THE WARM WINTER OF 2017-2018 FROM SOUTH-WESTERN ROMANIA IN THE CONTEXT OF CLIMATIC CHANGES

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Abstract. The winter of 2017-2018 was warmer than normal, with a general average of 1.5°C for the area below 600 m altitude. December 2017 was warm with the general average calculated for the whole region of 2.7°C and the deviation from normal of 2.5 ° C. Winter was marked by warm months, February with average for the entire region of 0.9°C. The statistical analysis of monthly temperature averages for the last winter month revealed a significant increasing linear trend. In December, there were three hot weather intervals: 7-9 December, 12-16 December and 24-29 December 2017 (totalling 14 days). The most intense heat wave of winter was between 24-29 December and the monthly thermal peaks for December were recorded on 25 December. January was warmer than normal and two intervals with temperatures much higher than normal were recorded: 1-8 January and 29-31 January, summing up to 11 days. Monthly thermal peaks were recorded in 30 January. In February, the weather kept warm during 1-24 February, and a moderate heat wave was recorded. Climate heating over the past 58 years is also well underlined for February. Analysis of the calculated temperature averages for the whole region shows the decrease in the intensity of the February cold waves and a significant upward trend of this parameter chart for the past 58 years. The warm winter had important impacts on biotopes, crops, and fruit trees, resulting in an early spring.

Keywords: monthly temperature averages, Hellmann criterion, hot winter phenomena, heat waves, vegetative processes.

Rezumat. Iarna caldă 2017-2018 în sud-vestul României în contextul schimbărilor climatice. Iarna 2017-2018 a fost mai caldă decât normal, cu media generală de 1.5°C pentru arealul cu altitudinea sub 600 m. Luna decembrie 2017 a fost caldă cu media generală calculată pentru întreaga regiune de 2.7°C şi abaterea faţă de normală de 2.5°C. Iarna a fost marcată de toate lunile calde. Luna februarie cu media pentru întreaga regiune de 0.9°C. Analiza statistică a mediilor lunare de temperatură pentru ultima lună de iarnă a relevat un trend liniar semnificativ crescător. În decembrie, s-au înregistrat trei intervale cu vreme caldă: 7-9.XII, 12-16.XII și 24-29.XII.2017 (însumând 14 zile). Cel mai intens val de căldură al iernii fost între 24-29.XII, iar maximele termice lunare pentru decembrie s-a înregistrat în data de 25.XII. Luna ianuarie a fost mai caldă decât normal şi s-au înregistrat două intervale cu temperaturi mult mai mari decât normalele corespunzătoare: 1-8.I şi 29-31.I însumând 11 zile. Maximele termice lunare s-au înregistrat în data de 30.I. În luna februarie vremea s-a menţinut caldă în intervalul 1-24.II şi un val moderat de căldură s-a înregistrat. Încălzirea climatică în ultimii 58 de ani este bine pusă în evidenţă şi pentru luna februarie. Analiza mediilor de temperatură calculate pentru întreaga regiune arată scăderea intensităţii valurilor de frig din luna februaurie şi o tendinţă crescătoare bine marcată a graficului acestui parametru pentru ultimii 58 de ani. Iarna caldă a avut afecte importante în cadrul biotopurilor, culturilor agricole şi pomilor fructiferi determinând premisele împrimăvărării timpurii.

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

INTRODUCTION

Hot weather prevailed throughout 2017 except in January. The warm winter of 2017-2018 is actually a prolongation of the warm weather in 2017. *The year 2015 achieved the first global climatic record of ≥ 1.0°C above the global average of the last century and the entire period of observations from 1880-1899.* At the end of 2015 it was estimated that an average of more than 1.0°C for global average temperature will not be recorded soon. Climate developments in 2016 outweighed this hope as the global average temperature in 2016 exceeded the average of the last century by 1.03°C (http://www.ziaruldevrancea.ro/international/1588839218-temperatures-globals-au-atins-a-level record-in-2016.html, http://www.click.ro/news/national/ianuarie-2017-fost-al-treilea-cel-mai-cald-ianuarie-din-istorie). The year 2017 was ranked among the top three hottest years, achieving a true global warming record, with solar activity at its minimum and in the absence of the El Nino climatic process, being the hottest under these conditions. "*Even if we do not take into account the warming caused by the El Nino phenomenon, 2016 remains the warmest year in modern history*," according to Professor Piers Forster, director of the Priestley International Center for Climatology, affiliated with Leeds University in the UK. The year 2017 was the world's second warmest in the history of weather records, surpassing only 2016 (European Union Monitoring Center, quoted by Reuters). The Copernicus Climate Change Monitoring Program, the world's first major international meteorological agency to issue a report on global temperatures of 2017, announced that it was on average 14.7°C or 1.2°C above the preindustrial period. The year 2017 „was slightly cooler than the warmest year in record history, 2016, and warmer than the second hottest year previously set in 2015”. (https://www.agerpres.ro/planeta/2018/01/04/2017-al-doilea-cel-mai-cald-an-din-istoria-inregistrarilor-meteorologice-dupa-2016-copernicus--31021) Globally, in the winter months of 2017-2018, average temperature deviations from the last century were positive across Atlantic to Pacific (Eurasia), and Siberia was warmer than the northern continent of America. At a regional level, in Romania, ***January 2018 was the warmest in the history of the National Meteorological Administration*** (Roxana Bojariu - Head of Climatology Laboratory NMA) (http://jurnalul.ro/stiri/vremea/luna-ianuarie-2018-cea-mai-calda-din-istoria-anm-765139.html).

This paper is part of a series of extensive studies on climate variability in the southwest of the country and the effects of climate warming, being useful to all those interested in climate developments in this part of Romania (BOGDAN et al., 2008; MARINICĂ & CHIMIŞLIU, 2008; BOGDAN & MARINICĂ, 2009; BOGDAN et al., 2010, 2014; MARINICĂ et al., 2010, 2011, 2012, 2013, 2016.

We will further analyse this exceptional climatic variability at regional level of Oltenia and its consequences on the agricultural crops, biotopes, the economy and the environment in general, characterizing the winter of 2017-2018.

MATERIAL AND METHOD

For this study I used the results of the daily data, processed with special software from the weather forecasting, the data archive of the NAM, the maps obtained in the operative activity, the ones from the internet provided by the international analysis and forecast centers and the NMA[1] Bucharest. We have used Office features to draw up tables and charts.

The paper analyses the climatic variability of the warm winter 2017-2018 in the southwest of Romania, based on the thermal and pluviometric regime of December 2017, January and February 2018 and the overall thermal and pluviometric regime of winter 2017-2018. The effects on the environment and biotopes were also analysed.

RESULTS

1a. Thermal regime of December 2017

Monthly air temperature averages ranged from 0.1°C in the Voineasa intracarpathian depression to 4.3°C in the extreme west at Drobeta Turnu Severin. Their deviations from normal were between 1.4°C in the Subcarpathian depression at Apa Neagră and 3.4°C in Caracal, leading to the classification of warm thermal (W) types in most part of Oltenia (Table 1). Warmish time (WS) was recorded on a restricted area in the Gorj Subcarpathians.

Table 1. Air temperature regime in Oltenia and minimum and maximum surface temperature in December 2017 (NXII = December normal for the period 1901-1990, MXII = monthly averages of December 2017, Δ = M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological Station	Hm	NXII	MXII	Δ=M-N	CH	air maxT		air minT		soil maxT		soil minT	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	1.4	**4.3**	2.9	W	16.5	25	**-3.2**	31	**18.7**	25	-6.4	21
2	Calafat	66	1.0	3.8	2.8	W	**18.9**	25	-4.1	11	16.8	8	**-2.1**	22
3	Bechet	65	0.4	3.3	2.9	W	17.5	16	-5.4	22	15.1	8	-4.0	23
4	Băileşti	56	0.4	2.9	2.5	W	15.9	25	-5.6	22	**18.7**	25	-4.5	22
5	Caracal	112	-0.1	3.3	**3.4**	W	14.9	25	-5.7	22	11.1	25	-2.7	22;23
6	Craiova	190	0.1	3.2	3.1	W	15.7	25	-6.5	22	15.6	14	-6.2	22
7	Slatina	165	0.3	2.9	2.6	W	14.8	25	-6.9	22	***8.7***	14	-4.2	24
8	Bâcleş	309	-0.4	2.9	3.3	W	14.3	25	-6.9	22	-	-	-	-
9	Tg. Logreşti	262	0.1	2.1	2.0	W	16.3	25	-9.0	22	16.5	7	-6.8	8
10	Drăgăşani	280	0.6	3.6	3.0	W	16.3	25	-7.2	22	10.1	14	-3.0	22
11	Apa Neagră	250	0.1	1.5	***1.4***	WS	14.2	25	-7.3	23	11.2	29	-5.2	24
12	Tg. Jiu	210	0.1	1.7	1.6	WS	16.4	25	-7.0	22	13.6	29	-4.8	23;24
13	Polovragi	546	0.1	2.4	2.3	W	17.1	25	-8.0	22	16.4	12	***-10.9***	22
14	Rm. Vâlcea	243	0.5	2.9	2.4	W	15.6	25	-7.5	22	11.2	26	-5.0	22
15	Voineasa	587	-1.9	***0.1***	2.0	W	***12.7***	25	***-10.0***	22	-	-	-	-
16	Parâng	1585	-3.7	-	-	-	8.3	12	-14.5	21	-	-	-	-
17	Mean Oltenia	-	0.2	2.7	2.5	W	15.3		-7.2		14.1	-	-5.1	-
18	Ob. Lotrului	1404	-4.9	-3.3	1.6	WS	5.0	25	-16.0	20	-	-	-	-

(Source: processed data from the NMA Archive)

The monthly average air temperature, calculated for the entire Oltenia region (with an altitude below 600 m) was 2.7°C, and its deviation from normal was 2.5°C, confirming that on average December 2017 was warm (W).

Monthly air temperature minima were recorded at 22 December and were -10.0°C (recorded in 22 December) at Voineasa and -3.2°C at Drobeta Turnu Severin registered on 31 December 2017. The coldest morning was recorded on 22 December 2017 with the average for the whole region of -7.0°C, and the December-specific thermal regime was installed only on 31 December 2016. *The frost units*[2] in December 2017 were insignificant and ranged from 0.0 at

[1] NMA = National Meteorological Administration Bucharest.

[2] ***The degree of winter bitterness*** in agrometeorology (winter type) is classified according to the sum of the agrometeorological frost units (∑ of the differences between the daily minimum temperature values <-15ºC and the agro-climatic critical threshold of -15.0°C in the XII-II interval) . ***Thus an agrometeorological frost unit is the difference of 1°C between the critical threshold of -15.0°C and a minimum thermal in air ≤ -1°C*** (for example for T min = -16.0°C then the difference -15.0°C - (-16.0°C) = 1, i.e. a unit of frost, (SANDU, MATEESCU, VĂTĂMANU, 2010) ***The Frost units for the whole cold season*** are calculated as ∑ average daily temperatures ≤ 0°C, between November and March. ***A cold day*** is the day when the average temperature is ≤ 0°C ***The active temperatures are ≥0°C*** and the biological minimum temperature is 0°C. It is called the winter day when the maximum air temperature is <0°C. ***Heat Units*** (∑ Daily average temperatures ≥ 0°C). For weather forecasts and diagnosis for the public, mean a temperature of ≤ -10.0°C. From the point of view of weather forecast, for people, the notion *'frost' means temperature values of ≤ -10°C*. Therefore

Drobeta Turnu Severin and 28.0 at Voineasa, and their average for the entire Oltenia region was 7.9. *The agro-meteorological frost* was not recorded. Cool weather in December fell into normal processes, and cold wave was recorded. *Heat units* ranged between 31.8 at Voineasa and 133.9 at Drobeta Turnu Severin, and their average for the whole region was 92.4, meaning a major difference between heat and frost units, ie an agrometeorological warm month. They have contributed to vegetative processes in autumn crops and generally in vegetal carpet and biotic processes in biocenoses[3]. Adaptation of plants from autumn crops to slow vegetative processes and induction of vegetative rest (preparation for wintering) was done slowly throughout December and January. *The maximum monthly temperature values* recorded the most on 25 December and were between 12.7°C at Voineasa and 18.9°C at Calafat, and their average for the whole region was 15.3°C. For 14 days in 7-9 December, 12-16 December and 24-29 December, moderate heat waves were recorded. Daily temperatures kept positive all day, combined with sunny days, keeping biotopes and vegetative processes active.

The air temperature variation chart in December 2017 shows slightly increasing trends for maximum values and slightly decreasing for average and minimum values due to the slow cooling of the weather produced mainly after 26 December (Fig. 1).

The hottest day of December 2017, according to the average temperature maxima for the whole region was 25 December, when the average for the whole region was 15.0°C, and *the coldest day* was 22 December with an average of -2.5°C. From a thermal point of view, there was no winter day, and in the mountain area only 14 days were registered in Parâng.

At the soil surface, *the minimum temperatures* were recorded most in the 21-24 December period, as well as those of the air, and were between -10.9°C at Polovragi and -2.1°C at Calafat, with the average for the whole region of -5.1°C. The processes of freeze-thaw and surface thaw have occurred since 5 December.

Maximum soil surface temperatures were recorded mostly in the period 14-29 December and ranged between 8.4°C at Slatina and 18.7°C at Băileşti and Dr. Tr. Severin and their average for the entire region was 14.1°C. At the surface of the soil, the December-specific thermal regime installed as early as 31 December.

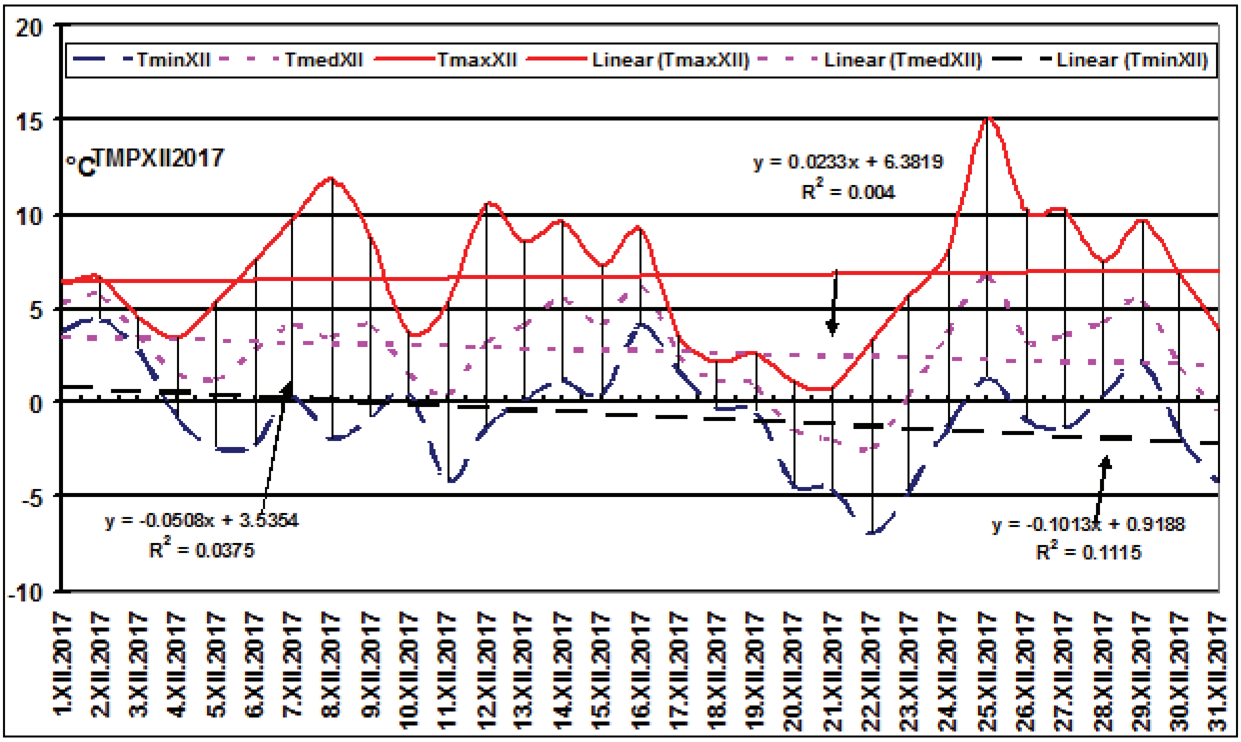

Figure 1. Air temperature variation (average daily minimum, daily average and average maximum daily) in December 2017. (Source: processed data from the NMA Archive).

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).

[3] The term ***biocenosis*** (from the Greek koinosis – to share) is an over-individual level of organization of living matter and describes the totality of living, vegetal (*phytocenosis*) organisms and animals (*zoocenosis*) interacting with each other and living in a particular environment or sector from the biosphere (*biotope*), forming with it a unitary one and that is in a dynamic dynamically dependent on that medium. It is characterized by a certain structure and function given by the model of circulation of matter, energy and information. The term biocenosis was proposed by Karl Möbius in 1877 (http://en.wikipedia.org/wiki/Biocenoz%C4%83).

1.b. The pluviometric regime of December 2017

In December 2017, the *monthly rainfall values* were between 30.7 l/m^2 at Drăgășani and 65.2 l/m^2 at Calafat, and in the Parâng mountain area 53.3 l/m^2. The percentage deviations from normal rainfall ranged from -33.3% at Apa Neagră to 45.7% at Bechet, leading to precipitation time ranges from very rainy (FP) to Southern Oltenia to very dry (FS) for the northern half of Oltenia, with the exception of the mountain area where the percentage deviation was -2.4%, ie normal (N) (Table 2). ***The average rainfall for the entire region*** was 46.0 l/m^2, and its percentage deviation from normal was -9.8%, which determines an average rainfall month (N) for the whole region. The crop plants did not suffer since the autumn of 2017 was rainy and the ground water reserve in the arable layer of 0-100 cm thick maintained optimal or close to optimal, the drought being only atmospheric[4].

Table 2. *Amounts of rainfalls[5] recorded in the winter of 2017-2018 (Σ),* compared to normal values (N); Δ% = percentage deviation from normal, CH = Hellmann's criterion.

No	Meteorological Station	Hm	December 2017				January 2018				February 2018			
			ΣXII	N	Δ%	CH	ΣI	N	Δ%	CH	ΣII	N	Δ%	CH
1	Dr. Tr. Severin	77	38.5	61.2	-37.1	VD	45.2	51.4	-12.1	LD	88.0	47.9	83.7	ER
2	Calafat	66	**65.2**	45.5	43.3	VR	***26.8***	40.4	-33.7	VD	83.6	38.0	120.0	ER
3	Bechet	65	52.9	36.3	**45.7**	VR	29.8	33.5	-11.0	LD	***66.7***	34.8	91.7	ER
4	Băileşti	56	53.6	46.8	14.5	LR	28.8	38.5	-25.2	D	74.5	36.1	106.4	ER
5	Caracal	112	49.0	39.5	24.1	R	38.9	34.7	12.1	LR	73.2	34.5	112.2	ER
6	Craiova	190	47.2	41.8	12.9	LR	32.6	37.5	-13.1	LD	81.6	30.4	**168.4**	ER
7	Slatina	165	41.4	42.8	-3.3	N	42.8	36.0	18.9	LR	73.9	38.4	92.4	ER
8	Bâcleş	309	31.8	54.7	***-41.9***	VD	***9.1***	50.5	-82.0	ED	-	-	-	-
9	Tg. Logreşti	262	36.0	44.8	-19.6	LD	37.0	35.9	3.0	N	75.6	41.0	84.4	ER
10	Drăgăşani	280	**30.7**	44.6	-31.2	VD	28.6	34.1	-16.1	LD	67.5	35.4	90.7	ER
11	Apa Neagră	250	54.9	82.3	-33.3	VD	**56.7**	70.9	-20.0	LD	**115.0**	66.4	73.2	ER
12	Tg. Jiu	210	46.3	64.0	-27.7	D	28.4	53.9	***-47.3***	VD	70.2	52.0	35.0	VR
13	Polovragi	546	60.9	56.1	8.6	N	42.0	48.9	-14.1	LD	81.9	48.4	69.2	ER
14	Rm. Vâlcea	243	42.2	46.2	-8.7	N	42.8	35.5	**20.6**	R	89.6	38.4	133.3	ER
15	Voineasa	587	32.7	55.1	-40.7	VD	***2.8***	42.7	***-93.4***	ED	-	-	-	-
16	Parâng	1585	53.3	54.6	-2.4	N	47.7	57.7	-17.3	LD	45.9	47.7	***-3.8***	N
17	Mean Oltenia	-	46.0	51.0	-9.8	N	33.8	43.9	-23.1	D	77.7	42.1	66.4	ER
18	Ob. Lotrului	1404	85.6				59.7				63.5	-	-	-

(Source: processed data from the NMA Archive)

2a. The thermal regime of January 2018

Monthly air temperature averages were between 1.7°C at Voineasa and 2.4°C at Drobeta Turnu Severin, and their deviations from normal were between 2.0°C at Apa Neagră in the area of Subcarpathian depressions and 4.0°C at Craiova and Bâcleş, determining classifications of warm months (W) types throughout Oltenia (Table 3).

Table 3. Air temperature regime in Oltenia and minimum and maximum temperature at ground level in January 2018. (N = normal values calculated for the 1901-1990 interval, M = monthly average values in January 2018, CH = Hellmann criterion).

No	Meteorological Station	Hm	N I	M I	Δ=M-N	CH	Tmax aer		Tmin aer		Tmax sol		Tmin sol	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	-1.1	**2.4**	3.5	W	15.1	30	**-6.3**	17	**23.2**	30	-8.2	26
2	Calafat	66	-1.8	1.7	3.5	W	**16.7**	30	-8.0	17	18.9	30	-8.2	25
3	Bechet	65	-2.2	1.1	3.3	W	16.4	30	-9.8	17	14.5	31	**-8.0**	17
4	Băileşi	56	-2.3	0.9	3.2	W	14.7	30	-8.1	17	19.5	1	-9.6	17
5	Caracal	112	-2.9	1.0	3.9	W	13.7	30	-8.9	25	11.3	31	-10.0	25
6	Craiova	190	-2.6	1.4	**4.0**	W	15.0	30	-8.4	25	17.3	7	-9.0	28
7	Slatina	165	-2.4	0.7	3.1	W	14.9	30	-11.5	25	***8.6***	30	-14.7	25
8	Bâleş	309	-3.0	1.0	**4.0**	W	13.4	30	-8.9	17	-	-	-	-
9	Tg. Logreşti	262	-2.7	0.8	3.5	W	15.2	30	-10.0	17	15.0	7	-10.4	17
10	Drăgăşani	280	-2.2	1.6	3.8	W	16.2	30	-8.6	16	15.2	29	-8.4	25
11	Apa Neagră	250	-2.6	-0.6	***2.0***	W	14.7	30	***-15.1***	16	14.3	7	-14.0	26
12	Tg. Jiu	210	-2.6	0.7	3.3	W	16.1	30	-9.2	16	16.2	7	-9.6	19
13	Polovragi	546	-3.2	0.4	3.6	W	13.6	30	-11.7	16	17.2	29	***-15.9***	17
14	Rm. Vâlcea	243	-2.2	1.4	3.6	W	16.3	30	-10.0	16	15.6	30	-7.0	17
15	Voineasa	587	-4.7	***-1.7***	3.0	W	***10.3***	30	-13.3	24	-	-	-	-
16	Parâng	1585	-	-	-	-	10.5	6	-14.5	15	-	-	-	-
17	Media Oltenia	-	-2.6	0.8	3.4	W	14.6		-10.1	-	15.9	-	-10.2	-
18	Ob. Lotrului	1404	-6.2	-4.1	2.1	W	8.9	26	-21.3	24	-	-	-	-

(Source: processed data from the NMA Archive)

4 ***The Hellmann criterion*** is very useful for determining the types of pluviometric time and only refers to the amounts of precipitations that are fallen, so useful for determining ***atmospheric drought and excess rainfall***. ***The soil drought*** is determined using criteria that use the ***ground water reserve.***

5 The Voineasa and Bâcleş Weather Stations because they have incomplete data, can not be taken into account nor discussed, are listed in the indicative table of these.

The monthly average air temperature for the whole region was 0.8°C, and the deviation from this normal was 3.4°C, which determines an average warm month (W) for the whole region. This overall monthly average (0.8°C) shows that January 2018 was the warmest month of the last 58 years, in decreasing order of overall temperature averages. The warmest eight months of January, over the past 58 years, were recorded in the years: ***2007*** (VW, average 4.73°C), ***1983*** (VW, average 2.62°C), ***1994*** (W, average of 1.21°C), ***1984*** (W, average of 0.96°C), ***2015*** (W, average of 0.83°C), ***2018*** (W, average of 0.80°C). ***January 2007 was the warmest winter month in all climatic data, surpassing with 2.11°C*** (almost twice) the average of the hottest ***January of the 20th century (1983), and the only January very warm (VW).***

Thus, ***in the 20th century, there was only one very warm January month (1983) which was exceeded in 2007 during the 2006-2007 Mediterranean winter with an almost double average, which indicates an increase in the climatic warming during the winter peak***. In the last 58 years (1961-2018), ***most January months were warm***, 28 cases (i.e. 48.2%), there were 19 cases of normal months (i.e. 32.8%) and with cold months - the lowest - 11 (i.e. 19.0%). The growth trend of the average monthly temperature calculated for the whole region is evidenced by a significant increase coefficient (0.0356). As a result of the increase in the average monthly temperature, the frequency, duration and intensity of cold waves in January decreased. ***Only two months of January were very warm (VW): January 1983 with an average of 2.62°C and January 2007 with a general average of 4.73°C*** (at a difference of only 0.27°C compared to an excessively warm month). As a result, climatic warming is evident even in January, which is the peak of winter In January 2018, *the frost units* registered mostly in the intervals 14-17 January and 23-28 January (totalling 10 days) and were between 19.5 at Drobeta Turnu Severin and 69.7 at Voineasa, and the average for the entire region it was 39.0, which means a mild winter month from an agrometeorological point of view. *Heat units* were significant and ranged between 16.9 at Voineasa and 93.6 at Drobeta Turnu Severin, with the average for the entire region of 64.8 surpassing the cold ones.

Monthly minimum air temperature values were recorded, most in the interval 16-25 January and were between -15.1°C at Apa Neagră and -6.3°C at Drobeta Turnu Severin, and their average for the whole region was -10.1°C. There *were two cooling periods,* between 14-17 January and 23-28 January, the duration of which amounted to 10 days. *The coldest mornings* were recorded in 16 January and 25 January, with the average for the entire region of -8.8°C, the days when the winter cold reached its peak. At 20 am, the temperature averages for the entire region were ≥ 0°C.

No agro-meteorological frost was recorded, only totally isolated in a single morning in the Subcarpathian area. *The amplitude of the air temperature* variation in January ranged from 22.3°C at Bâcleș and 29.8°C at Apa Neagră, and *for the whole region the maximum amplitude* was 31.8°C.

The maximum monthly temperature values were recorded in 30 January, when the daily maxima average for the whole region was 14.6°C, being the highest in January. Monthly thermal peaks were between 10.3°C at Voineasa and 16.7°C at Calafat, and their average for the whole region was 14.6°C.

The air temperature variation chart in January 2018 shows slightly decreasing trends for all three analysed parameters (daily minimum, daily average and daily peak) (Fig. 2). *A weak heat wave* with a duration of 6 days was recorded between 29 January - 3 February. At the surface of the soil, the minimum monthly temperature were recorded, ranging from 17-26°C, ranging from -15.9°C to Polovragi and -8.0°C at Bechet, and their average for the whole region was -10.2°C. As a result, at the soil surface in the range 14-31 January, frost / thaw alternations occurred. The value of -15.9°C, recorded at Polovragi, is the thermal minimum of the winter 2017-2018 at the surface of the soil.

The maximum temperature at the surface of the soil was recorded for the most part, in the range 29-31 January and was between 8.6°C at Slatina and 23.2°C at Drobeta Turnu Severin, and their average for the whole region was 15.9°C.

2.b. The rainfall regime of January 2018

The monthly rainfall values ranged between 26.8 l/m^2 at Calafat and 56.7 l/m^2 at Apa Neagră, and their percentage deviations from normal were between -47.3% at Tg. Jiu and 20.6% at Râmnicu Vâlcea, leading to the classification of the rainfall time types from very dry (VD) in the southwest of the region and some areas from Subcarpathian up to rainy (LR) in a restricted area in the Romanati Plain to Caracal and in the Olt River Corridor (Table 2). As a result, dry weather prevailed. *The average monthly precipitation* calculated for the entire region was 37.7 l/m^2, and its deviation from normal was -14.0%, resulting in slightly dry (LD) climate. In January there were three intervals with generally weak rainfalls: 2 January, 9-17 January and 19-23 January, and among them in one day of the last interval rainfalls were significant for agricultural crops. At first the precipitation was in the form of rain then turned into snow and a snow layer formed, starting with 14 January, which reached the maximum thickness in different data, disappeared in 19-21 January and was rebuilt in some areas between 22-25 January and then gradually melted. *The maximum thickness of the snow layer* in January was 7 cm at Calafat on 16th, Râmnicu Vâlcea in 17 January and Tg. Logrești in 22 January and 22 cm in the Subcarpathian depressions at Apa Neagră on the 18th, and in the mountain 73 cm at Parâng and 76 cm at Obârșia Lotrului. The maximum thickness of the snow layer as well as the maximum extension was recorded on 28 February, 08 hours after ***the late winter episode*** (Fig. 3). Due to the warm weather, the snow layer lasted a few days in January, and due to compaction and slow melting it gradually decreased in thickness until disappearance. It has achieved good protection for crops in the respective intervals. *The duration of the snow layer* was between 4 days in Calafat and 18 days in the Apa Neagră. The melting of the snow layer occurred in the range 26-31.

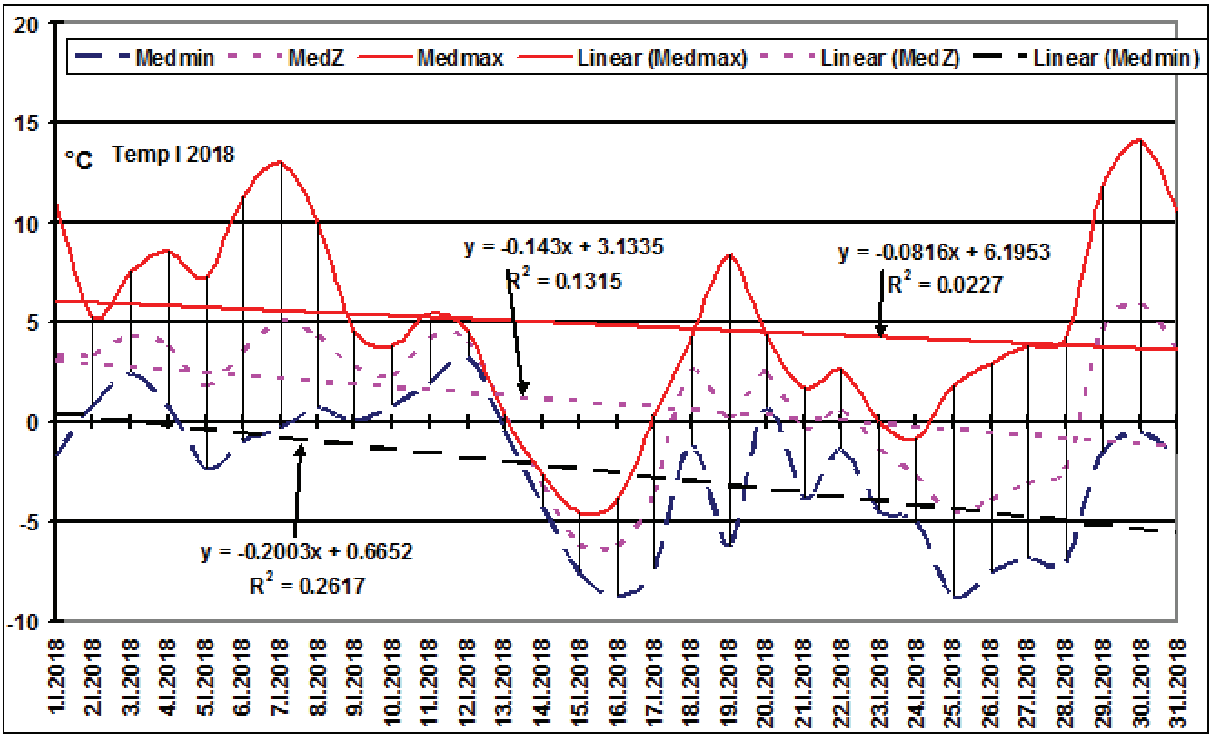

Figure 2. Air temperature variation (average daily minimum, daily average and average maximum daily) in January 2018. (Source: processed data from the NMA Archive).

3a. The thermal regime from February 2018

The statistical data on climate shows that in February, between 1901-1990 (averages considered normal values), *the average monthly temperature increases* compared to the second winter month – January, are between 1.8°C at Polovragi and 2.2°C at Calafat, Băileşti, Caracal, Craiova, Slatina, Târgu Jiu, Râmnicu Vâlcea and Voineasa, and the increase in the monthly average for the entire region is 2.0°C, ***being the first increase in the average monthly temperature during the year***, thus initiating the climatic process of spring arrival[6]. The overall average for the whole region is -0.8°C, recording a 2.0°C increase over January, being the lowest monthly increase over the course of the year. ***February 2016 was the warmest in the history of weather observations with a mean average of 6.04°C, and the monthly average in 2016 was between 3.0°C at Voineasa and 7.3°C by Drobeta Turnu Severin*** (MARINICĂ & MARINICĂ, 2016).

The coldest February in the last 58 years has been recorded in the years: ***1985*** (FR, average -5.95°C), ***2012*** (R, average -5.40°C), ***2003*** (R, with average -4.27°C), ***1965*** (R, with a mean of -3.63°C), ***1986*** (R, with a mean of -3.16°C), ***1976*** (R, with a mean of -3.08°C). ***February 1985 was the coldest winter month of the 20th Century, with the very cold month classification (FR), according to the soil temperature values*** (MARINICĂ & MARINICĂ, 2016). As a result, ***only a very cold February month (1985) was recorded in the 20th century*** (Table 4). ***The warmest February in the past 58 years*** was recorded in the years: 2016 (FC, with an average of 6.04°C), 2002 (FC, with an average of 5.93°C), 1995 (FC, with an average of 4.73°C), 1966 (FC, with an average of 4.63°C), 1977 (C, with an average of 4.40°C), 1990 (C, with an average of 3.81°C) and 1988 (C, with an average of 3.40°C). Most of the February months were hot, 31 cases (53.4%), the normal ones were the lowest, 12 cases (20.7%), and the cold months - 15 (i.e. 25.9%, i.e. less than half of the warm months). Results that in February the number of very warm months was double that of January. The growth trend of the average monthly temperature calculated for the entire region over the past 58 years is evident, with a significant growth rate (0.0283) (Fig. 4). February 2016 was the hottest winter end month (Table 4). The average February temperature, calculated for the entire region over the last 58 years, was 0.49°C, with an increase of 0.95°C over the period 1901-1990[7] (more than double that period). Most February warm months have been registered since 1988, 74.2%, which shows the acceleration of the heating process in February. As a result of the increase in the average monthly temperature, the frequency, duration and intensity of cold waves in February declined considerably. Climate warming is also demonstrated at a regional level in February, and the continuation of this climate process in 2017 and 2018 occurred ***under the conditions of the minimum solar activity and in the absence of the El Niño climate process***.

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[6] *Spring day = a day with average temp. ≥ 0°C.*

[7] It is irrelevant to compare permanently with the averages of the last 30 years (as they are normal values) because the latter also increase with the sliding of the average for the next 10 years and, as a result, the comparison with these sliding averages fades the actual increase compared to the last century, lower and thus diminishing the true magnitude of climate warming. In addition, the study methodology changes once every 10 years and therefore the results are no longer comparable.

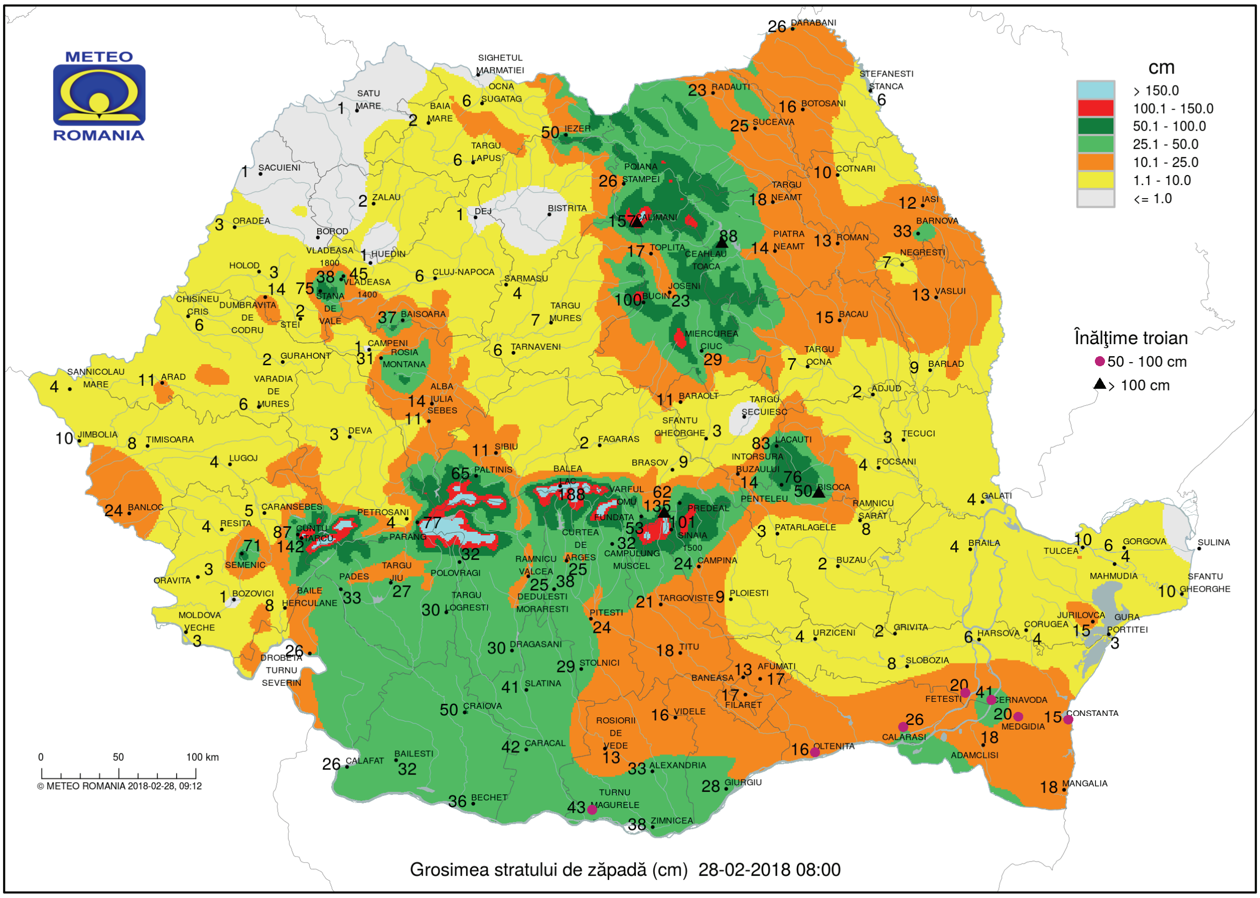

Figure 3. Spatial expansion of the snow layer, with the maximum thickness recorded in winter 2017-2018, on 28th of February 2018 at 08 o'clock. (NMA Bucharest).

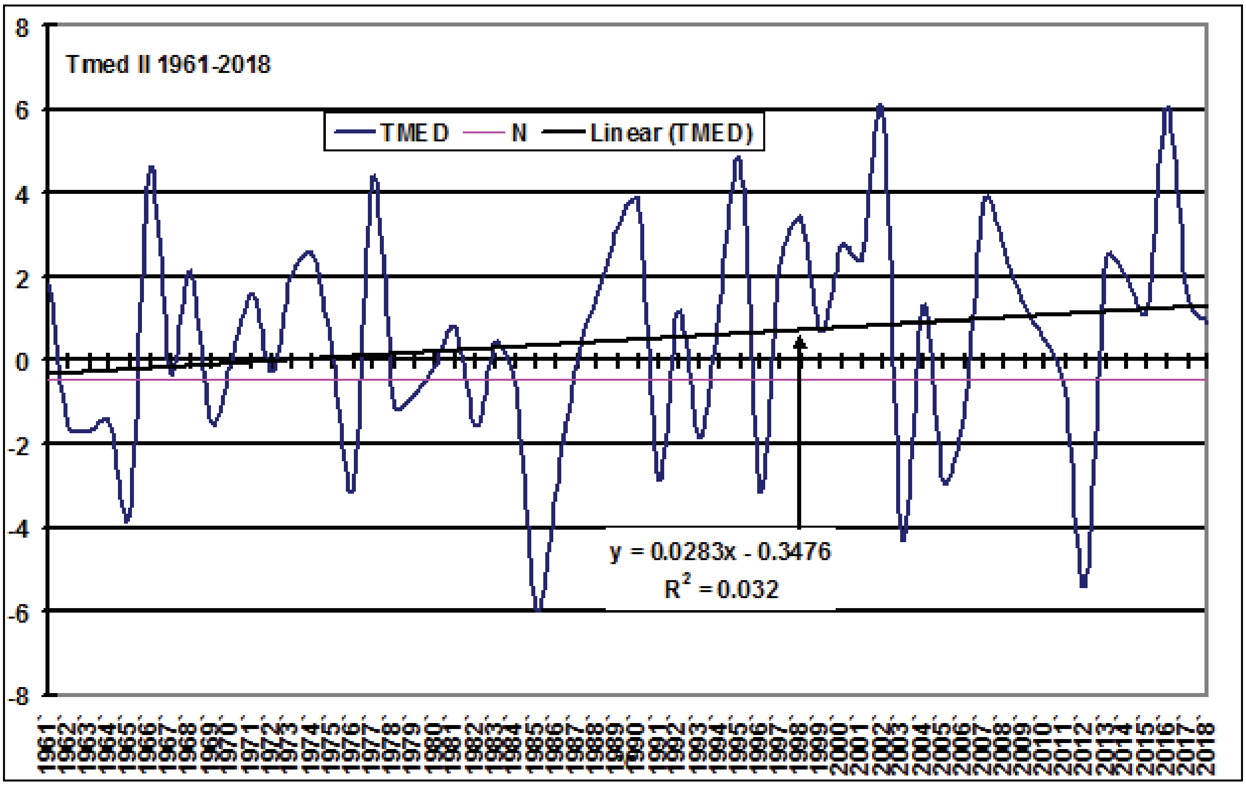

Figure 4. Monthly average air temperature variation in February calculated for the whole region (excluding the mountain range) in the period 1961-2018 (Tmed FEB = average temperature for Oltenia in February). (Source: processed data from the NMA Archive).

Table 4. The thermal classification of February in Oltenia in the last 58 years (AvgT = average temperature of February calculated for the entire Oltenia region with the area under 600 m altitude (°C), Type = thermal classification of the month according to the Hellmann criterion, Reci = number of cold winters and percentage, Normale = number of normal months and percentage, Calde = number of hot months and percentage, EC = exceptionally cold, VC = very cold, CL = cool, N = normal, WS = warmish, W = warm, VW = very warm, EW = exceptionally warm).

No	YEAR	AvgT	Type	No	YEAR	AvgT	Type	No	YEAR	AvgT	Type	No	YEAR	AvgT	Type
1	1961	1.83	W	17	1977	4.40	W	33	1993	-1.86	CO	48	2009	1.26	WS
2	1962	-1.59	CO	18	1978	-1.11	N	34	1994	1.34	WS	50	2010	0.50	WS
3	1963	-1.71	CO	19	1979	-0.79	N	35	1995	4.73	VW	51	2011	-0.86	CO
4	1964	-1.49	CO	20	1980	-0.14	N	36	1996	-3.11	CL	52	2012	-5.40	CL
5	1965	-3.63	CL	21	1981	0.78	WS	37	1997	2.29	W	53	2013	2.50	W
6	1966	4.63	VW	22	1982	-1.57	CO	38	1998	3.40	W	54	2014	2.03	W
7	1967	-0.32	N	23	1983	0.45	N	39	1999	0.70	WS	55	2015	1.20	WS
8	1968	2.13	W	24	1984	-0.63	N	40	2000	2.77	W	56	2016	6.04	VW
9	1969	-1.49	N	25	1985	-5.95	VC	41	2001	2.46	W	57	2017	1.40	W
10	1970	-0.04	N	26	1986	-3.16	CL	42	2002	5.93	VW	58	2018	0.90	WS
11	1971	1.59	WS	27	1987	0.06	N	43	2003	-4.27	CL		Reci	15	25.9%
12	1972	-0.30	N	28	1988	1.51	WS	44	2004	1.34	WS		Normale	12	20.7%
13	1973	2.06	W	29	1989	3.19	W	45	2005	-2.87	CL		Calde	31	53.4%
14	1974	2.54	W	30	1990	3.81	W	46	2006	-1.20	N				
15	1975	0.11	N	31	1991	-2.81	CL	47	2007	3.78	W				
16	1976	-3.08	CL	32	1992	1.19	WS	48	2008	2.71	W				

(Source: processed data from the NMA Archive)

In February 2018, the monthly air temperature averages were -0.5°C at Voineasa and 2.1°C at Drobeta Turnu Severin, and their deviations from normal were between 1.0°C on the Danube Plain at Calafat and in the Hills of Oltenia at Drăgăşani and Bâcleş and 2.0°C in the Voineasa intramontane depression, leading to the classification of the warmish thermal time (WS) in most of the region, to the warm (W) at Voineasa (Table 5).

Table 5. Air temperature regime in Oltenia and minimum and maximum soil temperature values in February 2018. (NII = normal February for the period 1901-1990, MII = monthly averages of February 2018; Δ = M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological Station	Hm	NII	MII	Δ=M-N	CH	air maxT		air minT		soil maxT		soil minT	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	0.9	2.1	1.2	WS	12.4	3	**-9.1**	28	**22.0**	1	**-7.3**	28
2	Calafat	66	0.4	1.4	***1.0***	WS	14.5	3	-10.4	28	15.5	3	-12.6	28
3	Bechet	65	-0.1	1.5	1.6	WS	**21.4**	3	-10.2	28	18.9	17	-9.6	28
4	Băileşti	56	-0.1	1.1	1.2	WS	18.7	3	-10.6	28	18.3	3	-9.8	28
5	Caracal	112	-0.7	1.0	1.7	WS	17.2	3	-10.9	28	13.9	3	***-17.0***	28
6	Craiova	190	-0.4	0.7	1.1	WS	15.5	3	-10.6	28	18.0	3	-10.8	28
7	Slatina	165	-0.2	0.9	1.1	WS	16.4	3	-10.7	28	13.1	3	-10.5	28
8	Bâcleş	309	-0.9	0.1	***1.0***	WS	11.4	3	-11.0	28	-	-	-	-
9	Tg. Logreşti	262	-0.7	0.6	1.3	WS	11.3	1	-10.8	28	14.5	17	-8.4	28
10	Drăgăşani	280	-0.2	0.8	***1.0***	WS	11.8	3	-11.4	28	***10.1***	9	-9.4	28
11	Apa Neagră	250	-0.6	0.5	1.1	WS	11.2	9	-11.5	28	15.8	17	-11.4	28
12	Tg. Jiu	210	-0.4	1.3	1.7	WS	11.8	9	-9.9	28	18.2	9	-9.6	28
13	Polovragi	546	-1.4	-0.1	1.3	WS	11.0	2	***-11.9***	28	18.2	9	-10.7	27
14	Rm. Vâlcea	243	0.0	1.7	1.7	WS	12.1	2	-9.8	28	18.1	4	-12.8	28
15	Voineasa	587	-2.5	-0.5	**2.0**	W	*7.9*	8	-8.7	27	-	-	-	-
16	Parâng	1585	-	-	-	-	3.6	3	-17.4	28	-	-	-	-
17	Mean Oltenia	-	-0.5	0.9	1.4	WS	13	-	-10.9	-	16.5	-	-10.8	28
18	Ob. Lotrului	1404	-5.5	-4.7	0.8	N	5.2	2	-15.1	6	-	-	-	28

(Source: processed data from the NMA Archive)

The monthly average air temperature calculated for the whole region was 0.9°C, and its deviation from normal was 1.4°C, leading to a warmish weather (WS) on average for the entire Oltenia region. *The daily average calculated for the entire region* was -9.0°C on 28 February and 7.2°C on the 3 February. *The warmest interval in February* was between 1-19 February, when thermal maxima, totally isolated, slightly exceeded 20.0°C (on 3 February) and some thermal periods of winter 2017 -2018. After 19 February, the air temperature gradually decreased, and during the period of 25 February – 2 March 2017 there was a ***short late winter episode***. ***The late winter episode*** was marked by abundant snowfall, blizzard and a wave of Siberian cold that covered most of Europe and Asia and in Romania peaked on the morning of 1 March, when after a clear night, were recorded the lowest temperatures of the cold season 2017-2018 (-24.8°C at Apa Neagră and Târgu

Logreşti became the absolute thermal minimum of March for the latter meteorological station). The vernalization[8] took place between the 25 February and 2 March 2018.

Minimum monthly air temperature values were recorded for the most part on 28 February and were between -11.9°C in the Subcarpathian depression area at Polovragi and 9.0°C at Drobeta Turnu Severin, and their average was -10.9°C, higher by 0.2°C than in January. *The coldest morning* was recorded on the 28th February when the average for the whole region was -9.0°C. *The frost units* were modest, ranging from 22.1 at Drobeta Turnu Severin to 40.0 at Polovragi, and their average for the whole region was 31.0. These were recorded for the most part of them in the period of 25-28 February, i.e. within 4 days. *The agrometerological frost* was not registered in February and only on the 1 March with a local character. *Heat units* were recorded between 1-24 February, i.e. for 24 days, and ranged between 15.4 at Voineasa and 81.5 at Drobeta Turnu Severin, and their average for the whole region was 54.8, far exceeding the frost units, which confirms the winter warmth feature and confirms the ***translation of the spring season to the winter.***

The hottest day was on 3 February, with the average temperature for the entire region of 7.2°C. *The maximum monthly temperature values* were recorded differently in data 1, 2, 3, 8 and 9 February. They ranged between 7.9°C in the Voineasa Depression and 21.4°C at Bechet (this was the maximum winter value) and their average for the whole region was 16.5°C, exceeding the average of the other winter months. The highest daily average of the temperature peaks was 12.3°C, recorded on 3 February. A moderate wave of heat was recorded between the 29 January and 9 February, which was extended until 18 February.2018, determining the starting of the crops into vegetation, the opening of the buds to pussy willow, and the beginning of the filling and the swelling of the almond buds and apricot, etc. which signifies an early spring arrival, although the late winter episode interrupted the development of vegetative processes between the 25 February and 2 March.

The air temperature variation chart in February 2018 shows decreasing trends for all three parameters analysed (daily minima, daily averages and daily maxima) (Fig. 5), and the fastest decreasing was the maximum temperature. ***This decreasing trend is a climatic anomaly,*** because air temperature is normally on an increasing trend in February.

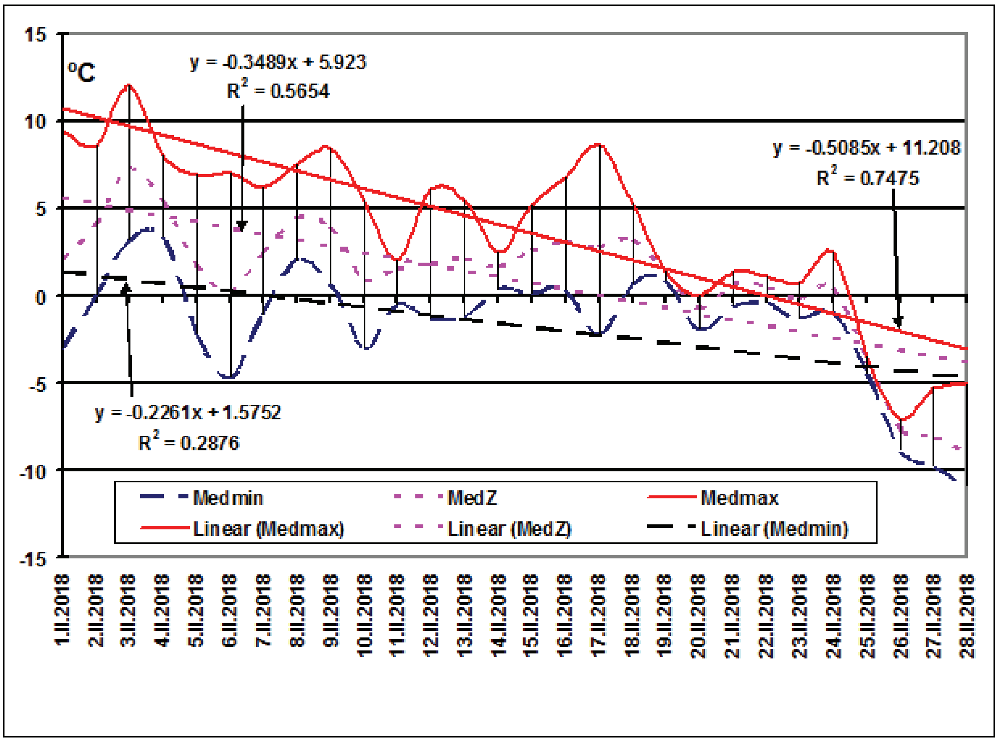

Figure 5. Air temperature variation (average daily minimum, daily average and average maximum daily) in February 2018. (Source: processed data from the NMA Archive).

As a result of the warm weather caused by the airflow on a large part of the continent Europe beginning with the end of January and maintained almost in the course of February, an early outbreak occurred, migratory birds arrived, and the starlings arrived from 2 March.2017. The bees came out to pick up pollen and propolis in many days of February. Biotopes have maintained their activity in almost all winter.

[8] Vernalization is a biochemical process that involves reaching or accelerating the flowering capacity under the influence of low temperatures. Under the influence of low temperatures immediately after germination, 4-100°C, a new plant has synthesized as a hormone that plays a role in the formation of future flowers, called vernalina. For most plant species, positive low temperatures have a profound influence on the initiation and development of reproductive organs; for this purpose annual plants require low temperatures in the first growth phases and biennial plants remain vegetative in the first year and bloom in the 2nd, if they are exposed to low-temperature treatment.

At the surface of the soil, *the monthly temperature minima* were recorded, with one exception on 28 February and ranged from -17.0°C at Caracal and -7.3°C at Drobeta Turnu Severin, and their average for the whole Oltenia region was -10.8°C. In almost all winter (with the exception of the interval between 25 February and 2 March) the superficial thawing occurred during the days and in some nights the frost (frost-thaw alternation), and then from the 2,III the soil remained defrosted. The freeze-thaw alternation can produce „***bare-root of plants***[9]" in some areas of autumn crops, and if there is subsequent cooling or heating, they can be compromised. *Monthly temperature peaks at the soil surface* were recorded at 1, 3, 4, 9 and 17 February and were between 10.1°C in Drăgăşani and 22.0°C at Drobeta Turnu Severin and their average for the entire region was 16.5°C.

3.b. The pluviometric regime of February 2018

The highest monthly rainfall in all winter months was recorded in February. *Monthly precipitation* ranged from 66.7 l/m^2 at Bechet and 115.0 l/m^2 at Apa Neagră, and their percentage deviations from normal were between -3.8% at Parâng in the mountain area and 168.4% at Craiova, determining classification of rainwater gradient by the relief steps into exceptionally rainy Oltenia (ER) throughout Oltenia and normally in the mountain area (Table 2). *The average monthly precipitation amount* for Oltenia was 77.7 l/m^2, and its percentage deviation from normal was 66.4% which classifies February as exceptionally rainy (ER) on average for Oltenia. The largest amount of precipitation was recorded on the night of 3-4 February, when the average for the whole region was 11.9 l/m^2. February was the richest in rainfall throughout the winter.

Since 25 February, a consistent layer of snow has been formed that has reached the highest thickness in the country for the winter of 2017-2018, in the low regions of Craiova, 50 cm on the 28 February and in the whole region ranging from 25 cm at Râmnicu Vâlcea and 50 cm at Craiova. It gradually melted between 2-9 March. The snow layer formed at the end of February as well as the cooling time interval played a particularly important role in maintaining vegetative rest on the fruit trees and the vine. At the end of February, the ground water reserve was optimal across the region.

4.a. General thermal characteristics of the winter season

Average annual temperatures ranged between -0.7°C at Voineasa and 2.9°C at Dr. Tr. Severin, and their deviations from normal were between 1.5°C in the area of the Subcarpathian depressions at Apa Neagră and 3.0°C in the Romanați Plain at Caracal, leading to the classification of the very hot winter (VW) in all Oltenia (Table 6).

The winter average value for the whole region was 1.5°C, and its deviation from normal was 2.7°C, confirming that the winter of 2017-2018 was very warm (VW) on average for Oltenia. The hottest month was December with a monthly average for the entire region of 2.7°C, then February with a monthly average of 0.9°C and January with an average of 0.8°C.

Table 6. *The total rainfall and thermal regime of winter 2017-2018* (Hm = meteorological station altitude, W`17-18 = verage temperature values in winter 2017-2018 (°C), NW = normal values of the seasonal averages winter temperature (°C), Δ = W-N = average temperature deviations from normal (°C); CrH = Hellmann criterion, SW = sum of precipitation in winter 2017-2018 (l/m^2), NW = normal values of the seasonal precipitation (l/m^2), Δ = S-N = amount deviations from normal (l/m^2), Δ% = percentage amount deviations from normal).

No	Meteorological Station	Hm	Thermal Regime (°C)				Rainfall Regime (l/m^2)				
			W`17-`18	NW	Δ=W-N	CrH	SW	NW	Δ=S-N	Δ%	CrH
1	Dr. Tr. Severin	77	**2.9**	0.4	2.5	VW	171.7	160.5	11.2	7.0	**N**
2	Calafat	66	2.3	-0.1	2.4	VW	175.6	123.9	51.7	41.7	**FP**
3	Bechet	65	2.0	-0.6	2.6	VW	149.4	104.6	44.8	42.8	**FP**
4	Băileşti	56	1.6	-0.7	2.3	VW	156.9	121.4	35.5	29.2	**FP**
5	Caracal	112	1.8	-1.2	**3.0**	VW	161.1	108.7	**52.4**	**48.2**	**FP**
6	Craiova	190	1.8	-1.0	2.8	VW	161.4	109.7	51.7	47.1	**FP**
7	Slatina	165	1.5	-0.8	2.3	VW	158.1	117.2	40.9	34.9	**FP**
8	Bâcleş	309	1.3	-1.4	2.7	VW	-	149.3	-	-	-
9	Tg. Logreşti	262	1.2	-1.1	2.3	VW	148.6	121.7	26.9	22.1	**P**
10	Drăgăşani	280	2.0	-0.6	2.6	VW	126.8	114.1	12.7	11.1	**PP**
11	Apa Neagră	250	0.5	-1.0	***1.5***	WS	**226.6**	219.6	7.0	***3.2***	**N**
12	Tg. Jiu	210	1.2	-1.0	2.2	VW	144.9	169.9	***-25.0***	-14.7	PS
13	Polovragi	546	0.9	-1.5	2.4	VW	184.8	153.4	31.4	20.5	**P**
14	Rm. Vâlcea	243	2.0	-0.6	2.6	VW	174.6	120.1	54.5	45.4	**EP**
15	Voineasa	573	***-0.7***	-3.0	2.3	VW	-	141.8	-	-	-
16	Parâng	1585	-	-5.1	-	-	***146.9***	160.0	-13.1	-8.2	**N**
17	Average Oltenia	-	1.5	-1.2	2.7	VW	163.4	137.2	26.2	19.1	**P**
18	Ob. Lotrului	1348	-4.0	-5.5	***1.5***	WS	208.8	-	-	-	-

(Source: processed data from the NMA Archive)

[9] The term ***bare-root of plants*** due to frozen-thaw alternation means the physical process of soil removal near the roots of the plants, leaving them uncovered, which expose them to frostbite under conditions of intense frost or drying under the warm-up time after this process, therefore it is considered a dangerous process for autumn crops.

Frost units for the whole winter ranged from 41.6 to Drobeta Turnu Severin and 132.1 to Voineasa. *Heat units* for the whole winter were between 64.1 at Voineasa and 309.0 at Drobeta Turnu Severin, and the average for the whole region was 212.0, indicating a gentle agrometeorological winter.

4.b. General rainfall characteristics of the winter season

The annual rainfall ranges ranged from 126.8 l/m^2 in Olt River Corridor at Drăgăşani and 226.6 l/m^2 in the area of the Subcarpathian Depressions at Apa Neagră, and the percentage deviations from normal were between -14.7% at Târgu Jiu and 38.2% at Caracal, which results in very rainy winter classifications (FP), mostly in Oltenia Plain, Getic Piedmont and Olt Corridor in Râmnicu Vâlcea, rainy (P) in the hills, normal in the mountain area at Parâng and a slightly dry on a restricted area at Tg. Jiu (Table 6). The average annual rainfall for the winter was 163.4 l/m^2, and its percentage deviation from normal was 26.2% confirming that the winter 2017-2018 was rainy (P) on average for the whole region due to the main rainfall in September.

DISCUSSIONS

December was the warmest month of winter, with positive thermal peaks and marked by three warm weather intervals 7-9 December (3 days), 12-16 December (5 days) and 24-29 December (6 days) totalling 15 days in which the temperature peaks exceeded 10.0°C. The warmest winter range was 24-29 December when a ***moderate heat wave*** was recorded, with the maximum heating intensity at 25 December (Table 1), and the maximum monthly thermal values were recorded.

The synoptic causes of this heat wave were determined by a tropical continental movement. On 25 December.2017 at 18 UTC *at ground level* the positioning of the main atmospheric centers of action on the continent of Europe was the following: the series of Icelandic cyclones positioned in the north of the continent between the parallel of 55-75°N with more nuclei of low pressure (with center values below 990 hPa). Above Greenland, the Greenlandic Anticyclone was positioned with values in the center above 1040 hPa (Fig. 6). The southern part of the continent was dominated by a vast anti-cyclonic field made up of the union of the Azoric Anticyclone with the North African one and having a secondary center above the Asia Minor Peninsula, with atmospheric pressure values above 1030 hPa. The vast thalweg of the depression field centered on the south of the Scandinavian Peninsula, extending to northern Africa, induced a south-western (tropical continental - cT) movement for much of Europe including Romania in the lower troposphere with a warm air mass in North Africa. In the mean troposphere at 500 hPa, the geopotential field was low in the north of the continent (north of 552 damgp) and raised in the south where field values slightly passed 568 damgp. The vast geopotential thalweg field with its axis along the western and north-western shores of Europe also determines this level of tropical continental circulation (cT).

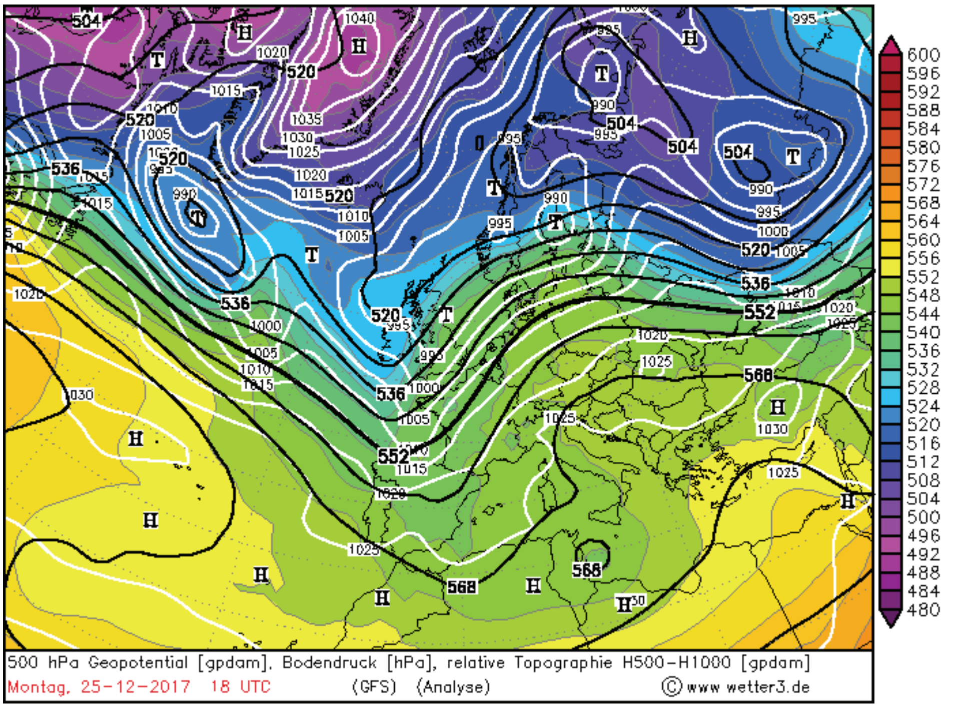

Figure 6. The synoptic situation at the ground level (pressure field, white isohypses) overlaps with the altitude synoptic situation at 500 hPa (about 5000 m altitude, geopotential field, thick black isohypses) and the relative bar topography field TR500 / 1000, thin isohypses (these are equivalent to average isotherms in the air layer between 1000 hPa and 500 hPa), on 25 December.2017 at 18 UTC (www.wetter3.de).

At 850 hPa, the hot air advection reached up to the south of the Scandinavian Peninsula (isotherm of 0°C), and above the southwest of Romania, northwest Bulgaria and Serbia was positioned on the 8°C isotherm (Fig. 7). As a result, this hot air advection across Europe had a warm air layer thickness of over 1500m. We also notice that in the period between 1 December-24 February, the air temperature deviations were positive, above the vast expanse of land formed in Europe and Asia, and in Siberia warmer than in North America, the Arctic cold air (A) was guided by the atmospheric circulation over North America. So the warm month of December 2017 confirmed the winter season's translation of the winter season across Europe and Asia.

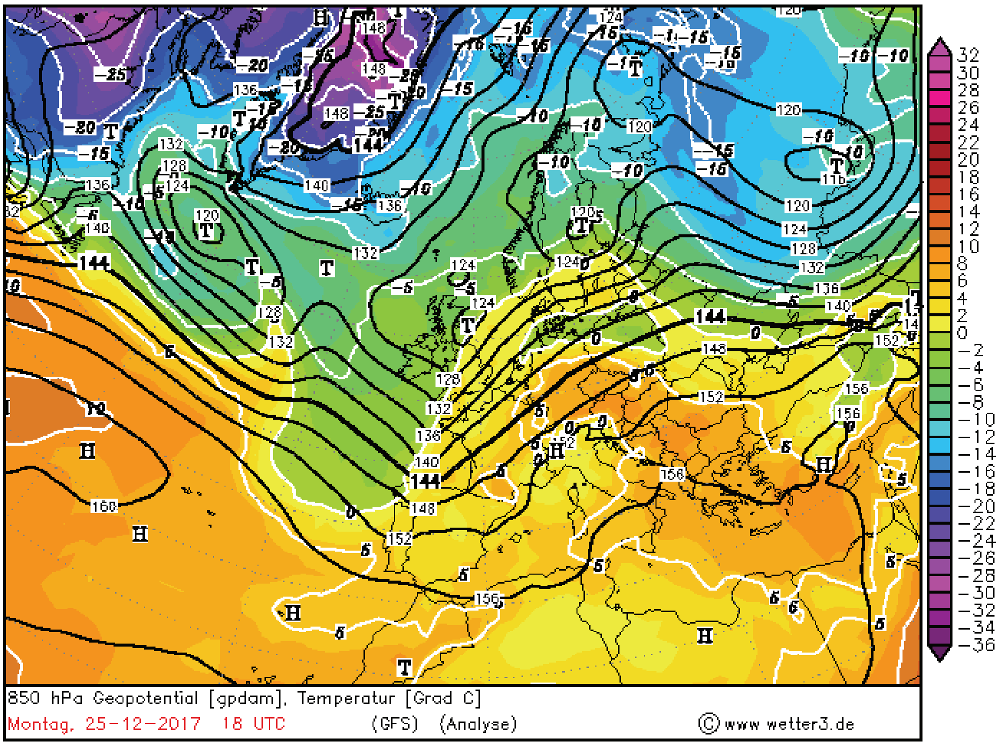

Figure 7. The thermal field (the thick white isohypses are the main isotherms, the thin isohypses that delimit the secondary isothermal colors (°C)), the black isohypses are thick with the geopotential field at 850 hPa, on 25 December.2017, 18 UTC (www.wetter3.de).

In January, two warm-day intervals were recorded, with daily thermal maximums exceeding 10.0°C: 1-8 January and 29-31 January, totalling 11 days. In January the maximum heating intensity was recorded in 30 January when the January maximum heating was recorded. The warm range was 29-31. It was extended until 3 February when most of February's thermal peaks were recorded. The warm January 2018 time was mainly due to the expansion of the Azoric anticyclone across the continent of Europe, and to the predominance of western and north-western circulation that have brought warm air over Oc. Atlantic over most of Europe.

In February, the hottest day was on the 3 February, and the maximum of this warming, characterized by the 21.4°C value at Bechet (the thermal maximum of this winter for Oltenia) was due to a south-west movement, induced by the formerly a Mediterranean Cyclone centered over the Adriatic Sea and Italy.

The coldest interval of February and the winter of 2017-2018 was between 25-28 February 2018, and this cold, gloomy weather of the night and morning extended until 2 March.2018. Frost was recorded especially on the night of 27-28 February and 28 February-1 March, when the thermal minima fell below -10.0°C on the morning of 28 February and even below -20.0°C on the morning of 1 March. ***The maximum intensity of this cold late wave*** is characterized by the lowest temperature value this winter for the whole country, -24.8°C the absolute thermal minimum of the winter recorded at two meteorological stations in Oltenia, Apa Neagră and Târgu Logreşti. ***For the Târgu Logreşti this value is an absolute climatic record of March*** being the lowest in the history of meteorological observations. Extremely intense weather cooling during the winter months had complex synoptic causes. The analysis of the synoptic situations has highlighted that the Arctic cold Siberian air (A) are brought to Europe by a vast anticyclonic field stretching across Europe and Asia, formed by the union of the regional anticyclones in the form of a large anticyclonic belt Aleksandr I Voeikov (1842-1916). The midline of this vast anticyclonic field (wind speed line 0 called the Voeikov axis) separates the west and northwest winds from the east and north east. This type of synoptic situation, due to the intense cooling it produces within a few days and the subsequent stability, determined over time the destruction of some armies considered invincible at the time, being a real terrible climate weapon of Russia, and the media called it "Beast of the East"[10]. This type of atmospheric circulation has a significant stability over time,

[10] Named the "Beast of the East" by the British press, the "Bear of Siberia" in the Netherlands, the "snow cannon" in Sweden or "Moscow-Paris" in France.

supported by the rotation of the Earth and Coriolis's deviating force that deviates cold air along a northeast trajectory, bringing it from the polar region and Siberia over Europe. The production of cooling time from the end of February 25 February-2 March.2018 was signalled by mathematical models 14 days before and then confirmed at each run.

We will analyse the synoptic situation at the moment of the maximum cooling intensity on the continent of Europe, i.e. for the night of 27 / 28 February, and in Oltenia the maximum cooling occurred on the night of 28 February-1 March because of the local causes the serene night and the presence of the thick layer of snow.

On 28th February 2018 at 00 UTC, at ground level, the vast anticyclonic field had maximum intensity above the Scandinavian Peninsula with atmospheric pressure values above 1050 hPa (Fig. 8).

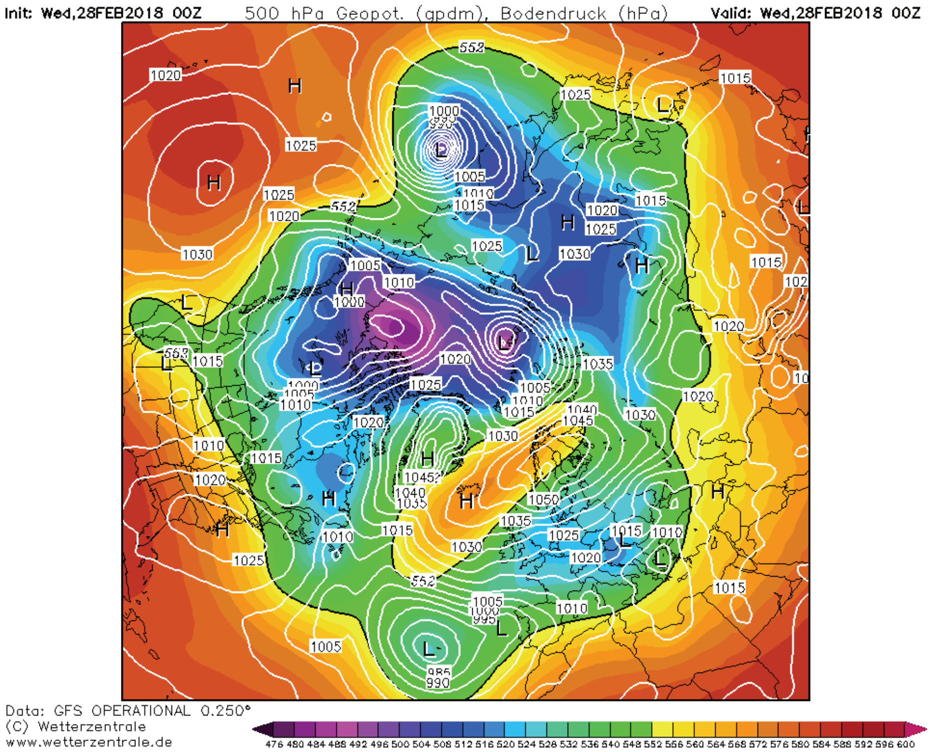

Figure 8. The synoptic situation at ground level above Europe and Asia on 28 February.2018, 00 UTC, (www.wetterzentrale.de).

For Europe, an extraordinary arctic (A) extra advection was produced over the Scandinavian Peninsula and its north polar area. The cold air reached Oltenia from the east and northeast, and during the night it continued to cool. The presence of the cyclonic field in the Mediterranean, which caused the snowy, blizzard snowfall in some time intervals, from 25-27 February accelerated the advection of cold air towards Oltenia. *At 850 hPa*, the analysis of the temperature field over the northern hemisphere highlights the massive advection of particularly cold air above Europe and Asia at temperatures between -28.0°C and -10.0°C, and even lower (Fig. 9).

As a result of the continuation of the extremely cold air, but also of the night-time cooling, with a duration of 12 hours and 53 minutes, in the presence of the snow layer the minimum air temperatures on the morning of 1 March were between -24.8°C to Apa Neagră and Târgu Logreşti and -14.4°C in Craiova and Drobeta Turnu Severin, except for the meteorological station in Calafat where the minimum was -9.4°C. Extremely low values were in the second place in descending order of the data series: Apa Neagră -24.8°C, Slatina -21.4°C, Bechet -18.4°C and Drăgăşani -16.9°C. As a result of the wave of cold and heavy snow, the school courses were stopped for one week (26 February-2 March), there was an energy crisis due to the high consumption of gas and electricity, vegetables were affected and flowers, it has been difficult to supply the markets and the shops with products, road and rail traffic has been closed in some regions, and the water of the Black Sea has frozen on the seaside. The energy crisis has affected other countries in Europe and 46 people died (AFP balance sheet on 28th February 2018) (http://www.economica.net/romania-se-pregatesste-pentru-limitarea-consumului-de-energie-electrica_131596.html#n), http://adevarul.ro/international/europa/bilantul-victimelor-valului-frig-europa-ajuns-46-morti 1_5a96e8f8df52022f75137ff7/index.html). In the 2-9 February, due to the strong, rapid warming of the weather, the snow melt quickly and floods occurred in some counties and landslides. Since 2 March.2018 the weather has been continuously warming up, which has led to the melting of the snow layer, the defrosting of the soil, the start of the vegetation of the autumn crops and initiated and supported the process of spring arrival[11].

[11] ***Spring arrival*** is the long-term climatic process that causes the gradual increase of air and soil temperature from February to 10 April. The process is complex and is mainly determined by the variation of the Earth-Sun geometry that produces an increase in the duration of the day, thus increasing the amount of heat received from the Sun from the northern hemisphere, resulting in significant changes in atmospheric circulation and increased

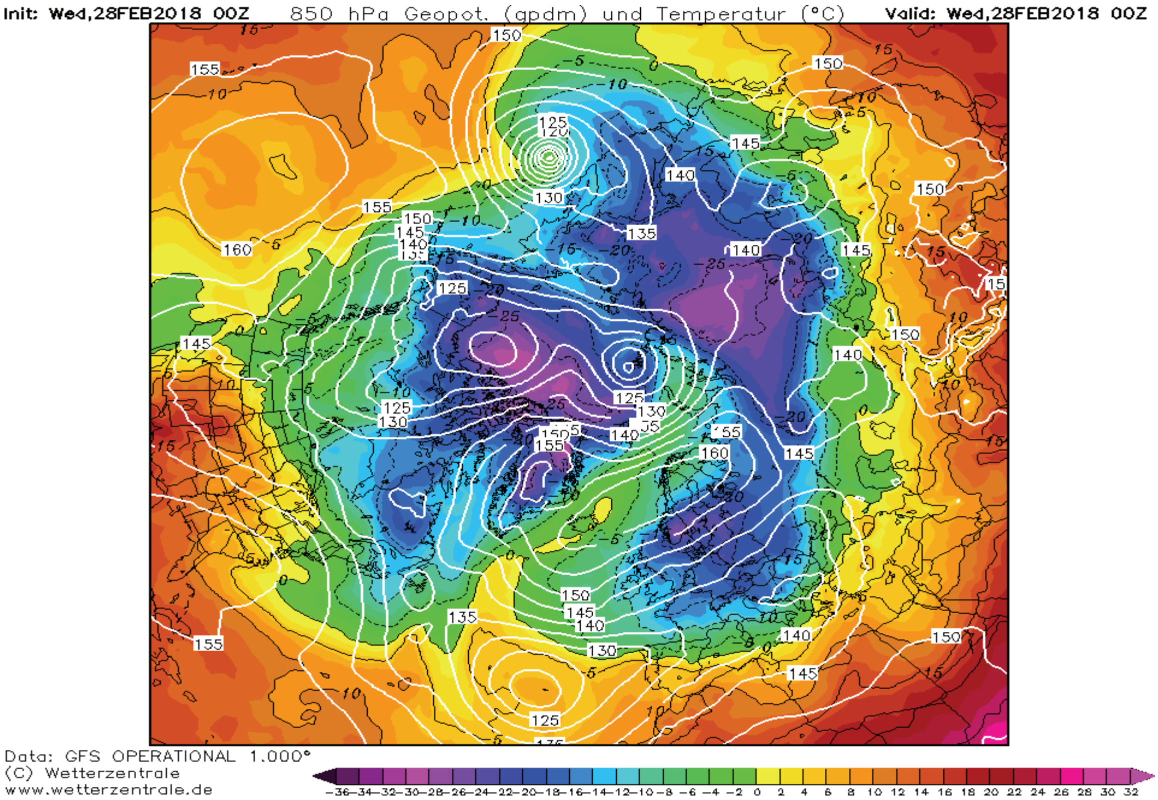

Figure 9. The geopotential and thermal field above the northern hemisphere, at 850 hPa (about 1500 m altitude) on 28 February.2018, 00 UTC (www.wetterzentrale.de).

CONCLUSIONS

Warm winter 2017-2018 was marked by a particular climatic variability due to a more pronounced variability on the Nordic Hemisphere and the continent of Europe. For Oltenia and Romania as well as for much of Europe the winter was warm, this feature was obtained by moderating the temperatures - December 2017 was the warmest (C) month of winter, January 2018 the third warmest (C) and February 2018 was the second hottest month. The soil was thawed for the most part of winter and frozen during the period 25-28. The crop protection against the frost of February was achieved due to the thick layer of snow (50 cm in the central part of Oltenia). The end of February, in just five days, caused human casualties (9 deaths in Romania and 46 in Europe) and material damage and triggered an energy crisis both in Romania and in much of Europe. All this shows that in the winter season, ***the climate risk of cold waves continues***, although global warming has continued, although solar activity has been minimized and the El Niño climate process absent, which is a climatic record for a winter warm under these conditions. We therefore conclude that national preparation for crossing the winter season must be done with great care and diligence, taking into account all the possibilities of producing energy and supply. Although a late 5-day cold wave was recorded at the end of February and the beginning of March, the startling was early, and the start of growing crops and the reactivation of biotopes occurred in the first decade of March. Migratory birds have arrived early on from the 3 March and even earlier due to the warm weather in Europe during most of the winter. ***The cold and snowy periods in the period 25 February-2 March have had important beneficial effects*** due to the maintenance of the vegetative rest on the fruit trees and vineyards, to the agricultural crops and the sanitation effect by destroying some pests, etc. Increasing climate variability is the direct consequence of climate warming, but nevertheless the seasons will never disappear due to the variability of Earth-Sun geometry. The danger of intense cold waves will be maintained and they will become more destructive by surprise the unprepared population, and the degree of adaptation to the cold and cold conditions will decrease. According to a study, "climate warming affects absolutely all aspects of life on Earth, from genetics to the whole ecosystem, and the consequences are extremely dangerous for humans. This study has shown that 80% of 94 ecological processes that ensure the normal freshwater marine ecosystem, as in the case of the land, have begun to be affected. This phenomenon leads to the emergence of harmful bacteria and disease outbreaks and affects crop yields "(Dr Brett Scheffers, University of California - http://www.descopera.ro/stiinta/15943823-incalzirea-climatica-afecteaza-deja-intreaga-viata-pe-pamant).

frequency and intensity of adventures warm from the south and southwest. The process is evaluated using ***the spring arrival index*** = ∑Positive Daily Average Temperatures in the range 1 February-10 April.

REFERENCES

BOGDAN OCTAVIA, MARINICĂ I., MIC LOREDANA-ELENA. 2008. Consideraţii asupra „fenomenului de iarnă caldă" din România. *Comunicări de Geografie. Universitatea din Bucureşti. Facultatea de Geografie*. Edit. Universităţii din Bucureşti. **12**: 139-144.

BOGDAN OCTAVIA & MARINICĂ I. 2009. Caracteristici climatice ale iernii 2007-2008 în Oltenia. *Revista Geografică Serie Nouă*. Edit. Ars Docendi. Bucureşti. **16**: 73-81.

BOGDAN OCTAVIA. MARINICĂ I., MARINICĂ ANDREEA FLORIANA. 2010. Frequency of warm winters within Oltenia in 1999-2008 decade. *Aerul şi Apa, Componente ale Mediului dedicat Conferinţei Ştiinţifice cu acelaşi titlu, 19-20 March.2010 Cluj-Napoca. Universitatea „Babeş-Bolyai" Facultatea de Geografie. Catedra de Geografie fizică şi tehnică în colaborare cu Direcţia Apelor Someş. Eds. Gavril Pandi şi Florin Moldovan*. Edit. Presa Universitară Clujană. Cluj-Napoca: 45-54.

BOGDAN OCTAVIA, MARINICĂ I., MARINICĂ ANDREEA FLORIANA. 2014. Caracteristici climatice ale iernii 2010-2011 în Oltenia. *Revista Geografică T. XIX – XXI 2012-2014. Serie nouă. Academia Română, Institutul de Geografie, Bucureşti 2014*. Edit. Ars Docendi. Bucureşti. www.geoinst.ro. (Accessed February 2018).

SANDU I., MATEESCU ELENA, VĂTĂMANU V. V. 2010. *Schimbări climatice în România şi efectele asupra agriculturii*. Edit. Sitech. Craiova. 406 pp.

MARINICĂ I. & CHIMIŞLIU CORNELIA. 2008. Climatic Changes on regional plan in Oltenia and their effects on the biosphere. *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **24**: 221-229.

MARINICĂ I., CHIMIŞLIU CORNELIA, MARINICĂ ANDREEA FLORIANA. 2010. The cooling bioclimatic index in Oltenia and the thermal risk at low temperatures during the cold season. *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **26**: 235-246.

MARINICĂ I., CHIMIŞLIU CORNELIA, MARINICĂ ANDREEA FLORIANA. 2011. Consideration upon climatic conditions characteristic to the winter 2010-2011, in Oltenia. *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **27**(1): 148-154.

MARINICĂ I. & MARINICĂ ANDREEA FLORIANA. 2012. Excessively droughty autumn in the south-west of Romania during 2011. *Aerul şi apa componente ale mediului / Air and water components of the environment, Conferinţa 23-24 martie 2012 Cluj Napoca*. Edit. Presa Universitară Clujană. Cluj Napoca: 351-358 http: aerapa.conference.ubbcluj.ro/ (Accessed February 2018).

MARINICĂ I., CHIMIŞLIU CORNELIA, MARINICĂ ANDREEA FLORIANA. 2012. Consideration on climatic conditions in Oltenia during the winter of 2011-2012. *Oltenia Studii şi Comunicări Ştiinţele Naturii.* Muzeul Olteniei Craiova. **28**(1): 149-160.

MARINICĂ ANDREEA FLORIANA, CHIMIŞLIU CORNELIA, MARINICĂ I. 2013. Considerations on the climatic conditions in oltenia during the warm winter of 2012-2013. *Oltenia. Studii şi Comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **29**(1): 233-244.

MARINICĂ I. & MARINICĂ ANDREEA FLORIANA 2016. Variabilitate climatică în Oltenia și schimbări climatice. Edit. Universitaria. Craiova. 306 pp.

***. http://www.ziaruldevrancea.ro/international/1588839218-temperaturile-globale-au-atins-un-nivel-record-in-2016.html.-(Accessed: February, 2017).

***. http://www.click.ro/news/national/ianuarie-2017-fost-al-treilea-cel-mai-cald-ianuarie-din-istorie. (Accessed: February, 2017).

***. (http://www.economica.net/romania-se-pregatesste-pentru-limitarea-consumului-de-energie-electrica_131596.html#n). (Accessed: February, 2017).

***. https://www.agerpres.ro/planeta/2018/01/04/2017-al-doilea-cel-mai-cald-an-din-istoria-inregistrarilor-meteorologice-dupa-2016-copernicus--31021 (Accessed: February, 2017).

***. http://jurnalul.ro/stiri/vremea/luna-ianuarie-2018-cea-mai-calda-din-istoria-anm-765139.html. (Accessed: February, 2017).

***. (http://ro.wikipedia.org/wiki/Biocenoz%C4%83) (Accessed: February, 2017).

***. www.wetterzentrale.de (Accessed: February, 2017).

***. http://adevarul.ro/international/europa/bilantul-victimelor-valului-frig-europa-ajuns-46-morti1_5a96e8f 8df52022f75137ff7 /index.html) (Accessed: February, 2017).

***. www.descopera.ro/stiinta/15943823-incalzirea-climatica-afecteaza-deja-intreaga-viata-pe-pamant (Accessed: February, 2017).

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