PLUVIAL HAZARDS IN OLTENIA IN MAY 2012

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ABSTRACT.- Pluvial hazards in Oltenia in may 2012. The paper analyses the situations of abundant precipitation, with torrential rains and severe weather cooling in May 2012. May came after a very rainy April, and these rainfalls caused an excess of humidity in soil, damages of communication networks and rapid floods. Weather cooling in some intervals of time has led to the stagnation of plants' vegetative processes and the late appearance of vegetables and fruits on the market. The diseases and pests favoured by the excessively moist weather have caused series of damages in vegetables and fruits crops. May 2012 has been one of the rainiest months of the last decade, and in Polovragi ***a monthly quantity of 350 l/m²*** was registered***, constituting an absolute pluviometric record of May for this meteorological station.*** Air temperature had a decreasing trend during the entire month, which constitutes an anomaly for May. The monthly maximum thermal values were registered on May 12, 2012, precisely in the previous day of the beginning of rainfalls, and the minimum thermal values were registered on de May 29, 2012. The quantities of precipitations registered in May 2012 were comprised between 73.3 l/m^2 in Caracal and 350.0 l/m^2 in Polovragi, which compared to the multiannual monthly average quantities, calculated in percentages for the interval 1901-1990 show values comprised between -6.2% in Voineasa and 236.9% in Polovragi. Therefore the paper analyses an important climate oscillation in Oltenia in May. The analysis of the climatic conditions in the south-west of Romania in May 2012 is a continuation of some extended studies on climate variability (Bogdan and Niculescu, 1999, Marinică, 2006). The paper is useful to specialists, doctoral candidates and master graduates and to all people interested in the climate's evolution.

Key words: *Mediterranean Cyclones, torrential rains, excedentary precipitations, thermal and hydric stress.*

1. Introduction

In the spring of 2012, in Oltenia, weather evolution has been marked by an exceptional variability with fast transitions from a warm weather to an extremely

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cold and even excessively cold in some intervals and from an excessively rainy weather to a droughty weather. These fast transitions from one extreme to another of weather aspect are due to the increase of climatic variability, an aspect which is directly connected to climatic global warming. We will further analyse this climatic variability and its causes.

2. Data and methods

The data used in the synoptic analysis from the case studied were provided by the Global Model European Center for Medium range Weather Forecasting - ECMWF, and the data for the mesoscale analysis were provided by ALARO Regional Model. We used satellite images METEOSAT9 (IR 10.8), source www.eumetrain.org. We also used products of Doppler radar in C-band from Craiova namely:

-Precipitation Intensity- Corrected intensity (PPI R): measures the instantaneous intensity of precipitations (mm/h). Mediate values of pressure, geopotential and temperature were obtained through the generation of products of Earth System Research Laboratory – Physical Science Division (http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/comp.day.pl).

We made a synoptic analysis on these data for baric, thermal and geopotential structures. The values of atmospheric parameters were compared with the multiannual means in order to characterise the general context in which the atmospheric instability and weather cooling from the case study occurred.

3. General synoptic characteristics of May 2012

From a synoptic point of view, May 2012 was characterised by the domination of poor anticyclonic fields for 17 days, and the cyclonic ones for 14 days.

The average pressure field at the continent level (Fig. 1) shows that the south-east of the continent was dominated by an average depression field with values comprised between 1008 and 1015 hPa, and in Romania the values of this field were comprised between 1012 and 1014 hPa, which indicates a severe weather instability for the overall May. This instability, for Oltenia, materialized through the 26 days of rainfall of which 6 days with abundant precipitations whose daily mean for the entire region exceeded 17.0 l/m^2 (Fig. 2).

The deviations of the average pressure field at the level of the entire country from the multiannual means calculated for the period 1981-2010 were negative and were comprised between -2 and -0.5 hPa.

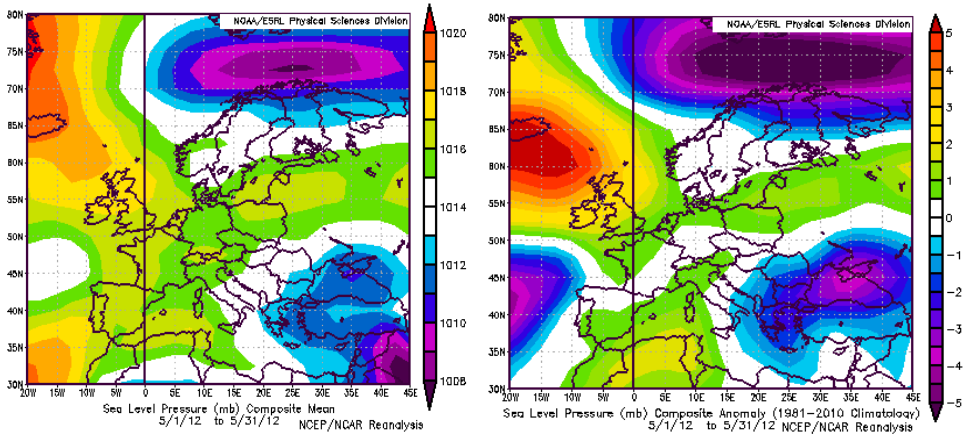

Figure. 1. The average pressure field on the European continent in May 2012 (left) and the anomaly from the multiannual means calculated for the interval 1981-2010 (according to http://www.esrl.noaa.gov/psd/data/composites/day/).

4. Pluviometric characteristics of May 2013

The rainiest and most compact period was the interval May 13-17, 2012 with the peak on May 13, 2012 (the mean for the entire region was 19.0 l/m^2). *The second rainy period* was registered in the interval May 22-27, 2012 with a "peak" on May 22 (the mean for the entire region was 18.7 l/m^2).

The monthly quantities of precipitations registered at the meteorological stations from Oltenia were comprised between 73.3 l/m^2 in Caracal in the south-east of the region and 350.0 l/m^2 in Polovragi in the subcarpathian area (table 1).

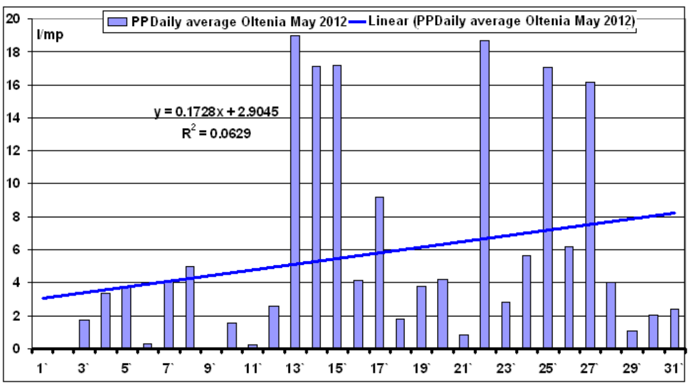

Fig. 2. The daily average precipitations calculated for the entire region of Oltenia, in May 2012 (Source: Processed data).

Table 1, The precipitations registered in Oltenia in May 2012 and their deviations from the multiannual means 2013 calculated for the interval 1901-1990*

Meteorological Station	**S**	**N**	**Δ=S-N**	**Δ%**	**CrH**
Dr. Tr. Severin	174.2	80.7	93.5	115.9	**ER**
Calafat	120.4	60.8	59.6	98.0	**ER**
Bechet	94.2	58.6	35.6	60.8	**ER**
Băileşti	106.8	70.1	36.7	52.4	**ER**
Caracal	***73.3***	61.4	11.9	19.4	**LR**
Craiova	110.6	60.6	50.0	82.5	**ER**
Slatina	121.0	64.8	56.2	86.7	**ER**
Bâcleş	150.1	74.9	75.2	100.4	**ER**
Tg. Logreşti	180.4	73.4	107.0	145.8	**ER**
Drăgăşani	129.4	69.7	59.7	85.7	**ER**
Apa Neagră	175.4	108.8	66.6	61.2	**ER**
Tg. Jiu	175.2	85.3	89.9	105.4	**ER**
Polovragi	**350.0**	103.9	**246.1**	**236.9**	**ER**
Rm. Vâlcea	165.4	97.3	68.1	70.0	**ER**
Voineasa	89.6	95.5	***-5.9***	***-6.2***	**N**
Parâng	178.0	114.8	63.2	55.1	**ER**
Average Oltenia	149.6	80.0	69.6	86.9	**ER**
Halânga	188.4		188.4		
Ob. Lotrului	137.8		137.8		

(Source: Processed data)

*S = Sum of precipitations in May, N = normal values, Δ=S-N = quantitative deviation, Δ% = percentage deviation, ER=Excessively Rainy, LR= Little Rainy, N= Normal

The percentage deviations of monthly means of precipitations from the multiannual means calculated for the interval 1901-1990 were comprised between -6.2% in Voineasa and 236.9% in Polovragi, which according to Hellmann criterion means that May 2012 was an exceedingly rainy month in the entire region with some exceptions on restricted areas, a fact also confirmed by the mean deviation for the entire region (86.9%) (tab. 1).

In Mehedinți, Gorj, Vâlcea Counties, at 13 pluviometric posts the monthly quantities of precipitations exceeded 200.0 l/m^2, and at a post over 300.0 l/m^2, these were:

-in Mehedinți: in Cloşani 206.0 l/m^2, in Sişeşti 223.5 l/m^2;

-in Gorj: in Sadu 201.2 l/m^2, in Runcu 208.2 l/m^2, in Tismana 211.0 l/m^2, in Rovinari 211.5 l/m^2, in Turburea 221.9 l/m^2, in Tg. Cărbuneşti 249.7 l/m^2, in Baia de Fier 233.8 l/m^2, in Nistoreşti 265.8 l/m^2;

-in Vâlcea: in Genuneni 220.5 l/m^2, in Olăneşti Băi 287.2 l/m^2 and ***in Vaideeni 316.0 l/m^2***.

5. Thermal characteristics of May 2013

There is an inverse correlation between the pluviometric and thermal regime in the periods when the precipitations increase, air temperature drops. In May 2012 there were two distinct intervals: a warm and a droughty one between May 1-12 and a cool (even cold in some days) and rainy interval, May 13-31.

Table 2. Thermal regime in Oltenia in May 2012 (N V = normal monthly mean temperature in May, M V = monthly mean temperature in May 2012*.

Meteorological Station	Hm	N V	M V	Δ=M-N	CrH	Min.T air		Max.T air	
						°C	Date	°C	Date
Dr. Tr. Severin	77	17.1	17.9	0.8	**N**	**9.0**	9	31.7	12
Calafat	66	17.3	18.0	0.7	**N**	8.5	18	**33.0**	12
Bechet	65	17.5	17.5	0.0	**N**	7.8	2	31.7	3
Băileşti	56	17.4	18.3	0.9	**N**	7.8	9	32.9	12
Caracal	112	17.1	17.6	0.5	**N**	8.8	29	30.7	12
Craiova	190	17.0	17.2	0.2	**N**	8.5	9	30.6	12
Slatina	165	16.9	16.9	0.0	**N**	8.4	29	30.5	12
Bâcleş	309	15.5	16.4	0.9	**N**	7.6	17	29.6	12
Tg. Logreşti	262	15.3	15.8	0.5	**N**	***4.7***	9	29.7	12
Drăgăşani	280	15.8	17.0	1.2	**WS**	7.8	29	30.2	11
Apa Neagră	250	15.1	17.6	2.5	**W**	4.8	29	30.5	12
Tg. Jiu	210	15.9	17.0	1.1	**WS**	7.2	29	31.1	12
Polovragi	546	14.3	15.5	1.2	**WS**	5.7	29	***28.1***	12
Rm. Vâlcea	243	15.4	17.0	1.6	**WS**	8.2	29	31.3	11
Voineasa	587	12.1	13.9	1.8	**WS**	6.1	29	29.1	1;2
Parâng	1585	7.1	8.9	1.8	**WS**	-0.4	18	19.8	2;3
Average Oltenia		15.4	16.4	1.0	**WS**	6.9		30.0	
Ob. Lotrului	1404	7.2	8.9	1.7	**WS**	0.1	1	24.2	1
Halânga			14.6			6.2	29	28.2	2

(Source: Processed data)

* Δ = deviation, CrH = Hellmann criterion, WS=Warmish, W = Warm, N = Normal

The monthly maximum temperature values were comprised between 28.1°C in Polovragi and 33.0°C in Calafat, both registered on May 12, precisely in the previous day of the beginning of the rainy period.

The monthly minimum temperature values were comprised between 4.7°C in Tg. Logreşti and 9.0°C in Dr. Tr. Severin registered on July 9.

The monthly temperature means were comprised between 13.9°C in Voineasa and 18.3°C in Băileşti, and their deviations from the multiannual means calculated for the interval 1901-1990 were comprised between 0.0°C in Slatina and 2.5°C in Apa Neagră, determining a classification of normal month from a thermal point of view for the half southern region and warmish (WS) for most part of the northern half, excepting a restricted area in Apa Neagră where it was warm (W) (table 2).

The chart of the daily average air temperature variation calculated for the entire region indicates a decreasing linear tendency (fig. 3), which for May constitutes a ***thermal anomaly***. This anomaly of May often occurs and is caused by the severe cooling from the second part of May. These cooling cause damages of plants, stagnation of vegetative processes and delays of plants' growing especially in the crops of vegetables, which lead to the late appearance of vegetables on the market.

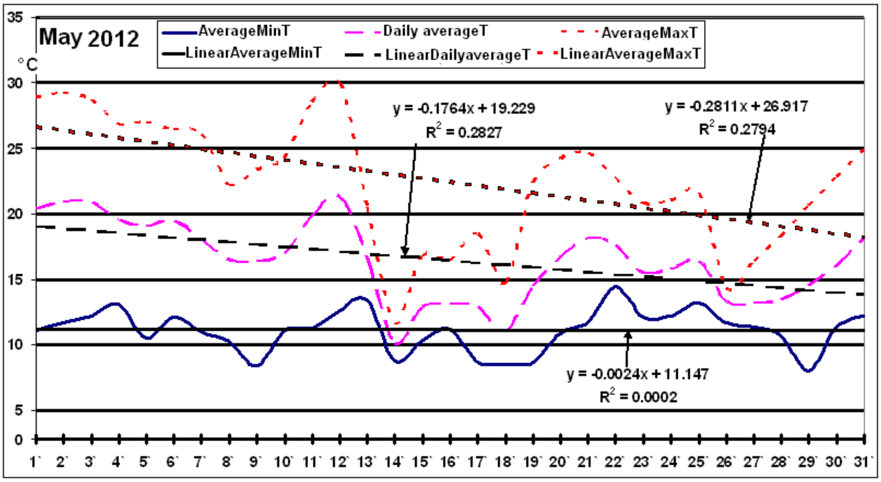

Figure 3. Variation of air temperature in May 2012 (mean of daily maximum thermal values, daily mean and mean of daily minimum thermal values calculated for the entire region) (Source: Processed data).

We notice the *cooling intervals* May 8-10, 16-18 and 23-30 which totalize 14 days. *The maximum intensity of weather cooling* was registered on May 9 when the minimum temperature values dropped below 11.2°C. The lowest maximum temperatures were registered on May 26 when dropped below 17.3°C

6. Synoptic causes of rainy periods

6.1 The rainfalls in the interval May 13-17, 2012

The rainfalls in this interval were caused by the evolution of a Mediterranean Cyclone on the transbalkan trajectory of Vc type, which had in some intervals of time a retrograde movement (according to Van Bebber quoted by Doneaud and Beşleagă (1966).

The Mediterranean cyclogenesis of Genoa Golf began on May 12, 2012, and at 18 o'clock UTC, over Genoa Golf, the Mediterranean Cyclone with has been already formed with the isohypse of 1015 hPa closed.

The process of cyclogenesis began and developed in the thalweg of altitude of the low geopotential field corresponding to the soil cyclonic field, helped also by the sheltering effect of Alpes ("sheltering cyclogenesis", the Serbian meteorologist Radinovici, quoted by Ec. Ion Bordei, 1983) (Fig. 4).

The cyclogenesis of Adriatic Sea occurred in the same time, leading at short time to the appearance of two cyclonic nuclei in the west and east of Italy (fig. 4), and subsequently the two nuclei merged.

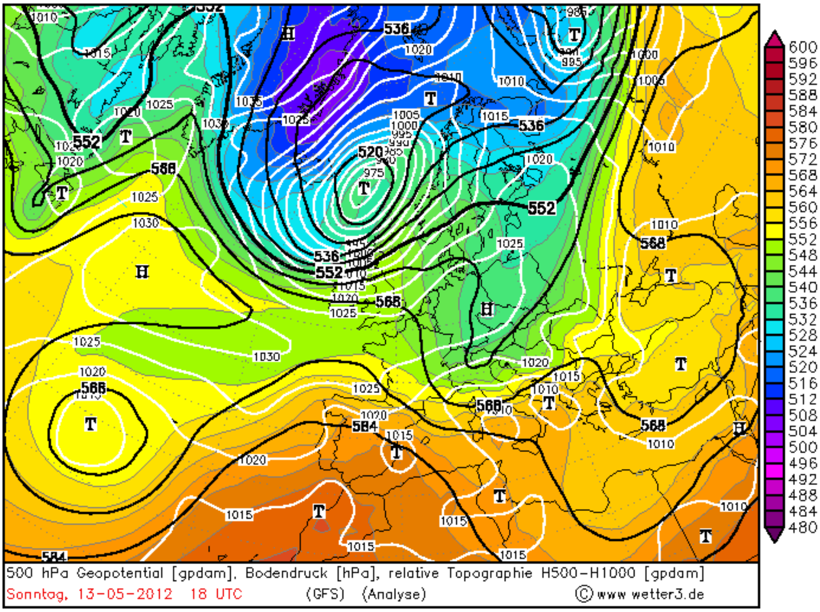

Figure. 4. The field of pressure at the soil level superposed on the geopotential one at the level of 500 hPa and TR500/1000 baric relative topography over Europe on May 13, 2012 at 18 o'clock UTC (according to http://www.wetter3.de/Archiv/).

The air mass which influenced Romania in this interval was a mass of mixture of mP+mT. The mass of polar marine air mP moist and cool was advected by the circulation of altitude due to the thalweg of geopotential from Atlantic Ocean (fig. 4), and also to the circulation from the inferior troposphere at the periphery of Azores High. The mass of cPw air which was pre-existent in the area of our country was replaced. The mass of mT air over Mediterranean Sea was somehow advected due to the altitude circulation, the geopotential thalweg extended fast towards the southern half of Italy. A moist air supply was also due to the advection of the mass of air situated over Black Sea, produced by the air circulation from the inferior troposphere. Consequently, there was a situation of rapid cyclogenesis of Genoa Golf and Adriatic Sea, with triple supply with moist and rich in water vapour air. The persistency and slow movement of the cyclone on the trajectory with intervals of retrograde movement caused the occurrence of some intervals of intense waterfalls in Oltenia.

6.2 Rainfalls in the interval May 22-27, 2012

In this interval there are three days with significant precipitations on: May 22, 25 and 27 in which the daily means of precipitations calculated for the entire region were 18.7 l/m^2, 17.0 l/m^2 and namely 16.2 l/m^2, and the maximum quantities registered in these days were: 79.0 l/m^2 in Siseşti in Mehedinți County, 49.0 l/m^2 in Tismana in Gorj County and 58.0 l/m^2 in Răcari in Dolj County.

–***The rainfalls from May 22, 2012*** were caused by a strong Mediterranean Cyclone initially formed on May 19 over Lion Golf in the thalweg of Iceland Depression which evolved subsequently on a trajectory of Vc type over Romania (right over Oltenia) (fig. 5).

On May 22, 2012 at 12 o'clock UTC at the soil level the cyclonic nucleus was places over the west and south-west of the country, and the pressure values of the cyclone central area were below 1005 hPa.

In altitude at the level of 500 hPa the cyclone nucleus, with values of the geopotential below 560 damgp was placed over Italy and Adriatic Sea, and the air circulation was south-western, bringing over our country a tropical marine air (mT), rich in water vapours. At that time on extended areas in Central and South-Eastern Europe Europa abundant rainfalls were registered, and at 18 o'clock UTC, the main nucleus of rainfalls was placed in the south-west of the country and the north of Balkan Peninsula (fig. 6).

–***The rainfalls on May 25, 2012*** were caused by a retrograde cyclone formed over Crimea Peninsula in the quasistationary depression field in warm season over the South-East of Europe and Asia Minor Peninsula. This depression field causes weather instability during afternoons in the east and south of Romania, known in literature as *summer north-eastern incidence.*

Under particular conditions this type of circulation causes the coast cyclogenesis of Black Sea (Ion Drăghici 1988), that the author places on the Romanian shore of Black Sea.

For the Western, Central and Northern Europe, air circulation was a blocking circulation, and Eastern Europe was situated in this interval in the anterior side of the atmospheric blocking.

In this case, the cyclogenesis occurred over Crimea Peninsula, and air circulation from the north-eastern sector caused the downgrade of the cyclonic nucleus towards Danube Delta, causing a continuous supply with cool and moist

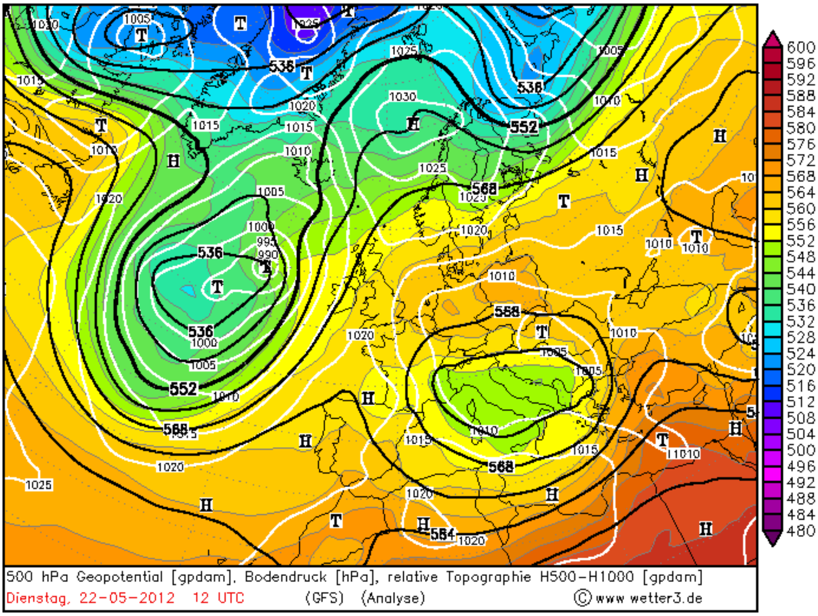

Figure 5. The field of pressure at the soil level superposed on the geopotential one at the level of 500 hPa and TR500/1000 baric relative topography over Europe on May 22, 2012 at 12 o'clock UTC (according to http://www.wetter3.de/Archiv/).

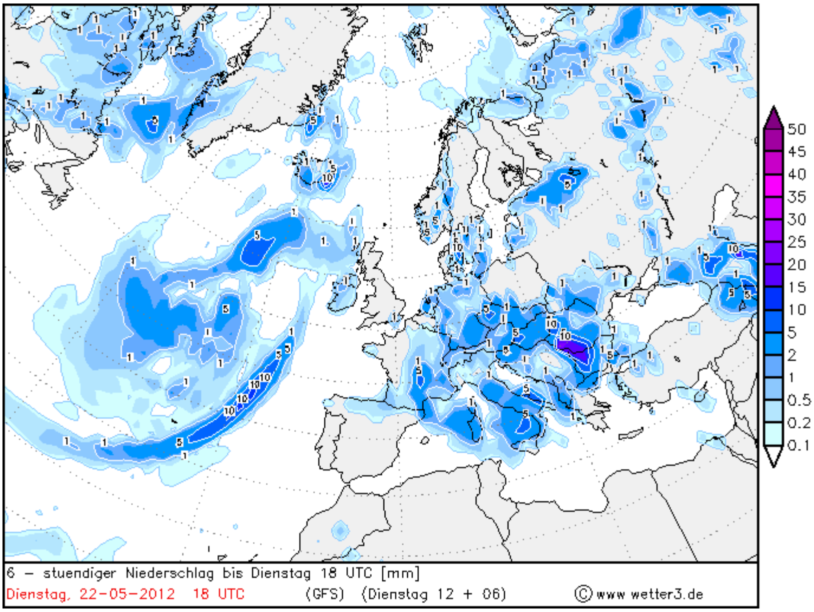

Figure 6. The field of precipitations over Europe on May 22, 2012 at 18 o'clock UTC (according to http://www.wetter3.de/Archiv/).

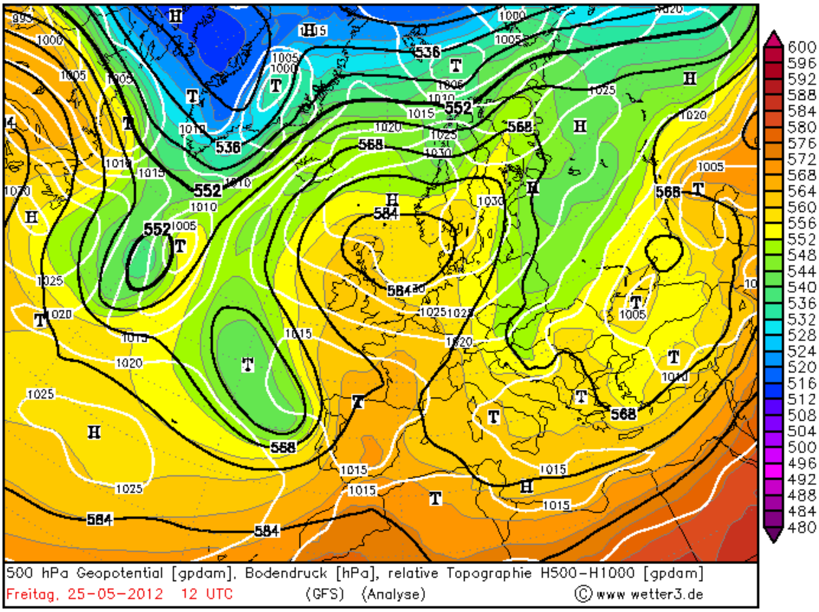

Figure 7. The field of pressure at the soil level superposed on the geopotential one at the level of 500 hPa and TR500/1000 baric relative topography over Europe on May 25, 2012 at 12 o'clock UTC (according to http://www.wetter3.de/Archiv/).

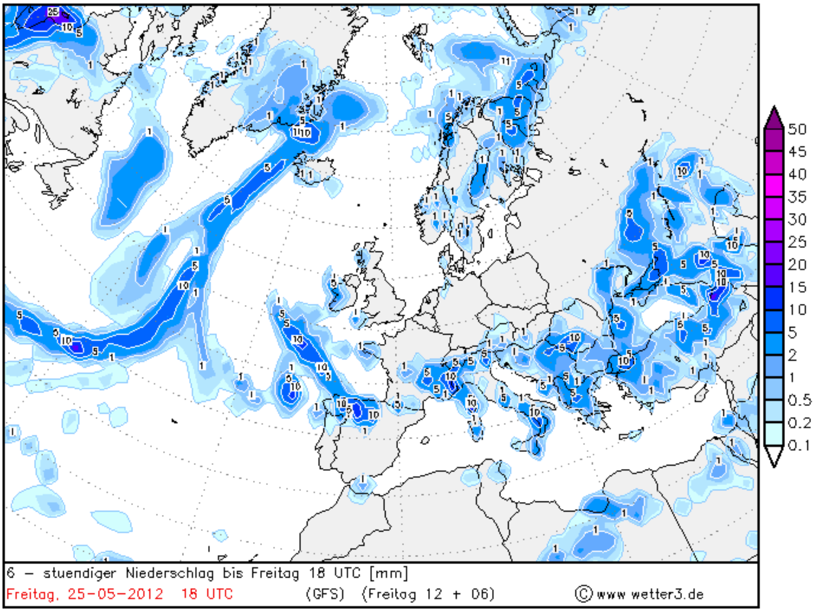

Figure 8. The field of precipitations over Europe on May 25, 2012 at 18 o'clock UTC (according to http://www.wetter3.de/Archiv/).

air over Black Sea, Northern Seas and Atlantic Ocean which was advected by the altitude circulation (fig. nr. 7). The downgrade of the baric thalweg from the anterior side if atmospheric blocking occurs naturally as a consequence of the deviation action of Coriolis force over the cold air advected from the north-eastern sector, and the interaction of air circulation with the relief specific to the east and south of Romania amplifies the processes of precipitation and contributes to the completion of the cyclogenesis process, which occurs systematically.

The field of precipitations in this situation occupies a significant part in the south and especially in the South-East of Europe (fig. no. 8), and in Oltenia it can be noticed the intensification of precipitation as a consequence of the orographic blocking effect produced by the Carpathian-Balkan Curvature and also by the interaction of air circulation with the terraced relief of the region.

–***The rainfalls on May 27, 2012*** were caused by a retrograde altitude cyclone, formed at the north-west of Romania over Slovakia, Poland and Ukraine.

The synoptic situation on May 27, 2012 at 18 o'clock UTC is typical for this case: over Western and Central Europe there was a blocking atmospheric circulation (fig. nr. 9). Eastern Europe was placed on the anterior side of the atmospheric blocking.

In altitude for this large area, air circulation was from the northern and north-eastern sector, with a mass of warm mP+cP, moist and cool air.

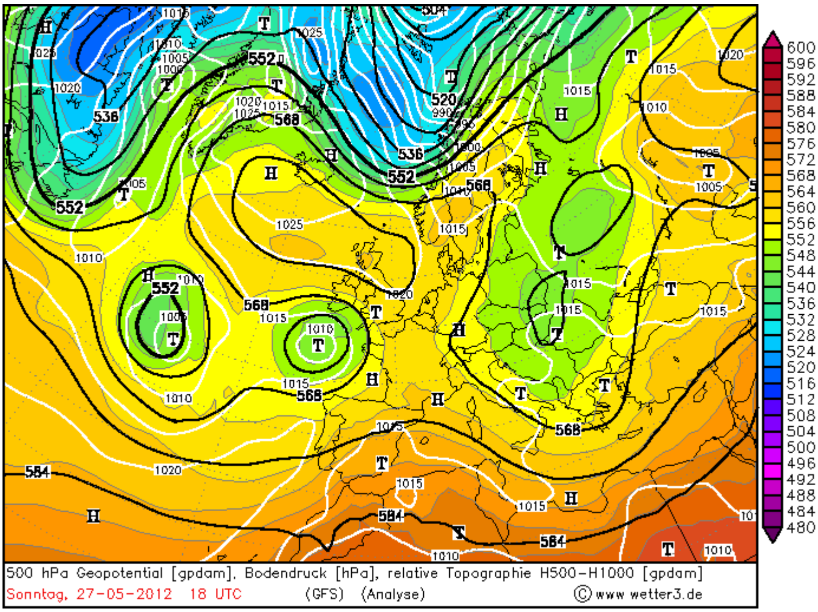

Figure 9. The field of pressure at the soil level superposed on the geopotential one at the level of 500 hPa and TR500/1000 baric relative topography over Europe on May 27, 2012 at 18 o'clock UTC (according to http://www.wetter3.de/Archiv/).

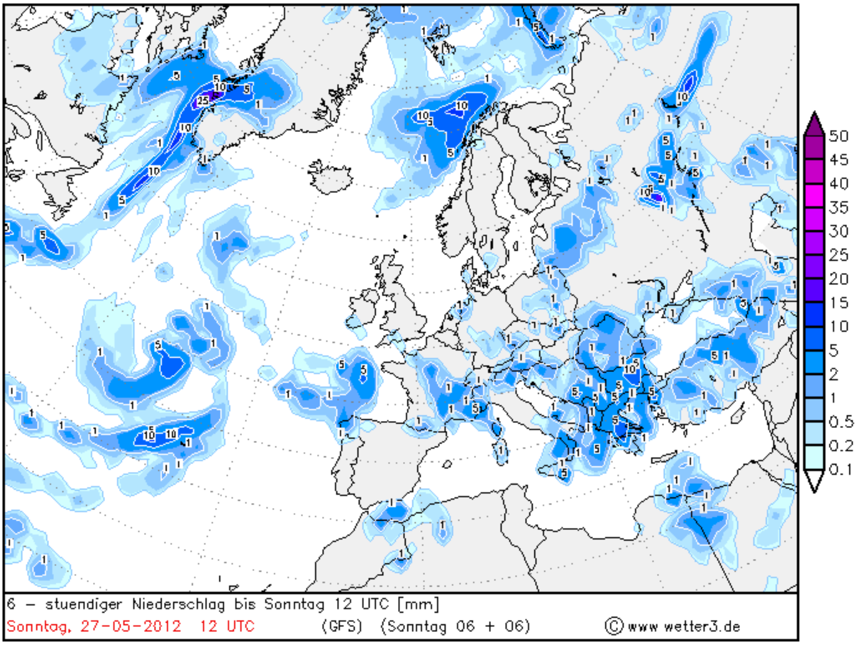

Figure 10. The field of precipitations over Europe on May 27, 2012 at 12 o'clock UTC (according to http://www.wetter3.de/Archiv/).

For Romania in the inferior troposphere it can be noticed an air circulation from eastern sector, with the mass of air rich in water vapours advected from over Black Sea.

In the altitude thalweg from the anterior side of atmospheric blocking cyclogenesis processes can be observed, caused by the advection of cool and moist air towards south and south-east.

Coriolis deviation force imprinted a retrograde trajectory to this cyclone, and the interaction with Carpathian mountainous chain amplified the precipitation processes.

Cyclone trajectory was initially towards south-west and afterwards towards south-east and east on May 28, 2012 at 06 o'clock UTC, at the soil level, in the east of Balkan Peninsula and west of Black Sea there was a Mediterranean Cyclone in the altitude thalweg of the atmospheric blocking.

The intense field of precipitations in this case was extended and covered the south-east of Europe and Asia Minor (fig. 10).

The most significant quantities of precipitations were registered in the hilly area and in Subcarpathians, as a consequence of the relief interaction with the atmospheric circulation.

Conclusions

In May 2012, there was a special climatic variability, after a period of 12 days in which weather was warm and droughty beginning with 13 May weather characteristics suddenly changed, because of the change of atmospheric circulation types over Europe. The frequent advections of moist and cool advections, the cyclogenesis processes of Mediterranean Sea and those from the anterior thalweg of atmospheric blocking circulations caused the formation of strong cyclones which brought significant quantitatively precipitations on extended area in the south and south-east of Europe including Romania.

Therefore we notice the ***4 waves of abundant and torrential rains*** which in Romania caused the registration of significant quantities of precipitation.

The rainfalls were accompanied by the significant weather cooling and caused an excess of humidity in soil, water bogging in low areas, fast floods in low regions, destructions of infrastructure elements (bridges and footbridges, landslips which damaged some highways and some part of railway lines).

In vegetable crops, vineyards and orchards series of diseases and pests specific to rainy and cool weather appeared and developed fast, which needed suitable treatment.

The last interval of significant rainfalls in the warm season 2012 was on June 1 followed by a warm and droughty summer and autumn of 2012.

The beneficial effect of these rainfalls consisted in the fact that water reserve in the soil contributed to a good development of crops up to the half of June.

Rainfalls occurred due to Mediterranean and retrograde Cyclones formed in the anterior thalweg of atmospheric blocking situations.

The circulation of atmospheric blocking often occur in the second part of spring, as a consequence of the intensification of the air advection from the North of Africa over the West of Europe, also supported by the presence of Golf Stream. Consequently, over Western and Central Europe a warm dorsal naturally occurs, and over Eastern Europe a thalweg of cold and cool air in which cyclogenesis phenomena occur. The action of Coriolis deviation force causes the downgrade of the baric thalweg peak towards south-west and supports the retrograde trajectory of formed cyclones.

Usually cyclones downgrade (finding from synoptic practice) by the time interact with Carpathian chain, causing the intensification of precipitation processes and therefore registers significant precipitations and after this “moment”, their trajectory becomes normal and moves away from the Romanian territory.

Consequently, apart from the Mediterranean Cyclones, the retrograde cyclone which form in the north-east of Romania in the anterior thalwegs of atmospheric blocking circulations lead to a significant contribution in nuancing the pluviometric regime in our country including in Oltenia.

The situation in May 2013 as droughty and warmish summer is directly connected with the North-Atlantic Oscillation.

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