CLIMATIC VARIABILITY OF THE WINTER 2016-2017 IN SOUTH-WESTERN ROMANIA

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Abstract. Winter 2016-2017 was normal from the thermal viewpoint, with a general mean value of -1.4°C for the area with altitudes below 600 m, although December 2016 was thermally normal. The winter was marked by the months December, thermally normal but dry, and January, which was cold, displaying a mean value of -5.07°C for the entire region, value that made it the fifth coldest January month in the last 57 years. In December 2016, between the 6th and the 12th (7 days), it was registered the first heat wave of the winter. Two cold waves of 10 days each (January 7-16 and January 20-29) marked January and, in spite of the fact that there were not registered absolute thermal records, the frosty days and nights and the continuous cold produced casualties and triggered an energy crisis during this month. In February, the weather warmed continuously starting with the 2nd and, in the interval February 21-28, it was also registered a moderate heat wave. Climatic warming is well-emphasized even in January, although it was a cold month. The analysis of the temperature mean values calculated for the entire region highlight the decrease of the intensity of the cold waves registered during the winter peak month and a well-marked upward tendency of this parameter. All winter months were dry. The warming occurred in February had important effects on biotopes, crops and fruit trees determining an early spring arrival. The paper is part of a series of extensive studies on climate variability in south-western Romania and the effects of climate warming. The paper is useful for all those interested in the climate evolution in this part of Romania.

Keywords: mean monthly temperatures, Hellmann criterion, warm winter phenomena, cold waves, vegetative processes.

Rezumat. Variabilitatea climatică din iarna 2016-2017 în sud-vestul României. Iarna 2016-2017 a fost normală termic, cu media generală de -1.4°C pentru arealul cu altitudinea sub 600 m, cu toate că luna decembrie 2016 a fost termic normală. Iarna a fost marcată de lunile decembrie, normală termic şi secetoasă, şi ianuarie, lună rece cu media de pentru întreaga regiune de -5.07°C, fiind a cincea lună ianuarie rece din ultimii 57 de ani. În decembrie, în intervalul 6-12 decembrie 2016 (cu durata de 7 zile) s-a înregistrat primul val de căldură al iernii. Două valuri de frig cu durata de câte 10 zile fiecare (7-16 ianuarie și 20-29 ianuarie), au marcat luna ianuarie şi cu toate că nu s-au înregistrat recorduri termice absolute, zilele şi nopţile geroase şi frigul continuu au produs victime umane şi apariţia crizei energetice din această lună. În luna februarie, vremea s-a încălzit continuu, începând cu data de 2 februarie, iar în intervalul 21-28 februarie s-a înregistrat un val moderat de căldură. Încălzirea climatică este bine pusă în evidenţă şi pentru luna ianuarie, cu toate că a fost o lună rece. Analiza mediilor lunare de temperatură calculate pentru întreaga regiune arată scăderea intensităţii valurilor de frig din luna de vârf a iernii şi o tendinţă crescătoare bine marcată a graficului acestui parametru. Toate lunile iernii au fost secetoase. Încălzirea vremii în luna februarie a avut afecte importante în cadrul biotopilor, culturilor agricole şi pomilor fructiferi, determinând premisele împrimăvărării timpurii. Lucrarea face parte dintr-o serie de studii extinse privind variabilitatea climatului în sud-vestul României şi efectele încălzirii climatice. Lucrarea este utilă tuturor celor interesaţi de evoluţia climatului în această parte a României.

Cuvinte cheie: medii lunare de temperatură, criteriul Hellmann, fenomene de iarnă caldă, valuri de frig, procese vegetative.

INTRODUCTION

On the 15th of June 2016, it was appreciated that El Nino ended (http://edition.cnn.com/2016/06/15/weather/weather-el-nio-dead-la-nia-coming/) and that a La Nina episode would occur (75% probability) by the end of 2016 (http://edition.cnn.com/2016/06/15/weather/weather-el-nio-dead-la-nia-coming/). The observation was correct and, in January, a short La Nina episode occurred, which would explain, also taking into account the teleconnection with the North Atlantic Oscillation, the cold and extremely cold weather registered for long periods in January. By the end of January, there began a La Nada episode (namely a period characterized by normal water temperature in the Eastern Equatorial Pacific) and it was mentioned the possibility of a new El Nino episode during spring (https://weather.com/news/climate/news/la-nina-noaa-update-november, https://www.yahoo.com/news/u-forecaster-says-la-ni-faded-sees-el-145420425.html). In February, warming occurred on large surfaces in Europe. Thus, on the 12th of February, it was registered a maximum value of 19.1°C at Eyjabakkar, Iceland. Positive maximum temperatures, even > 10.0°C, were registered on large surfaces within the Scandinavian Peninsula, which is the origin area of the cold air advection from January. *2015 registered the first climatic record of mean global temperature, namely ≥ 1.0°C than the global mean of the last century and the entire observation period 1880-1899.* By the end of 2015, it was considered that a mean 1.0°C above the mean global temperature would not be registered quite soon. The climatic evolution from 2016 infirmed this hope, as the global mean temperature in 2016 exceeded the mean value of the last century by 1.03°C (http://www.ziaruldevrancea.ro/international/1588839218-temperaturile-globale-au-atins-un-nivel-record-in-2016.html).

It is worth mentioning that this global thermal record was registered in the conditions of minimum solar activity. *”Even if we do not take into account the warming induced by El Nino phenomenon, 2016 will remain the hottest year registered in modern history”*, affirmed professor Piers Forster, director of Priestley International Centre for Climate, affiliated to University of Leeds, UK. At global level, January 2017 was a very warm month. In the 137 years of modern recordkeeping, it was *the third warmest January month* (http://www.click.ro/news/national/ianuarie-2017-fost-al-treilea-cel-mai-cald-ianuarie-din-istorie). The temperature was 0.92°C higher than the mean temperature of January calculated for the

period 1951-1980 (NASA). The map rendering Loti index for January 2017 (land-ocean temperature index) emphasizes that the highest positive anomaly was registered in North America and Siberia, where it was much warmer than in the period 1951-1980. A large part of the rest of Asia was also relatively warm. Two of the three top positive anomalies for January were registered in the last years. 2016 registered the greatest anomaly, 1.12°C warmer than the mean temperature, followed by 2007, 0.96°C (NASA, Goddard Institute for Spatial Studies (GISS) from New York based on data from 6,300 meteorological stations located all over the globe. There have not been processed the data from Antarctica yet). Consequently, there is to be noticed a great variability of air temperature at global level. The present paper is part of a series of extended papers dedicated to climate variability in the south-west of the country and the effects of climate warming, being useful to all those interested in the evolution of the climate in this part of Romania (BOGDAN et al., 2008; MARINICĂ & CHIMIŞLIU 2008; BOGDAN & MARINICĂ, 2009; BOGDAN et al., 2010; MARINICĂ et al., 2010; MARINICĂ et al., 2011; MARINICĂ & MARINICĂ, 2012; MARINICĂ et al., 2012; MARINICĂ et al., 2013).

We will further analyse this exceptional climatic variability registered in the winter 2016-2017 within Oltenia region and its consequences upon crops, biotopes, economy, and environment in general.

MATERIAL AND METHODS

In order to achieve the paper there were used the results of daily data processing with forecast specialized softs, the data archives of NAM, the maps realized on current basis during the operative activity, the maps supplied by international centres of analysis and forecast and those supplied by NAM Bucharest (http://www.meteoromania.ro/anm2/vremea/starea-vremii-romania/). Tables and graphs were achieved based on Office Software.

The paper analyses the climatic variability of the winter 2016-2017 in the south-west of Romania based on the thermal and pluviometric regime of the months December 2016, January and February 2017 and the thermal and pluviometric regime of the entire winter 2016-2017. There are also analysed the effects upon environment and biotopes.

RESULTS

1a. The thermal regime of December 2016.

The monthly mean air temperatures oscillated between -3.5°C within Voineasa intra-Carpathian depression and 2.2°C in the extreme south-west of the Danube Alluvial Plain, at Calafat. Their deviations compared to the normal values were between -2.3°C within Apa Neagră Sub-Carpathian depression and 1.2°C at Calafat, thus determining the classification of the thermal types from cold (C) on a small area near Apa Neagră to warmish (Ws) on a small area near Calafat. Within most of Oltenia, there were normal values, while cool (Cl) weather was registered in the hilly area and certain areas from the Sub-Carpathian depressions (Table 1). *The monthly air temperature mean*, calculated for the entire Oltenia region (at altitudes below 600 m) was -0.4°C, while its deviation compared to the normal was -0.3°C, thus confirming that the monthly mean of December 2016 was normal (N).

The minimum monthly air temperatures were mostly registered on the 14th and the 31st of December and varied between -14.4°C (registered on the 14th of December) within Romanaţi Plain, at Caracal, and -8.1°C (registered on the 31st of December 2016) within Mehedinţi Hills, at Bâcleş. The coldest morning was registered on the 14th of December 2016, when the mean minimum temperature for the entire region was -10.3°C; the thermal regime specific to December started with the 30th of November 2016. *Frost units*[1] in December 2016 oscillated between 15.4 at Calafat and 118.9 at Voineasa, while the mean value for the entire Oltenia region was 50.5. There was not registered *agrometeorological frost*. Weather cooling in December was normal and there was not registered any cold wave. *Heat units* varied between 9 at Voineasa and 83.9 at Calafat, and the mean value for the entire region was 38.3, thus marking a reduced difference between frost and heat units, which signifies a thermally normal month from the agrometeorological viewpoint. These values contributed to the development of vegetative processes at autumn crops and, generally, at vegetation, and biotic processes within biocoenoses[2]. The adaptation of autumn cultivated plants to the slower vegetative processes and to the appearance of the vegetative rest (preparation for wintering) occurred slowly during the entire month.

[1] *The degree of winter bitterness* in agrometeorology (winter type) is classified according to the sum of frost units (∑ of differences between the daily minimum temperatures <-15°C and the agroclimatic critical threshold of -15.0°C, in the interval December – February). Therefore, *a frost unit is the difference of 1°C between the critical threshold of -15.0°C and an air minimum thermal value ≤ -15°C* (for example, for T min = -16.0°C, then the difference -15.0°C - (-16.0°C) = 1, namely a frost unit (SANDU et al., 2010); *Frost units for the entire cold season* are calculated as Σ of daily mean temperatures ≤0°C, in the period November-March; *A day of frost* is the day in which the mean temperature is ≤ 0°C; *The active temperature are those ≥0°C*, and the temperature of the biological minimum is 0°C. A *winter day* is a day in which air temperature is < 0°C. *Heat units* (∑ of daily mean temperatures ≥ 0°C). From the point of view of weather forecast, for people, the notion *'frost' means temperature values of ≤ -10°C*. Therefore the term *frost* defined by weather forecast (which are adapted to living organisms) is different from *agrometeorological frost* (temperatures of ≤-15°C), plants being better adapted to climatic conditions (due to their cellular structure and specific biotic processes).

[2] The term of biocoenoses (Greek *koinosis* – to share) represents a supra individual level of organizing living matter and describes the totality of living, vegetal (*phytocoenosis*) and animal (*zoocoenosis*) organisms, which interact with each other and live together in a habitat or a sector of the biosphere (*biotope*), forming a whole and are in a dynamic balance dependent on that particular environment. It is characterized by a certain structure and functioning given by the model of matter, energy and information flow. The term of biocoenoses was proposed by Karl Möbius in 1877 (http://ro.wikipedia.org/wiki/Biocenoz%C4%83).

Table 1. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in December (N = normal values calculated for the interval 1901-1990, M = mean monthly values in December 2016, CH= Hellmann Criterion).

No.	Meteorological Station	Hm	N	M	Δ=M-N	CH	minT air		maxT air		minT soil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	1.4	1.6	0.2	**N**	**-8.5**	14	**17.8**	11	**-11.0**	14;15	**21.0**	11
2	Calafat	66	1.0	**2.2**	**1.2**	**WS**	**-9.1**	1	**19.9**	11	**-12.0**	1	**24.9**	11
3	Bechet	65	0.4	0.2	-0.2	**N**	**-13.0**	14	**16.8**	11	**-6.0**	14	**11.8**	11
4	Băileşti	56	0.4	0.3	-0.1	**N**	**-10.2**	1	**17.9**	11	**-11.0**	1	**19.3**	11
5	Caracal	112	-0.1	-0.5	-0.4	**N**	**-14.4**	14	**14.9**	11	**-14.0**	14	**20.1**	11
6	Craiova	190	0.1	-0.4	-0.5	**N**	**-12.3**	14	**15.5**	11	***-14.4***	14	**14.1**	11
7	Slatina	165	0.3	-0.6	-0.9	**N**	**-10.1**	14	**14.2**	11	**-12.8**	14	***10.4***	11
8	Bacleş	309	-0.4	-0.1	0.3	**N**	***-8.1***	31	**16.2**	11	-	-	-	-
9	Târgu Logreşti	262	0.1	-1.3	-1.4	**CO**	**-12.4**	31	**16.6**	9	**-12.6**	30	**19.0**	11
10	Drăgăşani	280	0.6	0.4	-0.2	**N**	**-9.1**	14	**13.6**	10	**-8.0**	5	**18.6**	2
11	Apa Neagră	250	0.1	-2.2	***-2.3***	**CL**	**-12.7**	31	**15.9**	11	**-9.8**	31	**12.6**	11
12	Târgu Jiu	210	0.1	-1.1	-1.2	**CO**	**-10.4**	31	**16.1**	11	**-10.6**	31	**15.6**	11
13	Polovragi	546	0.1	-0.9	-1.0	**CO**	**-11.4**	14	**14.2**	11	**-12.8**	31	**15.8**	11
14	Rm.Vâlcea	243	0.5	-0.1	-0.6	**N**	**-9.2**	30	**14.8**	11	**-9.8**	31	**18.6**	10
15	Voineasa	587	-1.9	***-3.5***	-1.6	**CO**	**-12.4**	31	***6.6***	12	-	-	-	-
16	Parâng	1585	-3.7	-	-	-	**-14**	30	**8.6**	11	-	-	-	-
	Mean Oltenia	-	-0.1[3]	-0.4	-0.3	**N**	**-11.1**	-	**15.0**	-	**-5.3**	-	**17.1**	-
17	Obârşia Lotrului	1404	-4.9	-7.2	-2.3	**CL**	**-19.8**	14	**6.4**	11	-	-	-	-

(Source: Data processed from NMA archive).

The maximum temperature values were registered in the interval December 9-12 (most of them on the 11th of December) and varied between 6.6°C at Voineasa and 19.9°C at Calafat; the mean value for the entire region was 15.0°C. In the interval December 6-12, there was registered a moderate heat wave. The daily maximum temperatures were positive in almost all the days, thus contributing to the maintenance of active biotopes and vegetative processes; moreover, there were also sunny days.

The graph rendering the variation of air temperature in December 2016 presents a reduced decrease tendency due to the slow cooling occurred mainly after the 13th of December.

The warmest day of December 2016, according to the mean of maximum temperatures for the entire region, was 14.7°C and it was registered on the 11th of December, while *the coldest day*, with a mean of -0.6°C, was registered on the 14th of December. There were registered only *2 winter days,* on the 13th and 14th of December, while in the mountain area, there were 18 days at Parâng.

At the ground level, most of the *minimum temperatures* were registered on the 14th and 31st of December, as well as in case of air temperature, and varied between -14.4°C at Craiova and -6.0°C at Bechet, with a mean value for the entire region of -5.3°C. Processes of superficial freeze-thaw of the soil occurred daily. *The maximum temperatures at the ground level* were mostly registered on the 11th of December and varied between 10.4°C at Slatina and 24.9°C at Calafat, while the mean value for the entire region was 17.1°C. The thermal regime specific to December installed on the 30th of the month.

1b. The pluviometric regime of December 2016

In December 2016, *the monthly precipitation amounts* were between 0.0 l/m^2 at Drobeta Turnu Severin and 9.5 l/m^2 at Caracal, while in the mountain area, at Parâng, they reached 34.0 l/m^2 (Fig. 1).

The percentage deviation of the precipitation amounts compared to the normal were between -100% at Drobeta Turnu Severin and -75.9% at Caracal, which determined the classification of the month as exceptionally dry for the entire Oltenia Region, except the mountain area, where the percentage deviation was -37.7%, which means very dry (VD) (Table 2). The mean precipitation amount for the entire region was 4.2 l/m^2, and the percentage deviation compared to the normal -91.8%, which confirms its classification as an exceptionally dry month (ED) for the entire region. However, crops were not damaged as the autumn 2016 was a rainy one and the available soil water reserve in the ploughed layer with a thickness of 0-100 cm was optimum or close to the optimum and there was registered only atmospheric drought[4].

[3] *The normal mean* calculated for the area below 600 m, as the entire territory of Oltenia except the mountainous area displays such altitudes, is +0.2°C, which determines a deviation of the monthly mean of -0.5°C, but this does not change the classification of the month as thermally normal.

[4] ***Hellmann criterion*** is very useful in the determination of the pluviometric types and it refers only to the registered precipitation amounts, thus becoming useful in determining ***atmospheric drought and precipitation excess***. ***Pedological drought*** is determined based on criteria that take into account ***the soil water reserve***.

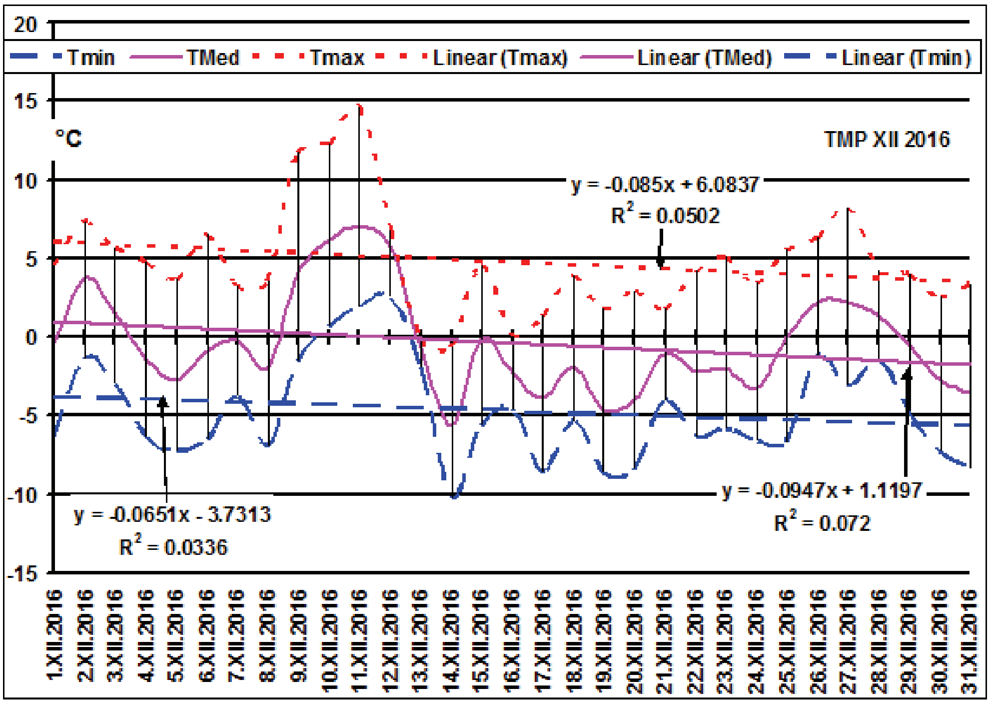

Figure 1. Air temperature variation (daily minimum, mean and maximum temperatures) in December 2016.
(Source: Data processed from NMA archive).

Table 2. Precipitation amounts registered in the winter 2016-2017 (Σ) compared to the normal values[9] (N); (Δ%=percentage deviation compared to the normal, CH=Hellmann criterion).

No.	Meteorological Station	Hm	December 2016				January 2017				February 2017			
			ΣXII	N	Δ%	CH	ΣI	N	Δ%	CH	ΣII	N	Δ%	CH
1	Drobeta Turnu Severin	77	***0.0***	61.2	***-100***	**ED**	17.0	51.4	-66.9	**ED**	39.8	47.9	-16.9	**LD**
2	Calafat	66	0.1	45.5	-99.8	**ED**	42.5	40.4	5.2	**N**	24.7	38.0	-35.0	**VD**
3	Bechet	65	3.8	36.3	-89.5	**ED**	43.4	33.5	29.6	**R**	14.5	34.8	-58.3	**ED**
4	Băileşti	56	1.0	46.8	-97.9	**ED**	44.8	38.5	16.4	**LR**	19.6	36.1	-45.7	**VD**
5	Caracal	112	**9.5**	39.5	**-75.9**	**ED**	**49.8**	34.7	**43.5**	**VR**	***12.5***	34.5	-63.8	**ED**
6	Craiova	190	4.1	41.8	-90.2	**ED**	33.4	37.5	-10.9	**LD**	31.5	30.4	3.6	**N**
7	Slatina	165	4.4	42.8	-89.7	**ED**	39.0	36.0	8.3	**N**	15.6	38.4	-59.4	**ED**
8	Bâcleş	309	0.0	54.7	-100	**ED**		50.5			11.5	44.1	-73.9	**ED**
9	Târgu Logreşti	262	1.2	44.8	-97.3	**ED**	24.8	35.9	-30.9	**VD**	29.2	41.0	-28.8	**D**
10	Drăgăşani	280	2.1	44.6	-95.3	**ED**	20.9	34.1	-38.7	**VD**	22.9	35.4	-35.3	**VD**
11	Apa Neagră	250	1.7	82.3	-97.9	**ED**	10.3	70.9	-85.5	**ED**	**51.8**	66.4	-22.0	**D**
12	Târgu Jiu	210	2.4	64	-96.3	**ED**	8.0	53.9	-85.2	**ED**	46.6	52.0	-10.4	**LD**
13	Polovragi	546	2.1	56.1	-96.3	**ED**	***4.7***	48.9	***-90.4***	**ED**	39.8	48.4	-17.8	**LD**
14	Râmnicu Vâlcea	243	0.5	46.2	-98.9	**ED**	6.7	35.5	-81.1	**ED**	33.0	38.4	-14.1	**LD**
15	Voineasa	587	0.2	55.1	-99.6	**ED**		42.7		**ED**	0.5	44.0	-98.9	**ED**
16	Parâng	1585	34.0	54.6	-37.7	**VD**	13.4	57.7	-76.8	**ED**	36.5	47.7	-23.5	**D**
	Media Oltenia	-	4.2	51.0	-91.8	**ED**	25.6	43.9	-41.1	**VD**	26.9	42.3	-36.5	**VD**
17	Obârşia Lotrului	1404	50.1	-	-	-	18.7	-	-	-	32.7	-	-	-

(Source: Data processed from NMA archive).

2a. The thermal regime of January 2017

The monthly mean air temperatures oscillated between -6.5°C at Voineasa and -3.3°C at Drobeta Turnu Severin, and their deviations compared to the normal values were between -4.0°C at Băileşti within Oltenia Plain and -1.4°C at Polovragi and Râmnicu Vâlcea, thus determining the classification of the month as cold (C) within most of the region (Table 3). Lower deviations that determined the classification of the weather as cool (Cl) were registered in the hilly area, the sub-Carpathian depressions and Voineasa intra-mountain depression. In the interval January 6-31, it was registered a thermal inversion, which explains the lower thermal deviations from the area characterized as cool. *The monthly mean air temperature* for the entire region was -5.06°C and the *deviation* compared to the normal -2.26°C, which determined the classification of the month as cold (C) within the entire region. This low general monthly mean value (-5.06°C) emphasizes that January was the fifth coldest month in the last 57 years in an upward hierarchy of the general temperature means (Table 4). The coldest January months in the last 57 years registered in: ***1963*** (VC, a mean temperature of -8.41°C), ***1985*** (C, a mean of -6.94°C), ***1969*** (C, a mean of -5.94°C), ***1964*** (C, a mean of -5.29°C), ***2017*** (C, a mean of -5.06°C). ***January 1942 was the coldest winter month of the 20th century and the only one classified as exceptionally cold (EC), according to the values of the temperature field at the 850hPa level, (reanalysis maps)*** (BOGDAN et al., 2014).

Table 3. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in January 2017 (N = normal values calculated for the interval 1901-1990, M = mean monthly values in January 2017, CH= Hellmann Criterion).

No.	Meteorological Station	Hm	N	M	Δ=M-N	CH	air Tmin		air Tmax		min Tsoil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	-1.1	**-3.3**	-2.2	**CL**	**-15.1**	10,	**10.9**	2,	**-18.0**	10,	**15.0**	2,
2	Calafat	66	-1.8	-5.3	-3.5	**CL**	**-19.9**	27,	**12.5**	2,	**-24.0**	10,	**18.6**	2,
3	Bechet	65	-2.2	-5.9	-3.7	**CL**	**-23.7**	12,	**11.1**	2,	**-25.0**	12,	**12.8**	4,
4	Baileşti	56	-2.3	-6.3	***-4.0***	**CL**	**-18.3**	22,	**11.3**	2,	**-21.4**	12,	**16.1**	2,
5	Caracal	112	-2.9	-5.5	-2.6	**CL**	**-19.2**	10,	**7.6**	2,	**-23.5**	10,	**12.1**	2,
6	Craiova	190	-2.6	-5.1	-2.5	**CL**	**-17.7**	10,	**8.6**	2,	**-19.6**	10,	***5.6***	2,
7	Slatina	165	-2.4	-5.3	-2.9	**CL**	**-21.3**	10,	**7.6**	2,	**-25.4**	10,	**8.3**	4,
8	Bacleş	309	-3.0	-5.2	-2.2	**CL**	**-16.4**	10,	**9.0**	2,				
9	Târgu Logreşti	262	-2.7	-5.9	-3.2	**CL**	***-25.4***	10,	**8.2**	3,	**-26.0**	10,	**10.8**	3,
10	Drăgăşani	280	-2.2	-4.1	-1.9	**CO**	**-16.2**	10,	**6.9**	2,	**-21.2**	10,	**9.9**	1,
11	Apa Neagră	250	-2.6	-5.1	-2.5	**CL**	**-21.1**	10,	**7.7**	3,	**-19.2**	10,	**10.9**	15,
12	Târgu Jiu	210	-2.6	-4.2	-1.6	**CO**	**-18.5**	10,	**8.5**	3,	**-18.6**	10,	**13.2**	3,
13	Polovragi	546	-3.2	-4.6	**-1.4**	**CO**	**-20.0**	10,	**7.8**	2,	***-28.9***	10,	**10.3**	2,
14	Râmnicu. Vâlcea	243	-2.2	-3.6	**-1.4**	**CO**	**-19.4**	10,	**8.0**	15,	**-20.8**	10,	**11.5**	2,
15	Voineasa	587	-4.7	***-6.5***	-1.8	**CO**	**-18.7**	10,	***5.1***	21,	-	-	-	-
16	Parâng	1585	-5.9	-	-	-	**-22.6**	8,	**6.3**	24,	-	-	-	-
	Mean Oltenia	-	-2.8	-5.06	-2.26	CL	**-19.6**	-	**8.6**	-	**-22.4**	-	**11.9**	-
17	Obârşia Lotrului	1404	-6.2	-10.7	-4.5	**CL**	**-28.8**	10,	**6.1**	28,	-	-	-	-

(Source: Data processed from NMA archive).

Thus, ***in the 20th century, it was registered only one exceptionally cold (1942) and only one very cold January (VC) (1963).*** In the last 57 years (1961-2017), ***most of the January months were warm***, 27 cases (namely 47.4%); there were also normal months, 19 cases (33.3%), while cold months registered the lowest number, 11 (namely 19.3%). The increasing tendency of the mean monthly temperature for the entire region is obvious, the increase coefficient being significant (0.033) (Fig. 2). Due to this temperature increase, the frequency, duration and intensity of cold waves decreased in January. ***Only two January months were very warm (VW): January 1983 with a mean value of 2.62°C and January 2007 with a general mean of 4.73°C*** (at a difference of only 0.27°C compared to an excessively warm month) (Table 4). Consequently, climatic warming is clear also in January, which is the winter peak month.

Table 4. The thermal classification of January months in the last 57 years. (avgT = mean January temperature calculated for the entire Oltenia region with altitudes below the 600 isohypse, (°C), Type = thermal classification of the month according to Hellmann criterion, Cold = no. of cold winters and their percentage, Normal = no. of normal winters and their percentage, Warm = no. of warm winters and their percentage, EC= exceptionally cold, VC = very cold, C = cold, Cl = cool, N = normal, Ws = warmish, W = warm, VW = very warm, EW = exceptionally warm).

YEAR	avgT	TIP	YEAR	avgT	TIP	YEAR	avgT	TIP	YEAR	avgT	TIP
1961	-1.99	**N**	1976	0.34	**C**	1991	-0.41	**C**	2006	**-4.23**	**RC**
1962	-1.17	**CL**	1977	-2.11	**N**	1992	-0.65	**CL**	2007	**4.73**	**FC**
1963	**-8.41**	**FR**	1978	-1.83	**N**	1993	-0.79	**CL**	2008	-3.05	**N**
1964	**-5.29**	**R**	1979	-2.16	**N**	1994	2.14	**C**	2009	-0.49	**C**
1965	-0.41	**C**	1980	-4.79	**R**	1995	-2.7	N	2010	**-4.81**	**R**
1966	-2.88	**N**	1981	-2.22	**N**	1996	-2.69	**N**	2011	-1.14	**CL**
1967	-3.12	**RC**	1982	-2.46	**N**	1997	-2.28	**N**	2012	-1.23	**CL**
1968	-2.31	**N**	1983	**2.62**	**FC**	1998	0.17	**C**	2013	-0.24	**C**
1969	**-5.94**	**R**	1984	0.96	**C**	1999	-0.22	**C**	2014	0.47	**C**
1970	-1.86	**N**	1985	**-6.94**	**R**	2000	**-4.07**	**RC**	2015	0.83	C
1971	-0.25	**C**	1986	0.46	**C**	2001	0.69	**C**	2016	-2.58	**N**
1972	-2.46	**N**	1987	-3.75	**RC**	2002	-0.81	**CL**	2017	**-5.06**	**R**
1973	-2.82	**N**	1988	1.31	**C**	2003	-1.47	**CL**	Cold	11	19.3%
1974	-1.99	**N**	1989	0.03	**C**	2004	-3.21	**N**	Normal	19	33.3%
1975	0.71	**C**	1990	-2.71	**N**	2005	1.21	**C**	Warm	27	47.4%

(Source: Data processed from NMA archive).

In January 2017, *frost units* varied between 112.4 at Drobeta Turnu Severin and 199.6 at Băileşti, while the general mean for the entire region was 160.3, which means a moderately cold winter month, from the agrometeorological point of view. *Heat units* were insignificant and varied between 0 at Voineasa and 12.0 at Calafat, with a mean for the entire region of 3.5°C.

The minimum values of air temperature were mostly registered on the 10th of January and oscillated between -15.1°C at Drobeta Turnu Severin, in the western extremity of the region, and -25.4°C at Târgu Logreşti, in the hilly area of Oltenia. The mean value for the entire region was -19.6°C. There occurred *two cold waves,* in the intervals January 7-

16 and 20-29, the duration of which totalized 20 days. *The coldest morning* was also registered on the 10th of January when the mean value for the entire region was -18.9°C, the day when cold reached the winter peak. In 12 mornings, the mean temperatures for the entire region were ≤ -10.0°C. After this date, air temperature slowly increased and the last cold morning was registered on the 2nd of February 2017. The only winter month characterized by ***agrometeorological frost*** was January. *The units of agrometeorological frost* were between 0.1 at Dr. Tr. Severin and 30.6 at Târgu Logreşti, and the classifications of the agrometeorological winter type at the meteorological stations (according to the criterion proposed by SANDU et al., 2010) varied between mild winter within most of the region to cold winter at Târgu Logreşti in the hilly area. Within Băileşti Plain, Apa Neagră Sub-Carpathian Depression and in the mountainous area, at Parâng, the winter was moderate. *The mean of agrometeorological frost units* for the entire region was 10.8, highlighting a moderate winter for the entire region of Oltenia. *Temperature mean range* in January was comprised between 23.1°C at Drăgăşani and 34.8°C at Bechet, while *the maximum range for the entire region* was 37.9°C.

Most of the *maximum monthly temperatures* were registered on the 2nd of January, when the mean of the daily maximum values for the entire region was 7.7°C, the highest in January. The monthly maximum values oscillated between 5.1°C at Voineasa and 12.5°C at Calafat, and their average for the entire region was 8.6°C. *The graph of the variation of air temperature* in January 2017 presents slightly decreasing tendencies of all the analysed parameters (daily minimum, mean and maximum values) (Fig. 3).

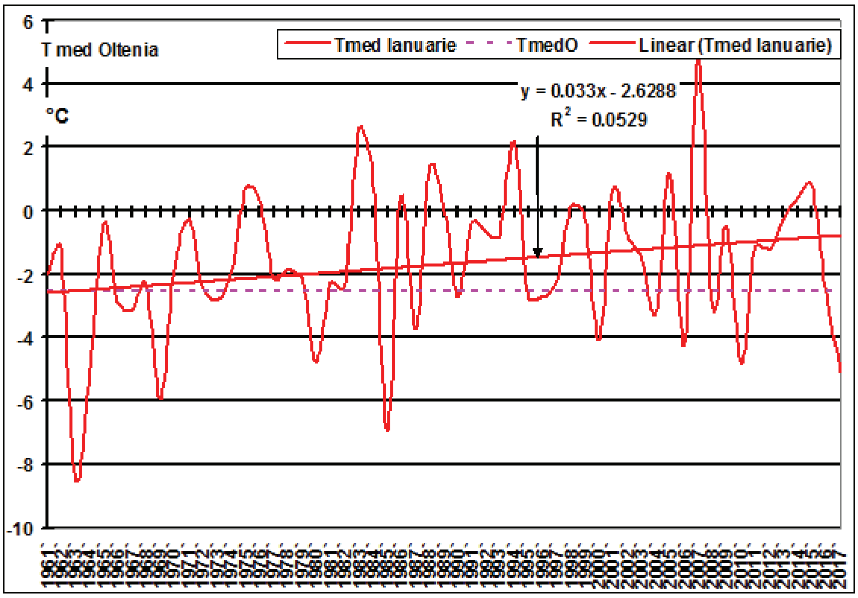

Figure 2. Variation of the monthly mean temperature calculated for the entire region (except the mountainous area) in the interval 1961-2017 (TmedO=mean temperature for Oltenia). (Source: Data processed from NMA archive).

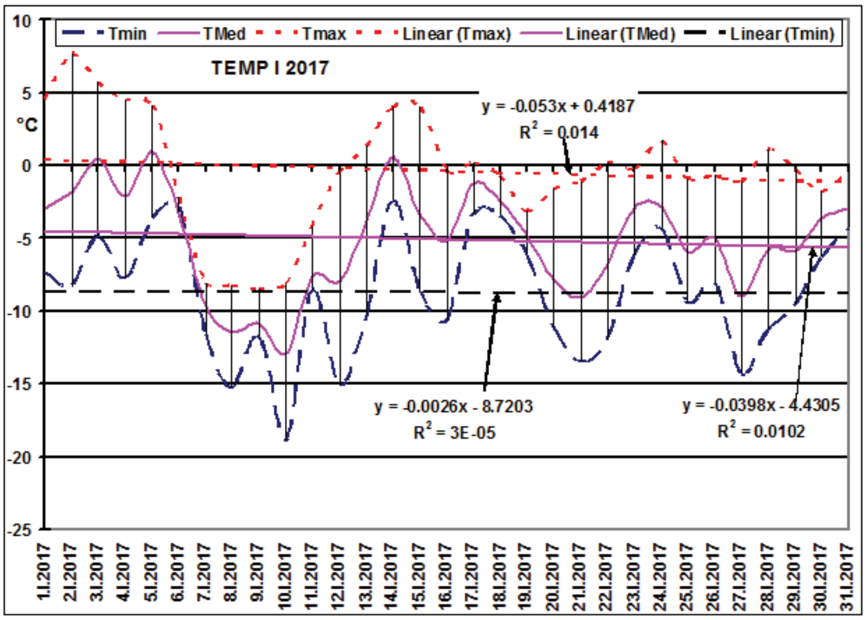

Figure 3. Variation of air temperature (daily minimum, mean and maximum values) in January 2017. (Source: Data processed from NMA archive).

There was also registered a *weak heat wave* of 5 days, in the interval January 1-5. *At the ground level, the monthly minimum temperatures* were mostly registered on the 10th of January and varied between -28.9°C at Polovragi and -18.0°C at Drobeta Turnu Severin, and their mean for the entire region was -22.4°C. Consequently, the soil was frozen in the interval January 6-31, and thaw started on the 1st of February. The value of ***-28.9°C, registered at Polovragi, represents the minimum thermal value of the winter 2016-2017 at ground level.*** Most of *the maximum temperatures at ground level* were registered in the interval January 1-4 and oscillated between 5.6°C at Craiova and 18.6°C at Calafat; their mean value for the entire region was 11.9°C.

2b. The pluviometric regime of January 2017

Precipitation amounts varied between 4.7 l/m^2 at Polovragi and 49.8 l/m^2 at Caracal, and their percentage deviations from the normal varied between -90.4% at Polovragi and 43.5% at Caracal, determining the classification of the months from exceptionally dry (ED) and very dry (VD) within most of the region to very rainy (VR) within a reduced area from Romanaţi Plain, at Caracal (Table 2). *The monthly mean amount of precipitations* calculated for the entire region was 25.6 l/m^2 and the deviation compared to the normal was -41.1%, thus determining the classification of the month as very dry (VD) as an average. In January, there occurred three intervals characterized by generally reduced precipitations: January 5-6, 8-11 and 16-18; in case of the first interval, precipitation amounts were significant for crops in the southern half of the region. In the beginning, precipitation were liquid and then, they transformed into snow; thus, starting with the 6th of January, there formed a snow cover, which reached the maximum thickness on the 7th of January and, isolatedly, on the 11th and the 12th of January, while in the mountainous area on the 13th and the 14th of January. *The maximum thickness of the snow cover* varied between 5 cm at Târgu Jiu and 38 cm within Romanaţi Plain, at Caracal; in the mountains, it reached 52 cm at Parâng and 75 cm la Obârșia Lotrului. Due to cold weather, the snow cover maintained during the entire month, although thickness gradually decreased as snow settled and thawed. It ensured a good protection for the crops in the southern part of the region; in the north, it was insignificant and, in certain areas, there was no snow cover during January (Fig. 4). *The length of the snow cover* varied between 9 days at Târgu Jiu and 26 days within most of the region. The thawing of the snow cover occurred in the interval February 1-6, persisting in the southeastern extremity until the 17th of February, even if it had an insignificant thickness, due to the thermal inversion phenomenon, and within the Sub-Carpathians, until the 23rd of February.

3a. The thermal regime of February 2017

The monthly mean temperatures gradually varied between 0.5°C at Voineasa and 2.7°C at Drobeta Turnu Severin, and their deviations compared to the normal were comprised between 0.9°C within Oltenia Plain, at Bechet and Băileşti, and 3.0°C within Voineasa intra-mountainous depression, determining the classification of the month from normal (N) within Băileşti Plain to warm (W) within the hilly area, in the Sub-Carpathians and the mountains (Table 5). *The monthly mean temperature calculated for the entire region* was 1.4°C and its deviation from the normal was 2.2°C, which means that this month was warm (W) for the entire region of Oltenia.

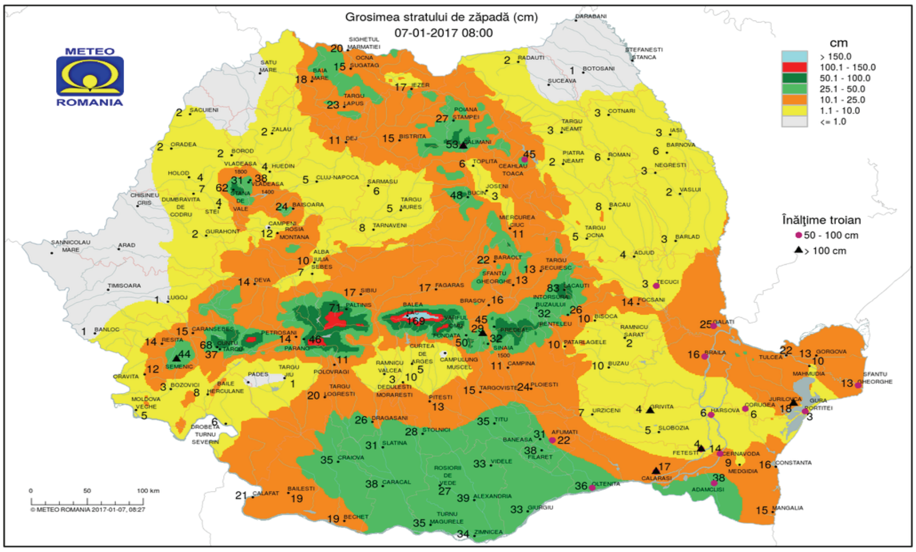

Figure 4. Spatial distribution of the snow cover with maximum thickness during the winter 2016-2017, on the 1st of January 2017, at 8 a.m. (according to NAM Bucharest).

The daily means calculated for the entire region varied between -5.9°C on the 12th of February and 9.4°C on the 28th of February. *The warmest interval of February* and of the entire winter 2016-2017 was February 21-28, when, isolatedly, the maximum values slightly exceeded 20.0°C and there were registered the maximum values of the winter 2016-2017. *The minimum monthly values of air temperature* were registered in the interval February 1-12 and varied

between -15.5°C within Romanaţi Plain, at Caracal, and -6.3°C at Drobeta Turnu Severin, while their average was -10.0°C, which is 9.6°C higher than that of January. *The coldest morning* was registered on the 12th of February, when the mean of the minimum values for the entire region was -8.0°C. *The frost units* were reduced and varied between 15.9 at Drobeta Turnu Severin and 51.8 at Caracal, while their mean for the entire region was 34.5. They were registered in the intervals February 1-2 and February 8-17, namely 11 days.

Table 5. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in February 2017.

No.	Meteorological Station	Hm	N	M	Δ=M-N	CH	minT air		maxT air		minT soil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	0.9	**2.7**	1.8	**W**	**-6.3**	12,	**19.7**	23,	**-9.4**	1,	**28.9**	27,
2	Calafat	66	0.4	1.6	1.2	**WS**	**-10.9**	1,	**20.8**	23,	**-13.2**	1,	**20.6**	24,
3	Bechet	65	-0.1	0.8	***0.9***	**N**	**-11.7**	1,	**20.9**	24,	**-11.8**	1,	**19.0**	23,
4	Băileşti	56	-0.1	0.8	***0.9***	**N**	**-11.4**	1,	**19.1**	24,	**-13.0**	1,	**20.2**	24,
5	Caracal	112	-0.7	0.7	1.4	**WS**	***-15.5***	1,	**18.9**	24,	**-16.0**	1,	**23.3**	27,
6	Craiova	190	-0.4	1.4	1.8	**WS**	**-9.5**	1,	**18.4**	24,	**-13.0**	1,	**19.8**	27,
7	Slatina	165	-0.2	1.3	1.5	**WS**	**-9.9**	2,	**18.2**	23,	**-11.8**	1,	**19.5**	23,
8	Bâcleş	309	-0.9	1.5	2.4	**W**	**-9.4**	12,	**18.8**	28,				
9	Târgu Logreşti	262	-0.7	1.1	1.8	**WS**	**-9.3**	11,	**18.5**	28,	**-13.2**	2,	**23.0**	23,
10	Drăgăşani	280	-0.2	1.9	2.1	**W**	**-9.5**	12,	**18.3**	24,	**-8.5**	1,	**22.4**	27,
11	Apa Neagră	250	-0.6	1.4	2	**W**	**-8.8**	21,	**17.2**	23;27,	**-8.8**	21,	***17.0***	27,
12	Târgu Jiu	210	-0.4	2	2.4	**W**	**-7.0**	12,	**18.7**	28,	***-8.2***	11;12,	**24.4**	26,
13	Polovragi	546	-1.4	1	2.4	**W**	**-10.5**	11,	***16.5***	28,	***-17.5***	11,	**20.7**	27,
14	Râmnicu Vâlcea	243	0.0	2.2	2.2	**W**	**-9.2**	11,	**19.6**	23,	**-14.8**	11,	**21.1**	23,
15	Voineasa	587	-2.5	***0.5***	**3**	**W**	**-10.9**	1,	**17**	28,				
16	Parâng	1585	-5.6				**-10.4**	14,	**17.8**	28,				
	Mean Oltenia	-	-0.8	1.4	2.2	**W**	**-10.0**		**18.7**		**-12.2**		**21.5**	
17	Obârşia Lotrului	1404	-5.5	-2.6	2.9	**W**	**-18.9**	13,	**10**	28,				

(Source: Data processed from NMA archive).

Agrometeorological frost did not occur in February. *Heat units* were registered in the intervals February 3-7 and February 18-28, namely 14 days, and varied between 42.7 at Voineasa and 92.8 at Dr. Tr. Severin; the mean for the entire region was 73.4, much higher than in case of frost units, which confirms the characteristic of warm winter month and ***the translation of the spring season towards winter***. *The hottest day* was registered on the 24th of February with a mean value for the entire region of 9.3°C. *The maximum monthly temperatures* were registered at different dates, namely the 23rd, the 24th and the 28th of February within most of the region, and on the 27th of February in the northern extremity of Apa Neagră Subcarpathian Depression. These oscillated between 16.5°C within Polovragi Subcarpathian Depression and 20.9°C at Bechet, while the mean value for the entire region was 18.7°C, exceeding the mean of maximum values registered in the other winter months. The highest daily mean of the mean maximum temperatures was 18.1°C, on the 28th of February. A moderate heat wave occurred during the interval February 21-28, which lasted until the 5th of March 2017, and triggered the start of the vegetation period at crops, the opening of the buds of weeping willows and the appearance of leaves, the blooming of the white magnolia (on the 5th of March) and the swelling of the buds of apricot, almond, cherry and cherry trees, etc. which means an early spring arrival.

The graph of the air temperature variation in February 2017 presents upward tendencies for all the analysed parameters (daily minimum, mean and maximum means) (Fig. 5); the most rapidly increasing was the maximum temperature. Due to the warm weather determined by air advection within most of the European continent starting with the end of January and occurring during most of February, it was registered an early spring arrival; migratory birds arrived and starlings arrived starting with the 30th of January 2017. Bees went for pollen and propolis in many days. Biotopes maintained their activity during February. At the ground level, *temperature minimum values* were mostly registered on the 1st of February and varied between -8.2°C at Târgu Jiu and -17.5°C at Polovragi, and their mean for the entire Oltenia region was -12.2°C. After the 30th of January, the soil superficial thaw occurred during days and freezing during nights (freeze-thaw cycle); starting with the 20th of February, the soil remained frozen. The freeze-thaw cycle may occur in certain areas cultivated with autumn crops, and there may occur 'bare-root of plants[5]' and, if after that, there is registered an intense cooling or warming, crops might be damaged. *The monthly maximum temperatures at the ground level* were mostly registered on the 26th and the 27th of February and varied between 17.9°C at Apa Neagră and 28.9°C at Dr. Tr. Severin, while their mean value for the entire region was 21.5°C.

[5] The term of ***bare-root of plants*** induced by the freeze-thaw cycle refers to the physical process of soil removal from the plant roots, thus the roots remaining exposed; consequently, there is an increased risk of frost bite in case of intense cold or dryness in case of warming, which makes it a dangerous process for autumn crops.

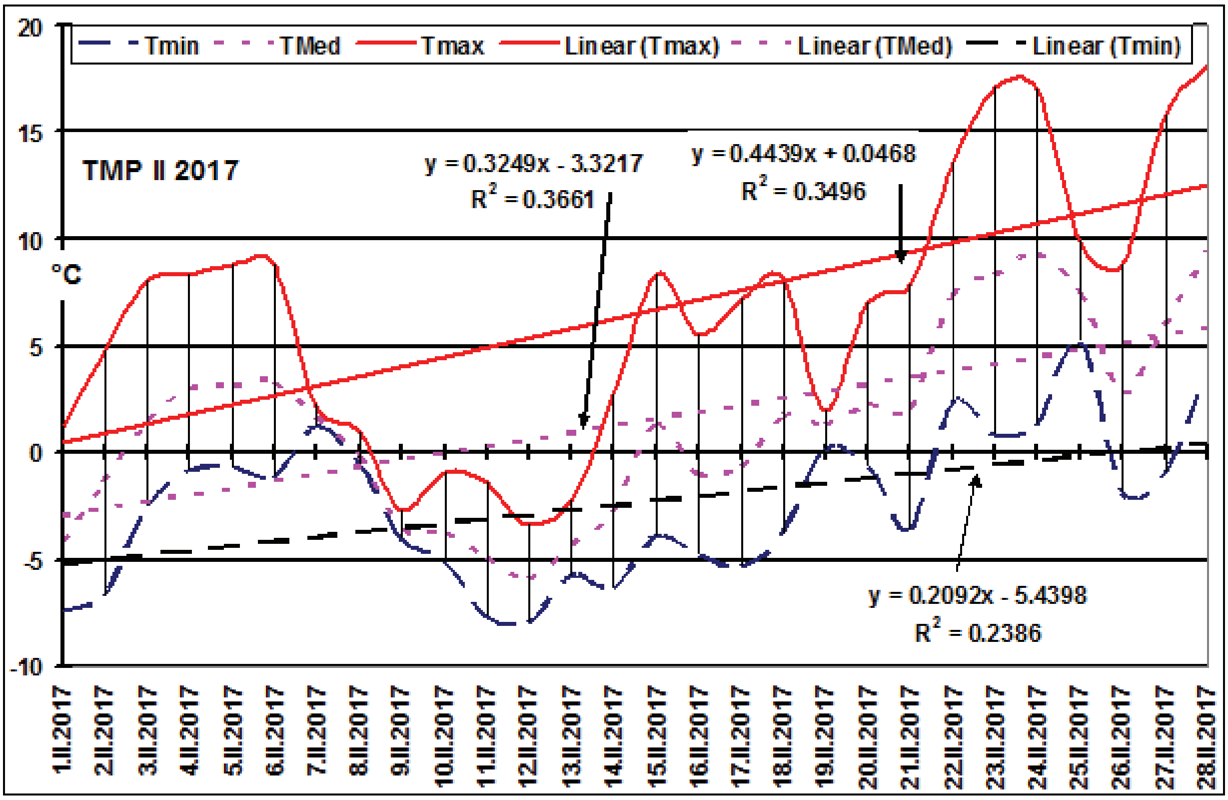

Figure 5. Variation of air temperature (daily minimum, mean and maximum values) in February 2017.
(Source: Data processed from NMA archive).

3b. The pluviometric regime of February 2017

The monthly precipitation amounts varied between 12.5 l/m^2 at Caracal and 51.8 l/m^2 at Apa Neagră, and their percentage deviations compared to the normal values were between -63.8% at Caracal and 3.6% at Craiova, determining the classification of the months from the pluviometric type viewpoint from exceptionally dry (ED) in the extreme south of Oltenia Plain, at Bechet, within Romanaţi Plain, at Caracal, and within the Getic Piedmont, at Slatina, to normal, on a reduced area in the central part, at Craiova. The mean amount for the entire Oltenia was 26.9 l/m^2, while the percentage deviation compared to the normal was of -36.5%, which classifies February as a very dry (VD) month. Precipitation amounts significant for crops were registered on the 7th, the 18th and the 19th of February. Except for the mountain area, precipitations were liquid.

4a. General thermal characteristics of winter

The mean seasonal temperatures oscillated between -3.2°C at Voineasa and 0.3°C at Drobeta Turnu Severin, and their deviations compared to the normal values were comprised between -1.0°C within Oltenia Plain, at Bechet, and Băileşti, within the Sub-Carpathian Depressions, at Apa Neagră, and 0.1°C in the area of high hills, at Bâcleş and on the Olt Valley, at Râmnicu Vâlcea; thus, the winter was thermally classified as cool (Cl) within Oltenia Plain and a small hilly area (Târgu Logreşti), within the Subcarpathian Depression, at Apa Neagră, and normal (N), within most of Oltenia (Table 6).

The winter mean temperature for the entire region was -1.4°C and its deviation compared to the normal was of -0.2°C, thus confirming that the winter 2016-2017 was thermally normal (N) for the entire Oltenia.

4b. General pluviometric characteristics of winter

The seasonal precipitation amounts were comprised between 40.2 l/m^2 on the Olt Valley, at Râmnicu Vâlcea, and 71.8 l/m^2 within Romanaţi Plain, at Caracal; the percentage deviations compared to the normal were between -70.9% at Apa Neagră and -33.9% at Caracal, which determined the classification of the winter as excessively dry within most of the region (Table 6). The mean winter precipitation amount for the entire region was 60.3 l/m^2, and its percentage deviation was of -55.7%, thus, confirming that the winter 2016-2017 was excessively dry for the entire region.

Table 6. *Overall pluviometric and thermal regime of the winter 2016-2017* (Hm = altitude of the meteorological station, W`15-16=mean ` of the winter 2016-2017 temperature values (°C), NW = normal values of winter temperature (°C), Δ = W-N = deviations of the mean temperatures compared to normal values (°C) CrH = Hellmann criterion; SW = sum of precipitation amounts for the winter 2016-2017 (l/m^2), NW = normal values of winter precipitation amounts (l/m^2), Δ = S-N= deviations compared to the normal (l/m^2), Δ% = percentage deviations compared to the normal).

	Meteorological Station	Hm	Thermal Regime (°C)				Pluviometric regime (l/m^2)				
			W`16-`17	NW	Δ=W-N	CrH	SW	NW	Δ=S-N	Δ%	CrH
1	Drobeta Turnu Severin	77	**0.3**	0.4	-0.1	**N**	56.8	160.5	-103.7	-64.6	**ED**
2	Calafat	66	-0.5	-0.1	-0.4	**N**	67.3	123.9	-56.6	-45.7	**ED**
3	Bechet	65	-1.6	-0.6	***-1.0***	**CO**	61.7	104.6	-42.9	-41.0	**VD**
4	Băileşti	56	-1.7	-0.7	***-1.0***	**CO**	65.4	121.4	-56.0	-46.1	**ED**
5	Caracal	112	-1.8	-1.2	-0.6	**CO**	**71.8**	108.7	-36.9	***-33.9***	**VD**
6	Craiova	190	-1.4	-1.0	-0.4	**N**	69.0	109.7	-40.7	-37.1	**VD**
7	Slatina	165	-1.5	-0.8	-0.7	**CO**	59.0	117.2	-58.2	-49.7	**ED**
8	Bâcleş	309	-1.3	-1.4	**0.1**	**N**	-	-	-	-	-
9	Târgu Logreşti	262	-2	-1.1	-0.9	**CO**	55.2	121.7	-66.5	-54.6	**ED**
10	Drăgăşani	280	-0.6	-0.6	0.0	**N**	45.9	114.1	-68.2	-59.8	**ED**
11	Apa Neagră	250	-2	-1.0	***-1.0***	**CO**	63.8	219.6	-155.8	***-70.9***	**ED**
12	Târgu Jiu	210	-1.1	-1.0	-0.1	**N**	57.0	169.9	-112.9	-66.5	**ED**
13	Polovragi	546	-1.5	-1.5	0.0	**N**	46.6	153.4	-106.8	-69.6	**ED**
14	Râmnicu Vâlcea	243	-0.5	-0.6	**0.1**	**N**	***40.2***	120.1	-79.9	-66.5	**ED**
15	Voineasa	573	***-3.2***	-3.0	-0.2	**N**	-	-	-	-	-
16	Parâng	1585		-5.1			83.9	160.0	-76.1	-47.6	**ED**
	Mean Oltenia	-	-1.4	-1.2	-0.2	**N**	60.3	136.1	-75.8	-55.7	**ED**
17	Obârşia Lotrului	1348	-6.8	-5.2	-1.6	**CL**	101.5	-	-	-	-

(Source: processed data from NMA archive).

DISCUSSIONS

In January, there were registered 25 cold, cool or frost days (80.6% of the month days) during the interval January 7-31; the significant cold waves of this winter were registered during the following intervals: January 7-16 and January 20-29, totalizing 20 days (67.7% of the month days). ***The coldest interval of the month and, at the same time, of the winter 2016-2017 was between the 7th and the 10th of January,*** when, in many settlements from Oltenia, frost was registered during the day, as well (maximum values did not exceed -10.0°C), and the mean of the daily maximum temperatures calculated for the entire Oltenia varied between -8.5°C (on the 9th of January) and -8.1°C (on the 7th and the 10th of January). The coldest morning was on the 10th of January, when there were also registered the lowest minimum temperatures of the winter and the thermal minimum value of the entire winter, namely -25.4°C at Tg. Logreşti. This value is the third lowest temperature of January for this station since determinations have been made and ***it characterizes the intensity of the cold wave within Oltenia***. In the same morning, the lowest temperature in the country was -31.0°C, at Întorsura Buzăului, which ***characterizes the intensity of the cold wave in Romania.*** There were registered casualties and damages as a consequence of frost and the price of fruit and vegetables increased. As the frost affected almost the entire Europe, most of the south-east of Europe was also affected by an energy crisis. We further render some press releases: 'On the 12th of January 2017, the Ministry of Energy, during a Government Meeting, made an analysis regarding the functioning of the National Energy System (NES), due to the six peak winter days, marked by historical consumption of natural gas and electric power. In the presented analysis, the minister referred to certain data regarding the state of the National Energy System, weather forecasts and evolution of fuel stocks. On the 11th of January 2017, Transelectrica, the transport and system operator, officially notified the Ministry of Energy, the Minister of Economy and ANRE with regard to the imminent crisis in the functioning of NES, motivated by:

- Weather forecasts, which indicate a new interval characterized by severe weather in the next period (January 17– 20, 2017)
- The electric power deficit induced by the Danube low flow, which decreased to a minimum unprecedented in recent years (about 1,800 m^3/s).
- Reduction of the water reserves of the large reservoirs due to their use to balance the system;
- The significant deficit of electric power in the south-east of Europe due to the cold wave affecting the region starting with the 6th of January 2017.
- Large consumption of natural gas (on an average, more than 70 million m^3/day) and electric power (more than 9,500 MW during the peak hours, starting with the 9th of January 2017, and a maximum of 9,730 MW on the 10th of January 2017, between 6 and 7 p.m.).
- Impairment of renewable sources of electric power, particularly wind farms.
- Difficulty of ensuring the coal supply due to transportation problems.
- Impact of malfunctions upon the production capacity of some energetic groups."

The decision to limit the consumption of electric power and gas, as well as energy exports, etc. was adopted by Law 123/2012, art. 24, which transposes the European Directive 2009/72/CE in the Romanian legislation. Article 42 of the Directive, crisis situations on the energy market in the next period (the 16th of January – the 15th of February 2017).

(http://www.economica.net/romania-se-pregatesste-pentru-limitarea-consumului-de-energie-electrica_131596.html#n).

The synoptic causes of the most extended and intense cold wave of the January 2017

The advection of cold air (arctic air mass (A)) above Europe started on the 5th of January 2017, 00 UTC, and was induced by a vast blocking circulation that persisted until the end of the month. Initially, the Carpathians played a blocking role for the cold air that stationed above Transylvania for two days, but then surpassed the mountains and reached Oltenia from the east and north-east, but also from the west, along the Danube Valley. Afterwards, on the 8th of January, at 6 p.m., a vast nucleus of extremely cold air, with temperatures of -20...-15°C at the 850 hPa level (about 1500 m) separated above South-Eastern Europe (including Romania), and, in spite of the fact it was not 'supplied' by cold arctic area from the polar zone, it continues to get colder. The cooling was favoured by the presence of a consistent snow cover, accumulated due to the heavy snowfall from the interval January 5-11, the thermal radiation registered during the long January nights, which, in the first part of the month, are of 15 hours (14 hours and 53 minutes on the 10th of January).

This nucleus of cold air slowly moved southwards above the Balkan Peninsula and, then, north-eastwards. The thermal inversion determined the positioning of this extremely cold air with temperatures of -31.0°C to -15.0°C at the ground level, at 0-2 m level.

In Fig. 6, it is rendered the vast atmospheric blockage positioned above Europe on the 9th of January 2017, 12 UTC. *At the ground level,* above the Balkan Peninsula, the east of the Black Sea and Asia Minor Peninsula, it can be noticed a weak cyclonic field, below 1015 mb, originating in the Mediterranean Cyclone, that generated the snowfalls from the interval January 6-9 and that, due to atmospheric circulation, naturally positioned here. The north of the continent was dominated by vast cyclonic field of Icelandic origin (delimited by the 1015 mb isobar). Between these, there was the western part of the anticyclone belt generated by the coupling of the Azores Anticyclone and the East European Anticyclone above Central and Western Europe (Voeikov ridge[6]). For Eastern Europe, this location of the baric centres represents a real mechanism of continuous transportation of the extremely cold air of arctic origin from Siberia above the Russian Plain in the lower troposphere. At altitude, at the 500 hPa level (the level of nondivergence of the atmosphere), where airflow is free (uninfluenced by the unevenness of the terrestrial surface), it can be noticed a vast blocking circulation (the 552 damgp isohypse had the shape of the letter '**Ω**'). In these conditions, the extremely cold arctic air from northern latitudes is transported by the atmospheric circulation above the south and south-east of Europe.

The massive advection of arctic cold air above the East and South-East Europe is well emphasized by the synoptic situation at the 850 hPa level registered on the 8th of January 2017, 00 UTC (Fig. 7).

At this level, it can be observed the atmospheric blocking circulation, the advection of the extremely cold air with temperatures of -20.0°C, above South-East Europe, the blockage of the cold air firstly induced by the Carpathians, when Oltenia and Muntenia remained under the dominance of an air mass with higher temperatures (-10.0°C), and then the penetration of the extremely cold air above this territory from two directions, west and north-east. At the same time, above the Atlantic Ocean and Western Europe, it can be observed a massive advection of warm air, favoured by the Golf Stream, which reached the south of the Scandinavian Peninsula. This type of atmospheric circulation is very stable as it is supported by the Earth rotation and Coriolis force that deviates the cold air on a north-eastern trajectory, bringing it from the polar region and Siberia above Europe.

Consequently, these dynamic and thermal causes contributed to the maintenance, with certain variations, of this type of atmospheric circulation during the interval January 8 – February 2, 2017, which determined this cold January episode.

The synoptic conditions for the most extended and intense warm air wave of the winter 2016-2017

Starting with the 2nd of February 2017, weather gradually got warmer, which led to the thaw of the snow cover, soil thaw, start of the vegetation period for autumn crops and initiated and sustained the process of spring arrival[12] (12: ***Spring arrival*** is the long-lasting climatic process that determines the gradual increase of air and soil temperature starting with February until the 10th of April (Fig. 8).

The process is complex and mainly generated by the variation in the geometry Earth-Sun that determines the increase of the day length, thus increasing the amount of heat received by the northern hemisphere from the Sun; consequently, there occur important modifications of the atmospheric circulation and increase of the frequency and intensity of warm air advections from the south and south-west. The process is evaluated by means of the ***spring arrival index*** = ∑of daily mean positive temperatures from the interval February 1 – April 10).

In the interval February 21 – March 9, 2017, there occurred a heat wave of 17 days, which reached the maximum intensity on the 28th of February (according to its extension and temperature values at the 850 hPa level). We will further briefly analyse the causes and dynamics of this heat wave that determined alternant climatic evolutions during the winter.

[6] The Russian-Siberian Anticylcone is called in certain climatology books the Asiatic Anticyclone. The East-European Anticyclone was treated by the Romanian researcher Ecaterina Ioan Bordei. In climatological works (especially Russian ones) the belt of high pressure uniting the Azoric Anticyclone with the Siberian one is called the ***Voeikov ridge***. Other notions bearing the name Voeikov: ***Axis of Voeikov*** – axis of the high pressure ridge on climatological maps joining in winter the Azoric Anticyclone to the Siberian one. It was discovered by the Russian climatologist A. I. Voeikov. ***Variant: Axis of Voeikov*** *– line separating the E and NE winds from the W and SW winds*. ***Variant: Axis of Voeikov*** – axis of the baric ridge formed by joining the W flank of the Siberian Anticyclone with the E flank of the Azoric Anticyclone, as a consequence the cold and dry air masses of Siberia (cPk+A) advance towards Western Europe, consiederably lowering the ground temperatures.

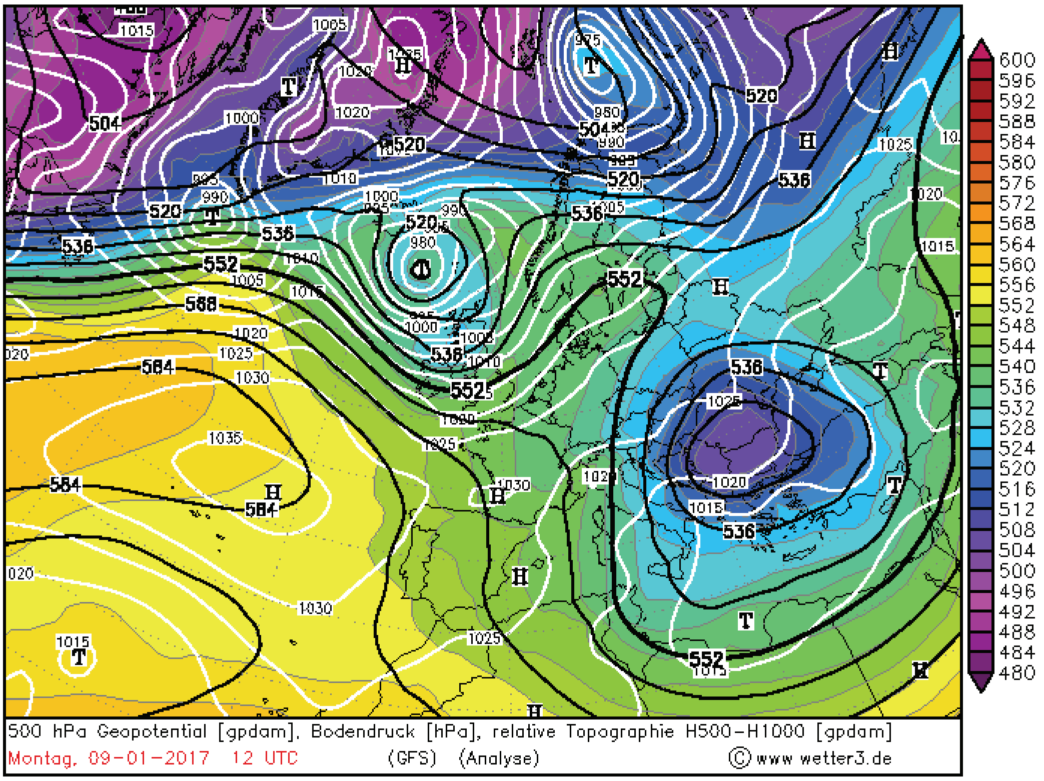

Figure 6. Synoptic situation at ground level (pressure field, white isohypses), superposed on altitude baric topography at the level of 500 hPa (about 5000 m altitude, geopotential field, black thick isohypses) and relative topography TR 500/1000, black thin isohypses (these are equivalent to the mean isotherms of the air comprised between 1000 hPa and 500 hPa), on the 9th of January 2017, 12 UTC.

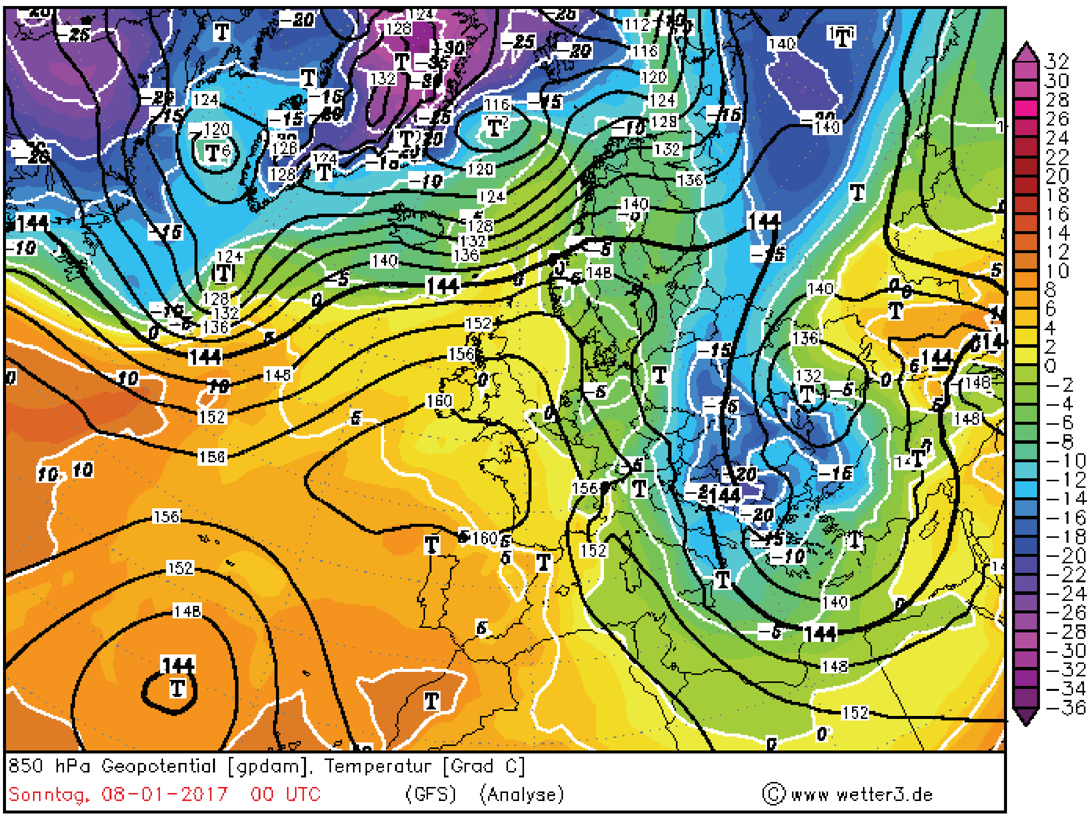

Figure 7. The geopotential field (black thick isohypses, the thermal field – white isohypses (°C)) and the thermal field at the 850 hPa level, on the 8th of January 2017, 00 UTC.

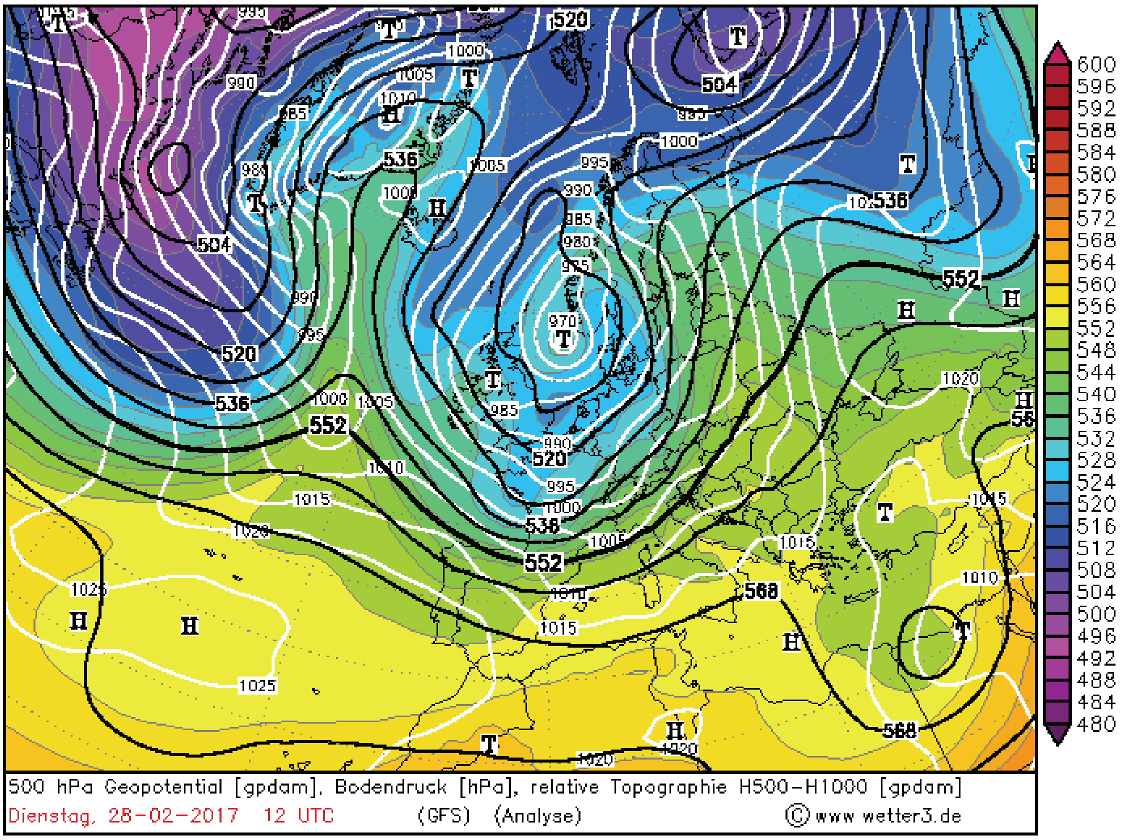

Figure 8. The synoptic situation at the ground level (pressure field, white isohypses), superposed on the synoptic situation at 500 hPa level (about 5000 m altitude, geopotential field, black thick isohypses) and relative topography TR 500/1000, black thin isohypses (these are equivalent to the mean isotherms from the air layer between the 1000 hPa and 500 hPa levels), on the 28th of February 2017, 12 UTC.

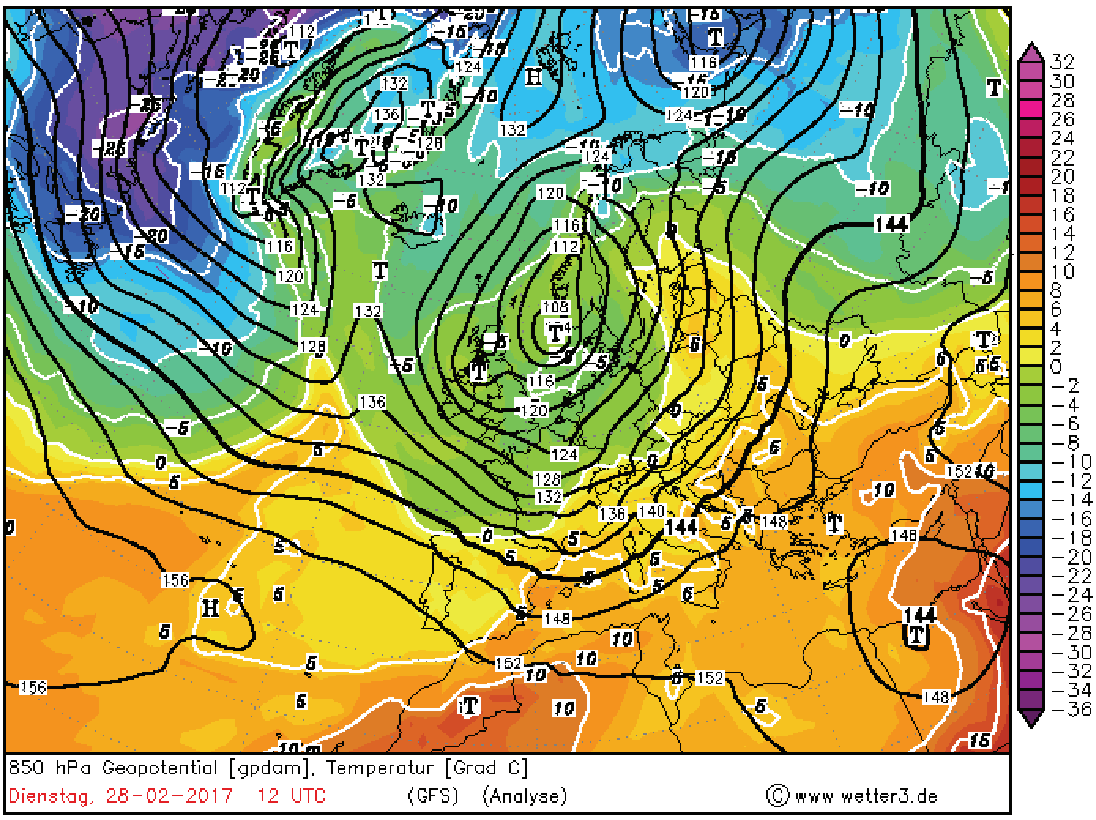

Figure 9. The geopotential field (black thick isohypses, thermal field white isohypses (°C)) and the thermal field at 850 hPa level, on the 28th of February 2017, 12 UTC.

The synoptic situation from the 28th of February 2017, 12 UTC, in the *medium and upper troposphere* (500 hPa level, about 5000 m), is dominated by a blocking circulation above the Atlantic Ocean (shape of '**Ω**' letter of the 520 damgp isohypse), while in front of this blockage, above a vast surface of Europe, there developed and maintained a tropical south-western circulation (Fig. 9). At the ground level, above Eastern Europe, it can be noticed the East-European Anticyclone (that triggered the cold waves from January) that gradually withdrew eastwards during February leaving space for warm air advections. Northern Europe but also a large part of Central Europe was dominated by the vast Icelandic Low with values below 970 hPa at the centre, while the extreme west of Europe was dominated by the Azoric Anticyclone centred above the Atlantic Ocean. This situation of typical tropical circulation is quite stable in time and, in the last years, it also determined early and more intense heat waves. *At the 850 hPa level,* it can be noticed the massive advection of warm air that exceeded the Arctic Circle (60° N), reaching the north of the Gulf of Bothnia. Above Romania, the air mass at this altitude (about 1500 m) had temperatures between 5 and 8° C, while at the ground level, the maximum values registered in Oltenia on the 28th of February varied between 16.5°C within Polovragi and Apa Neagră Sub-Carpathian Depressions and 19.5°C at Bechet. In Oltenia, the maximum temperature of February 2017 was 20.9°C, registered at Bechet on the 24th, value determined not only by the warm air advection, but also by the cloud cover and wind values registered during that day. An even higher value was registered on the 1st of March at Bechet, namely 22.4°C.

CONCLUSIONS

The winter 2016-2017 was marked by a particular climatic variability induced by an even more obvious variability in the northern hemisphere, including Europe. However, in Oltenia, the winter was normal, a characteristic based on the mean of the temperatures of a normal (N) month (December 2016), a cold (C) month (January 2017) and a warm (W) month (February 2017). The soil maintained frozen between the 8th of January and the 3rd of February, and, in the northern part of the region, crop protection against frost was poor as the snow cover was thin or even not present in certain areas. The frost registered in January provoked casualties and damages and determined an energy crisis both in Romania and a large part of Eastern Europe. The short interval of only three days (January 17-19) between the cold waves made us consider that cold and frost occurred almost continuously for 20 days in January. All these emphasize that, in winter, there still ***is a high risk of occurrence of cold waves*** although global warming continued even if solar activity was at its minimum. Therefore, we conclude that the preparation at national level for passing over winter should be carefully and thoroughly made, taking into account all the possibilities for energy production and supply. Although there were two cold waves lasting for 20 days, spring arrival was early and the vegetation of crops and habitats reactivation occurred in the first days of February. Migratory birds arrived early, starting with the 30th of January, due to the appearance of the heat wave developed over Europe beginning with February. The winter of 2016-2017 was excessively droughty (ED), but due to the rainy autumn, as well as the winter season precipitation and the snow layer, the soil water reserve in the 0-100 cm layer was optimal. As the weather warming progressed in February and March, on the 8th of March 2017, the water reserve in the soil was low for the largest part of Oltenia and a moderately pedological drought ("edaphic drought") was registered (according to the NAM website). Increased climate variability is the direct consequence of global warming. Although some authors speak about 'climate patterns', in our view, there are only general patterns caused by the cyclicity of seasons, which will always keep, in particular because of the geometry Earth-Sun.

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