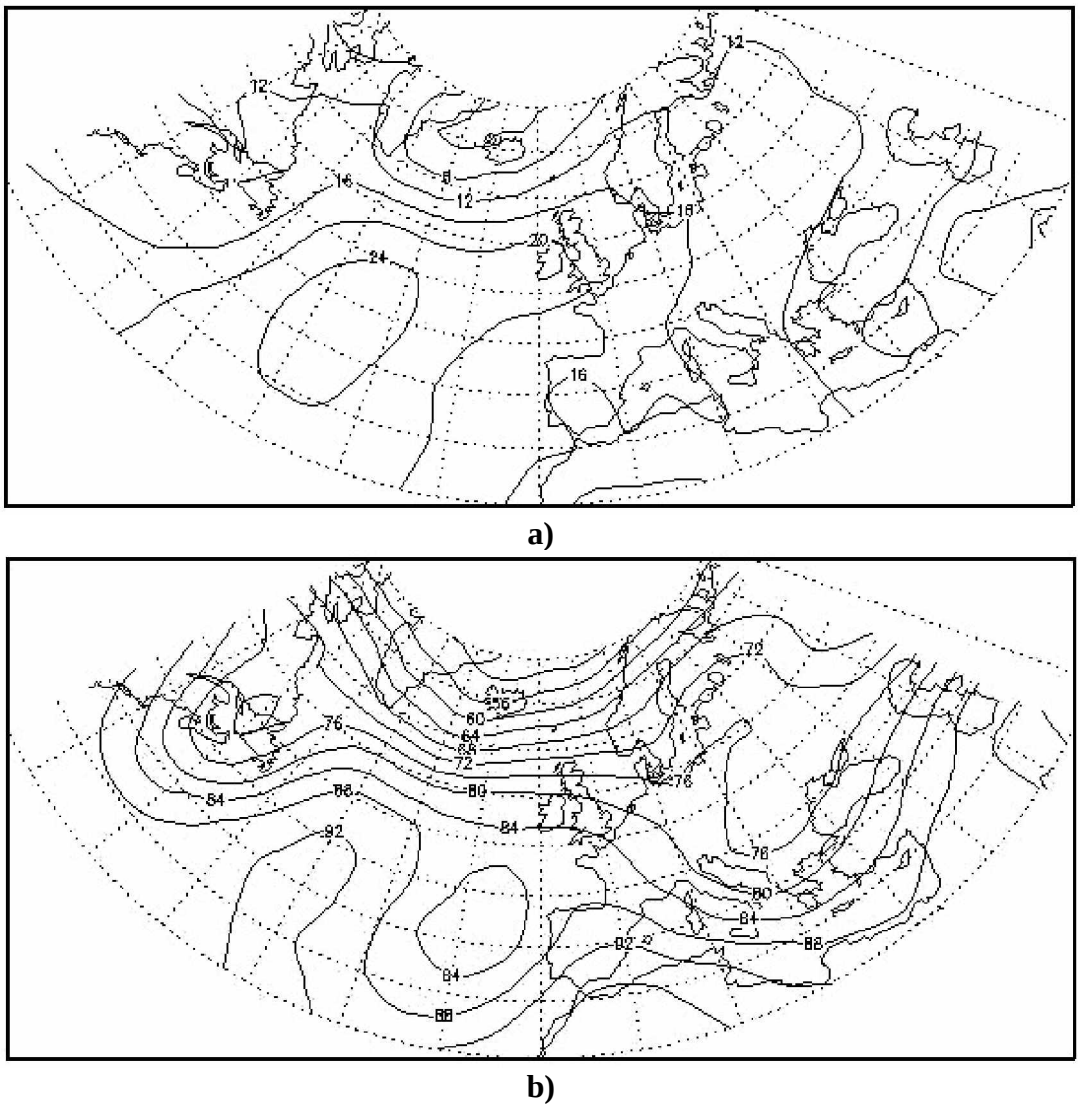


Fig. 4. a) Real MSLP (mb) for 11-17.07.2005 week**; b)** Real mean 500 hPa (damgp) for 11-17.07.2005 week

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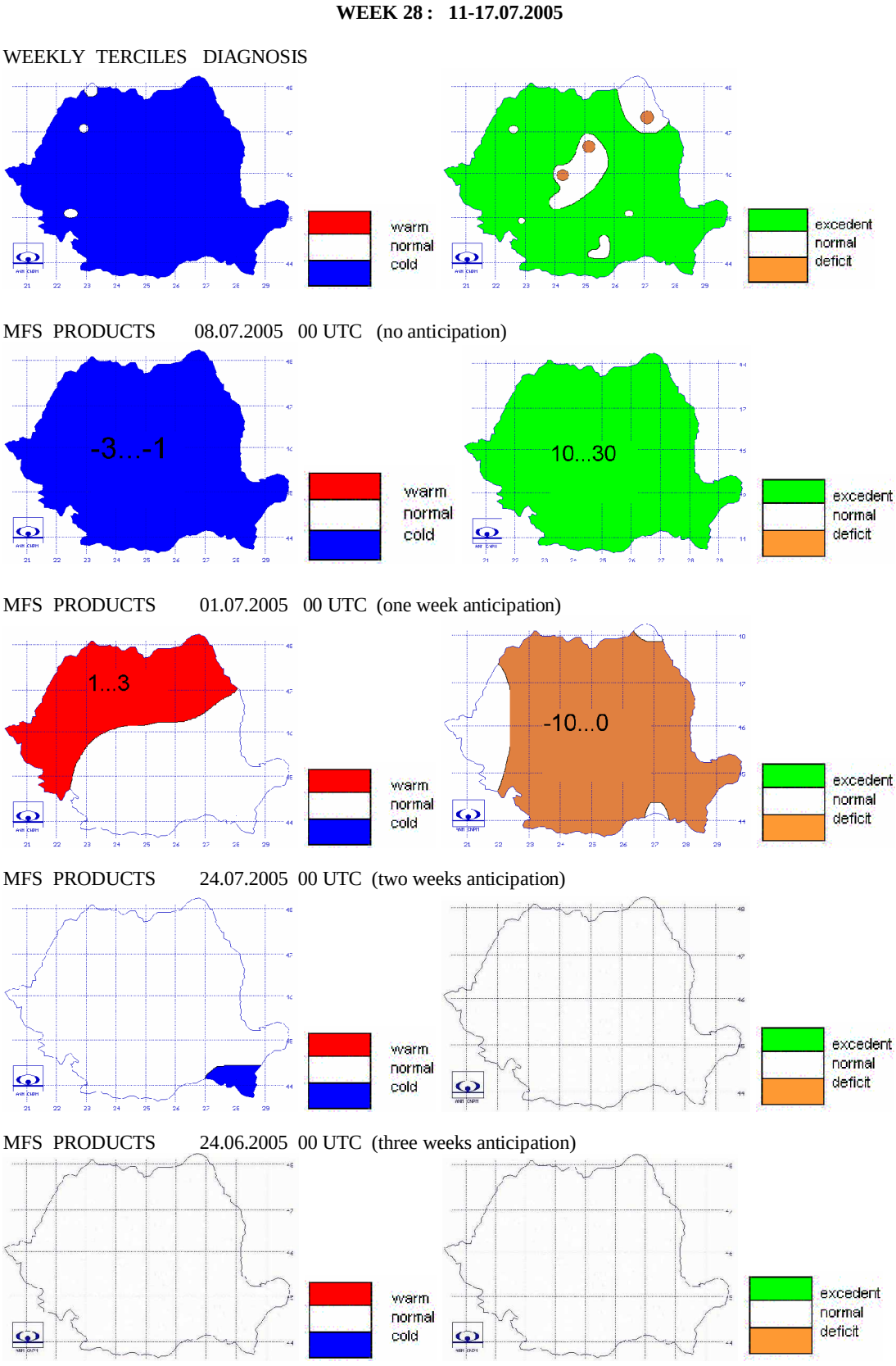

Fig. 5. MFS products for all the anticipation and terciles for 2-metre temperature (left) and total precipitation (right) for the week 28 (11-17.07.2005)

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