

# CONSIDERATIONS ON WEATHER WARMING IN THE PERIOD 10-15 JUNE 2010

I. MARINICĂ<sup>1</sup>, IULICA VĂDUVA<sup>2</sup>, ANDREEA FLORIANA MARINICĂ<sup>3</sup>

## **Abstract.- Considerations on weather warming in the period 10-15 June 2010.**

This paper analyzes the heat wave in the 10-15 June 2010 period, which was the most intense heat wave of June 2010 and also one of the earliest heat waves of this month in the entire history of the meteorological observations in Romania. The analysis highlights the physical process producing this heat wave, and its consequences. Although the whole month of June was considered a normal month regarding temperature in Romania, this situation shows that heat waves also occur in normal months. The paper is useful to master and PhD students and generally to specialists in climatology.

**Key words:** heat waves, daily temperature records, tropical air masses.

## **1. Introduction**

June is the first month of summer. It is characterized by the alternation of warm sunny days with maximum temperatures often above 30°C, with cloudy and cool or even cold days where the rain showers often give large amounts of precipitation in a short time. June is the most instable month of the year, and this is due to the characteristics of moist oceanic air masses (mP) conveyed to our country by the Azores Anticyclone dorsal and also due to the activity of Mediterranean cyclones which bring warm moist air masses.

**Regarding the temperatures of June** we can say that June is not as warm as July and August, but an important thermal feature is that *it is the first month of the year when the air temperature can reach 42 ° C* (Bogdan, Marinică, 2010, Văduva, Vlăduț, 2008, Văduva et al. 2009).

**The average monthly temperatures:** very rarely, the average monthly temperatures slightly exceed 20°C in the Romanian Plain and Dobrudja. The average monthly temperatures range between 18 and 20°C in the Western Plain, the Mureș corridor, central and southern parts of Moldavia and in the hilly areas of Oltenia and Muntenia.

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<sup>1</sup> Regional Meteorological Center Oltenia, ionmarinica@yahoo.com.

<sup>2</sup> Spiru Haret University, Faculty of Geography, Bucharest, iulicavaduva@yahoo.com.

<sup>3</sup> Jacobs University, Earth and Space Science, Bremen, gGmbH, seryblack@yahoo.com

In the rest of the territory excepting the mountains, the average monthly temperatures range between 15 and 18°C. In the mountain area these values range between 7 and 15°C.

***The maximum June temperatures:*** In some years June was very warm and dry and the maximum temperatures exceeded 40°C, being recorded even 42°C in the south-western part of Romania. One such year was 2007 when during the 22-26 June 2007 period the intensity of the heat wave reached 42°C in Oltenia (in Cujmir locality of Mehedinți County, at 16<sup>10</sup> on 26 June 2007), the thermometer from the meteorological station indicated 42.0°C. It was for the first time when in June there was recorded the value of 42°C in Oltenia in the entire history of the meteorological observations. The literature shows that in the past century in June only once the temperature reached 42°C in Romania, namely on 29 June 1938 there were recorded 42.0°C in Oravița, which until today it is the absolute maximum temperature of this month (Bogdan and Niculescu, 1999; Marinică, 2006; Bogdan, Marinică 2007). The absolute maximum temperatures of  $\geq 40^\circ\text{C}$  at the weather stations in June past century, excepting the one from Oravița, were recorded only in two meteorological stations: at Bucharest Filaret 40.3°C and Giurgiu 40.0°C. ***The frequency of the years in which the maximum temperature in June is  $\geq 40^\circ\text{C}$  is 2 years in a century.***

On 26 June 2007, there were also recorded exceptional maximum temperatures in Oltenia: 41.1°C at Băilești and Bechet, 41.3°C at Calafat, 38.6°C at Craiova and Băcleș, 39.7°C at Caracal and 38.5°C at Slatina.

Note that in the last 50 years in June, in Oltenia at Calafat for example, there were recorded six values of  $\geq 38^\circ\text{C}$ , all since 1993, and the temperature range is increasing at the most weather stations in the country.

In the south-eastern part of Romania, in the South Dobruđa Plateau, the maximum temperature is slightly "moderate" compared with those recorded in other regions due to the moderating influence of the Black Sea. The lowest temperatures are recorded on the seashore (28-32°C) and the highest on the inland areas (35-38°C) due to the differential influence of the two environments. Also, the date of the absolute maximum temperature is different at each station, indicating the randomness of fluctuations of the general circulation of the atmosphere (Văduva, 2005).

## **2. Data and methods**

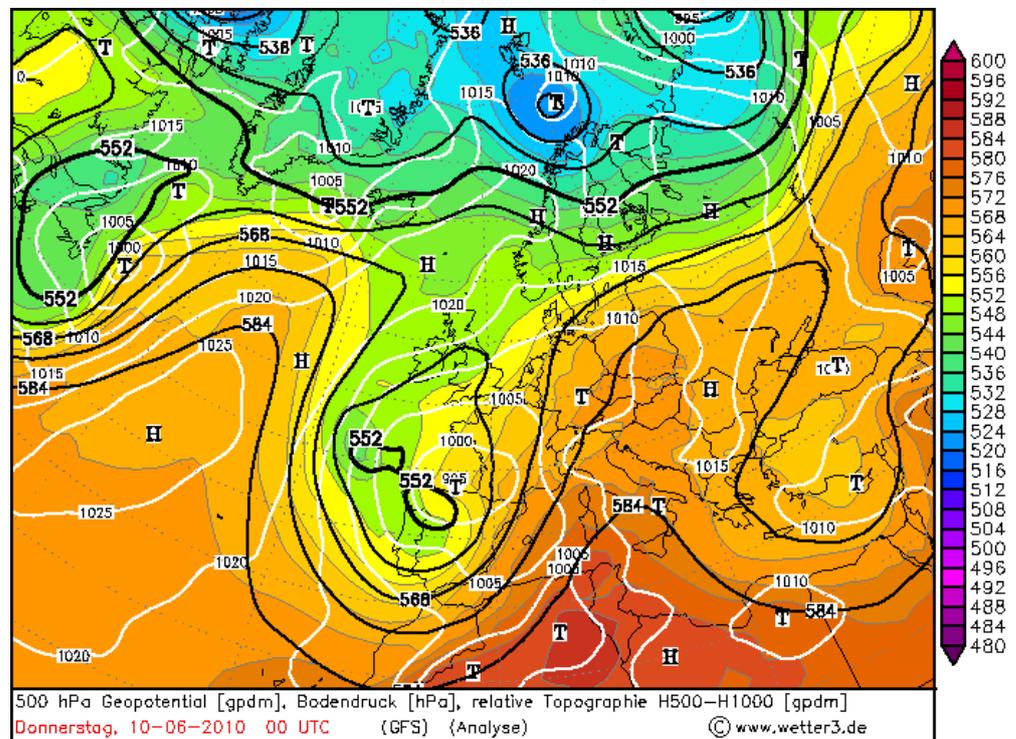
In this paper I analyzed the evolution of the heat waves on the basis of the synoptic maps and of the hourly temperatures in the 10-15 June 2010 period from all the weather stations in Romania.

### 3. Results and discussions

#### 3.1 The heat wave in the period 10-15 June 2010

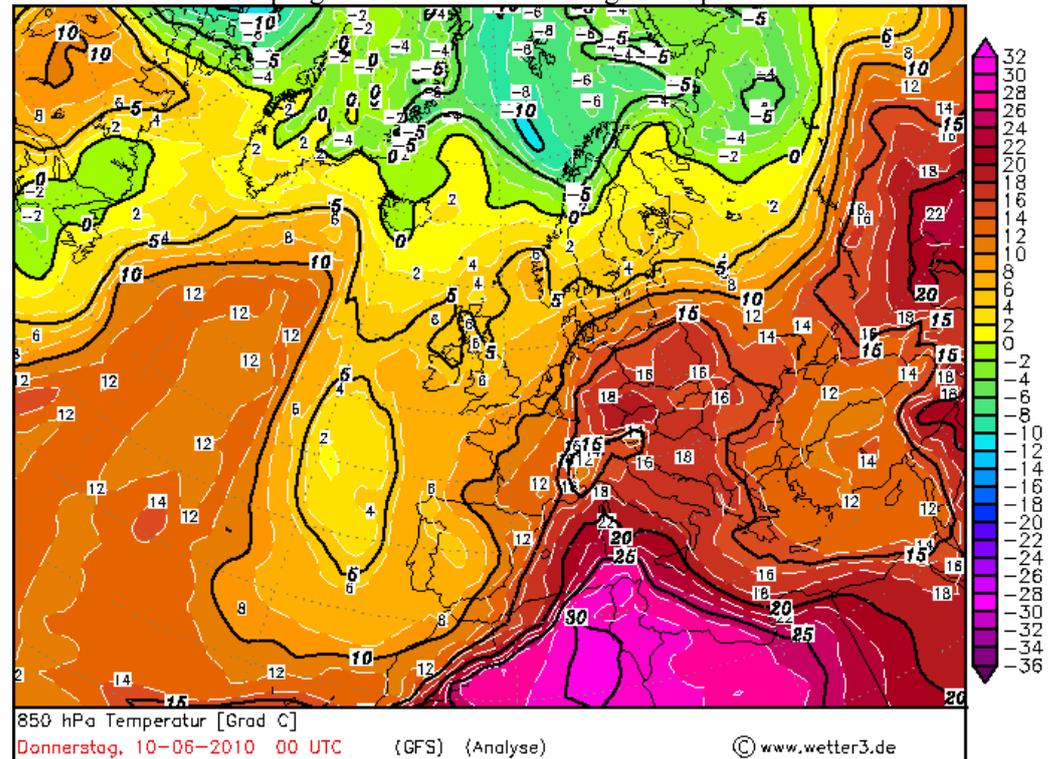
On 10 June 2010 at 00 UTC, the main weather formations over Europe were: the Azores anticyclone extended into the Atlantic Ocean northward close to Iceland (Fig. 1) and its dorsal, curved over Scandinavia was extended over Eastern Europe until southern Romania. A cyclonic field, originally ex Icelandic, was present over Western Europe centred in the Bay of Biscay with a centre value of 995 hPa. In the east of the Black Sea and in the Asia Minor Peninsula the low depression field specific to the warm season was present. Thus there was initiated an atmospheric circulation from the southwest in the lower troposphere, for the west of Romania.

At the 500 hPa level, at the date mentioned above there is a circulation specific to the **atmospheric blocking**; the dorsal of the high geopotential field with value of 568 damgp was extended over the Atlantic Ocean towards Iceland (Fig. 1).



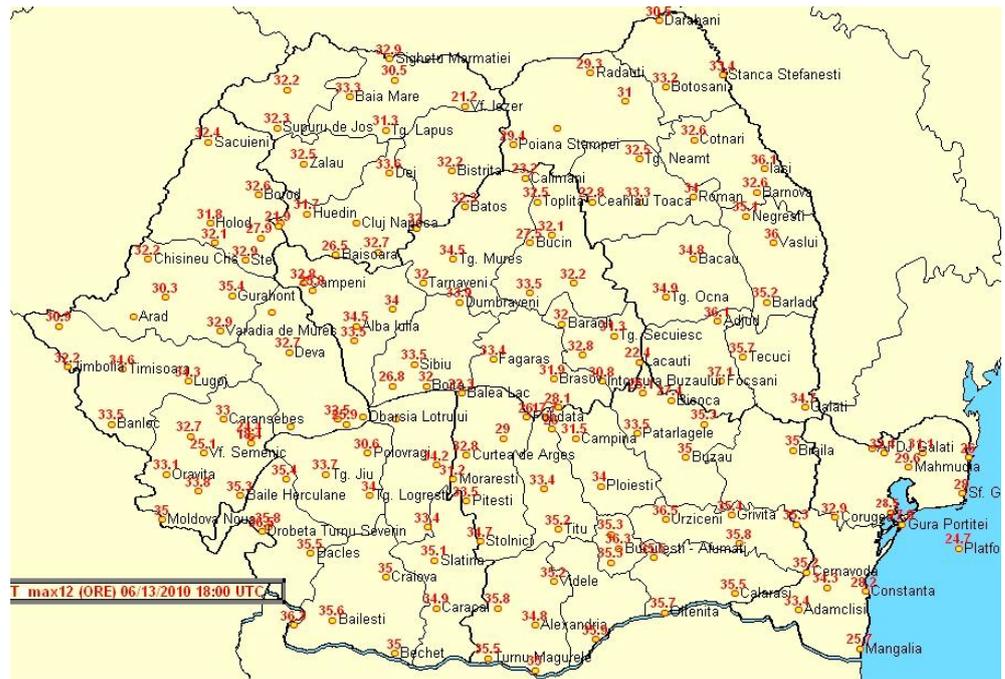
**Figure 1.** The synoptic situation on 10 June 2010, at 00 UTC, at the initial moment of the heat wave in June 2010 (the pressure field at ground level, the geopotential field at 850hPa and the relative topography of 500/1000 ) (source [www.wetter3.de](http://www.wetter3.de)).

The second dorsal of the field of geopotential was present over Central and Eastern Europe, extended northward to Russian Central Plateau (near Moscow) and the two thalwegs of geopotential were present in the extreme western and eastern continent. This type of circulation causes the warming of the weather on the rear of the blocking system due to the south-western and southern circulation and the cooling in front of it due to the circulation from north-east and north. The pressure wave is thus accompanied by a strong heat wave (fig. 2). It is noticed the rapid advance of hot air from North Africa over Central Europe to northern Poland. The slow eastward movement of the pressure wave induced by the general circulation of the atmosphere has led to the enhancement and extension of the south-western circulation and to the progressive weather warming in the period 10-15 June 2010.



**Figure 2.** The temperature field on 10 June 2010, at 00 UTC, at the initial moment of the heat wave in June 2010 at 850hPa. (source [www.wetter3.de](http://www.wetter3.de)).

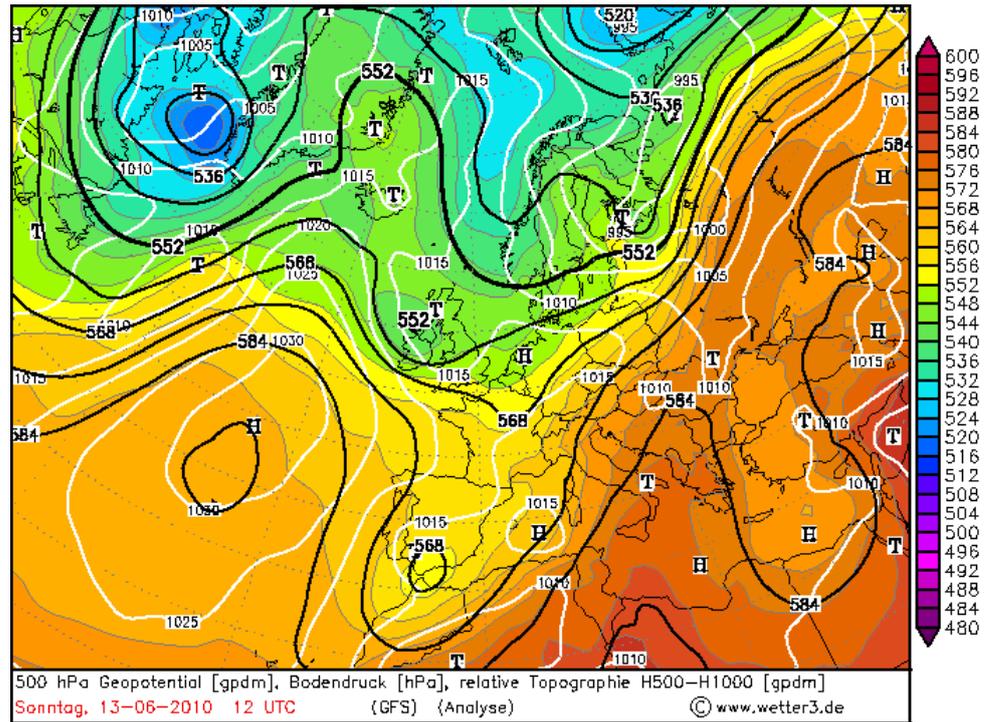
*The maximum intensity of the heat wave* was reached on 13 June 2010, when the maximum recorded values were the highest in this month: 37.1°C at Focșani and 36.5°C at Dr. Tr. Severin and Urziceni (Fig. 3).



**Figure 3**, The maximum temperature recorded on 13 June 2010 in the maximum intensity phase of the heat wave (source NMA).

On 13 June 2010, at ground level, the main atmosphere centres of action were: the Azores anticyclone present over the Atlantic Ocean, and in the east, the Eastern European anticyclone. In the Scandinavian Peninsula there was a cyclone originally ex Icelandic. In height the geopotential field had a vast thalweg extended over Northern and Western Europe and a dorsal extended over the southern Italy and the Balkan Peninsula to the southern Romania (fig. 4). In this case, for Romania the air flow in the lower troposphere was from south-west, the air mass was cT (continental tropical).

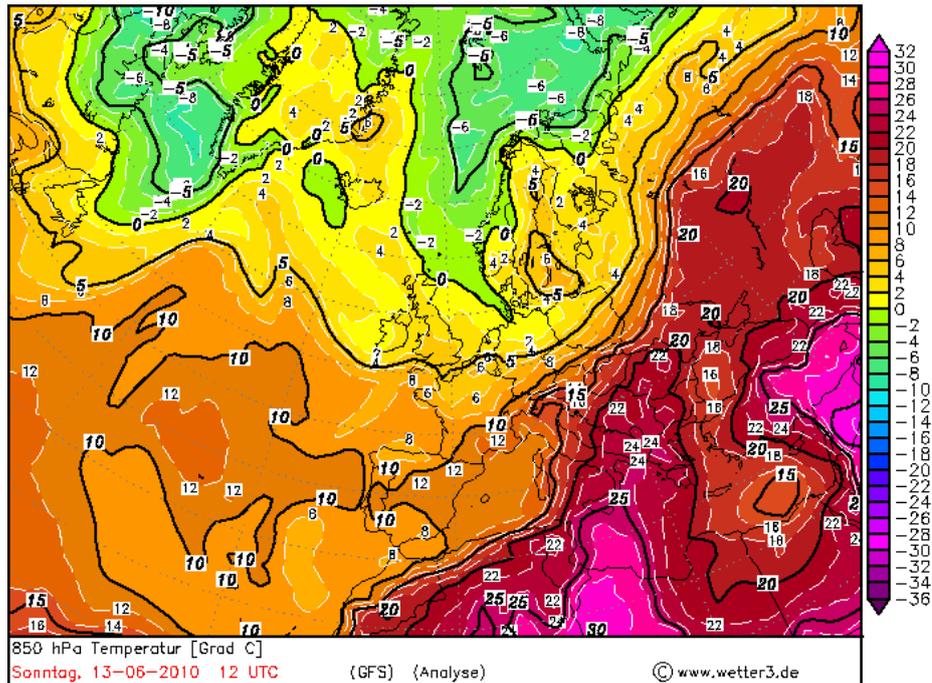
The thermal field at the altitude of 850 hPa shows a strong advection of warm air in the lower troposphere from northern Africa to eastern Romania where it had a junction with a warm air mass from the east of the continent advected on the anterior flank of the second dorsal of the geopotential field (the isotherms of 18 and 20°C) (fig. 5), and the very hot air mass occupied the whole Southern and South-eastern Europe.



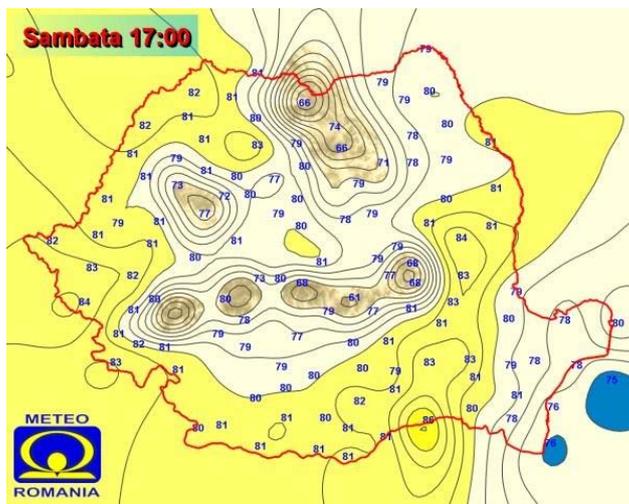
**Figure 4.** The synoptic situation on 13 June 2010, at 12 UTC, in the maximum intensity of the heat wave from June 2010 (the pressure field at ground level, the geopotential field at 850hPa and the relative topography of 500/1000) (source [www.wetter3.de](http://www.wetter3.de)).

Note that not only in June but throughout the summer of 2010 the blocking circulations were frequent, leading to the alternation of weather warming and cooling in our country.

The thermal field at the altitude of 850 hPa shows a strong advection of warm air in the lower troposphere from northern Africa to eastern Romania where it had a junction with a warm air mass from the east of the continent advected on the anterior flank of the second dorsal of the geopotential field (the isotherms of 18 and 20°C) (fig. 5), and the very hot air mass occupied the whole Southern and South-eastern Europe.



**Figure 5.** The temperature field on 13 June 2010, at 12 UTC, at the time of maximum intensity of the heat wave from June 2010 at 850hPa. (source [www.wetter3.de](http://www.wetter3.de)).

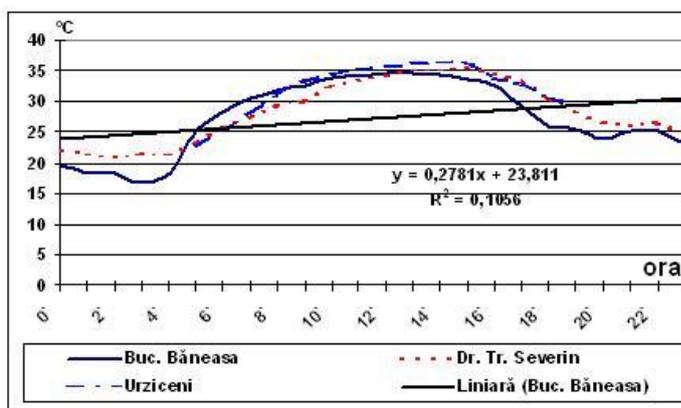


**Figure 6.** The values of thermal comfort index (TCI) on 12 June 2010, at 17 DST, in the day before the maximum intensity of the heat wave from June 2010 at 850hPa. (source NMA).

During this period in Romania, the thermal comfort index (TCI) frequently reached and surpassed the critical threshold of 80 in most of the country (fig. 6), the highest values being recorded in Bărăgan (the maximum TCI being of 85 at Oltenița).

The variation of air temperature at the weather stations: Bucharest Băneasa, Dr. Tr. Severin and Călărași shows that

after sunrise, the temperature increased rapidly till 16 o'clock DST<sup>4</sup> (fig. 7).



**Figure 7.** The variation of air temperature on 13 June 2010 at the weather stations: Bucharest Băneasa, Dr. Tr. Severin and Urziceni

**Table 1.** The maximal temperatures recorded at the weather stations on 13 June 2011.

Weather stations	The maximal temperatures (°C)		Weather stations	The maximal temperatures (°C)	
	registered in 14.06.2011	recorded		registered in 14.06.2011	recorded
Botoșani	33,2	32,7	Parâng	25,9	22,9
Iași	36,1	35,5	Drobeta Turnu Severin	36,5	34,9
Roman	34,0	32,7	Roșiori de Vede	35,8	35,6
Bacău	34,8	33,2	Turnu Măgurele	35,5	35,4
Bârlad	35,2	34,5	Giurgiu	35,9	35,7
Cluj-Napoca	33,8	32,0	București-Băneasa	35,3	34,2
Târgu Mureș	34,5	34,0	București-Filaret	35,3	35,0
Miercurea Ciuc	32,2	32,1	Râmnicu Sărat	35,3	34,6
Sibiu	33,5	32,5	Călărași	35,5	35,0
Vârfu Omu	17,7	16,0			

*The consequences of this heat wave*

Although there was not an exceptionally intense heat wave and the recorded maximum temperatures did not surpass the absolute maximum

<sup>4</sup> DST= Daylight saving time or summer time of Romania

temperatures of June, however for the daily temperatures for 13 June there were recorded **19 temperature records** for the maximum values and 26 records for minimum temperatures on 14 June (table 1 and table 2).

**Table 2.** The minimal temperatures recorded at the weather stations on 14 June 2011.

Weather stations	The minimal temperatures ( $^{\circ}\text{C}$ )		Weather stations	The minimal temperatures ( $^{\circ}\text{C}$ )	
	registered in 14.06.2011	reco- ded		registered in 14.06.2011	reco- ded
Satu Mare	19,6	18,0	Braşov	16,9	16,0
Baia Mare	20,7	18,3	Vf. Omu	8,6	8,1
Bistriţa	18,0	17,1	Sibiu	18,0	16,7
Cluj-Napoca	18,8	18,0	Râmnicu Vâlcea	19,0	18,6
Târgu Mureş	17,5	17,2	DrobetaTurnu Severin	22,6	22,0
Oradea	20,9	20,5	Craiova	21,8	18,9
Sibiu	18,0	16,7	Roşiori de Vede	22,4	19,3
Miercurea Ciuc	14,7	13,0	Bucureşti-Băneasa	20,9	19,7
Târgu Secuiesc	16,2	15,0	Bucureşti-Filaret	23,4	21,0
Ploieşti	21,2	19,3	Griviţa	21,0	19,3
Piteşti	20,3	18,8	Galaţi	22,0	21,3
Roman	19,1	18,3	Bârlad	20,7	20,4
Botoşani	18,4	18,0	Iaşi	20,3	19,5

The attenuation of the heat wave was gradually done during two days (14 and 15 June 2010), so although it was not as intense as on 13 and on 15 June 2010, there were records of daily minimum temperatures (7 records) at some weather stations in Romania, we cite from NMA:

**The minimum temperatures recorded on 15 June at the stations:** Buzău (22.7 $^{\circ}\text{C}$  compared with 20.4 $^{\circ}\text{C}$ ), Ploieşti (20.0 $^{\circ}\text{C}$  compared with 19.9 $^{\circ}\text{C}$ ), Bucharest- Filaret (22,0 $^{\circ}\text{C}$  compared with 20.2 $^{\circ}\text{C}$ ), Roşiori de Vede (20.1 $^{\circ}\text{C}$  compared with 19.0 $^{\circ}\text{C}$ ), Turnu Măgurele (22.4 $^{\circ}\text{C}$  compared with 19.8 $^{\circ}\text{C}$ ), Sf. Gheorghe Delta (22.4 $^{\circ}\text{C}$  compared with 20.8 $^{\circ}\text{C}$ ), Târgu Jiu (18.1 $^{\circ}\text{C}$  compared with 18.0 $^{\circ}\text{C}$ ) represent the highest values of the whole observations at this date.

So in the three days there was recorded a total number of 52 daily temperature records.

The explanation for this large number of records is that this heat wave **was** one of the earliest significant heat waves of June in the entire history of meteorological observations in Romania, which shows the tendency of early

installation of high temperatures specific in the past to the month of July, which is directly related to the global warming phenomenon<sup>5</sup>. June, being the first month of summer, at least in the first decade and in some years of its first half it still preserves some of the characteristics of spring, that is why until 2000, there was considered normal that the heat waves to occur in the second part of the month, and also the measurement statistics confirm this fact, the most intense heat waves occurred in the last 6 days, and the tendency of early occurrence was more obvious starting with the year 2000.

We also note that in the summer of 2010, the extreme west and the east of the continent were particularly affected by intense heat waves that caused the forest and vegetation fires and drought on large areas that affected the economy and the environment, and the consequences were felt across the entire continent.

#### 4. Conclusions

The analyzed situation presents *the earliest June heat wave* in the entire history of meteorological observations.

This marked the maximum temperature of June 2010 (37.1°C at Focșani, on 13 June) and 52 temperature records (daily maximum and minimum temperatures) for 13, 14 and 15 June at the level of the entire country.

Although the whole month of June in Romania was considered normal regarding the temperature, the analyzed situation shows that the heat waves also occur in the normal months.

The tendency of early occurrence of the heat waves in June was more obvious starting with the year 2000.

Exceeding the daily records of temperature and the tendency of early occurrence of the heat waves is directly related to the global warming.

We believe that the early occurrence of moderate heat waves is beneficial in some years, causing intense rates of vegetation growth, which in the conditions of a normal rainfall regimen or in excess sometimes (as, for example, June 2010 in Oltenia), determines the early growth of vegetables and fruits with significant economic effects. After late springs, this early warming effect of the weather in June is good for all vegetation and for the biosphere in general.

The large number of "blocking" type atmospheric circulation in June and in the summer of 2010 is due to the tendency to restore the thermal balance by the atmosphere which through intense "meandering" circulation transports the warm air from the southern latitudes farther to north on the ascending side of the blocking system and the cold air to the southern latitudes on the descending side of the

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<sup>5</sup> *An early June heat wave* was recorded on 11 June 2001 when the maximum June temperature was 38.2°C at Calafat.

blocking system thus doing an efficient heat transfer, and an overall surplus of rainfalls. From the dynamic point of view, this means an increased frequency of the Rossby waves and thus an acceleration of the atmospheric circulation.

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